TROPOSPHERIC O_3 OVER INDONESIA DURING BIOMASS BURNING EVENTS MEASURED WITH GOME (Global Ozone Monitoring Experiment) AND COMPARED WITH TRAJECTORY ANALYSIS

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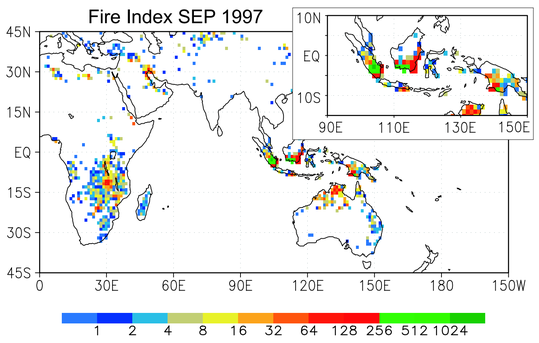
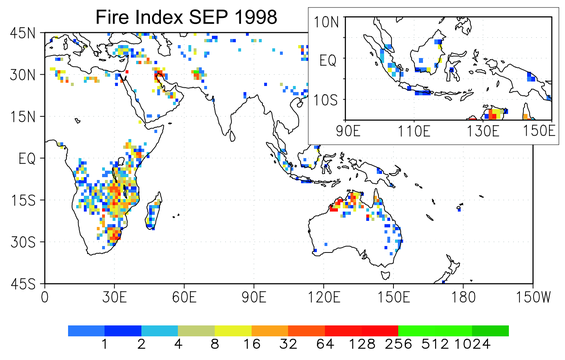
Introduction

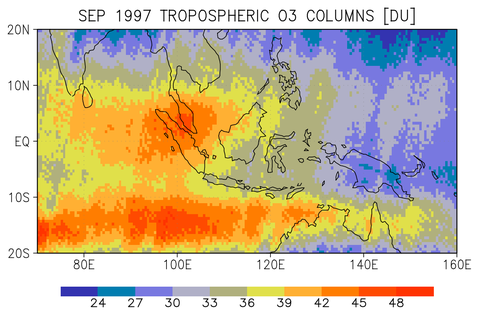
During the dry season, biomass burning - detected by the Along the track Scanning Radiometer (ATSR) (see Fig. 1) [Arino, 1997] - is an important source of ozone (O_3) precursors for the tropical troposphere in Indonesia and northern Australia. As GOME [Burrows et al. 1999 and 2000] is a nadir viewing instrument, both tropospheric and stratospheric absorptions contribute to the measured signal. The serve drought conditions during El Niño in September 1997 lead to a strong increase of tropospheric O_3 up to 50DU (Dobson Units) [Levine, 1999] , whereas during La Niña in September 1998 tropospheric O_3 columns up to 30 DU were observed by GOME (see Fig. 2).

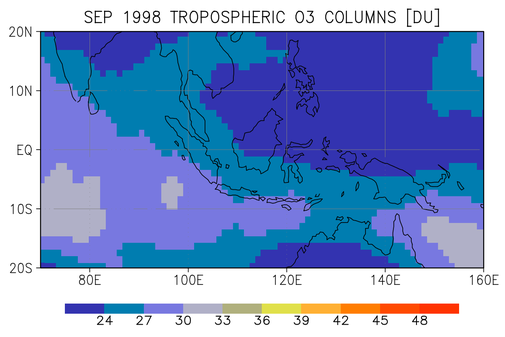




Figs. 1 Fire index as derived from ATSR hotspot data for September 1997 and September 1998.

The transport analysis with Traj.x, developed at the University of Bremen, Germany shows that this amount of tropospheric O_3 is due to biomass burning taking place both in September 1997 and September 1998 in northern Australia. To account for the chemistry goining on in the the airparcels and to evaluate how much O_3 precursors were emitted during the September 1997 fire episode a photochemical box model BRAPHO (BREmen's Atmospheric PHOtochemical boxmodel) is applied.





Figs. 2 Monthly mean tropospheric vertical columns of O_3 (given in DU (Dobson Units) as retrieved from GOME measurements performed in September 1997 and September 1998.

Results

The transport analysis of emissions from all the biomass burning areas (Australia, Africa and from the Indonesian region itself) shows the qualitative influence of each of the emission processes on the Indonesia region for September 1997/1998. Emissions from Australia are lifted up by convection or transported into the Indonesia region at lower altitudes whereas emissions from Africa raise up into the upper troposphere and underly long range transport. Polluted air masses from Indonesia stayed relatively local caused by the unusual meteorological conditions. Due to the fact that no trace gas measurements were performed during September 1997 over Indonesia, the model is initialised by airborne measurements conducted during the TRACE-A (Transport and Atmospheric chemistry near the Equator-Atlantic) campaign. The best agreement between the results of GOME data (see Fig. 3, tropospheric O_3) and model output concerning the tropospheric column amounts and the spatial distributions of O_3 , NO_2 (nitrogen dioxide) and HCHO (formaldehyde) [Ladstätter-Weißenmayer et al., 1998] is achieved when applying the 20-fold VOC (Volatile Organic Compounds) concentration and a 20% increase of methane as initialisation of the chemistry model (see Fig. 4).

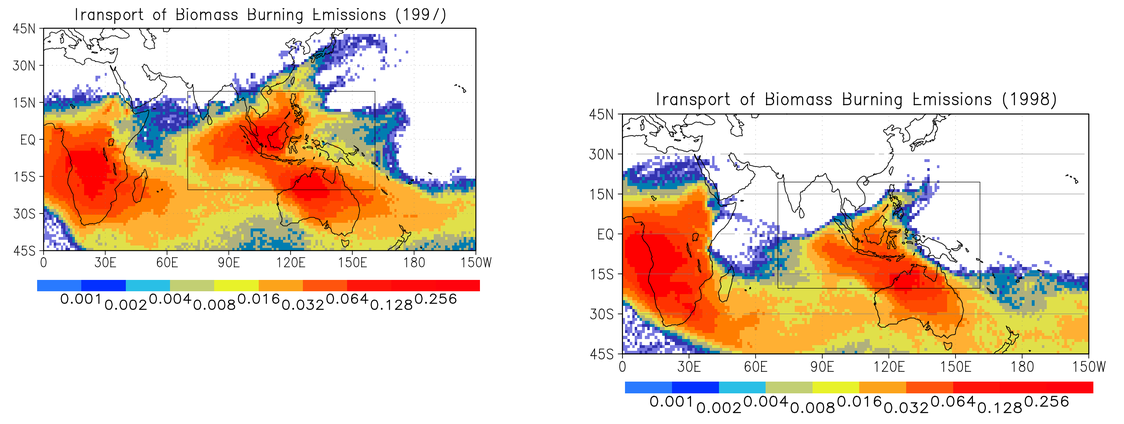


Fig. 3. Trajectory density of air masses beinig released from biomass burning in Africa, Australia and Indonesia for September 1997 and 1998.

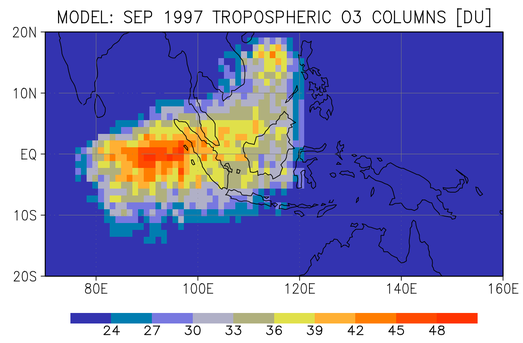


Fig. 4. Tropospheric column of ozone (background of 21 DU is already added) in DU.

Conclusions

During El Niño strong increase of tropospheric O_3 was observed by GOME, whereas during La Niña the tropospheric vertical column amount is close to background conditions. Trajectory analysis shows that emissions from Africa do not reach Indonesia and no significant increase of tropopsheric O_3 caused by air pollution from Australia can be observed over Indonesia. On the basis of this joint transport and chemistry analysis a stationary net production of 3.1 Tg of tropospheric O_3 for the burnt area over Indonesia in September 1997 was calculated. Thus these fires were a significant source of gaseous emissions to the local, regional and global atmosphere.

References

Arino, O., ESA Fire Product, Proceedings of the 7th ISPRS conference on Physical Measurement and Signatures in Remote Sensing, Courchevel, 1997.

Burrows, J. P. et al., The Global Ozone Monitoring Experiment (GOME): Mission Concept and First Scientific Results, *J. Atm. Sciences*, 56, 151-175, 1999.

Burrows, J. P. et al., Satellite observations of tropospheric and stratospheric gases, in: Chemistry and Radiation Changes in the Ozone Layer, eds. C. Zerefos et al., 301-329, *Kluwer Academic Publisher*, 2000.

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Duncan, B. N., et al. Indonesian wildfires of 1997: Impact on tropospheric chemistry, *J. Geophys. Res.*, 108, 15, doi:10.1029/2002JD003195, 2003.

Ladstätter-Weißenmayer A. et al., Biomass burning over Indonesia as observed by GOME, *Earth Obs. Quart.*, 58, 28-29, 1998.

Levine, J. S., The 1997 fires in Kalimantan and Sumatra, Indonesia: Gaseous and Particulate emissions, *J. Geophys. Res. Lett.*, 26, 815-818, 1999.

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