Earth System Research Laboratory
Global Systems Division
Modeling

Weather and Climate Modeling for the Future

What does ESRL's Global Systems Division Modeling Work do for the Nation?

NOAA's Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL) provides the National Weather Service (NWS) and the nation with environmental observing, prediction, computer, visualization, and information systems. These systems deliver forecasts and predictions of weather, including severe weather events, within the next few minutes to weeks away.

www.esrl.noaa.gov/gsd/

Modeling Research Highlights

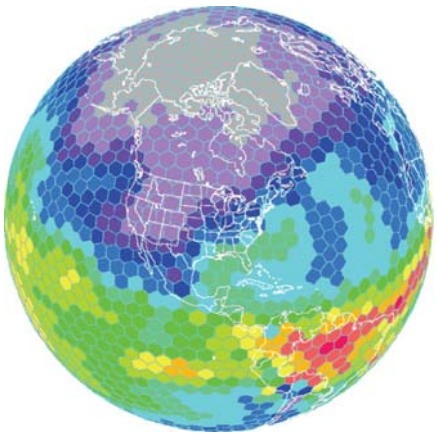
Global-Scale Modeling

The FIM (Flow-Following Finite-Volume Icosahedral Model) uses a unique 20-sided mesh grid to model the motion of large weather systems around the world.

NOAA's National Hurricane Center uses the FIM during hurricane season and found it useful to help predict Superstorm Sandy's track and strength at landfall. GSD has tested the FIM with data from past hurricane seasons and the forecast hurricane tracks were accurate.

GSD is working on the next new global model, the NIM (Non-Hydrostatic Icosahedral Model). The NIM uses the same unique grid as the FIM, plus advanced equations and computing, to make faster, more specific forecasts over the globe.

The NIM is designed to improve tropical cloud predictions, a major source of uncertainty in extended weather predictions.



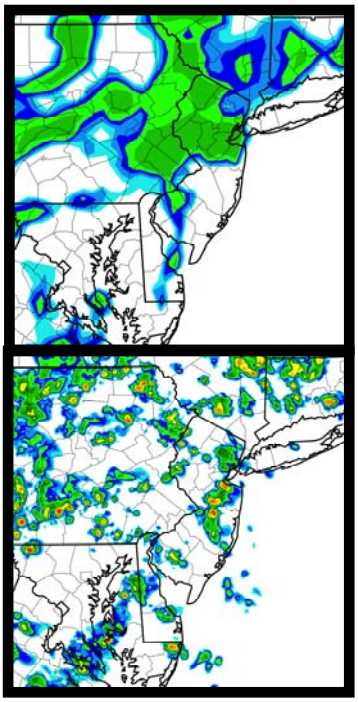
ESRL/GSD has successfully led development of the FIM, with the new and unique grid, that is now being tested for future use.

Regional-Scale Modeling

The Rapid Refresh (RAP) is NOAA's hourly updating model system that ingests data and produces predictions of weather for North America on a 13km grid. The RAP is designed for decision makers who need frequently updated forecasts of high-impact weather, including those in the aviation, energy, and severe weather forecasting communities. The RAP is used by many government groups and continues to be updated by GSD.

The High-Resolution Rapid Refresh (HRRR) model provides forecast guidance with even more detail, with the ability to specifically predict thunderstorms on an hourly updated 3km grid. Like the RAP, the HRRR uses weather observations from a network of ground and satellite-based sensors, radar, and aircraft. The HRRR is the only hourly updated, radar-initialized, storm-resolving model run over the US. The HRRR was transferred to NWS operations in September 2014 and provides 0-15h situational awareness guidance for many public and private entities. GSD leads development of the HRRR in partnership with other laboratories.

Both the HRRR and RAP are required by NOAA to meet the wide range of needs for the entire U.S. Further research and development on both HRRR and RAP is ongoing.



Rapid Refresh (RAP, top) model output at 8 mile (13-km) resolution and the High-Resolution Rapid Refresh (HRRR, bottom) model output at 2 mile (3-km) resolution. Shown are 6 hour forecasts of thunderstorms, with the more detailed HRRR forecast enabling better airline flight planning around weather-related hazards.

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Weather and Air Chemistry Modeling

The WRF-Chem is a next-generation model that couples weather and air chemistry into the existing Weather Research and Forecast (WRF) model. WRF-Chem is being used internationally to study how chemicals in the atmosphere are affecting global change processes, and also predict particles (e.g. pollution), dispersion, and air quality.

Coupled Ocean – Atmosphere Models

GSD is pursuing research in coupled atmosphere and ocean prediction systems. The main vehicle for this work is a global model combining the atmospheric FIM (see first page) and a grid version of the ocean model HYCOM (HYbrid Coordinate Ocean Model). The goal of this model is to improve skill in monthly to seasonal predictions that can provide information on long-term global circulation anomalies. Emphasis will be on weather events of potentially high impact, such as frequency and spatial clustering of tropical storms, El Niño, seasonal droughts, flooding, and atmospheric blocking.

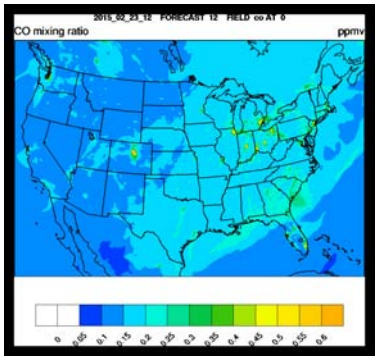
Local Models

GSD's Local Analysis and Prediction System (LAPS) is an efficient, portable, and adjustable model that blends a wide variety of global, national, and local weather data. LAPS provides customized analysis and forecast output with fine details and frequent updates of near-term weather conditions, helping citizens prepare for high-impact weather events. LAPS is used as a real-time situational awareness tool for local emergency managers to assist with short-term weather prediction. Other clients and collaborators include federal and state agencies, universities, the private sector, and international agencies.

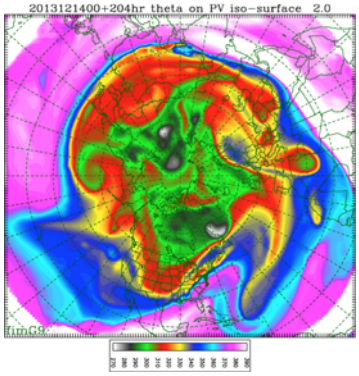
High-Impact Weather Prediction Project (HIWPP [High-Whip])

The HIWPP project will make U.S. weather modeling competitive with weather models worldwide by predicting high-impact weather one to two weeks in advance. Current HIWPP research includes:

- Testing current- and next-generation global models at higher resolution than have ever been run in an operational model (10 to 13 km).
- Releasing the latest version of the advanced visualization tool NEIS (NOAA Earth Information System) to view large volumes of data in a high-resolution interactive display.
- Verifying model performance for extreme precipitation events.
- Adapt models to use high-performance computing resources such as massively parallel, fine grain, GPU-based computers.



WRF-Chem 12-hour forecast of carbon monoxide mixing ratio (ppmv) over the continental U.S.



Coupled Model Display - Potential temperature on a upper atmosphere-level potential vorticity surface in a FIM forecast.

Cylindrical Panoramic View: top - re-projected LAPS analysis simulation, bottom - all-sky camera image

Screen from NEIS advanced visualization tool developed in HIWPP

For more information on the Global Systems Division, visit http://esrl.noaa.gov/gsd/

March 2015