ADM-AEOLUS, ESA'S WIND LIDAR MISSION

A.G. Straume-Lindner, P. Ingmann and A. Elfving

European Space Agency (ESA-ESTEC), PO Box 299, 2200 AG Noordwijk
anne.straume@esa.int

ABSTRACT

The European Space Agency is developing a direct detection Doppler Wind Lidar for the measuring of wind from space. With the successful qualification tests and delivery of the 1st Flight Laser in 2013, the launch date in summer 2015 has been further consolidated. The Lidar shall deliver horizontally projected single line-of-sight wind measurements at 24 vertical layers (0 to 30 km) from each of its two channels; one molecular (clear air) and one particle (aerosol and cloud backscatter) channel. Spin-off products are profiles of atmospheric optical properties. The required accuracy of the wind measurements is 2 m/s in the planetary boundary layer, 2-3 m/s in the free atmosphere, and 3 m/s in the lower stratosphere. The wind observations will be spatially averaged, continuously sampled along the satellite track. ADM-Aeolus will also deliver height profiles of backscatter and extinction coefficients. The satellite will fly in a polar dusk/dawn orbit, providing a global coverage of ~16 orbits per day. The wind measurements will be delivered near-real-time (NRT) for direct ingestion into operational numerical weather prediction (NWP) models. Optical properties products will be provided offline.

During the technical development of the ALADIN laser, changes to a.o. the mission measurement strategy had to be implemented to meet user requirements on stability and measurement accuracy. This led to changes in the spatial representativity of the data. New impact studies were initiated to consolidate an optimized the on-ground data processing and make best use of the Aeolus data in NWP assimilation systems. At the 2012 5th WMO Workshop on Observing Systems Impact, it was concluded that direct wind observations are amongst the top five observing systems concerning NWP Impact. This further emphasizes the great potential of further direct wind observation systems. The status of the Aeolus mission and its data products will be presented here, together with the CAL/VAL preparation activities, the results from impact studies, results from campaigns with the Aeolus Airborne Demonstrator (A2D) and the potential for assimilation of Aeolus's spin-off products.

An overview and the status of atmospheric motion winds derived from INSAT satellites at IMD

A.K. MITRA[1] and P.K. KUNDU[2]

[1] Satellite Meteorology Division, India Meteorological Department, New Delhi
[2] Department of Mathematics, Jadavpur University, Kolkata-700032, India

ABSTRACT

The AMVs are recognized as an important source of information for numerical weather prediction (NWP) and are particularly suited for tracking of low and middle level clouds mainly because of the good contrast in albedo between target and background whereas the upper level moisture pattern can be better tracked by water vapor winds (WVW) using water vapor (WV) channel (5.7μm- 7.1μm). Successful commissioning of indigenous satellite INSAT-3D on 26th July 2013 has provided a new opportunity to the Indian meteorologists. INSAT-3D data is being routinely processed at Satmet Division, IMD, New Delhi from 11.09.2013. The INSAT-3D imager is to provide imaging capability of the earth disc from geostationary altitude in one visible (0.52 – 0.72 mm) and five infrared; 1.55 – 1.70 mm (SWIR), 3.80 - 4.00 mm (MIR), 6.50 – 7.00 mm (water vapour),10.2 – 11.2 mm (TIR-1) and 11.5 – 12.5 mm (TIR-2) bands. The ground resolution at the sub-satellite point is nominally 1km x 1km for visible and SWIR bands, 4km x 4km for one MIR and both TIR bands and 8km x 8km for WV band.

There are five types of wind products are being generated at IMD, New Delhi from INAST-3D imager such as Visible(Day)/MIR wind (Night), WVW from WV channel and CMV from IR1 channel and two blended products of low level wind (using VIS/MIR channel and WV) and high level winds (WV and IR1 channel). The evaluation of CMV and WVW would be taken into both qualitative and quantitative measures. Quantitative assessment of the CMV and WVW product is possible from statistical analyses and impact on NWP.

Finally, the BUFR products of above mentioned winds are prepared and will be disseminated to GTS for user community.

SCATTEROMETER WINDS FOR MESOSCALE DYNAMICS

Ad.Stoffelen@knmi.nl, Anton Verhoef, Wenming Lin*, Marcos Portabella*, Patrick Bunn,
Jos de Kloe, Jur Vogelzang, Jeroen Verspeek

KNMI, de Bilt, the Netherlands
*CSIC, Barcelona, Spain

ABSTRACT

Several opportunities exist to improve our view on mesoscale dynamics using scatterometer winds. First, a constellation of scatterometers exists, measuring high-resolution winds on several local times a day, which enables the depiction of mesoscale dynamics. An update will be given of the quality, quantity and timeliness of the constellation winds. Second, MetOp-A and MetOp-B both operate an ASCAT scatterometer in tandem, where the left and right swaths of both instruments overlap between 40S and 40N with a time difference of about 50 minutes. Since the convection time scale is about 30 minutes, the subsequent spatial wind fields of the tandem ASCAT swaths, separated by 50 minutes, show unique signatures of the convective systems in the changing surface wind field. These changes are compared to satellite precipitation measurements in order to improve our understanding of the major convective downburst as depicted by the tandem ASCAT scatterometers. In particular in tropical convective areas, the convection downbursts principally affect the air-sea interaction process, but which are not incorporated in global weather and climate models. A third topic is our improved understanding of the scatterometer wind retrieval residual, called MLE, which is basically a measure of the surface wind variability. It will be shown that the MLE is indeed able to depict synoptic and mesoscale fronts, squall lines and convective features, which may aid forecasters in nowcasting extreme weather.

GEOMETRIC CLOUD MOTION WINDS IN A CONVOY OF SATELLITES

Ad.Stoffelen@knmi.nl, Karl Atkinson*, Amanda Regan^

KNMI, de Bilt, the Netherlands
*Astrium Ltd., Stevenage, UK
^ESTEC, Noordwijk, Netherlands

ABSTRACT

To investigate the potential that spacecraft constellations and formations present for Earth Observation, three ESA "Earth Observation Sentinel Convoy" studies are currently underway as part of the Support to Science Element (STSE) of the Earth Observation Envelope Programme (EOEP) of the European Space Agency (ESA). These studies aim to identify scientific and operational needs that would benefit from additional in-orbit support in three themed domains: 'Ocean and Ice', 'Land' and 'Atmosphere'. The studies also intend to identify and develop cost-effective mission concepts that can meet these needs by flying in convoy with the European operational missions, such as MetOp Second Generation (SG). This paper provides an overview of the progress made on the theme 'Atmosphere'. User needs and identified scientific gaps are outlined and to address these gaps the selected mission concept for further feasibility study is briefly described. To date, mesoscale winds are not well exploited in global NWP and climate models and phenomena of turbulence and convection are not explicitly represented in these models. These phenomena are however initiating atmospheric dynamics and are the basis of the interaction of the troposphere with the surface and stratosphere. The geometric Clouds Motion Winds (gCMW) concept targets the measurement of height-resolved wind fields exploiting the effect of parallax. A multi-angle imaging spectro-radiometer (cf. MISR) is targeted for providing cloud top heights and height-resolved wind, vertical motion, aerosol and cloud structures using a multi-angle imager and geometric optics. Enhanced performance with respect to earlier flown missions may be achieved by 1) launching a tandem of gCMW satellites, e.g., one leading and one following MetOp-SG, 2) allowing night-time measurements by using infrared channels and 3) obtaining winds at several heights by using different visible and infrared frequency channels. This information would greatly complement the MetOp instruments to vertically resolve dynamical structures. The MetOp-SG imagers and sounders would benefit from improved height assignment and cloud information, respectively. To maximise the correlation of images the temporal co-registration between the convoy and MetOp-SG spacecraft should be only a few minutes.

APPLICATION OF AEOLUS WINDS

Ad.Stoffelen@knmi.nl, Gert-Jan Marseille, Jos de Kloe, Harald Schyberg*,

KNMI, de Bilt, the Netherlands
*MetNo, Oslo, Norway

ABSTRACT

This IWW12 presentation will discuss the challenges of data assimilation and quality assurance of the Aeolus data. The Aeolus Doppler Wind Lidar mission has not been closer to a launch date on any IWW meeting than the one in Copenhagen. The Aeolus instrument will be continuously pulsed at about 50 Hz (CM), whereas it had been designed to emit a burst of laser pulses at 100 Hz every 200 km (BM). Now Aeolus observations will appear in a continuous 2D plane, one dimension in the vertical and the other along the satellite propagation direction. Data assimilation systems are in principle capable of assimilating irregularly-spaced observations and the spatial aggregation of Aeolus data can be optimized to obtain maximum beneficial forecast impact. To this end we determine Numerical Weather Prediction (NWP) model spatial errors statistically using scatterometer, radiosonde and aircraft winds and compare them to synthetically-determined error structures as operationally used in regional and global NWP data assimilation. The spatial NWP errors vary by height, season and climate region and distinct differences are present between the synthetic structures and those determined using observations. Moreover, the effect of spatial representativeness errors will be discussed, which essentially guides the observation thinning and/or aggregation level of observations in data assimilation. We will discuss the consequences of these results for setting the Aeolus vertical and horizontal aggregation and sampling. A second advantage of the continuous mode is in the possibility of continuous monitoring of instrument performance and thus in quality assurance. The talk will briefly address the development of quality assurance of the Aeolus observations in preparation for the forthcoming Aeolus launch.

MISR STEREO OBSERVATIONS OF KÁRMÁN VORTEX STREETS

Ákos Horváth[1] and Kevin Mueller[2]

(1) Leibniz Institute for Tropospheric Research, Leipzig, Germany
(2) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA

ABSTRACT

Mesoscale vortices often develop in the wake of mountainous islands when the boundary layer is well mixed and capped by a strong inversion below the mountaintop. These island wakes frequently take the form of a Kármán vortex street comprising a train of counterrotating vortices, which can extend hundreds of kilometers downwind. Such vortex trains still pose a challenge to atmospheric modeling, as they are a complex three-dimensional analog of the classic vortex pattern observed in two-dimensional inviscid flow around a bluff obstacle. In order to aid numerical simulations, we present MISR (Multiangle Imaging SpectroRadiometer) measurements of cloud-motion wind and cloud-top height for a few dozen well-developed Kármán vortex streets. The newly upgraded stereo algorithm allows the experimental retrieval of the horizontal wind vector (both along-track and cross-track components) at 4.4-km resolution, in addition to the operational 1.1-km resolution cross-track wind and cloud-top height products. We show that these high-resolution MISR retrievals can capture the fine structure of island wake flows, including the counter-rotating vortex pairs. The MISR-observed magnitude and downwind-decreasing trend of vorticity are in good quantitative agreement with recently published results from idealized large eddy simulations. The aspect ratio and dimensionless width of vortex streets derived from MISR imagery are within the range of previous satellite-based estimates and generally exceed the values predicted by similarity theory for inviscid laboratory flow.

VALIDATION OF SINGLE-MODE AND DUAL-MODE METOP AMVs

Ákos Horváth[1] and Regis Borde[2]

(1) Leibniz Institute for Tropospheric Research, Leipzig, Germany
(2) EUMETSAT, Darmstadt, Germany

ABSTRACT

The Metop-A and Metop-B satellites are part of the space segment of the EUMETSAT Polar System. Single-mode polar winds are derived separately for Metop-A and Metop-B by tracking cloud features in 10.8-µm AVHRR imagery within the overlapping area of two consecutive orbits, obtained ~100 minutes apart. Wind extraction from image pairs, as opposed to triplets, halves tracking time and considerably increases the overlap area, allowing retrievals down to 50° N/S. In addition to the single-mode polar winds, EUMETSAT has also introduced a novel dual-mode wind retrieval technique, taking advantage of the swath overlap between the Metop-A/Metop-B tandem, which flies in the same orbital plane but with a half orbit separation. Dual-mode winds are extracted from a pair of Metop-A and Metop-B scenes obtained ~50 minutes apart, allowing global wind retrievals from AVHRR for the first time. The increased coverage of both single- and dual-mode Metop winds helps filling the 55°-70° AMV data gap between the coverage areas of geostationary and polar sensors.

We present validation of Metop AMVs against GOES and MTSAT geostationary winds, MODIS polar winds, and MISR stereo winds. Comparison statistics are derived for the globe and separately for large climatological areas (polar regions, mid-latitudes, Tropics). Emphasis is put on investigating height assignment errors; therefore, validation results are stratified according to height assignment technique used (equivalent blackbody temperature, IASI CO_2-slicing, low-level temperature inversion correction). Here, inclusion of MISR stereo winds has proven doubly advantageous. First, MISR retrievals represent the only other satellite-derived wind dataset that covers the 55°-70° AMV data gap. Second, MISR winds feature a completely independent and purely geometric height assignment technique, which, unlike traditional radiometric methods, is insensitive to calibration drift and requires no ancillary forecast profiles, thus, providing potentially more accurate heights.

Improving the use of satellite winds at the German Weather Service

Alexander Cress; Alexander.Cress@dwd.de

Deutscher Wetterdienst, Frankfurter Strasse 135, 63067 Offenbach am Main

ABSTRACT

Geostationary and polar-orbiting satellites provide spatially and temporally highly resolved wind observations and are widely used operationally by global and regional NWP centers. Various impact studies demonstrate the positive benefit of AMV and scatterometer wind products in the data assimilation system of the German Weather Service (DWD). Currently, the DWD uses AMV wind data from 5 geostationary satellites (GOES 13/15, METEOSAT 7/10, MTSAT-2R and several polar satellites (MODIS from TERRA and AQUA; AVHRR winds from the NOAA satellites and Metop). Additionally, scatterometer wind observation derived from ASCAT (Metop A/B) and Oceansat-2 (OSCAT) 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 tasks at DWD. This presentation will give an overview of recent progress in the assimilation of AMV and scatterometer data at DWD. Since the last wind workshop, several new and upgrade AMV wind products become available At the DWD, the main focus was on the use of GOES 15, Meteosat10 AMV winds and the use of an improved height assignment method (CCC method) provided by Eumetsat. Monitoring and impact results will be presented. Additionally, results of an impact study, initiated by the International Wind Working Group, using MISR cloud tracked winds for the summer period 2010 and the winter period 2010/2011, will be presented.

This presentation will also show results of an on going task to specify AMV observation errors correctly in the data assimilation system. Increasing the observations error and adjusting the first guess
Quality control thresholds lead to some beneficial impacts

Recently, new near surface wind observations from the Ku-band scatterometer instrument on board the Oceansat-2 satellite and the ASCAT instrument on board of Metop B , both processed by KNMI, became operationally. This talk will present monitoring and impact results, confirming the high quality of the new scatterometer products.

PERFORMANCE OF THE NOAA AWG CLOUD HEIGHT ALGORITHM APPLIED TO CURRENT GEOSTATIONARY AND POLAR ORBITING IMAGERS.

Andrew K Heidinger
NOAA/NESDIS

ABSTRACT

The GOES-R Algorithm Working Group (AWG) Atmospheric Motion Vector (AMV) Product was designed to use a separate cloud height product for the height assignment of wind vectors. The cloud height algorithms used for this the NOAA AWG Cloud Height Algorithm (ACHA). ACHA is an optimal estimation (OE) approach based solely on infrared (IR) observations. It employs analytical forward models and scattering approximations to achieve the computational efficiency needed to support the AMV and other applications. While initially designed for the GOES-R Advanced Baseline Imager (ABI), ACHA has since been modified to operate on the various IR channel combinations offered by the current suite of geostationary and polar orbiting sensors.

This talk will use the OE diagnostics and direct CALIPSO/CALIOP comparisons to explore the performance of ACHA using the different IR channels on the current sensors. One of the outstanding questions with ACHA is in determining if water vapour channels benefit or hurt the performance.

CLOUD TOP, CLOUD CENTRE, CLOUD LAYER – WHERE TO PLACE AMVS?

Angeles Hernandez-Carrascal [1] and Niels Bormann [2]

(1) AEMET (2) ECMWF

ABSTRACT

This contribution investigates alternative interpretations of what AMVs represent best. Traditionally, in operational derivation of AMVs, these are interpreted as single-level point estimates of wind, and high-level (resp. low-level) AMVs are generally assigned to an estimate of the top (resp. base) of the cloud layer.

This study uses a simulation framework to explore alternative interpretations of AMVs: an integration with a high-resolution model provides the true atmosphere, including the wind and the spatial and vertical distribution of clouds, and AMVs are derived from images simulated from the model output. Provided the simulation is realistic, the detailed description of the atmosphere allows to explore and evaluate alternative vertical assignments for AMVs.

Our results suggest that AMVs are more representative of either a wind average over the model cloud layer or of wind at a representative level within the cloud layer, rather than of wind at the model cloud top or cloud base. We will discuss the implications of these findings, with a particular focus on the use of AMVs in Numerical Weather Prediction.

We would like to give a presentation (a poster would be fine) on the status of AMV usage at DMI. At present it is our aim to make an impact study of MSG AMV in our HARMONIE limited area model and also to make it operational in that model. For many years AMV have been operational in our HIRLAM limited area model systems and we will have some discussion on that as well.
Accordingly, we don't want to make a too specific title and abstract at the moment. The title etc... is for now:

Authors: Bjarne Amstrup and Mats Dahlbom
Affil.: Danish Meteorological Institute
Title: Status of AMV usage in NWP at DMI

PRELIMINARY ASSESSMENT OF THE IMPACT OF REPROCESSED AMVs FOR THE ERACLIM GLOBAL REANALYSES

C. Peubey, P. Poli, N. Bormann, K. Salonen

ECMWF

ABSTRACT

The EU-FP7 ERACLIM project aims to prepare accurate and detailed estimates of the global evolution of the climate system during the previous century, based on reanalyses of in-situ and satellite observations. The project involves recovery, digitisation, and quality control of large numbers of early 20th-century meteorological data as well as the production and validation of reprocessed satellite datasets. Several reanalysis datasets will be released by ECMWF; among them, one specific dataset will cover the satellite-era period and will replace the current ERA-Interim reanalysis. In this context, the AMV reprocessed data which have recently been made available by satellite agencies (amongst which are NOAA and METOP AVHRR AMVs, GMS and MTSAT AMVs, MSG AMVs) are of particular interest. Within the ERACLIM project, impact studies are currently being carried out at ECMWF in order to test the use of these datasets in reanalysis experiments. This presentation will show some preliminary results and will present the strategy adopted for the assimilation of AMVs in the next ECMWF reanalysis.

SATELLITE WINDS ACTIVITIES AT METEO FRANCE

Christophe Payan

CNRM and GAME, Météo France and CNRS

ABSTRACT

Over the two last years, the activity has focused mainly on the assimilation of OSCAT winds. OSCAT is a Ku-band scatterometer, onboard the satellite Oceansat-2 launched in September 2009 by the Indian Satellite Research Organization (ISRO). This work takes place in the follow-on of the results presented at the Eleventh Winds Workshop (2012), on the quality control for the assimilation of scatterometer winds and the evaluation of the OSCAT winds produced by the Royal Netherlands Meteorological Institute in the frame of the European response to an announcement of opportunity issued by ISRO. On October 2012, this wind dataset became available operationaly in near real-time through the EUMETSAT Ocean and Sea Ice Satellite Application Facility until the discontinuation of the instrument on February 2014.

The manner whose OSCAT winds were assimilated builds on the legacy of SeaWinds on the satellite QuikSCAT. The dependence of the specified observation error on the cross-track position has been introduced, on the basis of statistics (observation minus first-guess). The impact on the forecasts in the global model 4D-Var ARPEGE is neutral to slightly positive in the tropical areas and in the southern hemisphere. The OSCAT winds have also shown the capacity to improve the predictability of Tropical Cyclones in the regional model 3D-Var ALADIN-Réunion, used operationally for the predictions on the South-West Indian Ocean.

The availability of new instruments (onboard NPP, MetOp-B satellites) and the processing changes (channels adding, over land using, thinning changes) has doubled the number of observations effectively assimilated in the operational version of the model ARPEGE since July 2013. The contribution of satellite winds, and in particular of scatterometer winds from MetOp A and B satellites and from OceanSat-2, to the Forecast Error Reduction will be commented through the Forecast Sensitivity to Observations tool.

Observation Impact of Satellite Winds in NASA GEOS-5 Forecast System

Dagmar Merkova* and Ron Gelaro** *GMAO NASA, SSAI **GMAO NASA

The impact of satellite-derived atmospheric motion vectors (AMVs) on numerical weather forecasts is examined using the GEOS-5 global atmospheric data assimilation system. An experiment is conducted in which all AMVs used operationally in GEOS-5 are replaced by AMV's produced by the U.S. Navy's NAVDAS-AR atmospheric data assimilation system. The Navy AMVs are significantly greater in number, come from multiple sources and are spatially averaged as “superobs”. Assimilation of these data yields improvements in forecast skill and increased observation impact compared with the operational AMVs. Additional experiments using various subsets of the Navy AMVs in the GEOS-5 system are used to further determine the main causes of these improvements.

SATELLITE OBSERVATIONS OF TROPICAL PLANETARY BOUNDARY WIND SHEAR

David Halpern and Michael Garay

Jet Propulsion Laboratory, Pasadena, California, USA

ABSTRACT

The Jet Propulsion Laboratory (JPL) Multi-angle Imaging SpectroRadiometer (MISR) instrument on the National Aeronautics and Space Administration (NASA) Terra satellite provides global observations of near-instantaneous cloud height and cloud velocity. MISR cloud motion vectors (CMVs) or wind vectors at 700-m height were determined by linear interpolation of MISR CMVs with heights from 500-900 m. The JPL SeaWinds instrument on the NASA Quick Scatterometer (QuikSCAT) satellite recorded wind vectors at 10-m height. Collocated MISR and SeaWinds measurements in 0.5°X0.5° areas within a 4.5-h interval were analysed over 2003-2008. The difference between 700- and 10-m wind vectors provided planetary boundary layer (PBL) wind shear.

The annual mean longitudinal distribution of zonal wind component along the equator from 0.5°S-0.5°N and 1° resolution in longitude in 2007 showed substantial shear from about 180° longitude to 90°W with magnitude ~ 2 m s^{-1} over 690 m from 160-120°W. Very little zonal wind shear occurred elsewhere in the Pacific, Indian and Atlantic oceans. The meridional wind shear was large over the 120-90°W region and negligible elsewhere. Where significant wind shear occurred, the magnitude of the wind aloft was larger than at the surface. The high wind shear region coincided with equatorial sea surface temperature (SST) less than 27.0-27.5°C, which is the SST threshold associated with tropical convection. The connection between wind shear and occurrence of rainfall will be discussed. Other years remain to be analysed, including selected months associated with the moderate-intensity El Niños in 2004 and 2006, moderate La Niña in 2006, and strong La Niña in 2007-2008. In 2007, the observed 10-700 m wind shear was similar to that produced by the European Center for Medium-range Weather Forecast (ECMWF) Reanalysis Interim (ERA-I) data product and was different from that produced by the United States National Oceanic and Atmospheric Administration National Centers for Environmental Prediction (NCEP). The amount of aliased wind shear caused by the MISR sampling pattern will be examined with ERA-I data products. The correspondence between observed wind shear and that derived from several numerical weather prediction data products, including ERA-I and NCEP, will be described.

A NEW ATMOSPHERIC MOTION VECTOR INTERCOMPARISON STUDY

David Santek, Chris Velden, Iliana Genkova, Dave Stettner, Steve Wanzong,
Sharon Nebuda, Javier Garcia-Pereda

Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison, Wisconsin USA

ABSTRACT

Previous Atmospheric Motion Vector (AMV) intercomparison studies conducted from 2007 to 2009 compared the operational AMV algorithms of many of the satellite-derived wind producers using a common set of Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI) images and ancillary data. The study assessed how the cloudy AMVs from the various wind producers compared in terms of coverage, speed, direction, and cloud height.

The goal of this new effort was to:

- Include the Satellite Application Facility to Nowcasting and Very Short Range Forecasting (NWC SAF) High Resolution Winds (HRW) algorithm in the intercomparison studies and to quantify its performance relative to the other AMV algorithms.
- Update the results of the previous AMV intercomparison studies, because many of the operational AMV algorithms have changed since that time.

In this study, seven AMV producers participated: EUMETSAT, NOAA/NESDIS, CMA, JMA, KMA, NWC SAF, and the Brazilian Meteorological Center. Each center used the same input data and ran four different configurations, which was used to quantify the differences in the algorithms.

A detailed description of the four experiments along with the results of this intercomparison study will be presented.

FEATURE TRACKED WINDS FROM MOISTURE FIELDS DERIVED FROM AIRS SOUNDING RETRIEVALS

David Santek, Sharon Nebuda, Dave Stettner

Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison, Wisconsin USA

ABSTRACT

For more than a decade, polar winds from the Moderate Resolution Imaging Spectroradiometer (MODIS) imagery have been generated by NOAA and the Cooperative Institute for Meteorological Satellite Studies (CIMSS). These datasets are a NOAA/NESDIS operational satellite product that is used at more than 10 major Numerical Weather Prediction (NWP) centers worldwide.

The MODIS polar winds product is composed of both infrared window (IR-W) and water vapor (WV) tracked features. The WV atmospheric motion vectors (AMV) yield a better spatial distribution than the IR-W since both cloud and clear-sky features can be tracked in the WV images. As the next generation polar satellite era begins with the Suomi National Polar-orbiting Partnership (NPP), there is currently no WV channel on the Visible/Infrared Imager/Radiometer Suite (VIIRS), resulting in a data gap with only IR-W derived AMVs possible. This scenario presents itself as an opportunity to evaluate moisture retrievals from consecutive overlapping satellite polar passes to extract atmospheric motion from clear-sky regions on constant (and known) pressure surfaces; i.e., estimating winds in retrieval space rather than radiance space. Perhaps most significantly, this method has the potential to provide vertical wind profiles, as opposed to the current MODIS-derived single-level AMVs.

We will report on this technique as applied to Atmospheric Infrared Sounder (AIRS) moisture retrievals from NASA's Aqua satellite, the resulting winds, and assimilation and forecast impact results using the Goddard Earth Observing System Model, Version 5 (GEOS-5). Also, plans to produce these AMVs in near real-time at CIMSS will be detailed.

EVALUTAION OF A NEW QUALITY CONTROL METHOD APPLIED TO MODIS AND AVHRR WINDS IN THE NCEP GDAS/GFS

David Santek, Brett Hoover, Sharon Nebuda

Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison, Wisconsin USA

ABSTRACT

Atmospheric Motion Vectors (AMV) are routinely generated from geostationary and polar orbiting satellites and they are incorporated into most global numerical weather prediction models. The AMV thinning strategies vary in the modeling community, but they are usually based on thresholds of the quality flags from the winds producers and the deviation of the AMV from the model background.

In the NCEP Global Data Assimilation System/Global Forecast System (GDAS/GFS), Moderate Resolution Imaging Spectroradiometer (MODIS) polar winds are discarded if the zonal or meridional component of the wind deviates more than the threshold of 7 m/s from the background state. Since wind speeds vary across three orders of magnitude, using this fixed threshold has the disadvantage of retaining too many slow winds (regardless of direction) and discarding high-speed winds that do not deviate very much (as a percentage) from the background. To alleviate these issues, a new method is evaluated which discards observations based on the AMV vector departure from the background, normalized by the logarithm of the AMV speed: the Log Normalized Vector Departure (LNVD). For AMVs to be retained, the LNVD method requires slower speed winds to be in better agreement with the background, while allowing higher speed winds to deviate more, as compared to the current fixed threshold.

Results of current GDAS/GFS experiments using the LNVD to screen MODIS and Advanced Very High Resolution Radiometer (AVHRR) polar AMVs will be discussed.

GLOBALLY DISTRIBUTED TIME SERIES OF THE ENHANCED MISR CLOUD MOTION VECTOR PRODUCT

R. Davies (University of Auckland)
K. Mueller (Jet Propulsion Laboratory)

ABSTRACT

At the 10th IWW, Davies and Herber reported on the change in wind speed over the previous decade, using the first edition of the MISR cloud motion vector product. Since then, we not only have several more years of data, but the wind retrieval algorithm has been substantially enhanced to provide better coverage, higher resolution and to remove cross-track biases. Results from the latest analysis of the global distribution of MISR winds, and their changes over time, especially as a function of latitude, will be presented. We look especially at regions of the Southern Oceans, where reanalysis data currently are of limited accuracy.

Comparisons of MISR Cloud Motion Vectors with Reanalysis Winds

Dong L. Wu NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

Abstract

The recently-released MISR cloud motion vector (CMV) product has improved its coverage, precision and horizontal resolution (17.6 km). The reprocessed data are available for the entire mission period beginning in March 2000. MISR CMV measurements have demonstrated a promising capability to resolve boundary-layer dynamics with vertical resolution of 500 m. In this study, the new MISR CMV data are compared to ERA-Interim and MERRA reanalysis in terms of zonal and meridional winds, with emphasis on boundary-layer (0-3 km) mean biases in monthly zonal and meridional components. The reanalysis winds are collocated and interpolated to the location and local time of MISR data on a daily basis to minimize sampling biases. We find generally good agreement over ocean but slightly larger differences over land. In particular, the zonal winds over the northern Africa, eastern China, Rockies, and Antarctica exhibit large biases. Meridional winds differ more in the tropics where MISR shows stronger inter-tropical convergence over Africa. Different from the GEO and MODIS CMVs, MISR resolves cloud motion and height simultaneously with stereoscopic pattern matching of its nine high-resolution (275 m) images in <7 minutes. MISR CMV height determination is insensitive to atmospheric temperatures, and therefore not limited by atmospheric thermal structures or complex surface types as in the IR CMV technique. Tracking cloud motions in 7 minutes also helps to reduce CMV uncertainties from the cloud shape distortion in rapidly developing systems such as convective and frontal clouds.

Current status of COMS AMV in NMSC/KMA

Eunha Sohn, Hyunkyo Jeong

KMA (Korea Meteorological Administration)

Presenting Author: Eun Jeong, kenkyukan@korea.kr

COMS has been generating Atmospheric Motion Vector (here after AMV) at every hour with successive images of 15 minute intervals, since 1 April 2011 when it started to operate. KMA have applied operationally the COMS hourly AMV to a 4d-var data assimilation system since December 2011.

We are using target box 24x24 for COMS AMV estimation in operation but compared COMS AMVs derived from different two target boxes, 24x24 and 16x16, respectively. And we found the difference in AMV height, vector magnitude, vector number and quality etc. in terms of statistical results. We think that these results need to be analysed in terms of algorithm and through a plenty of case studies to know the causes of these differences.

We also compared our operational COMS AMV with one from HRW developed by NWCSAF, one from nested tracking method developed by CIMSS and one from Cross Correlation Contribution developed by EUMETSAT.

We validated COMS AMV with full resolution radiosonde wind data and compared these results with one from original radiosonde wind data at several standard pressure levels.

The presentation will introduce the some activities of KMA for COMS AMV.

Study of the target selection methods for AMV derivation of Geo-KOMPSAT 2A

Eunhee Lee , Tae-Myung Kim, Sung-Rae Jung, Jae-Gwang Won

NMSC/KMA

ABSTRACT

The second geostationary meteorological satellite (Geo-KOMPSAT 2A, here after **GK2A**) of Korea will launch in the end of 2017. The AMI, flown on the GK2A will have sixteen spectral bands, compared to five on the current COMS imager, and will provide three times more spectral information, four times the spatial resolution, and more than four times faster temporal coverage than the current system. Therefore, the new meteorological data processing system for the AMI will be needed to convert raw instrument data to calibrated radiance and derived geophysical parameters (atmosphere, land, ocean, and space weather).

The Atmospheric Motion Vectors (AMVs) extraction scheme will be developed in preparation for GK2A retrieves the AMVs in a generally similar fashion to the present scheme which was developed for GOES-R and MTG satellite. First of all, the optimal conditions of target selection and tracking for derivation of AMVs using AMI data have been studied in NMSC/KMA. The preliminary results will be announced in the 12th IWW.

Visible Channel CMV from Fengyun Geo. Stereo View—simulation and bias analysis

Feng Lu, Jianmin Xu

National satellite meteorological Center, Beijing,100081,CHINA

ABSTRACT

Before year 2020, over 5 Fengyun Geosynchronous satellite will be launched, the satellite SSP will covers from 79E to 133e, based on stereo view of two FengYun Geosynchronous satellite,The Cloud Top Height(CTH) could be derived, and applied for Visible channel CMV generation.
In this paper, the CMV bias and optimal FengYun satellite pair for stereo view will be discussed.

SCATTEROMETER WINDS ASSIMILATION IN THE MESOSCALE HARMONIE MODEL

Gert-Jan.Marseille@knmi.nl, Ad Stoffelen

KNMI, de Bilt, the Netherlands

ABSTRACT

Data assimilation experiments have been conducted with the high-resolution limited area model HARMONIE, operational at KNMI. Focus was on extreme weather events with strong winds, causing disruption over The Netherlands. Assimilated observations include satellite scatterometer ocean surface winds in addition to conventional observations from radiosonde, aircraft and synop stations. The work is part of the EU-funded MyWave project that aims at improving wave model forecasting, e.g., by driving wave models with high resolution wind information from mesoscale atmospheric models. Scatterometer winds may potentially improve atmospheric model wind and stress near the ocean surface and subsequent wave model forecasts.

Results will be presented for a storm event in November 2007 which required closure of one the barriers, as part of the Deltaworks, to protect the coastal part of The Netherlands from flooding. Both ASCAT (Metop-A) and QuikSCAT were available at the time. Demonstrating positive impact from assimilating observations (both conventional and from satellites) in mesoscale models is quite a challenge. For instance it was found that HARMONIE 10m model winds over sea are exaggerated for wind speeds exceeding 15 ms^{-1}. Assimilating scatterometer winds reduces the bias at analysis time but subsequent forecasts recovered the bias. Also, although the mesoscale model simulated atmosphere looks realistic, it is not real, i.e., small-scale weather phenomena may be wrongly positioned. Correct positioning of small-scale phenomena requires observations at high resolution, both spatial and temporal, which are generally not available. Challenges of mesoscale data assimilation will be highlighted and possible directions for solution discussed.

IMPACT STUDIES OF ASCAT WINDS IN THE ECMWF 4D-VAR ASSIMILATION SYSTEM

Giovanna De Chiara, Peter Janssen, Jean Bidlot, Stephen English
European Centre for Medium-Range Weather Forecasts (ECMWF)
Shinfield Park, Reading RG2 9AX, United Kingdom
e-mail: giovanna.dechiara@ecmwf.int

Scatterometer data are known to improve the quality of surface winds over the ocean. In particular C-band scatterometers, thanks to the microwave wavelength used, are capable of providing information also in the presence of rainfall. Their observations are therefore important for the analysis of winds in case of extreme events.

C-band scatterometers have been assimilated into the European Centre for Medium-Range Weather Forecasts (ECMWF) Integrated Forecasting System (IFS) since 1996, beginning with ERS-1 and ERS-2 Scatterometer data. Currently Metop-A ASCAT and Metop-B ASCAT wind products are assimilated together with the Ku-band Scatterometer products provided by the Indian satellite OCEANSAT-2.

At ECMWF, in collaboration with EUMETSAT, a research is on-going on the assessment of the ASCAT sensors. The main aim of the project is to evaluate the current impact of Scatterometer winds in the Global Observing System (GOS). The impact of Scatterometer observations is placed in the context of a full GOS scenario as well as scenarios assimilating only subsets of the GOS. The assessment of scatterometer winds has been performed using a range of diagnostics, from the traditional forecast scores to the verification against independent observations such as altimeter winds, wave height and wind speed buoy data. The benefit of Scatterometer observations on severe storms, such as tropical cyclones was also evaluated.

Results show that generally the assimilation of ASCAT winds is beneficial on the system and the largest impact is from the Tropics. ASCAT-A and ASCAT-B showed to have the same impact on the system. The study has nevertheless exposed some weaknesses in how the information from scatterometer is used. Solutions on how to better assimilate the data have been identified and will be tested in the remaining part of the project.

In this presentation, the impact studies performed will be described and the results will be discussed.

OPERATIONALLY USE OF NWCSAF AMV PACKAGE IN THE METOFFICE MESOSCALE FORECASTING SYSTEM

Graeme Kelly [2], Peter Lean [1], Stefano Migliorini [1]

[1]University of Reading
[2]Met Office, UK

ABSTRACT

Satellite derived Atmospheric Motion Vectors (AMVs) have given positive benefit to operational large-scale NWP forecasts for many years. Their use in Nowcasting has been limited due to the use of the large tracking box sizes that are used by operational AMV products. The NWCSAF AMV package allows local AMVs to be produced with smaller tracking boxes producing AMVs with scales that are more suitable for Nowcasting systems. Delays in the processing and reception of AMVs are also a problem for Nowcasting. Local AMVs can be produced within five minutes after the satellite image reception whereas the operational product may take up to 30 minutes.

The MSG NWCSAF software has been setup over the 1.5km UK model area and produces AMVs every 15 minutes. OSEs will be discussed using the 1.5km UK hourly 4DVAR Nowcasting system. The NWCSAF AMVs have been introduced into the Metoffice's Operational Mesoscale system.

OPERATIONAL WIND PRODUCTS AT NOAA/NESDIS

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.

William Pennoyer
Science Systems and Applications, Inc
Lanham, Maryland 20706, 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.

Presenting Author: ***Hongming Qi***, Hongming.Qi@noaa.gov

This paper summarizes the status of the operational wind products at NOAA/NESDIS. Recent improvements, new additions, processing changes and monitors, future plans of the Atmospheric Motion Vector (AMV) product suite and Scatterometer ocean surface wind product suite will be discussed. The current satellite constellation for operational AMV winds processing includes GOES-13 as the eastern operational geostationary satellite, GOES-15 serving as the western operational geostationary satellite, MODIS from Terra and Aqua and AVHRR from NOAA and MetOp series. The GOES hourly winds replaced 3-hour GOES AMV and have been in operation since May 2014. MetOp-B AVHRR Polar Winds was promoted into the operation in April 2013 and S-NPP VIIRS Polar Winds were successfully transitioned into the operation in May 2014. Besides the operational AMV products, several improvements in NOAA/NESDIS winds processing have been implemented. These improvements include the GOES, MODIS and POES AMV products by using GOES-R/VIIRS algorithms. Updates on the status of these operational AMV products, new wind processing system, data access policy, and other future plans will be presented. In addition, an overview of the operational ASCAT wind products at NOAA/NESDIS is also presented.

Investigating AMV and NWP model errors using the NWP SAF monitoring

James Cotton

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 SAF partners to improve the interface between satellite data and NWP for the benefit of EUMETSAT member states.

The main aim of the NWP SAF atmospheric motion vector (AMV) monitoring is to improve our understanding of AMV error characteristics in order to aid improvements to the AMV derivation and their treatment in NWP models. One of the ways this can be achieved is via long term monitoring of trends and patterns in observed minus background (O-B) statistics. The AMV wind retrievals are compared with short-range forecasts from a numerical weather prediction (NWP) model, valid at the same time and location of the observation. The NWP SAF maintains an archive of O-B statistics against both the Met Office and ECMWF global model backgrounds, providing a framework in which we can attempt to separate error contributions. Differences between centres suggest model-dependent problems whereas similarities suggest either problems with the AMVs or problems shared by the NWP models.

The NWP SAF O-B monitoring hosts a wealth of information for different satellites, channels and AMV producers and to exploit this resource requires a comprehensive and thorough investigation. This is where the AMV *analysis reports* come in. These reports, published very 2 years, attempt to summarise the main features identified in the O-B monitoring and record how they have evolved over time as updates are made to the AMV derivation and the NWP systems. Where possible, an attempt is made to diagnose the cause of the observed bias using tools such as model best-fit pressure and comparison to other wind and cloud top height products. This talk will highlight some interesting features from the 6th AMV analysis report published in early 2014.

AMV impact studies at the Met Office

James Cotton, Mary Forsythe, Francis Warrick, Richard Marriott

Met Office, UK

ABSTRACT

Atmospheric motion vectors (AMVs) derived from polar and geostationary satellite imagery provide tropospheric wind information with near-global coverage, at a high temporal frequency, and so are an important input to numerical weather prediction (NWP) analyses. This talk gives an overview of the status of AMV assimilation at the Met Office and efforts to diagnose and improve their impact in NWP.

A significant change in the use of AMVs at the Met Office has been the implementation of a temporal thinning scheme which, combined with a better handling of observation errors, has allowed the observations to be used at a far greater density. The overall impact of all observations within the Met Office NWP system has been diagnosed using the adjoint forecast-sensitivity to observations (FSO) technique and a substantial improvement has been observed in the impact of the AMVs on short range forecasts as a result of recent changes.

Further impact studies have been conducted at the Met Office to assess the potential of AMV datasets that are not currently assimilated in operations. The quality and impact of AMVs derived from the Chinese FY-2E satellite have been compared with those from Meteosat-7 as part of an investigation of winds providing coverage over the Indian Ocean. The Metop AVHRR wind products from EUMETSAT have the potential to improve coverage at mid-high latitudes. A set of polar wind impact experiments have been performed to compare the Metop wind products from CIMSS and EUMETSAT.

There have also been significant updates to AMV data sets currently used in operations. The EUMETSAT Meteosat Second Generation (MSG) AMV processing was updated to make use of the Cross Correlation Contribution (CCC) method bringing some significant improvements to the quality of the MSG winds. However, the statistics for the low level winds were slightly degraded. Results will be shown from efforts to establish the full impact of the CCC change and the subsequent update implemented by EUMETSAT.

Atmospheric Motion Vectors from the tandem operation of AATSR and ATSR-2

J-P. Muller[1] and D. Fisher[1]
[1] *University College London, Department of Space and Climate Physics, Mullard Space Science Laboratory, Holmbury St. Mary, Dorking, UK, RH5 6NT*

The soon to be launched SLSTR instruments on-board the Sentinel-3a (planned launch 2015) and -3b (planned launch 1.5 years later) satellites offer, due to the shared orbital tracks and phase delay of 180°, significant potential for atmospheric motion vector determination through a cloud feature tracking approach. Here the tandem operation of AATSR with ATSR-2 is examined as a precursor to this future operation. The Farneback optical flow algorithm [1], which employs polynomial expansion to effectively tack features across images, has been identified for application to the cloud tracking task. The algorithm can potentially produce robust AMV estimates at 1km resolution and 0.5 ms^{-1} quantisation [2]. Through a zero-wind analysis over the Antarctic ice sheet it is shown that the algorithm's flow estimates are within the accuracy limits defined by the quantisation. The spatial resolution of these wind estimates is currently unprecedented [e.g. 3,4], and demonstrates the excellent potential of advanced optical flow algorithms for the robust derivation of cloud tracked winds. In addition, the census stereo matching algorithm is employed to assign heights to the wind vectors to ~1km accuracy (including Polar Regions)[5]. Following the ATSR demonstration we explore the additional benefits that can be achieved through application of the above approaches to the SLSTR instruments.

Refs

[1] Farnebäck, G. (2003). Two-frame motion estimation based on polynomial expansion. In Image Analysis (pp. 363-370). Springer Berlin Heidelberg.
[2] Fisher, D. and J-P. Muller, Cloud Tracked Winds from AATSR-ATSR2 Tandem. In Prep. Planned submission to Atmospheric Science Letters.
[3] Mueller, K., Garay, M., Moroney, C., & Jovanovic, V. (2012, February). MISR 17.6 KM gridded cloud motion vectors: overview and assessment. In 11th International Winds Workshop. Auckland, Australia, February 20-24, 2012. Pasadena, CA: Jet Propulsion Laboratory, National Aeronautics and Space Administration, 2012.
[4] Key, J. R., Santek, D., Velden, C. S., Bormann, N., Thepaut, J. N., Riishojgaard, L. P., ... & Menzel, W. P. (2003). Cloud-drift and water vapor winds in the polar regions from MODISIR. Geoscience and Remote Sensing, IEEE Transactions on, 41(2), 482-492.
[5] Fisher, D. and J-P. Muller, Macrophysical Cloud Characteristics over Greenland from AATSR Stereo. In Prep. Planned submission to Atmospheric Measurement Techniques.

"NWC SAF/HIGH RESOLUTION WINDS" AMV SOFTWARE EVOLUTION BETWEEN 2012 AND 2014

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 locally and in real time by its users, considering up to seven MSG/SEVIRI channels.

A new version of HRW software was made available to users in August 2013 with some new elements, including the calculation of trajectories through the successive tracking of the same tracers, the update of the Quality control process, and the optimization of the algorithm for a default AMV calculation without wind guess in the tracking, among other ones. The validation shows additional improvements respect to previous versions, including the usability of all AMVs with a QI > 0% and a 7% or better reduction in the NRMSVD for all tracking methods, height assignment methods and tracer size options.

A new version (HRW v2015) is now being prepared, including the adaptation of HRW algorithm to GOES-N satellite series, and the inclusion of Microphysical information coming from NWCSAF/Cloud products in the AMV height assignment.

THE IMPACT OF THE TRACER SIZE, THE TEMPORAL GAP BETWEEN IMAGES AND THE WIND GUESS IN THE EXTRACTION OF ATMOSPHERIC MOTION VECTORS

Javier García Pereda [1] and Régis Borde [2]

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

2 EUMETSAT, Eumetsat Allee 1, D-64295 Darmstadt, Germany, regis.borde@eumetsat.int

ABSTRACT

The goal of this study has been to show the impact of the "tracer size", the "temporal gap between images" and the "use of the wind guess in the tracking", in Atmospheric Motion Vector (AMV) extraction schemes. The study has been performed using "NWC SAF High Resolutions Winds" AMV software for different configurations with a "tracer size" varying between 8x8 and 40x40 pixels and a "temporal gap between images" varying between 5 and 90 minutes, in different configurations using and not using the wind guess for the definition of the search area in the later image. AMVs have been extracted for four different MSG/SEVIRI channels (HRVIS, VIS0.8, WV6.2 and IR10.8) over the European and Mediterranean area for a six month period (January-June 2010). The AMV performance has been tested against Radiosonde winds and ECMWF model analysis winds.

Not using the wind guess to locate the search area produces more valid AMVs when large target boxes and short temporal gaps are used, and less valid AMVs when small target boxes and long temporal gaps are used. A general increase in the mean AMV speed and a general reduction of the Normalized Bias and the Normalized root mean square vector difference also occur when the wind guess is not used.

Considering the amount of valid AMVs, the results show a relatively small impact of the tracer size, more significant for Clear air AMVs, and a significant impact of the temporal gap between images (with largest amounts of valid AMVs for a temporal gap of 5 minutes for the 1 km pixel scale and a temporal gap of 10 minutes in general for the 3 km pixel scale). They also show a reduction of the "mean AMV speed" and the "Normalized BIAS (NBIAS)" with larger tracer sizes and a relatively small impact of the temporal gap on these parameters. Finally, they show minimum values of the "Normalized root mean square vector difference (NRMSVD)" for intermediate temporal gaps between 15 and 25 minutes, with a relatively small impact of the tracer size on this parameter.

STATUS OF VIIRS POLAR WINDS

Jeff Key[1], Jaime Daniels[2], Andrew Bailey[3], Steve Wanzong[4], Hongming Qi[2], Wayne Bresky[3], David Santek[4], Christopher Velden[4]

[1]NOAA/National Environmental Satellite, Data, and Information Service, Madison, Wisconsin USA
[2]NOAA/National Environmental Satellite, Data, and Information Service, Camp Springs, MD USA
[3]I.M. Systems Group (IMSG), Rockville, MD USA
[4]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, Wisconsin USA

ABSTRACT

In 2001, an experimental polar wind product was developed using imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. Since then, polar wind products based on data from the Advanced Very High Resolution Radiometer (AVHRR) on NOAA and Metop satellites have also been developed, as have mixed-satellite MODIS winds, and LEO-GEO composite winds. Today the MODIS and AVHRR winds are produced operationally at NOAA/NESDIS and at six direct readout sites in the Arctic and Antarctic. Many of these polar wind products are used in operational forecast systems at thirteen NWP centers in nine countries.

The most recent single-satellite winds product is based on data from the Suomi NPP Visible Infrared Imaging Radiometer Suite (VIIRS). VIIRS will eventually replace the AVHRR as NOAA's operational polar-orbiting imager. While VIIRS lacks water vapour absorption channels, it has some capabilities that will improve upon MODIS and AVHRR wind products, notably constrained-growth pixels, where pixels toward the edge of the swath are significantly smaller than for MODIS and AVHRR, and a significantly greater swath width than MODIS (though similar to AVHRR). Furthermore, the VIIRS polar winds product uses the algorithm developed for the GOES-R Advanced Baseline Imager (ABI), which employs a nested tracking approach and the use of externally generated cloud mask, height, and phase products.

VIIRS polar winds are now routinely generated by NOAA. Comparisons with rawinsonde data show that the winds are comparable to the cloud-track MODIS winds, and that the S-NPP system requirements are being met. The product will be operational at NESDIS in early 2014. A direct broadcast VIIRS winds system using the heritage winds algorithm is currently being implemented at Fairbanks, Alaska. This will help quantify the benefits anticipated from the use of the nested tracking algorithm.

THE OPERATIONAL GENERATION OF CONTINUOUS HIGH RESOLUTION AMVS IN THE AUSTRALIAN REGION AND THEIR BENEFIT TO OPERATIONAL NWP

John Le Marshall [1, 2], Rolf Seecamp[3] , Yi Xiao[1], Paul Gregory[1], Jim Jung[4], Peter Steinle[1] , Terry Skinner[3] and Jin Lee[1]

[1]CAWCR, Bureau of Meteorology, Melbourne, Australia, [2]RMIT University, Melbourne, Victoria, Australia, [3]Bureau of Meteorology, Melbourne, Australia,
[4]JCSDA, Camp Springs, MD, USA

Presenting Author: John Le Marshall, j.lemarshall@bom.gov.au

ABSTRACT

Recent studies have shown the current impact of Earth Observations from Space (EOS) on operational numerical weather prediction in the southern hemisphere is considerable. Results have shown for example that, in the southern hemisphere, the accuracy of a no-satellite data 24-hour (1 day) forecast is of the same accuracy, on average, as a 96 hour (4 day) with-satellite data forecast when forecasts were verified against the control (all data used) analysis. Here we discuss the development of high spatial temporal and spectral resolution operational AMV's and look at their impact in numerical weather prediction in the southern hemisphere, particularly in Australian region.

Operational Atmospheric motion vectors (AMVs) have been generated continuously at the Bureau of Meteorology from the early 1990s with the use of hourly AMV's in operations starting in 1996. Currently Multi-functional Transport Satellite 1 Replacement (MTSAT-1R) and more recently for MTSAT-2 radiance data, are used to generate atmospheric motion vectors near continuously throughout the day. Processing these data and even accommodating the routine change of satellite for maintenance is a fully automatic process. The satellites are the primary geostationary meteorological satellites observing the Western Pacific, Asia and the Australian region. Here we describe the error characterisation of the near continuous AMVs and their use in real time trials to quantify their impact on operational Numerical Weather Prediction (NWP), using four dimensional variational assimilation (4DVar). The use of near continuous vectors and 4DVar has resulted in *both improved temporal and spatial data coverage* in the operational forecast domain. The current beneficial impact of these data on the Bureau of Meteorology's (BoM's) current operational system, the operational Australian Community Climate Earth System Simulator (ACCESS) system is described. The vectors are also used operationally in regional offices, for example for analysis in the Darwin Regional Forecast Office

The utility of these continuous wind data for tropical cyclone prediction has already been demonstrated in a number of studies and recently in studies using the ACCESS Global and Regional models. Locally generated high spatial and temporal resolution AMVs from MTSAT-1R and MTSAT-2 have been employed with 4DVar and their beneficial impact in the Australian Region with tropical cyclone track prediction, has been recorded.

Recently work has begun to prepare for the use of high spatial temporal and spectral resolution winds from Himawari-8. Test winds have been generated for a complete day at 10 min resolution and these winds are being used in high temporal resolution 4DVar studies to prepare for the operational application of these type of data after the launch of Himawari-8.

Introducing Recommendations from CGMS 41 to the 12th International Winds Workshop

Johannes Schmetz

EUMETSAT

Rapporteur of the IWWG to CGMS

Sustained progress has been made over recent years on the part of the providers of operational wind products from satellites as well as on the part of the NWP users of the wind products. Notable is that the Fifth WMO Workshop on the Impact of Various Observing Systems on NWP held in Sedona, AZ, 22 - 25 May 2012 confirmed the important and complimentary role of wind observations from satellites. Inter alia this workshop also pointed at the need to infer winds at smaller spatial scales.
At the following CGMS meetings, especially at CGMS-41 held in July 2013, concrete actions and recommendations toward ongoing and future activities of the IWWG were discussed. This paper will briefly report on the relevant actions and recommendations and will provide a framework for discussions at IWW12.

HEIGHT CORRECTION OF ATMOSPHERIC MOTION VECTORS USING SATELLITE LIDAR OBSERVTIONS FROM CALIPSO

Kathrin Folger and Martin Weissmann Hans-Ertel-Centre for Weather Research, University Munich, Germany

ABSTRACT

Atmospheric Motion Vectors (AMVs) provide valuable wind information for the initial conditions of numerical weather prediction models. However, height assignment issues and horizontal error correlations require a rigid thinning of the available AMVs in current data assimilation systems. The aim of this study is to investigate the feasibility of correcting the pressure heights of operational AMVs from the geostationary satellites Meteosat-9 and Meteosat-10 with cloud top heights derived from lidar observations by the polar orbiting satellite CALIPSO. The study shows that the wind error of AMVs above 700 hPa is reduced by 12-17% when AMV winds are assigned to 120 hPa deep layers below the lidar cloud tops. This demonstrates the potential of lidar cloud observations for the improvement of the AMV height assignment. In addition, the lidar correction reduces the slow bias of current upper level AMVs and is expected to reduce the horizontal correlation of AMV errors. Further research is planned on the assimilation of lidar-corrected AMVs and the development of situation-dependent AMV height correction functions.

Current status and plans of JMA operational wind product

Kazuki Shimoji

JMA/MSC

ABSTRACT

The Meteorological Satellite Centre of the Japan Meteorological Agency (JMA/MSC) is currently operating two geostationary meteorological satellites, MTSAT-1R and MTSAT-2. Atmospheric Motion Vector (AMV) from MTSAT is derived by tracking cloud feature from animated satellite images, and the AMV data is utilized by NWP users for computing analysis field.

The agency is going to launch follow-on meteorological satellite Himawari-8 on September 2014, and will start dissemination of operational Himawari-8 AMV from June 2015. MTSAT AMV will be disseminated in parallel with Himawari-8 AMV until December 2015 as a transition period for NWP users.

Aim of this presentation is to introduce current status of MTSAT AMV and schedule for new AMV product generated from Himawari-8.

Motion tracking and cloud height assignment methods for Himawari-8 AMV

Kazuki Shimoji

JMA/MSC

ABSTRACT

Japanese next-generation Himawari-8/9 satellites will carry Advanced Himawari Imager (AHI) units capable of producing full-disk images every 10 minutes with 16 channels. The spatial resolution at the sub satellite point (SSP) is 2 km for IR channels. The use of observation data from these satellites is expected to enable the output of advanced products based on data with high temporal, spatial and spectral resolutions.

The Meteorological Satellite Centre of the Japan Meteorological Agency (JMA/MSC) is developing new tracking and height estimation algorithm for Himawari-8 Atmospheric Motion Vector (AMV). The new algorithm is designed for effective utilization of high spatial temporal and spectral resolutions of AHI.

Major changes of the algorithm are applied to cloud feature tracking and cloud height estimation process.

In the tracking method, small and large target boxes are prepared respectively for computing two correlation surfaces. Correlation surface from small target box is used as prior information for estimating wind vector, and another correlation surface derived from large target box is used as auxiliary information for determining optimal wind vector which is consistent with both of small and large scale atmospheric motion.

Approach to height estimation method for Himawari-8 AMV is based on optimal estimation to minimize the difference between observed radiance values and the theoretical ones determined from cloud assignment and radiative transfer model parameters using three or more channels. The method will be applied to upper-, medium and low-level clouds for Himawari-8/9 IR/WV wind vectors.

In this presentation, details of the above methods, characteristic of MTSAT AMV computed by the algorithm and its impact in NWP are shown.

THE MISR NRT CMV PRODUCT: MISR CLOUD MOTION VECTORS WITH THREE HOUR LATENCY

Kevin Mueller[1], Veljko Jovanovic[1], and Steve Protack[2]

[1] MISR, JPL, California Institute of Technology
[2] SSAI NASA Langley Research Center

ABSTRACT

The Multi-angle Imaging SpectroRadiometer (MISR) project, in association with the NASA Langley Research Center (LaRC) has adapted an operational software pipeline not originally intended for near real time (NRT) in order to provide cloud motion vector (CMV) data with typical latency under 3 hours for interval between observation and public data availability. This new MISR NRT CMV product is similar to the standard MISR CMV product introduced at the previous workshop, whose 13+ year record of 17.6 km resolution retrievals has now been well validated. Our talk will introduce this new product, which is planned to become available prior to June 2014. We will additionally characterize the latency of data availability, describe challenges overcome to make ithe product available, and assess its quality relative to the standard MISR CMV product.

AMVS IN THE OPERATIONAL ECMWF SYSTEM

Kirsti Salonen and Niels Bormann

ECMWF

ABSTRACT

This presentation gives an overview of the operational use of atmospheric motion vectors (AMVs) in the ECMWF system with an emphasis on recent changes. Currently AMVs from five geostationary and five polar orbiting satellites are used actively in the ECMWF system.

The use of AMVs has been extensively revised. This includes the use of situation dependent observation errors and revised quality control. As a result of the changes slightly more AMVs are used in the model analysis, and the specific characteristics of the observation type are taken into account in a more realistic way.

The number of active polar AMVs has recently increased by circa 75% with the introduction of NOAA-15,-16,-18 and -19 AVHRR AMVs into the system. Monitoring the quality of new data sets is an important part of the process of introducing new AMVs into the system. In early 2014 AMVs from e.g. tandem Metop-A/Metop-B, and NPP VIIRS are expected to become available. Also the dissemination of hourly GOES AMVs is expected to take place. Latest results related to the new data sets will be discussed.

INVESTIGATIONS ON ALTERNATIVE INTERPRETATION OF AMVS

Kirsti Salonen and Niels Bormann

ECMWF

ABSTRACT

Atmospheric motion vectors (AMVs) are typically interpreted as single level point estimates of wind at the assigned height. Cloud-top is assumed to be a representative height for high and mid-level clouds and cloud base for low level clouds, respectively. However, comparison to radiosonde and lidar observations as well as investigations in a simulation framework indicate some benefits from interpreting AMVs as layer averages, or as single-level wind estimates but within the cloud.

Alternative interpretations of AMVs are tested in the ECMWF system and the results will be reported in the presentation. A traditional single-level observation operator is currently used in the operational ECMWF system. A novel observation operator could interpret an AMV as a layer average. Averaging below the observation height is a realistic approach if the assigned height represents the cloud-top height. On the other hand, if the assigned height is interpreted as representative level, centred averaging would be more justifiable. One possible approach is also re-assigning the observation height. Model best-fit pressure bias statistics can provide some guidance for the re-assigning or positioning of the layer average.

Single observation experiments reveal how information from AMVs is spread in vertical. Layer averaging spreads the observation information more in vertical than a single-level observation operator. The choice where the layer is positioned determines where the maximum analysis increment is located. Thus, it is evident that the choice of the observation operator will have an impact on the resulting analysis and consequently on the forecasts.

OBSERVING SYSTEM EXPERIMENTS OF MTSAT-1R RAPID SCAN AMV USING THE JMA OPERATIONAL MESO-SCALE AND LOCAL NWP SYSTEM IN 2011 AND 2012

Koji Yamashita

Numerical Prediction Division, Japan Meteorological Agency, Tokyo, Japan

ABSTRACT

High resolution winds are increasing importance for NWP centres to assimilate them in high resolution NWP system. However, there are no standout solutions for assimilation of high resolution winds. Meteorological Satellite Centre of Japan Meteorological Agency (JMA/MSC) carried out operational Rapid Scan observation by MTSAT-1R in 2011 and 2012 summer, and produced MTSAT-1R Rapid Scan Atmospheric Motion Vectors (RS-AMVs) from the satellite images with 5 minute interval. As RS-AMVs which are one of the high resolution winds are derived from short satellite image intervals, they can catch many short lifetime atmospheric patterns in wind fields. Therefore, a more accurate analysis around mesoscale disturbance is expected by using RS-AMVs in the NWP system. Aiming to use the RS-AMVs in JMA operational Meso-Scale NWP system (4D-Var data assimilation system: Horizontal Res.: Outer/Inner/Layers: 5 km/15 km/50 layers), two quality control systems; two-step thinning scheme and super-observation scheme; have been developed since 2008. And these two schemes have been compared about forecast accuracy through observing system experiments (OSEs). The two-step thinning scheme is a method which thins to a resolution of 100 km (one AMV in each 1 deg. x 1 deg. x 100 hPa box in the hourly time window) after 200-km thinning (one AMV in each 2 deg. x 2 deg. x 100 hPa box in the 3-hour time window) of other AMVs. The other method, super-observation scheme, is a method which uses an average of AMVs (RS-AMVs and other AMVs) with 100 or 200 km intervals in hourly time window. Averaging of AMVs is carried out about time, level, space, wind directions and speeds.

Ongoingly we performed OSEs for MTSAT-1R RS-AMVs in both 2011 and 2012 summer using the JMA operational Meso-Scale NWP system. RMSEs of forecasts in 2011 summer against radiosonde observations in Japan were slightly reduced same as results of OSEs in the 11th International Wind Workshop. In case of typhoon Ma-on hitting Shikoku Island and bringing heavy rainfall in Niigata and Fukushima prefectures, moderate precipitation forecasts was improved in 33-hours forecast with 100km super-observation scheme. But in other cases of typhoon Muifa passing Okinawa Island and bringing thunderstorm by atmospheric instability, there was degradation of precipitation forecasts in 33-hours forecast with the super-observation scheme. Detailed results of OSEs will be presented in the workshop.

Additional OSEs for MTSAT-1R RS-AMVs also have been performed using the high resolution operational Local NWP system which has started on August 2012. Its initial condition is generated from a 3D-Var rapid update cycle at a resolution of 5 km. Its model has the 2 km horizontal resolution and 60 vertical layers. We also examined a forecast accuracy relationship between horizontal resolutions in NWP models (Meso-Scale and Local) and MTSAT AMVs generated from each time interval images (5, 10, 15, 30 minutes) to find an optimum AMV in high resolution NWP system.
We will give a presentation and discuss about these results at the workshop.

RECENT IMPROVEMENTS IN THE DERIVATION OF GEOSTATIONARY ATMOSPHERIC MOTION VECTORS AT EUMETSAT.

Manuel Carranza [1], Régis Borde [2], Marie Doutriaux-Boucher [2]

[1] GMV Aerospace and Defence S.A. at EUMETSAT
[2] EUMETSAT

ABSTRACT

EUMETSAT derives atmospheric motion vectors (AMVs) operationally from the imagery of four geostationary satellites: Meteosat 7 (sub-satellite longitude 57° E), Meteosat 8 (sub-satellite longitude 3.5° E), Meteosat 9 (sub-satellite longitude 9.5° E) and Meteosat 10 (sub-satellite longitude 0º).

Important changes have been recently implemented in the operational Meteorological Product Extraction Facility (MPEF), some of which are:

- Introduction of the Cross-Correlation Contribution (CCC) tracking method, together with an inversion correction algorithm for the infrared and visible channels, in order to correct the too-small amount of low-level winds.
- Introduction of the calculation of a best-fit pressure for every single AMV.
- Use of the Optimal Cloud Analysis (OCA) product in order to retrieve cloud-top pressure (CTP) information, instead of the current CLA product.
- Implementation of the nested-tracking algorithm from NOAA/NESDIS in the MPEF, and comparison of different test cases.

A summary of those and other recent changes will be presented.

Reprocessing of Atmospheric Motion Vectors at EUMETSAT

Marie Doutriaux-Boucher, Roger Huckle, Alessio Lattanzio, and Jörg Schulz

EUMETSAT, Eumetsat-Allee 1, 64295 Darmstadt, Germany

ABSTRACT

To contribute to the new global atmospheric reanalysis of the 20th century, the EUropean organisation for the exploitation of METeorological SATellites (EUMETSAT) has reprocessed the atmospheric motion vectors (AMVs) generated from imagers onboard polar (METOP) and geostationary (MTP and MSG) satellites operated by EUMETSAT. In the framework of the European Re-Analysis of global CLIMate observations (ERA-CLIM) project, the polar AMVs have been reprocessed using two independent algorithms for the period 2007-2013. The first algorithm is the EUMETSAT operational algorithm and the second one is the algorithm developed at the Cooperative Institute for Meteorological Satellite Studies (CIMSS). Both algorithms use the AVHRR infrared window channel (11 μm) but differ in many aspects (e.g. tracking, number of satellite orbit used, and height assignment method). The geostationary AMVs were reprocessed using MVIRI and SEVIRI images respectively onboard METEOSAT first and second generation satellites. The current operational algorithm run at EUMETSAT is used for the reprocessing.
In order to validate the reprocessed products, a comparison against radiosonde and NWP model analysis data was performed. The presentation will cover a description of the reprocessed AMVs, show the main similarities and differences between the various wind products, and conclude with the current standings of a unified global AMV processing code.

Update on the preparations for Aeolus at ECMWF

Michael Rennie[1], Andras Horanyi[1] and Lars Isaksen[1]

[1]European Centre for Medium-Range Weather Forecasts (ECMWF), Reading, UK

ABSTRACT

This presentation will focus on the progress made since the last Winds Workshop on the processing of Aeolus measurements to Level-2B wind observations — the product intended for assimilation at NWP centres. The processing software has been developed in collaboration with KNMI. Some verification of the quality of the L2B wind results will be shown, as produced through the chain of operational processing (L0, L1 and L2) applied upon realistic simulations (E2S) of raw Aeolus data. The L2B winds are compared to the simulation's input "truth" fields and also to the L1B winds (more basic processing than L2B). This provides a useful indication of the quality of the observations in preparations for when the satellite is planned to be launched in late 2015.

Next, the effect upon L2B winds of some newly discovered features to Aeolus data (i.e. features previously not simulated) and of errors in the calibration processing. With the launch date approaching quickly (at the time of writing!), plans for the operational processing and data assimilation of Aeolus at ECMWF will be presented.

Finally results from an impact study on the use of single component wind data (Aeolus like horizontal line-of-sight winds, as derived from in-situ observations) within the ECMWF data assimilation system will also be presented. The same study also provided some insight into the impact of mass versus wind observations.

EUMETSAT Operational dual-Metop winds products

Olivier Hautecoeur [1,2], Régis Borde [2], Marie Doutriaux-Boucher [2], Manuel Carranza [3,2]

[1] METIS S.A.S.
[2] EUMETSAT
[3] GMV Aerospace and Defence S.A.

ABSTRACT

EUMETSAT is currently deriving Atmospheric Motion Vectors (AMV) operationally from the EUMETSAT Polar System satellite Metop over polar areas. The launch of Metop-B in 2012 enables to double the product frequency, extracting AMVs from both Metop-A and Metop-B satellite data. Moreover the tandem configuration with two satellites on the same orbital plane but with a phase difference provided an interesting opportunity to create global AMVs from Metop satellites with a significant overlap in imagery data.

Therefore the latest EUMETSAT AMV processors produce new dual Metop winds derived from a pair of Metop-A and Metop-B images. The temporal gap between the two images used for the tracking is about 50 minutes. The dual-Metop product has a global coverage, which allows a direct comparison with other AMVs derived from geostationary satellite.

The updates of the algorithm of winds extraction using Metop satellites will be presented together with the results of dual-Metop products validation. Inter-products consistency and statistics of Metop-A, Metop-B, and dual-Metop AMV products over Polar Regions will also be discussed, as well as a summary of intended future developments, *e.g.* Triplet mode.

SCATTEROMETER OCEAN SURFACE VECTOR WIND PRODUCTS AT NOAA

Paul S. Chang, Zorana Jelenak, Seubson Soisuvarn, Suleiman Alsweiss and Faozi Said

Ocean Winds Science Team
Center for Satellite Applications and Research
NOAA/NESDIS

ABSTRACT

Ocean surface vector wind data received from the NASA QuikSCAT revolutionized operational marine weather warnings, analyses, and forecasting. QuikSCAT data give forecasters the ability to see the detailed wind field over vast ocean areas, to see the inner structure of ocean storms, and to identify areas of ocean wind wave generation. Until the nominal QuikSCAT mission ended on November 23, 2009, its data were routinely used around the world to help provide accurate marine weather warnings and forecasts. Its users spanned government agencies, commercial companies (ship routing, offshore wind farms, weather information providers), and individual users (surfers, sailboat racers, recreational boaters). Satellite OSVW data from QuikSCAT impacted many facets of daily life in marine and coastal communities.

Fortunately, EUMETSAT and the Indian Space Research Organization (ISRO) have both launched and are operating scatterometer systems that today are providing timely data to the global community. EUMETSAT's ASCAT and ISRO's OSCAT sensors are being utilized today continuing the advancements made with QuikSCAT in marine weather forecasting and warning. At NOAA, the level 1b (normalized radar cross-section) data from both ASCAT and OSCAT are ingested in near real-time into its ocean wind data processing system to produce a variety of level 2 (ocean surface vector wind) products. These products are distributed to NOAA's National Weather Service forecasters and a variety of other users around the world to support weather forecasting and warning. An overview of NOAA's ocean wind data processing system will be presented including case studies, specialized products, validation and future plans.

CHARACTERIZING AMV HEIGHT ASSIGNMENT ERRORS IN A SIMULATION STUDY

Peter Lean [1], Graeme Kelly [2], Stefano Migliorini [1]

[1]University of Reading
[2]Met Office, UK

ABSTRACT

Simulation studies, whereby synthetic Atmospheric Motion Vector retrievals are generated from high resolution NWP model radiances, provide a useful tool to help understand and characterize AMV errors.

In this presentation we present results from an investigation of height assignment errors using the Met Office 1.5km grid length UKV model to generate synthetic AMVs using the NWCSAF package. Statistics of cloud top height errors from the NWCSAF cloud products are calculated through a comparison against the model 'truth' cloud condensate profiles during a month long trial period.

Results indicate that biases in the assigned cloud top heights depend strongly on the diagnosed cloud type and cloud height. The feasibility of bias correction of the cloud top height product to reduce systematic height assignment errors in AMVs will be discussed.

FY-2 ON-ORBIT OPERATIONAL CALIBRATION APPROACH (CIBLE) AND ITS BENEFIT TO FY-2D/E AMV PRODUCTS

Qiang Guo

National Satellite Meteorological Center, China Meteorological Adminstration

ABSTRACT

Before 2012, the on-orbit operational calibration methods of FY-2 satellites were dominated by cross-calibration with the wide-band sensors AVHRR/HIRS or the high spectral resolution ones IASI/AIRS recommended by GISCS. During the last several years, the self-developed calibration of inner blackbody corrected by lunar emission (CIBLE) has been established and operationally working in FY-2F/E/D satellites in Jul.21, 2012, Mar.27, 2013 and May 21, 2013, respectively. The two kernels of CIBLE include lunar calibration and inner blackbody calibration. It is indicated that, the difficult problem of how to precisely calibrate the radiometric response varying frequently with the environmental thermal field for infrared bands for FY-2 satellite has been solved by CIBLE, which has been considered as the most important technical breakthrough in calibration society for geostationary meteorological satellite in China.

Compared with the synchronous observations of MTSAT-2 in the cold temperature region of below 230K, the calibration biases of CIBLE for FY-2D/E/F satellites have been convinced to be about 1-2K@220K. The real-time CIBLE results could be achieved in both the NOM files through website and the S-VISSR date stream with only 2 minutes delay from the beginning of observation. By using the latest CIBLE outcomes, the performances of the typical quantitative product, atmospheric motion vector (AMV) has also been greatly improved. Particularly, it is validated by ECMWF that the RMSE of WV-AMV for FY-2E satellite remains 4-5 m/s and the bias of IR-AMV for FY-2D satellite has been decreased by about 1.5 m/s after using CIBLE approaches.

AN OVERVIEW OF 10 YEARS OF RESEARCH ACTIVITIES ON AMVs AT EUMETSAT.

Borde Régis

EUMETSAT

ABSTRACT

In the last 10 years EUMETSAT conducted several research activities on AMVs through internal development, collaboration and external studies. These activities have led to some changes in the operational algorithm, like the introduction of CCC method in MSG AMV extraction algorithm in 2012, and have participated to a general better understanding of the AMVs. The height assignment step has been given special attention through a study of the classical semi transparency correction method's sensitivity to various atmospheric conditions, the comparison of AMV altitudes against A-Train instruments, the use of the new OCA product to set AMV altitude, the post-processing at low levels in inversion areas...etc. The respective impacts on the AMV product quality of the target box size, the temporal gap and the use of wind guess in the tracking step have also been investigated. The results may help to define appropriate future development in the AMV algorithms in getting smaller scale information to feed regional NWP models. EUMETSAT also investigated polar winds from AVHRR instrument using only a pair of images, which allowed for a reduction of the temporal gap between consecutive images and increased the coverage area of AMV extraction. The same strategy has been applied recently to develop a new dual Metop global coverage wind product, which should help to fill the 50-70° latitude gaps between geostationary and polar winds observations.
This paper will give an overview of these investigations, highlighting the most important results and the lessons learned which can help to identify potential opportunity for improvements to the AMV products and to define appropriate strategy for future development.

IMPROVING THE NOWCAST OF MESOSCALE CONVECTIVE SYSTEMS IN FORTRACC

Renato Galante Negri and Luiz Augusto Toledo Machado[1]

[1] Instituto Nacional de Pesquisas Espaciais / Centro de Previsão de Tempo e Estudos Climáticos - INPE/CPTEC

ABSTRACT

Winds estimated from an successive satellite image sequence has been widely used in numerical weather prediction models in the last decades. This wind data is known by many names, being Atmospheric Motion Vectors (AMV) a common one. The AMV are used, generally, to describe the large scale flows in data assimilation schemes for numerical prediction models (NWP). In the last years, with the regional NWP being configured at higher scales (10 to 1 km), AMV at higher spatial resolution will be probably necessary.

Recently, an new wind estimative technique has been developed at CPTEC/INPE, aiming to extract high resolution wind fields at deep convective cloud tops. This technique is based in the use of infrared channel combinations to identify different cloud structures (like thin cirrus, overshooting zones, etc) to be isolated and tracked. By this approach, the wind at the convective cells scale can be extracted from the large scale flow where the mesoscale convective cluster is inserted.

Using these high resolution AMV estimated from brightness temperature differences (Negri et al., 2014) is possible identify areas of a deep convective cluster which will intensify or dissipate. This can be done using the wind divergence calculated from these high resolution AMVs.

An algorithm for tracking and forecasting radiative and morphological characteristics of mesoscale convective systems through their entire life cycles using geostationary satellite thermal channel information (11 μm), called ForTraCC, was developed at CPTEC/INPE and is keep operationally since early 2000's. The ForTraCC can be used as a scientific tool, to extract many informations about the life cycle of the convective systems as well as a nowcasting tool.

This work evaluates the use of the BTD-AMV developed at CPTEC/INPE to improve the forecast of the mesoscale convective systems life cycle done by ForTraCC for nowcasting purposes.

RECENT STATUS OF ATMOSPHERIC MOTION VECTORS RETRIEVAL ACTIVITY AT ISRO

S. K. Deb, C. M. Kishtawal, Inderpreet Kaur and P. K. Pal

Atmospheric and Oceanic Sciences Group Space Applications Centre Indian Space Research Organization Ahmedabad-380015, India

Presenting Author: S. K. Deb E-mail: sanjib_deb@sac.isro.gov.in, sanjib_deb@rediffmail.com

Abstract

The operational derivation of atmospheric motion vectors (AMVs) from the different spectral channels of three successive geo-stationary satellite images started in the early seventies and for the last decade or so the AMV retrieval has become one of the most important component for operational numerical weather prediction. From the satellite measurement, the major contribution of atmospheric wind information are derived by considering the movement of cloud and water vapor tracers to determine wind operationally. In India, at Indian Space Research Organization (ISRO) the operational derivation of AMVs from the Indian Geostationary satellites have been initiated few years back using Kalpana-1/INSAT-3A infrared and water vapor channels. Subsequently over the course of time many changes have been made in the retrieval algorithm. The recent launches of INSAT-3D satellite with improved imager channels have significantly improved the status of AMV accuracy in India by widen its range of applications in tropical weathers. The capability to derive day-time AMVs using high-resolution visible images and 3.9 μm channel images for night-time is also explored using INSAT-3D data. Initial analysis with first few months of INSAT-3D data shows that AMV retrieved from INSAT-3D are comparable with AMVs retrieved from other contemporary satellite (viz. Meteosat-7) over this region. This paper describes the present status of AMV retrieval activity at ISRO and the improvement achieved in accuracies especially in terms of INSAT-3D for a last couple of months.

ASSIMILATION OF GOES-R ATMOSPHERIC MOTION VECTORS (AMVS) IN THE NCEP GLOBAL FORECAST SYSTEM

Sharon Nebuda[1], Jim Jung[1,2], Dave Santek[1], Jaime Daniels[3], and Wayne Bresky[4]

[1] Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, WI

[2] Joint Center for Satellite Data Assimilation, College Park, MD

[3] NOAA/NESDIS, Center for Satellite Applications and Research College Park, MD

[4] I.M. Systems Group (IMS), Rockville, MD

ABSTRACT

In preparation for GOES-R launch, proxy AMV data created using imagery from Meteosat-9 & 10 Spinning Enhanced Visible Infra-Red Imager (SEVIRI) and the new nested tracking algorithm has been assimilated in the NCEP Global Forecast System (GFS). Results from two seasons will be presented to show impact on the assimilation state and forecast skill from this new wind data. Discussion will also include quality control, observation error and other modifications to the Gridpoint Statistical Interpolation (GSI) software enacted to promote a positive GOES-R AMV data impact on the GFS.

IMPROVING THE USE OF RADIOSONDE AND SATELLITE-DERIVED WINDS AT THE METEOROLOGICAL SERVICE OF CANADA

Stéphane Laroche, Judy St-James, Iriola Mati and Réal Sarrazin
Meteorological Service of Canada

The extraction of more information from atmospheric observations available for operational numerical weather predictions represents a continuous and challenging research effort. In this talk we will give an overview of recent works on radiosonde and AMV data conducted at the Meteorological Service of Canada (MSC).

Radiosonde data are available in alphanumeric code, and more recently in Binary Universal Form for the Representation of meteorological data (BUFR) code. The latter can include much higher vertical resolution data with the position and time (4D) of observations which are not available in the alphanumeric codes. Since 2005, there has been a progressive transition to the BUFR code. However, as of the end of 2013, only 40% of the upper-air stations transmit data in both BUFR and alphanumeric codes. As a result, NWP centers must establish a strategy to start using the information in BUFR code from part of the stations while still supporting the alphanumeric code for all the others. Until now, the horizontal balloon drift of radiosondes by the wind has been ignored in both the data assimilation and verification systems of MSC. When the 4D position of radiosonde observations is not available, this information can be evaluated from the horizontal wind components and a representative elapsed ascent time profile. Such a pre-processing step has been implemented at MSC for radiosonde reports received in alphanumeric code, allowing these observations to be treated like those received in BUFR code. Thus, the 4D position of all soundings can be taken into account in the assimilation. Forecast impact of 4D radiosonde data has been examined with the global deterministic forecast system. For the winter season, the analysis and short-range forecast errors over the Northern Hemisphere are significantly reduced in the stratosphere and upper troposphere, especially for the wind field.

The work on AMVs has just been initiated. Our first objective is to examine the quality of those over land from the geostationary satellites in the Northern Hemisphere extra-tropics. AMVs located north of 30N over land are currently not assimilated in the MSC forecast systems, but could be beneficial where data from other observing systems are sparse, as over some regions of Canada and Russia. The validation of these AMVs will benefit from improved collation based 4D radiosonde data. This evaluation and other validation statistics pertaining to AMVs will be presented at the meeting.

HISTORICAL GOES AMV RE-PROCESSING

Steve Wanzong[+], David Santek[+], Christopher S. Velden[+], Jaime Daniels[*], Dave Stettner[+], Wayne C. Bresky[#] and Andrew Bailey[#]

[+] University of Wisconsin – Madison/SSEC/CIMSS, Madison, Wisconsin
[*]NOAA/NESDIS Center for Satellite Applications and Research, College Park, Maryland
[#] I.M. Systems Group (IMSG), Inc., Rockville, Maryland

ABSTRACT

The European Centre for Medium-Range Weather Forecasts (ECMWF) plans (2nd quarter of 2014) a new reanalysis effort encompassing the years of 1979 until mid-2013. The hope is to have an ERA-Interim replacement by the year 2015. Atmospheric Motion Vectors (AMVs) will be an important component of the reprocessed observation suite.

The Space Science and Engineering Center at the University of Wisconsin-Madison (UW-SSEC), in partnership with the NOAA/NESDIS Center for Satellite Applications and Research, is leading an effort to reprocess AMVs derived from the Geostationary Operational Environmental Satellite (GOES) series of satellites over the period 1995 to mid-2013. This is considered the first phase of a broader plan to eventually reprocess back to 1979. The current GVAR (GOES VARiable) transmission format began in 1994 on GOES-8, with improved calibration and navigation modules compared to the pre-GVAR data (1978–1996), making it easier to reprocess.

There have been eight operational GOES (8-15) in use since 1995, with a concurrent East (75W longitude) and West (135W longitude) satellite configuration. All past GOES data are stored online and accessible from the UW-SSEC Data Center. The current operational NESDIS AMV processing software is being used in the first phase of reprocessing, as is the ECMWF ERA analysis for the background fields. Future phases may employ an alternative processing algorithm being developed for the future GOES-R series of satellites.

This presentation will summarize the phase-1 GOES AMV reprocessing effort, outline the reprocessing goals, and report on lessons learned. It is hoped this initial demonstration will yield impacts in the ECMWF reanalysis, and stimulate resources for future reprocessing phases.

Study of the target selection methods for AMV derivation of Geo-KOMPSAT 2A

Eunhee Lee , Tae-Myung Kim, Sung-Rae Jung, Jae-Gwang Won

NMSC/KMA

ABSTRACT

The second geostationary meteorological satellite (Geo-KOMPSAT 2A, here after GK2A) of Korea will launch in the end of 2017. The AMI, flown on the GK2A will have sixteen spectral bands, compared to five on the current COMS imager, and will provide three times more spectral information, four times the spatial resolution, and more than four times faster temporal coverage than the current system. Therefore, the new meteorological data processing system for the AMI will be needed to convert raw instrument data to calibrated radiance and derived geophysical parameters (atmosphere, land, ocean, and space weather).

The Atmospheric Motion Vectors (AMVs) extraction scheme will be developed in preparation for GK2A retrieves the AMVs in a generally similar fashion to the present scheme which was developed for GOES-R and MTG satellite. First of all, the optimal conditions of target selection and tracking for derivation of AMVs using AMI data have been studied in NMSC/KMA. The preliminary results will be announced in the 12th IWW.

Scatterometer winds in rapidly developing storms (SCARASTO) – First experiments on data assimilation of scatterometer winds

Teresa Valkonen Norwegian Meteorological Institute

The EUMETSAT fellowship project *Scatterometer winds in rapidly developing storms (SCARASTO)* aims to develop data assimilations schemes to take better benefit of satellite derived ocean surface winds in situations of rapidly developing storms. The focus is on weather systems with rapid or unexpected development, strong winds or large damage potential. This includes both synoptic-scale mid-latitude cyclones and small-scale and short- lived low pressure systems, such as polar lows, with prevailing Atlantic or Northern flow direction. For selected storm cases, scatterometer surface wind data from Metop-A and Metop-B satellites are applied in the 3D-Var data assimilation system available in the high- resolution Harmonie NWP model used at the Norwegian Meteorological Institute. Quality and coverage of these wind data, and impact on forecast performance are studied. Despite the high data coverage and quality during daytime, verification results from preliminary model experiments show only a very weak impact of scatterometer winds on the weather forecasts in Norway. Experiences with data assimilation of scatterometer winds call for comparison and development of other approaches for optimal use of scatterometer winds in high-resolution NWP.

RECENT PROGRESS IN USING SATELLITE WIND AT CMA

Wei Han[1], ,Xiaomin Wan[1] , Jiandong Gong[1] , Jianmin Xu[2] and Xiaohu Zhang[2]

[1] Numerical Weather Prediction Center, Chinese Meteorological Administration, Beijing 100081 China
[2] National Satellite Meteorological Center, Chinese Meteorological Administration, Beijing 100081 China

Presenting Author: Wei Han, hanwei@cma.gov.cn

Geostationary and polar-orbiting satellites provide spatially and temporally highly resolved wind observations and are widely used operationally by global and regional NWP centers. In the recent two years, various studies of AMVs assimilation are conducted in the Global/Regional Assimilation PrEdiction System (GRAPES) at CMA, including quality control, the height assignment correction using best fit pressure, optimal spatial thinning and observation error tuning using Desroziers diagnostic method and the observation error model considering wind vertical shear and height uncertainty. This presentation will give an overview of recent progress in the assimilation of AMVs at Chinese Meteorological Administration (CMA).

Assimilation of GOES hourly AMVs in NCEP global data assimilation and forecast system

Xiujuan Su, Jaime Daniels. John Derber, Yangrong Lin
Andy Bailey, Wayne Bresky, Hongming Qi
IMSG/EMC, NOAA

ABSTRACT

NESDIS has been producing GOES hourly atmospheric moisture vectors (AMVs) since 2010. The algorithms to produce the hourly AMVs are similar to those used to produce the three hourly AMVs with a few updates such as improving height assignment when a low level temperature inversion is detected, the image scan line time defines the time for each satellite wind observation, and a reduced latency. The characteristics of the "observation minus background" from GOES hourly AMVs were studied and compared with current operational GOES AMV products. The quality markers from data were also examined. Based on these studies, the strategies to assimilate GOES hourly AMVs were defined and tested in the NCEP data assimilation (GSI) and forecast system (GFS). The experiments show that there are slight positive impacts on Southern hemisphere forecasts and precipitation forecasts over the CONUS. The assimilation of GOES hourly AMVs also improve observation fits for some AMV products.

OBSERVING SYSTEM SIMULATION EXPERIMENTS FOR SPACE-BASED DOPPLER WIND LIDAR OBSERVATIONS

Zaizhong Ma[1,2], Lars Peter Riishojgaard[1,2], Michiko Masutani[3], and John S. Woollen[3]
[1]NOAA/JCSDA, College Park, MD
[2]Univ. of Maryland/ESSIC, MD
[3]NOAA/EMC, College Park, MD

ABSTRACT

The three-dimensional global wind field is the most important remaining measurement needed to accurately assess the dynamics of the atmosphere. Wind information in the tropics, high latitudes, and stratosphere, is particularly deficient. Furthermore, only a small fraction of the atmosphere is sampled in terms of wind profiles. This limits our ability to optimally specify initial conditions for numerical weather prediction (NWP) models and our understanding of several key climate change issues.

Because of its extensive wind-measurement heritage (since 1968) and especially the rapid recent technology advances, Doppler lidar has reached a level of maturity required for a space-based mission. The Optical Autocovariance Wind Lidar (OAWL) concept, which funded by NASA, is expected to provide global wind profile observations with high vertical resolution, precision, and accuracy. The OAWL system uses a direct detection optical-autocovariance technique to measure winds from aerosol backscatter and can operate in a continuous two-look configuration. The assimilation of space-based Doppler wind LIght Detection And Ranging (Lidar) from the OAWL concept is being conducted in the Observing System Simulation Experiments (OSSEs) at the Joint Center for Satellite and Data Assimilation (JCSDA).

This paper sets out to assess the expected impact of Doppler wind lidar measurements from OAWL concept in meteorological analyses and forecasts. To this end, the National Centers for Environmental Prediction (NCEP) Global Data Assimilation System [Gridpoint Statistical Interpolation/Global Forecast System (GSI/GFS)] is used, at a resolution of T382-64 layers, as the assimilation system and forecast model in this lidar OSSE study, and a set of one-month assimilation and forecast experiments from July 28 to August 27, 2005 have been set up and executed. The impacts from the OAWL lidar wind are assessed by comparing the forecast results through 168 hours in this period. The Root-Mean Squared Error (RMSE) of wind vector and anomaly correlations (AC) of geopotential height forecasts are investigated carefully against Nature Run. Forecast impact experiments with OAWL Lidar measurements assimilated into the NECP operational model are a clear indication of the value of lidar-measured wind profiles.

Status of operational AMVs from FY-2 satellites since the 11th wind workshop

Zhang Xiaohu, Xu Jianmin, Zhang Qisong

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

ABSTRACT

This paper briefly introduces status of AMVs operations at NSMC. Since the 11th International Winds Workshop (IWW11) held in February 2012, CMA continues AMVs operations and services. At present, FY-2E (105oE) and FY-2D (86.5oE) are both in operation. AMVs derivations are performed for both FY-2E and FY-2D. For FY-2E, AMVs are provided at 00 06 12 18 UTC, while FY-2D at 03 09 15 21 UTC. The wind derivation scopes are in the regions of satellite zenith angle less than 60 degree.

There are several changes at the FY-2 operational AMVs derivation system in the last two years. In image calibration, a new calibration algorism called 'CIBEL' was realized in satellite operation system of FY-2E/FY-2D. In image navigation, improve or preventive measures were applied to the FY-2 operational AMVs derivation system to reduce the effect of some abnormal image cases which caused lower quality of AMVs than normal. Moreover, some improvements in AMVs' derivation algorithm are presented.