Comparison of MIPAS and AURA Cloud Products

Jane Hurley, Anu Dudhia and Don Grainger

Clouds are a source of major uncertainty in climate models – it is thus important to accurately model clouds in order to determine their properties. In this work, two cloud macrophysical parameters (cloud top height and cloud extinction coefficient) are retrieved from MIPAS-ENVISAT spectra. These parameters are then compared on a statistical basis with AURA cloud products from HIRDLS and TES for May 2006.

The **M**ichelson **I**nterferometer for **P**assive **A**tmospheric **S**ounding (MIPAS) is an infrared limb-viewing Fourier Transform Spectrometer onboard ESA's ENVISAT satellite, launched in March 2002.

- 685 – 2410 cm^{-1}, at 0.0625 cm^{-1} resolution
- 6 – 68 km, 1.5 km lower atmosphere spacing

MIPAS cloud products:

- Cloud Top Height (CTH_{MIP}) [km]
- Cloud Extinction Coefficient ($K_{ext\ MIP}$) [km^{-1}]

The **Hi**gh **R**esolution **D**ynamics **L**imb **S**ounder (HIRDLS) is a multi-channel limb scanning infrared radiometer onboard NASA's EOS Chemistry mission satellite AURA, launched in July 2004.

- 550 - 1670 cm^{-1}, at 0.02 cm^{-1} resolution
- 0 – 120 km, 1 km atmosphere spacing

HIRDLS cloud products:

- Cloud Top Height (CTH_{HIR}) [km]

The **T**ropospheric **E**mission **S**pectrometer (TES) is an infrared-imaging, limb and nadir sounding Fourier Transform Spectrometer on NASA's EOS Chemistry mission satellite AURA, launched in July 2004.

- 650 – 3050 cm^{-1}, at 0.02 cm^{-1} resolution
- 0 – 33 km, 2.3 km atmosphere spacing

TES cloud products:

- Cloud Top Height (CTH_{TES}) [km]
- Cloud Optical Depth (τ_{TES})

Comparison of MIPAS / HIRDLS / TES Cloud Frequencies

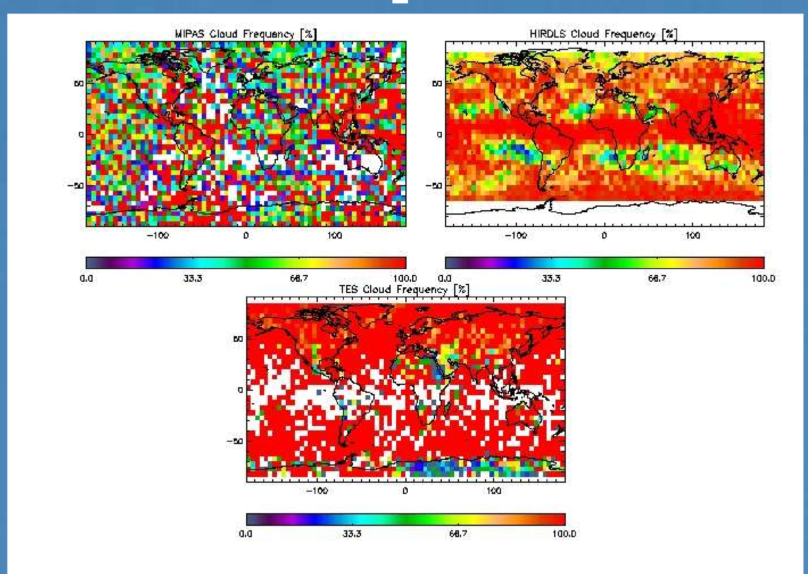

Fig.1

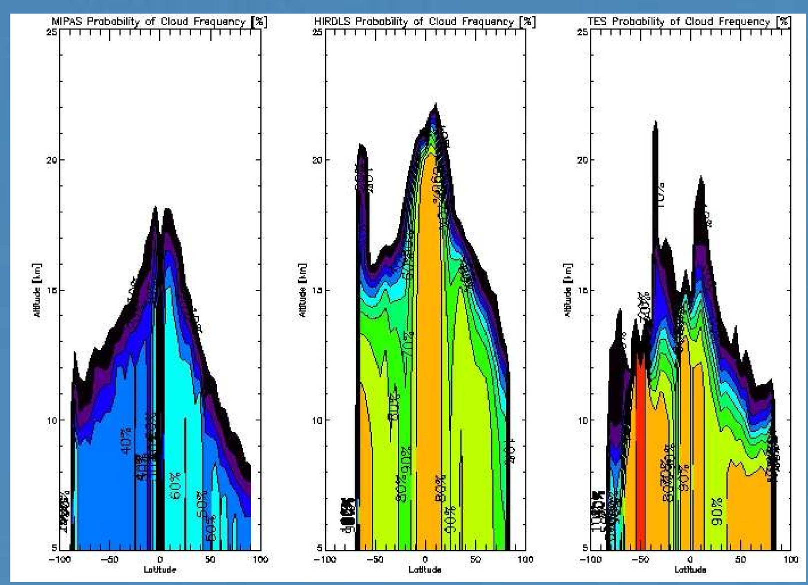

Fig.2

Fig.1: Mean cloud frequency (ie. Probability that a measurement taken in the troposphere will be cloudy) in 5° latitude/longitude grid for MIPAS (upper left), HIRDLS (upper right) and TES (lower) for May 2006.

Fig.2: Probability that there exists cloud at a given latitude and at or below a given altitude for MIPAS (left), HIRDLS (centre) and TES (right). HIRDLS detects cloud higher than do the other instruments while TES detects cloud significantly lower than either MIPAS or HIRDLS. Several expected features appear in all three instruments' cloud frequencies, namely heightened probability of cloud over the tropics and poles, but lower probability of cloud over regions of Hadley cell subsidence (~±20°-30° latitude). MIPAS sees significantly less cloud than HIRDLS and TES, but qualitatively registers similar trends.

All instruments see the same basic latitudinal trends in probability of cloud occurrence. HIRDLS detects the most high cloud, TES the least and MIPAS the least overall.

Comparison of MIPAS / HIRDLS / TES Cloud Top Heights

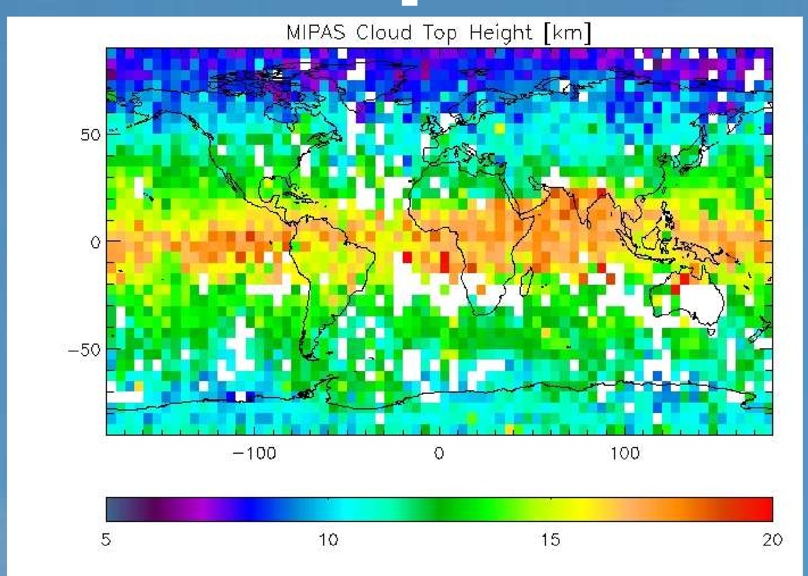

Fig.3

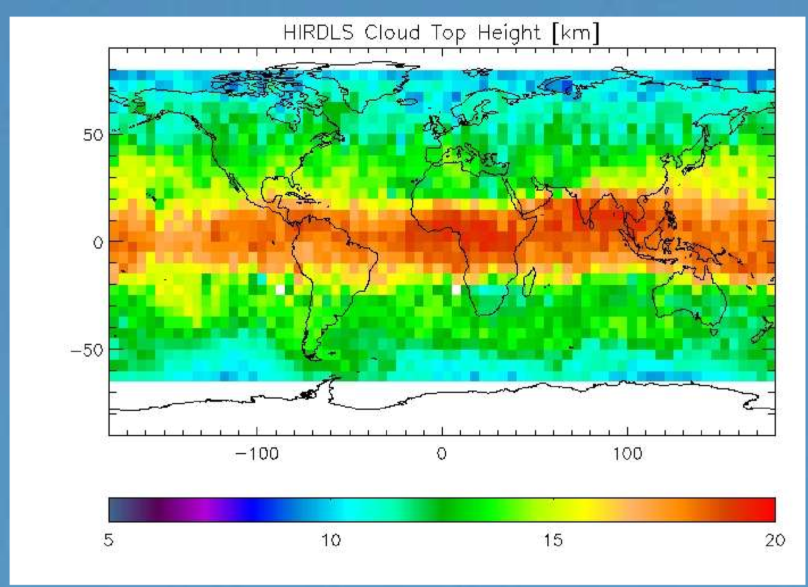

Fig.4

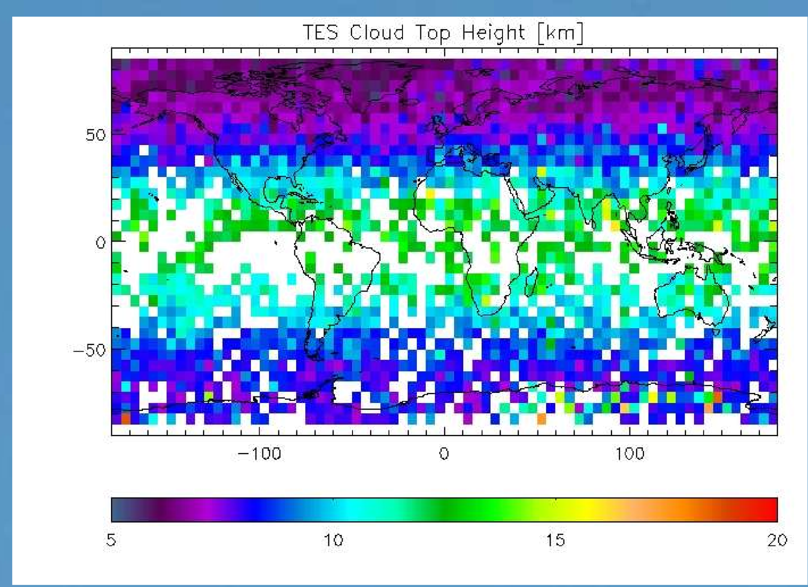

Fig.5

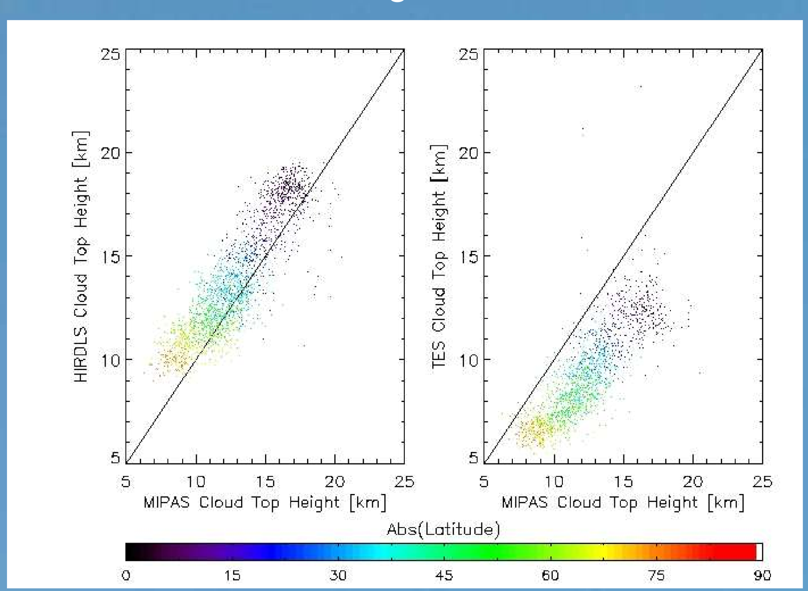

Fig.6

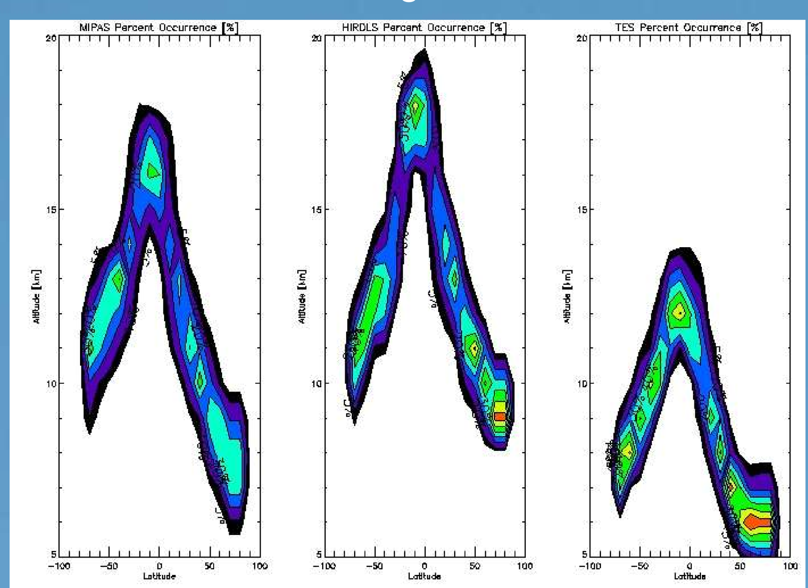

Fig.7

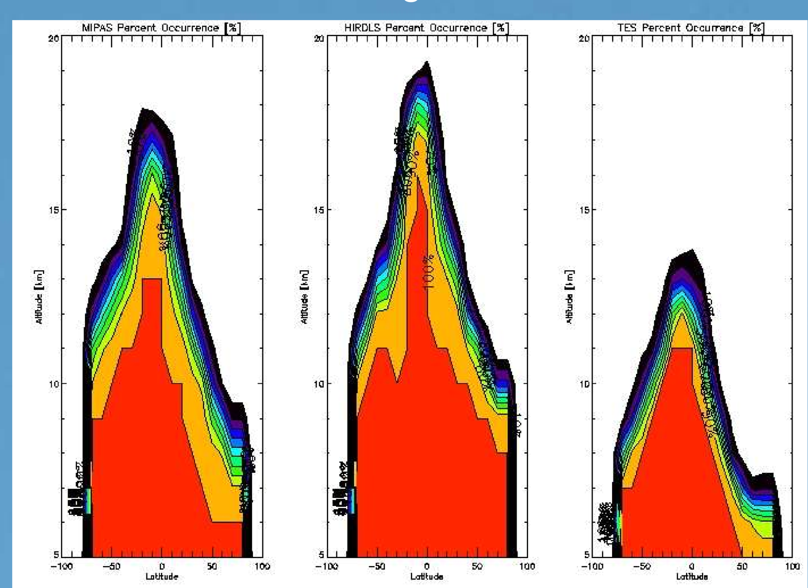

Fig.8

Fig.3-5: Mean CTHs for MIPAS (3), HIRDLS (4) and TES (5) in 5° latitude/longitude grid for May 2006.

Fig.6: Scatterplots of mean CTHs in each latitude/longitude grid-box for MIPAS vs. HIRDLS (left) and MIPAS vs. TES (right) as a function of latitude (red=polar, black = equatorial). HIRDLS seems to consistently retrieve cloud ~1.5 km higher than MIPAS, while TES sees cloud ~2 km lower than MIPAS.

Fig.7: Probability that, if there exists cloud at a given latitude, that it occurs at a given altitude from MIPAS (left), HIRDLS (centre) and TES (right).

Fig.8: Probability that, if there exists cloud at a given latitude, that it occurs at or below a given altitude from MIPAS (left), HIRDLS (centre) and TES (right).

Qualitatively, all show the same global patterns of CTH, but TES has CTHs much lower than MIPAS and HIRDLS which have similar CTHs and geographical features.

Comparison of MIPAS / TES Cloud Optical Depths

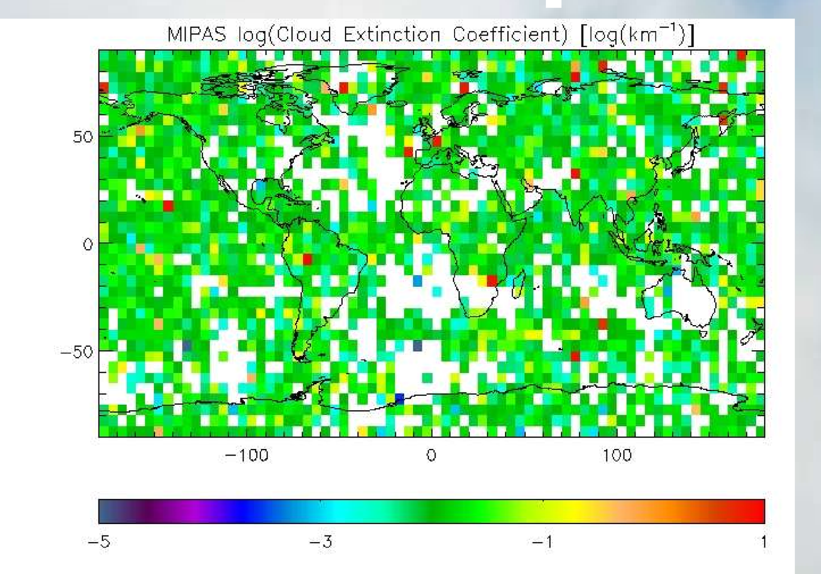

Fig.9

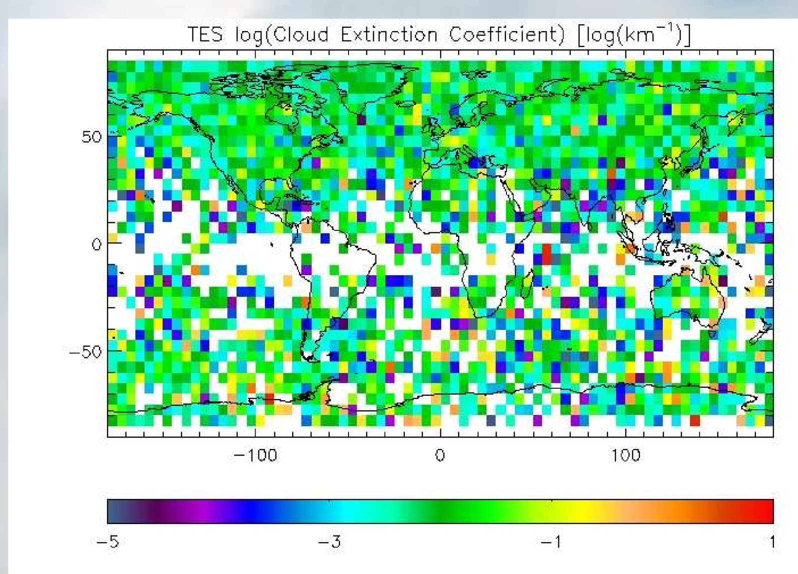

Fig.10

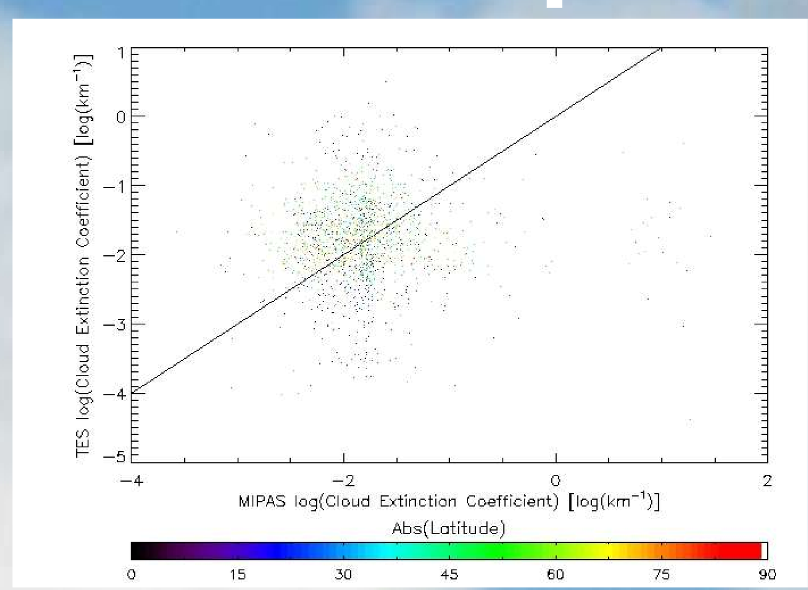

Fig.11

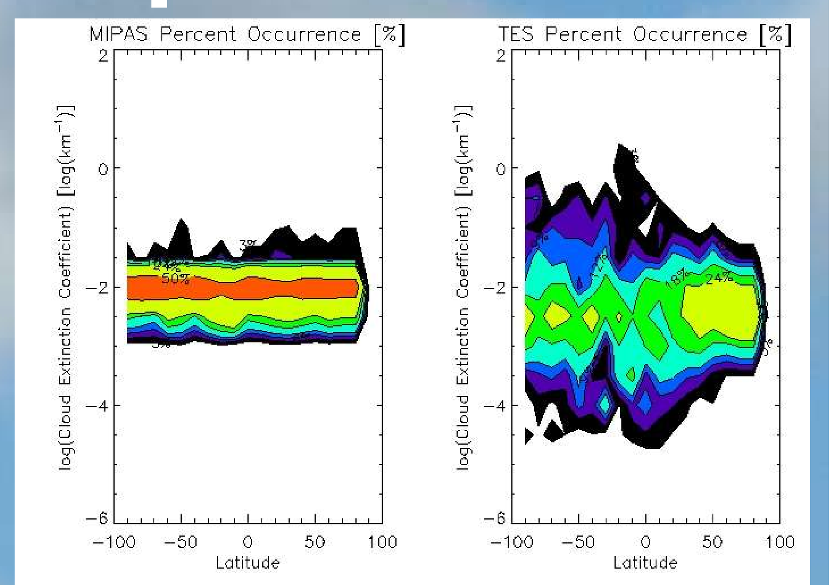

Fig.12

Fig.9-10: Mean K_{ext} for MIPAS (9) and TES (10) in 5° latitude/longitude grid for May 2006. Both show nearly global coverage of clouds with K_{ext} ~ 10^{-2} km^{-1}.

Fig.11: Scatterplot of mean K_{ext} for MIPAS vs. TES as a function of latitude (red = polar, black = equatorial).

Fig.12: Probability that, if there exists a cloud at a given latitude, that it occurs with a given extinction coefficient from MIPAS (left) and TES (right).

Qualitatively, both instruments show a nearly global extinction coefficient of 10^{-2} km^{-1}, but variations between the two occur undoubtedly due to different cloud layers detected.

hurley@atm.ox.ac.uk