Orographic Precipitation, Drying Ratio and Isotope Fractionation

1. Modified Upslope Model
2. A Drying Ratio Formula
3. Drying Ratio from Soundings
4. Drying Ratio from Isotopes
5. PaleoClimate: The OP Thermometer

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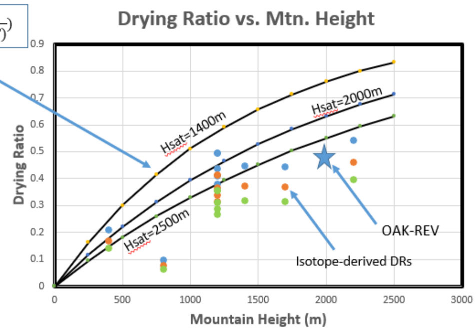
Mountain Meteorology

$$DR(h,T) = 1 - \exp\left(\frac{-h}{\mathrm{Hsat(T)}}\right)$$

Upslope Model Predictions of DR with Hsat values:
1400m
2000m
2500m



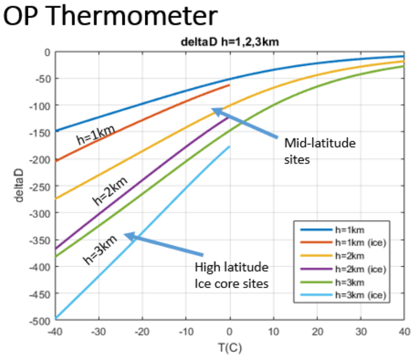
Alpha Values: Blue: $T = 0°\mathrm{C}$ Red: $T = -20°\mathrm{C}$ *liquid* Gray: $T = -20°\mathrm{C}$ *ice*

The OP Thermometer

Physics

1. Hsat increases with T
2. Alpha decreases with T
3. Sensitivity increases with mountain height

This plot shows isotope ratio in mountain top precipitation (or the ice core) as a function of regional temperature.



Conclusions

1. The OP Drying Ratio is fairly well estimated by:
   1. The new upslope DR formula
   2. Balloon Sounding Pairs
   3. Streamwater Isotope Ratios
2. OP isotope fractionation is larger and more sensitive to temperature in cold climates.
   1. Rising air dries faster at low temperature (i.e. smaller $Hsat(T)$)
   2. Fractionation factor $\alpha(T)$ is larger at low temperature (esp. ice phase)
   3. Sensitivity to T increases with mountain height
3. The OP Thermometers on Greenland and Antarctica record the Pleistocene polar climate