Gravity Wave Impact on Air Traffic

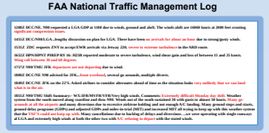
Observations on 25 January 2010 in the New York City Metropolitan Area

Richard F. Ferris, MIT Lincoln Laboratory, Lexington, MA

ATC Problem and Motivation

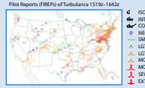
- Exceptionally strong vertical shear of horizontal winds from surface to cruise flight levels in northeast United States
- Severe turbulence and arrival compression into major New York City metro-area airports
- Excessive air traffic delays, flight cancellations, diversions, and airborne holding
- Severe weather event was under-forecast for FAA controllers and managers and led to a severe delay of aircraft into regions of suspected hazards
- Incorporate state-of-the-art weather information to improve air traffic safety, efficiency, and decision making

FAA National Traffic Management Log

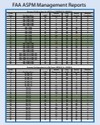


New York Airspace

Pilot Reports (PIREPs) of Turbulence 1519z–1642z

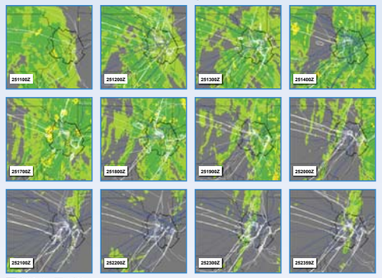


FAA ASPM Management Reports



FAA Ground Delay and Ground Stop Summary

Aircraft Trajectories

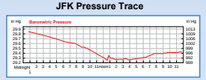


Weather Synopsis and Gravity Wave

- Complex low pressure system moved through the Northeast on 25 January 2010
- Pennsylvania, New Jersey, New York, and Connecticut were in warm sector and strong draw of southerly wind flow
- Intense but narrow prefrontal squall line formed suddenly ahead of main cold front
- Gravity or buoyancy wave – coincident with squall line – was detected in Doppler velocity field. Impacted EWR/TEB airports at 1717 UTC and LGA at 1741 UTC; overhead JFK airport at 1753 UTC
- Sudden shift in wind direction and increase in speed resulted in numerous wind shear and turbulence reports
- Wave propagated from west through east across most of New York TRACON airspace, impacting arrival and departure traffic for many hours

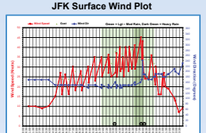
JFK Surface Observations

JFK Pressure Trace

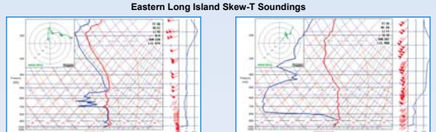


JFK Terminal Aerodrome Forecast

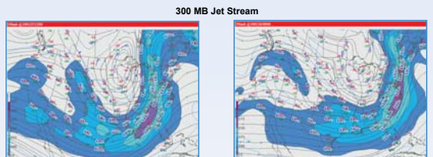
JFK Surface Wind Plot



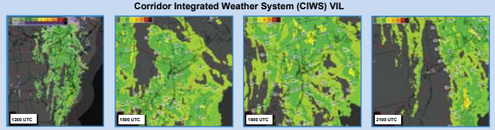
Eastern Long Island Skew-T Soundings



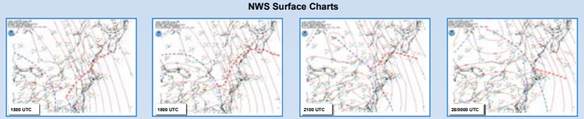
300 MB Jet Stream



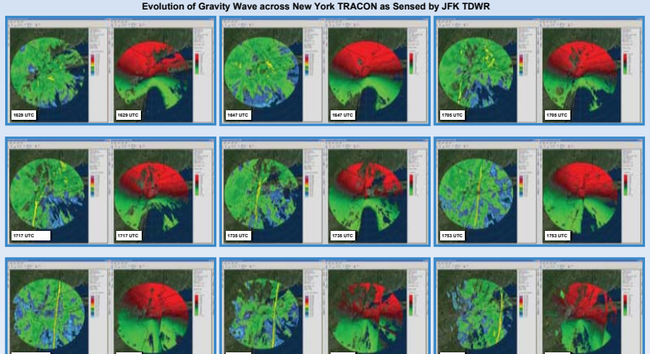
Corridor Integrated Weather System (CIWS) VIL



NWS Surface Charts

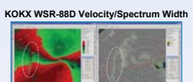


Evolution of Gravity Wave across New York TRACON as Sensed by JFK TDWR

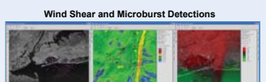


Gravity Wave Train

KOKX WSR-88D Velocity/Spectrum Width



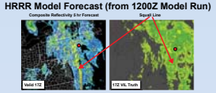
Wind Shear and Microburst Detections



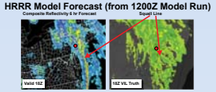
Numerical Model Forecasts and ATM Decision Support

- NOAA ESRL High-Resolution Rapid Refresh (HRRR) model accurately forecast prefrontal squall line 6 hours in advance
  - 3 km resolution; 0–15 hr forecast updated hourly
- FAA Consolidated Storm Prediction for Aviation (CoSPA) showed accurate 2–8 hr forecast location of north-south line, but intensity and extent off slightly
  - 3 km resolution interpolated to 1 km; 2–8 hr forecast updated every 15 min
- FAA Corridor Integrated Weather System (CIWS) verified, although VIL intensity was underestimated
  - 1 km resolution; 0–2 hr forecast updated every 5 min
- Extensive set of supplemental HRRR forecast output fields extremely valuable for real-time decision making and post-event analysis
  - Not currently incorporated into any operational forecast

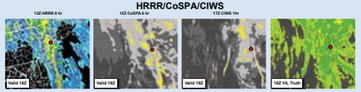
HRRR Model Forecast (from 1200Z Model Run)



HRRR Model Forecast (from 1200Z Model Run)



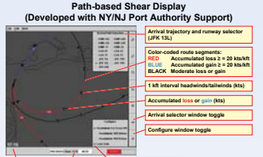
HRRR/CoSPA/CIWS



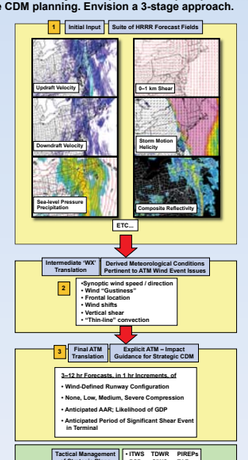
Translation of Wind Forecast into Path-based Shear Forecast

- Compression/expansion of arrival flows and aircraft encounters with hazardous turbulence significantly impact airport capacity
  - Computes headwind/tailwind along path of NY arrival corridors into airports
  - Indicates where, along path, significant gains or losses will be experienced
- Path-based Shear Display plots location of the arrival paths and highlights path segments where excessive gains and losses have been calculated
  - Excessive gains lead to compression of aircraft along arrival routes
  - Excessive losses lead to wider than desirable spacing between aircraft

Path-based Shear Display (Developed with NY/NJ Port Authority Support)



To optimize safety and minimize avoidable delay, wind forecasts must be surgical in predicting time, space, and severity of event and translated directly into explicit ATM impact predictions for objective CDM planning. Envision a 3-stage approach.



Future Work

- Identify other terminal synoptic wind events at New York airports and at other major airports, such as ORD, ATL, and BOS, and make a first order assessment of "avoidable" delay
- Assess capability of HRRR to forecast other significant terminal capacity impacts due to winds

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