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Multi-instrumental approach to quantify the aerosol-cloud interactions and its impact on climate (MULHACEN)

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Abstract:

The effect of changes in atmospheric aerosol properties on clouds formation, distribution and radiative properties is the most uncertain component of the Earth´s-Atmosphere energy balance. This uncertainty affects climate model estimates, key for the development of strategic plans for climate change mitigation and for policymakers worldwide. Thus, there is an essential need for understanding aerosol-cloud interaction (ACI) processes and reducing their associated uncertainties in radiative forcing (RF). Clouds and aerosols are closely inter-related through four main chemical, physical, microphysical and dynamical mechanisms. The proposed project is a multi-layer (height- resolved through the troposphere) and multi-sensor (multidisciplinary) comprehensive technique combining the four main mechanisms contributing to the ACI for liquid and ice clouds into one synergistic system of measurements. The novel and unique characteristic of this approach is to provide a description of the individual components contributing to the aerosol direct and indirect effects (ADE and AIE respectively) by use of multiple sensors (remote and in-situ techniques) capable to probe different atmospheric levels. More specifically, MULHACEN aims to be able to separate the meteorologically-induced and aerosol-induced changes in cloud albedo and the consequent more accurate quantification of the aerosol direct and indirect effects. Data integration from the different sensors will be used as main inputs of the latest-generation retrieval method SYRSOC (SYnergistic Remote Sensing Of Cloud) in order to improve the microphysical description of liquid and ice clouds. The combination of the quantified ADE for different degrees of air pollution and sources and the new and more accurate quantification of the AIE by the optimized parameterization will lead to a significantly improved quantification of the total radiative budget by WRF-Chem simulations.

MULHACEN will use the synergy of in- situ and ground-based remote sensing instrumentation for vertical profiles of aerosols and clouds at the The Andalusian Global ObseRvatory of the Atmosphere (AGORA) that is located in Southern Spain and include UGR station (37.16ºN, 3.60ºW, 680 m asl) in the city of Granada and the nearby high mountain site of Sierra Nevada station SNS (37.09º N; 3.38º W; 2550 m asl). AGORA measurements will be complemented by satellite-based remote sensing measurements of aerosols and clouds. MULHACEN will tackle the problem both from the instrumental and methodological sides. The special location of AGORA and the unique combination of the state-of-the-art instrumentation will allow the experimental study of cloud formation for different aerosol types (biomass burning, pollution, mineral dust, etc.).