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NOAA……NASA……US Navy……US Air Force *Editor: George Ohring* *web-site: www.jcsda.noaa.gov*

News in This Quarter

Science Update

Polar Winds and Forecast Busts

The impact of the MODIS polar Atmospheric Motion Vectors (AMV) in global numerical models has been historically neutral to slightly positive in mid-range forecasts, as measured by northern and southern hemisphere Anomaly Correlation Coefficient (ACC) at 500 hPa. However, several NWP centers have also found that the MODIS winds can improve the ACC scores in some forecast busts, also known as dropout events. We have discovered additional examples of dropout-improvement cases in our experiments to refine the quality control procedure for MODIS AMVs. We describe these below and attempt to explain these improvements in terms of flow regimes.

A two-month trial was carried out to test the feasibility of applying the Expected Error (EE) to the quality control of MODIS polar AMV in the hybrid ensemble/3D-VAR Global Data Assimilation System (GDAS) and Global Forecast System (GFS) between January and February 2012. The control forecast includes a dynamical rejection criterion: winds are excluded when they express an innovation in zonal or meridional flow greater than a threshold value, typically 7 m/s. This criterion was changed for the trial forecasts to exclude winds with a ratio of EE to observation wind speed in excess of 1.3367 – a value chosen (based on two weeks of assimilation data) to exclude roughly the same number of observations as those rejected by the original dynamical rejection criterion, while allowing for a level of context sensitivity. Light winds are more likely to be rejected with relatively low EE, while strong winds are more likely to be retained even with large EE. The goal is to allow winds into the analysis that have a greater than 7 m/s deviation from the background when the observed wind speed is sufficiently large (e.g. winds sampling the polar jet).

A positive impact was observed in some but not all forecast dropout events; performance on non-dropout days was largely unchanged. Furthermore, it was observed that for two dropout events in the northern hemisphere (Fig. 1c), in which one was improved while the other wasn't, both conformed to previously observed behavior for northern hemispheric dropouts: Errors originate near the eastern end of the Pacific jet (blue contours in Fig. 1a, b), with errors in the geopotential height field corresponding to the development of waves across the continental United States

Northern Hemisphere Dropouts

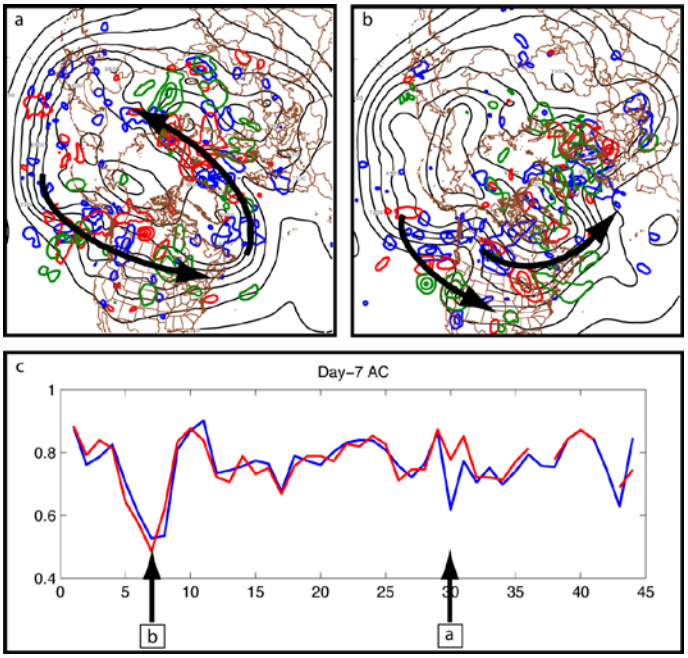

Figure 1*. Northern hemisphere dropouts. Control analysis state of 400 hPa geopotential heights (black contours every 120 m) for initialization of day-7 forecast dropout events on (a) 08 February 2012, and (b) 15 January 2012. For each case, the normalized root of the squared error in control forecast 400 hPa geopotential height versus a verifying analysis is provided for the 24 hour (blue), 48 hour (red) and 72 hour (green) forecast, with arrows depicting the movement of error-features. (c) Day-7 500 hPa geopotential height anomaly correlation scores for control (blue) and experiment (red), with verification of day-7 dropout events in panels a and b highlighted.*

downstream. In the improved case, the analysis initializing the day-7 dropout event was significantly modified in the Pacific jet region – an area far-removed from the relatively few MODIS winds that were changed for that particular analysis period. Modifications to the jet were smaller in the analysis that did not lead to dropout improvement.

We hypothesize that modifications to the background produced by the experiment may carry downstream over several analysis cycles. In a regime with enhanced cross-polar flow (Fig. 1a) these perturbations may be able to cut across the arctic and feed directly into the Pacific jet (see block arrows on Fig. 1a), creating the potential for large impacts on dropout events. On the other hand, when this cross-polar flow is suppressed, modifications to the background from the experiment cannot efficiently influence this important region (Fig. 1b).

In the southern hemisphere, dropout improvement was observed when wave activity was confined to high latitudes, where modification of the Antarctic environment could have a direct impact (Fig. 2a). On the other hand, when low wavenumber wave-activity is amplified, errors often originate in the deep troughs at more equatorward latitudes and propagate into the Antarctic (Fig. 2b), thus limiting the potential for polar wind observations to affect the forecast bust. Once again, the flow-regime may be playing a role, a finding consistent with other research on the subject that has been done at the University of Wisconsin.

Southern Hemisphere Dropouts

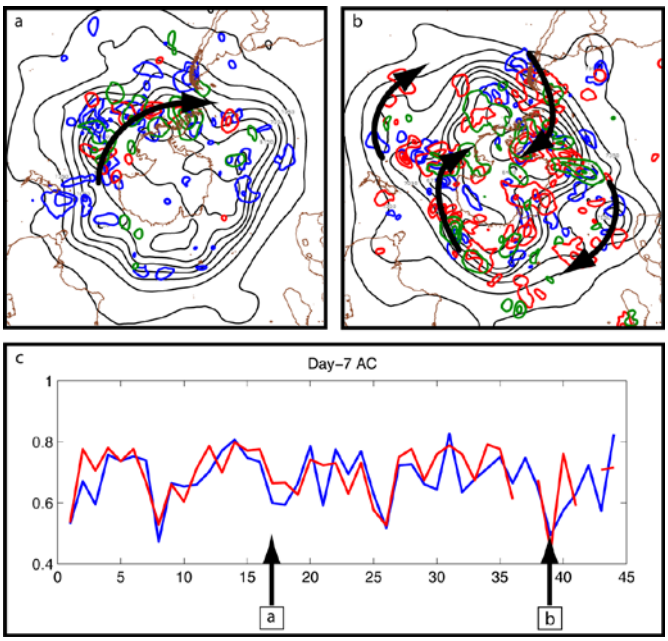

***Figure 2**. Southern hemisphere dropouts. Control analysis state of 400 hPa geopotential heights (black contours every 120 m) for initialization of day-7 forecast dropout events on (a) 25 January 2012, and (b) 18 February 2012. For each case, the normalized root of the squared error in control forecast 400 hPa geopotential height versus a verifying analysis is provided for the 24 hour (blue), 48 hour (red) and 72 hour (green) forecast, with arrows depicting the movement of error-features. (c) Day-7 500 hPa geopotential height anomaly correlation scores for control (blue) and experiment (red), with verification of day-7 dropout events in panels a and b highlighted. Note: Dropout 'a' was chosen because the difference in AC scores was much larger than others in this time period in the Day-5 and -6 forecasts.*

One last point: The experiments reported on here do not compare forecasts with and without MODIS winds, but rather forecasts with different quality control algorithms for the MODIS winds. In all cases the new QC algorithm performed at least as well as the control algorithm, and, as discussed, alleviated several forecast busts.

Several other dropout events occurred in the southern hemisphere (Fig. 2c). We plan to perform similar analyses on these to relate improvements (or lack thereof) in forecast busts to the flow regime.

(Brett Hoover and David Santek, U. Wisconsin)

Update on Satellite Data Assimilation at the UK Met Office

The last year has seen a number of developments in the use of satellite data in the Met Office global model. These have included: pre-operational testing of a package of satellite changes, which has resulted in significant improvements in forecast accuracy; detailed assessments of data from the Suomi-NPP ATMS and CrIS instruments; and an upgrade to the radiative transfer model used operationally (to version 9 of RTTOV).

A suite of enhancements in the use of satellite data, developed over the last two years by scientists across the Met Office's Satellite Applications Section, has been included in the current parallel suite (*PS 31*) – due to become operational in January 2013. Together with an upgrade to the hybrid data assimilation system, the changes have improved forecast quality significantly. **Figure 1** shows the performance of PS31 relative to the current operational model, verified against observations. For example, in the southern hemisphere, RMS errors in mean sea level pressure (PMSL) are reduced by ~2% at forecast day one, and by as much as ~9% at day five.

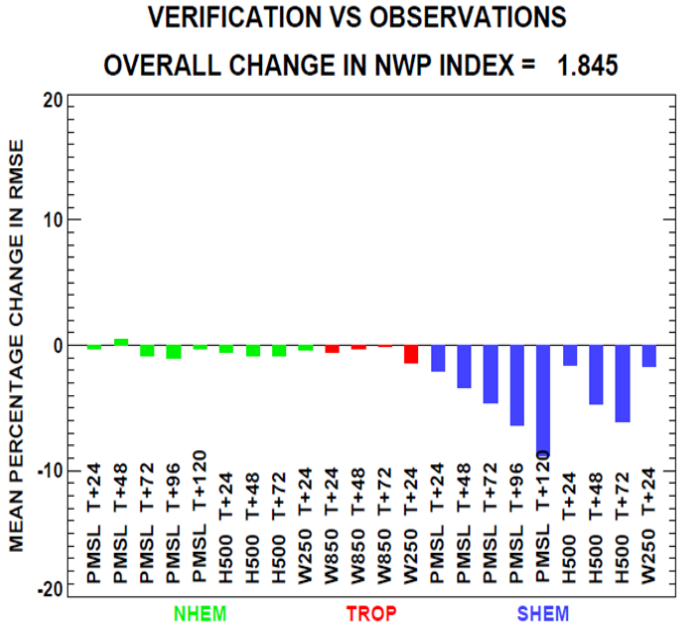

***Figure 1**: Performance of the Met Office Parallel Suite (31) after 65 days, verified against observations. The 'NWP index' is an internal measure, computed from a weighted combination of skill scores for a range of verification metrics that includes: Mean sea-level pressure (PMSL), 500 hPa height (H500), 850 hPa wind (W850), and 250 hPa wind (W250) verified over the following areas: Northern Hemisphere (NHEM) (90N-20N), Tropics (TROP) (20N-20S) and Southern Hemisphere (SHEM) (20S-90S), at the following forecast ranges: T+24, 48, 72, 96 and 120 hours. Historically, annual improvements of ~2 index points are normally achieved over three model+data assimilation upgrades, which usually take place over a one year period.*

Verification against analysis (not shown here) is more positive, with the same metrics improved by ~8-10% across all forecast ranges. The satellite changes included:

- The treatment of observation error correlations for IASI
- The use of a physically based observation error model for surface affected ATOVS channels.
- Introducing scatterometer winds from OSCAT
- Introduction of C/NOFS GPSRO data
- Reduced bending angle observation errors for GPSRO
- Temporal thinning for AMV winds
- A revised channel selection for low peaking AMSU-A channels
- Replacing GOES-11 clear sky radiances by GOES-15

2012 also saw the arrival of data from the Suomi-NPP instruments. Detailed evaluations of data from ATMS (see Doherty *et al*) and CrIS have been completed.

These investigations showed that the data from ATMS are generally of good quality. These studies, in common with studies at other NWP centres (for example see Bormann *et al*), have again shown the value of NWP data assimilation systems in the evaluation of sounding observations. Issues which have emerged include the identification of a smooth (‘*frown*’-like) cross scan bias in the temperature sounding channels, later found to be due to reflector emissivity, as well as *striping* effects due to 1/f noise in ATMS low noise amplifiers. When added in isolation to a full Met Office system, ATMS data are found to give coherently positive impacts on forecast quality in both hemispheres.

We find that CrIS data are of high quality, with excellent noise performance in the critical long wave temperature sounding channels. A comprehensive set of assimilation experiments has been completed in which: assumed observation errors in the long wave CO_2 channels were varied from 0.5K to 0.3K; water vapour channel selections ranging from no water vapour channels to 44 channels were tested; and a range of static bias corrections was evaluated. All tests produced positive results. The most aggressive configuration (low observation errors and 44 water vapour channels assimilated) gave the best results.

When ATMS and CrIS are added together to a full (PS31) operational configuration additional positive impact is obtained. The verification results are shown in **Figure 2**.

ATMS and CrIS are scheduled for inclusion in the next parallel suite (PS32), due to start in February 2013 and become operational in April 2013.

So what next? 2013 should see the introduction of data from MetOp-B; the introduction of AMSU-A imager and low peaking channels in clear and cloudy conditions; variational bias correction and significant improvements in the bias correction of SSMIS radiances.

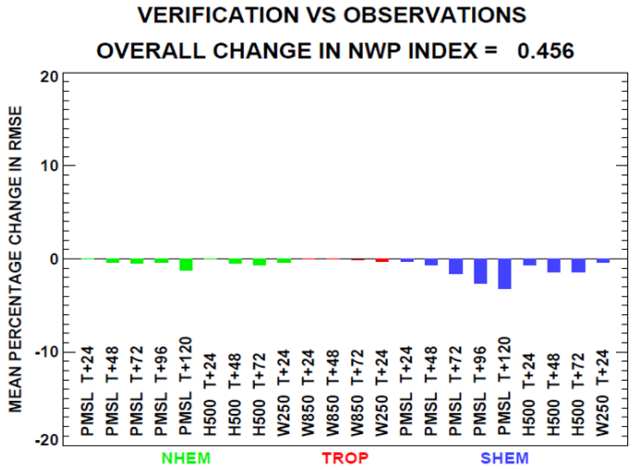

***Figure 2**: The impact of **ATMS** and **CrIS** when added together on top of a (PS31) operational configuration, verified against observations.*

(Bill Bell, Peter Weston, Katie Lean, Ed Pavelin, James Cotton, Chris Burrows, Ruth Taylor, Amy Doherty and Andrew Smith, and James Cameron, Met Office)

References

Bormann, N., A. Fouilloux and W. Bell, *Evaluation and assimilation of ATMS data in the ECMWF system*, December 2012, ECMWF Technical Memorandum Number 689. Available from :

http://www.ecmwf.int/publications/library/do/references/show?id=90654

Doherty, A. D., W. Bell, N. Atkinson and C. Cooper, *An Initial Assessment of Data from the Advanced Technology Microwave Sounder*, Forecast Research Technical Report Number 569, October 2012. Available from

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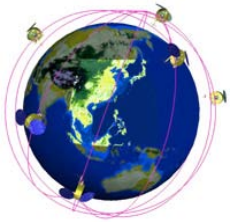

Cosmic Corner

The Air Force Weather Agency (AFWA) operationally assimilates data from several GPS-RO missions – COSMIC, METOP-A GRAS, and CNOFS; the data assimilated are the retrieved refractivities. AFWA is working to add additional GPS-RO sensors – TERRASAR-X and GRACE-A – to its

RO data stream. Assimilation of refractivities from these two instruments has recently transitioned to AFWA's GSI-prototype assimilation system. The GSI system will be implemented into operations in mid-2013, and at that time bending angle will replace refractivity as the assimilated observation for all of the RO sensors.

AFWA has also recently transitioned its data feed from BUFR Edition 3 to BUFR Edition 4. The changes between BUFR 3 and BUFR 4 are small, the most significant being in section 1 of the code, which provides information on the identification of the message. BUFR is the Binary universal form for the representation of meteorological data and is used to transmit and store meteorological data in a binary code.
(Jason Martinelli and Richard Ritz, AFWA)

Update of JCSDA Publications List

The publications list on the JCSDA website http://www.jcsda.noaa.gov/publications.php has recently been updated with the inclusion of papers appearing in 2012. The list is a compilation of papers resulting from research since 2004 by scientists associated with the Center. The update also includes a link to each article's abstract or full paper – if openly accessible – at the publisher's website.

JCSDA research is performed with proposal-based funds (internal research) as well as with external grants and contracts awarded via a competitive process open to the broader scientific community (external research).

There are also core projects that are not subject to the competitive process but are regulated by an on-going agreement between the funding agency and the project principal investigators (directed research).

In addition, the JCSDA partners conduct their own internal projects. Some of these are directly related to the JCSDA activities and are considered to be in-kind research projects supporting JCSDA objectives.

Update: JCSDA - 2013 Research in Satellite Data Assimilation for Numerical Environmental Prediction

The due date for submission of proposals to the Fiscal Year 2013 Federal Funding Opportunity for JCSDA external grants on Research in Satellite Data Assimilation for Numerical Environmental Prediction was January 2, 2013. The Joint Center management team has initiated a review and selection process which is expected to be completed by the end of the spring. We anticipate that the start date for approved projects will be August 1, 2013.

(Sid Boukabara, JCSDA)

Summary of 10th JCSDA Workshop on Satellite Data Assimilation

Participants JCSDA 10th Annual Science Workshop

Some 100 scientists from the JCSDA and its academic and private sector partners, including principal investigators, program managers and JCSDA management/staff, participated in the 10th Annual JCSDA Workshop on Satellite Data Assimilation, October 10 – 12, 2012. The venue for this year's workshop was NOAA's new Center for Weather and Climate Prediction on the research campus of the University of Maryland in College Park. The plenary sessions were held in the building's magnificent new auditorium with its state-of-the-art audio-visual and connectivity infrastructure.

The purpose of these annual workshops is to review the ongoing and planned scientific development sponsored by the Center, and to plan and coordinate future efforts. The Joint Center supports scientific development work with proposal-based, internally directed funds as well as with external grants awarded via a competitive process open to the broader scientific community. In addition, JCSDA individual partners undertake their own research contributing to the Center's objectives.

Dr. Louis Uccellini, Director, NOAA National Centers for Environmental Prediction, welcomed the participants on behalf of the Joint Center's Management Oversight Board. In the first session of the workshop, JCSDA Director Riishojgaard presented an overall program update and overview, in which he highlighted the Center's recent accomplishments, current activities, and future plans. A significant achievement during the past year was the operational implementation of the assimilation system for the Advanced Technology Microwave Sensor on the Suomi National Polar Partnership (NPP) satellite only seven months after its launch. Dr. Riishojgaard also highlighted the increasing use by JCSDA investigators of the Center's computers at NASA Goddard Space Flight Center and the University of Wisconsin.

Focusing on topics related to the Center's scientific priority areas, the plenary session subjects covered: Radiative Transfer Modeling and Validation, Assimilation of Data from Advanced Sensors, Cloud and Precipitation Data Assimilation, Land Data Assimilation, Ocean Data Assimilation, Regional Data Assimilation, OSSEs and OSEs, and Atmospheric Composition. The workshop included 32 oral presentations and 22 poster papers. In the final plenary, breakout group chairs summarized issues and recommendations for their scientific areas to Joint Center management. Copies of the oral presentations and poster papers are posted online at: http://www.jcsda.noaa.gov/meetings_Wkshp2012_Agenda.php

(Sid Boukabara and George Ohring, JCSDA)

A Note from the Director

In many ways 2012 was an interesting year with several ups and downs for us in the Joint Center. I don't want to dwell too much on the downs here. Instead I will cite the speedy implementation of NPP data, the complete porting of some of NOAA's operational data assimilation systems to our computers, and the highly successful WMO Impact Workshop in Sedona in May as just a couple of the ups. We look forward to continue to build on these and other developments in 2013, despite tough budget challenges that are facing both several of our partners and some of the satellite programs that keep feeding us new data.

The 2012 JCSDA Science Workshop in October was an opportunity for us to showcase not just the interagency collaboration, the new satellite data in operations and all the other great work that many of you are doing, but also the new venue in the NOAA Center for Weather and Climate Prediction where many JCSDA affiliates are located. As usual the Workshop was very well attended. With close to 100 participants we did not quite reach the record number of more than 150 that we had in 2011, but even this year's number ended up exceeding our expectations.

As some of you have noticed, the JCSDA Workshops have evolved quite a bit over time. Originally intended as venues for JCSDA management and funded investigators to discuss plans and progress, our Workshops have increasingly become part of our community outreach and to some extent even general-purpose scientific meetings on satellite data assimilation. The attendance numbers speak very clearly to the need for such meetings, but there is no denying that the original function of the JCSDA Workshops has become somewhat diluted as they have grown in size. Looking toward the future, the intent of JCSDA management is therefore now to revert back to the original workshop format and reserve participation for funded investigators and in-kind contributors from the partners. At the same time we intend to address the very clear need for a more general "open" JCSDA meeting via an increased presence at the AMS Annual Meeting.

At the time of writing, the 2013 AMS Annual Meeting is still a few days ahead of us, so we do not yet know whether the Special Symposium on the Joint Center for Satellite Data Assimilation – our initial foray into the AMS world - will be a success. However, what we do know already now is that we want to build on the

experience gained in Austin and hopefully address the need for a more general-purpose JCSDA meeting in that context in the future.

After a brief lull during the summer, the JCSDA computers have now been completely saturated for the last several months. On one hand this is of course very gratifying for us, since it shows that the resource met a clear need. On the other hand it shows that we need to start planning for upgrading this capability in order to keep up with both the planned resolution increases and further testing to get even more new satellite data into the operational systems. "Build it and they will come!" is a maxim of dubious origin and perhaps questionable general applicability, but in the particular case of JCSDA computing it turned out to be spot on. Not only do we have users that are eager to consume the cycles we provide, we have a veritable pipeline of R2O transition tasks, strategic issues and data impact and configuration questions that are lining up for time on the computers.

JCSDA was originally built around what the founders often liked to call the "three-legged stool" paradigm, the three legs being observations, research and computing, respectively. It looks as if 2013 will have to be the year in which we try to grow the third leg of the stool a bit more in order to maintain a healthy balance.

Happy New Year!

Lars Peter Riishojgaard, Director, JCSDA

Upcoming Seminars

JCSDA seminars are generally held on the third Wednesday of each month at the NOAA Center for Weather and Climate Prediction, 5830 University Research Court, College Park, MD. Presentations are posted at http://www.jcsda.noaa.gov/JCSDASeminars.php prior to each seminar. Off-site personnel may view and listen to the seminars via webcast and conference call. Audio recordings of the seminars are posted at the website the day after the seminar.

Check http://www.jcsda.noaa.gov/JCSDASeminars.php for updates.

Upcoming Seminars			
Date	*Speaker*	*Affiliation*	*Title*
Jan. 16, 2013	Ricardo Todling	NASA//Global Modeling and Assimilation Office	Hybrid Data Assimilation without Ensemble Filtering
April 17, 2013	Shobha Kondragunta	NOAA/NESDIS STAR	Using Satellite Data to Improve Operational Air Quality Forecasting Capabilities

Editor's Note: Unsolicited articles for the JCSDA Quarterly Newsletter are encouraged as are suggestions for seminar speakers or topics. Please send them to George.Ohring@noaa.gov.