Explained: How Does the Indian Monsoon Develop?

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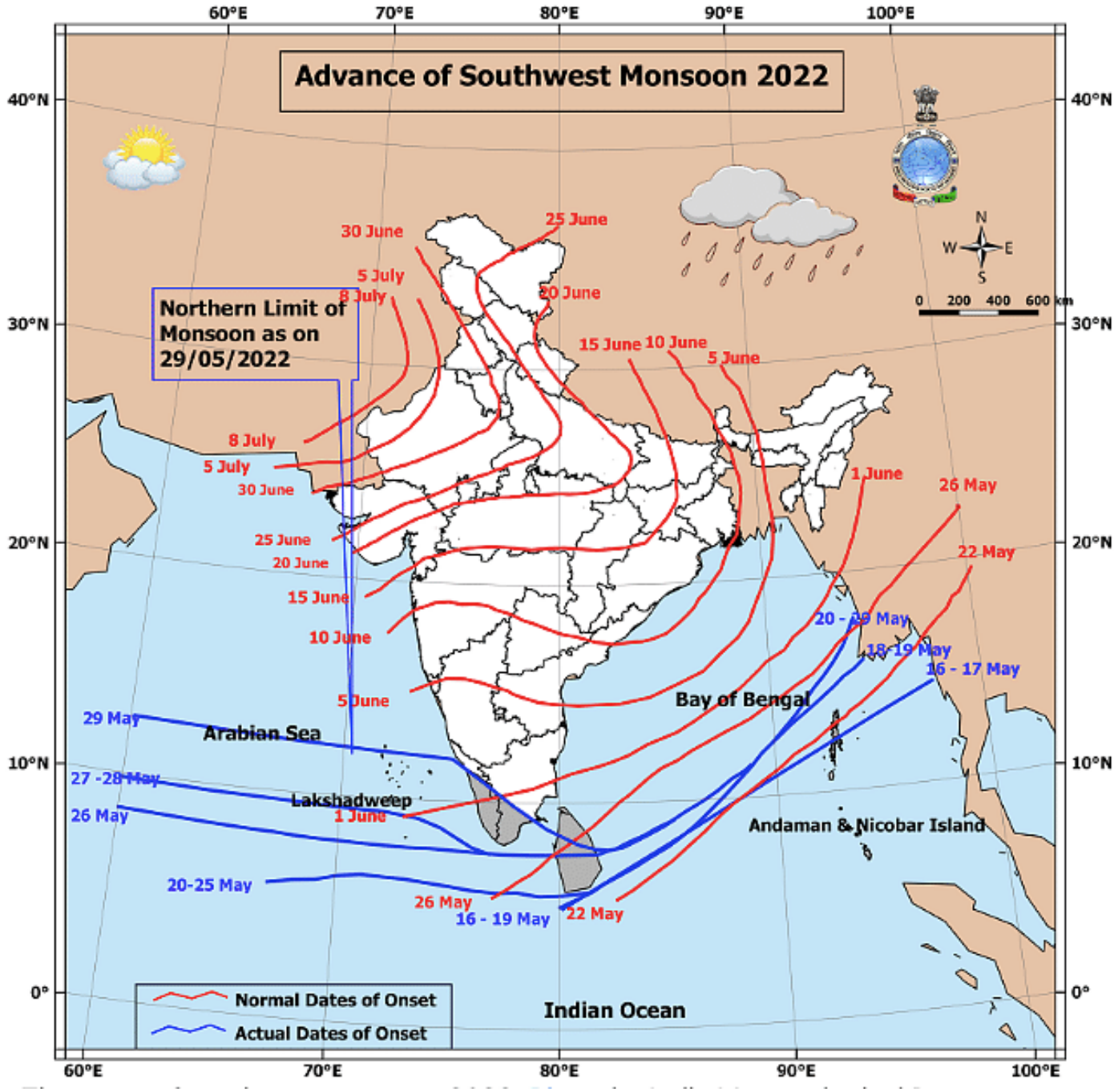
The southwest monsoon is one of the most anticipated events of the year, as India receives 70-90 percent of its annual rainfall during this monsoon.



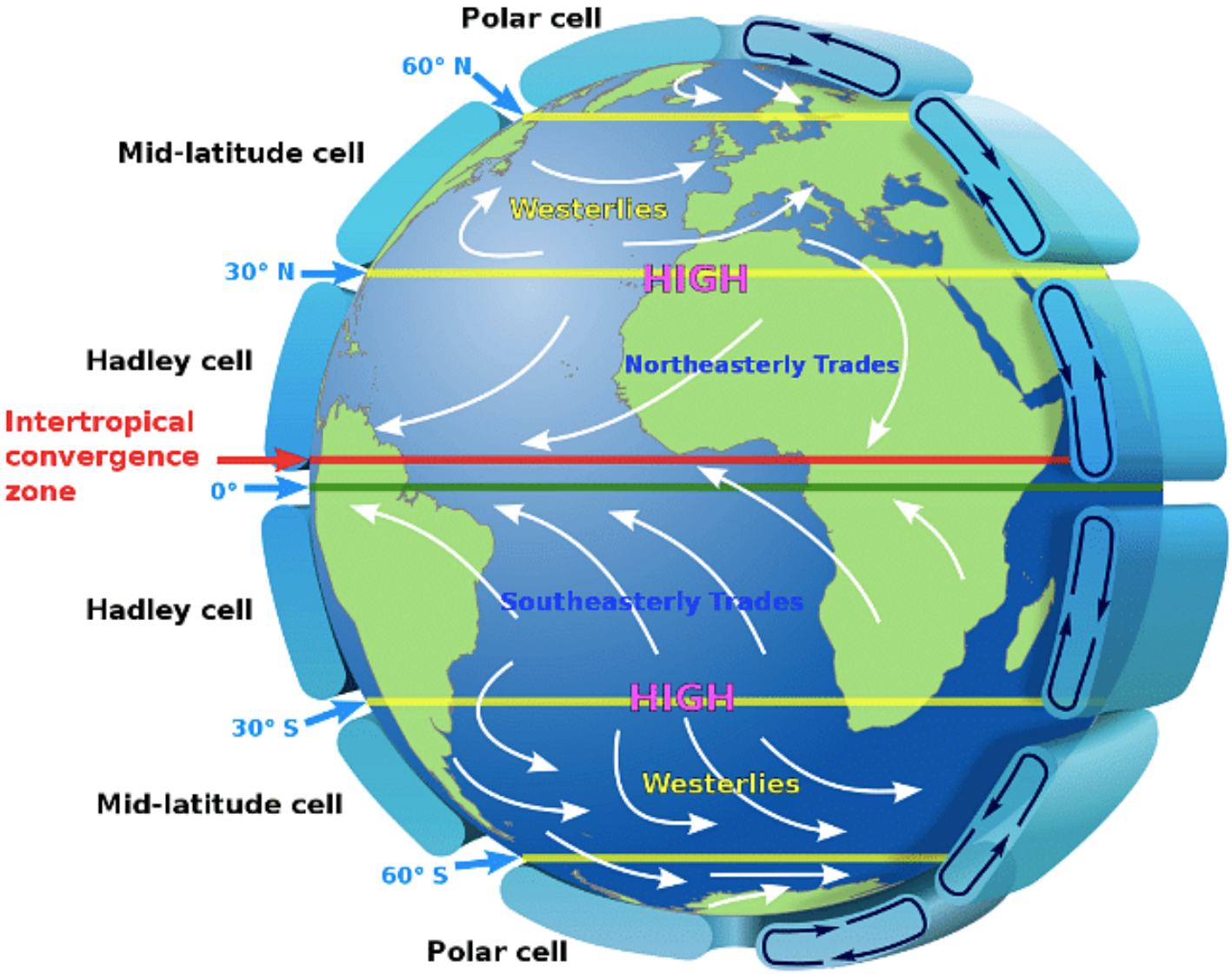
[Ref: The Quint]

What causes the Southwest Monsoon?

- **As per 'classical' Theory**, differential heating of land and water causes Indian summer monsoon.
- In summer, the **Asian land mass heats up to form a low-pressure system**, which attracts winds from Arabian sea and Bay of Bengal and thus high-pressure systems.

Energetics' Theory of the Monsoon:

- **Tilt in the Earth's axis** causes different parts of the Earth to receive direct rays from the sun.
- During summer, the **Tropic of Cancer** receives direct rays from the sun & continental land masses heat up, creating a low-pressure zone over **India and Central Asia.**
- This causes the **intertropical convergence zone** (ITCZ).
    - It is an **area of low pressure** that forms a band girdling the Earth to shift northwards from the Equator towards the **Tropic of Cancer.**



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- When the shift occurs, **ITCZ shifts northwards** to run directly through Indian subcontinent and strengthens low pressure forming over this area.
- The southeast trade winds, become deflected towards the east due to the **Coriolis effect.**
    - It is a force that causes fluids like air and water to curve as they travel across the Earth's surface.
- The **deflected trade winds blow towards India** from the southwest, picking up moisture from the

Arabian sea.
    - As they hit the Indian peninsula, they cause the **southwest or Indian summer monsoon**.
- **Seasonal migration of ITCZ** also sets in motion many events in the upper levels of the atmosphere.
    - **These events involve jet streams**, which are bands of narrow, fast-moving winds in the upper levels of the atmosphere.

Jet Streams:

- **Subtropical jet stream** is formed when warm air from the equator meets cool air from the polar regions and flows from west to east.
- During summer in the northern hemisphere, as the Tropic of Cancer begins to receive the sun's direct rays, two things happen:
    - The **subtropical jet stream moves northwards**, right over the Tibetan plateau from its position over central India.
    - Due to this, a seasonal jet stream, **the tropical easterly** is set up.
- **Tropical jet stream flows from east-to-west across India**.
    - It subsides above Indian Ocean, where it pushes the southwest monsoon towards India.
- The **Somali jet stream** is set up due to heating of the air over northern Bay of Bengal from moist convection.
- It attracts winds from **equatorial Indian Ocean** towards Indian subcontinent forming **low-level westerlies over Arabian Sea.**
    - These westerly winds bring moisture over Indian land, thus further enhancing the convection.

Retreating Monsoon:

- As summer wanes in northern hemisphere, **ITCZ drift down towards the south of the Equator.**
    - It causes a reversal in the movements of the trade winds.
- Now, the **Asian landmass cools rapidly** and forms a large area of high pressure, while the oceans form low pressure zones.
    - This causes drier and colder air from the continent to blow offshore causing the **retreating monsoon or northeast monsoon**.

Other Factors affecting Indian Monsoons:

- **El Nino and La Nina** are large scale warming or cooling events of the sea surface, along the central and east-central Pacific Ocean around the Equator.
- **Indian Ocean Dipole** (IOD) is an alternate warming and cooling of the equatorial region of the Indian Ocean in the west and east.
- EQUINOO refers to **enhanced cloud formation** between the western equatorial Indian Ocean and the eastern equatorial Indian Ocean.