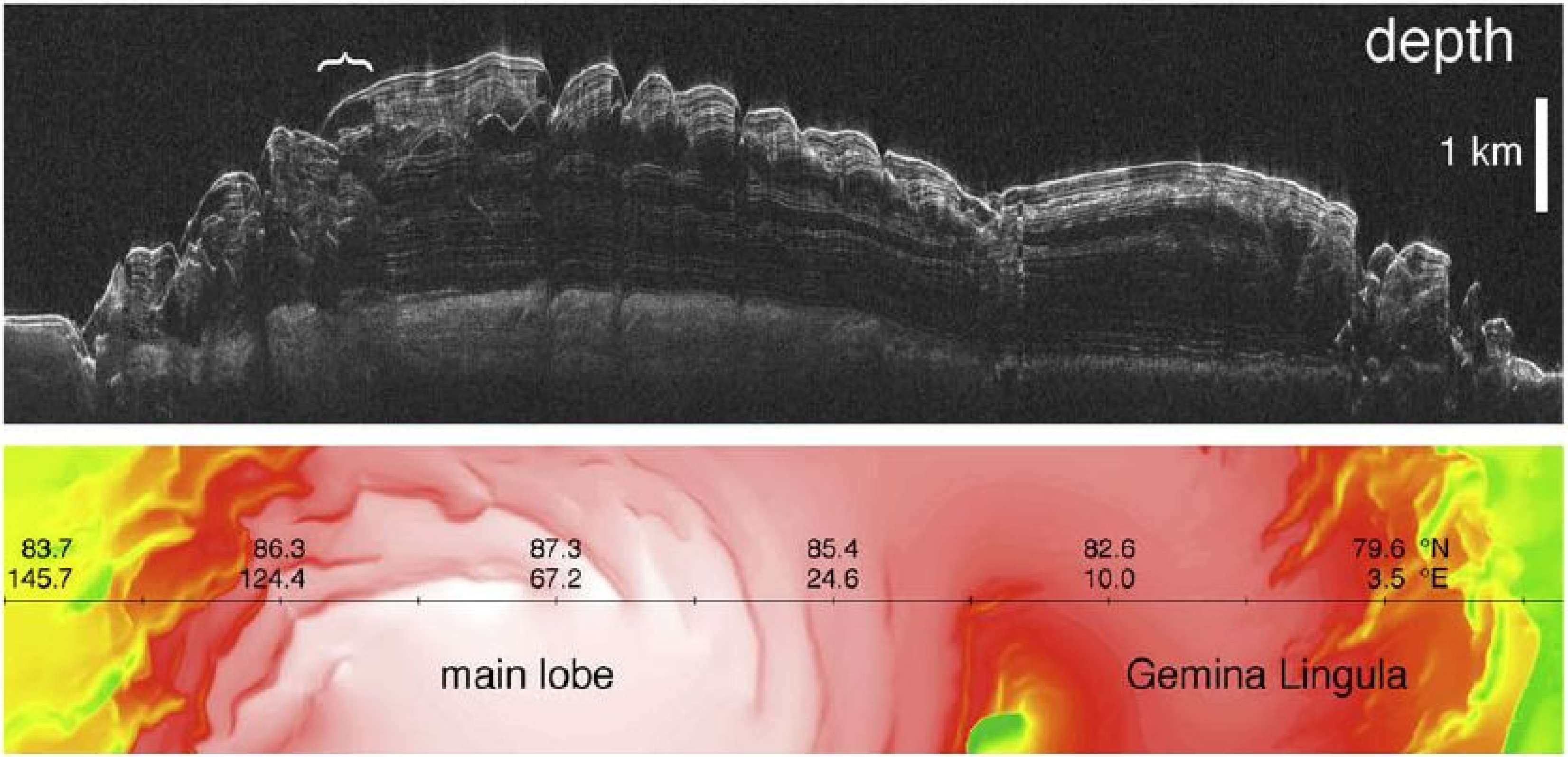
Mon. Mar. 26, 2018

- 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)

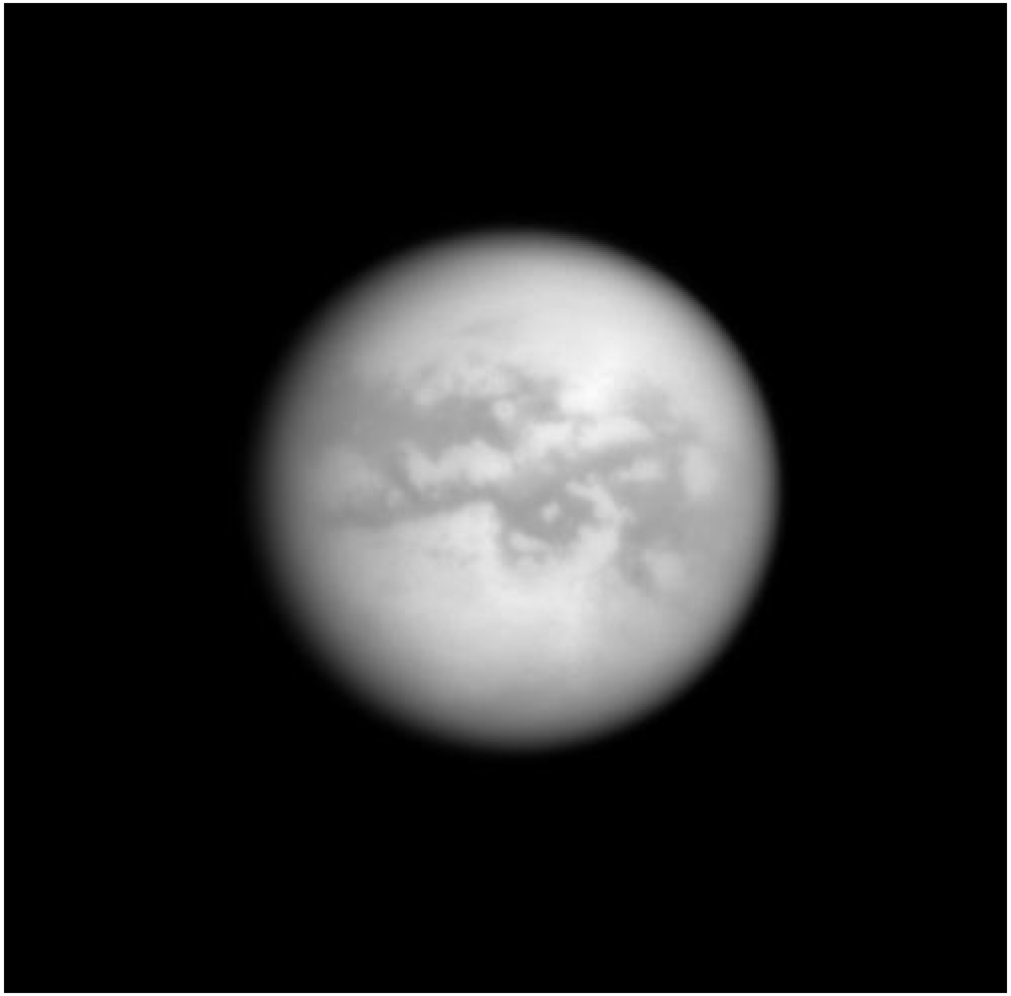


Large dialectric constant mostly due to <u>liquid</u> H_2O

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

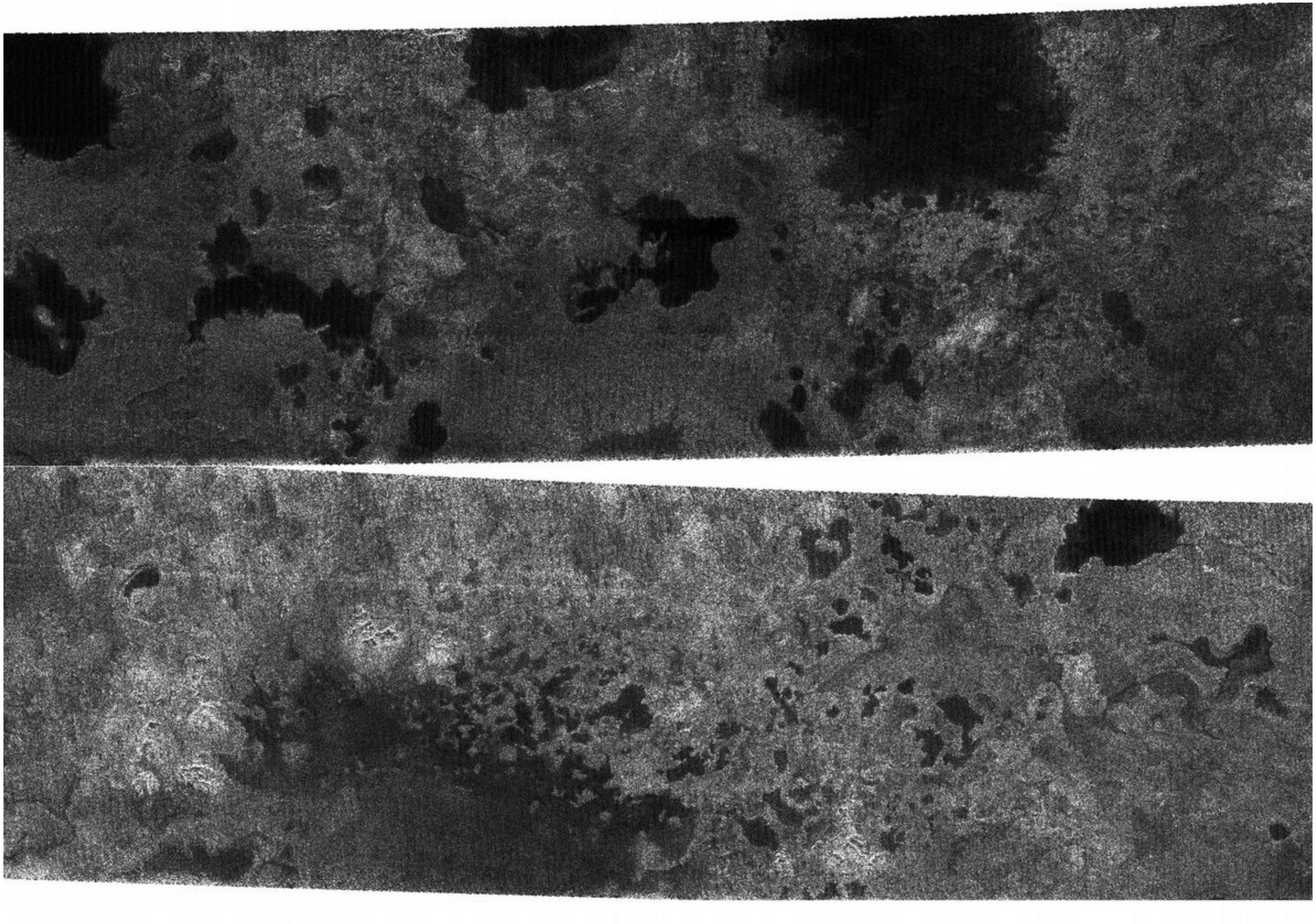
Cassini Titan – Observations



Haze obscures most of surface in visible and near-IR

Can barely see surface in some IR windows like this 0.938 μm one.

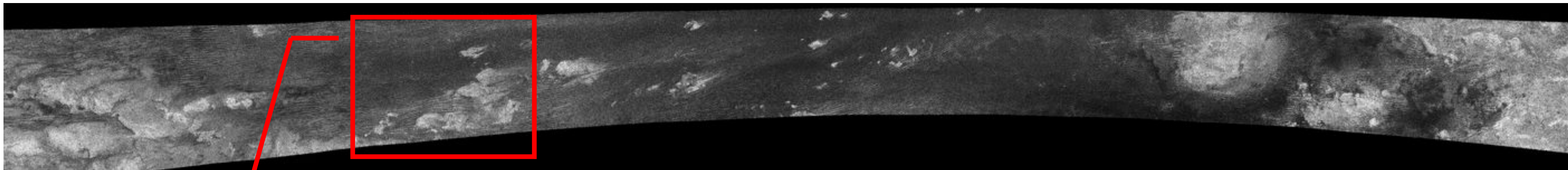
Cassini Titan – Radar Observations

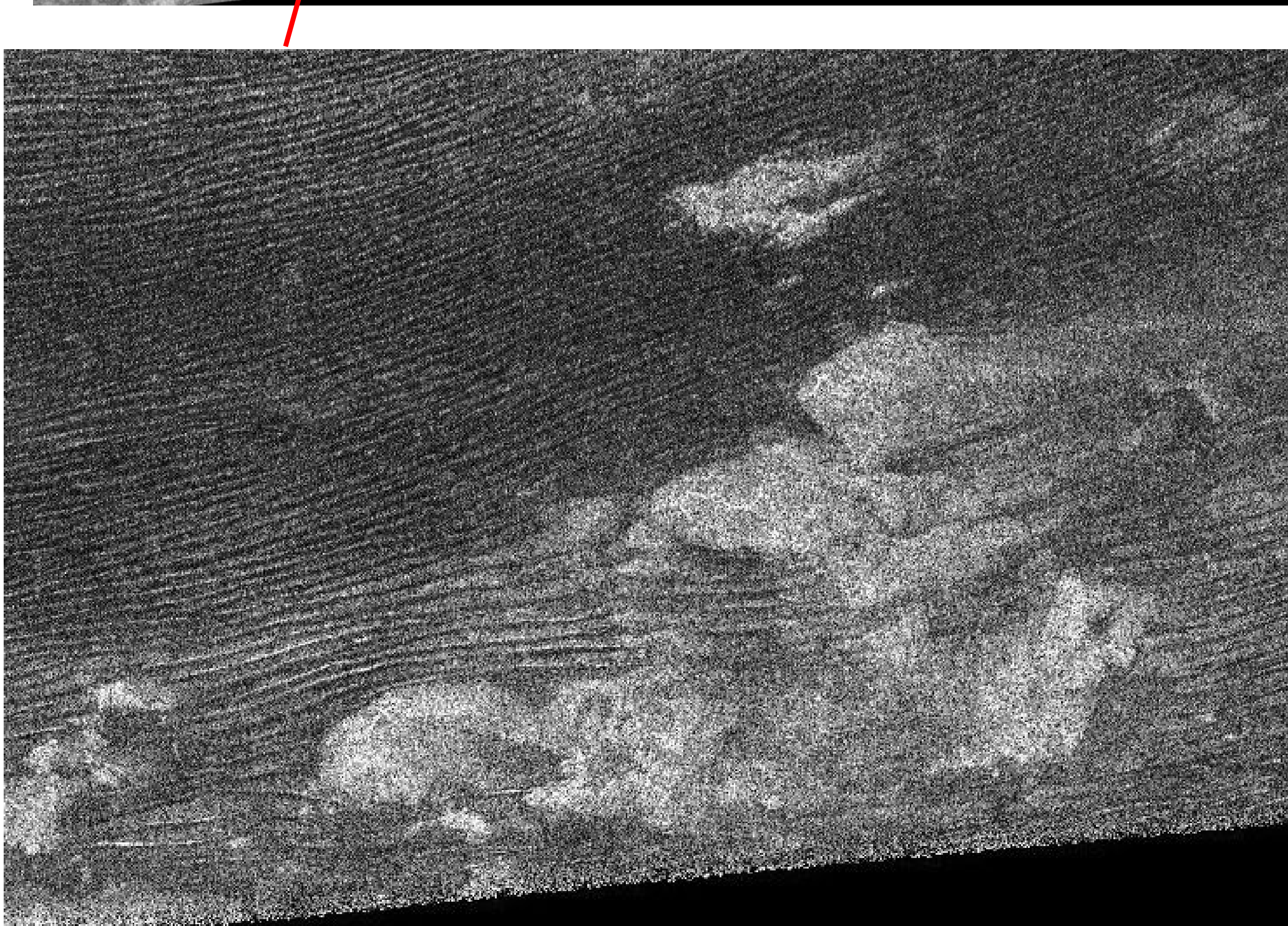


Hydrocarbon (Methane – Ethane lakes)
Smooth liquid surface?
Smooth dry lake bed?

Why are features dark:
(Later obs. prove this)

Cassini Titan – “Sand” Dunes

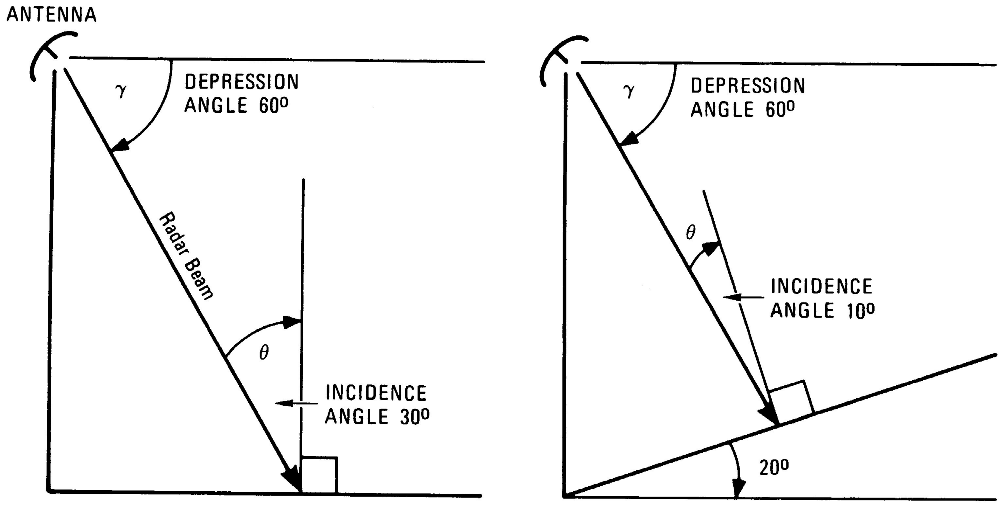




Synthetic
Aperture Radar

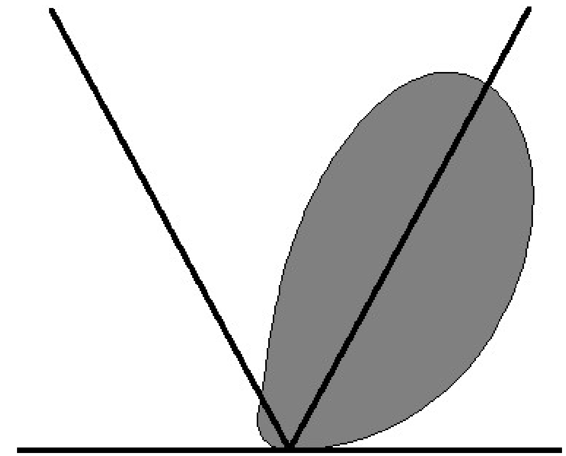
Ku (2.17 cm)
Long Swaths
on each flyby

Radarclinometry



A. Horizontal surface. B. Inclined surface.

Figure 6-5 Depression angle and incidence angle.

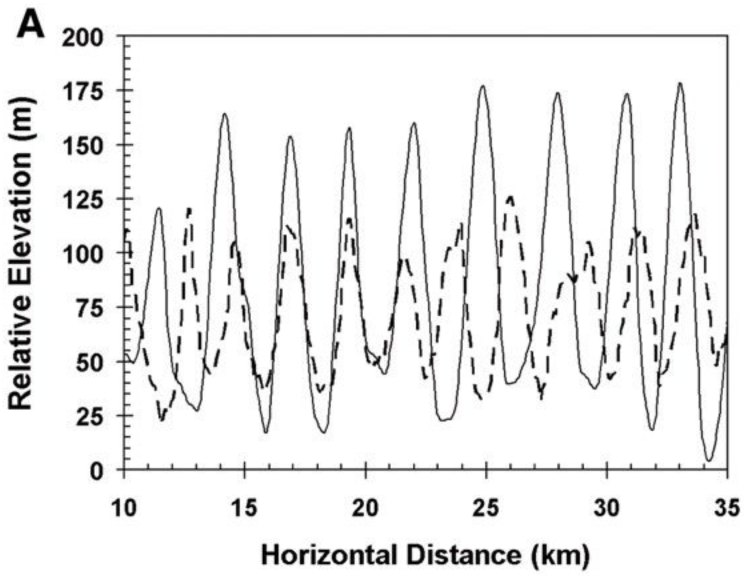


Changing surface slope gives changing incidence angle

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.

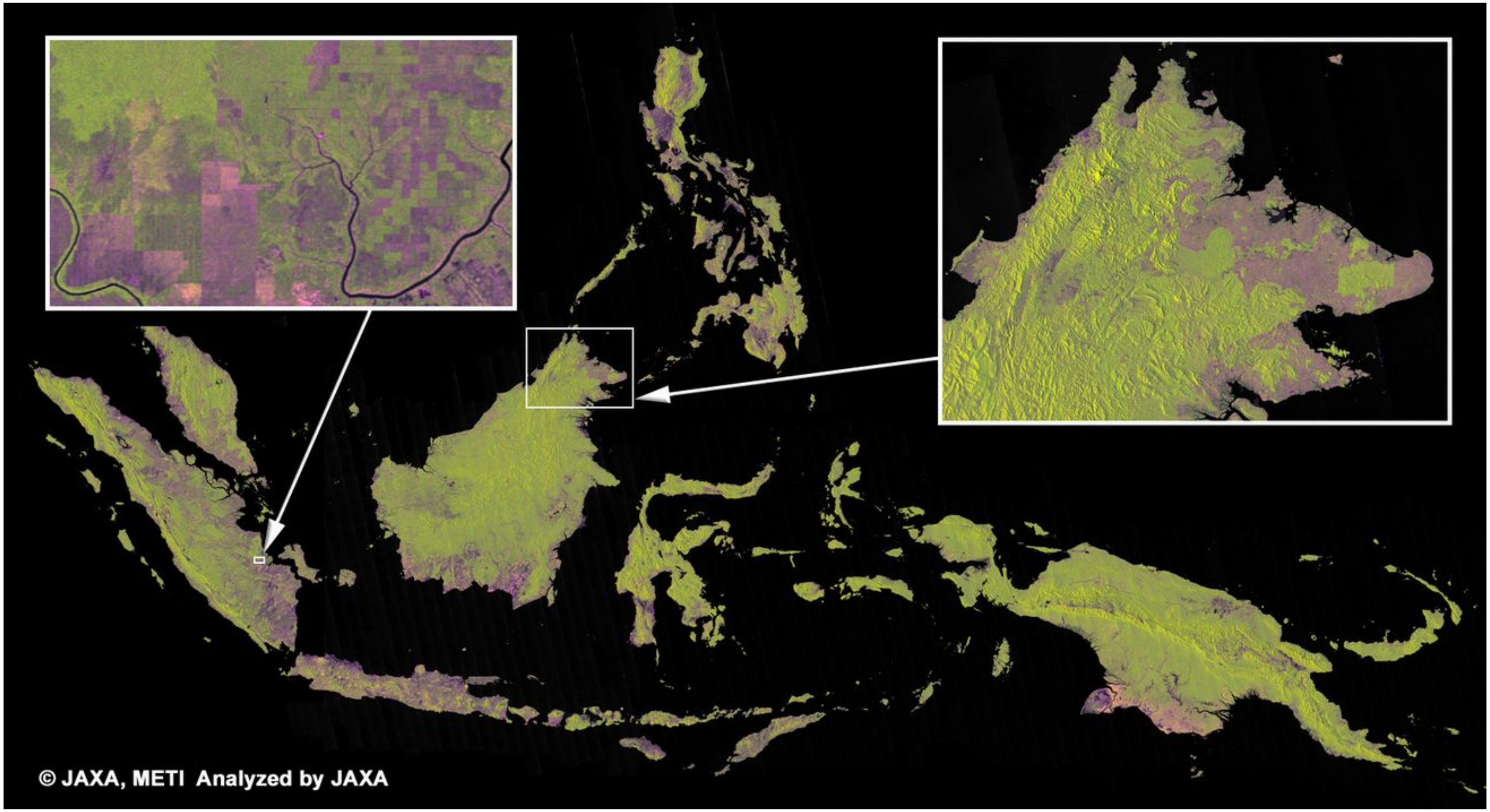
Cassini Titan – Radarclinometry



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

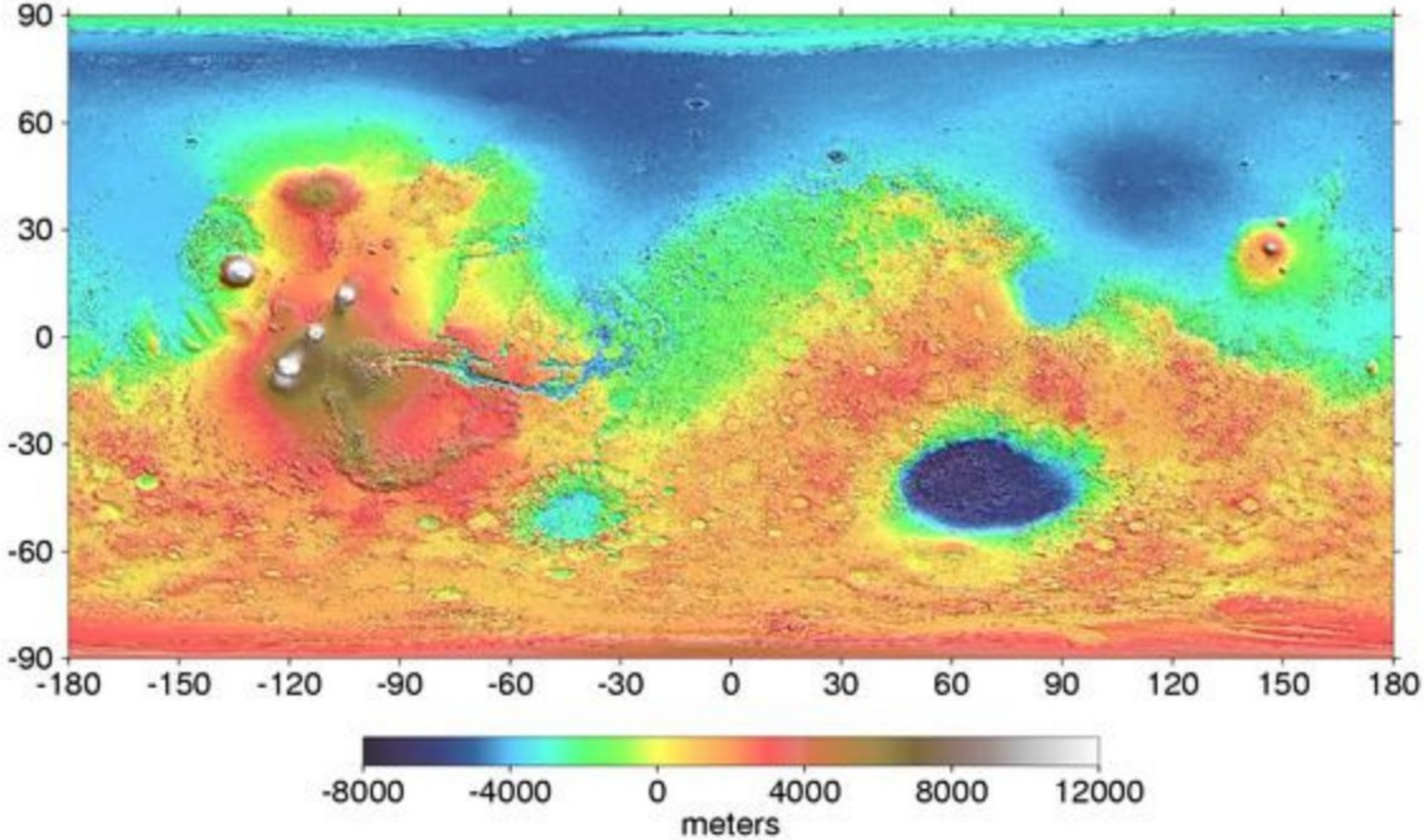
Simple ones give elevation

- MOLA: Mars Orbiter Laser Altimeter on Mars Global Surveyer

More complex ones can measure multiple returns / scatter: eg.

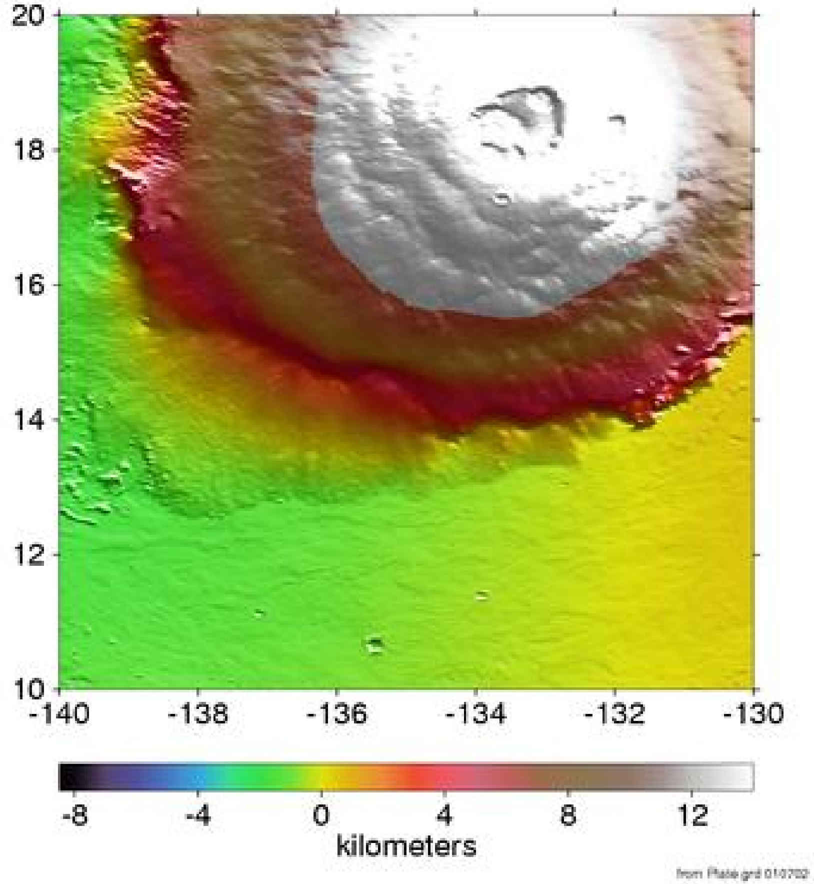
- First pulse from top of tree canopy
- Last pulse from ground surface
- Plus scattered light inside forest

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

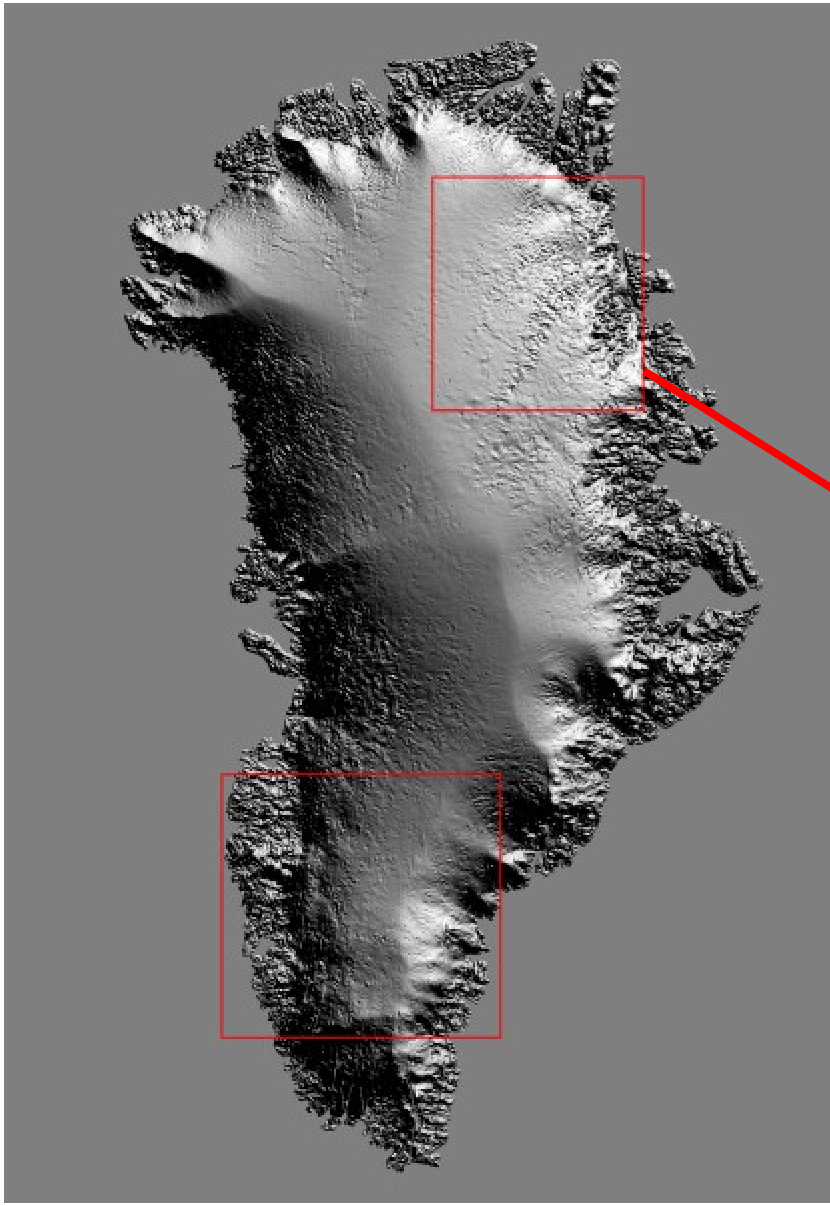
Receiver IFOV: 0.85 mrad

Vertical precision: 37.5 cm

Vertical accuracy: 10m

http://ssed.gsfc.nasa.gov/tharsis/Mars_topography_from_MOLA.new/

- from Korn et al. on-line poster



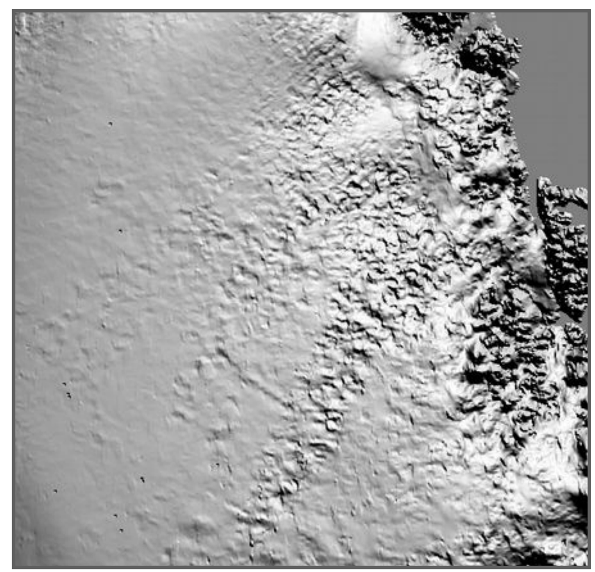
Laser Elevation from "IceSat: Ice, Cloud, and Elevation Satellite: Greenland

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

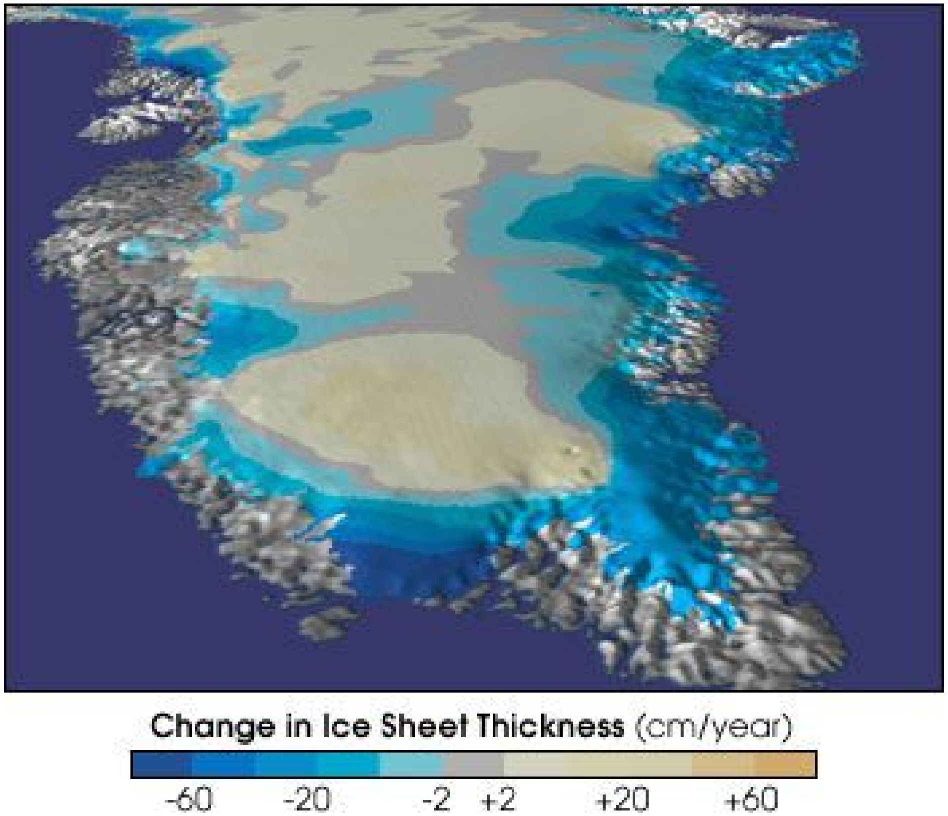
Monitor changing ice thickness

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



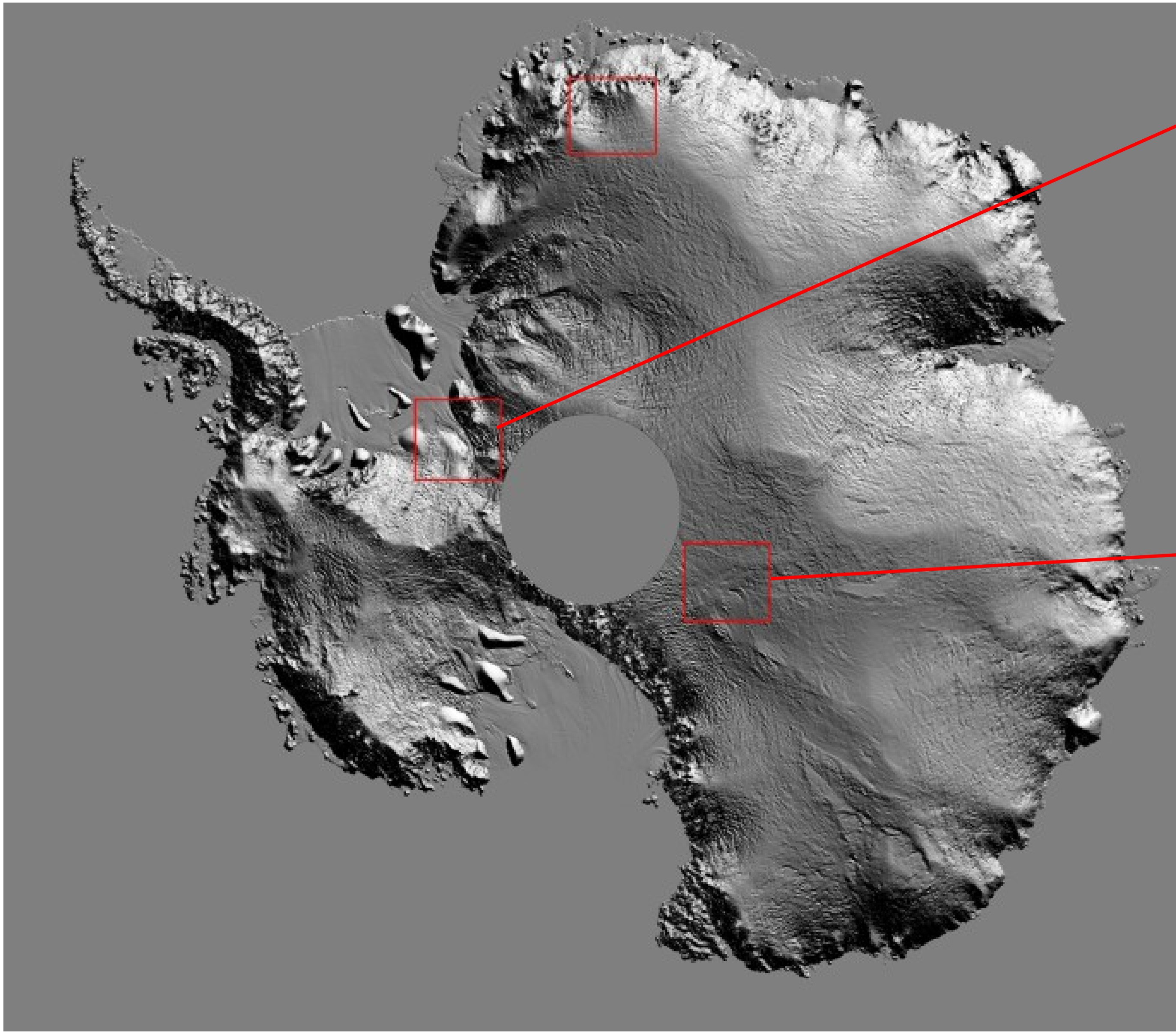
Changes in Greenland Ice thickness

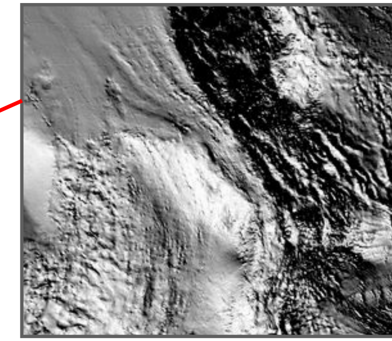


- Previously observed changes in Greenland ice thickness, from various airborn measurements:
- Edges thinning by up to 60 cm/yr
  Center thickening by 10 cm/yr
- Image from IceSat web site
- IceSat data available as DEM's from NSIDC (National Snow and Ice Data Center) at NSIDC.ORG

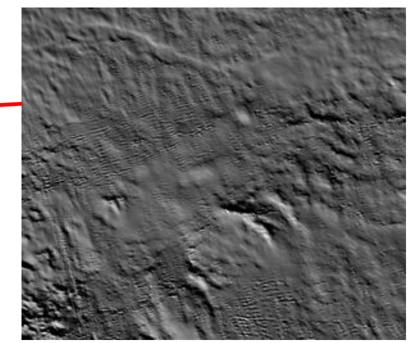
IceSat: Antarctic Data

From Korn et al. on-line poster



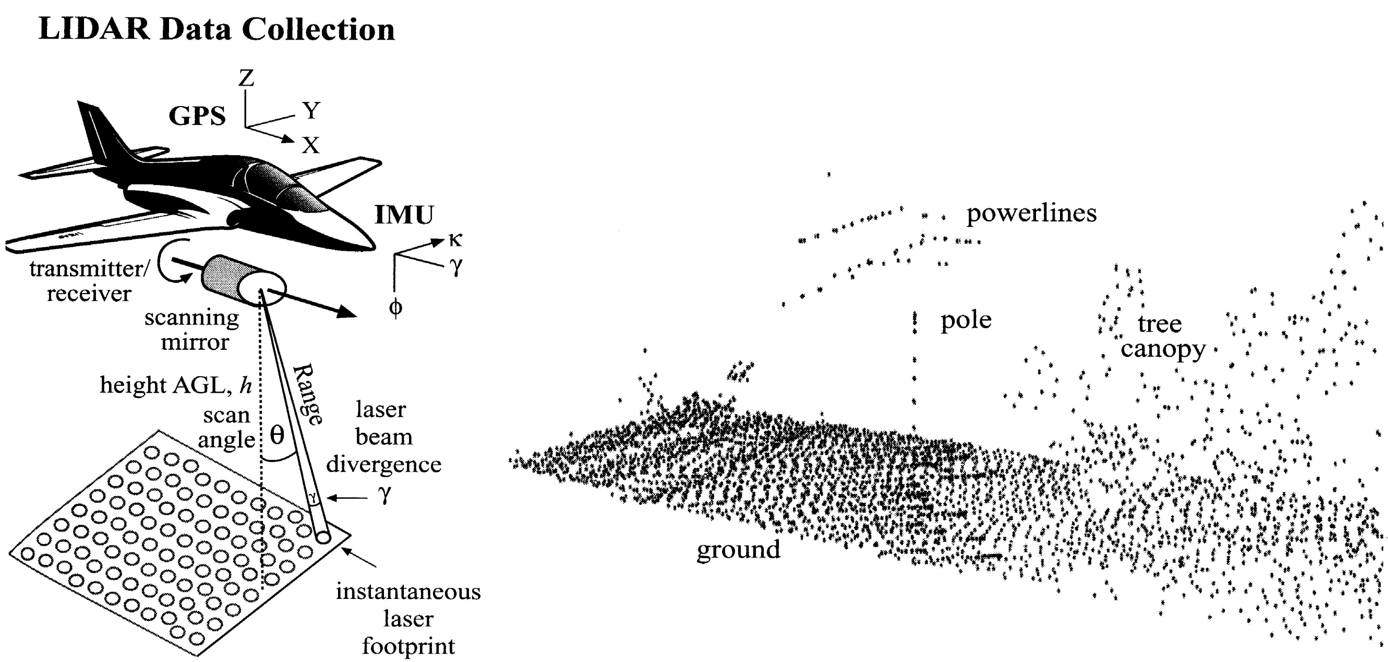


Foundation Ice Stream



Megadunes

Terrestrial LIDAR



a. LIDAR data collection.

b. LIDAR elevation masspoints for a small area.

Jenson Fig 10-1

Variety of return times from given ground pixel

First return – top of tree canopy?

Last return – ground itself?