

## ***Interactive comment on “Towards in-situ visualization integrated earth system models: RegESM 1.1 regional modelling system” by Ufuk Utku Turuncoglu***

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This paper describes a novel approach to in-situ (online) analysis and visualization of numerical model output by integrating the visualization package with a model coupling framework, the Earth System Modeling Framework (ESMF). Key contributions of the work include the ability to analyze fast moving processes at higher temporal and spatial resolution than would typically be possible (due to extreme size of data output) as well as offering a generic, reusable approach that could be applied to other models using ESMF.

The paper is well-written and clearly describes limitations of current data analysis ap-

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proaches and how the proposed architecture with integrated in-situ visualization addresses them. Existing approaches to in-situ visualization are discussed including implementations using the Model for Prediction Across Scales (MPAS) and Weather Research and Forecasting (WRF) models. However, these approaches use custom implementations, do not leverage standardized coupling interfaces, and are therefore could be hard to apply generally across a range of models.

The paper describes the architecture of the RegESM model, which supports coupled atmosphere, ocean, wave, and river models. The driver and coupling protocols are based on the National Unified Operational Prediction Capability (NUOPC) software layer. This architecture was extended to include the ParaView/Catalyst co-processing component using the same ESMF-based data structures and parallel communication operations used to exchange coupling data between the model components.

A major strength of the paper is that the fully integrated system was tested using real model components performing a simulation of Hurricane Katrina. This allowed for analysis of the hurricane at very high temporal resolution. Timing profiles of the full system show reasonable scaling for two separate resolutions, up to 588 cores.

Since a key focus on the paper is interoperability afforded by using a standard coupling framework, some additional discussion on details of the software engineering and approach to interoperability could be discussed including more details on the actual interfaces used between components as well as issues related to portability. Follow on work could look at applying the same co-processing component to a completely different model to understand how generic the approach is. A related question is how hard it would be to change out the visualization package itself, since there are a number of packages that offer custom analyses.

In addition to timing profiles and since the initial motivation was around the problem of data volumes, the paper could benefit from plots describing the amount of data exchanged and used in the in-situ case versus the amount of data that would be required

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for offline visualization at the same temporal frequency. This would allow an “apples-to-apples” comparison of the online vs. offline approaches.

The overall approach is novel and represents a significant contribution to the community, especially given the large number of models using the ESMF/NUOPC framework. If the work is extended, many of these models could benefit from the in-situ visualization approach.

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