Aircraft observations of trace gas correlations during the MINOS 2001 campaign – case studies on the origin of air masses

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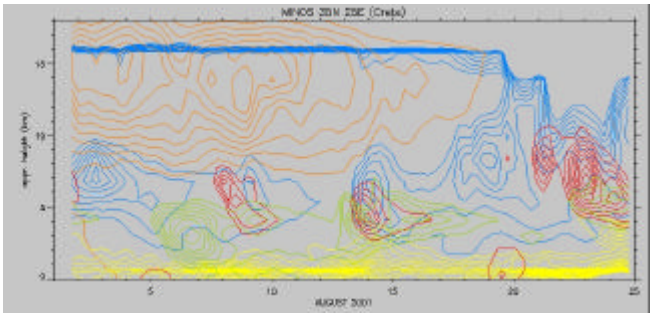
MOTIVATION

- During the Mediterranean Intensive Oxidant Study (MINOS) extensive measurements of trace gases and aerosol parameters were performed on board the DLR research aircraft Falcon over the eastern Mediterranean out of Heraklion, Crete, in August 2001. Briefly, the objective of the campaign was to study the main processes involved in the Mediterranean pollution build-up (*http://www.mpch-mainz.mpg.de/~reus/minos).*
- Based on ECHAM4 (T63) model runs using an inert tracer (IMAU) the overall picture of the air mass origins reveals a strong influence of the European boundary layer tracer (yellow). In the free troposphere a layer of stratospheric origin (blue) is mixed with North American (red) and North Atlantic (green) air. During most of the campaign the upper tropospheric air was mainly influenced by Asian Monsoon outflow (orange).
- In this study the correlations between $\Delta O_3/\Delta NO_y$, $\Delta O_3/\Delta CO$, $\Delta CO/\Delta NO_y$, and $\Delta NO_x/\Delta NO_y$ were calculated in air masses of different origins.



EXAMPLE 1

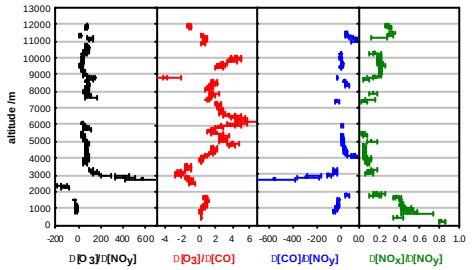
Altitude profiles of the trace gas correlations over the northern Aegaen sea and corresponding 10 day back trajectories on 3 August 2001.

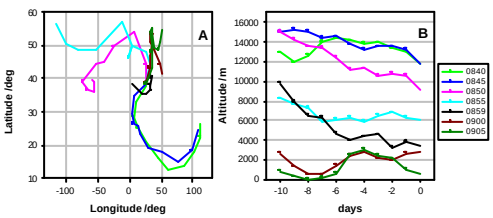
In the **boundary layer** (BL) fresh emissions from the north-east can be identified by high $\Delta NO_x/\Delta NO_y$ ratios and a negative slope of $\Delta O_3/\Delta NO_y$. The $\Delta O_3/\Delta CO$ correlations reveals typical BL values below 1. In addition, the good correlation between $\Delta CO/\Delta NO_y$ indicates common sources for these two species.

Just below **3 km** altitude the $\Delta O_3/\Delta NO_y$ ratio increases sharply in connection with negative $\Delta O_3/\Delta CO$ and $\Delta CO/\Delta NO_y$ correlations. This strong indication for stratospheric air masses is confirmed by the trajectory ending at approximately 3 km altitude (0859 UTC) which originated from the upper troposphere at ≈ 10 km.

Between **6 and 7 km** altitude enhanced $\Delta O_3/\Delta CO$ is observed, along with no correlation between the other species. This indicates O_3 production during the transport of the air parcel from north-western regions.

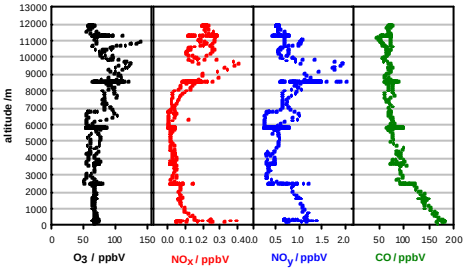
Other interesting features are the relatively constant and low $\Delta O_3/\Delta NO_y$ and $\Delta O_3/\Delta CO$ ratios indicating boundary layer air, together with $\Delta NO_x/\Delta NO_y$ ratios exceeding 0.2 at approximately **11-12 km** which, according to the trajectories, can be attributed to Asian Monsoon outflow.

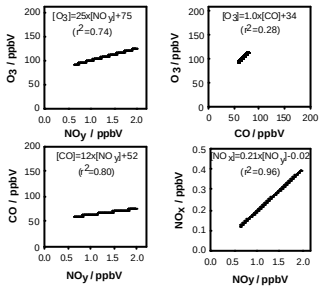




EXAMPLE 2

Altitude profiles of the trace gas mixing ratios observed on 17 August 2001and trace gas correlations in the plume between 9 and 10 km altitude carrying North Atlantic and North American air.





OVERVIEW AND COMPARISON

	MINOS		OTHER CAMPAIGNS		
	$\Delta[O_3]/\Delta[NO_y]$	Origin	$\Delta[O_3]/\Delta[NO_y]$	Area	Reference
PBL	10 ± 1 (0.91) 7 ± 1 (0.85) 10 ± 1 (0.56) 12 ± 1 (0.51) 8 ± 1 (0.51)	West Europe West Europe East Europe East Europe East Europe	6-10 (0.73-0.9) 15.9 (0.99) ~ 10 no corr. ~ 11 10	Israel, aged pollution Israel, aged pollution US, Maine marine air US, aged pollution US continental air	Peleg et al. 1994 Tov et al. 1997 Buhr et al. 1996 Hübler et al. 1992 Trainer et al. 1993 Olszyna et al. 1994
FT	22 ± 1 (0.77) 66 ± 4 (0.89) 72 ± 6 (0.54) 37 ± 1 (0.75) 49 ± 2 (0.81) 40 ± 2 (0.81)	East Europe East Europe North Atlantic West + East Europe N. America + N. Atlantic N. America + N. Atlantic	~ 33 ~ 22 ~ 85 185 158-173 167-258 83	New Mexico Alaska, haze layer Mt., aircraft obs. MLO Alaska, background US marine air New Mexico	Ridley et al. 1994 Wofsy et al. 1992 Hübler et al. 1992 Atlas et al. 1996 Wofsy et al. 1992 Hübler et al. 1992 Ridley et al. 1994
UT	44 ± 1 (0.94) 25 ± 4 (0.74) 102 ± 5 (0.93) 56 ± 2 (0.79) 72 ± 2 (0.80)	N. America + N. Atlantic N. America + N. Atlantic N. America + N. Atlantic Morocco Outflow Morocco Outflow	130±3.4 (0.95)	England	Lerner et al. 1994
LS	135 ± 7 (0.75)	Lower Stratosphere	~ 185 (0.97) 169-258 276-317 ~ 208-250 ~ 208	37-57 deg N > 60 deg N > 60 deg N 40-60 deg N NLO 170-318 ppbV	Singh et al. 1997 Zieres et al. 2000 Zieres et al. 2000 Weinheimer et al. 1993 Chang et al. 1996
S			~ 1800 ~ 338	≤ 10°N/S, 58-78 hPa ≤ 10°N/S, 58-78 hPa	Fahey et al. 1990, Murphy et al. 1993

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