# Detection and attribution of cloud and precipitation adjustments to aerosol perturbations

*M. Costa-Surós, O. Sourdeval, S. Crewell, and J. Quaas*

Although aerosols are a key factor for atmospheric water vapor to condensate and form clouds, the aerosol-cloud interactions continue to be a challenge for climate models. Therefore, it is crucial to study how changes in atmospheric aerosol concentration affect clouds and precipitation, either in terms of type, intensity, quantity, time duration or delay in formation. Moreover, changes in aerosol burden also have an effect to cloud microphysical properties, with more aerosol load the smaller the cloud droplets become. Ultimately, cloud adjustments to anthropogenic aerosol perturbations remain an important source of uncertainties on current radiative forcing estimates.

To study the adjustments of clouds and precipitation to aerosol perturbations a set of highly resolved simulations (165 m) with the ICOsahedral Non-hydrostatic Large Eddy Model (ICON-LEM) have been performed over Germany with the Cloud Condensation Nuclei (CCN) concentrations of the 2$^{nd}$ of May 2013, as control simulation, and with 1985 CCN concentration profiles (i.e. peak of pollution in Europe), as perturbed simulation. Thanks to the fact that the cloud resolving ICON-LEM model has an advanced two-moment mixed-phase bulk micro-physical parametrization scheme, the effects can be investigated by the analysis of the number concentration and specific content profiles of five hydrometeors, as well as for the integrated spatial distributed variables and macroscopic characteristics.

Preliminary results show increased LWP, and more and smaller cloud droplets which produce significant increase in cloud albedo, since changes in the solar radiation at the TOA are detected. Although negligible changes are found in surface rain rate domain average (c.a. 0.18%), with smaller cloud particles the collision-coalescence should be reduced, and actually, a change in the domain mean rain pattern is found since the rain peak around 17h is slightly reduced and more rain is precipitated in the perturbed simulation between 18 to 20h in comparison to control simulation. Cloud phase effects concerning mixed-phase and ice clouds are also investigated since smaller cloud droplets may delay the onset of freezing. Finally, regarding the vertical extent effects, slightly thicker clouds, and slightly higher cloud tops and bases are found.