

Toward Exascale Weather Forecast Application in the Big Data Era: A Perspective beyond “Big Data Assimilation”

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In 2013, the Japanese government started a strategic funding program for the Big Data science, and the “Big Data Assimilation” project for severe weather forecasting started. Here, 30-minute forecasts at a 100-m resolution are refreshed every 30 seconds, 120 times more rapid than the current hourly-updated systems. This will help prepare for sudden local torrential rainfalls that may cause flash flood and river outflow only within 10-20 minutes.

This revolutionary numerical weather prediction (NWP) is only possible due to the most advanced sensing and high-performance computing (HPC) technologies to date. The recent Phased Array Weather Radar can make a volume scan in 10-30 seconds at a 100-m radial resolution with 100 elevation angles, producing 100 times more data than a conventional parabolic-antenna radar making a volume scan in 5-10 minutes with 15 elevation angles. Also, the Japan Meteorological Agency’s new geostationary satellite Himawari-8 has a capability of the super-rapid scan every 30 seconds for a limited region. These sub-minute data would be frequent enough to capture the nearly linear evolution of rapidly changing convective activities. Assimilating the 30-second data into a high-resolution NWP model may lead to accurate representations of the lifecycles of each convective cell. However, these new observing platforms provide two orders of magnitude more data, and an effective use of these Big Data in very short range NWP is a challenge and may be possible with the Japanese 10-petaflops “K computer”.

The sensing technology advances day by day, and simulations become more and more precise. Data assimilation deals with the large-volume and wide-variety “Big Data” from both simulations and sensors, and its real-time high-velocity computation is essential. HPC plays a central role in such rapid processing of big simulations and big data. If we look at the past, NWP has been pioneering the HPC application with observation big data; Charney and von Neumann pioneered NWP using the ENIAC! We would expect that weather applications will keep pioneering the future developments of HPC and Big Data convergence.

This presentation will discuss the concept of the ongoing “Big Data Assimilation” research, and will also discuss what we would expect next from my personal perspective.