Spatial and Temporal Variability in Sea Level

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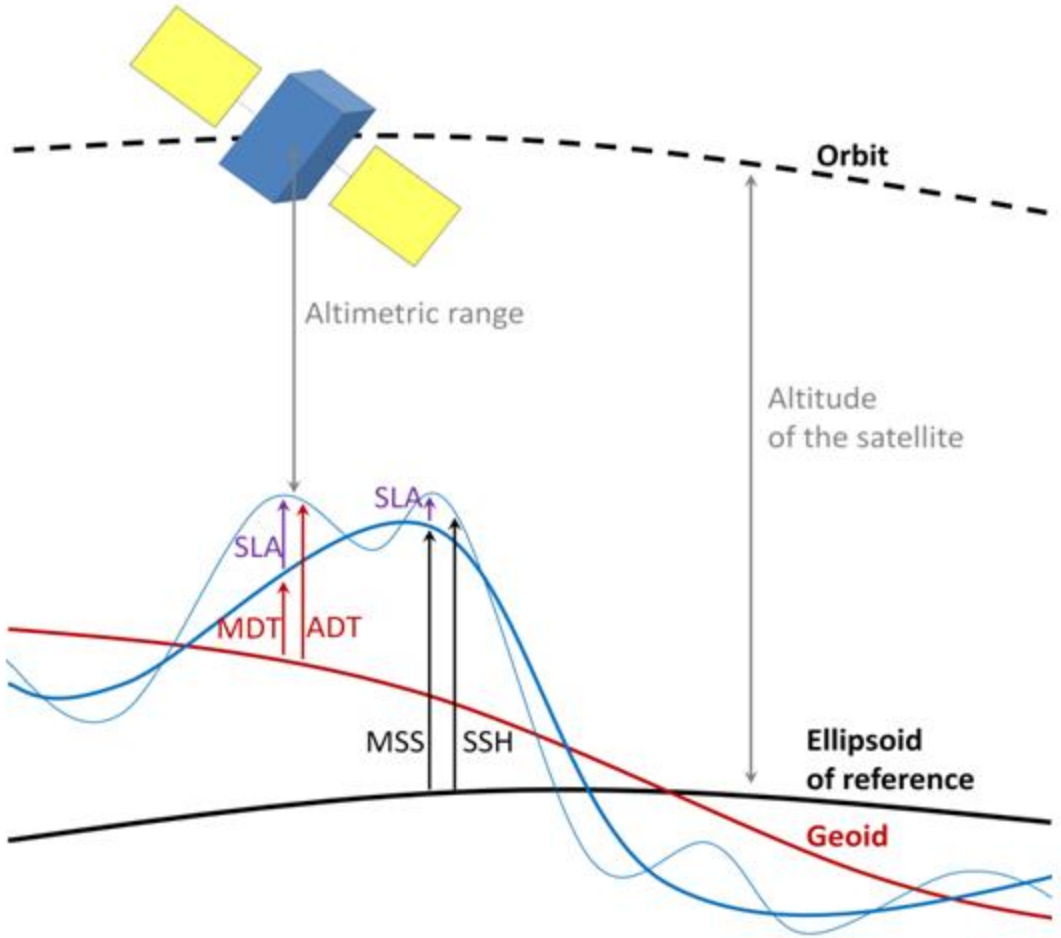
INCOIS

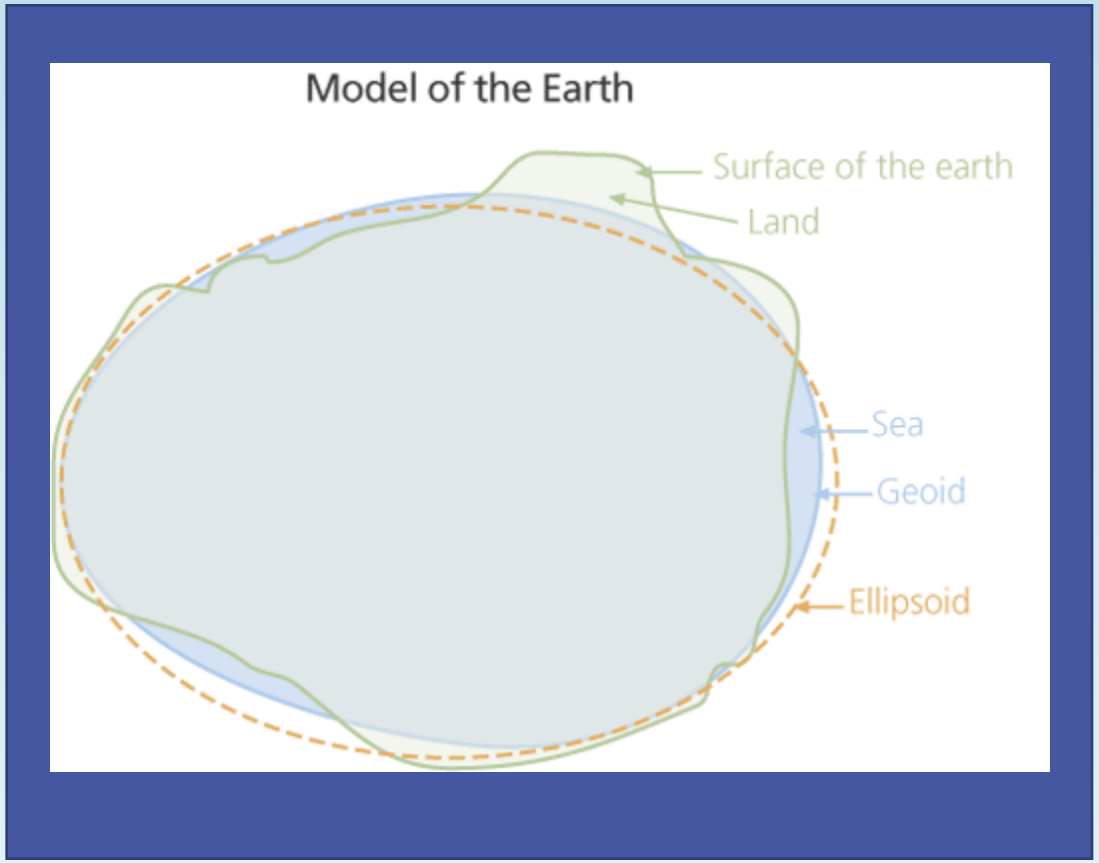
ITCOO Course on "**Understanding Sea Level: data analysis and applications**" during October 12-14, 2020

What is Sea Level?



SSH: Sea Surface Height
SLA: Sea Level anomaly
MDT: Mean Dynamic Topography
MSS: Mean Sea Surface

Sea surface height is the height from the reference ellipsoid to the instantaneous sea surface.



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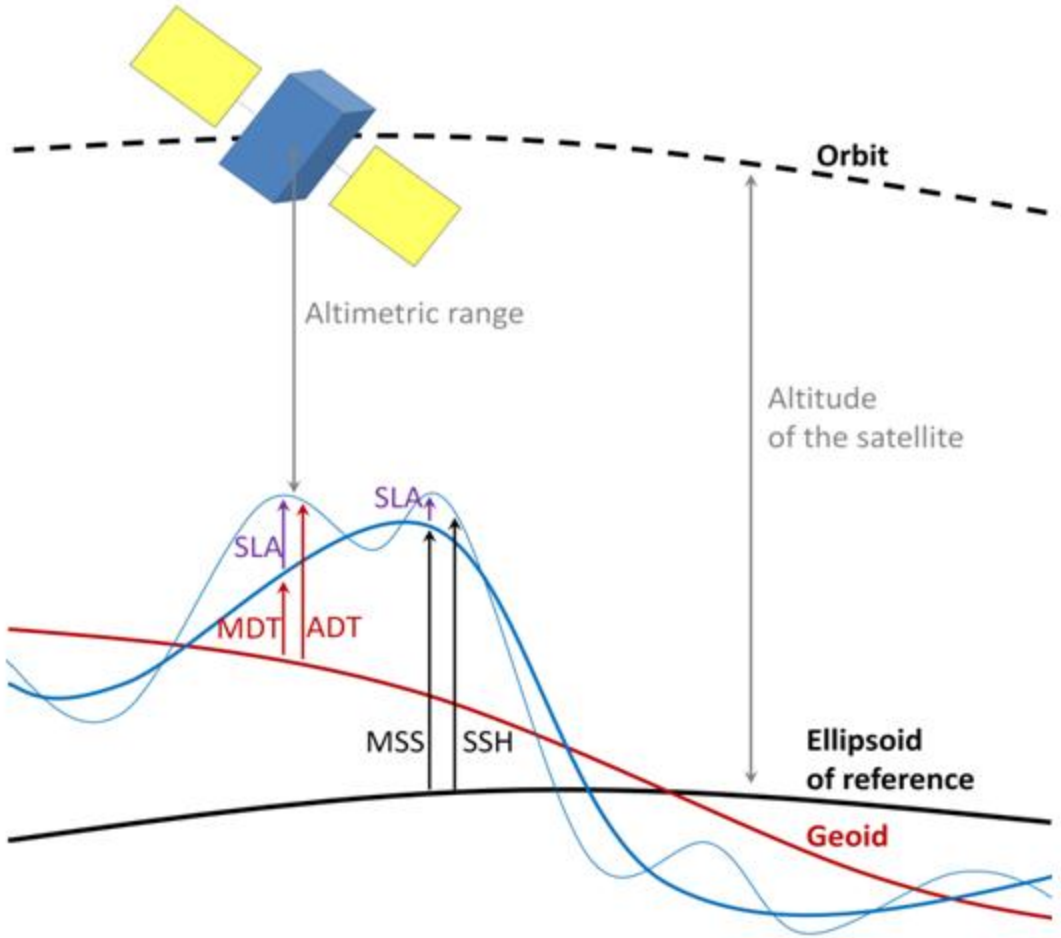

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Sea Level Anomaly (SLA) can be derived from mean Sea Surface (MSS) Height i.e.

SLA = SSH – MSS

Absolute Dynamic Topography (ADT) is the height of the instantaneous Sea Surface from the Geoid

What is Geoid?

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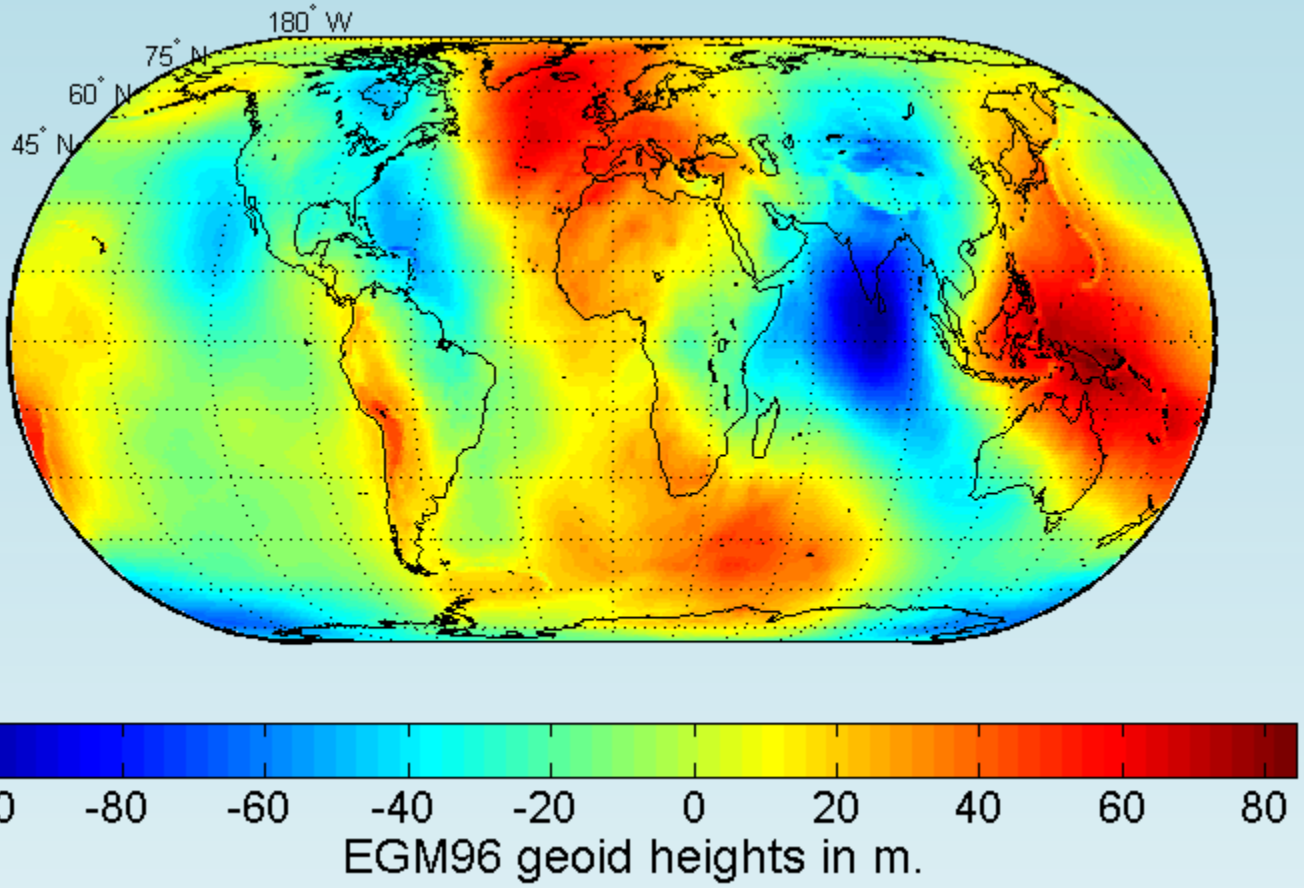


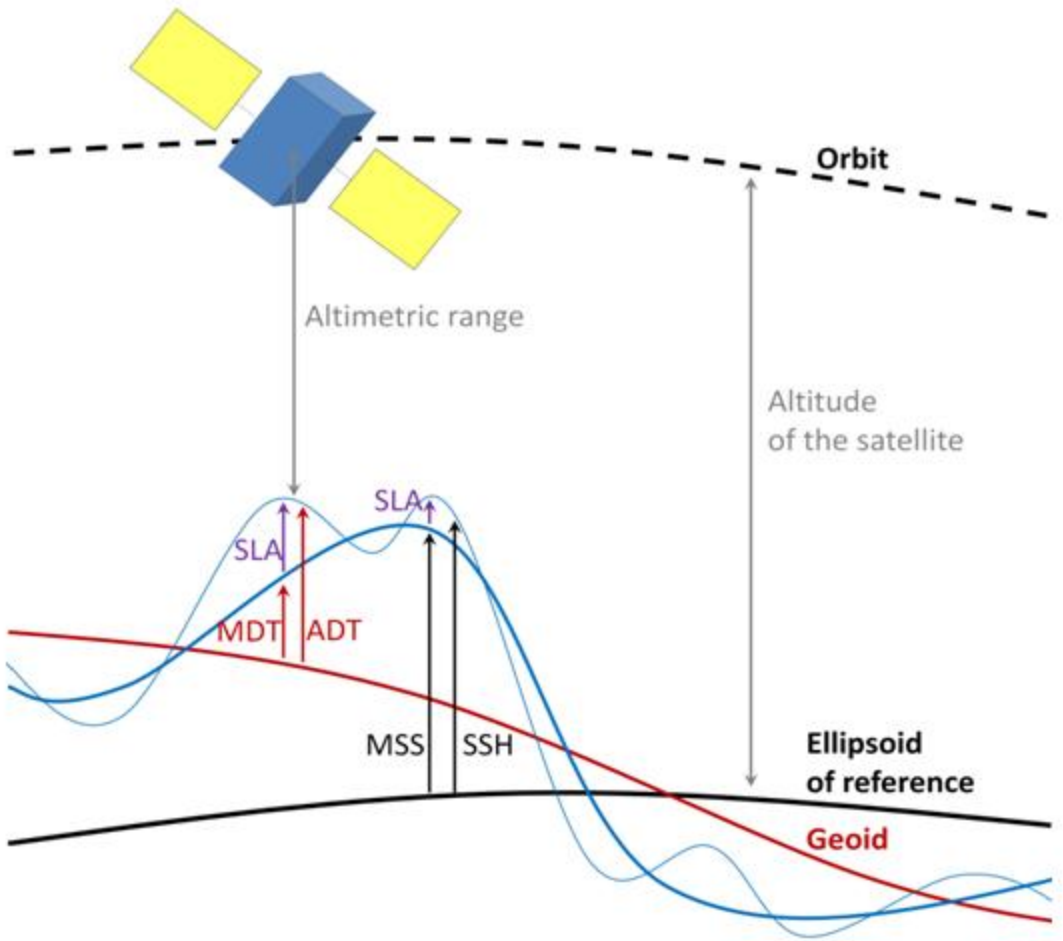
Geoid is the shape that the ocean surface would take under the influence of the gravity and the rotation of the earth alone.

All points on a geoid surface have the same effective potential (the sum of the gravitational potential energy and the centrifugal potential energy).

The force of gravity acts everywhere perpendicular to the geoid, meaning that plumb lines point perpendicular and water levels parallel to the geoid if only gravity and rotational acceleration were at work.

The surface of the geoid is higher than the reference ellipsoid wherever there is a positive gravity anomaly (mass excess) and lower than the reference ellipsoid wherever there is a negative gravity anomaly (mass deficit).

What is Sea Level?



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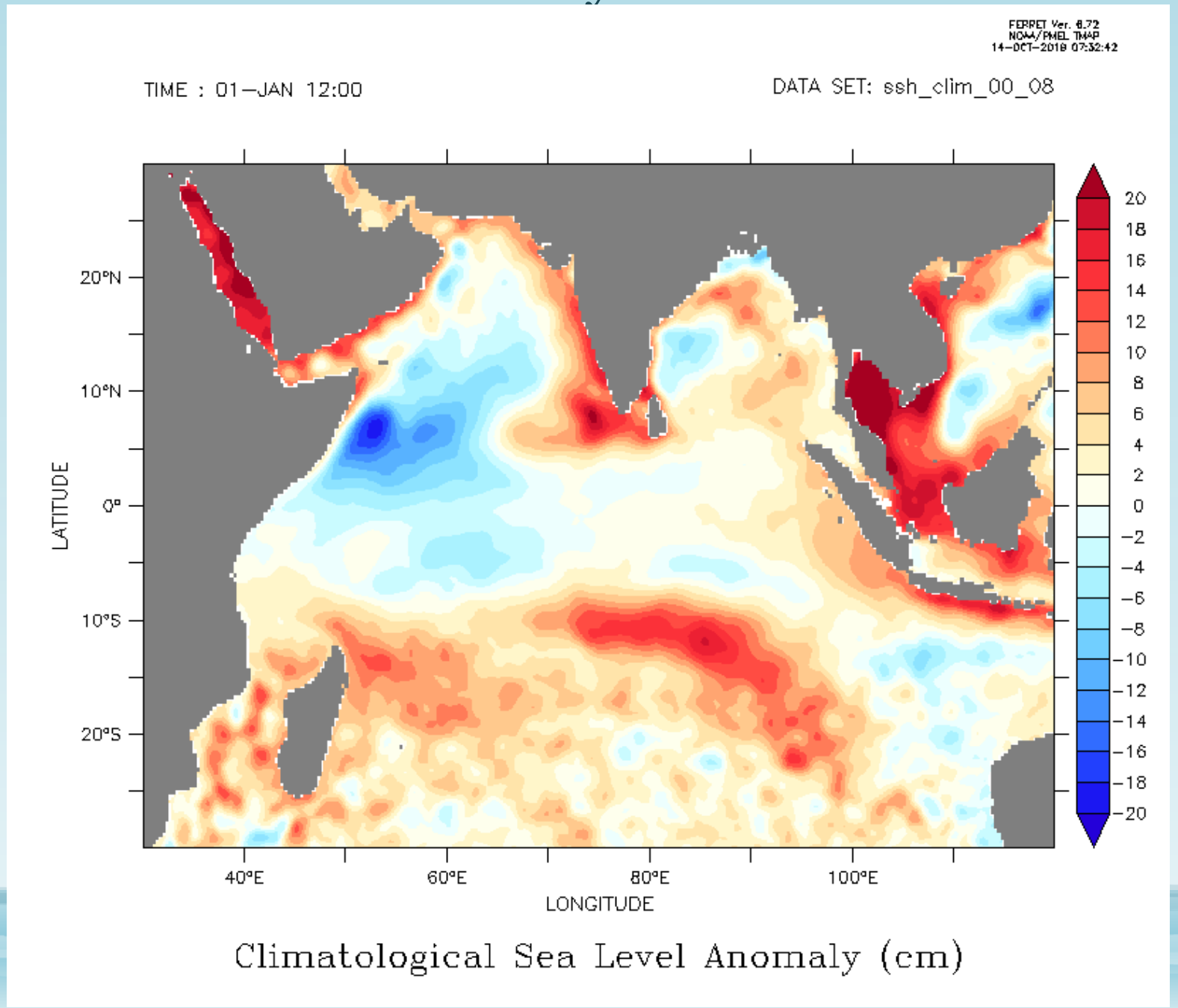
How Sea Level anomaly looks from a satellite?



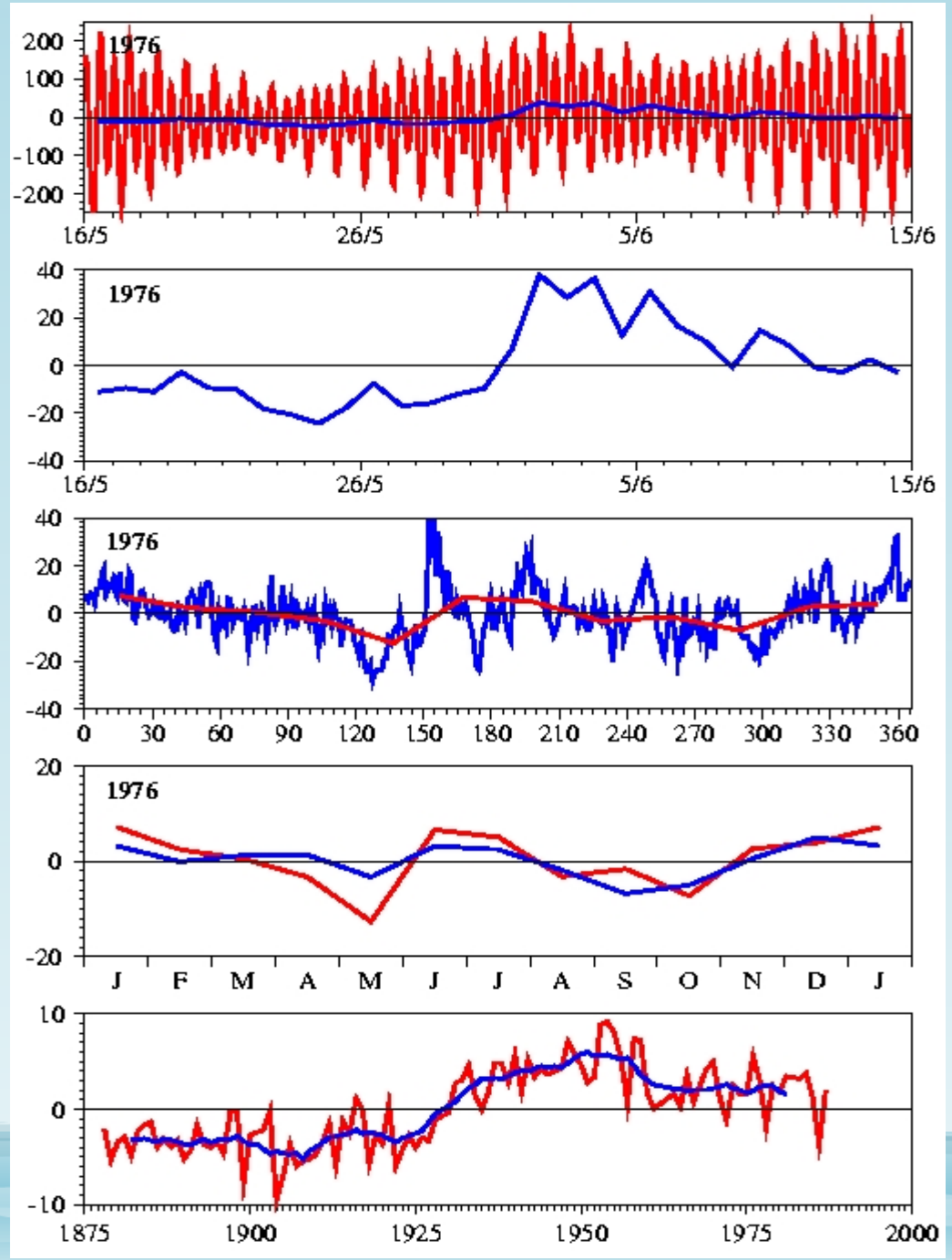
What about tide-gauge?

- Tides: Range ~ 4 m
- Storm surges: Range ~ 40 cm
- Intraseasonal variability:

  Range ~ 20–40 cm
- Seasonal variability:

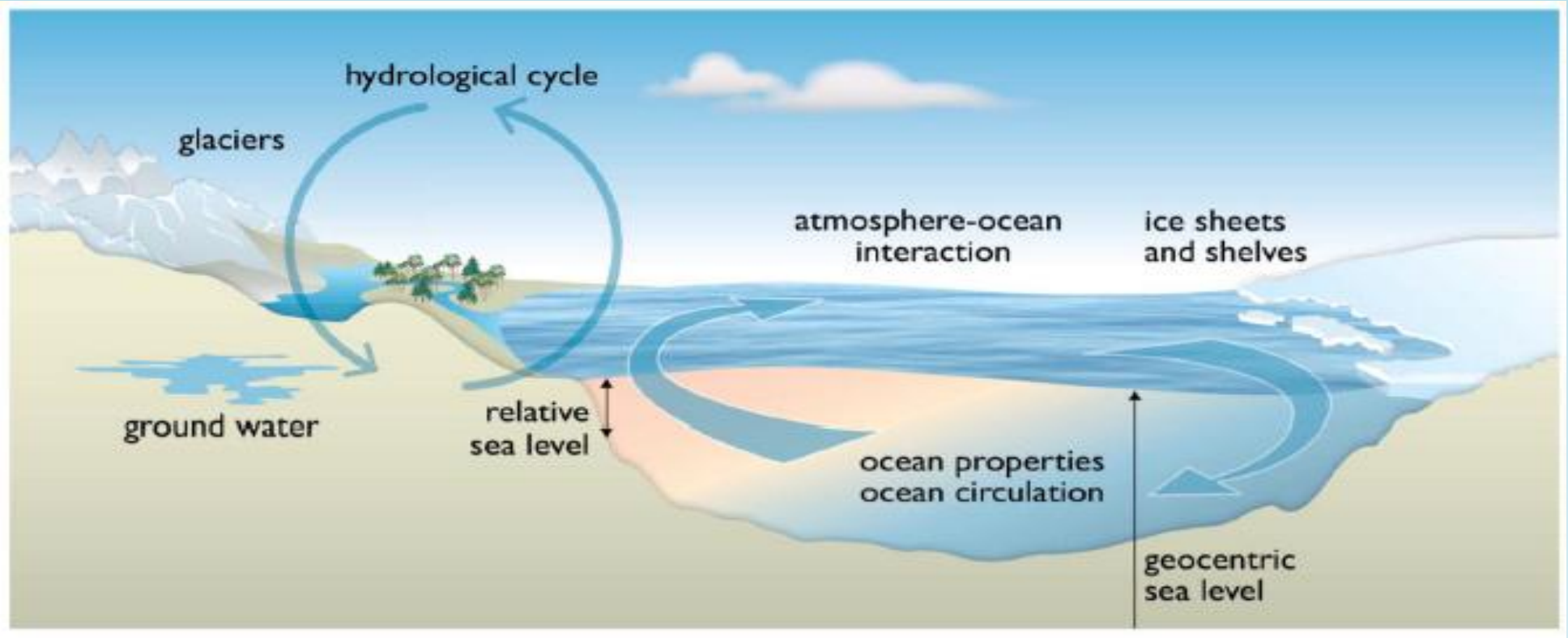
  Range ~ 20 cm
- Interannual and interdecadal variability:

  Range ~ 20 cm



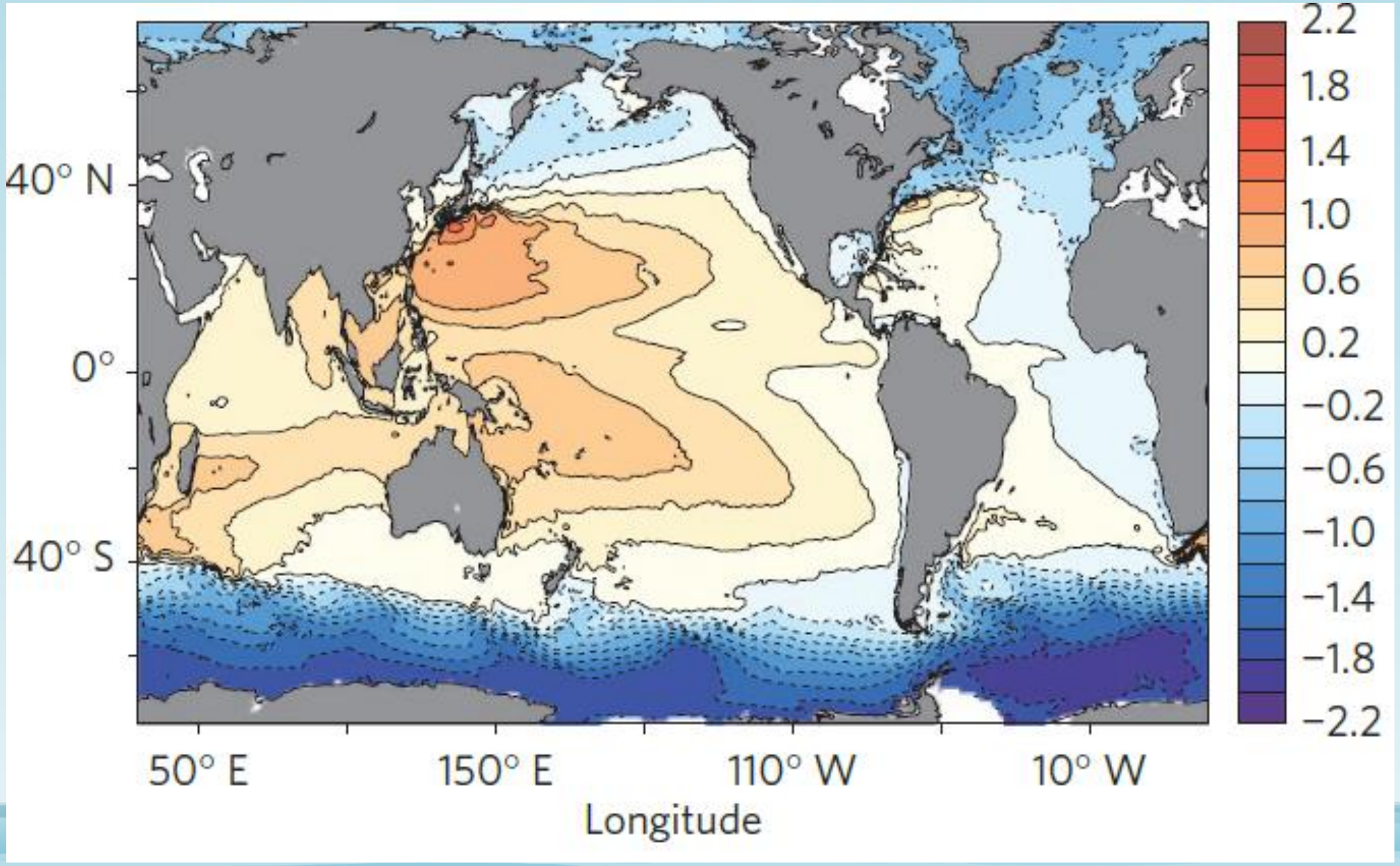
Observed Sea Level at Apollo Bandar, Mumbai

Causes of Sea Level Variability and Change

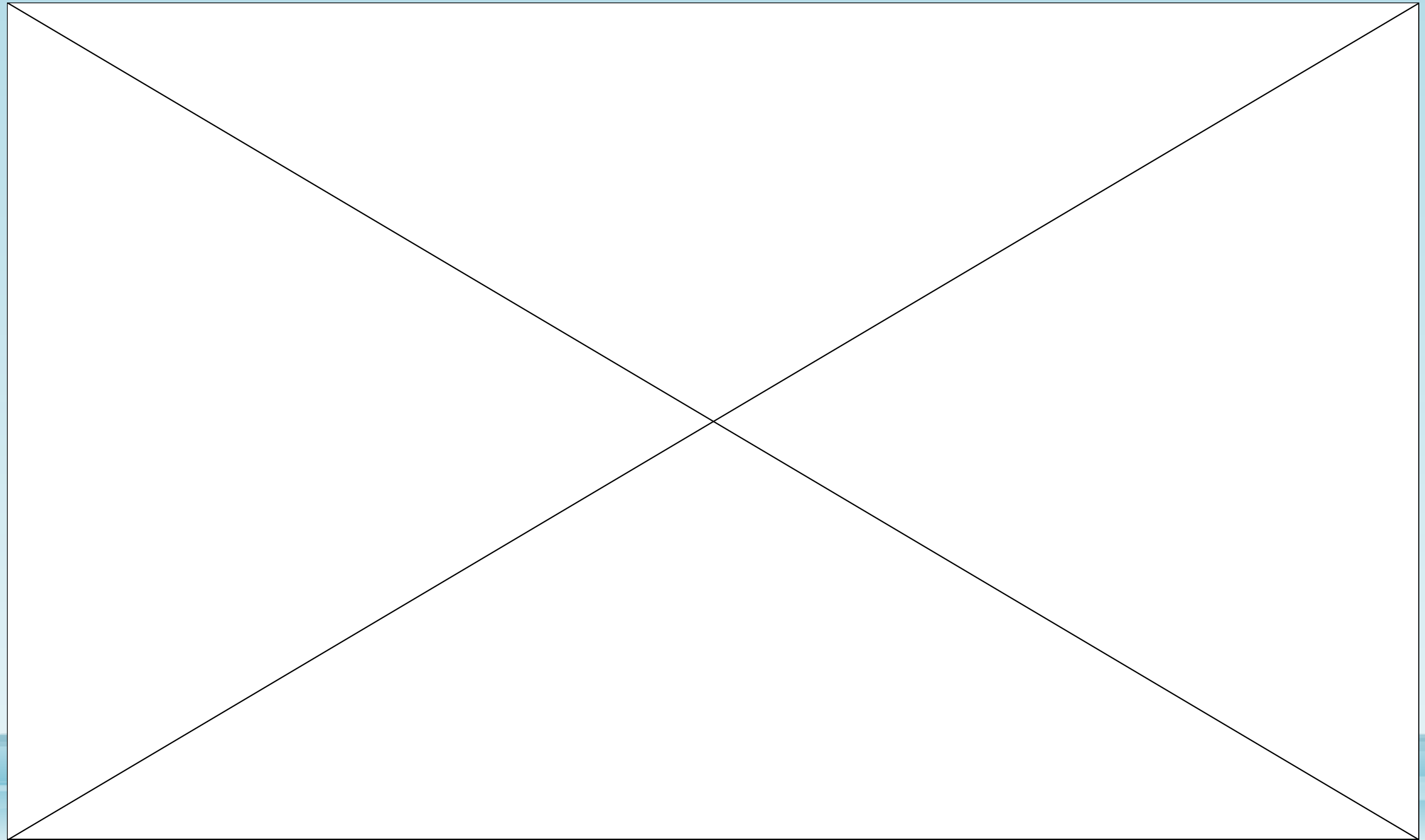


1. Thermostaric effect
2. Halosteric effect
3. Inverted barometer effect
4. Ocean currents, winds, etc.
5. Addition of mass
6. Vertical land movement
7. Land-Surface process
8. Ice-sheet rapid dynamics

Spatial Sea Level variability: Subtropical gyres



Spatial Sea Level variability: Subtropical gyres



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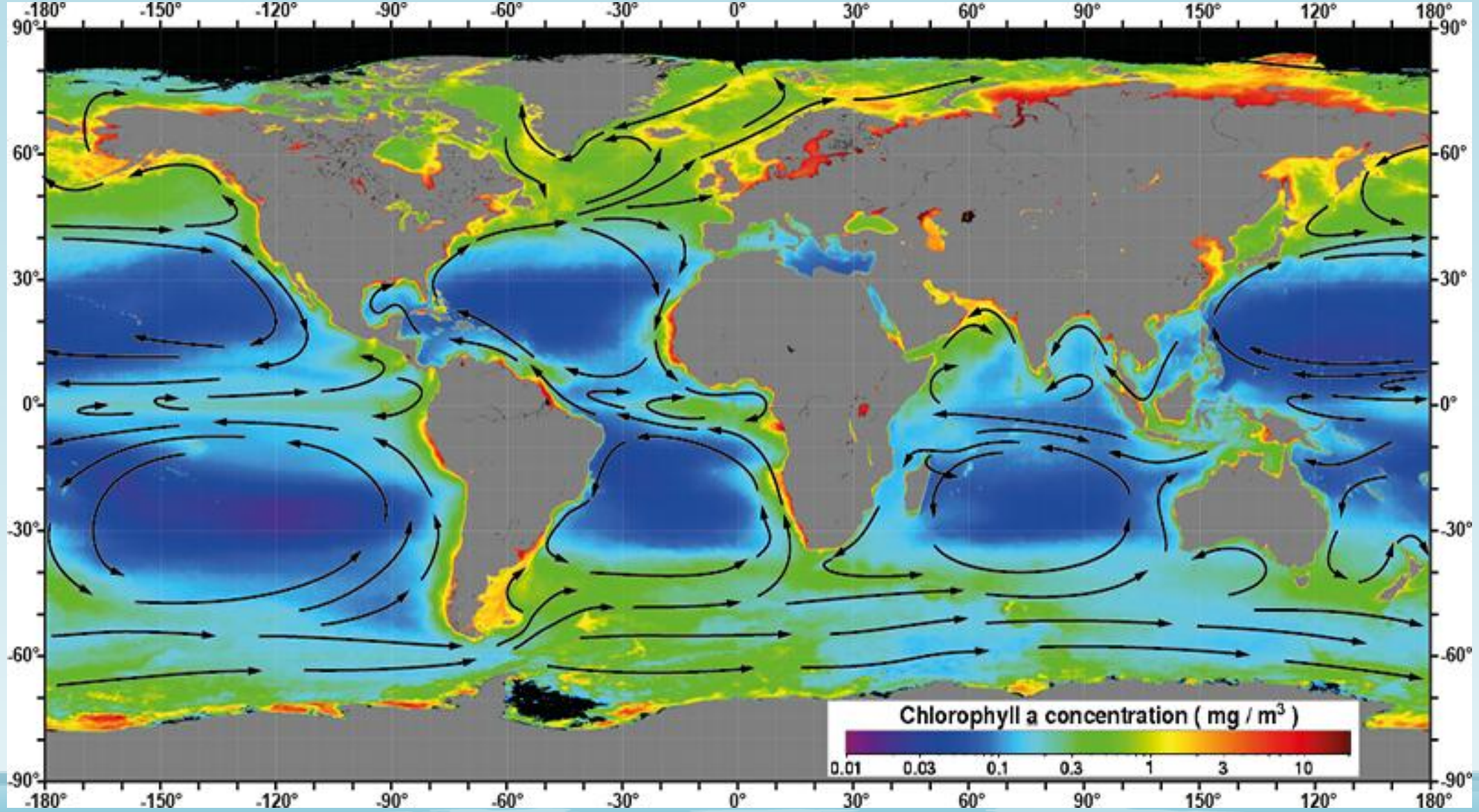
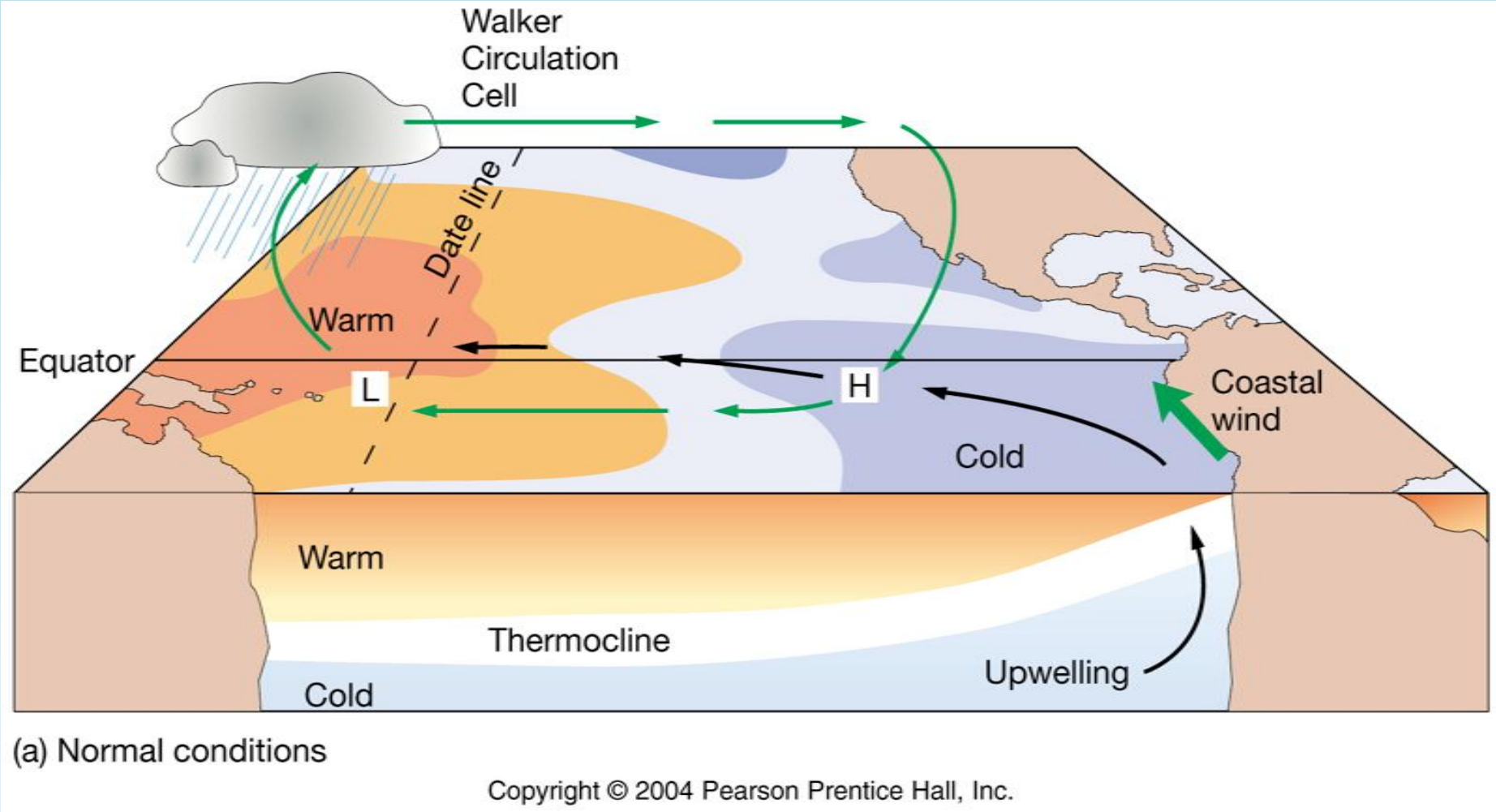
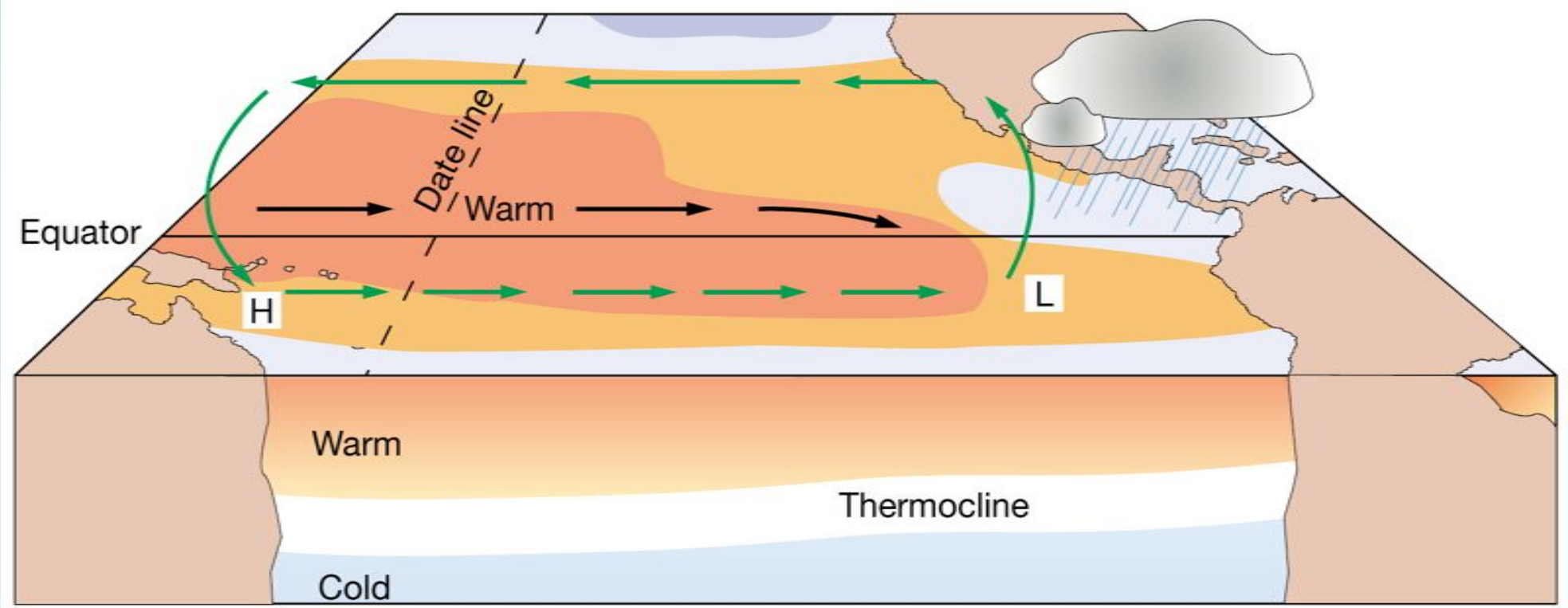


Climate Variability: El-Nino



Normal Conditions

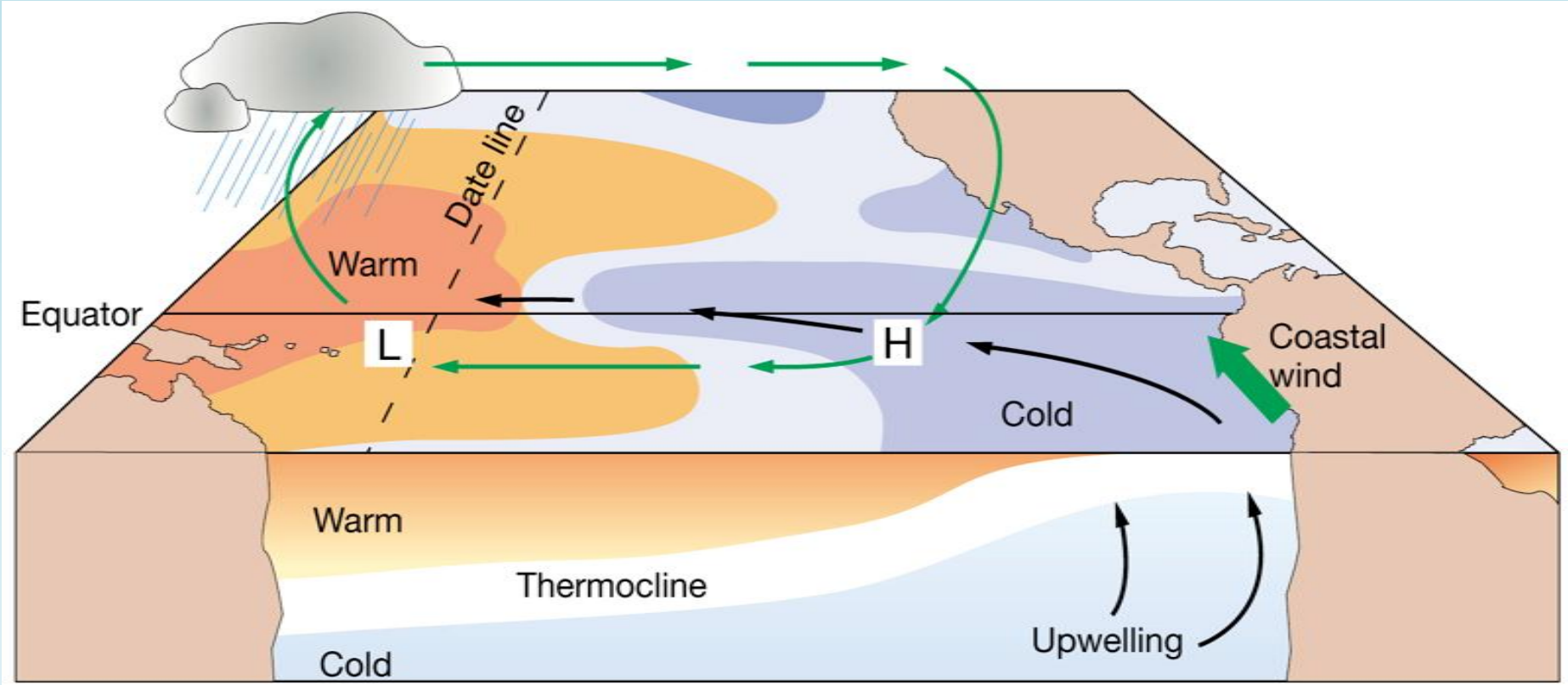
Climate Variability: El-Nino



(b) El Niño conditions

El-Nino

Climate Variability: El-Nino



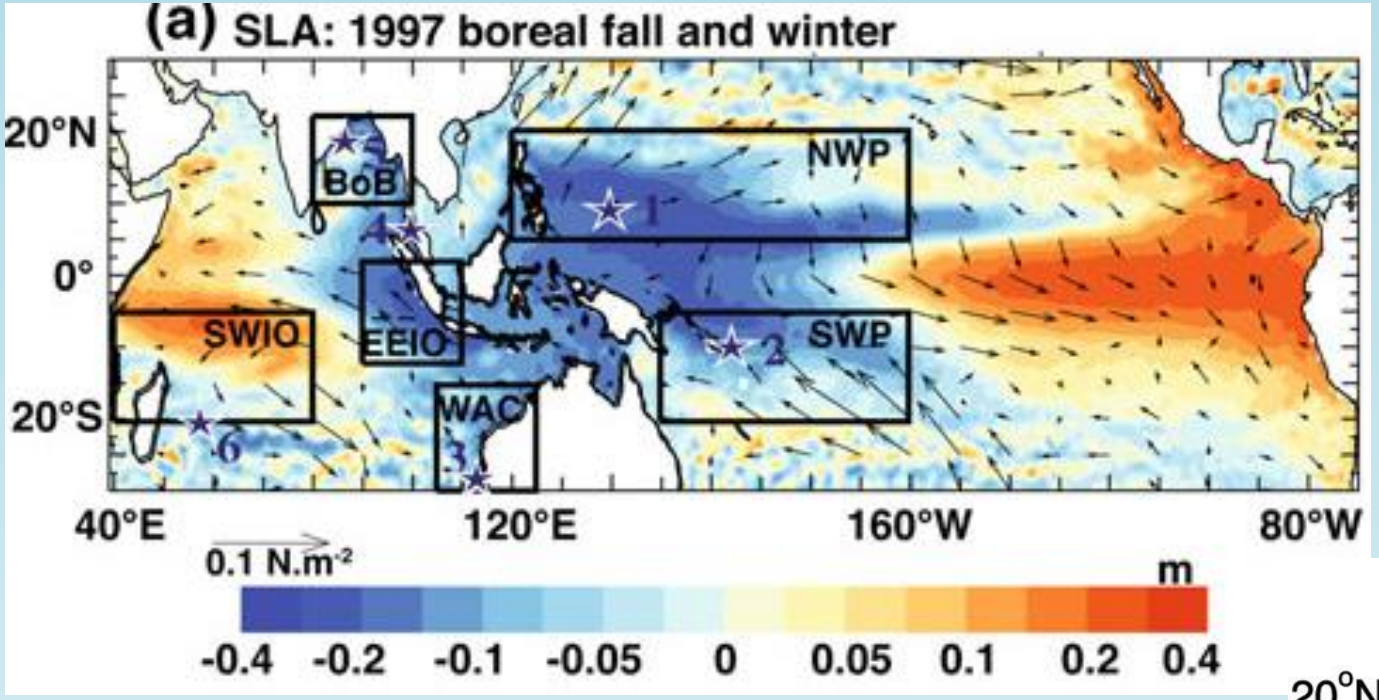
(c) La Niña conditions

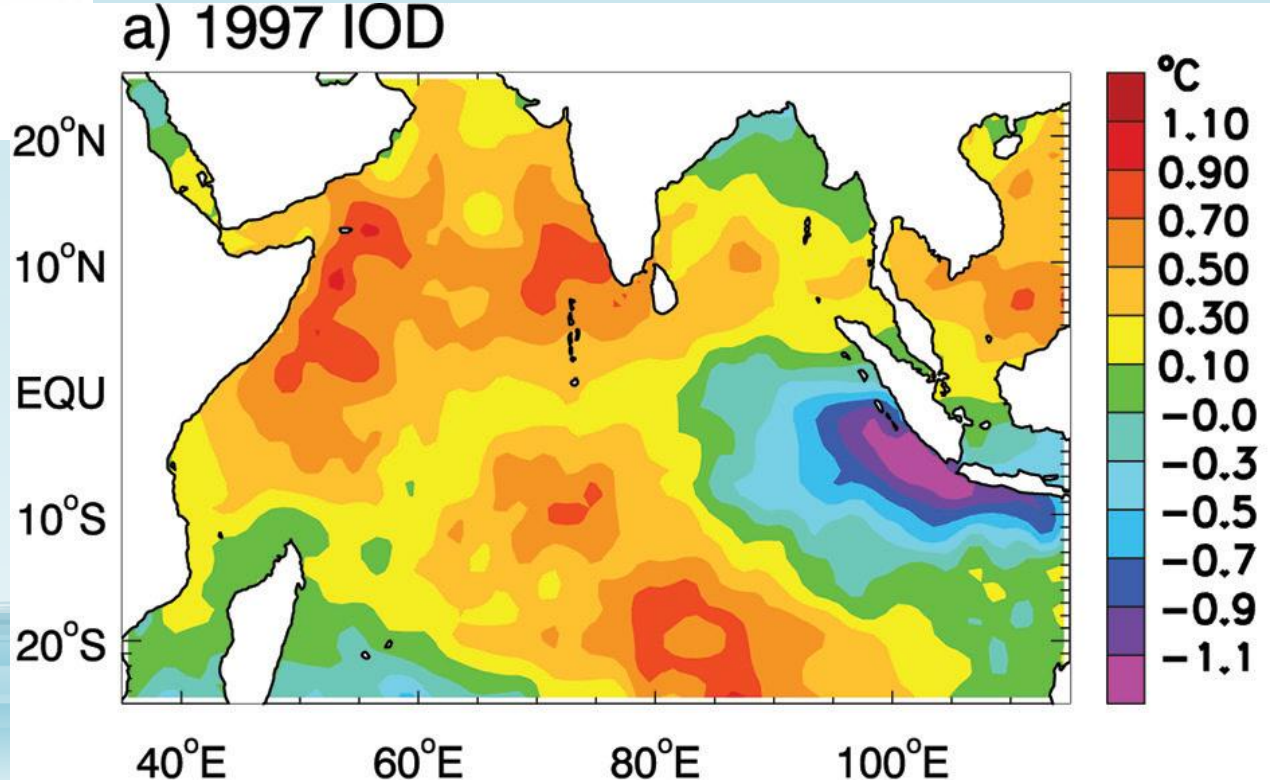
La-Nina

La_nina

Climate Variability: El-Nino

Sea Level during 1997 El-Nino and IOD



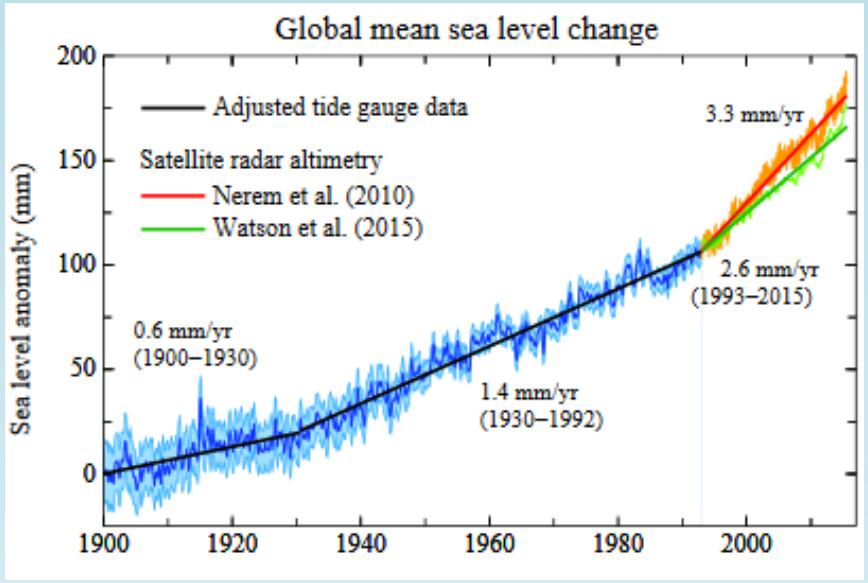


High Frequency Sea Level Variability

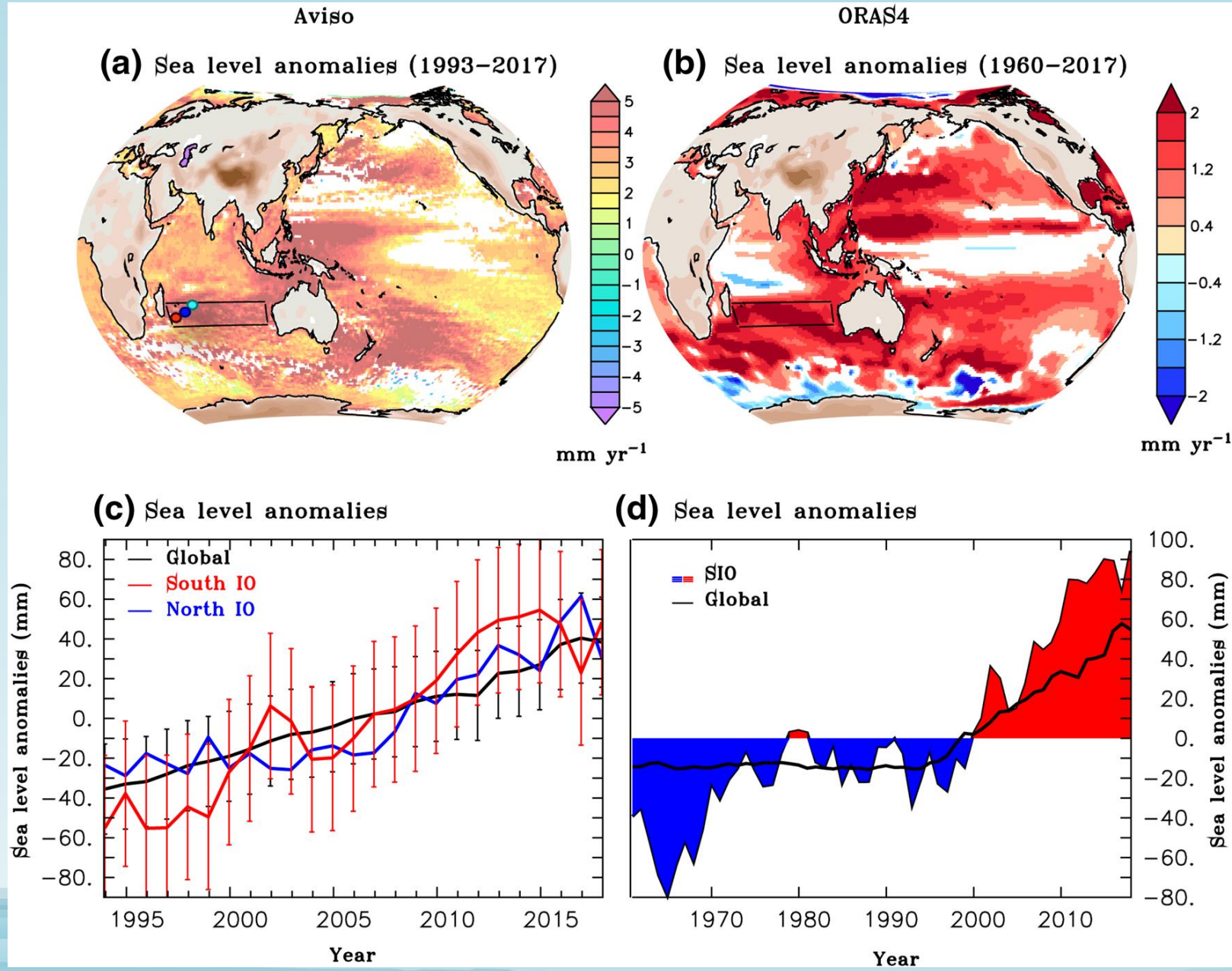
Wind waves

Stunami

Spatial variation in sea level Trend

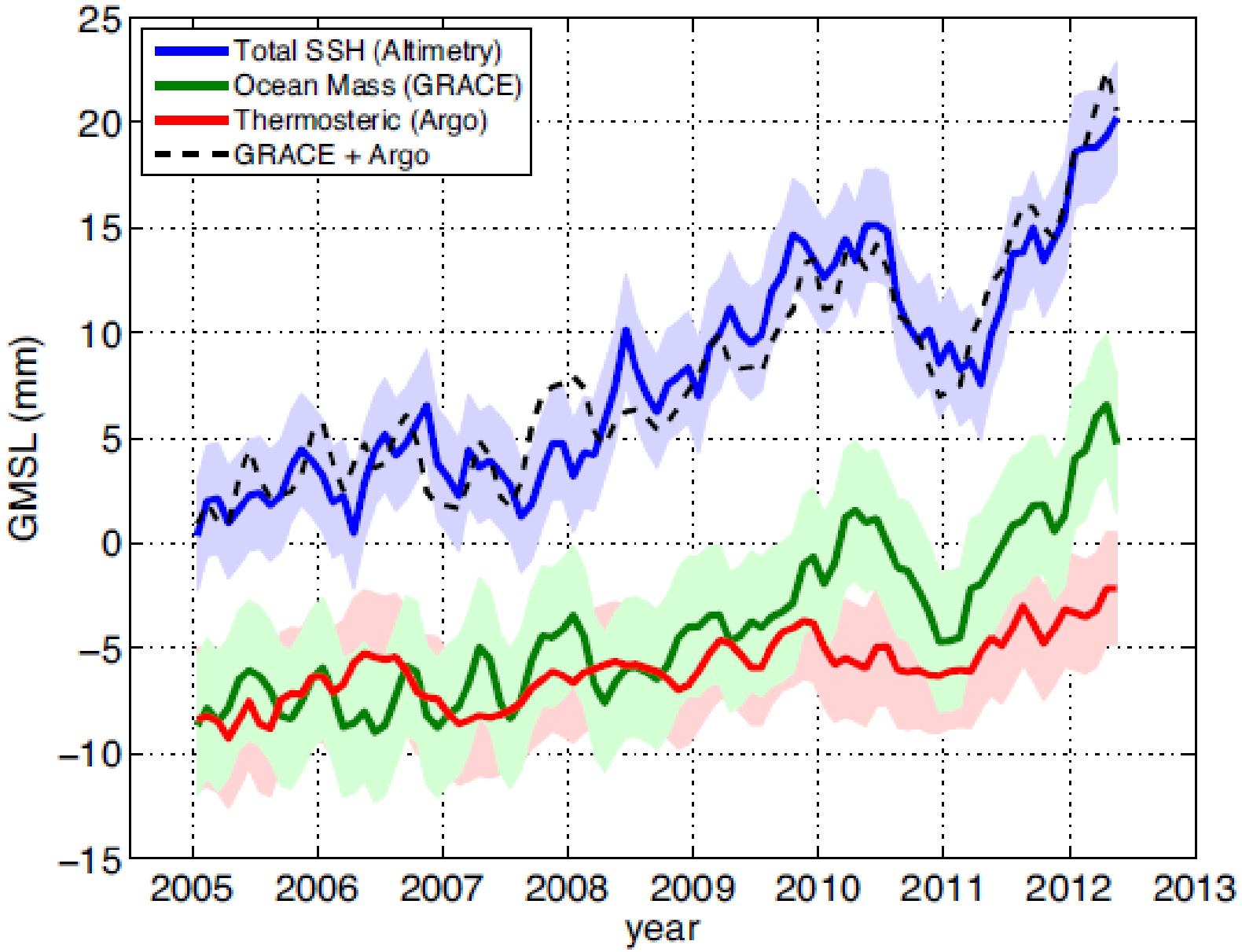


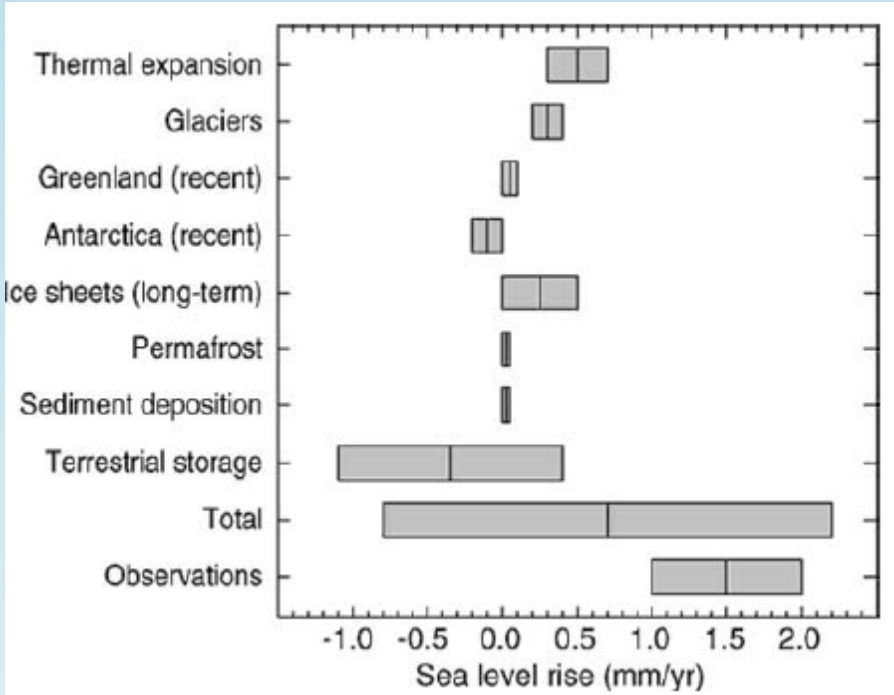
Hansen et al., 2016



Jyoti et al., Clim. Dyn., 2019

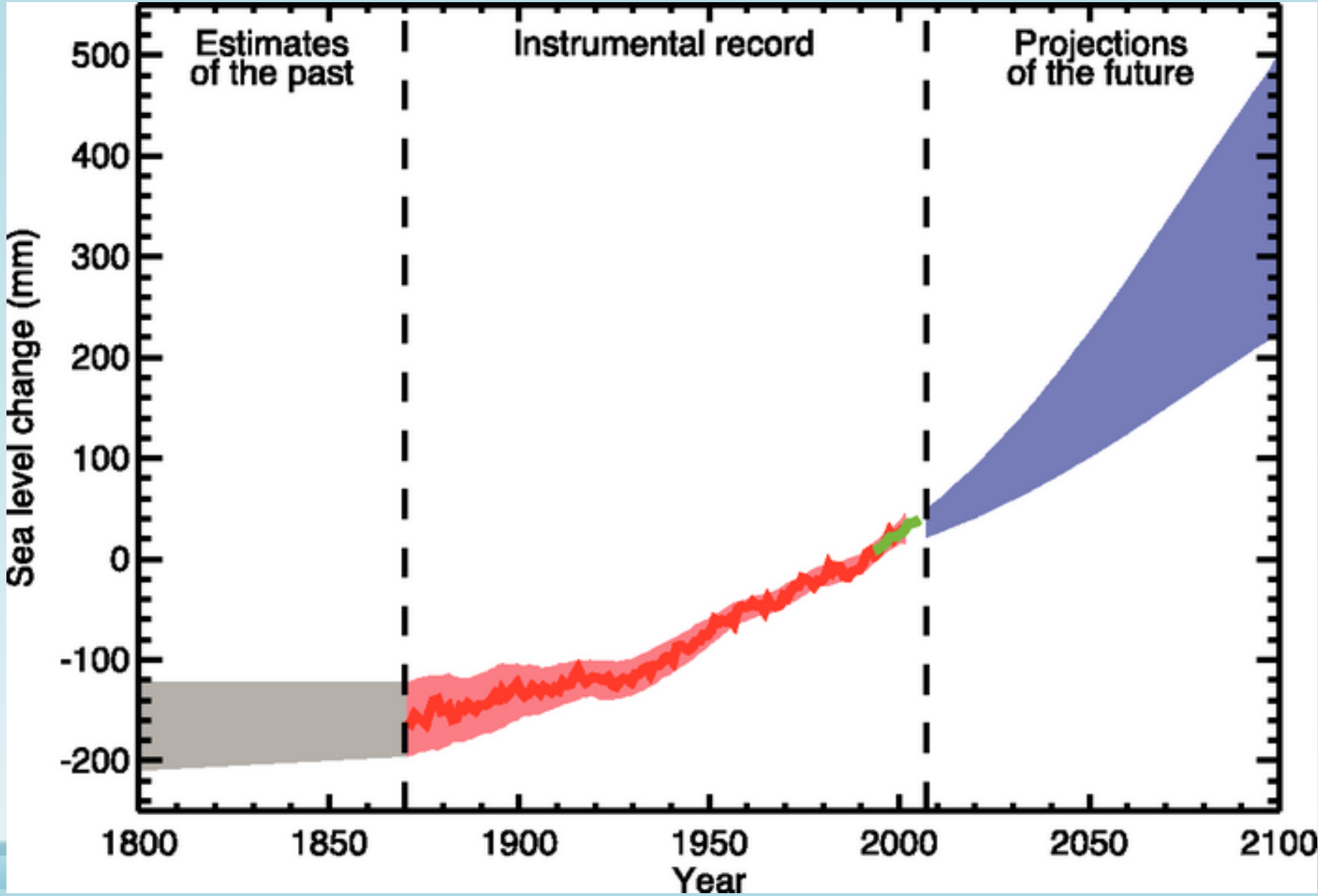
Causes of Sea Level Variability and Change





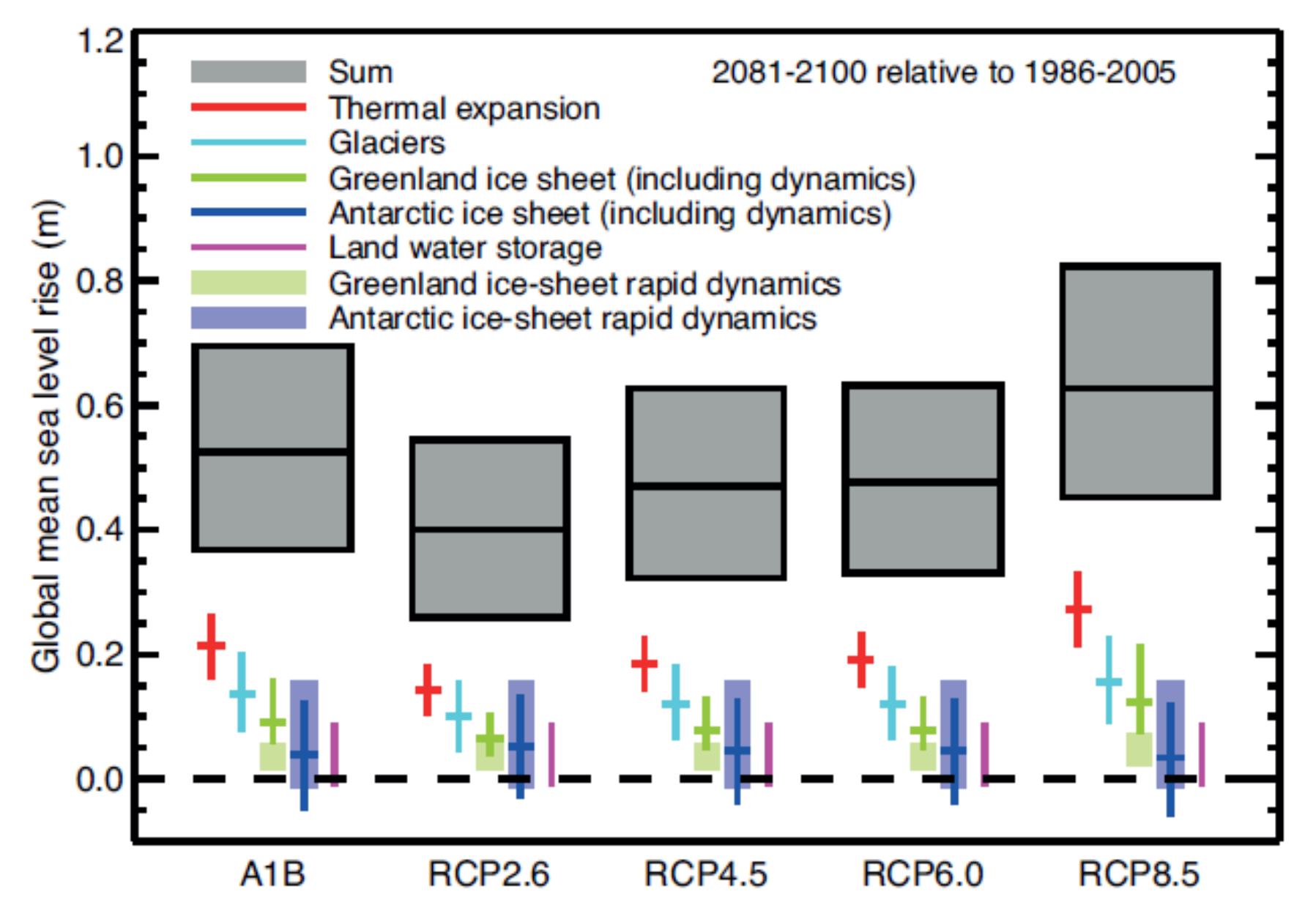
Various estimates of Global Sea Level Change for 1992-2003. (Cazenave & Nerem, Rev. Geophys., 2004)

Future sea level Trend



IPCC, AR4

Future sea level Trend



IPCC, AR5


Thank you