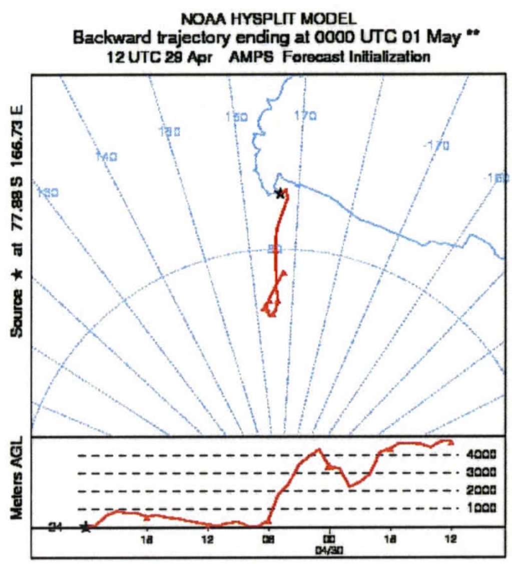
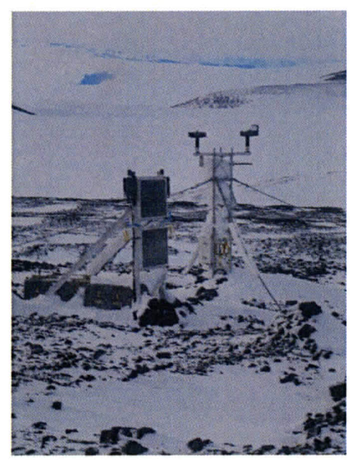
AWS-Ozone 2nd Annual Project Report: NSF-OPP Grant #1043478, June 30, 2012 to June 30, 2013

Collaborative Research: Augmenting the Ross Island-area automatic weather station network to develop a tropospheric ozone climatology

A Report to the Office of Polar Programs, National Science Foundation





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Space Science and Engineering Center
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Submitted on May 31, 2013

Preview of Award 1043478 - Annual Project Report

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1043478
Project Title:	Collaborative Research: Augmenting the Ross Island-area automatic weather station network to develop a tropospheric ozone climatology
PD/PI Name:	Matthew A Lazzara, Principal Investigator
Submitting Official (if other than PD\PI):	Matthew A Lazzara Principal Investigator
Submission Date:	05/31/2013
Recipient Organization:	University of Wisconsin-Madison
Project/Grant Period:	07/01/2011 - 06/30/2014
Reporting Period:	07/01/2012 - 06/30/2013
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Matthew A Lazzara

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Accomplishments

*** What are the major goals of the project?**

The Antarctic troposphere is the least anthropogenically influenced surface air on Earth and, as such, presents a unique opportunity for studying naturally occurring processes that control the chemical composition of the atmosphere. Antarctica is also the most sparsely instrumented area of the Earth for the in situ observation of atmospheric composition and chemistry. Knowledge of the composition and chemistry of the Antarctic troposphere is largely based on short duration campaigns at single locations, and as a result, the seasonal and spatial variations in tropospheric constituents are not well understood. This knowledge gap is compounded by the fact that many of the chemical processes occurring at high latitudes are strongly affected by extreme seasonal variations of solar radiation and temperature, as well as by geographical variations in surface type. This is particularly true at the continental margins of Antarctica where surface conditions alternate between snow-covered sea ice and open ocean and where air masses can originate from the Antarctic Plateau or the sub-Antarctic ocean.

Intellectual Merit: Of particular interest to the study of atmospheric chemistry is tropospheric ozone, which exhibits predictable seasonal variations, as well as poorly understood anomalies (ozone depletion events) at polar sunrise. In the proposed project, a network of reliable, low- power ozone sensors, to be co-located with existing Automatic Weather Stations (AWS) in the Ross Island region will be built to produce a multi-season data set of surface level ozone observations. A network approach to ozone monitoring has important advantages over a single station both for establishing a record of surface level ozone distributions and for the study of specific phenomena such as ozone depletion events. Due to the remote locations of the existing AWS sites and the use of renewable non-polluting energy sources, this network will provide ozone observations that are free of anthropogenic influence and hence more representative of the broader distribution in the region. This data set will be invaluable for studying the natural background processes that control tropospheric ozone, without the influence of transported pollution and local pollution sources that have muddied the interpretation of other polar ozone measurements. The addition of robust, low-power ozone sensors to the Ross Island-region AWS network capitalizes on this existing and proven system, and expands the type of scientific questions related to high latitude tropospheric ozone that can be addressed.

Broader Impacts: Chemical sensor networks present a new paradigm for measurements in the Antarctic. The feasibility of remote, near-real time Antarctic measurement systems has been demonstrated by the AWS systems, but this project will be the first to develop and deploy chemical sensors in the harsh conditions of the Antarctic. Success in this endeavor will pave the way for future design and deployment of more and varied chemical sensors to study the remote high latitude environment.

What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities: Year 2 of this project centered around 3 major activities:

- Continued quality control of the automatic weather station (AWS) data for use in the project
- Field season support at the AWS co-locations with the ozone sensor equipment
- Development of (Hybrid Single Particle Lagrangian Integrated Trajectory Model) HySPLIT forecast back trajectories to the 5 ozone sensor locations generated from the Antarctic Mesoscale Prediction System (AMPS) modeling system.

Specific Objectives: The basis for the major activities is to be prepared for ozone depletion events, and as soon as they occur to be able to participate with the collaborating teams in near-real-time analysis of the events. This project combines the ozone observations with the surface meteorological observations along with a model assessment of the air parcel trajectory to learn more about the causation of the events. Maintenance work at the AWS sites is to keep them ready to observe the meteorology associated with these events.

Significant Results: The development of using the AMPS model to drive the HySPLIT back trajectory system is the first ever marriage of these two systems. HySPLIT is a very commonly and widely used back trajectory system in meteorological applications. It is also the operational system used by the United States (e.g. NOAA, EPA, etc.) for a variety of applications. Having this system work with the AMPS real-time numerical model output will aid this study with a higher quality, higher resolution (spatial and temporal) information than would be available from standard global numerical models. It also opens the door for the use of this system for other researchers as well as operational use.

Additional results included routine maintanence at the AWS sites that are a part of the study. Additionally, quality control of the AWS observations at the observations sites and nearby sites has been conducted over the past year.

Key outcomes or Other achievements: One key outcome for this second year of the project is the development of the AMPS HySPLIT back trajectory system. This achievement stands out as it has applications not only for this project but also in other science research activities as well as for operational forecasting applications.

What opportunities for training and professional development has the project provided?

Team member Jonathan Thom has worked with Lee Welhouse on the maintanence and care of the AWS ozone sites, and associated power systems. More recently, Dave Mikolajczyk is being intergrated into this effort as well. Team member Linda

Keller has also worked with Dave on the quality control procedures for the AWS observations used in the project. This is a continuous and ongoing effort. The PI has worked with Nick Weber, an undergraduate student team member, on the development of the AMPS HySPLIT forecast back trajectories.

* How have the results been disseminated to communities of interest?

The AWS observations, which form one of the base observations for this study, are always available via the AWS web site at http://amrc.ssec.wisc.edu/ The development of the back trajectories from the HySPLIT driven by AMPS is a recent development. Once fully explored, these will also be available via the Web.

This project is included in existing outreach efforts that are a part of the Automatic Weather Station project and Antarctic Meteorological Research Center. This effort includes outreach via tours of the AMRC offices and open house events at the University of Wisconsin-Madison, speaking to nearby schools, libraries and senior centers along with participating in outreach at the Wisconsin State Fair.

What do you plan to do during the next reporting period to accomplish the goals?

In the upcoming year, there will be 3 main objectives worked on to accomplish the goals of the project:

- Continued quality control work on the AWS observations
- Continued generation of the AMPS HySPLIT forecast back trajectories
- Analysis of ozone depletion events with the collaborating team in the culmination of a paper on the findings of the project.

Other activities are pending including additional paper(s) on the back trajectories themselves and other supportive reports on the ozone events with the collaborating team.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
D2.AMPS.LOR.pdf	Figure 1. The forecast back trajectory ending at Lorne AWS site shows the source of the air parcels coming from the polar plateau near South Pole, and descending down onto the Ross Ice Shelf. This is generated from the HySPLIT model driven by AMPS 10 kilo	Matthew Lazzara	05/30/2013
D3.AMPS.MCM.pdf	Figure 2. An AMPS driven HySPLIT forecast back trajectory ending at McMurdo Station, Antarctica. This is driven by the 3.3 kilometer AMPS model output.	Matthew Lazzara	05/30/2013
PC260175z.pdf	Figure 3. AWS and ozone sensors with power system located at Minna Bluff can be seen here with the impact of rime ice on the AWS tower and guy chains.	Matthew Lazzara	05/30/2013
PC260172z.pdf	Figure 4. The ozone sensor and power system located at Lorne AWS. The AWS is just to the left of the photo, and its shadow can be seen on the snow surface.	Matthew Lazzara	05/30/2013

Products

Journals

Books

Book Chapters

Thesis/Dissertations

Conference Papers and Presentations

Mark W. Seefeldt, Allison M. Burg, Lars E. Kalnajs and Matthew A. Lazzara (4/29/13). *Ozone Depletion Events in the Ross Island Region, Antarctica and the Associated Meteorological Conditions*. 12th Conference on Polar Meteorology and Oceanography. Seattle, WA.

Status = OTHER; Acknowledgement of Federal Support = Yes

Lars E. Kalnajs, Mark W. Seefeldt and Matthew A. Lazzara (1/9/13). *Observations of Antarctic Tropospheric Ozone Depletion Events from an Autonomous Ozone Sensor Network*. 15th Conference on Atmospheric Chemistry. Austin, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Mark W. Seefeldt, Allison M. Burg, Lars E. Kalnajs and Matthew A. Lazzara (1/10/13). *An Evaluation of the Meteorology in Relation to Ozone Depletion Events in the Ross Island Region, Antarctica*. 15th Conference on Atmospheric Chemistry. Austin, TX.

Status = OTHER; Acknowledgement of Federal Support = Yes

Other Publications

Technologies or Techniques

The ability to read in real-time AMPS model fields into the HySPLIT back trajectory modeling system. Thanks to help from the authors of HySPLIT, the capability to accomplish this is now possible. Full procedures to accomplish this have been developed in the second year of the project.

Patents

Nothing to report.

Inventions

Nothing to report.

Licenses

Nothing to report.

Websites

Title:	AMPS HySPLIT Forecast Back Trajectories
URL:	http://amrc.ssec.wisc.edu/data/backtraj
Description:	This web site contains the near-real-time output of the HySPLIT forecast back trajectories from the AMPS D2, lower resolution and D3, higher resolution, model output. There are five sites they are computed for, Cape Bird AWS, Lorne AWS, McMurdo Station, Marble Point AWS and Windless Bight AWS.
Title:	AMRC-AWS Web site
URL:	http://amrc.ssec.wisc.edu/
Description:	This is the lead website for the AMRC-AWS projects, which include links to the AWS

observations, and other associated Antarctic meteorological datasets.

Title: AMRC RAMADDA Web site

URL: https://amrc.ssec.wisc.edu/repository

Description: This site hosts a variety of links to AMRC-AWS Antarctic data holdings, including some of the raw tropospheric ozone observations from the first year of the project.

ther Products

Product Type: Databases

Description: The Automatic Weather Station (AWS) observations that are used as a part of this project are shared via the AMRC-AWS Web, FTP and RAMADDA sites:

ftp://amrc.ssec.wisc.edu/pub/aws

http://amrc.ssec.wisc.edu/

http://amrc.ssec.wisc.edu/aws/

https://amrc.ssec.wisc.edu/repository/

Additionally available are raw observations from the first year of the project from operating ozone sensors

Other:

Participants

esearch Experience for Undergraduates (REU) funding

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Matthew A Lazzara	PD/PI	1
Jonathan Thom	Other Professional	1
Nick Weber	Undergraduate Student	0
Linda Keller	Other Professional	1
David Mikolajczyk	Other Professional	0
Lee Welhouse	Other Professional	0

What other organizations have been involved as partners?

Name	Location
University of Colorado - Boulder	Boulder, CO

Have other collaborators or contacts been involved? N

mpacts

What is the impact on the development of the principal discipline(s) of the project?

his project demonstrates the potential that the AWS network offers - to be a base platform to advance our understand of the atmosphere. Here, the base meteorological measurements are aiding in furthering our understanding of lower tropospheric zone: a fusion of both boundary layer meteorology and atmospheric chemistry.

What is the impact on other disciplines?

the first year of the project, the Wisconsin power system provides another contribution to advancing polar power systems that may be able to be used to satisfy the needs of some polar observing systems power requirements. This aids a variety of olar observing communities.

What is the impact on the development of human resources?

othing to report.

What is the impact on physical resources that form infrastructure?

othing to report.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

his project is likely to make a small, but perhaps important contribution in the use of the HySPLIT system driven by AMPS bservations. The possibility of mesoscale forecast back trajectories may impact other science research and operational weather forecasting in the Antarctic.

/hat is the impact on society beyond science and technology?

Nothing to report.

Changes

hanges in approach and reason for change

Nothing to report.

ctual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

hanges that have a significant impact on expenditures

Nothing to report.

gnificant changes in use or care of human subjects

Nothing to report.

gnificant changes in use or care of vertebrate animals

Nothing to report.

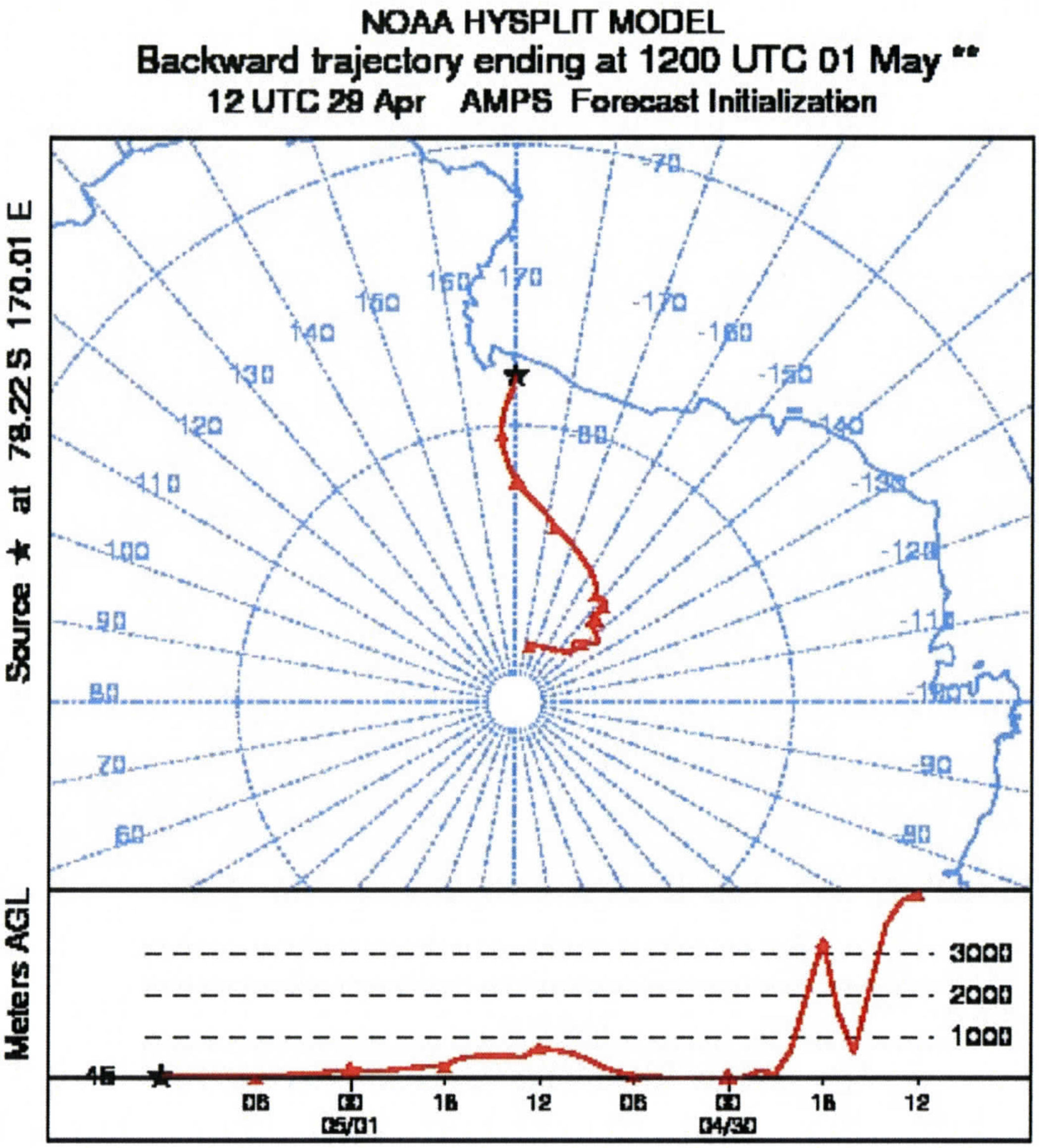
Significant changes in use or care of biohazards

Nothing to report.

Special Requirements

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

Nothing to report.



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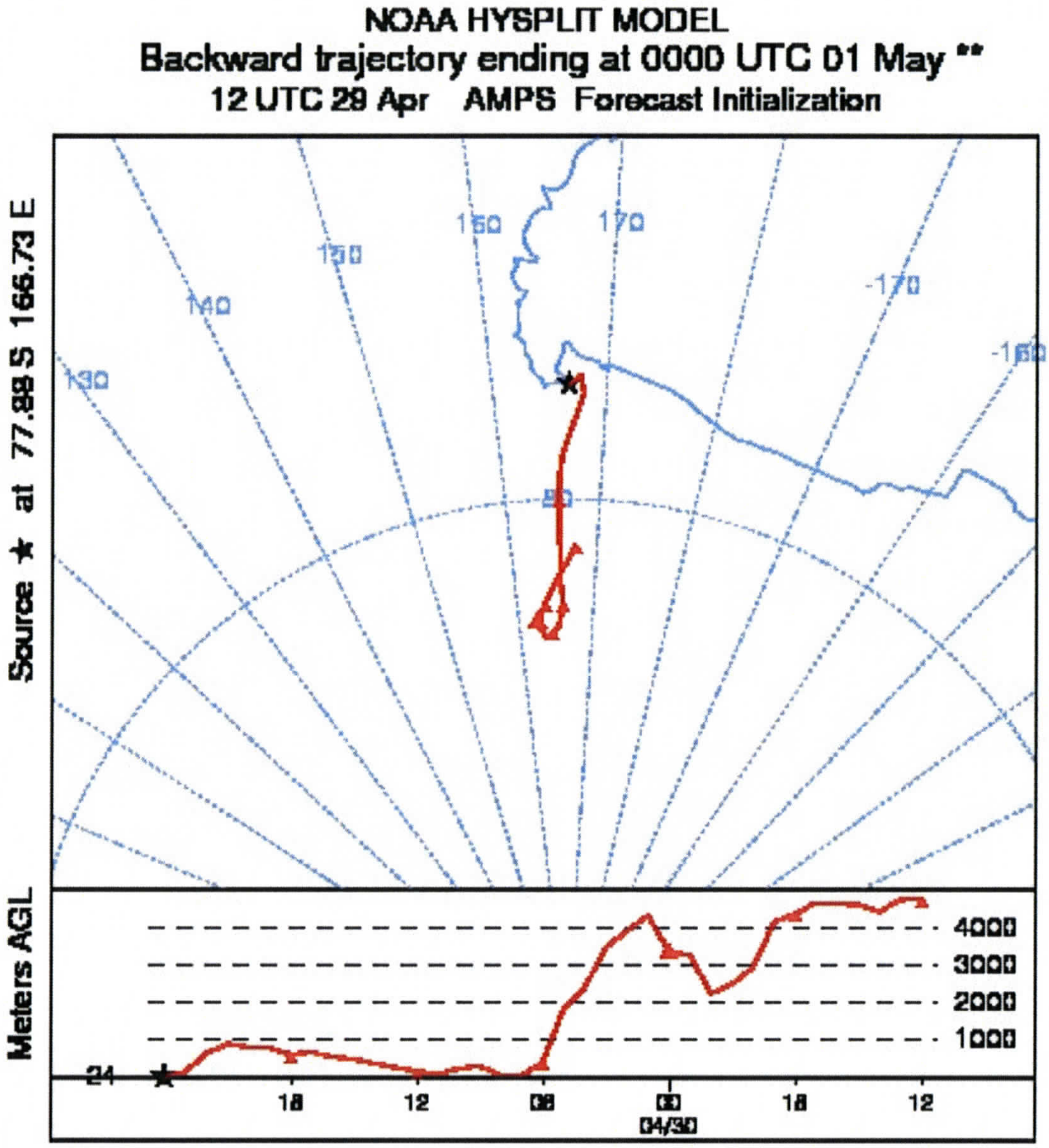

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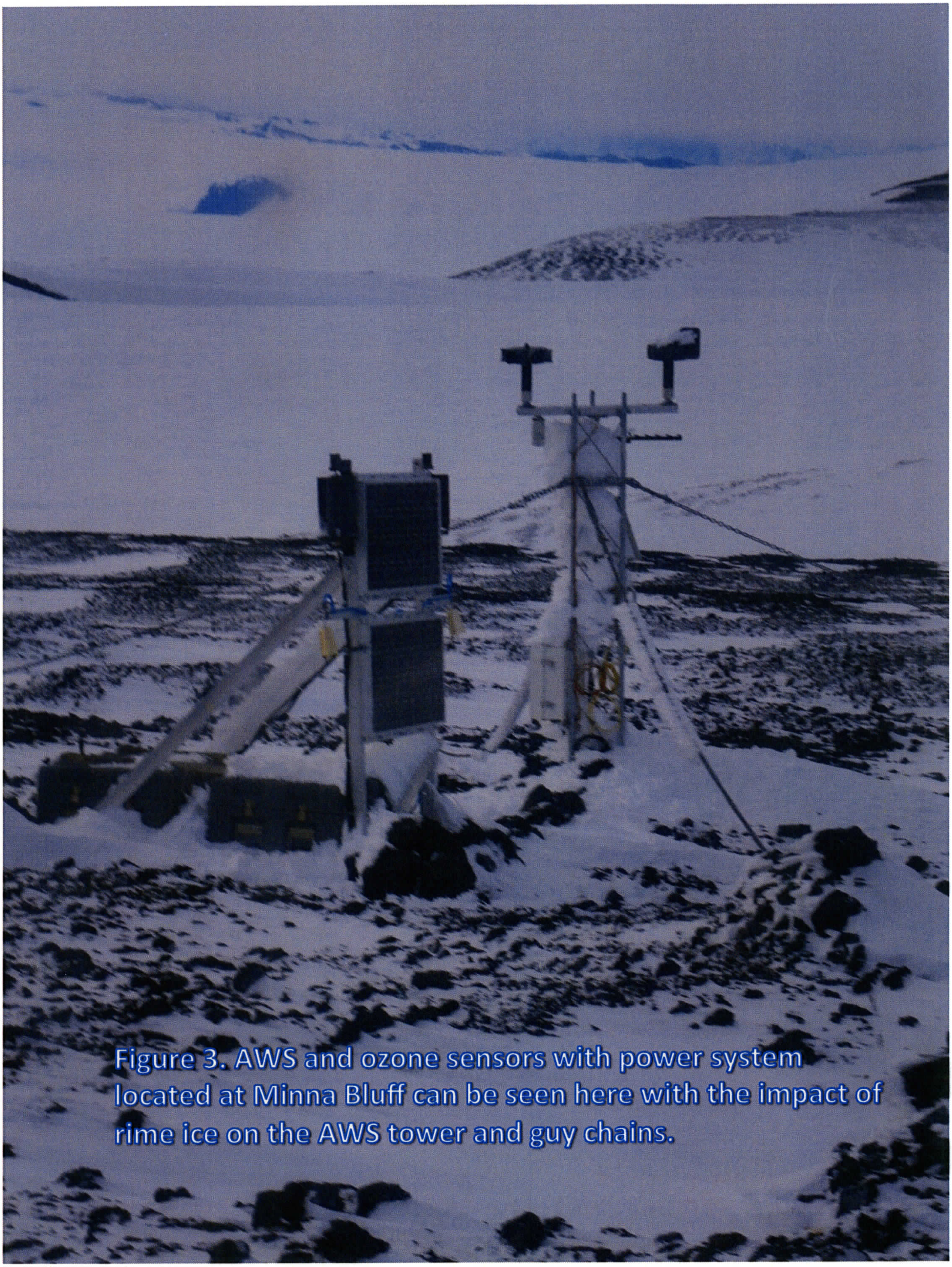

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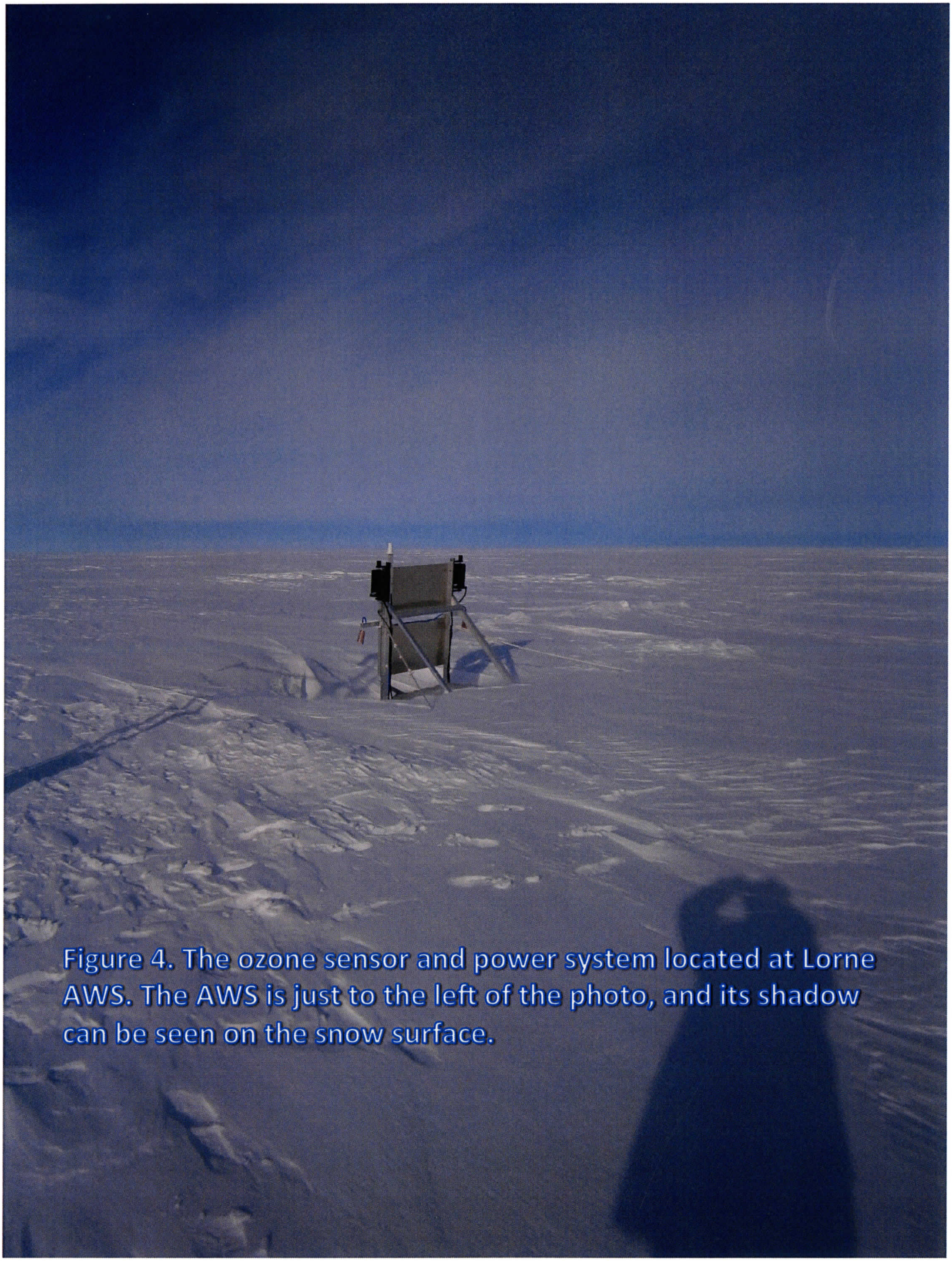

Figure 4. The ozone sensor and power system located at Lorne AWS. The AWS is just to the left of the photo, and its shadow can be seen on the snow surface.