JPDO Weather IPT: Forecasting Sub-Team

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Agenda

- Emphasis and Priorities
- Progress
- Plans
- Summary

Emphasis and Priorities

- The science, technology, and techniques of forecasting:
  - Numerical weather prediction models
  - Statistical forecasting systems
  - Automated intelligent forecasting systems
  - Human forecaster involvement
  - Production of comprehensive, authoritative, gridded and point product aviation weather information

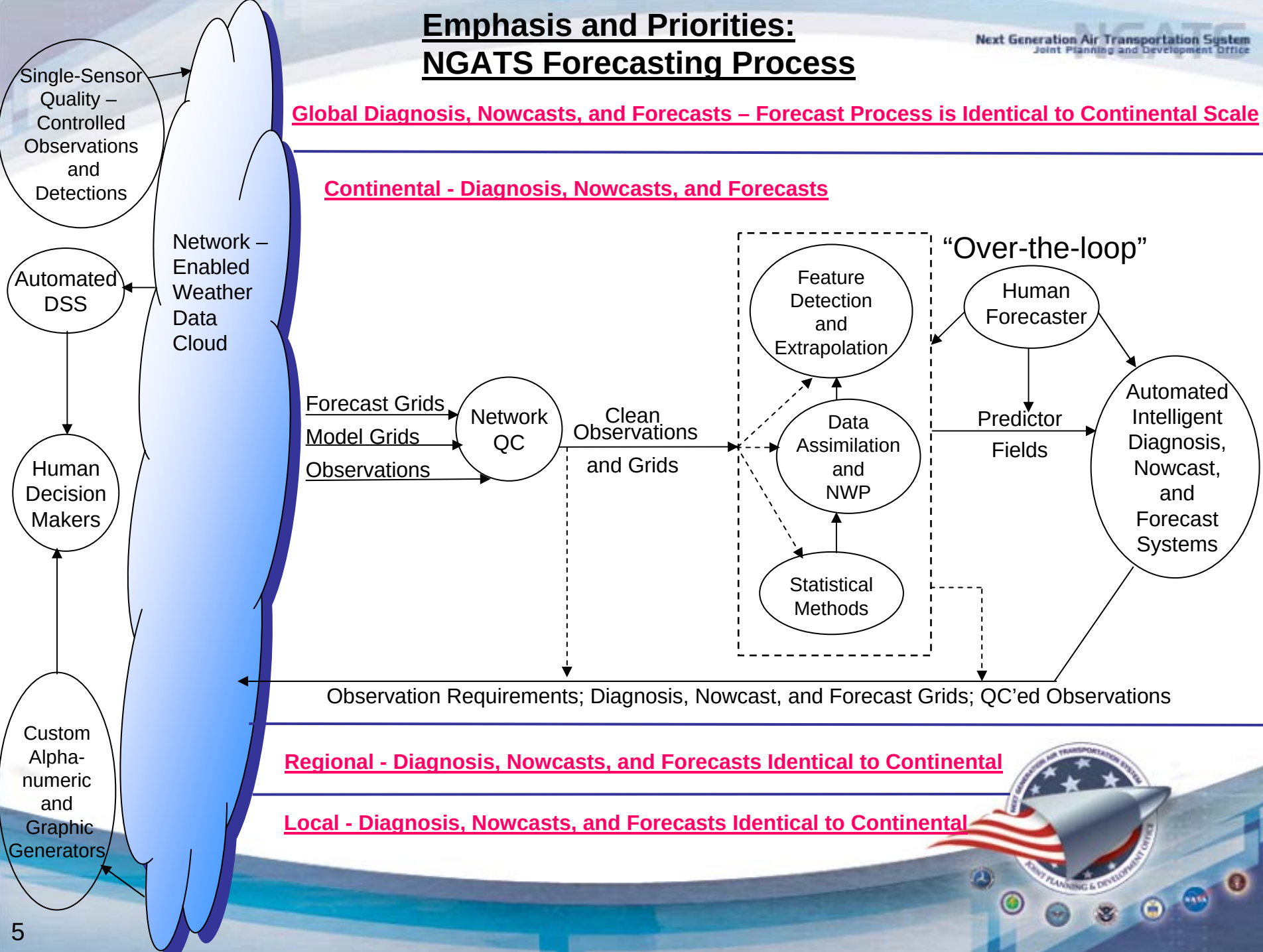
Emphasis and Priorities: Objectives

- Produce timely and accurate aviation weather forecasts.
- Maximize probability of detection, minimize false alarms, and maximize reliability of probabilistic forecasts.
- Extend the accurate forecast period.
- Provide forecasts with the flexibility to be customized to meet varied user needs.
- Produce timely, accurate, tactical forecasts of severe weather, including unanticipated changes.
- Provide forecast weather information to support homeland security and national defense objectives.

Emphasis and Priorities: NGATS Forecasting Process

Global Diagnosis, Nowcasts, and Forecasts – Forecast Process is Identical to Continental Scale

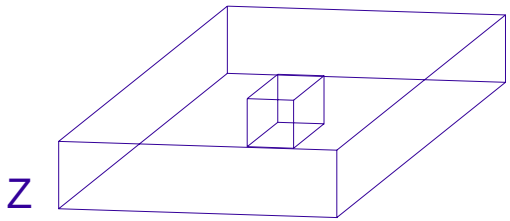
Continental - Diagnosis, Nowcasts, and Forecasts



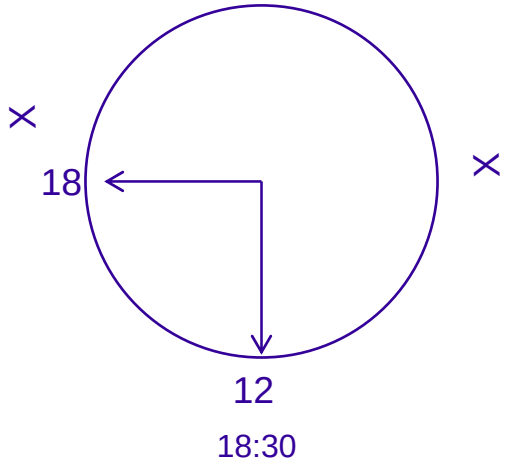
Regional - Diagnosis, Nowcasts, and Forecasts Identical to Continental

Local - Diagnosis, Nowcasts, and Forecasts Identical to Continental

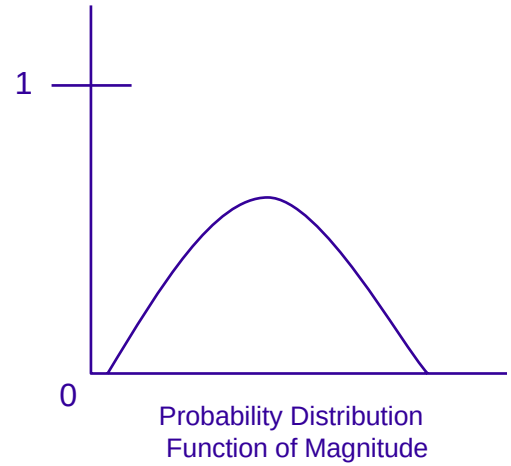
Emphasis and Priorities: 4–D Weather -- Official Product of the Future



- •Convection
- •Turbulence
- •Icing
- •Snowfall
- •Ceiling
- •Visibility
- •Radiation from Space



- •Wind Speed
- •Wind Direction
- •Temperature
- •Humidity
- •Noise Propagation Potential
- •Airport Plume Concentration
- •Atmospheric Sensitivity to Exhaust



- •Volcanic Ash Concentration
- •Wake/Vortex Dissipation Potential
- •
- •
- •
- •
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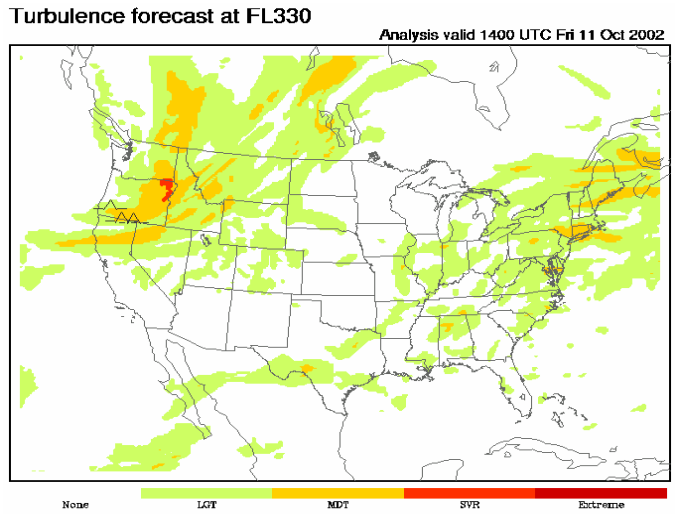
Progress:
Define Current Capability

- Current Capability
  - Limited Operational Production of 4D Gridded Information for CONUS and Alaska Domain Weather Elements Critical to Aviation
    - Defined as a SECONDARY Product for NAS Decision Making
    - Accuracy Equivalent or Better than Legacy Human-Generated Products

Progress: Define Major Work Areas for the Forecasting Sub-team

- *Convective Weather*
- *Turbulence*
- *In-Flight Icing*
- *Winter Weather (Ground Deicing)*
- *Ceiling and Visibility*
- *Space Weather*
- *Volcanic Ash*
- *Noise*
- *Airborne Hazards and Pollution*
- *Effects of Aircraft Exhaust on the Atmosphere*
- *Wake Vortices*
- *Numerical Weather Prediction Models*
- *Verification*



Progress: Form Sub-team

- Current organizations represented:
  - FAA
  - NASA
  - NOAA
  - DoD
  - Lincoln Laboratory
  - NCAR
- Target, future additions:
  - DHS
  - Customer organizations (e.g. airlines, GA)
  - Universities
  - Private sector

Progress: Develop Program Approach

- Program Approach
  - Inventory existing Agency Weather Forecast Initiatives/Programs/Research
  - Assist in Cost and Trade Studies both Internal and External
  - Develop Research Roadmaps/Milestones
  - Align/Redirect/Terminate Existing Agency Weather Forecast Initiatives/Programs/Research
  - Initiate Required New Weather Forecast Activities
  - Re-structure Government Provided Aviation Related Weather Forecast Operations
  - Establish Performance Measures to Track Outcomes
  - Assist in Development of Government/Industry Milestones

Progress: Identify Assumptions

- Observational Thrust of the IPT will provide all necessary observational data and the Dissemination Thrust of the IPT will result in a mechanism for managing the 4-D grids produced by the forecasting system
- FAA/aviation industry decision support systems will be configured to use forecast grids
- 4-D grids become the government provided “Weather Product”; the private sector will develop tailored products using the grids
- The specific form and content of the 4-D grids will be determined in concert with the other thrust areas
- Resources will be available to develop, generate, and provide the grids. This includes resources required for hardware, software, telecommunications to support new functionality in grids (new dimensions and new grid types)

Progress: Identify Barriers and Risks

- Policy and Operations:
  - A barrier within the NWS will be the ability to change the existing forecast process that includes forecast tasks and responsibilities at WFO's, CWSU's, AWC and AAWU. With rapidly updated, high-resolution forecast grids, this forecast structure can not continue; so how will forecasters be utilized in the automated process of producing timely and consistent forecast grids?
  - Frequency of updates required to keep the grids current will need to be addressed from a regulatory standpoint.
  - In addition, flight standards will need to address a potential "tiered level of service" with the high resolution grids vice the legacy text type products that would be produced from the grids, but would most likely be of less resolution.

Progress: Identify Barriers and Risks

- Capturing human forecaster skill in automated forecasts without affecting timeliness/consistency.
- Defining an operationally useful probability forecast.
- Extending the accurate forecast period.
- Defining standard forecast grids with the flexibility to be customized to meet varied user needs.
- Seamless integration of unanticipated changes in tactical forecasts into strategic forecasts.
- Making proper connection to motivate weather forecasting requirements from homeland security and defense.

Progress: Identify Barriers and Risks

- Changing the roles of the forecaster
- Improving the metrics for assessing the meteorological skill of specific forecast system improvements
- Understanding the forecast system implications of:
  - New observation technology
  - New types of aviation weather forecasts
- Transitioning new forecast processes into the forecasting system

Progress: Performance Planning

- Performance will be assessed by measuring the baseline skill of current operational forecast products and measuring the skill improvement in each succeeding generation of new products. This ongoing activity will provide metrics of pure meteorological skill.
- A second metric of performance will be the improvement in operational measures as the generations of improved forecasting products are introduced. This will involve careful coordination between the Forecasting Thrust and the Integration Thrust.

Near-term Plans

- **Develop accurate 4 dimensional (4-D) weather information critical to aviation**
  - **Includes probabilistic attributes**
  - **High resolution space and time**
- **Develop automated tools to generate traditional products from the 4-D grids**

Near-term Plans

- **For each gridded product, couple human forecaster with power of automated forecast process**
  - **Develop technically and scientifically feasible methods to couple human forecaster "over the loop"**
  - **Investigate and determine where forecaster adds value**
  - **Develop appropriate verification process to assess value of forecaster involvement**
- **Demonstrate forecast process to meet accuracy, timeliness and consistency requirements**
  - ***Accuracy, Consistency, Timeliness Requirements;* One Must Not Be Negatively Impacted when Addressing Others**

Near-term Plans

- **Short-term (0-2 Hour) Convective Forecasts**
  - **Couple power of automation with forecaster-provided boundary conditions to improve forecasts**
  - **"Proof of Concept" for forecaster "over-the-loop"**
  - **Verify performance against NCWF, RCWF, ITWS, CIWS**
  - **Benefits:**
    - **Potential alignment/termination of multiple products**
    - **Improved skill**

Near-term Plans

- **Strategic-term (2-6 Hour) Convective Forecasts**
  - **Data fusion expert system to blend improved model output, observations, climatology and forecaster input into a CCFP and Convective SIGMET replacement**
  - **Verify performance against CCFP and Convective SIGMET**
  - **Quantify performance with and without forecaster input**
  - **Benefits:**
    - **Potential alignment/termination of multiple products**
    - **Improved skill**

Near-term Plans

- **Develop and operationally demonstrate a suite of detection, nowcast, and forecast products to the cockpit via electronic flight bag technology**. Products would include turbulence, icing, convection, and ceiling/visibility; and would utilize fully automated diagnosis and nowcast techniques along with a test of human-over-the-loop skill improvement.
- **Develop and operationally demonstrate a suite of detection, nowcast, and forecast products to the cockpit via collaboration with the G/A avionics community**. Coordinate demonstration with AOPA and NBAA. These products would include turbulence, icing, convection, and ceiling/visibility. They would include fully automated diagnosis and nowcast techniques along with a test of human-over-the-loop skill improvement.

Near-term Plans

- **Develop an automated process to test new releases of operational models with all operational algorithms** that depend on those models. The objective is to ensure that new model releases do not degrade automated forecasting algorithms.

- **Expand the domain of all gridded aviation weather products to full North American scale.** This includes expanding the underlying models to North American scale, then modifying and testing icing, turbulence, convection, ceiling/ visibility, and winter weather forecast algorithms on the new domain.

Near-term Plans

- **Develop an aviation ensemble using Rapid Refresh WRF** and test the performance on critical aviation forecasts including convection, icing, turbulence, winter weather, and ceiling/visibility. Test the skill in producing the probability-based forecast information required for integration into DSS.
- **Support comprehensive data gathering exercises using instrumented aircraft** -- flying through gridded forecasts. A combination of the TAMDAR fleet and the NASA GRC S-3 may be appropriate.

Near-term Plans

- **Improve ARTCC Weather Forecast Production Process**
  - Integrate FAA CWSU and NWS Organization/Standard System
    - Aligns Weather Operations/Strengthens Process
    - Potential significant savings with FTE's/WARP
    - Track Performance

Near-term Plans

- **Sync US Government (NWS and Military) Forecast Operations**
  - Aviation Weather Grids for the Globe
  - CONUS Forecast Operations
- **Space Weather Forecasting**
  - Establish lead with International Community (ICAO, IATA, WAFC)
  - Establish PDT (Identified Gap-New Initiative)

Mid-Term Plans

- Operational, probabilistic, 4-D weather elements move towards 100% reliable forecast
- New 4-D products introduced
- Vastly improved end-to-end forecast process (*Monitor and observe, assess, predict, and verify)*
  - ***NWS organized, equipped and trained to support new role of forecaster in digital era***

Long-term Plans

- **Year 2025 Desired Performance**
  - Operationally produce 4D weather information on global, continental, regional, and local scales all weather elements critical to aviation decision making
  - Provide reliable accuracy for each forecast element (Probabilistic Attribute Added)

Summary

- Enable forecasting support to broad range of possible NGATS "futures"
  - Actual evolution to target curb-to-curb concept likely will consider multiple alternate paths
  - Develop weather forecasting systems to support those alternatives
  - Transition from today's forecasting system to future system
- Provide forecasts that support common situational awareness
  - Intelligent fusion of data, models, and predictors into a single authoritative data base
  - Common understanding of the definitions and limitations of the forecast elements
- Enable integration of weather information into DSS
  - Develop reliable probabilistic forecasts
  - Develop generic forecast products that can be customized to meet the needs of service provider and customer systems
  - Develop new forecast products jointly with DSS community