Visualizing Model Data Using a Fast Approximation of a Radiative Transfer Model

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Summary
✓ Useful to visualize model by creating a synthetic satellite image (visible channel).
✓ A radiative transfer model is too slow to do this routinely during operations
✓ Approximate the radiative transfer model using a neural network
✓ Run the neural network on model forecasts
✓ Starting in Spring 2011, run routinely on NSSL-WRF data and disseminated online

Why visualize models by creating synthetic satellite data?
Cloud imagery can provide inferences about physical processes not associated with precipitation. Simulated radar reflectivity useful only for precipitation, while most clouds are non-precipitating.

What options exist to create synthetic visible imagery?
A forward radiative transfer model computes gas optical depths for each model layer using absorption and scattering properties of each hydrometeor species predicted by microphysics scheme.

So, why not use the radiative transfer model?
Too slow: 13 hours to compute GOES 0.65µm reflectances for a single NSSL-WRF time step.

How the radiative transfer model was approximated
Took six days of NSSL-WRF output
Turned off sun-angle correction, etc.
Ran radiative transfer model on it
Did histogram correction and subsampling of non-clear pixels
Trained NN to predict visible channel from mixing ratios
Can create synthetic visible image in 15 seconds per model timestep!
(more details in journal article)

How good is the approximation?
Output of radiative transfer model vs. output of NN
All errors within 0.1 (brightness scale from 0 to 1)

An example of the technique
(a) 18-hour model forecast on Aug. 28, 2009
(b) With snow content superimposed
(c) With 1-hour precipitation superimposed
(d) With ice-content from the model
(e) With cloud-water content superimposed
(f) With rain-water content from the model
(g) GOES-13 visible image valid for time of forecast

Where can I get more information?
Real-time data here:
http://goo.gl/Ts437
Journal article accepted at J. Tech:
http://cimms.ou.edu/~lakshman/Papers/visnn.pdf

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