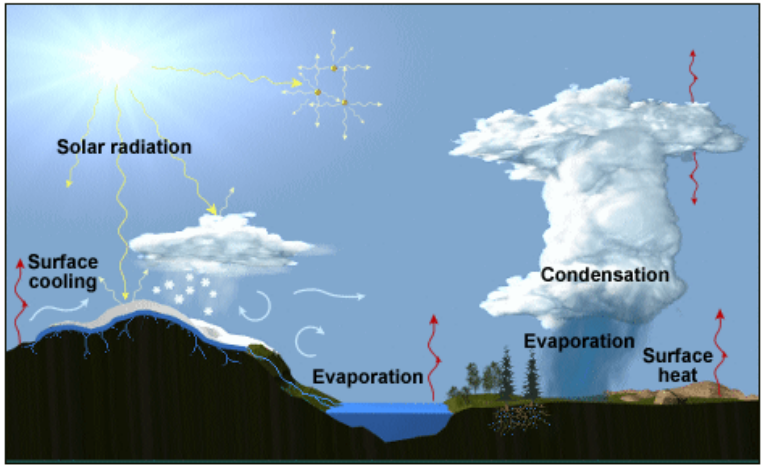
THE UNIVERSITY OF UTAH

ATMOS 5140
Lecture 1 – Chapter 1

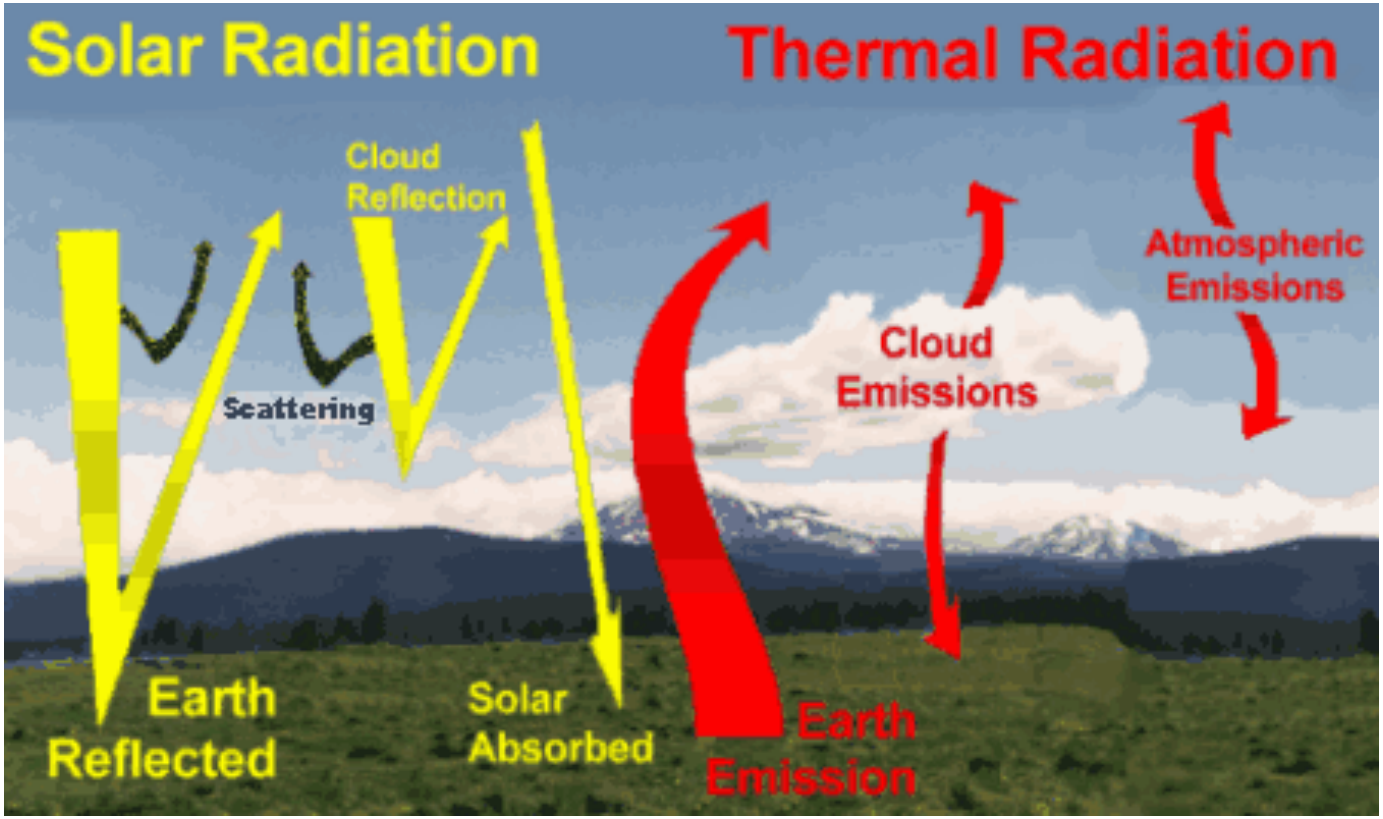
- Atmospheric Radiation
  - Relevance for Weather and Climate
  - Solar Radiation
  - Thermal Infrared Radiation
  - Global Heat Engine
  - Components of the Earth's Energy Budget
  - Relevance for Remote Sensing

Processes in Atmosphere

- Adiabatic
  - Last class – no heat exchange
- Diabatic
  - Thermal Conduction - Surface of the Earth
  - Latent heating and cooling - Covered in last class
  - Atmospheric Radiation



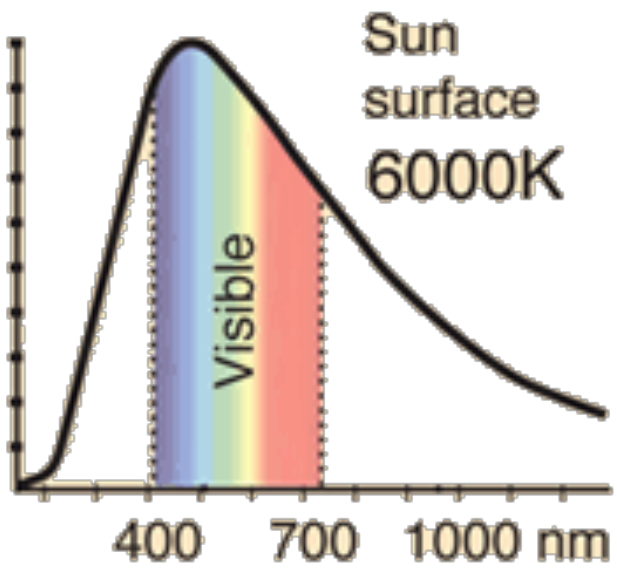
- Generally important only near the ground surface and within some clouds.
- Radiative heating and cooling lead to the formation of daytime low-level instability and nocturnal low-level stability, respectively.
- Radiative processes in the free air and at cloud tops, however, are slow and their effect on the lapse rate are generally minimal.



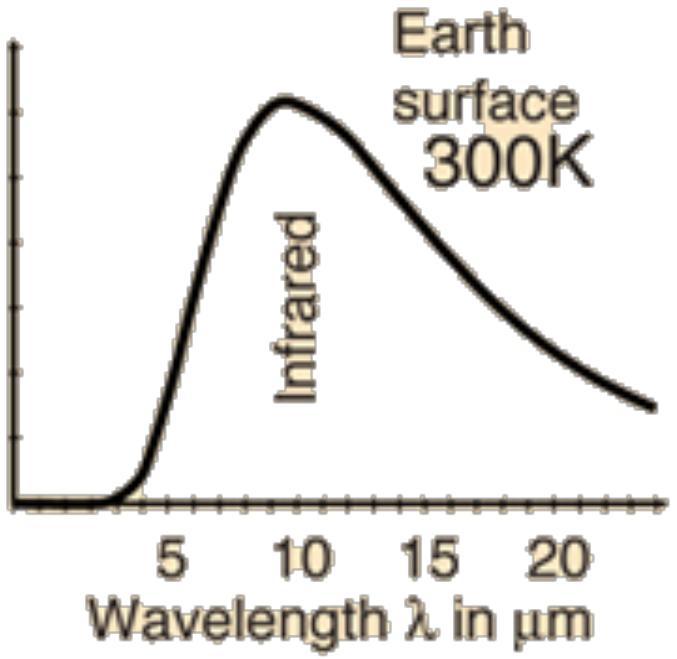
- Solar or Shortwave Radiation
- Thermal or Longwave Radiation

Blackbody Radiation

Solar Radiation

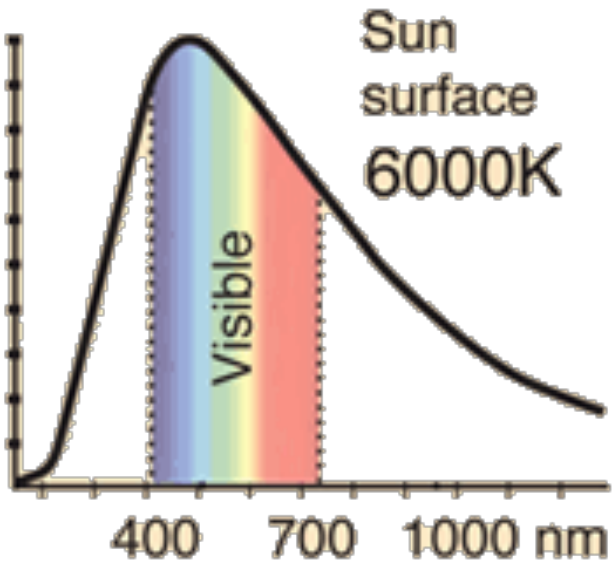


Thermal Radiation

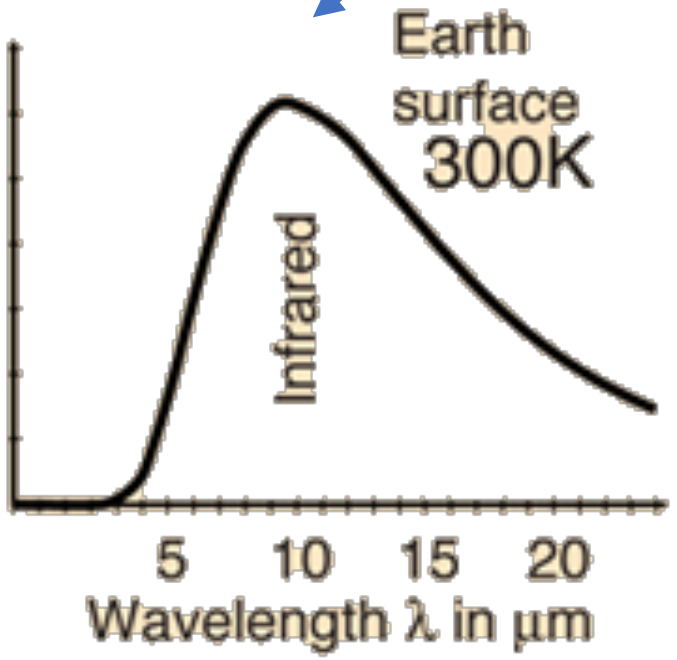


Blackbody Radiation

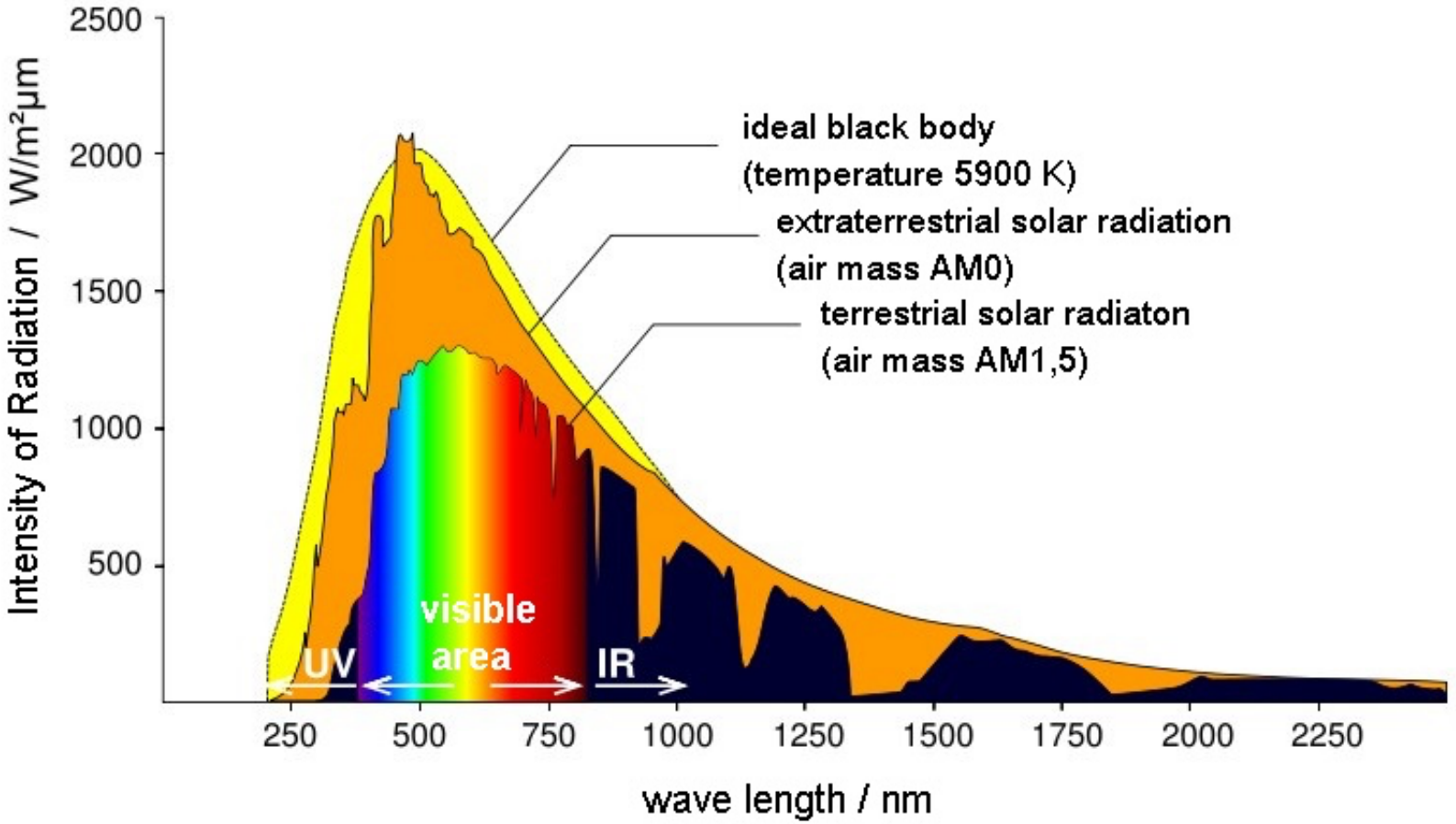
Solar Radiation



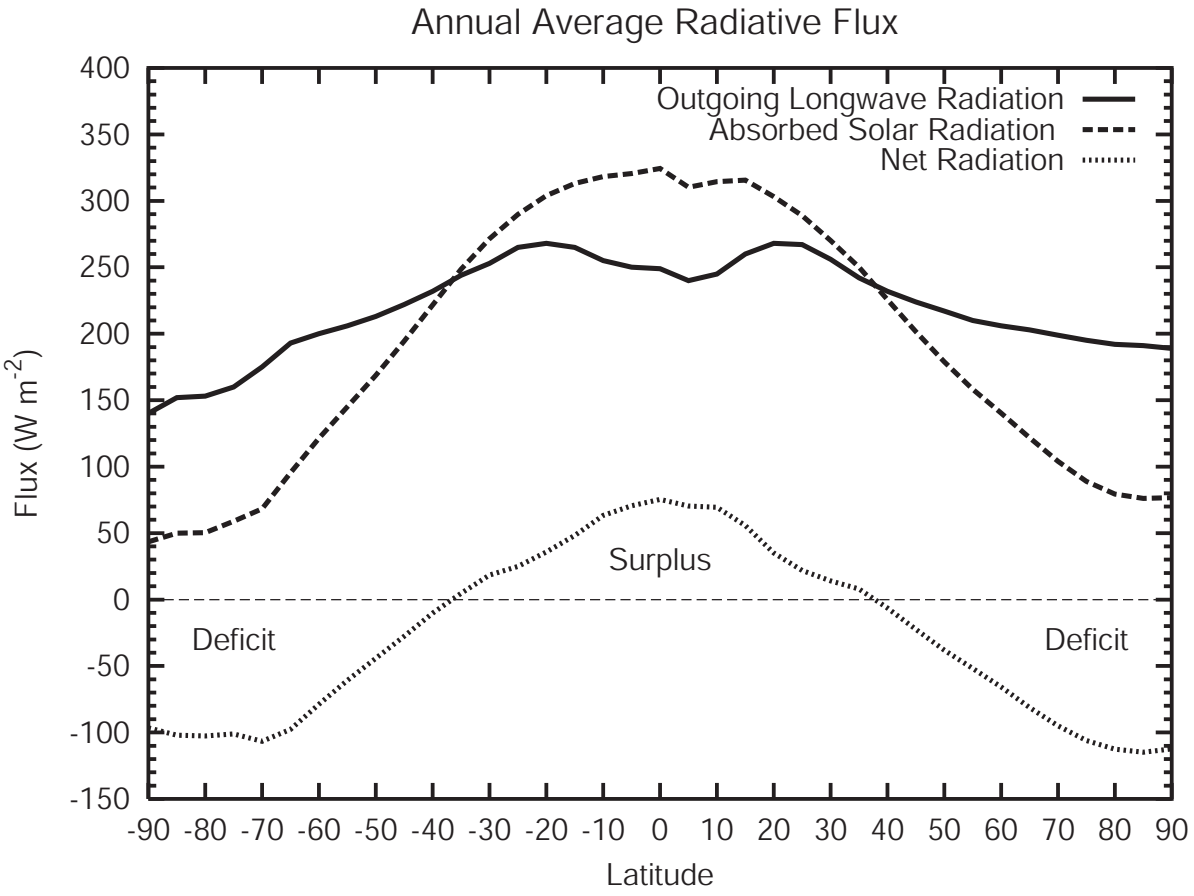
Thermal Radiation



Solar Radiation



Global Heat Engine



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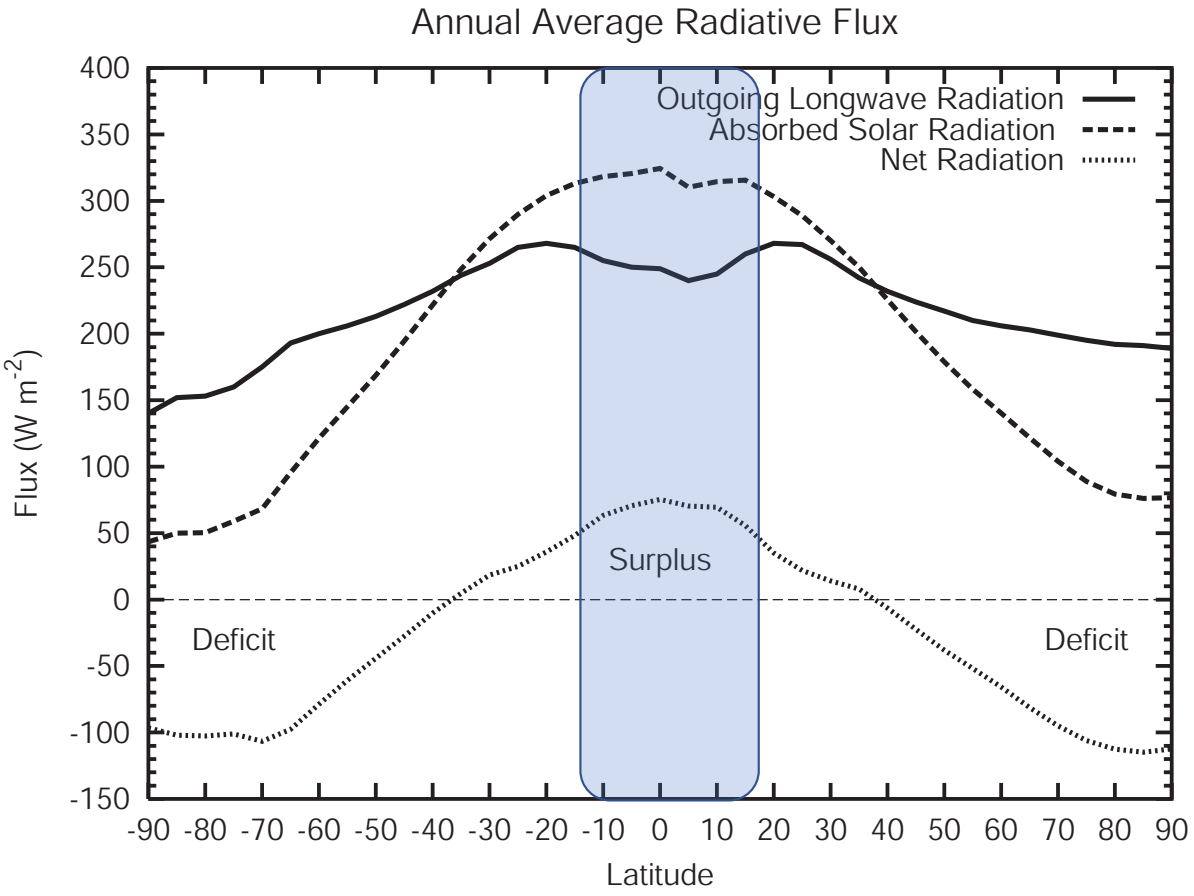
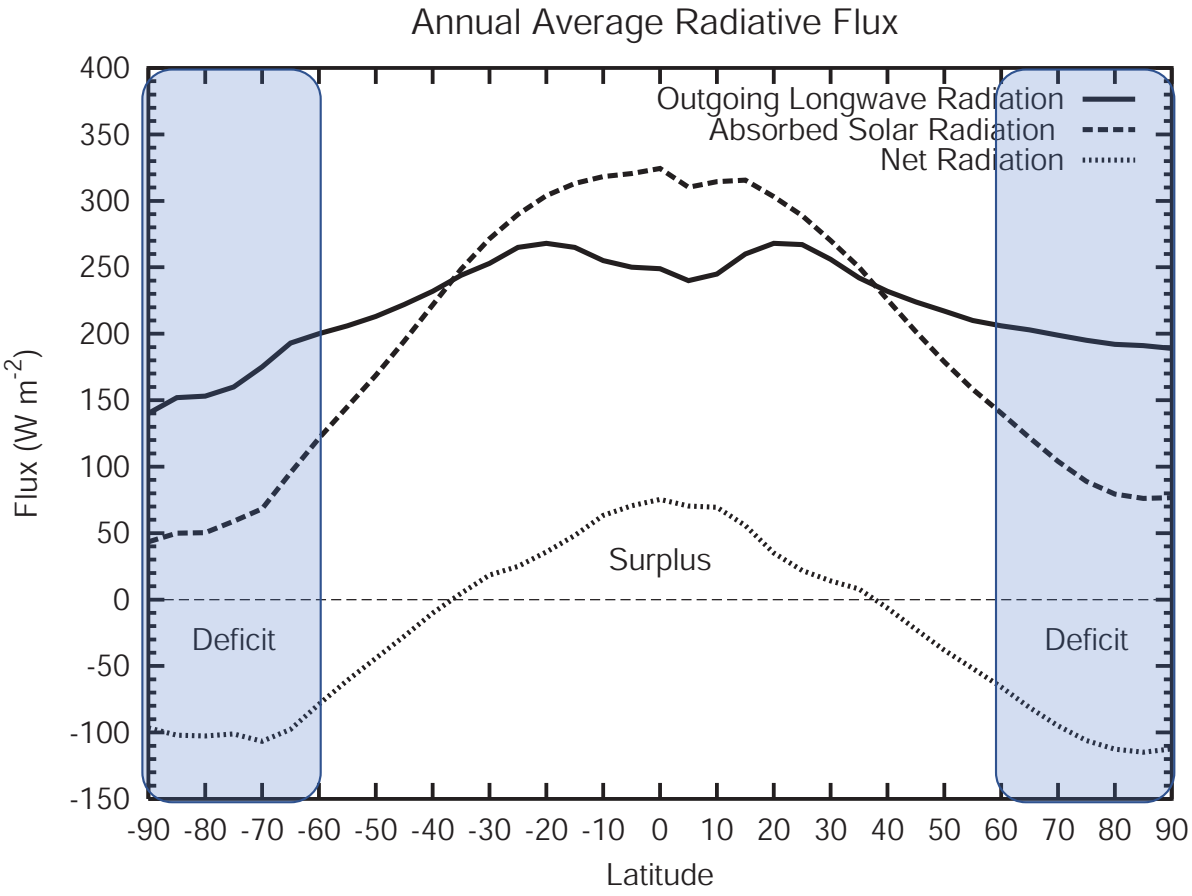


Tropics –
More solar received
than lost in Longwave

Global Heat Engine



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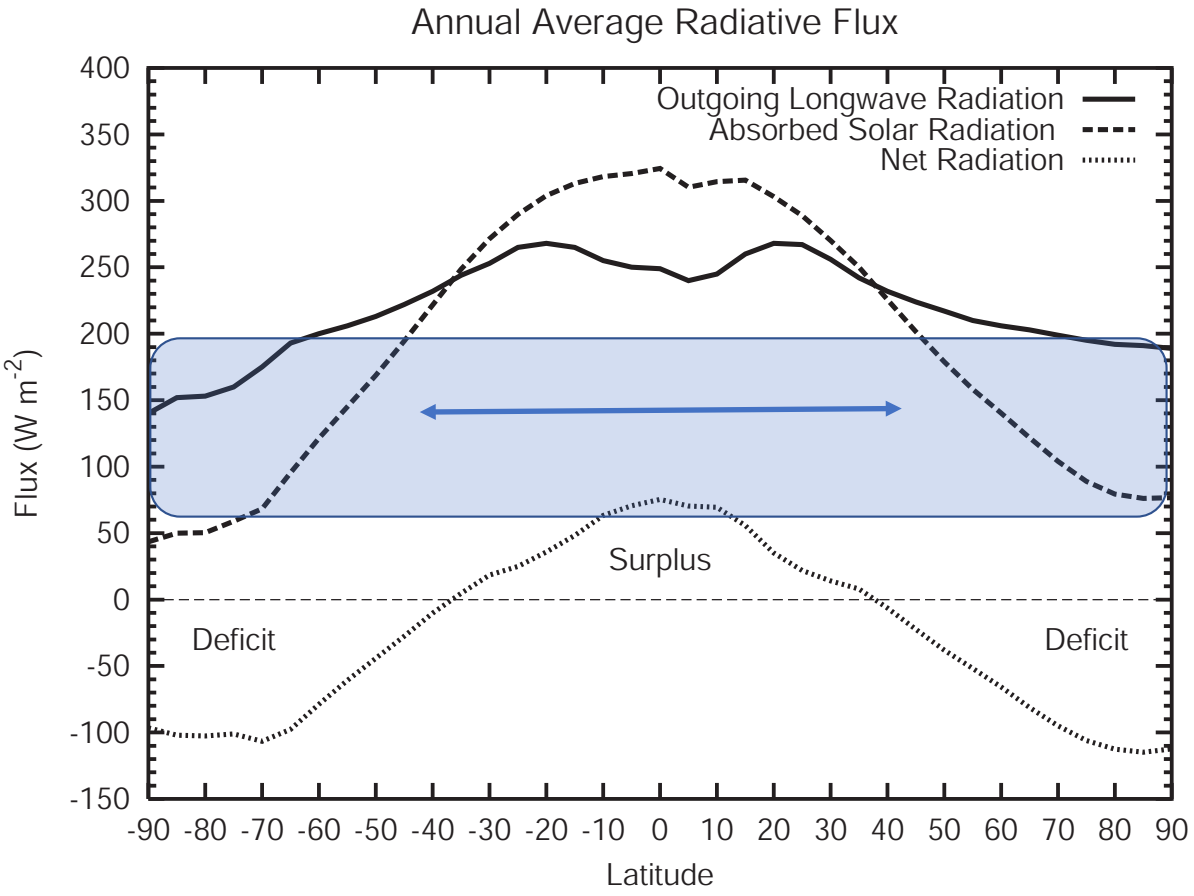
Poles –
More lost in Longwave Radiation than received in Solar

Global Heat Engine

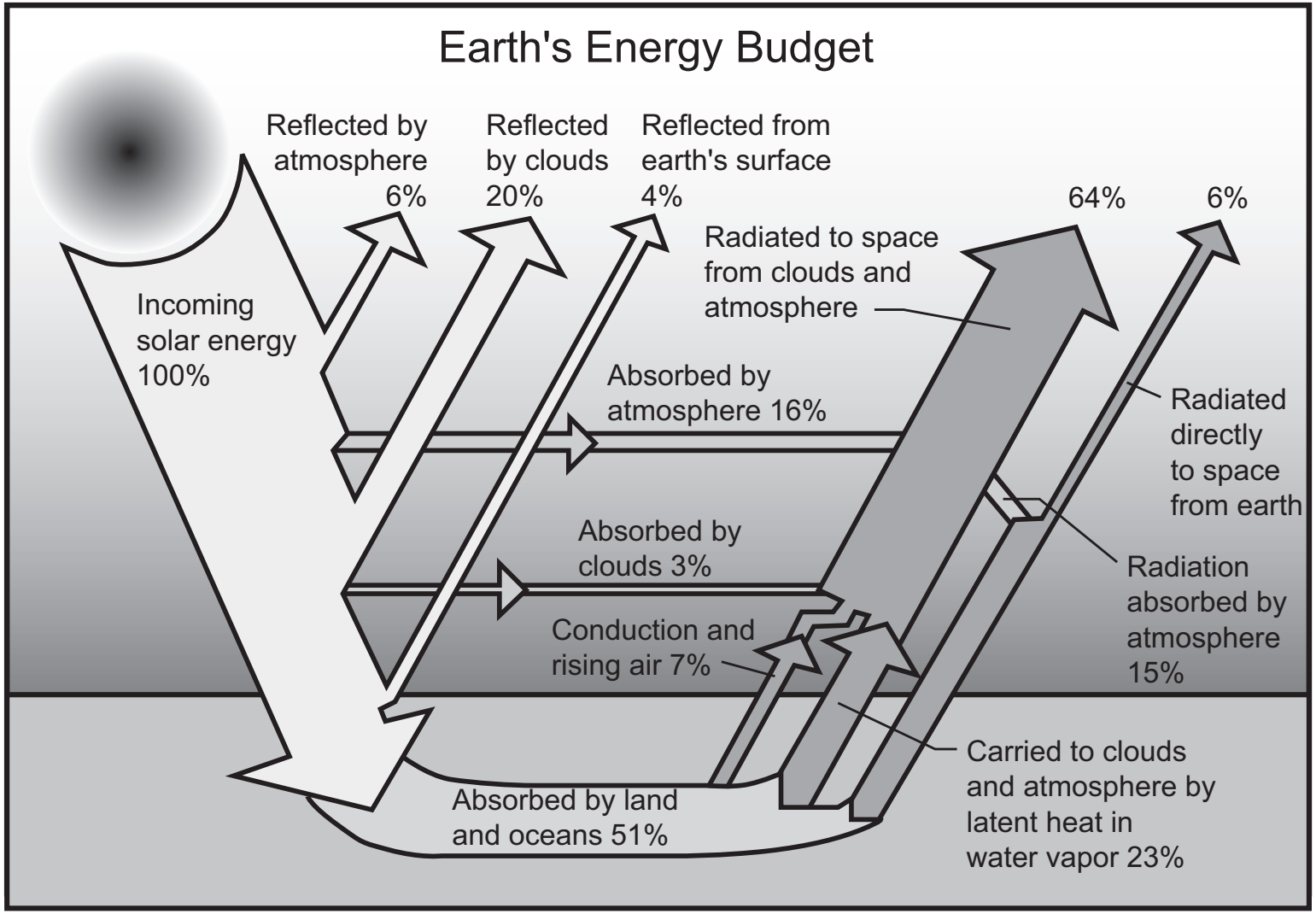


Tropics –
More Solar received than lost in Longwave Radiation

Poles –
More lost in Longwave Radiation than received in Solar

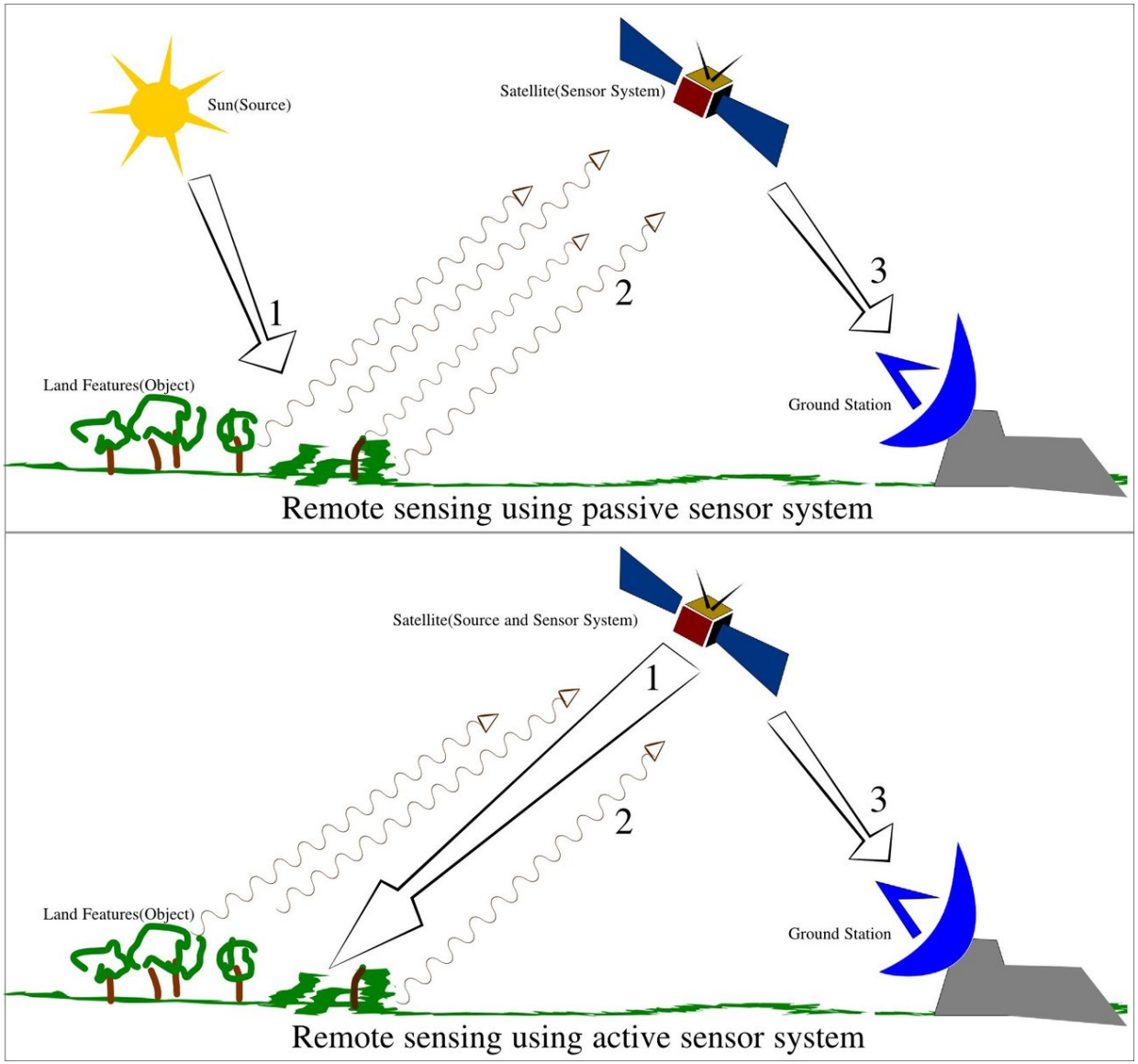
Creates a Meridional Temperature gradient –
Heat Transfers from Hot to Cold

Recall the heat engine – temperature gradient is transferred to mechanical work

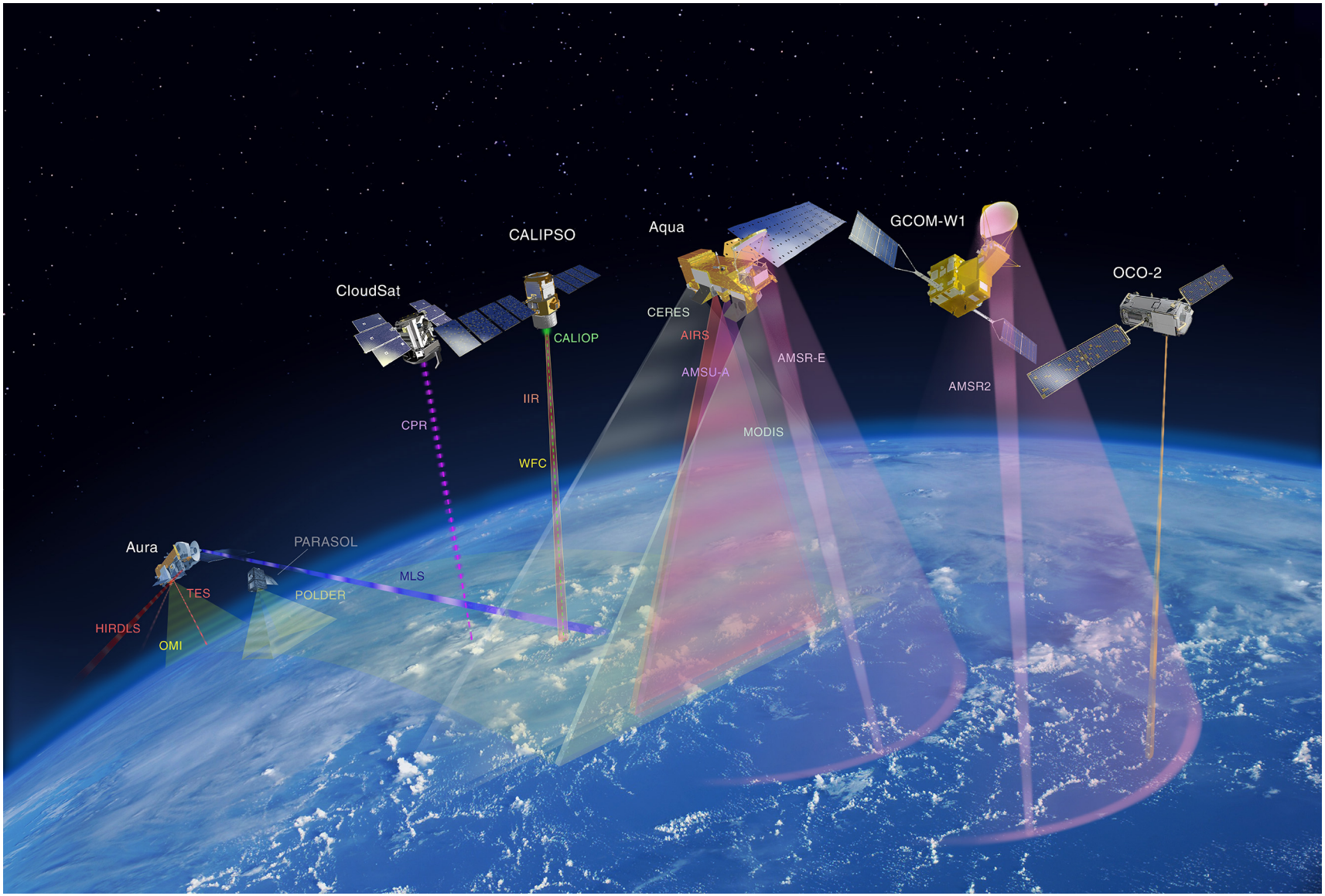


Atmosphere is responsible for radiating ~90% of total absorbed solar energy back to space!!

Application of Remote Sensing



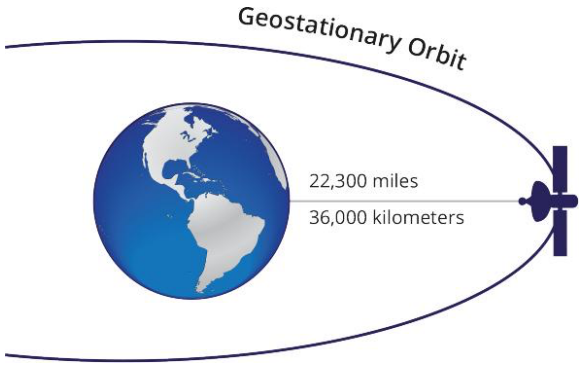
NASA A-TRAIN


CALIPSO
Aqua
GCOM-W1
CloudSat
OCO-2
CERES
AIRS
AMSU-A
AMSR-E
AMSR2
CALIOP
IIR
CPR
WFC
MODIS
Aura
PARASOL
MLS
TES
POLDER
HIRDLS
OMI

Satellite Orbits

- Geosynchronous
  - ~36,000 kilometers from Earth's surface
  - Orbit Matches Earth's orbit – moves same speed as earth
  - Weather Monitoring – See one spot
- Lagrange points
  - Pull of gravity from the Earth cancels out the pull of gravity from the Sun
  - 1.5 million kilometers away from Earth!
- Medium Earth Orbit
  - Semi-synchronous orbit
  - 26,560 kilometers from the center of the Earth
  - GPS orbit
- Low Earth Orbit
  - Sun-synchronous orbit
  - Regular adjustments to maintain a satellite in a Sun-synchronous orbit.

Satellite Orbits



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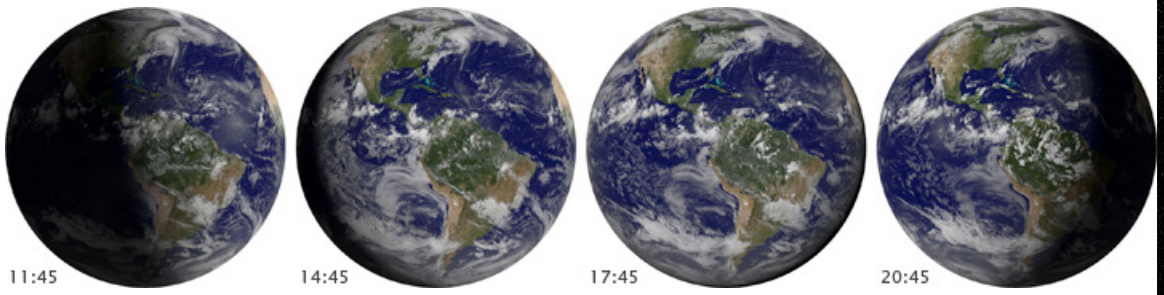

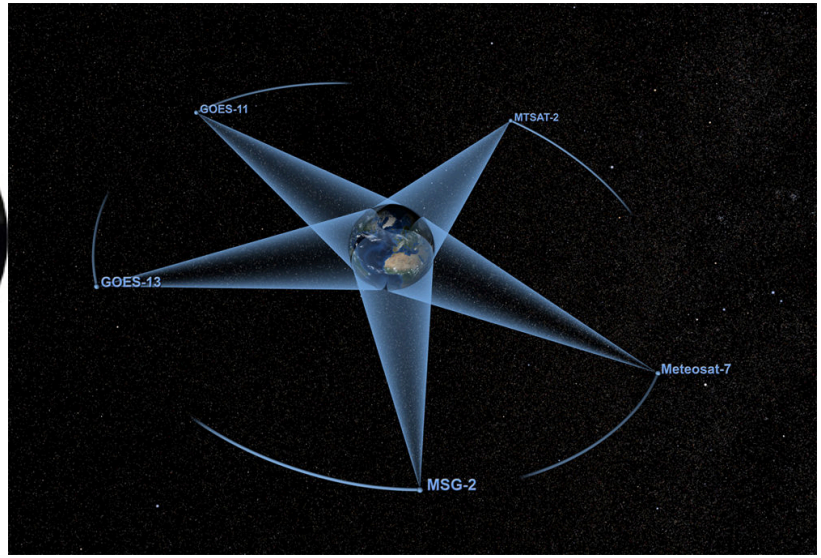

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Satellite Orbits

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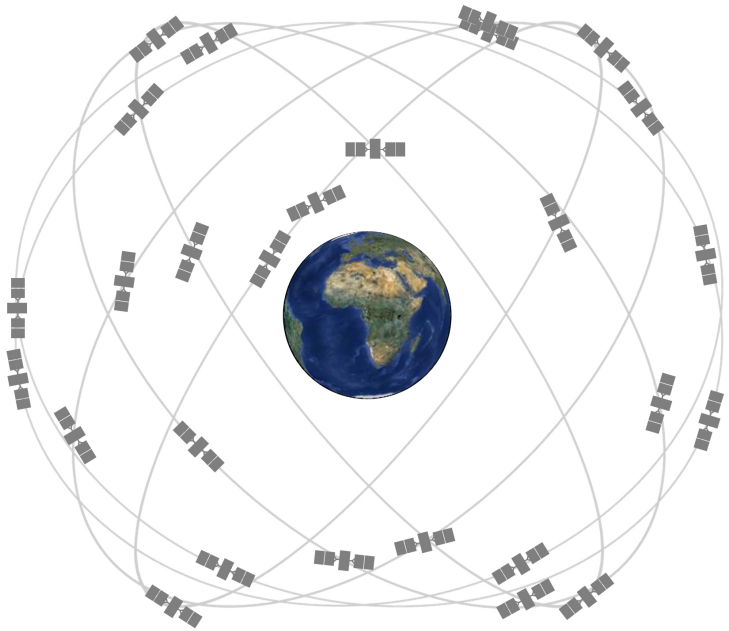

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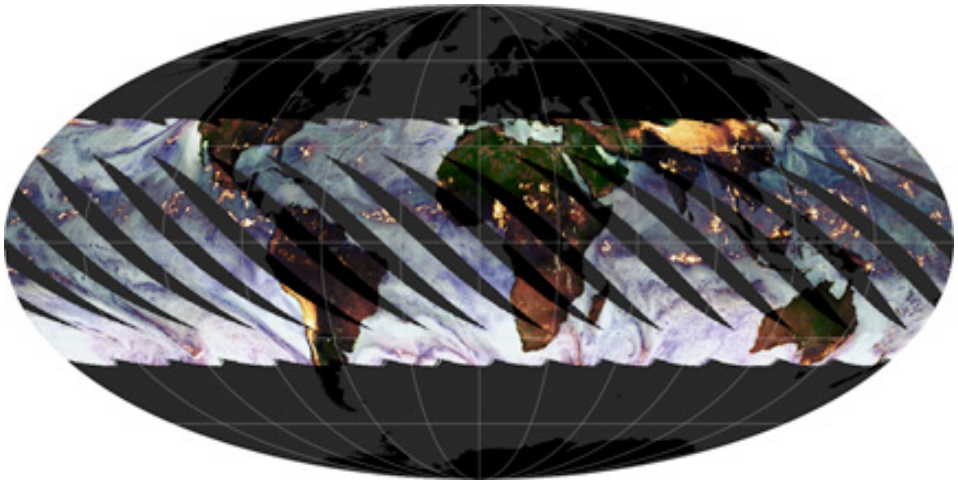
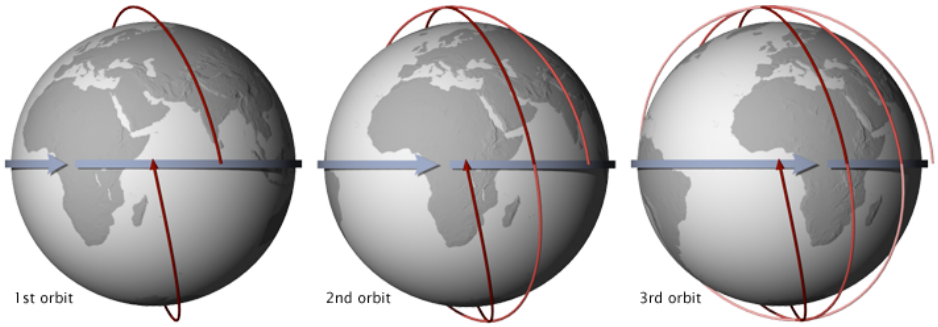
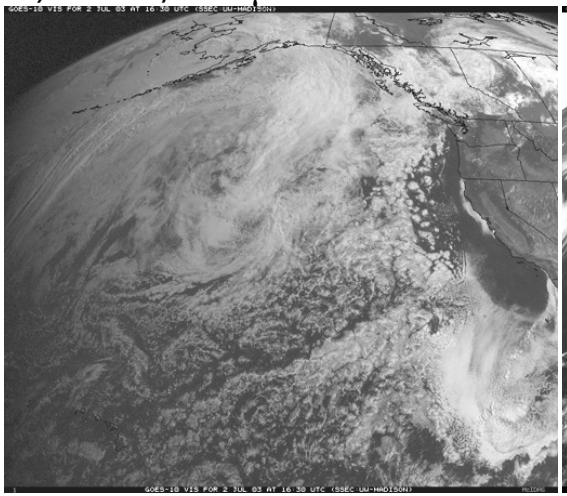
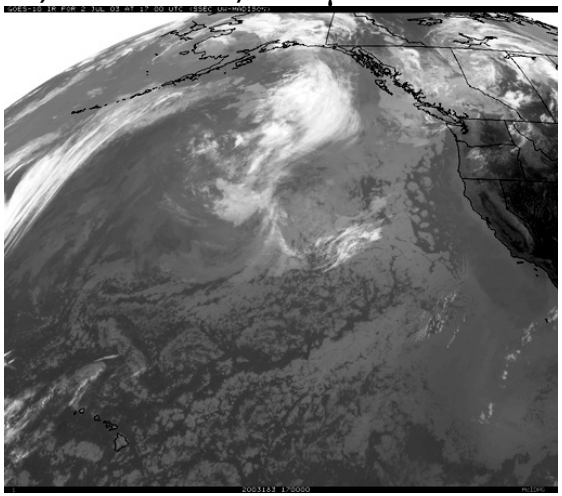




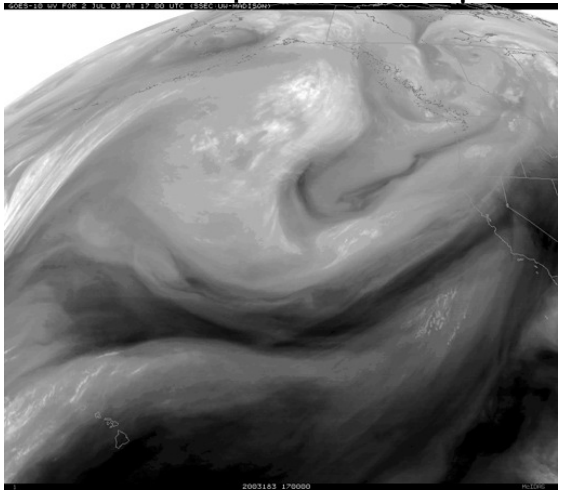
a) Visible, 0.65 µm



b) IR window, 10.7 µm



c) IR water vapor band, 6.7 µm



GOES IMAGE

Use IR window to see temperature gradient