PAG Fall Meeting 2014 (Seattle, USA)

KOPRI's Research Activities on Atmosphere and Sea Ice in the Arctic Ocean

Joo-Hong Kim

Division of Climate Change

Korea Polar Research Institute

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KOPRI Korea Polar Research Institute

Topics included

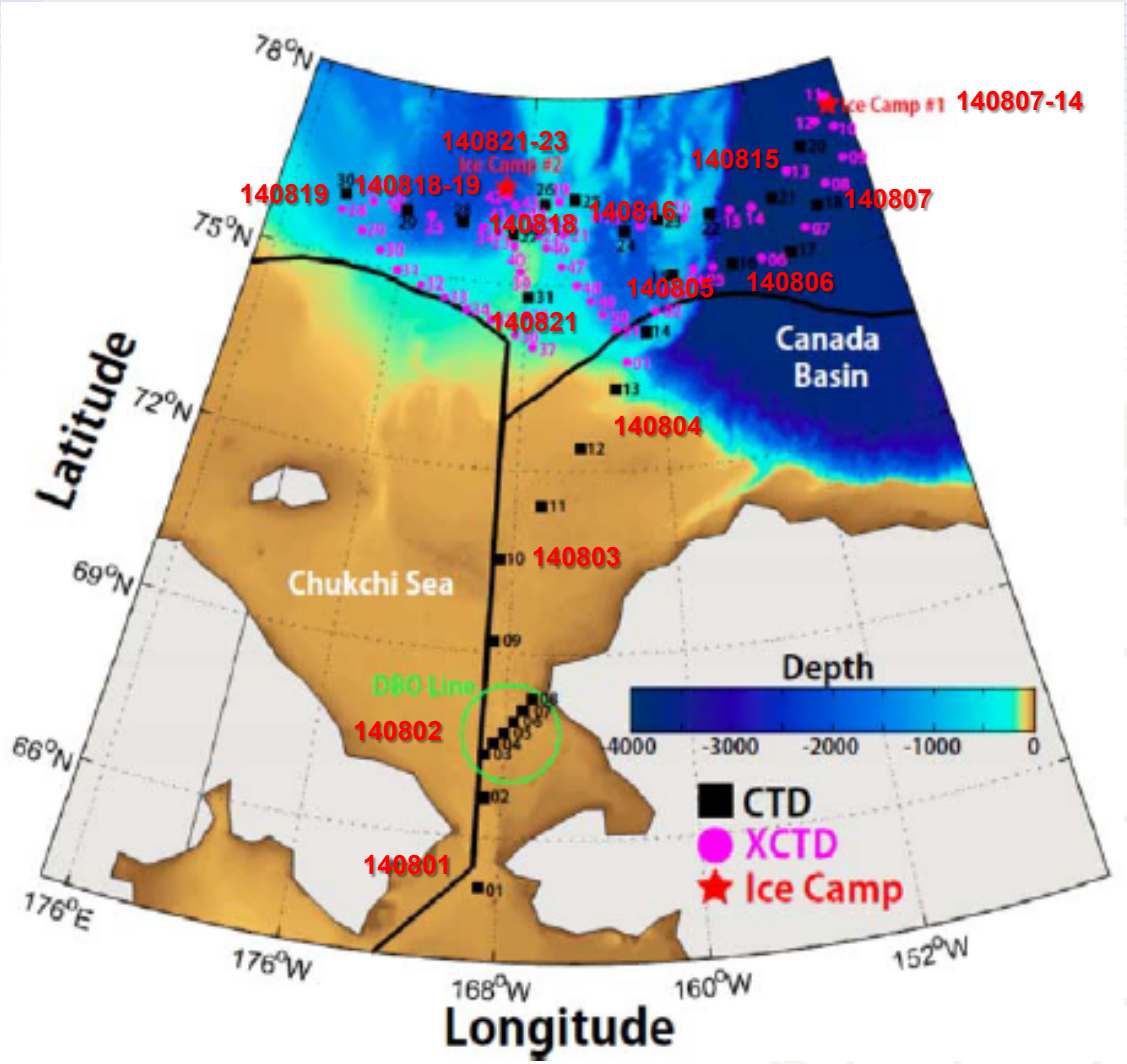
- 2014 ARAON Arctic Cruise
  - Atmospheric Observations
    - On-board instruments
  - Deployment of Sea Ice Buoys
    - Support the MIZ program

- Plans
  - Enhance on-board meteorological observations and cloud observing instruments (2015)
  - Autonomous platform to observe floe-scale dynamic sea ice deformation (2015)
  - Participate in the Norwegian young sea ice cruise 2015 (N-ICE2015) (Period: January to June 2015)
  - Integrated platform to study thermodynamic sea ice – atmosphere interaction (*in situ* sea ice energy balance) (2016~)

- “Climate Line” : Atmospheric Scientist’s Perspective
  - A lesson from other campaigns

2014 Araon Arctic Cruise (Leg 1)

- 2014.07.30 ~ 2014.08.25



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On-board Atmospheric Observing Instruments

- Basic meteorological variables
  - pressure, temperature, wind speed & dir ection, and humidity

Radarmast (38m)
Short-wave radiometer (PSP)
Long-wave radiometer (PIR)
Temperature & RH (HMP45D)
Pressure sensor (PTB100)
Quantum sensor (LI-200)
Data logger (CR3000)
2D sonic anemometer

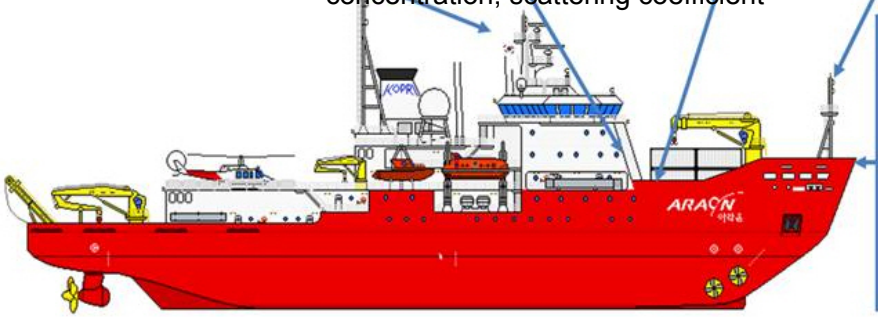
Atmospheric Sciences Lab. (03Deck)
CPC
Aethalometer
Nephelometer

CRDS Shelter 02Deck (15m, Port)
CRDS (G2301-f)
Data logger (CR3000)
Motion Sensor (MPII)

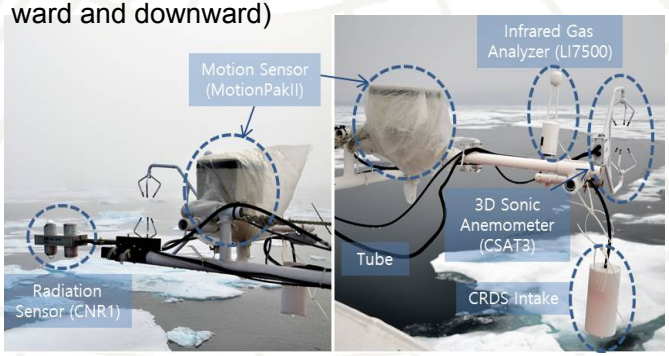
Foremast (29.8m)
Windmill Anemometer (031050-L)

- Aerosols properties
  - condensation particle count, black carbon mass concentration, scattering coefficient

- 4-component radiations
  - shortwave and longwave radiations (up ward and downward)



Bow (19m)
Sonic Anemometer (CSAT3)
Infra-red gas analyzer (LI7500)
Motion Sensor (MPII)
Net radiometer (CNR1)
CRDS intake



* Heights in parenthesis are the distance of instruments from design load waterline (DLWL)

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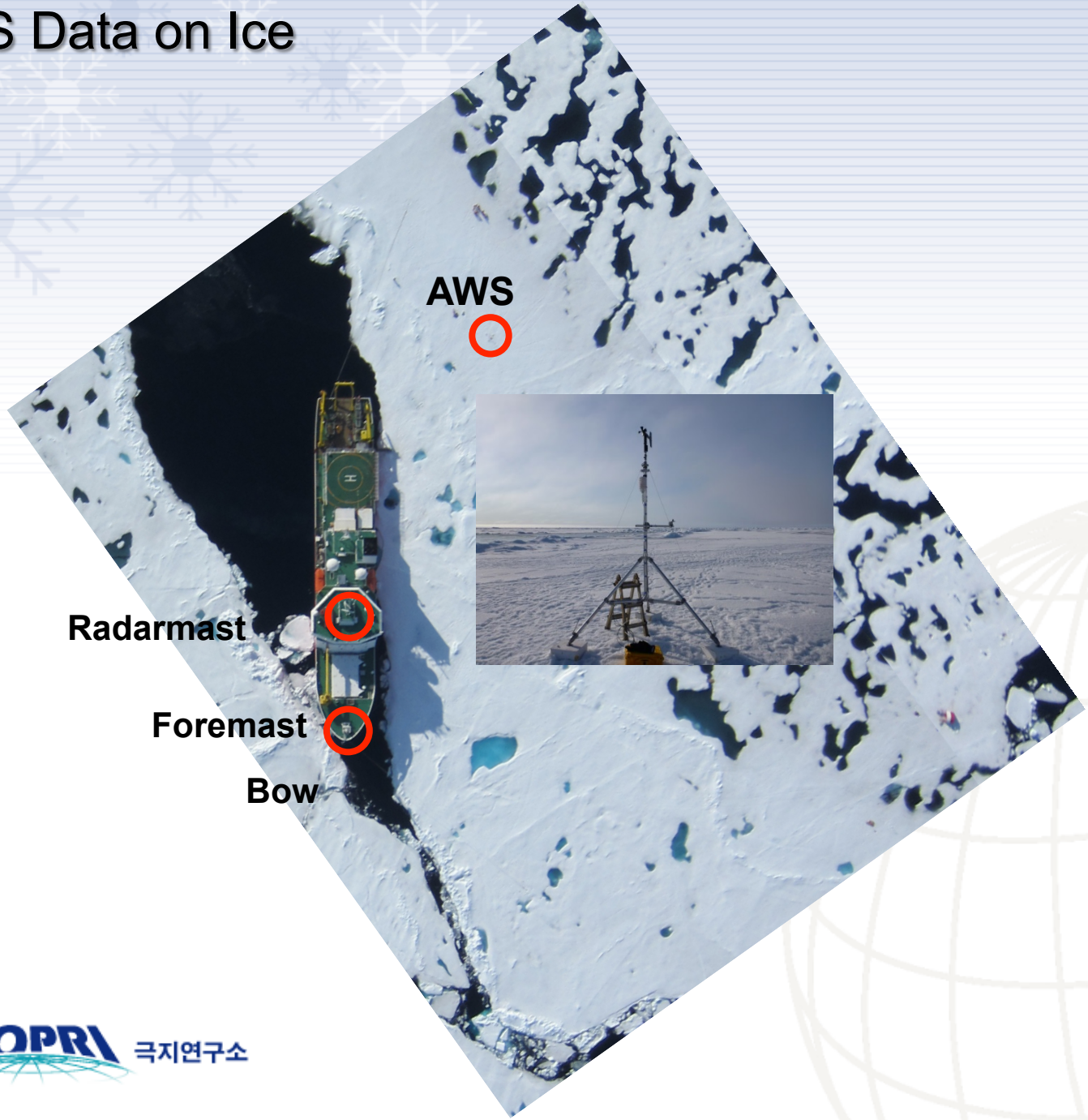
- Eddy covariance system
  - momentum, sensible heat, latent heat , and gas fluxes

AWS Data on Ice



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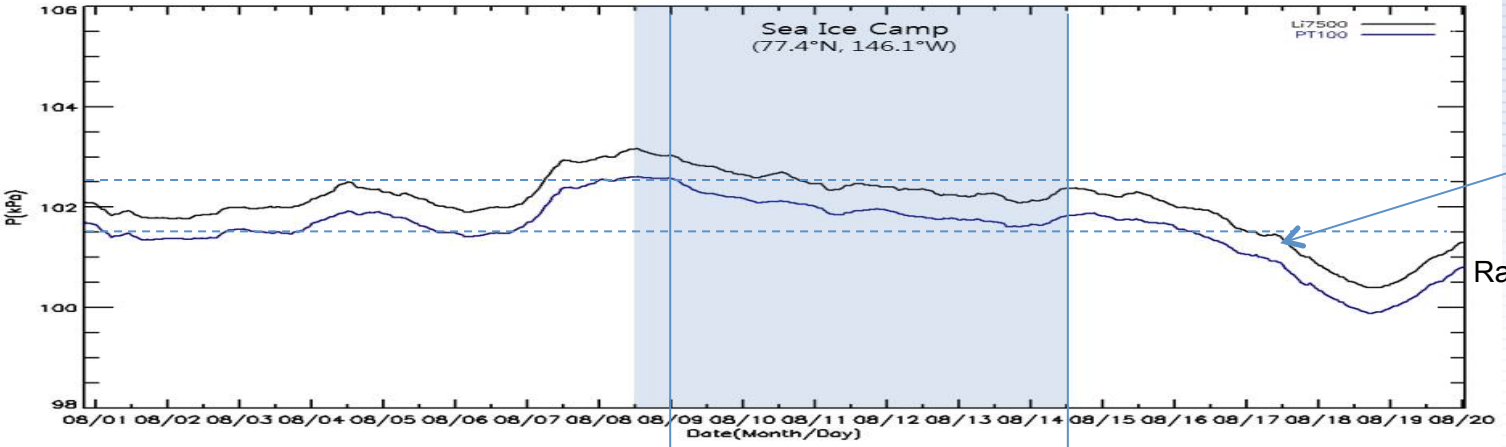
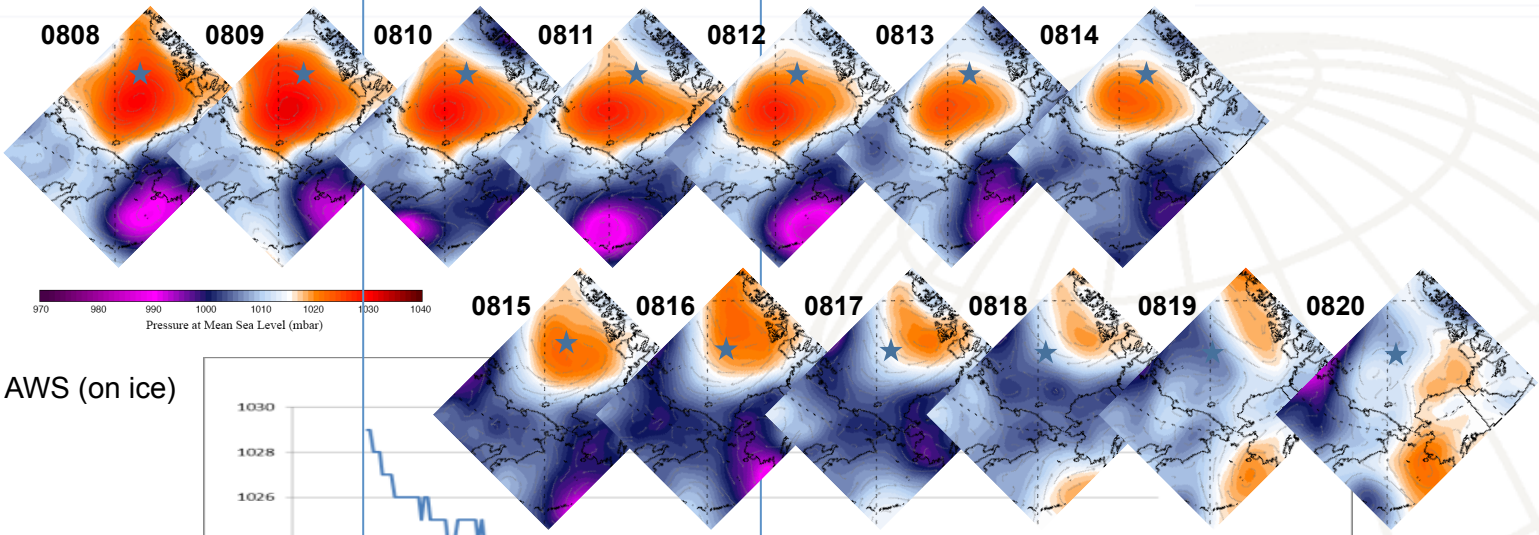
Meteorological Data (Air Pressure)



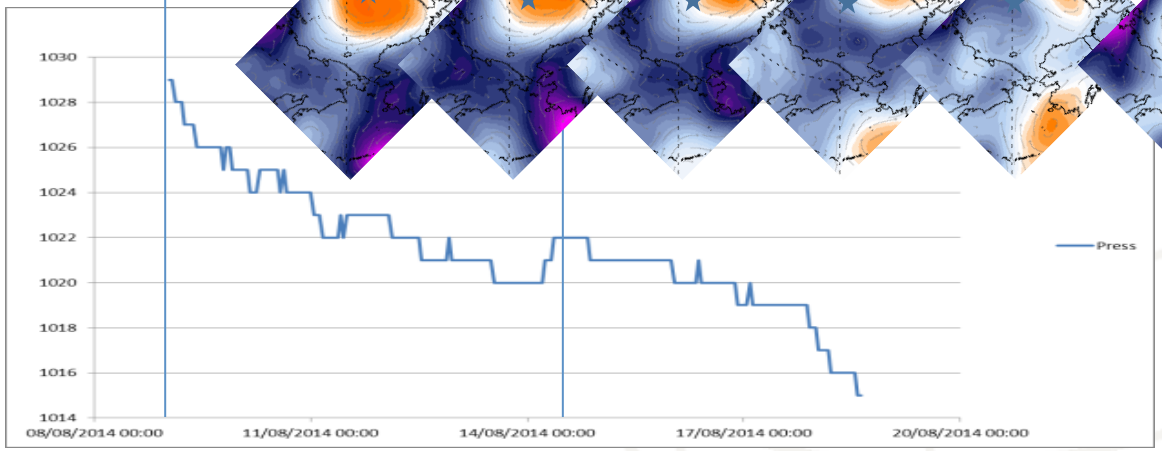
LI7500 (biased)

Radarmast (38 m)

NCEP CFSR



AWS (on ice)



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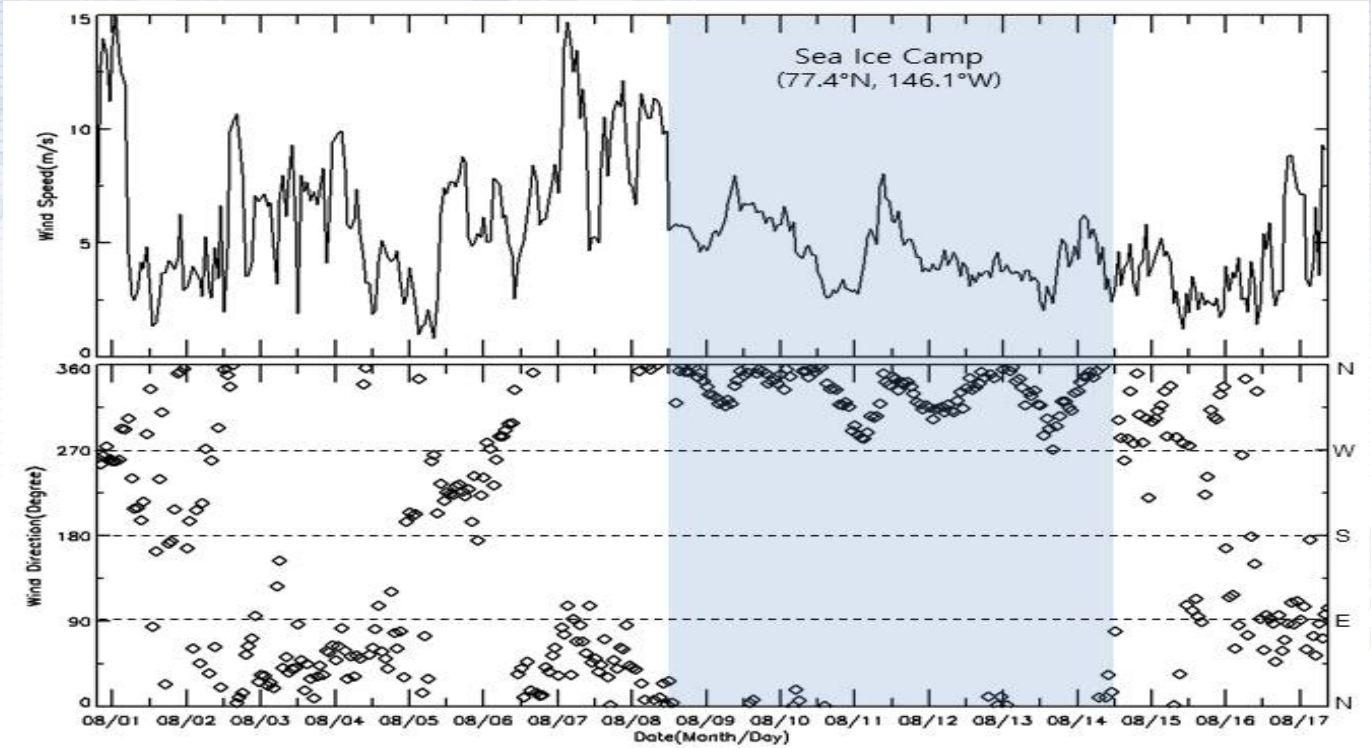
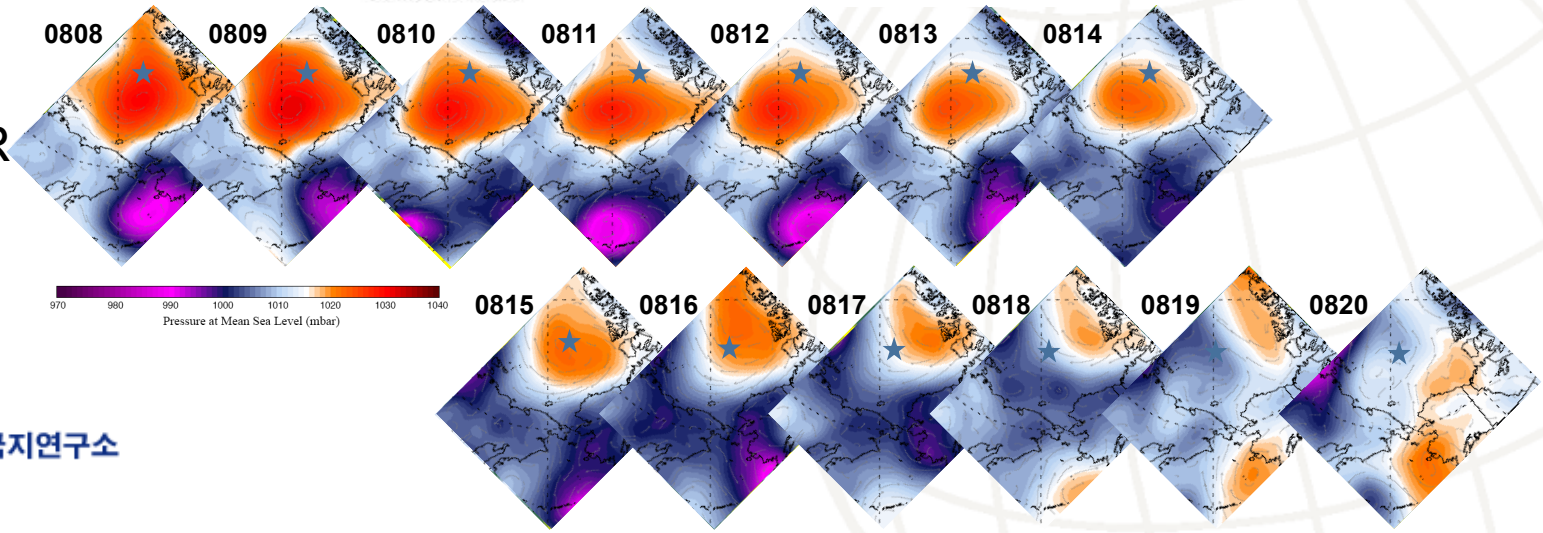
Meteorological Data (Wind)



Foremast (29.8 m)

NCEP CFSR



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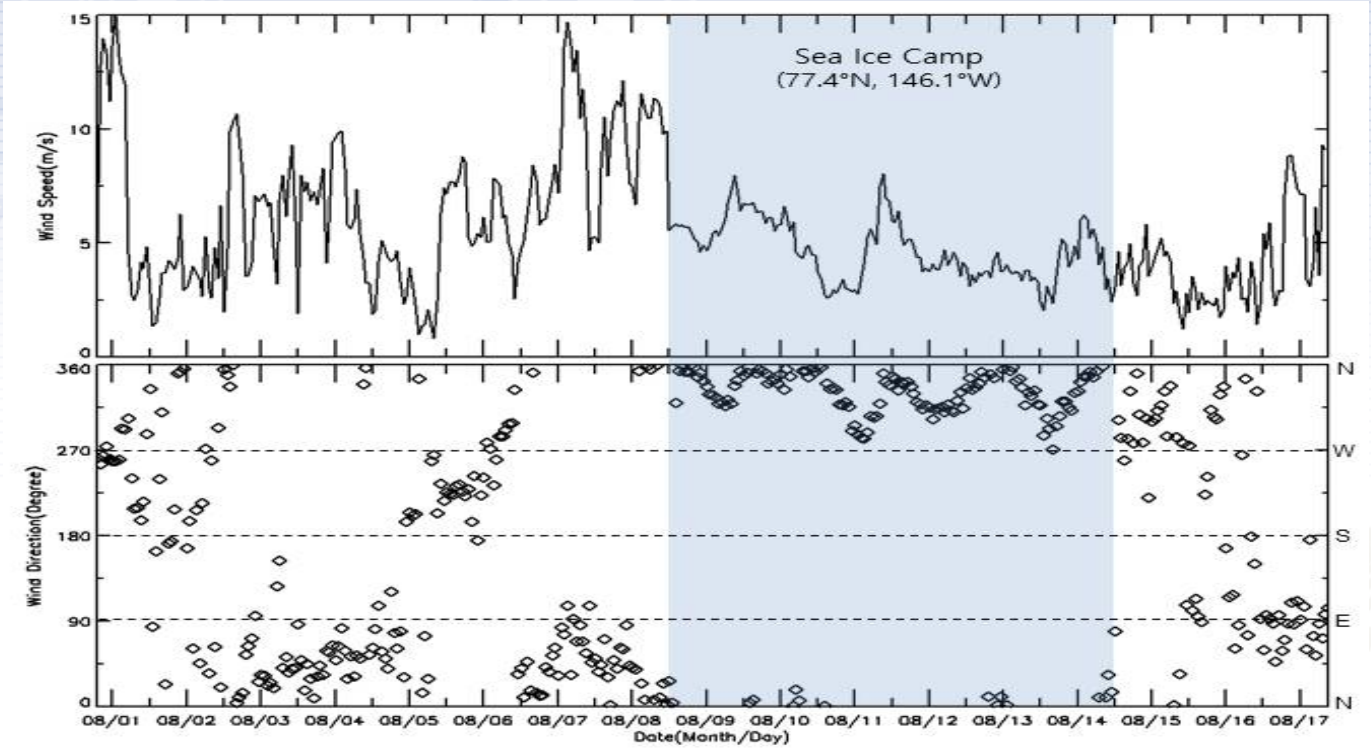
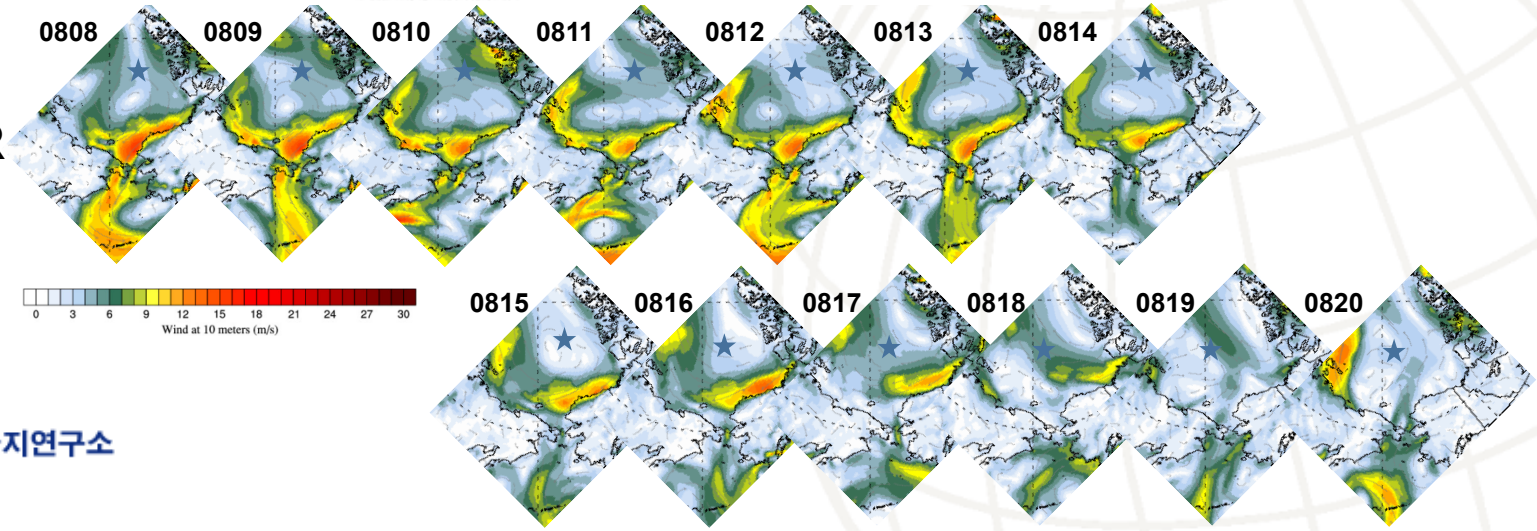
Meteorological Data (Wind)



Foremast (29.8 m)

NCEP CFSR



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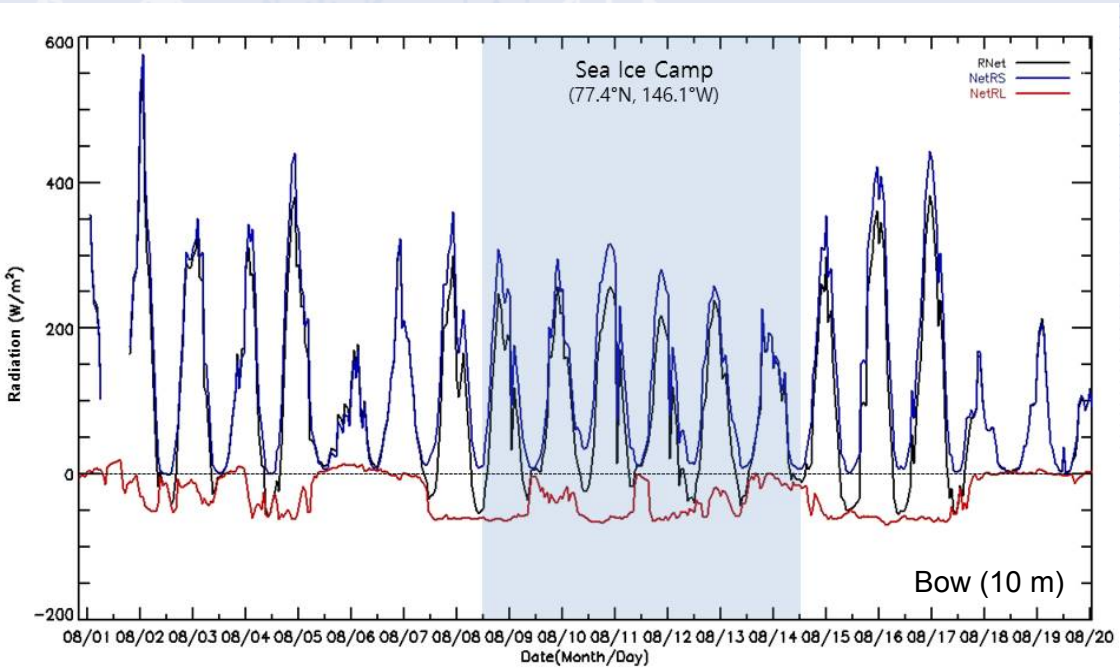
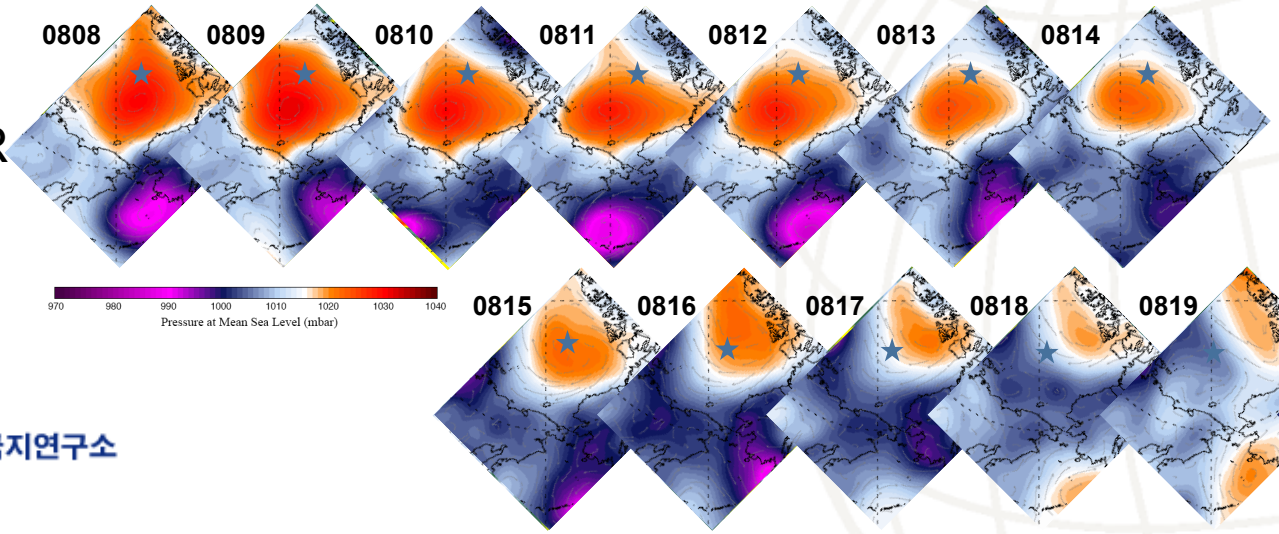
Meteorological Data (Net Radiation)



NCEP CFSR



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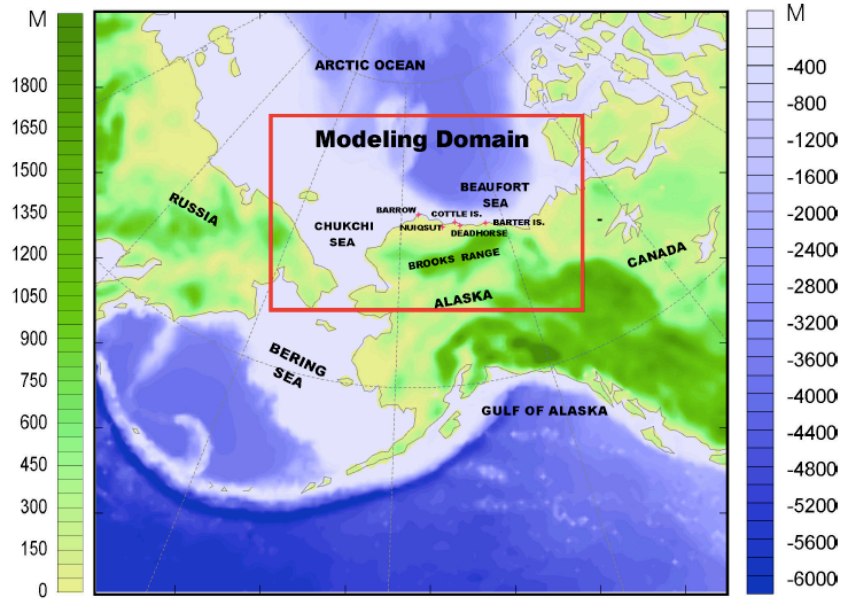
Plans with the Meteorological Data

- Comparison with the available atmospheric reanalysis data (e.g., ERA-Interim, NCEP CFSR, NCEP R1, NCEP R2, JRA55, NASA MERRA)

- Assimilation of cruise data to the CBHAR (Chukchi-Beaufort Seas High-resolution Atmospheric Reanalysis)
  - Contacted with X. Zhang (IARC)

The Chukchi-Beaufort seas High-resolution Atmospheric Reanalysis (CBHAR)



Model: WRF-ARW

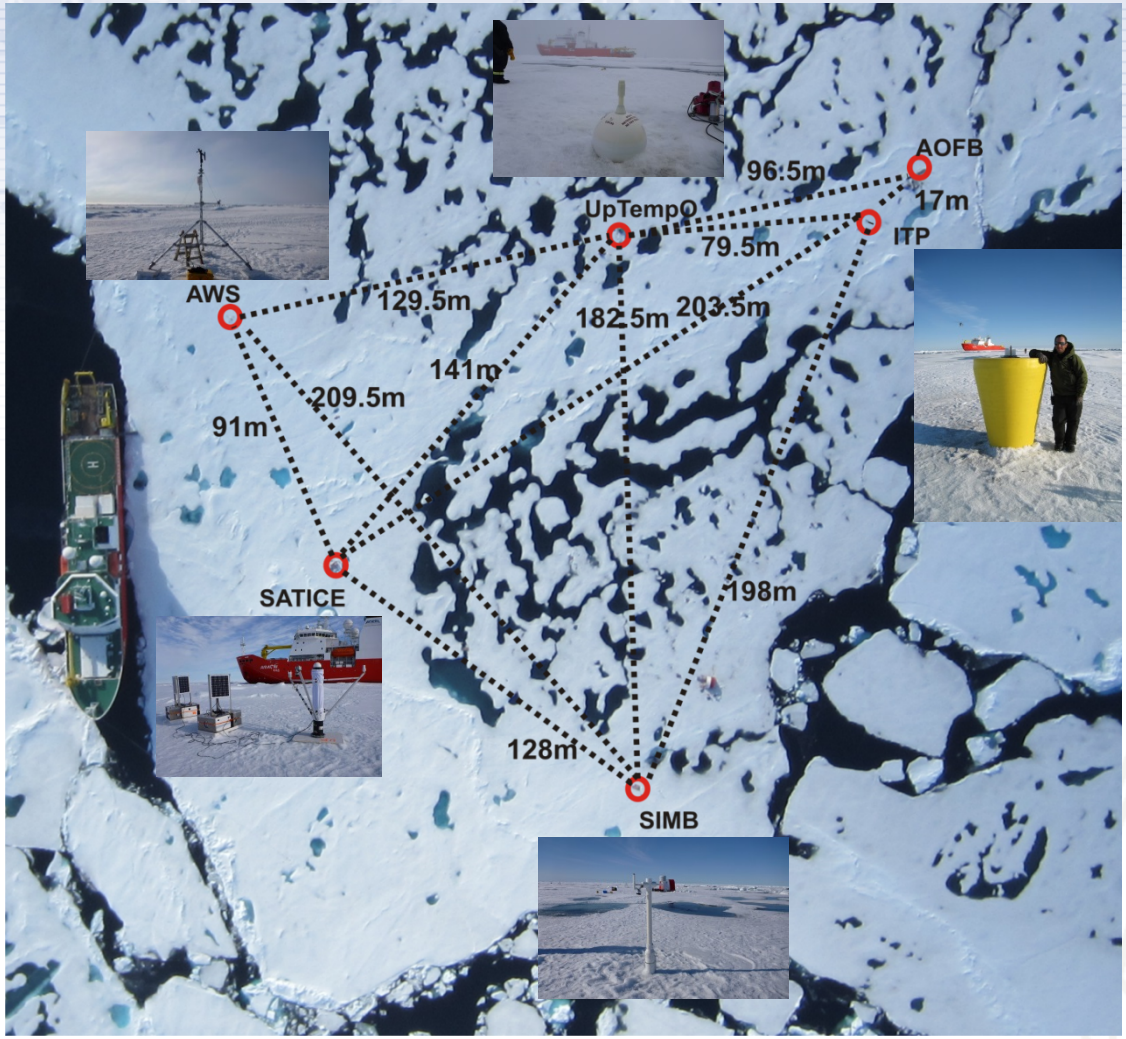
Data product:

Spatial resolution: 10 km

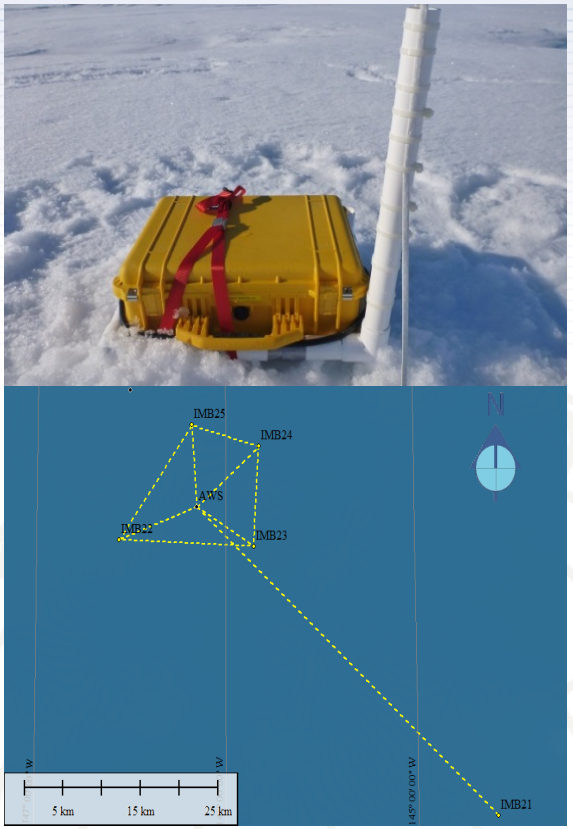
Temporal resolution: 1 hour

Courtesy of X. Zhang

Deployment of Sea Ice Buoys



Floe-scale buoy array



Large-scale IMB array

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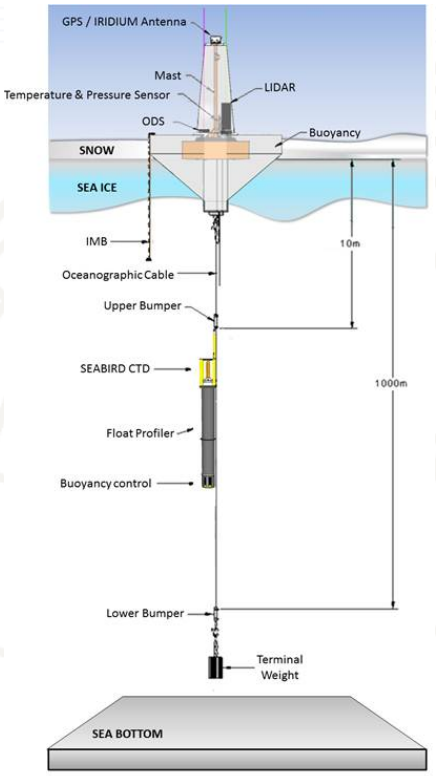
Provided by Phil Hwang (SAMS)

Plans

- Enhance on-board meteorological observations and **cloud** observing instruments (2015)
  - Install all sky camera on the top of foremast
  - Re-operate on-board lidar (dual polarization lidar)
  - Regular launch of a radiosonde balloon during the Arctic cruise

- Autonomous platform to observe floe-scale **dynamic** sea ice deformation (2015)
  - Instrument: Array of GPS buoys
  - Begin: early September (during Araon cruise)
  - Target: freezing season (October – March)
  - Large-scale feature: satellite SAR images

- Integrated platform to study **thermodynamic** s ea ice – atmosphere interaction (*in situ* sea ice energy balance) (2016~)
  - Cloud Instruments + AOFB + IMB + ITP -> IAO OS (Ice - Atmosphere - Arctic Ocean Observing System) like?
  - Trackable & Recoverable - Accurate positioning … but high cost and risk.



http://www.iaoos-equipex.upmc.fr/en/index.html

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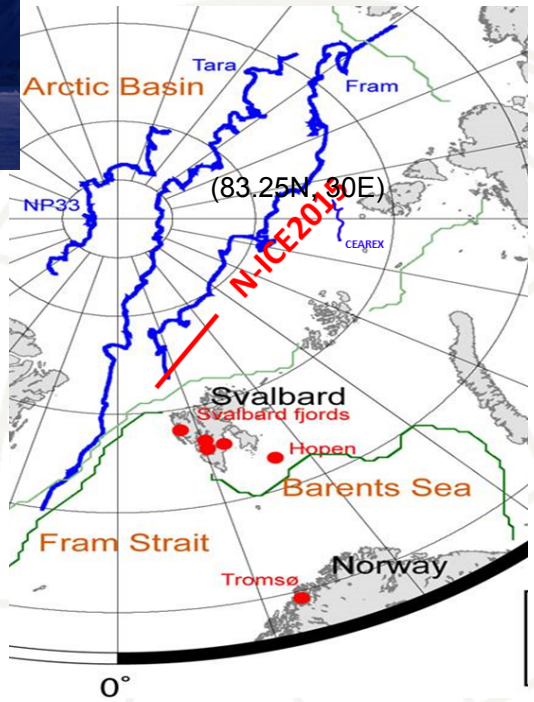
Special Plan in the Atlantic

- Participate in the **Norwegian young sea ice cruise 2015 (N-ICE2015)** (Period: January to June 2015)
  - Ship: RV Lance
  - Who: KOPRI's atmospheric scientist group
  - When: leg 1 (early January to mid-February, 2) and 2 (mid-February to late March, 2)
  - Topics of interest
    - Atmospheric boundary layer turbulence
    - Cloud – sea ice interaction

RV Lance



WP2 – Atmospheric Forcing

Lead: Stephen Hudson and Mats Granskog (**Norwegian Polar Institute, NPI**)

Participants: Lana Cohen and Alexey Pavlov (**NPI**), Von P. Walden (**Washington State University, WSU**), Annette Rinke, Christoph Ritter, Klaus Dethloff, Marion Maturilli, Roland Neuber and Gerhard Dieckmann (**Alfred Wegener Institute, AWI**), Baek-Min Kim, Joo-Hong Kim and Sang-Jong Park (**Korean Polar Research Institute, KOPRI**), Woosok Moon (**University of Cambridge DAMTP**), Joachim Reuder, Torbjørn Taskjelle and Børge Hamre (**University of Bergen, UiB**), CJ Mundy (**University of Manitoba, UM**), Daiki Nomura (**Hokkaido University, HU**), Anna Silyakova (**University of Tromsø, UiT**) and Jeremy Wilkinson (**British Antarctic Survey, BAS**)

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N-ICE2015 WP2 Datasets

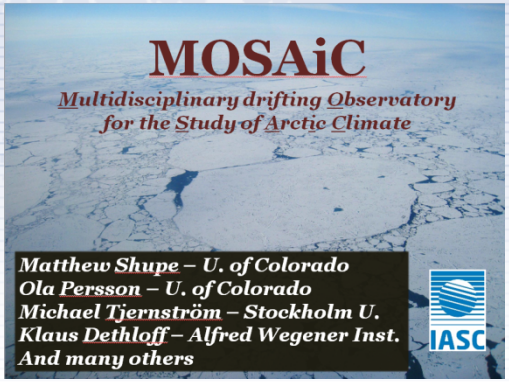
TABLE WP2.1 Datasets to be collected, parameters, frequency, period, and location. Bold datasets will be core data distributed in real time.

Data set	Type	Duration	Data Frequency	Location	Parameters
Weather data	Continuous	Whole	1-minute averages	Supersite, fixed 10 m mast	2-, 6-, and 10-m temperature, humidity, wind speed, and wind direction, surface pressure
Radiosonde	Routine	Whole	12 or 24 hours	From ice near ship and/or from helicopter deck	Temperature, humidity, pressure, wind speed and direction as function of height, 0-10+ km
Precipitation	Routine	Whole	Daily (08 UTC)	Supersite	Daily precipitation amount, isotope samples
Turbulent fluxes, fixed	Continuous	Whole	0.5-hr averages	Supersite, second fixed mast	Turbulent flux of sensible and latent heat, CO_2 and CH_4 between ice surface and atmosphere
Turbulent fluxes, mobile	Campaign	Whole	0.5-hr averages, intermittently	Mobile, moved to interesting areas	Turbulent flux of sensible and latent heat and CO_2 between ice surface and atmosphere
CO_2 and CH_4 fluxes (chambers)	Routine & Campaign	First half	Weekly to daily	A variety of undisturbed surfaces, new ice	CO_2 and CH_4 flux from ice/snow surface
Tethered balloon profiles	Campaign	Whole	Up to hourly	From ice near ship	Temperature, humidity as function of height 0-250 m (Cloud imaging?, photos?)
Boundary layer sodar/radar	Continuous	Whole	10-minute averages	Between ship and supersite	Temperature and 3-dimensional winds between 30 and 1000 m above the ice
Radiation station	Continuous	Whole	1-minute averages	Supersite fixed frame	Incoming and outgoing broadband shortwave and longwave radiative fluxes
Under-ice solar radiation	Continuous	Second half	1-minute averages	Several undisturbed places near supersite	Transmitted broadband shortwave radiation beneath the ice
Spectral radiation station	Continuous	Leg 2 and second half	10 minutes	Supersite fixed frame	Incoming, outgoing, and transmitted spectral shortwave radiation (400—900 nm)
Spatial variability surface radiation budget (*sled*)	Campaign	Second half	Weekly to daily	Undisturbed area, representative surfaces	Incoming and outgoing spectral solar radiation (350—2500 nm), 4-component broadband radiation, surface and sky photos, temperature, humidity
Spatial variability of trans-mitted radiation (*ROV*)	Campaign	Second half	Weekly to daily	Undisturbed areas, representative surfaces	Incoming and transmitted spectral solar radiation (400—900 nm), under-ice photos [ROV]
Radiation drifters (& IMBs)	Autonomous	Second half	Hourly	Free drift, deployed 10—20 km from Lance	Incoming and transmitted broadband solar flux
Upper ocean profiles of inherent optical prop.	Routine	Whole	Weekly	On-ice CTD site	Total absorption coefficient, separated into dissolved and particulate components [integrating sphere]
Inherent optical prop. from ice/water samples	Routine	Whole	Weekly	Ice coring area & on-ice CTD site	Total particulate absorption (400-800 nm), total dissolved absorption (300-700 nm) [filtration]
In-water irradiance profiles	Routine	Second half	Weekly to daily	Near supersite	Spectral irradiance (305—900 nm) versus depth, derive attenuation coefficients
All-sky camera	Continuous	Whole	5 min	Top of ship	Photos of sky conditions showing cloud cover
Cloud lidar	Continuous	Whole	1 min	Top of ship's bridge	Cloud base height, thickness and particle properties
Biological experiments	Campaign	Second half	Intermittent	FYI area to be manipulated	Transmitted radiation, ice (with algae) IOPs, melting rates, productivity rates…

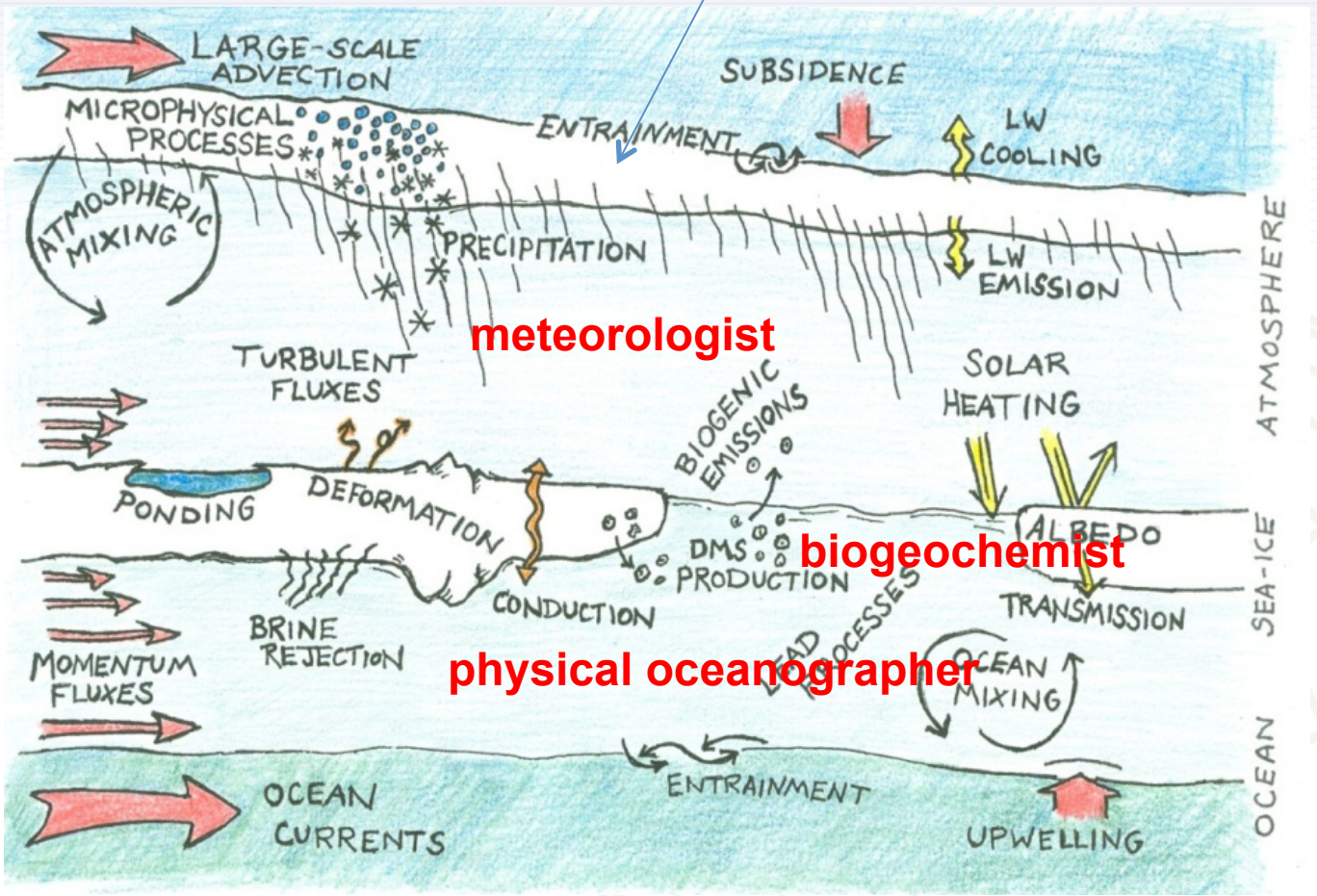
“Climate Line” : Atmospheric Scientist’s Viewpoint

- A lesson from other campaigns
  - SHEBA (1997-1998) – Surface Heat Budget of the Arctic Ocean
    - The interaction of the atmosphere, **clouds**, sea ice and upper ocean in determining the energy b alance in the Arctic.
  - ASCOS (2008) – Arctic Summer Cloud Ocean Study
    - Multidisciplinary program to study the role of **clouds** in the Arctic climate system
  - N-ICE2015 (2015) – Drift study on a first year ice floe
    - What role do **clouds** play in affecting the combined radiation budget (longwave and shortwave), and therefore the snow and ice mass balance, and how does that role change through the seaso ns?
  - MOSAiC (2017-2018) – Multidisciplinary drifting Observatory for the Study of Arctic Clima te
    - Regional Climate Models evaluated against SHEBA radiative fluxes reveal major biases and spr eads, especially under **clouds**. Such biases can have serious implications for sea-ice concentra tions.

Cartoon from MOSAiC Introduction



Cloud



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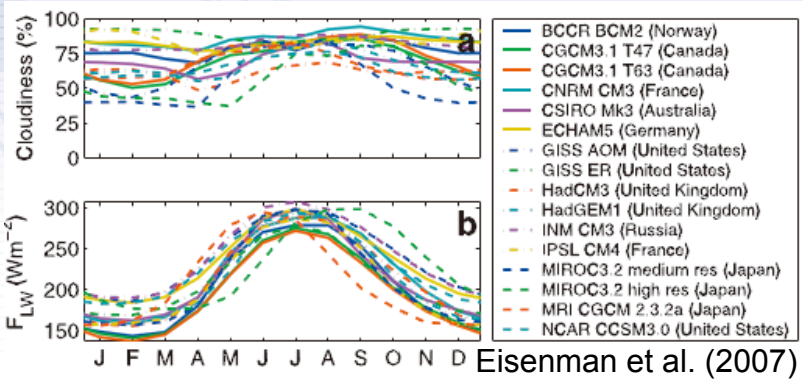
Clouds – Largest Atmospheric Source of Model Uncertainty

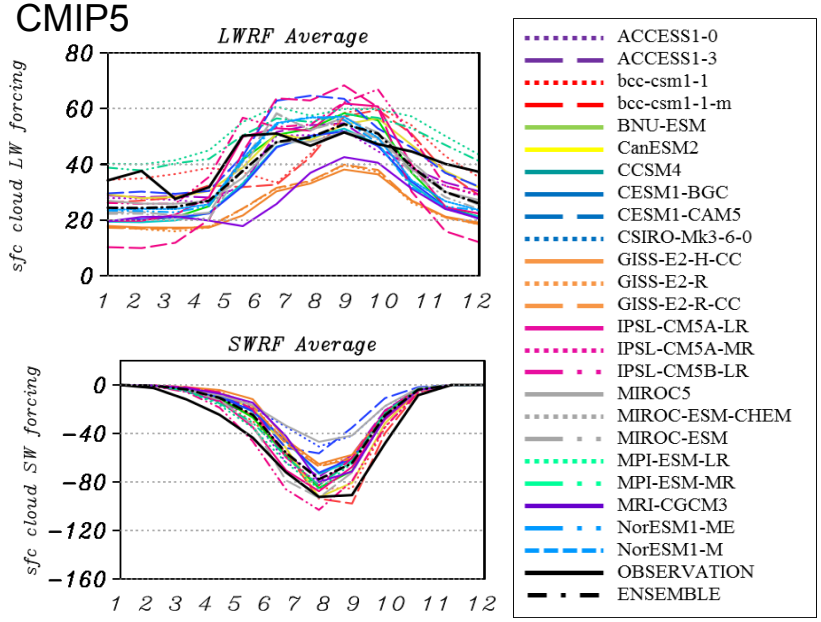
- Significantly influence the Arctic surface energy budget, thereby affecting sea ice

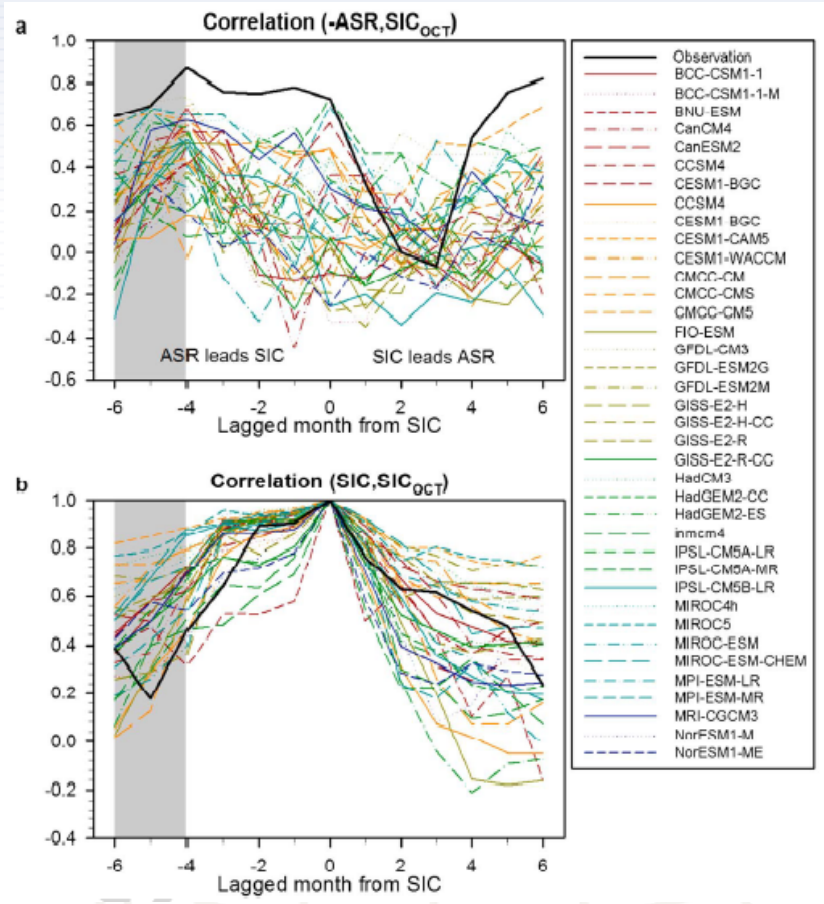
CMIP3



Eisenman et al. (2007)

CMIP5





Choi et al. (2014)

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Summary

- For the topic of sea ice and atmosphere,
  - KOPRI will enhance meteorological observations and **cloud** observing instrum ents.
  - As a legacy of the MIZ program, KOPRI will continue to observe floe-scale **dyn amic** sea ice deformation with an autonomous platform next year.
  - KOPRI atmospheric scientists will participate in N-ICE2015 to study cloud, turb ulence, sea ice energy balance, and atmospheric boundary layer.
  - KOPRI atmospheric science team will aim to have an integrated platform to stu dy **thermodynamic** sea ice – atmosphere interaction (*in situ* sea ice energy ba lance). (2016~)