CLIK Training: June 7-9, 2017 (Bangkok, Thailand)
June 14-16, 2017 (Naypyitaw, Myanmar)

Lecture 1.
Climate Variability

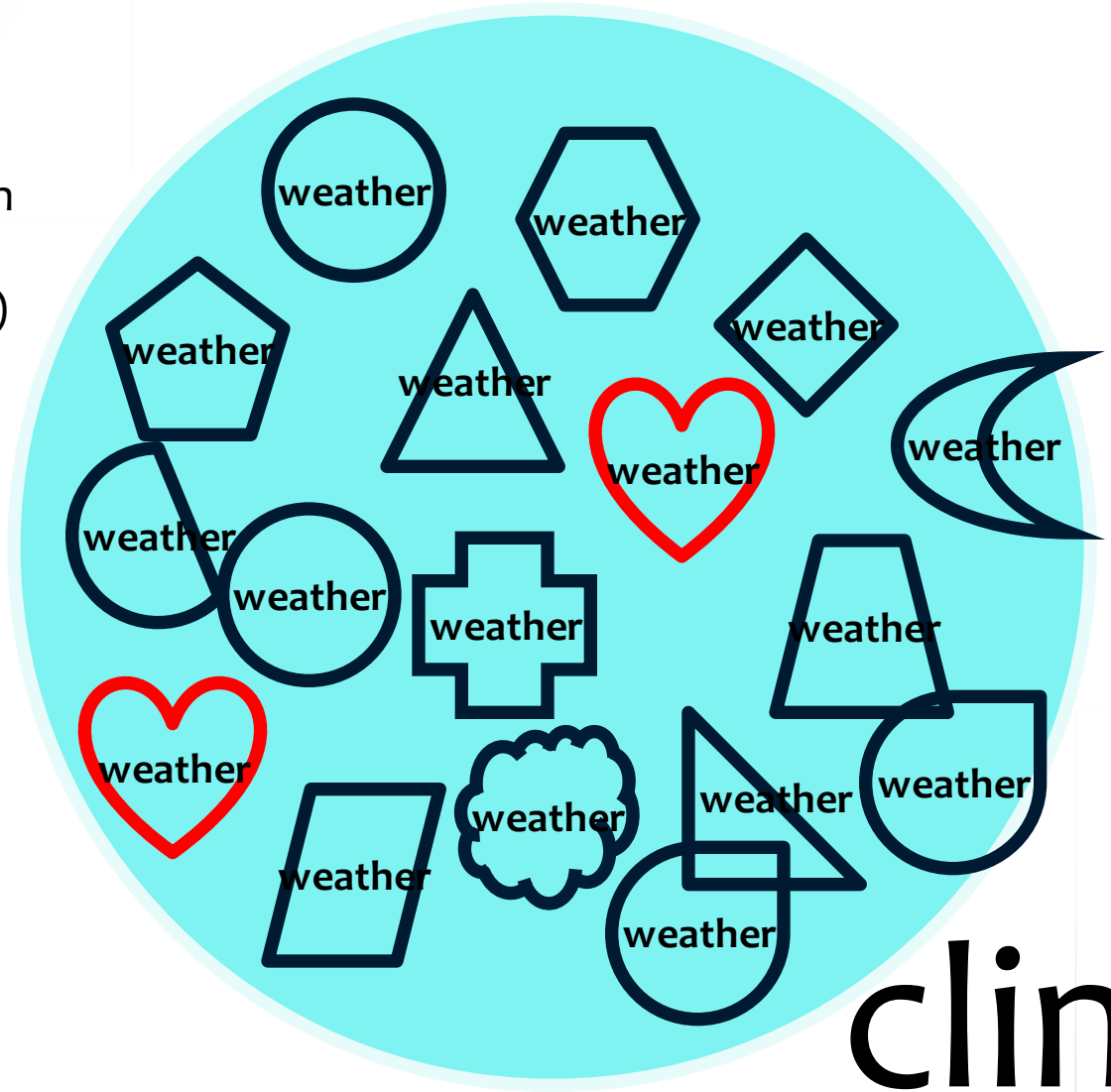
Yun-Young Lee

APCC APEC CLIMATE CENTER

CLIMATE VARIABILITY?

Weather summary = Climate

Expectation= mean condition of atmosphere (temp. & Prcp.)



Tell us your story…

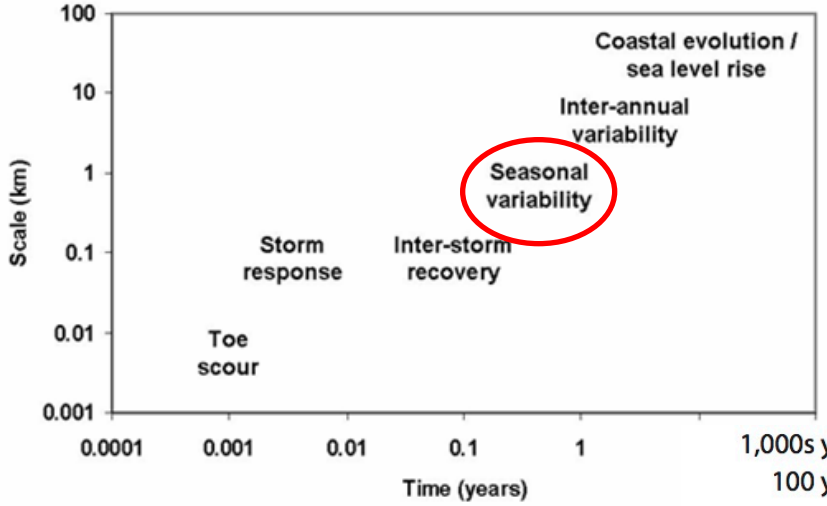
1. How many seasons do you have? What are they?

2. Climate variability (mode) modulating the intensity of wetness /dryness in your country?

CLIMATE VARIABILITY?

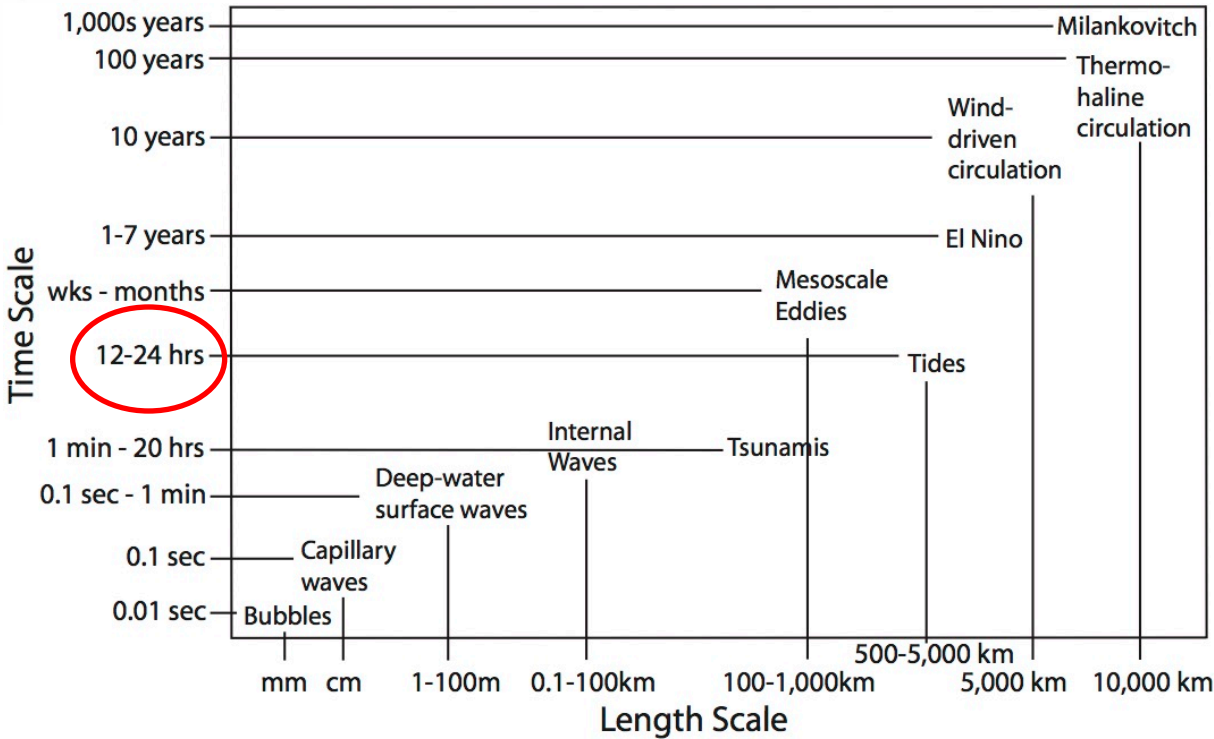
WHAT IS VARIABILITY?

Variability

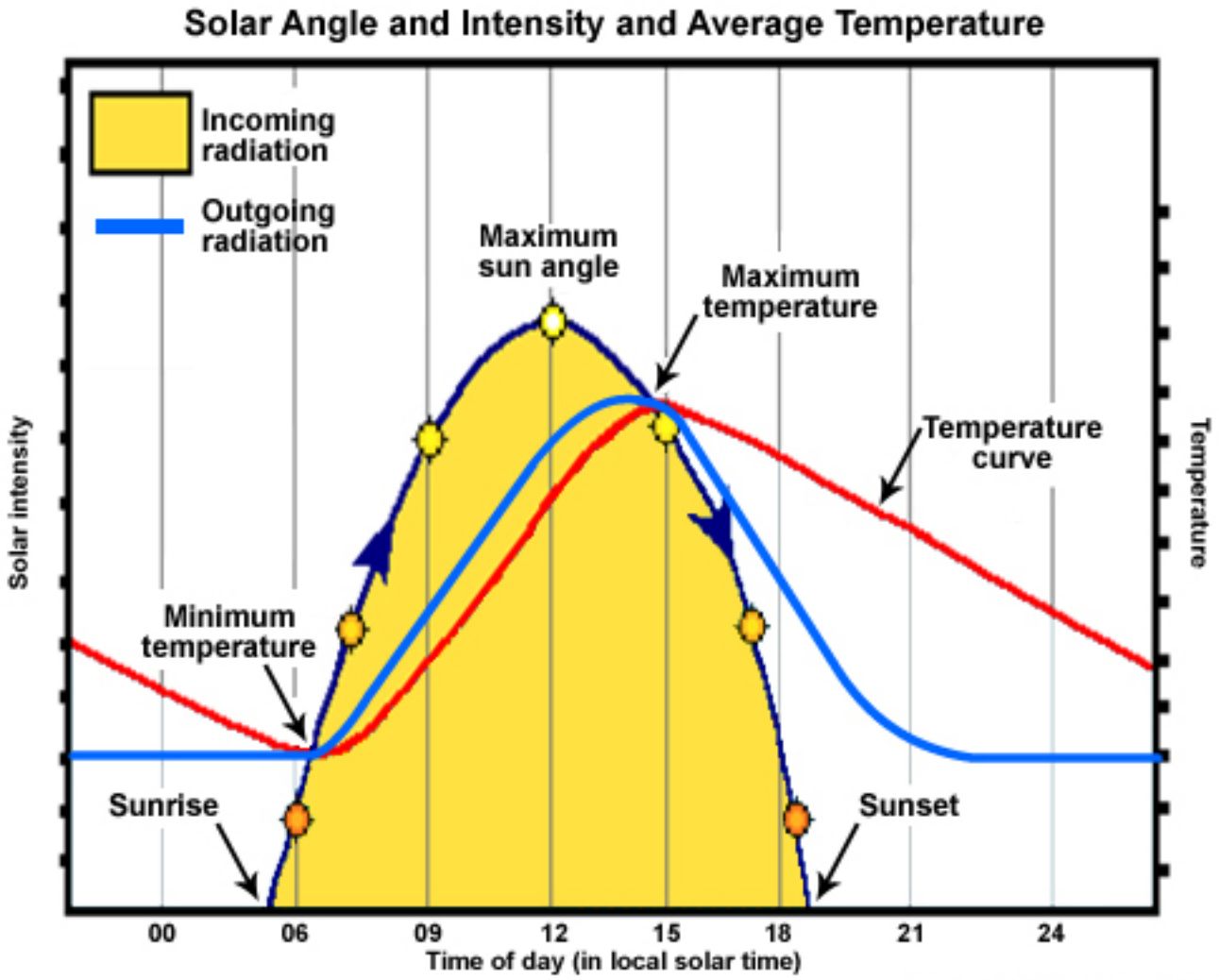


Energy Source: Solar insolation

Very obvious diurnal and seasonal cycle (oscillation) due to earth rotation & revolution (around the Sun)

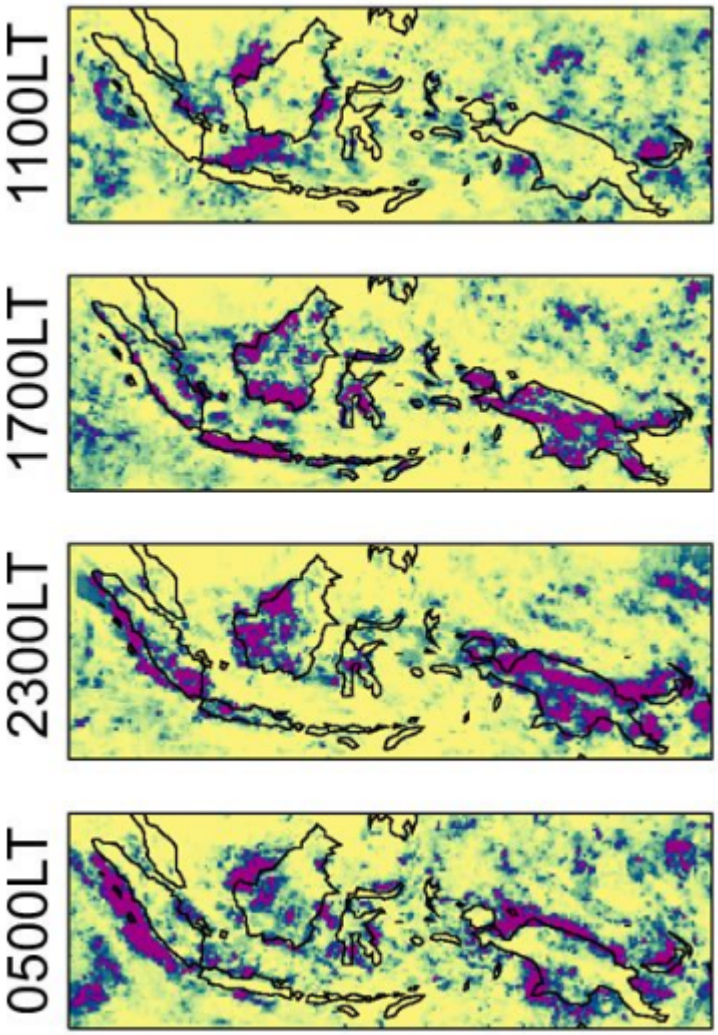


Diurnal cycle



- ✓ Humidity
- ✓ Cloudiness
- ✓ Wind

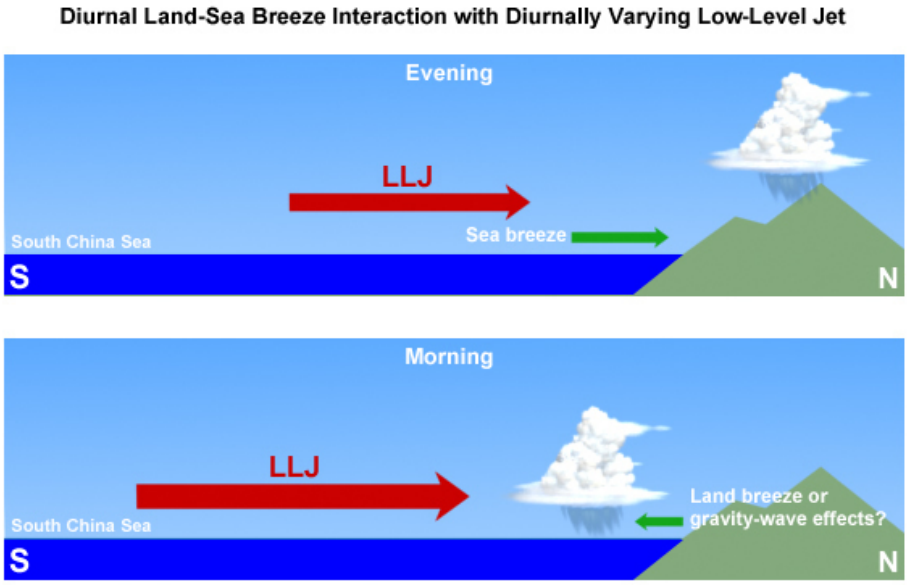
Diurnal cycle



From Jane Strachan

Land-sea breeze

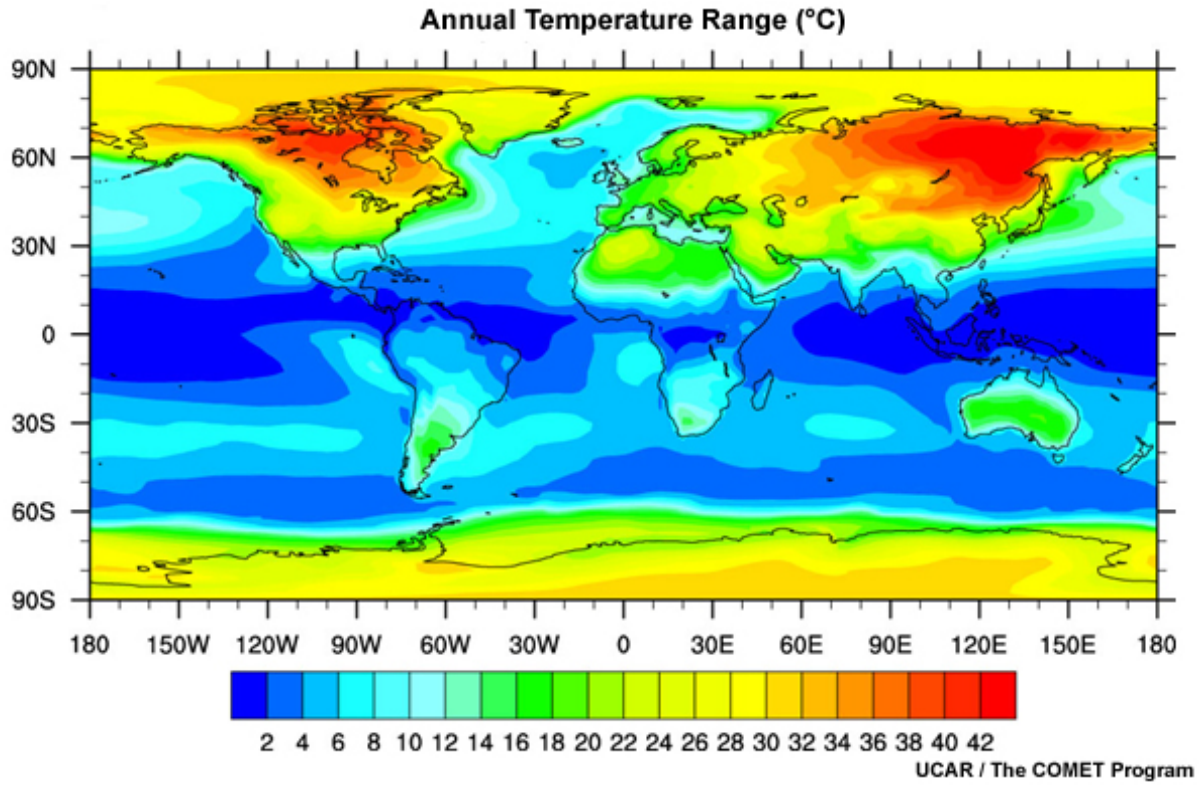
Mountain-Valley circulation

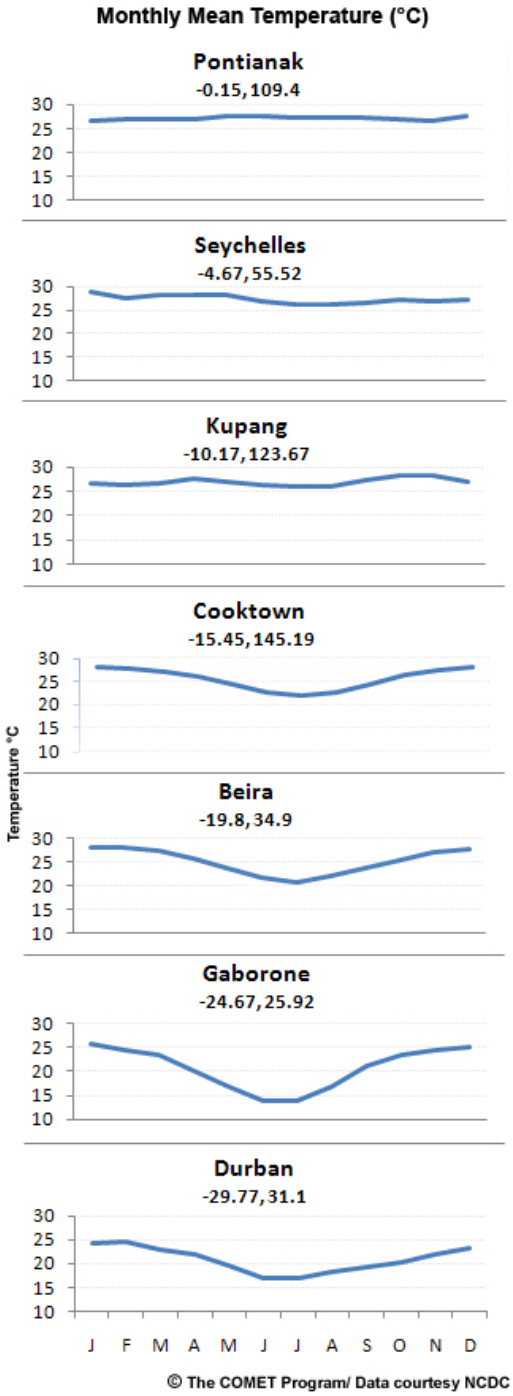


From R. Johnson

Seasonal cycle

- ✓ Latitude
- ✓ Continentality
- ✓ Clouds and Precipitation
- ✓ Albedo





Climate Variability

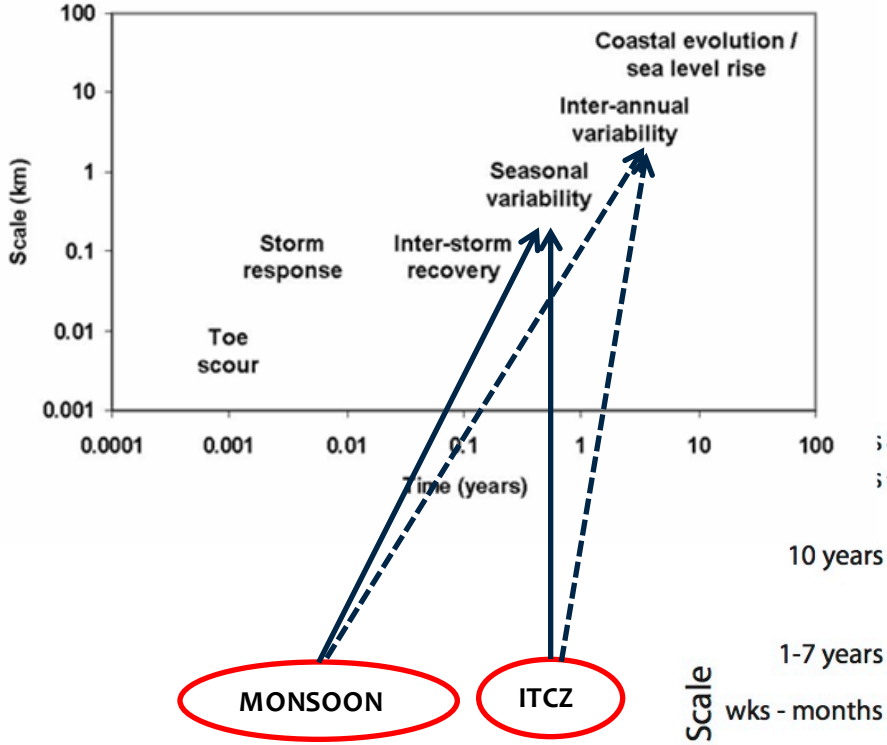
Weather = (a series of individual realization) = Temporal fluctuation of atmospheric condition

Climate variability = (variability of expectation) = spatiotemporal fluctuations (oscillations) of mean atmospheric condition associated with dynamical atmospheric/oceanic systems

What are they?

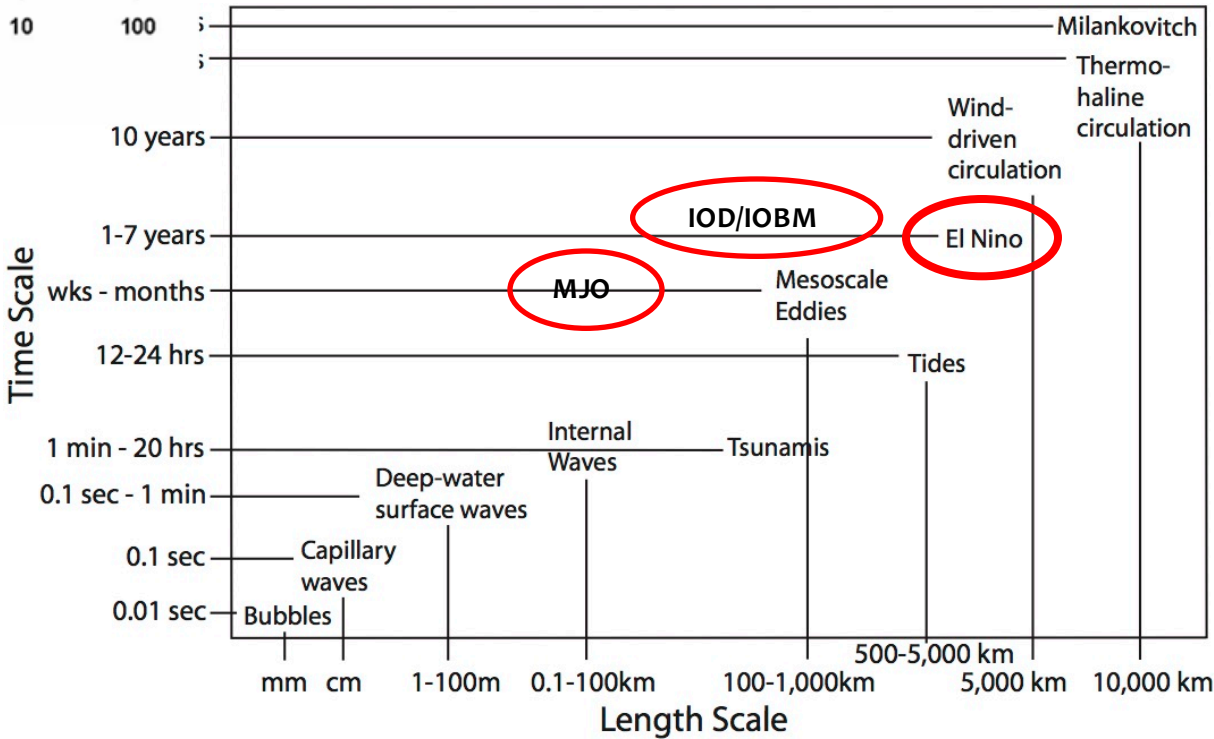
What kinds of climate variability are you familiar with?

Climate Variability



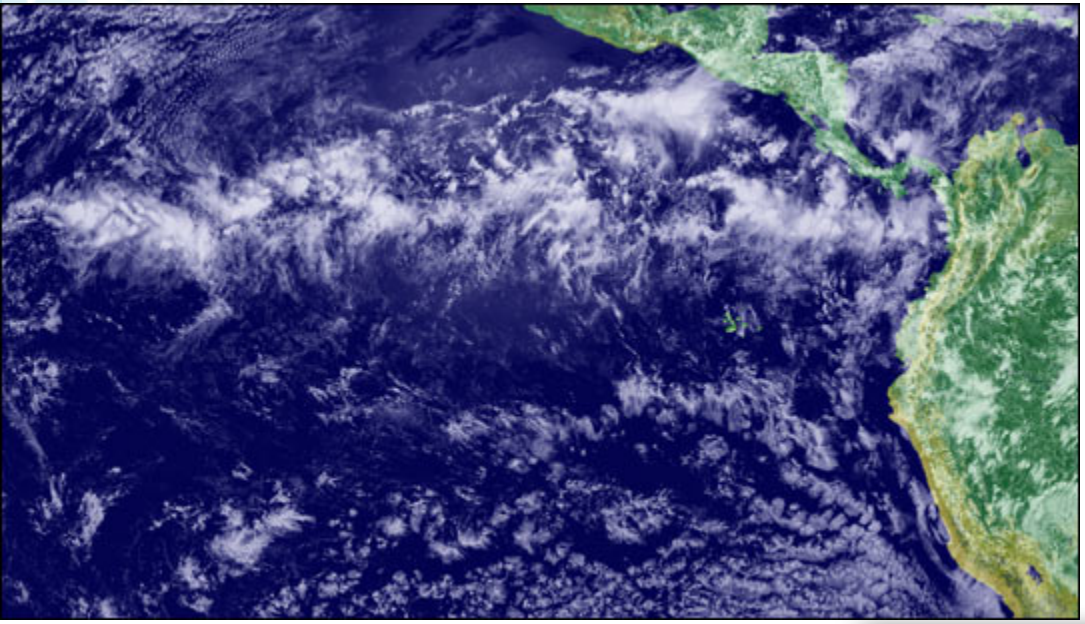
Energy Source: Solar radiation

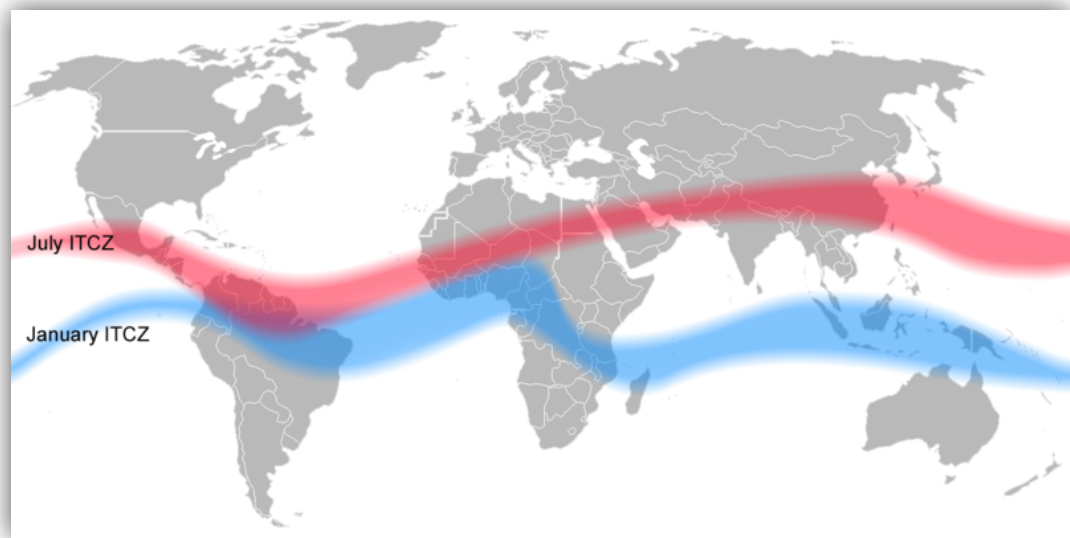
Very obvious diurnal and seasonal cycle (oscillation) due to earth rotation & resolution (relative to the Sun)



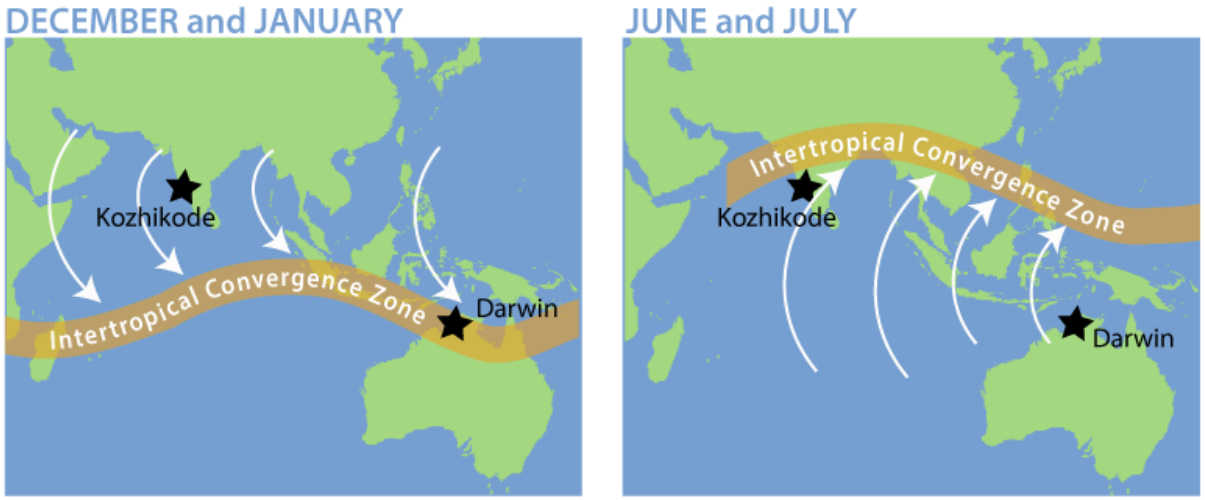
Inter Tropical Convergence Zone (ITCZ)

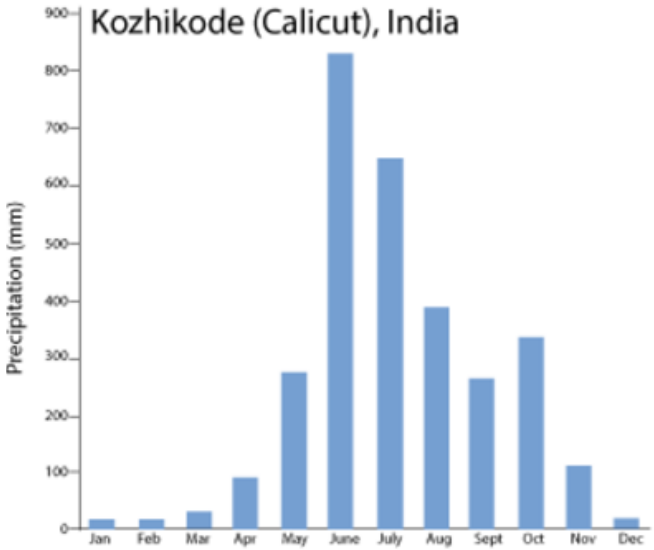
https://earthobservatory.nasa.gov/IOTD/view.php?id=703

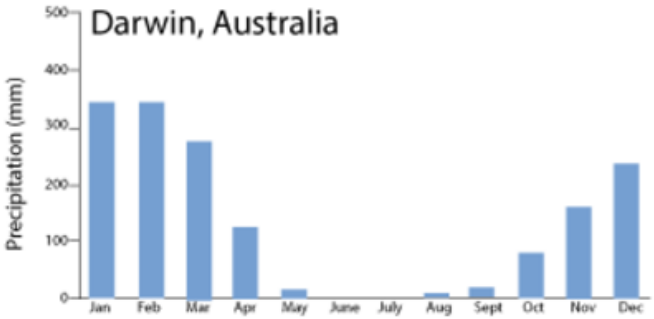




Inter Tropical Convergence Zone (ITCZ)







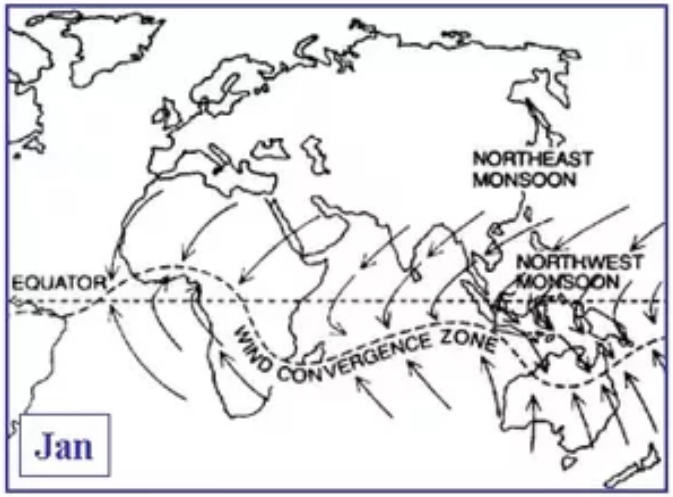
As the Intertropical Convergence Zone (ITCZ) changes location through the year, the winds, rains, and the location of wet monsoon weather changes, too. In this example from Asia and Australia, the ITCZ moves from the Southern Hemisphere (left map) to the Northern Hemisphere (right map). (Images: UCAR)

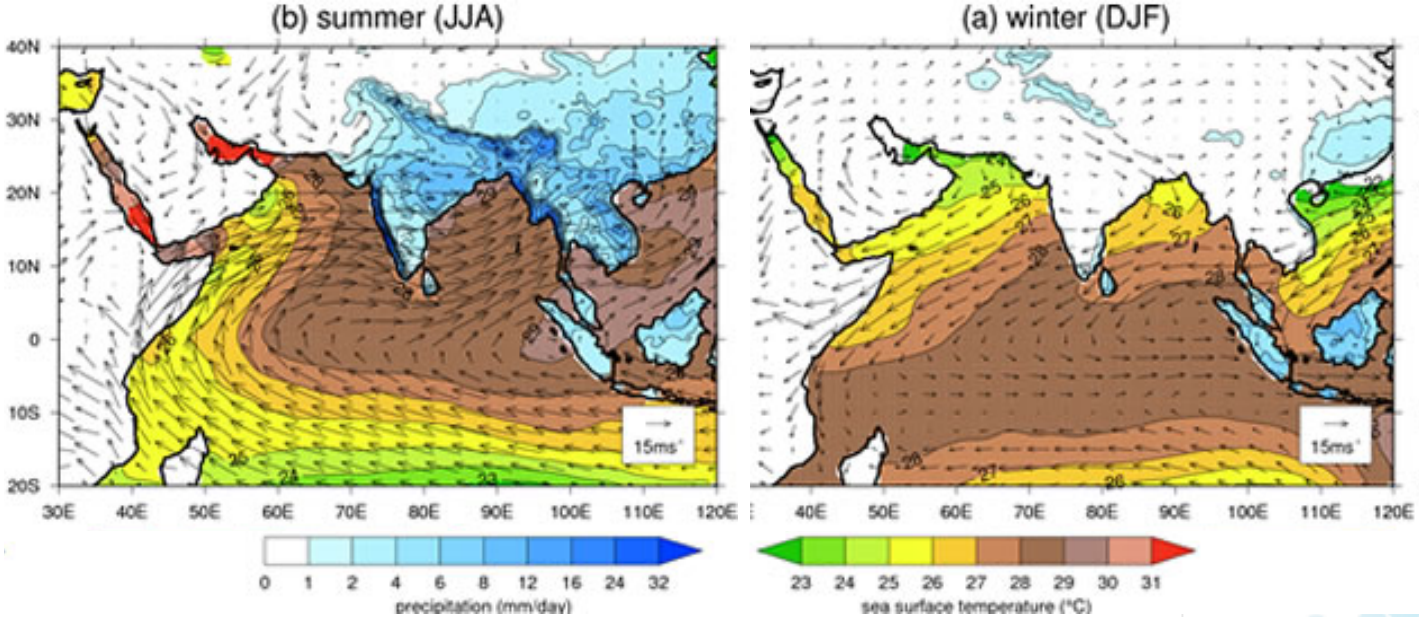
As the ITCZ swings north during the summer months, it brings monsoon rains to Kozhikode, India. As the ITCZ drops south during summer in the Southern Hemisphere, it brings monsoon rains to Darwin, Australia. (Images: UCAR)

http://monsoon.yale.edu/why-monsoons-happen/

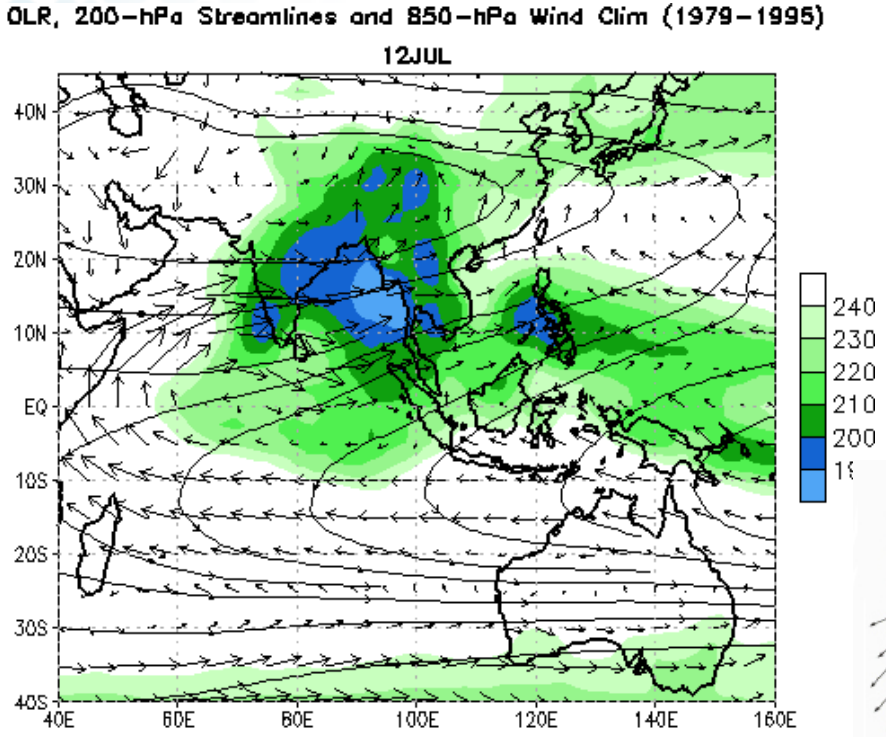
Monsoon


WIND CONVERGENCE ZONE
SOUTHWEST MONSOON
AFRICAN SOUTHWEST MONSOON
SOUTHEAST MONSOON
July

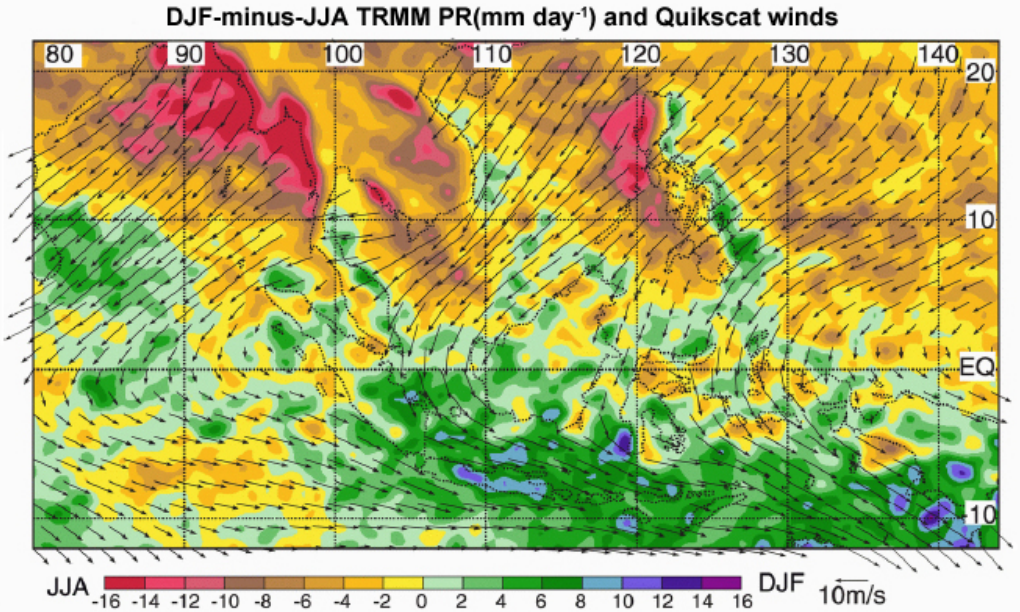

NORTHEAST MONSOON
EQUATOR
NORTHWEST MONSOON
WIND CONVERGENCE ZONE
Jan


(b) summer (JJA)
(a) winter (DJF)
40N
30N
20N
10N
0
10S
20S
30E
40E
50E
60E
70E
80E
90E
100E
110E
120E
15ms⁻¹
0 1 2 4 6 8 12 16 24 32
precipitation (mm/day)
23 24 25 26 27 28 29 30 31
sea surface temperature (°C)

Monsoon

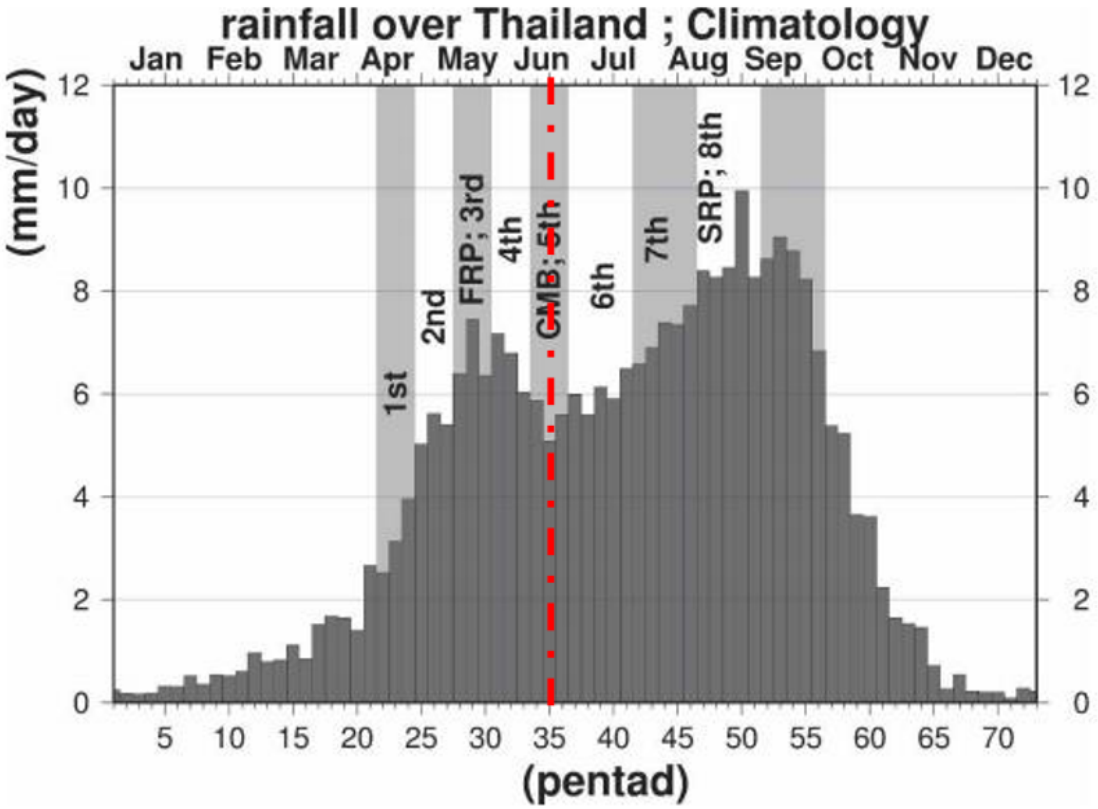


Data Sources: OLR – NESDIS/ORA, Winds – NCEP CDAS/ Reanalysis



Chang et al. 2005

Monsoon



Takahashi and Yasunari (2006)

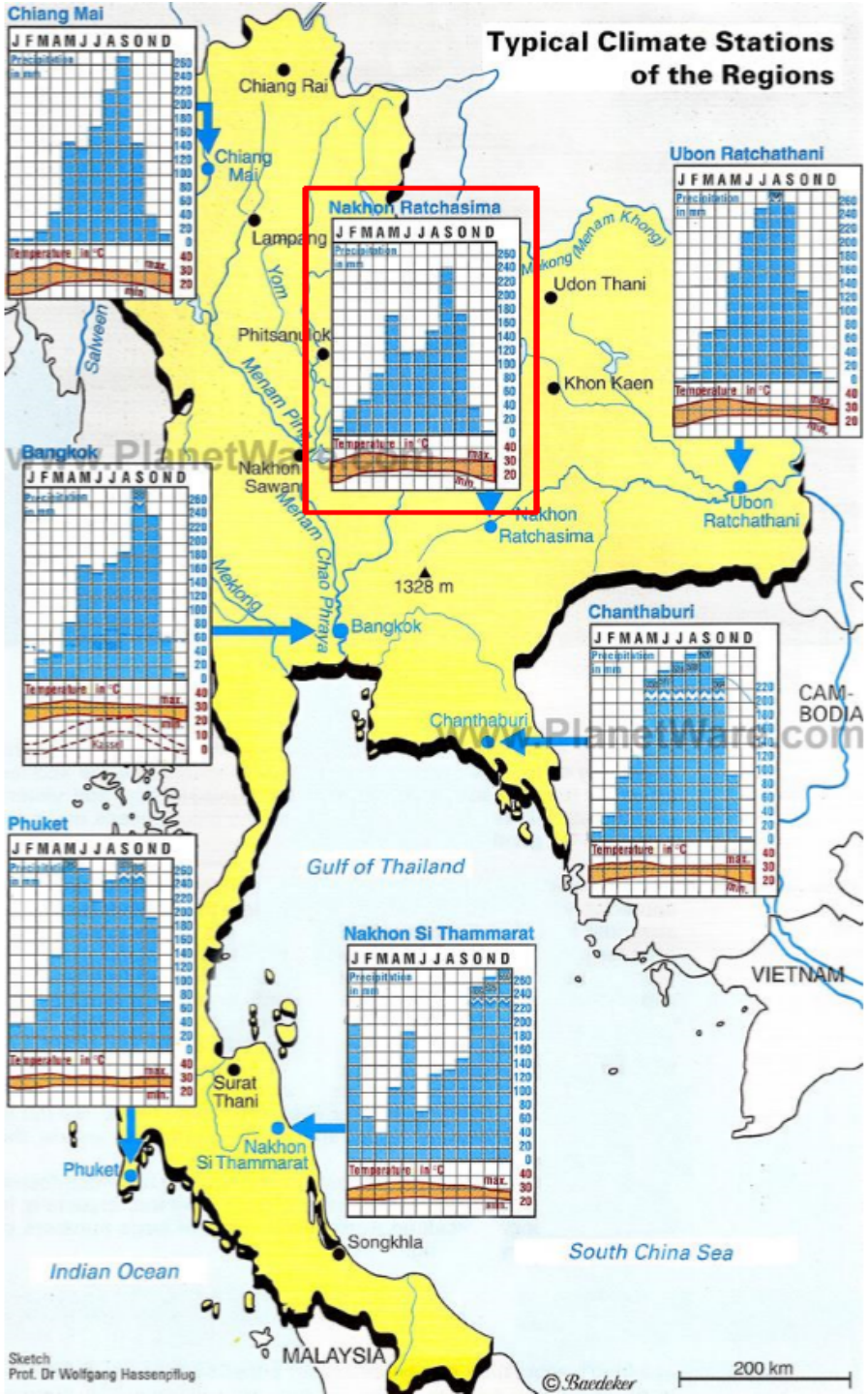
Rainy season in Thailand!

First half of the rainy season (from May to June) <- typical monsoon southwesterlies

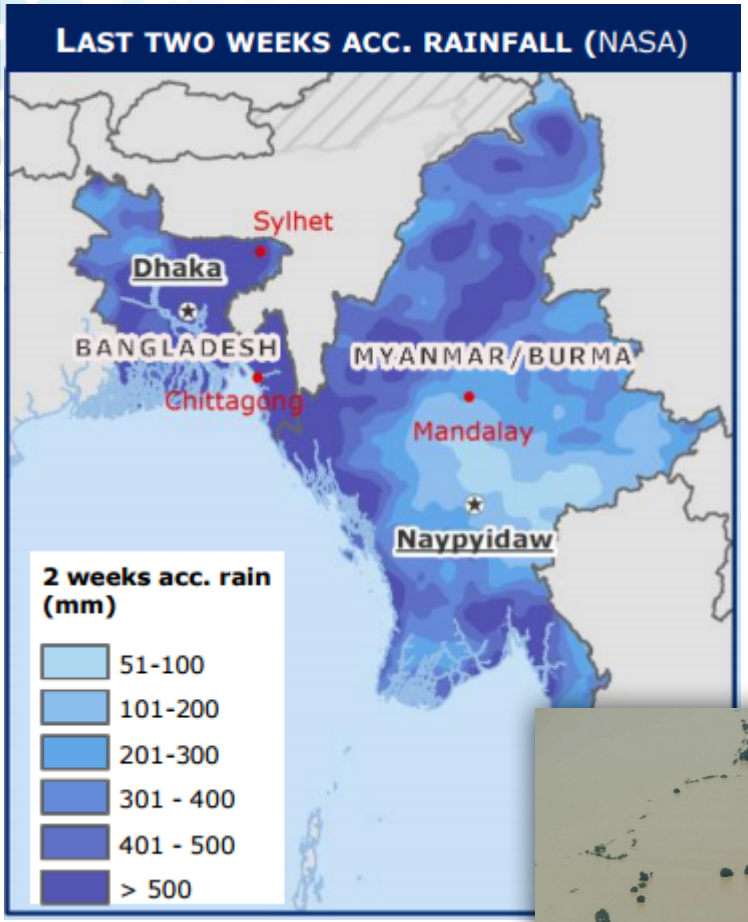
Second half of the season (from July to September) <- active TCs

Regional difference

Coastal area vs Inland



2015 July Myanmar Flood :the worst for decades



Beginning on 16 July 2015, unusually heavy monsoon rain fell on Myanmar, causing rivers and creeks to overflow with rainwater and flooding low-lying areas around waterways. In addition to the higher-than-average rainfall, **mismanagement of irrigation projects** and **deforestation caused by logging ~ Cyclone Komen**, which struck in late July, also made the situation worse.

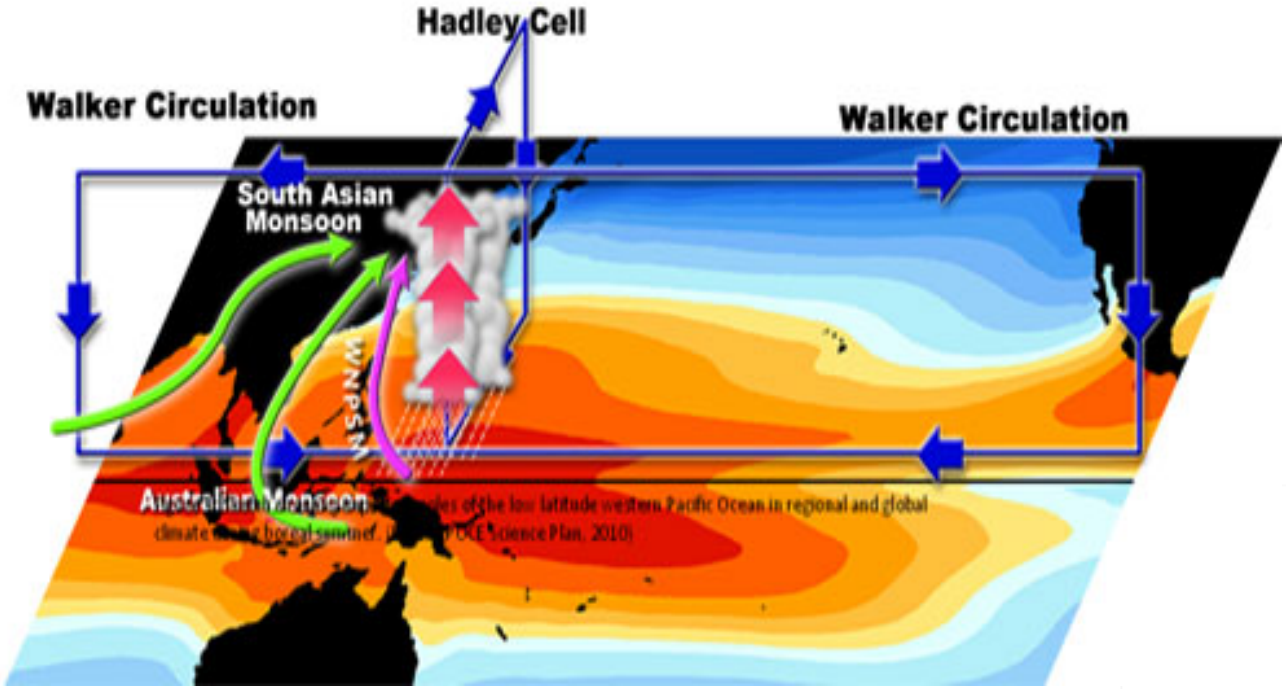
https://en.wikipedia.org/wiki/2015_Myanmar_floods

http://reliefweb.int/sites/reliefweb.int/files/resources/ECDM_20150727_MyanmarBurma_Bangladesh.pdf

Western Pacific Warm Pool (WPWP)

- Climate Engine : remember “mean” feature

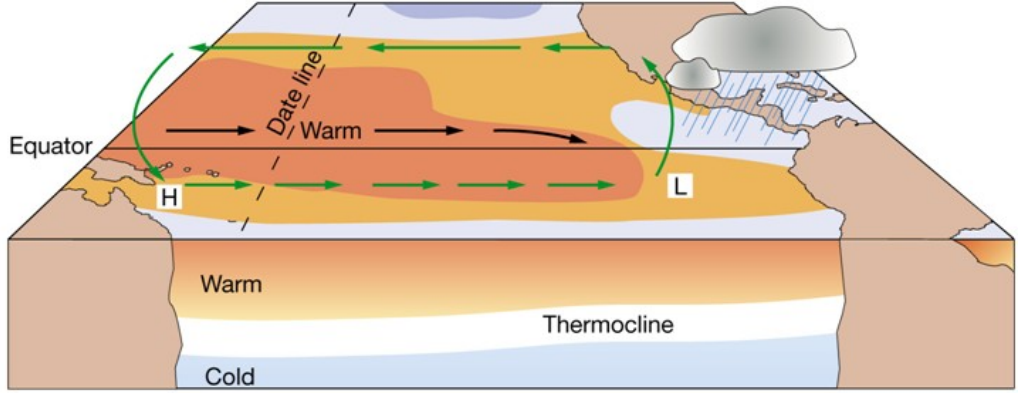
SST > 28.5° C



http://npoce.qdio.ac.cn/background

El Nino, ENSO

- A Big Ocean Swing



(b) El Niño conditions

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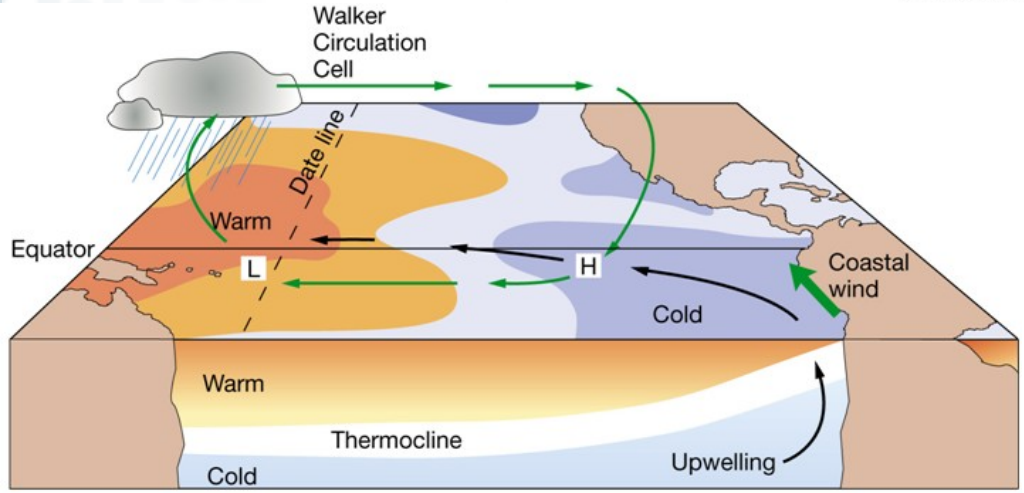

(a) Normal conditions

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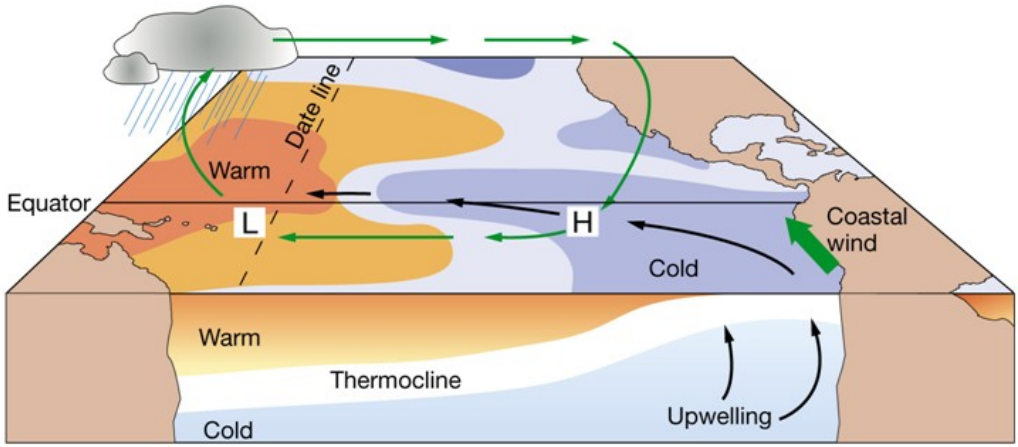

(c) La Niña conditions

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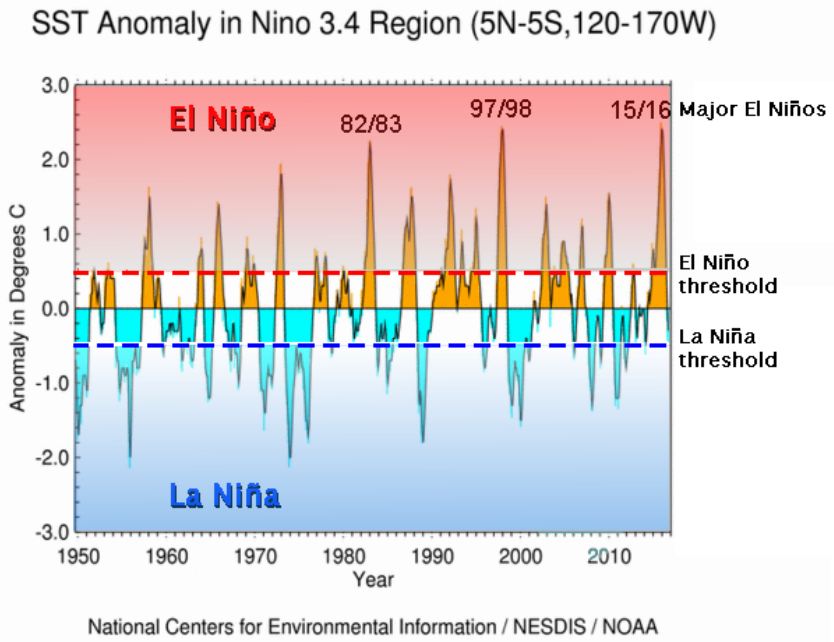
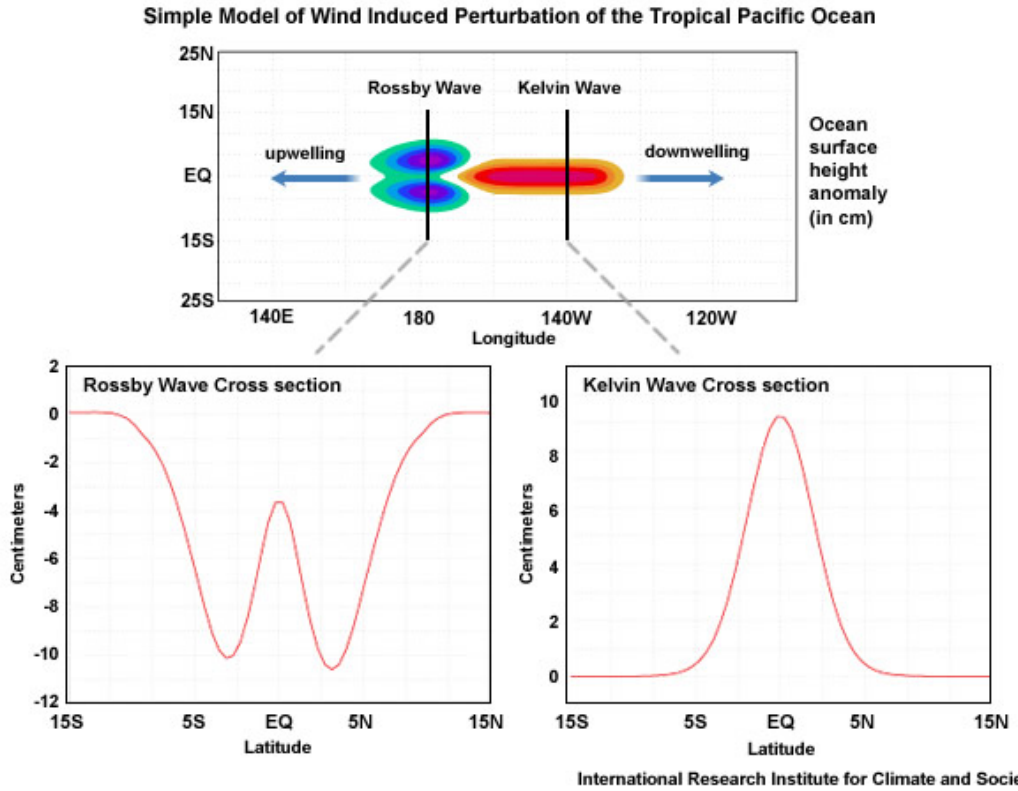
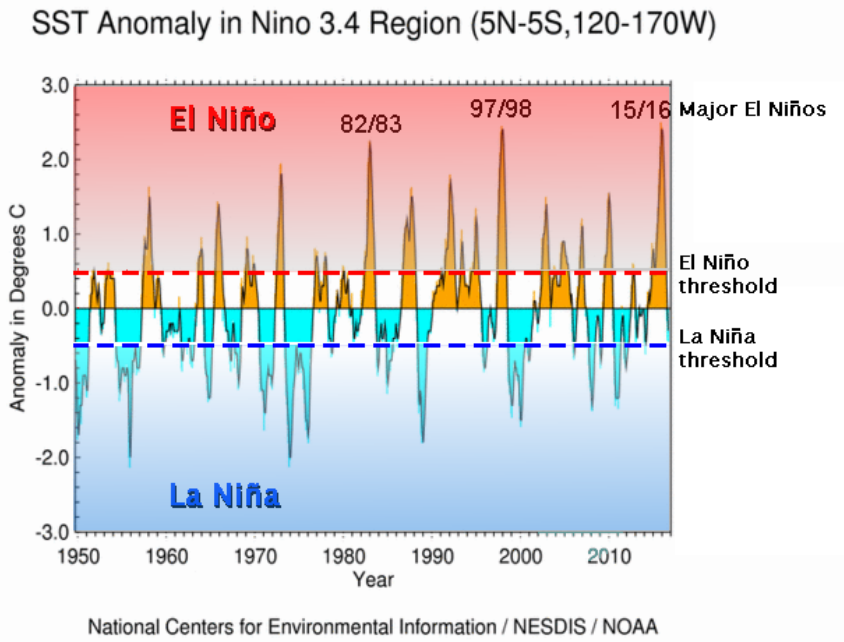
ENSO, why it oscillates?



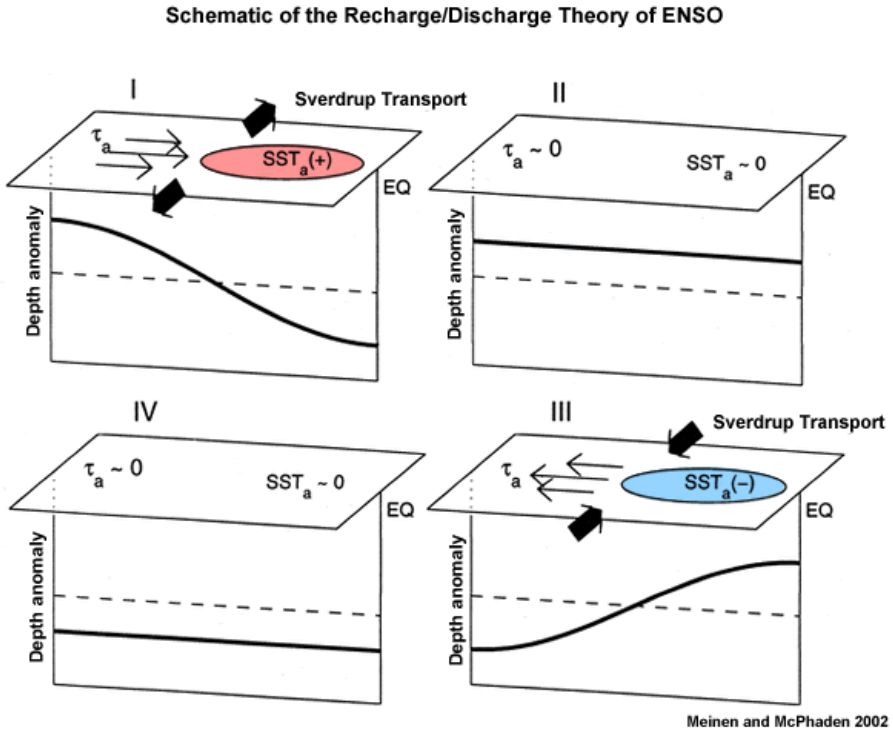
Delayed Oscillator



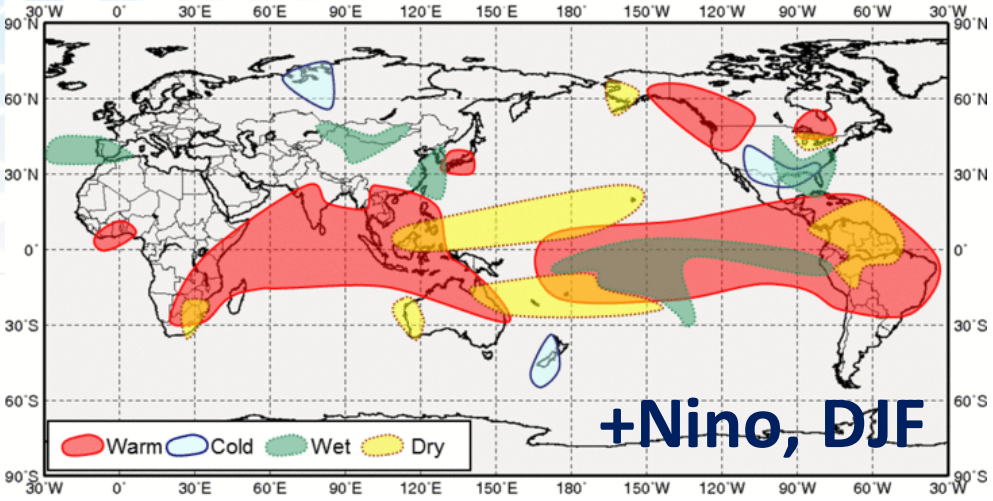
ENSO, why it oscillates?

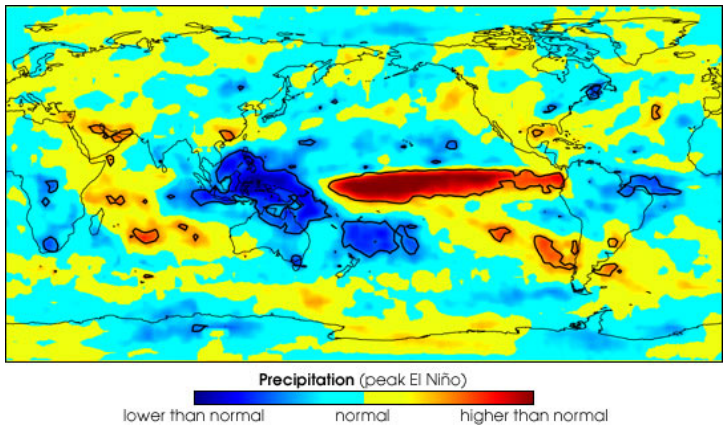


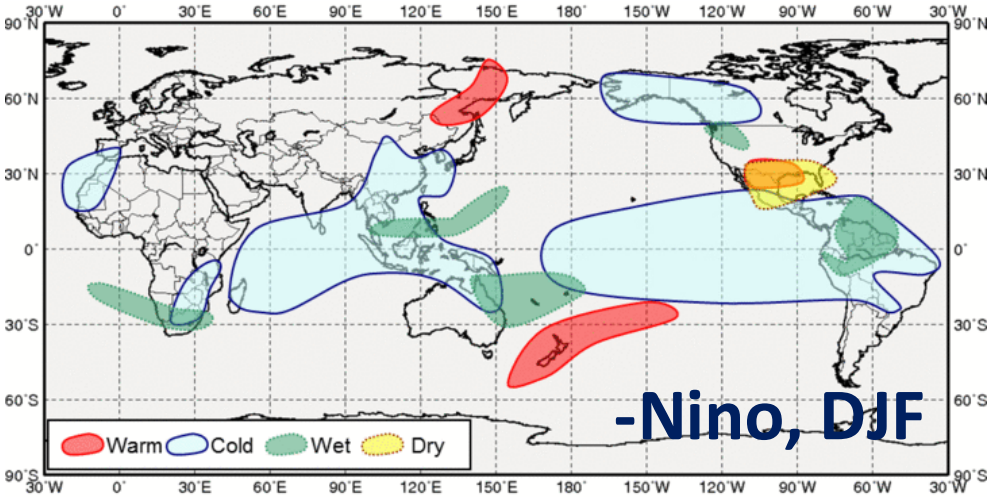
Recharge-discharge Oscillator

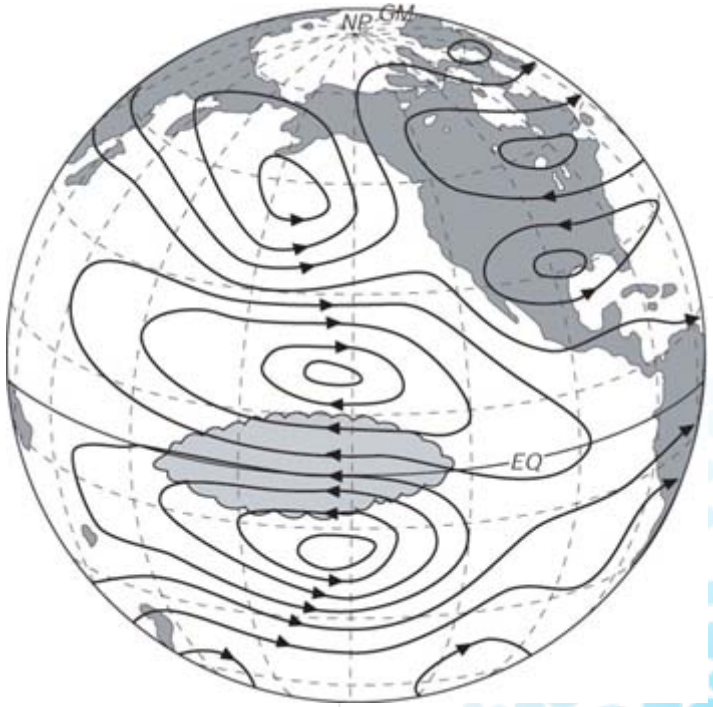


ENSO impact



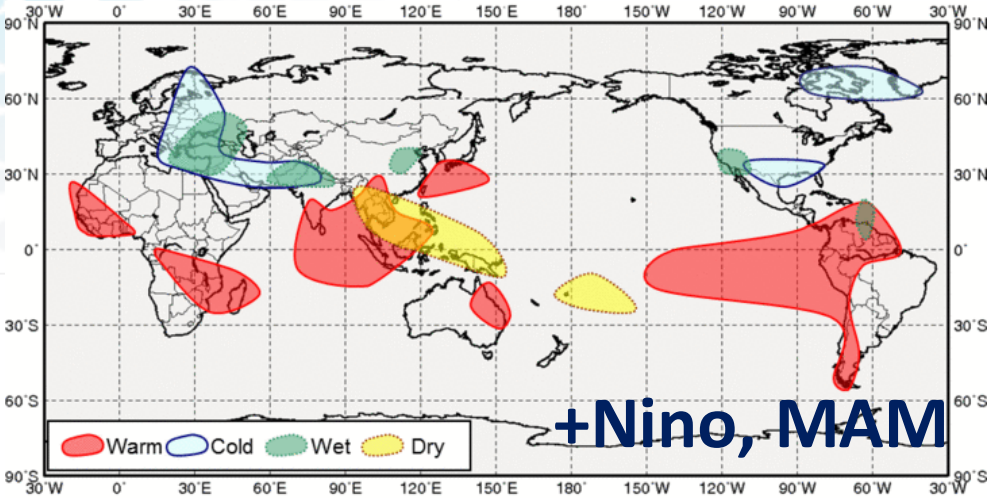


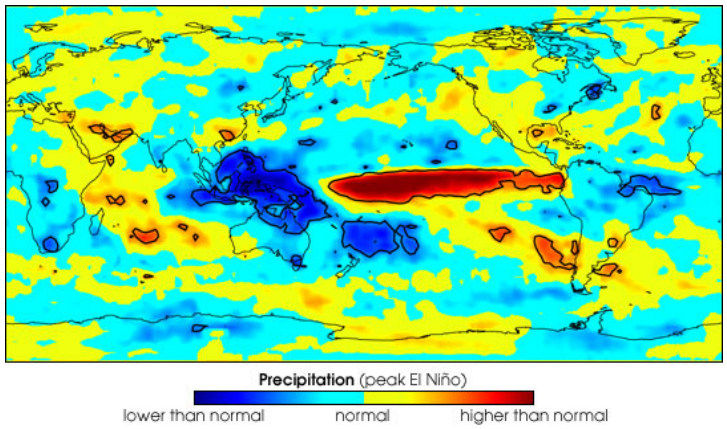


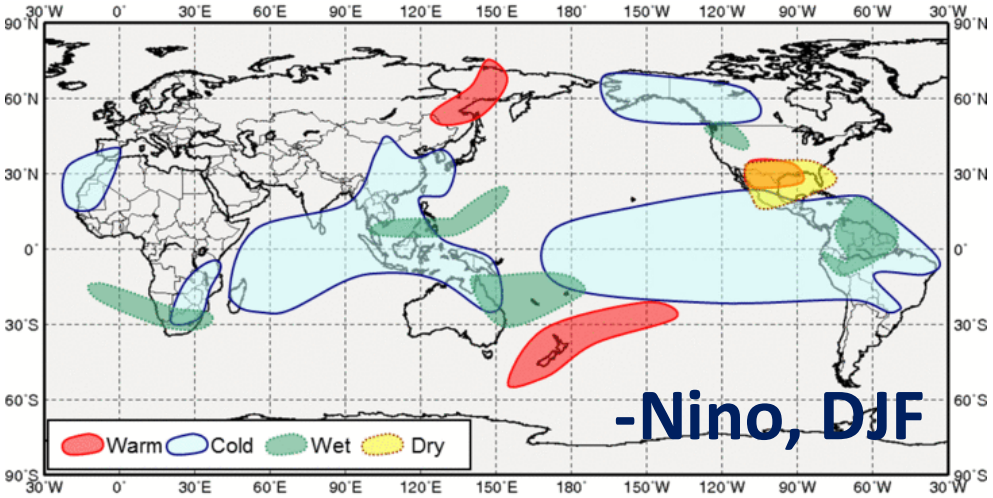


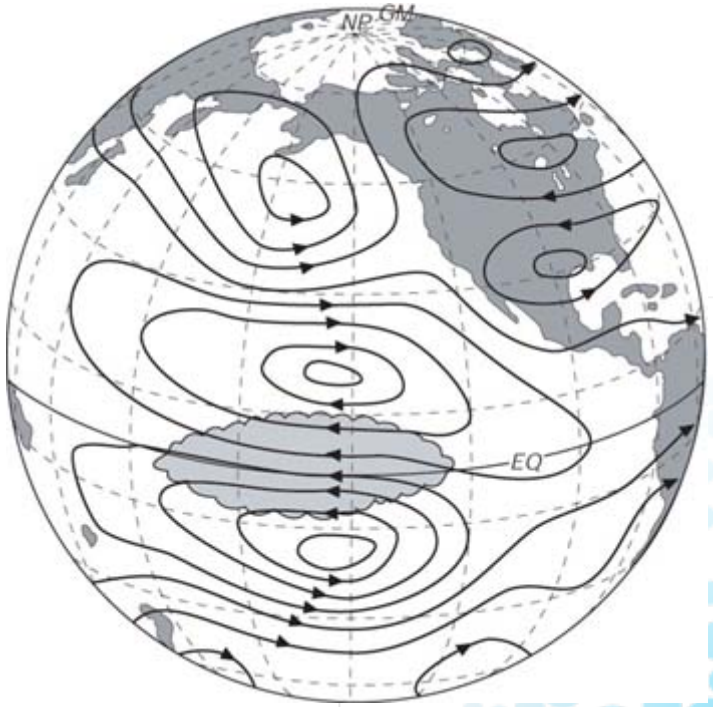
Source: TCC, JMA

ENSO impact



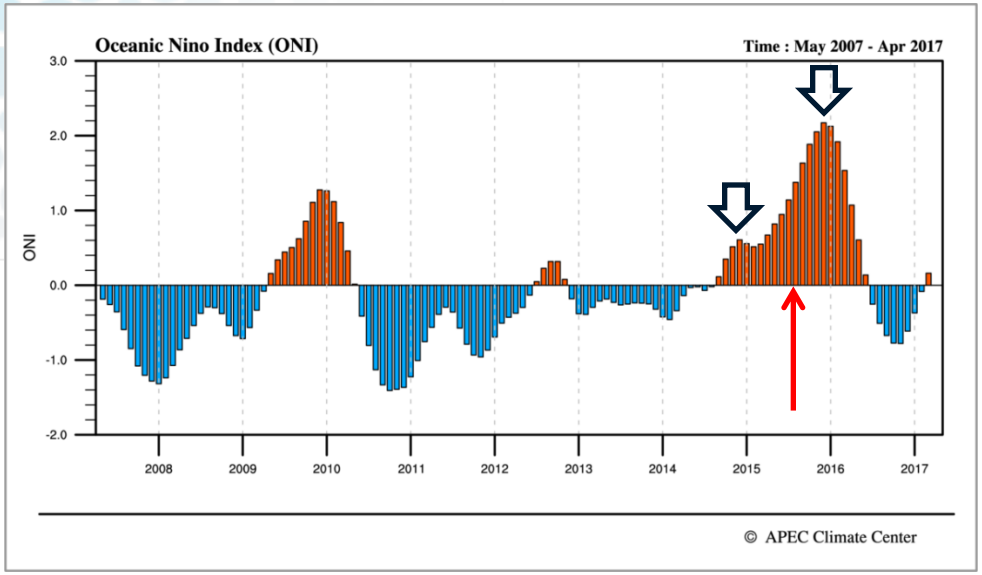






Source: TCC, JMA

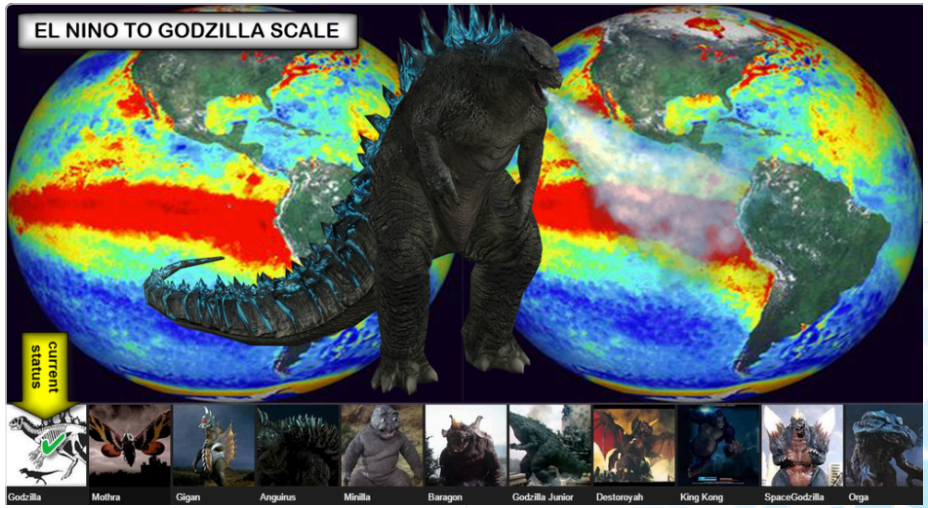
Prolonged El Nino (14-16)



✓marginal El Nino (14/15)

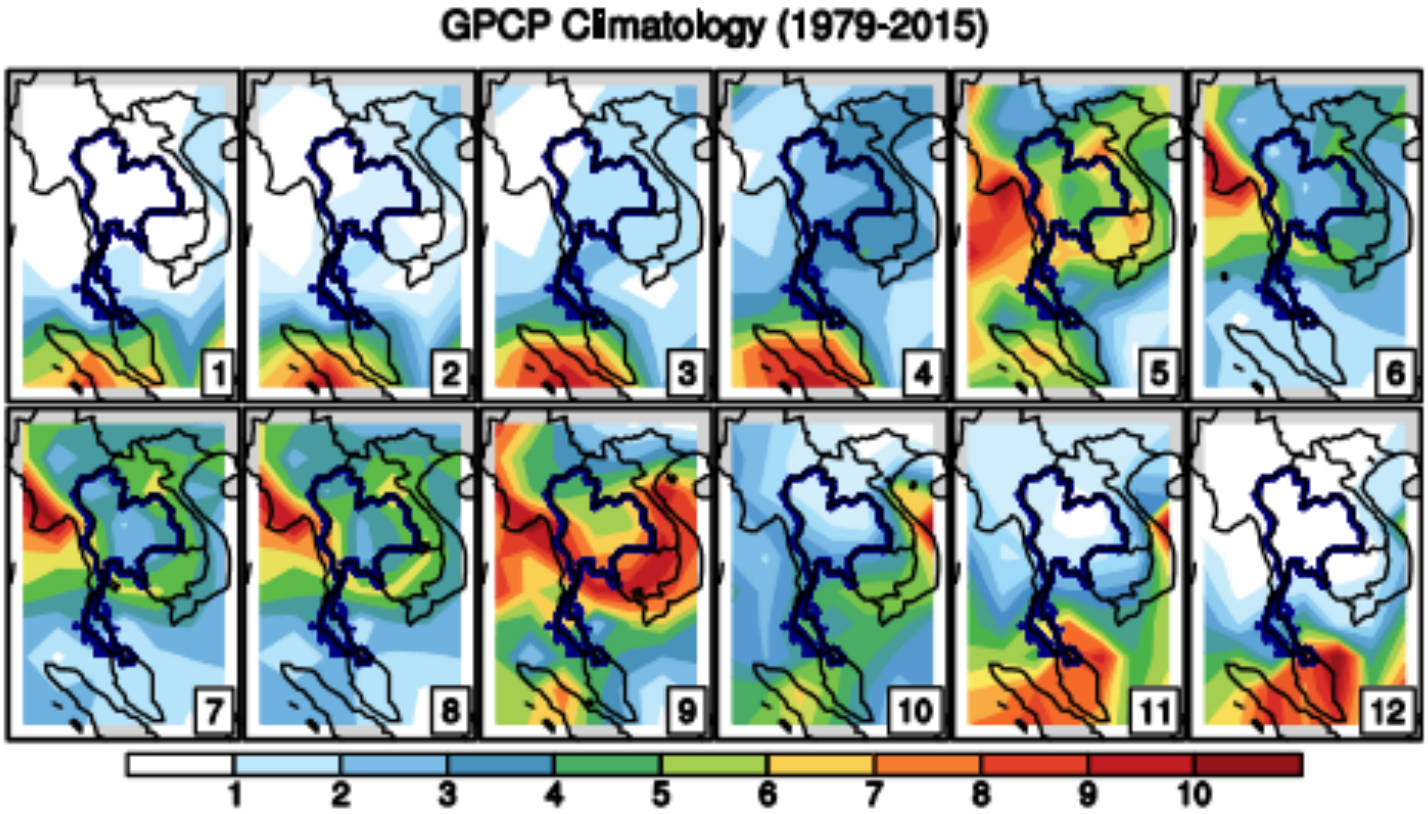
✓**2015 July: ONI > 1**

✓followed by "Super" winter El Nino (15/16)



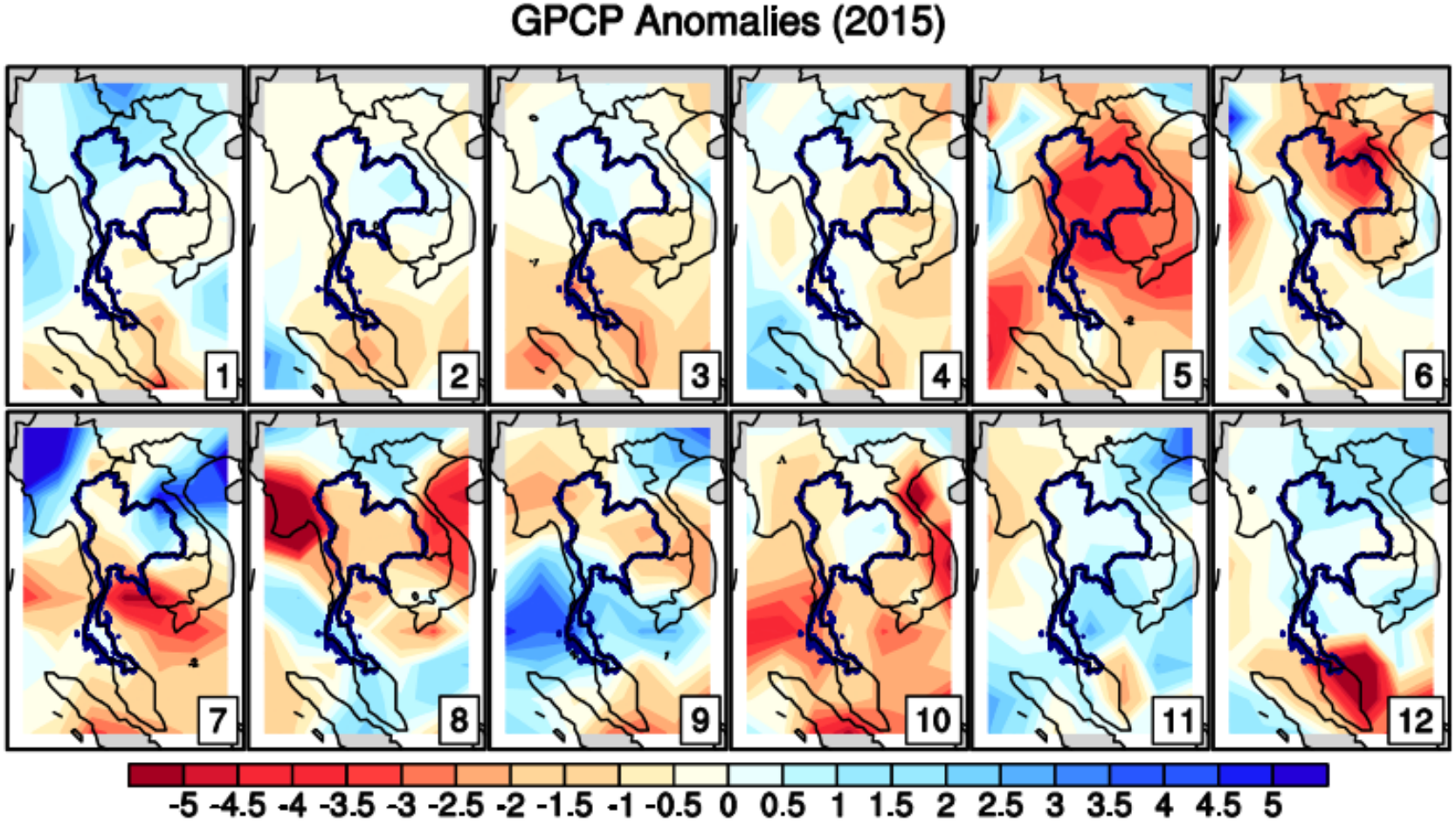
Extreme SST anomalies (up to 3 degrees) were recorded in the central Pacific, with values even higher than the records of the El Niño 1982-1983 and 1997-1998 seasons.

Seasonal cycle



By Ji-Hyun Oh (APCC)

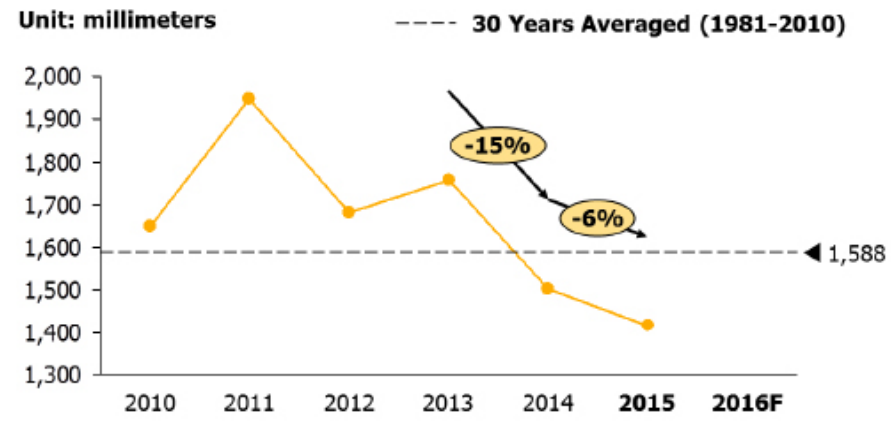
What happen in Southeast Asia during prolonged El Nino?



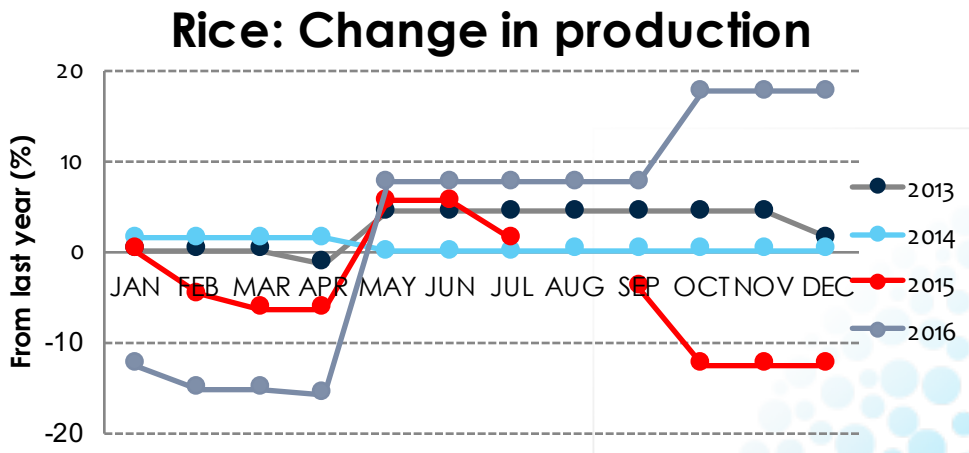
By Ji-Hyun Oh (APCC)

2015 Drought in Thailand

Figure 1: Cumulated rainfall in Thailand between 2010 and 2015



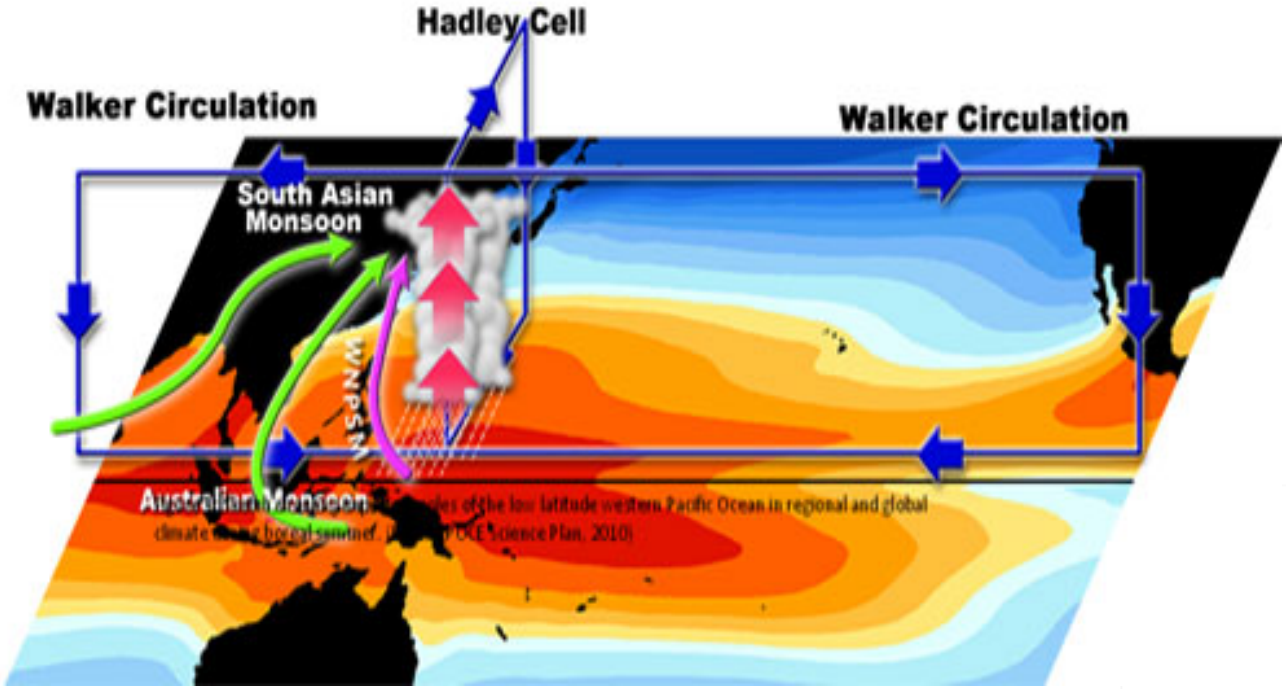
Source: EIC analysis based on data from Water Watch and Monitoring System, Royal Irrigation Department.



Source: USDA World Agricultural Production

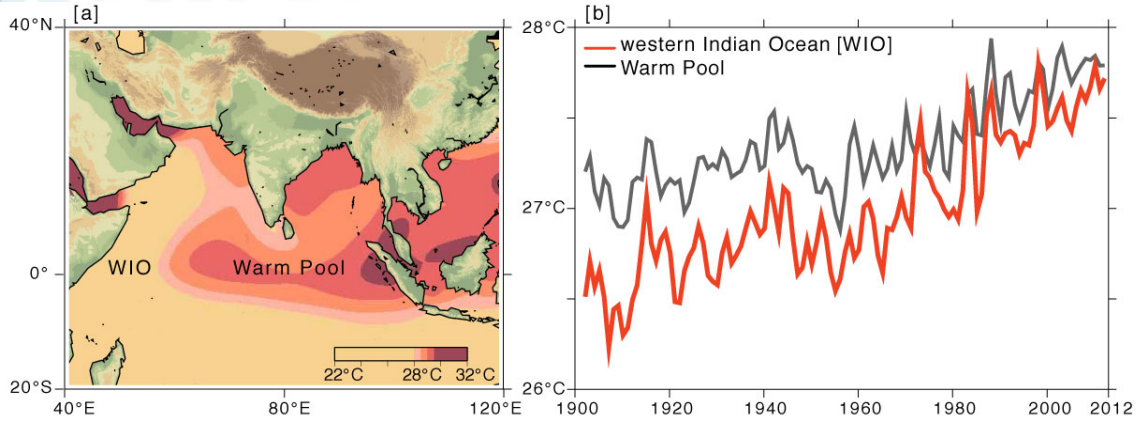
Western Pacific Warm Pool (WPWP)

- Climate Engine : remember “mean” feature



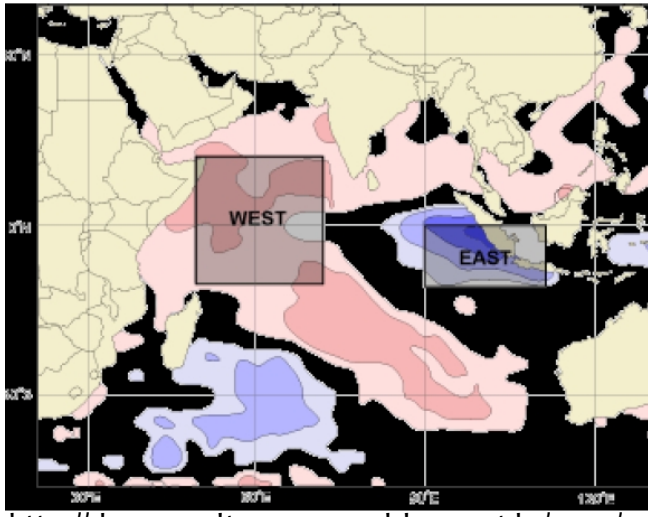
http://npoce.qdio.ac.cn/background

Don’t forget Indian Ocean



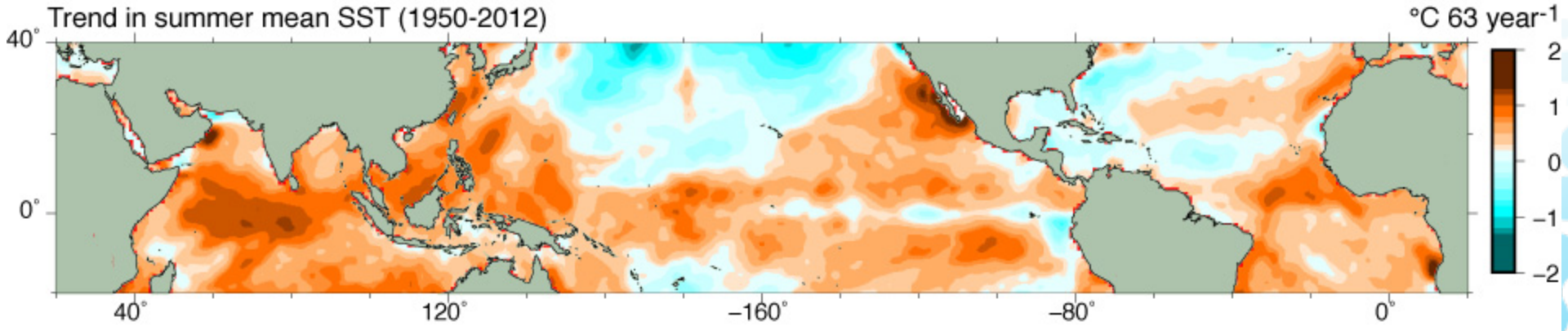
Source: http://www.climate.rocksea.org/research/indian-ocean-warming/

Indian Ocean Dipole

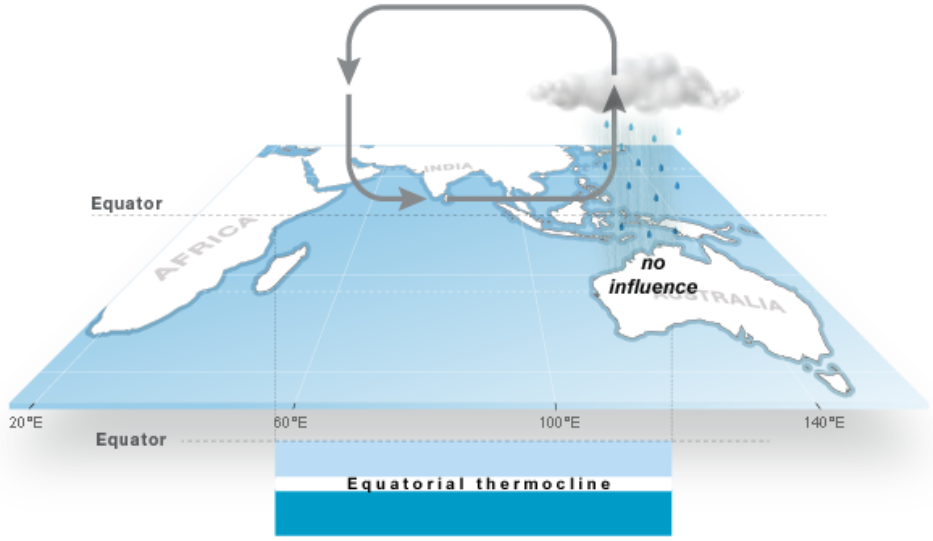


http://devconsultancygroup.blogspot.kr/2010/08/la-nina-disasters-much-worst-probably.html

Indian Ocean Basin Mode

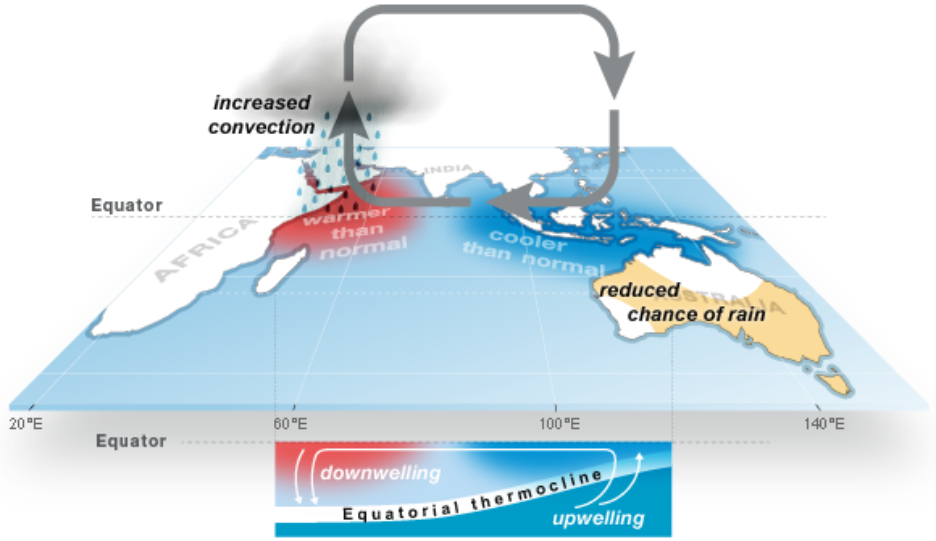


Indian Ocean Dipole (IOD)



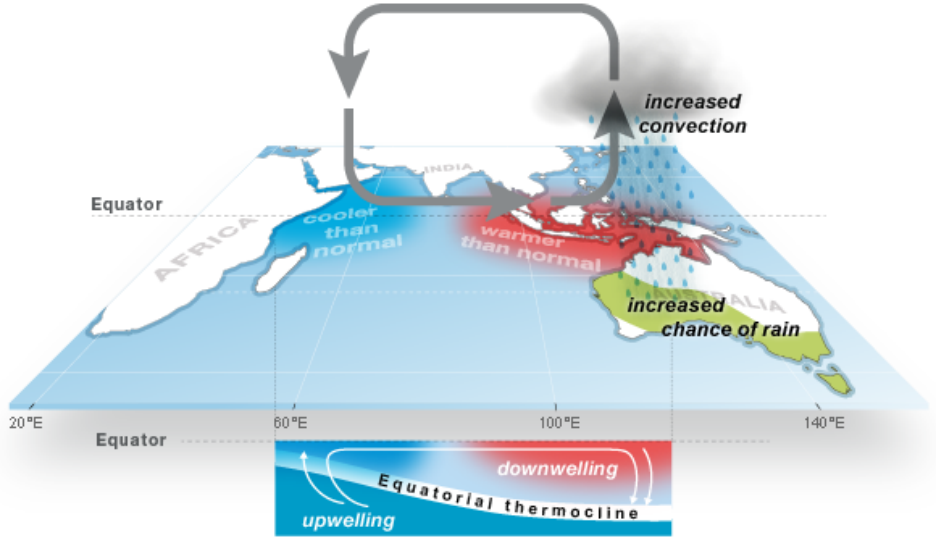
Indian Ocean Dipole (IOD): **Neutral phase**

© Commonwealth of Australia 2013.



Indian Ocean Dipole (IOD): **Positive phase**

© Commonwealth of Australia 2013.

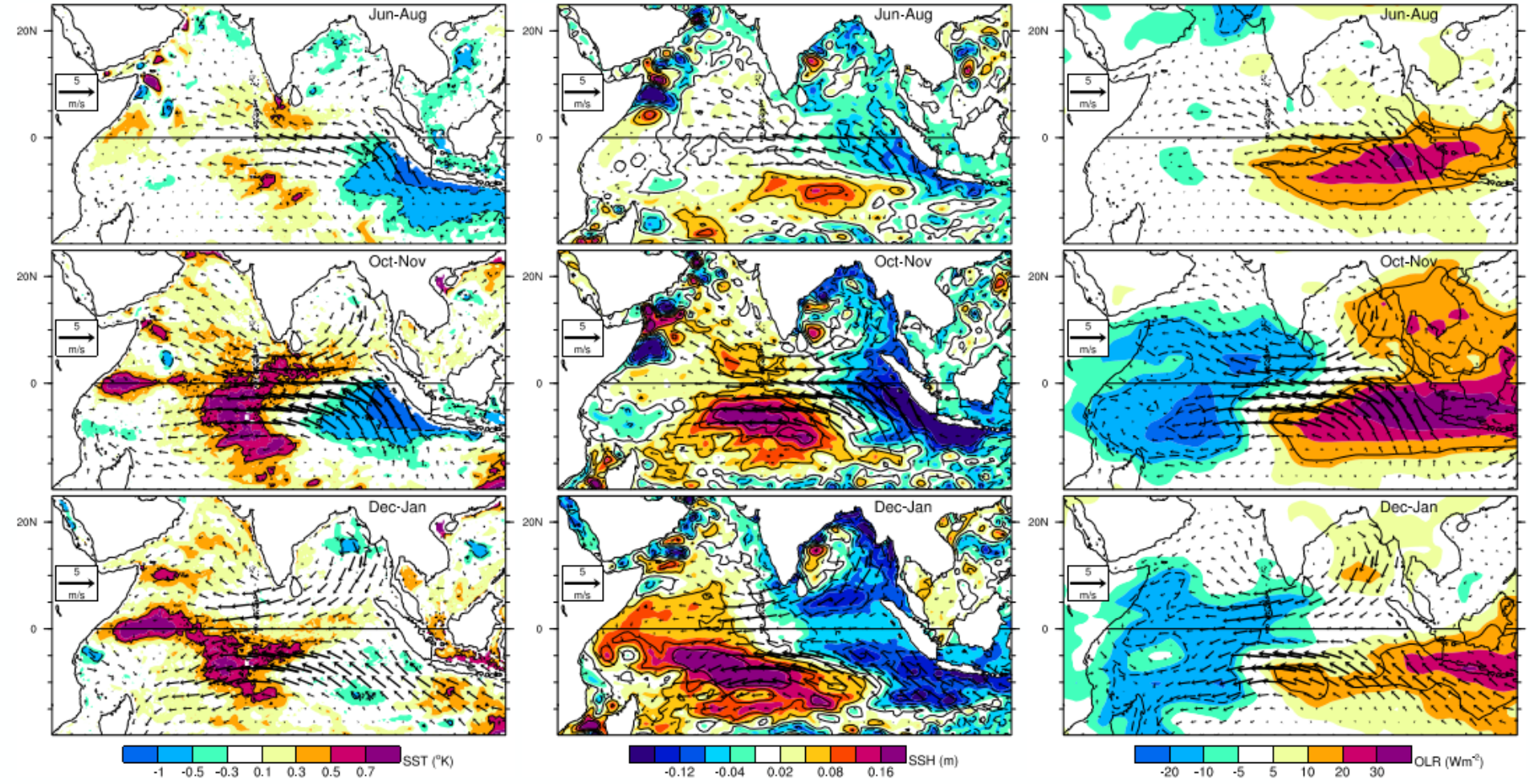


Indian Ocean Dipole (IOD): **Negative phase**

© Commonwealth of Australia 2013.

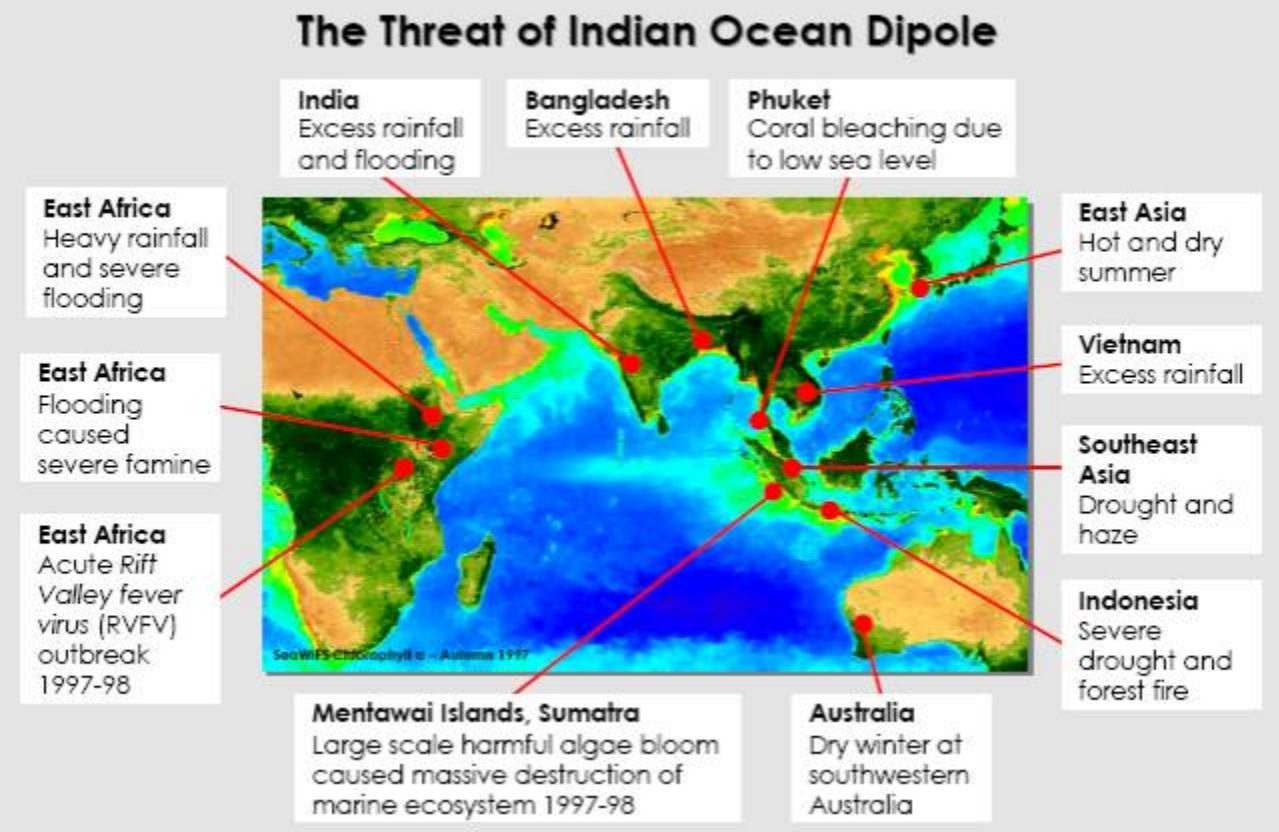
Indian Ocean Dipole (IOD)

By Saji N Hameed

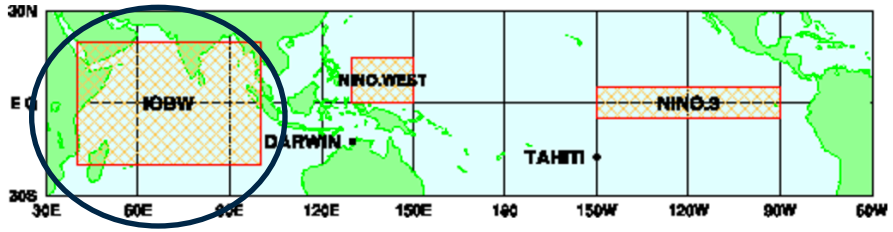


(a) SST (b) SSH (c) OLR

Indian Ocean Dipole (IOD)

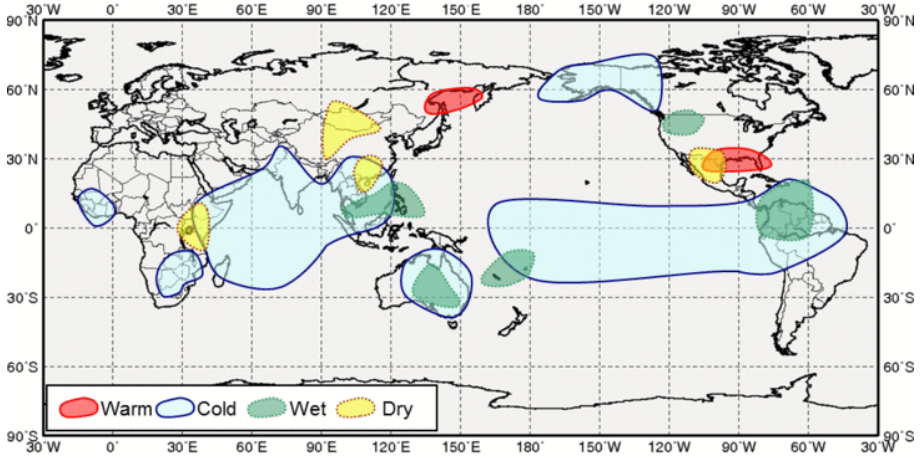


Indian Ocean Basin-wide Warming (IOBW)

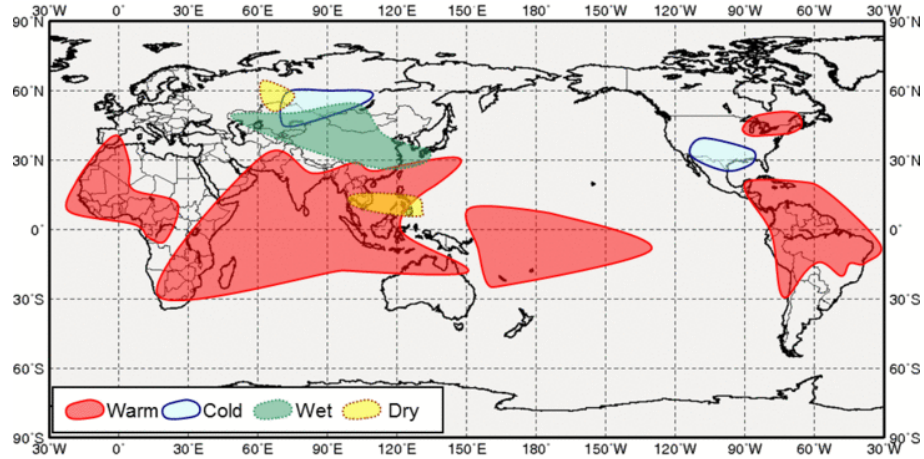


Source: TCC, JMA

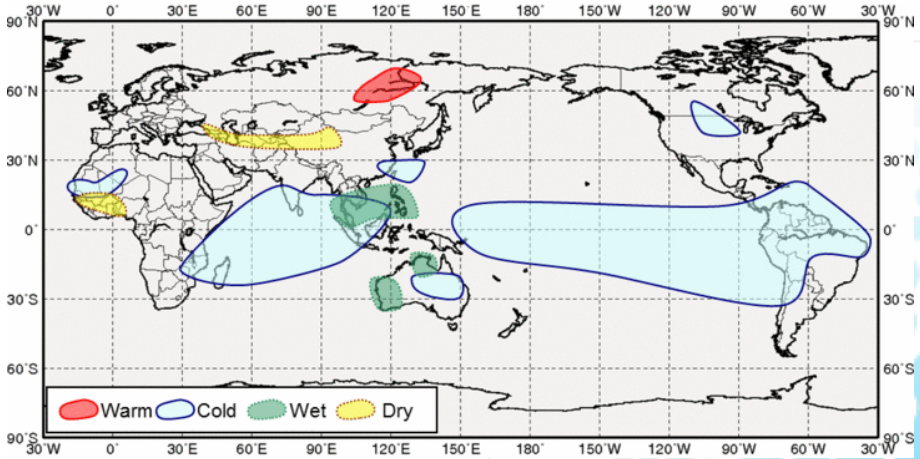
Negative IOBW, DJF



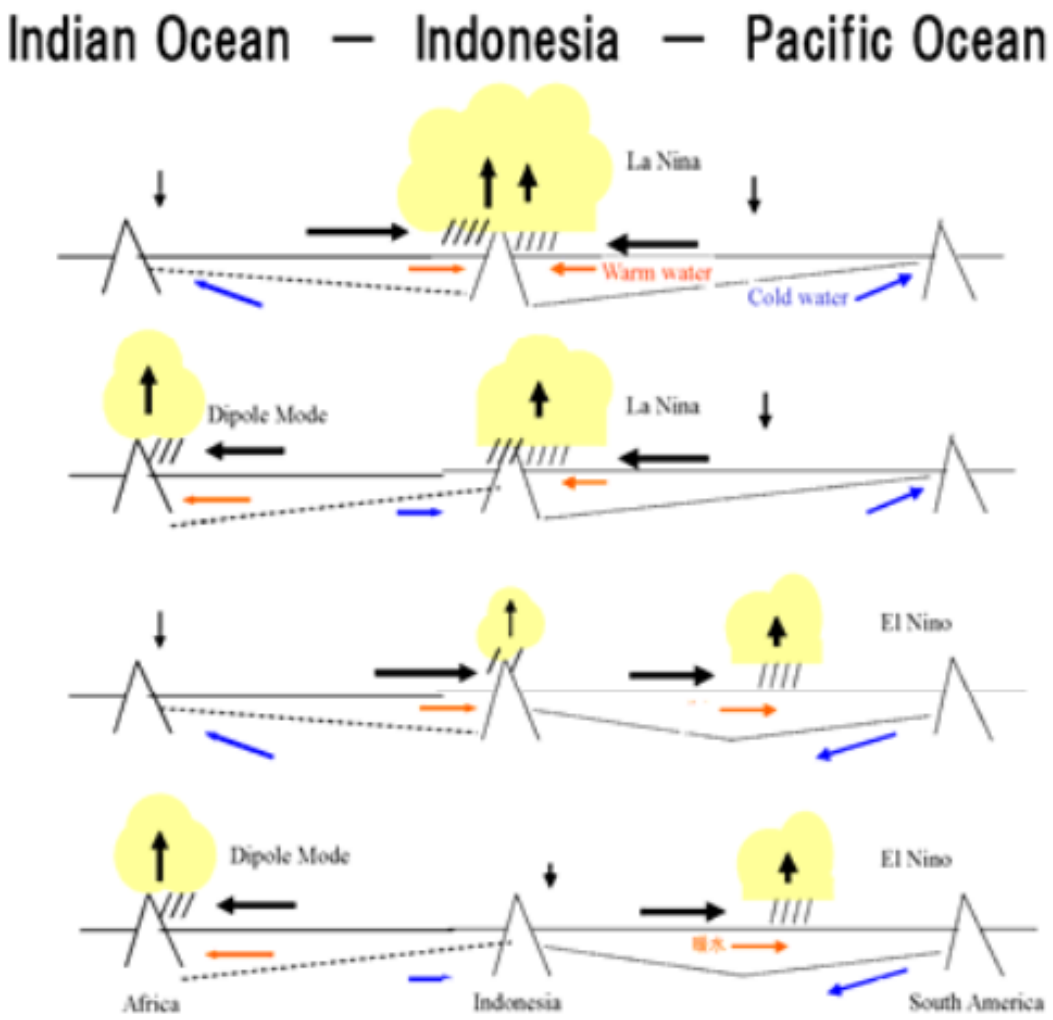
Positive IOBW, MAM



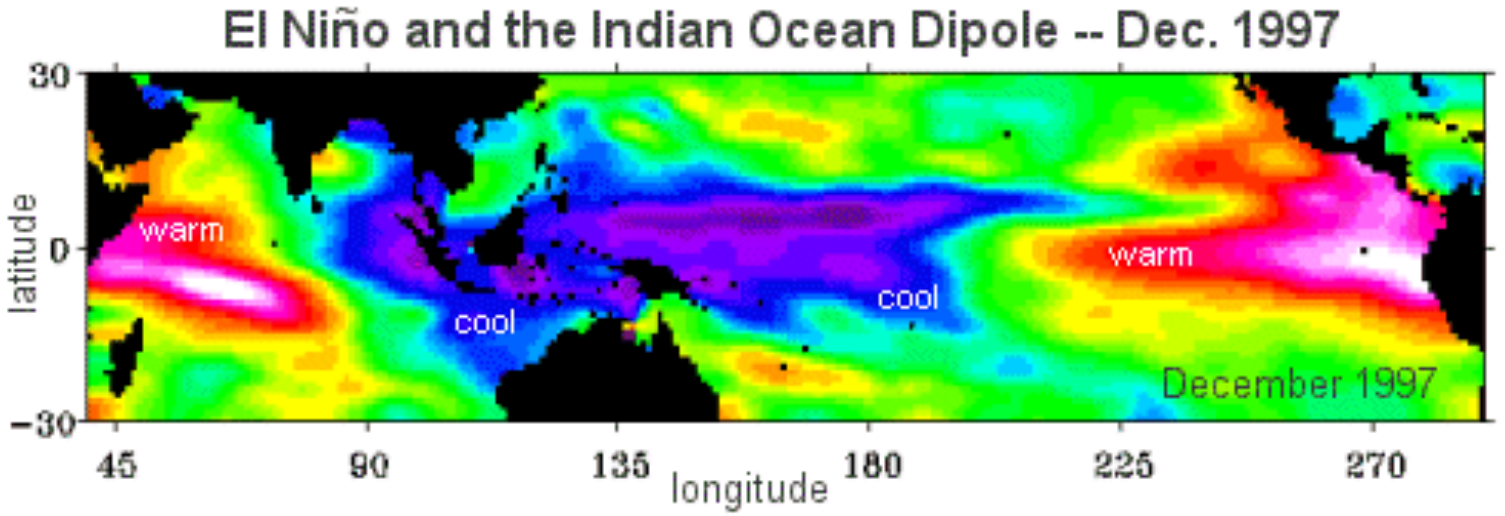
Negative IOBW, MAM



ENSO + IOD

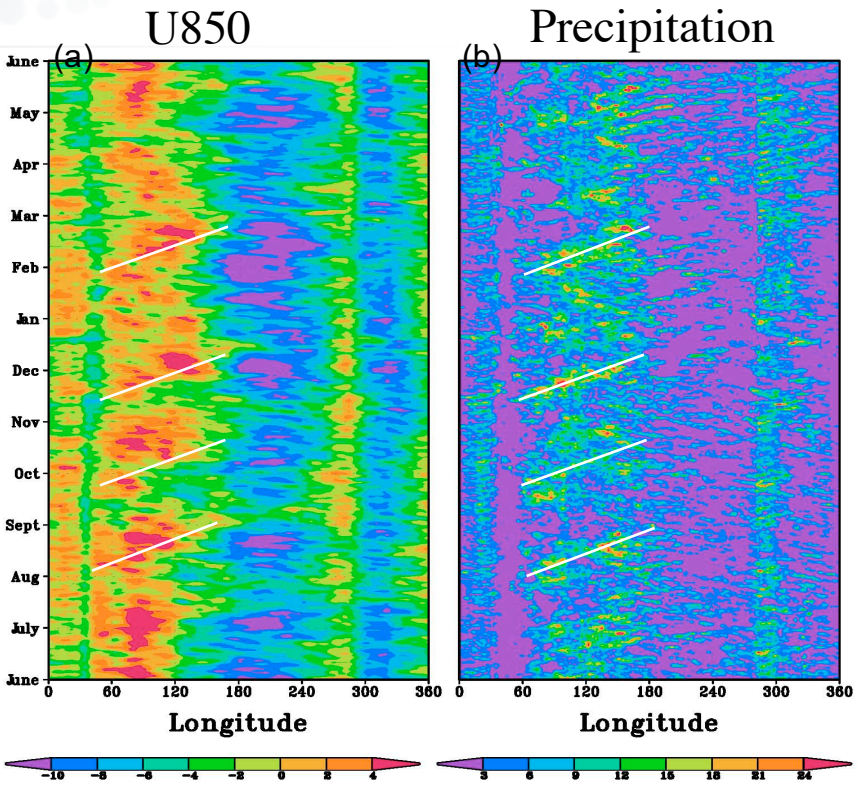

Indian Ocean — Indonesia — Pacific Ocean
La Nina
Warm water
Cold water
Dipole Mode
La Nina
El Nino
Dipole Mode
El Nino
暖水
Africa
Indonesia
South America

ENSO + IOD


El Niño and the Indian Ocean Dipole -- Dec. 1997
30
0
−30
latitude
warm
cool
cool
warm
December 1997
45
90
135
180
225
270
longitude

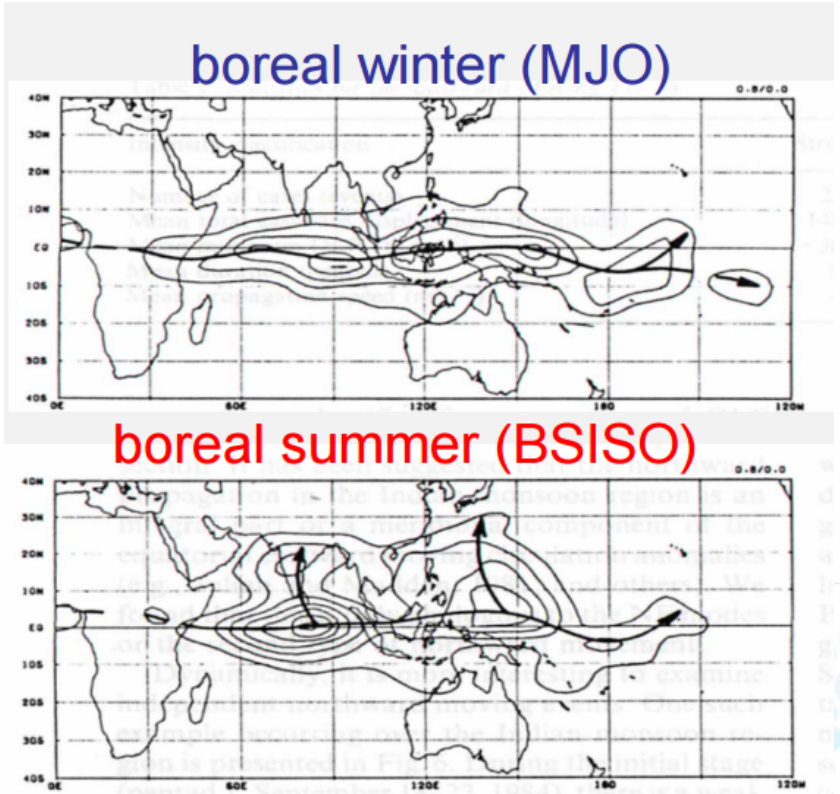
Intra-Seasonal Oscillation (ISO)

Intraseasonal : 20-90



By Ji-Hyun Oh

Northward & Eastward propagation

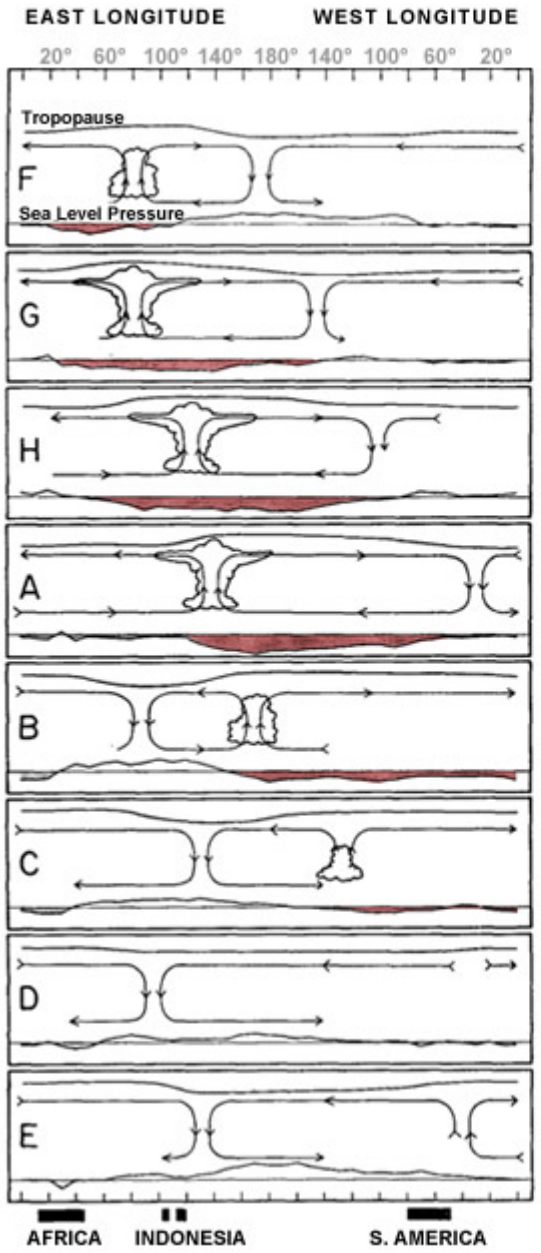


Wang and Rui 1990

Madden Julian Oscillation

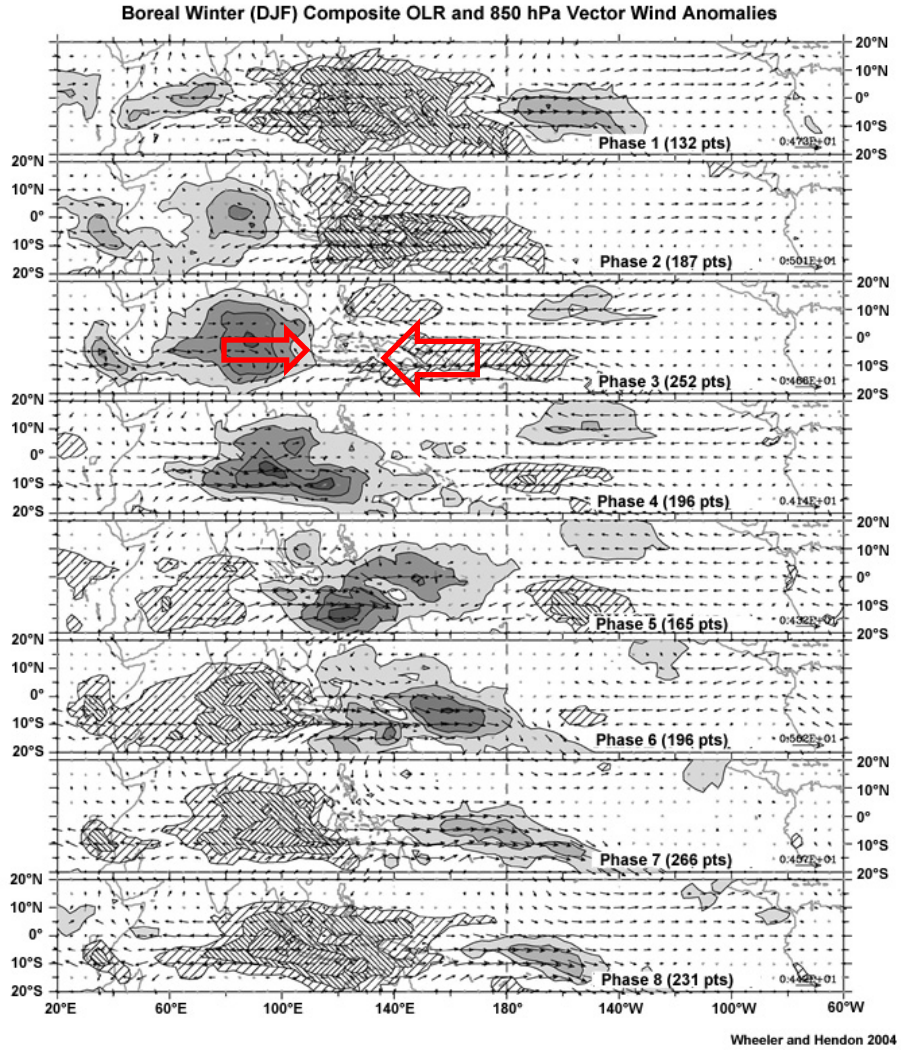
Intraseasonal Oscillation (ISO)
during boreal winter

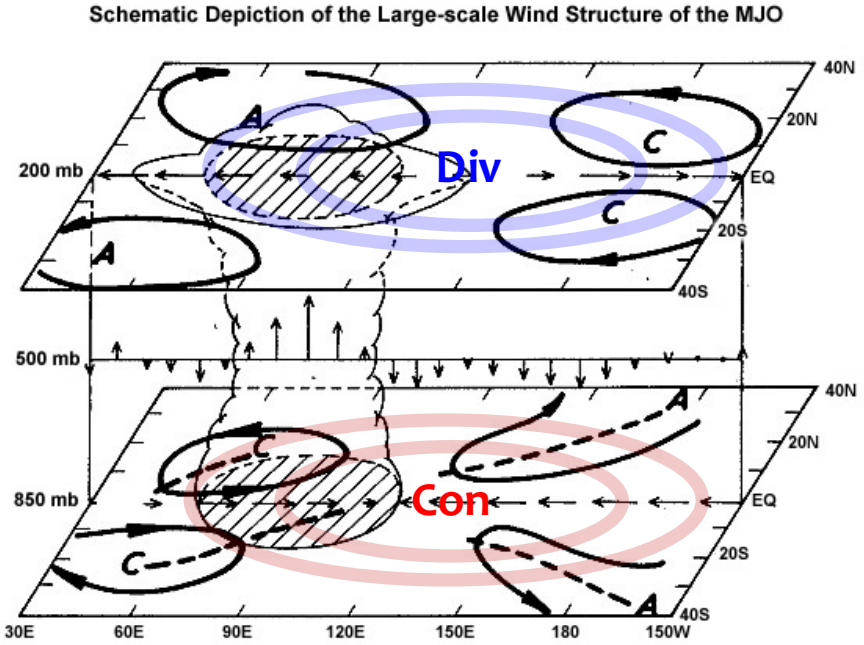
Intraseasonal: 20-90



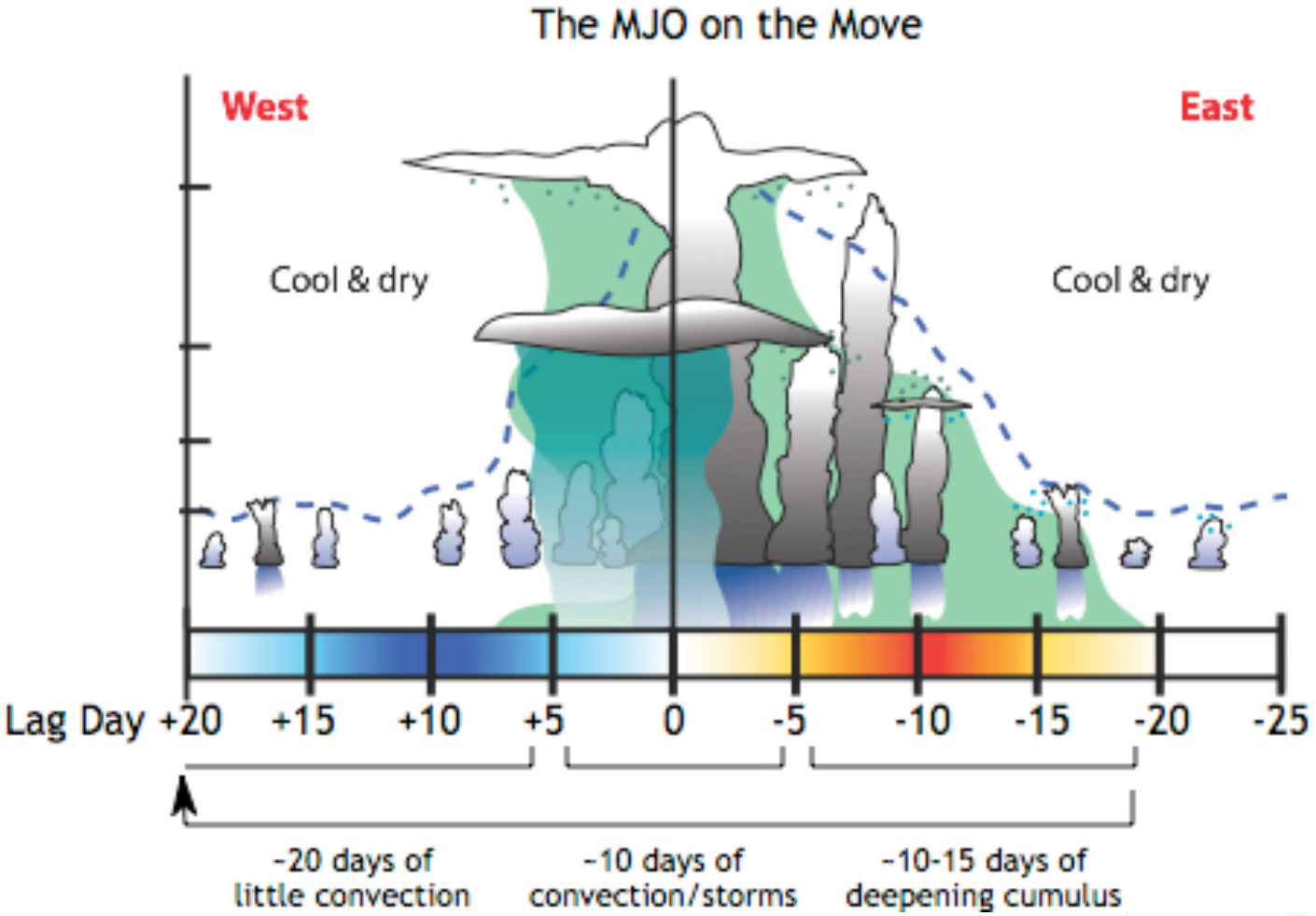
Madden and Julian 1972

MJO (Madden Julian Oscillation)



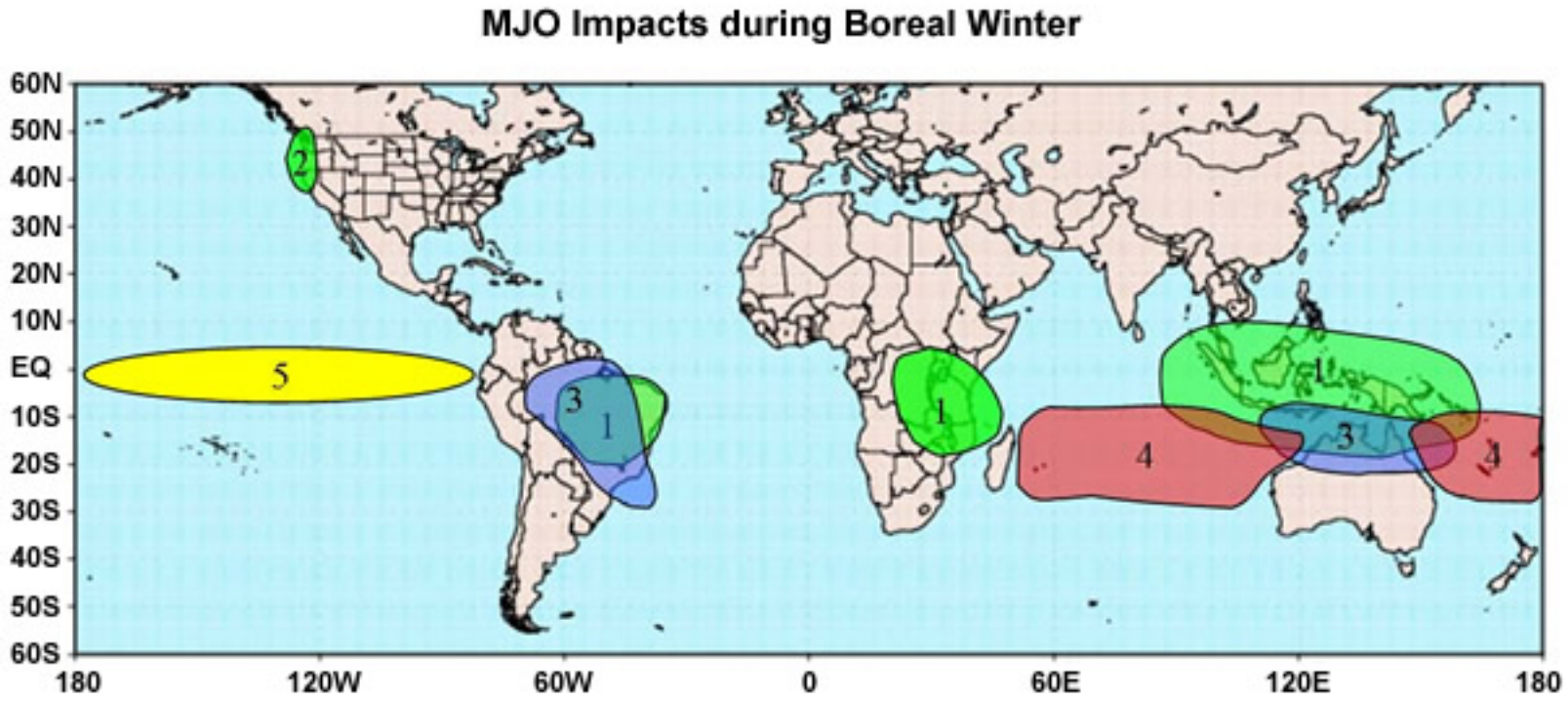


MJO (Madden Julian Oscillation)



A schematic of the MJO from cmmap.org

MJO impacts

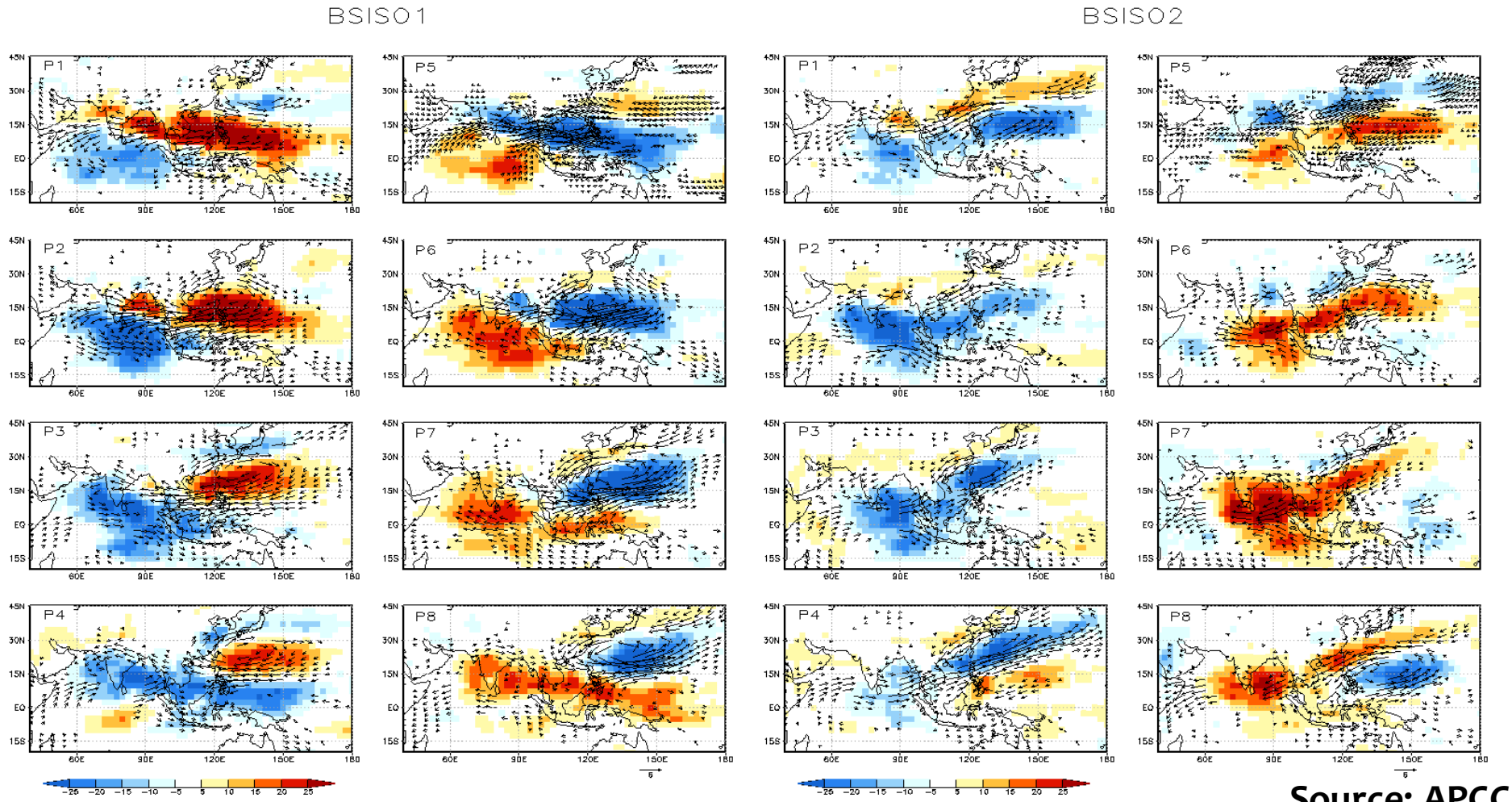


1 - Alternating wet/dry conditions
2 - Tropical moisture plume to higher latitudes
3 - Modulation of monsoon systems
4 - Modulation of tropical cyclone activity
5 - Modulation of ENSO through oceanic Kelvin waves

NOAA / CPC / NCEP / NWS

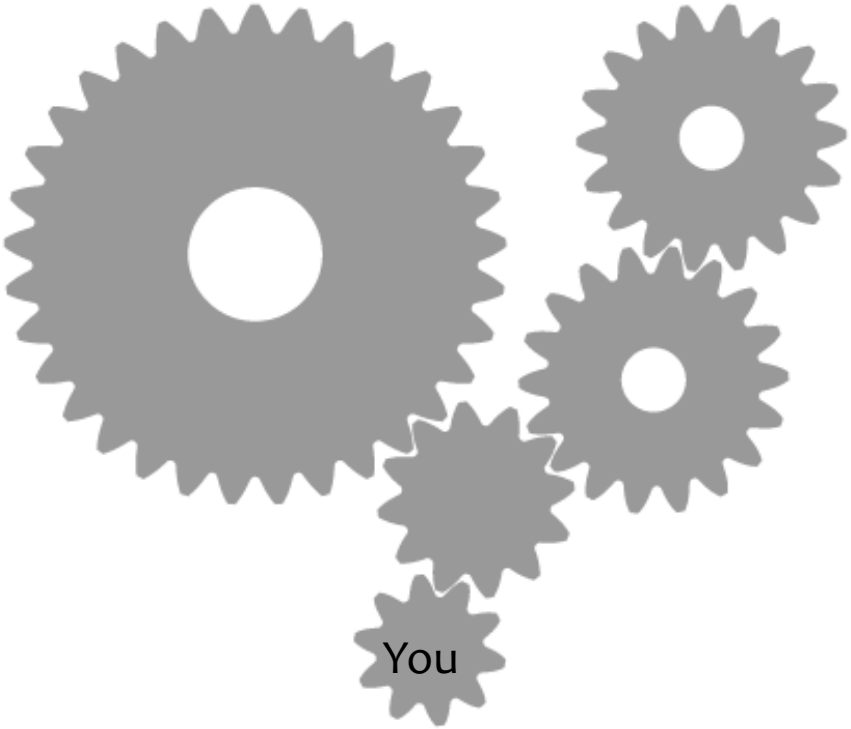
BSISO (Boreal Summer ISO)

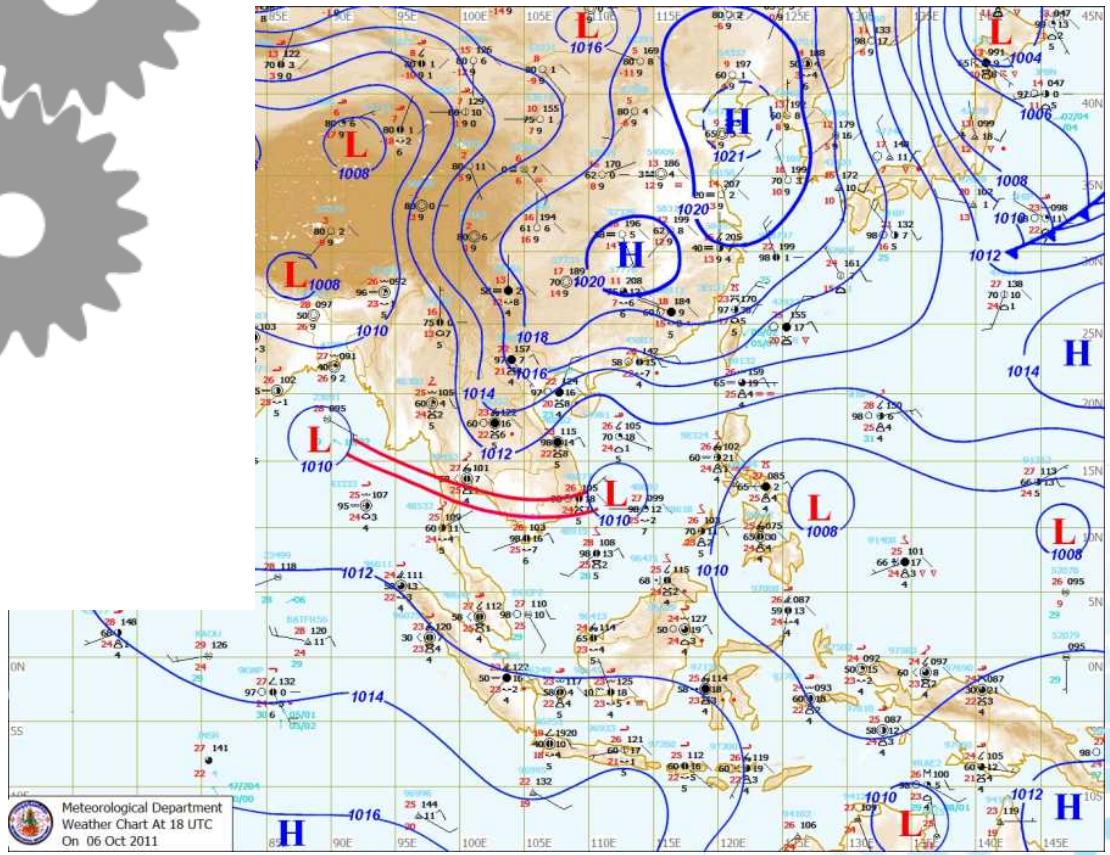
Intraseasonal Oscillation ISO during boreal summer



Source: APCC

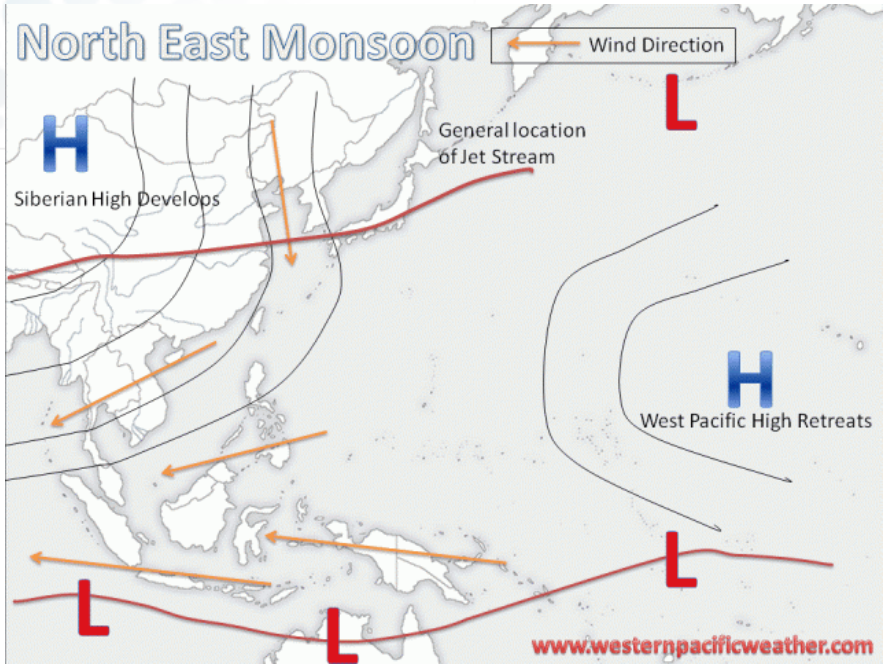
How they change weather?





Cold surge

- Outbreak of Siberian cold air



The Extreme Cold Anomaly over Southeast Asia in February 2008: Roles of ISO and ENSO*

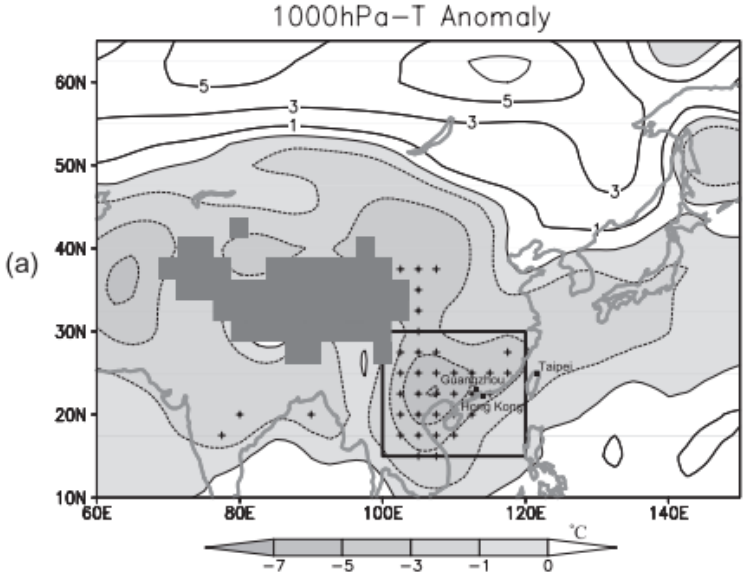
CHI-CHERNG HONG

Department of Science, Taipei Municipal University of Education, Taipei, Taiwan

TIM LI

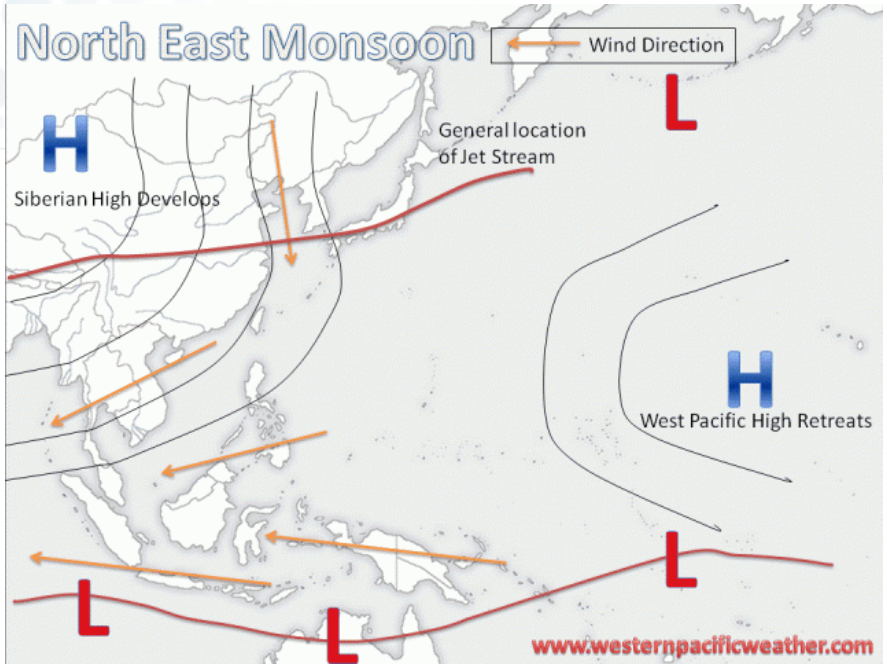
International Pacific Research Center/School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, Honolulu, Hawaii

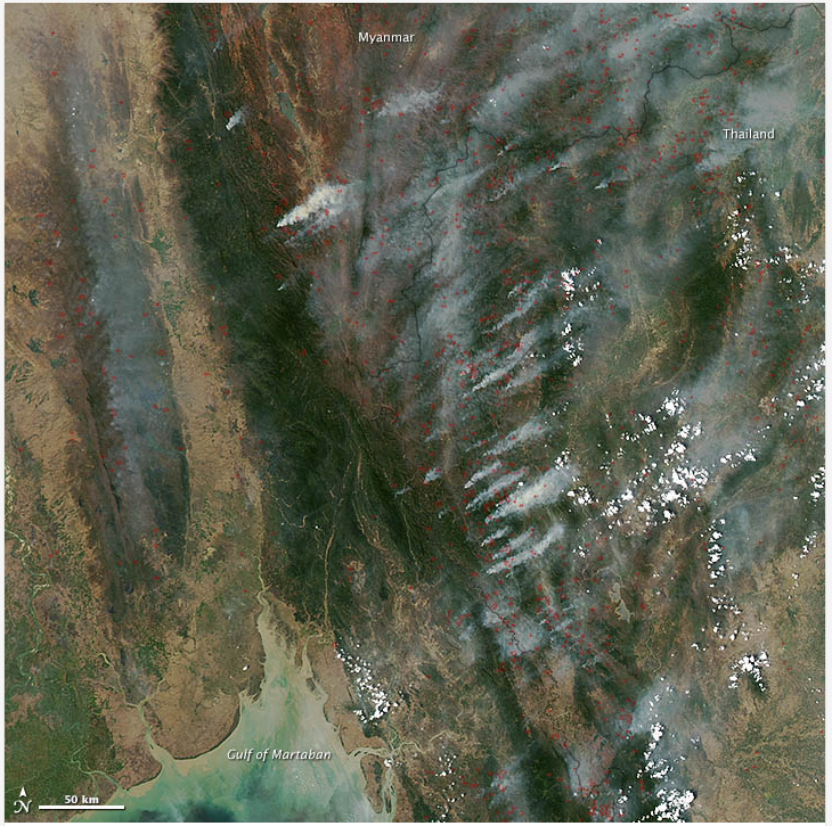
(Manuscript received 30 September 2008, in final form 12 January 2009)



Dry spell (wildfire)

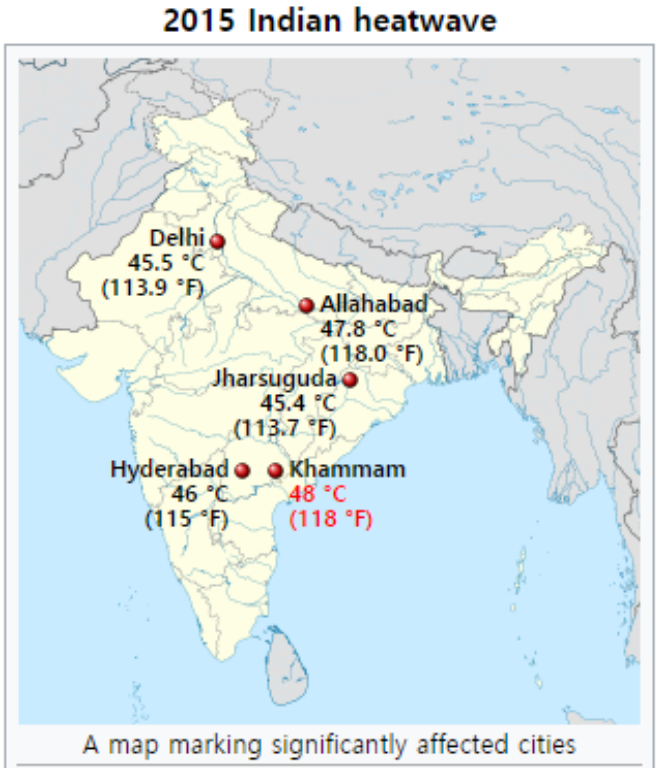
- Outbreak of Siberian dry air + dry monsoon (Nov-Mar)



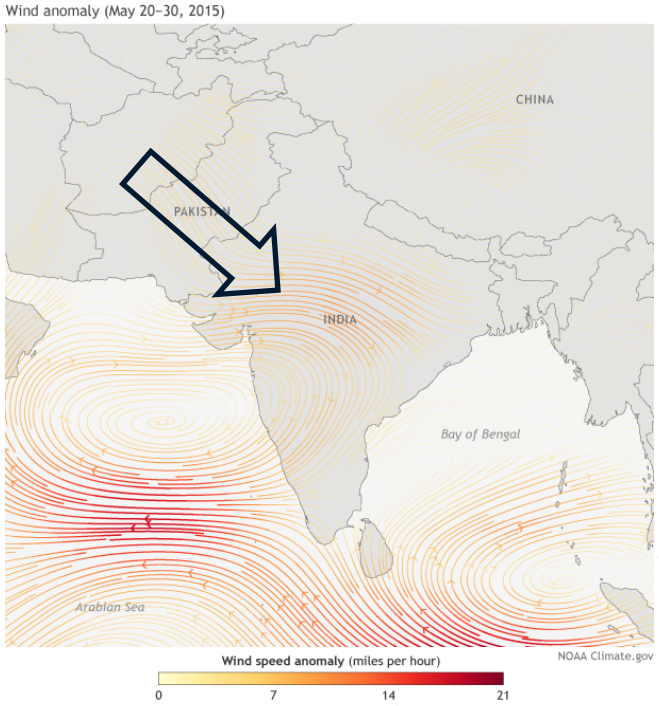


Heat waves

- 2015 India heat wave

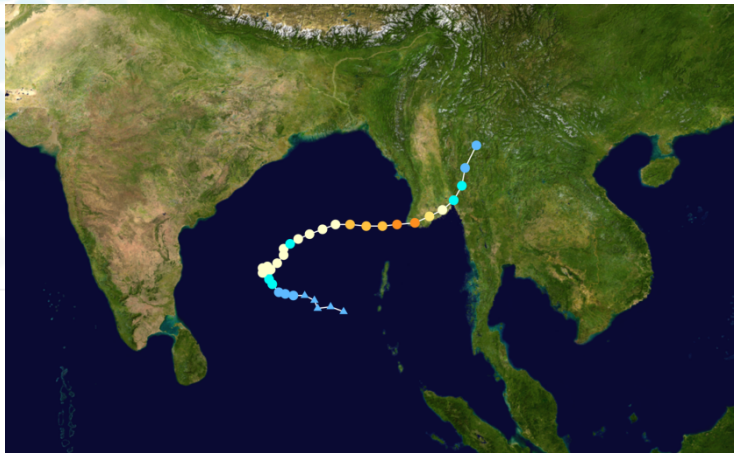


-"**Heat Bomb**" : unusual northwesteries → sparse showers and their sudden end during pre-monsoon season (before June)



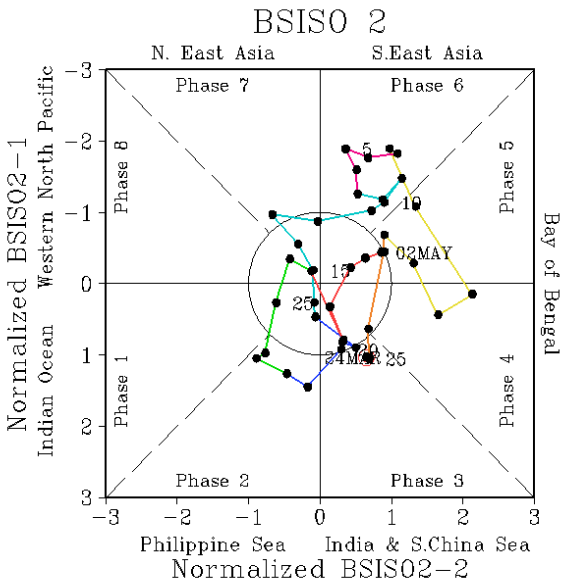
- El Nino effect?

Extreme rainfall (flood)



https://en.wikipedia.org/wiki/Cyclone_Nargis

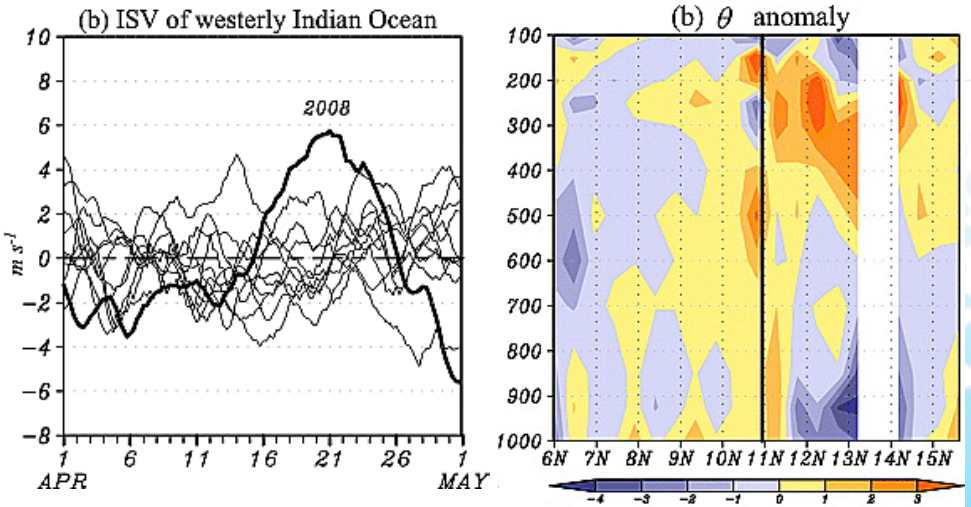
- Tragic Myanmar flood associated with **Cyclone Nargis**!



Source: APCC BSISO monitoring

✓ Northward movement of **MJO convection**

Kikuchi, K., B. Wang, and H. Fudeyasu (2009), Genesis of tropical cyclone Nargis revealed by multiple satellite observations, Geophys. Res. Lett., 36, L06811, doi:10.1029/2009GL037296.

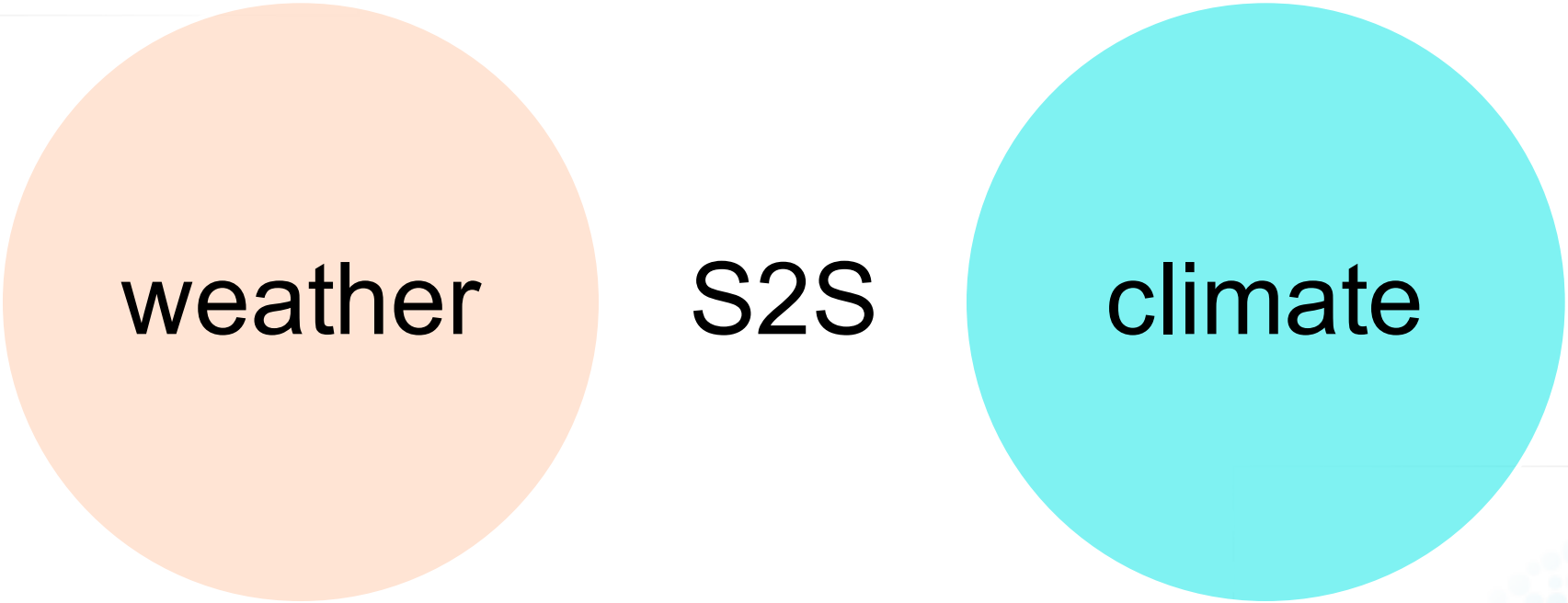



Thank you.

Weather VS Climate

A couple of days
~ 2 weeks

Season to season

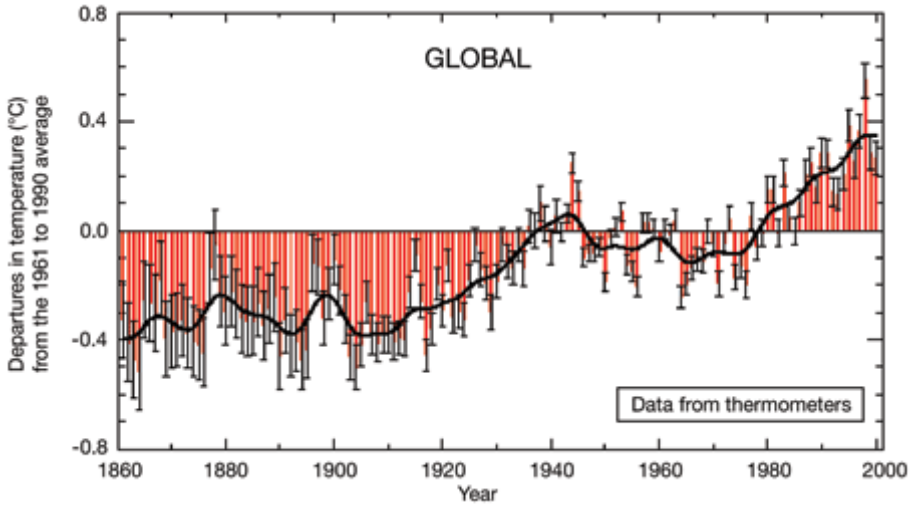


Weather Forecast

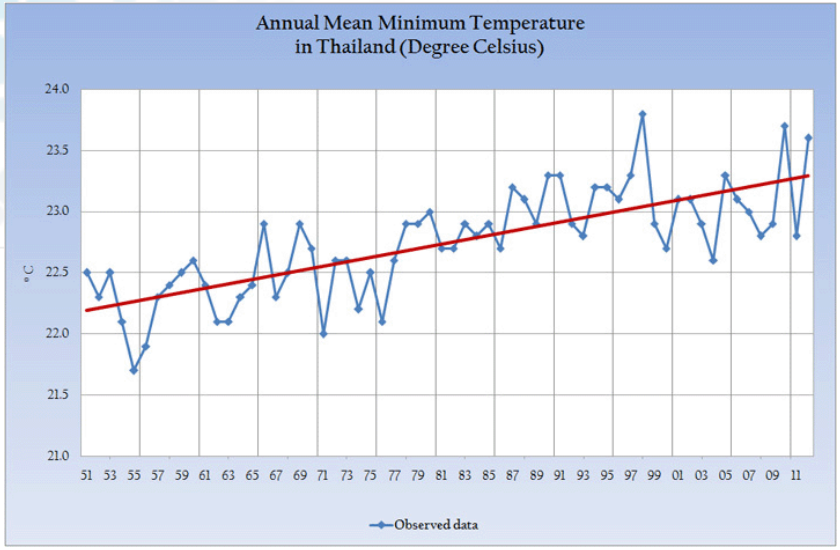
Seasonal Forecast

Climate Change

- Changes in our expectation

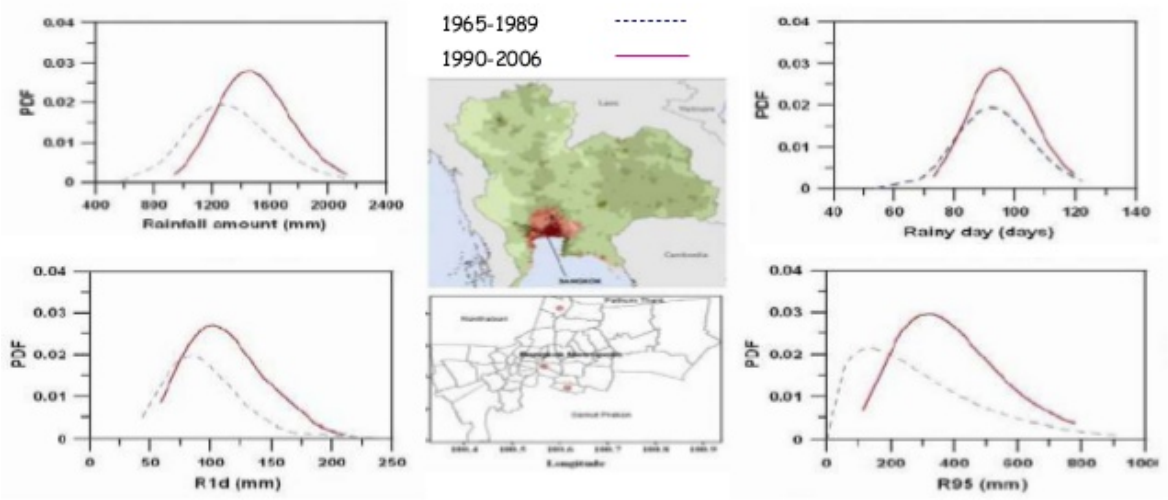


Climate Change



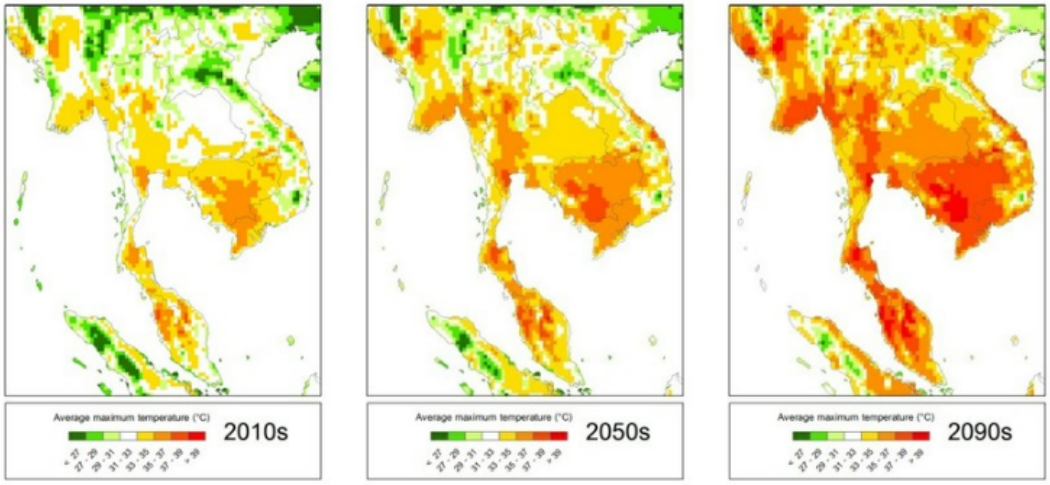
https://www.tmd.go.th/en/climate.php?FileID=7

Extreme climate in Thailand

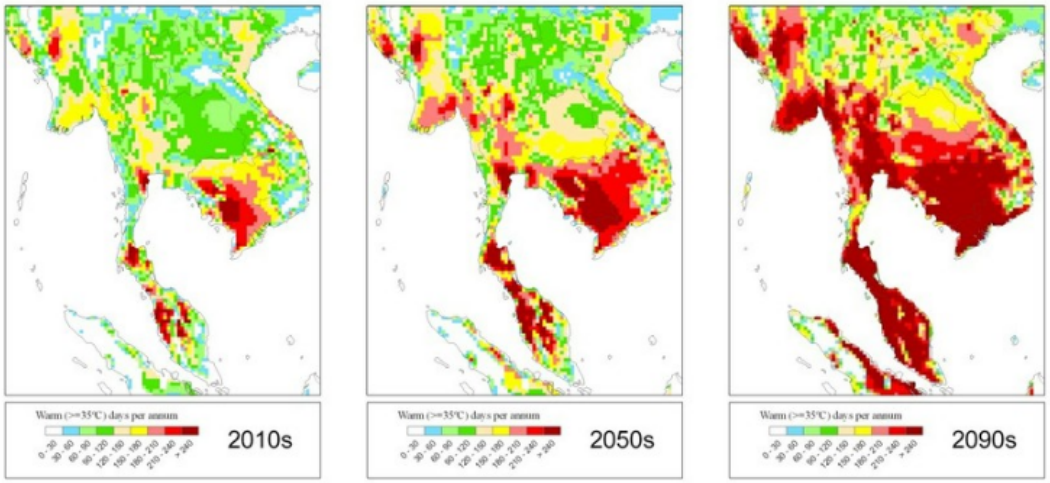


https://www.slideshare.net/ipcc-media/climate-change-effect-in-thailand-and-asean-region

Climate Change



Average annual maximum temperature (°C)



Average annual hot days (= >35°C)

http://startcc.iwlearn.org/project/copy9_of_hydro-agronomic-economic-model-for-mekong-river-basin-and-local-adaptation-in-thailand-model-development