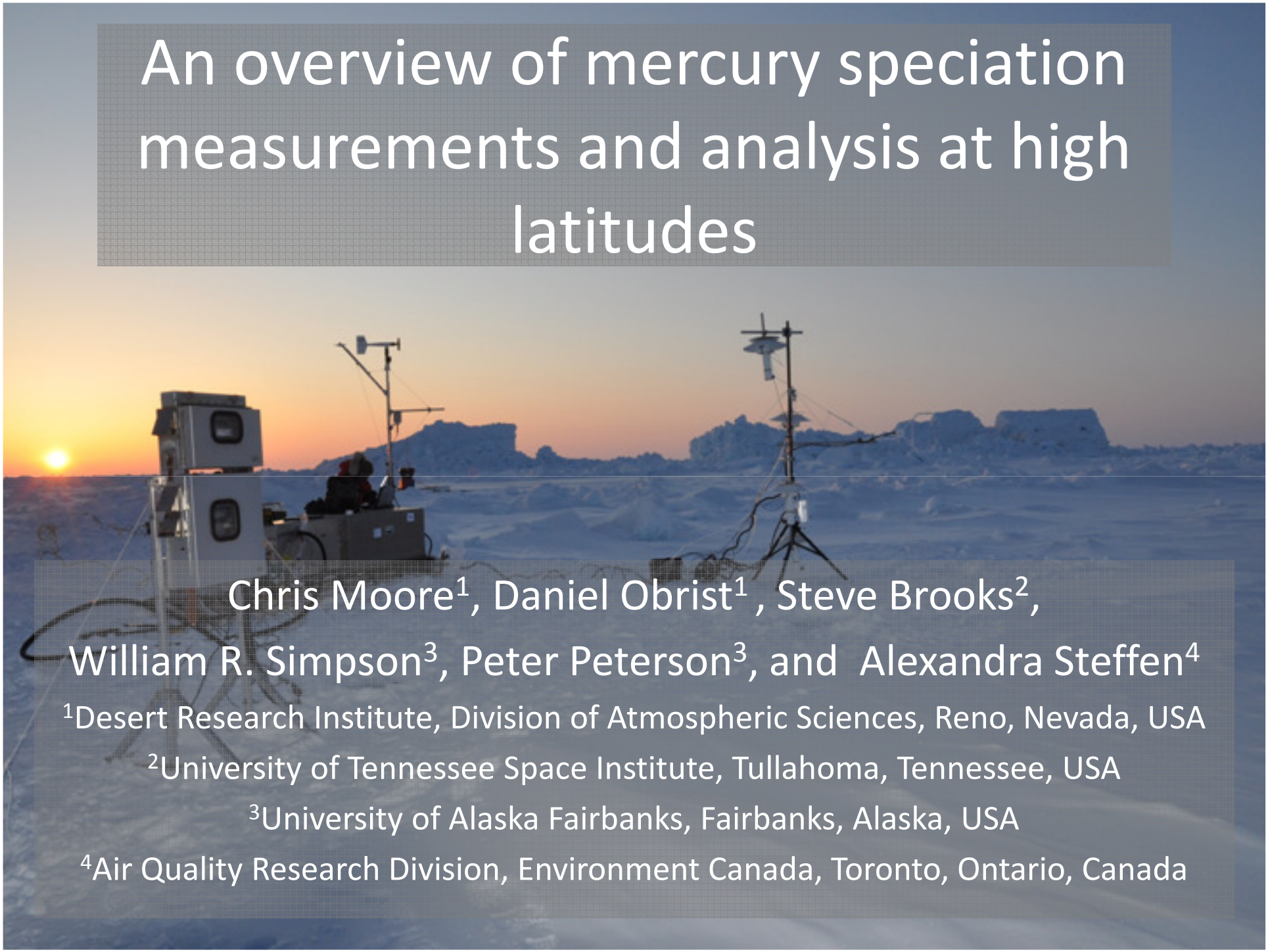
An overview of mercury speciation measurements and analysis at high latitudes



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Focus

- Quest to understand atmospheric mercury depletion events (AMDEs)
- Where we are in our understanding of the chemistry of AMDEs
- Importance of collocated Hg and halogens

The Journey Begins – Alert Canada

- Site where Atmospheric Mercury Depletion Events were first identified (Schroeder et al. 1998 *Nature*)
- Measurements of TGM began in 1995
- Full speciation measurements began in 2002
- One of the longest continuously operating mercury speciation measurement sites

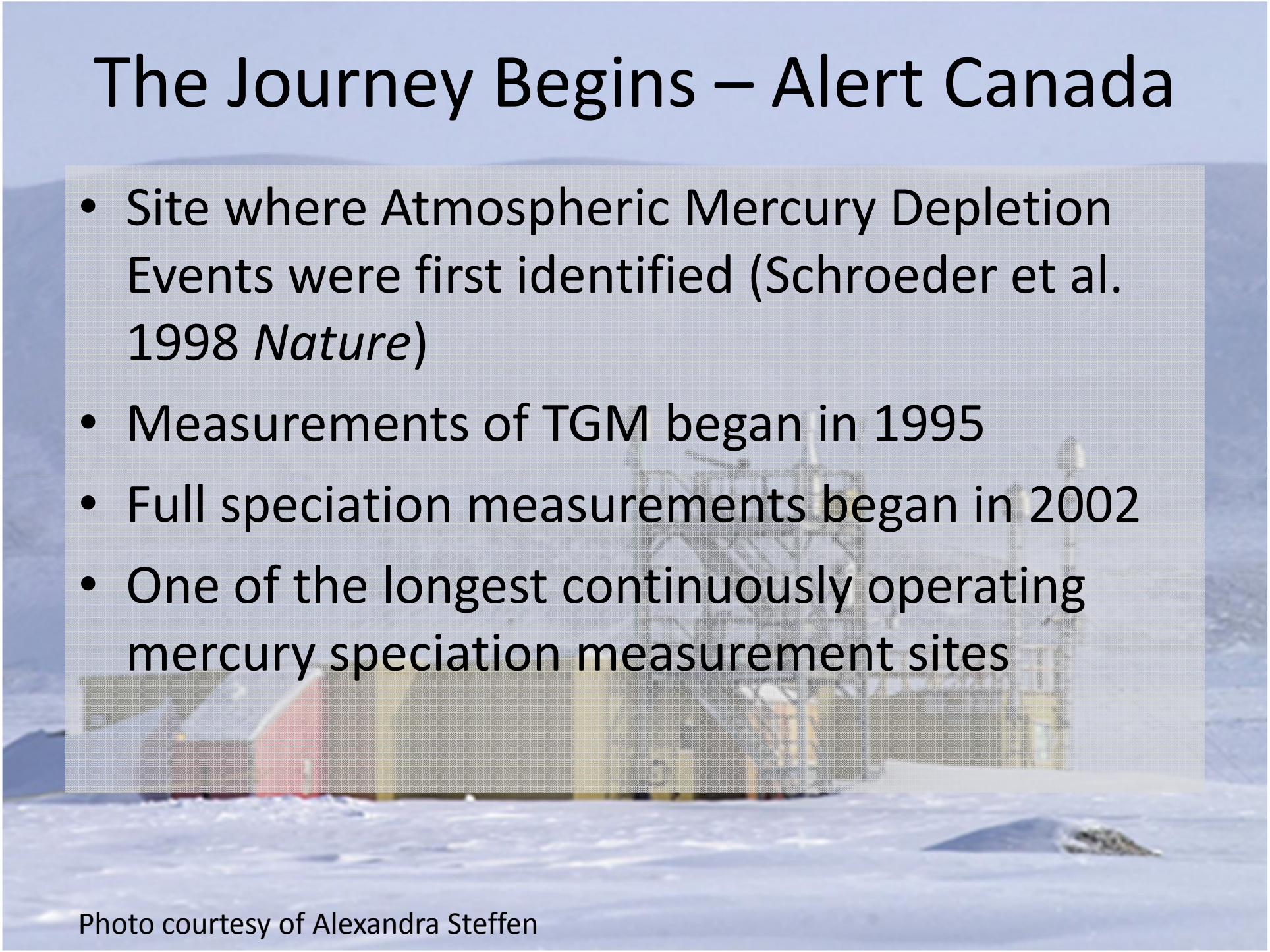
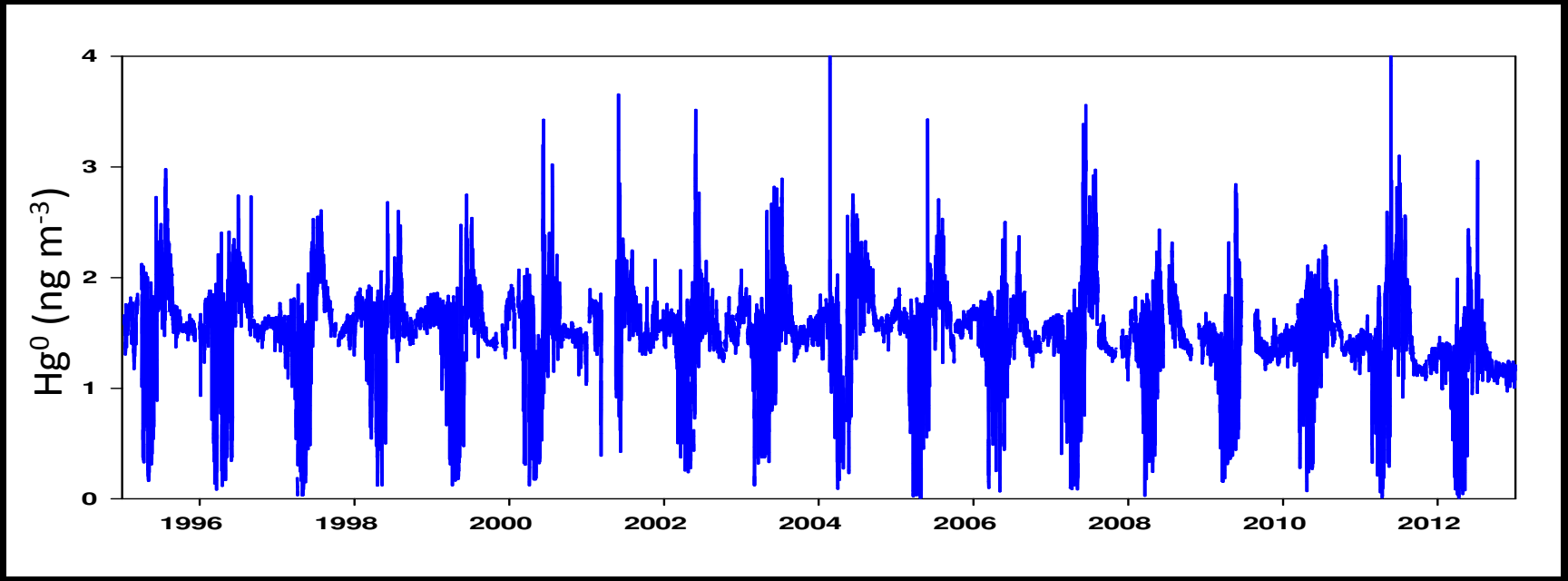
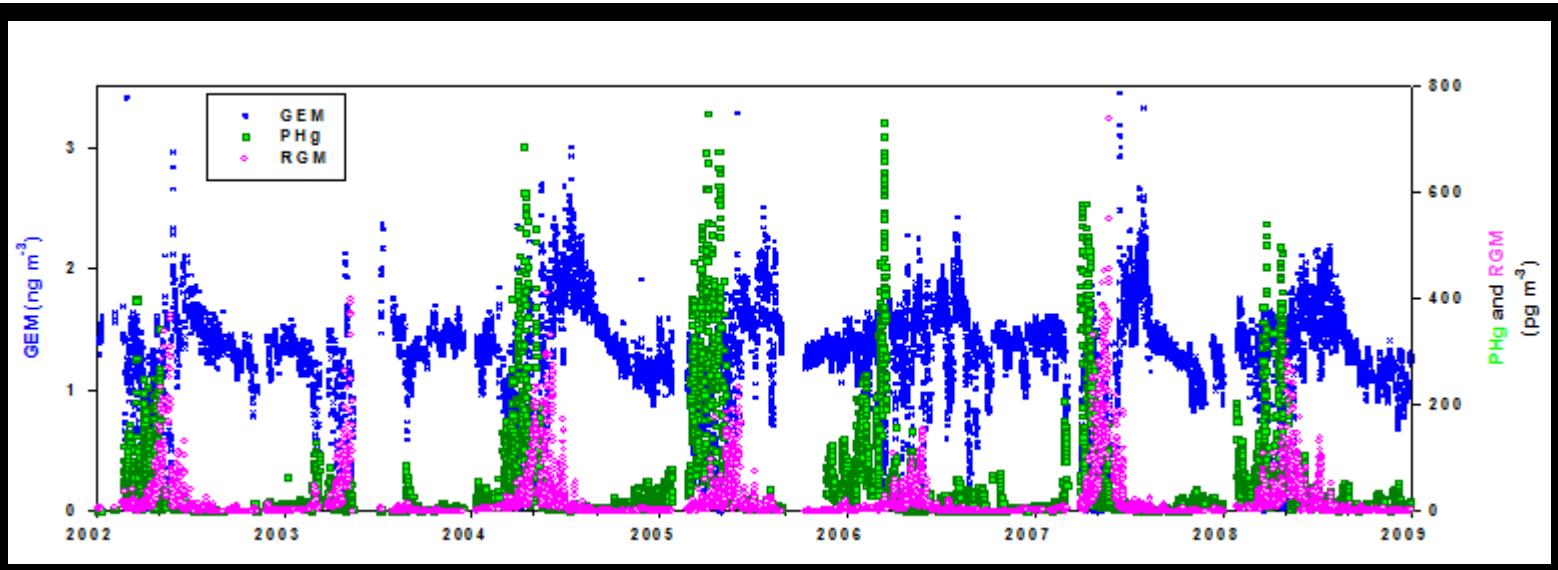


Photo courtesy of Alexandra Steffen

The journey begins - Alert





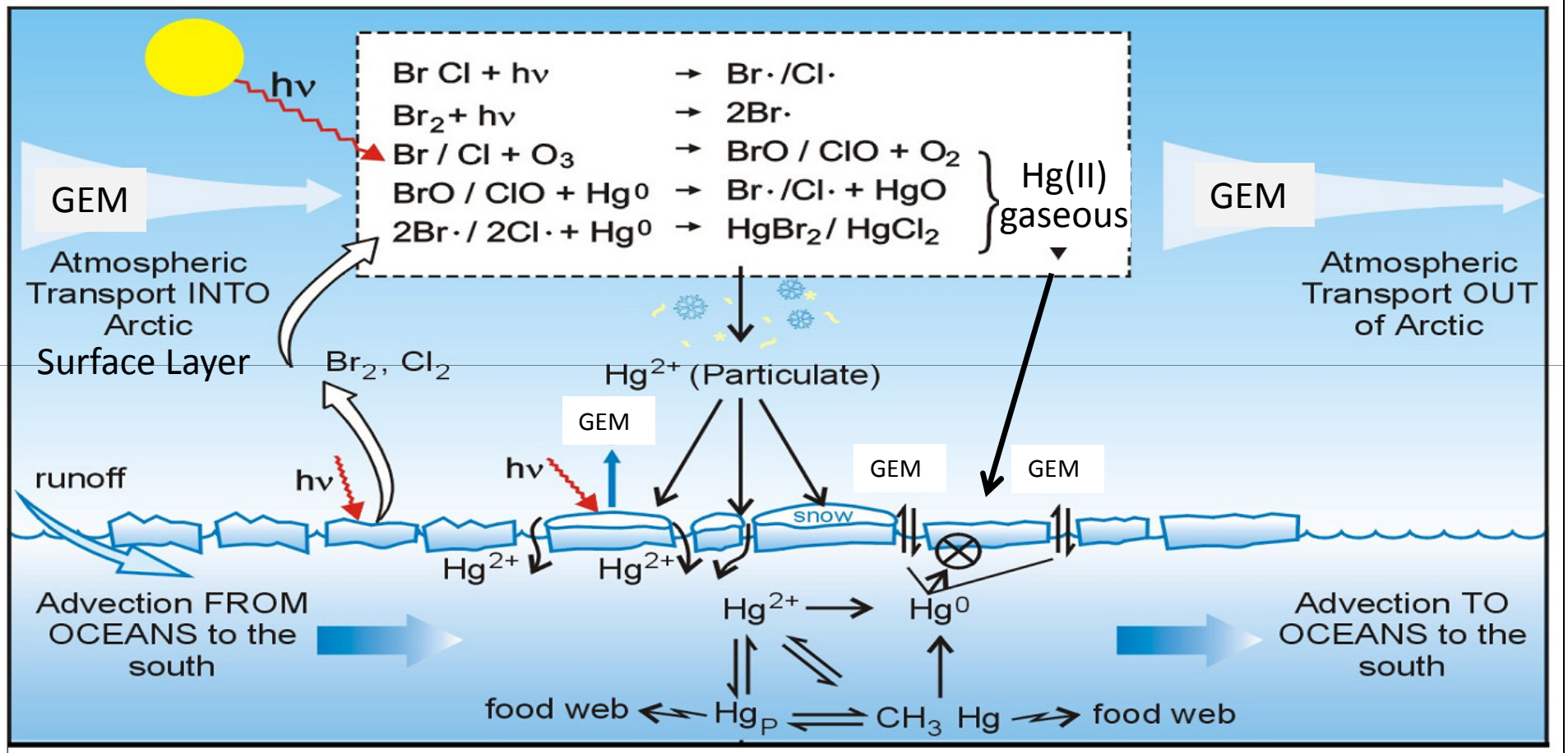
Arctic Ground Measurements



Antarctic Ground Measurements

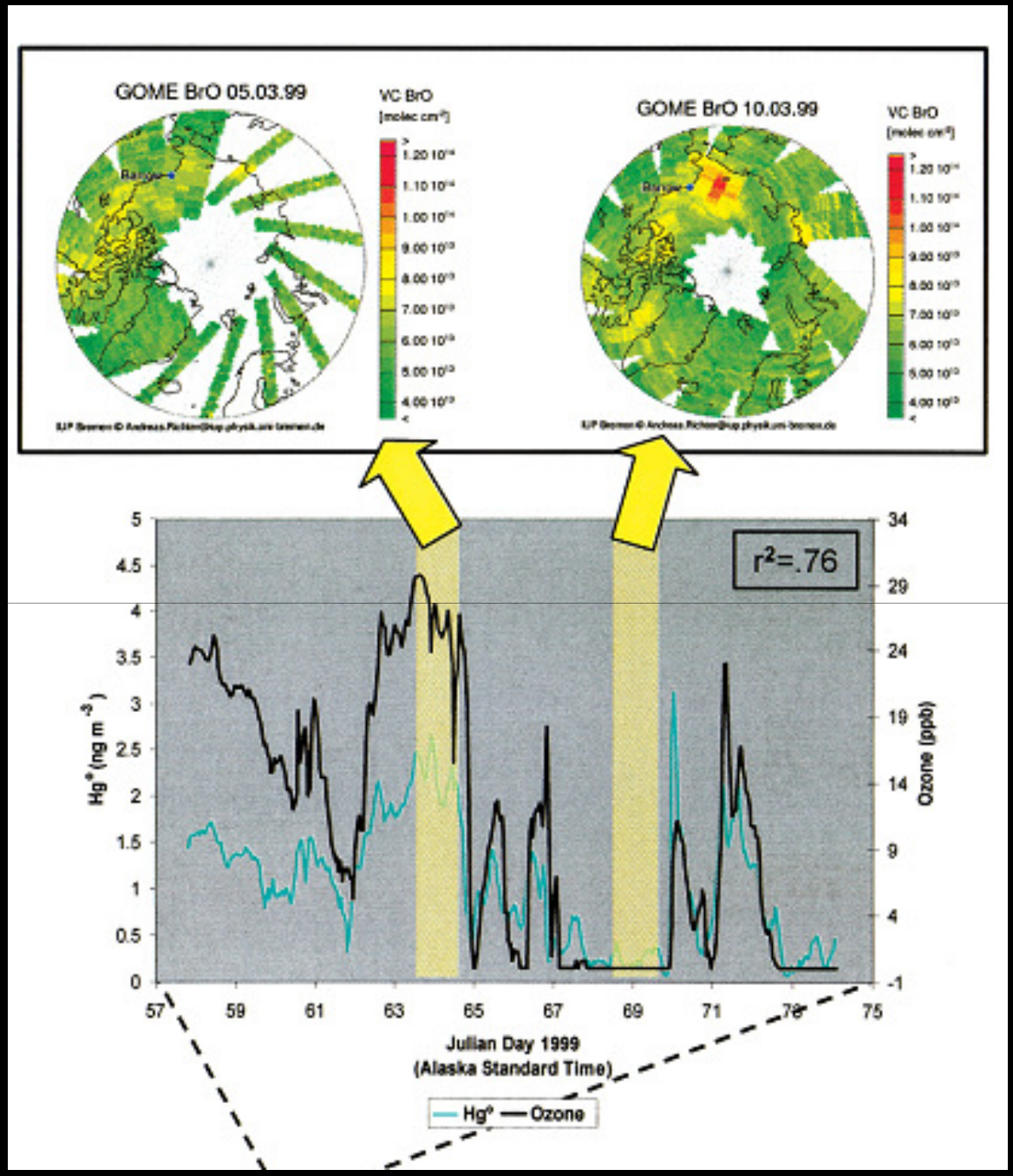


Atmospheric Mercury Depletion Events



From Steffen et al. 2008 *ACP*

Importance of BrO



From Lindberg et al. 2002 ES&T

Measurements of Hg and Bromine

Station Nord, Greenland

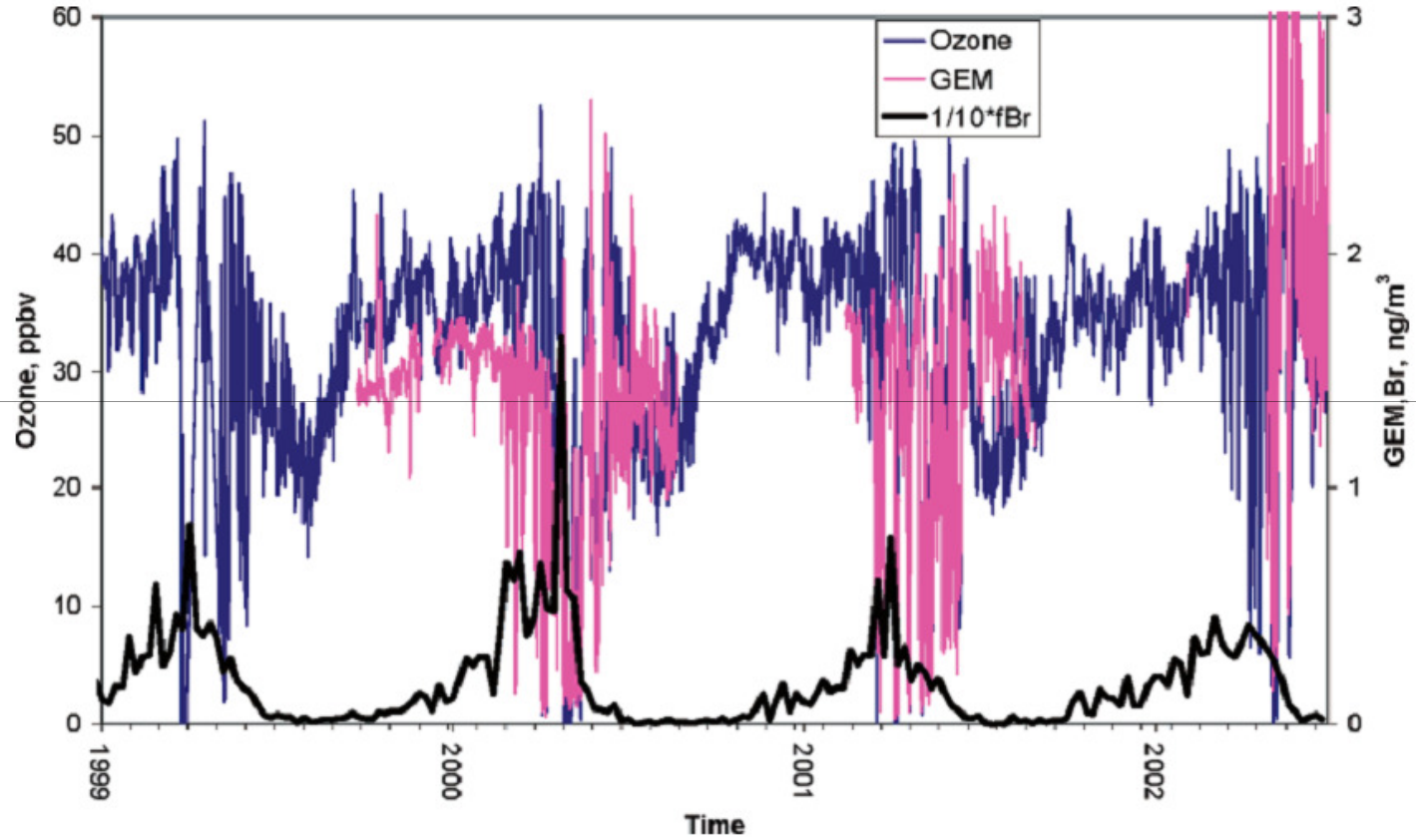
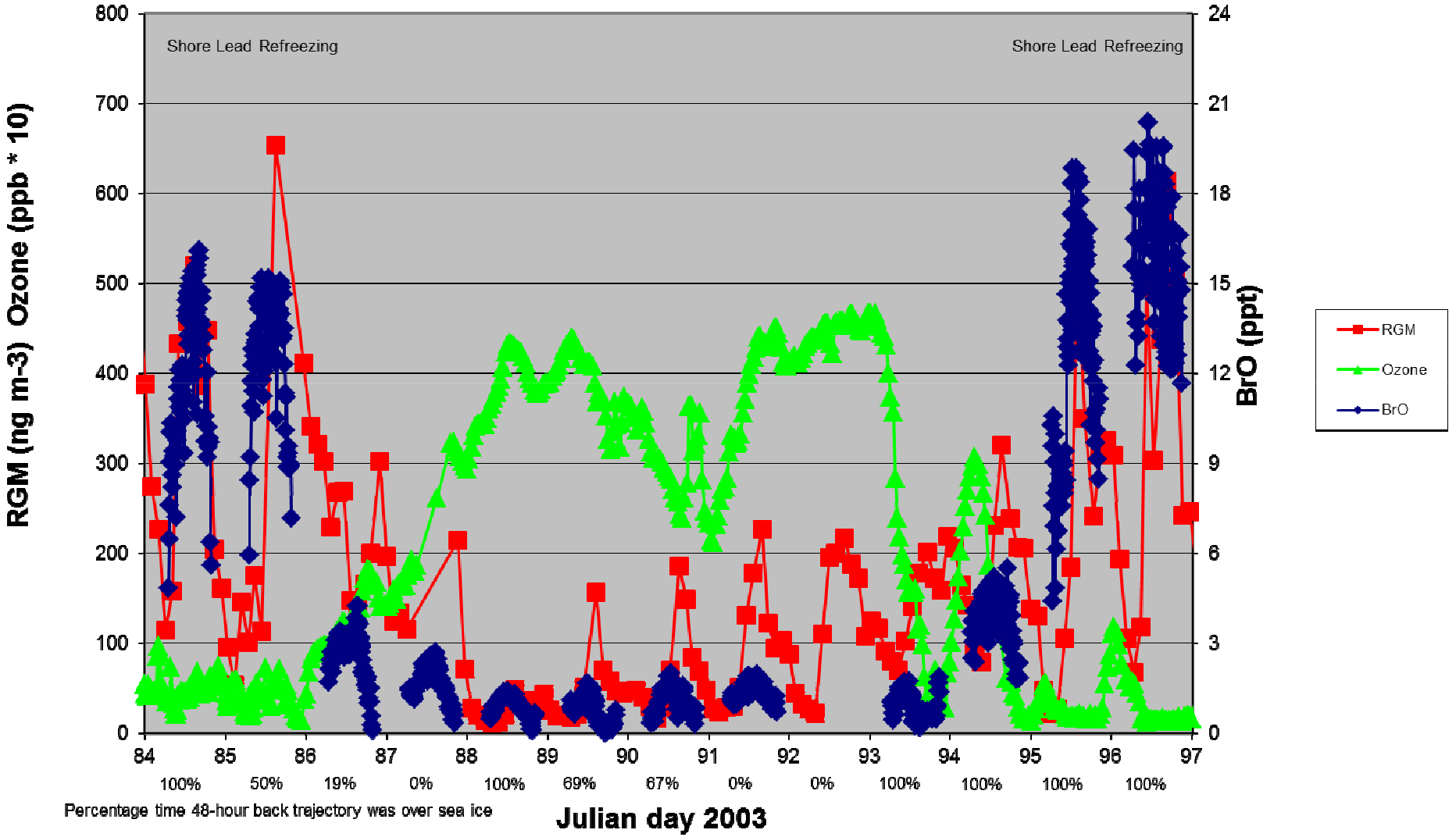


FIGURE 2. Hourly ozone mixing ratios and weekly concentration of fBr measured from 1999 to 2002 at Station Nord, Northeast Greenland. GEM is measured in the period from September 25, 1999 to August 23, 2000; February 14, 2001 to August 23, 2001; and April 26, 2002 to June 29, 2002.

From Skov et al. 2004 *ES&T*

Barrow 2003



Adapted from Brooks et al. 2006 GRL

Summit Greenland

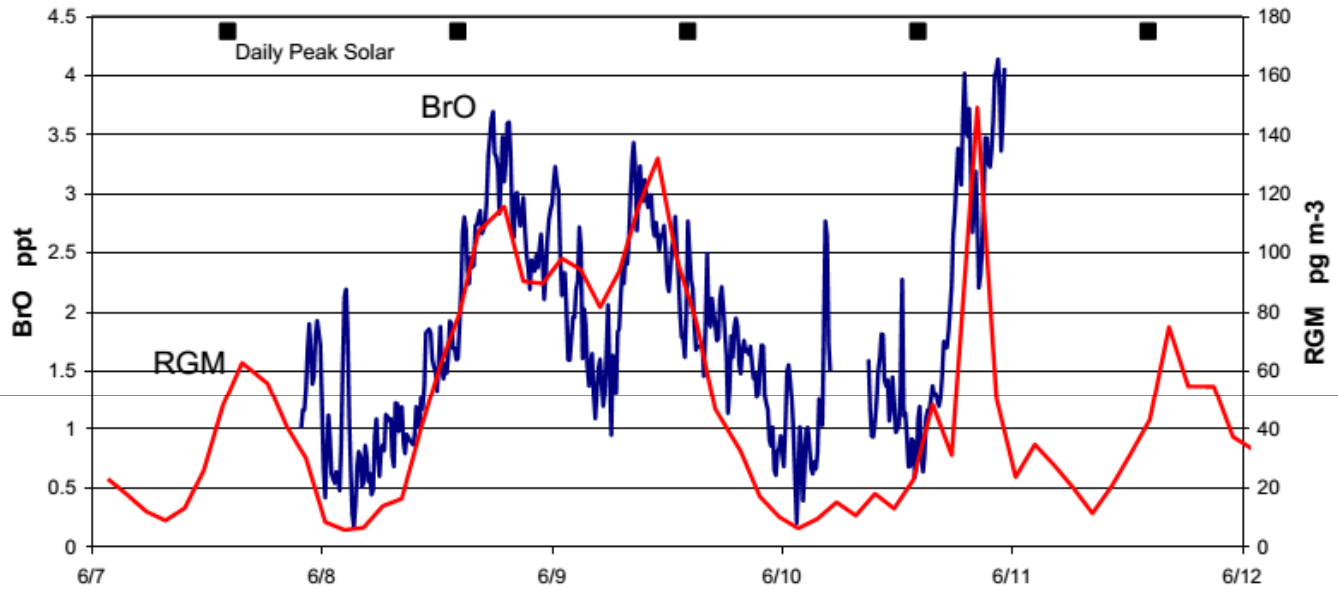
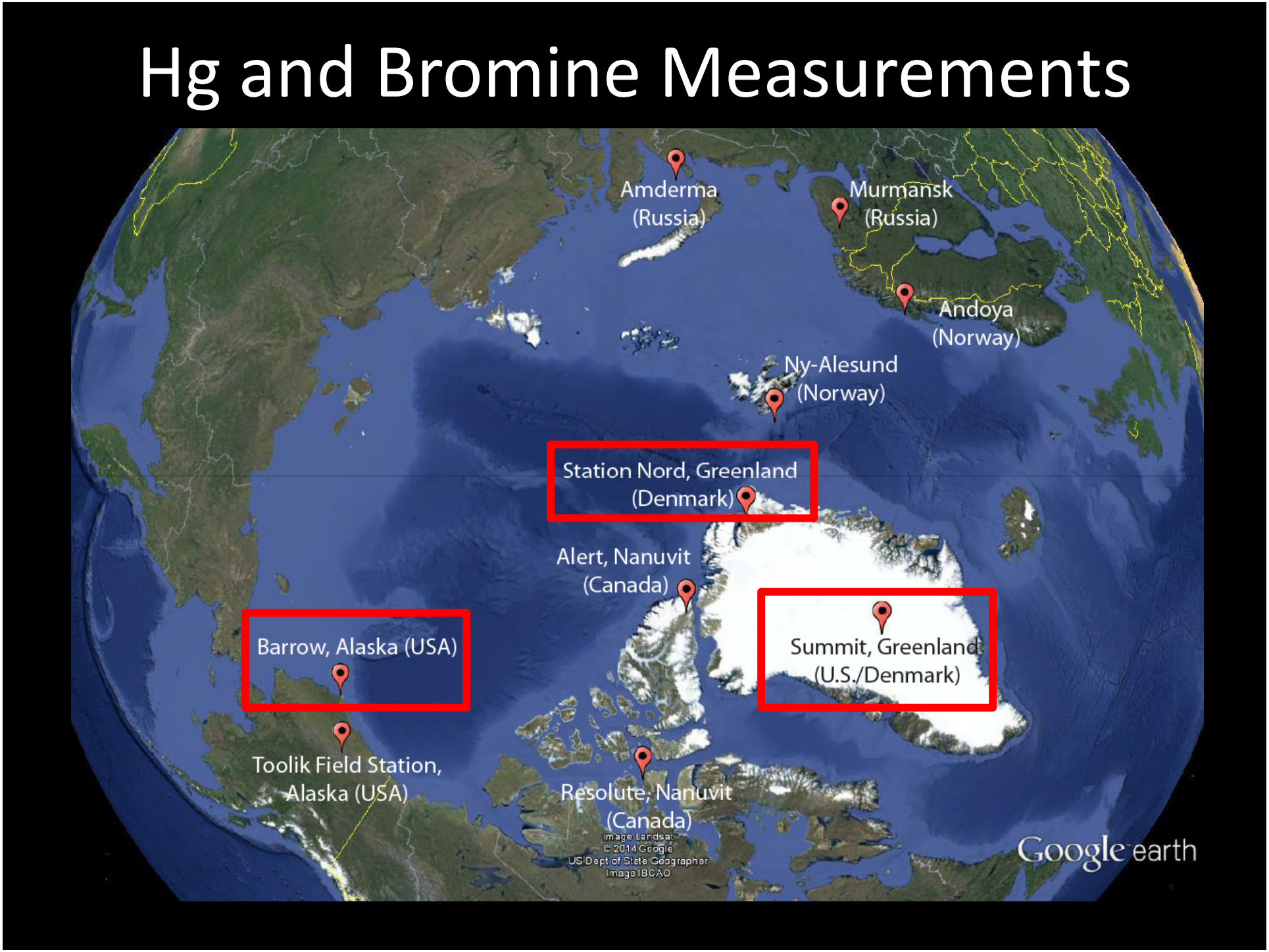


Fig. 9. RGM and BrO from CIMS, 2007 ($r = 0.76$).

From Brooks et al. 2011 *ACP*

Hg and Bromine Measurements



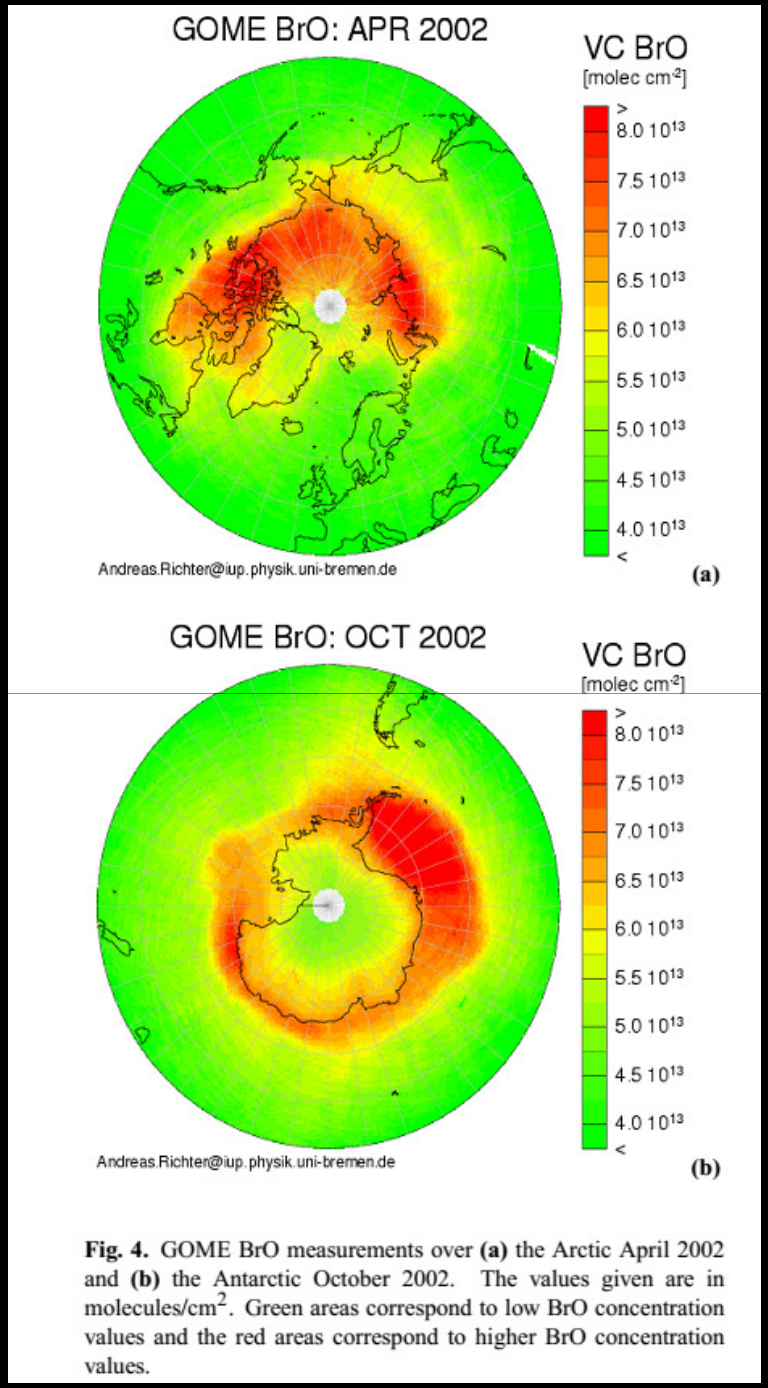


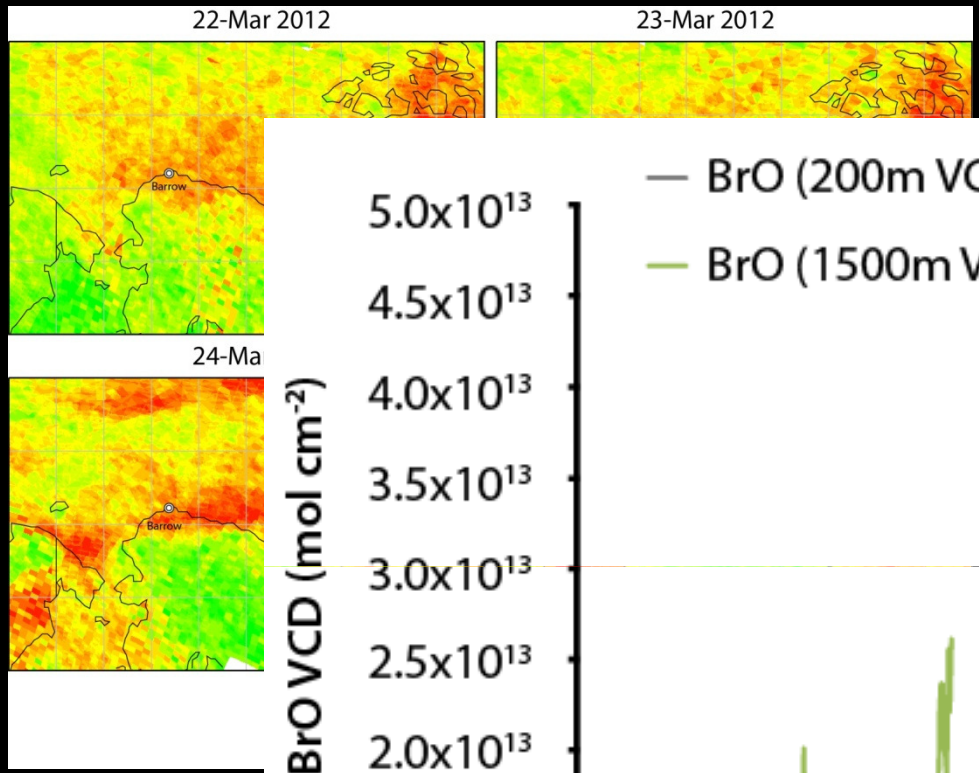
Fig. 4. GOME BrO measurements over **(a)** the Arctic April 2002 and **(b)** the Antarctic October 2002. The values given are in molecules/cm^2. Green areas correspond to low BrO concentration values and the red areas correspond to higher BrO concentration values.

BrO Satellite Measurements

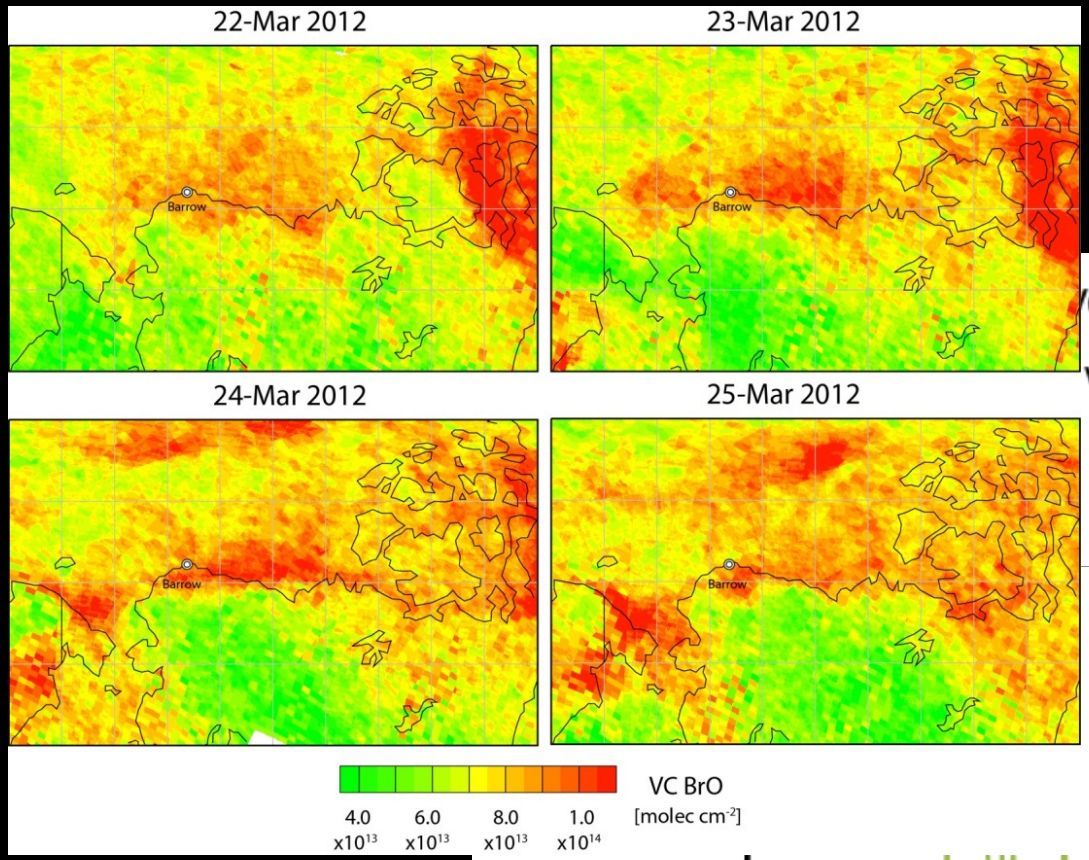
- Satellite images are used to identify "bromine explosions"
- Polar coastal areas are hot spots for bromine activity

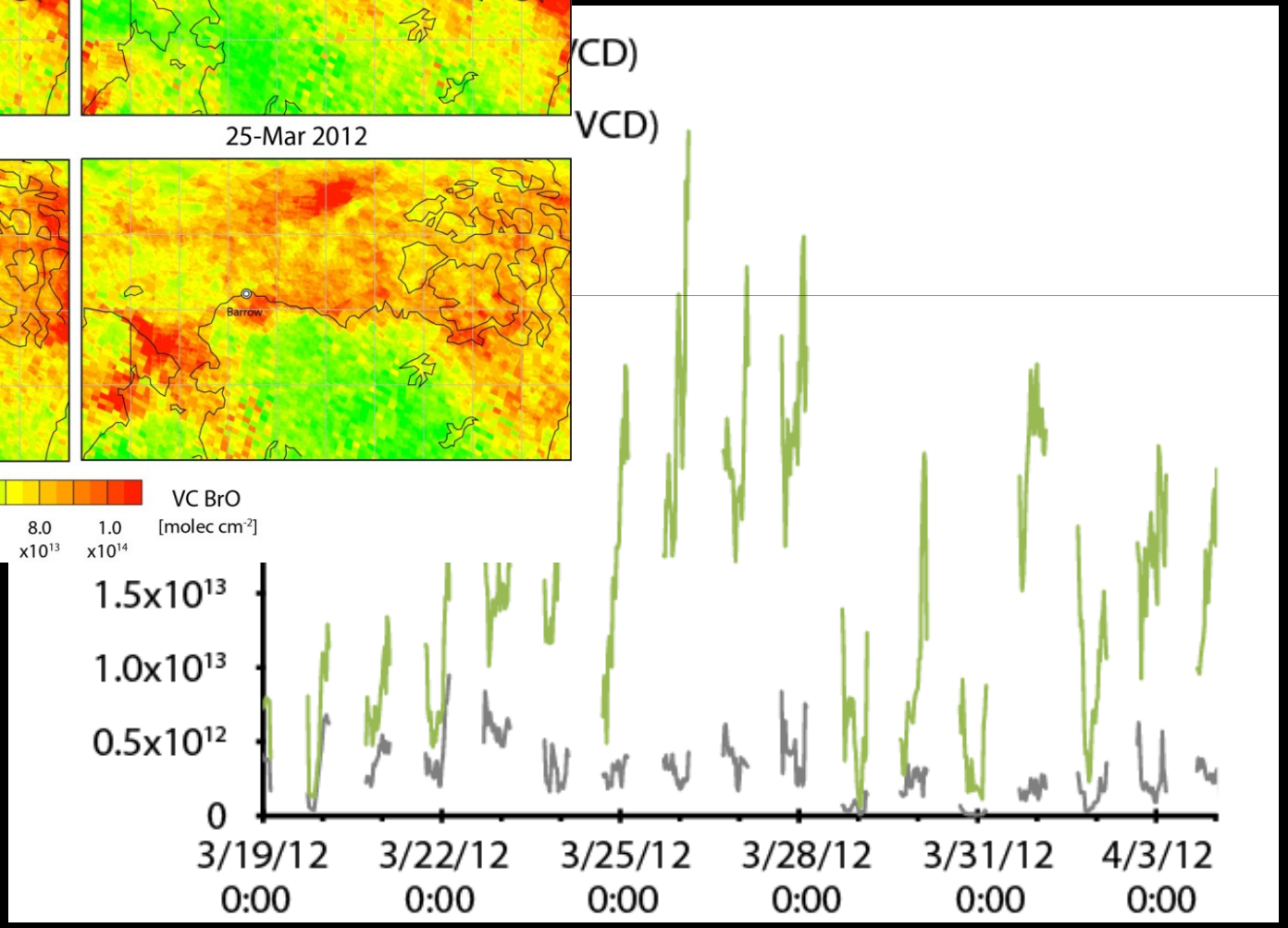
From Steffen et al. 2008

BrO Satellite and Ground Measurements

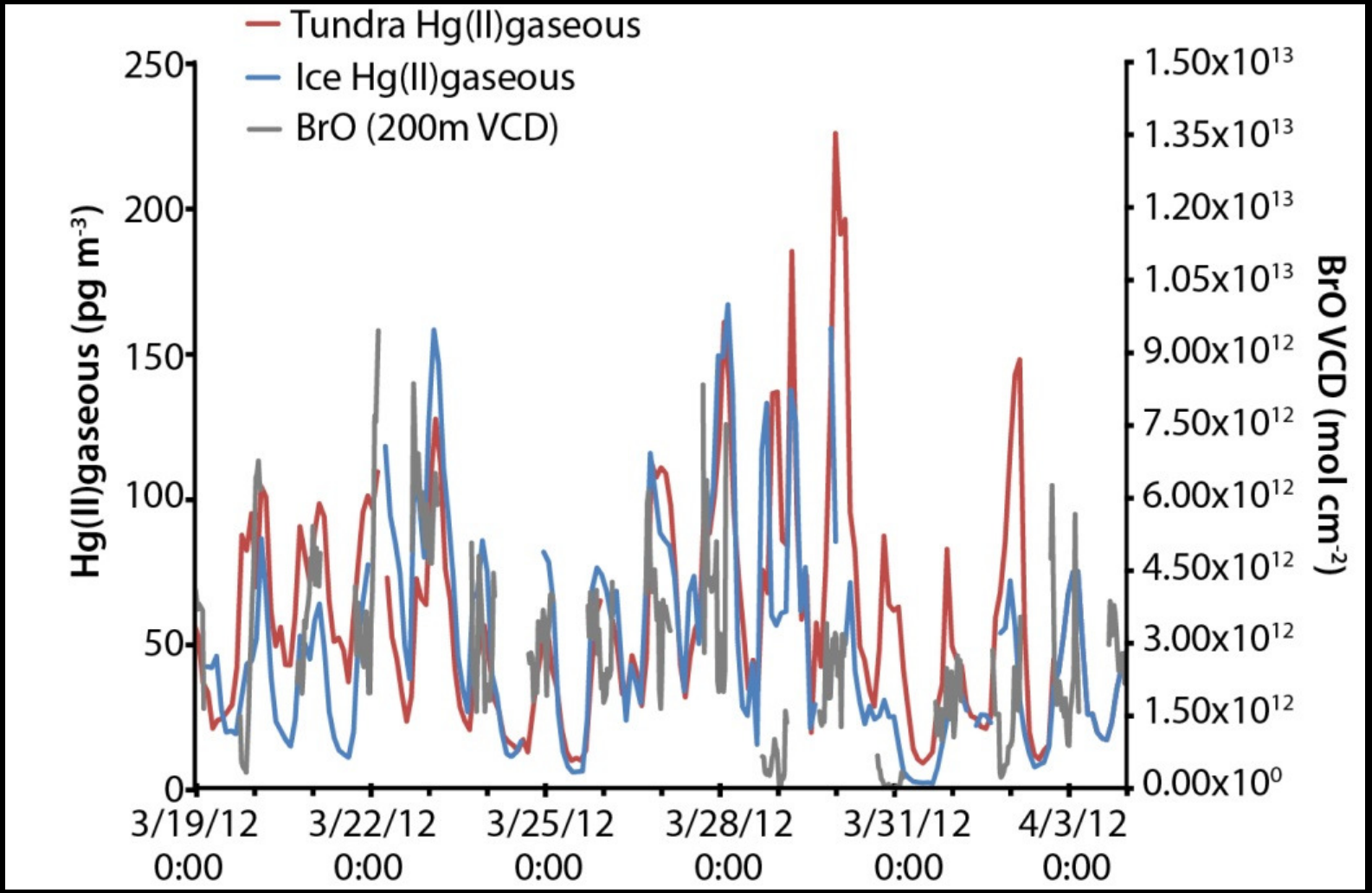


BrO Satellite and Ground Measurements



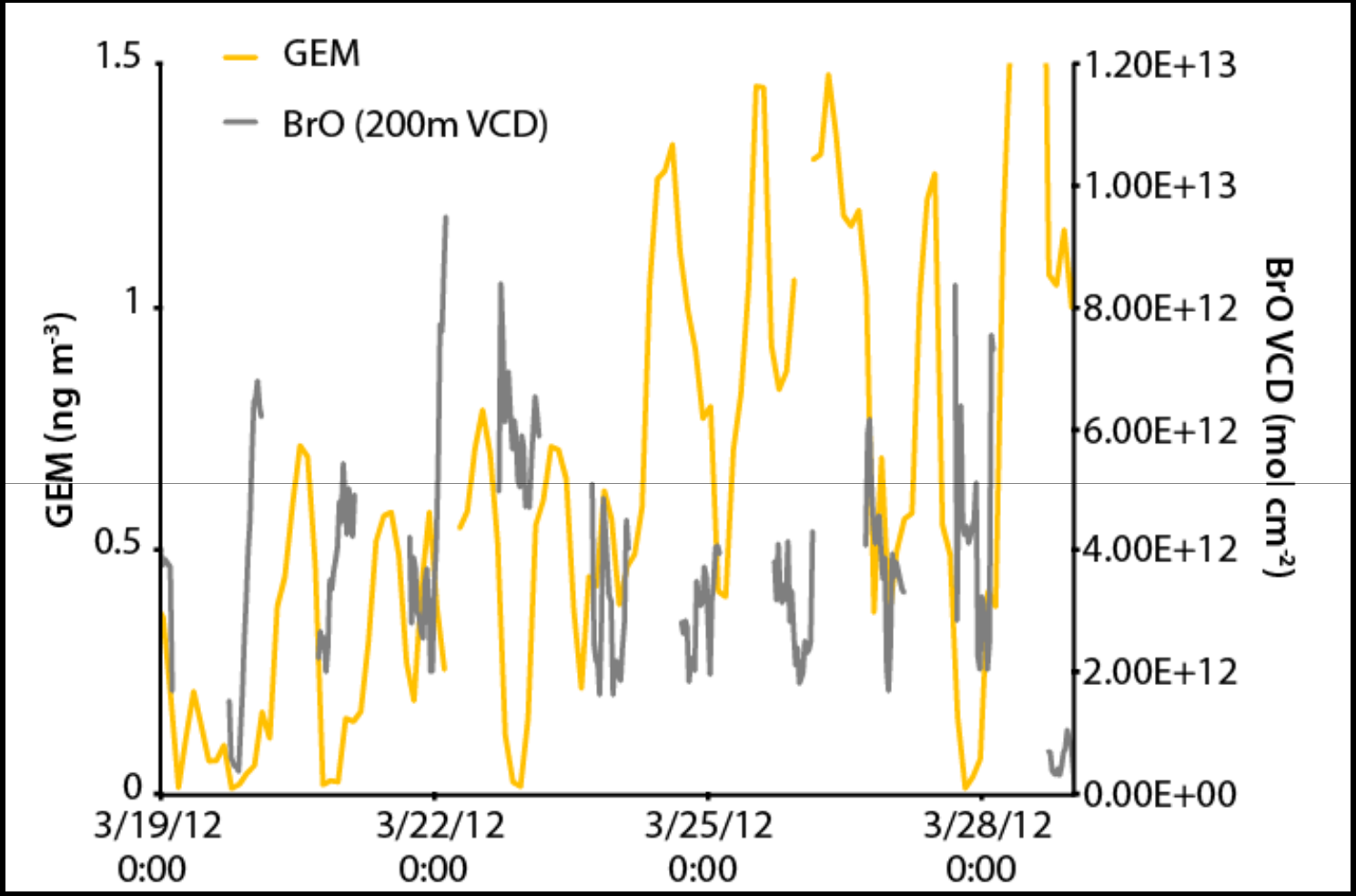


Barrow 2012



- Hg(II)gaseous formation corresponds with BrO within the first 200m

GEM depletion with BrO



- GEM depletion and recovery controlled by physical and chemical mechanisms

Summary

- RGM nicely corresponds to BrO at Polar sites
  - Need to use surface BrO not total column
  - Major challenge for scaling to entire Arctic
- GEM depletion
  - Poor correlation to BrO
  - Concentrations driven both by chemistry and atmospheric boundary layer mixing behavior
- Need better spatial and temporal coverage of Bromine chemistry measurement co-located with Hg measurements
- Hg measurements need to be involved as advances in halogen techniques are made

Thank you!



Barrow 2009

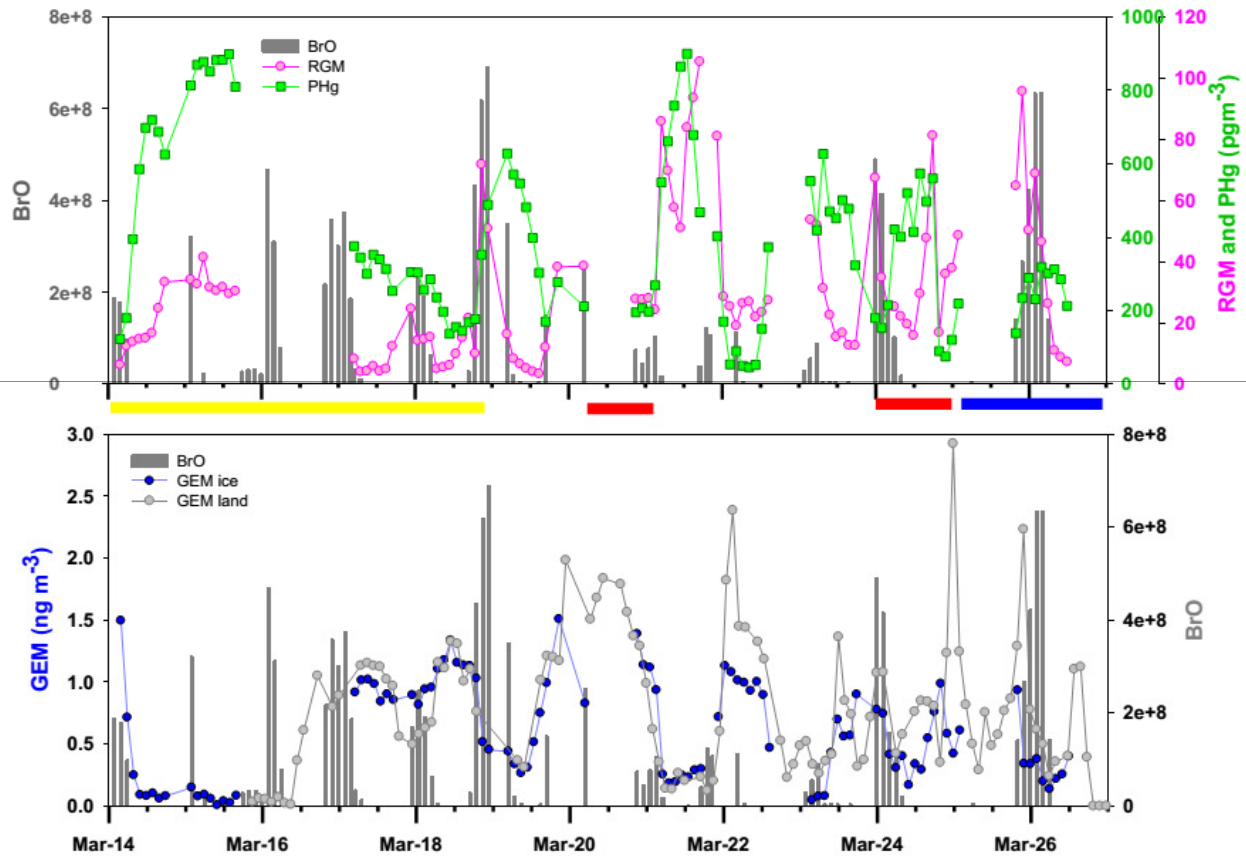
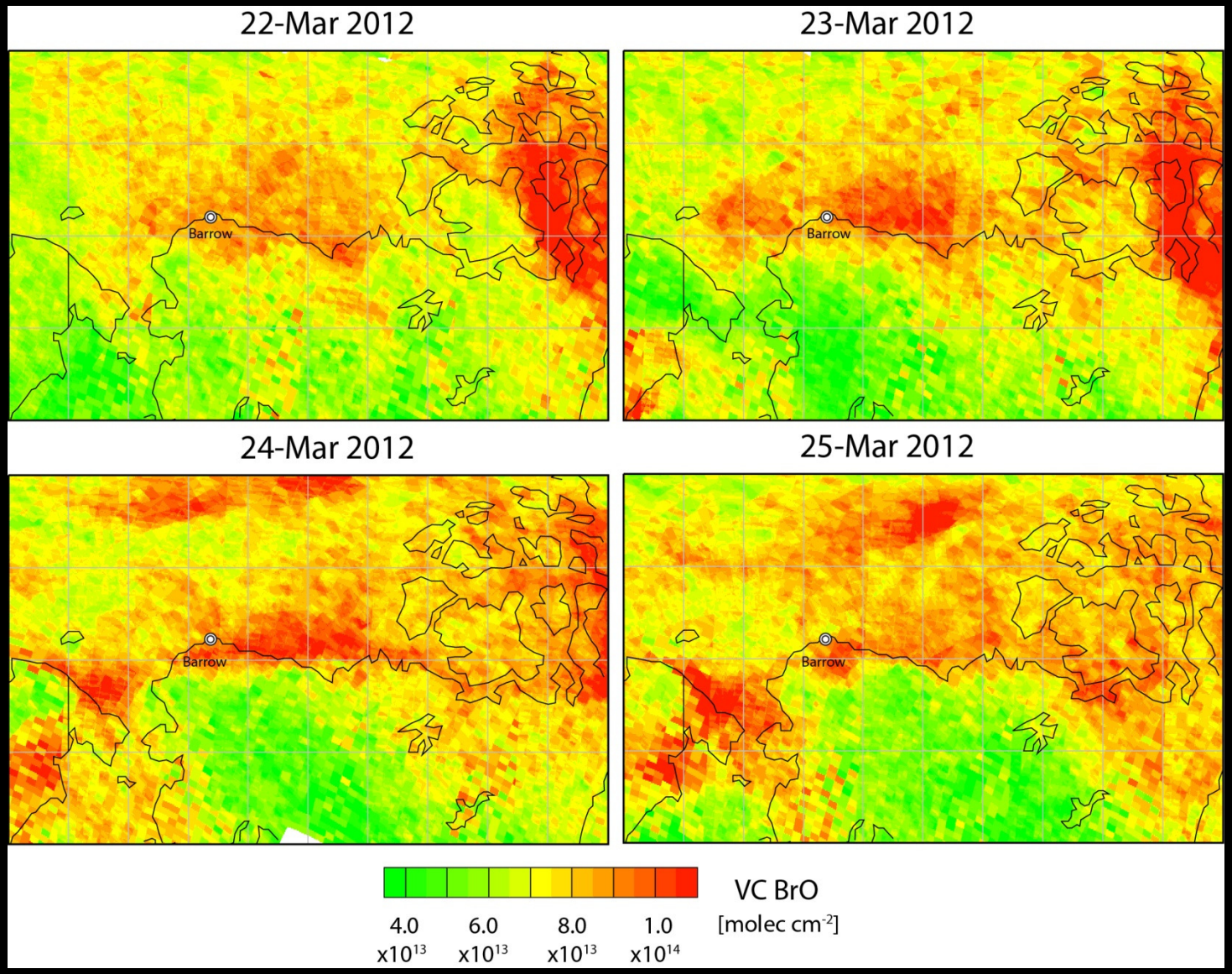


Fig. 5. BrO and PHg/RGM measurements over the sea ice and BrO and GEM measurements over both tundra and sea ice. Events 1, 2 and 3 are marked as yellow, red and blue, respectively.

From Steffen et al. 2013 *ACP*

BrO Satellite Measurements



Moore et al. 2014 Nature

Leads

