

# OCEAN CIRCULATION AND DYNAMICS

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POLAR SCIENCE  
FOR PLANET EARTH



# OVERVIEW

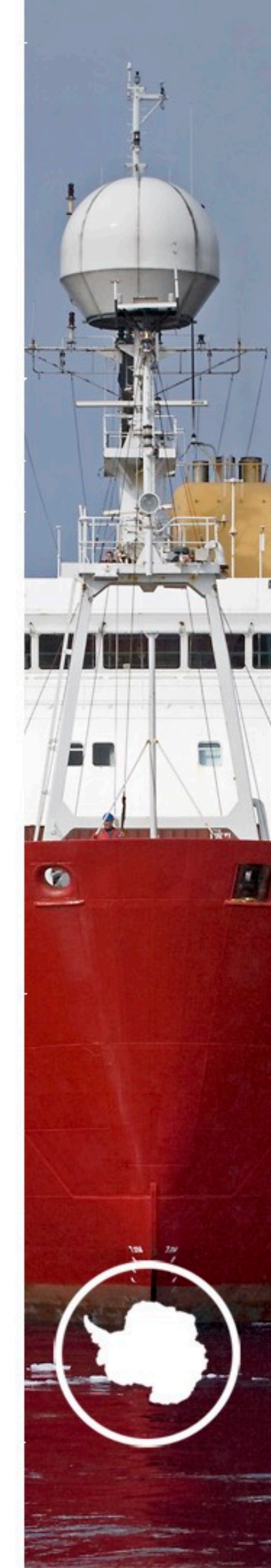
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- Why should we care about the ocean?
- Fundamentals of circulation and dynamics
- What don't we know?



# WHY SHOULD WE CARE ABOUT THE OCEAN?

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- Important for the climate
  - The ocean takes up over **90%** of the excess **heat** and **25%** of the **CO<sub>2</sub>** that human have added to the climate system



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  - Over three billion people depend on the ocean for their livelihoods.
  - 600 million people live less than 10m above sea level



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- Important for humans
  - Over three billion people depend on the ocean for their livelihoods.
  - 600 million people live less than 10m above sea level
- Interesting physics
  - Interactions across scales
  - Interactions with atmosphere, cryosphere, lithosphere



# EARTH'S ENERGY BALANCE

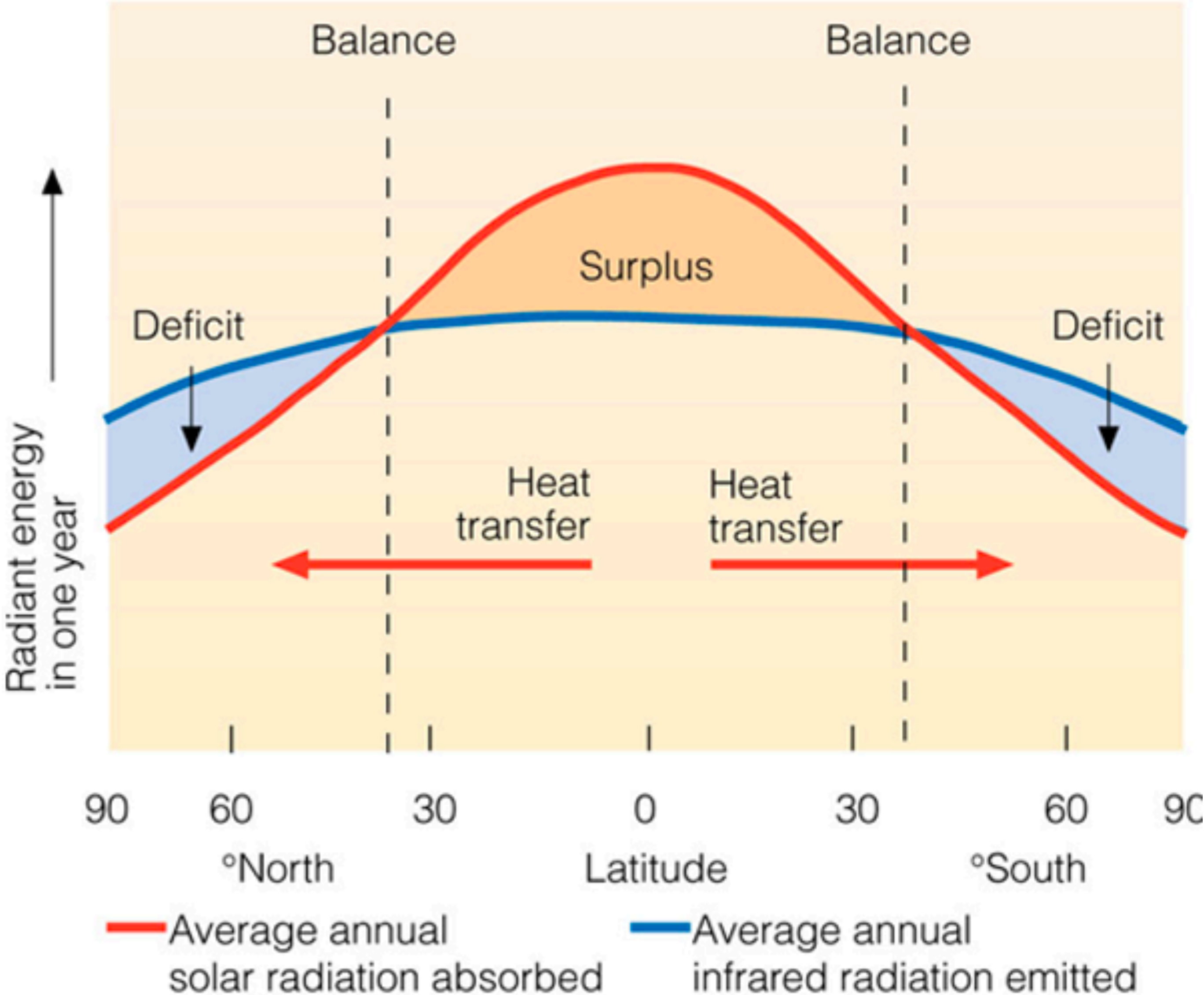
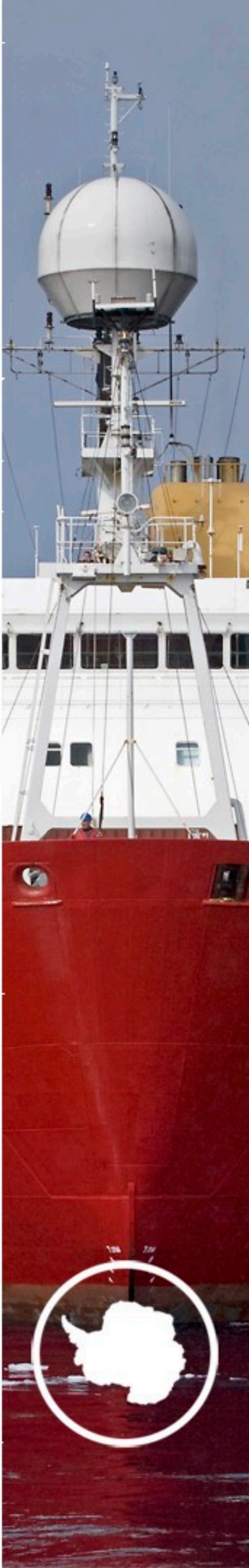


Image: NASA



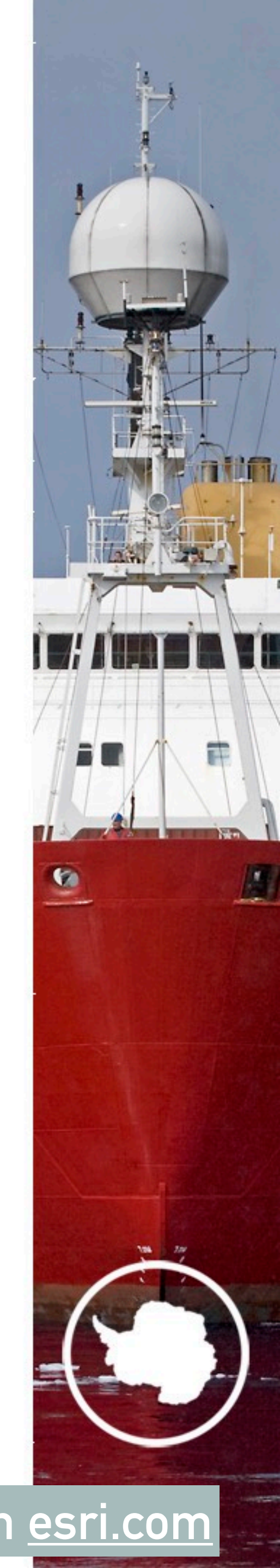
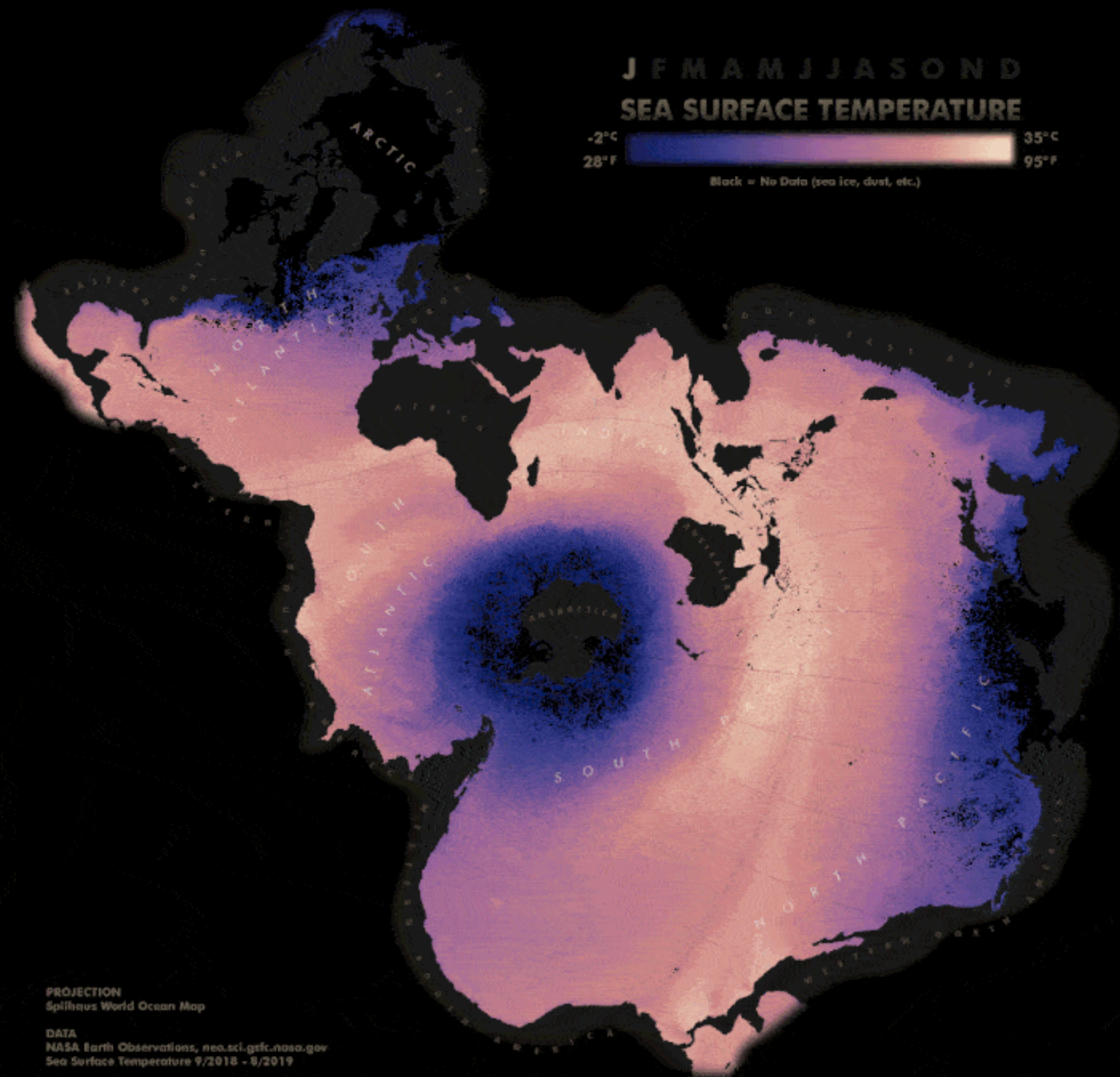


Image: John Nelson from [esri.com](http://esri.com)



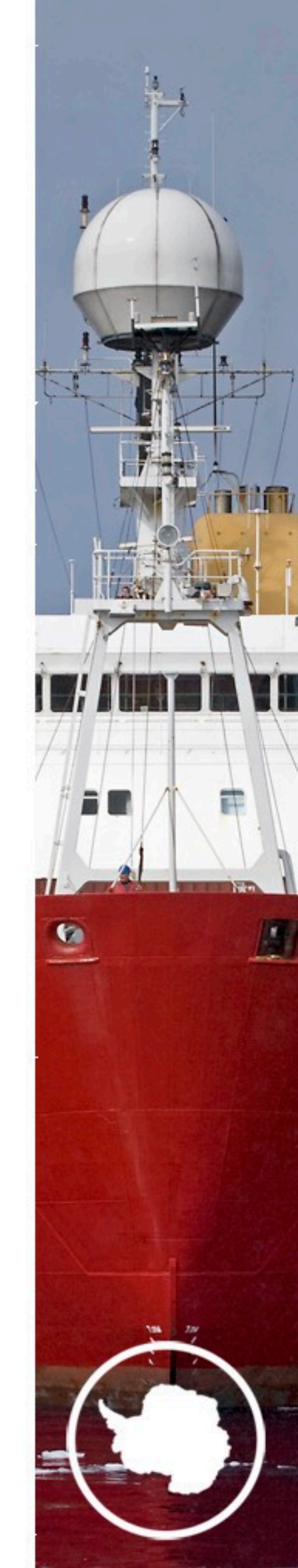
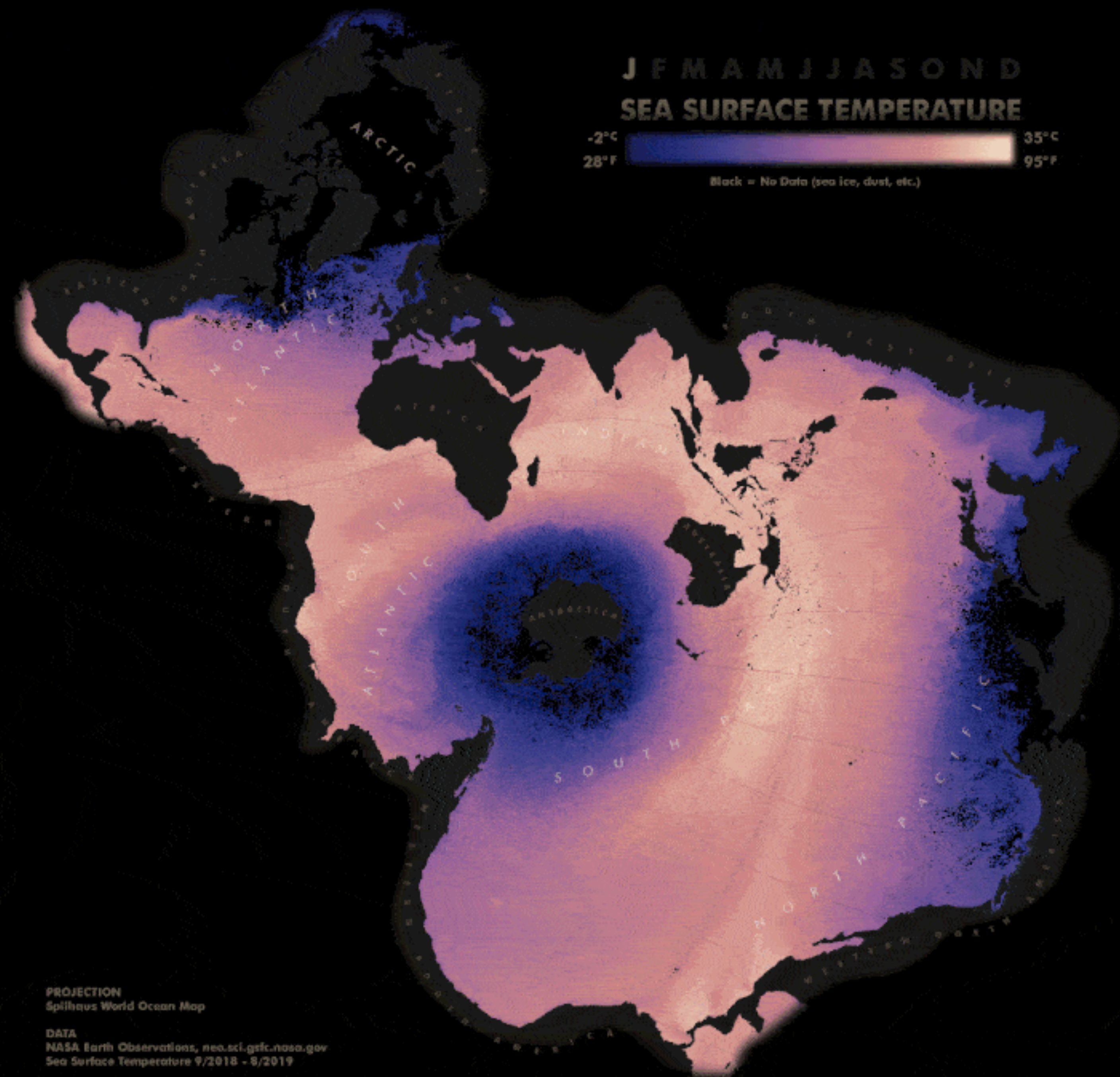


Image: John Nelson from [esri.com](http://esri.com)

# DENSITY STRUCTURE OF THE OCEAN

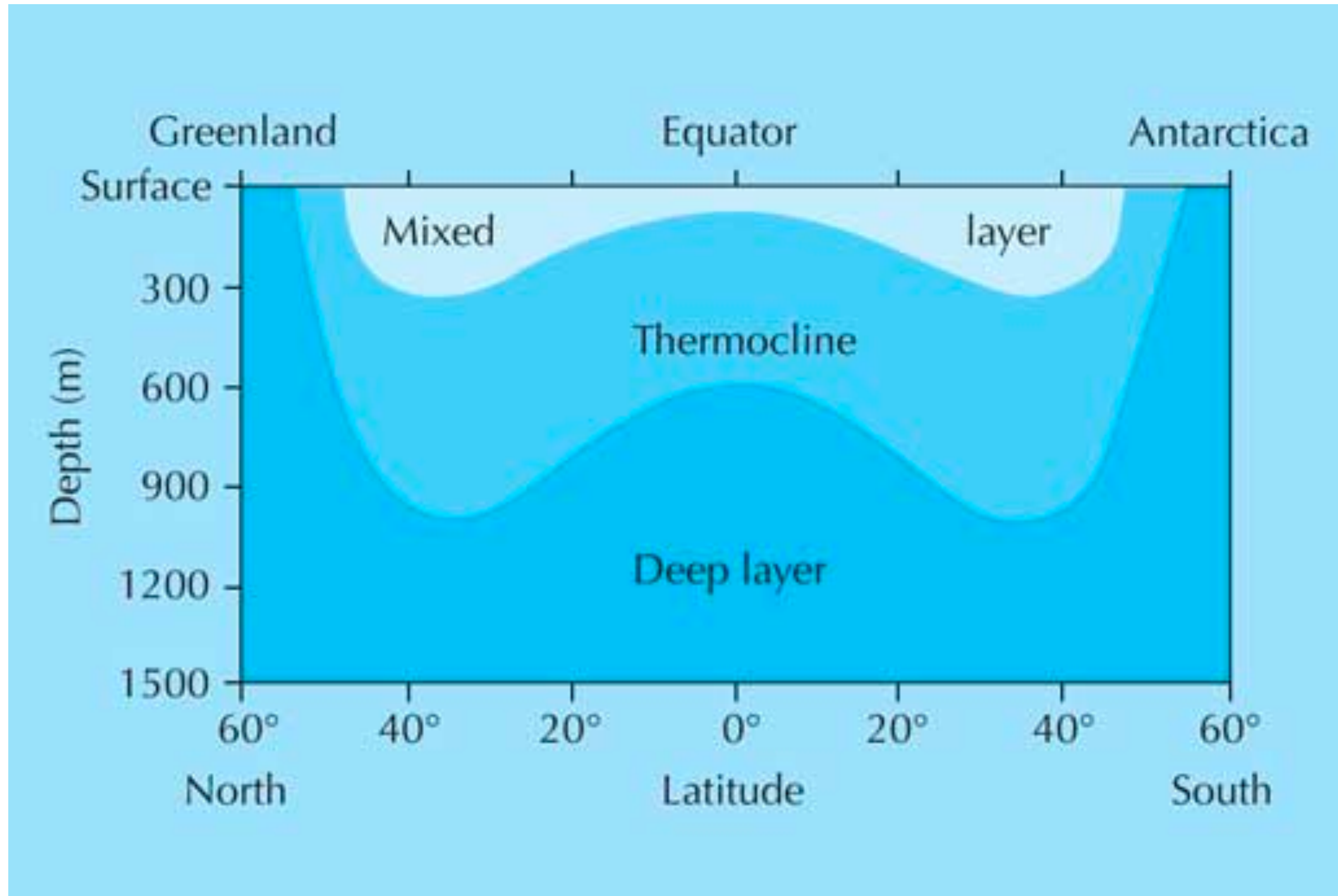


Image: DataStreme Ocean ©American Meteorological Society.



# OVERTURNING CIRCULATION

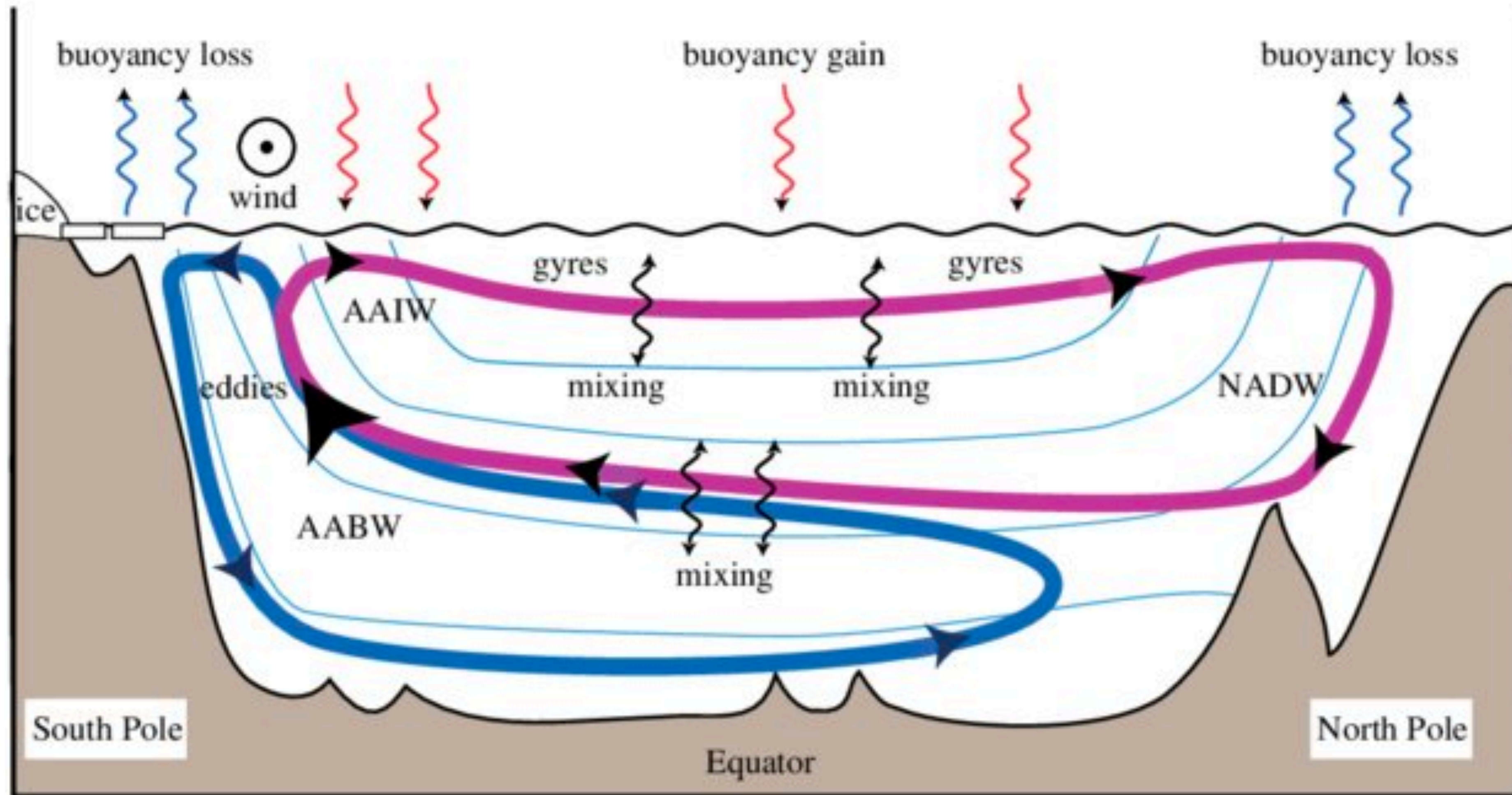


Image: G Vallis



# WIND DRIVEN GYRES

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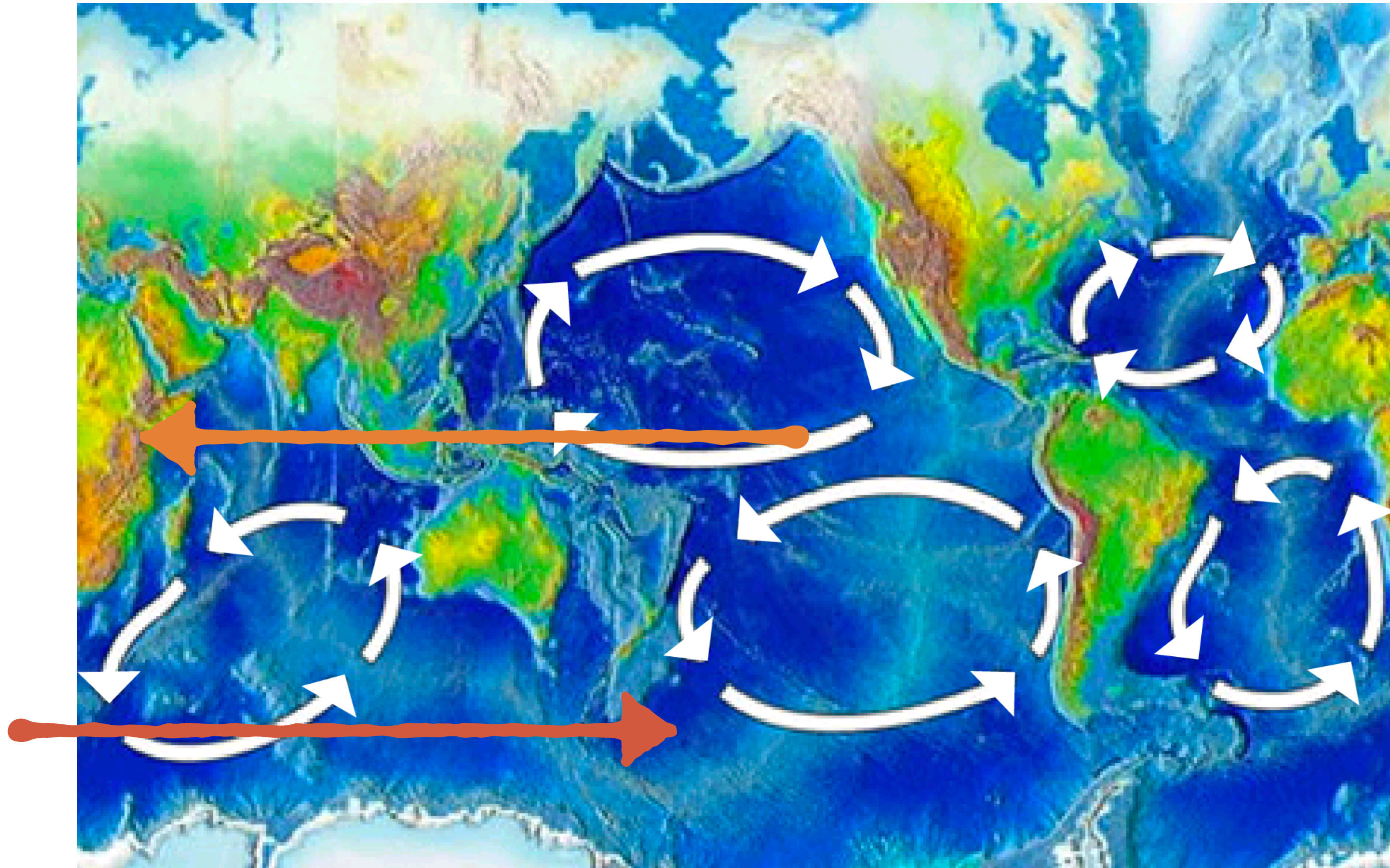


Image: Wikipedia



# WIND DRIVEN GYRES

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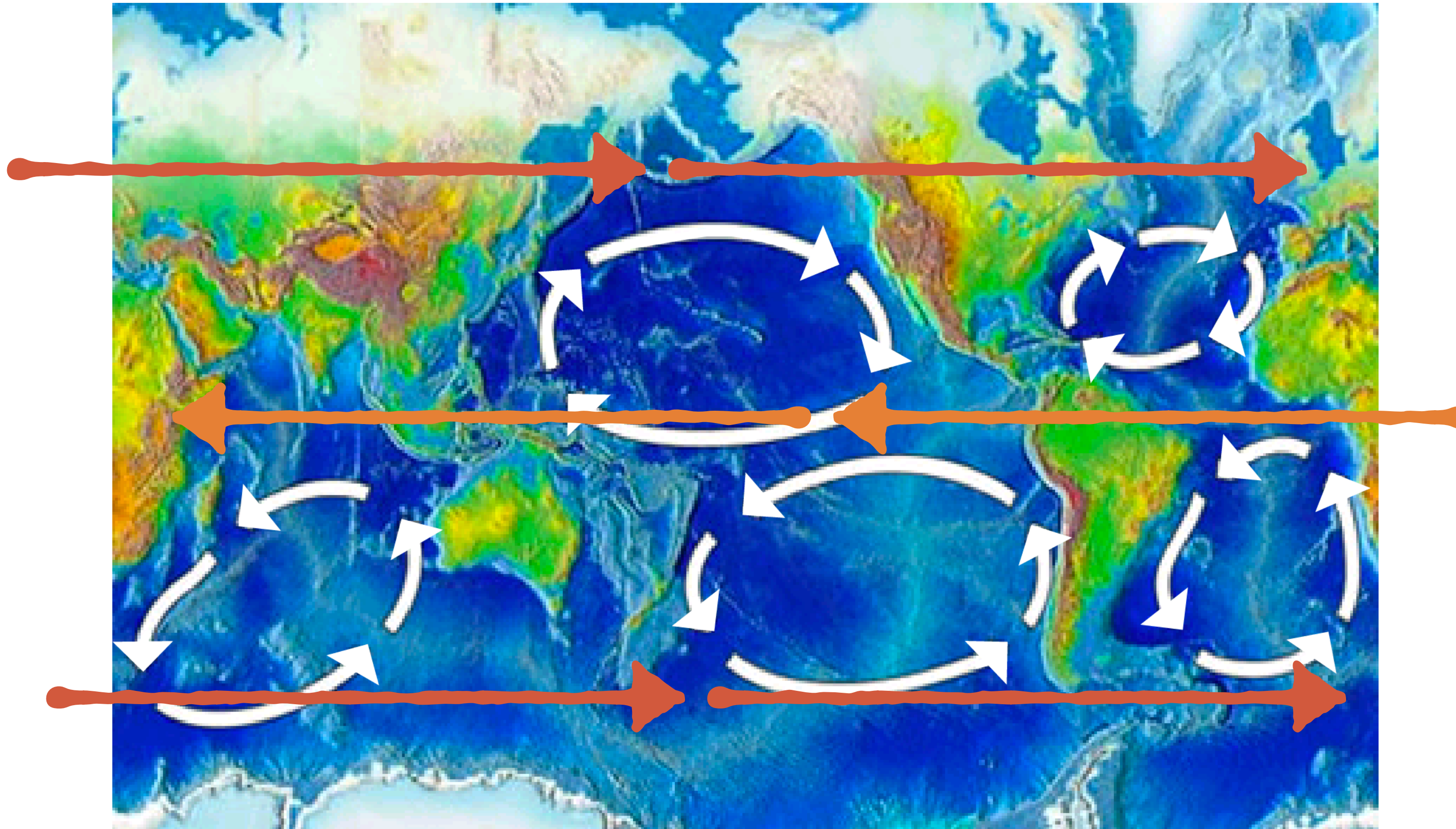


Image: Wikipedia



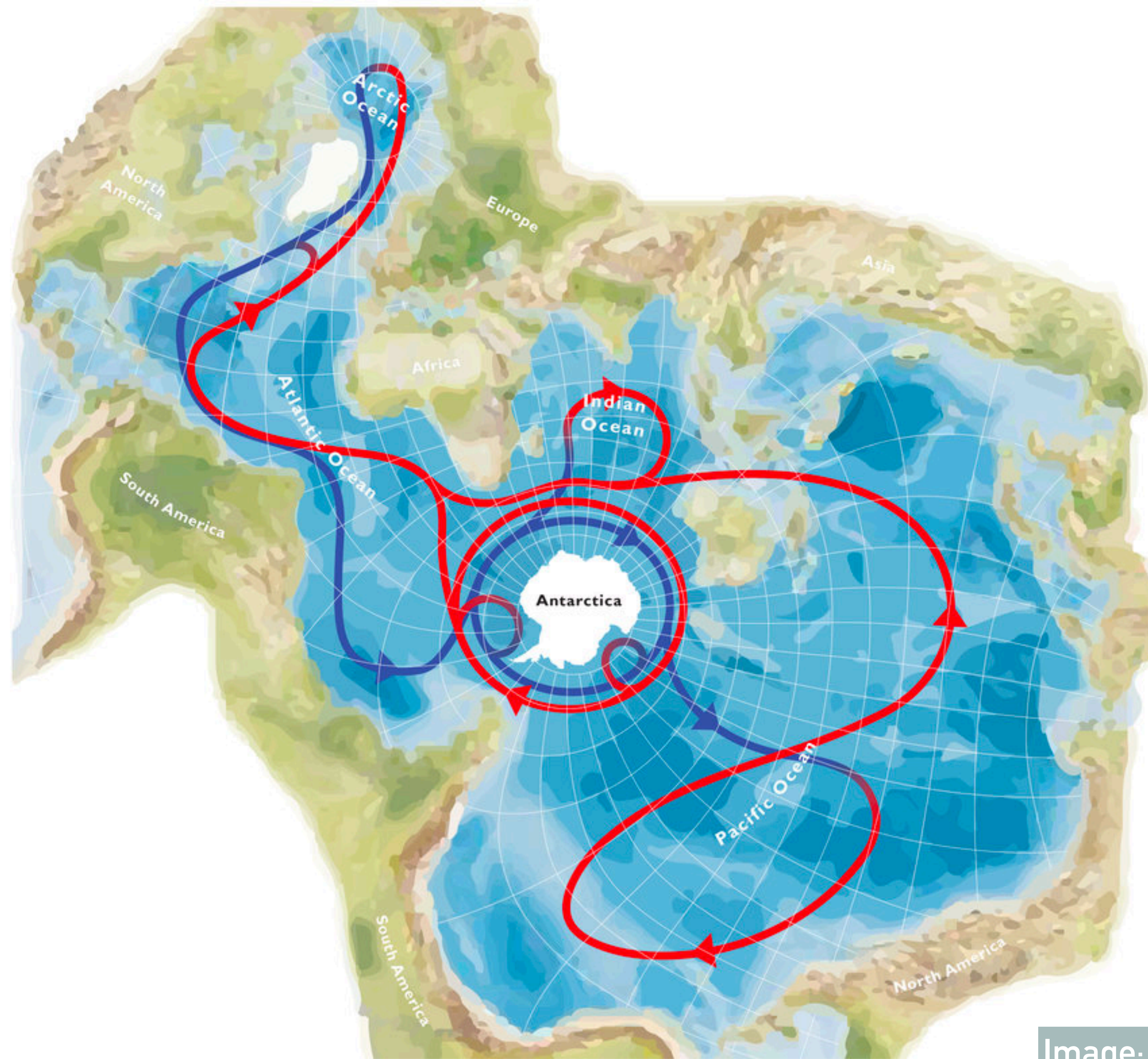
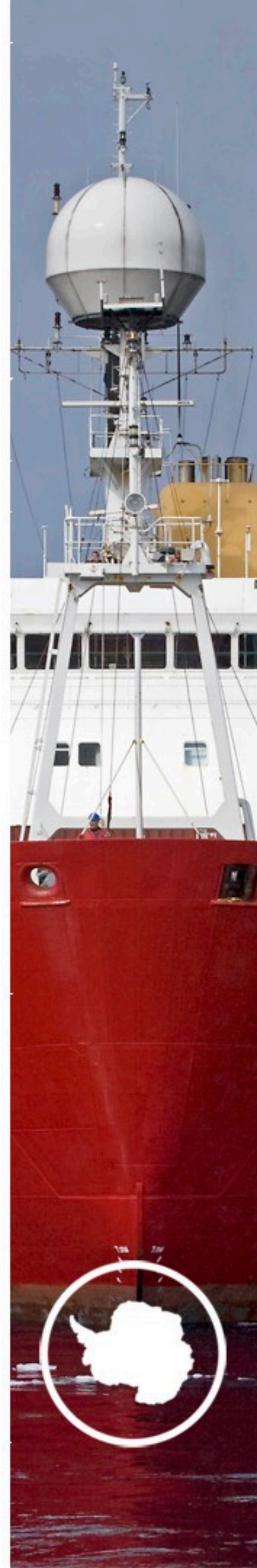


Image: M Meredith



# ENERGY CASCADE

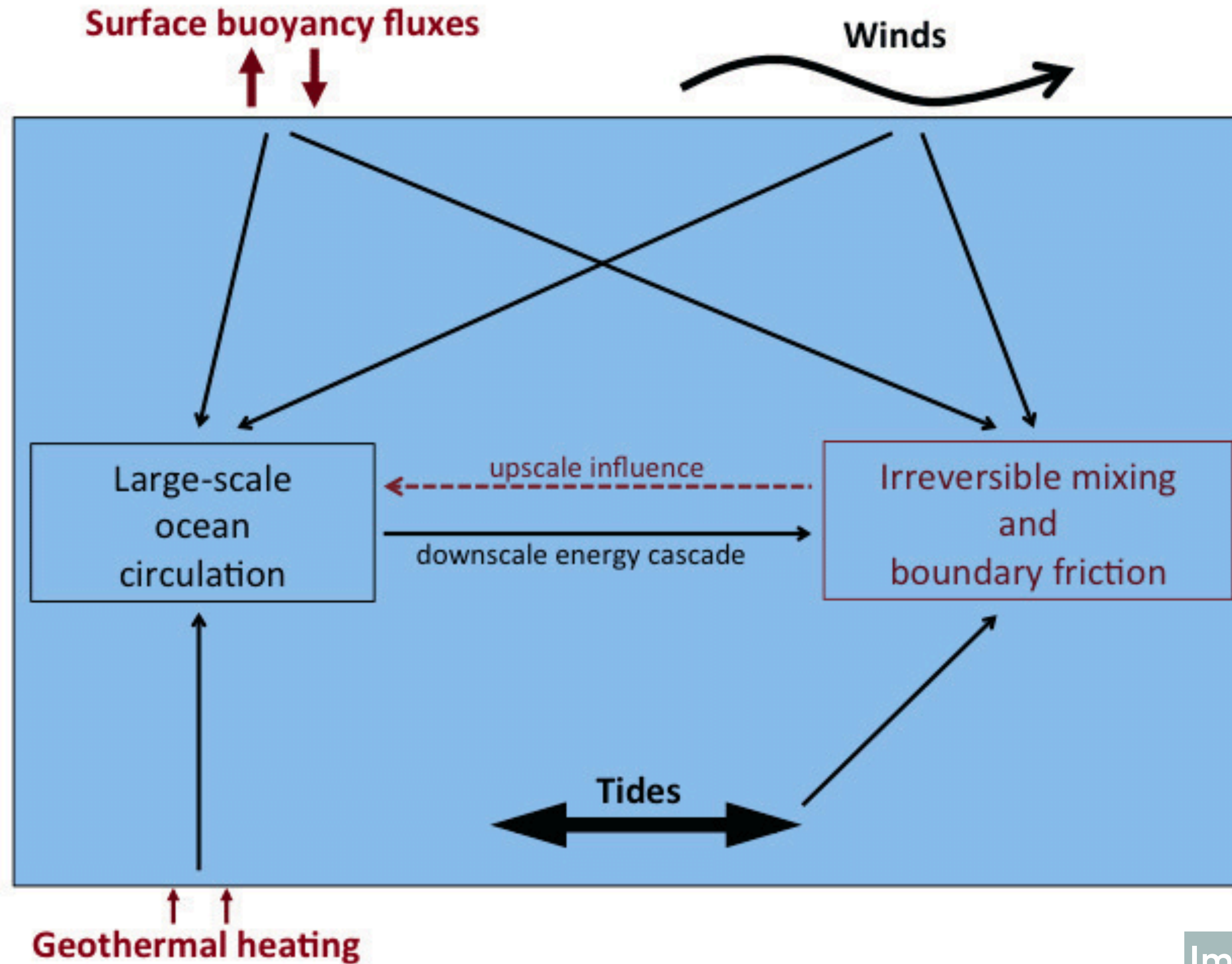
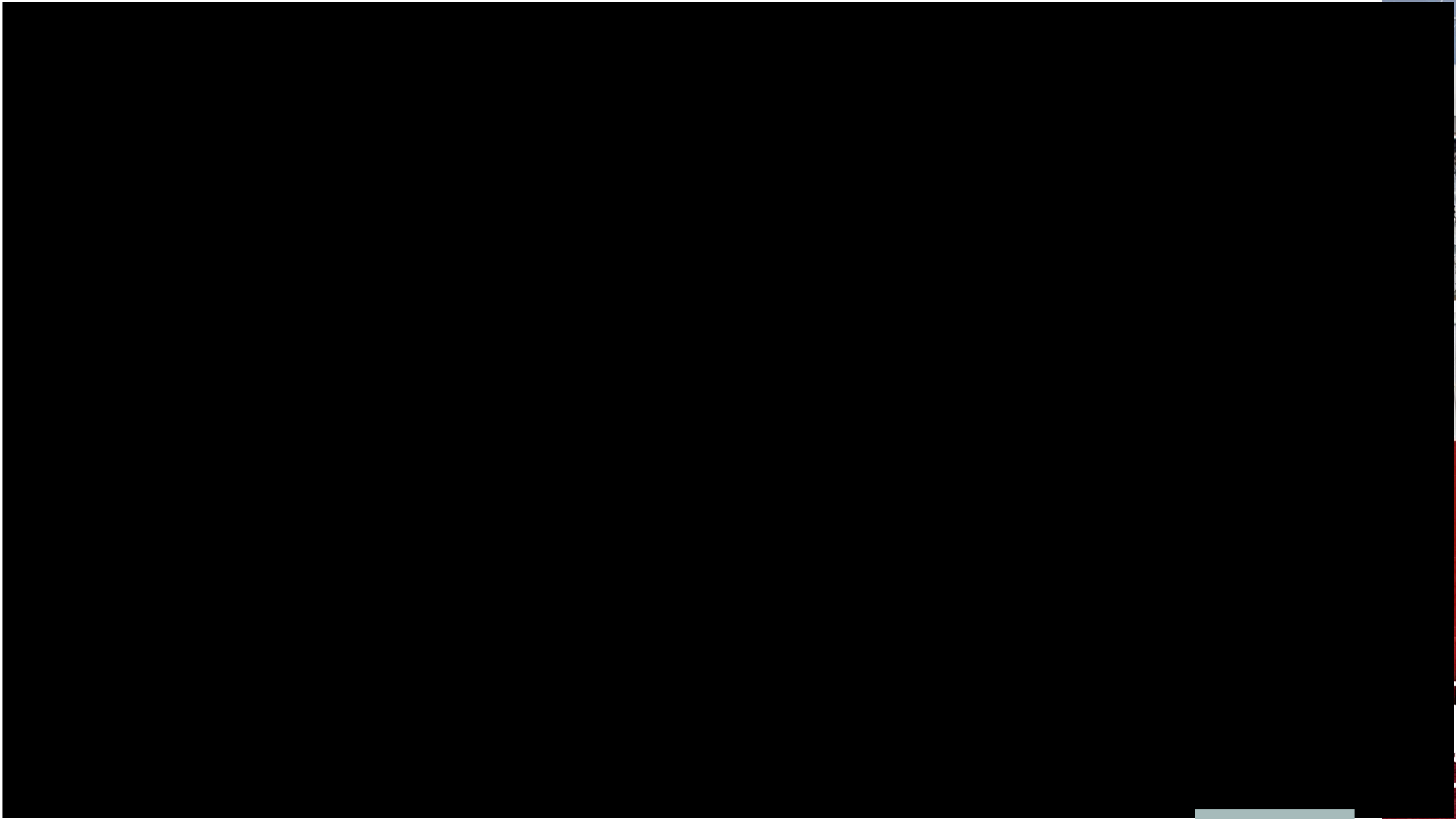


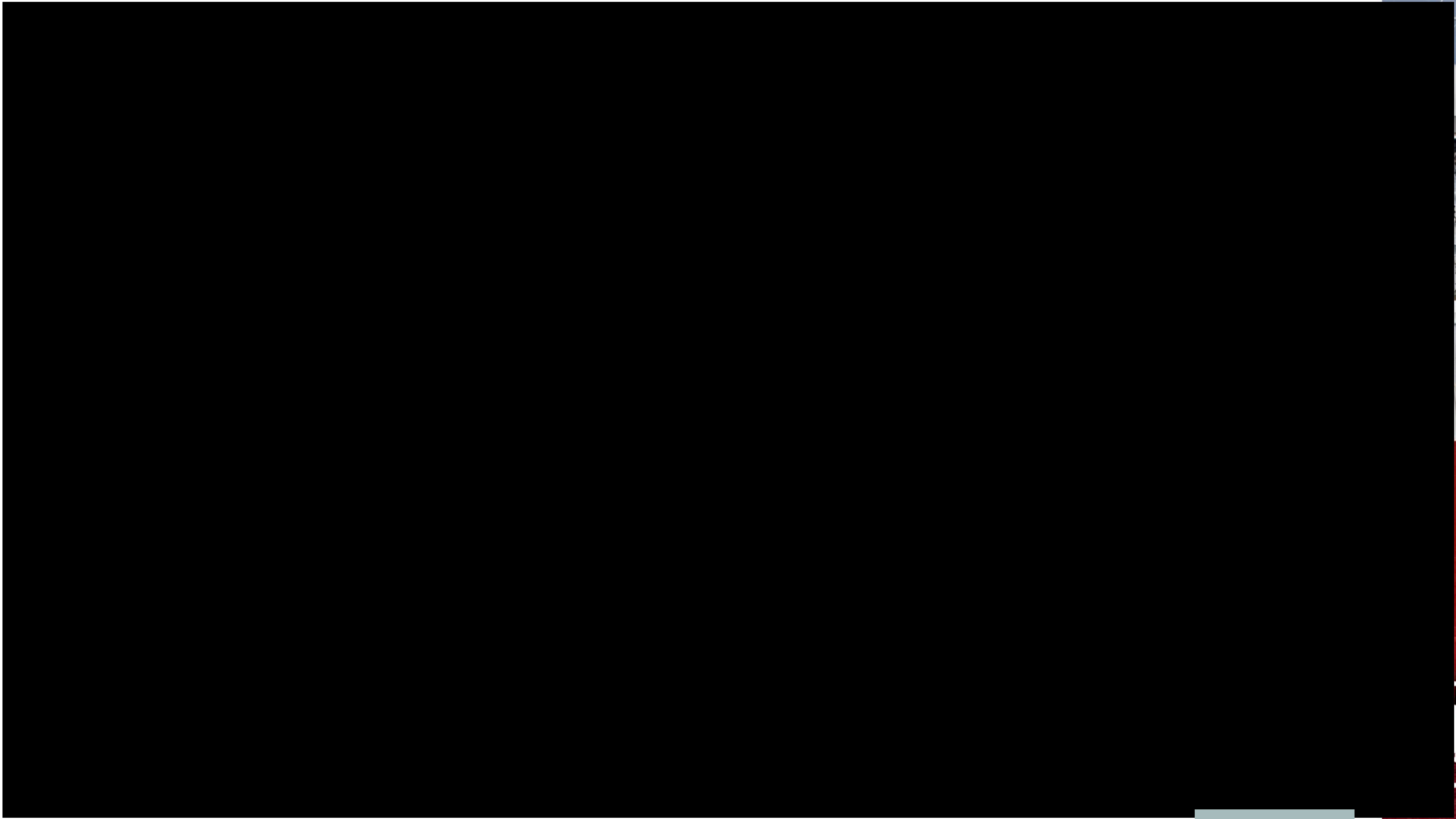
Image: C. de Lavergne





Video: NASA





Video: NASA

# EDDIES ARE CRUCIAL

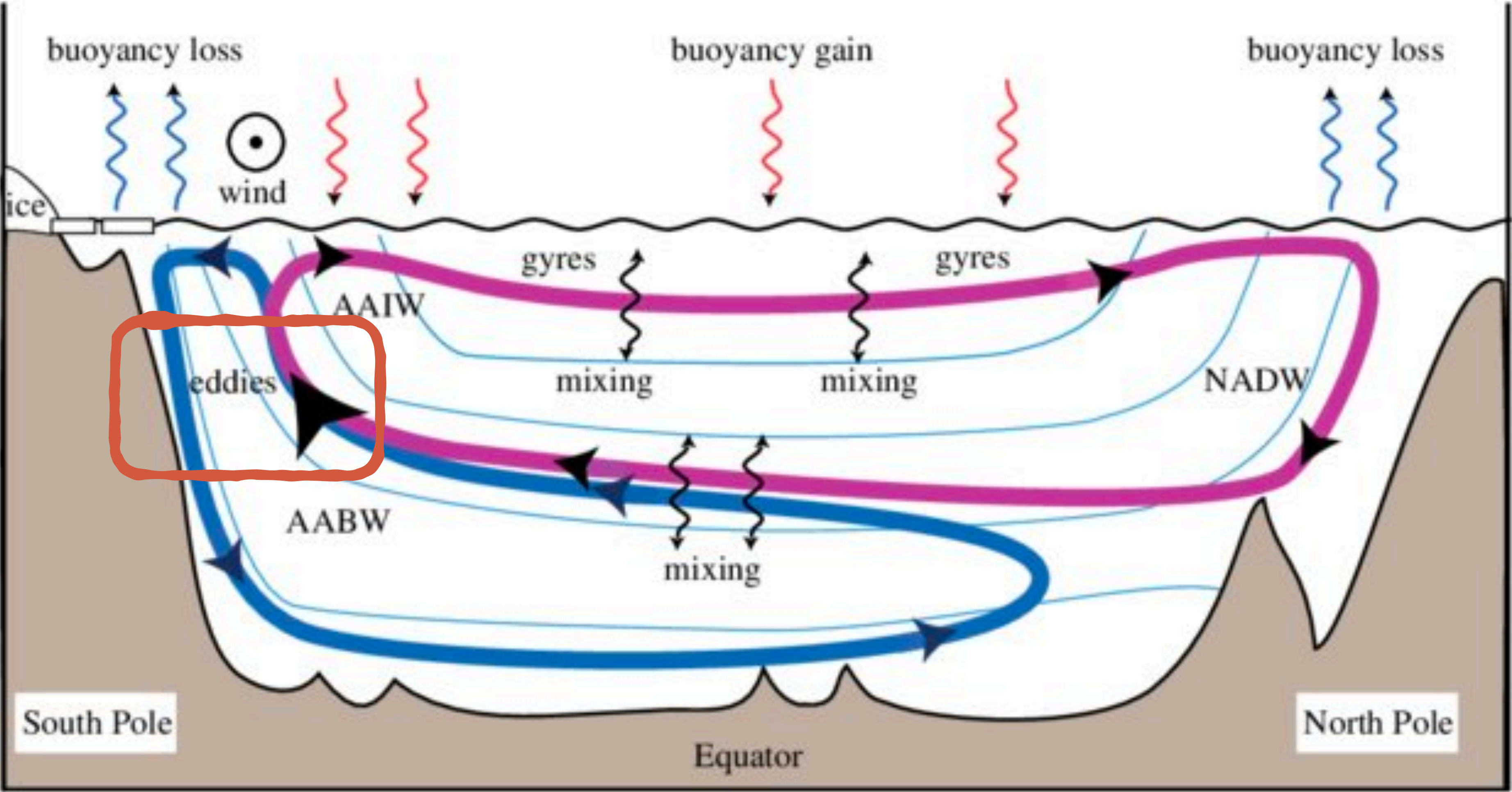
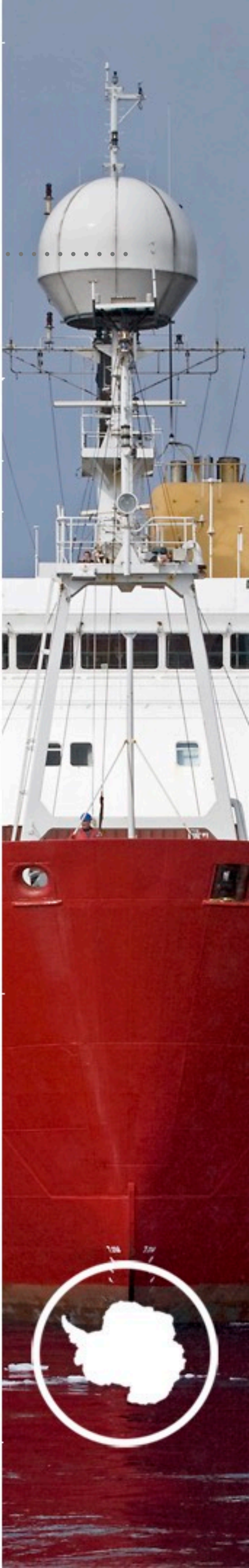


Image: G Vallis



# OPEN QUESTIONS/PROBLEMS

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- Observational/theoretical: “missing” mixing. Fundamental to closure of ocean circulation
- Modelling: correctly including small scale effects of
  - Eddies
  - Ice-ocean interactions
  - Tides
  - Internal waves
  - Sub-mesoscale instabilities
  - ....



QUESTIONS?

