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# Satellite Imagery from Numerical Weather Prediction Models

This paper reports on satellite imagery simulated from NWP model outputs for a monitoring tool of NWP models of JMA. This is the response to the Action Item 32.14 of CGMS XXXII.

# Satellite Imagery from Numerical Weather Prediction Models

At the Japan Meteorological Agency (JMA), satellite imagery has been simulated from the profile of Numerical Weather Prediction (NWP) outputs. The simulated imagery has been produced in the process of development of satellite data assimilation. It is used as a monitoring tool of the NWP models of JMA since it visualizes the cloud and water vapor distributions. Moreover it is used as a reference material of weather forecast operation at JMA.

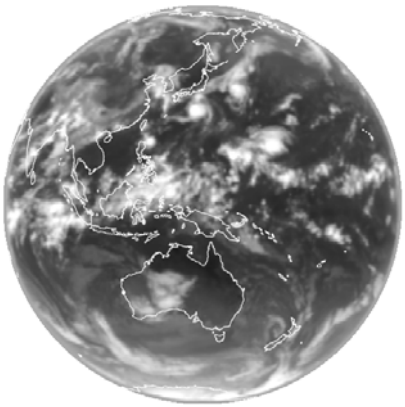
Since radiative calculation in NWP models contains cloud effects, it is possible to calculate satellite infrared brightness temperature and visible reflectivity at cloudy regions by applying the radiation scheme of NWP models. The radiative transfer models were developed based on radiation schemes of the Global Spectral Model (GSM) to estimate satellite brightness temperature and reflectivity. The simulation has been performed experimentally on the Meso-Scale Model (MSM) as well as GSM.

## 1. Infrared imagery

Infrared imagery is simulated by a radiative transfer model. The radiative transfer model was developed based on the longwave radiation scheme of GSM to calculate infrared brightness temperature. Only the effect of water vapor absorption is considered in the radiative transfer model. The cloud-related inputs are cloud water content and cloud amount, which are prognostic and diagnostic variables in GSM and MSM respectively. The radiative transfer model is applied for the calculation of brightness temperatures of IR channel (10.3 - 11.3 micrometer) and WV channel (6.5 - 7.0 micrometer). Figure 1 shows MTSAT-1R infrared and water vapor images observed and simulated from the 24-hour forecast of GSM.

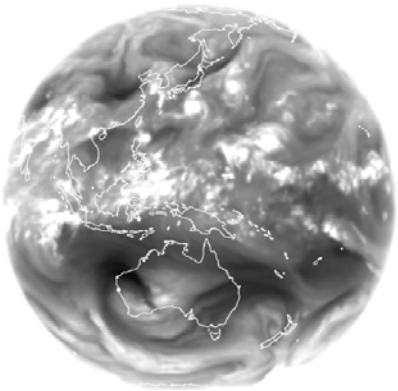
## 2. Visible imagery

Visible imagery is simulated by a radiative transfer model developed based on the shortwave radiation scheme of GSM. In the scheme, reflectivity and transmittance at each layer are calculated, and then shortwave radiation flux at each layer is produced in consideration of multiple reflectivity. In the layer where cloud exists, optical depth becomes large and its reflectivity high. Cloud optical depth is parameterized according to the path-integrated cloud water content. With the reflectivity and transmittance at each layer, upward and downward fluxes at the top of atmosphere are calculated, leading to the reflectivity of the visible channel. Figure 2 shows visible MTSAT-1R images observed and simulated from the 9-hour forecast of MSM.

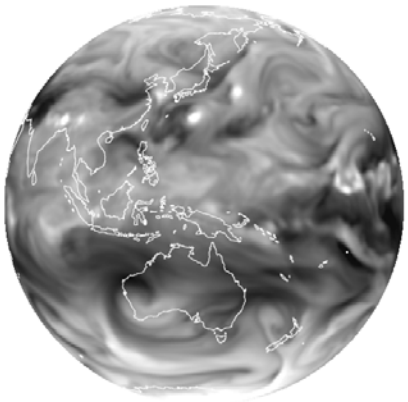


IR1 observation

IR1 simulation



WV observation



WV simulation

Figure1: Observed and simulated images of MTSAT-1R infrared and water vapor channels. Left: observations at 00UTC 24 Aug. 2005. Right: simulations from the 24-hour forecast of GSM of the same valid time.

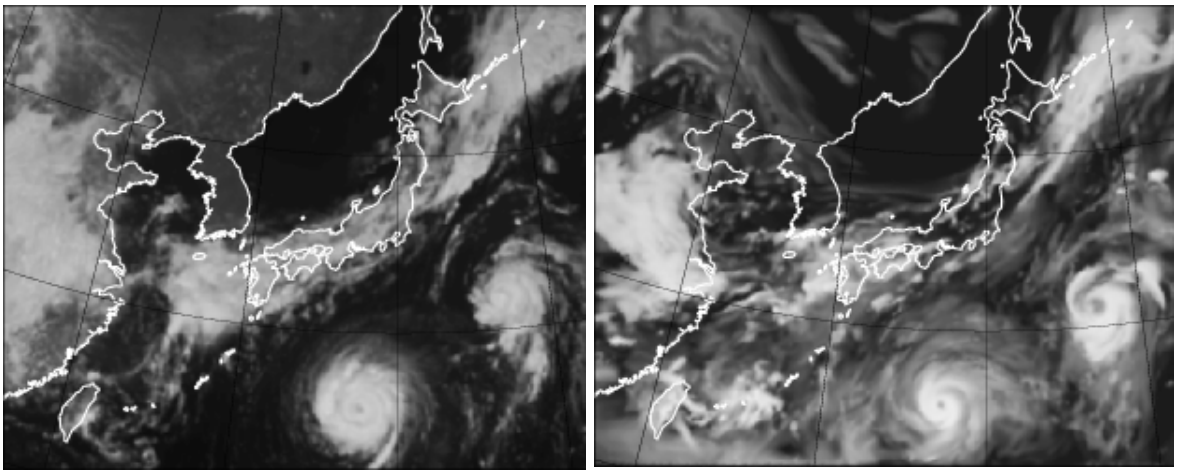


Figure 2: Observed and simulated VIS images of MTSAT-1R. Left: observation at 03UTC 25 Aug. 2005. Right: simulation from the 9-hour forecast of MSM of the same valid time.