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RA II WIGOS Project Newsletter

DEVELOPING SUPPORT FOR NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN SATELLITE DATA, PRODUCTS AND TRAINING

Contents of this issue

The Nineteenth International TOVS Study Conference (ITSC-19)

The Korea Meteorological Administration (KMA) and The National Meteorological Satellite Center (NMSC) are pleased to announce the Nineteenth International TOVS Study Conference, ITSC-19 to take place on Jeju Island, Korea from Wednesday 26 March through Tuesday 1 April 2014.

Background

The International TOVS Working Group (ITWG) is convened as a sub-group of the International Radiation Commission (IRC) of the International Association of Meteorology and Atmospheric Physics (IAMAP). ITWG has also provided reports to the Coordination Group for Meteorological Satellites (CGMS) and this now has been also formally recognized as a sub-group of CGMS. The ITWG continues to organize International TOVS Study Conferences (ITSCs) which have met approximately every 18 to 24 months since 1983.

Objectives

Through this forum, operational and research users of satellite sounding data including the TIROS Operational Vertical Sounder (TOVS), the Advanced TOVS (ATOVS) and other atmospheric sounding data build on the TOVS heritage. Working group members exchange information on data processing methods, derived products, and the impacts of radiances and inferred atmospheric temperature, moisture, and cloud fields on numerical weather prediction (NWP) and climate studies.

Conference Topics

The conference will cover a wide range of topics concerning atmospheric sounding, its applications and related issues. We propose that key issues for this meeting include:

- Preparations for and early results from FY3-C and Meteor-3M data
- Updates on operational processing and the exploitation of ATOVS, ATMS, SSMIS and hyperspectral sounder data (AIRS, IASI, CrIS)
- New applications of microwave and infrared sounder data in numerical weather prediction and nowcasting (e.g., new assimilation techniques, bias tuning, use of cloudy radiances), including blended products from polar orbiting and geostationary satellites
- Use of microwave and infrared sounder data over land and ice surfaces
- Generation of geophysical parameters with emphasis on surface emissivity, cloud, and precipitation
- Applications of microwave and infrared sounder data in climate monitoring and GCOS activities
- Direct readout software and retransmission services
- Studies and results for new and future infrared and microwave sounders. Examples include MIS, SAFIRE and MADRAS on Megha Tropiques, geostationary hyperspectral sounders, and others
- Updates on Satellite Programs and International Coordination (WMO, CGMS).

Other important and related issues include the validation and tuning of radiative transfer models, surface models, direct broadcast and community software, especially for METOP, NPP, NPOESS, FY3, METEOR-3M, retransmission of geostationary satellites, satellite sounding requirements for GEOSS, absolute calibration and cross-calibration of the global satellite observing system.

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The latest Conference

The ITSC-18
21-27 March 2012
Toulouse, France
Hosted by Météo-France at Météo-France Conference Center
http://cimss.ssec.wisc.edu/itwg/itsc/itsc18/

(Dohyeong KIM, KMA)

Current Status of COMS AMV in KMA/NMSC

Introduction

The Atmospheric Motion Vectors (AMV) product is one of the COMS 16 geophysical products. The COMS AMV data service was in operation on April 1, 2011, and used as input data for the NWP from December 1, 2011. The sensitivity test performed by KMA reported the COMS AMV made the positive effects on the NWP.

COMS AMV Algorithm

COMS AMVs are produced every hour for 5 channels. The target box is 24x24 pixels with three consecutive satellite images in every 15 minutes. Table 1 summarized the specification for COMS AMVs product.

<Specifications for COMS AMV estimation>

Interval time	15 minutes
Target box size	24x24 pixels (96kmx96km)
Search box size	80x80 pixels
Height assignment	IR AMV : EBBT, STC WV AMV : EBBT, NTC, NTCC VIS AMV & SWIR AMV : EBBT
Regular Grid	12x12 pixels (48kmx48km)
Used NWP data	UM N512L70 (25km)

Characteristics of errors

Figure 1 shows annual variation of the accuracies (bias & RMSVD) for IR AMVs at high level. The AMVs have slow bias due to strongest jet stream in the Northern Hemisphere, while it shows relatively small slow bias in the tropical regions during the winter season (December to March).

Figure 2 exhibits the spatial and vertical distributions of monthly mean biases of the COMS AMVs from those of NWP for July 2011 and January 2012, respectively.

Figure 3 shows the bias of vertical distribution of AMV shows the latitudinal and seasonal variations. It is notable that in tropical area, small positive biases are shown in all levels without seasonal variation.

As a result, the bias of COMS AMV tends to depend on the wind speed and direction.

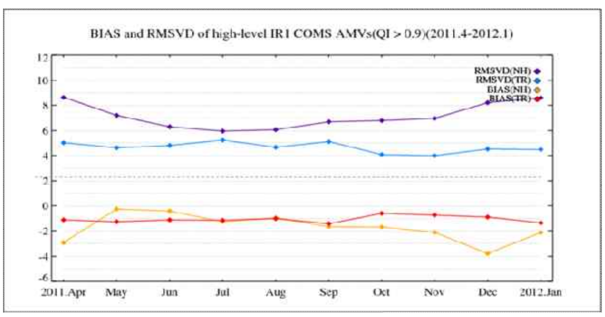

Figure 1. Accuracies(bias & RMSV) of high level AMVs during the period of April 2011 to January 2012.

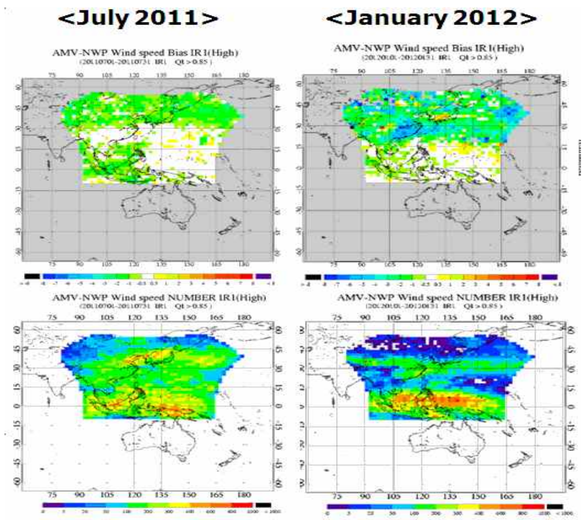

Figure 2 Statistical map (bias & RMSVD) of high level AMV.

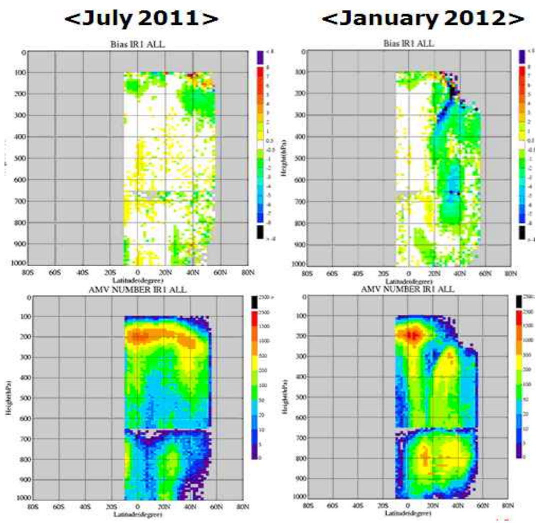

Figure 3. Vertical distribution of bias (upper) and RMSVD (bottom) of AMV

Recent activities for COMS AMV

The 11th IWWG (2012) reported that target size of 16 x 16 pixels (T16) is optimal in terms of accuracy when the images of interval time 15 minutes are selected.

Accordingly, the sensitivity tests for target sizes were performed and compared with NWP wind data. The result shows that T16 (bias: 0.67) rather than T24 (bias: -0.81) showed an improvement of accuracy. However, the numbers of vectors was reduced approximately up to 30%.

Currently, COMS AMV has a spatial resolution of 12 x 12 pixels (64 x 64 km, G12). The AMVs from spatial resolution of 8 x 8 pixels (G8) and optimal target selection (OTS) method were developed. The test result showed better improvement in terms of quality (see Figure 4). The maximum percentage of overlapping pixels is 62% between two target areas in OTS.

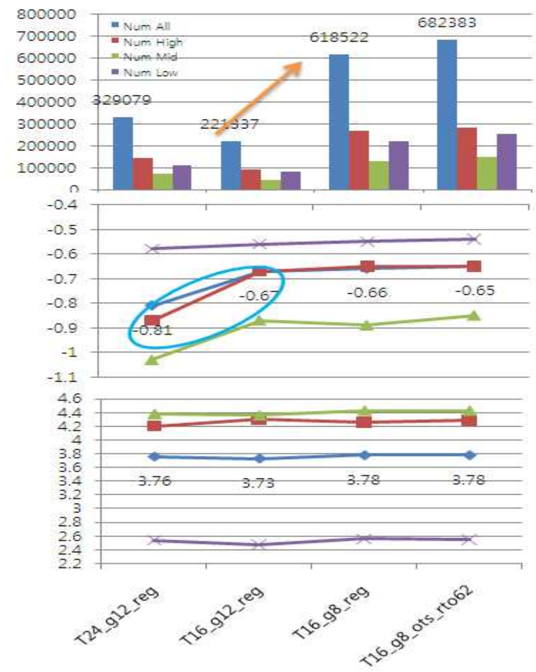

Figure 4. Number (first row), bias (second row) and RMSVD (third row) of IR AMV for different target size, spatial resolution and utilisation of optimal target selection (OTS) for January (left) and July (right) 2012. (T24(16)_g12(8)_regular (ots_rto62) : AMV with target size of 24x24 (16x16) pixels, spatial resolution of 12x12 (8x8) pixels and without OTS (with OTS of 62% overlapping).

Conclusions

In summary, the COMS AMVs have been in an operation since December, 2011. The sensitivity tests report the positive effects on KMA NWP model, in particular, over Eastern Asian region through NWP denial experiment. The high quality AMVs as well as better satellite based low-level winds are still required to improve the performance of regional NWP model.

KMA/NMSC focuses on developing satellite derived local wind with smaller target box size for regional NWP model and the improvement of accuracy from new tracking and height assignment. KMA/NMSC is ready to disseminate COMS AMVs via GTS in the near future.

(Eunha Sohn, NMSC/KMA)

Development and utilization of AHI simulation data on HIMAWARI-8

Introduction

JMA plans to launch Himawari-8 in 2014 and begin its operation in 2015. The launch of Himawari-9 is also scheduled for 2016 to ensure the robustness of the satellite observation system. Himawari-8 and -9 will carry a new unit called the Advanced Himawari Imager (AHI), which has capabilities comparable to those of the ABI imager on board GOES-R. Its functions and specifications are notably improved from those of the imager on board MTSAT as listed in Table 1.

Table 1: Specifications of imagers on board Himawari-8/9 and MTSAT-1R/2

	Himawari-8/9	MTSAT-1R/2
# of channels	16 (VIS: 3, NIR: 3, IR: 10)	5 (VIS: 1, IR: 4)
Spatial resolution at sub-satellite point	VIS: 0.5 – 1.0 km IR: 1 – 2 km	VIS: 1 km IR: 4km
Spatial coverage	- Full disk every 10 minutes - 5 small sector observations	Full disk every 30 minutes

Himawari-8 and -9 will offer high observation potential, which will enable users to develop and improve a wide range of products. Using AHI data, JMA plans to develop new products related to volcanic ash and instability indices. Current satellite products such as Atmospheric Motion Vectors (AMVs), cloud grid information, clear sky radiance and sea surface temperature will also be improved. In particular, significant improvement of the AMV product is foreseen because higher spatial and temporal resolutions are expected to provide better target tracking accuracy, and the increased number of observation channels will enhance AMV height assignment.

To support research and development for products derived from AHI observation on Himawari-8, simulation-based proxy data have been created. Numerical Weather Prediction (NWP) data used in the simulation provide the "truth" of the atmosphere. Simulation data can be used as proxy information for the pre-launch satellite as well as to improve products generated from existing satellite observation.

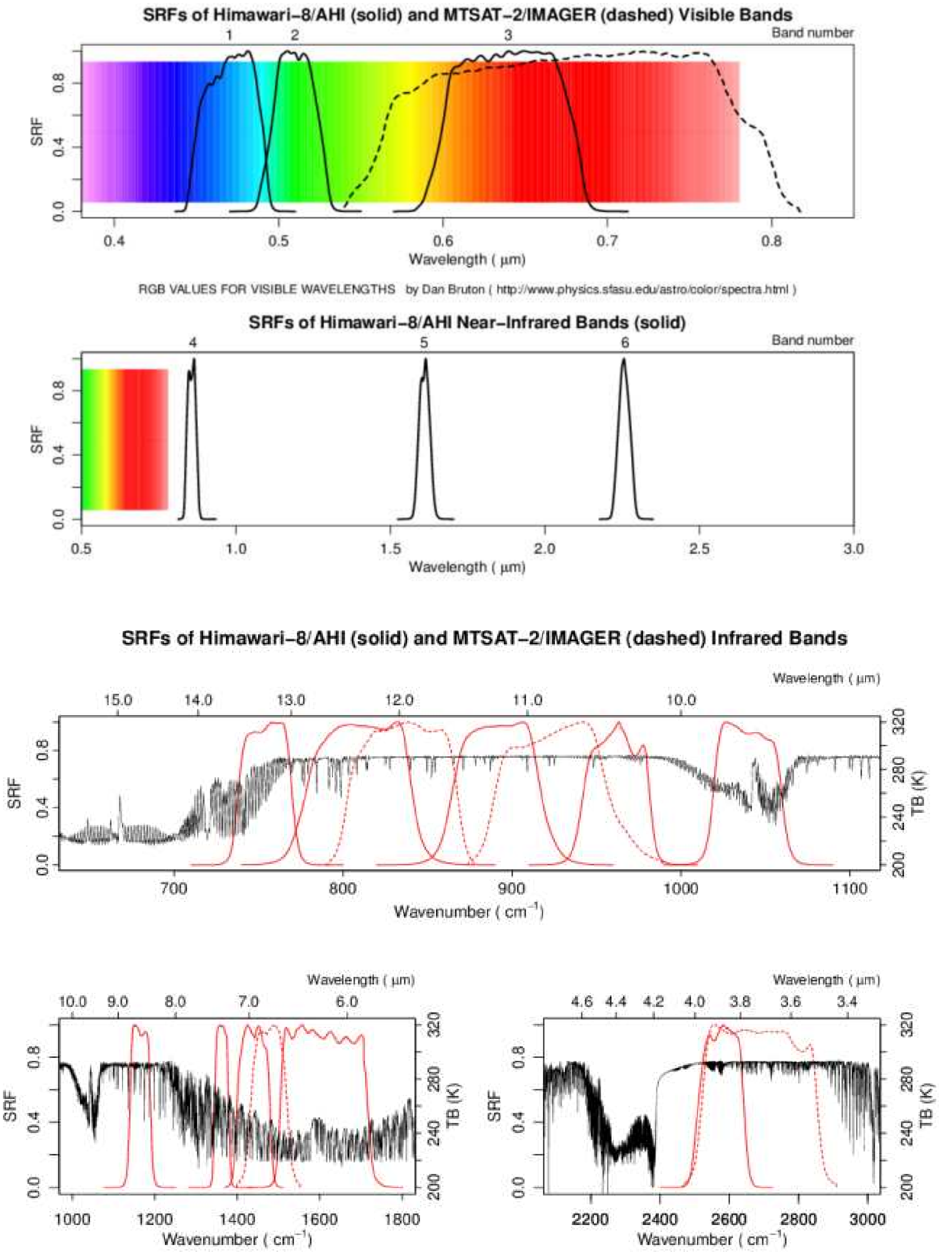

Figure 1: Spectral Response Functions (SRFs) of AHI on Himawari-8 and Imager on MTSAT-2. The solid and dashed curves represent the SRFs of AHI and Imager, respectively. The black lines in the infrared figures represent the brightness temperatures of up-welling radiances at the top of the atmosphere simulated by the radiative transfer model (LBLRTM) with HITRAN2000 (AER updates) line parameters based on the US standard atmosphere. The RGB spectra in the visible/near-infrared figures are generated by the program at http://www.physics.sfasu.edu/astro/color/spectra.html.

Simulation of AHI observation

Figure 1 shows the estimated SRFs (spectral response functions) of AHI as of June 2012. True-color images can be obtained from a combination of the three visible channels (blue: 0.46 μm; green: 0.51 μm; red: 0.64 μm). Using radiative transfer computation with these SRFs, AHI 16-band simulation data are generated. In this work, RSTAR (Nakajima and Tanaka 1986) is adopted as the Radiative Transfer Model (RTM). Table 2 shows its calculation design. Atmospheric fields were given by analysis and forecasts from JMA's global NWP model with a horizontal resolution of approximately 20 km. Surface parameters are derived from a MODIS product provided by NASA. For ozone and aerosol parameters, climatological values are currently adopted. Since February 2013, simulated AHI data have been made available online for use in AHI research and development during the pre-launch phase.

Table 2: Radiative transfer calculation design

RTM	Rstar6b (Nakajima and Tanaka 1986)
Longitude of sub-satellite point	140°E
SRF	Polygonal line expressed with five points
# of vertical layers in RTM	14
Atmospheric profiles	GSM
Wind speed	GSM
Surface reflectance	MODIS product (MOD09)
Aerosol and ozone	Climatology value used in GSM
Cloud	Retrieved from GSM

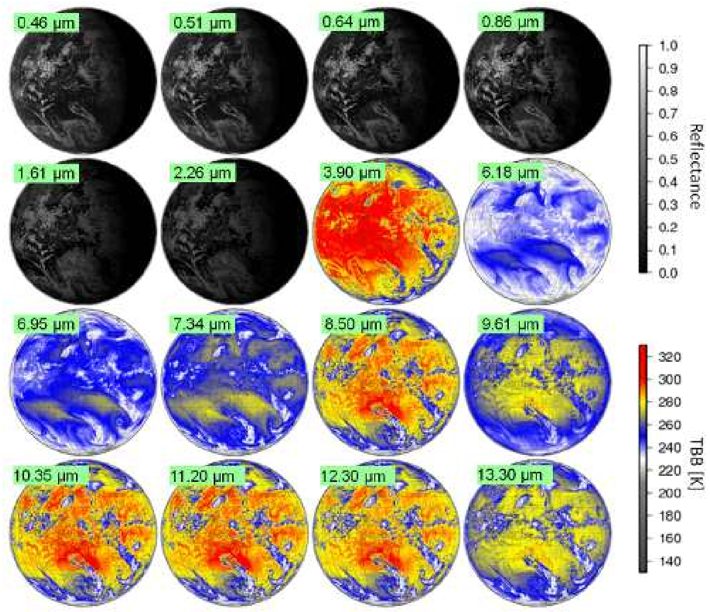

Figure 2: Simulated images for Himawari-8's 16 AHI bands based on RSTAR

Utilization of simulated AHI data for development

JMA/MSC currently uses simulated satellite data for product development. This approach is expected to improve the accuracy of satellite-derived products such as Atmospheric Motion Vectors (AMVs). The retrieval algorithm of satellite-derived products can be interpreted as involving inverse functions against observation functions. To construct an inverse function (or observation function), it is necessary to know the input and output of these functions. However, in most cases, it is difficult to obtain independent co-located observation data at observable areas, and co-located data are also often from a retrieved dataset. In addition, such data comparable to observation data do not always exist for the targets of interest. Accordingly, satellite product developers must have detailed knowledge of other observation methods and extensively collect co-located data until a specific meteorological situation of interest is well covered. Figure 3 shows conceptual diagrams highlighting the benefits of using simulated satellite data. The utilization of simulated observation data provides one solution to the construction of a consistent retrieval algorithm (inverse function), as "truth" data can be obtained in a simulated system.

AMV derivation from simulated Himawari imagery

JMA has started to generate AMVs from simulated AHI data for a Himawari-8 AMV algorithm study. As discussed before, AMVs are derived from simulated imagery with a spatial-temporal resolution of 0.5 degrees and 60 minutes. Figure 4 shows AMVs derived from simulated Himawari-8 data. Although the spatial resolution of the NWP dataset used for the simulation is coarser than that of AHI, it can be seen that atmospheric motion vectors of synoptic scales are well derived. In the next step, JMA plans to check consistency between wind vectors and allocated heights against the NWP vertical profile.

Conclusion

This article reports on the activities of JMA regarding the development and utilization of AHI simulation data on Himawari-8. To support research and development for Himawari-8 satellite products, JMA is currently generating simulated AHI data using radiative transfer computation software (RSTAR). As a first step, JMA used its global NWP model data as input to generate full disk images. This simulated imagery can be used in the development of satellite-derived products such as AMVs, but some limitations apply due to their coarse temporal and spatial resolution compared with practical AHI observation.

To address the low-resolution problem, JMA plans to generate high-resolution AHI imagery simulated from a regional NWP model. Simulated AHI data will also be applied to other satellite products in addition to AMVs.

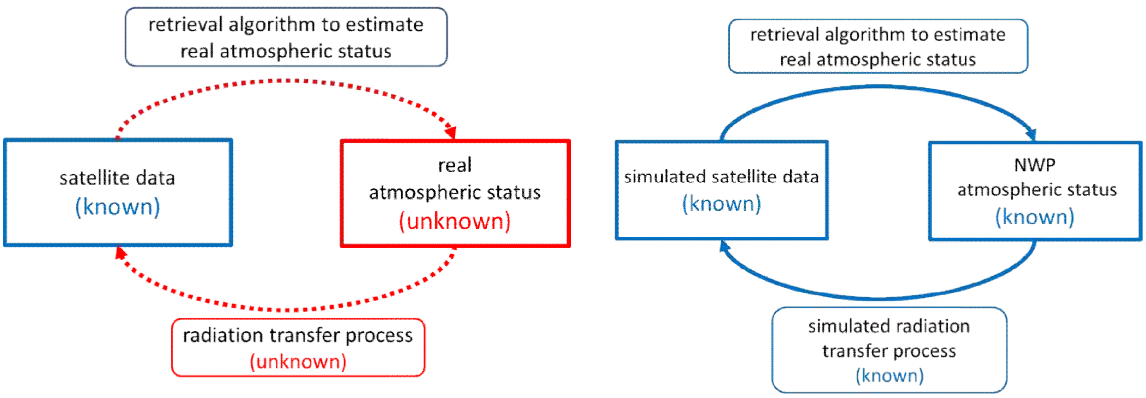

Figure 3: Conceptual diagram showing the benefits of using simulated satellite data. The panel on the left shows the processes involved in estimating the real atmospheric status from real satellite data using a retrieval algorithm. Satellite data are naturally generated from an unknown atmospheric status and an unknown radiation transfer process. After the retrieval process, the estimated atmospheric status is obtained. However, there are no real atmospheric data to compare with the estimated status. The panel on the right shows a case in which NWP atmospheric data are used as a substitute for real data. Here, the atmospheric status determined and the radiation transfer process are explicitly described. The presence of product input and output is useful in product development, because the values to be retrieved are explicitly given.

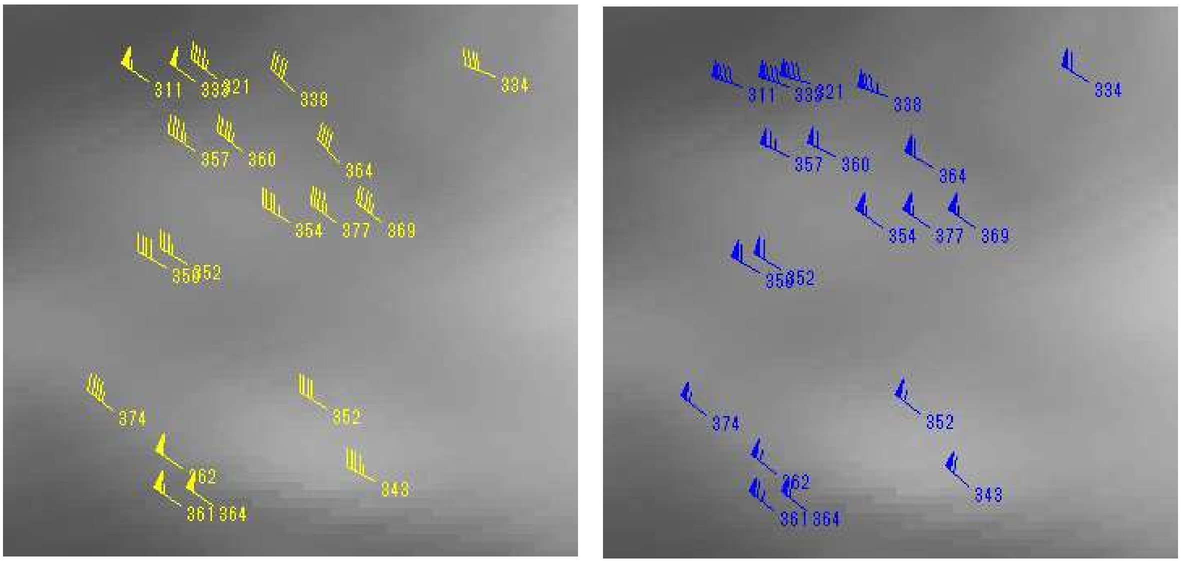

Figure 4: Comparison of IR upper level AMVs computed from 60 minute interval Himawari-8 simulated imagery (yellow arrows) and co-located NWP wind vectors (blue). The numbers indicate heights (hPa). The AMVs show lower speeds than NWP data. This result indicates that JMA‘s AMV tracking algorithm derives lower wind speeds than true winds for IR AMVs from simulated imagery.

Reference

Nakajima, T. and M. Tanaka, 1986: Matrix formulation for the transfer of solar radiation in a plane-parallel scattering atmosphere. *J. Quant. Spectrosc. Radiat. Transfer*, **35**, 13-21.

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From the Co-editors

The co-editors invite contributions to the newsletter. Although it is assumed that the major contributors for the time being will be satellite operators, we also welcome articles (short contributions of less than a page are fine) from all RA II Members, regardless of whether they are registered with the WMO Secretariat as members of the WIGOS Project Coordinating Group. We look forward to receiving your contributions to the newsletter.

(*Dohyeong KIM, KMA, and Tomoo OHNO, JMA*)

RA II WIGOS Project Mailing Lists

Two mailing lists for discussion on the WIGOS project will soon be set up using the Google Groups service, and will be implemented either through the Google Groups web interface or by e-mail.

One list is for WIGOS Project Coordinating Group members who are already registered with the WMO's Regional Office for Asia and the South-West Pacific.

Group name: ra2pp_sat_cg
Group home page:
http://groups.google.com/group/ra2pp_sat_cg
Group email address:
ra2pp_sat_cg@googlegroups.com

The other list is for RA II Members in general.

Group name: ra2pp_sat
Group home page:
http://groups.google.com/group/ra2pp_sat
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RA II WIGOS Project Home Page

http://www.wmo.int/pages/prog/sat/ra2pilot project-intro_en.php
(To be updated)

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