SACH4 - Source attribution of CH_4 using satellite observations, isotopic measurements and GEOS-Chem simulations.

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Objective : Improve our current understanding of the balance between the sources and sinks that shape the CH_4 distribution.
How ?

- Comparison of **IASI CH_4** observations and **GEOS-Chem tagged simulations** on a global scale to determine the contribution from different source regions to the total budget of CH_4.
- New **ground-based FTIR CH_4 isotopic products** (CH_3D,$^{13}CH_4$) are developed to complement the source attribution analysis.

Findings

Figures 1-3 show comparisons of daily mean partial columns between 4 and 17 km (in ppmv) of **IASI CH_4** (De Wachter et al., AMT, 2017) and **GEOS-Chem v11-01 smoothed** with the IASI-CH_4 averaging kernel.
Both IASI and GEOS-Chem show a **latitudinal gradient** with higher concentrations in the Northern Hemisphere (NH) than in the Southern Hemisphere (SH) which is consistent with the fact that most of the CH_4 sources are located in the NH. In the NH, we find **higher CH_4 concentrations** during **boreal summer** (July) compared to boreal winter (January) by both the model and observation, although more pronounced by the latter. In January and April 2011, we can identify CH_4 hotspots over Canada (Hudson Bay) and East-Russia, which are not captured by the model.
Relative differences (IASI-GEOS-Chem) are given in Figure 3. Overall, slightly higher IASI CH_4 concentrations than GEOS-Chem are found over the tropics and high-latitudes and lower IASI CH_4 values at mid-latitudes. Global mean differences (≤1.40%) and standard deviations of the difference are within the estimated retrieval uncertainty of IASI of 3.73% (De Wachter et al., 2017).

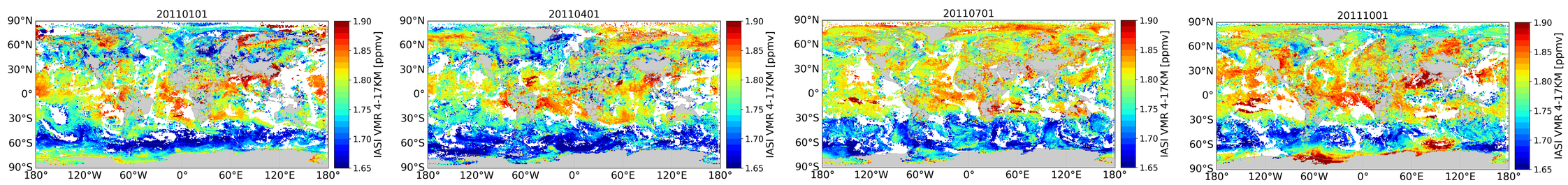

Figure 1 : **IASI CH_4** daily mean 4-17 km partial column mixing ratios for the 1st day of the month for January, April, July and October 2011.

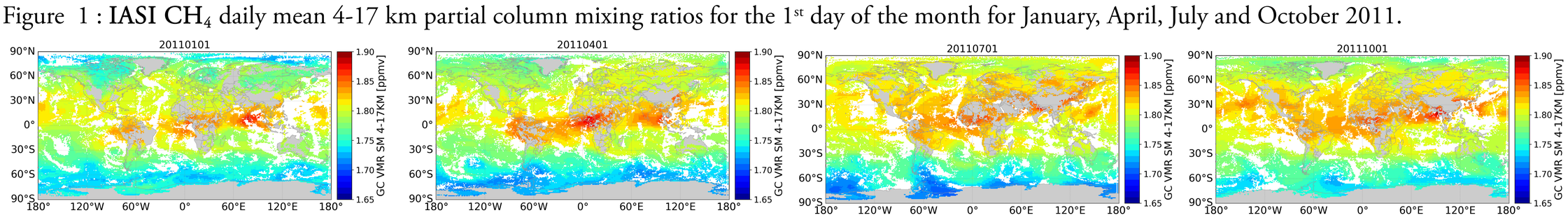

Figure 2 : **GEOS-Chem v11-01** daily mean 4-17 km partial column smoothed with the IASI-CH_4 averaging kernel for the same dates as Figure 1.

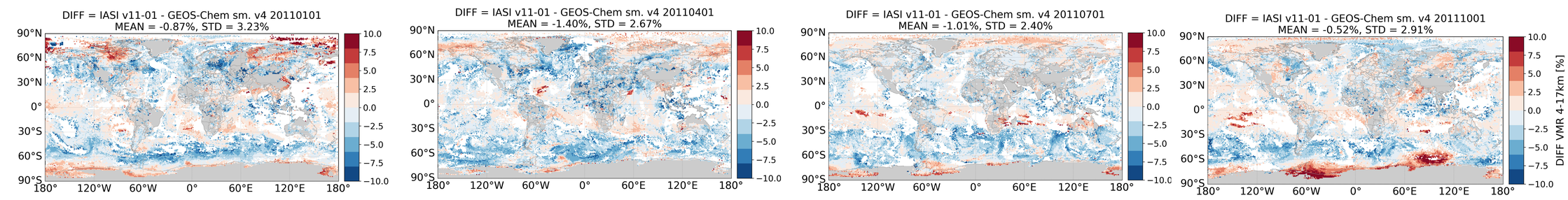

Figure 3 : **Relative differences** between IASI and smoothed GEOS-Chem 4-17 km partial columns (Figure1 - Figure 2).

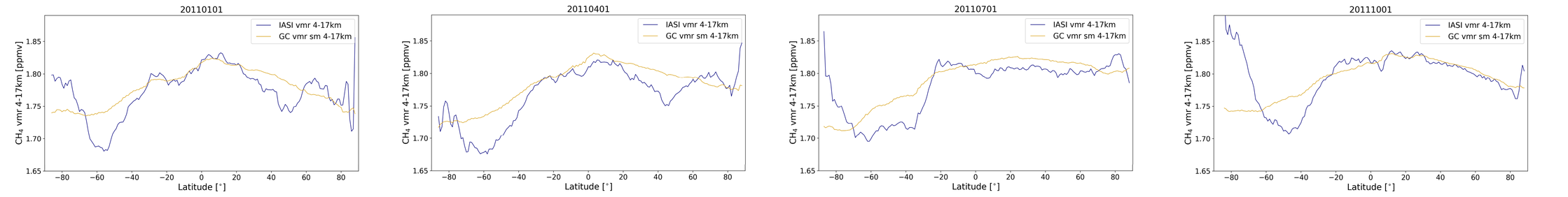

Figure 4 : Comparison **zonal mean** 4-17 km CH_4 partial columns of **IASI (blue)** and smoothed **GEOS-Chem (GC; yellow)**.

Zonal mean 4-17 km partial columns are presented in Figure 4 for IASI (blue) and smoothed GEOS-Chem (yellow). We find a **good agreement** between IASI and GEOS-Chem in the **tropics** for all seasons. Largest **differences** between the satellite data and model are found in the SH for **latitudes > 30°S**. In boreal winter (January and April) IASI observes a decrease in CH_4 in the Northern mid-latitudes (around 50°N) which is not captured by the model.

Outlook

Mid- to upper-tropospheric IASI CH_4 and GEOS-Chem have been compared on a global scale for the year 2011. This first study will be extended for additional years.
The satellite observations will be complemented by ground-based **NDACC FTIR observations** of CH_4, CH_3D and $^{13}CH_4$. The development of the **retrieval strategy for CH_3D** is currently undergoing QA/QC and is being tested for the NDACC FTIR sites Jungfraujoch (Switzerland), Porto Velho (Brasil), Maido and Saint-Denis (Reunion Island).
The **GEOS-Chem tagged simulations** will be updated to **version v11-02** and the tracers will be added for the source attribution analysis.

De Wachter, E., Kumps, N., Vandaele, A. C., Langerock, B., and De Mazière, M.: Retrieval and validation of MetOp/IASI methane, Atmos. Meas. Tech., 10, 4623-4638, https://doi.org/10.5194/amt-10-4623-2017, 2017.

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