Project: **1070**

Project title: **PerduS** (in 2020 will be renamed to ARIA)

Principal investigator: **Bernhard Vogel**

Report period: **2019-01-01 to 2019-12-31**

The PerduS numerical experiments on Mistral are separated in three groups. The progress in each group is outlined below.

Dust-Radiation Interactions:

Mineral dust is an important player in the Earth system with profound impacts on energy and material cycles. Through backscattering the solar radiation, dust particles decrease the incoming solar energy that in short-term reduces the photovoltaic energy generation (direct effect). The magnitude and variability of the dust direct effect not only depend on the dust burden in the atmosphere but also rely on the physicochemical characteristics of the dust particles (e.g. size distribution, shape, chemical compositions). Within the PerduS project, the effects of particle shape and size distribution on dust direct effect are investigated. Several numerical experiments are conducted to implement, test and verify these new developments. It has been shown that dust nonsphericity has a profound impact on its optical properties and leads to 20-30% higher optical depth (Hoshyaripour et al. 2019).

The ongoing high-resolution experiments aim at constraining the effect of dust on photovoltaic energy generation in Germany. The current set-up refines the ICON-ART grid over North Africa and Europe by 5 km horizontal resolution using three nests. The simulation period is 22-28.06.2019 when Saharan dust reached Germany in clear sky conditions. The preliminary results show that enhanced resolution leads to higher concentration and optical depth overall with the highest change over the source region (Fig. 2, top panel). As the surface winds remain unchanged (Fig. 2, bottom panel) the elevated concentration cannot be attributed to the emissions. Instead, this increase is related to the accumulation of the coarse particles due to higher vertical velocity in the fine domain. This investigation will continue by comparison of the modeling results with aerosol and radiation measurements in Germany.

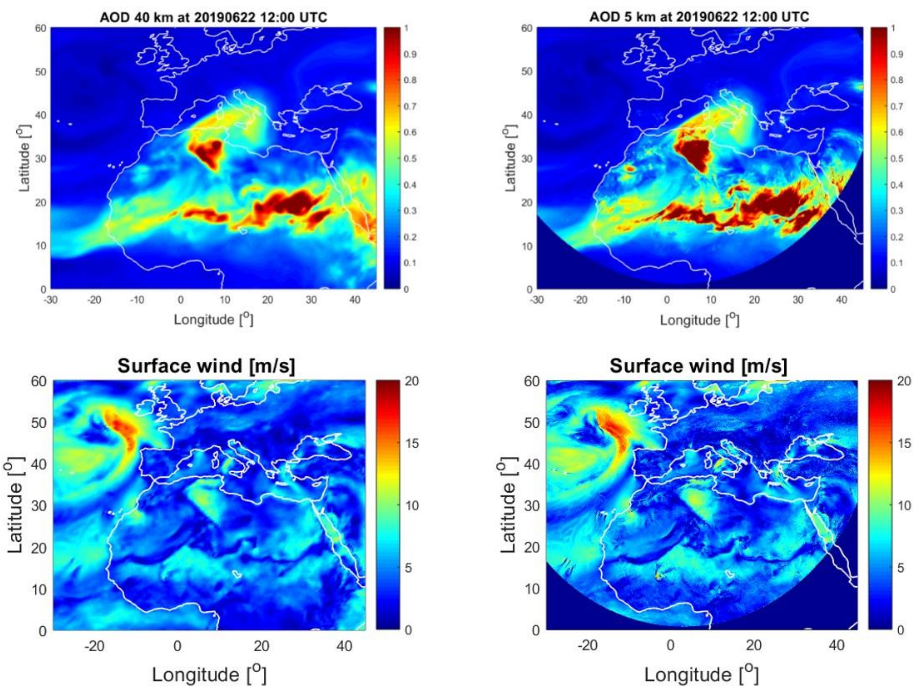

Figure 1: AOD (top panel) and surface wind (bottom panel) patterns on 22.06.2019 12:00 UTC in 40 km (left) and 5 km (right) simulations.

Impact of aerosol on clouds and radiation above the Southern ocean:

The Southern Ocean is one of the cloudiest regions on Earth. These clouds are often poorly represented in climate models. The consequence is a bias of cloud radiative properties. E.g. the CMIP5 model clouds did not reflect enough sunlight over the Southern Ocean. We apply ICON-ART to investigate which of the involved processes are important. In a first step we only consider the emissions of sea salt aerosol as a function of wind speed. These particles can then be activated to form cloud droplets. For the description of the microphysics we apply a Two-Moment-Scheme. In contrast to an operational setup also the feedback of the cloud droplet and ice particle number concentration on radiation is considered. Figure 2 shows simulated wind speed for the January 18th, 2018 and the according simulated sea salt mass concentration. The results show on the one hand side the correlation of wind speed and particle mass concentration on the other hand the variability.

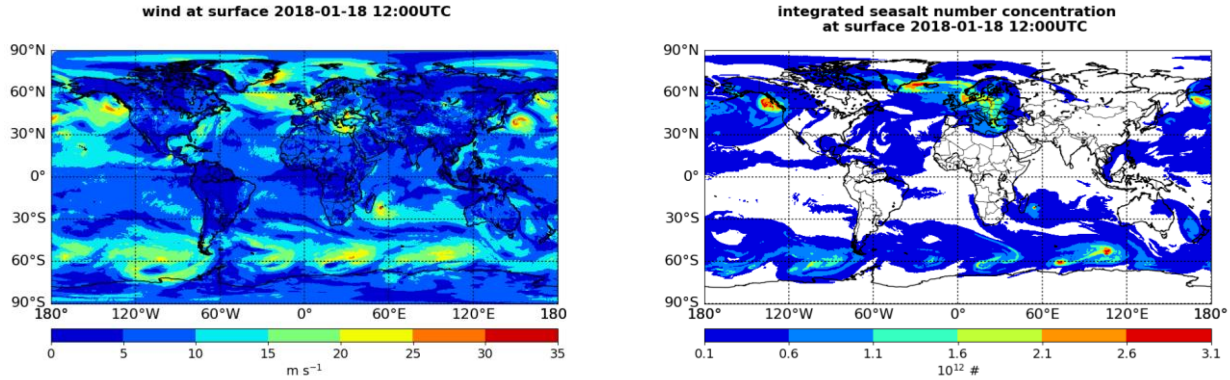

Fig. 2 Horizontal distribution of the simulated surface wind speed (left) and integrated sea salt number concentration (right), at 12 UTC, 18.01.2018.

Aerosol impact on CCN and aircraft icing:

Several experiments are conducted to investigate the impact of the supercooled large drops on the forecast icing intensity. Since aerosols are an important contributor to the droplet number distribution acting as CCN, their effect on the forming of supercooled large drops and on the droplet number distribution are studied. Most icing intensity algorithms do not consider droplet number distribution. Therefore, the derivation of a new algorithm is part of this project. Additionally, this project aims to investigate the impact of higher spatio-temporal resolutions and their comparison with the distribution oriented approach. Figure 3 shows the simulated relative humidity at supercooled layer.

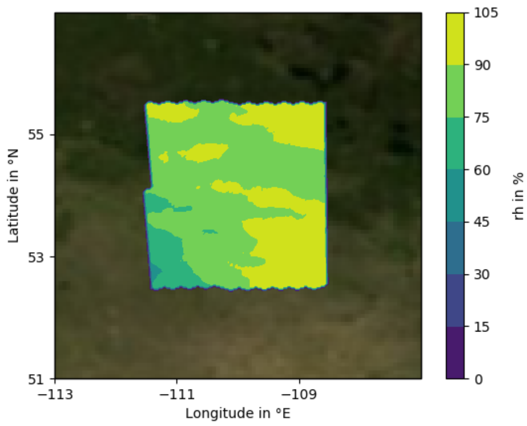

Figure 3: Modelled relative humidity at supercooled layer at 250 meters altitude

A summary of the resources consumption in the last year is given in the table below.

Table 1: Resource utilization until 29.10.2019

Resource	Granted	Consumed
Mistral CPU time (Node hours)	39300	32578
Lustre work (GiB)	13500	8027
HPSS arch (GB)	67500	-
HPSS doku (GB)	1200	-

References:

Hoshyaripour, G. A., Bachmann, V., Förstner, J., Steiner, A., Vogel, H., Wagner, F., Walter, C. & Vogel, B. (2019). Effects of particle nonsphericity on dust optical properties in a forecast system: Implications for model-observation comparison. Journal of Geophysical Research: Atmospheres, 124. https:// doi.org/10.1029/2018JD030228,