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Approaching the sub-mesoscale globally at 10 min temporal resolution through assimilating radiances measured by geostationary satellites

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A refined 4D-Var assimilation system within DestinE allows us to assimilate the Meteosat-10/SEVIRI clear-sky radiances over Europe, as well as GOES-16/ABI and GOES-18/ABI, or HIMAWARI/AHI globally at a spatial scale of 75 km instead of the previous 125 km in the ECMWF Integrated Forecasting System (IFS). Higher resolution observations can potentially improve the analysis and therefore the prediction of extreme weather events over Europe, as well as globally. The effects of using higher resolution observations have been investigated with a detailed set of experiments and the impact on wind, temperature, and humidity has been evaluated. A broad range of experiments indicate that exploiting the higher spatial density clear-sky radiances leads to an improvement of humidity sensitive fields in short-range forecasts with the IFS as independently measured for example by instruments on low-earth-orbiting satellites (IASI, CrIS, SSMIS, or ATMS). Due to a reduced displacement and representativeness error, these changes could further lead to improvements in longer range forecasts as these errors propagate upscale nonlinearly. However, so far the impact on the medium range has been mostly neutral.

In addition, pre-processed GOES-16/ABI and GOES-18/ABI observations by NOAA have been assimilated with 10 min sampling rates at 75 km spatial density. Exploring how to best assimilate relatively small spatial and temporal scales for one geostationary satellite, will allow us to approach these smaller scales with other satellites such as HIMAWARI/AHI above the Pacific or MTG-I/FCI above Europe. Data from both satellites will be available for us early in 2024. Preliminary experiments demonstrate the ability of IFS to assimilate observations at the highest available temporal resolution for the GOES-16 and GOES-18 satellites. Higher resolution radiances observed at these shorter time intervals naturally capture smaller scale atmospheric features such as mesoscale convective systems. In our experiments, simultaneously assimilating observations at a higher spatial and temporal resolution leads to an impact that is only marginally better than assimilating higher density observations alone, suggesting a combined investigation of optimal time-assignment, as well as assessment of the observation error are needed to optimise the integration of rapid update measurements in 4D-Var.