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http://www.epic.noaa.gov/SEARCH/obs/workshop/

Long-Term Intensive Atmospheric Observing Stations
A Draft White Paper for SEARCH

Taneil Uttal, Pat Sheridan. Bob Stone,
Russ Schnell and Betsy Weatherhead

OBJECTIVE

The primary objective of the SEARCH program will be to monitor and understand environmental Arctic change. The objective of this evolving white paper is to provide a draft plan for atmospheric monitoring that would be achieved through the operation of a small number of strategically placed, long-term, intensive, ground-based, atmospheric observing stations at both land sites and on icebreakers. This activity is intended to complement long-term monitoring activities that have been outlined in companion drafts describing related elements of the Arctic system including:

- Sea ice thickness and extent (Richter-Menge)
- Satellite observations (Key, and Francis)
- ocean buoy networks (Rigor and Ortermeyer)
- permafrost (Romanovsky)
- rawinsonde networks (Jenne)
- automated and autonomous networks and vehicles (Maslanik)

The measurements that would be made at the long-term, intensive, atmospheric monitoring sites will include:

- atmospheric radiation
- clouds cover, microphysics, geometry
- aerosols, arctic haze
- surface fluxes (Persson)
- ozone
- carbon dioxide
- standard meteorological observations

The long-term observations at the ground stations would optimally be supplemented with a regular, annually repeated, aircraft program to provide assessments of vertical retrievals via above station aircraft profiling, as well as a measure of large-scale horizontal variability with via strategic flight legs between stations. The aircraft program would provide a critical link with ocean/ice, satellite and autonomous network observing programs.

A key element of the Long-Term Observing Stations would be coordination with already existing Arctic research facilities including enhancements and revitalization. Data collection activities would be closely coordinated between the U.S., Russia, Canada and Scandinavian countries.

BACKGROUND

The atmospheric measurements being made at the NOAA/CMDL Baseline Observatory and the Department of Energy Cloud and Radiation Testbed site in Barrow Alaska represent some of the most technologically advanced and comprehensive measurements of the clouds, radiation, chemistry and other aspects of the physical atmosphere that impact climate change. The Barrow location is and it's unusually strong complement of atmospheric sensors is unique not only in the Arctic but also with respect to comparable stations throughout the world. Consequently, this station serves as a useful prototype for developing new stations, and provides a wealth of information on Arctic specific logistical and operational issues .

The CMDL observatory has the primary goal the monitoring of atmospheric constituents that are capable of forcing climate change and those that may cause depletion of the global ozone layer. Measurements such as meteorology, surface ozone, carbon dioxide, aerosols and radiation began in 1972-1974 and are some of the longest continuous atmospheric records in the Arctic. Today, over 200 different measurements are conducted at the Barrow Observatory along with 35 cooperative programs (Figure 1).

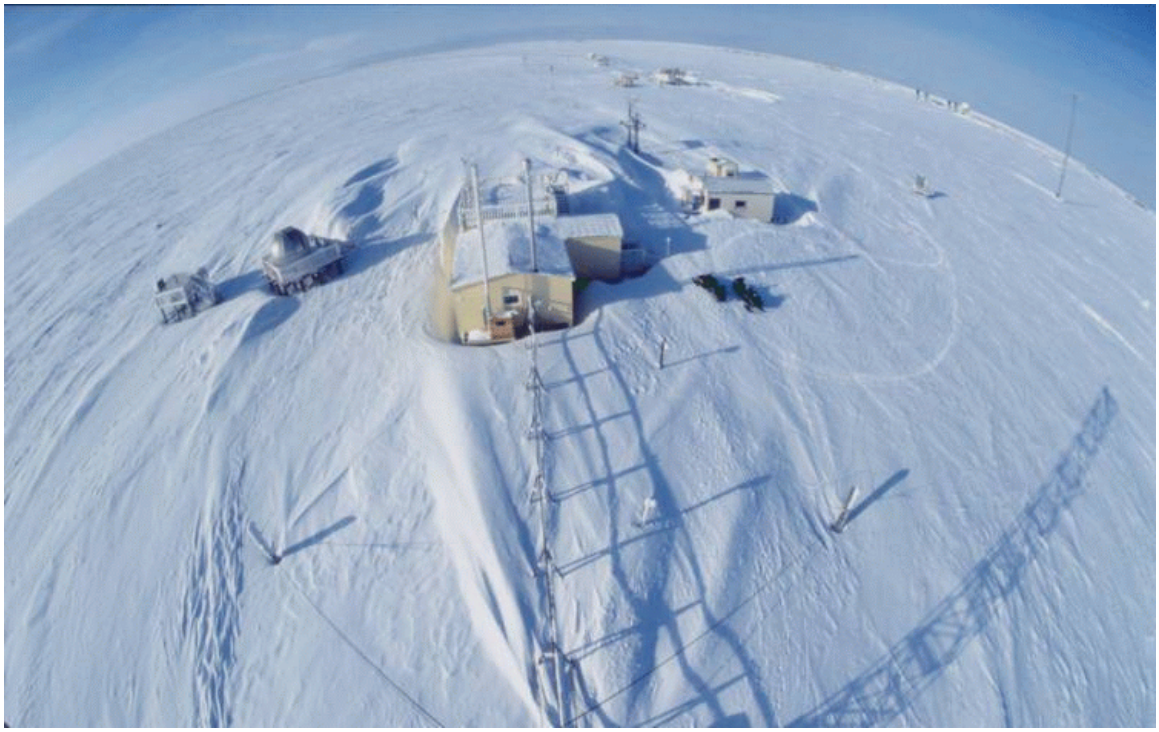

Figure 1: Fish eye lens view of the NOAA/CMDL Barrow Observatory

The DOE ARM North Slope of Alaska (NSA) facility next to the NOAA site contributes key radiation and cloud measurements which commenced in February of 1998. The radiation measurements are made by a number of broad-band and spectral sensors, and cloud measurements are made by millimeter cloud radar, and micropulse lidar. By combining measurements from these sensors, time-height records of detailed cloud properties (Figure 2) can be derived which are important in assessing cloud effects on atmospheric heating profiles and atmosphere-surface heat and exchanges.

The Barrow site not only provides long-term monitoring of key elements of the Arctic physical environment, it also is beginning to provide the necessary information to provide model parameterizations and satellite validation that will be essential to interannual and decadal climate variability.

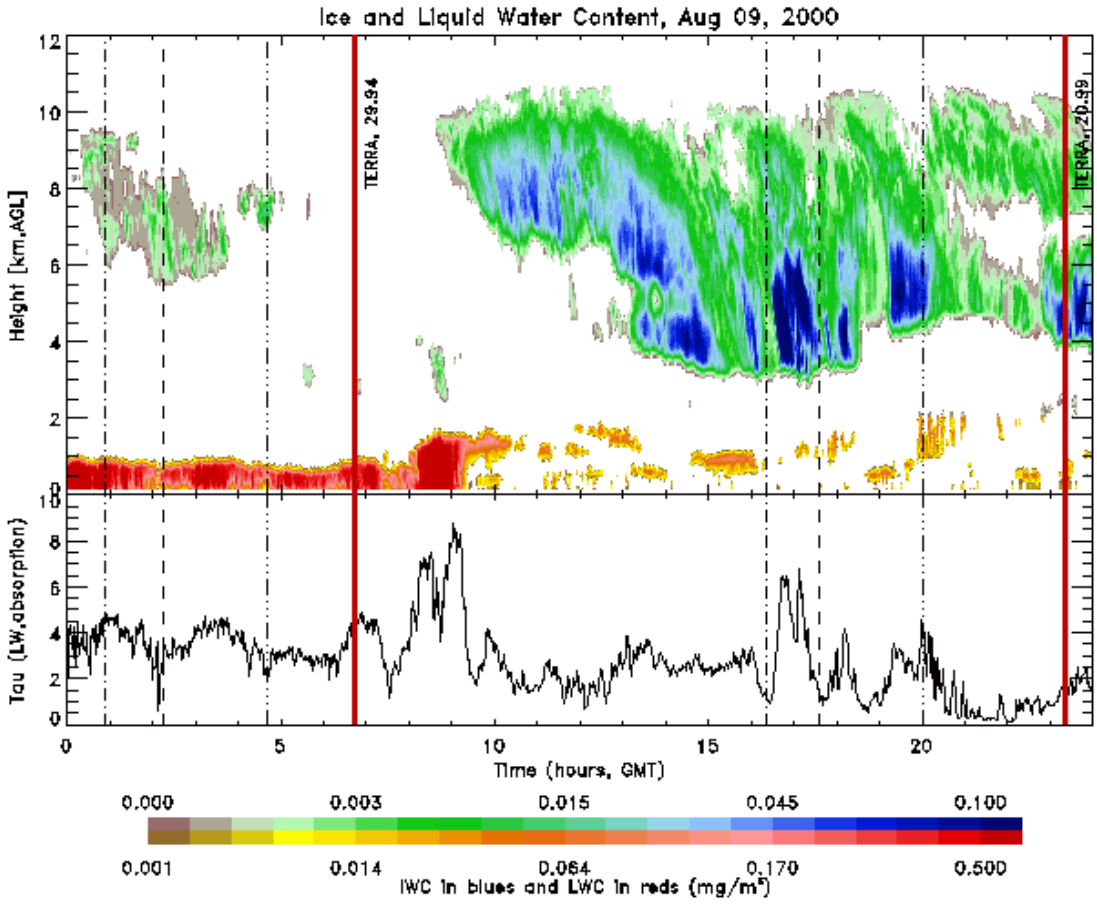

Figure 2 Retrieved water contents for both ice clouds (blue) and liquid clouds (red). Lower panel indicates cloud optical depth.

STRATEGY

In this section the rational and a draft plan for long-term atmospheric observing stations is described based on the hypothesis, goals, and science questions that were established in a SEARCH workshop conducted in Boulder, Colorado (November 14-15, 2001) by an Atmospheric working group. The primary hypothesis was stated as:

The Pan-Arctic is in a state of accelerated climate change which will have significant impacts on the environment over the next 50 years. These changes will not be limited to the Arctic regions and will effect the environment at lower latitudes where human populations were dense.

A number of science questions were developed, in particular, those relating to atmospheric measurements included:

- What are the atmospheric drivers controlling the onset and duration of the Arctic melt season?
- Is the observed acceleration of environmental change in the Arctic a part of natural variability or are there significant anthropogenic factors?
- Are the atmospheric transport pathways of contaminants changing in the Arctic?
- Will the Arctic witness continued stratospheric ozone depletion?
- What is the atmospheric observational evidence for the Arctic oscillation?
- How do clouds and aerosols interact in the Arctic?

In response to these questions the following goal statement was developed:

Increase understanding of the Arctic environment through a program of scientific, long-term, monitoring, diagnostic studies and modeling activities towards and eventual predictive capability on interannual and interdecadal time scales. This understanding will allow adaptation and mitigation strategies so that natural variability can be prepared for, and anthropogenic forced variability can be controlled in a program of sound environmental management.

The observing strategy envisioned is to develop widely distributed, largely autonomous observing networks in tandem with embedded high intensity, manned observing stations at key locations. Supplement with a program of annual sorties with aircraft and ships which are performed on a regular basis from year to year, at the same time of year and in the same regions. The ultimate goal is a long-term monitoring program through which Pan-Arctic climate change can be detected and understood. Some of the key variables to be measured include pressure, temperature, winds, skin temperature, spectral and broadband surface radiation fluxes, surface sensible and latent heat fluxes, surface albedo, clouds (fraction, vertical distribution, microphysical and optical properties), aerosols (chemical compostion, optical depth concentration, spatial distributions), greenhouse gases (CO_2, O_3, water vapor, NO_2, CH_4), and precipitation.

POTENTIAL SITES

The following is an incomplete list of possible sites that would be suitable for long-term atmospheric observing facilities. Further investigation is necessary to determine power, housing, laboratory space, transportation and other issues. Most importantly, site selection must be made on the basis of highest likelihood of facilitating observation of meaningful climate trends and answering the science questions outlined above.

Mould Bay, Canada

Geographic Coordinates: 76.31 N, 240.64 E
Elevation: 40 m
Years of Operation: 1952-1997
Current Status: Discontinued Seismology Station. An insulated wooden building of non-magnetic construction, 8 meters by 5 meters in size, and resting on a gravel pad, serves as the magnetic observatory building. This building is situated with its long axis approximately geographic east-west and is connected by a 7 meter corridor to the seismic observatory.

Kiruna, Sweden
Geographic Coordinates: 67.84 N, 20.41 E
Elevation:
Years of Operation:
Current Status: Operating radiometers, lidar, ozone spectrometers, trace gas measurements, weather station.

Thule, Greenland
Geographic Coordinates:

Resolute, Canada

Greenland Summit Station

Kangerlussuaq

Longeryearbyen

Ny-Alesund

Isachsen
Eureka
Alert
Mys Shalauvova
Ostrov Chetyrekhstolbo
Mys Schmidt
Ostrov
Vrangelya
Svalbard
Nuuq
Zackenberg
Abisko
Tiksi
Taymyr
Cambridge Bay
St Paul Island
USCGS Healy, Polar Star, Polar Sea