The use of SCIAMACHY data to study the impact of biomass burning pollution over Portugal in August 2003

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Introduction

During the first fortnight of August 2003 a heatwave occurred over Europe. The intense heatwave (T~40°) was directly responsible for a steep increase of mortality rates throughout Western Europe. In Portugal dozens of homes have been destroyed and 26,000 hectares of forest (of brush and trees) blackened in the wildfires (1,700 forest fires). During biomass burning events high amounts of the tropospheric trace gases formaldehyde (HCHO), carbon monoxide (CO), nitrogen dioxide (NO_2) and ozone (O_3) can be observed with SCIAMACHY (SCanning Imaging Absorption Spectrometer for Atmospheric ChartographY), [Burrows et al., 1995; Bovensmann et al., 1999] a spectrometer designed to measure sunlight, transmitted, reflected and scattered by the earth atmosphere. SCIAMACHY is operating in different viewing geometries (limb, nadir and occultation) and yields the amounts and distribustion of O_3, NO_2, BrO, OClO, SO_2, HCHO, CO, CO_2, CH_4 and H_2O.

Fires over Portugal

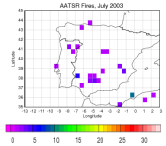
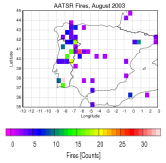
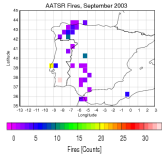


Fig1a: Only some fires over Portugal in July 2003.

The AATSR measurements show only some fires in e.g. July 2003 (Fig. 1a) and an increase of the fire counts in the months of August and September 2003 (Figs. 1b/c).

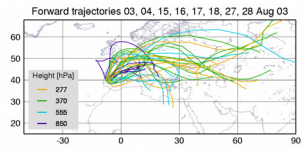


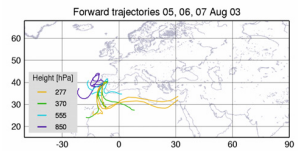


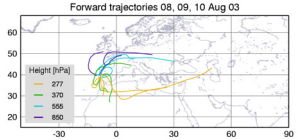
Figs.1b/c: Increase of fire counts in the months of August and September 2003.

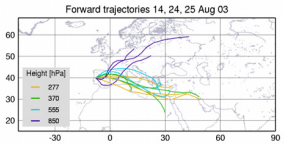
Transport of air masses

To qualitatively assess the transport of the emissions from the fires over Portugal, a forward trajectory analysis using Traj.x, the IUP Bremen trajectory model [Meyer-Arnek et al., 2005] has been carried out. ERA-40 data from the ECMWF (European Centre for Medium Range Weather Forecasts) are used as meteorological input. Clusters of forward-trajectories are released over Portugal at 0h, 6h, 12h and 18h each day of August 2003 at altitudes between 850 and 277hPa and are followed forwards in time for 5 days Figs. 2a-d).





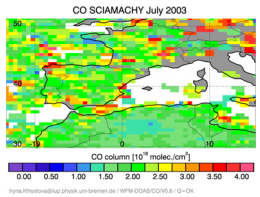


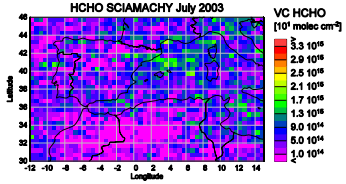


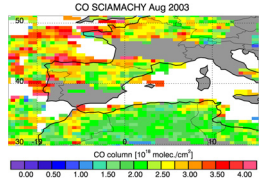
Figs.2a-d: Transport of air masses based on forward trajectory calculation in August 2003.

CO, HCHO and NO_2 from SCIAMACHY

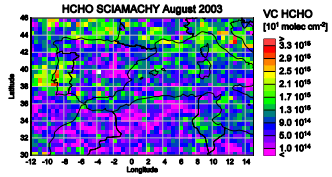
During the intense fires in August 2003 compared to July 2003 an increase of both trace gases CO (Figs. 3a/b) and HCHO (Figs. 4a/b) can be observed over Portugal from SCIAMACHY. During these biomass burning events besides CO [Buchwitz et al., 2007] and HCHO [Wittrock et al., 2006] an increase of the tropospheric trace gas NO_2 [Richter et al., 2002] as expected can be observed from SCIAMACHY. Figure 5 shows the tropospheric enhancement of NO_2 for the regions over Spain and over Portugal normalised on the tropospheric amounts under situations without fires e.g. in June and July 2003.







Figs.3a/b: Increase of tropospheric CO amount during the intense fire period in August 2003.



Figs.4a/b: Increase of tropospheric HCHO amount during the intense fire period in August 2003.

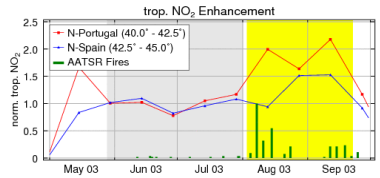


Fig. 5: Tropospheric NO_2 enhancement as observed from SCIAMACHY during the biomass burning events in August and September over Spain and Portugal 2003.

Conclusions and outlook

Fires over Portugal in August 2003 lead to an increase of the amounts of the troposheric trace gases CO, HCHO and NO_2 compared to July 2003 where almost no fires were observed. That means an increase for CO, HCHO and NO_2 of factors of 1.5, 2.6 and 1.9 respectively were observed by SCIAMACHY (Tab. 1) for the monthly mean values.
Similar results can be seen from ground based measurements carried out in Sonega (Lat 37.5°N, Long 08.4°W, www.qualar.org). From these measurements the calculated value of the ratio of O_3/CO is around 0.26. Based on this ratio 20.4 DU (Dobson Units) for the time period without and 30.1 DU with fires can be estimated for the tropospheric column of O_3. These values will be re-calculated that means a quantitative view of the impact of the Portugal fires with respect to tropospheric O_3 will be evaluated with the chemical boxmodel BRAPHO (BREmen's Atmospheric PHOtochemical boxmodel) along the trajectories [Meyer-Arnek et al., 2005].

Tab.1: Monthly mean values of the trace gases CO, HCHO, NO_2 and O_3 including the factor of their increase during the fire events in August 2003.

Trace Gas	July (molec/cm²)	August (molec/cm²)	$\Delta_{August/July}$
CO	2.1×10^{18}	3.1×10^{18}	1.5
HCHO	4.2×10^{15}	11×10^{15}	2.6
NO_2	1.3×10^{15}	2.5×10^{15}	1.9
$O_{3\,cal.}$ (DU)	20.4	30.1	1.5

Acknowledgements

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see also: www.iup.physik.uni-bremen.de/doas