

Introduction to KOPRI's Collaborative Activities for Sea Ice Observations in the Arctic

Kyoung-Ho Cho^{1*}, Joo-Hong Kim¹, Phil Hwang², Koji Shimada³, Eunjin Yang¹, Sung-Ho Kang¹, and MIZ team^{4*}

¹Korea Polar Research Institute, Korea; ²Scottish Association for Marine Science, UK; ³Tokyo University of Marine Science & Technology, Japan; ⁴ONR-Marginal Ice Zone team



Ministry of Oceans and Fisheries



Abstract: The Pacific Arctic Sector has experienced a massive decline in sea ice extent during recent decade. In order to unveil the primary factors controlling the sea ice loss, Korea Polar Research Institute (KOPRI) has conducted the ice-ocean observations on the Arctic sea ice since 2011. Most of KOPRI's activities for the observations include the international collaboration with the Scottish Association for Marine Science (SAMS), the Tokyo University of Marine Science and Technology (TUMSAT), the British Antarctic Survey (BAS), the Ocean University of China (OUC), and so on. One of the activities is the deployment of various ice-tethered buoys to measure ice bottom melting, heat exchange between the atmosphere-snow-ice-ocean interfaces, and the three dimensional deformation of the ice. These measurements help us to identify and understand the key physical processes between and within atmosphere-ice-ocean in the Arctic Ocean. Another activity is the melt pond study that reveals the evolution of two different types of melting ponds. In this study, thus, we introduce the overall activities for sea ice observations conducted from 2011 to 2015 and present what kinds of equipment used and some preliminary results.

1 KOPRI Arctic Cruises

◆ Hydrographic Surveys from 2010 to 2015

- 1) Equipment used on the ice breaker R/V ARAON
 - CTD, lowered ADCP, XCTD (Fig. 1, Table 1)
 - Bio/Geo/Chemical equipment
- 2) Items observed from the Araon
 - Temperature, salinity, water velocity,
 - DO, fluorescence, PAR, transmission, backscatter,
 - Atmospheric components,
 - Primary production and new production,
 - Chlorophyll-a and HPLC,
 - Phytoplankton, Zooplankton compositions,
 - Nutrients, POC, PON, DOC, DON, DOP,
 - N₂O gas, pCO₂, DIC, pH, SS, TA,
 - etc.

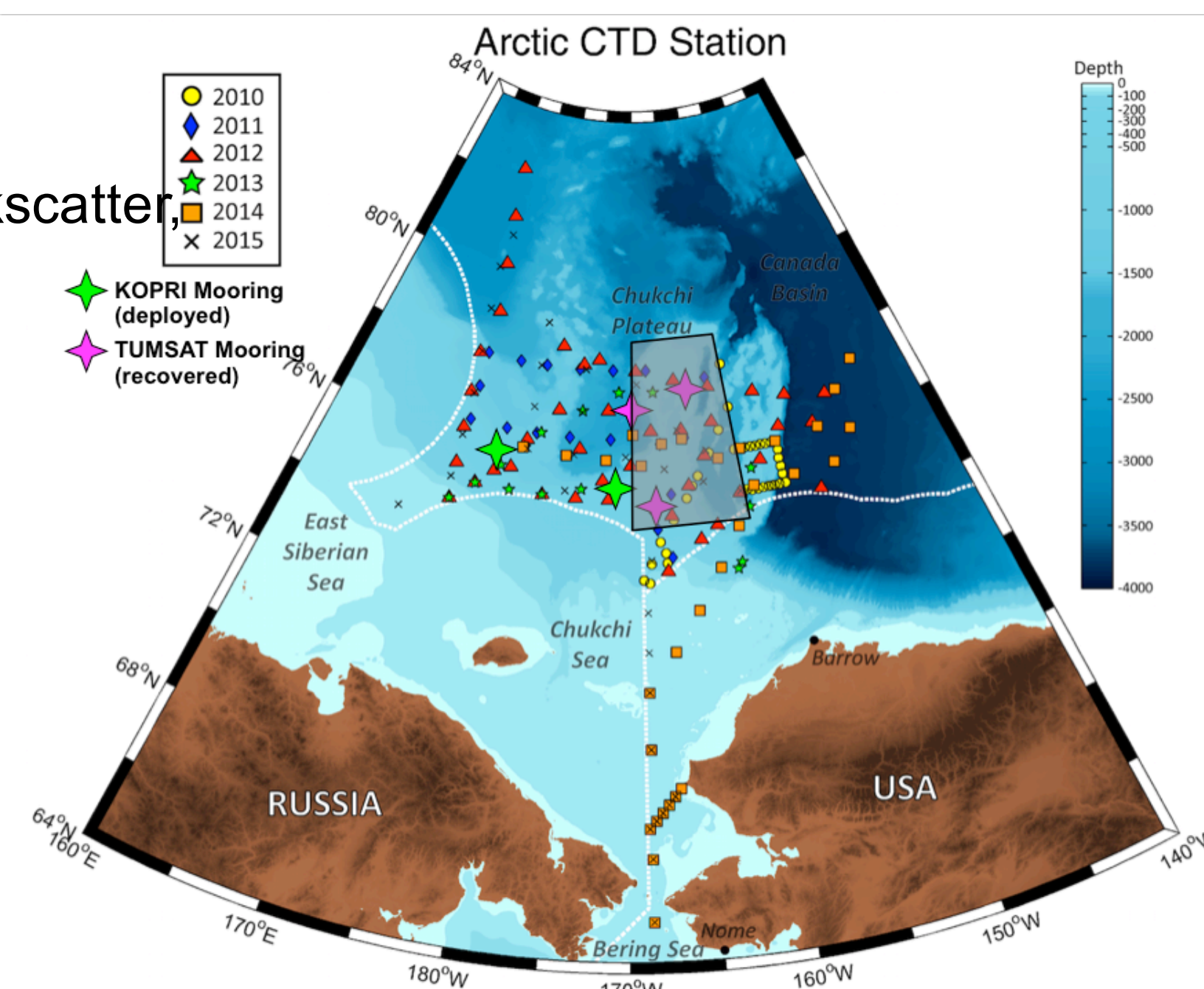


Figure 1. Station map of the Araon Arctic Cruises from 2010 to 2015.

Table 1. Information on the Araon Arctic Cruises from 2010 to 2015.

	2010	2011	2012	2013	2014	2015
CTD	38	18	44	16	32	42
XCTD	*	33	48	36	51	61
Period	07/20~08/10	08/02~08/16	08/04~09/06	08/24~09/01	08/01~08/23	08/01~08/21

2 Sea Ice Observations I

◆ Collaborative Activity in 2012

- 1) KOPRI-SAMS
 - Buoy deployment and helicopter survey during the 2012 ice camp study (Fig. 2)
 - 8 SAMS Ice Mass Balance (IMB) buoys (Fig. 3)

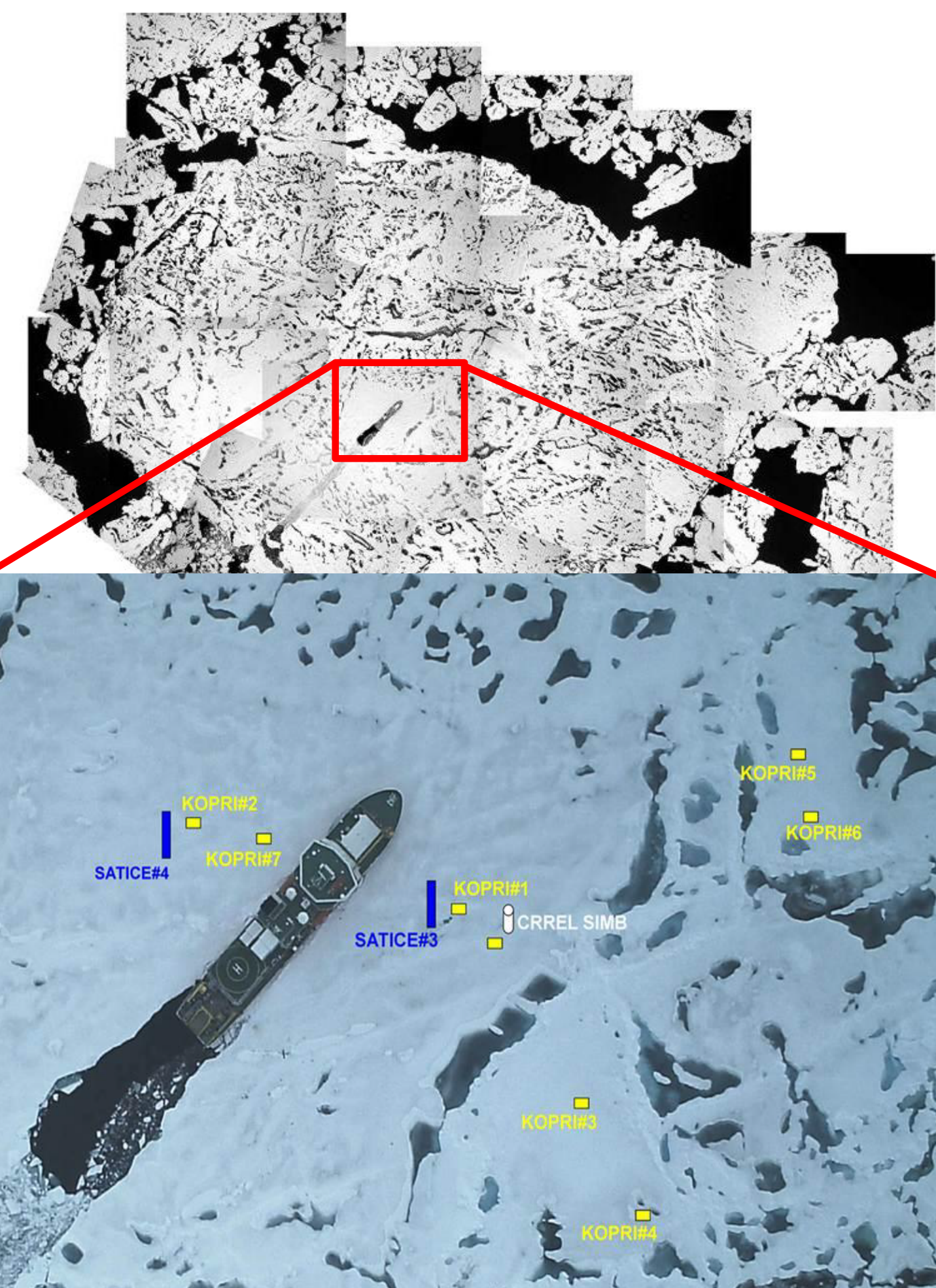


Figure 2. Aerial images of 2012 ice camp site

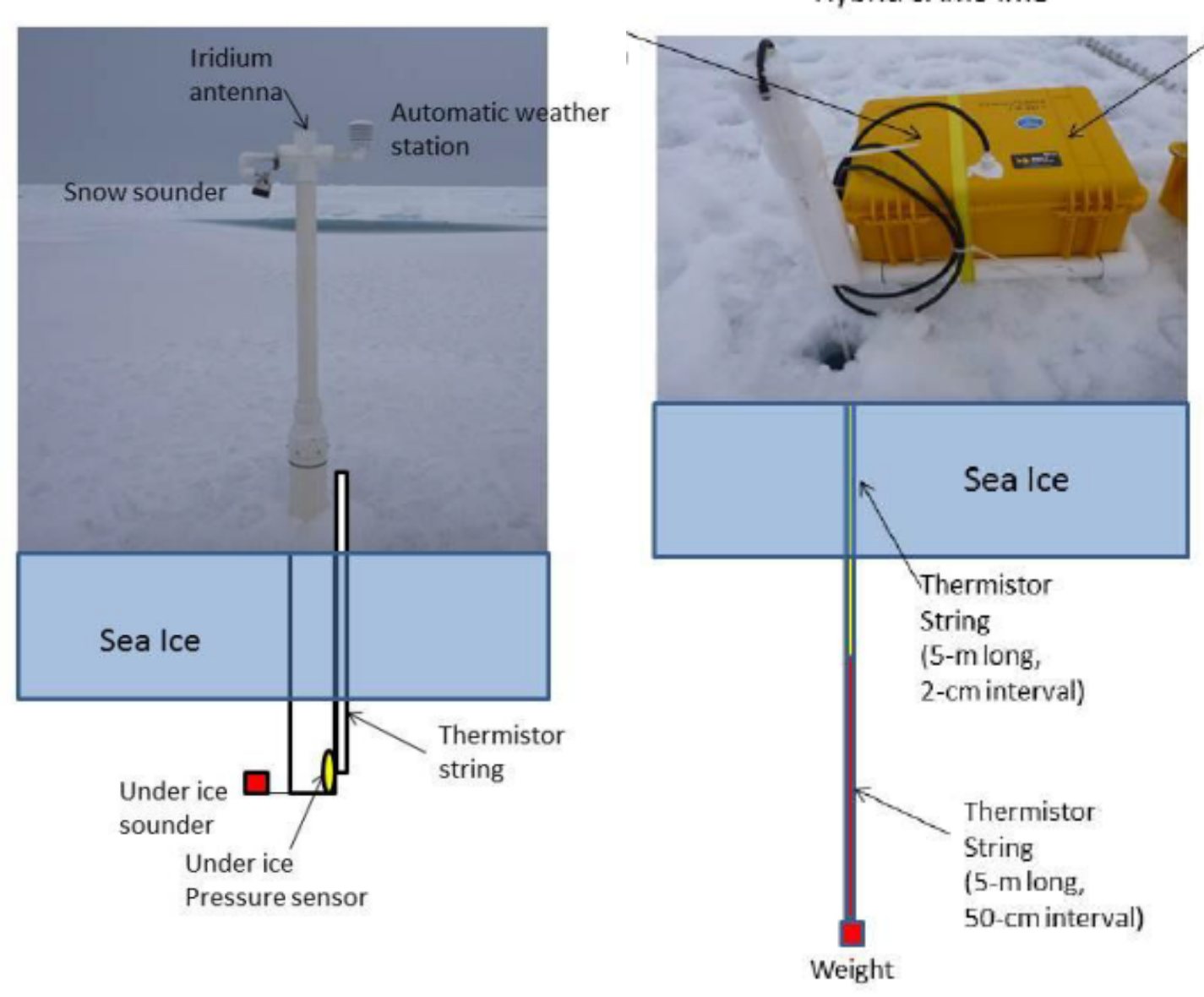


Figure 3. Illustration of SAMS IMB buoy

- 2) KOPRI-others
 - 2 SATICE buoys (Fig. 4)
 - 1 CRREL seasonal IMB (SIMB) buoy



Figure 4. Helicopter survey (left) and illustration of SATICE buoy (right)

- 3) Preliminary Results
 - T profiles from SAMS IMBs (Fig. 5)
 - Sea ice evolution (Fig. 6)
 - Photos from SATICE buoys (Fig. 6)

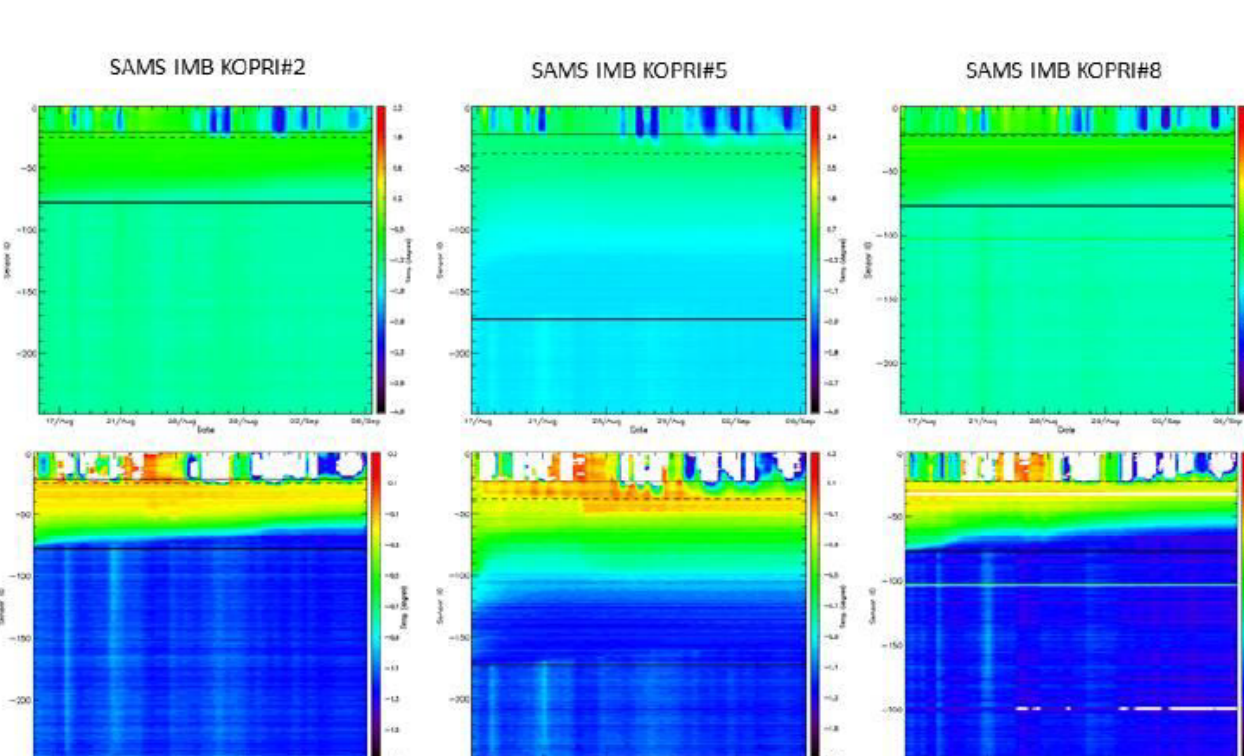


Figure 5. Temporal variations of T profiles from three selected SAMS IMBs

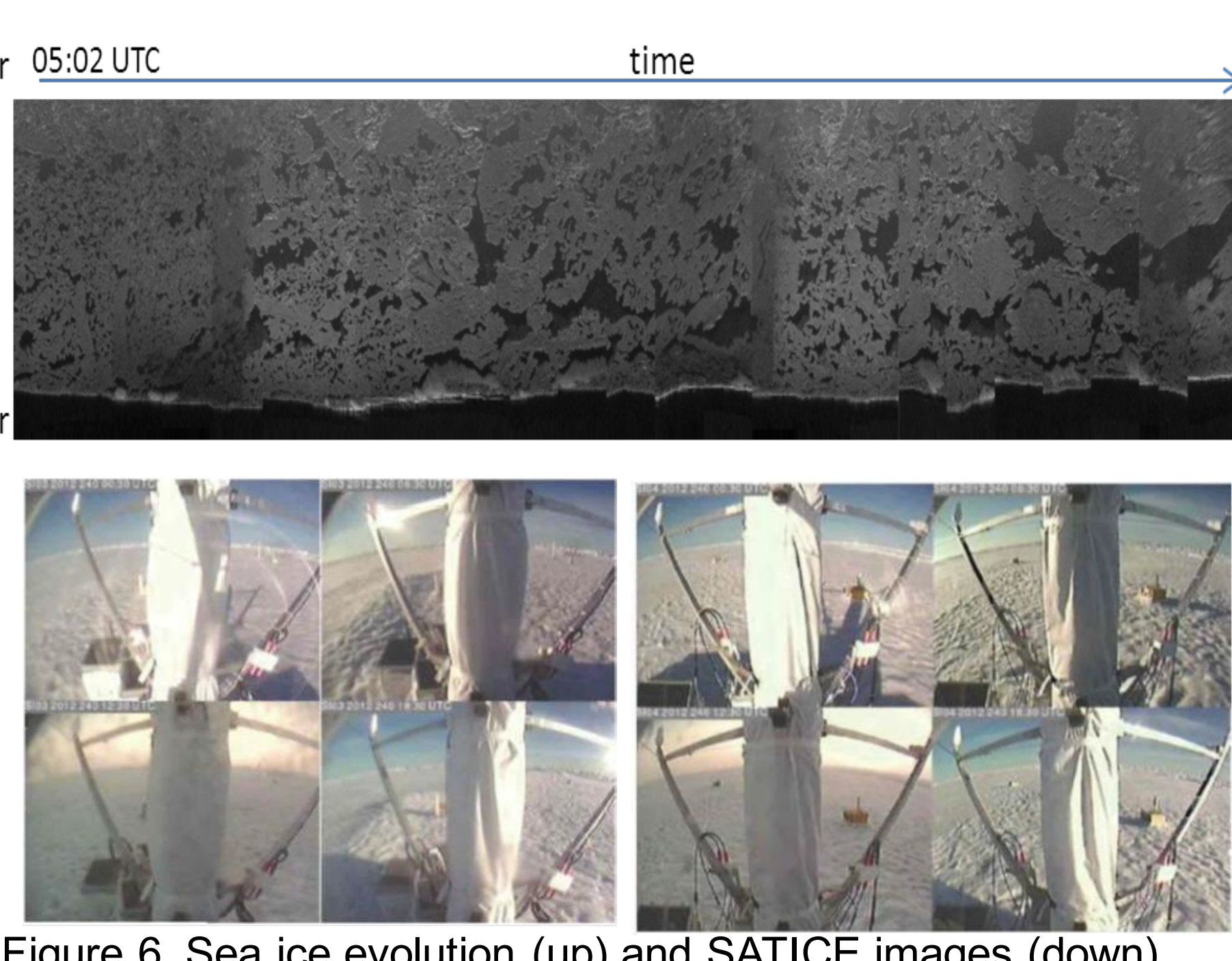


Figure 6. Sea ice evolution (up) and SATICE images (down)

3 Sea Ice Observations II

◆ Collaborative Activity in 2014

- 1) KOPRI-MIZ in-floe buoy deployment (Figs. 7 & 8)
 - SIMB: Seasonal Ice Mass Balance buoy (CRREL)
 - ITP: Ice-Tethered Profiler (WHOI)
 - AOFB: Autonomous Ocean Flux Buoy (NPS)
 - WB: Wave Buoy (BAS/UPMC)
 - AWS: Autonomous Weather Station (BAS/SAMS)
 - SATICE: High-precision GPS buoy (CSIC/MIT)
 - UpTempO: Upper layer T of the Polar Oceans (APL/UW)

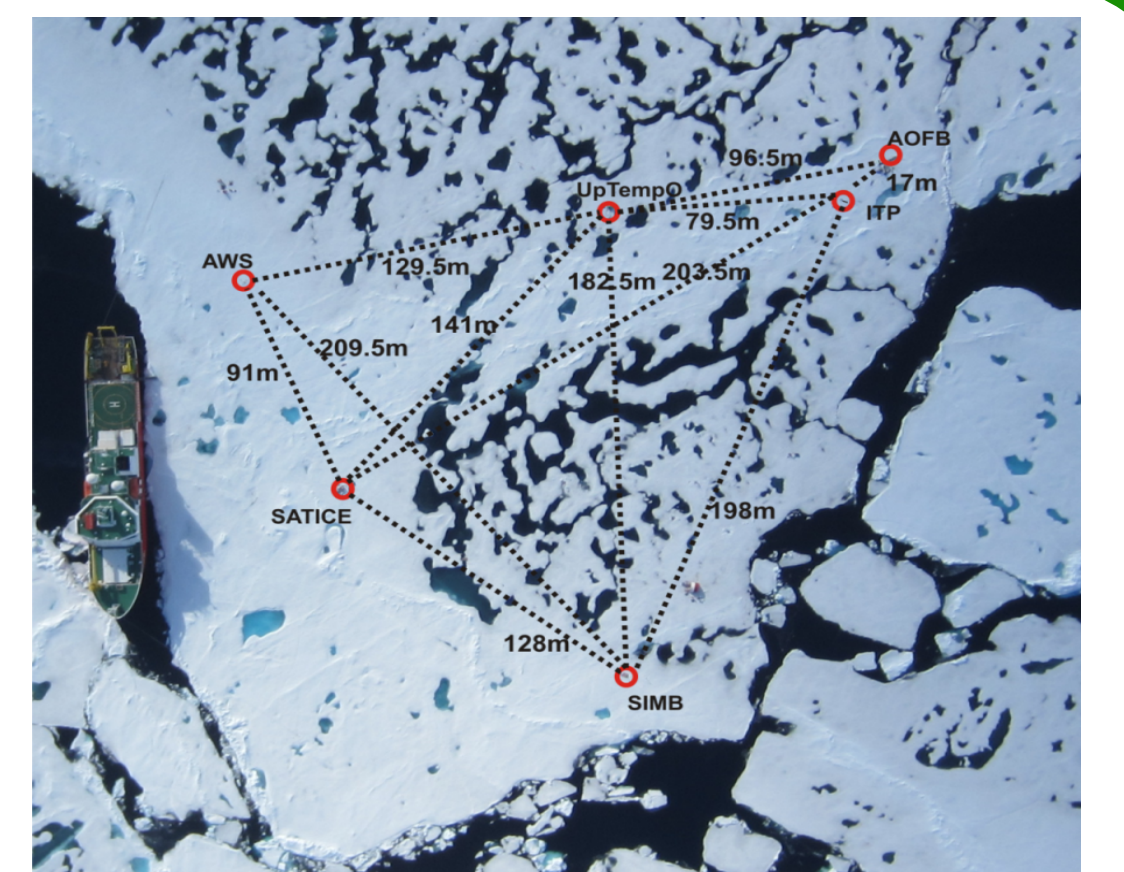


Figure 7. Aerial images of 2014 ice camp site and buoy locations

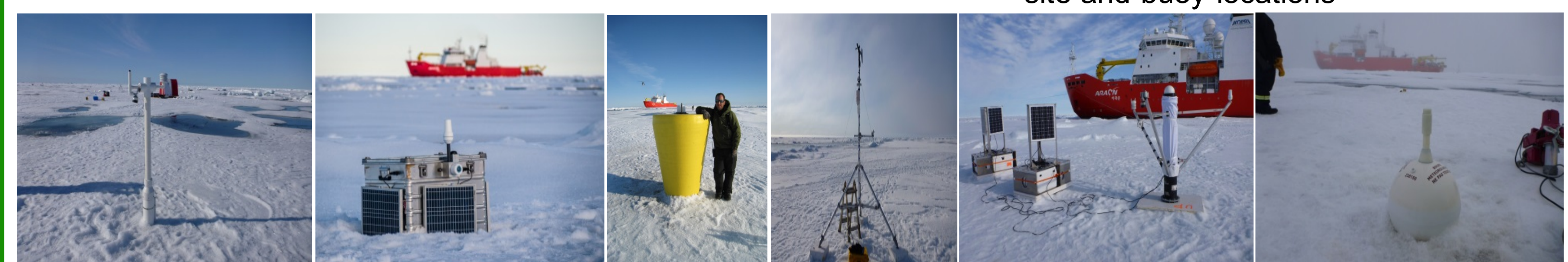


Figure 8. Photos of deployed buoys: SIMB, AOFB, ITP, WB, AWS, SATICE, and UpTempO buoys (from left).

- 2) Preliminary Results
 - SIMB: ice surface melt, ice growth, ice thickness, snow accumulation (Fig. 9)
 - ITP(-V): S, T, p, velocity, vertical turbulent momentum/heat fluxes (Figs. 9 & 10)
 - SATICE: ice deformation (Fig. 9)
 - AOFB: flux balance between upper ocean, ice cover, and incoming solar radiation (Fig. 11)

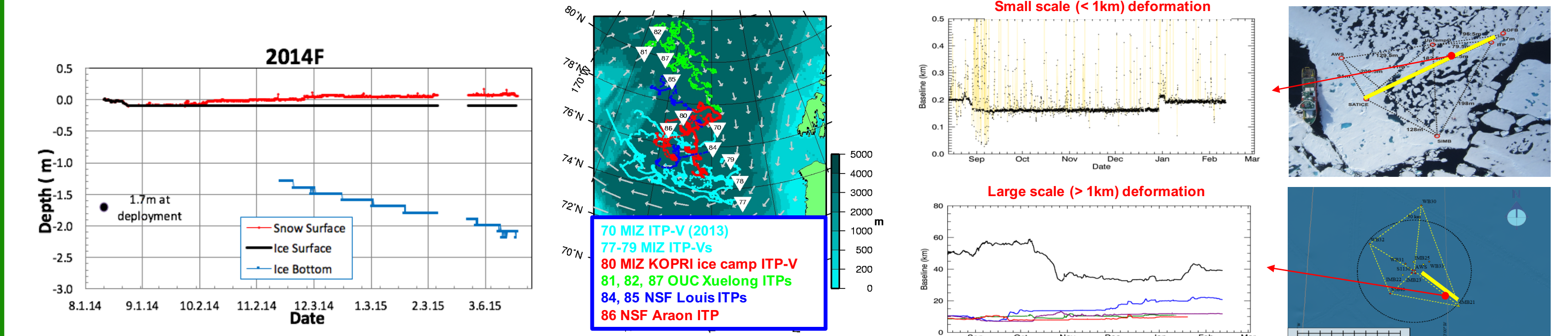


Figure 9. Results from SIMB (left), ITP (middle), and SATICE buoys (right).

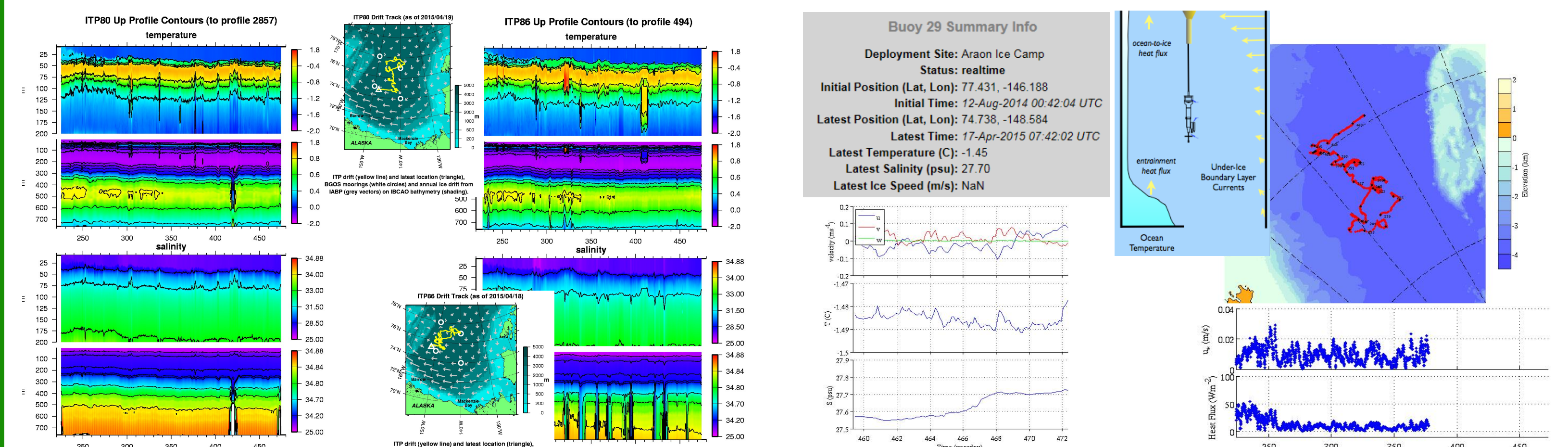


Figure 10. T and S profiles of upper ocean from ITP80 and ITP86 (<http://www.who.edu/itp/data/>).

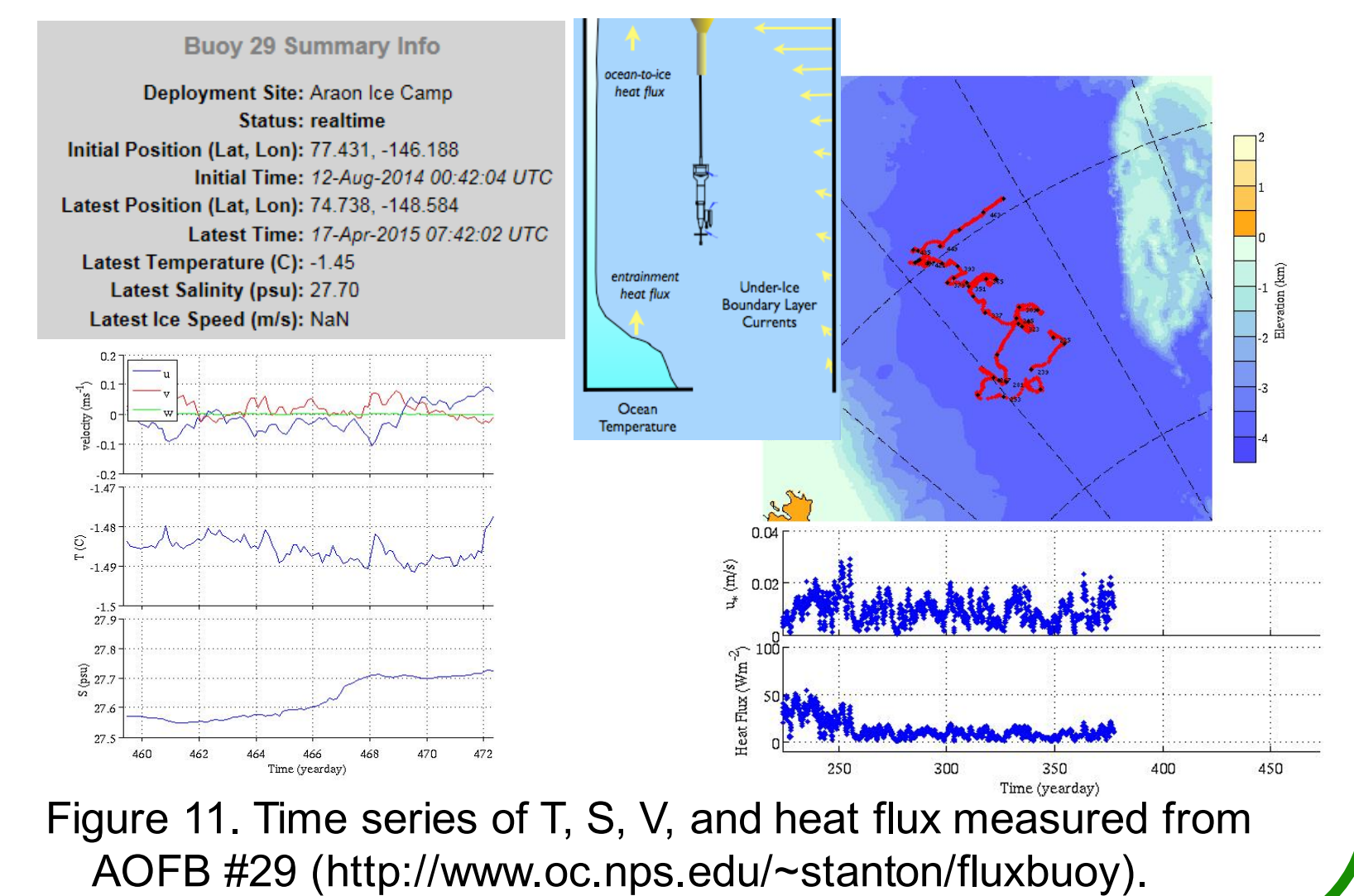


Figure 11. Time series of T, S, V, and heat flux measured from AOFB #29 (<http://www.oc.nps.edu/~stanton/fluxbuoy/>).

4 Sea Ice Observations III

◆ Collaborative Activity in 2015

- 1) KOPRI-MIZ in-floe buoy deployment (Fig. 12)
 - WB, IMB buoy, GPS ice drifter (ONR)
 - BAS-type IMB buoy (BAS)
 - SAMS-type IMB buoy (SAMS)
 - Seasonal IMB buoy (CRREL)
 - SATICE: High-precision GPS buoy (CSIC/MIT)
 - IAOS buoy: Ice-Atmosphere-Arctic Ocean Observing System (LATMOS/LOCEAN)
 - Smart (Shallow) ITP (OUC)

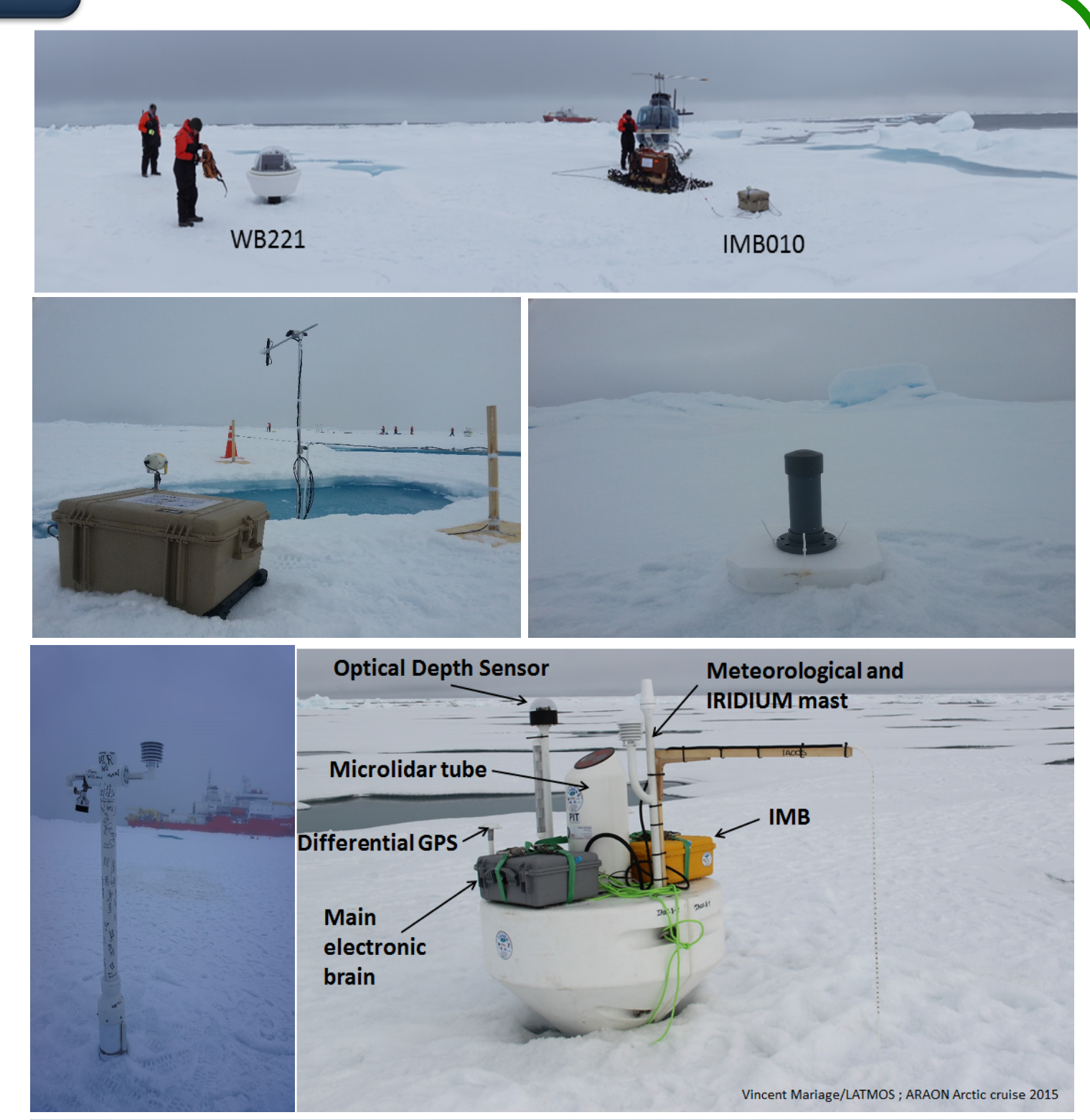


Figure 12. Photos of WB and IMB buoys, GPS drifter, SIMB, and SITP (from top).

- 2) Melt Pond observation (Fig. 13)
 - Freshwater pond vs. Salty pond (TUMSAT)

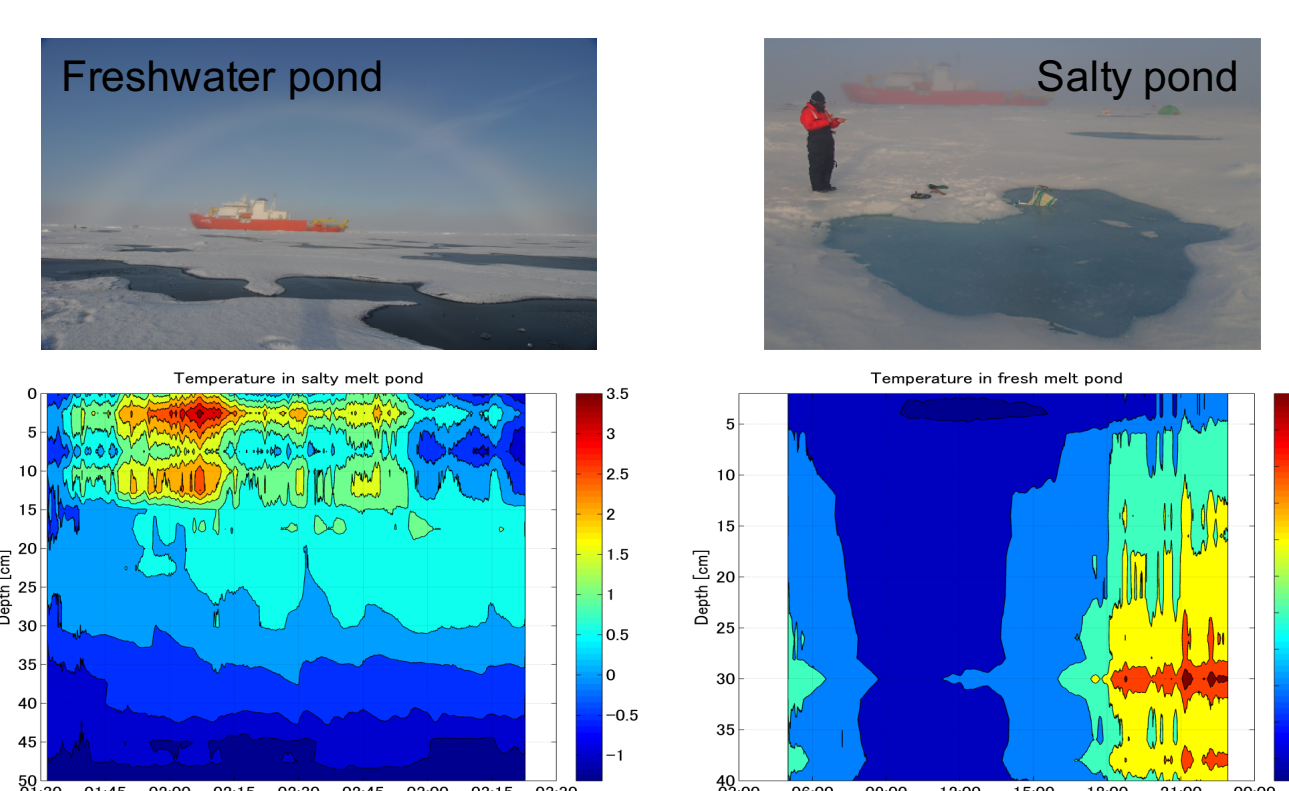


Figure 13. Photos of freshwater pond and salty pond (top), and temporal temperature profiles at individual ponds (down).

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