Seasonal pattern and variation of CH_4 retrieved from 5 complete years of IASI L1C radiances

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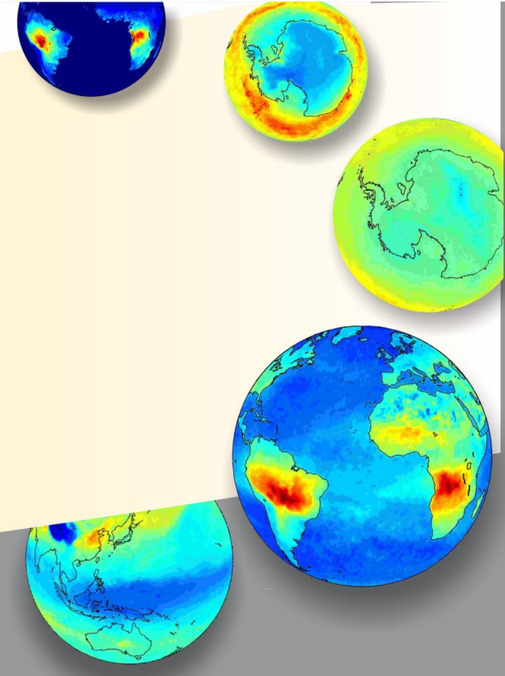


Introduction :

During the last decade, remote sensing sounders have demonstrated their capability to monitor atmospheric composition and pollution. Concentrations and seasonal patterns for several atmospheric key species are routinely retrieved from IASI spectra using inverse methods. Such processes rely on both observations and an *a priori*, which can lead to errors in the geophysical retrievals. Retrieving carbon dioxide (CO_2) or methane (CH_4) is challenging due to the sensitivity of infrared channels to both temperature and concentrations variations. Spectroscopic broadening effects (for example line-mixing) specific to these molecules add more complexity.

In this work we investigate the time variations of methane by using only the L1C radiances. This method avoids the simulation of the complex spectroscopic effects and provides a new process to analyze the IASI dataset.

Procedure

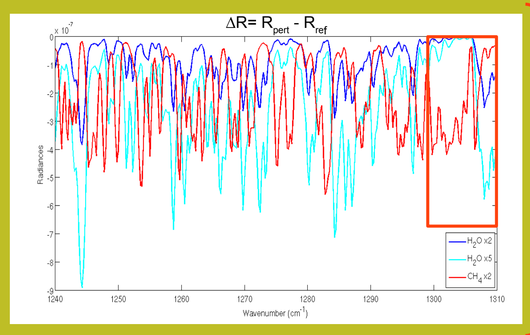
Atmospheric infrared spectra : collection of hundreds of transitions from several different atmospheric species. Molecule's transitions are sensitive to concentration, thus variations of radiance reflect the variations of concentration.
Investigating these radiances variations imposed : CH_4 high sensitive channels without other perturbating species

IASI observations

- January 2008 to December 2012 : 5 complete years
- Clear sky scenes selected using the L2 product cloud flags (FLG CLDSUM + FLG CLDFRM)
- Conversion into Brightness Temperature
- Normalization (using atmospheric channels) → to avoid surface temperature effect
- Averaging (day, month, year, …. depending on the area)

Sensitivity to CH_4 channels

Simulated atmospheric spectra obtained with the Atmosphit software (developped at ULB) under tropical conditions. Reference spectra : dataset of Atmosphit + H_2O IASI mean profile. Perturbed spectra : species of interest with profile multiplied and other species unchanged.

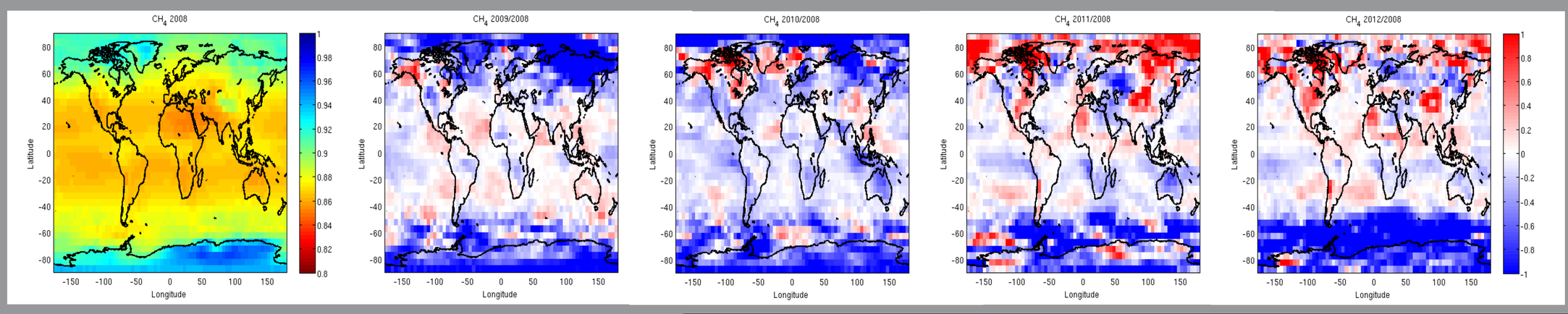


- Spectral range : 1290 – 1310 cm^{-1}

- Atmospheric channels (normalisation)

- CH_4 channels : set of 9 channels chosen between 1300 and 1305 cm^{-1} →the same as the ones used by C. Crevoisier et al (2011)

Geographic distributions



Averaged radiance for 2008 (grid 5°x5°)

Radiances are collected for the full year 2008, and averaged on a 5°x5° grid. This caculation is done only for the CH_4 channels (see procedure) and not all the spectral range. The same averaging was done for the other years, and expressed in % of radiance variation compared to 2008.

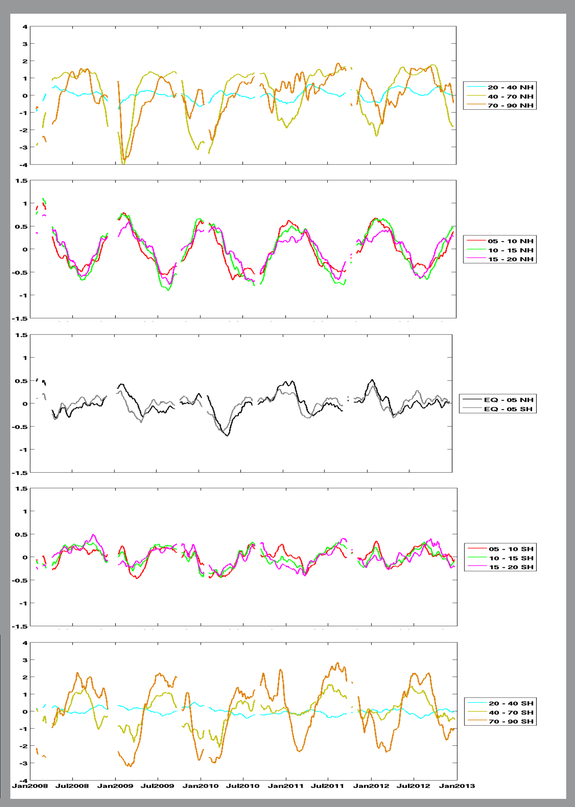
Even if the ground temperature is removed from the IASI observations during the caculation procedure, the atmospheric temperature is still present in the methane channels. In fact temperature is affecting each of the infrared channels, and separating temperature from molecule variation is quite challenging. Consequently we chose to compare relatively homogeneous scene (year to year) instead of looking at the seasonal variations.

Our geographic distributions show relatively small variations around +/- 1%. In the Nothern high latitudes, methane seems to grow up from 2008 to 2011, with a small decrease for the year 2012. These comparisons are not sufficient to discuss the long term variations and must be continued.

Times series

IASI daily averaged observations (9 channels) are compared to the global mean (reference) calculated over the 5 years. Results are expressed in % of radiance variation.

The times series obtained over the 5 complete years are not sufficient to discuss the long term variations of CH_4. Nevertheless these times series show a latitudinal dependance of the seasonal cycle : they are more important (in amplitude) for the high latitudes than in the Tropics. This conclusion was also made by J. Angelbratt (ground base FTIR, Northern high latitudes) and C. Crevoisier (IASI, Tropical belt).
The seasonal patterns obtained in this study are also in agreement with J. Angelbratt and C. Crevoisier.



High seasonal pattern with a minimum during boreal winter (Jan/Dec) and a maximum during boreal summer (Jul/Aug)

Completely different cycle, with a maximum in winter and a minimum in summer. CH_4 accumulate during winter (wetlands) and is removed by chemical process (radical OH) during summer time.

Near the Equator and in the Southern Tropics methane shows small variations (smaller than in the Northern Tropics). Even if it is not always clear a seasonal cycle can be distinguished, showing a maximum for Jul/Aug and a mimimum for Jan/Feb.

High variations with nearly the same cycle observed in the high Northern latitudes

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