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Volumes and Issues
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Title and Author Search
Online Library ACPD
Alerts & RSS Feeds
General Information
Submission
Review
Production
Subscription
Comment on a Paper

Volumes and Issues Contents of Issue 16

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Aerosol direct radiative effect in the Po Valley region derived from AERONET measurements

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Abstract. The aerosol direct radiative effect (ADRE) affecting the Po Valley and the adjacent North Adriatic Sea is studied using 10-year series of measurements collected at two AERONET sites located in the western part of the Valley (Ispra), and on a platform (AAOT) offshore Venice. This region is characterized by a high, mostly continental, aerosol load with comparable average aerosol optical thickness τ_a at both locations (0.21 at 500 nm) and more absorbing aerosols at Ispra. A dynamic aerosol model accounting for the changes in scattering phase function with τ_a is used for radiative transfer calculations, together with boundary conditions representative of terrestrial and marine surfaces. A sensitivity analysis allows the construction of an error budget for the daily ADRE estimates, found to be of the order of 20% and mostly due to uncertainties on aerosol single scattering albedo and τ_a. The daily radiative efficiencies, normalized by τ_a at 500 nm, increase from December to June, from −17 to −24 W m^{-2} $\tau_a{}^{-1}$ at top-of-atmosphere (TOA) and −33 to −72 W m^{-2} $\tau_a{}^{-1}$ at surface for the Po Valley, and from −15 to −32 (TOA) and −35 to −65 W m^{-2} $\tau_a{}^{-1}$ (surface) for the AAOT site. The average of log-transformed ADRE for TOA, surface and atmosphere are −5.2, −12.2 and +6.8 W m^{-2} for the Po Valley case, and −6.5, −13.0 and +6.5 W m^{-2} for the AAOT site but these values can be much higher for individual days. Concurrent clear-sky days give indications on the regional atmospheric heating spatial gradients. Differences between the atmospheric ADRE at the two locations average 6.3 W m^{-2} with a gradient positive towards the inner valley in 65% of the cases. This study confirms the importance of duly considering the radiative impact of aerosols on the regional climate.

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