Annual report 2020 for Med-CORDEX Aerosol FPS

Context

The Aerosol FPS was initiated to better apprehend the regional climatic effect of aerosol over the Mediterranean basin, with scientific questions ranging from exploring the feedback mechanisms to aerosol perturbations, to assessing the impact of aerosol trends in the regional climate change signal. The domain of interest initially defined as the Med-CORDEX region has been now extended to encompass the EURO-CORDEX region as well since the two domains are strongly inter-connected from an aerosol and climatic point of view. The FPS activity is based on different protocols detailed on the wiki page (https://www.hymex.org/cordexfps-aerosol/wiki/doku.php?id=start), involving different modeling options (aerosol prescribed data base vs on-line interactive aerosols) and analysis (event to climatic scales, past period and futur projections).

Scientifc highlights

Aerosol FPS at the November 2019 Med-CORDEX meeting

As part of the last Med-CORDEX meeting, a special session was organized focusing on the aerosol FPS. General presentaions dealing with the importance of including aerosol trends for climate change assessments have been made, as well as more specific group presentations relating individual model results, development or interest to join different protocols. Admitedly the Aerosol FPS have had some difficulties to identify and aggregate many participants in its firts phase, but this meeting showed a growing interest for aerosol related questions within CORDEX community. The meeting also helped to clarify protocol advancements , difficulties and priority to achieve concrete intercomparison analysis.

Aerosol trends and the Euro- Mediterranean Climate change signal

While the majority of Global Climate Models (GCMs) account for these trends, most Regional Climate Models (RCMs) have not considered evolving aerosol and their effect on radiative budget in the CORDEX downscaling of CMIP5 (see Annexe of Gutierrez et al. 2020, for a description of the aerosol representation in CORDEX RCMs to date). This can partly explain difficulties to represent past climate trends in RCM evaluation runs (Nabat et al. 2014) and a part of the climate change signal discrepancy between GCMs and RCMs (Boé et al. 2020) over specific domains such as Europe. In protocol 1.B a multimodel assessment of aerosol trend impact, based on prescribed climatologies, is carried out. So far 6 regional models are involved, and the results are presently being analysed. Figure 1 gives a fresh example of protocol 1.B outcome for the solar surface radiation evolution where most of the RCM simulate an increase of incoming solar radiation, driven in large par by aerosol surface radiative forcing reduction. .

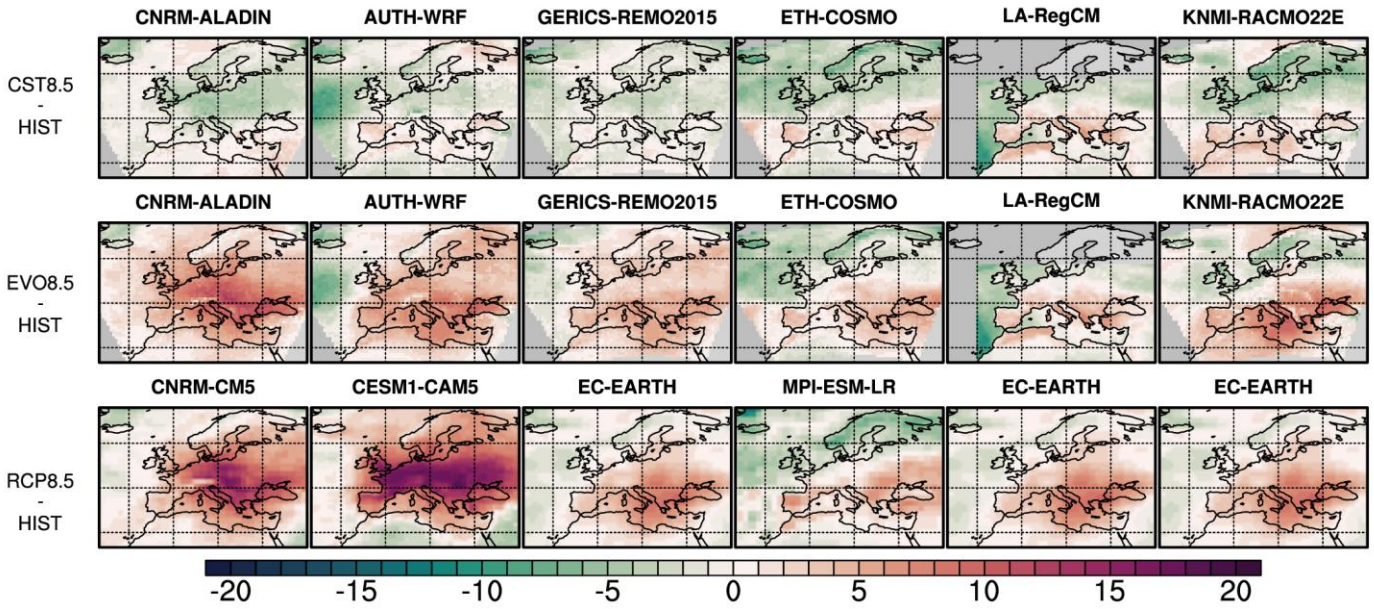

FIGURE 1 . S**olar radiation evolution at the surface for 6 RCMs models between the historical (1971-2000) and futur period (2021-2050) with evolving aerosols (EVO -HIST) and with constant climatology (CST-HIST). Corresponding climate change signal in driving GCMs (RCP8.5 -HIST).**

Intercomparison of on line natural aerosol modelling in RCMS

As part of protocol 2.a, a detailed analysis of natural aerosol processes simulated by RCMs and chemistry transport model is carried out. The study focuses on a three month period (June-August 2013) covering the ADRIMED experiment during which several in-situ observations of aerosol properties have taken place. The case study shows notably intense dust and sea-salt aerosol events over the Euro Mediterranean domain. The intercomparison assess the ability of RCMs participating in protocol 2 to simulate natural aerosol on short time scales, using both observatoins and comparisons with state of the art air quality and meso-scale models. Figure 2 illustrates such a comparison for the primary sea spray aerosol emissions for June 2013.

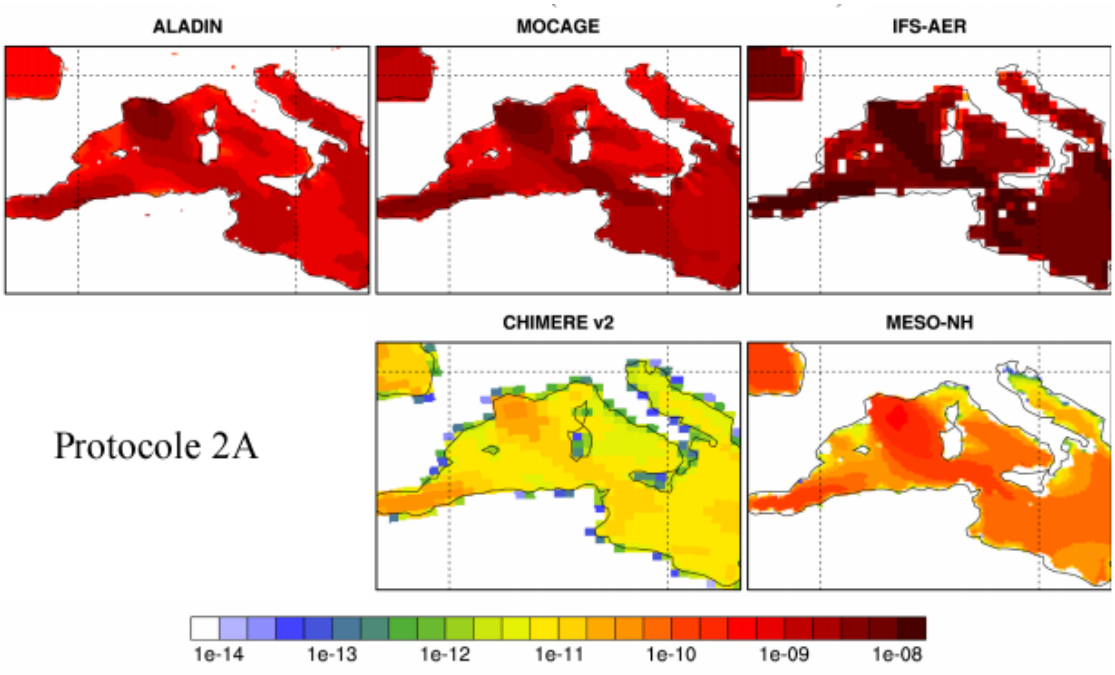

FIGURE 2. Primary Sea Spray Aerosol Emissions simulated by 5 different models during June 2013.

Interactive aerosol climate projections

In protocol 2.c, aerosol interactive modelling is used to investigate change in Euro-Meditteranean aerosol content and the future climate sensitivity to aerosol. Up to know only single model studies have been carried out using this approach as for example in Drugé et al., 2020. Using the CNRM Aladin model and following Shared Socioeconomic Pathways (SSP 1-1.9, SSP 3-7.0 and SSP 5-8.5) anthropogenic emissions scenarios, it is shown that a total AOD decrease between 30 and 40 % over Europe for the three scenarios is foreseen, mainly due to the sulfate AOD decrease (between −85 and −93 %), only partly offset by a nitrate and ammonium particles AOD increase (between +90 and +120 %) and a weak increase of natural aerosol. The resulting direct aerosl radiative forcing decrease explains about 65 % of the annual shortwave radiation change but also about 6 % (in annual average) of the warming expected over Europe by the middle of the century. Regional circulation is also effected showing localised feedback patterns (e.g. over the Iberian Peninsula) involving also semi-drect cloud reponse, and not seen so far in protocol 1.B. For robustness assessment of such regional scale responses it is expected that other RCM with on-line aerosol capabilities join the protocol 2.c in a near future.

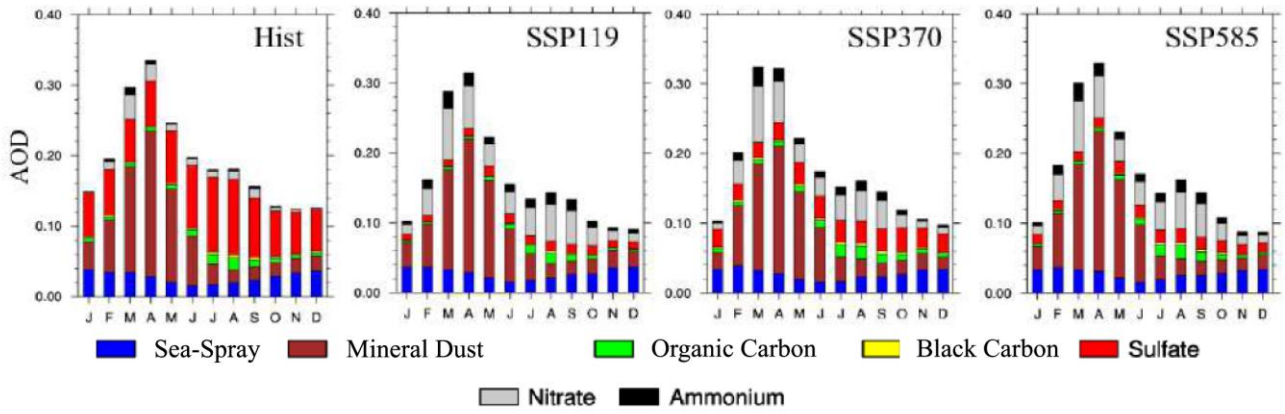

FIGURE 3. Changes in AOD for different natural/anthropogenic aerosol species between futur and historical periods (ALADIN model, Druge et al., 2020).

Aerosol FPS dissemination

The FPS is involved in providing advices and technical guidelines for the use of realistic aerosol climatologies by RCM involved in the next phase of CORDEX (collaboration G. Nikulin). It is expected that the outcome and experience gathered within the Med-CORDEX aerosl FPS will be of use for other CORDEX domains, notably where significant aerosol trend have been, or are expected to be, important. For more info see the shared document at :

https://docs.google.com/document/d/1Ueyx6U97asbO-bn7XxPXvneYPPtXr2A3B4dLiCUvZ-o/edit

Conferences/Papers

See also aerosol FPS wikpage:

https://www.hymex.org/cordexfps-aerosol/wiki/doku.php?id=publications

General

Somot, S., Ruti, P., Ahrens, B., Coppola, E., Jorda, G., Sannino, G. and Solmon, F. (2018): Editorial for the Med-CORDEX special issue, Climate Dynamics, 51, 771–777, https://doi.org/10.1007/s00382-018-4325-x.

Protocol 1A

Gutierrez, C., Somot, S., Nabat, P., Mallet, M., Gaertner, M. and Perpinan, O. (2018): Impact of aerosols on the spatiotemporal variability of photovoltaic energy production in the Euro-Mediterranean area, Solar Energy, 174, 1142-1152, https://doi.org/10.1016/j.solener.2018.09.085.

Protocol 1B

Boé, J., Somot, S., Corre, L. and Nabat, P. (2020): Large discrepancies in summer climate change over Europe as projected by global and regional climate models : causes and consequences, Climate Dynamics, 54, 2981–3002, https://doi.org/10.1007/s00382-020-05153-1.

Gutierrez, C., Somot, S., Nabat, P., Mallet, M., Corre, L., Van Meijgaard, E., Perpinan, O. and Gaertner, M. A. (2020): Future evolution of surface solar radiation and photovoltaic potential in Europe : investigating the role of aerosols, Environ. Res. Lett., 15, 034035, https://doi.org/10.1088/1748-9326/ab6666.

Protocol 2B

Drugé, T., Nabat, P., Mallet, M., and Somot, S. (2019): Model simulation of ammonium and nitrate aerosols distribution in the Euro-Mediterranean region and their radiative and climatic effects over 1979–2016, Atmos. Chem. Phys., 19, 3707–3731, https://doi.org/10.5194/acp-19-3707-2019.

Nabat, P., Somot, S., Cassou, C., Mallet, M., Michou, M., Bouniol, D., Decharme, B., Drugé, T., Roehrig, R., and Saint-Martin, D. (2020): Modulation of radiative aerosols effects by atmospheric circulation over the Euro-Mediterranean region, Atmos. Chem. Phys., 20, 8315–8349, https://doi.org/10.5194/acp-20-8315-2020.

Protocol 2C

Drugé, T., Nabat, P., Mallet, M., and Somot, S., Future evolution of aerosols and implications for climate change in the Euro-Mediterranean region, Atmos. Chem. Phys. Discuss., submitted, 2020.

Planned activities for next year

Med-CORDEX dissemination

- Scientific publications related to protocol 1.B and 2.A multi-model studies
- We hope that scientific exchanges between partners will start again.
- Med-CORDEX FPS aerosol conference , fall 2021 if possible.

Med-CORDEX simulations

- Availability of large ensemble of scenario simulations for phase 2 (FPS)
- CORDEX Baseline runs including evolving aerosol based on Aerosol FPS collaboration.

Additional relevant information