Collaborative research and education with reproducible numerical weather prediction enabled by software containers

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The rapid emergence of software container technology like Docker offers immediate potential to lower barriers in numerical weather prediction (NWP) research and education. A Docker container can contain one or more software applications, all necessary dependencies, and provide isolation from other containers and other installed software unless explicitly overridden. Modularity is inherent, and containers can be linked together arbitrarily to construct complex workflows. The same containers can be deployed on Windows, OS X, or Linux based machines. Applications within them give the same output regardless of operating system or chip set. In many instances containers can obviate the need for difficult and time-consuming compilation efforts, redundant flow control and analysis software, and uncertainty in results from running simulations on multiple platforms.

We present a set of Docker containers that provide both an educational and collaborative NWP environment. The widely used community Weather Research and Forecasting (WRF) model anchors the set. Linked containers include software to initialize the model, run the model, analyze the results, and serve the output to collaborators. We demonstrate the following: (1) how the often-difficult exercise in compiling the WRF and its many dependencies is eliminated to accelerate classroom learning and graduate research; (2) that identical results obtained on different computing systems eliminates uncertainty in results; (3) how sharing containers provides identical environments for conducting research; (4) how NWP research can become truly reproducible via containers.