Annual report 2022 for Flagship Pilot Study Aerosol/MedCORDEX

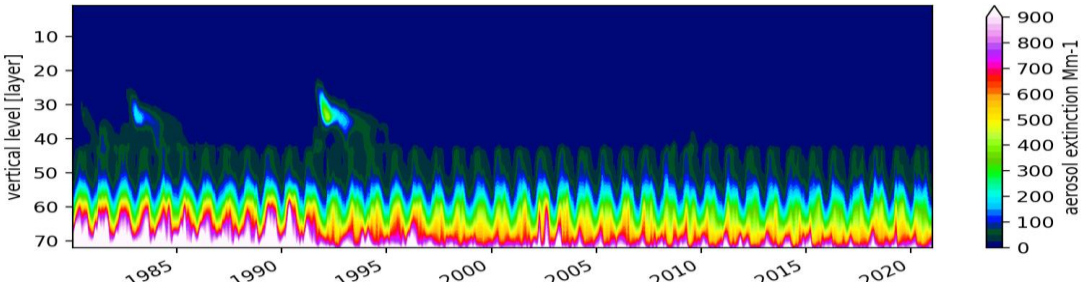
Status and progress during the year including scientific highlights, end to end perspective and participants engaged in the project

GCM-RCM conflicting messages for European summertime climate change

General circulation models (GCMs) and regional climate models (RCMs) are delivering conflicting messages about summertime climate change in Europe. This study aims at assessing the role of anthropogenic aerosols in these inconsistencies, using a multi-model ensemble of GCM-RCM simulations. This ensemble is composed of 9 GCM-RCM pairs, for which regional future simulations (2021-2050) with and without the evolution of anthropogenic aerosols, with respect to equivalent historical simulations (1971-2000), are compared and analysed. Anthropogenic aerosols are found to play an essential role in the future evolution of SW radiation and near-surface temperature. The decrease of their concentrations due to reduced anthropogenic emissions leads to an increase of SW surface radiation and an associated decrease of SW TOA radiation (respectively +6.7 W/m² and -7.7 W/m² in per -0.1 in AOD on average in the Central Europe domain), as well as an extra warming near the surface (+0.3 °C in 2m-temperature per -0.1 in AOD). For these three variables, time-varying anthropogenic aerosols are thus contributing to improve GCM/RCM consistency in Europe. However, no improvement has been found for water cycle, namely precipitation, evapotranspiration and cloud cover. These results underline the necessity to better consider aerosols in upcoming regional climate simulations.

Aerosol forcing for the CORDEX evaluation runs.

A global distribution of monthly aerosol optical properties (extinction, single scattering albedo and assymetry parameter, total and for different compounds, SO4,OC,BC,DUST,SSALT) has been created from the NASA MERRA2 3-hourly reanalysis profiles of aerosol mixing ratio and relative humidity, and the GOCART species level aerosol optical properties for different humidity level and spectral bands. The data are provided on the native MERRA2 vertical coordinate grid along with corresponding MERRA2 surface pressure, pressure layer thickness and layer air density fields. Different spectral bands are included in the data base (based on RRTMG spectral intervals) and allow spectral interpolation when importing the data base to a specific RCM. The period covers 1980 to 2020(…) and includes seasonal to interannual aerosol variability (including e.g. volcanic eruptions, wildfire occurrence) and trends. The foreseen advantages of using this database are the assimilation of observed aerosol optical depths constraining notably the surface radiative forcing, time evolving and vertical profiles of aerosol properties calculated by a state of the art chemistry transport model (GOCART) driven by consistent dynamical reanalysis (MERRA 2). Since it provides direct inputs to the radiative transfer scheme, the use of this database removes sources of intermodel variability linked to aerosol modeling (e.g. model dependant optical properties, assumed profiles etc) facilitating the objective analysis of RCM ensemble regarding climatic responses to aerosol forcing.
Fig1 : example of evolution of total aerosol extinction over Europe for the evaluation period



Summary of each workshop/activity held during the year

Title, date, short description, location, website, links	Responsible person/-s	Funder
Participation to EuroCORDEX on-line workshop 2022		
Participation to MedCORDEX on-line workshop 2022		
Technical meeting on the use of climatological aerosol optical properties data base		

Related publications during the year

Title, journal and link to publication	Author/-s	Date

Planned activities for next year

Technically this is the end of the Med-CORDEX FPS-aerosol (cf additional information for a possible way forward).

Publications relative to the different highlights are being finalized.

Additional relevant information

The FPS "aerosol" has revealed the importance of accounting for aerosol trends while assessing climate change signal over the Euro-Mediterranean region. This issue is likely to be relevant on other CORDEX regions. It has showed that CORDEX models and protocols were "kind of late" compared to the GCM community in term of properly accounting for aerosol effects. In the recent years this gap has been addressed by more and more groups involved notably in Euro/Med CORDEX, and hopefully this effort will extend to other CORDEX regions. As for the initial FPS, which focused on Mediterranean domain, the overall outcome is a bit mitigated with a relatively weak number of groups involved and motivated for carrying out specific aerosol studies. This has driven the FPS to extend to the Euro-CORDEX groups in order to reach a sufficient number of model participating to ensemble studies. However it is clear that aerosol is also a matter of concern for all the groups involved in CORDEX and different regions. It is our feeling that aerosol effect assessment protocols should be defined for every CORDEX regions, with possibly a new coordinated "trans-regional" activity focused on aerosol processes, and allowing to reach a larger number of participants. Interactive aerosol simulations allowing to account for both direct and indirect effects are clearly a way forward (and in the pipe for some groups) with possible strong scientific connections to other FPS focused e.g. on convection resolving, urban environments and land use interactions.

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The report is due the 15th of February each year and should be sent to ipoc@cordex.org.