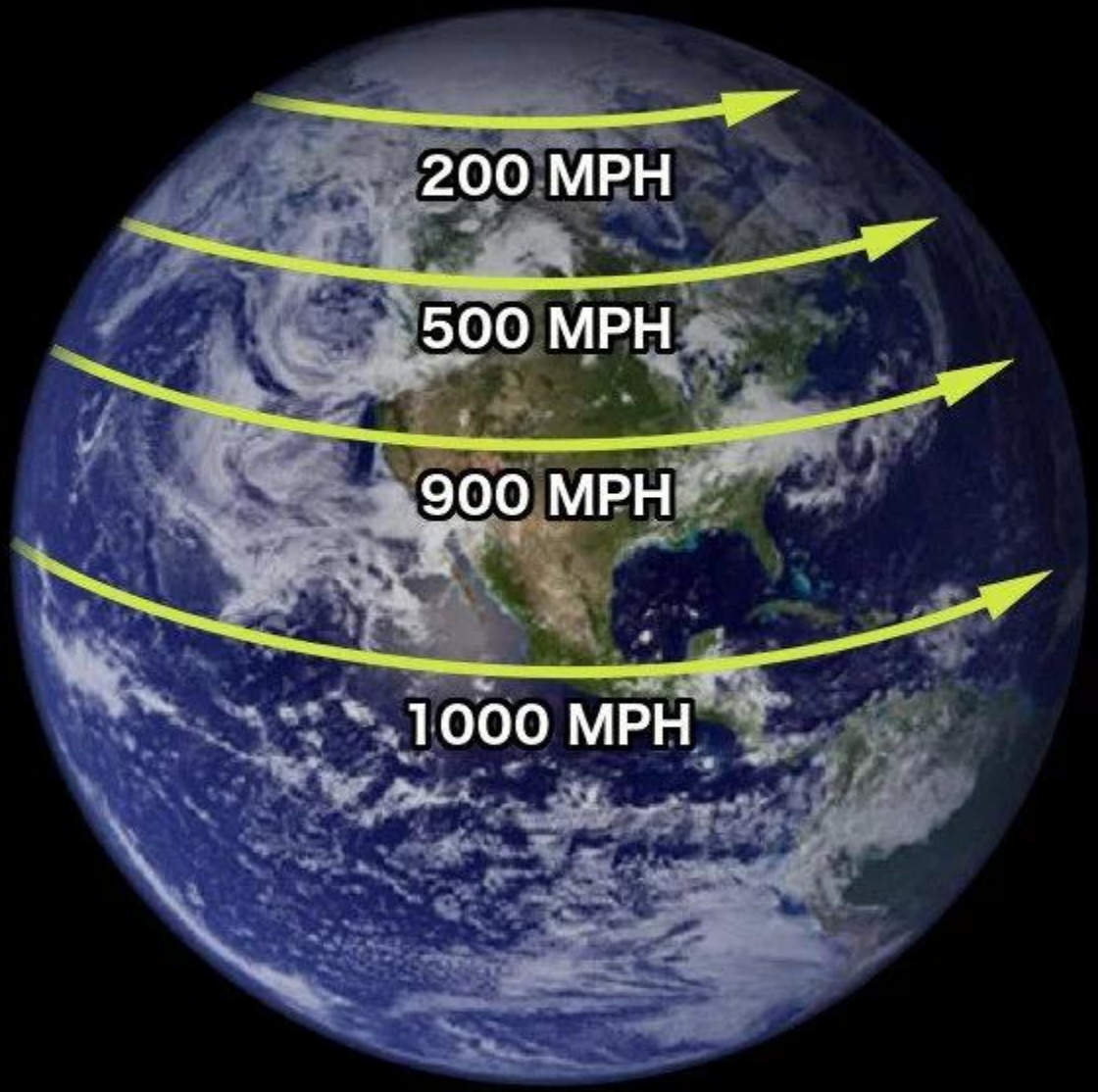
Understanding weather and the weather forecast

Week 6 Why do we have weather?

Terry Hart

Rotational velocity



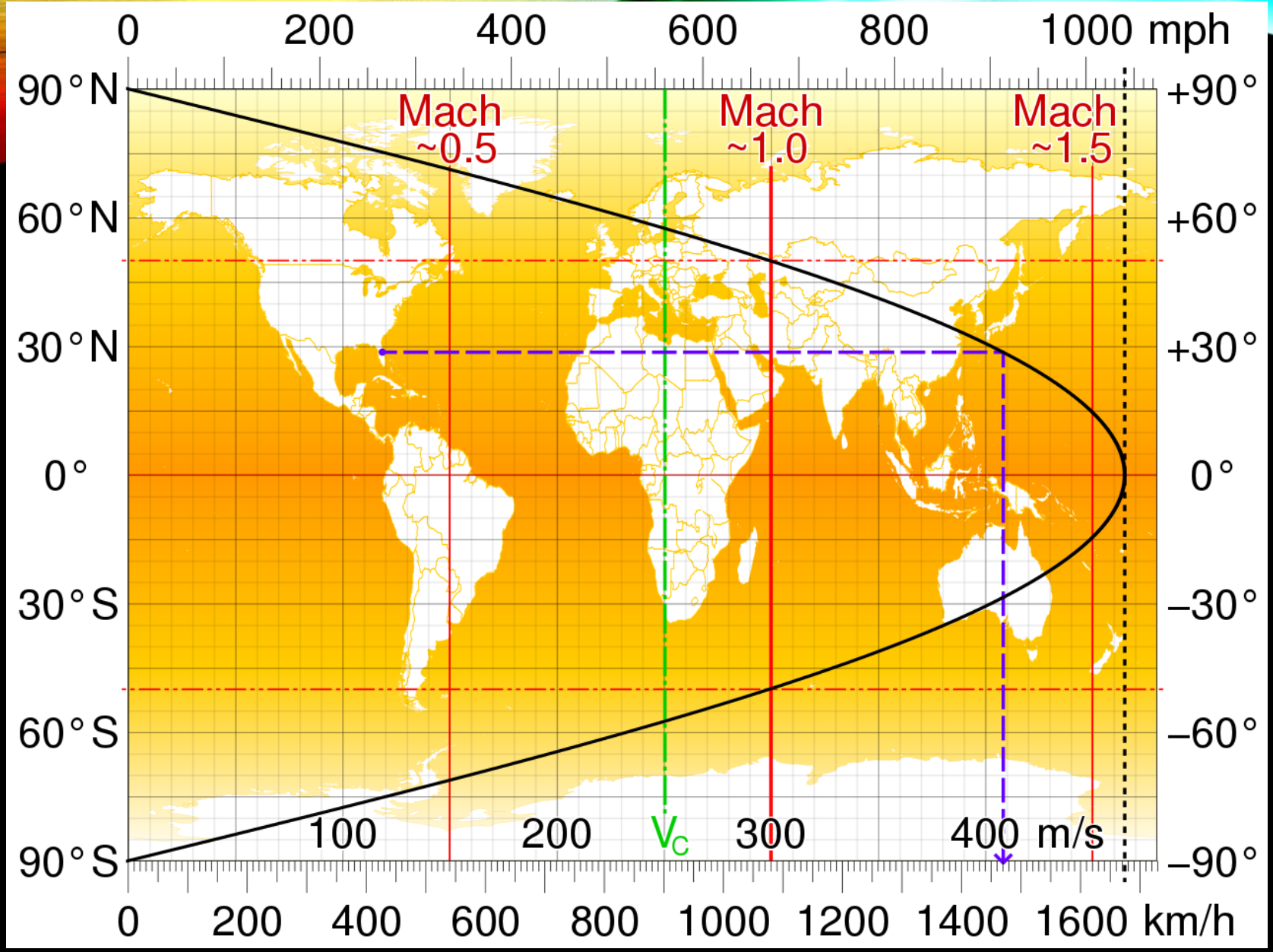


Diagram from Wikipedia

Green dashed line the typical passenger jet cruising speed

Coriolis Effect (Force)

- Named after Gustave Coriolis (1792-1843) who developed the mathematics of why anything that moves across the earth without being attached to it (including a long range artillery shell) follows a curved path.
- It is proportional to the wind speed and depends on wind speed and latitude (sine (latitude))
- **Explains the first two of the "weather map rules".**

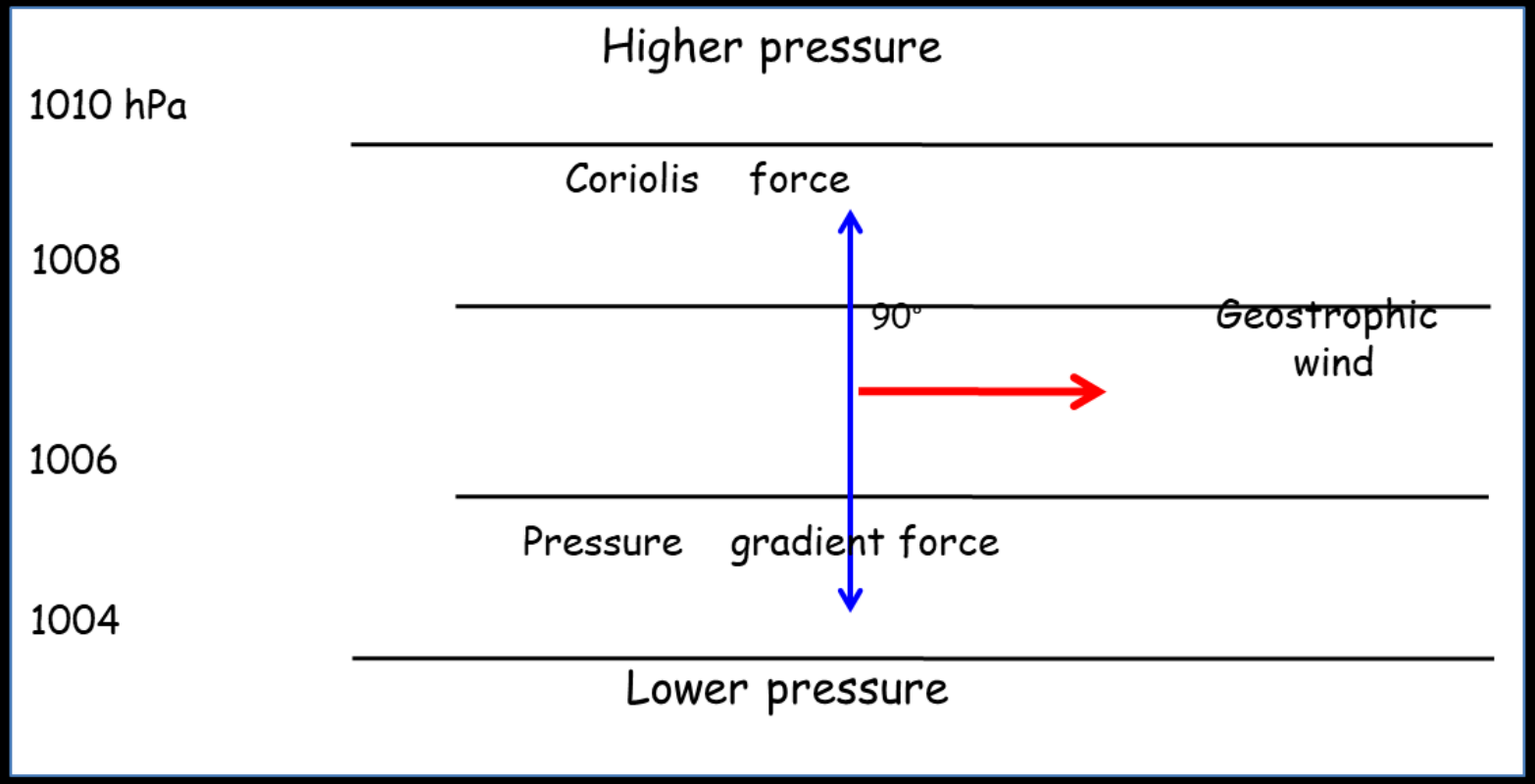


Diagram from Peter Jackson (Geology)

One last effect – friction near the ground

Wind is turned in towards the low pressure area – about 10 degrees over the ocean, and 30^{o} over rough land.

So in the 19th century argument over whether the wind went round the lows or went into the low, both were partly right – and it does spiral into lows.

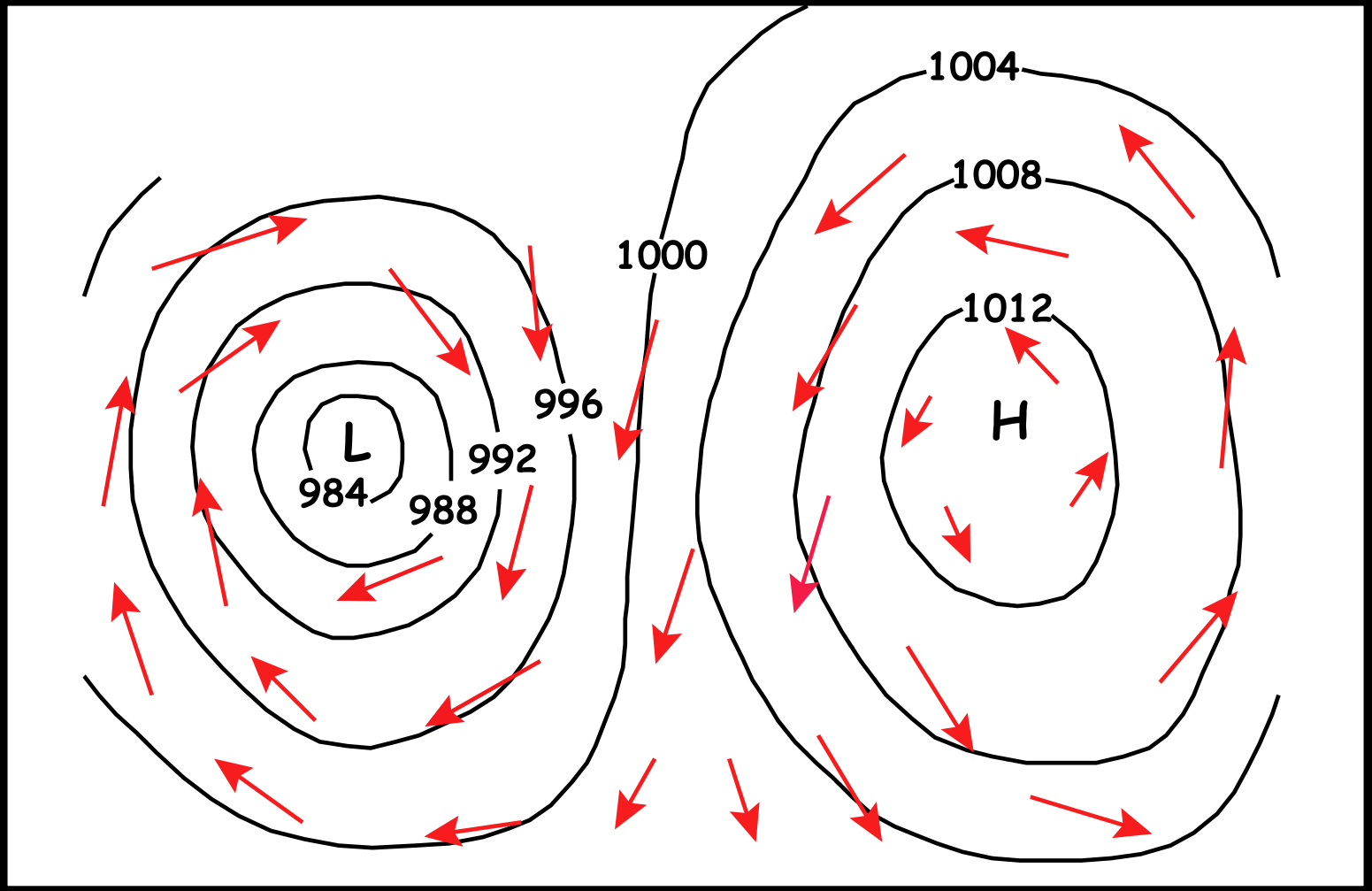
However, there are other dynamical effects than just friction at the earth's surface.

Summary of Airflow around pressure systems

Streamlines southern hemisphere

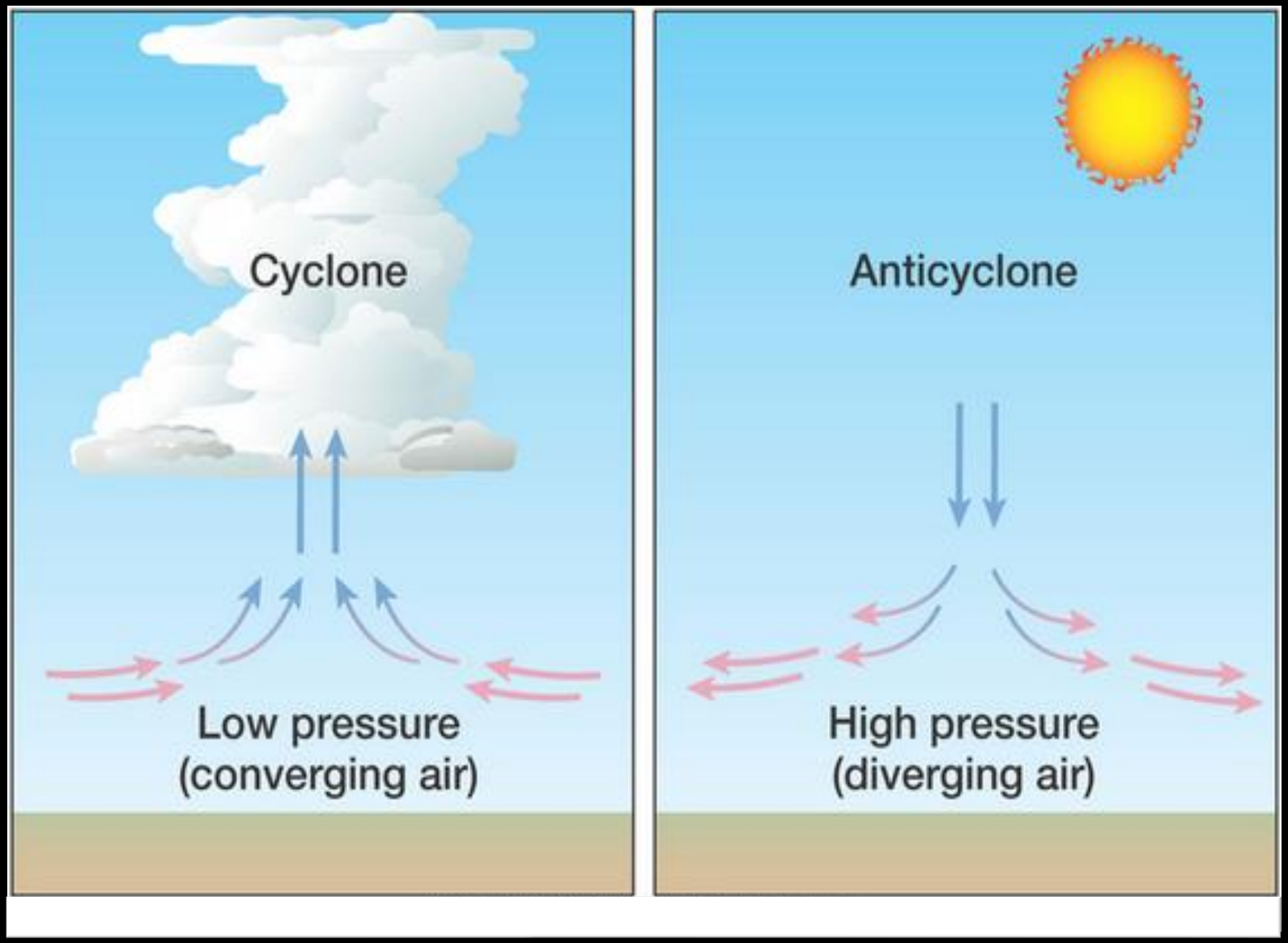
Low pressure system ➔ clockwise, convergent

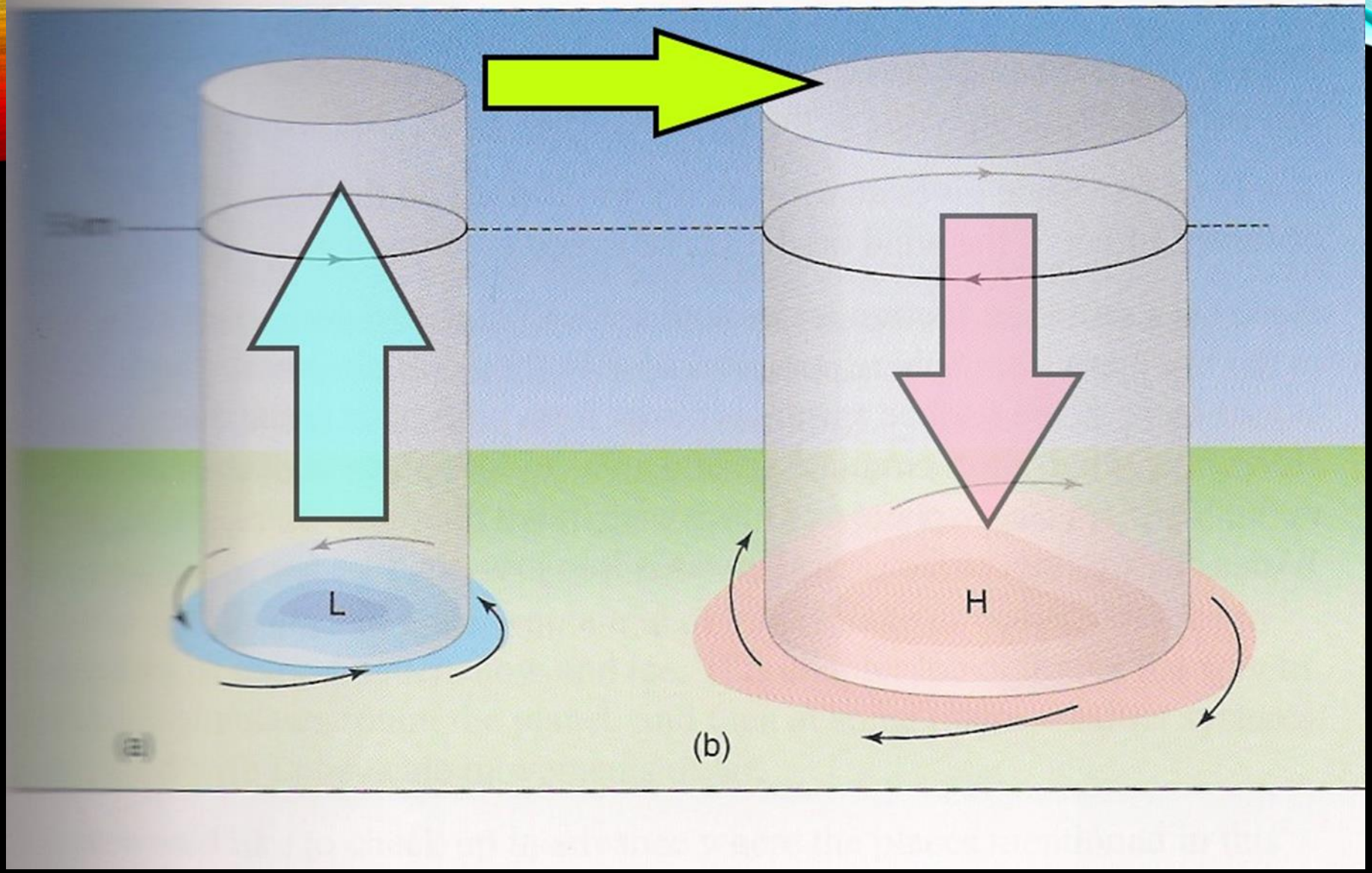
High pressure system ➔ anticlockwise, divergent



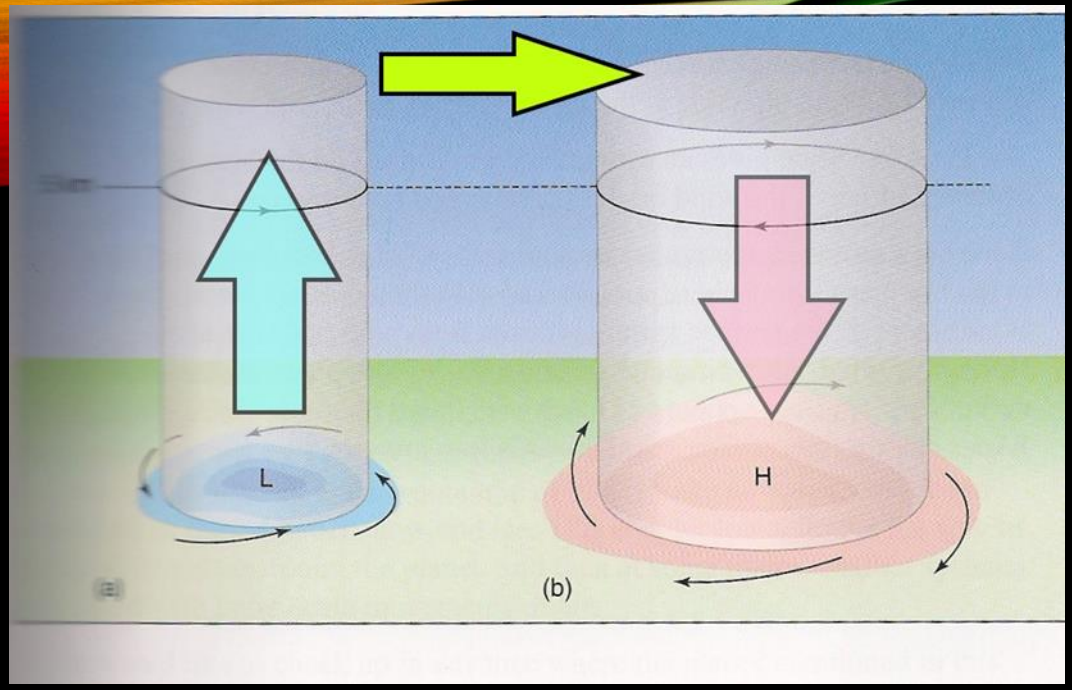
Wind

Air moves from areas of high pressure, to areas of low pressure





The basis for the **third weather map rule** – rising motion leads to condensation of water vapour and eventually to precipitation (rain, snow, hail).

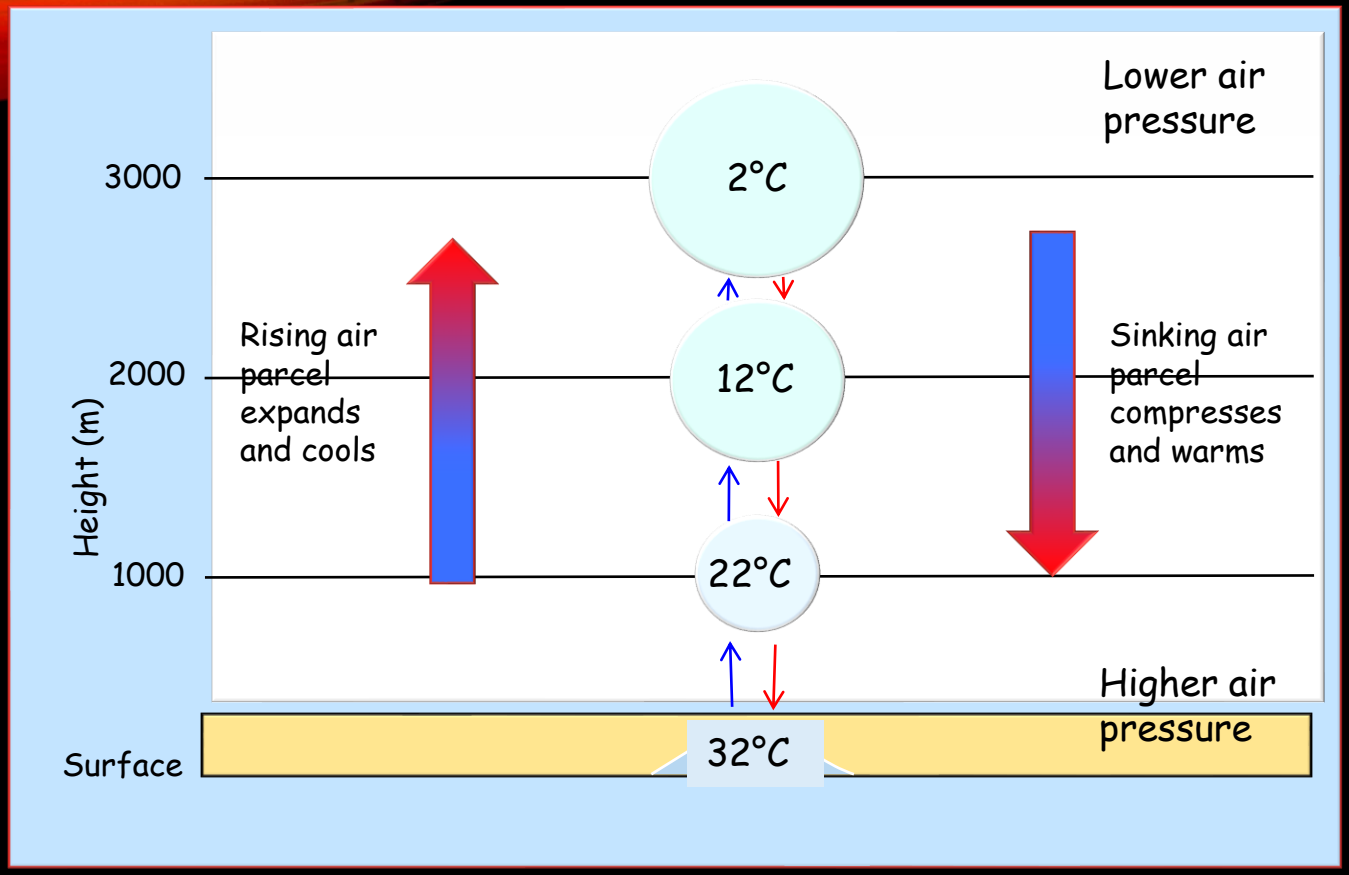


Rising motion leads to cooling of the air as it expands, condensation of water vapour and eventually to precipitation (rain, snow, hail).

Descending motion leads to warming and evaporation of any moisture.

Most of the world's rainforests are in the rising branch of the Hadley cell, while there are desert areas under the descending branch.

What happens when air rises or sinks?

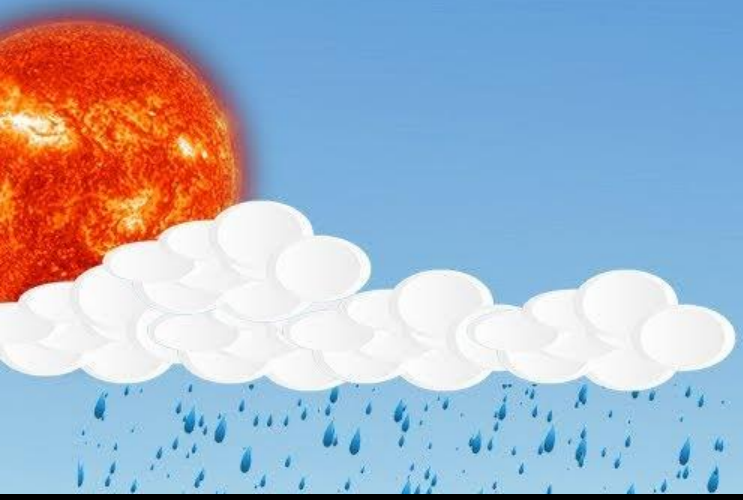


If the air rises and cools it can become saturated in moisture, which can lead to condensation into rain, snow or hail, etc. The heat stored in water in vapour form is released and heats up the air.

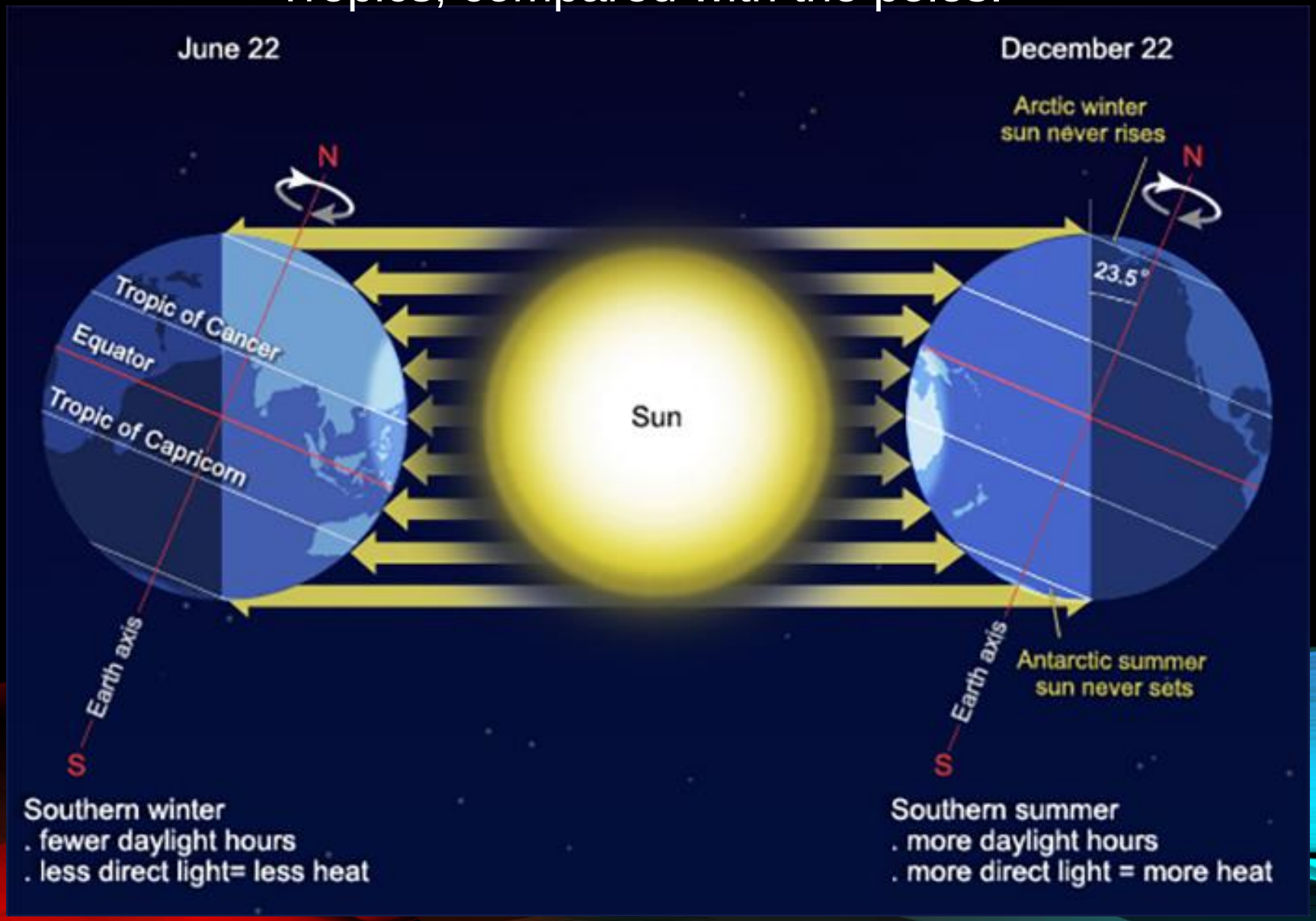
The water vapour becomes the fuel that can drive weather systems.

Rising air behaves very differently to sinking air.

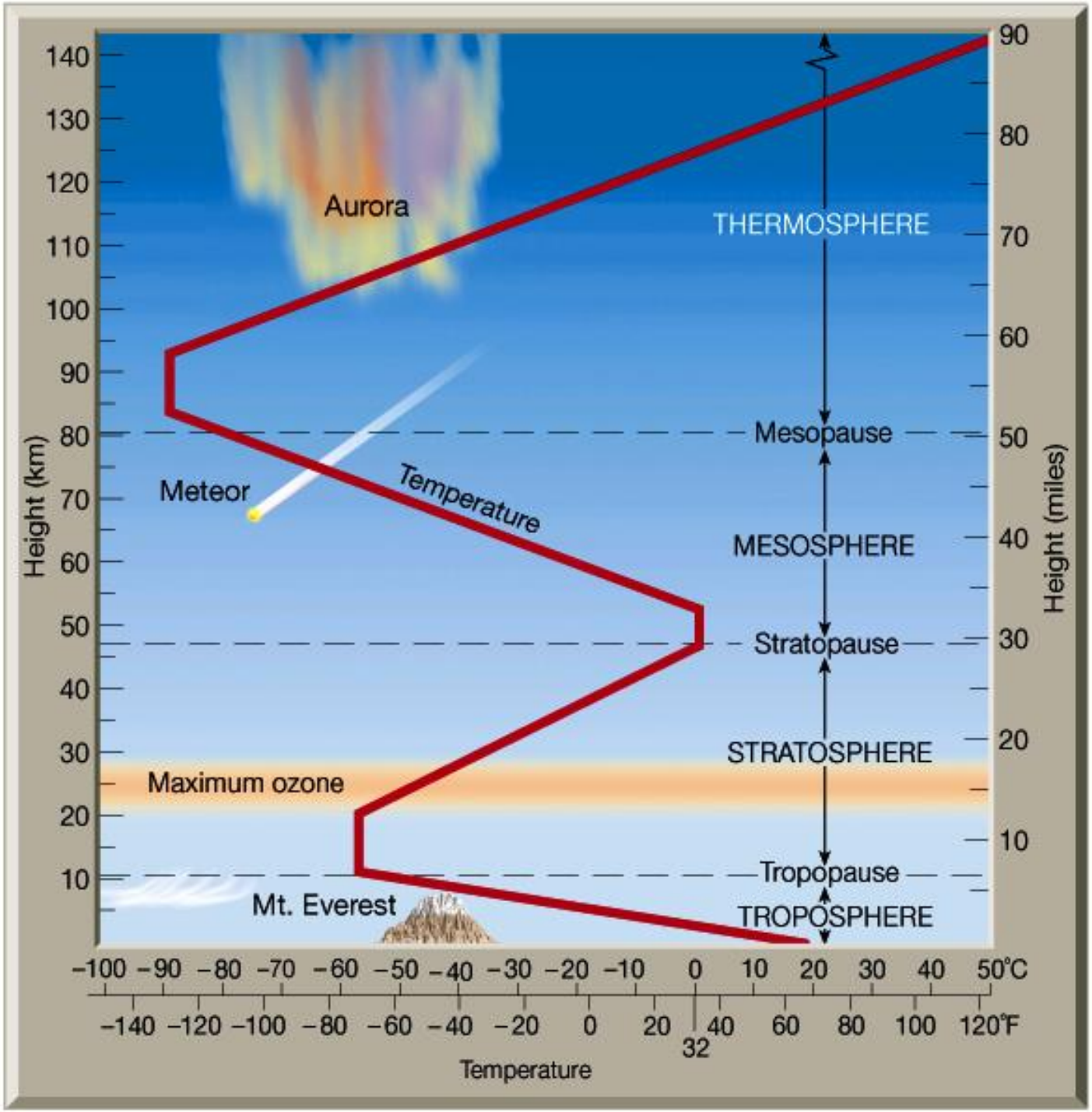
WHY DOES EARTH HAVE WEATHER?



The main driver for the earth's climate is the difference in energy from the sun in the Tropics, compared with the poles.



https://youtu.be/7fd03fBRsuU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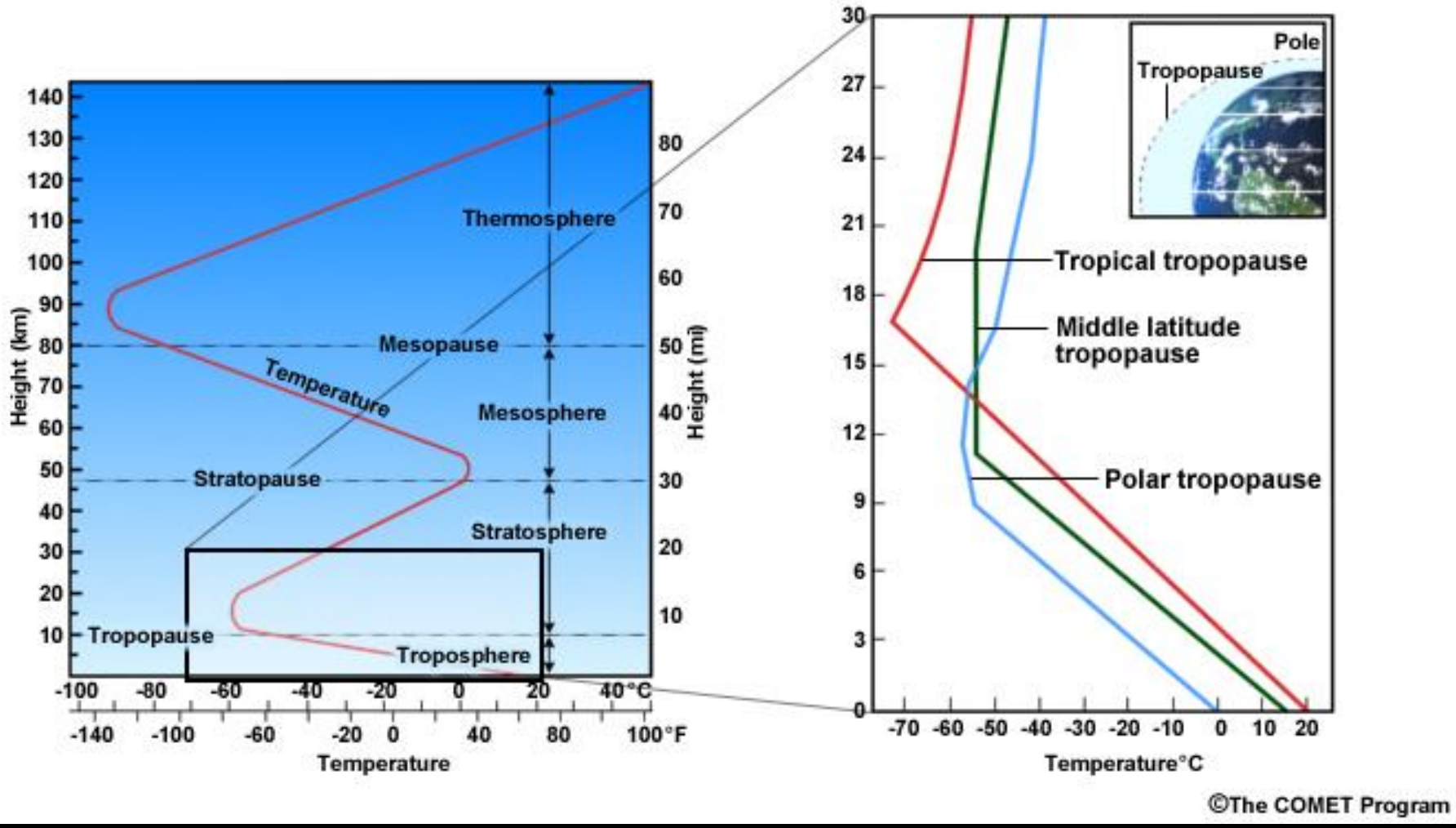

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Global circulation patterns

At any time there are many weather systems weaving around the globe, however when averaged over many years a global pattern of air movement emerges.

Over the major parts of the Earth's surface there are large-scale wind circulations present. The global circulation can be described as the world-wide system of winds by which the necessary transport of heat from tropical to polar latitudes is accomplished.

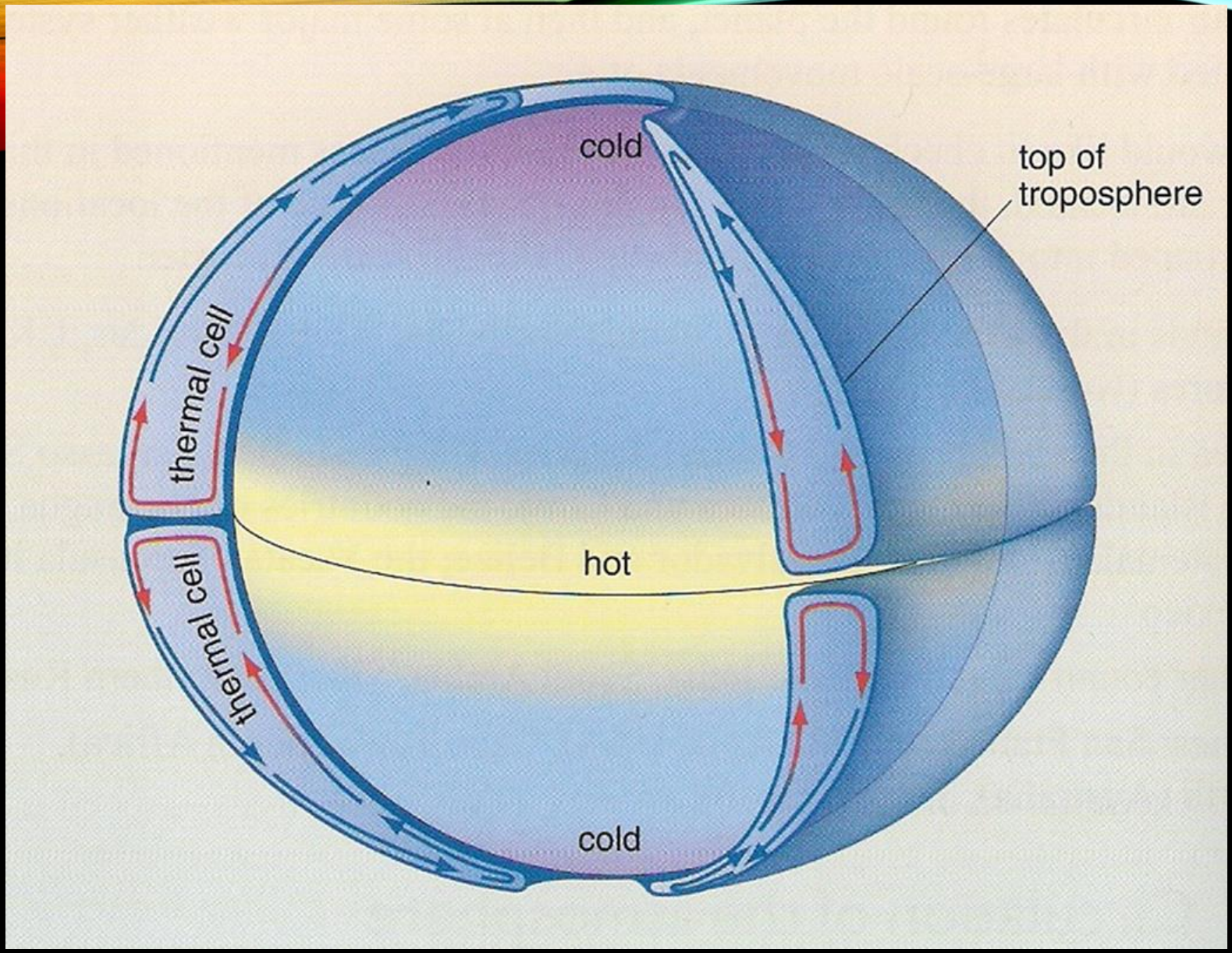
Halley proposed:

- heated air rose in the Tropics and flowed poleward, then sank as it cooled.
- with the movement of the sun across the sky – heated air is replaced by cooler air, creating NE/SE winds

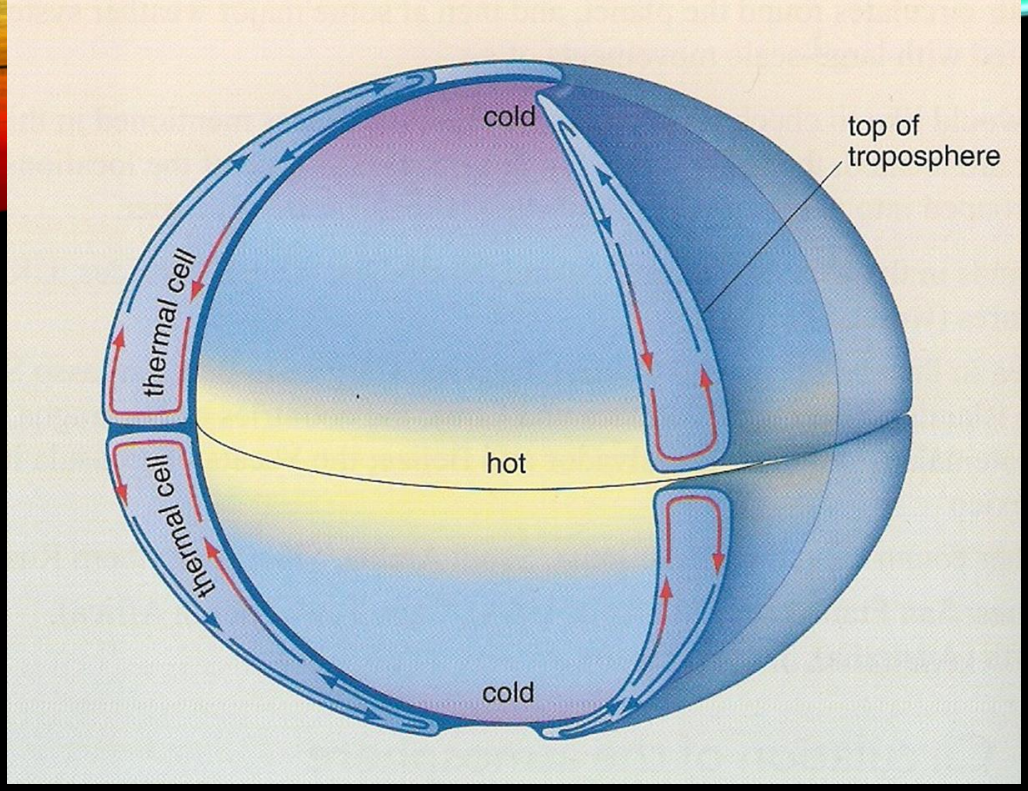
He began to doubt that when others queried it.

1735 George Hadley (lawyer and amateur student of the weather) made an important contribution.

- *He recognised the role of the rotation of the earth well before Coriolis*
- *Proposed the existence of a circulation (some decades later named the "Hadley cell")*

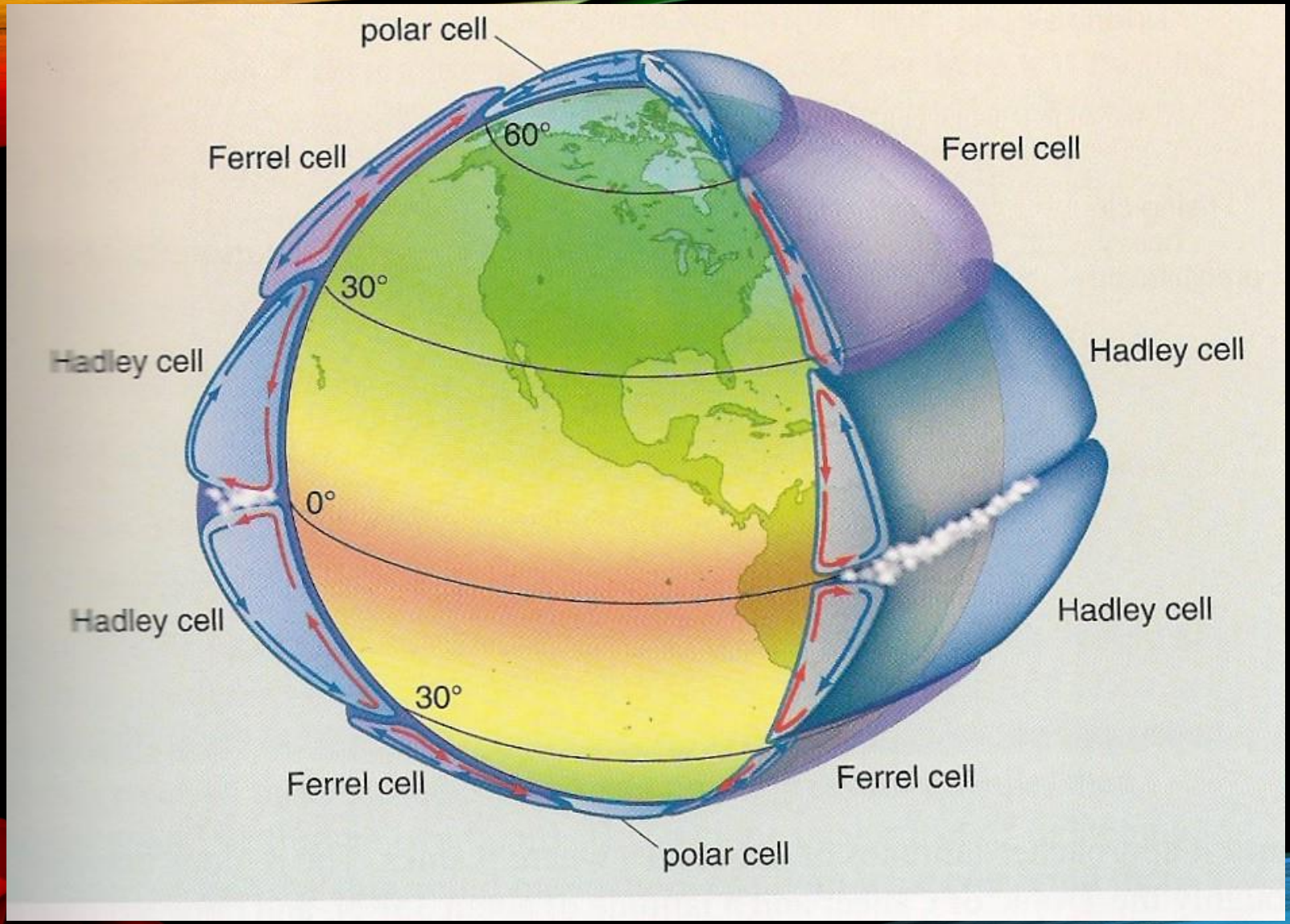


The early concept of the Hadley Cell



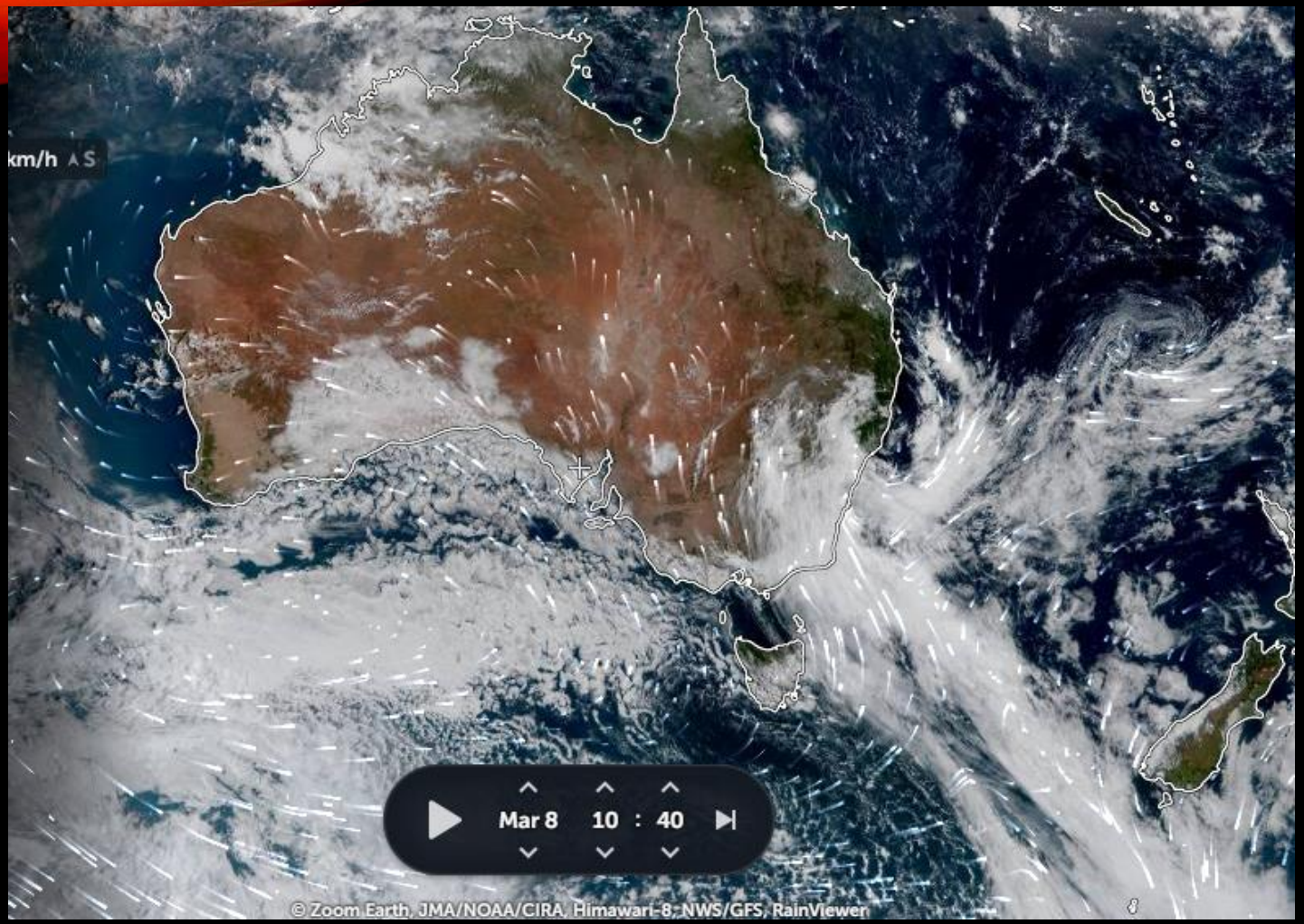
Air from more polar latitudes moves towards the Equator.
However, the rotational speed at higher latitudes is lower than at the Equator, so the air moves to the west as it moves towards the Equator (under the Coriolis Effect) giving rise to the **easterly trade winds**.

Conversely, although it was not known at the time, the upper air has to move away from the Equator toward the poles. It leads to **westerly winds** at upper levels (including the jet streams).



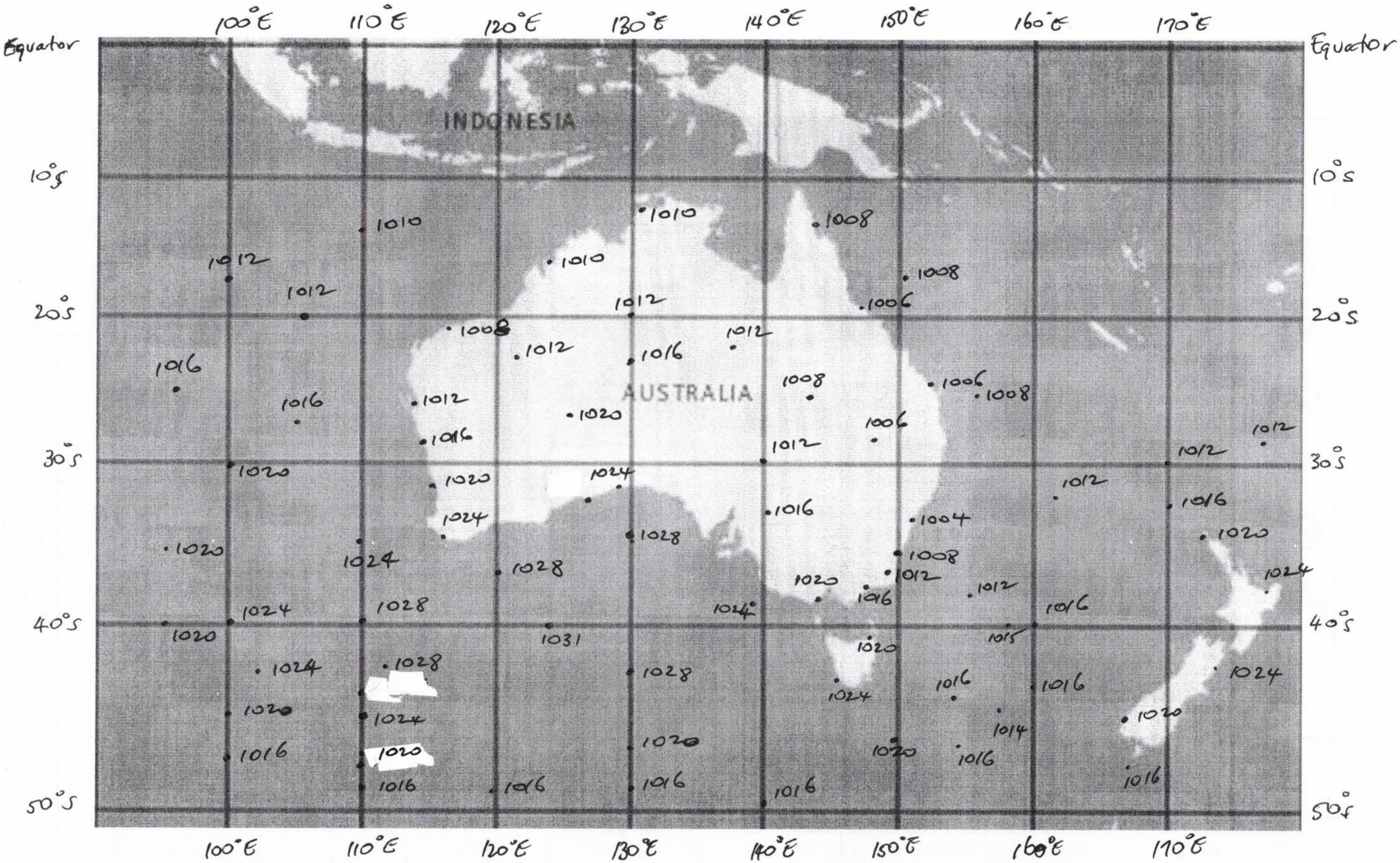
General circulation of the earth's atmosphere (Met Office, UK)
https://www.youtube.com/watch?v=xqM83_og1Fc

Satellite image 10.40 am Tuesday 8 March 2022



Task Draw the isobars on the blank chart (spacing 4 hPa).
(1004, 1008, 1012, 1016,.....)

- Satellite image for about the time of the weather map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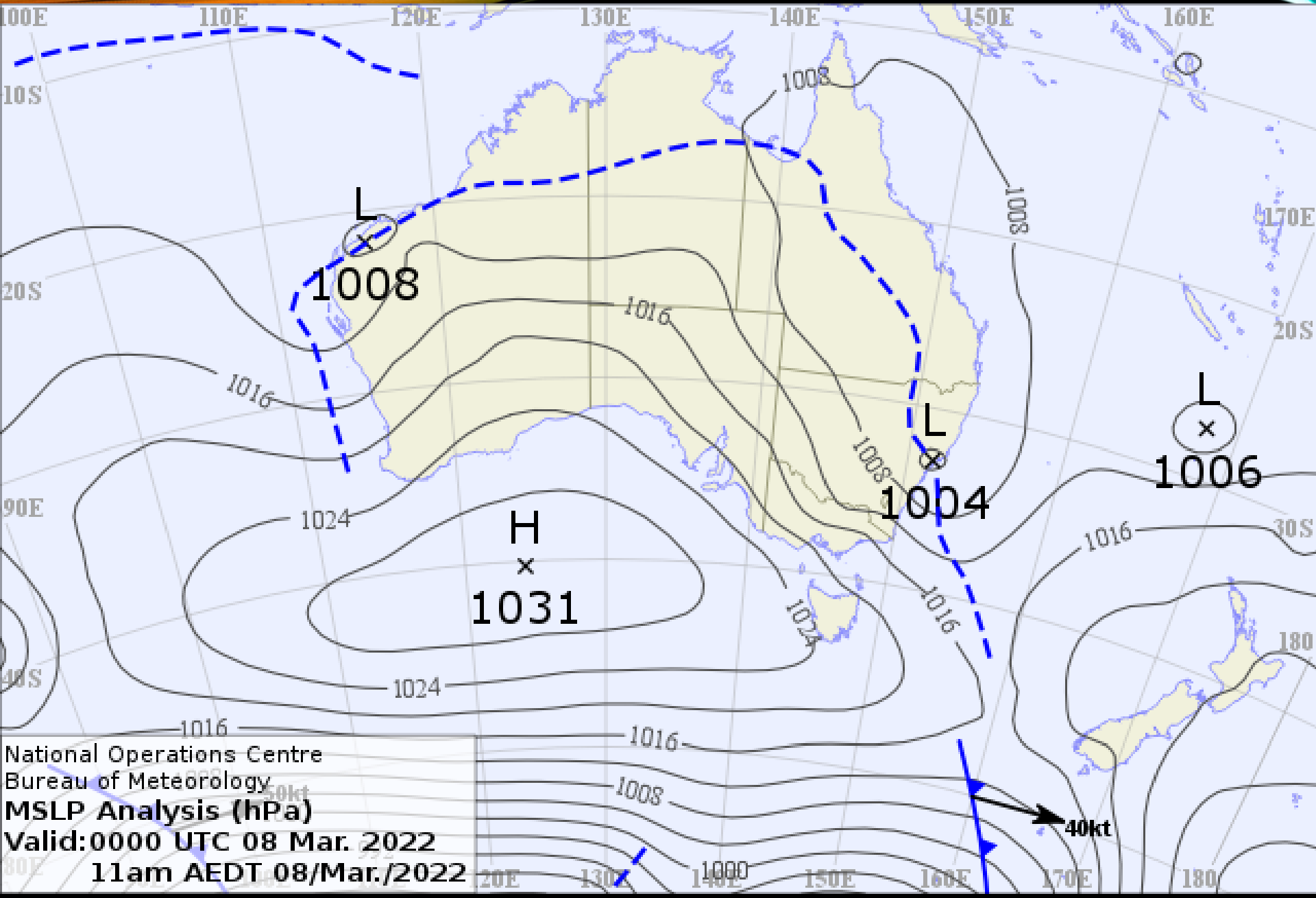
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National Operations Centre
Bureau of Meteorology
MSLP Analysis (hPa)
Valid:0000 UTC 08 Mar. 2022
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