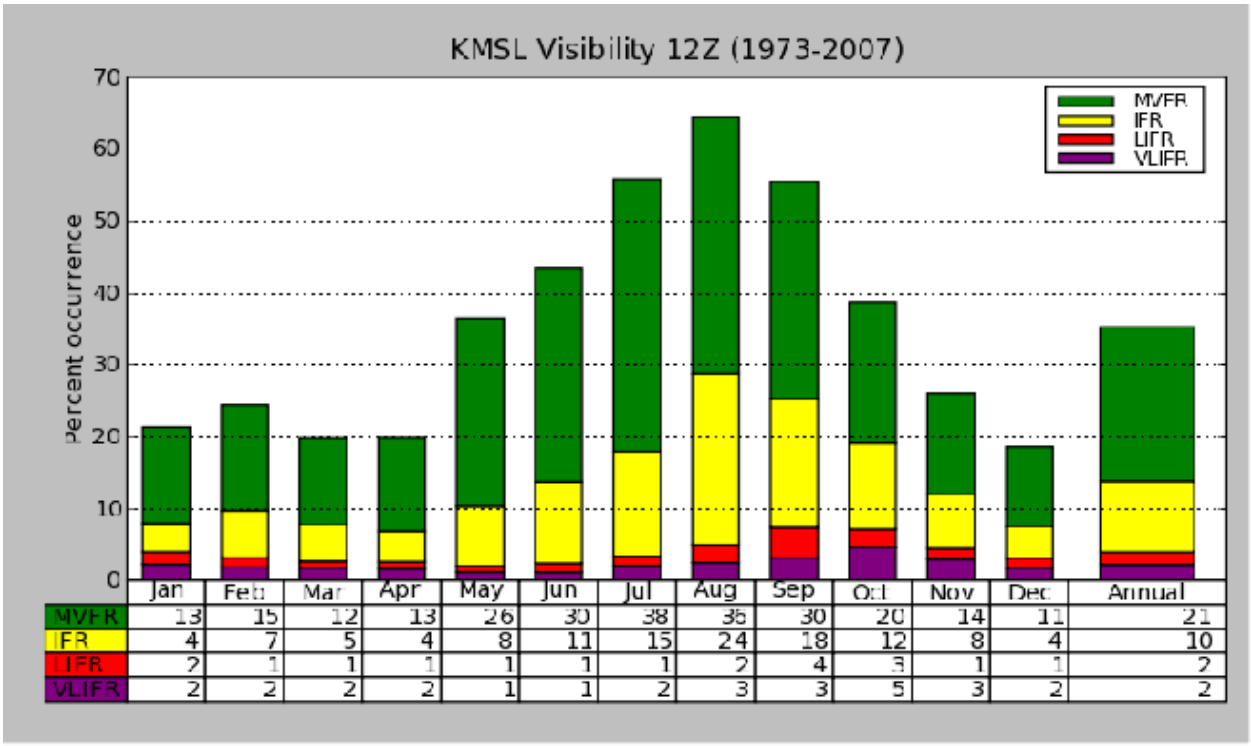
Preliminary Assessments of GOES Aviation Products – Fog Depth Enhancement & Low Cloud Base

August/September 2008 (Inland areas) and January 2009 (Coastal and Southwestern U.S. areas)

In spring of 2008, SPoRT began transitioning a set of GOES Aviation products to its partners in the NWS Southern Region. These NESDIS-created products were being tested with a few select offices prior to this wider implementation. In May of 2008 SPoRT developed a self-paced, web-based training module on the application of two of the products in the suite – the Fog Depth Enhancement and Low Cloud Base (LCB). With the data flowing and users primed with initial training, the time was right for an assessment of these products. SPoRT collaborated with each weather forecast office (WFO) to obtain climatological data showing the time of year when visibility restrictions are most prevalent at Terminal Aerodrome Forecast or "TAF" sites. For inland sites, the August and September months tended to have peaks in the occurrence of Instrument Flight Rules (IFR) and Low IFR (LIFR) conditions where visibility is less than 3 and 1 mile(s), respectively (Fig 1). For coastal WFOs in the southern U.S. the period of maximum occurrence of IFR and LIFR conditions tended to occur in the months of January, February, and March. We assumed that many of the IFR and nearly all of the LIFR events were due to fog and used these criteria to determine a common study period. The Huntsville, Birmingham, Nashville, and Knoxville WFOs were part of the initial intensive assessment period from August 25 to September 14, while the remaining coastal WFOs and the Albuquerque, New Mexico WFO are scheduled for a similar assessment from January 5-25, 2009. For the first assessment period there were a number of fog events for forecasters to examine the utility of the Fog Depth and Low Cloud Base products. During the 3 week period approximately 34 user surveys were submitted and site visits by Geoffrey Stano and Kevin Fuell were made to Birmingham and Nashville. Knoxville was visited on September 15, just after the assessment period, as they tend to have more events of low and very low IFR conditions in September and October. Approximately one third of the survey responses were positive indicating that the areas of fog were easier to identify in terms of spatial coverage and depth using the GOES Fog Depth enhancement and that the Low Cloud Base products. In certain cases, users indicated that TAF and/or short-term forecast statements were influenced by the use of these products. In addition, a case obtained from the Nashville site visit demonstrated that the maximum fog depth, and hence longest area of fog to "burn off," was correctly identified by the product enhancement (Fig. 2). Several WFOs experienced the limitation of using the infrared-based products when areas were obscured by mid and upper level cloud decks. Further limitations were seen at times in areas of either very narrow or very thin fog, and because of this limitation the fog was sometimes reported by ASOS sites ahead of the products being identifying in the imagery. One potential resource, already available to a few SPoRT partner WFOs, for these cases is the 1km resolution MODIS Fog product (i.e. 11-3.9 micron channel difference). While the MODIS product only provides a snapshot at a few times at night, the higher resolution data provides more detail to the fog structure, identifies smaller regions of fog, and is used in a complementary nature to the GOES products (Fig. 3). Several of the user surveys during the study

period indicated an interest in applying the NESDIS Fog Depth enhancement to higher resolution MODIS data from NASA's Aqua and Tera satellites. This MODIS product will soon be transitioned to all SPoRT WFO partners as part of a wider evaluation of its value in conjunction with the higher temporal GOES Aviation products. Users at Birmingham commented that they would like to see the Low Cloud Base product have further delineation of cloud bases at 250, 500, and 750 ft as opposed to simply a single category of < 1000 ft. This would better serve their needs in terms of the various flight rule categories (i.e. IFR, LIFR, & VLIFR). Forecasters at Knoxville provided consistent and quality feedback that included requests of making both products 15-minutes in frequency (the LCB is hourly vs. the 15-minute Fog Depth) and then combining them into a single product in some form. A more formal report of this Fall 2008 assessment period with example imagery will be available for NWS users and NESDIS product developers on the SPoRT website. Preparations for the January 2009 assessment period are ongoing with lessons learned from the first study period, and another report will follow.

A second intensive study period was conducted from 5–25 January 2009 regarding the operational use of MODIS and GOES fog and low cloud products. The first period was held in the Fall of 2008 with SPoRT's NWS partners at inland offices located in the Tennessee Valley region. This second period focused mostly on coastal locations in the southern U.S. User participation was especially high from the forecast offices in Corpus Christi, Houston/Galveston, and Albuquerque. The Science and Operations Officers (SOOs) from these offices (Alex Tardy, Lance Wood, and Deirdre Kann, respectively) and their staffs made extra efforts to collaborate with SPoRT in the evaluation of these products, making the study period a success. Several examples were captured describing the use of the products to aid decisions related to aviation forecasts, resulting in advanced warning to NWS customers. While the GOES Fog Depth and Low Cloud Base products were useful at times, limitations were realized regarding the difficulty in detecting shallow or sparse, sub-grid scale fog. The MODIS fog product was seen as superior to GOES and had success with showing fog at 1-km resolution, but the temporal resolution was a limitation as noted by forecasters. However, the Albuquerque forecast office collaborated with SPoRT on a case that showed the value of MODIS 1-km data. The MODIS image showed an area of fog (Fig. 4, top panel) that would later impact a nearby airport. Meanwhile, this same area was very difficult to discern in the GOES imagery (Fig. 4, bottom panel).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
MVFR	13	15	12	13	26	30	38	36	30	20	14	11	21
IFR	4	7	5	4	8	11	15	24	18	12	8	4	10
LIFR	2	1	1	1	1	1	1	2	4	3	1	1	2
VLIFR	2	2	2	2	1	1	2	3	3	5	3	2	2

Figure 1. Monthly climatology of the occurrence of aviation flight rule conditions based on a 25 year period for the Muscle Shoals (KMSL) location. Notice the peak in IFR conditions is in August, but the peak in LIFR conditions lags by a month. Fog is likely associated with all LIFR conditions and some IFR events.

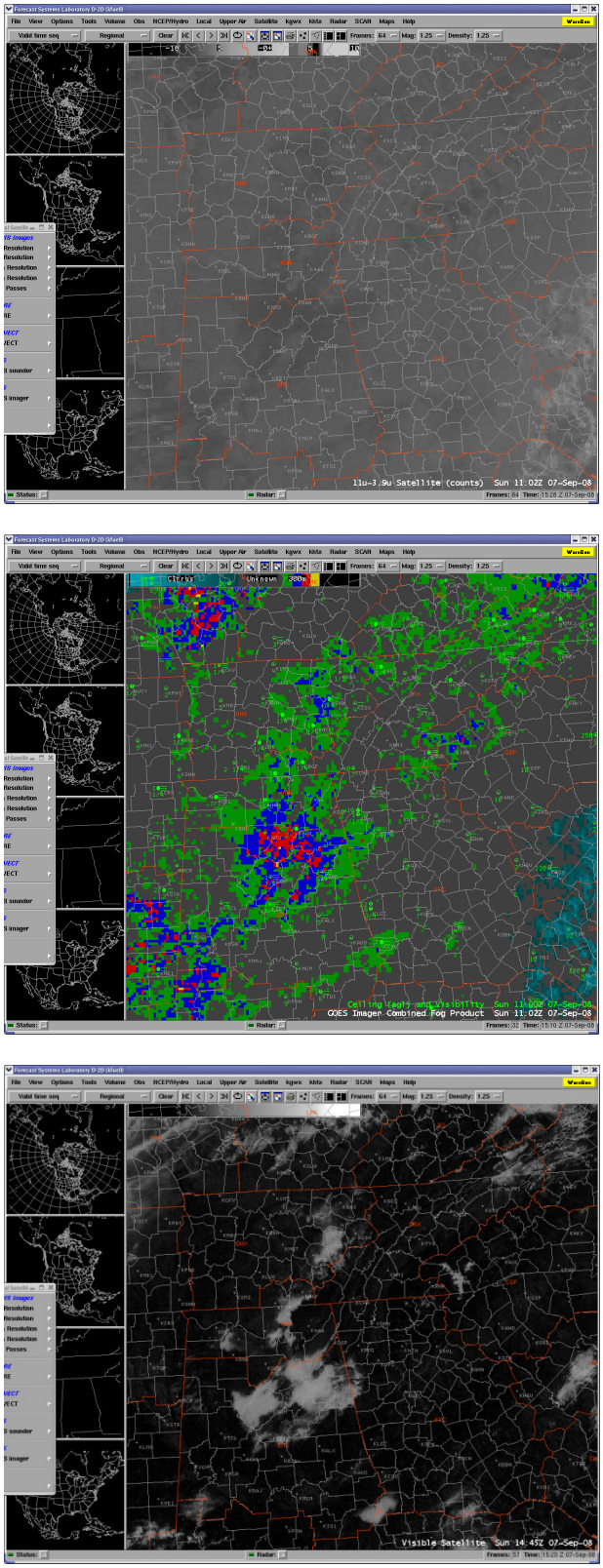


Figure 2. September 7, 2008 case where fog developed in Tennesse Valley, middle Alabama, and up the Appellation chain. The upper image from AWIPS shows the 11-3.9 micron IR image, traditionally used for fog detection at night, while the middle image shows the same data with the NESDIS Fog Depth enhancement; both occurring at 1100 UTC. The lower visible image shows fog and clouds at 1445 UTC after sunrise. The areas shown by the middle image to have thicker fog (blue and red areas) correlate well with areas of fog in the visible image that have yet to "burn off".

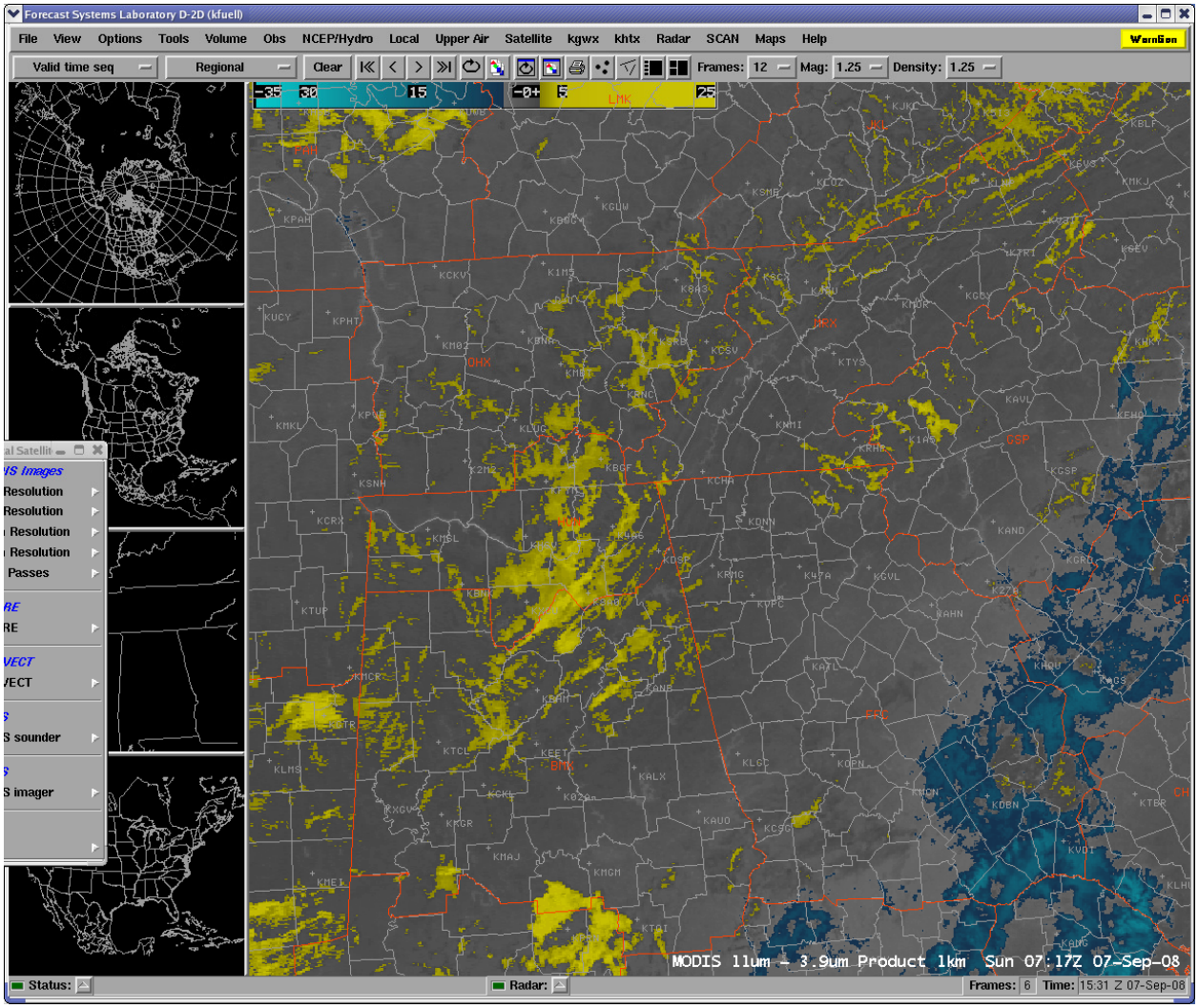


Figure 3. September 7, 2008 0717 UTC (2:17 AM Central Time). MODIS 1km imagery of the 11-3.9 micron channel difference (i.e. Fog Product) as seen in AWIPS. Yellow areas indicate fog and low stratus. Blue areas are higher cirrus-type cloud cover that block the view of low level cloud features. Narrow areas of fog in valleys and low lying river areas are better defined than in the GOES Aviation Fog Depth product

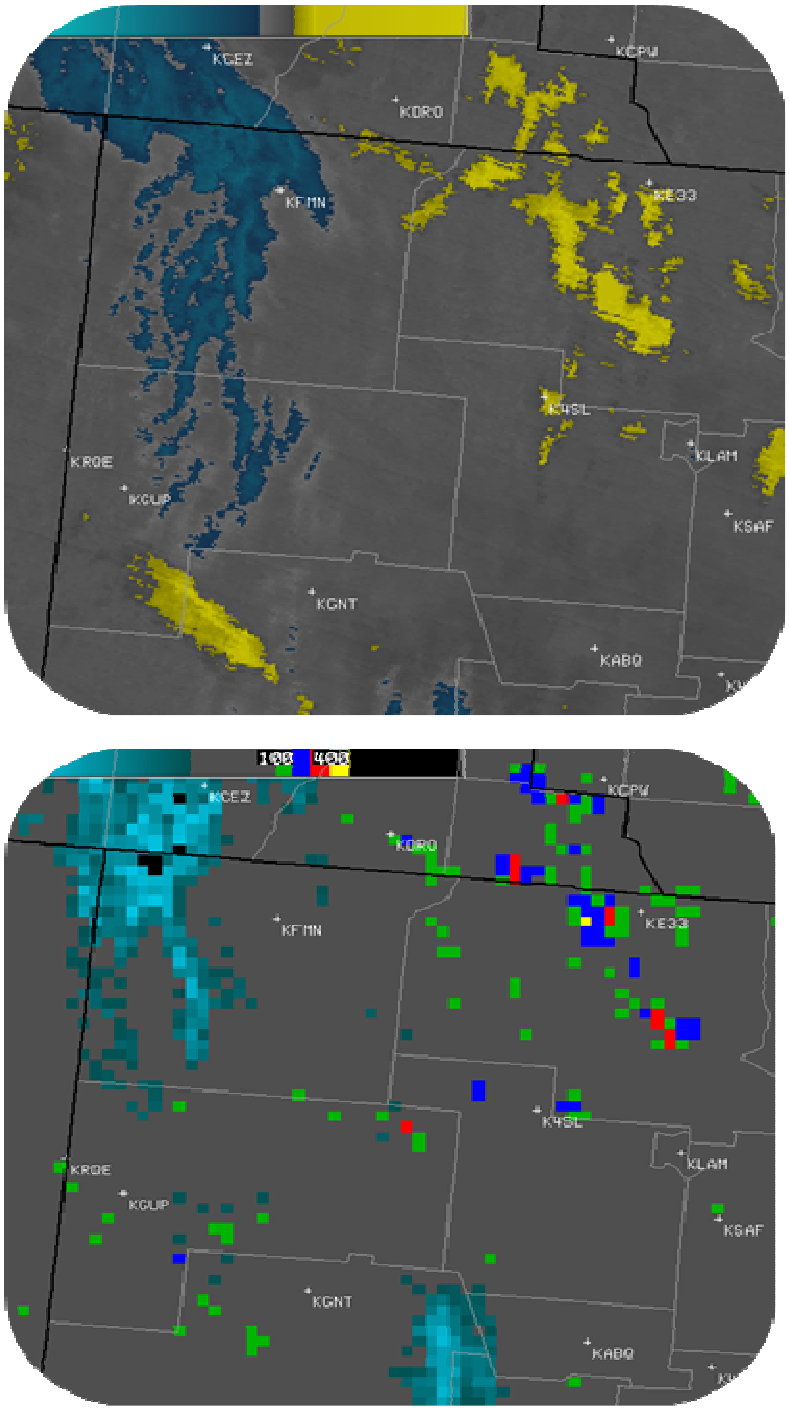


Fig 4. Depiction of the MODIS fog product (11–3.9 μm, top panel) over northwest New Mexico. Note the area of MODIS fog (yellow in top panel) west of Albuquerque is difficult to discern in the GOES image (bottom panel).