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How could/should digital twin thinking change how we use HPC in weather and climate?

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Digital twins are defined in many ways, but definitions usually end up something like "simulation of the real world constrained by real time data". This definition basically encompass our understanding of the use of weather and climate models whether using data assimilation or tuning to history. It would appear that we (environmental science in general and weather and climate specifically) have been doing digital twins for a long time. So what then should new digital twin projects in our field aim to do that is different from our business as usual approach of evolving models and increasing use of data?

There seem to be two key promises associated with the current drive towards digital twinning: scenario evaluation and democratising access to simulations. To make progress we can consider two specific exemplar questions: (1) How can I better use higher-resolution local models of phenomenon X driven by lower-resolution (yet still expensive large-scale) global models?; and (2) How can I couple my socio-economic S model into this system?

Delivering on these promises, even for just these two exemplars, requires some additional thinking beyond what we do now, and such thinking can take advantage of our changing computing environments, and in particular our use of tiered memory and storage, so that the burden of supporting these digital twin applications does not come with unaffordable complexity or cost in the primary simulation environment. It will also require much more transparency and community engagement in the experimental definition. In this talk I outline some of the possibilities in this space, building from existing technologies (software and hardware), models, and infrastructure (existing systems), and suggest some practical ways forward for delivering on some of the digital twin promises, some of which might even be possible within existing programmes such as the EC's Destination Earth (DestinE).

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