Ocean Acidification and Marine Trace Gas Production

Frances E. Hopkins

Sue Turner§, Phil Nightingale*, Michael Steinke*, Peter Liss§

2nd Symposium on the Oceans in a High CO₂ World
Monaco, 6th – 9th October 2008

§Laboratory for Global Marine and Atmospheric Chemistry, School of Environmental Sciences, University of East Anglia, Norwich, UK »Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth, UK. *School of Biological Sciences, University of Essex, Colchester, UK.
Ocean Acidification and Marine Trace Gas Emissions

- Background to the trace gases
  - Halocarbons
  - Dimethyl sulphide (DMS)

- Mesocosm CO$_2$ perturbation experiment, Norway, 2006
  - Findings and Conclusions

- Ischia – A natural laboratory
  - Findings and Conclusions

- Concluding remarks
Halocarbons
Iodocarbons, Bromocarbons

I-, IO-, Br-, BrO-

Cloud formation
New particle/CCN formation

Atmosphere

Transfer of I to terrestrial ecosystems in rain and aerosols

Land

Ocean

DOM/POM
Bacteria
Phytoplankton

CH$_3$I, CHBr$_3$
Seaweeds

Adapted from a schematic by Alex Baker, UEA
Dimethyl sulphide (DMS)

Adapted from Watson & Liss, Phil. Trans. R. Soc. London, 353, 41-51 (1998)
Mesocosm CO$_2$ Experiment

Norway May 2006

Two treatments:
High-CO$_2$ (~750 ppmv, pH 7.8) M1,2,3
Ambient control (~360 ppmv, pH 8.1) M4,5,6

6 x mesocosms

pH manipulated by aerating water column with CO$_2$/air mixtures

23-day CO$_2$-perturbation experiment – investigating impacts of high-CO$_2$ on development and decline of phytoplankton bloom.

Impacts on marine biogenic trace gas production?
Summary and Conclusions

• **Mesocosm experiments** – limitations, difficult to make global extrapolations but currently best way of assessing impacts of ocean acidification on phytoplankton blooms.

  Under high CO$_2$:
  
  - 31% decrease in [iodocarbons]
  - 46% decrease in [DMS]
  - 11% increase in [bromocarbons]

• DMS – modelling study, decrease of this magnitude enough to result in net cloud radiative forcing to increase surface air temp by 1.6 °C (Gunson et al. 2006 GRL 33, L07701, doi:10.1029/2005GL024982).

• Combined decrease in DMS and iodocarbons – warming effect?
Ischia, Bay of Naples, Italy
Volcanically acidified shallow marine site.

A natural laboratory.

2 fieldwork campaigns
Assessment of suitability of site for investigating impacts of ocean acidification on trace gas production

Measurements of Halocarbons, DMS, DMSP, Chlorophyll-a, Fv/Fm, Nutrients, CHN from seawater samples.
Preliminary data from Spring 2008 field campaign

From: Hall-Spencer et al., 2008
Summary and Conclusions

• Preliminary data from Ischia shows some affect of pH on concentrations of a number of climatically-relevant trace gases.
  – Bromocarbons increase – increased destruction of tropospheric ozone, alleviation of global warming?

• Further analysis of the data required in order to ascertain causes of the observed changes.

• Naturally-acidified sites represent powerful tool in exploration of future impacts of ocean acidification.
Concluding remarks

Seawater concentrations of climatically-important trace gases balanced by **production and removal** mechanisms – changes as a result of ocean acidification have potential to impact **sea-to-air flux**.

Impacts on atmospheric chemistry and global climate, with **feedbacks** to the **Earth-climate system**
Thank you for listening!