1. Objectives
   - Improvement of the technique for column-average CO₂ mixing ratio (QCO₂) retrieval in the upper troposphere from AIRS/EOS-Aqua data over Western Siberia
   - Validation of QCO₂ retrievals against aircraft flask CO₂ observations (over boreal zone)

2. AIRS QCO₂ Retrievals
   - The sensitivity studies based on synthetic clear-sky AIRS measurements (RTM SARTRA simulations) resulted in the selection of 3 subsets of CO₂ dedicated channels (5 LVW channels within the band 1595-2073 cm⁻¹ and 6 SWV channels within the band 1953-2167 cm⁻¹) with strong responses to CO₂ variations and minimum sensitivity to main interfering factors (inaccurate knowledge of state vector components, including atmospheric water vapor and ozone profiles, etc.)
   - Fig. 1.2: The CO₂ radiances for LV and SW CO₂ channels. The AIRS radiances in CO₂ channels have maximum sensitivity to CO₂ variations in the mid- to high tropospheric layer and minimum sensitivity to variations of interfering factors.

2.2. Improved technique for AIRS-based QCO₂ retrieval
   - Clear-sky and cloud-cleared radiances (brightness temperatures Tbb [K]) measured in CO₂ dedicated channels are used for QCO₂ retrieval.
   - Forward calculations of synthetic brightness temperatures, Tbb, are performed using RTM SARTRA (in the range 370-385 ppmv) and ancillary information (AIRS-based temperature profile Tp) retrievals and AIRS L2 retrievals for other state vector components.
   - Estimating QCO₂ is carried out using the inversion algorithm (Gauss-Newton iteration algorithm applied separately to bias-corrected AIRS data in LV and SW CO₂ channels in order to produce independent QCO₂ LV (QCO₂ LV) and QCO₂ SW (QCO₂ SW) retrievals).
   - The final monthly averaged estimate QCO₂ AIRS is produced as a linear combination of filtered QCO₂ LV and QCO₂ SW values if they are consistent to each other.

2.3. Validation exercise over Siberian boreal ecosystems
   - The series of retrieval experiments has been conducted for a sample of more than 600 granules of actual AIRS data that were downloaded together with AIRS L2 retrievals and AIRS-L1b (air mass factor) retrievals for pre-selected area and time period between January and October 2003 (1-2 granules daily) from the site http://l3 usra.edu/granules/airqco2/airqco2/airqco2.html.
   - The QCO₂ (AIRS) retrievals are inter-compared with the results of air-borne measurements (Arhimov et. al., 2005). The region of air-borne survey is located at the right bank of the southern part of the Ob Reservoir. The air-borne measurements of CO₂ concentration at heights of 0.5-7 km (available are the data at heights of 1.3 and 7 km) cover the region 54° 58'54" 53' 34" N, 51° 81' 82" 40" E; moreover, the boreal area consists 50% of coniferous trees. Similar observations has been conducted also for the Surgut region (90° 62' 58" 70° 76' E); available are the data in the 5 km.
   - The monthly averaged air-borne CO₂ observations have been compared to final QCO₂ (AIRS).

2.4. Comparison of AIRS retrieved QCO₂ and AIRS-L1b retrieved CO₂ concentration over Siberian boreal ecosystems
   - Figure 2: Comparison of AIRS retrieved QCO₂ and AIRS-L1b retrieved CO₂ concentration over Siberian boreal ecosystems.

3. IASI and AIRS-based CH₄ concentration retrievals: first results
   - 3.1. Selection of IASI CH₄ dedicated channels and super-channels
     - Sensitivity studies carried out with synthetic clear-sky IASI measurements (RTM LITMUS) enabled to select subset of 4 CH₄ dedicated channels within the methane absorption band around 7.7 µm. The plots of CH₄-observations for these channels show maximum sensitivity to the CH₄ variations in the troposphere with a peak around 10 km. The plots of averaging kernels obtained for CH₄ column retrievals demonstrate strong sensitivity to the CH₄ concentration in the layer between 7 and 10 km.
     - Besides, four CH₄-dedicated super-channels have been built in order to reduce the effect of profile Tp uncertainties on the accuracy of QCH₄ assessment.

3.2. Methodology QCH₄ retrieval from IASI or AIRS data
   - The CH₄ retrieval approach is based on the physical inversion and utilizes clear-sky IASI data in several super-channels (differences of signals in T- and CH₄-dedicated channels) as a priori specified T- and waver pressure profiles. Similar inversion algorithm is applied to AIRS data.

4. Case study experiment
   - The performance of same retrieval algorithm was evaluated in a case study experiment using the dataset of IASI/MLS/MIrP. IASI balloon-borne instrument measurements with ground-based and radiosonde observations for Environment Konturskaya, Sweden area. This dataset is kindly provided by Dr. Claude Camp-Peyret (Université Pierre et Marie Curie) and CHRS Physics department (J. Franca). Later was complemented with quasi-synonymous and collocated AIRS data as well as with AIRS-based L2 retrievals.

References
   - The results of validation exercise performance may be summarized as follows:
   - The inversion of actual AIRS data for 2 areas (Western Siberia) enables to retrieve QCO₂ values that agree reasonably with seasonal trend of those identified from in-situ air-borne measurements and have a precision of about 1% (comparing to air-borne measurements at 7 km). The temporal matching window between 2 weeks-1 month is suitable for QCO₂ retrievals averaging.