Large-Scale High-Resolution WRF Model Simulations Used for GOES-R Research Activities

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INTRODUCTION

The Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison is heavily involved in GOES-R satellite algorithm development, risk reduction, data processing, and measurement capability demonstration activities. In support of this work, an end-to-end processing system that utilizes proxy top of atmosphere (TOA) radiance datasets derived from numerical weather prediction model output has been developed. The first step in the end-to-end system is to use the Weather Research and Forecasting (WRF) model to perform high-resolution simulations for a variety of locations and atmospheric conditions. Model-simulated temperature, water vapor, and cloud data are subsequently combined with climatological information (such as ozone) to generate simulated atmospheric profile datasets that are then used by the forward radiative transfer model to produce proxy TOA radiances in the GOES-R spectral range. Noise and other instrument effects can be added to the data in order to fully characterize the performance of various GOES-R algorithms.

CURRENT SIMULATION ACTIVITIES

A large, memory-intensive WRF model simulation was recently performed on a supercomputer at the National Center for Supercomputing Applications (NCSA) at the University of Illinois in Urbana-Champaign. The simulation contains 3 nested domains configured to represent potential GOES-R scanning regions (i.e. full disk, CONUS, and a special mesoscale domain). The outermost domain covers most of the GOES-R viewing area with 6-km horizontal resolution, while the inner domains cover the CONUS and mesoscale regions with 2-km and 667-m resolution, respectively. The simulation required 1 TB of memory and took ~74000 CPU hours to complete. Proxy TOA radiances generated for this case study provide an important opportunity to realistically demonstrate GOES-R measurement capabilities. Representative images showing simulated GOES-R ABI and real GOES-12 brightness temperatures for each domain are shown below.

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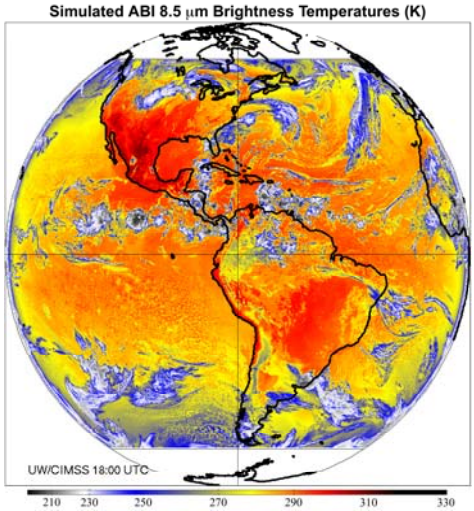
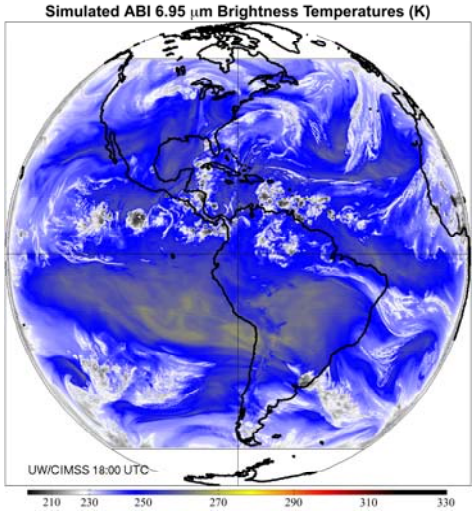
WRF Numerical Weather Prediction Model → Temperature, Humidity & Cloud Property Profiles → SOI Forward Radiative Transfer Model → Top of Atmosphere Radiances

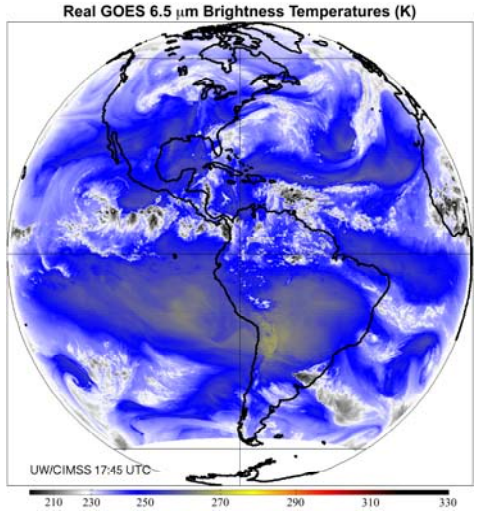
Simulated ABI 8.5 μm Brightness Temperatures (K)



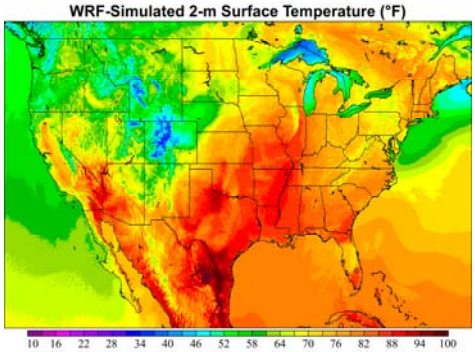
Simulated ABI 6.95 μm Brightness Temperatures (K)



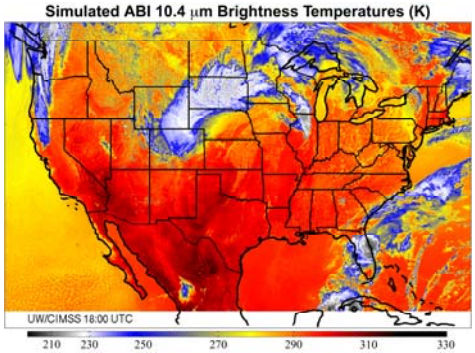
Real GOES 6.5 μm Brightness Temperatures (K)



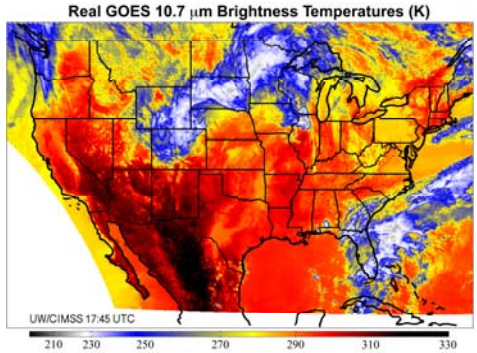
WRF-Simulated 2-m Surface Temperature (°F)



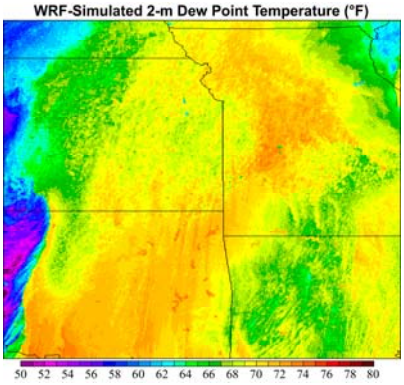
Simulated ABI 10.4 μm Brightness Temperatures (K)



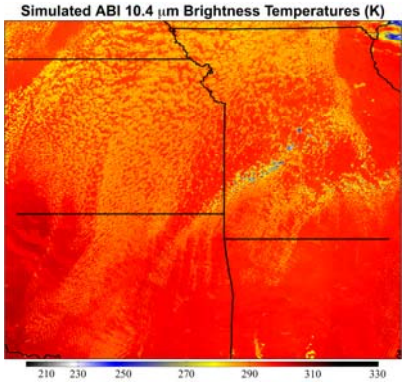
Real GOES 10.7 μm Brightness Temperatures (K)



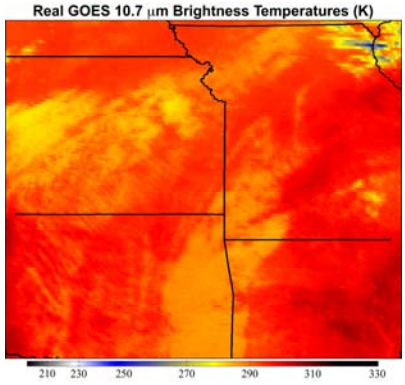
WRF-Simulated 2-m Dew Point Temperature (°F)



Simulated ABI 10.4 μm Brightness Temperatures (K)



Real GOES 10.7 μm Brightness Temperatures (K)



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