GLOBAL OBSERVATIONS OF FORMALDEHYDE

UP 9.7

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Introduction

Formaldehyde, the simplest but most abundant of the aldehydes

- is harmful to health, environment, ...
- HCHO is an **important indicator of hydrocarbon emissions and photochemical activity**

HCHO sources

- oxidation of Methane provides constant HCHO source
- tropospheric NMHC emissions
- biomass burning
- fossil fuel combustion

HCHO sinks

- reaction with OH
- photolysis (<400 nm)

Data retrieval

- Differential Optical Absorption Spectroscopy (DOAS) yields slant columns = averaged absorption along all contributing light paths
- Conversion to vertical columns using air mass factors (AMF) calculated by radiative transfer model SCIATRAN (Rozanov et al.)
- for satellites: constant background between 200 and 230°E assumed (normalisation)
- from MAX-DOAS observations profile retrieval possible

The Global View

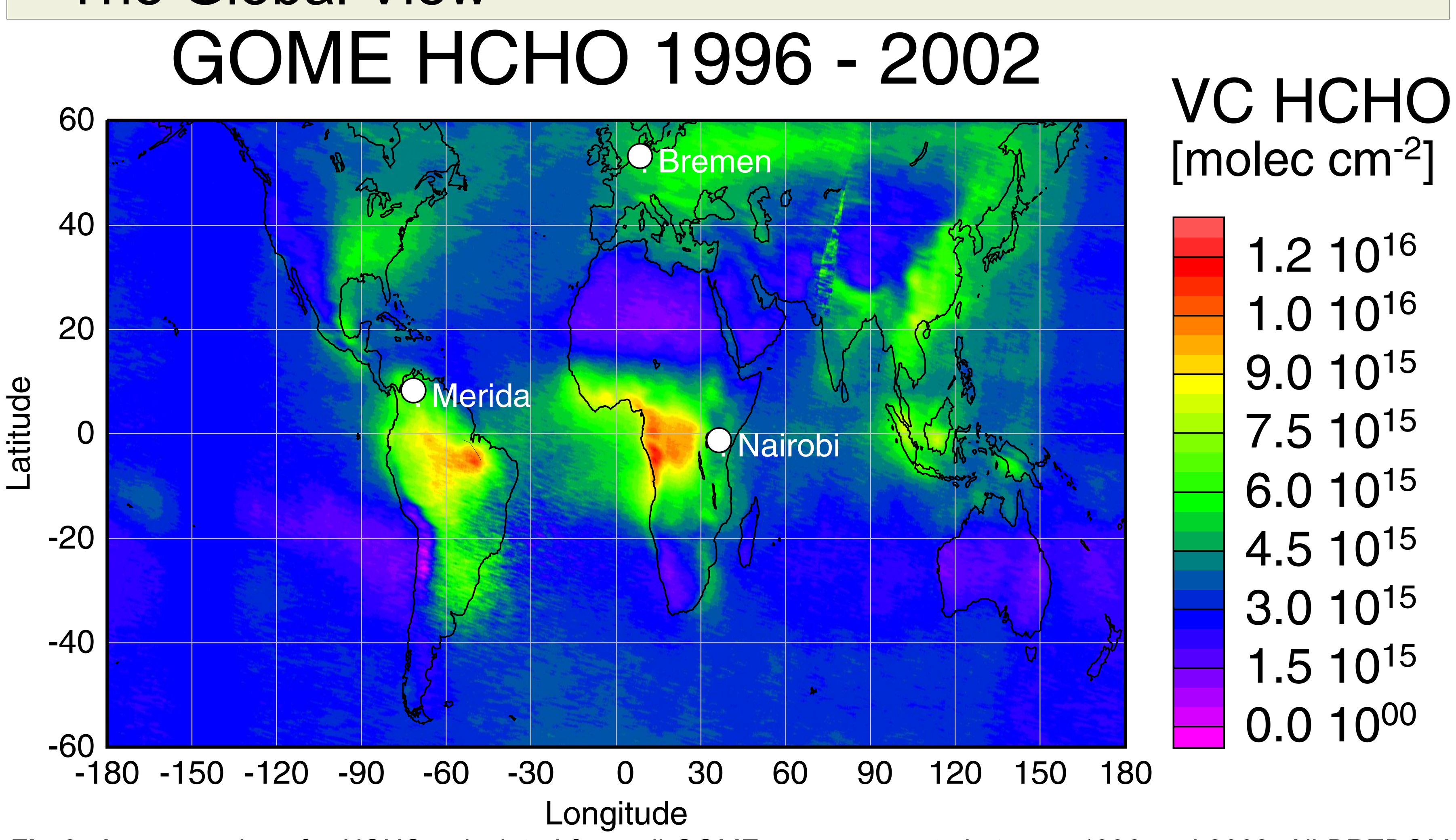
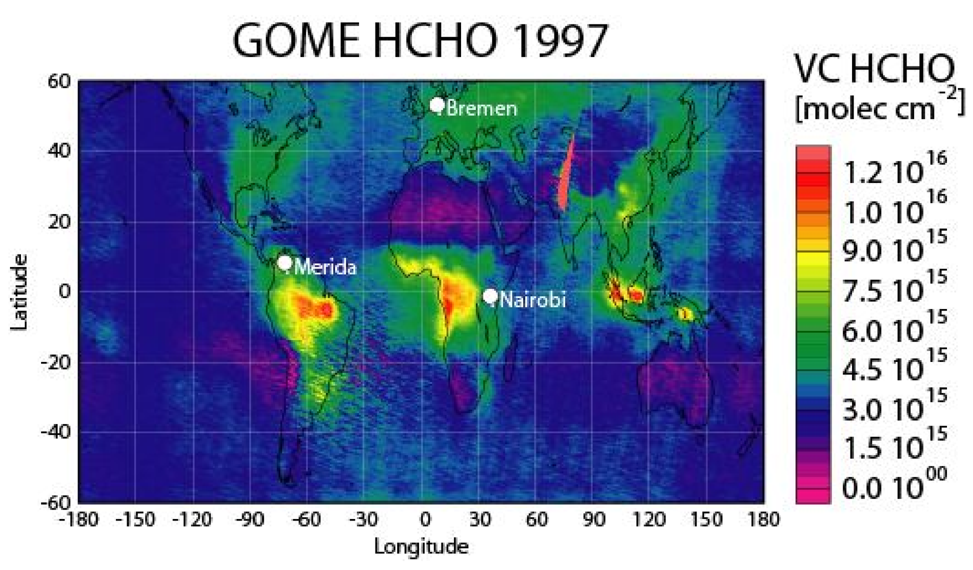
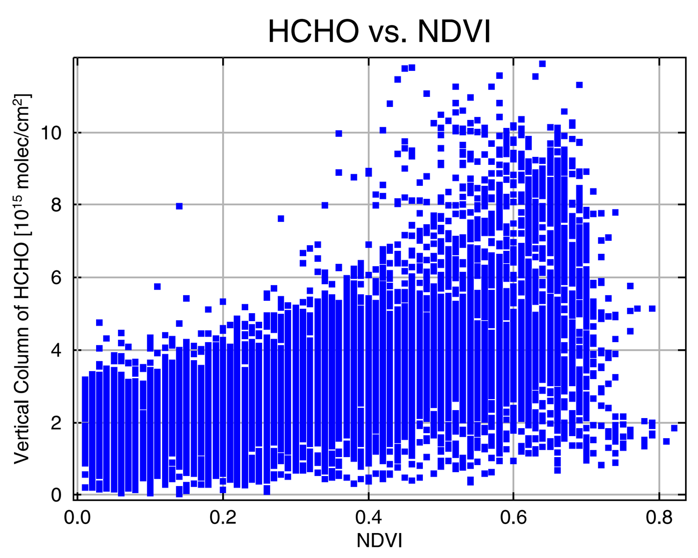
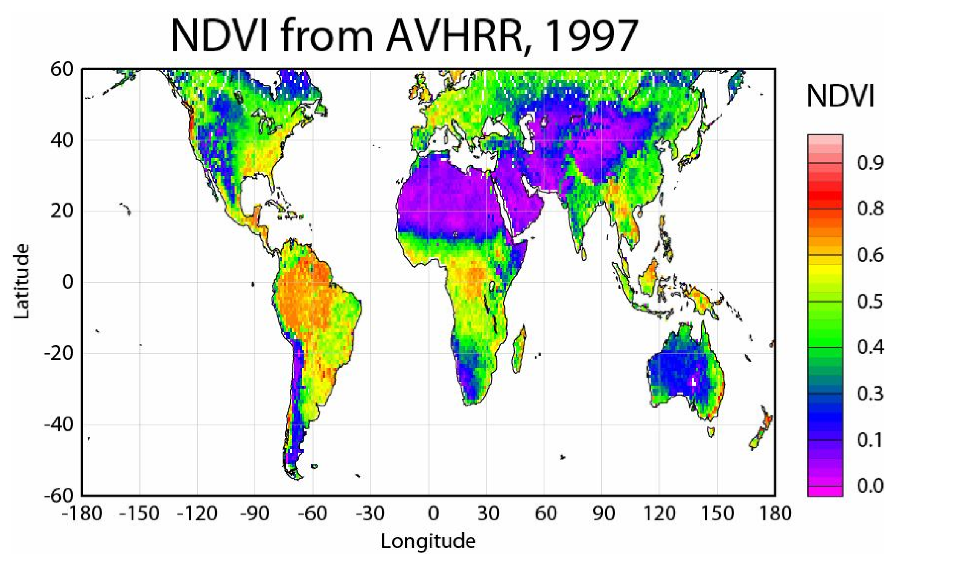


Fig 6: Average values for HCHO calculated from all GOME measurements between 1996 and 2002. All BREDOM stations for latitudes less than 60° are tagged.

- highest values of HCHO in regions with high normalised difference vegetation index calculated from visible and near-infrared channel of AVHRR
- in 1997 very high values of HCHO above Indonesia due to abnormal biomass burning (El Nino year)
- small impact of industry on total HCHO column







Figs 8-19: Comparison between GOME and NDVI data for 1997. GOME satellite data have been gridded to the NDVI resolution for the correlation plot . The correlation index is 0.66.

Experiments

GOME and SCIAMACHY satellite UV/vis instruments

- on sun-synchronous orbits
- global coverage within 3 (6) days
- spatial resolution 320x40 (60x30) km^2

Bremian DOAS Network for Atmospheric Measurements (BREDOM)

- High-sensitivity ground-based MAX-DOAS-instruments for stand-alone operation
- Zenith-sky and horizon (off-axis) viewing mode
- Two tropical stations (Nairobi and Merida)

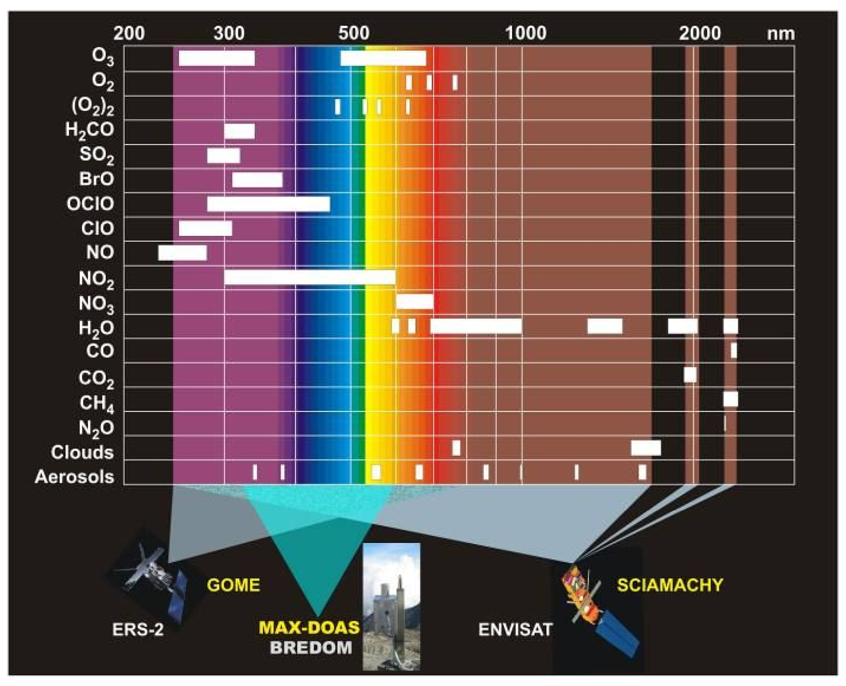


Fig 1: Spectral coverage of instruments used in this study.

Validation and Comparison

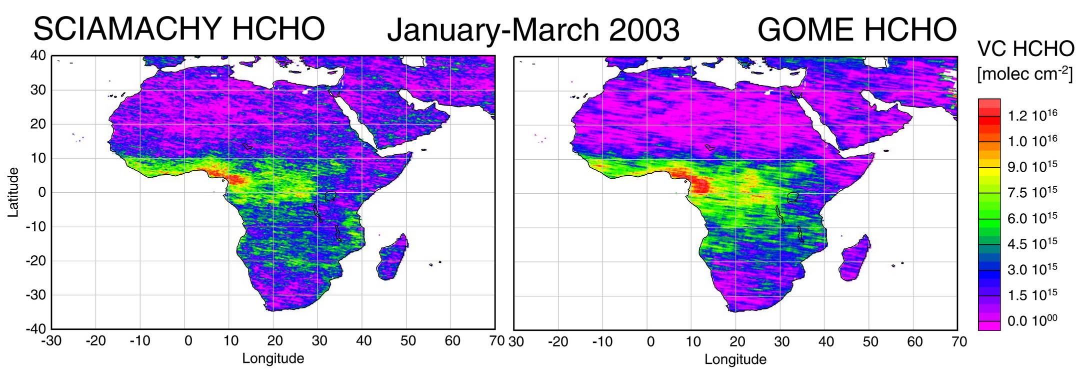


Fig 2: Comparison between GOME and SCIAMACHY. Better spatial resolution for SCIAMACHY, but bias to higher latitudes.

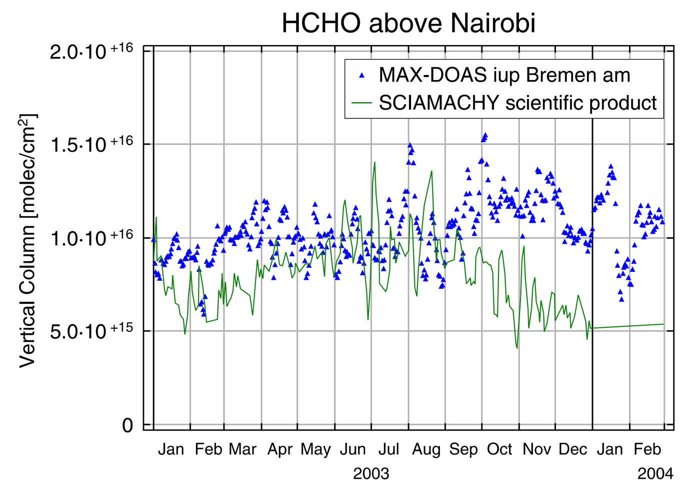
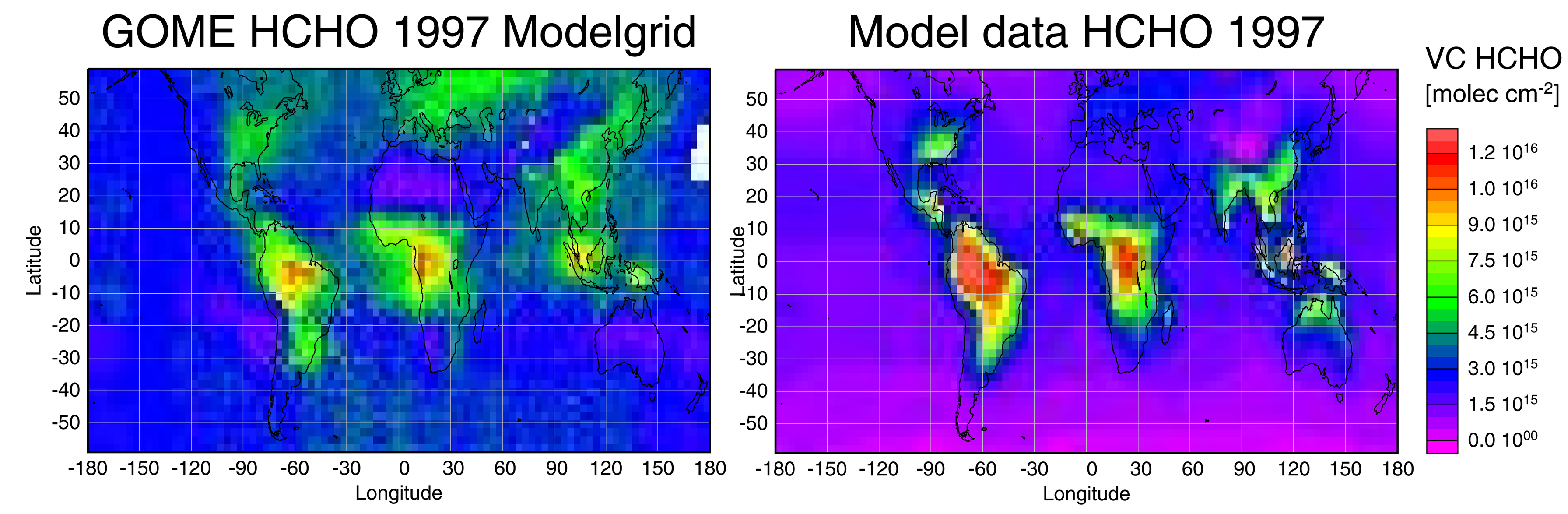


Fig 3: Comparison between GOME and MAX-DOAS data above Nairobi. Discrepancy in late 2003 probably due to wrong assumptions in radiative transfer modelling

- GOME data selected for SCIAMACHY nadir measurements
- ground-based values compared to satellite observations within 500 km radius



Figs 4-5: Comparison between GOME and model data for 1997. Satellite data have been gridded to the model resolution. Observations yield higher values above the oceans and smaller above the tropics.

- model data from LMDz-INCA (LSCE, CNRS-CEA, Service d'Aéronomie du CNRS, Laboratoire d'Optique Atmosphérique) a coupled climate-chemistry- aerosol global model
- Standard version for tropospheric ozone calculation including the methane oxidation cycle and NOx (23 chemical tracers).
- Tropospheric chemistry with NMHCs included

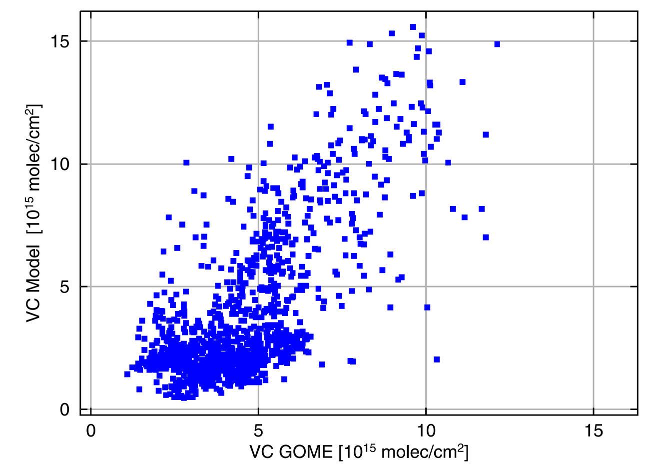


Fig 7: Correlation plot for model and GOME data in 1997. Correlation index 0.72, slope 1.1.

Conclusions

- continuous GOME nadir measurements of HCHO since July 1995
- SCIAMACHY HCHO available, but poorer quality at high latitudes
- agreement between different instruments reasonable at low latitudes
- Biomass Burning is a source, but not the main source
- the overall pattern of HCHO agrees well with the vegetation index
- industry and traffic have a minor impact
- biogenic (isoprene) emissions **major** source for HCHO
- trend analysis difficult, but seasonal variation captured well

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