Air Resources Laboratory

AEGL-3   > 180 ppm
AEGL-2   > 46 ppm
AEGL-1   > 1.5 ppm

Maximum: 8627 ppm
Minimum: 0.002 ppm

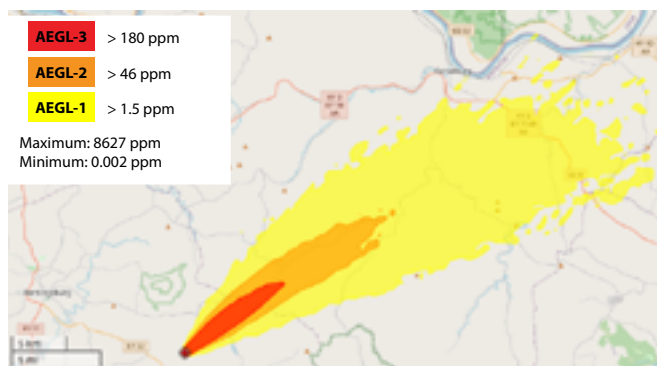*HYSPLIT models simulate the dispersion and trajectory of substances transported and dispersed through our atmosphere, over local to global scales.*

NOAA's Air Resources Laboratory's (ARL) Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) is a state-of-the-art analytical tool developed by ARL to produce operational and research-grade atmospheric transport and dispersion products. With continued development and enhancements over the past 30 years, HYSPLIT remains one of the most widely used models for atmospheric trajectory and dispersion calculations. HYSPLIT's applications range from simple allergens and common pollutants, to flight planning or emergency response to hazardous chemical or smoke plumes, providing invaluable assistance to emergency planners and first responders charged with protecting life and property and mitigating environmental damage.

HYSPLIT is available to all users for free and is publicly available via ARL's Real-time Environmental Applications and Display sYstem (READY) web server (https://www.ready.noaa.gov). Users worldwide access and display meteorological data and create trajectory and dispersion model products for activities such as student experiments, research, and climatological studies. NOAA's National Weather Service (NWS) is the primary operational user of HYSPLIT, and the model is accessible 24x7x365 via dedicated servers. NWS's nationwide network of 120+ Weather Forecast Offices (WFOs) use HYSPLIT's dispersion and trajectory guidance products on a daily basis to aid decision making in their local communities.

Decades of national and international collaboration have strengthened the model's capabilities through regular, ongoing, interaction within the scientific community. Developers participate in the exchange of ideas and differing perspectives and operational objectives continually inform HYSPLIT enhancements.

Emergency management partners in major cities frequently utilize contingency plume forecasts from HYSPLIT to prepare for large public events. HYSPLIT runs are created at regular intervals and maintained in the event that something occurs, enabling critical decisions to begin at a moment's notice. Immediately knowing where to look can significantly improve response time, which can make a critical difference in lives saved. Scenarios where HYSPLIT models inform a change to improve public and environmental health or mitigate bad outcomes are numerous. During incidents such as industrial accidents and wildfires, HYSPLIT informs local managers whether evacuations or stay- at- home orders may be necessary.

Non-traditional uses of HYSPLIT are evolving and can be rapidly deployed. Tracking the transport of air masses from the Gulf of Mexico into the U.S. has been used to model moisture and possible flooding. In 2020 the ARL team rapidly developed a tool to model the transport of locust swarms, which devastate crops in Africa. As new opportunities and scenarios arise, ARL's scientists will continue to develop HYSPLIT enhancements that serve public health and safety as well as economic and ecological concerns.

Range of HYSPLIT Use Cases and Estimated Economic Impact

Industrial Accidents, Toxic Emissions.

Industrial releases comprise roughly a quarter of all recorded events in HYSPLIT 2020 simulations. HYSPLIT usage on industrial events nearly doubled between 2018 and 2019. Incident modeling prevented the inhalation of chlorine, ammonia, and a variety of other toxic substances. For the 2018 Husky fire in Wisconsin, avoided health costs were conservatively estimated at $1.5 million for the group of health end-points examined. It is estimated that 750 people were spared exposure to levels of fine particulate matter above 250 ug/m3, a threshold where serious injury, including heart attack and death, can occur. In this study, it is unknown how many actual deaths or serious injuries were avoided through the use of HYSPLIT.

Wildfires and Prescribed Burns

HYSPLIT is used to plan prescribed burns and daily forecasts of wildfire smoke throughout the U.S. HYSPLIT is also the basis for a fire emission inverse modeling system that can improve smoke forecasting over North America by combining model estimates with satellite observations. Public economic studies correlate low air quality and smoke to well-being and life satisfaction, with a disproportionate effect on rural resident life satisfaction, which can also be estimated in terms of economic value.

Nuclear Nonproliferation

ARL is designated as a World Meteorological Organization Regional Specialized Meteorological Center, and works along with the US Depts. of Energy, State, and Defense to characterize the atmosphere and provide backtracking, or source, information for non-proliferation field experiments. ARL is tasked by the Comprehensive Test Ban Treaty Organization to ensure compliance with Nuclear Test Treaties.

Further technical information is available: Stein A F, Draxler R R, Rolph G D, Stunder BJB, Cohen M D, Ngan F, 2015. NOAA's HYSPLIT atmospheric transport and dispersion modeling system. Bulletin of the American Meteorological Society, 96(12): 2059–2077.
https://doi.org/10.1175/BAMS-D-14-00110.1

Volcanic Ash

HYSPLIT is also used to forecast downwind concentrations of ash after volcanic eruptions; these forecasts alert civil aviation authorities so that aircraft can avoid dangerous ash levels. Aircraft engines can be catastrophically damaged due to volcanic ash, causing crashes; the value of avoiding ash encounters is extraordinarily high. Estimates of the impact of volcanic ash on the commercial air transport industry are $70 million annually.

National and Special Events

HYSPLIT simulations are used by emergency management agencies to plan for many events of national significance, including major parades, the Presidential Inauguration, the Super Bowl and other national sporting events, NASA planetary launches and the Albuquerque Balloon festival, among others.

Global Impact and Research

HYSPLIT versatility has been demonstrated. It was rapidly adapted in 2020 for use by the United Nations to predict devastating Locust swarms in Africa. In its first year of operation, the Locust Forecasting tool saw over 5,000 runs. As a research tool, HYSPLIT atmospheric transport models are accepted globally for a policy-relevant analysis by governmental, non-governmental, and academic researchers.

Regulatory Compliance

HYSPLIT is one of the EPA's mandated models to determine state level compliance on Ozone emissions. In one case study, the state of Maine used HYSPLIT data to indicate that the source of ozone in southern Maine did not originate in Maine, but that ozone was instead transported to southern Maine from neighboring states. Based on HYSPLIT data, the Governor of Maine formally requested that the EPA remove a majority of Maine from the Ozone Transport Region, which would reduce annual compliance costs on Maine industry, estimated at $2.3 - $5.5 million per year.