CO monitoring with IASI: global and local variability

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Daniel Hurtmans (ULB)
Fast Operational Retrievals on Layers for IASI
(Hurtmans et al., JQSRT 2012)
Sources:
- CH$_4$
- VOC

Sinks:
- OH
- CH$_4$ → CO$_2$
- OH → O$_3$

Sources and sinks

Lifetime: few weeks

+ Deposition
+ Stratosphere loss

+ Vegetation
+ Ocean
8-year mean and std

IASI 8-year global mean (2008-2015) day

IASI 8-year global mean (2008-2015) night

CO total column $\times 10^{18}$ molecules/cm$^2$

Associated standard deviation
In Giens in 2013:

FORLI-CO data available from Ether data base


http://www.aeris-data.fr

Distributed by EUMETSAT in 2013 (profiles + AK)

Since September 2015

See Juliette Hadji-Lazaro’s poster S4-50
MOPITT/Terra  IASI/MetOp-A  IASI/MetOp-B  IASI/MetOp-C

N. Hemisphere Total Column CO, 12-month running average

Worden et al., ACP 2013
- IASI - MOPITT v5T comparisons:
  * a priori assumptions
  * IASI L2 v5 > v6
- Perspective:
  Preliminary work: Fires in Indonesia (2015)

Assimilation in the CAMS project

http://www.gmes-atmosphere.eu/d/services/gac/nrt/nrt_fields/
IASI / MOPITT

Total CO x 10^18 molecules/cm^2

Africa
China
Pacific
Siberia
USA
Europe

2008 2009 2010 2011 2012 2013

Mean bias [std]

-0.3 [10.3]
-3.8 [16.3]
-5.3 [8.2]
-16.5 [17.5]
DJ -35.9 [9.5]
-15.1 [8.5]
DJ -27.2 [5.3]
-15.7 [13.3]
DJ -35 [8.8]

George et al., AMT 2015

15 day averages
Vertical bars: variability
MOPITT:
Gaz correlation radiometer
2 spectral channels for CO (4.8 and 2.3 µm)
10h30 (Equator crossing time)

IASI:
Fourier transform spectrometer
154 spectral channels for CO
9h30 (Equator crossing time)

The two retrieval algorithms (MOPFAS et FORLI) are based on the optimal estimation method (Rodgers, 2000).

| A priori profile and variance-covariance matrix | MOPFAS variables | FORLI single |
| Temperature and H₂O profiles | NCEP | IASI L2 |
| Cloud filters | MOPITT/MODIS | IASI L2 |
| Emissivity | NCEP | Zhou et al. (2011) |
a priori profiles and covariance matrices

\[ x_\alpha \text{ MOPFAS FORLI} \]

\[ S_\alpha \text{ FORLI} \]

Collaboration with NCAR (National Center for Atmospheric Research)

**MOPITT vX1:** MOPITT with *a priori* assumptions from IASI
$\frac{100(\text{IASI-MOPITT}_v5T)}{\text{IASI}}$  

$\frac{100(\text{IASI-MOPITT}_vX1)}{\text{IASI}}$

**January-December:**

- **Siberia:** -35.9% [9.5]  -12.6% [8.7]
- **USA:** -27.2% [5.3]  -11.4% [5.3]
- **Europe:** -35% [8.8]  -18.1% [6.7]

*George et al., AMT 2015*
Changes in EUMETSAT Temperature, Humidity, Clouds (IASI L2)
Differences between FORLI v20100815 (L2V5) and FORLI v20140922 (L2V6)

On average, for 8 days in September 2014, IASI v20100815 (IASI L2 V5) total columns are smaller than IASI v20140922 (IASI L2 V6). The relative differences are the smallest in the Northern Hemisphere (20°N-60°N) with 1.4% and the largest in the Southern Hemisphere (20°S-60°S) with 4.2%. On a globe scale, the relative difference is 2.9% (V6>V5).
IASI L2 V5 > IASI L2 V6

IASI / MOPITT

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=> Thomas    => David
Conclusions:

IASI - MOPITT v5T comparisons
For Europe, Siberia and USA
=> Biases can be reduced when using the same *a priori*
=> Biases can be reduced when improving IASI L2

Perspectives:
1) Daily observed total CO masses

\[ \text{TM}_X = \frac{M_X C_X S}{N_a}, \]

where \( M_X \) is the molar mass of \( X \) (in g mol\(^{-1}\)), \( C_X \) is the mean column retrieved from IASI daytime observations (in molec cm\(^{-2}\)), \( N_a \) is the Avogadro number and \( S \) represents a defined surface area.

2) Mean Burden = smoothed total mass - background (Yurganov 2011)

3) Emission fluxes assuming a simple box model and first order loss terms (Jacob 1999) using two values of \( \tau_{eff} \)—namely, 7 and 15 days.

\[ E_{i+1}(X) = \frac{B_{i+1} - B_i e^{-t/\tau_{eff}}}{\tau_{eff} (1 - e^{-t/\tau_{eff}})}. \]  

Here, \( E_i \) and \( B_i \) are respectively the flux and the burden on day \( i \), \( t \) is time between two observations (here one day) and \( \tau_{eff} \) is the effective lifetime of the species \( X \). This lifetime term includes chemical losses, but also losses due to transport outside the considered area.

R’Honi et al., 2013
Fire emissions estimated using the APIFLAME model

Based on the area burned calculated using MODIS data.

The area burned is therefore multiplied by fuel loads and emission factors characteristic of the vegetation type burned (MODIS classifications).

Work in progress...
M. Krol (University of Utrecht)