

# Air-sea interaction: Monsoon

---

ATM2106

# A new webpage of the department

연세대학교 English



학과소개 연구활동 사람들 학사안내 학과소식

## 대기과학이란?

21세기 인류가 당면한 가장 도전적인 문제인 지구환경 분야를 선도하는 대기과학은 자연과 인간의 조화로운 공존을 위해 책임 있는 해결을 제시할 수 있는 핵심 과학입니다.

video source

축하합니다.

대기과학과 구성원들의 수상을 축하합니다.





# 학부/대학원 연구원 모집

대기과학과 대기-해양 모델링 연구실

대기-해양 상호관계 / 대기-해양 접합 모델  
지구 탄소 순환 / 자료 동화

문의 : 송하준 ([hajsong@yonsei.ac.kr](mailto:hajsong@yonsei.ac.kr) / 과학관 544호)

Western Ghats in dry season (<https://en.wikipedia.org/wiki/Monsoon>)



Western Ghats in wet season (<https://en.wikipedia.org/wiki/Monsoon>)



Monsoon clouds and shower, Nagercoil, India  
[\(<https://en.wikipedia.org/wiki/Monsoon>\)](https://en.wikipedia.org/wiki/Monsoon)



In southern and Southeast Asia, Summer monsoon  
(from <https://svs.gsfc.nasa.gov/12303>)



“모내기하고 열흘. 6월 말. 장마가 시작되었고...”



Dry monsoon





Flooding during the summer monsoon, looks like in India  
(from <https://svs.gsfc.nasa.gov/12303>)

# Flooding in 2017 summer



Before the monsoon, May 2017





# Flooding in 2017 summer

After the monsoon, September 2017



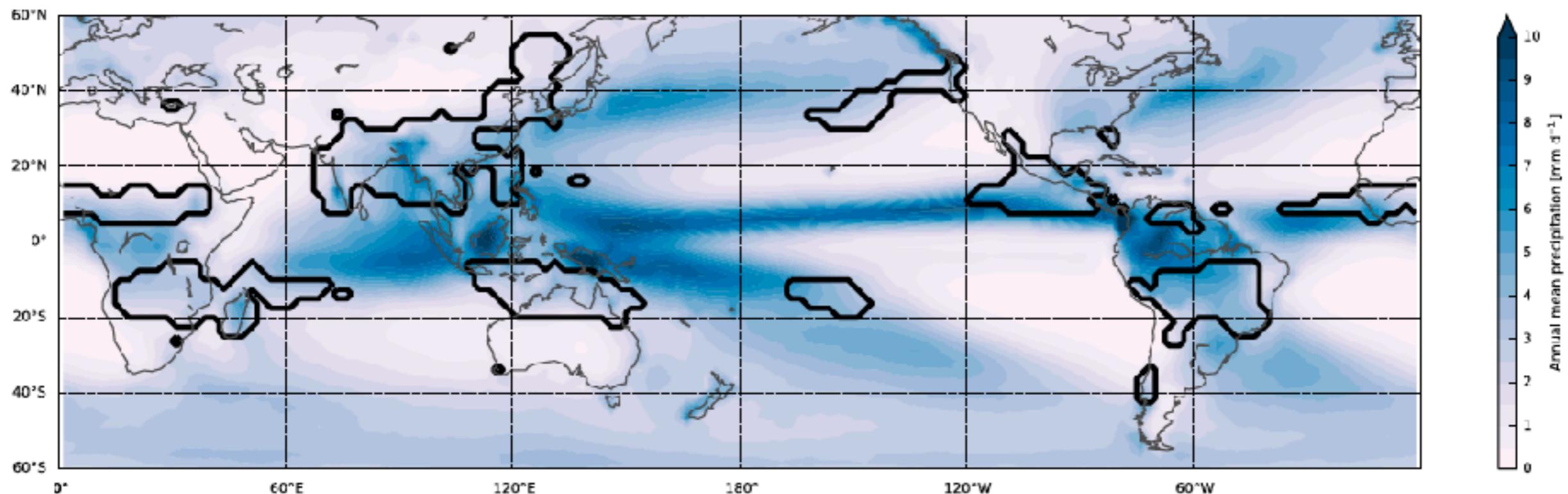
More than 40 million people have been suffered!

Movie from <https://svs.gsfc.nasa.gov/12583>

Movie from <https://svs.gsfc.nasa.gov/12303>

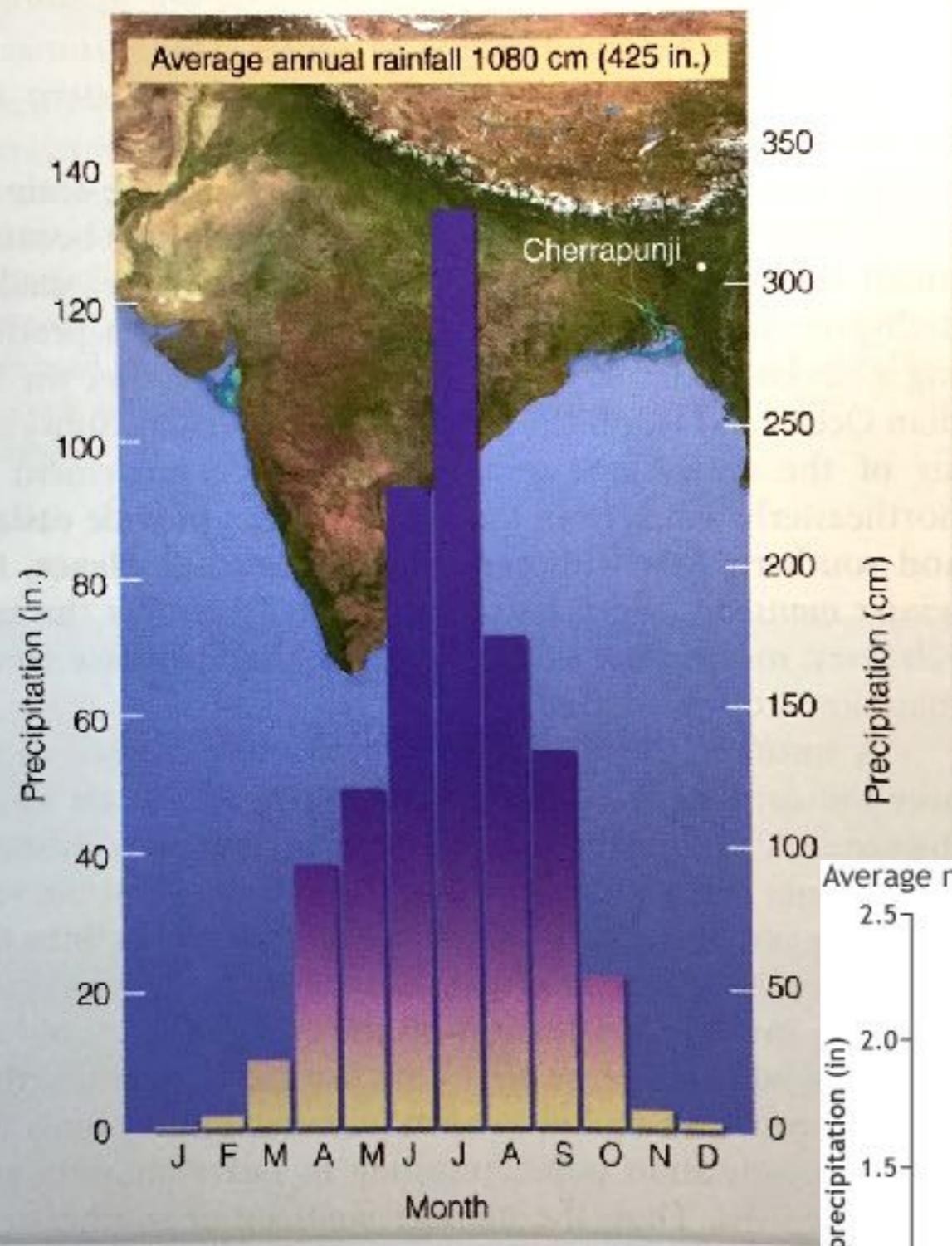
# One definition of the monsoon

---

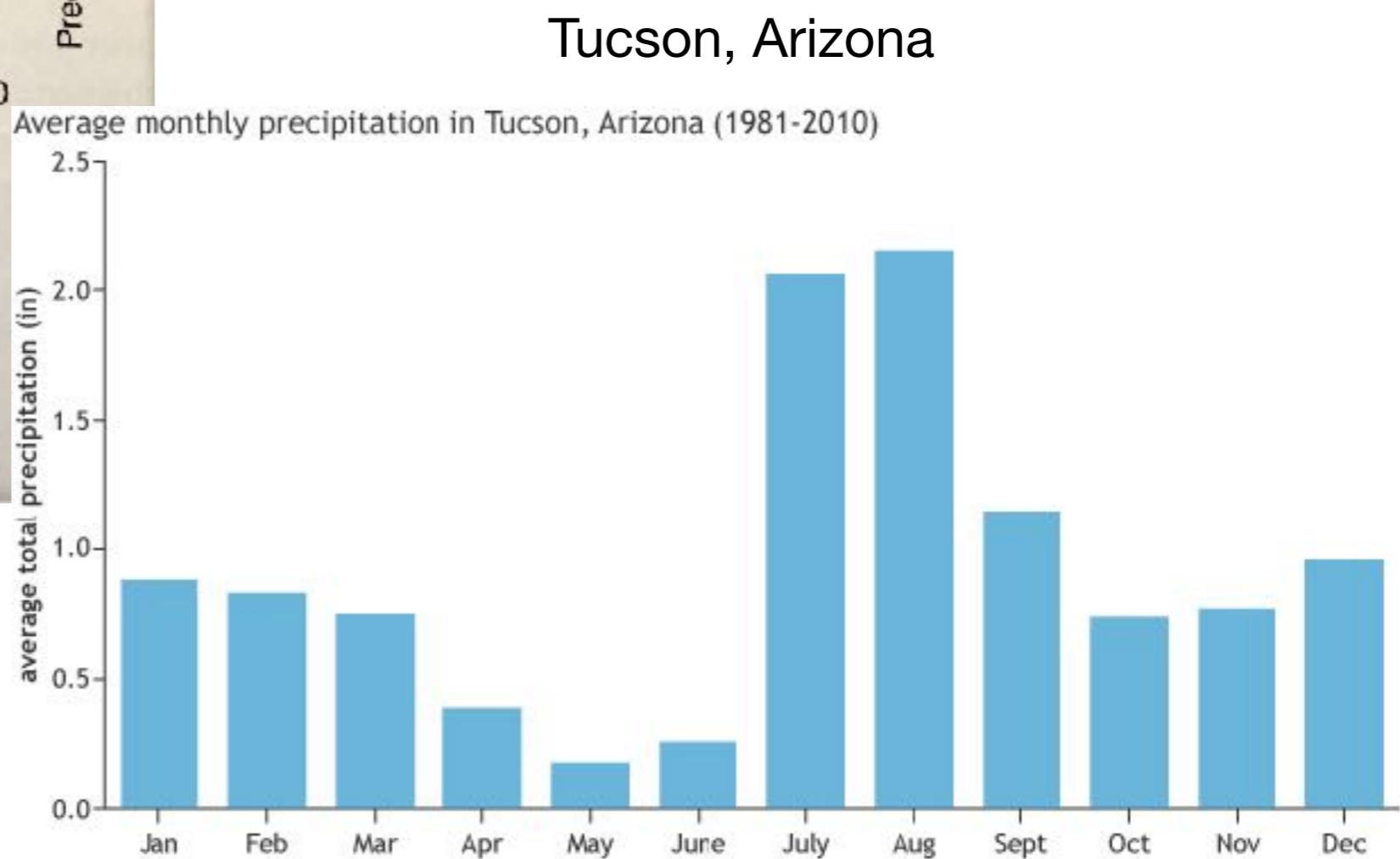


At least 40% of precipitation during local summer  
AND  
Summer mean more than 2 mm/d above annual mean

# Precipitation data



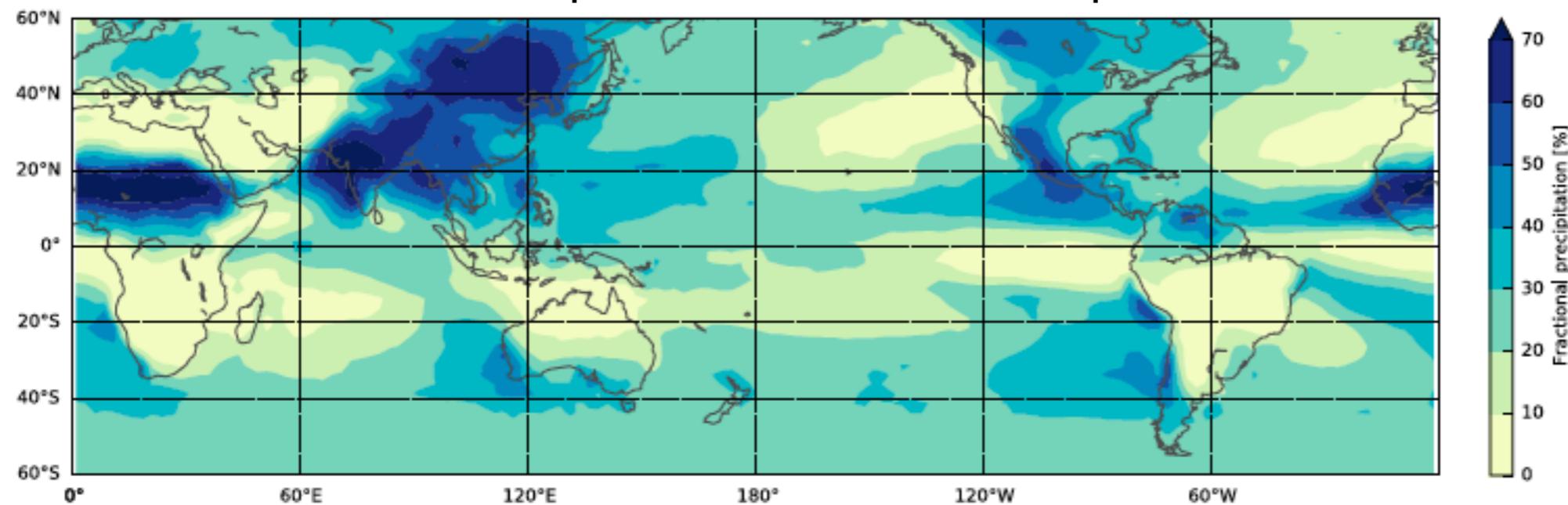
Cherrapunji, India



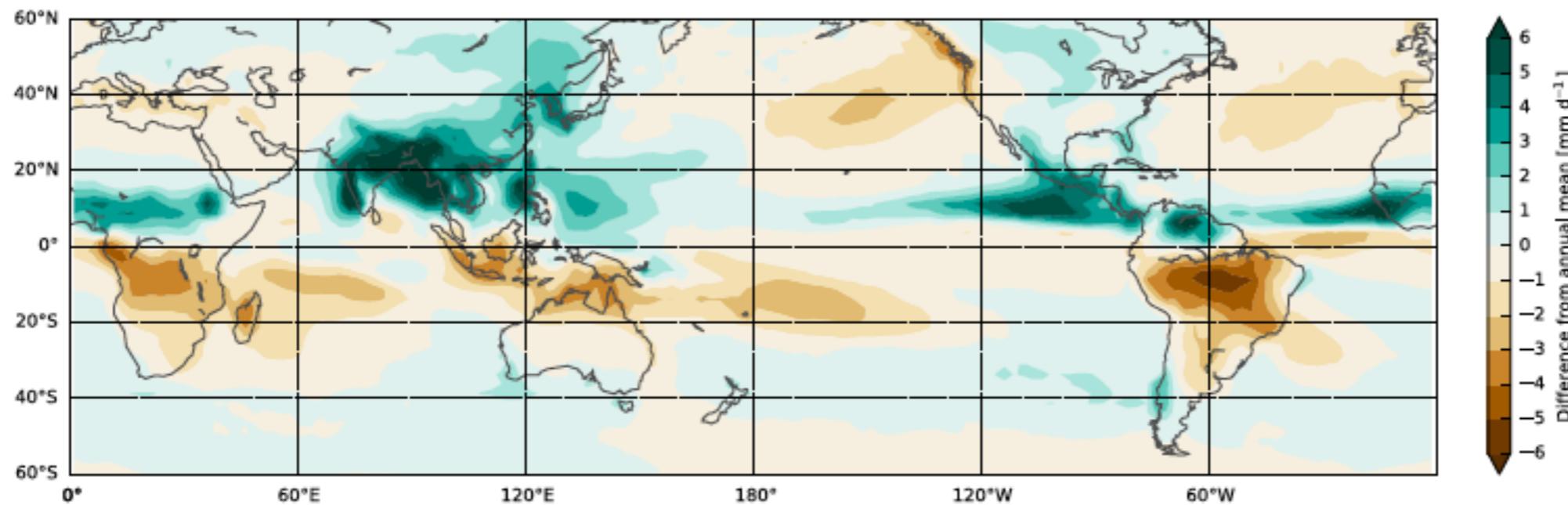
# Concentrated precipitation

Figure from the slide by Jonathan Wright

Precip. in JJA / Annual Precip.



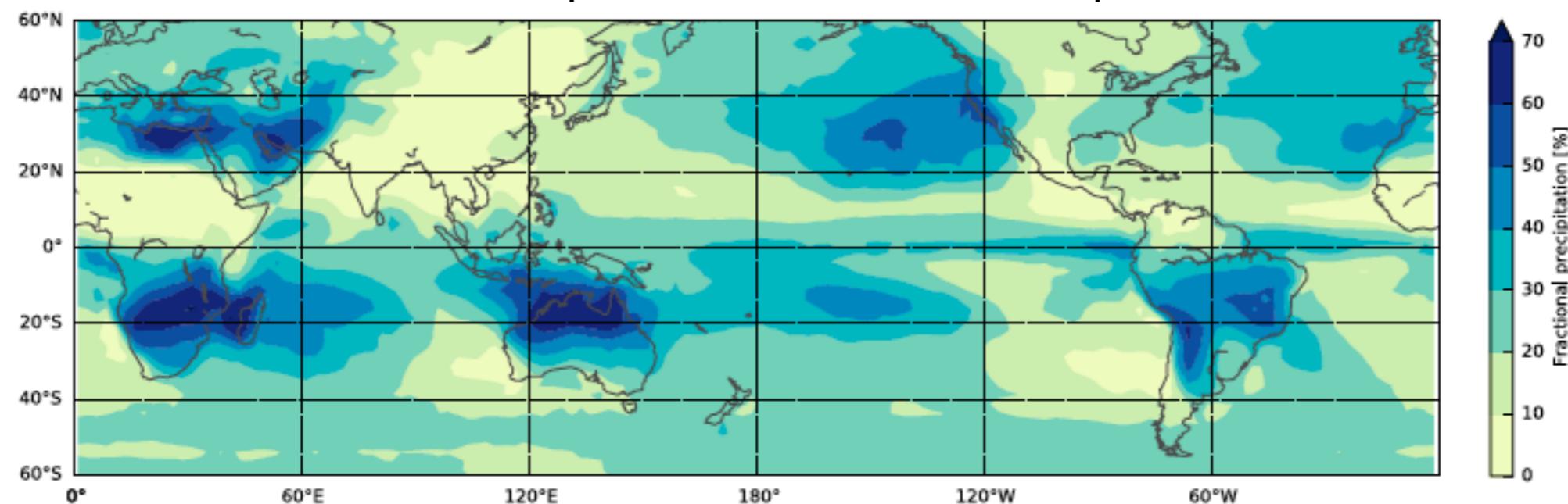
Precip. rate in JJA - Annual mean Precip. rate



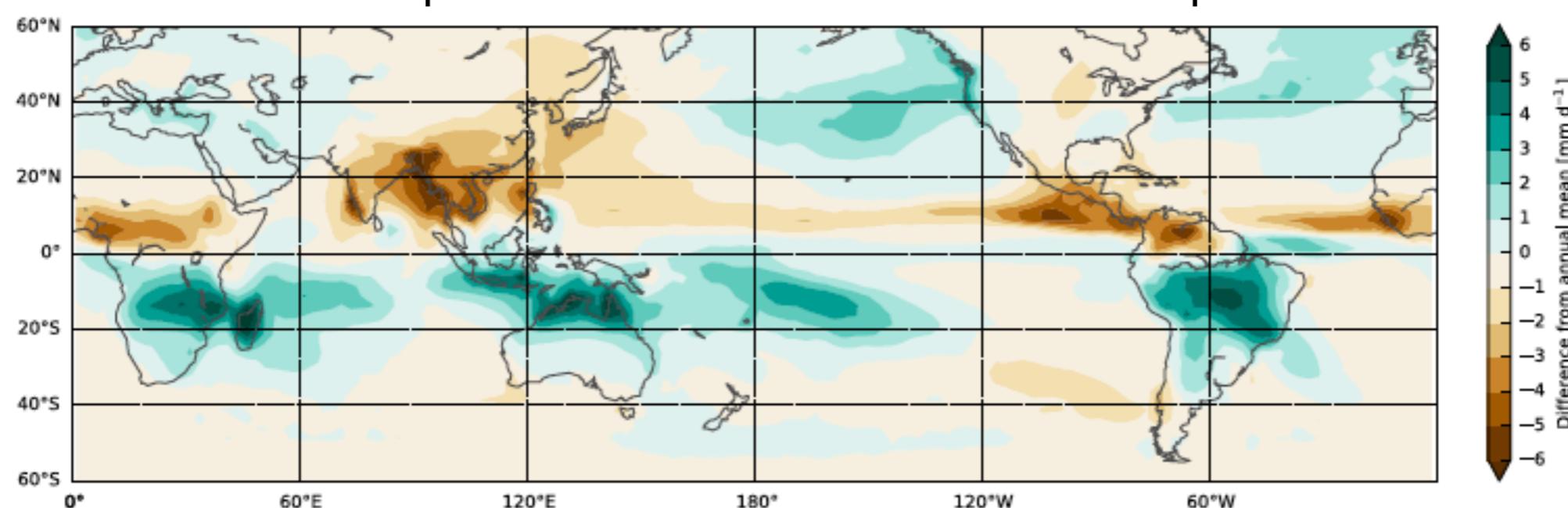
# Concentrated precipitation

Figure from the slide by Jonathan Wright

Precip. in DJF / Annual Precip.

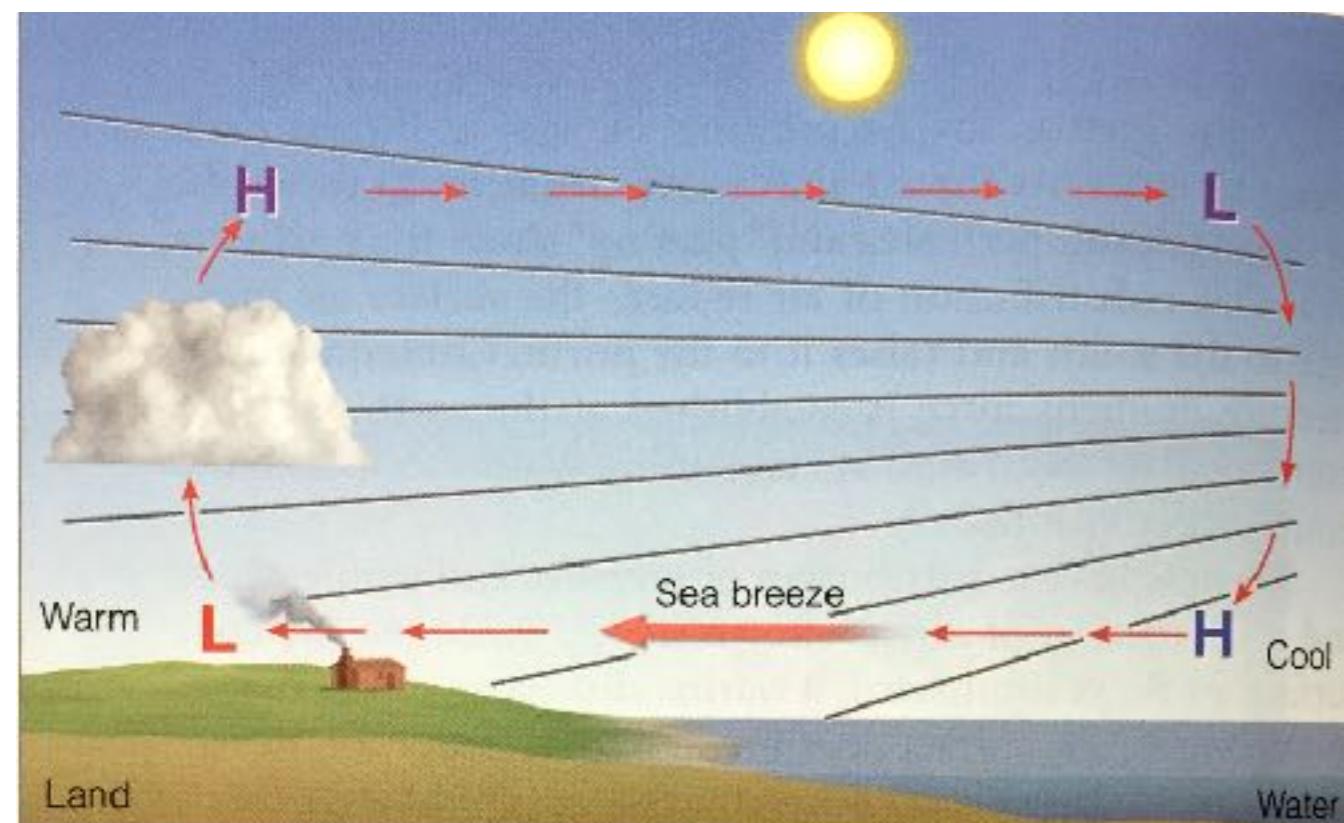


Precip. rate in DJF - Annual mean Precip. rate

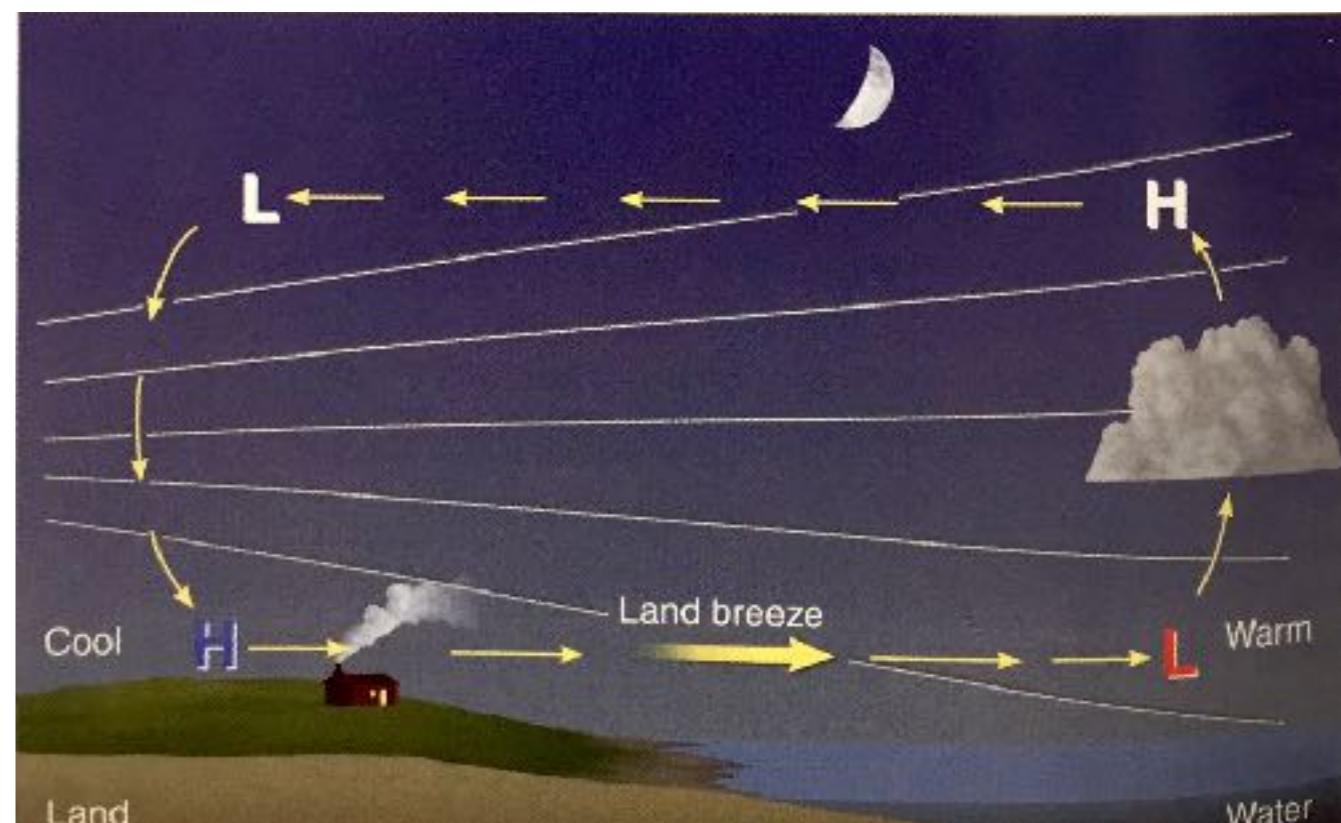


# How does the monsoon work?

- Strong land-sea contrasts in surface temperature like land-sea breeze
- Temperature difference affects the moist energy budget.



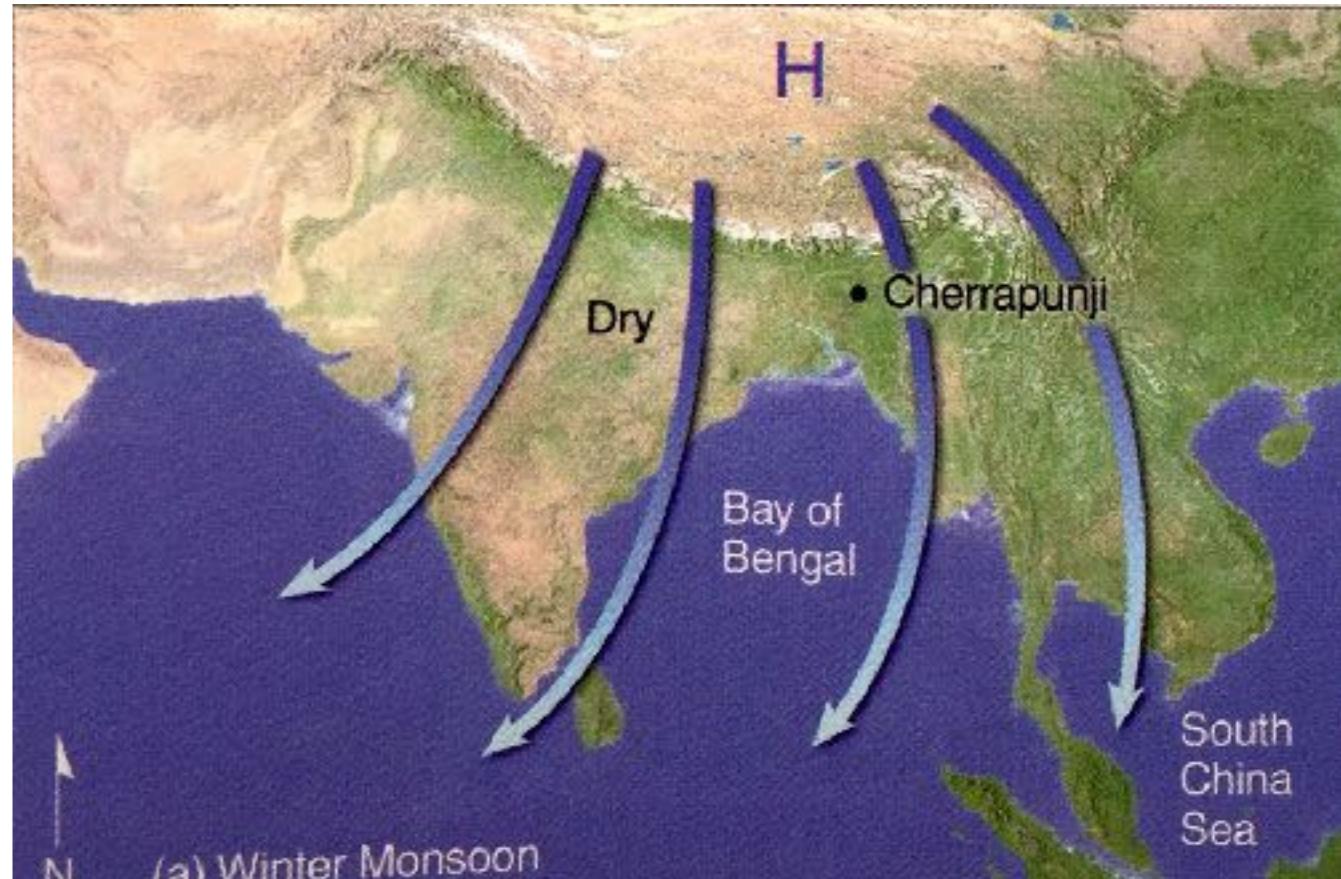
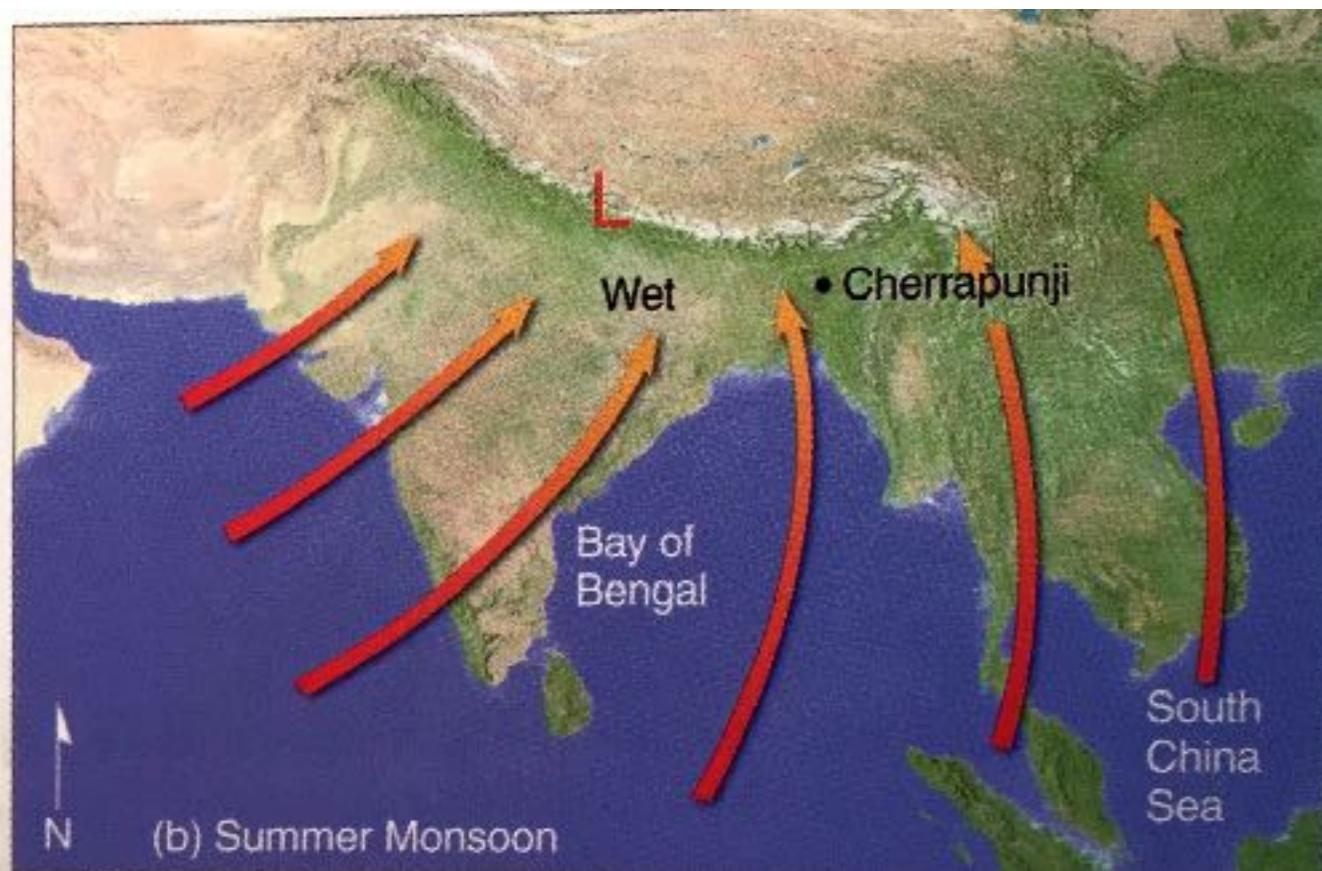
Sea breeze



Land breeze

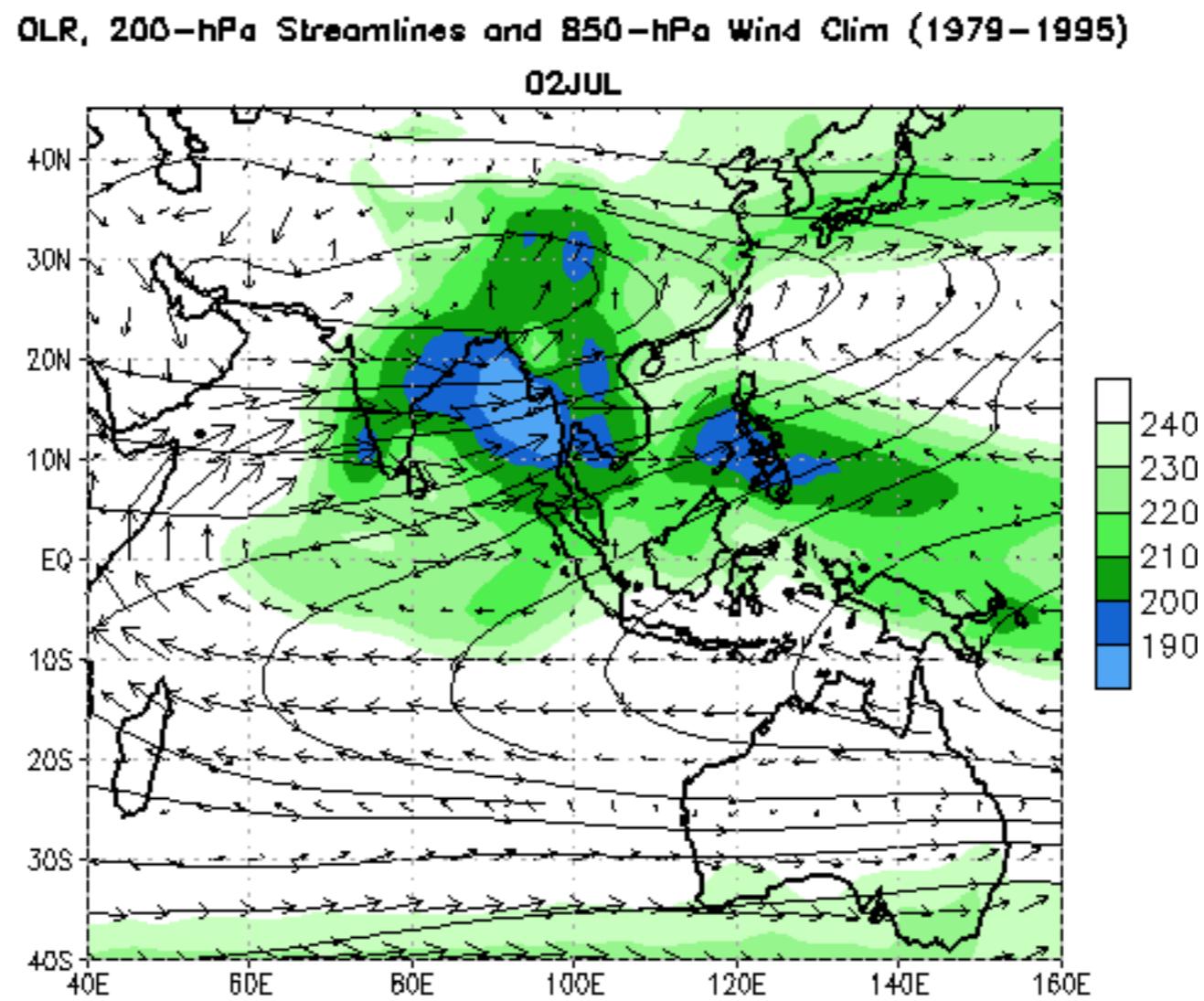
# How does the monsoon work?

- Strong land-sea contrasts in surface temperature like land-sea breeze
- Temperature difference affects the moist energy budget.



# The development of the Indian monsoon

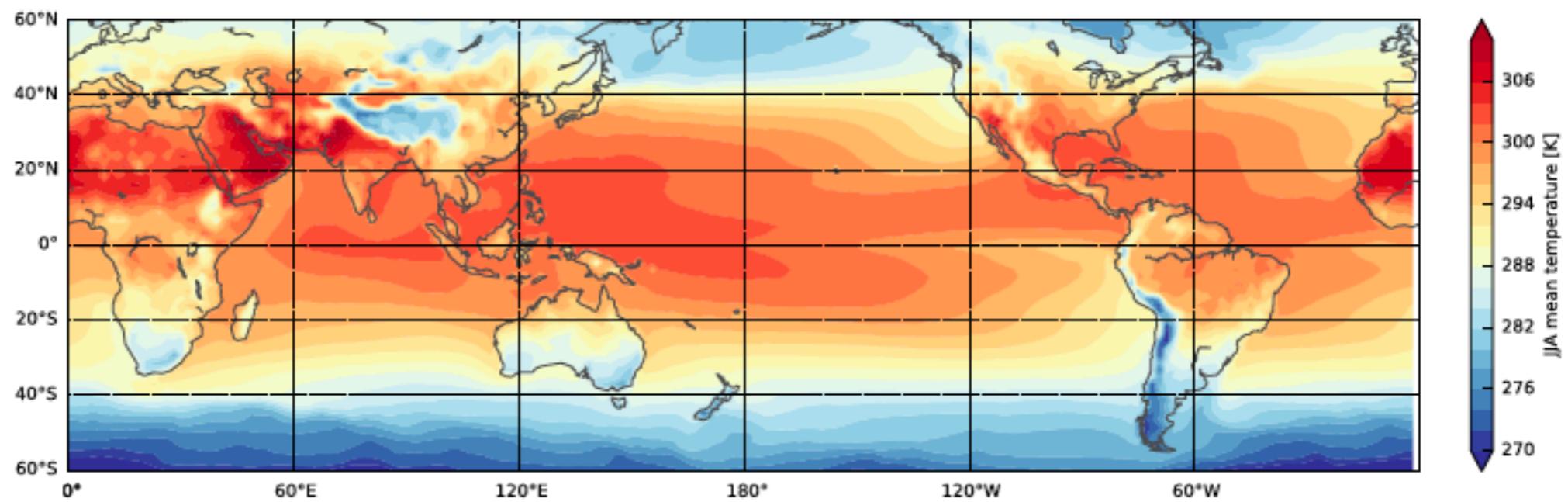
---



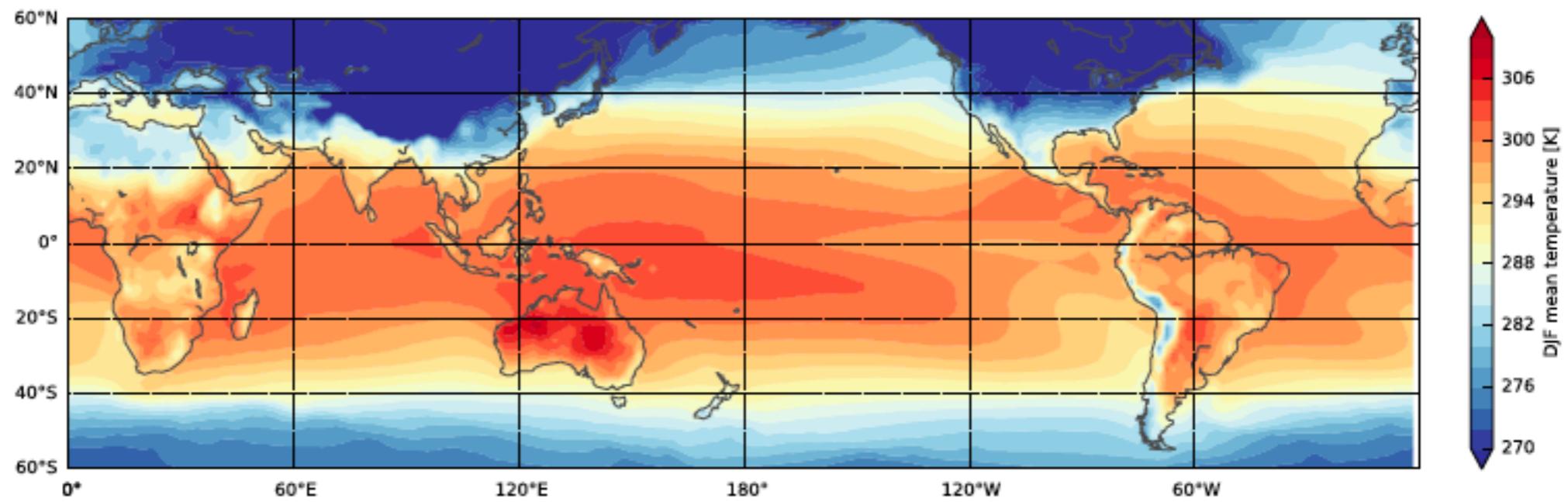
Data Sources: OLR – NESDIS/ORA, Winds – NCEP CDAS/ Reanalysis

# Surface temperature

JJA surface temperature



DJF surface temperature



# Energy input in the atmosphere

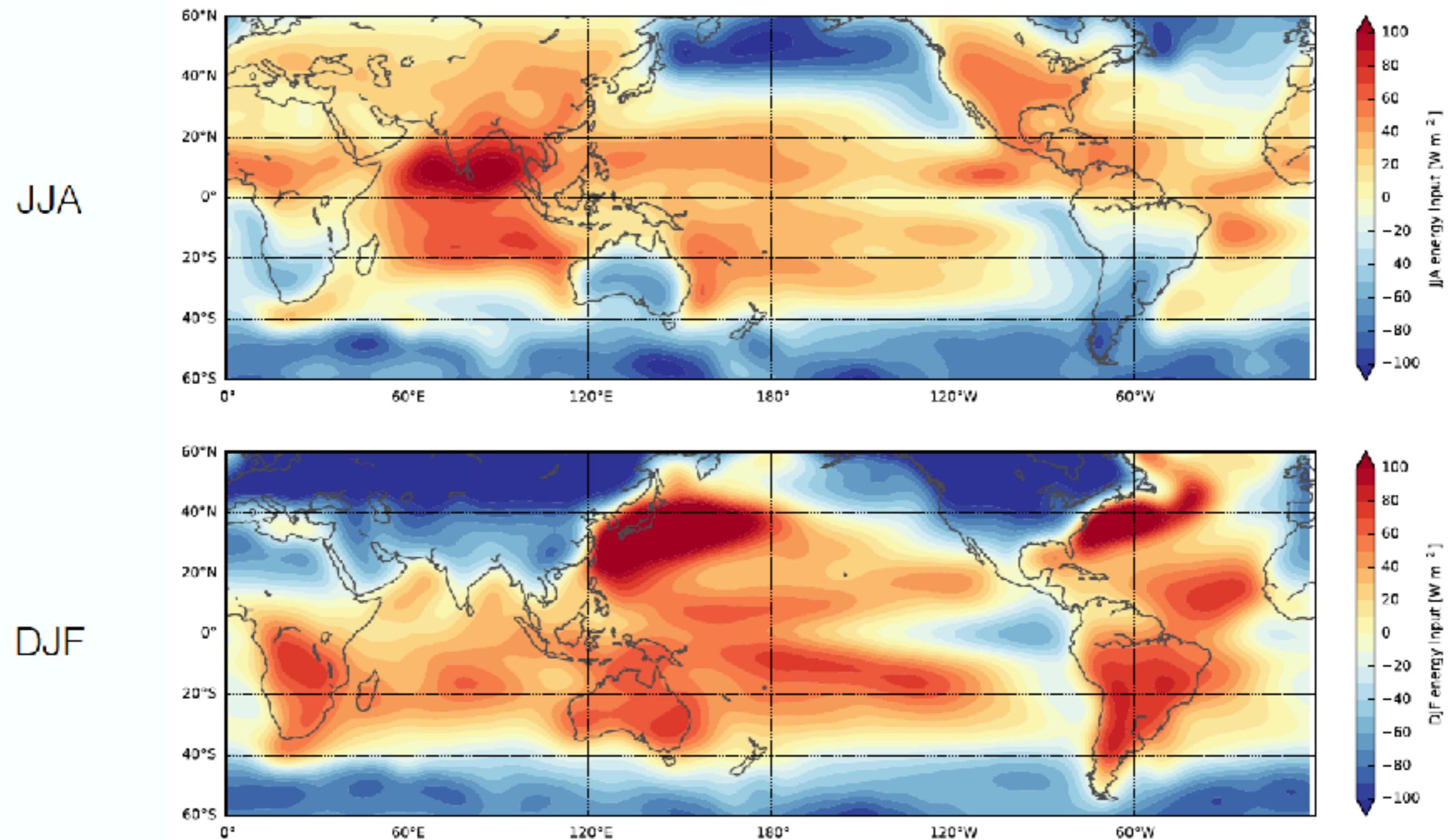


Figure from the slide by Jonathan Wright

# The air-sea coupling and the monsoon

A northwestward shift of the warm pool into the Bay of Bengal

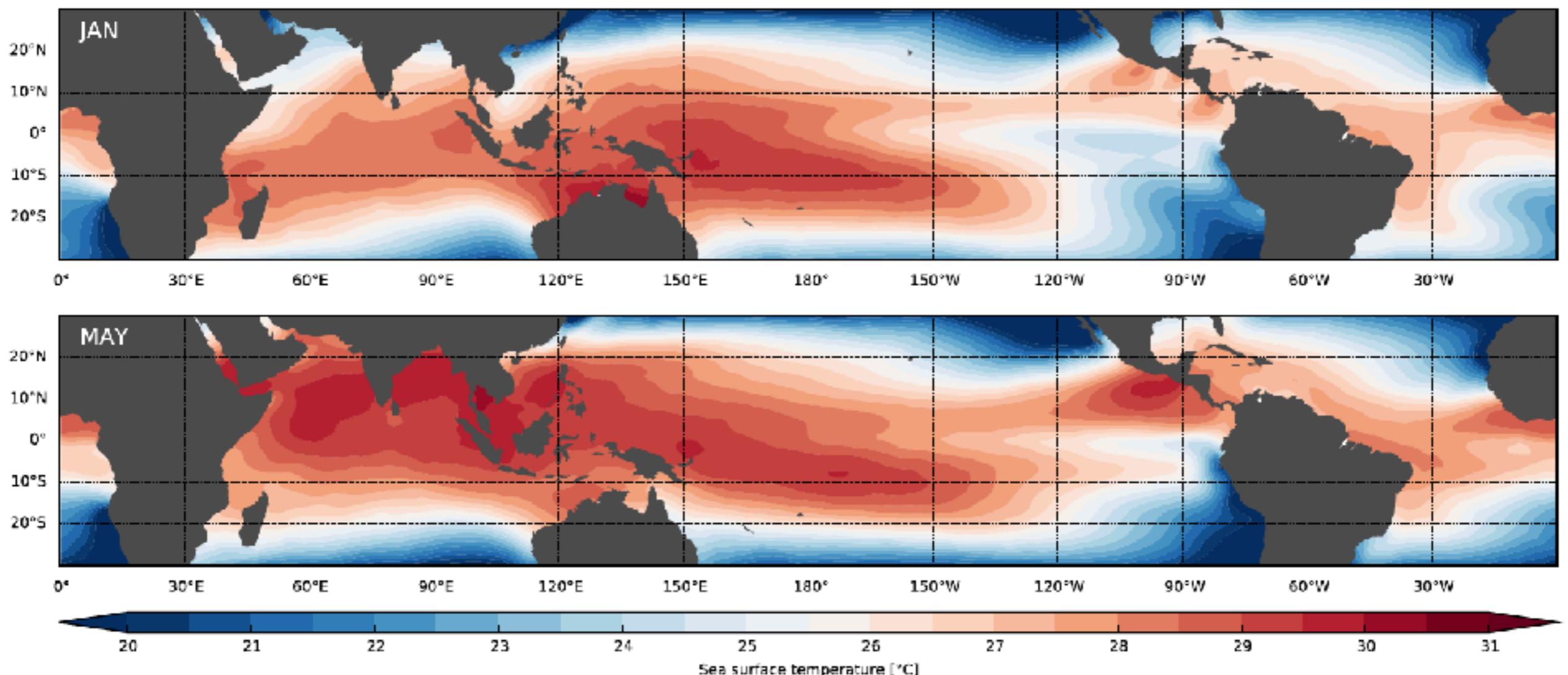


Figure from the slide by Jonathan Wright

# Wind and outgoing longwave radiation

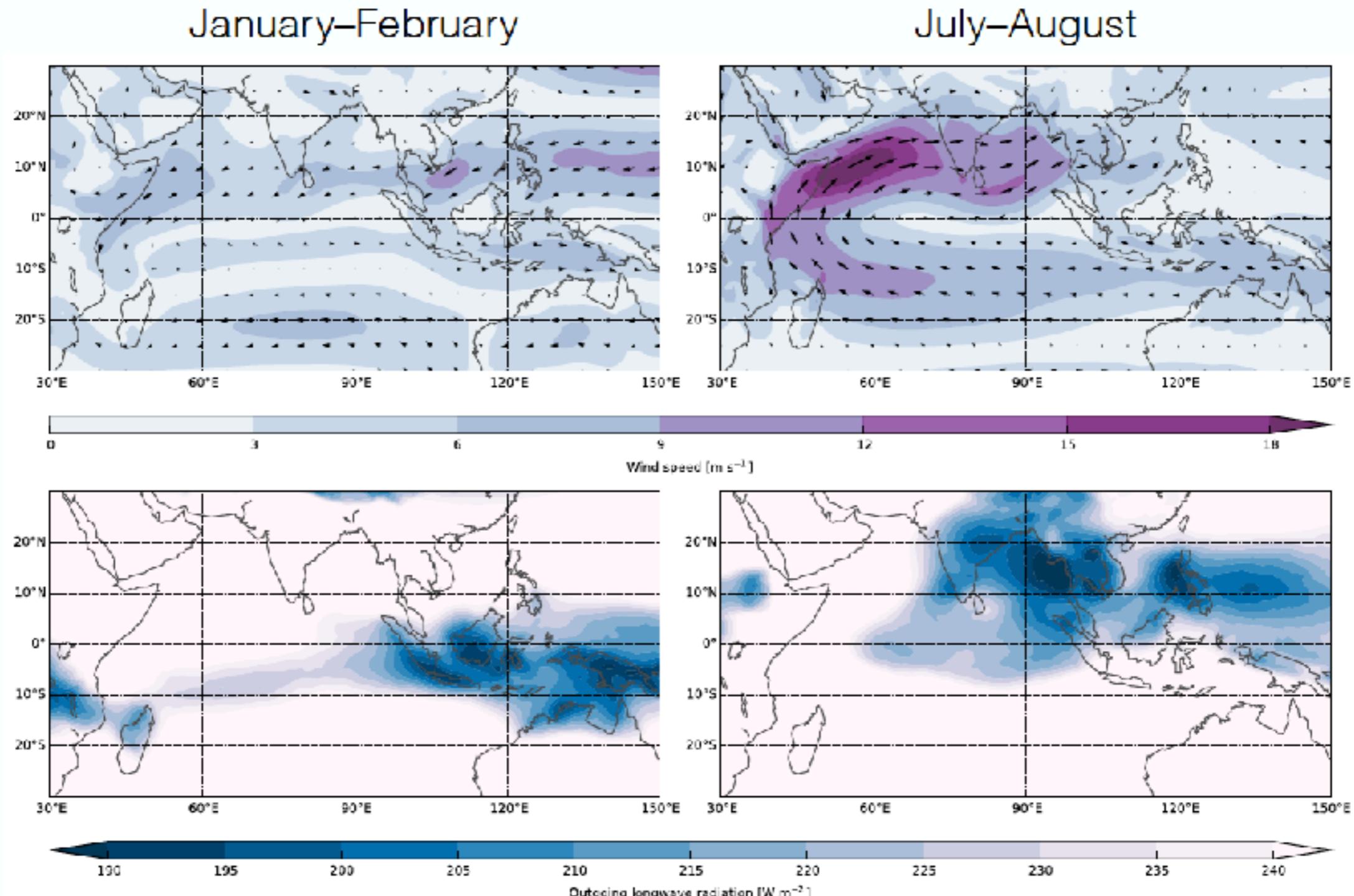


Figure from the slide by Jonathan Wright

# The coupled annual cycle

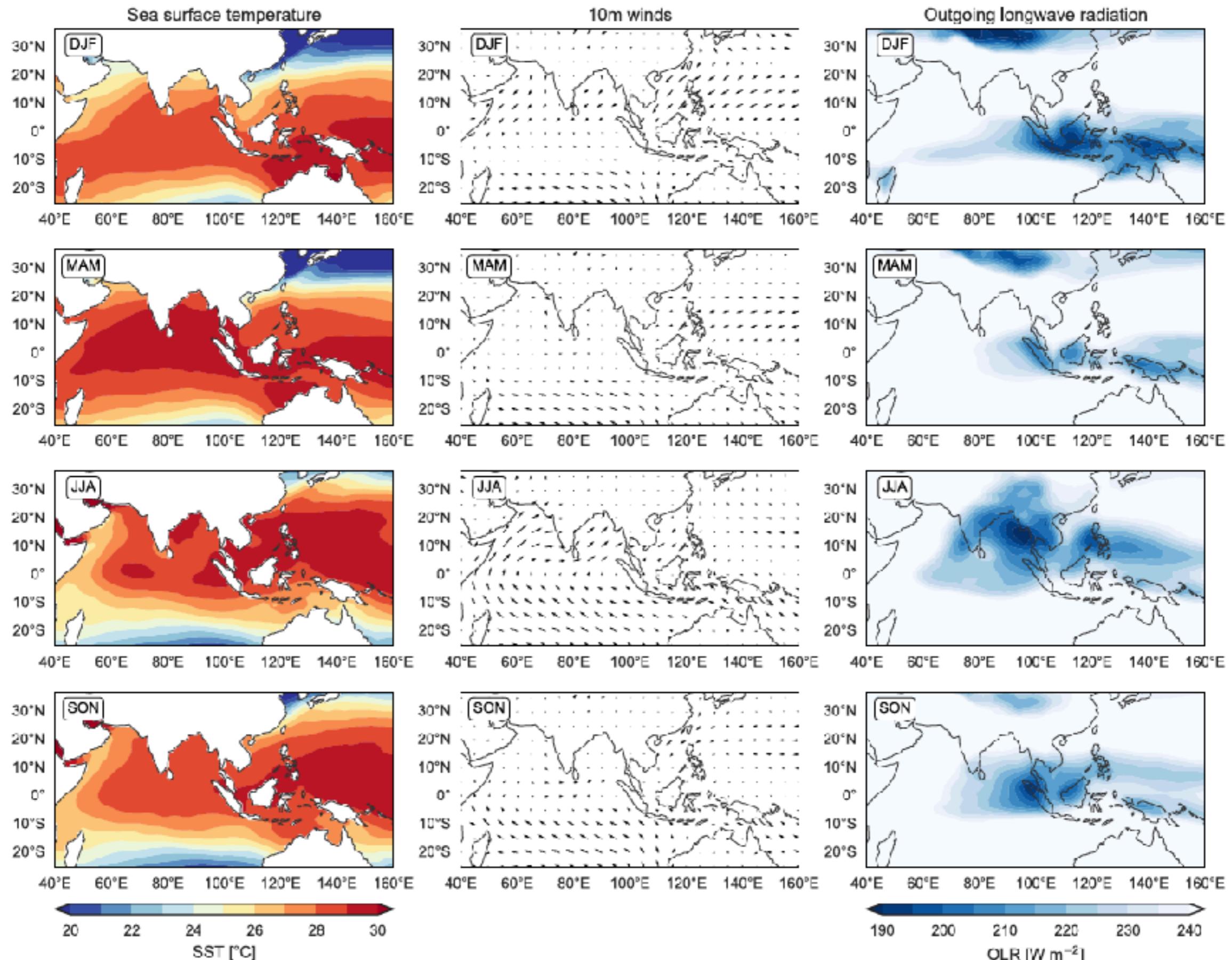
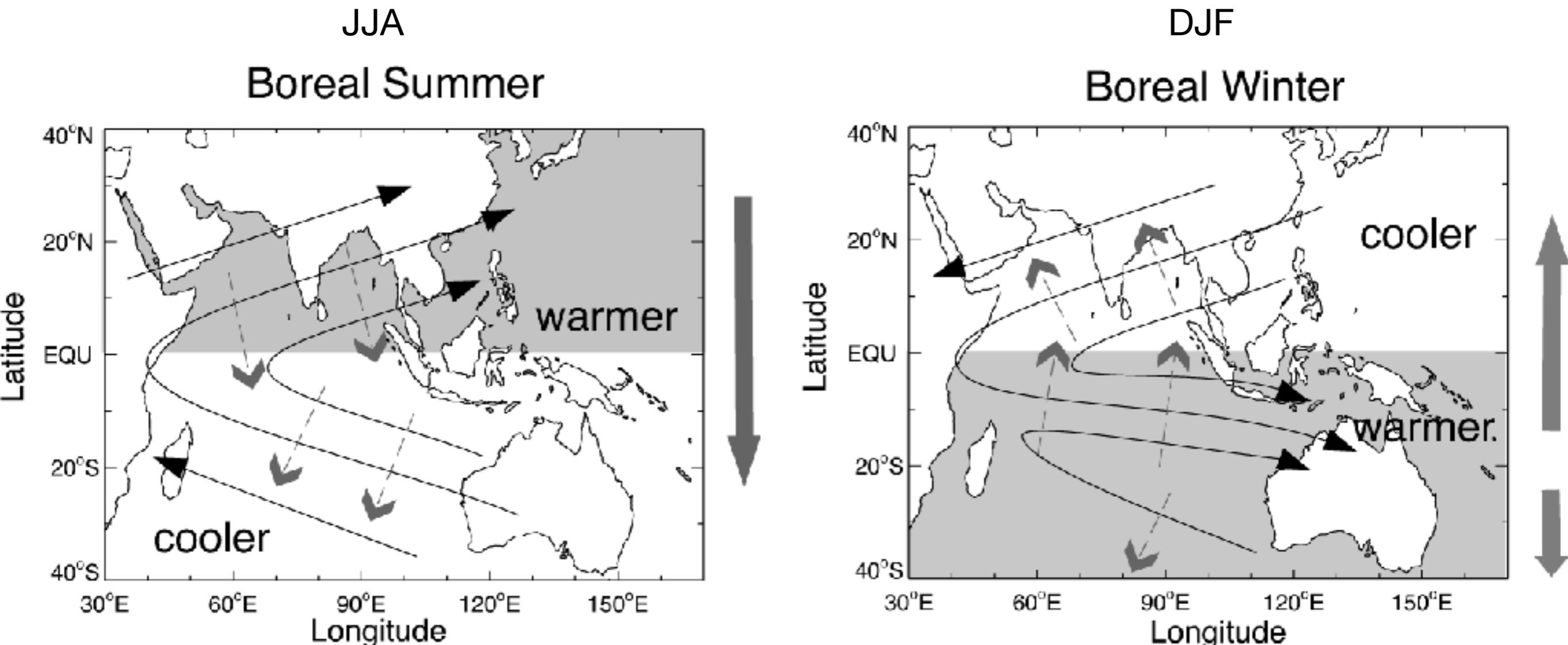


Figure from the slide by Jonathan Wright

# Ocean heat transport

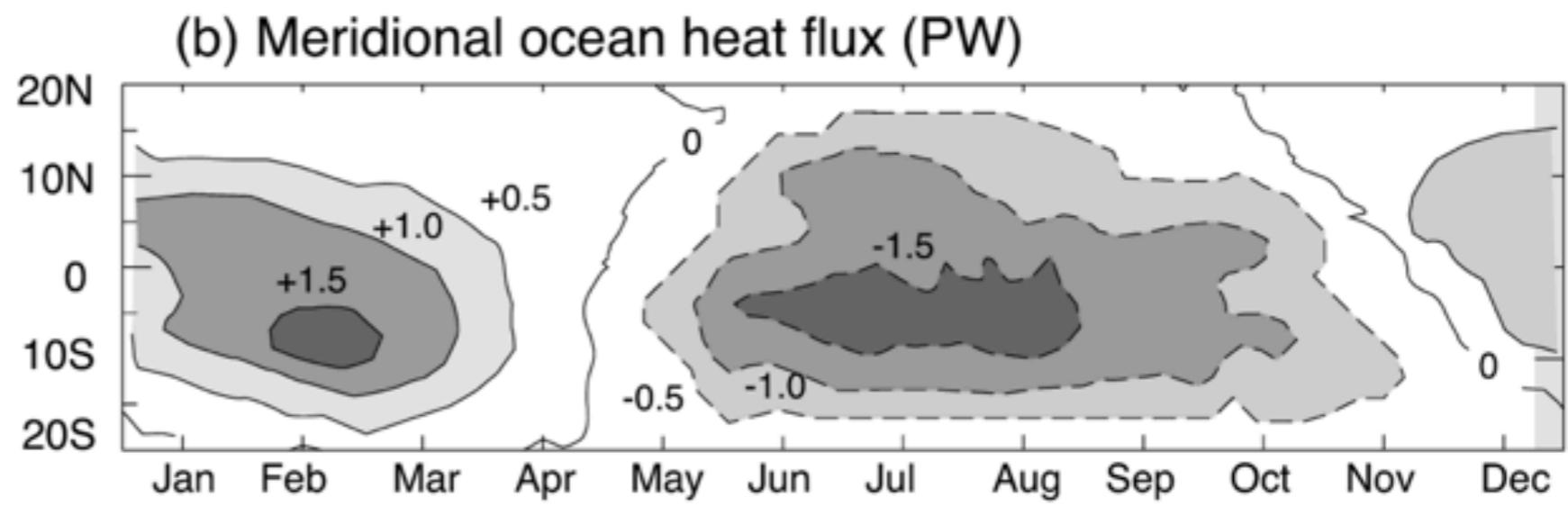
Figure from the slide by Jonathan Wright



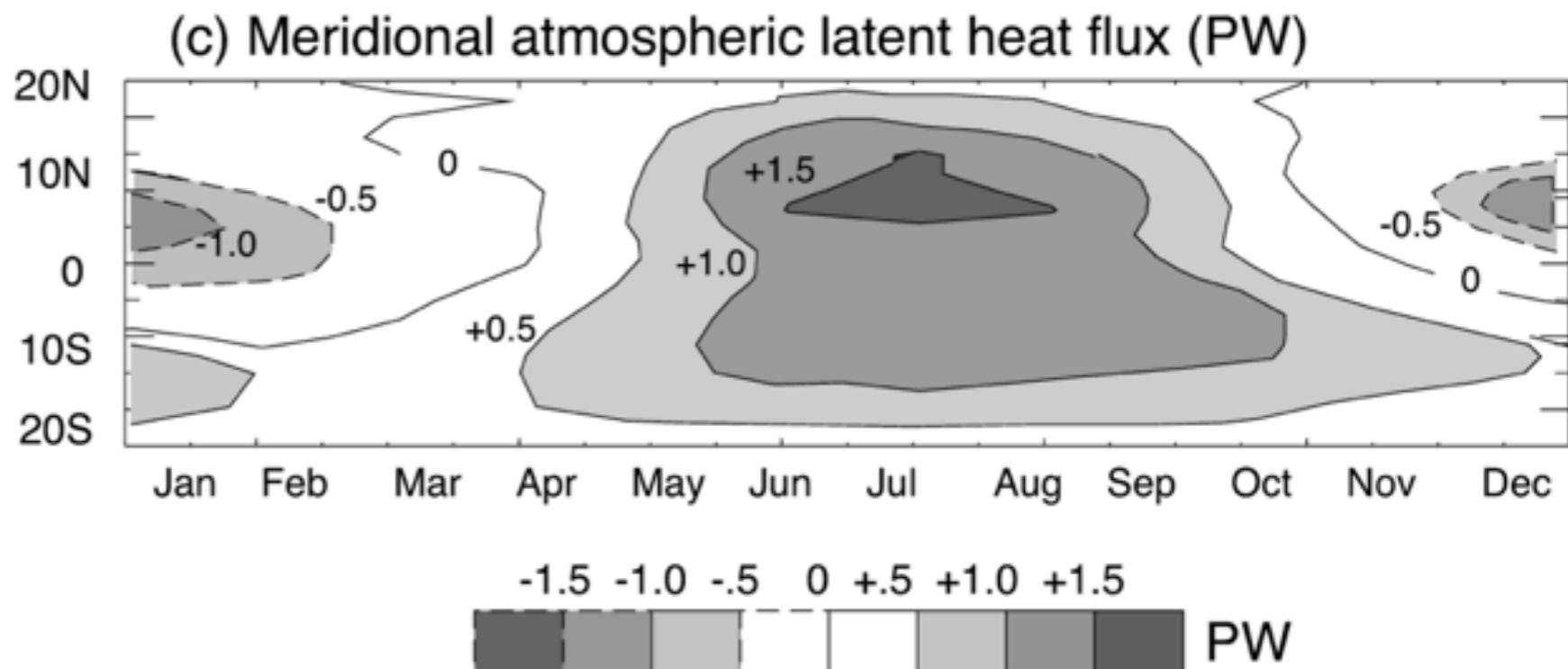
- Ocean heat transport by atmospheric circulation
- Atmospheric circulation is driven by surface heat flux
- **A negative atmosphere-ocean feedback**

# Atmospheric latent heat flux

The ocean moves energy from the summer hemisphere to the winter hemisphere



The atmosphere moves energy from the summer hemisphere to the winter hemisphere



# Variability of the monsoon in India

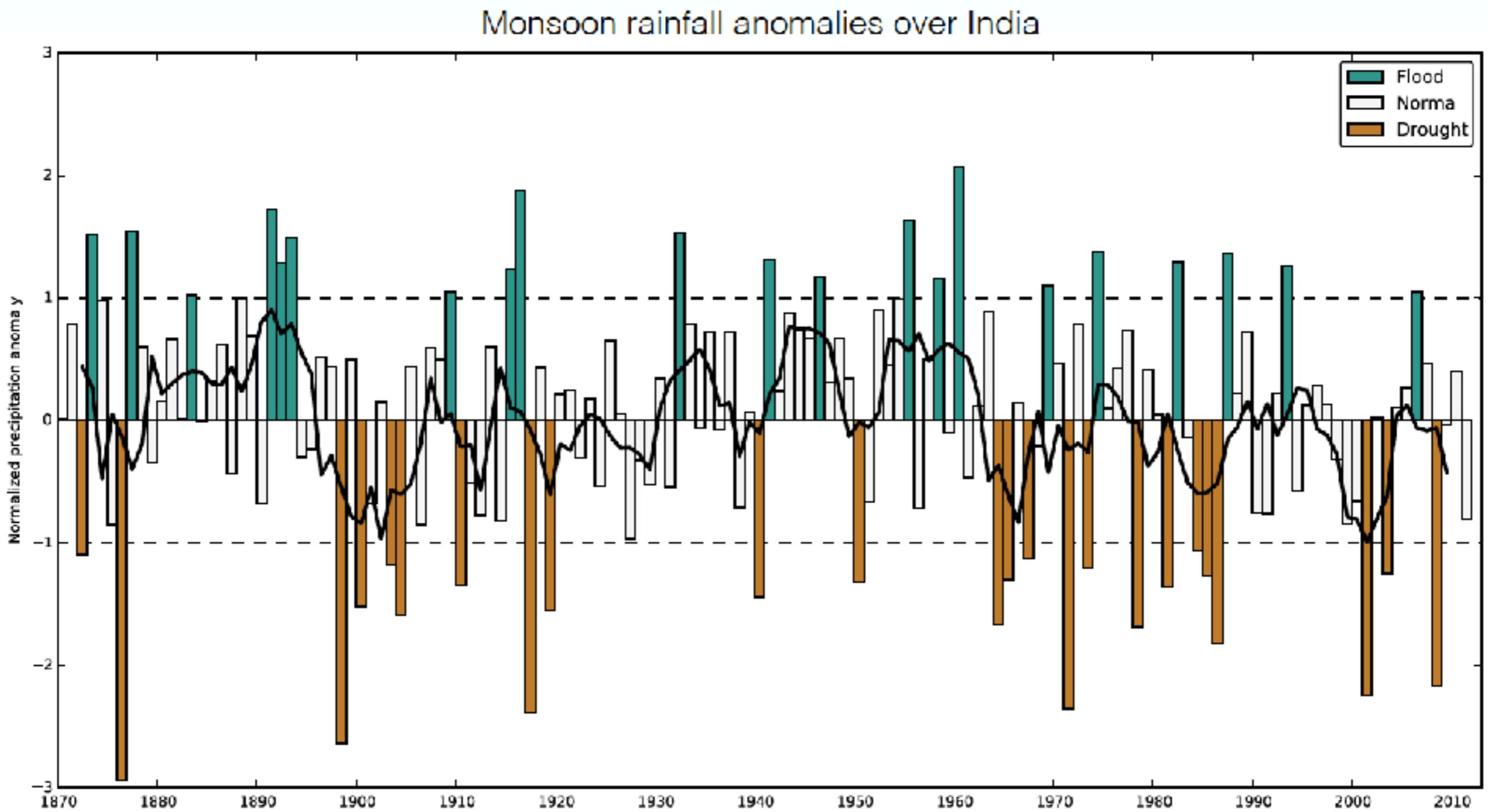


Figure from the slide by Jonathan Wright

# Variability of the monsoon in India

---

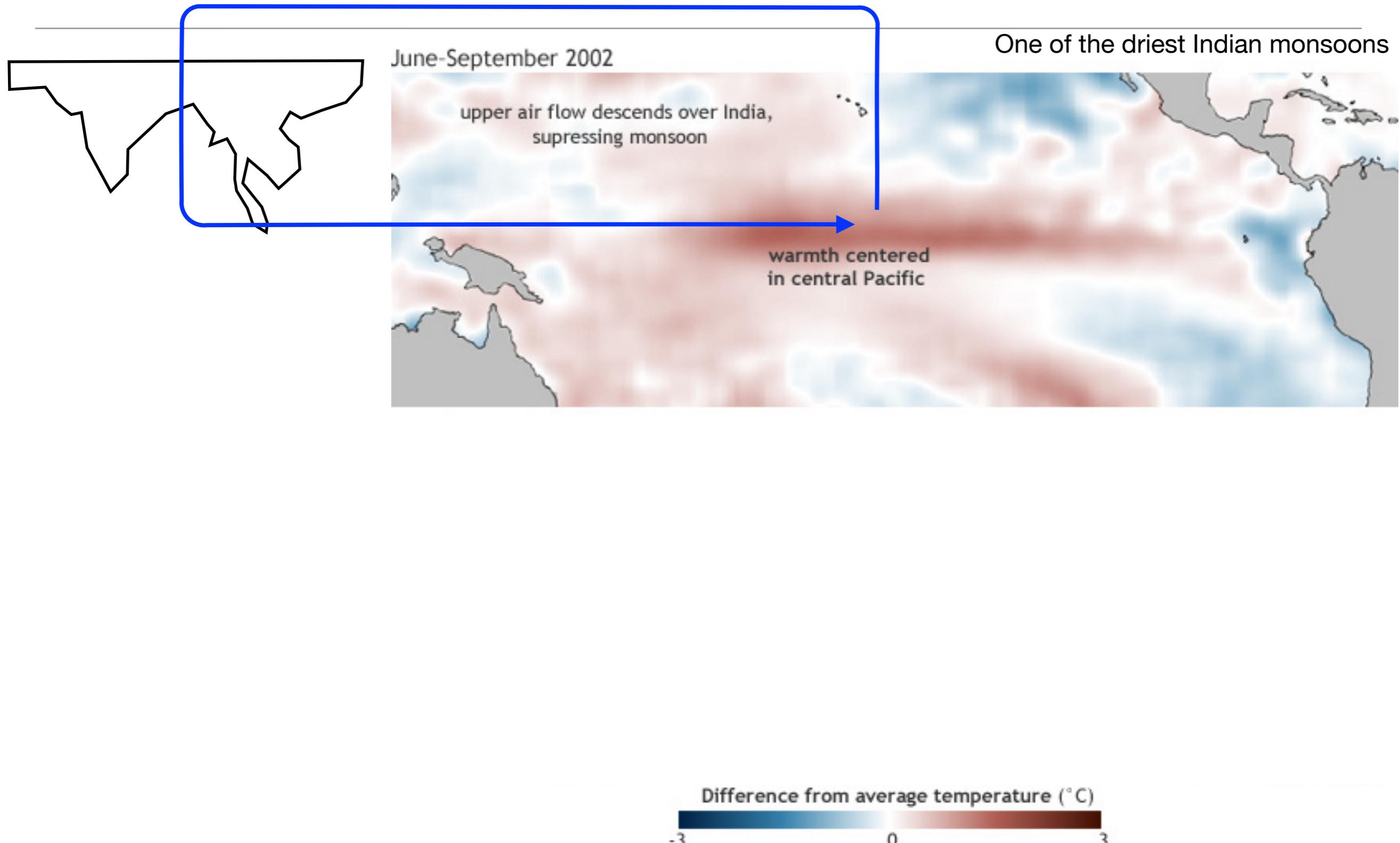
“In India, where more than 60% of agricultural land is rainfed and the average farm size is only 3.5 acres, a failed monsoon often means complete loss of a crop. Recent increases in suicides among heavily indebted farmers have highlighted the extreme desperation in some areas.”

“According to the agriculture ministry, relief expenses totaled about \$5 billion during the last major drought in 2002.”

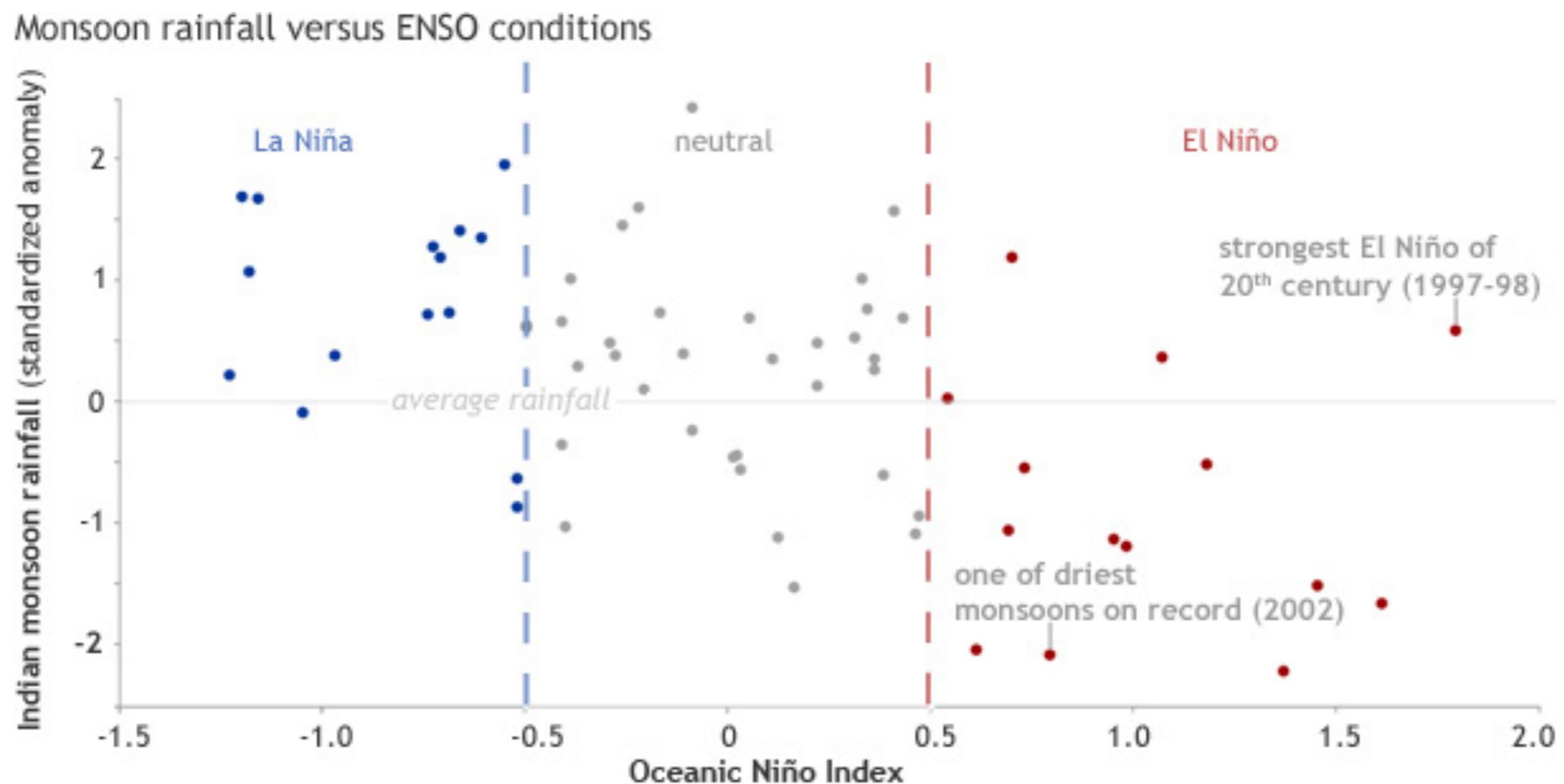


**\$5 billion = 5,408,700,000,000.00 South Korean Won**

# ENSO and Monsoon

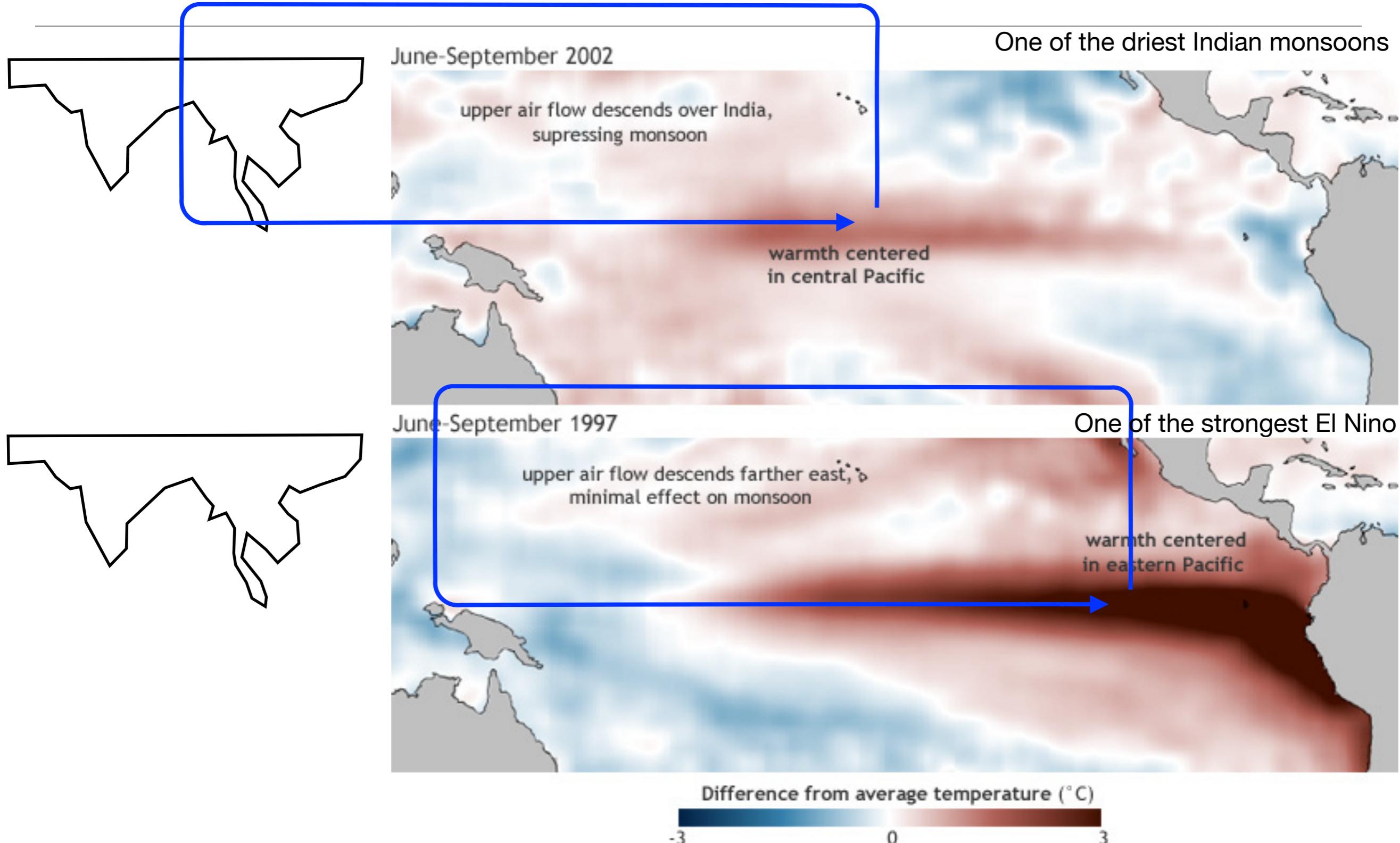


# ENSO and Monsoon

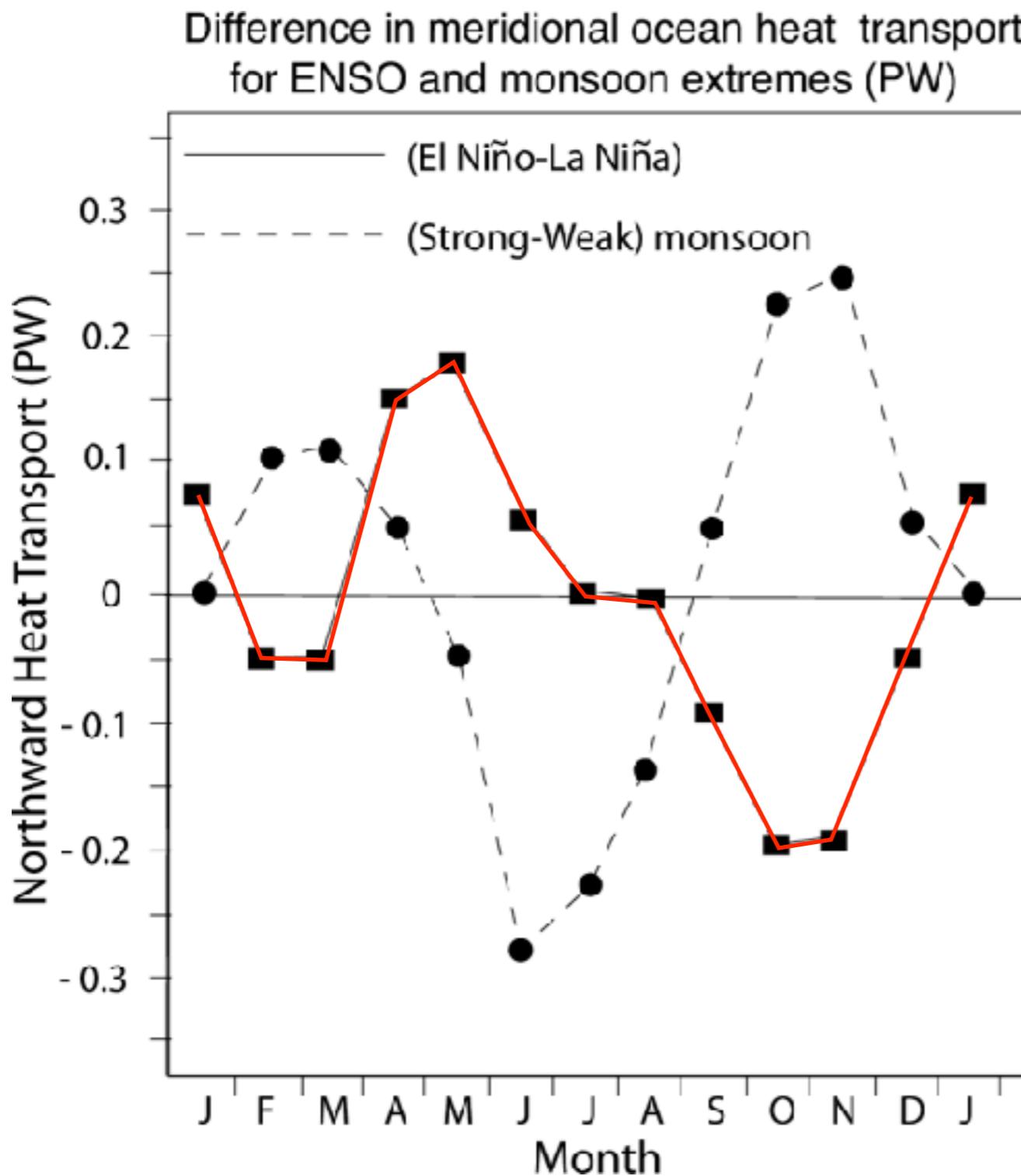


Comparison of the **Oceanic Niño Index** to **Indian monsoon rainfall** from 1950-2012. La Niña years are blue, neutral years are gray, and El Niño years are red. El Niño years *tend* to be drier than average, but the strongest El Niño of the century (1997-98) produced a monsoon season with above-average rainfall. Graph adapted from Kumar et al. 2006.

# ENSO and Monsoon



# ENSO and Monsoon



El Nino : delayed oceanic heat transport and possibly the weakened monsoon

La Nina : early oceanic heat transport and possibly the enhanced the monsoon

# Summary

---

- Monsoons are seasonal variations in precipitation and winds, showing concentrated precipitation in summer.
- Different heating and temperature gradient can drive the monsoon.
- The interplays between the atmosphere and ocean are important to understand the monsoons.
- Interannual variability associated with large scale climate events (e.g. El Nino) makes it difficult to predict the monsoons.



5 km