RS Activities of KOPRI

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Ocean Color Validation and application

Aim : Improve ocean color data quality

Ocean Optics : major components of OC

 - IOPs (Inherent Optical Properties)

   Chlorophyll-a, Suspended sediment (SS),

   Absorptions by phytoplankton and colored dissolved organic matters (CDOM)

 - AOPs (Apparent Optical Properties)

   Downward irradiances and Upwelling radiance (400-800nm):

   HPRO (at Station, vertical), HSAS (during Expedition, horizontal)
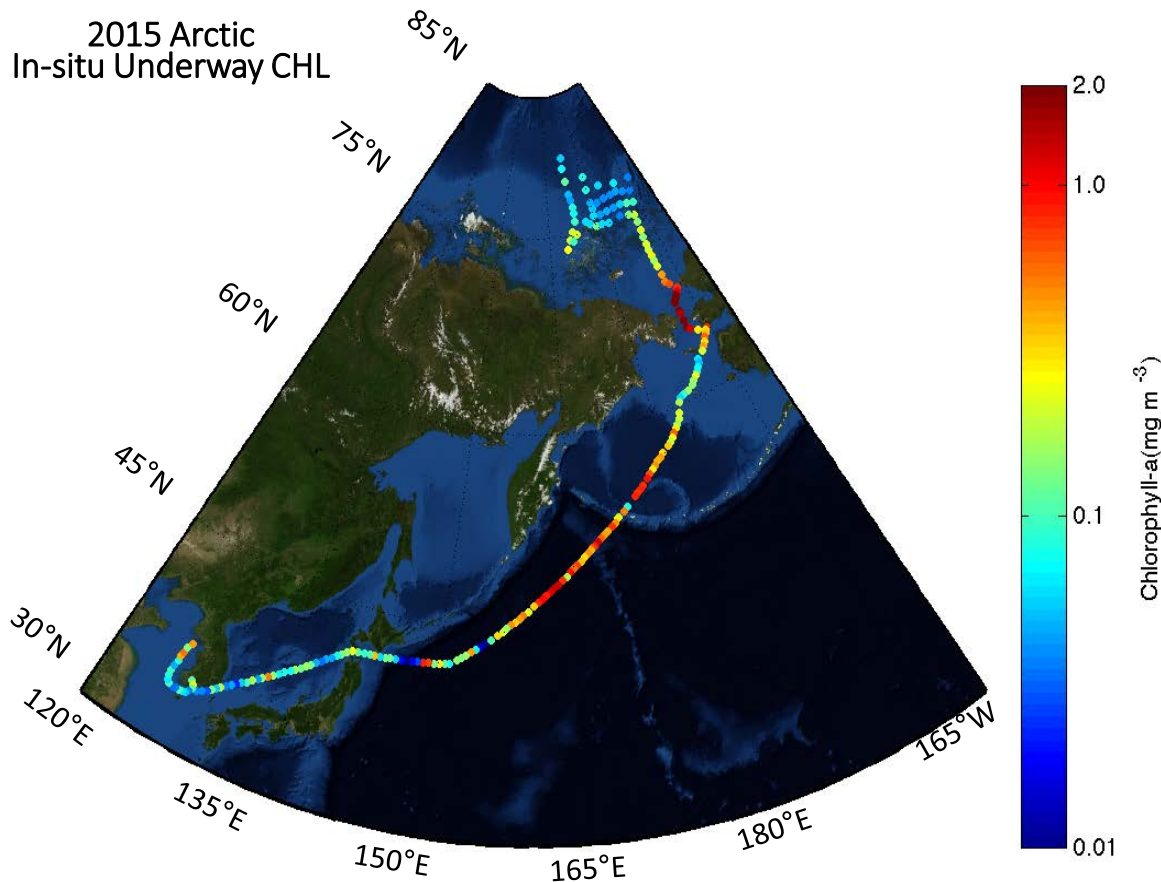
Extra Application:

 - Melt ponds

   type classify based on spectral reflectance + HR multi band (K-3)
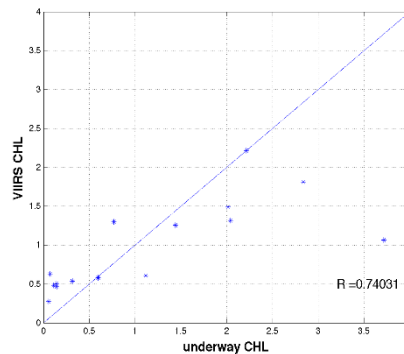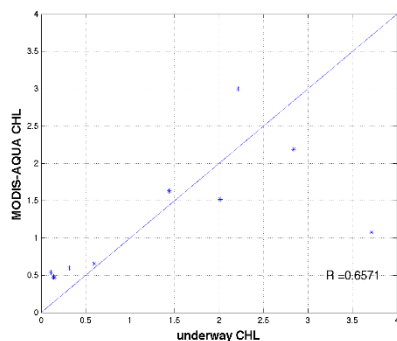
IOPs (Inherent Optical Properties)

2015 Arctic
In-situ Underway CHL

Chlorophyll-a(mg m^{-3})

Sampling bio-optical data to improve algorithms for ocean color products in High Latitude.
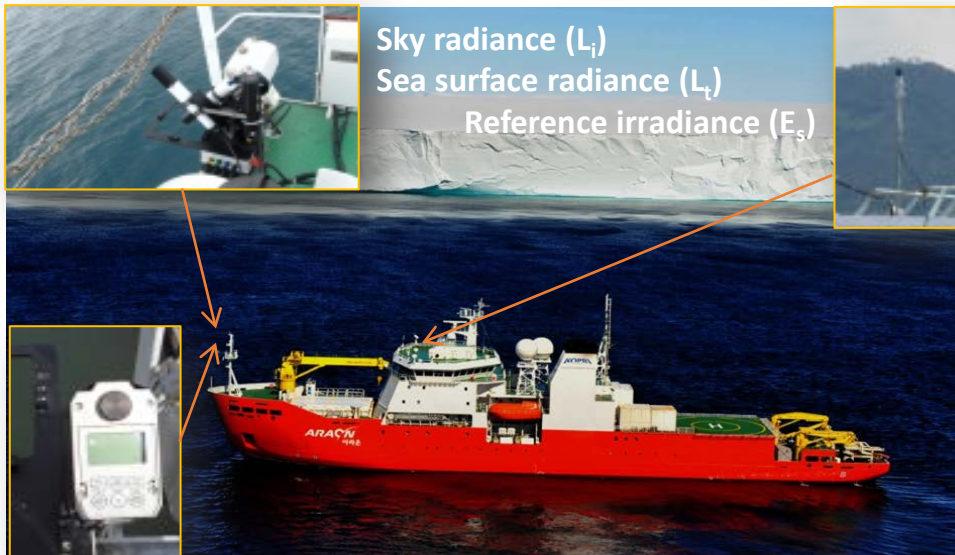
Concentrations and Absorptions

- Phytoplankton,

- Suspended Sediment (SS),

- Colored Dissolved Organic Matters (CDOM)
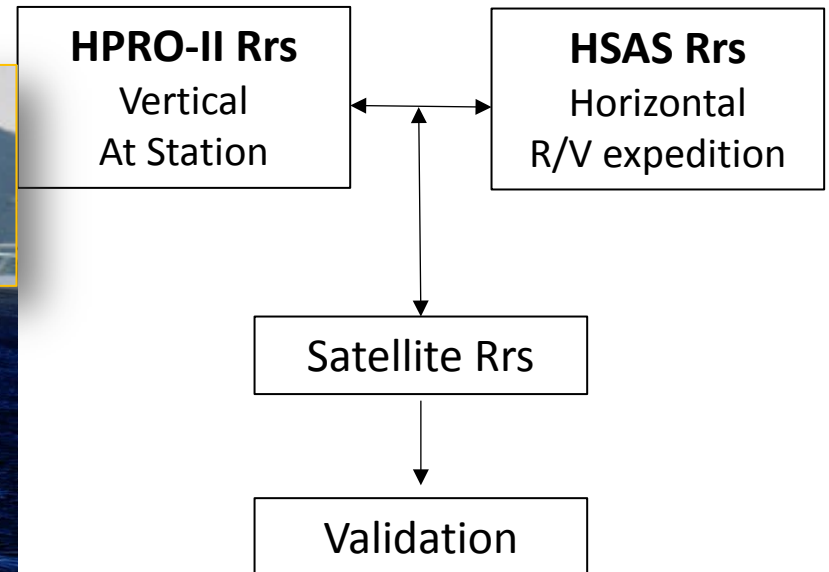
AOPs (Apparent Optical Properties)

Downward irradiance (E_d)
Upwelling radiance (L_u)
Reference irradiance (E_s)

1. In-water Hyper-spectroradiometer of Satlantic Inc. (HPRO-ll)

Sky radiance (L_i)
Sea surface radiance (L_t)
Reference irradiance (E_s)

2. Above water Hyper-spectroradiometer of Satlantic Inc. (HSAS)

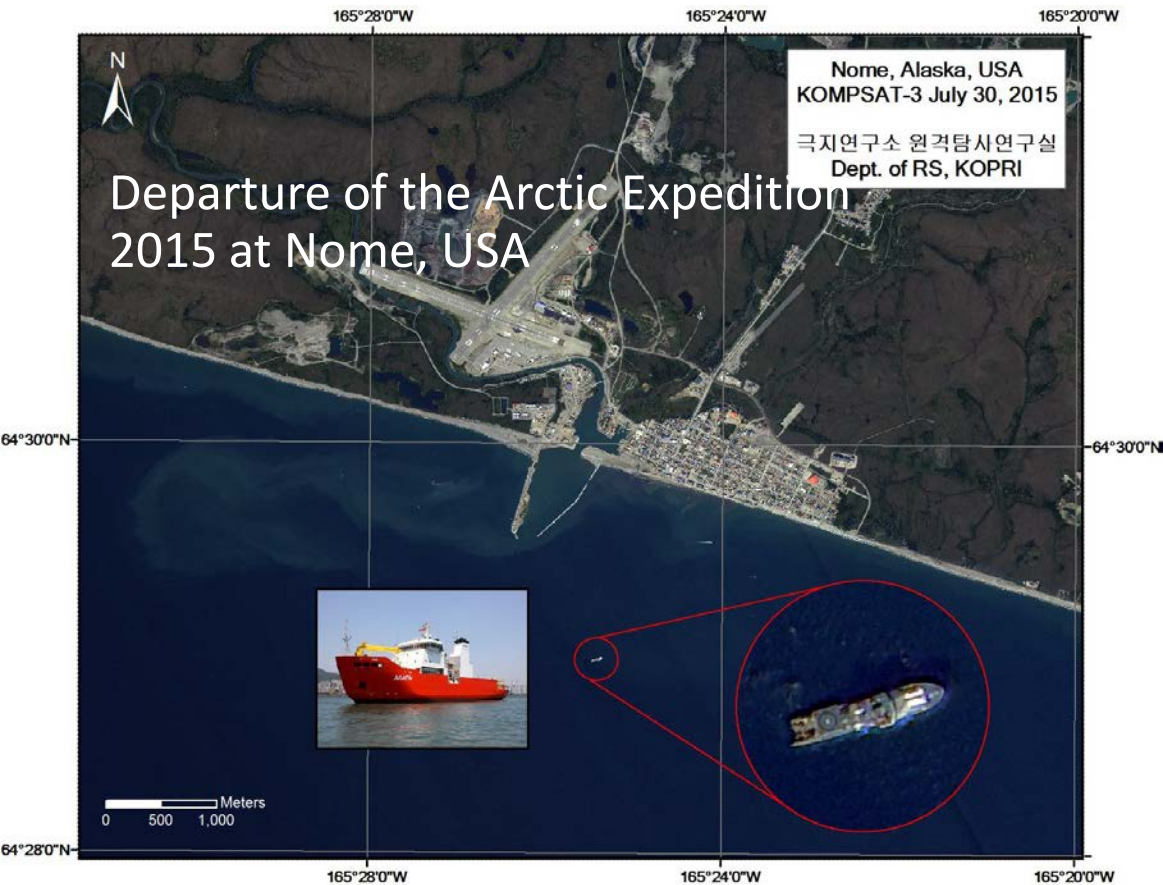| HPRO-II Rrs	HSAS Rrs
Vertical	Horizontal
At Station	R/V expedition

Satellite Rrs

Validation

KOMPSAT 2,3,5 for Arctic Expedition

- Sea Ice condition
  - KOMPSAT-5 SAR images
    : Wide Swath Mode (20m, 100km)
    : Standard Mode (3m, 30km)
    : High resolution Mode (1m, 5km)
  - Near real time image acquisition
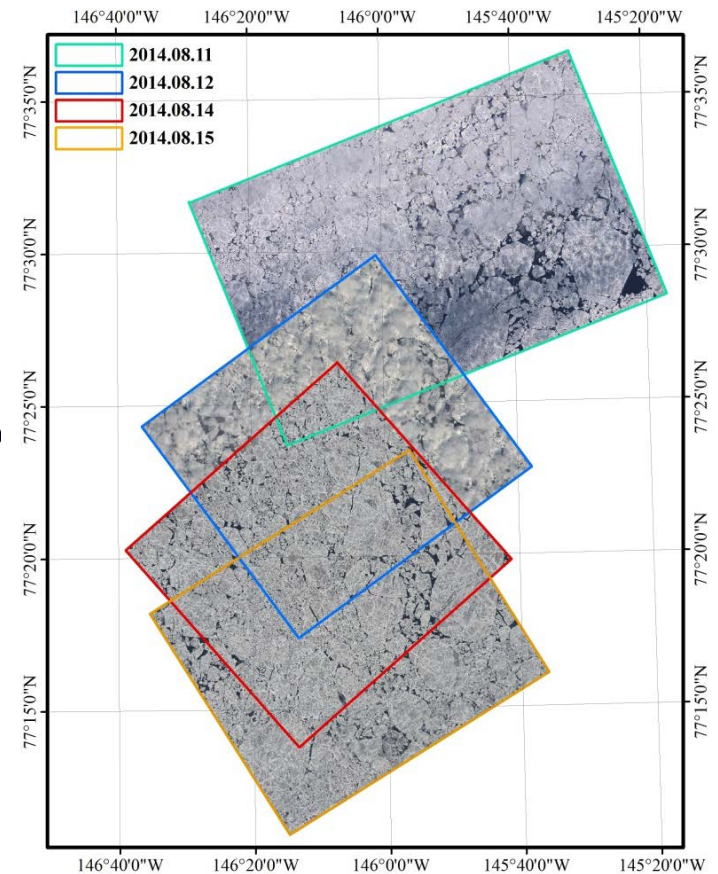   : within 1.5 day
  - Korea Aerospace Research Institute

Enhanced Wide Swath Mode

Standard Mode

Route of
IBRV Araon
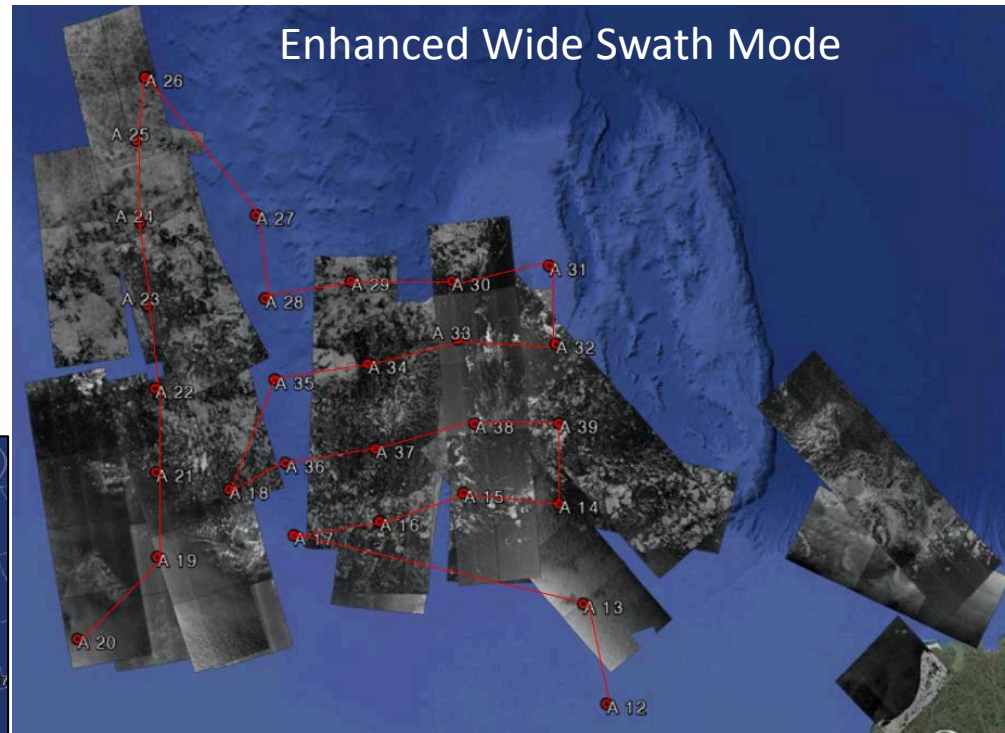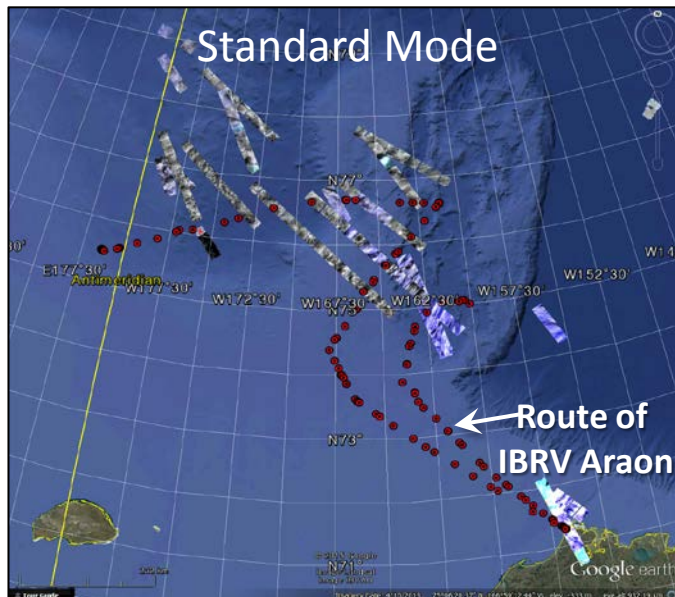
- High Resolution image
  - KOMPSAT-2,3 MSC images
    : K-2 (Pan-1m, Multi- 4m, Swath-15km)
    : K-3 (Pan-0.7m, Multi- 2.8m, Swath-15km)
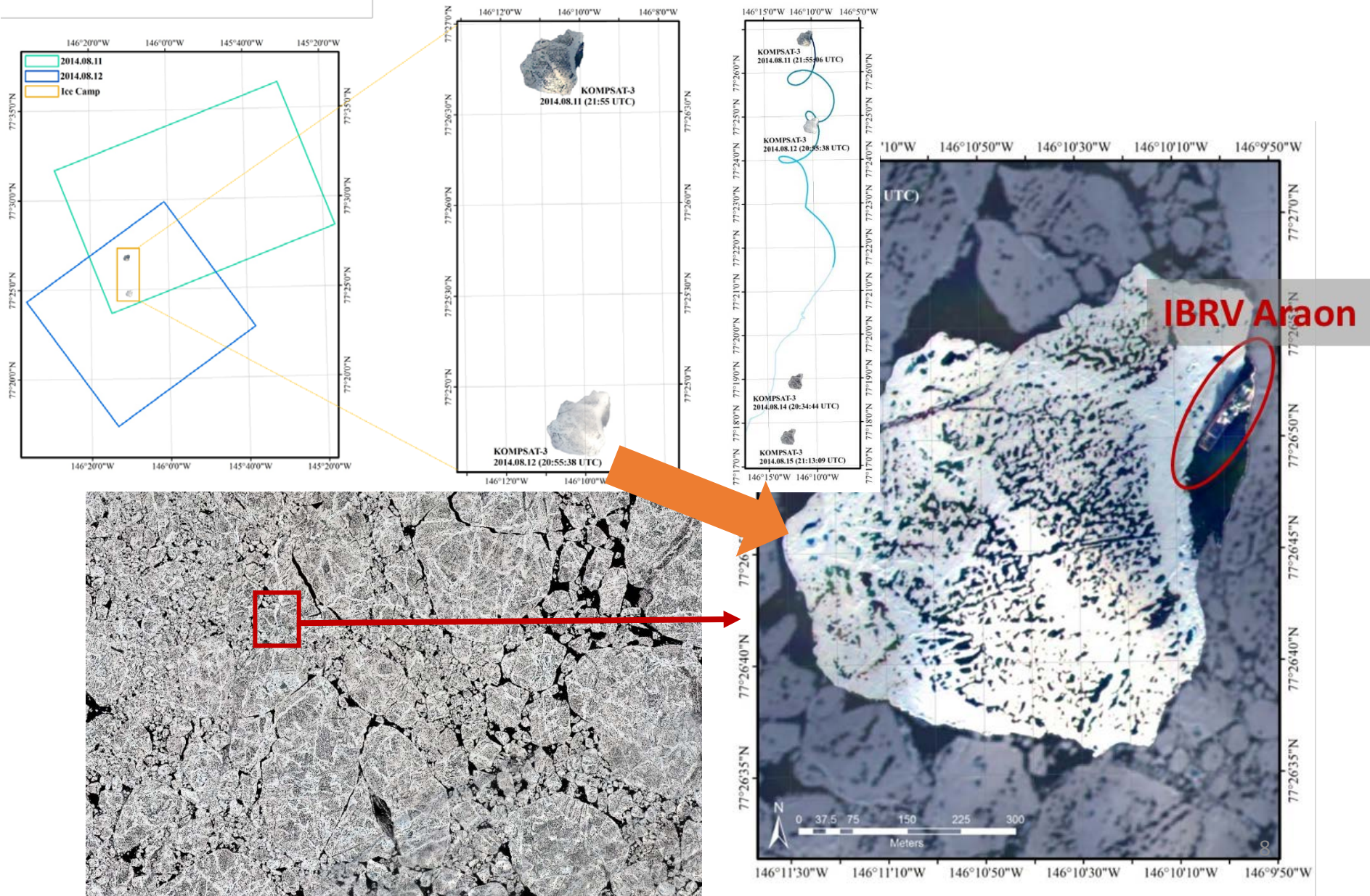 - Near real time image acquisition
    : within 1.5 day

HR Sea Ice Images

Nome, Alaska, USA
KOMPSAT-3 July 30, 2015
극지연구소 원격탐사연구실
Dept. of RS, KOPRI

Departure of the Arctic Expedition
2015 at Nome, USA

2014.08.11
2014.08.12
2014.08.14
2014.08.15

- Sea ice floe drifting
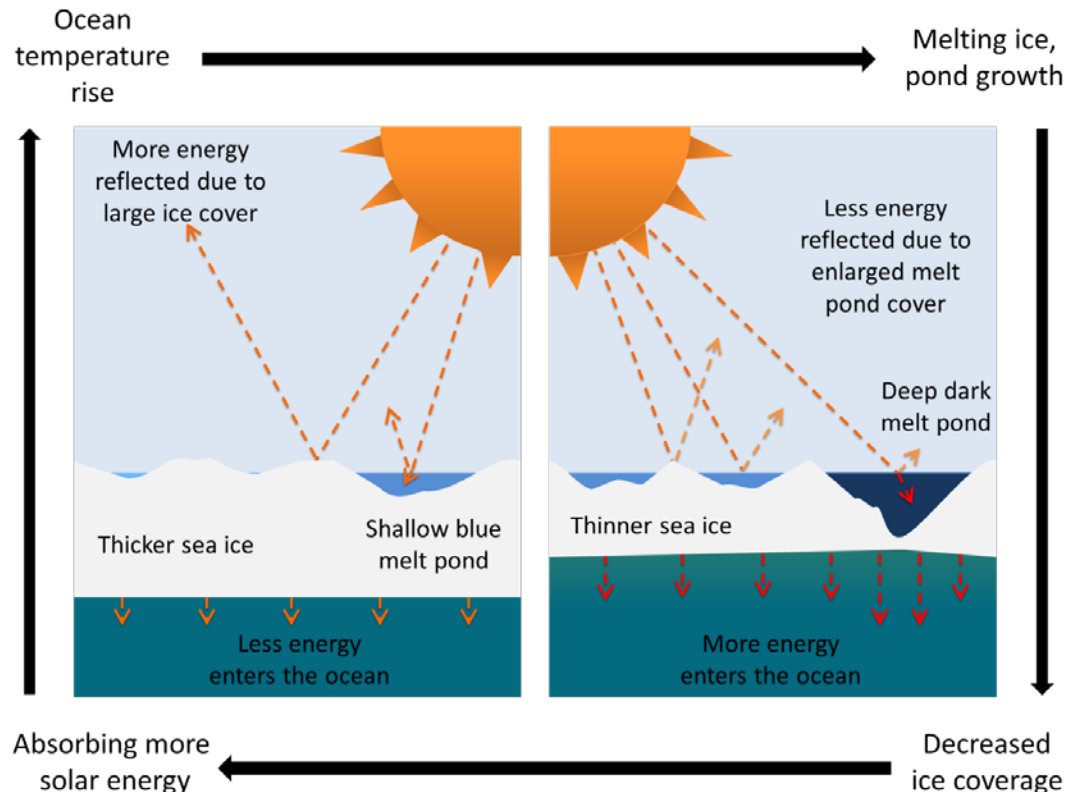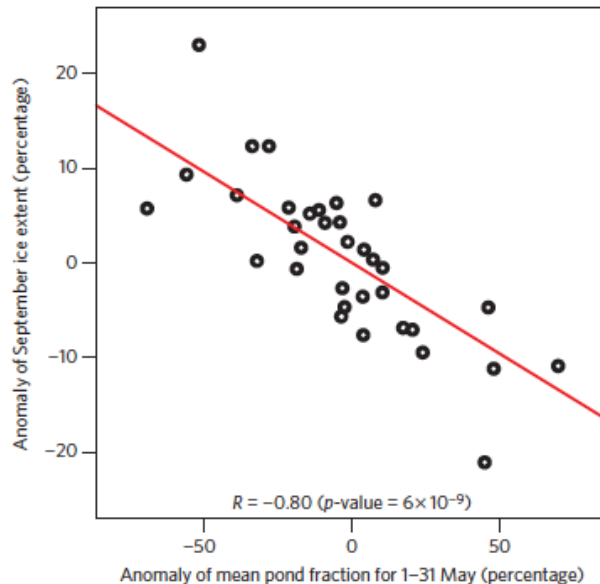 : K-3 (VHR satellite images)

Melt Pond and ice Albedo

September Arctic sea-ice minimum predicted by spring melt-pond fraction

David Schröder*, Daniel L. Feltham, Daniela Flocco and Michel Tsamados

$R = -0.80$ (p-value $= 6 \times 10^{-9}$)

Anomaly of September ice extent (percentage)

Anomaly of mean pond fraction for 1–31 May (percentage)

Ocean temperature rise → Melting ice, pond growth

More energy reflected due to large ice cover

Less energy reflected due to enlarged melt pond cover

Deep dark melt pond

Thicker sea ice

Shallow blue melt pond

Thinner sea ice

Less energy enters the ocean

More energy enters the ocean
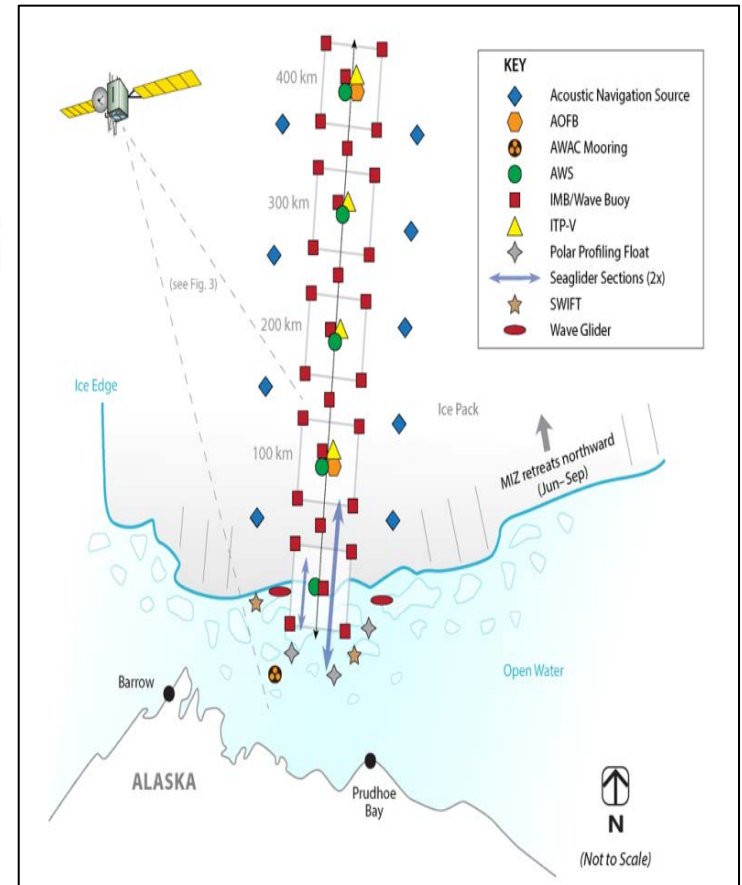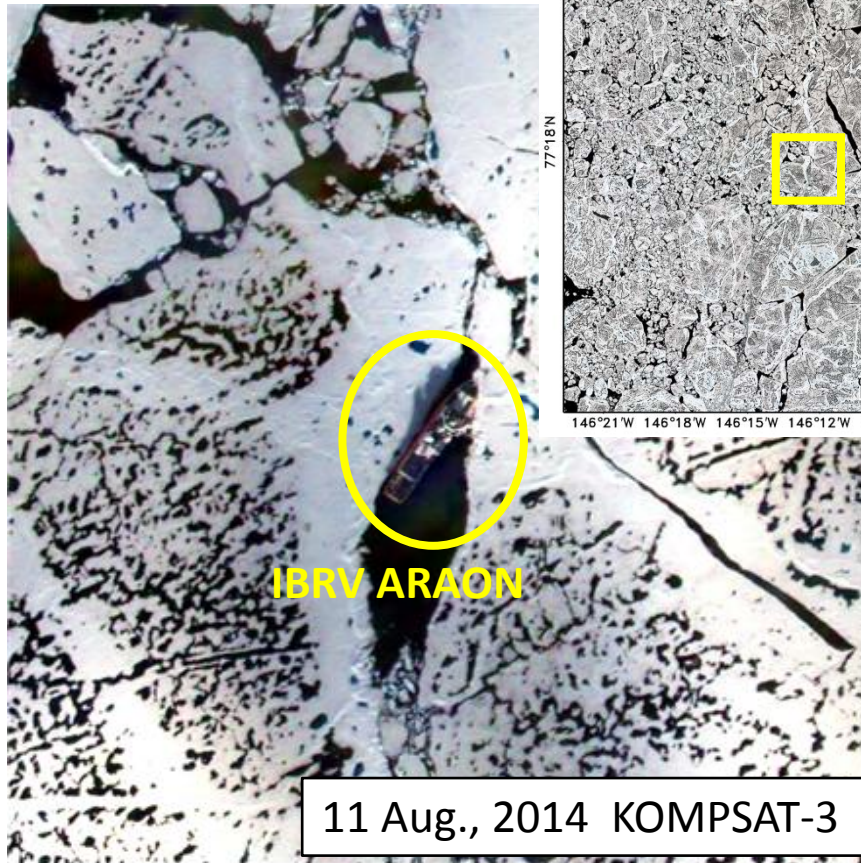
Absorbing more solar energy ← Decreased ice coverage

(Modified from U. Reading, 2013)

The size of melt pond ranges from few meters to few tens of meters only …

➔   We need high-res. observation for understanding the melt-pond induced ice-albedo feedback mechanism in detail.

KOPRI 2014 Ice Camp & MIZ Project

11 Aug., 2014 KOMPSAT-3

IBRV ARAON

< MIZ project webpage >
http://www.apl.washington.edu/project/project.php?id=miz

4 KOMPSAT-3 optic images and 18 TerraSAR-X radar images were acquired during the mission period as a research collaboration of KOPRI and MIZ team.
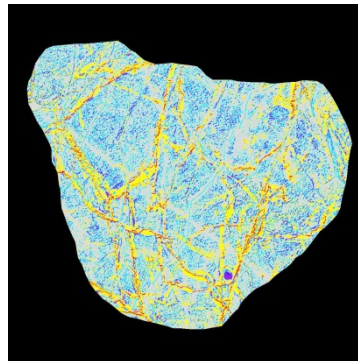
10

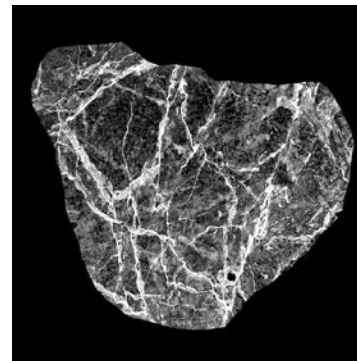# High-Resolution Remote Sensing for Monitoring Sea Ice Surface Change (Optic+Radar)
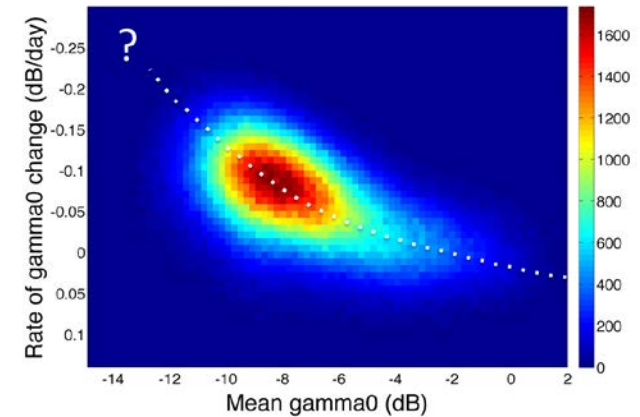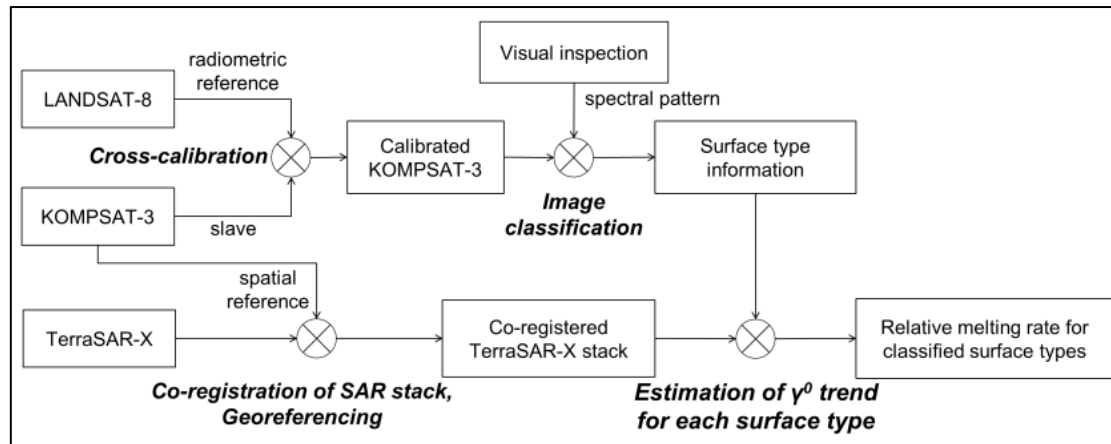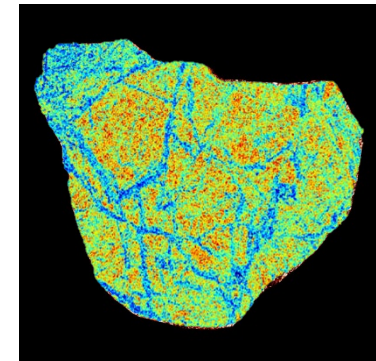

Optic Image

Surface type classification

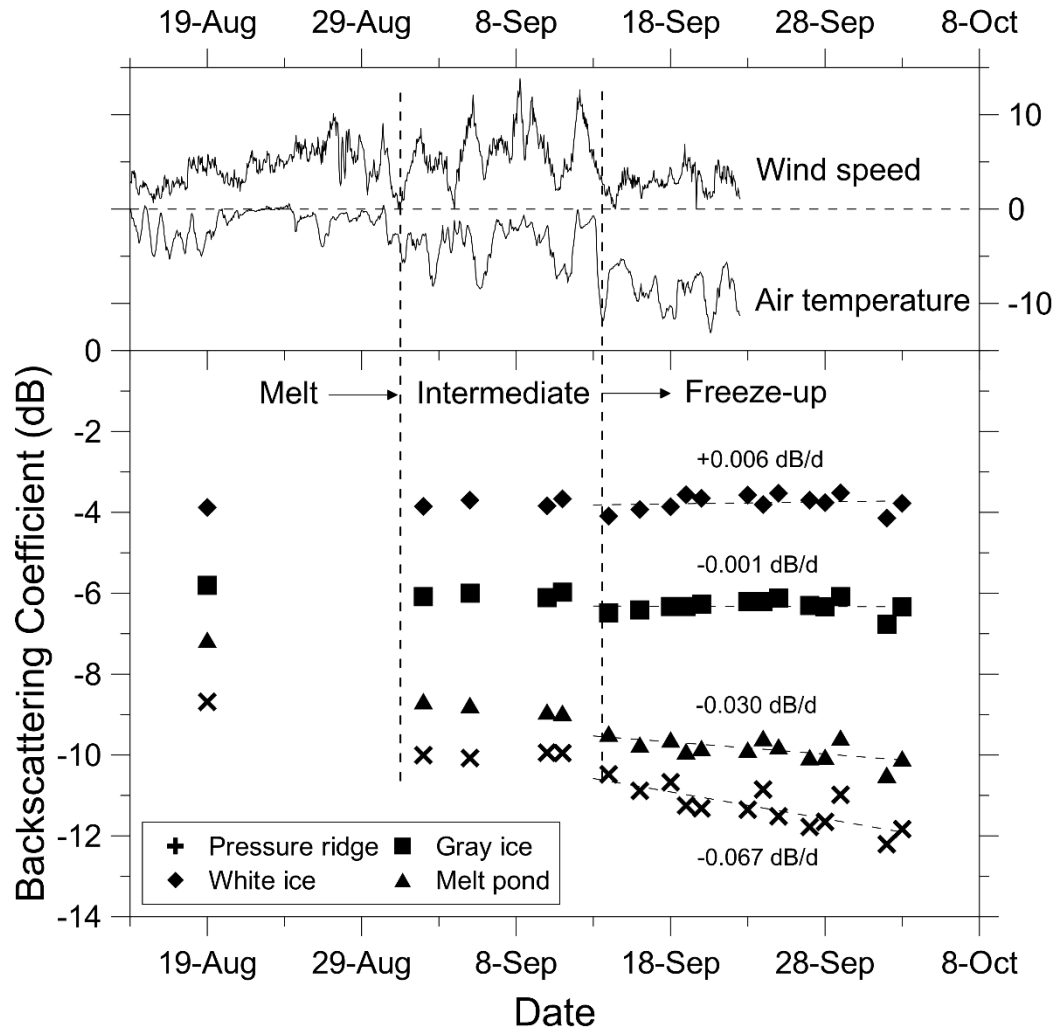Mean radar backscattering

Linear rate of backscattering change

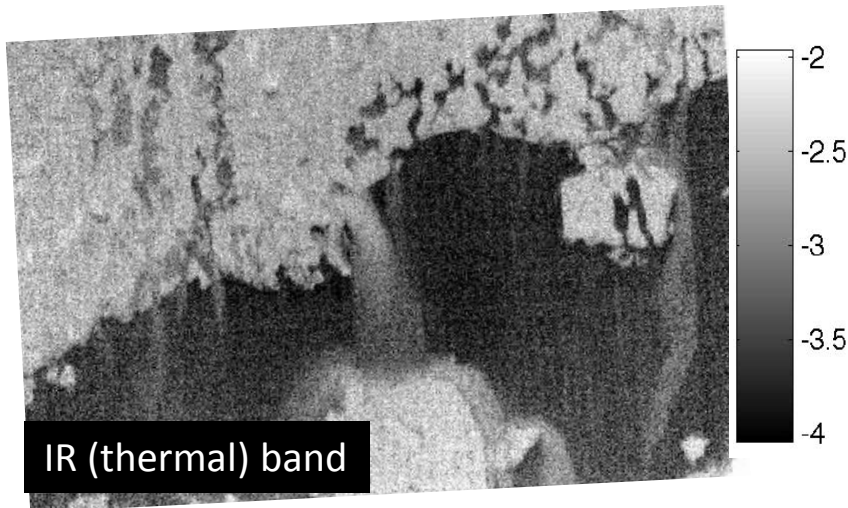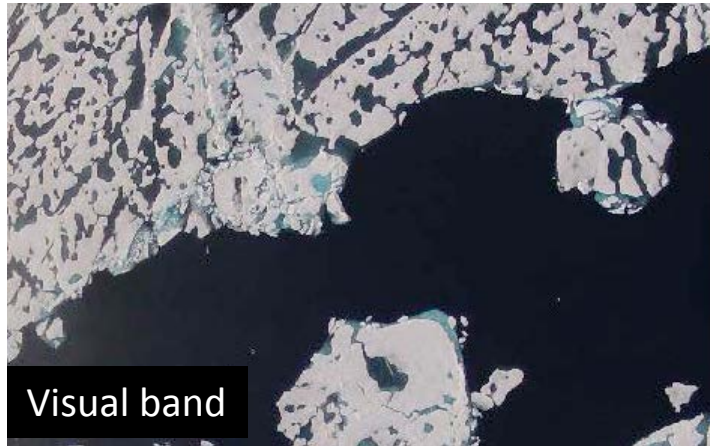# Late Summer – Early Autumn Changes

16 Aug. (18.2%)

17 Sep. (4.5%)

Each class shows distinct patterns in not only spectral reflectance but also radar backscattering ➔ reduced ambiguity in sea ice classification
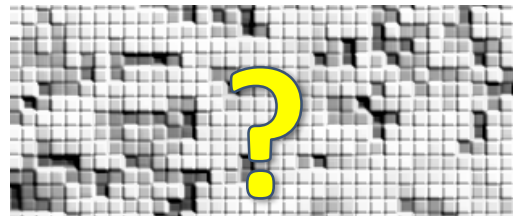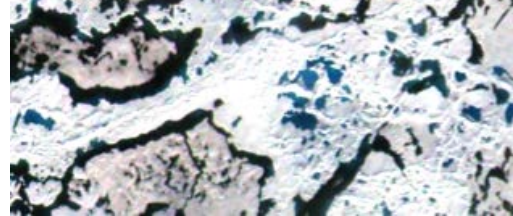
Thermal response of Sea Ice and Melt Pond

Visual band

IR (thermal) band

< US Navy report, 2013 >

KOMPSAT-3 Multi-spectral (2.8m)
Launched in 2012, now in operation

Reduced spatial Resolution

(Relative) Temperature information

KOMPSAT-3A Mid-infrared (5.5m)
Launched in 2015, now in commissioning phase

Discrimination of pond types
(open/closed) and evolution stage
by sensing temperature difference
(related to pond bottom structure)
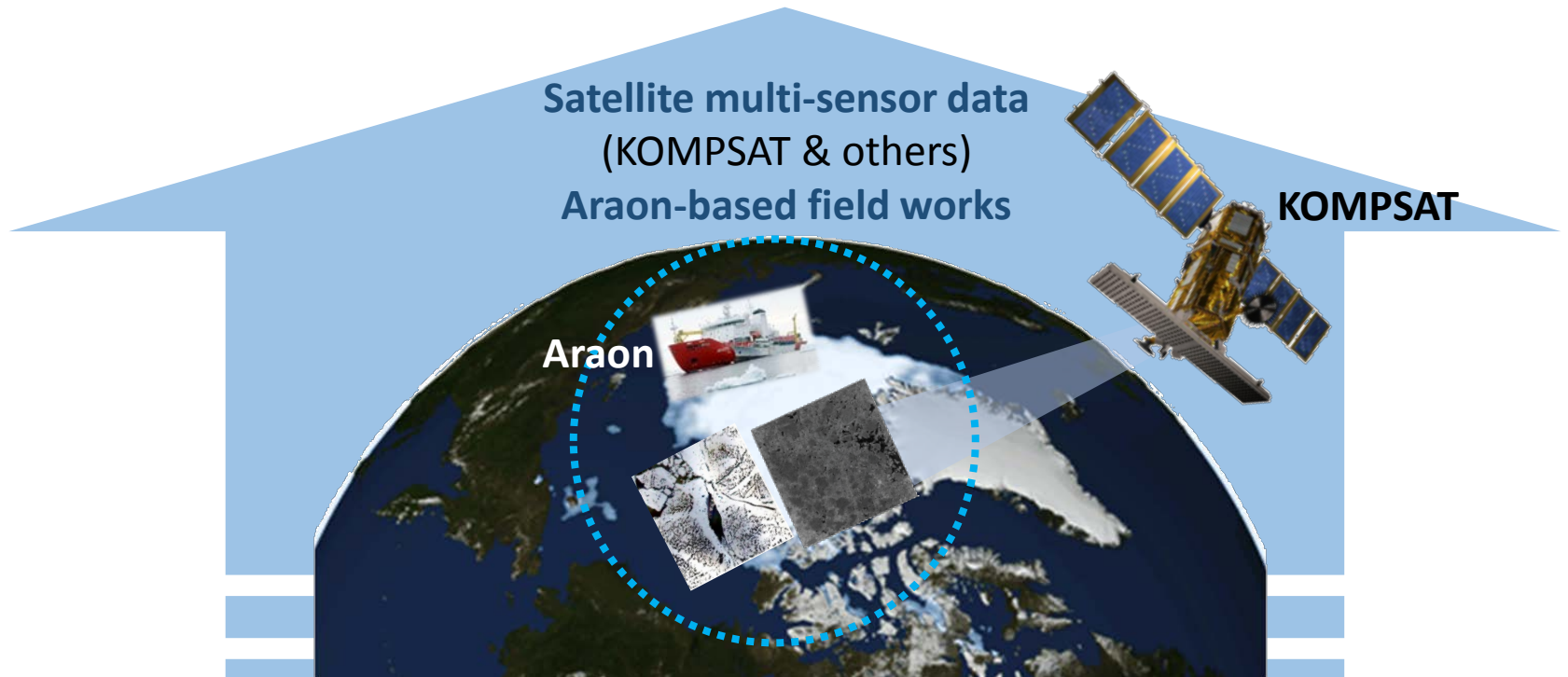
Future plans for sea ice

Production of sea ice information

Sea ice types **Sea ice concentration** **Melt pond statistics** **Sea ice thickness**

Satellite multi-sensor data
(KOMPSAT & others)
Araon-based field works

KOMPSAT

Araon

Production of sea ice information

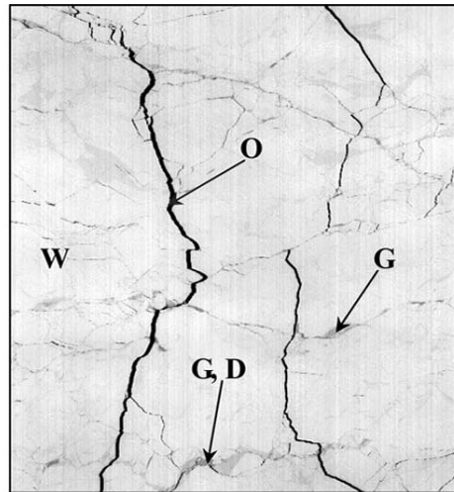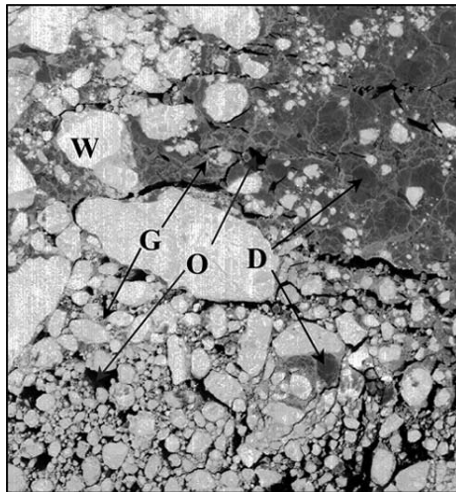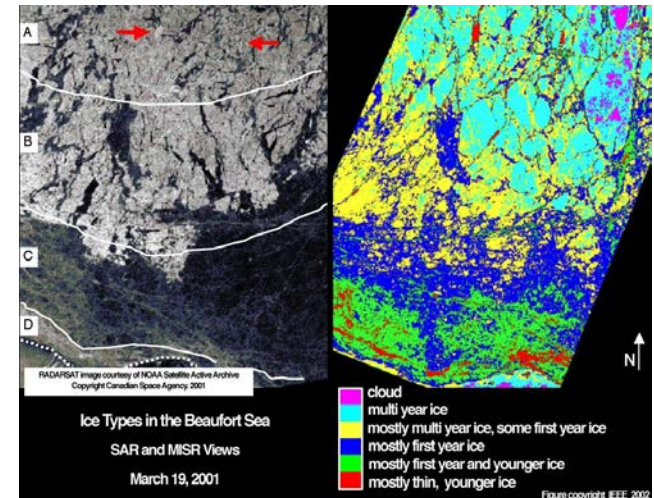| Sea ice types | Sea ice concentration | Melt pond statistics | Sea ice thickness |

Development of sea ice classification techniques

Sea ice analysis

Identification of ice types from satellite images

Sea ice development stages

Ice Types in the Beaufort Sea
SAR and MISR Views
March 19, 2001

cloud
multi year ice
mostly multi year ice, some first year ice
mostly first year ice
mostly first year and younger ice
mostly thin, younger ice

Production of sea ice information
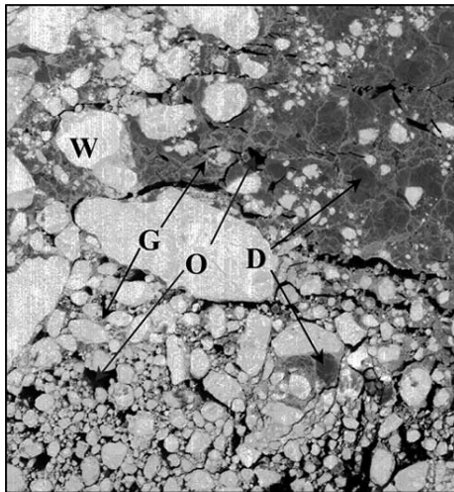
Sea ice types | **Sea ice concentration** | Melt pond statistics | Sea ice thickness
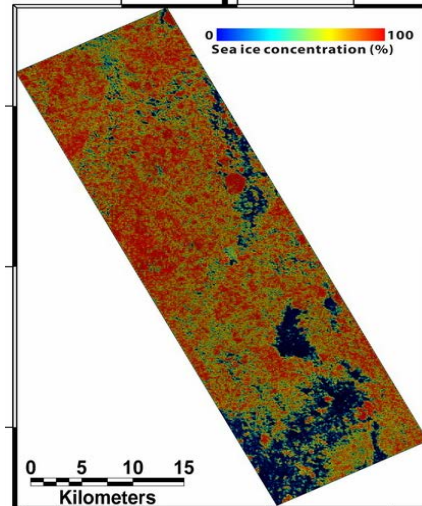
Accurate & High resolution SIC products

Evaluation & Improvement of operational SIC algorithms
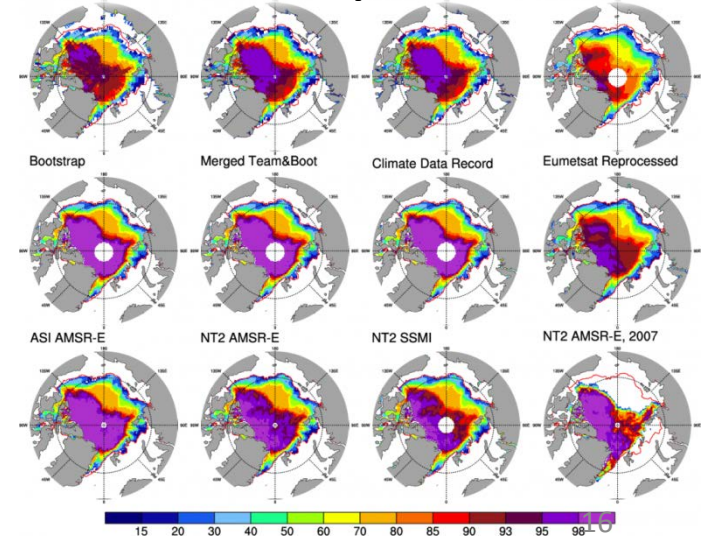
Sea ice detection

New SIC products

Evaluation of operational SICs

credit: National Center for Atmospheric Research, Climate Data Guide, climatedataguide.ucar.edu

Production of sea ice information

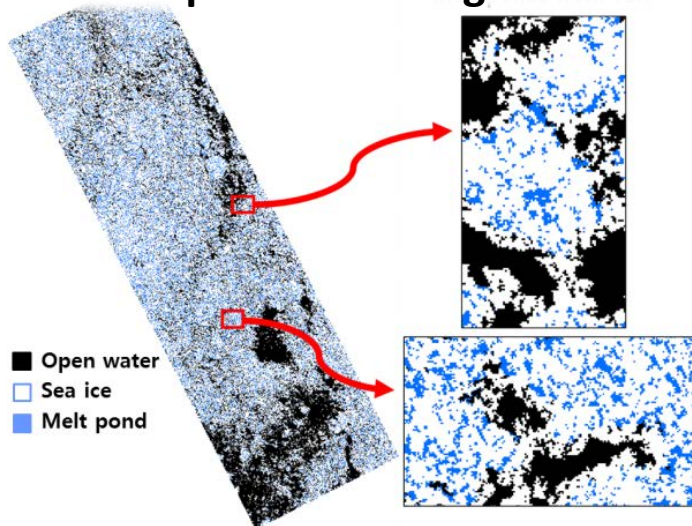Sea ice types | Sea ice concentration | **Melt pond statistics** | Sea ice thickness
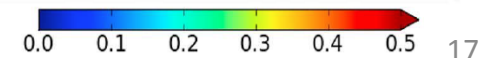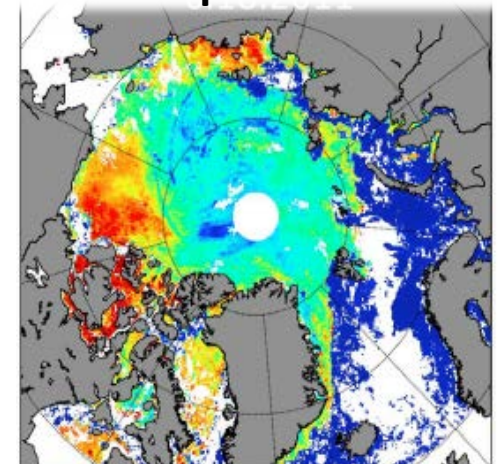
Development of melt pond detection techniques

Retrieval of accurate pond statistics (pond fraction, pond area, etc.)

Detection of melt ponds from high resolution images

Accurate pond statistics

■ Open water
□ Sea ice
■ Melt pond

0.0   0.1   0.2   0.3   0.4   0.5

Production of sea ice information
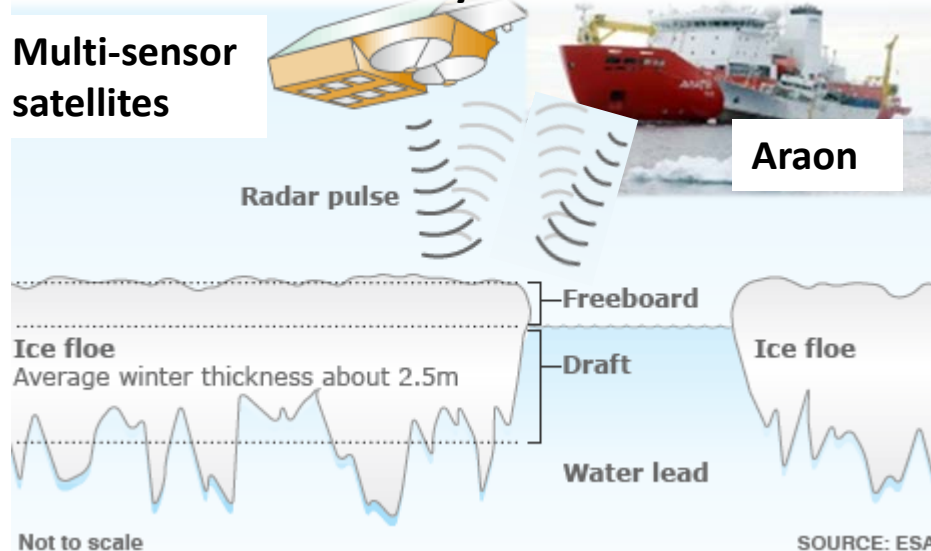
Sea ice types | Sea ice concentration | Melt pond statistics | **Sea ice thickness**
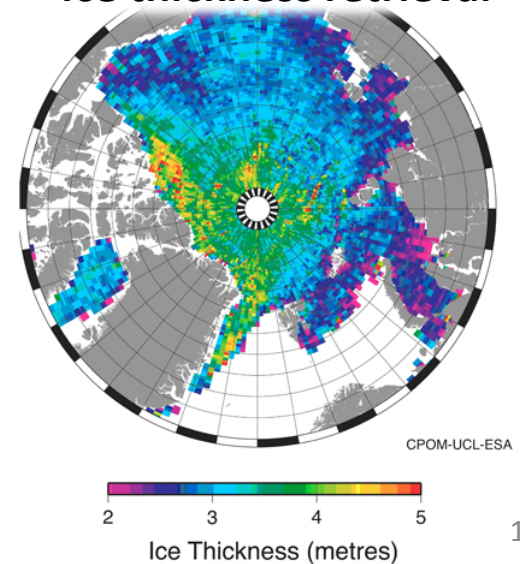
Assimilation of multi-sensor dataset and in situ observations

Improvement of ice thickness estimation techniques

Ice thickness observed by satellites and icebreakers

Ice thickness retrieval

Multi-sensor satellites

Araon

Radar pulse

Freeboard

Ice floe
Average winter thickness about 2.5m

Draft

Ice floe

Water lead

Not to scale

SOURCE: ESA

CPOM-UCL-ESA

2   3   4   5
Ice Thickness (metres)

Thank you for listening.