Annual Report for Period: 01/2002 - 01/2003

Principal Investigator: Bales, Roger C.

Organization: U of Cal - Merced

Title: Core Measurements at Summit, Greenland Environmental Observatory

Project Participants

Senior Personnel

Name: Bales, Roger

Worked for more than 160 Hours: Yes

Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:
Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Special Requirements

Special reporting requirements: None
Change in Objectives or Scope: None
Unobligated funds: less than 20 percent of current funds
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:
Organizational Partners
Activities and Findings: Any Research and Education Activities
Activities and Findings: Any Findings
Activities and Findings: Any Training and Development
Activities and Findings: Any Outreach Activities
Any Journal
Any Book
Any Web/Internet Site
Any Product
Contributions: To Any within Discipline
Contributions: To Any Other Disciplines
Contributions: To Any Human Resource Development
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering
Annual Report for Period: 01/2002 - 01/2003

Principal Investigator: Bales, Roger C.
Organization: University of California, Merced

Title:
Core Measurements at Summit, Greenland Environmental Observatory

Project Participants

Senior Personnel
Name: Bales, Roger

Worked for more than 160 Hours: Yes

Contribution to Project:
Provided general oversight for coordination of sample collection, shipment, and analysis. Provided general oversight for web interface design.

Post-doc
Name: None

Worked for more than 160 Hours: No

Contribution to Project:

Graduate Student
Name: Burkhart, John

Worked for more than 160 Hours: Yes

Contribution to Project:
Specific tasks included participation at numerous meetings presenting GEOSummit data and facility opportunities, participation at the GEOSummit Planning Meeting in January 2004, and continued development and operation of the on-line data archive. Additionally, worked to maintain and update the GEOSummit project web page: www.geosummit.org

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

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<td>monthly accumulation markers</td>
<td>UCM - R. Bales / J. Burkhart</td>
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Activities and Findings

Project Activities and Findings:

Principal Activities:

The purpose of this grant is to develop and maintain year-round observations of baseline variables including meteorology, snow chemistry, and atmospheric chemistry at the Summit, Greenland Environmental Observatory (GEO-Summit), an international observatory for measurements and experiments of the atmosphere and ice sheet. Measurements include baseline meteorology, radiation, tropospheric chemistry, snow properties and snow chemistry, some measurements in cooperation with NOAA-CMDL and measurements initiated by individual investigators. Measurements are aligned with the objectives of the World Meteorological Organization's Global Atmospheric Watch (GAW) program. The atmospheric gas-phase and aerosol species being studied are all either sensitive indicators of anthropogenic impacts on regional and global atmospheric change, or are important chemically coupled species whose concentrations may be strongly influenced by changes in the Arctic, including changes in snow/ice surface temperatures, ice/snow cover, and atmospheric circulation. Related chemical measurements in the snow provide the needed link to investigate feedbacks between Arctic climate change, air-snow exchange, and atmospheric composition.

Over the past year the specific tasks have included:

- Establish baseline measurement program at Summit Station.
- Coordinate with on-site staff the collection, handling, storage, and shipment of samples.
- Coordinate locally sample storage and analysis.
- Develop collaboration and partnership between GEOSummit, NOAA-CMDL, and the WMO-GAW program.

In this first year of the program, the bulk of efforts have been on developing the measurement program at Summit such that instrumentation, sample collection, and sample handling/shipment can be done safely and in a timely manner. Groundwork has been laid out to develop sampling areas for clean snow and clean air samples that will minimize impact from other station activities. Staff on-site have been trained to collect snow and atmospheric samples, and are communicating regularly with each of the collaborative investigators who are participating to provide baseline measurements. Regular communication between the collaborative groups has been established to assure timely delivery of baseline datasets.

Principal Findings:

Snow accumulation:

Regular sampling of the accumulation grid was conducted weekly without problems. The grid was moved at the beginning of the season to accommodate the new station layout and to prevent station-influenced drifting. Accumulation from the most recent year appears to be consistent with previous measurements and furthers our understanding of sub-annual accumulation variability. The 12-km transect was also successfully sampled monthly without complications. This transect will be moved later this summer to accommodate the new station sectors.

Snow ion samples:

Bi-weekly samples of surface snow were collected and stored on-site until the first available C-130 transport flight was available to return the samples to the US. The samples were shipped to DRI where they are presently being stored pending operability of our ion chromatograph later this summer.

Snow ICP-MS samples:

Weekly samples of surface snow were collected and stored on-site until the first available C-130 transport flight was available to return the samples to the US. The samples were shipped to DRI where they are presently being analyzed. Data should be available in the fall of this year.
NOAA-CMDL canister samples:
Canister samples for the NOAA-CMDL group were collected weekly without complications. The preliminary analysis of the samples was very promising to NOAA investigators, and demonstrated that GEOSummit is indeed clean enough despite concerns regarding local pollution, and the site is sampling the free troposphere.

Meteorology:
Continuous meteorological measurements were made at Summit by an automated weather station maintained by the GC-NET group at the University of Colorado. Data is available real-time via the web at http://cires.colorado.edu/people/steffen/group/aws/current_plot_06.6day.jpg
For longer archives please contact: K.Steffen

Surface Ozone Monitoring:
Continuous hourly sampling of ozone has been successful at Summit with cooperation of S. Oltmans at the NOAA-OZWV group. Data is being archived and available at:
ftp://140.172.192.211/ozwv/surfo3/summit%20greenland/

Radionuclides:
Radionuclide filter samples have been collected continuously since August 2003. Filters are changed every two days and shipped at the first opportunity to J. Dibb of UNH.

Aerosol Drum Impactor:
A continuous aerosol drum impactor has been operating at Summit since July 2003. There were a few minor data losses as a result of power supply, but otherwise the results have been very promising. An update is attached from T. Cahill at UC Davis.

Aethelometer/Black Carbon samples:
Black carbon measurements at Summit proved very successful and further demonstrated the pristine nature of the site. The spikes in the dataset shown at the right are a result of regular inlet cleaning.

One-meter snow pits:
Monthly 1 meter snow pits were excavated and sampled at 3-cm resolution. Stratigraphy is recorded and available by request of the GEOSummit SCO (www.geosummit.org).

Project Training and Development:
Working with VECO, the NSF, and the GEOSummit SCO the baseline measurement program has been a key component of the future development of the Summit Station. New boundaries at the station have been designed to allow for maximum utilization of the site from multiple science platforms while ensuring clean air and snow facilities for baseline measurements.

Research Training:

Outreach Activities:
www site, email list serve
Journal Publications

Burkhart JF; Hutterli, MA; Bales RC; McConnell JR. Seasonal accumulation timing and preservation of nitrate in firn at Summit, Greenland. Accepted for publication to the Journal of Geophysical Research, April 2004

Books or Other One-time Publications

Burkhart JF; Bales RC; Hutterli MA; McConnell JR. Sub-annual preservation of HNO3 at Summit, Greenland. To be presented at the European Geophysical Society Annual Meeting, Nice, France, April 2004

Hutterli MA; Burkhart JF; McConnell JR; Belle-Oudrey D; Bales RC. Atmospheric formaldehyde (HCHO) and hydrogen peroxide (H2O2) mixing ratios in the past 450 years inferred from Greenland firn records. To be presented at the European Geophysical Society Annual Meeting, Nice, France, April 2004

Burkhart JF; Bales RC; McConnell JR. Core atmospheric measurements at the Summit, Greenland Environmental Observatory: GEOSummit. Presented at the SEARCH Open Science Meeting, Seattle, WA, 27-30 October 2003

Burkhart JF; Bales RC; McConnell JR. Core atmospheric measurements at the Summit, Greenland Environmental Observatory: GEOSummit. EOS, Transactions AGU Fall Meeting 2003

Web/Internet Site

URL(s):
http://www.geosummit.org

Description:
The website contains numerous resources for investigators and the general public to gather more information about the conditions at Summit. There are links for logistics, scientific coordination, and data availability. Additionally, besides the publications listed above, which are limited to those that have received support directly under this grant, there is a more comprehensive publications list for which any SCO-coordinated activities were involved.

Other Specific Products

Product Type: Data or databases

Product Description:
A database of atmospheric and surface data for summit is being compiled, and is accessible via the website.

Sharing Information:
Data is accessible via the website and through direct contact of the SCO.

Contributions

Contributions within Discipline:
Facilitate and coordinate cooperative research, and dissemination of measurements.

Contributions to Other Disciplines:
Facilitate and coordinate cooperative research, and dissemination of measurements.
Contributions to Human Resource Development:
One graduate student is involved in this interdisciplinary effort.

Contributions to Science and Technology Infrastructure:
Baseline, meteorology, atmospheric chemistry, surface snow chemistry, and snow property measurements are made available to investigators by request and through our website for use in constraining models.

Contributions: Beyond Science or Engineering:

Special Requirements

Special reporting requirements:
None

Change in Objectives or Scope:
None

Unobligated funds: less than 20 percent of current funds
Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:
Organizational Partners
Activities and Findings: Any Research Training
Activities and Findings: Any Outreach Activities
Any Journal
Any Book
Contributions: Beyond Science or Engineering
Attachments / Progress Reports:
Aerosols at the Greenland Summit Site

Thomas A. Cahill
and the DELTA Group, Steve Cliff, Kevin Perry (Met, U. Utah), Michael Jimenez-Cruz, and Lee Portnoff, http://delta.ucdavis.edu,
University of California, Davis

Goal:
To make measurements of aerosols by size, time, and composition at the Greenland Summit site in order to support evidence of aerosol deposition in the ice cores.

Technical approach:
In order not to miss the summer, 2003 sampling period, loaned standard DELTA Group slotted 8 DRUM was sent at short notice to the Summit Site, where it was installed in the tunnel at the clean site by station personnel. All indications that the placement was excellent, and the station personnel are to be commended. However, calculations showed that the high time resolution of this unit, 3 hr, would result in very light mass loadings and thus poor sensitivity, while require many unit changes throughout the year.

The sampler operated from June 16 to roughly July 11, when a failure of the battery back up system stopped DRUM rotation. It was then shipped back to UC Davis.

Since funding had not yet been received in July, modifications were made of an existing DELTA 8 DRUM and the battery back system, which were then shipped to the Summit site in August. Duration of sampling was raised from 6 weeks in the standard unit to 48 weeks, capable of operating all winter without replacement, but at the cost of reducing time resolution to 24 hr. This unit operated correctly for roughly 24 weeks, then lost rotation in Spring, 2004. This was recorded and corrected by station personnel on May 8, but there will be a period with no data before that date. Again, the battery back up failed.

With the arrival of funding on October, an entirely new system is being prepared for the project, with scheduled for shipment in June, 2004, with better diagnostics and back up capabilities.

Analysis:
Examination of the received DRUM samples from summer, 2003, showed that there was adequate collected mass for Synchrotron-X-ray Fluorescence (S-XRF) analysis. This was performed in March, 2004. Mass and optical attenuation are scheduled for this month with the upgraded soft-beta mass and wavelength-dependent analysis system of the DELTA Group. These results must be considered preliminary until these latter measurements are folded into our quality assurance (QA) protocols.

The first point is that essentially no sea salt (chlorine) was seen at this site in the super-micron size modes, other than a small amount on the first two days that could well have been contamination during emplacement.

Figure 1 shows silicon and calcium (from soil) for the super-micron size modes. The most striking fact in this plot is the total lack of particles below 5 μm during the major soil episodes of June 26. This is essentially never seen in typical ground level sampling.
We ran HYSPLIT trajectories for June 26, and find that the local air at ground level is a slow terrain driven upslope-downslope pattern off the ice sheet, while the upper level winds reach to the Pacific where they could easily pick up Asian dust.
This could provide a mechanism for the size results, in that the coarse material at high levels could settle and reach the ground while the finer material would not.

Sulfur presents an entirely different pattern, with almost all mass in the sub-micron modes. Note that the June 24 episode has a typical accumulation mode size profile, while the June 27 episode is enriched in the very finest particles below 0.26 μm. This could be the result of a local source of combustion aerosols or very fresh conversion from SO₂ to sulfate. Note that the upper level air came from western Europe.
The episode on July 5 is very interesting. The extremely sharp resolution in time normally indicates a more local source or plume. Trajectory analysis for this period shows that the low level winds came from the east and west in this period. There were many trace metals in this episode and near this episode (with a day) including nickel, zinc, and copper, though normally not on the same exact time (Recall, we have 3 hr time resolution on this period). Additional work is needed to examine these intriguing plumes.
NOAA HYSPLIT MODEL
Backward trajectories ending at 15 UTC 27 Jun 03
FNLS Meteorological Data

Source ★ at 71.50 N 40.30 W

Meters AGL

Job ID: 361959   Job Start: Thu May 13 17:56:53 GMT 2004
lat: 71.5 lon: -40.3 hghts: 1000, 3000, 5000 m AGL
Trajectory Direction: Backward   Duration: 48 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYSPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)
NOAA HYPLIT MODEL
Backward trajectories ending at 15 UTC 05 Jul 03
FNL Meteorological Data

Source ★ at 71.50 N 40.30 W

Meters AGL

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<tr>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>2500</th>
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<td>07/02</td>
<td>07/03</td>
<td>07/04</td>
<td>07/05</td>
<td></td>
</tr>
</tbody>
</table>

Job ID: 362057    Job Start: Thu May 13 17:59:42 GMT 2004
Lat: 71.5°    Lon: -40.3°    Hgts: 1000, 2000, 3000 m AGL

Trajectory Direction: Backward    Duration: 96 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Produced with HYPLIT from the NOAA ARL Website (http://www.arl.noaa.gov/ready/)