Global observations of glyoxal columns from OMI/Aura and GOME-2/Metop-A sensors

Christophe Lerot[1,✉]

F. Hendrick[1], I. De Smedt[1], C. Gielen[1], T. Stavrakou[1], J.-F. Müller[1], R. Volkamer[2,3], S. Coburn[2,3], S. Baidar[2,3], T. Koenig[2,3] and B. Dix[3], and M. Van Roozendael[1]

[1] Belgian Institute For Space Aeronomy, BIRA-IASB (Belgium)
[2] Cooperative Institute for Research in Environmental Science (CIRES),USA
[3] University of Colorado, USA
✉ Christophe.Lerot@aeronomy.be

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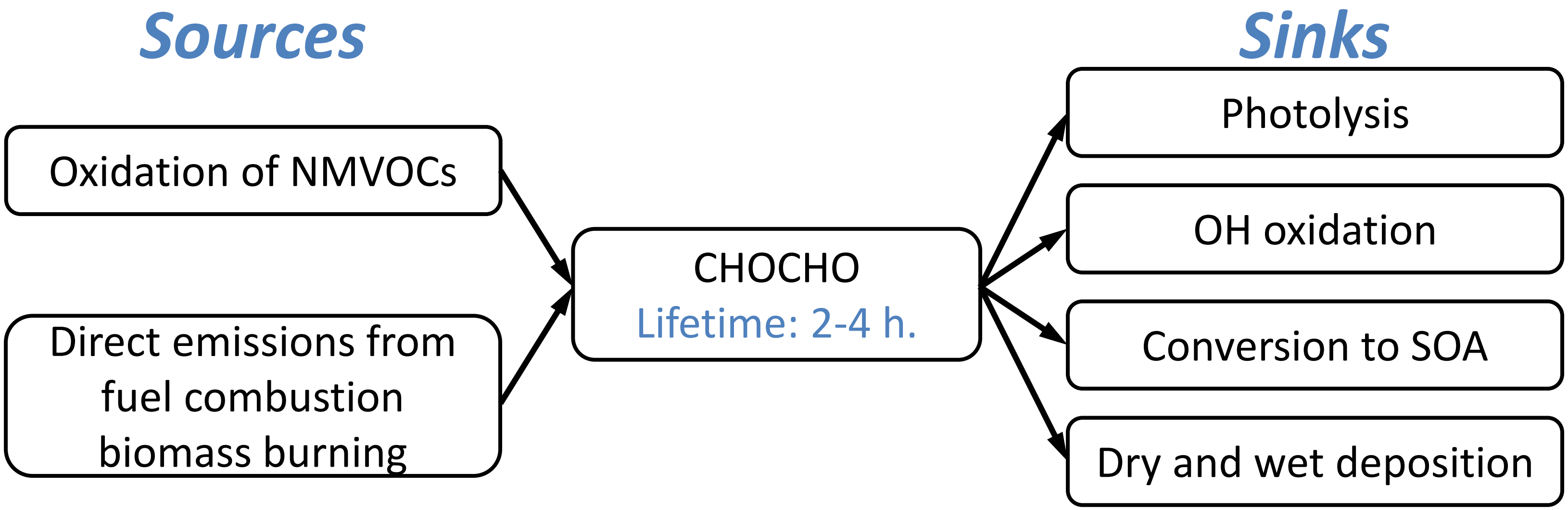
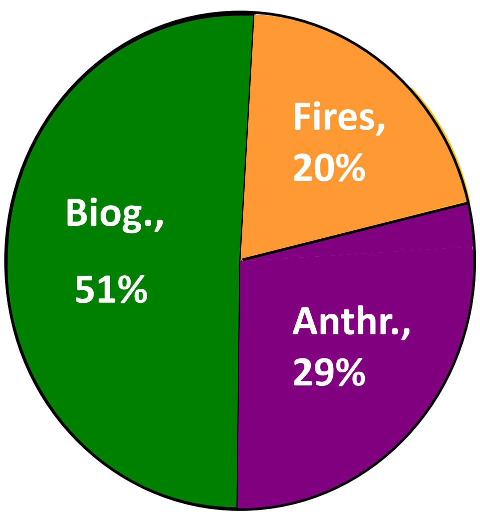
GOME-2 Global Ozone Monitoring Experiment

OMI

Why observing glyoxal from space?



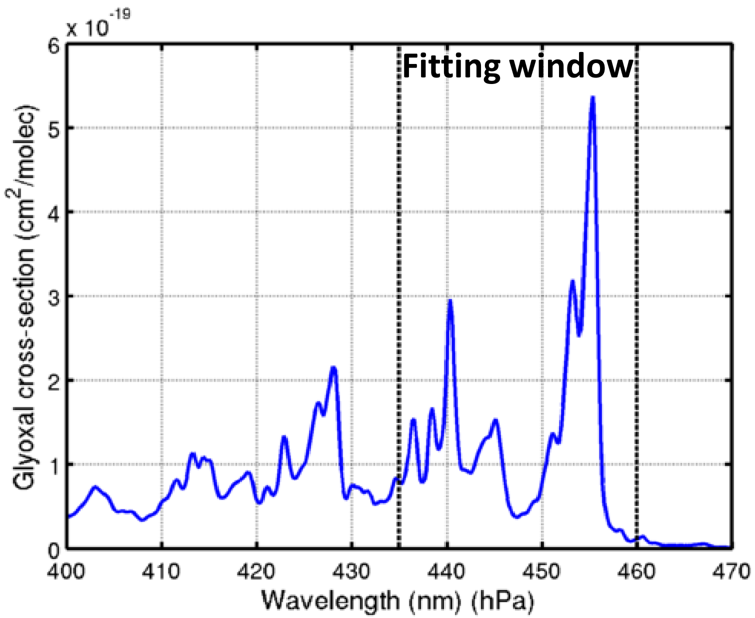


- VOCs play an important role in air quality issues (e.g. production of tropospheric ozone in polluted area)
- Glyoxal is an indicator of short-lived NMVOCs
  ➔ Constraints for the quantification of their emissions.
- Combined with measurements of other short-lived VOCs, it allows a better speciation of precursor VOCs (e.g. CHOCHO:HCHO ratio).
- Constraints for the budget of secondary organic aerosols

Glyoxal retrieval algorithm @ BIRA-IASB

- Original algorithm has been developed for GOME-2A in 2010 (Lerot et al., ACP).
- Update and adaptation of the algorithm to OMI.
- Relies on the standard DOAS approach, including two main steps:

1. Slant column retrieval from measured reflectances



Updated **Absorption cross-sections**	**CHOCHO +** O_3, NO_2 (two temperatures as in Alvarado et al., Miller et al., 2014), H_2O, O_4, **Ring, liquid water** (fixed) and **VRS**

Typical glyoxal optical density: 1-3 x 10^{-4}
one order of magnitude smaller than the other species

→ Very sensitive to spectral interferences.
→ Individual measurements are useless; averaging needed.

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2. Conversion to vertical columns

2a. Background/destriping correction procedure:

- Reference sector: Pacific ocean, Reference CHOCHO value: 1×10^{14} molec/cm^2.
- Normalization values are row- or VZA-dependent

2b. Air mass factors are computed using:

- weighting functions simulated with LIDORT at 448 nm .
- a priori profile shapes:
  a. Over lands: provided by the CTM IMAGESv2.
  b. Over oceans: one profile measured over Pacific with an Airborne MAX-DOAS during the TORERO campaign[1].
- No cloud correction applied: only pixels with cloud fraction < 20% are kept.

[1] *Volkamer et al., AMTD, 2015;*
Poster B166 by Coburn et al., Session AS3.13

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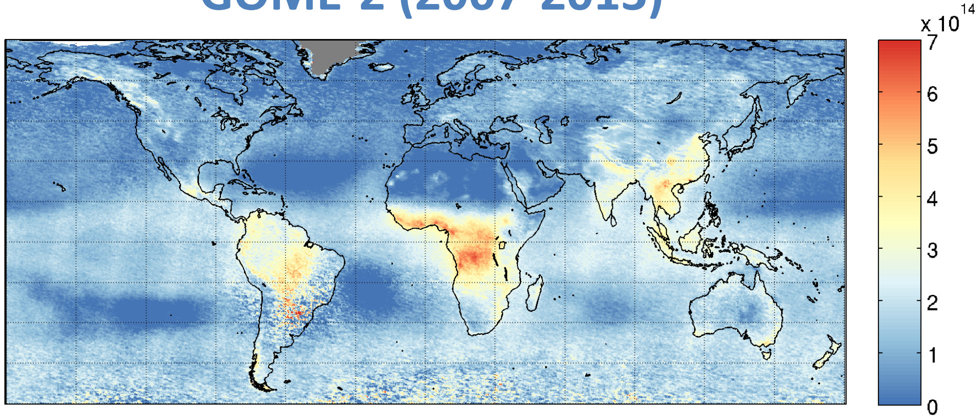
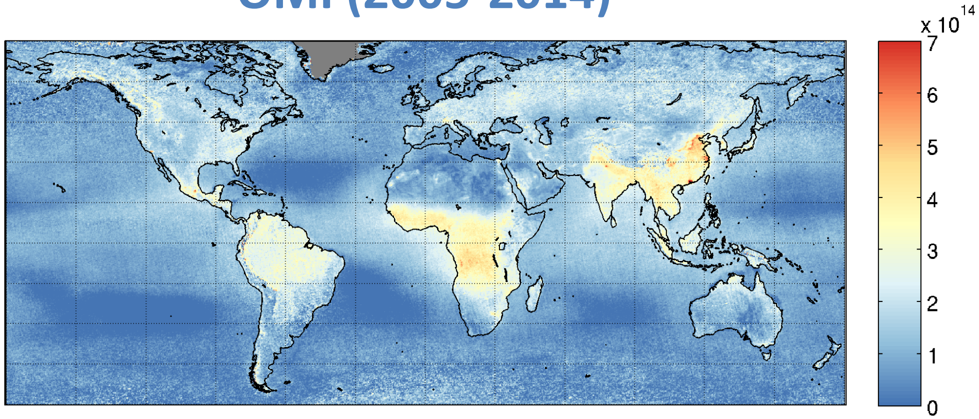
GOME-2 and OMI glyoxal VCD fields

CHOCHO total columns (molec/cm²)

GOME-2 (2007-2013)

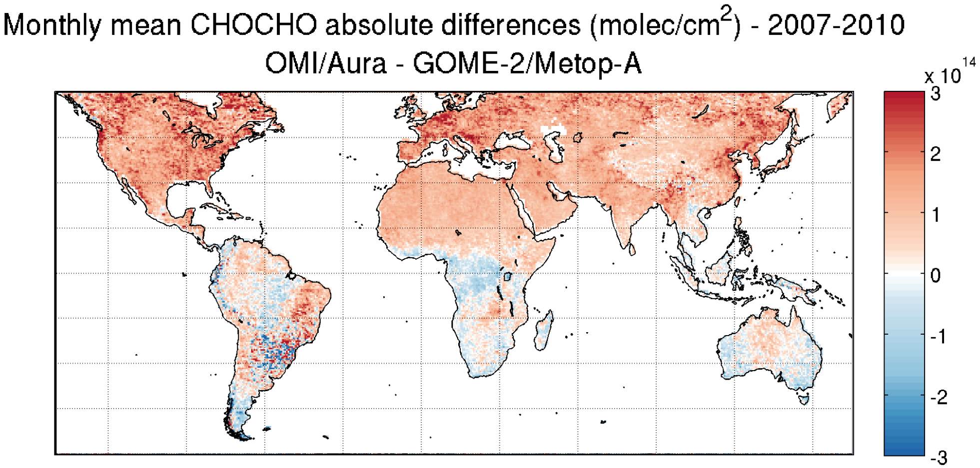


OMI (2005-2014)



- Consistency between the global fields of glyoxal columns seen by OMI and GOME-2.
- Strong glyoxal signal in Tropics where the most important biogenic emissions and fire events take place. At mid-latitudes, the signal is important during Summertime only.
- Oceanic glyoxal signal stronger for GOME-2 than OMI.

GOME-2 and OMI glyoxal VCD fields



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GOME-2 and OMI glyoxal VCD fields

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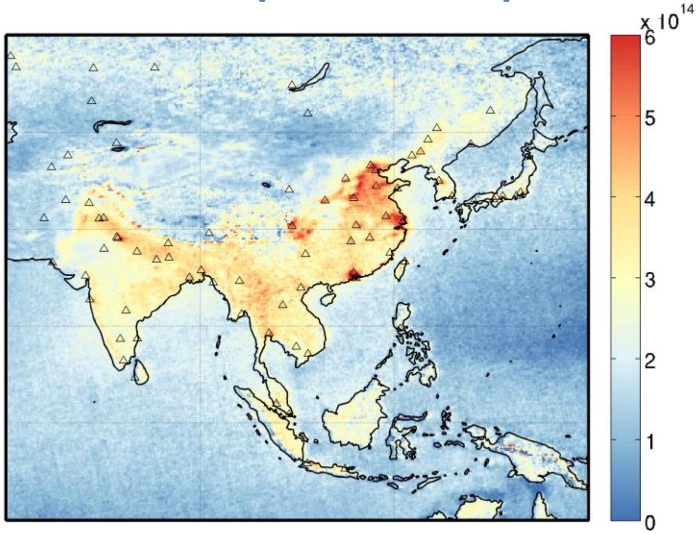

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- OMI expectedly captures better local sources and highly polluted cities (e.g. Mexico, Hong-Kong, Shanghai, New-Delhi,…).

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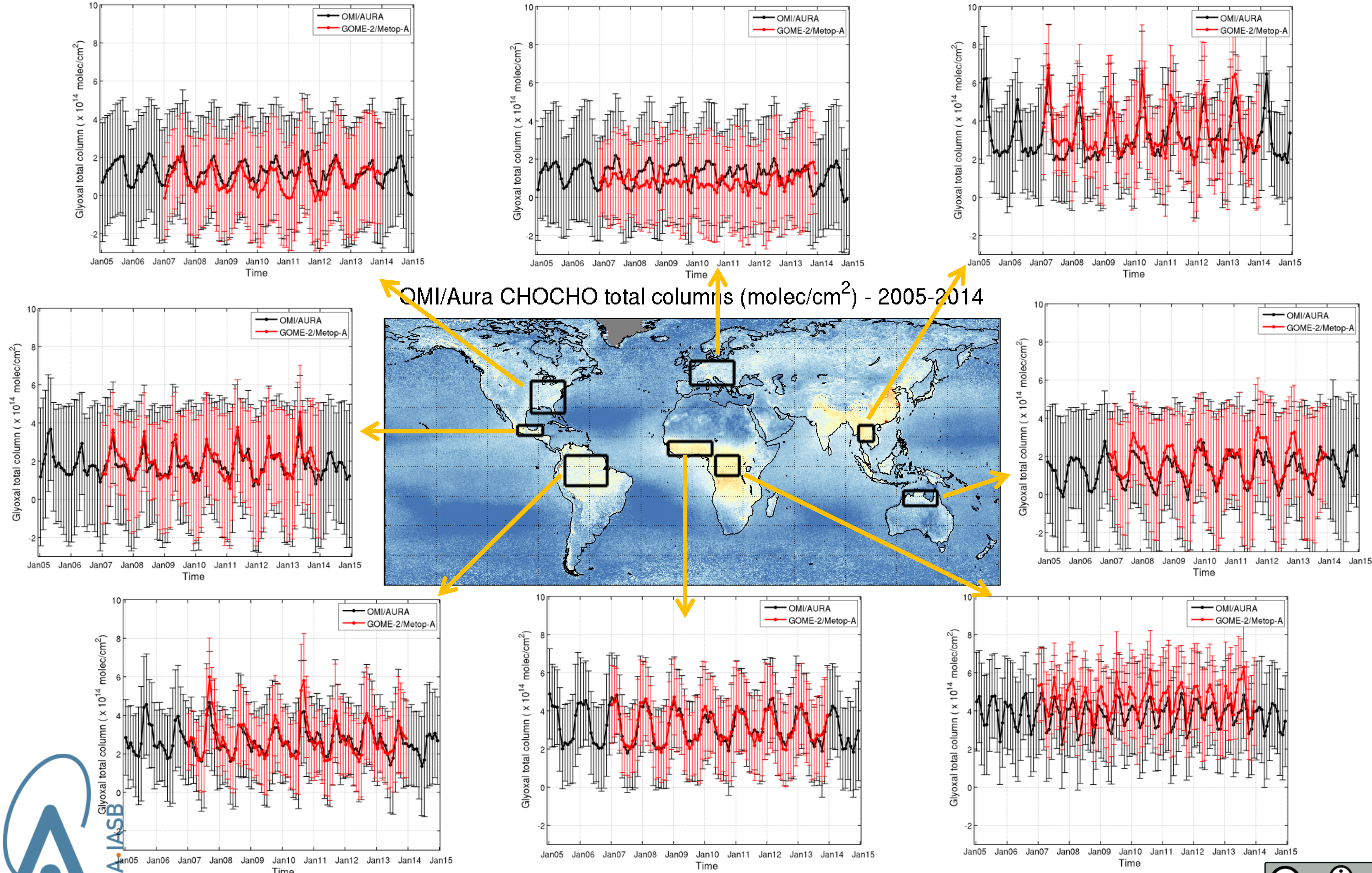
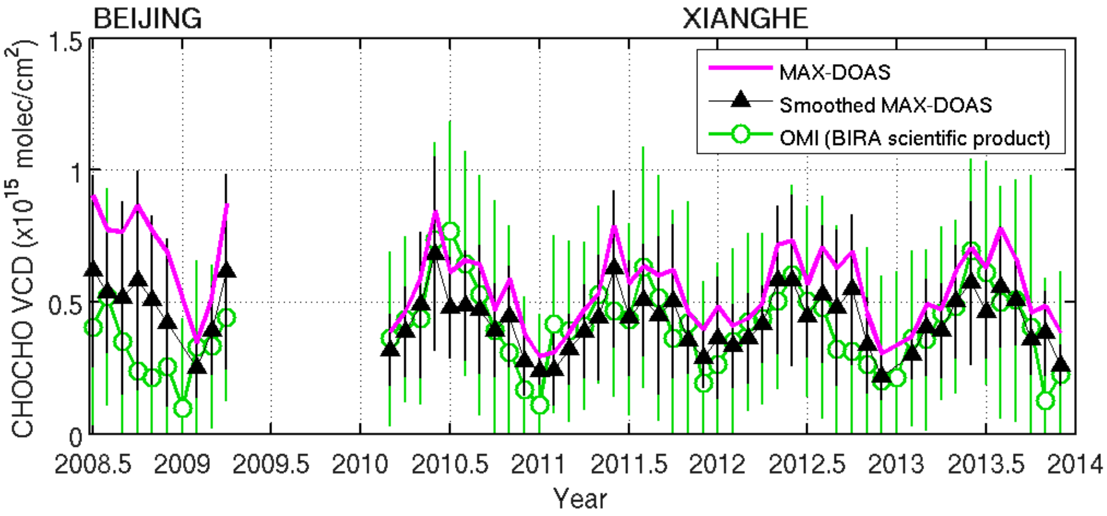
GOME-2 and OMI glyoxal VCD fields



First validation results in Beijing/Xianghe (China)

- Since 2008, BIRA-IASB operates a MAX-DOAS instrument initially located in Beijing and then moved to Xianghe.
- This instrument provides long time series of concentration profiles for many species (NO_2, SO_2, HCHO, HONO,…) useful for the validation of satellite products.
- MAX-DOAS glyoxal retrieval settings have been presented by Hendrick et al. in Session AS3.13.
- Focus on OMI data (overpass radius=100 km).
- Outstanding agreement between the MAX-DOAS and OMI time series
- Application of OMI AKs to the MAX-DOAS columns further reduces the small systematic bias.

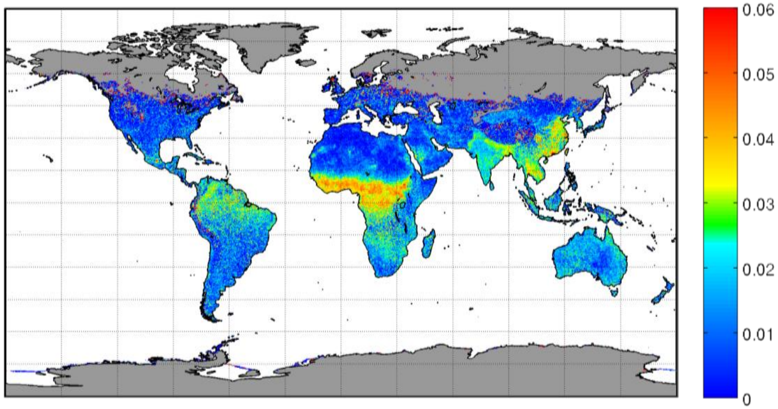


OMI glyoxal/formaldehyde ratio

- Useful indicator of precursor VOC speciation.
- The BIRA-IASB OMI formaldehyde[1] and glyoxal products have been combined to compute multi-annual (2005-2013) estimates of this ratio.

[1] *De Smedt et al., ACPD, in press*

DJF



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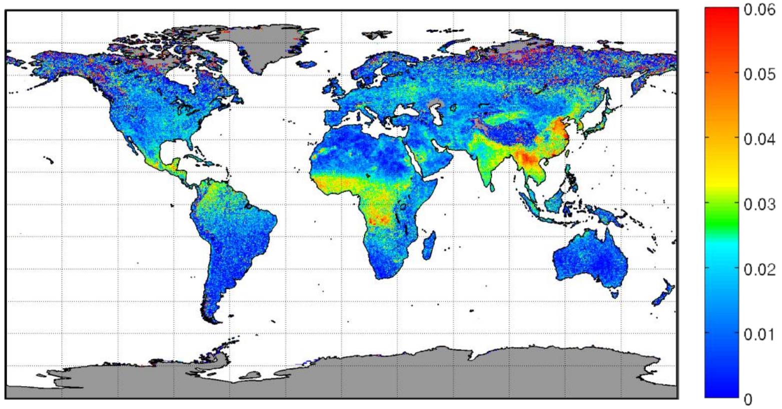

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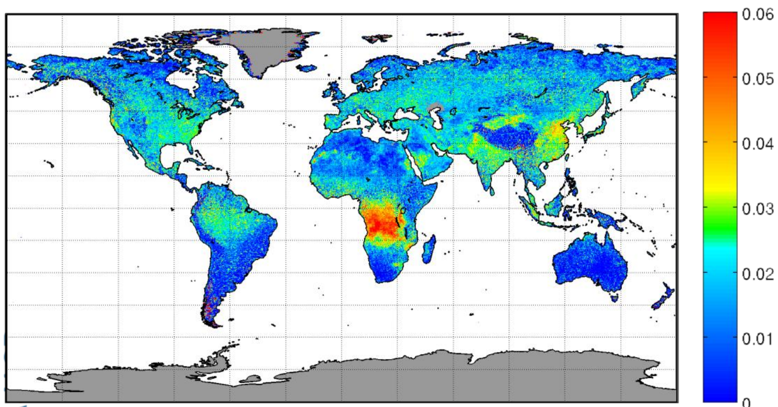

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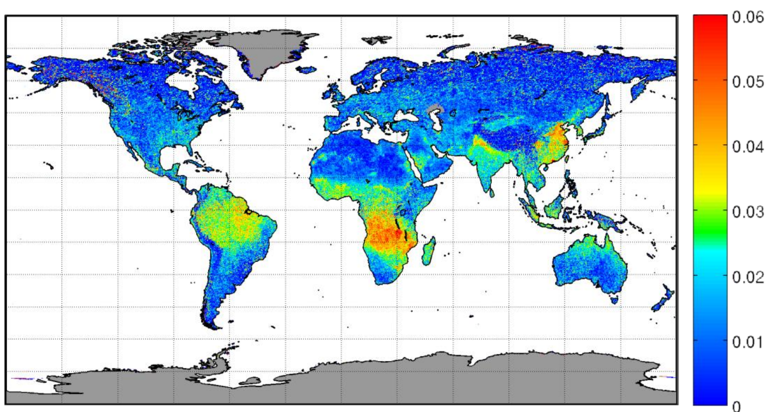

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MODIS Fire Counts 2007 (# fires/1000km²/day)

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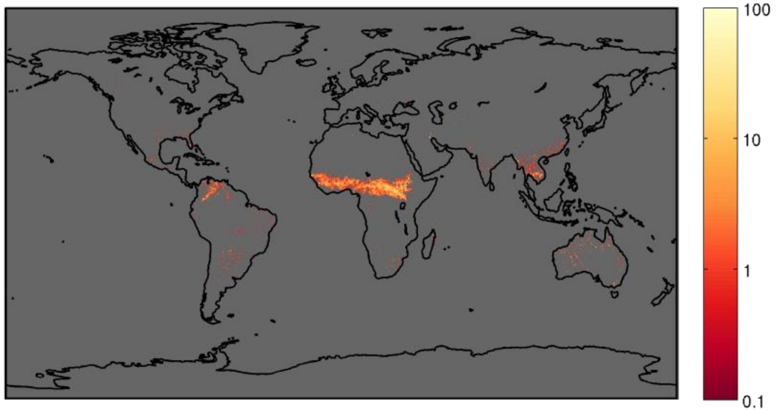

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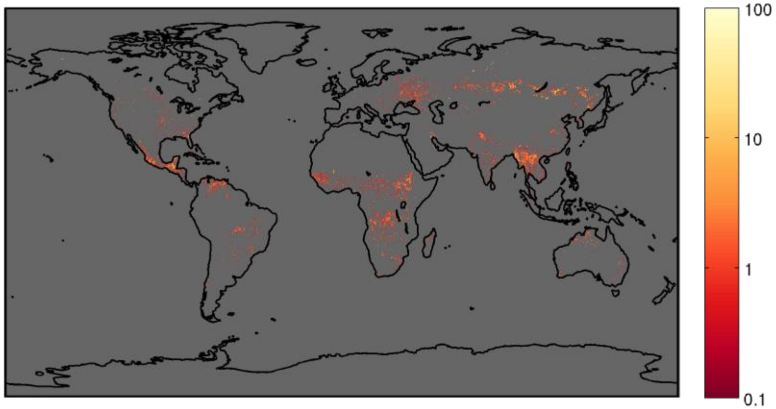

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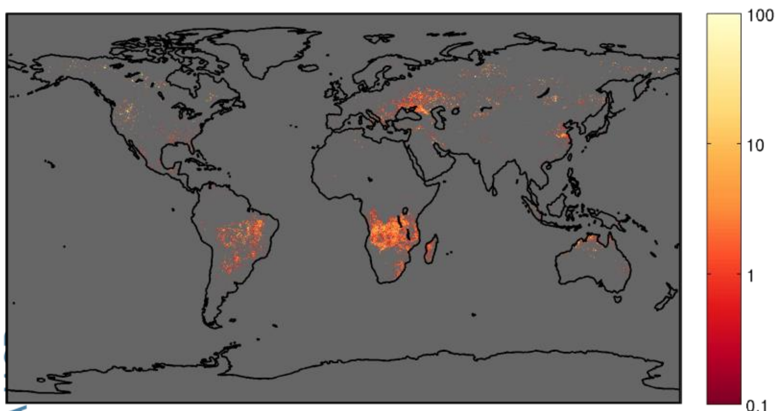

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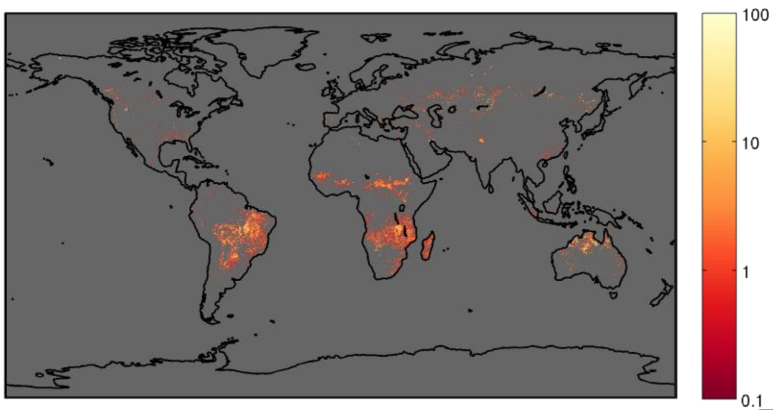

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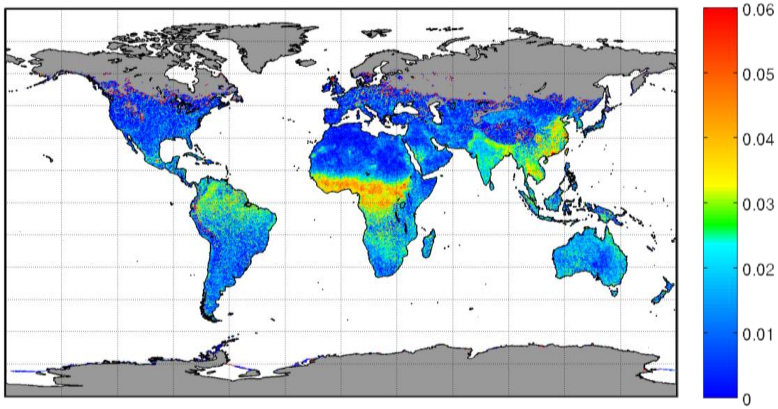

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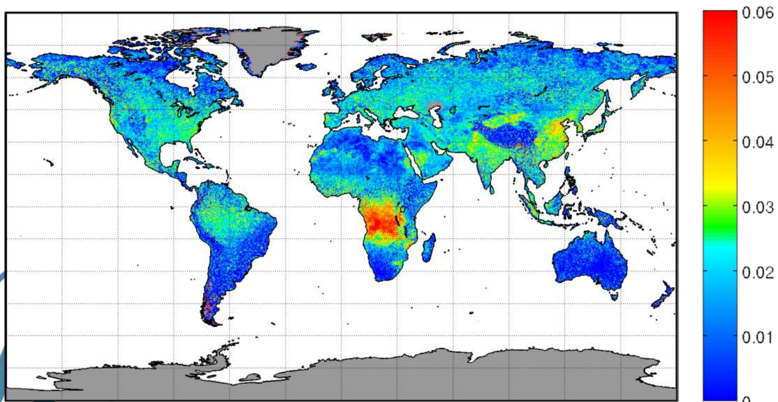
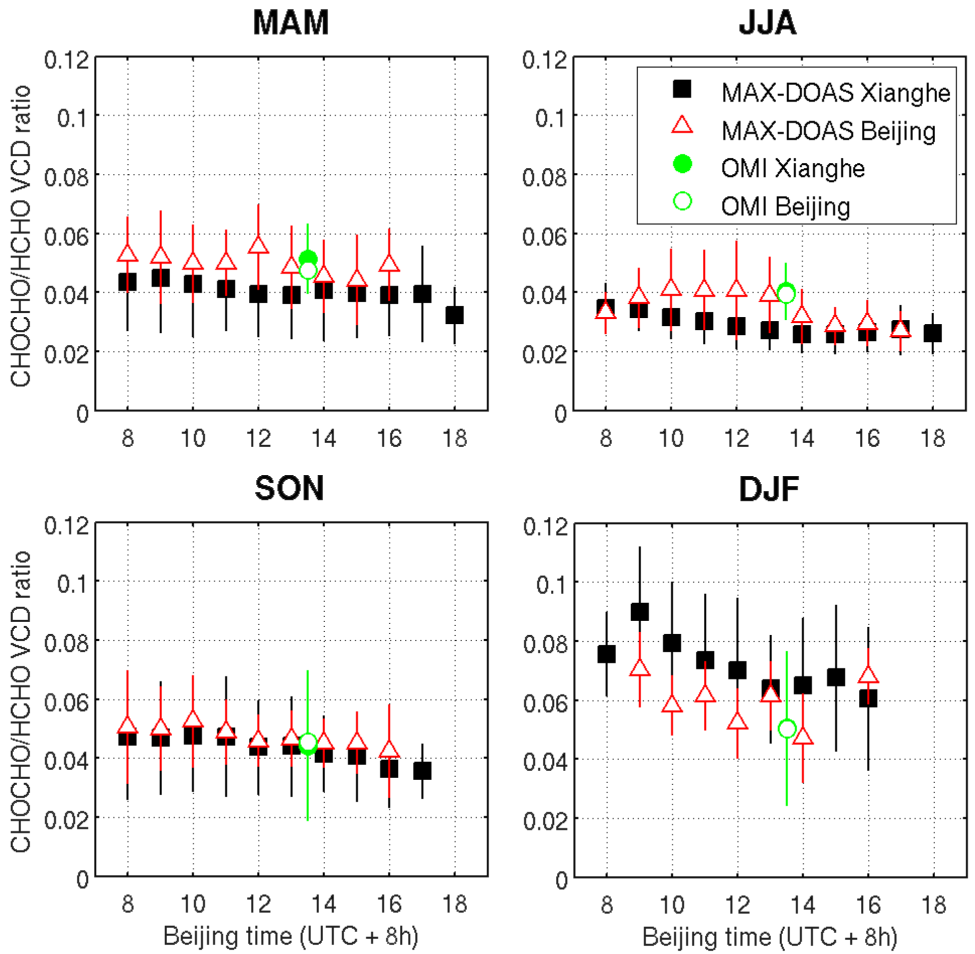


- R_{gf} is small where biogenic emissions dominate.
- R_{gf} slightly increases in highly populated area.
- R_{gf} has the largest values in case of extreme fire events.
- Consistent with other recent studies based on in situ (*Di Gangi et al., ACP, 2012; Kaiser et al., ACPD, 2015*) and space measurements (*Miller et al., AMT, 2014*). It is however in contrast to an older study (*Vrekoussis et al., ACP, 2010*) suggesting highest ratios for biogenic areas.

OMI glyoxal/formaldehyde ratio

MAX-DOAS ratios in Beijing/Xianghe

- Ratio also computed from MAX-DOAS observations in Beijing/Xianghe.
- Limited diurnal variation, except in winter where it is more pronounced.
- Very satisfactory agreement between MAX-DOAS and OMI ratios.
- Seasonal variation more important in MAX-DOAS data.



Summary

- The BIRA-IASB glyoxal retrieval algorithm, originally developed for GOME-2A, has been updated and adapted to the imager-type OMI sensor.
- Full reprocessing of GOME-2A and OMI led to generally highly consistent glyoxal column data sets.
- Early afternoon columns are lower than morning columns in Tropics, and larger at mid-latitudes. This is consistent with HCHO observations.
- The glyoxal/formaldehyde VCD ratio has the largest values in regions with strong pyrogenic emissions. The ratio has intermediate values in highly populated area and biogenic emission regimes lead to smaller values.
- First validation results using a long time series of MAX-DOAS observations in Beijing and Xianghe are very promising: An excellent consistency between OMI and ground data is obtained all along the time series. The glyoxal/formaldehyde ratios from OMI and the MAX-DOAS agree also very well.
- Glyoxal data products may be provided on request.