Turbulence Forecast - Nowcast Technology

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Outline:

- Introduction
- Approach
- WBS Plan
- Results status
- Challenges & Concerns

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Introduction:

- Aviation safety aspects of turbulence forecasts
- Weather relationships to flight safety
- Evolving turbulence forecast tools / methods
- Turbulence phenomena & extreme gust magnitudes
- Development, application & implementation issues

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Safety Aspects:

- **Pre- and in-flight forecasts -**
  Increase awareness and attentiveness to cockpit and cabin procedures

- **Higher quality forecasts -**
  Reduce errors due to surprise and increase seatbelt compliance (explicit & implicit)

- **High-quality high-intensity forecasts -**
  Lead to avoidance via altitude and route deviations

- **High-quality "smooth" and “very light” forecasts -**
  Improve cabin service scheduling at times and implicitly condition frequent passengers to better seatbelt compliance

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Weather relationships to flight safety:

- **Structural design avoids premature loss of airframe**
- **Flight-worthy handling & controllability**
- **Effective sensors & information displays**
- **Weather hazard training: flight crews and systems staff**
- **Pre-flight briefing, traffic routing**
- **Real time weather observation, sensing & display**
- **Decisions to "buckle up," change altitude, speed or route**
- **Report observations/ experience to other traffic**

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Evolving turbulence forecast tools / methods:

- **Forecasts based on empirical patterns and predictor values**
- **High resolution, manual interpretation of sparse data**
- **A nowcast process augmented with forecaster judgement**

***Evolving to* machine interpretations from model grids**

- **Greater data density in time and space**
- **Capacity to process increasing numbers of predictors**
- ***From* Raobs & manual AIREPS *to* automated / integrated systems**
- **More frequent forecast model initialization & updates**
- **Automated PIREPS & customized nowcast displays**
- **Stochastic and deterministic decision aides**

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Turbulence phenomena & extreme gust magnitudes:

- **Very strong gusts with extremely rapid reversals**
  > 100 fps, 1 sec reverse, 5-10 sec bursts
- **Sudden surprise encounters**
- **Unexpected & undesirable systems responses**
- **Characterized by apparent non-stationarity**
- **Extreme gusts may belong to the forcing instability**

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Development, application & implementation issues:

- **Define physical and statistical nature of extreme gust processes**
- **Potential forecast skill vs. maximum gust intensity**
- **Predictor skill variations with synoptic pattern, profile & mechanism**
- **Effective application of skilled forecasts to air traffic**
- **"*Data Driven*" Safety Program requires highly relevant observations**

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Approach:

The WxAP Turbulence Forecast - Nowcast tasks in meteorology, observations, atmospheric dynamics and traffic management will;-

- **Compliment related development efforts by FAA & other agencies**
- **Define extreme gust characteristics critical to forecasting, detection, control and design**
- **Support WxAP flight research with turbulence forecasts & diagnostics**
- **Inter-agency collaboration on related development and applications**

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Aviation Safety Program

Plan Overview

FY00 FY01 FY02 FY03 FY04 FY05 FY06

Project forecast skill improvements
Clarify interagency roles

Fine-scale models reproduce gust structures & account for production model sub-grid variability

Gust input & meteorology Descriptions representing >80% of injury cases

Forecast skill leads to effective avoidance and /or seatbelt use in >90% of severe turbulence events