An Experiment in Hybrid Weather Prediction for Downslope Windstorms

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Public utilities, especially in California, are responsible for anticipating threatening weather conditions and proactively de-energizing electrical circuits as they arise. Many of these conditions involve high winds in complex terrain associated with downslope windstorms. Utilities are also required to warn customers of potential outages in advance and need to stage personnel and other resources, so accurate forecasts at high resolution with lead times of several days are needed. As current operational products such as the HRRR and NAM nest use 3 km grid spacing and only go out as far as 48 (for HRRR) and 60 (for NAM) hours, finer resolution and/or longer lead times are often needed.

As a consequence, many utilities operate their own NWP systems, usually WRF-based, to get higher resolution forecasts extending out over longer periods. Many also employ high-resolution ensembles, initialized with GEFS members, in an effort to gauge uncertainty. This is very resource-intensive and the investment needed for high resolution simulations over multiple days can limit the utility's ability to expand its ensemble forecasting efforts.

Partly motivated by the need for greater efficiency, we illustrate incorporating an machine learning weather prediction model, Google's GraphCast (GC), into a proposed utility forecasting strategy for downslope winds. GC was trained with, and shares, the 0.25 degree latitude/longitude grid of, the ERA5 reanalysis product from ECMWF, and produces forecasts at six-hour intervals. For synoptic scale fields, GC appears to be competitive with the best operational forecasts from ECMWF. Yet, with suitable hardware, GC can generate a global, 10-day forecast in about one minute.

This coarse grid spacing, however, does not provide circuit- and station-based wind forecasts needed by utilities. Thus, we developed a strategy for using WRF and MPAS to downscale GC forecasts in space and time. We illustrate the advantages and challenges of this strategy using the Marshall fire downslope windstorm that impacted the Boulder, Colorado, area in December 2021. We will show that GC-initialized WRF forecasts are competitive with those commencing with analyses or forecasts from GFS and ECMWF operational products.