STATUS OF OPERATIONAL AMV PRODUCTS AT EUMETSAT

Régis Borde [1], Manuel Carranza [2], Olivier Hautecoeur [3]

[1] EUMETSAT
[2] GMV Insyen
[3] Exostaff

ABSTRACT

EUMETSAT is deriving operational Atmospheric Motion Vectors (AMVs) from the geostationary orbit over the Meteosat Second Generation (MSG) disks at 0 and 41.5 deg. longitudes, and from the EUMETSAT Polar System (EPS) low earth orbit Metop satellites over the northern and southern high latitude (>40 deg.) areas. The Meteosat Third Generation (MTG) and EUMETSAT Polar System Second Generation (EPS-SG) programmes will take over some of the AMV production in 2021 and 2022 respectively. The improved characteristics and capabilities of MTG-FCI and EPS-SG-METImage instruments require a tailored implementation of the AMV algorithms, and both technical and scientific verifications are already ongoing and will continue in the timeframe 2018-2022.
A high level of innovation is maintained at EUMETSAT to fulfil the increasing AMVs user needs and requirements. Therefore, the extraction of 3D winds from Infrared sounders has been investigated during the last years, and the development of new AMV products from Sentinel-3 is planned in the upcoming two years.

Several important changes are planned for the next years in the EUMETSAT satellites configuration which will require specific work on the AMV products. In 2018, Meteosat-9 will be relocated to 3.5 deg. east, Meteosat-10 will replace Meteosat-9 at 9.5 deg. East providing the Rapid Scan service, and Meteosat-11 will ensure the primary service at 0 deg. Longitude after a commissioning period. The last satellite of the Metop series, Metop-C, is scheduled for launch in October 2018. A tristar configuration of three Metop satellites has been decided for commissioning, and it could provide operational service until 2020-21. This will need appropriate development and adaptation of the algorithm in order to manage the impact on the production of AVHRR AMVs extracted from dual Metop operation, and to study the potential benefit of the tristar configuration.

OPERATIONAL WIND PRODUCTS AT NOAA/NESDIS: A STATUS UPDATE

Hongming Qi
NOAA/NESDIS, Office of Satellite and Product Operations
NOAA Center for Weather and Climate Prediction
College Park, Maryland 20740, U.S.A.

Jaime Daniels
NOAA/NESDIS, Center for Satellite Applications and Research
NOAA Center for Weather and Climate Prediction
College Park, Maryland 20740, U.S.A.

Jeff Key
NOAA/NESDIS, Center for Satellite Applications and Research
University of Wisconsin-CIMSS
Madison, Wisconsin 53706, U.S.A.

Paul Chang
NOAA/NESDIS, Center for Satellite Applications and Research
NOAA Center for Weather and Climate Prediction
College Park, Maryland 20740, U.S.A.

Nicholas Esposito
EMCS, LLc
Greenbelt, Maryland 20770, U.S.A.

Andrew Bailey
I.M. Systems Group (IMSG)
Rockville, Maryland 20852, U.S.A.

Jeffrey Augenbaum
SGT, Inc.
Greenbelt, Maryland 20770, U.S.A.

ABSTRACT

This paper summarizes the status of the operational and new improved wind products at NOAA/NESDIS. Recent improvement, new additions, processing changes and monitors, future plans of the Atmospheric Motion Vector (AMV) product suite will be discussed. The current satellite constellation for operational AMV winds processing includes new GOES-16 (eastern operational geostationary satellite), GOES-15 (western operational geostationary satellite), VIIRS from S-NPP, AVHRR from NOAA and MetOp series, and MODIS from Terra and Aqua. Besides the currently operational AMV products, several improvements in NOAA/NESDIS AMV products have been and will be implemented. These improvements include new GOES-16, the transition from heritage BUFR template to new BUFR template, enhancement of VIIRS AMV from S-NPP, and MODIS and AVHRR AMV products by using GOES-R/VIIRS AMV algorithms. Updates on the status of these operational AMV products, new wind processing system, new AMV BUFR template, data access policy, and other future plans like GOES-S and JPSS-1 will be presented. In addition, an overview of the operational ASCAT ocean surface wind products at NOAA/NESDIS is also presented.

RETRIEVAL AND APPLICATIONS OF ATMOSPHERIC MOTION VECTORS USING INSAT-3D/3DR DATA: ISRO STATUS

Sanjib K Deb, D K Sankhala and C M Kishtawal

Atmospheric and Oceanic Sciences Group, Space Applications Centre,
Indian Space Research Organization, Ahmedabad-380015,
E-mail: sanjib_deb@sac.isro.gov.in

ABSTRACT

It is almost a decade now, the operational derivation of atmospheric motion vectors (AMVs) from Indian geostationary meteorological satellites started at Space Applications Centre (SAC), Ahmedabad, under INSAT Meteorological Data Processing System (IMDPS) project. Over the time many improvements in the operational retrieval algorithm have taken place with the advancement in the retrieval techniques as well as in the sensors. At present two advanced Indian geostationary meteorological satellites INSAT-3D and INSAT-3DR launched on 26 July 2013 (placed at 82^0E) and 06 September 2016 (placed at 74^0E) are providing continuous coverage at every 15-minute over the Indian Ocean region. The different spectral channel data from these satellites has enhanced the scope for better understanding of the different tropical atmospheric processes over this region. The retrieval techniques and accuracy of atmospheric motion vectors (AMVs) has improved significantly with the availability of improved spatial resolution data along with more options of spectral channels in the INSAT-3D/3DR imager. In this work, a brief summary of the INSAT-3D/3DR data and operational AMV retrieval algorithm using four different spectral channels (visible, infrared, mid-infrared and water vapour channels) of INSAT-3D/3DR at 4 km spatial resolution are discussed. It also discusses the retrieval of staggering AMV using simultaneous use of INSAT-3D and INSAT-3DR data. The long-term quality assessment of INSAT-3D/3DR AMVs with different other observations viz. radiosonde winds, model analysis winds and other available AMVs (viz. Meteosat-8) over this region are also presented. The derivation of different wind derived products (viz. convergence, divergence, vorticity, wind shear etc) using INSAT-3D/3DR data and their possible applications in different atmospheric phenomena are also discussed. To demonstrate the initial application, INSAT-3D/3DR AMVs are also assimilated into numerical model to assess the impact for forecast improvement for few case studies. The validation results and impact assessment from this study will provide some guidance to the international operational agencies for the applications of this new AMV data-set for future applications in the Numerical Weather Prediction (NWP) over the south Asia region.

CURRENT STATUS OF ATMOSPHERIC MOTION VECTORS AT JMA

Kenichi Nonaka

JMA/MSC

ABSTRACT

The Meteorological Satellite Center (MSC) of the Japan Meteorological Agency (JMA) started to disseminate Atmospheric Motion Vectors (AMVs) of Himawari-8 via the Global Telecommunication System (GTS) since July 7 2015 operationally. Himawari-9 was successfully launched in November 2016 and started standby operation as a backup of Himawari-8 on March 10 2017. Himawari-9 carries the Advanced Himawari Imager (AHI) which can observe 16 bands from visible to infrared with the approximately equivalent specification to Himawari-8/AHI. Himawari-8 and -9 are stationed at almost the same longitude (140.7° E) and cover the same observation area. In case of Himawari-8 malfunction, Himawari-9 starts observation and JMA/MSC provides Himawari-9 AMVs instead of Himawari-8 AMVs after a quality checking.

In order to confirm that instruments and systems of Himawari-9 work properly, JMA/MSC has operated Himawari-9 and performed tentative observations several times so far. Himawari-9 AMVs were derived and validated using the taken images. In this presentation, we will report characteristics of the Himawari-9 AMVs and also present current status of Himawari-8 AMVs.

STATUS OF AMVS FROM FENGYUN GEO. SATELLITES

Xiaohu Zhang, Jianmin Xu, Feng Lu, Peng Cui

National Satellite Meteorological Center
China Meteorological Administration, Beijing 100081, CHINA

ABSTRACT

This paper briefly introduces status of AMVs operations at NSMC.

In the last two years, CMA continues FY-2 AMVs operations and services. At present, FY-2G (105ºE) and FY-2E (86.5ºE) are both in operation. AMVs derivations are performed for both FY-2G and FY-2E. For FY-2G, AMVs are provided at 00 06 12 18 UTC, while FY-2E at 03 09 15 21 UTC. The wind derivation scopes are in the regions of satellite zenith angle less than 60 degree. The AMVs passed quality control are transmitted through GTS in BURF code.

FY-4A was successfully Launched on Dec. 10, 2016. After about one-year in-orbit testing, FY-4A will be put into trial operation and will distribute data to the public in 2018. This paper introduces the algorithm of FY-4A AMVs, the framework and performance of the FY-4A AMVs system and the preliminary validation result of FY-4A AMVs in the period of in-orbit testing respectively.

In addition, this paper shows the result of FY-2 AMVs historical dataset reprocessing.

TECHNICAL AND SCIENTIFIC VERIFICATIONS OF THE EUMETSAT MTG-FCI AMV PROTOTYPE

Manuel Carranza [1], Régis Borde [2]

[1] GMV Insyen
[2] EUMETSAT

ABSTRACT

In preparation for the launch of the first MTG-I satellite, currently scheduled for the fourth quarter of 2021, the MTG-FCI AMV prototype has been developed at EUMETSAT based on the current operational MSG AMV processor. In the framework of MTG's Ground Segment preparation, technical and scientific verifications of the MTG-FCI AMV prototype are currently ongoing using both MSG and Himawari-8 data.

A thorough comparison of the MSG and MTG AMV extraction algorithms has been performed using one month of MSG data (14th May to 14th June 2016) in order to test the impact of the main algorithm changes proposed for MTG-FCI (use of three images instead of four, no intermediate product averaging, etc.). The performances of the two schemes against forecast fields and radiosonde observations will be presented.

Due to the similar spectral and spatial characteristics of the AHI (Advanced Himawari Imager) and MTG-FCI instruments, the potential improvements and scientific characteristics of the future MTG-FCI AMV product can be assessed using Himawari-8 data. Thanks to collaborations with JMA and KMA, the MTG-FCI AMV prototype has been successfully adapted to use Himawari-8 data, and AMVs extracted with the MTG-FCI prototype have been compared against those extracted with the Himawari and GeoKompsat AMV algorithms.

Finally, very preliminary results of a new approach that aims to estimate AMV speed and direction errors from Level-1 image navigation errors will also be presented in this paper.

INTRODUCING ATMOSPHERIC MOTION VECTORS DERIVED FROM THE GOES-16 ADVANCED BASELINE IMAGER (ABI)

Jaime Daniels[1], Wayne Bresky[2], Andrew Bailey[2], Americo Allegrino[2], Steven Wanzong[3], Chris Velden[3]

1. NOAA/NESDIS Center for Satellite Applications and Research, NOAA Science Center, College Park, Maryland 20740, U.S.A.
2. I.M. Systems Group (IMSG), Rockville, Maryland 20852, U.S.A.
3. Cooperative Institute for Meteorological Satellite Studies (CIMSS), Space Science and Engineering Center (SSEC), University of Wisconsin – Madison, Wisconsin 53706, U.S.A

ABSTRACT

The GOES-16 satellite was successfully launched on November 19, 2016. The Advanced Baseline Imager instrument data and the Level 1B products were declared provisionally operational on June 1, 2017. This paper introduces the GOES-16 derived motion winds product derived from measurements taken from the Advanced Baseline Imager (ABI). More specifically, image triplets involving ABI bands 2 (0.64um), 7 (3.9um), 8 (6.2um), 9 6.9um), 10 (7.3um), and 14 (11.2um) over the Full Disk, CONUS, and Mesoscale sectors are used to identify and track cloud or moisture features to arrive at estimates of atmospheric motion. The higher spatial and temporal resolution of the ABI imagery enables more winds to be produced while also capturing motion at smaller scales. A new nested tracking algorithm, designed and developed in advance of the launch of GOES-16, captures the dominant motion in each target scene and minimizes the slow speed bias typically observed in winds derived at upper levels of the atmosphere. Heights assigned to derived winds are achieved through judicious use of cloud-top heights produced upstream of the winds algorithm. Intensive validation of the GOES-16 wind product has been ongoing during and after the Post-Launch Test (PLT) period and is aimed at characterizing the performance of the wind product relative to available reference/ground truth wind measurements from rawinsondes and commercial aircraft. Examples of the GOES-16 wind product and validation results obtained so far will be presented and discussed.

CURRENT STATUS OF GK-2A AMV ALGORITHM IN NMSC/KMA

Soomin Oh, Byung-il Lee, Sung-Rae Chung, Seongkyun Baek

National Meteorological Satellite Center/KMA, Republic of Korea, bilee01@korea.kr

ABSTRACT

KMA plans to launch the next Korean geostationary meteorological satellite GEO-KOMPSAT-2A (GK-2A) in 2018. The 16-channel advanced meteorological imager (AMI) of GK-2A will provide high resolution data in time and space. KMA has started to develop fifty-two meteorological products for GK-2A/AMI since 2014 for applying now-casting, numerical weather prediction, climate and so on.

Atmospheric motion vector (AMV) algorithm is retrieved wind using continuous satellite images. We have been developing AMV algorithm for the AMI of GK-2A. The algorithm has developed using Himawari-8/AHI as a AMI proxy data. The algorithm consists of four steps from target selection to quality check. The first step is selection of a target in an image and selection of specific points. We use an optimization method to select a target. The second step is tracking of the target to calculate wind speed and direction using displacements of clouds or water vapor in the images. The third step is height assignment to the wind using cloud height information for the L2 product or the output of the RTM model. The last step is a quality check to compare the results to radiosonde data or the wind field of the NWP model.

In this paper, we will introduce the more detailed development status and future plan of the AMV algorithm for AMI of GK-2A.

OPERATIONAL GENERATION AND ASSIMILATION OF HIMAWARI-8 ATMOSPHERIC MOTION VECTORS

John Le Marshall[1], David Howard[1], Xingbao Wang[1], Yi Xiao[1], Jamie Daniels[2], Jim Jung[3], Agnes Lim[3], Steve Wanzong[2], Wayne Bresky[2], Andrew Bailey[2], Chris Tingwell[1], Tan Le[1] and Tim Morrow[4]

[1]Bureau of Meteorology, Australia, [2] NOAA/NESDIS USA, [3] UW/CIMSS, Madison, USA, [4]Melbourne University.

ABSTRACT

The Himawari-8 satellite provides imagery in sixteen wavebands every 10 min over the Asian and Australasian regions. Navigated and calibrated imagery has been used operationally in the Bureau of Meteorology (BoM) to generate Atmospheric Motion Vectors (AMVs) over the full earth disk viewed from the satellite *every* ten minutes. Each vector has been error characterised including the assignment of an expected error. To further enhance the use of these 10 min high temporal and spatial density data in operational assimilation their spatial, temporal and error distribution has been analysed and the data subsequently have been used with the full BoM operational database to provide forecasts from the current operational forecast model and also the nested tropical cyclone forecast model TCX. Results from these tests indicate these locally generated Himawari-8 AMVs, which are available for every 10 minutes, are of high density and quality and have the ability to improve numerical weather prediction (NWP) model initialisation and forecasts. The results also provide an indication of the temporal density, spatial density and data selection methods appropriate for effective use of these high resolution data. These results have aided effective use of these data for analysis and forecasting, an important issue because of their current use in operational forecasting at the BoM.

VIIRS POLAR WINDS FROM S-NPP AND NOAA-20 IN TANDEM

Jeff Key[1], David Santek[2], Richard Dworak[2]

[1]NOAA/National Environmental Satellite, Data, and Information Service, Madison, Wisconsin USA
[2]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, Wisconsin USA

ABSTRACT

The Visible and Infrared Imaging Radiometer Suite (VIIRS) polar winds product is currently operational for the Suomi National Polar-orbiting Partnership (S-NPP) satellite, providing wind speed, direction, and pressure of cloud-tracked features at high latitudes, both Arctic and Antarctic. The product has been operational since May 2014. The VIIRS winds are being assimilated in the Naval Research Lab (NRL) forecast system and are currently being monitored in NCEP's pre-operational model. They are also used by a number of numerical weather prediction centers worldwide.

The VIIRS, Moderate Resolution Imaging Spectroradiometer (MODIS), and Advanced Very High Resolution Radiometer (AVHRR) wind products use three successive orbits (100-minute time step) from a single satellite to derive cloud motion. Since JPSS-1 – now NOAA-20 – is in a similar orbit as S-NPP but delayed by ½ orbit in time, there is an opportunity to track clouds from the NOAA-20/S-NPP tandem. This will reduce the time interval between images to approximately 50 minutes, which will result in reduced latency in product availability, potentially higher quality winds due to the shorter time interval for tracking, and global rather than only high-latitude coverage. The NOAA-20/S-NPP orbit configuration is similar to that of Metop-A/-B. EUMETSAT has exploited this orbit configuration and developed a Metop-A/-B wind product. Metop-A/-B case studies done by the authors and EUMETSAT's own analyses show that the tandem winds are in general agreement with single-satellite winds at high latitudes. There are, however, large uncertainties in the tropical regions.

Factors that impact the accuracy of tandem satellite winds are being investigated. This includes, but is not limited to, the impact of parallax in the tropics, and the increased uncertainty in winds derived at short time scales and with only two orbits. Results of these investigations and early results from the NOAA-20/S-NPP tandem will be presented, both for orbit pairs and orbit triplets.

AMV FROM FENGYUN GEO. STEREO VIEW – SIMULATION AND BIAS ANALYSIS-SYSTEM AND BIAS ANALYSIS

Feng Lu, Yixuan Shou, Peng Cui, Xiaohu Zhang

ABSTRACT

The prototype system for deriving AMV from Geo satellite has been developed. In this system, some new techniques are adopted. Such as the optical flow technique is adopted for target tracking, and multiple geostationary satellites asynchronous observations is used for deriving cloud height and motion information. In this presentation, some preliminary result from this new system will be presented, and some quality control approach and bias analysis will also be discussed.

NWCSAF/HIGH RESOLUTION WINDS AMV SOFTWARE VERSION 2018

Javier García Pereda

NWC SAF/AEMET, Leonardo Prieto Castro 8, E-28040 Madrid, Spain, jgarciap@aemet.es

ABSTRACT

The “High Resolution Winds product (HRW)”, developed inside the “Satellite Application Facility on support to Nowcasting and very short range forecasting (NWCSAF)” standalone software package, provides a detailed calculation of Atmospheric Motion Vectors and Trajectories locally and in real time by its users.

Last operational version was released to users in November 2016 inside NWC/GEO v2016 software package. A new version of “High Resolution Winds product”, version 2018, is now being prepared and expected for release in the Autumn 2018.

Its main new features include: the calculation of AMVs and Trajectories with Himawari-8/9 satellite series, the auto-validation of the calculated AMVs during the running of the product against NWP forecast or analysis winds, the option to calculate larger densities of AMVs at low levels, and the option to mix several time frames for the AMV calculation (considering short time frames for the tracer tracking and large time frames for the displacement calculation).

The common Quality Index and the new BUFR format for the AMV output files, such as defined by the International Winds Working Group, have also been included for homogenization with other AMV products. A parallelization process is also to be included, to ease the processing of the product in larger regions.

A STUDY OF THE AMV CORRELATION SURFACE

Mary Forsythe[1], Graeme Kelly[1], Javier García Pereda[2]

[1]Met Office, UK
[2]NWCSAF/AEMET, Spain

ABSTRACT

There are various sources of error in the AMV data. Recent effort has focussed on errors in the AMV height assignment, which is thought to be the major contributor in many cases. However, there is increasing interest in errors from the tracking step, particularly for the generation of high resolution AMVs and for polar AMVs where the smaller target box size or longer image interval make the tracking more challenging.

The purpose of this study is to use code recently provided from the NWC SAF (a modified version of HRW v2016) to plot examples of the AMV correlation surface. Can we identify cases where poor agreement of the AMV and model background wind vectors (O-B) are associated with correlation surfaces containing multiple maxima or broad maxima suggesting the tracking is poorly constrained? One area we plan to investigate is the jet wind regions where previous NWP SAF analyses have highlighted that clouds with a smoother appearance in the satellite imagery were sometimes associated with a negative O-B bias. Do we see correlation surfaces with broad, elongate maxima in these cases? A future aim would be to use the knowledge gained from this work to develop constraint flags or estimates of the uncertainty in the tracking using the correlation surface. This information could be used to improve the AMV blacklisting and error assignment in NWP.

Another, more specific, goal of this work relates to the derivation of AMVs more representative of the local flow, targeting high resolution NWP models and nowcasting applications. Work elsewhere has shown that using smaller target boxes results in more noisy wind fields and investigation of the correlation surfaces often shows there are multiple maxima. Can we use the correlation surfaces to help screen out the poorly constrained cases?

TELESCOPING DOWN TO THE CONVECTIVE SCALES: DEVELOPMENT AND APPLICATION OF AMVS

David Stettner[1], Christopher Velden[1], Robert Rabin[2], Jason Apke[3], Steve Wanzong[1], Jamie Daniels[4], Wayne Bresky[5]

[1] Cooperative Institute for Meteorological Satellite Studies/Univ. Wisconsin
[2] NOAA/National Severe Storms Laboratory
[3] Atmospheric Sciences Department/University of Alabama-Huntsville
[4] NOAA/NESDIS Center for Satellite Applications and Research, NOAA Science Center, College Park, Maryland 20740, U.S.A.
[5] I.M. Systems Group (IMSG), Rockville, Maryland 20852, U.S.A.

ABSTRACT

AMVs have traditionally been developed for capturing the large-scale flow patterns, owing in part to NWP analyses that ignored convective scales. However, this paradigm is changing, as numerical models and associated data assimilation systems are at the point of trying to better resolve these fine scales. In parallel with this, satellite sensors and associated scanning strategies have improved and are now able to resolve convective flow fields. Spatiotemporal sampling is no longer an issue. Coupled with the increased availability of computing capacity and more sophisticated algorithms to track cloud motions, we are now poised to explore the development and application of AMVs to convective scale events.

Understanding the physical processes that govern convectively-driven weather systems is usually hindered by a lack of observations on the scales necessary to adequately describe the events. In this presentation we explore this frontier. Can emerging AMV processing methodologies be combined with very high spatiotemporal resolution geostationary satellite imagery to help deduce convective-scale wind flows? Can the resultant AMV fields help diagnostic studies of severe weather and tropical cyclone behavior? And could they benefit rapid-refresh data assimilation for mesoscale NWP model forecast improvement?

In this presentation we will show several examples of mesoscale and convective scale applications, ranging from tornadic storms to tropical cyclones. We focus on the use of the newly available GOES-16 meso-sector rapid-scan (30–60-sec.) imagery, and emerging methods to extract information (winds) from close-in-time sequences.

ASSESSMENT OF MISR WIND HEIGHTS RELATIVE TO CATS LIDAR AND MODIS

Kevin Mueller

Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA, USA

ABSTRACT

Cloud motion vectors (CMVs) derived from the Multi-angle Imaging SpectroRadiometer (MISR) instrument continue to be produced both with as a near-real time (NRT) product with 2 hour latency and as an archived continuous and nearly global record dating back to 2000 and expected to continue past 2020. From aboard the polar-orbiting Terra satellite, MISR exploits stereo imagery captured over the 7 minute duration of an overpass from multiple camera angles to jointly resolve geometric cloud height and motion, avoiding known issues with AMV assigned heights determined by radiometric techniques.

Demonstrated to improve forecast quality in several studies, the most recent highlighted the benefits within the GEOS-5 framework- particularly when assigning greater uncertainty to the along-track wind component. Consequently, assimilation of MISR winds will be incorporated into forward processing at GMAO.

In this talk, I will review recent assessments of stereo wind heights relative to radiometric wind heights, before showing the results from comparing 2.5 years of globally distributed collocations of MISR cloud top height and motion, MODIS cloud top height, and Cloud-Aerosol Transport System (CATS) lidar profiles of cloud scattering. CATS has operated from February 2015 to November 2017 aboard the International Space Station, whose ground track regularly crosses that of the Terra platform carrying MISR and MODIS, producing 70k spatial collocations with lag between instrument observation times of less than 10 minutes.

INTERCOMPARISON OF THE DIFFERENT AVHRR WINDS PRODUCTS AT EUMETSAT

Olivier Hautecoeur[1,2], and Borde Régis[1]

1, EUMETSAT, Germany
2, Exostaff GmbH, Germany

ABSTRACT

Atmospheric Motion Vectors (AMVs) are derived operationally at EUMETSAT from the AVHRR/3 instrument on Polar System satellite Metop A since 2011. The launch of Metop B in 2012 allowed doubling of the production of AMVs over the Polar Regions using both Metop A and Metop B satellite data. In addition to the Single AVHRR polar wind product, in 2014 EUMETSAT developed a new Global AVHRR winds product extracted from a pair of Metop A and Metop B images. This new product is extracted using the large overlap in the imagery data obtained from the tandem configuration of the two satellites on the same orbital plane but with a phase difference of about 50 minutes. The tandem configuration also provides the possibility to derive wind vectors over polar areas using a triplet of AVHRR images, keeping the same time period necessary to derive the Single Metop polar wind product, but allowing a temporal consistency check in the calculation of the AMV quality index. Three different AMV products are currently extracted from AVHRR imagery at EUMETSAT, using two or three images taken by one or two satellites, having different coverage and time integration.

This paper focuses on the inter-comparisons of these different products to highlight the role of the temporal gap between the images used to extract the wind and the impact of the consistency check on the calculation of the quality index. The drift of Metop-A and the future trident configuration with Metop-C is also discussed.

MIGRATION TO A FORECAST INPENDENT QUALITY INDICATOR AND FURTHER QUALITY CONTROL CHANGES AT THE MET OFFICE

James Cotton, Mary Forsythe

Met Office, UK

ABSTRACT

AMVs are supplied with quality indicator (QI) values which are largely based on spatial and temporal consistency checks on the derived wind components, but can also include a first-guess check against the forecast from a numerical weather prediction (NWP) model. In this study we investigate the migration from using the QI with the first-guess check, QI1, to the model-independent QI2 for data screening in NWP. We also relax the applied QI thresholds since the QI2 is found to have little skill in discriminating 'good' data. The current set of QI thresholds (operational thresholds) vary by satellite, channel and latitude band, and are very strict in the tropics. The revised set of QI thresholds (relaxed thresholds) simply vary by satellite and are much lower, such that essentially no filtering is applied for GOES and Himawari-8. For QI2 there is a greater proportion of data with very high QI values so combining this with the relaxed thresholds allows a far greater number of winds available for assimilation.

The forecast impact of migrating to use QI2 has been evaluated through a series of assimilation experiments in the Met Office global model. Using QI2 and the relaxed thresholds results in 20% more AMVs assimilated compared to the control case using QI1 and the operational thresholds. The background (T+6 forecast) U/V wind fit to the AMVs is found to be degraded by 8%. To improve the quality of AMVs assimilated we tighten the background check against our own model forecast. This removes only a small number of winds but ensures the overall quality of the AMVs assimilated remains largely unchanged in the migration to QI2. It is found that the background fit to the geostationary radiance data remains worse however, especially for SEVIRI channels 9/10. To counter this increase a minimum wind speed threshold is introduced for the AMVs to remove winds slower than 4 m/s.

The overall impact of these changes on forecast RMSE is neutral or slightly beneficial when verified versus observations and ECMWF analyses. In particular, benefit is seen for 250 hPa wind scores in the tropics. Against own analyses, there are reductions in RMSE in the extra-tropics but a large increase in RMSE in the tropics which persists through the forecast range. It is shown that the migration to QI2 has changed the character of the wind analyses in the tropics substantially, but these changes are not propagated very far into the forecast and so this appears as a bias in the RMSE scores versus the experiments own analyses.

ASSIMILATION OF WIND PROFILING RADAR DATA IN GRAPES-MESO MODEL SYSTEM

WANG Dan[1], Ruan Zhen[2] TIAN WeiHong[1]
1 National Meteorological Center, Beijing 100081,China
2 Chinese Academy of Meteorological Sciences, Beijing 100081,China

ABSTRACT

Based on observational datasets of the wind profiling radars (WPR) in China during July 2015, a two-step quality control procedure for the WPR data is developed. Firstly, we start from the five-beam radial velocity, and recalculate the horizontal winds. After a series of processes including the spatial consistency check, time consistency averaging and vertical wind shear check, the hourly-resolution wind datasets were finally generated with quality indicator (QI) labels. We then use the ECMWF reanalysis data and radiosonde data to evaluate the newly generated WPR data. Results show that the method used for the QI labeling performs well. When its value is greater than 50, the root mean square error of u and v components are 2.29m/s and 2.37m/s respectively. This is consistent with previous research conclusions, and confirms the reliability of the pre-processing algorithm. Secondly, a second–round quality control based on the data assimilation is conducted. This procedure includes (1) removing the wind filed data located below the GRAPES model terrain, (2) configuring the effective height, (3) background check and (4) vertical thinning. The distributions of the innovations corresponding to observations after the QC are more close to a Gaussian distribution. The WPR observations after the QC were used in one-month continuous experiments based on the GRAPES modeling system. Results show that the assimilation of wind profiling radar data can effectively improve the wind state in the initial conditions. The corresponding 0-24h forecast of wind performs better. An analysis of 6-hourly verification scores like ets and bias of the precipitation field suggests that the assimilation of wind profiling radar data makes a positive contribution to the rainfall forecast, especially in the short–range forecasting within 12 hours.

Key words: Wind profiling radar, Quality control, GRAPES-3DVAR, Impact experiment

FORECAST IMPACT OF GOES-13 AND -15 WINDS DERIVED USING GOES-R AMV DERIVATION SCHEME ON JMA GLOBAL NWP SYSTEM

Kazuki Shimoji

Japan Meteorological Agency/ Numerical Prediction Division, 1-3-4 Otemachi, Chiyoda-Ku, Tokyo, Japan

ABSTRACT

Atmospheric Motion Vectors (AMVs) are one of crucial observation data for Numerical Weather Prediction (NWP). The change of AMV derivation scheme may have a significant impact on analysis fields and, therefore, forecast skills of NWP.

NOAA plans to change the derivation scheme of GOES-13 and -15 AMVs in spring 2018. The new scheme, called GOES-R AMV derivation scheme, is designed for GOES-16 (Daniels, J 2010). To investigate the forecast impact of this change on the JMA's global NWP system, three Observing System Experiments (OSEs) are conducted. The first experiment (TEST1) utilizes GOES-13 and -15 AMVs computed with a currently operational algorithm. Second experiment (TEST2) also utilizes GOES-13 and 15 AMVs but derived using GOES-R AMV derivation scheme. And no GOES AMVs are utilized in the third experiment (BASELINE).

The results of OSEs reveal that both of current and new GOES winds enhance convergence, divergence and circulation of analysis wind fields at upper levels, but its enhancements can be seen more clearly in TEST1 than TEST2. On the other hand, opposite trend can be confirmed at low levels. More detailed results will be reported in my presentation.

Besides, forecast impact of upcoming GOES-16 AMVs on the JMA's global NWP system will be also introduced at the end of my presentation.

RECENT WORK USING SATELLITE WINDS AT THE GERMAN WEATHER SERVICE

Alexander Cress; Alexander.Cress@dwd.de

Deutscher Wetterdienst, Frankfurter Strasse 135, 63067 Offenbach am Main

ABSTRACT

Satellite winds derived from geostationary and polar-orbiting satellites are one of the most important data sources for global and regional NWP: Currently, the Deutscher Wetterdienst (DWD) uses satellite winds (AMVs) from five geostationary and several polar-orbiting satellites. Additionally, scatterometer wind observations derived from the ASCAT instrument on board of Metop A and Metop B are used routinely.

Monitoring of AMV wind vectors, product upgrades and the evaluation of new wind products which have the potential to improve the quality of analyses and forecasts, are an ongoing task at DWD. This presentation will give an overview of recent progress in the assimilation of AMV and scatterometer data. Since the last wind workshop, several new and upgrade AMV wind products become available.

Meteosat 8 replaces Meteosat 7 over the Indic Ocean, dual Metop winds became operational and test data sets using the Optimal Cloud Analysis (OCA) to derive AMV heights are compared to the previous CCC method. Additionally, if available, first monitoring results using the new GOES-R AMV wind products can be presented.

In future, data assimilation is going to play a major role in nowcasting, where timeliness will be a major issue. Therefore, the DWD is testing to derive Metosat-10 AMVs locally using the EUMETSAT processing package developed in the framework of the Nowcasting SAF. First results will be presented.

Additionally, an impact study using the previously available Ku-bad scatterometer wind product ScatSat, which has a similar design as Oceansat-2 provided by KNMI and ISRO, will be presented and a view of using the upcoming LOS winds from the ADM mission in the DWD assimilation system will be given.

STATUS OF AMVS USE IN NOAA"S WEATHER PREDICTION MODEL

Iliana Genkova*, Andrew Collard*, John Derber**, Sharon Nebuda***, Jim Jung***

*IMSG, College Park, MD, **NOAA, College Park, MD, ***CIMSS, Madison,WI

ABSTRACT

During the last two years, the focus of AMVs use at NOAA was on including data from two new satellites – Meteosat 8 and GOES 16. All winds data sets were derived from imagery from instruments with improved temporal and spatial resolution, additional spectral channels and new retrieval algorithms. Additional challenge in the transitions from Meteosat 7 to 8 and from Goes 13 to 16 was/is the relatively short overlap period between old and new winds. Therefore priority was given to avoiding data gaps and including the new data into the Data Assimilation System with as much data investigation as possible.

Meteosat 8 winds showed to be superior to those from Meteosat 7 and at the moment there is consistency in the winds coverage over Europe and parts of Asia, which is beneficial to the NWP Model.

Having the GOES 16's ABI instrument lead to the development of a new wind retrieval algorithm at NESDIS, which in turn drove the implementation of a new BUFR format table in order to accommodate a list of new variables characterizing the AMVs. Reading from WMO approved BUFR data format was a big part of accommodating the GOES-16 winds into NOAA's data assimilation system. We are currently evaluating the available real time winds with the hope to have concluded this study by the time the Workshop takes place.

GOES-R AMV DATA EVALUATION AND ALGORITHM ASSESSMENT

Katie Lean and Niels Bormann

ECMWF

ABSTRACT

The GOES-R satellite successfully launched on 19th November 2016 as the first of the third generation of GOES satellites and it has become the replacement for GOES-13. GOES-R carries the Advanced Baseline Imager (ABI) instrument from which Atmospheric Motion Vectors (AMVs) can be derived. ABI has a higher temporal and spatial resolution and AMVs can be derived from three water vapour channels, similar to Himawari-8, compared to only one on its predecessor. As well as advances in the imaging instrument, a new AMV derivation method has been developed which employs a nested tracking method to calculate the initial vector and uses an optimal estimation approach for the height assignment. Results of the AMV assessment on early data from GOES-R will be presented, focusing primarily on using first guess departure statistics to indicate the data quality compared to GOES-13 and GOES-15. Preliminary results from assimilation experiments, considering the longer term forecast impacts, will also be discussed. In addition, we will further characterise the respective benefits in GOES-R AMV quality arising from the new derivation algorithm and the new instrument by evaluating AMVs derived from the previous generation GOES-13 and GOES-15 satellites with the new GOES-R algorithm.

STUDYING AMV ERRORS WITH THE NWP SAF MONITORING WEB SITE

Francis Warrick

Met Office, UK

ABSTRACT

The NWP SAF (Satellite Application Facility for Numerical Weather Prediction) is a EUMETSAT-funded activity that exists to co-ordinate research and development efforts among the SA partners to improve the interface between satellite data and NWP for the benefit of EUMETSAT member states.

The AMV monitoring activities of the NWP SAF help to identify and understand errors in the AMV data. This understanding can be useful to inform improvements both to the AMV derivation and to the way the data are used in NWP. The monitoring includes an archive of observation-minus-background (O-B) statistics, which compare the AMVs to short-range NWP forecasts. The O-Bs are calculated against both Met Office and ECMWF backgrounds. This helps us to see whether the source of the O-B difference is due to the model or the AMVs.

To make sense of the large amount of monitoring information held on the website, every two years an Analysis Report is produced. These assess whether features seen in the monitoring statistics have improved or worsened, and identify any new features which have appeared since the previous report. Ideally, the cause of the feature is investigated using more O-B statistics, height assignment differences (between the AMVs, model best-fit pressures and cloud-top height products), model fields and satellite imagery. In this talk highlights of the 8th Analysis Report will be shown.

GOES-16 ATMOSPHERIC MOTION VECTORS PRODUCTION AND USE AT CPTEC/INPE

Renato Galante Negri, Luiz Fernando Sapucci and Eder Paulo Vendrasco

Center of Weather Prediction and Climate Studies, National Institute for Space Research (CPTEC/INPE), Rod. Pres. Dutra, km 40, Cachoeira Paulista, SP, Brazil

ABSTRACT

AMVs are produced operationally at CPTEC/INPE since early 2000's. Various GOES satellites were used during this period and now it is being done using the visible, near infrared (3.9 µm) water vapor absorption (6.2, 6.9 and 7.3 µm) and window infrared (10.3 µm) channels from GOES-16 ABI. The higher spatial and temporal resolution of GOES-16 images, compared to previous GOES satellites, improved the AMVs coverage over South America and surroundings oceans. Higher AMV amount allows to set a more restricted QI and it still have a good spatial coverage of AMVs to be effectively used in data assimilation. The use of AMVs in data assimilation has show to be very effective in improving the atmospheric motion in numerical weather models. GOES-16 AMVs generated by CPTEC are being tested within the CPTEC's data assimilation system in order to assess their impact on analysis and forecast. The AMVs are also used as an ancillary data to nowcasting and weather monitoring activities at CPTEC/INPE. This work present the status of operational production of Atmospheric Motion Vectors using GOES-16/ABI channels at CPTEC/INPE and its locally use on data assimilation and weather monitoring activities.

A VARIATIONAL APPROACH FOR ESTIMATING AMV REASSIGNED HEIGHTS

Stéphane Laroche

Meteorological Research Division, Environment and Climate Change Canada (ECCC)

ABSTRACT

The situation dependent observation error algorithm for AMVs, developed by Forsythe and Saunders (2008, IWW10), has recently been tested in the ECCC global deterministic data assimilation system. Most results with this algorithm for both winter and summer periods are positive and consistent with results reported by the UK Met Office and ECMWF in recent years. This is another confirmation that estimating height assignment and tracking errors separately and making flow dependent the error component due to uncertainties in height are important. However, the assigned height is not modified in this algorithm and the AMV is still treated as a single level wind. Several studies have shown that AMVs are more representative of layer average and assigned heights can be systematically higher or lower than model best-fit pressure, radiosonde or lidar observations. On the other hand, Salonen and Bormann (2014, IWW12) showed that reassigning the height gives better forecasts than using a level-average observation operator for assimilating AMVs. These results indicate that an objective procedure to modify the assigned height before data assimilation could be beneficial for numerical weather prediction.

In this paper, we explore a variational approach to reassign the height prior to assimilation. The height is estimated by minimizing a cost function that includes two terms: the height departure and the difference between AMV and background wind vectors. Both terms are weighted by their respective error variances. The reassigned height error variance is estimated after the minimization and then used to calculate the flow dependent error component due to uncertainties in height. Two data assimilation experiments (two-month winter and summer periods) were carried out to assess the impact of reassigning the height on short to medium range forecasts. Various verification scores as well as height departure distributions will be discussed.

ASSIMILATION IMPACT OF THE LEOGEO ATMOSPHERIC MOTION VECTORS ON EAST ASIA

Sihye Lee and Hyo-Jong Song

Korea Institute of Atmospheric Prediction Systems (KIAPS), Seoul, South Korea

ABSTRACT

A study has been carried out to investigate the impact of the assimilation of LEOGEO AMV on the accuracy of global model forecast over East Asia for January 2017. In the global cycle system, assimilation of LEOGEO AMVs shows globally significant benefit in wind analysis over the 50˚-70˚ latitude band for all levels in both Hemispheres. Even though its spatial coverage is confined to higher latitudes and the characteristics of observable variable is wind, not mass, the assimilation of LEOGEO AMV has a positive impact on synoptic patterns represented by surface pressure weather chart over East Asian domain. A Monte Carlo technique has been conducted for testing the statistical significance of the positive impact of the LEOGEO AMVs. All RMSDs of wind, temperature and surface pressure of the experiment assimilating the LEOGEO AMVs decreases compared to those of the control experiment without LEOGEO AMVs with two-tailed 90% statistical significance.

USE OF WIND RETRIEVALS IN THE HARMONIE-AROME DATA ASSIMILATION SYSTEM

Roger Randriamampianina, Teresa Valkonen, Roohollah Azad, Harald Schyberg

ABSTRACT

At the Norwegian Meteorological Institute, both the geostationary and polar orbiting satellite based atmospheric motion vectors (AMV) and the scatterometer wind data were tested in our operational regional models (MetCoOp and AROME-Arctic). The operational systems are based on the HARMONIE-AROME model. While the scatteromer data were introduced into operational in both the systems already a while ago, the decision about the AMV data was taken for the AROME-Arctic and the realisation will follow as soon as possible. Since the latest impact was done with older model version and in system with relatively less observations, we plan to look at the efficiency of the use of the observations in the data assimilation and the forecasts systems through computation of the degrees of freedom for signals (DFS), evaluation of the (observation and model) uncertainties, and computation of the most total energy loss in the forecast system related to the denied observations.

Apart of the above mentioned study, we will also discuss the impact of the AMV data in a nowcasting system.
We will be also presenting some results related to a new project that was started in 2017, where the main objective is to calibrate and validate the simulated AMD Aeolus wind data.

INITIAL IMPACT ASSESSMENT AND QUALITY EVALUATION OF HIMAWARI-8 AMVS RETRIEVED BY GK-2A ALGORITHM IN KMA NWP SYSTEM

Eunhee Lee, MeeJa Kim, YoonJae Kim

Numerical Modeling Center/KMA, Republic of Korea

ABSTRACT

The Korea Meteorological Administration (KMA) has successfully assimilated Atmospheric Motion Vectors (AMVs) derived from the first geostationary satellite of Korea, COMS (communication, ocean and meteorological satellite) in the operational NWP system since December 2011. The COMS AMV data has the effect of reducing the forecast error of the global model by about 1%, and the improvement in the East Asian region is especially significant. The second geostationary satellite of Korea, GEO-KOMPSAT-2A (GK-2A), will be launched in November 2018, and it will provide 52 types of meteorological products such as AMV and CSR (Clear Sky Radiance). GK-2A AMVs are expected to provide more accurate wind information due to the high resolution, the increase in channel, and improved algorithm compared to COMS AMVs. In order to utilize the data as soon as possible in the KMA operational NWP model, the preliminary application study must be started prior to the launch of the GK-2A.

In this study, the quality evaluation and initial impact assessment to prepare the assimilation of GK-2A AMV in KMA NWP system was conducted using Himawari-8 AMV data generated by GK-2A algorithm. Himawari-8 was launched in October 2014 and provides operational services since July 2015. The Advanced Himawari Imager (AHI) instrument on board Himawari-8 has similar spectral and spatial characteristics to the Advanced Meteorological Imager (AMI) equipped on the GK-2A satellite.

REPROCESSING OF ATMOSPHERIC MOTION VECTOR FOR JRA-3Q AT JMA/MSC

Miki Abe (1), Kazuki Shimoji (2), Kenichi Nonaka (1)

(1) JMA/MSC, 3-235 Nakakiyoto, Kiyose City, Japan
(2) JMA, 1-3-4 Ootemachi, Chiyoda-Ku, Tokyo, Japan

ABSTRACT

The climate research and seasonal forecasts demand for the re-analysis for quantitative assessment of past and current climate conditions to analyse extreme weather and climate monitoring. This re-analysis is required for long-term high-quality dataset with homogeneity in time and space. The Japan Meteorological Agency (JMA) has ever conducted two types of re-analysis, the Japanese 25-year Reanalysis (JRA-25) and the Japanese 55-year Reanalysis (JRA-55), and plans to carry out the Japanese 75-year Reanalysis (JRA-3Q) projects (3Q means three quarters of a century).

Meteorological Satellite Center (MSC) of JMA is reprocessing Atmospheric Motion Vectors (AMV) from the past satellite images using the latest derivation algorithm of Himawari-8 AMV to cooperate on JRA-3Q project. AMVs are reprocessed from GMS-5 (1995-2003) and GOES-9 (2003-2005), MTSAT-1R (2005-2010), MTSAT-2 (2010-2015). This reprocessing starts from the period of GMS-5 operation in terms of the need for water vapor observation in Himawari-8 AMV algorithm.

In order to validate whether Himawari-8 AMV algorithm is better than MTSAT AMV algorithm, reprocessing data were compared against the first guess of numerical weather prediction model and radiosonde observation. As a result, we confirmed that the errors of the AMV with Himawari-8 AMV algorithm are smaller than ones with the MTSAT AMV algorithm. Therefore the reprocessing AMV gives a high-quality AMV dataset.

This presentation will be reported about the progress of derived AMV dataset using the Himawari-8 AMV algorithm and detail with the future AMV reprocessing plans.

ATMOPHERIC MOTION VECTORS CLIMATE DATA RECORD PRODUCED AT EUMETSAT

M. Doutriaux-Boucher[1], J. Schulz[1], O. Hautecoeur[3], Régis Borde [1], Manuel Carranza [2], O. Sus[1], L. Medici[1], and K. Petraityte[1]

[1] EUMETSAT
[2] GMV Insyen
[3] Exostaff

ABSTRACT

Imagers have been flying onboard polar and geostationary orbiting satellites for more than 35 years providing a suitable data source for climate research. The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) generates Atmospheric Motion Vectors (AMVs) from polar and geostationary satellites. The polar AMVs are reprocessed using data from AVHRR instruments that flew on board NOAA and MetOp satellites. An adapted version of the EUMETSAT polar AMV algorithm is used for the reprocessing. The geostationary AMVs are reprocessed using images from MVIRI and SEVIRI instruments, respectively on board Meteosat first and second generation satellites. An adapted version of the current operational algorithm are used. The aim of the new long-term dataset is to contribute to the next European Center for Meteorological Weather Forecast (ECMWF) climate reanalysis (ERA6) that will be the sixth generation of ECMWF atmospheric reanalyses of the global climate. The reprocessed products are validated through a comparison against radiosonde and NWP model analysis data. This paper will present the AMV dataset and detail the future AMV reprocessing activities at EUMETSAT.

Observation requirements and capabilities for vertical wind profiles

Ad Stoffelen[1], Gert-Jan Marseille

[1]KNMI, the Netherlands

ABSTRACT

The European Space Agency (ESA) Aeolus mission is set to launch a Doppler Wind Lidar (DWL) in 2018, following a well-expressed need for wind profile observations to initialize Numerical Weather Prediction (NWP) models. Currently, wind profile observations are obtained operationally from radiosondes, aircraft ascends/descends and profilers, but leaving a large volume of the troposphere and lower stratosphere void of wind observations, particularly over the oceans, tropics and southern hemisphere. Aeolus is set to demonstrate the beneficial impact of partially filling this gap and several observation impact and sensitivity experiments in NWP have confirmed this expectation. Given the proximity of the Aeolus launch, the Aeolus Mission Advisory Group considered it is high time to look forward to future vertical wind profiling capability to fulfill the rolling requirements in operational meteorology. The following considerations will be illustrated and presented at the workshop.
Requirements for wind profiles and information on vertical wind shear have evolved, since the need for wind information to capture and initialize small-amplitude, fast-evolving and mesoscale dynamical structures increases as the resolution of global NWP improved well into the 3D turbulence regime on horizontal scales smaller than 500 km. In addition, requirements to describe the transport and dispersion of atmospheric constituents and better depict the circulation on climate scales are eminent. These requirements are generally well captured by the WMO OSCAR and Rolling Requirements Review.

The increasing demand for well-resolved wind information may be met by a number of different techniques. Wind scatterometers and microwave radiometers provide information on ocean surface winds in a growing virtual constellation (CEOS), but do not provide information on vertical shear or the upper air. Moreover, research missions are studied with satellite Doppler cloud radars or tandem multi-angle imagers to provide vector winds near clouds. Since clouds constitute only about 30% of the tropospheric volume and represent a dynamically and optically heterogeneous environment, the development of these techniques to fulfill the global demand for 3D wind information can only be partial. Also, research in obtaining winds from tandem IASI profiles by employing optical flow techniques, may not meet the requirement to obtain the ageostrophic flow.

Operational wind profiles exist in radiosondes and airplane ascends and descends, which generally do not cover areas over the oceans, tropics and southern hemisphere, which are currently void of such profiles. AMVs do fill this gap partially, as they may be obtained at high temporal resolution and at several heights. However, height assignment and vertical sampling will remain an issue for this class of winds.

Therefore, an Aeolus-like follow-on mission, obtaining wind profiles in clear air by exploiting molecular scattering appears worthwhile. Several aspects of such mission need further consideration by the wind community.

STATUS OF THE AEOLUS DOPPLER WIND LIDAR MISSION LAUNCH PREPARATIONS AND RESULTS FROM THE ON-GROUND INSTRUMENT CHARACTERIZATION

Anne Grete Straume-Lindner, Thomas Kanitz, Anders Elfving, Frank de Bruin, and Denny Wernham

European Space Agency, ESTEC, Noordwijk, the Netherlands

ABSTRACT

The European Space Agency (ESA)'s wind mission, Aeolus, is getting ready for launch in July 2018. The Doppler wind lidar, ALADIN, was integrated on the Aeolus satellite in autumn 2016 and underwent a successful mechanical qualification campaign early 2017. At the time of writing, November 2017, the satellite is undergoing Thermal Vacuum testing where also the instrument performance in a representative space environment will be characterized and verified. The lidar shall deliver horizontally projected single line-of-sight wind observations from ~30 km down to the Earth's surface, or down to optically thick clouds. The vertical sampling will be 500 m in the planetary boundary layer (PBL), 1 km in the troposphere, and 2 km in the stratosphere. The horizontal observation resolution is typically ~85 km. The required accuracy of the wind measurements is 2 m/s in the PBL, 2-3 m/s in the free troposphere, and 3-5 m/s in the lower stratosphere. Spin-off products are parallel polarized atmospheric extinction and backscatter profiles. The satellite will fly in a polar dusk/dawn orbit, measuring at 6 am/pm local time. The Earth coverage is ~16 orbits per 24 hours, which will result in ~6400 globally distributed line-of-sight wind profile observations. The orbit repeat cycle is 7 days. The wind and optical properties products will be delivered near-real-time (NRT) for direct ingestion by operational numerical weather prediction (NWP) and potentially also air quality models.

In this presentation, the status of the Aeolus mission and launch preparations will be given. Results from the on-ground instrument characterization which is linked to the wind random and systematic error requirements will be presented. The readiness of ESA member states to analyze and assimilate the Aeolus observations will be provided together with the upcoming mission CALVAL and science activities.

CHARACTERISTICS OF 3D ATMOSPHERIC MOTION VECTORS (AMV) FROM WATER VAPOR FEATURE-TRACKING TECHNIQUE

Hui Su, Derek Posselt, Longtao Wu, Kevin Mueller, Noppasin Niamsuwan, Fredrick Irion and Tom Pagano

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA

ABSTRACT

Atmospheric motion vectors (AMVs) can be derived from tracking clouds or water vapor features in consecutive satellite images. Considering future space-borne lidar can produce 3D winds but in very narrow slices, AMVs from constellations of passive sensors on LEO or GEO orbits can provide 3D distributions of horizontal winds in broad areas complementary to lidar wind measurements. Accurate determination of the uncertainties of AMVs is crucial if the observations are to be properly assessed in the context of Observing System Simulation Experiments (OSSE). In this study, we derive AMVs by water vapor feature-tracking technique based on maximum correlation between two consecutive water vapor fields. Ten WRF simulations of an extratropical cyclone off the US east coast are used as ensemble nature runs. The sensitivity of the derived AMVs to temporal gap of the water vapor fields, tracking box size, water vapor and its gradient, wind speed and direction will be examined. We also coarse out the high-resolution model outputs to match the proposed horizontal and vertical resolutions of a CubeSat infrared sounder to estimate its 3D wind measurement uncertainties. Hypothetical orbital simulations will be performed to estimate possible spatial coverage of 3D winds by CubeSat constellations of IR sounders.

3D IASI WINDS PRODUCT AT EUMETSAT

Olivier Hautecoeur[1,2], Borde Régis[1], and Patrick Héas[3]

1, EUMETSAT, Germany
2, Exostaff GmbH, Germany
3, INRIA, France

ABSTRACT

Atmospheric Motion Vectors (AMVs) derived from satellite imagery constitute a significant part of the observation data assimilated in Numerical Weather Prediction (NWP) models because they are the only upper wind observations with good global coverage for the tropic, mid-latitudes and polar regions. AMVs are routinely extracted from the Meteosat geostationary satellites at EUMETSAT as well as from the EUMETSAT low orbit Polar System satellite Metop AVHRR instrument.

If AMVs are commonly extracted from imagers provide information of cloud motions at a single level in the troposphere, wind profiles can be estimated from humidity profiles retrieved from hyperspectral sounding, for which the height information is already available together with the retrievals. Time sequences of retrieved water vapour fields constitutes the “imagery” for tracking winds and the corresponding AMV heights are directly inferred from the profile heights information.

A processor was designed and developed based on the 3D optical flow algorithm (Heas and Mémin, 2008). The method was improved and applied on IASI level 2 humidity fields to extract dense wind fields from a pair of IASI data taken consecutively by Metop A and Metop B satellite over high latitudes areas. This presentation will present the method and the preliminary results of this novel algorithm on a month of test data, and will discuss the short-term perspective of this project at EUMETSAT.

MISTiC WINDS, A MICRO-SATELLITE CONSTELLATION APPROACH TO HIGH RESOLUTION OBSERVATIONS OF THE ATMOSPHERE USING INFRARED SOUNDING AND 3D WINDS MEASUREMENTS: AN UPDATE

Kevin R. Maschhoff

BAE Systems

ABSTRACT

MISTiC™ Winds is an approach to improve short-term weather forecasting based on a miniature high resolution, wide field, thermal emission spectrometry instrument that will provide global tropospheric vertical profiles of atmospheric temperature and humidity at high (3-4 km) horizontal and vertical (1 km) spatial resolution. MISTiC's extraordinarily small size, payload mass of less than 15 kg, and minimal cooling requirements can be accommodated aboard an ESPA-Class micro-satellite. Low fabrication and launch costs enable a LEO sun-synchronous sounding constellation that would collectively provide frequent IR vertical profiles and *vertically resolved* atmospheric motion vector wind observations in the troposphere. These observations are highly complementary to present and emerging environmental observing systems, and would provide a combination of high vertical and horizontal resolution not provided by any other environmental observing system currently in operation. The spectral measurements that would be provided by MISTiC Winds are similar to those of NASA's Atmospheric Infrared Sounder that was built by BAE Systems and operates aboard the AQUA satellite. Key technical risks have been reduced through laboratory and (NASA ER2) airborne testing under NASA's Instrument Incubator Program, and through an OSSE performed by NASA GMAO. A summary of the airborne test results and the OSSE will be presented.

OBSERVING SYSTEM SIMULATION EXPERIMENT (OSSE) FOR FUTURE SPACE-BASED DOPPLER WIND LIDAR OF JAPAN.

Kozo Okamoto[*1,2], Toshiyuki Ishibashi[1], Shoken Ishii[2], Philippe Baron[2], Kyoka Gamo[3], Taichu Tanaka[1], Takuji Kubota[4]

1: Meteorological Research Institute (MRI) of Japan Meteorological Agency (JMA)
2: National Institute of Information and Communications Technology (NICT)
3: FUJITSU FIP Corporation
4: Japan Aerospace Exploration Agency (JAXA)

ABSTRACT

Space-based Doppler Wind Lidar (DWL) can provide global wind profiles that are significantly beneficial for the numerical weather prediction. The feasibility of DWLs has been investigated using OSSE. Our DWL OSSE features a realistic simulation of line-of-sight wind observationsusing 3-dimentional, hourly aerosol and clouds that are consistent to wind field and created by a full-brown lidar simulator. The aerosol is produced by a global aerosol chemical transport model developed by MRI in which wind field is nudged with pseudo-truth. The pseudo-truth atmospheric field is generated from the Sensitivity Observing System Experiment (SOSE) approach. Simulated line-of-sight wind speeds are assimilated with the four-dimensional variational (4D-Var) scheme based on the operational global data assimilation system at JMA.

We assessed impacts of DWLs onboard polar and low-inclination orbiting satellites in different seasons (January and August). We found positive impacts of DWLs on any of these conditions, but the magnitude of impact varies with seasons. We also found that DWL assimilation can cause negative impacts if we do not implement appropriate quality control procedures and observation errors settings.

IMPACT OF HYPERSPECTRAL INFRARED RADIANCES ON WIND ANALYSES

Kirsti Salonen and Anthony McNally

ECMWF, Reading, United Kingdom

ABSTRACT

In 4D-var data assimilation a trajectory of model states is fitted to the available observations. Model variables are linked through the model governing equations and physical parametrizations. Changes made to fit the humidity sensitive observations will result also in adjustment of the trajectory for the other model variables. Assimilation of radiance observations in 4D-Var framework impact the wind analysis via adjustments in the mass field of the atmosphere, and via adjustments in the wind field directly. The wind field can be changed to advect humidity to and from other areas. This process is called wind tracing and it has been demonstrated with clear sky geostationary radiances as well as with microwave instruments in the all-sky framework in earlier studies.

The upcoming hyper-spectral infrared instruments on board geostationary satellites will provide information with high temporal and vertical resolution and have huge potential to further improve numerical weather predictions. In order to understand the possibilities of this data from the wind tracing perspective, observing system experiments with the current hyperspectral IR instruments on board polar orbiting satellites are performed. The presentation will discuss the results.

THIRD AMV INTERCOMPARISON STUDY

David Santek[1], Rich Dworak[1], Javier García Pereda[2]

[1] CIMSS/UW-Madison, 1225 W. Dayton St, Madison, Wisconsin, 53706 USA
[2] NWC SAF/AEMET, Leonardo Prieto Castro 8, E-28040 Madrid, Spain, jgarciap@aemet.es

ABSTRACT

This study is a continuation of the previous "2014 AMV Intercomparison study", for which seven different institutions participated (EUMETSAT, NOAA, CMA, JMA, KMA, CPTEC/INPE and NWCSAF), and in which the corresponding AMVs calculated with MSG satellite images were evaluated.

In this continuation, AMVs calculated with JMA's Himawari-8 satellite data are compared. This way, two main goals are going to be considered: on one side, to verify the advantages of the calculation of AMVs with the new generation of geostationary satellites, which started with Himawari-8 launched in 2014 (with better spatial and temporal resolution, and with new spectral channels), with respect to those calculated with MSG series; on the other side, to extract conclusions about the best options for the calculation of AMVs with this new generation of geostationary satellites, considering the options taken by the different satellite centres for their AMV calculation.

Two different input datasets with two different image triplets from Himawari-8/AHI data for 21 July 2016 are defined for the AMV calculation. Image data are similar to those used by the "ICWG's Cloud Intercomparison study" to improve synergies between both studies. The different centres use a prescribed configuration and their own configuration for the AMV production with these datasets.

Results and conclusions of this study will be presented for evaluation and discussion with the AMV producers.

POSTER ABSTRACTS

ERROR CHARACTERIZATION AND VALIDATION OF ATMOSPHERIC MOTION VECTORS DERIVED FROM THE GOES-16 ADVANCED BASELINE IMAGER (ABI)

Andrew Bailey[1], Wayne Bresky[1], Jaime Daniels[2], Americo Allegrino[1], Steven Wanzong[3], Chris Velden[3]

1. I.M. Systems Group (IMSG), Rockville, Maryland 20852, U.S.A.
2. NOAA/NESDIS Center for Satellite Applications and Research, NOAA Science Center, College Park, Maryland 20740, U.S.A..
3. Cooperative Institute for Meteorological Satellite Studies (CIMSS), Space Science and Engineering Center (SSEC), University of Wisconsin – Madison, Wisconsin 53706, U.S.A

ABSTRACT

Following the successful launch of the GOES-16 satellite on November 19, 2016, and subsequent Post-Launch Test (PLT) period, the Advanced Baseline Imager (ABI) instrument data and Level 1B products were declared provisionally operational on June 1, 2017. Throughout this PLT period, intense effort was and continues to be dedicated to validating and characterizing the performance and quality of the Derived Motion Winds (DMW) product. To that end, a number of validation and deep-dive analysis tools were developed to support this ongoing effort. More specifically, a stand-alone tool has been developed that permits deep-dive analysis of individual DMWs on a case by case basis. This tool, capable of displaying detailed output from the two major components of the wind derivation process (height assignment and tracking), allows for a more thorough examination of individual DMW target scenes. Another tool was developed that allows for interrogation of the DMW vs. Rawinsonde (RAOB) match verification database. This tool is useful for identifying and isolating DMW outliers for further study utilizing the stand-alone tool. The combination of these tools and others has been and continues to be critical to understanding and characterizing errors associated with the derived winds. This poster will present in depth results and detailed findings from the use of all the validation and deep-dive tools via case study analyses, qualitative and quantitative comparisons to current GOES DMW processing, and performance of the GOES-16 DMW relative to available reference/ground truth wind measurements from RAOBs and commercial aircraft.

UPDATE ON SURFACE WIND ACTIVITIES AT THE MET OFFICE

James Cotton

Met Office, UK

ABSTRACT

This poster will give an overview of recent activities at the Met Office to improve the assimilation of satellite surface wind products. This includes the assessment of new scatterometer winds from the Indian ScatSat mission, the migration to a 'neutral' stability wind observation operator, and an evaluation of ocean wind speeds retrieved from TechDemoSat-1 (TDS-1) Global Navigation Satellite System-Reflectometry (GNSS-R) measurements.

AMVS QUALITY CONTROL METHOD FOR GEO-KOMPSAT-2A

Jae Hwan Kim*, Hyungmin Park

Pusan National University, Department of Atmospheric Science

ABSTRACT

The second generation geostationary satellite of Korea (Geo-KOMPSAT 2A; GK-2A) is scheduled to be launched in mid 2018. The Advanced Meteorological Imager on GK-2A will have sixteen spectral bands with 0.5-2 km spatial resolution and will scan every 10 minutes for the Full Disk. It will provide four times better spatial and temporal resolution, and three times better spectral information compared to the Communication, Ocean and Meteorological satellite Meteorological Imager, currently operating satellite.

A new GK-2A wind derivation algorithm is under development. Total ten types of wind vector, which consist of 7 cloud targets from 7 channels and 3 clear targets from 3 water vapor channels, will be obtained every hour over full-disk region.

GK-2A AMVs Quality Control (QC) will be performed in two approaches. The first one is well-known Quality Indicator (QI) based on vector consistencies and the other one is Expected Error (EE) based on multiple linear regression analysis with past collocation data. This paper will present the QC method for Atmospheric Motion Vectors algorithm for the GK-2A and analyze its characteristics with respect spatial and temporal distribution.

AMV ACTIVITIES AND PROGRESS AT THE METEOROLOGICAL SERVICE OF CANADA

Stéphane Laroche[1], Judy St-James[2] and Iriola Mati[2]

[1]Meteorological Research Division, Environment and Climate Change Canada
[2]Meteorological Service of Canada, Environment and Climate Change Canada

ABSTRACT

AMV data processing and assimilation for the global and regional forecast systems have substantially been upgraded. Hourly AMV data from all geostationary satellites are now used. Dual-Metop AMVs in the 40-60S and 40-60N latitude bands are assimilated. Several modifications to the blacklisting were brought. AMVs above 160 hPa over the Tropics and above 200 hPa elsewhere are rejected. AMVs from geostationary satellites are rejected beyond zenith angle of 68 degrees instead of 62 degrees. The recursive filter flag (RFF) has been replaced by the quality indicator (QI with first guess check) for GOES satellites. The horizontal data thinning has been improved and does not rely on boxes anymore. The AMVs are now first sorted according to their QI before selection. For each satellite, the selection process starts from the AMV with the highest QI. The next AMVs are selected if all previous data chosen in the same layer and within 1h30 time difference are beyond 200 km. The background check is applied to the square vector difference instead of on individual wind components. Finally, the situation dependent observation error algorithm has been implemented into the 4D-EnVar scheme. The impact of all these changes on forecasts will be presented.

AMV RESEARCH ACTIVITIES AT ECMWF

Katie Lean and Niels Bormann

ECMWF

ABSTRACT

An overview of recent research activities and the status of the operational assimilation of Atmospheric Motion Vectors (AMVs) at ECMWF will be presented. We will focus particularly on work with Indian Ocean satellites - moving from Meteosat-7 to Meteosat-8 and evaluating other satellites covering the same region - and the switch from Meteosat-10 to Meteosat-11.

On 2nd March 2017, Meteosat-8 replaced Meteosat-7 in the operational system at ECMWF. In moving to a newer generation of Meteosat satellite, the more advanced imaging instrument results in a larger number of AMVs being available and improved data quality. The initial quality assessment using first guess departure statistics revealed reduction of large negative speed biases in the high level, extra-tropics present in Meteosat-7. Statistics from Meteosat-8 were, reassuringly, very similar to Meteosat-10. Assimilation experiments, testing the longer term forecast impacts of the change in satellite, showed continued benefit from the Indian Ocean coverage, particularly in the high level winds. A challenging area at low levels for both the AMVs and model was identified in a localised region over the ocean.

While the priority was to use the Meteosat-8 AMVs, a subsequent investigation explored the benefit of assimilating other satellites with good coverage of the Indian Ocean region including FY-2E (86.5°E) and INSAT-3D (82°E). Differences in imaging instrument and derivation techniques led to variation in the first guess departure statistics. However, assimilation experiments revealed a lot of similarity in the forecast impacts. For ECMWF forecasts, the availability of Clear Sky Radiances (CSRs) or All Sky Radiances (ASRs) is also an important aspect of the geostationary data and will be considered here as well.

In a further change of satellites, Meteosat-11 will be brought out of storage early in 2018 and replace Meteosat-10 (same generation) as the primary service at 0°. Comparisons using test data shortly after launch indicated good agreement while small differences were mostly attributed to the high inclination orbit. Now in its stable, operational configuration results from the re-evaluation will be discussed.

AMV INTER-COMPARISON BETWEEN GK-2A AND MTG ALGORITHM USING HIMAWARI8/AHI DATA

Soomin Oh[1], Byung-il Lee[1], Regis Borde[2], Manuel Carranza[2], Sung-Rae Chung[1], Seongkyun Baek[1]

[1] National Meteorological Satellite Center/KMA, Republic of Korea
[2] European Organization for the Exploitation of Meteorological Satellites, Germany

ABSTRACT

The GEO-KOMPSAT-2A (GK-2A) and METEOSAT Third Generation (MTG) AMVs were compared to evaluate the accuracy of algorithm. The 3rd AMV inter-comparison study cases were selected for validating wind speed, wind direction, height and quality indicator. We compared two results using exactly same input data and configuration and their own one on 12:10 UTC at 21 July 2016. The first case showed very similar results for the 4 variables. For the second case, the distribution of wind speed and wind direction show very similar because both algorithms are using same methods such as optimal target selection and Cross Correlation Coefficient in target selection and tracking, respectively. However, the height distribution and quality indicator of the vectors are not similar since methods used are different from each other.

We will introduce more detailed inter-comparison results and further plans for improving accuracy of both algorithms.

SENSITIVITY TESTS OF TARGET BOX SIZES AND HEIGHT ASSIGNMENT METHODS FOR GK-2A AMV ALGORITHM

Soomin Oh, Byung-il Lee, Sung-Rae Chung, Seongkyun Baek

National Meteorological Satellite Center/KMA, Republic of Korea

ABSTRACT

NMSC/KMA has developed AMV algorithm for GEO-KOMPSAT-2A/Advanced Meteorological Imager (GK-2A/AMI) which will be launched in November 2018. GK-2A AMV algorithm consists of four steps: target selection, feature tracking, height assignment, and quality indicator evaluation. The target box size in target selection is highly related to speed and direction of AMV. And height assignment has the greatest effect on the accuracy of AMV. Thus, sensitivity tests were performed to find the optimum target box size and height assignment method with 2km/10minite in spatial and temporal resolution for GK-2A AMV algorithm. The AMVs were compared with radiosonde and NWP forecast wind fields for various box 8 x 8, 16 x 16, 24 x 24, 32 x 32, 40 x 40, and 48 x 48 in size, and for several height assignment methods such as CCC, EBBT, IR/WV rationing, CO2 slicing for cloudy target and NTC and NTCC for clear target. The preliminary results showed that 24 x 24 box size and the combination of EBBT and IR/WV height assignment method has the smallest MVD, RMSVD, bias and RMSE compared with other methods.

The more detailed methodology and results will be presented in the 14th International Wind Workshop, in Jeju, South Korea.

SATELLITE WINDS ACTIVITIES IN MÉTÉO-FRANCE

Christophe Payan

CNRM, Météo-France and CNRS

ABSTRACT

The activities around the satellite winds for their assimilation in the operational numerical weather predictions systems of Météo-France are always varied, depending on either the news from spatial agencies, or the model software evolutions.

In the perspective of the dance of geostationary satellites (MET-7 to MET-8, GOES-R), a geographical mask based on latitude/longitude coordinates was replaced by a satellite zenith angle mask, as it is done in almost all NWP centres. The satellite zenith angle threshold was chosen in a conservative spirit, for having the same amount of selected AMVs, but in practice not especially in the same areas. Nevertheless the short study showed the potential to use a zenith angle threshold less restrictive and which can help to resolve the coverage gap between the geostationary and polar satellites.

Otherwise, the model configuration has evolved with the use of inputs from the surface scheme so-called SURFEX for the assimilation of scatterometer winds. This change has allowed to fix a bug in the observation operator, the computation of the model equivalent of the observation, which paradoxically increases a negative speed bias of scatterometer winds against the model background, but improves their fit to the analysis. And moreover the forecast skill is improved with this correction.
In this new frame, two studies are ongoing:
- the use of coastal ASCAT winds, 12.5 km grid, in the meso-scale model AROME, 1.3 km grid spacing, in replacement of the 25 km grid product;
- the study of scatterometer winds, from the ISRO's satellite ScatSAT-1, processed by KNMI for the EUMETSAT Ocean Sea-Ice SAF in an experimental mode.
According to the state of progress, first results may be shown.

A similar evaluation will have to be made for the new NESDIS AMVs product from GOES-R when data will be available at the end of 2017. Lastly, some informations will be given about the preparations for the missions CFOSAT and AEOLUS which will launch in 2018.

THE APPLICAITON OF FY-4A ATMOSPHERIC MOTION VECTORS IN GRAPES

Xiaomin Wan[1] , Wei Han[1]

[1] Numerical Weather Prediction Center, Chinese Meteorological Administration, Beijing

ABSTRACT

FY-4A was launched on 11 Dec 2016.With the improvements in the image navigation and calibration system, the accuracy of AMVs derived from FY-4A is expected to be improved. There is no Quality Indicator for FY-4A AMVs yet. This paper describes the distribution of FY-4A AMVs, the first guess statistics and the assimilation in GRAPES system. The contrast numerical experiments are conducted for typhoon Hato (1713) from 00UTC 23 August, 2017.

The experiments show neutral to positive impact on wind and height analysis field. Due to the improvement of the initial fields for the model prediction, the performance scores for regional precipitation forecast are improved. Especially the 24h precipitation forecast results show positive contribution to rainfall intensity and location prediction after assimilating FY-4A WV AMVs. Finally, ongoing research and future plans are also discussed.

ASSESSMENT AND TRIALLING OF NEW DATASETS IN THE MET OFFICE GLOBAL NWP MODEL SINCE IWW13

Francis Warrick

Met Office, UK

ABSTRACT

AMVs are an important observation type in the Met Office's global numerical weather prediction (NWP) model. This poster will give an update on new AMV data sets trialled in the Met Office global model since the last Winds Workshop.

Many trials have been conducted for the transition from GOES-13 to GOES-16. These include several using AMVs from GOES-13 and 15 derived with the GOES-R 'nested tracking' algorithm. The purpose of these was to determine how much of the impact from the change in algorithm was due to the new tracking, the removal of the auto-editor, and the change from forecast-dependent to forecast-independent Quality Indicator. Assessment and trials of the GOES-R winds themselves will also be shown.

Winds from the Meteosat Second Generation satellites were supplied with an alternative height assignment during 2016-17. These heights are from the EUMETSAT cloud product called Optimal Cloud Analysis. The effect of using the alternative MSG heights on O-Bs was studied. Trials were also conducted using the OCA heights.