APPENDIX K--OPERATIONAL LOG FORMS

LOG INDEX

A- Arctic Cloud Experiment Daily Mission Summary	K-2
B- Arctic Cloud Experiment Forecaster Log	K-5
C- Arctic Cloud Experiment ER-2 Flight Log	K-6
D- Arctic Cloud Experiment ER-2 Instrument Operating Log	K-7
E- Arctic Cloud Experiment Flight Tape Operating Log	K-8
F- Arctic Cloud Experiment NCAR C-130 Flight Log	K-10
G- Arctic Cloud Experiment NCAR C-130 Instruments Operating Log	K-11
H- Arctic Cloud Experiment UW CV-580 Flight Log	K-13
I- Arctic Cloud Experiment Canadian CV-580 Flight Log	K-14
J- Arctic Cloud Experiment Canadian CV-580 Instruments Operating Log	K-15
K- Arctic Cloud Experiment Satellite Log-SHEBA Ice Camp	K-18
L- Arctic Cloud Experiment Satellite Log-Barrow	K-19
M- Ship-SHEBA/Arctic Cloud Experiment Surface Instruments Log	K-20
N- Ship-ARM/Arctic Cloud Experiment Surface Instruments Log	K-22
O- Ship-FIRE/Arctic Cloud Experiment Surface Instruments Log	K-23
P- Barrow-ARM/Arctic Cloud Experiment Surface Instruments Log	K-24
Q- Outgoing Telephone Call Log	K-26
R- Cellular Phone Call Log	K-27
S- Daily Ship Report	K-28
T- INMARSAT Calls Log	K-29
U- Registration Form	K-30

A- ARCTIC CLOUD EXPERIMENT DAILY MISSION SUMMARY
(prepared by Daily Mission Scientist)

Date:

Daily Mission Scientist: Deputy Daily Mission Scientist:

Mission Objective:

Mission Description:

Weather Synopsis:

Synoptic Situation:

Aircraft	Depart Time	Land Time	Comments
NASA ER-2			
NCAR C-130			
UW C-580			
Canadian C-580			

Aircraft Mission Debrief Notes:

Satellite	Ship/Barrow Overpass Time	Zenith	Azimuth	Comments
NOAA-12				
NOAA-14				
DMSP F 12				
DMSP F 13				
RESURS				
Earth Probe				
RADARSAT				
LANDSAT				

Surface Operation Notes:

Highlights of Mission:

Significant Hardware/Other Problems:

Actions Prior to Next Mission:

Signature:

B- ARCTIC CLOUD EXPERIMENT FORECASTER LOG

(prepared by Lead Forecaster)

Date:

Weather Synopsis:

Synoptic Situation:

Note: Attach Satellite Image with appropriate mb overlay Signature:

C- ARCTIC CLOUD EXPERIMENT ER-2 FLIGHT LOG
(prepared by Aircraft Scientist)

Date: ER-2 Mission Scientist:

Primary Mission: Alternate Mission:

Proposed T/O: Proposed Land: Proposed Duration:

Actual T/O: Actual Land: Actual Duration:

ER-2 Mission Log:

Time	Flight Leg	Comments

Debrief Notes:

Significant Problems:

Signature:

D- ARCTIC CLOUD EXPERIMENT ER-2 INSTRUMENTS OPERATING LOG
(prepared by Instrument PI/Aircraft Scientist)

ER-2 Instruments	UTC Start:		Hours Not Operational			UTC Stop:			Comments
	01	02	03	04	05	06	07	08	
ARC - SSFR									
GSFC - CLS									
GSFC - MAS									
GSFC - MIR									
JPL - AirMISR									
LaRC - SHIS									
MSFC - AMPR									
DFRC - Navigation									

Readiness Assessment for Next Flight:

Signature:

E- ARCTIC CLOUD EXPERIMENT FLIGHT INSTRUMENT TAPE OPERATING LOG(one per instrument)
(prepared by Instrument PIs for ER-2, C-130, UW CV-580 and Canadian CV-580)

Aircraft: ID:

Day: Flight Number:

Investigator: Instrument(s):

Flight Operator(s):

Status Before Takeoff:

Instrument Data Tape Log:

Tape #	Time On	Time Off	Comments

Important Observations:

Problems:

Comments on This Flight Plan:

Suggestions for Next Flight Plan:

Signature:

F- ARCTIC CLOUD EXPERIMENT NCAR C-130 FLIGHT LOG
(prepared by Aircraft Scientist)

Date: NCAR C-130 Mission Scientist:

Primary Mission: Alternate Mission:

Proposed T/O: Proposed Land: Proposed Duration:

Actual T/O: Actual Land: Actual Duration:

NCAR C-130 Mission Log:

Time	Flight Leg	Comments

Debrief Notes:

Significant Problems:

Signature:

G- ARCTIC CLOUD EXPERIMENT NCAR C-130 INSTRUMENTS OPERATING LOG
(prepared by Instrument PI/Aircraft Scientist)

NCAR C-130 Instruments	UTC Start:			Hours Not Operational			UTC Stop:		Comments
	01	02	03	04	05	06	07	08	
PMS-PCASP 100									
PMS-FSSP-100									
PMS-FSSP-300									
PMS-FSSP-2D-C									
PMS-FSSP-2D-P									
OAP-260X									
Cryo. Dewpoint Hygrometer									
Lyman-alpha absorption hygro.									
UV Hygrometer									
Dew-point hygrometer									
Atmos./satur. water vapor press.									
Amb./dew pt. temp. & water vapor pressure									
Stat. press & water vapor press.									
Water vap. press & stat. press.									
PMS/CSIRO liq. water probes									
Near-IR Laser Spect H2O Vapor									
Multiangle Spect Probe(MASP)									
Gerber PVM 100A									
Rosemount 871F ice-accr. probe									
TSI CN counter									
Heinmann KT19.85 IR Radiom.									
NCAR-mod. Eppley PIR									
NCAR-modified Eppley PSP									
Eppley UV rad./photometer									
Multichannel Cloud Rad.(MCR)									
Airborne Imaging Microwave Radiometer(AIMR)									
Honeywell Laser Inertial Ref Sys									
APN-159 and -232 radar									
Barometric pressure									
Trimble TANS-III GPS Receiver									

NCAR C-130 Instruments	UTC Start:			Hours Not Operational			UTC Stop:		Comments
	01	02	03	04	05	06	07	08	
Dynamic/static pressure									
IRS & plane speed & attitude									
Radome/IRS Wind Gust System									
Cloudscope									
Exter. Video; Down & Left/Right									
Rosemount									
Rosemount Model 1201F1 Absolute Pressure Transducer									
Ophir III Rad. Temp. Sensor									
Continuous Flow Diffusion(CFD) Chamber									Rogers
CN Particle Counter									Rogers
Cloud Particle Imager(CPI)									Lawson
CCN Spect. & CN counter									Hudson
Radiometers(RAMS)									Valero
TDDR									
MCR									
TSBR(2)									
IRBR(2)									
NFOV									
RDAS									

Readiness Assessment for Next Flight:

Signature:

H- ARCTIC CLOUD EXPERIMENT UW CV-580 FLIGHT LOG
(prepared by Aircraft Scientist)

Aircraft Flight Log for the University of W ashington, Cloud and Aerosol Research Group

Date	Flight Number	Experimental Observations
Project name		
Engines on time	Engines off time	
Departure airport	Arrival airport	
Flight Scientist signature		
Pilot signature		
Surface met. & visual obs. at take off	Clouds sampled: Ac, As, Ns, Sc, St, Cu, Cb	
Research crew	Equipment failure	FIRE-III OBJECTIVES ADDRESSED: NEXT POSSIBLE FLIGHT:

I- ARCTIC CLOUD EXPERIMENT CANADIAN CV-580 FLIGHT LOG
(prepared by Aircraft Scientist)

Date: Canadian C-580 Mission Scientist:

Primary Mission: Alternate Mission:

Proposed T/O: Proposed Land: Proposed Duration:

Actual T/O: Actual Land: Actual Duration:

Canadian CV-580 Mission Log

Time	Flight Leg	Comments

Debrief Notes:

Significant Problems:

Signature:

J- ARCTIC CLOUD EXPERIMENT CANADIAN CV-580 INSTRUMENTS OPERATING LOG
(prepared by Instrument PI/Aircraft Scientist)

Canadian C-580 Instruments	UTC Start:			Hours Not Operational			UTC Stop:		Comments
	01	02	03	04	05	06	07	08	
Inboard PCASP									
Epply UV									
Dropsonde									
LandSat Simulator									
U. of Arizona Radiometer									
LIDAR(up and downward looking)									
Nephelometer									
AES Rosemount Temperature									
Reverse Flow									
CVI									
Rosemount Ice Detector and Vibrometer Ice Detector									
Airbus Icing Rod									
King Probes									
Nevzorov Probes									
FSSP-100-96									
FSSP-100-124									
2D2-C or 2D-C 2D-GA 2D-P									
DRI Replicator									
DRI Cloudscope									

SPEC. Probe									
PCASP									
FSSP-300									
Extinction Meter									
IR Pyrgeometer (up and down)									
SW Pyranometer (up and down)									
PRT-5									
EG & G Dew point									
Russian Lyman-Alpha Hygrometer									
U. of Wyoming CCNC									
TSI 3025 CN Counter									
PMS 7610, CN Counter Flowmeter									
IAR 858 Gust Probe									
TECO 49,43S									
Hg Monitor Calibrator									
Aerosol filter &flow meter									
Moudi Impactor & flowmeter									
Tenax Cartridge flowmeter									
DMA 3025									
Hi Vol. Flowmeter									

Readiness Assessment for Next Flight:

Signature:

K- ARCTIC CLOUD EXPERIMENT SATELLITE LOG-SHEBA Ice Camp
(prepared by Satellite Scientist)

Date: Satellite Scientist:

Satellite	SHEBA Overpass Time	Zenith	Azimuth	Comments
NOAA-12				
NOAA-14				
RADARSAT				
DMSP F 12				
DMSP F 13				
RESURS				
Earth Probe				
LANDSAT				

Significant Satellite/Other Problems:

Signature:

L- ARCTIC CLOUD EXPERIMENT SATELLITE LOG-BARROW
(prepared by Satellite Scientist)

Date: Satellite Scientist:

Satellite	Barrow Overpass Time	Zenith	Azimuth	Comments
NOAA-12				
NOAA-14				
RADARSAT				
DMSP F 12				
DMSP F 13				
RESURS				
Earth Probe				
LANDSAT				

Significant Satellite/Other Problems:

Signature:

M- Ice Camp-SHEBA/ ARCTIC CLOUD EXPERIMENT SURFACE INSTRUMENTS LOG
(prepared by Surface Scientist)

Ice Camp-SHEBA

Date:

Arctic Cloud Experiment Surface Scientist: Signature:

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
35 Ghz Cloud Radar																									
LIDAR(DABUL)																									
Balloon																									
Rawinsonde																									
Vaisala DW t'mistor probe																									
Vaisala DW humidity probe																									
RM Young propellor/vane																									
Aneroid																									
Eppley BB pyranometer																									
Eppley BB pyrgeometer																									
Tower Sonic anem.therm.																									
Ophir rapid-resp. hygromet.																									
Vaisala mean thermistor																									
Vaisala mean humidity																									
U/D Solar Eppley pyran.																									
U/D LW Eppley pyrgeo.																									
Scintec scintillometer																									
Cooled-mirror hygrometer																									
Barnes IR thermometer																									
Setra barometer																									
Hourly Sonic anem. therm.																									
Snow Properties																									
Ice Cores																									
Snow/Ice particulates																									
Ice Mass bal. thick.gage																									
Ice Mass bal. acous. sound.																									
Ice temp.thermistor string																									

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
BB albedo Kipp radiometer																									
Spectroradiometer																									
Ice Irrad. radiometer																									
Sea-bird conductivity																									
Sea-bird temperature																									
Turbulence Inst. cluster																									
therm. microstructure sens.																									
Acoustic dopp. current prof.																									

N - Ship-ARM/ ARCTIC CLOUD EXPERIMENT SURFACE INSTRUMENTS LOG
(prepared by Surface Scientist)

Ice Camp-ARM

Date:

Arctic Cloud Experiment Surface Scientist: Signature:

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
M'wave radiometer(MWR)																									
Millimeter wavelength temp. profiler(MMTP)																									
Vaisala ceilometer(VCEIL)																									
Whole-sky imager(WSI)																									
Down ER-AERI zen. rad.																									
Down IR thermometer(IRT)																									
MFRSR																									
NIMR																									
PSP/DS																									
PSP/DD																									
NIP																									
PIR/DI																									
PIR/DDI																									
UVB																									
RN																									
Dupe PSP & PIR																									
Up IR thermometer(IRT)																									
PSP/US																									
PIR/UI																									
GND MFR																									

O - Ship- FIRE ARCTIC CLOUD EXPERIMENT SURFACE INSTRUMENTS LOG
(prepared by Surface Scientist)

SHEBA Ship-FIRE

Date:

Arctic Cloud Experiment Surface Scientist: Signature:

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
U. Utrecht																									
Tethersonde AIR017																									
Photoelectrical Detector																									
Vector A100R																									
Vector W200P																									
Vaisala HMP35AC																									
Kipp CM14																									
Eppley PIR																									
Campbell CSAT3 3D																									
Lyman-Alpha KOH2																									
PVM-100A																									
Microwave Radiometer																									
NASA ARC																									
SSFR																									

P- Barrow-ARM/ARCTIC CLOUD EXPERIMENT SURFACE INSTRUMENTS LOG
(prepared by Surface Scientist)

Barrow, Alaska

Date:

Arctic Cloud Experiment Surface Scientist: Signature:

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Tower wind speed/dir.																									
Tower dew/frost point																									
Tower standard precip. gage																									
MWR																									
Radiosonde																									
Raman Lidar																									
MMCR																									
MPL																									
VCEIL																									
WSI																									
Down ER-AERI zen. rad.																									
UV Spectrometer																									
Down IRT																									
CSPHOT																									
MFRSR																									
NIMR																									
BB PSP/DS																									
PSP/DD																									
NIP																									
Down PIR/DI																									
Down PIR/DDI																									
UVB																									
RN																									
Dupe PSP & PIR																									
Up IRT																									

UTC	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	Comments
Local	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
PSP/US																									
PIR/UI																									
Up MFR																									
Multi Wave Integ. Nephelo.																									
CNC																									
Filter Samplers																									
Flask Samplers																									
Gas Chromat. G/H Gases																									
UV Ozone Mon.																									
Col. Ozone Mon.																									

Q - Outgoing Telephone Log

You may use this telephone for long distance calls for the planning and conduct of mission operations only. Please log in your call. All other calls must be credit card or reverse charges (no need to log in).

TELEPHONE CALLS LOG-IN SHEET

This Phone Number:_____

Date	Start/Stop Time	Caller's Name	Caller's Organization	Person Called	Number Called	Purpose

R - Cellular Phone Call Log

You may use this cellular telephone for emergency calls for the planning and conduct of mission operations only. Whenever possible, a conventional land-line telephone should be used rather than the cellular telephone. Please log in all your in-comming and out-going calls. All other calls must be credit card or reverse charges (no need to log in). Keep cellular phone on at all times.

TELEPHONE CALLS LOG-IN SHEET

This Phone Number:_____

Date	Start/Stop Time	Caller's Name	Caller's Organization	Person Called	Number Called	Purpose

S- Daily Ship Report

DATE_____TIME_____SHIP OBSERVER_____

GPS SHIP POSITION_____SHIP MOVEMENT IN LAST 24 HRS_____

CLOUD HEIGHTS_____
(from radar and lidar)
_____

LIQUID WATER LAYERS_____
(from lidar)
_____

INVERSION HEIGHT_____SHIP ORIENTATION_____PREVAILING WINDS_____

RAWINSONDE STATUS_____

TETHERED BALLOON STATUS_____

VISUAL OBSERVATIONS_____
(from surface observer)
_____

LEAD REPORT_____

SHIP INSTRUMENT STATUS_____

_____

HELICOPTER STATUS_____ULTRALIGHT STATUS_____

SHIP-TO-AIR COMMUNICATION FREQUENCIES_____

SHIP-TO-LAND COMMUNICATION FREQUENCIES_____

COMMENTS AND MISSION RECOMMENDATIONS_____

_____

T - INMARSAT Phone Call Charges Log

INMARSAT calls are expensive and this log is an attempt to keep charges within budget. The budget is based on two calls per day from each site, 5 minutes each and $4 per minute. Calls to/from Barrow and Inuvik are to be charged to a credit card at the Ship. Calls to/from Fairbanks are to be charged to the Fairbanks phone service.

TELEPHONE CALLS LOG-IN SHEET

This Phone Number:_____

Date	Start/Stop Time	Caller's Name	Caller's Organization	Person Authorizing Charge	Location Initiating Call	Purpose

U -- FIRE Arctic Field Mission Registration Form

All people who are participating in the FIRE Arctic Cloud Field Mission are asked to complete the following registration form. With this information, we can provide the required security lists for both Ft. Wainwright and the Geophysical Institute. Additionally, we will use this information when arranging desks, telephone lines, and computer drops in the Ft. Wainwright hangar and to develop a roster of where participants are located.

Groups participating in both Phase 1 and Phase 2 should provide information for both phases, as indicated. Exact dates are not important; please give us your best estimate now and call or e-mail us about changes later.

This form was sent only to personnel listed in the directory(Appendix J) of the Arctic Cloud Experiment Operations Plan. PRIMARY INVESTIGATORS AND THOSE WHO WILL BRING OTHERS WITH THEM ARE TO PROVIDE THIS INFORMATION FOR EACH MEMBER OF THEIR TEAM.

Please return this information to the SAIC FIRE Project Office at r.w.chesson@larc.nasa.gov or fax it to 757-825-4968 no later than March 15.

Full Name:

Organization:

Citizenship:

Instrument group:

Hotel - Phase 1:

Hotel - Phase 2:

Fairbanks arrival and departure dates - Phase 1:

Fairbanks arrival and departure dates - Phase 2:

Other site arrival/departure dates:

Do you require access to the Geophysical Institute after normal working hours?:

APPENDIX L--PARTICIPATION AGREEMENT BETWEEN SHEBA AND FIRE

1.0 Purpose and Scope

The purpose of this Participation Agreement is to define the respective roles of the Surface Heat Budget of the Arctic Ocean (SHEBA) Project and the First ISCCP Regional Experiment-III (FIRE) Project regarding the participation of FIRE in SHEBA. SHEBA is supported by the National Science Foundation (NSF) Arctic Systems Science (ARCSS) program. The goal of SHEBA is to demonstrably improve the capability to diagnose and predict the effects of arctic ocean-atmosphere-ice interactions on global climate. To reach this goal, SHEBA is focused on the ice-albedo and cloud-radiation mechanisms over the ice pack of the Arctic Ocean. A major objective of SHEBA is to establish a comprehensive data set that accurately quantifies the surface energy balance, sea ice mass balance, upper ocean heat and salt balance, atmospheric radiation, and cloud processes over a full annual cycle and over a region of sufficient size to be useful in comparing observations with GCM parameterizations of the key variables and physical processes. The main activities of SHEBA are the deployment, operation, and recovery of a research station on the pack ice of the Arctic Ocean, and the establishment and initial analysis of an integrated data set that documents surface/atmosphere interactions over approximately one annual cycle during 1997-1998. A number of surface-based in situ and remote instruments will be operated continuously by SHEBA, as well as intensive aircraft campaigns in the spring and summer 1998. As such, there are a number of measurements, data sets, and logistics/infrastructure items that are of particular interest and benefit to FIRE.

FIRE will be conducting two intensive measurement campaigns called the FIRE Arctic Cloud Experiment, to be conducted in the spring and summer 1998 (see Table 1). FIRE is supported by the National Aeronautics and Space Administration (NASA) Radiation Sciences Program. The goal of FIRE is to study the impact of Arctic clouds on radiation exchange between the surface, atmosphere, and space and the influence of surface characteristics (including sea ice and leads) on these clouds. FIRE will produce an integrated data set that supports the analysis and interpretation of physical processes that couple clouds, radiation, chemistry, and the atmospheric boundary layer; provides in situ data for testing of satellite and ground remote sensing analyses; and provides initial data, boundary conditions, forcing functions, and test data to support Arctic FIRE modeling efforts. Several aircraft, satellites, and surface-based instruments will make coordinated measurements of the clouds and radiation over the Beaufort Sea. As such, there are a number of measurements, data sets, and logistic/infrastructure items that are of interest and benefit to SHEBA.

Table 1 - Arctic Cloud Experiment Schedule of Aircraft Operations

Phase	**Season**	**Principal Thrust**	**Aircraft**	**Period**
Phase I	Spring 1998	Arctic Cloud Experiment	AES C-580 NCAR C-130 NASA ER-2 U Washington C-580	April 7 - May 7 May 2-28 May 15 - June 7 May 15 - June 7
Phase II	Summer 1998	SHEBA	NCAR C-130	July 7 - August 4

The combined data sets of SHEBA and FIRE will be significantly more useful for surface/atmosphere interactions research than either data set in isolation, which provides the primary rationale for this interagency collaboration.

2.0 Definitions

For the purposes of this agreement, "SHEBA" means the SHEBA Project Office and "FIRE" means the FIRE Project Office. The ability and authority of SHEBA and FIRE to meet the commitments and responsibilities described in this agreement derive from a variety of sources, including:

a. Direct funding of the respective Offices by the sponsoring agencies,
b. Participation Agreements with other organizations,
c. Assignment by the sponsoring agency,
d. Designation by a Science Team recognized by both programs,
e. Designation by an advisory committee recognized by both programs.

Specific resources referred to in this agreement as "SHEBA-supplied" and "FIRE-supplied" may be derived from any of the sources listed above.

3.0 FIRE Commitments to SHEBA

3.1 FIRE Data

The principles of data rights and access are given in section 5.0. However, several sets of FIRE data have been specifically requested by SHEBA. These data sets are as follows:

3.1.1 Satellite-derived estimates of the top of the atmosphere (TOA) planetary albedo (spectral and integrated), outgoing longwave radiation (OLR) (spectral and integrated), cloud parameters, surface parameters, and radiation parameters.

This information will be compiled by the satellite investigators in FIRE utilizing several satellites, including the National Oceanic and Atmospheric Administration (NOAA) Polar Orbiters. Data will be acquired and analyzed for two 500 km diameter areas centered on the SHEBA ice station and Barrow, Alaska. Cloud analyses will be provided by the International Satellite Cloud Climatology Project (ISCCP) (both D1 gridded data and DX pixel data) and by individual FIRE investigators.

Validation of satellite retrievals (and surface remote sensing) will use a variety of strategies facilitated by analyses of special high-resolution satellite data sets. These special data sets will not only allow for closer, direct match-ups of measurement area and time, but will also allow for more direct comparisons of the <u>distribution</u> of quantities at smaller space and time scales. Comparing <u>distribution shapes</u>, rather than simple averages, separates biases from sampling noise. Aircraft observations will provide surveys of variations at small spatial scales (i.e. conducting area-covering flight patterns), whereas surface-based remote sensing will provide surveys of small time scale variations (i.e., long time records). The aircraft in situ measurements will be used to validate the analysis methods applied to the surface remote sensing measurements. Then <u>distributions</u> of quantities obtained from the combination of surface remote sensors and in situ aircraft measurements will be used to check the errors introduced by variations of parameters that are held fixed in the satellite retrievals. This includes checking the effects of sub-resolution variations of the retrieved quantities. Thus, over the whole intensive field period, a nested set of analyses will be performed, ranging from the highest resolution attained by satellites (about 1 - 10 km) in a 500 km region centered on the two surface sites (SHEBA ice breaker and Barrow), through

intermediate resolutions cover the whole intensive operations period (IOP) region (bounded by 65N latitude to the pole and 90-180 W longitude), up to lower resolution, but longer term coverage of the whole Arctic Basin.

Many quantities are retrieved directly from satellite measurements of spectral radiances; however, total radiative fluxes and radiation budgets, in particular, are inferred more indirectly from these retrievals. Although these approaches may prove reasonably accurate when based primarily on satellite observations (FIRE has an objective to show this or indicate needed improvements), the combination of in situ and remote sensing at the surface sites and from the aircraft over the sites will also be used to supplement this type of satellite analysis in more detailed diagnostic studies at the sites. In other words, the best analysis of energy budgets at the surface sites is likely to result from the use of maximum information obtained from all available measurements, including those from the satellites.

Table 2 identifies the data sets that will be obtained from various satellites/instruments. The specific data parameters and responsible investigators are listed in Table 3.

Table 2 - Data Sets to be Retrieved from Various Satellite Instruments and Responsible Investigators

Data Sets	**Investigator**	**Satellite**
AVHRR 1 km, 4 km	Minnis & Welch; Wylie	NOAA 12 & 14
AVHRR 4 km sampled	Rossow (ISCCP?)	NOAA 12 & 14
HIRS full & sampled	Wylie	NOAA 12 & 14
SAR	RGPS (operational?)	RADARSAT
SCARAB	L. Smith	RESURS

Table 3 - Satellite Data Parameters and Responsible Investigators

Quantity	**Investigators**	**Sensor**
Cloud cover/fraction	Minnis	AVHRR
Cloud cover/ fraction	Rossow?	
Cloud cover/fraction	Wylie	HIRS
Cloud height	Wylie	HIRS
Cloud temperature	Wylie	HIRS
Cloud top temperature	Minnis	AVHRR
Cloud top temperature	Rossow?	
Cloud IR optical thickness	Wylie	HIRS
Cloud optical thickness	Minnis	AVHRR
Cloud optical thickness	Han & Rossow?	
Cloud emissivity	Wylie	HIRS
Longwave fluxes	Minnis	AVHRR
Broadband clear sky albedo	Minnis	AVHRR
Broadband cloudy sky albedo	Minnis	AVHRR

Cloud particle size	Minnis	AVHRR
Cloud particle size	Han & Rossow?	
Cloud liquid water path	??	
Cloud ice water path	??	
Snowfall	Curry(?)	
Atmospheric temperature	Operational (Pathfinder)?	
Atmospheric humidity	Operational (Pathfinder)?	
Ozone abundance	Operational?	
Aerosol	??	
Surface albedo	Minnis	AVHRR
Surface albedo	Brest & Rossow?	
Surface temperature	Minnis	AVHRR
Surface temperature	Brest & Rossow?	
Sea ice cover	Operational microwave?, (SAR)?	
Sea ice type	Operational?	
TOA radiative fluxes	Rossow?	
TOA radiative fluxes	TBD	HIRS
Sea ice thickness	??	
Other sea ice	Operational?	
Snow cover	??	
Surface radiative fluxes	Rossow?	

3.1.2 Aircraft-derived measurements of cloud and radiation parameters for "ground truthing" the parameter retrievals by the SHEBA radar, lidar, and sodar.

FIRE will perform both remote and insitu aircraft measurements of a variety of cloud, surface, and radiation parameters. The NASA ER-2 will perform remote measurements; the University of Washington (UW) C-580, National Center for Atmospheric Research (NCAR) C- 130, and Canadian Atmospheric Environment Service (AES) Convair 580 will perform in situ measurements.

The in situ aircraft measurements upwind and over the surface stations (SHEBA ice station and Barrow) will provide important information on spatial structure and in situ data for comparison with and improved interpretation of surface-based remote sensing measurements. The timing of the flights will be coordinated with satellite overpasses. All flights will be conducted during daylight hours. The ensemble of measurements will include cloud microphysical properties, liquid water content and vertical profiles of liquid density, turbulence structure, radiative fluxes, and chemical and aerosol properties. Not all properties will be measured by all aircraft.

The flight plans will attempt to address the competing requirements of measuring horizontal variability and vertical structure. Horizontal traverses in the boundary layer will range from 60 to 200 km in length, to insure a sufficient sampling length for turbulence and radiation statistics and for meteorological tendencies. In some instances, including observations of upper level clouds or situations in low-level clouds were turbulence statistics are not needed, shorter traverses (10-20 km) may suffice. Horizontal traverses in the boundary layer will be made at a number of different levels within the boundary layer. Additionally, slow ascents and descents will be used to contain continuous vertical profile.

3.1.3 NASA ER-2 aircraft-derived data parameters.

The NASA ER-2 will typically fly at an altitude of 20 km so that it can view the entire troposphere. The ER-2 will overfly the UW C-580 and/or the NCAR C-130 so that the ER-2 observations can be interpreted in the context of aircraft measurements of cloud characteristics as well as surface observations.

The ER-2 data will be used by the SHEBA investigators Lindsay, Stamnes, and Curry, plus others as required. The data sets include:

TBD

3.1.4 European Centre for Medium-range Weather Forecasts (ECMWF) data sets for the SHEBA site and environment, including both access to and right to use.

FIRE is in the final stages of signing an agreement for the delivery of requested ECMWF data products to the NASA FIRE Archive, located at the Langley Research Center (LaRC) Distributed Active Archive Center (DAAC). The principal points of contact are:

John Olson
CSC NASA LaRC
EOSDIS Langley DAAC
Mail Stop 157D
Science, User, and Data Support Group
Hampton, VA 23681-0001
757-864-8609
757-864-8807 (fax)
j.o.olson@larc.nasa.gov

Dr. David A. Randall
Colorado State University
Department of Atmospheric Science
Fort Collins, CO 80523
970-491-8474
970-491-8428 (fax)
randall@redfish.atmos.colostate.edu

Dr. Martin J. Miller
ECMWF
Shinfield Park
Reading
Berks RG2 9AX
UNITED KINGDOM
44-734-499070
44-734-869450 (fax)
pab@ecmwf.int

It is noted that ECMWF has designated the SHEBA ice station as a (moving) model grid point that will be updated monthly as the ice station drifts.

3.1.5 Aggregate-scale data on surface physical and radiometric properties, including albedo, Bi-Directional Radiative Flux (BDRF), temperature, ice concentration, and melt pond fraction.

FIRE will not be directly responsible for these data products, as Dr. Judy Curry, University of Colorado, has received a grant from SHEBA to provide these data parameters. However,

because of Dr. Curry's role as Lead Mission Scientist for the Arctic Cloud Experiment, FIRE will cooperate as much as possible to ensure that these parameters are acquired.

3.2 FIRE will provide support for additional rawinsondes for the enhanced launch frequencies during the FIRE Arctic Cloud Experiment intensive operation periods.

It is assumed that SHEBA will be launching two sondes per day (00 and 12Z) from the SHEBA ice station throughout the SHEBA experiment period. FIRE requests that the sonde launches be increased to four per day (00, 06, 12, and 18Z) for the periods of April 7 - June 7 and July 26 - August 16.

NASA will provide support for the estimated (62x2+21x2=166 or rounded up to 180) additional sondes. Assuming a cost of $200 per sonde including helium, it is estimated that this support will be approximately $36,000.

It is assumed that SHEBA will put the sonde data on the Global Telecommunications System (GTS) so the data can be utilized by the global weather models, such as ECMWF and National Center for Environmental Prediction (NCEP), in their weather prog predictions.

3.3 FIRE will provide support for several of the researchers that are participating in the SHEBA-supported NCAR C-130 aircraft campaigns in the spring and summer, 1998.

3.3.1 FIRE will provide lodging and per diem support for the following researchers that will be participating in the NCAR C-130 aircraft campaigns in spring and summer 1998:

University of Colorado - Curry, Pinto, Maslanik, Steffen, Fowler, Haggerty
SPECinc - Lawson, two technicians
Scripps - Valero, two technicians
Naval Postgraduate School - Wang
Boston University - Key

It is estimated that this support will be in the order of $110K, to be provided through the offices of SAIC, the support contractor to the FIRE Project Office.

3.3.2 FIRE will provide support for several research efforts on the NCAR C-130, whose data will be available and used by SHEBA investigators, as follows:

Radiation measurements - Valero, Scripps
Shape, size, number, and single scatter phase function measurements on cloud particles - Lawson, SPECinc
CCN measurements - Hudson, Desert Research Institute

3.4 FIRE will provide support for the extensive analysis of cloud radar and lidar measurements obtained during the FIRE IOP spring period.

FIRE will provide sufficient support to the NOAA Environmental Laboratory (ETL) for the extensive analyses of their radar and lidar measurements during the FIRE IOP period April 7 - June 7. These data products will be available and used by SHEBA investigators.

4.0 SHEBA Commitments to FIRE

4.1 Principle of Services to be Supplied by SHEBA to FIRE

The principle upon which a determination of the services to be supplied to FIRE by SHEBA is that FIRE instrumentation, supporting hardware, and personnel will be accorded the same support as if the FIRE instrumentation were funded through SHEBA. The scope of those services in accordance with this principle is as follows.

4.2 Logistics Support

SHEBA will provide logistic support for at least three FIRE researchers at the SHEBA ice station. At present, one researcher from the Ames Research Center (ARC) will operate one or more surface radiation sensors during the period of May 7 to June 7. In addition, two researchers from the University of Utrecht will operate a small tethered balloon, also from May 7 to June 7. The contact points are:

Dr. Peter Pilewskie
NASA ARC
Atmospheric Physics Research Division
Mail Stop 245-4
Moffett Field, CA 94035
415-604-0746
415-604-3625 (fax)
pil@ra.arc.nasa.gov

Dr. Peter G. Duynkerke
University of Utrecht
Institute for Marine and Atmospheric Research
Princetonplein 5
3584 CC Utrecht
THE NETHERLANDS
31 30 253 2909
31 30 254 3163 (fax)
nduinker@fys.ruu.nl

The logistics support provided by SHEBA will include:

a. logistics services to move the FIRE-supplied hardware and personnel from the SHEBA shore base(s) to the research station during the deployment phase, and back to the shore base(s) during the recovery phase;

b . transportation to and from the ice station for routine movement of operating and maintenance personnel, hardware, and supplies during the field effort. At a minimum, the routine flights will be performed every 6 weeks. However, there may be more frequent flights (approximately every 14 to 21 days) during the spring and early summer period. If FIRE requires a non-scheduled flight, FIRE will reimburse SHEBA for this cost;

c . electrical power to run the FIRE-supplied instrumentation and supporting hardware;

d. heated living quarters, food, and standard ice camp supplies and infrastructure for the specified FIRE personnel during deployment, operation, and recovery of the FIRE instrumentation at the research station;

e. fuel to heat the instrumentation shelters;

f. helium for the University of Utrecht tethered balloon, to be reimbursed by FIRE if requested.

Support for additional researchers or logistics may be requested as mutually agreed. For example, in the event that researchers from the Canadian Polar Sunrise group trequire support, that support will be part of this agreement. The Atmospheric Radiation Measurement (ARM) instruments and on-site researchers are supported through a separate SHEBA/ARM agreement.

4.3 Infrastructure Support

4.3.1 SHEBA will provide access to its real time data parameters. It is assumed that access to these data will be through the SHEBA local network or the Cooperative Distributed Interactive Atmospheric Catalog (CODIAC) on-line system operated by University Cooperation for Atmospheric Research (UCAR)/Office of Field Project Support (OFPS). The principles of data rights and access are given in section 5.0. These data are:

a. S-MET (surface meteorological sensor suite).

10 minute averages at 10 minute intervals: wind speed and direction, air temperature, relative humidity, and surface air pressure

3-hourly: precipitation

Daily: snow depth

b. BBSS (Rawinsonde profiles: standard and significant levels, as well as the full set of raw data). Special procedures may be worked out to obtain improved accuracy in the boundary layer.

12-hourly (00 and 12Z) at standard and significant levels: wind speed and direction, temperature, humidity, and pressure

6-hourly (00, 06, 12, and 18Z) for the periods April 7 - June 7 and July 26 - August 16 at standard and significant levels: wind speed and direction, temperature, humidity, and pressure

c. Surface Optical Characterization:

Bi-Spectral Reflectance Distribution Function (BSRDF) * and spectral albedo*

* The surface optical characterization will be provided in real time for at least one site representing the predominant ice surface type near the station, and sampled with a frequency that resolves the significant changes in these parameters.

d. R-WX (routine surface/aviation weather reports by a weather observer)

3-hourly: sky cover (total, low, medium, and high cloud), current weather, surface temperature (2m), surface dew point temperature (2m)

e. R-CL (routine climatological data)

Daily: maximum temperature, minimum temperature, mean temperature, mean relative humidity, mean wind speed, resultant wind speed, and resultant wind direction

f. If any of the instruments designated below is supplied by SHEBA to the research station, SHEBA agrees to provide to FIRE the data from the following instrumentation:

Tethered balloon system, MMW cloud radar, and lidar

The details of the temporal sampling, raw measurements, calculated quantities and subsets to be provided in real time will depend on details of the SHEBA Data Management Plan, in preparation.

4.3.2 SHEBA will increase the launching of sondes from their normal two per day (00 and 12Z) to four per day (00, 06, 12, and 18Z) for the periods of April 7 - June 7 and July 26 - August 16. FIRE will provide support for approximately 180 additional sondes and helium.

SHEBA will put the sonde data on the Global Telecommunications System (GTS) so the data can be utilized by the global weather models, such as ECMWF and National Center for Environmental Prediction (NCEP), in their weather prog predictions.

4.3.3 SHEBA will provide, through an appropriate medium (telephone, fax, email, internet, ...) and time periods (0645 and 1700), the current meteorological and cloud observations to the Lead Mission Scientist, Mission Operations Center, Fort Wainwright, Fairbanks. This information will be of great utility for the FIRE mission planning of aircraft operations during the intensive periods April 7 - June 7 and July 26 - August 16. The point of contact will be either one of the FIRE personnel located at the ice station during the May 7 - June 7 period or an appropriate SHEBA personnel, as mutually agreed.

4.3.4 SHEBA will provide access to a VHF radio for the communication between the SHEBA ice station and the FIRE in situ aircraft (AES C-580, University of Washington C-580, and NCAR C-130). The communication information will include current meteorological observations and the confirmation that all tethered balloons (SHEBA and University of Utrecht) are safely positioned at or near the ground. This information is critically need before the in situ aircraft will commit to making close passes over or near the ice station. The point of contact at the SHEBA ice station will either be one of the FIRE researchers during the May 7 - June 7 period or a SHEBA person, as mutually agreed. The aircraft radio frequencies are give in table 4.

Table 4 - Arctic Cloud Experiment Radio Frequencies

Aircraft	**Call Sign**	**Radio Frequency**
NASA ER-2	NASA 706	118-135.95; TBD
NASA ER-2 Base Radio	NASA OPS	118-135.95; TBD
NCAR C-130	?	TBD
University of Washington C-580	Husky-one	118-135.95 MHz(0.05 MHz); 116-149.975 MHz (0.025 MHz); 500.0-29.999 KHz (30 MHz)

AES C-580	?	117-141; TBD
SHEBA Ice Station	?	TBD
SHEBA Quicksilver	?	?
Polar Bear Helicopter	?	?
SHEBA Helicopter	?	?
SHEBA Logistics Aircraft	?	?

4.3.5 SHEBA will coordinate their tethered balloon flight operations to minimize interference with the FIRE in situ aircraft in the conduct of close passes over or near the ice station, as mutually agreed. To assist in this planning, FIRE will provide preliminary mission plans by 1830 the day before and specific mission plans by 0900 the day of aircraft operations.

5.0 Data Agreement

5.1 Definitions

"SHEBA Science Team (SST)" means the total set of PIs that participate in SHEBA through projects formally approved and funded by SHEBA (National Science Foundation(NSF)/Office of Naval Research (ONR)), or formally approved and funded by FIRE (NASA). The FIRE-FIRE-funded PI's in the SST are a subset of the total FIRE Science Team designated by FIRE as SST members.

Similarly, "FIRE Science Team (FST)" means the total set of PIs that participate in FIRE through projects formally approved and funded by NASA and other agencies, or formally approved and funded by SHEBA (NSF/ONR). The SHEBA-funded PI's in the FST are a subset of the total SHEBA Science Team designated by SHEBA as FST members.

"Archive" refers to data that have been traThe archive facility for SHEBA is the National Snow and Ice Data Center (NSIDC) atnsferred by the SHEBA and FIRE Science Teams and other authorized personnel, to the long-term data archiving facilities of the respective programs. The archive facility for SHEBA is the National Snow and Ice Data Center (NSIDC) at the Cooperative Institute for Research in the Environmental Sciences (CIRES). The archive facility for FIRE is the FIRE Data Archive at the NASA LaRC DAAC. The funding agreements between the sponsoring agencies and PI institutions contain deadlines and specifications for the delivery of data sets to the archive facilities.

5.2 Principles of Data Rights and Access

The general principle upon which the data agreement rest is that all members of the SST have the same rights to data generated by the SHEBA field experiment, irrespective of whether their affiliation derives from NSF/ONR-SHEBA or from NASA-FIRE. In particular, FIRE-FIRE-funded members of the SST using non-FIRE data from SHEBA will have all of the rights, privileges, and obligations as any other SHEBA investigator, as

specified in the SHEBA Data Protocol (see SHEBA Data Management Plan, in preparation).

Similarly, all members of the FST have the same rights to data generated by the FIRE field experiment, irrespective of whether their affiliation derives from NASA-FIRE or from NSF/ONR-SHEBA. In particular, SHEBA-funded members of FST using non-SHEBA data from FIRE will have all of the rights, privileges, and obligations as any other FIRE investigator, as specified in the FIRE Data Protocol (see FIRE Arctic Cloud Implementation Plan, 1996, or FIRE Arctic Cloud Experiment Operations Plan, in preparation). Any adjustments to this basic principle necessary to accommodate the special needs of each program must be documented and agreed to by SHEBA and FIRE.

For archive data, the general principle suffices: All members of the SST will have equal access to the SHEBA- Teams will also have theline and archive systems and all members of the FST will have equal access to the FIRE on-line (TBD) and archive systems. All members of the SHEBA and FIRE Science Teams will also have the same rights, privileges, and obligations relative to the data systems of the respective programs.

More detailed data agreements may be added as attachments to this Participation Agreement as SHEBA develops, subject to approval by SHEBA and FIRE.

6.0 Period of the Agreement

This agreement will be in effect from the time it is signed by both authorized representatives of the respective programs until the SHEBA and FIRE Projects are officially concluded.

7.0 Management Policies and Procedures

FIRE management policies and procedures will be in accord with relevant National Aeronautics and Space Administration (NASA) directives, and shall be documented in the FIRE Arctic Cloud Implementation Plan (1996) and the FIRE Arctic Cloud Experiment Operations Plan (in preparation). General SHEBA management policies and procedures shall be in accord with relevant National Science Foundation directives, and shall be documented in the SHEBA Operations Plan and the SHEBA Data Management Plan.

8.0 Environment and Safety

In carrying out this agreement, FIRE will be bound by the SHEBA environment and safety plans. SHEBA environment and safety policies shall be in accord with National Science Foundation directives, and will be documented in the SHEBA Operations Plan.

9.0 Modification of this Agreement

If either program finds it impossible to satisfy its commitments under this Participation Agreement in a material way, the other program shall have the right to request a renegotiation of the agreement, thereby appropriately adjusting its own commitments.

APPROVAL:

Richard Moritz, Director	David McDougal
SHEBA Project Office	FIRE Project Manager
Applied Physics Laboratory	Atmospheric Sciences Division

APPENDIX - ACRONYMS

AES	Atmospheric Environment Service
ARC	Ames Research Center
ARCSS	Arctic Systems Science
ATSR	Along-Track Scanning Radiometer
AVHRR	Advance Very High Resolution Radiometer
AVNIR	Advanced Visible and Near Infrared Radiometer
BBSS	Balloon-Borne Sounding System
BDRF	Bi-Directional Radiative Flux
BSRDF	Bi-Spectral Reflectance Distribution Function
CIRES	Cooperative Institute for Research in the Environmental Sciences
CODIAC	Cooperative Distributed Interactive Atmospheric Catalog
DAAC	Distributed Active Archive Center
ECMWF	European Centre for Medium-range Weather Forecasts
ETL	Environmental Laboratory
FIRE	First ISCCP Regional Experiment-III
GTS	Global Telecommunications System
HIRS	High Infrared Radiation Sounder
IMG	Interferometric Monitor for Greenhouse Gases
IOP	intensive operations period
ISCCP	International Satellite Cloud Climatology Project
LaRC	Langley Research Center
MMW	millimeter wave
NASA	National Aeronautics and Space Administration
NCEP	National Center for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
OCTS	Ocean Color and Temperature Scanner
OFPS	Office of Field Project Support
OLR	outgoing longwave radiation
ONR	Office of Naval Research
PI	Principal Investigator
R-CL	routine climatological data
R-WX	routine surface/aviation weather reports by a weather observer
RADARSAT	Radar Satellite
RASS	Radio Acoustic Sounding System
RGPS	RADARSAT Geophysical Processing System
S-MET	surface meteorological sensor suite.
SAR	Synthetic Aperture Radar
SCARAB	Scanner for the Radiation Budget
SHEBA	Surface Heat Budget of the Arctic Ocean
TOA	top of the atmosphere
TOMS	Total Ozone Mapping Spectrometer
UCAR	University Cooperation for Atmospheric Research
UW	University of Washington

APPENDIX M--AGREEMENT BETWEEN ECMWF AND FIRE

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

August 6, 1997

Reply to Attn of: YS

Dr. Massimo Capaldo
European Centre for Medium-Range Weather Forecasts
Shinfield Park, Reading
Berkshire RG2 9AX
ENGLAND

Dear Dr. Capaldo:

In response to your letter of March 7, 1997, 1 am returning the signed Licence Agreement between ECMWF and NASA, relative to the FIRE project. It is my understanding that ECMWF will provide real-time forecasts and point diagnostics for use by FIRE, in the framework of its participation in the FIRE project. In addition to that I am aware that your organization is willing to make available related and archived global data sets to be defined more precisely as the project progresses. I also understand that these various datasets will be available at zero cost. In this respect and in view of our cooperation with the ARM project, I would like to ask your permission to share with the ARM scientists the ECMWF Products archived for FIRE purposes. Given this permission, we agree to keep a list of ARM scientists who receive ECMWF data in this form and undersign your conditions for data distribution.

As requested in your letter, I have listed on the attached page the name and addresses for both the FIRE science point of contact and the FIRE data transfer point of contact.

We greatly appreciate this offer and look forward to a continuing and productive collaboration.

Sincerely,

Robert J. Curran

cc:
ECMWF/M. Miller
CSU/S. Cox

CSU/D. Randall
LaRC/D. McDougal
LaRC/J. Olson
Univ. Colorado/J. Curry
DOE/T. Cress

FIRE III - Arctic Cloud Experiment, Science related point of contact:

Professor David Randall
Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado 80523

Telephone: (970) 491-8474
Fax: (970) 491-8428
Email: randall@redfish.atmos.colostate.edu

FIRE III - Arctic Cloud Experiment, Data Transfer related point of contact:

Mr. John O. Olson
EOSDIS Langley DAAC Science, User, and Data Support Group
NASA Langley Research Center
Mail Stop 157D
Hampton, VA 23681-0001

Telephone: (757) 864-8660
Fax: (757) 864-8807
E-mail: j.o.olson@larc.nasa.gov
URL: http://eosweb.larc.nasa.gov

LICENCE AGREEMENT

Between
ECMWF
Shinfield Park
Reading RG2 9AX
United Kingdom

represented by its Director
(hereinafter called the Licensor)

and **NASA (FIRE Project)**
represented by Dr. Robert Curran
(hereinafter called the Licensee)

Article 1
Purpose

The purpose of this agreement is to define the conditions under which the Licensee may use Products from the ECMWF Catalogue (hereinafter called the Catalogue) for project FIRE.

Article 2
Scope

The Licensee is authorised to use on a non-exclusive basis the Products from the Catalogue listed in the Annex to this Agreement provided that the Products are used by the Licensee solely in connection with FIRE. The Licensee shall make all participants in FIRE save the Licensor aware of the provision of this Agreement and shall require any such participants to agree in writing to observe said provisions.

Article 3
Exclusions

1. The use of the Products is limited to the scope of the Licence which Licensee declares has been described in Article 2 hereof. In particular the Products will be used by the participants in the field experiment only for uses directly related to the field experiment.

2. The Licensee shall not use, store or deal with the Products or any associated data, software, documentation or other information in a manner that is in contradiction with the object of the Licence without the prior written consent of the Licensor.

3. The Licensee shall not reproduce, distribute, licence, transfer, assign, sell, disclose to or otherwise forward the Products or any associated data, software, documentation, or other information to any third party without the written consent of the Licensor, nor use the Products to provide any services outside those specified in the scope.

4. The Licensee shall be liable, notwithstanding any other remedies that Licensor may have against Licensee, including termination of this agreement, to indemnify Licensor for any loss Licensor suffers and/or to reimburse Licensor for the gain Licensee obtains in contravention to this clause.

5. The Licensee shall not engage in the generation or distribution of meteorological value added services based on the Products but shall, as stated in Article 2, only use it for its own purpose defined in Article 2.

Article 4
Duration

1. Subject to fulfilling the obligations of the agreement the Licensee shall be entitled to exercise the rights set out in Article 2 in the period from 1 September 1997 to 31 October 1998.

Article 5
Charges

1. The rights set out in Article 2 are not subject to payment of fees. The Licensee will be responsible for any delivery and transmission costs.

Article 6
Ownership, Intellectual Property Rights

1. The Licensee acknowledges the full title and ownership by the Licensor to all Products from the Catalogue.

2. The Licensee acknowledges that the Products from the Catalogue are protected from use by unauthorised third parties by the Licensor intellectual property rights and by unfair competition law.

3. The licensee agrees when using Products from the Catalogue in any recognisable form to mention the Licensor as the source (i.e. "© [year], ECMWF").

Article 7
Default

1. Default and the consequences thereof shall be governed by the applicable legal system with the following exception:

   Default by the Licensee on the obligations of Articles 2 and 6 shall entitle the Licensor to cancel this agreement without notice. The Licensor shall furthermore be entitled to full damages regardless of whether the agreement is cancelled.

Article 8
Termination

This Agreement will terminate at the end of the period specified in Article 4.

Article 9
Warranty and Liability

1. The Licensor warrants that it has the authority to grant this Licence by virtue of Article 1(4) of its Convention.

2. The Licensor shall not be liable for the consequences of any uses made of the Products by the Licensee.

3. The Licensee shall be held liable for any misuse of the Products, the subject of this Licence, by its employees.

4. The Licensor shall in no way whatsoever be liable for results related to the use of the Products from the Catalogue. The Licensee accepts the Products from the Catalogue whatever the quality, as long as the Licensor decides to continue to provide such data as part of an operational service.

Article 10
Force Majeure

The Licensor shall not be liable for failure to fulfil this agreement due to circumstances outside the control of the Licensor which could not have been foreseen at the time of entering into this agreement and which could not be avoided or overcome by the Licensor.

Article 11
Arbitration

Unless otherwise agreed in writing, the validity, construction and performance of the Licence shall be governed by the law of England. In the event of a dispute arising in connection with the Licence, the Parties shall attempt to settle their differences in an amicable manner. In the event that any dispute cannot be settled, it shall be finally settled under the Rules of Conciliation and Arbitration of the International Chamber of Commerce by three arbitrators appointed in accordance with the said rules; unless otherwise agreed in writing, the arbitrators shall sit in England. In accordance with Sections 45 and 69 of the Arbitration Act 1996, the right of appeal by either party to the High Court on a question of law arising in the course of any arbitral proceedings or out of an award made in any arbitral proceedings is hereby agreed to be excluded.

Article 12
Transfer of Agreement

The Licensee shall not transfer this agreement to a third party either in whole or in part.

In.....(pl
ace) In.....(place
.....

on .....
(date) on..... (date

for Licensee.....for Licenso

ANNEX TO LICENCE AGREEMENT FOR FIRE

Products to be provided

1. Single level parameters

   MSL pressure
   precipitation (total)

2. Upper air parameters

   Height (Z)
   Temperature (T)
   Rel. Humidity (rel hum)

   Levels

   850, 700, 500, 300 hPa

3. Model level data

   Cloud liquid water content
   Cloud ice water content
   cloud cover

4. Area

   Alaska, NW Canada, Beaufort Sea
   80N/170W, 50N/100W

5. Resolution

   I x I degree latitude/longitude

6. Forecast times

   T+6, 12, 18..... 30, 36 (6 hour intervals)

APPENDIX N--MEMORANDUM OF AGREEMENT BETWEEN U. S. ARMY AND FIRE

FIRE/Fort Wainwright Memorandum of Agreement

1.0 Purpose and Scope

The purpose of this Memorandum of Agreement (MOA) is to identify the facilities at Fort Wainwright, Fairbanks, Alaska, that National Aeronautics and Space Administration (NASA) wishes to use in the conduct of its upcoming First ISCCP Regional Experiment (FIRE) Arctic Cloud Experiment.

By way of background, three NASA Photochemistry of Ozone Loss in the Arctic Region in Summer (POLARIS) missions were conducted at Fort Wainwright in 1997. POLARIS included the operation of the NASA ER-2 aircraft plus a field operations team of about 80-100 people. POLARIS was based at hangar 4. Accordingly, NASA paid for a number of facility improvements to hangar 4 that included clean-up, painting, office/lab modifications, enhanced electrical power service, additional telephones, high speed data lines, limited area network (LAN), etc. Based on the superior facilities and cooperation of Fort Wainwright that POLARIS enjoyed, FIRE desires to continue the utilization of these same facilities for its upcoming Arctic Cloud Experiment operations. This agreement identifies the facilities and operations.

The FIRE Arctic Cloud Experiment will be conducted in two phases: May 1 - June 7 and July 26 - August 16, 1998. The objective of the experiment is to study the impact of Arctic clouds on radiation exchange between surface, atmosphere, and space; and the influence of surface characteristics (including sea ice and leads) on these clouds. FIRE will collaborate with the National Science Foundation's SHEBA (Surface Heat Budget of the Arctic Ocean) and Department of Energy's ARM (Atmospheric Radiation Measurement) programs. Aircraft, satellites, and surface-based sensors will measure the physical processes of coupling between clouds, radiation, chemistry, and the atmospheric boundary layer over the Arctic sea ice in the Beaufort Sea and over Barrow, Alaska. Scientists from U.S., Canada, Great Britain, and Netherlands will participate.

FIRE requests that the NASA ER-2, National Center for Atmospheric Research (NCAR) C-130, and Mission Operations Center be located at hangar 4, Fort Wainwright, Fairbanks. The ER-2 will operate at Fort Wainwright from May 15 to June 7. The NCAR C-130 will operate from May 1-26 and from July 26 - August 16. Both aircraft will have about 20-25 people. There will be an additional 8-12 people associated with mission planning, forecasting, modeling, satellite analyses, and project administration for the first phase and about half that for the second phase.

The specific facilities requested to be used by FIRE are listed in Section 2.0. The responsibilities of FIRE to Fort Wainwright are described in Section 3.0. The Period of the Agreement, Management Policies and Procedures, Environment and Safety, and Modification of This Agreement are listed in Sections 4.0, 5.0, 6.0, and 7.0, respectively.

2.0 Facilities That FIRE Requests

The facilities requested by FIRE to use in its field operations are as follows:

2.1 Space inside hangar 4 for the NASA ER-2.

2.2 Tarmac space outside hangar 4 for the NCAR C-130 aircraft.

2.3 Office/laboratory/storage space in rooms in hangar 4 that were used by POLARIS. These rooms include the meeting room, small room beside the meeting room, rooms on the west wall, and rooms on the south wall.

2.4 Use of existing power outlets, lights, heating, etc. that are normally available at hangar 4.

2.5 Request that the high speed data lines (T1 lines) and Limited Area Network (LAN) lines that were installed by POLARIS be allowed to remain.

2.6 Security of hangar and tarmac, according to normal Ft. Wainwright procedures.

2.7 Access to special gases, such as liquid oxygen, liquid nitrogen, etc.

2.8 Access to hangar 4 for all FIRE participants. It is understood that Fort Wainwright is an open post. FIRE will work with Wainwright to determine the procedures for any foreign nationals that may participate.

3.0 Infrastructure That FIRE Will Be Responsible For

FIRE will enter into negotiations with Fort Wainwright for reimbursement of expenses, such as aircraft fuel, power, heating, scientific gases, etc. for which Fort Wainwright requires reimbursement. Non-NASA participants, i.e., NCAR C-130, will pay for aircraft fuel, etc. themselves.

In addition, FIRE will be responsible for the installation, use, and de-installation of certain infrastructure and equipment that FIRE deems necessary. This may include items such as telephones, fax machines, copiers, furniture, additional T1 lines, additional LAN network, etc.

The mechanism for payment will be mutually agreed on, but could be reimbursement of submitted vouchers or the establishment of a FIRE account against which costs could be incurred.

4.0 Period of the Agreement

This agreement will be in effect from the time it is signed by both authorized representatives of the respective agencies until the completion of FIRE experiment operations. After this period, the MOA may be extended, as mutually agreed.

5.0 Management Policies and Procedures

FIRE field operation policies and procedures will be in accord with relevant NASA directives, and shall be documented in the FIRE Arctic Cloud Experiment Operations Plans. General Fort Wainwright management policies and procedures shall be in accord with relevant U.S. Army directives.

6.0 Environment and Safety

In carrying out this agreement, FIRE will be bound by the Fort Wainwright environment and safety plans. Fort Wainwright environment and safety policies shall be in accord with U.S. Army directives.

7.0 Modification of this Agreement

If either program finds it impossible to satisfy its commitments under this MOA in a material way, the other program shall have the right to request a renegotiation of the agreement, thereby appropriately adjusting its own commitments.

APPROVAL:

William Strause, Director Plans, Security, and Mobilization Fort Wainwright Fairbanks, Alaska	David S. McDougal NASA Langley Research Center Hampton, Virginia

APPENDIX - ACRONYMS

ARC	Ames Research Center
FIRE	First ISCCP Regional Experiment-III
ISCCP	International Satellite Cloud Climatology Project
LAN	Limited Area Network
LaRC	Langley Research Center
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NSF	National Science Foundation
MOA	Memorandum of Understanding
POLARIS	Photochemistry of Ozone Loss in the Arctic Region in Summer

APPENDIX O--MEMORANDUM OF AGREEMENT BETWEEN U. AK-GI AND FIRE

Dr. Syan-Ichi Akasofu
Director, Geophysical Institute
University of Alaska-Fairbanks
Fairbanks, AK 99775

Dear Dr. Akasofu

On May 9, 1997, Dr. Robert Curran, National Aeronautics and Space Administration (NASA) Headquarters, David McDougal of my staff, and several researchers from the FIRE (First ISCCP Regional Experiment) Science Team, met with you and your staff at the Geophysical Institute (GI). In response to a suggestion from you, NASA would like to request the use of some facilities at the GI for an upcoming field experiment called the FIRE Arctic Cloud Experiment, to be conducted in the spring and summer of 1998.

The scientific objectives of the FIRE Arctic Cloud Experiment are to study the impact of Arctic clouds on the radiation exchange between the surface, atmosphere, and space and the influence of surface characteristics (including sea ice and leads) on these clouds. Aircraft, surface-based, and satellites will be used to measure the physical processes of coupling between clouds, radiation, chemistry, and the atmospheric boundary layer over the Arctic sea ice in the Beaufort Sea. The National Science Foundation (NSF) is also conducting a collaborative experiment called SHEBA (Surface HEat Budget of the Arctic) which will operate a permanent ice station (actually an ice breaker frozen in the sea ice) located about 500-700 km off the north coast of Alaska. The FIRE aircraft will focus on the SHEBA ice station as the principal target of interest. The mission operations center would be based at Wainwright, along with the NASA ER-2 and National Center for Atmospheric Research (NCAR) C-130 aircraft. Additional aircraft will operate out of Inuvik and Barrow

The experiment schedule for operating out of Wainwright will be:

Phase I (Spring):
NCAR C-130 - May 1-31, 1998
NASA ER-2 - May 15 - June 7, 1998

Phase II (Summer):
NCAR C-130 - July 15 - August 15, 1998

For Phase I, there will be about 20 people associated with each of the two aircraft, plus another 10 representing meteorologists, mission planners, satellite and model researchers, and project support for a total of about 50. There will be about 25 people for Phase II. Hangar 4 will serve as the Mission Operations Center for both phases.

There are some items that the GI could possibly provide that would benefit the experiment. They include:

1. Use of the visualization office for the visualization of SAR images to determine leads.

2. Satellite data from the NOAA Polar Orbiters for the Arctic Basin area.

3. Keep open the T1 line, that was installed between hangar 4 at Fort Wainwright and GI for the POLARIS missions, for the FIRE mission periods. FIRE would use this line for communications with the lower 48, including data transfer to and from the University of Wisconsin for the operation of the McIDAS system.

It is noted that, according to discussions with you, the GI is exploring establishing stronger ties with Fort Wainwright, especially if Senator Stevens is successful in acquiring a surplussed C-130 aircraft for the GI. One possibility is to base the C-130 at Wainwright at hangar 4. This would take advantage of the office/lab/storage space that NASA has enjoyed to date and hopes to establish on a more permanent basis with a proposed U.S. Army/NASA Memorandum of Agreement, currently in draft. Depending on approval by Wainwright, it appears that there is sufficient space for both a permanent C-130 and periodic NASA presences. A permanent T1 line to GI would be of benefit to both GI and NASA.

4. Provide a network administrator for the proposed FIRE experiment real time homepage that will feature daily mission plans, schedule of activities, future plans, participants, and possible quick look results. This homepage would be the principal media of information for the on-site researchers, researchers at the SHEBA and RAM sites, aircraft deployments at Univik and Barrow, and interested researchers and managers from the lower 48.

5. Access to the electronic, machine, etc. shops for the emergency repair of instruments.

6. Access to expendables, such as special gases, electronics, chemicals, etc., which would be reimbursed at cost.

7. Office space (one room, two desks).

It is understood that, if allowed the use of the facilities of GI, NASA would pay for any expenses that it incurs, such as telephone, expendables, etc., or any other charges that are mutually agreeable.

If you have any questions or desire additional information, you may contact Mr. McDougal at M. S. 483, or 757-864-5832, 757-864-5841 (fax), or d.s.mcdougal@larc.nasa.gov.

NASA looks forward to receiving your reply and to working with you and your staff in the near future.

Sincerely

Darrell R. Branscome, Director
Office of Space and Atmospheric Sciences Program Group

cc:

YS/R. Curran

J. Barrilleaux/NASA ARC

483/D. McDougal

cc:
101/

107/
401/
483/
483/

483/DSM
483/JMH
401/JRN
107/DRB

APPENDIX P--ARM/FIRE AGREEMENT

APPENDIX Q--SATELLITE OVERPASS PREDICTIONS

Q.1 NOAA 12 and 14

Table Q.1-1 NOAA 12 Overpass Predictions

Site: SHEBA Ship Space Craft: NOAA_12 Predict Date: Nov 4, 1997
lat= 75.40 long= 214.45 geocentric lat= 75.31 locl earth radius, km= 6358.144

gmt yr mo da hr mn	viewing zenith	sat azm fr. north	relative azimuth	solar zenith	satellite direction	satellie position lat	long	satellit sol. tim	site sol.tim	sol azm fr. north	phas fnct scat angl
98 5 11 4 4	52.58	265.55	15.20	74.38	asce	72.79	186.56	16.40	18.42	280.76	154.38
98 5 11 16 1	55.44	91.87	1.09	71.22	d	72.72	245.10	8.33	6.38	90.77	164.19
98 5 11 17 42	20.91	114.82	0.98	65.02	d	74.09	222.82	8.46	8.06	115.79	135.88
98 5 11 19 22	21.05	318.74	176.67	60.10	d	77.10	206.97	9.07	9.73	142.07	98.88
98 5 11 21 2	41.06	344.17	174.46	57.51	d	80.52	205.25	10.36	11.39	169.71	81.58
98 5 11 22 41	43.49	8.39	170.64	57.90	asce	81.20	220.15	12.89	13.05	197.75	79.06
98 5 12 0 21	30.29	31.67	166.67	61.15	asce	78.37	224.38	15.16	14.71	225.00	89.24
98 5 12 2 1	5.60	232.92	17.96	66.48	asce	74.90	212.44	16.05	16.38	250.88	118.84
98 5 12 3 41	46.34	260.17	15.37	72.75	asce	72.93	191.82	16.38	18.06	275.54	150.56
98 5 12 17 20	30.35	110.95	0.83	66.07	d	73.56	227.15	8.44	7.69	110.12	144.27
98 5 12 19 0	13.36	312.33	176.19	60.76	d	76.32	209.54	8.88	9.36	136.14	105.90
98 5 12 20 40	38.46	339.07	175.53	57.59	d	79.90	204.03	10.00	11.03	163.54	84.04
98 5 12 22 19	44.17	2.26	170.62	57.31	asce	81.43	216.07	12.37	12.69	191.64	78.98
98 5 12 23 59	34.86	26.54	167.36	59.98	asce	79.15	225.15	14.83	14.34	219.18	85.85
98 5 13 1 39	4.21	51.08	165.66	64.95	asce	75.60	215.94	15.85	16.01	245.42	110.97
98 5 13 3 19	39.02	254.59	15.67	71.11	asce	73.18	196.88	16.36	17.69	270.26	145.60
98 5 13 16 57	38.81	105.12	0.61	67.18	d	73.22	231.97	8.42	7.32	104.50	151.62
98 5 13 18 38	4.47	47.25	177.51	61.54	d	75.65	212.94	8.70	9.00	130.27	114.00
98 5 13 20 18	34.96	332.59	175.20	57.81	d	79.12	203.39	9.69	10.66	157.40	87.33
98 5 13 21 57	44.18	357.15	171.69	56.86	d	81.42	212.42	11.86	12.32	185.46	79.32
98 5 13 23 37	38.39	21.41	168.14	58.92	asce	79.86	225.00	14.45	13.98	213.27	83.35
98 5 14 1 17	13.13	44.83	165.02	63.47	asce	76.36	219.04	15.82	15.64	239.81	103.81
98 5 14 2 57	30.59	250.53	14.42	69.47	asce	73.62	201.46	16.34	17.32	264.95	139.77
98 5 14 16 35	46.15	99.62	0.59	68.31	d	72.97	237.01	8.30	6.96	99.03	157.84
98 5 14 18 16	5.32	124.21	0.18	62.42	d	74.95	216.45	8.68	8.63	124.39	122.90
98 5 14 19 56	30.43	327.27	175.99	58.17	d	78.34	204.20	9.42	10.30	151.28	91.46
98 5 14 21 35	43.52	352.04	172.78	56.56	d	81.21	209.04	11.37	11.96	179.26	80.19
98 5 14 23 15	41.00	16.29	169.01	57.99	asce	80.49	223.84	14.04	13.62	207.27	81.60
98 5 15 0 55	20.86	39.57	165.38	62.07	asce	77.14	221.62	15.58	15.28	234.18	97.66
98 5 15 2 35	21.17	244.50	15.08	67.85	asce	74.04	206.03	16.32	16.95	259.58	132.42
98 5 15 4 16	55.59	268.94	15.01	74.18	asce	72.81	183.47	16.47	18.63	283.95	157.03
98 5 15 16 13	52.42	94.27	0.73	69.48	d	72.83	242.27	8.29	6.59	93.54	162.93

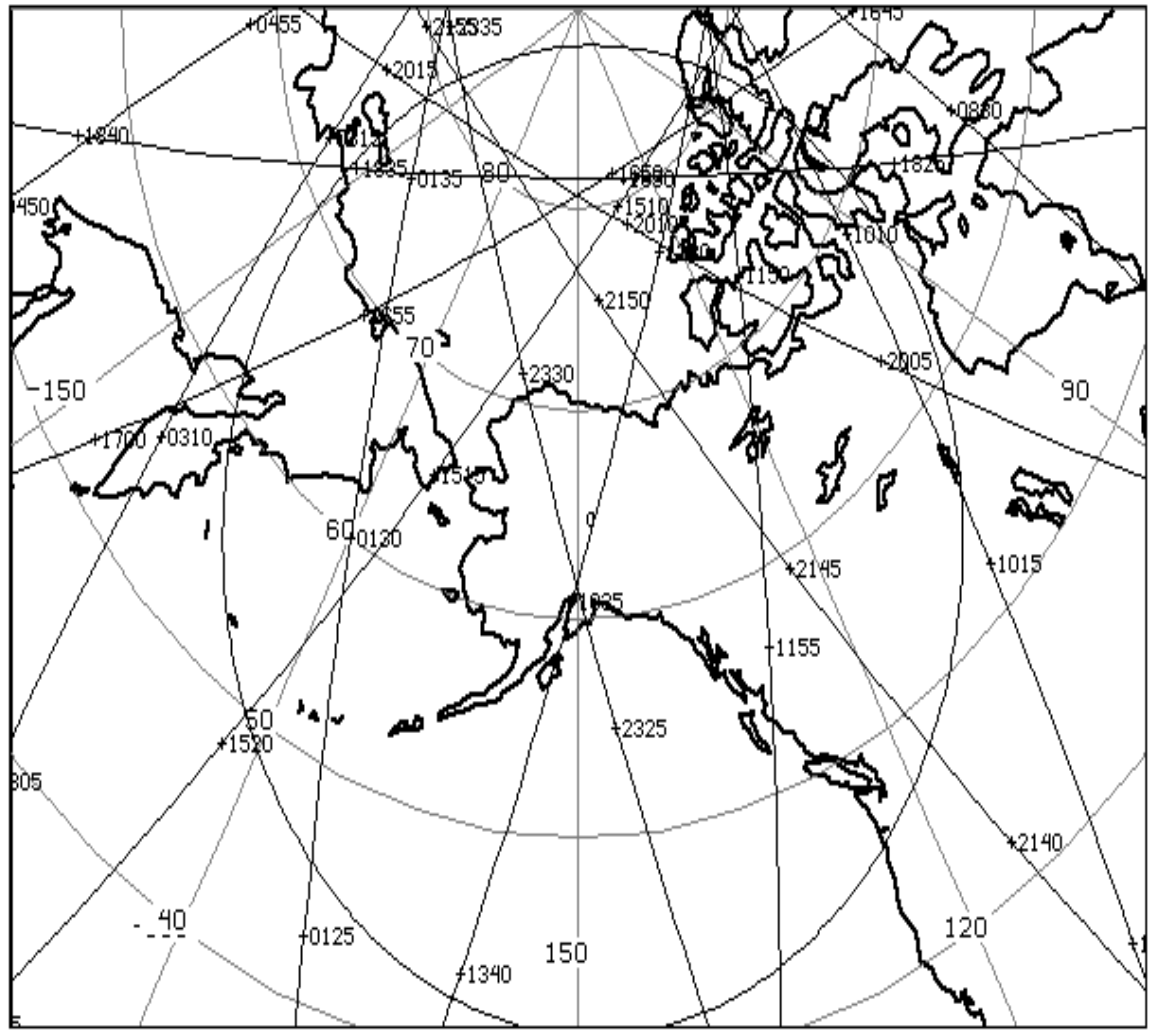
Table Q.1-2 NOAA 14 Overpass Predictions

Site: SHEBA Ship Space Craft: NOAA_14 Predict Date: Nov 4, 1997
lat= 75.40 long= 214.45 geocentric lat= 75.31 locl earth radius, km= 6358.144

gmt yr mo da hr mn	viewing zenith	sat azm fr. north	relative azimuth	solar zenith	satellite direction	satellie position lat	long	satellit sol. tim	site sol.tim	sol azm fr. north	phas fnct scat angl
98 5 11 20 3	32.64	24.94	128.46	58.69	asce	79.07	224.05	10.67	10.42	153.41	98.68
98 5 11 21 44	4.06	54.66	126.97	57.30	asce	75.58	216.04	12.00	12.10	181.62	120.20

98	5	11	23	25	37.47	252.11	42.18	59.02	asce	73.03	197.52	12.51	13.78	209.92	142.66
98	5	12	13	10	41.01	104.62	54.48	81.00	d	72.94	233.79	4.64	3.53	50.14	119.64
98	5	12	14	51	0.39	65.95	8.05	75.36	d	75.32	214.64	5.04	5.21	74.00	105.02
98	5	12	16	32	30.79	332.40	125.80	69.03	d	78.72	204.89	6.03	6.89	98.20	91.60
98	5	12	18	12	40.55	357.09	126.39	63.11	d	80.95	212.63	8.13	8.56	123.47	89.98
98	5	12	19	52	34.38	21.39	128.93	58.78	asce	79.45	223.61	10.60	10.24	150.32	97.15
98	5	12	21	33	8.36	43.80	134.69	57.05	asce	76.02	217.33	11.95	11.91	178.49	116.89
98	5	12	23	14	33.41	249.34	42.43	58.44	asce	73.23	199.90	12.48	13.60	206.91	141.56
98	5	13	12	58	44.57	102.02	54.61	81.31	d	72.79	236.28	4.73	3.34	47.41	120.63
98	5	13	14	40	4.89	131.66	60.36	75.80	d	74.91	216.15	5.01	5.03	71.30	106.58
98	5	13	16	21	28.55	330.36	125.12	69.47	d	78.37	205.41	5.74	6.71	95.48	92.89
98	5	13	18	1	40.28	5.07	125.69	63.45	d	80.88	211.34	7.63	8.38	120.62	90.20
98	5	13	19	41	35.88	19.31	128.00	58.89	asce	79.75	223.44	10.17	10.05	147.31	96.30
98	5	13	21	22	12.42	43.11	132.24	56.85	asce	76.37	218.81	11.91	11.73	175.34	114.40
98	5	13	23	3	29.12	248.47	44.62	57.89	asce	73.55	201.94	12.45	13.41	203.85	139.26
98	5	14	0	44	59.09	272.32	40.89	61.79	asce	72.58	178.64	12.61	15.11	231.43	144.52
98	5	14	12	47	47.88	99.44	54.69	81.58	d	72.66	238.82	4.70	3.15	44.75	121.49
98	5	14	14	29	9.67	125.23	56.62	76.22	d	74.60	218.08	4.97	4.84	68.61	108.94
98	5	14	16	10	26.03	328.43	124.28	69.94	d	78.01	206.07	5.70	6.53	92.71	94.36
98	5	14	17	50	39.83	351.61	126.08	63.83	d	80.74	209.45	7.54	8.20	117.69	90.01
98	5	14	19	30	37.16	15.88	128.34	59.05	asce	80.08	222.49	10.08	9.87	144.22	95.08
98	5	14	21	11	16.18	41.50	130.77	56.68	asce	76.73	220.18	11.65	11.55	172.27	112.05
98	5	14	22	52	24.62	245.85	45.07	57.39	asce	73.78	204.18	12.42	13.23	200.78	137.54
98	5	15	0	33	56.71	268.90	40.35	61.02	asce	72.47	181.67	12.58	14.92	228.55	145.41
98	5	15	12	36	50.93	96.87	54.78	81.83	d	72.56	241.42	4.68	2.97	42.09	122.20
98	5	15	14	18	14.50	121.39	55.46	76.65	d	74.31	220.09	4.95	4.66	65.93	111.21
98	5	15	15	58	23.21	324.39	125.56	70.42	d	77.57	206.54	5.65	6.34	89.95	95.28
98	5	15	17	39	39.19	349.47	125.40	64.22	d	80.58	208.43	7.09	8.02	114.87	90.43
98	5	15	19	19	38.23	13.77	127.47	59.23	asce	80.32	221.85	9.60	9.69	141.24	94.50
98	5	15	21	0	19.65	36.79	132.31	56.56	asce	77.18	221.05	11.60	11.36	169.11	109.27
98	5	15	22	41	19.95	243.17	45.48	56.92	asce	74.03	206.35	12.39	13.04	197.69	135.52

Figure Q.1-1 NOAA 12 Overpass Ground Tracks

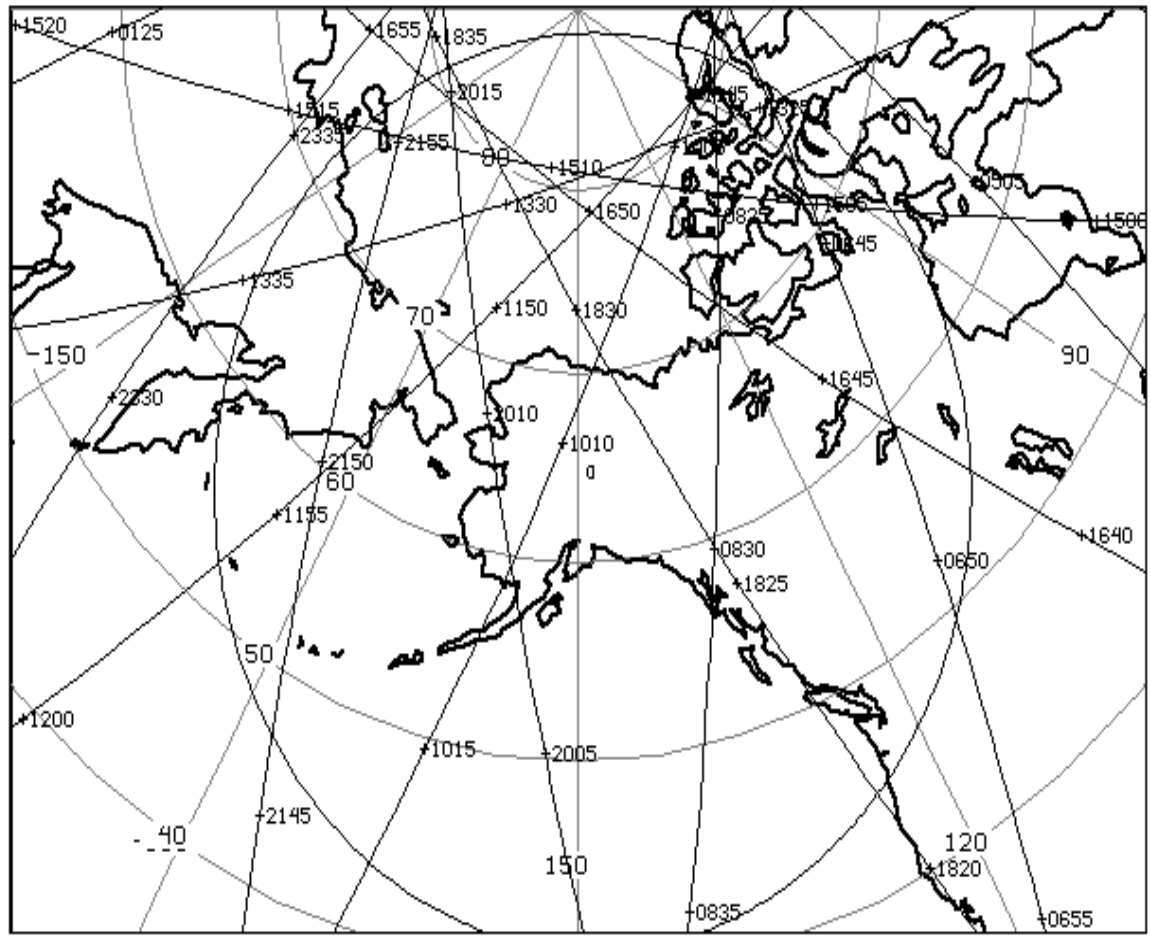


PREDICTED ON OCTOBER 31, 1997

NOAA-12 AVHRR 15 MAY 98 (98135)

1 McIDAS

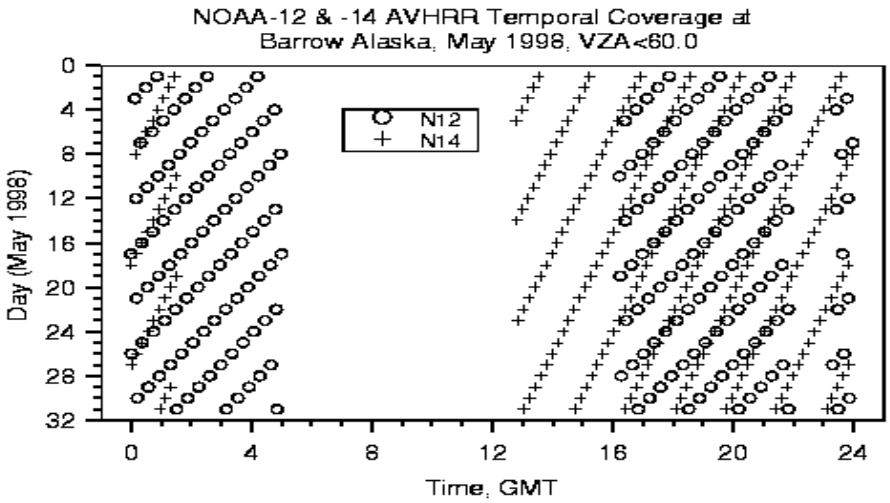
Figure Q.1-2 NOAA 14 Overpass Ground Tracks

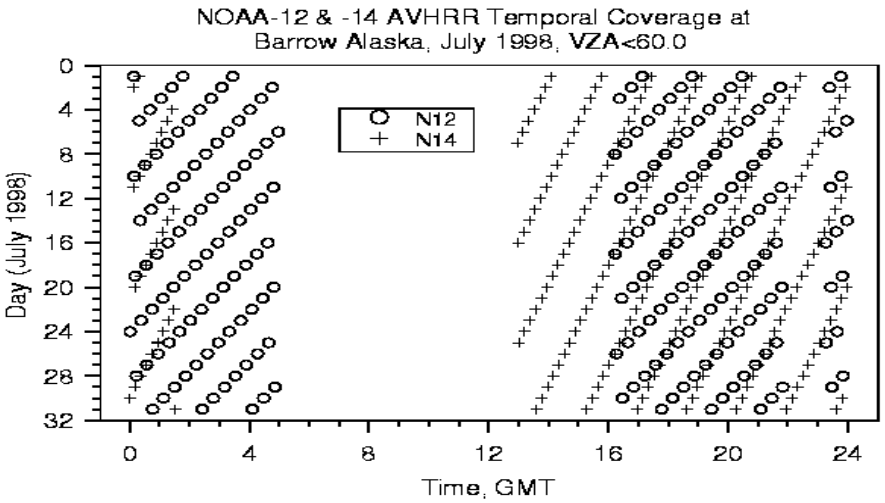


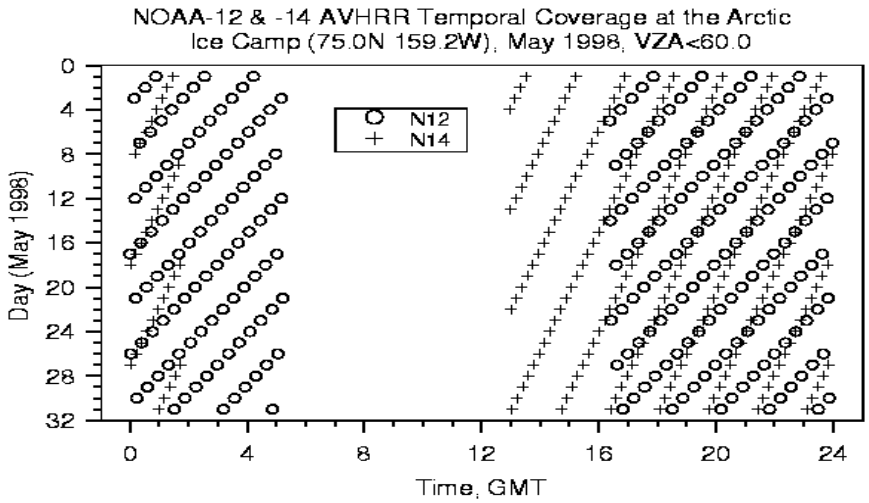
PREDICTED ON OCTOBER 31, 1997

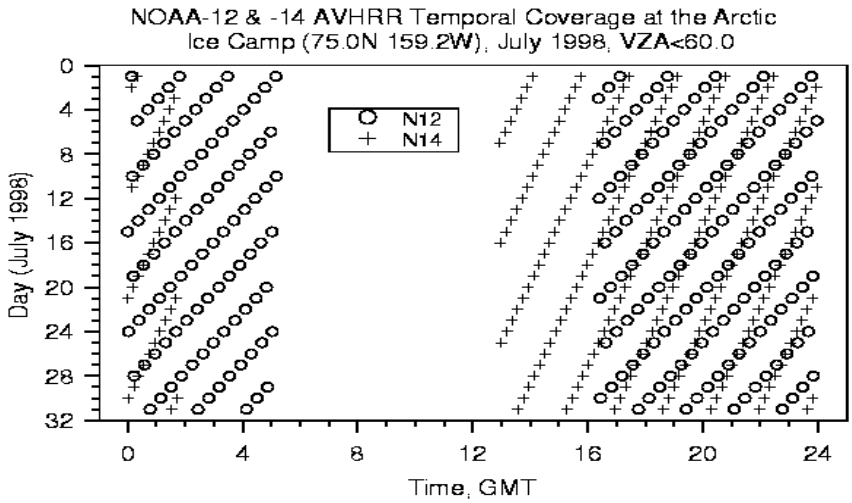
NOAA-14 AVHRR 15 MAY 98 (98135)

1 McIDAS


NOAA-12 & -14 AVHRR Temporal Coverage at
Barrow Alaska, May 1998, VZA<60.0
N12
N14
Day (May 1998)
0
4
8
12
16
20
24
28
32
Time, GMT


NOAA-12 & -14 AVHRR Temporal Coverage at
Barrow Alaska, July 1998, VZA<60.0
N12
N14
Day (July 1998)
Time, GMT
0
4
8
12
16
20
24
28
32

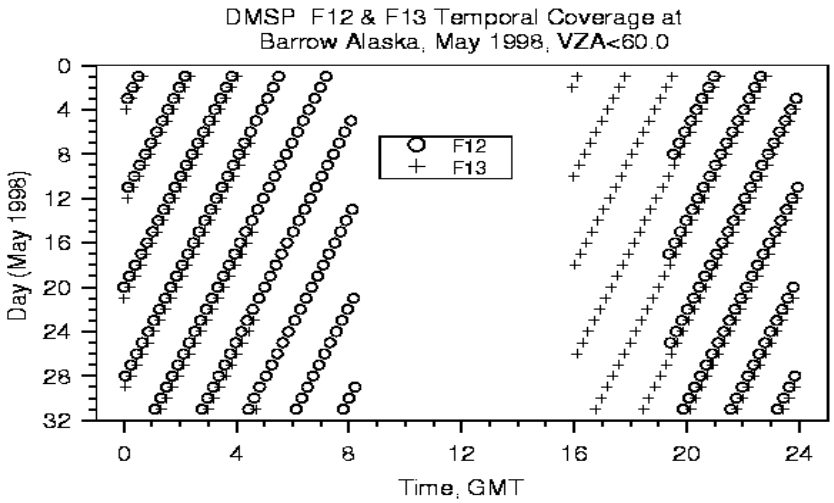

NOAA-12 & -14 AVHRR Temporal Coverage at the Arctic
Ice Camp (75.0N 159.2W), May 1998, VZA<60.0
N12
N14
Day (May 1998)
Time, GMT
0
4
8
12
16
20
24
28
32

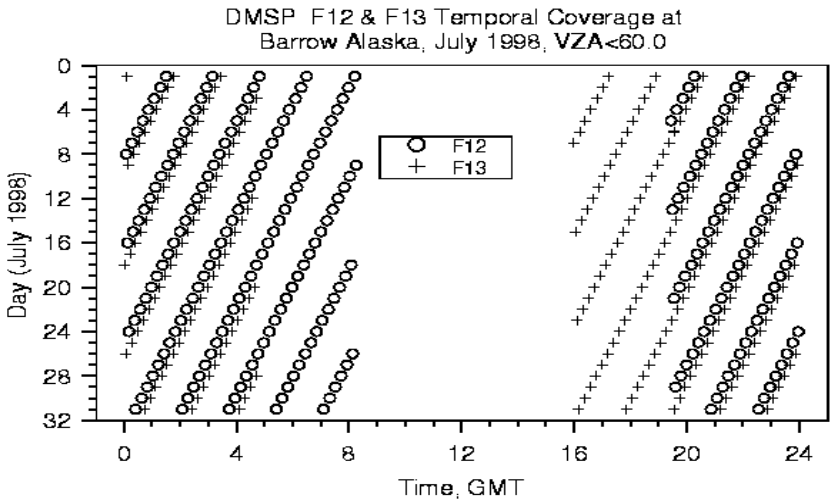


Q.2 DMSP F12 and F13

Table Q.2-1 DMSP F12 Overpass Predictions

Table Q.2-2 DMSP F13 Overpass Predictions


DMSP F12 & F13 Temporal Coverage at
Barrow Alaska, May 1998, VZA<60.0
F12
F13
Day (May 1998)
Time, GMT
0
4
8
12
16
20
24
28
32



Q.3 RADARSAT
Table Q.3-1 RADARSAT Overpass Predictions

Q.4 Earth Probe
Table Q.4-1 Earth Probe Overpass Predictions

Q.5 RESURS
Table Q.5-1 RESURS Overpass Predictions

Q.6 LANDSAT
Table Q.6-1 LANDSAT Overpass Predictions