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

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For several decades, ice-core water-isotope research was focused on retrieving and interpreting single cores, measured on increasingly finer resolution and higher analytic precision. However, not only the sampling resolution or analytical precision limits the ability to recover the climate signal, but also the way the climatic signal is imprinted in the isotopic composition profile obtained from ice cores. Therefore, despite three decades of Antarctic ice-coring and dozens of firn cores, especially the temperature evolution in the low accumulation region of East Antarctica during the last millennium is still barely known. In the recent years, strong progress has been made in the understanding of the isotopic signal formation based on process studies, snow pits, snow trenches and replicate cores. Using this knowledge, we will review the limits of temperature reconstructions based on theoretical considerations, empirical signal-to-noise ratio estimates and forward models of the signal formation. We will further discuss new avenues for sharpening the ability to recover high-resolution temperature signals from firn and ice cores by optimally combining multiple cores and by combining isotope with impurity records.