NWS HYSPLIT atmospheric transport and dispersion modeling

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Understanding and predicting atmospheric transport and dispersion is essential for protecting the health and welfare of the public and emergency response personnel when harmful substances are released into the air in significant quantities. The Federal National Response Framework, approved by the President in January, 2008, assigns NOAA atmospheric transport and dispersion (ATD) prediction responsibilities for smoke and radioactive and hazardous materials, maintenance and development of Hybrid Split Puff Langrangian Integrated Trajectory Model (HYSPLIT), and coordination with the World Meteorological Organization on international incidents. The Air Resources Laboratory (ARL) develops many of NOAA's capabilities for these services.

The need for ATD or "plume" understanding and tools is continually evolving, driven by demands for more accurate predictions, estimates of uncertainties, finer spatial resolution, easier-to-use tools, and tools to address evolving risks. For instance, in 2008 the U.S. Government Accounting Office (GAO)[1] recommended that the Secretary of Homeland Security "work with the federal plume modeling community to accelerate research and development to address plume model deficiencies in urban areas and improve federal modeling and assessment capabilities. Such efforts should include improvements to meteorological information, plume models, and data sets to evaluate plume models." NCEP works with ARL's research and development (R&D) to addresses each of these areas with the HYSPLIT dispersion modeling system.

Currently, the HYSPLIT system is used to provide the following Operational atmospheric dispersion products:

- 48-hour wild-fire smoke forecasts from the daily 06 UTC cycle for CONUS, Alaska, Hawaii driven by the 12 km North American Model (NAM).
- 48-hour dust forecasts from 06 and 12 UTC cycles for CONUS
- 48-hour volcanic ash forecasts whenever requested by the International Civil Aviation Organization (ICAO)-designated U.S Volcanic Ash Advisory Centers (Washington, DC and Anchorage, Alaska). This is typically driven by NOAA Global Forecast System (GFS), although other model output can be used.
- 72-hour radiological emergency response plume forecast when requested per the World Meteorological Organization (WMO)-designated Regional Specialize Meteorological Center (RSMC) arrangements (IAEA or other country's National Meteorological Services; NMS). This is typically driven by GFS, although other model output can be used.
- 16-hour dispersion forecast for HAZMAT-type (chemical spill, explosion, etc.) incident upon the request of a WFO, almost always driven by 12-km North American Model (NAM), though other model output can be used.
- 16-hour dispersion forecasts for HAZMAT-type incidents, driven by NAM 12 km, for about 25 locations are run four times a day to support U.S. National Weather Service (NWS) Weather Forecast Office (WFO ; "canned" runs).
- 48-hour back-tracking product when requested per the WMO/RSMC arrangements. This is typically driven by GFS, although NAM can be used.

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[1]GAO, 2008. First Responders' Ability to Detect and Model Hazardous Releases in Urban Areas is Significantly Limited. GAO-08-180 Homeland Security.

- HYSPLIT-formatted meteorology files are created for input to the above dispersion applications.
  - GFS (1 degree, pressure-level), GDAS(Global Data Assimilation System; 1 degree, pressure-level), NAM (hybrid-level: CONUS, Alaska, Hawaii nest, fire weather nest CONUS nest; and pressure-level: CONUS), and RAP (Rapid Refresh model; 20 km, pressure-level)
- HYSPLIT-formatted meteorology files are disseminated to ftpprd.ncep.noaa.gov, where they are
  - Automatically retrieved by the NWS Weather Operations Center (WOC) to operationally support the web-based HYSPLIT interface for NWS WFO (https://www.hysplit.noaa.gov)
  - Automatically retrieved by NOAA/ARL to support
    - a test of HYSPLIT trajectories-by-email for the NWS Fire Weather program, and
    - customers on the ARL Real-time Emergency Access and Display sYstem (READY) website (http://ready.arl.noaa.gov/).

For all applications, dispersion is simulated using either the multi- or single-processor version of the same code. The smoke and dust forecast guidance is sent in gridded form to the NOAA/MDL National Display and Graphics System (NDGD) for distribution to forecasters and emergency managers at the individual state level.

The RSMC predictions are initiated by the NCEP/SDM (Senior Duty Meteorologist) and distributed to National Forecast Centers via fax. Digital and graphical products are also shared between other country RSMCs through a protected ARL (non-operational) web page. Monthly exercises are performed by the SDM with other RSMCs.

The volcanic ash predictions are initiated by the NCEP, NESDIS/SAB (Synoptic Analysis Branch), or NWS AAWU (Alaska Aviation Weather Unit) and distributed via WAFS and made available over the Internet operationally at the AWC and non-operationally at ARL and SAB.

The HAZMAT-type output is made available on a secure NCEP server (https://hysplit.ncep.noaa.gov/).
The NCEP AWC is able to initiate a HAZMAT-type.

Recently, HYSPLIT was improved to meet the NCEP requirements for volcanic ash product dissemination, and meet NOAA requirements for back-tracking support to the Comprehensive Test Ban Treaty Organization (CTBTO). Improvements were accomplished mainly by upgrading the wet deposition scheme for radiological materials and volcanic ash.