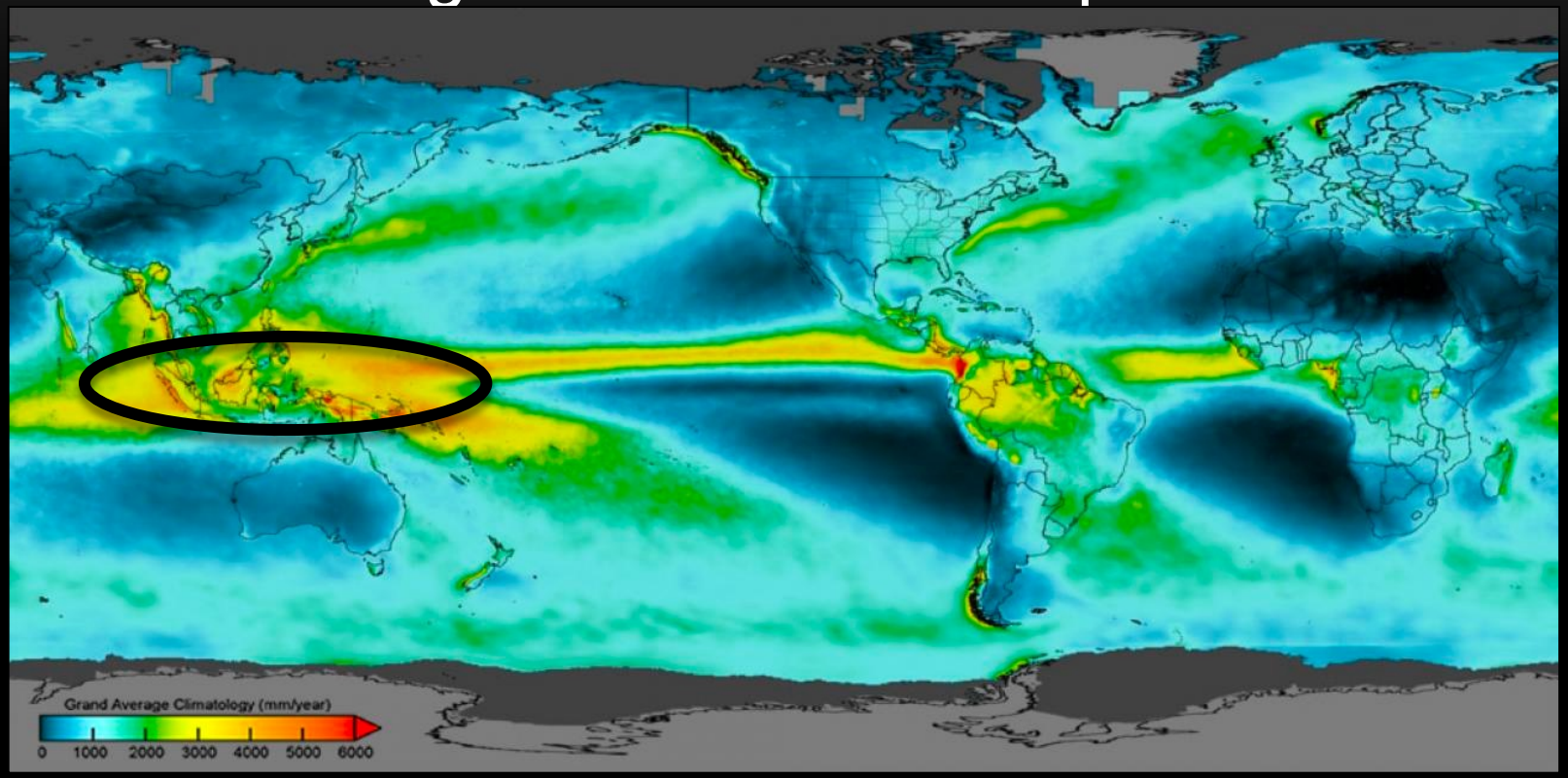
The zonally asymmetric circulation

Outline

- The Walker circulation
- Monsoons
- Stationary Waves

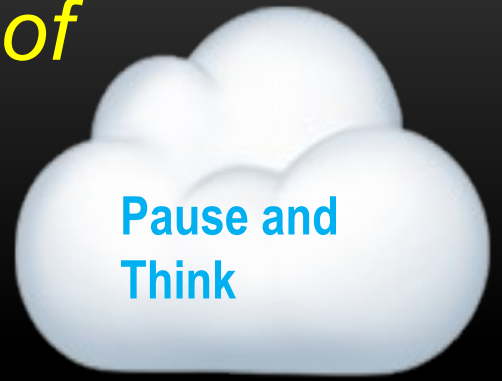
Long-term Mean Precipitation



- More precipitation occurs in the Indian Ocean-western Pacific warm pool region than in the tropical eastern Pacific.
- East-west asymmetry is also found over the tropical Atlantic

https://gpm.nasa.gov/data/imerg/precipitation-climatology

What contributes the east-west variability of precipitation in the tropics?

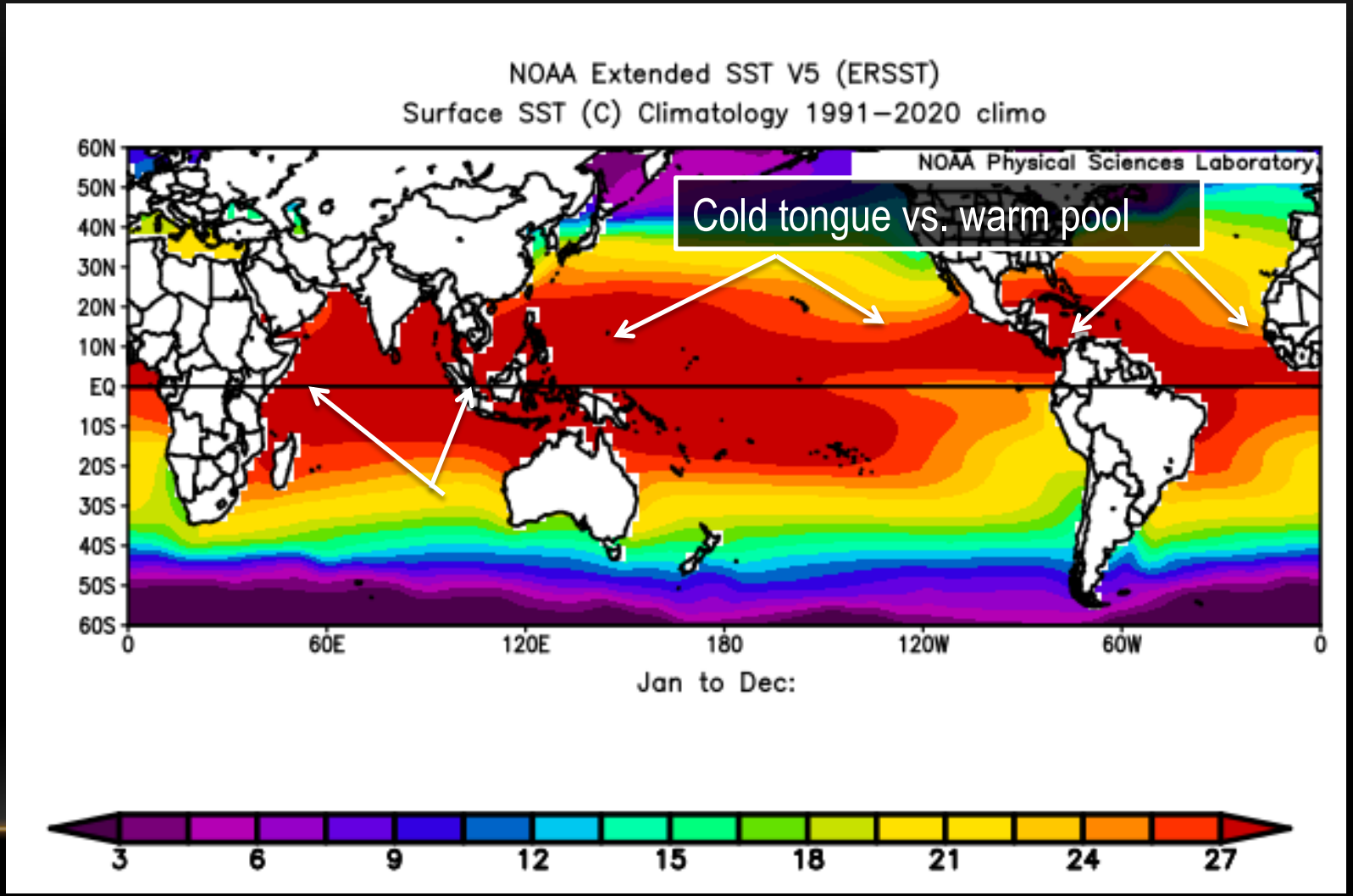


- zonal variations of **SST** due to ocean currents
- the non-uniform distribution of **land** and ocean areas and topography, which would cause differential heating in the zonal direction
- zonally propagating disturbances, or equatorial waves:
  - Such waves may be associated with enhanced or organized convection. Due to the variations of the mean flow, they may be amplified in some regions and weakened in other regions.

Long-term Annual Mean SST

How would you describe the zonal variations of SST over the tropical Indian Ocean, the tropical Pacific and the tropical Atlantic?

- Pac and Atl: warmer in the west and cooler in the east
- IO: warmer in the east and cooler in the west



Plots created from https://psl.noaa.gov/cgi-bin/data/composites/printpage.pl

The Walker Circulation over the Pacific

- warmer SST over the West Pacific (WP)
- larger latent heat release over WP→
- warmer air column over WP and cooler air column over the East Pacific (EP) →
- low (high) pressure in the lower (upper) troposphere over WP→
- east-west pressure gradient→
- east-west overturning circulation→
- moisture convergence over WP, fueling further convection
- the Walker circulation: an east-west overturning circulation consisting of low-level easterly winds and upper-level westerly (return) winds over the equatorial Pacific

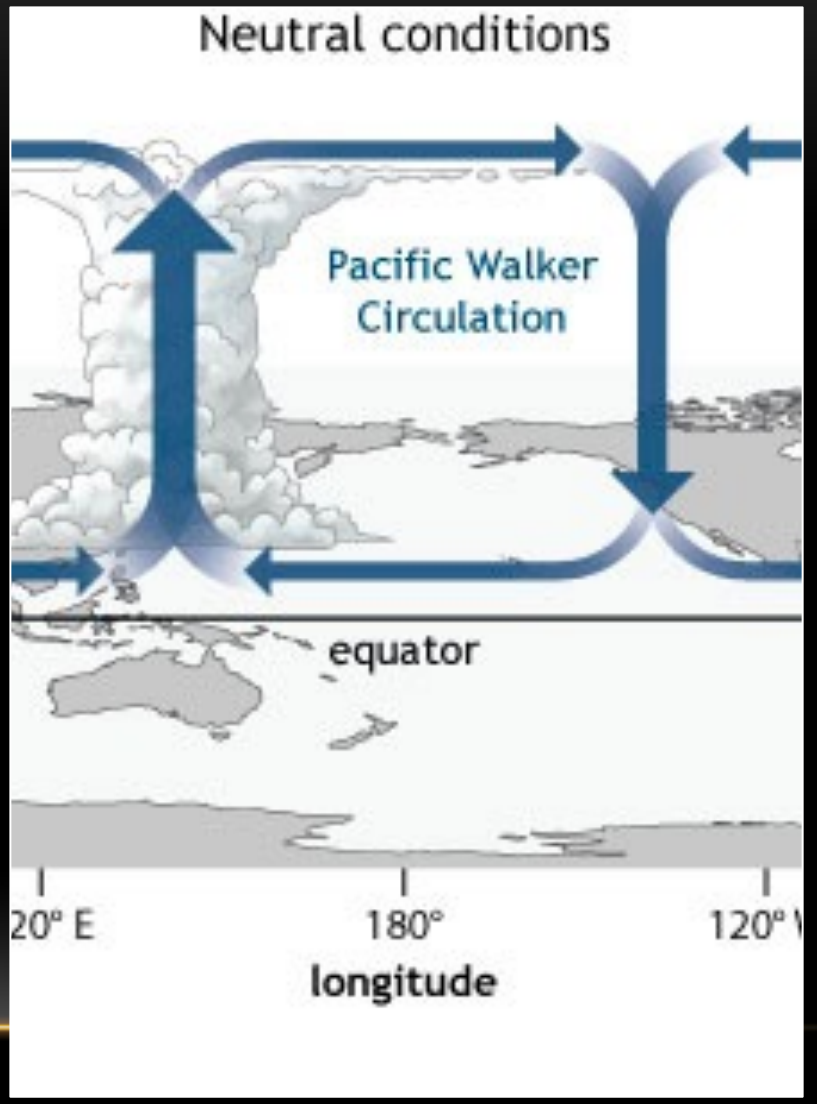
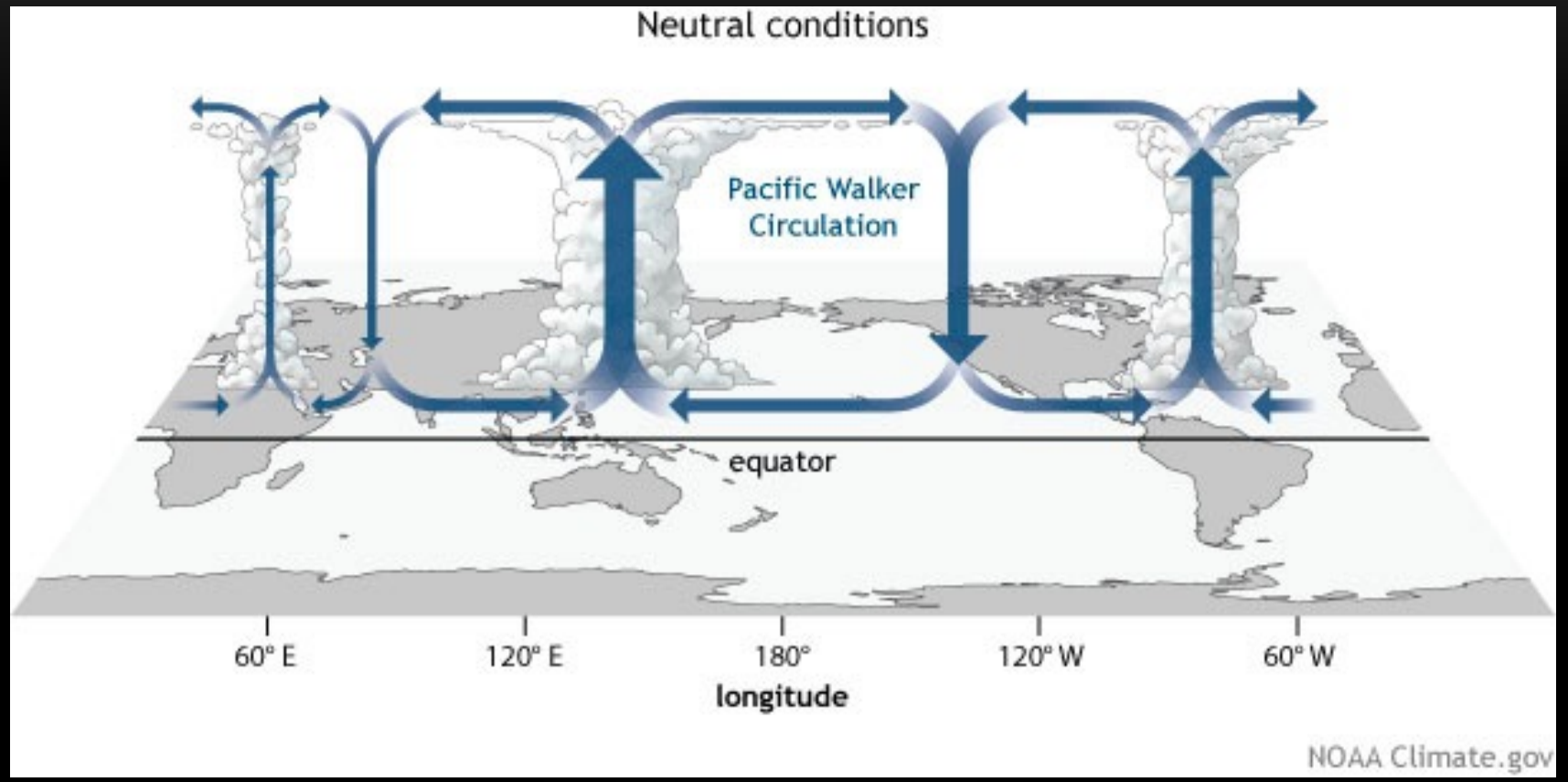


Figure adapted from NOAA

Global Walker Circulation



The ascending branches of the global Walker Circulation are associated with enhanced precipitation (diabatic heating) over equatorial Africa, the Maritime Continent, and Central and South America.

From https://www.climate.gov/news-features/blogs/enso/walker-circulation-ensos-atmospheric-buddy

Hadley Circulation and Walker Circulation

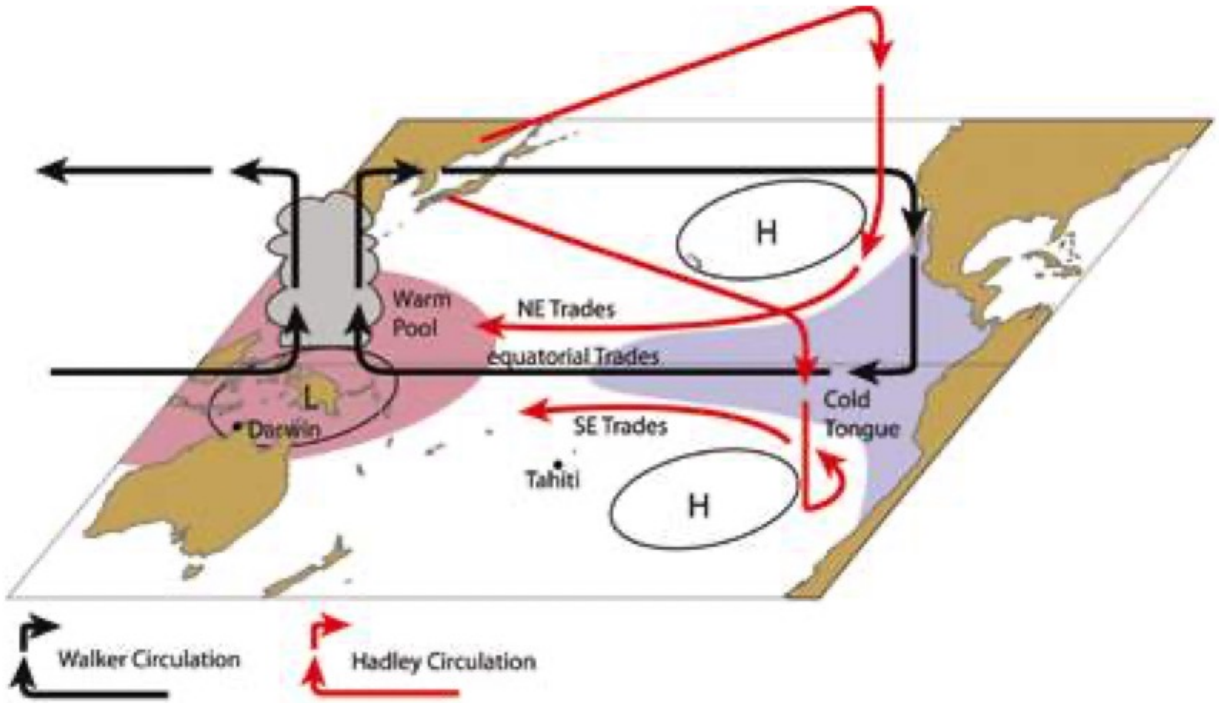


Figure 2.5 Schematic showing the Walker and Hadley Circulation Cells, the associated surface low (L) and high (H) pressure systems, the WPW and eastern Pacific cold tongue. The sea-level pressure difference between Tahiti and Darwin, the Southern Oscillation Index (SOI), is a measure of the strength of the Trade Winds and ENSO activity.

Figure from Lough et al. 2016 (https://eprints.usq.edu.au/42384/)

References

- COMET: Introduction to Tropical Meteorology, Section 3.1 and 3.2
- https://www.meted.ucar.edu/tropical/textbook_2nd_edition/navmenu.php?tab=4
- Cook, K. H., 2013: Section 2.1