CE 361A : Engineering Hydrology

Precipitation

Lecture -3

Revision

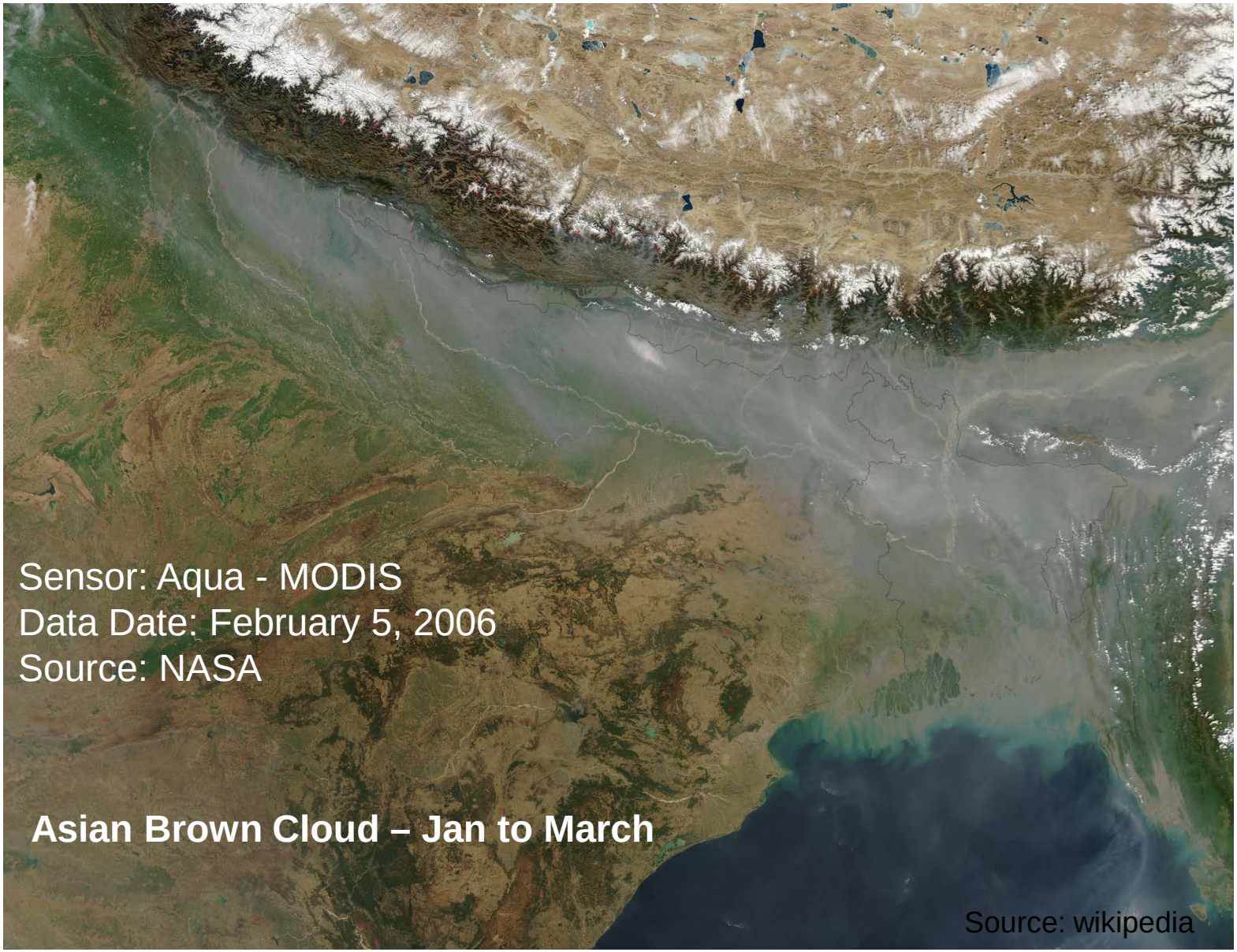
- Forms of precipitation
  - Rain, Drizzle
  - Snow, Hail
  - Glaze/Freezing rain, Sleet
- Mechanism of precipitation
  - Presence of moisture in the air
  - Mechanism to cool air
  - **Presence of cloud condensation nuclei (CCN)**
  - **Conditions for condensation product to reach earth**

Mechanism of precipitation

3. Cloud condensation nuclei (CCN)

- Natural – Volcanoes, airborne sea salt, forest fire, desert
- Anthropogenic – Industry, transportation, waste disposal, automobiles,
- Cloud seeding - Silver iodide
- Typical size: 0.2 micron
- International political issue

Haze over India



Haze over India

Three Kilometer Thick Pollution Layer Diverted Monsoon

By Sanjay Suri
Indo-Asian News Service
8-11-2

LONDON (IANS) - A three-kilometre brown cloud hanging over South Asia could have thrown the monsoon rains off course, says a major study by the United Nations Environmental Programme (UNEP).

"The global models used in the report suggest the haze may reduce precipitation over northwest India, Pakistan, Afghanistan, western China and neighbouring western central Asian region by between 20 and 40 percent," the report says.

"There have been two consecutive droughts in 1999 and 2000 in Pakistan and the northwestern parts of India while increased flooding in the high rainfall areas of Bangladesh, Nepal and the northeastern states of India."

Haze over India

CHINA HK ASIA WORLD COMMENT BUSINESS TECH LIFE CULTURE SPORT WEEK IN ASIA POST MAG STYLE .TV

Tech / Science & Research / POLLUTION

Soot from India a 'serial killer' for glaciers in Tibet, scientists say

PUBLISHED : Wednesday, 10 June, 2015, 8:00am
UPDATED : Wednesday, 10 June, 2015, 8:00am

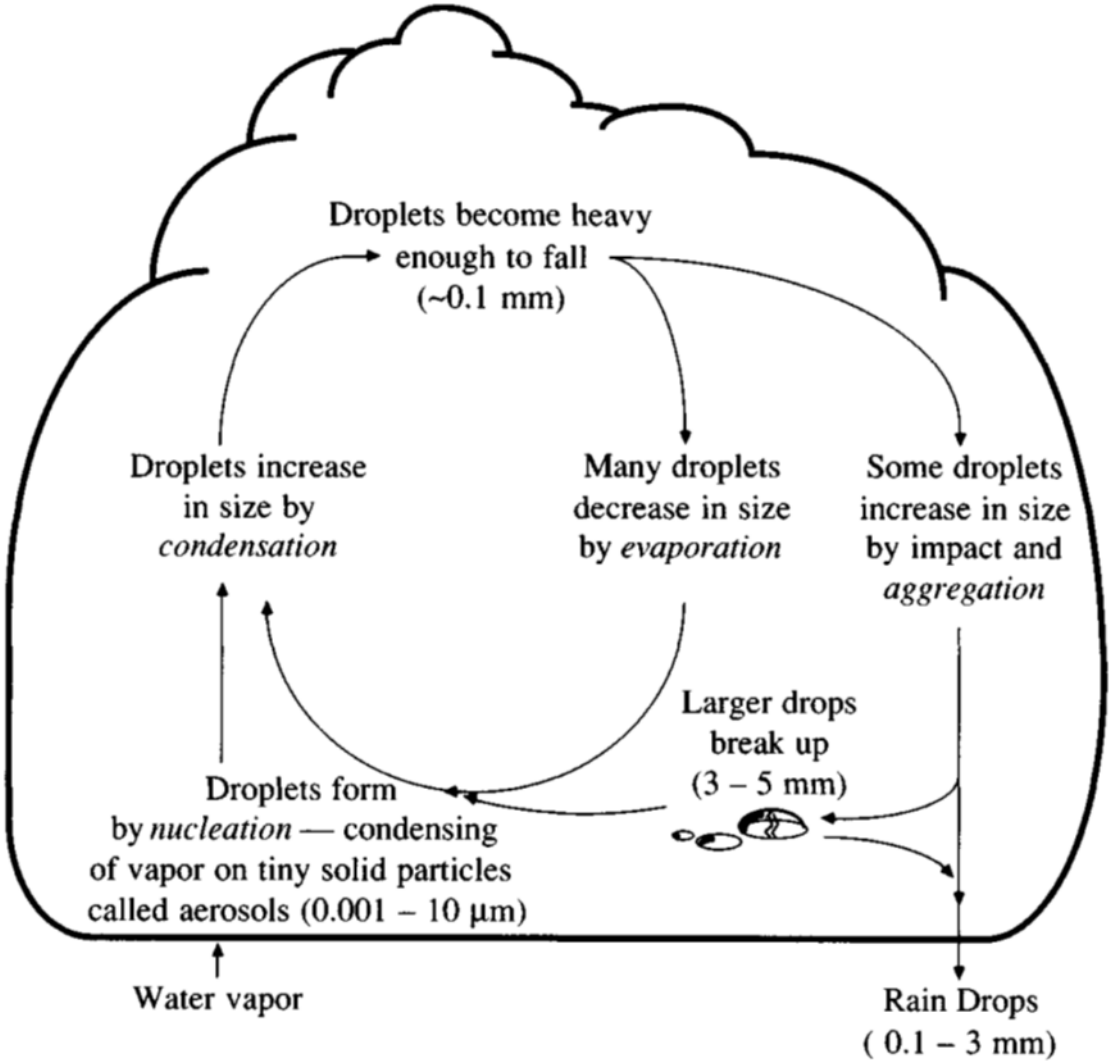
COMMENT: 1

Binglin Chen

Soot from India has proven more destructive than global warming in terms of harming glaciers in parts of Tibet, according to a joint study by researchers in China and the United States.

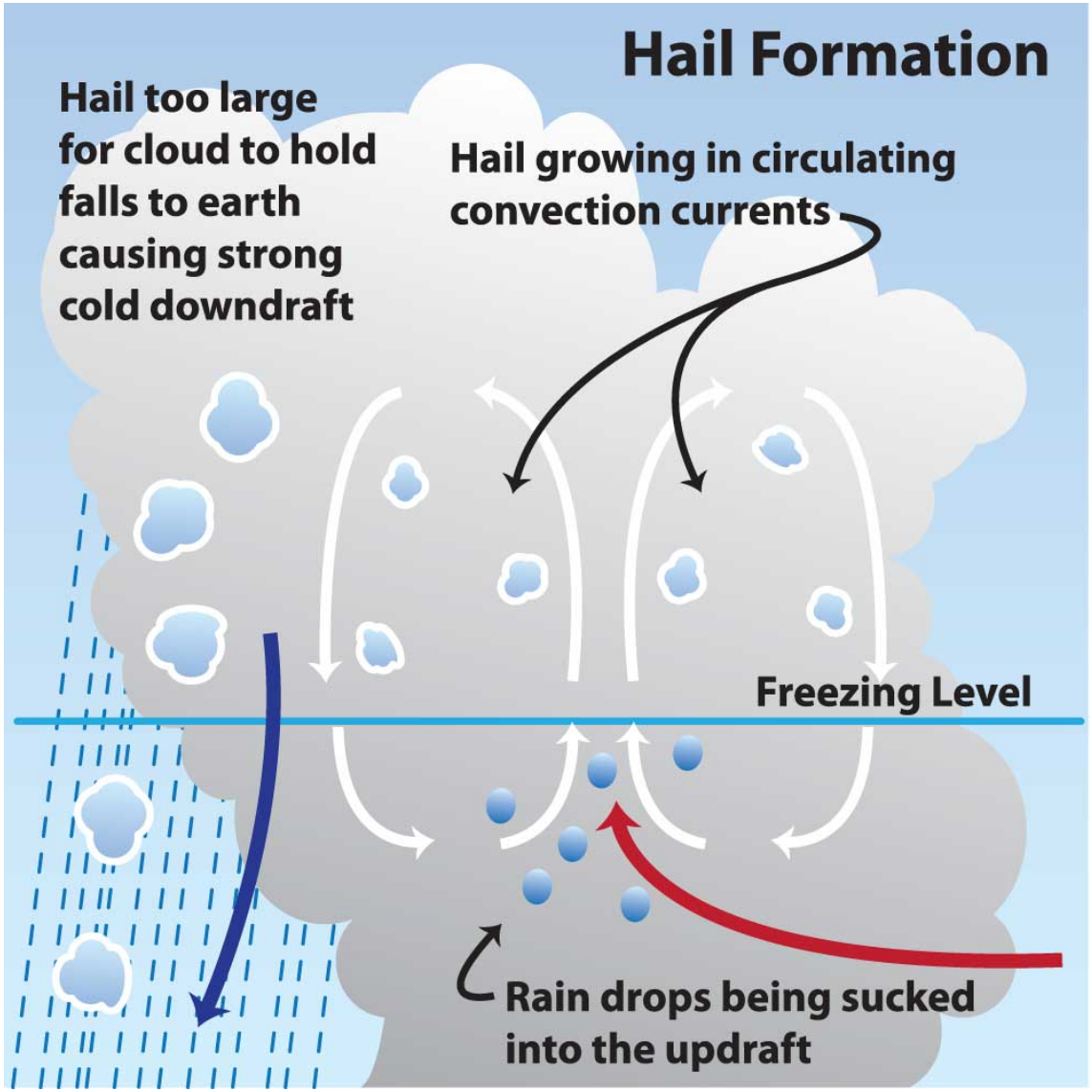
Mechanism of precipitation

4. Conditions for condensation product to reach earth



Source: Chow et al.,

Mechanism of precipitation



Source: NOAA/NASA SciJinks

Characteristic of Precipitation in India

How many seasons in India?

Two Major Seasons and Two Transitional Seasons

- South-West Monsoon (June-September)
- Transition-I : Post Monsoon (October-November)
- Winter Season (December-February)
- Transition-II: Summer (March-May)

South-west monsoon

- Monsoon: Seasonal reversal of wind
- Is it confined to India?
- Characteristics of Monsoon
  - Origin
  - Onset
  - Features during the monsoon - Active and break spells, Monsoon trough, cyclones
  - Withdrawal

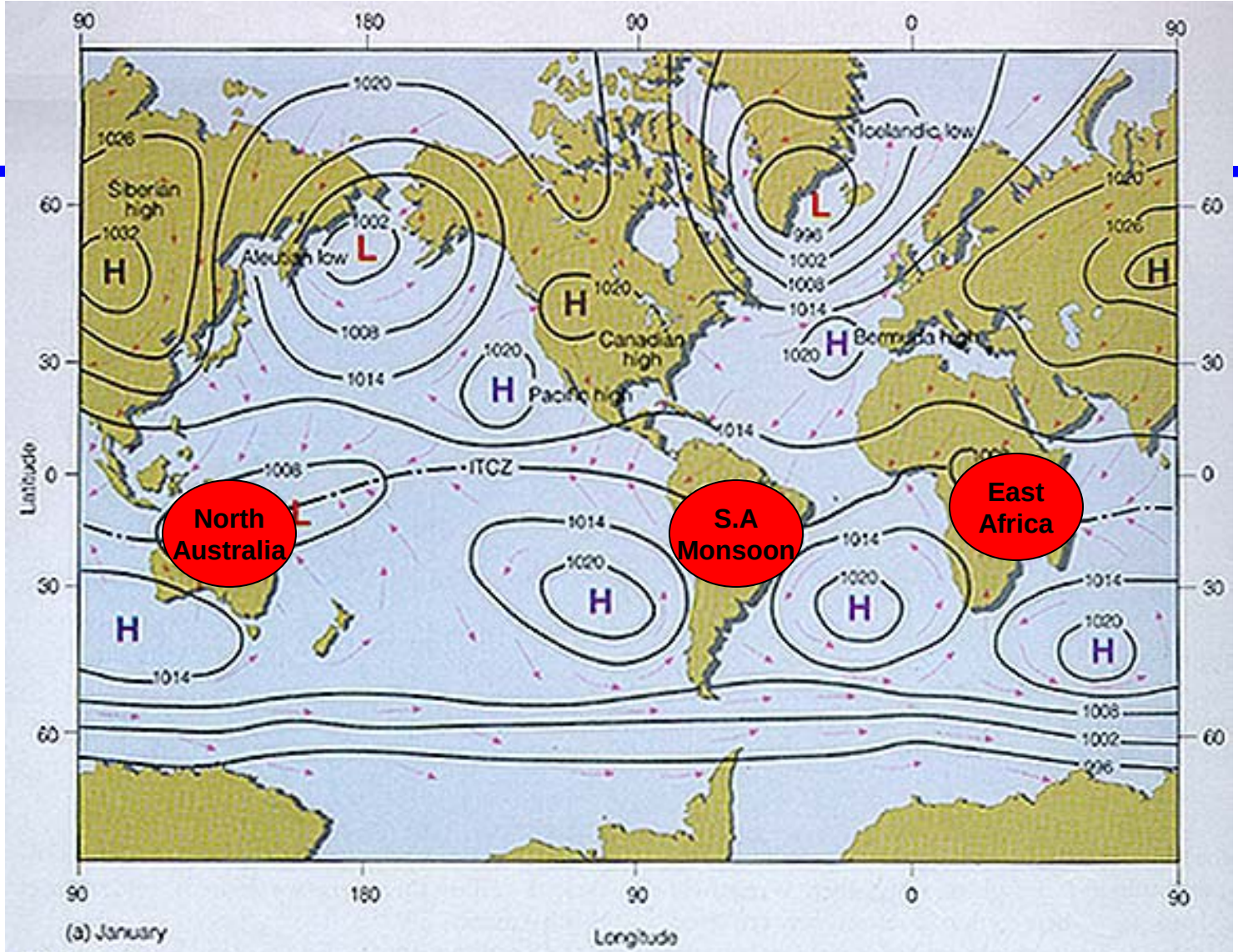
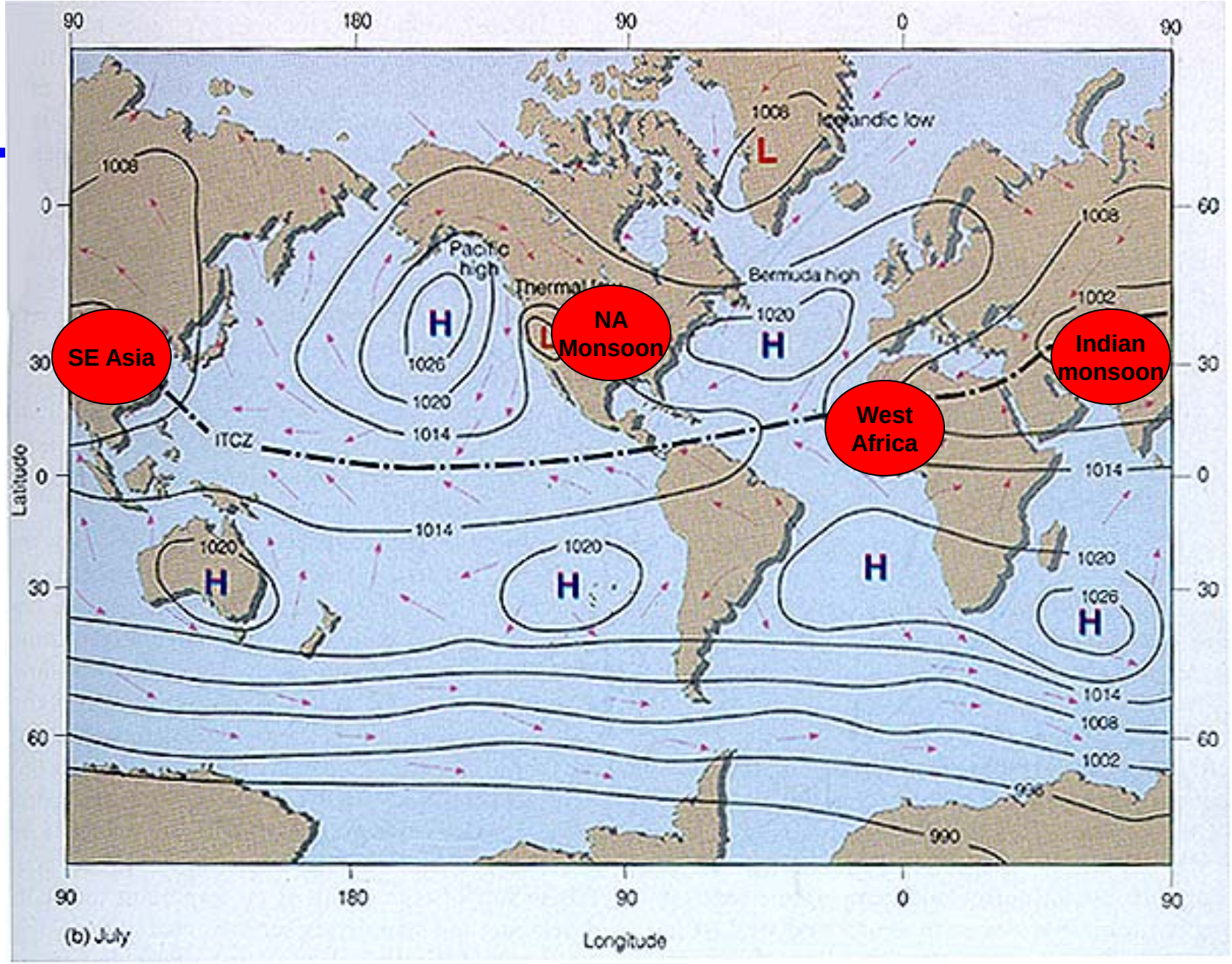


FIGURE 7.15
Average sea level pressure distribution and surface wind flow patterns for January (a) and for July (b). The heavy dashed line represents the position of the ITCZ.

JANUARY

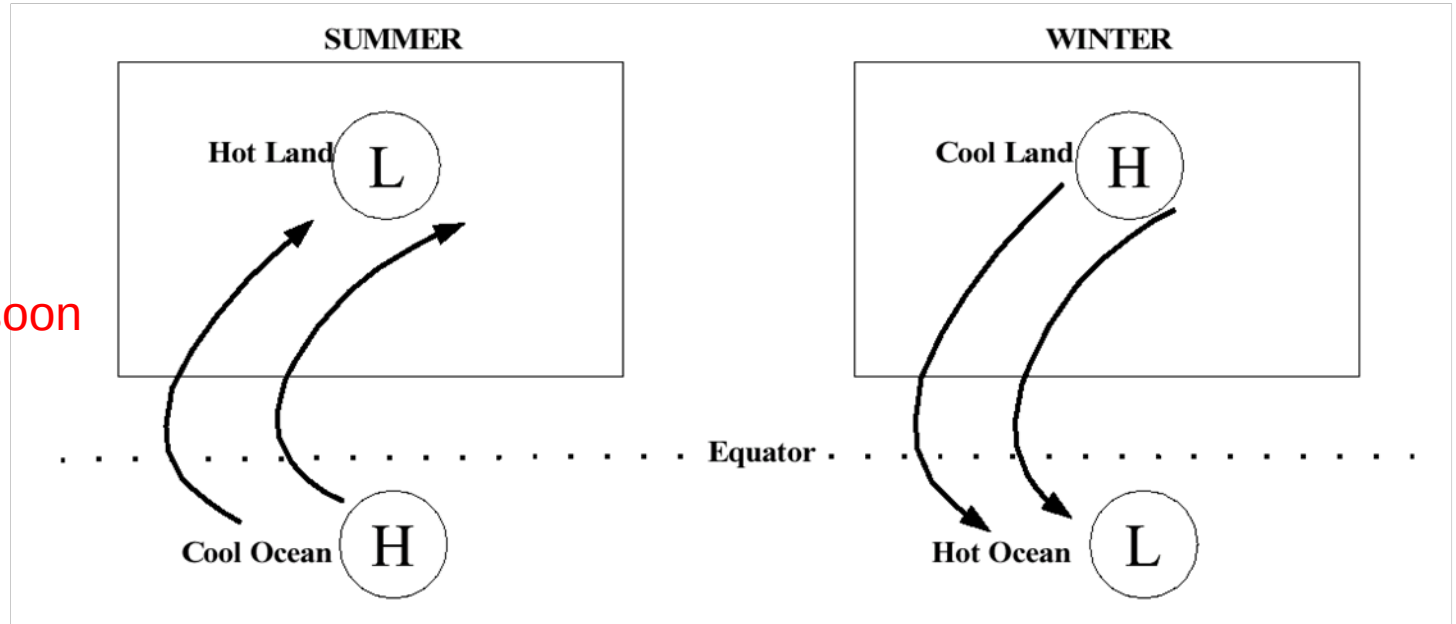

SE Asia
NA Monsoon
Indian monsoon
West Africa
Icelandic low
Pacific high
Thermal low
Bermuda high
ITCZ
Latitude
Longitude
(b) July

JULY

Origin of monsoon

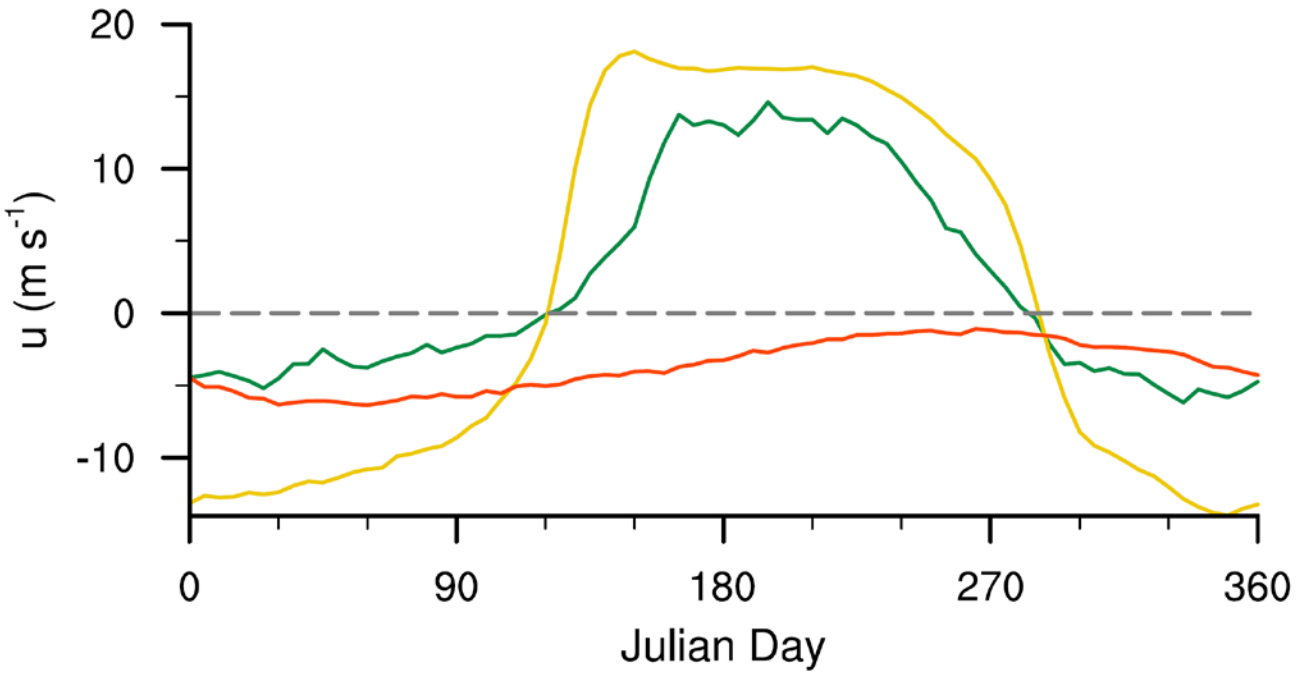
Classical model of monsoon: Land-sea breeze

Monsoon



Origin of monsoon

Seasonal reversal of wind for planet with no land (Aquaplanet)



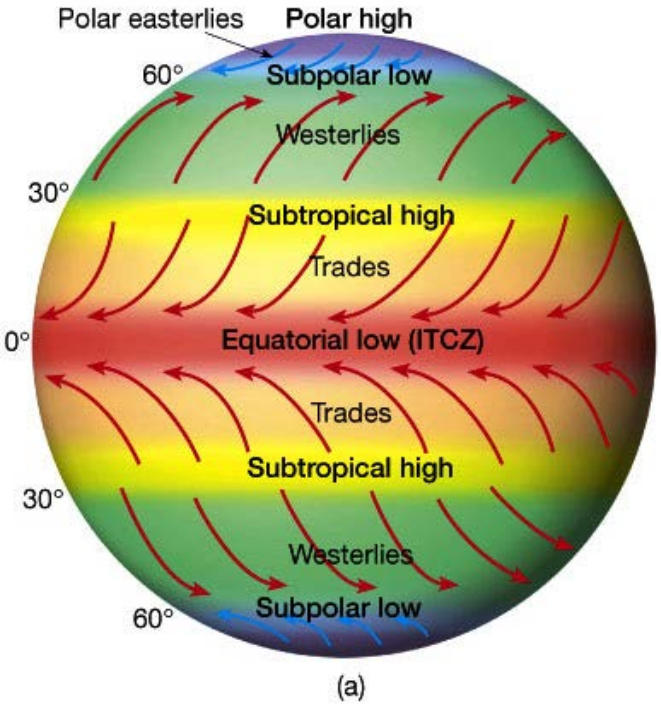
Observed

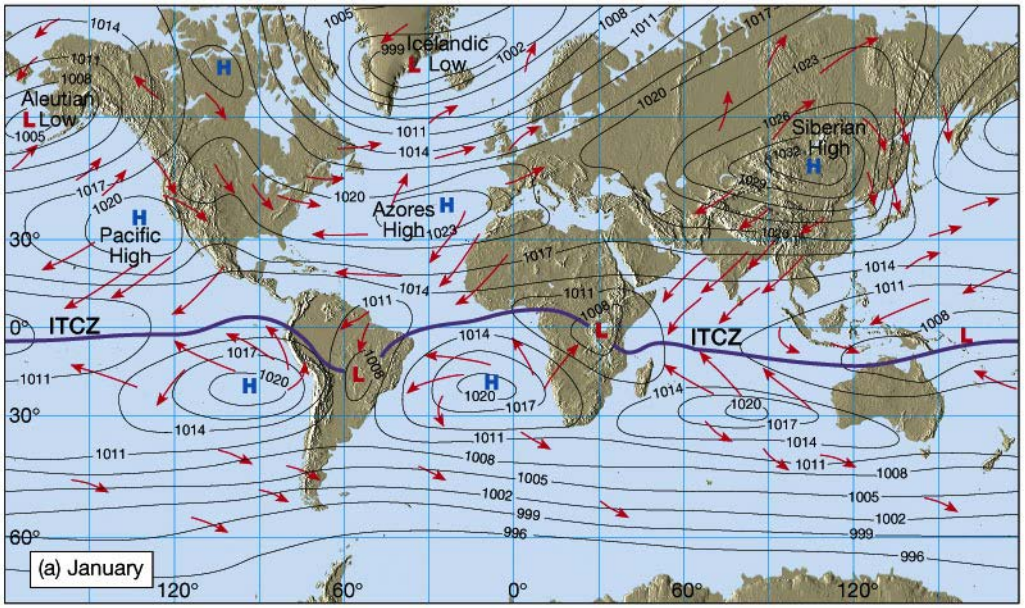
Aquaplanet model

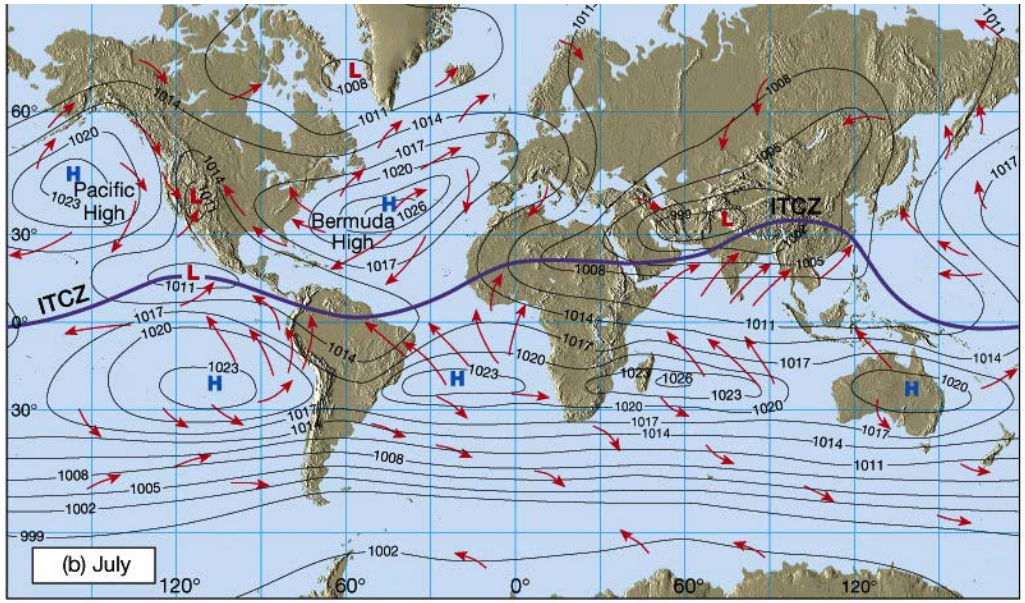
Source: Modified from Bordoni and Schneider (2008)

Origin of monsoon: Intertropical convergence zone

What is ITCZ ?

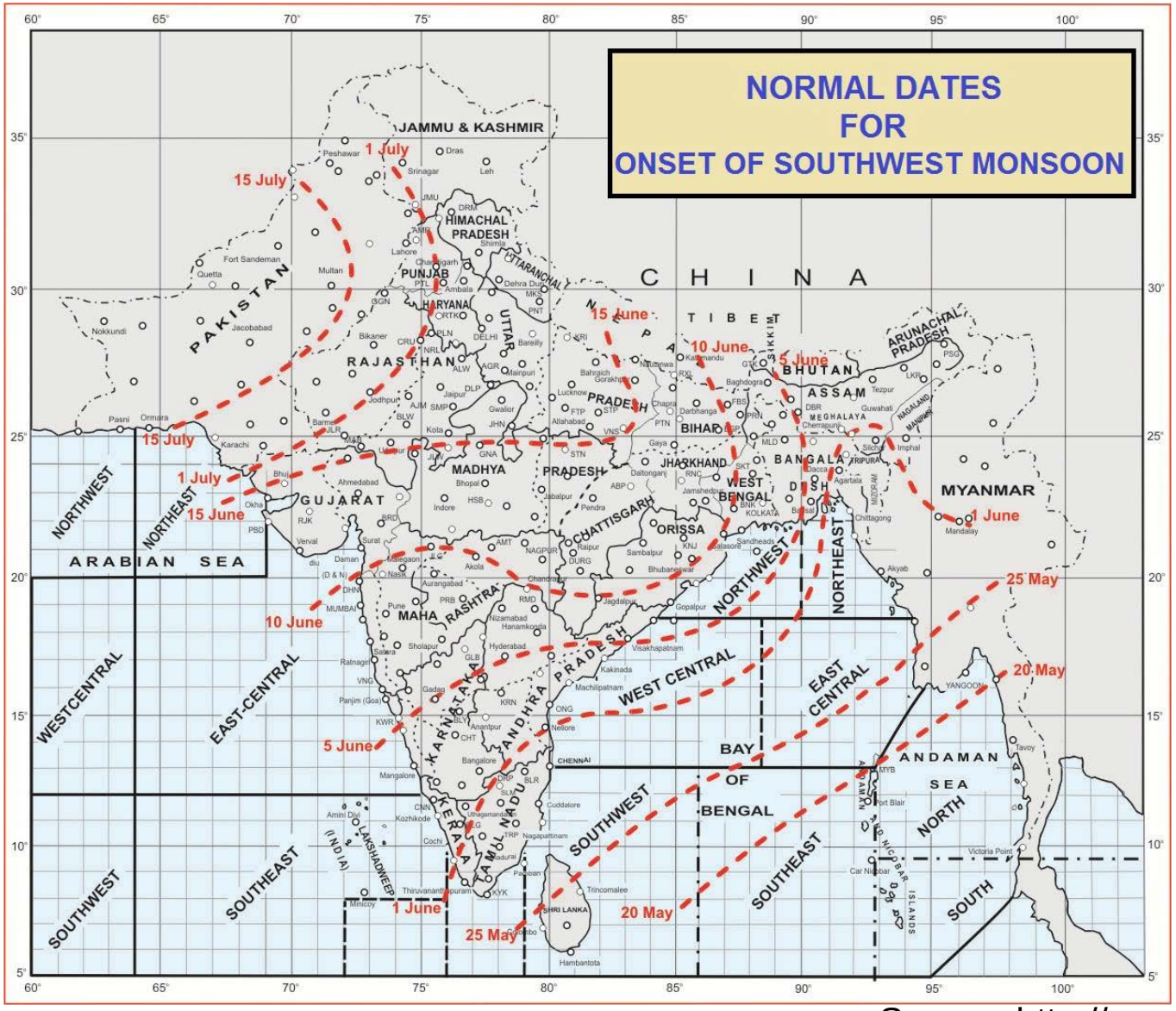




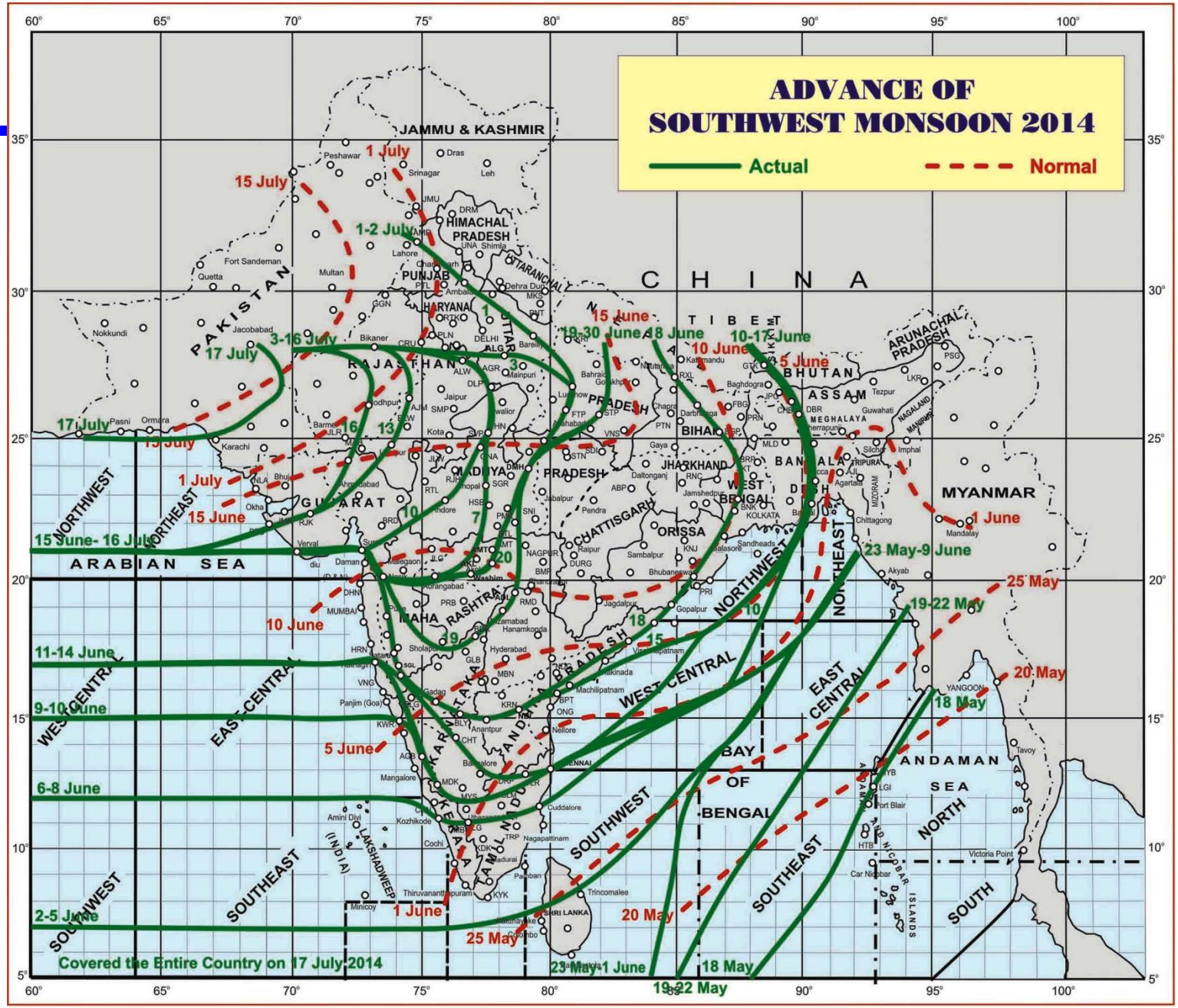


Source: The Atmosphere, by Lutgens and Tarbuck (2001)

Onset of monsoon

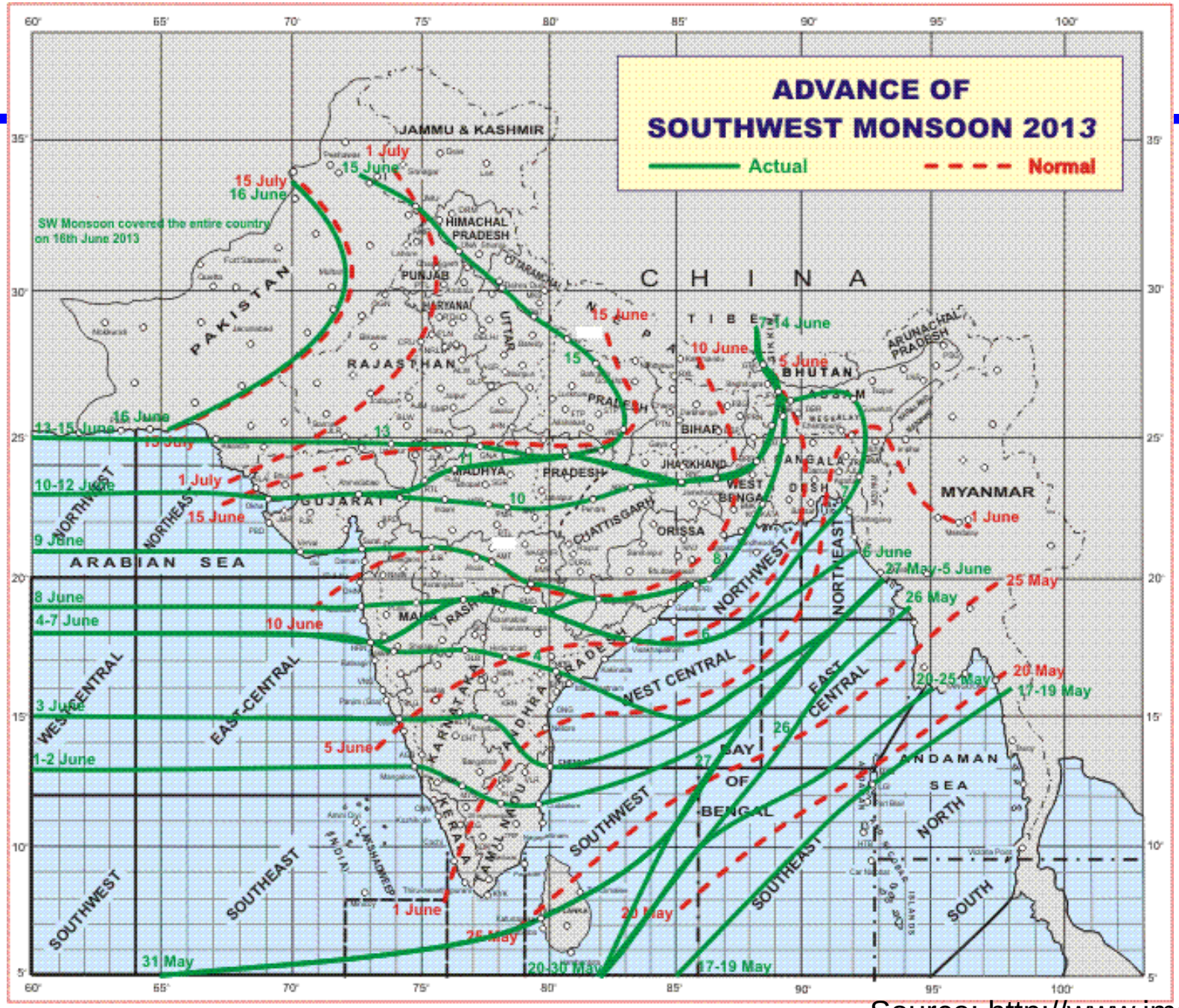


Source: http://www.imd.gov.in



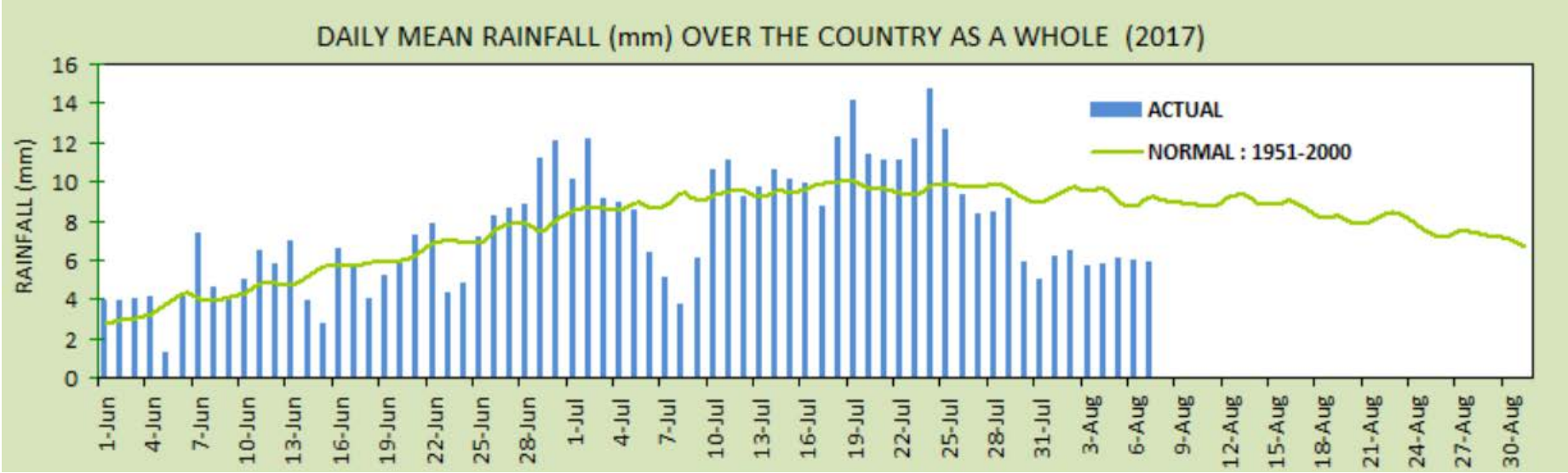
The Southwest Monsoon has advanced on the 17th July 2014, into remaining parts of north Arabian Sea, Saurashtra & Kutch, Gujarat region and west Rajasthan. Thus it covered the entire country.

Source: http://www.imd.gov.in



Source: http://www.imd.gov.in

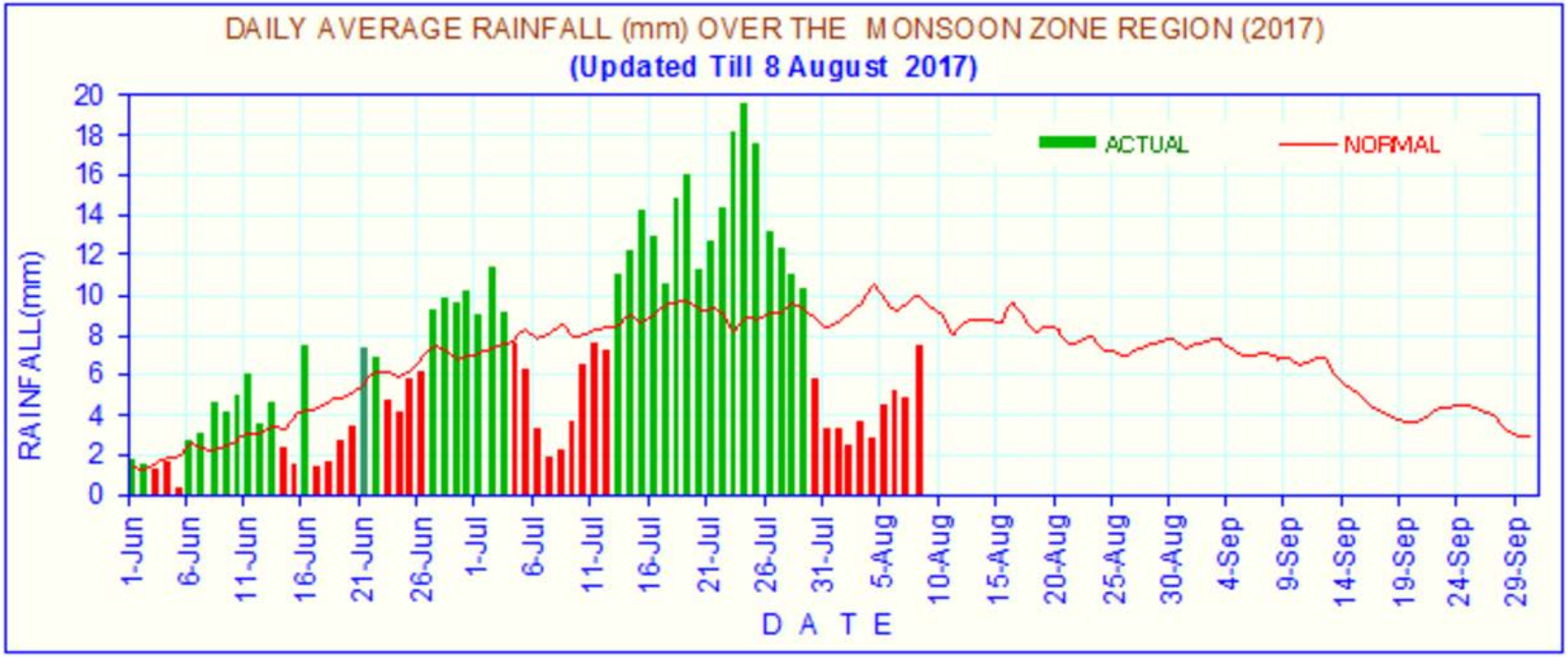
Features during a monsoon



Active and Break Spells

Source: http://www.imd.gov.in

Features during a monsoon

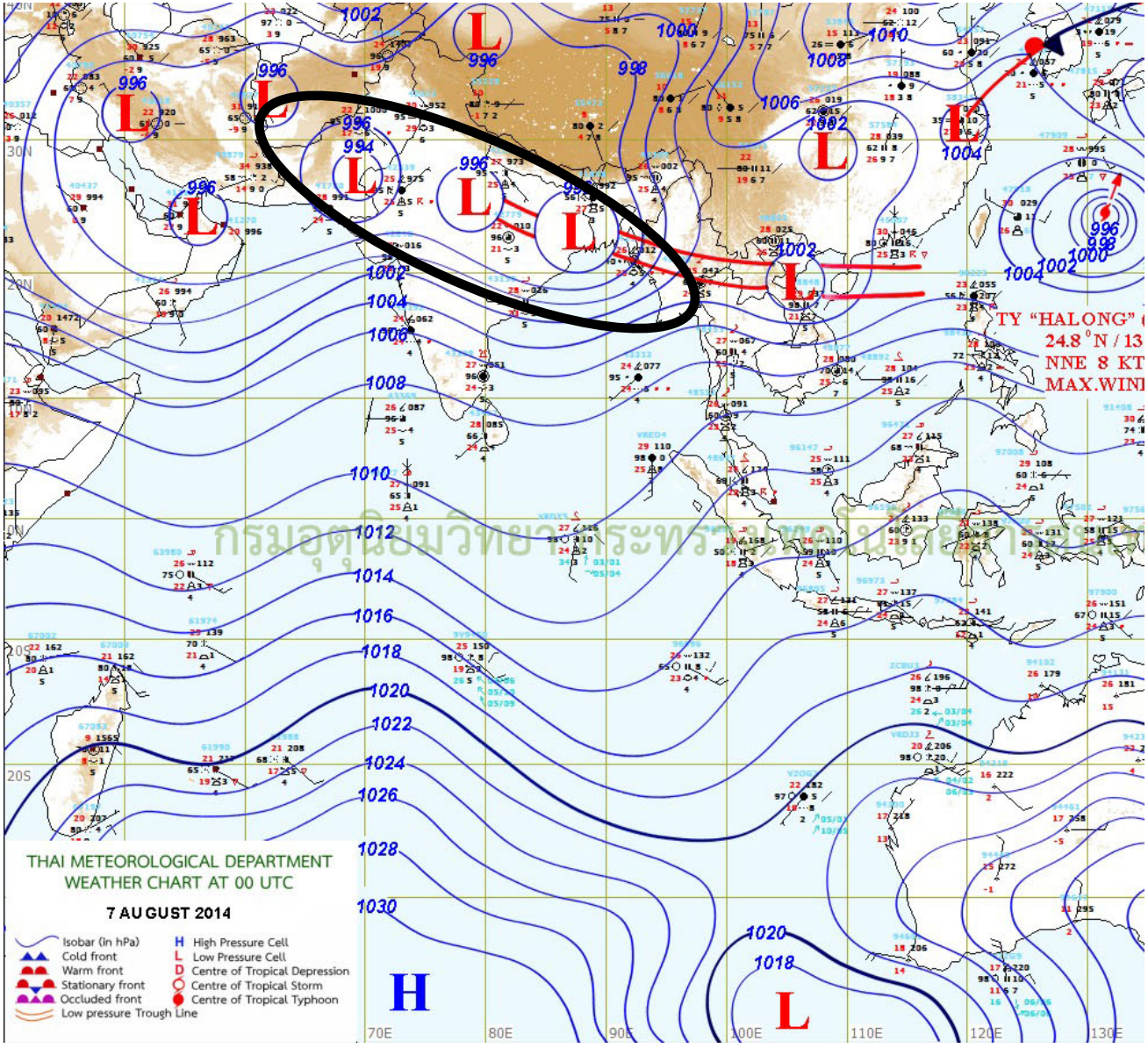


Active and Break Spells

Source: http://www.imd.gov.in

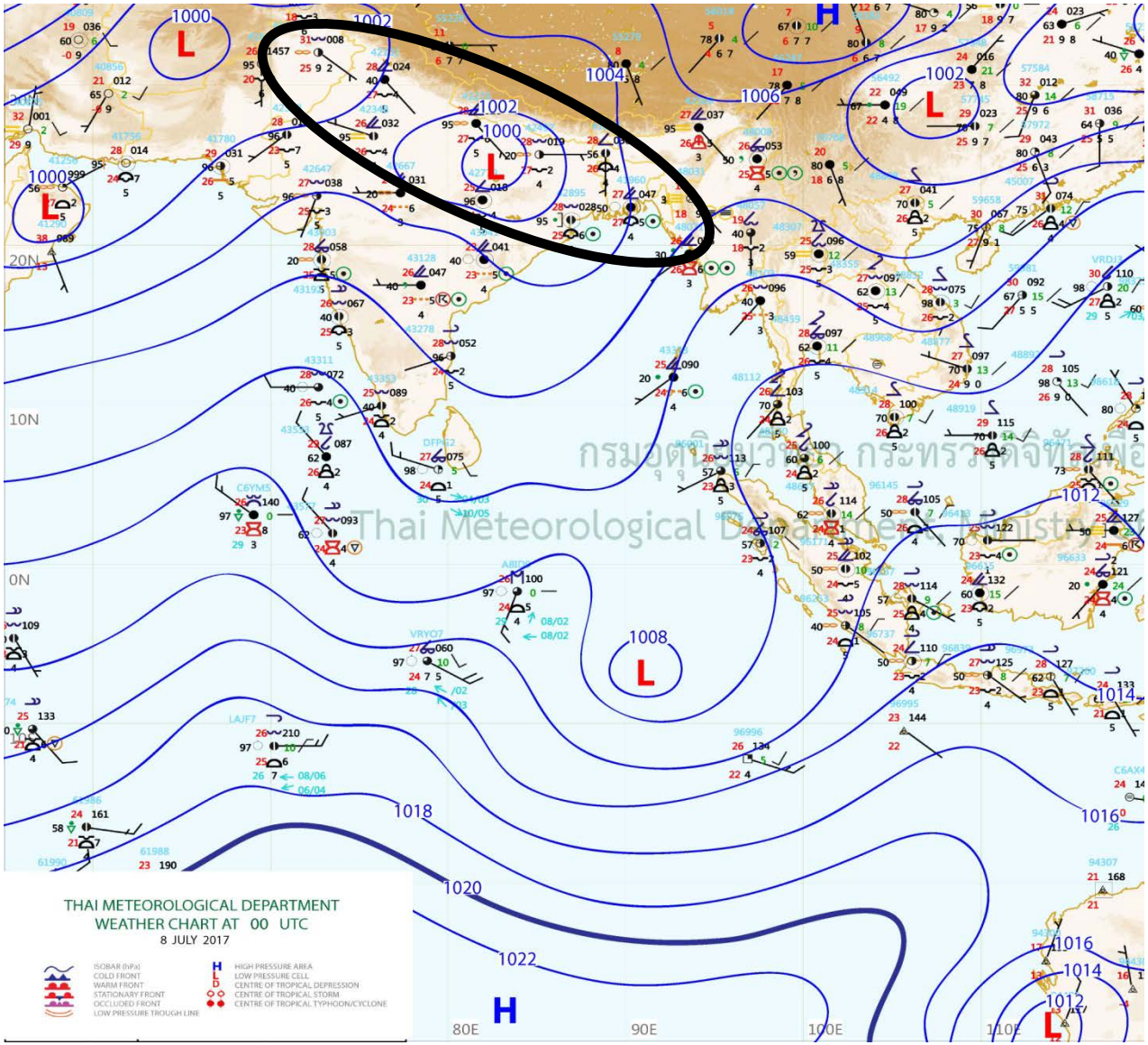
Features during a monsoon

Monsoon Trough



Features during a monsoon

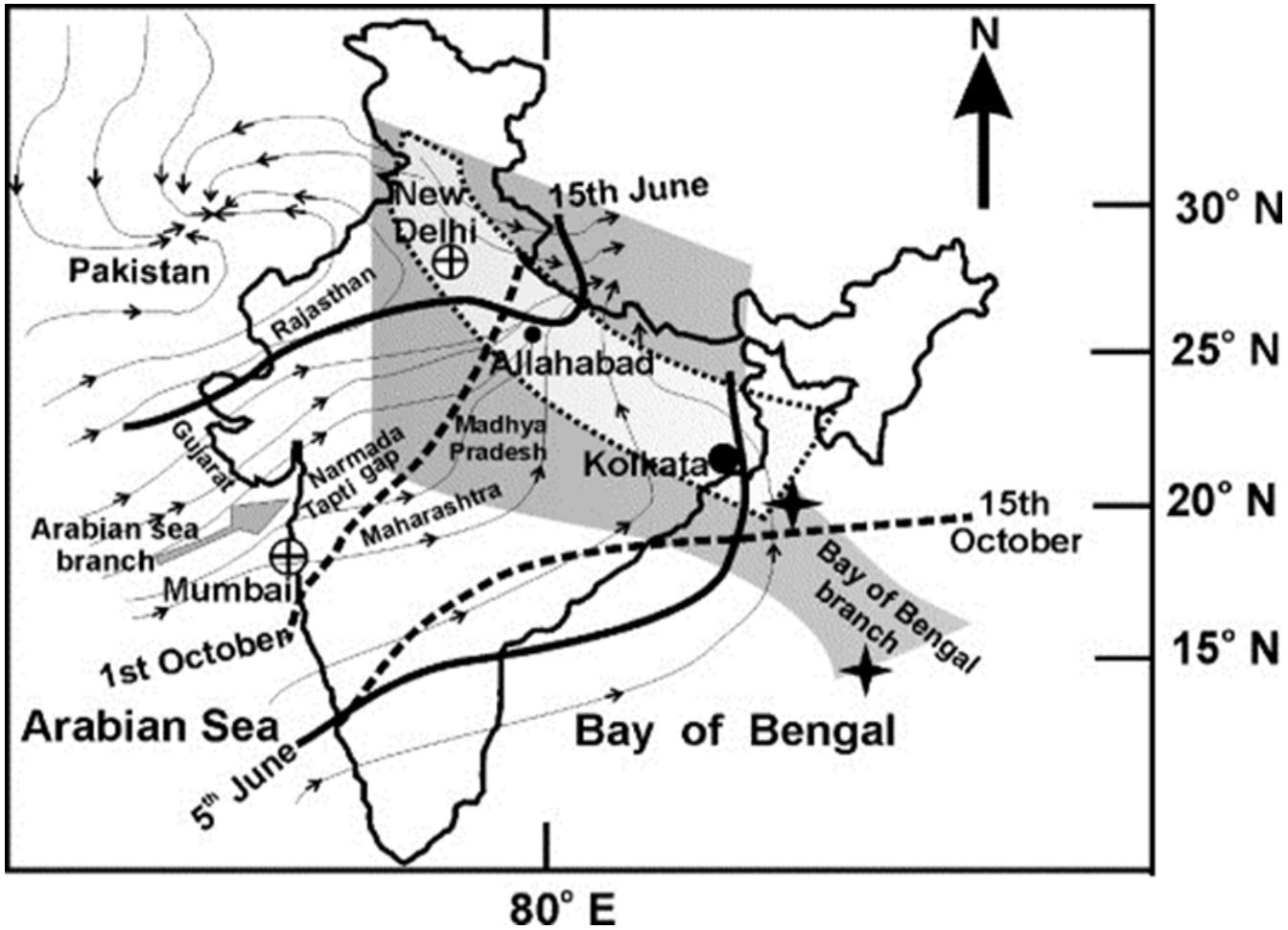
Monsoon Trough



Source: www.tmd.go.th

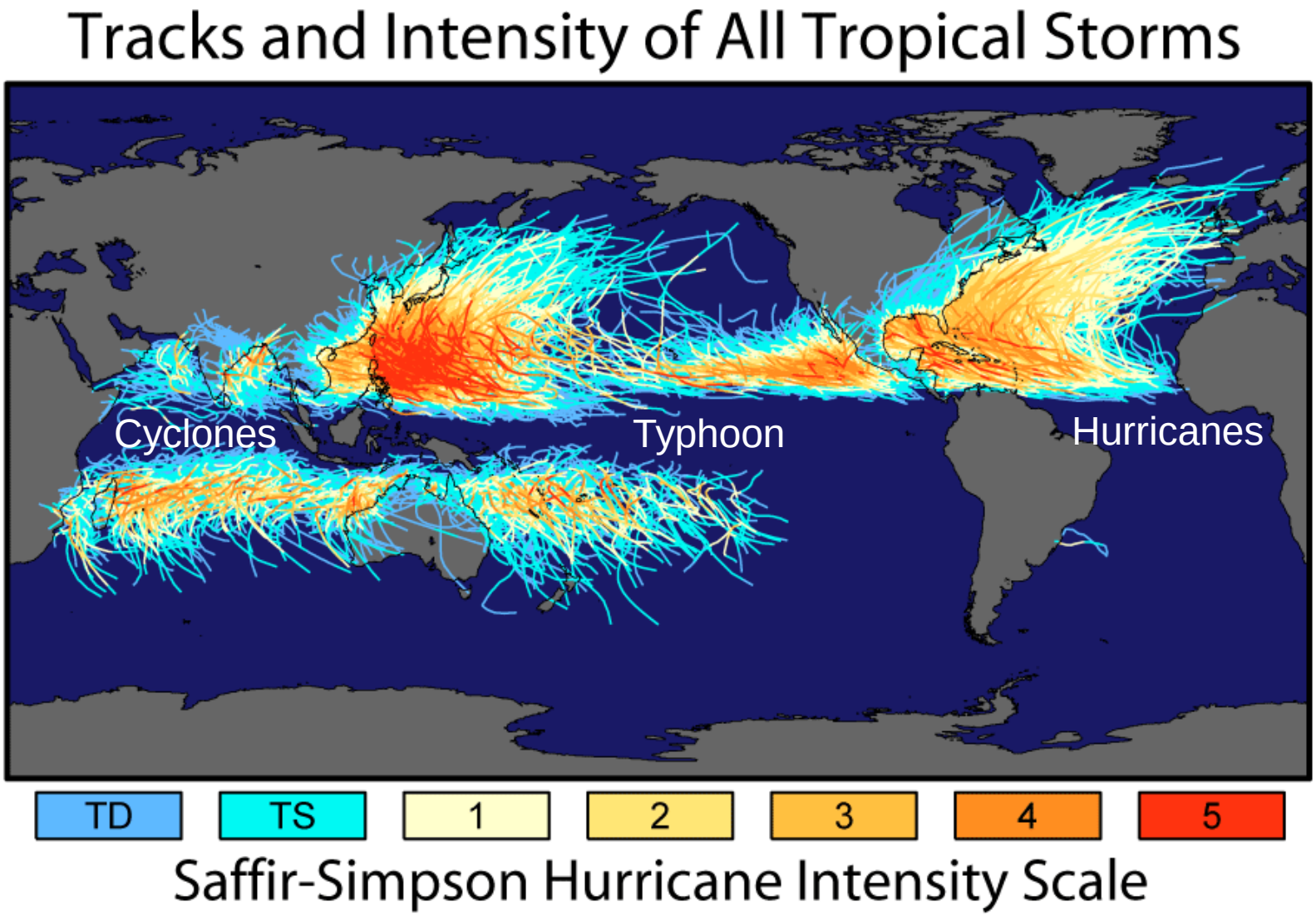
Features during a monsoon

Arabian Sea and Bay of Bengal branches



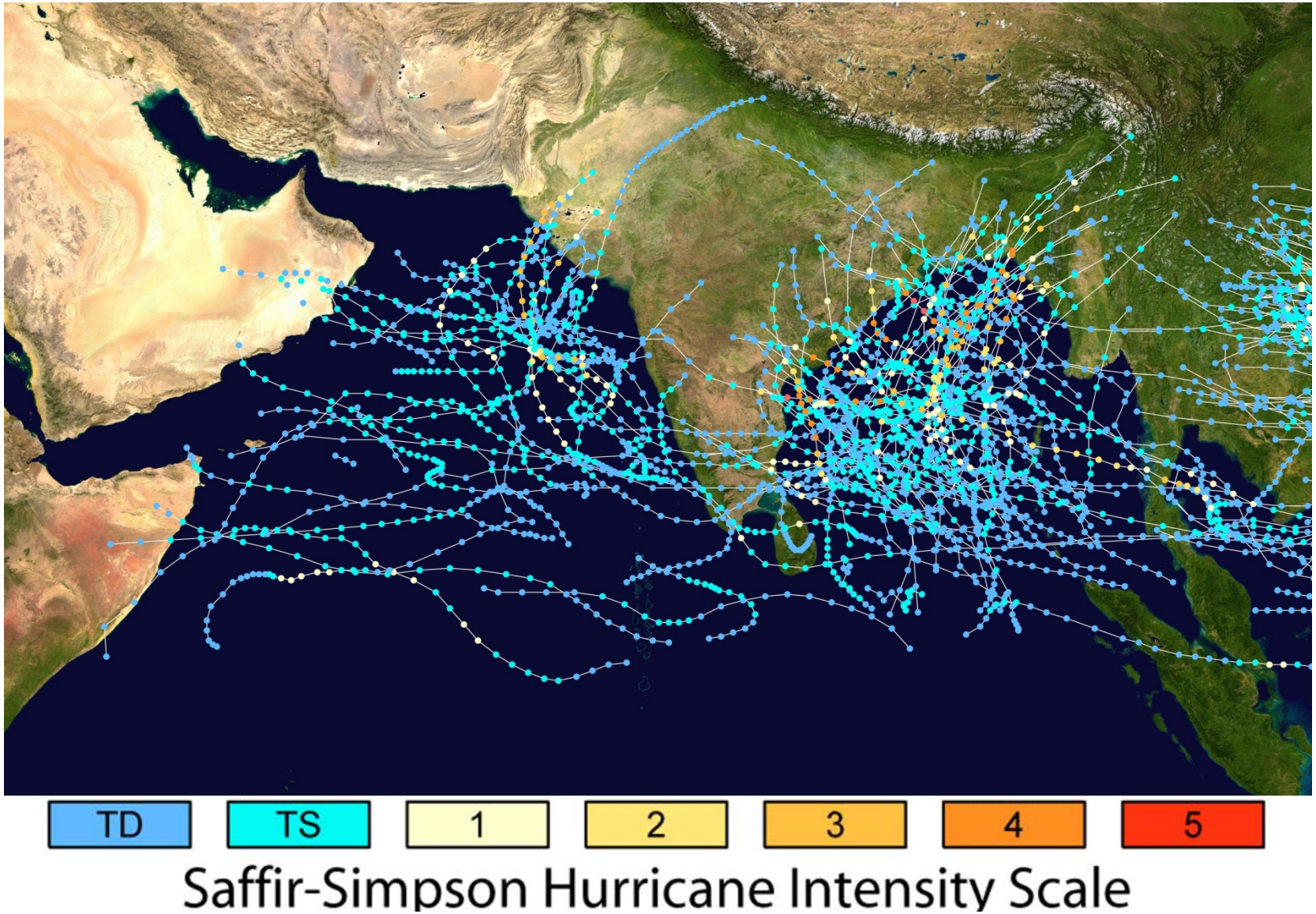
Source: Sengupta and Sarkar, 2006

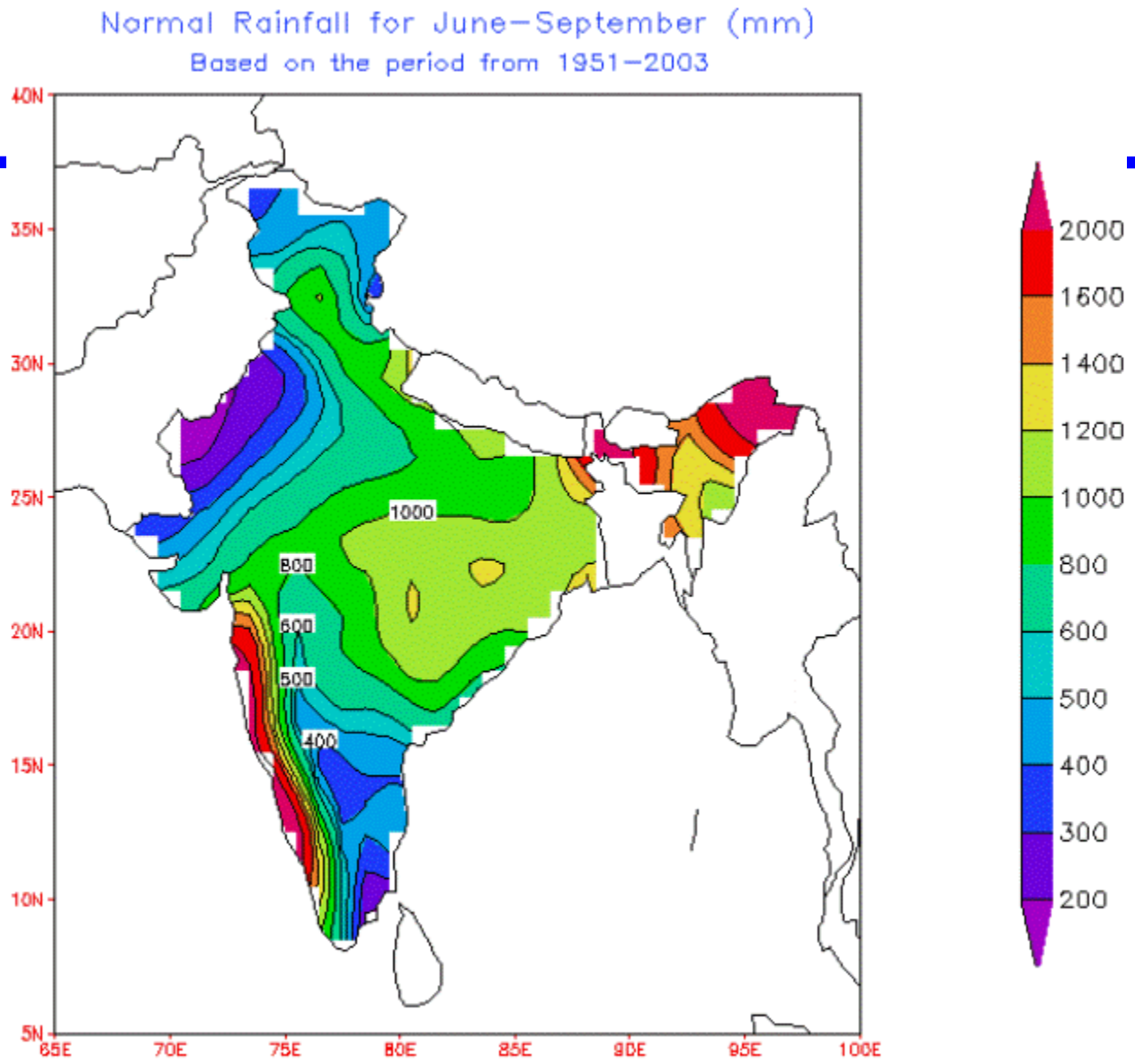
Cyclones



Source: The Earth Observatory, NASA

North Indian Ocean cyclone tracks 1980-2005



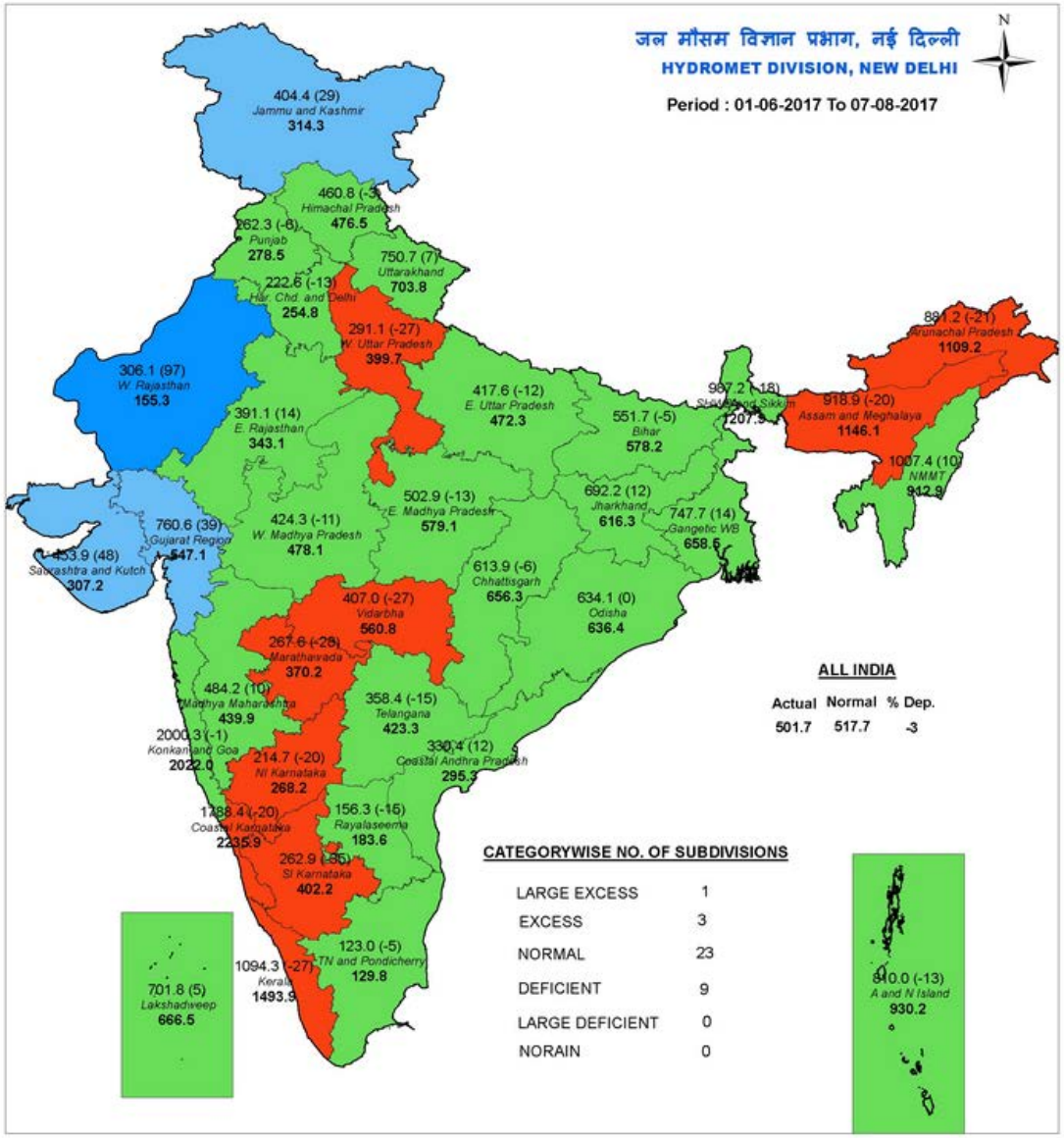


Average monsoon rainfall : 95 cm

Average Annual rainfall : 117 cm

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT

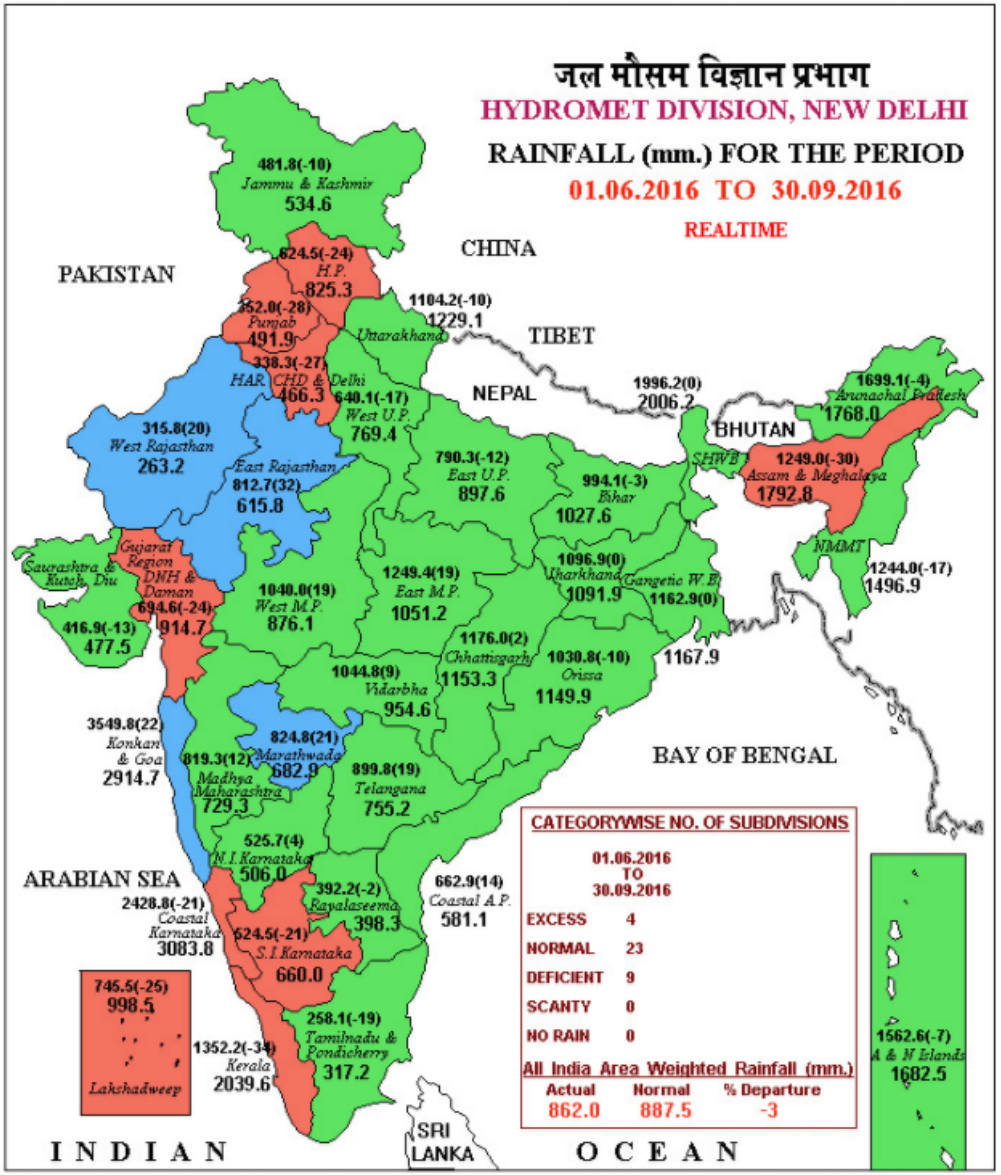
SUBDIVISION RAINFALL MAP



Legend

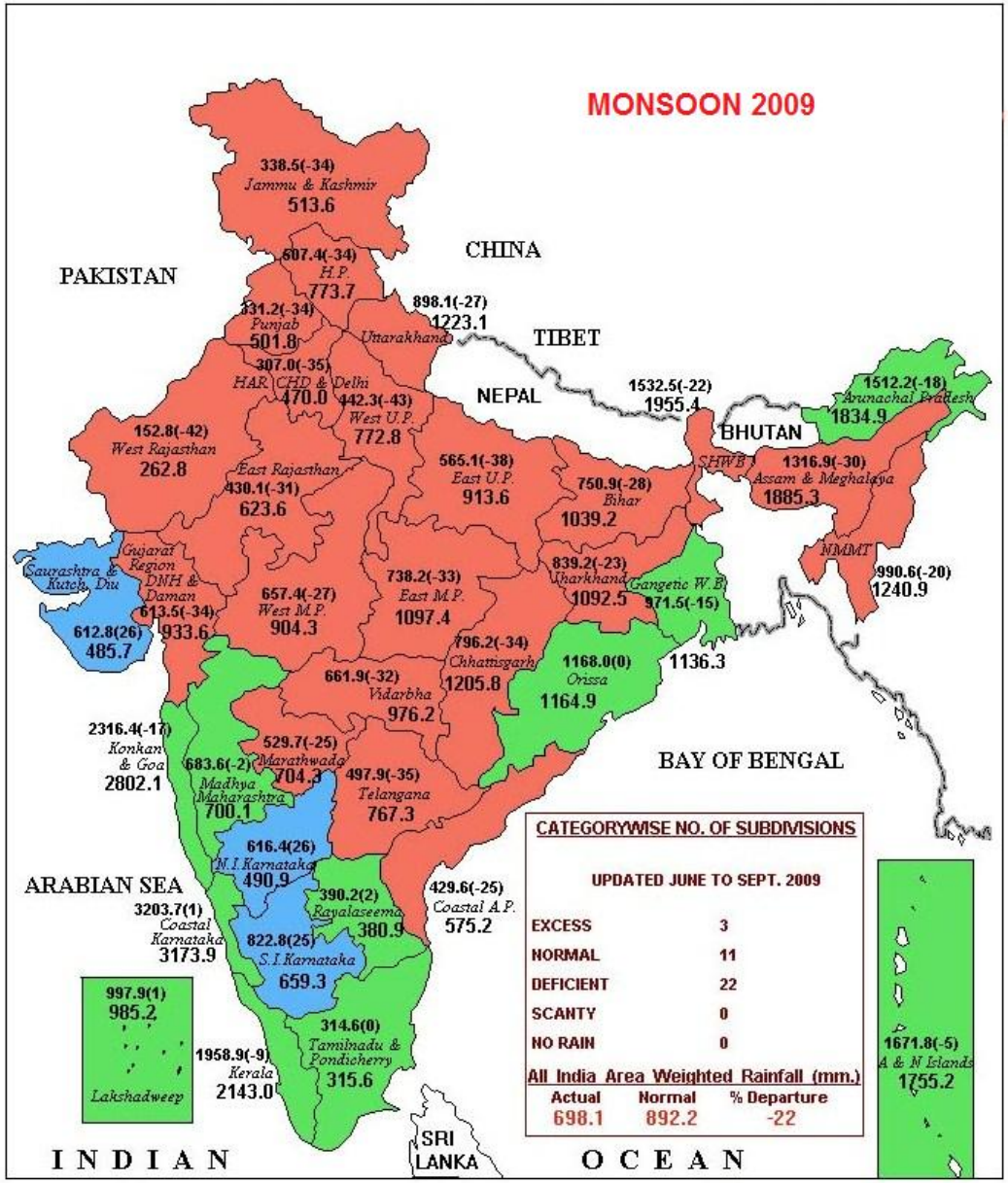
Large Excess [60% or more] | Excess [20% to 59%] | Normal [-19% to 19%] | Deficient [-59% to -20%] | Large Deficient [-99% to -60%] | No Rain [-100%] | NO DATA

भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT



LEGEND: EXCESS (+20% OR MORE) | NORMAL (+19% TO -19%) | DEFICIENT (-20% TO -59%) | SCANTY (-60% TO -99%) | NO RAIN (-100%) | NO DATA

NOTES:



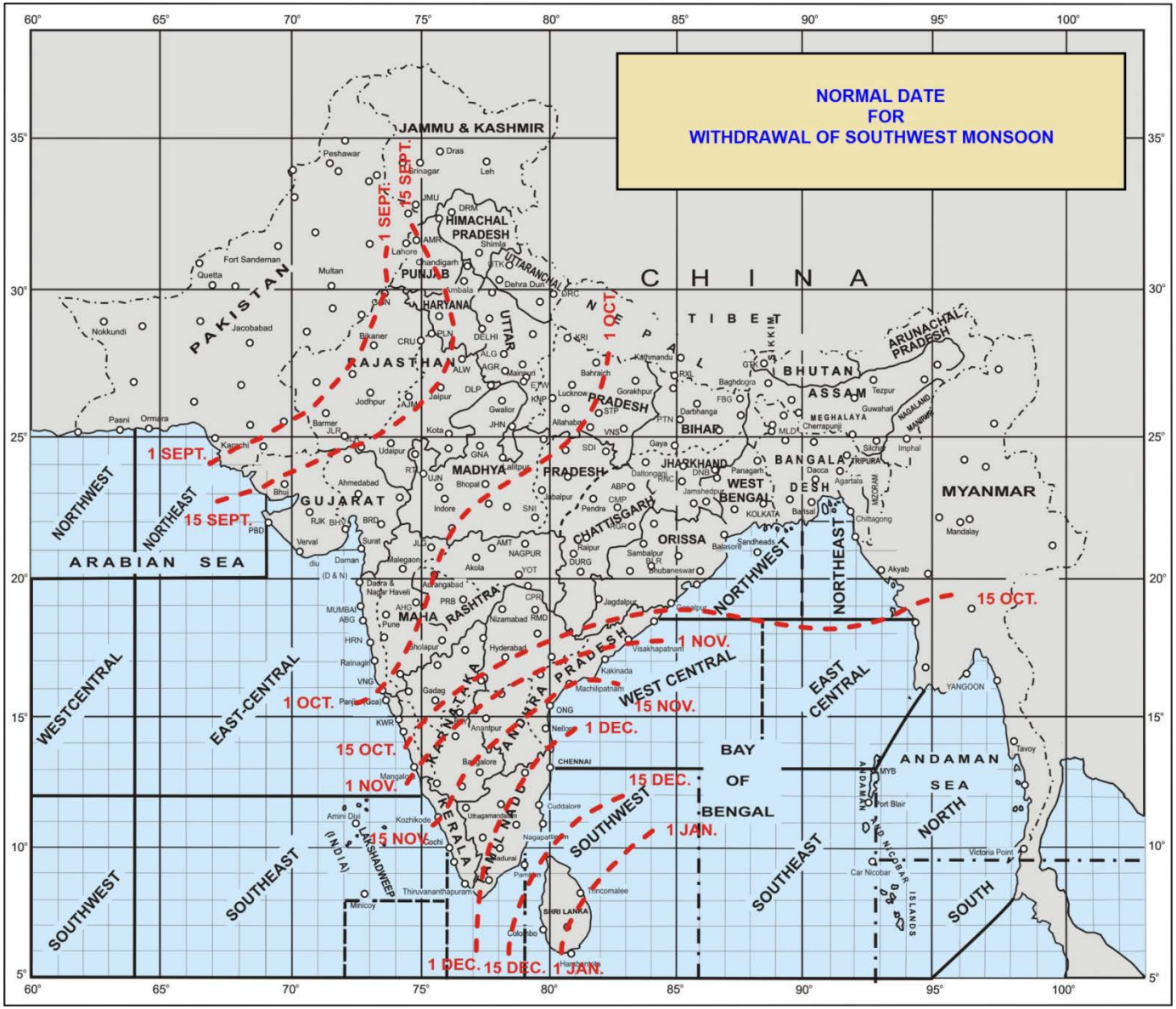
LEGEND: EXCESS (+20% OR MORE) NORMAL (+19% TO -19%) DEFICIENT (-20% TO -59%) SCANTY (-60% TO -99%) NO RAIN (-100%) NO DATA

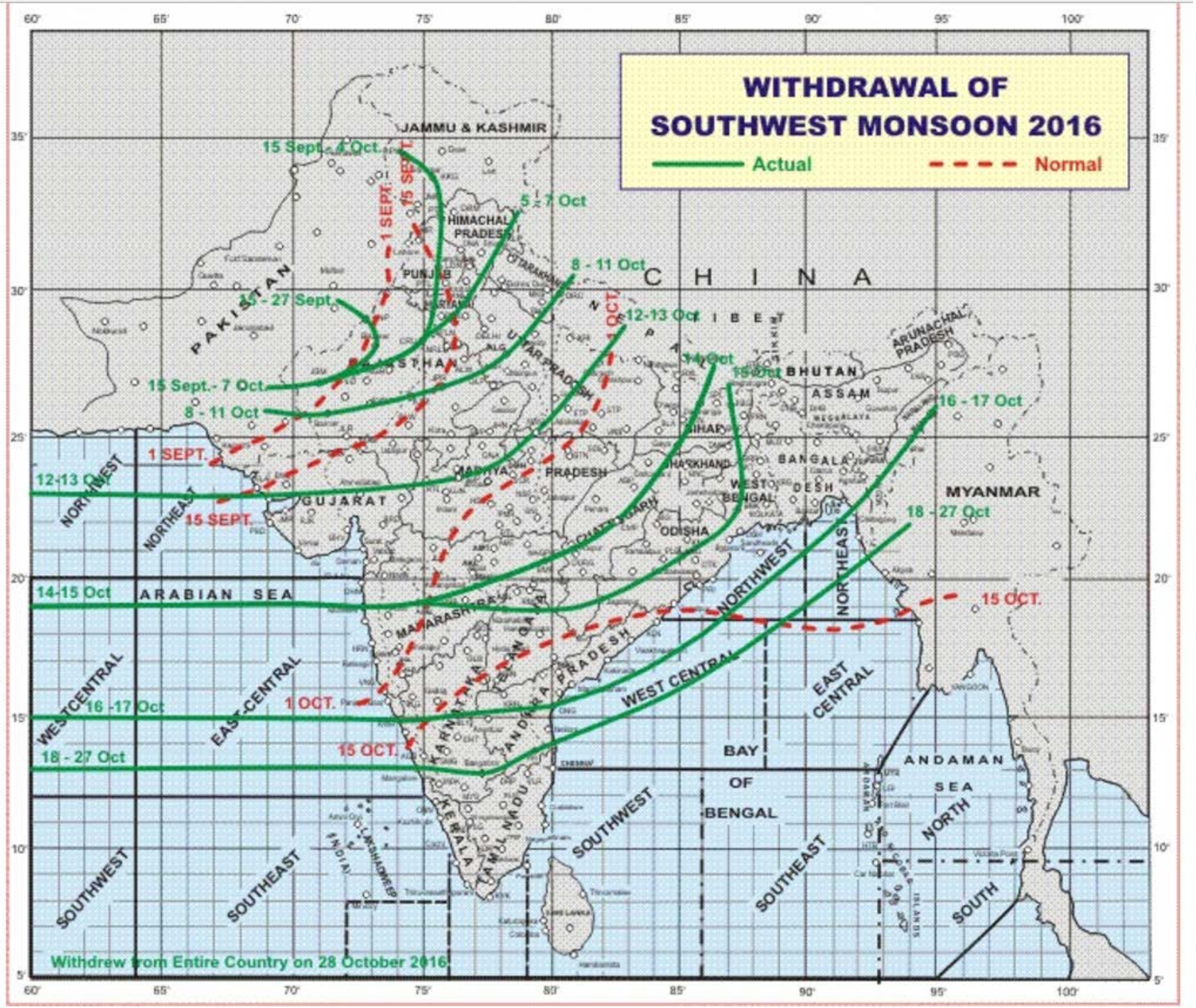
NOTES:

(a) Rainfall figures are based on operational data.

(b) Small figures indicate actual rainfall (mm.), while bold figures indicate Normal rainfall (mm.)
Percentage Departures of Rainfall are shown in Brackets.

Withdrawal of monsoon




WITHDRAWAL OF
SOUTHWEST MONSOON 2016
Actual
Normal
JAMMU & KASHMIR
15 Sept.- 4 Oct.
1 SEPT.
15 SEPT.
5 - 7 Oct
HIMACHAL PRADESH
8 - 11 Oct
C H I N A
PAKISTAN
15 - 27 Sept.
1 OCT.
12-13 Oct
14 Oct
15 Oct
BHUTAN
ARUNACHAL PRADESH
ASSAM
16 - 17 Oct
15 Sept.- 7 Oct.
8 - 11 Oct
1 SEPT.
12-13 Oct
NORTHWEST
NORTHEAST
15 SEPT.
GUJARAT
MADHYA PRADESH
BIHAR
JHARKHAND
WEST BENGAL
BANGLADESH
MYANMAR
ODISHA
18 - 27 Oct
14-15 Oct
ARABIAN SEA
MAHARASHTRA
NORTHWEST
NORTHEAST
15 OCT.
WESTCENTRAL
EAST-CENTRAL
16 -17 Oct
1 OCT.
WEST CENTRAL
EAST CENTRAL
15 OCT.
18 - 27 Oct
BAY OF BENGAL
ANDAMAN SEA
SOUTHWEST
SOUTHEAST
SOUTHWEST
SOUTHEAST
NORTH
SOUTH
Withdrew from Entire Country on 28 October 2016

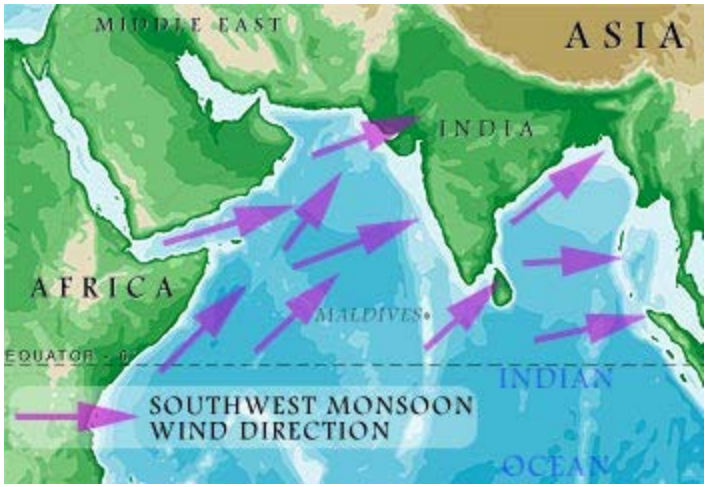
Factors effecting monsoon

- Land surface conditions over the subcontinent
- El-Nino Southern Oscillation
- Indian Ocean Dipole
- ...

How intense will be the monsoon without Himalayas?

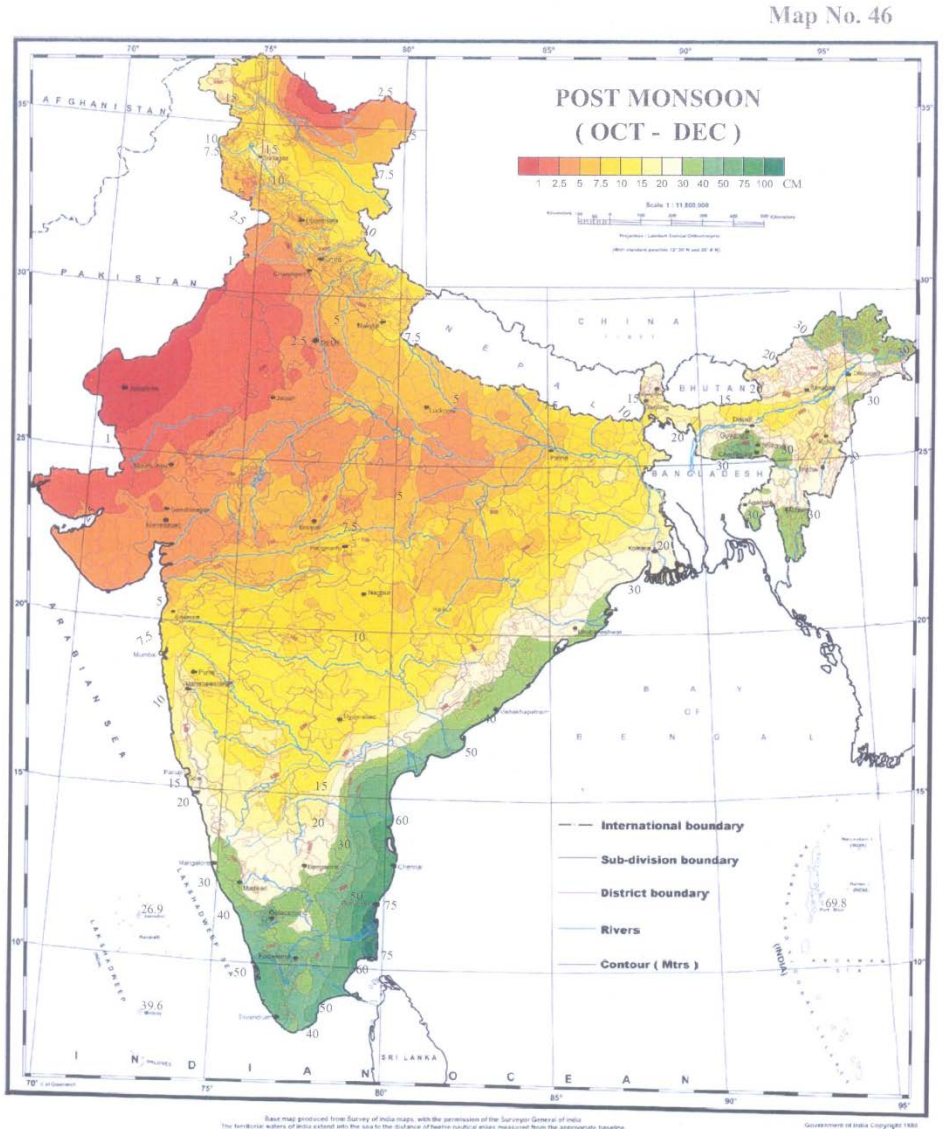
Post Monsoon (Oct-Nov/Dec?)

- Retreating southwest monsoon or Northeast monsoon major source of rainfall over the southern Peninsular India
- Normal start date : October 20



Source: Public Broadcasting Service (PBS)

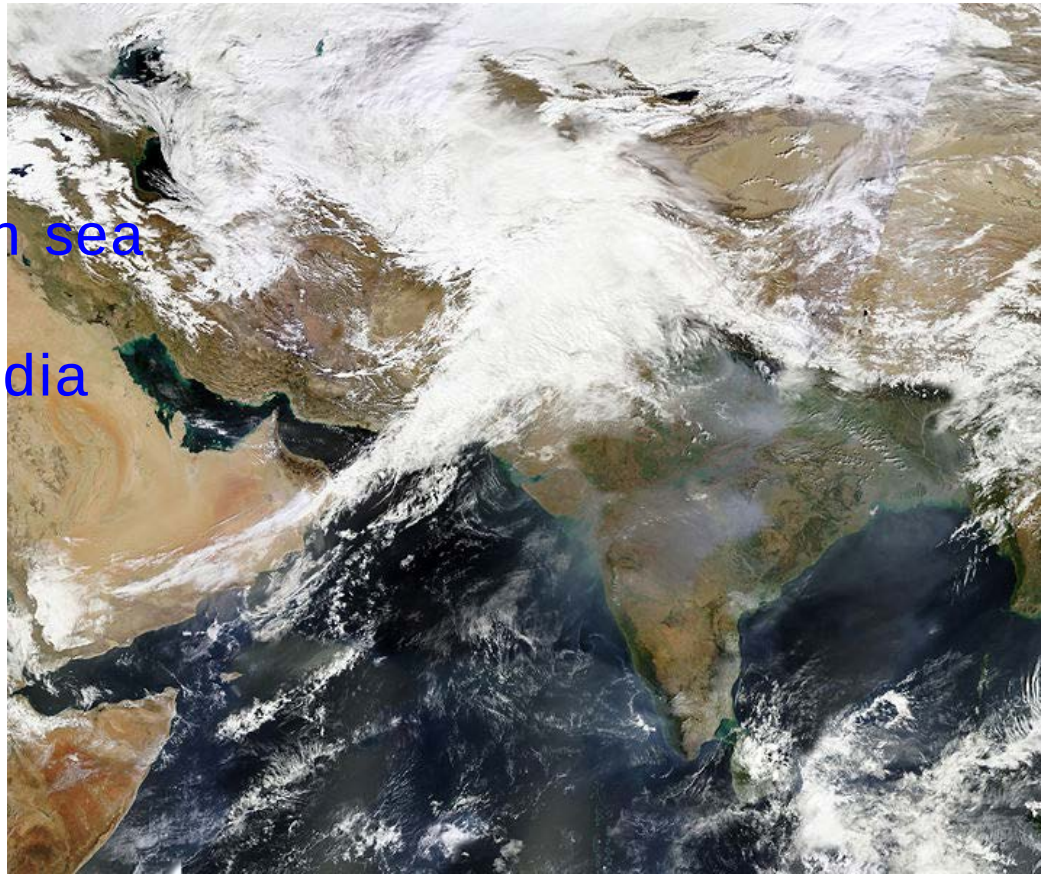
Post Monsoon



Source: IMD

Winter Season (Dec-Feb)

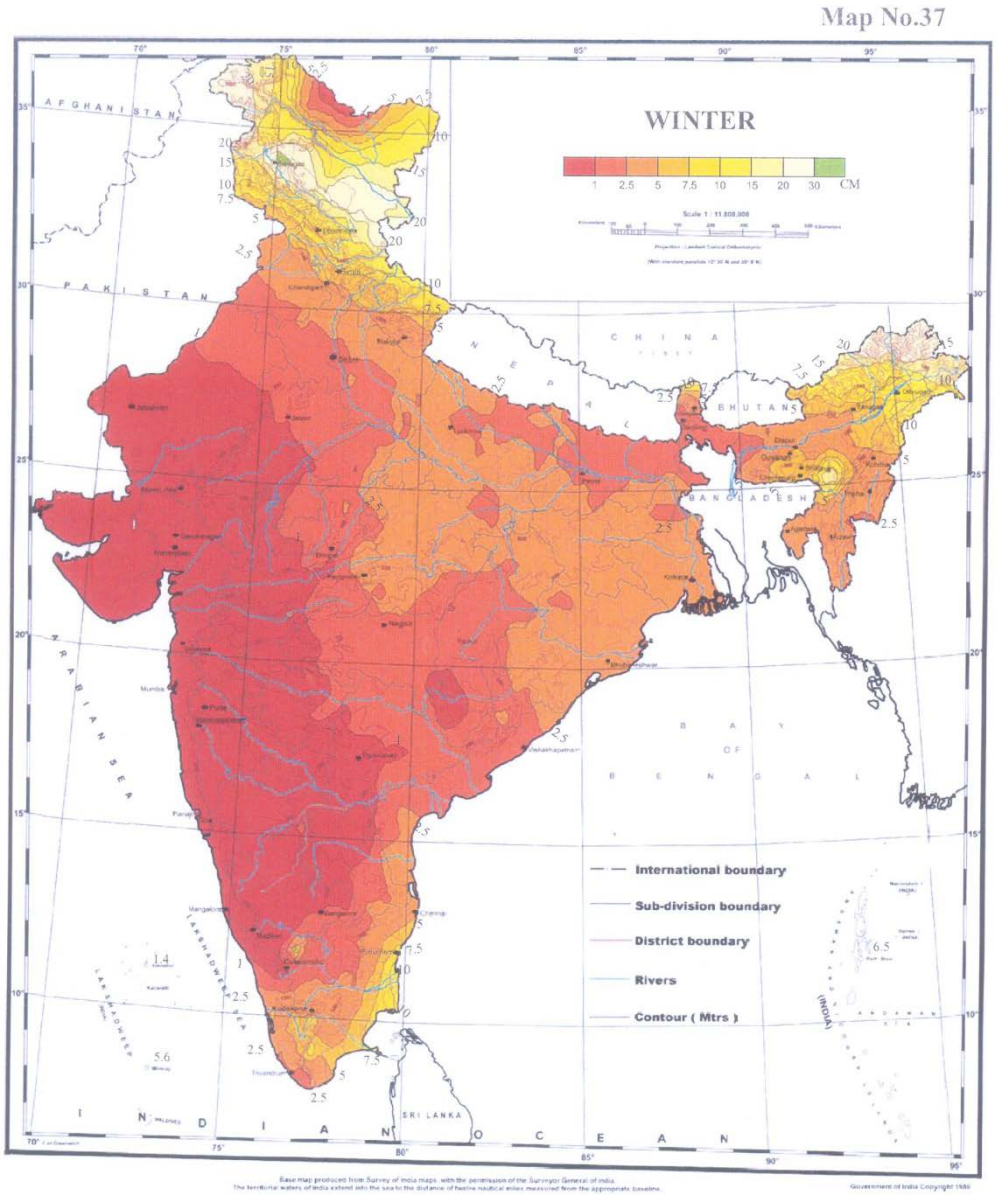
- Winter disturbances
- Originates in Mediterranean sea
- Rainfall over North-west India
- Useful for Rabi crops



Date: 3 February 2013 by NASA MODIS

Source: Wikipedia

Winter Season (Dec-Feb)

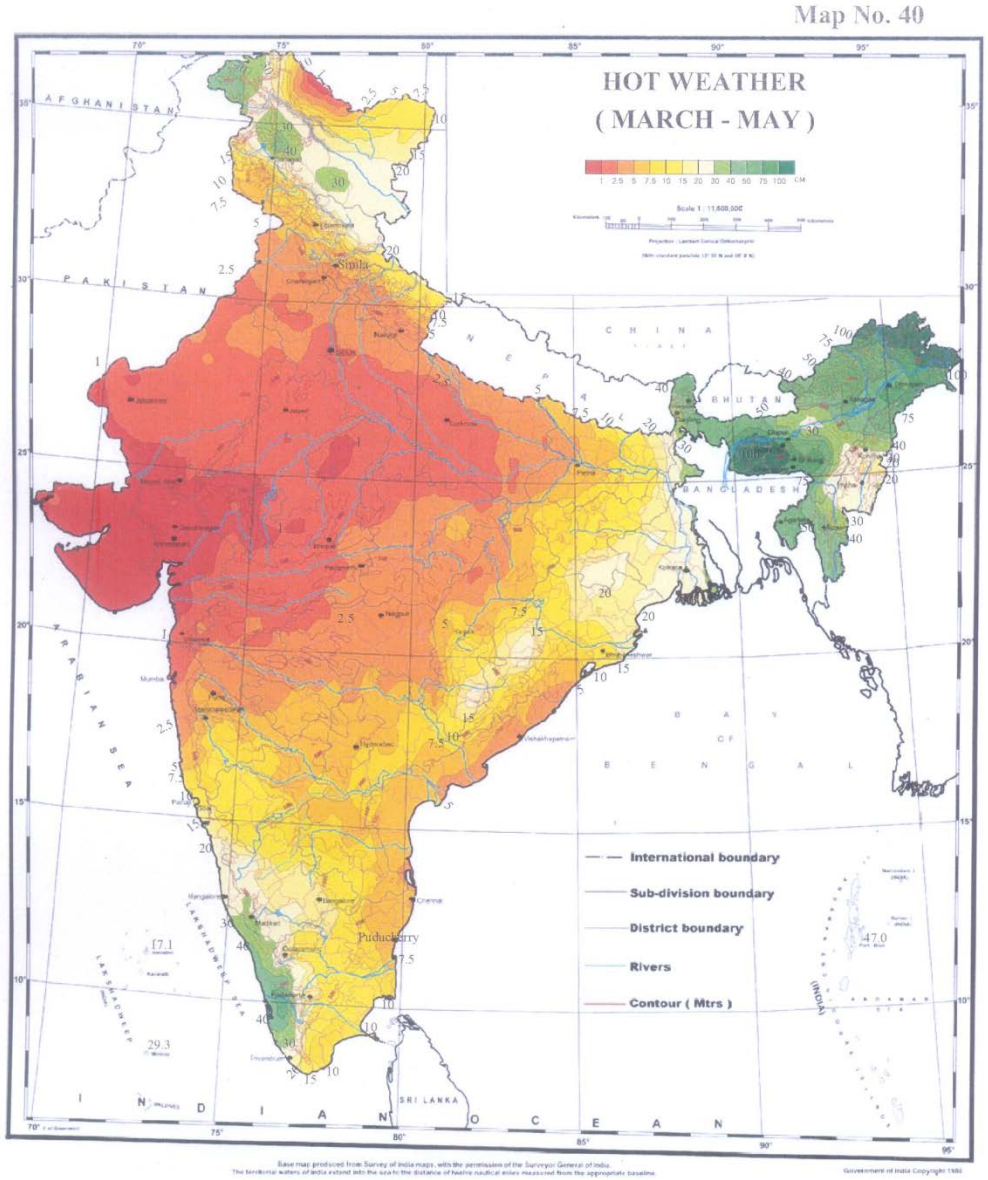


Source: IMD

Summer Season (March-May)

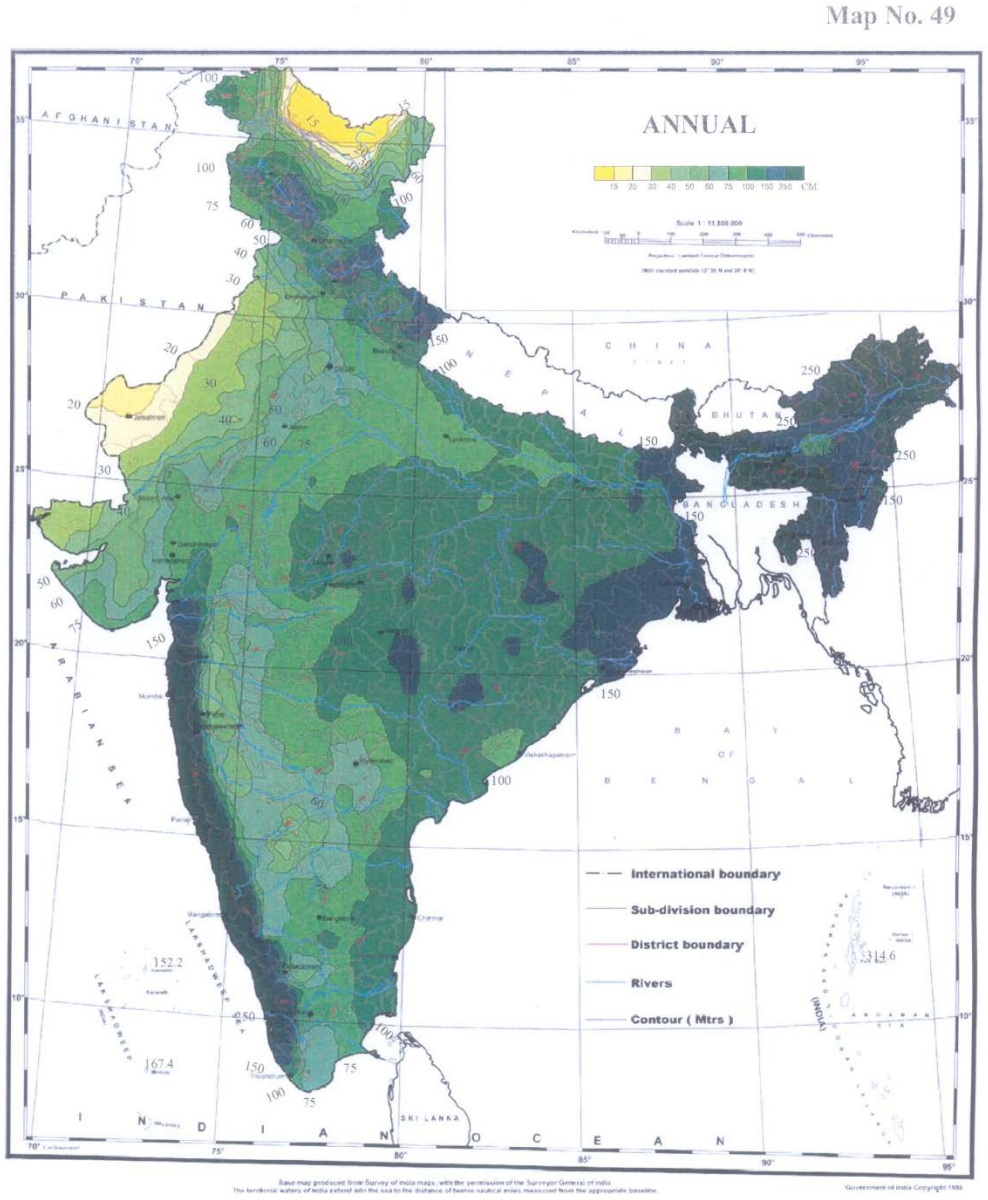
- Scanty rainfall over India
- Local convection in Kerala, West Bengal and Assam

Summer Season (March-May)



Source: IMD

Annual Rainfall



Source: IMD