# First measurements of the new 22 GHz water vapor spectrometer VESPA-22 obtained during the SVAAP campaign at Thule, Greenland

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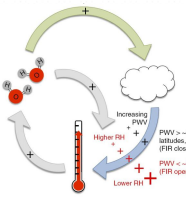
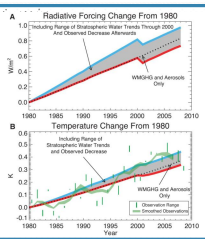
## INTRODUCTION

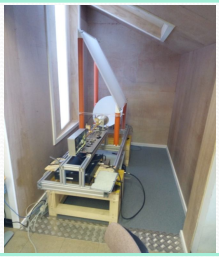
Water vapor has a large impact on the Earth radiative budget, affecting both infrared and shortwave radiation. In the Arctic region, the importance of water vapor is enhanced by the so called Artic Amplification effect [*Serreze and Francis*, 2006], that links water vapor, clouds properties and surface temperature with the radiative surface balance. [*Cox et al.,* 2015].



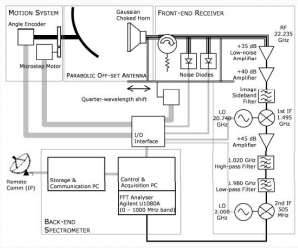




Additionally, about 10% of the surface warming measured during the last two decades can be ascribed to stratospheric water vapor [*Solomon et al.,* 2010]. Water vapor concentrations have also an impact on the formation of Polar Stratospheric Clouds, which are involved in ozone depletion processes.
In order to identify and quantify the contribution of water vapor to the changes that are occurring in the Arctic, long-term measurements of tropospheric and stratospheric water vapor are necessary.

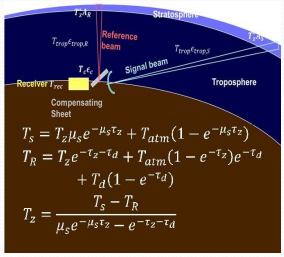
## INSTRUMENTATION



In order to improve the knowledge of water vapor in the Artic, during the SVAAP measurements campaign (see Poster by Meloni et al.) a new 22 GHz spectrometer, VESPA-22 (water Vapor Emission Spectrometer for Polar Atmospheres at 22 GHz) [*Bertagnolio et al.*, 2012], was installed at Thule Air Base (76.5° N, 68.8° W), Greenland. VESPA-22 has been set-up for continuous unattended measurements. The instruments measures the water vapor emission line at 22.23 GHz with a bandwidth of 500 MHz and a resolution of 31 kHz. The dependence of the line shape to atmospheric pressure allows the retrieval of water vapor stratospheric vertical profiles. VESPA-22 can also estimate the atmospheric Precipitable Water Vapor (PWV).

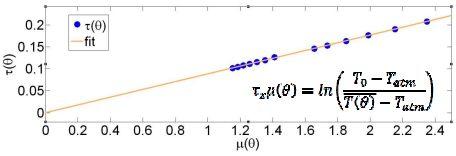



## TECHNIQUE




The instrument observes the difference between the signal from 10°-20° of elevation and the signal from the zenith (reference).

VESPA-22 measures the atmospheric optical depth $\tau_z$ with the skydip technique, observing signal from different elevation angles.

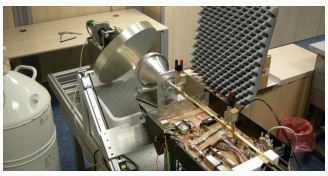



During clear weather we can estimate the PWV from the measured optical depth [*Deuber et al.*,2005] using

$$PWV = a\tau_z + b\tau_z T_{atm} + c$$

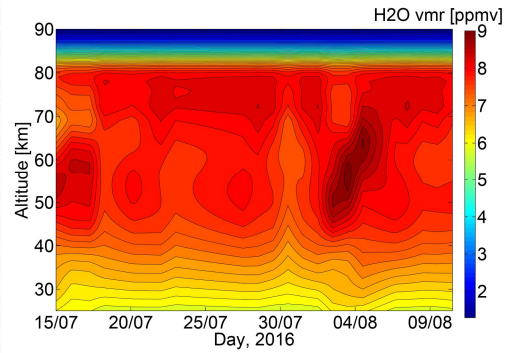
VESPA-22 is continuously calibrated against the emission from noise diodes. An absolute calibration with two black bodies at different temperatures is used to measure the emission from the noise diodes.

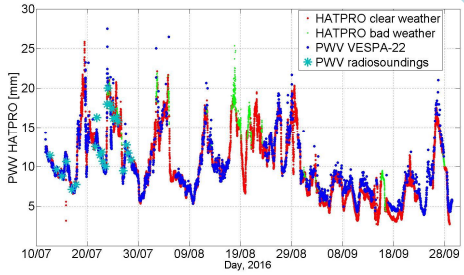
$$T_S - T_R = \frac{T_{ND}}{V_{S+ND} - V_S}(V_S - V_R)$$



## PRELIMINARY RESULTS

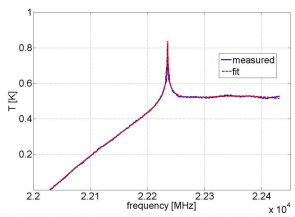
Some preliminary results obtained by VESPA-22 during the SVAAP measurements campaign carried out during July 2016 at Thule Air Base.

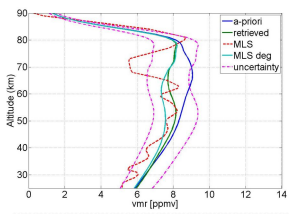


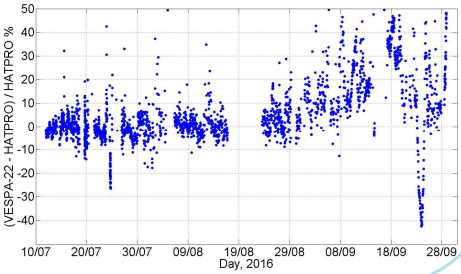




PWV measured by VESPA-22 and by the radiometer HATPRO. The 1σ standard deviation of the difference between VESPA-22 and HATPRO PWV data is about 10% during clear-sky weather. The increase in relative difference observed in September could be due to the emission from the snow partially covering the roof observing window.

An inversion example: measured and synthetic spectra (bottom left) and retrieved profile (bottom right). We retrieve water vapor profiles between 30 and 70 km with spectra integrated for about 10 hours (depending on weather conditions).




## Future work

- The retrieval algorithm can be improved by finding the best set of retrieval parameters that maximize sensitivity without causing unrealistic oscillations.
- A careful comparison with Aura/MLS time series could help understanding the source of biases in our retrievals.
- VESPA-22 data will be used to study the potential impact of stratospheric and tropospheric (PWV) variations of water vapor on the surface radiation budget.

## References

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•Deuber, B., Morland J., Martin L., and Kaémpfer N.: Deriving the tropospheric integrated water vapor from tipping curve–derived opacity near 22 GHz, Radio Science, 2005.
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