Project 4: Research Team

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PhD students:
- David Webb (2020)
- Zhi Li (2021)
- Hannah Dawson (2023)
- Julia Neme (2023)
We aim to advance our understanding of the dynamics, circulation and water-mass formation of the Southern Ocean, its role in the uptake of heat and carbon, and its impact on global climate.
Analysis of Subantarctic Mode Water formation and variability at two mooring sites in the southeast Indian and southeast Pacific.

Dynamics and properties of eddy variability in the ACC.

Quantify subduction rates of Subantarctic Mode Water and Antarctic Intermediate Water using Argo data (Lagrangian, WMT, and volumetric methods).

Analyses of bottom water properties, variability and pathways, from Deep-Argo floats and historical observations.

Studying exchange of water masses across and along the Antarctic shelf with modelled Lagrangian particle expts.

Quantifying the exchange of mass and heat in the Ross and Weddell gyres.

Analyses of the dynamics of an eddy/upwelling hotspot in the Antarctic Circumpolar Current.
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Subantarctic Mode Water formation, subduction, and variability

Geophysical Research Letters

Research Letter

Tropical Indo-Pacific teleconnections to Southern Ocean mixed layer variability

Qian Li, Matthew H. England

Tropical Teleconnections to Antarctic Sea Ice During Austral Spring 2016 in Coupled Pacemaker Experiments

Ariaan Purich and Matthew H. England

Winter MLD > 400 m  +++ Max MLD variation  Ekman transport  Rossby wave train
Subantarctic Mode Water formation rates estimated during the Argo era, using a water mass transformation framework alongside Eulerian and Lagrangian approaches. SAMW subduction pathways also calculated using a Lagrangian analysis.
Subantarctic Mode Water formation and variability using Argo measurements

Zhi Li, England, Groeskamp, Cerovečki and Luo

Journal of Physical Oceanography
Work planned for 2020/2021:

1. Analyze the processes controlling the transport and variability of the Ross and Weddell gyres (including heat transport toward the shelf)
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3. Examine the two-time scale response of the Southern Ocean to global warming and wind intensification across ocean model simulations at 1, 0.25 and 0.1 degree resolutions
Welcome to the COSIMA Home Page.

COSIMA is the Consortium for Ocean-Sea Ice Modelling in Australia, which brings together Australian researchers involved in global ocean and sea ice modelling.

COSIMA's origins date back to 2012. We are comprised of a number of university nodes (ANU, UNSW, UTas) and the major publicly-funded research agencies (Bureau of Meteorology, Australian Antarctic Division and the CSIRO) and are strongly supported by the National Computational Infrastructure and the Australian Research Council.
Mooring Observations of Air–Sea Heat Fluxes in Two Subantarctic Mode Water Formation Regions

Veronica Tamsitt; Ivana Cerovečki; Simon A. Josey; Sarah T. Gille; Eric Schulz

https://doi.org/10.1175/JCLI-D-19-0653.1

Composites of ERA5 net heat flux winter anomaly preceding deep/shallow MLD at OOI


OOI Southern Ocean flux mooring

Credit: MNF
Lagrangian pathways and residence time of warm Circumpolar Deep Water on the Antarctic continental shelf

- 0.1° horizontal resolution ocean, sea-ice model, released
- Water mass transformation limits CDW access to ice shelves in dense shelf regions even when there is strong upslope CDW transport
- CDW has a short residence time in dense shelf regions (Prydz, Ross/Adelie, Weddell), but there are highly localised spatial patterns particles every 5 days for 1 year along 1000 m isobath and track on continental shelf for 5 years
Lagrangian pathways and residence time of warm Circumpolar Deep Water on the Antarctic continental shelf

- CDW in dense/fresh shelf regions undergoes a two-timescale transformation: isopycnal (cooling+freshening) on the slope followed by diapycnal (cooling+salinification) on the shelf.

- Future: Ongoing work to understand seasonality and regional patterns, submission of manuscript to GRL (Tamsitt et al. in prep)
Future work

- Extend Antarctic shelf work to look at sensitivity of warm water on shelf to different atmospheric forcing, and inclusion of tides in the model.

Other projects near completion:

- The **imprint of the Polar Front on air-sea interaction** and heat fluxes - manuscript to be submitted this year (Bharti, Tamsitt et al)
- **Submesoscale upwelling** of Circumpolar Deep Water in the Polar Front - manuscript to be submitted this year (Wang, Tamsitt et al)

Temperature anomalies in the Amundsen Sea in response to +/- Southern Annular Mode conditions
Dynamics of eddying hotspot in the ACC

Survey Area

Data from Oct-Nov 2018 voyage

South ↔ Distance from PF core [km] → North

Mean buoyancy

SSH standard deviation (m)

Mean Udownstream [m/s]
Elephant seal data used to estimate cross-slope eddy transport for the first time around East Antarctica (red arrows = eddy transport hot spots)
Water mass exchange across the continental slope

"Along-slope variability of cross-slope eddy transport in East Antarctica" - Foppert, Rintoul, and England (GRL, 2019)

- Cross-slope eddy transport inferred from observed density-layer thickness gradient in East Antarctica
- Enhanced transport (1.5 x East Antarctic mean) of warm, salty Circumpolar Deep Water found in regions of high isopycnal spice variability
- Eddy-induced overturning carries about 0.8 m²/s of CDW poleward, increasing the reservoirs of heat and salt available to cross the shelf break in those eddying regions
Future work: participation on R/V Investigator voyage to conduct a hydrographic survey of the Antarctic slope/shelf region near Prydz Bay in summer 2021

- Quantify the structure of the Antarctic Slope Front/Current system
- Characterize the regional hydrography for krill population and distribution studies lead by AAD
- Deployment of BGC-Argo floats
Trends in SO uptake (GtC/yr/decade)

- Synthesis of observations and models
- Very large decadal SO Variability
- SO CO₂ sink variability is more dominated by climate var than CO₂ var

The biogeochemical structure of Southern Ocean mesoscale eddies

- Vertical BGC structure characterized (1st time)
- Controlled by eddy dynamics below MLD & biological processes in the mixed layer.
- Eddy transport supports productivity outside the Southern Ocean (i.e. at lower latitudes)
Decoupling of projected oceanic uptake of carbon and heat in the 21st century - 1/10° simulations

High resolution projections of the ocean carbon cycle changes under different emissions pathways (1/10° simulations)


Tamsitt, V. et al. Lagrangian pathways and residence time of warm Circumpolar Deep Water on the Antarctic continental shelf, In prep GRL.


