Mon. Mar. 26, 2018

• Finish Radar Ch. 6 &7
  – Radar Roughness
  – Titan Radar results
  – Lidar

• Start remaining Ch. 8 material
  – For Wed. lab review Filtering and Principal Components Analysis (PCA)

• Lab Projects for final two weeks of labd
Radar Roughness:
Use previously posted slides
Ice/Ground Penetrating Radar (GPR)

Large dielectric constant mostly due to liquid \( \text{H}_2\text{O} \)
At cold temperatures (so no liquid present) and low frequency ice is very transparent to radar.
Above shows Mars North polar cap (Putzig et al. 2009)
SHARAD (20 MHz) on MRO
Cassini Titan – Observations

Haze obscures most of surface in visible and near-IR

Can barely see surface in some IR windows like this 0.938 μm one.
Cassini Titan – Radar Observations

Hydrocarbon (Methane – Ethane lakes) Why are features dark:
Smooth liquid surface? (Later obs. prove this)
Smooth dry lake bed?
Cassini Titan – “Sand” Dunes

Synthetic Aperture Radar
Ku (2.17 cm)
Long Swaths on each flyby
Changing surface slope gives changing incidence angle

Smaller incidence angle means larger return signal

If you know backscatter coefficient as function of incidence angle, you can find surface slope from returned signal strength.
Cassini Titan – Radarclinometry

Lorentz et al. (2006) use brightness to estimate slopes:

Solid curve: Elevation profile of titan
Dashed curve: Elevation profile for Namib dunes shown on right
Deforestation monitoring in Indonesia and Malaysia using PALSAR

RGB = (HH, HV, HH-HV)
  Green = Forests (strong depolarization as L band =1.27 Ghz = 23.6 cm penetrates canopy then scatters from trunks and limbs)
  Purple = Cleared areas

PALSAR: Phased Array L-band Synthetic Aperture Radar
  flying on Japan’s ALOS (Advanced Land Observing Satellite)
  Jan. 24, 2006 launch, Sun-synchronous orbit
  Also has visible stereo camera (PRISM) and visible/NIR instrument (AVNIR-2)
LIDAR / Laser Altimeter Systems

Light Detection and Ranging
Typically use Laser pulse system

Simple ones give elevation
MOLA: Mars Orbiter Laser Altimeter on Mars Global Surveyor

More complex ones can measure multiple returns / scatter: eg.
First pulse from top of tree canopy
Last pulse from ground surface
Plus scattered light inside forest
MOLA: Mars Orbiter Laser Altimeter

http://ssed.gsfc.nasa.gov/tharsis/Mars_topography_from_MOLA.new/
MOLA: Mars Orbiter Laser Altimeter

1.064 μm
10 Hz pulse rate
48 mJ per pulse (at Mars)
Laser spot: 0.4 mrad ⇒ 130 m
Receiver IFOV: 0.85 mrad
Vertical precision: 37.5 cm
Vertical accuracy: 10m

http://ssed.gsfc.nasa.gov/tharsis/Mars_topography_from_MOLA.new/
Laser Elevation from
"IceSat: Ice, Cloud, and Elevation Satellite: Greenland"

2003 -- Feb. 2010
NASA filling gap with aircraft LIDAR flights
~2016 ICESAT-2 will give follow-on data
Monitor changing ice thickness

Laser pulses: 40 per second (170m spacing)
Laser spot size: 70 m
Vertical resolution: 5 cm for single pulse
Repeat cycle: 8 days early in mission, 183 days during multiyear phase

Theses images from Korn et al. on-line poster
Changes in Greenland Ice thickness

- Previously observed changes in Greenland ice thickness, from various airborne measurements:
  - Edges thinning by up to 60 cm/yr
  - Center thickening by 10 cm/yr
- Image from IceSat web site
- IceSat data available as DEM's from NSIDC (National Snow and Ice Data Center) at NSIDC.ORG
IceSat: Antarctic Data

From Korn et al. on-line poster

Foundation Ice Stream

Megadunes
Variety of return times from given ground pixel

First return – top of tree canopy?

Last return – ground itself?