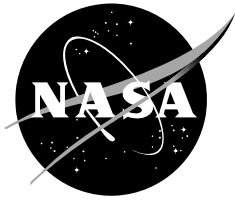


NASA Contractor Report NASA/CR-2010-216286



HYSPLIT Graphical User Interface

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November 2009

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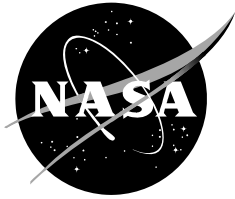
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Acknowledgements

The author thanks Mr. Peter Blottman and Mr. David Sharp of the National Weather Service (NWS) in Melbourne, Florida and Mr. Brian Hoeth and Mr. Kurt Van Speybroeck of the NWS, Spaceflight Meteorology Group in Houston, Texas for providing input and valuable feedback on the overall direction of this task.

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Executive Summary

The National Weather Service Forecast Office in Melbourne, Florida (NWS MLB) is responsible for providing meteorological support to state and county emergency management agencies across East Central Florida in the event of incidents involving the significant release of harmful chemicals, radiation, and smoke from fires. Responding to these incidents is a continual challenge for Weather Forecast Offices in the National Weather Service. Forecasters at the NWS Spaceflight Meteorology Group (SMG) at Johnson Space Center in Houston, Texas are responsible for very short, highly accurate, de-orbit burn weather forecast for current Space Shuttle landings at the Kennedy Space Center in Florida and Edwards Air Force Base in California. SMG may also be responsible for many other NASA landing sites with future space launches. Output graphics from the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) guidance are generated for the purpose of obtaining useful trajectory and concentration plume forecasts that are associated with the significant release of harmful chemical gases, radiation, wildfire smoke and other pollutants into the local atmosphere.

In a previous task, the Applied Meteorology Unit (AMU) developed Linux parameter files containing the various model runtime options for the HYSPLIT simulations. However, changing the values in the parameter files proved to be a time-consuming task prone to human error. The NWS MLB forecasters requested a graphical user interface (GUI) be created to modify the parameter files and change the variables in an operational environment easily and quickly.

The AMU developed the HYSPLIT GUI to give forecasters control of critical input parameters and other site information to the HYSPLIT model. The GUI was designed in close collaboration with members of the NWS MLB for operational efficiency. The GUI allows forecasters to retrieve automated guidance from a number of source locations using meteorological input from several of the National Centers of Environmental Prediction (NCEP) North American models. Dispersion plume output is iteratively generated throughout the day using the GUI with input data from the NCEP models and local versions of the Weather Research and Forecasting model. Emergency HYSPLIT model runs may also be submitted through the GUI for a critical real-time incident.

Prior to the GUI development, forecasters at the NWS MLB and Spaceflight Meteorology Group had to enter parameter values manually into configuration text files which was difficult and time consuming. The goal of this task was to develop a user-friendly GUI that allows the forecaster to quickly monitor, view, select and change the different chemical or dispersion parameters. The HYSPLIT GUI meets this goal and, with its functionality, will reduce the possibility of human error and increase operational efficiency, allowing forecasters to do other duties.

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1. Introduction

The National Weather Service Forecast Office in Melbourne, Florida (NWS MLB) is responsible for providing meteorological support to state and county emergency management agencies across East-Central Florida in the event of incidents involving the significant release of harmful chemicals, radiation, smoke from fires and/or toxic plumes into the atmosphere. Accurate and timely guidance is critical for decision makers charged with protecting the health and well-being of populations at risk. Information that can describe the geographic extent of areas possibly affected by a hazardous release, as well as to indicate locations of primary concern, offers better opportunity for prompt and decisive action. NWS MLB uses the National Oceanic and Atmospheric Administration (NOAA) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to provide trajectory, concentration, and deposition guidance during such events. Forecasters at the NWS Spaceflight Meteorology Group (SMG) at Johnson Space Center in Houston, Texas have also expressed interest in using the HYSPLIT GUI. The GUI would allow them to manage certain parameters used with assessing the weather Flight Rules (FR) during Space Shuttle landings at the Kennedy Space Center in Florida and Edwards Air Force Base in California.

In previous work, the Applied Meteorology Unit (AMU) developed Linux parameter configuration files containing the various model runtime options for the HYSPLIT simulations. However, changing the values in the parameter files for different scenarios proved to be a time-consuming task prone to human error.

The NWS MLB and SMG requested that the AMU create a graphical user interface (GUI) to modify the parameter files and change the variables in an operational environment easily and quickly. Such a GUI would reduce the possibility of human error and increase efficiency, allowing forecasters to do other duties.

The GUI helps forecasters manage the local HYSPLIT for both routine and emergency use. It allows them to quickly determine the current HYSPLIT configuration for the list of predefined sites, and to make any necessary adjustments to key parameters such as site location, input model, forecast hour duration, type of map plot and the plume release height. During emergencies, forecasters also have the ability to invoke playbook options such as a low-altitude rocket mishap or a nuclear power plant incident to assist them in optimizing certain parameter settings such as emission duration, emission rate and emission elevation. The interface is written in Tool Command Language (Tcl) / Toolkit (Tk), version 8.5, making it compatible to run within most LINUX and Windows operating systems.

2. Previous Work

In a recent task (Dreher et al., 2009), the AMU obtained and installed the latest version of HYSPLIT on a Linux system at NWS MLB that ingests routine National Centers of Environmental Prediction (NCEP) model products. The AMU also configured a utility program to convert Weather Research and Forecasting (WRF) Environmental Modeling System (EMS) output into HYSPLIT binary format, and wrote several scripts that run through a Linux job-scheduling capability to produce automated HYSPLIT trajectory and concentration guidance from several models. The scripts are configured to download the model guidance, convert the meteorological grids into the proper format, run the model from several latitude/longitude sites, and post-process the data to create output graphics. The scripts use parameter files for each product that contain the necessary trajectory and concentration HYSPLIT parameter variables.

The NCEP model retrieval was configured to run up to eight times daily from a variety of user-defined source locations and forecast intervals. The guidance is controlled through a set of scheduled scripts that automatically download the NCEP model products, convert the meteorological grids into HYSPLIT binary format, run the model, and post-process the data to create output graphics, including an option to display the output in Google Earth™ or within Geographic Information System (GIS) mapping applications.

3. HYSPLIT GUI Software Development and Testing

The main functionality of the HYSPLIT configuration files such as site locations, model(s) preference, map output selection, emission control data and allowing for playbook options was transferred into a user-friendly GUI. The Tcl/Tk programming language was used for its flexibility in coding modules that allow parameter selection, user input, and data processing and then output into formatted configuration files.

3.1 Development

Parameter files developed in the previous task were used as a starting point for the development of the HYSPLIT GUI. The AMU convened several meetings with NWS MLB personnel to review the task and discuss in detail the desired layout and functionality of the GUI. The concept of a Local Configuration Manager layout resulted from the meeting discussions, as well as a parameter baseline for the GUI development.

The GUI is divided into three distinct sections. The first section is designed to handle scheduled HYSPLIT runs multiple times per day for pre-determined sites and select times, and according to a default configuration. Sufficient space has been provided to accommodate output for ten fixed sites and up to five floating (e.g., movable) sites. The second section is designed to address contingency HYSPLIT runs for potential incidents several days in advance for a given site. Unfortunately, the need for this feature became clearer after the task was scoped and underway. Although the functionality for HYSPLIT contingency runs is not yet available, the AMU was still able to incorporate this section within the GUI facade at the request of NWS MLB. Incorporating the associated functionality is being considered as a follow-on task for the next tasking cycle. Finally, the third section is specifically coded to handle emergency HYSPLIT runs for actual incidents having exact latitude/longitude locations and incident times. Features of the HYSPLIT GUI include:

- **Tcl/Tk:** A script and interpreter-type programming language.
- **Configuration File:** A text file that has default or real-time parameter settings. The text file is used at program startup or when defaults are requested.
- **Scripts:** User- or code-defined text files that control file execution or start other processes.
- **Fixed Sites:** 10 sites for which the HYSPLIT model runs daily. The forecaster can enter or update information such as, Name, Latitude, Longitude, Forecast Time, Model choice, Emission Duration and Rate on the 10 sites.
- **Floating Sites:** Five sites that can be added. The forecaster can enter or update the same information as for Fixed Sites along with a playbook option. Once changed, these sites are added to the 10 fixed sites in the HYSPLIT model run.
- **Emergency Site:** A single site entry was developed for emergencies. The forecaster can enter or update the same information as for Fixed Sites along with a playbook option on a single site and then have the HYSPLIT model run with those parameters once the submit button is clicked.
- **Playbook Option:** A category of source release particulate that can be selected by the forecaster.

The Playbook Option allows the forecaster to select the initial release pollutant type. The values for the chosen release particulate are updated in the parameter file so the HYSPLIT model computes the correct trajectory and concentration plumes.

3.2 HYSPLIT GUI

As code was developed and functionality added to the GUI, the AMU shared the code with NWS MLB for their review and input to ensure the final product would be useful in their operations. Adjustments were made in the GUI code based on their suggestions and comments. Once the parameter selection, layout and button functionality were developed, the AMU inserted background code to manipulate the model parameter files and code to save and retrieve the different parameter input file settings.

Figure 1 shows an example of the HYSPLIT GUI. It has many input windows, parameter pull-down menus, option buttons, widgets and control files that allow the user to choose the information selected for output to build the parameter files and run the HYSPLIT model. The forecaster has control over all input and selectable fields. All titles, fields and labels have mouse-over help that describes their functionality. Once the forecaster has completed updating the site(s) incident and other parameter information, a “Submit” button is highlighted. This updates the selected model parameter files and/or makes an emergency HYSPLIT model run.

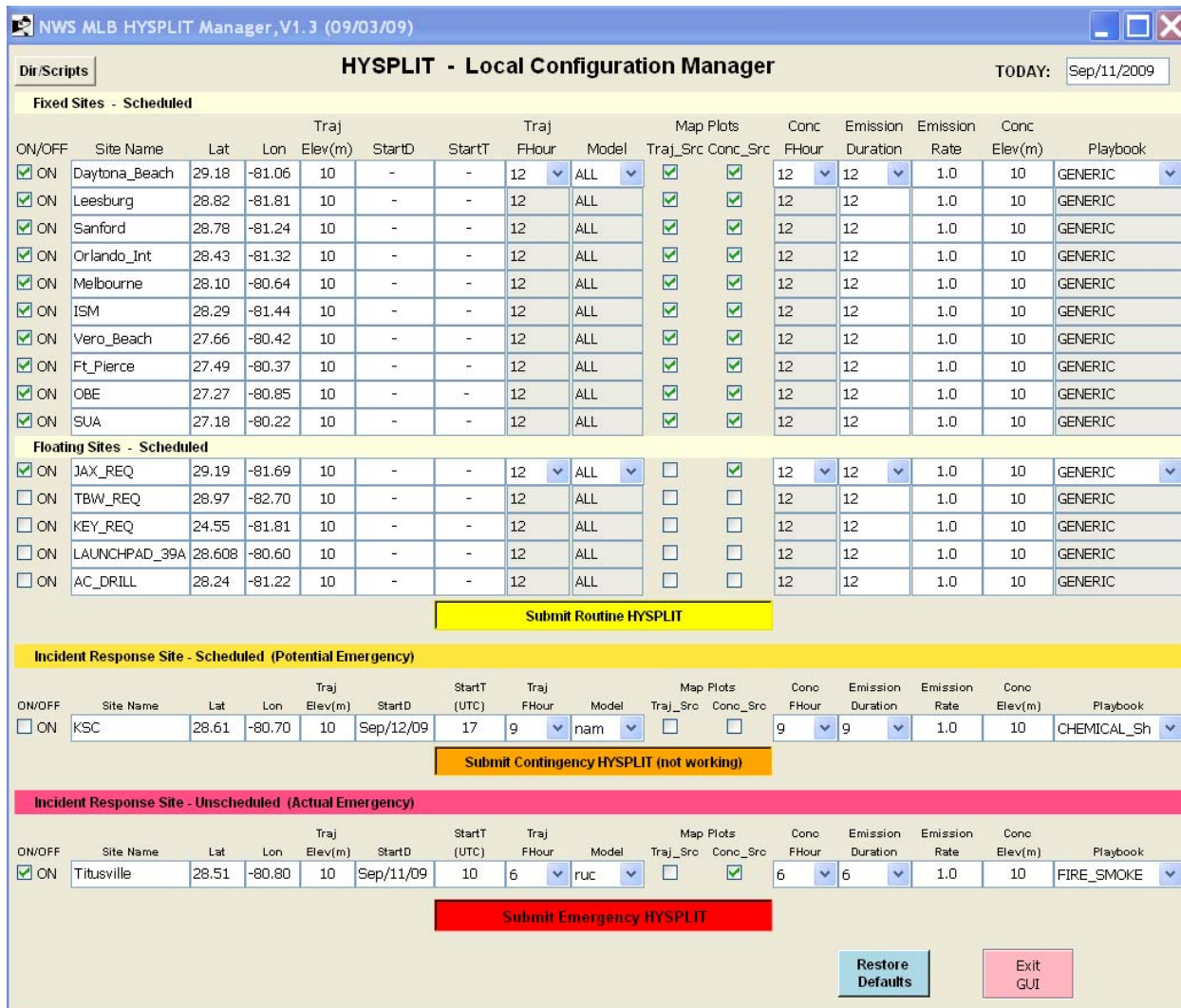


Figure 1. Example of the layout of the HYSPLIT Local Configuration Manager GUI.

To allow the user control over the directories where the different parameter files are written, the popup window “Setup Directories” was developed (Figure 2). This menu allows the forecaster to change the directory path depending on the operating system being used. The forecaster can also modify the names of the HYSPLIT scripts.

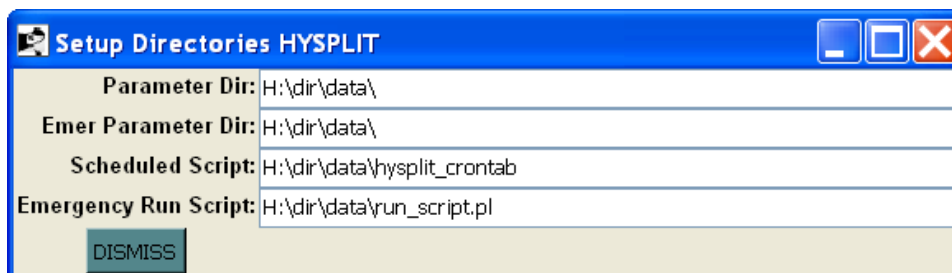


Figure 2. Example of the Directories popup menu. The parameter directories and script names can be changed.

Several additional popup windows were developed that allow the forecaster to select playbook options and restore parameter settings. Figure 3 shows two examples. The playbook selection menu on the left in Figure 3 allows the forecaster to select from a preset number of likely events. Depending on which playbook option the forecaster selects changes several chemical or particulate parameters in the HYSPLIT model. One of the options in the restore

popup window on the right in Figure 3 is “Restore to Last Previous State”. This option restores the HYSPLIT GUI parameters to the same values the last time the GUI was closed. A text file is written each time the GUI is closed to keep track of the parameter values. An example of this file is shown in Figure 4. The menu option can also be used after the user has made some parameter changes but decides to reverse them to their original state.

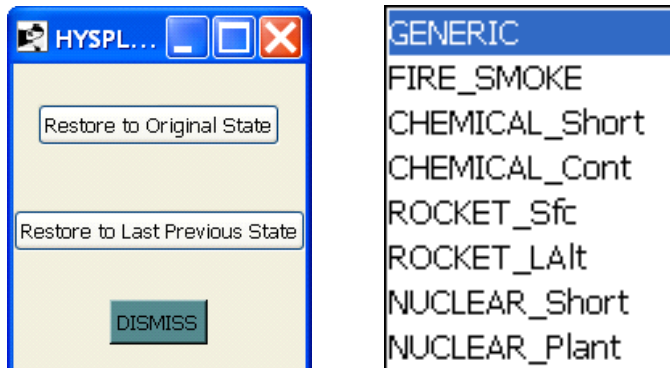


Figure 3. On the left is an example of the Parameter Restore popup menu and on the right shows a listing of the Playbook options that the user can select from.

```
idc1=Daytona_Beach
lat1c=29.18
lon1c=-81.06
idc2=Leesburg
latc2=28.82
lonc2=-81.81
idc3=Sanford
latc3=28.78
lonc3=-81.24
idc4=Orlando_Int
latc4=28.43
lonc4=-81.32
idc5=Melbourne
latc5=28.10
lonc5=-80.64

eparm_dir=H:\dir\data\
parm_dir=H:\dir\data\
sscript=H:\dir\data\hysplit_crontab
escript=H:\dir\data\run_script.pl
```

Figure 4. Example of a configuration file written to manage the parameter settings.

When the forecaster completes and submits the GUI parameter selections, HYSPLIT scripts run in the background to output maps and overlay configuration files. A trajectory plot of dispersion plumes created from the GUI is shown in Figure 5 overlaid on a Google Earth map.

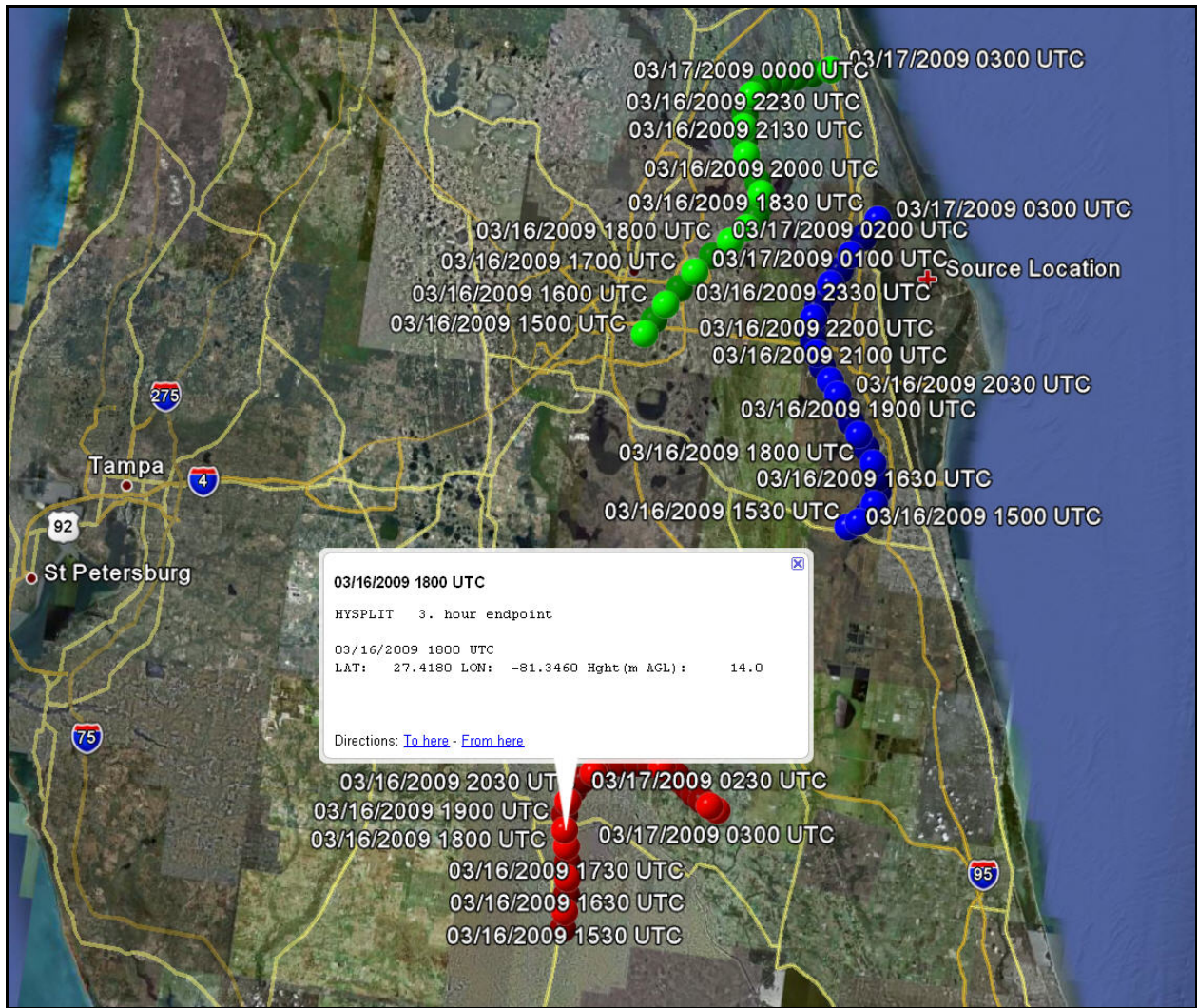


Figure 5. Example of a dispersion plume plot on a Google Earth map.

3.3 Testing

After the Tcl/Tk code development was completed, the AMU and NWS MLB went through several testing cycles fixing bugs and making changes to the GUI. They tested each of the fields to verify that the HYSPLIT model parameter files updated with the proper values and that the model ran with the selected parameters. These changes made the GUI more responsive and user friendly. For final testing, NWS MLB successfully tested the GUI functionality in both daily and emergency configurations.

4. Summary

The AMU developed the HYSPLIT GUI using the Tcl/Tk language. The GUI provides a user-friendly way for forecasters to modify the parameter files in order to manage the local HYSPLIT model for both routine and emergency use. It also allows forecasters to quickly determine the current HYSPLIT configuration for a list of predefined sites (e.g. fixed and floating sites), and to make any necessary adjustments to key parameters. During emergencies, forecasters also have the ability to invoke playbook options for predefined source pollutants. All titles, fields, menu options and labels display a mouse-over help message describing their functionality. When using the GUI interface, forecasters will obtain the desired output confidently and without the danger of corrupting essential configuration files.

Previously, the forecasters entered values into configuration text files manually to run HYSPLIT and output graphic files. The HYSPLIT GUI developed in this task gives forecasters the ability to select and view different parameters while reducing the possibility of human error and increasing efficiency, allowing forecasters to do other duties.

5. References

Dreher, Joseph, 2009: Configuring the HYSPLIT Model for National Weather Service Forecast Office and Spaceflight Meteorology Group Applications. NASA Contractor Report CR-2009-214764, Kennedy Space Center, FL, 36 pp. [Available from ENSCO, Inc., 1980 N. Atlantic Ave., Suite 830, Cocoa Beach, FL, 32931, and <http://science.ksc.nasa.gov/amu/final.html>]

List of Acronyms

AMU	Applied Meteorology Unit
AWIPS	Advanced Weather Information Processing System
EMS	Environmental Modeling System
FR	Flight Rules
GIS	Geographic Information System
GUI	Graphical User Interface
HYSPLIT	HYbrid Single-Particle Lagrangian Integrated Trajectory
MLB	Melbourne
NCEP	National Centers of Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
SMG	Spaceflight Meteorology Group
STI	NASA scientific and space information
Tcl	Tool Command Language
Tk	ToolKit
WRF	Weather Research and Forecasting

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