Spectrometer limb viewing mode

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1. ABSTRACT

Initial retrievals and characterization of nitric acid (HNO_3) are presented using data from the Tropospheric Emission Spectrometer (TES) limb viewing mode from a global survey taken on September 20-21, 2004. The characterizations of HNO_3 retrievals show that TES has sensitivity to HNO_3 between 8 and 35 km with 3-9 total degrees of freedom and 1-4 degrees of freedom in the troposphere. This characterization demonstrates that the TES HNO_3 limb product has sufficient accuracy and precision to be useful for constraining local HNO_3 production due to lightning, long-range pollution transport in the upper troposphere, and HNO_3 chemistry in the lower stratosphere.

2. DATA

The TES L1 algorithm has undergone a major revision that includes calibrated limb data (see poster by Edwin Sarkissian et. al). This "R9" algorithm will be used to reprocess the entire TES dataset by October 1, 2006.

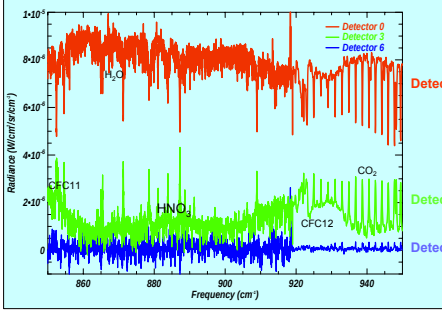
Some TES runs have been processed with this algorithm for testing and validation. These runs are:

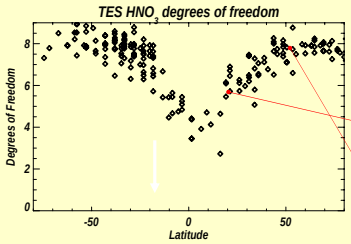
Sept 20-21, 2004 (run 2147) global survey
October 31, 2004 (run 2262) AVE nadir special obs
November 7, 2004 (run 2298) AVE nadir special obs
January, 2005 (run 2587) PAVE limb special obs

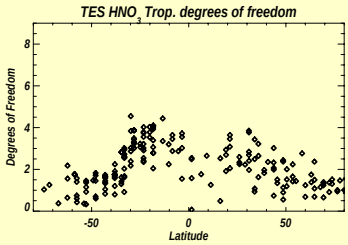
The limb algorithm currently has the following strategy: (1) retrieve pointing angle (2) Compare brightness temperatures to determine which detectors are observing cloudy air (3) retrieve T_{ATM}, H_2O, and HNO_3 in clear-sky detectors.

3. RADIANCES

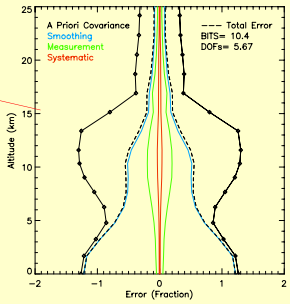
The HNO3 signal can be seen in mid-range detectors in th
mid-latitude limb radiance from September 20, 2004.





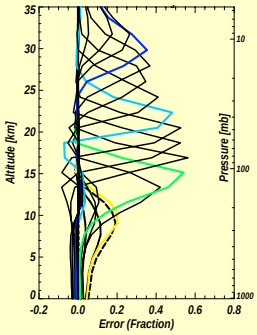


CHARACTERIZATION

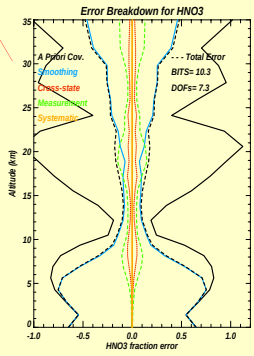


TES improves on initial state at altitudes above 5 km

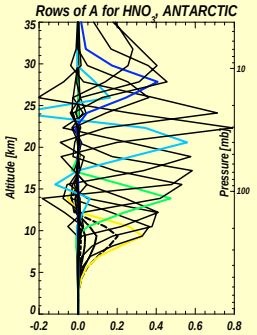
TES averaging kernels show sensitivity between 8 and 32 km



MIDLAT CASE



ANTARCTIC CASE



4. PROCESSING

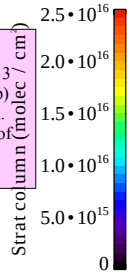
f the 1152 targets
* 605 were processed without failure
* 330 were processed with at least 11/16 detectors. Fewer than 11/16 resulted in spurious results and was discarded
* 189 were processed with all detectors.

esidual RMS looks pretty good (RMS average 1.12)
esidual mean is too high (|mean| average is 0.09)
rofiles can show jerky behavior indicating offset or thin clouds may e needed in the forward model
hroughput needs to be improved
oor results for cases with >5 identified cloud-viewing pixels needs be investigated

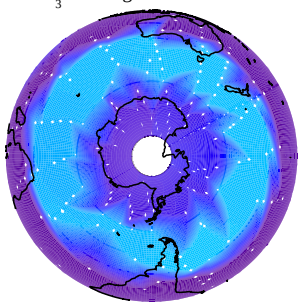
Spectrometer (TES) limb viewing mode

STRATOSPHERIC RESULTS

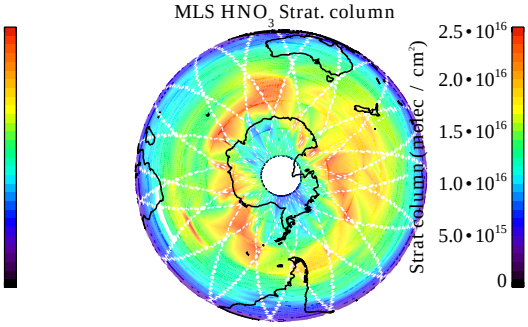
ES stratospheric columns are compared to MLS ratospheric columns for September 20-21, 2004 (bottom 3 anels). The difference between the TES initial guess (top) nd the retrieval indicates the value added by the retrieval. ES compares very well to MLS, despite the low density of rocessed TES data (targets shown with white dots).



HNO_3 initial guess strat column

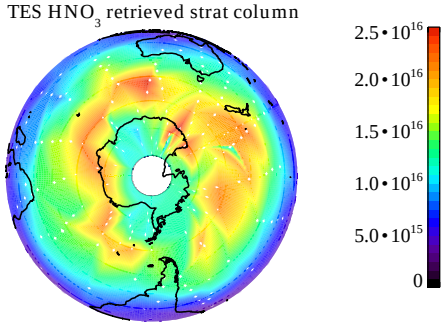


MLS HNO_3 Strat. column



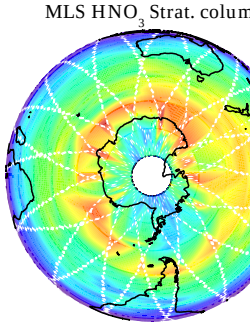
Sept 20, 2004

TES HNO_3 retrieved strat column



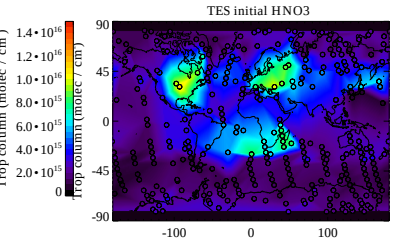
Sept 20-21, 2004

MLS HNO_3 Strat. colum



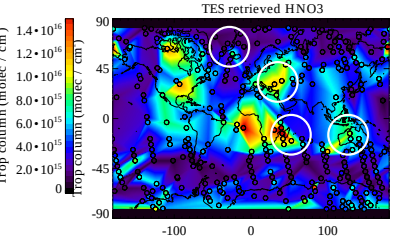
Sept 21, 2004

TES initial HNO3



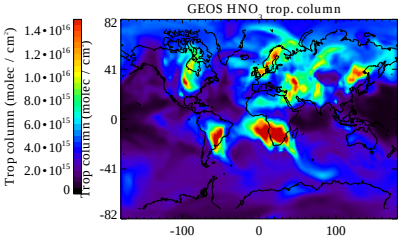
Initial guess trop.column (MOZART)

TES retrieved HNO3



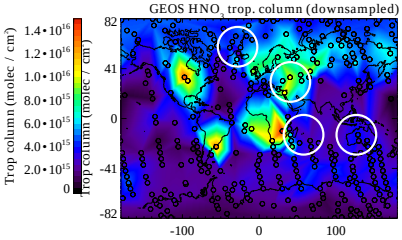
TES retrieved trop.column

GEOS HNO_3 trop. column



GEOS-CHEM trop. column

GEOS HNO_3 trop. column (downsampled)



GEOS-CHEM trop. Column (sampled at TES observation locations)

TROPOSPHERIC RESULTS

TES tropospheric columns for September 20-21, 2004 are ompared to a GEOS-CHEM run for the same day. TES esults (lower left) display features different from the initial uess (top left) and similar to GEOS-CHEM (lower right). GEOS-CHEM results (upper right) were down-sampled to TES observation locations (lower right) to better compare o the TES result. The circled locations show regions where TES and GEOS-CHEM show interesting ifferences.

CONCLUSIONS

- **TES is sensitive to HNO_3 in the 8-35 km range in the limb viewing mode**
- **TES limb retrievals with R9 calibrated data show results consistent with MLS for stratospheric HNO_3 columns**
- **Tropospheric column comparisons to GEOS-CHEM in the troposphere show interesting differences, especially over Africa and Australia, that need to be explored**
- **TES HNO_3 profiles have 3-9 total degrees of freedom, peaking at high latitudes, and 1 tropospheric degrees of freedom, peaking in the mid-latitudes**