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Dust–air pollution dynamics over the eastern Mediterranean

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The Eastern Mediterranean is subject to intercontinental transport of air pollution from Europe, North America and Asia, which increases the loadings of aerosols and precursor gases during the usually dry summer period and the lack of sufficient precipitation. Especially the loading of acids such as H_2SO_4 and HNO_3 are enhanced, as a result of the high insulation and the resulting photo-oxidation of the ubiquitous gaseous air pollutants (e.g., NO_x and SO_2 of ship and road traffic, waste and biomass burning).

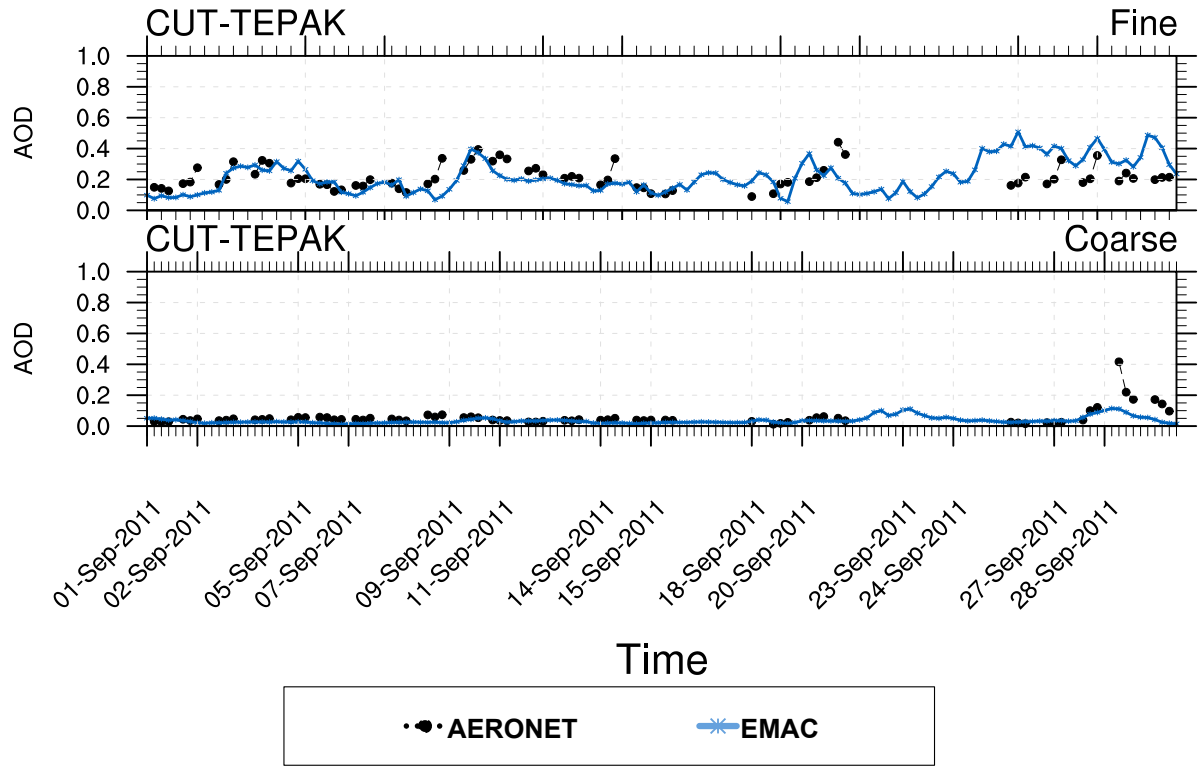

Figure 1: shows the fine and coarse mode AOD for the AERONET observations and the EMAC model results for the CUT-TEPAK station, Cyprus. The figure reveals that the fine mode AOD is dominating the total AOD during September 2011. The model compares well with the AERONET observations, especially during the dust outflow-2 on 28 September. AERONET shows an AOD of 0.4 for the coarse mode contribution to the total AOD of 0.6, which is underestimated by EMAC mainly as a result of the steep gradient of the dust load. The dust outflow-2 was predicted to be slightly more east (see discussion of the LIDAR results in the main text).

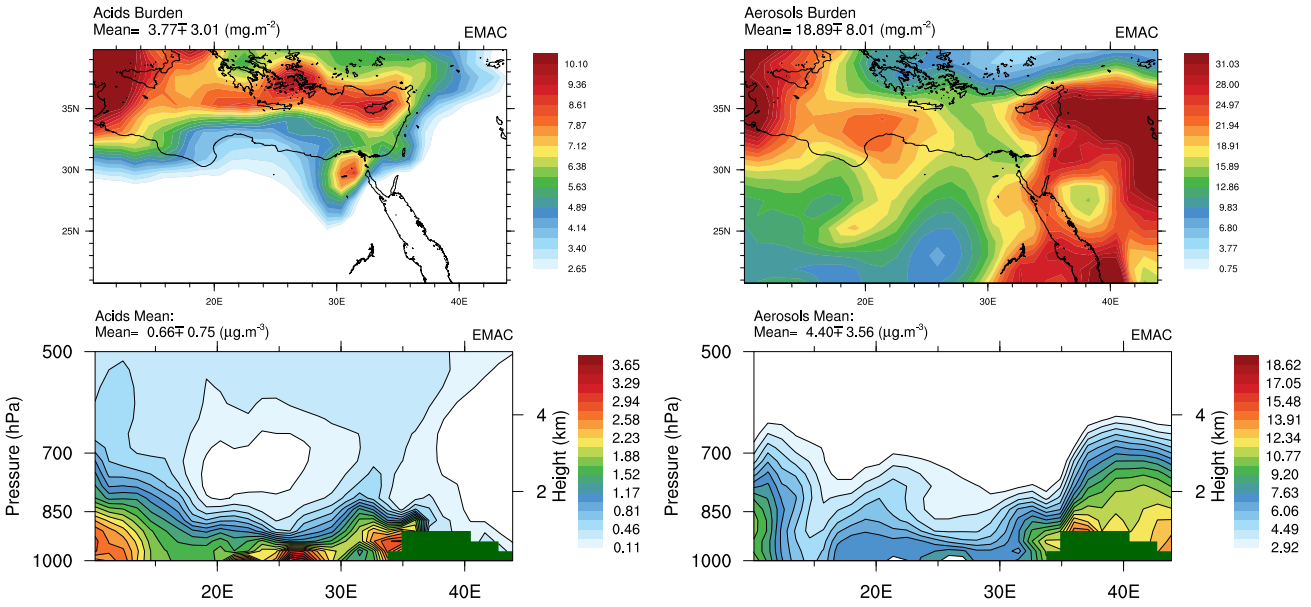

Figure 2: shows enhanced air pollution over the EM that causes dust-air pollution interaction according to EMAC model results. The upper panel shows an indicative air pollution loading, the lower panel the corresponding cross section passing through CUT-TEPAK station. The air pollution loading represents the vertical integral (burden) of the mass concentration $[mg\ m^{-2}]$ of (left) total inorganic acids ($HCl+HNO_3+H_2SO_4$) that are present in the gas phase, maintaining gas-aerosol equilibrium, (right) the corresponding lumped aerosol burden ($SO_4^{2-}+HSO_4^-+NO_3^-+NH_4^+ +H_2SO_4$); both average over 20^{th} September - 1^{st} October 2011. The pollution loading basically covers the northern part of the EM and decreases eastwards. Figure 2 is consistent with the back trajectories (Fig. 14) shown in the text, which support the north-southeast air pollution gradient that seems to be typical for the Mediterranean basin.

Table 1: Long-term average (arithmetic mean, linear scale) of the EMAC model results versus station observations (2000-2010) for major aerosol properties: total aerosol optical depth (AOD) [−], total particulate (aqueous+solid) matter (PM), lumped anions sulfate, nitrate, chloride, and cations ammonium, sodium, potassium, magnesium and calcium; with PM and ion concentrations in $[\mu g/m^3(air)]$ and NPoints, the number of station data used for the statistics. The results are part of a comprehensive model analysis that will be presented separately and which will include additional statistical measures on a logarithmic scale, which are less sensitive to the maximum values.

	AOD	PM		SO_4^{2-}		NO_3^-		Cl^-	
Stat	AERONET	EMEP	CASTNET	EMEP	CASTNET	EMEP	CASTNET	EMEP	CASTNET
$Mean_m$	0.12±0.43	14.72±17.41	NA	2.05±1.69	1.85±0.95	1.55±1.36	1.06±0.81	0.40±0.62	0.12±0.30
$Mean_o$	0.17±0.41	11.82±11.13	NA	2.07±2.04	2.69±2.27	2.12±3.45	0.86±1.23	1.23±2.34	0.16±0.67
NPoints	965353	47669	NA	131052	44961	79246	44960	21853	30137

	NH_4^+		Na^+		K^+		Mg^{2+}		Ca^{2+}	
Stat	EMEP	CASTNET	EMEP	CASTNET	EMEP	CASTNET	EMEP	CASTNET	EMEP	CASTNET
$Mean_m$	1.16±1.12	0.95± 0.57	0.33±0.54	0.12±0.29	1.12±0.09	0.12±0.07	0.09±0.16	0.03±0.08	0.22±0.84	0.42±2.11
$Mean_o$	1.12±1.32	0.97± 0.80	1.05±2.00	0.19±0.43	0.09±0.18	0.07±0.06	0.17±1.41	0.06±0.06	0.17±0.61	0.25±0.30
NPoints	66560	44951	26510	44881	21311	44864	18039	44883	23904	44883