Current status of the predicted satellite imagery generation in NMSC/KMA

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Introduction

- National Meteorological Satellite Center (NMSC) of Korea Meteorological Administration (KMA) successfully launched the second geostationary meteorological satellite, Geo-KOMPSAT-2A(GK-2A) on 5 December 2018. NMSC/KMA has developed the algorithm for extracting 52 meteorological and geophysical products from GK-2A advanced Meteorological Imager(AMI) observations.
- In addition, we has developed the predicted satellite imagery production algorithm for nowcasting application in collaboration with Kyungbook National University(KNU).
- This algorithm has two methods of producing forecast field using McGill algorithm for Precipitation Nowcasting by Lagrangian Extrapolation (MAPLE) and using KMA global NWP model(Unified Model, UM).
- The predicted motion vector is calculated using simulated brightness temperature calculated through the fast Radiative transfer model (RTM). As a result, the calculated motion vector is merged with the motion vector obtained through NWP model. To optimize the predicted satellite imagery production of GK-2A, we used Himawari-8/AHI data which is most similar to GK-2A.
- The prediction performance of this algorithm are tested and validated by using Himawari-8/AHI data.

Algorithm of the predicted satellite imagery products

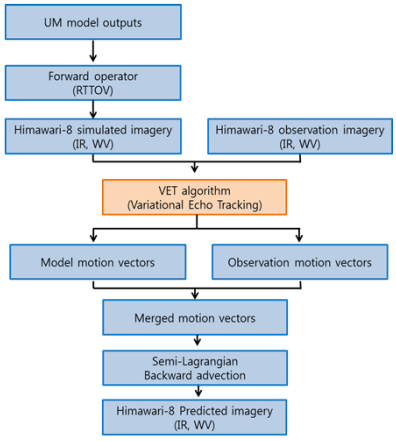


Fig. 1 Flowchart of production of the predicted satellite imagery

VET(Variation Echo Tracking)

- Improved echo tracking using MAPLE algorithm
- Use 2 or 3 consecutive satellite imagery
- Minimizing cost function → conjugate gradient method
- A large-scale moving vector → small-scale moving vector(scaling guess procedure)

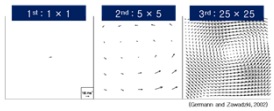


Fig. 2 Scaling-guess procedure

- Preventing local minima problems
- Reduce the processing time of nonlinear minimization

Merged motor vectors calculation

- Using satellite-based and NWP model motion vectors
- Determination of weights using accuracy evaluation results of each motion vector

Semi-Lagrangian backward advection method

- Use the semi-Lagrangian backward advection scheme for these input data to calculate the grid corresponding to grid point to be predicted

Algorithm modification/improvement

- To optimize the predicted satellite imagery production algorithm of GK-2A, we used data from Himawri-8 satellite in Japan.
- Converted satellite data from count to brightness temperature, and then brightness temperature is reversed using maximum(320K) and minimum(180K) thresholds.
- Removed the clear region using cloud mask produced by Himawari-8 satellite.
- Calculated the motion vector using VET method

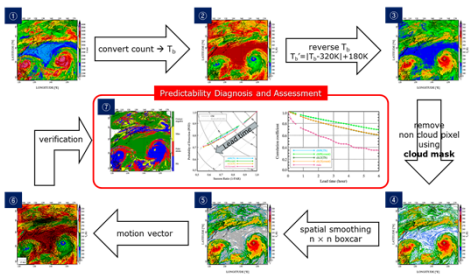


Fig. 3 Flowchart of satellite data preprocessing method for based on satellite motion vector calculation.

Himawari-8 observation and simulated imagery

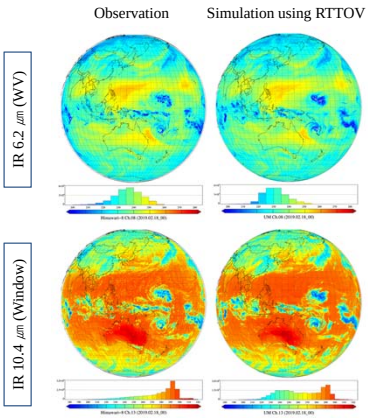


Fig. 4 Himawari-8 observation and simulated imageries using RTTOV-11 for Infrared and WV channel at 00:00 UTC on Feb. 18 2019.

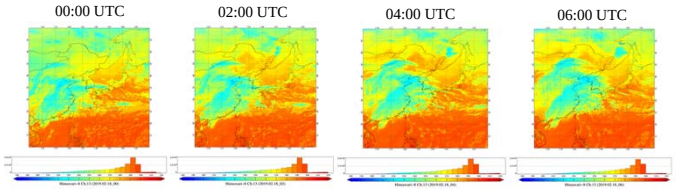
Simulated imagery production

- We employed the Hiawari-8 imagery simulated using the Radiative Transfer for TOVS(RTTOV) v11.3 with the atmospheric state from the KMA global NWP model.
- Figure 4 shows an example of Himawari-8 satellite observation and simulated imageries at 00:00 UTC on February 18, 2019.
- These imageries can be seen that the positions and directions of the typhoon over the east regions of Australia, cloud distribution of the east Asia, and other main weather systems in the simulated imageries are consistent with the observed imageries.
- In IR 10.4 ㎛ channel, the simulated brightness temperature of cloud are generally greater, whereas the brightness temperature of cloud-free areas are generally smaller. For IR 6.2 ㎛ channel, the simulated and observed brightness temperature values have the greatest consistency in both distribution and size.
- The simulated imagery data is produced at interval of one hour, which motion vectors are merged is also one hour.

Results

Merged motion vectors

- Himawari-8 satellite observation imageries of IR10.8 ㎛ channel(2019. 02. 18 00:00 UTC ~ 06:00 UTC)



- Predicted satellite imageries using merged motion vectors

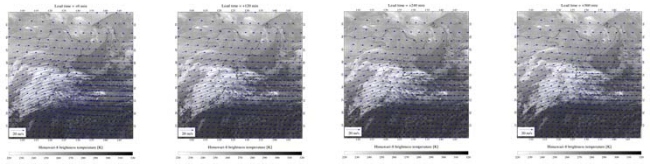


Fig. 5 Observation imageries(top) and results of production of predicted satellite imageries(bottom) for infrared channel of Himawari-8.

Figure 5 shows the results of the production of predicted satellite imageries according to the predicted time of Himawari-8 satellite infrared channel(IR 10.8 ㎛). The area around the Korean peninsula showing a low brightness temperature due to clouds is widely seen and the relatively rapid movement around the Korean peninsula can be seen as the forecast time increase. We can be seen that the trend is accelerating.

- Himawari-8 satellite observation and predicted satellite imageries of IR 6.2 ㎛ channel

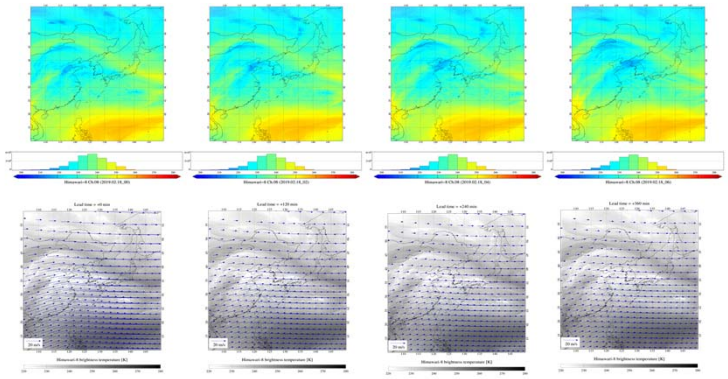


Fig. 6 Observation imageries(top) and results of production of predicted satellite imageries(bottom) for water vapor channel of Himawari-8

Compared with Himwari-8 satellite observation imageries of IR6.2 ㎛ channel, the predicted satellite imageries are similar. These results are all reflected the positional and range characteristics in both water vapor distribution and current.

Validations of the prediction performance

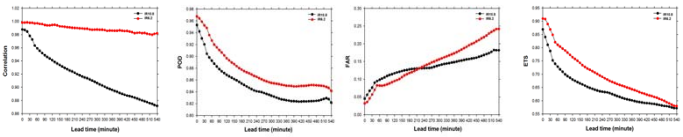


Fig. 7 The results of the prediction performance verification according to the merged motion vector for IR10.8 and IR 6.2 ㎛ channel data of Himawari-8

For the prediction performance verification, 9 hours prediction field is produced using merged motion vector. The prediction performance is compared using satellite observation. The results of prediction performance for IR 6.2 ㎛ channel is better than IR 10.8 ㎛ channel.

Summary

- The algorithm of the predicted satellite imagery production has been improved the MAPLE algorithm. Validations of the prediction performance are carried out for IR6.2 and IR10.8 channel of Himawari-8 observation. These results showed a good predictive performance.
- For the future work, we plan to apply the improved algorithm using GK-2A observation data. In addition, the predicted satellite imagery will be utilized in very short range forecast.