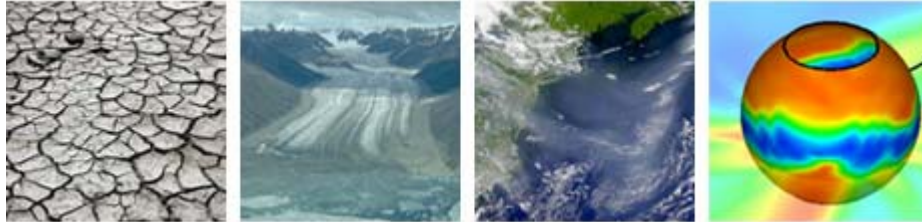


*Cooperative Institute for Research
in Environmental Sciences*



FY 2007 & FY 2008
Scientific Workplan
For collaborative work with
NOAA's Boulder research laboratories
by the University of Colorado



Based upon Cooperative Agreement
NA17RJ1229 dated 1 July 2001



PROJECT DIRECTOR: Konrad Steffen, Director of CIRES

INCLUSIVE DATES: 1 July 2006 – 30 June 2008

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I. INTRODUCTION

This document represents CIRES' proposed annual science workplan for the sixth and seventh year (July 1, 2006 – June 30, 2008) of its current cooperative agreement between NOAA and the University of Colorado. It describes collaborative research that integrates scientific projects conducted by CIRES under the research themes discussed in that cooperative agreement. This workplan is driven by scientific objectives, identifies *goals* and *approaches* for each of these objectives, and incorporates *milestones* and *impacts* for the proposed research projects.

II. SCOPE

This workplan covers the research activities funded by NOAA through its cooperative agreement with the University of Colorado. This support currently includes funding through OAR (Oceanic and Atmospheric Research), CPO (Climate Program Office), NESDIS (National Environmental Satellite Data and Information Service), and the NWS (National Weather Service). Task I within this agreement provides base funding for CIRES administration, research support, a visiting scientists program, and start-up funds for emerging research activities. Task II covers the NOAA/NESDIS research done at the National Snow and Ice Data Center (NSIDC) and is included within the following workplan. The bulk of the work and funding is allocated within Task III which constitutes the collaborative research conducted between CIRES and NOAA research centers and laboratories.

CIRES administration is currently comprised of approximately 26 people that support scientific planning and reporting, financial functions, human resources, facilities management, communication and information systems, scientific computing, and outreach. The latter strengthens the link between research and education, supports youth science excellence (through programs such as the National Ocean Science Bowl), promotes teacher science excellence (through programs such as Earthworks), and assists in making research more relevant and useful to society through application of the science-to-decision processes.

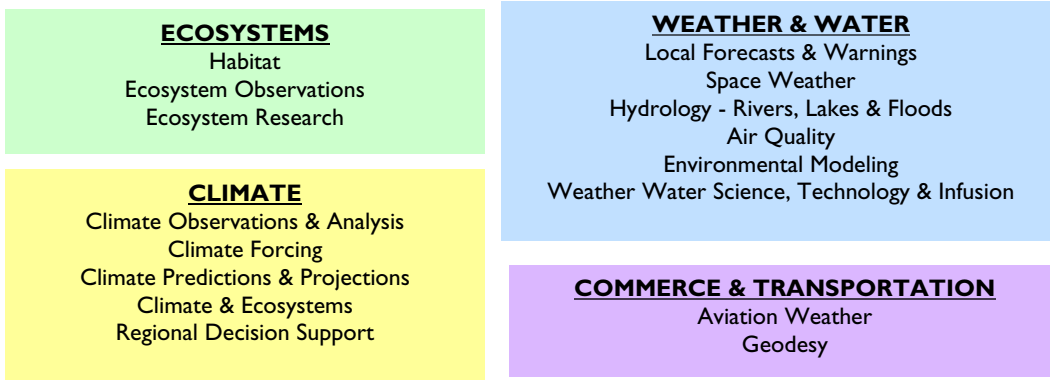
III. FIT WITH NOAA'S STRATEGIC GOALS

CIRES is contributing to over half of the 28 scientific mission goals within NOAA's *Strategic Vision*. The following are examples where CIRES' research will be supporting NOAA's cross-cutting priorities.

1. Protect, restore and manage use of coastal and ocean resources through ecosystem management approaches. CIRES is contributing to the second Ecosystems objective to "protect, restore, and manage species habitats listed under the Endangered Species Act" by documenting riparian habitat impacts in Rocky Mountain watersheds. CIRES is also studying forest ecosystems to understand their ability to recover from stresses including drought, wildfire and land use changes.
2. Understand climate variability and change to enhance society's ability to plan and respond. CIRES contributions to long-term remote observations and air quality respond to "build an end-to-end system of integrated global observations of key atmospheric, oceanic, and terrestrial variables." Ensemble data assimilation of pre-radiosonde era surface observations and tree-ring studies serve to "enhance scientific understanding of past climate variations." Studies to assess predictability from deterministic as well as

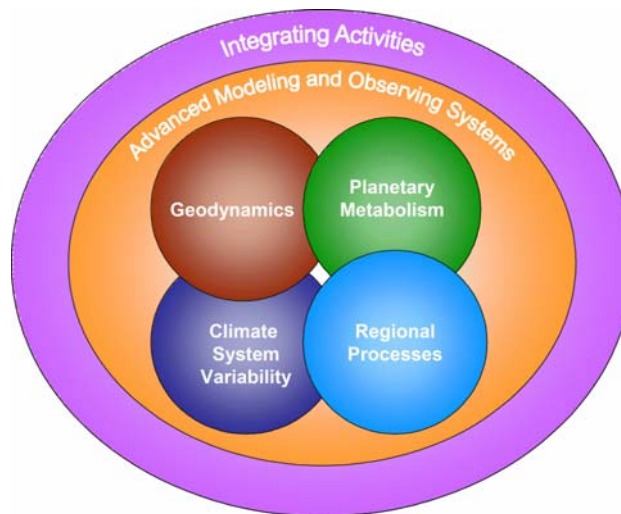
probabilistic perspectives will help achieve an “improved understanding to create more reliable climate predictions on all time scales.”

3. Serve society’s needs for weather and water information. RISA (Regional Integrated Sciences and Assessments) studies conducted within CIRES’ Western Water Assessment serve to “respond to user needs with the most recent, reliable information possible.” Monitoring solar disturbances and modeling Earth’s upper atmosphere promise to “improve the performance of our suite of weather and water, air quality, and space-weather prediction capabilities.”
4. Support the Nation’s commerce with information for safe and efficient transportation. The design and evaluation of new verification approaches and tools will provide information about the quality of aviation forecasts and their value to aviation decision makers.



IV. CIRES' SCIENTIFIC THEMES

The CIRES FY Cooperative Agreement with NOAA identifies the scientific themes at right which organize and align its collaborative research with NOAA and affiliated university entities. These themes were identified and selected through strategic planning retreats and represent the current scientific emphases within CIRES. They also provide the mechanism for identifying parallel and complementary activities that span a broad range of organizational entities within NOAA, CIRES, and the University of Colorado. Future workplans will anticipate and build upon this integration to achieve greater synergy between groups within these organizations. Projects within these themes will evolve over the cooperative agreement period as the science matures. The scientific themes currently identified are briefly discussed below.



Advanced Modeling and Observing Systems: The development of new measurement techniques, instrumentation, and analysis methods throughout CIRES makes this one of the largest and over-arching themes, including activities in every unit. The space domain links most research fields ranging from local and regional to global scales. It includes the optimization of observing and modeling systems for the various science disciplines, such as atmospheric chemistry processes, atmosphere and ocean physical processes, cryospheric processes, remote sensing of terrestrial applications, non-linear systems applications, and data centers and data management. Modeling efforts deal with data assimilation applied to space weather forecasting, forecasts of the geomagnetic environment, and turbulent processes, among others. Instrumentation for more rapid and accurate real-time sampling of the atmosphere has been developed to better study the environment, and understand the complex processes affecting it. Because of its emphasis on technology rather than subject, this theme frequently brings together CIRES scientists of disparate backgrounds in work of cooperative interdisciplinarity that the institute was created to promote. Since all themes utilize measurement and modeling techniques, activities listed within this theme are those where the tools were primarily developed through CIRES-NOAA-CU partnerships or where the tools themselves are the focus of the research.

Climate System Variability: Climate variability affects virtually all natural systems and human activities. Climate directly impacts such vital areas as agriculture, water quantity and quality, ecosystems, and human health. Understanding, and potentially predicting, climate changes is therefore critical to the public, as well as to a broad array of decision-makers within federal and state government, industry, resources management and hazard mitigation. Indeed, basic issues include determining whether observed changes may be attributable to either natural or anthropogenic forcing, and the extent to which natural and human-induced changes may be linked. Fundamental problems include: 1) detection and description of climate changes; 2) identification of causes (attribution); and 3) prediction, which is intrinsically stochastic in nature. Prediction problems of vital importance include estimating changes in the likelihood of extreme events, and identifying risks for abrupt climate change, recognizing that the potential for major societal and ecosystem impacts is likely to be particularly significant in such cases. The major research partners in this theme include the Physical Science Division (PSD), the Chemical Science Division (CSD), the Global Monitoring Division (GMD), the National Snow and Ice Data Center (NSIDC) and the Department of Atmospheric and Oceanic Sciences (ATOC). Research done under this theme is especially

useful to CIRES' Center for Science and Technology Policy Research, as results are often relevant to risk forecasting, management, and mitigation.

Geodynamics: The goal of geodynamics is to better understand the internal processes of the planet, including the properties of the core-mantle (CM) boundary, convection within the Earth's mantle, and how that convection affects the surface of the planet. The slow changes of flow processes in Earth's deep liquid interior which drive the magnetic field are frequently described using spherical harmonic analysis of the nearly 300 years of surface magnetic observations. The convective motion within the mantle, which is on the order of a few cm per year, causes oceans to open and close, continental plates to drift across the Earth's surface, and the Earth's crust to buckle and deform creating mountain ranges and other structural features. These convective displacements are the underlying source of earthquakes and volcanic activity. This convective process plays a fundamental role in determining the Earth's climate, through its influence on surface topography. The overriding goals of the CIRES effort in geodynamics are to 1) increase our knowledge of the fundamental processes that drive the mantle and core-mantle boundary; 2) use spherical harmonic analysis to model Earth's magnetic field; 3) use new experimental methods to detect and monitor internal motions of the mantle, the presence of layering, the movements of continents and the transfer of mass between atmosphere, continent and ocean; 4) examine the chemistry and physics of near-surface rock processes; and 5) investigate links between geophysical processes and human responses. Partners in geodynamics include the National Geophysical Data Center and National Ocean Service at NOAA and the Physics and Geological Sciences departments of the University.

Integrating Activities: CIRES engages in a wide range of integrating activities in research, education, and outreach that encompass each of the institute's research themes and contribute to the overall mission of the Institute, NOAA, and the University of Colorado. The primary focus is on five overlapping categories that include 1) education and outreach, 2) graduate and post-graduate education, 3) scientific assessments, 4) interdisciplinary research, and 5) science and technology policy research. For example, one team is focused on the decision-making processes of the individuals, groups, and organizations in the Interior West that have responsibility for managing, using, treating, and protecting water resources. By understanding decision-making processes, the stresses and the constraints of this community, researchers seek to assess vulnerability to climate variability and develop hydro-climate products that enable better-informed decisions. Such scientific assessments bring together CIRES' expertise across a range of fields, including policy research and technology transfer, in collaboration with experts and end users who partner from outside the Institute. Collaborations with colleagues in the local NOAA laboratories have resulted in the transformation of basic research into applied science.

Planetary Metabolism: The sustainability of the biosphere during the current period of rapid changes in the Earth system is an issue of prime importance for the environmental sciences. The physical and chemical features of the Earth are intimately tied to organisms and the activities required for their sustenance. The health of the biosphere can usefully be considered using the concept of "planetary metabolism," which refers to the complex web of biochemical and ecological processes that occur within the biosphere, and the interaction of these processes with the lithosphere, atmosphere and hydrosphere. Both natural and anthropogenic disturbances drive the structure and dynamics of natural systems, and a thorough understanding of these complex processes is essential to efforts to protect the biosphere from adverse effects due to pollution, destruction of natural landscapes, and alteration of climate. This theme's overriding goals are to: 1) increase our knowledge of the fundamental processes that drive the biosphere; 2) use experimental tools to accurately measure indicators of change; 3) enhance the sophistication of prognostic models capable of forecasting the response of ecosystems and the global biosphere to future environmental changes; 4) carry out research that will develop science and technology to help restore and protect the health of the biosphere. The predominant collaborations and parallel activities include the Chemical Science Division (CSD), the National Geophysical Data Center (NGDC), the Molecular, Cellular and Developmental Biology (MCDB) department and the Ecology and Evolutionary Biology (EEB) department.

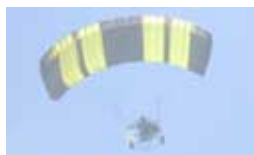
Regional Processes: Many of the research endeavors within CIRES and NOAA have a regional focus because they address a particular confluence of geography, demographics, weather and climatic regimes, or scientific challenge. This confluence of factors has produced a range of research within CIRES and NOAA that is not only rich in its diversity but provides an essential connection between science and its constituents. These constituents include human populations ranging from coastal megalopolises to communities of indigenous peoples on the margin of the Arctic Ocean, all of which must coexist with sensitive aquatic and terrestrial ecosystems in a highly variable and evolving climate. Indeed, the impact of short-term climate variability and extremes is often regionally focused, influencing very specific populations, economies, and ecosystems. CIRES scientists in the Chemical Science Division (CSD), the Global Monitoring Division (GMD), and the Physical Science Division (PSD) work on such projects as the mechanisms of atmospheric transport on climate and air quality, chemical transformation of products of biomass burning, air/sea gas transfer, and ozone pollution. This research contributes substantially to CIRES' Center for Science and Technology Policy Research and the Western Water Assessment Program. The latter is of particular value because of its broad focus which includes social scientists in the areas of economics, geography and behavioral sciences in addition to CIRES physical science experts.

V. 2006-2008 SCIENTIFIC WORKPLAN

The following is the proposed CIRES-NOAA research workplan for two fiscal years beginning July 2006. CIRES' first workplan was approved by NOAA and DOC as a scientific roadmap with increased clarity and accountability. Administration was greatly streamlined by replacing hundreds of individual personnel actions with a single integrated plan. Science also benefited from the definition of explicit research objectives with a more complete perspective of the overall research program.

This scientific workplan largely mirrors the one submitted last year. The former laboratory structure of Boulder's Environmental Research Laboratories (ERL) changed in October 2005 to the Earth System Research Laboratory comprised of four divisions: Chemical Science Division (CSD), Global Systems Division (GSD), Global Monitoring Division (GMD) and Physical Science Division (PSD). This change is reflected in this document. Additionally, a few projects have changed, one has been completed and two others have been added. The current 53 projects have been combined into some 22 efforts that more thoroughly integrate related activities. These redefined projects are also organized along CIRES objectives rather than by NOAA division affiliation.

While recognizing this plan accounts for Task III research of the NOAA-CIRES-CU cooperative agreement, it also seeks to weave scientific objectives into an integrated fabric of earth systems science. The following pages are grouped along CIRES' six research themes, then CIRES' projects within those themes.



Scientific Theme: **ADVANCED MODELING AND OBSERVING SYSTEMS**

- AMOS-01 Instrumentation Design, Prototyping and Analysis
- AMOS-02 Data Management, Products and Infrastructure Systems
- AMOS-03 Prediction, Model Development and Evaluation
- AMOS-04 Observing Facilities, Campaigns and Networks

AMOS-01: INSTRUMENTATION DESIGN, PROTOTYPING AND ANALYSIS

CSD-01	Instrumentation for Atmospheric Observation and Analysis
PSD-08	Sensor and Technique Development
CET-01	Remote Hydrologic Sensing

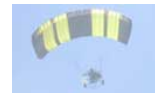
CSD-01 Instrumentation for Atmospheric Observation and Analysis

GOAL: Design and evaluate new approaches and instrumentation to make atmospheric observations of hard-to-measure species that are important players in the chemistry of the troposphere and stratosphere.

APPROACH: Identify key atmospheric species that are not adequately measured by current methods; research potentially effective new ways to enhance the quantitative measurement of the species at their anticipated atmospheric abundance levels; and design and evaluate prototype instrumentation in the laboratory for eventual deployment in field missions.

JULY 2006-JUNE 2007 MILESTONES:

- *Report airborne observations of gas-phase ammonia (NH₃) that were made aboard the NOAA WP-3D by a newly chemical ionization mass spectrometry (CIMS) technique during the New England Air Quality Study - Intercontinental Transport and Chemical Transformation (NEAQS-ITCT). **Impact:** Ammonia is thought to play an important role in the formation of aerosols. NH₃ was measured in biomass burning and urban outflow plumes and downwind from major agricultural areas. The present measurements allow fast response airborne measurements of ammonia. These measurements allowed the investigation of regional sources in the Northeastern United States.*
- *Develop instrumentation to make fast-response, airborne measurements of ethylene, an important precursor for ozone formation in Texas. **Impact:** Previous research has shown that small alkenes from petrochemical emission sources, particularly ethylene, are the most important precursors for ozone formation in and around Houston, Texas. To enhance our capability of measuring this compound, we have developed a fast-response detector based on laser photo-acoustic spectroscopy (LPAS). In 2006 we will deploy this instrument onboard the NOAA WP-3D research aircraft during the Texas Air Quality Study – Gulf of Mexico Atmospheric Chemistry and Climate Study (TexAQS-GoMACCS). The performance of the LPAS instrument will be assessed by comparing the measurements with the ethylene determined from whole air samples collected in canisters. The much higher measurement frequency of the LPAS instrument is expected to significantly enhance our insight into the sources and chemical removal of ethylene in*

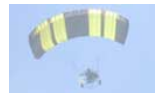


the polluted atmosphere, and will provide air quality managers in Texas with the information to decide which reductions in emissions will have the greatest benefit for ambient ozone.

- (i) *Characterize quantitatively the response of the cavity ring-down single particle aerosol instrument, and plan use of it on actual air-flows brought into the laboratory.* (ii) *Deploy the organic aerosol collector on the NOAA RV Ron Brown and use suitable mass spectrometry to analyze the samples.* **Impact:** This CIRES research will enable us to obtain the single scattering albedo of individual aerosol particles. When achieved, we will then be able to understand the dependence of the scattering on chemical composition, and obtain molecular speciation of the organic content of marine aerosols. Both could have substantial impacts on climate computations.
- *Develop ship-based and aircraft-based lidar systems to measure ozone and aerosol profiles.* **Impact:** Determining the spatial and temporal variability of aerosol and ozone is a critical component to understanding the creation and transport of pollutants for the study of air quality.
- *Develop a ship-based remote sensing lidar to measure wind and turbulence profiles.* **Impact:** Low-level winds and turbulence impact transport and mixing of pollutants and are therefore an important component to understanding the creation and transport of pollutants for the study of air quality.

JULY 2007-JUNE 2008 MILESTONES:

- *Develop fast response, state-of-the-art instrumentation suitable for airborne measurements of atmospheric mercury (Hg).* **Impact:** This CIRES research should substantially improve NOAA's ability to provide sound scientific guidance on atmospheric mercury (Hg) chemistry, exposure, and control strategies. The proposed research complements a new initiative within NOAA to address the atmospheric mercury cycle, including emissions, transport, transformation, and deposition. Given recent measures by the U.S. Environmental Protection Agency to control point-source mercury emissions from coal-fired power plants, this research is timely and should greatly contribute to the scientific knowledge required for sound decision-making.
- *Modify and construct to get a field-worthy single-particle cavity ring-down instrument and deploy it, analyzing the data.* (ii) *Analyze and write up the results on the molecular speciation of the organic content of marine aerosols. Plan for airborne data acquisition.* **Impact:** (i) Provide first estimates of the single scattering albedo of individual aerosol particles as a function of chemical composition, with an unknown but potentially significant impact on calculations of the radiative balance and climate. (ii) Obtain molecular speciation of the organic content of aerosols, understand it in terms of geographical and altitude coordinates, assess implications for the radiative and chemical effects of aerosols. There could be a substantial impact in both areas.
- *Develop an aircraft-based lidar to measure wind and turbulence profiles.* **Impact:** Measurement of winds and turbulence profiles from an aircraft platform will allow for the study of the creation, transport and mixing of pollutants over a much larger area than currently possible.
- *Develop lidar systems to measure atmospheric constituent profiles.* **Impact:** These measurements will improve our understanding of the spatial and temporal variability of water vapor, ozone and aerosol and their impact on air quality and climate.



PSD-08 Sensor and Technique Development

GOAL: Design, develop, enhance and evaluate remote and in situ sensing systems for use from surface and other platforms of opportunity in order to measure critical atmospheric, surface, and oceanic parameters.

APPROACH: Deploy sensors in focused field programs designed to evaluate and refine sensor performance. Deploy sensors for new applications that extend our ability to observe and understand the Earth system.

JULY 2006-JUNE 2007 MILESTONES:

- *Continue construction of a roving calibration standard for ship flux measurements.*
- *Field test fast ozone sensor on Houston A/Q field program for ship-based ozone flux measurements.*

JULY 2007-JUNE 2008 MILESTONES:

- *Complete construction of a roving calibration standard for ship flux measurements.*
- *Evaluate results of field test fast ozone sensor on Houston A/Q field program for ship-based ozone flux measurements.*
- *Field test roving flux standard on one ship deployment.*

CET-01 Remote Hydrologic Sensing

GOAL: Develop microwave remote sensing capabilities to facilitate NOAA measurements of key hydrological variables.

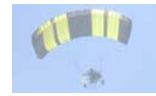
APPROACH: Utilize advanced microwave radiometric techniques, including ground-based, shipborne, airborne, and satellite techniques using frequencies up to ~1 THz to quantitatively measure hydrological variables for NOAA research and forecasting applications. Variables of interest include atmospheric moisture, soil moisture, snow water equivalent, ocean salinity, clouds and precipitation, and sea ice. The project will incorporate advances in microwave sensing and data assimilation technology along with integration of microwave sensors on new platforms such as UAVs.

JULY 2006-JUNE 2007 MILESTONES:

- *Develop a new microwave sensing capability to enable NOAA measurements of soil moisture and/or snow water equivalent.*
- *Development an improved version of the DOTLRT radiative transfer model with radiance assimilation capabilities*
- *Demonstrate the potential for geostationary microwave imaging of precipitation using simulation experiments.*

JULY 2007-JUNE 2008 MILESTONES:

- *Develop a ground-based microwave profiling system for long-term arctic cloud and water vapor measurements*
- *Develop submillimeter microwave radiometers for ground-based and airborne cloud sensing.*
- *Develop all-weather radiance assimilation of satellite passive microwave observations.*



AMOS-02: DATA MANAGEMENT, PRODUCTS AND INFRASTRUCTURE SYSTEMS

NGDC-01	Geospatial Technology for Global Integrated Observing and Data Management Systems
NGDC-02	Marine Geophysics Data Stewardship
SEC-03	Information Technology and Data Systems
SEC-04	Space Environment Data Algorithm and Product Development

NGDC-01 Geospatial Technology for Global Integrated Observing and Data Management Systems

GOAL: Develop methods and processes for integrating multiple types of observations (gridded satellite products, in-situ measurements) using new Geographic Information System (GIS) data management and access tools; develop methods and processes for partnering with scientists to facilitate interoperability by producing metadata for scientific observations that is compliant with national FGDC (Federal Geographic Data Committee) and international ISO (International Standards Organization) standards; and, create tools that allow the mining of vast environmental archives for the purpose of knowledge extraction, data quality control and trend detection.

APPROACH: During the last several years the World Wide Web, Relational Database Management Systems, and Geographic Information Systems have converged to form a powerful foundation for environmental data management, integration and access. Taking advantage of this foundation in the arena of scientific research requires building technologies for transitioning legacy systems into the new framework and understanding the sociology of such transitions; develop, implement, and test web-based tools for creating and managing metadata for scientific datasets while ensuring that scientists and other data creators can use those tools effectively. Data Mining technology will create a system for connecting distributed data archives, a set of data models for representing that data in a common data format and tools based on advanced mathematics for extracting the required information/knowledge in an automated fashion. Data mining technology will help address the ever increasing data volumes.

JULY 2006-JUNE 2007 MILESTONES:

- *Increase access to environmental observations from Internet applications (Internet Mapping, Google Earth, etc.) using Open Geospatial Consortium standards and spatial databases.*
- *Integrate satellite granule metadata into spatial databases and Geographic Information Systems.*

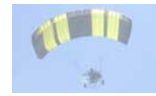
JULY 2007-JUNE 2008 MILESTONES:

- *Integrate near real-time observations into Data Center access systems.*
- *Design, develop, and demonstrate archive systems that provide integrated access to data in spatial databases and file systems.*

NGDC-02 Marine Geophysics Data Stewardship

GOAL: Contribute to a streamlined, more fully automated, accessible, and web-based management and stewardship process for marine geophysical data in support of seafloor research at CIRES research and throughout the environmental science community.

APPROACH: Acquire, archive, quality assess, store, and make available the fullest extent of publicly-available, UNCLASSIFIED, marine geophysical data collected by national, international, and academic marine institutions. Data stewardship includes assuring the quality of the data, documenting the quality



and pedigree in generated metadata, and developing and adapting new data delivery systems to meet the needs and requests of the user community for rapid, web-based access to data for analysis and research.

JULY 2006-JUNE 2007 MILESTONES:

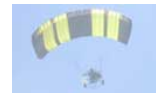
- *Add generic set of Federal Geographic Data Committee (FGDC)-compliant metadata files for each survey in the Multibeam Bathymetric Data Base (MBDDDB) at <http://map.ngdc.noaa.gov/website/mgg/multibeam/viewer.htm>, thereby improving the infrastructure for search and access. **Impact:** This addition will provide additional, standardized metadata to support widened search and access support to geospatial search and retrieval systems, thus making our data more readily accessible to researchers.*
- *Search, target, and acquire multibeam data from the larger, worldwide oceanographic community. **Impact:** More complete acquisition, archiving, and access to the world's multibeam bathymetry will provide significant synergy for not only the bathymetric community, but the environmental sciences in general. A single point source for the vast majority of data ensures completeness, effective quality comparison, and standardized description of the data for the world's oceans, which in turn extends the effectiveness of modeling ocean basin boundary conditions, circulation, and other environmental impacts.*
- *Implement an effective on-line, web-based, data submission interface for multibeam bathymetry by which even a casual user will be able to submit data into the Multibeam Bathymetric Data Base (MBDDDB). **Impact:** The complement to easy retrieval is easy submission, permitting ready distributed authority to submit data to the data center. This is key to effectively acquiring as much of the available multibeam bathymetry as possible, while effectively managing these huge volumes of data. User-friendly input, and automatic generation, of appropriate and generic metadata complete this critical component of world-class stewardship of multibeam bathymetric data.*

JULY 2007-JUNE 2008 MILESTONES:

- *Develop and test accurate, efficient, and effective system status monitoring software and metrics for management and oversight of rates of acquisition, evaluation, archiving, and access of marine geophysical data. **Impact:** Effective data stewardship requires appropriate and effective management tools to maximize the efficiency with which large volumes of data are handled. These tools will serve as a pilot development for effective and efficient management of multibeam bathymetric data and as a prototype for more general application across the spectrum of geophysical data.*
- *System integration and extension, to provide user friendly, highly navigable web access to all marine geophysical and geological data. **Impact:** Evolving technologies and standards require vigilance to provide users with tractable solutions to their data requirements. Providing uniform and standard, easy-to-use interfaces with context-sensitive help will open the access of those data to a broader spectrum of users, expert to novice. Careful use of terms, definitions, tags, and graphics will permit more useful and direct access by the full spectrum of potential users of these environmental databases.*

SEC-03 Information Technology and Data Systems

GOAL: Determine the necessary research data systems and infrastructure required to implement successfully the empirical and physical scientific models of the space environment such as those envisioned in SEC-01 and SEC-02 with fast and efficient access to appropriate data sources.



APPROACH: Scientific specification and forecasting of the space environment requires fast and efficient access to appropriate data sources in order to understand and predict complex events such as the response of the thermosphere and ionosphere to solar activity. It requires powerful computing resources to manipulate, display, and process data and model output. The current era of information technology is rapidly evolving and it is imperative to keep abreast of new approaches to handling disparate data sources to evaluate the use of data assimilation techniques for specification and forecast of the space environment, and to modeling output in order to achieve our scientific goals.

JULY 2006-JUNE 2007 MILESTONES:

- *Realign SEC data processing systems for better security and reliability. Identify and partition off National Critical Systems (NCS) from rest of the IT infrastructure.*
- *Complete the phase-I migration of older and non-supported computing platforms to newer platforms. Complete and deploy SEC programmatic data subscription service. Complete and deploy next generation SEC status monitor and lay down a project plan for integrating existing applications to the new status monitor. Complete next version of the data bridge server and clients to provide aggregate and atomic domain-name based data-retrieval, and auto-switching between main and warehouse data stores.*
- *Develop and deploy a secure and reliable data ingest, storage, processing and dissemination system for space weather data streams. Re-architect 4-5 existing applications to reduce complexity and increasing reliability by integrating them with the new SEC shared services.*
- *Complete development of the GOES-N ground data systems IT infrastructure needed for post-launch test. Provide analysis and technical support to algorithm development, instrument checkout and data verification.*

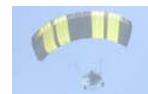
JULY 2007-JUNE 2008 MILESTONES:

- *Complete the phase-II migration of older and non-supported computing platforms to newer platforms. Migrate existing Data Display system and its supporting software components to the new shared services architecture. Complete and deploy next generation SEC status monitor and lay down a project plan for integrating existing applications to the new status monitor. Complete next version of the data bridge server and clients to provide aggregate and atomic domain-name based data-retrieval, and auto-switching between main and warehouse data stores.*
- *Develop and deploy a secure and reliable data ingest, storage, processing and dissemination system for space weather data streams. Re-architect 4-5 existing applications to reduce complexity and increasing reliability by integrating them with the new SEC shared services.*
- *Complete development of the GOES-N ground data systems IT infrastructure needed for post-launch test. Provide analysis and technical support to algorithm development, instrument checkout and data verification.*

SEC-04 Space Environment Data Algorithm and Product Development

GOAL: Explore new techniques for analyzing and modeling GOES space environment data, and develop and validate new algorithms and products.

APPROACH: The GOES-N series and the GOES-R series satellites will include instruments with new capabilities that will enable improved space weather products. Also, new scientific understanding will continue to enable new data processing and new modeling capabilities. Using data from current GOES satellites and other complementary instruments, new concepts for data processing and modeling will be tested. New algorithms and products will be developed and validated using available data. These activities will insure that GOES space environment data will be fully utilized in support of space weather needs.



JULY 2006-JUNE 2007 MILESTONES:

- *Assemble proxy data sets for the GOES-R instruments. **Impact:** Data from existing instruments will be necessary to develop and to test algorithms for use with the future GOES-R instruments.*

JULY 2007-JUNE 2008 MILESTONES:

- *Develop and validate new algorithms and products to be generated with the GOES-N and the GOES-R series satellites. **Impact:** The availability of new validated products will insure that the maximum value is obtained from the space environment data on the GOES satellites.*
- *Explore new models and analysis techniques to improve the accuracy and to expand the scope of operational products derived from the GOES data. **Impact:** By developing new scientific understanding and utilizing this understanding in the processing and modeling of GOES data, enhance products and services will be enabled that will enhance the value of GOES data to the users of space environment services.*

AMOS-03: PREDICTION, MODEL DEVELOPMENT AND EVALUATION

CSD-02	Chemical Transport Model Research
PSD-09	Environmental Modeling and Prediction
GSD-01	Numerical Weather Prediction
GSD-03	Verification Techniques for the Evaluation of Aviation Weather Forecasts
NGDC-03	Space Weather
SEC-01	Solar Disturbances in the Geospace Environment
SEC-02	Modeling the Upper Atmosphere

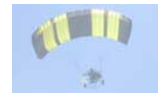
CSD-02 Chemical Transport Model Research

GOAL: Undertake research that contributes to the ability to forecast regional air quality and improves the understanding of the budget of ozone in the upper troposphere.

APPROACH: Design and evaluate state-of-the-art model capabilities to describe the transport and chemical evolution of pollutants in the atmosphere. Focus is regional air quality with an emphasis on ozone and particulates. The regional chemical transport model will integrate the emission, the vertical and horizontal transport, and the chemical conversions of pollutants. Evaluation by comparison of the model results with integrated field studies will lead to an improved model system and its components. Detailed tracer transport studies, meteorological analysis including satellite observations and coordinated measurements with a network of ozone sondes will lead to an improved understanding of the ozone budget over the United States during the summertime.

JULY 2006-JUNE 2007 MILESTONES:

- *Use the forecast capabilities of current chemical transport models for the planning of the deployment of the RV Ronald H. Brown and the WP-3 and other aircraft during the 2006 Texas Air Quality Study / Gulf of Mexico Atmospheric Composition and Climate Study experiment. **Impact:** This CIRES research will allow the coordinated deployment of multiple platforms to examine the processes that shape the air quality over eastern Texas and the adjacent Gulf of Mexico.*
- *Gather remote sensing observations during the 2006 Texas field study to investigate the capability of models to represent important boundary layer parameters. **Impact:** This research will focus on application of airborne and ship based lidars to characterize the diurnal variability*



important boundary layer parameters such as mixing layer depth, ozone plume structure, and aerosol scattering profiles over varied terrain for comparisons with models.

JULY 2007-JUNE 2008 MILESTONES:

- *Use measurements of ozone, aerosols, and their precursors made during the 2006 Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study to evaluate the forecast capability of the current tracer and chemical forecast models. Impact: This CIRES research contributes to improved forecasts of ozone and aerosol air quality. The evaluated models will enable measurements obtained during intensive field experiments to be set into broader context and allow the examination of factors that control the formation of pollution in the troposphere.*
- *Continue to use model sensitivity studies to examine the effects of changing power plant emissions of nitrogen oxides (NO_x) on the formation of ozone over the eastern USA. Impact: This CIRES research will contribute to an improved understanding of the factors that influence the formation of ozone in the plumes of power plants and the impact that the documented strong reduction of this emission source category has for the regional ozone levels over the Eastern United States. This study will provide insights into the ozone changes that can be anticipated as power plant NO_x emission reductions continue to be implemented throughout the U.S. Compare remote sensing observations with model forecasts to assess representation of boundary layer characteristics in various forecast models. Impact: Accurate representation of the growth of the boundary layer and the distribution of winds, ozone and aerosols over different surfaces is critical for obtaining an accurate model-based forecast of regional air quality. Lidar observations from the 2006 Texas study, along with measurements from surface sites, will be used to assess the capability of forecast models to characterize the distribution and evolution of important boundary layer parameters.*

PSD-09 Environmental Monitoring and Prediction

GOAL: Improve numerical model performance through development of new data streams that directly impact forecast ability and through focused observational campaigns supporting geophysical process studies.

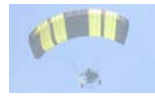
APPROACH: Perform research in each of these key areas associated with improved regional weather forecasts: i) Data assimilation, including use of new observation types as well as improved use of existing observations, ii) Numerical forecast models, including dynamical solvers as well as parameterizations of sub-grid-scale and complex processes, iii) diagnosis of key weather parameters from numerical model output and applicable to different problems including aviation and severe storm forecasting, and iv) display and visualization techniques and data acquisition and computer processing. This research will be conducted primarily with the Weather Research and Forecast (WRF) model and Rapid Update Cycle (RUC) model.

JULY 2006-JUNE 2007 MILESTONES:

- *Develop intersatellite bias correction and apply both diurnal sampling and intersatellite bias corrections to the High-Resolution Radiation Sounder (HIRS) satellite radiances. Determine the impact these corrections have on the radiances by comparing with HIRS simulated radiances from the GFDL climate model.*

JULY 2007-JUNE 2008 MILESTONES:

- *Publish two peer-review journal articles discussing (1) the HIRS intercalibration method and (2) comparison of HIRS corrected observations with HIRS simulated radiances from GFDL climate model.*



GSD-01 Numerical Weather Prediction

GOAL: Design and evaluate new approaches for improving regional-scale and global numerical weather forecasts, including forecasts of severe weather events.

APPROACH: Perform research in each of these key areas associated with improved regional weather forecasts: i) data assimilation, including use of new observation types as well as improved use of existing observations, ii) numerical forecast models, including dynamical solvers as well as parameterizations of sub-grid-scale and complex processes, iii) development of new numerical techniques for global models including use of icosahedral coordinates, finite volume, and hybrid isentropic-sigma coordinates, iv) diagnosis of key weather parameters from numerical-model output and applicable to different problems including aviation and severe storm forecasting, and v) display and visualization techniques and data acquisition and computer processing. This research will be conducted primarily with the Weather Research and Forecast (WRF) model, the Rapid Update Cycle (RUC) model, and the Flow-following Finite-volume Icosahedral Model (FIM).

JULY 2006-JUNE 2007 MILESTONES:

- *Begin 1-h cycling of initial version of the North American Rapid Refresh using GSI and the chosen configuration of the WRF model.*
- *Incorporate enhancements to Gridpoint Statistical Interpolation (GSI) code to improve use of surface weather observations (METARs) and introduce GSD-developed procedures into GSI to incorporate three-dimensional, high-frequency National Weather Service WSR-88D radar data in the initialization of cloud and precipitation hydrometeors.*

JULY 2007-JUNE 2008 MILESTONES:

- *Continue ESRL/GSD testing of North American Rapid Refresh 1-h intermittent assimilation cycling, paying particular attention to performance of GSD enhancements in the use of surface observations and cloud and radar data in the Gridpoint Statistical Interpolation analysis and initialization of hydrometeors, and to the performance of physics suites in the WRF forecast component.*
- *Port well-tested ESRL/GSD code for North American Rapid Refresh to NCEP and begin pre-implementation testing at NCEP/EMC in preparation for Rapid Refresh implementation into NCEP operations in the year 2008.*
- *Conduct real-data testing with the global FIM model.*

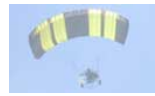
GSD-03 Verification Techniques for the Evaluation of Aviation Weather Forecasts

GOAL: Design and evaluate new verification approaches and tools that will provide information about the quality of aviation forecasts and their value to aviation decision makers.

APPROACH: Research key verification approaches that can apply to aviation verification problems such as icing, turbulence, convection, and oceanic weather; design and test the verification approaches using the Real-Time Verification System (RTVS); analyze the statistical results using the new approaches and summarize information in written reports. Contribute to the ongoing development of the RTVS by enhancing system design and functionality.

JULY 2006-JUNE 2007 MILESTONES:

- *Participate in the redesign of the Real-Time Verification System (RTVS) by enhancing the functionality of the database, web-interface, and real-time processing modules of the system to support verification of aviation parameters, such as icing, turbulence, and convective weather.*
Impact: This work will result in a well designed, easy to maintain, and fully interactive



verification system that will be use to support the FAA Aviation Weather Research Program and be transitioned to the National Weather Service (NWS).

- *Investigate and develop new verification techniques for evaluating the accuracy of convective echo tops, high resolution automated convective probabilistic forecasts, and ceiling and visibility forecast lead times.* **Impact:** This work will result in techniques that will be implemented into RTVS for on-going long-term evaluation of forecast quality, used to determine the quality of convective forecasts that are appropriate for transition to NWS operations, and support the NWS performance measure requirement for ceiling and visibility forecasts.
- *Summarize results from statistical evaluations of turbulence and convective weather forecasts in written reports.* **Impact:** The reports are provided to the Aviation Weather Technology Transfer Technical Review Panel. The Panel members use the information as evidence to determine whether the forecast product should transition from research to NWS operations.

JULY 2007-JUNE 2008 MILESTONES:

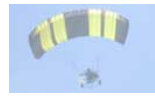
- *Continue with the redesign of the Real-Time Verification System (RTVS) by enhancing the functionality of the database, web-interface, and real-time processing modules of the system to support verification of aviation parameters, such as icing, turbulence, and convective weather.* **Impact:** This work will result in a well designed, easy to maintain, and fully interactive verification system that will be use to support the FAA Aviation Weather Research Program and be transitioned to the National Weather Service (NWS).
- *Investigate and develop new verification techniques appropriate for volcanic ash forecasts and turbulence forecasts in data-sparse oceanic regions.* **Impact:** This work will result in techniques that will be implemented into RTVS to determine forecast quality and to aid in product transition from research to NWS operations.
- *Summarize results from statistical evaluations of turbulence, convective weather, icing, volcanic ash, and cloud top height forecasts in written reports.* **Impact:** The reports are provided to the Aviation Weather Technology Transfer Technical Review Panel. The Panel members use the information as evidence to determine whether the forecast product should transition from research to NWS operations.

NGDC-03 Space Weather

GOAL: Assess the current state of the space environment from the surface of the sun to the upper atmosphere; use data-driven physical models to construct a realistic and authoritative gridded database of the space environment; and place that description into its long-term climatological perspective.

APPROACH: NOAA's National Geophysical Data Center is responsible for the long-term archive of and access to space environmental monitoring data and the assessment of the near Earth space environment. These data provide the foundation and physical models provide the technique required to assess the state of the space environment. This project will assist in the archive of data from NOAA's and DoD's observing systems; will evaluate the different physical models of the space environment developed by academia, i.e., the coupled ionosphere and thermosphere, the radiation belts, the inner and outer magnetosphere, interplanetary space, and solar source; will construct the data assimilation required to drive the best models; will generate gridded databases of the space environment over the long-term; will use the data-driven models to support virtual observatories which can be placed anywhere in the space environment; and will construct the first climatology of the space environment. This is a joint project with the DoD's Air Force Weather Agency, NASA's Living With a Star Program and NOAA's Space Weather Program.

JULY 2006-JUNE 2007 MILESTONES:



- *Develop space weather climatological products using the Space Weather Analysis database.*
- *Publish project results via web and integrate them with ongoing research projects.*
- *Develop the Virtual Radiation Belt Observatory Convert the real-time ionosonde network to a single architecture to better support operations.*

JULY 2007-JUNE 2008 MILESTONES:

- *Develop automated quality control techniques for ionospheric data.*
- *Integrate the Comprehensive Large Array Stewardship System (CLASS) with NOAA data management systems.*
- *Develop a generalized Virtual Observatory and support the Electronic Geophysical year (eGY)*
- *Create a unified magnetics data management system. Impact: By managing all magnetically related data in a single system the scientific community will be more easily be able to access this key national resource.*

SEC-01 Solar Disturbances in the Geospace Environment

GOAL: Improve the prediction of traveling solar disturbances that impact the geospace environment. Such disturbances, which are associated with both coronal holes and coronal mass ejections (CMEs) from the Sun, can cause substantial geomagnetic effects leading to the crippling of satellites, disruption of radio communications, and damage to electric power grids.

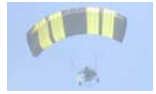
APPROACH: (i) *Solar Sources.* Acquire, analyze, and interpret relevant solar data providing information on the launch and properties of traveling interplanetary disturbances that affect the geospace environment. (ii) *Propagation.* Develop empirical and numerical simulation tools that provide improved forecasts of traveling solar disturbances in the inner heliosphere.

JULY 2006-JUNE 2007 MILESTONES:

- *Calibrate GOES X-ray Instrument: Use selected solar observations and 2005 rocket underflight data.*
- *Global Solar Wind Predictions: Improve the SEC predictions system based on the Wang-Sheeley-Arge source-surface model, as coupled into a 3-D MHD propagation model, through advanced post-processing of input data.*
- *Coronal Mass Ejection (CME) Locator: Develop and implement fully operational version of the CME Locator based on white-light corona observations from the NASA STEREO mission.*
- *EIT waves and dimmings: Compare EUV dimming properties (intensity, solar location, and mass) with associated CME properties.*

JULY 2007-JUNE 2008 MILESTONES:

- *Calibrate GOES X-ray Instrument: Use selected solar observations and 2006 rocket underflight data.*
- *Global Solar Wind Predictions: Further improve the SEC predictions system by utilizing data from various observatories, and by extending the domain farther out into the heliosphere.*
- *Coronal Mass Ejection (CME) Locator: Develop and implement polarization technique to complement the purely geometric method used in the CME Locator, and to enhance understanding of CME properties.*

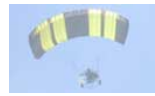


- *EIT waves and dimmings: Determine if any clear association exists between the characteristics of a given dimming and the subsequent CME. If so, utilize dimmings to predict CME properties.*

SEC-02 Modeling the Upper Atmosphere

GOAL: Understand responses of the upper atmosphere to solar, magnetospheric, and lower atmosphere forcing, and the coupling between the neighboring regions. Since many of the space weather effects occur in the ionosphere and neutral upper atmosphere it is important to develop an understanding of the system to the point where accurate specification and forecasts can be achieved.

APPROACH: Develop empirical and physical models of the Earth's upper atmosphere in order to understand and predict the response of the thermosphere and ionosphere to solar events such as flares and geomagnetic storms resulting from solar coronal mass ejections and co-rotating streams. Evaluate the use of data assimilation techniques for specification and forecast of the space environment and determine the essential and most beneficial data sources required for a robust assimilative system. Investigate coupling between the upper atmosphere and the geophysical regions above, the magnetosphere, and below, the lower atmosphere.



JULY 2006-JUNE 2007 MILESTONES:

- *Include the upper atmosphere physical processes into the Integrated Dynamics through Earth's Atmosphere (IDEA) model, and establish the structure to integrate the ionosphere-plasmasphere-electrodynamics (IPE) module. **Impact:** The IDEA model will be used to estimate the impact of periodic wave forcing in the lower atmosphere on the dynamics and electrodynamic in the lower thermosphere.*
- *Expand the input data network for the US-TEC data assimilation scheme to include Canadian stations. **Impact:** The accuracy of the electron content on the northern section of the CONUS will be improved for GPS navigation and other users.*

JULY 2007-JUNE 2008 MILESTONES:

- *Obtain the operational version of the data assimilation model Global Assimilation of Ionospheric Measurements (GAIM). Implement in a test mode utilizing available global ground-based GPS and ionosonde data, and perform a preliminary validation of differential TEC using GPS dual frequency phase data. **Impact:** The GAIM model provides the three-dimensional reconstruction of the global ionosphere suitable for specification of high frequency (HF) communication frequencies and for ray tracing of HF radio propagation paths.*
- *Couple the thermosphere-ionosphere-plasmasphere-electrodynamic (CTIPe) model with the Rice University Magnetospheric Convection Model (RCM). **Impact:** Combining the models will enable quantification of the impact of penetration and dynamo electric fields on the storm-time structure of the mid and low latitude ionosphere.*

AMOS-04: OBSERVING FACILITIES, CAMPAIGNS AND NETWORKS

GMD-01	Central Ultraviolet Calibration Facility
GMD-02	Surface Radiation Network

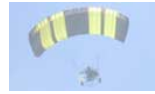
GMD-01 Central Ultraviolet Calibration Facility

GOAL: Provide a central facility for the calibration and characterization of solar ultraviolet broadband and spectral measurement systems to improve the long-term stability and comparison of measurements across national and international networks.

APPROACH: Maintain indoor and outdoor laboratories containing state-of-the-art characterization and calibration tools to understand the performance of available broadband and spectral instruments used for the measurement of solar ultraviolet radiation.

JULY 2006-JUNE 2007 MILESTONES:

- *Analyze and publish 10-year study of the stability of the CUCF's reference UVB broadband radiometers and 50+ network UVB radiometers. Includes analysis of multi-year spectral response and cosine response measurements.*
- *Publish paper on suite of filter radiometers involved in the June 200 Spectroradiometer Intercomparison at Table Mountain, Colorado.*
- *Update UV-MFRSR calibration data files from 1997 to 2005 for CUCF horizontal scale corrections, NIST vertical scale corrections, and Out-of-Band corrections.*



JULY 2007-JUNE 2008 MILESTONES:

- *Collaborate with the National Institute of Standards and Technology's Optics Division to compare vertical and horizontal irradiance scales as part of the interagency project between CUCF and NIST.*

GMD-02 Surface Radiation Network

GOAL: Collect long-term research-quality up-welling and down-welling broadband solar and infrared radiation data at seven U.S. sites. Collect long-term, broadband ultraviolet radiation data to evaluate variations in the erythemal doses. Collect long-term, spectral filter data to measure column aerosol optical depth and cloud optical depth. Collect cloud cover data to assess the effect of clouds on the surface radiation budget.

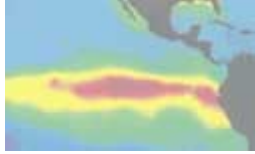
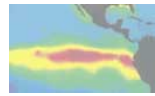
APPROACH: The Solar Radiation Research Branch (SRRB) operates the first climate radiation budget climate network ever established in the U.S. It currently consists of sites in seven distinct climate regimes of the country. Measurements are made of broadband solar and terrestrial infrared radiation following the guidelines of the WMO/WCRP (World Meteorological Organization/World Climate Research Programme) Baseline Surface Radiation Network (BSRN). All sites also maintain ultraviolet, cloud cover, and column aerosol and cloud optical depth measurement capabilities for assessing the primary causes of surface radiation variability.

JULY 2006-JUNE 2007 MILESTONES:

- *Analyze 10-year plus aerosol optical depth record of SURFRAD sites and publish the results.*
- *Analyze the 10-year plus SURFRAD data record of irradiance for trends in the context of the current global dimming/brightening issue and publish results.*

JULY 2007-JUNE 2008 MILESTONES:

- *Publish results of an objective comparison of automated total-sky imager cloud fraction retrievals and sky cover determinations from trained observers at Eglin Air Force Base and the Desert Rock rawinsonde station.*



Scientific Theme: **CLIMATE SYSTEM VARIABILITY**

CSV-01	Detection of Climate Modes, Trends and Variability
CSV-02	Mechanism and Forcings of Climate Variability
CSV-03	Stratospheric Ozone Depletion
CSV-04	Climate Dynamics
CSV-05	Climate Research Database Development
CSV-06	Regional Climate Systems
CSV-07	Climate Services

CSV-01: **DETECTION OF CLIMATE MODES, TRENDS AND VARIABILITY**

GMD-03	Climate Trend Analysis
PSD-04	Decadal Climate and Global Change Research
NGDC-04	Paleoclimate: Understanding Decadal to Millennial Scale Climate Variability

GMD-03 Climate Trend Analysis

GOAL: Interpret operational data (ozone column, ozone profile, aerosol extinction, broadband spectral radiation, and other environmental parameters) collected by NOAA ground-based and NCAR aircraft-based instruments. Assess data for long-term quality. Evaluate stability and inter-annual variability in the ground-based and aircraft-based data sets. Provide scientific community with information relevant to climate research and evaluate usefulness of data for validation of other independent measurements, including satellite observations.

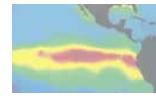
APPROACH: Exercise statistical and analytical methods to assess quality of the data. Develop new approaches to improve quality of the product derived from ground-based and aircraft-based measurements. Evaluate data for trends using state-of-the art radiative transfer models and statistical analysis. Provide support for validation of climate related products.

JULY 2006-JUNE 2007 MILESTONES:

- Assess newly updated ozone-profile database for trends and changes in trends and validate it against ozone products derived from remote and in situ measuring systems such as satellites and ozone-sounding. **Impact:** This will provide expanded resources for validation of ozone recovery.
- Optimize and validate algorithm for ozone column retrievals from photo-actinic flux hyper-spectral measurements on board an aircraft under a variety of atmospheric conditions. Provide data to OMI/AURA satellite validation campaigns. **Impact:** This dataset will be used for validation of ozone satellite products.

JULY 2007-JUNE 2008 MILESTONES:

- Develop ozone profile retrievals from the automated Dobson and Brewer radiometric measurements. Quantify aerosols interference in ozone retrievals. **Impact:** This will provide expanded resources for validation of ozone recovery.
- Continue to retrieve ozone column data from photo-actinic flux hyper-spectral measurements on board an aircraft under a variety of atmospheric conditions. Provide data to OMI/AURA satellite validation campaigns. **Impact:** This dataset will be used for validation of ozone satellite products.



- *Develop new products for Brewer NOAA network, such as tropospheric ozone and NO₂ column. Evaluate and characterize new products against well-established and co-located measurements. Provide data to OMI/AURA satellite validation campaigns. Impact: This new dataset will provide expanded resources for climate change and tropospheric pollution studies.*

PSD-04 Decadal Climate and Global Change Research

GOALS: i) Improve understanding of long-term climate variations through analysis of observations and hierarchies of GCM experiments. (ii) Seek dynamical explanations of oceanic variability and changes through observational analyses and GCM experiments. (iii) Provide attribution for long-term regional climate changes.

APPROACHES: (i) CIRES is assessing the significance of and diagnosing the relationships between observed recent multi-decadal changes in tropical ocean temperatures and the global atmospheric circulation. Techniques include the use of atmospheric models forced by SSTs, ocean models forced by wind stresses and heat fluxes, and hierarchies of coupled ocean-atmosphere GCMs, including runs forced by greenhouse gases. (ii) Similar techniques are being used to understand the markedly different climate during the mid-Holocene (ca 6000 years BP) in terms of the generally colder tropical Pacific Ocean and reduced greenhouse gas concentrations existing during that period. (iii) Researchers will study the origin and climatic impact of decadal midlatitude ocean variability, particularly over the north Pacific. (iv) It is believed that progress can be made by improving the understanding of regional responses around the globe to slow changes in the tropical Pacific, Indian, and Atlantic oceans. Understanding these decadal-scale oceanic changes will require careful observational and climate model diagnosis.

JULY 2006-JUNE 2007 MILESTONES:

- *Diagnose impacts of ENSO-related and non-ENSO related tropical SST changes over the last 50 years.*
- *Assess possibility of abrupt climate change over North America in the next several decades triggered by continued warming of the Indian Ocean.*
- *Assess impacts of coupled air-sea interactions, decadal ocean dynamics, land-surface feedbacks, and land-use changes on decadal atmospheric variability.*

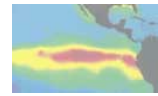
JULY 2007-JUNE 2008 MILESTONES:

- *Diagnose impacts of ENSO-related and non-ENSO related tropical SST changes over the last 130 years.*
- *Continue assessing importance of coupled air-sea interactions, decadal ocean dynamics, land-surface feedbacks, and land-use changes on decadal and longer-term atmospheric variability.*
- *Diagnose impacts of subseasonal tropical and stratospheric variability on longer-term global climate variability and the mean climate.*

NGDC-04 Paleoclimatology: Understanding Decadal- to Millennial-Scale Climate Variability

GOAL: Improve our understanding of observed long-term climate variations through compilation and analysis of data from the pre-instrumental record and provide access to both data and information from the paleoclimatic record.

APPROACH: Because instrumental records of climate are rarely over a century long, paleoclimatic data are the only way we can understand the full range of climate variability. In collaboration with



paleoclimatic researchers from around the world, we will compile and make available new paleoclimatic data and research results, and develop systems for data archive, access, visualization, and analysis. This work will also draw upon collaborations with educators and communications professionals to develop new approaches for presenting information to students, policy makers and the public.

JULY 2006-JUNE 2007 MILESTONES:

- Create a fire history portal on the FRAMES (Fire Research and Management System) web site.
- Implement protocols that provide paleoclimate metadata to remote crawlers and harvesters, including the PAGES and FRAMES portals.
- Implement harvesting and indexing of paleoclimate data to make data sets from remote servers and remote databases available from the NOAA Paleoclimatology web site.

JULY 2007-JUNE 2008 MILESTONES:

- Extend Tree Flow data and information products to include other regions.
- Improve climate reconstruction data sets by adding new data and by creating a searchable index (catalog) and database.
- Create a catalog of paleoclimate data needed to compare numerical climate model simulations with paleoclimate and improve climate models. This effort will archive new paleoclimate data useful in data-model comparisons.

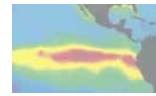
CSV-02: MECHANISM AND FORCINGS OF CLIMATE VARIABILITY

CSD-03	Chemistry, Radiative Forcing and Climate
PSD-01	Modeling of Seasonal to Interannual Variability
PSD-02	Understanding and Predicting Subseasonal Variations and their Implications for Longer Term Climate Variability
GMD-04	Climate Forcing

CSD-03 Chemistry, Radiative Forcing, and Climate

GOALS: (i) Observe and model the radiative forcing due to stratospheric ozone changes and tropospheric radiatively active gases. (ii) Carry out upper-troposphere airborne experiments and diagnostic analyses that characterize the dynamical and chemical processes that influence the radiative balance in the global atmosphere. (iii) Quantify the chemical and optical properties that determine the lifetimes, abundances, and trends of greenhouse gases. (iv) Use passive cloud observations to develop techniques that can be used to estimate cloud properties.

APPROACHES: (i) Use line-by-line radiative models to calculate the profile of radiative forcing. Evaluate the tropospheric cooling/warming due to ozone layer losses/increases. From airborne and surface observations in convective areas, estimate the radiative forcing from biomass burning, lightning, and pollution. (ii) Design, evaluate, and apply computer-controlled apparatus for measurements aboard the NASA WB-57 high-altitude research aircraft. The current analytical focus is on water vapor, methane (which is radiatively active and a dynamical tracer), and particles. (iii) Use laboratory analytical methods to establish chemical reaction rates, their temperature and isotopic sensitivities, and the optical band strengths. The current emphasis is on precursors of tropospheric ozone, many of the non-carbon dioxide greenhouse gases (methane, hydrofluorocarbons (HFC's), perfluorocarbons, sulfur hexafluoride), and other potential greenhouse gases. (iv) Measure near-infrared spectra in the presence of clouds and analyze them using the differential optical absorption spectroscopy (DOAS) technique with a focus on estimating liquid and ice abundances in the cloud.



JULY 2006-JUNE 2007 MILESTONES:

- *Plan and execute the Gulf of Mexico Air Quality and Climate Change Study (GoMACCS) field study. Impact: The Gulf of Mexico Air Quality and Climate Change Study (GoMACCS) that will be carried out in late summer/early fall of 2006 to examine the direct and indirect effects of aerosol on the radiative balance in the Gulf of Mexico region.*
- *Use global chemistry/dynamics models to examine the effect of future ship traffic in the Arctic northern passages on Arctic pollution, particularly in regard to the role of black carbon. Impact: Expansion of key conclusions relating to how the Arctic may change in a future warming world.*
- *Understand the processes that maintain the observed fall-off in tropical methane profiles between 12 km and the tropopause. Understand how these processes affect the corresponding profiles of ozone and water. Impact: Provides a critical, high-resolution test of the interplay of dynamics, chemistry, and radiation in the crucial region where many of IR spectral line change from being optically thick below to optically thin above, so having large leverage on climate.*

JULY 2007-JUNE 2008 MILESTONES:

- *Present and publish the results from the Gulf of Mexico Air Quality and Climate Change Study (GoMACCS). Impact: The Gulf of Mexico Air Quality and Climate Change Study (GoMACCS) will be carried out in late summer/early fall of 2006 to examine the direct and indirect effects of aerosol on the radiative balance in the Gulf of Mexico region.*
- *Apply global chemistry/climate models to quantify the anthropogenic and biomass burning emissions for the 1860 to 2000 period, and their impact on ozone distributions. Impact: Preliminary work suggests that biomass burning emissions may have been higher than generally thought during the preindustrial period. We will gather different datasets on both biomass burning and land-use change, assess previously reported work, and develop a biomass burning inventory for the past 150 years. The impact of these long-term changes in biomass burning emissions on ozone and other tropospheric species will be quantified using numerical model calculations.*
- *Employ high-resolution modelling, using MM5, of the dynamical processes around the subtropical jet stream; compare with observations, both statistically and in direct simulation. Impact: Establish the sensitivity of three-dimensional models to the small-scale structure in transport, with potential implications for climate modelling.*

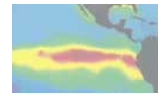
PSD-01 Modeling of Seasonal to Interannual Variability

GOAL: Understand how much predictability, especially outside the tropics, exists on seasonal-to-interannual timescales beyond that associated with linear ENSO signals, and what additional useful predictive information can be extracted by making large ensembles of nonlinear General Circulation Model (GCM) integrations.

APPROACH: Explore the nonlinearity and sensitivity of the global response to the details of anomalous tropical Sea Surface Temperature (SST) fields. Focus on the distributional aspects of the response, especially changes of variance and altered risks of extreme values, and not just shifts of the mean. Since the utility of deterministic predictions of the chaotic climate system is limited, our intent is to shift the emphasis from deterministic to probabilistic seasonal predictions. The utility of probabilistic predictions is unbounded in principle, in the important sense that it is ultimately determined by the needs of particular users.

JULY 2006-JUNE 2007 MILESTONES:

- *Determine sensitivity to past and future SST changes in different parts of the tropical oceans.*



- Document and diagnose the causes of skewed Seasonal Precipitation distributions in observations and models.
- Continue 20th century reanalysis efforts in collaboration with NCEP, NCAR, NCDC, ECMWF, U. of East Anglia, Environment Canada, ETH-Zurich, and the UK Hadley Centre.

JULY 2007-JUNE 2008 MILESTONES:

- Continue 20th century reanalysis efforts in collaboration with NCEP, NCAR, NCDC, ECMWF, U. of East Anglia, Environment Canada, ETH-Zurich, and the UK Hadley Centre.
- Assess the importance of the global nonlinear impacts of central equatorial Pacific sea surface temperature changes.
- Assess the predictability of Northern American Summertime precipitation using a number of atmospheric general circulation models.

PSD-02 Understanding and Predicting Subseasonal Variations and their Implications for Longer-Term Climate Variability

GOAL: Investigate the variability and predictability of weekly averages of the atmospheric circulation through modeling and diagnosis of the observed statistics, and also through detailed analysis of numerical weather forecast ensembles for Week Two.

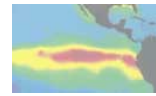
APPROACH: Extracting useful information about which aspects of the circulation remain predictable beyond a week presents interesting challenges given that the details of daily weather become unpredictable beyond that time. Forecast information on these time scales is in great demand from users. CIRES scientists are addressing these issues by developing low-dimensional empirical-dynamical models that not only successfully represent the statistics of weekly anomalies, but also demonstrate comparable forecast skill in Week Two to that of state-of-the-art comprehensive numerical weather prediction (NWP) models. They are also making extensive use of large ensembles of retrospective two-week forecasts generated in-house using the NCEP NWP model for the period 1979-2004 to develop methods for optimally extracting useful predictive information from such ensembles. An intelligent combination of the empirical and numerical model forecasts may yield Week Two forecasts that are superior to either in isolation.

JULY 2006-JUNE 2007 MILESTONES:

- Investigate the variability and predictability of extratropical subseasonal variations in all seasons of the year using a linear empirical-dynamical model that includes both tropical and stratospheric influences. Assess the predictability from deterministic as well as probabilistic perspectives, particularly in regard to the case-by-case and regime-dependent variations of predictability.
- Develop an empirical-dynamical coupled atmosphere-ocean model of tropical subseasonal variations.
- Investigate tropical intraseasonal variability using OGCMs, with emphasis on the impact of multiple MJO events on the ocean.

JULY 2007-JUNE 2008 MILESTONES:

- Use an empirical-dynamical coupled atmosphere-ocean model of tropical subseasonal variations to assess the impact of air-sea coupling on the variability and predictability of the MJO.
- Investigate subseasonal atmospheric variability in the tropical Indian Ocean using AGCM experiments, with emphasis on the influences of the Indian Ocean SST dipole.



- *Continue investigating the variability and predictability of extratropical subseasonal variations in all seasons of the year using a linear empirical-dynamical model that includes air-sea coupled tropical and stratospheric influences. Assess the predictability from deterministic as well as probabilistic perspectives, particularly in regard to the case-by-case and regime-dependent variations of predictability.*

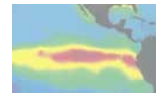
GMD-04 Climate Forcing

GOALS: *i) Greenhouse gases:* Conduct research to better understand the interactions of the atmosphere with the land and ocean. *ii) Aerosols:* Characterize the means, variabilities, and trends of climate-forcing properties for different types of aerosols, and understand the factors that control these properties. *iii) Radiation:* Conduct research into broadband irradiance to improve benchmarks for climatic processes.

APPROACH: Understanding climate forcing is a long-term experiment of global proportions that can only be addressed through sustained high quality observations around the world. This sampling strategy will help link chemical and physical measurements, provide ground-truth data for satellite remote sensing, and provide inputs to global models. Data records of sufficient duration are expected to reveal the extent of irradiance variations over time that reflect a combination of cause and effect of climate change.

JULY 2006-JUNE 2007 MILESTONES:

- *Merge mesoscale model B-RAMS with global transport model TM5. **Impact:** Estimation and evaluation of Amazonian trace gas fluxes.*
- *Begin measurements of Radon-222 at two tower sites in the continental USA. **Impact:** Improve estimates of regional scale carbon flux and atmospheric boundary layer ventilation.*
- *Implement following carbon flux emissions models for use within GMD Ensemble Kalman Filter Carbon Data Assimilation System: fire, fossil fuel and ocean carbon.*
- *Implement full description of $^{14}\text{CO}_2$ (radio-carbon) within TM5 global transport model, for simulation of North American and global $^{14}\text{CO}_2$ measurements. **Impact:** This combination of measurements and modeling will help to assess North American fossil fuel emissions.*
- *Establish two new tall-tower sites in the NOAA/GMD North American Carbon Observing System (Carbon America). **Impact:** This work will aid in reducing the uncertainty of carbon uptake by the North American continent (as outlined in the U.S. Climate Change Science Program).*
- *Complete development of automated quality control algorithms. **Impact:** This work will enable us to estimate the uncertainty of the trace gas measurements and enable rapid identification of measurement problems from the tall-tower network sites.*
- *Develop and field test a temperature/humidity/GPS system to augment current trace gas vertical profile measurements in the NOAA/GMD Carbon America aircraft network (allowing for automated measurements of the ambient temperature and humidity and the position and altitude of each sample in a vertical profile); and install systems at five sites.*
- *Field test new automated carbon dioxide analyzer systems aboard the small-aircraft platforms used in the NOAA/GMD Carbon America aircraft network. **Impact:** This system will allow for continuous measurements of carbon dioxide mixing ratios during ascent and descent phases of sampling flights.*
- *Establish two new overseas sampling sites in the long-term NOAA/GMD Cooperative Global Atmospheric Sampling Network.*
- *We will modify an existing spectro-radiometer as well as develop algorithms for the instrument to measure wavelength-dependent aerosol optical properties throughout the shortwave spectrum.*



- We will deploy a counter-flow virtual impactor (CVI) to two locations. The first location is in the United Kingdom downstream of an urban environment. The second deployment is onboard an aircraft.

JULY 2007-JUNE 2008 MILESTONES:

- Incorporate models of ocean carbon, fire emissions, and fossil fuel emissions in GMD Ensemble Kalman Filter Carbon Data Assimilation system. **Impact:** Improve global and regional estimates of carbon flux.
- Use North American measurements of $^{14}\text{CO}_2$ and CO_2 to diagnose and improve representation of vertical transport within TM5 transport model.
- Use measurements of CO_2 , CH_4 , CO and N_2O from the Brazilian Amazon to evaluate process-based model estimates of emissions of these gases.
- Implement representation of CH_4 within Ensemble Kalman Filter Carbon Data Assimilation system. **Impact:** Estimate fluxes of this greenhouse gas within for North America and globally.
- Develop tools to compare in situ aerosol measurements from two NOAA-mentored airplane packages with measurements from ground-based sunphotometers and lidars. **Impact:** This work may improve retrievals of derived aerosol properties (e.g., size distribution) from remote sensing instruments and thus is applicable to remote sensing platforms both at the surface and in space (e.g., CALIPSO).

CSV-03: STRATOSPHERIC OZONE DEPLETION

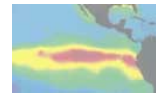
CSD-04	Tropospheric & Stratospheric Transport & Chemical Transformation
GMD-05	Ozone Depletion

CSD-04 Tropospheric and Stratospheric Transport and Chemical Transformation

GOALS: (i) Improve theoretical capabilities to predict the natural and human influences on the stratospheric ozone layer. (ii) Characterize the photochemical reactions relating to the human-induced loss of ozone in the stratosphere. (iii) Carry out in-situ studies of the photochemical and dynamical processes that influence the stratospheric ozone layer.

APPROACHES: (i) Design and evaluate multidimensional models of the chemistry and transport of the global stratosphere. The current focus is on simulating the integrated response of the ozone layer to volcanoes and chlorofluorocarbons, Halons, and other halogens, with the effects of changing temperatures included. The scope includes both polar and global processes. Ozone Depletion Potentials (ODP's) will be calculated for gases of policy relevance. (ii) Use fast-flow reactors and laser photolytic cells to measure the rate of chlorine- and bromine-induced chemical reactions associated with ozone loss. Determine the pressure and temperature sensitivities associated with stratospheric conditions. The current emphasis is on reactions associated with substitutes of the banned ozone-depleting substances, such as n-propyl bromide. Extend these studies to the reactions that occur on the surfaces of particles, both sulfate and ice, to resemble volcanic and other types of particles. (iii) Use high-altitude research aircraft to conduct a suite of chemical measurements in a variety of global locations and seasons. Collaborate with numerous institutions to assemble a broad chemical spectrum of measurements. Emphases include investigations of the impact of stratospheric aircraft on the ozone layer, particle formation processes and their role in the depletion of stratospheric ozone, and the connections between ozone depletion and climate-related factors.

JULY 2006-JUNE 2007 MILESTONES:



- *Understand transport processes associated with the subtropical jet stream, both by analysis of airborne and dropsonde data and by high-resolution modelling. **Impact:** With this data it can be determined what the role of all scales is in transport in the upper troposphere/lower stratosphere, and how they affect the distributions of water, methane, and ozone. These distributions are important in climate calculations.*

JULY 2007-JUNE 2008 MILESTONES:

- *Examine what is necessary to improve the simulation of transport by three-dimensional numerical models of the atmosphere. **Impact:** Establishing whether or not small-scale processes have a significant impact on climate modelling.*

GMD-05 Ozone Depletion

GOALS: (i) *Stratospheric Ozone Measurements:* Measure ozone declines during the past two decades at northern hemispheric midlatitudes and the tropics and to characterize dramatic ozone depletions over Antarctica. (ii) *Ozone-Depleting Gases:* Conduct research in the troposphere, stratosphere, oceans, polar snowpack, and terrestrial ecosystems in an effort to understand and predict the atmospheric behavior of these gases. (iii) *Stratospheric Aerosols:* Conduct experiments and measurements on aerosols to determine their impacts on solar insolation. (iv) *Stratospheric Water Vapor:* Conduct measurements to determine the change in water vapor and its coupling with aerosols.

APPROACHES: Understanding the production and fate of ozone and the compounds that deplete it is a focal point of collaborative CIRES research with CSD and GMD.

i) Stratospheric Ozone Measurements: Six Dobson instruments have been automated to provide ozone vertical profiles using the Umkehr technique and eight balloon-borne ozonesonde stations provide ozone profiles to an altitude of ~32 km. These ozone-measuring techniques are being used to monitor spectral UV and quantify the expected anticorrelation between ozone and UV.

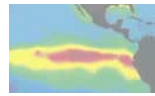
ii) Ozone-Depleting Gases: Gases that make a significant contribution to stratospheric ozone depletion (CFC-11, CFC-12, N₂O, HCFC's, and other halogenated compounds) have been incorporated into the measurement program as the number of monitoring sites has increased. Most of the gases that are responsible for depleting stratospheric ozone are anthropogenic, but some, such as CH₃Br and CH₃Cl, have natural contributions as well. CIRES scientists will monitor the distributions and trends of these gases as well as investigate their sources and sinks.

iii) Stratospheric Aerosols: Ozone depletion, through halogen-related chemistry, is facilitated by increased stratospheric particles as provided by stratospheric clouds in the polar regions and globally by volcanic eruptions. CIRES modeling suggests that with present halogen levels, a major eruption such as that of Pinatubo in 1991 could decrease total column ozone by as much as 10% at mid-latitudes.

iv) Stratospheric Water Vapor: From balloon-borne frost-point hygrometers, an approximately 1% per-year increase in stratospheric water vapor has been detected since 1980. Besides implications for climate change, increased water vapor can affect the rate of chemical ozone loss, for example, by increasing the incidence of polar stratospheric clouds.

JULY 2006-JUNE 2007 MILESTONES:

- *Measure ozone-depleting nitrous oxide (N₂O) in the planetary boundary layer (PBL) of the Amazon basin during a month-long aircraft-based campaign scheduled for October 2006. Estimate the large-scale natural emissions of N₂O from this region of very high primary productivity.*
- *A new index for assessing the changes in the atmospheric burden of ozone-depleting gases will be introduced. This Ozone Depleting Gas Index will be derived from the atmospheric measurements*



of ozone depleting gases that are regularly conducted at NOAA in collaboration with CIRES personnel.

- Utilize aircraft and stratospheric balloon platforms to measure several ODSs (N_2O , CFC-11, CFC-12) in the troposphere and stratosphere. These data will be used to validate measurements by space-borne instrumentation aboard the Aura satellite.

JULY 2007-JUNE 2008 MILESTONES:

- The Ozone Depleting Gas Index will be updated and refined, as needed, with continued measurements of ozone depleting gases by NOAA and CIRES personnel.
- Utilize NASA aircraft and stratospheric balloon platforms to validate tropospheric and stratospheric measurements of ODSs (N_2O , CFC-11, CFC-12) by space-borne instrumentation aboard the Aura satellite. **Impact:** These measurements, made as part of NASA-sponsored campaigns, also increase our knowledge about upper atmospheric transport and chemistry, which in turn improve our understanding of stratospheric ozone and its projected recovery.

CSV-04: CLIMATE DYNAMICS

PSD-06	Climate Dynamics
CSD-06	Turbulent Meteorological Motions
PSD-03	Empirical and Process Studies
PSD-15	Surface Processes

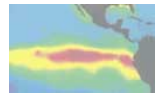
PSD-06 Climate Dynamics

GOALS: Conduct research to improve understanding of (i) tropical Pacific Ocean dynamical processes related to the subseasonal atmospheric variability, (ii) the dynamics and the microphysics of precipitating cloud systems, and (iii) atmospheric circulation, convection, and moisture and heat budgets associated with the El Niño phenomenon.

APPROACH: Analyze wind profiler, TAO buoy, and satellite data, combined with reanalysis products, to examine circulation, convection, marine boundary layer winds, and moisture/heat budgets. Deploy Doppler radar profilers and surface instruments to observe the vertical structure and evolution of precipitating cloud systems. Current emphases are on the processes associated with precipitation and on the interactions between and interannual variability of various atmospheric and surface daily cycles.

JULY 2006-JUNE 2007 MILESTONES:

- Retrieve the vertical profile of raindrop size distributions from 50-MHz, 920-MHz, and 2835-MHz profiling radar observations collected during the Tropical Western Pacific - International Cloud Experiment (TWP-ICE) conducted in Darwin, Australia, in January-February 2006. The profiler retrieved raindrop size distributions with their estimated uncertainties will be used to quantify the error characteristics of differential reflectivity measurements from simultaneous C-band polarimetric scanning radar observations made over the profiler site. **Impact:** This analysis will help determine the error characteristics of polarimetric scanning radar observations and the propagation of these errors into Quantitative Precipitation Estimates (QPE).
- Analyze multi-frequency profiler observations and multi-frequency polarimetric scanning radar observations collected during the Front Range Pilot Study in Colorado will be analyzed to determine the error characteristics of Quantitative Precipitation Estimates (QPEs). The use of normalized raindrop size distributions will be investigated as a means of describing the profiling and scanning radar retrieved raindrop size distributions. **Impact:** Understanding the error



characteristics of QPE from polarimetric scanning radar will be critical for NOAA as polarimetric capabilities are added to NOAA's NEXRAD scanning radar network.

- *Investigate the effect of coupled vs. decoupled lower-tropospheric flow over the East Pacific Cold Tongue on equatorially trapped waves over the East Pacific.*

JULY 2007-JUNE 2008 MILESTONES:

- *Determine the climatology of vertical air motions during precipitation events using the 17-year record of 50-MHz profiler radar observations collected at Darwin, Australia. **Impact:** The frequency distribution of vertical air motions during the 'On Set', 'Monsoon', and 'Break' periods over Darwin are not well documented and are not well understood. This climatology of observed vertical air motions will be needed to validate the frequency distributions of vertical air motion simulated in numerical weather prediction and climate models.*
- *Retrieve and analyze the raindrop size distribution (DSD) from multiple years of profiler observations producing tens-of-thousands of DSD profiles in different rain regimes that will lead to physically based DSD parameterizations. **Impact:** These parameterizations are needed to reduce the errors in current and future satellite based precipitation algorithms. These improved DSD parameterizations will also improve numerical weather prediction and climate model descriptions of precipitation. Data for this analysis will include profiler observations made in Darwin, Australia, and Estacion Obispo, Mexico.*
- *Document the daily cycles of lower-tropospheric winds and surface fluxes at Estación Obispo (Mexico) during the 2005 and 2006 North American Monsoon seasons, and evaluate the extent of interannual variability during 2004-2006.*

CSD-06 Turbulent Meteorological Motions

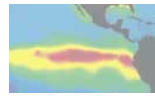
GOAL: Understand the mechanisms and effects by which turbulence influences atmospheric chemistry, composition, radiation, and transport on all scales, from that of molecular diffusion to that of the globe, some nine orders of magnitude.

APPROACH: Apply the theory of generalized scale invariance, based on multifractal concepts, to high resolution aircraft observations of winds, temperature, ozone, and tracers over four orders of magnitude, from 200 meters to one Earth radius. The theory will also be applied to chlorine and nitrogen oxides in the polar vortex to examine whether the current formulation of the rate of polar ozone loss is correct.

JULY 2006-JUNE 2007 MILESTONES:

- *Continue efforts to link, via high-resolution observations, the macroscopic theory of scale invariance with molecular-scale non-equilibrium statistical mechanics; examine the implications for the definition of atmospheric temperature in the horizontal with aircraft data and in the vertical with dropsonde data. **Impact:** Establish whether the distribution of energy in the atmosphere requires explicit inclusion of microscopic fluctuations.*

JULY 2007-JUNE 2008 MILESTONES:



- *Explore methods of incorporating molecular-scale non-equilibrium statistical thermodynamics into the meteorological formulations of the Navier-Stokes equation for air flow. **Impact:** Modify the formulation of numerical models of the atmosphere.*

PSD-03 Empirical and Process Studies

GOAL: Improve understanding of basic physical processes that contribute to climate variability across a broad spectrum of scales, with emphasis on (i) Moist atmospheric convection, (ii) Radiative transfer in cloudy areas, and (iii) Air-sea interaction.

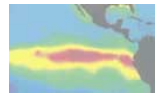
APPROACH: (i) CIRES will use observations and hierarchical modeling to better understand moist atmospheric convection and investigate its behavior in various environments. A key objective is to evaluate the assumptions at the heart of cumulus parameterization schemes used in current weather and climate models. (ii) Research into the climatic importance of clouds will be conducted to understand the impact of east Pacific stratocumulus decks on the seasonal cycle of sea surface temperature (SST), and to develop statistically-based prescriptions of subgrid scale cloud variability for improving the representation of radiative transfer in cloudy regions. (iii) CIRES scientists will study air-sea interactions in the tropical west Pacific during different phases of the MJO cycle in order to improve its representation in weather and climate models. The MJO influence on ENSO, particularly in its onset and decay phases, and on the extratropical circulation are other topics of interest.

JULY 2006-JUNE 2007 MILESTONES:

- *Continue improving the representation of physical processes and the Madden-Julian Oscillation (MJO) in the NCEP Global Forecasting System (GFS).*
- *Diagnose the physical mechanisms behind the tropical biases in current GCMs, such as double-ITCZ, ENSO, and MJO.*
- *Investigate improved methods of representing subgrid-scale variability in clouds and radiative transfer in weather and climate models, conceptually as a series of sub-columns within a GCM's large-scale column. Explore connections with more traditional single-column parameterizations as well as "super-parameterizations" being developed by other researchers.*
- *Assess stochastic influences on climate variability and predictability, through (a) linear and nonlinear inverse modeling, and (b) development and implementation of stochastic parameterizations in weather and climate models.*

JULY 2007-JUNE 2008 MILESTONES:

- *Continue improving the representation of physical processes and the Madden-Julian Oscillation (MJO) in the NASA GEOS5 climate model.*
- *Use three dimensional cloud resolving model simulations of deep convection to explore how convection parameterizations may be linked to information about subgrid-scale variability. Focus on understanding how convection begins ("triggers") in a range of environments, and on the relationships between large- and small-scale variability and the initiation of convection.*
- *Develop empirical models of rapidly varying sea surface winds that accurately represent the local and global behavior of observed stochastic wind variability (on sub-daily timescale). **Impact:** Such models are critical for improving the understanding parameterization of sea surface fluxes that are at the heart of coupled climate system dynamics.*
- *Continue assessing stochastic influences on climate variability and predictability, through (a) linear and nonlinear inverse modeling, and (b) development and implementation of stochastic parameterizations in weather and climate models.*



PSD-15 Surface Processes

GOAL: Develop and/or improve physical representations of atmosphere-surface interactions.

APPROACH: Combine state-of-the-art observations of surface fluxes, boundary-layer structure, and mesoscale features with high-resolution numerical modeling. Current work focuses on boundary layers over ice/snow surfaces and the effects of terrain on coastal precipitation. High quality observations of surface turbulent, radiative, and precipitation fluxes are combined with radar measurements and mesoscale model simulations. Parameterizations are being developed for stable surface-layer flux-profile relationships and linking terrain slopes and wind-vector profiles to spatial patterns of precipitation accumulations.

JULY 2006-JUNE 2007 MILESTONES:

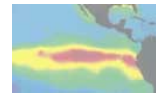
- *Examine role of artificial correlation in data analysis of turbulent Prandtl number.*
- *Complete study and submit paper on the role of shallow boundary layer processes on nitric oxide concentrations over the Antarctic Plateau.*
- *Install an "HMT Mesonet" to enhance surface observations in the American River Basin to try to trace the radar and free-air meteorology to what actually happens on the ground surface and gets into the streams. This will include more snow measurements and surface precipitation measurements and some soil and radiation measurements.*
- *Compare soil moisture measurements with river gage height and precipitation events in the Russian River Basin of Northern California. How does the correlation between precipitation and river flow change after the soil has reached field capacity?*

JULY 2007-JUNE 2008 MILESTONES:

- *Investigate problem of compatibility of boundary layer models and surface layer boundary condition.*
- *Further investigate the role of boundary layer and synoptic-scale weather processes on surface chemical exchange in the polar regions.*
- *Analysis of the polarimetric scanning radiometer measurements during the melt season in March 2003 to estimate feasibility of simultaneously observing soil moisture and snow water equivalent using remote sensors.*
- *Submit a paper on comparing the snow-level measured by radar profilers with the snow-level on the ground surface (looking at surface heating affects and antecedent snowcover).*
- *Install high accuracy solar irradiance measurement capability and surface sensible and latent heat flux observing system in the North Fork of the American River for use in snow melt studies.*

CSV-05: CLIMATE RESEARCH DATABASE DEVELOPMENT

NSIDC-01	Digitizing Analog Cryospheric Data under the Climate Database Modernization Program
NSIDC-02	Observations for SEARCH: Data Integration for Arctic Reanalysis and Change Detection
NSIDC-03	World Data Center for Glaciology, Boulder: Current Programs



NSIDC-01 Digitizing Analog Cryospheric Data under the Climate Database Modernization Program

GOAL: Scan and make available on line data from NSIDC's analogue collections so that it is more easily located, browsed, and obtained by users.

APPROACH: Working with the NOAA Climate Database Modernization Program (CDMP), have glacier photographs from NSIDC's collection inventoried, scanned, and made available through an on line search tool. In their analogue form, the photos are difficult to use and in danger of loss through deterioration. Many of these photographs exist only as mounted prints. Also through CDMP, we are scanning a collection of sea ice charts from Alaska, covering the years 1953-1986. This collection was compiled by William H. Dehn and his organization Sea Ice Consultants, Inc., and donated to NSIDC by his estate after his death for use by the climate and global change research community. We are working in partnership with Lason, a NOAA contractor, to accomplish the scanning.

JULY 2006-JUNE 2007 MILESTONES:

- *Complete metadata entry for the several thousand scanned images now at NSIDC, and post the images on-line.*

JULY 2007-JUNE 2008 MILESTONES:

- *Begin working with the CDMP contractor on scanning material related to the IPY, if NSIDC's IPY data rescue project receives funding.*

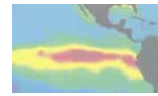
NSIDC-02 Observations for SEARCH: Data Integration for Arctic Reanalysis and Change Detection

GOAL: "Unaami," the changes in the Arctic that are the subject of the Study of Environmental Arctic Change (SEARCH) program, became apparent to researchers in the context of long-term and pan-Arctic observations. This work aims to assess what data are relevant to SEARCH reanalysis and change detection activities, collect these data from a wide variety of sources, and facilitate the SEARCH research community's access to the data. Another key element of the effort is to assess the Arctic performance of existing atmospheric reanalyses, with the aim of identifying shortcomings that will need to be addressed in developing a dedicated Arctic System Reanalysis (ASR). Note that this work is funded through Task III, rather than Task II.

APPROACH: The data component of this work has several components: (1) identifying target data sets, (2) acquiring or facilitating the acquisition of targeted data. Scientists will rely on extensive contacts in the cryospheric research community, and select data sets in consultation with scientists doing SEARCH and Arctic Reanalysis research at PMEL and NSIDC. Assessments of existing atmospheric reanalyses are focusing on aspects of the Arctic hydrologic cycle, including precipitation, net precipitation and evaporation, as well as key fields such as surface temperature. Evaluations are with respect to available observations as well as new data sets being acquired as part of the overall effort. In addition, extensive intercomparisons are being made between different land surface models, with the eventual aim of developing the best land surface package for use in the ASR.

JULY 2006-JUNE 2007 MILESTONES:

- *Due to funding cuts, data development efforts under this project will be in maintenance mode in July 2006-July 2007, and our milestone will be to report on the Indicator work in appropriate venues, and to provide data management support to the NOAA SEARCH program as resources allow. We hope that funding will resume in FY2008.*
- *To finalize ongoing assessments of the Arctic performance of the ERA-40 reanalysis. As assessments of precipitation and surface temperature are nearly complete, efforts will thus focus*



on other important aspects of the Arctic climate system, including its large-scale heat budget. In addition, we will examine output from the new JRA-25 reanalysis (from the Japan Meteorological Agency).

- To complete inter-comparisons between the Arctic performance of different land surface packages, and identify shortcomings that will need to be addressed for the ASR.

JULY 2007-JUNE 2008 MILESTONES:

- Pending the availability of funding, finalize studies of the JRA-25 reanalysis, focusing on elements of the hydrologic cycle.
- Pending the availability of funding, continue the collection of key data sets for change detection. With regard to applications for the Arctic System Reanalysis, efforts to obtain previously undigitized atmospheric sounding data may represent a viable focus area.
- Adopt appropriate modifications to the land surface package to be used in the Arctic System Reanalysis. This effort is contingent on sufficient funding levels to perform the reanalysis itself. Leveraging from work supported under the present NOAA funding, a proposal to conduct a three-year reanalysis for the period of the International Polar Year (IPY) was submitted to the National Science Foundation in spring 2006. If this activity is funded, additional support would be sought from NOAA and NASA.

NSIDC-03 World Data Center for Glaciology, Boulder: Current Programs

GOAL: Improve our understanding of recent and unexpected changes in polar regions including lower sea-level atmospheric pressure, increased air temperature over most of the Arctic, lower temperatures over eastern North America and Greenland, reduced sea ice cover, thawing permafrost and changes in precipitation patterns.

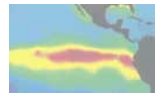
APPROACH: Investigate hypotheses that relate changes to the Arctic Oscillation, to feedbacks among ocean, land, ice and atmosphere, and to global climate change. Central to these investigations are long-term and pan-Arctic observations. The preparation of the requisite observational data sets involves quantifying time variability of the measured parameter, assessing consistency in observational method, flagging erroneous data, and examining issues of spatial and temporal coverage.

JULY 2006-JUNE 2007 MILESTONES:

- Maintain and update existing research data sets (e.g. the Online Glacier Photo Collection). Publish new data sets such as the NIC Ice Chart collection. Improve access to existing data sets, provide data via new access methods (e.g. Geospatial One Stop) and formats (e.g. more data sets in GeoTIFF and GIS formats).
- Make research information available through the NSIDC Information Center, acquire and catalog cryospheric materials in the NSIDC library, and maintain NSIDC's analog data sets.
- As resources allow, play a lead role in data management for the SEARCH program (NOAA and NSF) and for NOAA's IPY activities, and accelerate production of climate data records from NPP and NPOES missions, with a focus on sea ice.

JULY 2007-JUNE 2008 MILESTONES:

- Maintain and update existing research data sets (e.g. the Sea Ice Index). Publish new data sets such as the Japan Meteorological Agency ice chart series.
- Make research information available through the NSIDC Information Center, acquire and catalog cryospheric materials in the NSIDC library, and maintain NSIDC's analog data sets.



CSV-06: REGIONAL CLIMATE SYSTEMS

PSD-10	Cloud and Aerosol Processes
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PSD-10 Cloud and Aerosol Processes

GOAL: Make observations of clouds, aerosols, and water vapor over a variety of ice, land, and sea surfaces using a multi-sensor, multi-platform approach to improve retrieval techniques useful for satellite validation studies.

APPROACH: Employ research radars (cloud, clear-air, and precipitation), lidars and radiometers on land, ships and aircraft. Deployment periods can last for weeks or years, and marine observations may re-visit critical regions during a particular season over many years in order to build up the climatological record.

JULY 2006-JUNE 2007 MILESTONES:

- Participate in VOCALS research cruises in October 2006; deploy cloud radar, radiometer, and flux systems to measure key surface marine boundary layer parameters, low cloud macrophysical, microphysical, and radiative properties.
- Complete deployment of ground-based cloud, aerosol, radiative, and surface meteorological instruments in Canada for SEARCH Arctic observations with an emphasis on regions with strong connections to the Arctic oscillation.
- Participate in AMMA research cruises in June-July 2006; deploy cloud radar, radiometer, and flux systems to measure key surface marine boundary layer parameters, low cloud macrophysical, microphysical, and radiative properties.

JULY 2007-JUNE 2008 MILESTONES:

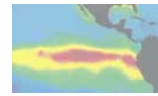
- Participate in VOCALS research cruises in October 2007; deploy cloud radar, radiometer, and flux systems to measure key surface marine boundary layer parameters, low cloud macrophysical, microphysical, and radiative properties.
- Preliminary evaluation of data from ground-based cloud, aerosol, radiative, and surface meteorological instruments in Canada for SEARCH Arctic observations with an emphasis on regions with strong connections to the Arctic oscillation.
- Participate in planning for VOCALS intensive field program.
- Participate in AMMA research cruises in June-July 2007; deploy cloud radar, radiometer, and flux systems to measure key surface marine boundary layer parameters, low cloud macrophysical, microphysical, and radiative properties.

CSV-07: CLIMATE SERVICES

PSD-05	Experimental Regional Climate Services
PSD-07	Experimental Climate Data and Web Services

PSD-05 Experimental Regional Climate Services

GOAL: Couple enhanced observations and research in regions of strong climate variability and societal impact with analysis of past data and improved modeling. Determine factors influencing the occurrence of extreme events. Improve the diagnosis, modeling, and prediction of the regional consequences of



climate change and variability on timescales of days to decades on hydrological variables of relevance to society.

APPROACH: The impact of climate variability is regionally specific and is often strongly influenced by local topography, watersheds, and other geographical features. CIRES is seeking to better understand the impacts of ENSO, and of anomalous SSTs in general, on climate variability over the U.S., especially hydroclimatic variability associated with droughts and floods. Our current emphasis is on 1) evaluating the ability of the current suite of ENSO forecast models to correctly "predict" the evolution of past El Niño events in terms of their timing, duration, intensity, and spatial extent, and 2) examining how past droughts in the southwestern U.S. have persisted, been interrupted, or terminated through the evolution of an El Niño, employing both analyses of the instrumental record and ensemble climate model simulations for this purpose. This is being done in conjunction with CIRES' Western Water Assessment and the Climate Assessment Project for the Southwest (CLIMAS), concerned with assessing the impacts of climate variability and longer-term climate change on human and natural systems.

JULY 2006-JUNE 2007 MILESTONES:

- *Monitor daily, seasonal, and longer-term precipitation variability over the western U.S. Complete alternate classification of U.S. climate divisions based on coherent regional precipitation variability. Downscale NCEP Week Two ensemble forecasts for Colorado water resource managers.*
- *Continue developing seasonal forecast guidance tools for the U.S. based on the predictability of tropical SSTs several seasons in advance, training these tools on the atmospheric responses to different types of anomalous tropical SSTs in large new sets of seasonal integrations made with the NCAR, GFDL, and NCEP GCMs.*
- *Conduct studies of recent climate change in the hydroclimatology of the western U.S., partly resulting from changes in tropical teleconnections, with emphasis on changes in streamflow and watershed health.*
- *Continue programmatic development and impact assessments of climate, weather, and water services, especially in conjunction with the newly established National Integrated Drought Information Service (NIDIS).*

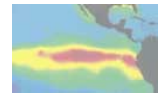
JULY 2007-JUNE 2008 MILESTONES:

- *Survey Colorado temperature and precipitation trends over the last century in collaboration with the State Climatologist' Office at CSU, and assess the importance of multidecadal variability (AMO, PDO) for our region.*
- *Continue monitoring daily, seasonal, and longer-term precipitation variability over the western U.S. Continue downscaling NCEP Week Two ensemble forecasts for Colorado water resource managers. Continue developing seasonal forecast guidance tools for the U.S. based on the predictability of tropical SSTs several seasons in advance.*
- *Continue programmatic development and impact assessments of climate, weather, and water services, especially in conjunction with the newly established National Integrated Drought Information Service (NIDIS).*

PSD-07 Experimental Climate Data and Web Services

GOAL: Improve public access to climate information and forecast products to facilitate research, to inform public planning and policy decisions, and to assist any interested parties impacted by climate.

APPROACH: Climate services require sustained and systematic communication of climate information to a broad spectrum of users, and interactions with users to determine their priorities and needs. Research at



CIRES and elsewhere indicates that there remain substantial barriers to the effective use of climate information (e.g., better and more timely access to data, improved visualization, addressing user-specific needs, and organizational obstacles to using climate information in decisions). CIRES is developing several approaches to overcome such barriers, such as 1) enhanced weather and climate monitoring products and experimental climate forecasts; 2) enhanced on-line access, analysis, and visualization tools for climate data; 3) studies of specific user groups and societal interactions; 4) Western Water Assessment activities (covered elsewhere in this plan); and 5) studies of the links between climate and public health. All of these are long-term ongoing efforts, with adjustments made every year in response to new opportunities and needs.

JULY 2006-JUNE 2007 MILESTONES:

- *Continue updating the extensive publicly accessible climate data holdings on the PSD website. Develop and install on local platforms netCDF versions of the ECMWF ERA-40 and other reanalysis datasets of the global and North American atmospheric circulation. Acquire new precipitation and soil moisture datasets.*
- *Finish ingesting a new dataset, NCEP's North American Regional Reanalysis (NARR), that is much higher in resolution (vertically as well as horizontally) than any of PSD's previous data sets, in a CF-compliant NetCDF format.*
- *Continue developing and maintaining the CIRES/NOAA website dedicated to real-time predictions of tropical convection variations associated with the MJO and their remote impacts. Display various experimental and operational ensemble predictions in a uniform format to enable intercomparisons and skill evaluation.*

JULY 2007-JUNE 2008 MILESTONES:

- *Continue updating the extensive publicly accessible climate data holdings on the PSD website. Continue acquisition of new precipitation and soil moisture datasets.*
- *Continue developing and maintaining the CIRES/NOAA website dedicated to real-time predictions of tropical convection variations associated with the MJO and their remote impacts. Display various experimental and operational ensemble predictions in a uniform format to enable intercomparisons and skill evaluation*
- *Continue with acquisition and major updating of our special South and North American historical daily precipitation datasets.*
- *Continue with acquisition and major updating of our special South and North American historical daily precipitation datasets.*



Scientific Theme: **GEODYNAMICS**

GEO-01 Geophysical Data Systems

GEO-01: GEOPHYSICAL DATA SYSTEMS

NGDC-05	Improved Integration and Modeling of Geophysical Data
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NGDC-05 Improved Integration and Modeling of Geophysical Data

GOAL: Improve integration and modeling of geophysical data, further research into core-mantle processes, improve representation of magnetic fields at or near the Earth's surface, improve models of tsunami-threatened coastal regions, and improve understanding of past hazardous events and potential future impacts.

APPROACH: Apply new techniques and methods to improve acquisition, analysis, and integration of geophysical data collected from ship, plane, satellite, and surface platforms, creating a long-term research-quality global database. These databases will be used for modeling the geomagnetic field, for modeling tsunami propagation and run up, and for identifying other of hazard risks.

JULY 2006-JUNE 2007 MILESTONES:

- *Produce a global spherical-harmonic degree-720 model of the Earth's crustal magnetic from a joint inversion of all available marine magnetic, aeromagnetic, and CHAMP satellite magnetic measurements.*
- *Produce a climatological model of the equatorial electrojet by analyzing CHAMP, Oersted, and SAC-C satellite magnetic data.*
- *Produce the 2006/2007 CIRES/NGDC scientific geomagnetic field model, accounting for recent changes of the Earth's magnetic field.*
- *Produce bathymetric-topographic digital elevation models sufficient for tsunami propagation, run up and inundation prediction for 19 priority regions, defined by the U.S. tsunami community. **Impact:** Accurate and effective prediction of tsunami threat requires accurate, high-resolution topographic boundary conditions for modeling. These models will provide the necessary foundation for effective forecasting of tsunami effects for the selected regions.*
- *Provide community with web access to bathymetric-topographic grids developed for tsunami prediction as standard products, with documentation of procedures, analysis, quality control and quality assessment of data. **Impact:** The research community can benefit by access to products generated for purposes other than the original motivation. These high-resolution, accurate relief models will impact a host of coastal management and research arenas.*
- *Produce a U.S. Tsunami Hazard Assessment which will describe tsunami sources and estimate tsunami frequency based on historical and geological tsunami data.*



JULY 2007-JUNE 2008 MILESTONES:

- *Produce the 2007/2008 CIRES/NGDC scientific geomagnetic field model, accounting for recent changes of the Earth's magnetic field.*
- *Establish links between satellite magnetic signatures of electrical currents in the low-latitude ionosphere and equatorial ionospheric instabilities impacting radio-wave communication and navigation.*
- *Produce bathymetric-topographic digital elevation models sufficient for tsunami propagation, run up and inundation prediction for 14 priority regions, defined by the U.S. tsunami community. Impact: Accurate and effective prediction of tsunami threat requires accurate, high-resolution topographic boundary conditions for modeling. These models will provide the necessary foundation for effective forecasting of tsunami effects for the selected regions.*
- *Produce a pilot study of the social and economic impacts of tsunamis on Seaside, Oregon.*



Scientific Theme: **INTEGRATING ACTIVITIES**

IA-01	Science and Society
IA-02	Western Water Assessment
IA-03	Resource Development for Educators and Decision Makers

IA-01: SCIENCE AND SOCIETY

CSD-10	Scientific Assessments for Decision Makers
Policy-01	Science Policy Lecture Series

CSD-10 Scientific Assessments for Decision Makers

GOAL: Plan, lead, prepare, and disseminate assessments for the decision making communities associated with ozone-layer depletion, greenhouse warming, and regional air quality.

APPROACH: Current foci are on i) the UNEP/WMO Ozone Science Panel of the Montreal Protocol, ii) the Intergovernmental Panel on Climate Change (IPCC), iii) the synthesis and assessment products of the U.S. Climate Change Science Program, and iv) the surface-level ozone and fine particles assessments of the North American Research Strategy for Tropospheric Ozone (NARSTO). These assessments form a link to CIRES, Chemical Science Division, other NOAA, national, and international research groups and results. CIRES researchers serve as Lead Authors, Coauthors, Contributors, reviewers, and Coordinating Editor of the assessments. The assessments interact with governments, industry, and the public to describe scientific findings in "user-friendly" terms.

JULY 2006-JUNE 2007 MILESTONES:

- *Serve as authors, reviewers, and coordinating editor to accomplish the final preparation and printing of the World Meteorological Organization/United Nations Environment Programme 2006 scientific state-of-understanding assessment of the ozone layer for the U.N. Montreal Protocol. **Impact:** This CIRES research contributes to the international scientific community's periodic updates of scientific understanding, which support the decision making of the over 180 nations that are Parties to the United Nations Montreal Protocol on Substances that Deplete the Ozone Layer.*

JULY 2007-JUNE 2008 MILESTONES:

- *Contribute to the coordination and preparation of the synthesis and assessment product of the U.S. Climate Change Science Program (product 2.4, on chemistry related to the stratospheric ozone layer). **Impact:** This research contributes to information needed by U.S. decision makers on topics related to climate.*

Policy-01 Science Policy Lecture Series

GOAL: Provide useful information that will help improve the relationship between societal needs and science and technology policies.

APPROACH: Develop a regular lecture series focused each year on a different topic of interest to the science and technology policy (and larger) community. The first year may involve a series of lectures by



former science advisors to the US president organized along the lines of the Center of the American West's Secretaries of Interior series.

JULY 2006-JUNE 2007 MILESTONES:

- *We recently completed the highly acclaimed Presidential Science Advisor lecture series. Milestones for the July 2006-June 2007 period include editing a book that will include chapters based on each science advisor's talk in the series supplemented by chapters written by other science policy experts. We also will continue the planning process for our second science policy lecture series, which likely will focus on a series of debates on science policy and energy-related topics.*

JULY 2007-JUNE 2008 MILESTONES:

- *Implement the second science policy lecture series, most likely a series of debates over relevant science policy and energy-related topics.*

IA-02: WESTERN WATER ASSESSMENT

WWA-01	Scientific Assessments
WWA-02	Climate Products
WWA-03	Climate and Water Affairs
WWA-04	Management

WWA-01 Scientific Assessments

GOAL: Identify and characterize regional vulnerabilities to climate variability and change for use by Intermountain water-resource decision makers.

APPROACH: Using models, analyses, surveys, written reports, and presentations, acquire and disseminate information about the relationship between Rocky Mountain climate and water resources.

JULY 2006-JUNE 2007 MILESTONES:

- *Front Range water needs to 2040. Colorado's Front Range is one of the most rapidly growing areas in the West. This on-going model-based study ("SPRAT – South Platt Regional Assessment Tool") will investigate the region's ability to meet new water needs through proposed projects, conservation, and groundwater. How a varying climate might affect these future needs and projects will also be studied.*
- *Front Range large water providers' vulnerabilities and climate products needs. This on-going task will inform future assessment and climate products of the Western Water Assessment through studying six large water providers in the Front Range of Colorado.*
- *Current and Future Water Demand at a Major Front Range City. This task will investigate the many forces that impact water demand at a major Denver suburb, Aurora, with infrastructure requirements over the next ten years in excess of \$1B. A literature review on water demand will be created. How the recent drought, climate variables, demographics, pricing, irrigation technology, in-home water meters and other variables affect demand will also be studied.*
- *Colorado Meteorological Station Data long-term trends. In conjunction with the Colorado State Climatologist's office, evaluate all suitable stations in Colorado for long term precipitation and temperature trends.*
- *IPCC AR4 Model Suitability for Colorado. Investigate value of recent AR4 model run data for use by Denver Water and others.*



- *Streamflow Variability.* In parallel with ongoing NSF effort, we will investigate apparent tendencies for Western rivers to show increasing variability and synchronicity.
- *Colorado River Flow Yield Study.* Synthesize lessons from paleo streamflow reconstructions, future streamflow projections from models and other sources, and native streamflow reconstructions.
- *Colorado River Drought Analysis.* Build upon the 1995 Severe and Sustained Drought Study by updating analysis including lessons learned from the 1999 – 2004 drought.
- *Colorado River Climate Change Analysis.* Utilize USBR CRSS Model to investigate vulnerability of basin to changes in inflows based on IPCC AR4 model runs.
- *Estimating the impacts of complex climatic events: The economic costs of drought in Colorado, Nebraska and New Mexico.* In addition to developing impact assessment methodologies, this study will develop guidelines for impacts reporting at the state and local levels. This effort supplements a SARP funded proposal and will be a joint effort with the National Drought Mitigation Center.

JULY 2007-JUNE 2008 MILESTONES:

- *Front Range water needs to 2040.* Colorado's Front Range is one of the most rapidly growing areas in the West. This on-going model-based study ("SPRAT – South Platt Regional Assessment Tool") will investigate the region's ability to meet new water needs through proposed projects, conservation, and groundwater. This portion of the project will involve helping transfer the model to a larger regional water provider.
- *Colorado River Climate Change Analysis.* Utilize USBR CRSS Model to investigate vulnerability of basin to changes in inflows based on IPCC AR4 model runs.
- *Dust on Snow Studies.* Investigate impacts of dust storms on Southwest Colorado snowpack.

WWA-02 Climate Products

GOAL: Develop information, products and processes to assist water resource decision makers throughout the Intermountain West.

APPROACH: Provide decision makers with datasets, documents, websites and other products to enable more informed decision making.

JULY 2006-JUNE 2007 MILESTONES:

- *Nonparametric streamflow reconstructions.* This task will investigate an entirely new way of reconstructing streamflows using a statistical technique not previously used by dendrochronologists. Jointly funded by US Bureau of Reclamation, Boulder City, NV Office.
- *Streamflow Reconstructions for Water Managers in Gunnison Basin for EIS.* Using a novel combination of historic gage data, and tree-ring data, create new streamflow reconstructions.
- *Monthly Intermountain Climate Summary.* Climate information is widely scattered on the web and other locations. Water managers and other climate sensitive sectors have requested a single monthly summary of climate information including precipitation, temperature, snow water equivalent, long-lead temperature and precipitation outlooks, reservoir levels and streamflow forecasts.
- *Web-based seasonal guidance for Water Managers, Climate Prediction Center.* Improve ability of federal, state, and local water managers to plan water operations during drought. Provide input to CPC seasonal outlooks.



- *National Integrated Drought Information System. As necessary, WWA will provide support activities for NIDIS implementation efforts.*
- *Grand Canyon Adaptive Management. Develop forecasts of late-summer storms and associated sediment input into the Grand Canyon to support multi-stakeholder adaptive management experiments aimed at sustaining ecological, cultural and recreational activities. This work is in collaboration with the Grand Canyon Monitoring and Research Center.*
- *Dendrohydrological Website. Expand and redesign existing website on tree-ring streamflow reconstructions for Colorado, to encompass reconstructions across the western U.S. Allow water managers to utilize streamflow sequences vastly in excess of the historical gage record to better plan for climate variability and change. Jointly funded by the NCDC Paleoclimatology Branch.*
- *Lee Ferry Reconstructions website. This site will provide information on the new Woodhouse, Gray, Meko tree-ring reconstruction of Colorado River streamflow, and a comparison with other reconstructions of the same gage.*
- *Colorado River Climate, Management, Law and Policy website. Enhance and update existing site on matters of interest to Colorado River water managers. Add discussion of useful existing climate products and new climate product needs by water managers.*
- *Colorado River Climate Primer. Summarize climate of the basin in one document.*

JULY 2007-JUNE 2008 MILESTONES:

- *Monthly Intermountain Climate Summary. Climate information is widely scattered on the web and other locations. Water managers and other climate sensitive sectors have requested a single monthly summary of climate information including precipitation, temperature, snow water equivalent, long-lead temperature and precipitation outlooks, reservoir levels and streamflow forecasts*
- *Web-based seasonal guidance for Water Managers, Climate Prediction Center. Improve ability of federal, state, and local water managers to plan water operations during drought. Provide input to CPC seasonal outlooks.*
- *National Integrated Drought Information System. As necessary, WWA will provide support activities for NIDIS implementation efforts.*
- *Lee Ferry Reconstructions website. Enhance existing site on Colorado River streamflow.*
- *Colorado River Climate, Management, Law and Policy website. Enhance and update existing site on matters of interest to Colorado River water managers. Add discussion of useful existing climate products and new climate product needs by water managers.*

WWA-03 Climate and Water Affairs

GOAL: Increase decision makers' level of knowledge about climate science so they can become better consumers and demanders of climate products and assessments, and help WWA set its research agenda.

APPROACH: Using workshops, personal interactions, web sites and written documents, communicate climate and hydrology information to key water-resource decision makers.

JULY 2006-JUNE 2007 MILESTONES:

- *Dendrohydrological Workshops. Increasing interest by water managers in tree-ring reconstructions of streamflow has led to demand for a hands-on workshop on how the reconstructions are generated and assessed. Goal is to provide managers with the tools to better interpret and apply the reconstructions to planning.*



- *Dendrohydrological Capacity Building.* Researchers in Wyoming have expressed interest in learning technical details about streamflow reconstructions. This workshop will provide these researchers with capacity to begin streamflow reconstructions
- *Climate Change for Water Resource Managers Workshop.* In conjunction with local consulting firm which is working on a NOAA CPO grant to study climate change with a local water provider (Stratus), sponsor a workshop on climate change for water managers. Invitees will include Colorado and Wyoming managers.
- *Forecast Verification Workshop.* In order to gauge forecast quality, users must know the accuracy and skill of seasonal forecasts. This workshop will introduce water managers to the basics of forecast verification statistics. Invitees will include Colorado and Wyoming managers.
- *Climate and Tourism Workshop.* Tourism and recreation in the West are a large part of the economy and are strongly linked to climate. This workshop will result in an applied research and services agenda.
- *Water Availability Task Force.* Provide technical support for Governor's drought task force as needed.
- *Law School Climate Change Workshop.* Co-sponsor a large event at the CU Law School on climate change for attorneys and other decision makers.
- *Speakers for Interested Organizations and Public Events.* From time to time, WWA is invited to speak on the interaction of climate and water at public events or to various organizations.

JULY 2007-JUNE 2008 MILESTONES:

- *Climate Change for Water Resource Managers Working Group.* Convene group of Front Range water managers to discuss and implement helpful research and synthesis products for water managers.
- *Southwest Colorado Workshop.* Convene group of stakeholders in Southwest Colorado to discuss regional needs with respect to research on climate variability and change. Jointly hosted with CLIMAS and Center for Snow and Avalanche Studies.
- *Water Availability Task Force.* Provide technical support for Governor's drought task force as needed.
- *Speakers for Interested Organizations and Public Events.* From time to time, WWA is invited to speak on the interaction of climate and water at public events or to various organizations.

WWA-04 Management

GOAL: Provide overall guidance to project as well as day-to-day management.

APPROACH: Using regular meetings, web sites and written documents.

JULY 2006-JUNE 2007 MILESTONES:

- *General Management Activities.* Hold biweekly team meetings. Prepare Annual budget. Interact with RISA Program managers. Interact with CIRES and NOAA administrative staff. Establish strategic activities.
- *Western Water Assessment Website.* Provide a portal into all Western Water activities for researchers, water providers and the public.



- *Inform NOAA about Climate Services Needs. An important part of the WWA mission is to keep NOAA NWS and OAR informed of new and evolving user needs, existing product limitations, and general lessons from the water management community.*

JULY 2007-JUNE 2008 MILESTONES:

- *General Management Activities. Hold biweekly team meetings. Prepare Annual budget. Interact with RISA Program managers. Interact with CIRES and NOAA administrative staff. Establish strategic activities.*
- *Western Water Assessment Website. Provide a portal into all Western Water activities for researchers, water providers and the public.*
- *Inform NOAA about Climate Services Needs. An important part of the WWA mission is to keep NOAA NWS and OAR informed of new and evolving user needs, existing product limitations, and general lessons from the water management community.*

IA-03: RESOURCE DEVELOPMENT FOR EDUCATORS AND DECISION MAKERS

Policy-02	Outreach to Decision Makers through the Internet
Policy-03	Outreach to Decision Makers through Newsletters

Policy-02 Outreach to Decision Makers through the Internet

GOAL: Provide useful information that will help improve the relationship between societal needs and science and technology policies.

APPROACH: The Center maintains an extensive website to disseminate research results and other information of interest to science and technology policy decision makers.

JULY 2006-JUNE 2007 MILESTONES:

- *In the July 2006 - June 2007 period we intend to completely revamp our widely read science policy weblog, Prometheus, to make it more user-friendly, as well as continue to maintain and upgrade the Center's website as a whole. Impact: This activity will improve one of the means through which the Center provides useful information to decision makers and others in the science and technology policy community.*

JULY 2007-JUNE 2008 MILESTONES:

- *Continue to maintain and upgrade the Center's website in terms of appearance, quality, and quantity of content, reliability, and ease of maintenance. Impact: This activity will improve one of the means through which the Center provides useful information to decision makers and others in the science and technology policy community.*

Policy-03 Outreach to Decision Makers through Newsletters

GOAL: Provide useful information that will help improve the relationship between societal needs and science and technology policies.

APPROACH: The Center currently publishes a newsletter, Ogmios, three times a year. Each issue includes at least one opinion piece and news of interest to the science and technology policy community. Ogmios is available online and in pdf format. Subscriptions are free and subscribers receive email notification when a new Ogmios is available. The Center plans to resume publication of the Weatherzine newsletter, which temporarily suspended publication in 2002 when funding ran out. This newsletter, which addresses the societal aspects of weather, follows a format similar to Ogmios.



JULY 2006-JUNE 2007 MILESTONES:

- *Continue to improve content of newsletter to make it of greater interest to the science and technology policy community and decision makers. Increase number of subscribers and distribute newsletter more widely. We also recently added a bimonthly science policy briefing email that is sent to hundreds of science policy decision makers in Washington, D.C. and elsewhere highlighting our activities. We will continue to expand and upgrade this effort in the 2006-07 time period. Impact: These newsletters provide a mechanism through which the Center disseminates information to decision makers and others in the science and technology policy community. They also provide a forum for exchange of ideas on topics of interest to this community.*

JULY 2007-JUNE 2008 MILESTONES:

- *Continue to improve content of newsletter to make it of greater interest to the science and technology policy community and decision makers. Increase number of subscribers and distribute newsletter more widely. Continue to expand and upgrade our science policy briefing in the 2007-08 time period. Impact: These newsletters provide a mechanism through which the Center disseminates information to decision makers and others in the science and technology policy community. They also provide a forum for exchange of ideas on topics of interest to this community.*



Scientific Theme: **PLANETARY METABOLISM**

- PM-01 Biosphere-Atmosphere Interactions
 PM-02 Response of Natural Systems to Perturbations

PM-01: BIOSPHERE-ATMOSPHERE INTERACTIONS

CSD-07	Biosphere-Atmosphere Exchange
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CSD-07 Biosphere-Atmosphere Exchange

GOAL: Gain an improved understanding of the role that the exchange of gases between the surface and the atmosphere plays in shaping regional climate and air quality.

APPROACH: Perform measurements and modeling analyses to make frequent, ultra-sensitive measurements of gases that are emitted by vegetation (such as oxygenated organic compounds) or that are the result of biomass burning (whether natural or human-caused) that subsequently influence regional climate and air quality. Design studies to gain a better understanding of the compounds that are emitted, the sources and extent of those sources, and the impact on the atmospheric environment. Focus particularly on those compounds likely to play an important role in the chemistry related to air quality in the lowermost troposphere, as well as climate-related gases. In addition, study the processes that deliver atmospheric gases and fine particles from the atmosphere to the biosphere, with potentially harmful consequences for ecosystems.

JULY 2006-JUNE 2007 MILESTONES:

- *Determine the impact of the 2004 forest fires in Alaska and western Canada on the atmosphere over North America. **Impact:** Emissions from large forest fires in Alaska and western Canada were sampled during the ICARTT study (International Consortium for Research on Transport and Transformation) in 2004. Research is ongoing to determine the impacts of these emissions on the atmosphere. Notably using the measurement results of acetonitrile, a unique and well-conserved tracer for biomass burning emissions, we will quantitatively separate the forest fire and pollution sources of carbon monoxide, an important trace gas in the atmosphere. The results will be compared with state-of-the-art emissions estimates combined with transport models. This research will help to quantify the impact of large-scale forest fires on the global atmosphere and possibly the air quality in urban areas downwind from these fires.*

JULY 2007-JUNE 2008 MILESTONES:



- *Analyze field observations from the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) field mission in 2004 and the Texas Air Quality Study in 2006 related to the natural sources of volatile organic compounds, such as isoprene, that could influence air quality. **Impact:** Estimates of the emissions of biogenic volatile organic compounds (VOCs) based on the field data will provide an important comparison with the latest high-resolution emission estimates. The study will provide information needed to better understand how emissions from natural sources combined with anthropogenic emissions could influence air quality in the United States. Ultimately this research will provide air quality managers in the U.S. with information that helps them to develop scientifically sound approaches to air quality improvement.*

PM-02: RESPONSE OF NATURAL SYSTEMS TO PERTURBATIONS

NGDC-07	Anthropogenic Remote Sensing
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NGDC-07 Anthropogenic Remote Sensing

GOAL: Provide spatial and temporal depictions of human activities based on satellite detection and mapping of population centers, fires, gas flares, and heavily lit fishing boats.

APPROACH: The technique will use nocturnal observations of anthropogenic lighting associated with human settlements, biomass burning, gas flares and heavily lit fishing boats. Time series analysis through individual years makes it possible to separate these four types of lighting. The resulting products will be used in mapping urban growth and modeling the density of impervious surface areas, gross domestic product (GDP), poverty levels, national level gas flaring volumes and trends in fishing activity.

JULY 2006-JUNE 2007 MILESTONES:

- *Produce the first global ~1 kilometer map of the density of constructed impervious surface areas.*
- *Develop near-real time global nighttime lights mosaic processing and access system.*
- *Develop time series of national gas flaring volume estimates extending from 1992 through 2005.*
- *Develop the first global map of poverty rates derived from satellite data.*

JULY 2007-JUNE 2008 MILESTONES:

- *Completion of annual time series of lighting from human settlements, gas flares, biomass burning and heavily lit fishing boats extending from 1992 through 2005.*
- *Completion of an improved global map of poverty rates.*
- *Complete an analysis of global trends in gas flaring, urban growth, and heavily lit fishing boat activity from 1992 through 2005.*



Scientific Theme: REGIONAL PROCESSES

RP-01	Regional Hydrological Cycles in Weather and Climate
RP-02	Surface/Atmosphere Exchange
RP-03	Regional Air Quality
RP-04	Intercontinental Transport and Chemical Transformation
RP-05	Aerosol Chemistry and Climate Implications

RP-01: REGIONAL HYDROLOGICAL CYCLES IN WEATHER AND CLIMATE

PSD-11	Water Cycle
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PSD-11 Water Cycle

GOAL: Improve weather and climate predictions through an increased knowledge of regional and global water cycle processes.

APPROACH: Design innovative measurement systems for improved water cycle observations. Deploy ground-, ship-, and aircraft-based systems as part of focused field program designed to increase our understanding of regional water-cycle processes. Use available satellite data to better understand global water cycle processes. Use knowledge gained from observational studies to improve forecast model performance.

JULY 2006-JUNE 2007 MILESTONES:

- *Plan and execute the 2006 HMT (Hydrometeorology Testbed) field campaign in the northern California American River basin, located in the Sierra Nevada Mountains west of Lake Tahoe and east of Sacramento. This effort will involve deployment of several instrument systems utilized in earlier HMT's conducted in the Russian River basin of northern California but will yield critical new understanding of orographic influences on airflow and precipitation growth over the Sierra Nevada mountains, a barrier that is substantially wider and taller than the coastal mountains. CIRES investigators will be key participants and contributors to this activity.*
- *Develop and test an attenuation-based method to retrieve vertical profiles of rainfall rate from vertically pointing Ka-band radars.*

JULY 2007-JUNE 2008 MILESTONES:

- *Plan and execute the 2008 HMT-West (Hydrometeorology Testbed) field campaign in the northern California American River basin, located in the Sierra Nevada Mountains west of Lake Tahoe and east of Sacramento. The HMT-West 2008 effort will be conducted in coordination with the NSF-oriented Sierra Hydrometeorology and Atmospheric River Experiment (SHARE), where several NSF observing systems will be added to the HMT-West backbone of observations. CIRES investigators will be key participants and contributors to this activity.*
- *Validating the Ka-band attenuation method by comparing Ka-band retrievals with results from longer wavelength precipitation radars.*



RP-02: SURFACE/ATMOSPHERE EXCHANGE

PSD-12	Air-Sea Interaction
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PSD-12 Air-Sea Interaction

GOAL: Perform cutting-edge micrometeorological and climatological research over the open ocean aboard research vessels, sea-based towers, and buoys.

APPROACH: Design and deploy innovative measurement systems for open-ocean observations within the marine boundary layer, including cloud, precipitation, wind profiling, and clear-air radars, a variety of lidar systems, air-sea turbulence systems for measurement of the fluxes of gas, momentum, and heat, and sea-spray droplet spectral observations. Deployments may last a few weeks or many months, or may reoccur every year at a particular cruise location in order to develop a climatological record. Resulting data sets are processed and analyzed for interpretation of surface, boundary-layer, and cloud processes over the ocean and are used to make improvements to the physics in small-scale parameterizations which can be applied to larger-scale predictive models.

JULY 2006-JUNE 2007 MILESTONES:

- *Process Eastern Pacific Investigations of Climate (EPIC) and North American Monsoon Experiment (NAME) data sets, provide a detailed analysis of these air-sea interaction data products, and make the final data set publicly available. Deployment on new excursions within the EPIC STRATUS region is imminent, as is a cruise in the African Monsoon Multidisciplinary Analyses (AMMA) region.*
- *Parameterization of sea spray will continue as part of the NOAA hurricane studies.*
- *Further quantify the air-sea transfer of gases and use a detailed physical analysis of data obtained from the Post-GasEx surface processes experiments to evaluate and improve gas transfer parameterizations. Participate in the 2006 TexAQS Air Quality Study in the Houston and deploy ship-based system for ozone flux measurements.*
- *Develop a robust ship-based system for routine ship-based CO₂ flux measurements which will be integrated into the existing ESRL-PSD ship-based turbulent flux measurement system.*
- *Create a multi-year global oceanic data set of near-surface temperature and humidity using a multi-sensor satellite retrieval method recently developed in the ESRL Physical Science Division (PSD).*
- *Study and parameterization of stable boundary-layers as part of the NOAA/NSF Polar Programs.*

JULY 2007-JUNE 2008 MILESTONES:

- *Process Eastern Pacific Investigations of Climate (EPIC), the North American Monsoon Experiment (NAME), and the African Monsoon Multidisciplinary Analyses (AMMA) data sets, provide a detailed analysis of these air-sea interaction data products, and make the final data set publicly available.*
- *Parameterization of sea spray will continue as part of the NOAA hurricane studies.*
- *Further quantify the air-sea transfer of gases and use a detailed physical analysis of data obtained from the Post-GasEx and TexAQS surface processes experiments to evaluate and improve gas transfer parameterizations.*
- *Develop, deploy, and test a robust ship-based system for routine ship-based CO₂ flux measurements.*



- Create a multi-year global oceanic data set of near-surface temperature and humidity using a multi-sensor satellite retrieval method recently developed in the ESRL Physical Science Division.
- Study and parameterization of stable boundary-layers as part of the NOAA/NSF Polar Programs.

RP-03: REGIONAL AIR QUALITY

CSD-08	Regional Air Quality
GMD-06	Baseline Air Quality
PSD-13	Air Quality
GSD-02	Regional Air Quality Prediction

CSD-08 Regional Air Quality

GOALS: Carry out laboratory measurements, atmospheric observations, and diagnostic analyses that characterize the chemical and meteorological processes involved in the formation of pollutant ozone and fine particles. Undertake research that contributes to the enhancement of air quality prediction and forecasting capabilities.

APPROACHES: (i) Design, evaluate, and apply state-of-the-art measurement methods from airborne platforms and ground-based sites. Focus on natural and anthropogenic ozone and fine-particle precursors and diagnostic species. Initial attention will be on the Southeastern, Midwestern, and Northeastern U.S. Current special foci include the examination of the roles of natural sources, the effect of manmade emission sources such as power plants and refineries, coastal meteorological influences on ozone production over adjacent land areas, the regionality of ozone production, and the chemical makeup of fine particles. A hallmark of this research is the collaborative involvement of CIRES researchers affiliated with several NOAA laboratories, as well as partners in numerous other organizations and Agencies. (ii) Apply laboratory analytical methods to quantify the rates of reactions and their temperature and other dependencies, and the chemical products that are produced. The current emphasis is on using the newly-developed optical cavity approaches to study the photochemistry of highly reactive, short-lived chemical species that evoke much of the ozone formation, nighttime species, and particle-forming species such as ammonia. (iii) Design and evaluate the detailed chemistry and height resolution in air quality models using the detailed, simultaneous multi-species measurements carried out in (i). A current emphasis is on diagnostic modeling that can guide the planning of a forthcoming field study in the New England region. A further emphasis is on the advancement and evaluation of models used to forecast air quality.

JULY 2006-JUNE 2007 MILESTONES:

- Plan and execute the 2006 Texas Air Quality Study (TexAQS) field study. **Impact:** TexAQS data and analyses will be used to help the State of Texas develop a plan to bring several areas into compliance with the federally mandated National Ambient Air Quality Standards for ozone and particulate matter.
- Evaluate sulfur dioxide emissions from power plants sampled during the New England Air Quality Study campaign using new ultraviolet spectroscopy methods. **Impact:** Measurements of power plant emissions will enable improved estimates of the impact of electric power-generating facilities on regional air quality in the northeastern U.S.
- Gather data during the 2006 Texas Air Quality study to investigate the role of meteorological processes in transport and mixing of pollutant species in the nighttime stable boundary layer (SBL). **Impact:** This research will develop observational strategies to investigate mixing processes in the nighttime SBL, which control both nocturnal pollutant losses via dry deposition and nighttime acceleration of the winds aloft into low-level jets. Accelerated nighttime winds have an



important role in distributing pollutants from localized sources (urban, power-plant, etc.) into rural areas of Texas, establishing and potentially increasing background pollutant concentrations.

- *Contribute to the 2006 TexAQS/GoMACCS Air Quality Study in the Houston, TX vicinity by deploying several lidars on an aircraft and a research ship. **Impact:*** The deployment of lidar remote sensing instruments on various research platforms will result in a rich data set that will allow researchers to address several open science questions regarding local buildup of pollution in the Houston, TX area as well as regional transport of pollutants and its impact on air quality in east Texas. This CIRES research will improve understanding of how meteorological processes, such as the land-sea breeze, the nocturnal low-level jet, and the formation and downward mixing of pollution reservoirs aloft, act to regulate high-pollution events and distribute locally generated pollution over broader regions
- *Measure the absorption cross sections for formyl (HCO) radicals to high accuracy for use in future laboratory studies of aldehyde (RCHO) photochemistry. **Impact:*** This CIRES research will provide the foundation for novel, direct laboratory measurements of the odd hydrogen (HOx) yields from the solar photodissociation of aldehydes, which is critical to accurate modeling of these radicals but which is currently based largely on indirect methods.
- *Measurement of vertical profiles in NO₃, N₂O₅, and related compounds within and above the shallow, nocturnal boundary layer. **Impact:*** The day-to-night changes in nitrogen oxide chemistry in the lower atmosphere are intimately coupled with day-to-night shifts in surface mixing depths and atmospheric stratification. Measurements of vertical profiles of several different nitrogen oxides from both the NOAA P-3 aircraft and a tall tower in Erie, CO will characterize this coupling over an appropriate altitude range and with sufficient resolution.
- *Measure the rate coefficient for the reaction of hydroxyl radical with acetaldehyde, CH₃C(O)H, over the range of temperatures common to the troposphere and lower stratosphere to better elucidate the role of oxygenated hydrocarbons in radical (HOx) and ozone production. **Impact:*** This research will provide rate coefficient data for the accurate determination of the atmospheric loss of acetaldehyde by reaction with the OH radical. Knowledge of atmospheric lifetimes and chemical destruction pathways for acetaldehyde (an oxygenated hydrocarbon) is important for characterizing climate-chemistry coupling.

JULY 2007-JUNE 2008 MILESTONES:

- *Present and publish results from the 2006 Texas Air Quality Study (TexAQS) field study. **Impact:*** TexAQS data and analyses will be used to help the State of Texas develop a plan to bring several areas into compliance with the federally mandated National Ambient Air Quality Standards for ozone and particulate matter
- *Characterize the volatile organic compounds in three mega-cities: New York City, Beijing, and Mexico City. **Impact:*** Over the last two years we have made state-of-the-art measurements of volatile organic compounds (VOCs) in three of the world's largest mega-cities: New York City, Beijing, and Mexico City. Work will be done to assess the differences and similarities in the VOC composition of urban air from these three cities. The impact of mega-cities on regional and global scales is currently under intense investigation, and will become even more important in the future when a larger fraction of the world's population moves from rural to urban areas. There is currently very little understanding of the VOC emissions from such large urban complexes, in particular those in lesser-developed countries. This study will provide some first data, and will allow scientists to quantify the impact of mega-cities on the global atmosphere.
- *Analyze data obtained during the Texas Air Quality study to investigate the role of meteorological processes in transport and mixing of pollutant species in the nighttime stable*



*boundary layer (SBL) in the Houston area, and publish findings in scientific journals. **Impact:** This research will use observations obtained during the Texas study to investigate the role of mixing processes in the nighttime SBL on regional air quality. Nighttime processes control both nocturnal pollutant losses via dry deposition and nighttime acceleration of the winds aloft into low-level jets. Based on observations, the relative effect of nighttime winds in distributing pollutants from localized sources (urban, power-plant, etc.) to increase background levels and eventually degrade local air quality will be studied.*

- *Process and analyze lidar observations collected during the 2006 TexAQs/GoMACCS Air Quality Study, present results at international conferences, and publish findings in scientific journals. **Impact:** The lidar data set will be crucial to address several key science objectives of the 2006 TexAQs/GoMACCS Air Quality Study, in particular the role of transport and mixing processes and the spatial and temporal variation of boundary layer depth in the formation of local high-ozone events and the distribution of these pollutants over broader regions. The lidar observations of ozone and aerosol structure and high-resolution wind fields will also be used to compare against air quality forecasting model predictions. These comparisons will help elucidate how well boundary layer transport and mixing processes are represented in the models.*
- *Analyze results from the measurement of the nocturnal nitrogen oxides, NO_3 and N_2O_5 , during the 2006 Texas Air Quality Study. **Impact:** Nocturnal formation and loss of NO_3 and N_2O_5 has a large effect on ozone formation and loss in polluted environments such as Houston, TX. Analysis of results from this campaign will assess the specific impact of these nighttime processes (e.g., NO_x and O_3 loss, VOC oxidation) on air quality in this region.*
- *Make direct measurement of quantum yields for formyl radical, HCO , production in the photolysis of aldehydes, $RC(O)H$. **Impact:** This research will provide the data required for atmospheric model calculations of the wavelength, pressure, and temperature dependence for aldehyde photolysis channels that lead to odd hydrogen (HO_x) production in the atmosphere. This research has implications for regional air quality and climate-chemistry coupling.*

GMD-06 Baseline Air Quality

GOAL: Study intercontinental transport events to improve our understanding of their importance in affecting overall air quality and its impacts on public health.

APPROACH: Although much effort has been focused on obtaining long-term measurements of the remote atmosphere, it has been necessary to make observations at sites that are influenced regionally in order to understand the distribution and nature of the sources of climatically important gases. Large-scale pollution and dust from Asia, for example, is transported at mid-latitude across the Pacific Ocean in a matter of days and affects sites in the United States. Fires in Central America send smoke plumes across Mexico and the South-Central U.S., and dust from Africa regularly reaches the eastern U.S.

JULY 2006-JUNE 2007 MILESTONES:

- *Carry out daily ozone profile measurements at Trinidad Head, CA and Boulder, CO during the intensive Measurements of Ozone over North America (MONA) study in August 2006.*
- *As part of the Department of Energy Atmospheric Radiation Measurement Program we will deploy a mobile measurement facility to the Murg Valley in Heselbach Germany. The instrument package measures aerosol radiative, hygroscopic and cloud forming properties.*

JULY 2007-JUNE 2008 MILESTONES:



- *As part of the Global Atmospheric Watch Network of monitoring sites the NOAA/GMD Aerosol Group will build and deploy an instrument package to measure aerosol radiative properties to Taiwan.*
- *As part of the International Geophysical Year and also 50th anniversary of the NOAA Mauna Loa Observatory there will be a field campaign at Mauna Loa to calibrate the Dobson ozone instruments from around the world.*

PSD-13 Air Quality

GOAL: Gather and analyze atmospheric observations to characterize meteorological processes that contribute to high-pollution episodes. Compare these measurements with air-quality forecasting model predictions to assess and improve research model performance.

APPROACH: Develop and deploy state-of-the-art lidar and wind profiler remote-sensing and supporting instruments in various regions of the United States that have difficulty meeting the national air-quality standards. The remote-sensing observations will also be used to evaluate the performance of air-quality forecasting models in terms of the meteorological processes crucial for air quality.

JULY 2006-JUNE 2007 MILESTONES:

- *CIRES investigators will participate in the second Texas Air Quality Experiment (TexAQS-II) by leading the deployment of six integrated wind profiling observing systems and two flux towers. The field study will occur in August and September of 2006.*
- *CIRES investigators will help collect wind profiler, air/sea fluxes, ozone fluxes, and rawinsonde data onboard the NOAA Research Vessel Ronald H. Brown during the TexAQS-II field study.*
- *CIRES investigators will use datasets collected during TexAQS-II to develop specific results for the Rapid Science Synthesis Team. These findings will assist the state of Texas in development of their state implementation plans.*
- *Publish analysis of measurements of air-sea fluxes and gas transfer in the New England experiment on the Ron Brown in August 2004.*
- *Perform measurements of air-sea fluxes and gas transfer in the Houston Air Quality experiment on the Ron Brown in August 2006.*

JULY 2007-JUNE 2008 MILESTONES:

- *CIRES investigators will participate in the planning and execution of the NOAA Health of the Atmosphere Program field study tentatively planned for the winter of 2008.*
- *Further quantify the air-sea transfer of gases and use a detailed physical analysis of data obtained from the TexAQS surface processes experiments to evaluate and improve gas transfer parameterizations.*
- *Process data from measurements of air-sea fluxes and gas transfer in the New England experiment on the Ron Brown in August 2006.*

GSD-02 Regional Air Quality Prediction

GOAL: Design and evaluate new approaches for improving air-quality prediction.

APPROACH: Perform research to develop and evaluate new techniques for improved transport and chemical evolution in fully coupled atmospheric/chemistry models capable of real-time forecasts. Engage in real-time air quality forecasts for ozone and particulate matter (PM_{2.5} and PM₁₀). Evaluate forecasts using observations from special observing periods.



JULY 2006-JUNE 2007 MILESTONES:

- *In collaboration with national and international scientists implement generalized tools such as the Kinetic PreProcessor (KPP) into the next version of the fully coupled Weather Research and Forecasting Chemistry (WRF/Chem) model.*
- *Perform real-time weather/air quality forecasts with WRF/Chem during the Houston 2006 field experiment.*

JULY 2007-JUNE 2008 MILESTONES:

- *Use data from real-time weather and air-quality forecasts during the Houston 2006 field experiment for further evaluation and improvements of the coupled modeling system WRF/Chem.*
- *Prepare documentation and tutorials to support WRF/Chem as a community model.*



RP-04: INTERCONTINENTAL TRANSPORT AND CHEMICAL TRANSFORMATION

CSD-05

Tropospheric and Stratospheric Transport and Chemical Transformation

CSD-05 Tropospheric and Stratospheric Transport and Chemical Transformation

GOAL: Carry out modeling studies and airborne and surface measurements of chemical species in order to elucidate the processes involved in the intercontinental transport of photochemical pollution.

APPROACH: Design, evaluate, and apply state-of-the-art measurement methods from airborne platforms and ground-based sites. Use these data and correlations among species to establish natural and human influences on global "greenhouse" tropospheric ozone and related species, with an emphasis on analysis of the data collected over the North Atlantic and Eastern Pacific regions. The research has an initial focus on the long-lived pollutants, carbon monoxide, ozone, and fine particles.

JULY 2006-JUNE 2007 MILESTONES:

- *Use measurements from a fully instrumented NOAA P-3 aircraft to accurately and precisely characterize the chemistry of plumes of pollutants from urban areas as they are transported over the North Atlantic Ocean. Use recently developed fast-response instruments that measure both emitted trace gases (NO, CO, and others) and secondary products (HNO₃, O₃, and others) formed from chemical reactions that occurred in that atmosphere. **Impact:** Ozone-related pollutants can survive longer in the atmosphere when they are transported in layers above the ocean. Consequently, urban areas can affect air quality far from the source and even over remote regions of the globe. Nitric acid is not always a terminating step in ozone formation. Nitric acid abundance can be sufficiently elevated to make a substantial contribution to NO_x levels in remote regions. These elevated NO_x levels allow for continuing O₃ production. This could have important implications for long-range transport of pollution and radiatively important trace compounds.*

JULY 2007-JUNE 2008 MILESTONES:

- *Examine the influence of transport pathways on the ozone profile measurements across North America during the 2006 Texas Air Quality Study/Gulf of Mexico Atmospheric Composition and Climate Study experiment, as measured by ozone sondes, research aircraft, and commercial MOZAIC aircraft. **Impact:** This CIRES research will improve the understanding of the budget of ozone in the free troposphere over North America by examining the relative contributions from downward transport of ozone from the stratosphere to troposphere, and from photochemical production of ozone in the oxidation nitrogen oxides produced by lightning or transported upwards out of the planetary boundary layer.*



RP-05: AEROSOL CHEMISTRY AND CLIMATE IMPLICATIONS

CSD-09	Aerosol Formation, Chemical Composition, and Radiative Properties
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CSD-09 Aerosol Formation, Chemical Composition, and Radiative Properties

GOAL: Carry out airborne and ground-based experiments that characterize the chemical composition of radiatively important aerosols in the upper troposphere and at the Earth's surface.

APPROACH: Conduct experiments aboard airborne platforms to characterize the chemical composition of individual particles, which is a key to establishing their radiative role. Emphases include the chemistry of rocket plumes, the chemical makeup of Northern Hemisphere tropical aerosols, and particle-cloud interactions. Conduct laboratory experiments to elucidate formation mechanisms of atmospheric aerosols.

JULY 2006-JUNE 2007 MILESTONES:

- *Use field data from the NOAA R/V Ronald H. Brown in combination with laboratory experiments to assess the effect of the molecular speciation of organic aerosols in their effectiveness as cloud condensation nuclei. **Impact:** This CIRES research will help to clarify the effect of organic molecules, both natural and anthropogenic, on cloud formation.*
- *Plan for and participate in the Gulf of Mexico Atmospheric Composition and Climate Study in August/September 2006, specifically investigating the role of urban aerosol in cloud microphysics and cloud evolution in Houston. **Impact:** This research will attempt to assess the primary factors determining cloud droplet number concentration and size in a polluted urban environment exhibiting large variability in aerosol composition.*
- *Study the relative humidity dependence of aerosol light extinction for surrogate atmospheric aerosol using cavity ring-down aerosol extinction spectroscopy. **Impact:** This laboratory research helps determine improved parameterization for the relative humidity dependence of aerosol light extinction for atmospheric aerosol and accuracy of radiative forcing calculations.*
- *Measure particle nucleation and particle growth rates in laboratory experiments following the gas-phase oxidation of biogenic monoterpene compounds by O₃ and the OH radical. **Impact:** This research will provide information currently needed to quantitatively evaluate the role of biogenic compounds in new particle formation as well as secondary organic aerosol formation.*

JULY 2007-JUNE 2008 MILESTONES:

- *Add airborne data to those from the R/V Ronald H. Brown to examine the role of organic molecules in aerosols, particularly during cloud formation. Consider the implications for the role of the biosphere and human activity in climate. **Impact:** This CIRES research potentially has important implications for the role of aerosols in climate, via both the direct and indirect effects.*
- *Analyze data acquired during the Gulf of Mexico Atmospheric Composition and Climate, focusing on measurements and modeling of the radiative forcing of clouds in the Houston area. **Impact:** The radiative forcing of clouds, and the modification of this forcing due to aerosols, is one of the largest unknowns in climate change. The combination of measurements and models will enable us to evaluate the magnitude of this forcing.*
- *Analyze the aerosol optical property data from instruments (e.g. cavity ring-down aerosol extinction spectrometer and photo-acoustic absorption spectrometer) fielded in FY 2006, aboard the NOAA WP-3 aircraft and NOAA R/V Ronald H. Brown during TexAQS/GoMACCs 2006, to evaluate the role of atmospheric aerosol on climate and regional air quality. **Impact:** The data from this mission and its interpretation helps identify the key factors influencing the ability of anthropogenic aerosol to alter the Earth's radiative balance and visibility*

VI. CONCLUSION

The foregoing pages detailing CIRES projects grouped by CIRES research themes have sought to weave scientific objectives into a fabric of earth systems science. This effort was initiated to integrate scientific initiatives conducted by CIRES employees and represents a cultural change in the way the science is being planned and conducted with their NOAA colleagues. The actual distribution of work efforts and budget among the units are shown in the following tabulations that are organized first by CIRES scientific research theme, then CIRES project, and finally by NOAA laboratory.

VII. ACRONYMS

AMMA	African Monsoon Multidisciplinary Analyses
AMOS	Advanced Modeling and Observing Systems (CIRES scientific theme)
ASR	Arctic System Reanalysis
ATOC	Atmospheric and Oceanic Sciences Department (CU)
BP	Before Present
BSRN	Baseline Surface Radiation Network
CDMP	Climate Database Modernization Program
CFC	Chlorofluorocarbon
CH ₃ Br	Methyl Bromide
CH ₃ Cl	Methyl Chloride
CIMS	Chemical Ionization Mass Spectrometry
CLASS	Comprehensive Large Array Stewardship System
CLIMAS	Climate Assessment Project for the Southwest
CM	Core-Mantle
CME	Coronal Mass Ejection
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
CPO	Climate Program Office
CSD	Chemical Science Division (ESRL)
CSV	Climate System Variability (CIRES scientific theme)
CTIPe	Coupled Thermosphere-Ionosphere-Plasmasphere-electrodynamic
CU	University of Colorado
CUCF	Central UV Calibration Center
CVI	Counterflow Virtual Impactor
DOAS	Differential Optical Absorption Spectroscopy
DOC	Department of Commerce
DoD	Department of Defense
DSD	Drop Size Distribution
ECMWF	European Center for Medium-Range Weather Forecasting
ECUV	European reference Center for Ultraviolet radiation measurements
EEB	Ecology and Evolutionary Biology
eGY	Electronic Geophysical Year
EIT	Extreme Ultraviolet Imaging Telescope
ENSO	El Niño/Southern Oscillation
EPIC	Eastern Pacific Investigations of Climate
ERL	Environmental Research Laboratories (now ESRL)
ESRL	Earth System Research Laboratory
ESS	Earth Systems Science
EUV	Extreme Ultraviolet
FGDC	Federal Geographic Data Committee
FAA	Federal Aviation Administration
FRAMES	Fire Research and Management System
FTE	Full Time Equivalent
GAIM	Global Assimilation of Ionospheric Measurements
GasEx	Gas Exchange Experiment
GCM	Global Circulation Model
GDP	Gross Domestic Product
GEO	Geodynamics (CIRES scientific theme)

GFDL	Geophysical Fluid Dynamics Laboratory
GFS	Global Forecast System (NCEP model)
GIS	Geographic Information System
GMD	Global Monitoring Division (ESRL)
GOES	Geostationary Operational Environmental Satellite
GoMACCS	Gulf of Mexico Atmospheric Chemistry and Climate Study
GSD	Global Systems Division (ESRL)
GSI	Gridpoint Statistical Interpolation
H ₂	Hydrogen
HIRS	High-Resolution Radiation Sounder
HFC	Hydrofluorocarbons
HMT	Hydrometeorological Testbed
HNO ₃	Nitric Acid
IA	Integrating Activities (CIRES scientific theme)
ICARTT	International Consortium for Research on Transport and Transformation
IDEA	Integrated Dynamics through Earth's Atmosphere
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
ISO	International Standards Organization
ITCT	Intercontinental Transport and Chemical Transformation
ITCZ	Intertropical Convergence Zone
KPP	Kinetic PreProcessor
LPAS	Laser Photo-Acoustic Spectroscopy
MBDDDB	Multibeam Bathymetric Data Base
MCDB	Molecular Cellular and Developmental Biology
MHD	Magnetohydrodynamic
MJO	Madden-Julian Oscillation
MM5	Mesoscale Model 5
N ₂ O ₅	Dinitrogen Pentoxide
NAME	North American Monsoon Experiment
NARR	North American Regional Reanalysis
NARSTO	North American Research Strategy for Tropospheric Ozone
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NCS	National Critical Systems
NEAQS	New England Air Quality Study
NESDIS	National Environmental Satellite Data and Information Center
NetCDF	Network Common Data Form
NGDC	National Geophysical Data Center
NIDIS	National Integrated Drought Information Service
NIST	National Institute of Standards and Technology
NO ₂	Nitrogen Dioxide
NO ₃	Nitrate ion
NPOES NOAA	Polar orbiting Operational Environmental Satellite
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
NWP	Numerical Weather Prediction
NWS	National Weather Service
O ₃	Ozone

OAR	Oceanic and Atmospheric Research
ODP	Ozone Depletion Potentials
OMI/AURA	ESS spacecraft
PACS	Pan-American Climate Study
PBL	Planetary Boundary Layer
PDO	Pacific Decadal Oscillation
PM	Planetary Metabolism (CIRES scientific theme)
PSD	Physical Science Division (ESRL)
QPE	Quantitative Precipitation Estimates
R/V	Research Vessel
RISA	Regional Integrated Sciences and Assessments
RP	Regional Processes (CIRES scientific theme)
RTVS	Real-Time Verification System
RUC	Rapid Update Cycle
SBL	Stable Boundary Layer
SEARCH	Study of Environmental Arctic Change
SEC	Space Environment Center
SHARE	Sierra Hydrometeorology and Atmospheric River Experiment
SRRB	Solar Radiation Research Branch
SST	Sea Surface Temperature
SURFRAD	Surface Radiation
SWE	Snow Water Equivalent
TEC	Total Electron Count
TexAQS	Texas Air Quality Study
TWP-ICE	Tropical Western Pacific – International Cloud Experiment
UV	Ultraviolet
VOC	Volatile Organic Carbon
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting
WSR-88D	Weather Surveillance Radar 88 Doppler
WWA	Western Water Assessment

