

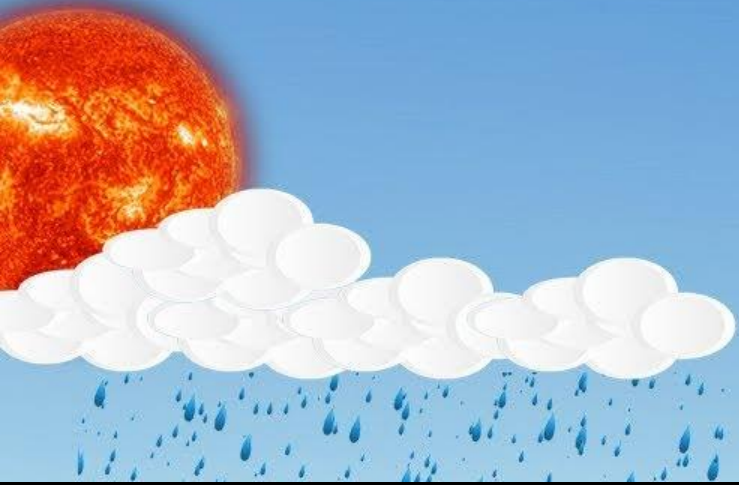


Understanding weather and the weather forecast

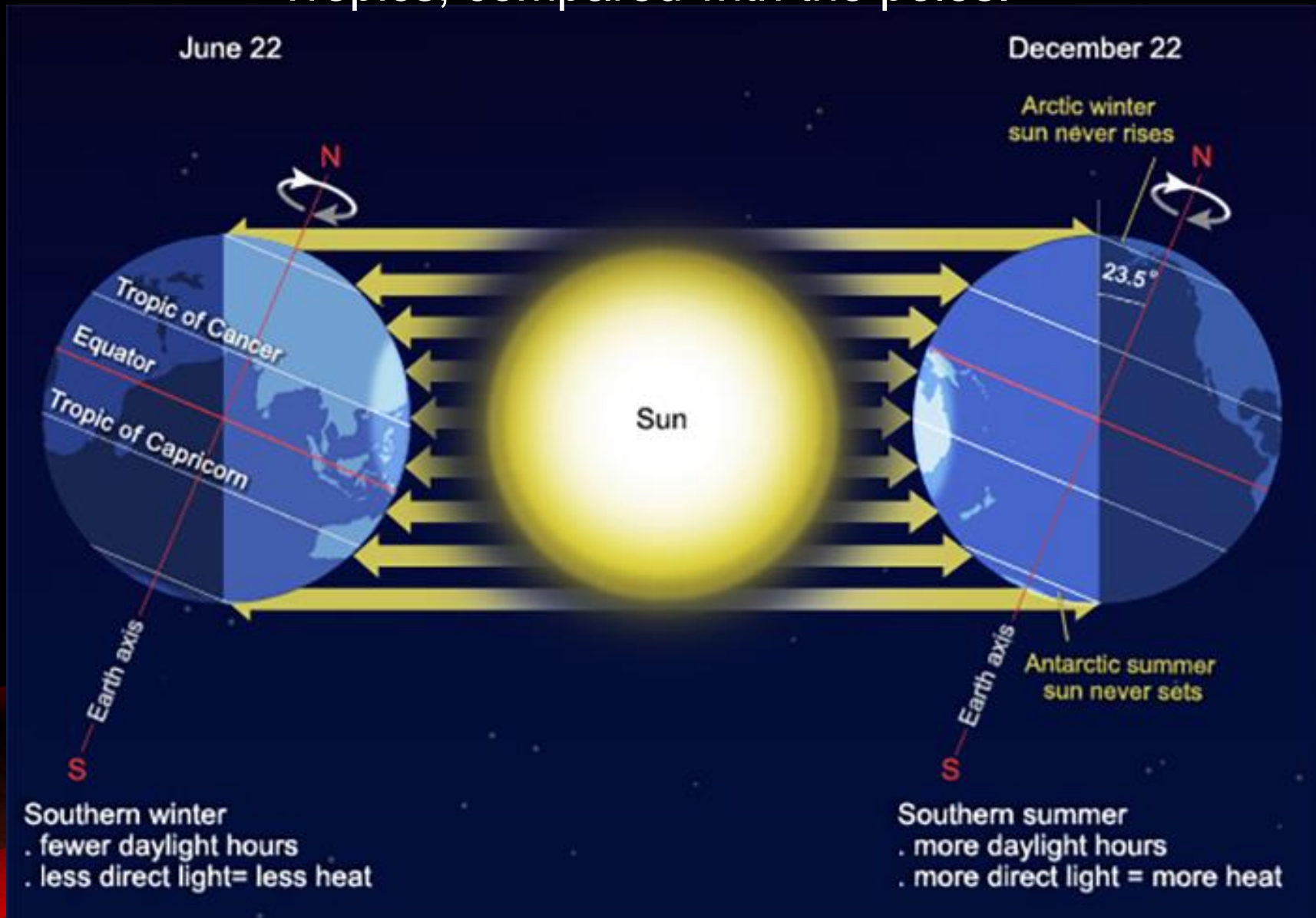
Week 7 The Global Circulation

Terry Hart

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.





What is global circulation? | Part One | Differential heat...

Met Office




Watch later



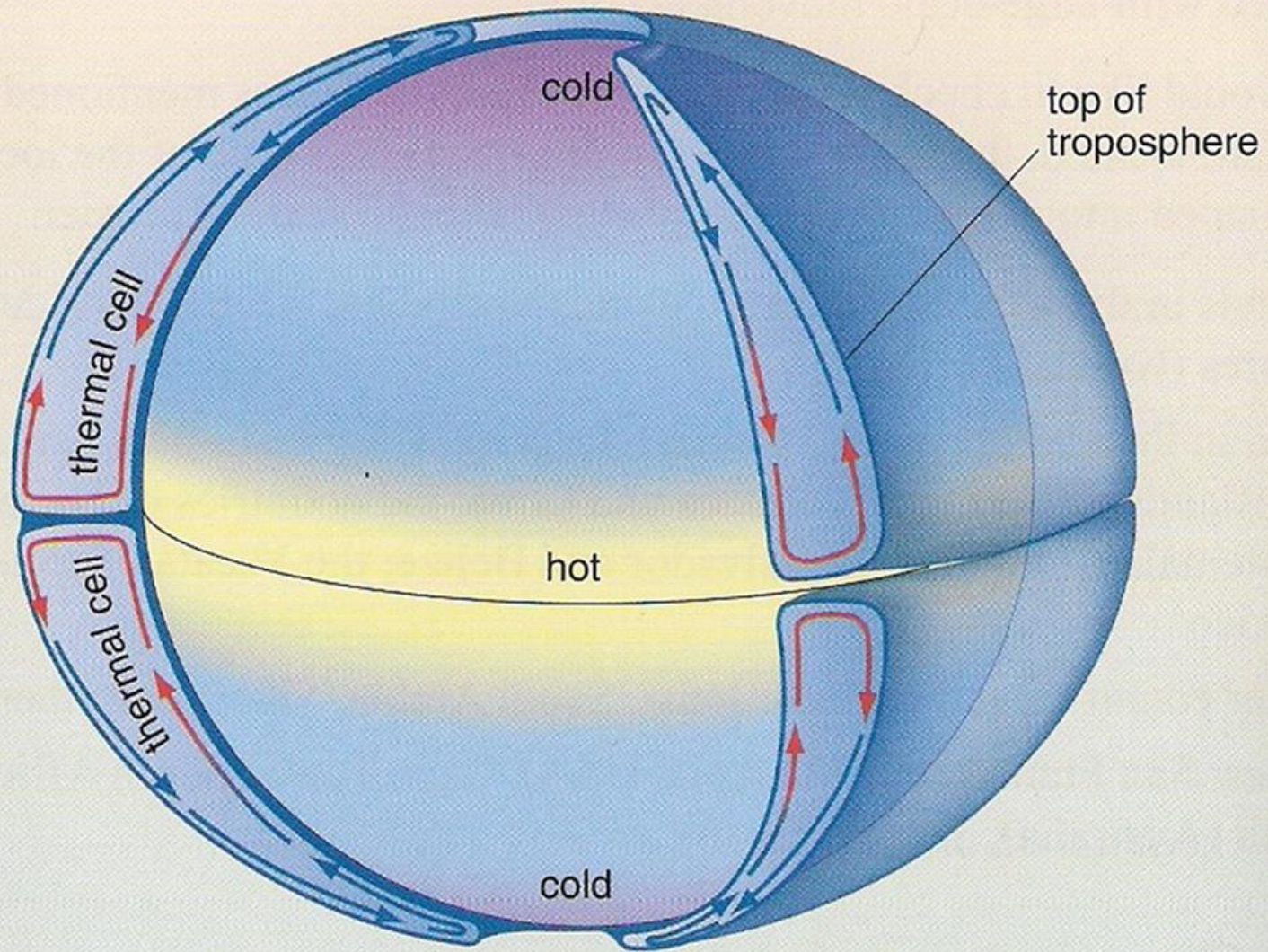
Share



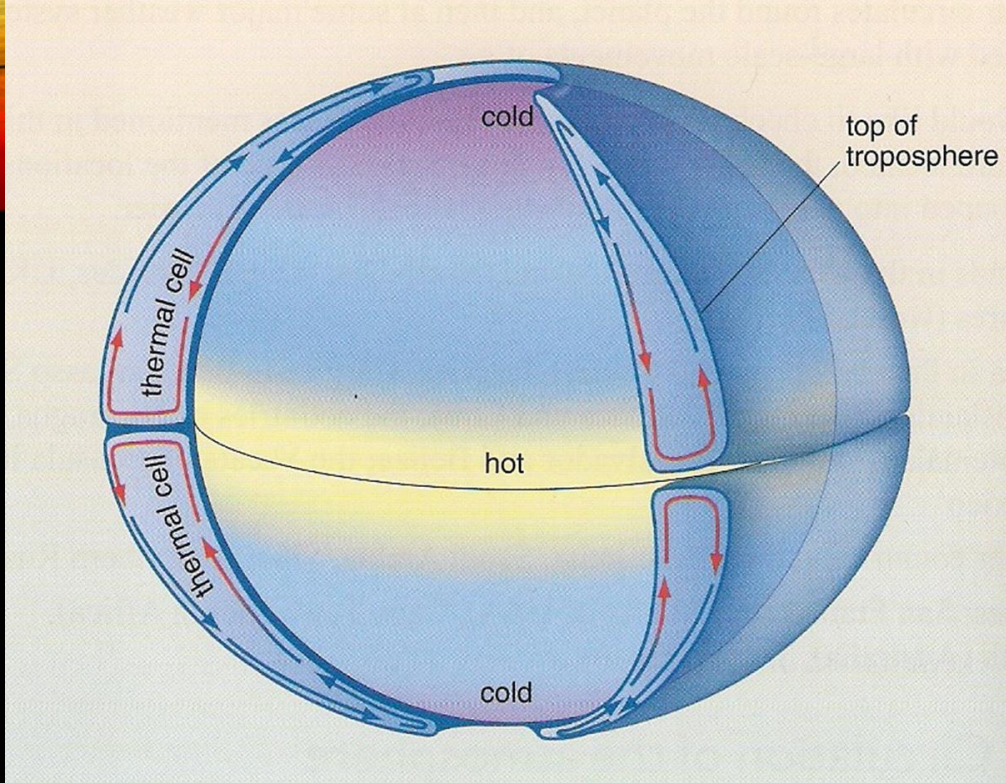
DIFFERENTIAL HEATING

Watch on  YouTube

<https://youtu.be/7fd03fBRsuU>

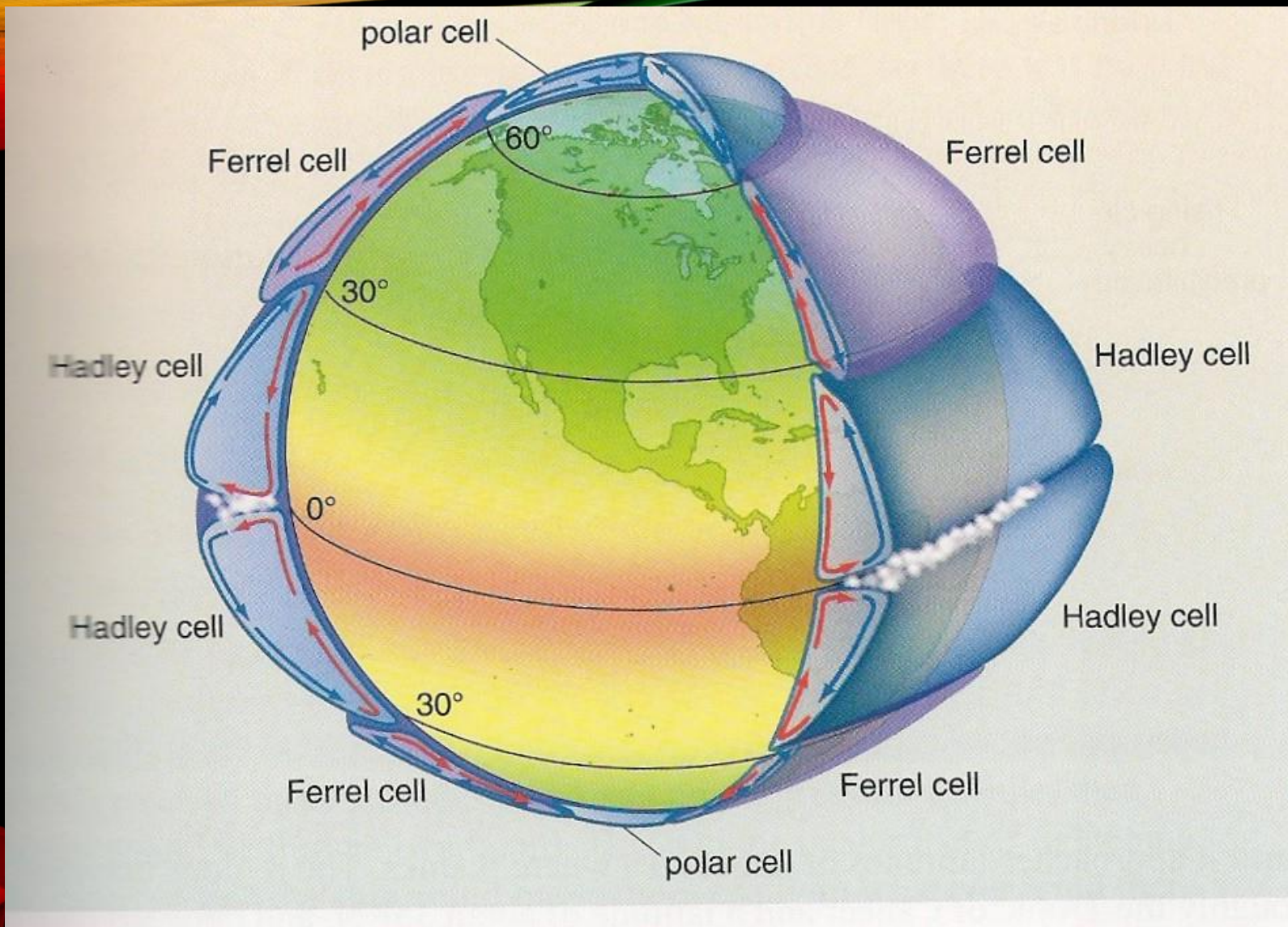


The early concept of the Hadley Cell



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).

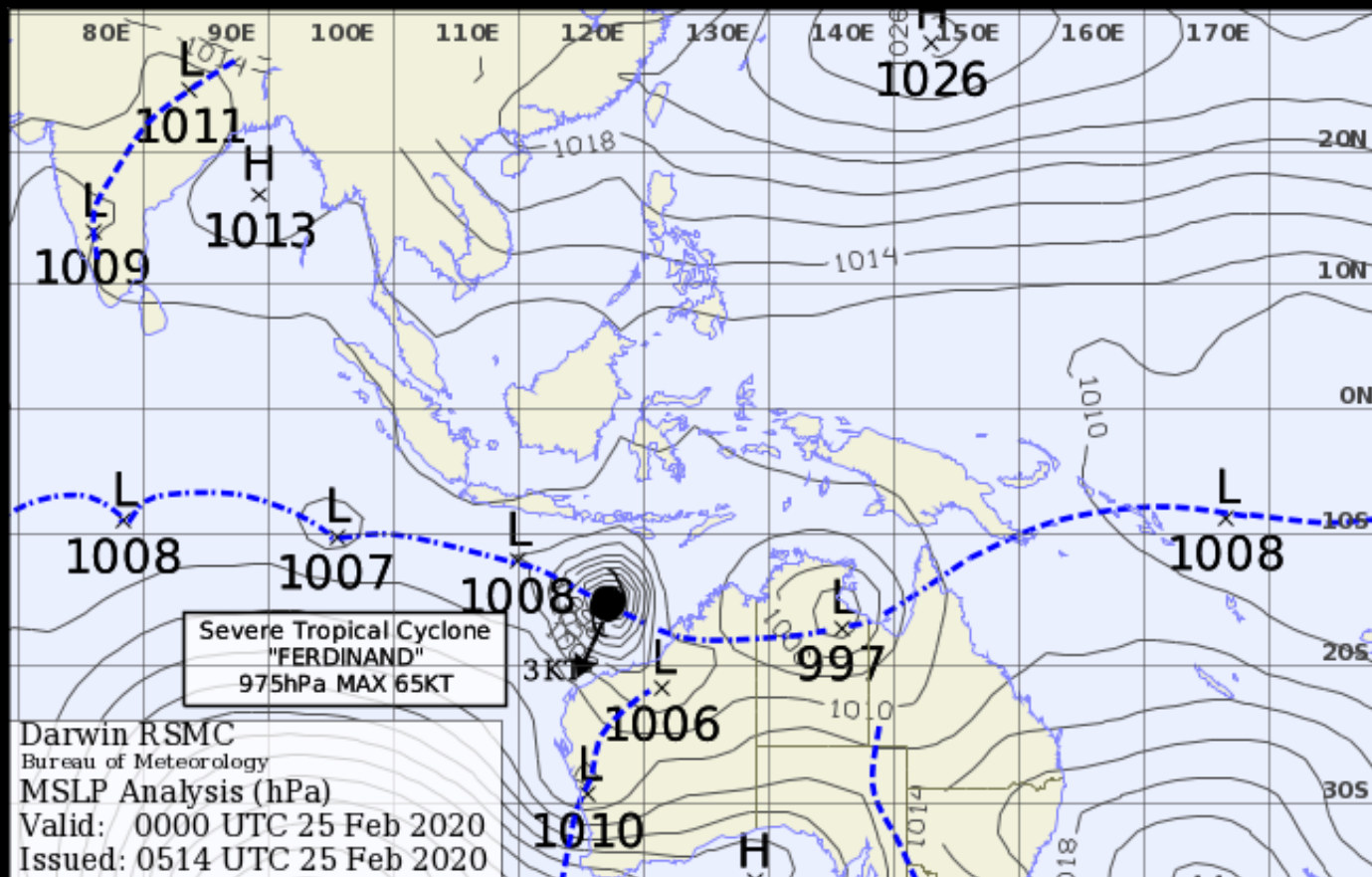


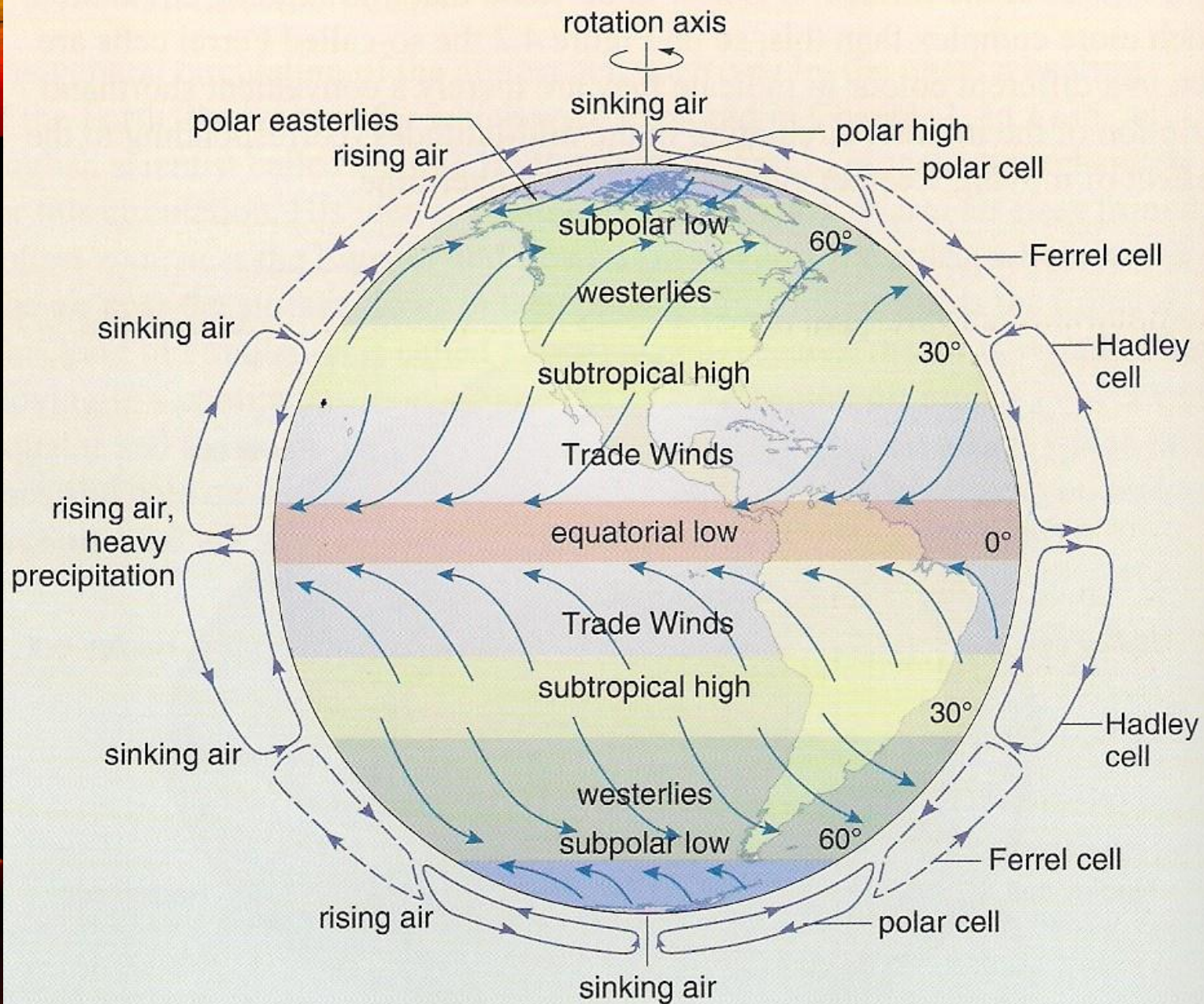
General circulation of the earth's atmosphere (Met Office, UK)

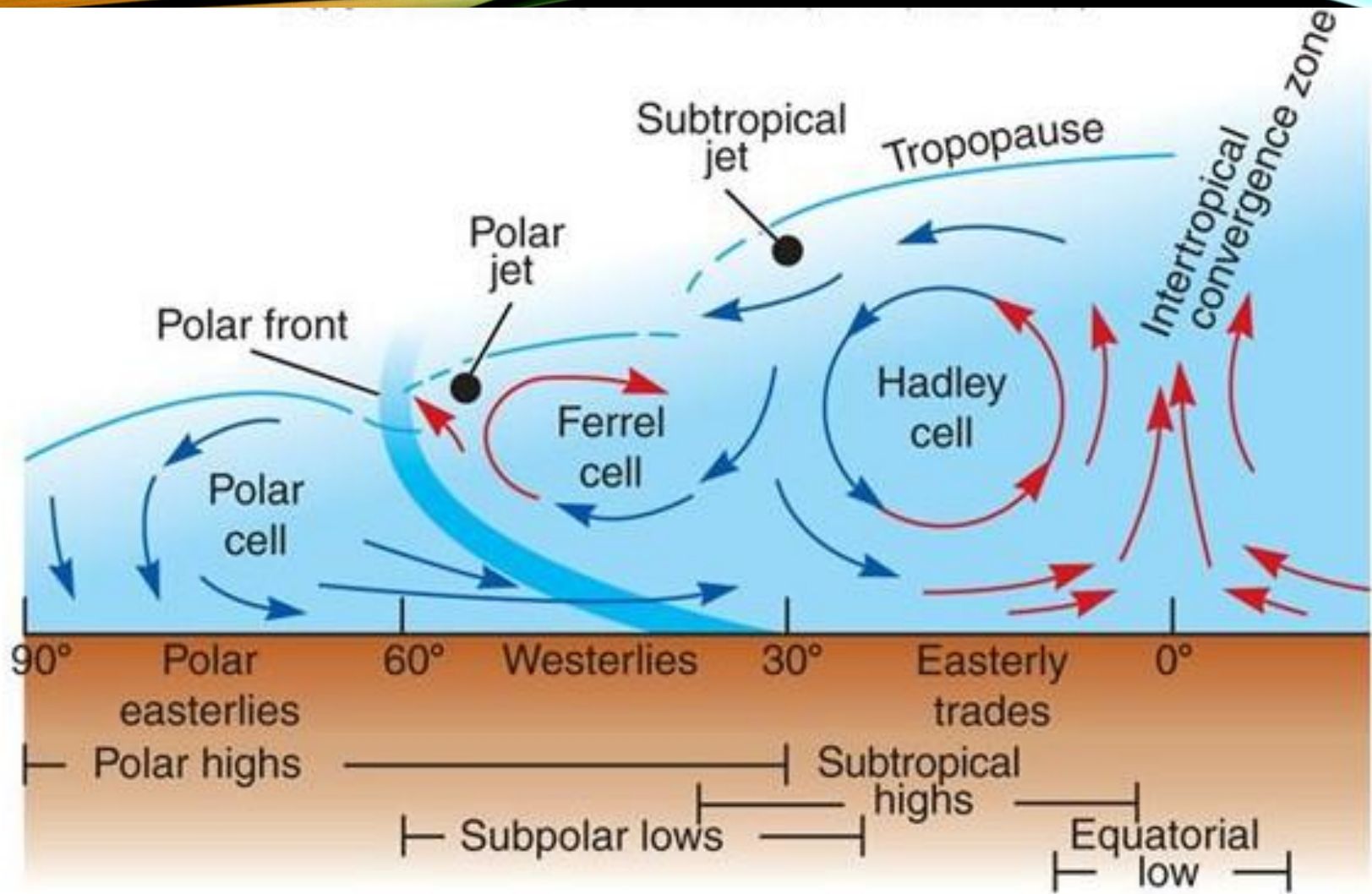
https://www.youtube.com/watch?v=xqM83_og1Fc

Some particular examples of the Coriolis Effect:

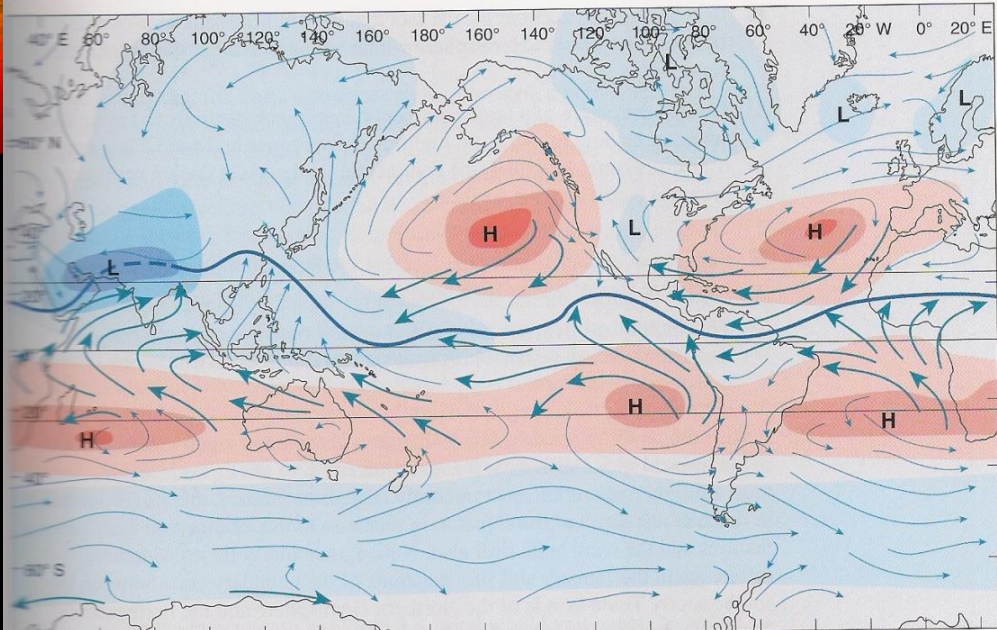
- **Trade Winds (Hadley Circulation)**
- Jet Streams
- Weather charts in deep tropics (the latitude effect)
- No tropical cyclones form at the Equator



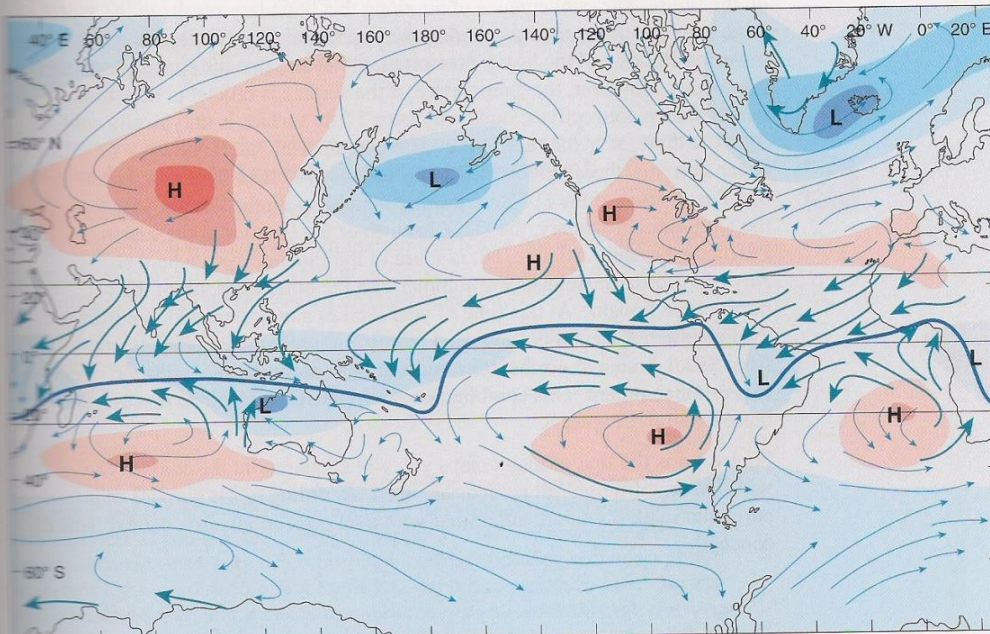




The idea of a zonal average over-simplifies the picture but it shows the basic features



Key ——— mean position of ITCZ ← most frequent wind direction ← prevailing wind direction (>50% of observations)



January

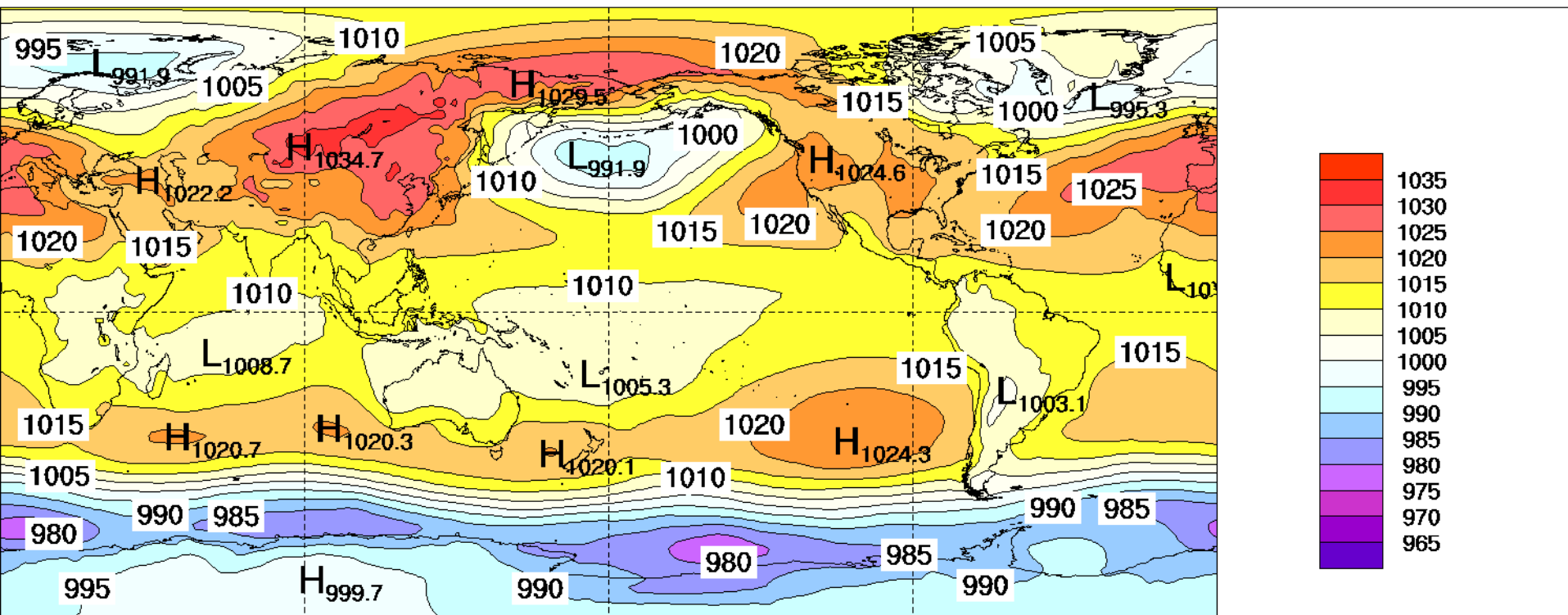
Average MSLP for July

The idea of a zonal average over-simplifies the picture but it captures some basic principles

Average MSLP for January

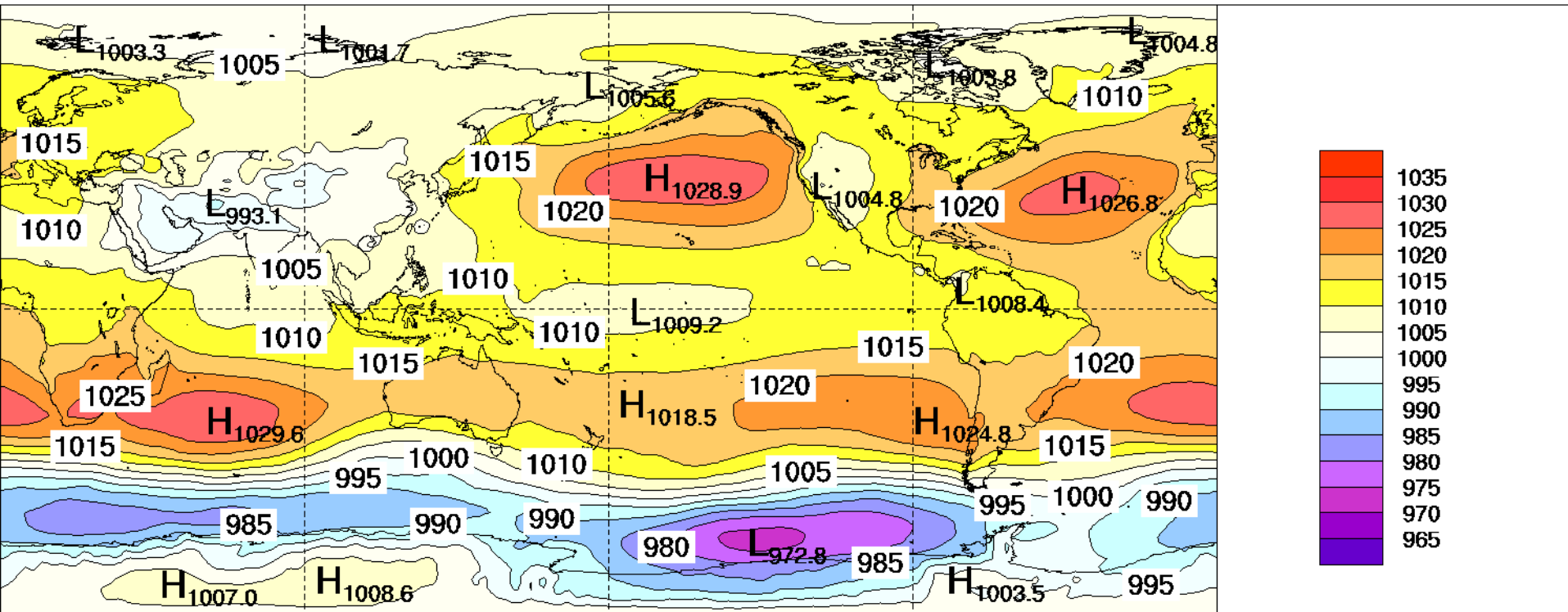
Monthly mean MSLP - Global

MSLP 2.5X2.5 ACCESS OP. ANAL. (hPa) 20220101 0000 20220131 0000



Monthly average Mean Sea Level Pressure (MSLP) January 2022

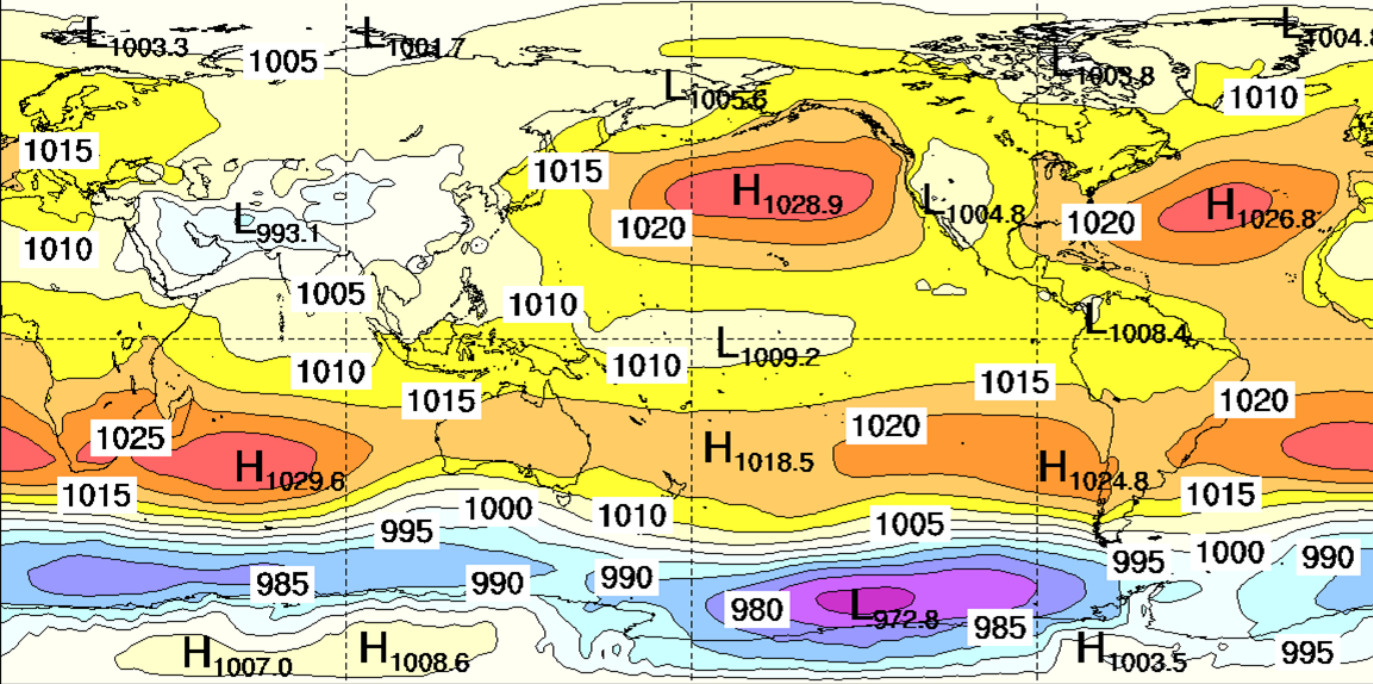
MSLP 2.5X2.5 ACCESS OP. ANAL. (hPa) 20210701 0000 20210731 0000



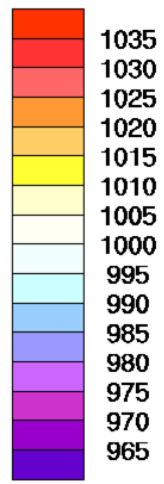
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Issued: 01/08/2021

Monthly average Mean Sea Level Pressure (MSLP) July 2021

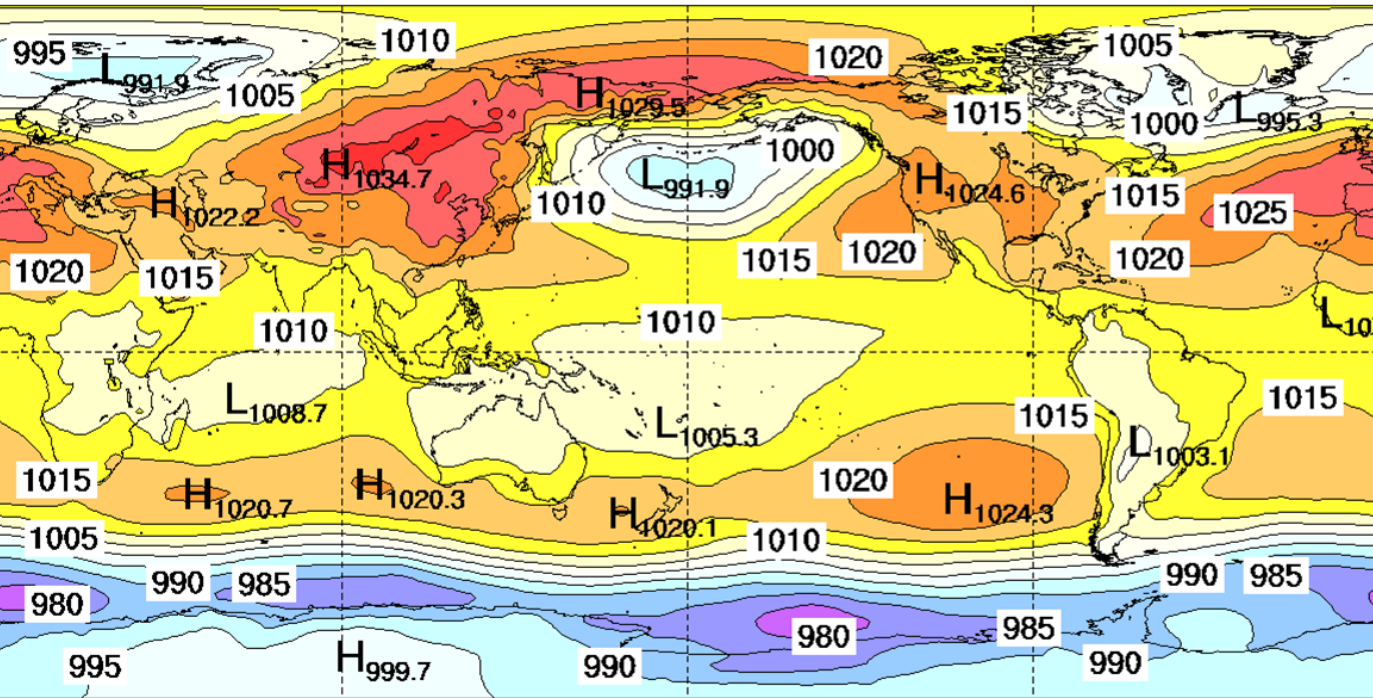


July 2021

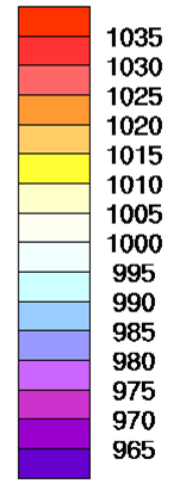


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Issued: 01/08/2021

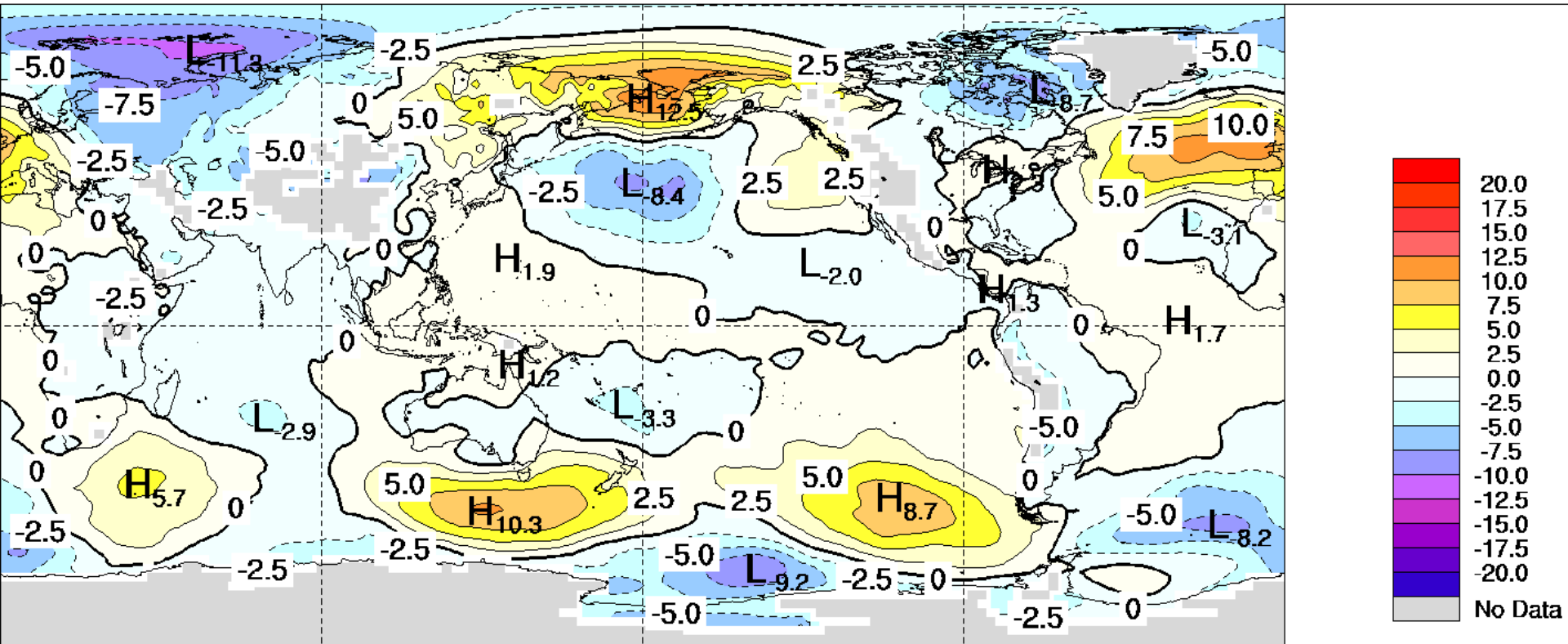


January 2022



A few things to note:

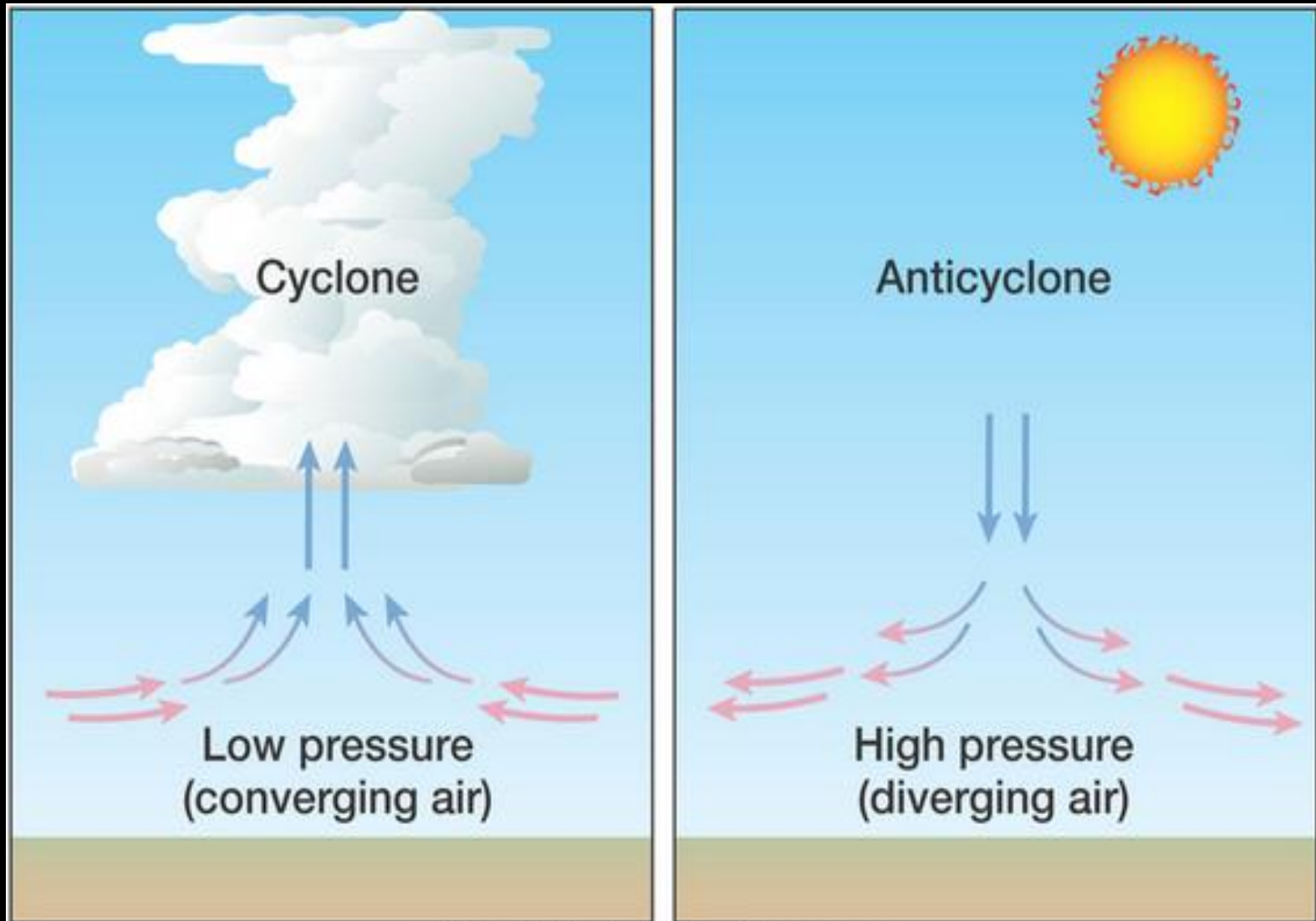
- The pressure pattern “follows the sun” north and south between winter and summer
- There are big differences in the pattern between the northern and southern hemispheres
- The pattern in the northern hemisphere changes much more between summer and winter than the south
- In the southern hemisphere the band of westerly winds (“roaring forties”) is present in both summer and winter.
- **Why?**
 - More land and mountain ranges in the north
 - More ocean in the south and relatively little land
 - Large, high continent over the south pole.



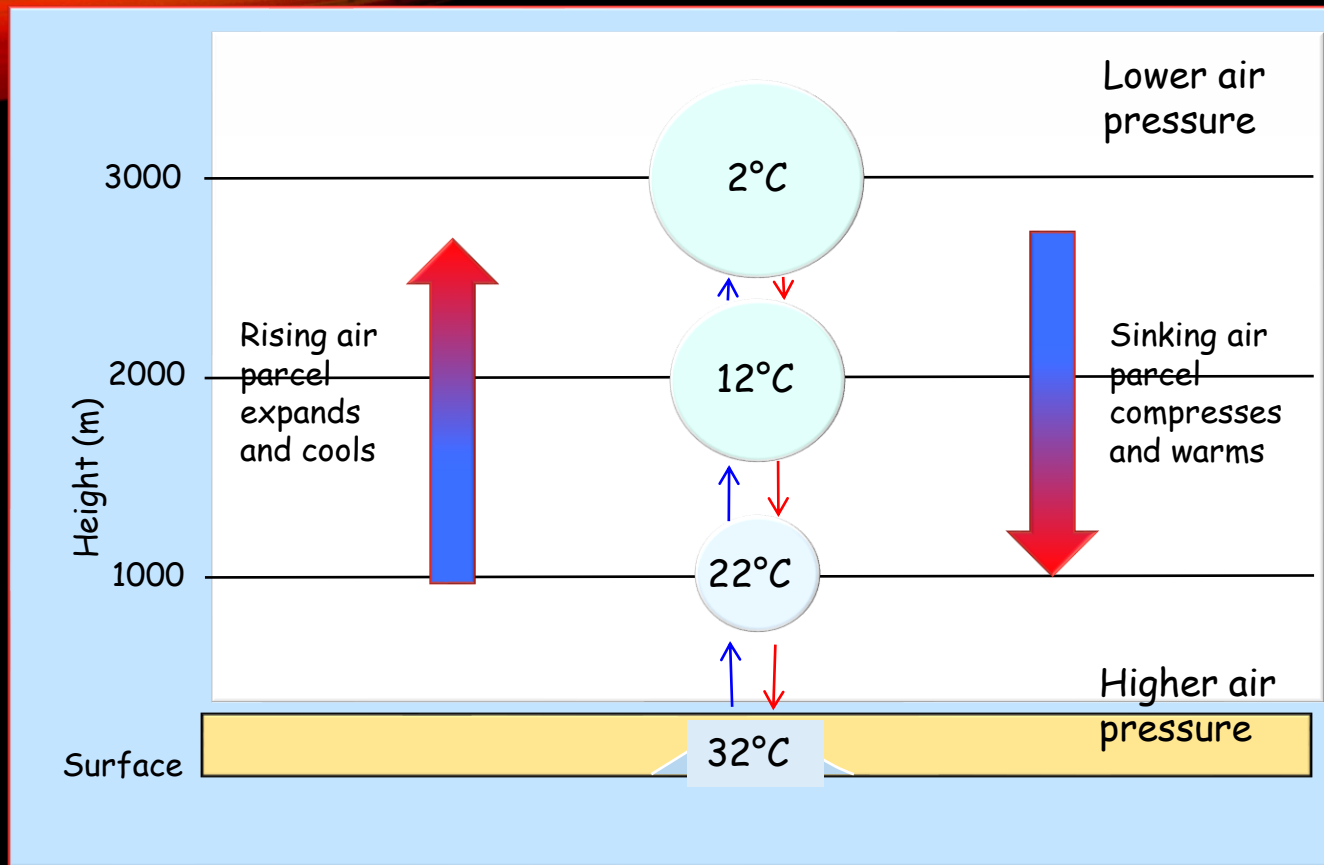
Comparison of January 2022 with the long-term average of January MSLP

Wind

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



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.

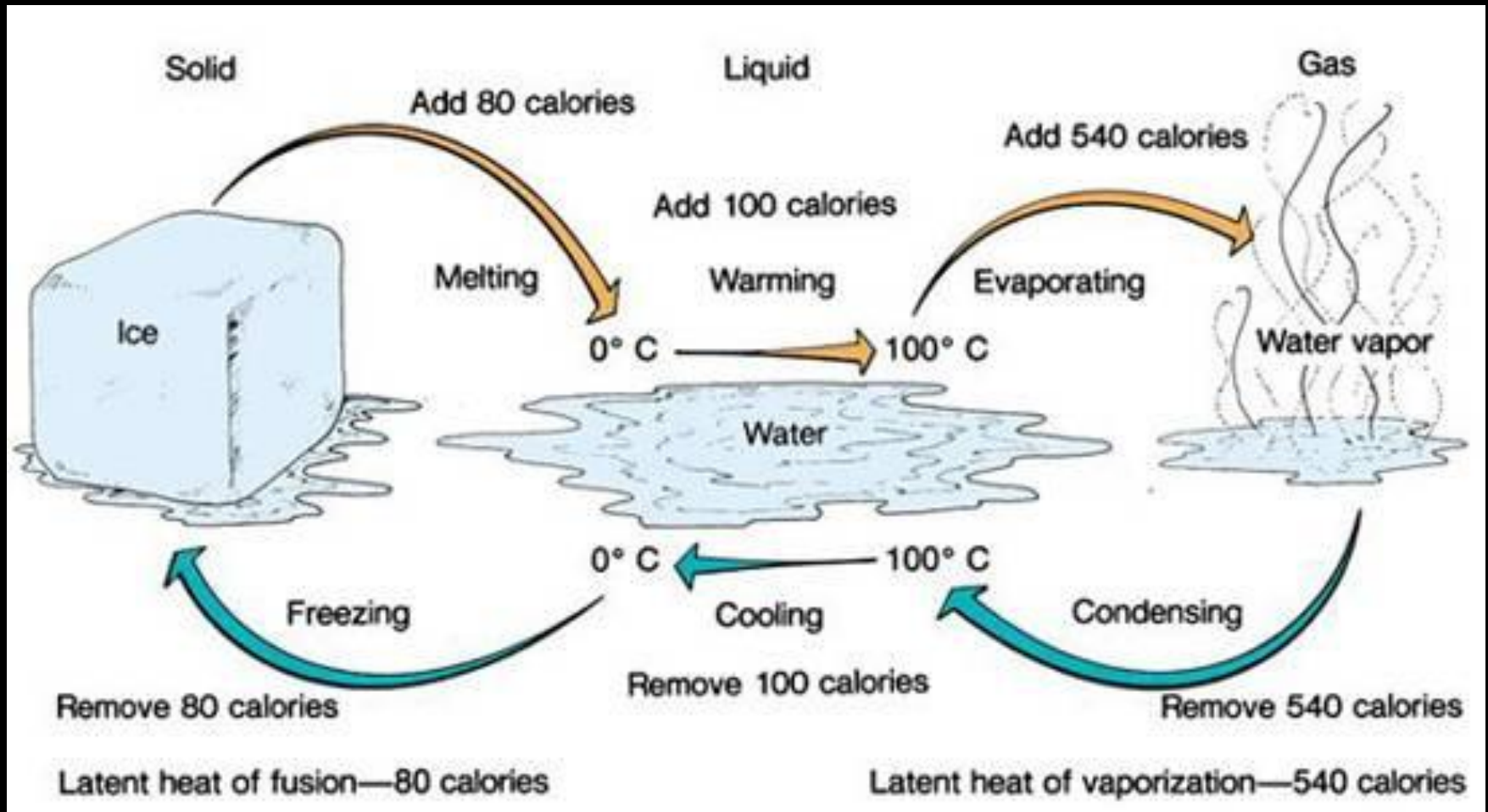
The water vapour becomes the fuel that can drive weather systems.

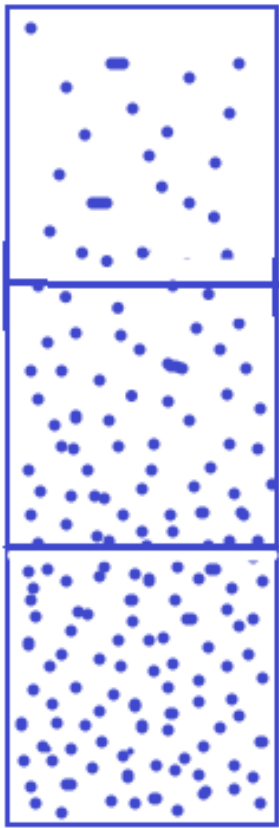
Rising air behaves very differently to sinking air.

Concept of water vapour as fuel for cyclones and storms

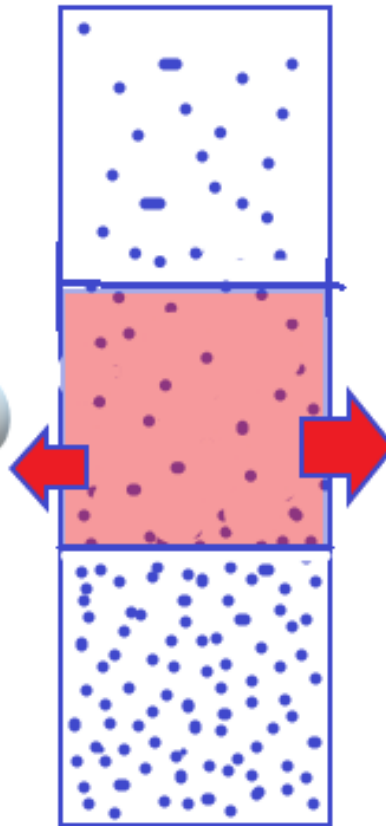
Phase changes are important:

Condensation of water vapour to water or ice releases heat in clouds and rain





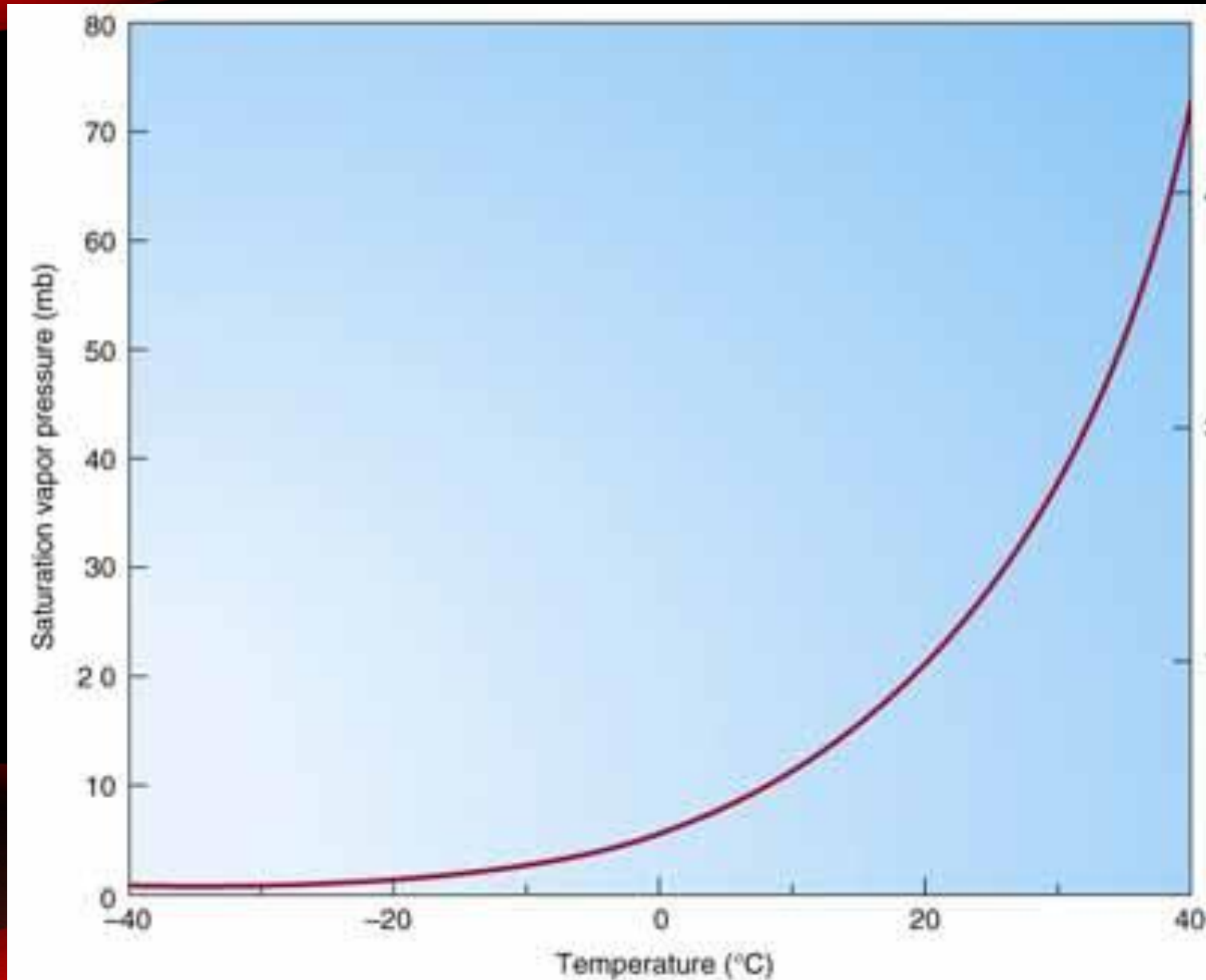
Air pressure at the surface

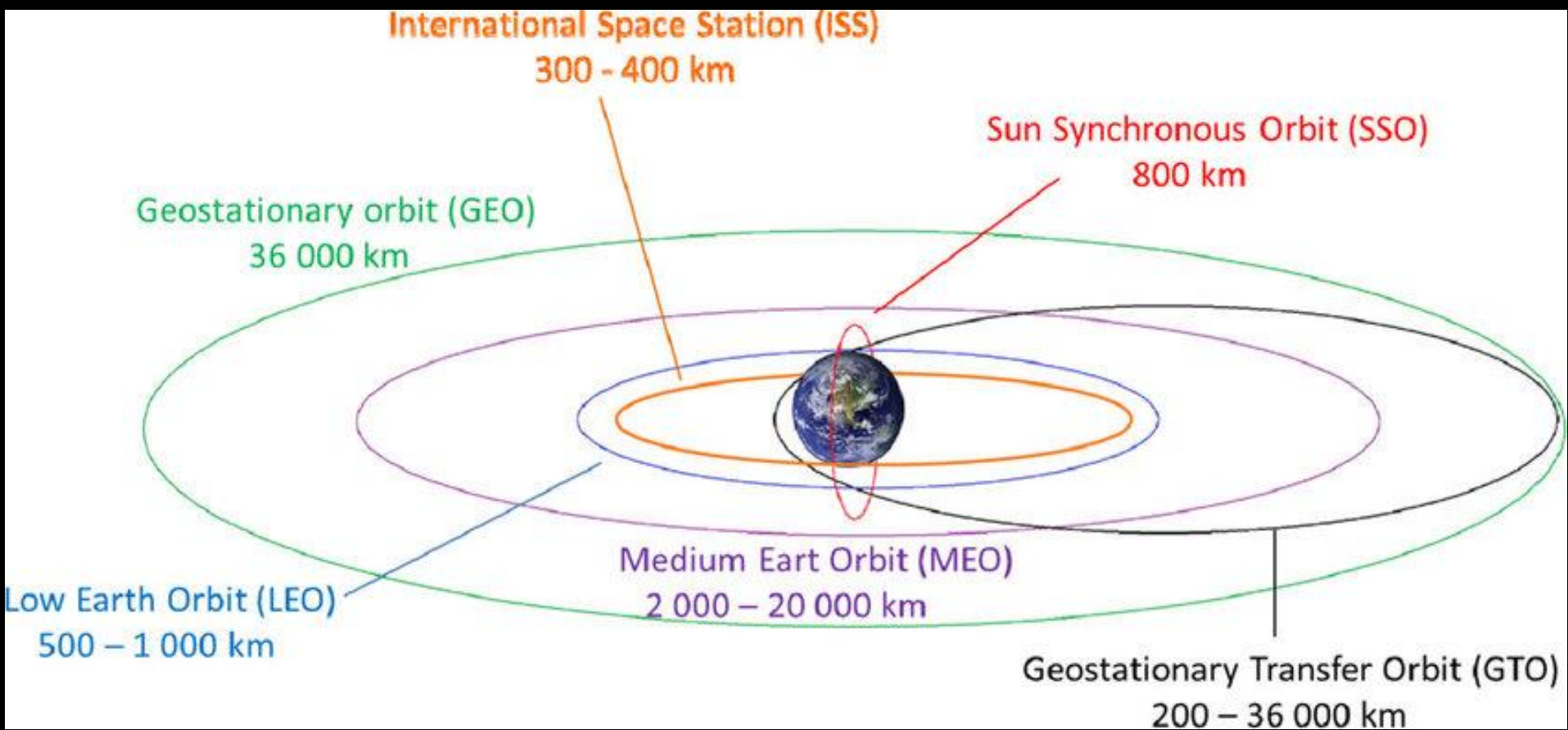


Lower air pressure at the surface

Condensation of water vapor in cloud and rain heats the air (latent heat)

Some interesting facts about the role of water

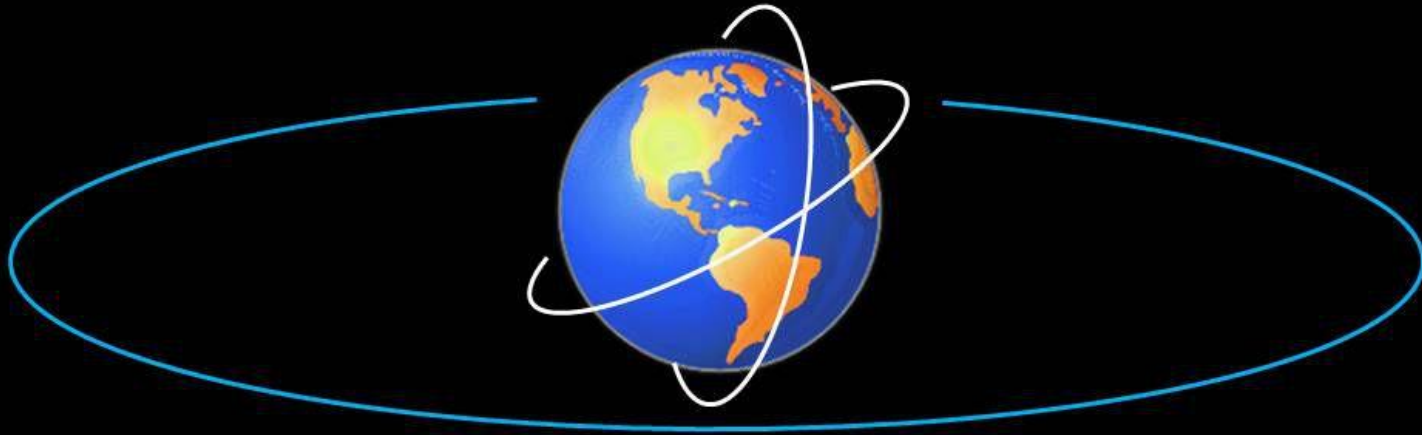




Low Earth Orbit (LEO)

Altitude: 200-2000 km

Satellites travel faster than Earth



A geosynchronous satellite
above the Equator is
geostationary

Geo Synchronous Orbit (GEO)

Altitude: 35,786km

Satellite speed same as Earth – 24hrs

- A “geostationary” satellite is travelling at 9400 km/hour around the earth.
- Distance to moon: 360,000 – 400,000 km
- There are over 500 geostationary satellites at present!

How many satellites are orbiting the Earth?

At the end of January 2022, according to the Index of Objects Launched into Outer Space, maintained by the United Nations Office for Outer Space Affairs (UNOOSA):

8261 individual satellites in space, an increase of 12% compared to April 2021.

- About 80% are in a Low Earth Orbit.
- About 8% in a geostationary orbit
- The others mainly in a Medium Earth Orbit but a few in Elliptical Orbit.

Purposes: Communications, earth observation, navigation/positioning, technology development

<https://www.pixalytics.com/satellites-in-2022/>

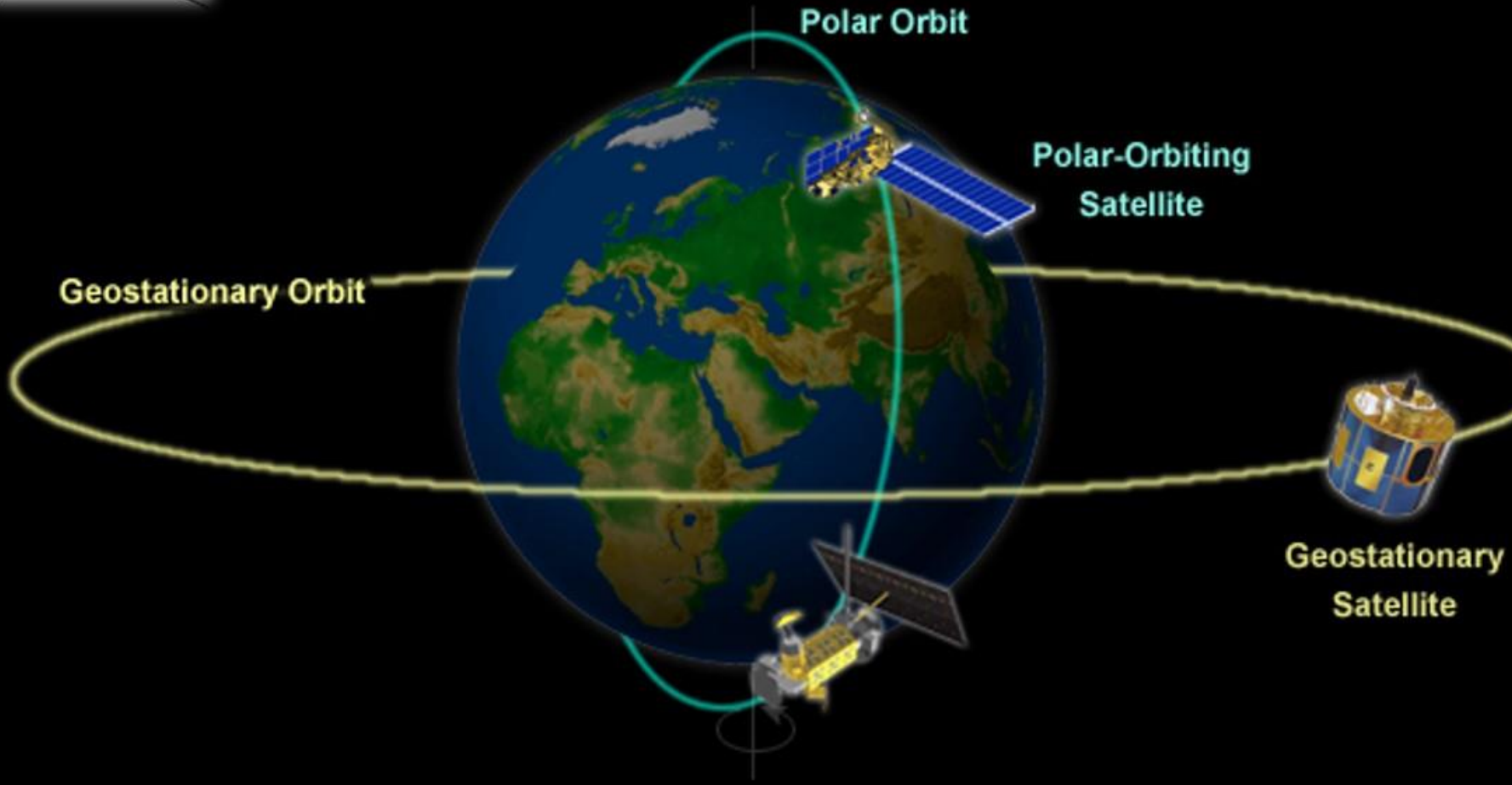
Helpful article on types and uses of orbit types:

<https://earthobservatory.nasa.gov/features/OrbitsCatalog>

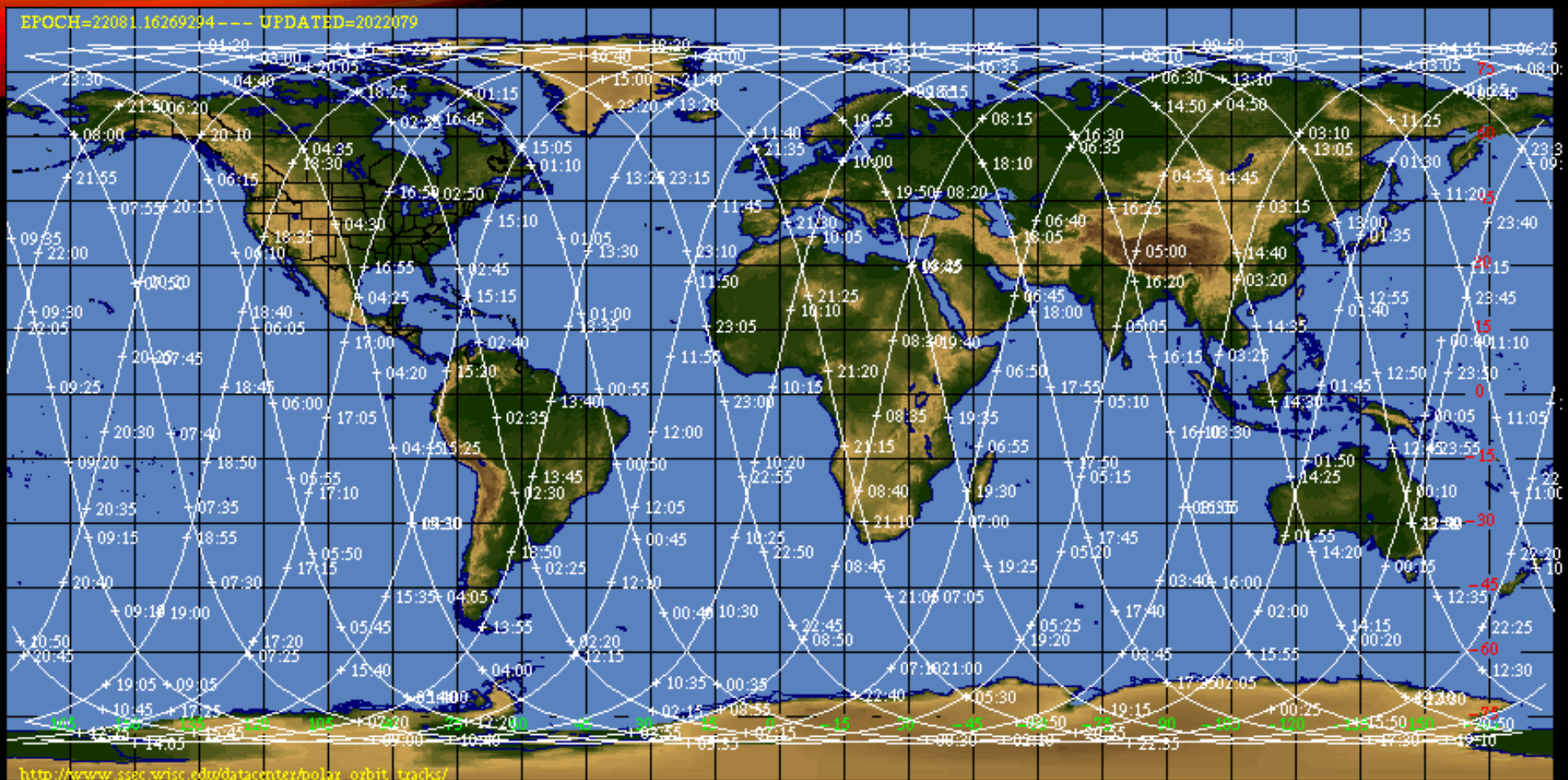


Polar-Orbiting and Geostationary Satellites

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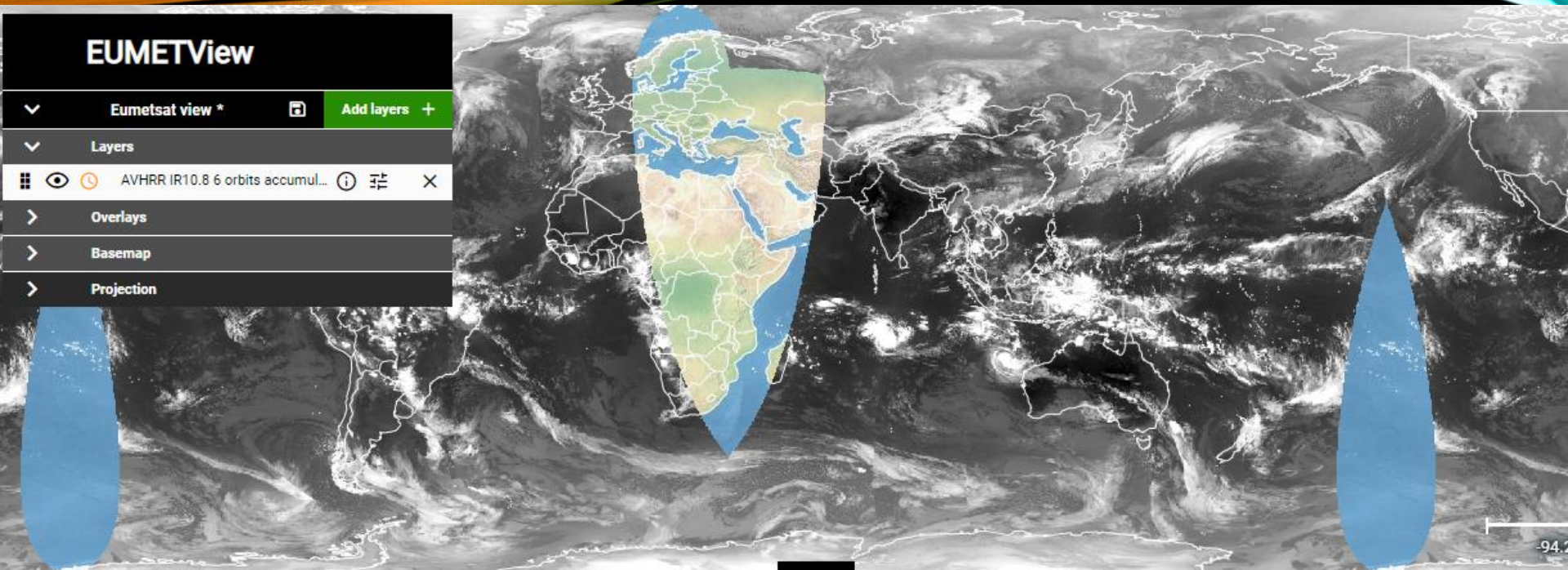


Main orbits for weather satellites



7 NOAA18 PREDICTED PASSES MARCH_20,2022 (DAY 2022079) (ALL TIMES IN UTC)

Orbit paths for a polar orbiting satellite

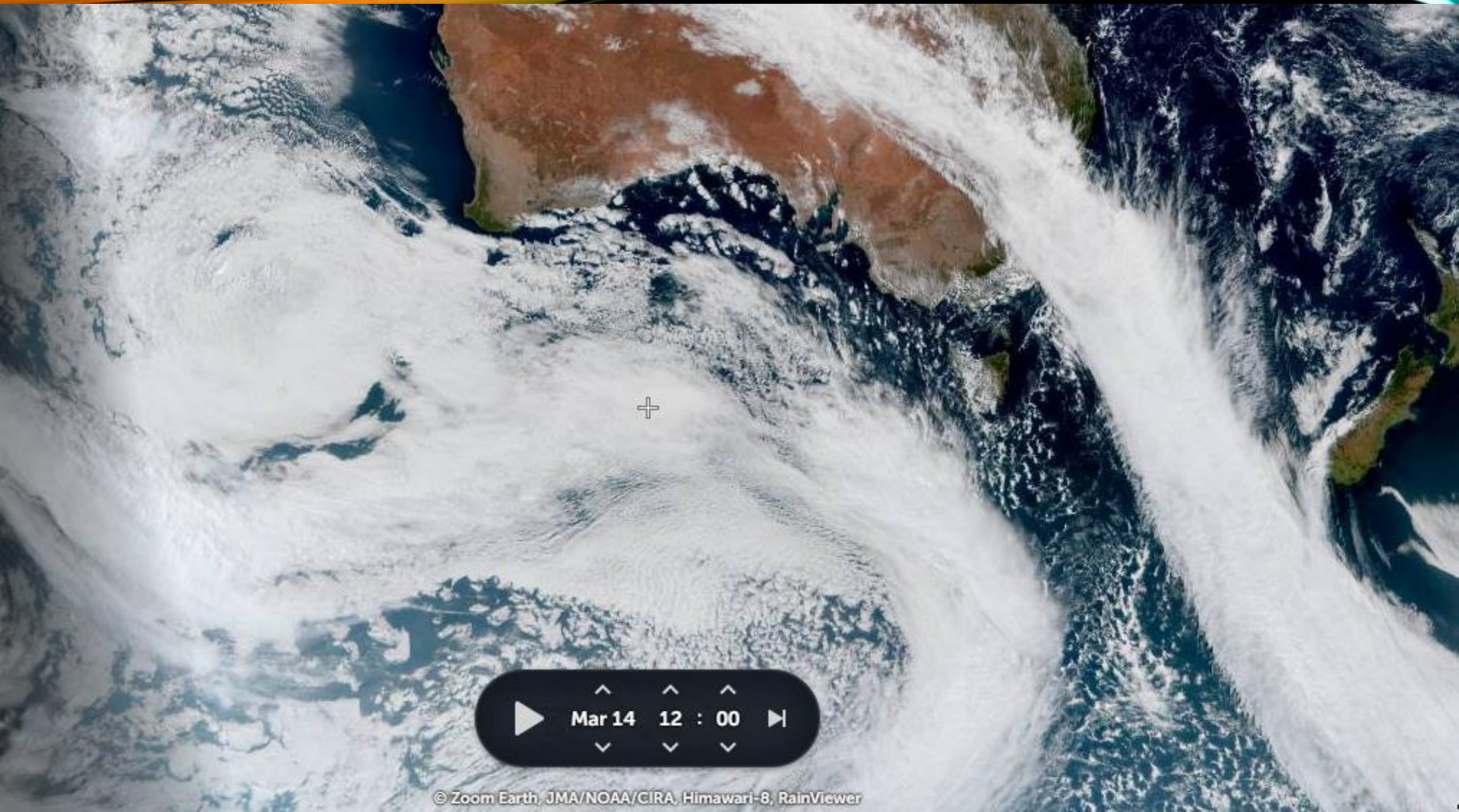


A composite of polar orbiting satellite images

<https://view.eumetsat.int/productviewer>

European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

- an intergovernmental organisation based in Darmstadt, Germany, currently with 30 Member States.



<https://zoom.earth/> a very useful web site

You can turn on wind flow also