

HyHelper:
A Python framework for interpreting and
managing Hysplit air parcel trajectory files

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1 Introduction

1.1 Hysplit

The Hysplit (Hybrid Single Particle Lagrangian Integrated Trajectory) Model is a web-based computer model used to compute simple air parcel trajectories, as well as other complex simulations. Hysplit is widely used; applications include "tracking and forecasting the release of radioactive material, wildfire smoke, windblown dust, pollutants from various stationary and mobile emission sources, allergens and volcanic ash." After 30 years, Hysplit remains one of the most extensively used atmospheric transport and dispersion models.¹

1.2 HyHelper

Clearly, the Hysplit model is a very powerful and prominent tool in the atmospheric sciences community, but working with the web-based model and its air parcel trajectory files can be better optimized. HyHelper has 3 main modules aimed at making the Hysplit-to-trajectory analysis workflow more time and memory efficient.

1. Automated Data Retrieval

Using BeautifulSoup and Mechanize, HyHelper offers a Python script capable of automatically generating air parcel trajectory files from the web-based Hysplit model.

2. File Interpreter and Manager

The HyHelper framework allows users to intuitively load files and conduct trajectory calculations. Trajectory groups allow users to analyze multiple files at a time and save filtered groups. The modular infrastructure allows users to easily create and implement their own functions and filters.

3. Data Analysis and Visualization

Using Basemap, HyHelper can plot multiple trajectories and/or trajectory groups for side-by-side comparison and analysis with appropriate labeling and colormapping by trajectory data.

¹<https://www.arl.noaa.gov/hysplit/hysplit/>

2 The HyHelper Library

The HyHelper library is made up of the following files. Its modular framework is built to encourage users to easily construct and run their own functions.

2.1 AutoSplit

AutoSplit automatically generates air parcel trajectory files through Hysplit based on the following user inputs:

- **traj_name:** name of the trajectory
- **coords:** target coordinates of the trajectory in lat/lon format
- **dates:** dates over which the trajectory will run
- **runtime:** total runtime of each trajectory
- **file_type:** meteorological file type
- **alts:** starting altitudes of each trajectory
- **traj_dump:** file output location

AutoSplit will use these inputs to generate the files at the given output location by running through the web-based Hysplit model. One key advantage of AutoSplit is that it eliminates the manual labor of having to click through the Hysplit website (you need to go through 5 weblinks to generate 1 file!). Additionally, generating files through the desktop version of Hysplit takes up a lot of memory space. For example, 1 GDAS file is around 500MB and one GDAS file stores only a week's worth of data. AutoSplit uses the web-based model, meaning that you do not have to download the huge data files needed to generate these trajectories. Now, users can run one script to generate hundreds of files automatically.

2.2 HyHelper_traj

HyHelper_traj provides the foundation for HyHelper. The file interpreter and manager lives in this Python program. The three main components of this program are the Point, Traj, and Traj_Group objects which allow for easy and intuitive file manipulation and analysis. Trajectory calculations can be done simply and custom user functions can be easily implemented given the clear design of the objects.

2.3 HyHelper_plot

HyHelper_plot provides a toolkit for data visualization and side-by-side comparison across multiple trajectory files. The colormap feature allows users to plot and analyze a third dimension of the trajectory data. A common use of the colormap feature is to plot the rainfall along a trajectory. Users can plot any amount of trajectories and trajectory groups in one run of the file. The plot function will automatically choose the optimal dimensions of the grid of subplots in order to provide the cleanest data visualization environment.

2.4 HyHelper_filters

HyHelper_filters provides pre-built functions to be used with Traj_Group for trajectory filtering. Filtering is an essential part of data analysis as it cleans data for easier analysis and visualization. These pre-built filters utilize supplementary files (also included in HyHelper) to scrape web-based data tables for deeper trajectory evaluation.

2.5 The Webscripts

HyHelper comes with three working web-scripts that provide a framework for users to create their own web-scripts using BeautifulSoup and Mechanize. The three web-scripts are:

- KNML_webscript
- ONI_webscript
- WebWIMP_webscript

These web-scripts are passed into the built-in filter_group function in Traj_Group for simple trajectory filtering.

3 Tutorial

To see how HyHelper works, please see the Jupyter notebook file titled "HyHelper Demo."