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Tackling systematic model errors related to the representation of convective precipitation at storm-scale resolutions in ECMWF's Integrated Forecasting System

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In the H2020 Next Generation Earth Modelling Systems (NextGEMS) project, we aim at building a new generation of eddy- and storm-resolving global coupled Earth System Models. At storm-scale resolutions (1-9 km), deep convective systems are becoming at least partially resolved, which means that the parameterisation of deep convection can possibly be switched off.

However, this introduces at least two systematic errors. The first error is that at storm-resolving scales, explicit convection is triggered too late and too scarcely because subgrid-scale heterogeneity is not resolved, and convective inhibition is thus too hard to overcome. The second error is that at storm-resolving scales, the mixing of updrafts with their immediate environment is underestimated, as most of the scales on which the mixing happens are not resolved.

Therefore, as soon as the parameterisation of deep convection is switched off, tropical deep convection is associated with too much convective instability, too high updraft buoyancy and too strong updraft velocities, resulting in too intense and too localised precipitation events. The large-scale pattern of mean precipitation is biased as well, particularly the amount of precipitation in the inter-tropical convergence zone is strongly overestimated.

Here we focus on the rain band over the tropical Pacific at 5°N, which is 2-3 times stronger in the IFS simulations for the NextGEMS project than in observations. We perform a sensitivity study, testing how different assumptions in the moist physics schemes relevant to storm-resolving scales affect the results. We show that by choosing a setup that is more suitable for storm-resolving simulations, we can significantly improve the representation of convective precipitation in the IFS, both with respect to the intensity and the spatial pattern in the tropics.

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