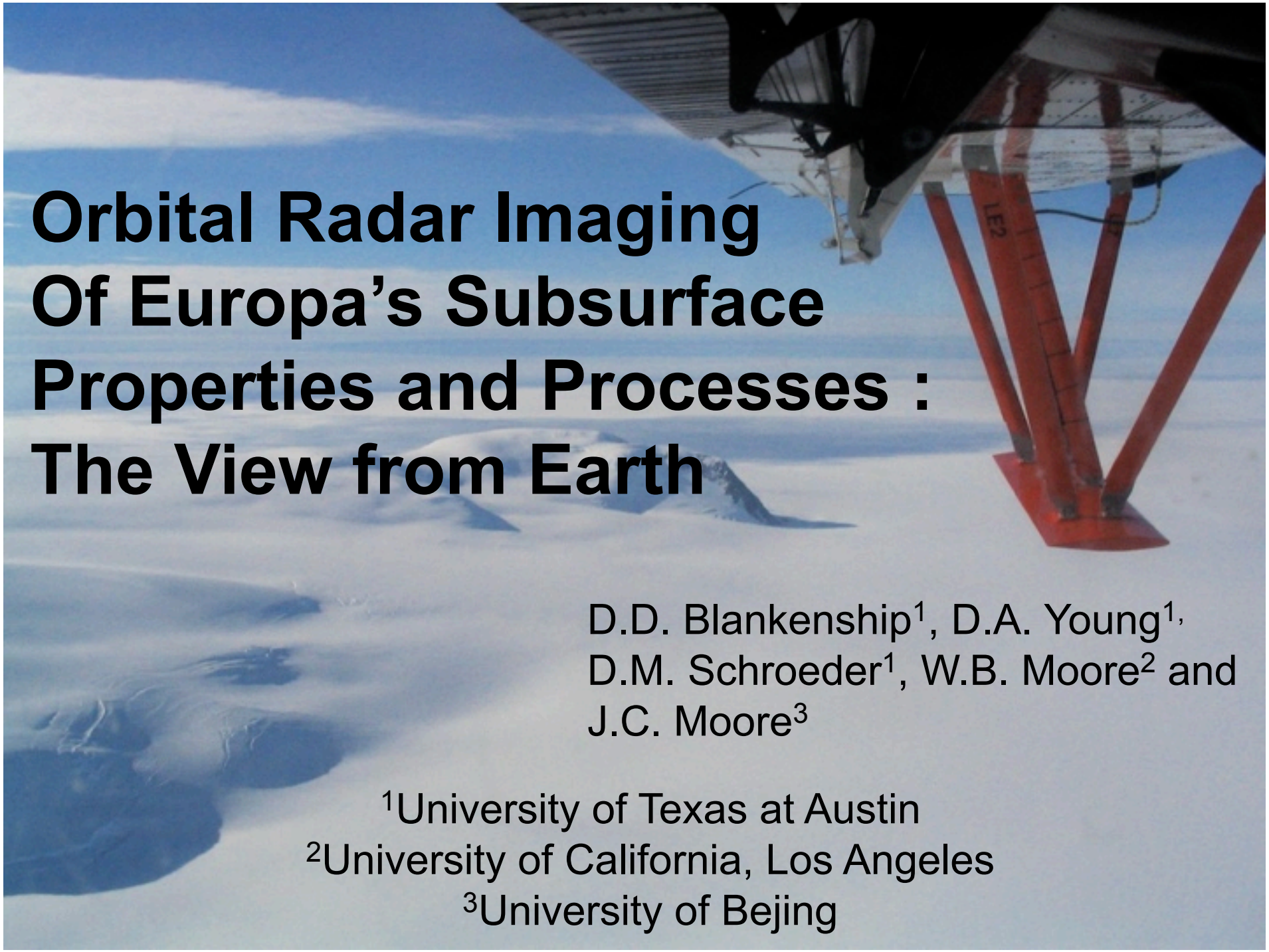


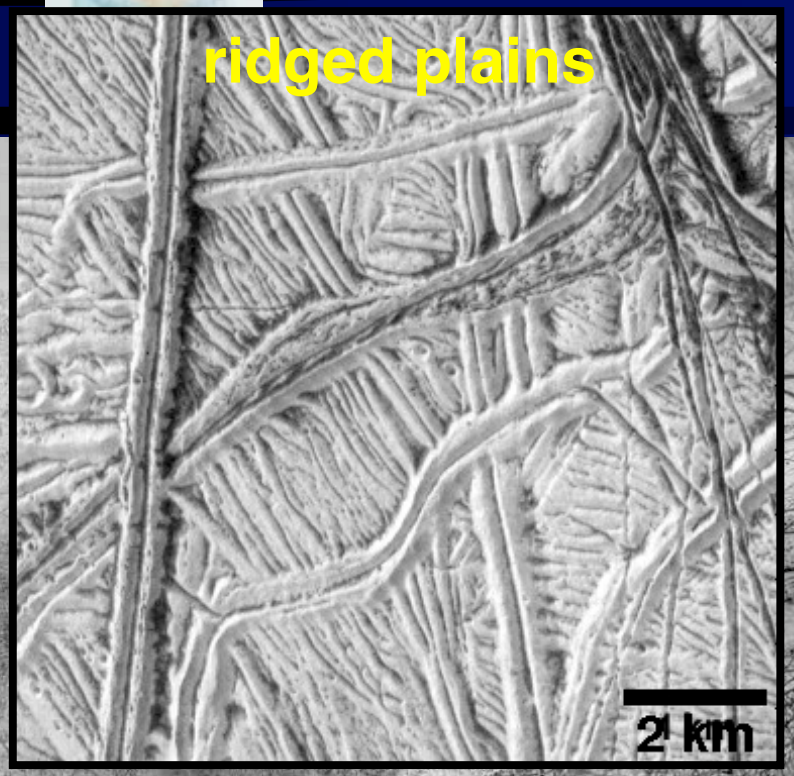
Orbital Radar Imaging Of Europa's Subsurface Properties and Processes : The View from Earth

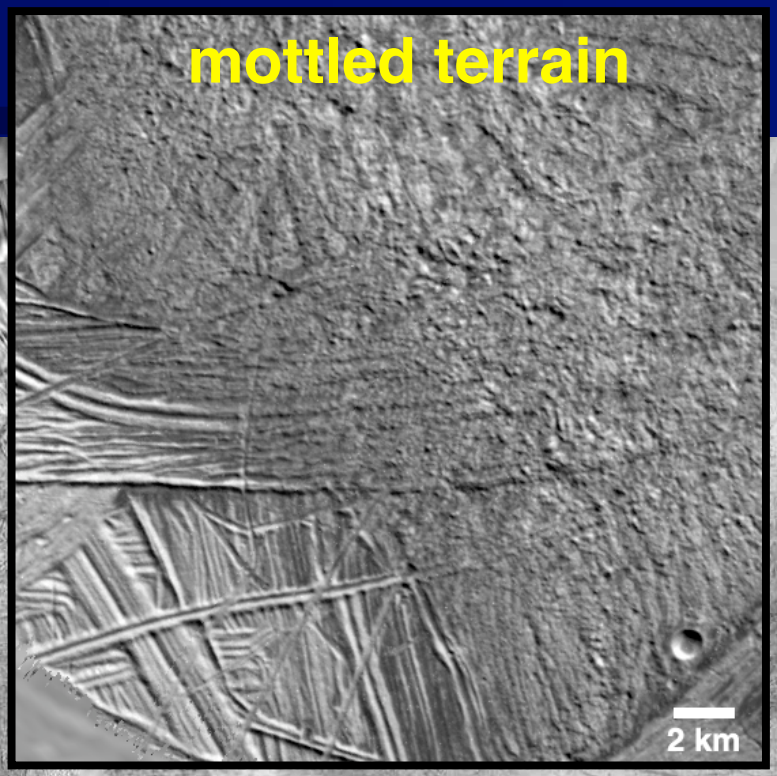
D.D. Blankenship[1], D.A. Young[1,]
D.M. Schroeder[1], W.B. Moore[2] and
J.C. Moore[3]

[1]University of Texas at Austin
[2]University of California, Los Angeles
[3]University of Bejing

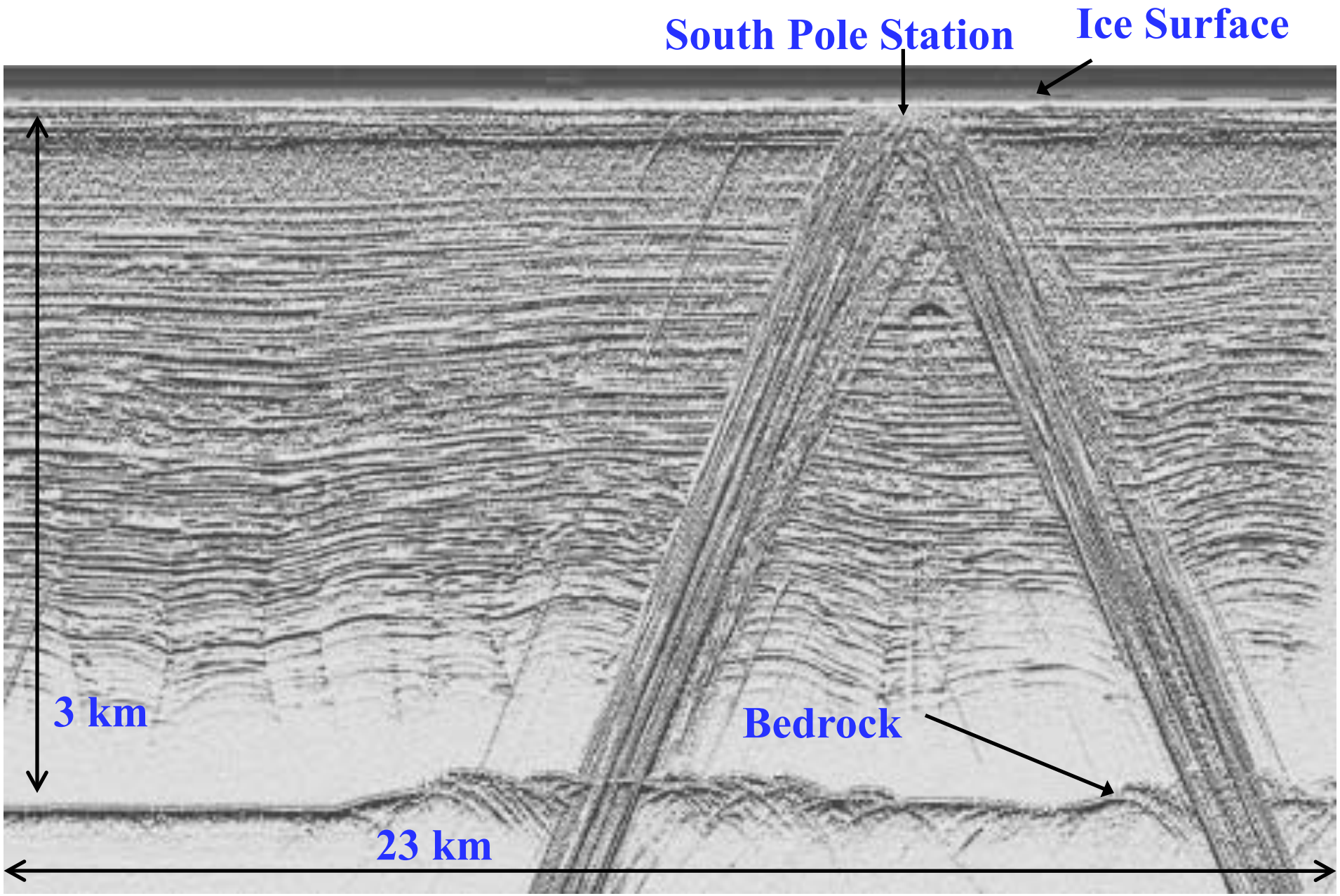
Return to Europa: How do we prepare?

Background: Europa's Geology



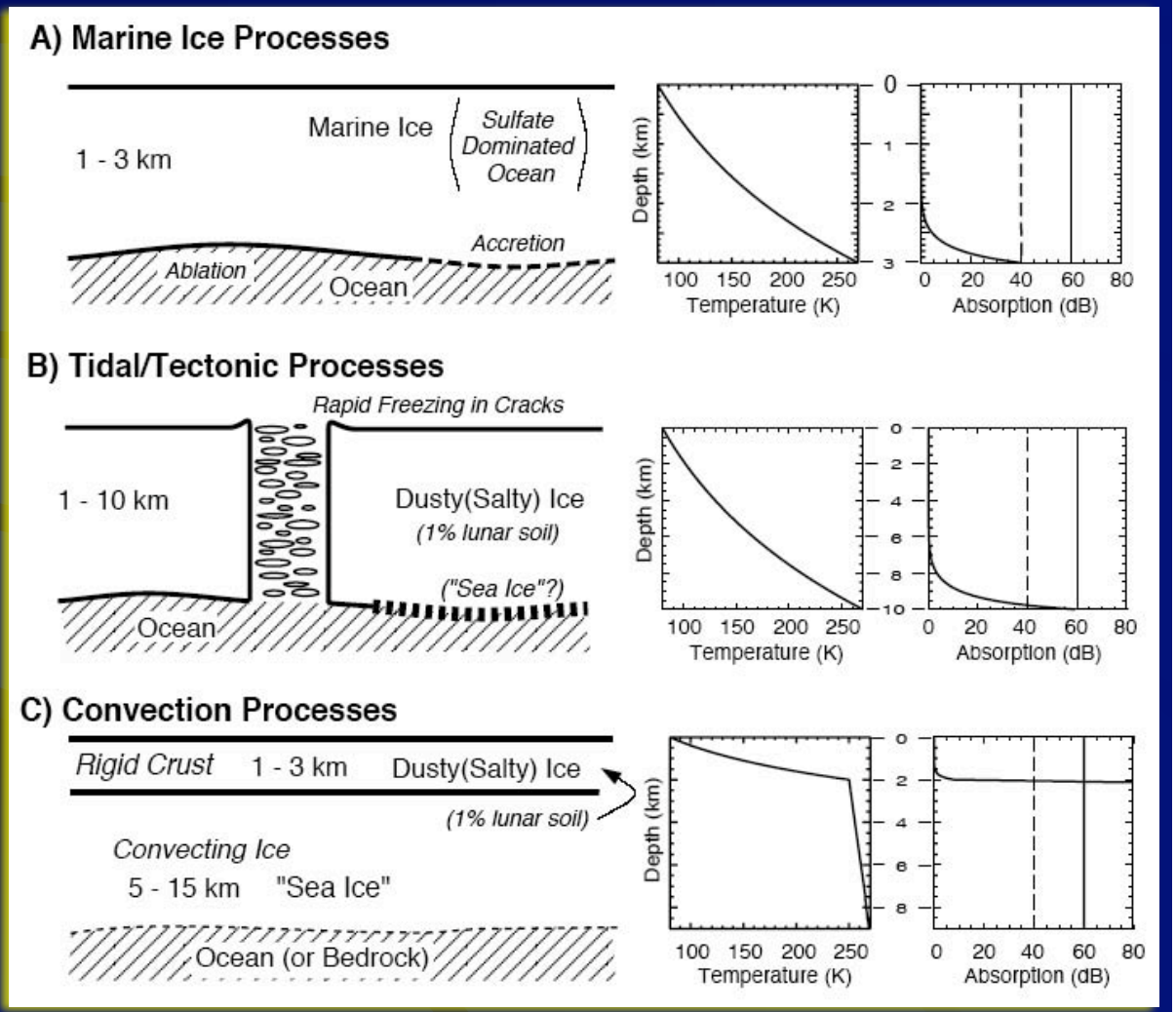


Radar sounding of Earth's ice sheets is routine…

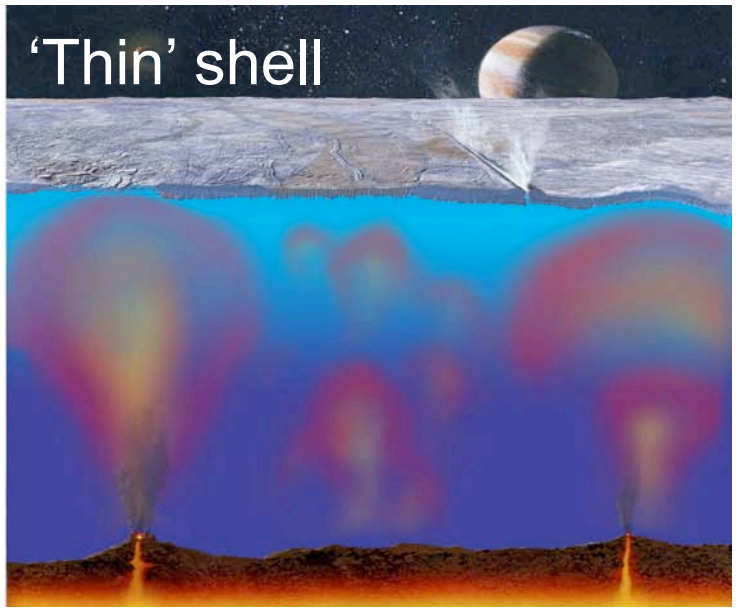


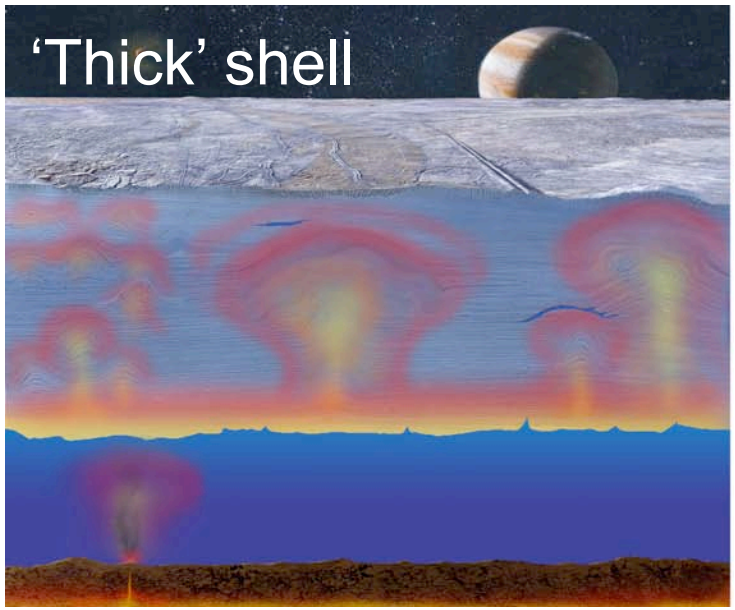
Jupiter-Europa Orbiter: Ice Shell Science Investigations

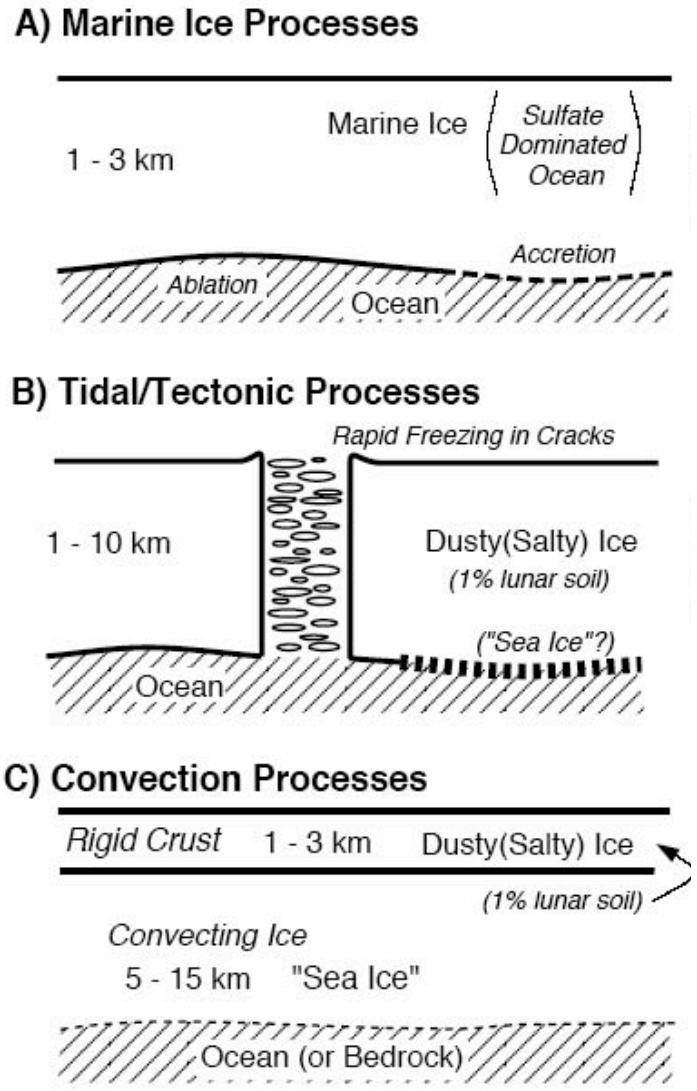
- Characterize the distribution of any shallow subsurface water.
- Search for an ice-ocean interface.
- Correlate surface features and subsurface structures to investigate processes governing communication among the surface, ice shell and ocean.



Orbital radar sounding of Europa is feasible; what do we need to learn?



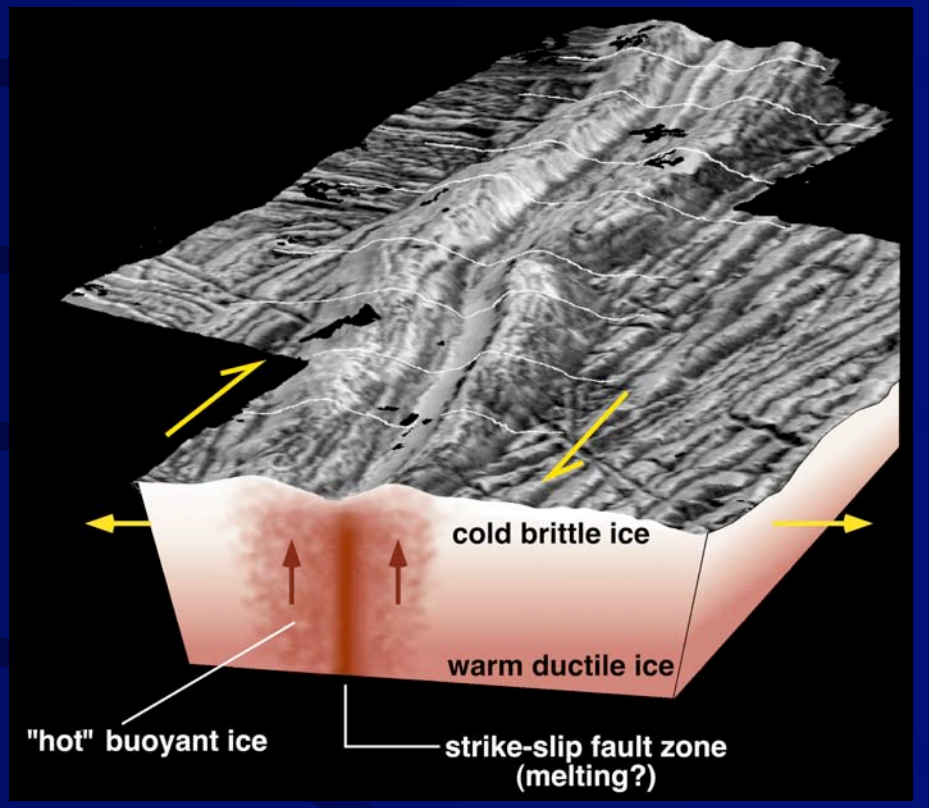


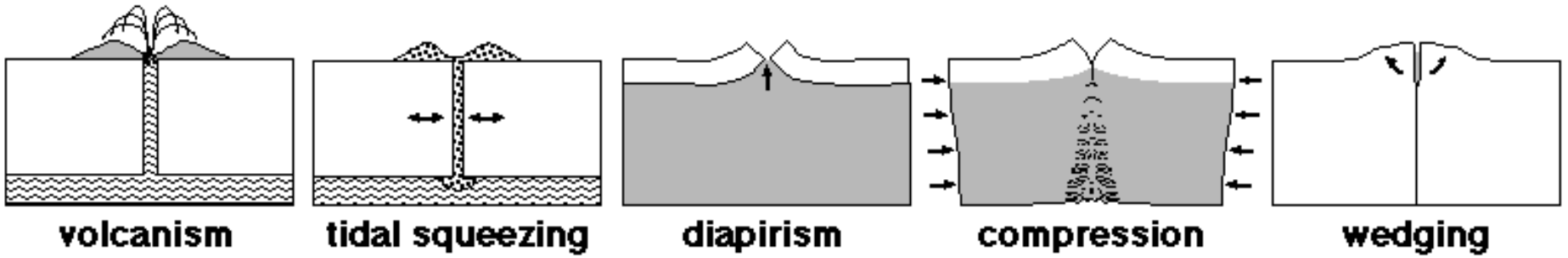


Chyba et al., (1999); Moore (2000), Blankenship et al (1999, in press).

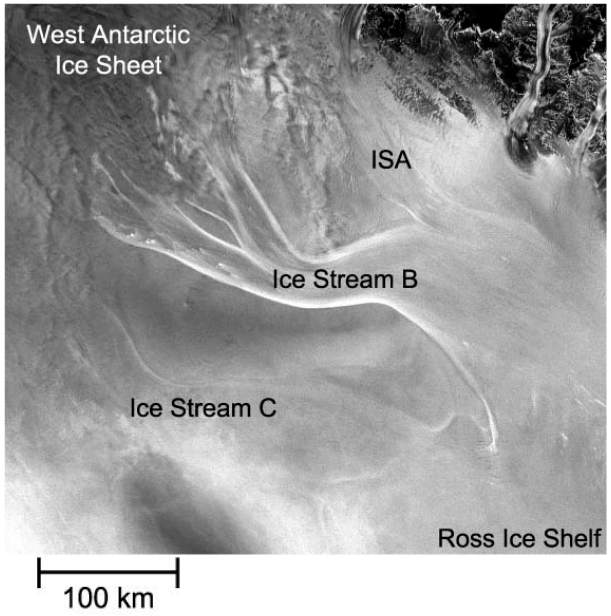
Ridge Formation Models

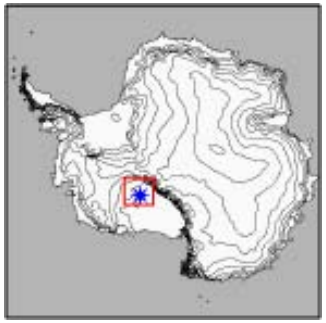
- Several candidate models
- Shear heating along fracture plains is a leading model.

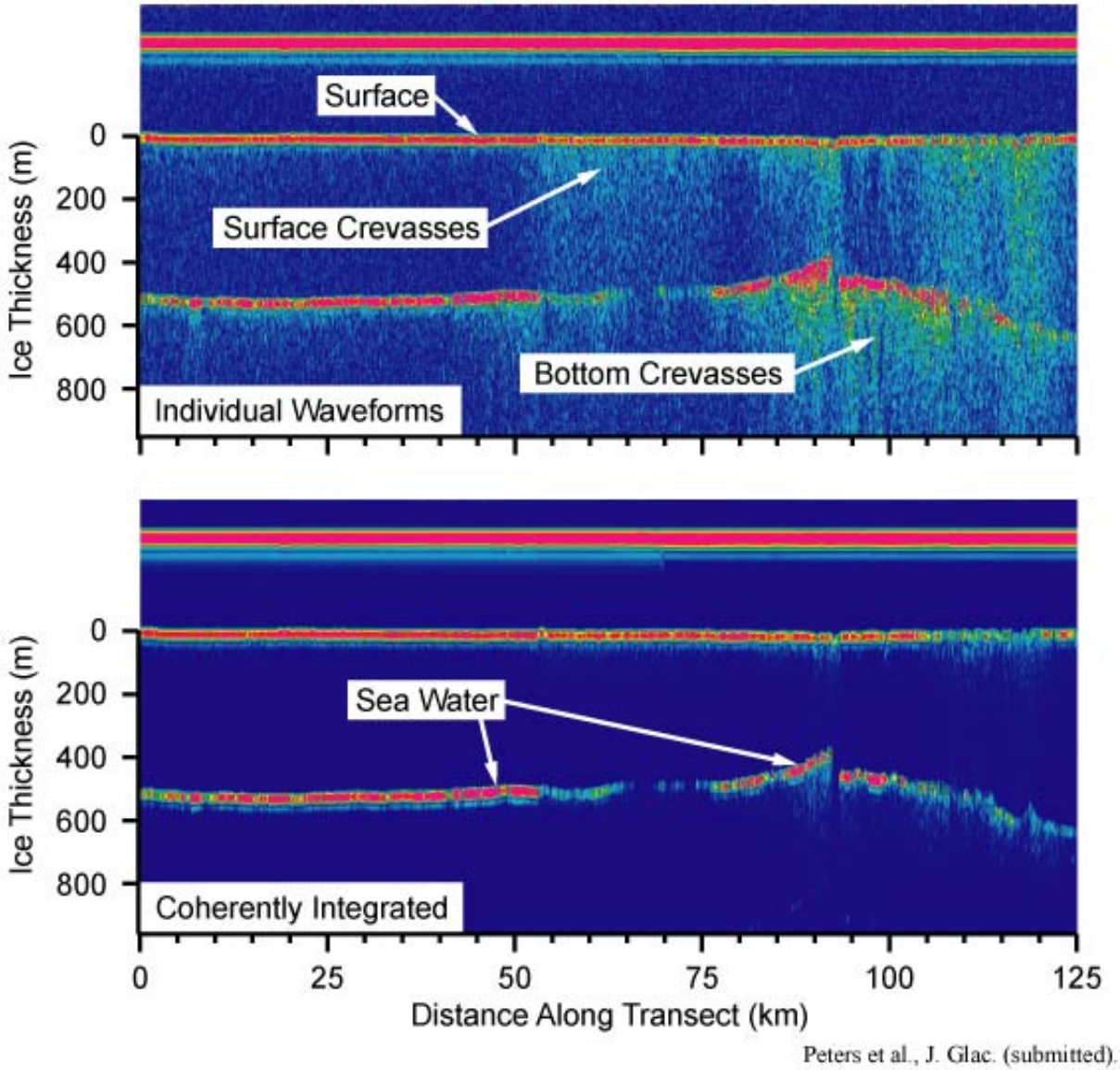




Antarctic Ice Shelves (fracture/infiltration)







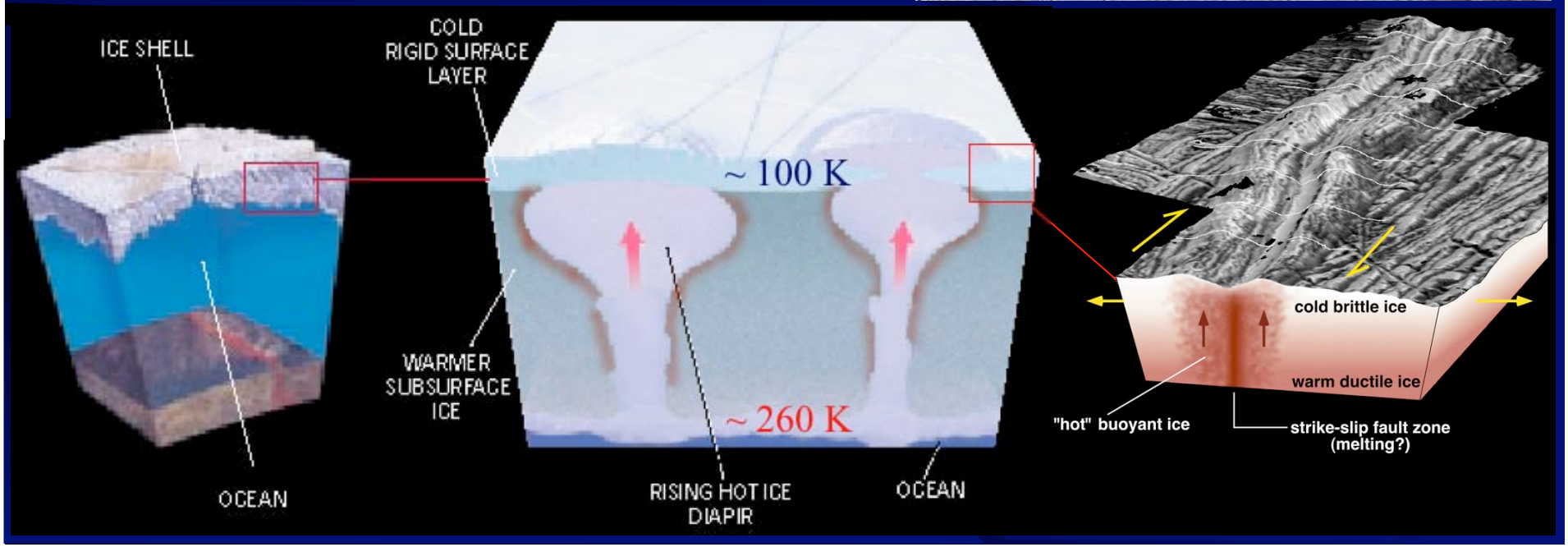
Peters et al., J. Glac. (submitted).

Earth: ice/ocean interface and tidal cracking near ice shelf origin

Europa: ice/ocean interface and ridge/band formation

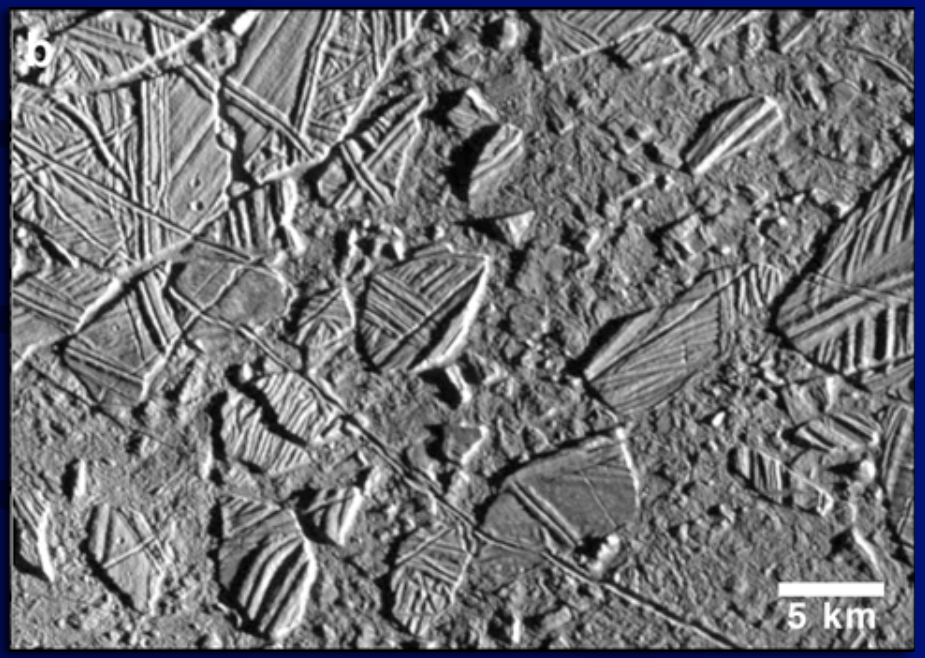
Convection in Europa's Ice Shell

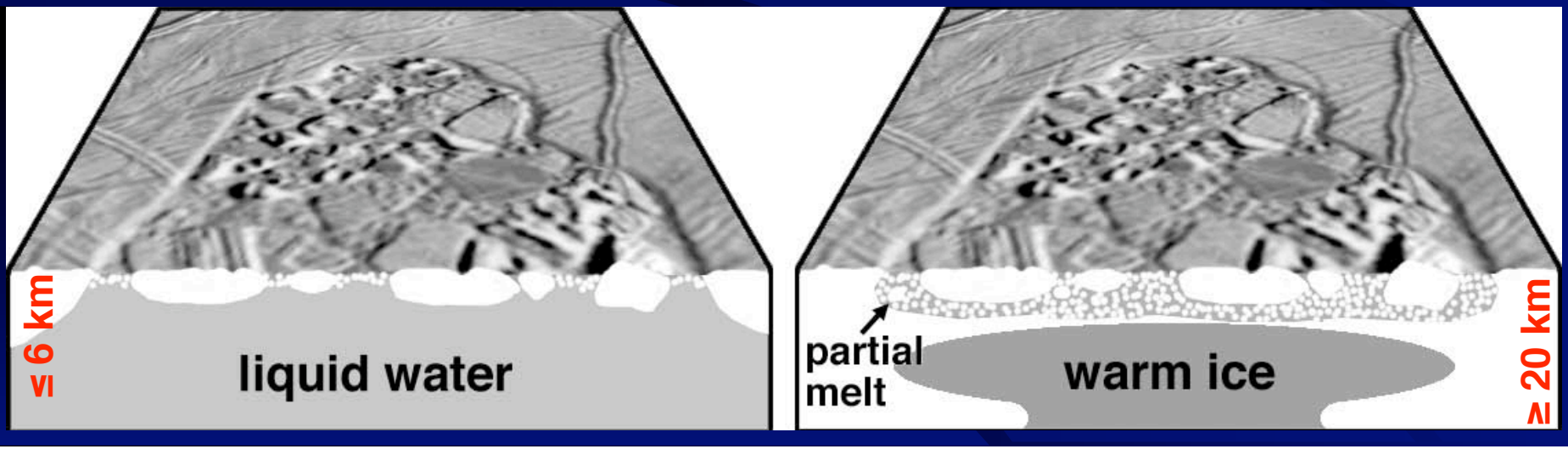
- Pits, spots, and domes suggest ice convection.
- Near-surface melt?
- Salts may be expelled from warm plume cores.



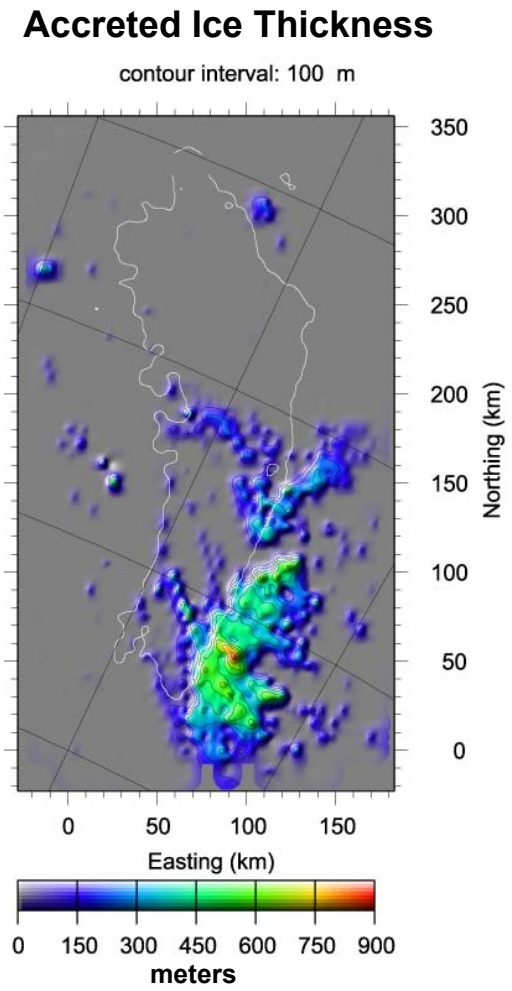
Chaos Models

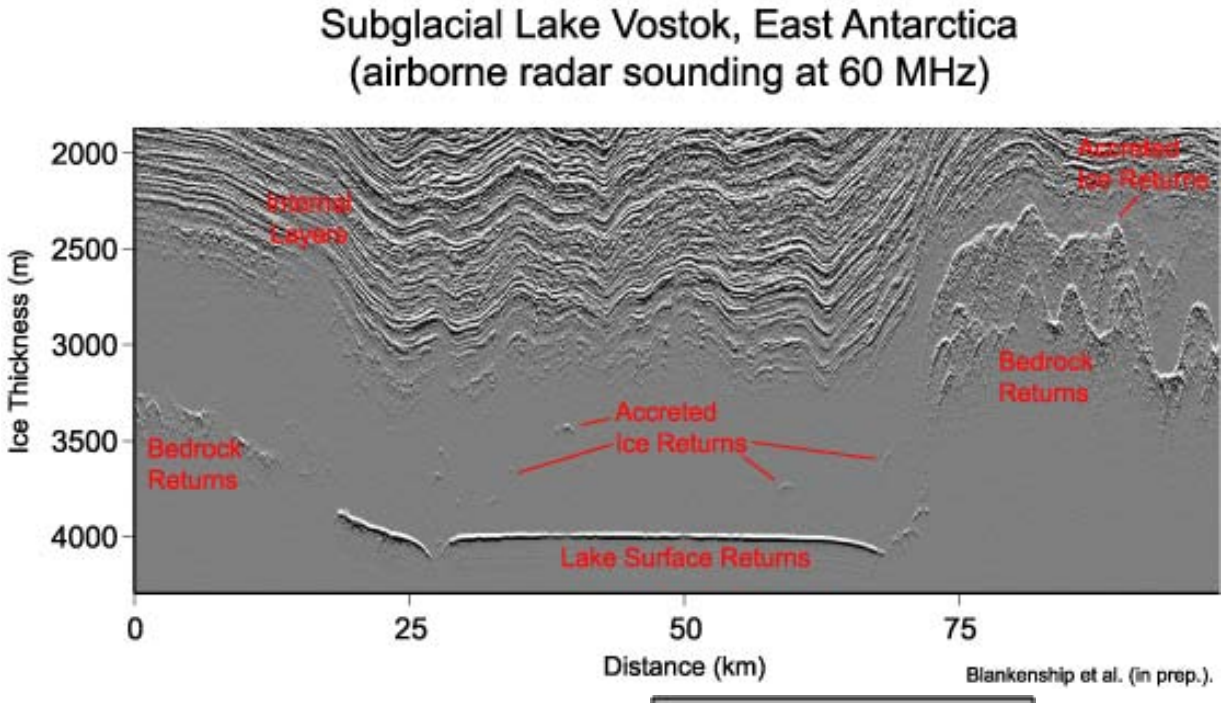
- *Melting model:*
  - ✧ Ice shell thins and melts above oceanic megaplumes.
- *Diapirism model:*
  - ✧ Ice convection partially melts salty ice.

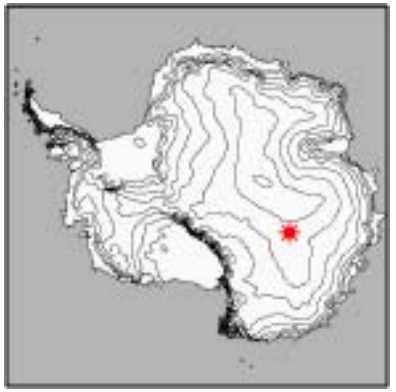




Antarctic sub-ice hydrology (melt/accretion)





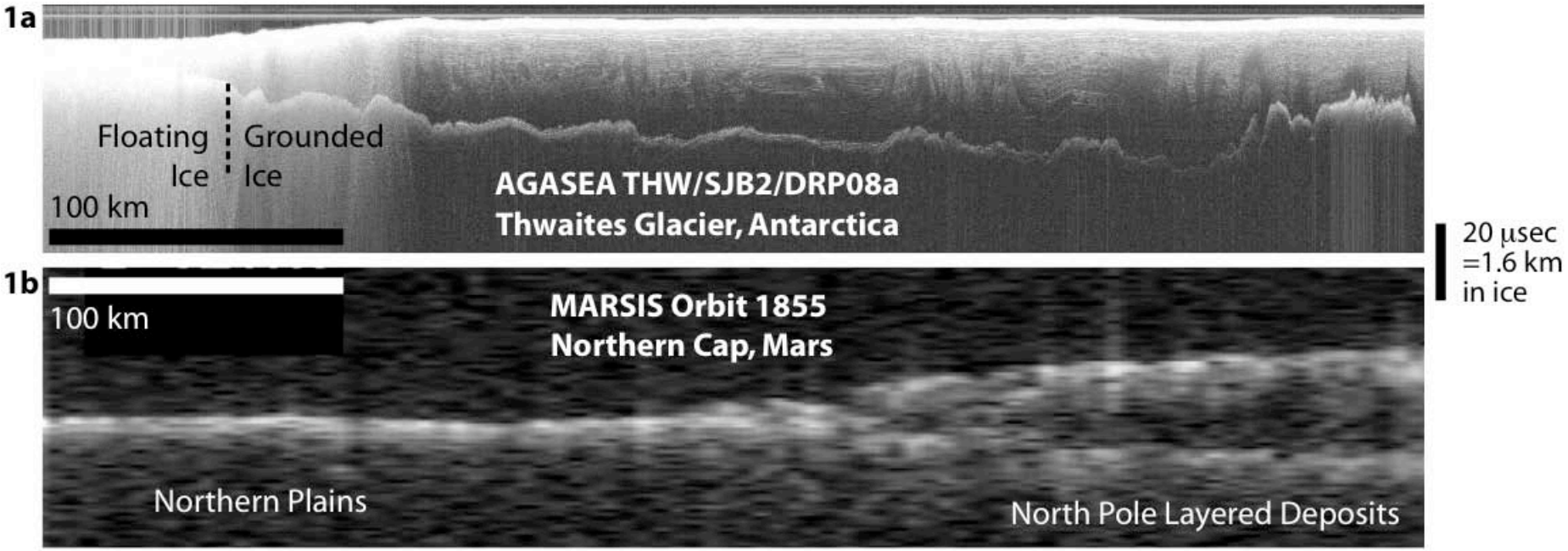


Earth: sub-ice lakes/rivers and lake-ice accretion

Europa: plume hydrology and rigid shell accretion (chaos matrix?)

Airborne and Orbital radar sounding work!

Earth/MARSIS profiles at the same scale



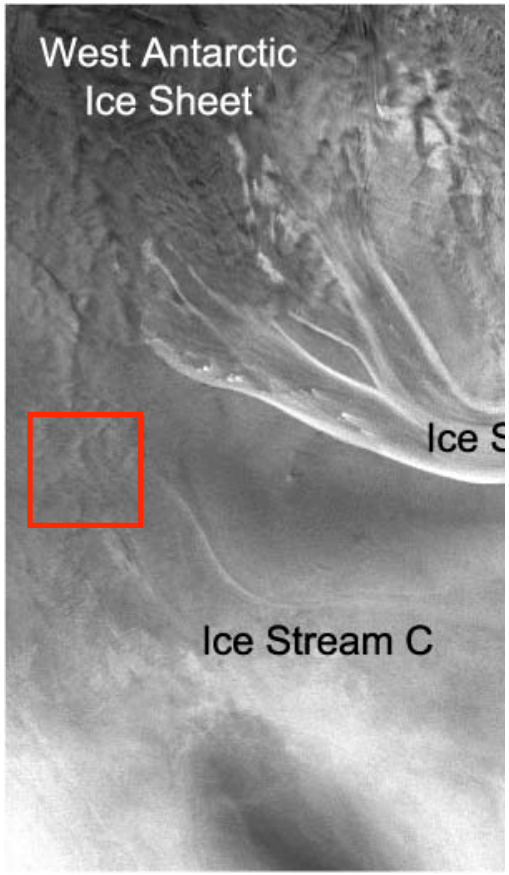
UTIG Instrumentation: Ice-Penetrating Radar

phase coherent
60 MHz center frequency
15 MHz bandwidth
8 MW peak power
6.4 kHZ PRF

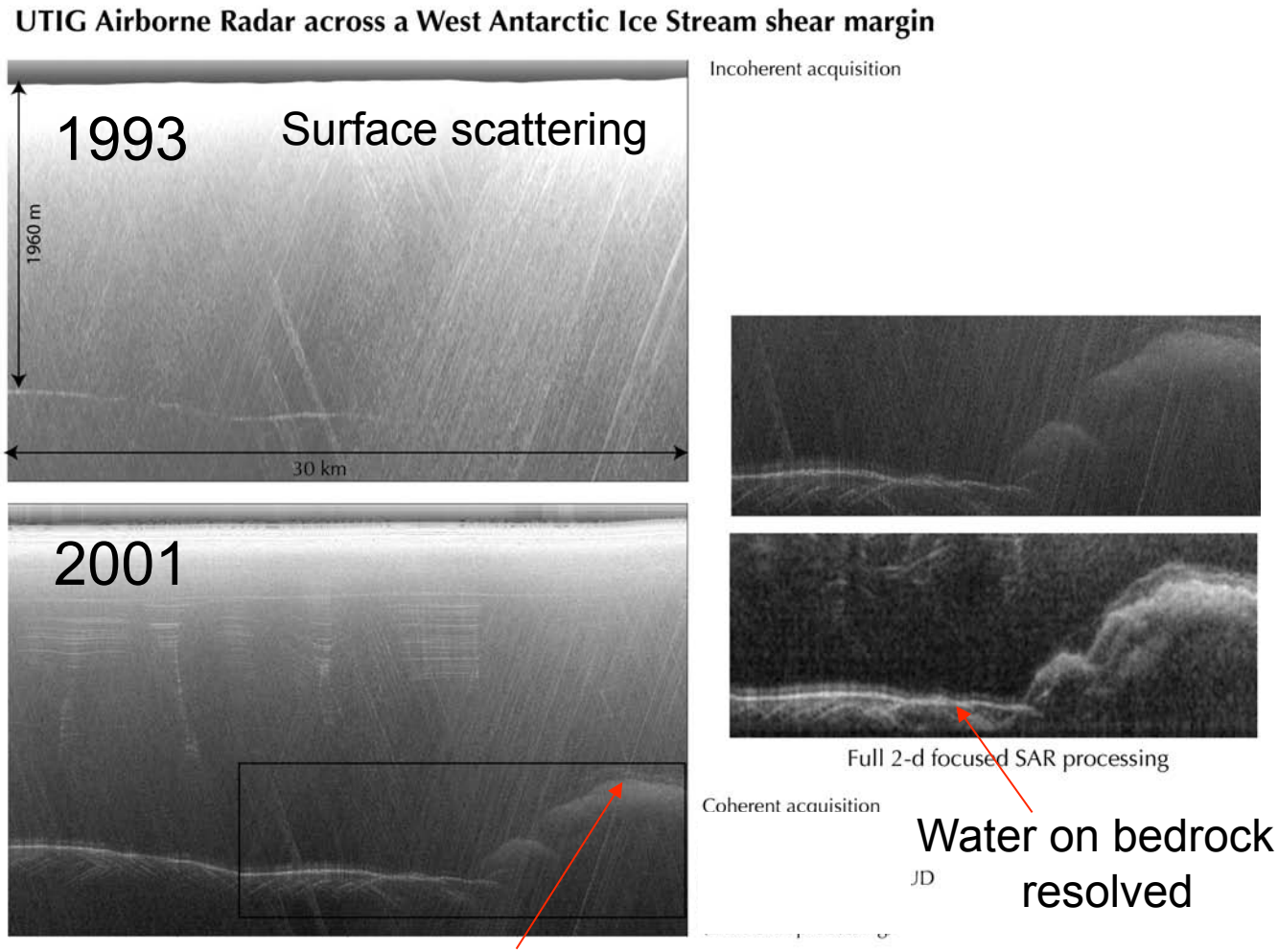
Basler (DC-3)

Europa has inspired development of new radar acquisition and imaging technologies.

…



(Peters et al. 2005, 2007)



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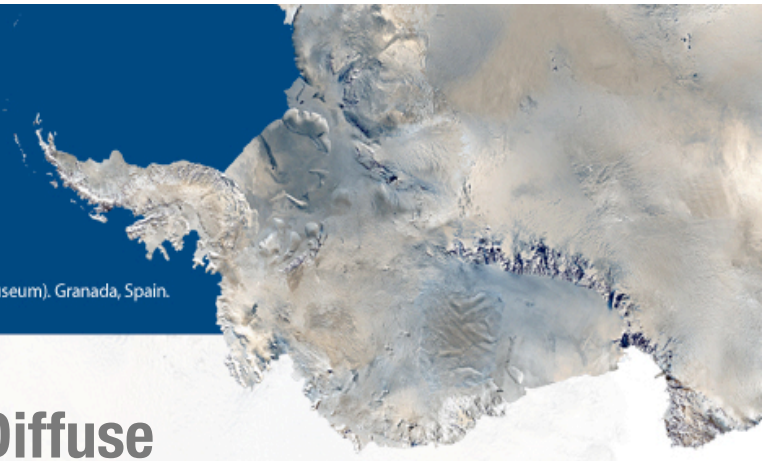
Parque de las Ciencias (Science Museum). Granada, Spain.



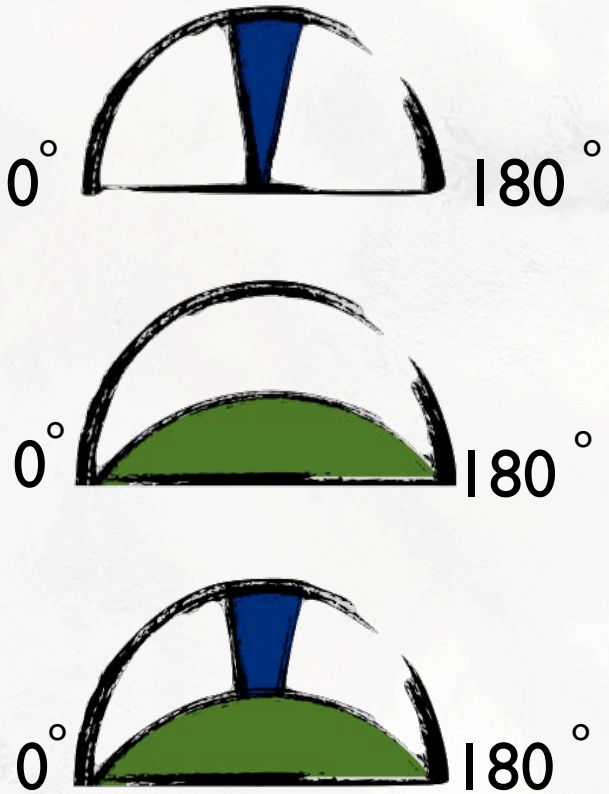
Reflecting Interfaces: Specular and Diffuse

Specular Reflection

Diffuse Reflection

Both Diffuse and Specular

Basal Interface



Angular Visibility

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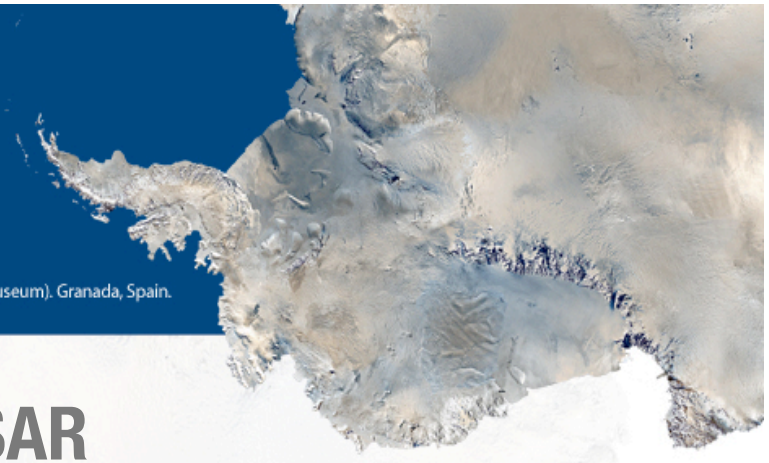
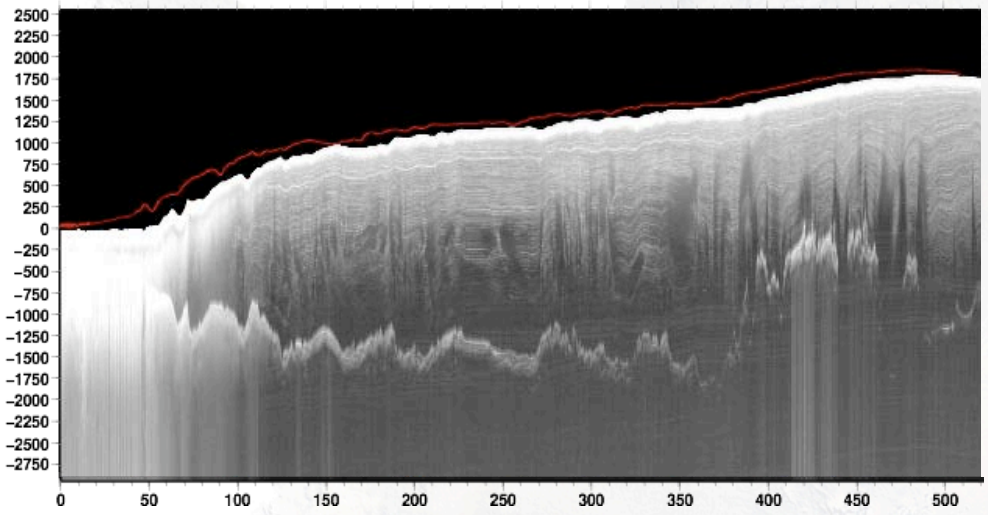
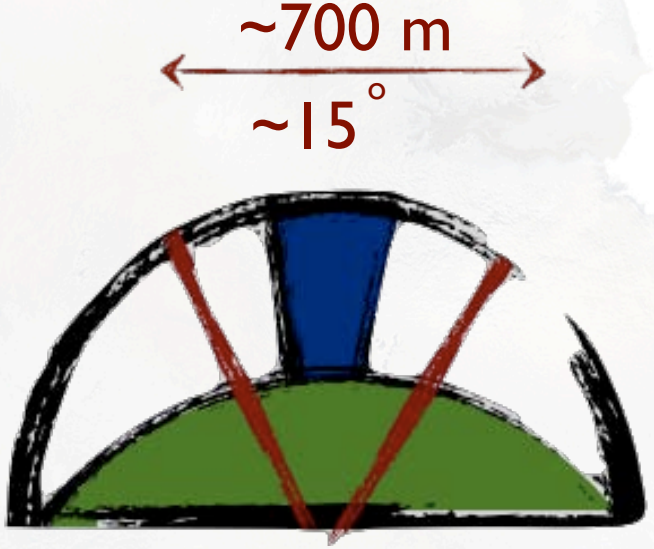


Radar Data Products: 1D Focused SAR



Focused Radar Profile



Focusing Window Extent

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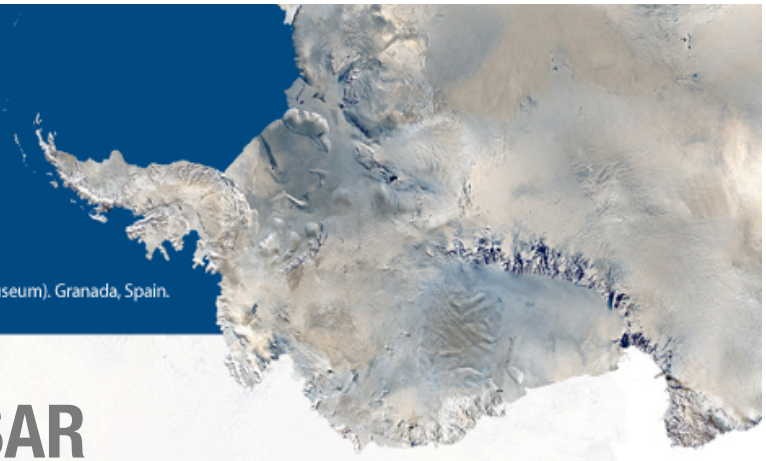
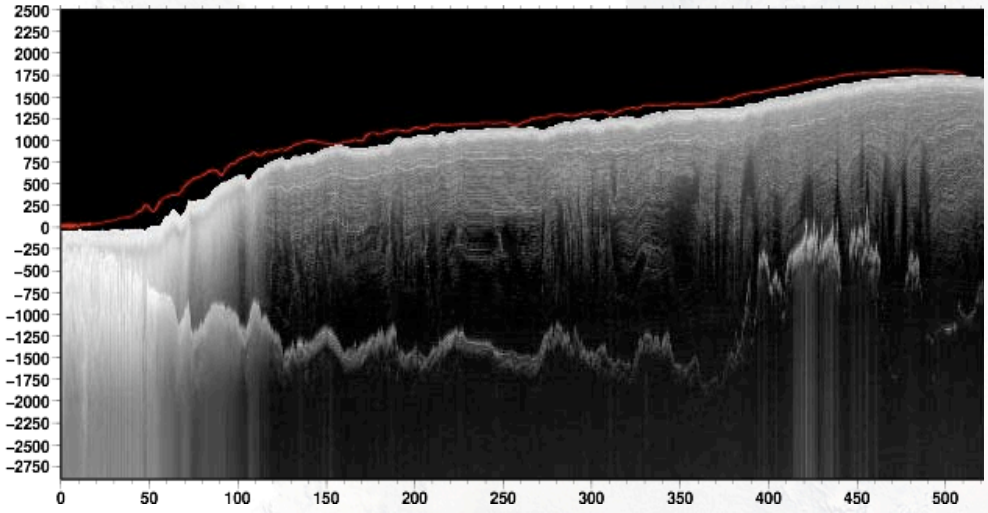
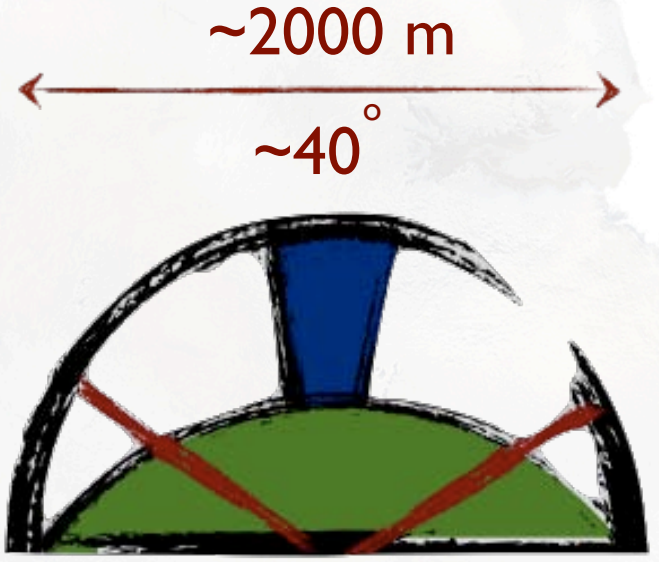


Radar Data Products: 2D Focused SAR



Focused Radar Profile



Focusing Window Extent

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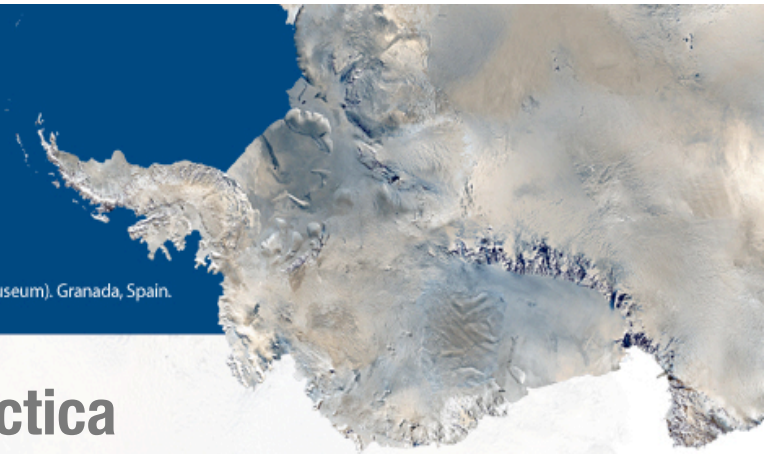
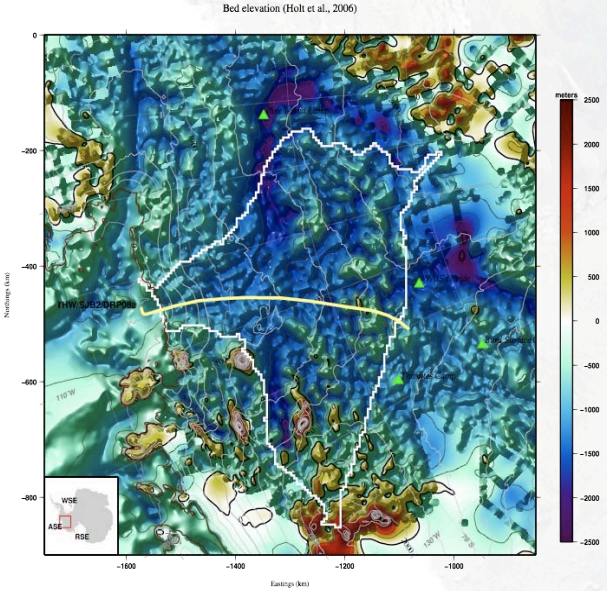


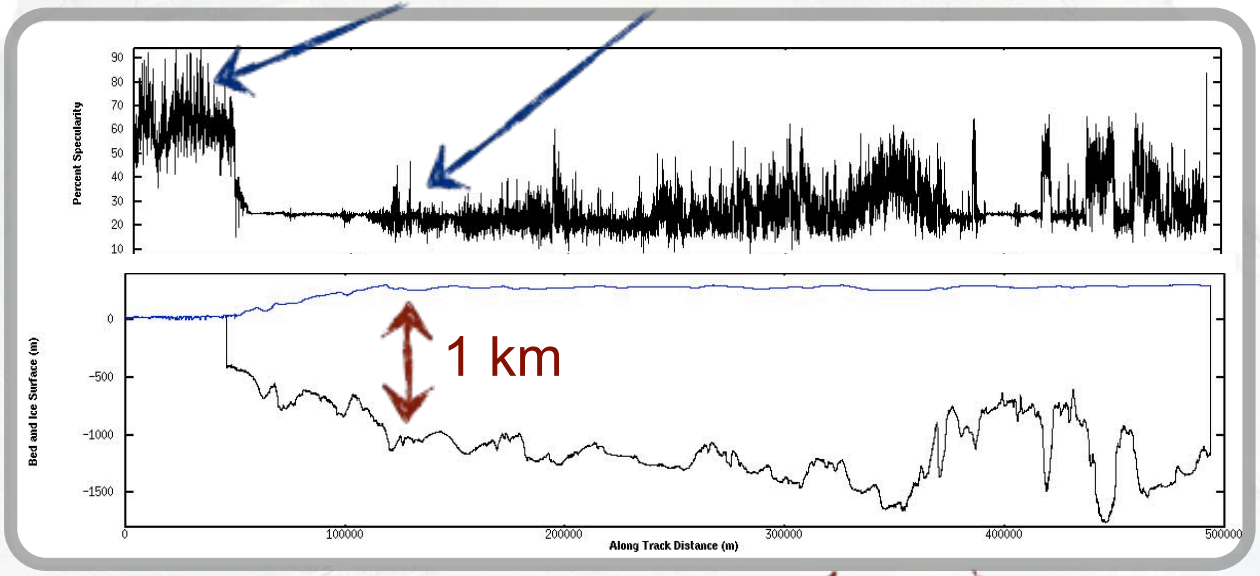
Application: Thwaites Glacier, West Antarctica



Percent Specularity

80%

20%



Surface & Bed Profile

100 km

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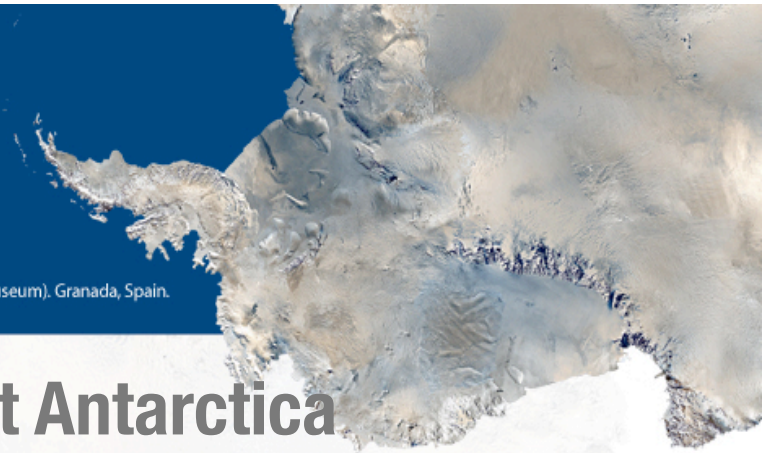
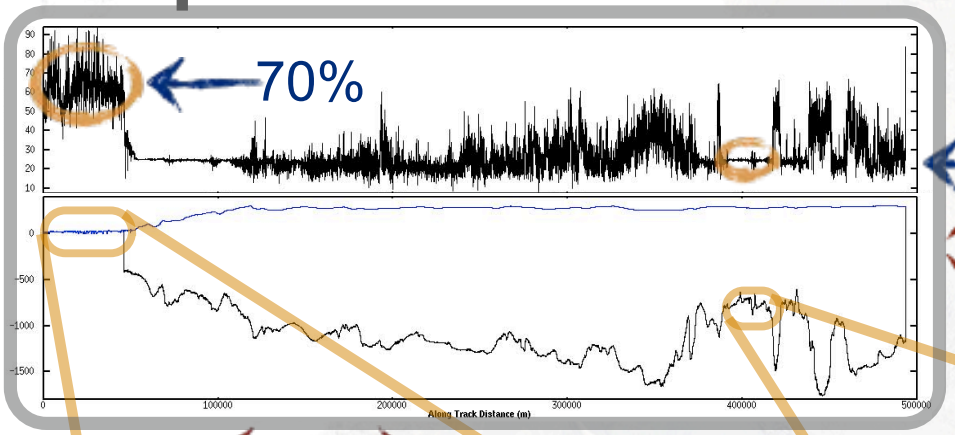
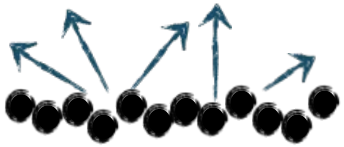


Interpretation: Thwaites Glacier, West Antarctica



Floating Ice

Highlands



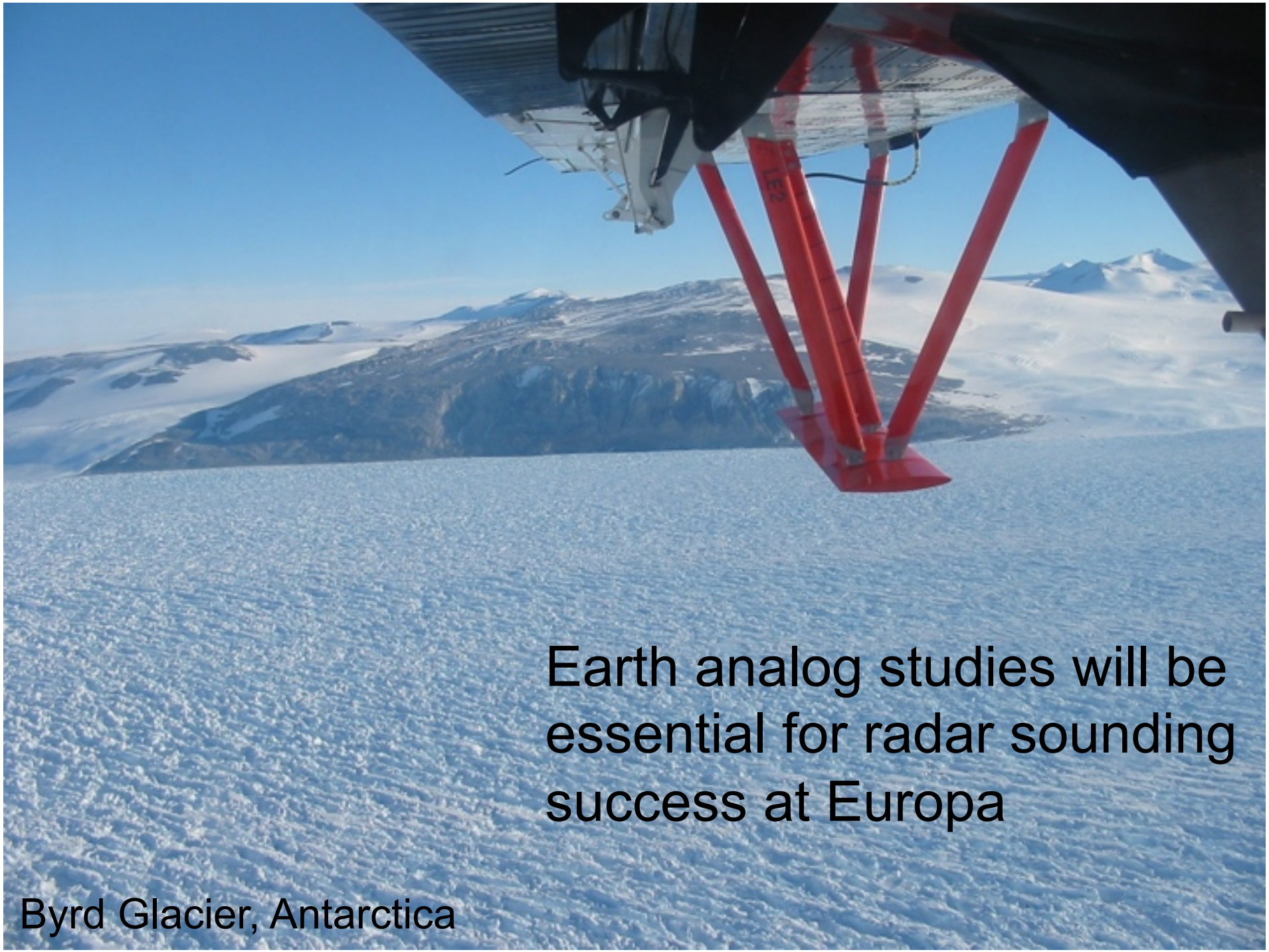
A Path

Antarctic Analogs for Shallow Subsurface Water on Europa

- Ice shelf origins and margins → ice-ocean boundary and brine infiltration / water filled ridges
- Sub-ice lakes/rivers → accretion ice and plume hydrology with implications for the formation of chaos matrix

Radar Sounding Approach - Use multiple radar focusing windows to calculate percent specularity, which is a likely proxy for free water.

- provides a metric to characterize patchy water that is independent of ice temperature structure.
- Thwaites Glacier analog in Antarctica shows features on scales from hundreds of meters to hundreds of kilometers.
- more experience is needed in using this approach in the presence of extreme surface scattering.


Earth analog studies will be essential for radar sounding success at Europa
Byrd Glacier, Antarctica