

Annual Report for Period: 07/2011 - 06/2012

Submitted on: 05/02/2012

Principal Investigator: Kalnajs, Lars E.

Award ID: 1043266

Organization: U of Colorado Boulder

Submitted By:

Kalnajs, Lars - Principal Investigator

Title:

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

Project Participants

Senior Personnel

Name: Seefeldt, Mark

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Kalnajs, Lars

Worked for more than 160 Hours: Yes

Contribution to Project:

Please note: Lars Kalnajs is now the PI, all information for Lars Kalnajs will be entered under that role.

Name: Kalnajs, Lars

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

UNAVCO, Inc.

UNAVCO provided an additional renewable power system and technical and logistical support and advice for the installation of the systems.

University of Wisconsin-Madison

The University of Wisconsin-Madison Antarctic Meteorological Research Center provided renewable power systems, and communications infrastructure to the project and will provide meteorological data from the Automatic Weather Stations (AWS). AMRC staff also provided significant technical knowledge on the design and installation of remote instrument systems in Antarctica.

Other Collaborators or Contacts

Dr Mark Sefeeldt at University of Colorado Cooperative Institute for Research in Environmental Science (CIRES) has provided meteorological analysis of Automatic Weather Station data and model output from the Antarctic Meteorological Prediction System (AMPS) .

Activities and Findings

Research and Education Activities:

The major activities for the first stage of this project were focused on the modification of an existing UV-LED (Ultra Violet Light Emitting Diode) based ozone photometer design for use at remote autonomous locations in the Antarctic troposphere. Our existing instrument design (developed for the NSF/OPP sponsored Concordiasi long duration balloon campaign) was refined to provide higher sensitivity at the lower ozone mixing ratios found in the Antarctic troposphere. Furthermore, the data acquisition and control systems were redesigned, replacing commercial off-the-shelf hardware with a custom ARM processor based system to lower power consumption (currently < 1W average power consumption) and to provide the flexibility to interface with the AWS telemetry system and with standalone bi-directional Iridium satellite communications. Additional functionality and data acquisition channels were added to supervise the renewable power system and to monitor the environmental conditions and power system performance over the Antarctic winter. New instrument firmware was developed and tested to support the new telemetry system and power system monitoring functions. Six instruments were manufactured in-house at the Laboratory for Atmospheric and Space Physics, and tested in an environmental chamber to reproduce the conditions that are expected to be experienced over the Antarctic winter. Dr Kalnajs also coordinated the activities of the Wisconsin and UNAVCO groups to ensure interoperability between the ozone instrumentation, power systems, Iridium communications and AWS infrastructure.

The second stage of the project was the deployment of the ozone instruments and power systems to Ross Island region of Antarctica. Dr Kalnajs, a graduate student and an engineer deployed to McMurdo station from December 29th 2011 through February 13th 2012. The ozone photometers for each station were assembled, tested and calibrated against a reference photometer/ozone generator in the Cray lab before deployment. The Marble Point AWS site was the first field deployment of the ozone photometer on January 14th followed by the Minna Bluff system on January 21st, the Lorne AWS site on January 30th and finally the Cape Bird on February 3rd. Data from the instrument network is aggregated, reduced and analyzed on a server located in Boulder Colorado. Quick-look and engineering data is available on a near-real-time basis on the university intranet and will be available on the internet once quality control has been performed. Overall data availability over the 2+ months that the network has been in operation is 91%, with missing data largely due to server down time on the base station server in McMurdo, and to the occasional need to update instrument operating parameters for changing environmental conditions.

Daily monitoring of the instruments will continue over the 2012 Austral winter and instrument configurations will be updated over the air to ensure measurement integrity and to maximize instrument life time. Furthermore, any anomalies observed in the instrument or power system state-of-health will be carefully analyzed in preparation for the maintenance and calibration campaign in November 2012.

Dr Seefeldt has commenced work on integrated data analysis and modeling through the combination of ozone measurements with weather station data and model output. In preparation for the measurement campaign, Dr Seefeldt retrieved and post-processed quality-controlled AWS observations from the University of Wisconsin and archived output

from the Antarctic Mesoscale Prediction System (AMPS) by the National Center for Atmospheric Research (NCAR). The collection of observations and numerical weather prediction (NWP) output will be used for understanding the meteorology of the region. Furthermore, Dr. Seefeldt and an undergraduate student have reviewed multiple years of AWS observations at sites in the Ross Island region, including all of the sites with installed ozone instruments. The review is being used to develop a climatology and for characterization of the conditions at each location. Currently work is progressing towards creating analysis tools and plots of the AWS observations in combination with the AMPS output to provide the necessary information for the corresponding meteorological conditions associated with the ozone observations.

Findings:

Data collected from the AWS ozone instruments is still in the process of initial quality control, and will not be suitable for public distribution until a repeat calibration of the instruments has been performed in the Austral spring of 2012. However the preliminary data that has been quality controlled from the Marble Point and Cape Bird sites exhibit good general agreement with the mean annual ozone profiles from the NOAA Arrival Heights monitoring station (see Figure 1: Red - Cape Bird Ozone Mixing Ratio, Blue: Marble Point Ozone Mixing Ratio, Background: Historical ozone range from Arrival Heights). Marble Point has the most similar geographic character to Arrival Heights (altitude, distance from sea ice, distance from open water), whereas the Cape Bird site is lower in altitude and closer to both sea ice and/or open water. The Cape Bird site is at the lower end of the range of ozone mixing ratios observed at Arrival Heights and has on average 3-5 ppb lower ozone than the Marble Point station. This is broadly consistent with the hypothesis of the sea ice / ice edge being a primary location for ozone depletion. However any rigorous interpretation of these ozone differences will require analysis of the meteorological fields from the weather stations in conjunction with trajectory modeling, which is yet to be performed.

Data from the other sites is still undergoing initial quality control, however the state-of-health data from the Minna Bluff site indicate that the pump at this site may have ingested flowing volcanic grit, which, combined with low temperatures, has caused a solenoid valve failure. We are currently testing an ozone-inert particle filtration system for installation on the ozone instruments in November 2012.

Training and Development:

Dr Seefeldt has been working with two undergraduate students at Providence College on research projects involving the meteorology and climatology of the region.

Outreach Activities:

During our Antarctic deployment, we video-conferenced with a group of middle school students from Trail Ridge Middle School in Longmont, Colorado as well as maintaining a blog of our science and activities. After returning from the field, Dr Kalnajs met with the students in person and was interviewed about his Antarctic research as part of a student-produced documentary on local scientists and careers in science.

Journal Publications

Books or Other One-time Publications

L.E. Kalnajs, L.M. Avallone, M.A. Lazzara,
W. Seefeldt, J.E. Thom
A New Autonomous Sensor Network for Measurements of Atmospheric

Composition in Antarctica", (2012). Conference Proceeding, Accepted
Collection: International Polar Year Conference 2012
- Montreal
Bibliography: Proceedings not yet published

M.W. Seefeldt, L.M. Avallone, L.E. Kalnajs
M.A. Lazzara, "Review of the Meteorology of the Ross
Island Region for the Evaluation of
Multi-Season Surface Level Ozone
Observations and Ozone Depletion
Events", (). Conference Proceeding, Accepted
Collection: International Polar Year Conference 2012
- Montreal
Bibliography: Proceedings not yet published

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

Contributions to Other Disciplines:

Contributions to Human Resource Development:

We have provided a real-world field research exposure to one graduate student (field assistant in Antarctica) and two undergraduate students (data analysis at Providence College).

Contributions to Resources for Research and Education:

The initial technical success of our instrumentation, and the successful integration of advanced instrumentation into the AWS network has provided a proof-of-concept for the augmentation of the AWS network. This should help pave the way for the use of the AWS infrastructure as an Antarctic observing network with scientific applications beyond meteorology.

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Journal

Any Web/Internet Site

Any Product

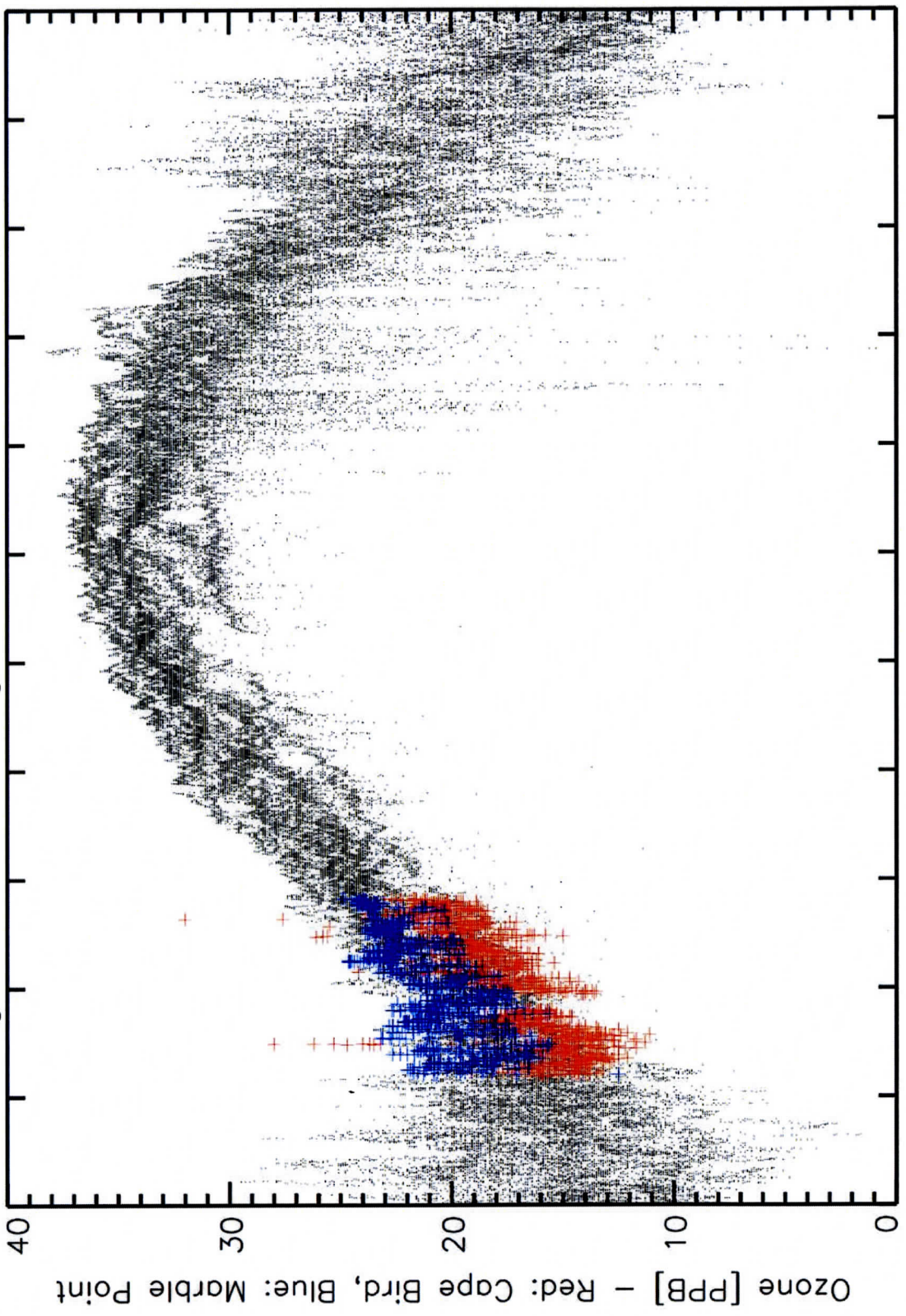
Contributions: To Any within Discipline

Contributions: To Any Other Disciplines

Contributions: To Any Beyond Science and Engineering

any Conference

Arrival Heights Ozone Mixing Ratio 1997 - 2008 / AWS Ozone



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Jan
Day of Year

Annual Report for Period: 07/2011 - 06/2012

Submitted on: 05/07/2012

Principal Investigator: Lazzara, Matthew A.

Award ID: 1043478

Organization: U of Wisconsin Madison

Submitted By:

Lazzara, Matthew - Principal Investigator

Title:

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

Project Participants

Senior Personnel

Name: Lazzara, Matthew

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Matthew Lazzara has overseen the start of the project with the first year focused initially on building the power systems and updating the AWS system to support and interface with the ozone sensor system. Follow-on effort includes facilitating the quality control of the AWS observations, for associated meteorological analysis.

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Putman, Lee

Worked for more than 160 Hours: No

Contribution to Project:

Lee has worked on the fabrication of base components of the homebuilt power systems used to power and support both the AWS and ozone sensor systems.

Name: Thom, Jonathan

Worked for more than 160 Hours: No

Contribution to Project:

Jonathan has worked on designing, building, and installing the power systems used by the AWS and ozone sensor systems. He also worked on the freewave networking system design and setup, as well as installation of these systems during the past field season.

Name: Welhouse, Lee

Worked for more than 160 Hours: No

Contribution to Project:

Lee has assisted Jonathan in the assembly and deployment/installation of the power system used at the AWS/ozone sensor system sites.

Other Participant

Research Experience for Undergraduates

Organizational Partners

University of Colorado at Boulder

This project is a collaborative effort with the University of Colorado at Boulder. Project staff at both the University of Wisconsin-Madison and University of Colorado at Boulder work together on the joint AWS-ozone sensor systems, including the base power systems as well as the relay of the observations made at these sites. Additionally, staff at both institutions are collaborating on the quality control of the AWS observations being used in the companion meteorological analysis that is a part of this research study.

Other Collaborators or Contacts

UNAVCO project has provided a power system for one of the AWS ozone sensor sites (Marble Point site).

Activities and Findings**Research and Education Activities:**

Project Activities for 2011-2012:

The first year of activities on this project focused primarily on the fabrication and the building of the power systems needed to support the ozone sensor systems and associated Automatic Weather Stations (AWS). Only one UNAVCO power system was utilized for the project (at Marble Point), the remaining systems were constructed by UW-Madison project members. In conjunction with the AWS project (O-283), new AWS equipment was installed or upgraded at several of the sites, along with the conversion to Freewave modem communications. Additional infrastructure for collecting the observations at McMurdo Station and relaying the data to the US was also worked on. The sites installed are:

Marble Point AWS
Minna Bluff AWS
Cape Bird AWS
Lorne AWS
Windless Bight AWS

Two conference presentations were presented at the time of this report's submission:

Kalnajs, L.E., L.M. Avallone, M.A. Lazzara, M.W. Seefeldt, and J.E. Thom, 2012: A New Autonomous Sensor Network for Measurements of Atmospheric Composition in Antarctica. IPY2012, Montreal, 22-27 April, 2012.

Seefeldt, M.W., L.M. Avallone, L.E. Kalnajs, and M.A. Lazzara, 2012: A Review of the Meteorology of the Ross Island Region for the Evaluation of Multi-Season Surface Level Ozone Observations and Ozone Depletion Events. IPY2012, Montreal, 22-27 April, 2012.

See the attached figure for a photograph of the Marble Point AWS and ozone sensor system, along with the one UNAVCO power system used in this project.

Findings:

Project Findings for 2011-2012:

The development, construction and deployment of the UW-Madison power system
 * Utilization of the AWS Freewave modem network for return of the meteorology and ozone
 observations.

Training and Development:

The team members, especially Jonathan Thom, have gained hands-on experience working on
 design, fabrication, assembly, and installation of an advanced power system to provide
 the higher level of power need for the joint AWS-ozone sensor system. Lee Welhouse
 continues to gain field experience in working with these surface based observing systems.

Outreach Activities:

The AMRC/AWS research group continue a grass roots program of outreach to the public via
 various venues include engaging the public at University open house events, visiting middle
 school classrooms, and giving presentations to senior citizens at retirement home/assisted
 living facilities.

Journal Publications

Books or Other One-time Publications

Web/Internet Site

URL(s):

<http://amrc.ssec.wisc.edu> <ftp://amrc.ssec.wisc.edu>

Description:

The AMRC/AWS web site will be hosting real-time displays of the meteorological observations
 from the AWS ozone sites. The RAMADDA portion of the website and the FTP site hosts the
 formal archive of the AWS observation, both raw and quality controlled data sets.

Other Specific Products

Contributions

Contributions within Discipline:

This 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 ozone: a fusion of both
 boundary layer meteorology and atmospheric chemistry.

Contributions to Other Disciplines:

In 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 polar observing
 communities.

Contributions to Human Resource Development:

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Conference Proceedings

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Any Journal

Any Book

Any Product

Contributions: To Any Human Resource Development

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Any Conference



Figure 1. A photograph of the Marble Point Automatic Weather Station (AWS) ozone sensor joint system along with the UNAVCO power system. (Photo Courtesy of Lars Kalnajs)

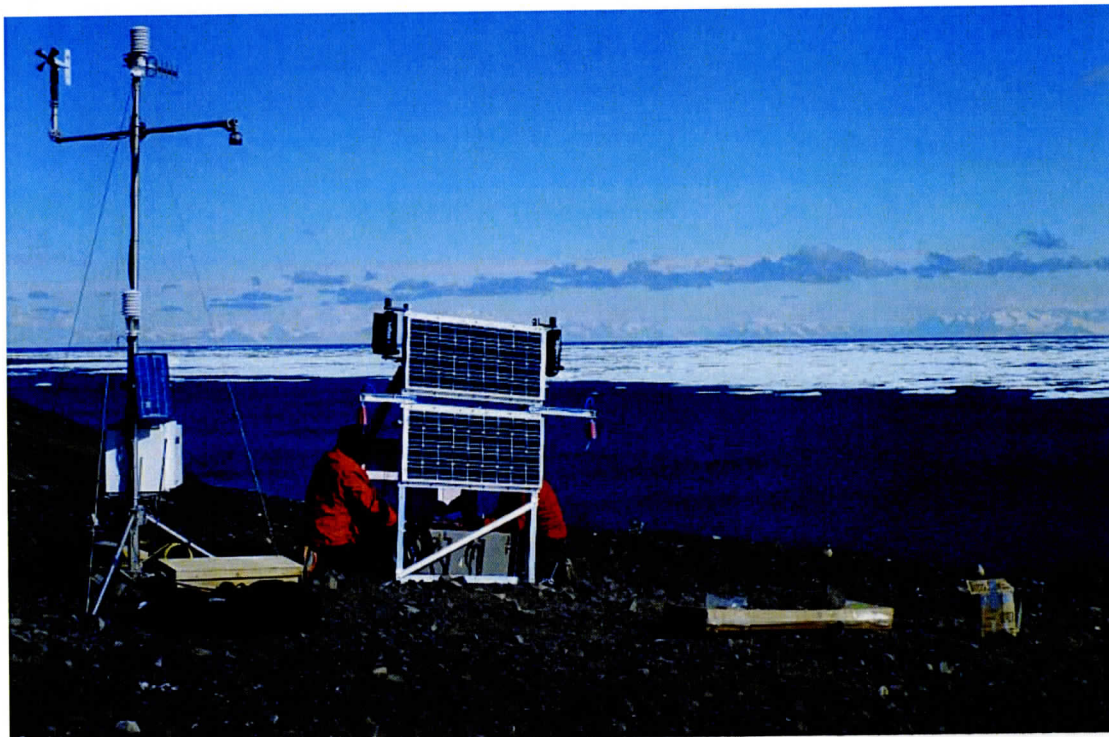


Figure 2. Installation of a Wisconsin power system and ozone sensor system at Cape Bird AWS site. (Photo Courtesy of Patrick Brown)



Figure 3. Lorne AWS ozone sensor and Wisconsin system photographed with sundogs in the background. (Courtesy of Patrick Brown)

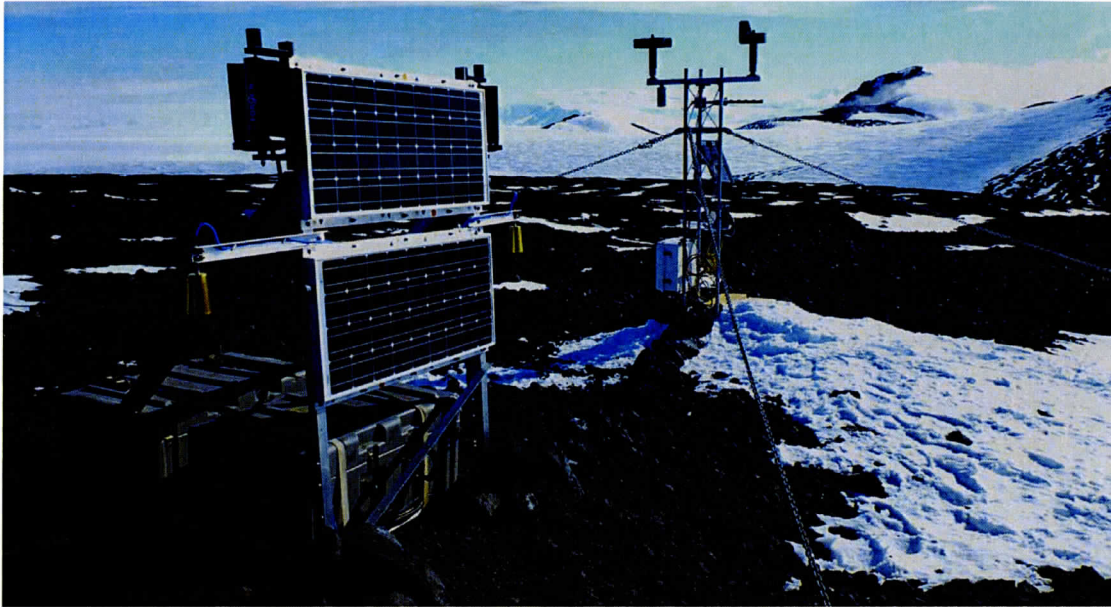


Figure 4. Minna Bluff AWS ozone sensor and Wisconsin power system.
(Courtesy of Patrick Brown)