NEW HOT PAPERS - 2008

July 2008

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Solene Turquety talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Geosciences. The author has also sent along images of their work.

Article Title: Inventory of boreal fire emissions for North America in 2004: Importance of peat burning and pyroconvective injection
Authors: Turquety, S;Logan, JA;Jacob, DJ;Hudman, RC;Leung, FY;Heald, CL;Yantosca, RM;Wu, SL;Emmons, LK;Edwards, DP;Sachse, GW
Journal: J GEOPHYS RES-ATMOS
Volume: 112, Issue: D12
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* Natl Ctr Atmospher Res, Div Atmospher Chem, POB 3000, Boulder, CO 80307 USA.
(addresses have been truncated)

SW: Why do you think your paper is highly cited?

This paper describes and evaluates a daily inventory of the pollution emitted by extremely large fires that burned millions of hectares of boreal forests in Alaska and Canada during the summer of 2004. It was highly cited for two main reasons.

First of all, the inventory developed was used in several studies. The pollution resulting from these fires emitted into the atmosphere was huge, affecting air quality locally but also on larger scales. Direct impact was predicted and observed as far as the Southern United States and Europe. The scientists therefore needed to account for this great perturbation of atmospheric chemistry in their analyses. Furthermore, using a daily inventory proved essential as the fires varied in location and intensity through the summer.

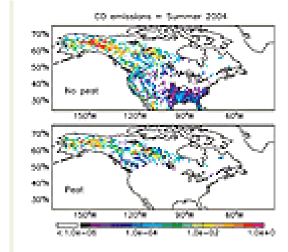
Our study also highlighted several sources of uncertainties in current inventories that need to be better accounted for: the contribution from the burning of the surface layer in peatlands (large reservoir of carbon), and the potential importance of injection at high altitude of fire emissions for the modeling of pollution transport events.

Figure 1: +details

Figure 2:

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Rather than a new discovery or methodology, the strength of this paper resided in its integrated approach of the different stages of the work: starting with the development of a state-of-the-art emission inventory, then incorporating the inventory into a global chemistry and transport model to simulate their impact on atmospheric chemistry, and finally confronting the simulations with the available atmospheric observations.



The comparisons allowed the evaluation of our knowledge and pointed out the uncertainties without indulgence. It also allowed the formulation of several hypotheses explaining the disagreements.

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

Wildfires constitute an important contribution to the emissions of pollutants into the atmosphere, resulting in a strong perturbation of atmospheric chemistry, affecting both air quality and climate. It is essential to evaluate this contribution correctly—and this for each fire season.

Fires are indeed highly variable in location and timing with large interannual variability, but also large variations occur during the fire seasons reflecting meteorological conditions, agricultural practices, and accidental fires.

The summer of 2004 was characterized by strong fires in Alaska and Western Canada which burned more than five million hectares between June 1st and August 31st—a record breaking fire season for Alaska. We have developed a daily inventory of the emissions associated with these fires and evaluated it using the available observations of atmospheric composition.

We have focused on the emissions of carbon monoxide (CO) since there are a lot of valuable observations for this molecule, in particular from the Measurements of Pollution in the Troposphere (MOPITT)/Terra space-borne instrument which allow the monitoring of CO total amounts with good spatial resolution and coverage (global coverage every three days). This intense burning also occurred as a field campaign sampling intercontinental transport of pollution from fires was underway over the Northeastern United States—the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) campaign—so that a lot of aircraft *in situ* observations were available.

The inventory of the areas burned was first developed combining reported daily total areas burned in the different states and provinces of the US and Canada, with hotspots detected in space by the Moderate-resolution Imaging Spectroradiometer (MODIS) instrument. The resulting emissions were then derived depending on the type of ecosystems burning, their corresponding fuel loads, and emission factors.

We evaluated the contribution from the burning of peat, usually not specifically accounted for in current inventories. This important carbon reservoir proved to be a critical parameter since we evaluated that a third of our total emissions of 30 teragrams of CO is associated with peat burning. We then incorporated our inventory in the global chemistry and transport model GEOS-Chem (Goddard Earth Observing System) developed at Harvard University to simulate the impact of these emissions on atmospheric composition. This allowed us to evaluate our inventory against the available atmospheric observations of CO. These comparisons highlighted good general consistency as well as the importance of the additional contribution from peat burning. But they also showed that significant uncertainties remain.

"We have focused on the emissions of carbon monoxide (CO) since there are a lot of valuable observations for this molecule"

In particular, while the agreement is good above the source region (with a small tendency to overestimate CO) we tend to underestimate CO downwind, in the transported plume. This is still not well understood. An element of explanation could be the injection at high altitude of emissions associated with the largest fires. Indeed, some fires may have enough energy to inject trace gases and particles as high as 10km into the free troposphere and even into the stratosphere (so-called pyroconvective events). A simple parameterization of injection height in our model shows the sensitivity of the simulation for specific transport events which needs to be further analyzed.

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

I came to work on the impact of boreal fires as part of my postdoctoral research project at Harvard University—but quite by chance. I was interested in the information on the intercontinental transport of pollution provided by several new satellite missions. I became involved in the ICARTT campaign, analyzing simulations of the atmospheric composition and the transport of pollution.

Although we expected the boreal fires to have some impact during the summer, it turned out that they were a major perturbation during the summer of 2004. It was then urgent to include this parameter in the analyses of the observations, and I chose to confront our knowledge of the expected emissions with the wealth of available observations. Of course global model simulations and observations were not in good agreement, revealing a large underestimate of the fire emissions. The challenge was then to reconcile emissions and observations, a huge work we hope we have contributed to in this publication.

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

Wildfire emissions are still subject to strong uncertainties. In order to improve our knowledge of the emissions and their impact, it is essential to have more observations close to fires with the use of experimental fires and dedicated field campaigns.

The summer component of the POLARCAT international campaign conducted in the summer of 2008 was largely dedicated to the sampling of boreal biomass burning plumes, close to their emission regions and further downwind after long range transport. The *in situ* data collected will very certainly add a lot of input to our understanding of the emissions, their export to the free troposphere and the chemical evolution of the plumes. The overall objective of POLARCAT, which proposes a coordinated program of measurements and modelling, is to quantify the impact of trace gases, aerosols and mercury transported to the Arctic and their contribution to pollutant deposition and climate change in the region.

New satellite observations of atmospheric chemistry, with improved horizontal resolution and coverage, such as observations from the Infrared Atmospheric Sounding Interferometer (IASI/METOP) instrument, will also provide decisive long-term monitoring. In particular, inverse modeling techniques using the observations as a constraint to the emissions with a model as an intermediate are increasingly used in the scientific community. More than the constrained inventories, I am interested in the information the constraint may provide on the processes we are currently missing.

My research is also dedicated to the quantification of the impact of these wildfires in the Northern Hemisphere, both on air quality in the short term, and on the global radiative forcing and thus on climate on a longer term.

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

A significant increase of wildfires is predicted as a response to climate change, particularly in the boreal regions. This additional forcing, and the potential burning of large reservoirs of carbon such as peatlands, is currently not included in the models. A better knowledge and understanding of the evolution of wildfires and the associated emissions could therefore be crucial both for air quality monitoring and forecasting during the fire seasons, and for future projections.

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Keywords: boreal fire emissions, boreal forests in alaska and canada, summer of 2004, pollution resulting from these fires, southern united states and europe, burning of the surface layer in peatlands, modeling of pollution transport events, strong perturbation of atmospheric chemistry, affecting both air quality and climate, meteorological conditions, agricultural practices, accidental fires, emissions of carbon monoxide, measurements of pollution in the troposphere, international consortium for atmospheric research on transport and transformation, moderate-resolution imaging spectroradiometer, goddard earth observing system, infrared atmospheric sounding interferometer.

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Figures and descriptions:

Figure 1:

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Photograph of a fire in Alaska during the summer of 2004.

Figure 2:

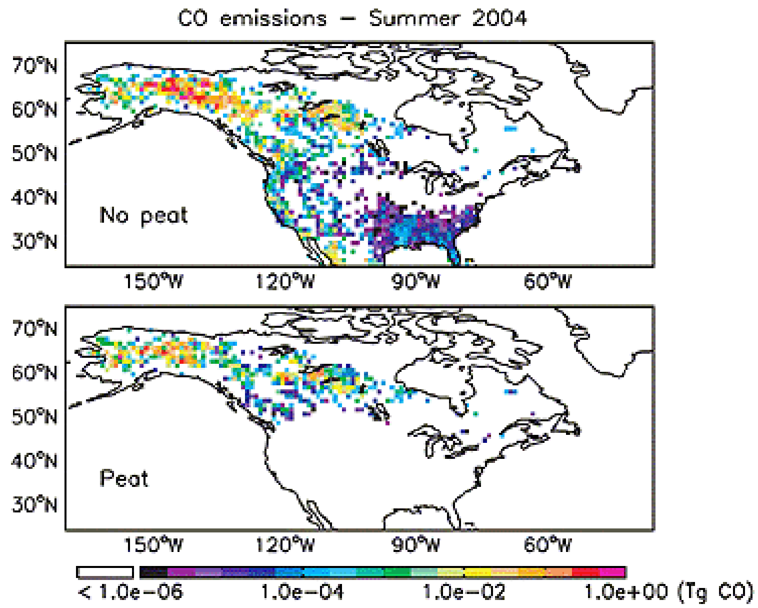

Figure 2:

Map of the forest fire CO emissions derived for the summer of 2004 (top panel) and additional contribution from the burning of peat (bottom panel).

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