VALIDATION OF WEIGHTED COLUMNS OF CH_4 AND CO_2 RETRIEVED FROM SPACE OBSERVATIONS WITH BALLOON-BORNE AIRCORE

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Launch site

1 Atmospheric variability as challenge for L2 product validation

- **AirCore profiles obtained by LMD** over the past years during short-term campaigns were **not optimized for satellite validation**
- Balloon flights were carried out mostly at northern hemisphere sites with **high spatio-temporal variability of XCH4** and XCO2 (see Figure 1)
- Can **air mass trajectories** ensure that AirCore and targeted satellite **sample same air masses**?

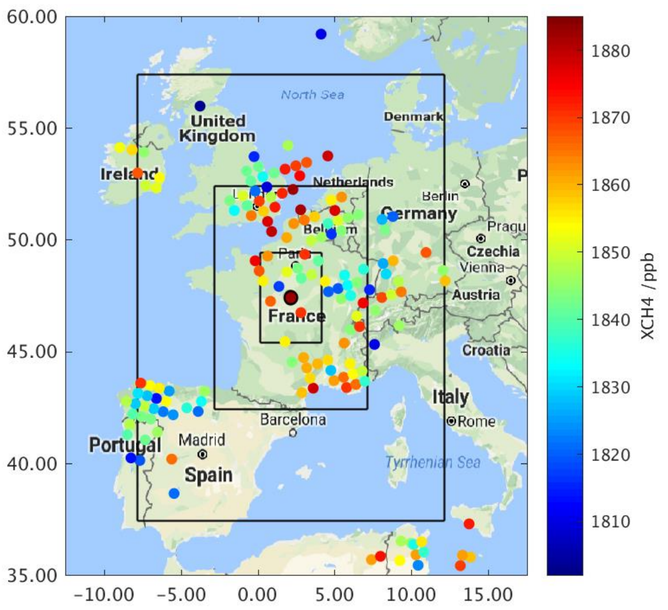

Figure 1: Variability of XCH4 over Europe on 21 October 2016. The black rimmed circle denotes the location of the AirCore landing. Depicted are XCH4 derived by LMD from IASI spectra within squares of different sizes (2°x2°, 5°x5°, 10°x10°) centred on an AirCore landing spot. XCH4 differences between AirCore and IASI over such squares are computed over completely different air masses.

3 Co-location approach

- Assume **purely vertical AirCore profile** above balloon landing spot and **complete profile** above burst altitude **with** co-located **CAMS** (Copernicus Atmospheric Monitoring Services) profiles
- Computation of **12 hr forward and backward trajectories** using trajectory model LAGRANTO based on ECMWF IFS forecast fields
- Search for **co-locations AirCore-trajectory-satellite** on same day
- A FOV is considered co-located if it is located within the horizontal space spanned by the trajectories and close to one individual trajectory as well as to the AirCore landing spot

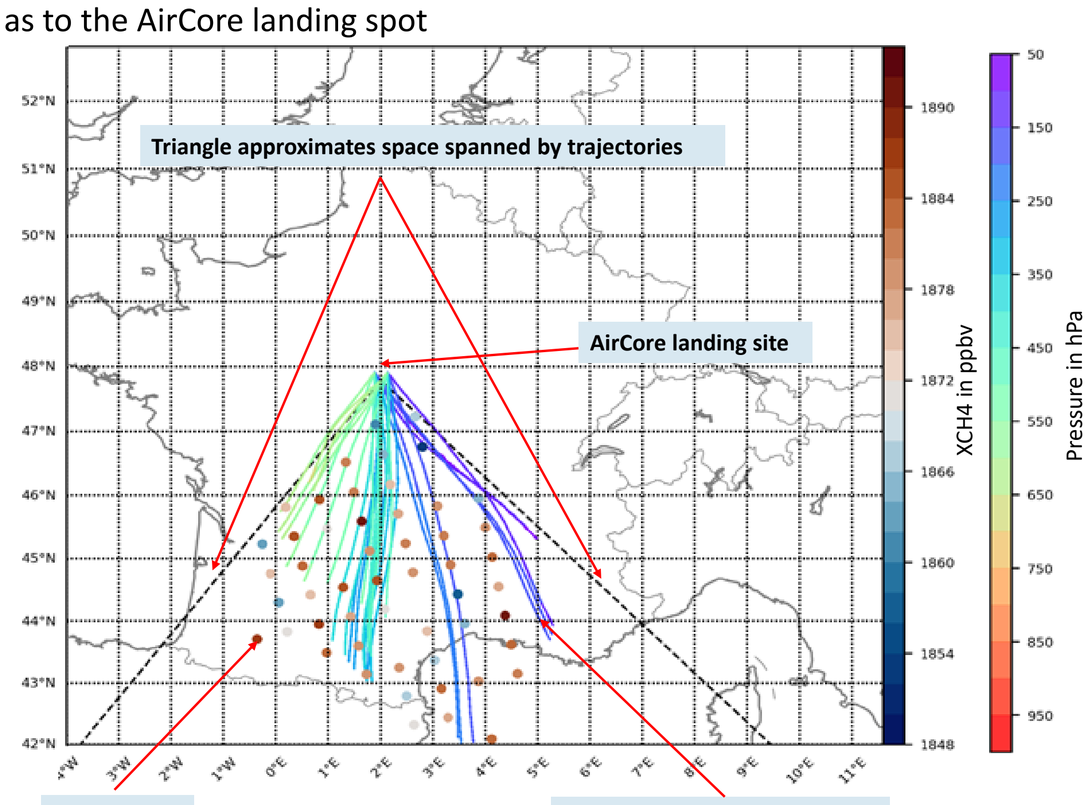

Figure 3: Example of applying 12 hour backward trajectories to co-locate AirCore flown from Trainou-Orléans with IASI/CH_4 FOVs.

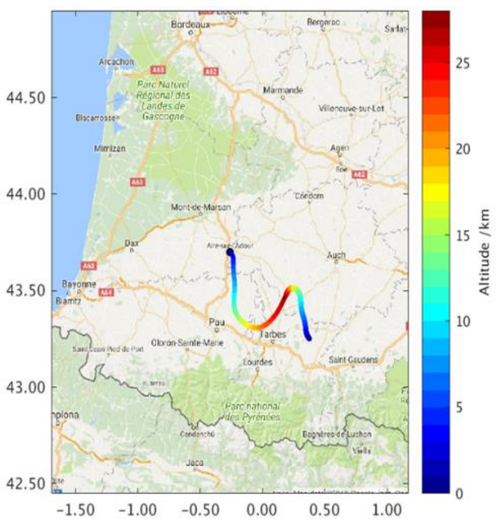

Figure 4: Example of a trajectory of a balloon carrying an AirCore instrument.

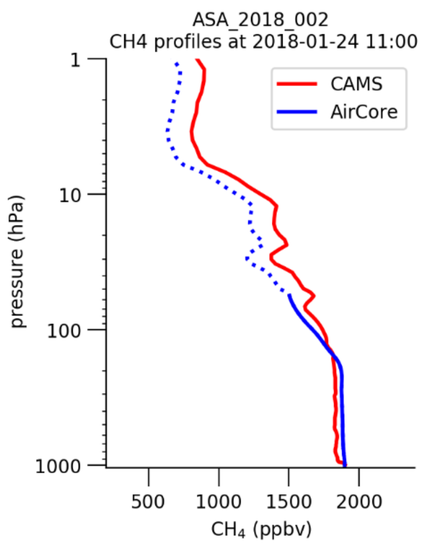

Figure 5: Co-located CAMS (solid red line) and AirCore (solid blue line) CH_4 profile. The dotted blue line denotes the continuation of the AirCore profile with CAMS, taking into account observed differences.

2 Trajectory initialization and validity assessment

- Generally, **trajectories separate with time** due to wind shear and error accumulation
- For **column validation** it is crucial to ensure that **trajectories do not diverge too much**. **Quantify divergence** using absolute **horizontal transport deviation (AHTD)** that measures the horizontal separation of the test trajectories with respect to a reference trajectory
- **Initialization altitude of trajectories depend** on **satellite's vertical sensitivity.**

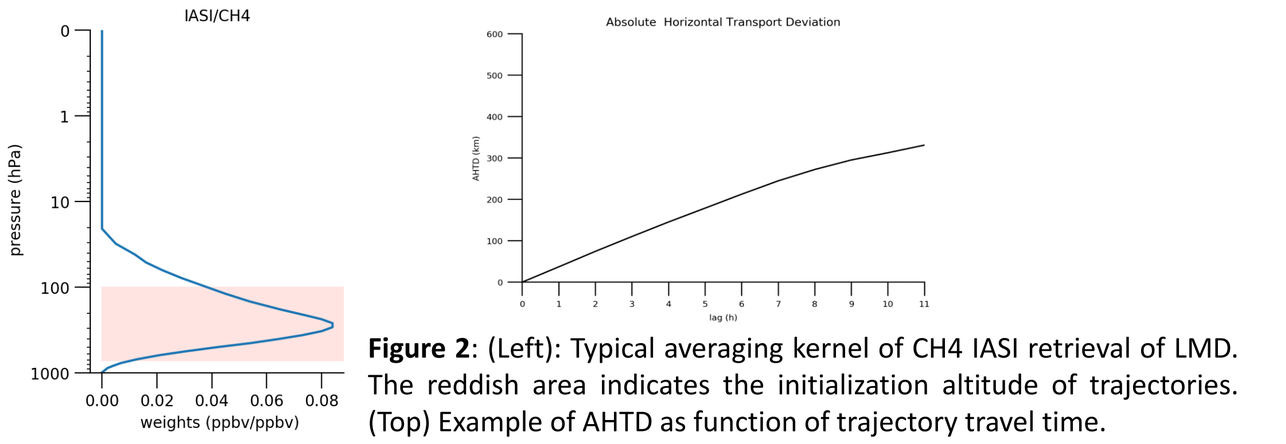

Figure 2: (Left): Typical averaging kernel of CH4 IASI retrieval of LMD. The reddish area indicates the initialization altitude of trajectories. (Top) Example of AHTD as function of trajectory travel time.

4 Results for XCH4 from IASI/LMD retrievals

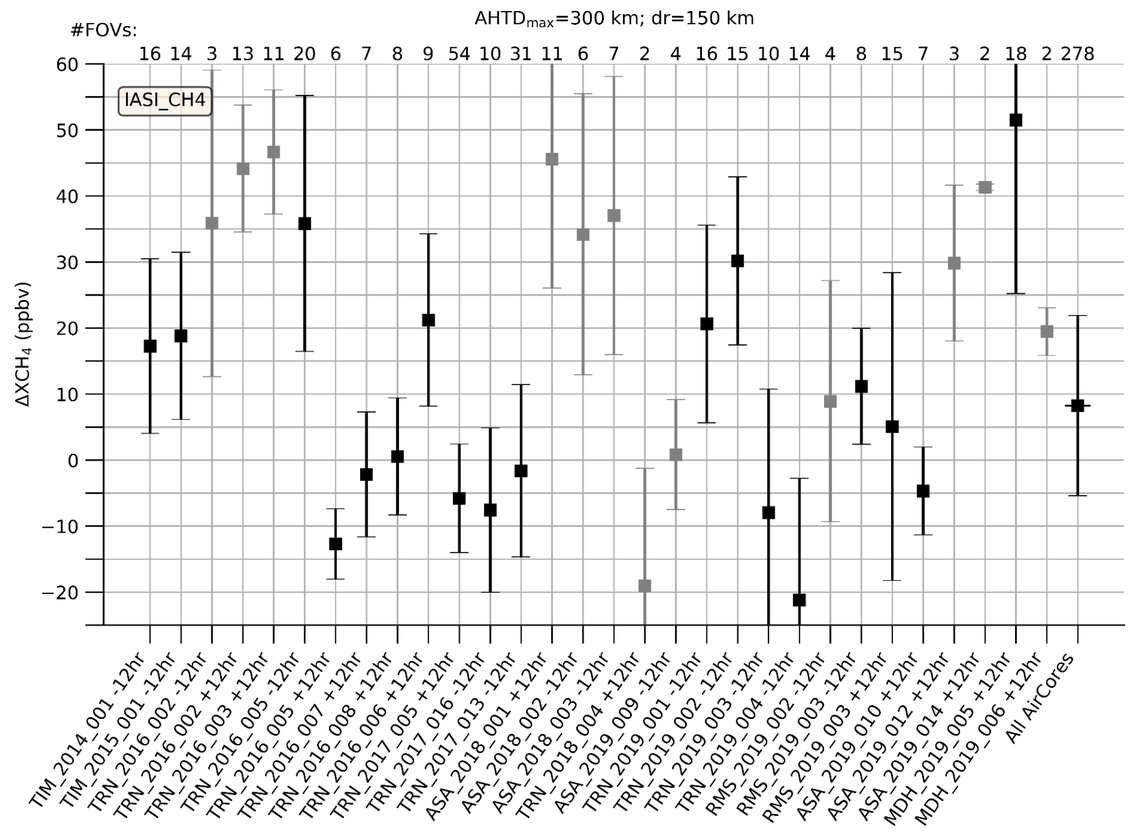

Figure 6: Time series of XCH4 differences between AirCore and collocated IASI/CH4 FOVs. Depicted are XCH4 differences and corresponding 1-σ values for each AirCore flight. "All AirCores" denotes the XCH4 differences averaged over all flown AirCores, with results depicted in grey do not contribute to this mean.

5 Conclusions

- A **Lagrangian method** was developed to **compare optimally AirCore** to **total CH_4 columns** estimated by **IASI/LMD**. It can also be applied to TROPOMI data.
- **Trade-off** between **number of FOVs** for comparison and requirement of **air masses** sampled by AirCore and satellite **stem from** approximately the **same region**.
- High XCH4 variability among the collocated FOVs (20 ppv - 50 ppbv) is frequently found. This indicates that **trajectories can only partly reduce the atmospheric CH_4 variability** in the comparison sample

Model study: Spatio-temporal variability around AirCore sites using CAMS

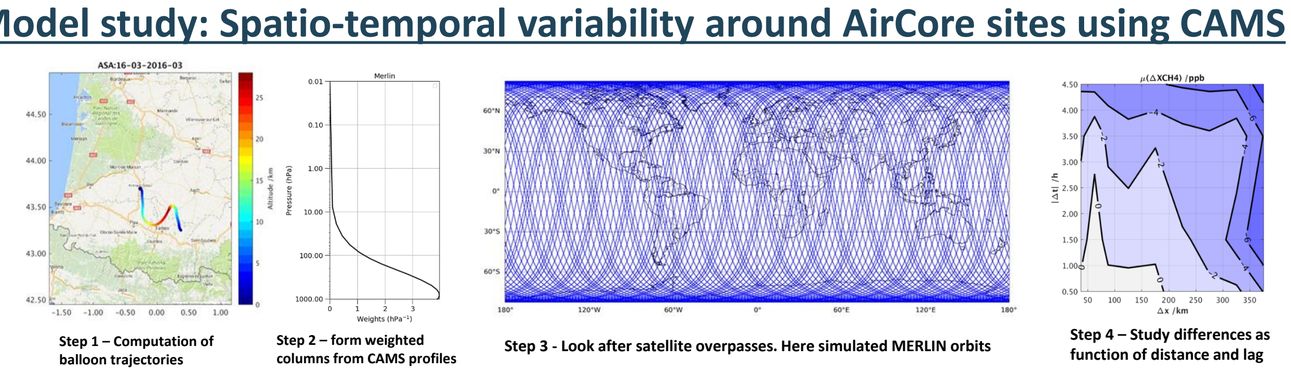

Figure 7: Scheme of method used to study the spatio-temporal XCH4 variability around existing and future AirCore sites.

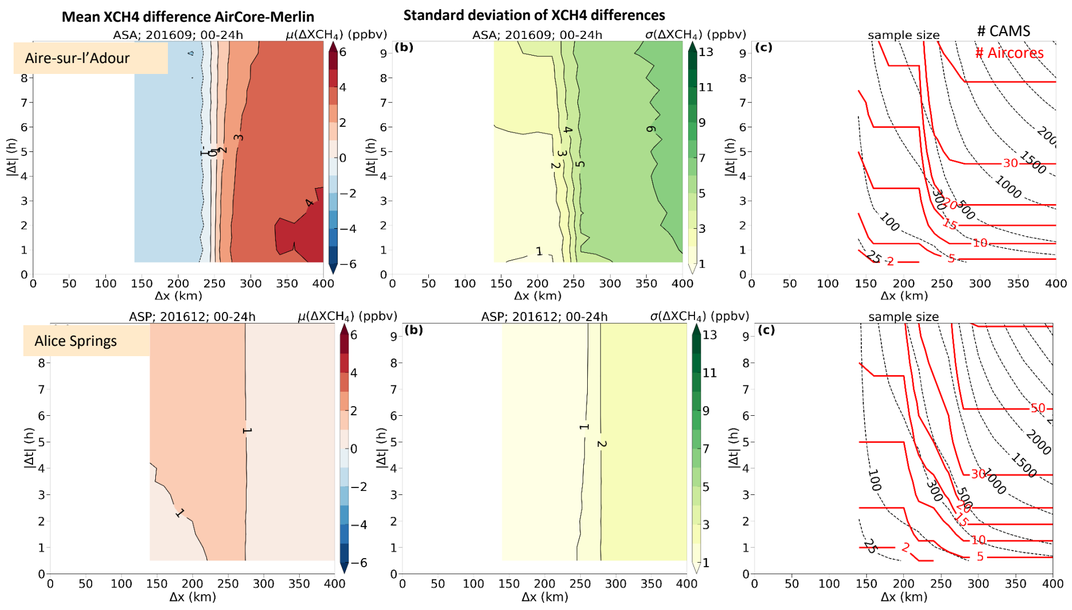

Figure 8: Spatio-temporal XCH4 variability around Aire-sur-l'Adour (top) and Alice Springs (bottom) in September and December 2016, respectively.

Results show remarkably low standard deviation of XCH4 differences at remote sites like Alice Spring!

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