

PLANS FOR CLOUD AND BOUNDARY-LAYER RESEARCH DURING THE ARCTIC SUMMER CLOUD-OCEAN STUDY

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NASA McDonnell-Douglas DC-8-72 research aircraft



Dual Component

I. Deployment of surface-based sensors near North Pole with R/V Oden, Aug 1- Sep 12, 2008 (ASCOS)

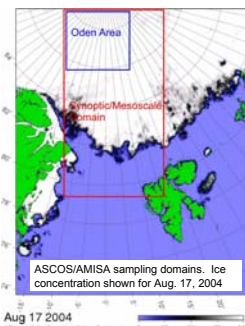
High-temporal resolution point measurements of

- Cloud properties and processes
- Boundary-layer structure, properties, and processes
- Surface energy budget
- Boundary-layer aerosol properties and sources

II. Six airborne missions using NASA DC-8 research aircraft based in Kiruna, Sweden (AMISA)

Spatial measurements focused on

- Synoptic/mesoscale structure of clouds, dynamics parameters, and surface features
- Testing and validation of satellite retrieval techniques
- In-situ sampling of cloud microphysics, aerosol species, and size distributions

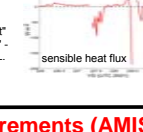
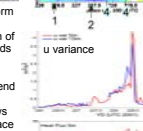
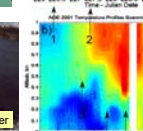
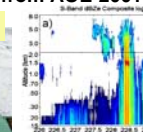
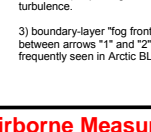
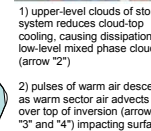
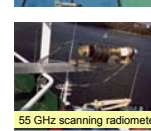


Boundary-Layer and Surface Measurements

Instrumentation

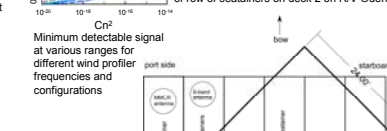
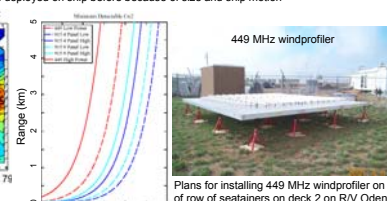
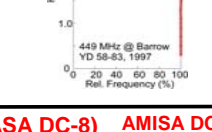
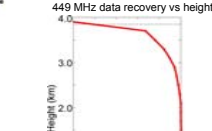
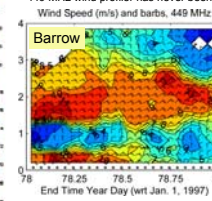
- 5-mm scanning radiometer - temperature profiles (0-1 km; 1 s - 10 min)
- 449 MHz wind profiler - hourly profiles of wind speed/direction, turbulence intensity (0.2 - 5 km, 100 m)
- 4X daily rawinsondes - profiles of basic state parameters
- on-ice flux towers (15m, 30m) - SL profiles of turbulent fluxes of momentum and sensible/latent heat
- broadband radiometers - 4 component radiative fluxes
- tethered balloon - basic state parameters, turbulence, aerosol sampling
- Scintex phased array sodar - backscatter, 3D mean winds, CT², z/L, turbulent dissipation, 10 m resolution, 10-min averaging

Example from AOE-2001



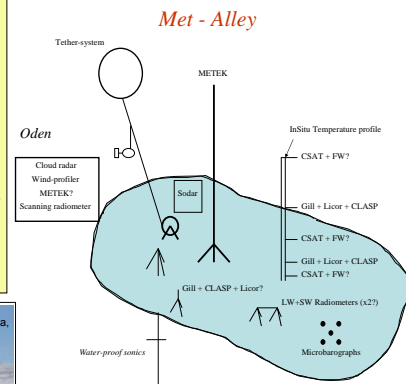
Unique use of 449 MHz wind profiler

- though developed for Arctic deployment (SHEBA), a 449 MHz wind profiler has never previously been deployed in the Arctic in a scientific field program
 - 449 MHz frequency gives large sensitivity advantages in dry Arctic environment
 - 449 MHz wind profiler has never been deployed on ship before because of size and ship motion



Science Objectives of Surface-based Measurements

- Determine atmospheric processes controlling boundary layer clouds north of 80°N.
- Temporally and spatially link cloud properties to the evolution and distribution of boundary-layer wind, thermodynamic structure, aerosols, and surface energy budget
- Compare pack-ice cloud macro- and microphysical properties to those similarly derived over the pack ice during SHEBA and at Arctic Ocean coastal sites (e.g., SEARCH)
- Determine evolution of boundary-layer cloud condensation (CCN) and ice forming nuclei (IFN)
- Determine role of boundary-layer turbulence and surface properties for the exchange of heat, water, momentum and aerosols between the troposphere and the ocean/ice/air interface
- Determine role of marine biochemical processes for CCN and IFN formation, with emphasis on the open-lead surface microlayer
- Provide comprehensive data set on the high Arctic climate system as short-term "mirror" data to that from long-term Arctic coastal sites for developing and testing integrated climate models.



Cloud Measurements

Instrumentation:

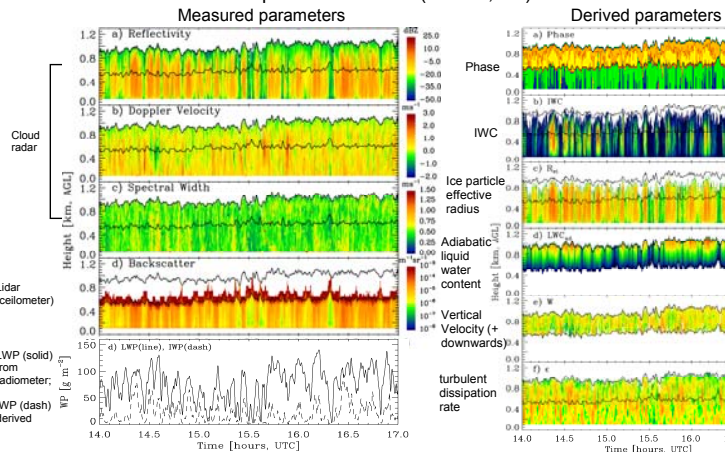
- Ka-band ($\lambda = 8$ mm) Doppler cloud radar
- dual-channel (24/31 GHz) microwave radiometer
- ceilometer
- enhanced S-band Doppler cloud and precipitation radar



Measurement Parameters:

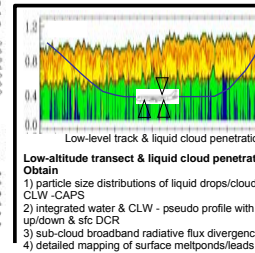
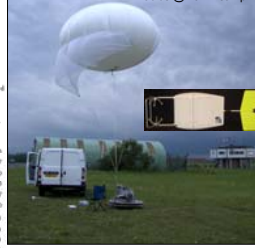
cloud macro-/microphysical properties, reflectivity, vertical velocity, spectral width within both clouds and precipitation

Example from M-PACE (Barrow, AK) 10/28/2004



SkyDoc Tethered Balloon System

- U. of Leeds modification of Gill basic system
- custom motion pack, GPS, 3-5 h battery duration
- Mean T, RH, P @ 1 Hz,
- Turbulence measurements @ 10 Hz
- CLASP aerosol probe, 16 channels, 0.12 - 9.25 μ m radius @ 10 Hz sampling

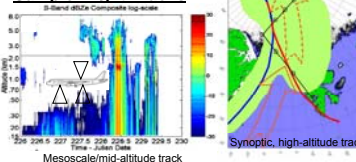


Airborne Measurements (AMISA; NASA DC-8)

Science Objectives

- in-situ validation for ship, aircraft, satellite data
- determine processes linking cloud radiative/microphysical properties to synoptic/mesoscale disturbances, boundary-layer structure, and surface energy budgets near freezeup
- determine type and size distribution of aerosols in/near high-altitude, low-level clouds and thermal inversion
- aircraft/satellite sea-ice imaging/mapping and atmospheric radiometric profiling
- validate/improve NASA Aqua AMSR-E sea-ice concentration algorithm under fall transition conditions
- evaluate C-/L-band for lead/meltpond discrimination

Sample Flight Tracks



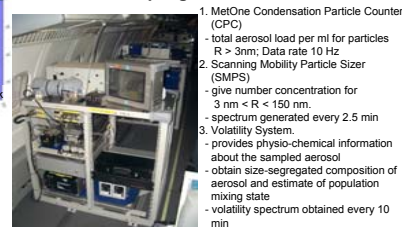
Synoptic/mesoscale sampling track

- high-level passes (10 km) on way to Oden (black dot) and mid-level (1 km) in vicinity of Oden
 - use dropsondes (D) and remote sensors for mapping and profiling
- Obtain
- synoptic thermodynamic/kinematic structure of environment upwind and near Oden
 - integrated water & CLW - pseudo profile with up/down & sfc DCR
 - radiative flux divergence of low-level cloud tops

AMISA DC-8 Instrumentation

Instrument	Description	Observables
Polarimetric Scanning Radiometer (PSR)	Multiband polarimetric radiometric imaging system; Airborne AMSR-E equivalent	high resolution sea ice mapping; cloud cover; integrated water vapor
Dual-channel radiometer (DCR)	21/31 GHz, up/downlooking	integrated water vapor & cloud liquid water above/below aircraft
Scanning Low Frequency Microwave Radiometer (SLFMR)	L-band salinity mapping	L-band brightness; mapped salinity with ~5 ppt precision for lead/meltpond discrimination
Cloud, aerosol, and precipitation spectrometer (CAPS)	From Droplet Measurements Technology	Cloud droplet and ice particle spectra, liquid water content, droplet/ice discrimination
Expendable digital dropsondes	Yankee Technology	Sub-aircraft profiles of temperature, pressure, humidity, and wind
OAT Rosemount probe	Outside air temperature adjusted for Mach number	Air temperature
Solar flux pyranometers (SFPs)	Hemispheric integrating thermopile irradiance sensors	Up- and downwelling shortwave fluxes
Volatiles Aerosol Concentration and Composition (VACC)	University of Leeds' system	Aerosol number concentration spectra and aerosol composition

Aerosol sampling: Leeds airborne VACC



- total aerosol load per ml for particles $R > 3$ nm; Data rate 10 Hz
- Scanning Mobility Particle Sizer (SMPS)
 - give number concentration for 3 nm $< R < 150$ nm.
 - spectrum generated every 2.5 min
- Volatility System:
 - provides physico-chemical information about the sampled aerosol
 - obtain size-segregated composition of aerosol and estimate of population mixing state
 - volatility spectrum obtained every 10 min

Remote Sensors: U of CO PSR mounted on aircraft

