USING HIGH RESOLUTION MODEL OUTPUT IN SUPPORT OF THE HYSPLIT DISPERSION MODEL

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1. INTRODUCTION

National Weather Service (NWS) Weather Forecast Offices (WFOs) use the Hybrid Single Particle Lagrangian Integrated Trajectory model (HYSPLIT) to support customers and partners with critical decision making information during certain emergencies. National, state and local government emergency management agencies may require atmospheric trajectory and dispersion plume model guidance in the event of unfortunate chemical, biological or radiological releases. Timely dispersion model output, such as that provided by the HYSPLIT model (Draxler 2007), is essential for supporting decisions whether to instruct threatened populations to evacuate the immediate area or to shelter in place. Detailed plume and trajectory guidance with a high degree of accuracy in both time and space can be of important use toward the safety of the public as well as the emergency responders on the scene. HYSPLIT can also assist in forecasting the character and behavior of smoke plumes for such events as wildfires or prescribed burns conducted as part of land management activities. Dense smoke can be a hazard many miles away from an active fire. Reduced visibilities from smoke can impact transportation systems and cause short-term respiratory health concerns.

WFOs across the nation obtain HYSPLIT model guidance from an interactive web site supported by the Air Resources Laboratory (ARL). Requested model runs are computed on dedicated servers (https://www.hysplit.noaa.gov/) as initiated via the web interface. This comprehensive interface allows for the production of unique guidance from specific input parameters. Recently the web site has included the Areal Locations of Hazardous Atmospheres (ALOHA) capability for providing chemical specific dispersion guidance. This web site, as configured on "high availability" servers, is the primary method for NWS forecasters to obtain dispersion and trajectory information for hazardous plumes in emergencies. Output is yielded for each submitted request.

2. LOCAL HYSPLIT BENEFITS

Each WFO has the responsibility for providing weather-related decision support for highly localized geographic areas, and often for microscale space and time scales. In an era of increasing customer demand, a local implementation of HYSPLIT can be of great value to increase timelines and improve operations flexibility. More so, many WFOs have local versions of the Weather Research Forecast Environmental Modeling System (WRF-EMS) configured that may provide input meteorological fields at higher spatial and temporal resolutions than that available from national center models. The benefits of local models in depicting small scale features, especially when the model has adequate initial conditions provided by data assimilation schemes, has been discussed in recent literature (Bogenschutz, 2004; Case et. al, 2006). With a locally run HYSPLIT, the WFO forecasters have the ability to interact with all parameters and configuration options that are allowed by the modeling system.

Having a version of HYSPLIT locally configured provides the opportunity for forecasters to have multiple and frequent interactions with the system. This promotes a better understanding of model capabilities and improved skills in output interpretation by forecasters. The availability of routine HYSPLIT data at various points within the forecast area helps to maintain a high degree of situational awareness relative to the current flow regime and overall dispersive nature of the atmosphere within the WFO's forecast/warning area. For example, a situational awareness tool used at WFO Melbourne (MLB) is shown in Figure 1. Output at predetermined times and locations provide ready dispersion information for sensitive areas including power plants, hazardous storage facilities, and vulnerable populations such as tourist attractions and recreational venues. Importantly, routine HYSPLIT runs at pre-positioned locations provide ready guidance for initial decision support in an actual emergency. General information about the effects of transport speed and direction on average plumes would already be available to help provide immediate support in an emergency. This would then be followed up with an urgent run having more detailed input specifics (i.e. exact time, location, emission character, etc.) as given by the requesting authority. Emergency HYSPLIT guidance is then secured from both the official NWS HYSPLIT web site and the local office HYSPLIT installation.

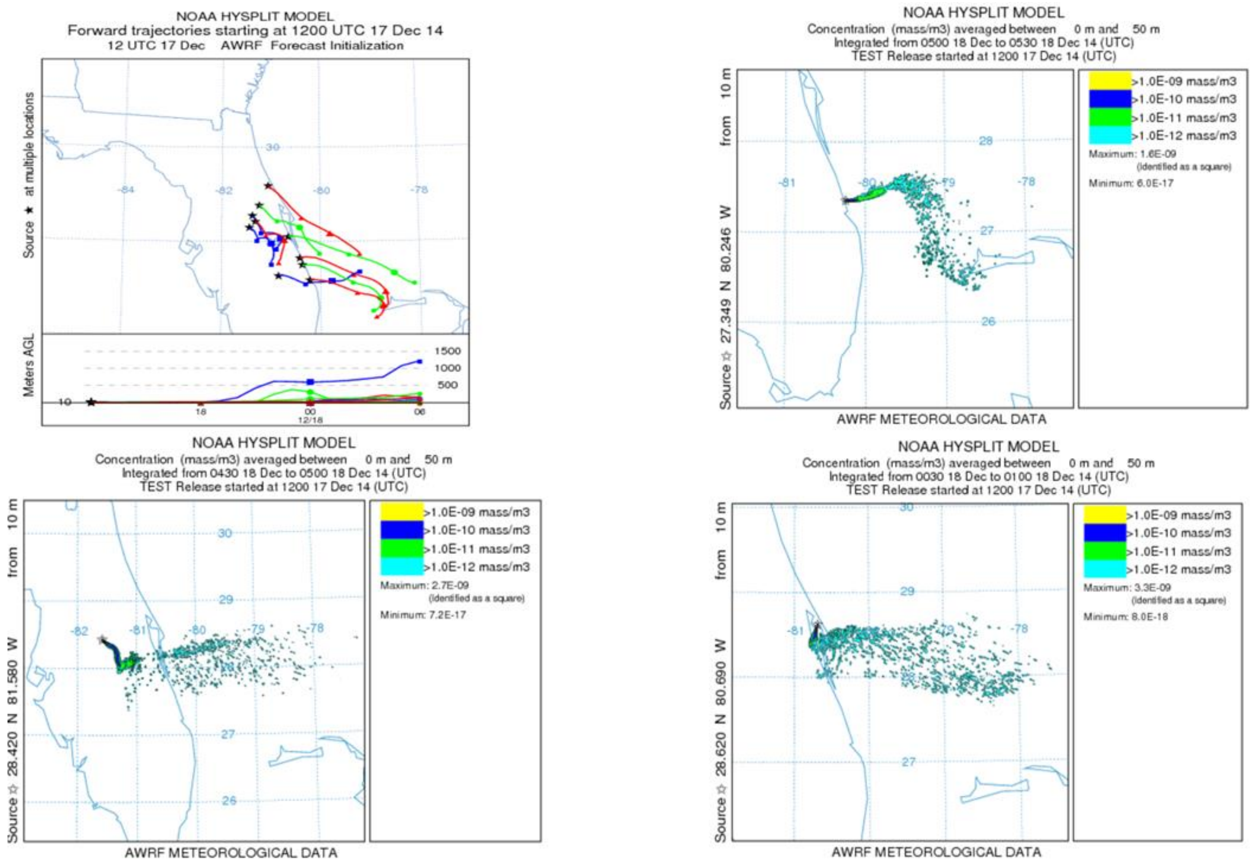

Fig. 1. Routine HYSPLIT guidance configured at predetermined locations. Output is displayed as animated GIF images on forecaster situational awareness monitors.

3. WFO MELBOURNE SPECIFIC INSTALLATION

A tasking proposal through the NASA Applied Meteorology Unit (AMU) brought the HYSPLIT capabilities to WFO MLB in 2007 (Dreher, 2009). The original installation employed version 4.8 of the software. Since that time the system has been upgraded to version 4.9. The configuration also uses the GRIBmaster (Rozumalski, 2012) software to download background models for subsequent use as input. The local HYSPLIT configuration was installed on an office Linux server with various computer shell and Perl scripts developed to provide an interface for interacting with the model. The computer scripts read in text files as input to the actual model which gives a forecaster the ability to interact with the complete array of parameters. Routinely scheduled HYSPLIT model runs are generated at regular intervals (every 3 hours).

WFO forecasters can interact with the routine scheduled model runs by adding and subtracting source locations through text products at their Advanced Weather Interactive Processing System (AWIPS) workstations. Since AWIPS is the primary computer system for forecaster use, an interface on AWIPS was fitted to facilitate a streamlined approach for acquiring additional guidance with respect to the next scheduled HYSPLIT run. Forecasters enter latitude and longitude pairs in to a text file (WRKHYS) which are then incorporated within the next run. HYSPLIT output in the form of animated (i.e. looping) GIF images and Geo-referenced KML files are generated for a dozen or more locations every three hours based off the NCEP Rapid Refresh (RAP) model as well as a 9km version of a locally configured WRF-EMS ARW model run.

WFO forecasters may also be called upon to provide decision support to emergency management officials during high-stress and short-fused emergencies. A second stand-alone HYSPLIT installation is configured on WFO MLB servers to accept urgent requests from forecasters and provide rapid HYSPLIT guidance. The interface is again through a simple AWIPS text product generation (WRKHYE) method (Figure 2). In addition to a latitude and longitude pair for location information, an onset time and duration period is entered. The interface also accepts a release period interval for instances where there is not a continuous release of the hazardous material. After product entry, computer scripts begin the process of running the model with the input parameters. Within approximately three minutes, dispersion plume information is available to forecasters based on both RAP and WRF-ARW model guidance. The forecasters' expertise is leveraged in their being aware which short-term model behavior is best representing the local environmental flow pattern at the time of the hazardous release. Both the routine scheduled (WRKHYS) and emergency (WRKHYE) HYSPLIT configurations produce output in looping GIF images and Geographic Information System (GIS) output. The KML files (Figure 3) displayed within a tool such as Google Earth, etc., provide highly detailed geographic specific information that can be easily shared with emergency management officials.

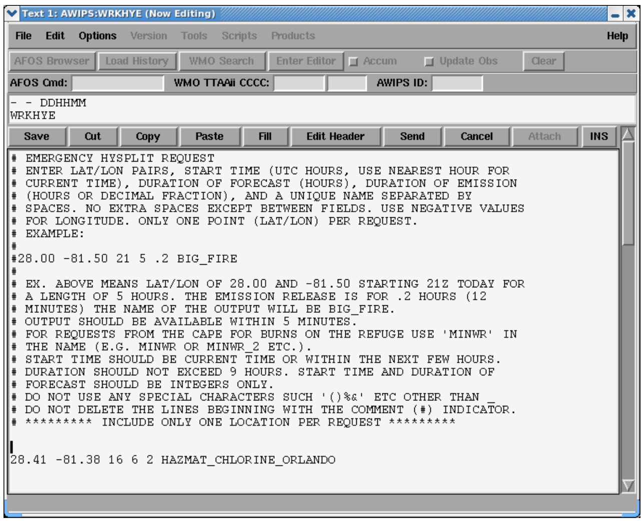

Fig. 2. AWIPS text product interface (WRKHYE)

4. SUMMARY

A local HYSPLIT installation has been incorporated into WFO MLB operations for several years. The availability of this resource has proven to be beneficial as demand for sensitive decision support continues to increase. WFO MLB has experienced a steady increase of such requests which is consistent with the overall NWS goals for a Weather Ready Nation (NWS Strategic Plan, 2011). The local HYSPLIT provides enhanced situational awareness as well as ready-access to plume dispersion information. The system uses the best high resolution NCEP models as well as high resolution models run locally within the WFO. The mesoscale models run at a local WFO have the added benefit of providing output at temporal intervals finer than that currently available from NCEP.

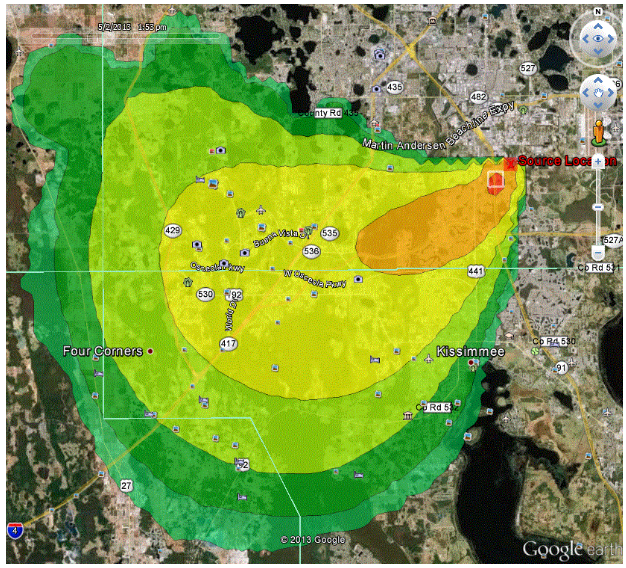

Fig. 3. HYSPLIT KML output used in a GIS.

It has been discussed by Bowman et. al., that Lagrangian dispersion model improvements can only be realized in the future through improved mesoscale models with improved spatial and temporal resolutions (Bowman et.al., 2013). As HYSPLIT is a Lagrangian model, its performance is totally dependent on the quality of the background model used for the dispersion simulations. Moreover, local NWS forecasters are in the best position to choose the most appropriate mesoscale model due to their knowledge of the local meteorology and an understanding of the most recent performance of the available background models.

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