Validation of MetOp-A/IASI SOFRID CO retrieval with IAGOS vertical profiles on 2008-2020

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Context and goal

Carbon Monoxide (CO) is mainly produced by :
- fossil fuel combustion
- biomass burning
- oxidation of CH_4 and other volatile organic compounds.

It is a precursor of O_3 and CO_2 and has an average lifetime of ~2 months.
The reaction with the hydroxyl radical OH is its principal sink. Because these OH could otherwise react with greenhouse gases, CO emissions have a positive radiative forcing.

In order to be scientifically useful and to provide thorough information about trends and variabilities, IASI CO data require careful validation with independent in situ observations.

Method

SOFRID is the algorithm developed at LAERO since 2011 that allow to retrieve CO, N_2O and O_3 concentrations on 43 levels.
It is based on the optimal estimation method and the RTTOV fast radiative transfer model.
The v2.2 of SOFRID-CO uses air temperature and humidity from ECMWF operational analyses as input for RTTOV v9.3.

We validated the SOFRID CO partial columns with IAGOS vertical profiles. The IAGOS program lead by LAERO is providing regular tropospheric CO profiles worldwide since 2001 thanks to measurements acquired on commercial aircraft.
Since airliners do not fly above ~200 hPa, the IAGOS profiles were complemented in the stratosphere with Aura/MLS data. They were filtered based on data completeness.
IASI pixels were extracted in ±1° lat/lon squares around the positions of the IAGOS aircraft at 6000 m asl, on the days of the profiles (9h30 and 21h30 local time retrievals). Pixels were filtered according to their retrieval quality.

Fig 1 : For the moment, the validation has been performed at 9 airports

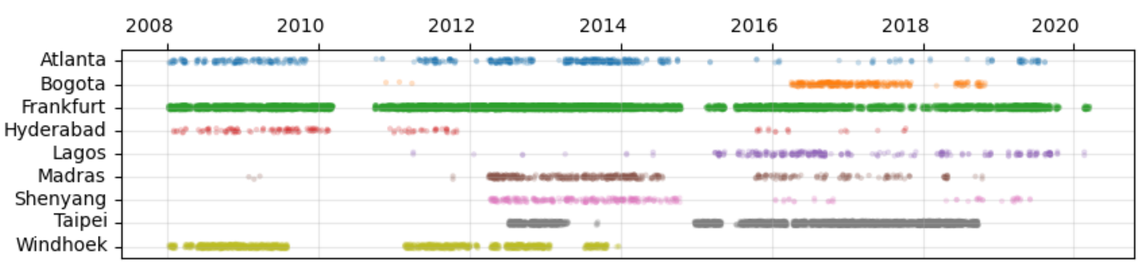

Fig 2 : Temporal availability of the IAGOS data

Results

As already seen by De Wachter et al. (2012) on 2008-2009 data, dayttime retrievals are generally more sensitive to lower layers than nighttime retrievals (not shown).

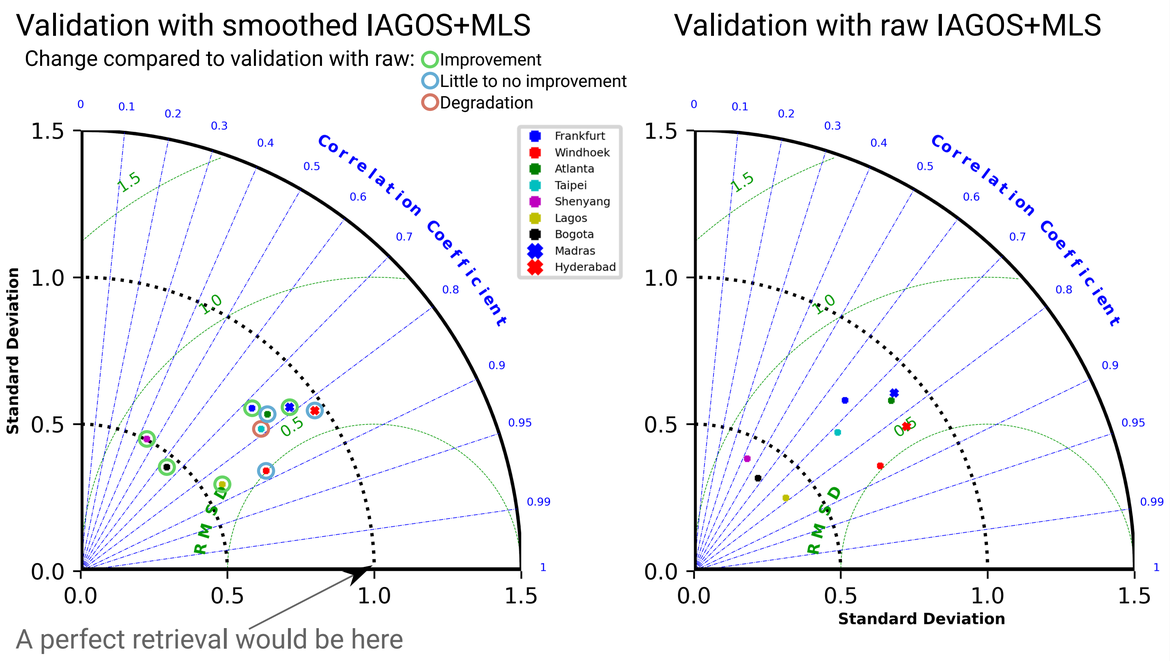

Fig 3 : Total column validation of SOFRID-CO v2.2 with IAGOS+MLS
(RMSD is centred and both RMSD and STD are normalised with observations STD)

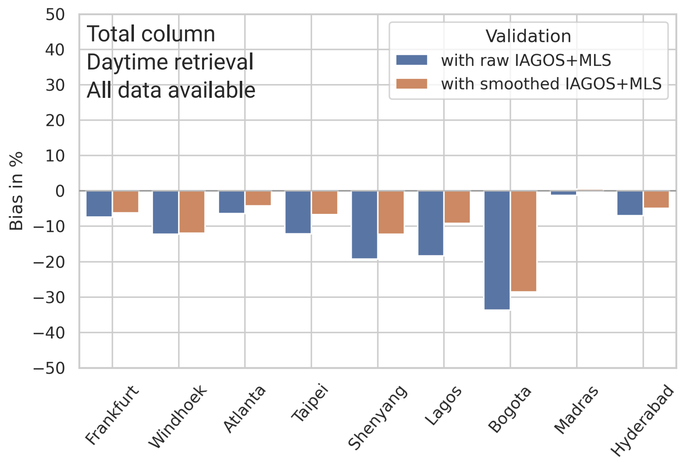

Fig 4 : The bias (SOFRID − "smoothed IAGOS+MLS")/"smoothed IAGOS+MLS" is mostly negative but stays below [-12,+1]%, except at Bogota. The larger bias at Bogota is related to the high altitude of the surface (2500 m asl) and potential uncertainties in the input meteorological parameters and surface pressure of the IASI pixels in mountainous regions

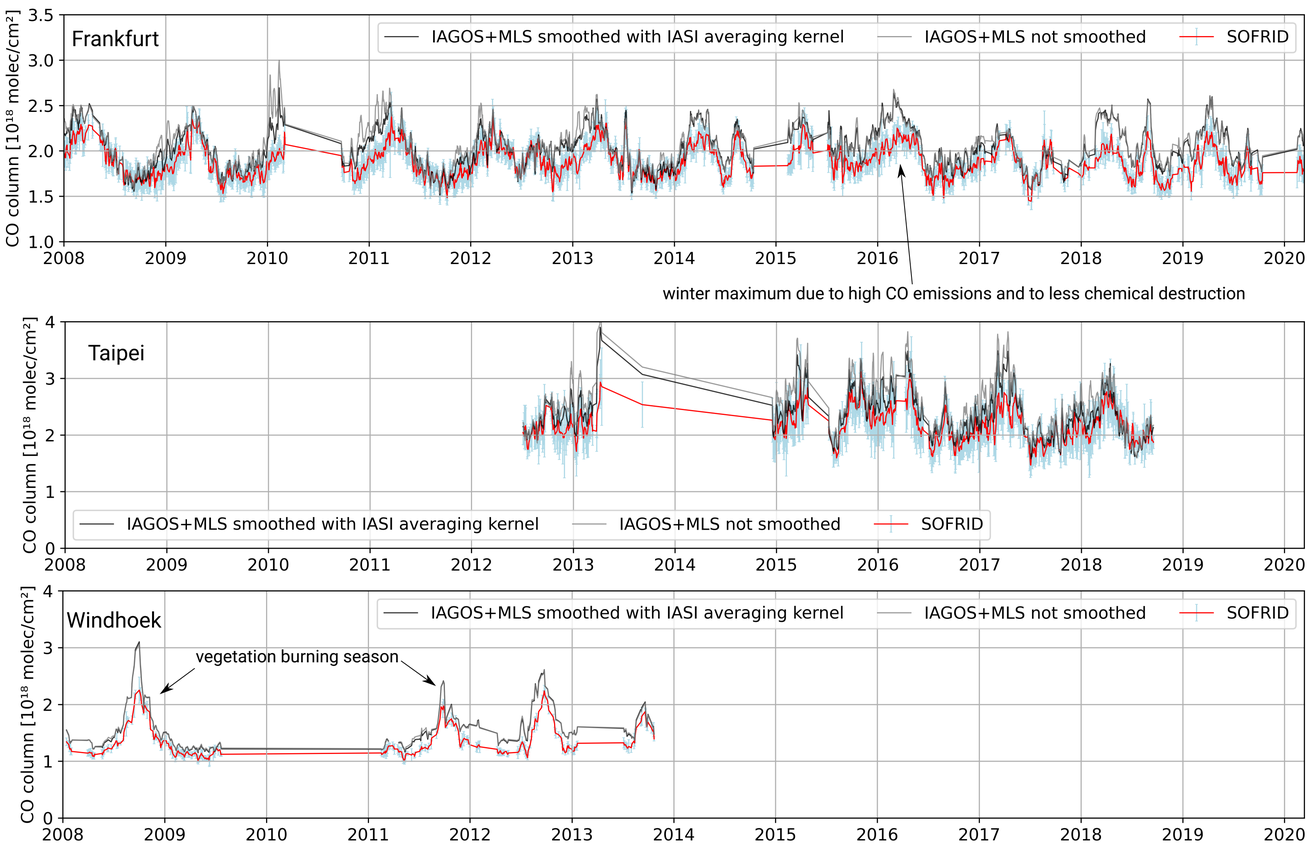

Fig 5 : Time series of CO total column (daytime retrieval, moving average of 5 days)

At Shenyang, the lack of IASI sensitivity at low altitudes (shown by the averaging kernels) limits the detection of high concentrations close to the surface :

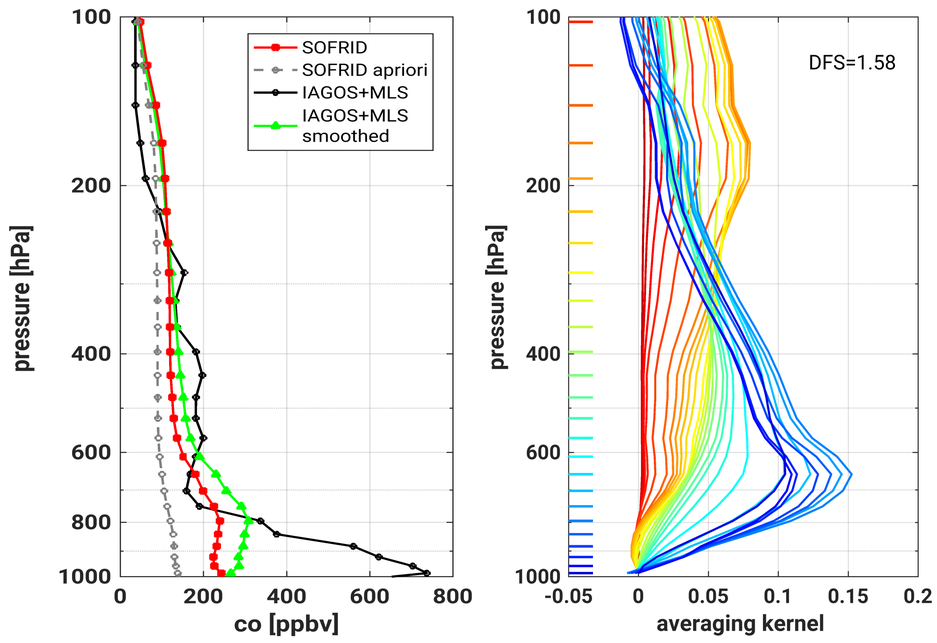

Fig 6 : Profiles and averaging kernel for the 10 April 2012 (daytime retrieval) above Shenyang (600 km NE from Beijing)

Perspectives

Validation will be achieved on 50 airports that have more than 100 IAGOS profiles on 2008 - 2021.

References

De Wachter et al. (2012) Retrieval of MetOp-A/IASI CO profiles and validation with MOZAIC data. Atmospheric Measurement Techniques 5, 2843–2857

Acknowledgments

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