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Data assimilation as a tool for upscaling

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In ocean and atmospheric sciences, grid nesting is a common procedure in order to achieve (very) high resolution model outputs in regions of particular interest, at an acceptable computational cost. Nesting of grids can be passive (one-way nesting) or active (two-way nesting, with feedback from the high resolution to the low resolution grid). The benefits of active nesting have been shown multiple times in the litterature (see e.g. [1]). The positive effect of the feedback is visible inside the nested grid, but also outside of it, as corrections are advected with the flow. It must be noted however that in many operationnal implementations, only passive nesting is used, usually because active nesting requires too much data exchange between models, which should then wait for each other during their run.

Data assimilation techniques are also widespread in oceanic and atmospheric models. They are usually applied in order to merge observations in models, but also e.g. to merge different outputs from ensemble runs of a model, to merge outputs from different models, or to replace downscaling between nested grids (see [3]).

In our work, we present an alternative to active nesting (for implementations currently using passive nesting). First, the low-resolution model is run, followed by the local model. Afterwards, the low-resolution model is run once more, assimilating outputs from the local model as pseudo-data.

The benefits of this approach over simple passive nesting are shown using a twin experiment. The GHER model (see [2]) is configured with a 0.25° resolution of the Mediterranean Sea, and with a 0.05° resoluion of the North-Western part; a twin experiment is then set. The reference run uses full two-way nesting, another run uses one-way nesting, and in a third run the assimilation procedure described above is implemented.

Conclusions from this experiment are that our "upscaling" has positive impacts on the forecasts, provided a fair amount of EOFs is used during (reduced-rank) assimilation cycles.

Finally, the set-up of ongoing work to implement our upscaling procedure in a realistic, operationnal system (the MFS system) is presented.

References:

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