SABER/TIMED MESOSPHERIC WATER VAPOR AND TEMPERATURE

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Abstract

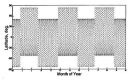
The SABER instrument on board the TIMED Satellite is a limb scanning infrared radiometer designed to measure temperature and minor constituent vertical profiles and energetics parameters in the mesosphere and lower thermosphere. This paper describes the methodology of the water vapor retrieval from the broadband 6.3 μm non-LTE emissions and discusses some aspects of the temperature retrieval from the 15 μm non-LTE CO_2 emissions measured by SABER. The non-LTE models of H_2O and CO_2 are validated using the comparisons with the ACE-FTS occultation measurement and lidar temperature measurements, respectively. The seasonal and latitudinal distributions of water vapor and temperatures retrieved from the SABER measurements are shown and the conditions for ice clouds forming are discussed.

TIMED Mission

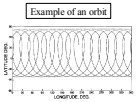
TIMED: Thermosphere, Ionosphere, Mesosphere Energetics & Dynamics

Mission launched on December 7, 2001
Data available since January 25, 2002
4 instruments:
GUVI, SEE, TIDI, SABER

Latitudinal coverage



Example of an orbit



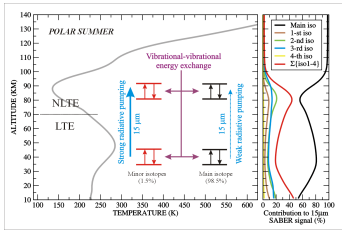
The SABER Instrument Aboard the TIMED Satellite

SABER: Sounding of the Atmosphere Using Broadband Emission Radiometry

SABER instrument:

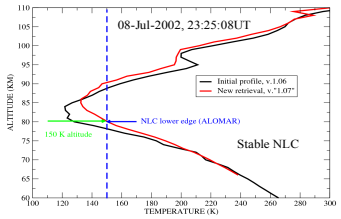
- Designed to study the Mesosphere and Lower Thermosphere (MLT)
- Limb scanning infrared radiometer (~10-100 km, ~2 km footprint)
- 10 broadband channels (1.27-17 μm)
- Products: kinetic temperature, CO_2, O_3, H_2O, NO, O_2, OH, O, H

Temperature retrieval from 15 μm CO_2 radiance

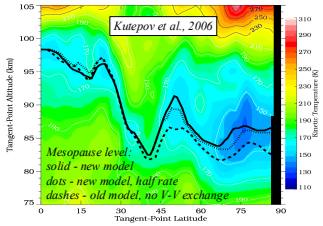


SABER vs ALOMAR NLC measurements

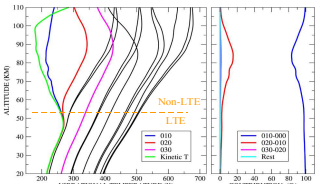
(courtesy of U.von Zahn and F.-J. Luebken, 2006)



Modified SABER temperatures, V1.07

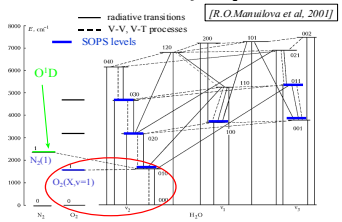


H_2O radiance in 6.3μm band: LTE and NLTE

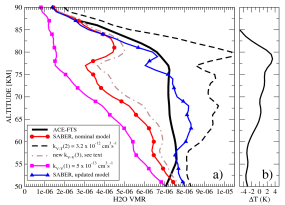


Non-LTE model for H_2O

[R.O.Manuilova et al, 2001]



Validating the H_2O non-LTE model: comparison with ACE-FTS, July 2004, NH

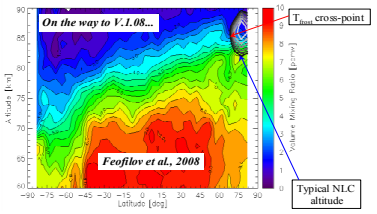


Updated set of rates for H_2O non-LTE model

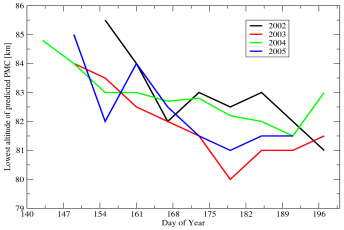
Process	Rate coefficient, cm^3s^{-1}
$k_{V-V}(1)$	$Nv_2 \times 1.0 \times 10^{-12}$
$k_{V-T}(2)$	$3.2 \times 10^{-12} \times (T/315.0)^{1/2}$
$k_{V-V}(3)$	$9.1 \times 10^{-15} \times T^{1/2} \times \exp(-56.7/300^{1/3})$

- $k_{V-V}(1)$: estimated from MIPAS measurements
- $k_{V-T}(2)$: Kalogerakis et al. 2005, Esposito and Capitelli, 2007
- $k_{V-V}(3)$: re-evaluation of extrapolation formula of Lopez-Puertas et al., 1995 based on Bass, 1973
- Set of rates validated using comparison with ACE-FTS solar occultation instrument onboard SCISAT-1 satellite

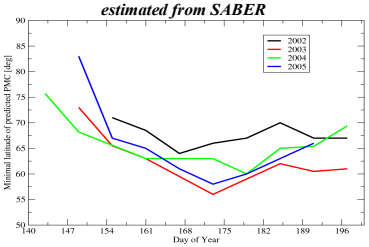
H_2O meridional distribution for 2004_197



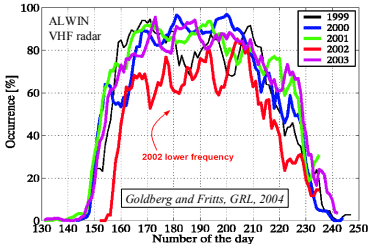
Altitude of ice clouds estimated from SABER



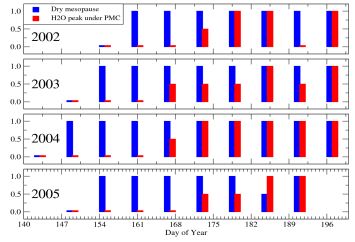
Minimal latitude of ice clouds formation estimated from SABER



PMSE occurrence at ALOMAR



Freeze drying and H_2O enhancing effects



Conclusions

- SABER provides reliable measurements in the intricate non-LTE area of the atmosphere up to 100 km in temperature registration channel and up to 85 km in H_2O registration channel.
- H_2O non-LTE model parameters have been validated using simultaneous measurements with non-LTE free occultation instrument SCISAT1/ACE.
- Estimates of ice forming conditions for the period of 2002-2005 confirm the anomalous warm polar summer mesopause of 2002 that is in agreement with other measurements.
- We assign the decrease in H_2O VMR in polar summer mesospheric region to freeze drying effects and the increase of H_2O VMR below the frozen area to ice particles sublimation.