MODIS- and AVHRR-derived Polar Winds Experiments
using the NCEP GDAS/GFS

NA10NES4400011

Year 2 Second-half Progress Report
December 2011 to May 2012

29 June 2012

David Santek, PI

Proposed Work

Atmospheric Motion Vectors (AMV) are routinely generated from geostationary and polar orbiting satellites and they are incorporated into most global numerical weather prediction models throughout the world. However, advances to the AMV derivation process together with changes to assimilation systems and forecast models require the strategies for use of the satellite-derived winds to be continually evaluated.

The focus of our proposal will be in three areas using AMVs generated from polar orbiting satellite data: (1) Quality control and thinning using the Expected Error; (2) Experiments assimilating polar winds derived from Advanced Very High Resolution Radiometer (AVHRR) images; and, (3) Experiments designed to simulate winds from the Visible/Infrared Imager/Radiometer Suite (VIIRS) instrument onboard the future NPOESS Preparatory Project (NPP) and National Polar-Orbiting Operational Environmental Satellite System (NPOESS) satellites [now restructured as the Joint Polar Satellite System (JPSS)] .

Year 2 plans from the proposal:

Our second area of interest is the assimilation of polar winds derived from the AVHRR on the current NOAA satellites and the new Metop satellite series. This will be an important source of polar wind information as the NASA research satellites, Terra and Aqua, near the end of their lifetimes.

The NOAA AVHRR AMVs will result in additional spatial coverage (over what the MODIS currently provides) in the Arctic and Antarctic, with data available from up to four satellites. However, the satellite schedule may be problematic due to priority given to the operational satellites. Therefore, the actual availability of AMVs will be closely monitored with respect to cutoff times in the assimilation. Also, the thinning of the NOAA AVHRR AMVs using the EE will require investigation because of the lower resolution in the Global Area Coverage (GAC) data compared to MODIS.

The AMVs from the NOAA and Metop satellites have been routinely produced at CIMSS for several years, with a transition to NOAA operations planned by the end of 2009. Once the procedure is in NOAA operations, we expect the EE parameter will be included with the AVHRR polar winds, which we will use for screening and filtering in our experiments. We expect to begin this task in Year Two as the AVHRR polar winds product should be available in real-time from NOAA operations. In the event that it is not

available from NOAA in the expected timeframe, we at CIMSS are able to produce essentially the same product and we will use that for initial tests and experiments.

The experiments using the AVHRR will be similar to those conducted for the MODIS polar winds: determining an optimal use of the EE for quality control and evaluating the forecast impact from two different seasons. We do not anticipate any problems transitioning the use of the AVHRR polar winds product into NCEP operations as it will be in the same format as the MODIS product, which has been in operations for many years.

End of Second Year Progress

The primary effort during this time was to assimilate the AVHRR polar winds. We expected to begin this work in April 2012, but for the following two reasons this did not occur:

1. The GDAS/GFS was not available on s4.
2. Two remaining issues with the AVHRR winds (computing the Expected Error and generating the winds across the day boundary) were not fully integrated into NESDIS operations until the last week of June 2012.

Therefore, the majority of this six-month period was spent completing MODIS experiments before access to vapor ended, preparing for using s4, and waiting for the availability of the AVHRR winds from NESDIS operations. Specifically, these areas were addressed or identified:

- Access to vapor and zeus
- Run additional control and experiments using the EE with MODIS winds
- Analyze forecast impact
- Importing AVHRR polar winds
- Transition to s4
- Subversion access
- Personnel update
- Conferences

Access to vapor and zeus

Access to vapor ended in mid-March 2012. A request was sent to Jim Yoe in January 2012 to delay the decommissioning of vapor until June 2012, in anticipation that s4 would be available by then. This request was denied.

We decided not to pursue running experiments on zeus for the following reasons:

- The eventual goal is to run on s4; moving to zeus for just a few months did not seem worth the effort (moving data, updating code, modifying scripts, learning new procedures).
- The reliability and stability of zeus did not appear to be very good during the time following the decommissioning of vapor.
- There was enough work to do in preparation for using s4.

MODIS experiments

We continued to run control and EE experiments using the MODIS AMVs for the fall of 2010 using the same version of the GSI/GFS that we retrieved from nwprod in January 2011. We will update the code base when we move to s4.

Forecast impact

a) EE threshold experiment

The first experiment run with the Expected Error showed a neutral impact using an EE threshold of 5 ms^{-1} (discarding winds with an EE larger than that threshold). However, we found that many high-speed winds were also being discarded because the EE is generally larger for faster winds. Therefore, we designed a 2nd experiment to retain higher winds by using these criteria: Discard the wind vector if the EE > 9 ms^{-1} AND ObservationSpeed < EE.

The results of this experiment, from 01 September to 03 October 2010, are shown in Figure 1. The solid curves show a neutral impact for this time period for the southern hemisphere. However, the dashed lines show a slight improvement using the EE. These dashed ACC curves are computed using only cases where the control performed at a standard deviation lower than the mean or less (i.e., the worst cases). This improvement implies that using the EE results in a better forecast at Day 7 and 8 in cases where forecasts are poor. The curves are similar for the northern hemisphere (not shown), but tend to be more neutral.

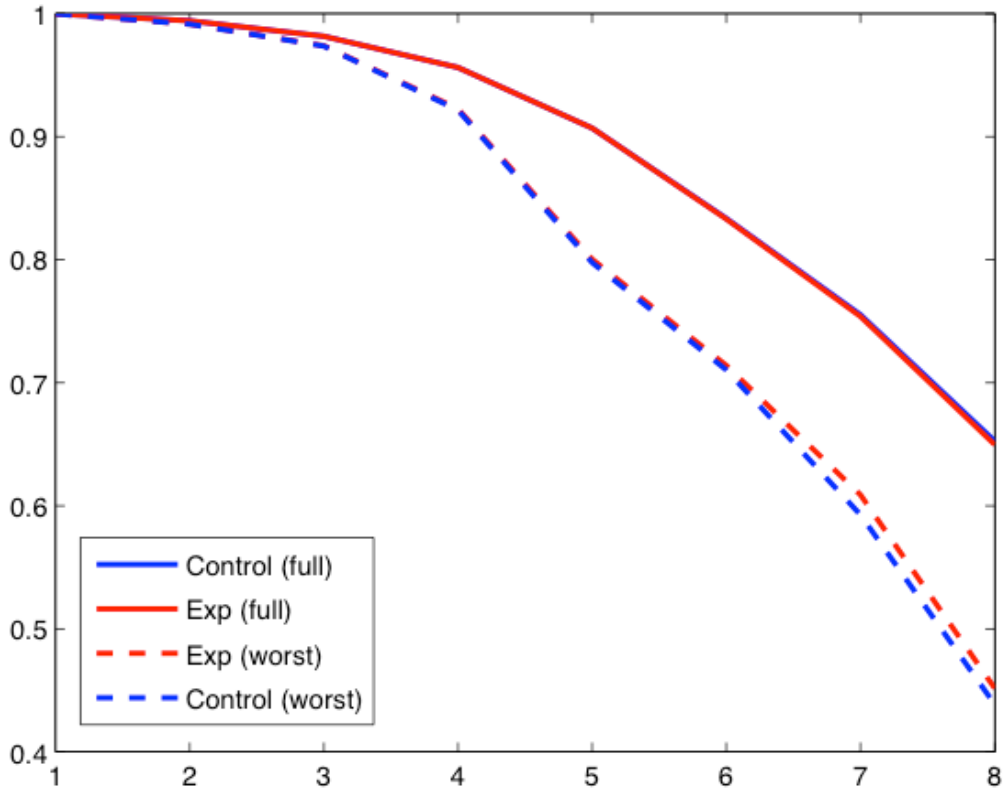

Figure 1. The southern hemisphere 500 hPa ACC die-off curve for 01 September to 03 October 2010. Solids lines are all cases; dashed lines are worst cases (more than one standard deviation below the mean). Control in blue; experiment in red.

b) Wind observation error experiment

This is a continuation of an experiment started in the first half of year two. All experiments to this point use the EE to filter the input winds. This experiment uses all the winds, but the *observation error* is assigned the EE value. Typically, satellite winds are assigned an observation error of 7 ms^{-1}, so using the EE will set the observation error to a lower value in many cases and retain winds that may be otherwise discarded.

The EE ranges from 0 to 10 ms^{-1}; the observation error is set to this value, except values less than 3 ms^{-1} are set to 3. The experiment ran from 24 August to 25 September 2010.

The ***solid lines*** in figures 2 (northern hemisphere) and 3 (southern hemisphere) depict the ACC die-off curves and the daily variation for a three-week time period. Through Day 6 there is a neutral impact in both hemispheres, which is a somewhat surprising result given the significant change to how the satellite winds are included and observation error assigned.

The ***dashed lines*** in figures 2 and 3 depict the ACC die-off curves using only cases where the control performed at a standard deviation lower than the mean or less. Through Day 6 in the northern hemisphere, there is still a neutral impact. However, for Days 7 and 8 there is an improvement in the experiment. So, although there is an overall neutral impact, there is an improvement in the worst forecast cases.

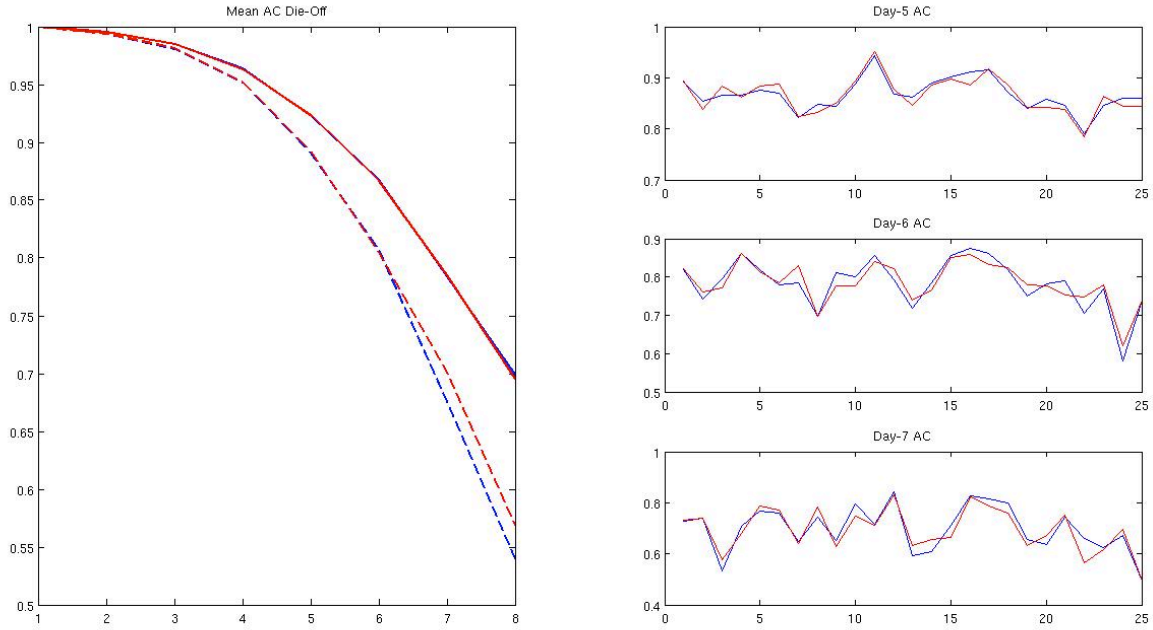

Figure 2. Anomaly Correlation scores averaged over three weeks (left) and the daily scores for Day-5, -6, and -7 (right). Date: 01 – 25 September 2010. Scores are computed for 500 hPa geopotential heights over the northern hemisphere (20N-80N) for the control (blue) and the experiment (red), using the EE as the observation error. Solid lines are all cases; dashed lines are worst cases.

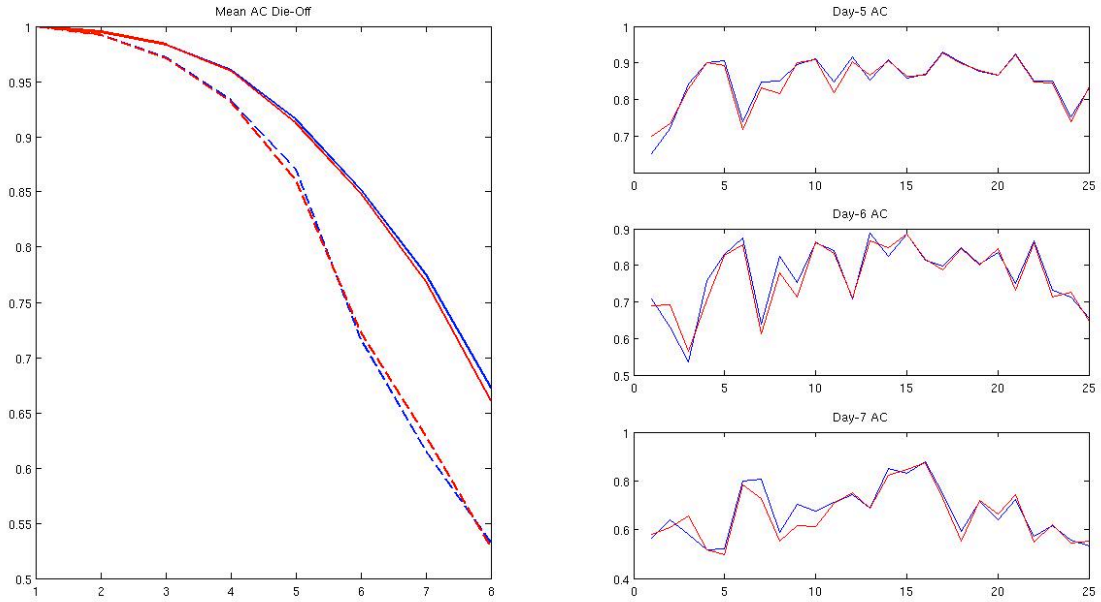

Figure 3. Same as Figure 2, except for the southern hemisphere.

Import AVHRR winds

NESDIS operations began sending AVHRR polar winds to NCEP in 2011. However, this dataset did not include the EE nor did it span the day boundary. We anticipated that these two issues would be resolved in the first quarter of 2012. Unfortunately, the former issue was not complete until the last week in June 2012. Spanning the day boundary is very important in determining the impact of the winds, since it's typically the 00 UTC run where the full forecast is run and statistics computed.

For this reason, and the fact the GDAS/GFS will not be available until mid-summer 2012, we will not begin running AVHRR experiments until August or September 2012.

Transition to S4

Jim Jung visited CIMSS during the week of 30 January 2012 to train Nebuda, Hoover, and Santek on running the GDAS/GFS on s4. We were all able to run short experiments at the conclusion of the week.

Subversion access

A request was sent to John Derber to gain access to the GSI Subversion code base. This includes write access to the branches, but not the trunk. The request was approved in early February 2012.

Personnel update

Brett Hoover reduced his time commitment to the project during this time. He finished experiments running on vapor and began porting data and code to s4.

Sharon Nebuda will increase her time on the project once the GDAS/GFS is available on s4. As of June 2012, we are not able to run a version of the code that Jim Jung is satisfied with; Jim expects to complete the code port by August 2012.

Conferences and workshops

Oral presentations were given the AMS annual meeting in New Orleans and the International Winds Workshop in Auckland, New Zealand. Travel costs were shared with other projects.

Santek, D., B. Hoover, J. Jung, 2012. The quality control of satellite-derived polar winds using the Expected Error. *Symposium on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS),* 16th, New Orleans, LA, 22-26 January 2012. American Meteorological Society, Boston, MA, 2012.

Santek, David, B. Hoover, J. Jung, 2012. Assimilation and forecast impacts using the Expected Error in the quality control of MODIS polar winds. *International Winds Workshop*, 11th, Auckland, New Zealand, 20-24 February 2012.