ATACAMA DESERT,

THE DRIEST PLACE ON EARTH

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March 4, 2010.

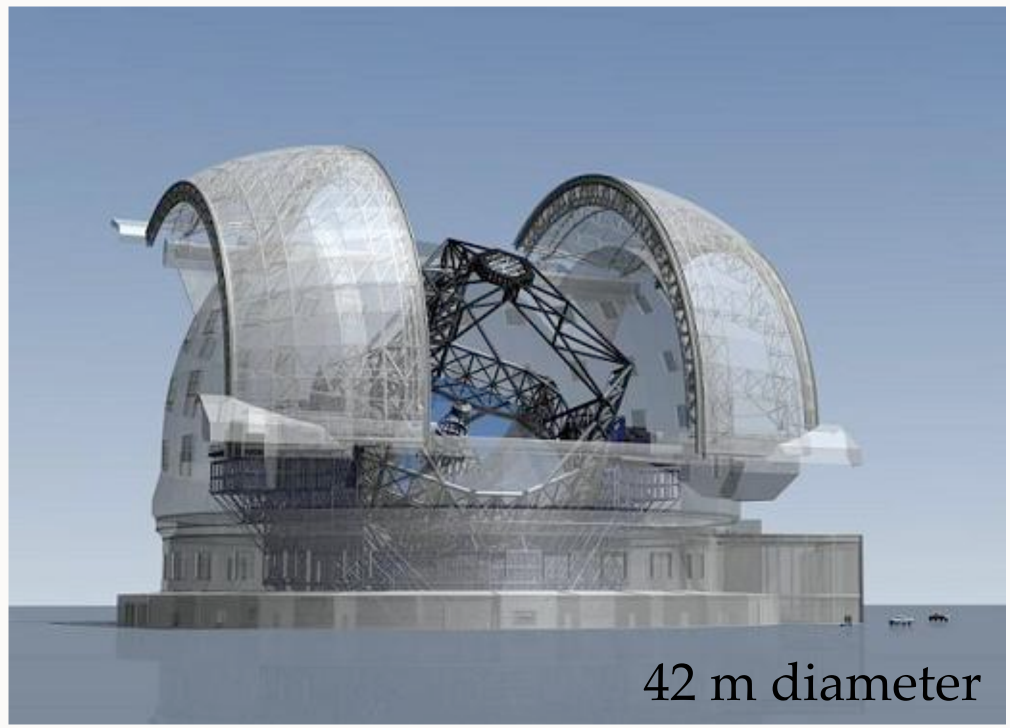
E-ELT

In march 2010: ESO scientists will decide where to install the E-ELT

Now remains only 2 options:

- Cerro Armazones,
  Atacama desert, Chile.

- Roque de los Muchachos,
  Canary Islands, Spain.



SITES:

Why go so far?

Selection is based on:

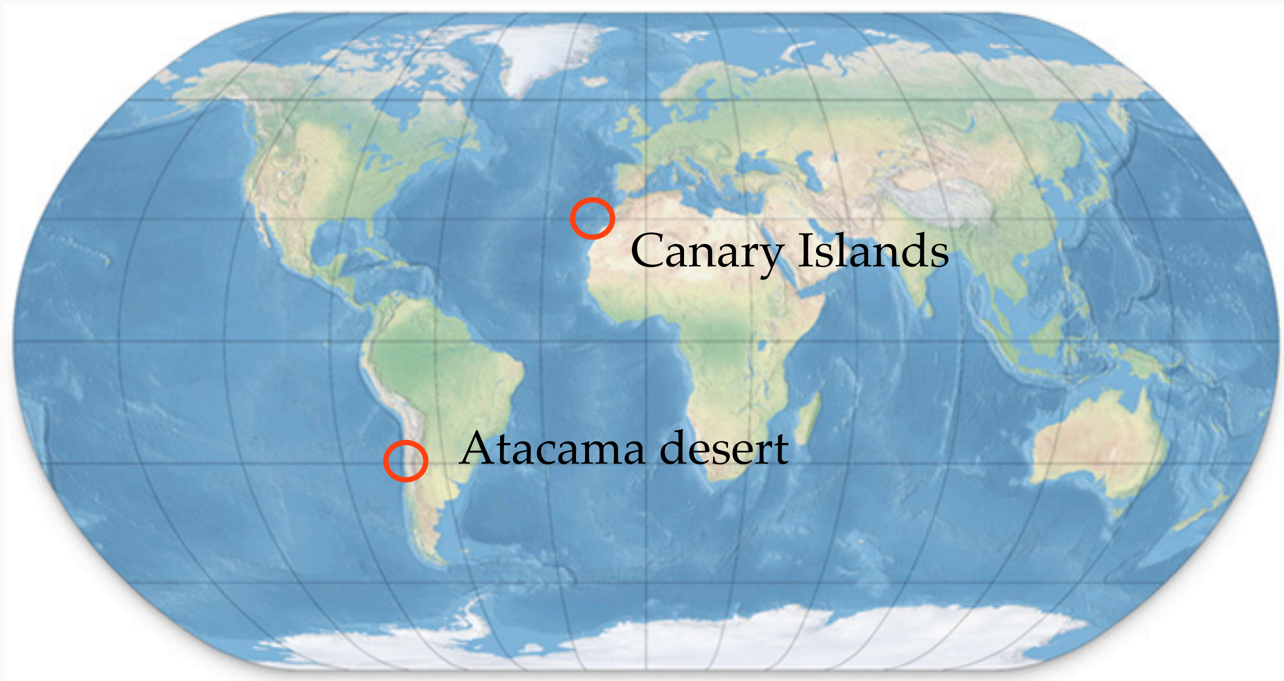
1.- **Location**

2.- **Location**

3.- Logistics

Determines:

- winds
- seeing
- dust
- extinction
- sky emission
- cloud cover
- humidity
- light pollution



SITES:

Why go so far? The big telescopes in the world:

Mauna Kea:

Gemini N., Subaru
Keck
CSO, JCMT
SMA, VLBA

Chile:

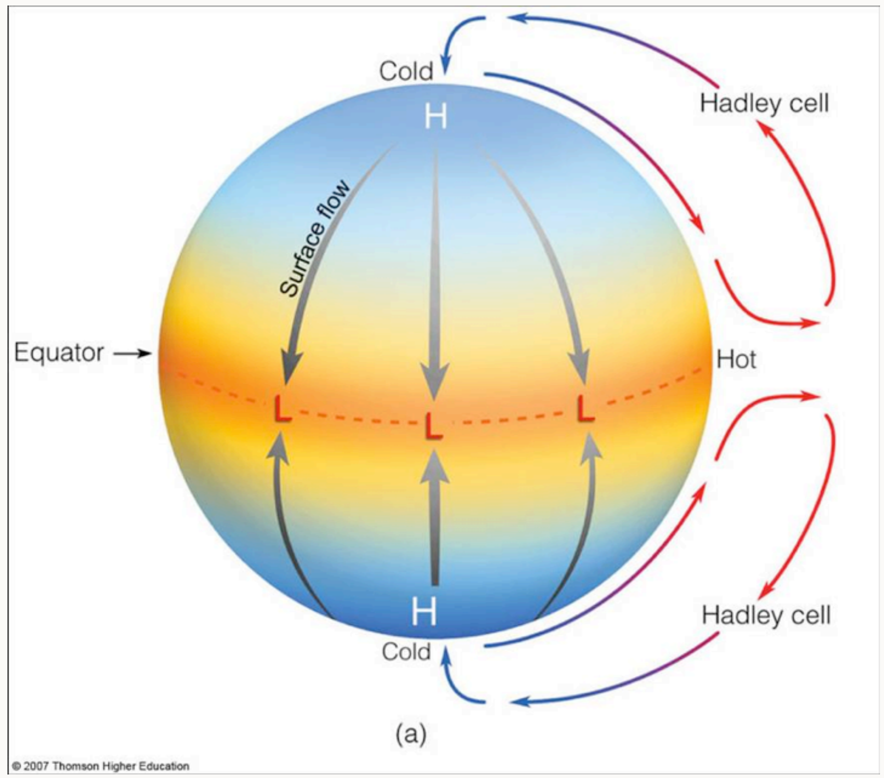
Gemini S., VLT, Magellan
ASTE
ALMA, APEX
Tololo, La Silla

AIR CIRCULATION

Single-Cell model:

For an Earth:
- uniformly covered with water
- sun directly over equator
- non-rotating

The '*Hadley Cell*'



AIR CIRCULATION

More realistic: 'The three cell model'

When the Earth rotation and the geography are considered:

$$\vec{a}_r = \vec{a} - 2\vec{\Omega} \times \vec{u} - \vec{\Omega} \times \left(\vec{\Omega} \times \vec{r}\right)$$

$$\frac{D\vec{u}}{Dt} + \frac{1}{\rho}\vec{\nabla}p + 2\vec{\Omega} \times \vec{u} + \vec{\Omega} \times \left(\vec{\Omega} \times \vec{r}\right) = \vec{F}$$

$$\frac{1}{\rho}\,\vec{\nabla}p \,+\, 2\,\vec{\Omega} \times \vec{u} = 0$$

And geostrophic approximation:

- small accelerations
- slow rotation
- negligible friction

AIR CIRCULATION

More realistic: 'The three cell model'

$$\frac{1}{\rho}\vec{\nabla}p + 2\,\vec{\Omega}\times\vec{u} = 0$$

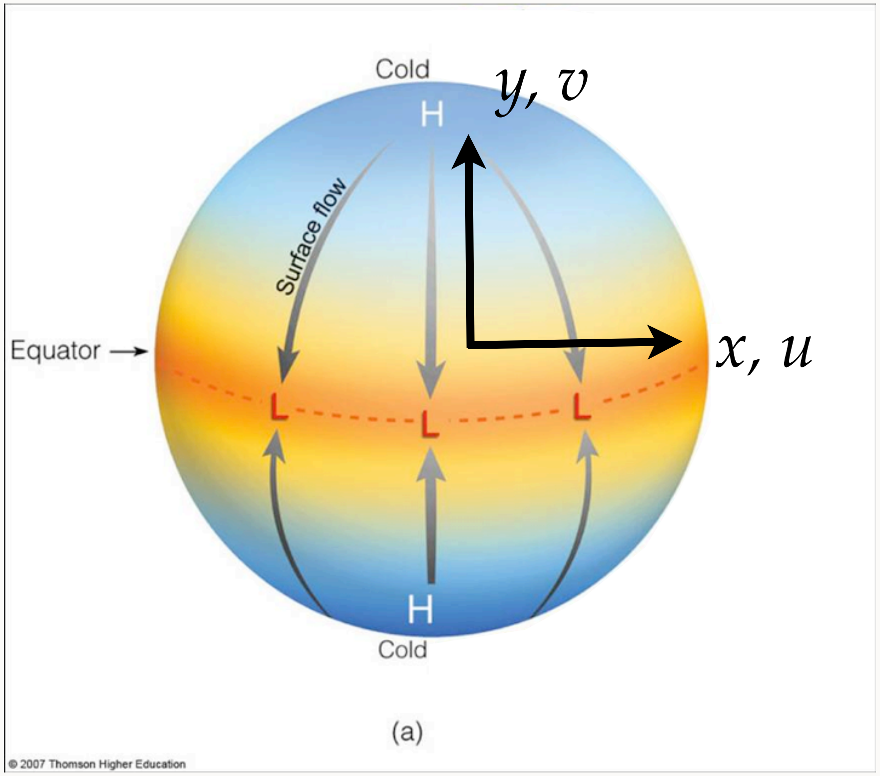
$$\frac{1}{\rho}\frac{\partial p}{\partial x} - v\,2\Omega\sin\phi \;=\; 0$$

$$\frac{1}{\rho}\frac{\partial p}{\partial y} + u\,2\Omega\sin\phi \;=\; 0$$

north and east-ward winds are:

$$v = \frac{1}{2\rho\Omega\sin\phi}\,\frac{\partial p}{\partial x}$$

$$u = -\frac{1}{2\rho\Omega\sin\phi}\,\frac{\partial p}{\partial y}$$

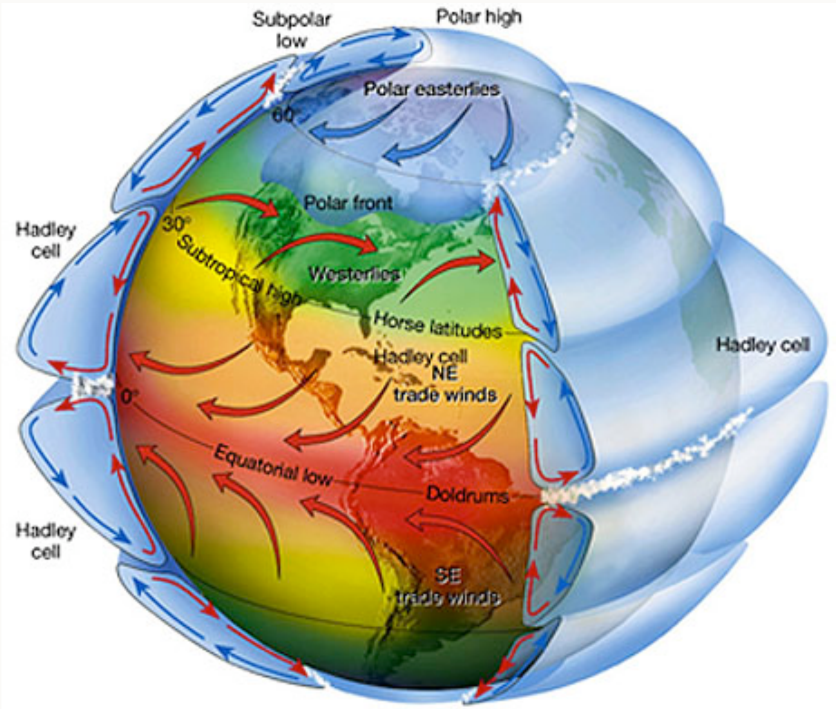


AIR CIRCULATION

More realistic: 'The three cell model'

$$v = \frac{1}{2\rho\Omega \sin\phi} \frac{\partial p}{\partial x}$$

$$u = -\frac{1}{2\rho\Omega \sin\phi} \frac{\partial p}{\partial y}$$



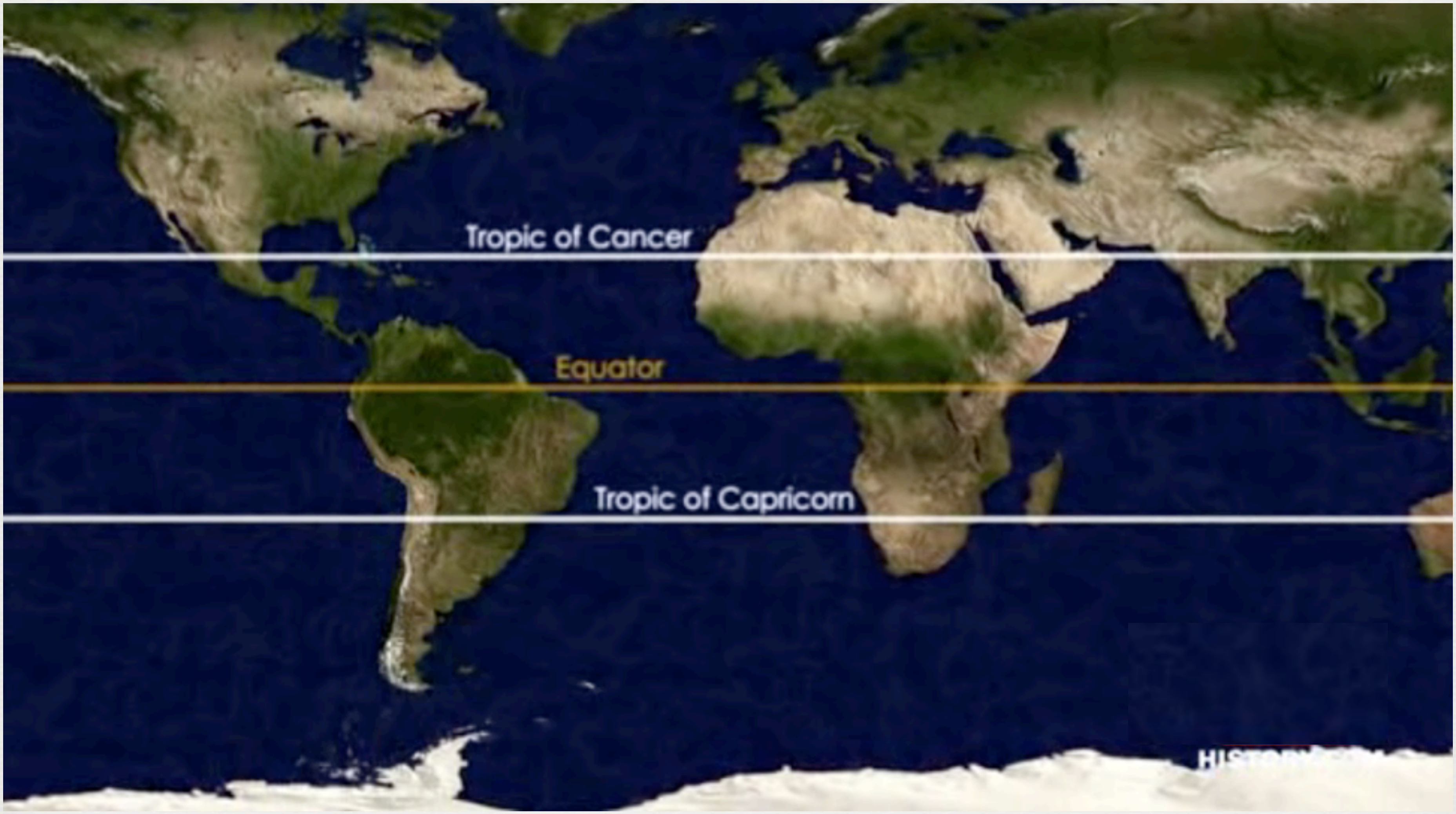
below the equator:

$\sin\phi < 0$

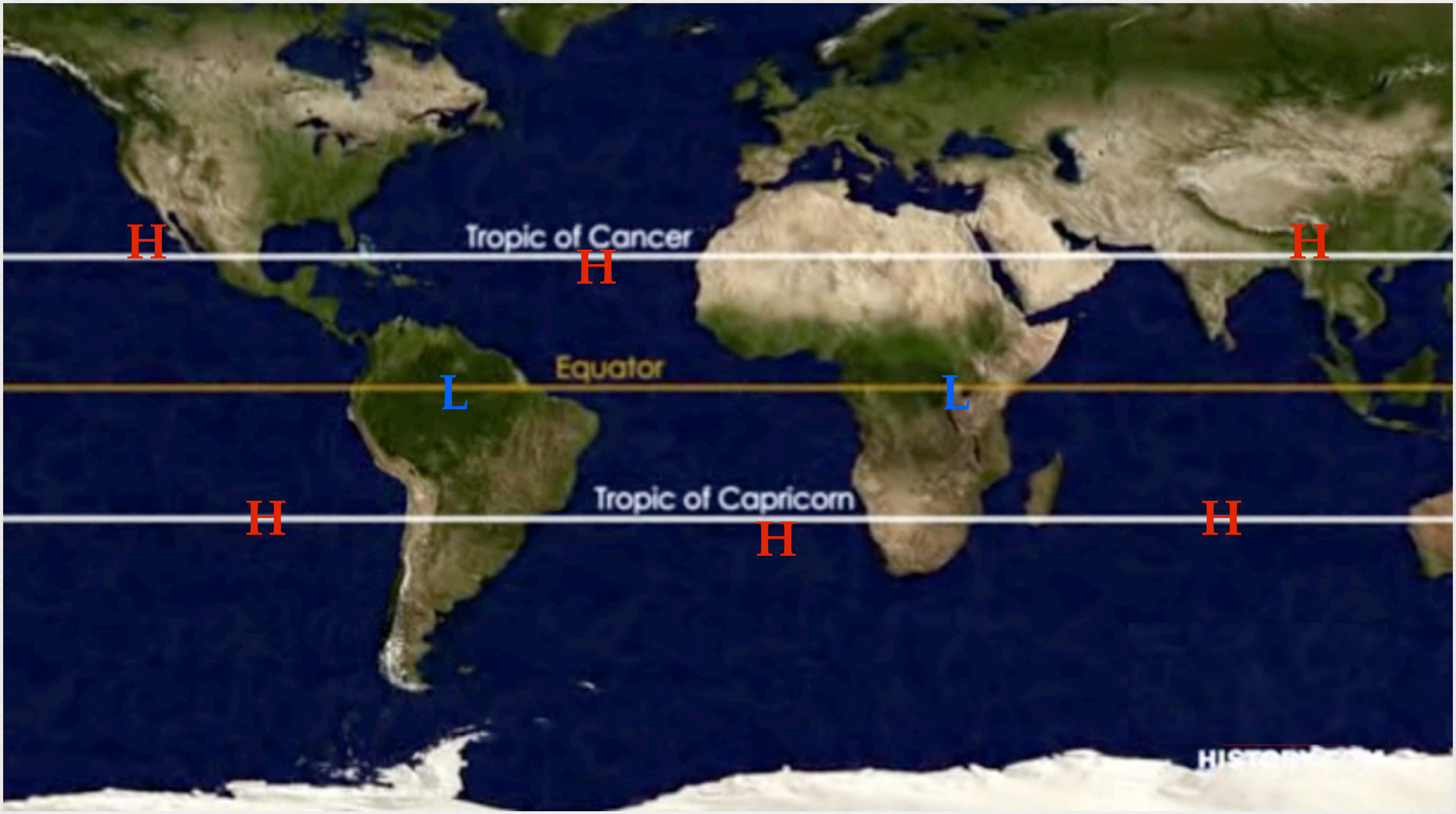
pressure increases to the pole

$\Rightarrow u < 0$

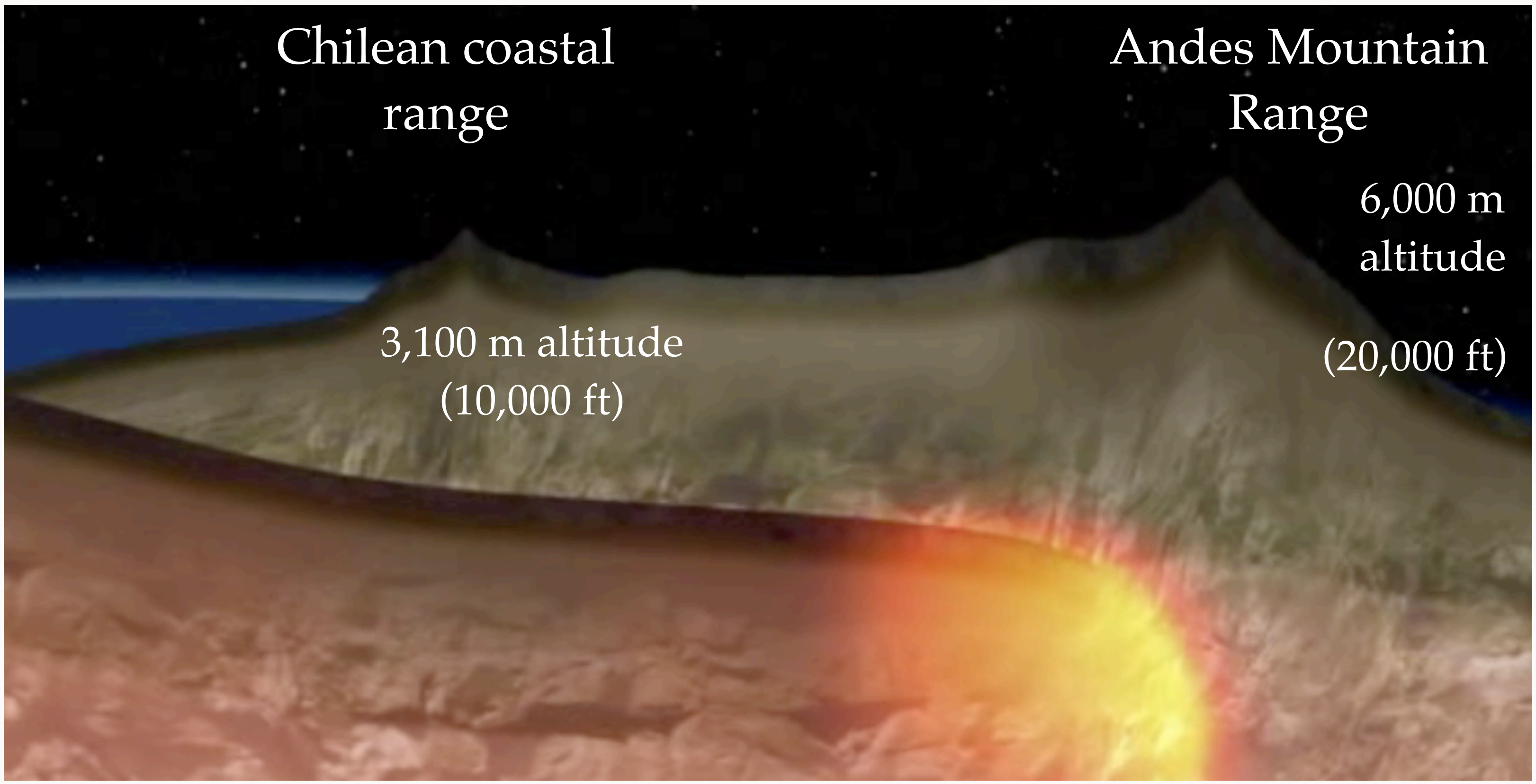
Moist air rises from the Equator, while dry air sinks in the tropics.



The deserts on Earth are located in the tropics



Geography of the Atacama desert:



HUMBOLDT CURRENT

The Coriolis effect and geography determines the direction of the rotation of currents:

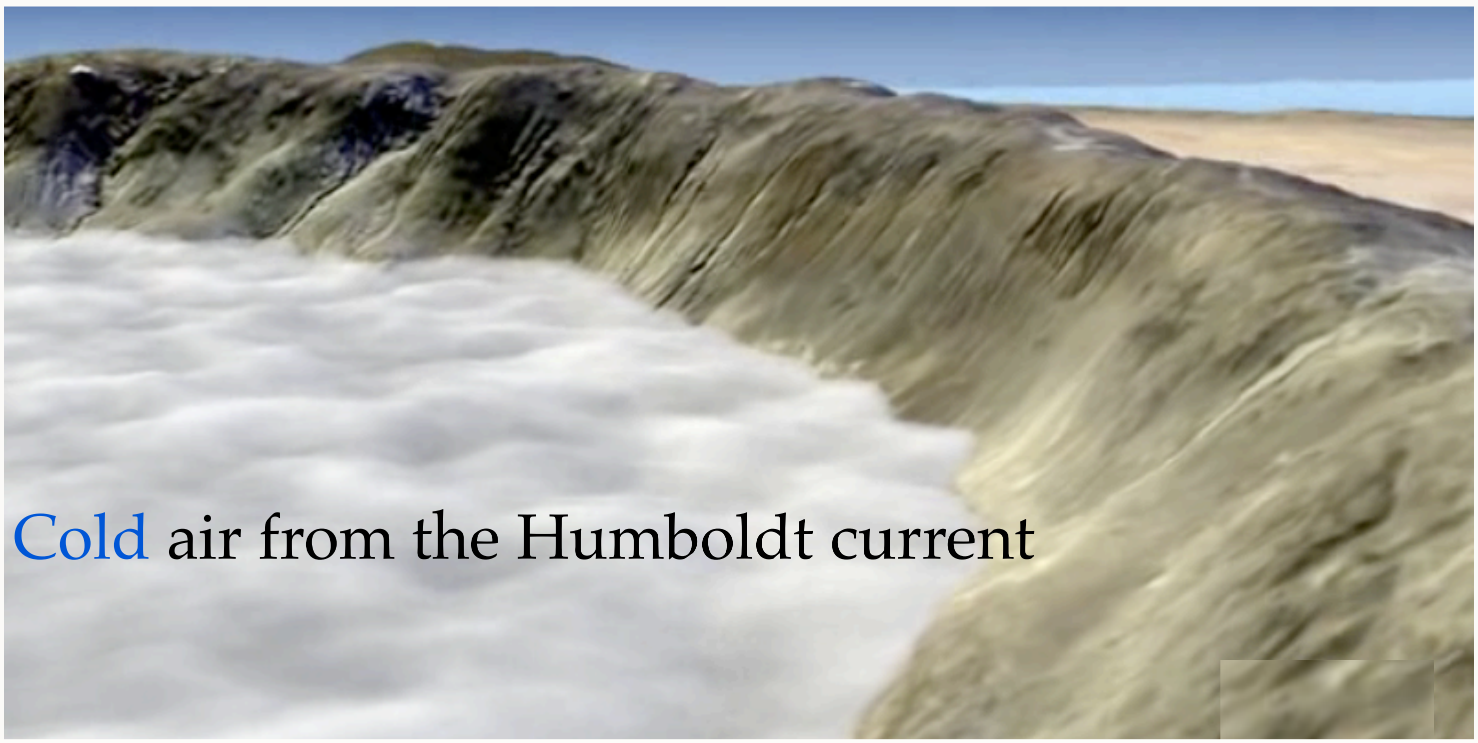
$$v = \frac{1}{2\rho\Omega\sin\phi}\frac{\partial p}{\partial x}$$

$$u = -\frac{1}{2\rho\Omega\sin\phi}\frac{\partial p}{\partial y}$$

From the West, the Humboldt current bring cold water to the coast.

An inversion layer prevents the moist air circulate into the continent.

Hot air from the Hadley cell

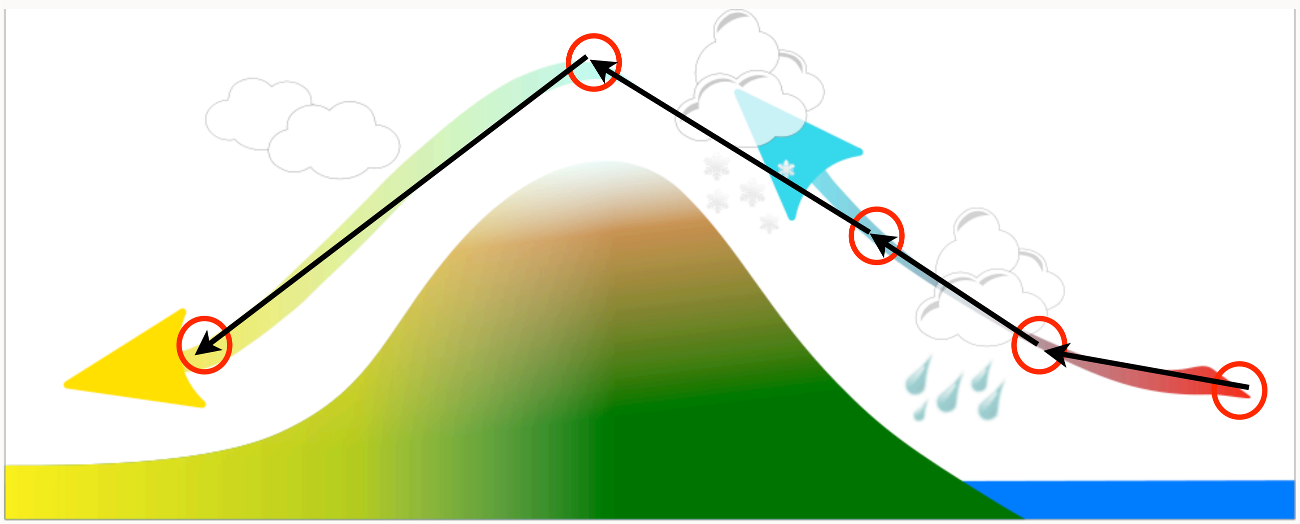


RAIN SHADOW

The Andes mountain range prevents of moisture from the East.

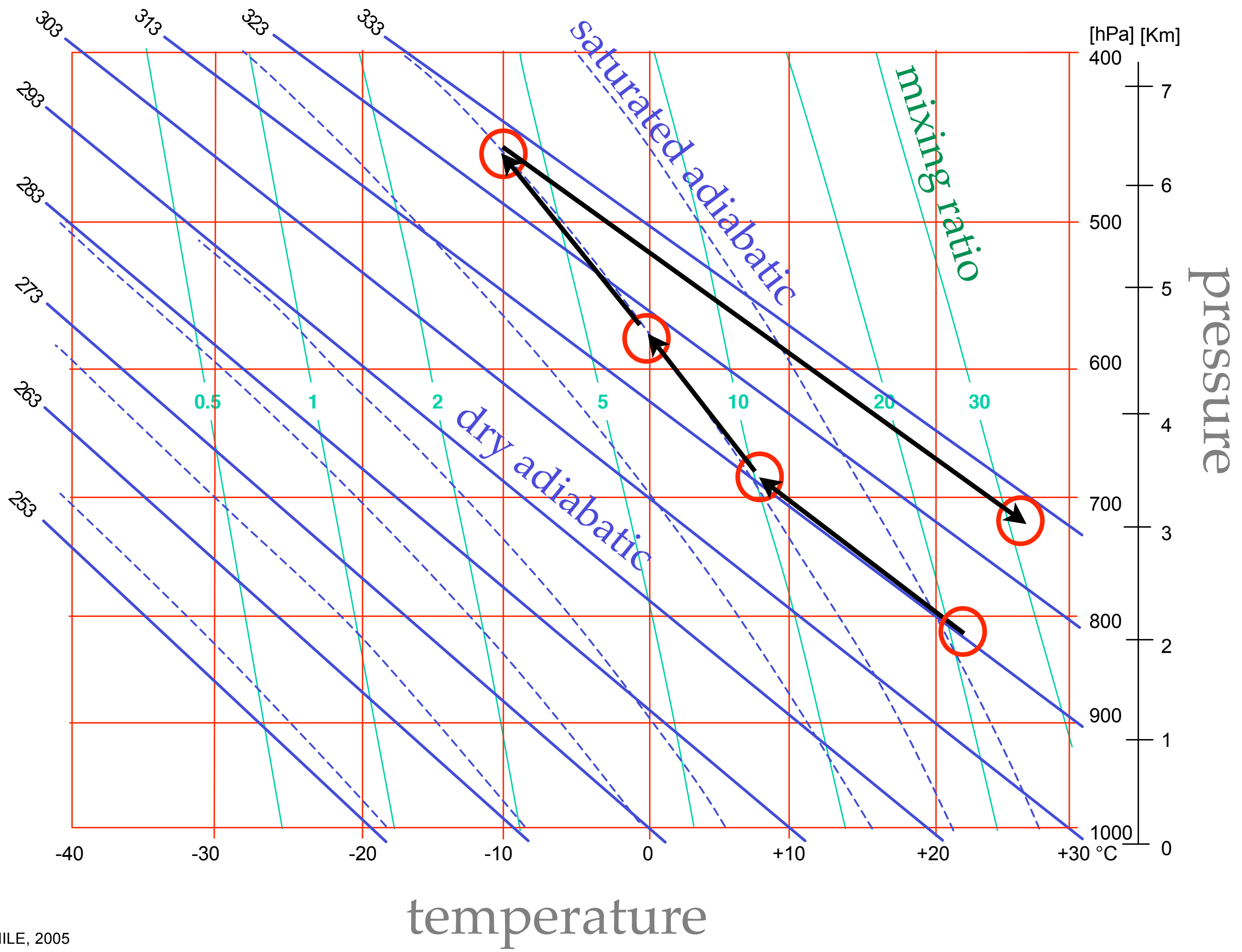
Keep in mind: the relative humidity:

$$\mathrm{RH} = \frac{\mu}{\mu_s}$$



let's follow a parcel with an initial mixing ratio of 10 g/kg in Argentina.

Tephigram


303
313
323
333
293
283
273
263
253
saturated adiabatic
mixing ratio
dry adiabatic
0.5
1
2
5
10
20
30
[hPa] [Km]
400
500
600
700
800
900
1000
7
6
5
4
3
2
1
0
pressure
-40
-30
-20
-10
0
+10
+20
+30 °C
temperature

RAIN SHADOW

the saturated mixing ratio at 3 km is about 35 g/kg, while the parcel mixing ratio is ~ 4 g/kg

giving a RH = μ / μ_s = 11%

AS CONSEQUENCE

The Atacama desert is isolated from moisture practically from any front.

Relative humidity is ~10%
360 days of cloud-free skies

+ large distances from populated areas
+ altitudes from 2500^{+} m

makes this place a perfect location to observe the Universe