Ice and Ocean
Around Antarctica
Ocean Model

White = fast
Blue = slow

Los Alamos (USA) National Laboratory
Nutrients for biology: \(\frac{3}{4}\) of remaining ocean

30° South
Nutrients for biology: 3/4 of remaining ocean

Heat uptake: 3/4 of ocean total
Nutrients for biology: $\frac{3}{4}$ of remaining ocean

Heat uptake: $\frac{3}{4}$ of ocean total

$\text{CO}_2$ uptake: $\frac{1}{2}$ of ocean total
Sea ice extent
2017-04-08

National
(USA)
Snow and
Ice Data
Centre
Sea ice extent
2017-04-08

National
(USA)
Snow and
Ice Data
Centre
Sea ice extent
2017-04-08

National
(USA)
Snow and
Ice Data
Centre

extent

thickness
Sea ice extent
2017-04-08

National (USA)
Snow and Ice Data Centre

Ice volume!
Use ocean to understand ice?
Use ice to understand ocean?
sverdrup: 1 million cubic metres per second:
$10^6 \text{ m}^3 / \text{s}$
$(1,000,000,000 \text{ litres} / \text{s})$
sverdrup: 1 million cubic metres per second:

$10^6 \text{ m}^3 / \text{s}$

(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:
$10^6 \text{ m}^3 / \text{s}$
$(1,000,000,000 \text{ litres / s})$

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

Largest ocean current: Antarctic Circumpolar Current, approximately 125 sverdrups
Antarctic Circumpolar Current: \[ \approx 125 \text{ sverdrups} \]
Antarctic bottom water

Circumpolar deep water

Sub-Antarctic mode water

Antarctic intermediate water

SAMW

AAIW

CDW

26 Sv

Ice melting
0.50 fwSv

22 Sv

4 Sv

Brine rejection
-0.36 fwSv

Glacial melt
0.05 fwSv

Antarctic bottom water
Precipitation - evaporation over ocean south of 50° S: 0.28 fwSv

Snow interception by ice: 0.14 fwSv

Glacial melt: 0.05 fwSv

Ice melting: 0.50 fwSv

Sea ice

SAMW

AAIW

CDW

26 Sv

AABW

22 Sv

4 Sv

Brine rejection: -0.36 fwSv
Use ice to understand ocean

FRESHWATER: 0.36 sv

OCEAN → ICE
FRESHWATER:

OCEAN 0.36 sv ICE

salty deep water
Use ice to understand ocean

FRESHWATER:

OCEAN 0.36 sv ICE 0.14 sv SNOW

salty

wind
deep water
Use ice to understand ocean

**FRESHWATER:**

- **OCEAN** → **ICE**: 0.36 sv
- **ICE**: wind 0.14 sv back to ocean
- Salty deep water

**SNOW**: 0.50 sv
Use ice to understand ocean.

FRESHWATER: 0.50 sv back to ocean

OCEAN: 0.36 sv to ICE

ICE: 0.14 sv to ocean by wind

salty deep water

ICE: 0.50 sv to PRECIPITATION

PRECIPITATION: 0.28 sv to Glacial surface melt

Glacial surface melt: 0.05 sv
Use ocean to understand ice from ocean into ocean

From atmosphere and land

To ocean

Subtract this from this
Use ocean to understand ice from ocean into ocean

Sea-ice redistribution

Freshwater flux (m yr⁻¹)

0.05 m² s⁻¹

150° W  180°  150° E

Longitude
Use ocean to understand ice?
Sea ice extent
2017-04-09

Ice shelf erosion from underneath?

University of Bremen (Germany)
Use ice to understand ocean

FRESHWATER: 0.50 sv

ICE

OCEAN 0.36 sv⇌ICE

salty deep water

0.14 sv back to ocean

wind

Glacial surface melt

0.28 sv

0.05 sv

Ice erosion from underneath?
Climate challenges the human spirit