



**ANTARCTICA**  
INSYNC

## **Theme III**

# **Melting Ice Shelves and Ice Sheets and Their Connections to Coastal Ocean and Continental Margin Zones**

Ice sheets & shelves: challenges & uncertainties

**Alexandra Zuhr**

University of Tübingen, Germany

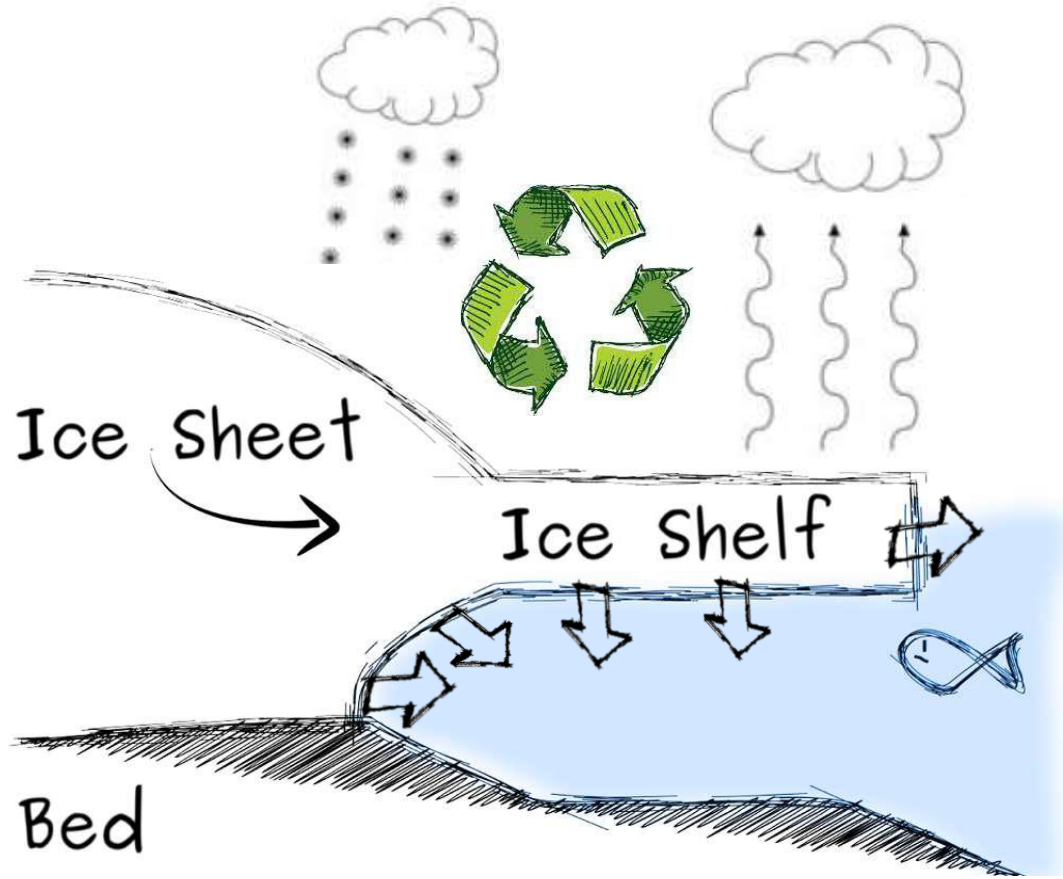
**Felicity McCormack**

Monash University, Clayton, Australia

**+ many Theme III representatives**

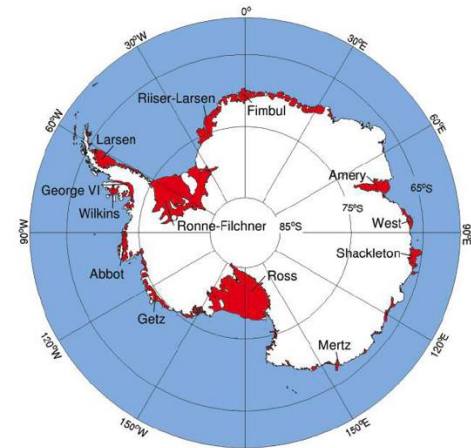
Antarctica InSync Webinar | 22 May 2025

# The Antarctic hydrological cycle and sea level



Antarctica contains about 2/3 of all freshwater on earth; ~58 m of sea level.

80% of all Antarctic mass loss is drained through floating ice shelves.



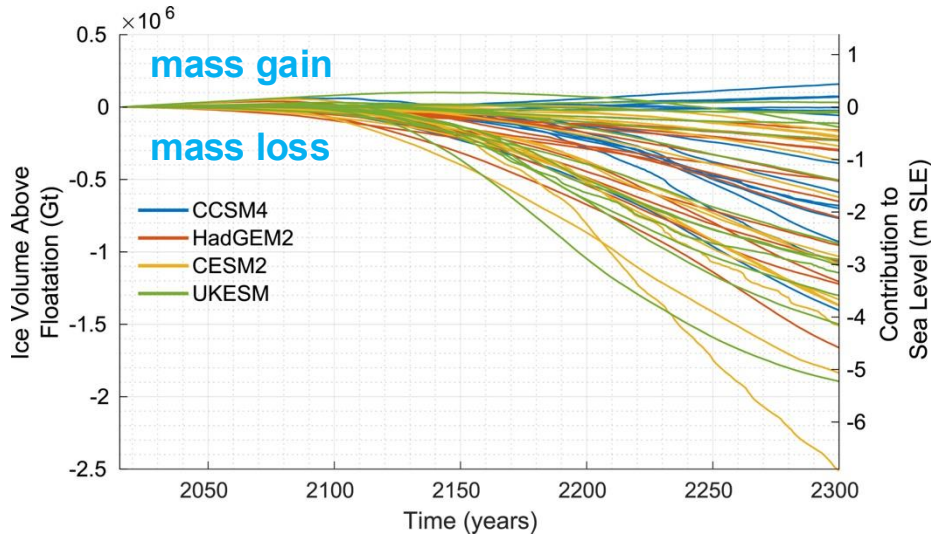
Galton-Fenzi (2012)

Courtesy R. Drews

# Antarctic ice sheet projections



IPCC AR6 to policymakers:  
could not rule out  
5 m Sea Level Rise by 2150  
15 m Sea Level Rise by 2300



## How to help?

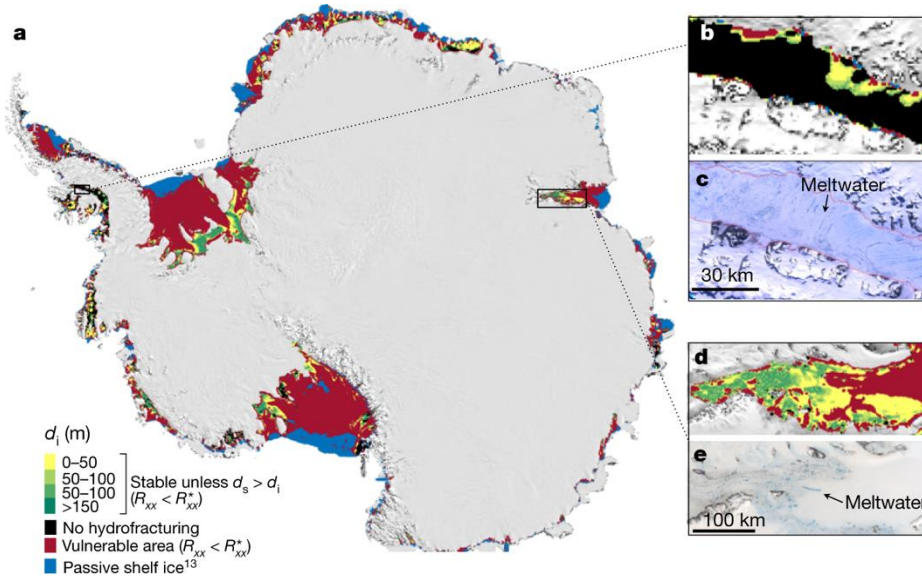
“...the need for more physics and less calibration in the parameterizations and for **more observations of hydrographic properties and melt rates at interannual and decadal timescales.**”  
(Edwards et al. 2020)

Seroussi et al. (2024)

# “Warm” oceans eroding ice shelves from below

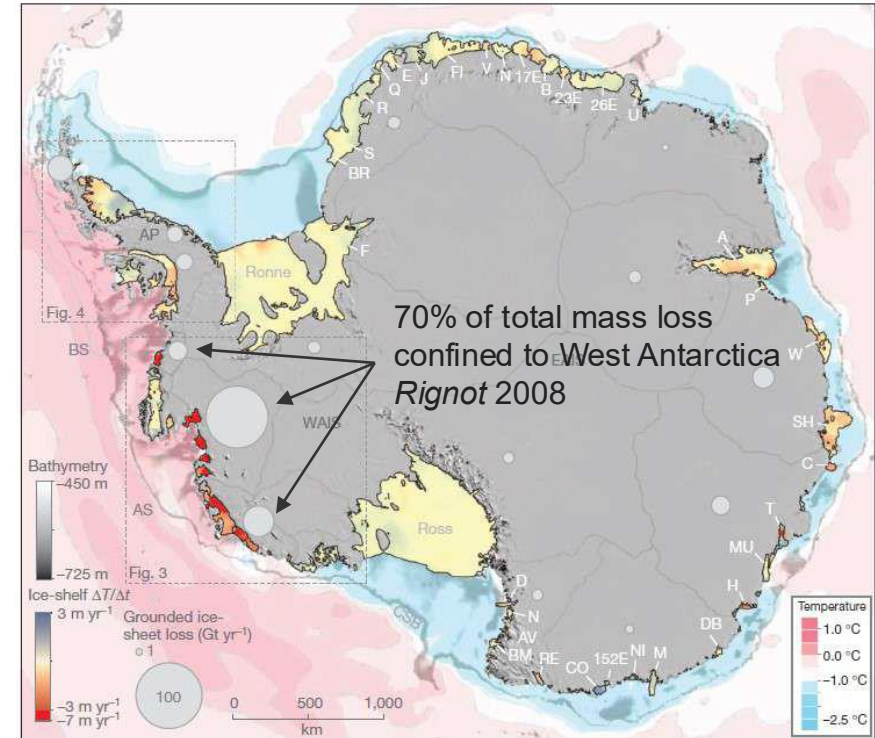


Mass loss due to hydrofracturing and calving caused by melting



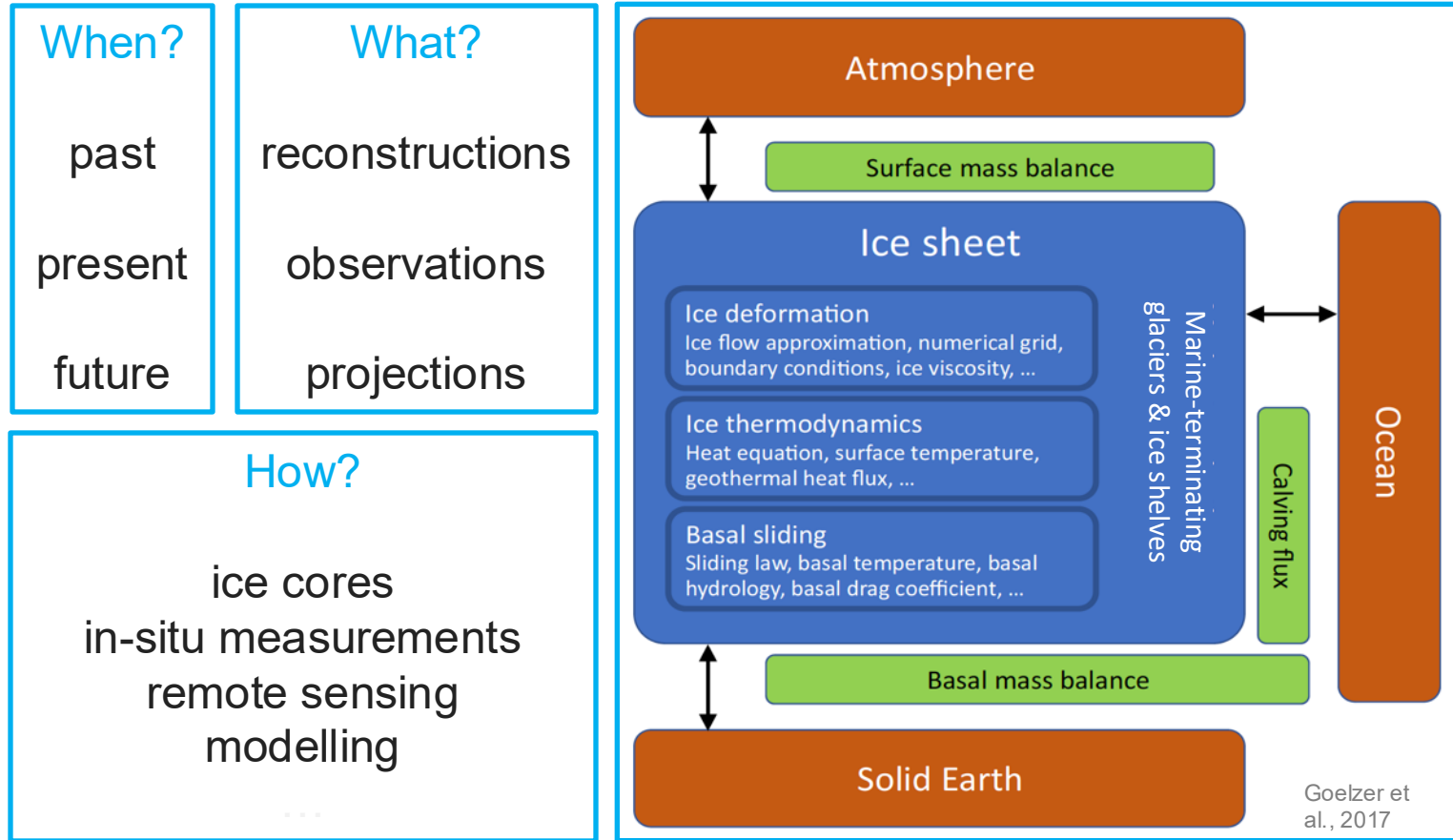
Lai et al. (2020)

Mass loss from warmer water on the continental shelf



Pritchard et al. (2012)

# How to characterize an ice sheet



# Research Foci



- Ice shelves: basal melting, surface elevation changes, structural integrity
- Ice shelves – sea ice – ocean: water formation, freshwater, circulation
- Ice – ocean interactions: boundary conditions, parameterizations in ice-flow and climate models (processes, ice – ocean – mélange)
- Ice sheet / shelf – ecosystem: ice retreat and runoff, habitats and ecosystems
- Ice sheet: climate change on the Antarctic plateau
- Solid Earth – ice sheet: boundary conditions

→ Addressing the complex relationships between cryospheric processes, oceanography, geology, ecology, and climate change in the Antarctic region

# Existing Initiatives in Antarctica



## NECKLACE

- Time series of ice-shelf basal melt rates at selected locations
- Circum-Antarctic coverage over ~5a

SOOS endorsed

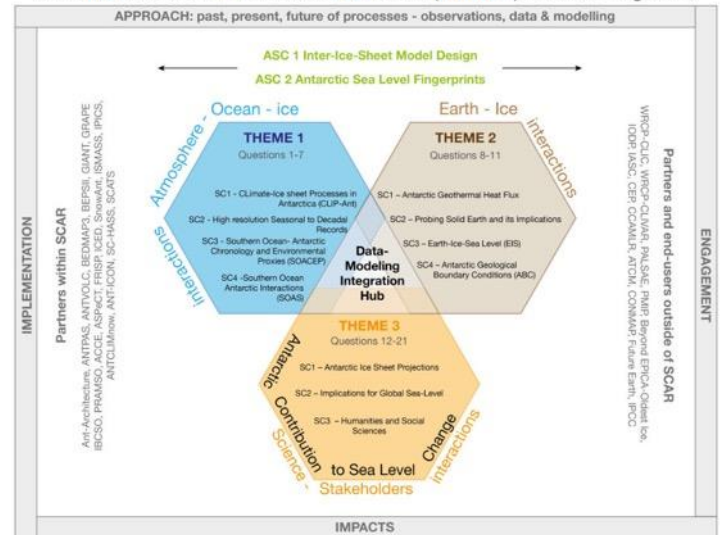
## RINGS



SCAR Action Group  
COMNAP endorsed

## INSTANT

SCAR **INST**abilities and **Th**resholds in **ANT**arctica (**INSTANT**) Research Programme



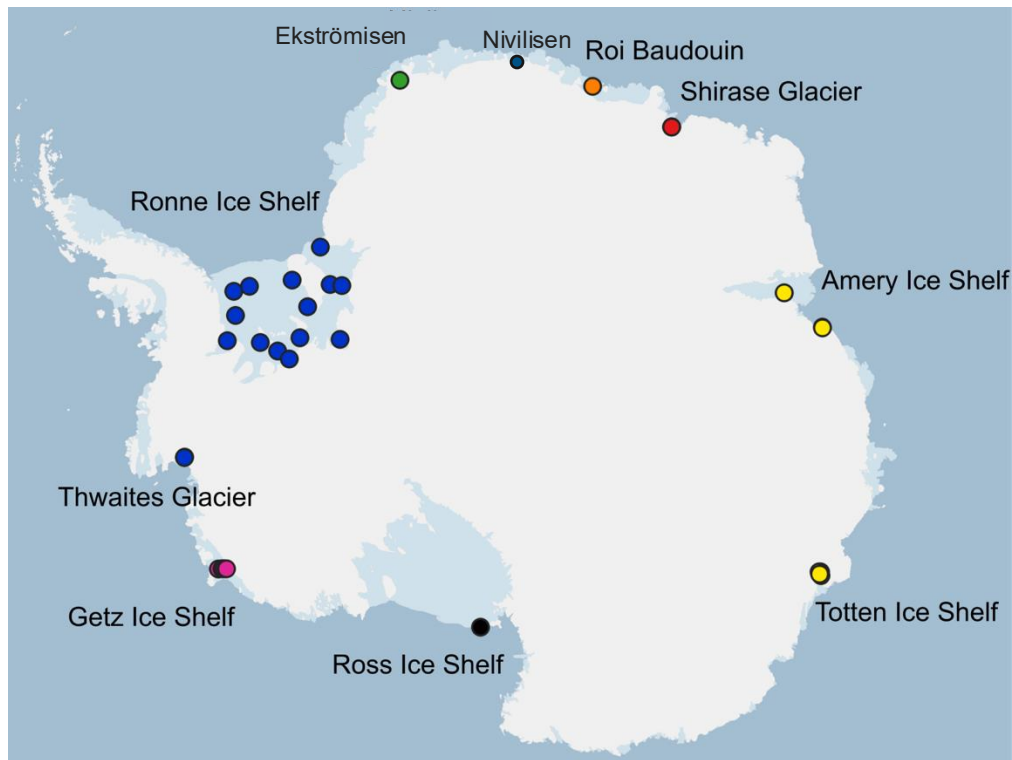
SCAR SRP



# NECKLACE

A circum-Antarctic dataset of basal melt rates

Contact: Sue Cook (UTAS)



Aims to collate field observations of ice shelf basal melt rates for use in validating model and satellite datasets

Autonomous radar (ApRES) have been deployed at 28 sites on 12 ice shelves (and growing)

Further instrument deployment encouraged to increase spatial and temporal coverage of dataset

Still need community engagement in creating and using standardised data format



AAP  
Australian Antarctic  
Program Partnership

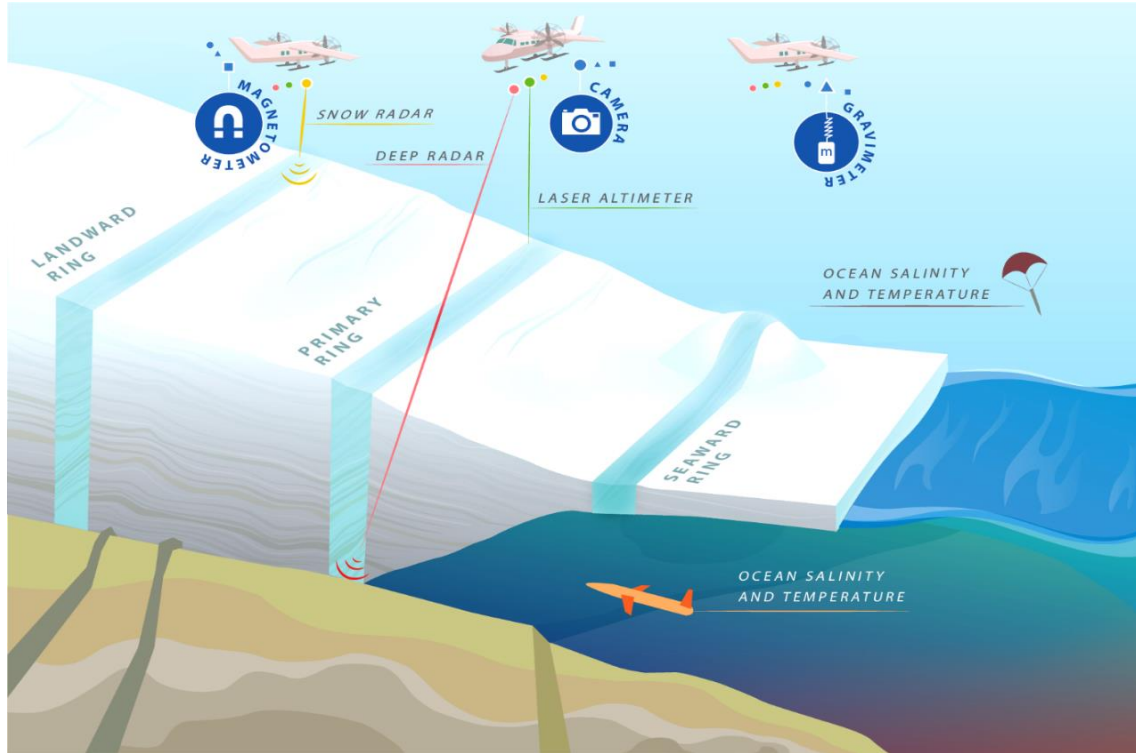


British  
Antarctic Survey  
NATURAL ENVIRONMENT RESEARCH COUNCIL



# SCAR RINGS Action Group

Contact: Kenny Matsuoka (NPI)



Interdisciplinary, coordinated airborne missions

Primary target = bed topography at the margin

- Complete reference bed topography data for robust assessments of ice discharge from all around Antarctica

Primary RING + seaward + landward RINGS

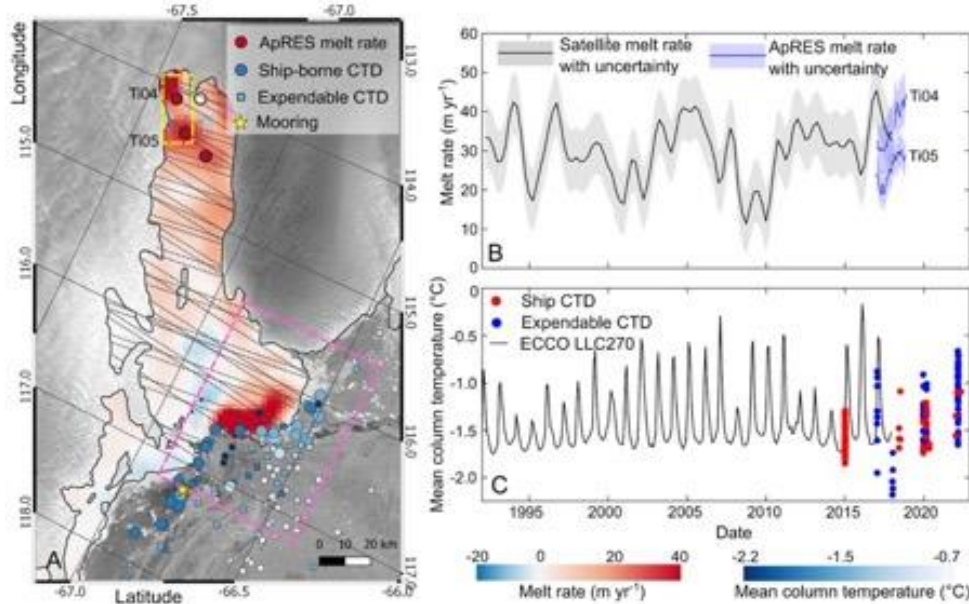
- Prediction of future retreat of the margin
- Sub-ice-shelf bathymetry and quantification of ice-ocean interactions
- Geology and subglacial hydrology

# RECOIL

Contact: Dan Goldberg (Edinburgh)



A framework for REconciling Cross-platform Observations of Ice-shelf meLt

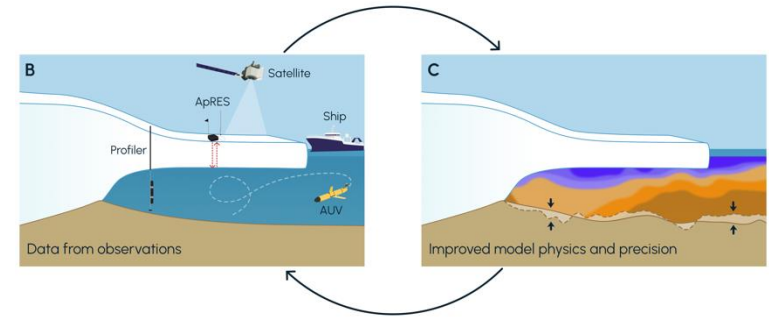


Ensuring intercomparability between in-situ-, satellite- and oceanographic-derived estimates of ice shelf melt

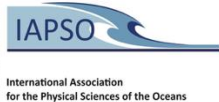
Recommendations for:

1. How to evaluate proposed field campaigns to maximise comparability between melt measurements
2. "Ice-shelf laboratory" style campaigns to instrument single ice shelf to comprehensively

First workshop hosted Sept 2024; manuscript in progress! Thanks to IAPSO, EU project OCEAN:ICE, and SOOS for funding.



Figures: McCormack et al. (2024)



OCEAN:ICE

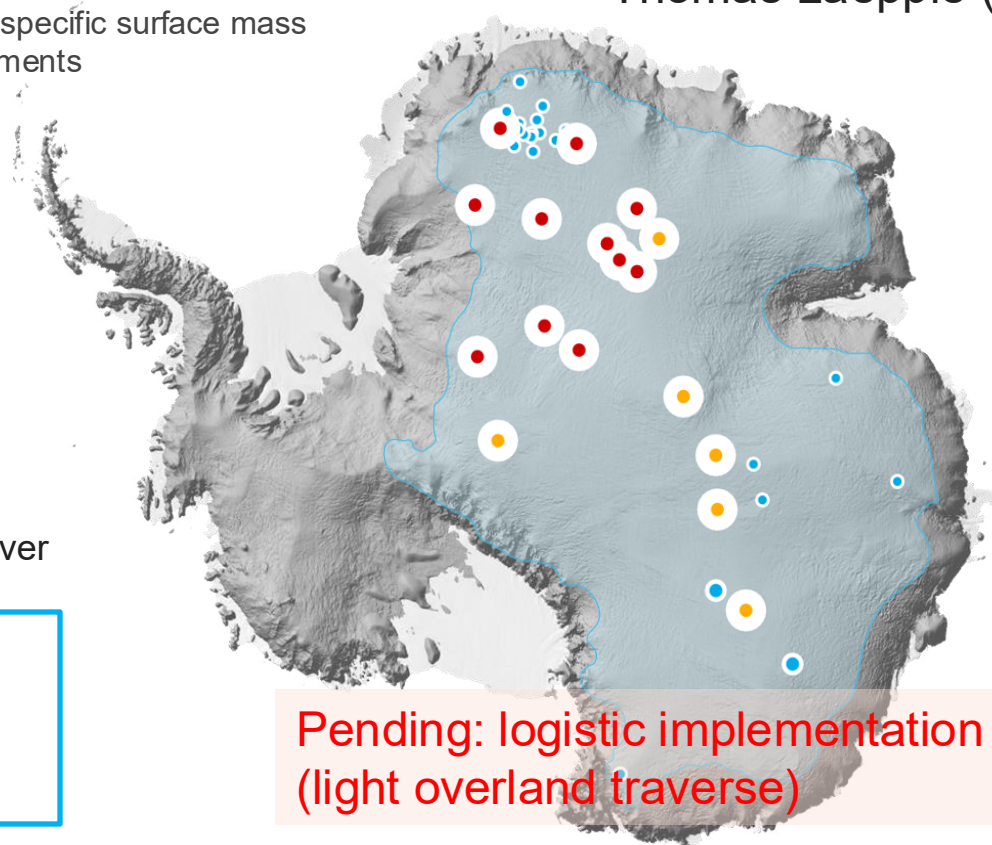
# The Plateau-InSync Expedition: Unraveling Recent Climate Change Across East Antarctica



Contact:  
Thomas Laepple (AWI)

- Proposed Plateau-InSync expedition
- Possible extension
- Possible extension
- Similar program on collaboration sites
- other ice-cores

Temperature and specific surface mass balance measurements



Time constraint to <2027 as the existing boreholes get more and more difficult to recover

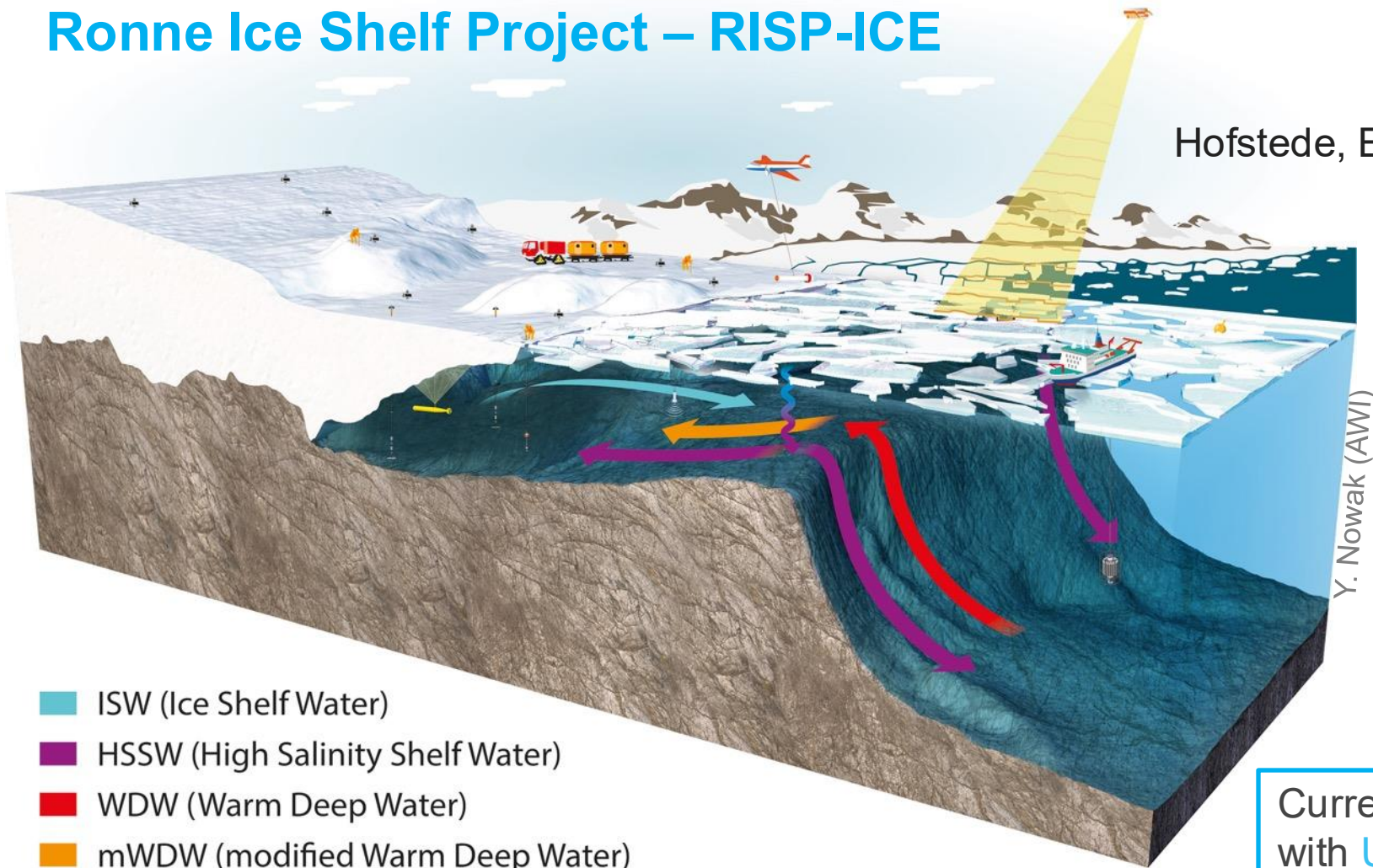
Current contacts:

- Switzerland
- Norway
- France
- South Africa

# Ronne Ice Shelf Project – RISP-ICE



Hofstede, Eisen et al.

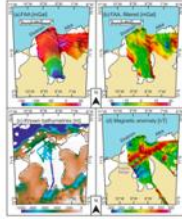


Current planning  
with [UK](#), [Norway](#)

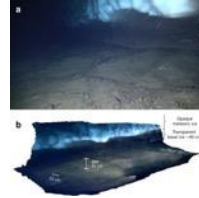
# Ronne Ice Shelf Project – RISP-ICE

Pending: ship support

Airborne gravimetric and magnetic data  
Eisermann et al. 2020



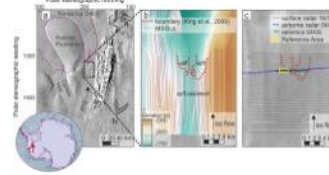
Sediment coring and AUV surveys  
Owsianowski, 2021



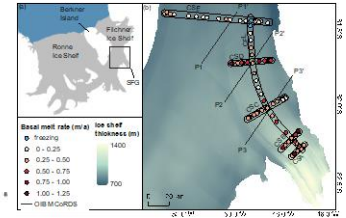
Hofstede, Eisen et al.,  
Current planning with UK, Norway



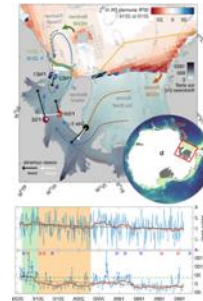
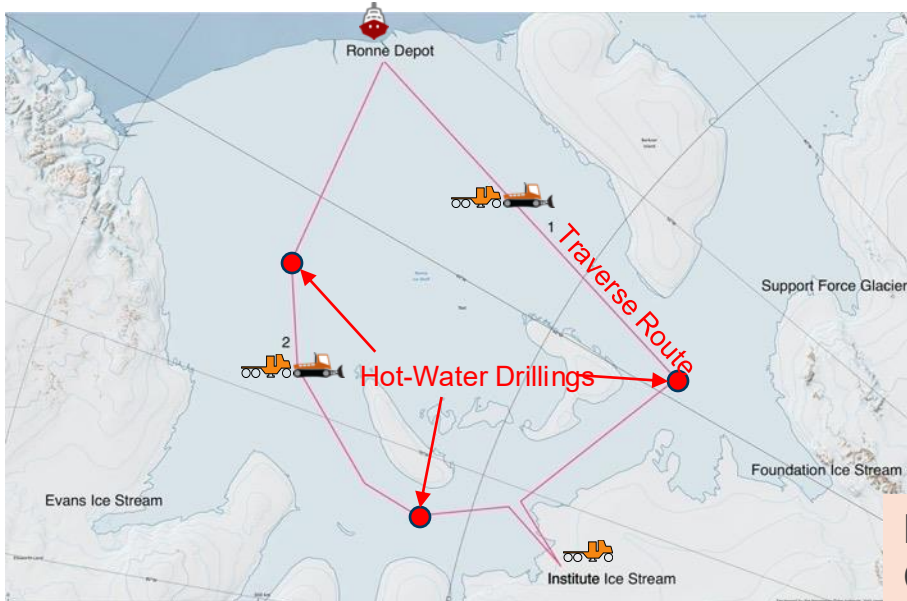
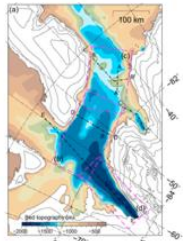
Ice stream properties  
Schlegel et al. 2021



Basal melt rates  
ApRES Zeising et al. 2021



Improved sub-ice shelf bathymetry from seismics  
Rosier et al. 2019



Sub-shelf instrumentation for ocean circulation  
Hattermann et al. 2021

Sub-shelf biology (cf. Sub-EIS-Obs)



Related to UN, Ocean & Cryosphere Decade and SCAR, Southern Ocean Action Plan

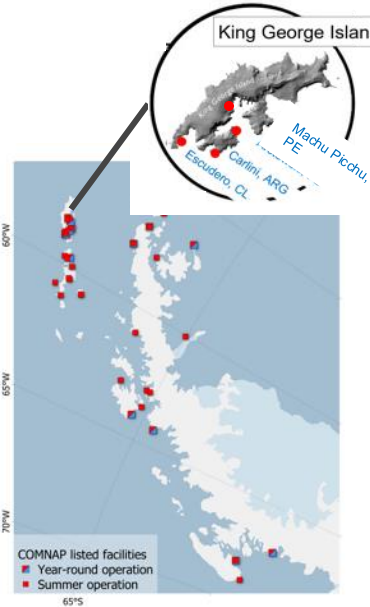
# Impacts of ice retreat on coastal benthic ecosystems



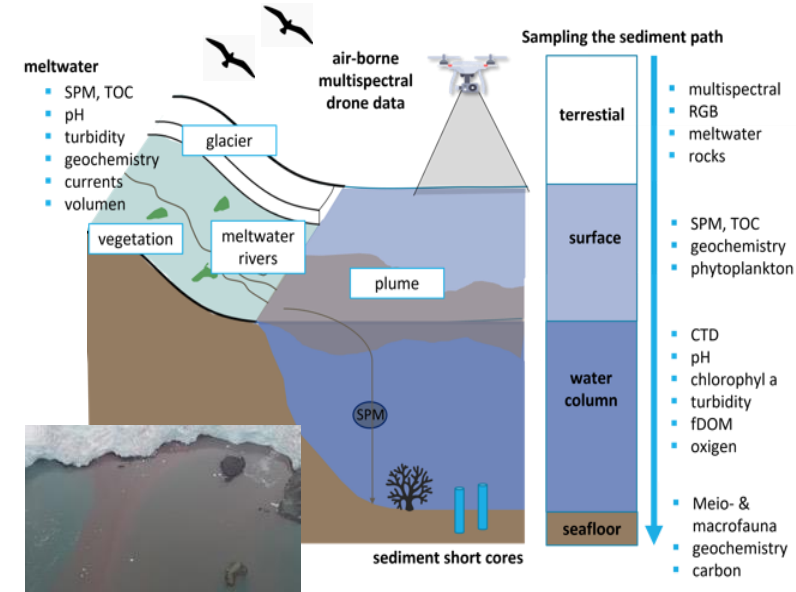
## GOALS – insights along WAP

(most threaten region by impacts of climate change)

Jerosch, Weith, Lisovski, Steinhöfel-Sasgen, Richter et al. | AWI



- **mapping of marine glacial outflow areas** (plumes) of in front of glaciers along WAP
- survey **erosional processes and meltwater streams** which are directly **linked to changes in the marine and benthic ecosystem** (sediment and freshwater delivery from the shore)
- mapping **implications for sediment and landscape stability** by opportunistic vegetation succession in deglaciaded areas
- to analyze the **multidirectional transport of organic matter via animals** to identify source and sink regions
- relate findings to **benthic biodiversity and ecosystem functions** (sedimentation rates, habitat shifts, community modelling)



Interlinkage with InSync Animal Tracking group