Earth System Research Laboratory / Global Systems Division

325 Broadway – R/GSD, Boulder, CO 80305 / 303-497-6818
http://www.esrl.noaa.gov/gsd

Vision Statement:
*"*Making forecasts better*"*

Mission Statement:
The Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL) conducts world-class applied research and directed development resulting in technology transfer of environmental data, models, products, and services that enhance environmental understanding with the outcome of supporting commerce, supporting NWS in protecting life and property, and promoting a scientifically literate public.

Core Competencies:
- Local-to-global weather prediction models with advanced data assimilation on time scales from hours to sub-seasonal
- Advanced computing systems and architectures to handle the enormous computational demands of environmental models
- Environmental information systems to support commerce, transportation, weather forecast decisions for emergency management, the public, and other societal needs
- Assessments of the value of new observations and observing systems for improving forecasts
- Education and outreach using tools such as Science-on-a-Sphere

Statutory Authority and/or Charge Under NOAA Strategic Plan:
GSD is aligned under Weather Research and Forecasting Innovation Act of 2017 (Pub.L 115-25, H.R. 353), NOAA's Weather Ready Nation goal, and the NOAA Ocean and Atmospheric Science Education Program (33 USC 893a). GSD's research specifically addresses the objectives to:
- Reduce loss of life, property, and disruption from high-impact events
- Improve transportation efficiency and safety
- Improve freshwater resource management
- Create a more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy
- Healthy people and communities due to improved air and water quality services
- Improve public literacy in Science, Technology, Engineering, and Math (STEM)

Science Themes and Research Areas:
Perform research and development of regional and global Numerical Weather Prediction (NWP) models and data assimilation techniques for research applications and operational forecasting using convection allowing models including the FV3 dynamic core. Perform evaluations of existing and new observations and assimilate new data into weather prediction models.

Develop environmental information systems with tools for collecting, processing, displaying, sharing, and disseminating environmental data for use by forecasters, analysts, and researchers.

Develop decision-support systems to provide information needed to enable decision makers to utilize and improve high-impact weather and water forecasts, in order to mitigate aviation hazards, recognize and advise public on potential adverse health impacts due to air quality, support the renewable energy industry, and reduce loss of life and property. Integrate social science into the development process.

Explore new hardware and software technologies to run high-resolution weather models more quickly and accurately on High-Performance Computing systems (HPC). Research includes working with modelers during development to ensure that software is designed to take advantage of the latest developments in HPC system architectures.

Products and Results:
Among the list of technologies (e.g., numerical weather models, numerical modeling algorithms, high-performance computing system tools, information systems, observing systems) transferred from GSD to operations or applications in NOAA, other agencies, and the private sector, are:

1) Modeling
   - Regional Rapid Refresh (RAP) and High-Resolution Rapid Refresh (HRRR) models
   - Global models
   - Physics schemes (convection, (Grell-Freitas), boundary layer, land surface)
   - Data assimilation – radar, satellite, surface, and other observations into forecast models
2) Forecasting tools
   - Critical hardware, software, and science innovations for the Advanced Weather Information Processing System (AWIPS)
   - Meteorological Assimilation Data Ingest System (MADIS)
3) Science Education
   - Science on a Sphere®
   - Science on a Sphere Explorer™
4) Weather forecasts for renewable energy
   - Turbine-height wind forecasts
   - Solar radiance forecasts

Customers:
GSD's primary customer is the NOAA NWS. Modeling and data assimilation work is a collaborative effort with NCEP (including EMC, SPC, and WPC) and other laboratories toward delivery of operational forecast model improvements and next-generation models that support both operational forecasting and research applications. Information systems work includes design and development of systems and components that allow weather forecasters to display and interpret meteorological information and enable collaboration among Weather Forecast Offices.

GSD has a long-standing collaborative research and development relationship with the FAA to achieve improved weather forecasting, verification, and visualization capabilities for the broad aviation community.

Other customers include other NOAA laboratories (notably NSSL and ARL), DHS, USDA, DOI, DOD, NASA, DOE, non-profit organizations, educational institutions, private sector, and international government agencies (e.g., Taiwan).

Future Directions:
During the next five to ten years, GSD will continue to support NOAA in the following areas:

- Develop modeling and data assimilation techniques, decision support systems, and environmental information systems to improve the short to mid-range high impact weather forecasting necessary for heavy precipitation events, air quality forecasting, fire weather prediction, aviation operations, and severe weather watches and warnings
- Support NOAA's Warning on Forecast Program and the Forecasting a Continuum of Environmental Threats (FACETs) paradigm and include social science into our development efforts
- Coordinate, support, and help lead NOAA's implementation of the FV3-based Unified Forecast System
- Develop global and regional coupled Earth system models needed for global chemical transport and regional sub-seasonal to seasonal simulations
- Support NOAA in high-performance computing through new computing technology and improved software engineering practices aimed at improving the efficiency of supercomputer utilization to accommodate more complex models
- Test meteorological observing systems and their impact on improving forecasts
- Anticipate and respond to customer needs in an ever-changing technological world through new program development, collaborations, and enhanced environmental science education
- Provide environmental information and the most accurate forecasts that include uncertainty and probabilities for optimal understanding and decision-making.