Retrieval of atmospheric CO_2 from satellite near-infrared nadir spectra: The EnseMble Median Algorithm EMMA

M.Reuter, H.Bovensmann, M.Buchwitz, J.P.Burrows, J.Heymann, O.Schneising

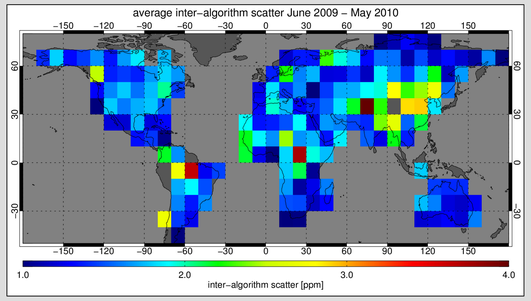
Institute of Environmental Physics, University of Bremen, Germany

Overview

Validation of satellite retrieved XCO_2 (the column-average dry-air mole fraction of atmospheric CO_2) typically relies on highly accurate ground based TCCON (total carbon column observing network) data. Unfortunately, the TCCON network is very sparse and in many regions no ground-truth is available. Since long time, climate modelers use ensemble approaches to analyze the ensemble median and to estimate uncertainties of climate projections where no ground-truth is known. Following this idea, the ensemble median algorithm EMMA composes level 2 data of the independent GOSAT XCO2 retrievals ACOS (NASA), NIES (NIES), PPDF (NIES), RemoteC (SRON), UOL-FP (University of Leicester) and the SCIAMACHY XCO_2 retrievals BESD (IUP), and WFMD (IUP). In 10°x10° grid boxes EMMA determines monthly averages and selects the level 2 data of the median algorithm. Intelligent thresholds (depending on potential information content) prevent from over-weighting individual algorithms with a considerably larger amount of data. EMMA can be used to identify potential outliers, estimate regional uncertainties, and potentially also for future inverse modeling studies.

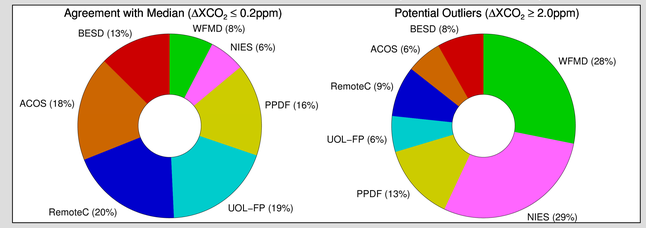
Systematic Errors

Regions with large deviations between individual algorithms are obviously more “complicated” for the retrievals. The inter-algorithm standard deviation can be interpreted as uncertainty due to systematic retrieval issues.



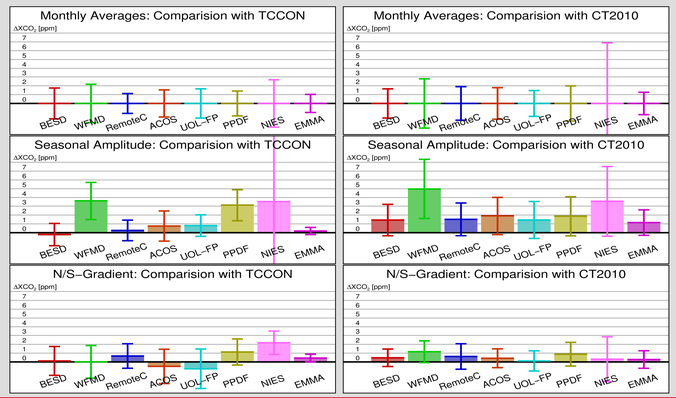
Identification of Outliers

If systematic errors of the individual algorithms are independent and seldom, the majority of algorithms are scattering around the truth. A deviation from the median can than be interpreted as likely outlier.



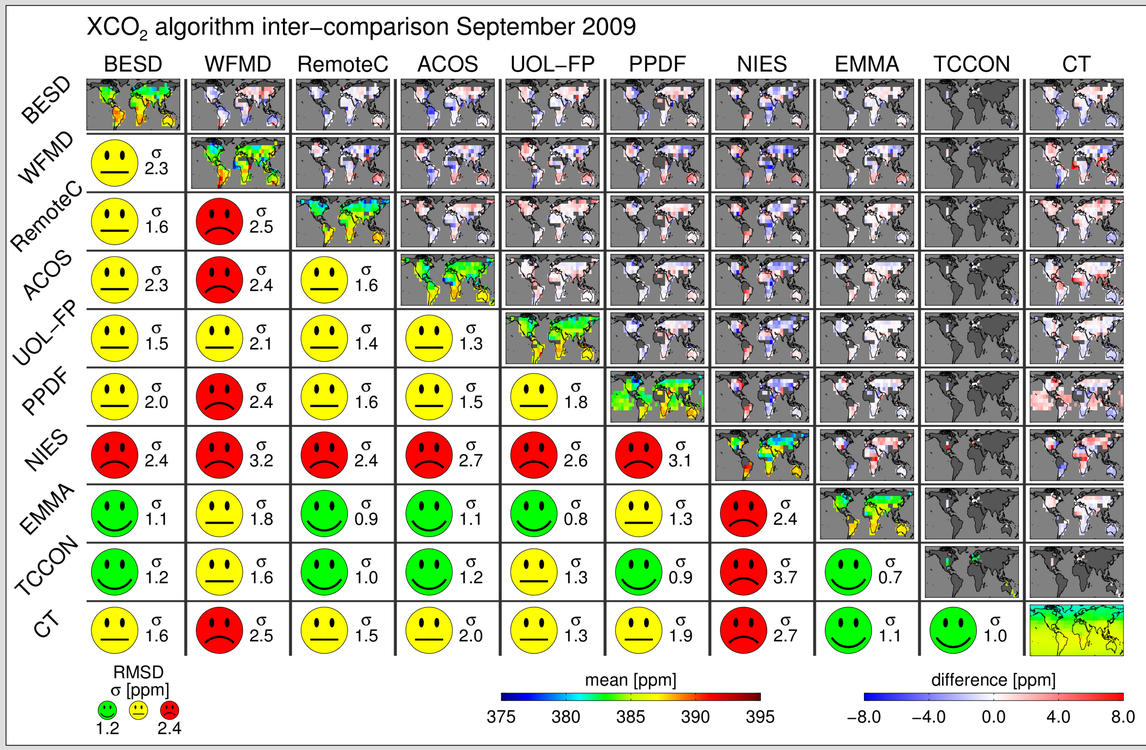
Performance of EMMA

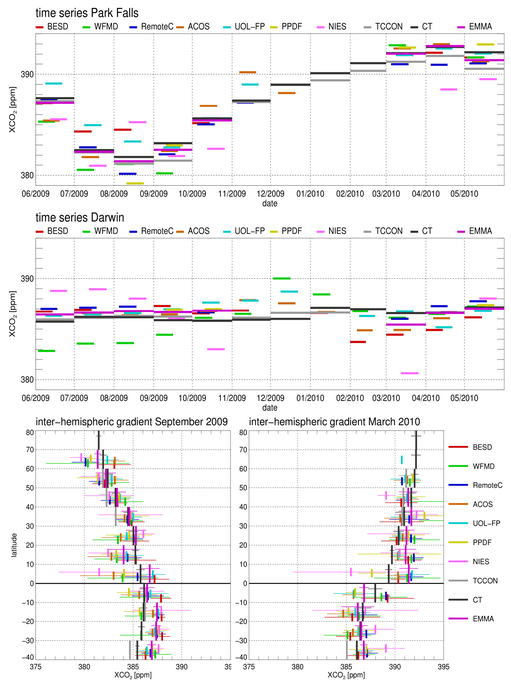
EMMA’s performance has been assessed by analyzing the difference of monthly averages, the seasonal amplitude, and the north/south gradient to TCCON and CarbonTracker .



Algorithm Inter-Comparison

Basis for the algorithm inter-comparison are global level 3 data, namely monthly averages at 10°x10°. Seven satellite retrievals and EMMA are compared against each other and TCCON ground based validation measurements as well as the NOAA CarbonTracker model. Our results show often good agreement but also distinct differences in global patterns (**left**), time series (**right**, **top**), and inter-hemispheric gradients (**right**, **bottom**).





Results and Data Access

- Largest systematic retrieval uncertainties in the Tropics and east Asia
- ACOS, RemoteC, and UOL-FP are often close to the median
- WFMD and NIES have the largest fraction of potential outliers
- All algorithms show consistently larger seasonal amplitudes than CT2010
- **EMMA performs very well in terms of agreement with TCCON and consistency with CarbonTracker**
- **One year of EMMA XCO_2 data (06/2009–05/2010) can be downloaded at: http://www.iup.uni-bremen.de/~mreuter/emma.php**
- All included retrieval algorithms are under active development which will also further improve future EMMA releases

Acknowledgements

DLR SRON University of Leicester NASA esa JAXA TCCON

Universität Bremen

maximilian.reuter@iup.physik.uni-bremen.de
http://www.iup.uni-bremen.de/~mreuter/
http://www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/