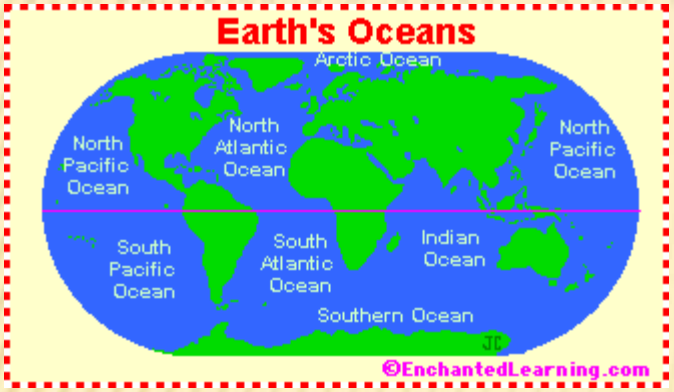
SEA LEVEL AND CURRENTS ALONG THE INDIAN COASTLINE

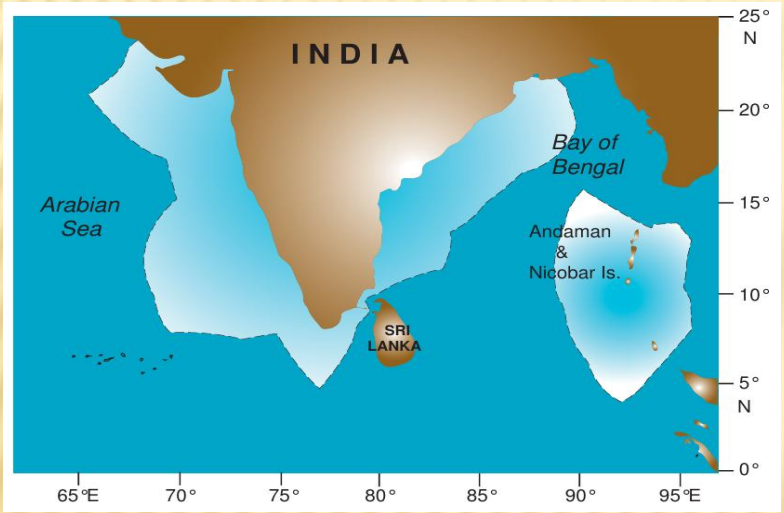
Abhisek Chatterjee
Scientist, ISG
ESSO-Indian National Centre for Ocean Information Services

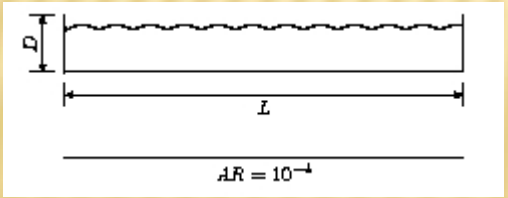
Presented at
Training courses on Ocean State Forecast (OSF) services

ITCOOcean
26 November 2014

SHOULD WE CARE ABOUT OCEAN ?







Ocean and seas cover 70.8% of the surface of earth, which amounts to 361,254,000 km^2.

Average depth is ~3700 m.

Width of the Pacific is ~ 13,000 km.

India's EEZ covers ~ 23,72,298 km^2 (60% of India's land area) along 7516 km long coastline.

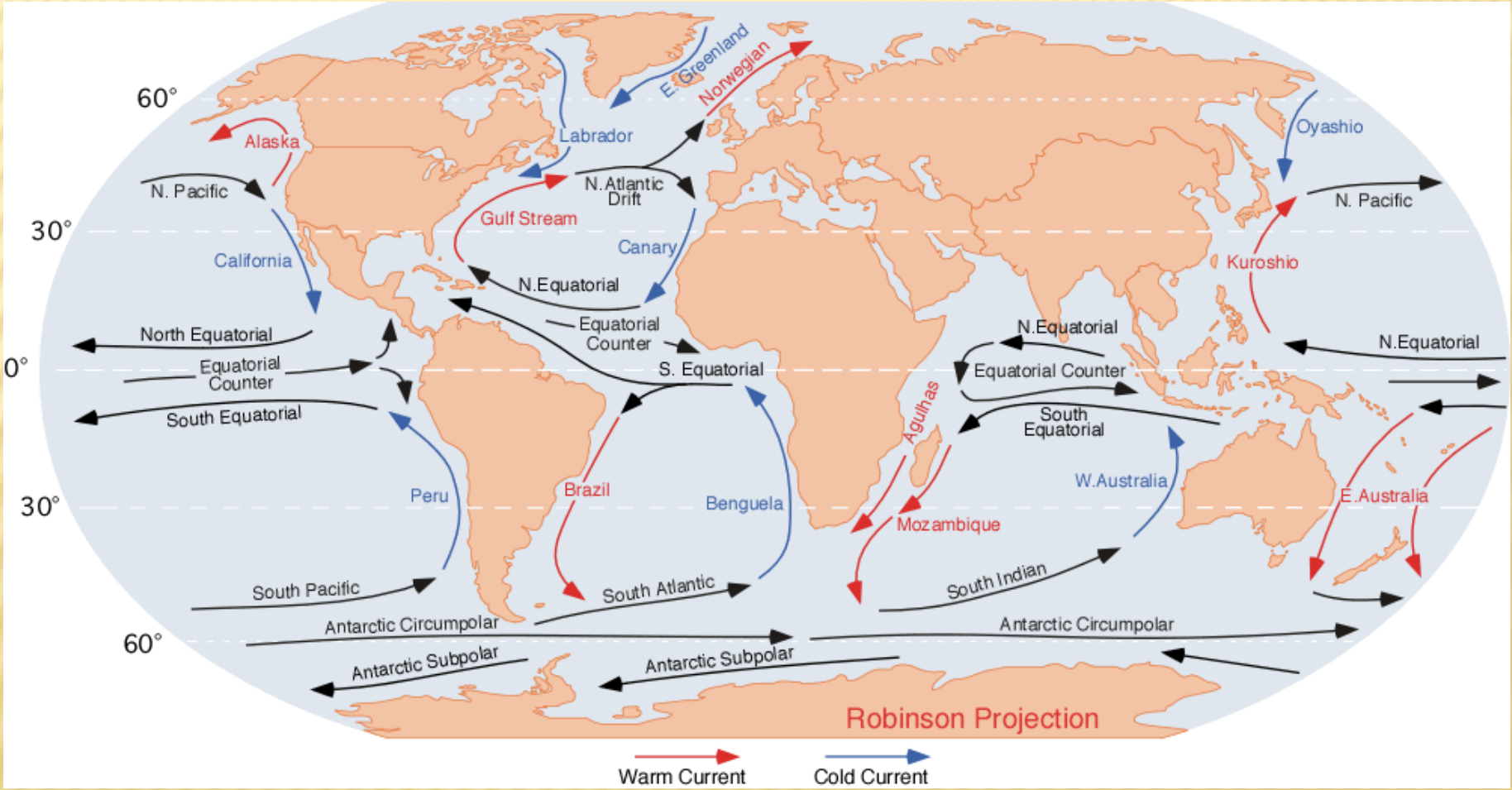
WORLD OCEAN CIRCULATION

- Traditionally divided into 2 components:
  - 1) Surface Water Circulation
  - 2) Deep Water Circulation
  - Actually Both Influence each other. . .
  - Best TERM: WORLD OCEAN Circulation

WORLD OCEAN CIRCULATION

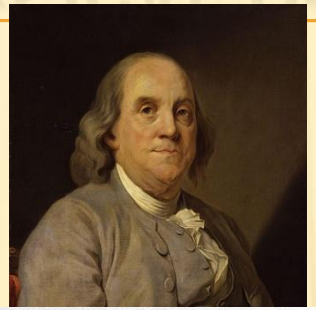
- Based on Dynamic Physical Oceanography
  - Describes Ocean based on:
    - Physical laws & conservation equations in conjunction with
      - Atmospheric and oceanographic observations
  - GOAL:
    - Quantify flow patterns & property distributions in the Ocean
  - Many PRACTICAL Applications:
    - Ship Routing
    - Search and Rescue
    - Marine pollutant trajectories
  - OUR GOAL:
    - Explore the Nature of Ocean Circulation –
    - become aware of Forces that govern .

GLOBAL OCEAN SURFACE CIRCULATION



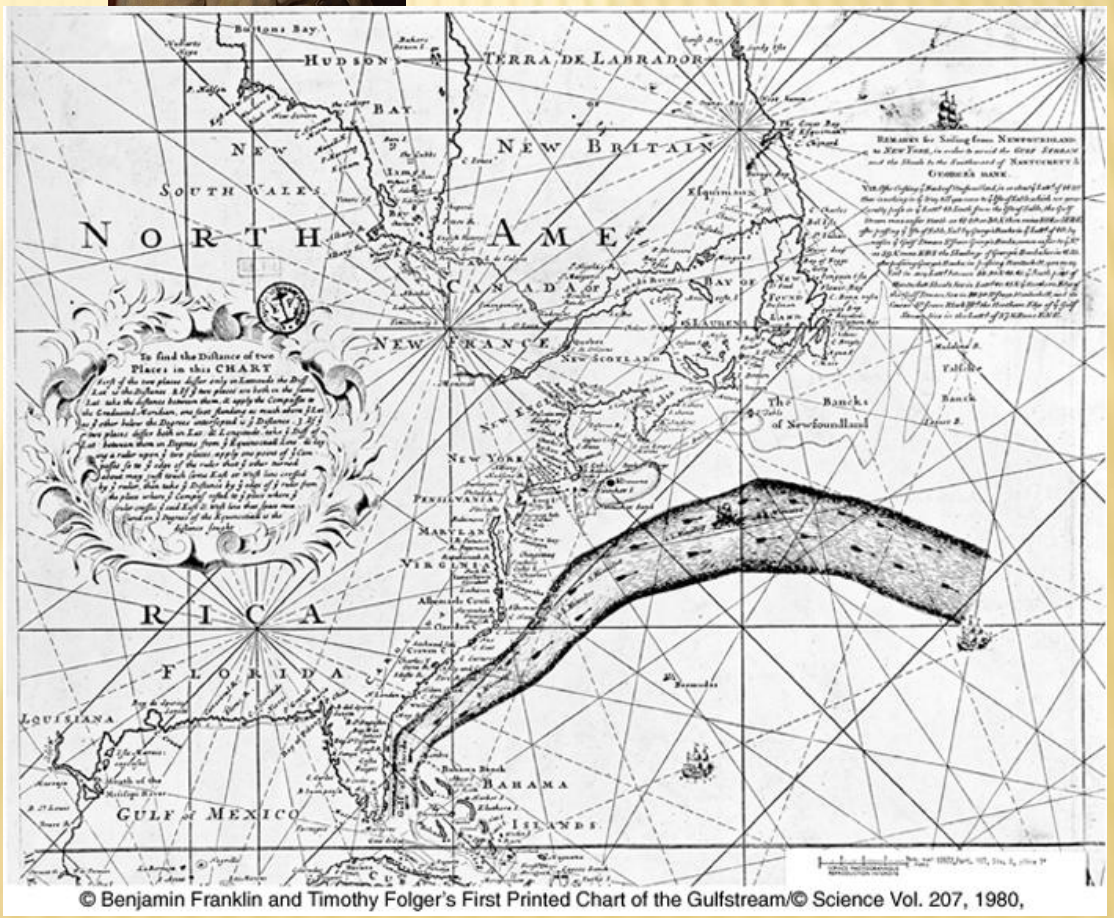
FOUNDATIONS OF PHYSICAL OCEANOGRAPHY

Ben Franklin (1706-1790)



- US Postmaster General (reduce transit time)
- Publishes First Maps of Gulf Stream

- By 1800 many circulation patterns worked out by seaman
- Via Trial and error
- Little understanding of
  - Why?



© Benjamin Franklin and Timothy Folger's First Printed Chart of the Gulfstream/© Science Vol. 207, 1980,

MOTION IN THE OCEAN – CHALLENGE QUESTIONS

- The existence of the 4 Big Gyres- Where are they?
  - How do they arise?
    - What direction are their rotations Clockwise or Counterclockwise?
    - **What is so important about Gyres anyway?**

CORIOLIS DEFLECTIONS

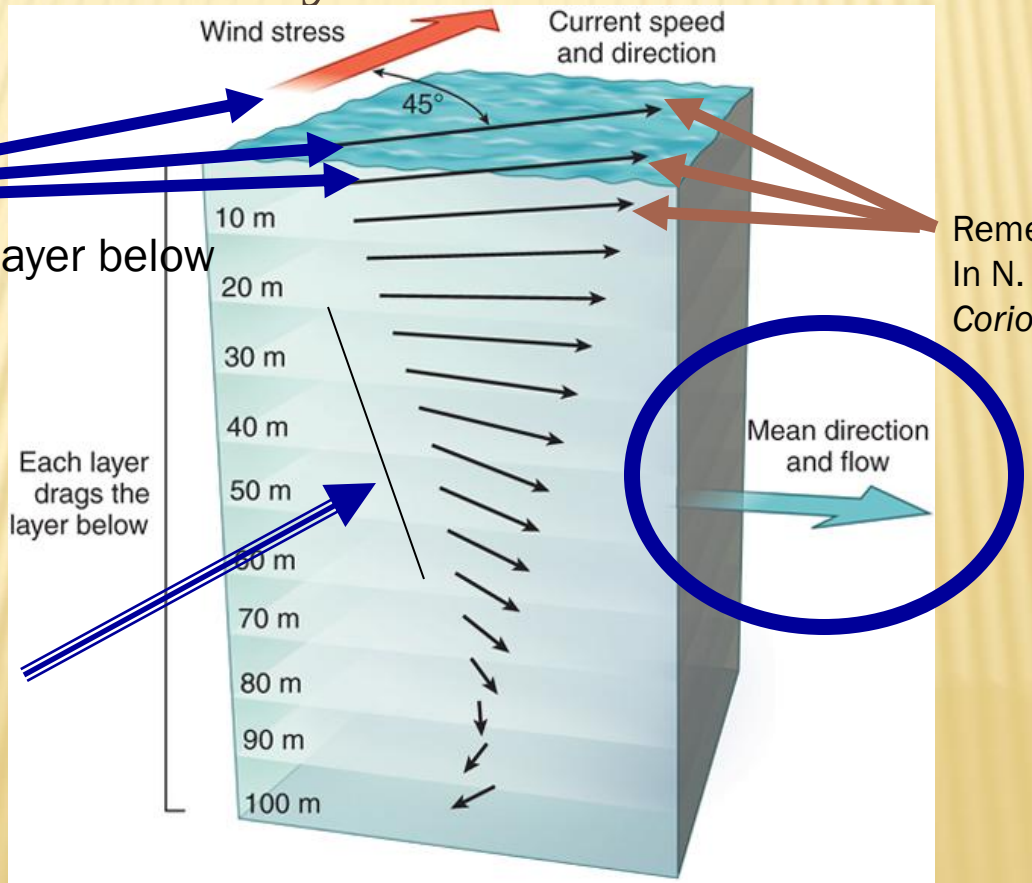
- Apparent force due to Earth's rotation
- Deflection in path of motion when viewed from rotating frame
- Gustave-Gaspared Coriolis (1835)
- Significant only for large distance

- *Lets see a movie….*

MOTION IN THE OCEAN

- The existence of the Gyres
  - How do they arise? V. Walfrid Ekman (1861-1930)

((Wind stress))
Friction drags layer below
And so on. . .



Remember:
In N. Hemisphere
Coriolis deflects this *to Right*

NOTE:
Arrows indicate:
-direction
-intensity

- **CHALLENGE Question**

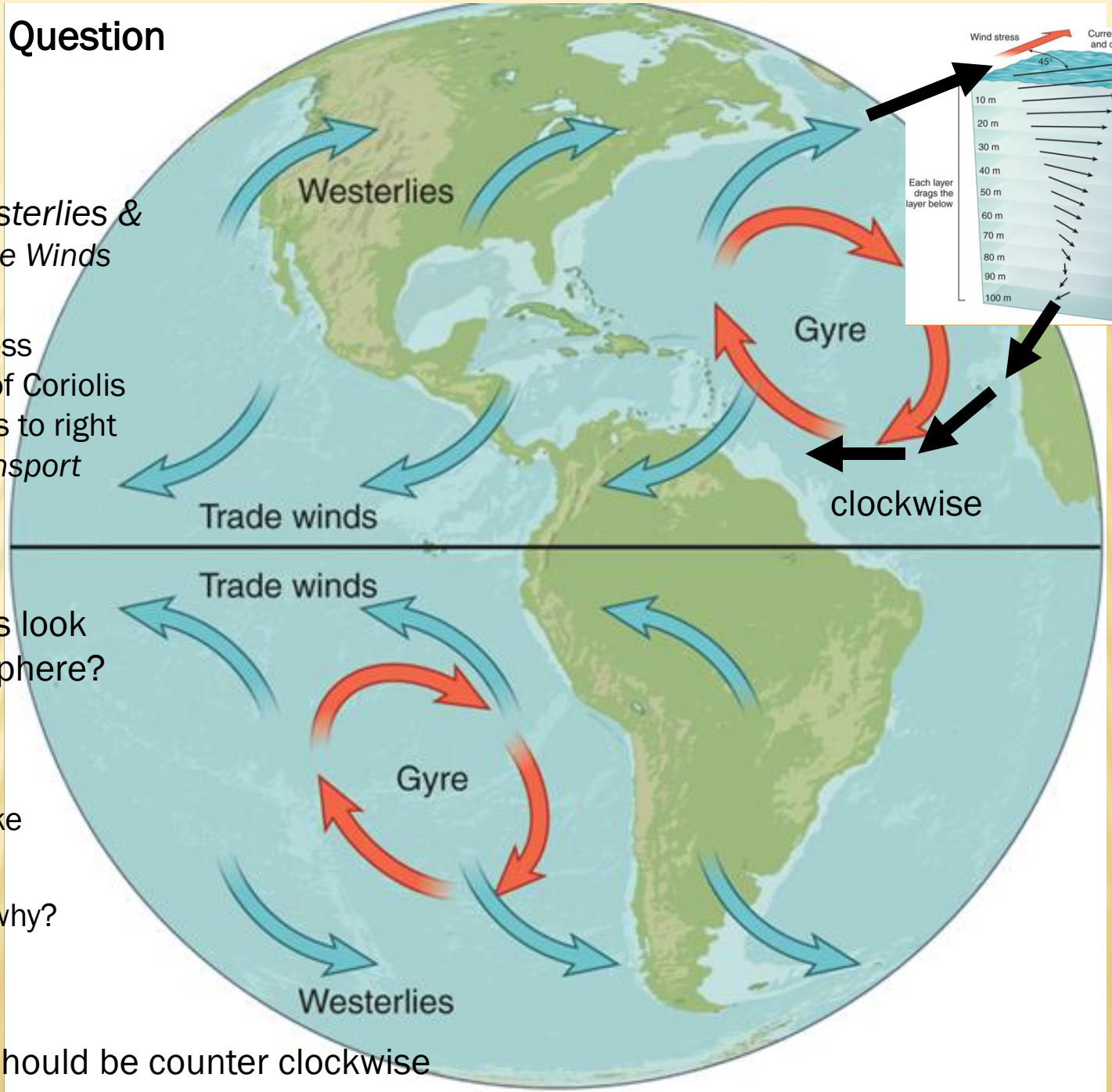
RECALL
The *Westerlies* &
The *Trade Winds*

Provide Wind stress
Under influence of Coriolis
→Curves currents to right
→*Via Ekman Transport*

How Should this look
in the S. Hemisphere?

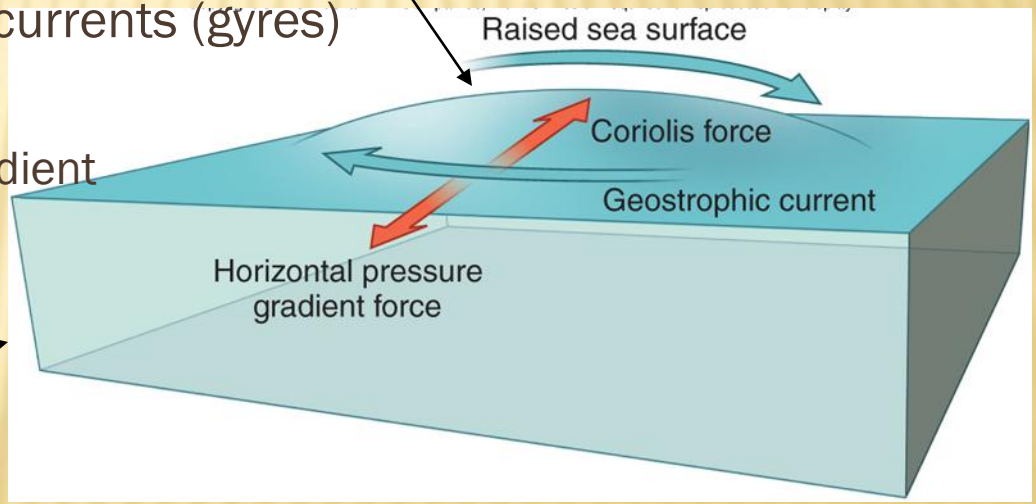
NOTE:
–There is a mistake
in the Text
– where is it and why?

S. Pacific Gyre should be counter clockwise

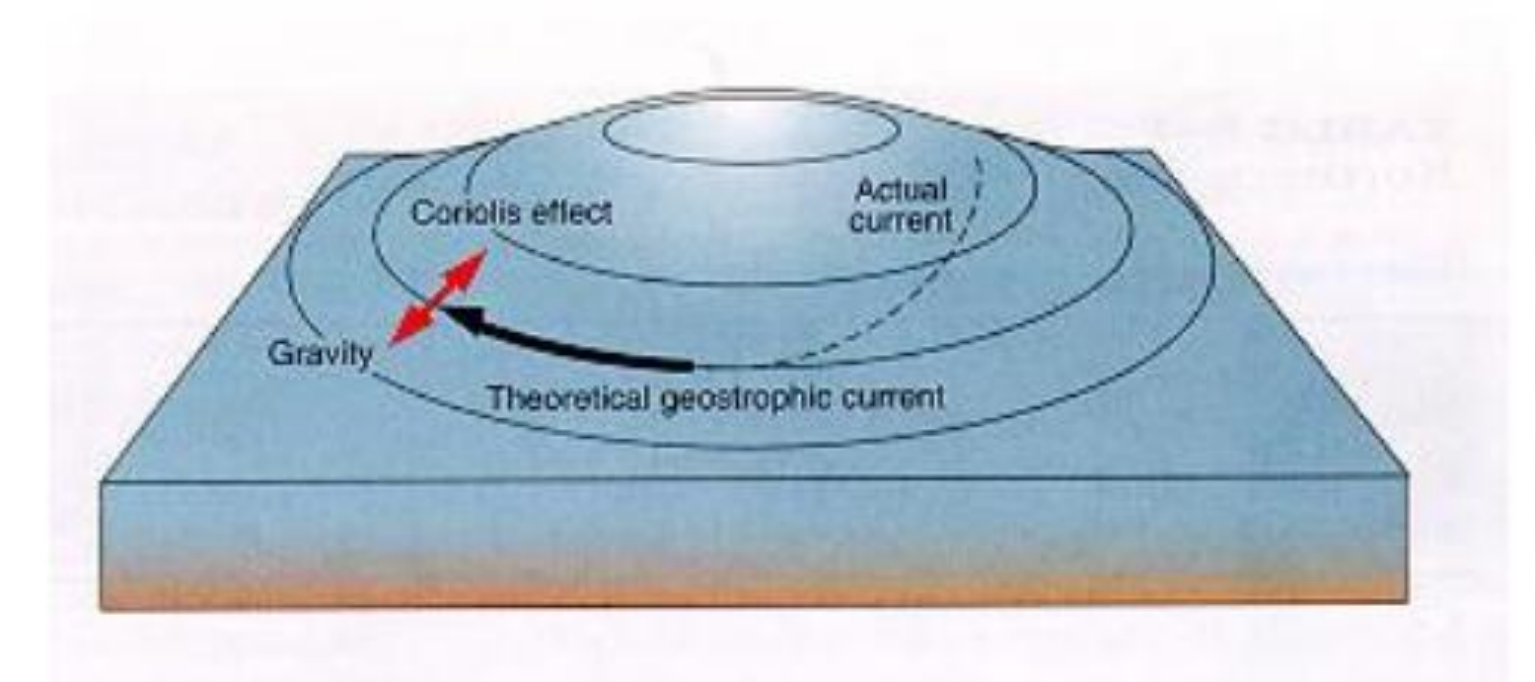


Geostrophic Flow: The *Hill* in the Gyre

- What does geostrophic stand for?
  - "Earth-turning" –refers to "flow under influence of Coriolis"
  - EKMAN Transport Directs water to middle of Oceans (Gyres)
    - Creates sloping Sea Surface (a Hill)
    - Water flows from High Pressure to Low pressure
    - Forms geostrophic currents (gyres)
    - A balance of:
      - Horiz. Press. Gradient
      - Coriolis force

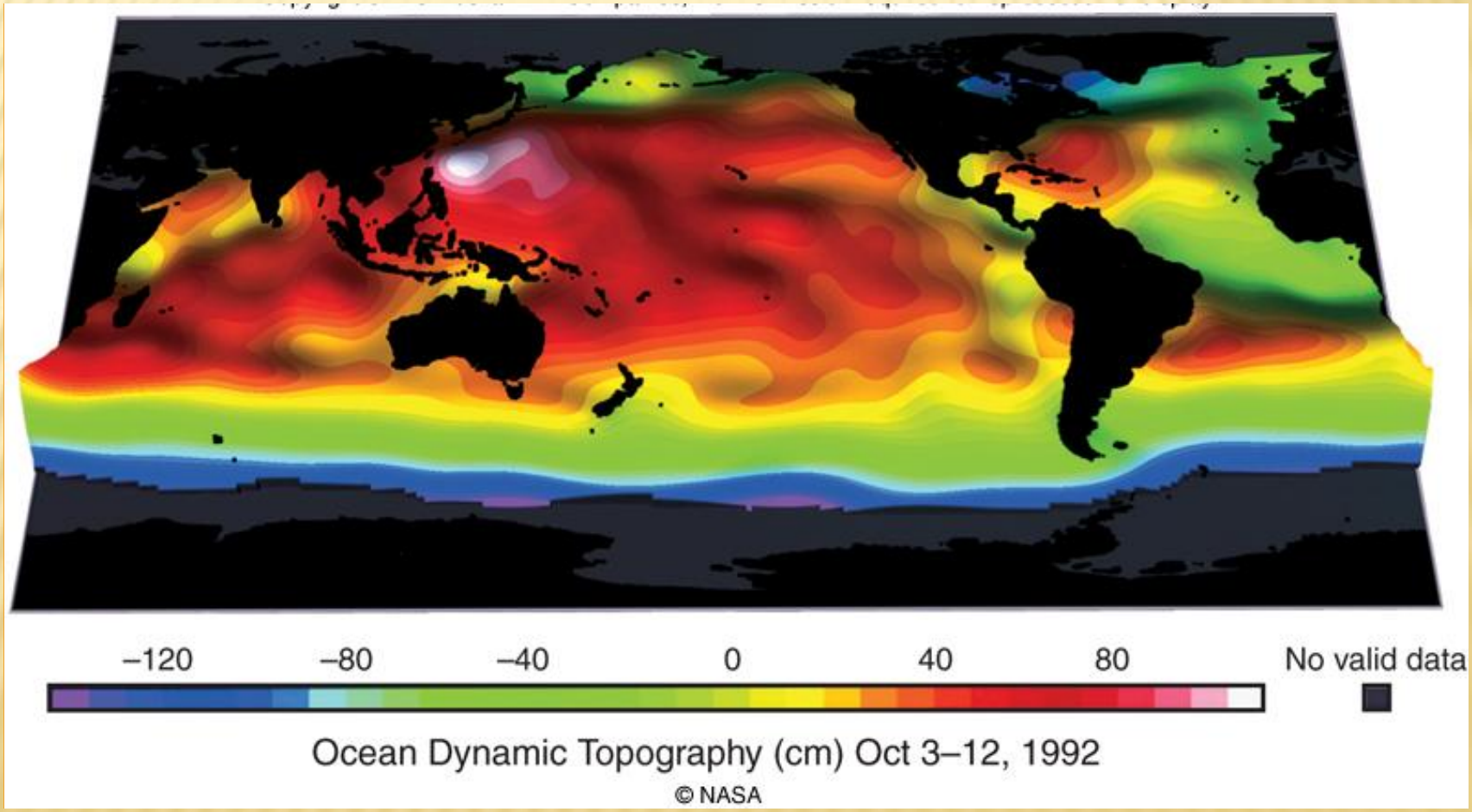


Geostrophic Flow: The *Hill* in the Gyre

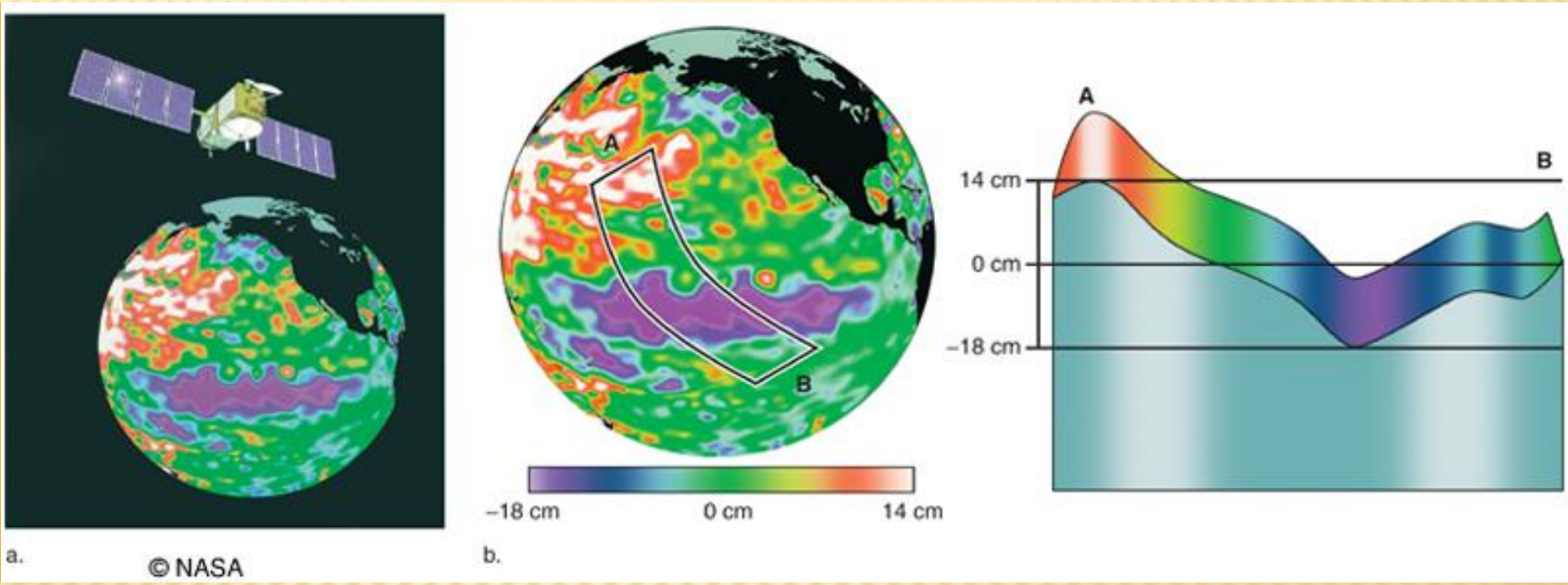


Geostrophic Flow: The *Hill* in the Gyre

Consequences .. (see TOPEX Satellite Alimeters)
Elevated Sea Surface Heights across the Oceans

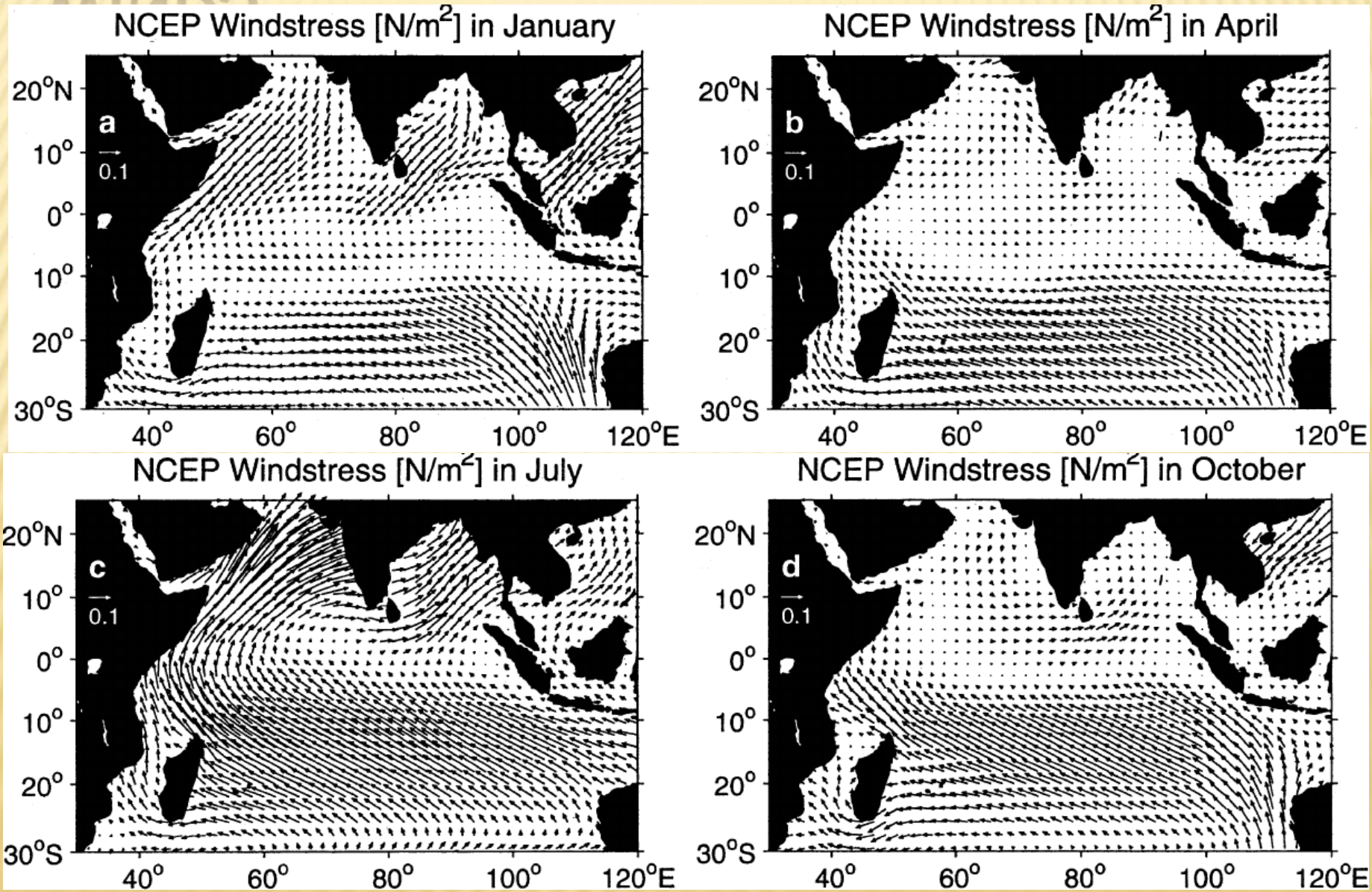


- Geostrophic Flow: The *Hill* in the Gyre
  - Satellite Jason 2001
    - 32 cm difference in elevation b/w Pt. A vs Pt. B

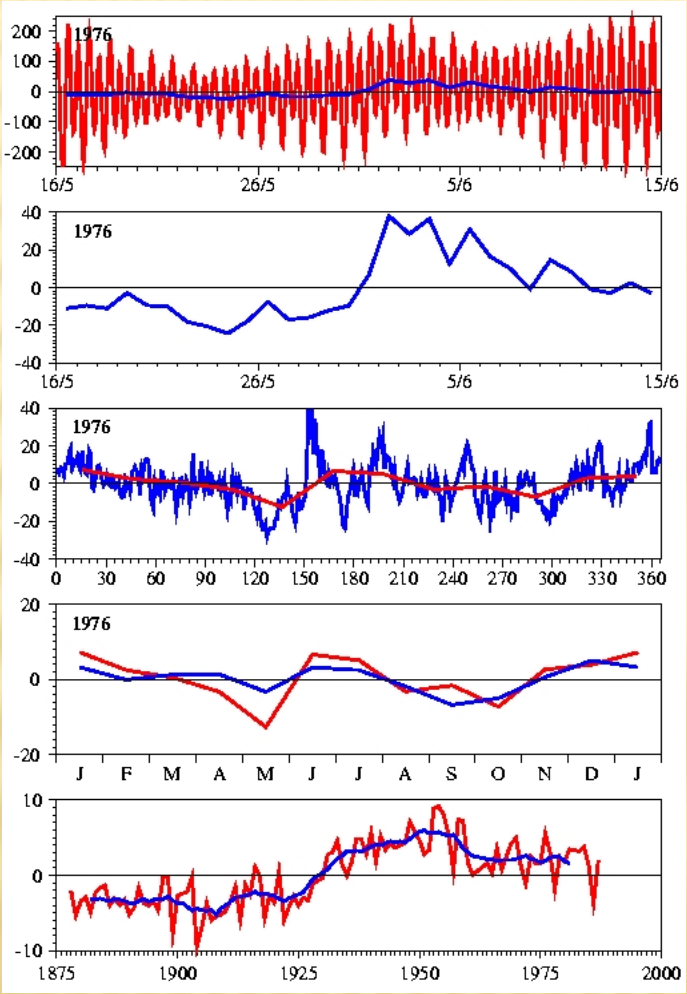


INDIAN OCEAN

WINDS

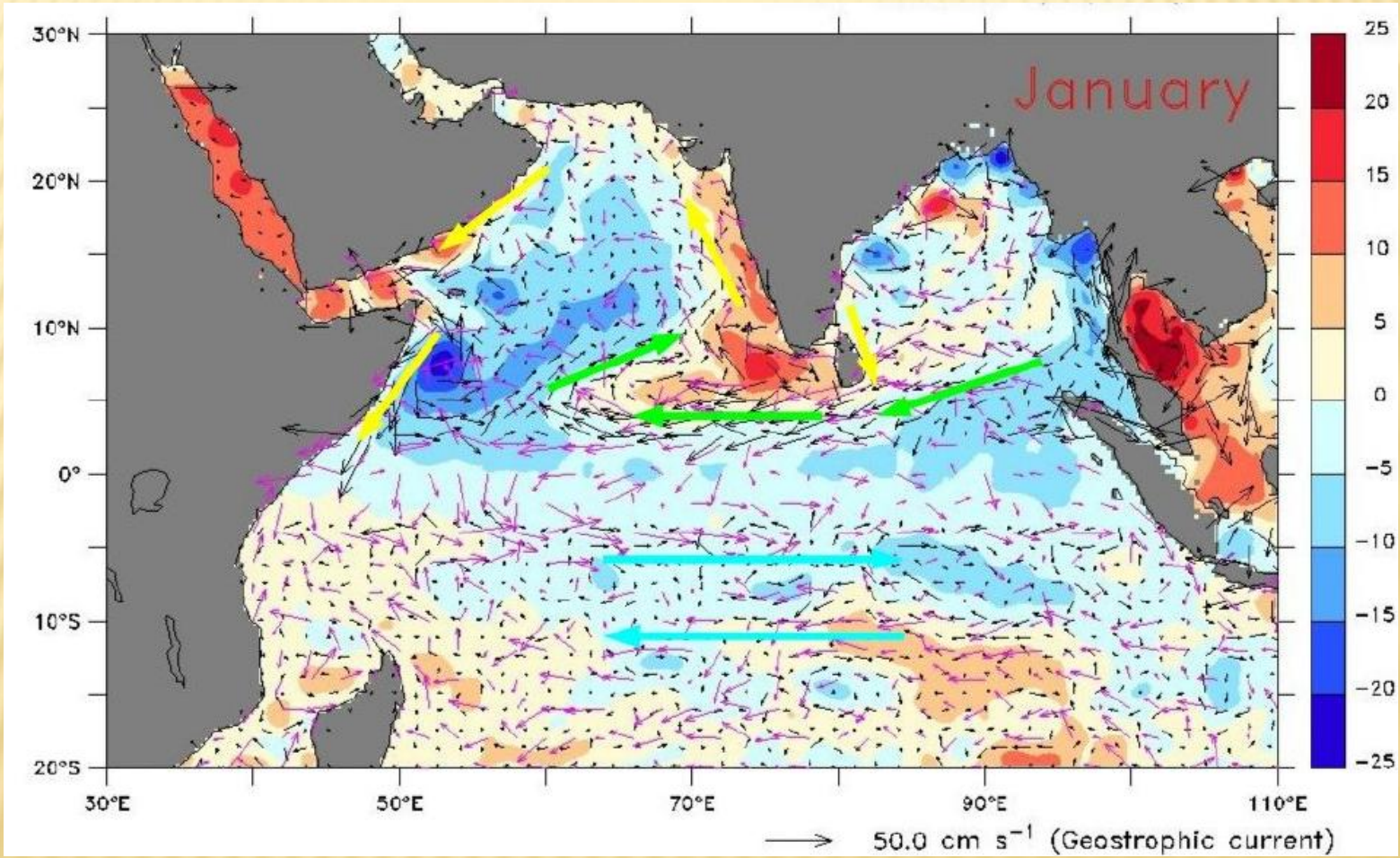

NCEP Windstress [N/m^2] in January
NCEP Windstress [N/m^2] in April
NCEP Windstress [N/m^2] in July
NCEP Windstress [N/m^2] in October
a
b
c
d
0.1
20°N
10°
0°
10°
20°
30°S
40°
60°
80°
100°
120°E

SEA LEVEL

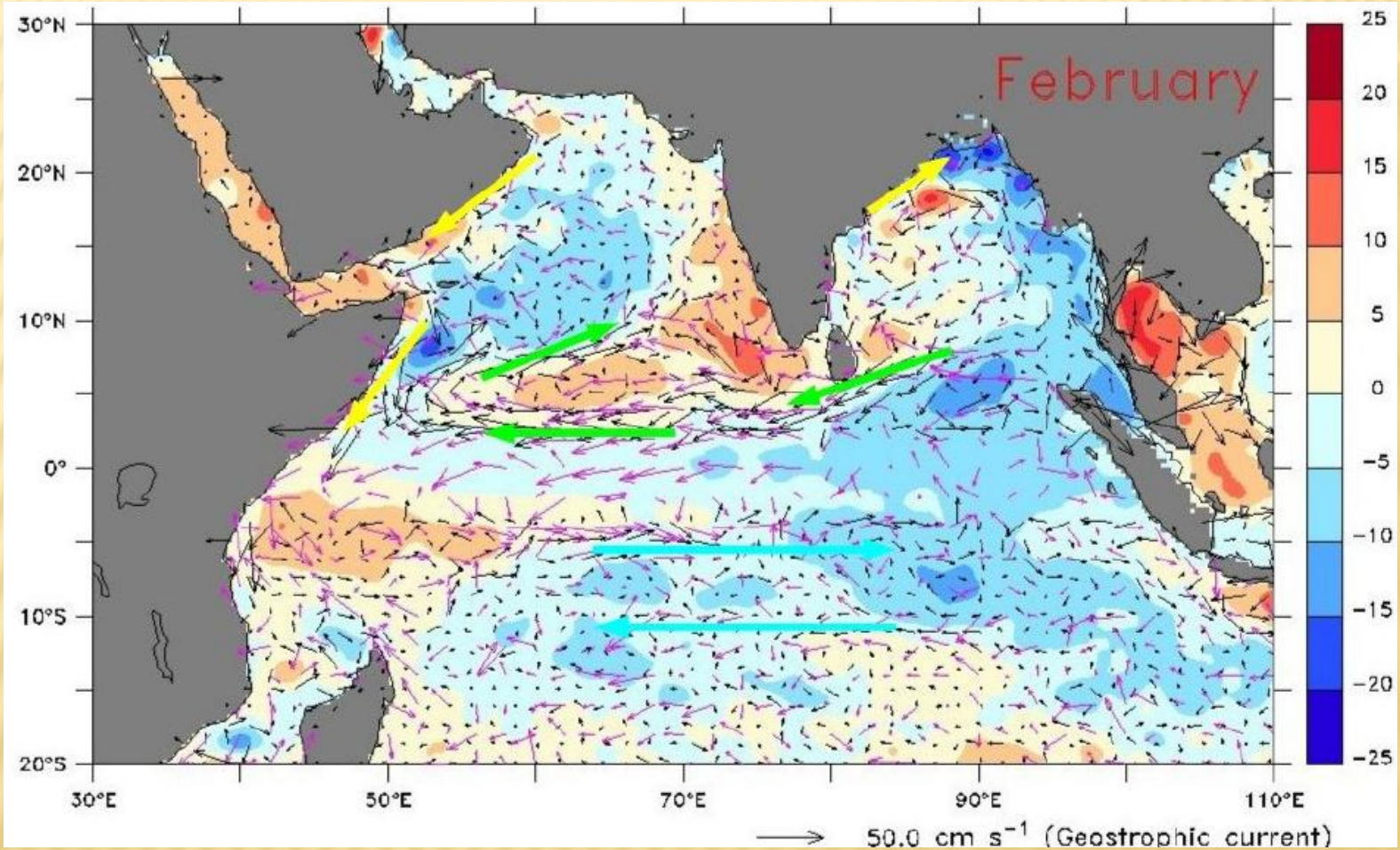


- Tide range ~ 4 m
- Storm surges ~40 cm
- Intraseasonal ~20-40 cm
- Seasonal ~ 20 cm
- Interannual and decadal ~ 20 cm

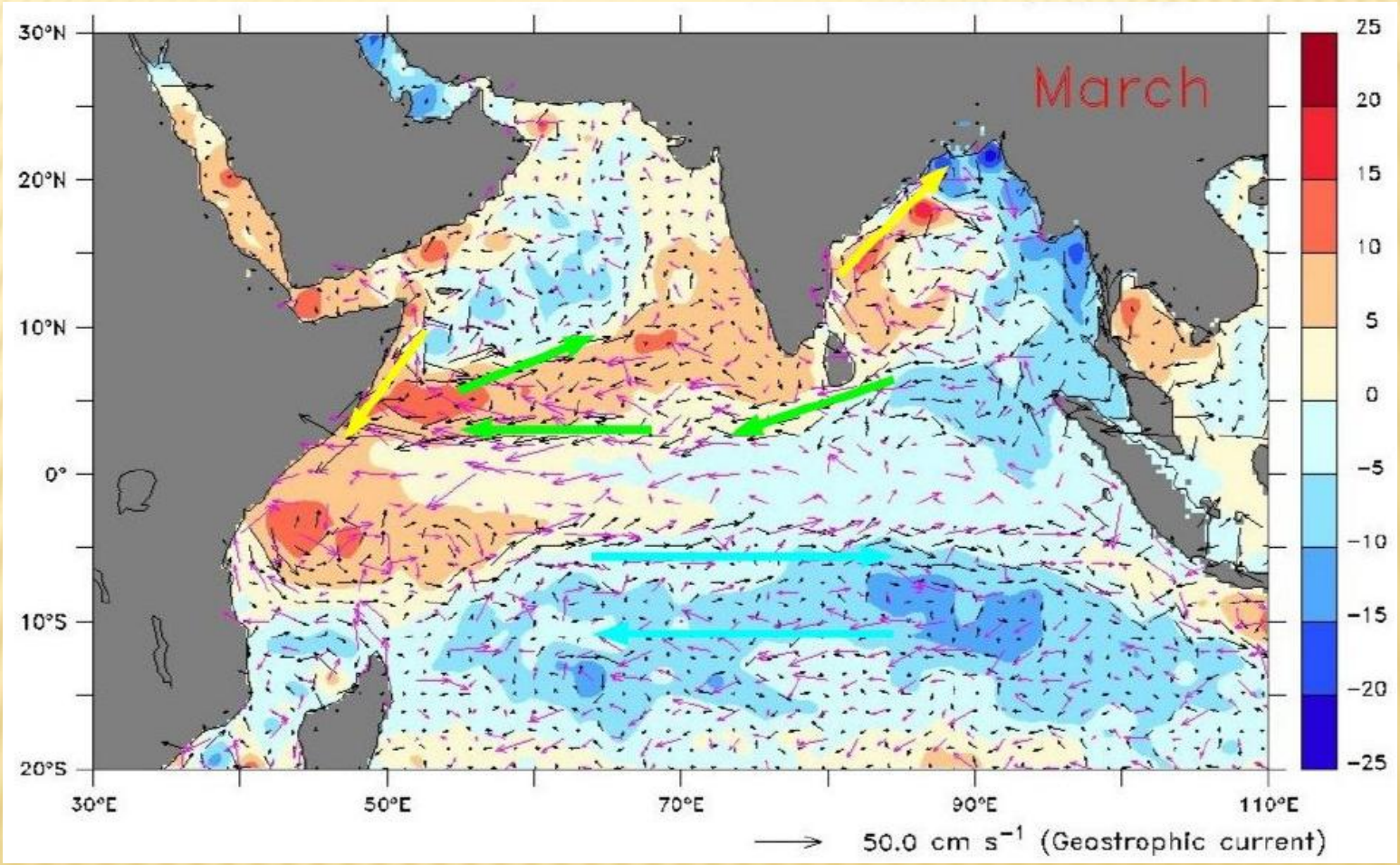
SEA LEVEL AND CURRENTS



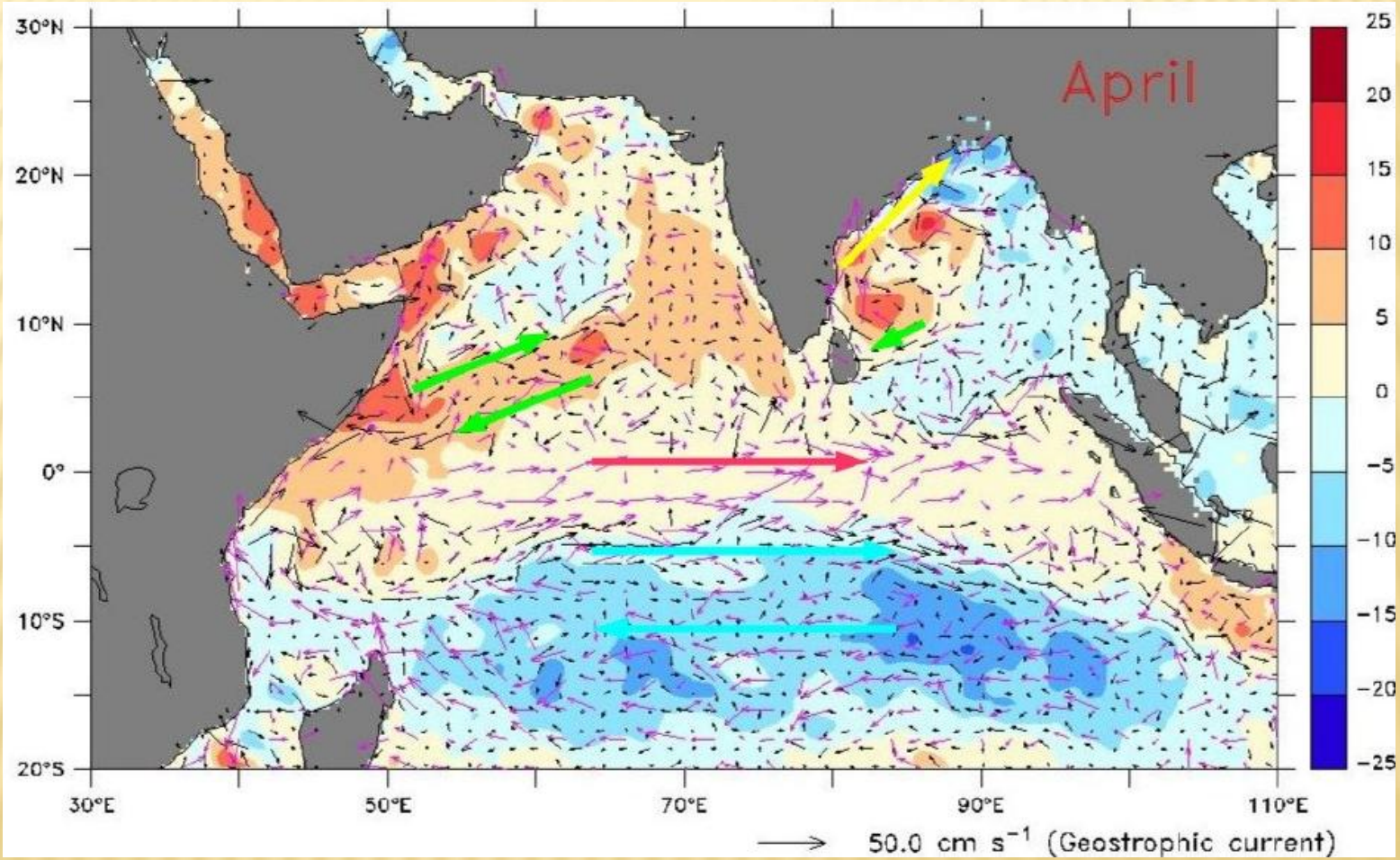
SEA LEVEL AND CURRENTS



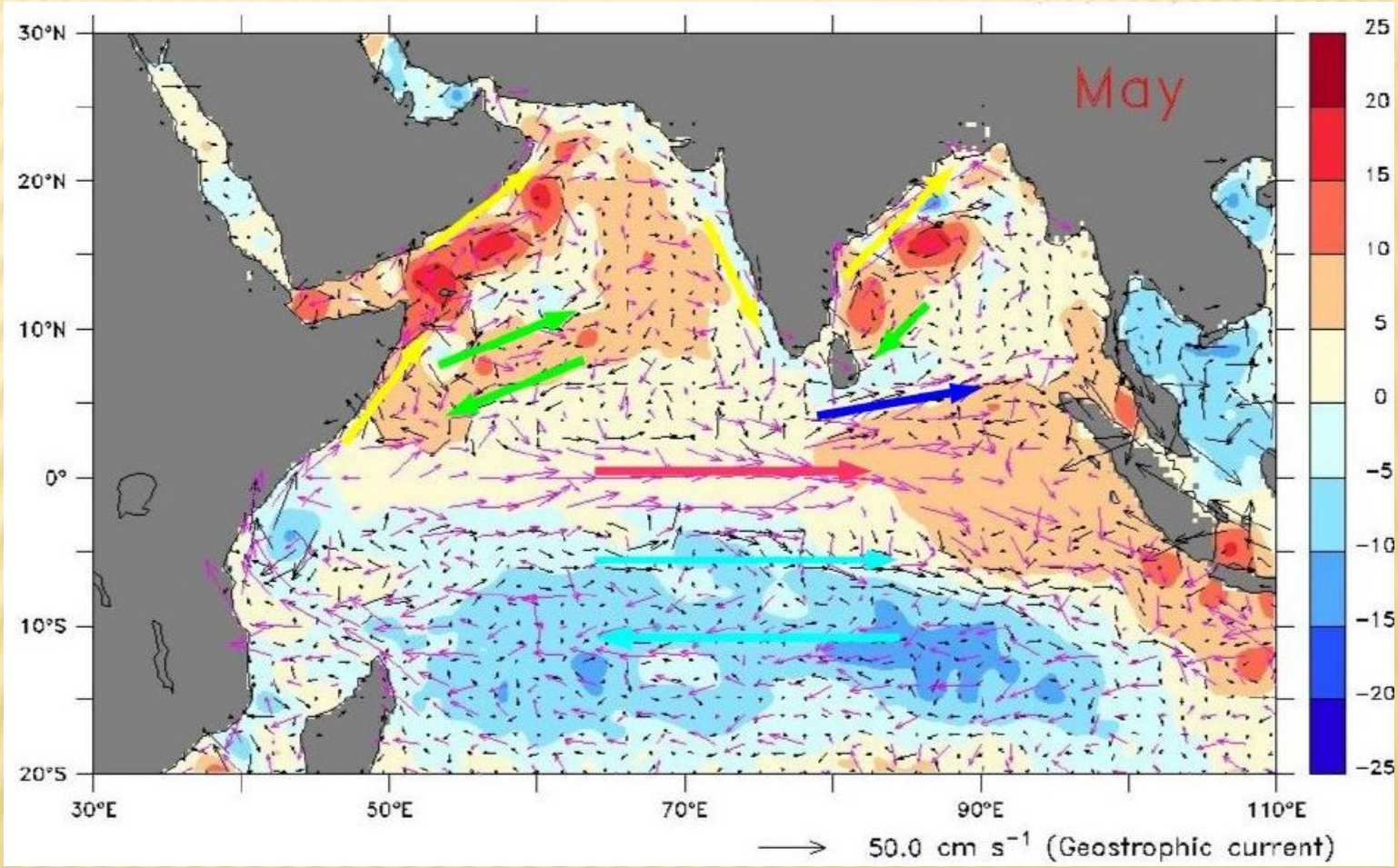
SEA LEVEL AND CURRENTS



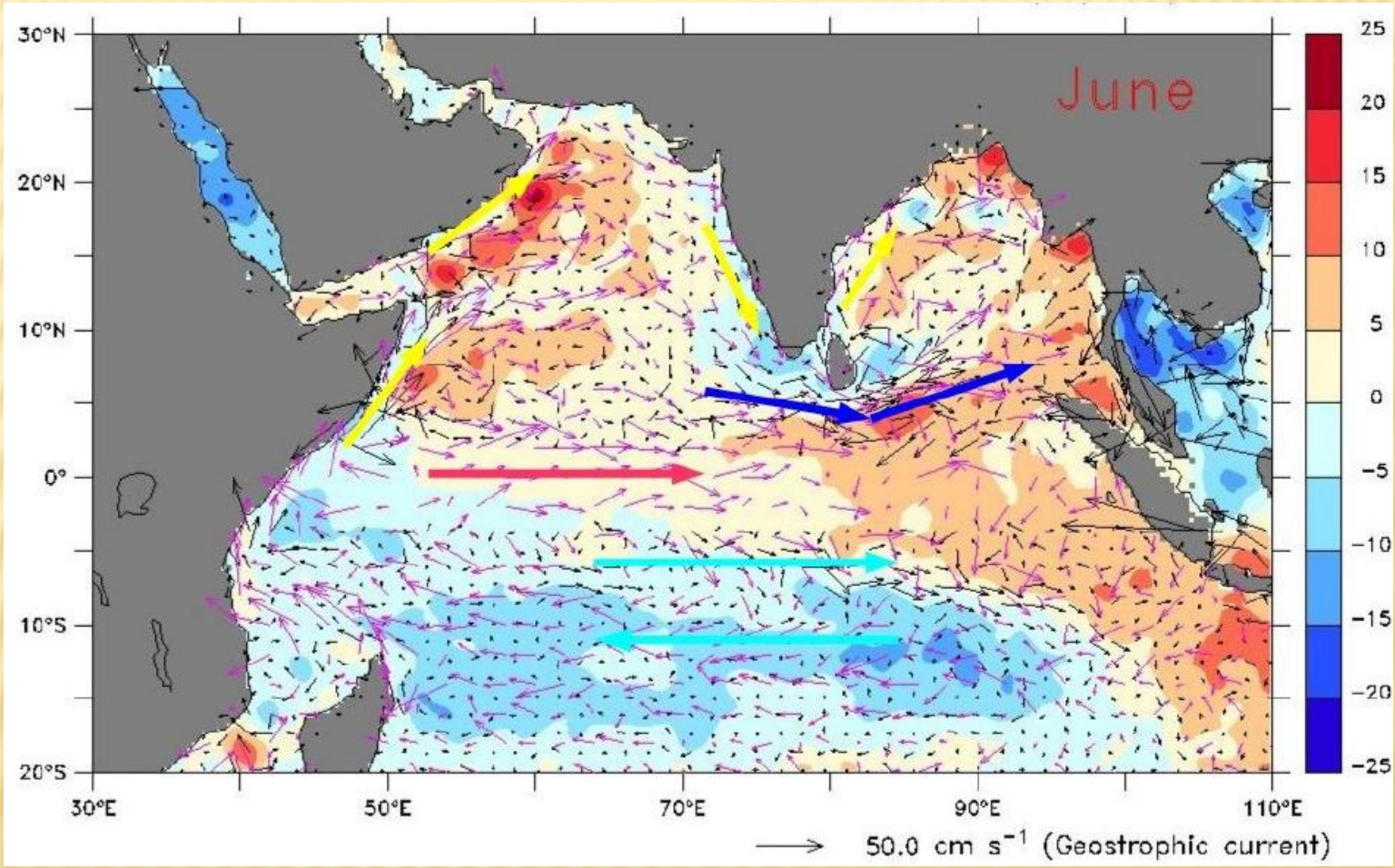
SEA LEVEL AND CURRENTS



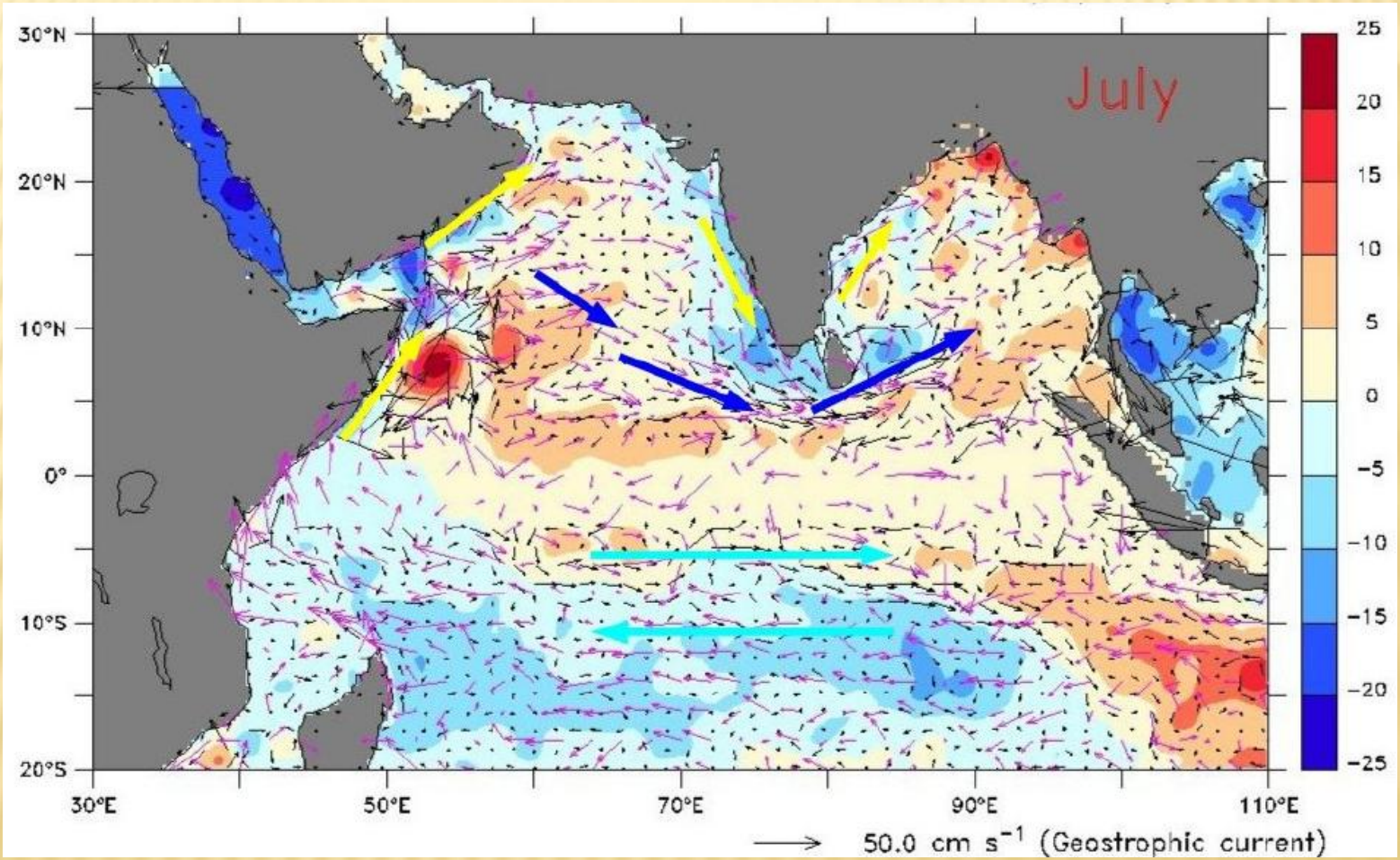
SEA LEVEL AND CURRENTS



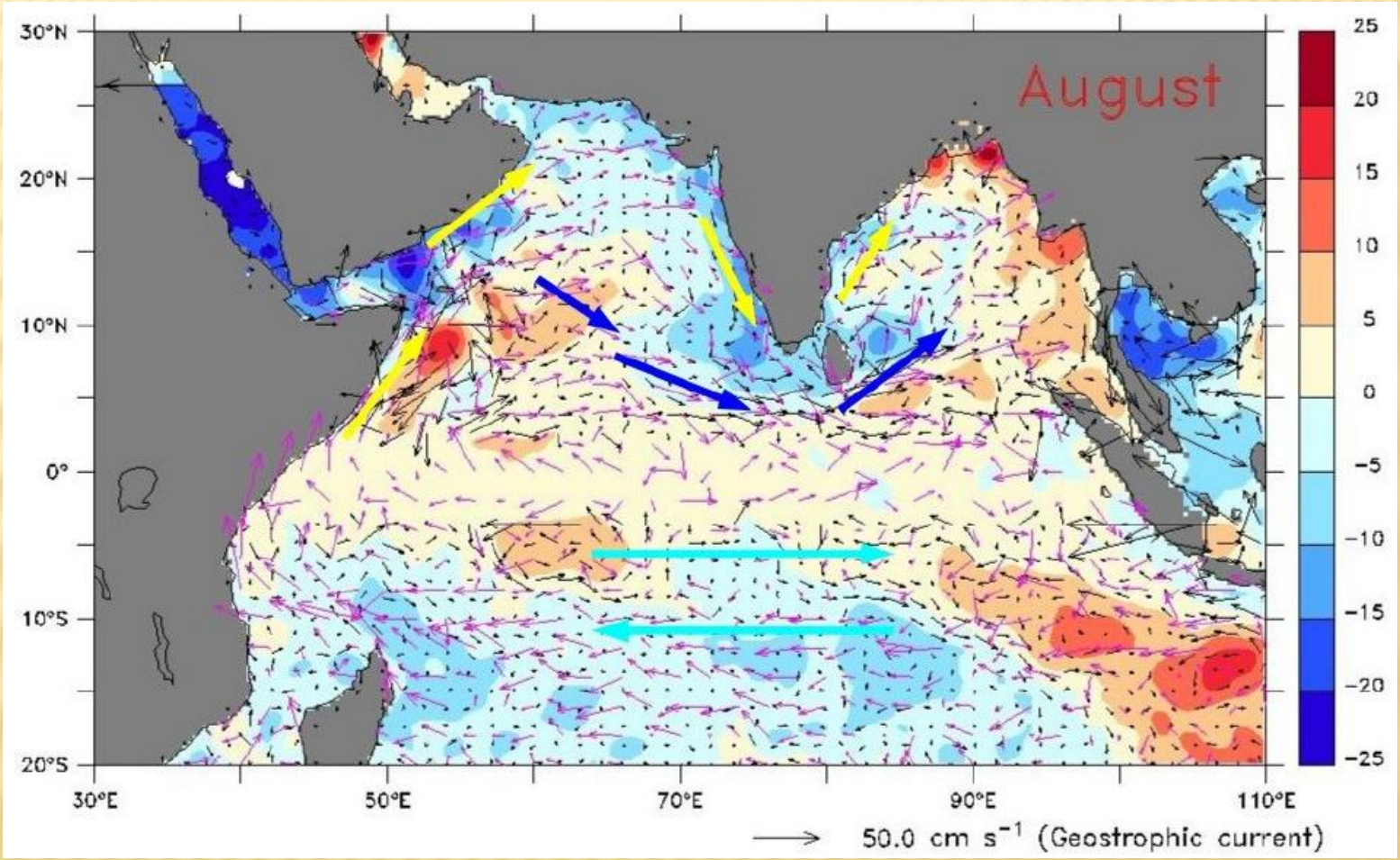
SEA LEVEL AND CURRENTS



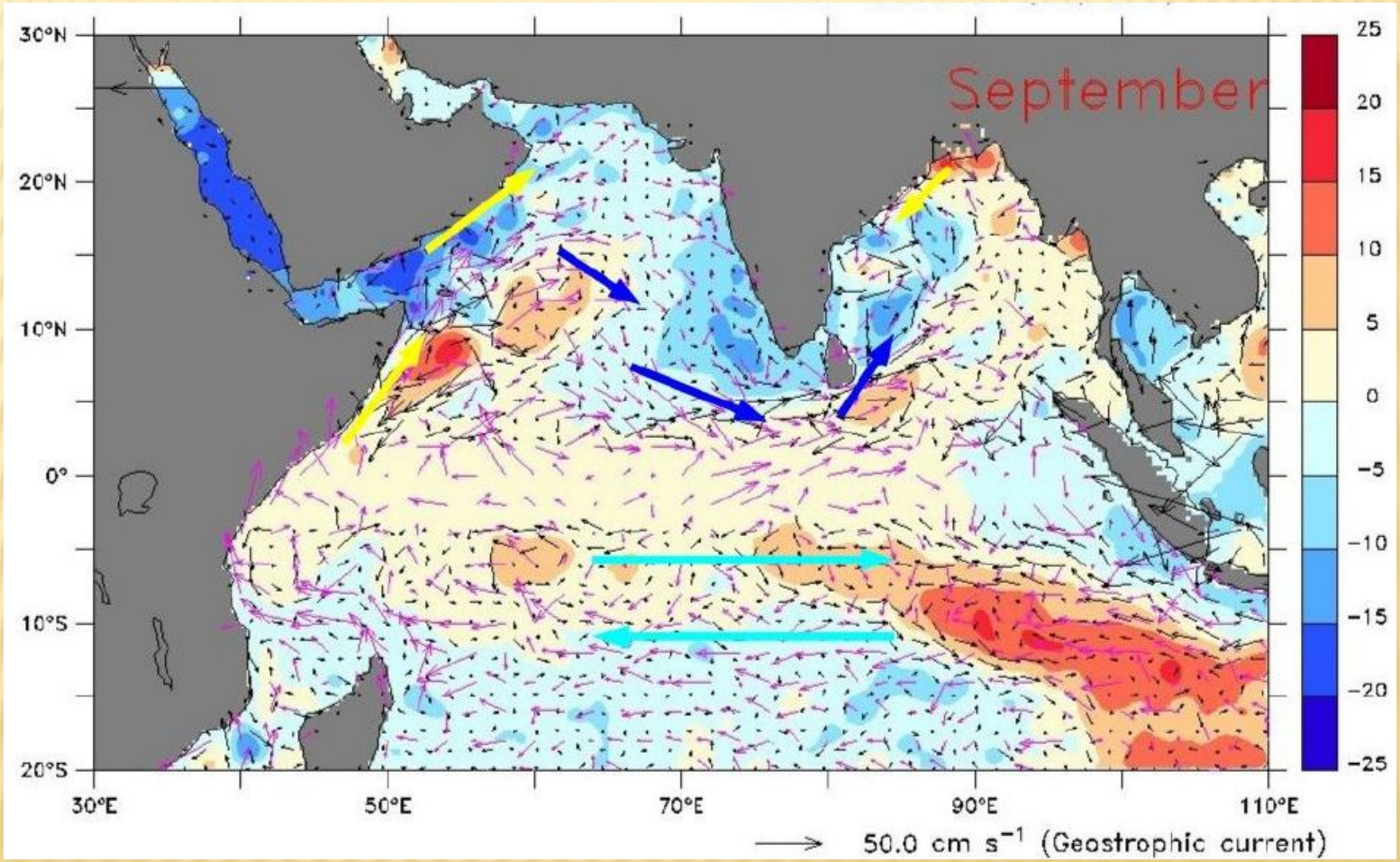
SEA LEVEL AND CURRENTS



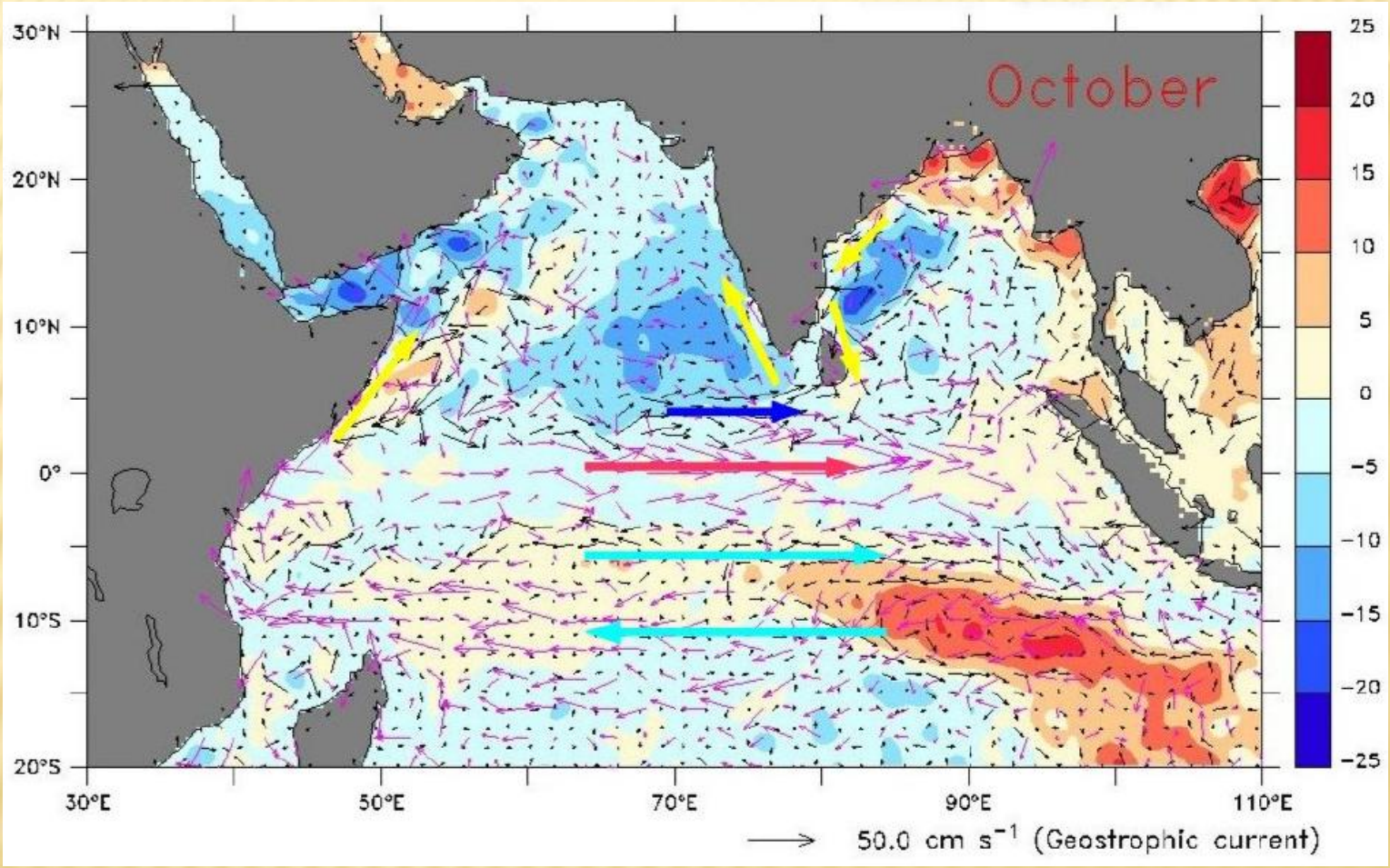
SEA LEVEL AND CURRENTS



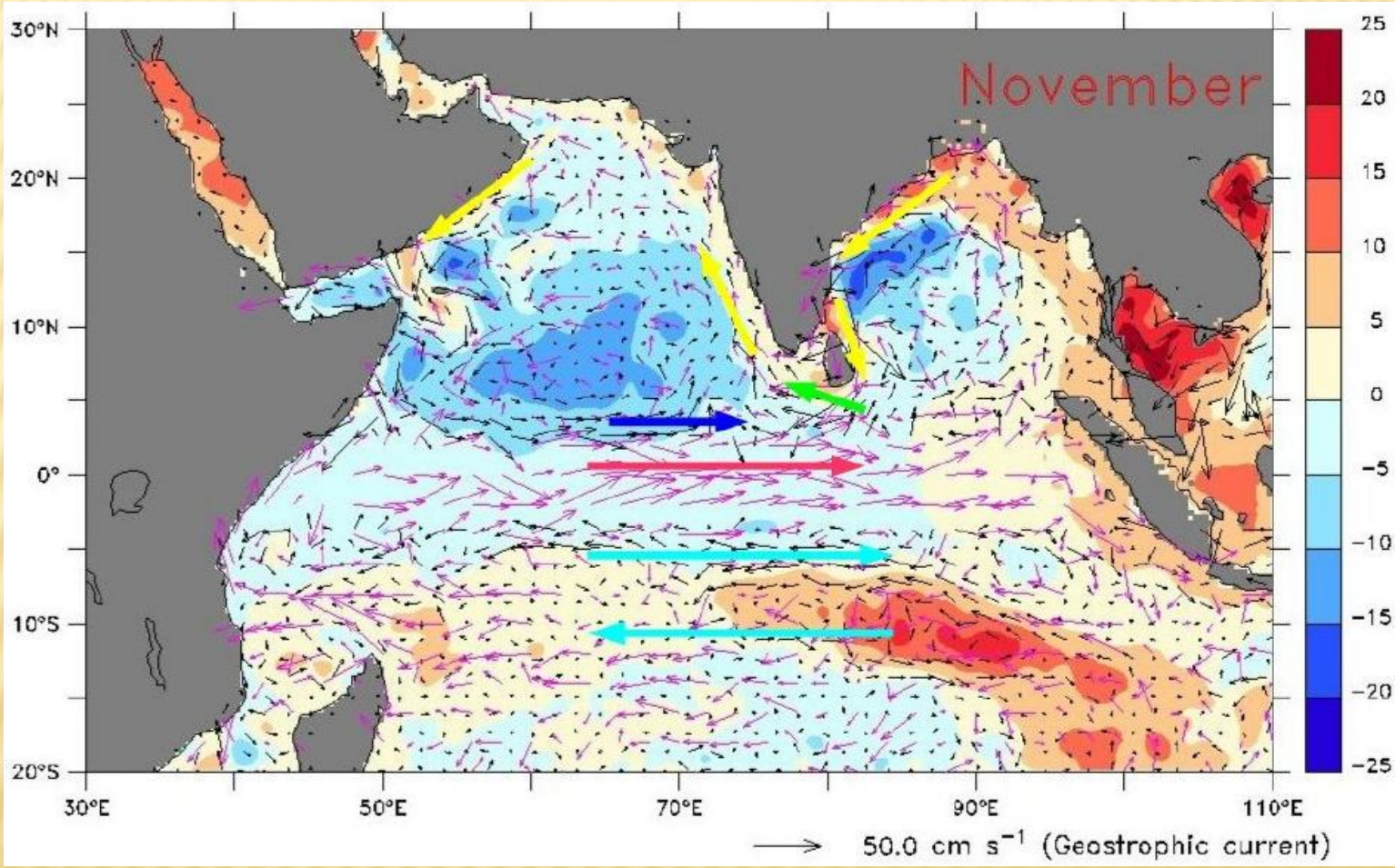
SEA LEVEL AND CURRENTS



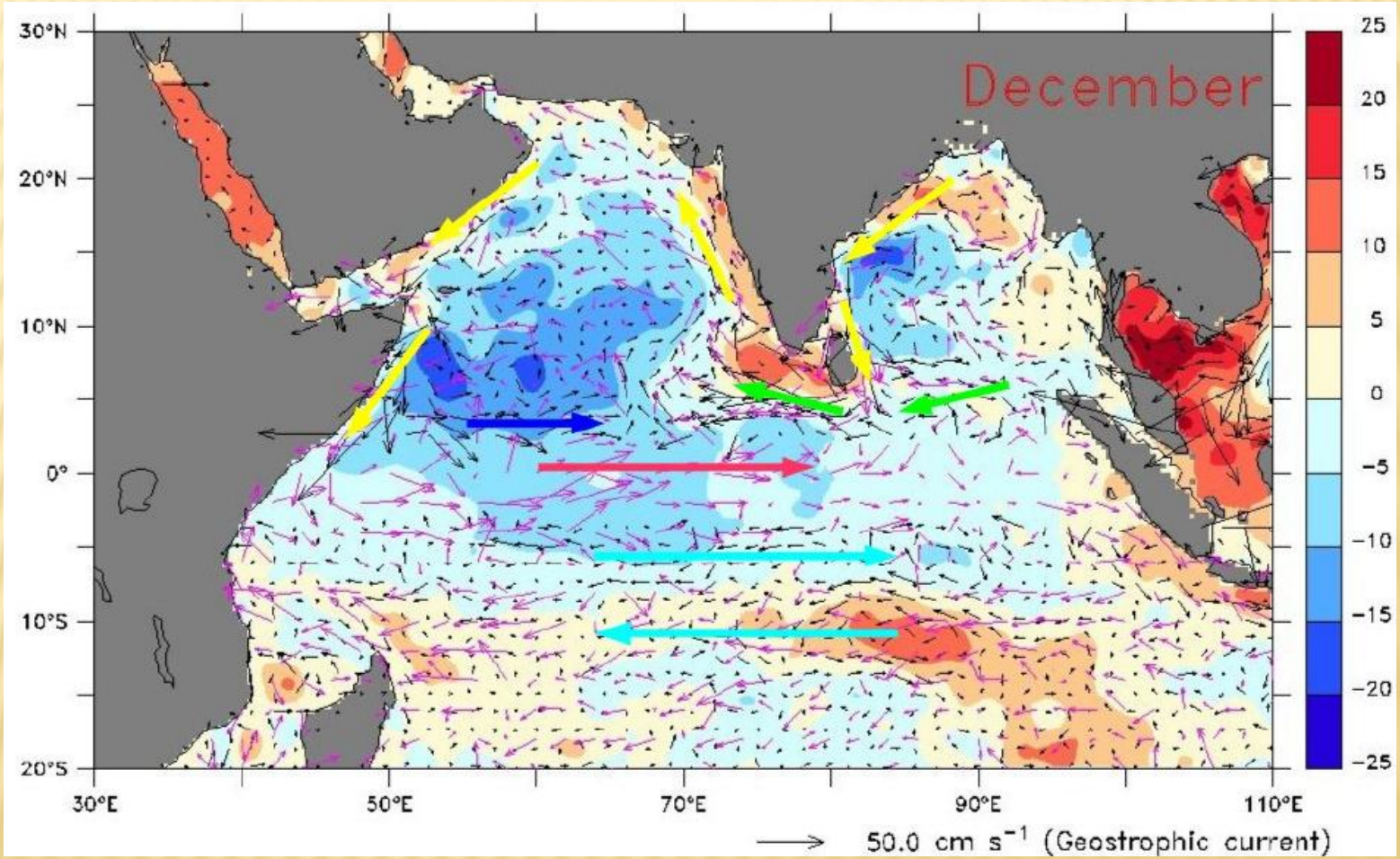
SEA LEVEL AND CURRENTS



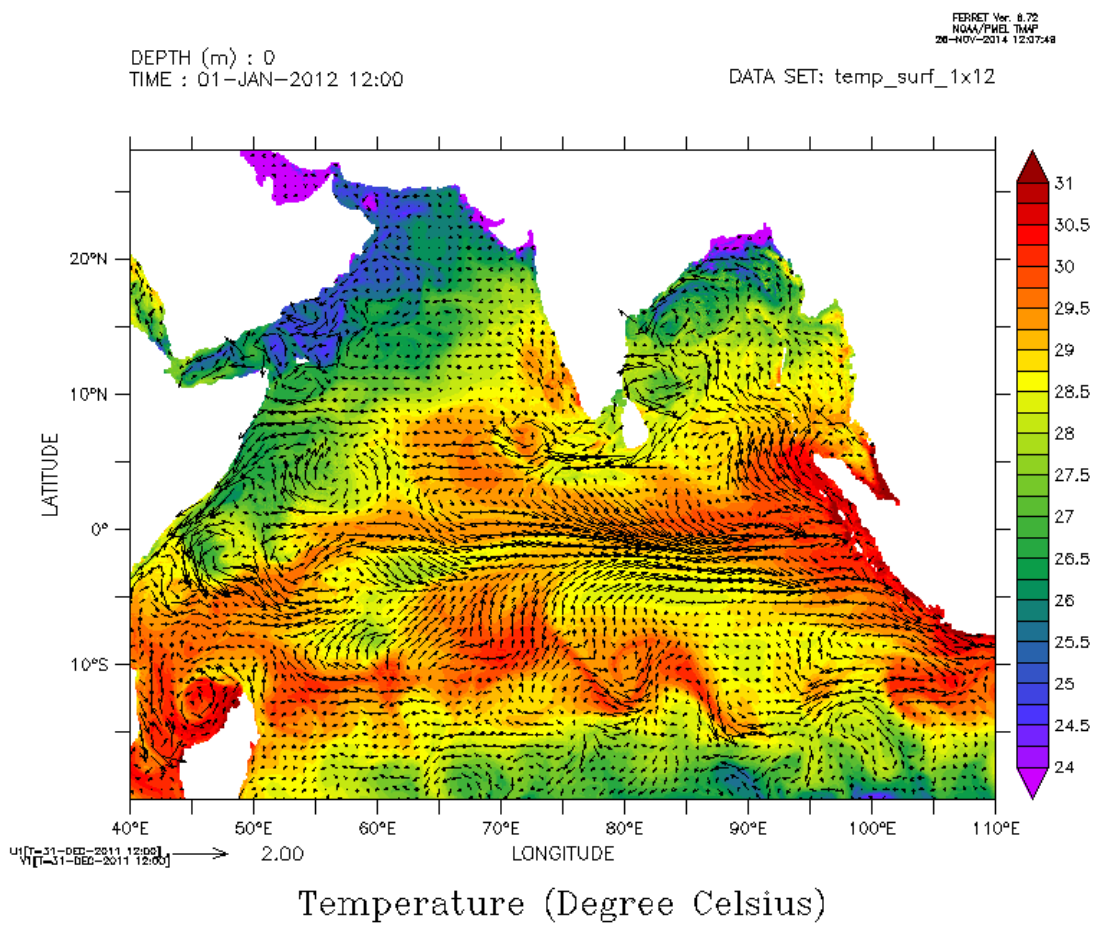
SEA LEVEL AND CURRENTS



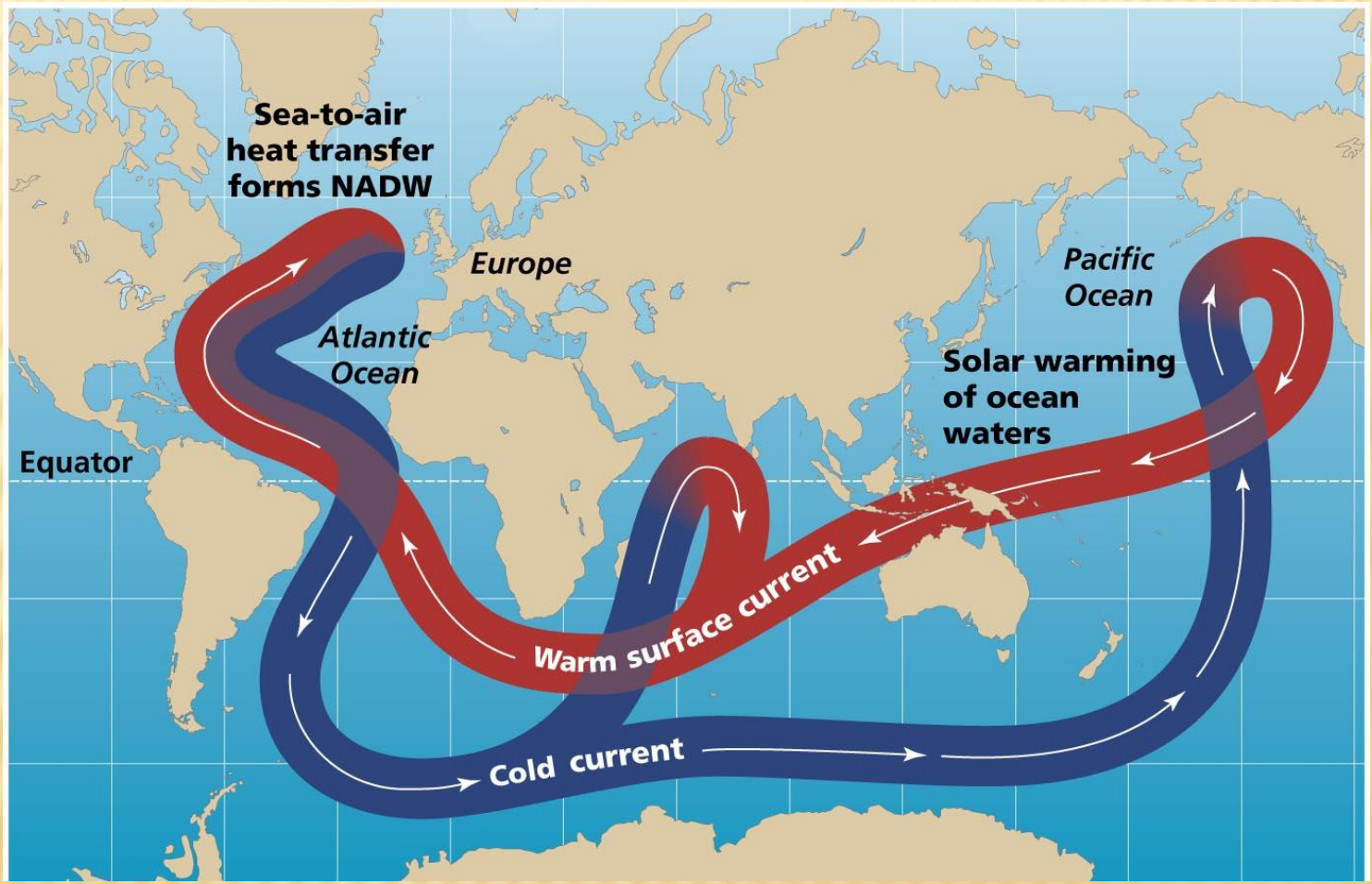
SEA LEVEL AND CURRENTS



SST AND CURRENTS

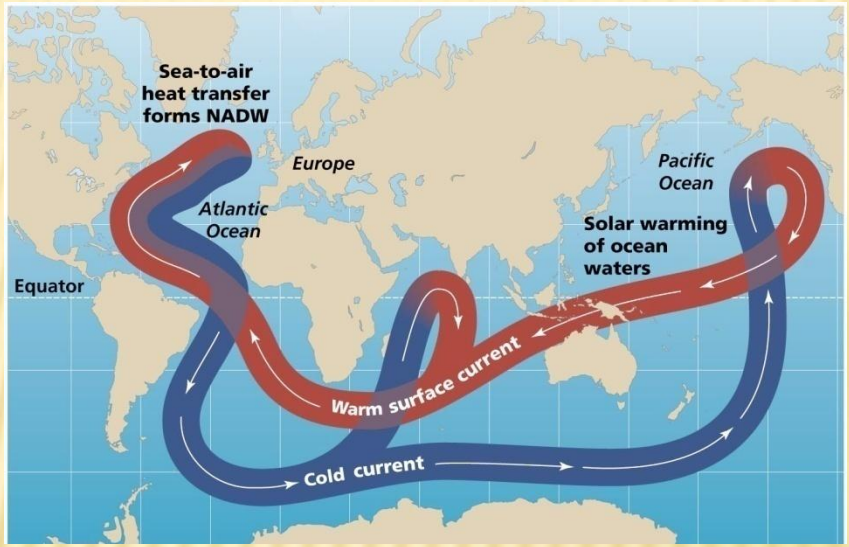


DENSITY DRIVEN CIRCULATION



OCEANS AND CLIMATE

If global warming causes enough of Greenland's ice sheet to melt, freshwater runoff into the north Atlantic could shut down current and abruptly change the climate of Europe and eastern North America.



Such "abrupt climate change" would not be as rapid and dramatic as in the fictional Hollywood movie *"The Day After Tomorrow,"* but would have major consequences nonetheless.

THANK YOU