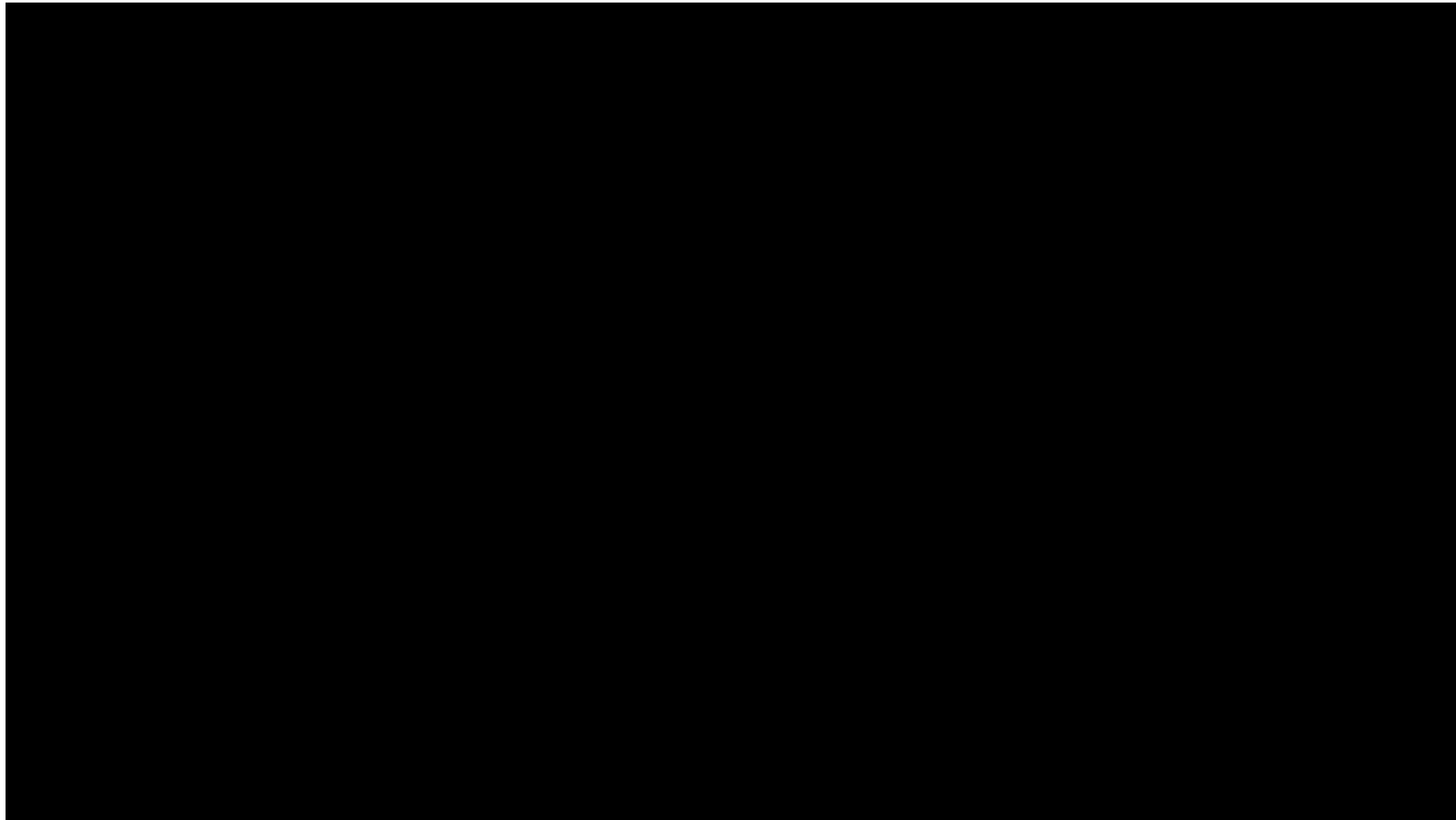


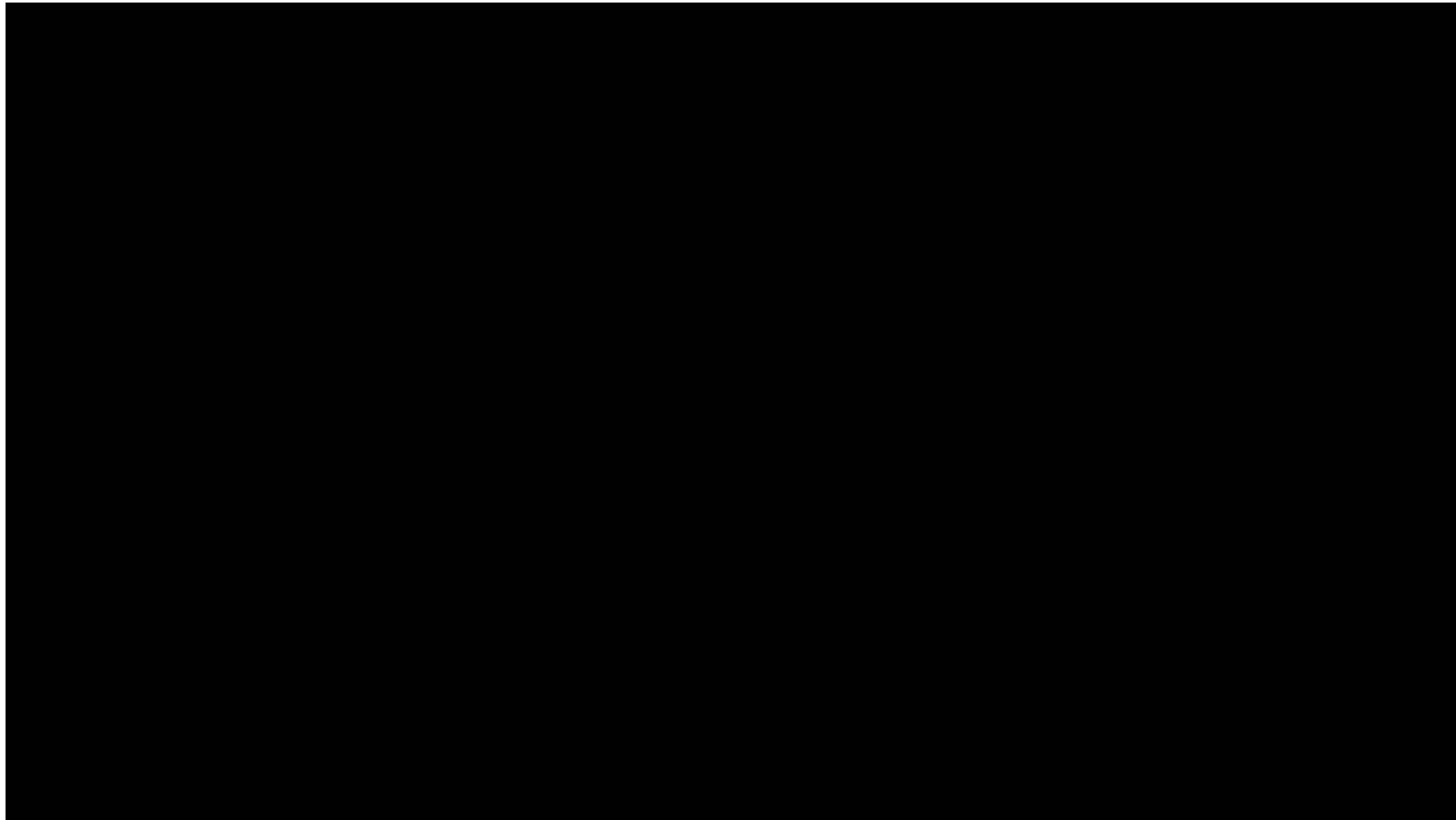
Horizontal circulation and Coriolis

EPS131, Introduction to Physical Oceanography and Climate
Dept of Earth and Planetary Sciences, Harvard University
Eli Tziperman



Horizontal circulation and Coriolis

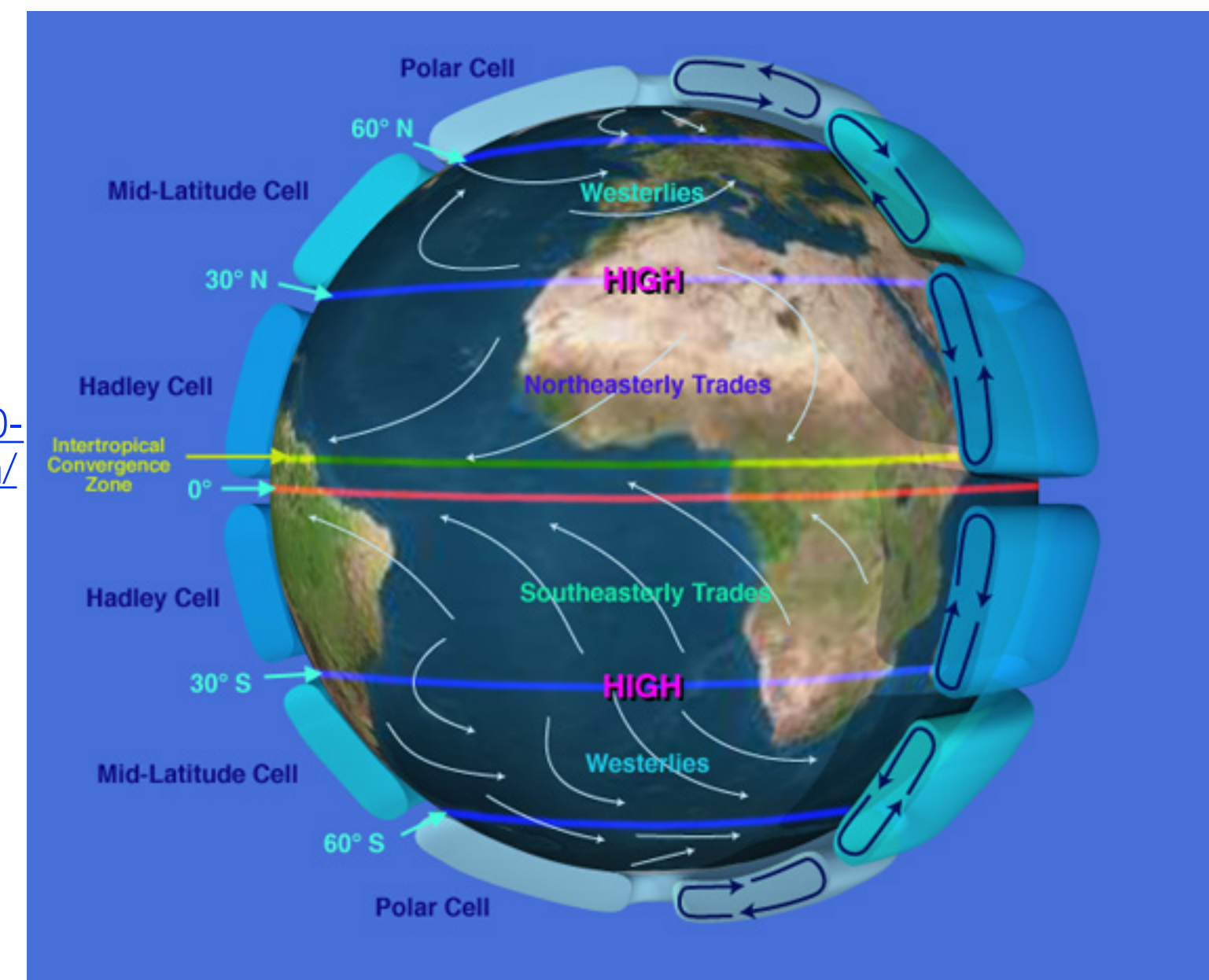
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1 Geostrophy - introduction (wind driving of ocean currents)

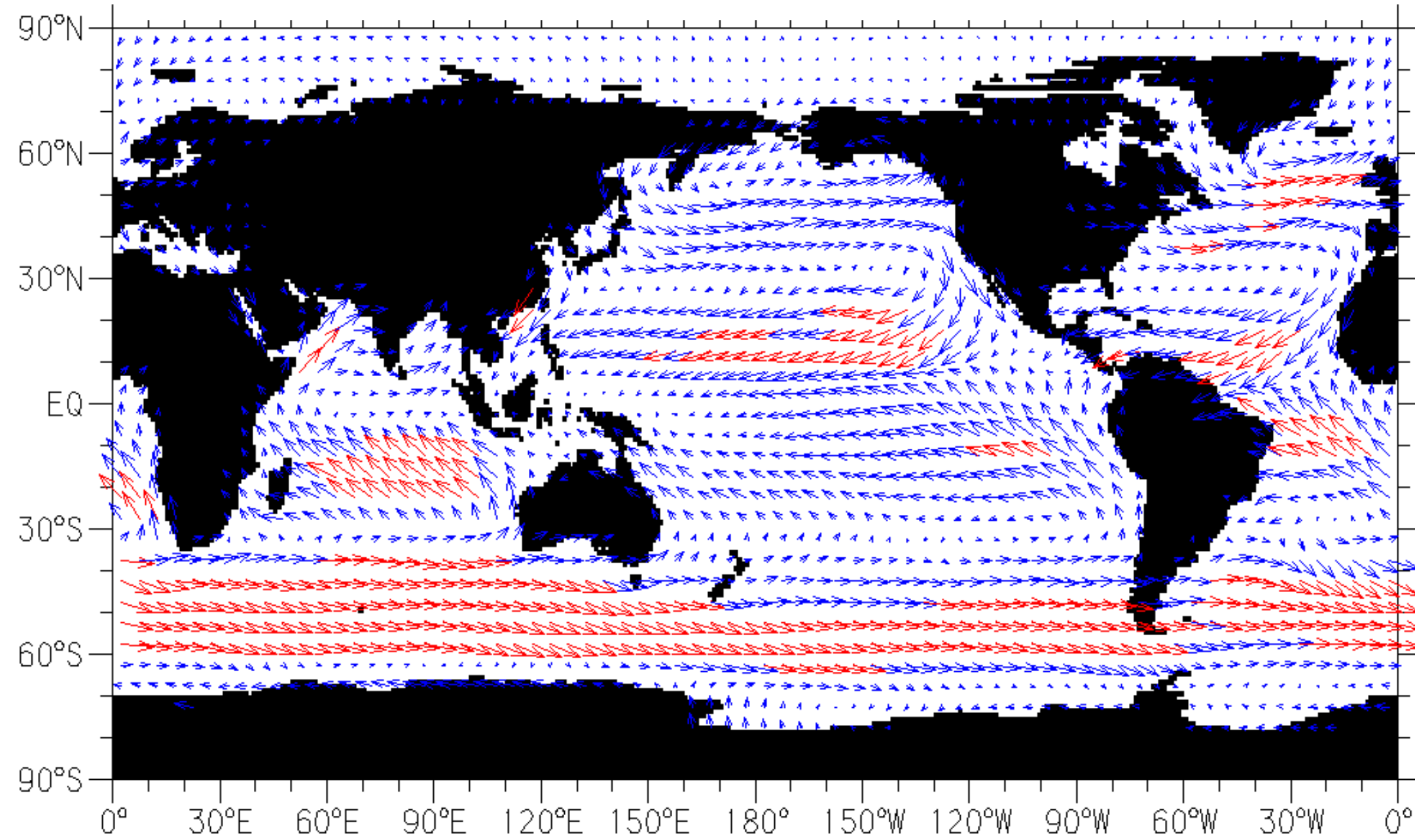
winds schematic

<https://slidetodoc.com/astr-2310-chapter-9-earth-and-moon-earth/>

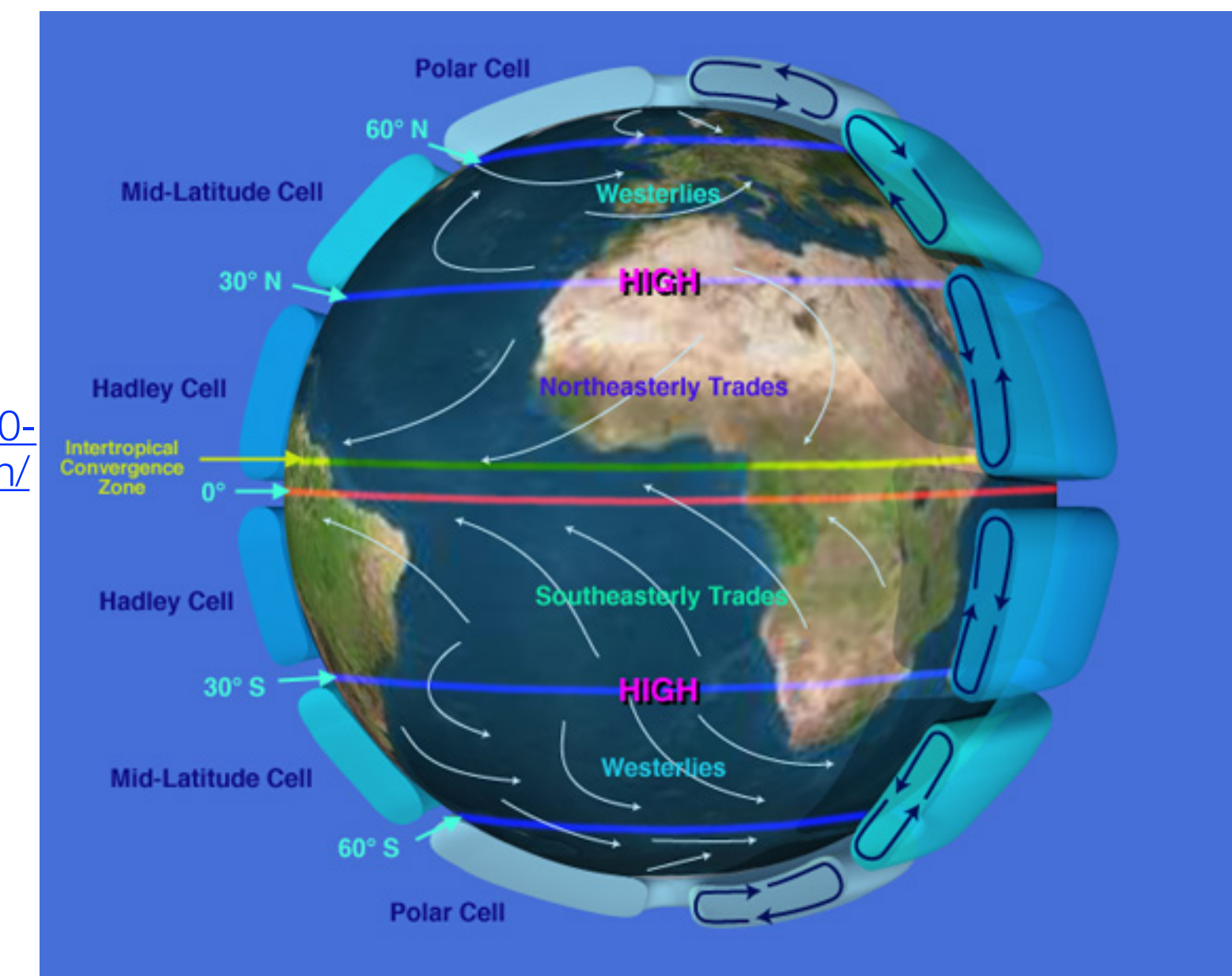


1 Geostrophy - introduction (wind driving of ocean currents)

a annual mean surface winds stress



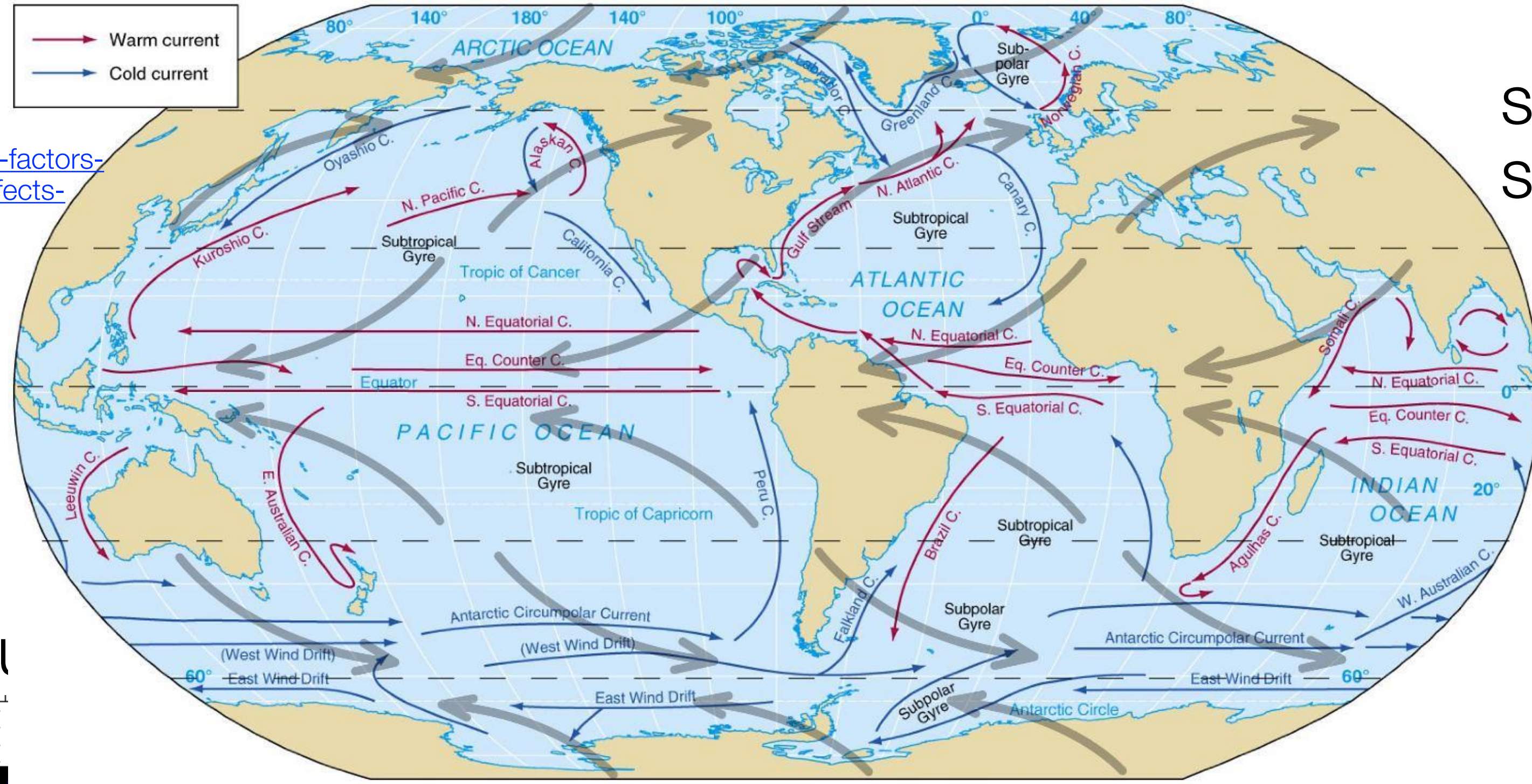
winds schematic



<https://slidetodoc.com/astr-2310-chapter-9-earth-and-moon-earth/>

<https://dandelionsandthings.blogspot.com/2018/09/33-label-global-winds-worksheet.html>

1 Geostrophy - introduction (wind driving of ocean currents)

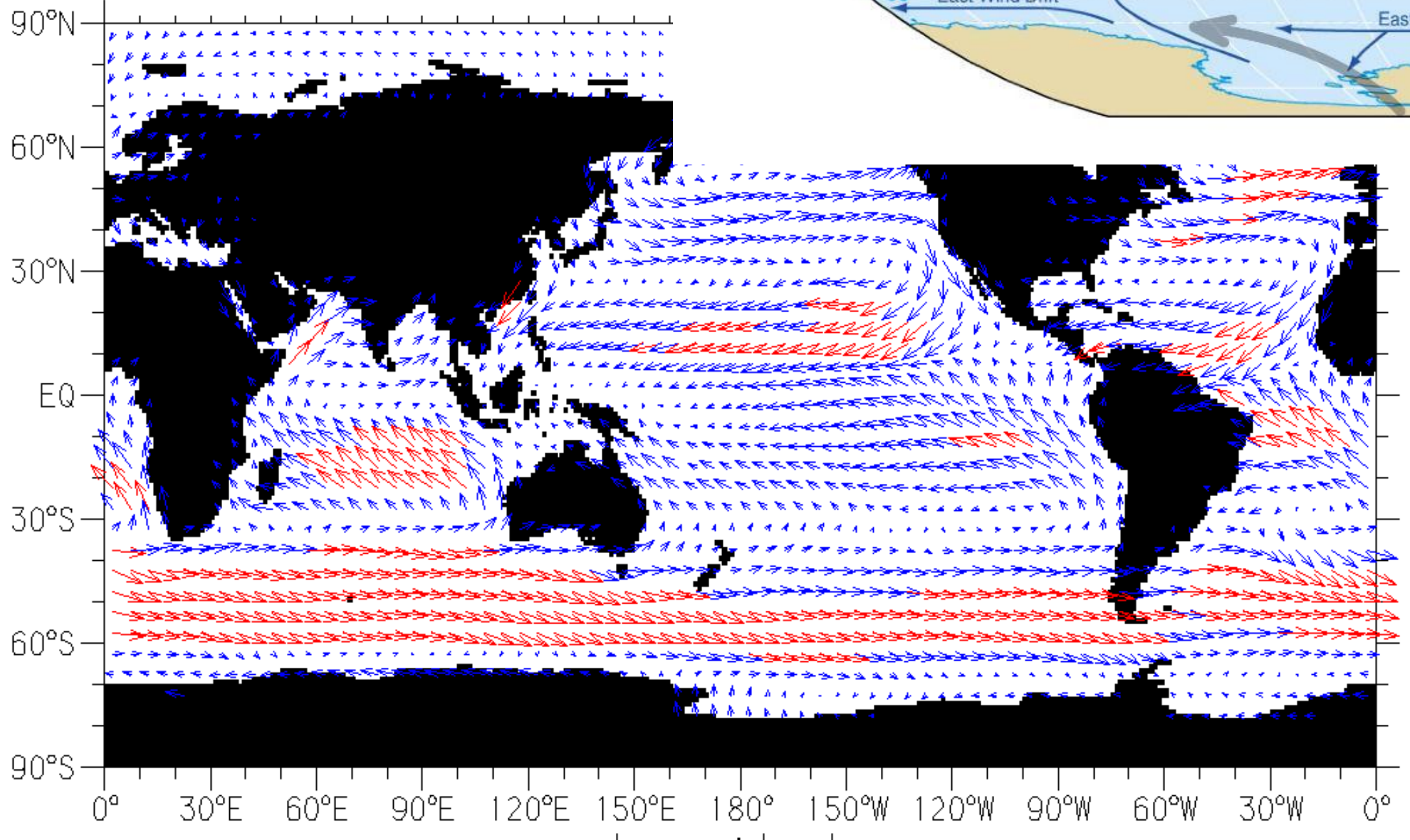


surface currents schematic

<https://www.pmfias.com/ocean-currents-factors-responsible-formation-ocean-currents-effects-ocean-currents/>

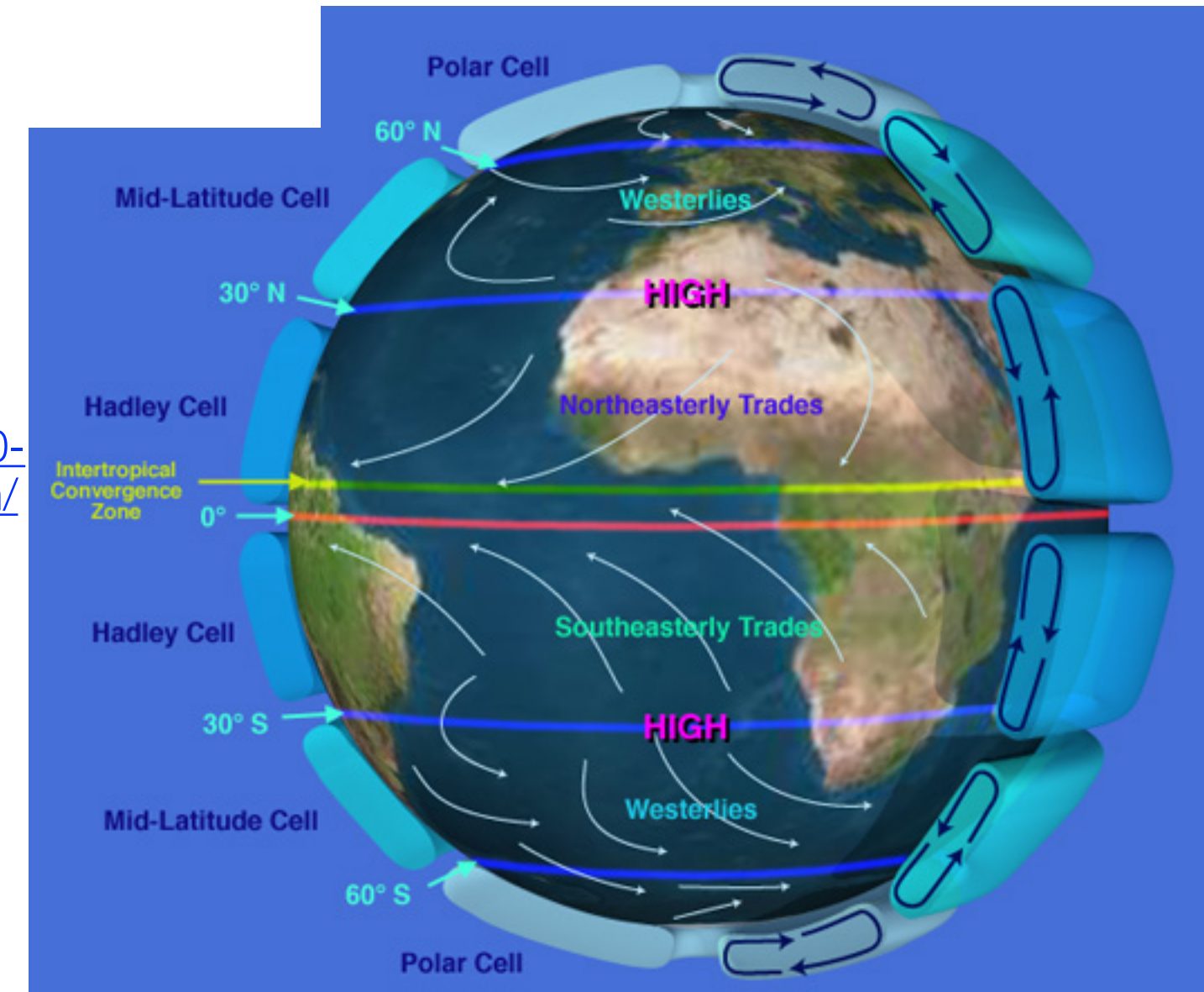
http://staff.orecity.k12.or.us/steve.tebor/atm%20currents/current/images/world_circulation.jpg

annual mean surface winds schematic



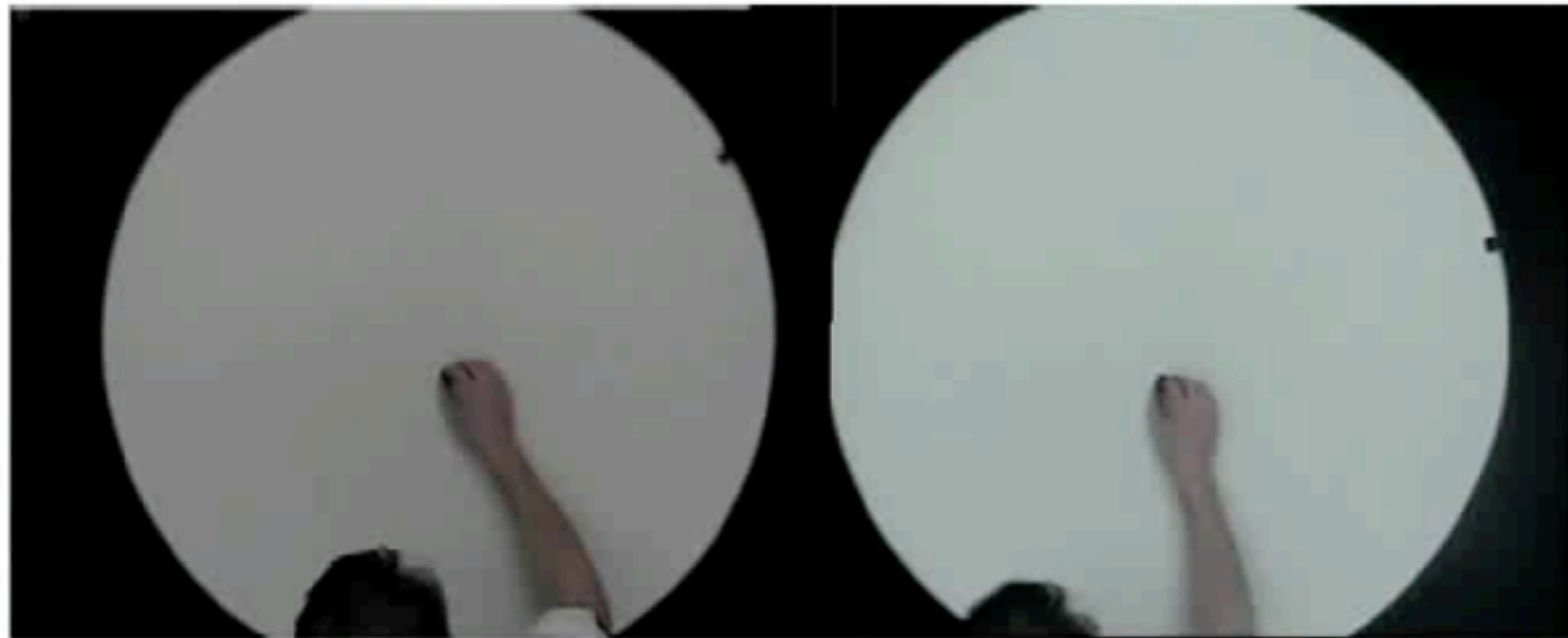
<https://dandelionsandthings.blogspot.com/2018/09/33-label-global-winds-worksheet.html>

winds schematic

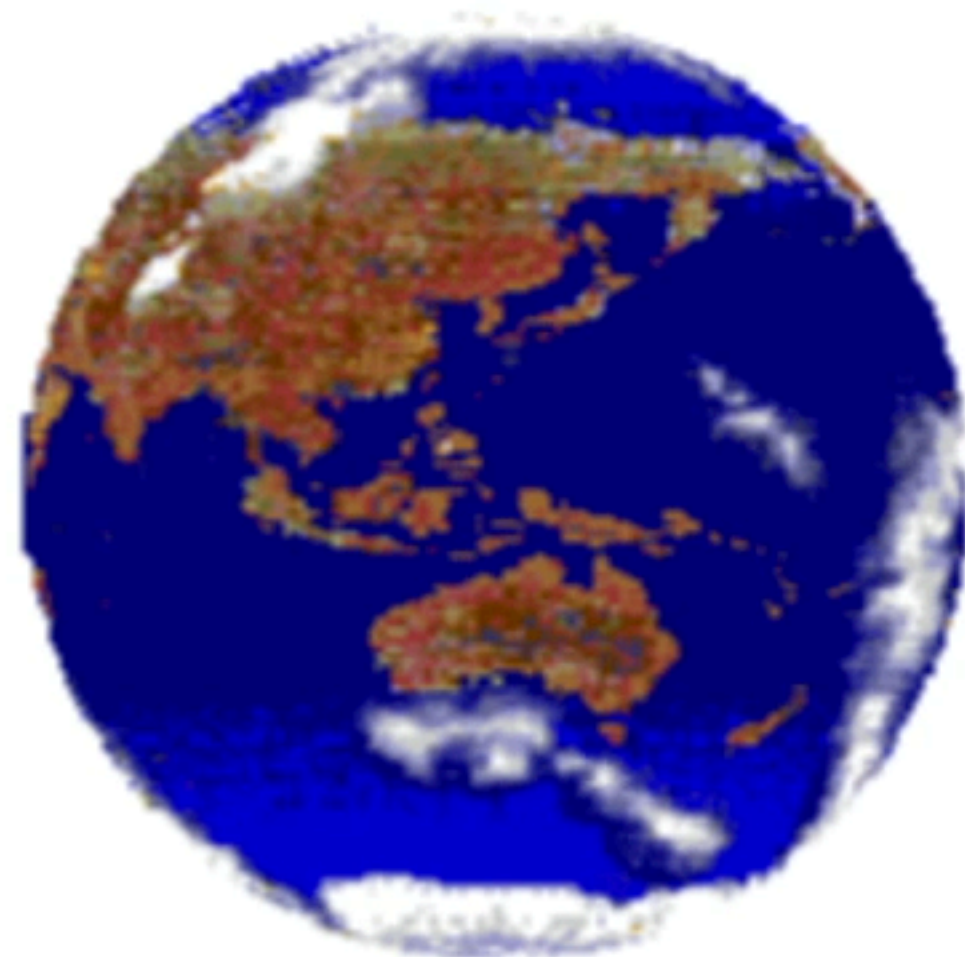


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1 Geostrophy - introduction (the Coriolis force)



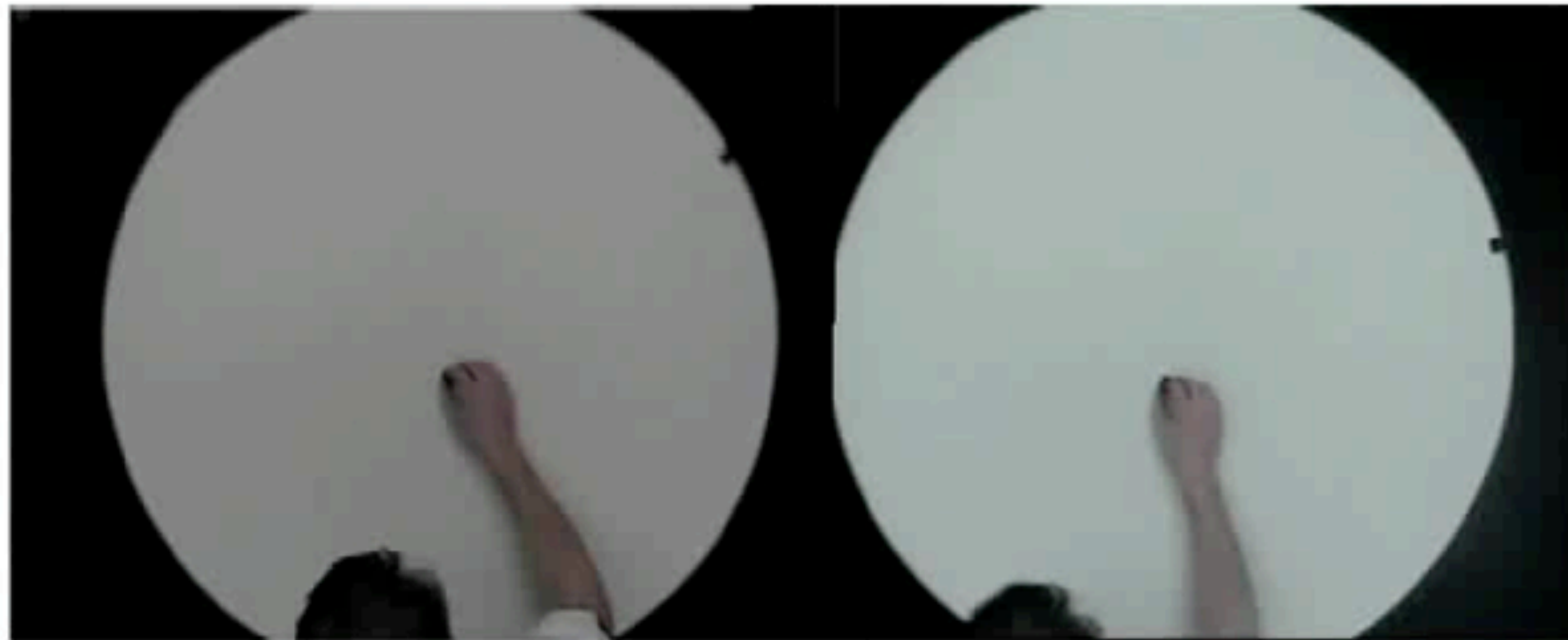
(<https://www.youtube.com/watch?v=RrWKS0vqV-0> J. Marshall, MIT)



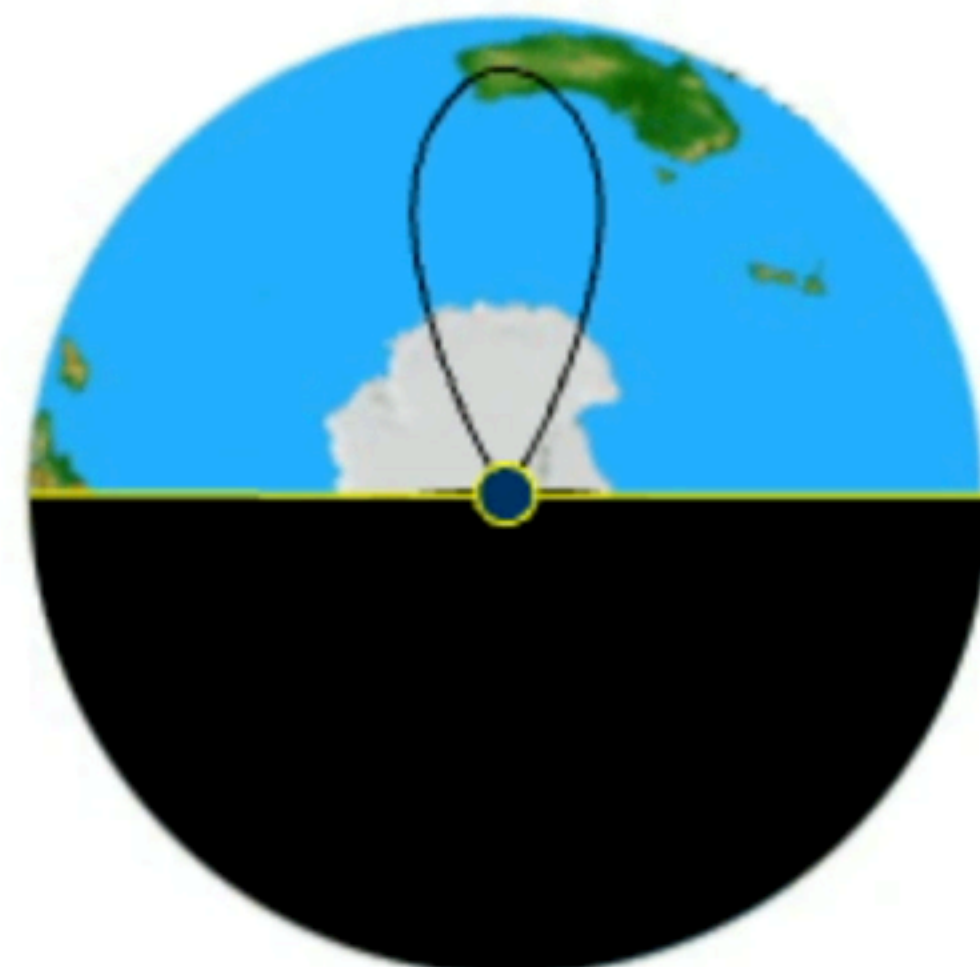
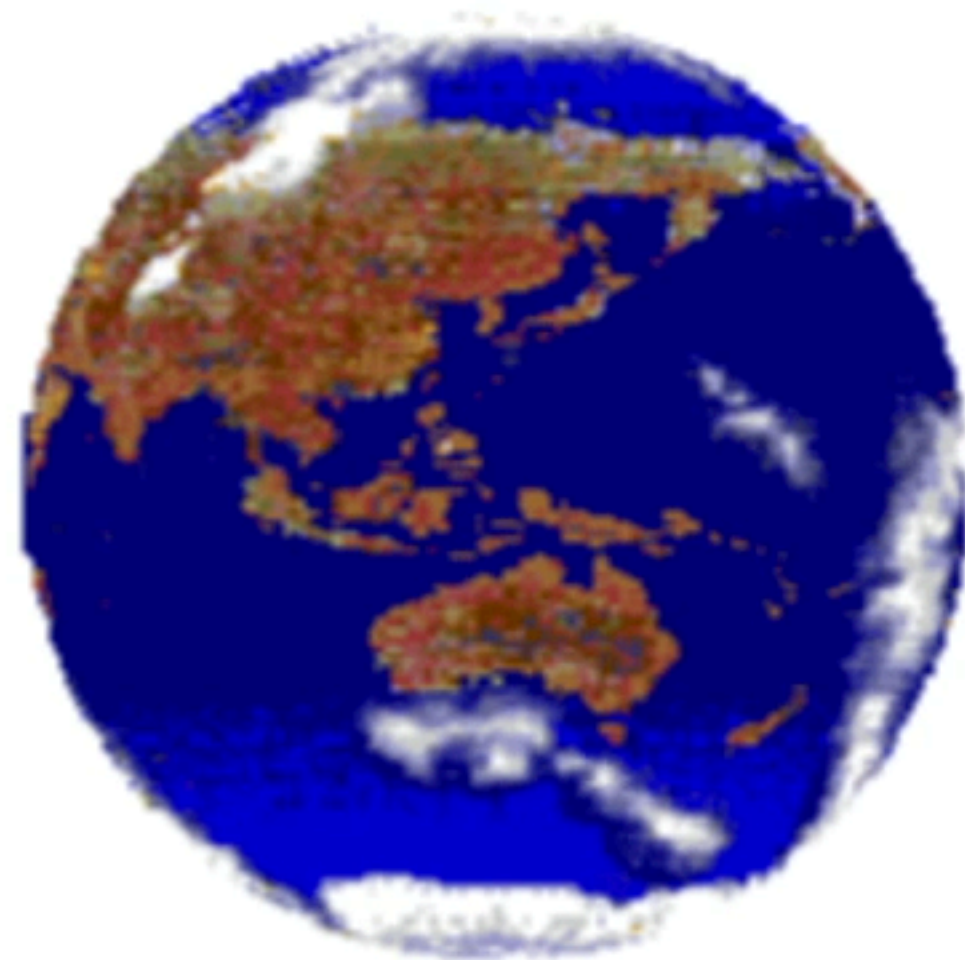
https://www.animations.physics.unsw.edu.au//jw/foucault_pendulum.html



1 Geostrophy - introduction (the Coriolis force)

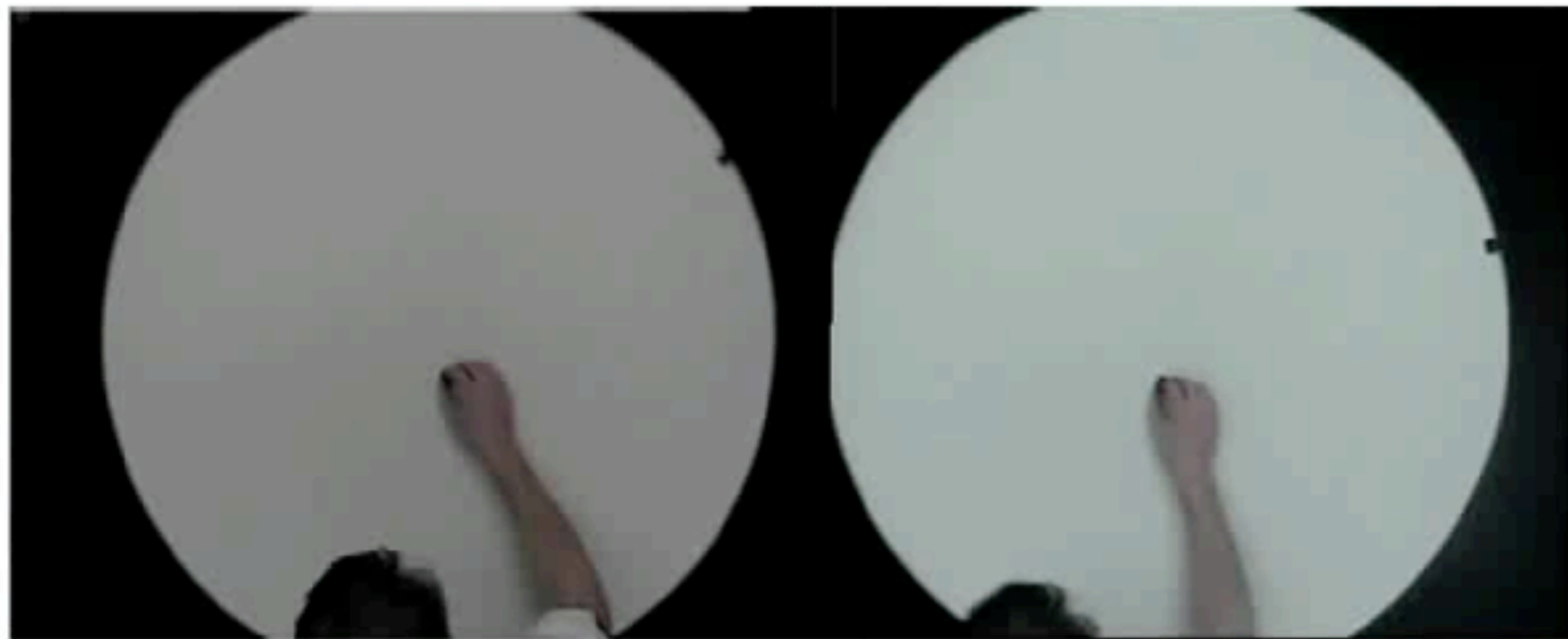


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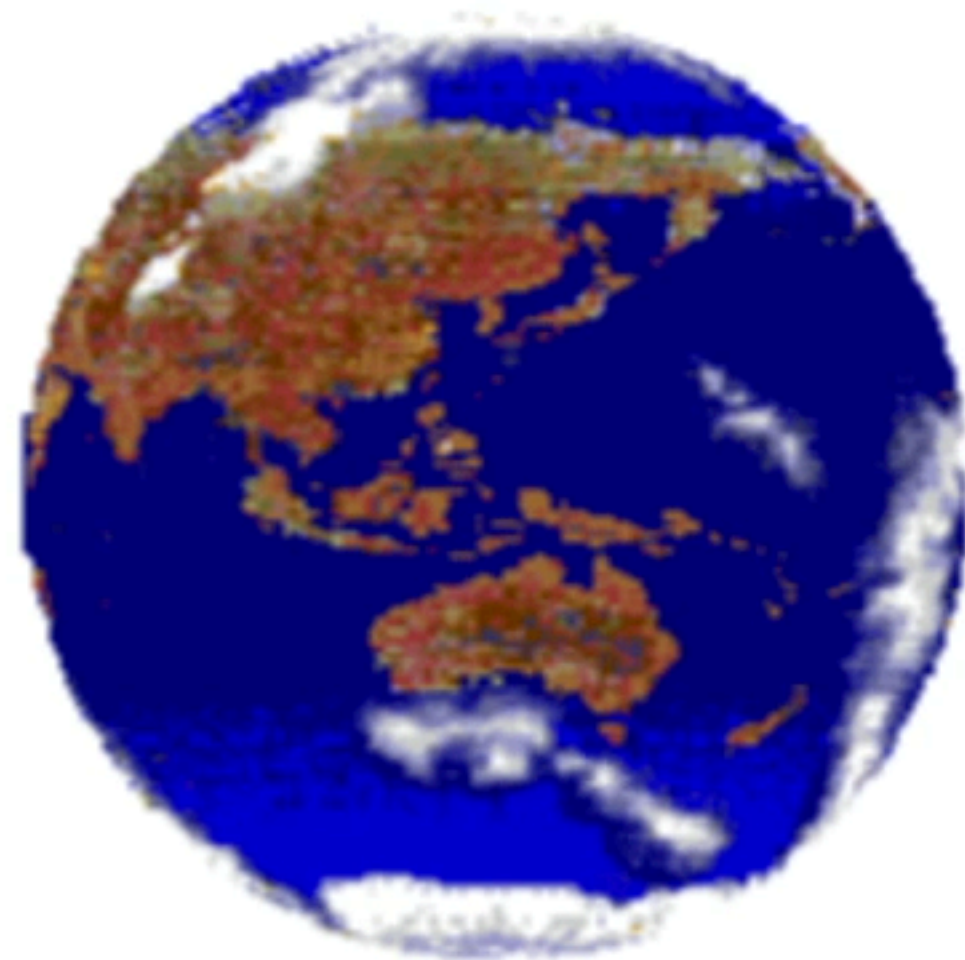


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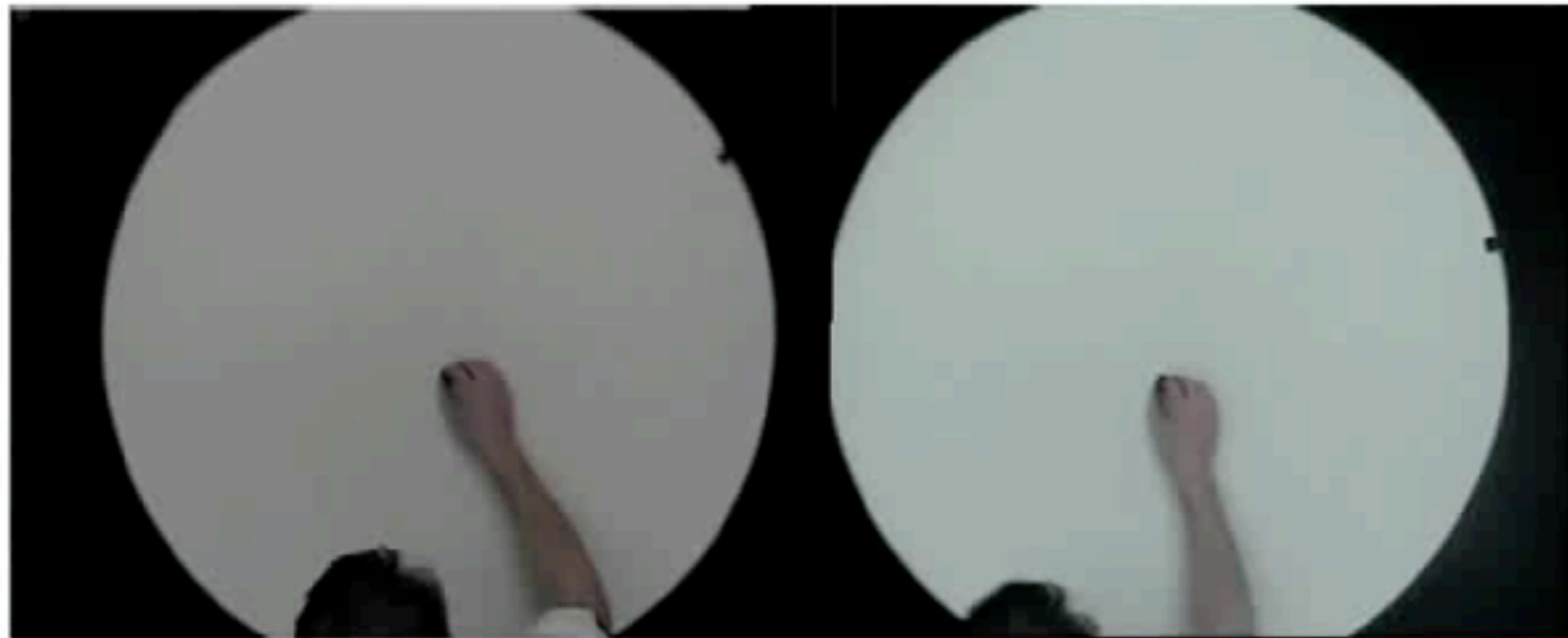
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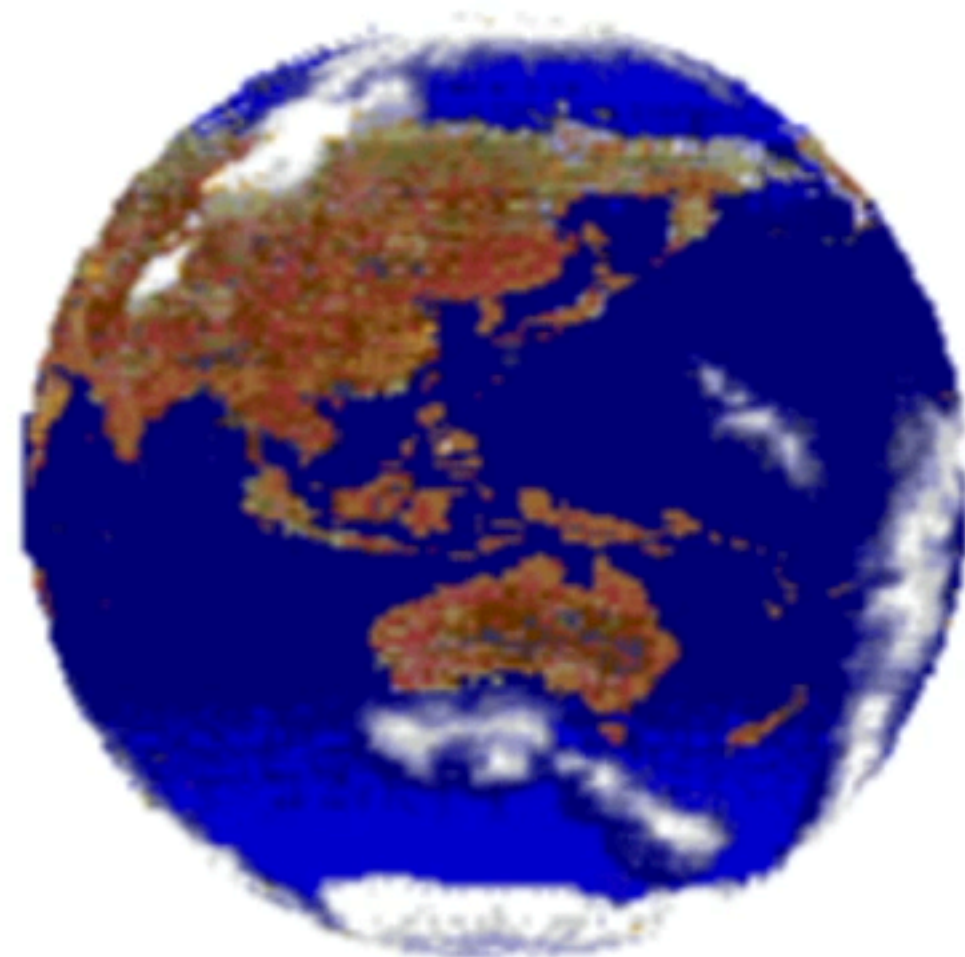
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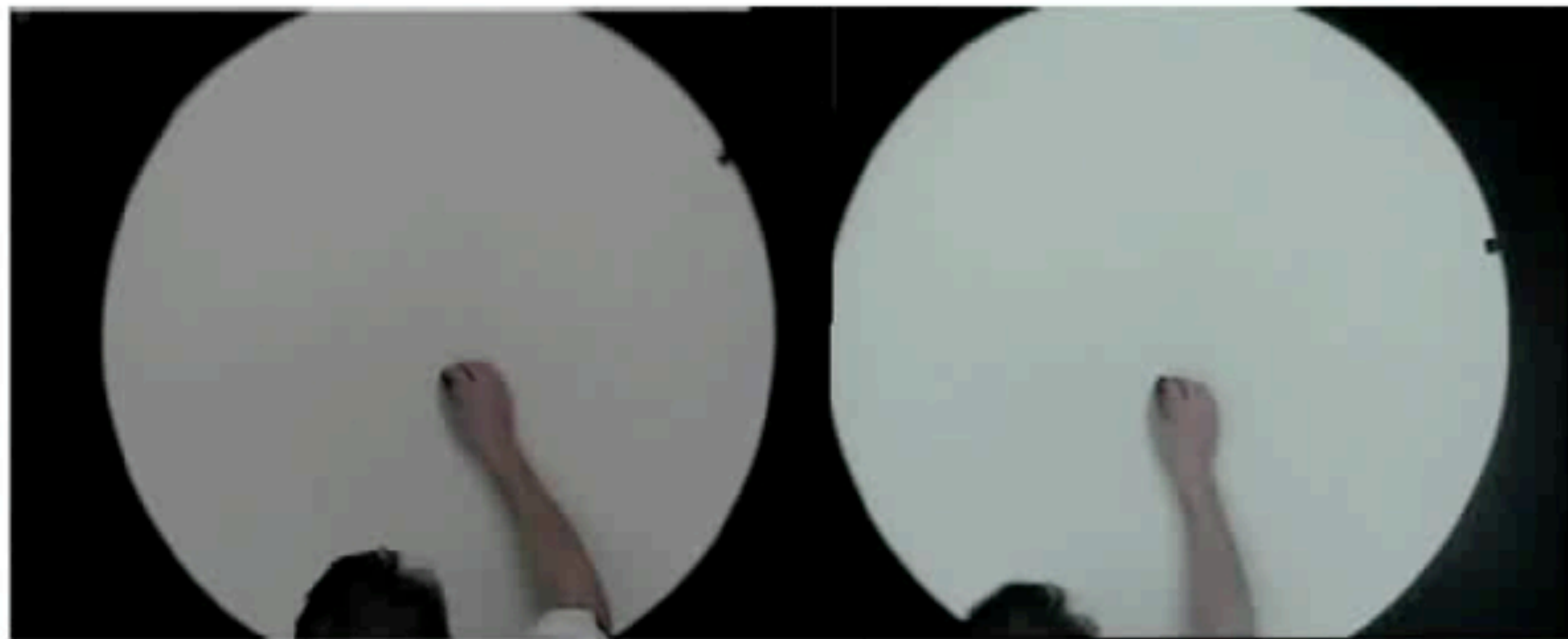
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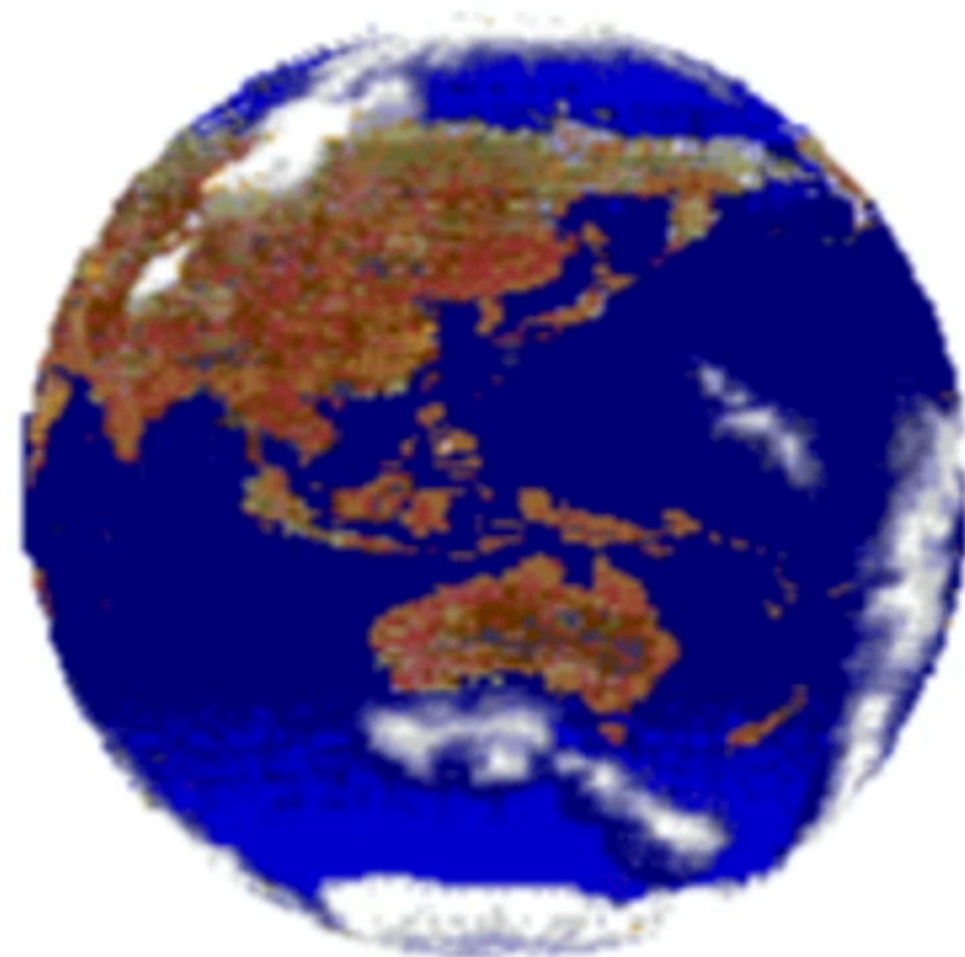
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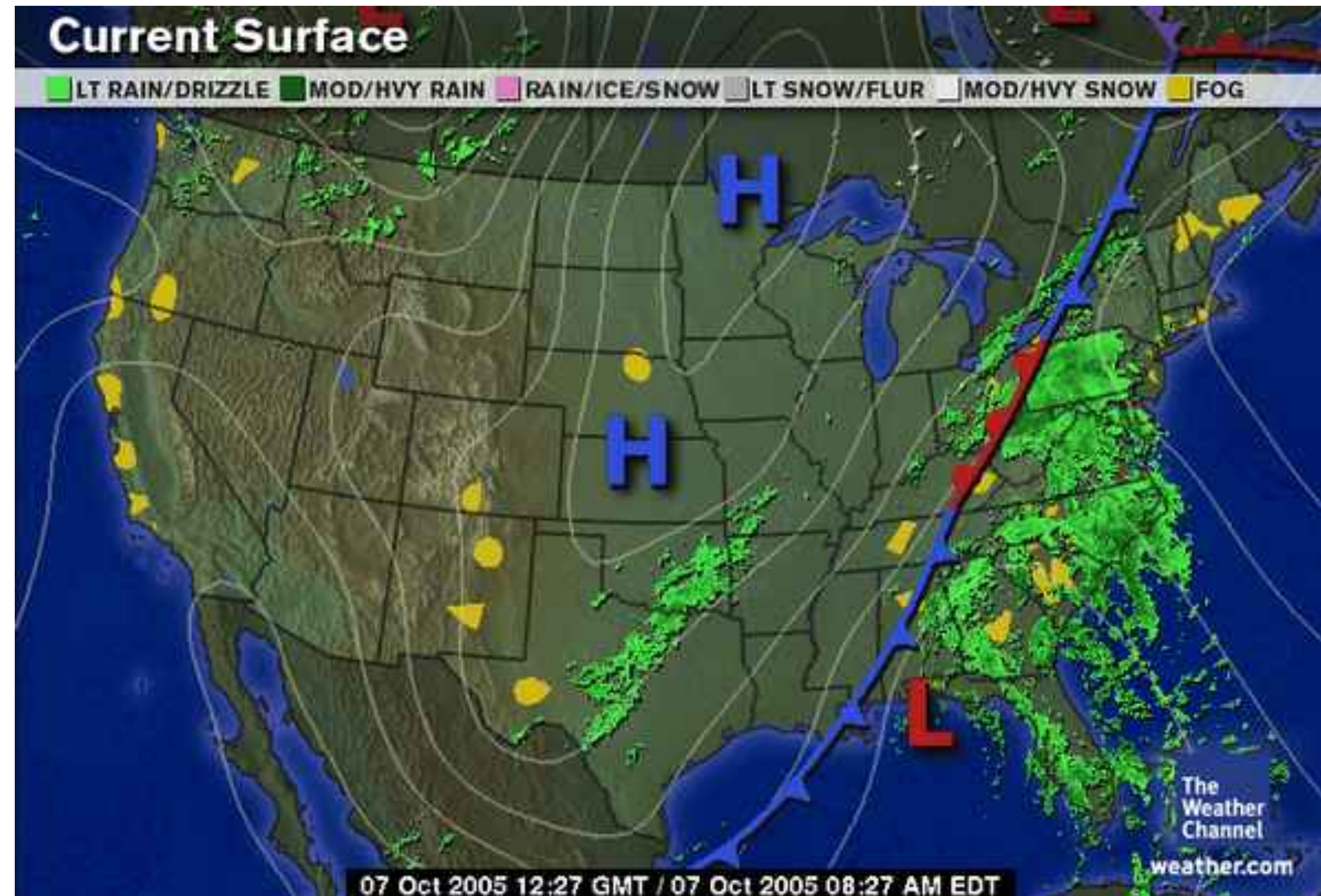
(<https://www.youtube.com/watch?v=RrWKS0vqV-0> J. Marshall, MIT)



https://www.animations.physics.unsw.edu.au//jw/foucault_pendulum.html

geostrophy - motivation

Atmosphere: sea level pressure and wind direction



The weather channel

Notes

2 Geostrophy - derivation

Miniquiz

Coriolis force form and sign in two horizontal $F=ma$

Miniquiz:

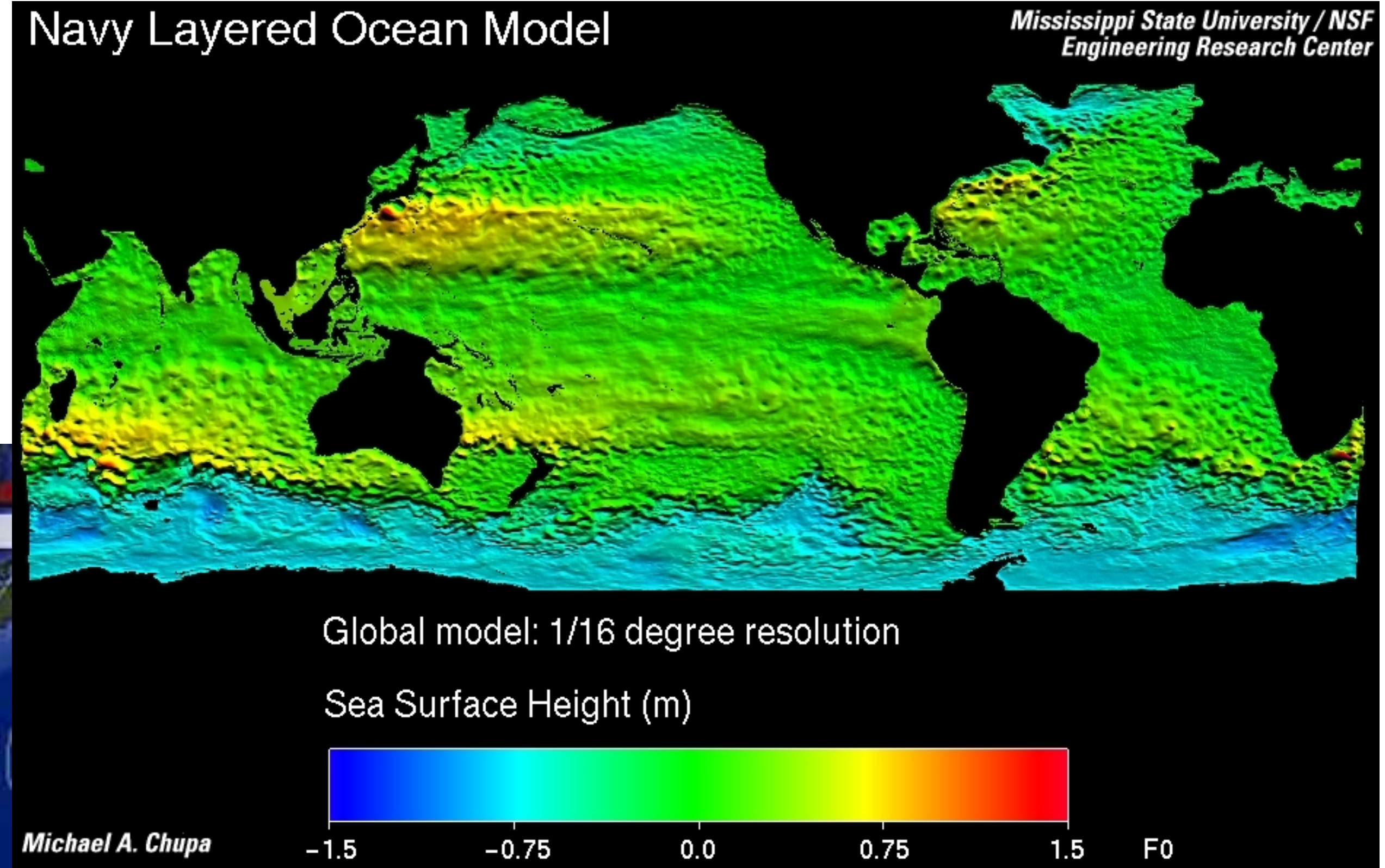
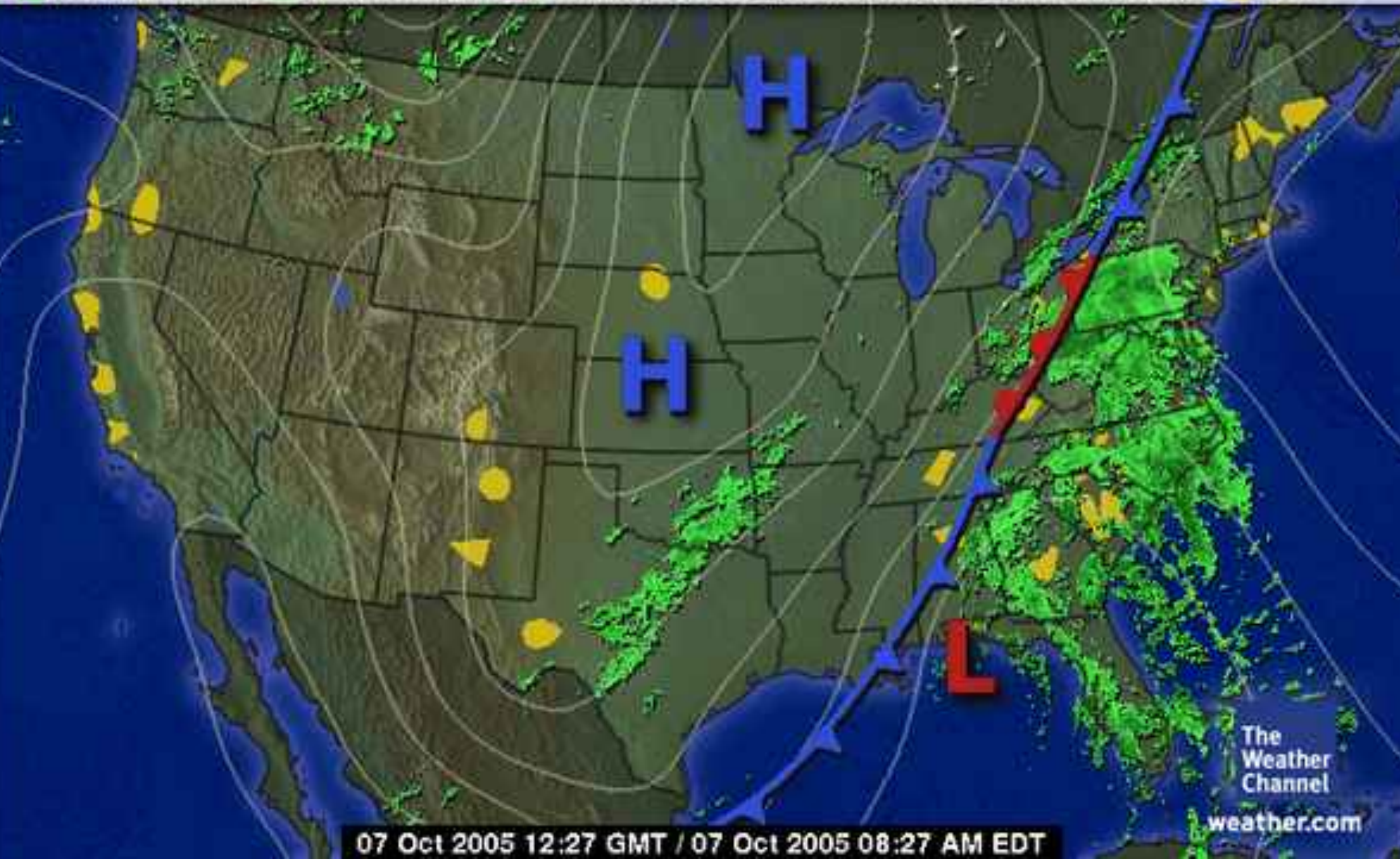
geostrophy: the form of the two horizontal momentum equations

3 Examples of geostrophic balance

Atmosphere: sea level pressure corresponding to winds

Current Surface

LT RAIN/DRIZZLE MOD/HVY RAIN RAIN/ICE/SNOW LT SNOW/FLUR MOD/HVY SNOW FOG



Ocean: sea surface height variations involved with major currents

The weather channel

Miniquiz

wind velocity from SLP on a weather map

miniquiz:

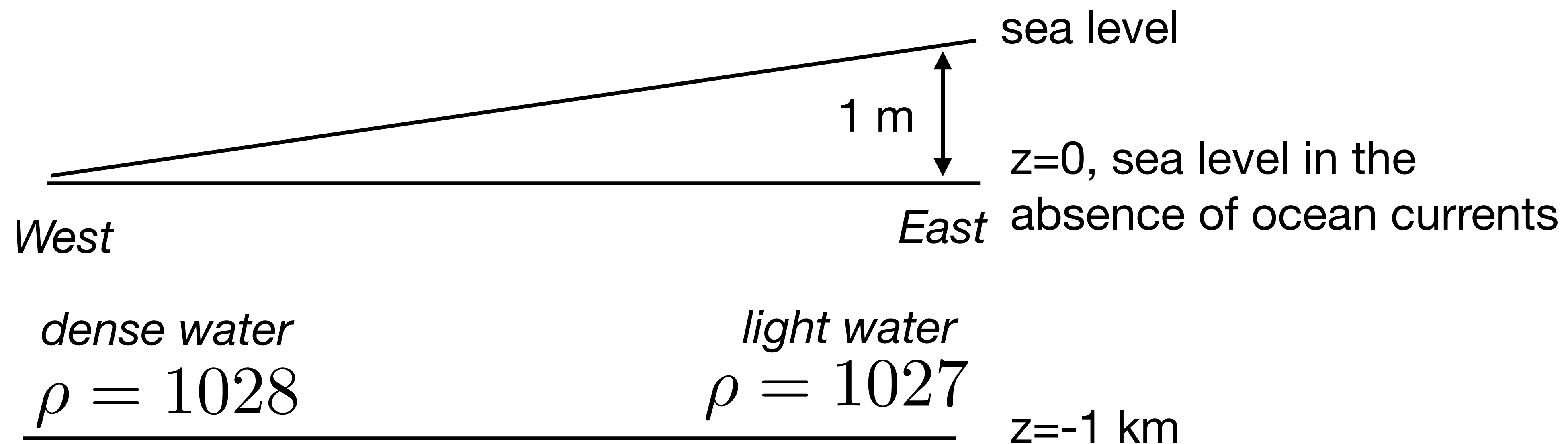
direction of velocity from a temperature section

Notes

- 4 The hydrostatic balance
- 5 Boussinesq approximation

Notes

6 sea level vs stratification in a stratified geostrophic flow such as the Gulf Stream

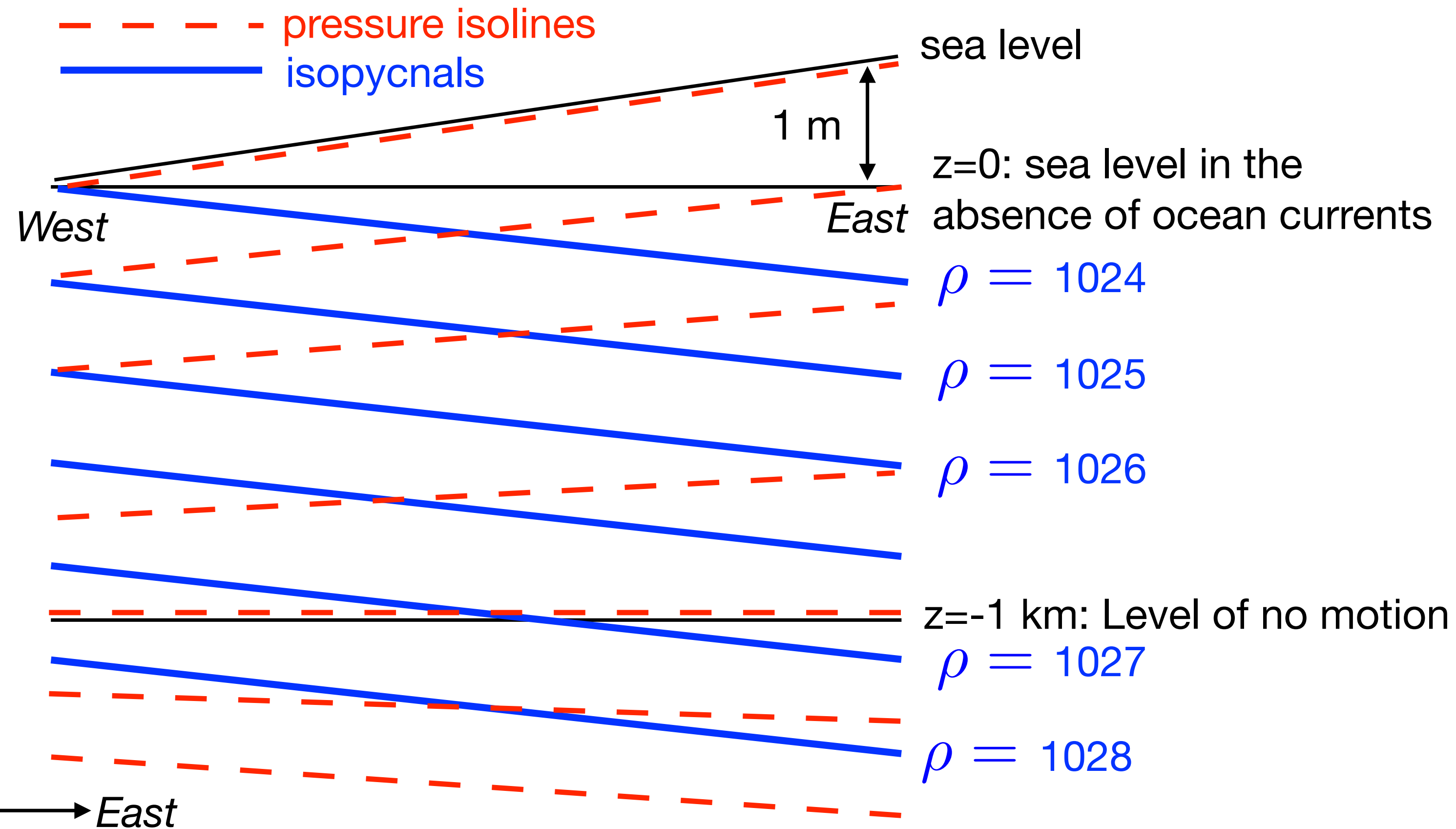


Notes

6 sea level vs stratification in a stratified geostrophic flow such as the Gulf Stream

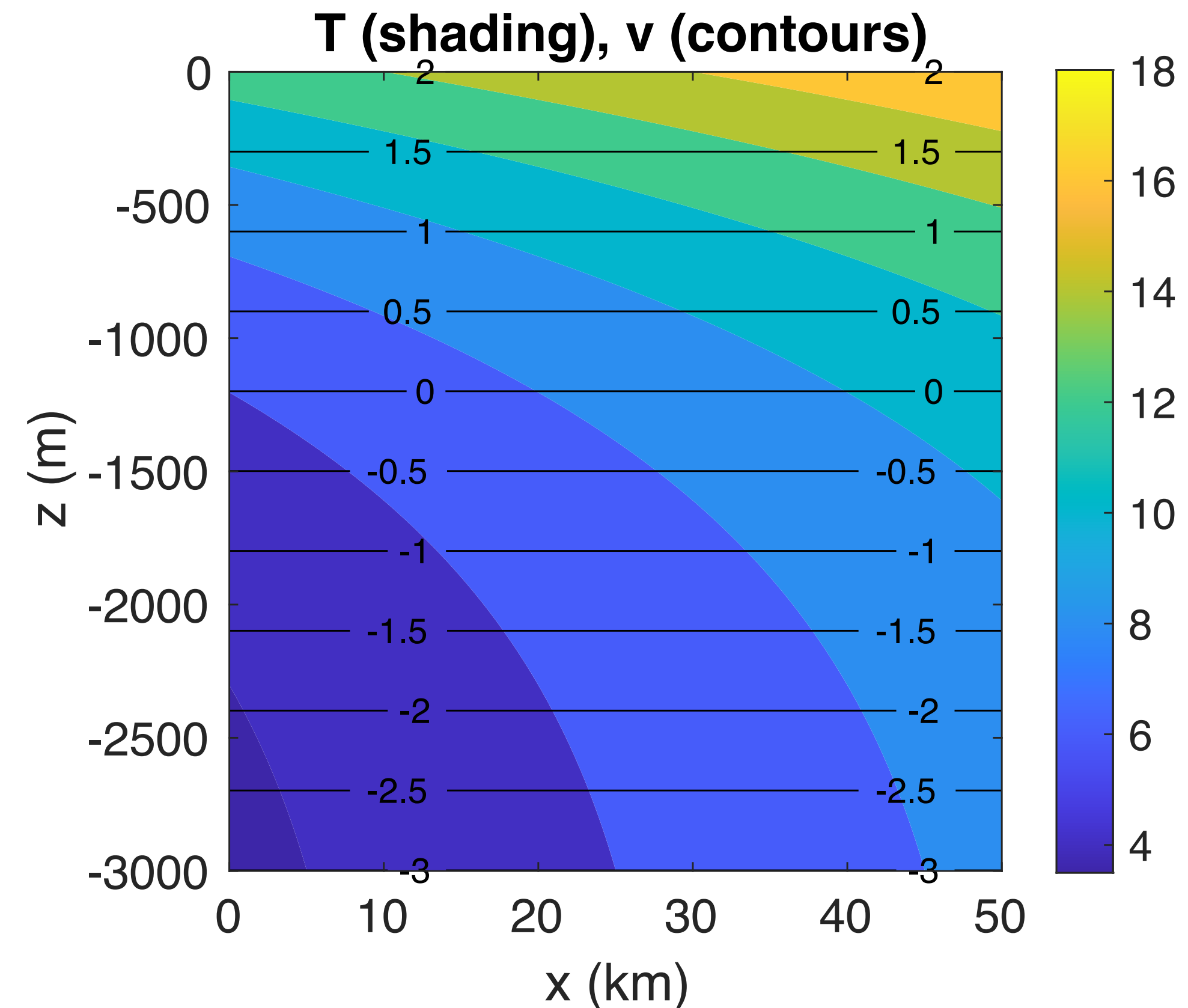
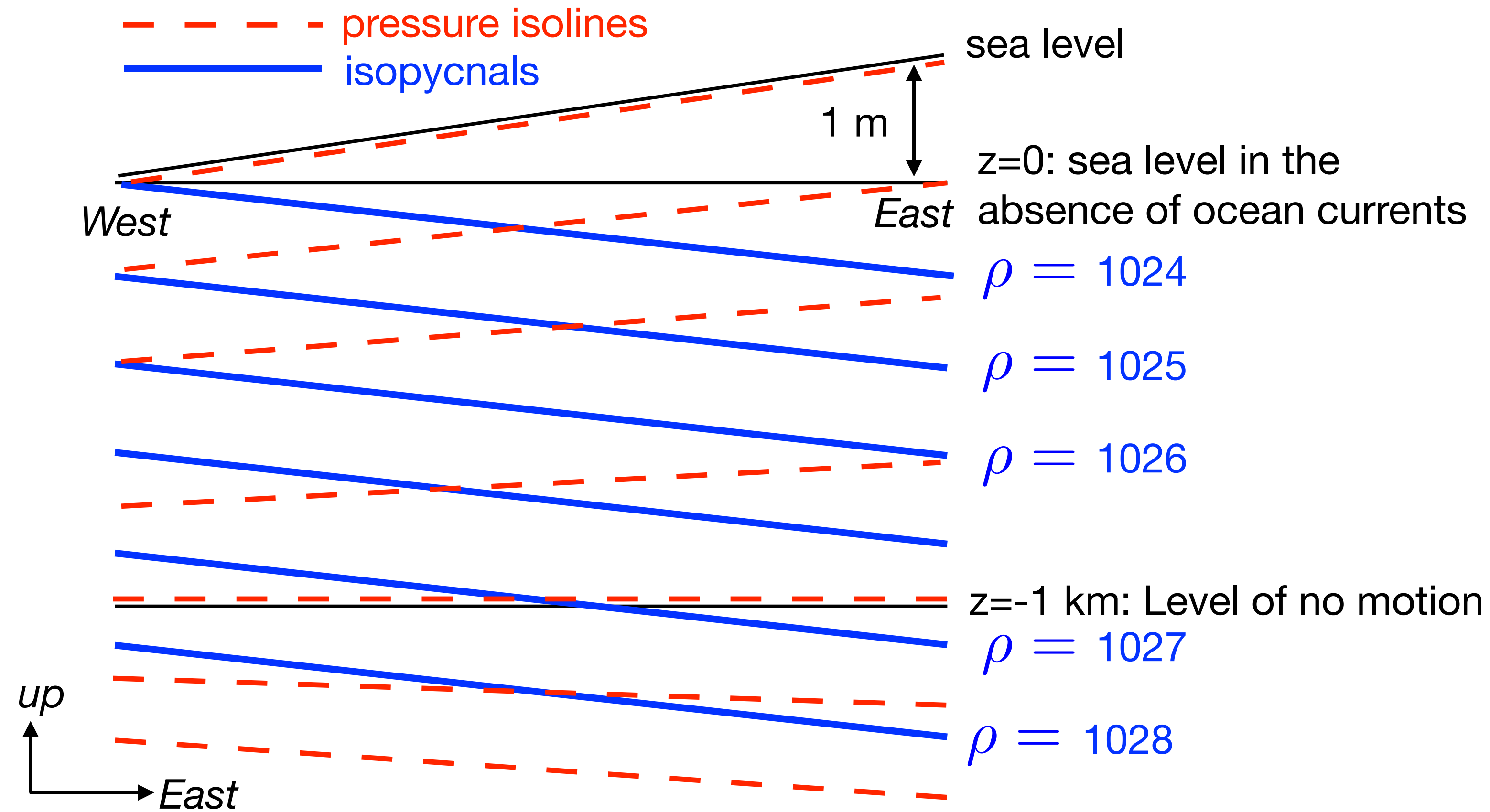
Notes

6 sea level vs stratification in a stratified geostrophic flow such as the Gulf Stream



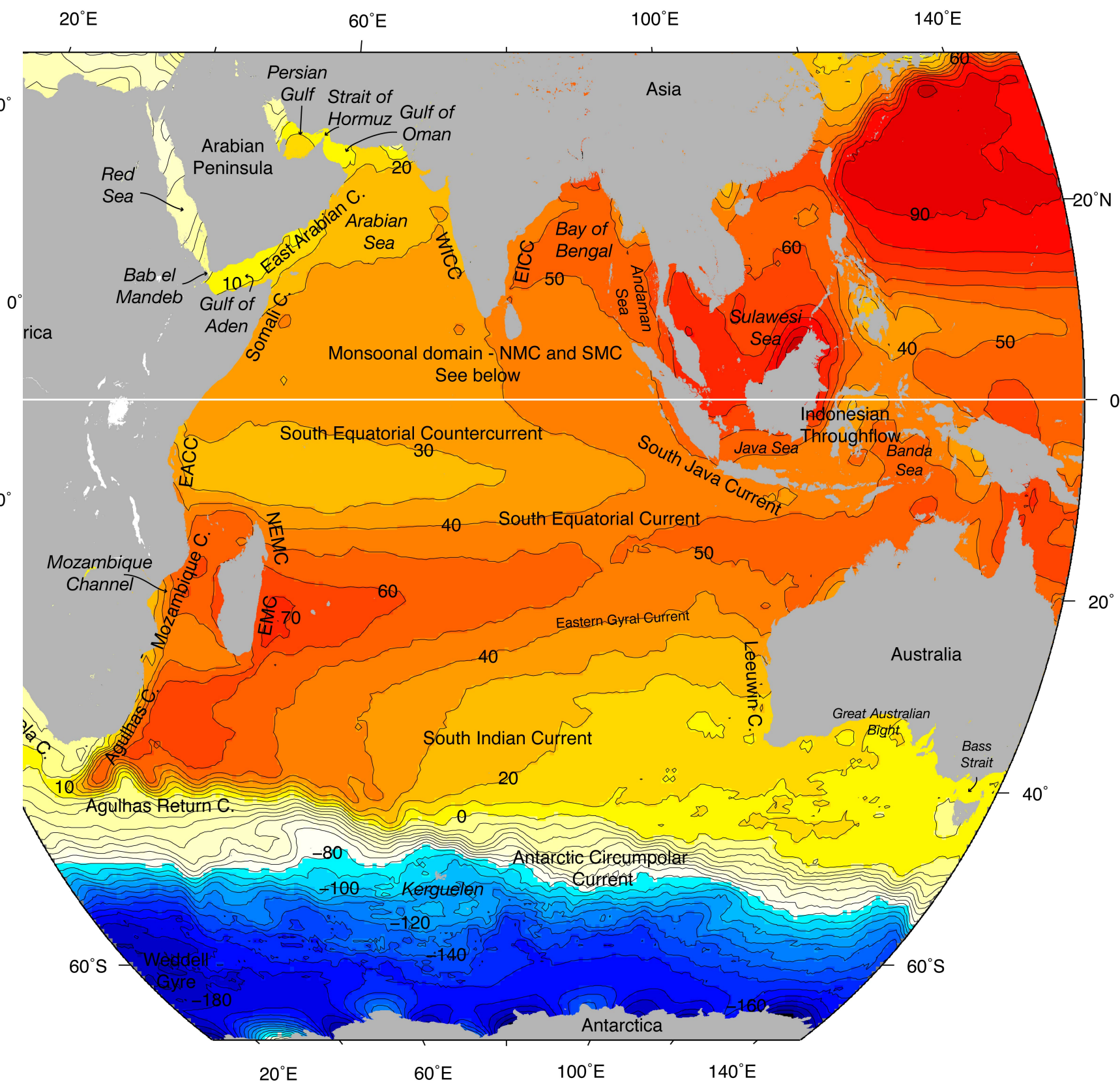
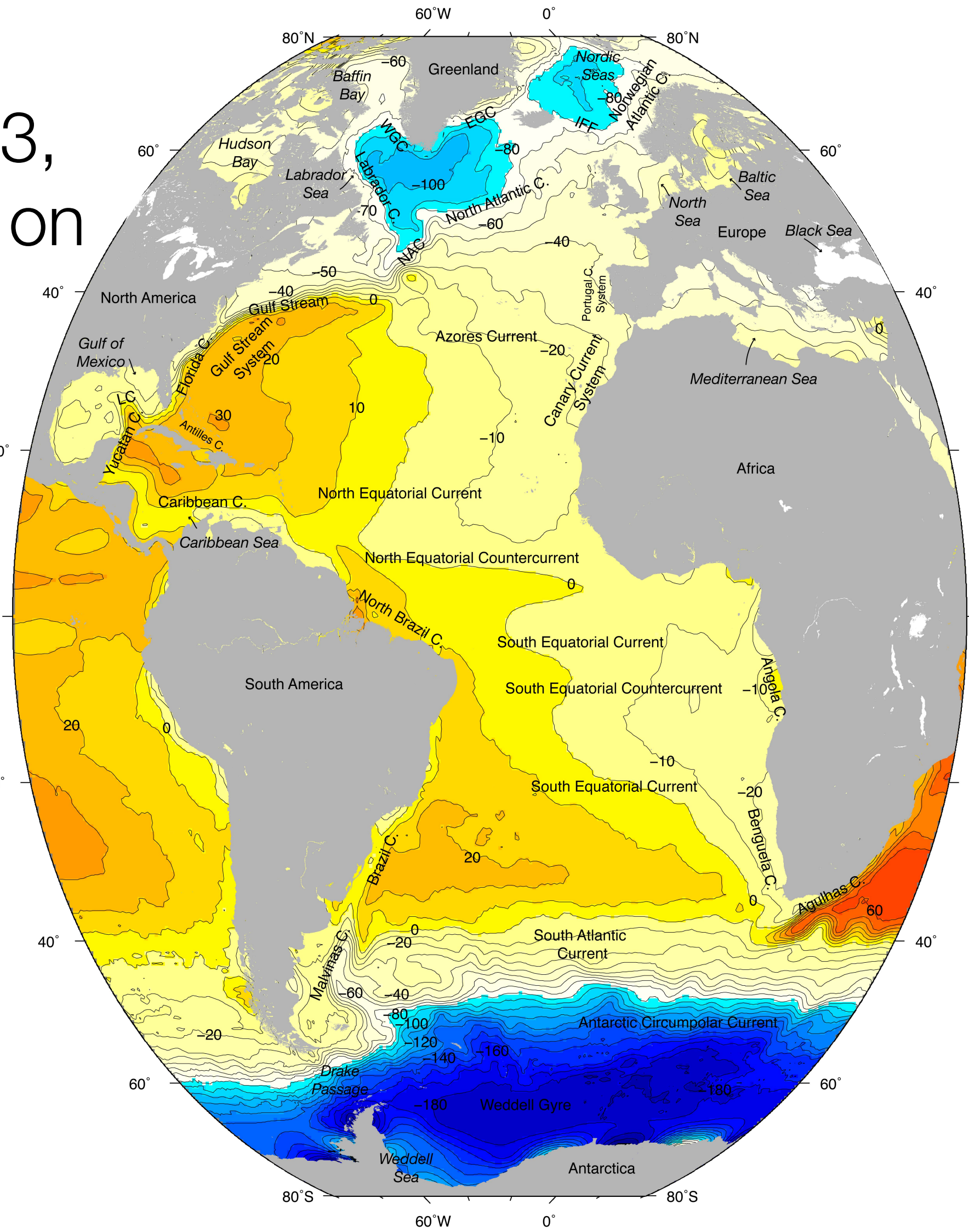
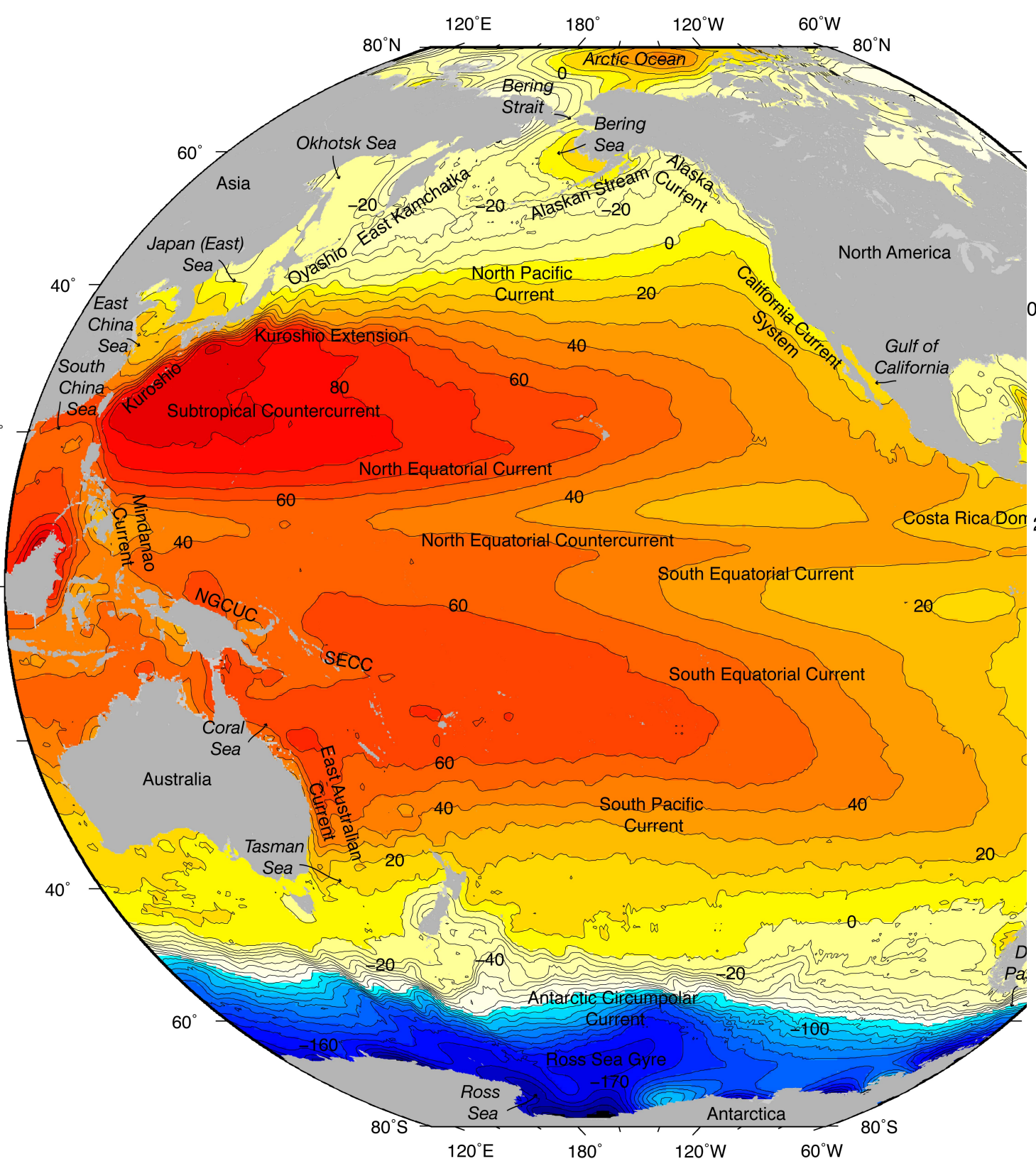
Notes

6 sea level vs stratification in a stratified geostrophic flow such as the Gulf Stream



7 Calculating currents from temperature & sea level

“Sea surface height (Using Niiler et al., 2003, surface heights based on drifters)”(*)



(*)From [http://talleylab.ucsd.edu/ltalley/sio210/dynamics rotation/lecture dynamics geostrophy.pdf](http://talleylab.ucsd.edu/ltalley/sio210/dynamics%20rotation/lecture%20dynamics%20geostrophy.pdf)

RAPID: monitoring the Atlantic Meridional Overturning Circulation at 26.5°N (motivation for calculating currents from T,S and sea surface height)

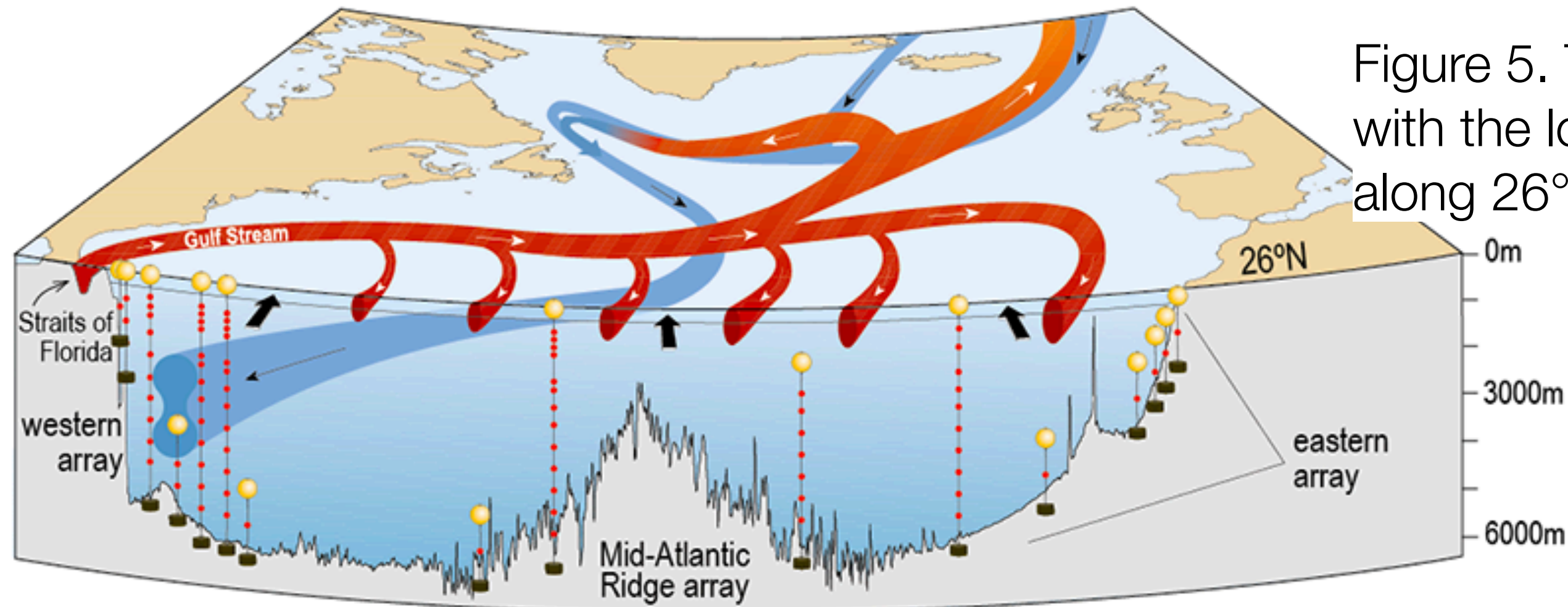


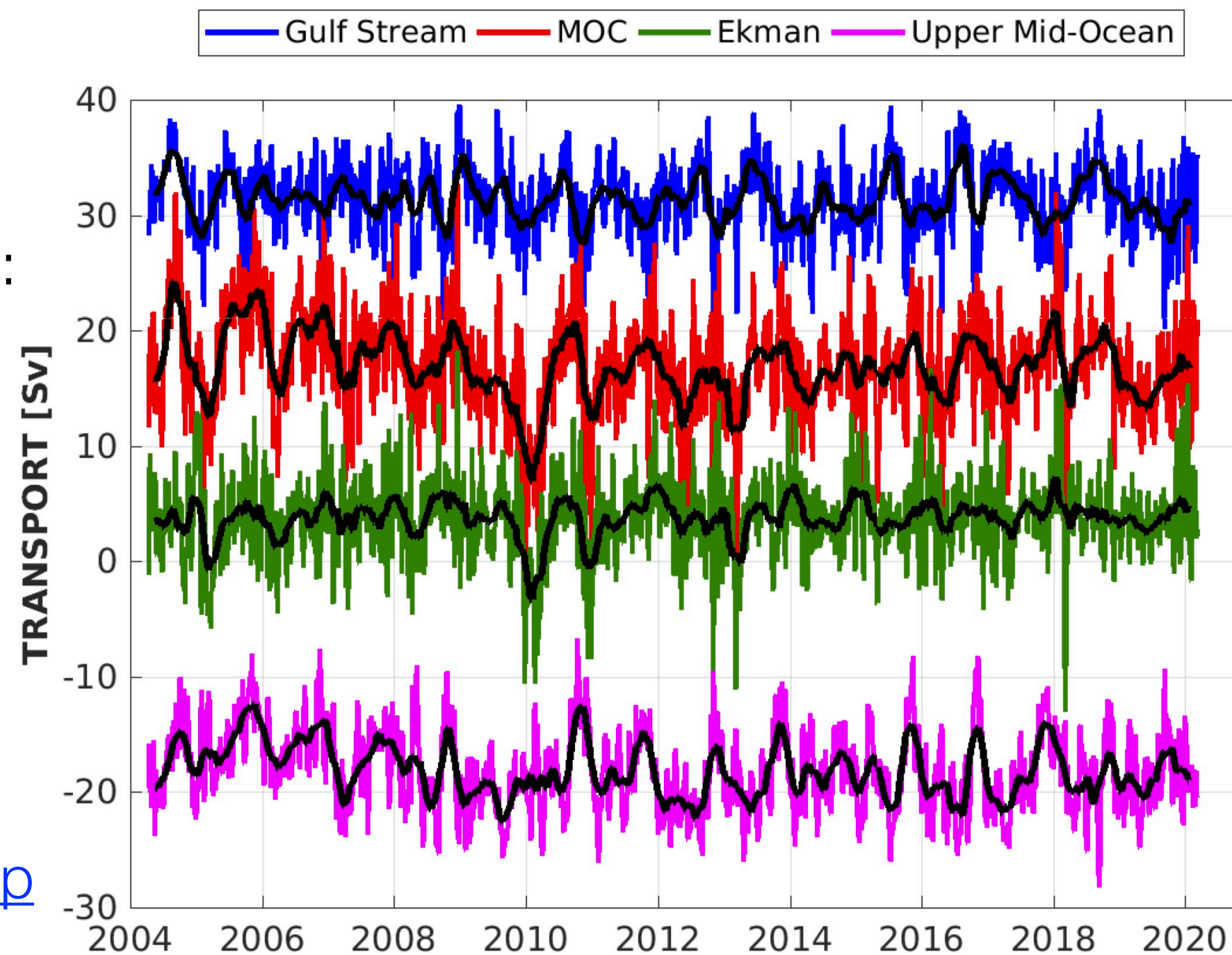
Figure 5. The North Atlantic overturning circulation with the location of the RAPID array moorings along 26°N. Modified from Church, 2007.

<https://www.rapid.ac.uk/background.php>

A view of the back deck of the RRS James Cook during the RAPID cruise in April 2014.



RAPID results for AMOC:



<https://www.rapid.ac.uk/data.php>

Notes

8 Thermal wind equations and level of no motion

Miniquiz

Derive thermal wind equations

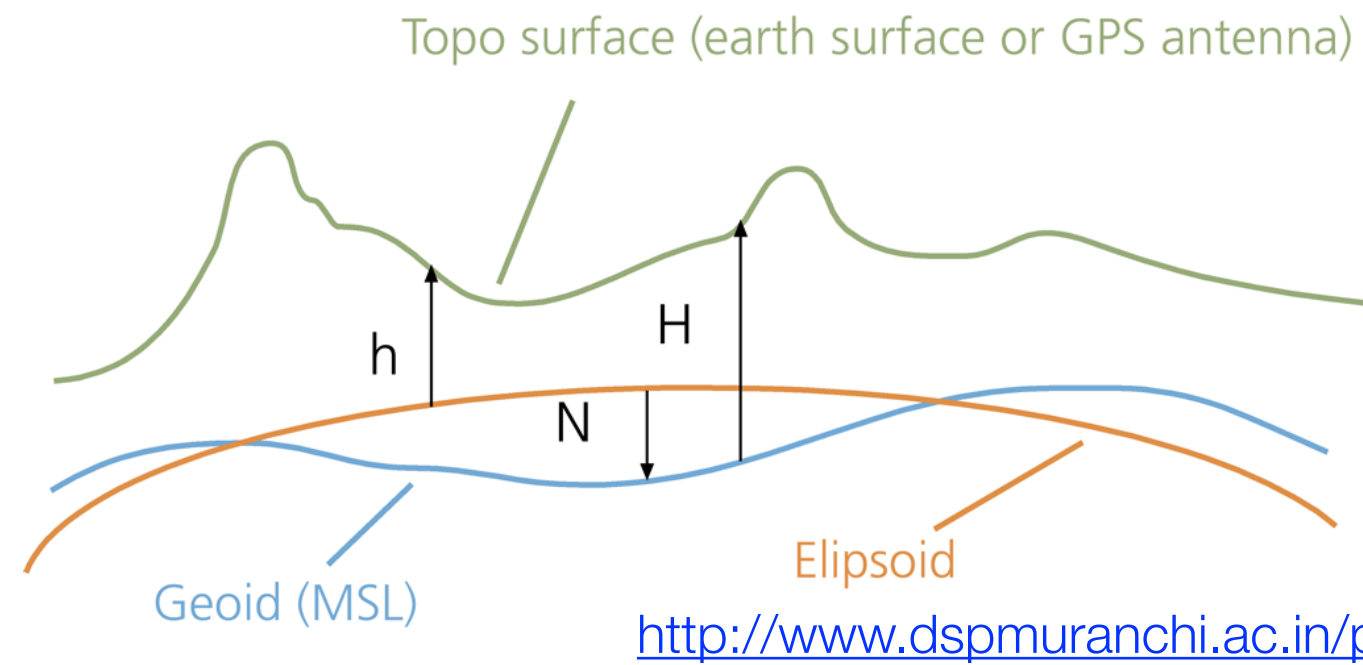
Miniquiz - calculate the depth of the level of no motion

optional, time permitting:

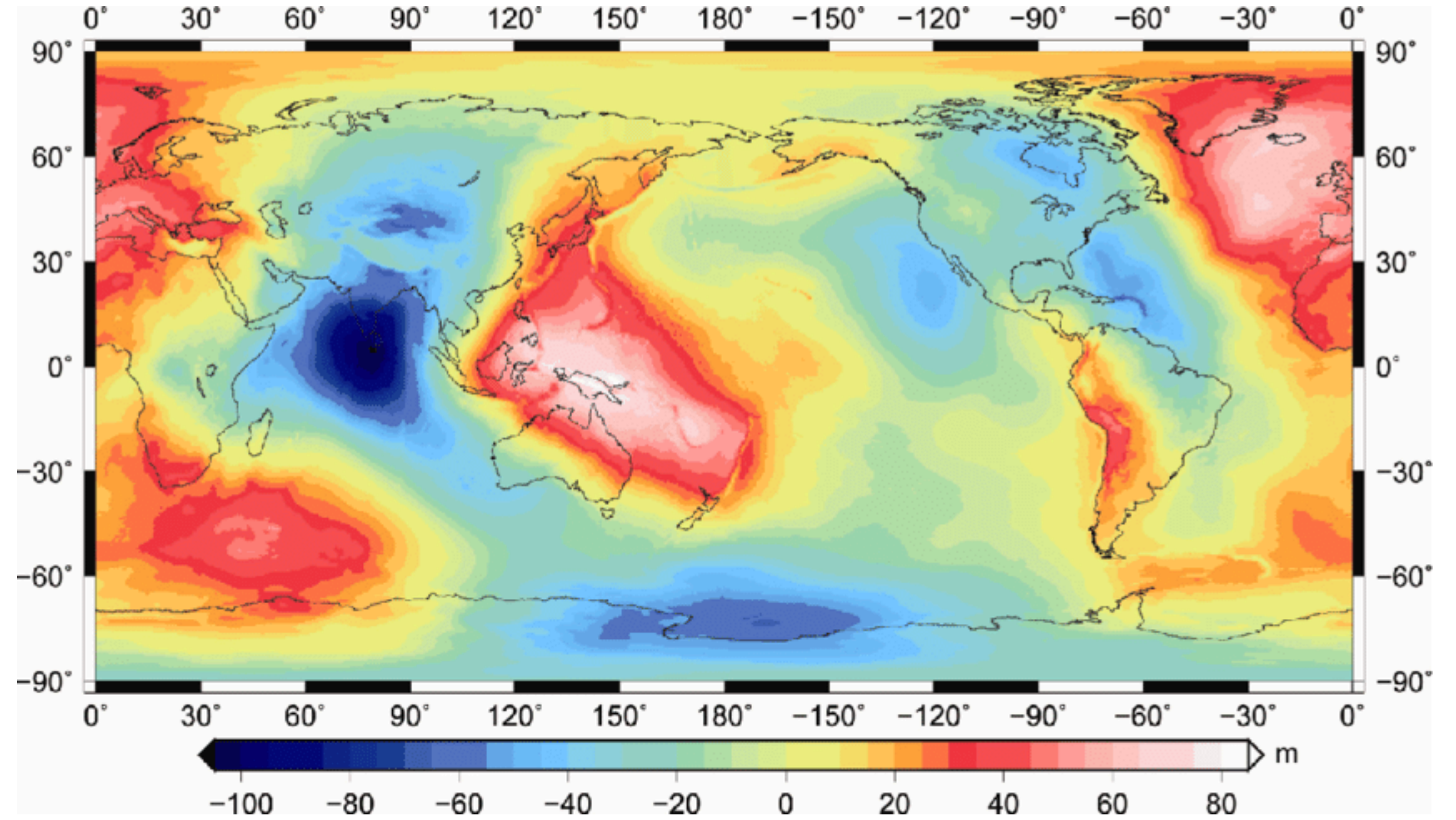
9 Dynamic height derived from geostrophy

Geoid

$$h=H+N$$



h=elipsoid height
 H=orthometric height
 N=geoid height



https://www.researchgate.net/figure/Global-geoid-from-EGM-2008-model-137_fig1_316255397

Model of the Earth

