PLANS FOR CLOUD AND BOUNDARY-LAYER RESEARCH DURING THE ARCTIC SUMMER CLOUD-OCEAN STUDY

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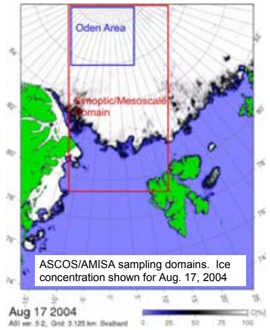
Dual Component

I. Deployment of surface-based sensors near North Pole with R/V Oden, Aug 1- Sep 12, 2008 (ASCOS)

High-temporal resolution point measurements of
A. Cloud properties and processes
B. Boundary-layer structure, properties, and processes
C. Surface energy budget
D. Boundary-layer aerosol properties and sources

II. Six airborne missions using NASA DC-8 research aircraft based in Kiruna, Sweden (AMISA)

Spatial measurements focused on
A. Synoptic/mesoscale structure of clouds, dynamics parameters, and surface features
B. Testing and validation of satellite retrieval techniques
C. In-situ sampling of cloud microphysics, aerosol species, and size distributions

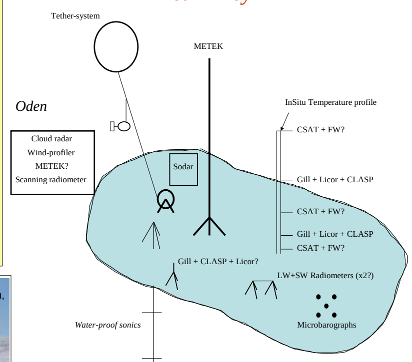


ASCOS/AMISA sampling domains. Ice concentration shown for Aug. 17, 2004

Science Objectives of Surface-based Measurements

1) Determine atmospheric processes controlling boundary layer clouds north of 80°N.
2) Temporally and spatially link cloud properties to the evolution and distribution of boundary-layer wind, thermodynamic structure, aerosols, and surface energy budget
3) Compare pack-ice cloud macro- and microphysical properties to those similarly derived over the pack ice during SHEBA and at Arctic Ocean coastal sites (e.g., SEARCH)
4) Determine evolution of boundary-layer cloud condensation (CCN) and ice forming nuclei (IFN)
5) Determine role of boundary-layer turbulence and surface properties for the exchange of heat, water, momentum and aerosols between the troposphere and the ocean/ice/air interface
6) Determine role of marine biochemical processes for CCN and IFN formation, with emphasis on the open-lead surface microlayer
7) Provide comprehensive data set on the high Arctic climate system as short-term "mirror" data to that from long-term Arctic coastal sites for developing and testing integrated climate models.

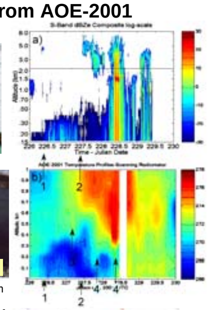
Met - Alley

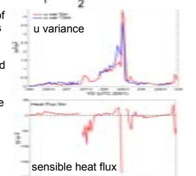


Boundary-Layer and Surface Measurements

Instrumentation
1) **5-mm scanning radiometer** - temperature profiles (0-1 km; 1 s -10 min)
2) **449 MHz wind profiler** - hourly profiles of wind speed/direction, turbulence intensity (0.2 - 5 km, 100 m)
3) **4X daily rawinsondes** - profiles of basic state parameters
4) **on-ice flux towers** (15m, 30m) - SL profiles of turbulent fluxes of momentum and sensible/latent heat
5) **broadband radiometers** - 4 component radiative fluxes
6) **tethered balloon** - basic state parameters, turbulence, aerosol sampling
7) **Scintec phased array sodar -** backscatter, 3D mean winds, C_T^2, z/L, turbulent dissipation, 10 m resolution, 10-min averaging

Example from AOE-2001





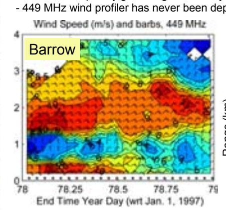
1) upper-level clouds of storm system reduces cloud-top cooling, causing dissipation of low-level mixed phase clouds (arrow "2")

2) pulses of warm air descend as warm sector air advects over top of inversion (arrows "3" and "4") impacting surface turbulence.

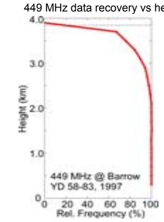
3) boundary-layer "fog front" between arrows "1" and "2" - frequently seen in Arctic BL.

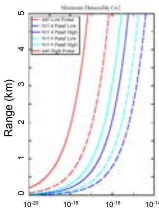
Unique use of 449 MHz wind profiler

- though developed for Arctic deployment (SHEBA), a 449 MHz wind profiler has never previously been deployed in the Arctic in a scientific field program
- 449 MHz frequency gives large sensitivity advantages in dry Arctic environment
- 449 MHz wind profiler has never been deployed on ship before because of size and ship motion



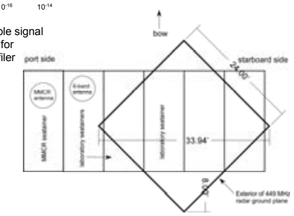
449 MHz data recovery vs height





Minimum detectable signal at various ranges for different wind profiler frequencies and configurations

Plans for installing 449 MHz windprofiler on top of row of seatainers on deck 2 on R/V Oden



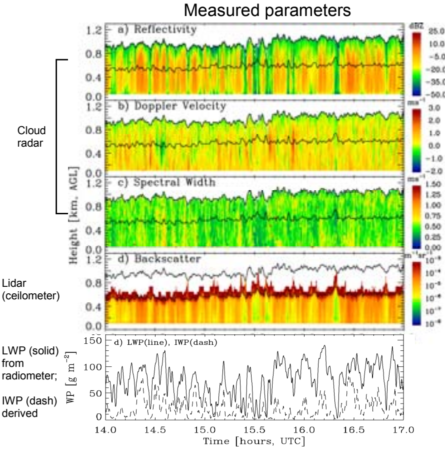
Cloud Measurements

Instrumentation:
1) **Ka-band (λ = 8 mm) Doppler cloud radar**
2) **dual-channel (24/31 GHz) microwave radiometer**
3) **ceilometer**
4) **enhanced S-band Doppler cloud and precipitation radar**

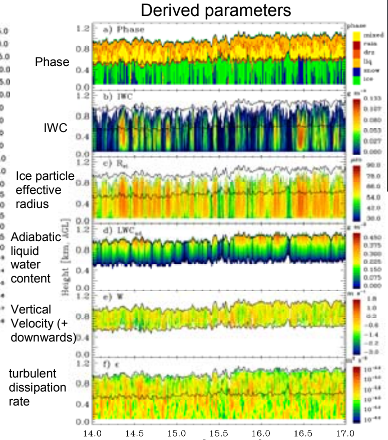
Measurement Parameters:
cloud macro- /microphysical properties, reflectivity, vertical velocity, spectral width within both clouds and precipitation

Example from M-PACE (Barrow, AK) 10/28/2004

Measured parameters



Derived parameters



SkyDoc Tethered Balloon System

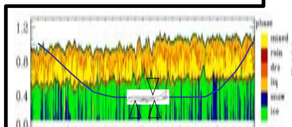
- U. of Leeds modification of Gill basic system
- custom motion pack, GPS, 3-5 h battery duration
- Mean T, RH, P @ 1 Hz,
- Turbulence measurements @ 10 Hz
- CLASP aerosol probe, 16 channels, 0.12 - 9.25μm radius @ 10 Hz sampling

Airborne Measurements (AMISA; NASA DC-8)

Science Objectives

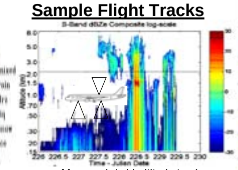
1) in-situ validation for ship, aircraft, satellite data
2) determine processes linking cloud radiative/microphysical properties to synoptic/mesoscale disturbances, boundary-layer structure, and surface energy budgets near freezeup
3) determine type and size distribution of aerosols in/near high-latitude, low-level clouds and thermal inversion
4) aircraft/satellite sea-ice imaging/mapping and atmospheric radiometric profiling
5) validate/improve NASA Aqua AMSR-E sea-ice concentration algorithm under fall transition conditions
6) evaluate C-/L-band for lead/meltpond discrimination

Sample Flight Tracks

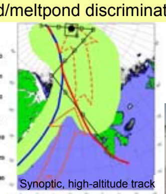


Low-level track & liquid cloud penetration

Low-altitude transect & liquid cloud penetration
Obtain
1) particle size distributions of liquid drops/cloud ice, CLW -CAPS
2) integrated water & CLW - pseudo profile with up/down & sfc DCR
3) sub-cloud broadband radiative flux divergence
4) detailed mapping of surface meltponds/leads



Mesoscale/mid-altitude track



Synoptic, high-altitude track

Synoptic/mesoscale sampling track
1) high-level passes (10 km) on way to Oden (black dot) and mid-level (1 km) in vicinity of Oden
2) use dropsondes (D) and remote sensors for mapping and profiling
Obtain
1) synoptic thermodynamic/kinematic structure of environment upwind and near Oden
2) integrated water & CLW - pseudo profile with up/down & sfc DCR
3) radiative flux divergence of low-level cloud tops

AMISA DC-8 Instrumentation

Instrument	Description	Observables
Polarimetric Scanning Radiometer (PSR)	Multiband polarimetric radiometric imaging system; Airborne AMSR-E equivalent	high resolution sea ice mapping; cloud cover; integrated water vapor
Dual-channel radiometer (DCR)	21/31 GHz, up/downlooking	integrated water vapor & cloud liquid water above/below aircraft
Scanning Low Frequency Microwave Radiometer (SLFMR)	L-band salinity mapping	L-band brightness; mapped salinity with ~5 ppt precision for lead/meltpond discrimination
Cloud, aerosol, and precipitation spectrometer (CAPS)	From Droplet Measurements Technology	Cloud droplet and ice particle spectra, liquid water content, droplet/ice discrimination
Expendable digital dropsondes	Yankee Technology	Sub-aircraft profiles of temperature, pressure, humidity, and wind
OAT Rosemount probe	Outside air temperature adjusted for Mach number	Air temperature
Solar flux pyranometers (SFPs)	Hemispheric integrating thermopile irradiance sensors	Up- and downwelling shortwave fluxes
Volatile Aerosol Concentration and Composition (VACC)	University of Leeds' system	Aerosol number concentration spectra and aerosol composition

Aerosol sampling: Leeds airborne VACC

1. MetOne Condensation Particle Counter (CPC)
- total aerosol load per ml for particles R > 3nm; Data rate 10 Hz
2. Scanning Mobility Particle Sizer (SMPS)
- give number concentration for 3 nm < R < 150 nm.
- spectrum generated every 2.5 min
3. Volatility System.
- provides physio-chemical information about the sampled aerosol
- obtain size-segregated composition of aerosol and estimate of population mixing state
- volatility spectrum obtained every 10 min

Remote Sensors: U of CO PSR mounted on aircraft