

Update on the Chemistry-Aerosol Mediterranean Experiment (ChArMEx, 2010-2020)

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The Chemistry-Aerosol Mediterranean Experiment (ChArMEx, <https://charmex.lsce.ipsl.fr>) is a large multi-lateral federative research project on atmospheric chemistry in the Mediterranean region and on its impacts on the regional climate, air quality and human health, and marine biogeochemistry. It is part of the multidisciplinary regional programme MISTRALS (Mediterranean Integrated Studies at Regional and Local Scales; <http://mistrals-home.org>) initiated in 2010 and planned to continue until 2020. We briefly summarize activities related to aerosol sciences during ChArMEx first experimental phase that included four regional airborne campaigns focused on the western basin in summer 2012, 2013 and 2014 and an additional one in August 2014 along a west-east transect. Surface stations have been established or augmented for enhanced observation periods of 2-3 years, and long-term remote sensing products and 3-D modelling have been widely used.

A glimpse of results

The background air quality during the long Mediterranean dry season is poor and mainly affected by long-range transport. Large particles are mainly contributed by mineral dust but not PM_{2.5}, especially in the north of the basin. Aircraft and drifting balloons suggest the unexpected persistence of coarse dust particles (> 15-20 µm in radius in Saharan plumes) and little change in their light scattering and absorption properties compared to those near source regions. Apart from sea-salt, non-continental sources appear important for black carbon in the north-western basin and Sicily channel region due to ship traffic, and for nucleation due to marine biogenic iodine-containing gas precursors. Highly oxidised organic aerosols are a major component of the fine particles in the western basin, among which secondary particles from biogenic precursors play an important role in summer. The fine particle background is relatively homogeneous at the regional scale.

Results show the occurrence of very long-range transport (> 1 week) over the Mediterranean of very polluted or very clear air masses from North America, tropical Africa, and southern Asia.

In terms of aerosol-climate interactions, results based on an original satellite-model blended, long-term time series of the 3-D monthly distribution of the main aerosol types show the important role of aerosol direct radiative forcing on the regional water cycle and climate. They show the need for ocean-atmosphere coupled modelling to account for the aerosol effect on sea surface temperature and evaporation.

In terms of dust deposition, fluxes have decreased by a factor of 5 to 10 compared to the 1980's and 90's. A new deposition network shows that deposition is heterogeneous and allows testing dust models.

Perspectives

The proposed roadmap for the 2nd experimental phase of the project includes a new project (CEMBAI) of airborne campaign in the eastern basin on aerosol-cloud interactions, an oceanographic cruise project (PEACETIME) to study the air-sea interface, a regional model intercomparison effort on the recent past, present and future direct radiative and climatic effect of aerosols and impact on the regional air quality. ChArMEx also works at building a regional climate and air quality health impact assessment (ARCHIMEDES), aiming at filling the gaps in our knowledge in the eastern and southern sides of the Mediterranean basin.

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