

# Access ANTARCTICA



## Bromine Explosions and Ozone Depletion in McMurdo Sound

*Tim Hay, a PhD student from the UC Physics and Astronomy Department and NIWA in Lauder, and Katja Riedel from NIWA in Wellington*

The Antarctic ozone hole that forms between about 12 to 25 km up in the stratosphere each spring is a well known phenomenon, but rapid ozone depletion events also occur in the lowest few hundred metres of the polar atmosphere, known as the marine boundary layer. These springtime ozone depletion events, first observed in the mid 1980's, occur over periods of hours or days with ozone concentrations dropping from 25-40 parts per billion (ppb) to as low as 0.05 ppb.

It is now widely accepted that the main mechanism for these sudden and rapid depletion events involves autocatalytic release of bromine, referred to as 'bromine explosions', from sea-salt surfaces. Satellite images show that extensive areas of bromine-enriched air masses, associated with sea ice zones around Antarctica, form for short periods in the spring. The conditions that trigger these events are not fully understood, but young sea ice and a low inversion layer, which acts like a cap permitting little exchange with the air above, are known to be important.

Recent studies are beginning to recognize the importance of reactive bromine, even in small concentrations, not only in the polar boundary layer but in the free troposphere (above the boundary layer) as well. Bromine oxide is involved in the oxidation of gaseous mercury and other toxic substances, resulting in deposition on the sea ice and subsequent releases into the sea during the spring melt. Bromine can potentially influence global climate by removing ozone, which absorbs solar radiation, by oxidation of greenhouse gases such as methane, and by altering the production of cloud condensation nuclei by oxidation of dimethyl sulphide (DMS). Conversely, the potential impact of climate change on the chemistry of bromine, ozone and mercury by altering sea ice cover is uncertain and needs further investigation.

NIWA has been making measurements of tropospheric bromine oxide and ozone at the Arrival Heights observatory (~184 m above sea level) near Scott Base since 1998 and several bromine explosion events have been observed there each spring. Similar observations have also been made at Neumayer, the German base in the Weddell Sea region.



Towing the instrument on the sea ice back to Scott Base. Mt Erebus in the background. Photo: Tim Hay

However, since the boundary layer height is often lower than 200m and the prevailing wind at Arrival Heights is off the land, some ozone depletion events may not be detected there. Therefore, the object of this research is, for the first time in Antarctica, to obtain measurements out on the sea ice itself.

Tim Hay, a PhD student from the UC Physics and Astronomy Department and NIWA in Lauder, and Katja Riedel from NIWA in Wellington recently returned from a 3 month field campaign with a new prototype instrument. The insulated, battery powered system, developed at NIWA in Lauder, contains a spectrometre to measure bromine oxide, a webcam to monitor cloud cover, an air sampler to measure ozone, and a weather station.

After a period of testing and calibration at Arrival Heights the instrument was towed on a sledge to a site on the sea ice below Arrival Heights. Though several kilometres upwind from young sea ice zones, this site provided a useful comparison with Arrival Heights and the spectrometre could still be aimed in the direction of young ice and open water. By repeatedly scanning from the horizon to zenith and comparing the spectra from a series of set elevation angles, a relative measure of bromine oxide in the boundary layer can be retrieved. This is then compared to the ozone concentration measurements to determine if there are any ozone dips anti-correlated with elevated bromine.

At least two ozone depletion events were detected on the sea

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### Directors Note



#### Reflection on past 12 months

As we approach the end of another year it is timely to reflect on the past 12 months and to look forward to 2007. 2006 has been an expansive year for Gateway Antarctica having recruited a new member of staff, Dr Wolfgang Rack as a senior lecturer in remote sensing and glaciology, and having seen an increase in the number of post graduate students at the centre. Our Antarctic courses continue to be popular with high student numbers throughout the year and with close to 200 students having just completed our first year summer courses. We have become part of the International Antarctic Institute which held its first council meeting in Hobart in July and look forward to being part of a global network of Antarctic courses. For the first time we delivered an Antarctic module via the web to a class of students at the University of Georgia. The students will be visiting Antarctica in the new year. Sixteen students from our Graduate Certificate in Antarctic Studies course will be visiting Antarctica over the Christmas period. As one of the aims of the course is to increase the number of people involved in Antarctic research, it is most encouraging to see two of our former graduates return to Gateway Antarctica to enroll for PhDs over the past 12 months.

I would like to take this opportunity to thank all those people who have contributed in many ways to the work of Gateway Antarctica during 2006 and to wish our readers a very happy Christmas and every success for 2007.

--Prof. Bryan Storey

## Graduate Certificate in Antarctic Studies

Gateway Antarctica's Graduate Certificate in Antarctic Studies commenced on 13<sup>th</sup> November with 17 students taking part. The participants have come from around New Zealand, Germany, Finland and England. The group spent two days at Canterbury University's field station at Cass, where they familiarised themselves with equipment to be used in Antarctica and undertook a wet and rainy tramp. The group recently completed a two day first aid certificate and will leave for Antarctica on 21<sup>st</sup> December. The staff members accompanying the group are Yvonne Cook, geologist, Wolfgang Rack, glaciologist, Patti Virtue, biologist and Daniela Haase, tourism specialist. For the duration of the course the participants are divided into four syndicate groups which will examine the following topics:

- The CEP: how effective has this body been and what are the key issues going forward?
- Scientific research projects in the Antarctic: how best can we achieve value for money?
- Minerals under ice: how far do we go to utilize Antarctic resources?
- Defining and valuing wilderness in the Antarctic.

Presentations by the syndicate groups will take place on Thursday 18<sup>th</sup> January at 12:30pm in the Commerce Building, Room 233. All are welcome to attend.



GCAS students at Cass Field Station.

ice, including one event that was not observed by the instruments at Arrival Heights. An initial analysis indicates bromine oxide in the boundary layer during at least one of these events and satellite images also show elevated bromine oxide columns over the Ross Sea region. The occurrence of polar tropospheric ozone depletion events is unpredictable and uncommon, so this is an exciting first result.

In mid-October the instrument was flown by helicopter to Cape Bird on the northern end of Ross Island and set up on the beach overlooking young sea ice. Slightly elevated bromine oxide was detected at the end of October when the temperature dropped below -20 °C and frost flowers formed on the refreezing water in the tide crack. Open leads, further out, had also refrozen and it is likely that frost flowers were also there. Frost flowers are delicate structures that form during freezing at cold temperatures and have been reported as a potential surface for reactions that release reactive bromine.

Overall, it was a very successful first field campaign in Antarctica made possible with support from Gateway Antarctica, NIWA, Antarctica New Zealand and Christchurch City Council.

### ...in Brief

**Congratulations** to Bill Davison and Wendy Lawson in their recent success in the UC promotion round. Wendy is now Associate Professor and Bill is Professor.

**Jean de Pomereu** (GCAS 5) is currently in Antarctica as part of a National Science Foundation Artist and Writers Grant project entitled "Stellar Axis: Antarctica". The two-part project will entail a tracing of the stars above the North and South Pole onto the ice at both poles. Jean is one of the 5 member team who will position ninety-nine blue spheres in alignment to the stars over the South Pole onto the Ross Ice Shelf on December 22, 2006. A performance indicating the motion of the stars at the poles will also be filmed.

#### Christchurch City Council Antarctic Scholarship

The deadline for applications for the 2007 Christchurch City Council Antarctic Scholarship is March 9<sup>th</sup>. The scholarship provides both financial and logistic support for a University of Canterbury student to undertake Antarctic field research. Details of this scholarship are available on the Gateway Antarctica website.

#### Icebergs visit New Zealand

Bryan Storey and Wolfgang Rack provided commentaries for five separate tourist flights over the Antarctic icebergs for Vincent Aviation. This is the first time for over 70 years that a similar armada of icebergs has been spotted off the New Zealand coast. They are believed to have originated from the Weddell Sea region of Antarctica in 2001.



Photo: Leo Schuler (University of Canterbury)



Bryan Storey and Michelle Rogan-Finnemore met with colleagues at the Centro de Estudios Científicos (CECS) in Valdivia, Chile, in October. The meeting was an opportunity to meet with Chilean stakeholders involved in the GEF Medium-Sized Proposal entitled "Southern ICE masses: Targeted Research to support Adaptation to Climate Change". A final draft of the project proposal was prepared at the meeting which will be submitted for GEF Funding consideration early in 2007.

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