fast breaking papers - 2010

February 2010

PDF

Jose-Luis Jimenez & Ingrid Marie Ulbrich talk with *ScienceWatch.com* and answer a few questions about this month's Fast Breaking Paper Paper in the field of Geosciences.

Article Title: Interpretation of organic components from Positive Matrix Factorization of aerosol mass spectrometric data
Authors: **Ulbrich, IM**;Canagaratna, MR;Zhang, Q;Worsnop, DR; **Jimenez, JL**
Journal: ATMOS CHEM PHYS, Volume: 9, Issue: 9, Page: 2891-2918, Year: 2009
* Cooperat Inst Res Environm Sci, Boulder, CO USA.
* Cooperat Inst Res Environm Sci, Boulder, CO USA.
(addresses have been truncated.)

SW: Would you summarize the significance of your paper in layman's terms?

The atmosphere is full of tiny particles, too small to see, yet they are a deadly pollutant that kills millions of people every year and also impacts climate change. These particles contain thousands of different "organic" chemical compounds, i.e., those composed primarily of carbon, oxygen, hydrogen, and nitrogen. There are too many compounds to measure and analyze individually.

In our paper, we used a mathematical method to simplify the analysis of atmospheric organic particles into a few classes, such as those coming from cars, forest fires, etc. This type of analysis is very powerful but also quite tricky, and in this study we investigated the power and limitations of the method thoroughly. We also presented results from a study in Pittsburgh which showed the influence of pollution emissions from the city, with an even larger influence of particles transported regionally.

SW: Why do you think your paper is highly cited? Does it describe a new discovery, methodology, or synthesis of knowledge?

Our paper is being highly cited for three main reasons. First, we describe in detail an analysis method that many other people are finding useful. Second, we also developed and shared publicly a piece of software for this data analysis and a database of chemical fingerprints of different types of atmospheric organic particles, and lots of people are now using both of those.

Finally, we present new results about the sources of a type of particle material called "oxygenated organic aerosols" (OOA). OOA is mostly formed from the reactions of gases in the atmosphere, which produce "sticky" molecules that form particles. In our paper, we show that we can distinguish an "old" fraction which has been in the atmosphere for several days from a younger fraction which had probably been formed within the past day. This had only been shown once before, for a study in Zurich.

Coauthor:
Ingrid Marie Ulbrich

"The atmosphere is full of tiny particles, too small to see, but they are a deadly pollutant that kills millions of people every year and also impact climate change..."

SW: How did you become involved in this research, and were there any problems along the way?

Jose-Luis Jimenez:

I started working on advanced instrumentation for atmospheric particles in 1999. It quickly became clear that our technique ("Aerosol Mass Spectrometry") produced a lot of information about organic particles, but it was difficult to quantify and learn what it could tell us about the sources of these particles.

I was aware of the type of mathematical techniques known as "multivariate analysis" which had been applied successfully to similar problems, and, in 2004, I began working with Dr. Qi Zhang (then a postdoctoral researcher in my group, and now a professor at the University of California, Davis) in applying those techniques to our data. We produced some initial results which attracted a lot of attention, and, after Qi moved on, Ingrid Ulbrich undertook the task of applying a new type of technique (known as "Positive Matrix Factorization") which we knew would be more powerful than what we had done before.

Ingrid Ulbrich:

I learned about these factorization techniques while working at a job I held after my undergraduate work. It was amazing that math could help you find commonalities about the sources of particles that were measured just in one place. I wanted to apply this type of technique to data that had higher information content (chemical and time resolution) to try to learn more about sources and transformations of pollution in the atmosphere, and, for that reason, I decided to do my Ph.D. studies with Jose-Luis Jimenez at the University of Colorado, Boulder.

SW: Where do you see your research leading in the future?

We are continuing to improve the mathematical techniques which we use for our analyses, to apply them to atmospheric particles from other locations, and also to apply them to data from other instruments. Much has been learned recently about the sources of atmospheric organic particles, but there is still a lot that we don't know, and looking at more places and using better techniques should allow us to make more rapid progress.

SW: Do you foresee any social or political implications for your research?

We need to control particle concentrations in the atmosphere because they have severe health effects on people and also because of their impact on climate. However, it is expensive to control particle sources, e.g., to install filters on school buses or to reduce emissions from power plants.

There are also tradeoffs between reducing particle concentrations and other societal goals: e.g.,

suppressing forest fires improves the air we breathe, but is bad for many forests because it allows dead branches, etc. to accumulate that will eventually cause an extremely intense fire some years down the road which will be harder for the forest to recover from.

In order to use resources efficiently to reduce pollution in the air that people breathe, manage our impacts on climate, and manage natural resources such as forests, we need better information about where the atmospheric particles are coming from. Then we can put the most resources and effort to reduce the impacts of the sources that contribute a lot of pollution. Our work represents a step in that direction.

Jose-Luis Jimenez,

Associate Professor

Fellow of the Cooperative Institute for Research in the Environmental Sciences (CIRES)

Department of Chemistry & Biochemistry

University of Colorado

Boulder, CO, USA

Web

Ingrid Marie Ulbrich

Doctoral candidate, Chemistry

Department of Chemistry & Biochemistry

University of Colorado

Boulder, CO, USA

KEYWORDS: POLYCYCLIC AROMATIC-HYDROCARBONS; FACTOR-ANALYTIC MODELS; SOURCE APPORTIONMENT; HIGH-RESOLUTION; ATMOSPHERIC AEROSOLS; CLUSTER-ANALYSIS; PARTICULATE; URBAN; SECONDARY; SPECTRA.

PDF

back to top

2010 : February 2010 - Fast Breaking Papers : Jose-Luis Jimenez & Ingrid Marie Ulbrich on Analyzing Tiny Particles of Deadly Pollutants

Science Home | About Thomson Reuters | Site Search