

DRILL BABY DRILL!

but how to do it for microbial studies

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Outline

- What are some of the requirements for microbial studies
- What are some of the potential future drill features to help meet these needs

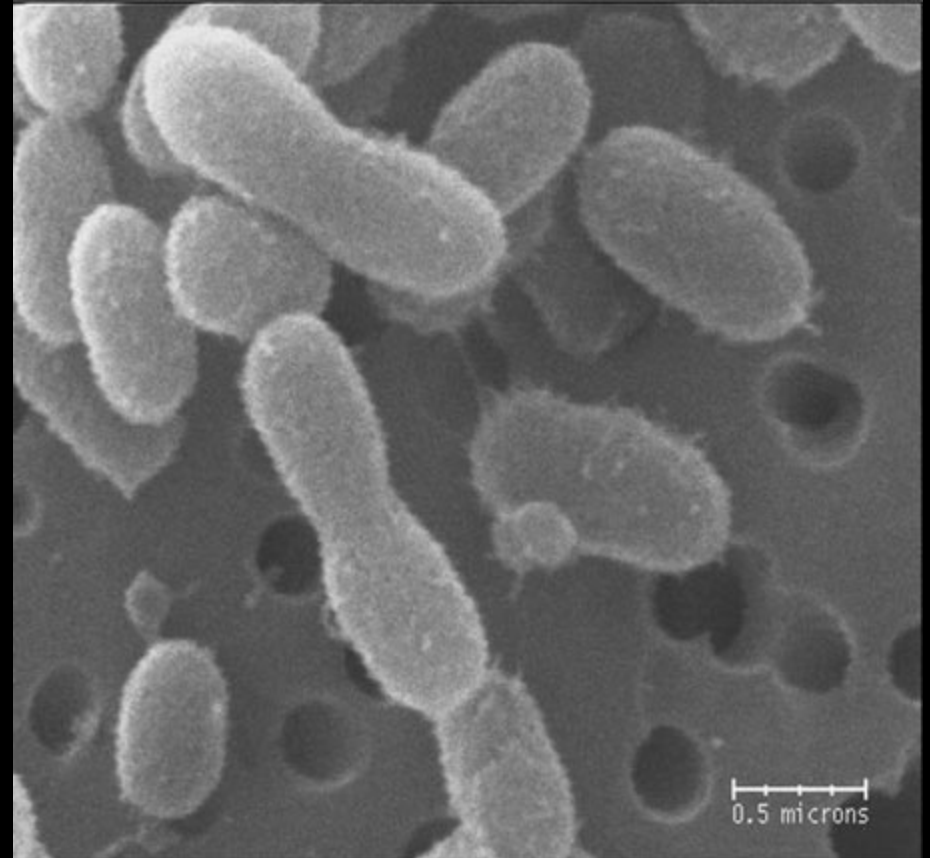
Requirement

Enough sample to perform microbial analyses

Clear glacial ice 10^2 - 10^4 cells ml^{-1}

**fluctuates with dust particles*

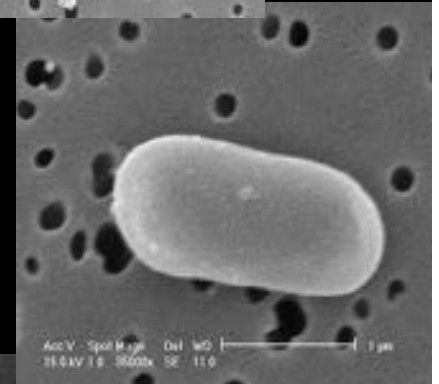
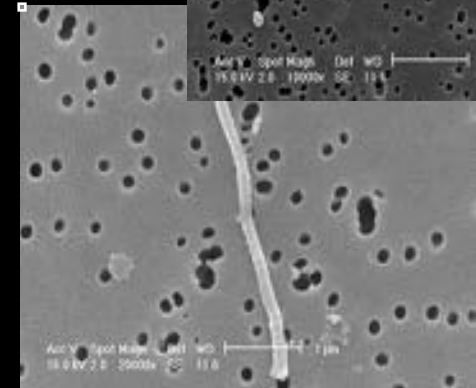
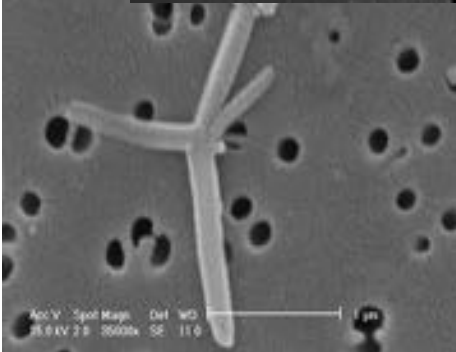
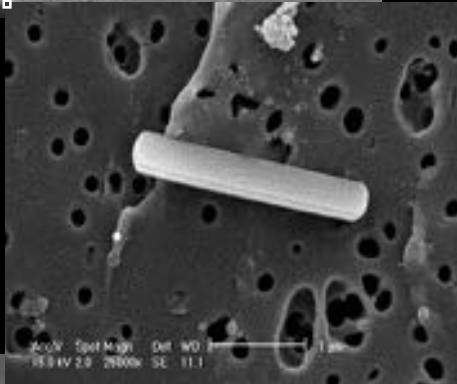
Basal ice GISP2 10^7 cells ml^{-1}



Chryseobacterium greenlandensis

Loveland-Curtze et al., 2010 Extremophiles

To get beyond
images and
counts we need
more volume.



Activity measurements
Microbial diversity

SEMs of Lake Vostok Accretion Ice

Requirement

Enough sample to analyze the carbon

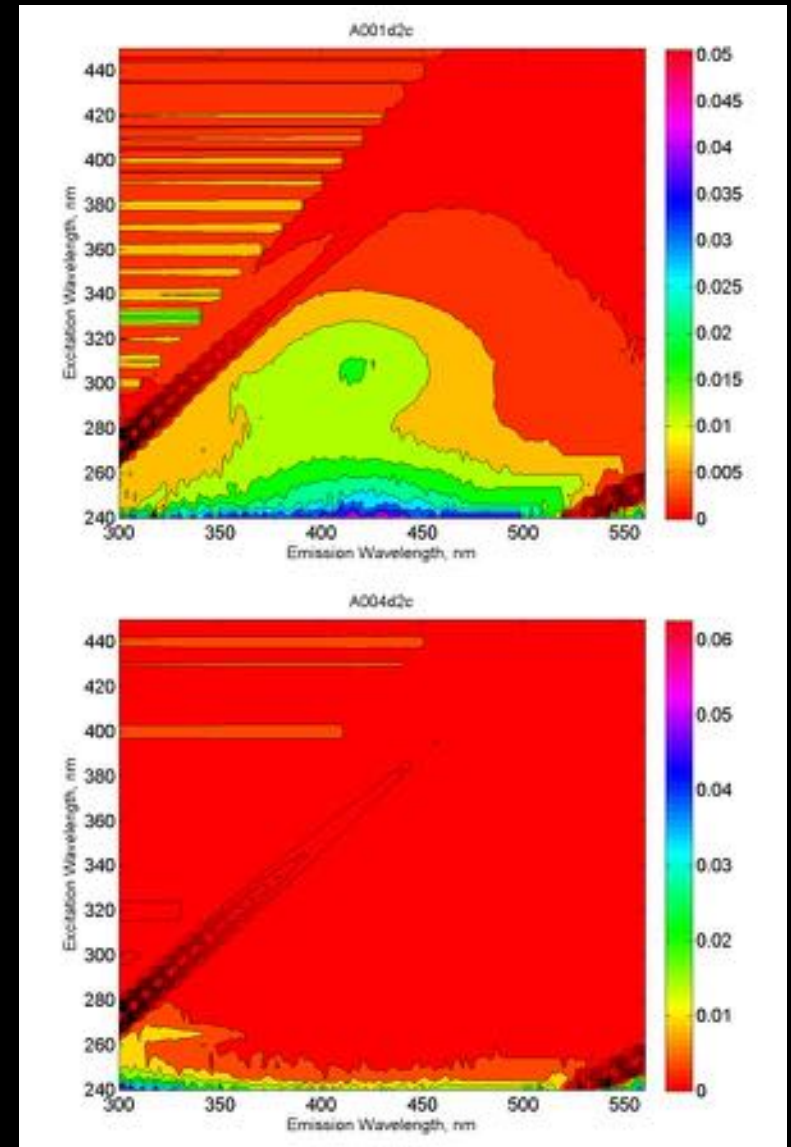
Dissolved organic carbon (DOC)

High Arctic basal ice 100uM

High Arctic glacier ice 24uM

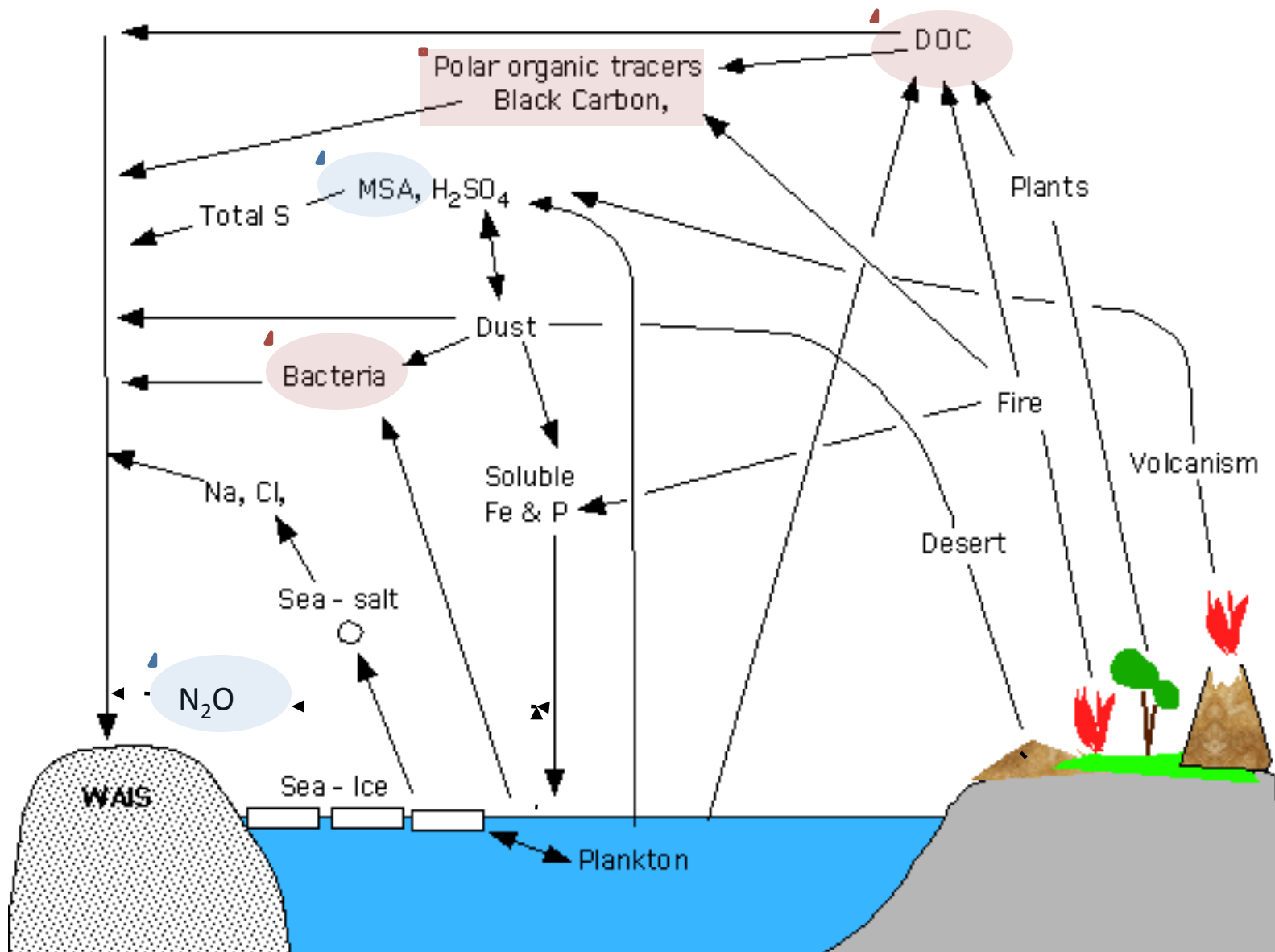
Vostok glacial ice average 16 uM

Skidmore et al. 2000, Bhatia et al. 2006, Christner et al. 2005



Cell Number and Organic Carbon in Polar Ice

	Polar			Global		
	Antarctica	Greenland	Both Poles	Fresh water	Open Ocean	Soils
Cell Number	4.0×10^{29}	3.5×10^{23}	4.0×10^{29}	1.3×10^{26}	1.2×10^{29}	2.6×10^{29}
Cell C (Pg)	4.4×10^0	3.8×10^{-6}	4.4×10^0	1.4×10^{-3}	1.3×10^0	2.6×10^1
DOC (Pg)	1.0×10^1	9.5×10^{-1}	1.0×10^1	5.1×10^{-1}	6.8×10^2	NA
Cell C+ DOC (Pg)	1.4×10^1	9.5×10^{-1}	1.5×10^1	5.1×10^{-1}	6.8×10^2	NA



DOC in ice is important not only for what it tells us about the past and its roles as a microbial energy source, but it may be a biological signature of sea ice extent

Potential Solutions:
Larger diameter cores
Replicate coring



Blue ice drill , 9.5 inch diameter core



3 year post replicate coring

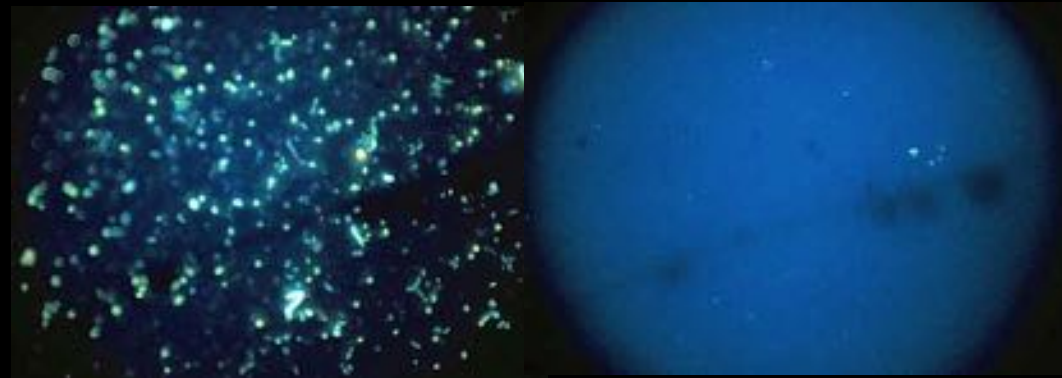
Photo: K. Taylor



View of WAIS arch facility by camp put in crew 2010. Drill arch is 27 ft. Photo : RPSC

Requirement

Ability to monitor microbial contamination during drilling and post-core relaxation



Christner et al. 2005 Icarus

Chemical and/or fluorescent tracing techniques

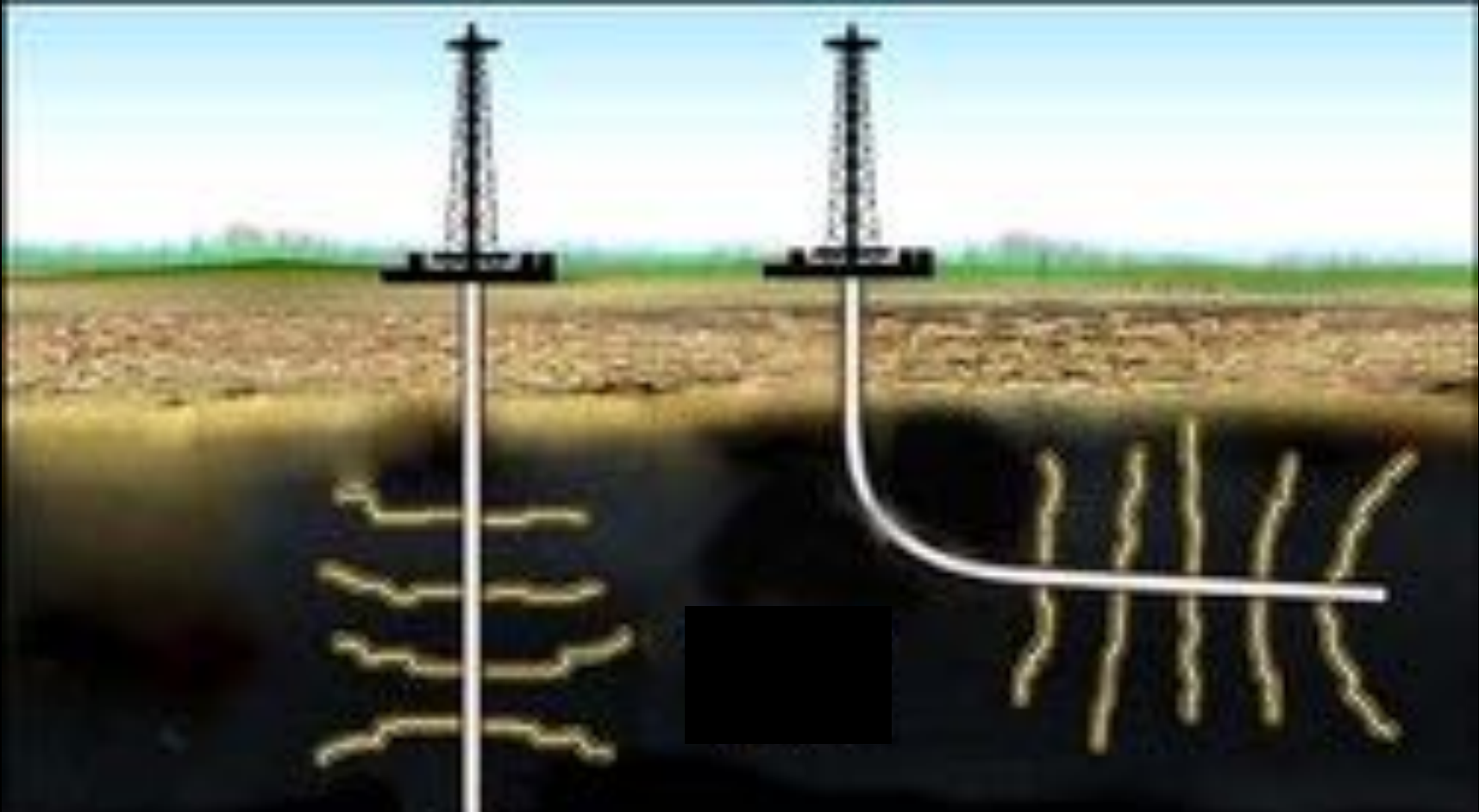
Canadian High Arctic permafrost and ground ice, Juck et al. 2005 AEM

Deep Sea Crust drilling, Smith et al. Geomicrobiology 2000

Requirement

Targeted or directional drilling





Directional coring?







Video Scott Montross, Taylor Glacier

Requirement

Design modifications for shallow drilling



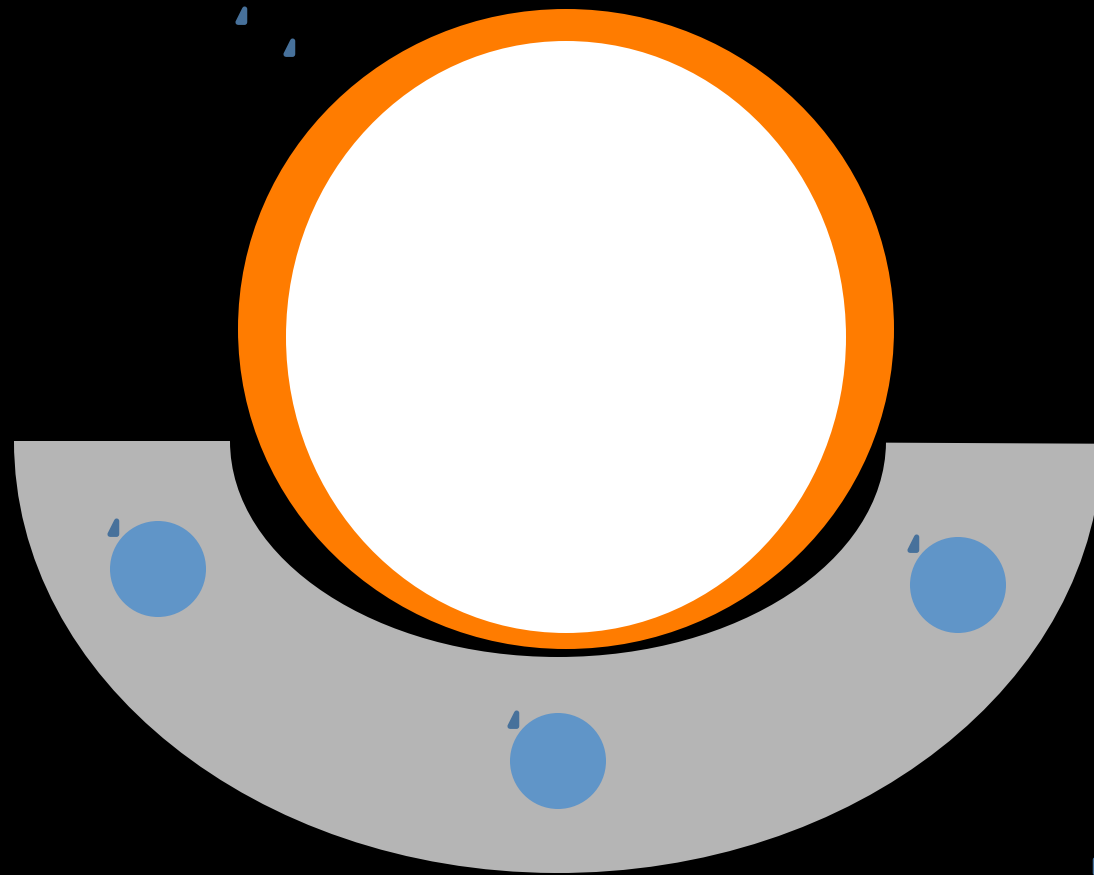
Kovacs and sipre, ~10cm diam, 10-20m



Chipmunk, 40mm diam, 0.5m depth







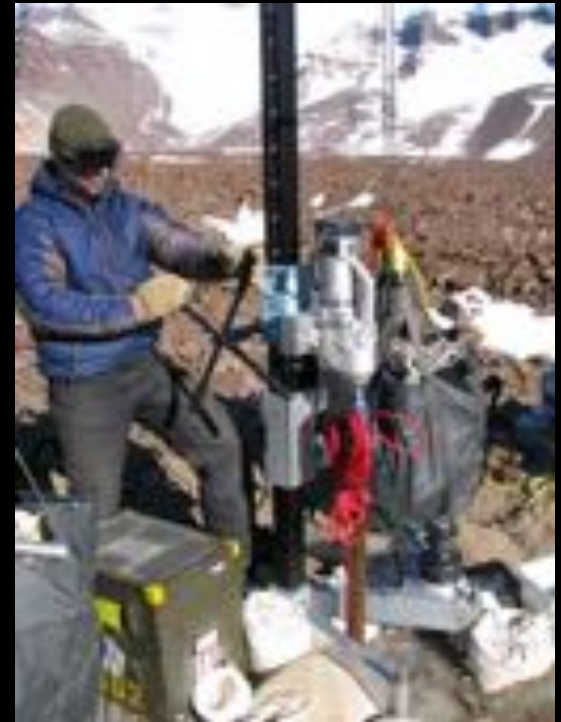
Hand auger support platform anchored into the ice with ice screws



Video Scott Montross, Taylor Glacier

Requirement

Ability to drill through debris laden ice



Koci drill

Can the siple be modified with stronger (i.e. diamond) cutting bits?

Conclusions

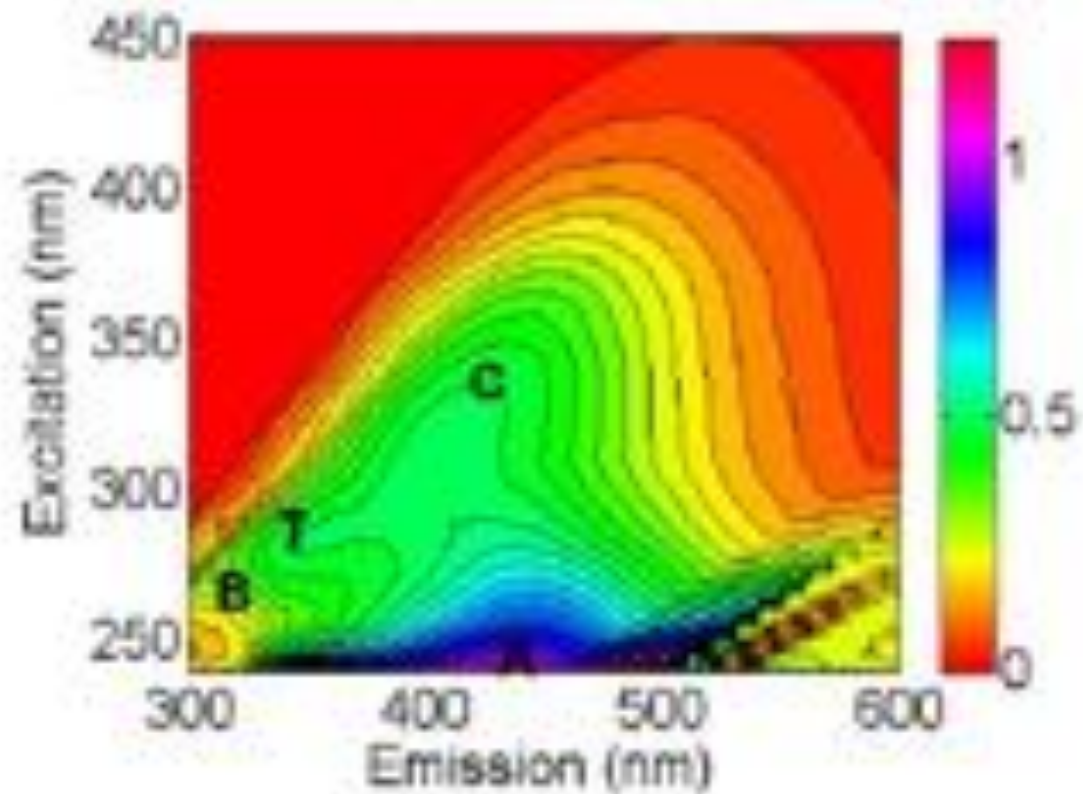
- We are just at the beginning of understanding the microbial ecology of ice. We know little about the numbers, diversity, where they are, or how their influence on ecosystem processes (e.g., nutrient cycling, carbon flux, feedbacks to climate, hydrology...) will affect, and be affected by, global changes.
- Small modifications to existing drill technologies and practices can greatly aid in this effort.



Future locations

- Basal Bell
- TransAntarctic Mountains
 - Platforms that are helo friendly

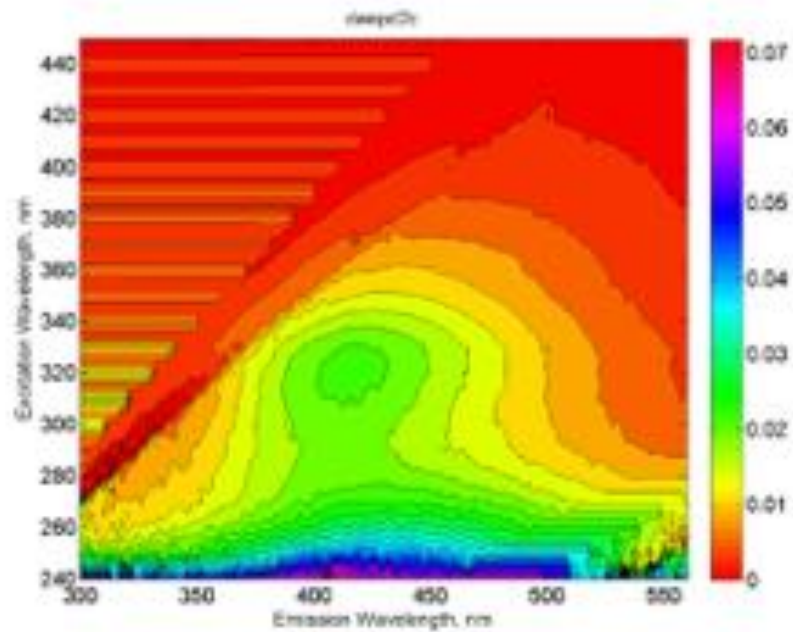
Excitation –Emission Matrices, aka EEMs



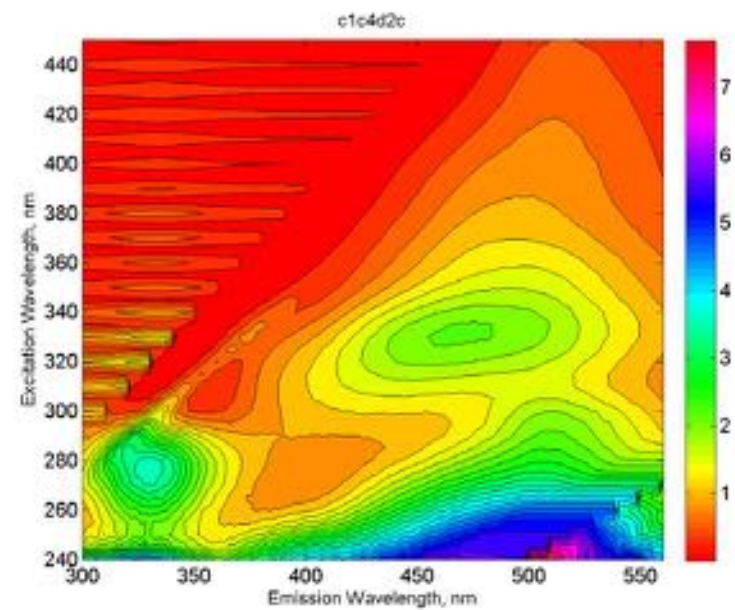
A and C correspond to humic and fulvic fluorophores

B and T correspond to tyrosine and tryptophan like amino acids, respectively

Sargasso Sea Deep



Greenland cryoconite waters July 2010



Desired drill features

- Ability to keep environment anaerobic- Yde etal basal ice GIS anaerobic
- Targeted ice coring- coiled tubing drill
- directional drilling or horizontal drilling
- Larger bore diameter
- Helicopter portable

Requirements

- Clean access- current decontamination issues, drill tracers
- Drill fluid n-butyl acetate, isopar K
- Good quality core- no cracks for contamination
- Ability to keep environment anaerobic- Yde etal basal ice GIS anaerobic
- Large enough sample volume for microbial studies, phylogenetics