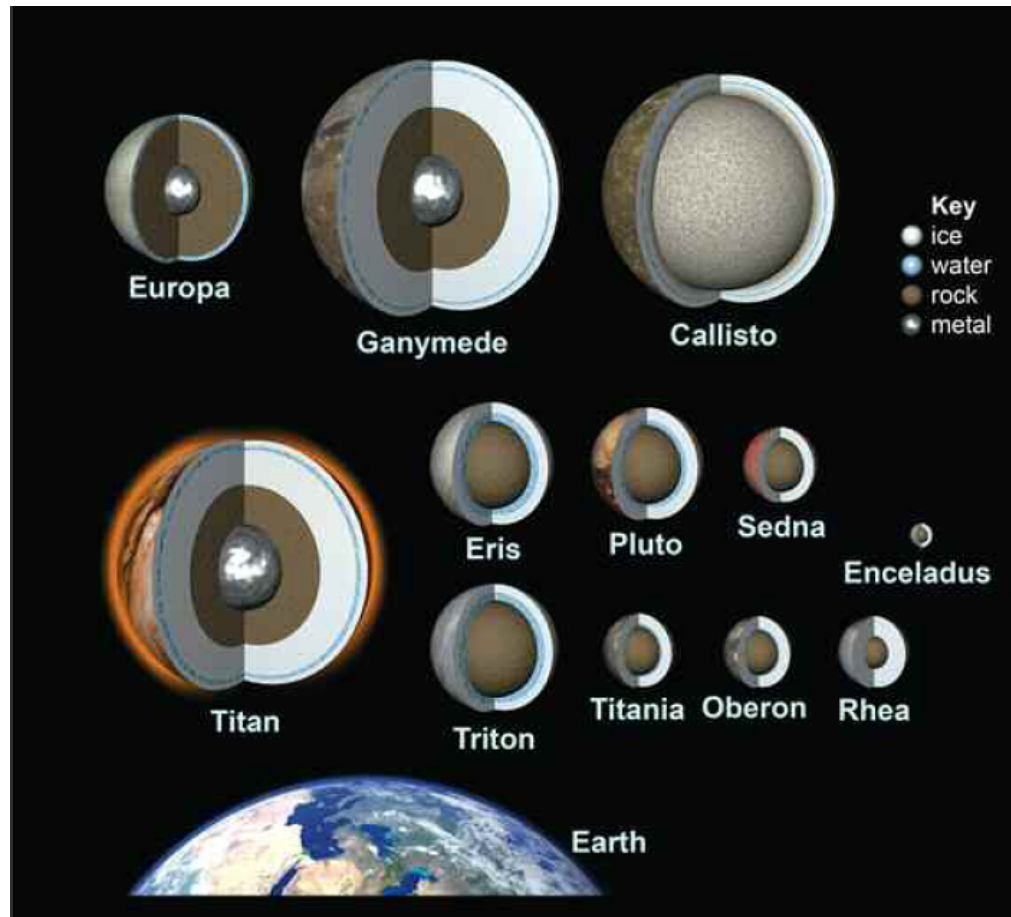


Ice-Covered Seas on Earth, Europa, Enceladus...

Dale Winebrenner, Paul Kintner
Dept. of Earth and Space Sciences



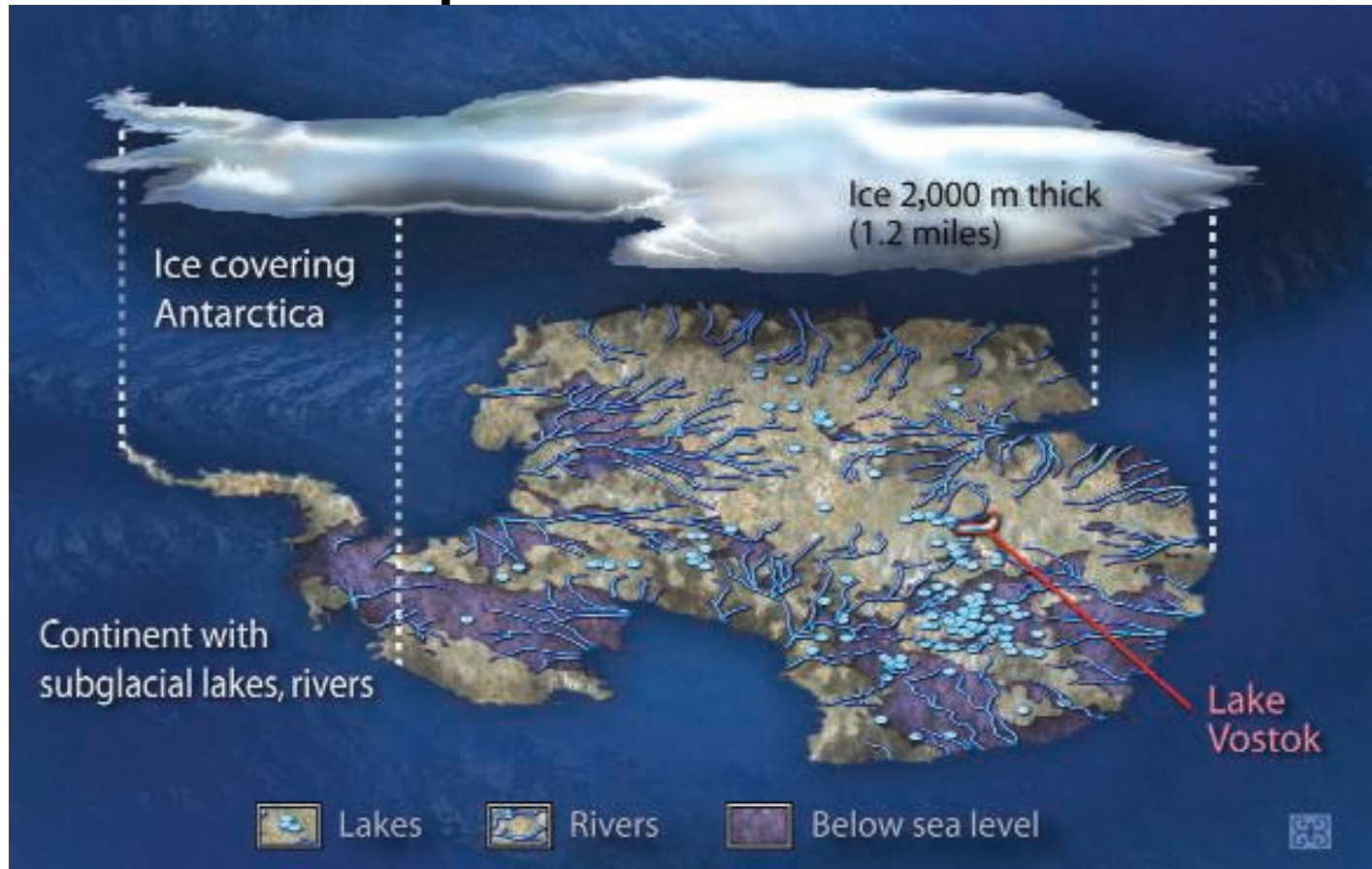
“Free” Samples



400 Lakes Under East Antarctica

Number Visited: 0

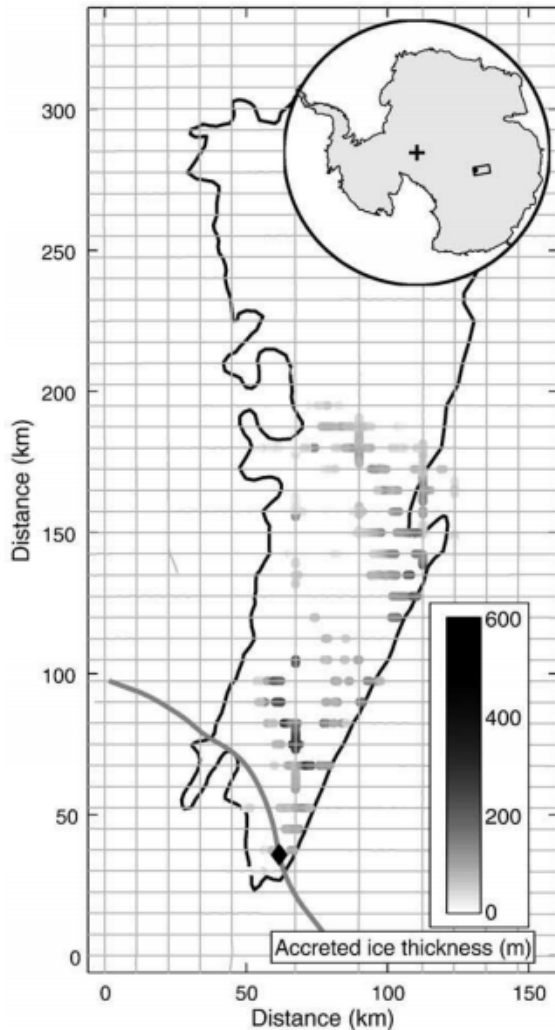
Oxygen input from melting
'compressed snow'



Are They Alive, Or Not?

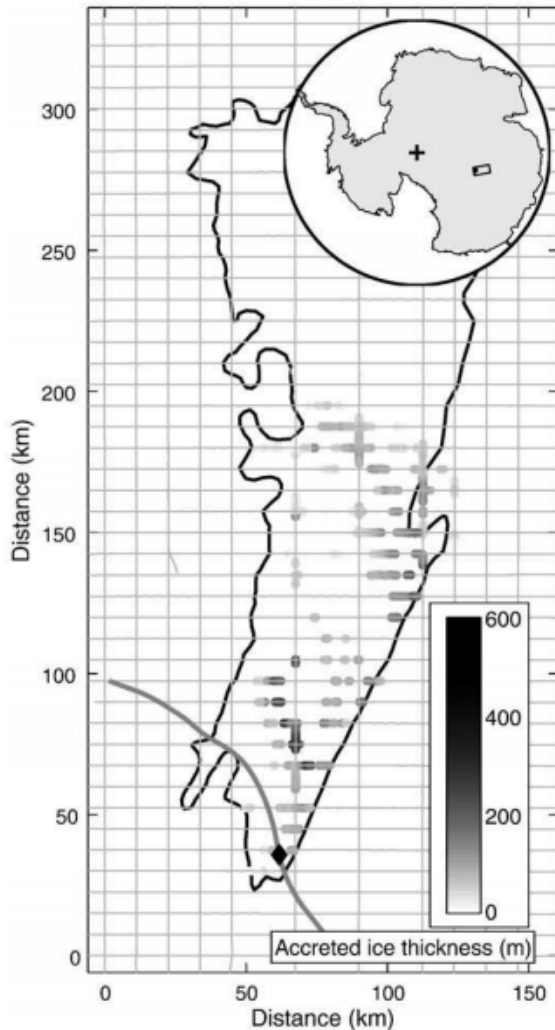
- They're wet – essentially no doubt about that
- But is there energy? No photosynthesis, but geochemical inputs for redox chemistry
- Reduced chemicals (H_2 , H_2S , CH_4 ,...) from ocean floors
- Oxidizing chemicals from (where?) O_2 , CO_2 ,...
- So what are the ways life could “make a living”, and how do those translate to observables?
- Lakes on Earth can be investigated **now** with observation and modeling.

From Radar to Oxygen Flux



- Oxygen flux from melting
- Melting affects temperature in the ice
- Temperature affects radar echoes from the lake lid
- So observe variations in echoes to infer melting to infer oxygen flux

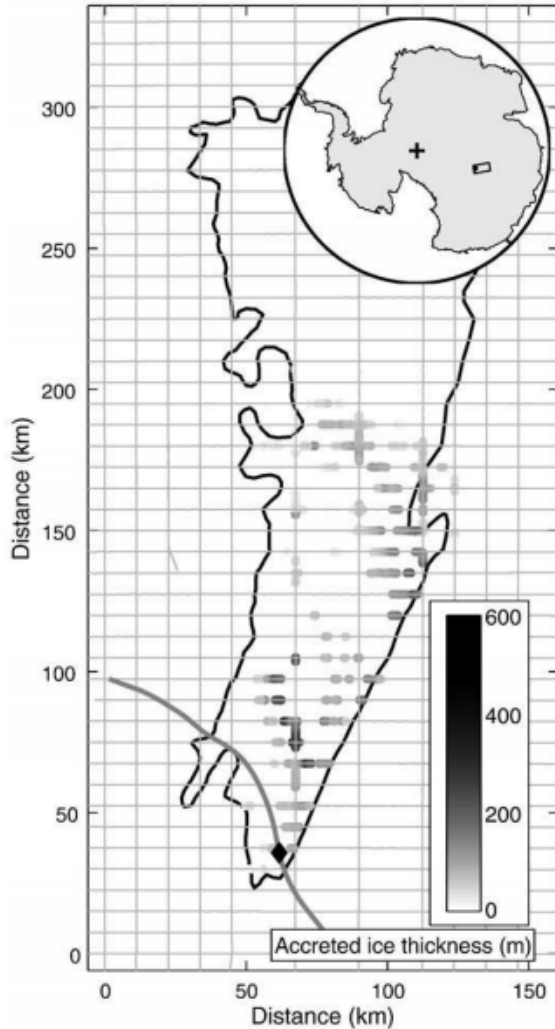
Pre-MAP Learning Objectives



- Learn about radar, glaciers, and ice covered seas.
- Learn some ways that large quantities of data are stored and processed.
- Work with Python and MATLAB.

Goals

Radar Data



Identify grid points over Lake Vostok

Identify grid intersections

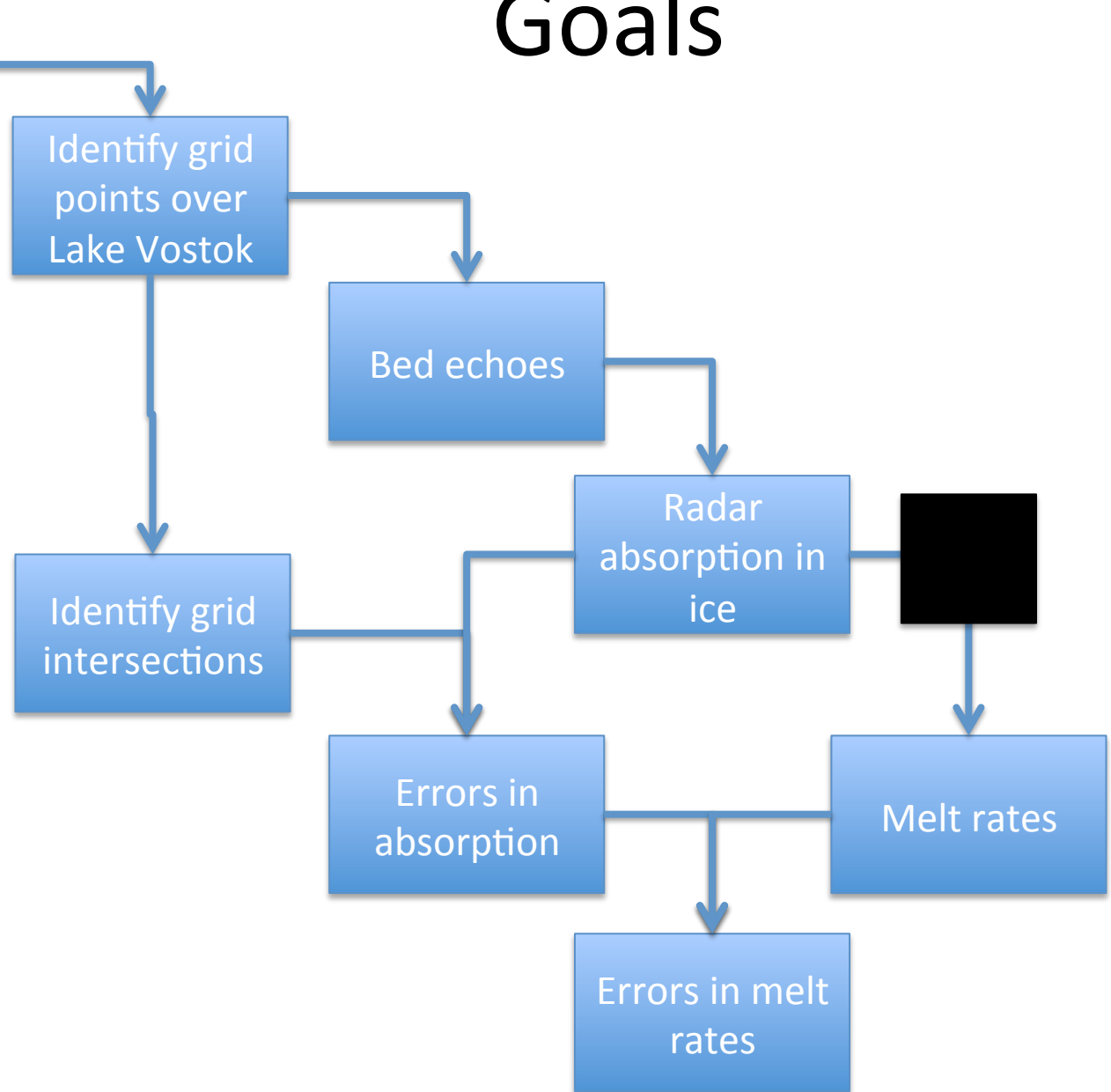
Bed echoes

Radar absorption in ice

Errors in absorption

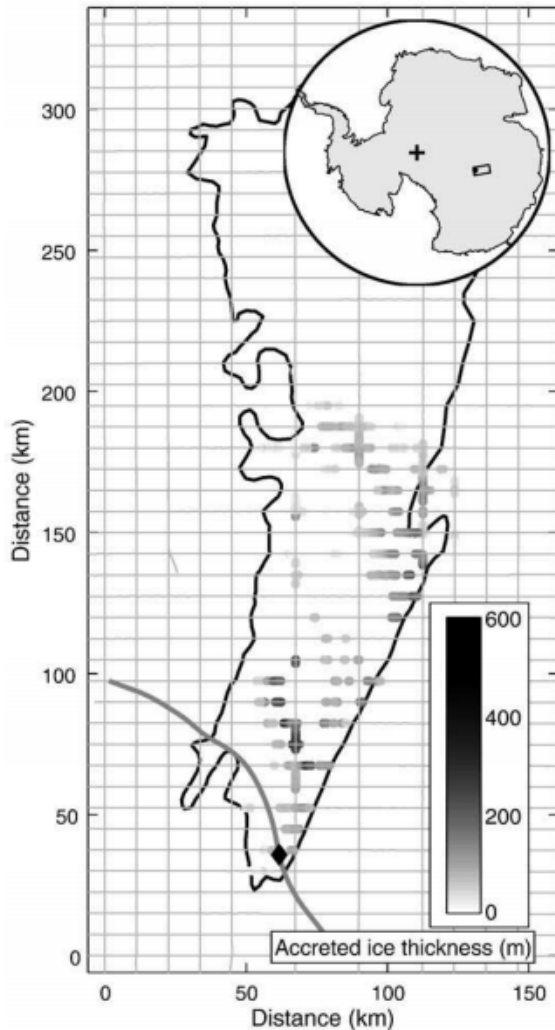
Errors in melt rates

Melt rates



Example of Practical Goals

Radar Data



Identify grid points over Lake Vostok

Identify grid intersections

Bed echoes

Radar absorption in ice

Errors in absorption

Errors in melt rates

Melt rates

Example of Results

- Melting and freezing map.
- Flexible goals:
 - Observable changes in absorption rate over Lake Vostok.
 - Is Lake Vostok in steady state?
 - What's the oxygen flux?

