WCRP
World Climate Research Programme

Analysis & Prediction

Polar Educators International April 2017

D Carlson
Director, WCRP

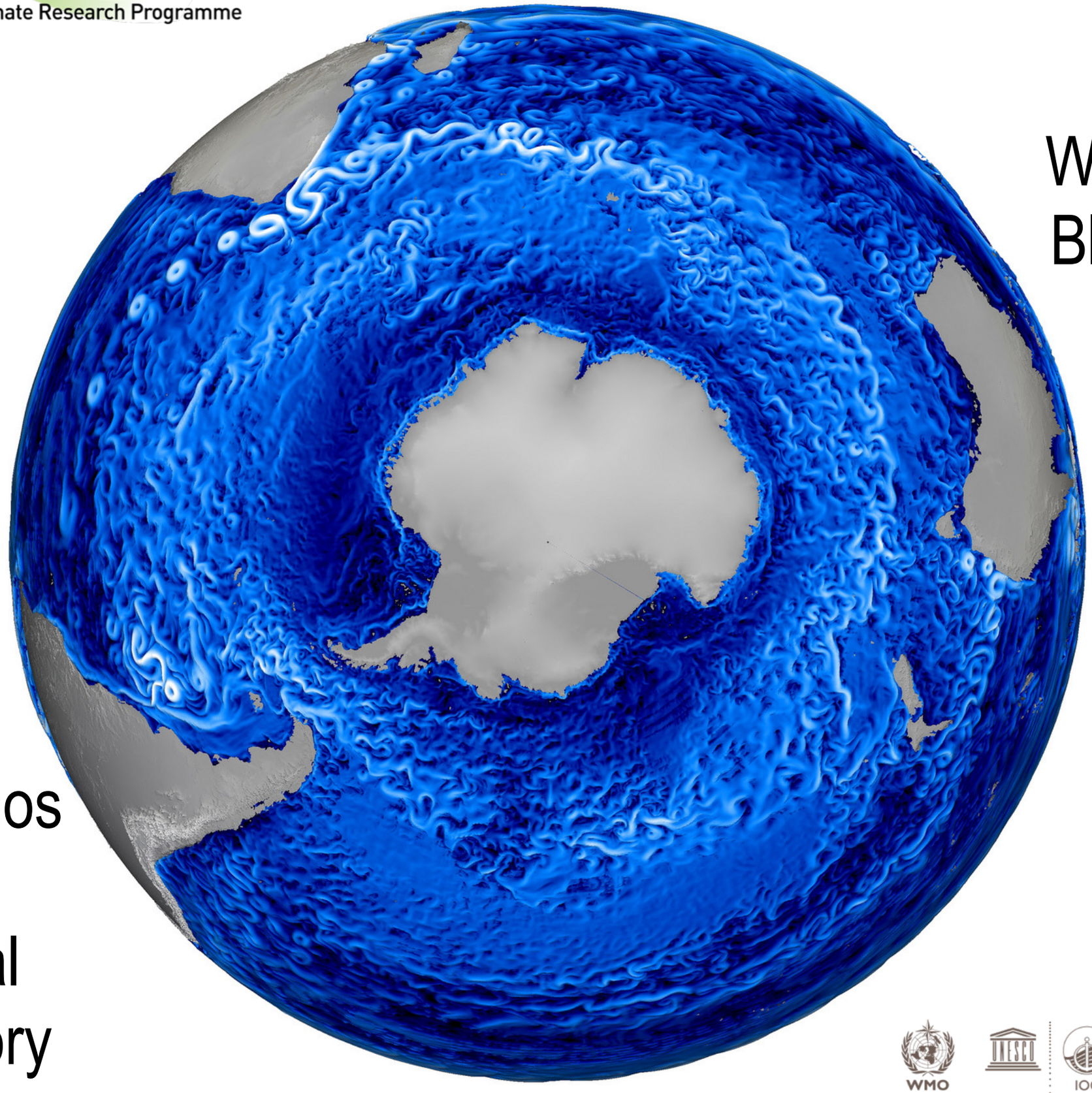
WMO IOC ICSU International Council for Science

Ice and Ocean Around Antarctica

WCRP
World Climate Research Programme

Ocean
Model

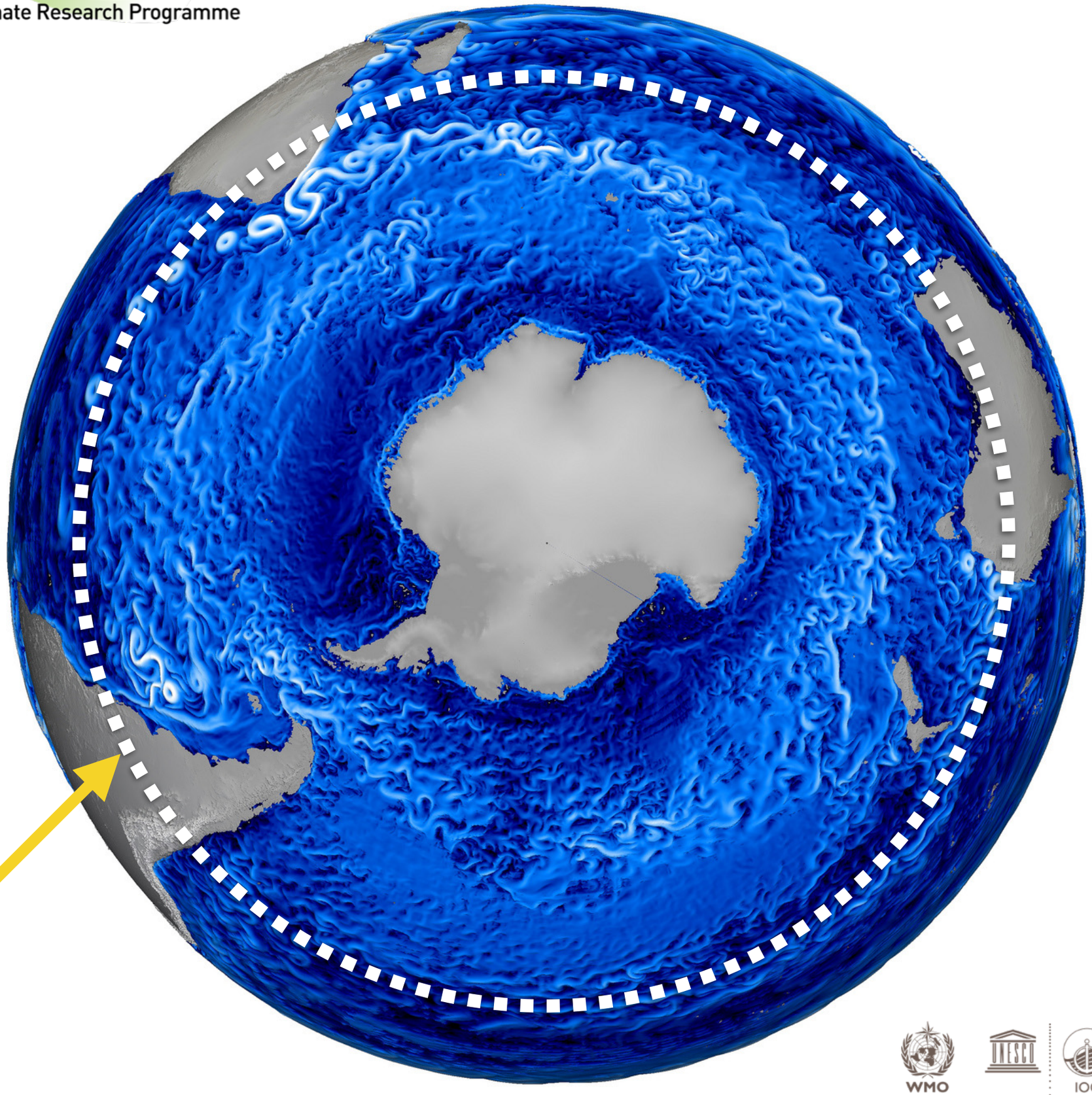
White = fast
Blue = slow



Los Alamos
(USA)
National
Laboratory

WMO IOC ICSU International Council for Science

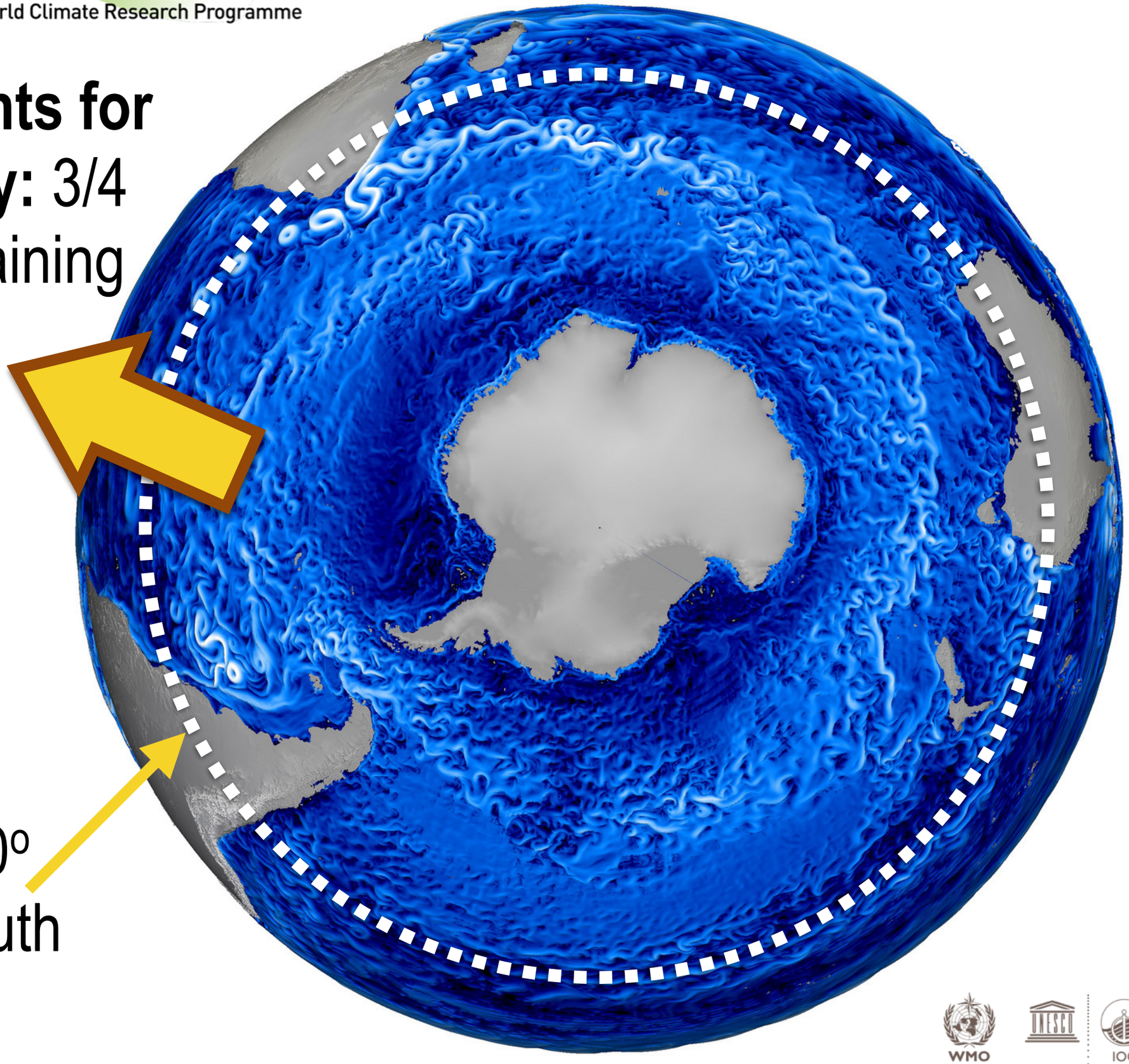
WCRP
World Climate Research Programme



WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Nutrients for biology: 3/4 of remaining ocean



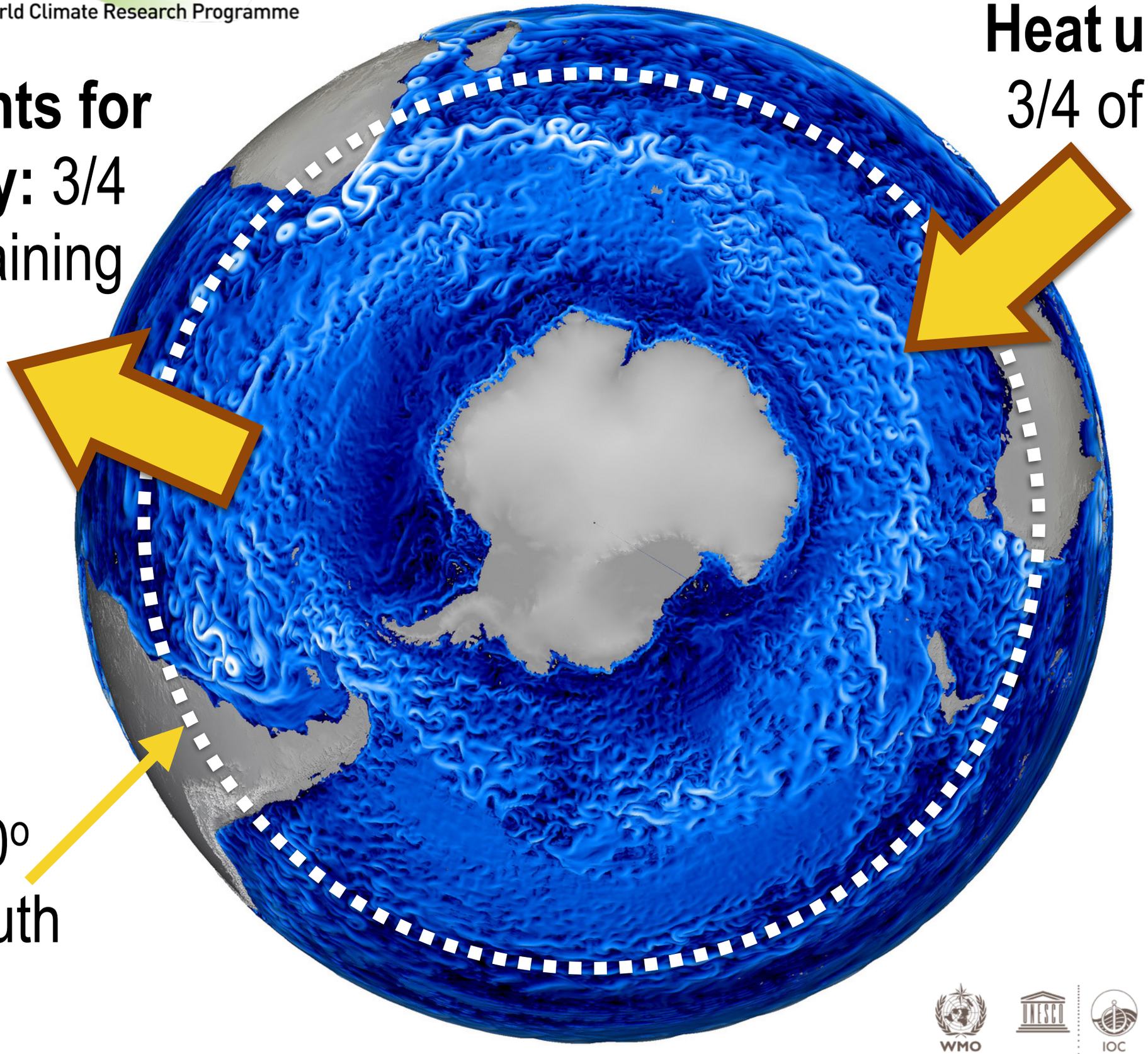
30° South

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Nutrients for biology: 3/4 of remaining ocean

Heat uptake: 3/4 of ocean total



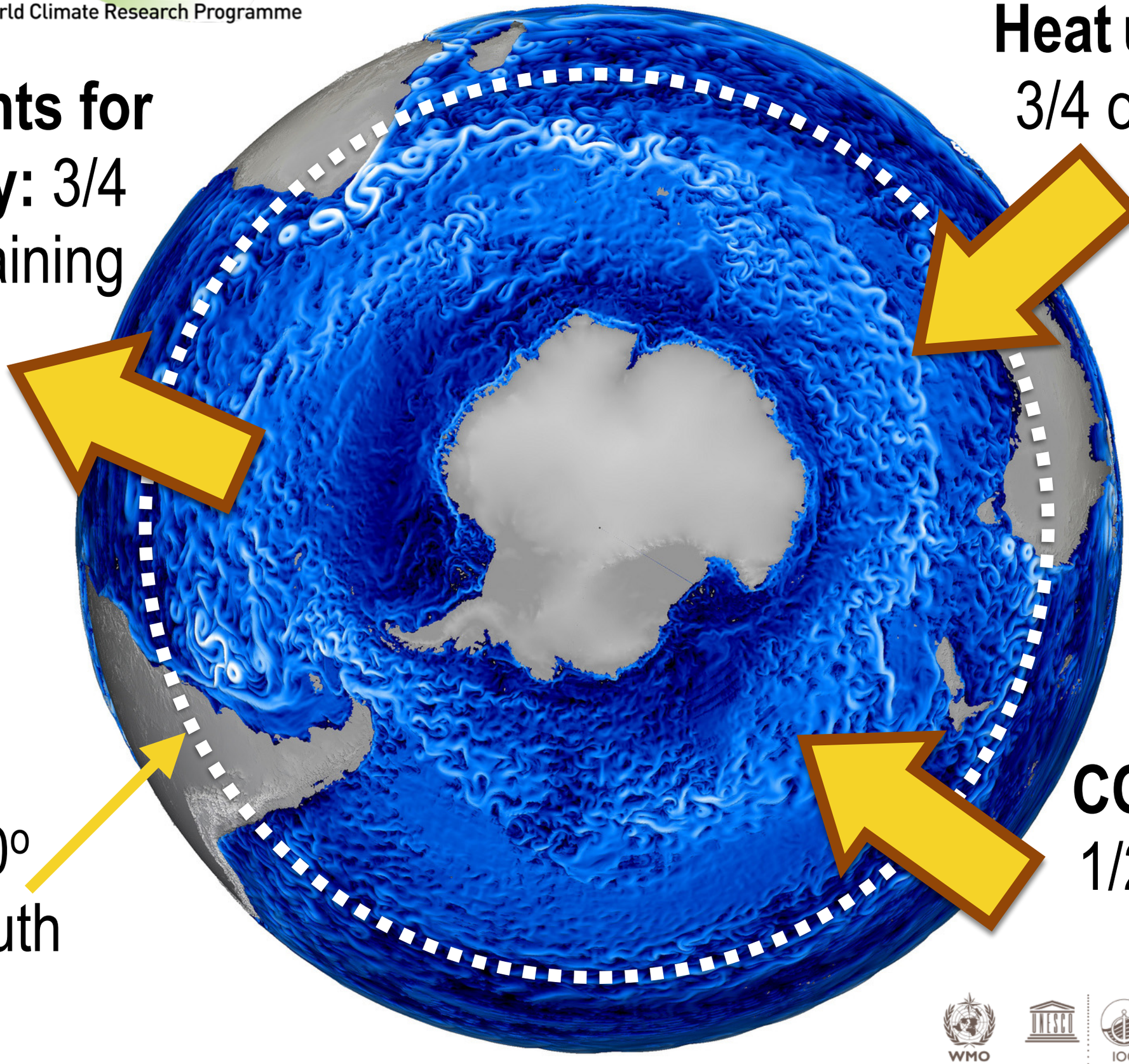
30° South

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Nutrients for biology: 3/4 of remaining ocean

Heat uptake: 3/4 of ocean total



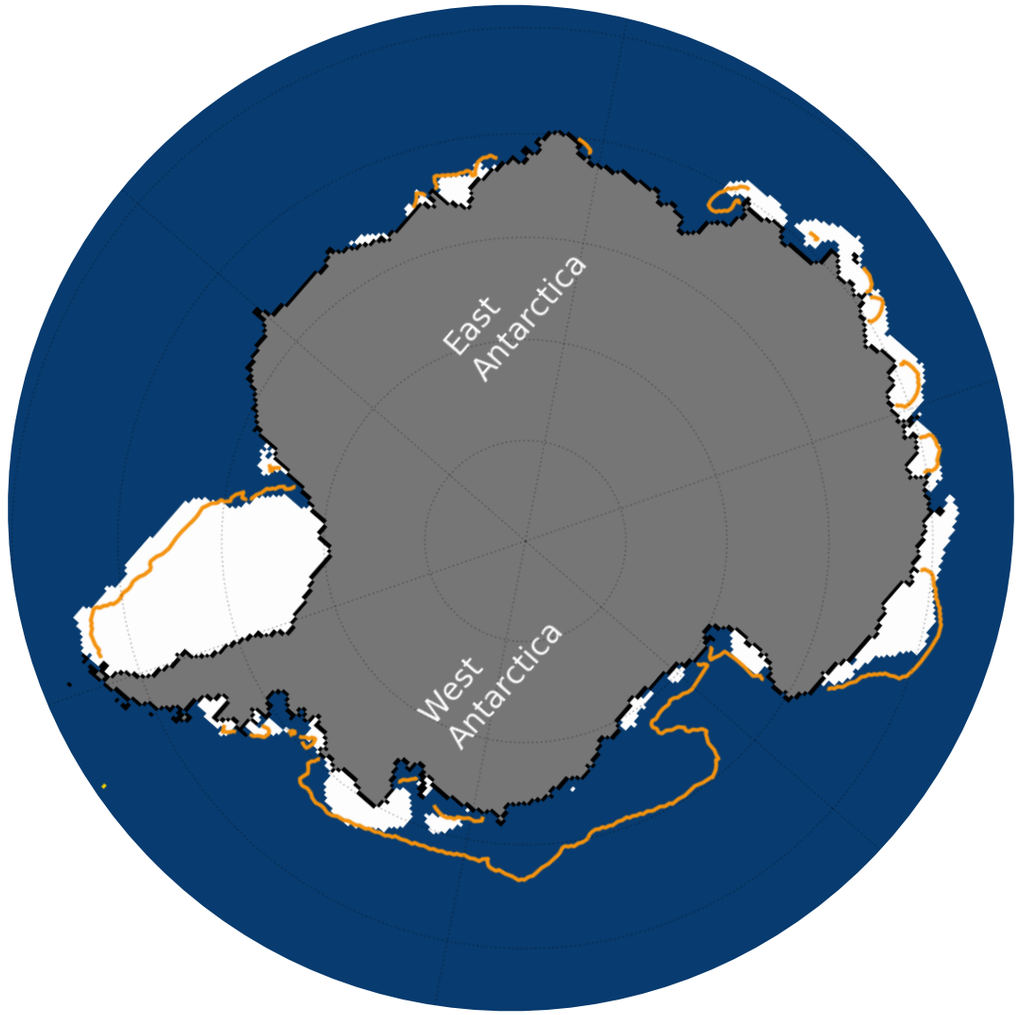
30° South

CO^2 uptake: 1/2 of ocean total

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Sea ice extent
2017-04-08



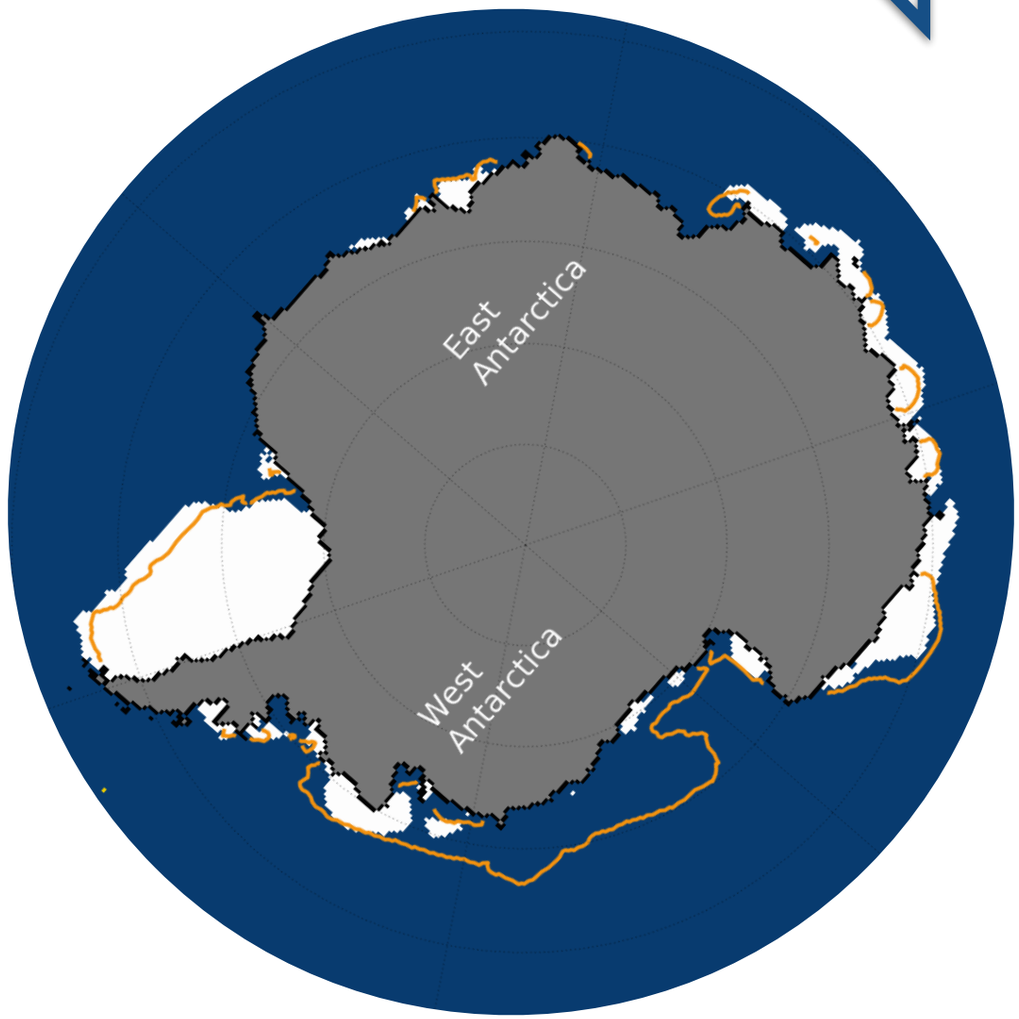
National (USA) Snow and Ice Data Centre

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

extent

Sea ice extent 2017-04-08

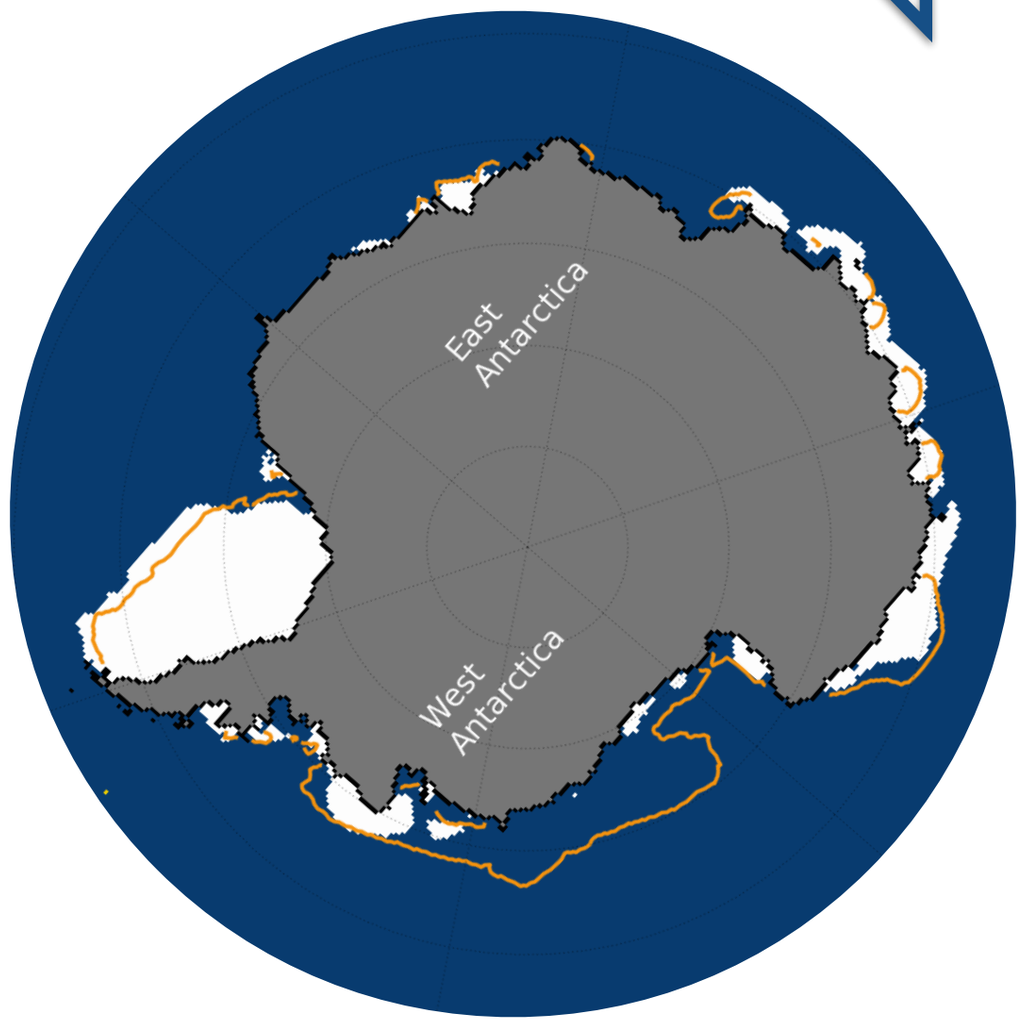


National (USA) Snow and Ice Data Centre

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Sea ice extent 2017-04-08



extent

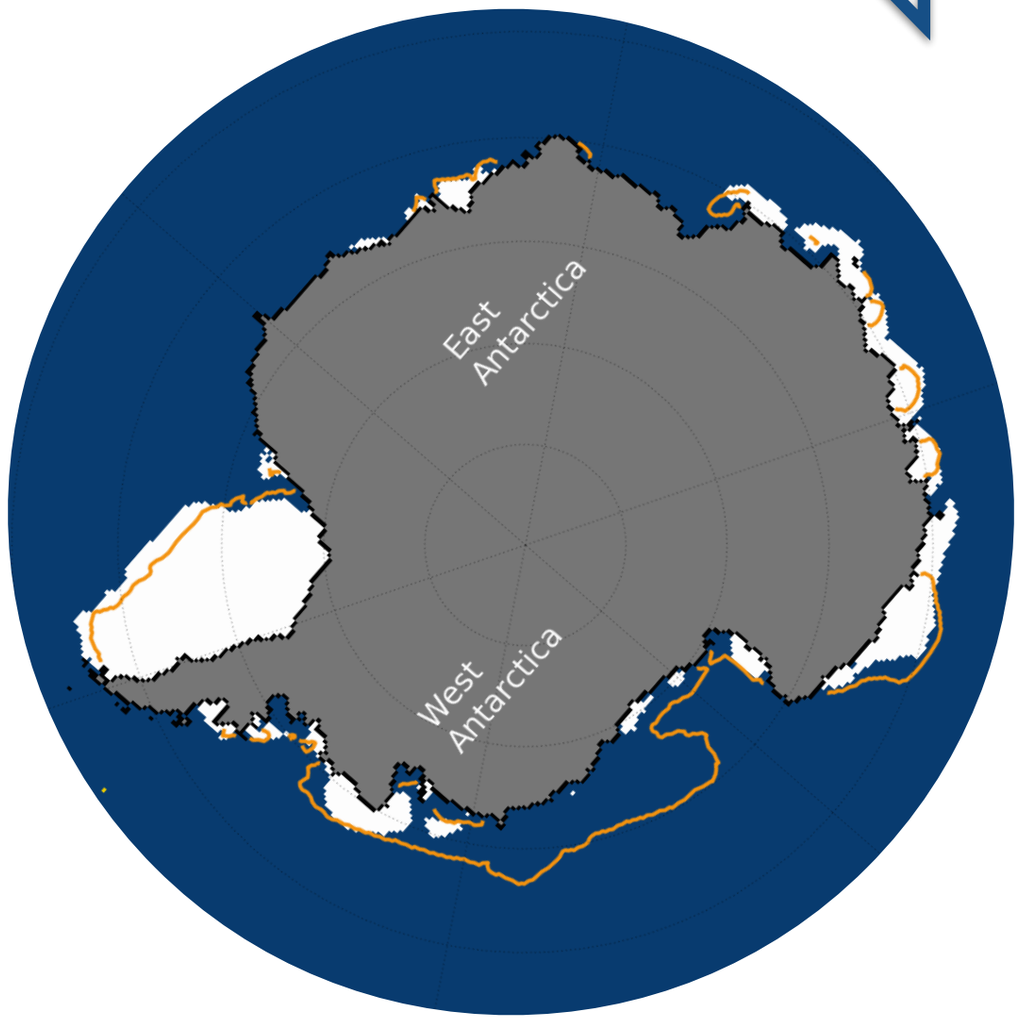
thickness

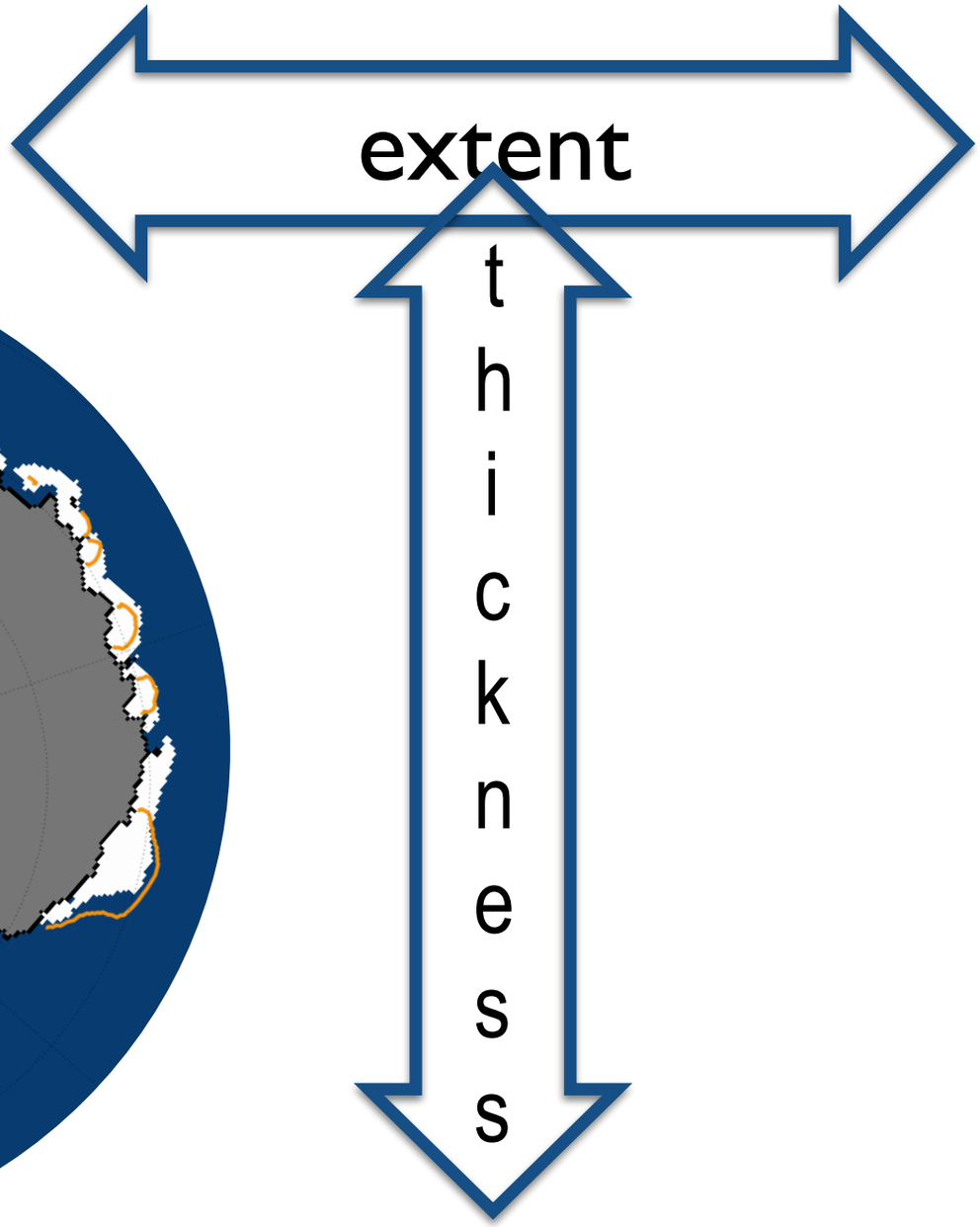
National (USA) Snow and Ice Data Centre

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Sea ice extent 2017-04-08





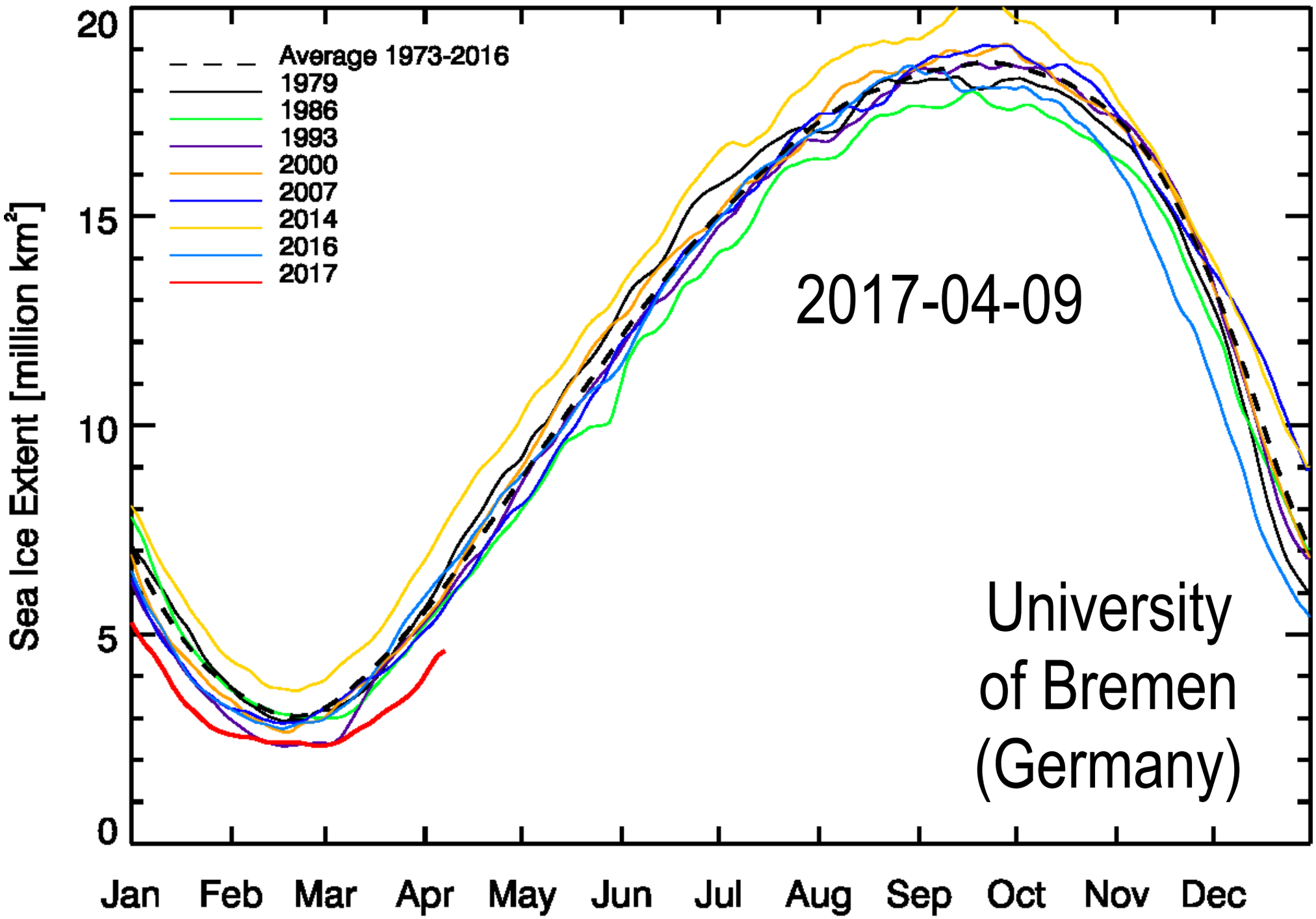
Ice volume!

National (USA) Snow and Ice Data Centre

WMO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

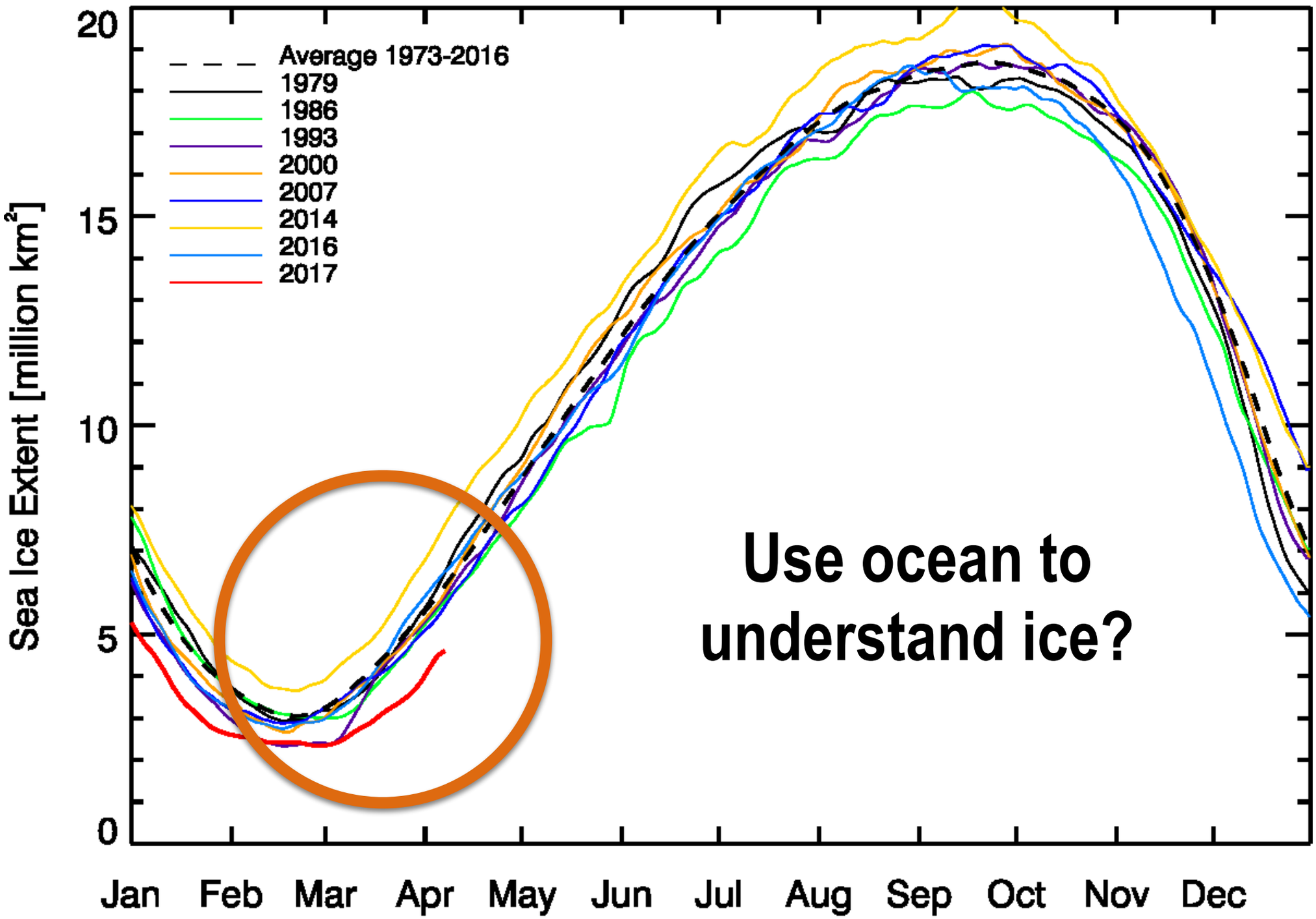
Antarctic Sea Ice Extent



Updated on 2017.04.09

WMO IOC ICSU International Council for Science

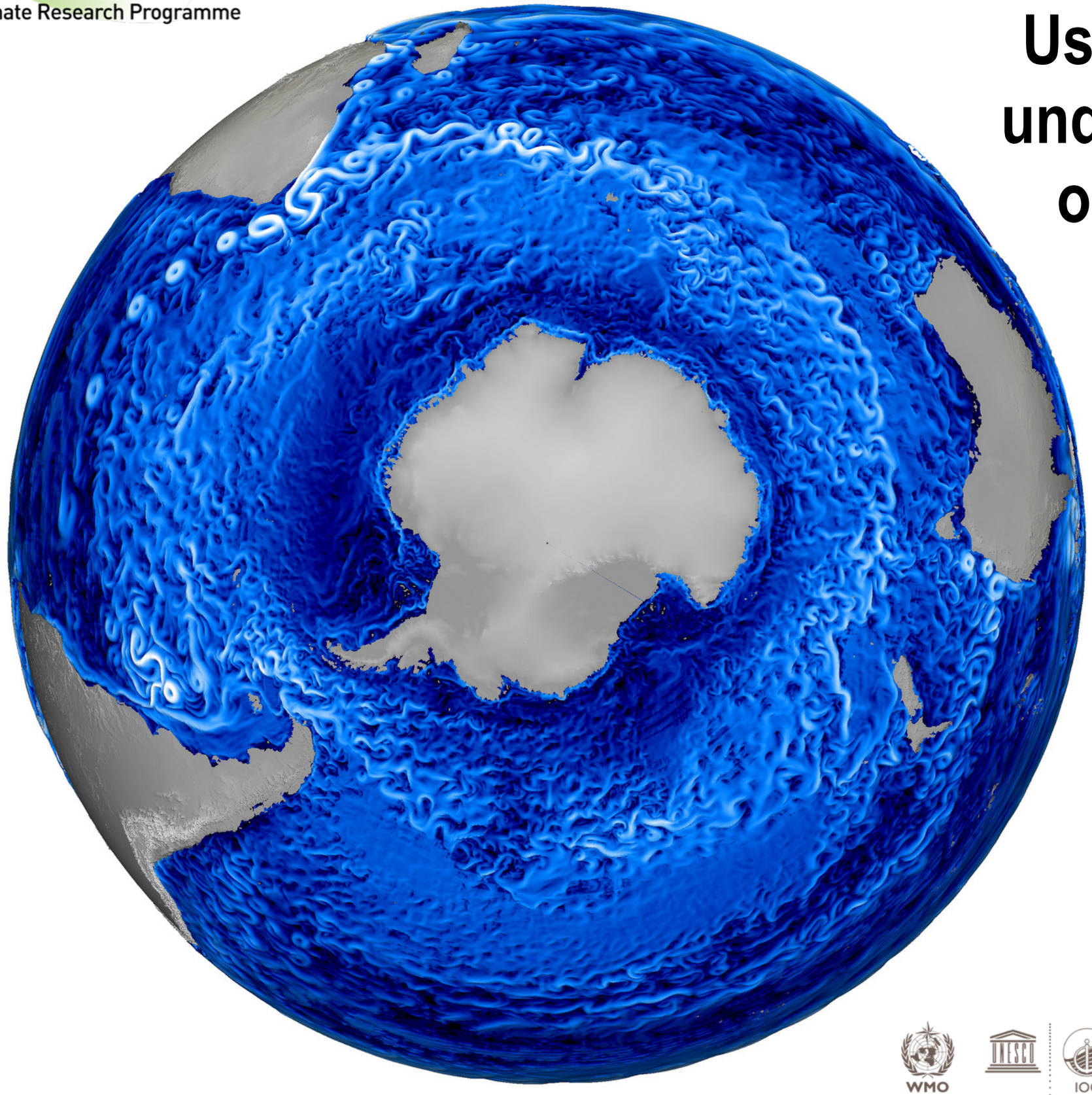
Antarctic Sea Ice Extent



Updated on 2017.04.09

WCRP
World Climate Research Programme

Use ice to understand ocean?



WMO IOC ICSU International Council for Science

sverdrup: 1 million cubic metres per second:

10^6 m^3 / s

(1,000,000,000 litres / s)

sverdrup: 1 million cubic metres per second:

10^6 m^3 / s

(1,000,000,000 litres / s)

Global input of fresh water from rivers to the ocean equals about 1.2 sverdrup

sverdrup: 1 million cubic metres per second:
10^6 m^3 / s
(1,000,000,000 litres / s)

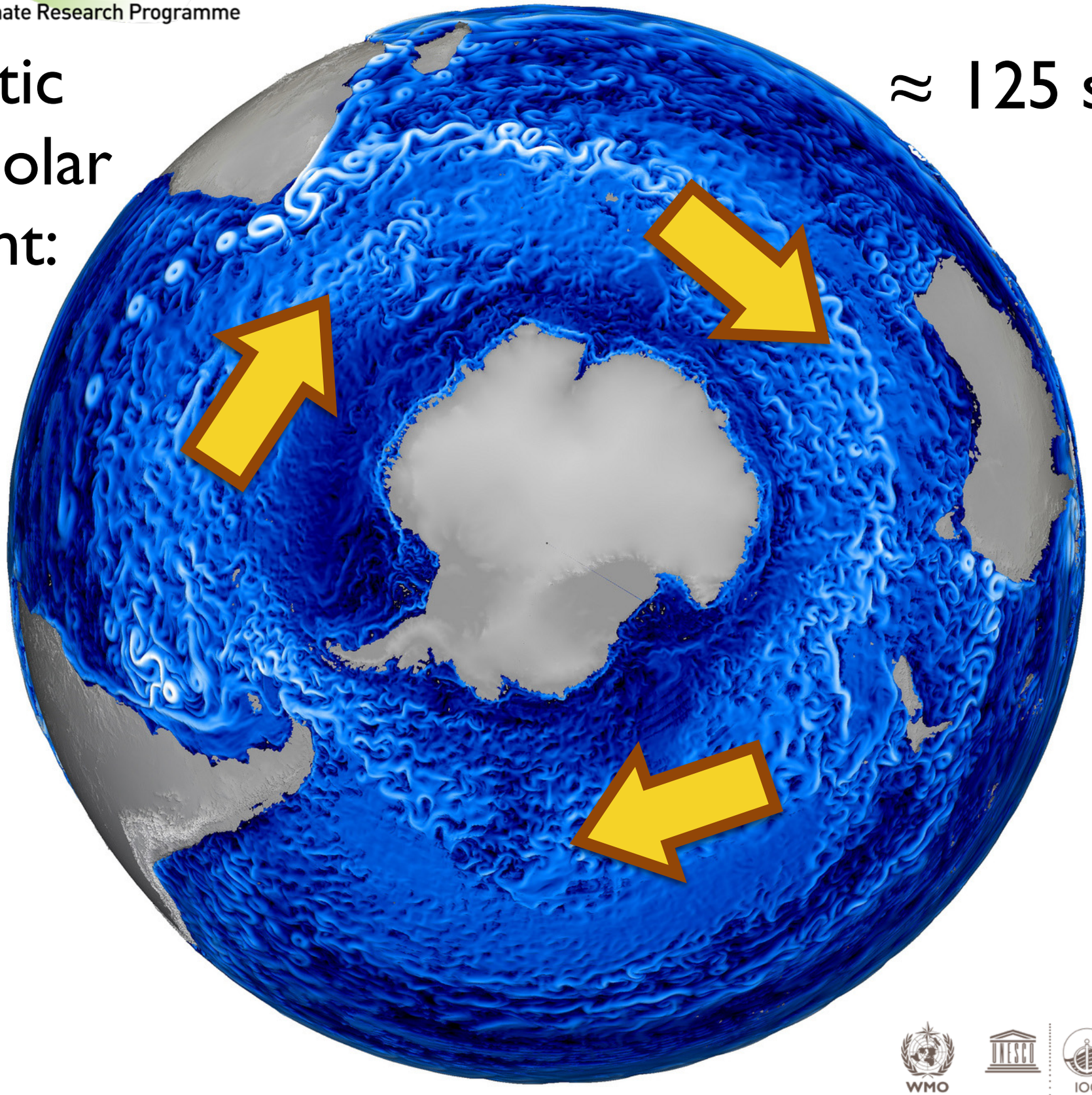
Global input of fresh water from rivers to the ocean equals about 1.2 sverdrup

Largest ocean current: Antarctic Circumpolar Current, approximately 125 sverdrups

WCRP
World Climate Research Programme

Antarctic Circumpolar Current:

≈ 125 sverdrups

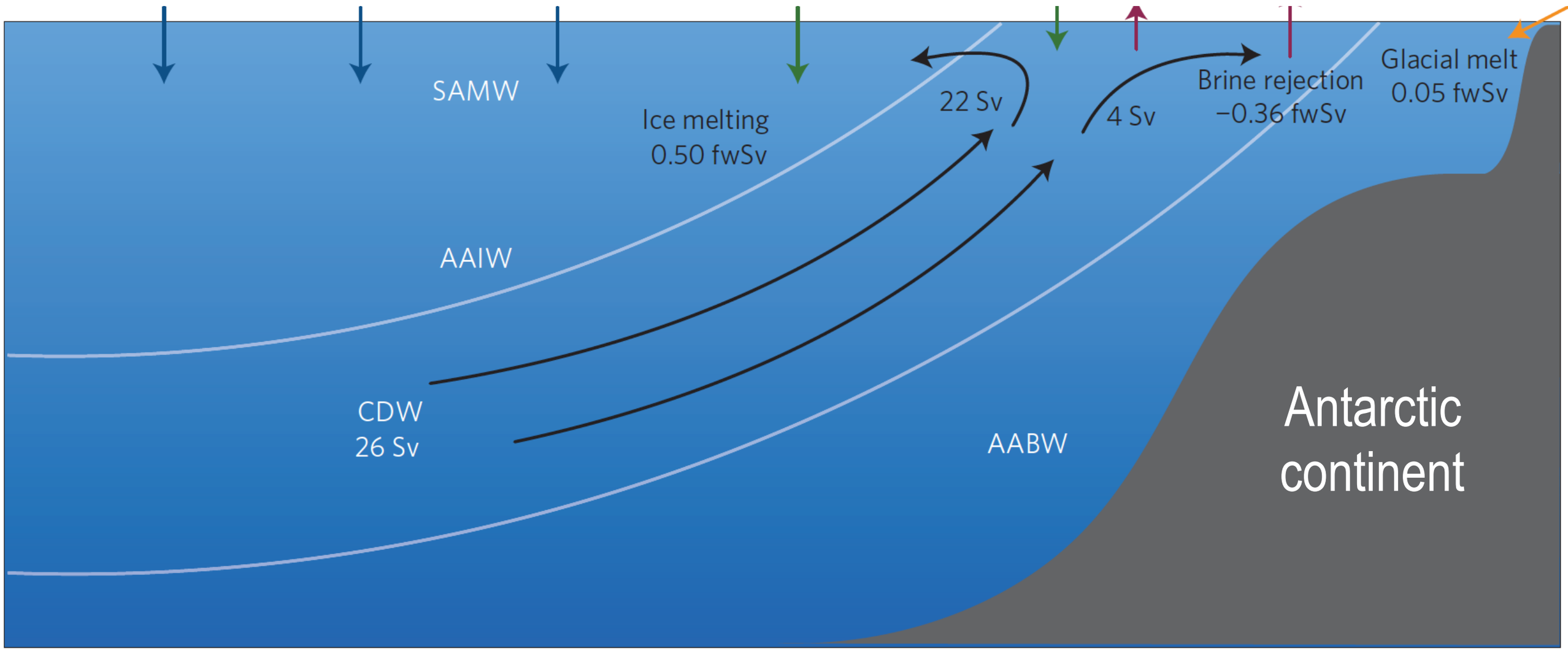


WMO IOC ICSU International Council for Science

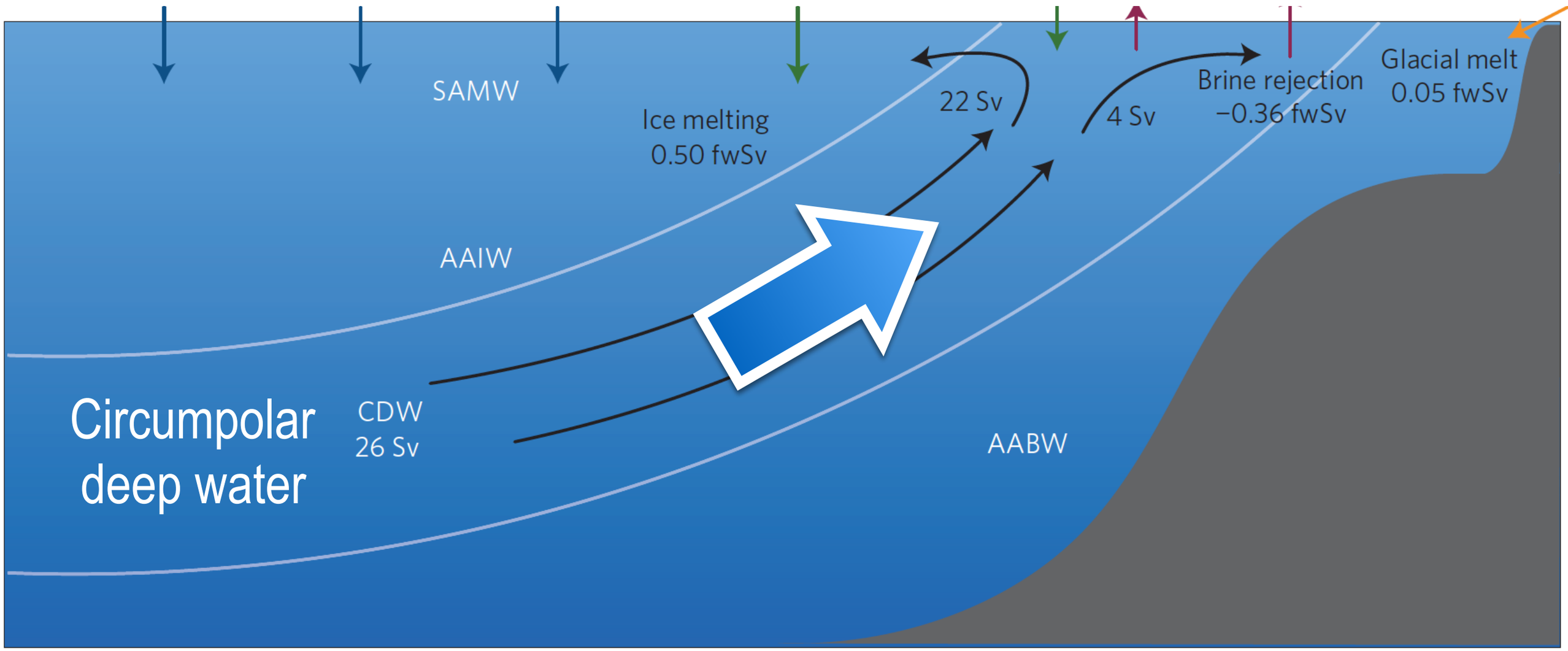
6 YEARS, 2005 thru 2010

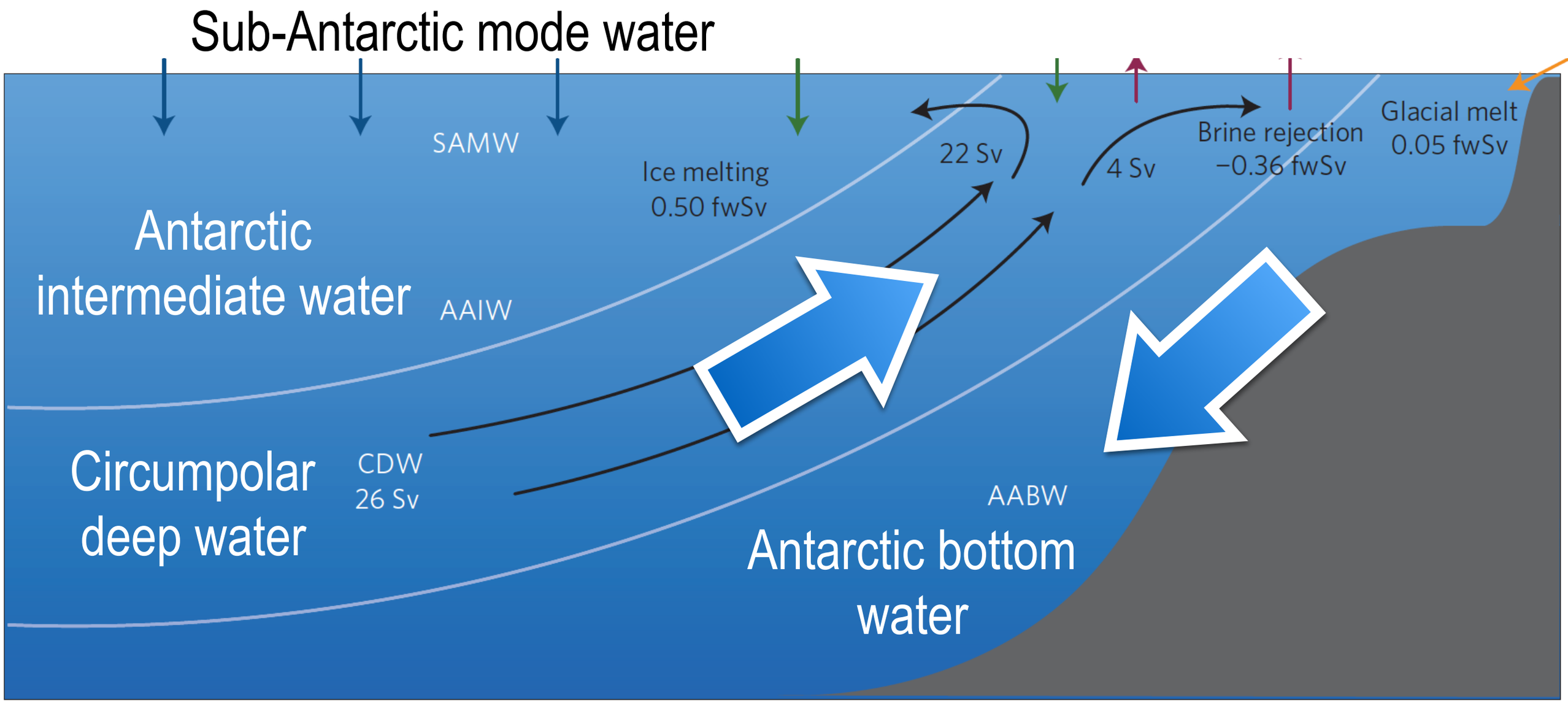
< — North

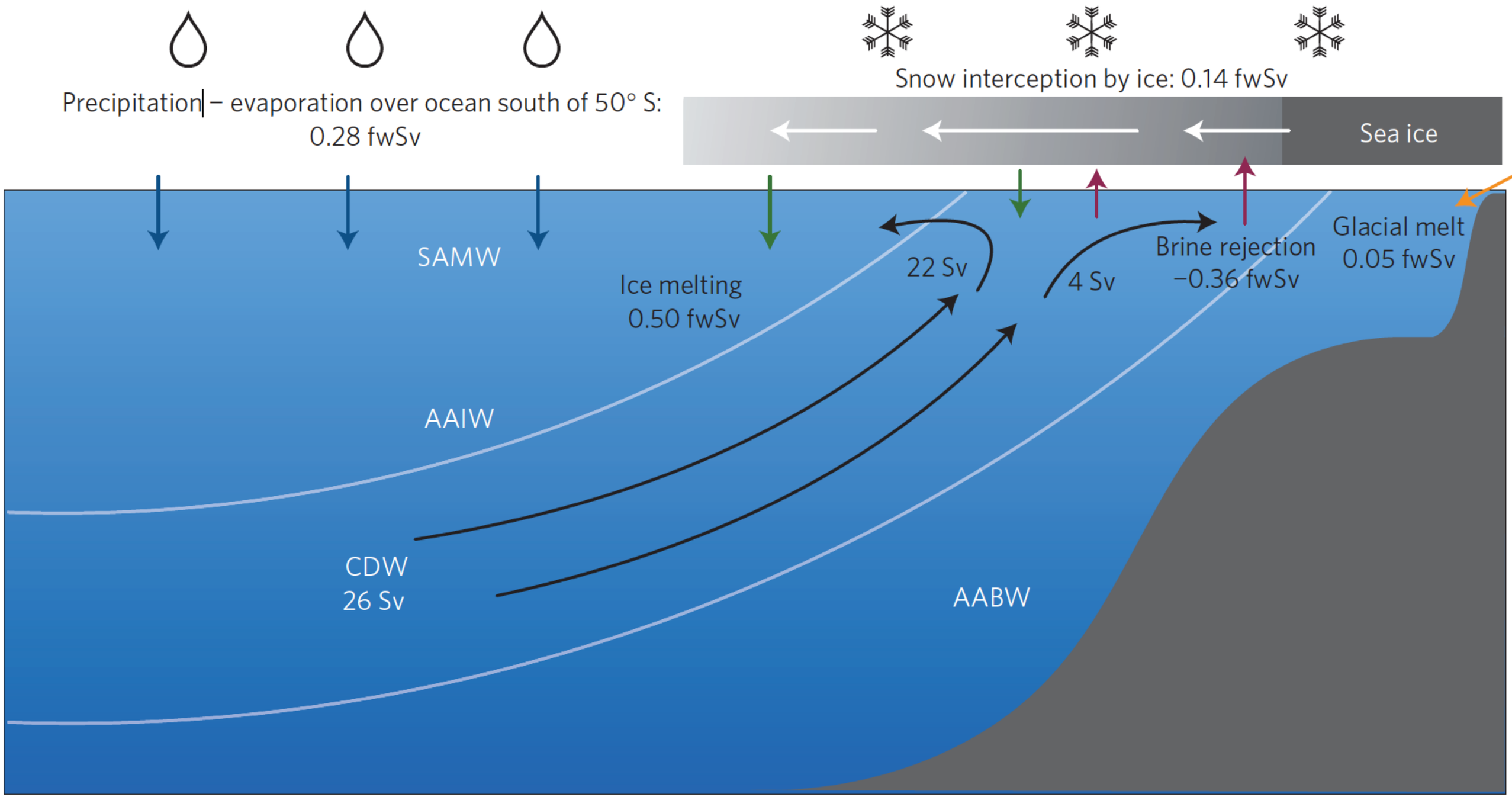
South —>



Southern Ocean State Estimate


SAMW
Ice melting
0.50 fwSv
22 Sv
4 Sv
Brine rejection
−0.36 fwSv
Glacial melt
0.05 fwSv
AAIW
Circumpolar
deep water
CDW
26 Sv
AABW


Sub-Antarctic mode water
SAMW
Ice melting
0.50 fwSv
22 Sv
4 Sv
Brine rejection
−0.36 fwSv
Glacial melt
0.05 fwSv
Antarctic
intermediate water
AAIW
Circumpolar
deep water
CDW
26 Sv
AABW
Antarctic bottom
water


Precipitation – evaporation over ocean south of 50° S:
0.28 fwSv
Snow interception by ice: 0.14 fwSv
Sea ice
SAMW
Ice melting
0.50 fwSv
22 Sv
4 Sv
Brine rejection
−0.36 fwSv
Glacial melt
0.05 fwSv
AAIW
CDW
26 Sv
AABW

Use ice to understand ocean

FRESHWATER:

OCEAN $\xrightarrow{0.36\ sv}$ ICE

Use ice to understand ocean

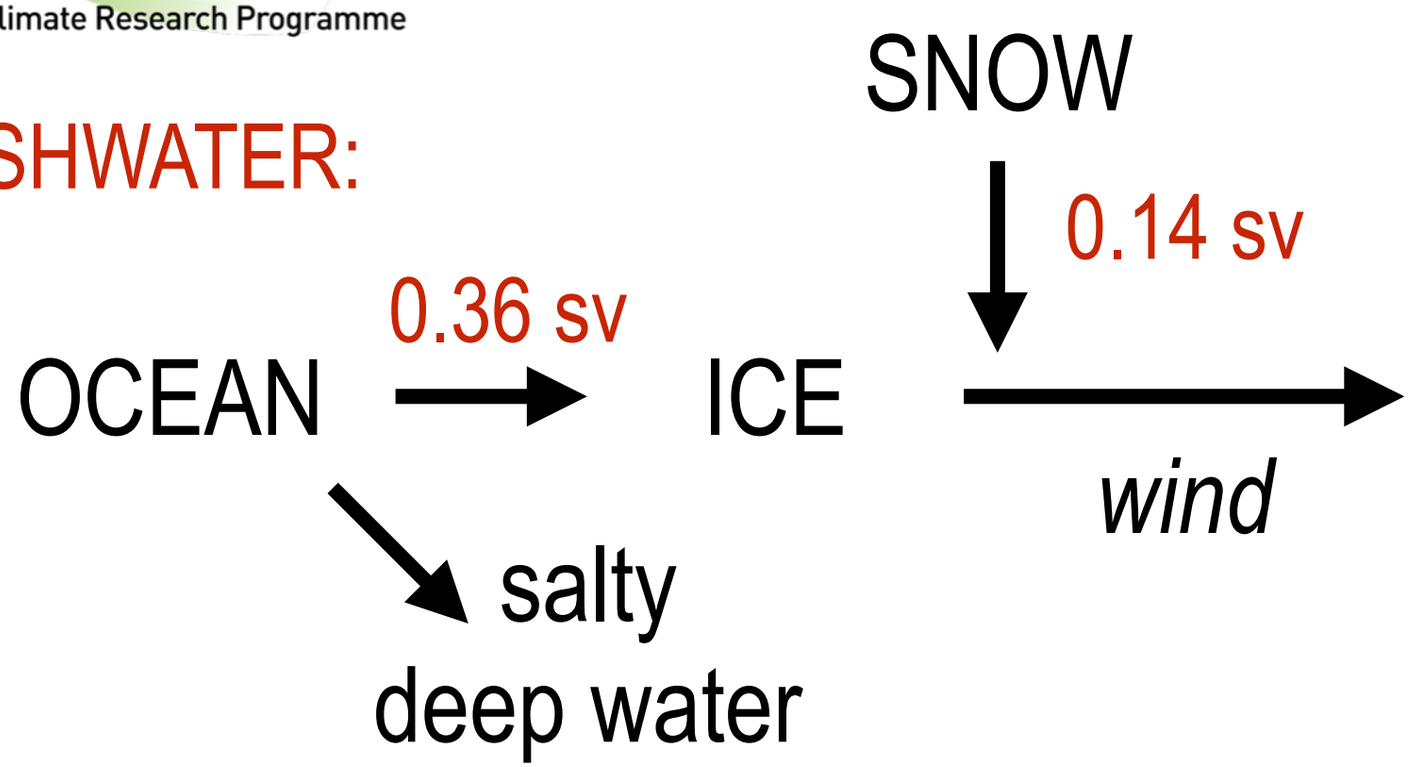
FRESHWATER:

OCEAN $\xrightarrow{0.36\ sv}$ ICE

$\searrow$ salty deep water

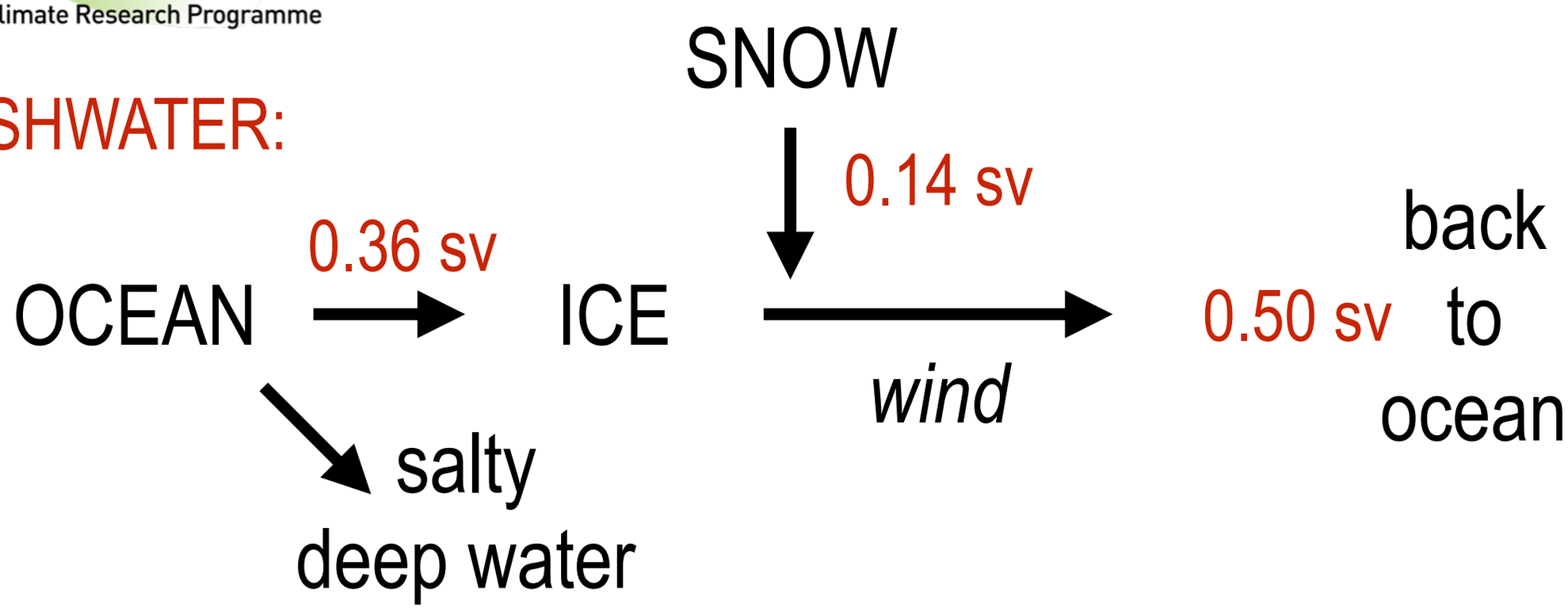
Use ice to understand ocean

FRESHWATER:



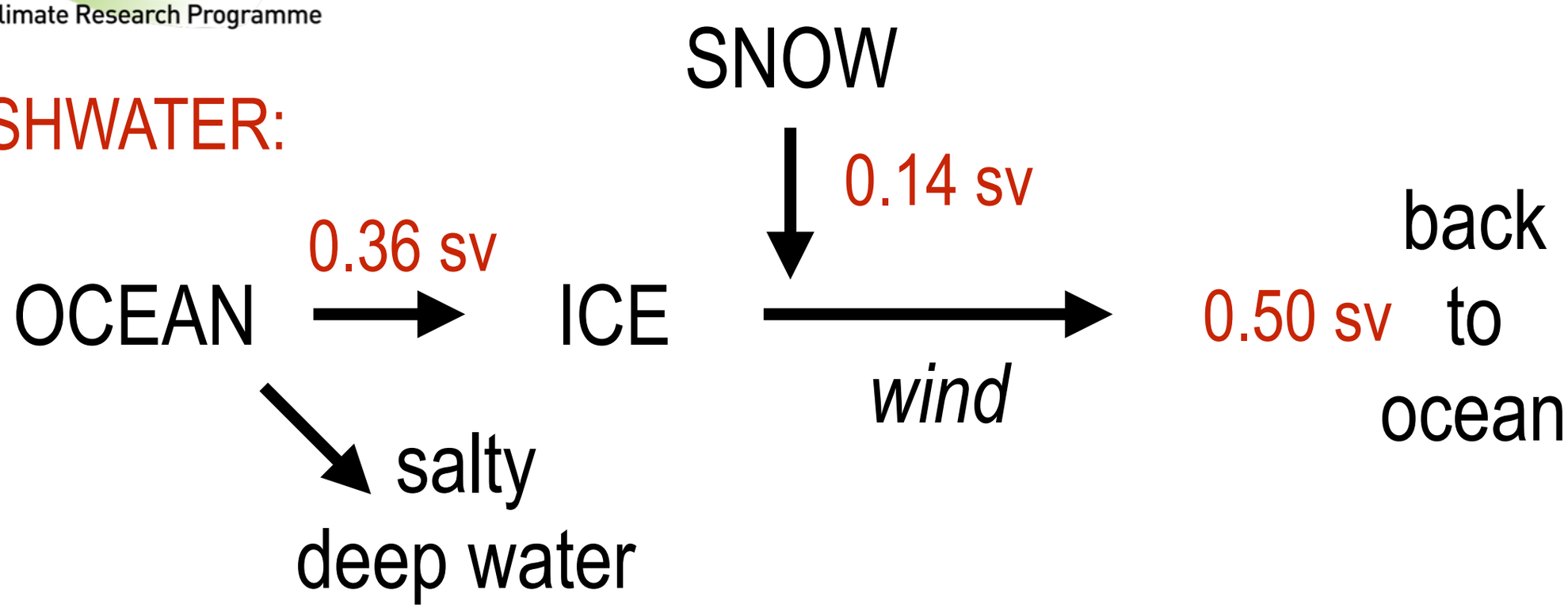
Use ice to understand ocean

FRESHWATER:



Use ice to understand ocean

FRESHWATER:

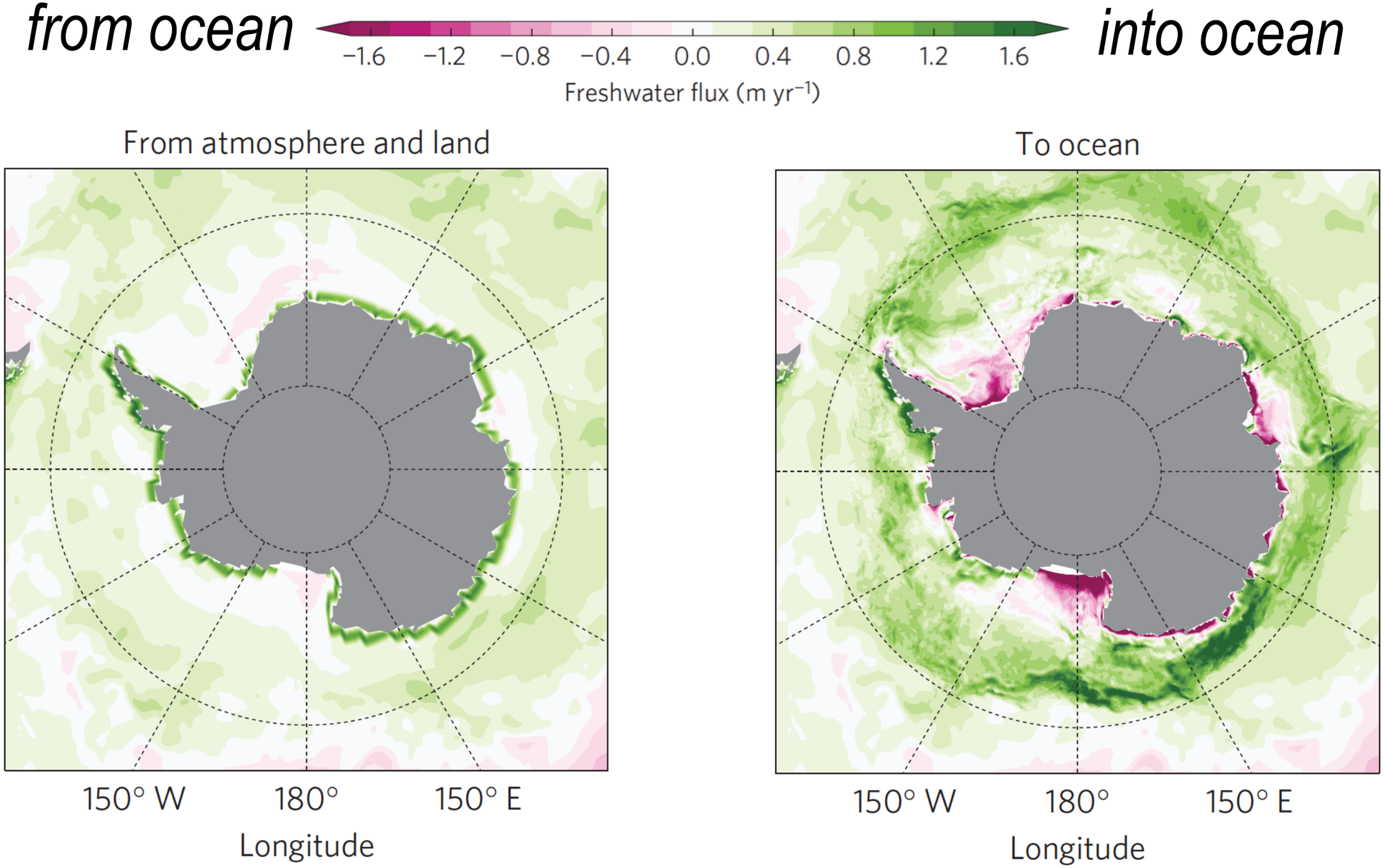


ICE > PRECIPITATION >> Glacial surface melt

0.50 sv 0.28 sv 0.05 sv

Use ocean to understand ice

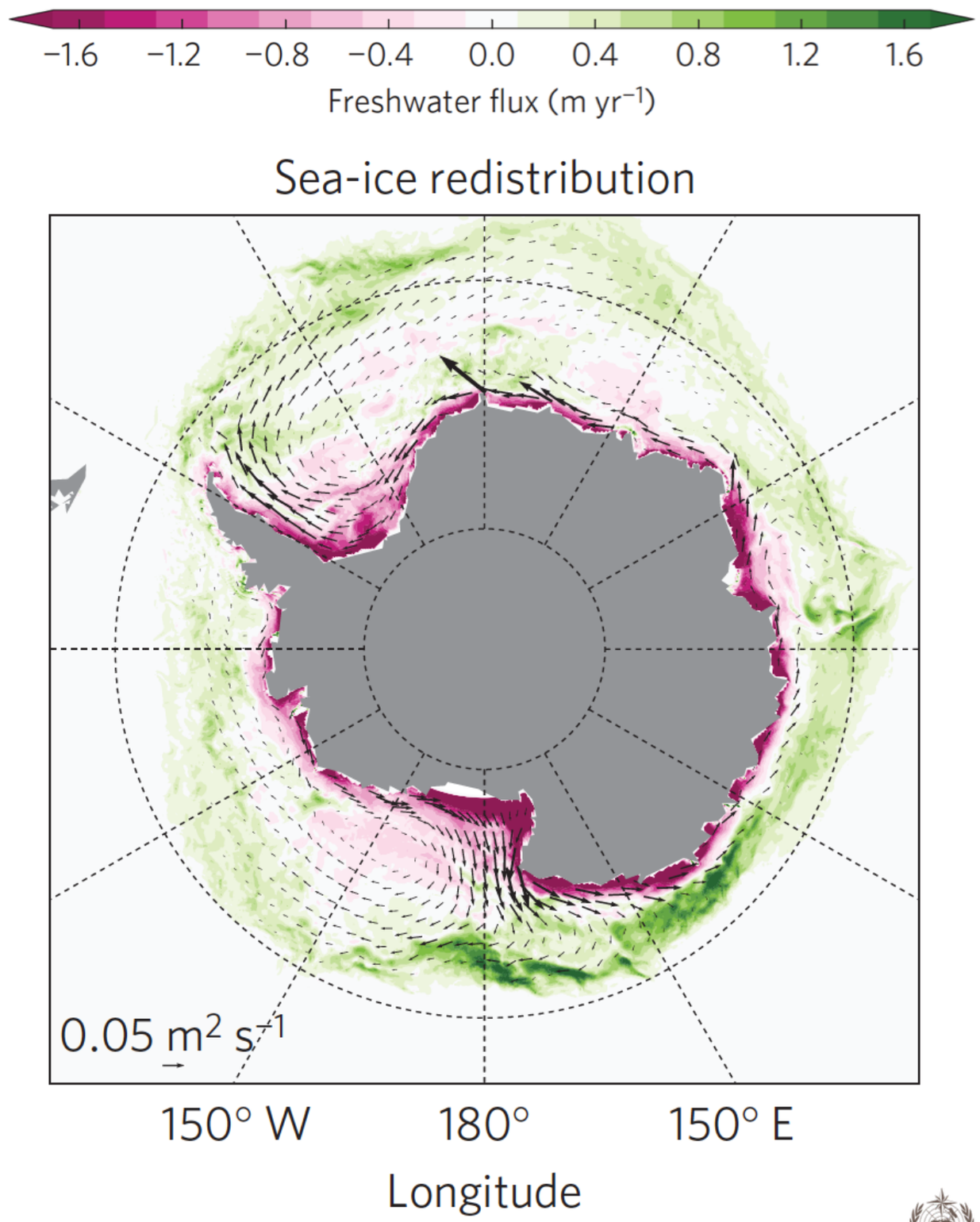
from ocean *into ocean*



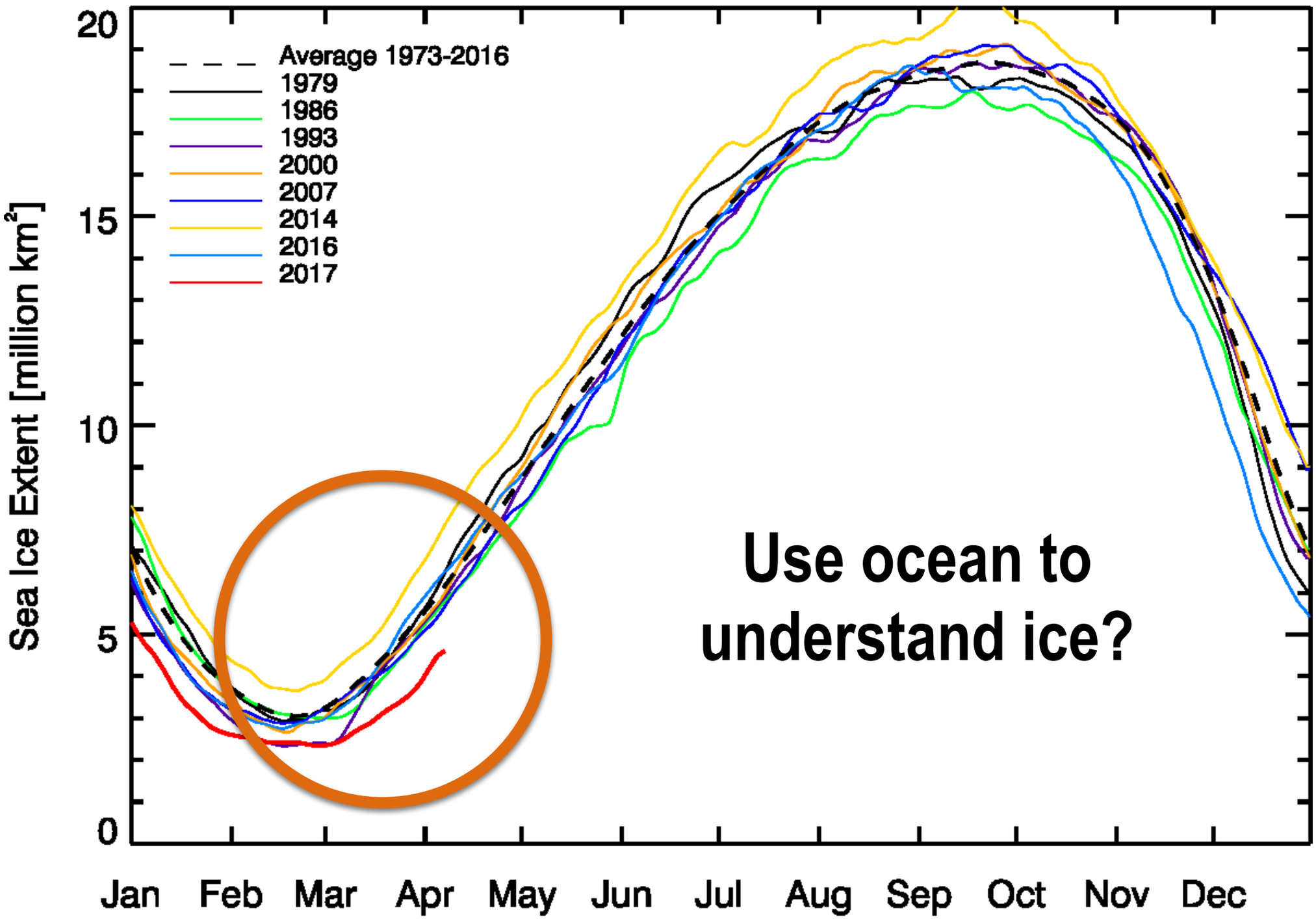
Subtract this from this

Use ocean to understand ice

from ocean *into ocean*



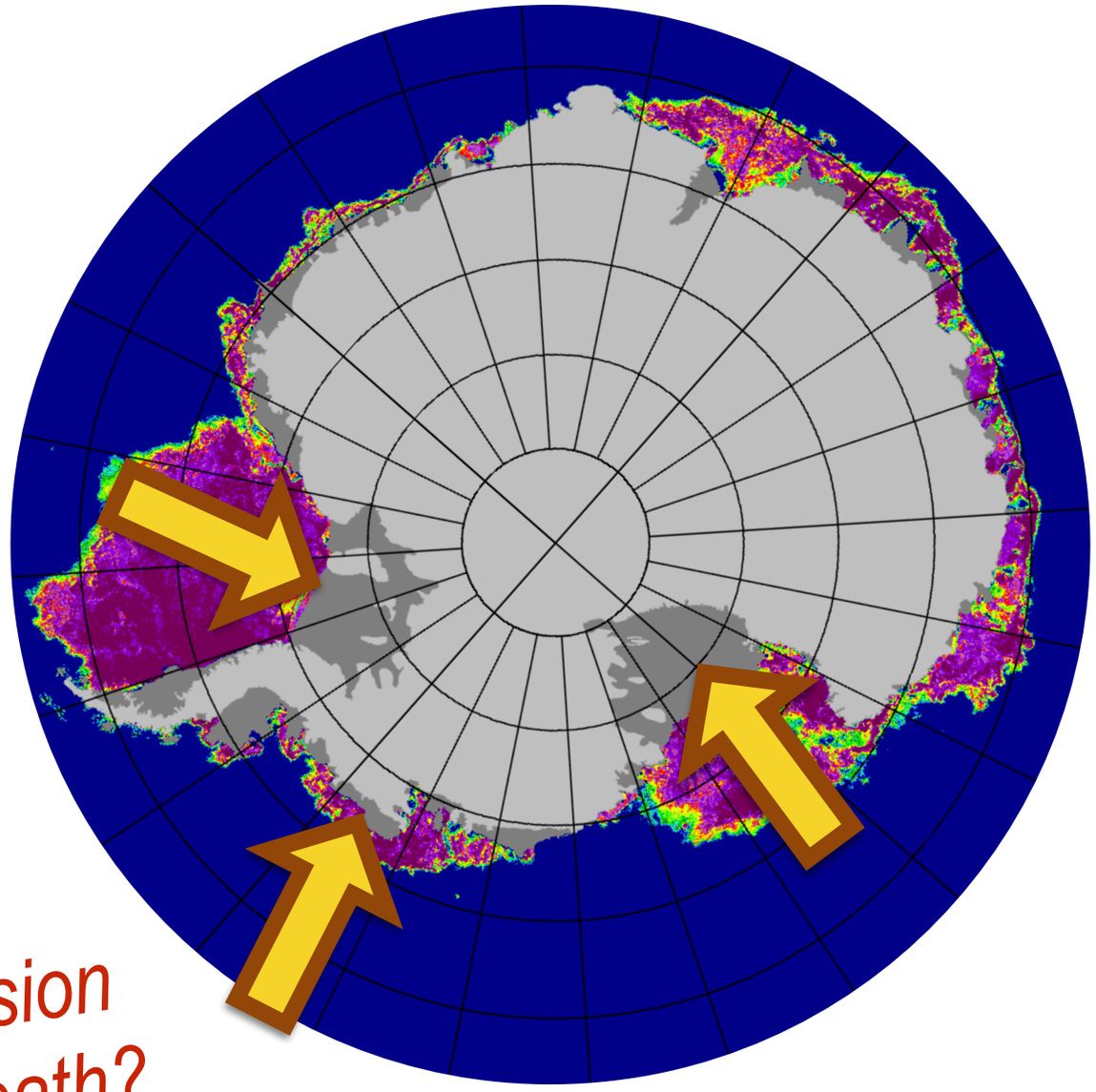
Antarctic Sea Ice Extent



Updated on 2017.04.09

WCRP
World Climate Research Programme

Sea ice extent
2017-04-09



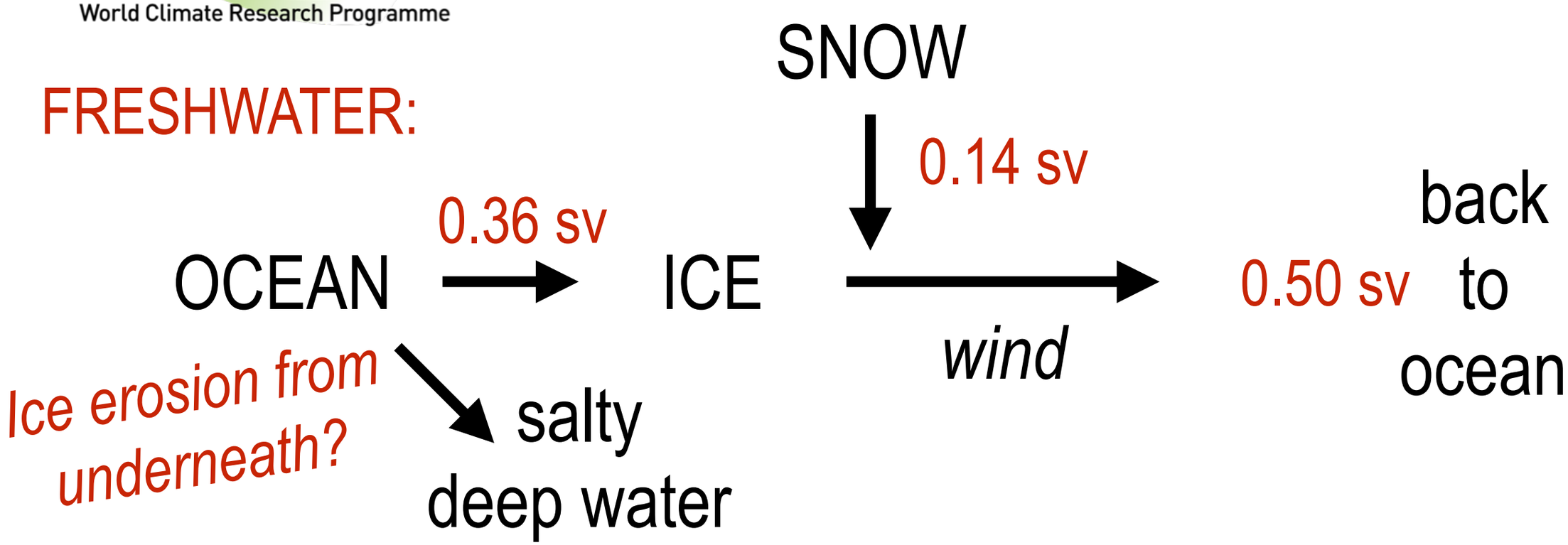
Ice shelf erosion
from underneath?

University
of Bremen
(Germany)

WMO IOC ICSU International Council for Science

Use ice to understand ocean

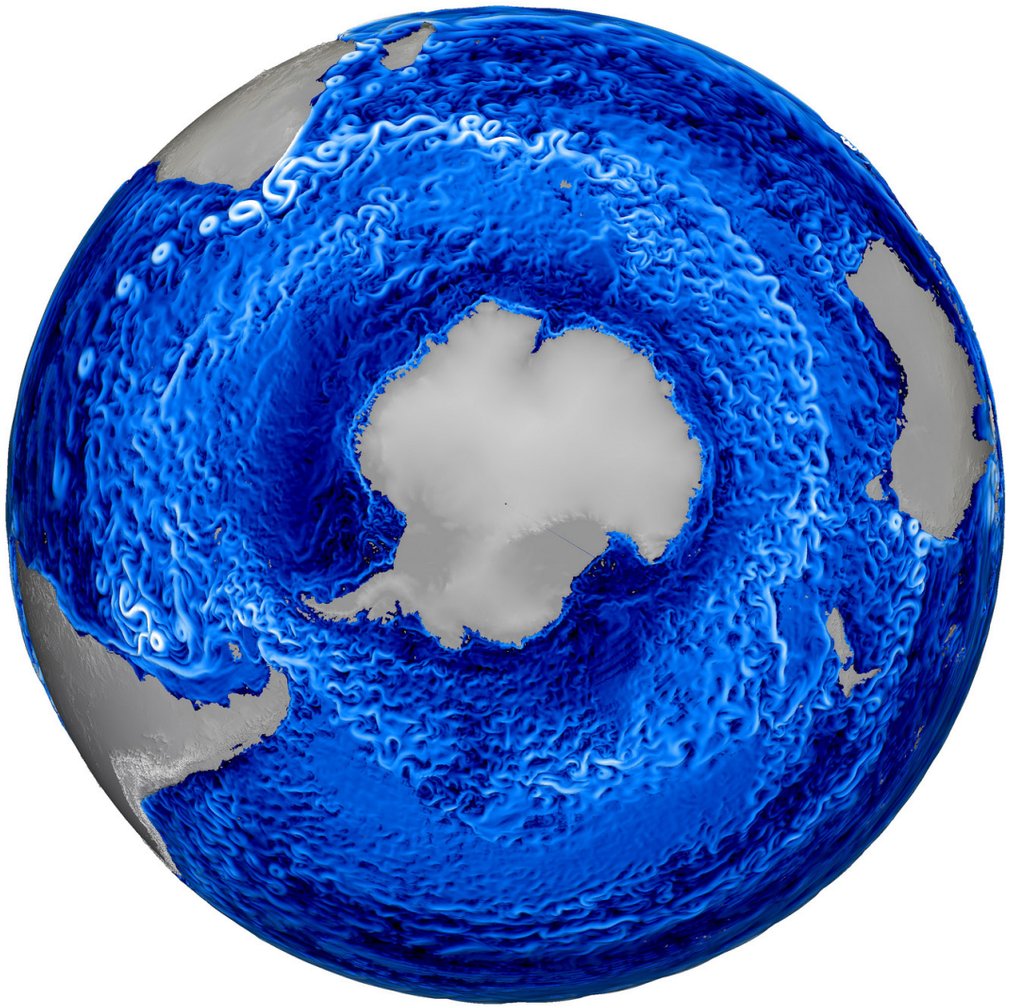
FRESHWATER:

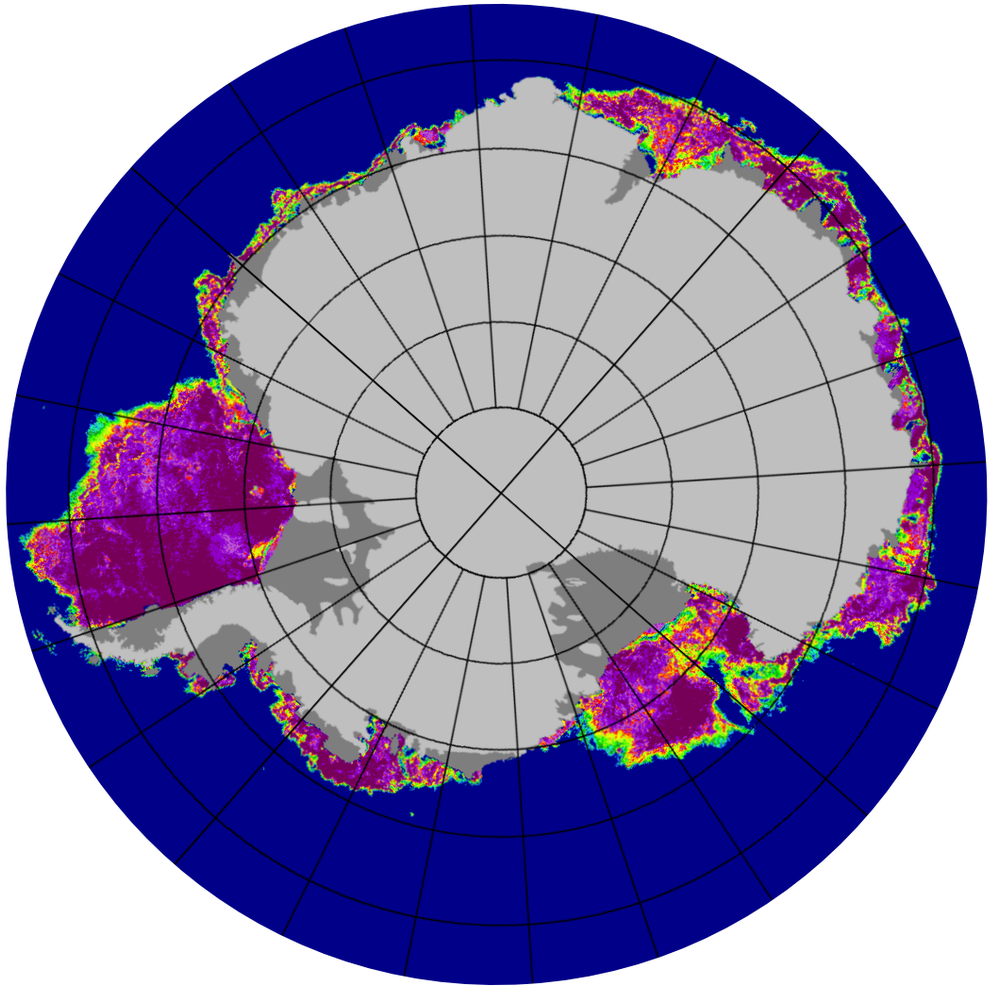


ICE > PRECIPITATION >> Glacial surface melt

0.50 sv 0.28 sv 0.05 sv

WCRP
World Climate Research Programme





WCRP PEI 2017.04.12

WMO UNESCO IOC ICSU International Council for Science

WCRP
World Climate Research Programme

Analysis & Prediction

Climate challenges the human spirit

WMO IOC ICSU International Council for Science