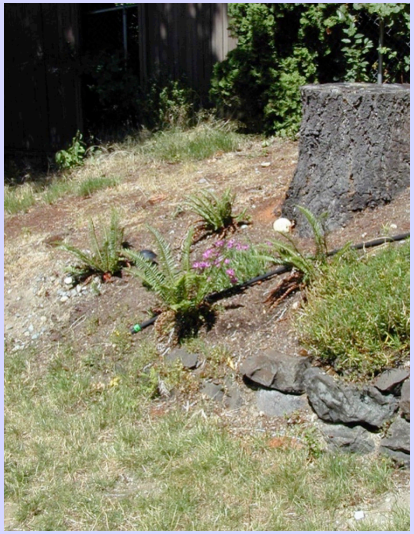
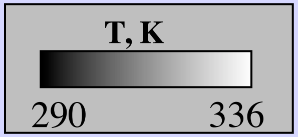
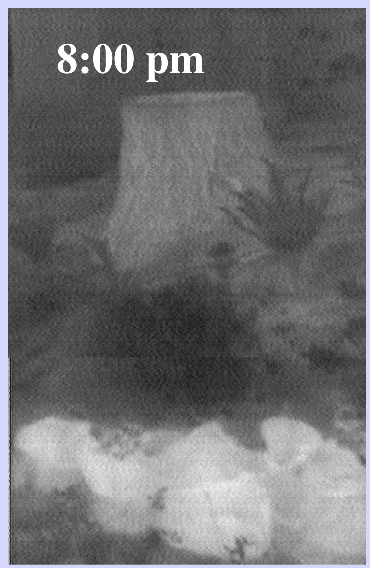
Day/night

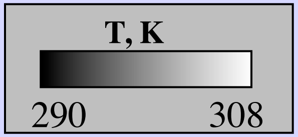
Vis

10.8 μm



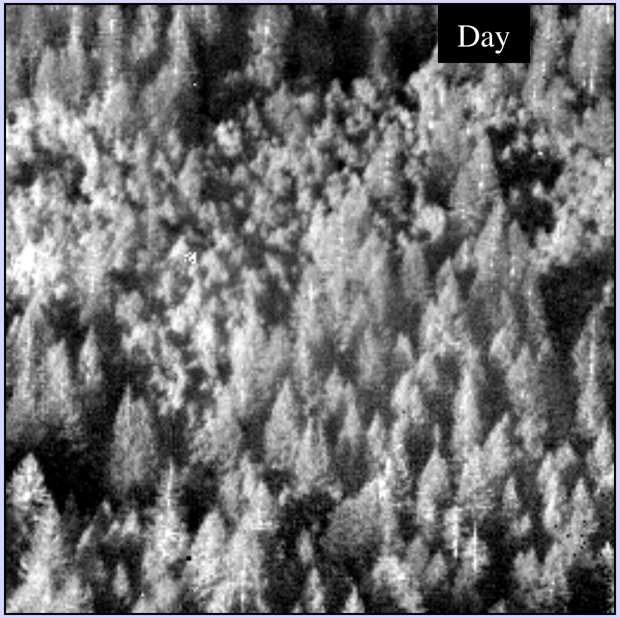


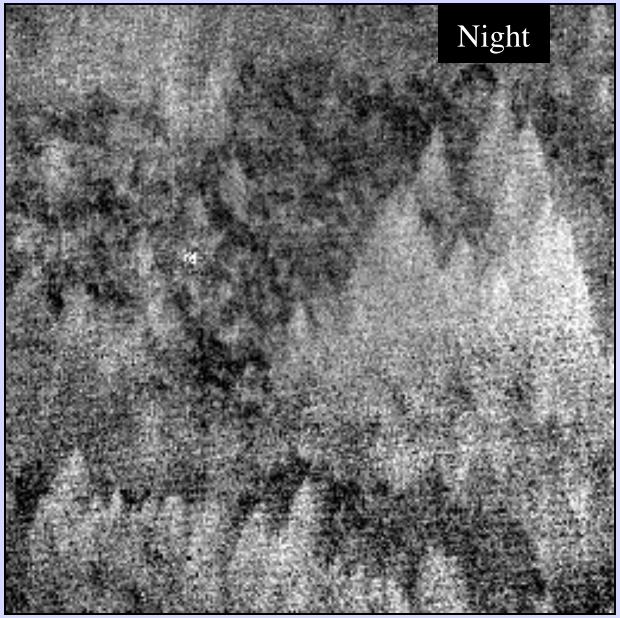


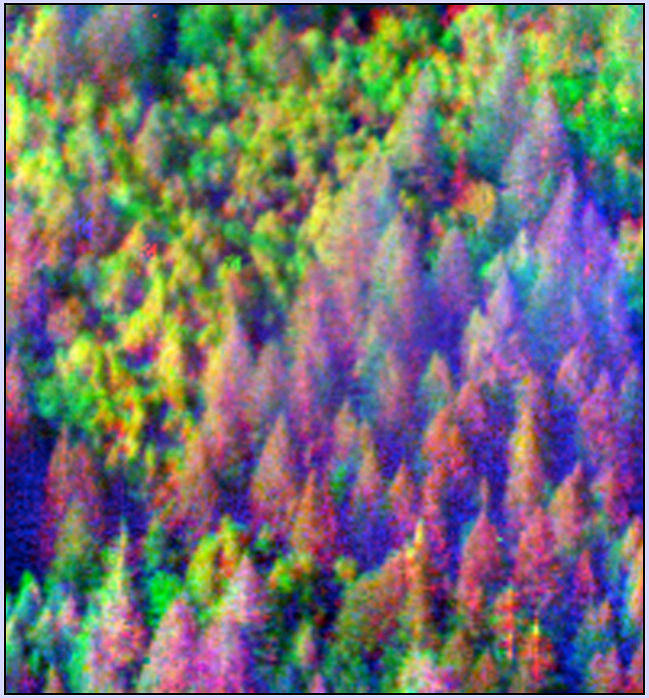


Thermal inertia:
dQ/dT
Resistance of matter
to changing temperature
as heat is applied

Veg Mapping - Thermal

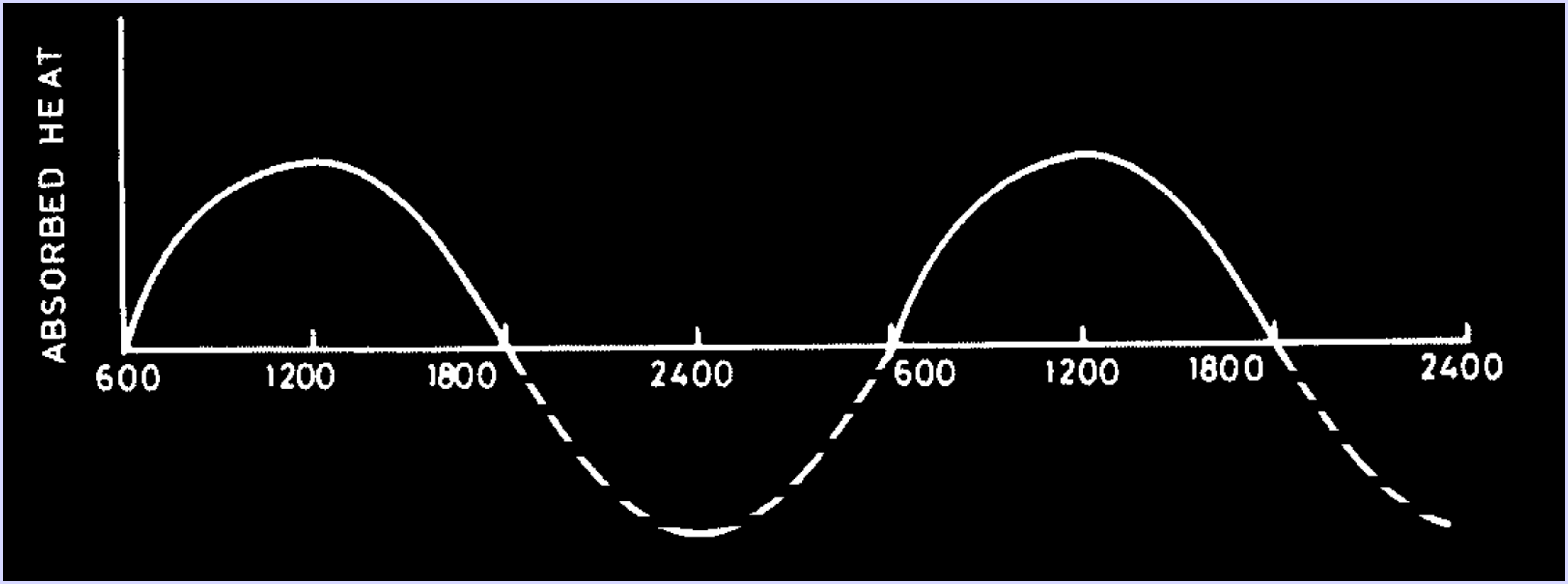






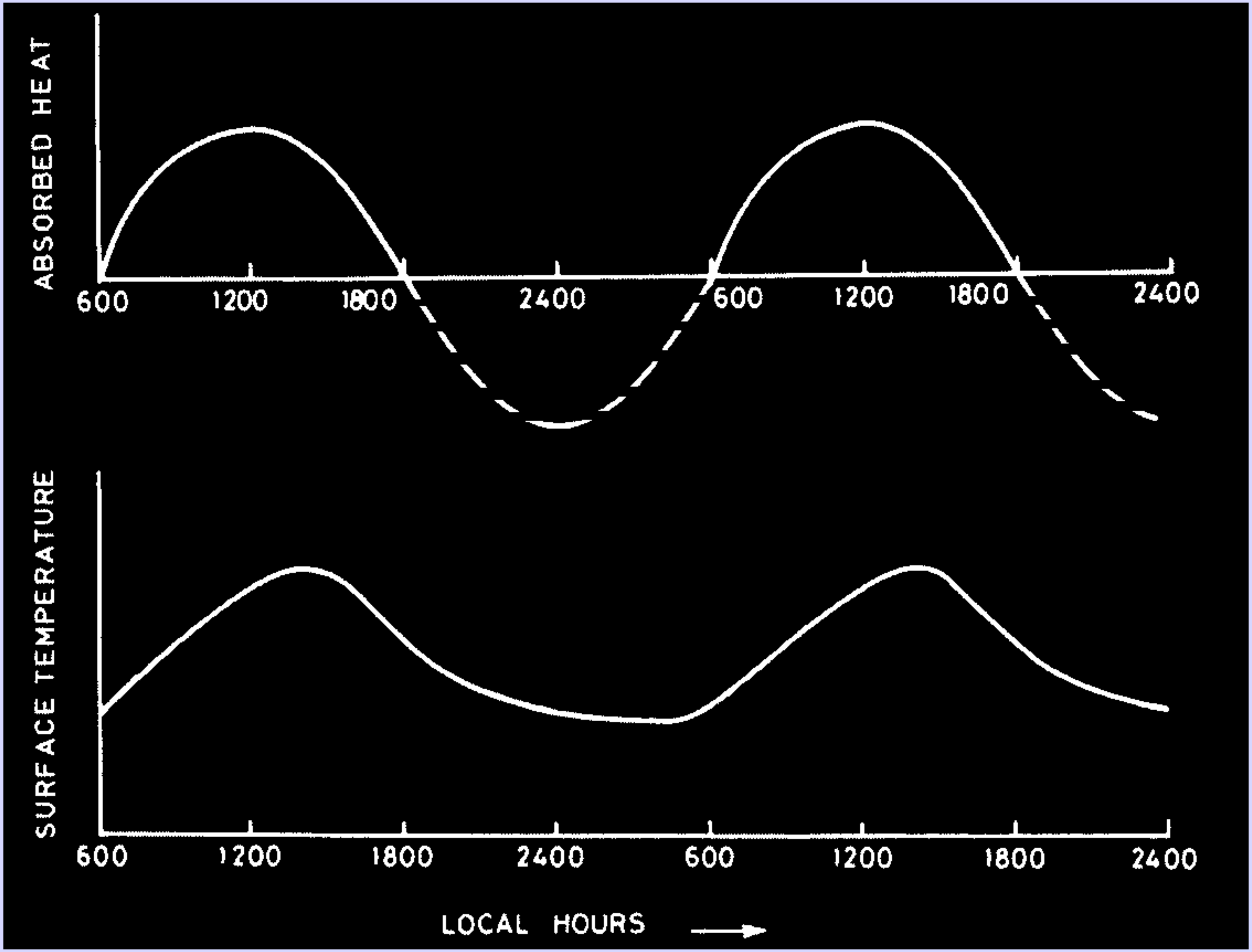
Red = 10:00 am
Green = 2:00 pm
Blue = 11:00 pm

Conifers cooler during day & warmer at night



Sunlight heats planetary surfaces

in a sinusoidal pattern



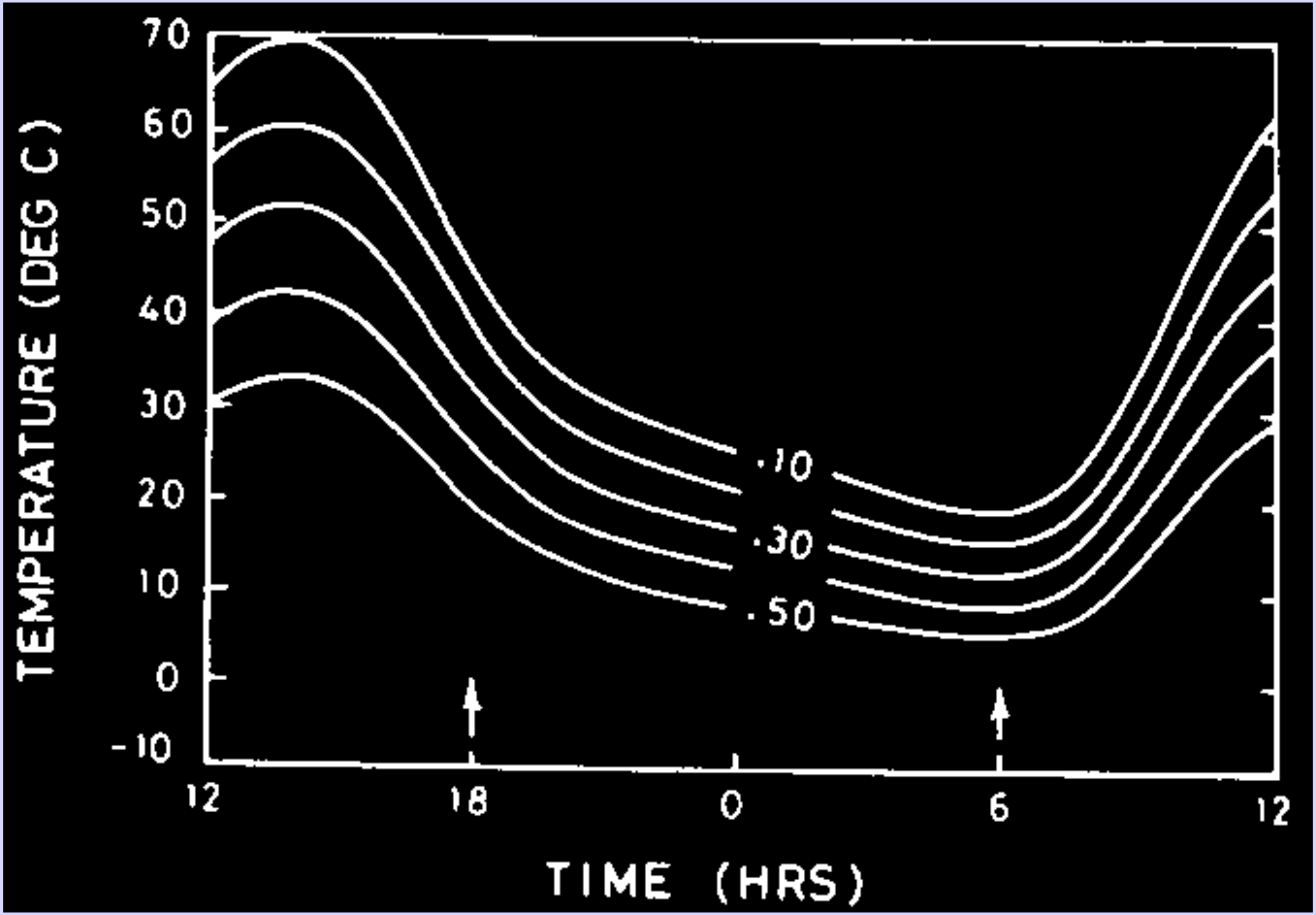
Surface temperature responds to heating (and lack of heating), but with a lag.

Albedo

- The *albedo* of a planetary surface (A) is the percent of sunlight that it reflects.

- Albedo can range from A=1 (pure white) to A=0 (pure black). For Earth, average A is 0.39. For the Moon, average A is 0.12.

- The amount of sunlight absorbed by a surface is 1-A



The effect of varying albedo on diurnal temperature curves

Other physical quantities that affect temperature

- Thermal Conductivity (k) is a measure of the rate at which heat is conducted by a medium.

$$k_{\text{rock}} < k_{\text{water}} < k_{\text{steel}}$$

- Specific heat capacity (C) is a measure of the amount of heat required to raise the temperature of a given amount of material by a certain number of degrees.

$$C_{\text{water}} > C_{\text{rocks}} > C_{\text{steel}}$$

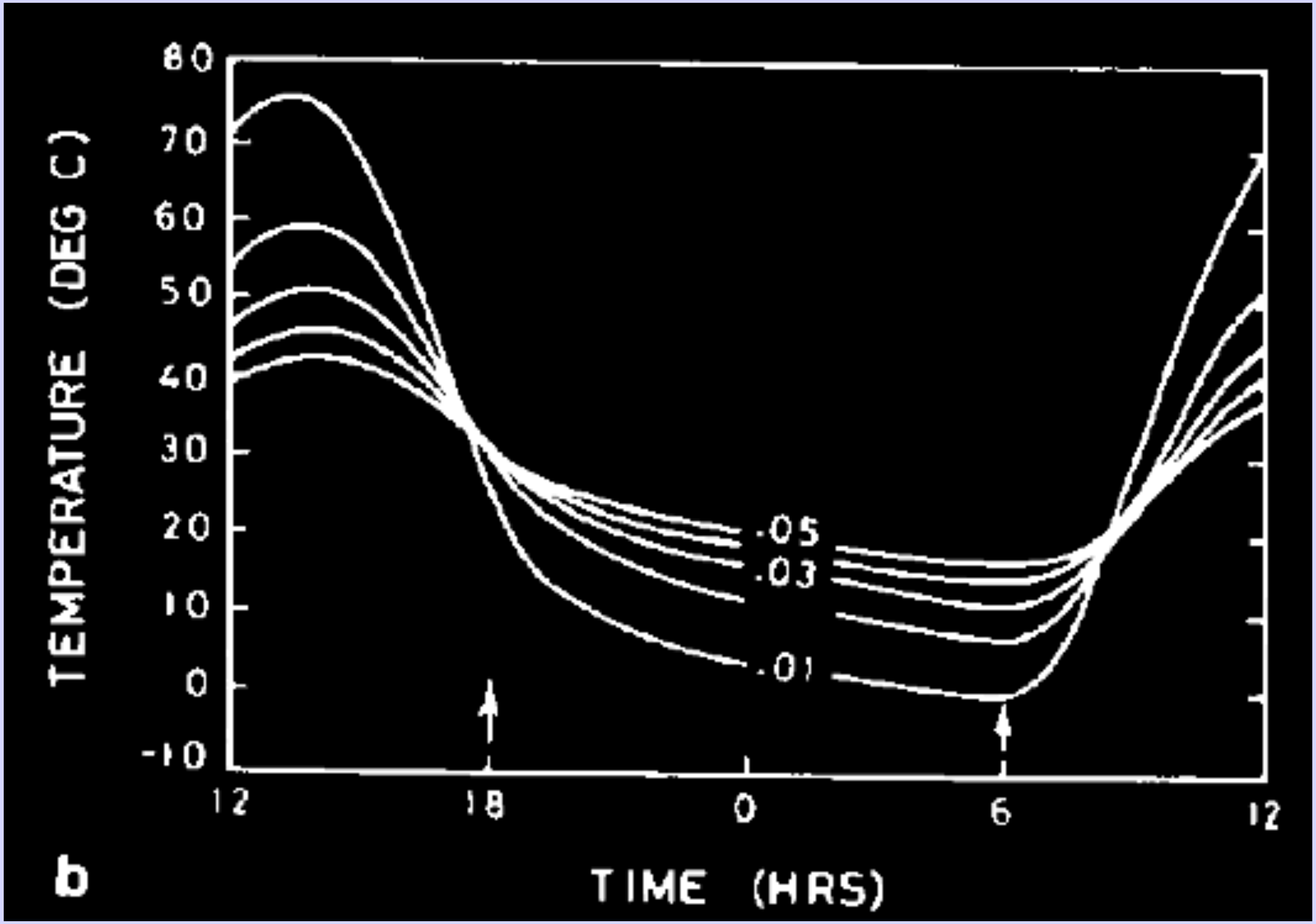
- Density (ρ) also important

Thermal Inertia

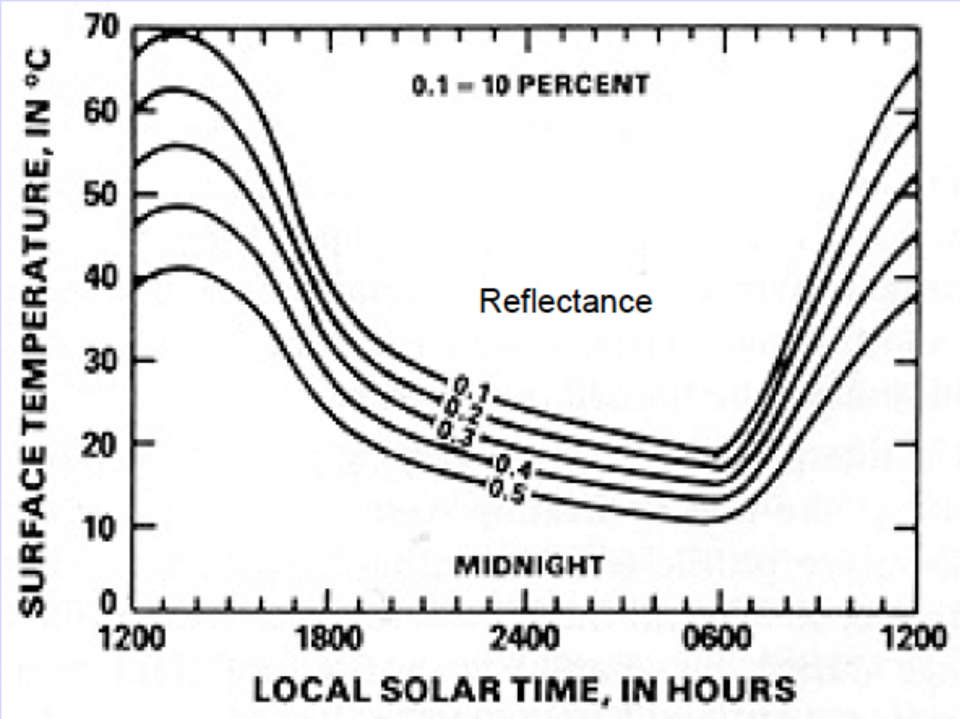
- Thermal inertia is a measure of the resistance offered by a substance undergoing temperature changes. It is given by:

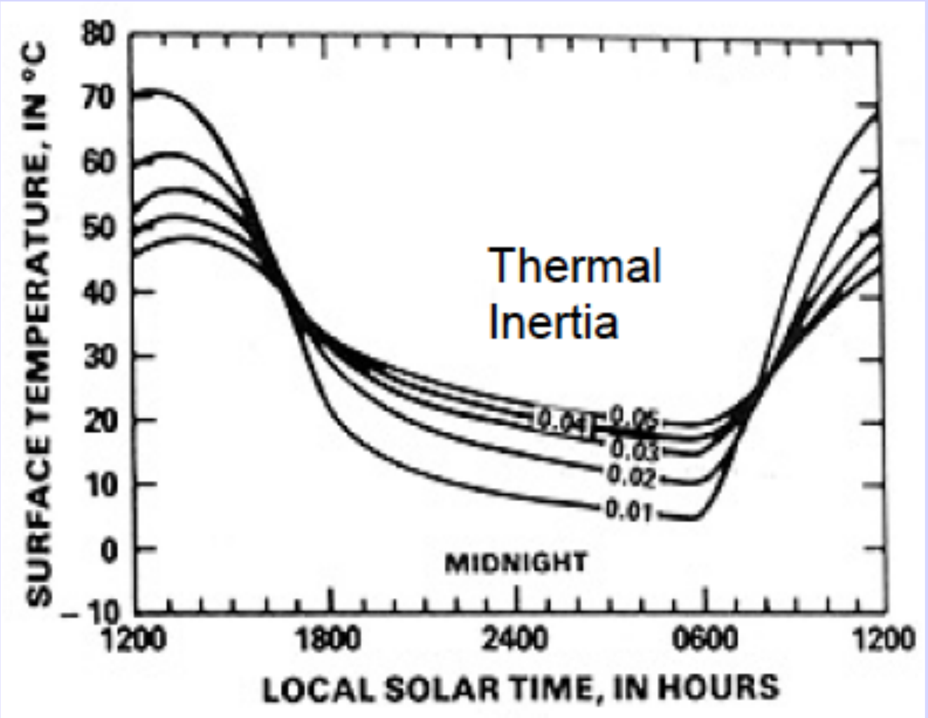
$$T.I. = (k\ \rho\ C)^{1/2}$$

Units are J m^{-2} $s^{-1/2}$ K^{-1} (tiu)



The effect of thermal inertia on diurnal temperature curves





Thermal inertia and albedo are the two parameters that fundamentally control the shape of the diurnal temperature curve.

Thermal Inertia of Geologic Materials

$$\text{T.I.} = (k \rho C)^{1/2}$$

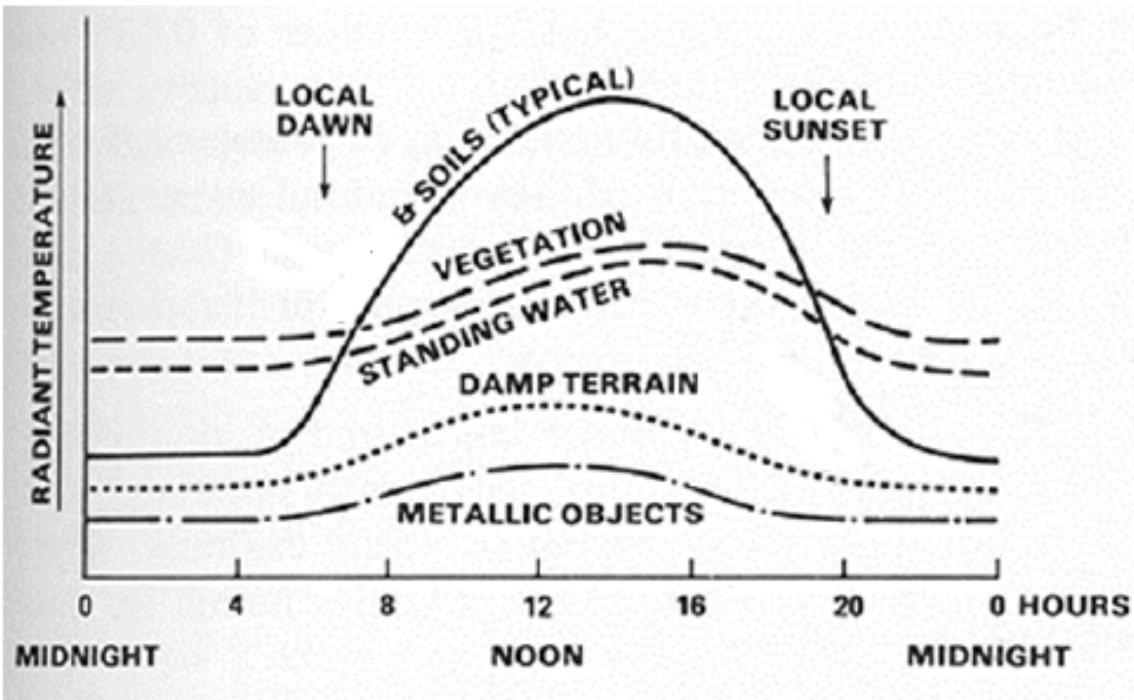
- For most geologic materials, ρC only varies by a factor of two, whereas k varies by many orders of magnitude.

- k is mostly determined by particle size, degree of induration.

⇒ A concrete sidewalk has a much higher thermal inertia than a sandy beach!

Note that on Earth, the high C of water means moisture content also plays a big role in determining T.I.

Diurnal Temperature Curves



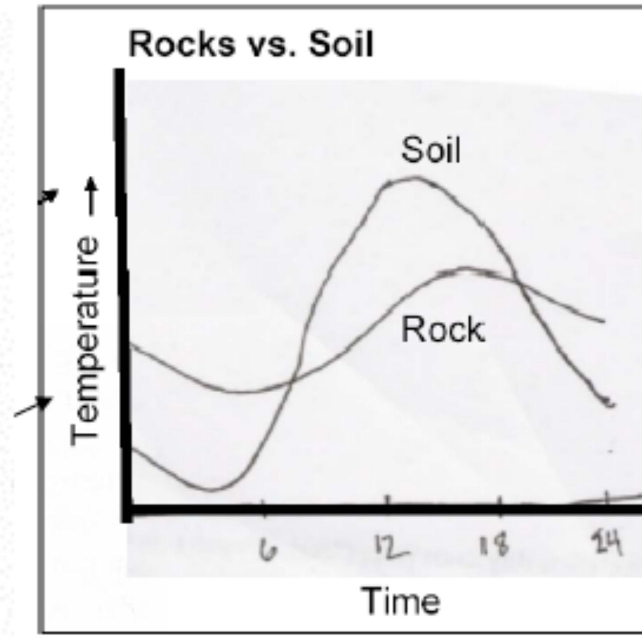
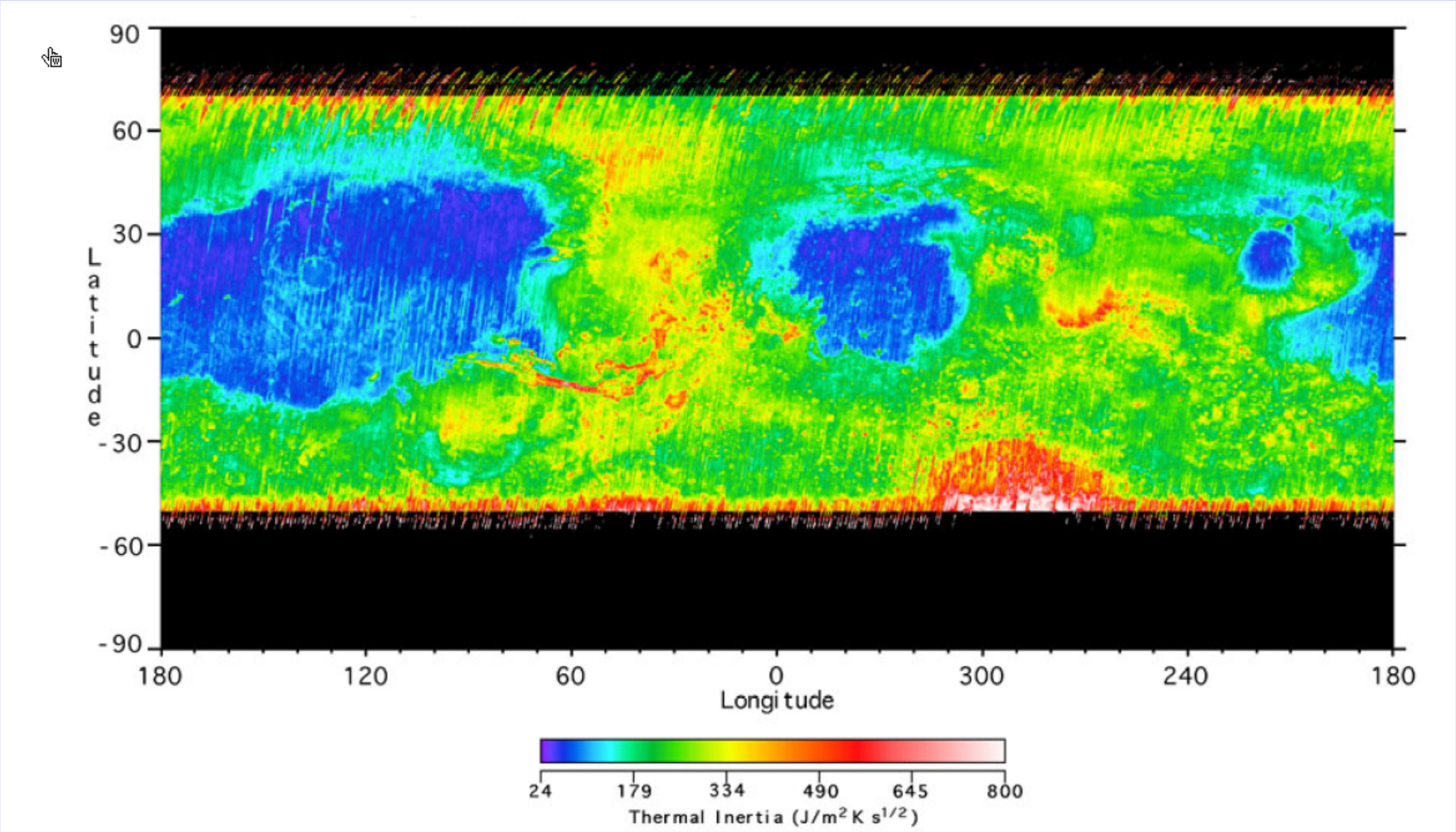


Table 1. Estimated thermal properties of Mars-like geologic materials

Material	Density	Specific Heat Capacity	Thermal Conductivity**	Thermal Inertia
	$kg\ m^{-3}$	$J\ kg^{-1}\ K^{-1}$	$W\ m^{-1}\ K^{-1}$	$J\ m^{-2}\ s^{-1/2}\ K^{-1}$
Basalt	2600	800*	2.5	2280
Sandstone	2300	800*	0.5	960
Coarse Sand	1750	800*	0.1	374
Fine Sand	1500	800*	0.02	155
Fine Dust	1000	800*	0.001	28

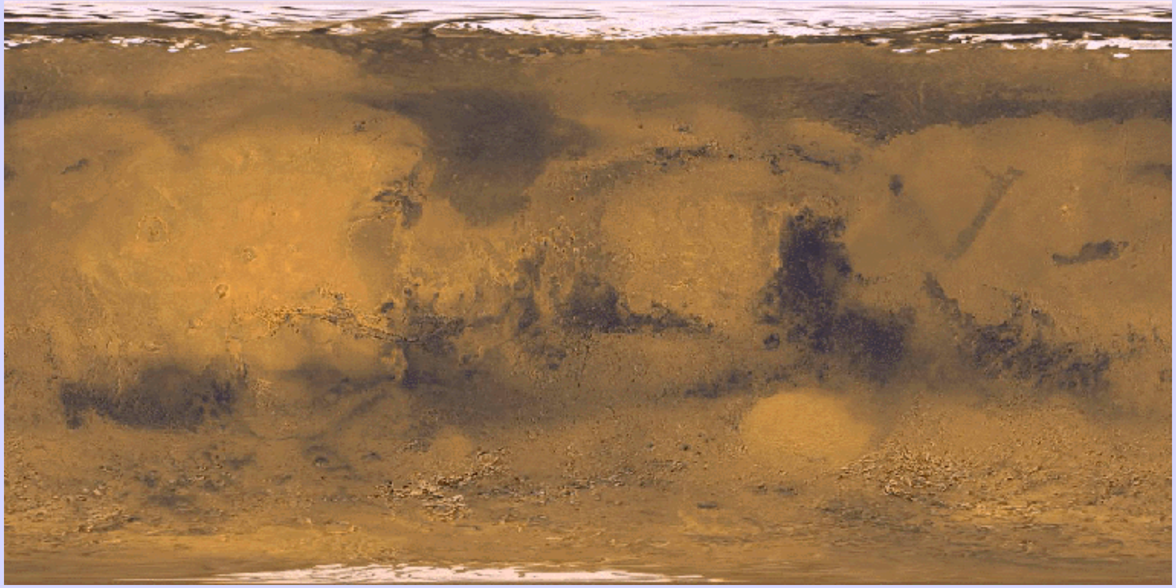
* Assuming a basaltic mineral composition for each material.
** Assuming martian atmospheric pressures in the interstice of the porous materials.

Martian Global Thermal Inertia Map



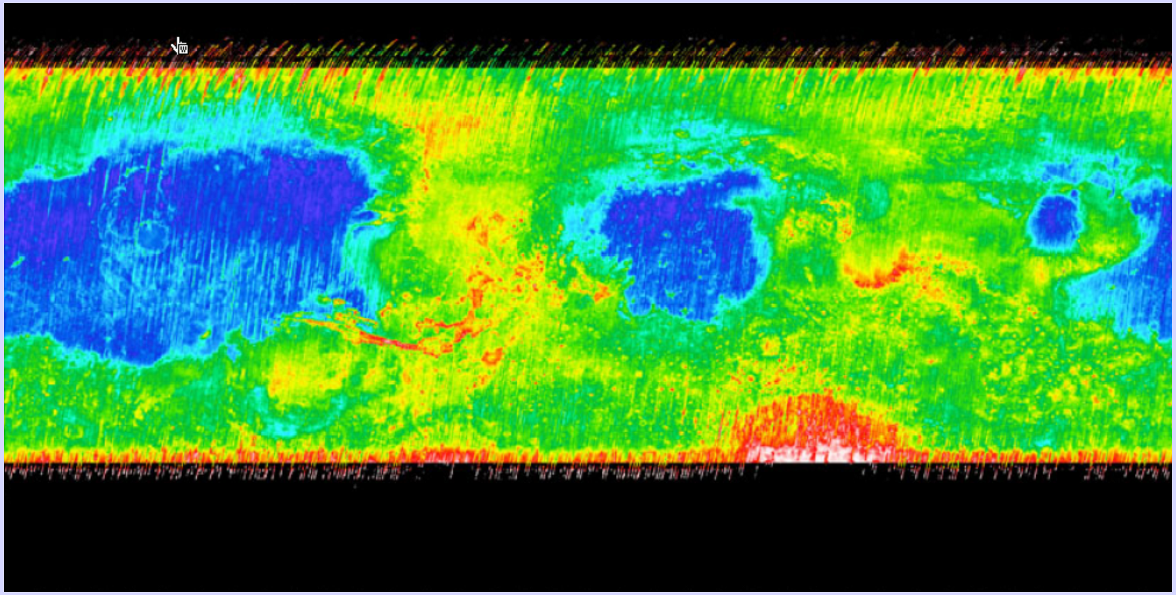
Blues indicate low TI ⇒ Fine-grained dust

Reds indicate high TI ⇒ Lots of rocks and outcrop



Martian

albedo



Martian
thermal
inertia

Very low T.I. on Saturn moons → high porosity?