

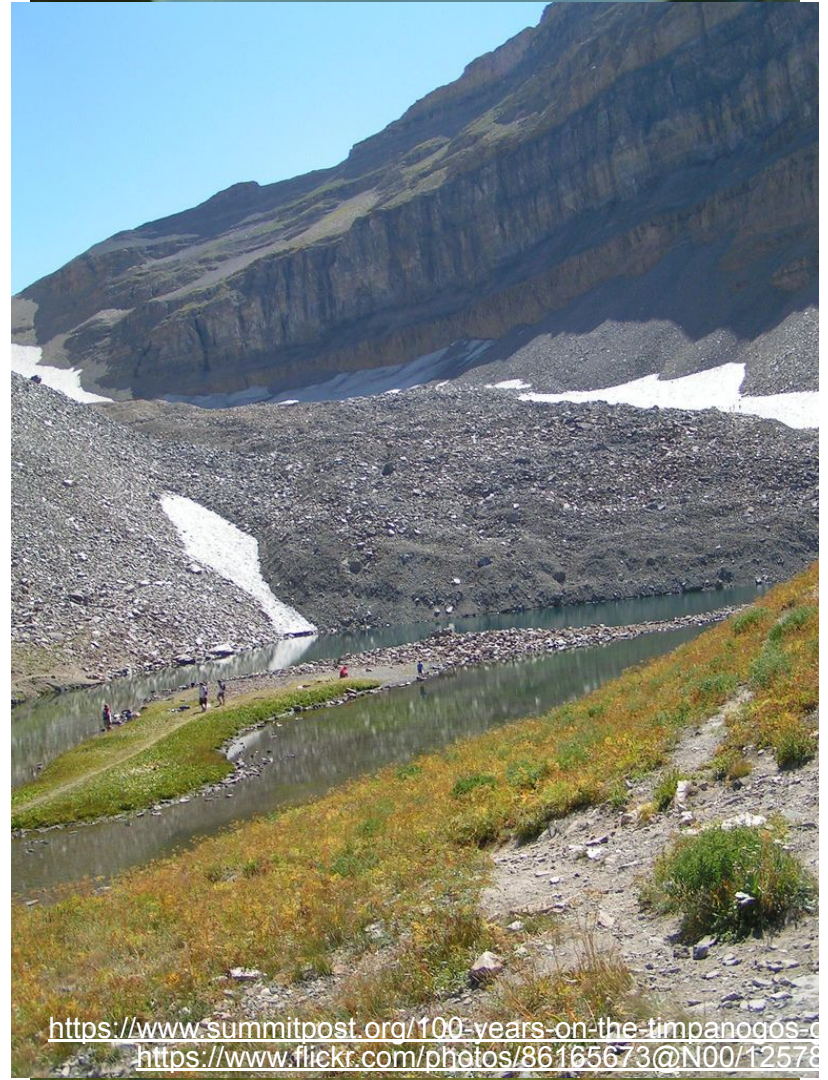
Mount Timpanogos



Jewell Lund, Jon Wagner, Morgan McDonnell

Rock glacier

- Mass of talus and interstitial ice
- Movement result of mountain permafrost creep
- 0.5 km long tongue-shaped
- Lobate, hummocky surface
- Steep front and sides (36 degrees)
- Crevasses reported throughout the 20th century



Snow/Water Sample Summary

- Site: Mount Timpanogos
- 124 total samples
- Three snowpits
 - Pit 1: 18 samples (0-136 cm), Date: 2012-06-30
 - Pit 2: 22 samples (0-119 cm), Date: 2012-08-16
 - Pit 3: 18 samples (0-154 cm), Date: 2012-08-16
- 66 spatial samples
 - one sample thrown out - believed to be erroneous
- Ran all samples in the Picarro for isotope analysis
- Ran samples from one snowpit in the sp2 for black carbon analysis

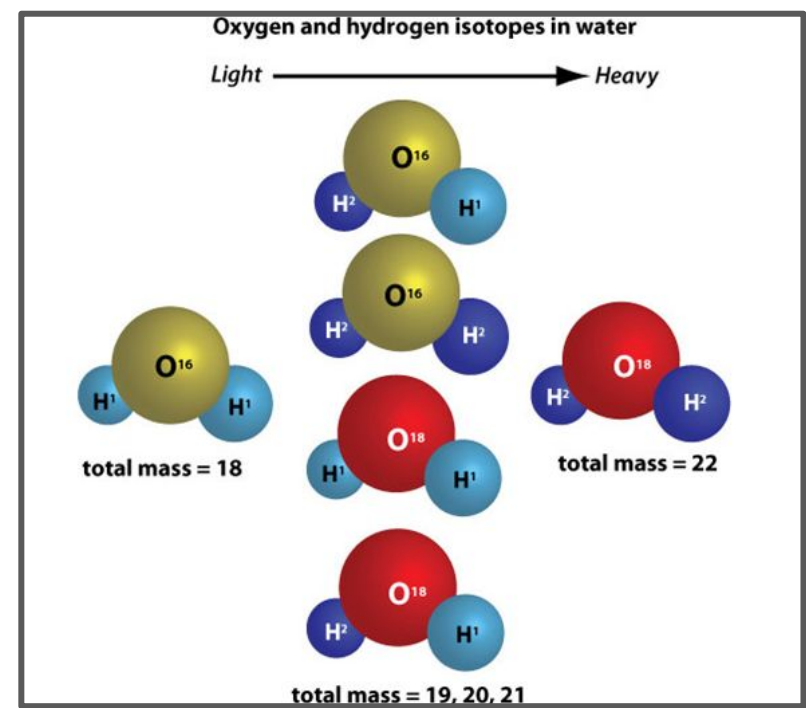
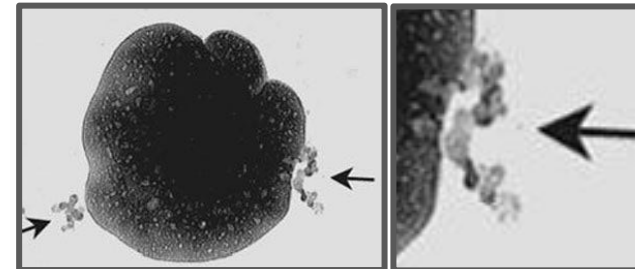


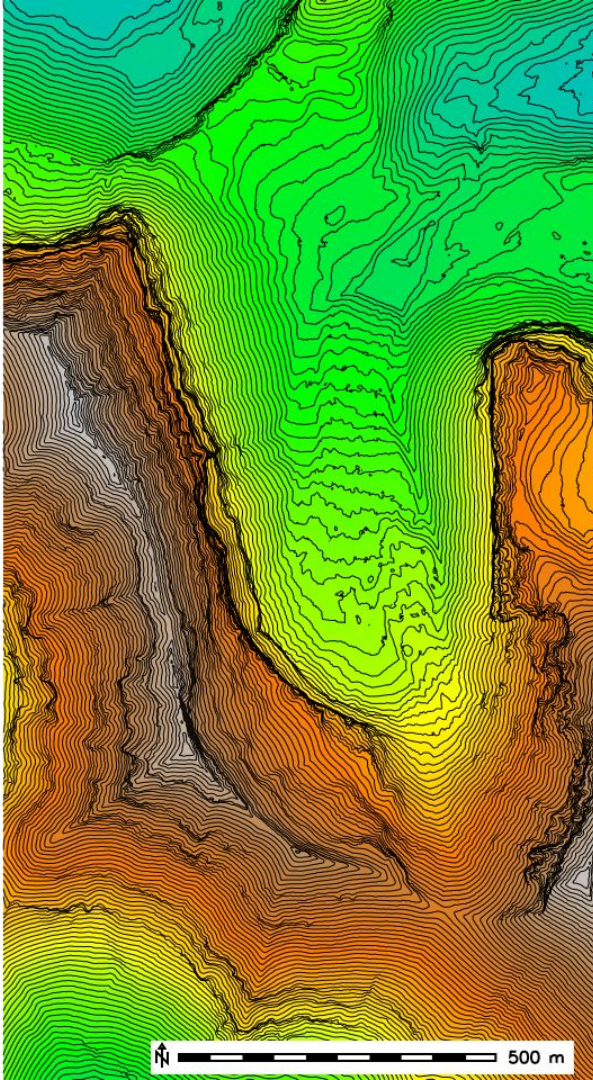
Figure from www.usgs.gov



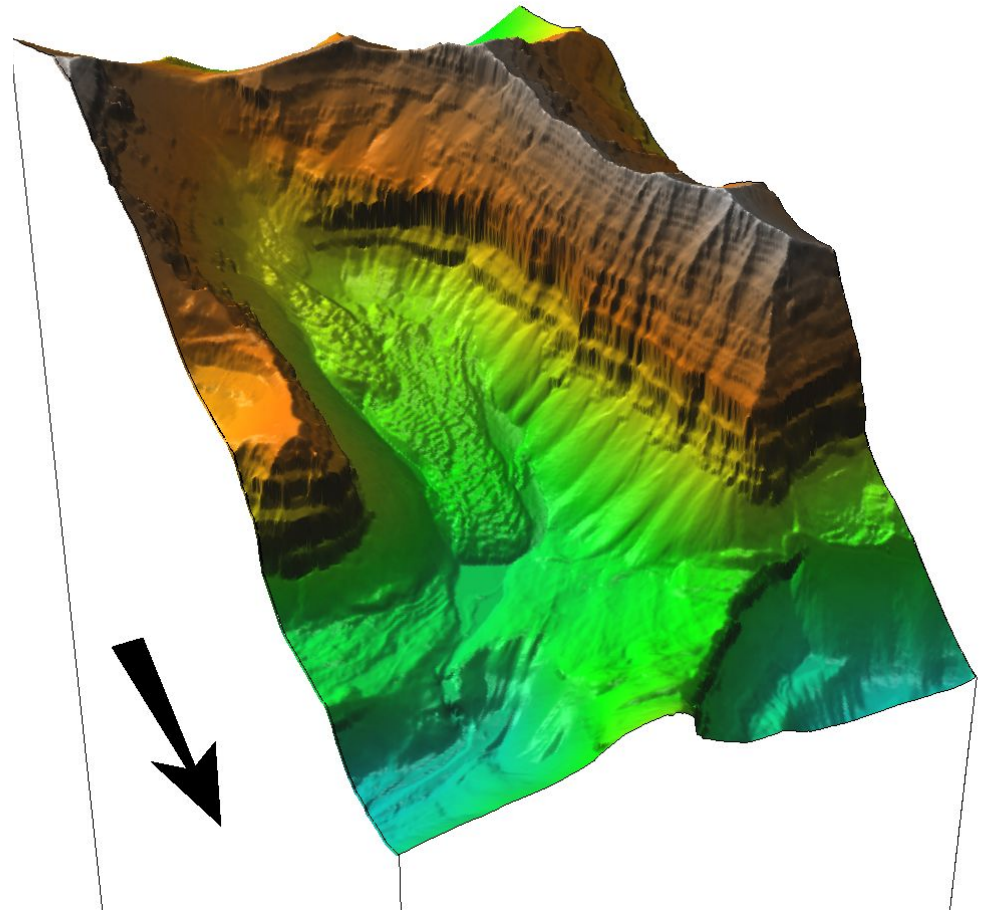
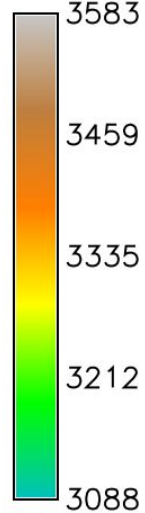
Black Carbon
Particle in Ice

Figure from www.wildculture.com

Mount Timpanogos: Study Area Map

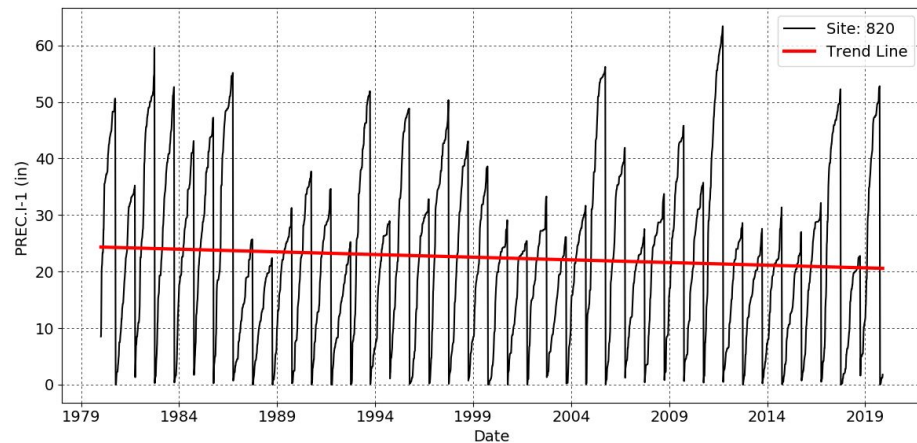
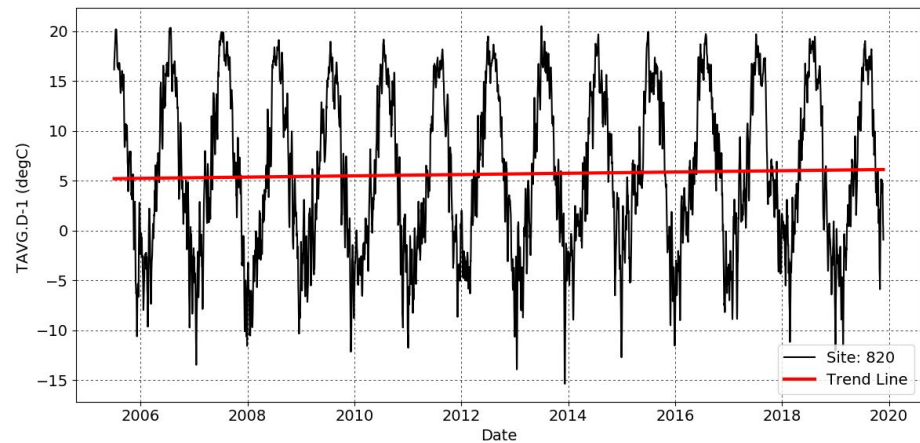
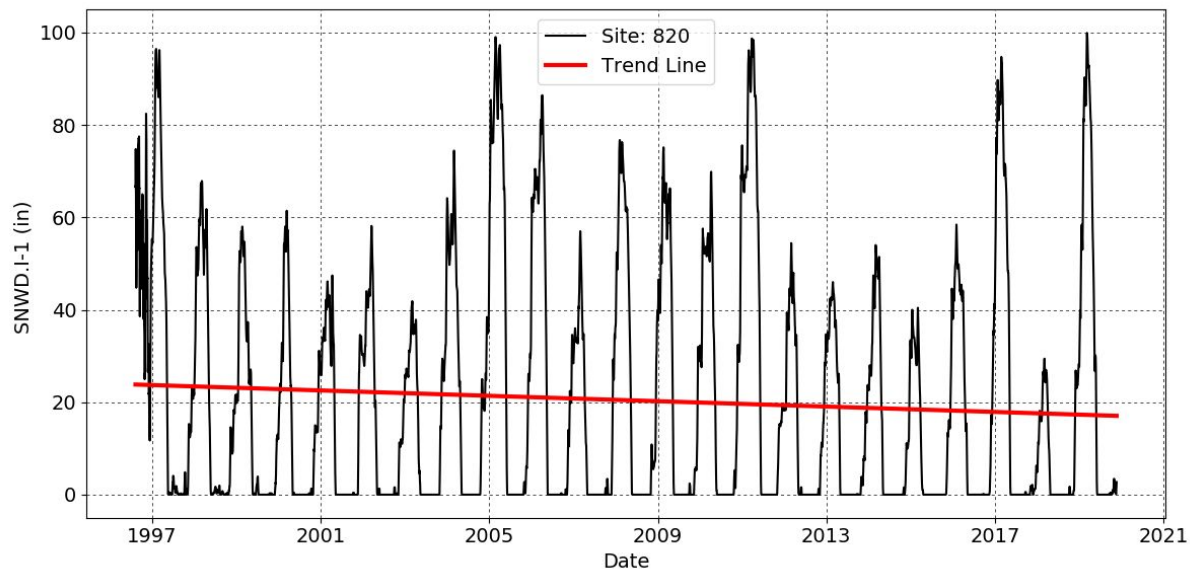


Elevation (m)

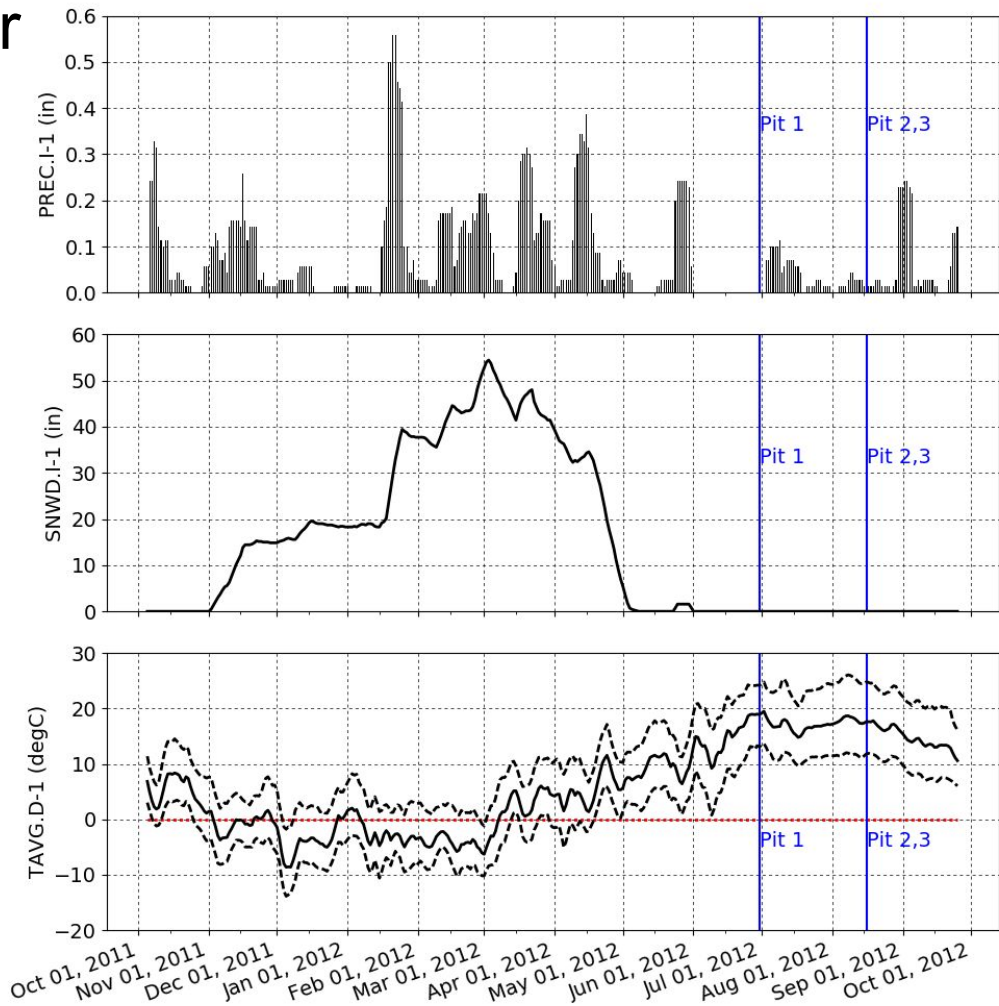
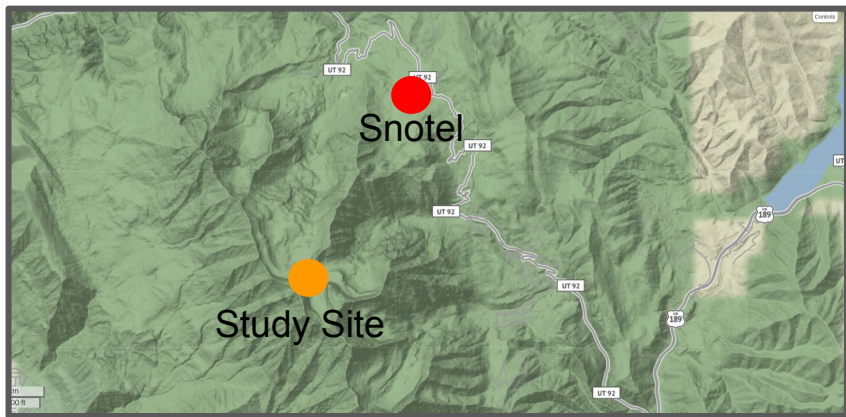


Historical Data: Snotel

- Timpanogos Divide
 - Site # 820
- Latitude: 39.9333
- Longitude: 111.6166
- Elevation: 2481 m
- Operating since: 1978

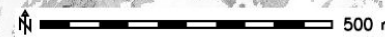
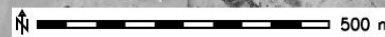
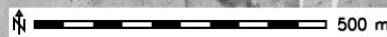
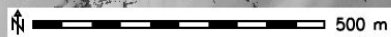


Snotel Data: 2012 Water Year





Historical Satellite Imagery: Date and Snow Extent Comparison



d18O spatial distribution

September 2018 Landsat

Legend

- -11:-13
- -13:-14
- -14:-15
- -15:-16
- -16:-17
- < -17
- ☆ snowpit

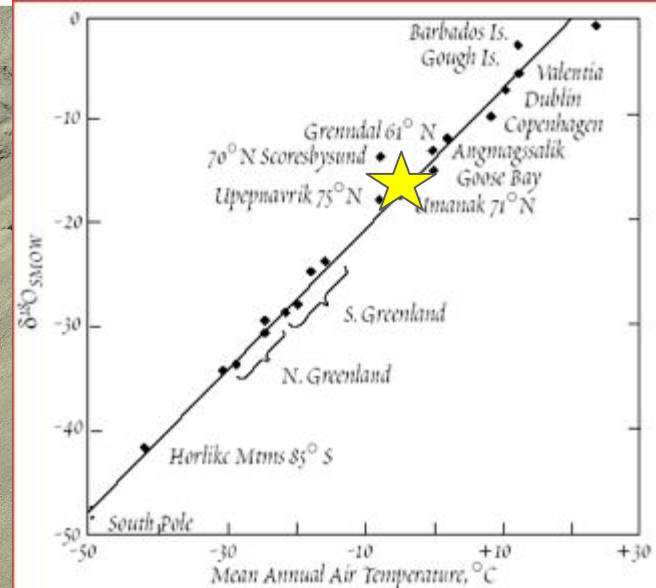
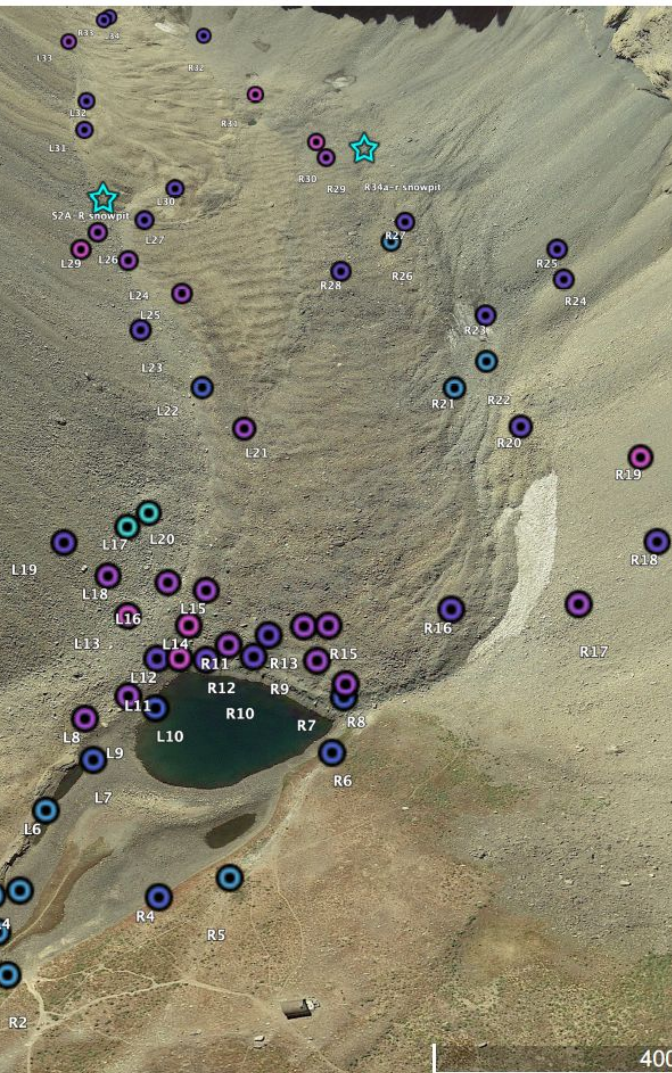


Figure 9.8. Variation of $\delta^{18}\text{O}$ in precipitation as a function of mean annual temperature.



Rozanski, 1993

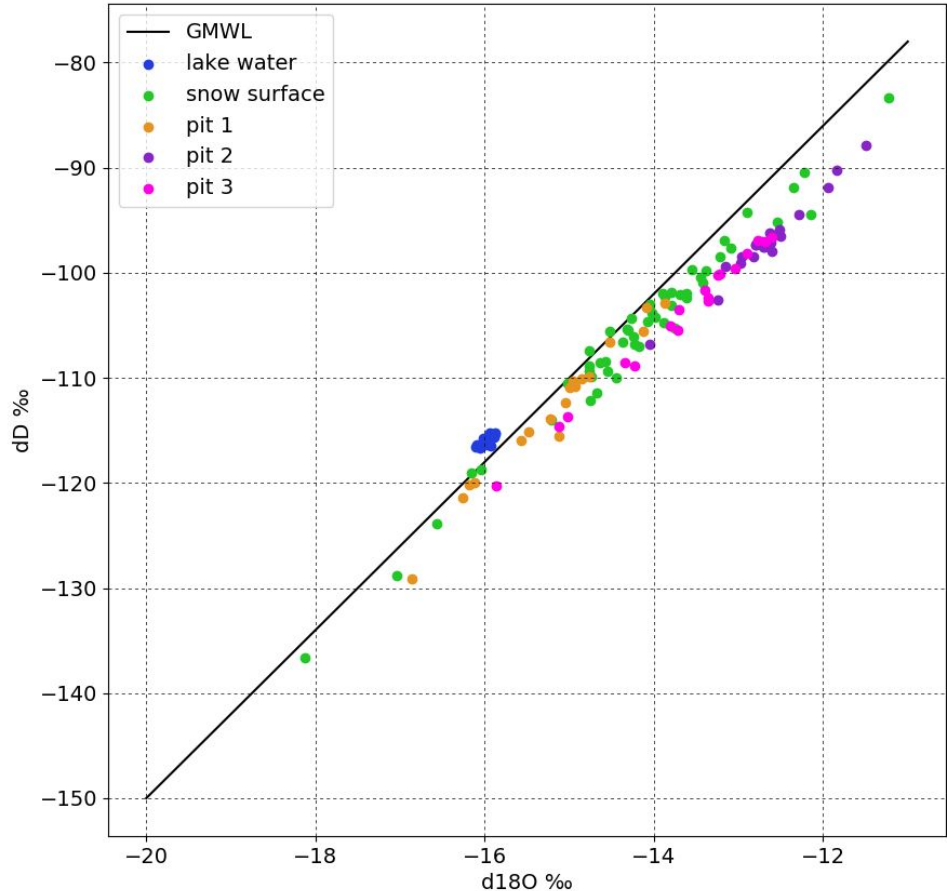
400 ft

Google Earth

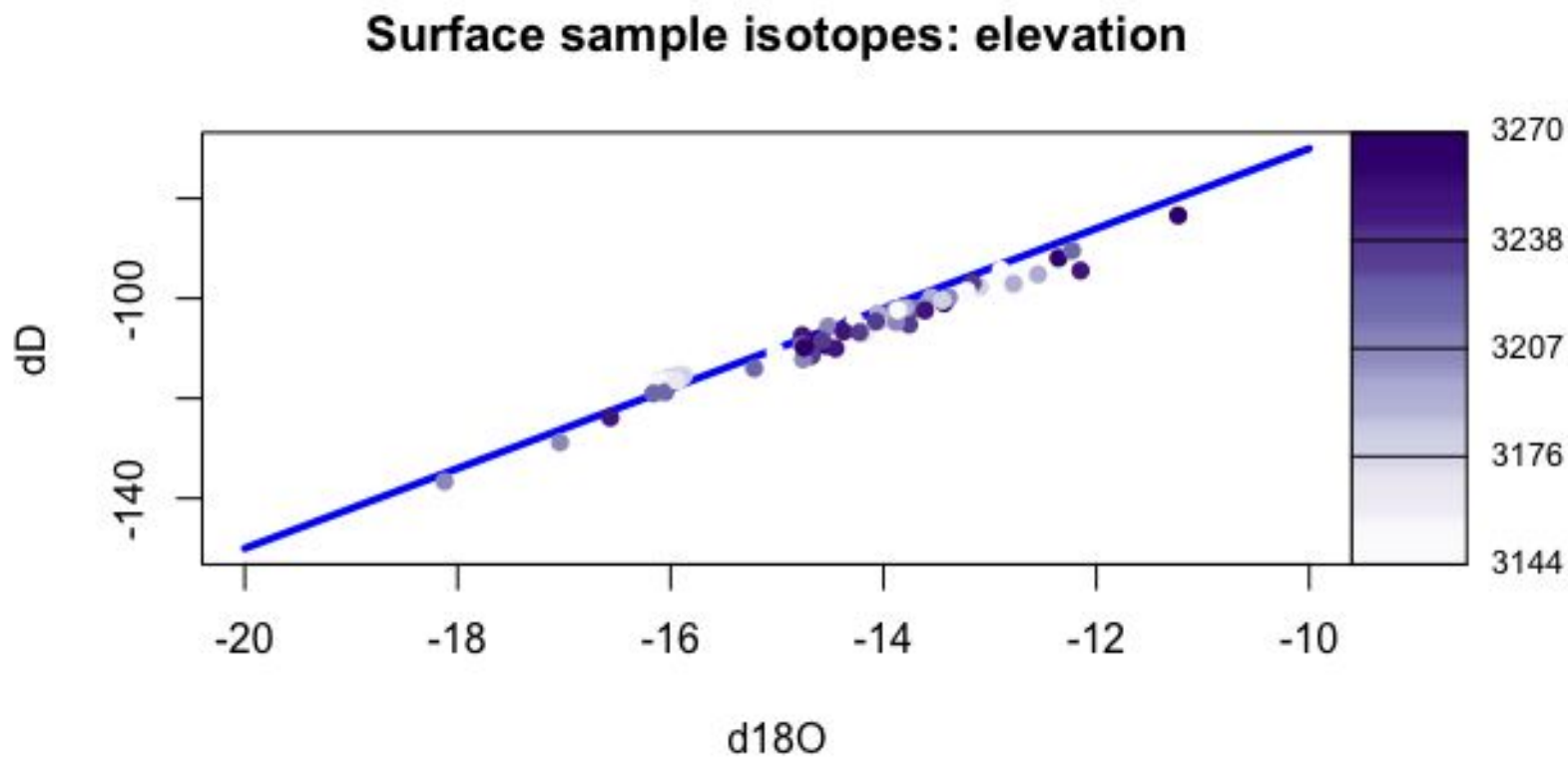
Image Landsat/ Copernicus

Isotope Analysis

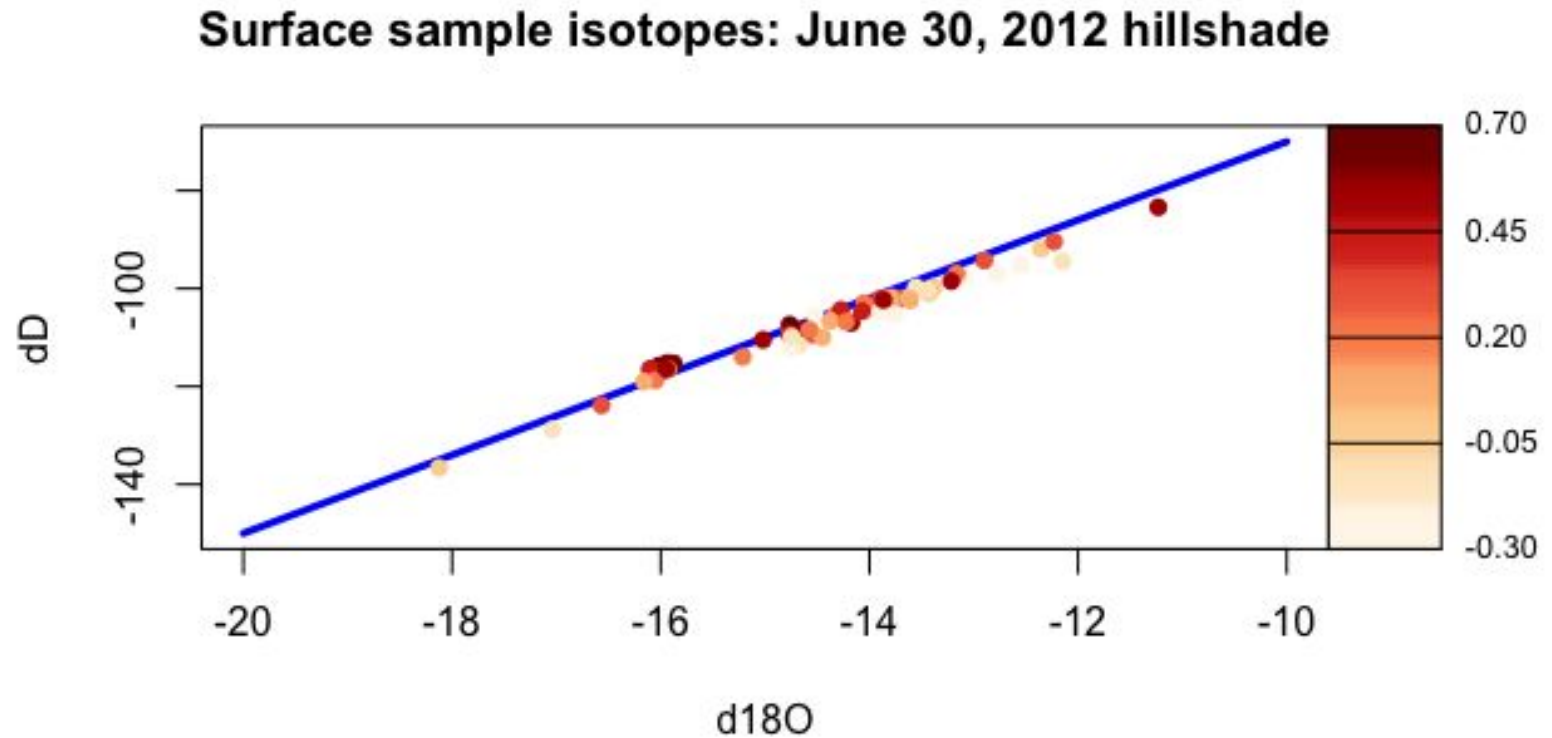
- Surface samples and pit 1 samples show similar trends
- Lake samples plot above GMWL
- Pit 2 and Pit 3 samples plot below surface and Pit 1 samples



Elevation

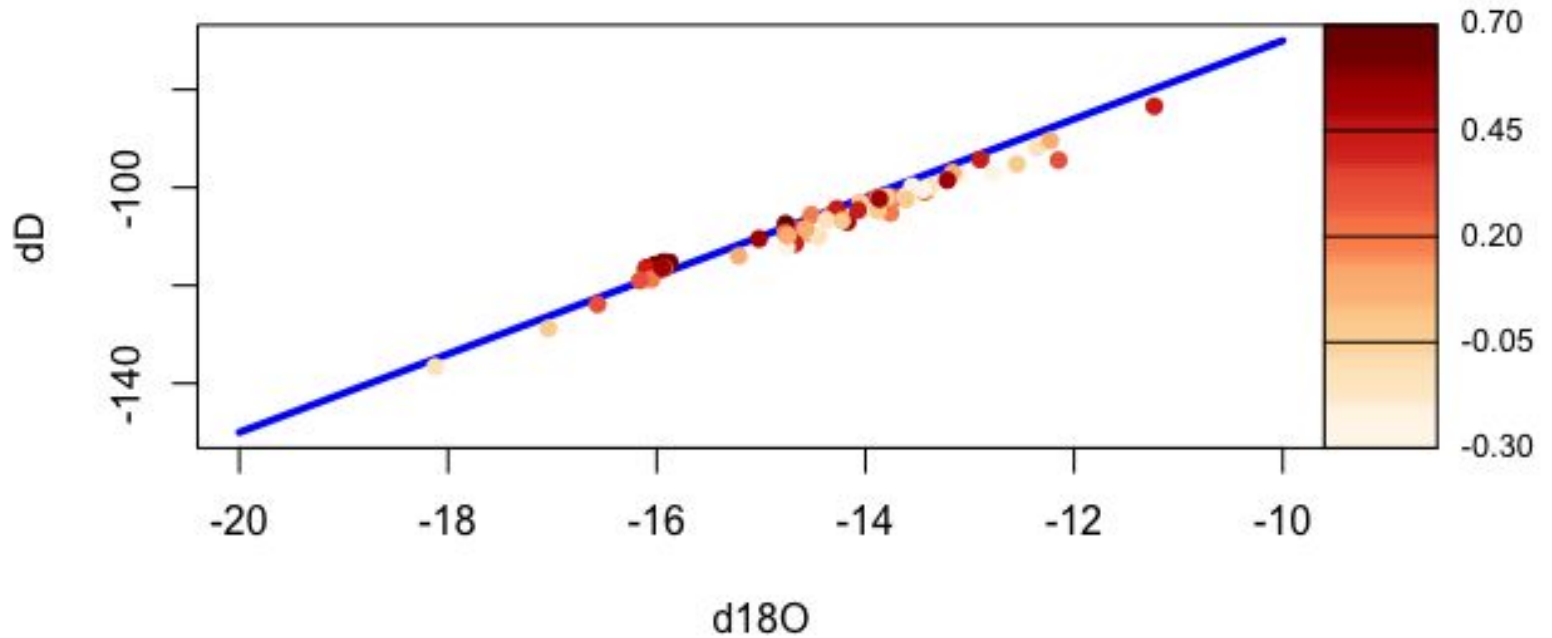


Hillshade: summer



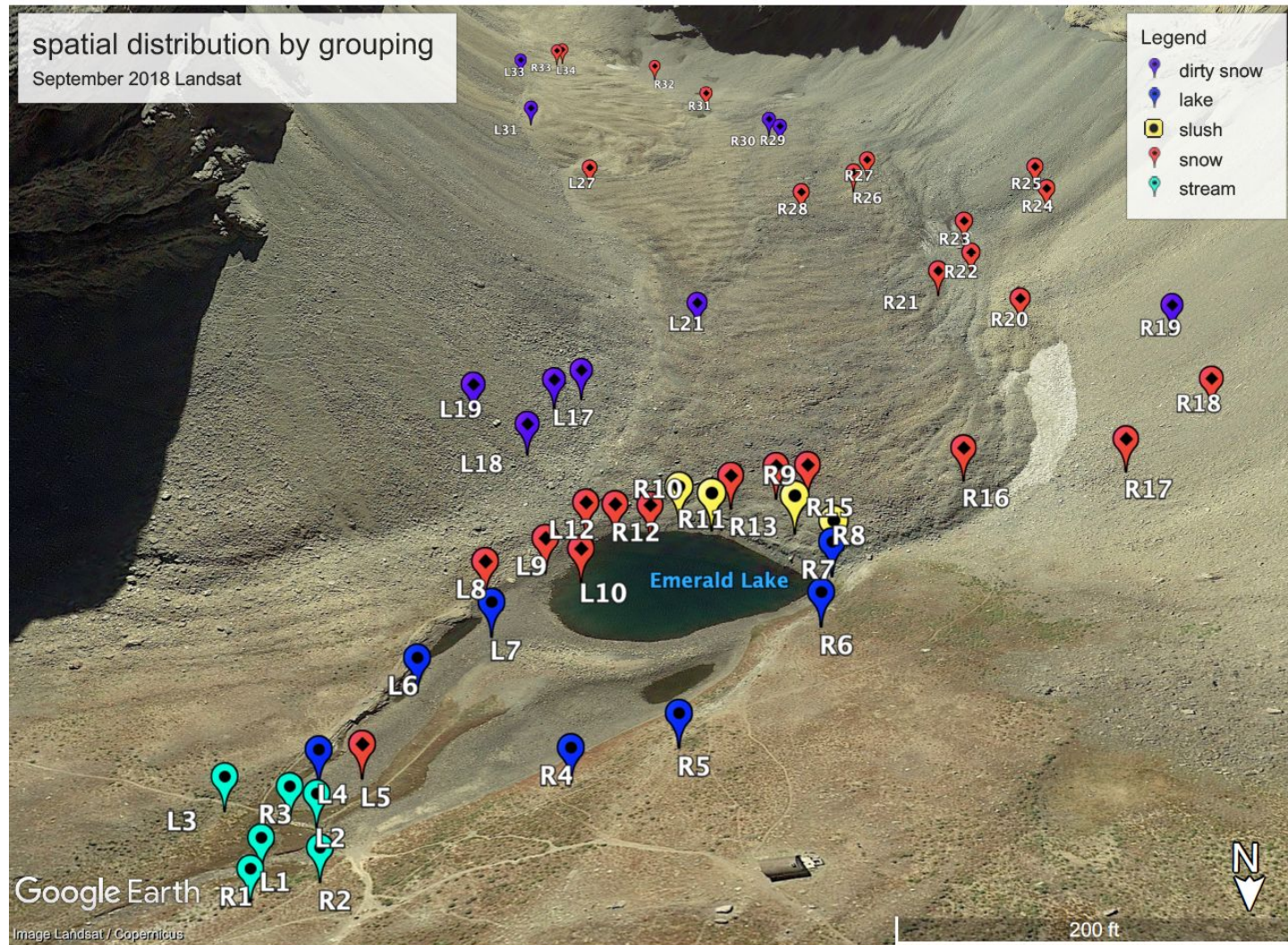
Hillshade: winter

Surface sample isotopes: Jan 1, 2012 hillshade

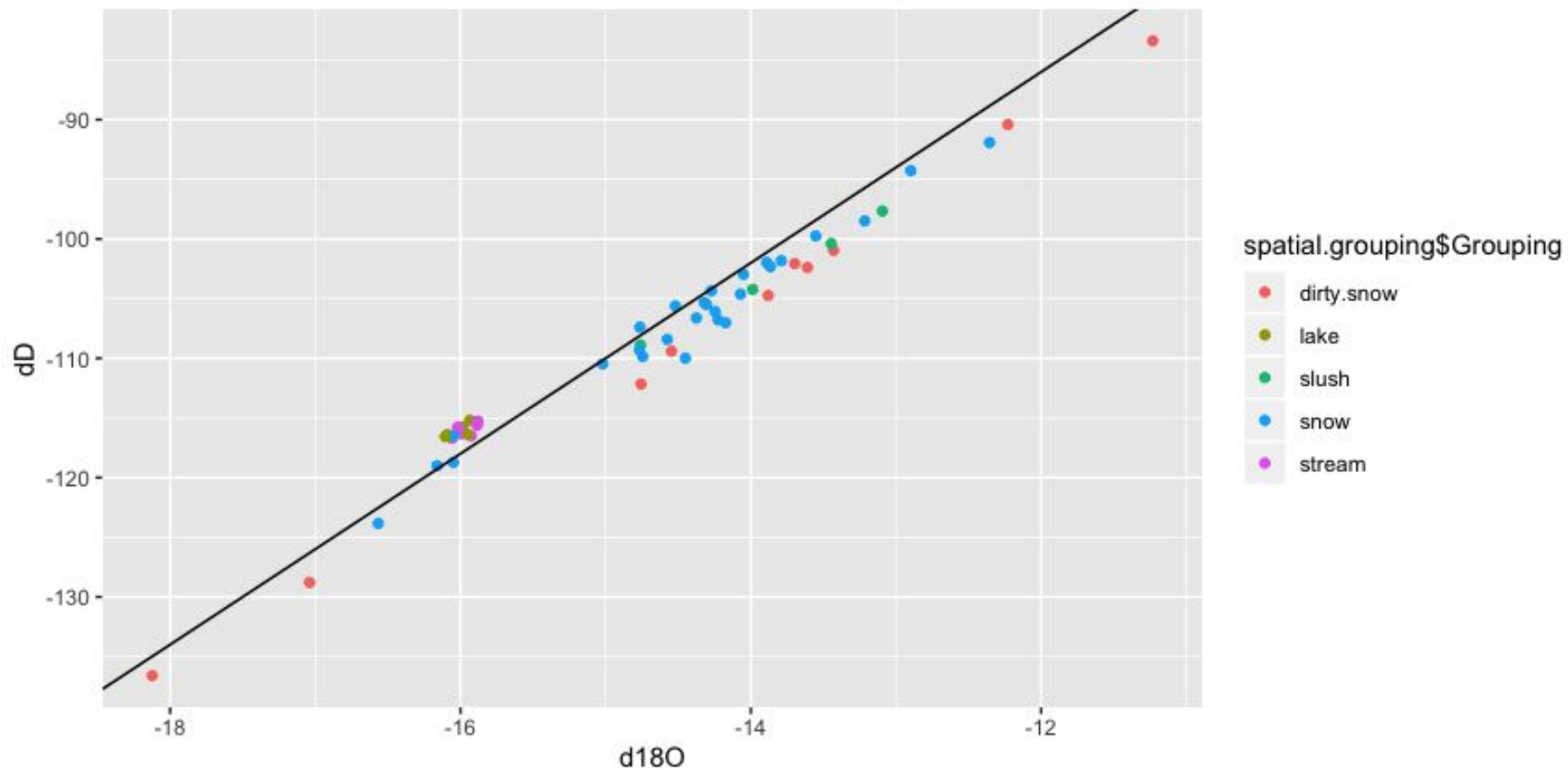


spatial distribution by grouping

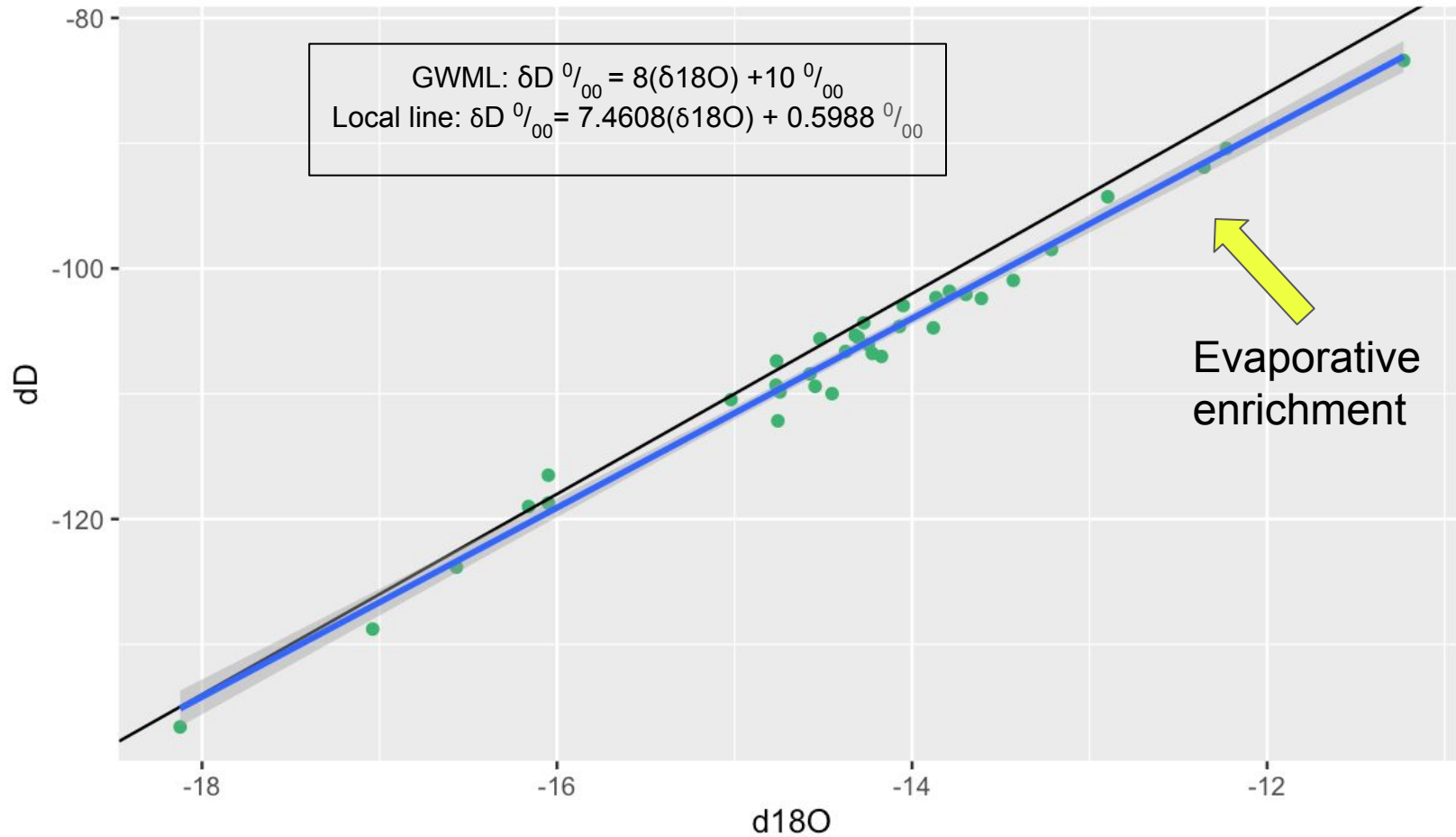
September 2018 Landsat

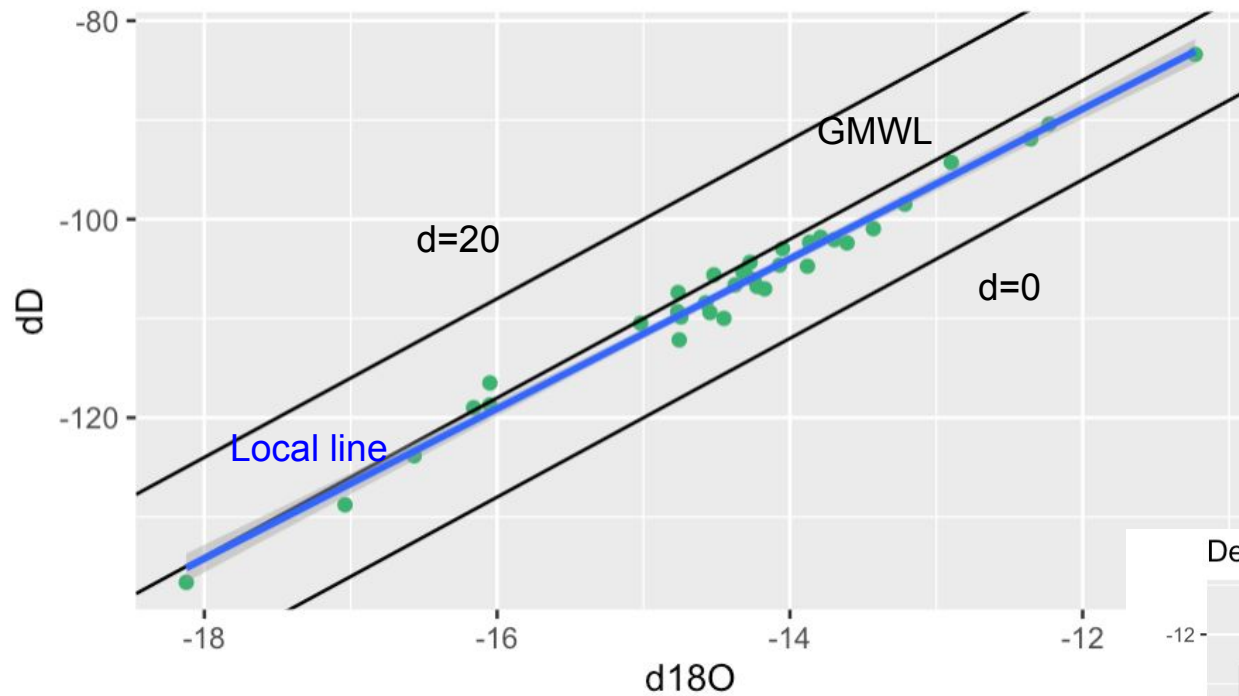


clustered spatial samples



Local trend

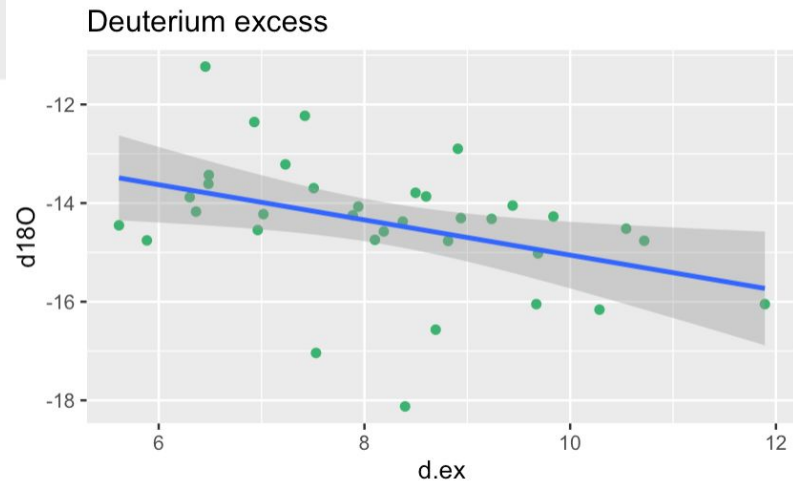




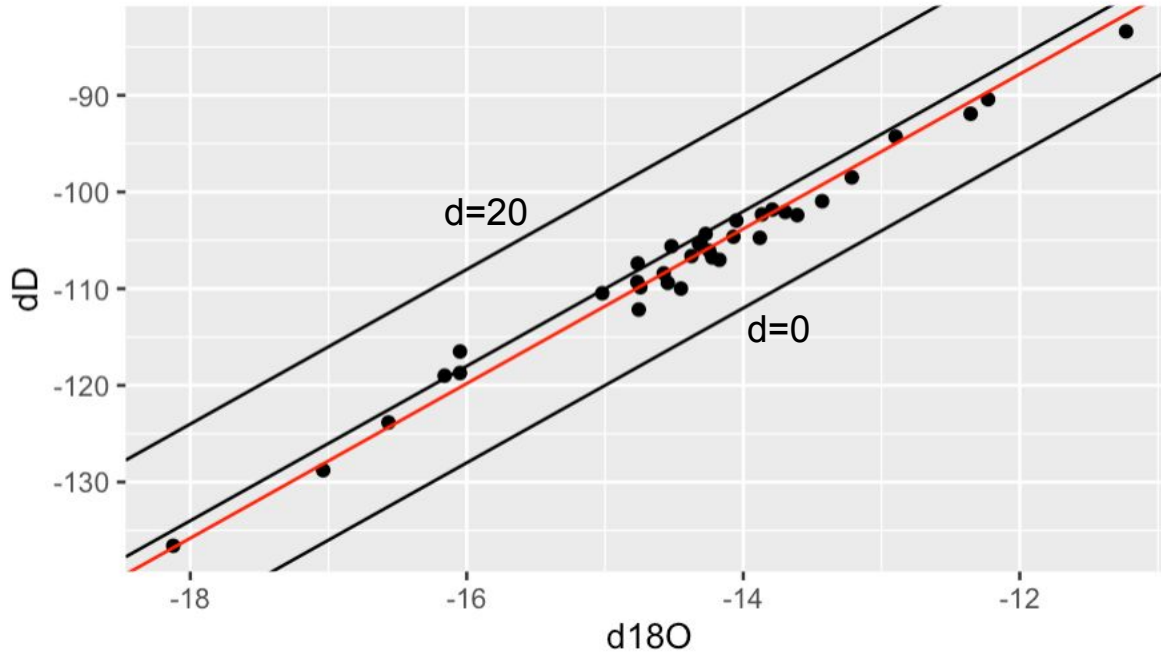
Deuterium excess
 $d = 8\delta D - 8(\delta^{18}O)$

Difference between δD and
 $\delta^{18}O$ scaled by 8 (slope)

Average global $d = 10\text{‰}$



Excess line



Deuterium excess
 $d = 8D - 8(\delta^{18}\text{O})$

Mean deuterium = intercept = 8.195148
 maintain slope of 8

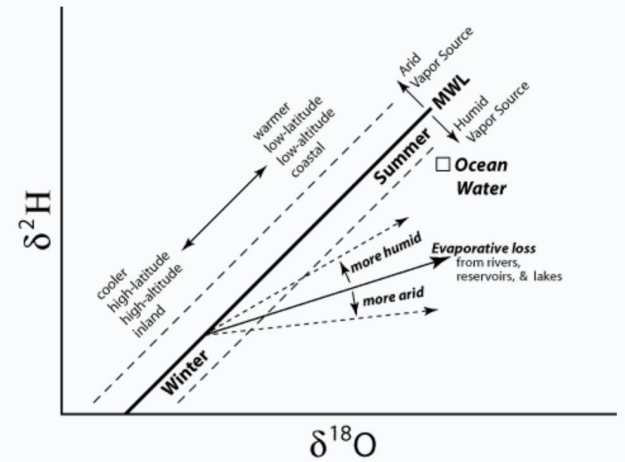
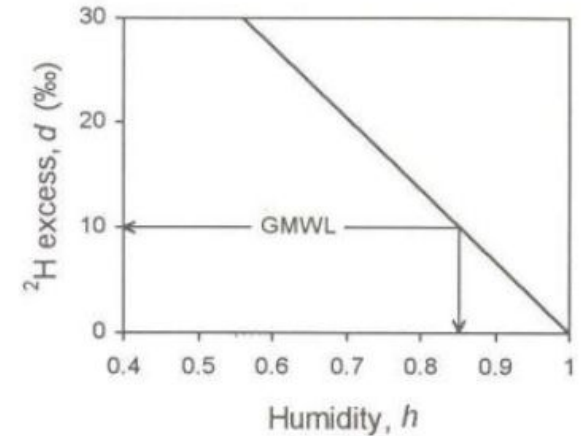


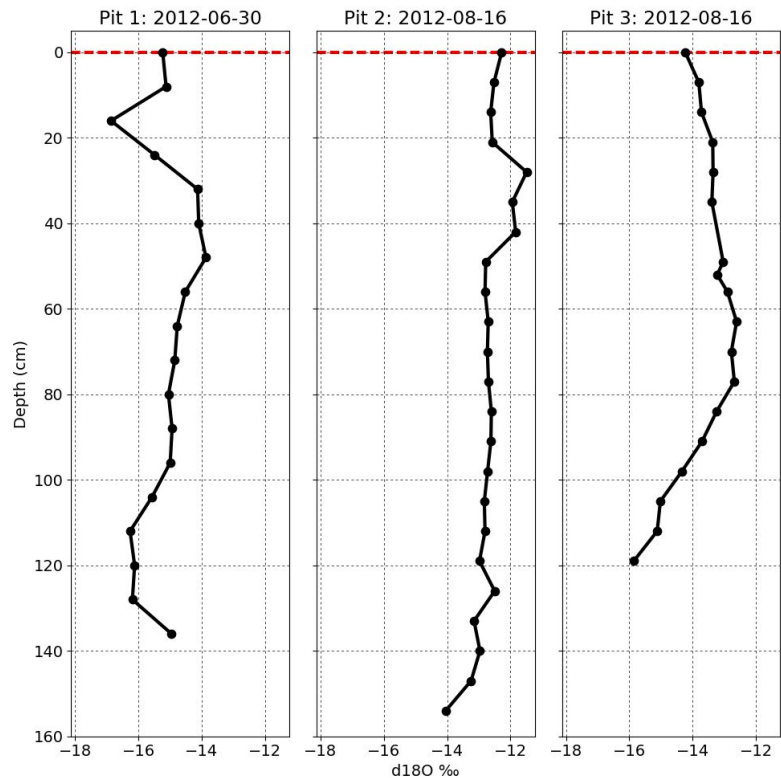
Figure 6. Summary diagram of how hydrologic processes affect oxygen and hydrogen isotopic composition of water.



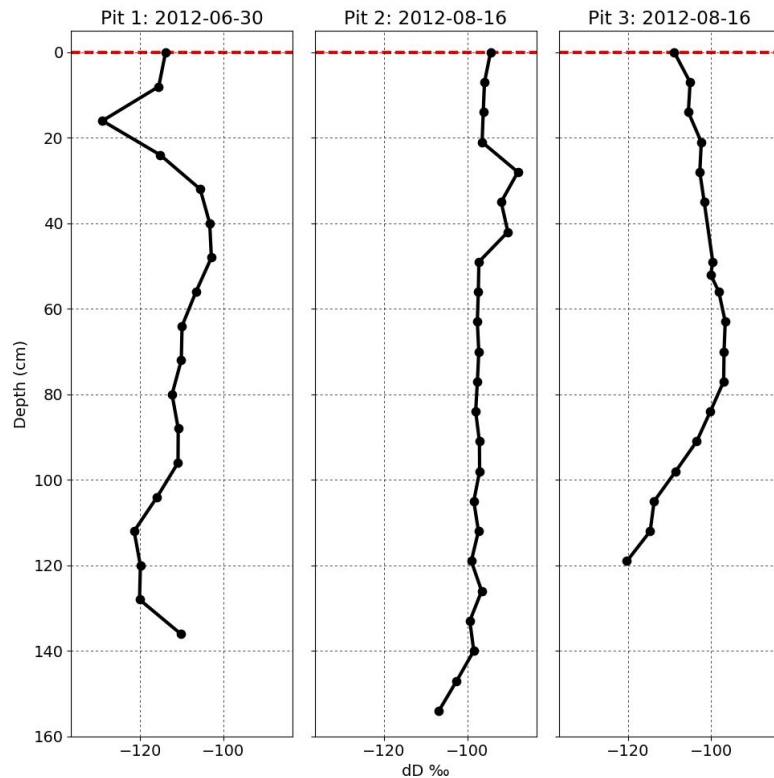
$d \sim$ humidity during kinetic evaporation from ocean surface (after Merlivat and Jouzel, 1979)

Comparison of Snow Pit 1-3 Isotopes

d18O

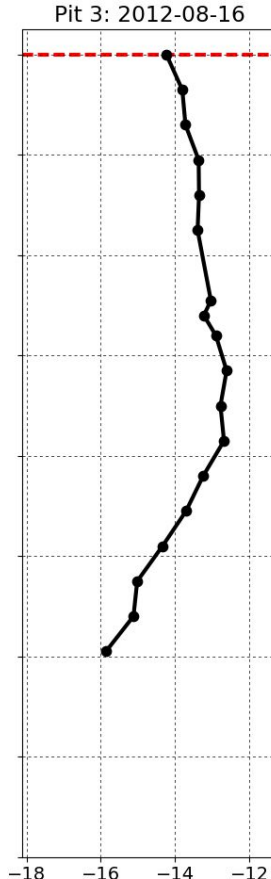
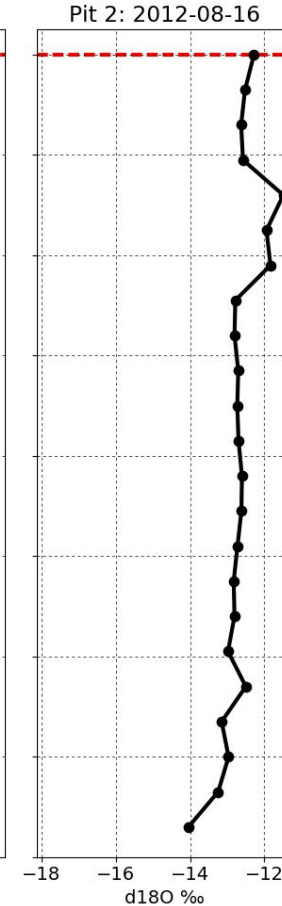
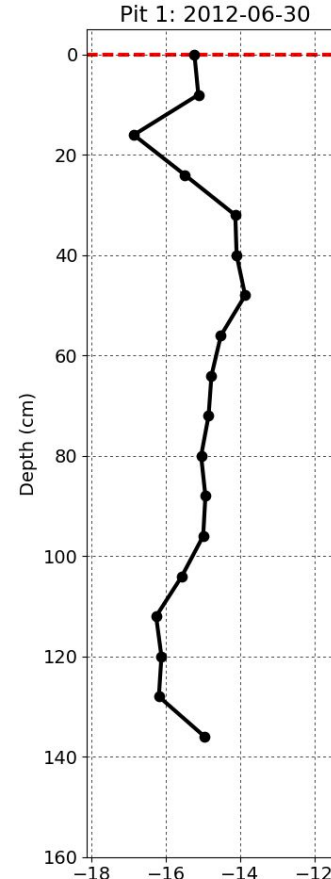
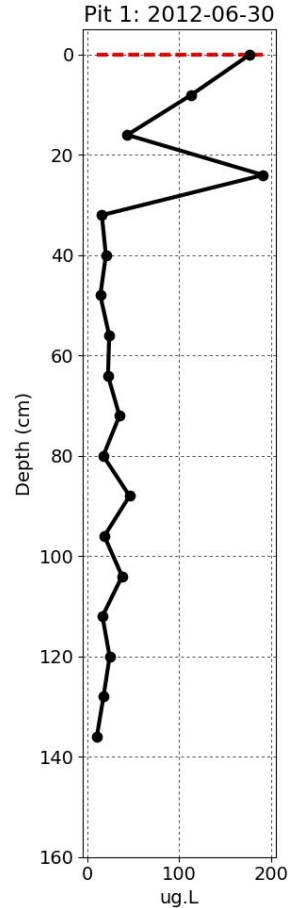


dD



Pit 1 Black Carbon Analyses

- Black carbon horizon at approx. 30 cm depth
- Isotope horizon also near 30 cm depth
- Perhaps these horizons represent an old snow surface layer



Conclusions

- Spatial distribution of isotopic composition not elucidated by physical parameters such as elevation or hillshade
- Snow condition (e.g. dirty vs. clean snow, slush) does show a difference in isotopic signature
- Horizons in snow pit 1 suggest a correlation with black carbon concentrations and depleted isotopes: an old snow surface that then got buried by late season snow storms

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