INTRODUCTION OF GEOPHYSICAL OBSERVATIONS DURING THE 2016 AMUNDSEN SEA CRUISE

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ABSTRACT: During the 2016 Amundsen Sea cruise, we carried out geophysical surveys on the Getz Ice Shelf (GIS) in order to investigate the response of ice-shelf basal melt rates to changes in the underlying ocean. There were three activities performed during the cruise: autonomous phase-sensitive radio echo sounder (ApRES) deployments to measure ice-shelf basal melt rates, seismic surveys with geopebbles to determine the ice base and seabed depths for supporting the gravity survey, and helicopter gravity field observations to provide wide area estimates of water depth below ice shelves. The ApRES deployments and seismic experiments were performed at four sites on the western GIS and three two-hour helicopter gravimetry survey flights were flown over the GIS. These observation data will be used to analyze ice-shelf basal melt rates and insight into geological boundaries and structures in the Getz Ice Shelf region. Additionally, some methods of ice mass balance estimation using ApRES and satellite data will be introduced for the future research.

INTRODUCTION

◆ Motivation

- The strongest thermal forcing and highest melt rates were found near the deep grounding line of some glciers, and melt rates are strongly correlated with ocean thermal forcing (Rignot & Jacobs, 2002)
- Half of the meltwater comes from 10 small Southeast Pacific ice shelves occupying only 8% of the area (Fig.1) and basal melt exceeds a calving flux (Rignot *et al*., 2013)
- Antarctic ice-sheet loss driven by basal melting of ice shelves (Fig.2, Pritchard *et al*., 2012)

◆ Research objective

- to determine the sensitivity of the ice shelves around the Amundsen Sea to changes in ocean circulation and temperature and the ocean's response to changes in the freshwater input by the ice sheet

Name	Basal Melt Gt/yr (m/yr)
Antarctic Peninsula	191 (1.5)
East Antarctica	480 (0.7)
West Antarctica	654 (0.9)
Total surveyed	1,325(0.85)
Getz	144.9 (4.3)
Pine Island	101.2 (16.2)
Thwaites	97.5 (17.7)
Dotson	45.2 (7.8)

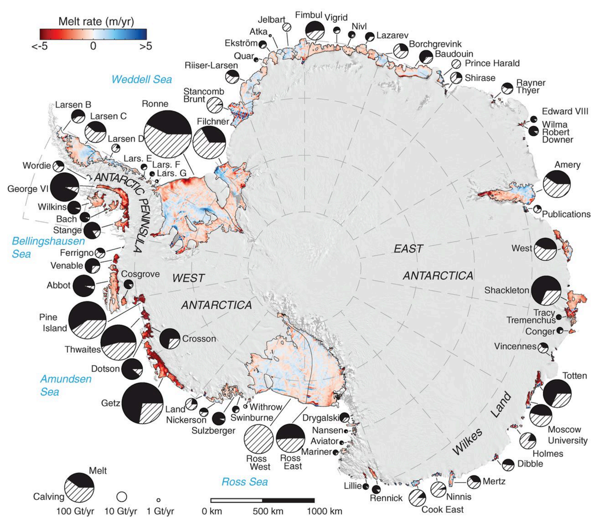


Fig.1 Basal melt rates (2003-2008)

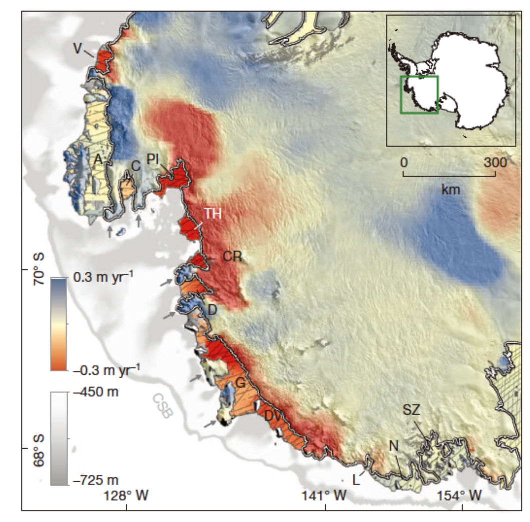


Fig.2 Basal melting and ice-sheet loss

◆ 2015/2016 ARAON Amundsen Sea Expedition (ANA06B)

- Expedition Period: 6 Jan~23 Feb, 2016
- Objective (physical): to identify the spreading of meltwater from the shelves and its effect on the ocean circulation, and to reveal main forcing that affects the flow rate of Circumpolar Deep Water (CDW) onto the Amundsen shelf
- Main method: total 81 CTD stations (Fig.3) and six mooring systems

◆ Geophysical objective: to investigate the response of ice-shelf basal melt rates to changes in the underlying ocean on the Getz Ice Shelf.

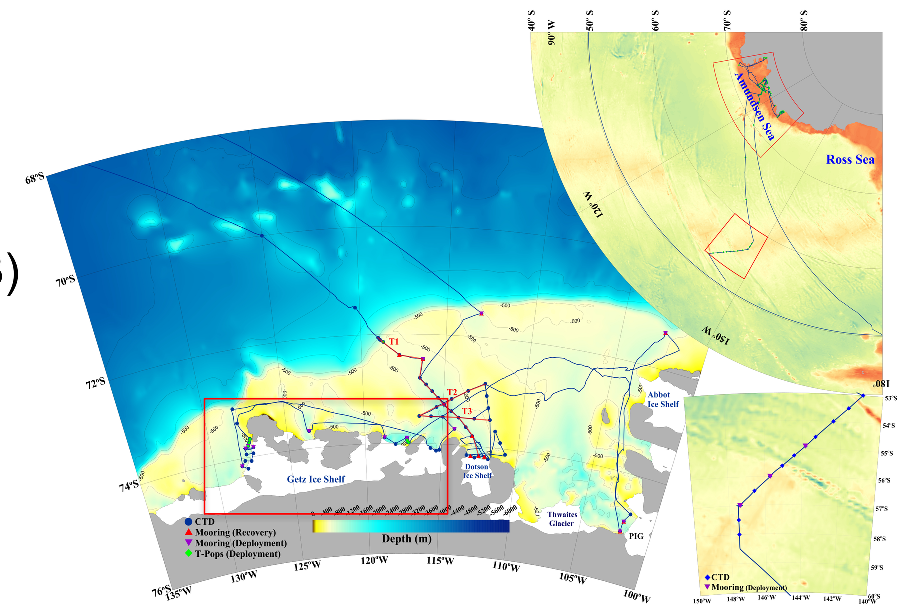


Fig.3 A station map for the 2016 Amundsen Sea Expedition that used the Korean ice breaker Araon.

OBSERVATION

◆ Autonomous Phase-sensitive Radio Echo Sounder (ApRES) : led by P. Abrahamsen

- ApRES: developed by BAS, each radar was connected to compact GPS and Iridium antennas mounted on a 6-m long aluminum pole (Fig.4)
- It can measure every 2 hrs for 2 yrs with one 100 Ah 12 V; GPS for position/recovery; new flat-packable bowtie antennas; subset of data sent back by Iridium; full data set stored internally
- Four ApRES units were deployed on the western side of Getz Ice Shelf, 27 Jan 2016 (Fig.5).

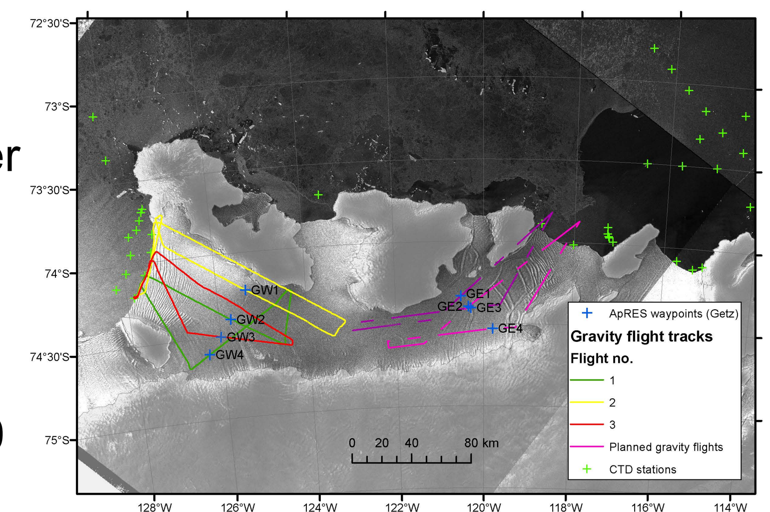


Fig.5 A SAR image of Getz Ice Shelf from Dec 2015 with CTD stations, ApRES/seismics waypoints and actual and planned gravity flight lines superimposed

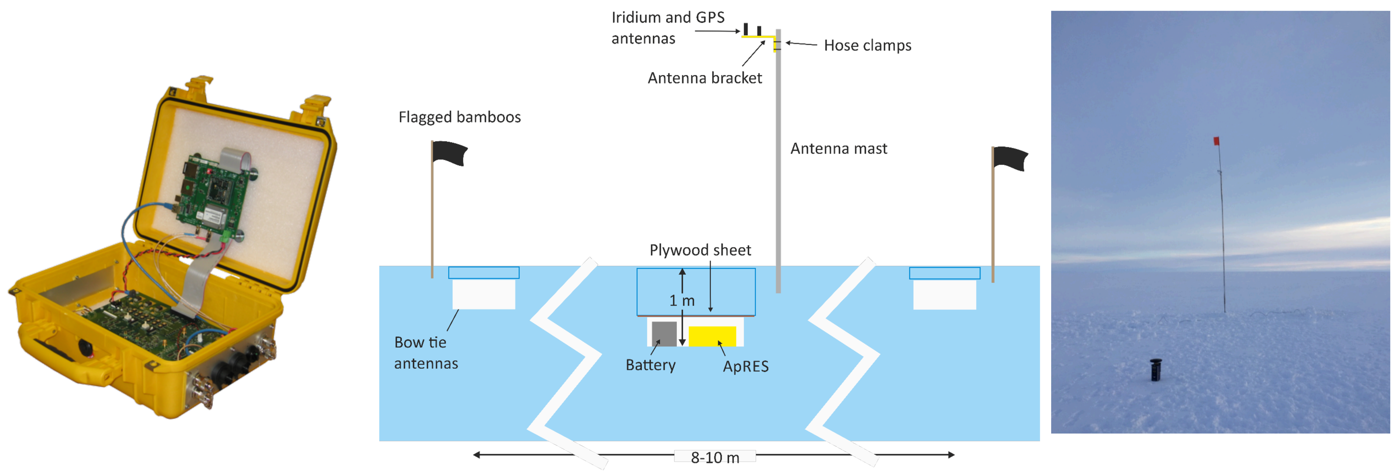


Fig.4 ApRES (left) and schemtic of an ApRES site, showing the wiring connections on each radar (middle), and a photograph taken after installation (right)

◆ Seismic surveys : led by K. Assmann

- Seismic surveys were performed at each of the ApRES sites to determine the position of the bedrock in order to support the gravity surveys and future AUV work under Getz Ice Shelf
- Used a set of 13 wireless geophones called geopebbles that were deployed along a 100m-long line at intervals of 10 m in numerical order with the writing on them facing to the right of the line (Fig.6).
- The sites were completed in the order GW2, GW3, GW4, and GW1.

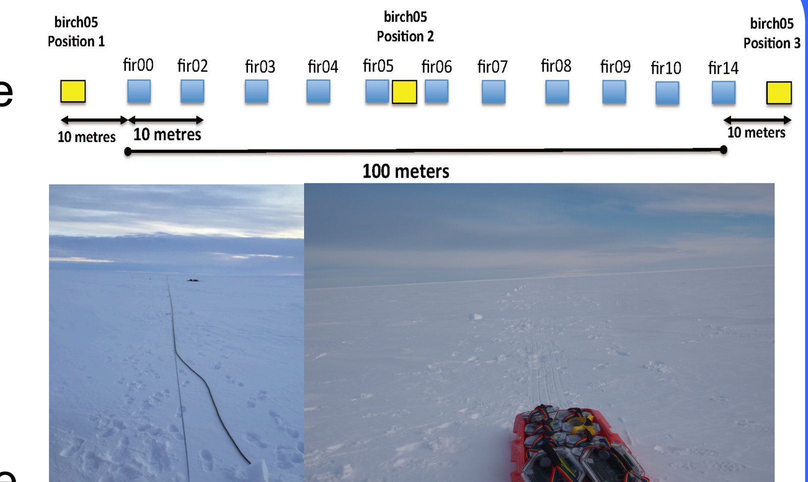


Fig.6 A SAR image of Getz Ice Shelf from Dec 2015 with CTD stations, ApRES/seismics waypoints and actual and planned gravity flight lines superimposed

◆ Airborne gravimetry : led by T. Richter

- To obtain gravimetric data over the Getz Ice Shelf in support the seismic and radar observation
- Gravity field observation provides wide area estimates of water depth below ice shelves as well as insight into geological boundaries and structures
- Three two-hour flights for data collection over the Getz Ice Shelf (Fig.7)

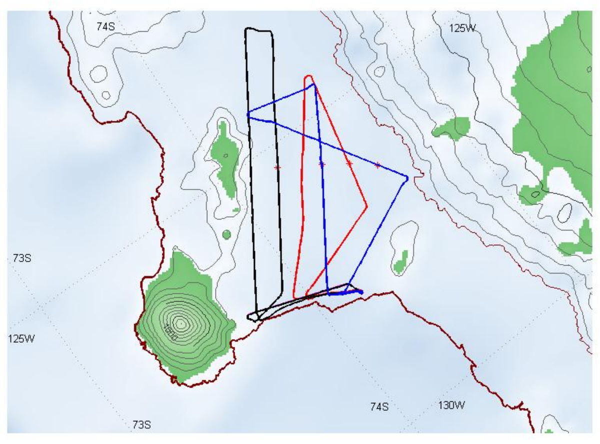


Fig.7 Tracks of the three flights over the western part of the Getz Ice Shelf. Red stars show the locations of the seismic/radar sites

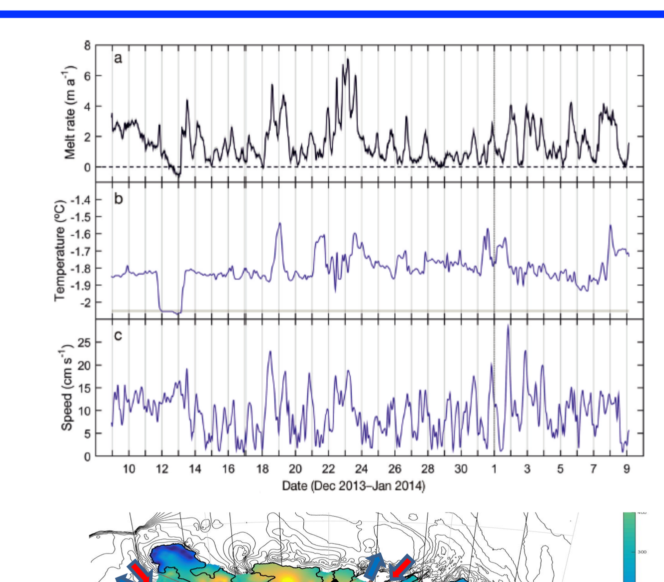
FUTURE WORK

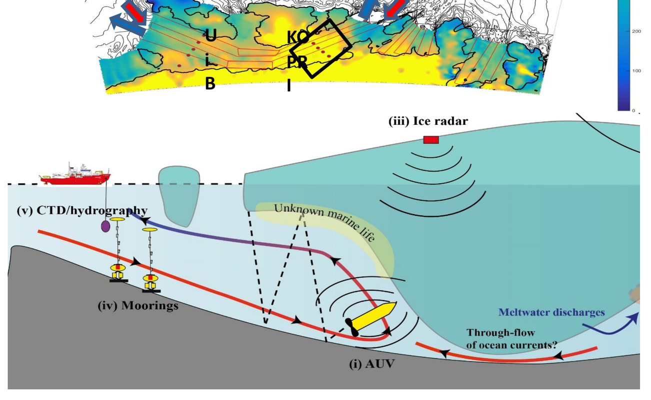
◆ Analysis of ApRES data : led by BAS

- ApRES can provide the variability of key parameters from seasonal down to a day, such as the melt rate at an ice-shelf base (Nicholls *et al*.,2015)

◆ Under-ice shelf observation using autonomous underwater vehicle (AUV) and hydrography survey ice-edge: led by UGOT and KOPRI

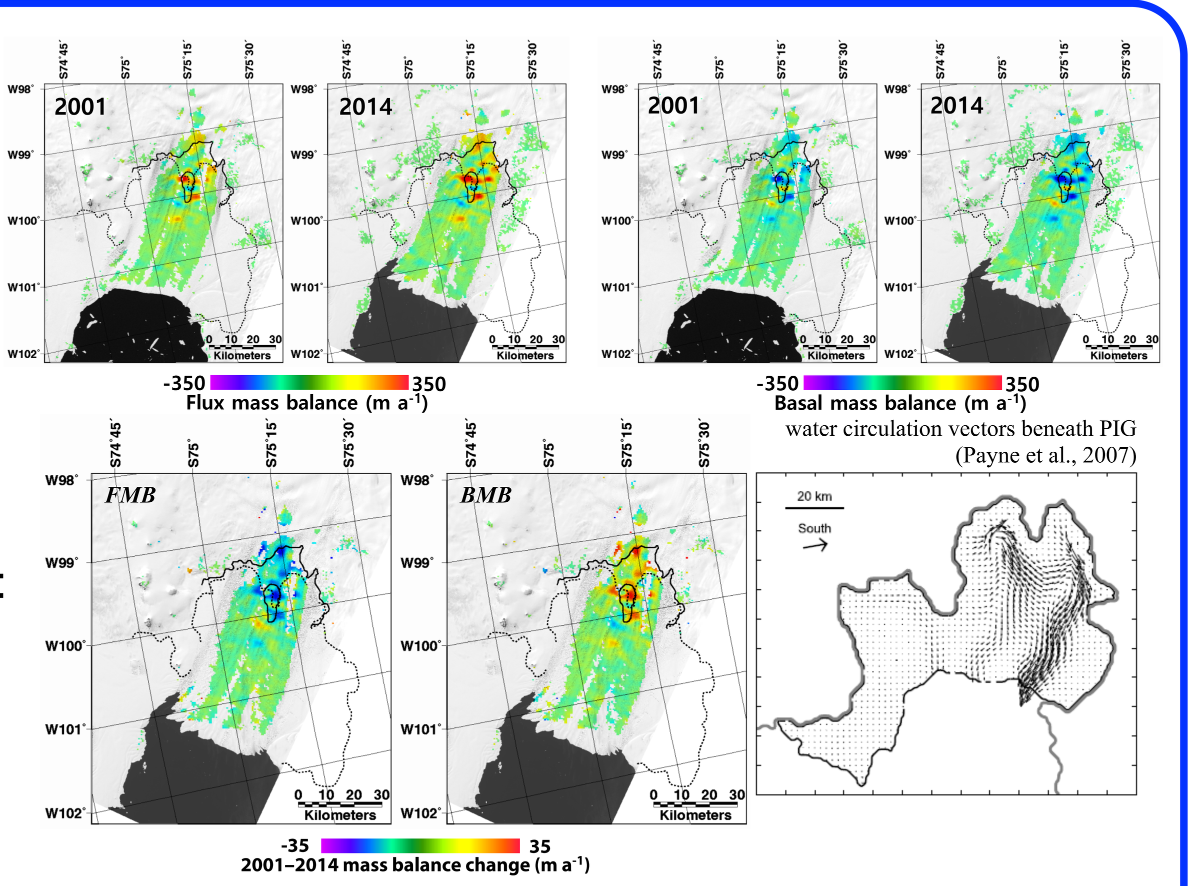
- Combination of ice radar, AUV, and hydrographic survey (CTD, mooring) can provide the whole feature of what is going on beneath the ice shelves in the Amundsen Sea





◆ Estimate of speed and ice mass balance changes using satellite images : led by H. Han

- Mass balance estimation using mass conservation theory
- Ice thickness change: ICESat, Cryosat-2
- Surface mass balance & Firn: RACMO v2.3
- Ice velocity: Landsat multispectral image matching



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