

RADAR => *RA*dio
*D*etection *A*nd
*R*anging

X-SAR
image from
the SRTM
mission of
the Mojave
Desert

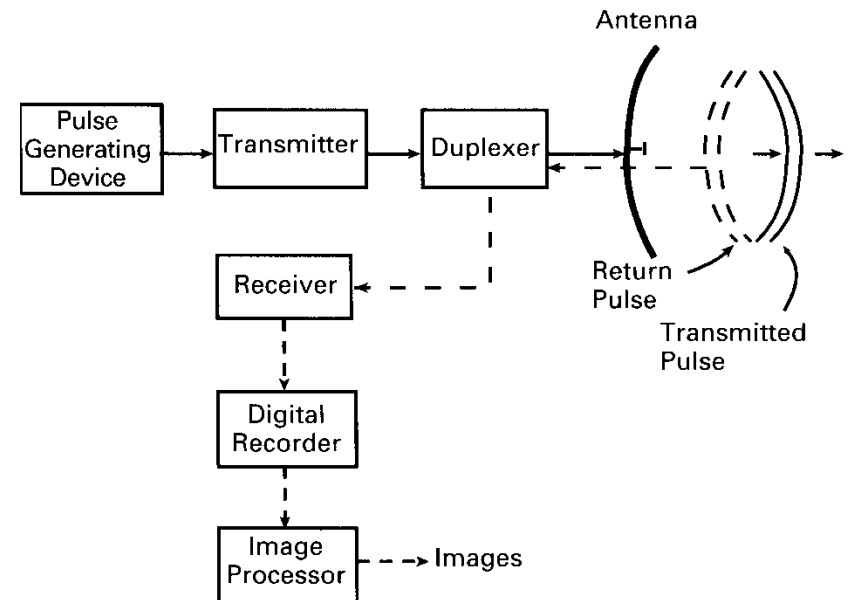
Introduction and Definitions

RADAR = Radio Detection and Ranging

“Active” remote sensing technique

Typical applications:

- “See through” clouds and haze, surface veneers
- Map surface textures
- Map topography
- Map moisture content
- Temporal change detection



Radar Wavelengths

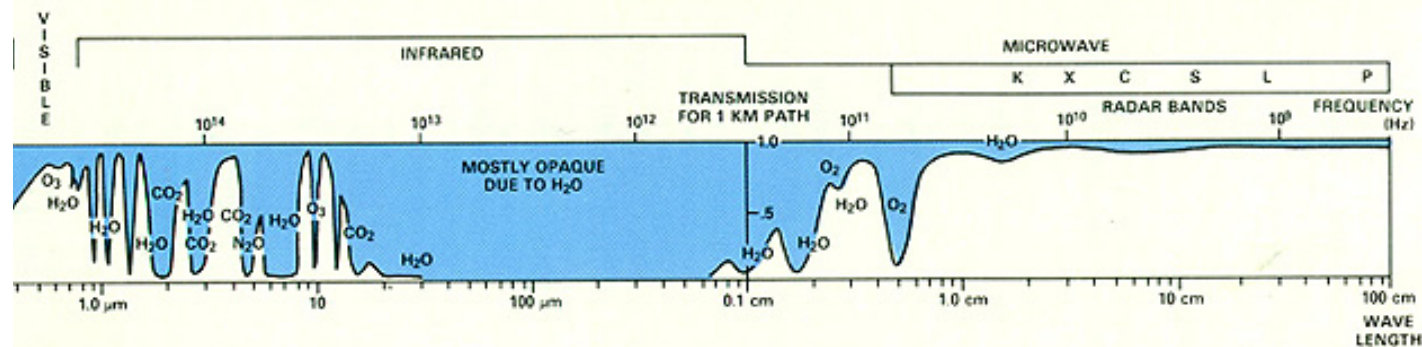
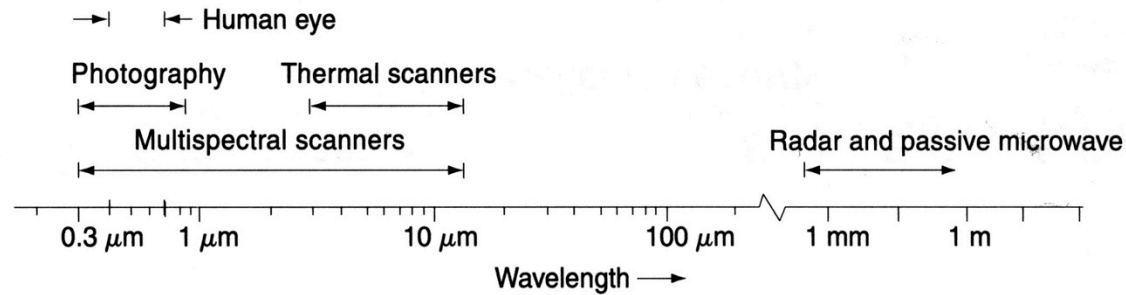
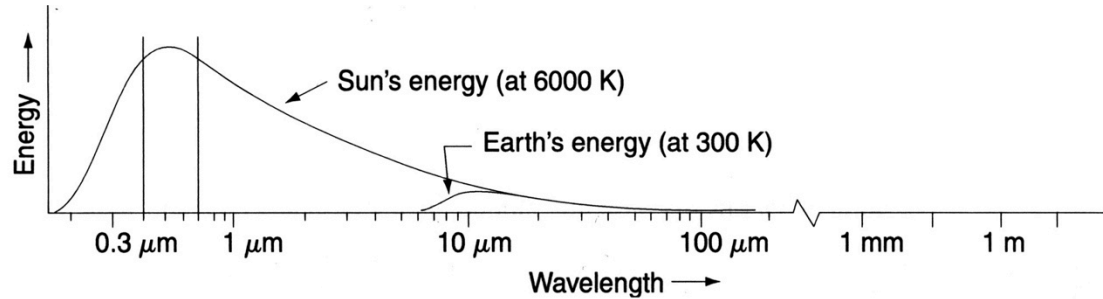
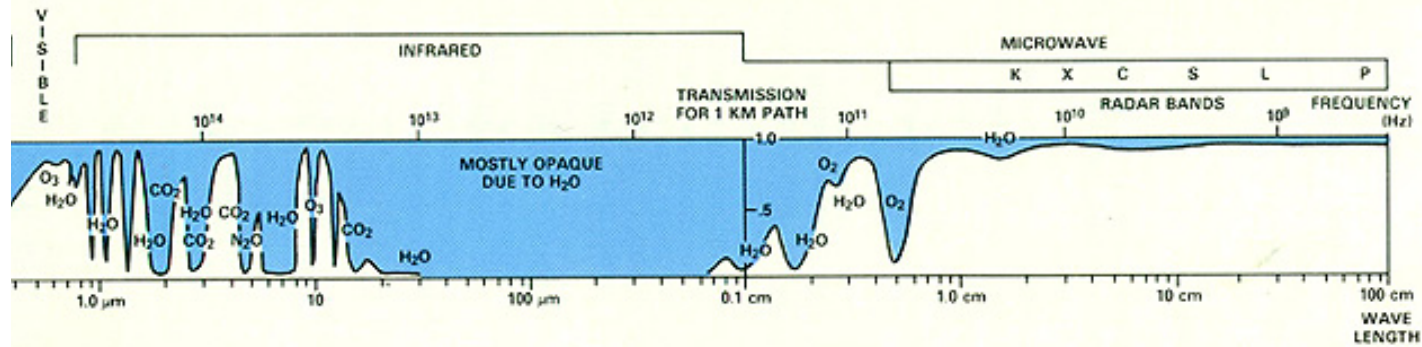


TABLE 8.1 Radar Band Designations

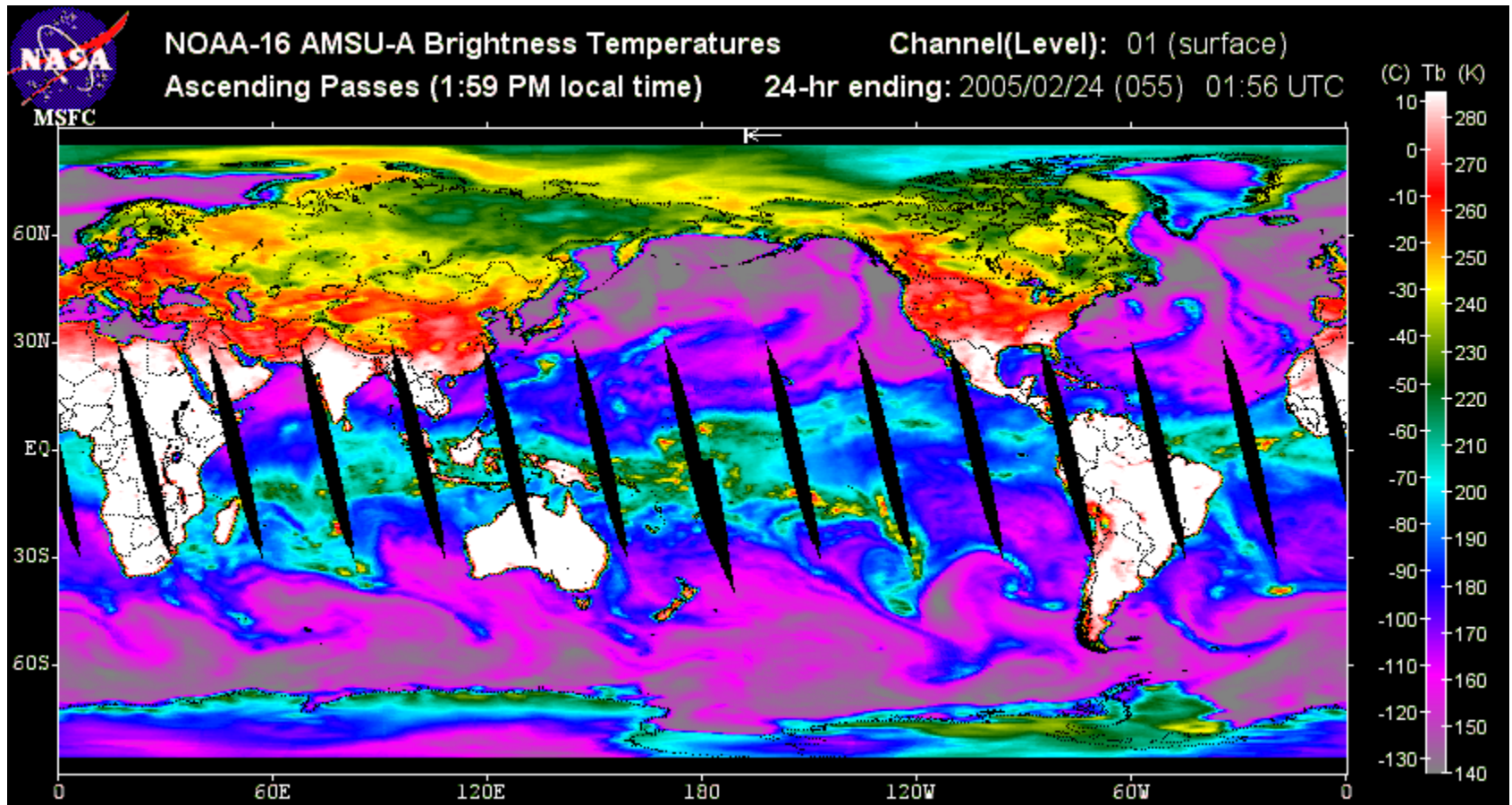
Band Designation	Wavelength λ (cm)	Frequency $\nu = c\lambda^{-1}$ [MHz (10^6 cycles sec^{-1})]
K_a	0.75–1.1	40,000–26,500
K	1.1–1.67	26,500–18,000
K_u	1.67–2.4	18,000–12,500
X	2.4–3.75	12,500–8,000
C	3.75–7.5	8000–4000
S	7.5–15	4000–2000
L	15–30	2000–1000
P	30–100	1000–300

$$\lambda \text{ (cm)} = 30 / \nu \text{ (GHz)}$$

Microwave spectral region



Passive Microwave



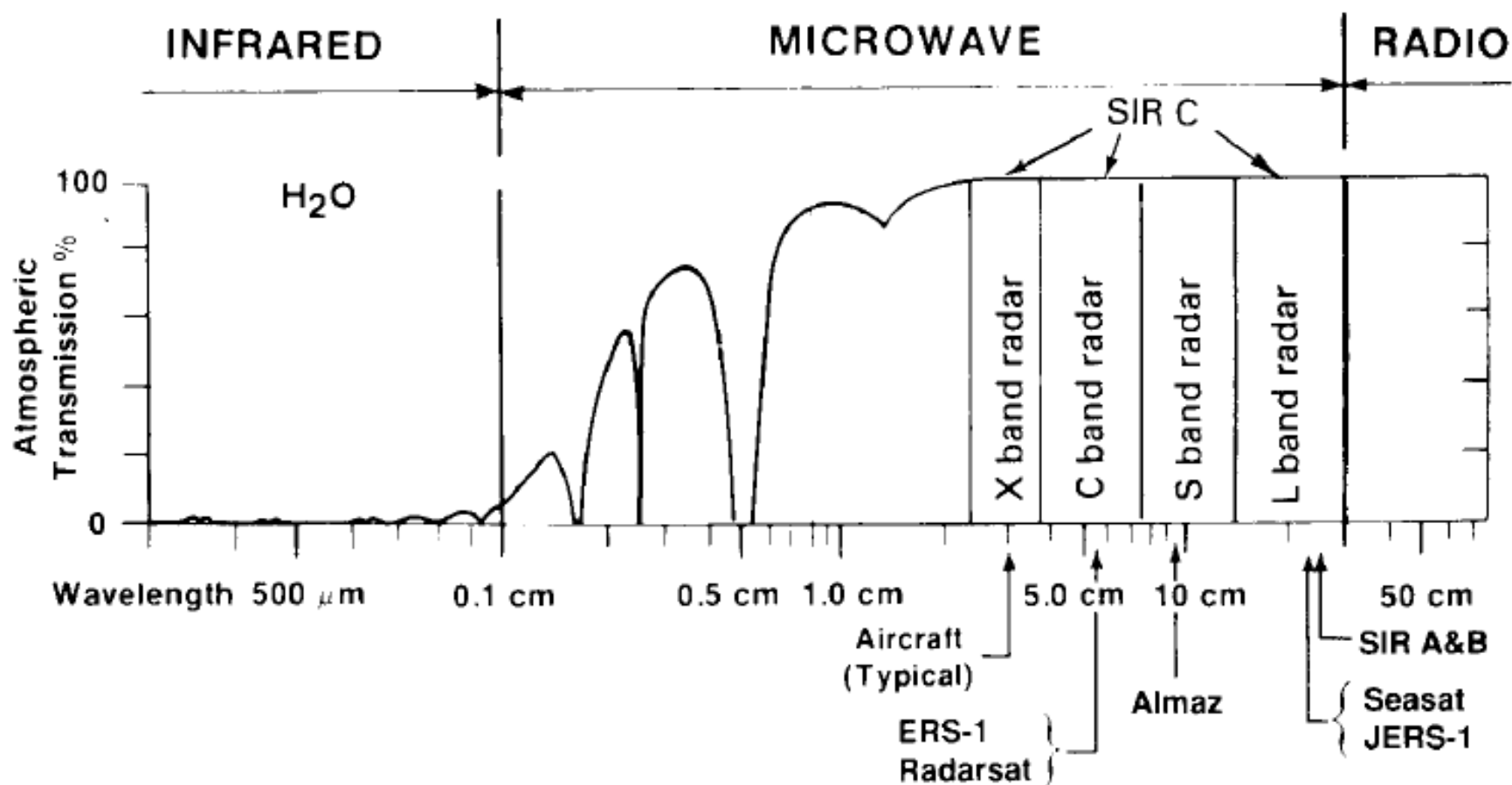
Q: Why are these brightness temperatures so low (especially over the oceans)?

A: emissivity of water < 1

Can measure ocean temperature, salinity, roughness (waves, and thus winds)

Land applications: soil moisture, ice/snow cover, vegetation (but low resolution from space)

Microwave Atmospheric Window



Radar Systems

- SEASAT (1978-; U.S.)
- RADARSAT (1995- ; Canada)
- JERS (1992 ; Japan)
- RISAT (2012; India)
- AIRSAR (airplane-based) - Flies in DC-8 with C, L, and P bands
- SRTM - X-band and C-band radar (shuttle based)
- SIR-A,B,C (1981-1994)

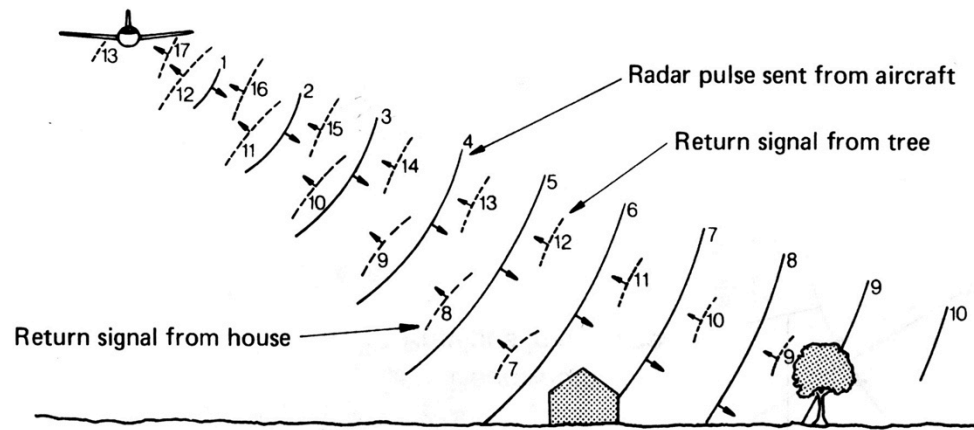
- Magellan (1989 to Venus)
- Sharad and MARSIS (2001, 2005 to Mars)
- Cassini Radar (1997 to Titan)

Radar Applications

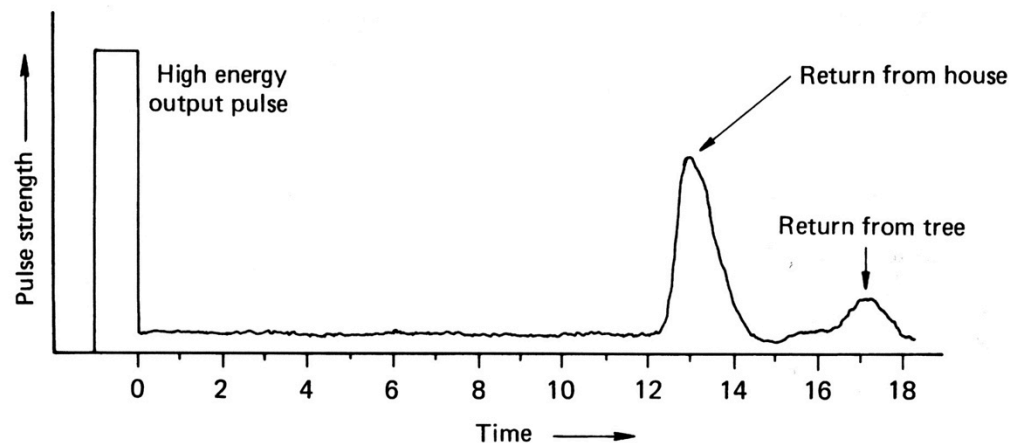
- Radar altimetry
 - Measure round trip travel time to determine distance between antenna and surface
- Radar interferometry
 - Broadcast from one antenna and receive at two antenna with known distance between them
 - Phase difference for two antennas used to determine topography.
- Radar imaging
 - Measure returned energy flux
 - Return controlled by dielectric constant (index of refraction) of materials, roughness of surface at wavelength scale, and slopes at many multiples of wavelength

Radar Imaging: Side Looking Radar (SLR)

In remote sensing, the view is to the side and the motion of the airplane or spacecraft allows an image to be built up, line by line.



(a) Propagation of one radar pulse (indicating the wavefront location at time intervals 1-17)



(b) Resulting antenna return

Figure 8.1 Operating principle of SLR.