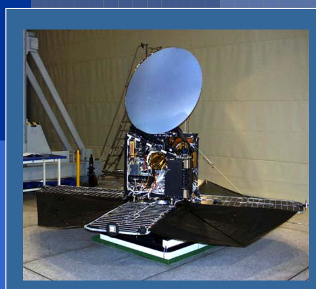
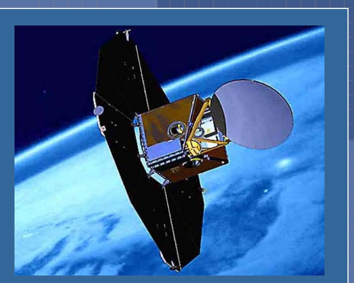


Spatio-temporal variability of stratospheric water vapour as observed by Odin



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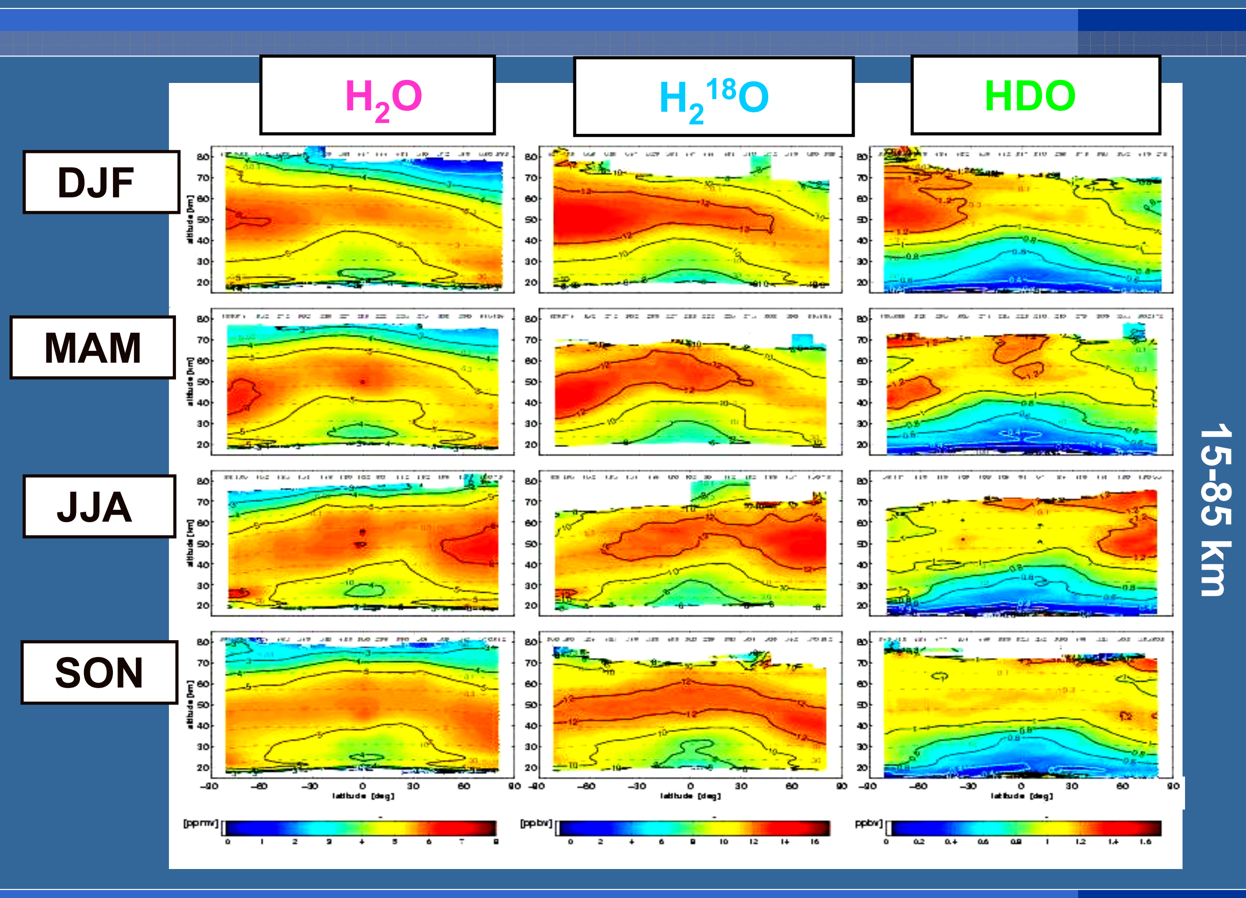
CHALMERS Radio and Space Science

1 Introduction.

The Sub-Millimetre Radiometer (SMR) on board the Odin satellite, launched in February 2001, measures thermal emission lines in the 486-581GHz spectral range of a large number of middle atmospheric constituents. Water vapour is observed in regular intervals using several different bands, providing information from the upper troposphere up to the lower thermosphere (~10-110 km). Emphasis is here put on results obtained for the stratosphere / lower mesosphere region.

2 Global distribution.

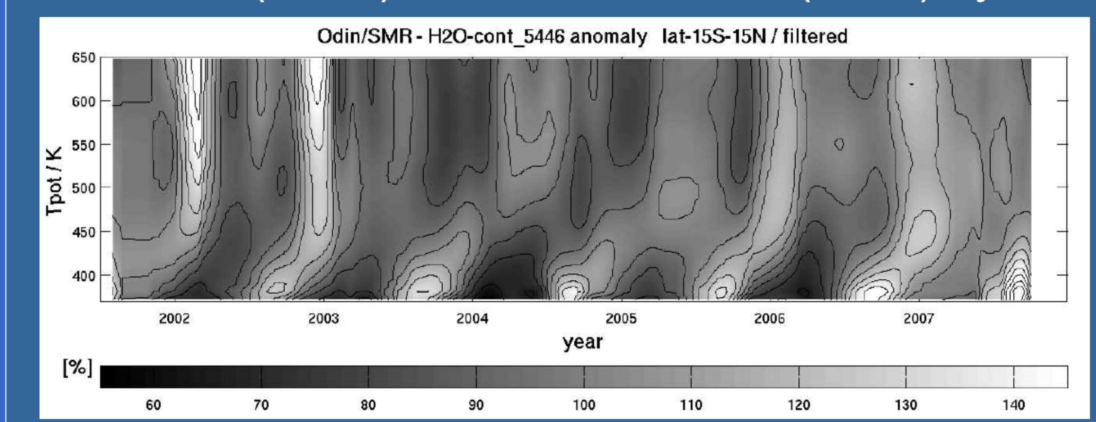
Odin/SMR observations of the global distribution of the water vapour isotopologues H_2O-16, H_2O-18, and HDO are performed on approximately one measurement day per week using bands around 488.9 and 490.4 GHz, providing information from roughly 20 to 75 km with a vertical resolution of ~3 km. Due to the relatively long photo-chemical lifetime of stratospheric water vapour, the distribution is governed by the global circulation and its seasonal variations, with up-welling strongest in the polar regions of the summer hemisphere and in the tropics, as well as down-welling in the winter hemisphere.

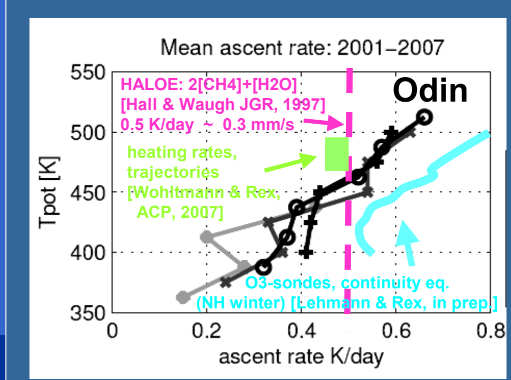


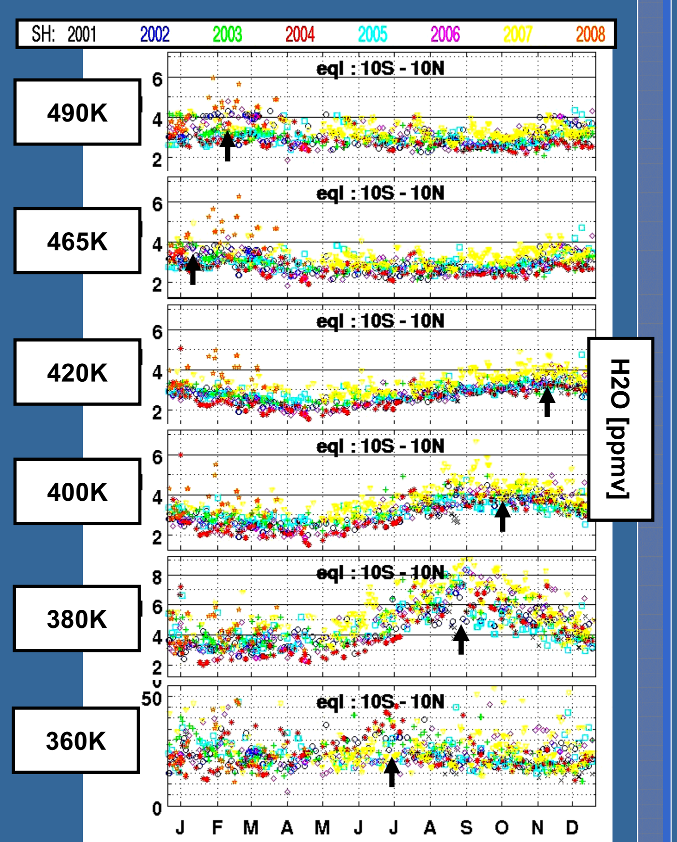
Right: Seasonal zonal mean fields of H_2O, H_2O-18, and HDO for 2001-2006 (DJF: Dec-Jan-Feb; MAM: Mar-Apr-May; JJA: Jun-Jul-Aug; SON: Sep-Oct-Nov).

3 Tropical tape-recorder.

Odin/SMR observations of a band near 544.6 GHz allow H_2O to be retrieved from the tropopause up to ~25km. The slow diabatic ascent of air in the tropical lower stratosphere leads to the so-called tape-recorder effect, since ascending air masses preserve the seasonal signal of water vapour entering the stratosphere, characterised by minima during northern hemisphere winter and modulated by tropical oscillations such as quasi-biennial (QBO) and semi-annual (SAO) cycles.



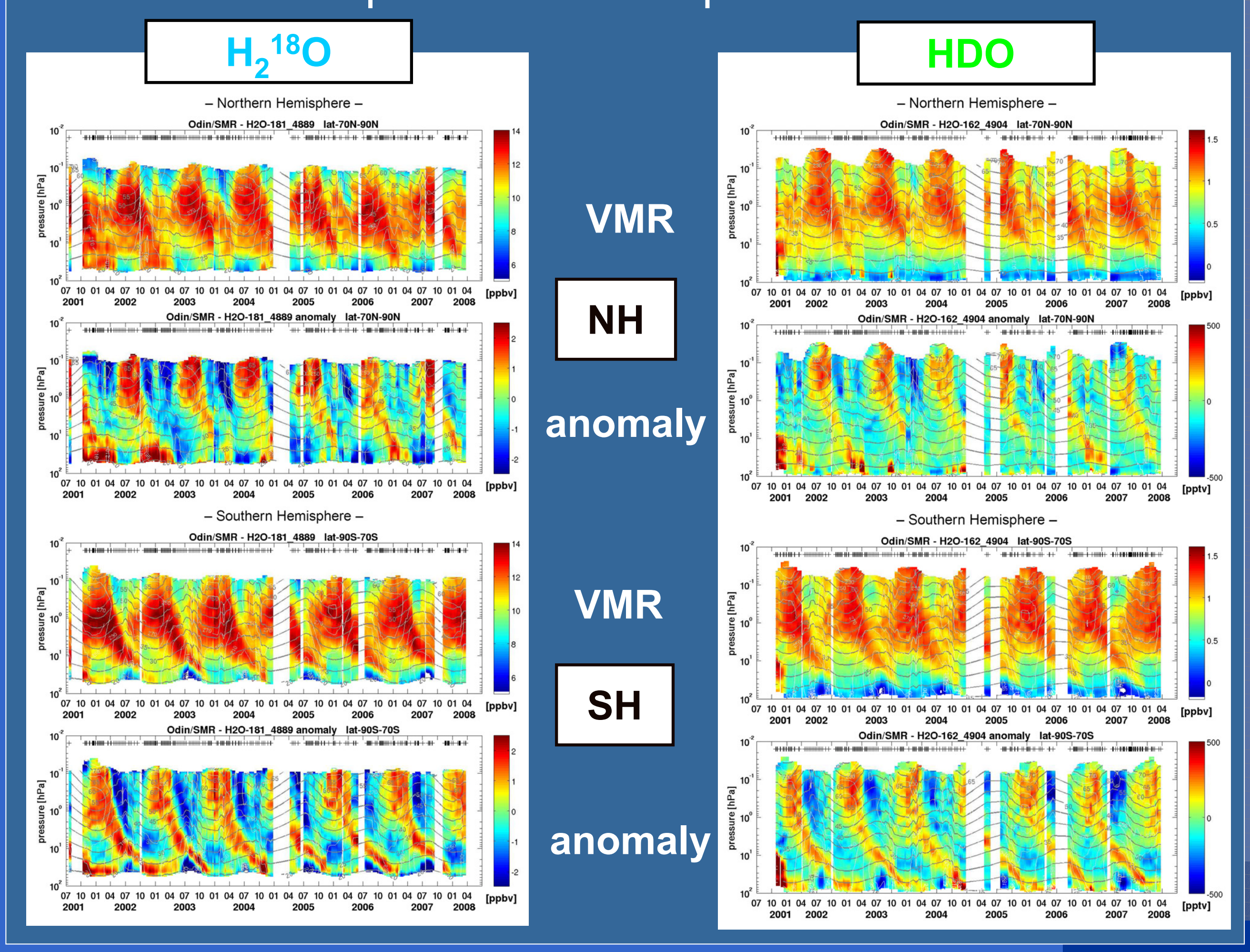




Top and right: Odin 544.6 GHz water vapour tape-recorder in the tropics. Left: Ascent rates from Odin/SMR increase with altitude. Good agreement of the mean ascent rate in the ~375-550K range (0.5 K/day) with that derived from HALOE.

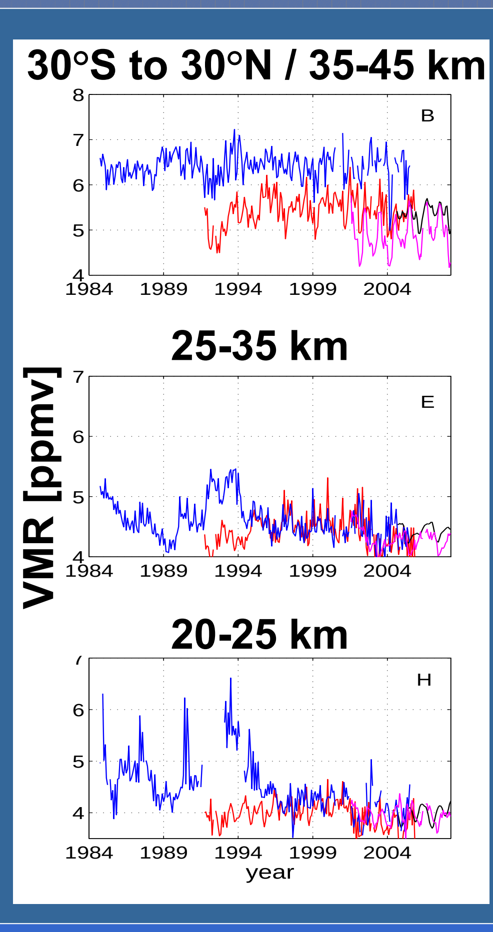
4 Polar descent.

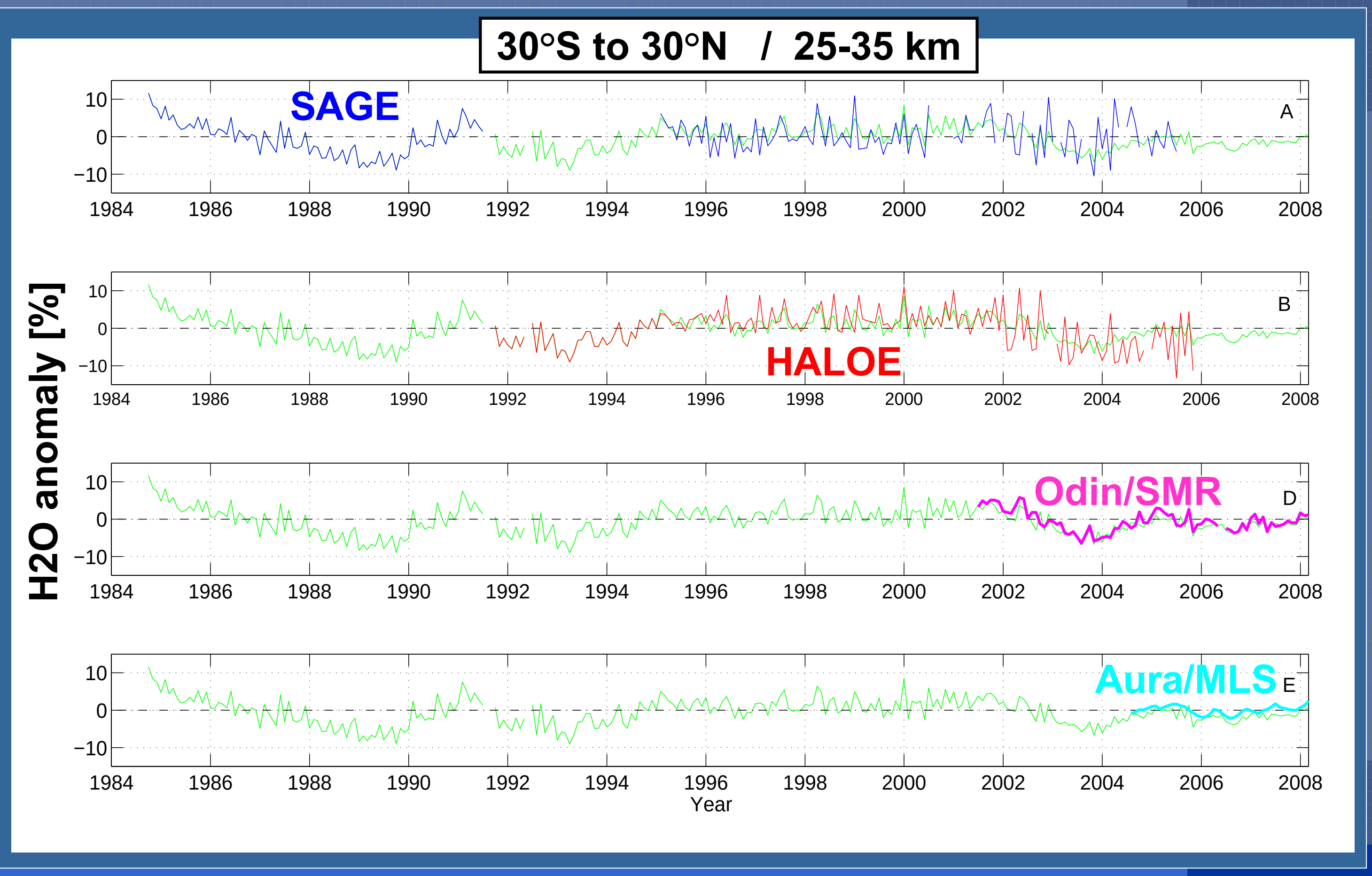
Time-series of Odin/SMR water isotopologues at high latitudes (70-90º) reflect the variability of downward transport in the polar regions during winter and highlight the impact of major stratospheric warmings on the stratospheric water vapour distribution.



5 Temporal evolution of stratospheric H_2O.

Regular Odin/SMR H_2O measurements started in November 2001 and cover now a period of ~7-years, allowing the historical satellite time-series from SAGE and HALOE to be extended and the variability of stratospheric water vapour to be studied. Shown are time-series of monthly zonal mean H_2O in the tropics (30°S to 30°N) from **SAGE (blue)**, **UARS/HALOE (red)**, **Odin/SMR (magenta)** and **Aura/MLS (cyan)**.





Left: VMR for three altitude ranges. Right: H_2O anomaly for 25-35 km, corrected for offsets, seasonal and quasi-biennial oscillations, as well as for solar cycle effects. The green line represents the all instrument mean.

Odin is a Swedish-led satellite project funded jointly by the Swedish National Space Board (SNSB), the Canadian Space Agency (CSA), the National Technology Agency of Finland (Tekes), the French Centre National d'Études Spatiales (CNES), and the European Space Agency (ESA).