

Short Range, Low-Level HYSPLIT Trajectory Model Forecasts for the Prediction of Coastal Stratus and Fog

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1. Introduction

The prediction of low stratus and fog is a critical forecast problem for aviation and surface transportation operations. An important element in forecasts of advection fog and stratus is low level flow from sources of moisture into the forecast area. In transition situations, such as a change from offshore to onshore flow, rapid changes in wind direction and speed make it difficult for forecasters to visualize the origin of the air mass over the area after 18-24 hrs.

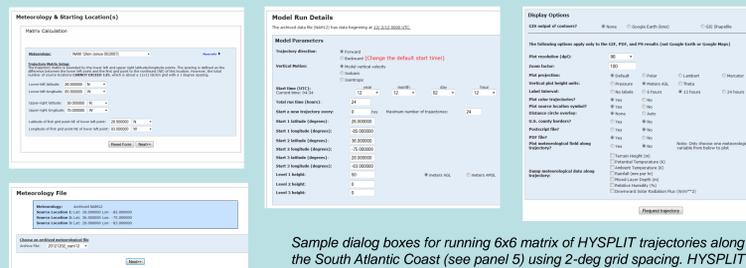
The National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory's (ARL) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model can provide forecasts of low level trajectories out to 24 hours using data from a variety of numerical prediction models generated by the National Centers for Environmental Prediction (NCEP) (Draxler and Hess, 1998).

While the HYSPLIT model is most often used in Hazardous Materials (HazMat) events such as nuclear accidents, smoke plumes from wildfires, and volcanic eruptions, meteorological applications, such as its use for prediction of coastal advection fog and stratus, are also possible.

2. Procedures

Some proof-of-concept cases were collected for the California, South Atlantic, and New England coasts by producing a matrix of HYSPLIT trajectories based on data from the North American Mesoscale (NAM) or Global Forecast System (GFS) models for 18-24hr with a starting point altitude of 50m. Trajectories were then compared to stratus and fog coverage in GOES visible near the verifying time. Mean 18h trajectories were also obtained for 30 cases of stratus/no stratus for San Francisco Bay.

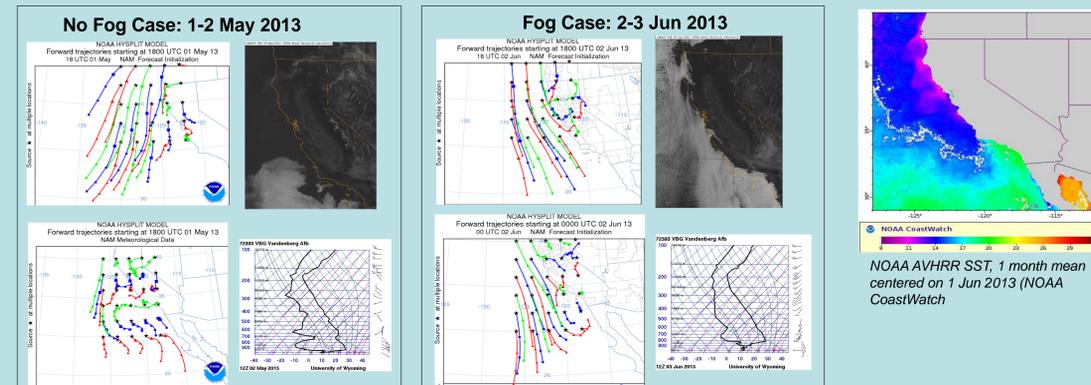
Website URL for NOAA HYSPLIT model is: <http://ready.arl.noaa.gov/HYSPLIT.php>



Sample dialog boxes for running 6x6 matrix of HYSPLIT trajectories along the South Atlantic Coast (see panel 5) using 2-deg grid spacing. HYSPLIT runs in <1min on a PC.

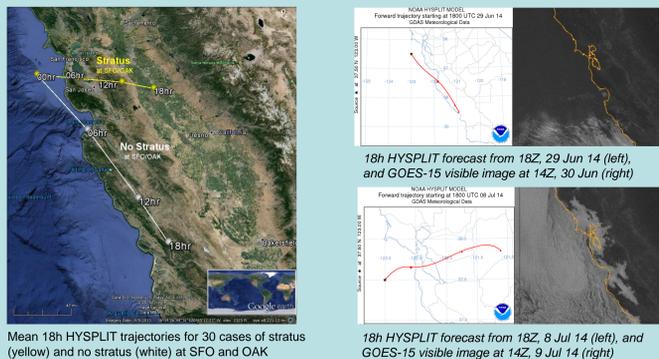
3. Coast of California

In California coastal stratus events, NAM HYSPLIT trajectories showed strong north to northwest flow, with paths that intersected the coast line, sometimes with pronounced curvature into coastal bays such as San Francisco and Monterey. In Southern California, cyclonic eddies with relatively weak flow were observed in the Los Angeles bight during significant onshore stratus and fog events. In some instances, it was possible to differentiate which sections of coast line would be affected by stratus the following morning versus those which were not affected. Days with no fog showed predominately offshore trajectories as when Santa Ana winds occur.

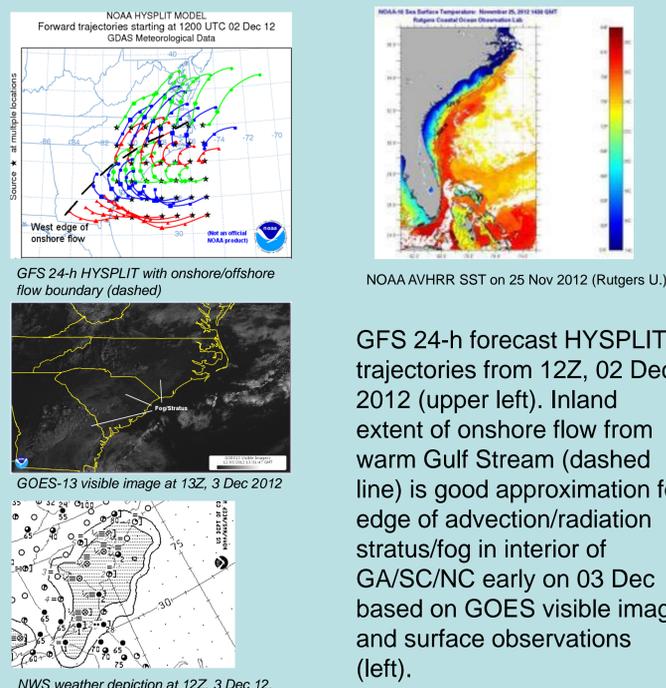


4. Local Aviation Application: San Francisco Bay Stratus

SFO airport is among those with the highest average flight delays in the U. S., due to frequent summer stratus and closely spaced, parallel runways. 18h HYSPLIT forecasts using GFS model data were run for 30 cases of both stratus and no-stratus at 1200 UTC in May-Sep of 2013-14, from a point west of SFO (37.5N -123w). Mean values below show onshore flow for stratus days, and stronger along-shore flow on cloud-free days. Thus, HYSPLIT may help with afternoon forecasts of stratus at SFO/OAK for the following morning.

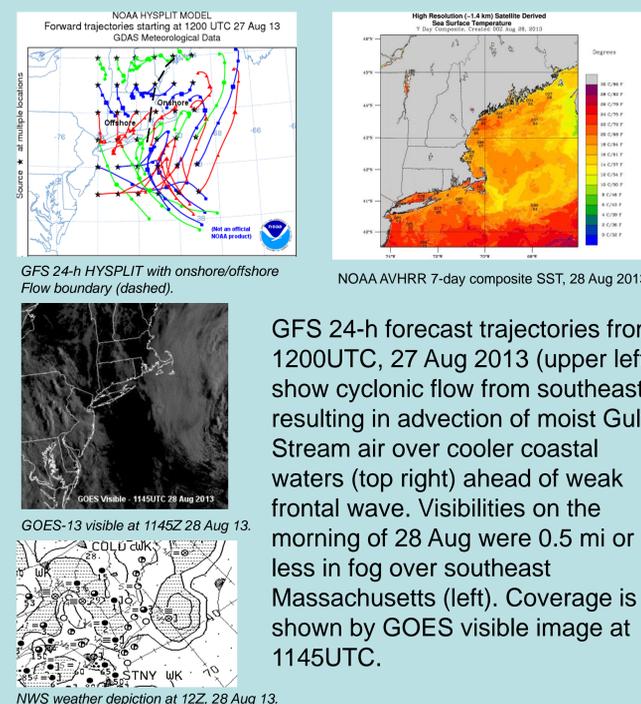


5. South Atlantic Coast



GFS 24-h forecast HYSPLIT trajectories from 12Z, 02 Dec 2012 (upper left). Inland extent of onshore flow from warm Gulf Stream (dashed line) is good approximation for edge of advection/radiation stratus/fog in interior of GA/SC/NC early on 03 Dec based on GOES visible image and surface observations (left).

6. New England



GFS 24-h forecast trajectories from 1200UTC, 27 Aug 2013 (upper left) show cyclonic flow from southeast, resulting in advection of moist Gulf Stream air over cooler coastal waters (top right) ahead of weak frontal wave. Visibilities on the morning of 28 Aug were 0.5 mi or less in fog over southeast Massachusetts (left). Coverage is shown by GOES visible image at 1145UTC.

7. Preliminary Findings

HYSPLIT forecast trajectories can help the forecaster visualize the paths of boundary layer air parcels up to 24h in advance of possible coastal advection stratus and fog episodes. In some cases, analysis of HYSPLIT trajectories can shed light on where the boundaries between low ceilings/visibilities and cloud free areas will be located. In the San Francisco Bay area, mean 18h trajectories show promise in predicting stratus for the following morning at SFO or OAK.

8. Reference

Draxler, R.R., and G.D. Hess, 1998: An overview of the HYSPLIT_4 modeling system of trajectories, dispersion, and deposition. *Aust. Meteor. Mag.*, **47**, 295-308. (Available at: <http://www.arl.noaa.gov/documents/reports/MetMag.pdf>)

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