GOES-R AWG Visibility Retrieval

NOAA Satellite Science Week, Kansas City, MO, April 30 – May 4, 2012

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This poster presents an update on the status of the GOES-R Advanced Baseline Imager (ABI) Visibility retrieval development and demonstrates the utility of the ABI Visibility retrieval to monitor reduced visibility due to regional haze associated with western US wildfires. Validation of the V4 Visibility algorithm shows a 66.9% categorical success rate during May-June 2010. This is significantly better than the V3 algorithm for the same period, which had an accuracy of 59.26%, but still less than the design threshold of 80% categorical success rate.

Background

The GOES-R Visibility retrieval will provide a satellite-based estimate of boundary layer visibility to augment existing measurements from surface networks. The ability of GOES-R to continuously monitor visibility over the continental US will allow smoke and fog related transportation hazards to be monitored in real time, providing valuable information to the Aviation Weather Center (AWC), National Weather Service (NWS), Federal Aviation Administration (FAA), and Department of Transportation (DOT).

V4 Algorithm Improvements

The V4 algorithm uses multiple regression approaches instead of simple bias correction to improve the categorical skill of the visibility algorithm. The 10 predictors for V4 aerosol visibility consist of 1) Aerosol Optical Depth (AOD), 2) temperature at the top of the Planetary Boundary Layer (PBL), 3) 2m temperature, 4) height of the PBL above sea level (including topography), 5) PBL lapse rate, 6) first guess aerosol visibility, 7) 2m relative humidity, 8) relative humidity at the top of the PBL, 9) PBL mean relative humidity, and 10) PBL depth. The 11 predictors for V4 fog visibility consist of 1) fog probability, 2) PBL mean relative humidity, 3) relative humidity at the top of the PBL, 4) height of the PBL above sea level (including topography), 5) 2m relative humidity, 6) PBL lapse rate, 7) PBL depth, 8) 2m temperature, 9) first guess fog visibility, 10) temperature at the top of the PBL, and 11) Cloud Optical Thickness (COT). First guess aerosol visibility is defined as $3.0/\sigma$ where σ is the PBL mean aerosol extinction (AOD/PBL height). First guess low cloud/fog visibility is defined as $3.0/\sigma$ where σ is the PBL mean low cloud/fog extinction (COT/fog depth) and is used when the IFR low cloud/fog probability is greater than 50%. The final "blended" visibility retrieval is constructed using a weighted mean of the first guess and regression-based visibility estimate for aerosol and low cloud/fog visibilities. MODIS L2 AOD and L1 radiances are used to generate the first guess aerosol and low-cloud/fog visibility.

V4 Algorithm Tuning

Optimal weightings for the blended aerosol and low-cloud/fog visibility retrievals are determined based on assessment of Heidke Skill Score (HSS), percent correct, and False Alarm Rates (FAR) using 2007-2008 ASOS/ABI coincident pairs. HSS and FAR were calculated for each visibility category. Percent correct was determined based on overall categorical accuracy. Weightings between the first guess and regression-based visibility estimates varied by 5% from 0% to 100%. Results of HSS and FAR show that a 80% regression weighting resulted in the largest improvement relative to chance for both Clear and Moderate aerosol visibility and reduced false detections for Low aerosol visibility. A 70% regression weighting resulted in the largest improvement relative to chance for Poor low-cloud/fog visibility and maintained low false detections for Clear visibility.

Validation Using Categorical Histogram Analysis

Figure 1 shows categorical histograms of the coincident ASOS (green) and ABI merged (red) visibilities. The merged aerosol and low-cloud/fog visibility retrieval results in a 66.9% categorical success rate for 11,697 coincident ASOS/ABI measurement pairs during May-June 2010. This is significantly better than the V3 algorithm for the same period which showed a categorical success rate of 59.26%.

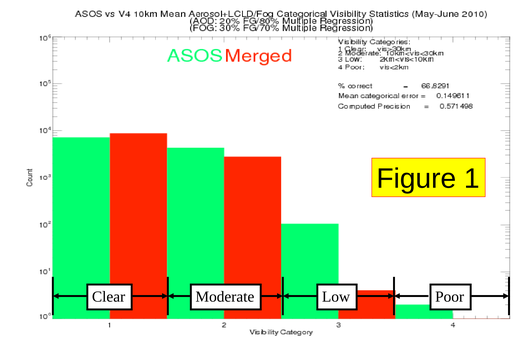

Figure 1

Application to Regional Haze Monitoring

In addition to important safety considerations, reduced visibility due to regional haze also obscures the view in our nation's parks. The Clean Air Act authorizes the United States Environmental Protection Agency (EPA) to protect visibility, or visual air quality, through a number of different programs, including the EPA's Regional Haze Rule. The ability of GOES-R to continuously monitor visibility in remote regions of the US will improve visibility monitoring within our National Parks and provide useful information to the regional planning offices responsible for developing mitigation strategies required under the EPA's Regional Haze Rule. We are currently assessing the ability of the ABI visibility retrieval over the Western US during 2007-2008.

Western US Wildfires 2007-2008

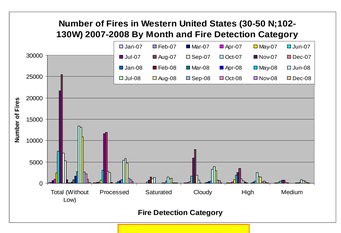

Figure 2

Western wildfire activity peaked during July and August 2007 (Figure 2) with over 10,000 processed WF-ABBA fire detections between 30-50N and 102-130W.

Visibility Reductions Due to Idaho Wildfires on August 4th, 2007

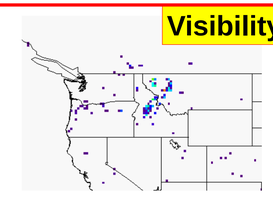

Figure 3

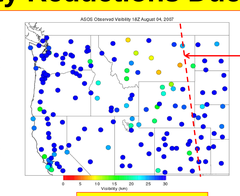

Figure 4

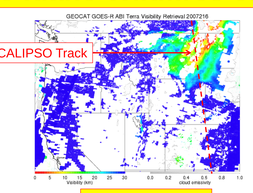

Figure 5

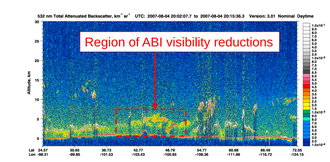

Figure 6

Figure 3 shows WF-ABBA fire detections for August 4th, 2007, during the peak of the August 2007 Western US fire season. Large fires were detected in Central Idaho and Western Montana. Figures 4 and 5 show the ASOS and ABI visibilities on August 4th, 2007. Both ASOS and ABI show significantly reduced visibility downwind from the wildfires although the ABI visibility retrieval shows reduced visibility extending further into NE Montana and NW North Dakota. CALIPSO attenuated backscatter profiles (Figure 6) along the Montana/North Dakota border show that the aerosols were aloft in this region.