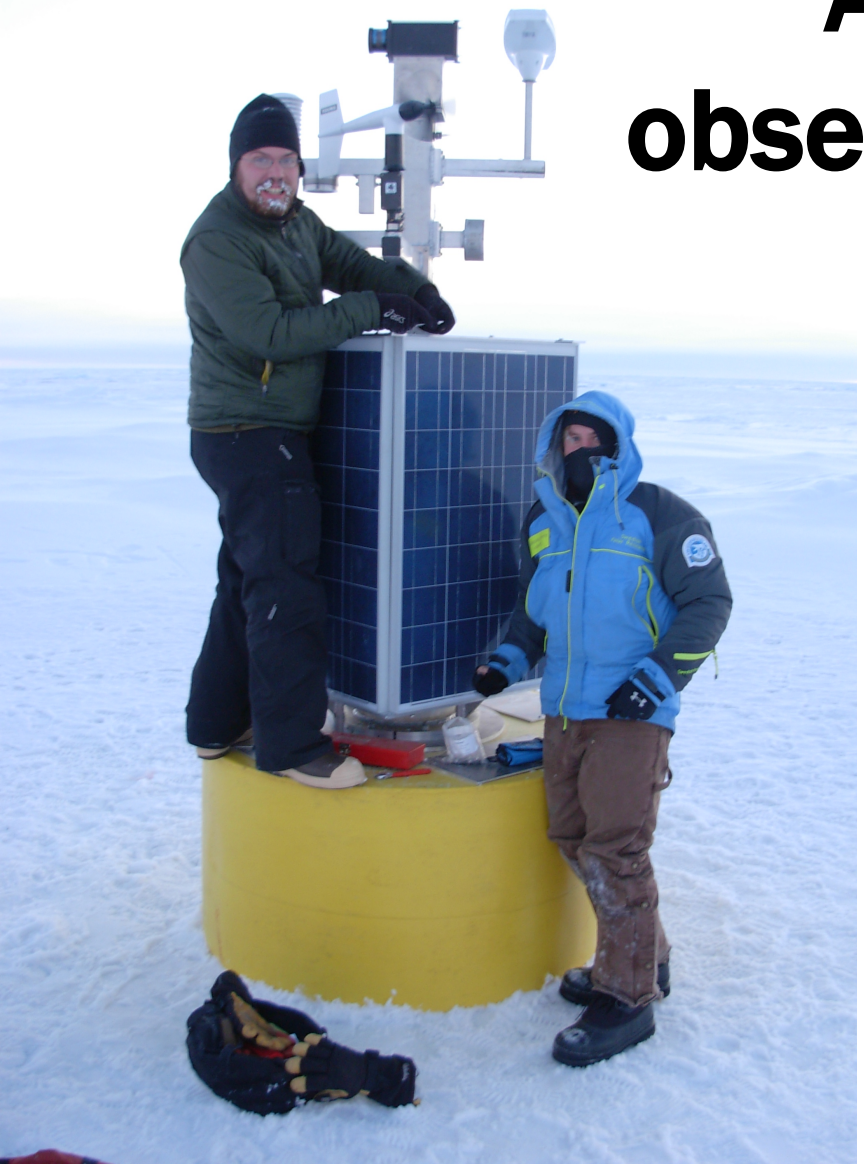


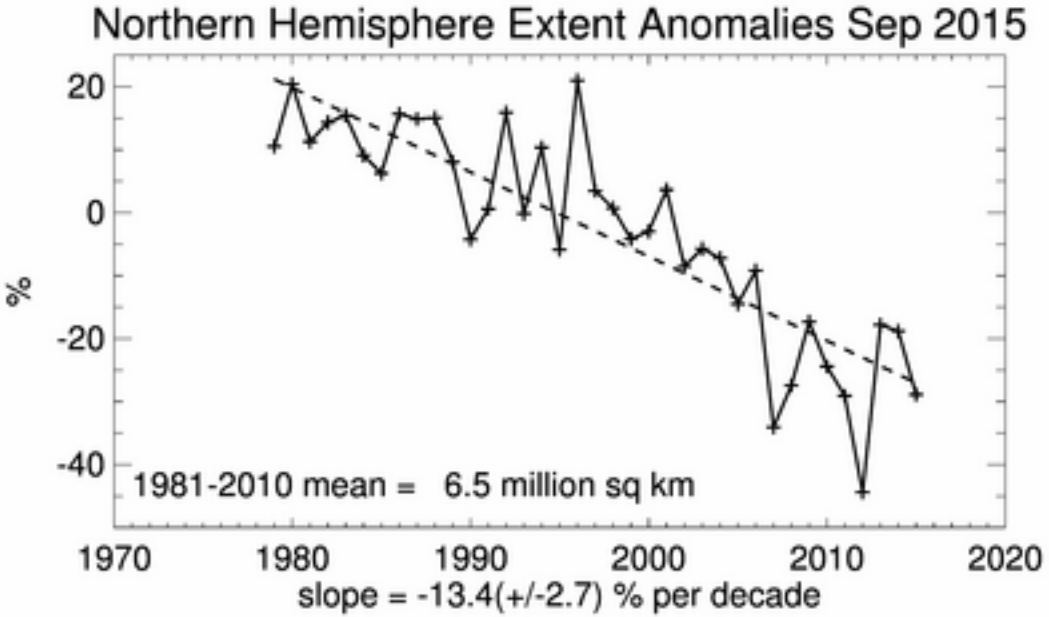
Autonomous "OBuoy" observations of the Arctic atmosphere

William Simpson, University of Alaska Fairbanks, wrsimpson@alaska.edu
Paty Matrai, Bigelow Laboratory for Ocean Sciences
Francisco Chavez, Monterey Bay Aquarium Research Institute
Paul Shepson, Purdue University,
Donald Perovich, Cold Regions Research and Engineering Laboratory,
Peter Peterson, University of Michigan,
John Halfacre, Purdue University,
The Obuoy Team

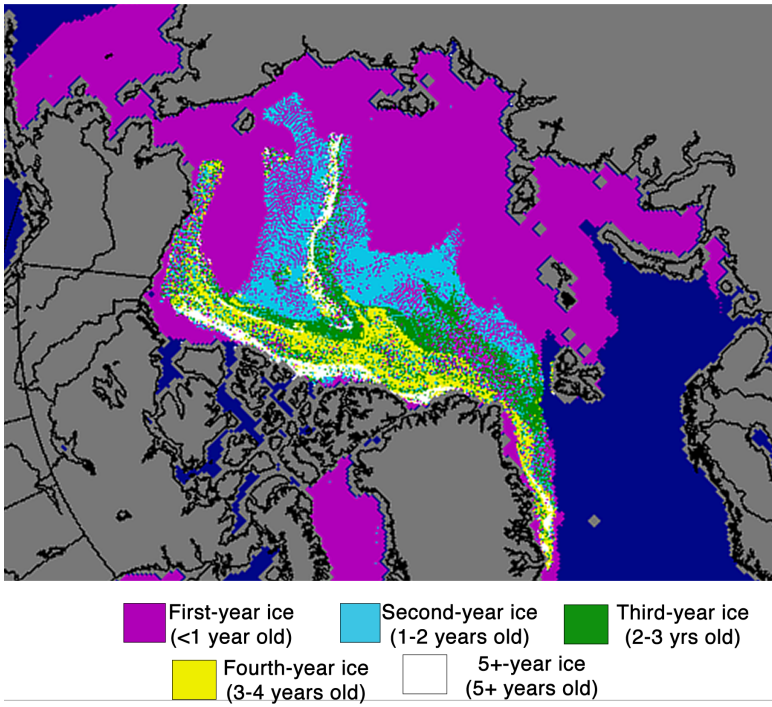
Environment Canada

Environnement Canada

Sea ice is changing



Arctic Sea Ice Age
March 2012



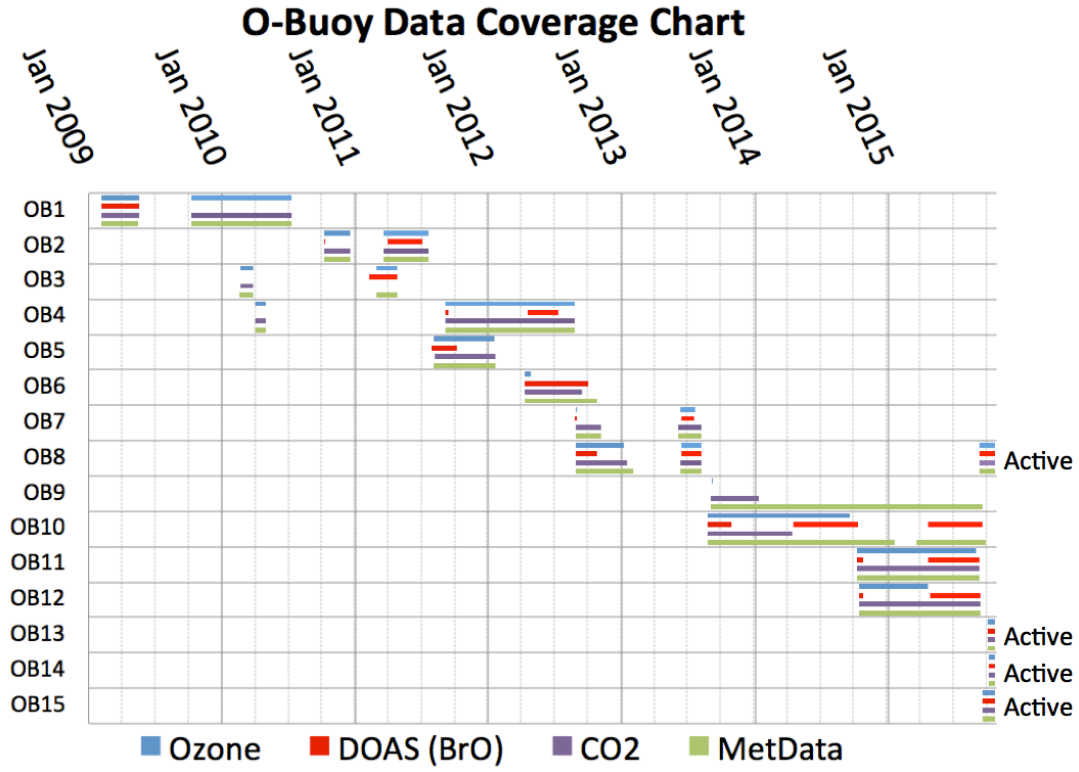
- Summer sea ice is declining.
- Winter sea ice is getting younger, saltier, more leads. **How does this affect the air?**

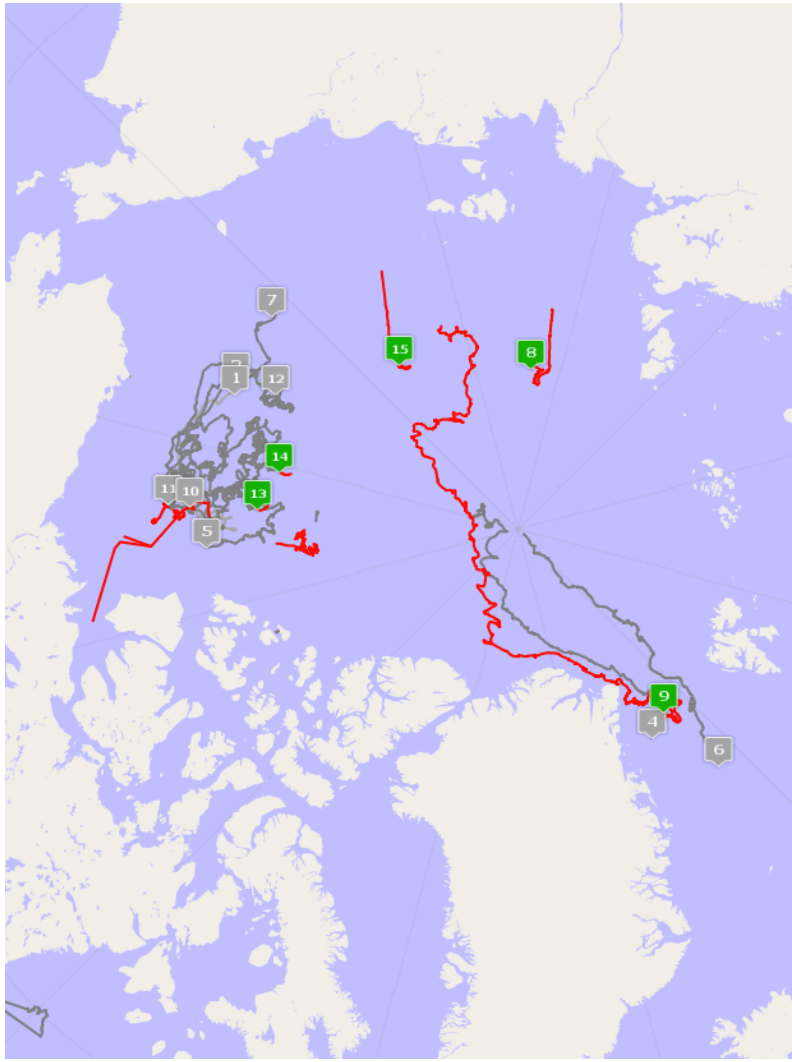
From NSIDC Arctic Sea Ice data. http://nsidc.org

O-Buoy sentinel species

- CO_2 – Greenhouse gas, ocean exchange
- O_3 – Indicates oxidation capacity
- BrO – Modifies oxidation capacity
- Meteorology and Time-lapse images

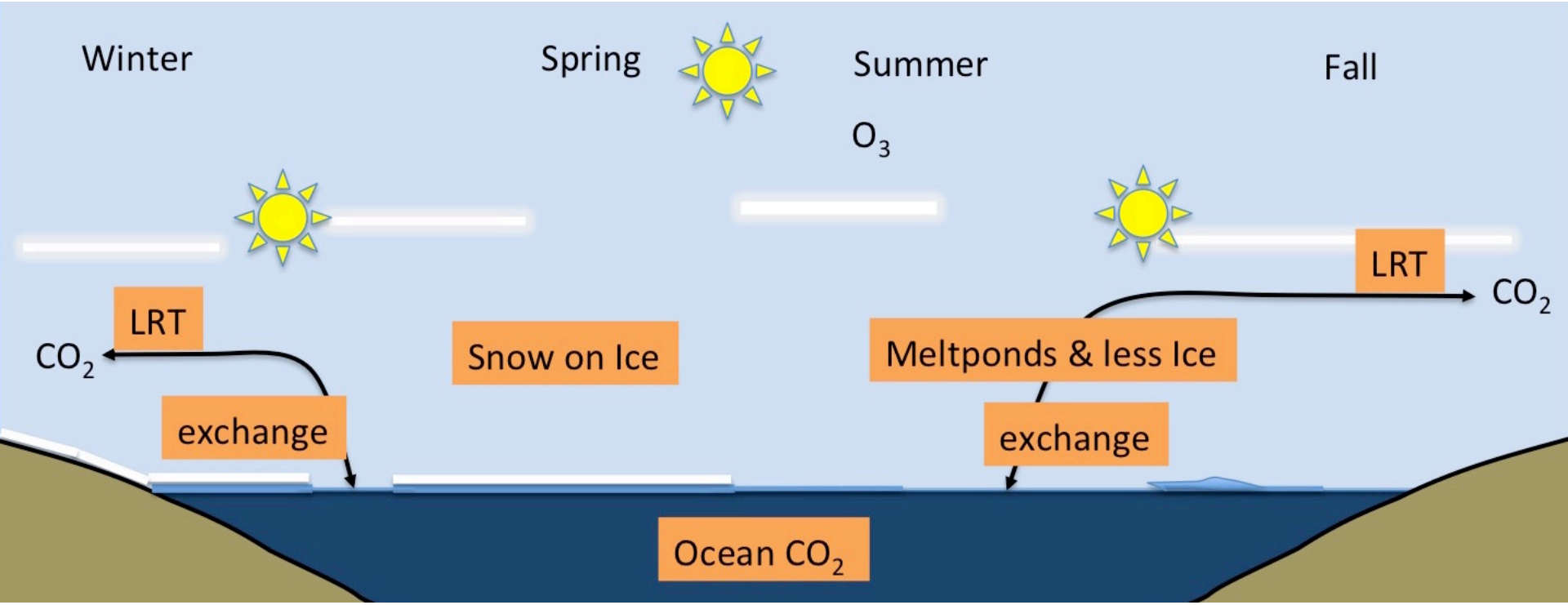
O-Buoy data covers the Arctic Ocean





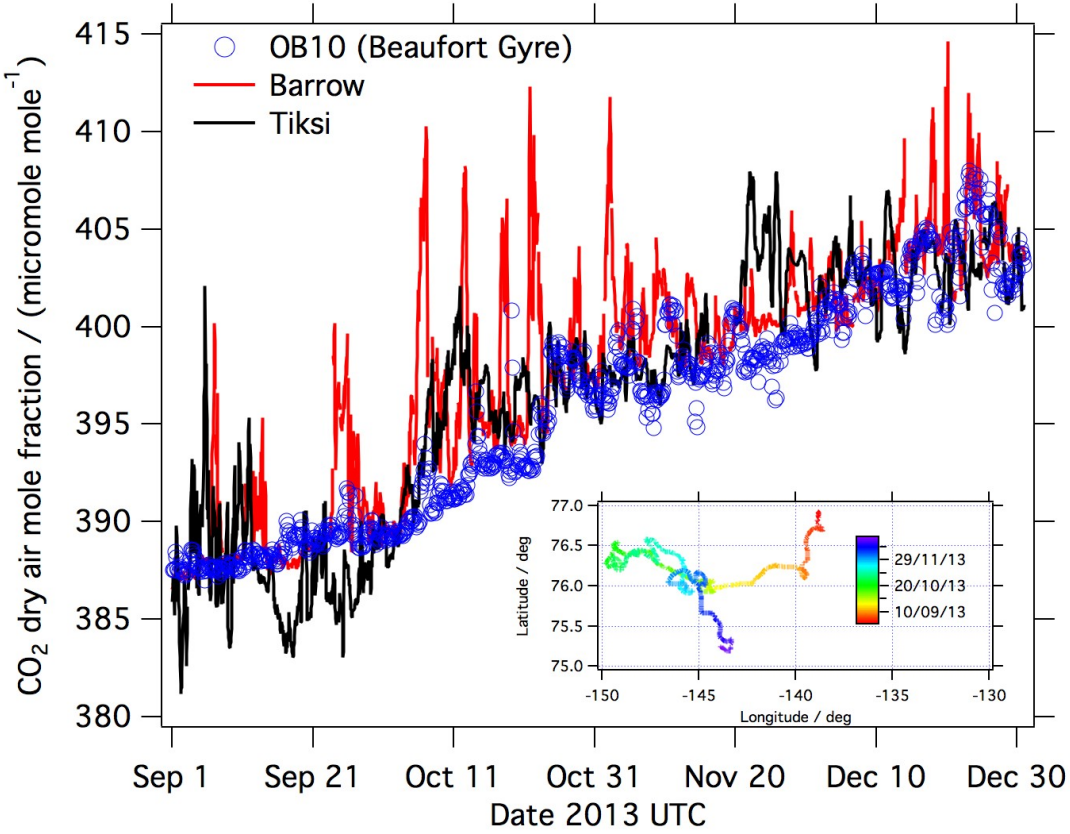
Data available at
http://www.aoncadis.org

O-Buoys sense CO_2 exchange



CO_2 is transported into and out of the Arctic and can exchange with the Arctic Ocean, possibly moderated by sea ice.

CO_2 observations (Matrai / Chavez)



These observations help us understand Air-ocean exchange and its moderation by sea ice.

See talk by Paty Matrai in Robust Autonomous Arctic Observations (Wed 3:00 PM)

Oxidation capacity…

… is the ability of the atmosphere to clean itself by chemically oxidizing pollutants.

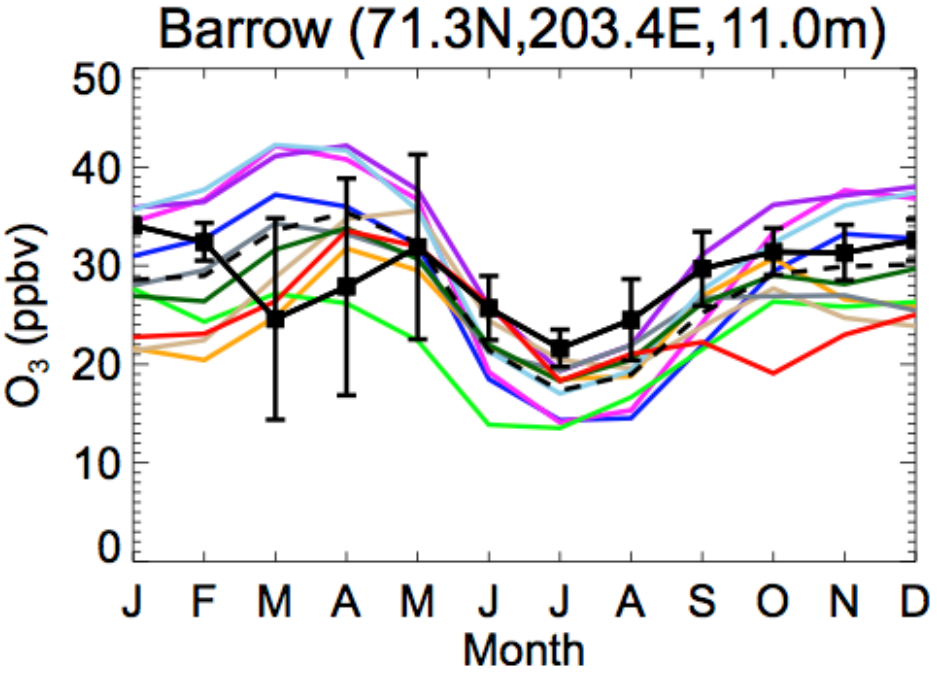
… globally controls methane lifetime.

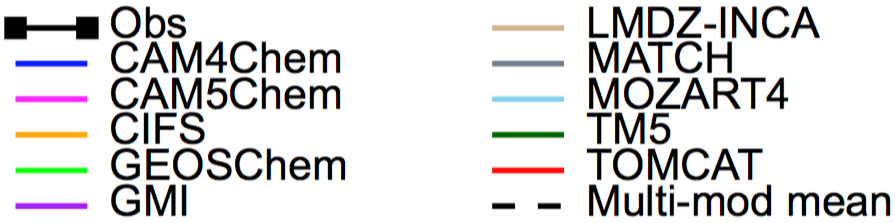
… produces new particles.

… makes existing particles better CCN.

O_3 photochemistry produces OH radicals, the primary global oxidizer, thus **O_3 typically indicates oxidation capacity.**

Models fail for O_3



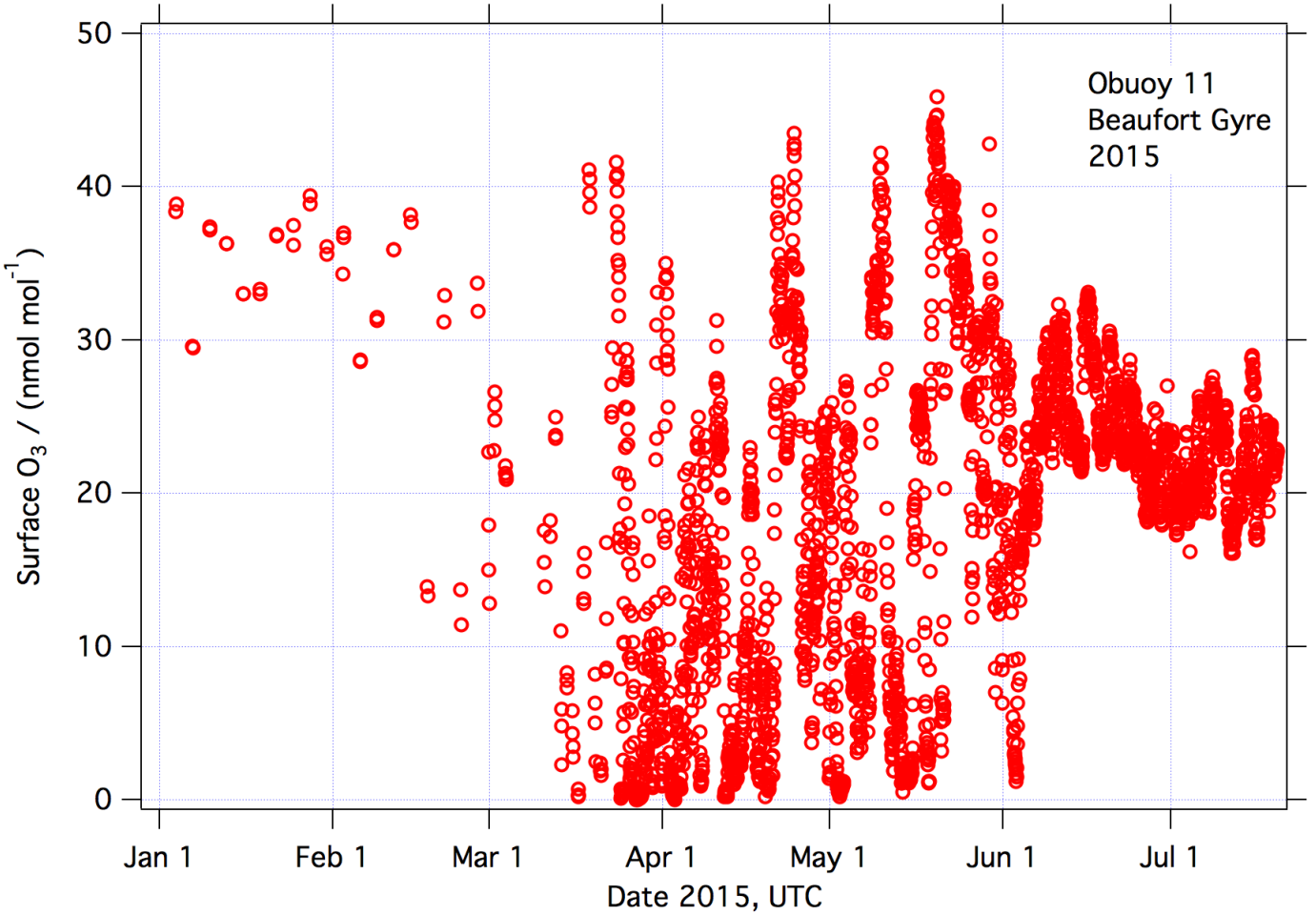


2008 annual O_3 cycle, observational error bars are 1σ

We do not understand or cannot model O_3 in the Arctic, esp. Spring + Summer. This impacts our understanding of Arctic oxidation capacity.

From Monks et al. (2015) Atmos. Chem. Phys., **15**, 3575, doi:10.5194/acp-15-3575-2015

O-Buoys observe surface O_3



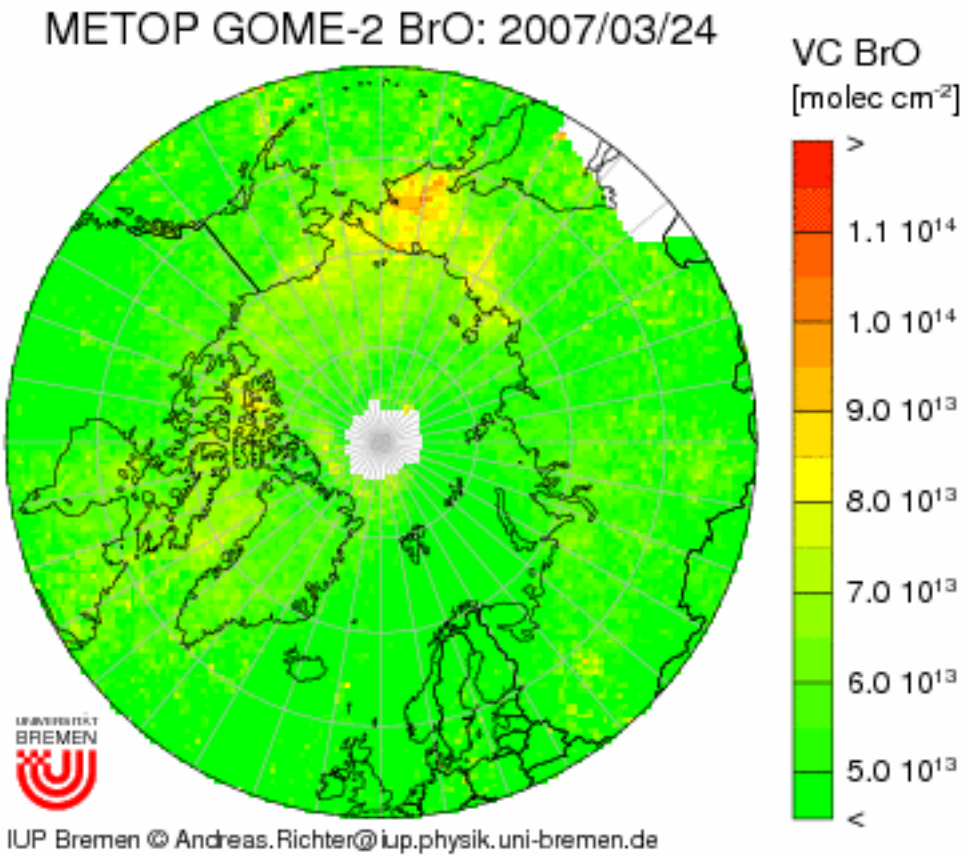
Spring (March–May) O_3 is episodically depleted.

See poster by John "Wes" Halfacre in Arctic Atmosphere I

Springtime Artic Chemistry

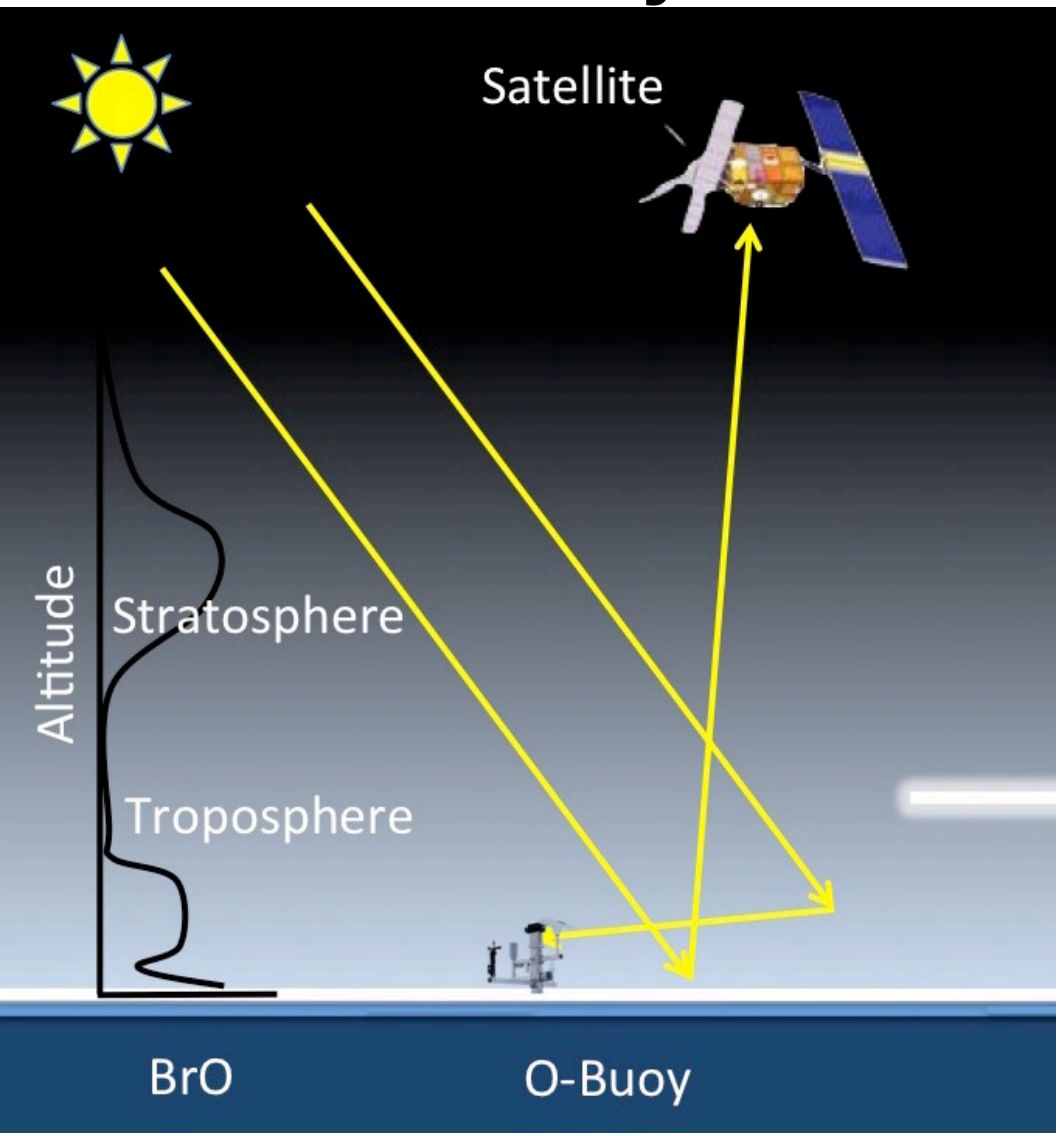
Photochemistry on snow and aerosol releases reactive halogens detected here as BrO (bromine monoxide)

Reactive halogens destroy O_3 and alter oxidation capacity



BrO animation from Andreas Richter, IUP Bremen, Germany

O-Buoy BrO observations



UV-Vis Spectrometer in O-Buoy measures scattered light

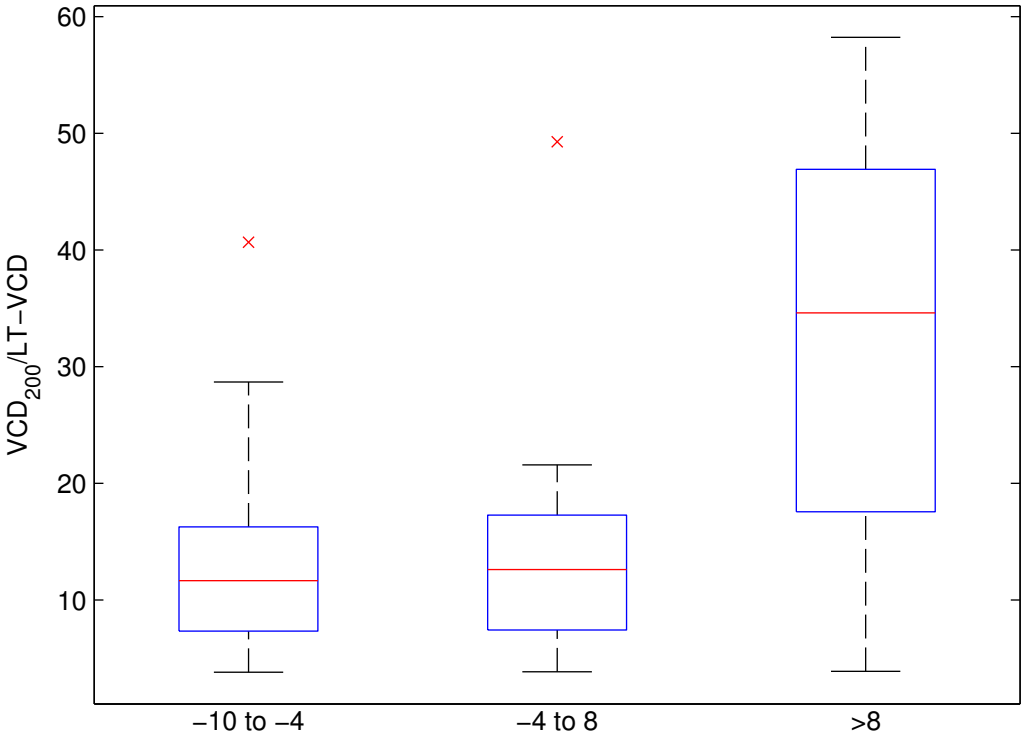
Tangent geometry isolates lower troposphere and measures BrO in lowest 200m and 2000m

Inversions control BrO profile

Shallow

Event Type Spectrum

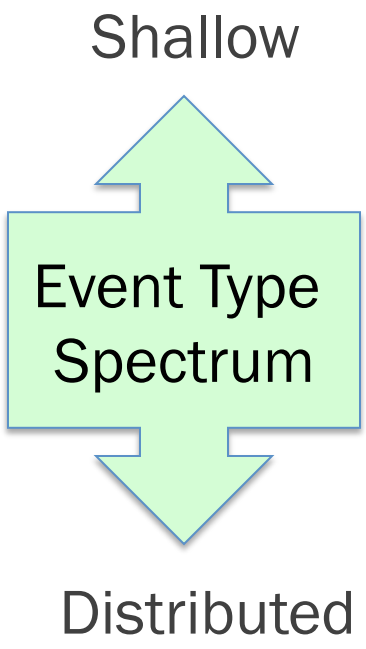
Distributed

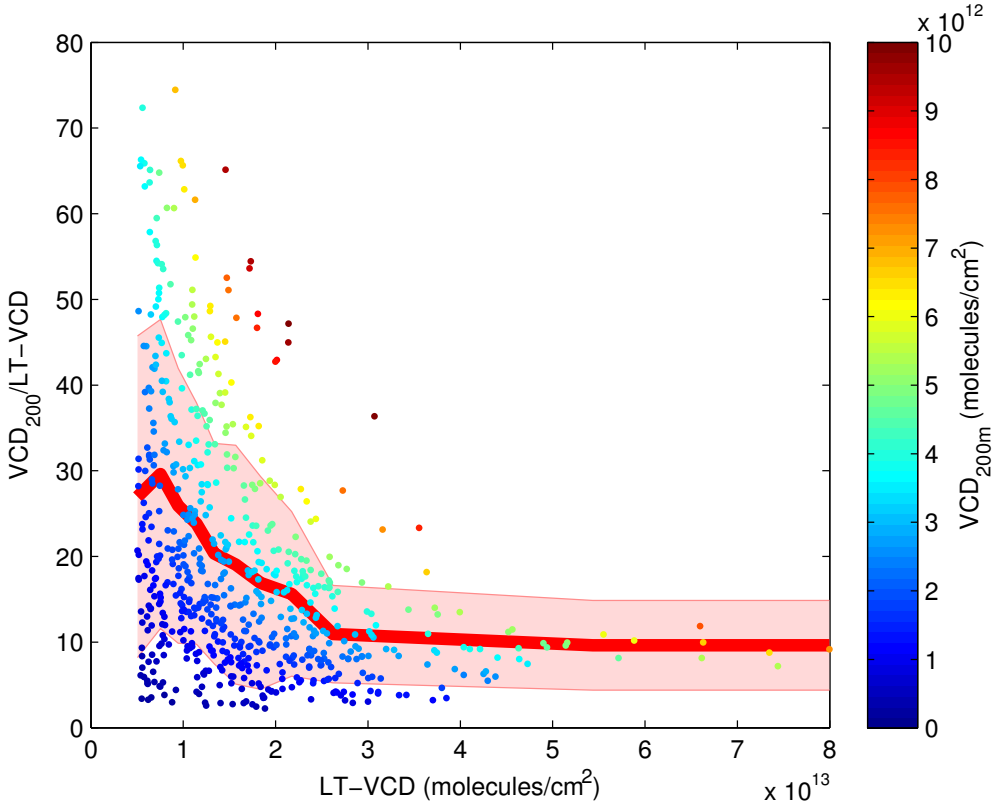


Neutral dT/dz Stable = Inversion

From Peterson et al. (2015) Atmos. Chem. Phys., **15**, 2119, doi:10.5194/acp-15-2119-2015

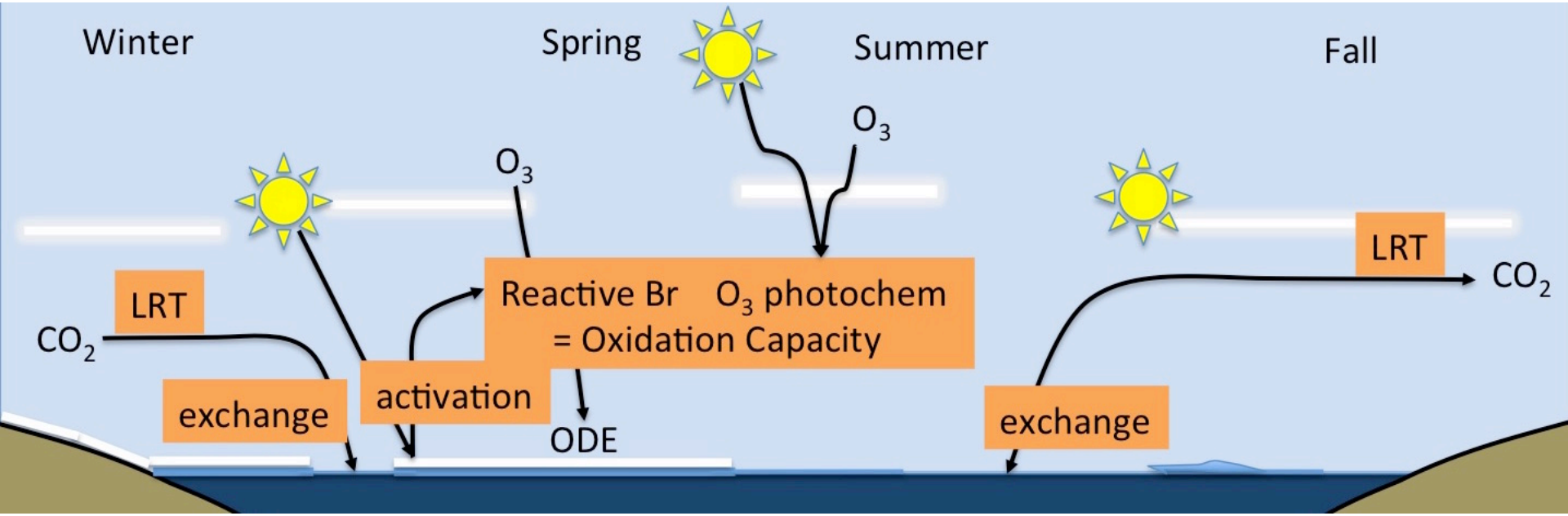
High BrO column events are mixed





High column events are “distributed”, while “shallower” events have less total BrO column.

O-Buoys also sense oxidizers



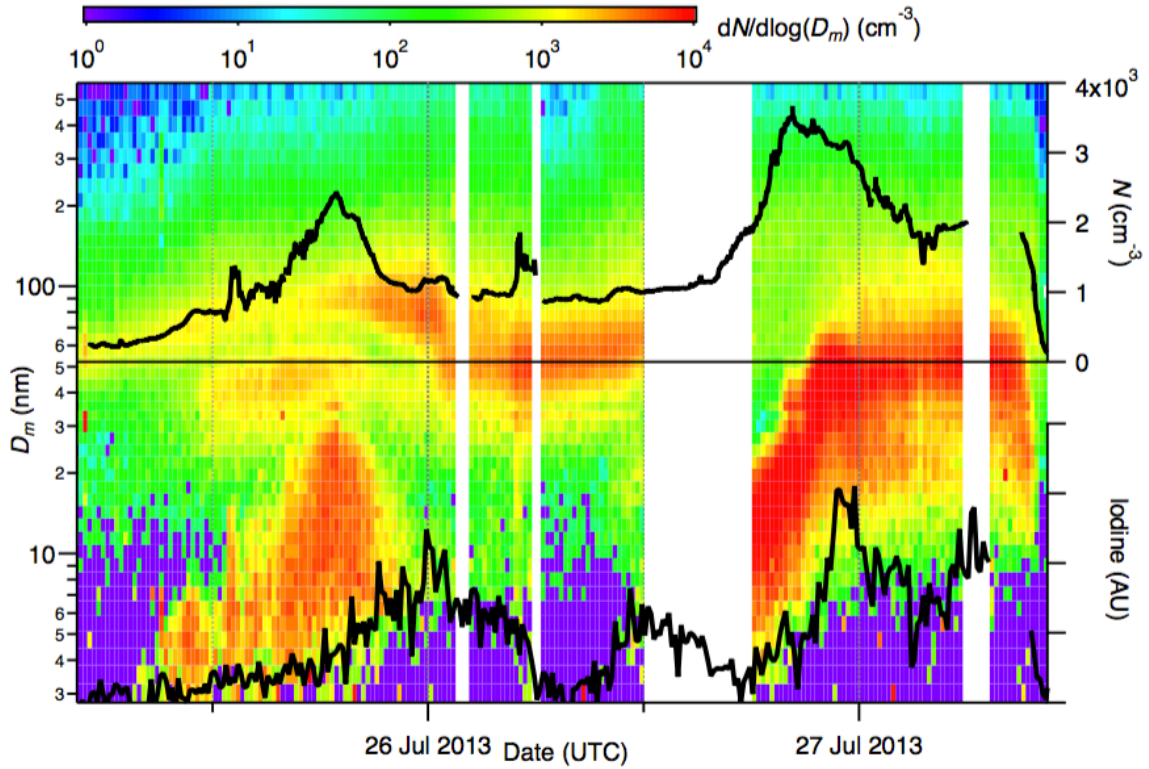
During springtime, photochemistry releases reactive bromine from sea ice, which depletes O_3. After snowmelt, halogens are gone and O_3 now controls oxidation capacity.

O-Buoy initial findings

- O-Buoys provide a rich data set that observes air over Arctic sea ice.
- Vertical exchange effects are critical to understand.
- We welcome collaboration to understand these data and their impacts.

How might halogens and oxidation affect other parts of the Arctic climate system?

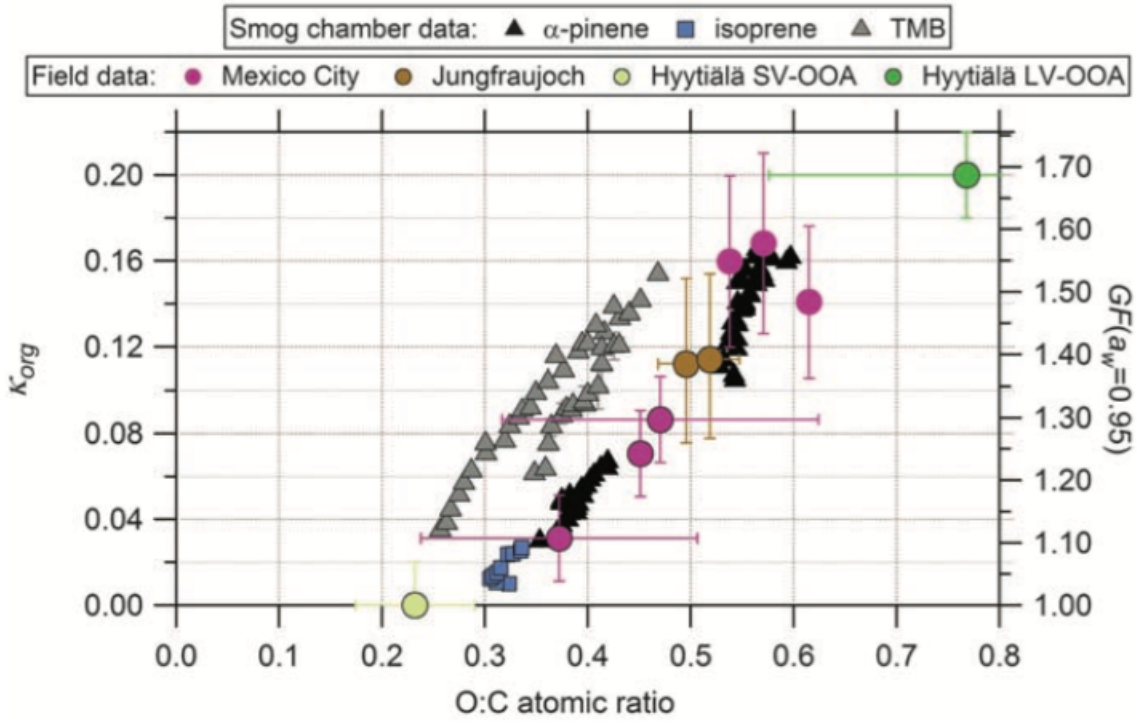
Iodine in new particle production



Allan and co-workers observed new particle production events in the Arctic and found iodine (another halogen) in the particles.

From Allan et al. (2015), Atmos. Chem. Phys., 15, 5599, doi:10.5194/acp-15-5599-2015

Oxidation modifies particles



Jimenez and co-workers found that oxidation, which increases O:C ratio, made organic matter more hydrophyllic, which would make it better CCN

From Jimenez et al. (2009), Science, **326**, 1525, doi:10.1126/science.1180353

Future work

- Analysis of O-Buoy data can improve understanding of how changing ice affects the atmosphere.
- Oxidation may affect CCN and clouds – needs future study
- We look forward to working on these problems

We acknowledge funding from NSF AON under grants to our five institutions: ARC-1022834, ARC-1022773, ARC-1023221, ARC-1023393, and ARC-1023118