Maurice Huguenin

UNSW SYDNEY → WOODS HOLE OCEANOGRAPHIC INSTITUTION

Acknowledgment of Country

- **Bedegal people**

- sovereignty has never been ceded
- climate justice for First Nations people

Mindil Beach, Darwin, AU

Processes and dynamics of global to regional ocean heat uptake and variability

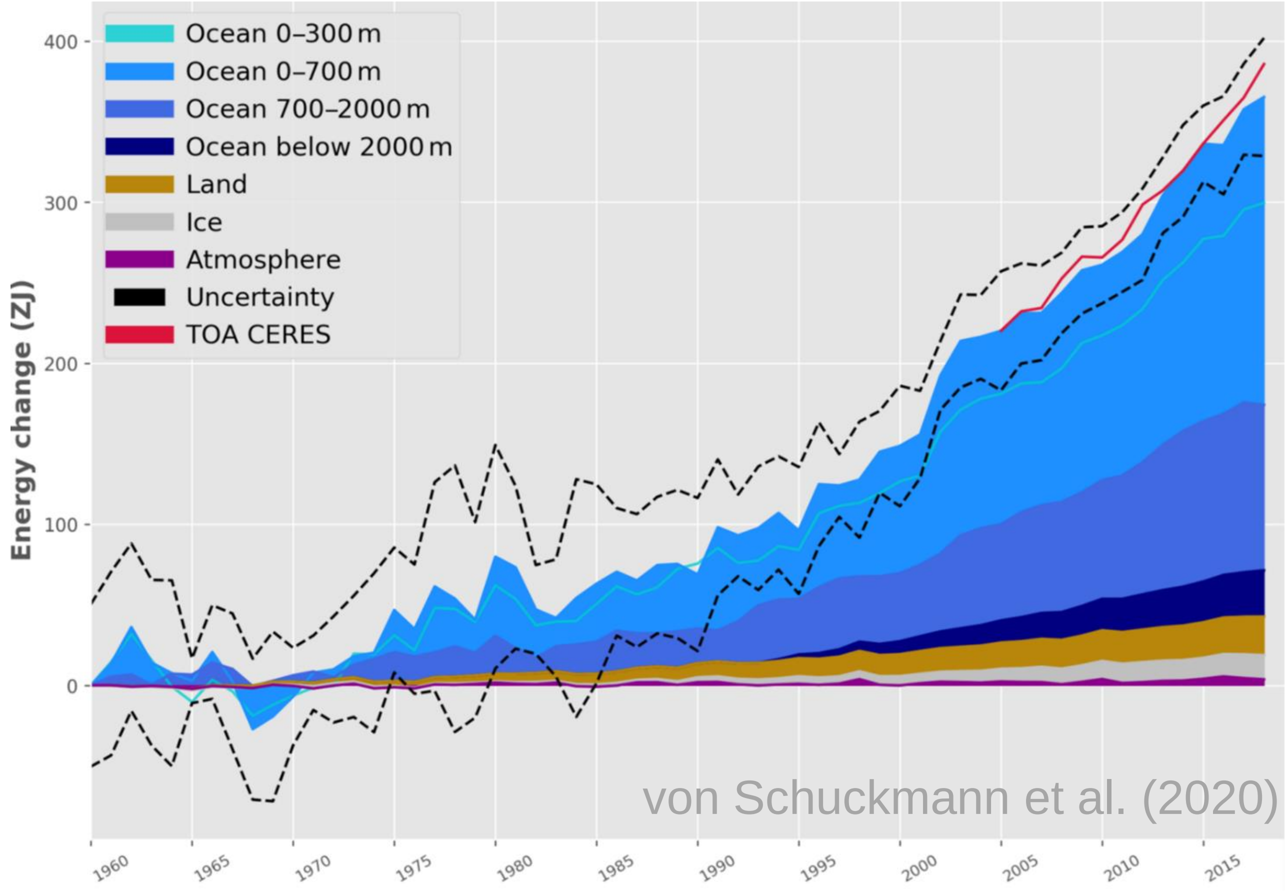
with Matt England & Ryan Holmes

I

Drivers and distribution of global ocean heat uptake over the last half century. *Nature Communications*.

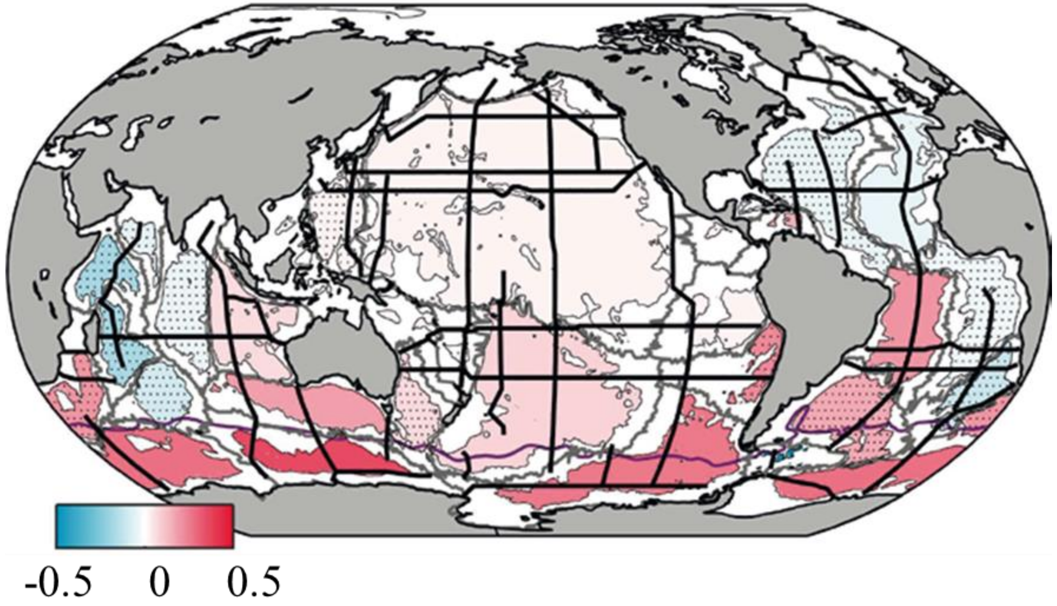
Importance of ocean heat content

Earth heat inventory relative to 1960 (ZJ = 10^{21} J)



von Schuckmann et al. (2020)

Warming rate (°C century^{-1}) below 4000 m

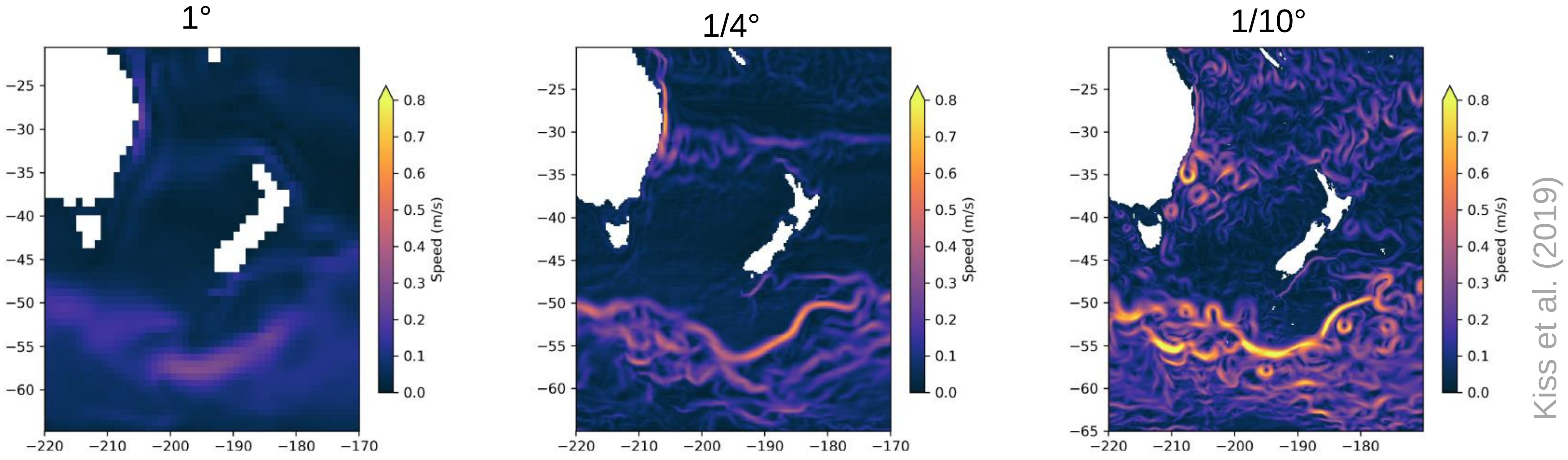


IPCC SROCC, Ch. 5, Fig. 5.4b, Allison et al. (2019)

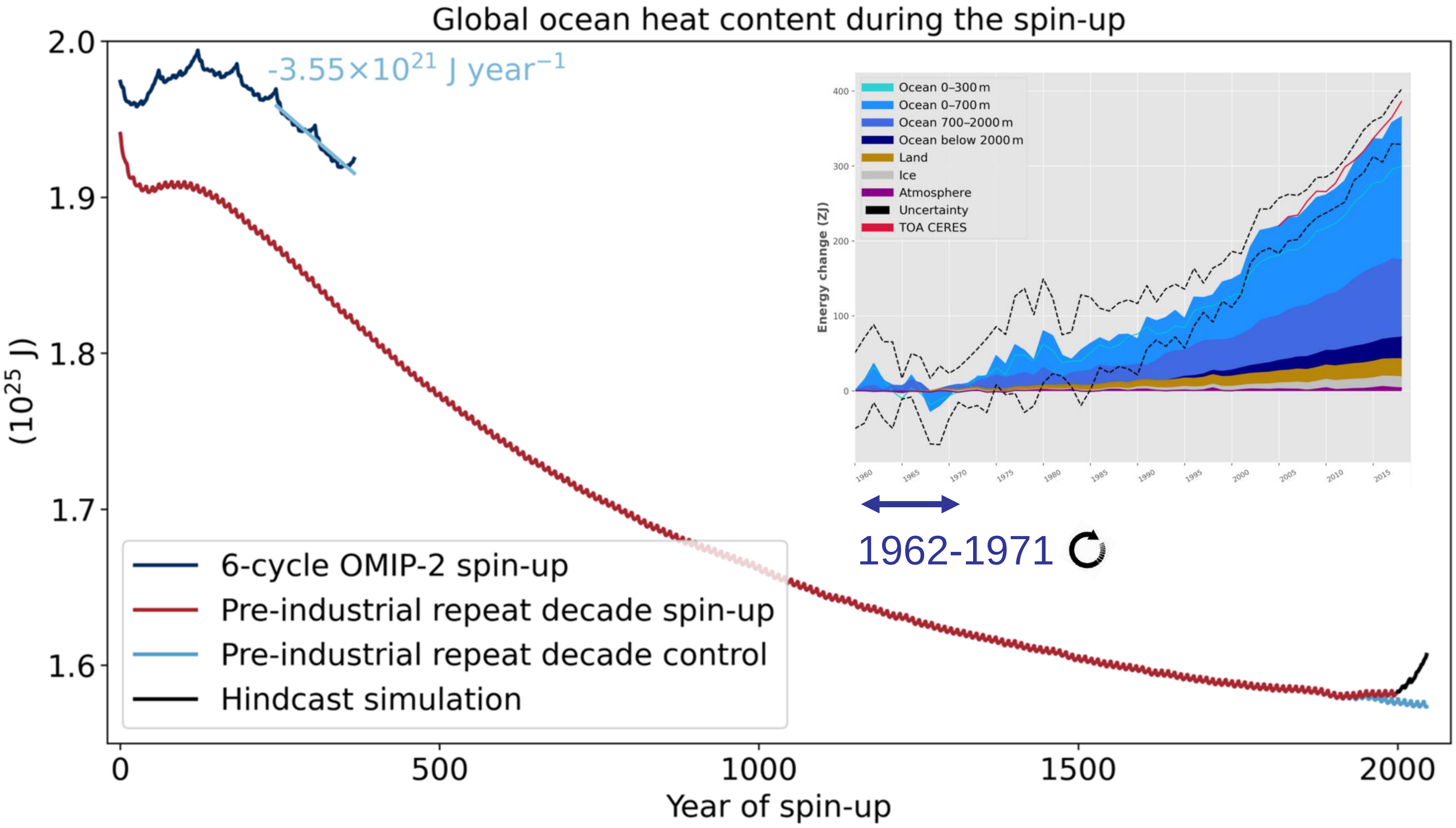
- Where has heat entered the ocean?
- Where is it today?
- What are the roles of wind and thermal forcing?

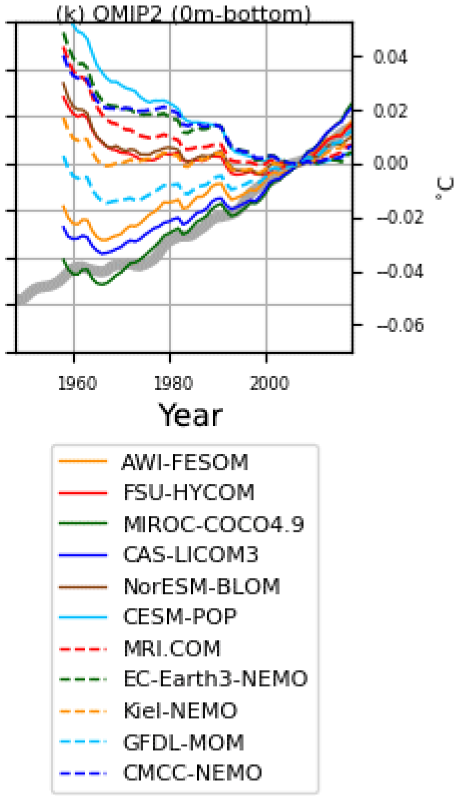
Global ocean-sea ice model

- ACCESS-OM2 (Kiss et al., 2019)
- MOM5.1, CICE5.1.2
- <u>Input:</u> atmospheric reanalysis JRA55-do (Tsujino et al., 2018)



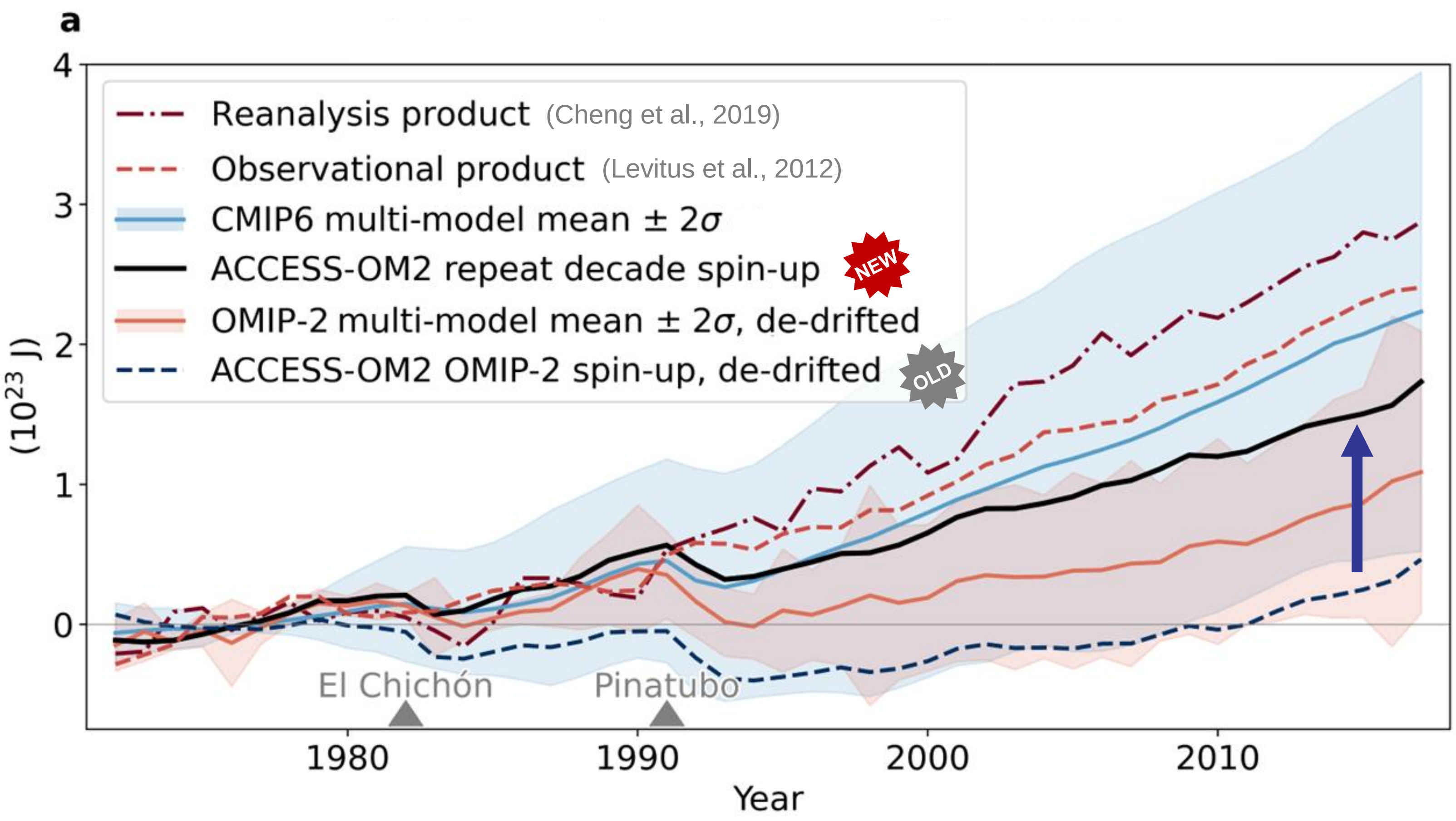
New spin-up for ocean-sea ice models



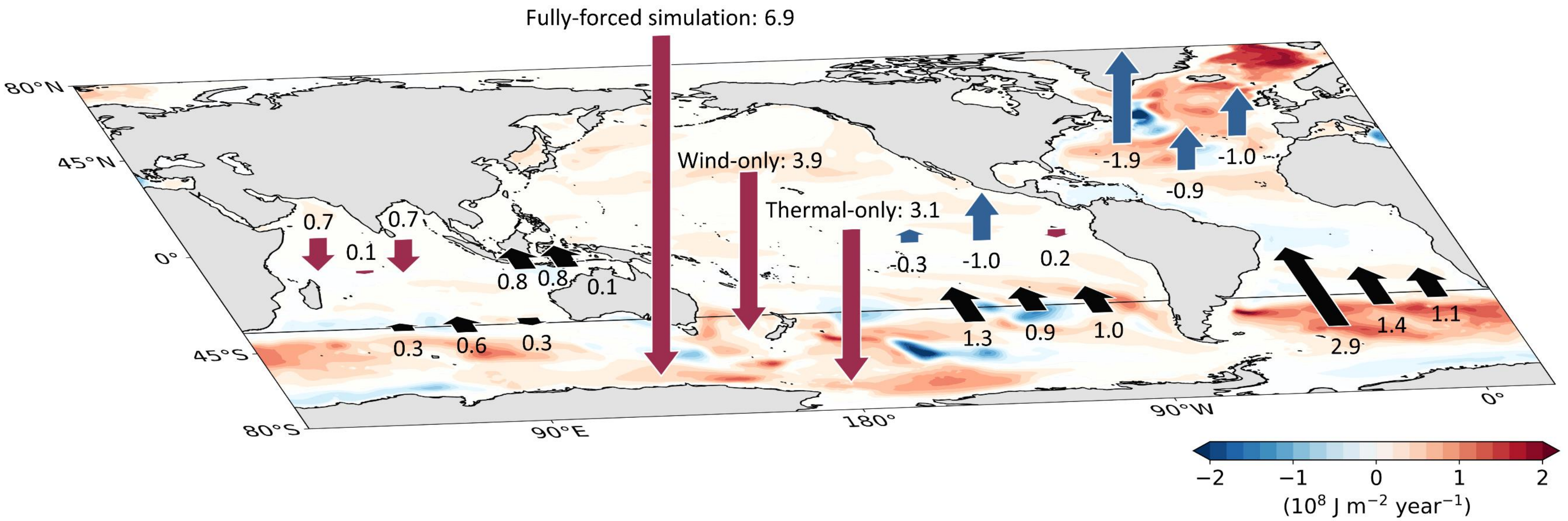


Tsujino et al. (2020)

Global ocean heat content anomalies, 0-2000 m



Schematic



Fully-forced simulation: 6.9
Wind-only: 3.9
Thermal-only: 3.1
80°N
45°N
0°
45°S
80°S
90°E
180°
90°W
0°
0.7
0.1
0.7
0.8
0.8
0.1
0.3
0.6
0.3
-0.3
-1.0
0.2
1.3
0.9
1.0
-1.9
-0.9
-1.0
2.9
1.4
1.1
−2
−1
0
1
2
(10^8 J m^{-2} year^{-1})

10^{21} J year^{-1}
Heat uptake
Heat loss
Heat transport
10^{19} Snickers year^{-1}

UNSW SYDNEY

7 April 2022

rm –rf *

- deleted 12 TB of data
- everything from every project

It's such a horrible feeling when you realise what you've done - but it's so common! In addition to deleting a control run during my PhD, I also incorrectly ran an ensemble of runs last year. Luckily ESM1.5 is (relatively) cheap and fast to re-run... but I felt ridiculous and like a modelling imposter who has no idea what they're doing. I messaged a friend (who's much better at running models than me!) and she was like "oh, don't worry, once I did something similar and ran a whole simulation with X set as -1 instead of 1" and I felt so much better! Hearing these stories make it so much more bearable I think!

Great to hear that you have got things going already and that your results are reproducible. I hope the run completes easily.

Menu THE CONVERSATION

Shutterstock

The Southern Ocean absorbs more heat than any other ocean on Earth, and the impacts will be felt for generations

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Maurice Huguenin, *UNSW Sydney*, Matthew England, *UNSW Sydney*, Ryan Holmes, *University of Sydney*

46,342 0

Processes and dynamics of global to regional ocean heat uptake and variability

with Matt England & Ryan Holmes

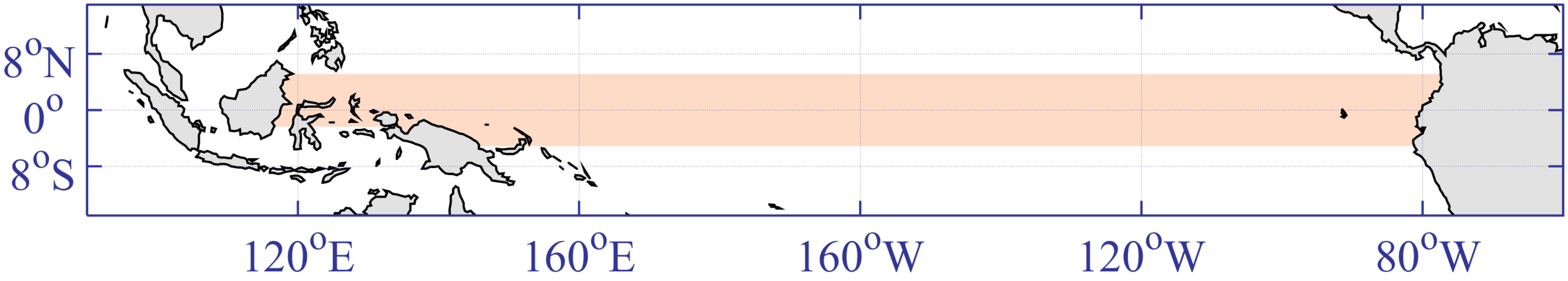
I

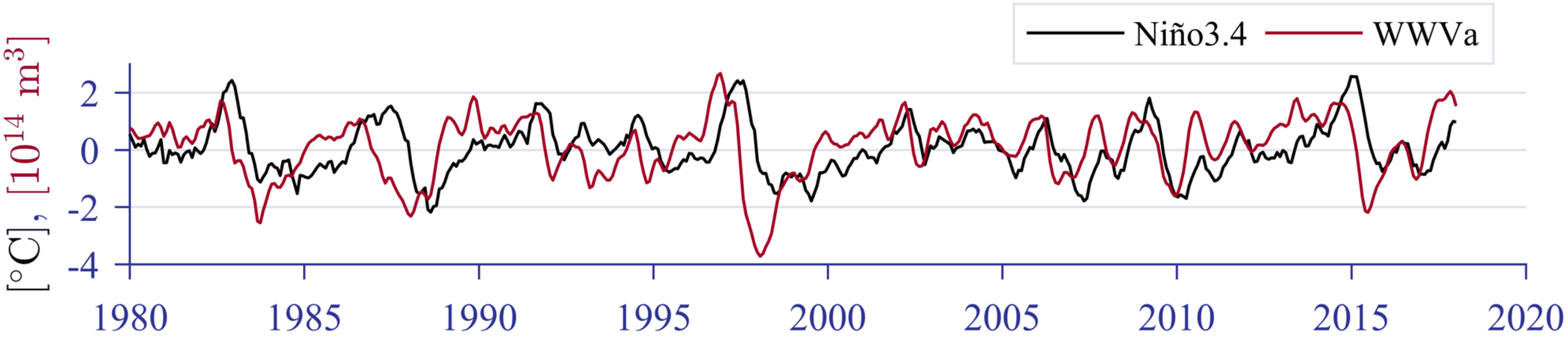
Drivers and distribution of global ocean heat uptake over the last half century. *Nature Communications*.

II

Key Role of Diabatic Processes in Regulating Warm Water Volume Variability Over ENSO Events. *Journal of Climate*.

Motivation





Reynolds et al. (2007); Meinen & McPhaden (2000)

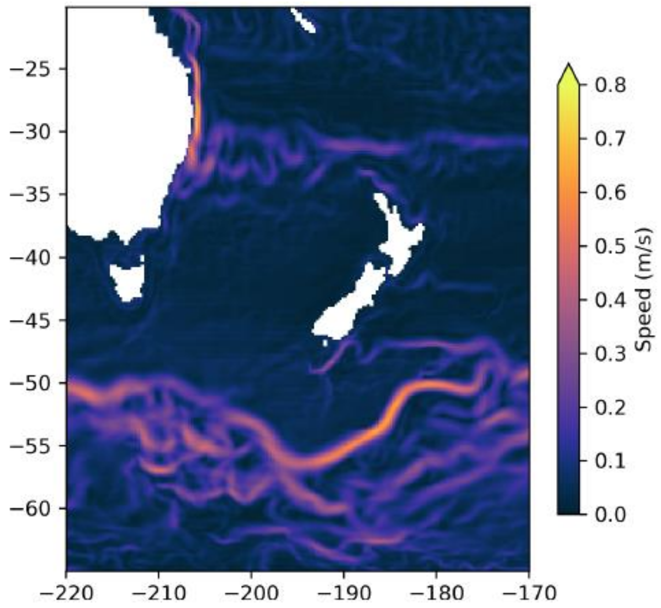
Goals

1. Revisit warm water volume budget using online calculated fluxes
2. Simulate ENSO variability over 1979-2016
3. Examine extreme El Niño & La Niña events and asymmetries

More ocean-sea ice modelling!

1/4° ACCESS-OM2 with 50 z* levels

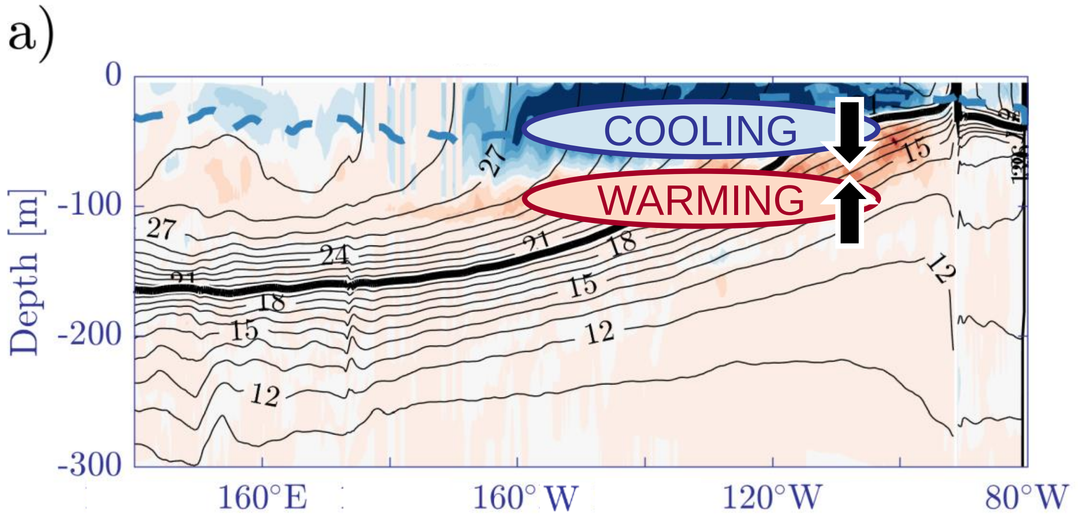
1/4°



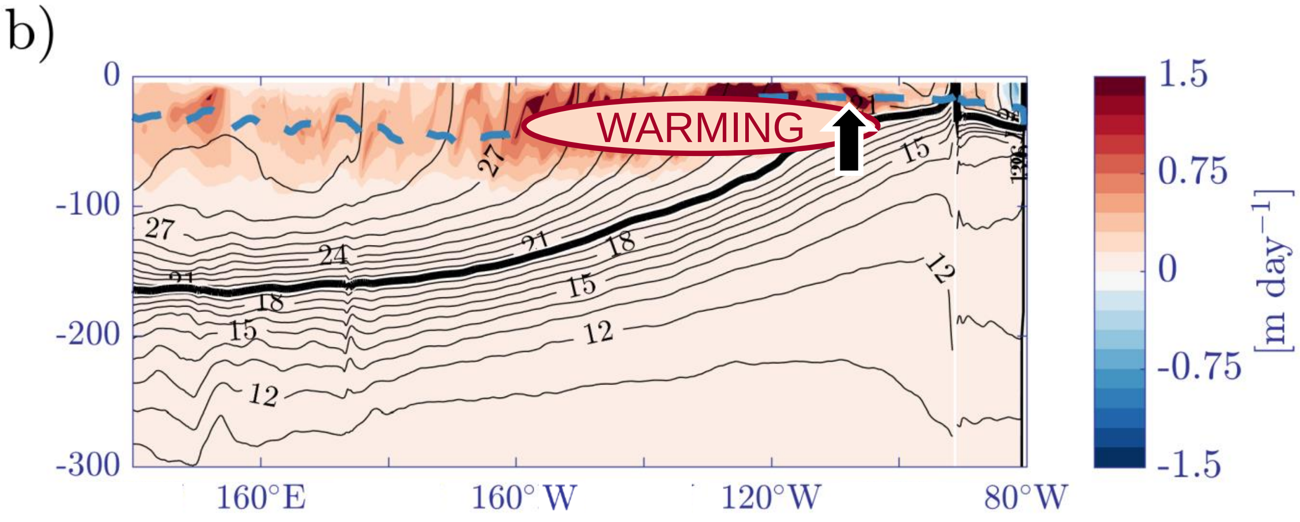
Kiss et al. (2019)

The diabatic volume fluxes: September-November

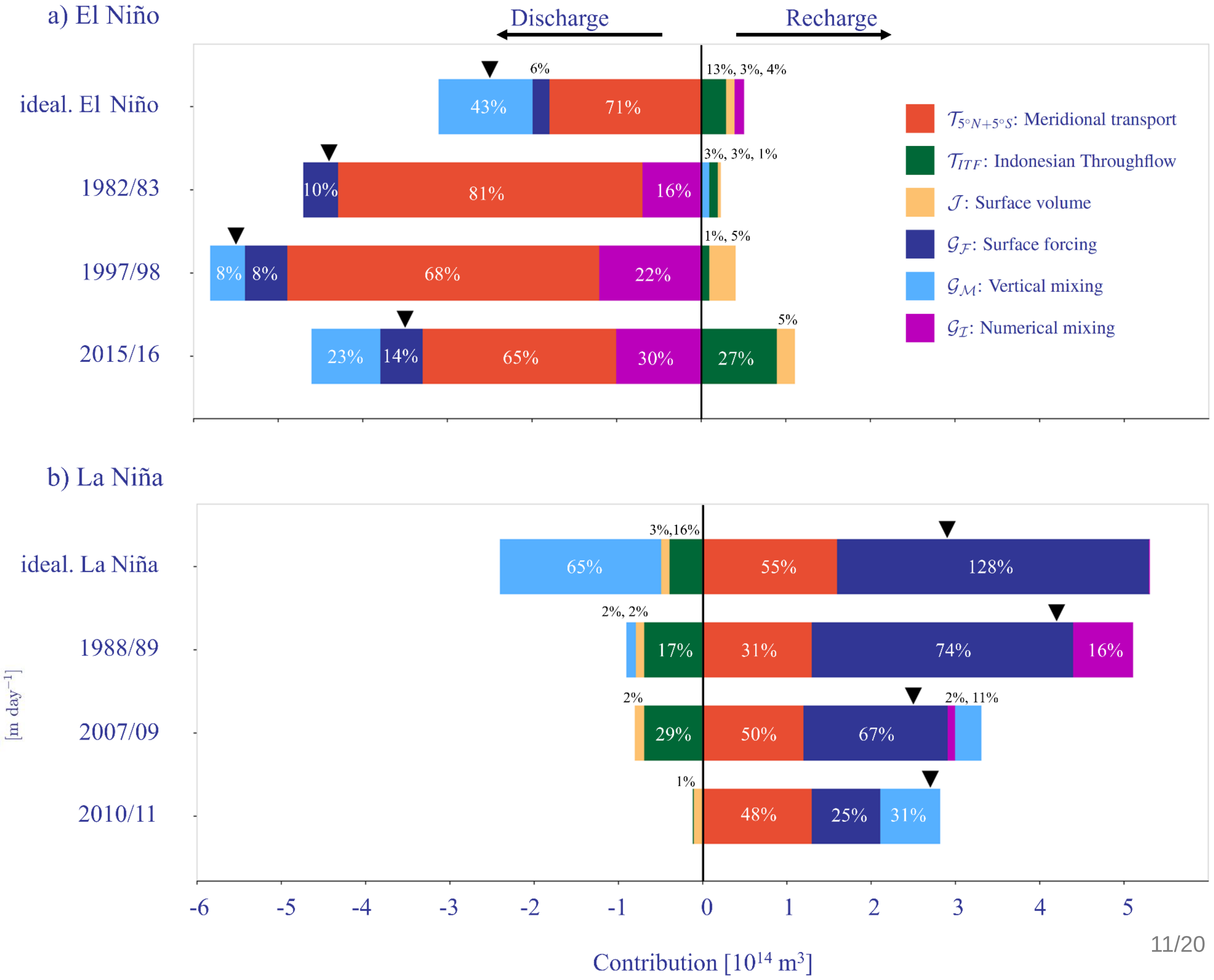
Vertical Mixing



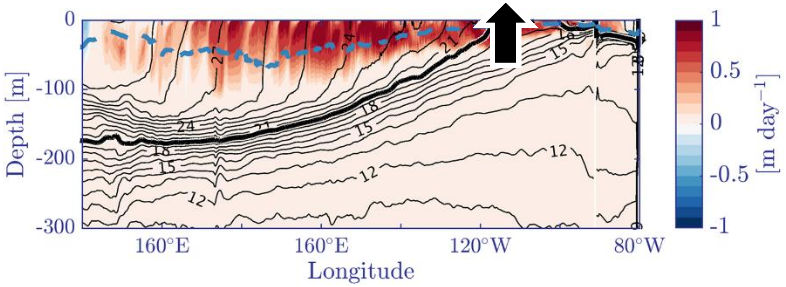
Surface Forcing



Summary figure



Surface Forcing DEC 1988



Processes and dynamics of global to regional ocean heat uptake and variability

with Matt England & Ryan Holmes

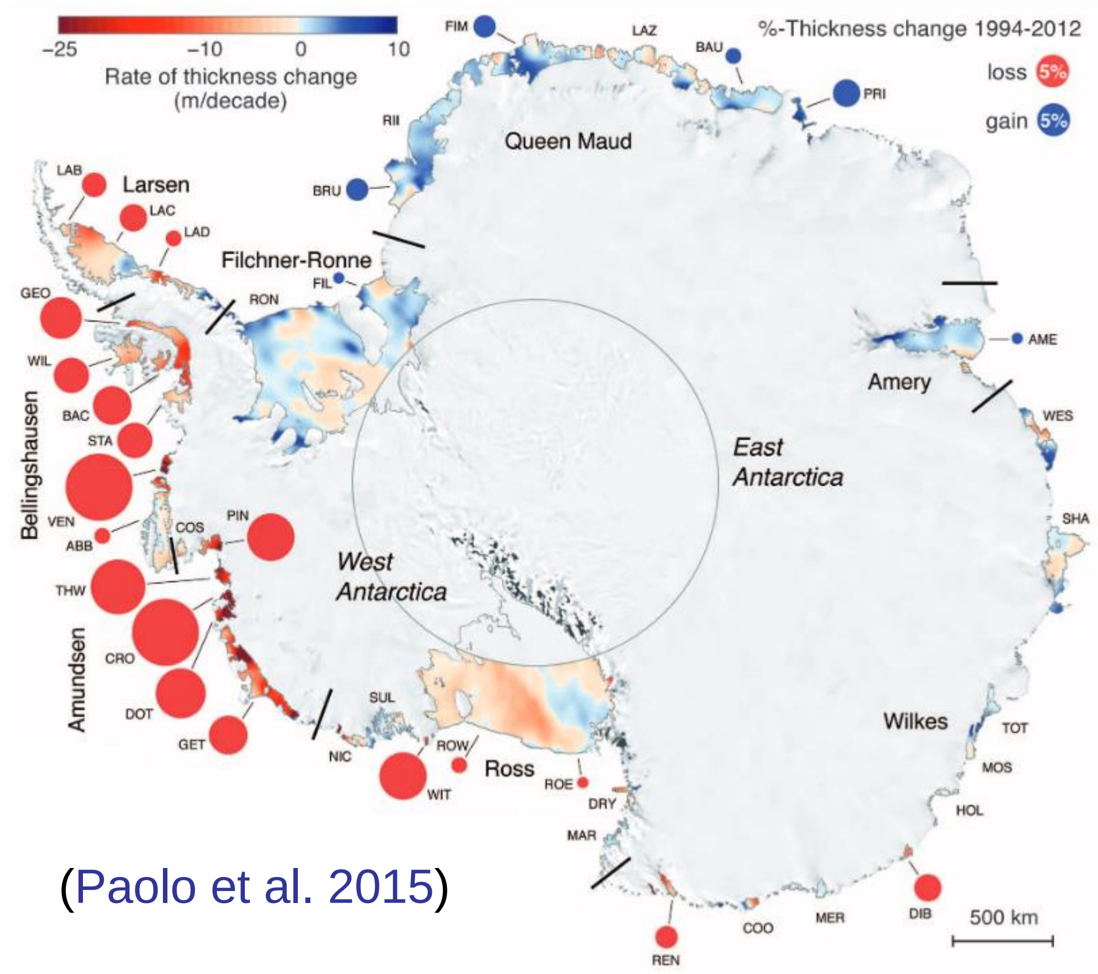
I **Drivers and distribution of global ocean heat uptake over the last half century**. *Nature Communications*.

II **Key Role of Diabatic Processes in Regulating Warm Water Volume Variability Over ENSO Events**. *Journal of Climate*.

III **Subsurface warming of the West Antarctic continental shelf linked to El Niño-Southern Oscillation**. *Geophysical Research Letters.*

Background

- Volume loss from Antarctic ice shelves is accelerating (Paolo et al. 2015)
- Ice loss influenced by internal climate variability and anthropogenic forcing (Holland et al. 2019)
- El Niño: ↑height but ↓mass of West Antarctic ice shelves (Paolo et al. 2018)



(Paolo et al. 2015)

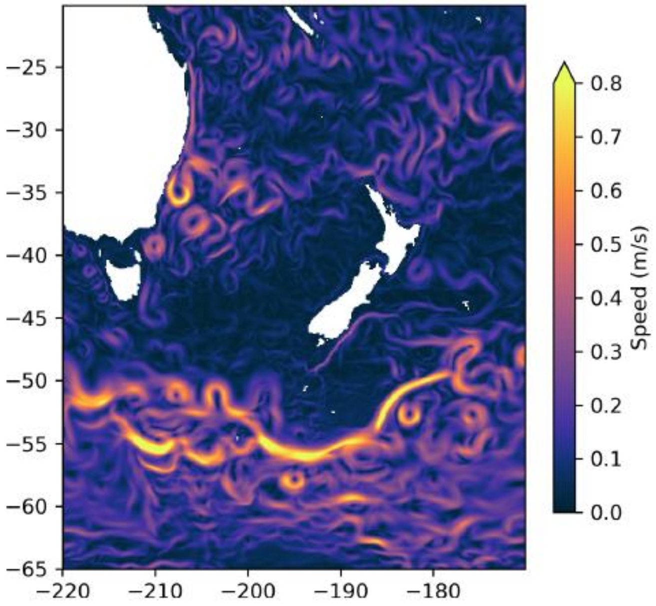
The questions

- How do El Niño & La Niña impact the West Antarctic shelf circulation?

- What processes are responsible for warming and cooling on the shelf?

The method

1/10° configuration of ACCESS-OM2



Kiss et al. (2019)

- Repeat-year forcing spin-up
- ENSO anomalies on top

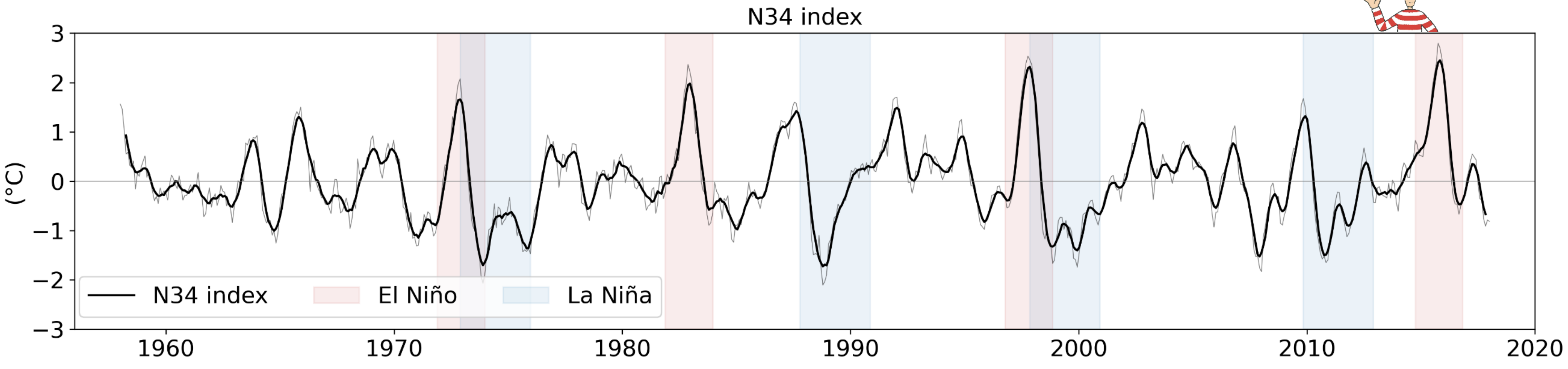
Forcing for the idealised simulations

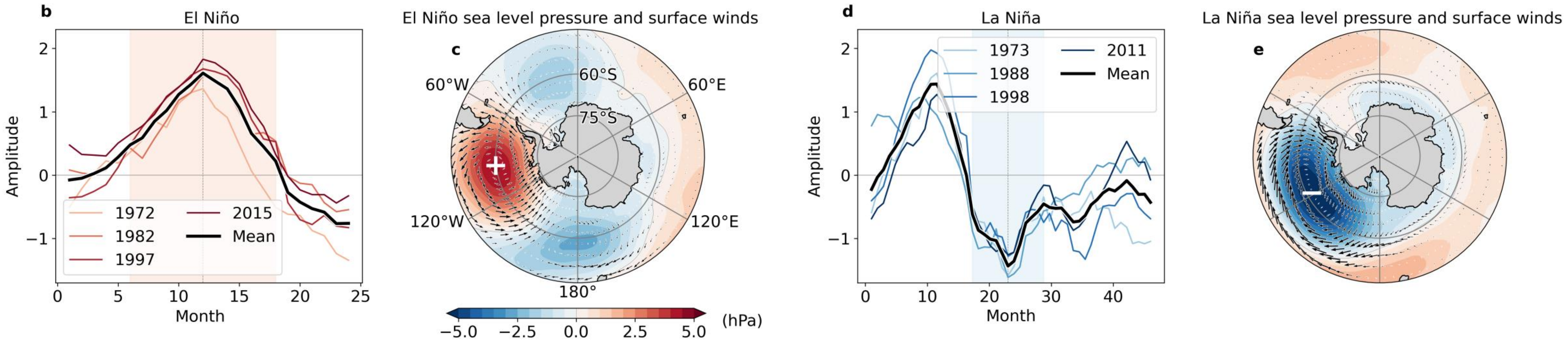
Repeat-year forcing [t, x, y]

+

ENSO anomalies (time series [t] × spatial pattern [x,y])

Forcing for the idealised simulations

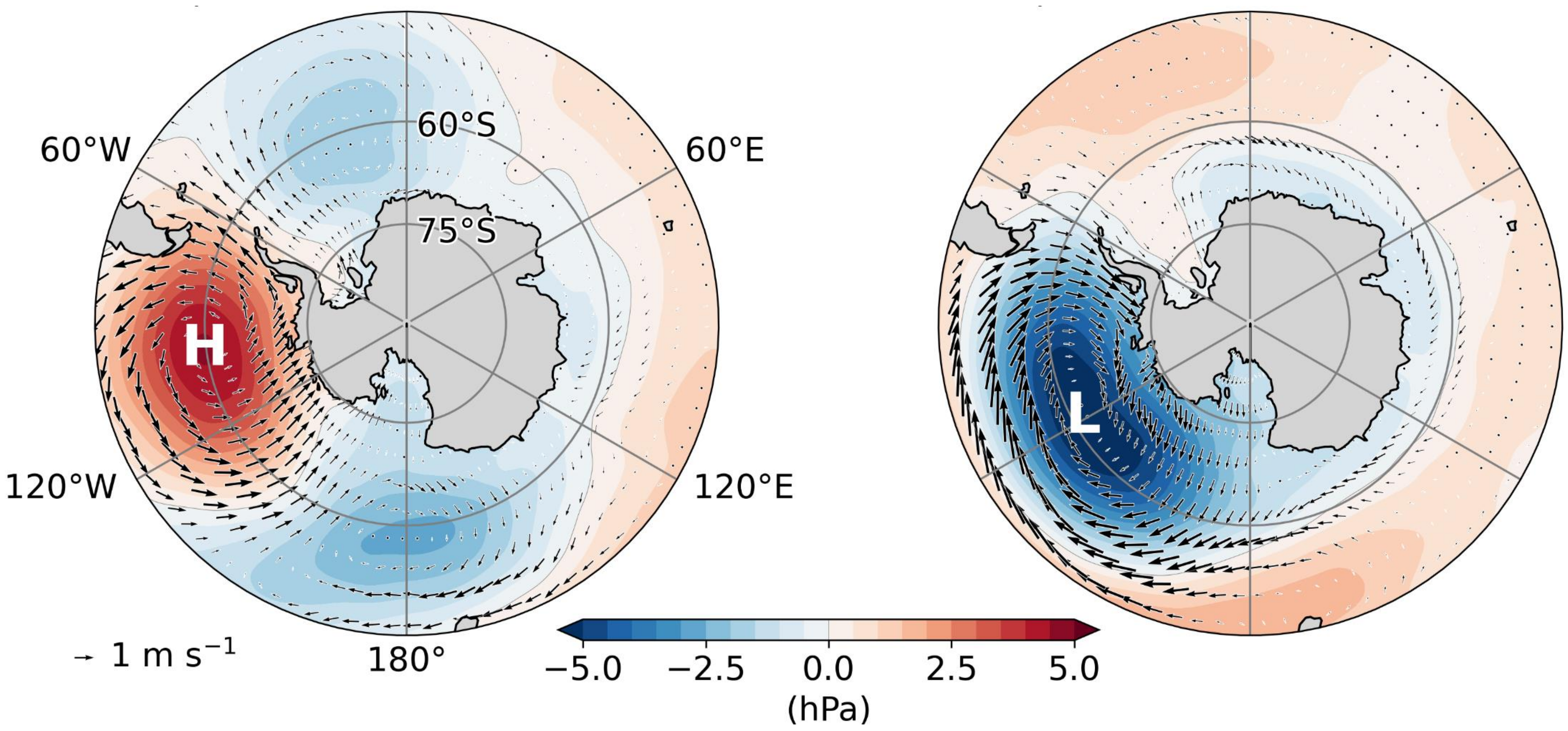




Forcing for the idealised simulations

El Niño sea level pressure and surface winds

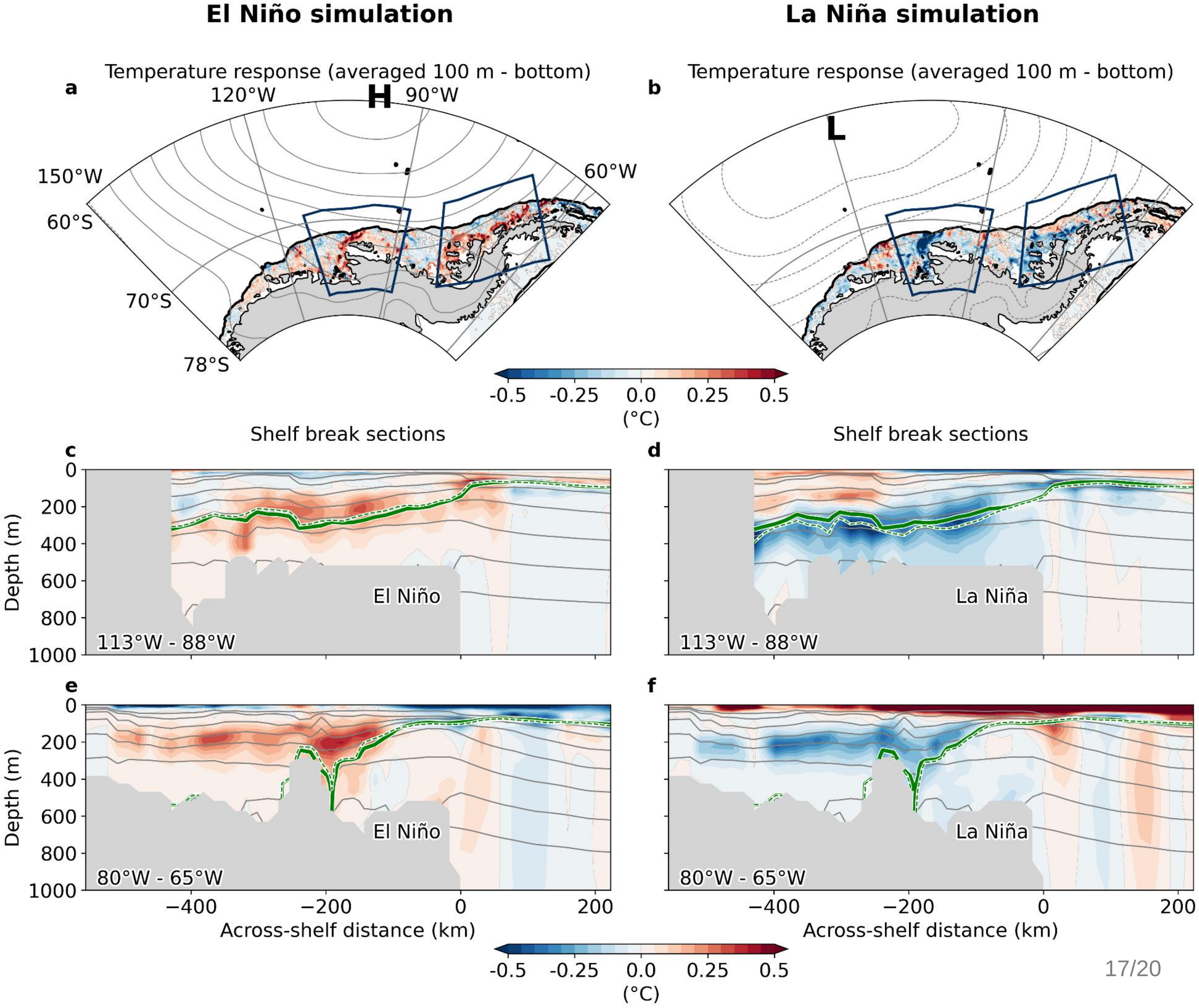
La Niña



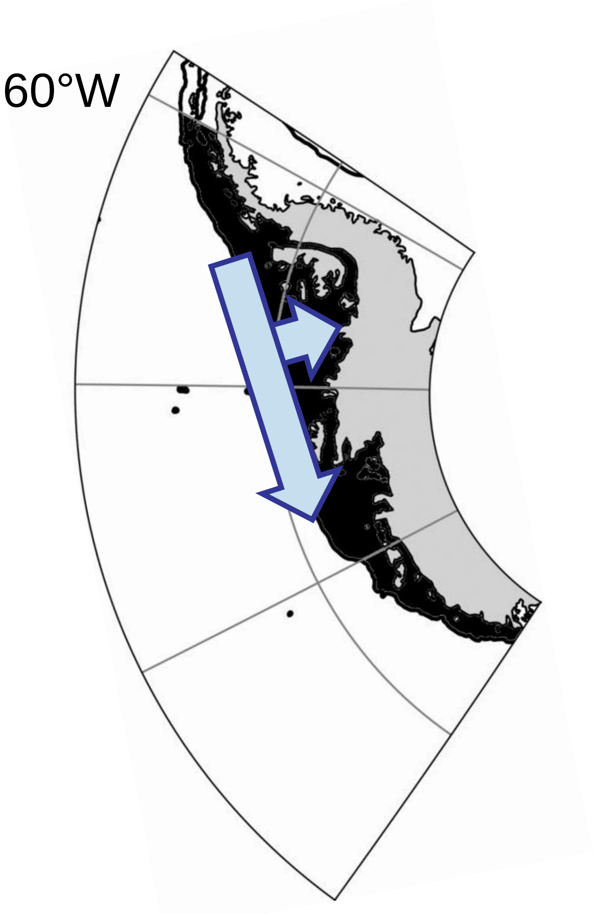
Shelf response to ENSO forcing

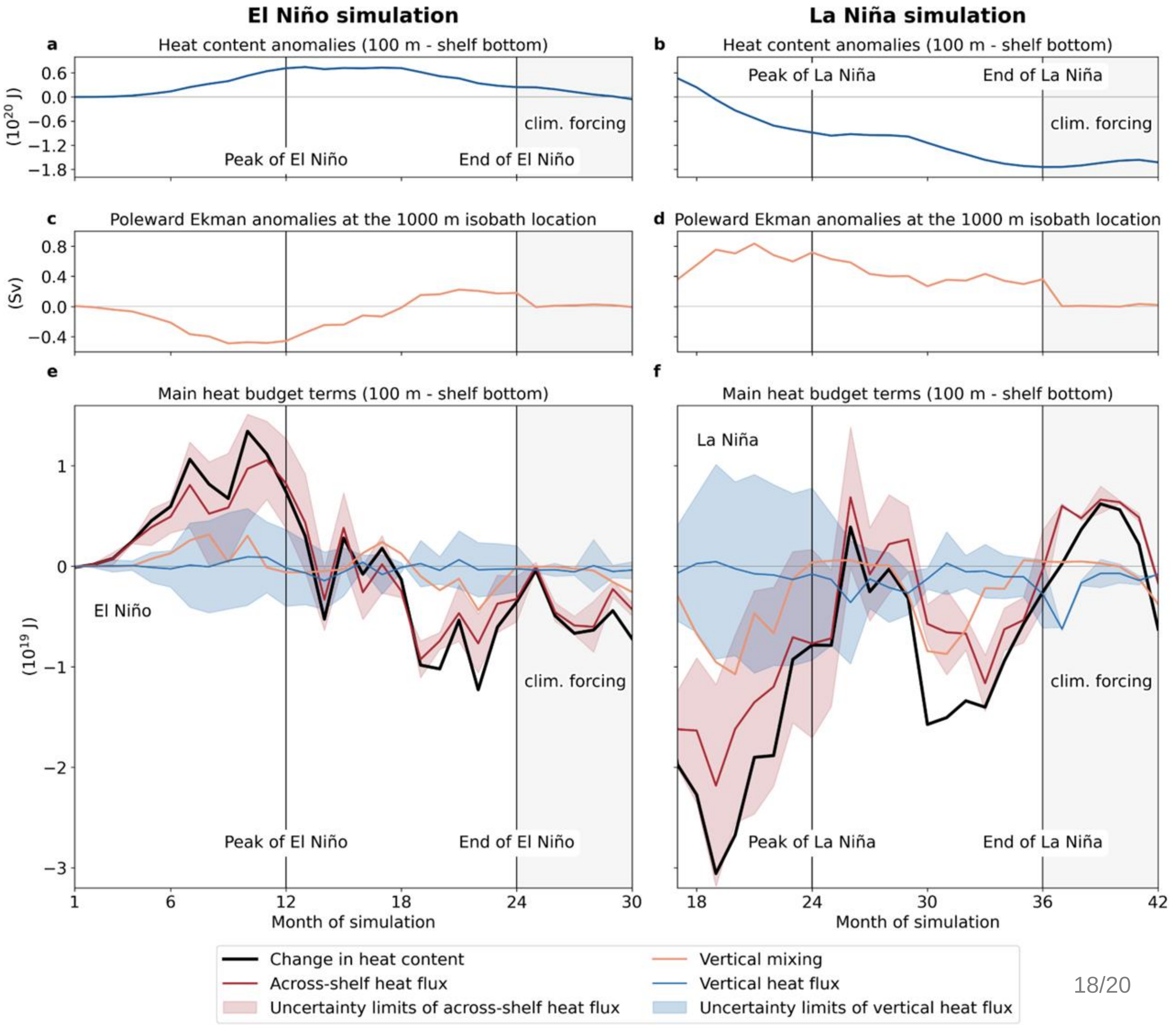
isopycnals

0°C isotherm

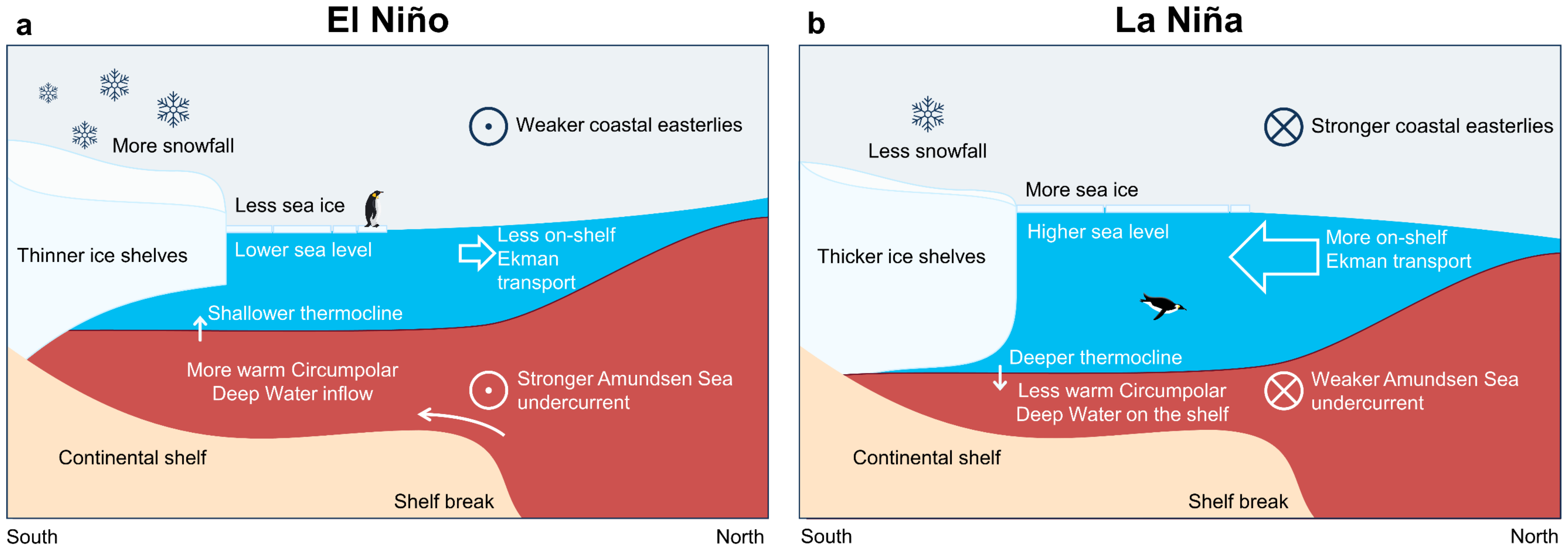


The subsurface heat budget





Schematic



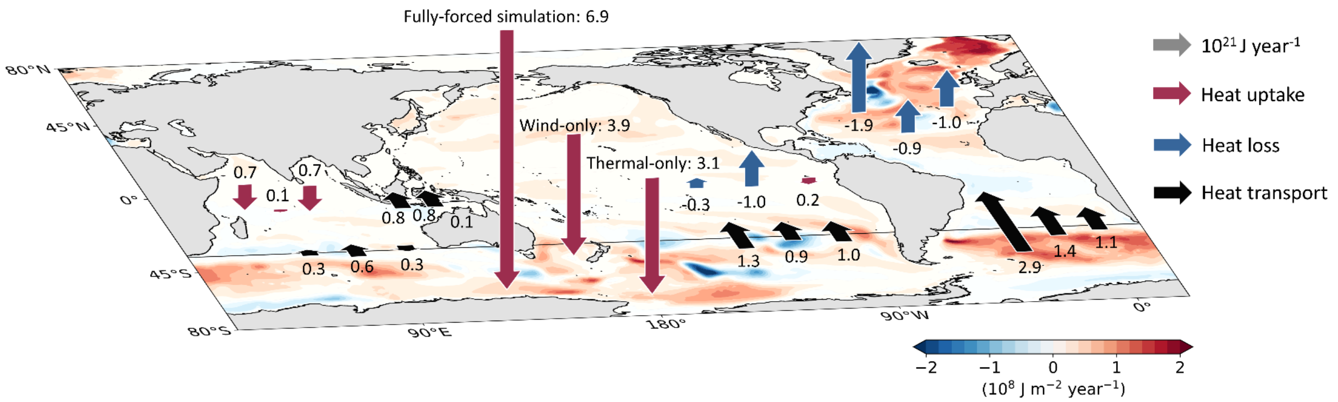
- *bottom Ekman response*
- *baroclinic adjustment*
- *Amundsen Sea undercurrent*
- *eddies*

A journey through my PhD chapters

I

Drivers and distribution of global ocean heat uptake over the last half century

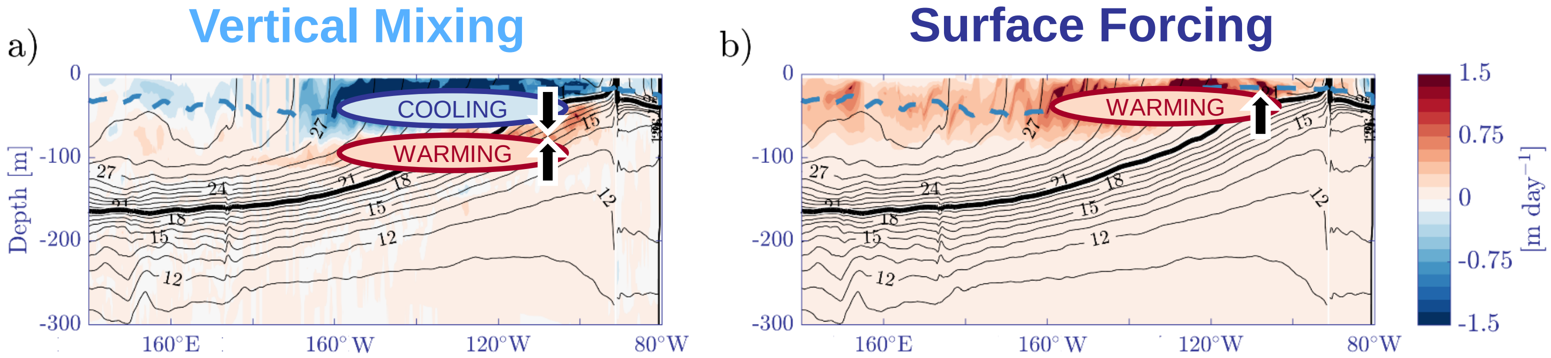
(Huguenin et al. 2022)



II

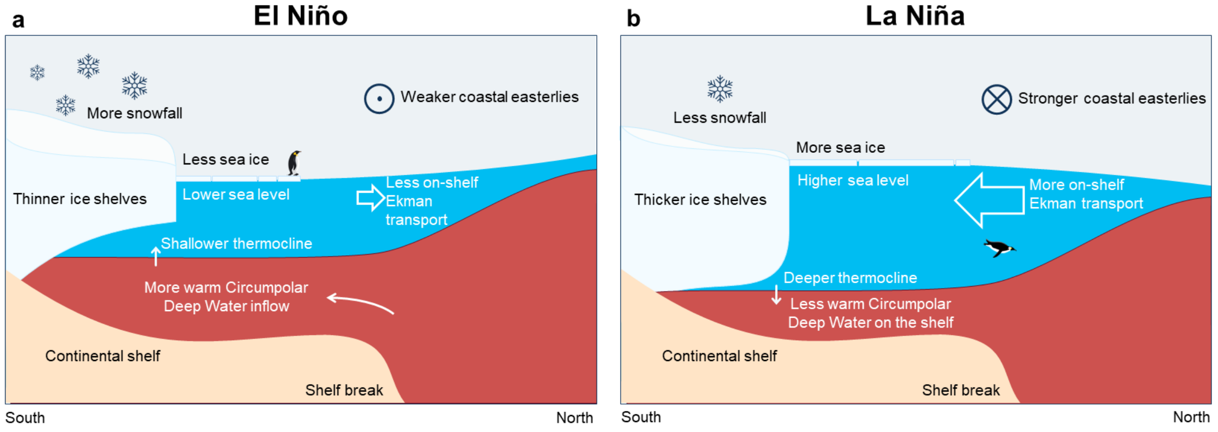
Key role of surface forcing and vertical mixing in changing warm water volume during ENSO

(Huguenin et al. 2020b)



III

Subsurface warming of West Antarctic coastal waters linked to El Niño events *(Huguenin et al., 2024)*



https://mauricehuguenin.github.io