Dissertation Abstract

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Terabytes of weather data are generated every day by gridded model simulations and in situ and remotely-sensed observations. With the accelerating accumulation of weather data, efficient computational solutions are needed to process, archive, and analyze the massive datasets for various applications. This work demonstrates how object-based storage technology is used to efficiently archive multiple years of the High-Resolution Rapid Refresh (HRRR) model, a weather forecast system run operationally by the Environmental Modeling Center of the National Centers for Environmental Prediction. This model is relied on for short-term (0-18 hour) weather forecasts for a variety of operational applications, and the archive supports air quality and wildland fire research activities at the University of Utah and hundreds of other researchers.

The Open Science Grid—a high-throughput computing resources—was used to efficiently calculate large sets of empirical cumulative distributions from three years of archived HRRR hourly gridded analyses. These cumulative distributions are computed for seven variables, over 1.9 million grid points, and each hour of the calendar year. The cumulative distributions are used to evaluate techniques that may be appropriate to discriminate between typical and atypical atmospheric conditions in a historical context for situational awareness of hazardous weather conditions. In addition, HRRR predicted lightning threat is compared with observations from the Geostationary Lightning Mapper (GLM) on board the GOES-East geostationary satellite. The HRRR forecasts showed little skill in the placement, timing, and intensity of short-lived convective storms for lead times of greater than three hours, but these forecasts are still informative to incident meteorologists who add value to the forecasts for wildfire applications. With case studies of recent wildland fires in the western United States, this work illustrates how the techniques developed could be applied to assess future fire weather conditions. Knowledge of prior numerical weather forecast behavior can help incident meteorologists recognize typical or unusual conditions in remote locations and help them determine if forecast model output can be trusted.