The Atmospheric Radiation Measurement North Slope of Alaska and Adjacent Arctic Ocean Cloud and Radiation Testbed Climate Change Research Facility: Material Progress at Last!

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Since the Atmospheric Radiation Measurement (ARM) Science Team Meeting in March, there has been dramatic progress on the North Slope of Alaska and Adjacent Arctic Ocean (NSA/AAO) site. Rather than publish an abstract that is already badly out of date, the abstract has been updated to accurately represent the current status of the NSA/AAO.

On July 1 of this year, the NSA/AAO Cloud and Radiation Testbed (CART) site was formally dedicated. Martha Krebs, Director of the U.S. Department of Energy (DOE) Office of Energy Research; Ben Nageak, Mayor of the North Slope Borough; and Max Ahgeak, President of UIC (Ukpeagvik Inupiat Corporation, the engineering, construction, and support contractor) jointly cut the ribbons releasing a weather balloon in a ceremony symbolizing partnership in developing these new ARM facilities near Barrow.

The instrumentation for this first element of the North Slope CART site is being installed on National Oceanic and Atmospheric Administration (NOAA) Climate Monitoring and Diagnostics Laboratory (CMDL) land near Barrow, but with a laboratory and offices in the UIC-NARL (former Naval Arctic Research Laboratory) complex. Over the next few months that instrumentation will grow to be quite extensive. We already have in place a multi-level 40-m meteorological tower, a 40'x8'x8' instrumentation shelter, a 15' high by 20'x20' deck for upward-looking radiometric instrumentation, and two other comparable size decks for other instrumentation, as well as a Sun data acquisition system to service the instrumentation array, and a T1 line to the lower 48 to move the large volumes of data that will be produced (see Figure 1).

The ARM hardware on NOAA land near Barrow will include both radiometric and remote sensing instrumentation, respectively, to measure the downwelling and upwelling radiant energy flows and to characterize the atmospheric column over the site through which those flows take place. The radiometric instrumentation includes the usual broadband

Figure 1. Aerial view of the instrument shelter and associated instrumentation decks at the NSA/AAO Barrow facility before any instrumentation was mounted. The 40-m meteorological tower is just above the upper boundary of the photograph.

solar and infrared hemispherical sensors (both shaded and unshaded), as well as both broadband and spectral narrow field of view sensors in the visible, which track the sun. In the infrared (IR), the most sophisticated instrument is an extended range (4-25 micrometer) atmospheric emitted radiance interferometer (ER-AERI). This instrument has roots in roughly similar instrumentation, which is satellite-borne and is a modification of the instrumentation used at the Southern Great Plains CART site. It focuses on downwelling IR radiation from the atmosphere itself, an important component of the radiative energy balance, especially in the Arctic. Its extended range (to 25 instead of to 16 micrometers) takes into account the fact that in winter when the atmosphere is cold and dry, substantial energy flows occur in the Arctic in the 16-25 micrometer spectral range (the so-called "dirty window").

There will also be a subset of the radiometric instrumentation looking at the upwelling radiation from the surface. Upwelling radiation is more important at high latitudes than at mid and low latitudes. The high albedo (reflectivity) of the surface when it is snow covered and the large change in albedo when the snow melts are extremely important for high latitude climate, as is the radiation of energy in the IR. For all but a few weeks of the year in early summer, the polar regions lose more energy by radiation to space in the IR than they gain from the sun in the visible.

The remote sensing instrumentation includes a 35-GHz cloud radar, an elastic backscatter lidar, a ceilometer, a whole-sky imager (multi-spectral horizon-to-horizon video imager; gives cloud cover even at night), a two-channel microwave radiometer (gives column density of water vapor and liquid water), a microwave temperature profiler (gives temperature vs. altitude to 600 m), a 915-MHZ wind profiler with RASS (Radio Acoustic Sounding System; profiler gives wind speed, wind direction, and temperature profiles to varying altitudes depending upon atmospheric conditions). In addition, experimentation will take place with a Raman lidar (gives water vapor profiles to cloud base) and with a newly developed microwave water vapor profiler. The Barrow instrumentation is expected to be in routine operation by around the turn of the calendar year.

Much of the remote-sensing instrumentation to be used at the North Slope ARM site, as at the other CART sites, was developed originally by NOAA for potential use by the National Weather Service (NWS). ARM has sought and maintains a close working relationship with NOAA, largely focused on this instrumentation, but also extending to field operational elements of NOAA such as CMDL. At the NSA/AAO Barrow facility, NOAA/CMDL accommodates ARM instrumentation on their land under the NOAA cooperative program, provides ARM with the data from their extensive trace gas and aerosol monitoring instrumentation, consults on experiment design and execution, and will make use of the ARM data and T1 line. The NSA/AAO also works closely with the NWS itself: The Barrow Observing Office, the Fairbanks Forecast Office, and NWS Alaska Regional Headquarters in Anchorage.

If all goes according to plan, over the next few years, the ARM NSA/AAO instrumentation at Barrow will be joined by similar, but perhaps somewhat less extensive instrumentation in the vicinity of the inland village of Atqasuk and in the vicinity of Oliktok Point. A sprinkling of modest automated weather stations are expected to fill in the area between these facilities. The goal of this enlarged instrumentation array is to permit studies to take place on the formation, evolution, and eventual evaporation of clouds under arctic conditions. Such studies require instrumentation over an extended area.

In the nearer term, ARM will also participate in the SHEBA (Surface HEat Budget of the Arctic Ocean) experiment. SHEBA is funded primarily by the National Science Foundation and the Office of Naval Research, but with the participation of several other national and international agencies. For SHEBA, a Canadian icebreaker will carry instrumentation into the arctic ice pack this fall, where it will operate for one full year. The objective is to better understand the heat balance of the ice pack so that its future behavior in the presence of global climate change can be more credibly predicted. The ARM instrumentation for use in SHEBA is a subset of the types of ARM instrumentation that will be operated at Barrow. Most of the ARM/SHEBA instrumentation was operated at Barrow beginning in February to test its performance under arctic winter conditions. During SHEBA, NASA (National Aeronautics and Space Administration) will also conduct a related instrumented aircraft-based study called FIRE[a] over the region. When SHEBA is completed, the ARM/SHEBA instrumentation will be used in the expansion of the NSA/AAO site.

Planning for the NSA/AAO CART site has been in progress for more than 6 years. To say that it is gratifying to the authors to see those plans finally coming to fruition is an understatement.

(a) International Satellite Cloud Climatology Project.