Introduction

Methane is one of the most important greenhouse gases in the atmosphere, and is also important for the role it plays in atmospheric chemistry.

There is a general trend for methane to increase with time. However, this trend is not consistent and variations are not fully understood. In recent years, the increase in methane appeared to stabilise between 1999 and 2006 before starting to increase again from 2007 (e.g. Dlugokencky, 2009).

Tropospheric methane can be measured from space by two main classes of nadir sounding instrument, providing complimentary information.

- Short-wave infrared: e.g. SCIAMACHY, GOSAT — sensitive to methane columns, including the near-surface, but only over land and only in the daytime.
- Thermal infrared: e.g. AIRS, TES, and IASI — less sensitive near the surface but provides height-resolved information within the troposphere, day and night, over land and sea.

In this poster we describe methane distributions derived at RAL from the IASI instrument on MetOp (see box opposite).

Results

Data is currently available for 6 months (August 2008, April 2009, August – November 2009). Results have been extensively evaluated by comparison to TCCON ground-based observations and model intercomparisons.

Vertical sensitivity

- Figure 1 shows simulated averaging kernels (dshort/dlong_term) for a typical IASI methane retrieval. Key features are:
  - Sensitivity to tropospheric methane, with two distinct peaks in the mid-southern troposphere.
  - Limited sensitivity near the surface.
  - Real retrieval levels are set at 1000 hPa, 422 hPa, 178 hPa, 160 hPa and higher stratospheric levels.

Global distributions and model comparisons

- IASI data is being compared to model data and other satellite instruments in the NCEO atmospheric composition theme. Monthly mean data for August 2009 is shown in Figure 2.
- Vertical and latitudinal distributions derived from IASI show good agreement with models, although biases exist in the data.
- The two most sensitive tropospheric levels are illustrated in comparison to model data with IASI averaging kernels applied. Key features can be seen in both IASI and model data.
- Particularly high values are seen over southern Asia, and continuing in a tongue between SE Asia though to Africa. High values also exist in this level at high northern latitudes which can be seen in most of the model data.
- At 178 hPa the high values are more restricted to a region over southern Asia, this would be consistent with methane being emitted and uplifted to higher altitudes in the monsoon region.
- Column averaged mixing ratios have also been calculated, and the comparison with GOSAT data from the University of Leicester is shown (Parker et al., 2011). No a-bombing kernels are applied to the model data in this case.

Seasonal variations

Figure 3 illustrates seasonal variations in the data. GOSAT data is again shown for comparison:

- IASI data shows global coverage, and the expected latitudinal gradient (starting from a constant a-priori).
- Many similarities to GOSAT are seen. Both show the highest values in August, particularly over southern Asia, high values over S. America in April.
- IASI retrievals higher values compared to GOSAT (and several other data sources).

Summary

- An optimal estimation IASI retrieval scheme has been developed to retrieve CH4 distributions.
- IASI provides height resolved information which is highly complementary to that from short-wave sensors such as GOSAT.
- Benefits of IASI include the ability to profile globally at both day and night, over land and sea and the fact that planned follow on instruments will allow long term monitoring (2006–2030).
- Existing results clearly demonstrate the potential to distinguish some separate information on two levels within the troposphere, as well as providing an estimate of the total column. This should provide additional information to GOSAT to constrain estimates of surface fluxes via model inversion (a subject of ongoing work in the NCEO AC theme).
- Retrieving tropospheric methane to which, if not accounted for, causes a huge bias in the data. A new scheme has been developed which strongly mitigates this sensitivity by exploiting the presence of NO2 features in the CH4 fit range to improve effective cloud parameterisations. This scheme will be used as the basis for imminent processing of the MetOp/MetOS data.

References: