

Thoughts on limits and new approaches to reconstruct temperature from the isotopic composition of ice cores in low-accumulation regions

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| Process | Time-scale (and why) | Spatial-scale | strength estimate /amplifying factors | Ways to overcome | research directions (limited personal view) |
|--|--|--|--|---|---|
| temperature -> water isotopes in precipitation | GCM's suggest stronger relationship towards longer time-scales but slopes may depend on mean climate state | unclear, non-temperature effects likely spatially coherent | unclear | inherent limitation some gain by spatial averaging across large distances & temporal averaging use of non water isotope proxies | Continue to test isotope enabled GCM's across time-scales (spatial, seasonal, interannua). T vs. isotope frequency spectra in GCM's and obs. |
| vapour exchange with surface snow | Unclear, likely fast | unclear, maybe linked to local topography | lower accumulation+ | use of excess parameters | Study relation of excess parameters and local surface conditions-> simple testable models |
| precipitation intermittency | white noise = averages out (aliasing of the seasonal cycle) | 100-500km | seasonal cycle strength x intermittency | averaging across cores & time active noise correction using other seasonal parameters | precip vs. accum. obs. check/use covariance between water isotopes and impurities |
| (local) stratigraphic noise & accumulation intermittency | blue noise = averages out quickly (Antarctica is flat...) | 1-10m | amplitude of topographic undulations / accumulation rate | averaging across cores & time active noise correction using other seasonal parameters | Strat. noise estimates across different sites (e.g. trenches) to inform a model for stratigraphic noise check/use covariance between water isotopes and impurities |

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| topographic noise | flow-speed x accumulation rate low frequency variations are possible = might not average out | scale of accumulation variations, linked to scale of bedrock variations | wind-speed+ topography+ | choose sites with minimal flow speed and minimal spatial accumulation rate variations | spatial investigation of accumulation rate vs. topography vs. mean isotope variations to bracket the effect |
| firn and ice-diffusion | only affects fast time-scales fast can also mean millennia in the deep part of the Oldest Ice Core | local response function | diffusion length / layer thickness | high precision measurements + optimal deconvolution However, possible gain is limited to a narrow frequency range | Ice-diffusion in warm ice? Analysing deep parts of deep ice-cores |