PAG Climate Line Workshop 2015 (TUMSAT, Tokyo, Japan)

Updates – atmosphere and sea ice researches

Joo-Hong Kim

Division of Climate Change, Korea Polar Research Institute

KOPRI 극지연구소

KOPRI

Korea Polar Research Institute

Summary (2014 fall meeting, Seattle)

- For the topic of sea ice and atmosphere,
  - KOPRI will enhance meteorological observations and **cloud** observing instruments.
  - As a legacy of the MIZ program, KOPRI will continue to observe **floe-scale dynamic** sea ice deformation with an autonomous platform next year.
  - KOPRI atmospheric scientists will participate in **N-ICE2015** to study cloud, turbulence, sea ice energy balance, and atmospheric boundary layer.
  - KOPRI ~~atmospheric~~ physical scientists will aim to have an integrated platform to study **thermodynamic** sea ice – atmosphere – ocean interaction (& sea ice energy balance). (2016??~)

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On-board atmospheric observation

- Basic meteorological variables
  - pressure, temperature, wind speed & direction, 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

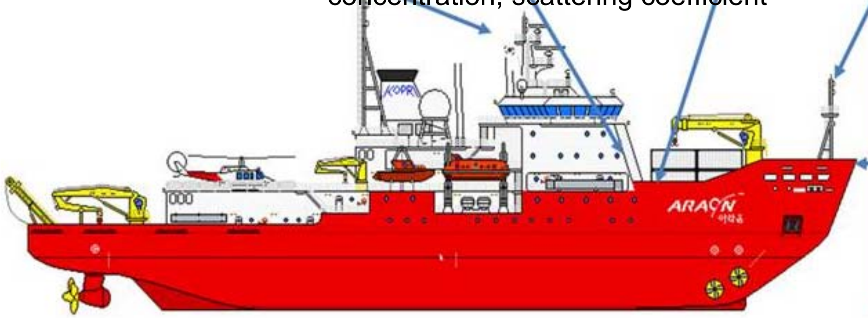
Atmospheric Sciences Lab. (03Deck)
CPC
Aethalometer
Nephelometer

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

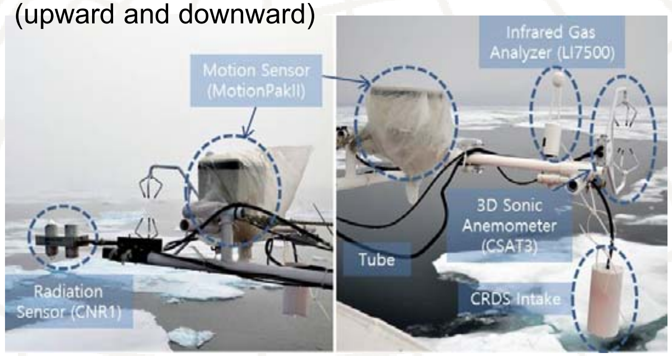
Foremast (29.8m)
Windmill Anemometer
(031050-L)

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

- 4-component radiations
  - shortwave and longwave radiations (upward and downward)



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



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

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

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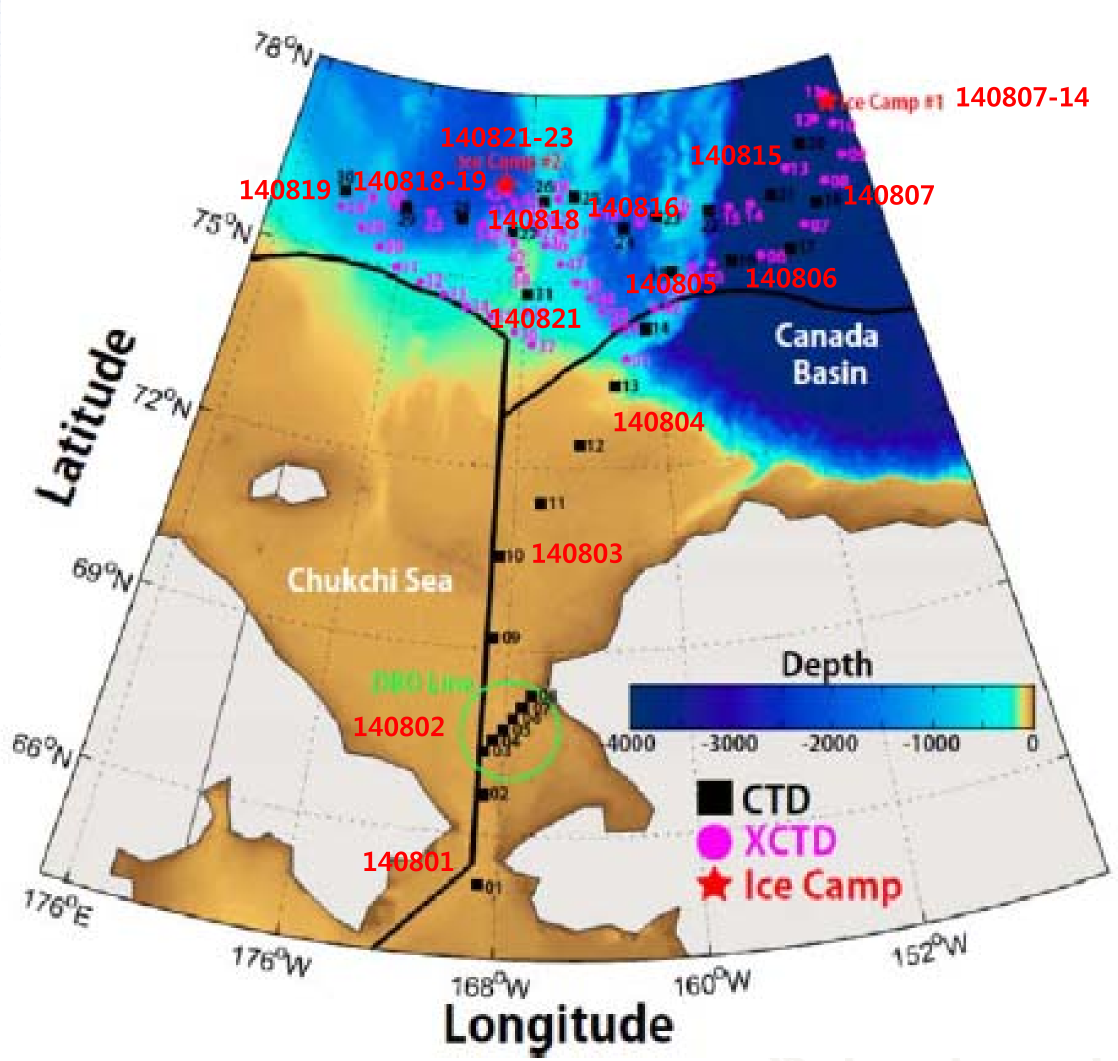
2014 Araon Arctic cruise (Leg 1)

- 2014.07.30 ~ 2014.08.25



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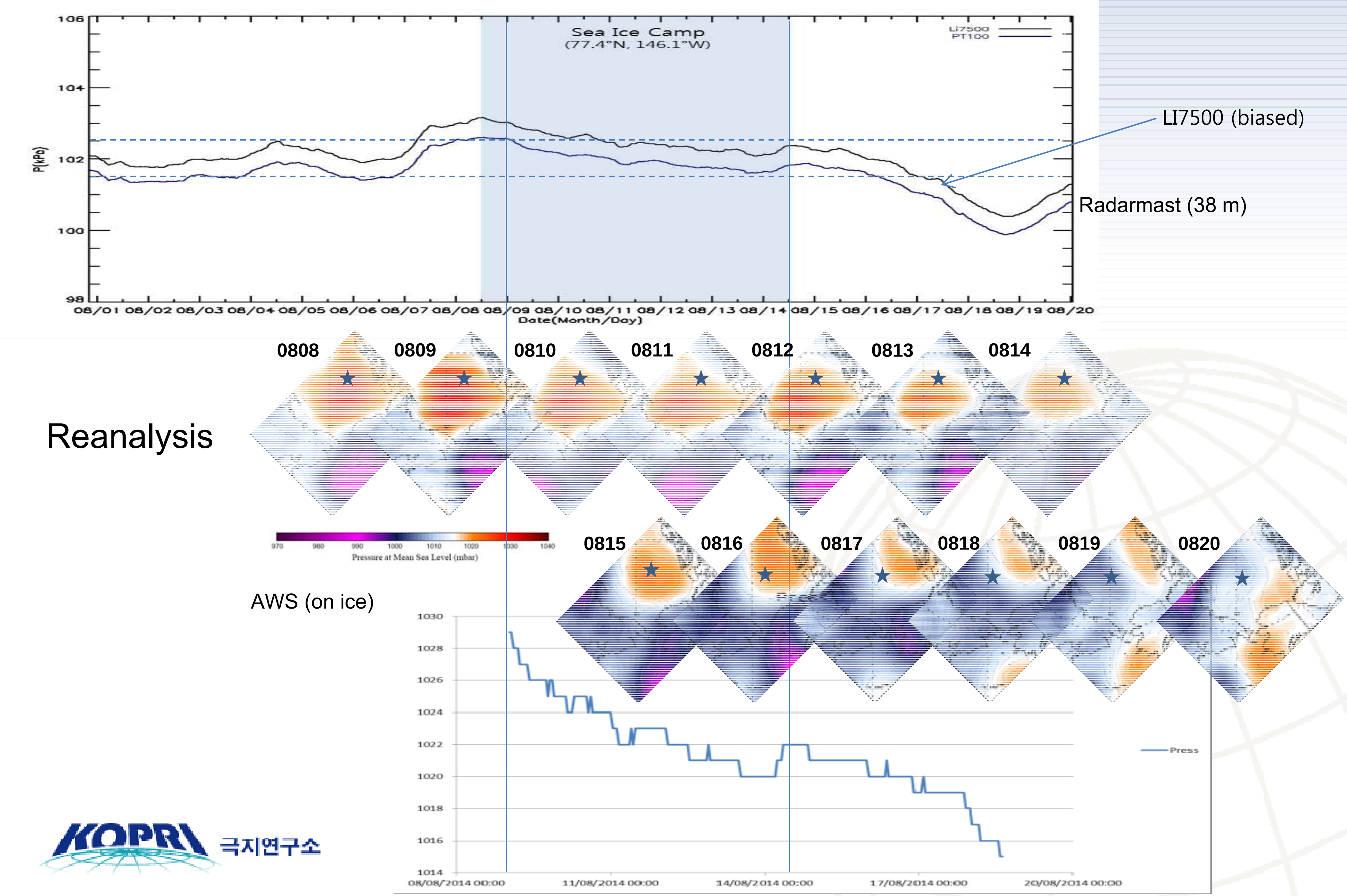
Meteorological Data (Air Pressure)



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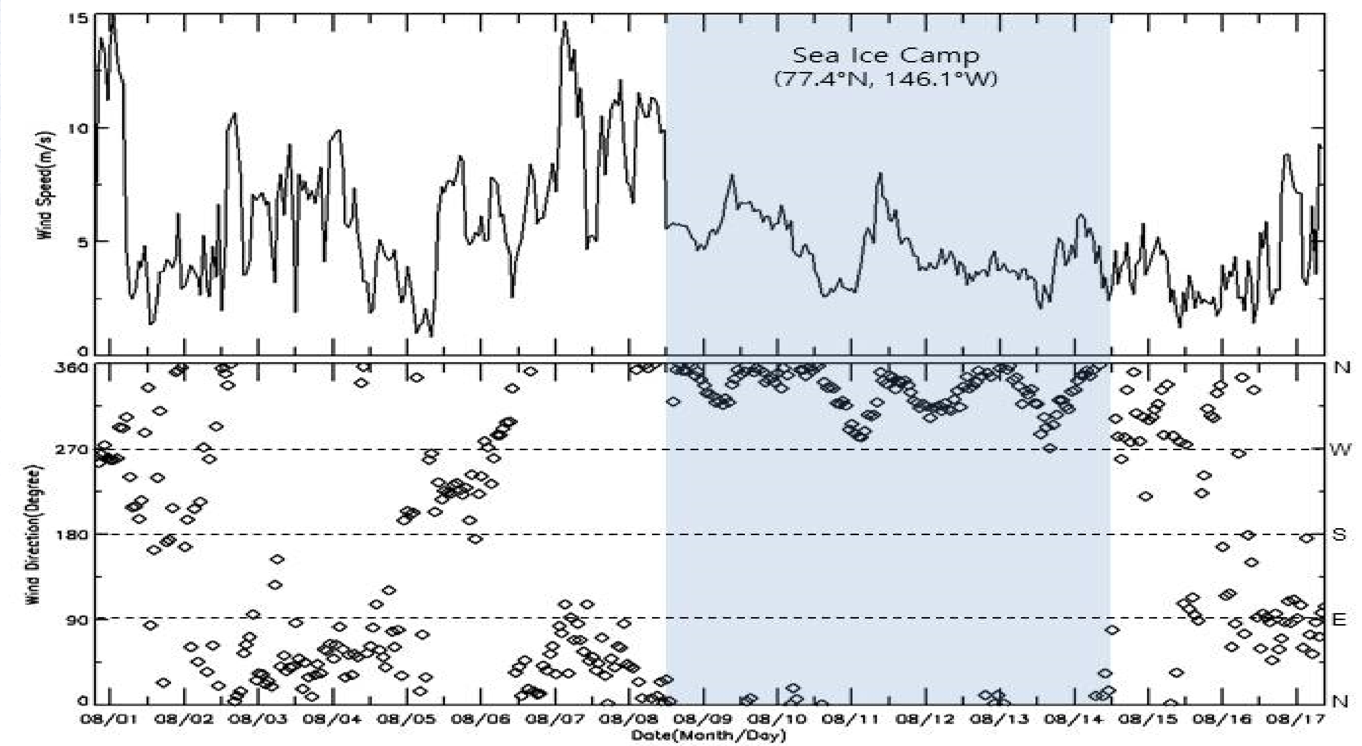
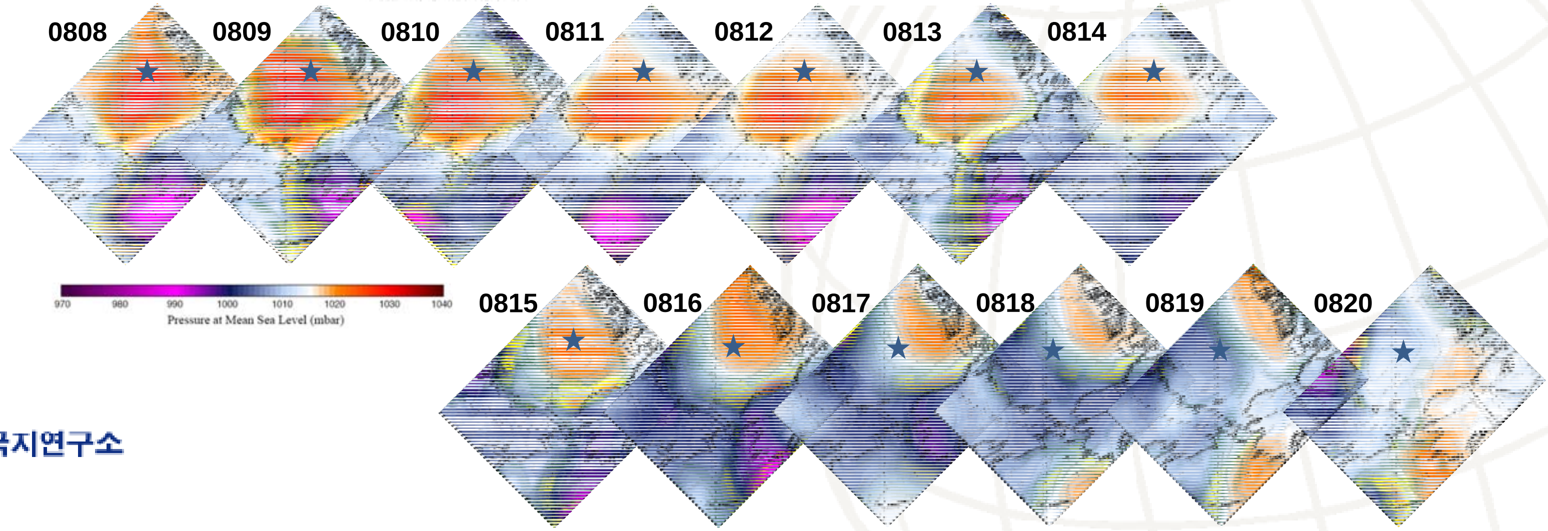
Meteorological Data (Wind)



Foremast (29.8 m)

Reanalysis



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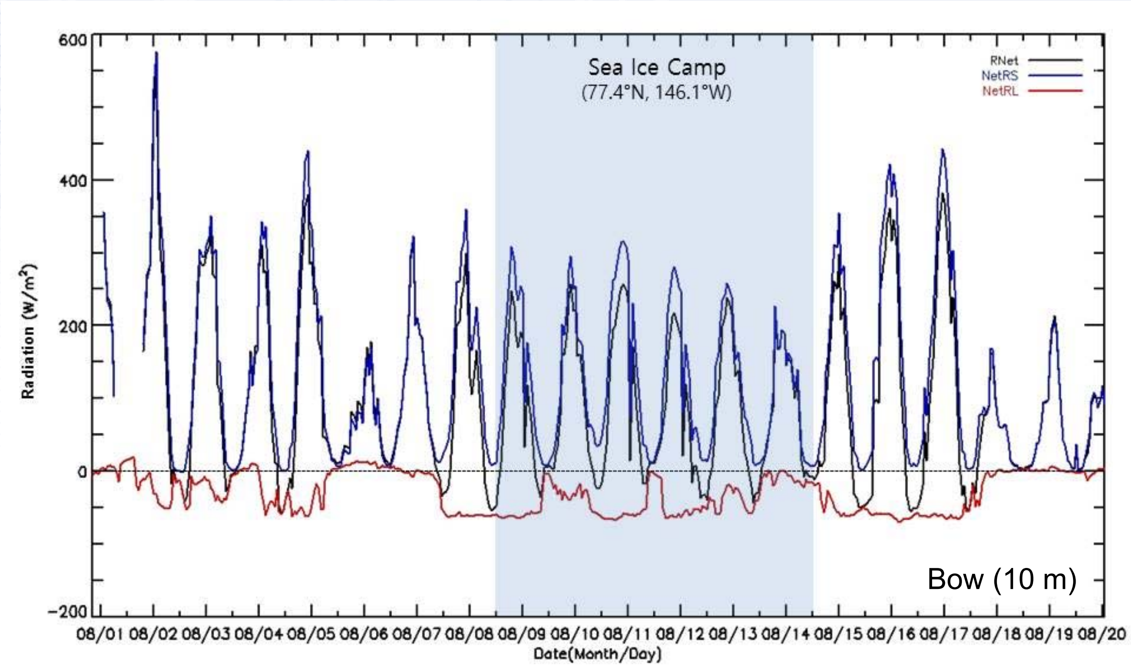
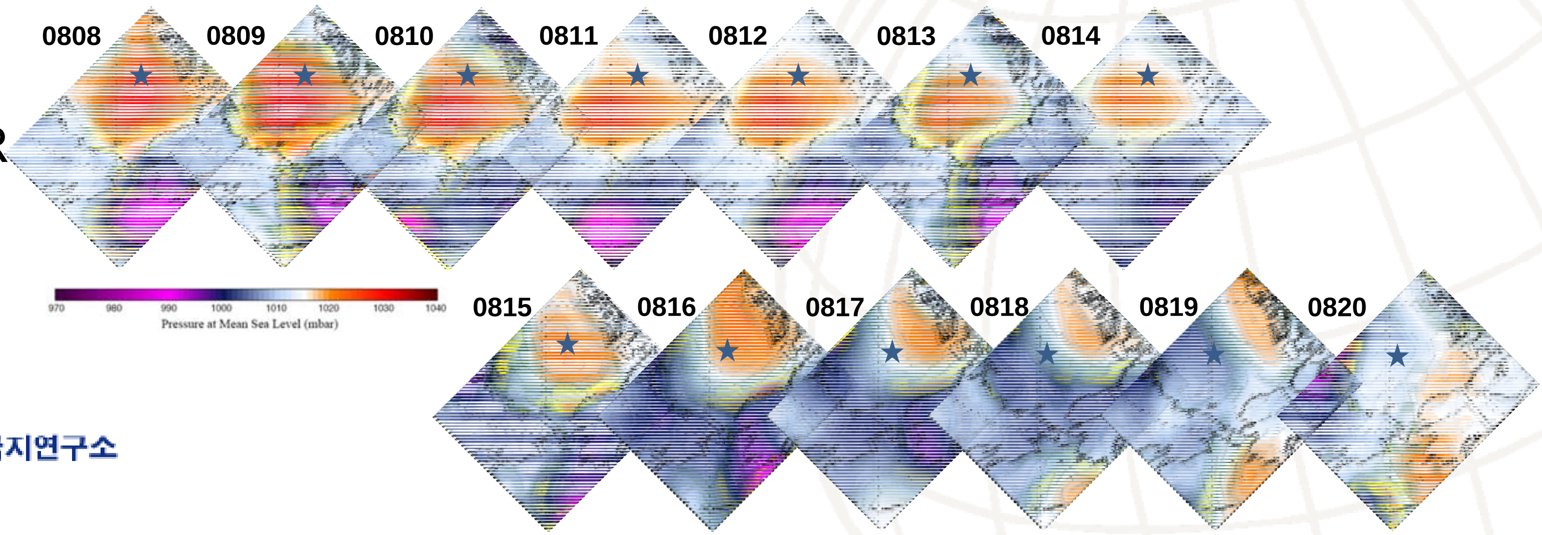
Meteorological Data (Net Radiation)



NCEP CFSR



극지연구소

nced atmospheric observations (vertical profiles & clouds)

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

ast (38m)
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& RH (HMP45D)
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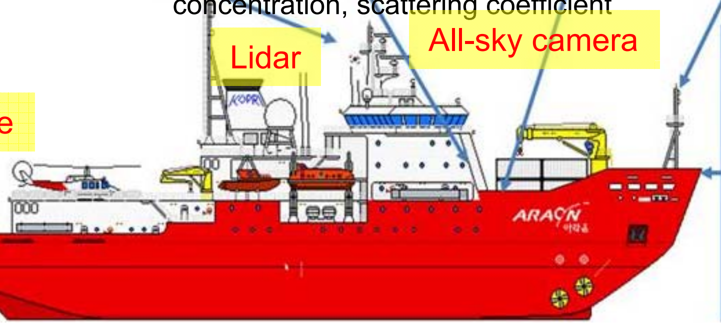

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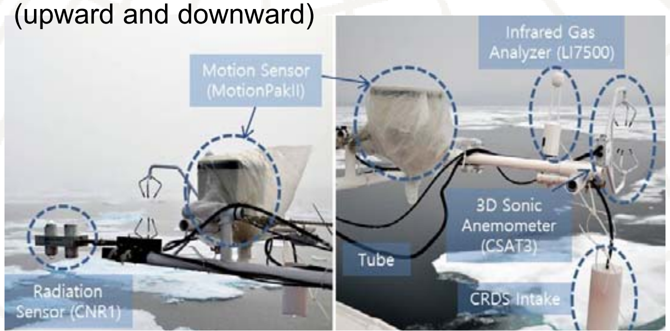
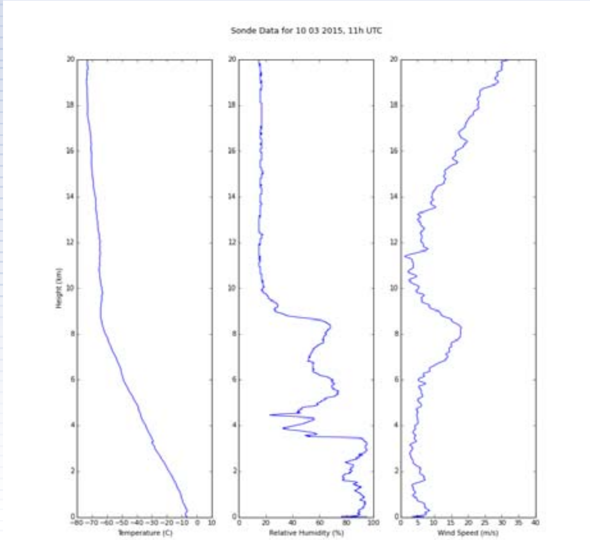
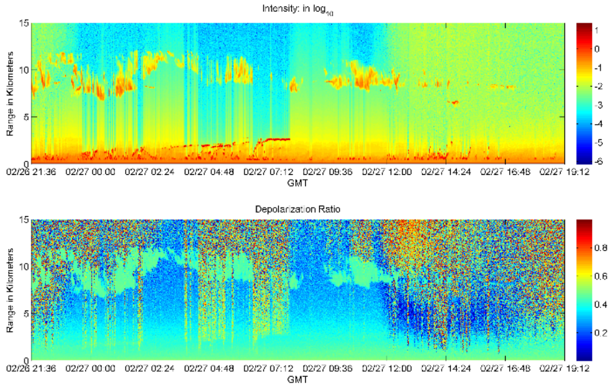


d observations

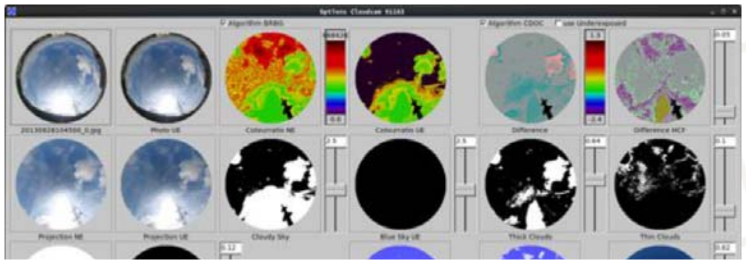
sonde



(Laser Radar)



y camera



necessary?

s far…

- Only routine on-board surface observations along the ship track
- No atmospheric field scientists mainly involved in the Pacific Arctic met observation

e coming years, under the auspices of PAG climate line…

- Enhance on-board measurements of upper atmosphere & clouds
- Participate in the internationally coordinated observation supportive of the **YOPP** nitiative
- Try a sea ice-based observing platform for the ice-atm-ocn interaction with scientific motivations and organized international collaboration (e.g., MOSAiC)

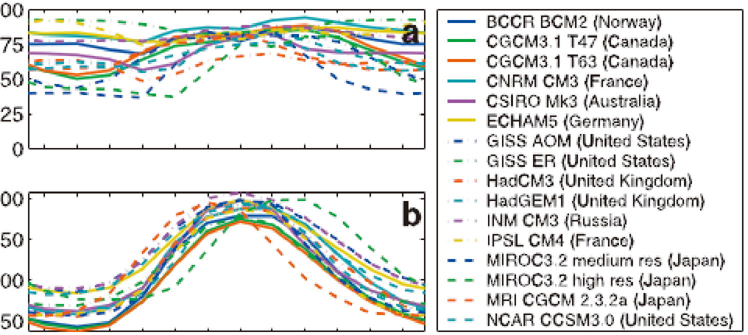
ed observing components

- **Atmospheric vertical profiles** to study characteristics of atmospheric stability, cloud, and moisture distribution under different synoptic backgrounds and to be used to evaluate numerical model predictability
- **Clouds** (cover, height, optical thickness, etc.) as a key factor to control the surface radiative fluxes
  - Clouds can respond to the change in Arctic surface type (open ocean, marginal ice zone, ice

s – Largest Atmospheric Source of Model Uncertainty

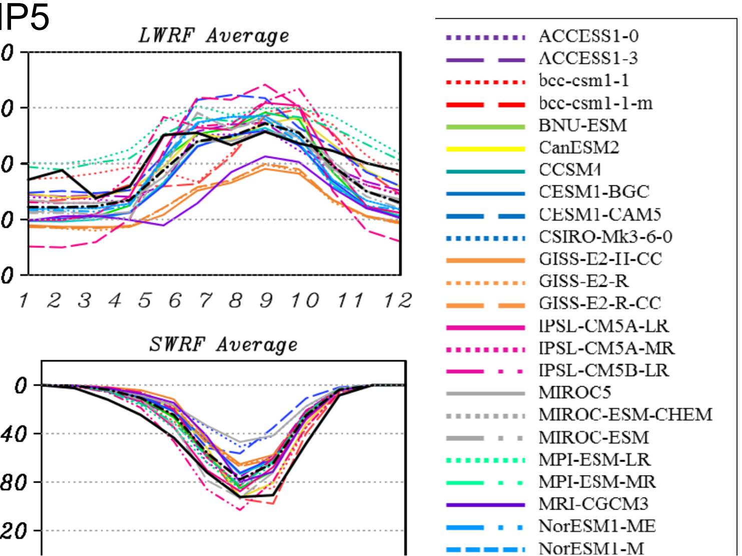
ificantly influence the Arctic surface energy budget, thereby affecting sea ice

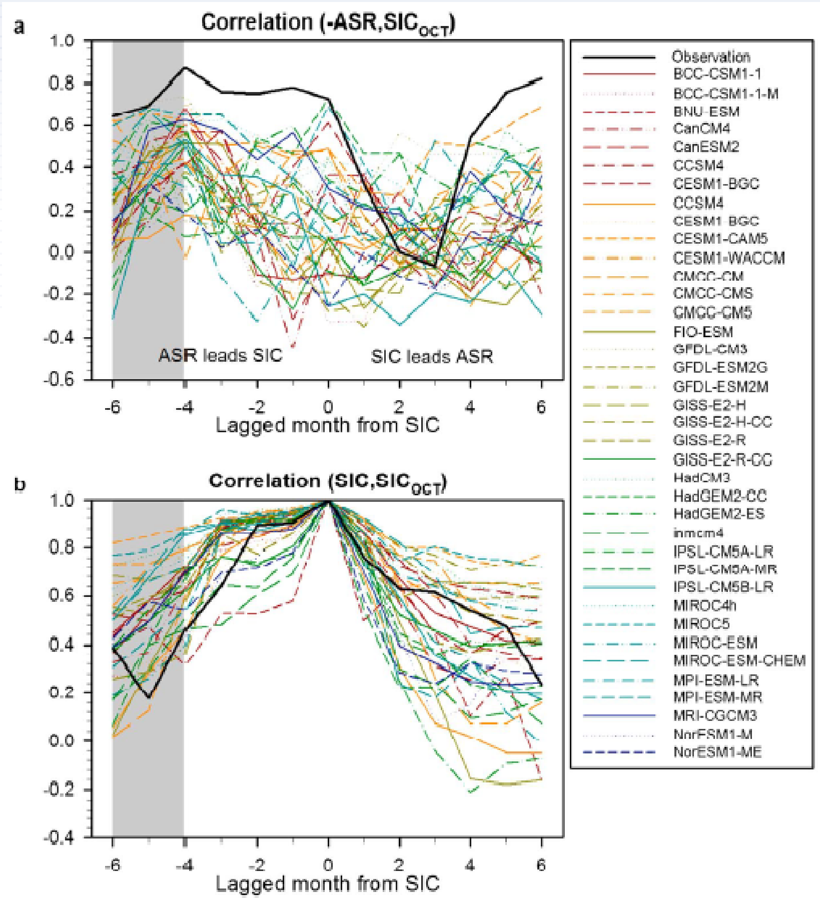
IP3



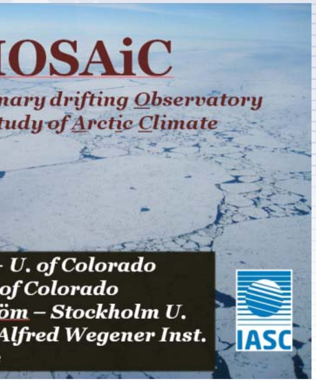
Eisenman et al. (2007)

IP5

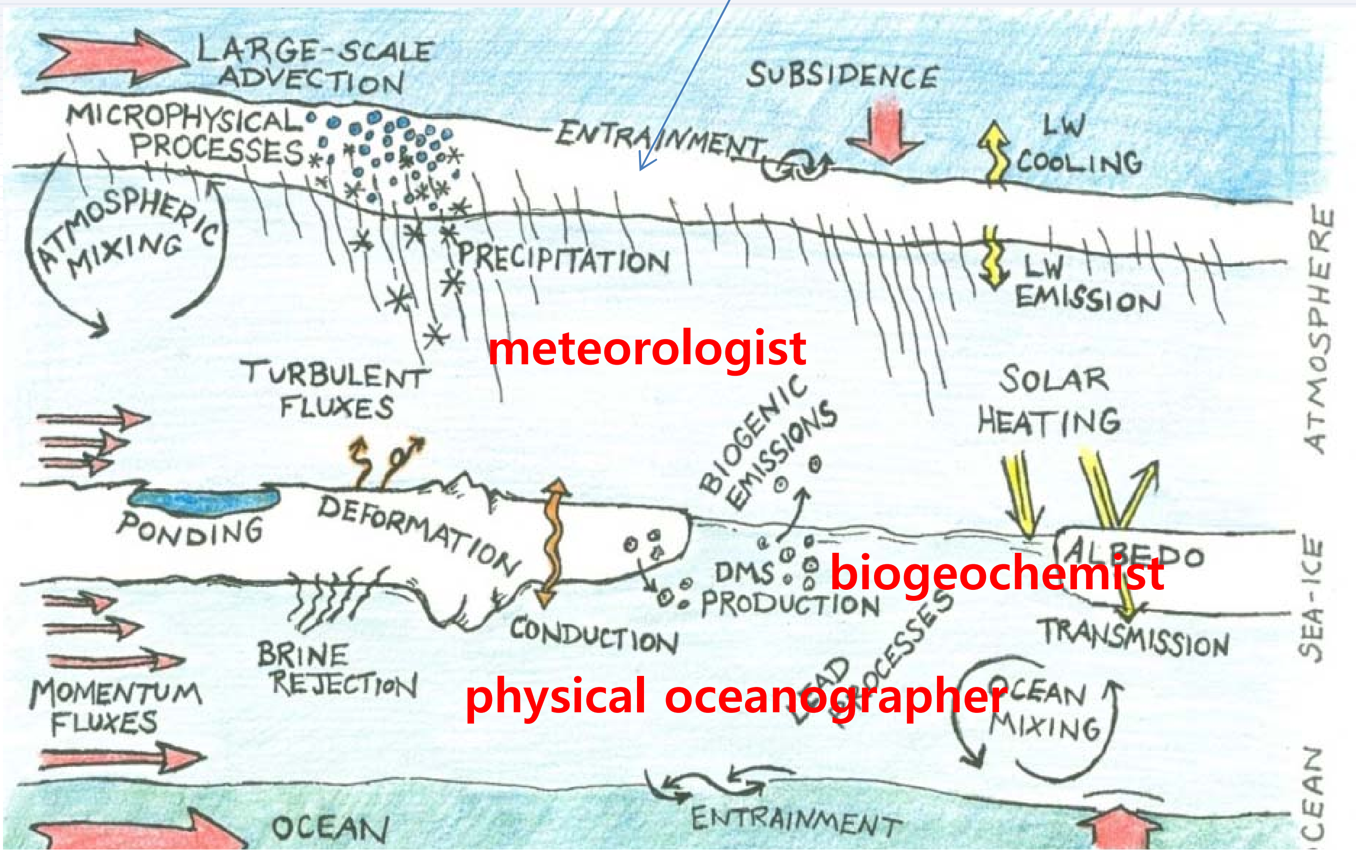




oon from MOSAiC Introduction



Cloud

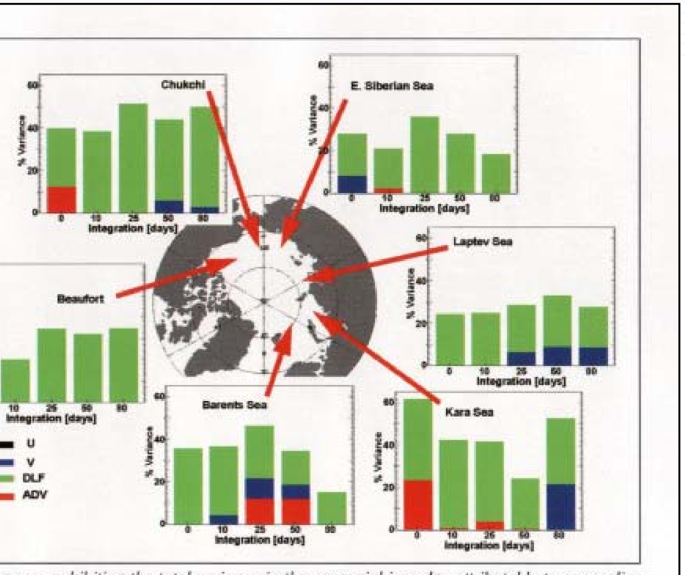


ts from satellite data provide us a nice motivation…

malies and trends in the downwelling **longwave radiation flux** have been cated as important drivers of perennial sea ice loss [Francis and Hunter, 2006]

osorbed solar radiation in early summer plays a precursory role in rmining the Artic sea ice concentration in late summer [Choi et al., 2014]

nall changes in the cloud-radiative forcing fields can play a significant role as a ate feedback mechanism [Ramanathan et al., 1989]



grams exhibiting the total variance in the perennial ice edge attributable to anomalies arameters, integrated backward in time from the date of maximum ice retreat. Colors portion contributed by each forcing parameter.

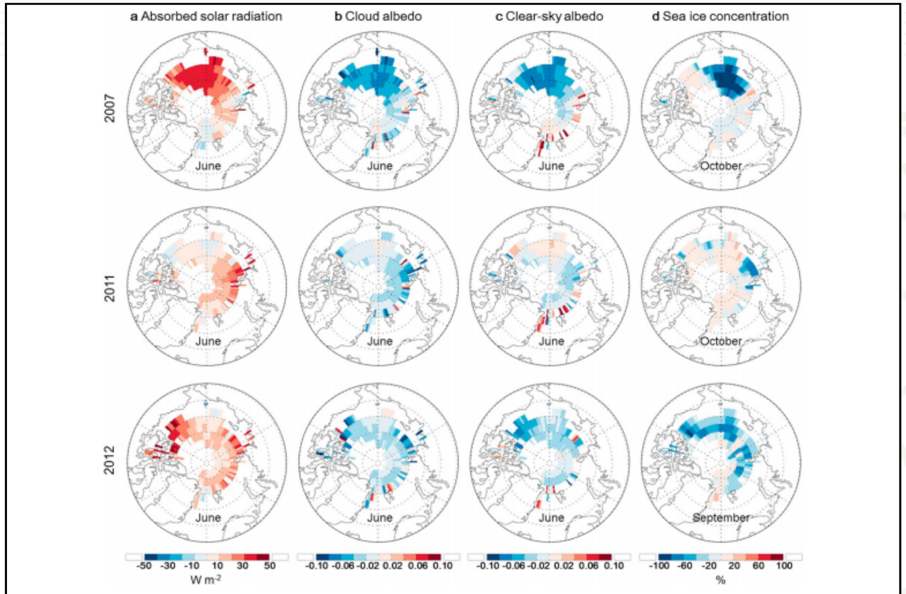


Figure 1. Regional distribution of the anomalies of (a) absorbed solar radiation (ASR), (b) the cloud albedo, and (c) the clear-sky albedo, all for June 2007, 2011, and 2012, and (d) sea ice concentration (SIC) for October 2007 and 2011 and September 2012. In these years, record-breaking minimal SIC was observed. Note that these figures do not include the regions where total SIC for August, September, and October were less than 15% or the regions with permanent SIC throughout the year.

ce Cloud Radiative Forcing (SCRF)

$$\text{SCRF} = \text{NetSW\_CRF} + \text{NetLW\_CRF}$$
$$= (\text{NetSW} - \text{NetSW}_{cs}) + (\text{NetLW} - \text{NetLW}_{cs})$$

⇓ After some manipulation

$$= (SW\downarrow - SW_{cs}\downarrow)\cdot\cancel{(1-\alpha)} + (LW\downarrow - LW_{cs}\downarrow)$$

[Ramanathan et al., 1989]

ce SW Cloud Rad. Forcing
ud shield ~~& Surface albedo effects~~ (Cooling)
Always negative

Surface LW Cloud Rad. Forcing
= Greenhouse effect (Warming)
Always positive

- Surface SW CRF ↓ ⇒ Cloud shield effect↑, ~~Surface albedo effect↓~~
- Surface LW CRF ↑ ⇒ Cloud shield effect↑

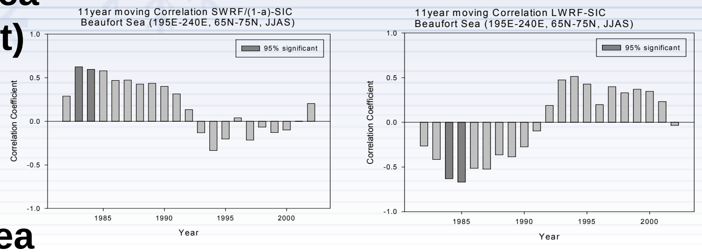
Caution: For SW, ↓ indicates more negative (i.e., the increase of absolute value)

$SW\downarrow$: Surface downwelling shortwave radiation [W/m^2]
$SW_{cs}\downarrow$: Clear-sky surface downwelling shortwave radiation [W/m^2]

running cor. (CRF & SIC) 1982-2012 JJAS

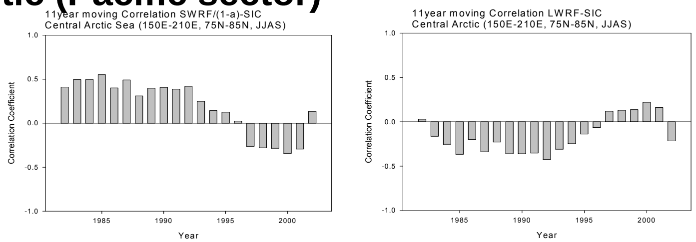
SW_CRF LW_CRF

Sea ast)



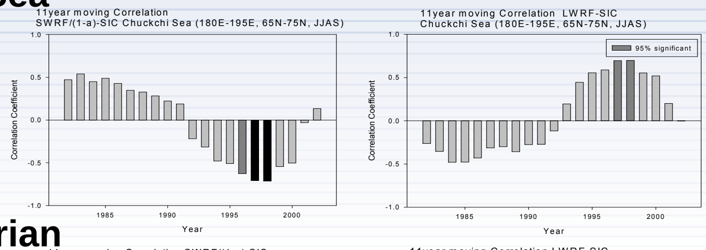
Sea basin)

rctic (Pacific sector)

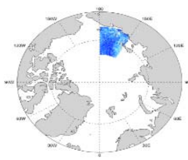


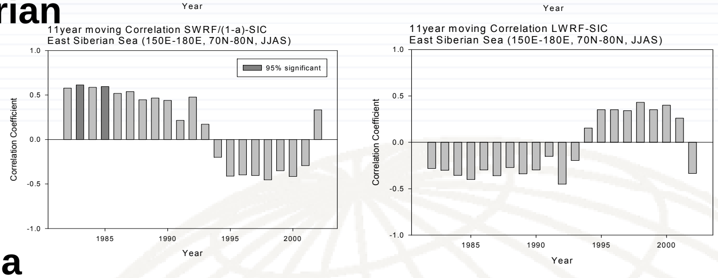
SW_CRF LW_CRF

Chukchi Sea

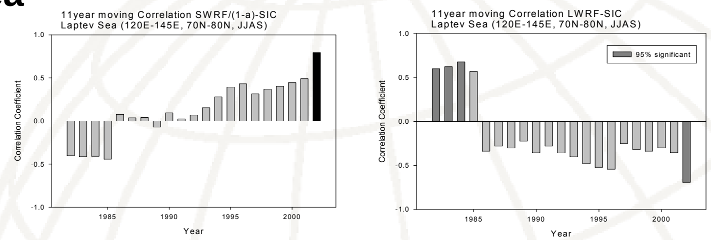


East Siberian





Laptev Sea



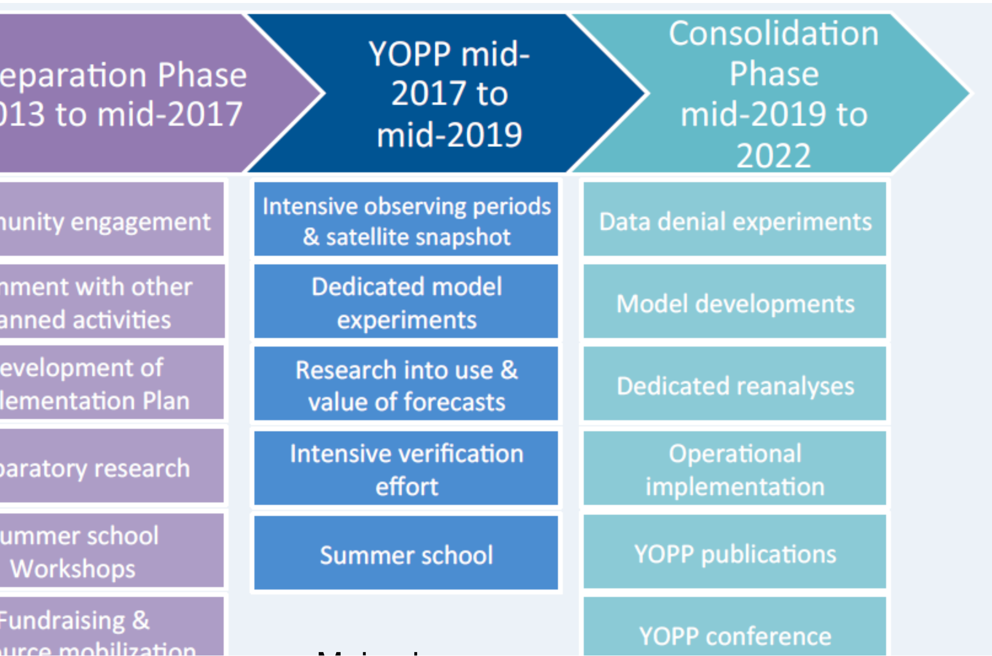
relationship between sea ice concentration (SIC) and cloud radiative forcing F) show large decadal changes

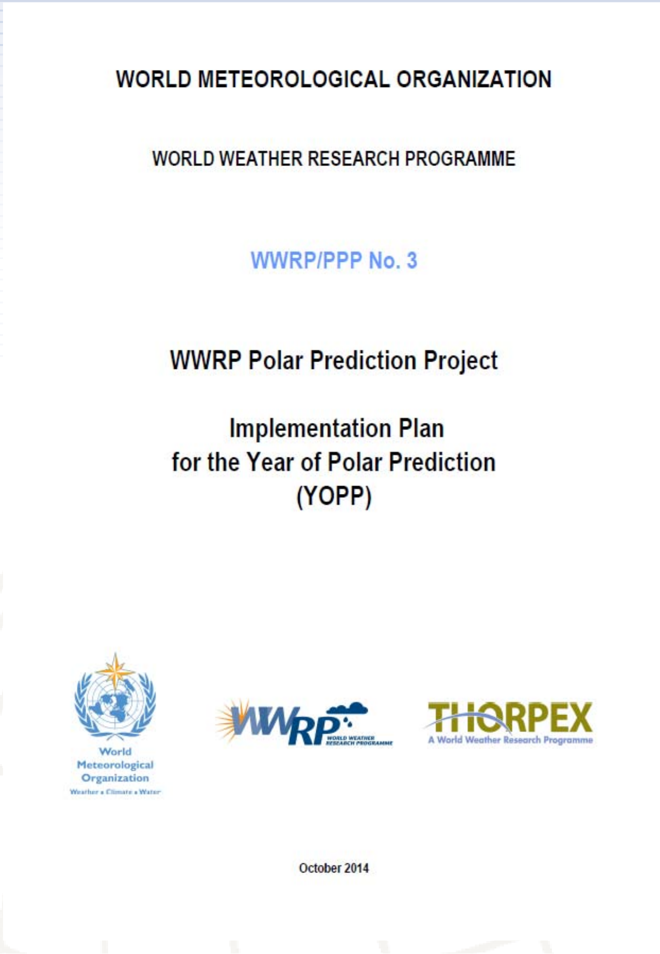
sible attributing factors: clouds response to the changing surface condition

P (Year of Polar Prediction)

xtended period of coordinated intensive ervational and modelling activities, in order to ove prediction capabilities for the polar regions beyond, on a wide range of time scales from s to seasons

y element of the WWRP-PPP





WORLD METEOROLOGICAL ORGANIZATION

WORLD WEATHER RESEARCH PROGRAMME

WWRP/PPP No. 3

WWRP Polar Prediction Project

Implementation Plan
for the Year of Polar Prediction
(YOPP)

World Meteorological Organization

THORPEX
A World Weather Research Programme

October 2014

rvational support

ON-based

- Met observation and radiosonde sounding for Arctic summer
- Met observation and radiosonde sounding for Antarctic summer at Ross Sea and/or Amundsen Sea
- ce-tethered buoys in the Arctic

c land-based

- Dasan station: N/A (Met data from Norway and German stations including T, q profile)
- Svalbard (Hopen?) site: U,T,Q profile (wind lidar and MW radiometer) since 2017 summer? + additional sounding?
- Russian (Baranova?) site: support AARI frequent sounding? (limited period 2017, 2018?)

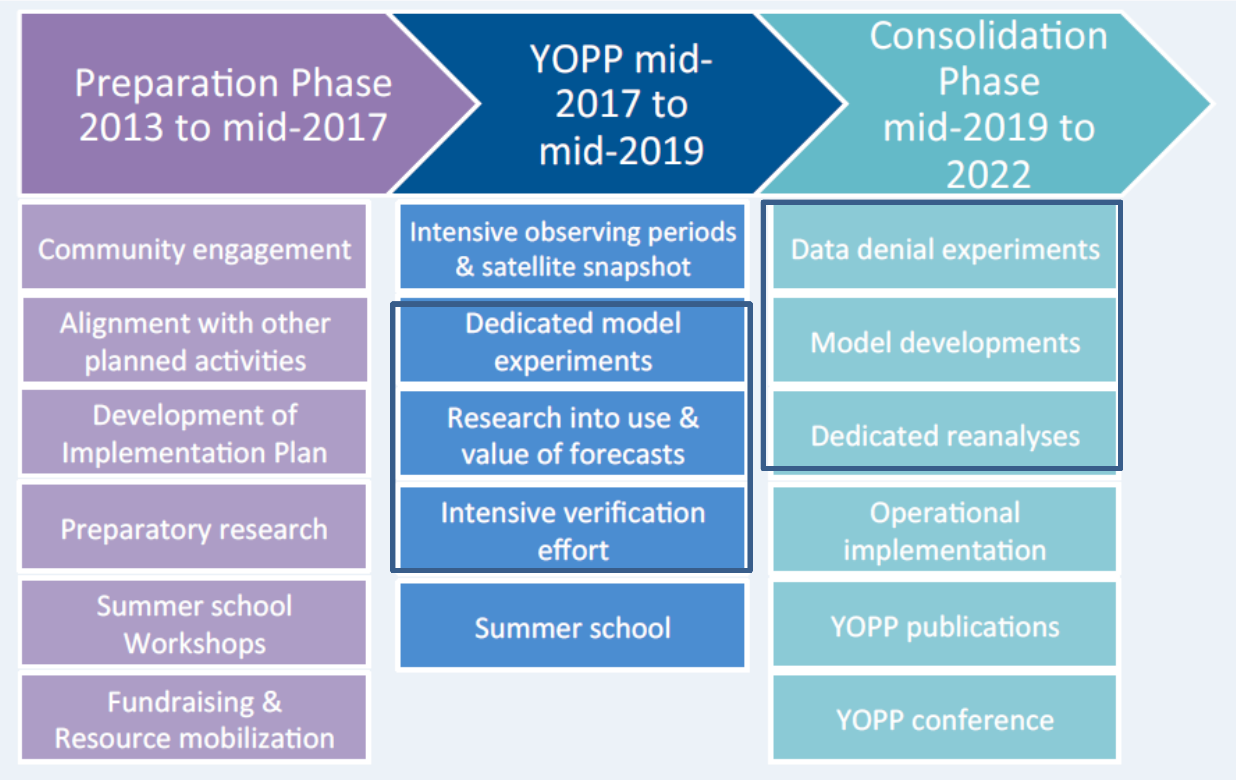
rctic land-based

- Sejong station: radiosonde sounding (2018?)
- Jangbogo station: frequent radiosonde sounding (2018?)

ing support

act of the intense observation data on the predictability

yses of model performance in various aspects (cloud, ABL, sea ice etc.)

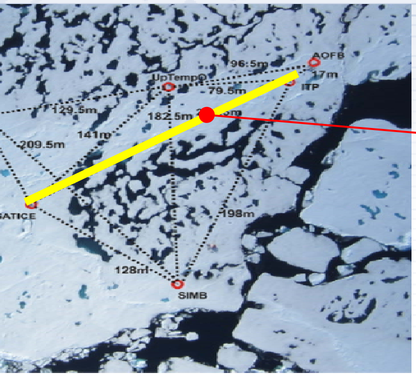


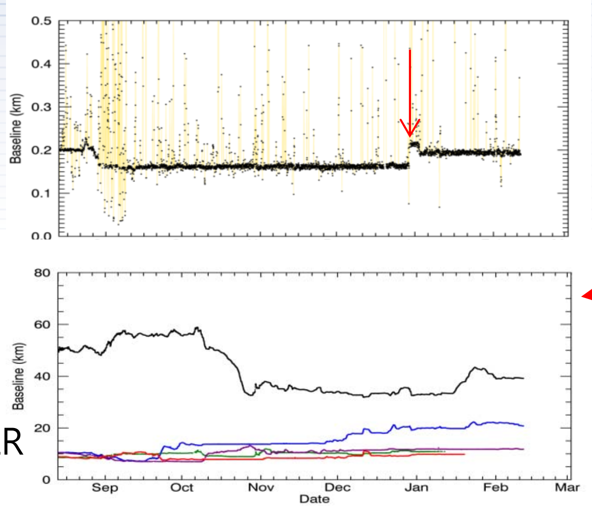
a ice dynamics – effects of scales on deformation

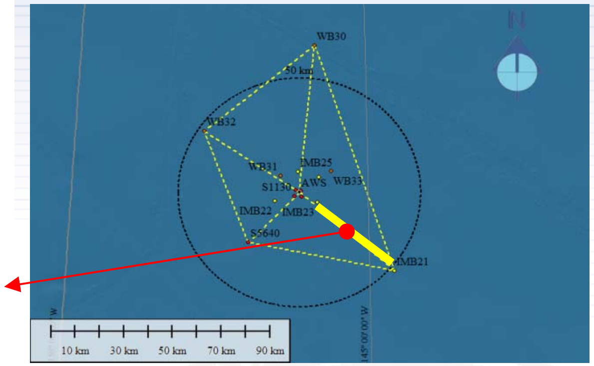
Phil Hwang, SAMS, Pedro Elosegui, ICM-CSIC/MIT, Jeremy Wilkinson, BAS

scale (< 1km) deformation

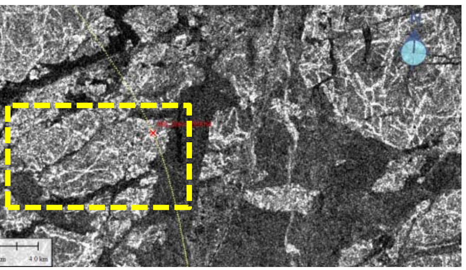
Large scale (> 1km) deformation



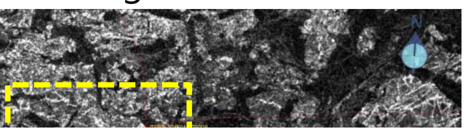




R-X image 28/Nov/2014 ©DLR



R-X image 20/Jan/2015 ©DLR

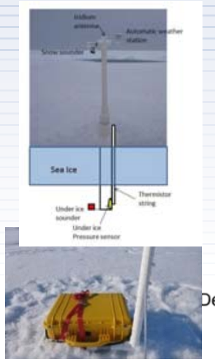


Early January the buoys deployed on the floe detected "displacement" (see red arrow above), indicating deformation of the floe. SAR images taken across this period show significant deformation of the floe (see yellow rectangles in the images on the

- ***How atmospheric forcing is related to sea ice deformation at different scales?***
- ***What is the spatial and temporal correlation across the scale?***
- ***Can we parameterize ice***

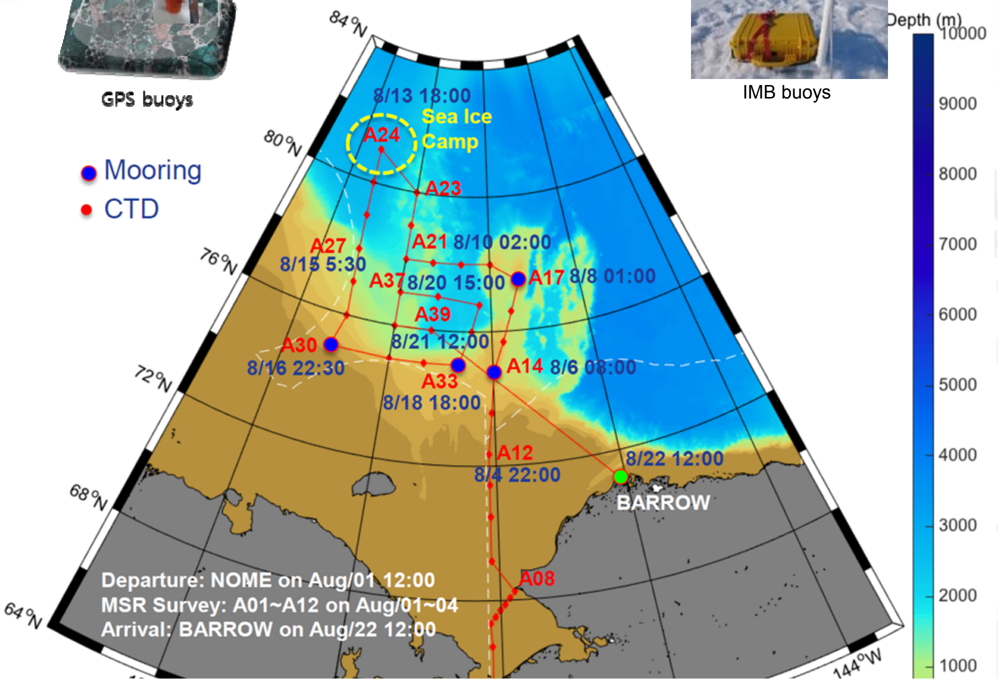
ming 2015 summer cruise

atmospheric forcing is related to sea ice deformation at different scales?



IMB buoys

- 10 KOPRI GPS
- 1 KOPRI IMB

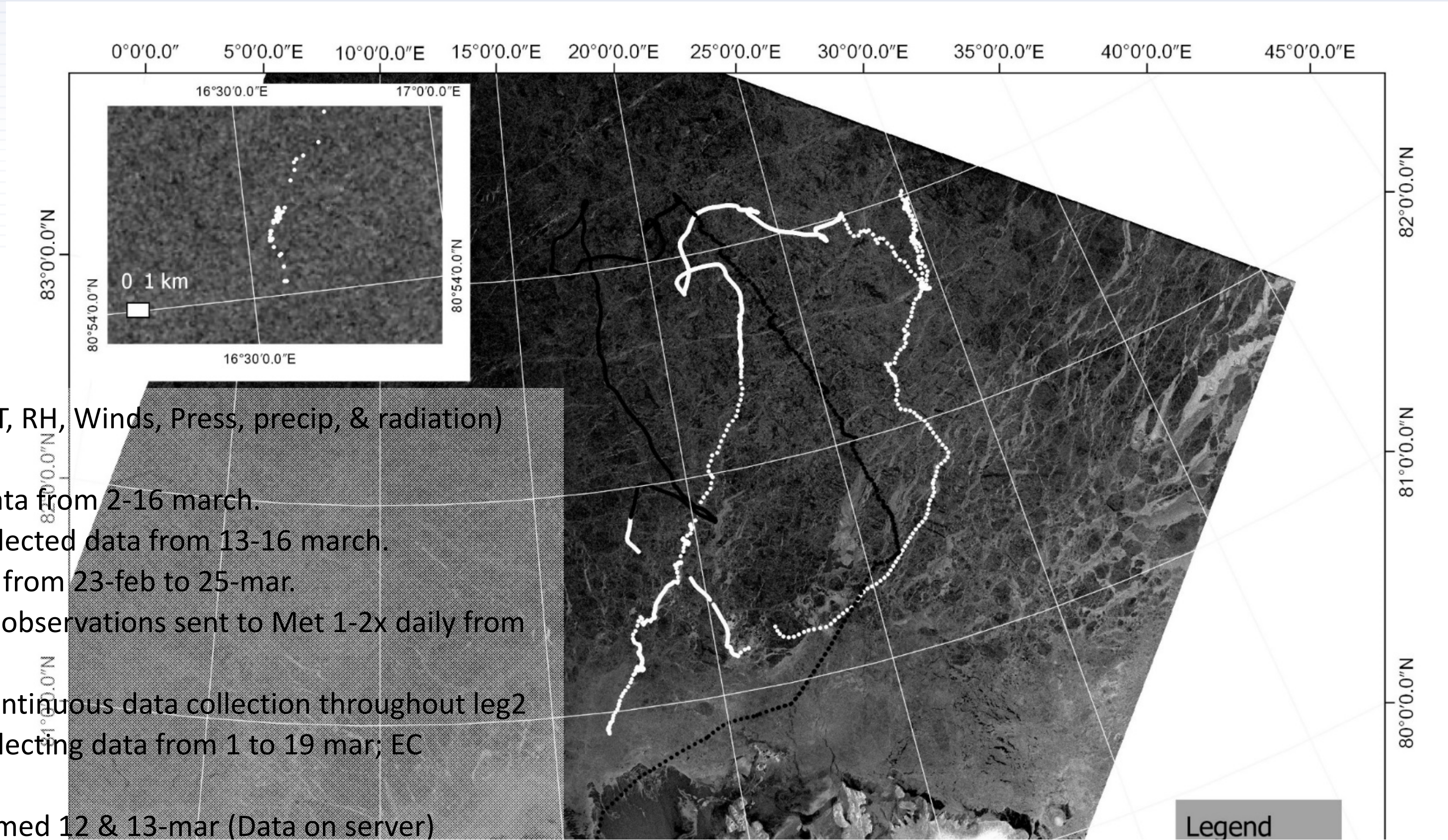


egian young sea ice cruise 2015 (N-ICE2015)

od: January to June 2015

Norwegian RV Lance

eg 1 (early January to mid-February, 2) and 2 (mid-February to late March, 2)



station data (T, RH, Winds, Press, precip, & radiation)
2-15 march.
collecting data from 2-16 march.
ne sensor collected data from 13-16 march.
des—2x daily from 23-feb to 25-mar.
eteorological observations sent to Met 1-2x daily from
24-mar.
ceilometer continuous data collection throughout leg2
filer & EC collecting data from 1 to 19 mar; EC
on 9-march
sonde performed 12 & 13-mar (Data on server)

egian young sea ice cruise 2015 (N-ICE2015)

od: January to June 2015

Norwegian RV Lance

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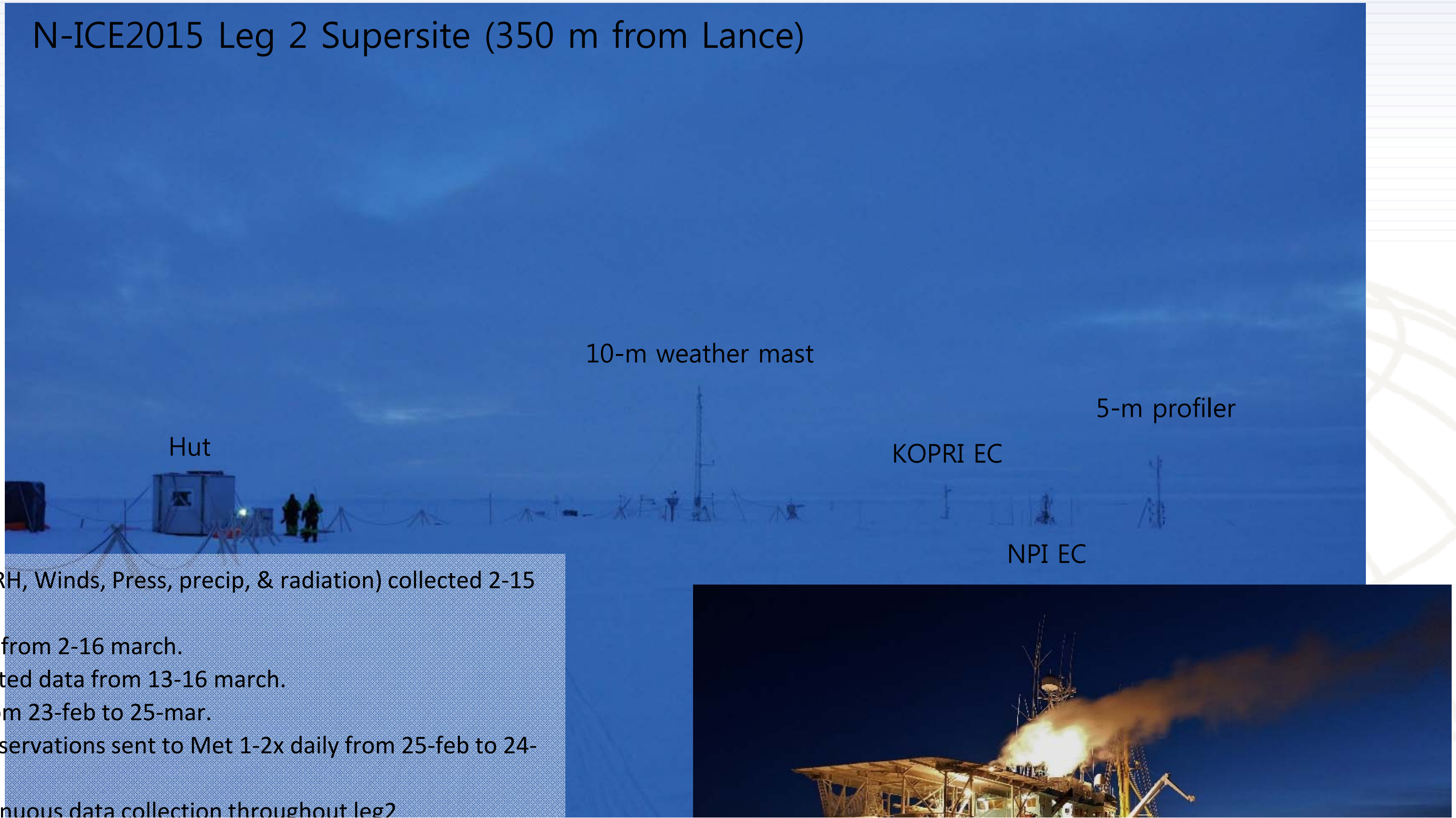

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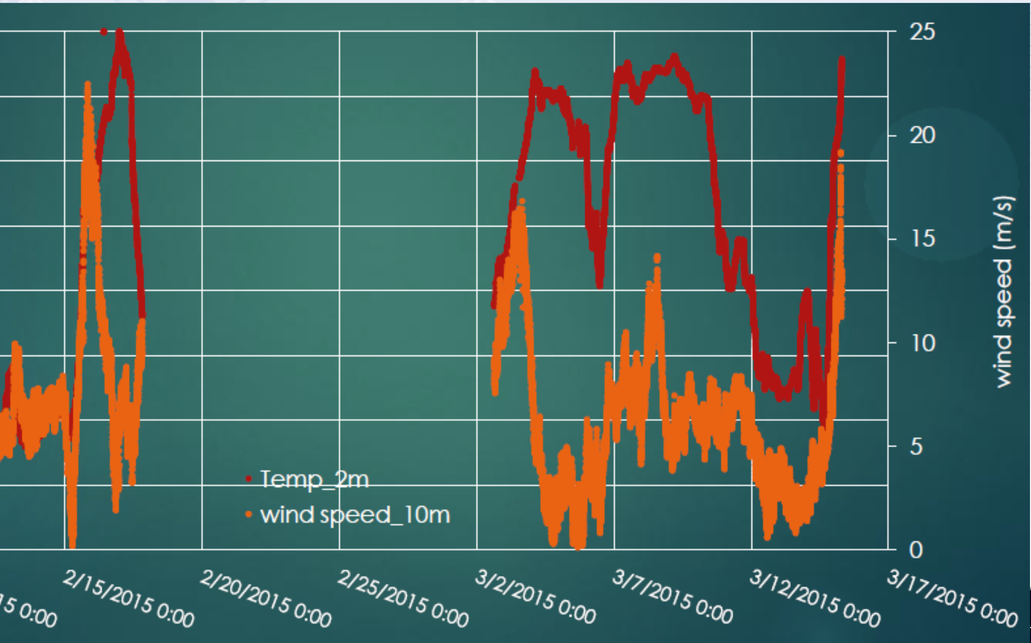
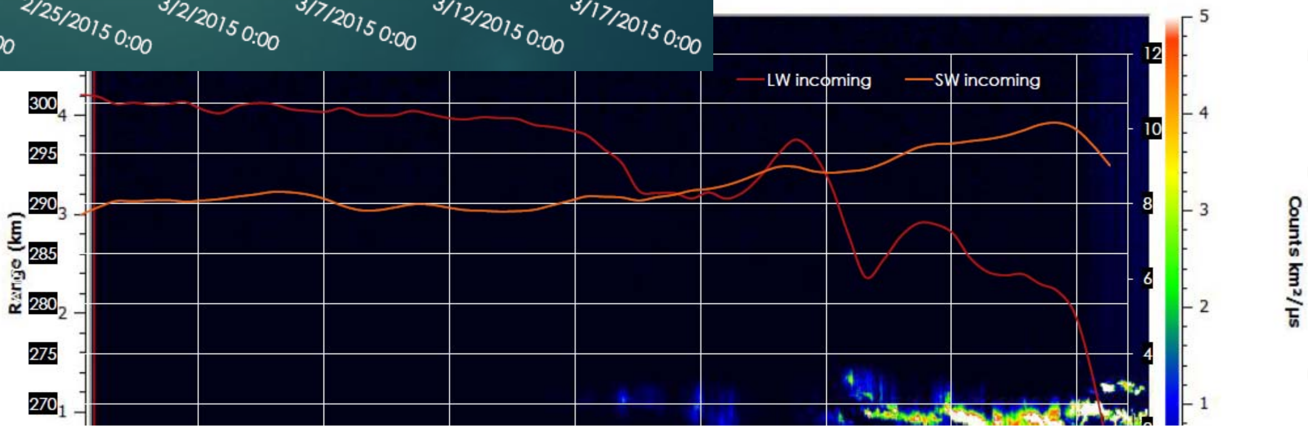
ceilometer continuous data collection throughout leg2

ul outdoor labor, polar beak attack, but lots of fun

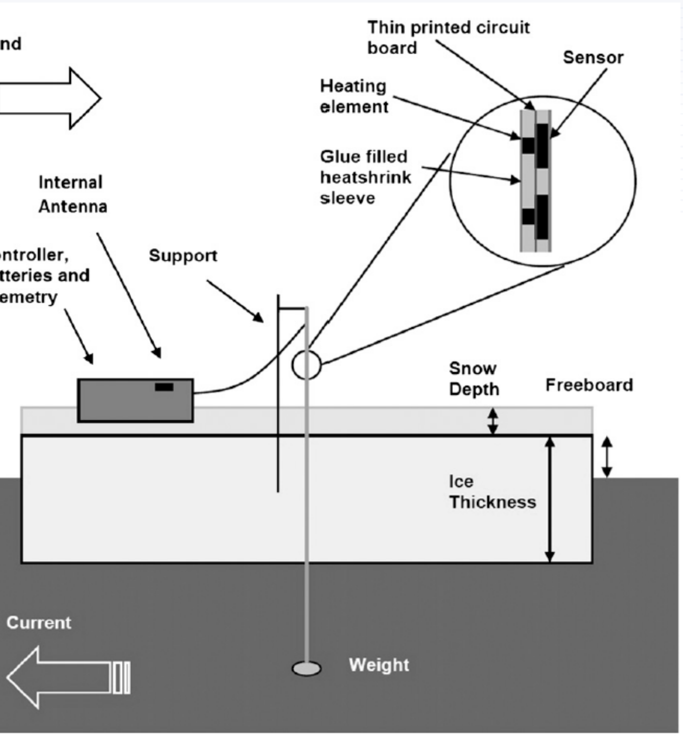
preliminary results





S Ice Mass Balance Array (SIMBA)

ected 24 IMB data (from Jeremy Wilkinson, BAS) during the MIZ campaign



G. 1. Schematic of main system components in a typical deployment. The design consists of nsor string lowered through a 2-in. drill hole through the ice and snow and connected to all Pelican Case that houses electronics, batteries, and Iridium modem.

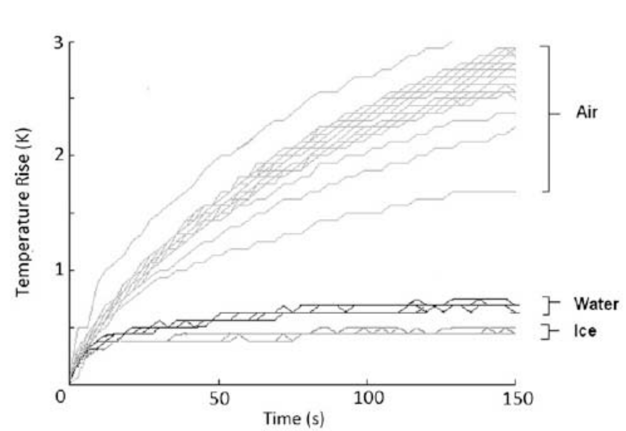
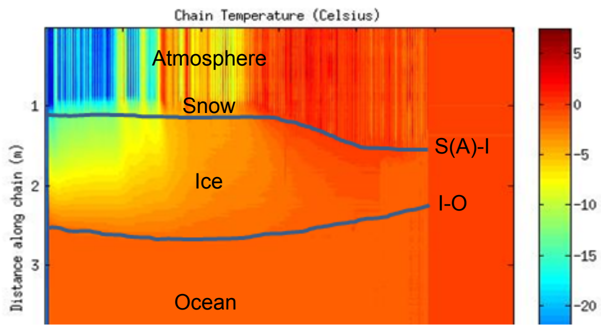


FIG. 4. Temperature rise of sensors during the heating cycle at 50% duty cycle (32 mW).

Temperature profile (MIZ_IMB04)



nary

the topic of sea ice and atmosphere,

KOPRI will enhance meteorological observations and **cloud** observing nstruments.

As a legacy of the MIZ program, KOPRI will continue to observe **floe-scale dynamic** sea ice deformation with an autonomous platform next year.

MB buoy will be continuously deployed to measure sea ice mass balance and emperature profile.

KOPRI ~~atmospheric~~ physical scientists will aim to have an integrated platform o study **thermodynamic** sea ice – atmosphere – ocean interaction (& sea ice energy balance). (2016??~)

ance on-board meteorological observations and **cloud** observing instruments
5)

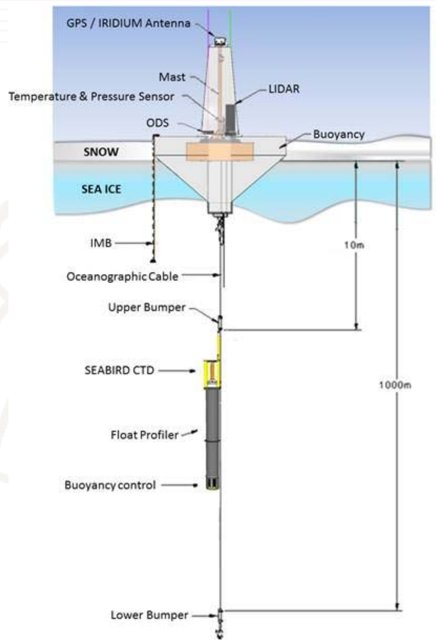
- nstall all sky camera on the top of foremast
- Re-operate on-board lidar (dual polarization lidar)
- Regular launch of a radiosonde balloon during the Arctic cruise

nomous platform to observe floe-scale **dynamic** sea ice deformation (2015)

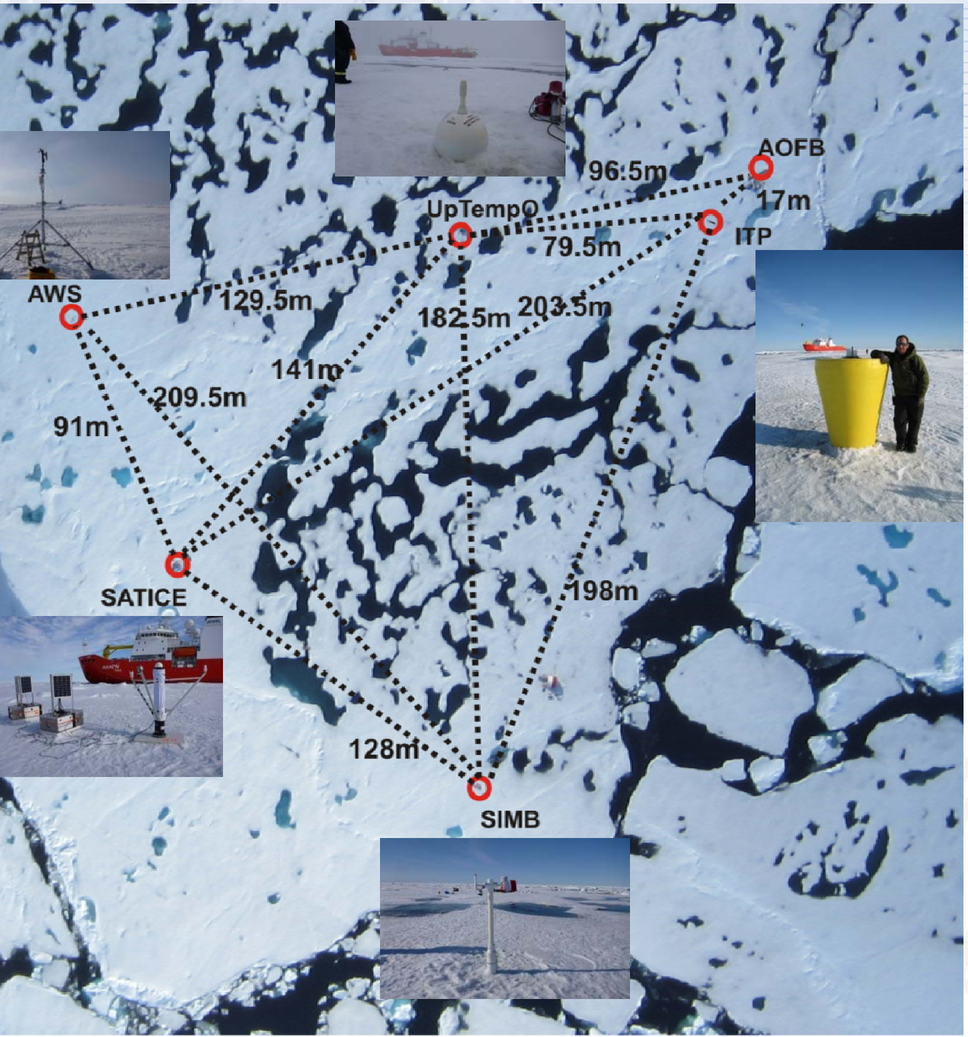
- nstrument: Array of GPS buoys
- Begin: early September (during Araon cruise)
- Target: freezing season (October – March)
- Large-scale feature: satellite SAR images

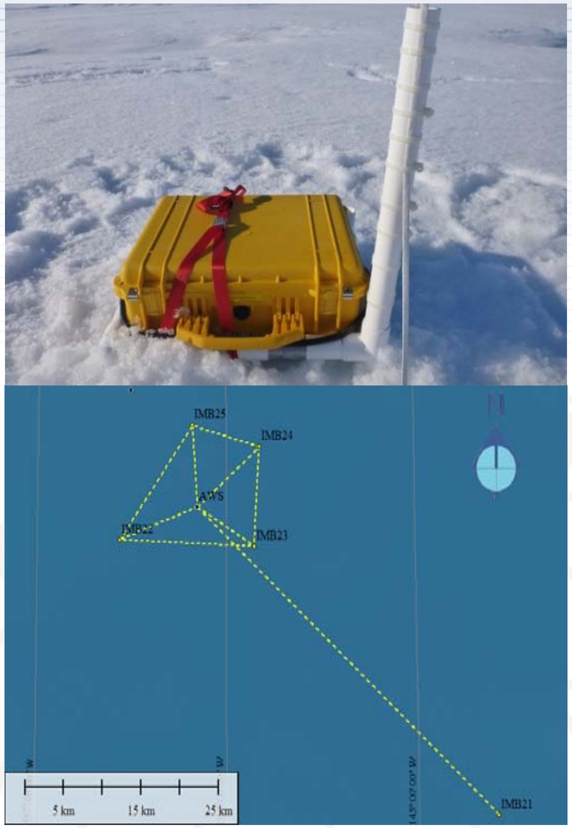
grated platform to study **thermodynamic** ice – atmosphere interaction (*in situ* sea energy balance) (2016~)

- Cloud Instruments + AOFB + IMB + ITP -> AOOS (Ice - Atmosphere - Arctic Ocean Observing System) like?
- Trackable & Recoverable - Accurate



yment of Sea Ice Buoys





Large-scale IMB array