Universidad Industrial de Santander

GRUPO HALLEY DE ASTRONOMÍA Y CIENCIAS AEROESPACIALES

Astronomía Planetaria

Clase 16 – Formación Sistema Solar

Mauricio Suárez Durán

Escuela de Física
Grupo Halley de Astronomía y Ciencias Aeroespaciales
Universidad Industrial de Santander

Bucaramanga, II semestre de 2013

Avisos varios

- Martes 04 de marzo:
  - Charla: Nuevas formas de hacer conocimiento.
- Jueves 06 de marzo:
  - Taller Nightshade. CENTIC sala 3-5.
- Jueves 13 de marzo:
  - Primera entrega del script.

Avisos varios

- Viernes 14 de marzo (12-12):
  - Segundo previo. Mecánica Celeste, Instrumentación y Sistemas planetarios.

- Viernes 04 de abril (12-12):
  - Tercer previo. Medio Interestelar, Estrellas y Galaxias.

- Martes 22 de abril:
  - Entrega final.

Avisos varios

- Martes 11 de marzo:
  - Segundo previo. Mecánica Celeste, Instrumentación y Sistemas planetario

- Martes 01 de abril:
  - Tercer previo. Medic

- Martes 22 de abril:
  - Entrega final.

Avisos varios

- Viernes 14 de marzo (12-12):
  - Segundo previo. Mecánica Celeste, Instrumentación y Sistemas planetarios.

- Viernes 04 de abril (12-12):
  - Tercer previo. Medio Interestelar, Estrellas y Galaxias.

- Martes 22 de abril:
  - Entrega final.

Los objetivos para hoy

- Describir los diferentes tipos de atmósfera presente en el Sistema Solar.

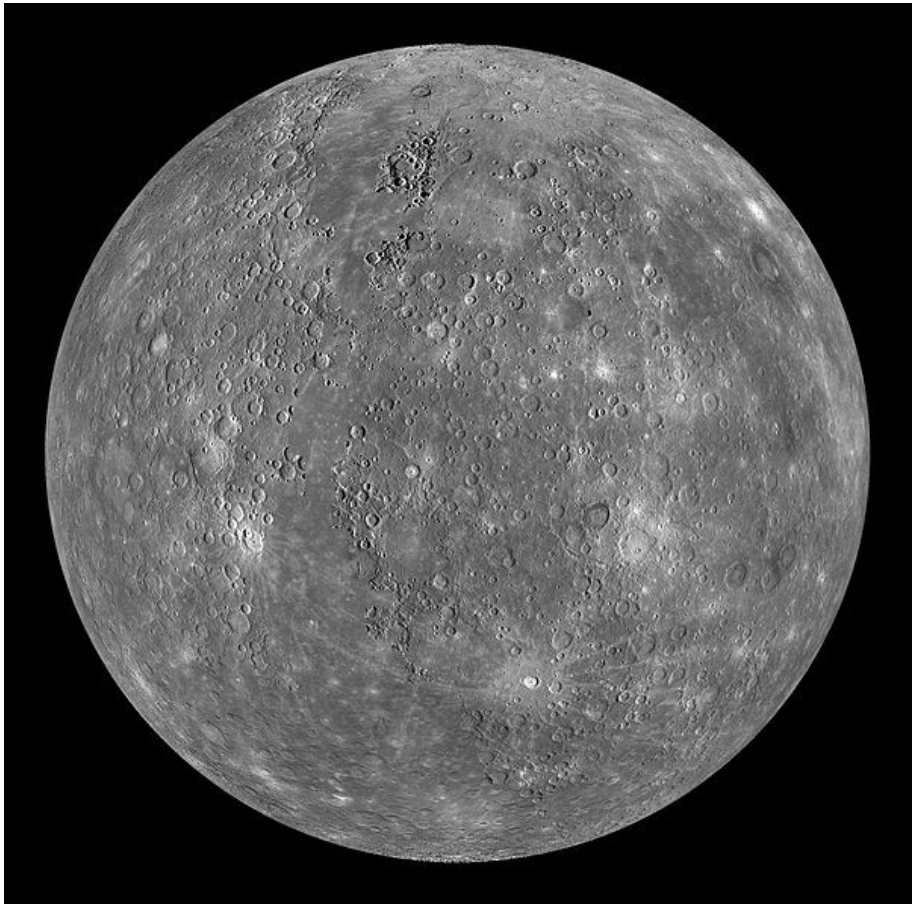
- Describir los teorías actuales de formación de sistemas planetarios.

Atmósferas planetarias

- La atmósfera de un planeta se define como el conjunto de gases que se mantiene en orbita respecto de un planeta.

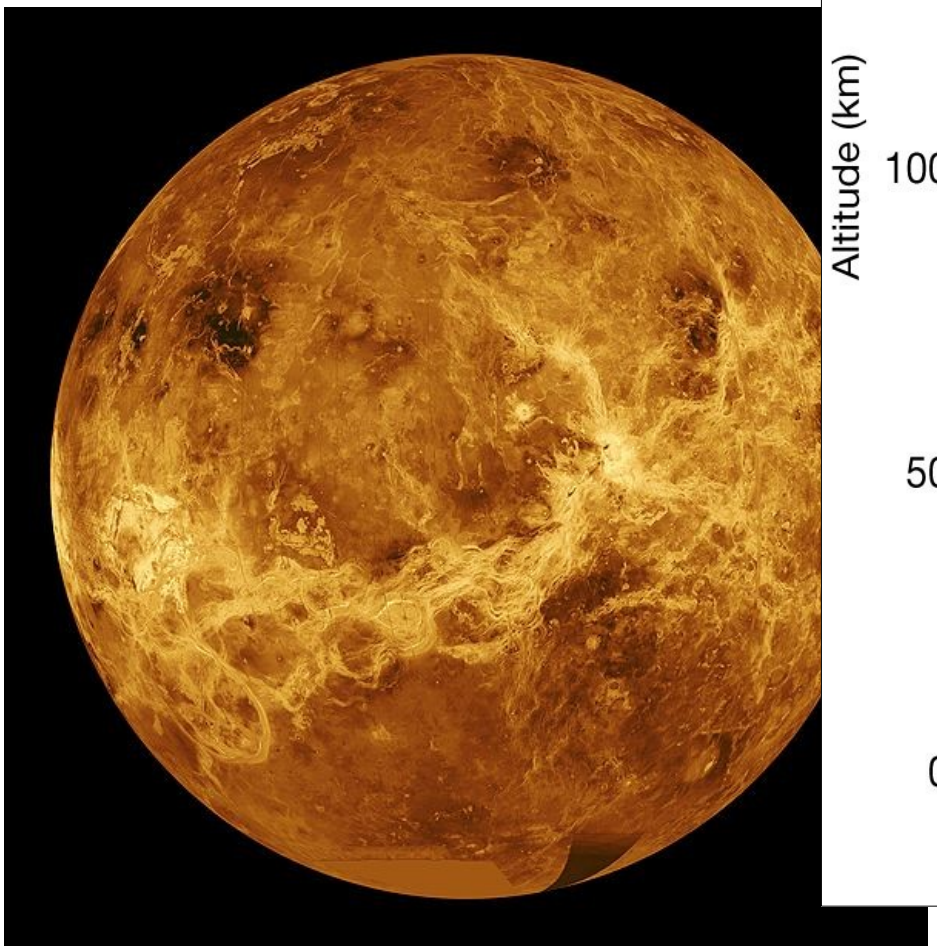
Mercurio

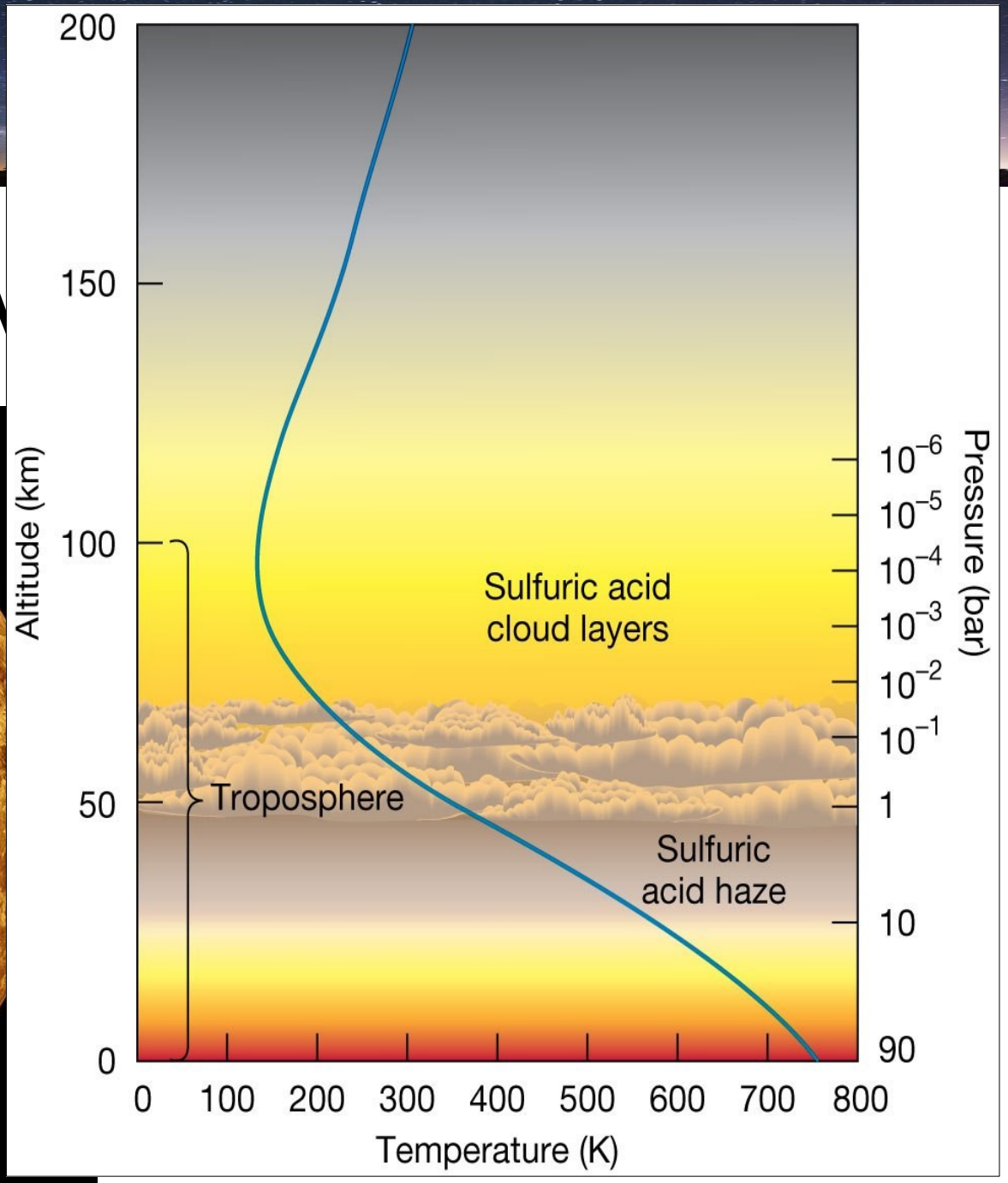
- Casi vacío
  - O_2: 42%
  - Na: 29%
  - H_2: 22%
  - He: 6%
  - K:0.5%
- Densidad: 5.427 g/cm³



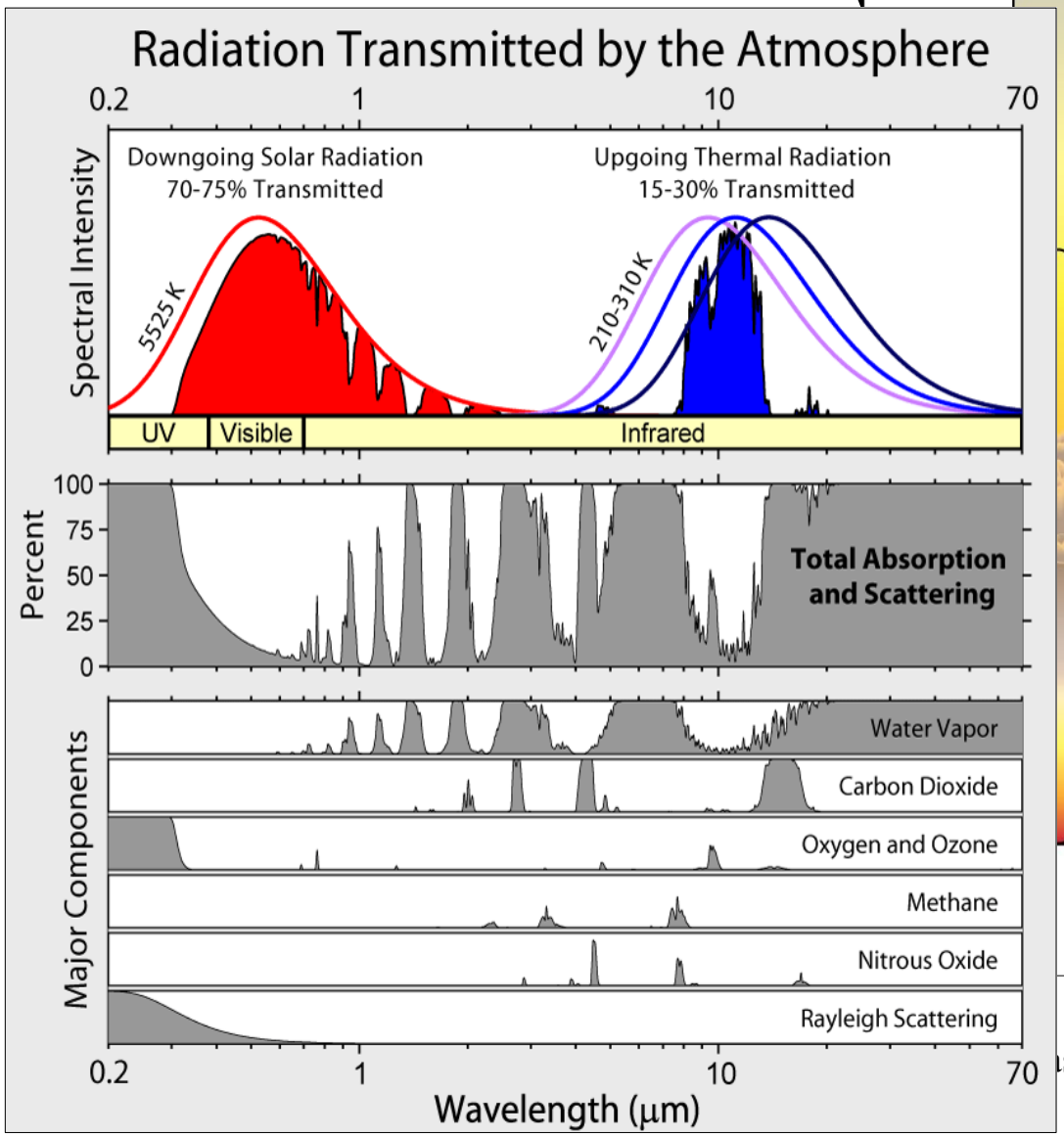
Venus

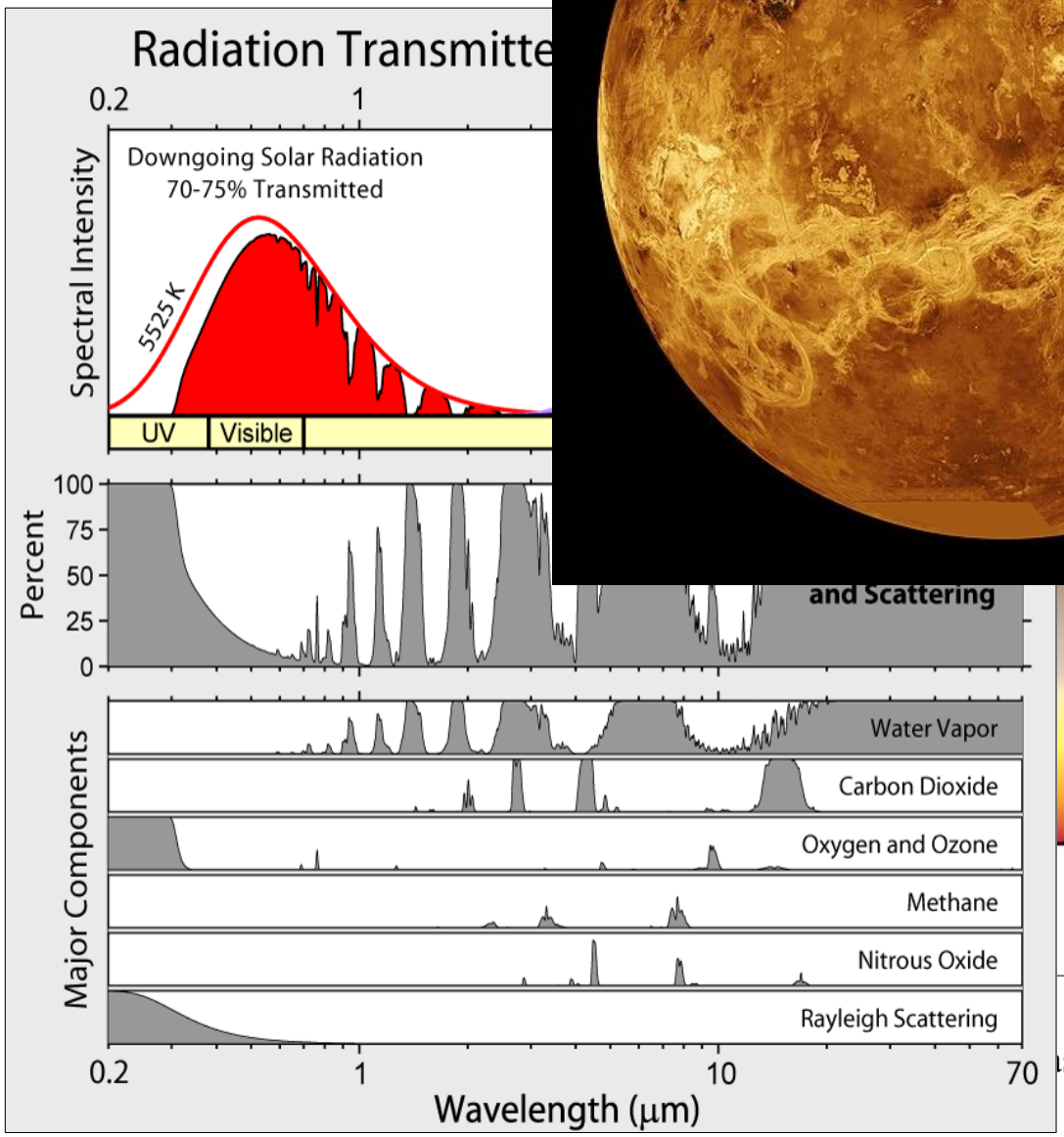
- Composición:
  - CO_2: 96,5%
  - N_2: 3,5%
- Densidad: 5.243 g/cm³

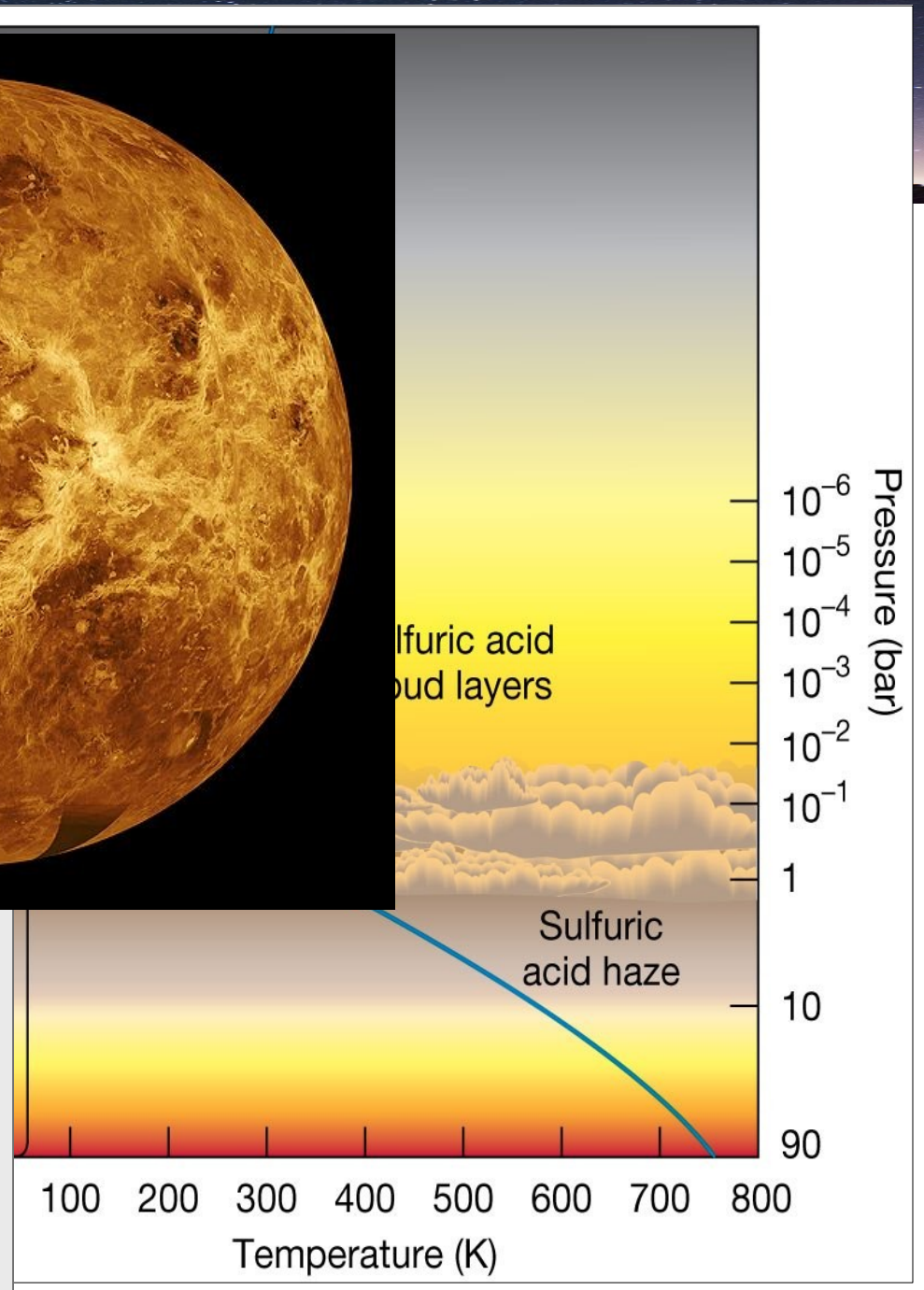



200
150
100
50
0
Altitude (km)
Sulfuric acid
cloud layers
Troposphere
Sulfuric
acid haze
0
100
200
300
400
500
600
700
800
Temperature (K)
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
90
Pressure (bar)

200
150
Sulfuric acid
cloud layers
Troposphere
Sulfuric
acid haze
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
90
Pressure (bar)
100 200 300 400 500 600 700 800
Temperature (K)

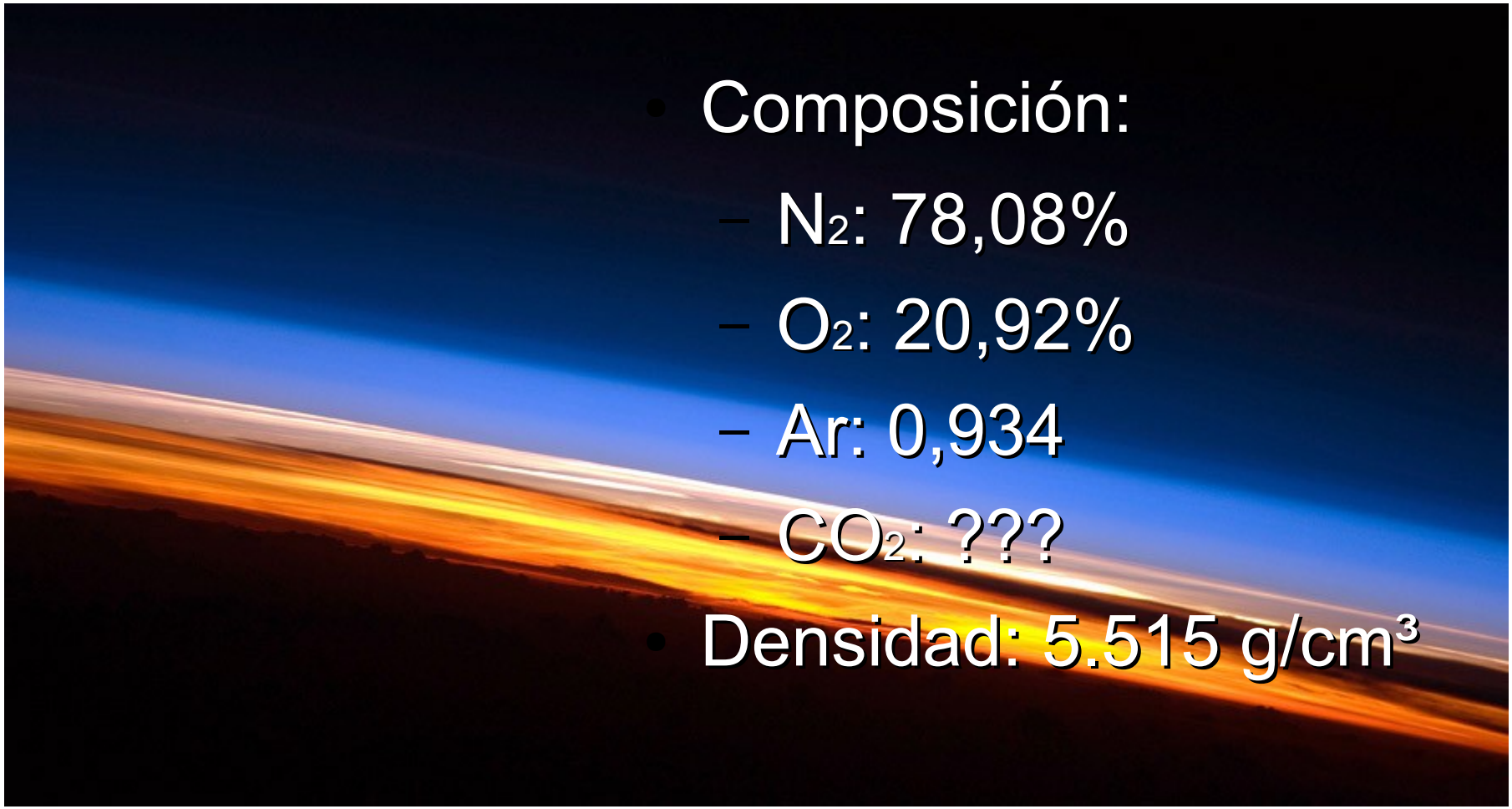

Radiation Transmitted by the Atmosphere
0.2
1
10
70
Spectral Intensity
Downgoing Solar Radiation
70-75% Transmitted
Upgoing Thermal Radiation
15-30% Transmitted
5525 K
210-310 K
UV
Visible
Infrared
Percent
100
75
50
25
0
Total Absorption
and Scattering
Major Components
Water Vapor
Carbon Dioxide
Oxygen and Ozone
Methane
Nitrous Oxide
Rayleigh Scattering
0.2
1
10
70
Wavelength (μm)


Radiation Transmitte
0.2
1
Downgoing Solar Radiation
70-75% Transmitted
Spectral Intensity
5525 K
UV
Visible
Percent
100
75
50
25
0
and Scattering
Major Components
Water Vapor
Carbon Dioxide
Oxygen and Ozone
Methane
Nitrous Oxide
Rayleigh Scattering
0.2
1
10
70
Wavelength (μm)

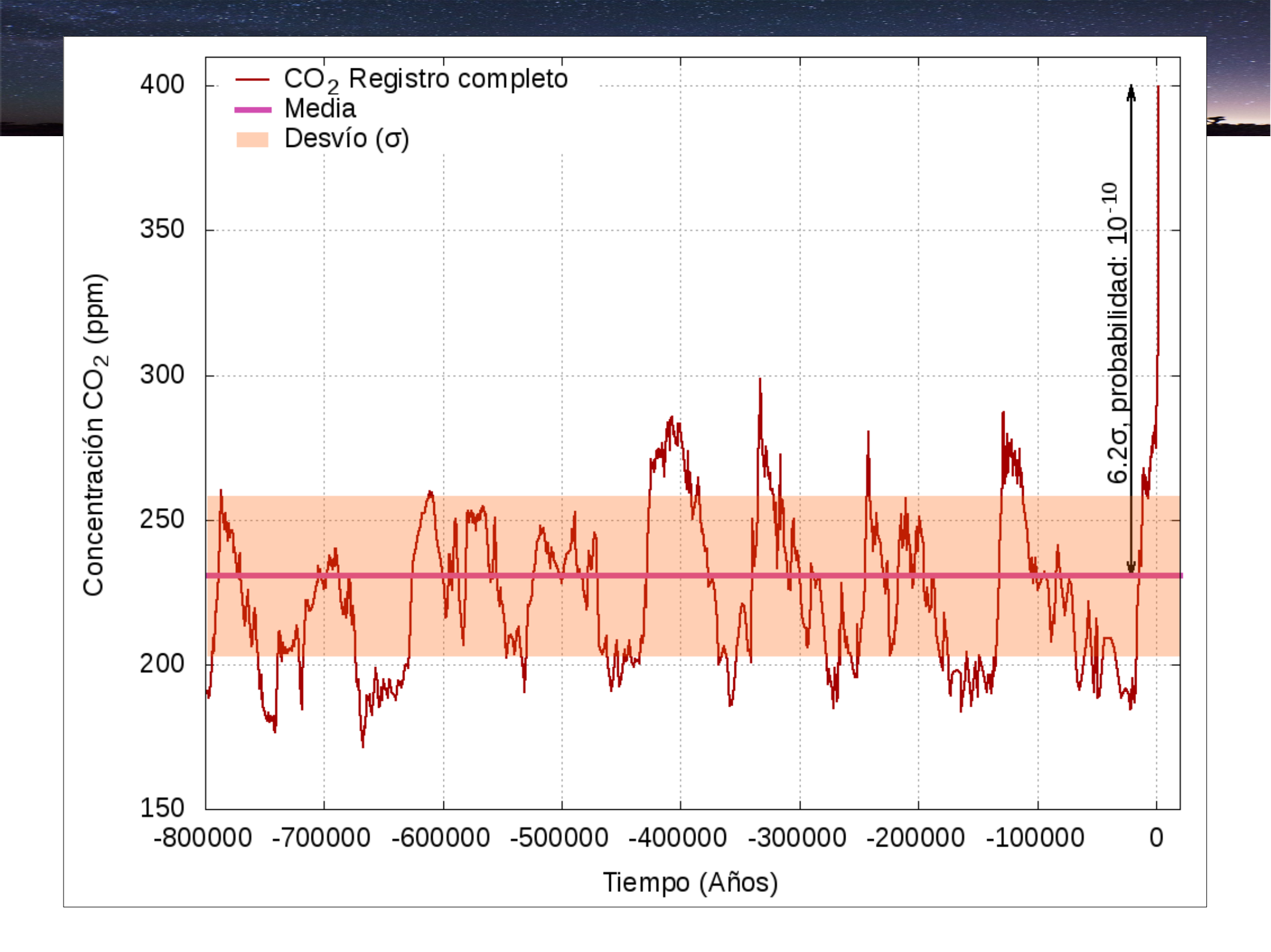

lfuric acid
ud layers
Sulfuric
acid haze
Pressure (bar)
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
90
100
200
300
400
500
600
700
800
Temperature (K)

Tierra

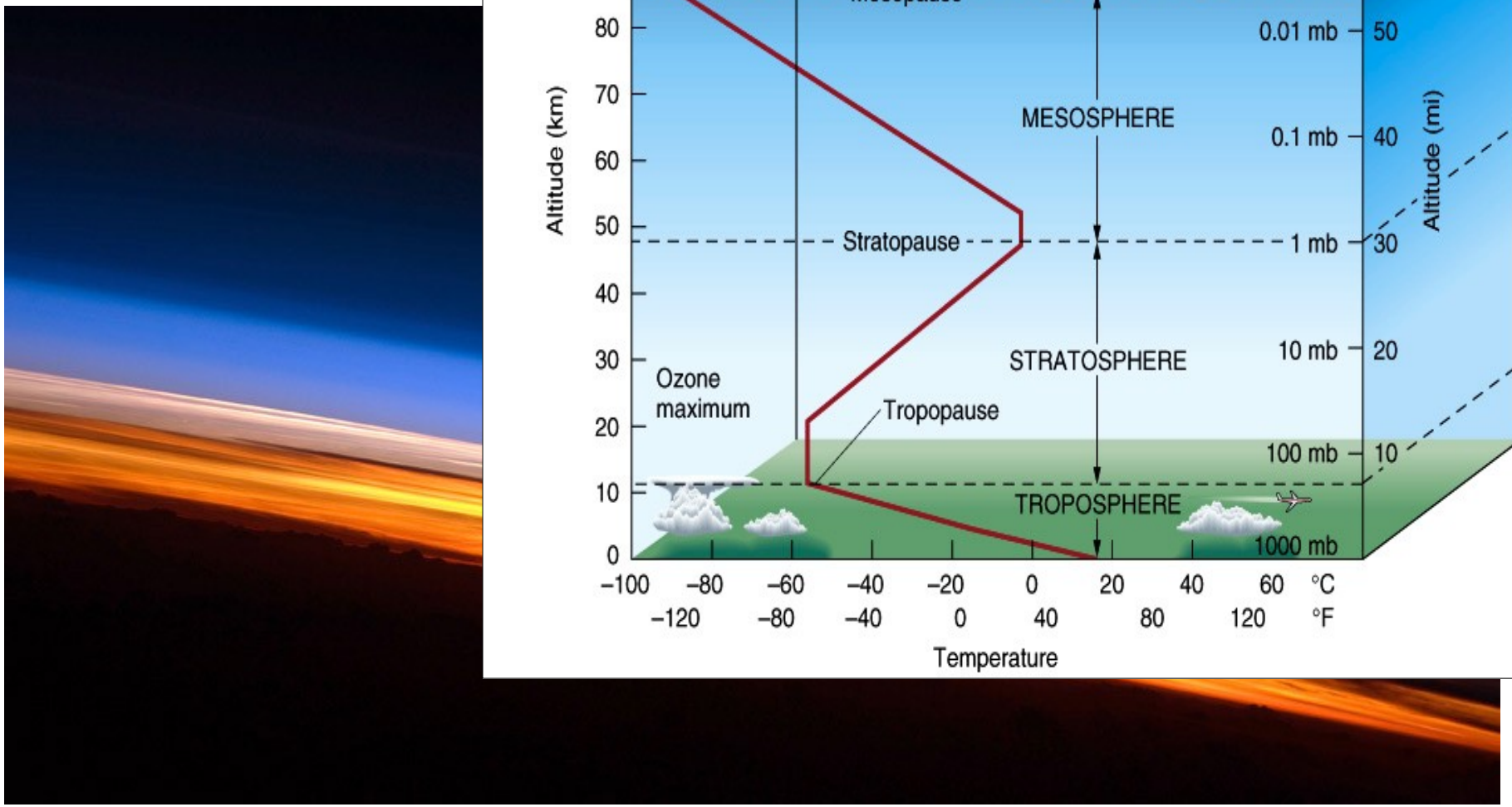
Tierra



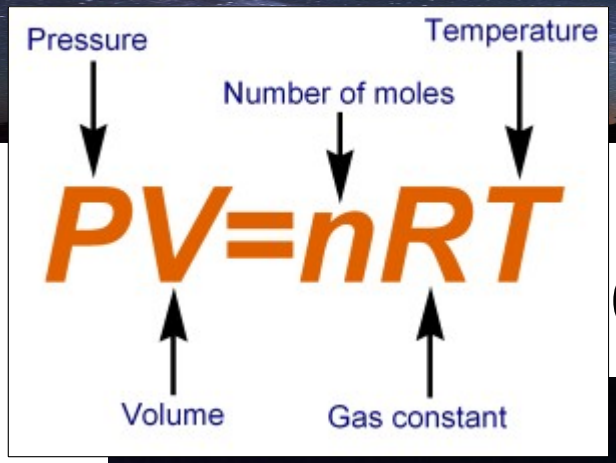
- Composición:
  - N_2: 78,08%
  - O_2: 20,92%
  - Ar: 0,934
  - CO_2: ???
- Densidad: 5.515 g/cm³

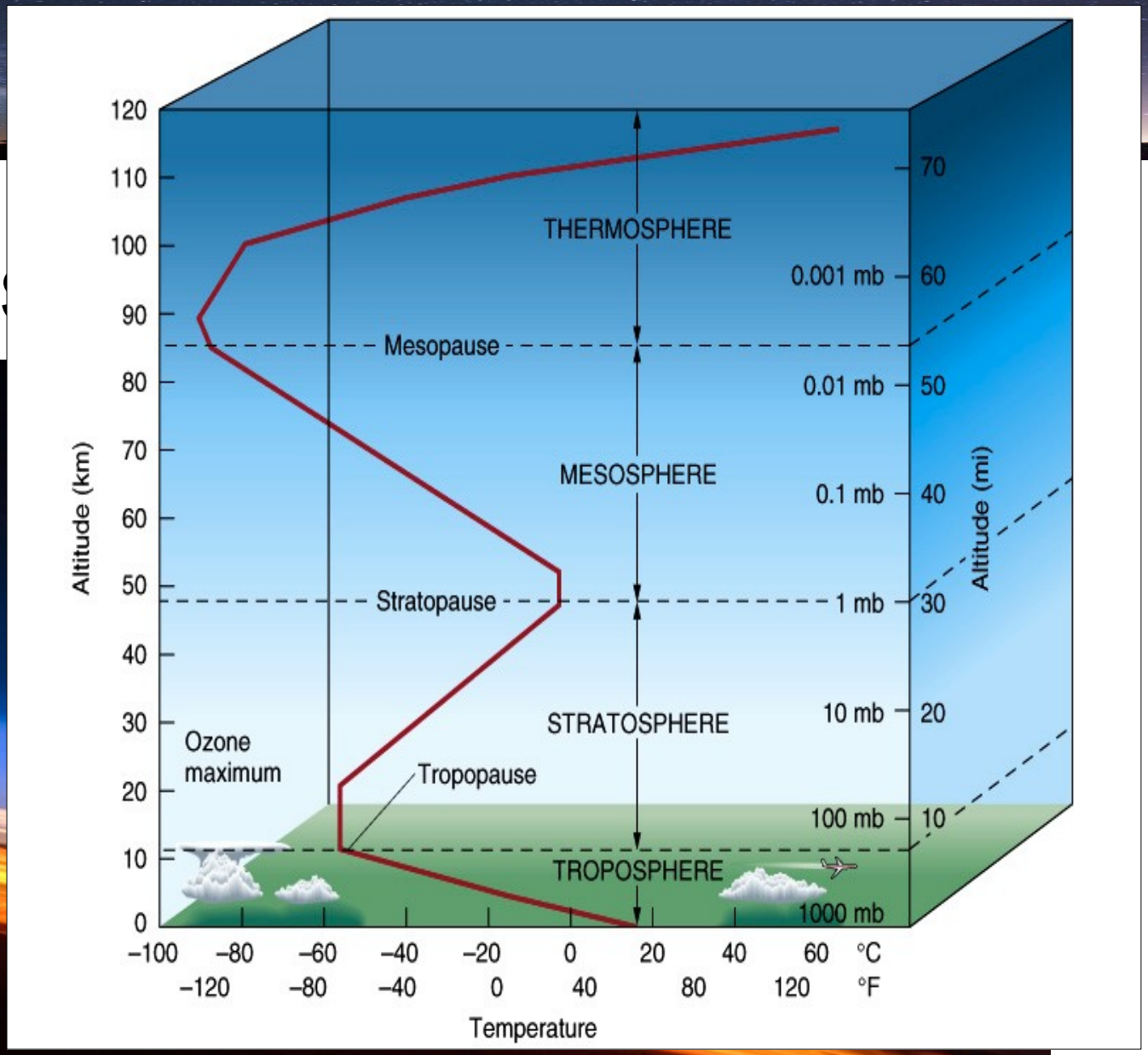

CO_2 Registro completo
Media
Desvío (σ)
400
350
300
250
200
150
Concentración CO_2 (ppm)
-800000
-700000
-600000
-500000
-400000
-300000
-200000
-100000
0
Tiempo (Años)
6.2σ, probabilidad: 10^{-10}

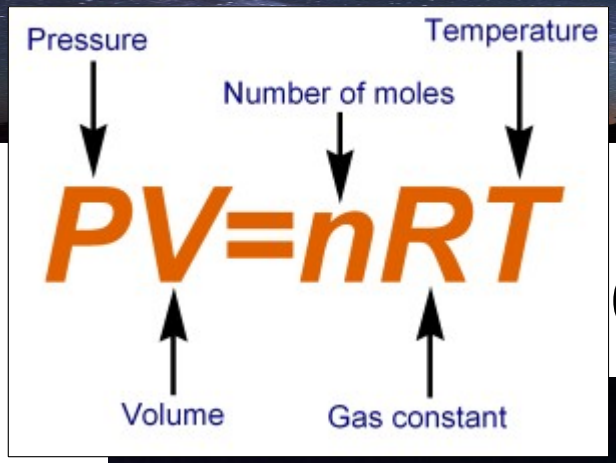
Atmós

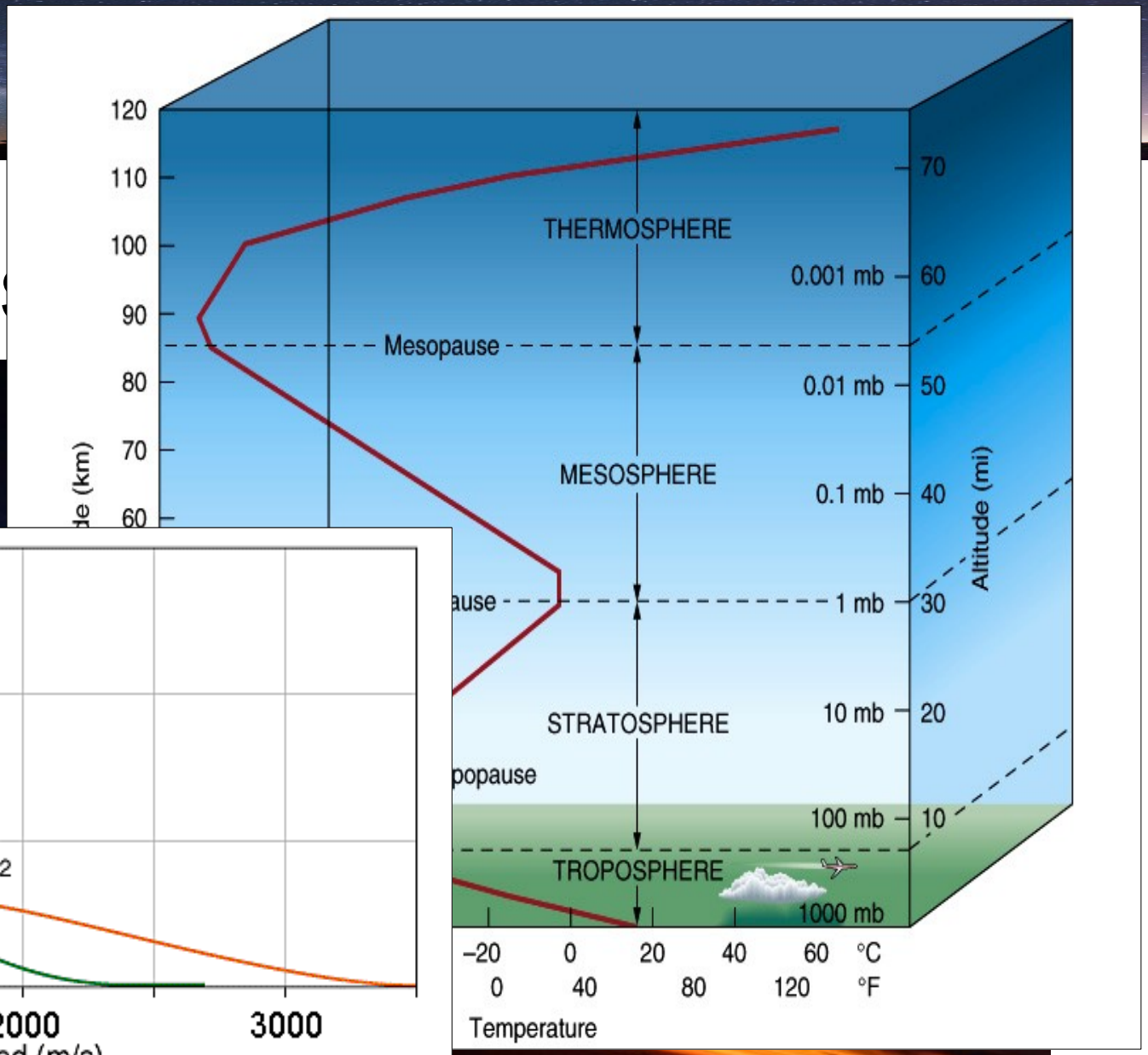


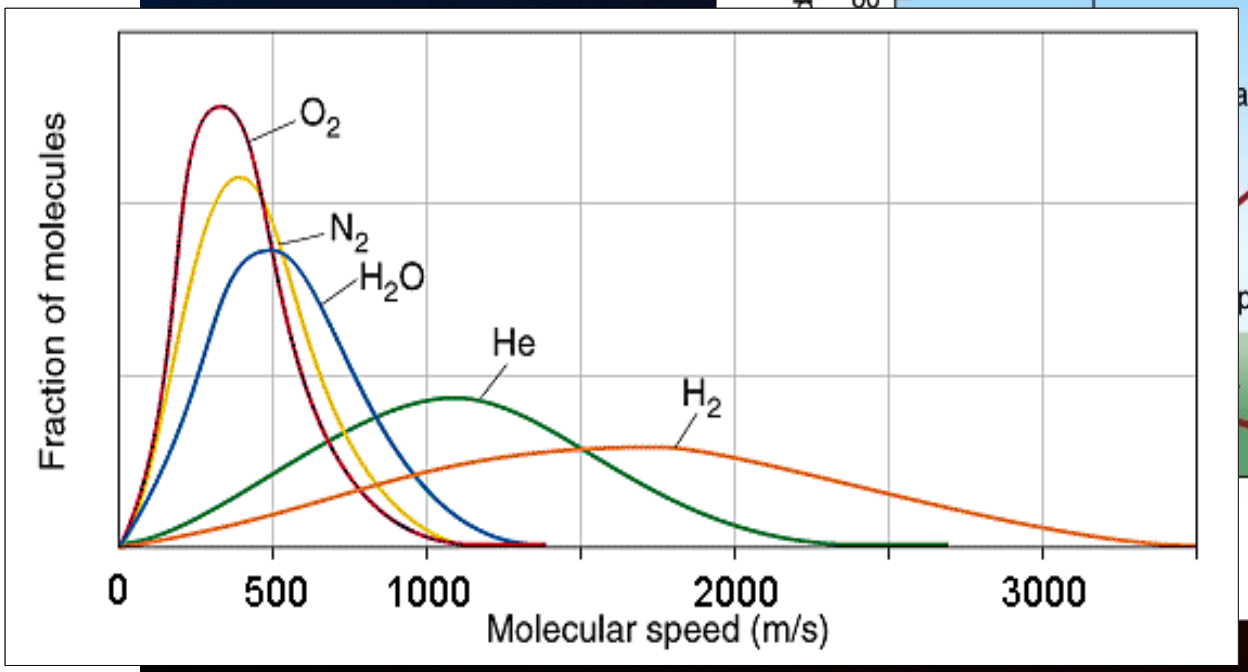
THERMOSPHERE
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
Mesopause
Stratopause
Tropopause
Ozone maximum
0.001 mb
0.01 mb
0.1 mb
1 mb
10 mb
100 mb
1000 mb
Altitude (km)
Altitude (mi)
Temperature
°C
°F

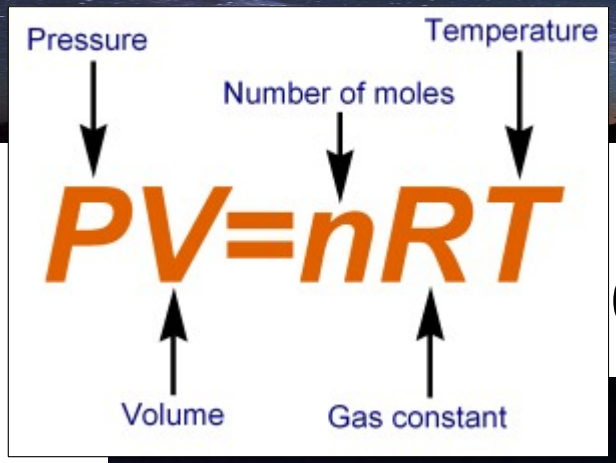

Pressure
Temperature
Number of moles
PV=nRT
Volume
Gas constant

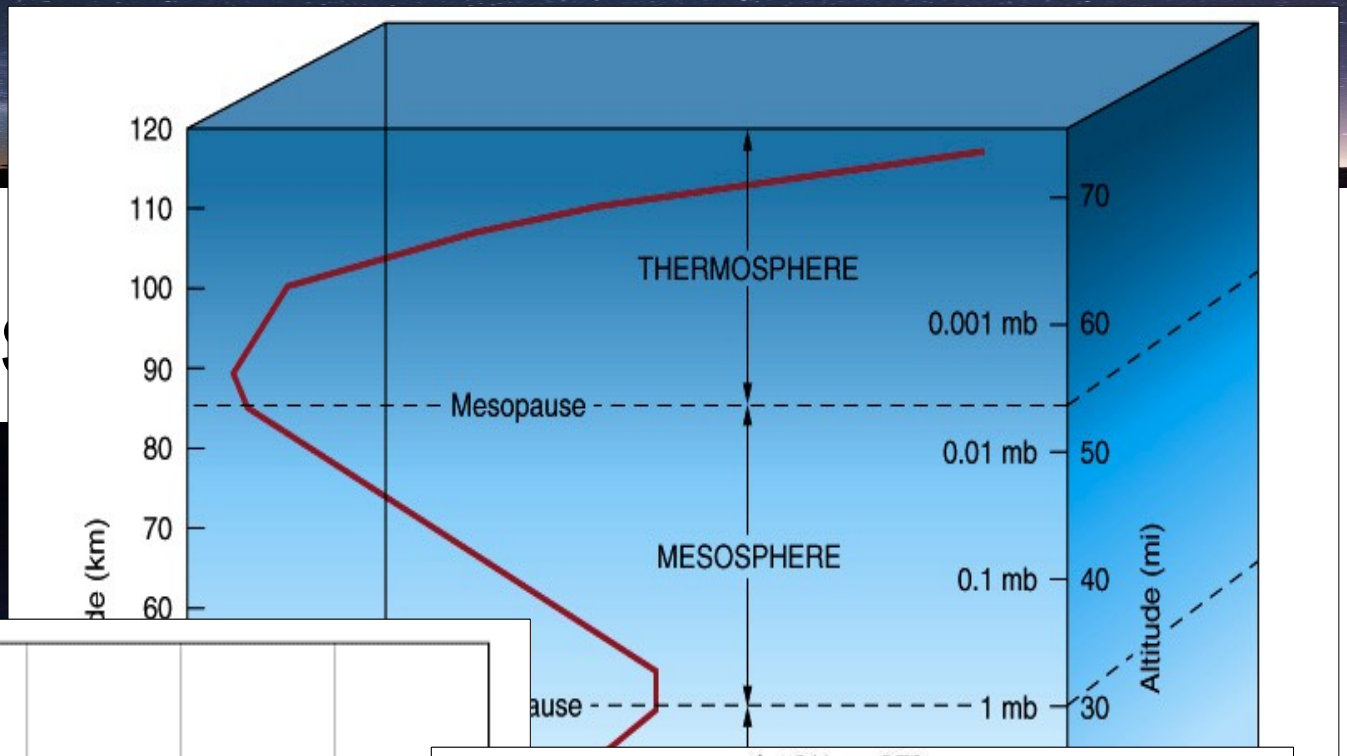

THERMOSPHERE
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
Mesopause
Stratopause
Tropopause
Ozone maximum
0.001 mb
0.01 mb
0.1 mb
1 mb
10 mb
100 mb
1000 mb
Altitude (km)
Altitude (mi)
Temperature
°C
°F

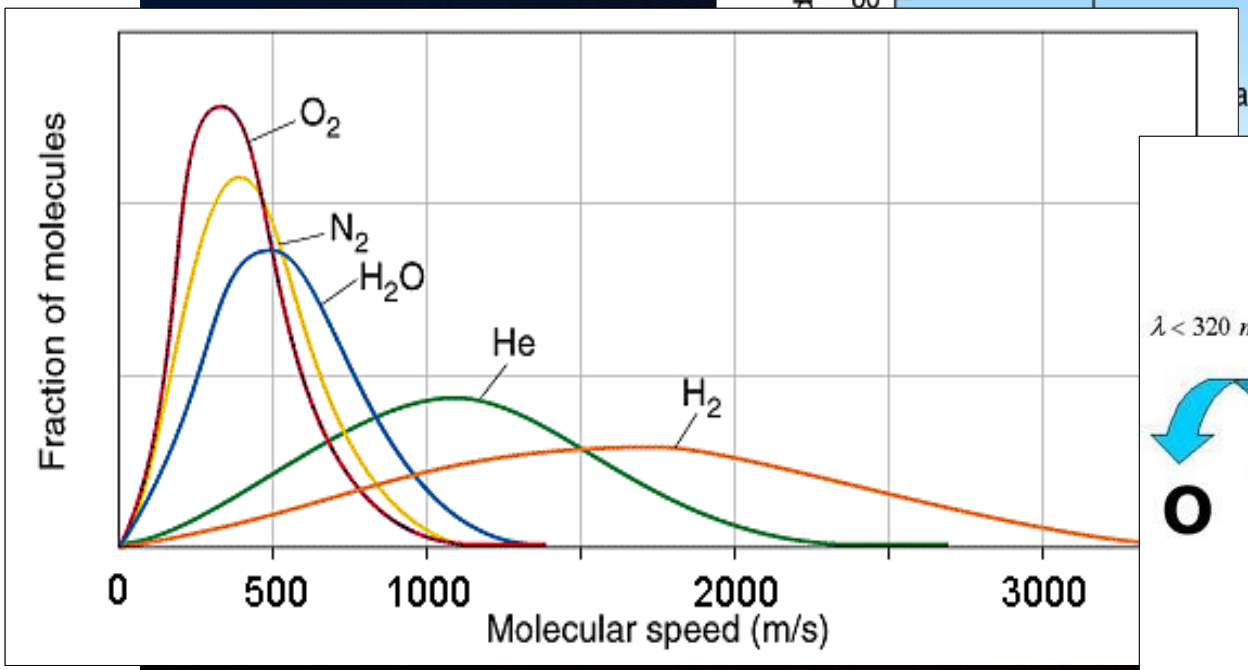

Pressure
Temperature
Number of moles
PV=nRT
Volume
Gas constant

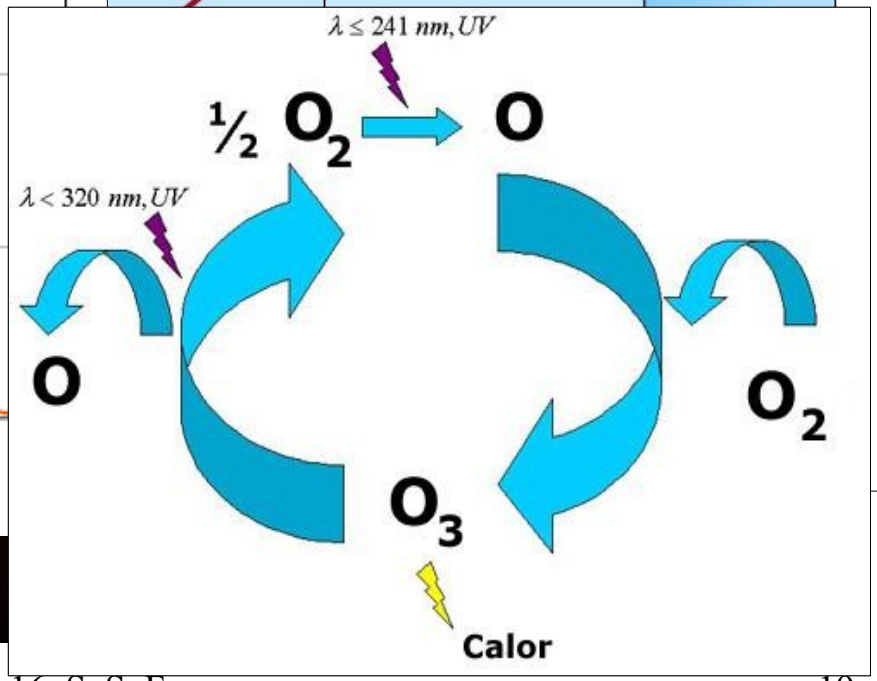

120
110
100
90
80
70
60
THERMOSPHERE
Mesopause
MESOSPHERE
STRATOSPHERE
TROPOSPHERE
0.001 mb
0.01 mb
0.1 mb
1 mb
10 mb
100 mb
1000 mb
70
60
50
40
30
20
10
Altitude (mi)
–20
0
20
40
60
°C
0
40
80
120
°F
Temperature


Fraction of molecules
O_2
N_2
H_2O
He
H_2
0
500
1000
2000
3000
Molecular speed (m/s)

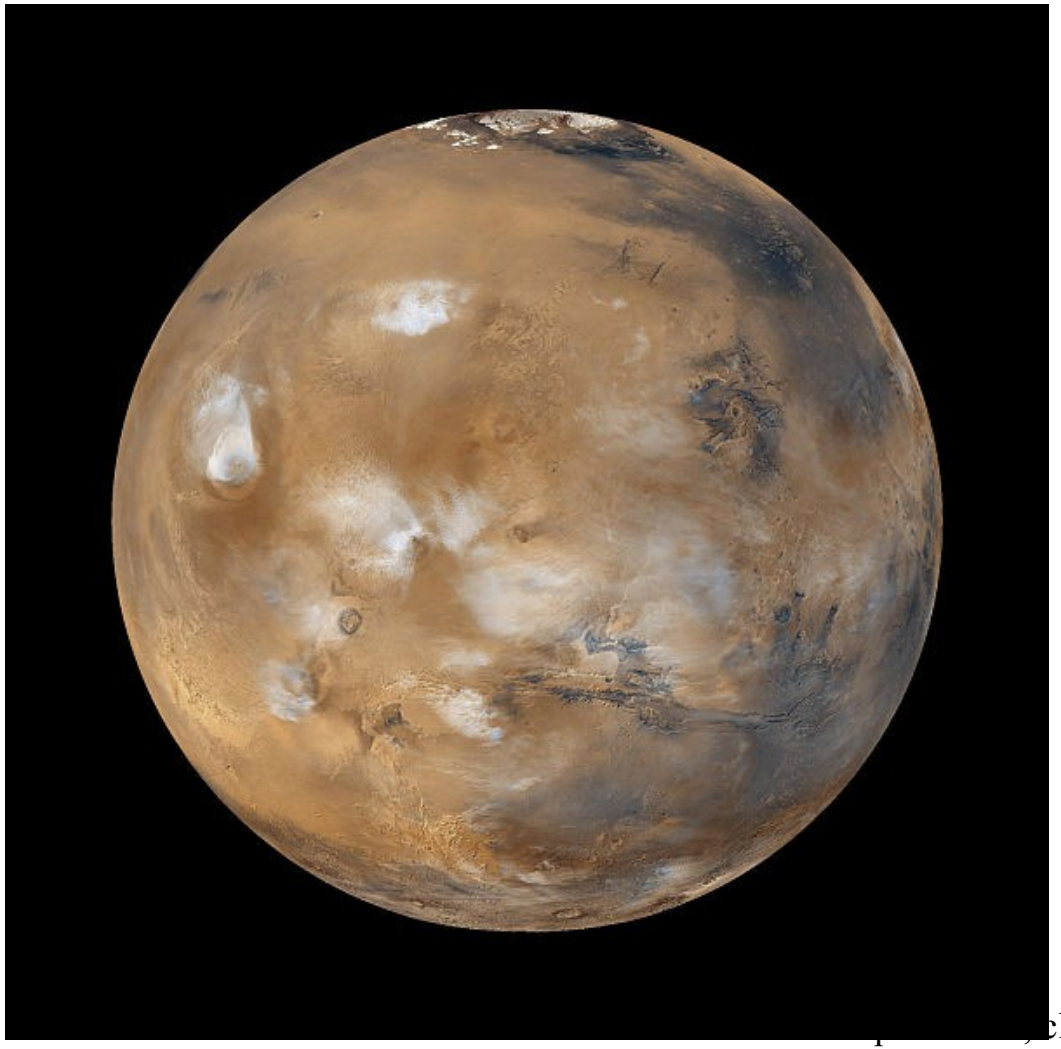

Pressure
Temperature
Number of moles
PV=nRT
Volume
Gas constant


120
110
100
90
80
70
60
THERMOSPHERE
0.001 mb
Mesopause
0.01 mb
MESOSPHERE
0.1 mb
1 mb
70
60
50
40
30
Altitude (mi)

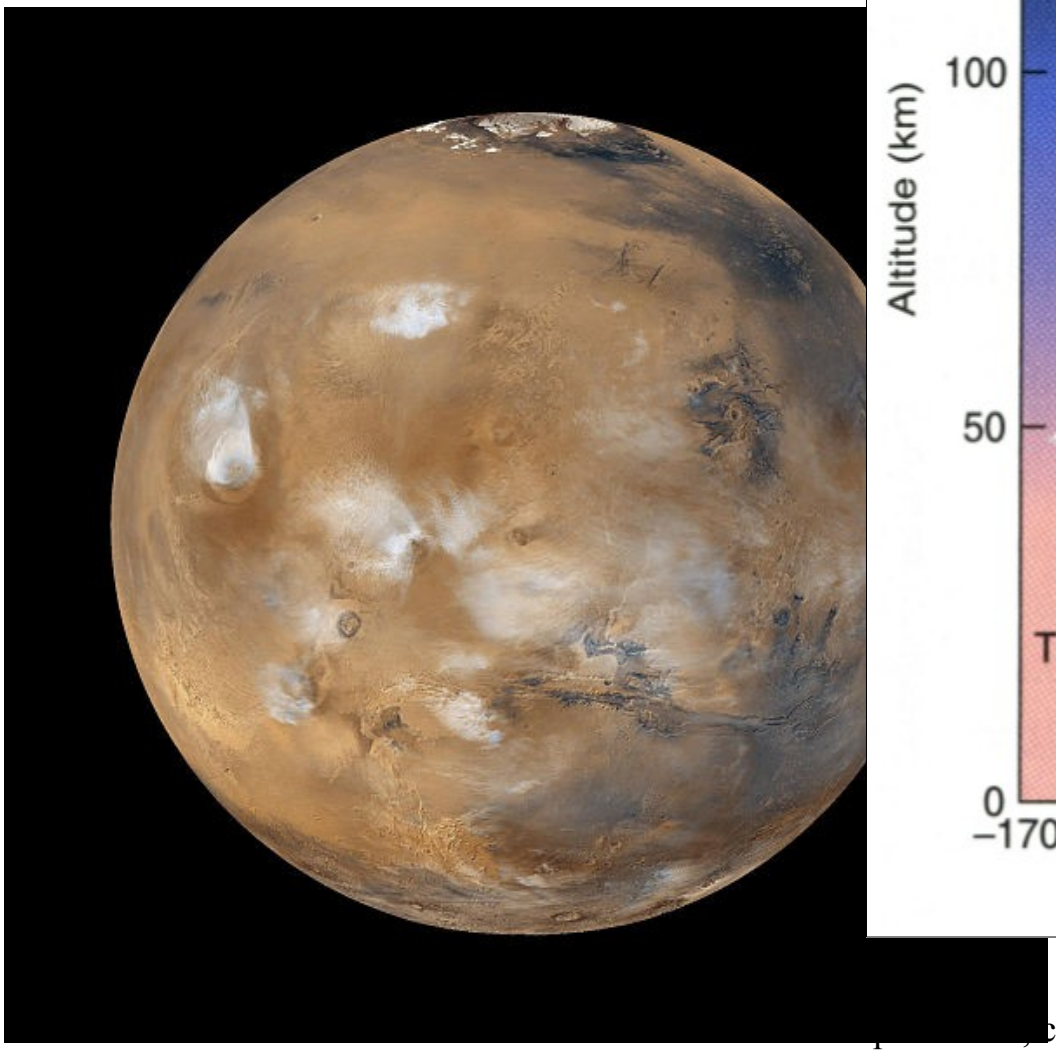

Fraction of molecules
O_2
N_2
H_2O
He
H_2
0
500
1000
2000
3000
Molecular speed (m/s)

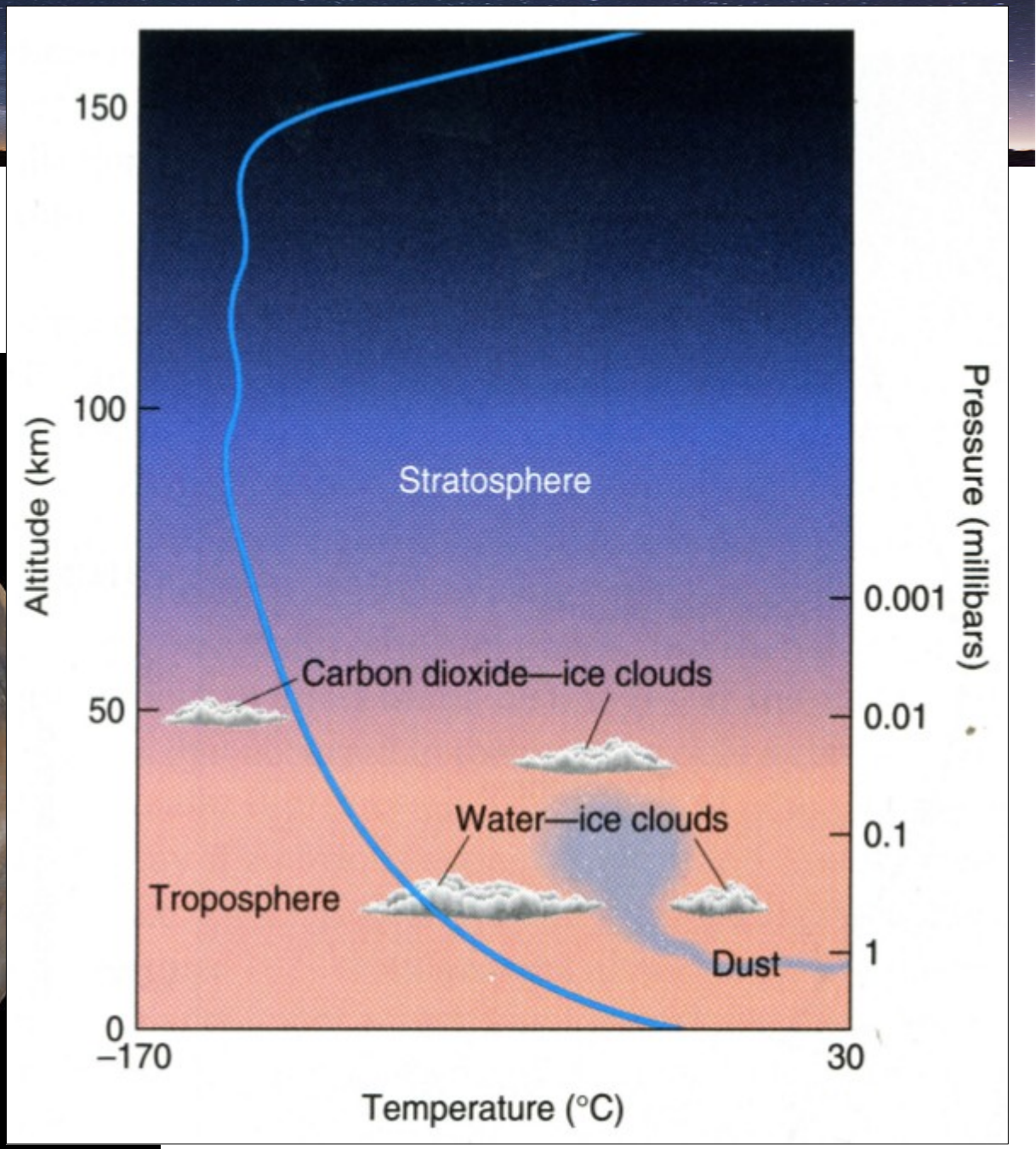

$\lambda \leq 241$ nm, UV
½ O_2
O
$\lambda < 320$ nm, UV
O
O_2
O_3
Calor

Marte



- Composición:
  - CO_2: 95,32%
  - N_2: 2,7%
  - Ar: 1,6%
  - O_2: 0,13%
- Densidad: 3.93 g/cm³




150
100
50
0
Altitude (km)
Stratosphere
Carbon dioxide—ice clouds
Water—ice clouds
Troposphere
Dust
0.001
0.01
0.1
1
Pressure (millibars)
−170
30
Temperature (°C)

Júpiter, Saturno, Urano y Neptuno

Júpiter, Saturno, Urano y Neptuno

- Consultar, para cada uno de estos planetas:
  - Composición atmósferica, densidad, y presión
- Entrega martes 4 de Marzo, vía correo electrónico

Pressure

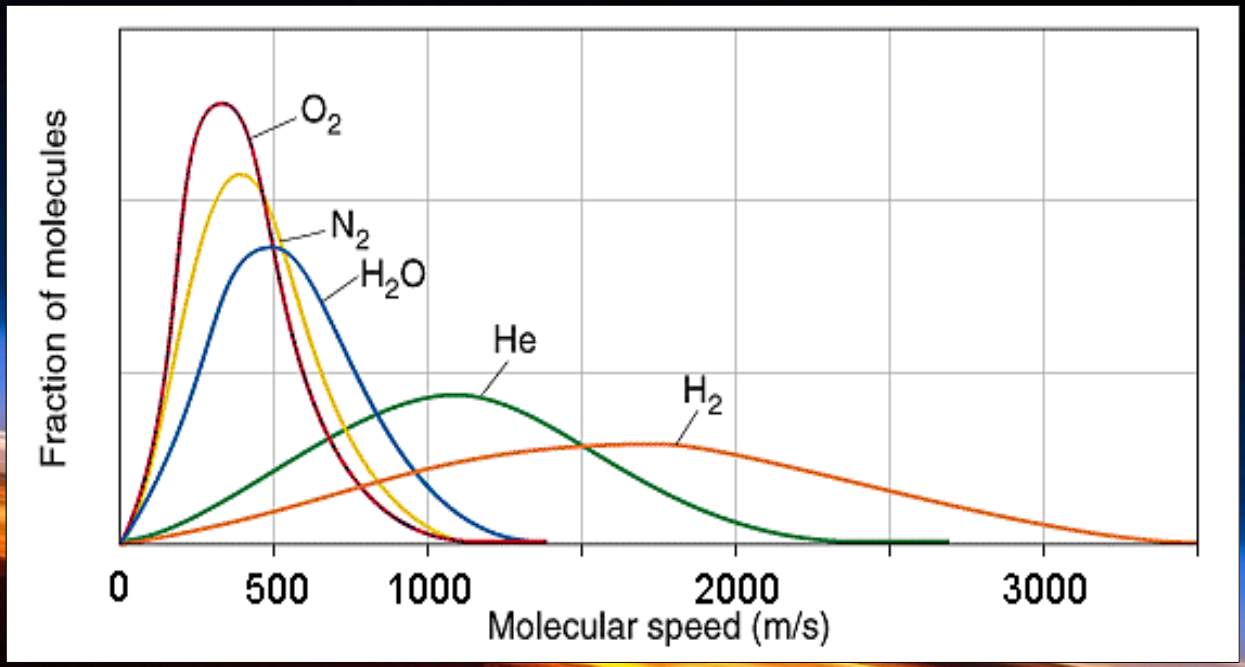
Temperature

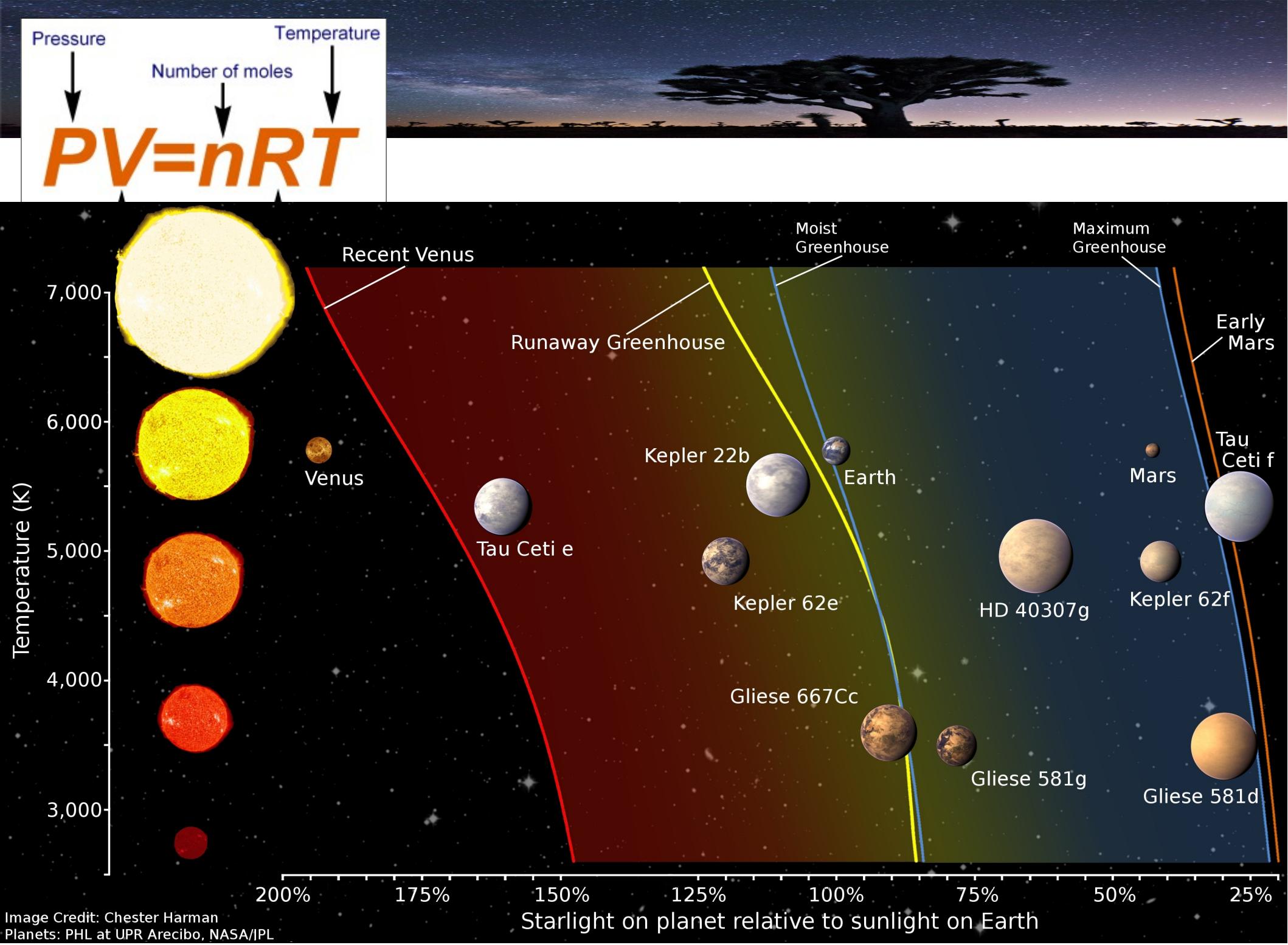
Number of moles

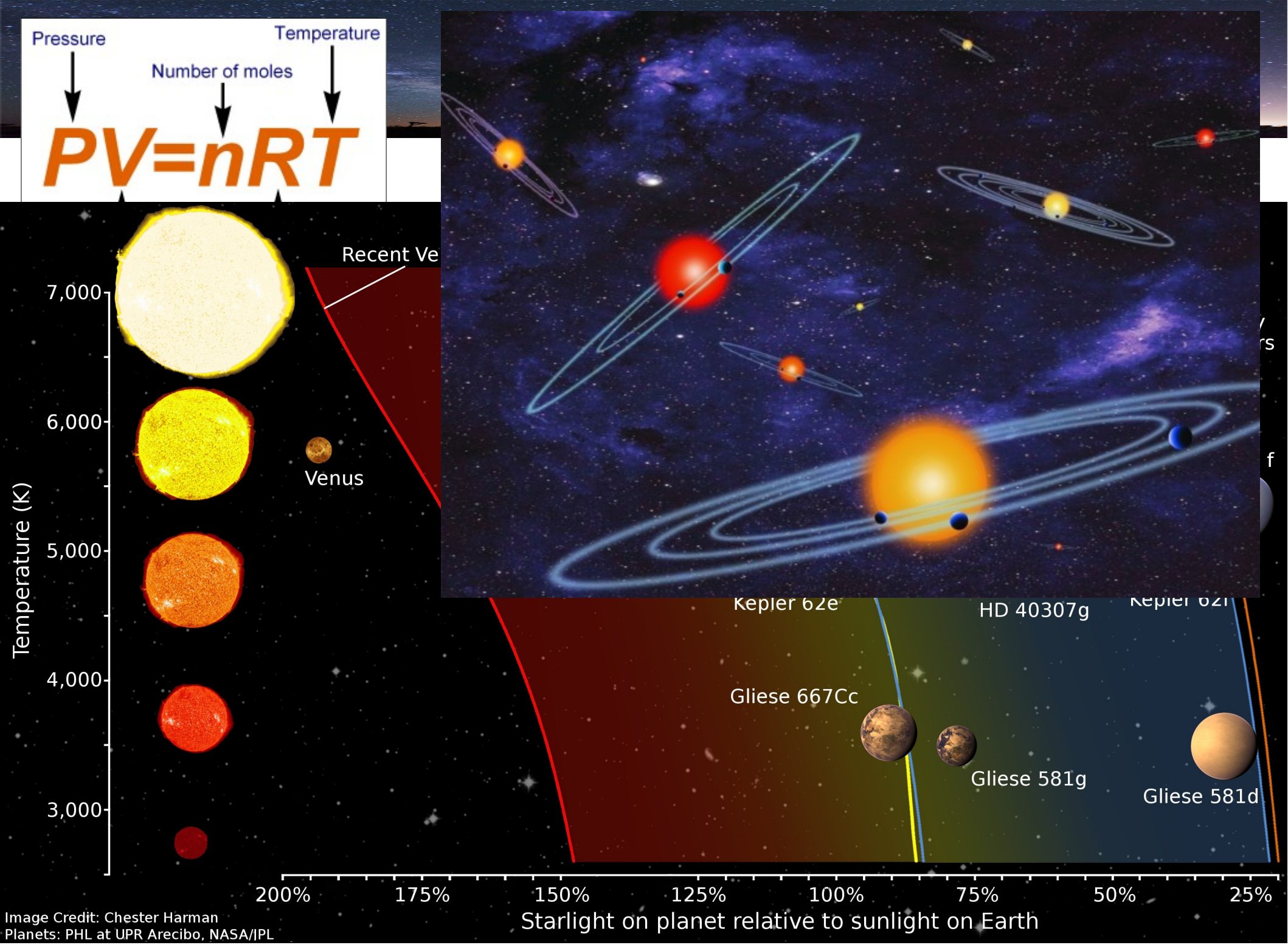
$$PV=nRT$$

Volume

Gas constant




Pressure
Temperature
Number of moles
PV=nRT
Recent Venus
Moist Greenhouse
Maximum Greenhouse
Runaway Greenhouse
Early Mars
Venus
Tau Ceti e
Kepler 22b
Earth
Mars
Tau Ceti f
Kepler 62e
HD 40307g
Kepler 62f
Gliese 667Cc
Gliese 581g
Gliese 581d
Temperature (K)
7,000
6,000
5,000
4,000
3,000
200%
175%
150%
125%
100%
75%
50%
25%
Starlight on planet relative to sunlight on Earth
Image Credit: Chester Harman
Planets: PHL at UPR Arecibo, NASA/JPL


Pressure
Temperature
Number of moles
PV=nRT
Recent Ve
Venus
Kepler 62e
HD 40307g
Gliese 667Cc
Gliese 581g
Gliese 581d
7,000
6,000
5,000
4,000
3,000
Temperature (K)
200%
175%
150%
125%
100%
75%
50%
25%
Starlight on planet relative to sunlight on Earth
Image Credit: Chester Harman
Planets: PHL at UPR Arecibo, NASA/JPL

Pressure Temperature

Number of moles

$PV = nRT$

http://phl.upr.edu/

phl.upr.edu

PHL

Planetary Habitability Laboratory

University of Puerto Rico at Arecibo

MAPPING THE HABITABLE UNIVERSE

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Main Projects

- Habitable Exoplanets
- Visible Paleo-Earth

Related Sites

vpl

Virtual Planetary Laboratory

The Habitable Exoplanets Catalog

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Latest Kepler Discoveries

NEXT WEEK: New results will be presented in the Habitable Exoplanets Catalog

'The Exoplanet Stellar Catalog' – a showcase of the stars with other worlds

The Exoplanet Orbital Catalog (EOC): A visualization of the orbits of all exoplanets.

Periodic Table of Exoplanets

"The Habitable Universe: Up to 5 Trillion Habitable Worlds in the Universe"

Habitable Zone Calculator for Multiple Star Systems by Müller & Haghighipour (2014)

PBS Program: Alien Planets Revealed

Last Update: February 26, 2014

Current Potentially Habitable Exoplanets

Ranked in Order of Similarity to Earth

#1 #2 #3 #4 #5 #6

Earth 1.00

HD 40307g

Kepler 62f

Gliese 581g

Gliese 581d

75% 50% 25%

sunlight on Earth

Pressure

Temperature

Number of moles

http://phl.upr.edu/

phl.upr.edu

MAPPING THE

Content

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Main Projects

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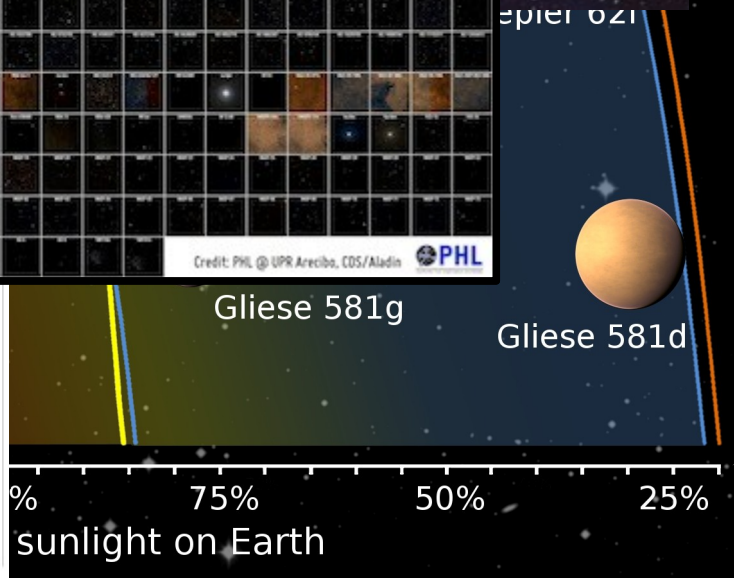
- Visible Paleo-Earth

Related Sites

vpl

Virtual Planetary Laboratory

Last Update: February 26, 2014



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An Electronic Newsletter

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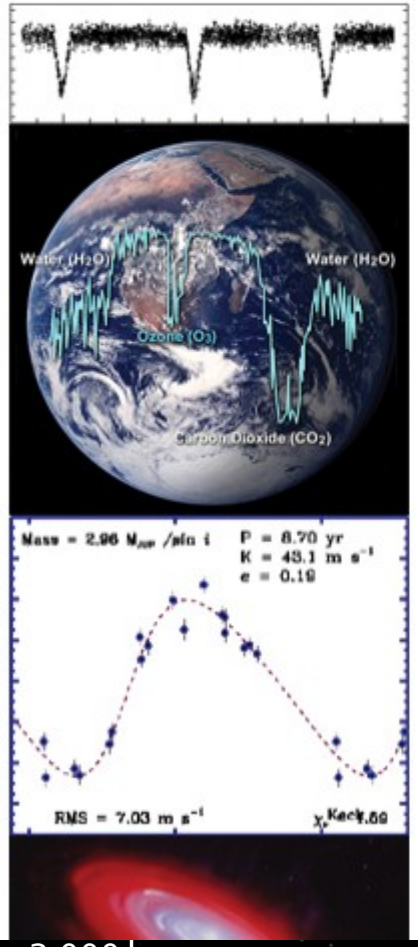

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- Discoveries and observations of exoplanets
- Protostellar and Debris Disks
- Theoretical simulations of planet formation
- Exoplanetary atmospheres and interiors
- Comparative planetology
- Formation and dynamics of planetary systems
- Planetary evolution and habitability
- Instrumentation and missions
- Origin and evolution of life on terrestrial planets
- Co-evolution of life, atmospheres and climate
- Characterisation of terrestrial exoplanets
- Detection of biomarkers

Other sections describe recent PhD theses, new meetings, new books and job offers specifically aimed at the ExoPlanet community

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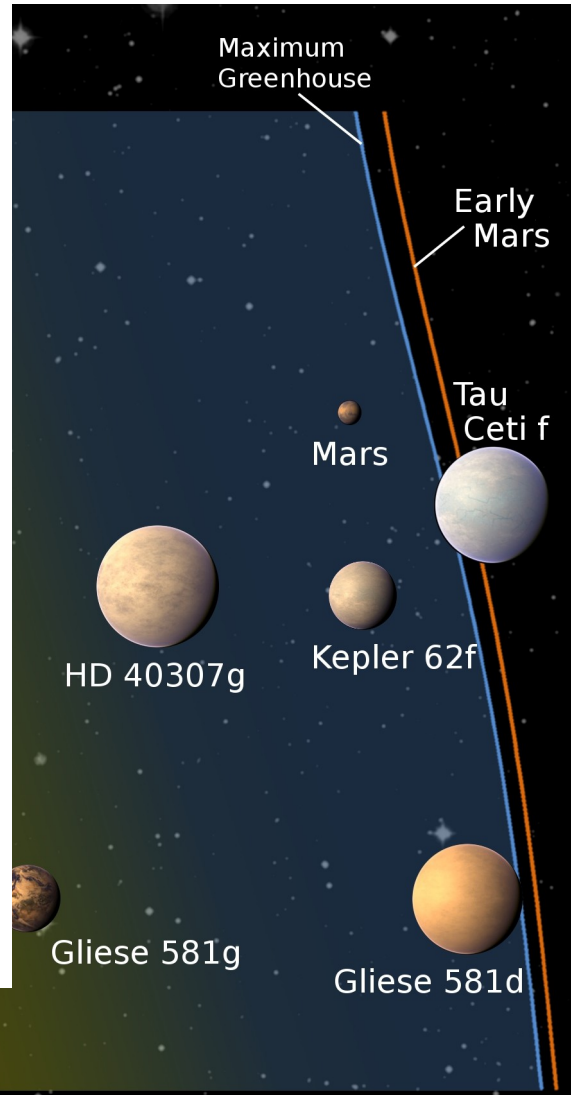

Image Credit: Chester Harman
Planets: PHL at UPR Arecibo, NASA/JPL

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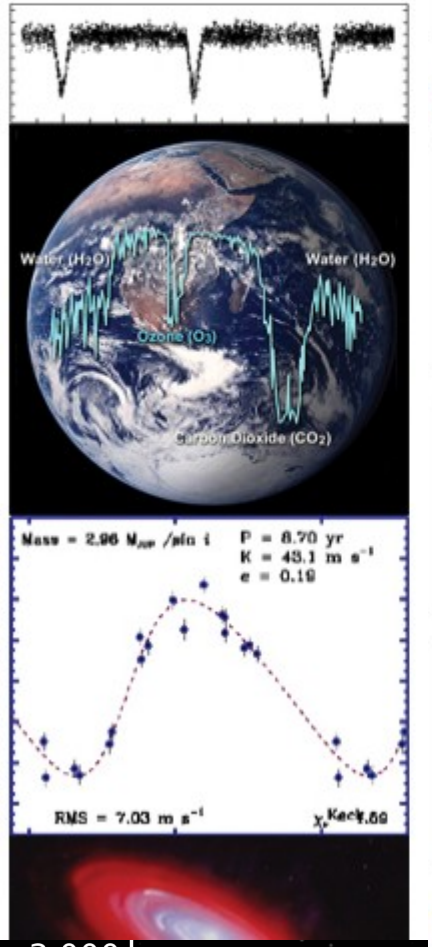
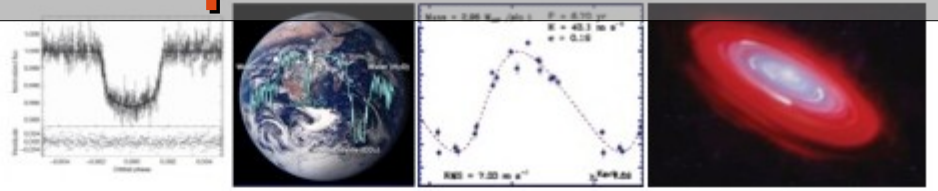
ExoplanetNews LaTe)



ExoPlanet News
An Electronic Newsletter



Help Search for Exoplanets and Extraterrestrial Life from Home

Planet Hunters
Search for planets through data taken by the NASA Kepler Space Mission

AGENT EXOPLANET
Study known exoplanets using images taken by LCOGT's Telescopes

SETILIVE
Search for Extraterrestrial Intelligence LIVE from the SETI Institute's Allen Telescope Array

Travel to the Exoplanets from Home

Exoplanet App Download on the App Store

3,000

200

Image Credit: Chester Harman
Planets: PHL at UPR Arecibo, NASA/JPL

Formación Sistemas Planetarios (Sistema Solar)

/media/now/Physics/docencia/astronomia2013-II/videos-clase/El nacimiento del sistema solar.mp4