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Continuous On-Line Water Vapor Isotope Measurements In Antarctica

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In the context of a globally warming climate it is crucial to study the climate variability in the past and to understand the underlying mechanisms (1).
Precipitation deposited on the polar ice caps provides a means to retrieve information on temperature changes (through the paleo-temperature dependence of the isotopic composition of the ice) and atmospheric composition (of gas stored in bubbles in the ice) on time scales from one to almost one million years, with sub-annual resolution in the most recent centuries. However, it is now widely recognized that the calibration of the paleo-thermometer is highly problematic. For this reason attempts to model the global water cycle, including the isotope signals, are ongoing with the aim of providing a more physical basis of the isotope - temperature relation. Currently, there is a large divergence in the results obtained by different modeling strategies. The missing link in these model studies is their forcing by experimental data on the pre-deposition isotopic composition of the vapor phase compartment of the hydrological cycle. We propose to measure the isotopic composition of moisture carried towards and deposited on Antarctica, in order to constrain the numerical models. In this context we have developed a modified, more sensitive and precise, version of a laser water vapor isotope spectrometer, originally designed for stratospheric studies (2, 3). This instrument, which will first be operated at the Norwegian station of Troll in Queen Maud Land in early 2011, enables the continuous, online measurement of all three stable isotope ratios of atmospheric water vapor. Laboratory Allan variance studies have shown a measurement precision of 0.06‰ and 0.1‰ for δ18O and δ17O, respectively with an averaging time of 300 s, and a precision of 0.5‰ for δ2H with an averaging time of 1000 s, all at a water volume mixing ratio of 580 ppmv. We will present preliminary data that should improve the validity of the models and improve the understanding of the physical mechanisms at the basis of the isotope thermometer. This in turn will lead to an increased confidence in the predictions of (general circulation) models concerning climate variability.

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