Global Fire Emission Estimates for 2009-2010
Derived From GOME-2 HCHO Columns

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Pinealode (HCHO) is a key intermediate product in the oxidation chain of the emitted VOCS in the atmosphere. Anthropogenic, pyrogenic and biogenic precursors constitute a significant part of the total HCHO production, the remainder sourced from methane oxidation. An important contribution of 30% on the global scale comes from biogenic sources, and dominates over other sources during the growing season. Anthropogenic sources are responsible for only 6% and biomass burning for 3% of the global HCHO source. In addition, besides photolysis, HCHO is also directly emitted by biomass burning and fossil fuel combustion. HCHO is removed mainly through OH oxidation and photolysis.

In this work we derive global fire estimates for MMVOCs using HCHO columns retrieved from the Global Ozone Monitoring Experiment-2 (GOME-2) instrument on board MetOp satellites. The Global Fire Emission Database version 3 (GFEDv3), see de Wever et al. (2020), is used as bottom-up inventory for fire emissions in the IMAGES2 global chemistry-transport model. The agreement between modeled IMAGES-2 HCHO columns is optimized using the adjoint technique (Stavrakou et al., 2009). This method allows for the optimization of emission strengths at the model resolution and provides a differentiation among the emission sources.

Monthly updated fire estimates are obtained for 2009 and 2010 at a resolution of 2° x 2.5°. They are evaluated through comparison with the fire inventory from NCAR (FINN, Wiedinmyer et al., 2011) for the target years. Further, CO columns retrieved from IASI (George et al., 2010) are compared with CO simulated columns over fire affected regions using a priori and the optimized fire emissions.

![Images2 global CTM and the inversion technique](image)

**Results from inversion**

**Modelling vs. observed HCHO columns in July 2010 (10^16 molec.cm^-3)**

**GOME2 HCHO IMAGES HCHO**

**After inversion**

**Annual GFED3 VOC emissions (10^17 molec.cm^-3)**

**Ratios of the optimized by the a priori (GFED3) biomass burning emissions in 2009 and 2010**

**Evaluation of the results**

**Over North America**

The very low fire emission during the Atlantic phase in July 2009 is not supported by the inversion which suggests a further increase of the flux by 7%. The emission due to the Atlantic phase in July 2010 is found to be decreased and closer to the FINN inventory. In June 2009, the posterior solution is identical to the GFED3 estimate due to the absence of FINN data for this month. Big difference between the two inventories over southern Mexico in April, the inversion supports the lower value of GFED3 in 2009, but in 2010 FINN’s higher emission allows for a better model-data agreement.

**Over Russia**

In April-May of both years the inventory cannot help to decide which inventory captures the emissions of Siberian fires. The two inventories in May 2010 are in better agreement with FINN. In May, the fire events in both inventories are located in the eastern Siberia and their flux is decreased after the optimization. In June, the optimization that occurred in FINN is well supported by the inversion. The inferred increase of up to a factor of 5 is supported by the analysis between Moscow and high Nornegrad.

**Over South Asia**

The good correlation of GFED3 over Ammania in 2009’s burning season provide a very good agreement with the observed HCHO columns, containing the high FINN emissions. The simulations are much closer with GFED3, and best magnitude appear to be strongly overestimated (factor of 2) inGFED3, but is captured quite well in FINN.

**GOME-2 HCHO columns - New version (2012)**

HCHO vertical tropospheric columns have been retrieved from GOME-2 observations between 2007 and 2011, using an improved version of the algorithms previously developed for the GOME and SCIAMACHY instruments (De Smedt et al., 2010). The product includes a detailed error estimate and the averaging kernel for every observation. Main features of the new retrieval scheme include (i) a two-step fitting procedure that strongly reduces the interference between HCHO and CO, and (ii) a modified DOAS approach allowing a better handling of the strong O3 absorption effects. These corrections lead to a significant scatter reduction in the slant columns and improve the agreement with coincident SCIAMACHY observations. Furthermore, an asymmetric Gaussian line shape is fitted during the calculation of the spectra, allowing to take into account changes of the GOME-2 fit function with time and to mitigate the instrumental degradation effects on HCHO retrievals.

Additionally, external parameters used for the tropospheric air mass factor computation have been updated. We use the monthly aerosol-optical-depths from GEOS-Chem at the resolution of 0.25°. Finndrill cloud product (Weng et al., 2008) and daily a priori profile shapes from IMAGES2 at the resolution of 2° x 2.5°. The present version of the HCHO columns is available on the TIMES website: [http://ioo.aeronomie.be](http://ioo.aeronomie.be).

**Seasonal means between 2007 and 2011**

![Seasonal means between 2007 and 2011](image)

**References**


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