

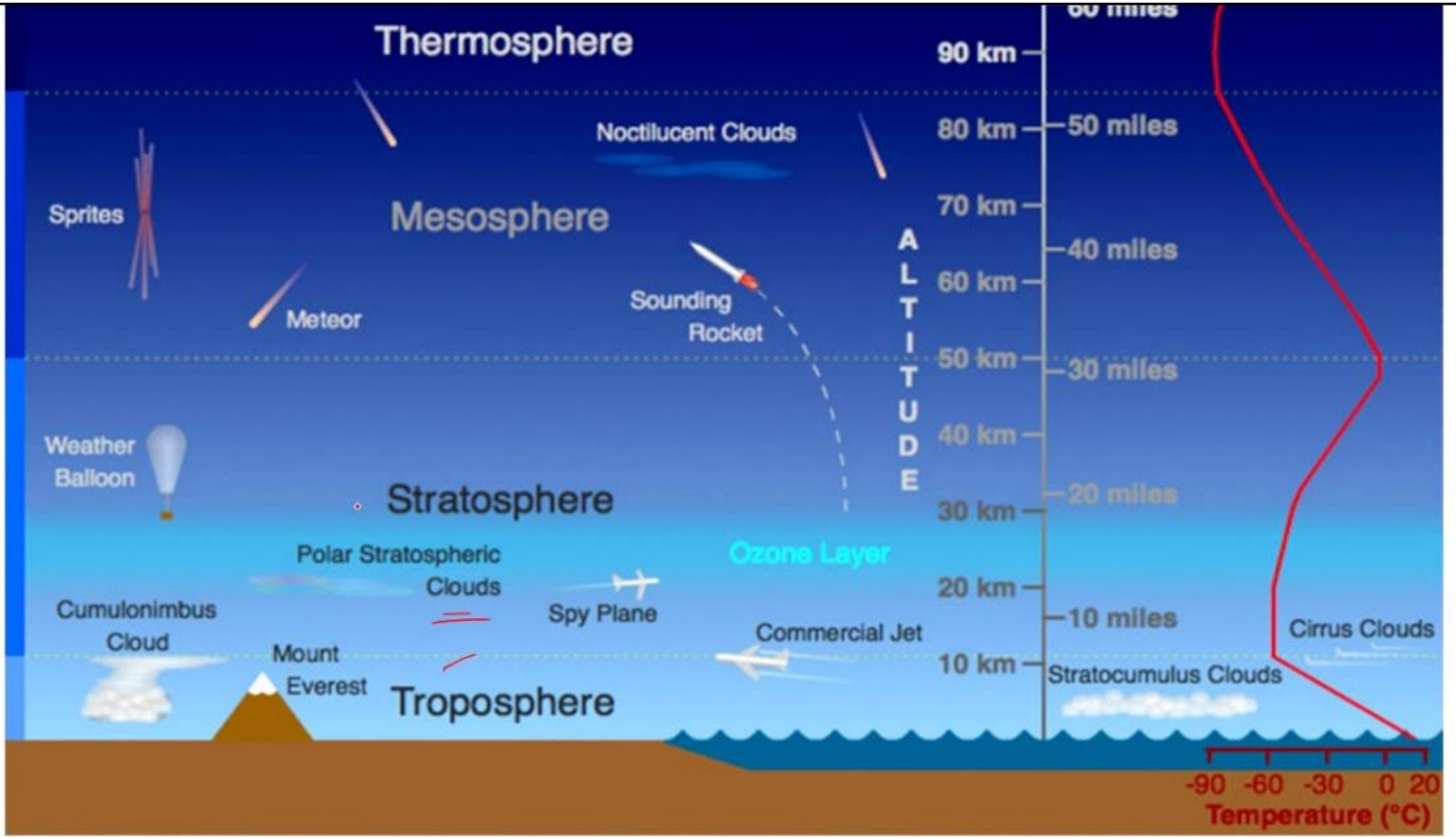
# Science of Weather

- Lectures in the morning (recorded)
- Practical work in the afternoon (experiments, data, clouds, presentations, role acting...)
- Topics: atmosphere, global circulation, extreme weather, clouds, weather forecasts, numerical models, data, WMO, climate...
- Grading: based on work in the afternoon, presentations and role acting participation

# Science of Weather

Basics of atmosphere

<https://www.youtube.com/watch?v=I6jIMkPwahQ>



Exosphere

Thermosphere

Mesosphere

Stratosphere

Ozone layer

Troposphere

600 km

372 miles

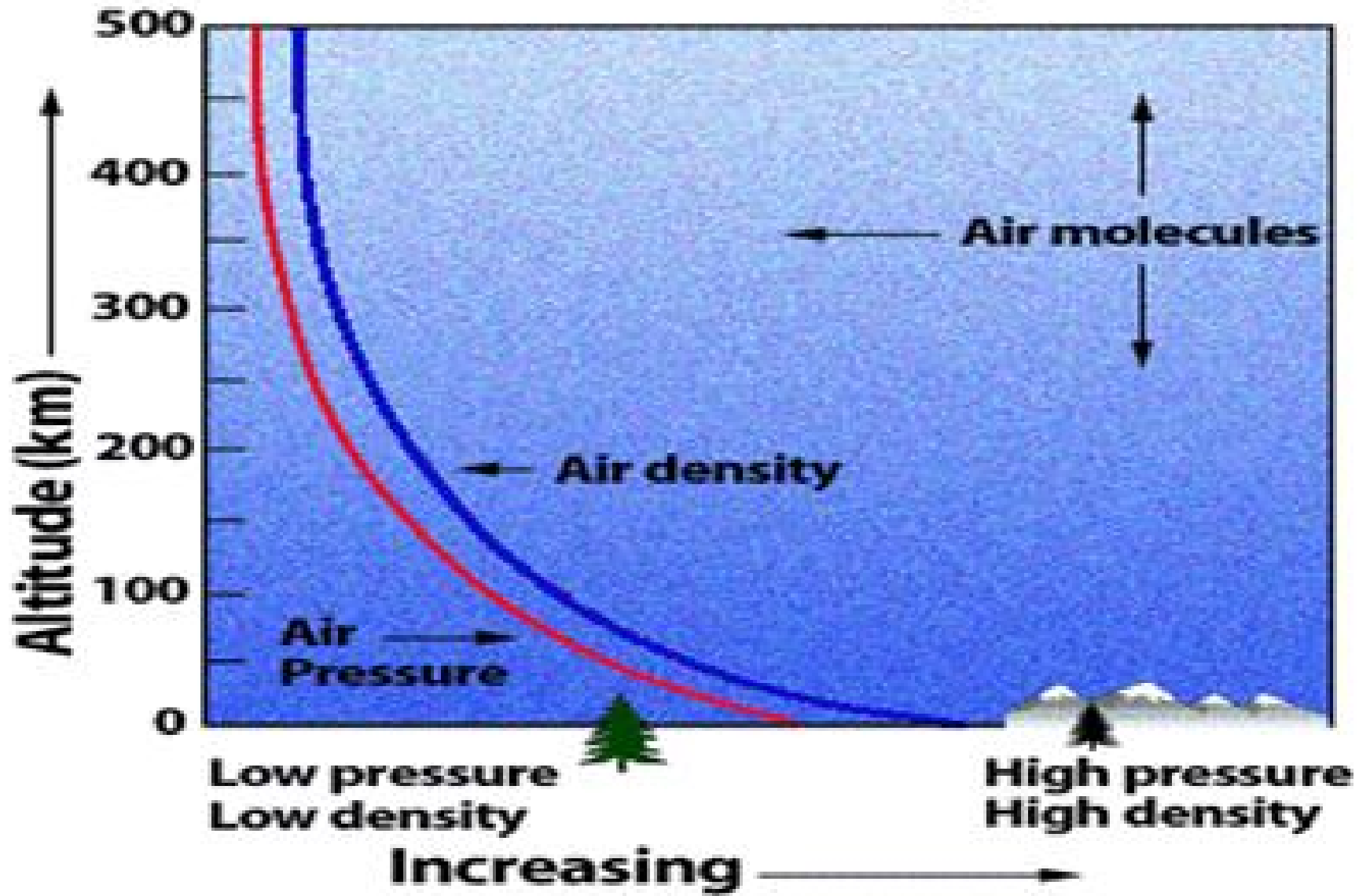
85 km

53 miles



- [https://www.youtube.com/watch?v=1Xtcqlv\\_EHs](https://www.youtube.com/watch?v=1Xtcqlv_EHs)

**Both air pressure and air density decrease with increasing altitude.**



# Troposphere

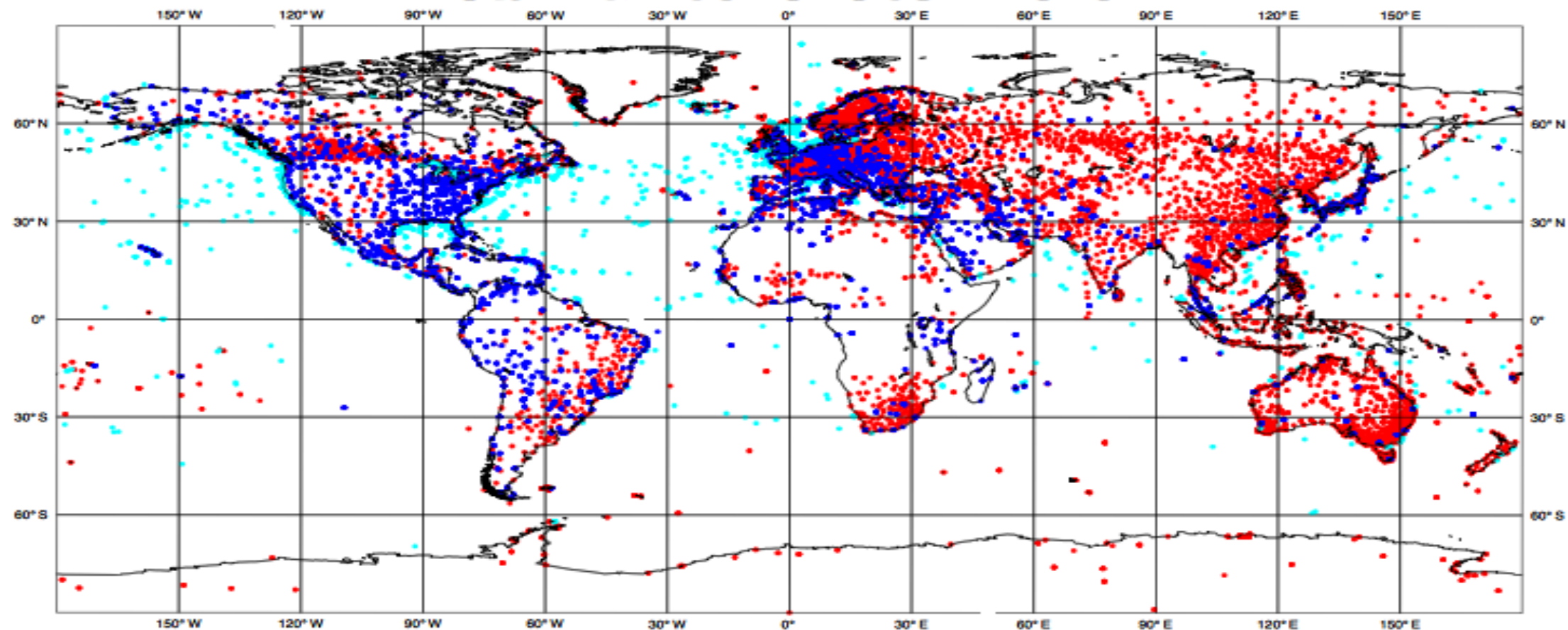
- The **troposphere** is where all the **weather** occurs.
- It is the **closest** layer to Earth's surface.
- It is the layer **we live in**.
- Higher altitude = colder temps.



## Obs Type

● 15885 SYNOP   ● 2359 SHIP   ● 9937 METAR

# ECMWF Data Coverage (All obs DA) - SYNOP/SHIP 12/OCT/2007; 00 UTC Total number of obs = 28181





Non-orographic wave drag



Long-wave radiation



Short-wave radiation



O<sub>3</sub> Chemistry  
CH<sub>4</sub> Oxidation

Cloud

Cloud

Deep convection

Shallow convection

Subgrid-scale orographic drag



Turbulent diffusion



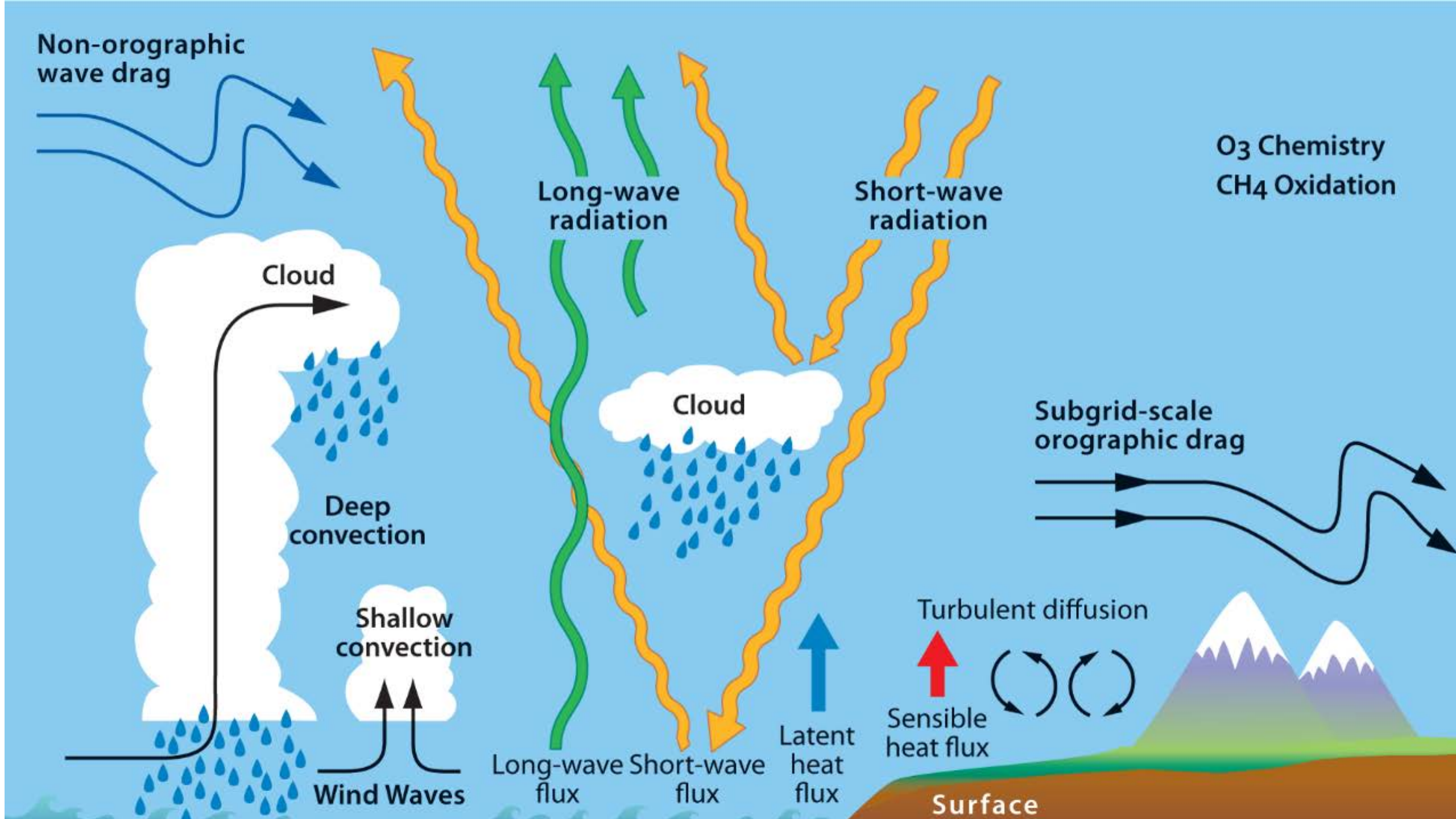
Sensible heat flux

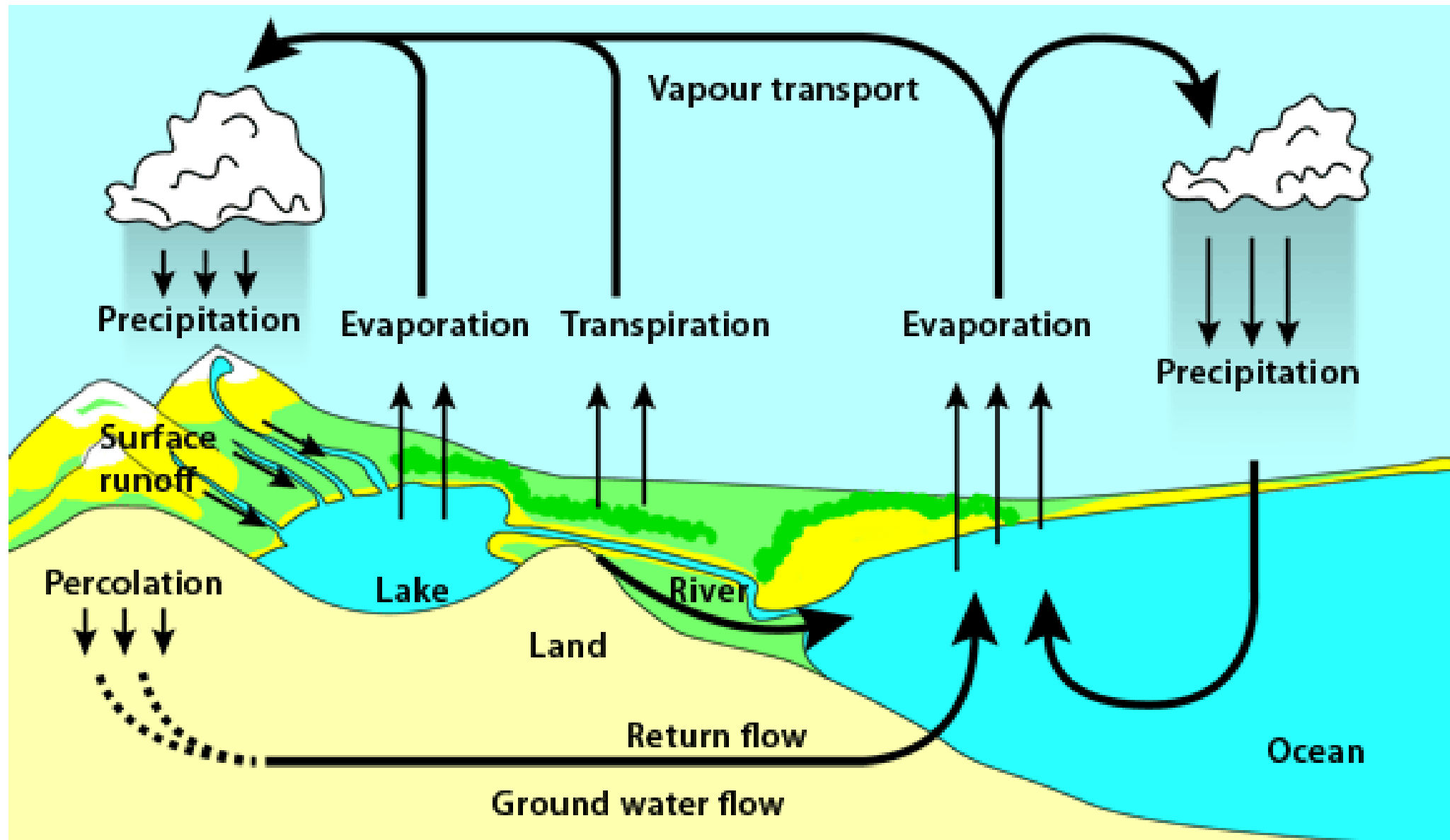
Latent heat flux

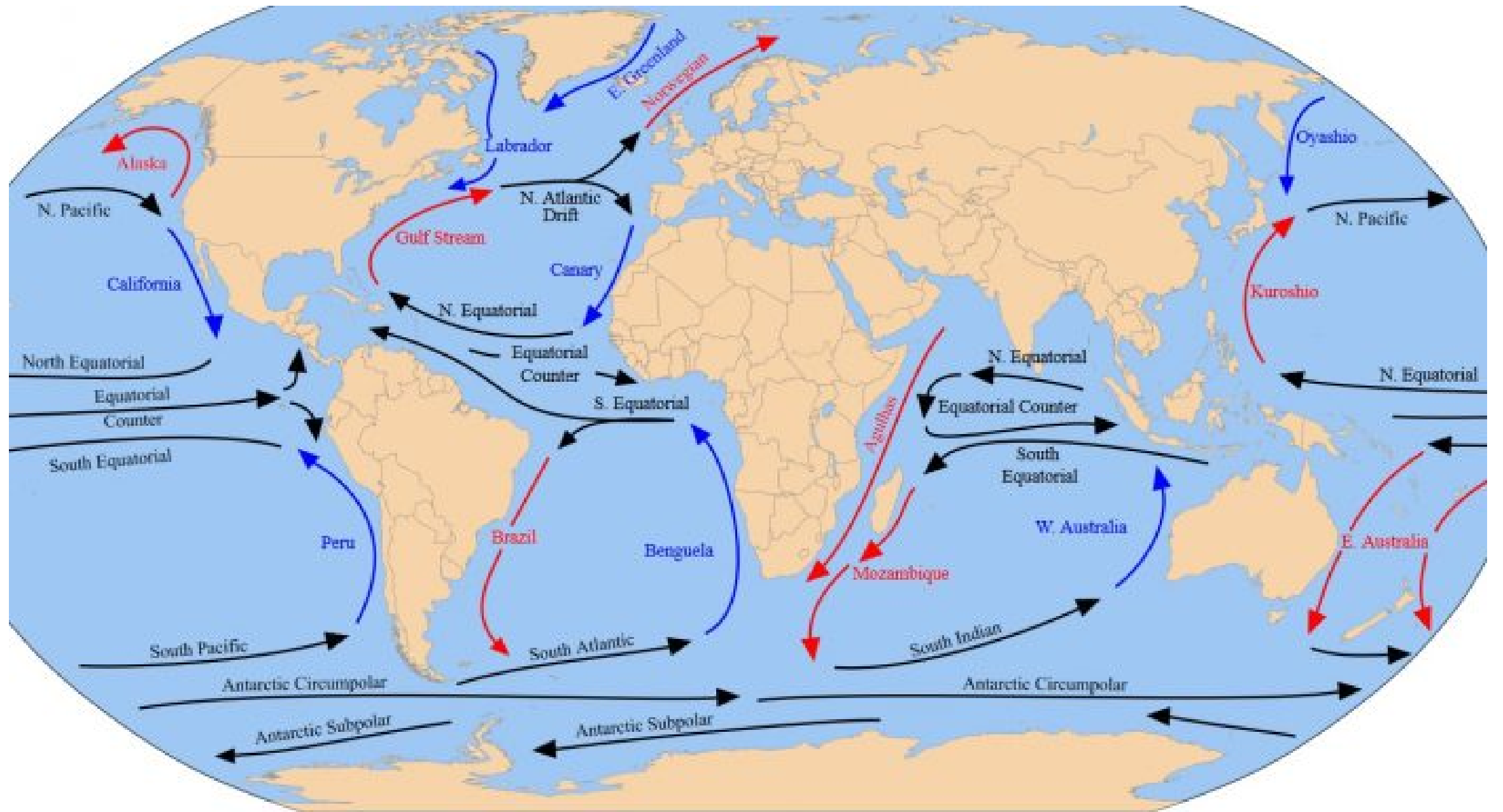
Long-wave flux  
Short-wave flux

Wind Waves

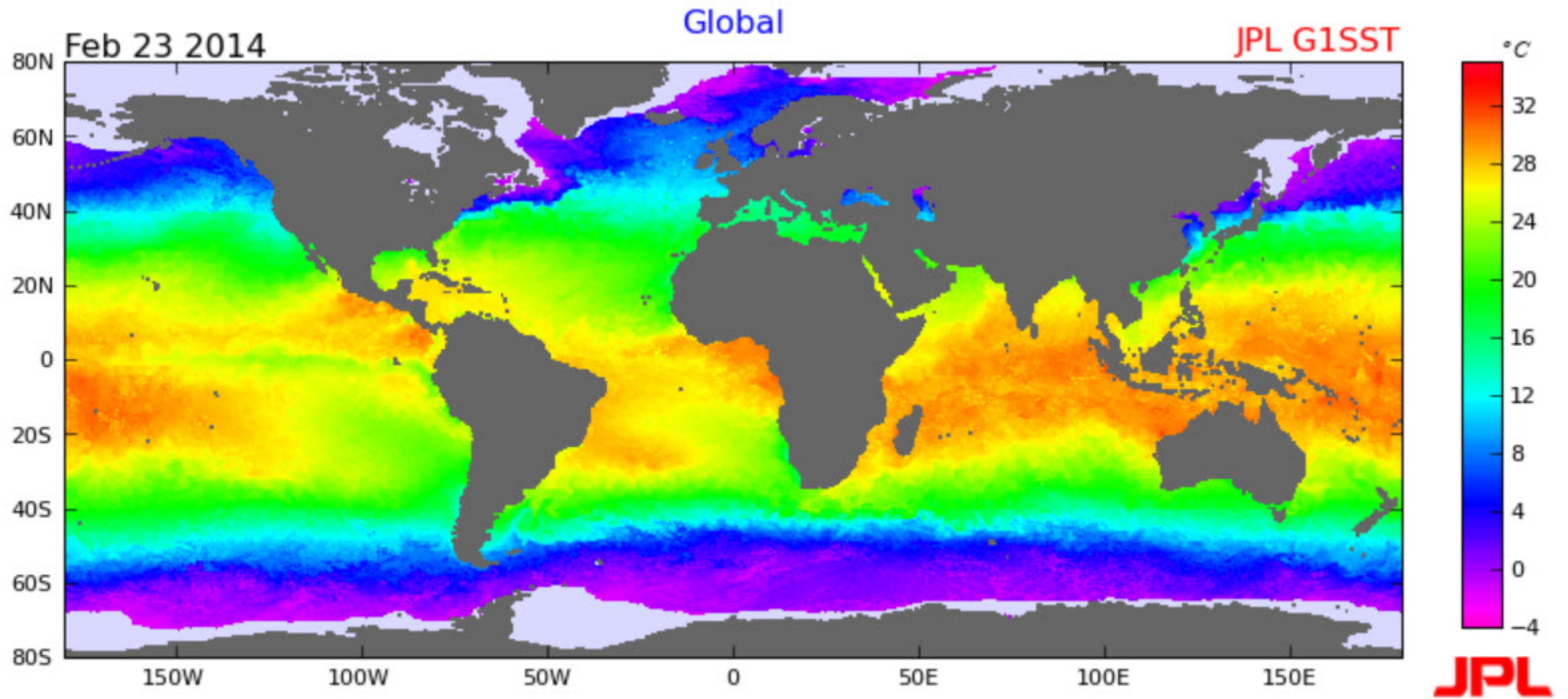
Surface



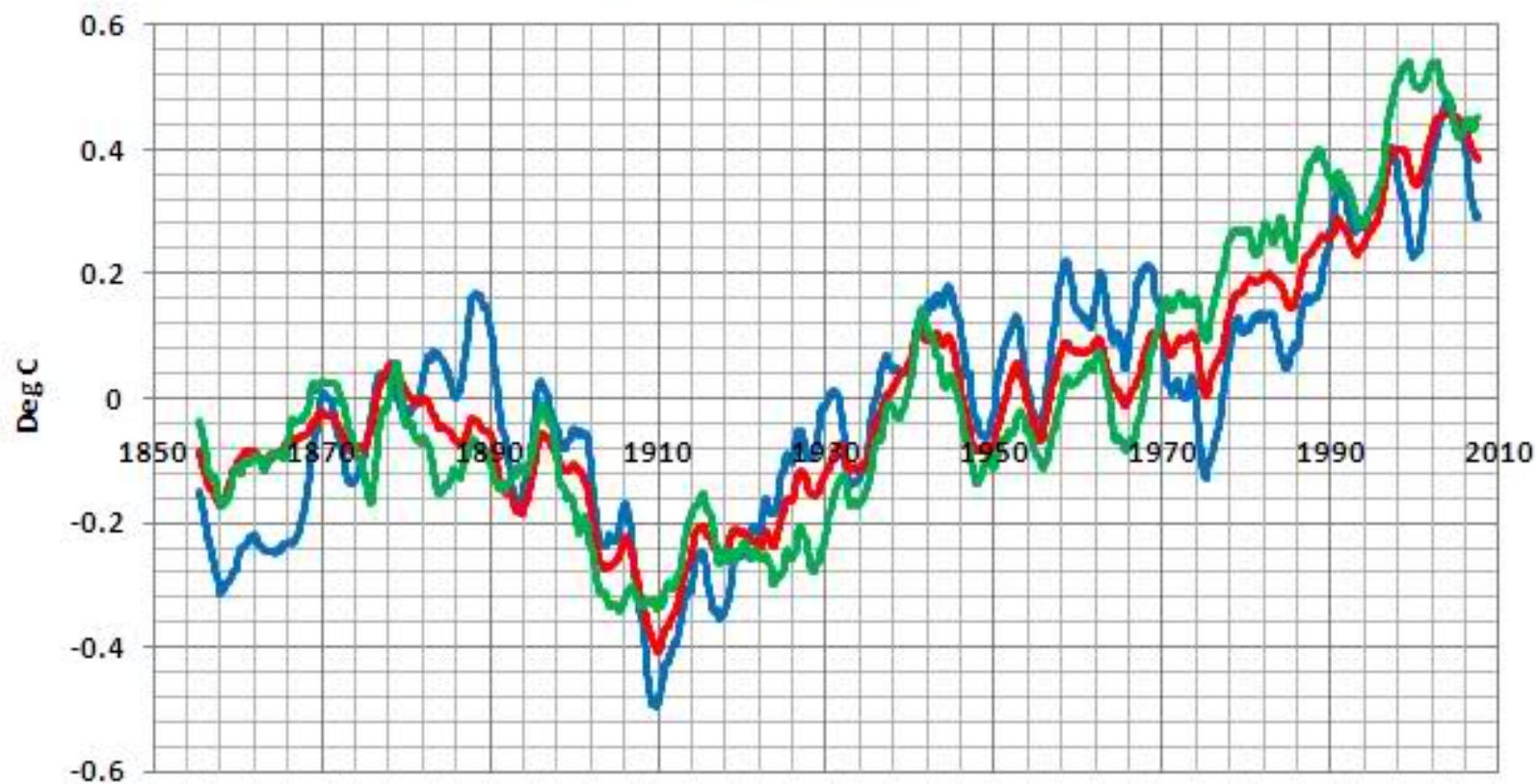




# Sea surface temperature SST



SST Anomalies [ERSST.v3b]  
Global, Indian Ocean, North Pacific Ocean  
Smoothed w/ 37-Month Filter  
Jan 1854 To Mar 2009



Weather

<https://www.youtube.com/watch?v=YbAWny7FV3w>

**I LOVE SUMMER IN  
SCOTLAND**

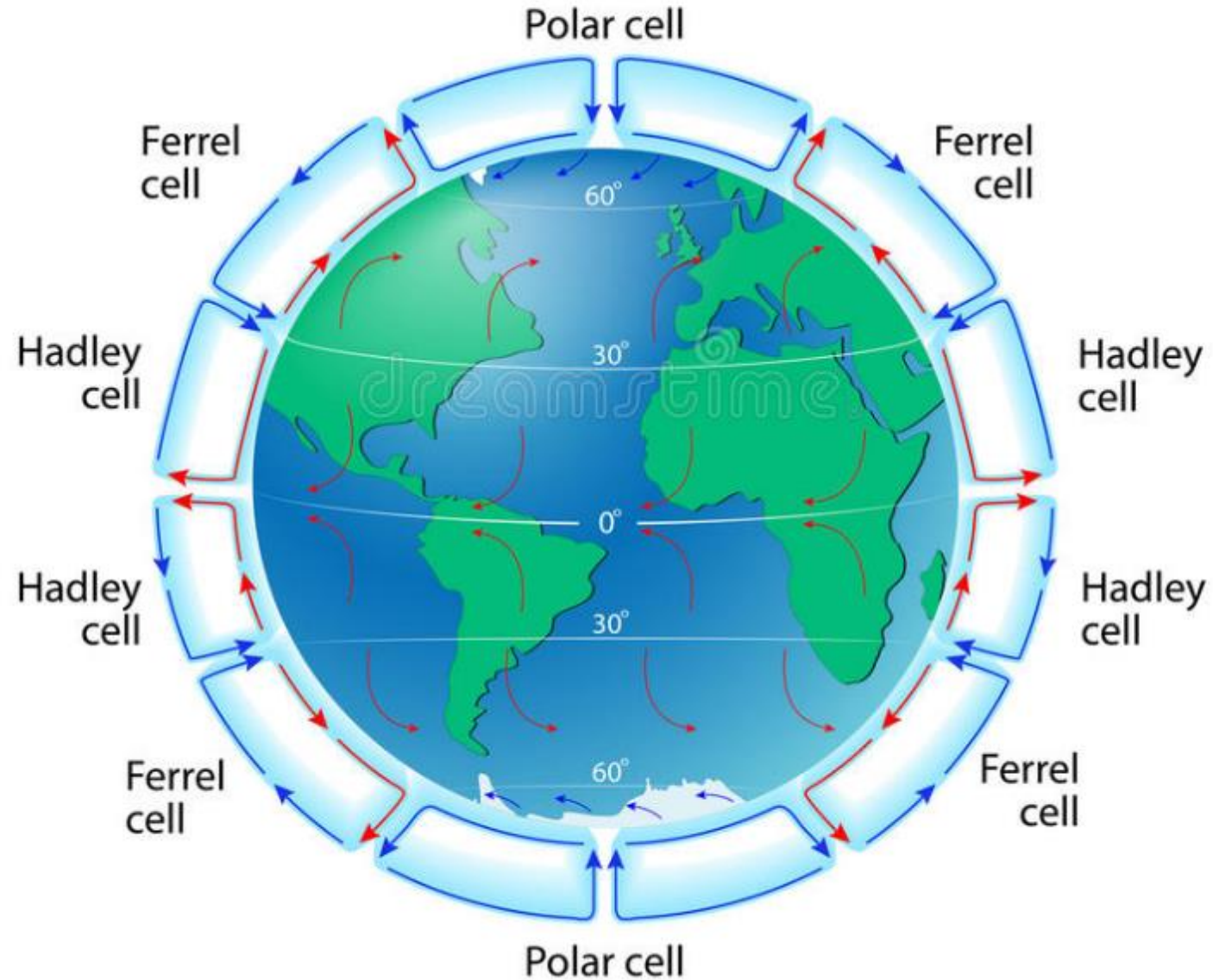


**THIS YEAR IT WAS A  
WEDNESDAY**

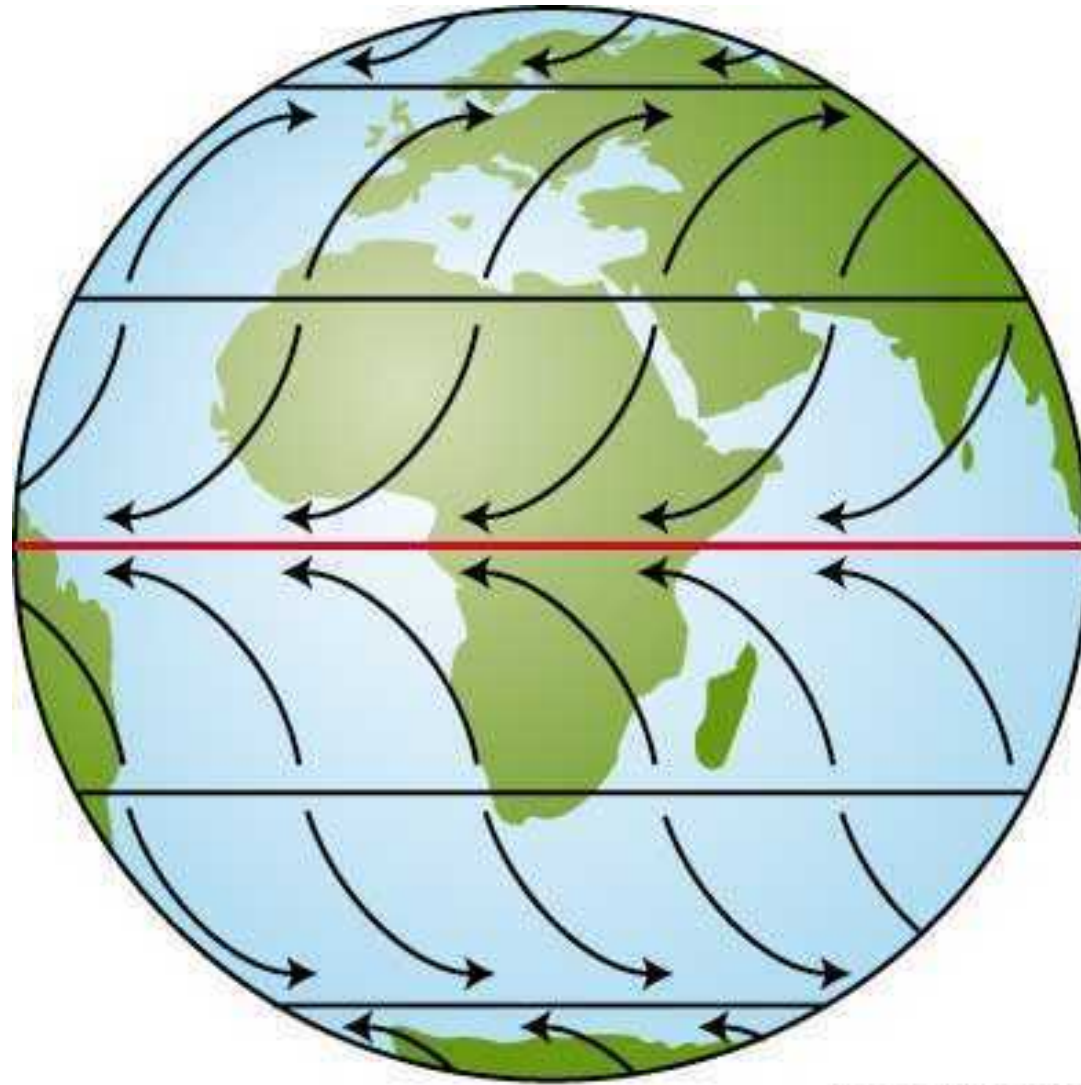




# GLOBAL ATMOSPHERIC CIRCULATION



# Trade Winds

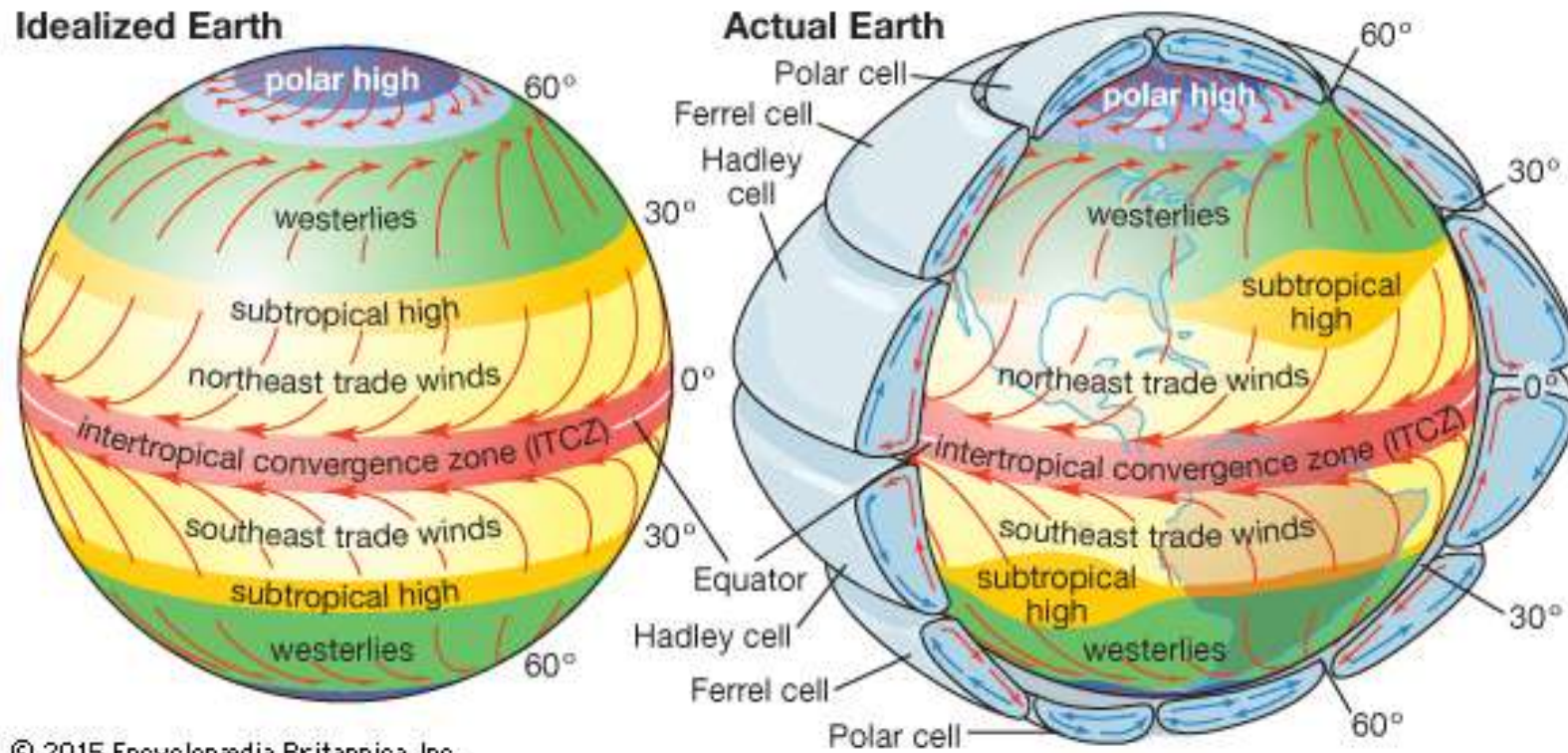


Elizabeth Morales

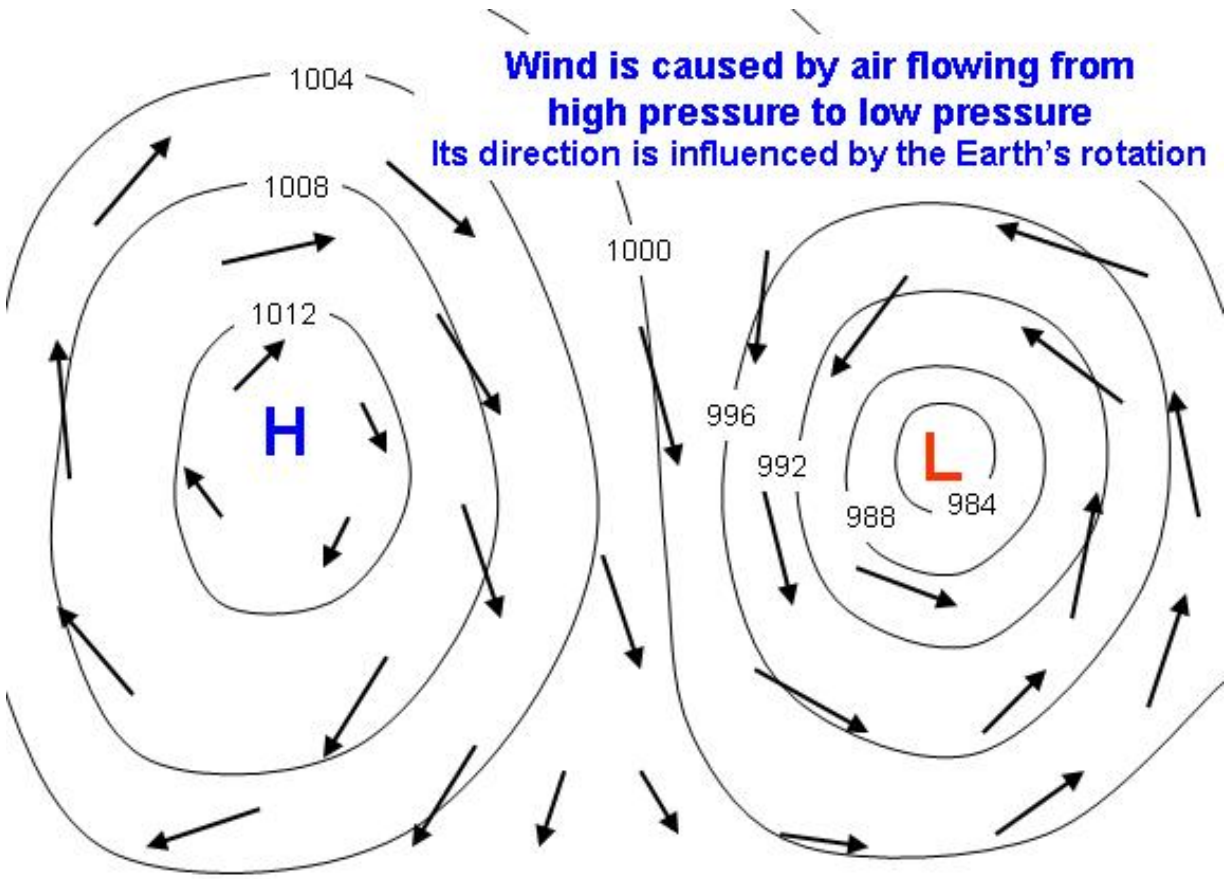
# Coriolis force

<https://youtu.be/aeY9tY9vKgs>

# Prevailing westerly winds of middle latitudes

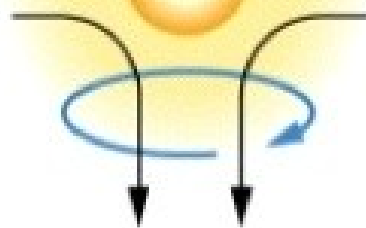
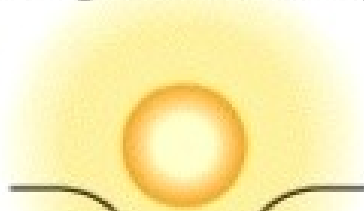


# WIND



**Wind is caused by air flowing from high pressure to low pressure**  
**Its direction is influenced by the Earth's rotation**

Cold and dry,  
bright and sunny



High pressure,  
Air descends



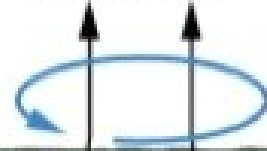
**H**

Ground  
surface

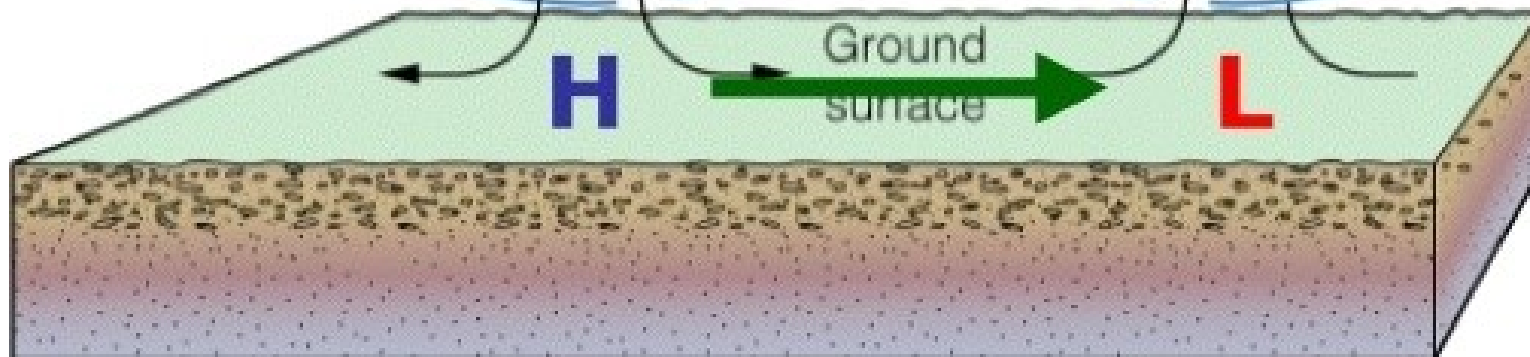
Warm and wet,  
cloudy and rainy



Low pressure,  
Air rises



**L**

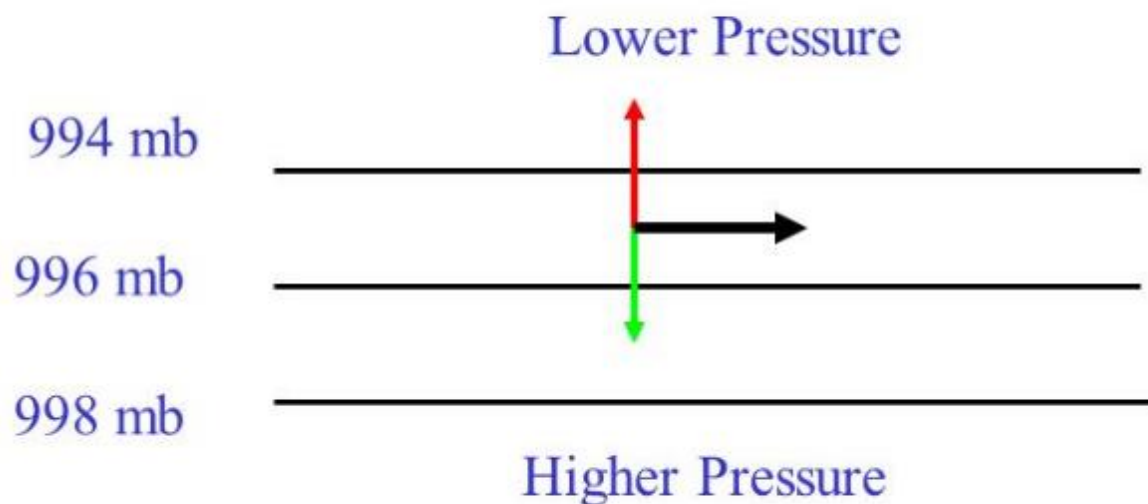


# Approximated balance – horizontal/vertical

- Geostrophic balance
- Hydrostatic balance
  
- In middle latitudes the wind is mainly geostrophic, not in fronts
- In tropics it is not

# *Geostrophic Balance*

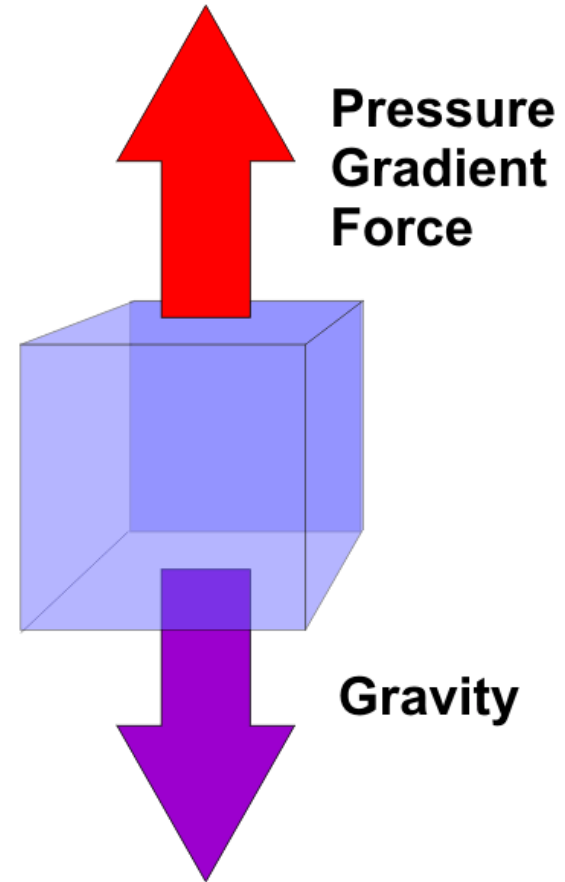
- The "Geostrophic wind" is flow in a straight line in which the pressure gradient force balances the Coriolis force.



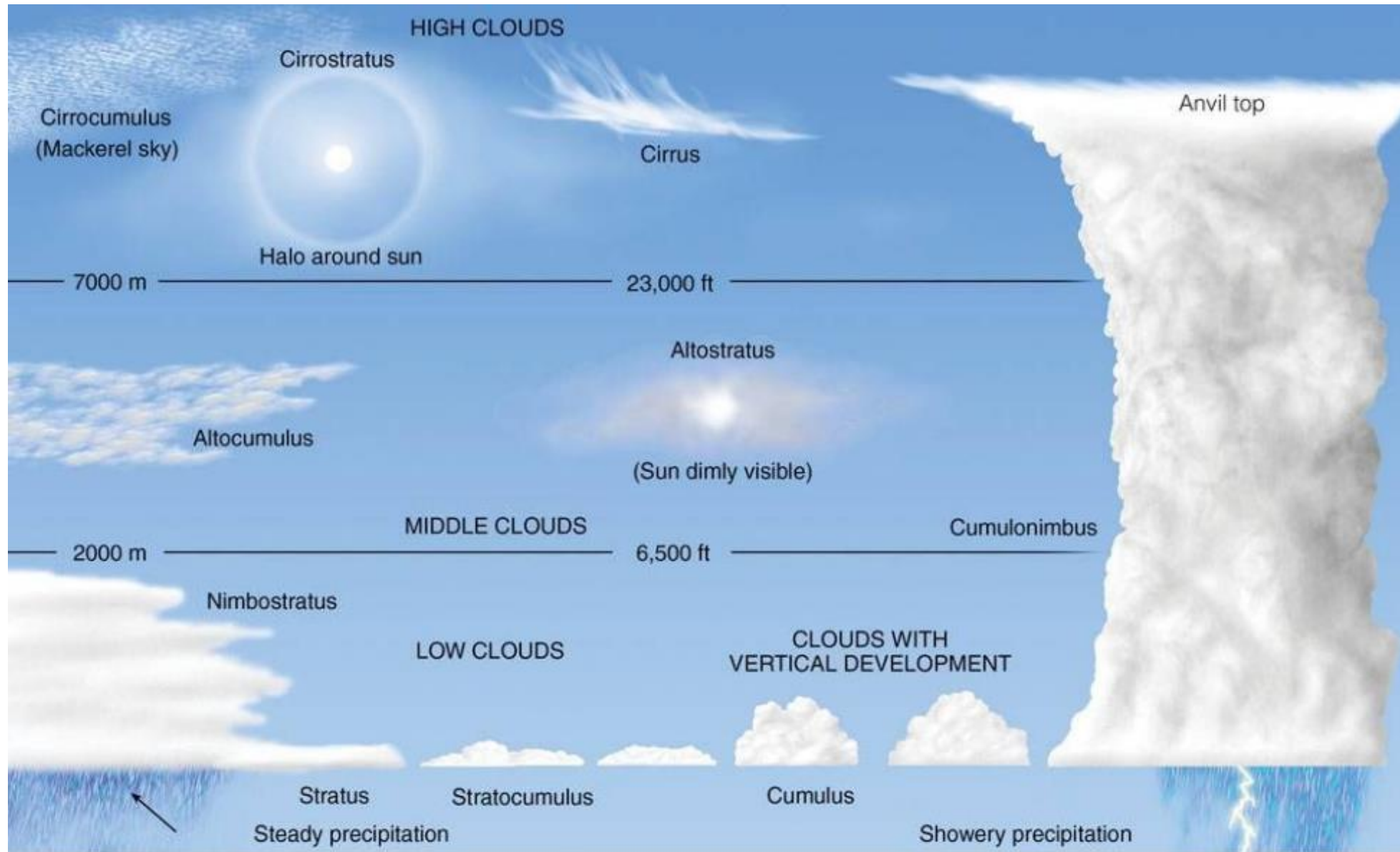
Note: Geostrophic flow is often a good approximation high in the atmosphere (>500 meters)



# Hydrostatic balance



# Clouds



# Clouds

- Clouds: <https://www.youtube.com/watch?v=FMagDRCpJ14&t=217s>

# Cirrusi



# Alto cumulus



# Stratocumulus



# Nimbostratus



# Cumulonimbus





# Middle latitudes: Fronts

- Fronts I: <https://www.youtube.com/watch?v=PJ4M6sERLM4>
- Fronts II: <https://www.youtube.com/watch?v=G7Ewqm0YHUI>
- Synoptic charts and fronts: [https://www.youtube.com/watch?v=wl\\_FFK\\_HbjY](https://www.youtube.com/watch?v=wl_FFK_HbjY)

# Dew point

- the atmospheric temperature (varying according to pressure and humidity) below which water droplets begin to condense and dew can form.

# Practicum: Temperature and dew point

[http://www.atmos.millersville.edu/~lead/SkewT\\_HowTo.html](http://www.atmos.millersville.edu/~lead/SkewT_HowTo.html)

