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Site Scientific Mission Plan for the DOE/ARM North Slope of Alaska/Adjacent Arctic Ocean (NSA/AAO) Cloud and Radiation Testbed (CART)

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Disclaimer

Abstract

The purpose of the North Slope of Alaska/Adjacent Arctic Ocean (NSA/AAO) Site Scientific Mission Plan is to provide an up-to-date snapshot of current scientific priorities for the NSA/AAO Cloud and Radiation Testbed (CART) site, and of how it is proposed that these priorities be pursued in the near term. This very brief report will be updated twice yearly. Because this is the first NSA/AAO Site Scientific Mission Plan, this document also briefly reviews site history, in particular, the campaigns and Intensive Operational Periods (IOPs) that have taken place there since the site was dedicated in July 1997. For the planning period covered here, a major focus will be on completing the facilities at Atqasuk, 100 km inland from Barrow. Presently, the instrumentation shelters are located on a gravel pad turn-around at the end of a dead end road between the town of Atqasuk and its airport. To comply with the terms of our land lease, we will construct a platform on pilings adjacent to the gravel pad and move the shelters off the roadway and onto the platform. The platform will permit long-term deployment of the Atqasuk instrumentation in a manner very similar to that at Barrow. Sky radiation (SKYRAD) radiometric instrumentation will be mounted above the level of the roof of the shelters so as to avoid shadowing, and the ground radiation (GNDRAD) instrumentation will be mounted on a tip tower such as the one about to be installed at Barrow. At Atqasuk, during the CY 2000 melt season, the science team heat flux study begun during the CY 1999 melt season will resume in spring with the redeployment of a laser scintillometer. In addition, heat flux measurements will begin near Barrow on the shore of the Beaufort Sea in the same time frame. Also at Barrow, a mini-IOP is planned during spring 2000 that will bring together two extended-range atmospheric emitted radiance interferometers (ER-AERIs) (including the one permanently installed at Barrow), one normal range downward-looking AERI (for snow characterization), and one or two other extended-range upward-looking Fourier transform infrared spectrometers (FTIRs). Various other less major enhancements will be made to the instrumentation suites of both Barrow and Atqasuk. Both facilities, however, will continue to be strongly focused on Instantaneous Radiative Flux (IRF) experiments for this planning period. A Single-Column Model (SCM) experiment utilizing either subscale or full scale aircraft that had been proposed for the NSA/AAO for CY2000 will be delayed for a year.

Acronyms

AAO	Adjacent Arctic Ocean (to the North Slope of Alaska)
AERI	atmospheric emitted radiance interferometer
ARCS	Atmospheric Radiation and Cloud Station
ARCSS	Arctic System Science (NSF program)
ARCUS	Arctic Research Consortium of the U.S.
ARM	Atmospheric Radiation Measurement (DOE program)
ATLAS	Arctic Transitions in the Land Atmosphere System [NSF]
ATTEX	Russian vendor of a microwave sounder
ATV	all terrain vehicle
BASC	Barrow Arctic Science Consortium
BEO	Barrow Environmental Observatory
BRDF	Bi-directional Reflectance Distribution Function
CART	Cloud and Radiation Testbed
CB	Cloud Behavior (experiment)
CIMEL	a sunphotometer made in France
CMDL	Climate Monitoring and Diagnostic Laboratory (NOAA)
CY	calendar year
DABUL	depolarization and backscatter unattended lidar
DEW	distant early warning
DOE	(U.S.) Department of Energy
ER2	a high-altitude research aircraft
ER-AERI	extended-range AERI
ETL	Environmental Technology Laboratory (NOAA)
FAA	Federal Aviation Administration
FIRE	First ISCCP Regional Experiment (NASA Program)
FTIR	Fourier transform infrared spectrometer
FY	fiscal year
GCM	general circulation model
GHz	giga hertz
GI	Geophysical Institute (UAF)
GNDRAD	Ground (upwelling) Radiation
GPS	Global Positioning System
INSTR	instrument
IOP	intensive operational period

IR	infrared (portion of the spectrum)
IRF	Instantaneous Radiative Flux (experiment)
IRT	infrared thermometer
ISCCP	International Satellite Cloud Climatology Program
IT	(ARM) Instrument Team
K-12	Kindergarten through 12th grade
KB	Kilo Byte, or Kilo Bit
LIDAR	Light Detection and Ranging
MET	meteorological
MFR	multifilter radiometer
MFRSR	multi-filter rotating shadowband radiometer
MHz	mega hertz
MMCR	millimeter cloud radar
MMTP	millimeter temperature profiler
MPL	micropulse lidar
MWR	microwave radiometer
Nanuq	A specific electronic file server
NARL	(former) Naval Arctic Research Lab
NASA	National Aeronautics and Space Administration
NET	net radiometer
NIMFR	Normal Incidence MFR
NIP	Normal Incidence Pyranometer
NOAA	National Oceanic and Atmospheric Administration
NSA	North Slope of Alaska
NSB	North Slope Borough
NSBSD	North Slope Borough School District
NSF	National Science Foundation
NWS	(U.S.) National Weather Service
ONR	Office of Naval Research
PAARCS	Portable Arctic Atmospheric Radiation and Cloud Station
PIR	precision infrared radiometer
PNNL	(Battelle) Pacific Northwest National Laboratory
PSP	precision spectral pyranometer
PWS	Present Weather Sensor
QC	quality control

RASS	radio-acoustic sounding system
RESET	Regional Service Team
RF	radio frequency
RH	relative humidity
RSS	Radiometric Sounding System
RWP	radar wind profiler
SCM	Single-Column Model (experiment)
SGP	Southern Great Plains (CART Site)
SHEBA	Surface Heat Budget of the Arctic Ocean
SKYRAD	sky (downwelling) radiation
SOM	Surface Optical Model (experiment)
SPM	Site Program Manager
T	temperature
TWP	Tropical Western Pacific (CART Site)
UAF	University of Alaska, Fairbanks
UAV	unmanned aero vehicle
UIC	Ukpeagvik Inupiat Corporation
US	United States
USAF	U.S. Air Force
USGCRP	U.S. Global Change Research Program
UV	ultraviolet (portion of the spectrum)
UVB	a portion of the UV spectrum
VAP	value-added procedure
VCEIL	Vaisala ceilometer
WCRP	World Climate Research Programme
WD	wind direction
WS	wind speed
WSI	whole sky imager

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1. Introduction

The purpose of the North Slope of Alaska/Adjacent Arctic Ocean (NSA/AAO) Site Scientific Mission Plan is to provide an up-to-date snapshot of current scientific priorities for the NSA/AAO Cloud and Radiation Testbed (CART) site, and of how it is proposed to pursue those priorities in the near term. This brief report will be updated twice yearly. A companion report, "Background for the Department of Energy (DOE)/ARM NSA/AAO CART Site Scientific Mission Plan" (Zak et al. 2000) contains a detailed description of the site and its scientific context. The information in both documents is expected to be most useful to current and prospective users of site data, and to the personnel who help develop, operate, and maintain the site throughout the Atmospheric Radiation Measurement (ARM) infrastructure.

2. NSA/AAO Science: Focus and Priorities

For reference purposes, the primary and secondary scientific foci of the site (discussed at considerable length in the companion document) and the site temporal priorities are listed here without discussion.

1. Primary Focus, Cold Region Cloud and Radiation Phenomena:
    - Atmospheric Radiative Transfer
    - Ice and Mixed Phase Cloud Formation, Evolution and Dissipation
    - Behavior of Surface Radiative Characteristics
    - Direct and Indirect Aerosol Radiative Effects
    - Development and Testing of Satellite Remote Sensing Algorithms.
2. Secondary Focus, Targets of Opportunity Important to ARM:
    - Generic Marine Stratus
    - High Heat and Water Vapor Fluxes Over Water
    - Transition Zones.

Temporal Priorities:

1. Infrared (IR) radiative transfer under cloudless skies for very cold, dry conditions. This issue pertains to both high latitudes and high altitudes [Instantaneous Radiative Flux (IRF) Experiment].

2. Influence of stratus clouds on near ultraviolet (UV), visible and near IR (<1 µm) radiative transfer, especially in the troposphere. Start with liquid water clouds; next go to ice clouds; attack mixed phase clouds last (in order of increasing measurement challenges). This issue pertains to the influence of stratus clouds, and to high altitude ice (cirrus) clouds worldwide (IRF Experiment).

3. Influence of stratus clouds on IR radiative transfer beyond the near IR, especially in the troposphere. Start with liquid water clouds; next go to ice clouds; address mixed phase clouds last. This issue has the same broad applicability as number 2 above (IRF Experiment).

4. Solar radiative transfer to the surface under cloudless skies (IRF Experiment).

5. Interactions of surface albedo and related optical and physical factors with surface heating [Surface Optical Model (SOM) experiments].

6. Local factors affecting the formation and properties of stratus clouds [Cloud Behavior (CB) experiments; horizontal measurement scale, few to tens of kilometers; e.g., coastal, open lead, snow cover edge, lake and other discontinuity effects].

7. Stratus cloud formation and evolution processes on general circulation model (GCM) grid cell scales [CB/SCM (Single-Column Model) experiments].

Where the NSA/AAO site stands, with regard to the foci and priorities, currently will be made clear in the discussion under each facility location.

3. Barrow

3.1 Status and Plans

During the period covered by this report, at least three improvements to the Barrow instrumentation are planned:

1. The GNDRAD (ground radiation; upwelling radiation from the surface) instrumentation will be moved from a swing set-like mount at about 1.5 m above the tundra to the top of a 10-m tall tip tower. The piling for the tip tower is already in place. The original mount was found to be unsatisfactory at the NSA/AAO. The height of 1.5 m was not adequate to prevent the instrumentation from becoming buried in snowdrifts. Even if that had not occurred, at a height of 1.5 m, the effective area being sampled for upwelling radiation is so small that it is unlikely to be characteristic of the region. Even with a 10-m mount, questions of this nature remain. They will eventually need to be dealt with by incorporating periodic airborne or other mobile measurements.

2. A downward-looking video camera with time lapse framing will be mounted on top of the 40-m tower for snow cover measurements during melt and freezeup. To test the camera's response to cold, it is currently mounted on the sky radiation (SKYRAD) platform, where it is more accessible. A straightforward way of dealing with partial snow cover in modeling radiative transfer is by using an average albedo dependent upon percent snow cover. The combination of the SKYRAD and the GNDRAD sensors will provide albedo measurements before and after melt is complete, and before and after freezeup. These measurements taken together with fractional snow cover measurements from analysis of selected video camera frames taken during the transitions will provide the data needed for use during those periods. This is essential information for IRF and SOM experiments.

3. Incorporation of the radar wind profiler (RWP) with radio acoustic sounding system (RASS) into the suite of ARM instrumentation at Barrow will be completed. The RASS accessory provides temperature profiles. The RWP is a Sandia instrument that was deployed at the NSA/AAO in a test

mode. It appears to be functioning well, but needs some modifications to its hardware and software to become a fully operational instrument. It is planned to dedicate the instrument to the NSA/AAO site and to make the installation permanent.

The status of other major Barrow site operations are described below:

1. The first biennial 40-m tower safety inspection was completed. There is a safety requirement that towers be periodically inspected. The 40-m tower itself as well as the pilings for the tower base and for the guy wires were examined to assure that each component retains its mechanical integrity. In addition, the guy wires were adjusted to maintain tension in the recommended range. The inspection was carried out in August by Tower Systems Inc., the vendor that originally installed the tower. A report is expected shortly.

2. A year or so ago, ARM contributed to an interagency fund [contributors: National Oceanic and Atmospheric Administration/Climate Monitoring and Diagnostic Laboratory (NOAA/CMDL), National Science Foundation (NSF), DOE/ARM] for the upgrade of the road from the U.S. Air Force (USAF) Long Range Radar site [former Distant Early Warning (DEW) Line Radar site] to the NOAA land on which the ARM sensors are located. The road also provides access to the Barrow Environmental Observatory (BEO) from the north. The road had deteriorated so that a significant portion of it was below the level of the surrounding tundra. During winter, blowing snow accumulated in the roadway, closing it with snowdrifts. The snowdrifts necessitated commuting to the instrumentation site by snow machine, which takes more time and involves more risk than commuting by truck when the road is open. Plowing opened the road only until blowing snow again occurred, usually within a few days. In summer after the snow melted, the road became increasingly impassable as deep pools of water formed in the roadbed. The interagency upgrade was to support raising the level of the road well above the surrounding tundra to make it easier to keep open in winter, and to prevent the formation of pools in the roadbed in summer. The upgrade was done through Ilisagvik College by students in its heavy equipment operator's course. The road project was essentially completed this fall although the students may continue to manicure the road in the future. Thus far this winter, it has been possible to keep the improved road open.

3.2 Unmet Measurement Needs

Measurement "needs" come in various gradations. Certain needs must be satisfied for significant progress to be made. These are the most critical. Other needs can be finessed with little loss by clever modelers using a combination of assumptions and minor model modifications. These needs are less important. As models improve, however, initially less important measurement needs frequently move up in importance. All of the anticipated measurement needs associated with the early priorities given in Section 2 were reviewed in Zak et al. (2000). They represent the output from a series of ARM and interagency workshops on NSA/AAO planning held in the mid 1990s. Here we discuss only the most important unmet measurement needs associated with each priority.

1. IR radiative transfer under cloudless skies for very cold, dry conditions.

   It has been recognized for some time that to make the most of the radiometric data in addressing this IRF issue, it would be highly desirable to have much more frequent temperature and water vapor soundings of the atmosphere. Temperature and humidity sensors at 2, 10, 20, and 40 m on the tower help, but only over the height range of the tower. Regular balloon-borne soundings such as these already being conducted at the NSA/AAO are necessary, but are not cost effective for routinely obtaining profiles several times a day. The cost of expendables becomes prohibitive. For this application, ground-based remote sensing techniques are far more attractive.

For temperature profiles, the RWP w/RASS may offer some hourly or more frequent data of value above its first range gate (75 m), and below about 1 km, at least for part of the year. However, the experience base with this instrument is not yet sufficient to determine the extent to which it will provide useful data in winter when absolute humidities are low, and hence, atmospheric reflectivities are as well. This coming year should tell the tale.

Another possibility for continuous temperature profiling is a millimeter temperature profiler (MMTP), which is designed to give data up to about 600 m. A Russian version of this instrument made by ATTEX had been deployed at Barrow for about a year. However, it was inoperative much of the time and even when functional did not appear to be able to provide useful data under the intense surface inversions common in the Arctic. It was recently removed. NOAA/ETL (Environmental Technology Laboratory) (Ed Westwater) has a similar one-of-a-kind instrument that is more robust and seems to perform much better. Work proceeds on this front. However, even if this particular microwave approach does not realize its promise, there are other options. Radiometrics Inc. (Fred Solheim) has developed a microwave radiometric instrument for retrieving temperature profiles that works by a somewhat different principle. The instrument was tested this spring at the NSA/AAO. The results are not yet available; however, the Radiometrics instrument may be a better answer.

For water vapor profiles, the options are more limited. At the request of the ARM Program Office, a white paper was produced some time ago to survey the options on both temperature and water vapor measurement needs at the NSA/AAO. It was recommended that the Raman lidar option be explored. As will be discussed in more detail in Section 6.3, a Raman Lidar Intensive Operational Period (IOP) was conducted in spring 1998 by The Pennsylvania State University (Rus Philbrick), but the results are just becoming available. The Radiometrics instrument may also provide a useful water vapor profiling capability for the NSA/AAO as well, but that remains to be seen.

The extended-range atmospheric emitted radiance interferometer (ER-AERI) data could be routinely analyzed to produce a value-added product giving temperature and humidity profiles. However, although altitude resolution would be good near the surface, it would degrade to about 1 km at an altitude of 1 km. Nevertheless, this option is being explored.

In the absence of sounding data, accurate column water vapor measurements made frequently would be of great value. There is presently a controversy as to whether the standard microwave radiometer (MWR) is capable of producing column water vapor data of sufficient precision and accuracy under very cold conditions to meet IRF needs. As a result, a more sensitive National Aeronautics and Space Administration (NASA)-owned MWR (Paul Racette), which operates at a higher frequency (183 GHz), was tested at the NSA/AAO this past spring. The results are not yet available.

In summary, various avenues for addressing these needs are being actively pursued, but for now, the need for frequent data remains unmet. That does not mean that one cannot do the relevant IRF experiments. They can and are being done. It does mean that these IRF experiments can only use radiometric data taken near in time to the onsite radiosonde soundings, which prevents use of the majority of the radiometric data.

2. Influence of stratus clouds on near UV, visible and near IR (<1 µm) radiative transfer, especially in the troposphere.

   For this near term priority, there are unmet measurement needs both in connection with radiometric and cloud measurements. On the radiometric side, there are unmet needs with regard to the visible and the near IR. It has been recognized that higher resolution measurements are needed to assure that any problems that exist with the models in this wavelength region will be appropriately identified and addressed. Furthermore, there are difficulties in obtaining the quality of calibration needed to meet anticipated precision and accuracy requirements. This unmet measurement need is common to all three CART sites. A higher resolution instrument developed by the State University of New York at Albany [the rotating shadowband spectroradiometer (RSS), Joe Michalsky] for this wavelength region was tested at Barrow during spring 1999, but the results are not yet available.

   On the cloud side, the cloud remote sensing instruments [millimeter cloud radar (MMCR), micropulse lidar (MPL), ceilometer, CIMEL multiband sun photometer, multifilter rotating shadowband radiometer (MFRSR), normal incidence multifilter radiometer (NIMFR), whole sky imager (WSI), and MWR] do not yet produce a sufficiently complete and validated microphysical description of clouds to allow tight intercomparisons between IRF model and measurement results. Flights by instrumented aircraft over the facility can help bridge this gap in two ways. First, an adequately instrumented aircraft could characterize the cloud layer overhead well enough to permit direct radiometric measurement and model comparisons. This is a potential solution, but not one that is affordable on a routine basis. Second, the instrumented aircraft could be used to validate the remote sensing algorithms so that in the future, the remote sensing instrumentation alone would be adequate to provide the cloud data for routine tight model/measurement comparisons. This latter process was begun in connection with the First (ISCCP) Regional Experiment (FIRE) and the Surface Heat Budget of the Arctic Ocean (SHEBA) IOPs. The anticipation is that the FIRE and SHEBA results will advance the cause, but not solve the problem.

3. Influence of stratus clouds on IR radiative transfer beyond the near IR, especially in the troposphere.

   The remarks made under priority 2 above regarding cloud characterization are equally applicable here. However, the remarks made about radiometric measurements do not apply. The ER-AERI has adequate resolution for the job at hand, and its provisions for continual calibration are excellent.

4. Solar radiative transfer to the surface under cloudless skies (IRF Experiment).

   Although there is a connection to the unmet measurement needs mentioned under priority 1 above, the main concern here is with optical characterization of the surface. One of the cited measurement needs is “surface bi-directional reflectance distribution function (BRDF) and albedo at local sites selected to span the representative surface types; BRDF and albedo need not be measured continuously.” How to make these measurements is reasonably well understood, but the instrumentation and procedures to carry out these measurements are not yet in place at the Barrow facility.

5. Interactions of surface albedo and related optical and physical factors with surface heating (SOM experiments).

   The NSA/AAO site is just beginning to come to grips with the measurement needs of SOM experiments. SOM experiments are the surface analog to single column model (SCM) experiments.

Just as it does little good for general circulation models (GCMs) to be able to model radiative transfer through clouds of known optical characteristics unless one can also predict the occurrence and optical characteristics of clouds (the focus of SCM experiments), so too it does little good for GCMs to be able to model radiative transfer at surfaces of known optical characteristics unless one can also predict the temporal evolution of those characteristics (the goal of SOM experiments). For regions where freezeup and melting do not occur, the range of surface optical characteristics is fairly limited, so surface optical models can be relatively simple. Such is not the case in cold regions.

For SOM experiments, it is expected that measurements at local sites selected to span the range of representative surface types would be needed. Measurement types not mentioned before that would also be needed include: frequent or continual profiles of snow, ice, liquid water, thermal conductivity, and temperature through the snow pack and within the active layer; vegetation and other relevant forms of surface physical characteristics; precipitation at the surface for all forms of water; and surface fluxes of sensible and latent heat.

6. Local factors affecting the formation and properties of stratus clouds (CB experiments; horizontal measurement scale, few to tens of kilometers; e.g., coastal, open lead, snow cover edge, lake, and other discontinuity effects).

   Virtually all of the measurement needs mentioned in priorities 1-4 would be required here, but at multiple locations strategically sited relative to the surface discontinuity of interest (say the coastline). The choice of SHEBA, Barrow, and Atqasuk addressed these needs. However, it seems unlikely that adequate data to fully address the transition zone issue could be acquired without the use of instrumented aircraft during IOPs. In light of the fact that a research group at San Diego State University (Walt Oechel) brings an aircraft with much of the relevant instrumentation to the North Slope with some regularity, the outlook for addressing this priority in an IOP mode is relatively favorable.

7. Stratus cloud formation and evolution processes on GCM grid cell scales (CB/SCM experiments).

   Again, while many of the measurements already cited will be needed for SCM experiments, the principal unmet measurement need upon which we focus here is that of convergence and/or divergence on a horizontal spatial scale of perhaps 200 km. At the Southern Great Plains (SGP) site, SCM experiments are conducted on an IOP basis using multiple radiosonde teams deployed at appropriate distances from the central facility to acquire the data from which convergence and/or divergence can be calculated. That approach does not appear to be logistically feasible for the NSA/AAO, given existing and anticipated budgetary constraints. Consequently, other options are being explored. All options under consideration involve the use of aircraft – either subscale or full size. More on this subject later.

3.3 Science Status

The focus of the Barrow facility taken alone thus far is atmospheric radiative transfer under both clear and cloudy conditions. Barrow is not yet equipped optimally even for this focus, but we are furthest along in this area. The inadequacy of the available temperature and humidity profiling and surface characterization capabilities are the major unmet measurement needs. The Barrow facilities taken together with the facilities at Atqasuk and the temporary deployment, which took place as part of SHEBA, also have a major role to play with regard to transition zones. So overall, priorities 1, 3, and 6 are receiving the most attention at Barrow, with priorities 2 and 4 awaiting better instrumentation in the visible and near IR (same for all three CART sites). The Aerosonde IOP (spring 1999; see section 6) represented the first tentative effort at the NSA/AAO to address priority 7, but clearly, further technique development work will be required.

4. Atqasuk

4.1 Status and Plans

Whereas all of the instrumentation at Barrow is operated continuously, and the Barrow facility is staffed 8 hours a day 5 days a week, anticipated budgetary constraints make 40-hour-per-week staffing unfeasible for Atqasuk. The present plan is to operate at least the low maintenance meteorological and radiometric instrumentation continuously, but only to operate instrumentation, which proves to be unaffordably labor-intensive during scheduled IOPs. Local part-time operators resident in Atqasuk are available for daily checks on the instrumentation. But for IOPs, additional staffing will be needed.

The Portable Arctic Atmospheric Radiation and Cloud Station (PAARCS) and a supporting insulated container were transported to Atqasuk from the Pacific Northwest National Laboratory (PNNL) in late June 1999. This was the hardware used by the NSA/AAO on the SHEBA campaign. This hardware contained most of the instrumentation to be deployed at Atqasuk, with the notable exception of the site data system. The data system was installed in mid August in parallel with the deployment of the other instrumentation. Before that time, data were only collected on the individual instrument PCs and loggers. An initial installation of a more limited set of instruments had been accomplished at a temporary site in Atqasuk proper in April to accommodate a specific request for data from the Science Team. The current deployment is on and adjacent to a gravel pad at the end of a road between the town of Atqasuk and its airport (Zak et al. 2000). In early spring 2000, once there is enough snow to move heavy equipment around on the tundra and enough light to function easily outdoors (the polar night extends through late January at this latitude), holes for the pilings will be augered, and construction of a platform begun adjacent to the gravel pad. The platform will accommodate the instrumentation for the longer term. The Atqasuk Corporation from whom the land is leased had specified that the equipment not remain on the gravel pad, which serves as a turn-around at the end of the road. Once the platform is completed, the shelters and other instrumentation will be moved to the platform and data acquisition resumed.

4.2 Unmet Measurement Needs

Since there is less permanent instrumentation at Atqasuk than at Barrow, all of the unmet measurement needs listed in Section 3.2 also apply here. Here we discuss only the unmet measurement needs that the deletions from the Barrow instrumentation list exacerbate.

1. IR radiative transfer under cloudless skies for very cold, dry conditions (IRF experiments).

   There has not yet been a commitment to locate the ER-AERI at Atqasuk that operated on SHEBA. Without the ER-AERI, this number one priority cannot be adequately addressed at Atqasuk. The issue is whether the instrument is supportable at this more remote location. In light of our experience at SHEBA and the fact that Atqasuk is only a half hour flight from Barrow (three scheduled flights per day), the NSA/AAO staff is confident that it can be. Hopefully, the issue will be resolved and the ER-AERI installed during the next planning period.

The principal additional issue here is that without the cloud radar and the micropulse lidar, it is more difficult to tell when the skies are cloudless. The WSI, the ceilometer, and the MFRSR all help, but it is not certain whether those data streams will be adequate for the job. In light of the fact that Atqasuk is overcast less frequently than Barrow, and hence is more desirable for clear-sky IRF experiments, this is a potentially damaging blow. NOAA/ETL has some interest in IOPs that would temporarily place the NOAA millimeter cloud radar (MMCR) and MPL that were used at SHEBA at Atqasuk, but that remains to be explored. For the purpose of this priority, the MPL is more important than the MMCR.

The lack of a 40-m tower and RWP w/RASS may also degrade the quality of the temperature and humidity profiles available near the ground, but it may be that the 10-m tower together with value-added temperature and humidity profile products from the ER-AERI may adequately fill the gap. Of course, without the ER-AERI, this possibility would be a dead letter. Lack of routine radiosonde soundings at Atqasuk is also likely to be problematic except during IOPs when such soundings are to be taken. Routine periodic soundings at Atqasuk less often than daily are another possibility, with the total number per year limited by budget considerations.

2. Influence of stratus clouds on near UV, visible and near IR (<1 µm) radiative transfer, especially in the troposphere. (IRF Experiment).

   For the purpose of this priority, lack of the MMCR is most critical. In the absence of an MMCR, some of the most relevant characteristics of a stratus deck are not determinable. It is possible, but not assured, that the beam from an MPL could penetrate the thin stratus enough of the time so as to make the MMCR less essential. The possibility could be explored in the existing data set from Barrow. If such were the case, it would argue even more strongly for investing in an MPL for Atqasuk. If the MPL would do most of the job, that would be financially attractive in light of its much lower cost than an MMCR.

3. Influence of stratus clouds on IR radiative transfer beyond the near infrared, especially in the troposphere (IRF experiment).

   Same comment here as under 2 above.

4. Solar radiative transfer to the surface under cloudless skies (IRF experiment).

   Neither Barrow nor Atqasuk are well equipped to address this priority. However, Barrow will very shortly have a downward-pointing video camera to track snow cover during the melt and refreeze. As of now, Atqasuk lacks this feature. The cost is sufficiently low that this gap can and should be filled as soon as possible.

5. Interactions of surface albedo and related optical and physical factors with surface heating (SOM experiments).

   The comment under 4 above is relevant here as well.

6. Local factors affecting the formation and properties of stratus clouds (CB experiments; horizontal measurement scale, few to tens of kilometers; e.g., coastal, open lead, snow cover edge, lake, and other discontinuity effects).

   This priority is one of the major motivations for the Atqasuk facility. Yet the lack of the MMCR and particularly the MPL limit the extent to which a Barrow-Atqasuk transition zone comparison can be made. Also needed to make an adequate comparison are routine radiosonde soundings, and of course, the ER-AERI and the value-added temperature and humidity profiles its data can provide.

7. Stratus cloud formation and evolution processes on GCM grid cell scales (CB/SCM experiments).

   The comment above is equally applicable here.

   To summarize, it remains to be seen how serious the effect on the science will be of Atqasuk being less well equipped than Barrow. Limited augmentation of the instrumentation suite, however, together with creativity, could go far in minimizing the negative impact. At the present time, the most critical issue is the restoration of the existing ER-AERI to the Atqasuk instrumentation suite. Next most important would be the addition of an MPL. Finally, the initiation of limited periodic radiosonde soundings would complete the atmospheric instrumentation suite needed for IRF experiments at Atqasuk. Surface characterization during the melt season for IRF (and SOM) experiments requires the addition of a surface-imaging video. Filling the gaps even on an IOP basis through the participation of NOAA/ETL with an MPL and MMCR would also be very helpful.

4.3 Science Status

The comments made in section 3.3 about the primary current focus at Barrow (IRF) are equally applicable here. However, because this facility is just coming on line, it still needs the instrumentation mentioned above to realize the goals inherent in the NSA/AAO plan.

5. Oliktok Point

During the next six months, the only action contemplated for Oliktok is continued investigation of its potential for use as an IOP site for tethered balloon operations, and for acquisition of restricted airspace to support such operations. Tethered balloon operations to 2 kilometers in altitude are feasible and have been undertaken by one of the authors. Because Oliktok is accessible by road from the lower 48, it is also a particularly convenient place for IOPs that involve the use of larger instrumentation that may be difficult to get to Barrow. Van- or trailer-mounted lidar systems frequently fall into this category. Unless their height is less than 8 ft, such systems would require disassembly to deploy by air to Barrow or Atqasuk, but they are easily and less expensively deployed to Oliktok. They could go by barge to Barrow, but there is only one barge per year. The road to Oliktok is open year-round. The combination of remote sensing systems with in situ measurements made by instrumentation carried aloft by a tethered balloon would make possible the cost-effective validation of selected ground-based remote sensing atmospheric profiling techniques. Since such techniques are particularly needed in cold regions where issues associated with ice and mixed-phase clouds are to be addressed, an IOP site at Oliktok could become a high value asset to ARM. In addition, Oliktok is valuable as an upwind site for Cloud Behavior experiments also involving Atqasuk and Barrow.

6. IOPs, Campaigns, Temporary Deployments: Past and Future

Since this is the first Site Scientific Mission Plan for the NSA/AAO, we review what has been done up to this point as well as what is planned for the immediate future.

6.1 SHEBA (Campaign)

SHEBA was a year-long field experiment focused on a manned drifting ice station in the Arctic Ocean perennial ice pack. (See web site at http://sheba.apl.washington.edu/manuscript/sheba.article.html.) The station was centered on a Canadian Coast Guard ice breaker (Des Groseilliers) intentionally frozen into the arctic ice pack during October 1997 and removed from the pack in October 1998. The SHEBA effort was led by the NSF as part of its Arctic System Science (ARCSS) program, and by the Office of Naval Research (ONR). The SHEBA observational effort emphasized the interactions of the surface radiation balance, the resulting growth and decay of the sea ice, the storage and retrieval of energy and salt in the mixed layer of the ocean, the formation and radiative properties of low-level clouds and their interplay with the radiation balance, and the relationships between the atmosphere-ocean-ice system and the data acquired by satellite remote sensors. Its principal aim was to increase understanding of the behavior of the arctic ice pack so that its response to global warming could be predicted with greater accuracy and confidence. ARM participated in SHEBA principally by supplying the more sophisticated radiometric measurements for downwelling and upwelling radiant energy. The ARM instrumentation, taken together with other SHEBA instrumentation, created a mini-CART site out in the ice pack. A more complete description of the ARM/SHEBA instrumentation is given in Zak et al. (2000).

There was considerable commonality in areas of interest between ARM NSA/AAO and SHEBA. The principal difference was that whereas SHEBA concentrated on the ice pack environment, the NSA/AAO devotes most of its resources to the land environment. With the two efforts being carried out collaboratively, they complemented each other very well. Another difference, however, was that the SHEBA field effort was limited to one year. In that year, many questions were raised that could not be answered in that time frame. However, because it is so expensive to go to the ice pack, the next SHEBA-like extended drift experiment may not take place for a generation. At least some of the questions raised by SHEBA may be answerable through ARM NSA/AAO, which has a much longer time horizon, or by further collaborations involving ARM and NSF and/or ONR through measurements on the AAO in the near-shore environment—perhaps at Oliktok.

One benefit to the NSA/AAO was working with SHEBA scientists who were engaged in much more detailed surface optical characterization than is now in place at the NSA/AAO facilities. As already noted under unmet measurement needs, this expertise needs to be added to the NSA/AAO.

As far as SHEBA results are concerned, most of the analysis has not yet been completed. Since most SHEBA data were acquired by individually funded academic researchers, the data itself are only now coming into the SHEBA archive. ARM data acquired at SHEBA are resident in the ARM archive and are available to other SHEBA researchers. However, some important preliminary results have already been released. From the ER-AERI data, ARM researchers (Tony Clough et al.) found that the model used to represent atmospheric radiative transfer in the 16-26 micrometer wavelength range represented reality poorly under cold conditions. Another model was found to be superior, and so it has been adopted for use in GCMs.

Other very interesting results concerned how thin the ice was relative to expectations based on measurements from two decades ago, and on an apparent change in the thermal and salinity structure of the part of the Arctic Ocean sampled by SHEBA.

6.2 FIRE (IOP)

Participation in SHEBA also brought with it the benefit of collaboration with FIRE Phase III (which focused on arctic clouds), a NASA-led effort that emphasizes satellite and airborne data. In spring and summer 1998, NASA FIRE aircraft made in situ measurements above both the SHEBA icebreaker and the Barrow ARM facility. One of the NASA aircraft, the University of Washington Convair-580 (Figure 1), was based in Barrow and hence took much more data over the Barrow ARM facility than would have been the case had it been based elsewhere. All told, four instrumented aircraft took part, including a NASA ER2 carrying downward-looking remote sensing instrumentation. Results are just now coming out.

6.3 Raman Lidar (IOP)

In late winter 1998, The Pennsylvania State University (Rus Philbrick) was commissioned by ARM to bring its water vapor profiling Raman lidar to Barrow to test how well it would perform in measuring the low water vapor concentrations common in the Arctic at this time of the year. There was a problem, however. A failure of the electronics took several weeks to find and fix. The failure had no apparent connection with the cold environment (all components of the lidar were operated in warm shelters). The result was that by the time the lidar was operational, it was no longer cold enough to challenge the instrument. As a result, the lidar operations team rotated home for several weeks and returned in time to overlap with FIRE and the University of Washington Convair-580 at Barrow. The modified effort was to get comparisons between lidar water vapor measurements and in situ measurements made by the aircraft. The data set is just now becoming available.

Figure 1. University of Washington's Convair-580 research aircraft at Barrow airport during FIRE arctic cloud.

6.4 DABUL (temporary deployment)

In late winter 1999, NOAA/ETL (Wynn Eberhard) brought their depolarization and backscatter unattended lidar (DABUL) polarization sensitive elastic scatter lidar to Barrow as part of an arctic haze study. Because the NOAA-proposed measurements were of interest to ARM, the NSA/AAO team facilitated the setup and running of this equipment, and made our facilities available. This permitted the DABUL to be operated in the vicinity of NARL (former Naval Arctic Research Lab), where it could be serviced much more easily than at NOAA/CMDL. The instrumentation was operated in an unattended mode, as designed. The equipment remained in place until late spring. Results are not yet available.

6.5 Water Vapor/Microwave (IOP)

The Water Vapor/Microwave IOP was conceived as a test of the capabilities of the NASA 183-GHz MWR's ability to provide good data on column water vapor under arctic winter conditions when the standard lower frequency MWR may not be sufficiently sensitive to provide high accuracy data. Once planning began, IOP participation grew to include NOAA/ETL, NASA Goddard, Radiometrics Inc, State University of New York at Albany, and the University of Denver. The instruments were primarily passive microwave remote sensing devices designed to measure either total column water vapor in the atmosphere, or water vapor profiles. However, visible and IR instruments, which can be used to make similar measurements, were also included. The University of Denver instrument was a special longwave slow scan AERI covering out to 50 micrometers. Because the amount of water vapor in the winter arctic atmosphere is so low, accurate remote sensing of water vapor at this time of year is a real challenge. Similar problems exist year-round in the stratosphere worldwide. Because several of the instruments were large and heavy, significant logistical support was required. Heated staging areas, snow removal on the road to the CART site, and flatbed trucks and forklifts were some of the services required to get the instruments installed and operating on the platforms at the instrumentation site. One of the advantages of Barrow is that it is one of the few locations in the Arctic where such support infrastructure is readily available. After expected startup delays, some associated with the use of equipment at temperatures around –40°, the Water Vapor/Microwave IOP was remarkably successful. The low operating temperature problems appear to have all been overcome, and a number of promising water vapor remote sensing techniques were tested. For more information, see the Water Vapor IOP web site at http://neptune.gsfc.nasa.gov/~per/MMWRarctic/index.html.

6.6 SCM/Aerosonde (IOP)

The Aerosonde is a unmanned air vehicle (UAV) developed by an Australian group (Aerosonde Robotic Aircraft Inc.) associated with the Australian Bureau of Meteorology (Greg Holland). The Aerosonde, with a 3-m wingspan and 13-kg total weight, is equipped to obtain vertical profiles of winds, temperature and relative humidity, much like that acquired by radiosondes. Radiotelemetry is utilized for acquisition of data in real time. However, on-board data storage capabilities also exist. The Aerosonde can be flight programmed to collect multiple profiles, acquiring such data hundreds of kilometers from its launch and landing site. The system's capabilities are particularly attractive for ARM SCM experiments that require atmospheric profiles over large areas. Such interest is especially strong for the NSA and the Tropical Western Pacific (TWP) CART sites, where deploying an adequate number of balloon launch teams in an array around the site is not cost-effective.

This was the first trial of the Aerosonde in a winter arctic environment, and the deployment was used to identify engineering modifications required for routine use in this environment. Problems with cold weather operations were indeed found. Seven hours after launch, the first flight came to an unexpected end on the sea ice about 40 km north of Barrow as a result of airframe icing. The second flight, conducted local to Barrow was successful. A third flight also had an unexpected end after six hours 100 km north of Barrow as a result of engine failure, and a fourth and final flight suffered a similar fate just north of Barrow. The Aerosonde is equipped with a reciprocating engine. Unless special adaptations are made to accommodate the cold, small engines of this type appear to have performance problems under low temperature conditions. On the plus side, the hardware and software measuring the wind, temperature, and humidity performed flawlessly, as did the radio frequency (RF) link from the aircraft to Barrow out to 100 km (40-ft high poles with antenna rotators were installed at the duplex for the Aerosonde receiving and transmitting antennas).

The Aerosonde developers are already considering a number of engineering modifications to remedy the cold-weather problems. These problems are thought to be an impediment only in the short term. The Aerosonde team is proposing to NSF that a permanent Aerosonde port be established at Barrow to cover the western Arctic. Their use of one of the old NARL hangers and the old NARL airstrip (both courtesy of Ilisagvik College) during this experiment, coupled with the other logistical advantages of Barrow, caused them to rate Barrow as the best place in the Arctic for a permanent Aerosonde port. For more information, see the Aerosonde web site at http://www.aerosonde.com/.

The Aerosonde/SCM IOP also offered the opportunity to try out arrangements for the acquisition of additional radiosonde data at the NSA/AAO. SCM experiments, even if utilizing the Aerosonde, might require radiosonde soundings at Atqasuk, and more frequent soundings at Barrow [the Federal Aviation Administration (FAA) only permitted the Aerosonde to operate offshore from Barrow, in part because Aerosondes do not yet carry radar transponders]. Rune Storvold of the Regional Service Team (RESET) at the University of Alaska, Fairbanks (UAF) organized radiosonde teams of graduate students for deployment to Atqasuk and Barrow for the duration of the experiment. Sandia National Laboratories personnel trained the students. The radiosonde launches went relatively smoothly, although there were a surprising number of dropouts of wind data with the Vaisala global positioning system (GPS) sondes. This outcome is being explored to ascertain if it is to be expected with the Vaisala GPS hardware, or if there were problems with the instrumentation. The National Weather Service (NWS) reported that wind dropouts with the GPS sounding systems NWS had tested were not unusual and were believed to be due to loss of lock.

6.7 Melt Season Heat Fluxes (temporary deployment and IOPs)

Strong discontinuities in surface characteristics develop in a relatively narrow coastal transition zone during the spring as the snow begins to melt. Over a period of a 2-3 weeks, the land surface changes from being fully snow-covered to essentially snow-free. This happens long before the sea ice adjacent to the shore disappears. Strong differences in the cloud characteristics at coastal and inland sites result. Comparisons of surface heat and water vapor fluxes at both Barrow and Atqasuk are needed to help characterize the surface conditions that contribute to the formation of the boundary layer at the two locations.

These phenomena are included in a study by a group from PNNL headed by Chris Doran. The ARM-funded project is entitled “Point-Area Relationships for Global Climate Modeling.” They plan to use NSA/AAO measurements to construct a climatology of optical depths and liquid water paths at Barrow and Atqasuk that will include means and distributions of both quantities extending over the melt season (May-September). They also propose to construct a corresponding description of surface heat fluxes, albedos, and ambient winds over the same time period. They will use the information to answer questions about the relative importance of surface fluxes of heat and moisture, as well as of radiative exchange in determining the optical depth and liquid water path of arctic stratus clouds in the coast-inland transition zone; about how the relationship varies with season and surface conditions; and about how well the relevant processes are treated in existing numerical models.

With Site Operations help, in late spring 1999, the group deployed a laser scintillometer at Atqasuk for measuring heat fluxes over an extended path. This instrument is in the immediate vicinity of where the ARM NSA/AAO instrumentation is installed, and where an eddy correlation instrument measuring the same and additional parameters at a point has already been deployed. The eddy correlation instrumentation is fielded by the San Diego State University as part of the NSF-sponsored Arctic Transitions in the Land Atmosphere System (ATLAS) project. Because the laser is class 3 (eye safe, but with caveats) rather than class 1, special care needed to be exercised to assure eye safety for the general public. The safety measures taken were described in a North Slope Borough permit application specifically for this instrument that was duly approved before deployment.

6.8 Plans

The melt season heat flux study will continue through CY 2000. The laser scintillometer instrumentation at Atqasuk was removed in fall 1999 and will be redeployed in spring 2000 to remain through the year 2000 melt season. This plan requires that the other Atqasuk instrumentation operate in a full-up mode throughout the CY 2000 melt season.

As part of the heat flux study, it is also planned that heat flux instrumentation be deployed in the vicinity of Barrow. The desire is to make these measurements right at the shore of the Beaufort Sea in a location where on-shore winds predominate. An ideal location of this nature has been found. Crescent Island is one of a series of sand spits that delineate the outer boundary of Elson Lagoon just to the east of the NSA/AAO Barrow facility. Like the other sand spits delineating Elson Lagoon, Crescent Island is only a foot or two above mean sea level, is 100-200 ft wide, and is occasionally swept by waves. In the absence of some robust support structure, it would be difficult to operate instrumentation for any length of time on such an island. However, a 40-ft by 80-ft barge (Figures 2 and 3) is grounded on Crescent Island. The barge has been there since a major storm in the early 1960s. This barge would make an excellent base for an unattended meteorological station such as is needed for the melt season study. The island and the barge belong to Ukpeagvik Inupiat Corporation (UIC). We have begun the process of obtaining use privileges in support of this element of the melt season study.

It was proposed that in winter 1999-2000 another SCM trial experiment be conducted at the NSA/AAO. However, there are reasons for delaying the trial until perhaps the following year. The Aerosonde system is not presently ready for such use, and although alternatives exist, they require development as well.

There are two potentially attractive alternatives. One is equipping a full-size aircraft with dropsonde capability. There are a number of suitable aircraft owned by Cape Smythe Aviation based in Barrow. Another possibility is putting the Aerosonde sounding capability on a full-sized aircraft. Since the Aerosonde sounding capability instrumentation performed flawlessly even though the Aerosonde robotic

Figure 2. Grounded barge on Crescent Island proposed for use as an instrument platform.

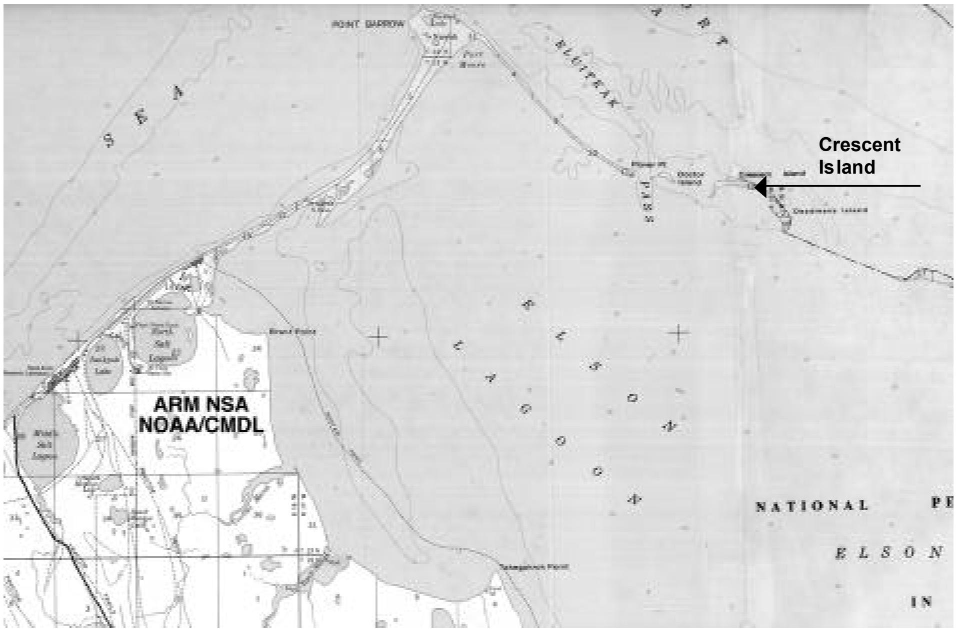

Figure 3. Map of Pt. Barrow showing Barrow CART site and Crescent Island.

aircraft had problems, mounting that instrumentation on a full-size aircraft would eliminate the problems encountered this spring. Cape Smythe is willing to explore either possibility. Even if another SCM experiment is deferred as now seems likely, work will need to proceed on one or both of these alternatives.

Finally, a mini-IOP based on the presence of multiple AERIs at Barrow is planned for spring 2000. First, the ER-AERI originally destined for Atqasuk will be operated in parallel with the ER-AERI permanently at Barrow. In addition, the longwave Fourier transform infrared spectrometer (FTIR) (to 50 micrometers) currently being operated at Barrow by the University of Denver will be kept in operation during this period. It is also planned that another AERI owned by the University of Wisconsin be operated in a downward-looking mode for snow characterization during this period. Very recently, word of the possibility of a fifth AERI coming to Barrow during this period was received. We intend to explore what additional radiosonde soundings would be optimal during this period under existing budgetary constraints.

7. Data Status

7.1 SHEBA Data and Data Processing Status

This section contains a brief overview of instruments deployed by ARM at SHEBA, a brief comment on the instrument performance, and the status of the processing of the data collected. Starting date gives the time when the NSA site scientist team considered the data to be of known and reasonable quality. Most instruments had problems sometimes during SHEBA. The exact dates and descriptions of these problems and how they influence the quality of the data are available in the metadata attached to the parametric data submitted to the archive. Table 7.1 lists all the instruments ARM deployed at SHEBA, as well as 1) period of operation, 2) general operational status, 3) current processing levels, and 4) availability at the ARM archive.

7.2 Barrow Data Collection and Data Processing Status

This section gives a brief status (as of 07/15/99) of the data collection and processing for each instrument currently deployed at the ARM NSA/AAO site in Barrow. The development of data processing tools [ingest modules, value-added procedures (VAPs) etc.] still in progress, and many of the instruments listed in the table below will have higher level data streams available in the near future. Several data streams have been released, and others are ready for release. All data streams are expected to be online in near-real time within the next several months for the Barrow facility. The situation will shortly be similar for Atqasuk, but at this writing (early December 1999), Atqasuk data are not yet available to the general public. Table 7.2 provides an instrument-by-instrument overview of 1) the date when data of “known and reasonable quality” were available, 2) operational status, 3) level of processing, and 4) data archiving status.

8. Educational Outreach

The educational outreach effort as a whole was described in the companion background document. Here only an update is given. For FY 2000, it is anticipated that additional small contracts will be awarded for the K-12 component of the program, and that a proposal will be entertained from Ilisagvik College for the continuation of the college and community element of the program. It is planned that both elements will continue to be administered through Arctic Research Consortium of the U.S. (ARCUS).

Table 7.1. Instruments deployed at SHEBA.

Instrument	Start Date	End Date	Operational Status	Data Level	At the Archive
SKYRAD					
PIRg	11/09/97	09/30/98	Good	00,a1,b1	Yes
PIRd	11/09/97	09/30/98	Good	00,a1,b1	Yes
PSPg	10/21/97	09/30/98	Good	00,a1,b1	Yes
PSPd	10/21/97	09/30/98	Good	00,a1,b1	Yes
NIP	10/21/97	09/30/98	Good	00,a1,b1	Yes
UVB	10/21/97	09/30/98	Good, problems with frosting and icing on dome	00,a1,b1	Yes
IRT	12/15/97	09/30/98	Good, had to be replaced on 3/28/98	00,a1,b1	Yes
NIMFR	03/15/98	09/30/98	Good, but occasional drop out or bad data	00,a0,a1, b1	Yes
MFRSR	03/09/98	09/30/98	Good, but occasional drop outs or bad data	00,a0,a1, b1	
GNDRAD					
PIR	11/08/97	09/30/98	Good	00,a1,b1	Yes
PSP	10/19/97	09/30/98	Good	00,a1,b1	Yes
IRT	11/18/97	09/30/98	Good	00,a1,b1	Yes
NET	03/13/98	09/30/98	Fair, had a lot of frosting and internal condensation	00,a1,b1	Yes
MFR	10/26/97	09/30/98	Good, but occasional drop out or bad data	00,a0,a1, b1	Yes
Auxiliary Instruments					
VCEIL	10/18/97	10/01/98	Good, 12/10/97-01/14/98 missing due to instrument component failure	00,a1,b1	
ER-AERI	11/09/97	6/15/98	Good, 2/5/98-2/18/98 and 5/21/98-6/2/98 missing due to instrument failure	00,a1	Yes
MWR	10/20/97	10/01/98	Good, 11/19/97-12/05/97 missing data, frequent problems with frosting and snow on dome.	00,a1,b1	Yes
WSI	10/22/97	10/01/98	Good, some internal dome frosting problems.	00,a1,b1	
GPS	10/17/97	10/04/98	Good, frequent short periods of data drop outs.	00,a1,b1	

GPS - global positioning system
IRT - infrared thermometer
MFR - multifilter radiometer
NET - net radiometer
NIP - normal incidence pyranometer
PIR - precision infrared radiometer
PSP - precision spectral pyranometer
UVB - a portion of the UV spectrum
VCEIL - Vaisala ceilometer

Table 7.2. Instrument overview for Barrow.

Instrument	Date	Operational Status	Data Level	Available at the Archives
SKYRAD				
PIRg	05/15/98	Good	00,a1	Yes
PIRd	05/15/98	Good	00,a1	Yes
PSPg	05/15/98	Good	00,a1	Yes
PSPd	05/15/98	Good, direct sun obstructed close to local midnight	00,a1	Yes
NIP	05/15/98	Good, field of view obstructed close to local midnight	00,a1	Yes
UVB	07/01/98	Good,	00,a1	Yes
IRT	03/01/99	Good, Quality effected during precipitation events	00,a1	Yes
NIMFR	06/04/98	Good, field of view obstructed close to local midnight	00,a0,a1,b1	
MFRSR	05/01/98	Good	00,a0,a1,b1	
GNDRAD		Shaded around 7 p.m. local time by the instrument shelter, is to be moved to a tip tower		
PIR	05/01/98	Noisy signal	00,a1	Yes
PSP	05/01/98	Good	00,a1	Yes
IRT	06/05/98	Good	00,a1	Yes
NET	05/01/98	Good	00,a1	Yes
MFR	05/01/98	Good	00,a0,a1,b1	
MET-data	05/01/98			
2,10,20,40 m T, RH, WS, WD		Good	00	
Barometer		Good		
ORG	04/03/99	Good, some problems with integration of daily averages	00	
PWS	05/01/98	Good	00	
Sonde	09/24/98	Good, launches performed once daily on weekdays only, exceptions may occur during IOPs, or extreme weather	00, a1	
Auxiliary Instruments				
VCEIL	05/01/98	Good	00,a1	
MPL	05/01/98	Good	00,a1	
MMCR	05/09/98	Good	00	
ER-AERI	05/05/98	Good, Noise at small wave-numbers.	00	
MWR	11/20/98	Good,	a1	
WSI	10/02/98	Raw data collected on Nanuq, Quality not inspected	00	
MMPT	-	Under testing.	-	
RWP-RASS	-	Will be operational in near future, currently only in testing mode	-	

MET - meteorological
MMPT - millimeter temperature profiler
PWS - present weather sensor

The K-12 effort will require special attention in that our principal NSBSD contact, Mike Davis, retired from the school district at the end of this past school year. A new principal contact needs to be found. Davis has suggested a replacement.

9. Management and Personnel

Here only an update is given. In June 1999, Walter Brower came on board as the NSA/AAO Onsite Facility Manager. This is a new position. Consequently, it is necessary that Walter's functions, responsibilities, and interfaces with the rest of the NSA/AAO team be worked out in detail. In the same time frame, Knut Stamnes (NSA/AAO Site Scientist) announced that he would be taking a position at Stevens Institute of Technology in New Jersey, while retaining a joint appointment with the Geophysical Institute at the University of Alaska, Fairbanks. The majority of Knut's group will remain at UAF and will continue to carry out the quality assurance functions of the Site Scientist as before. However, some as yet undetermined accommodations to the altered situation may prove necessary. These two changes made it desirable that a review of all functions, responsibilities, and interfaces within the NSA/AAO team and with the rest of the ARM infrastructure be undertaken. That review was initiated in July. However, the NSA/AAO review was superceded by the ARM Infrastructure Review (AIR), the results of which were made public in September 1999. Shortly thereafter, it was announced that many of the recommendations put forward in the AIR report would be implemented through reorganization. However, at this writing, the details of the reorganization are still being worked out.

10. Reference

Zak, B., K. Stamnes, and K. Widener, and H. Church, 2000: *Background for the DOE/ARM North Slope of Alaska/Adjacent Arctic Ocean (NSA/AAO) Cloud and Radiation Testbed (CART) Site Scientific Mission Plan.* Available on the ARM web site: http://www.arm.gov/.

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