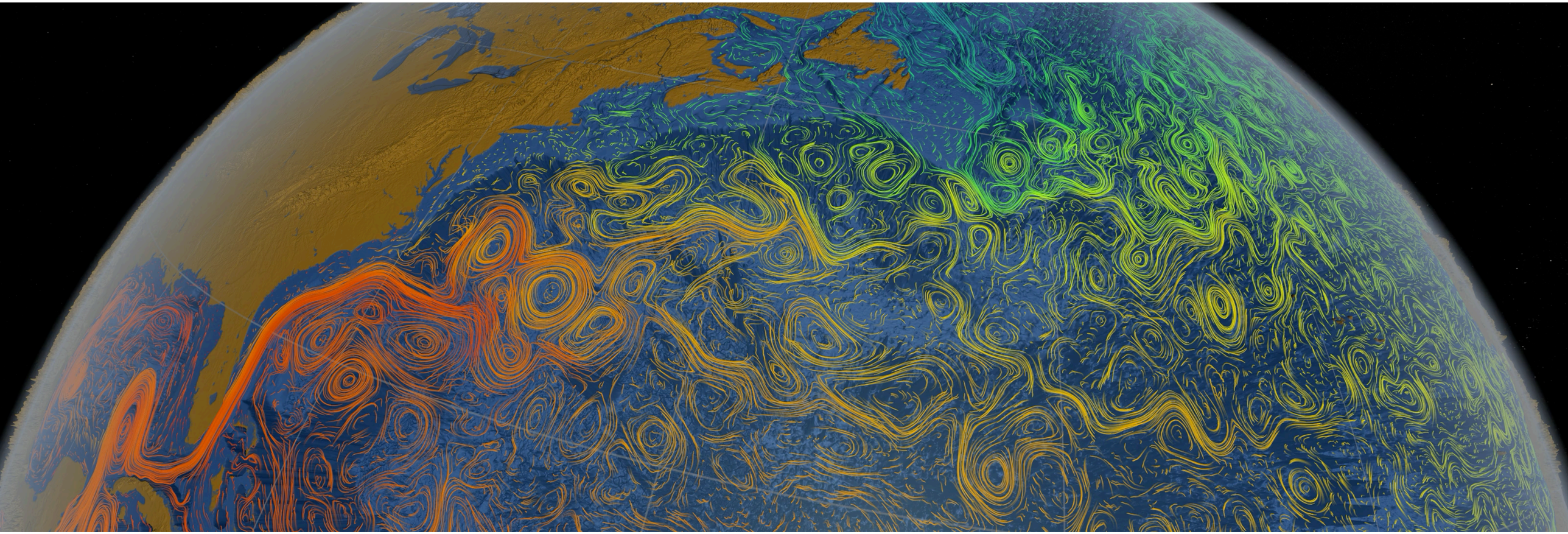
Australian National University

The ocean currents in a changing climate

Navid Constantinou



Remark: Not to be confused with Van Gogh's "Starry Night"

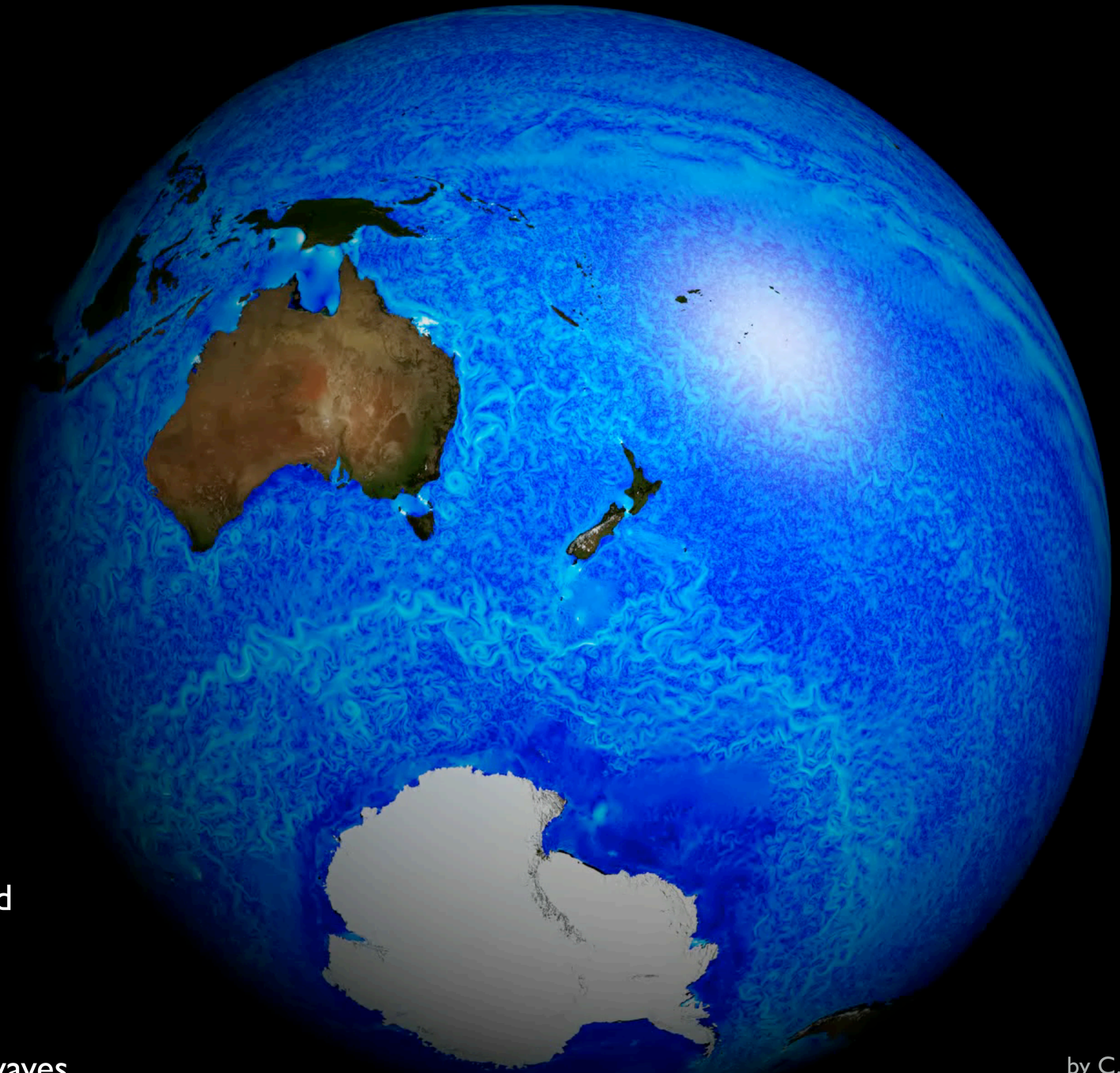
Sapphire Coast Symposium
14th August 2021

Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio

“How inappropriate to call this planet Earth, when clearly it is Ocean.”

Arthur C. Clark

NASA JPL

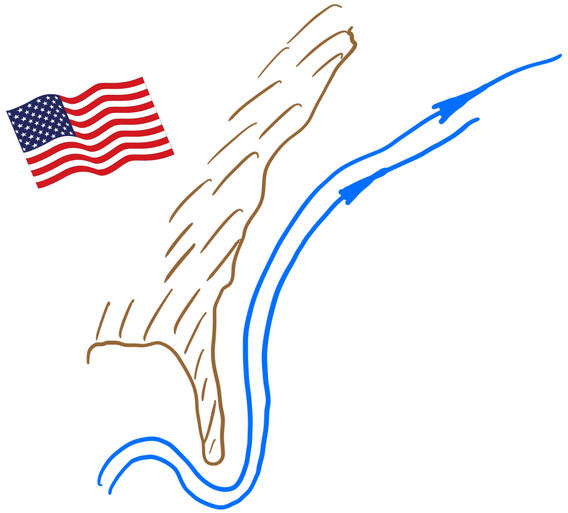


sea-surface current speed
from an extremely
high-resolution model

includes tides and resolves waves

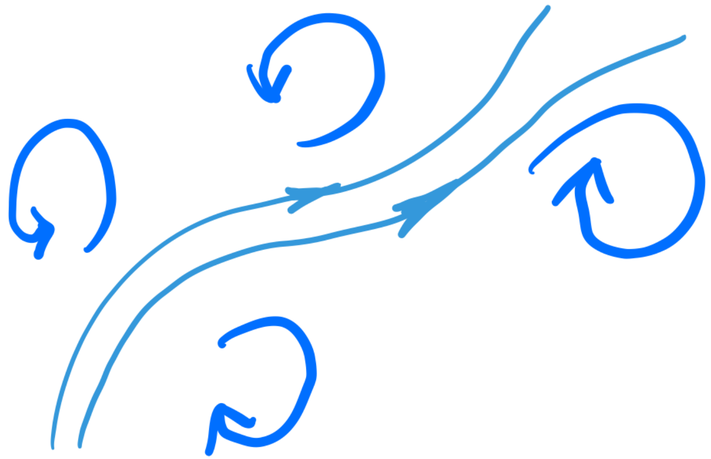
by C. Henze and D. Menemenlis (NASA/JPL)

so, ocean circulation is definitely not boring…



western boundary currents

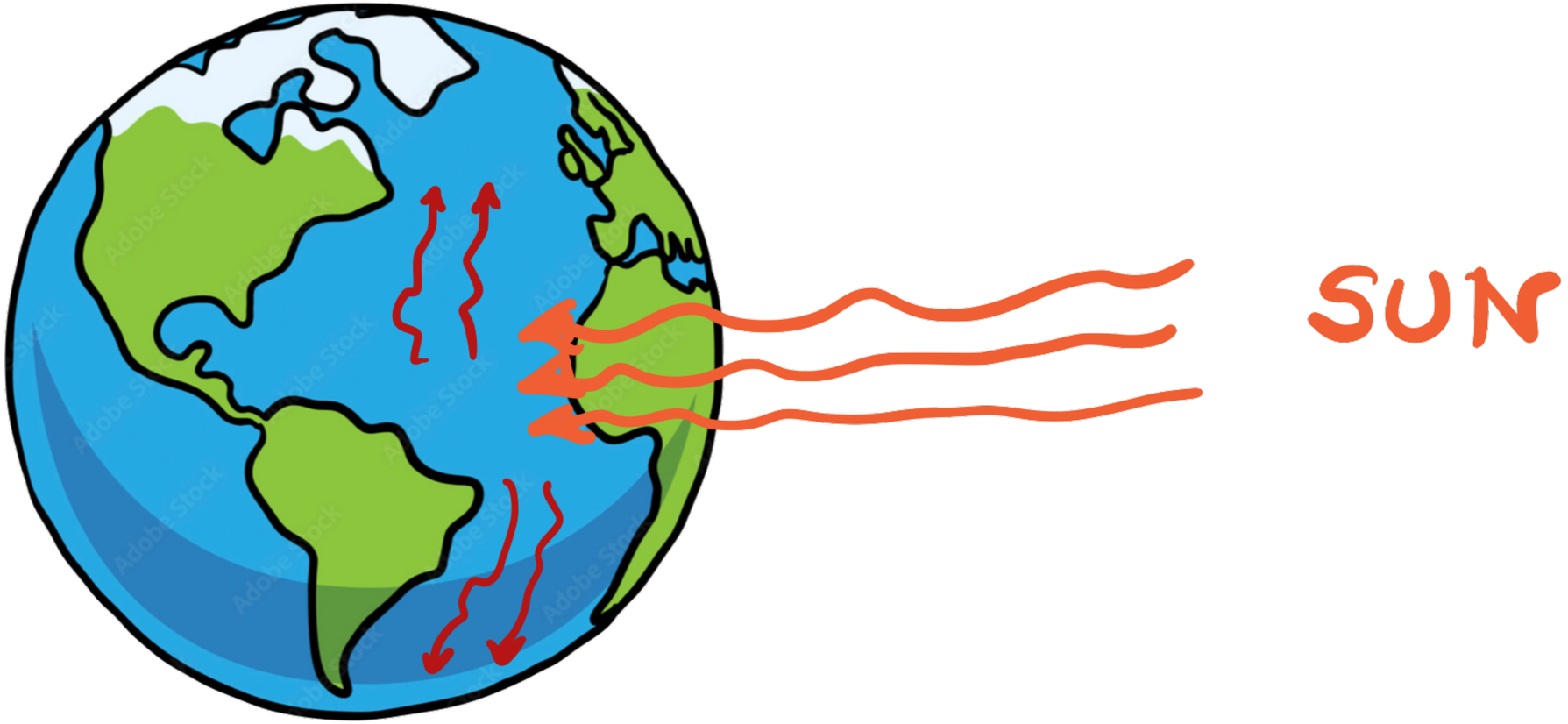
e.g., Gulf Stream



eddies

tides, waves, …

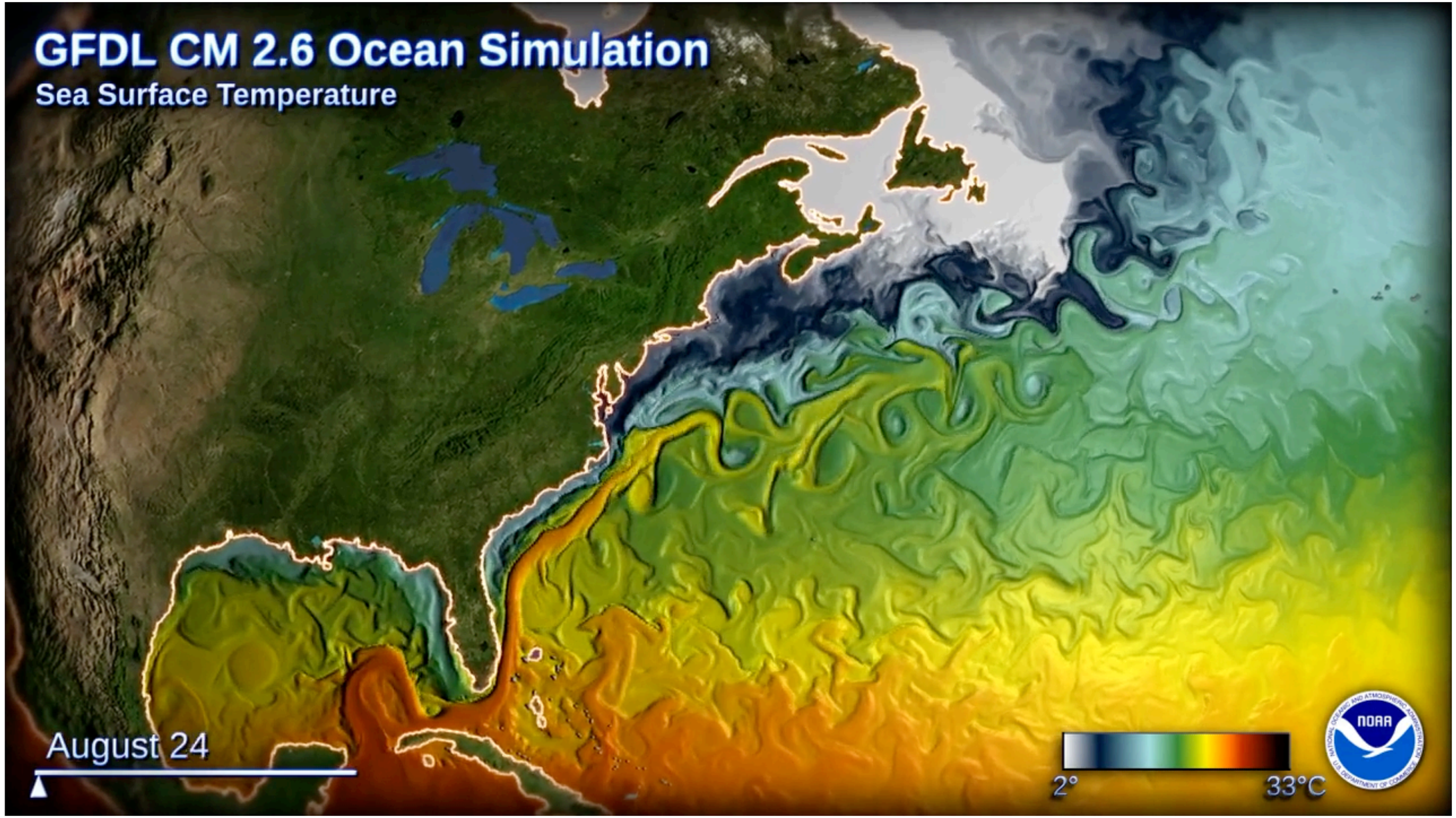
why is there ocean (or atmosphere) circulation?



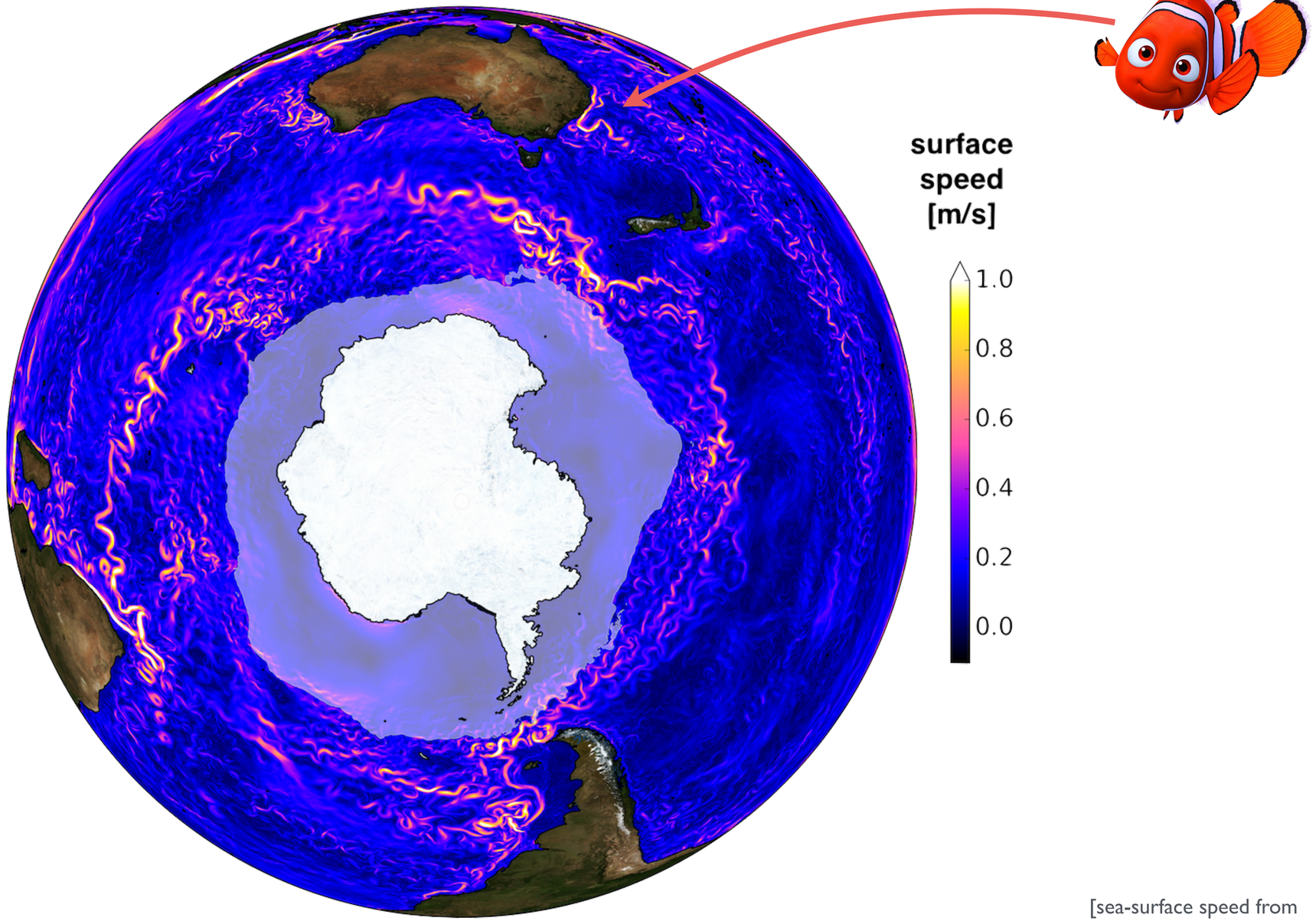
sun heats the tropics…

…ocean & atmosphere carry some of the heat to the poles

major features of ocean circulation



Southern Hemisphere ocean features

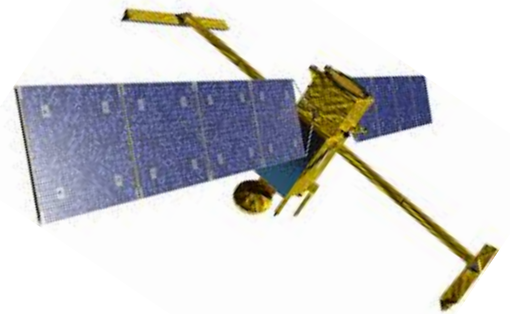


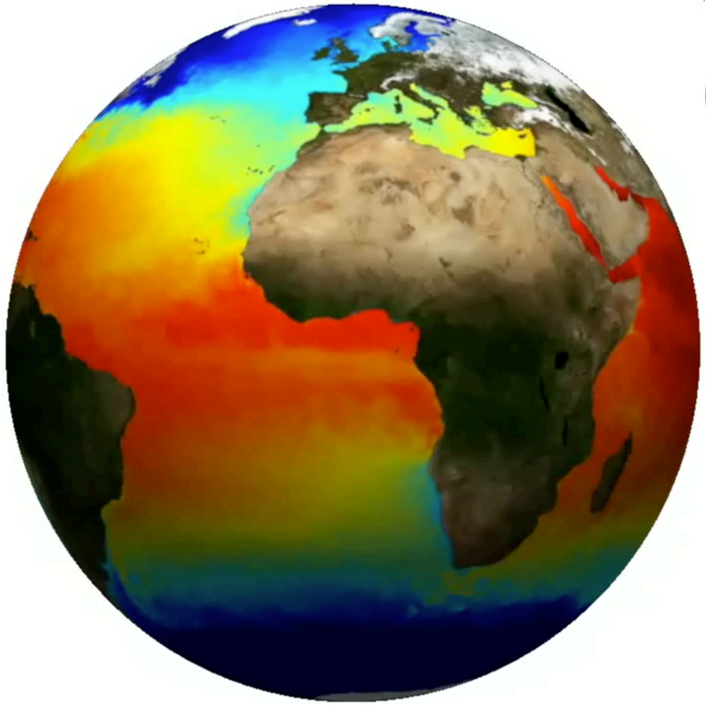
[sea-surface speed from Australia's ACCESS-OM2 sea-ice-ocean model]

how do we study the ocean?

observe the real world
seek for patterns/underlying phenomena
discover unknown processes

Observations





[NASA's Goddard
Space Flight Center]

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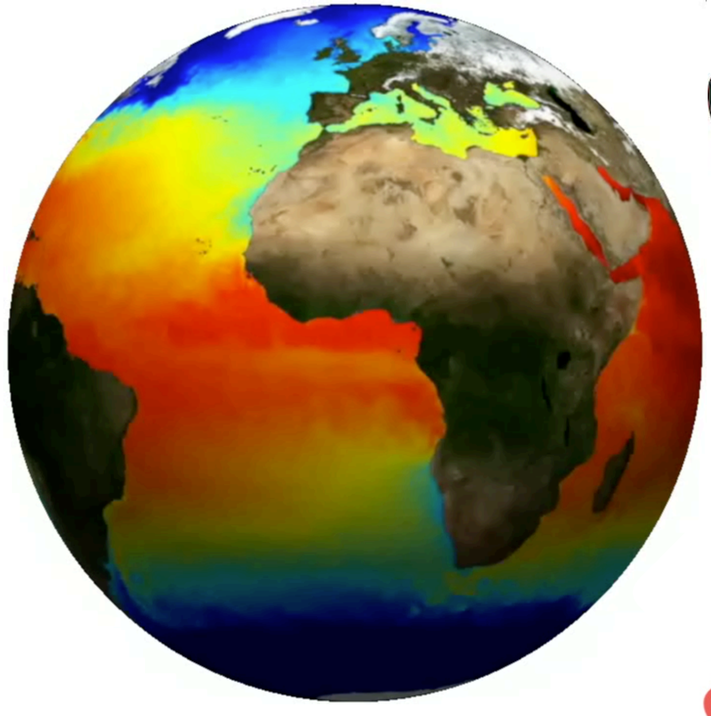
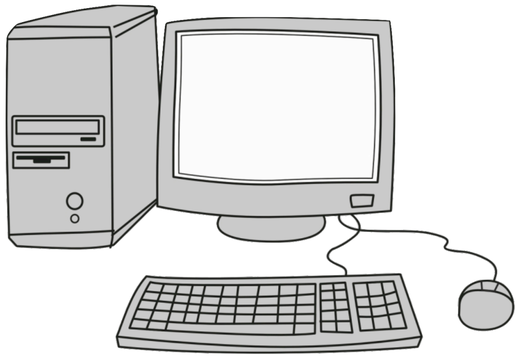


[NASA's Goddard
Space Flight Center]

Simulation

model and simulate "reality"
predict future
look for patterns/correlations



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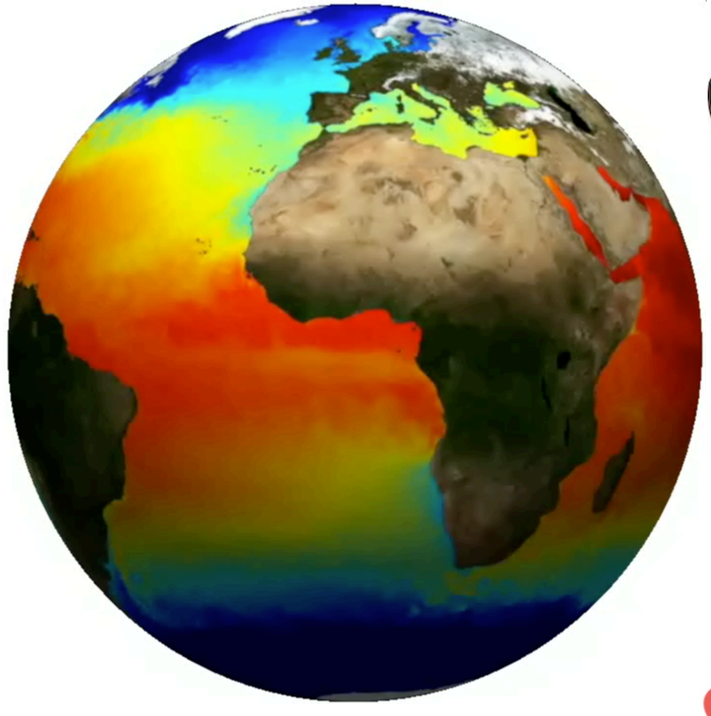

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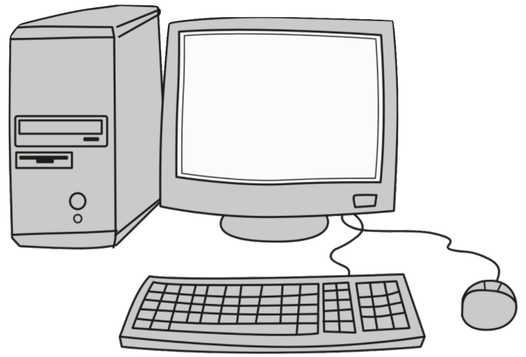


Theory

$$\rho\left(\frac{\partial \boldsymbol{u}}{\partial t} + \boldsymbol{u}\cdot\nabla\boldsymbol{u}\right) = \ldots$$

start from dynamical laws
predict consequences
understand phenomena

what drives the ocean circulation?

winds

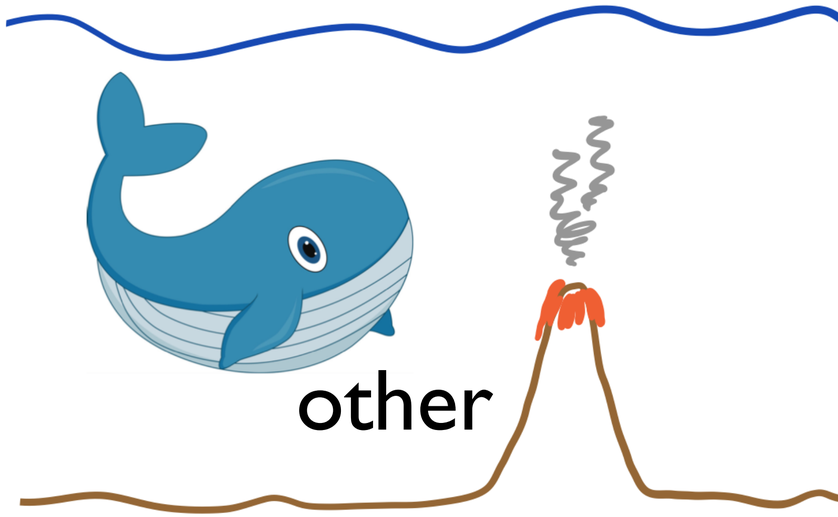
(≈Sun)

89-90%

tides

(≈Moon)

10%



other

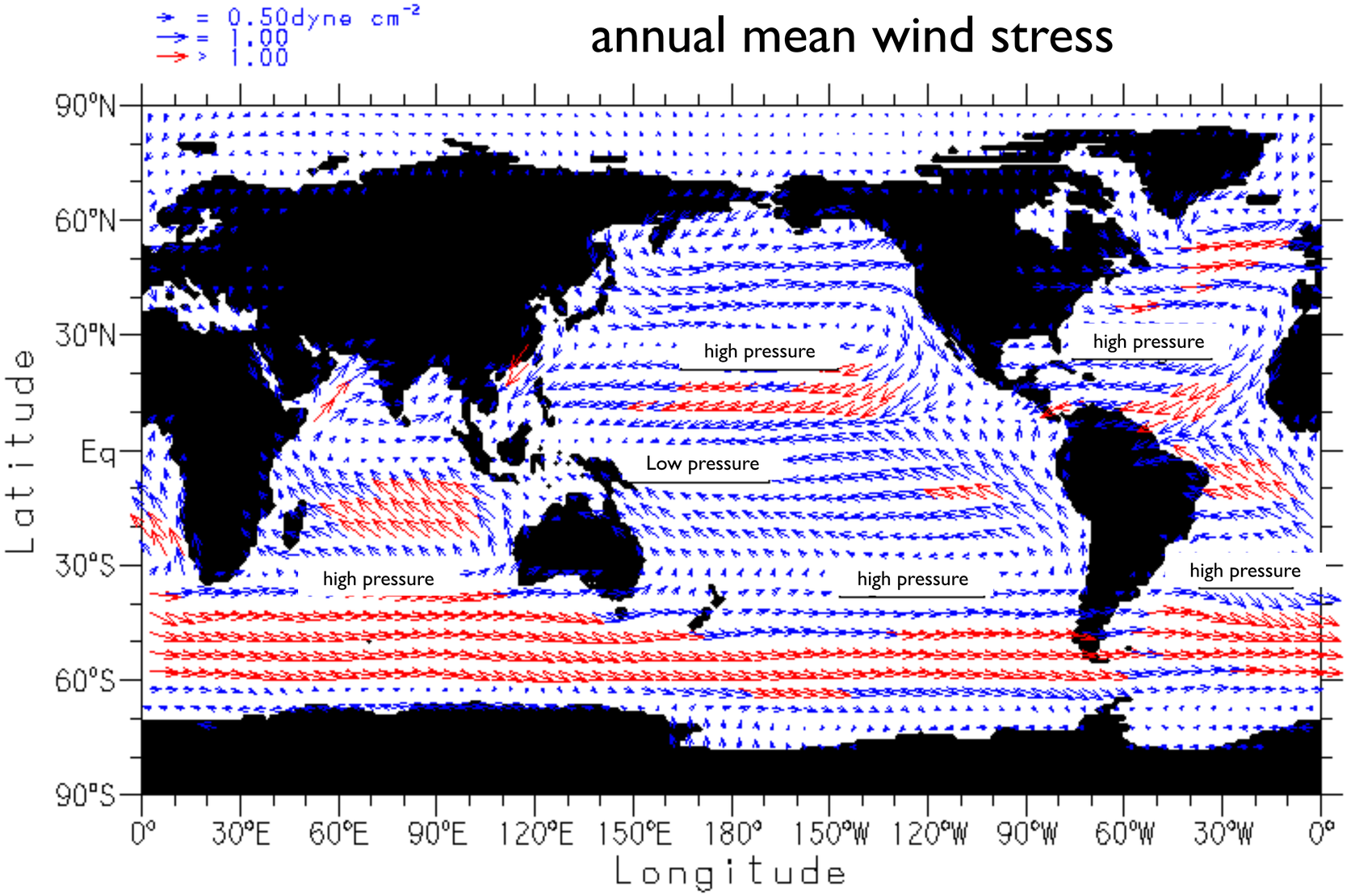
Surface heating

Geothermal heating
(volcanoes at bottom of ocean)

Whales moving around?

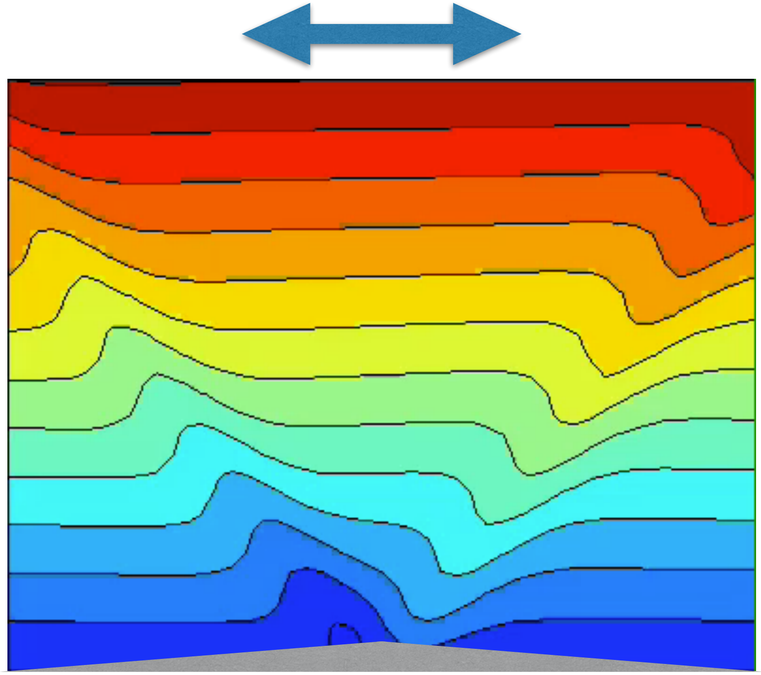
~1%

winds act on the surface of the ocean

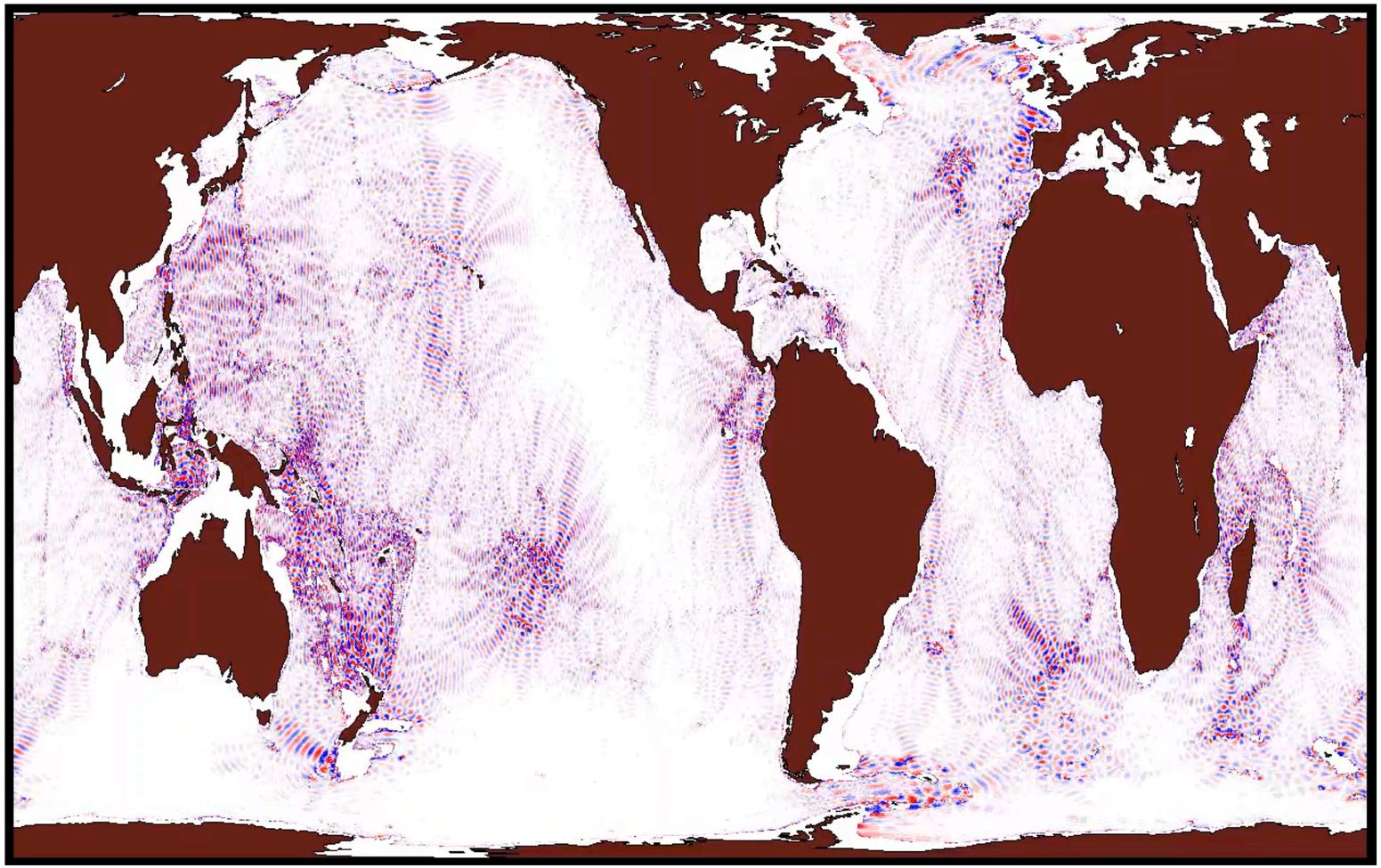


how tides lead to ocean motions?

tidal oscillation



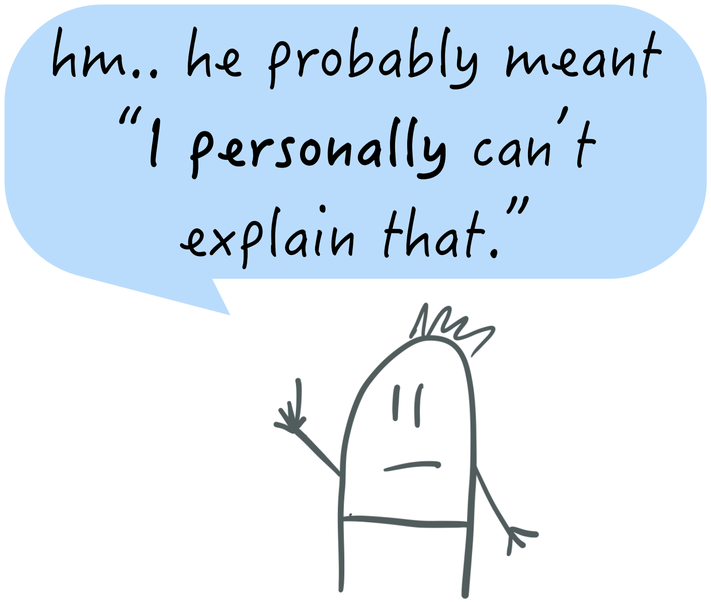
a mountain at the
bottom of the ocean



Credit: Arbic et al., (2010), *Ocean Modelling*.

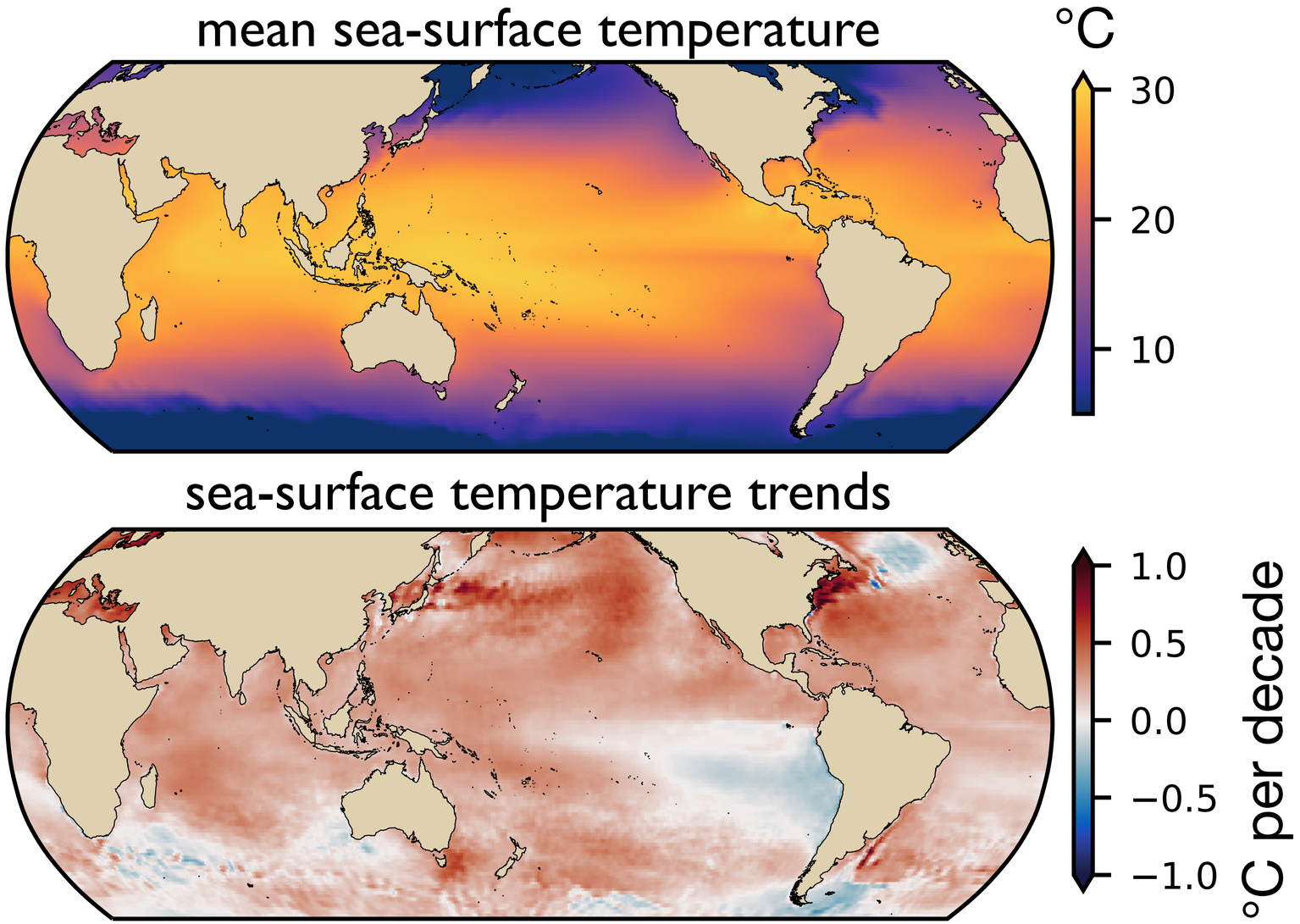
"Tide goes in, tide goes out.
We can't explain that."

Bill O'Reilly



How have the oceans been changing over the last 30 years?

ocean is getting warmer



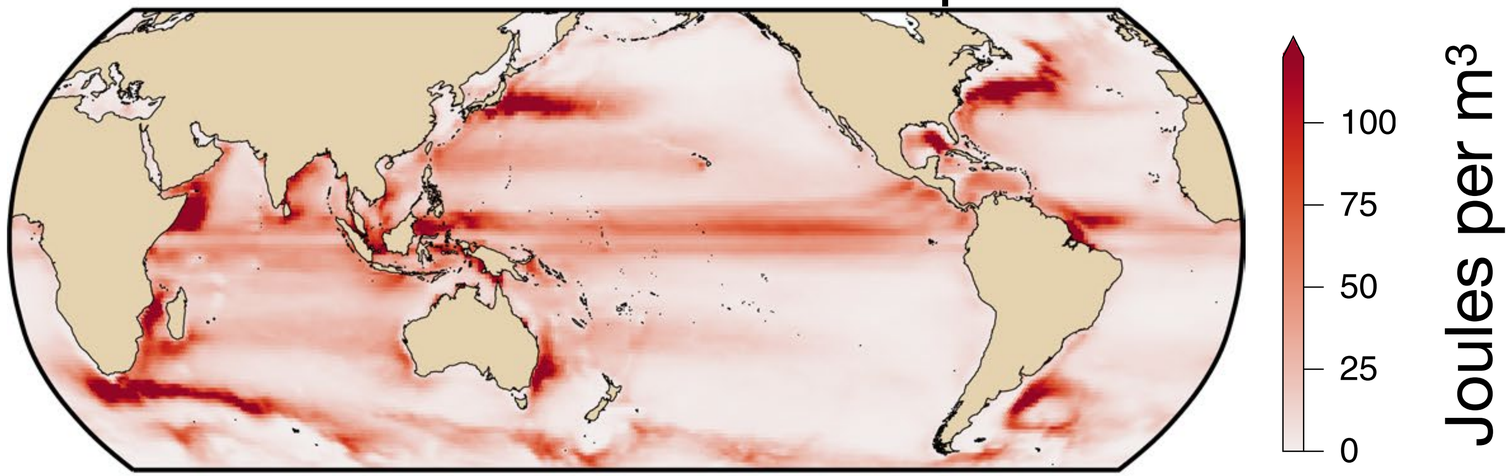
global increase of around
0.1 degree per decade

Satellite product:
National Oceanic and Atmospheric Administration
Optimum Interpolated Sea-Surface Temperature

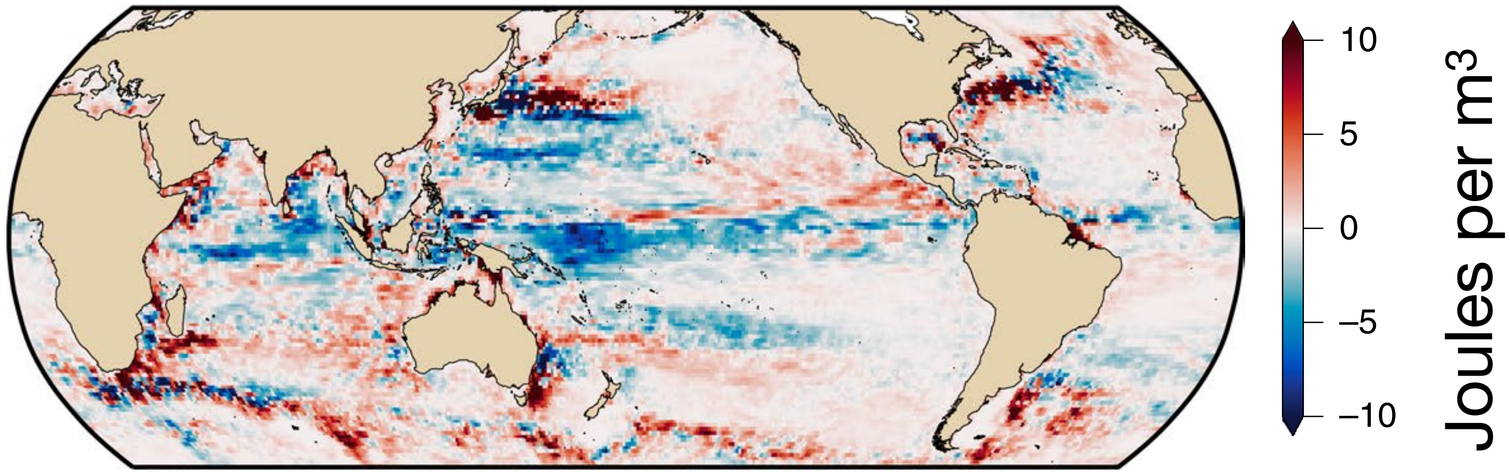
Martinez-Moreno et al., (2021), *Nature Climate Change*.

are ocean currents speeding up?

mean sea-surface currents "speed"



sea-surface currents "speed" trends



regions rich in eddies are speeding up

read more @ The Conversation
https://bit.ly/conversation2021

Satellite product:
Satellite Altimetry produces by Ssalto/Duacs and distributed by EU CMEMS

Martinez-Moreno et al., (2021), *Nature Climate Change*.

Ocean captures ~90% of the CO_2 from atmosphere and "stores" it in the abyss.

Changing oceans may induce:

- Ramifications on amount of CO_2 left in the atmosphere
- Changes in global and regional climate patterns

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We are hiring! 🎉

Understanding climate is not that easy. We need help!!
Come join us — it's fun and it's also for a good cause!!
Positions are open.