



Probabilistic Wind Forecasts for WTMA-S

(Wake Turbulence Mitigation for Arrivals – System)

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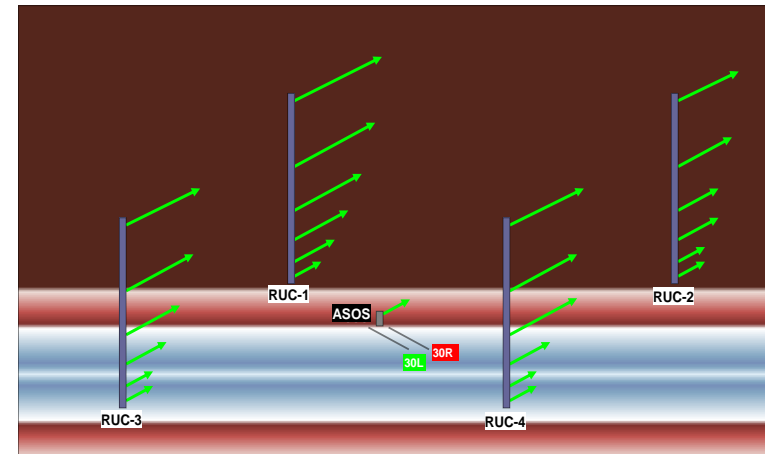
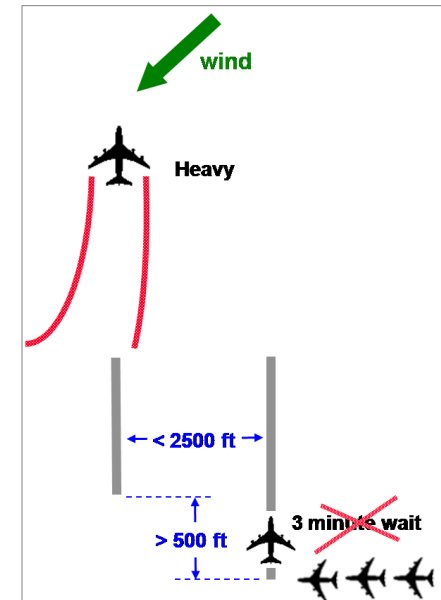
Outline

- **History of two-tier forecast (Nowcast, Outlook)**
- **New Probabilistic Outlook Concept**
- **Sample Concept Display**
- **Summary**



Review of Wind Forecast for WTMD

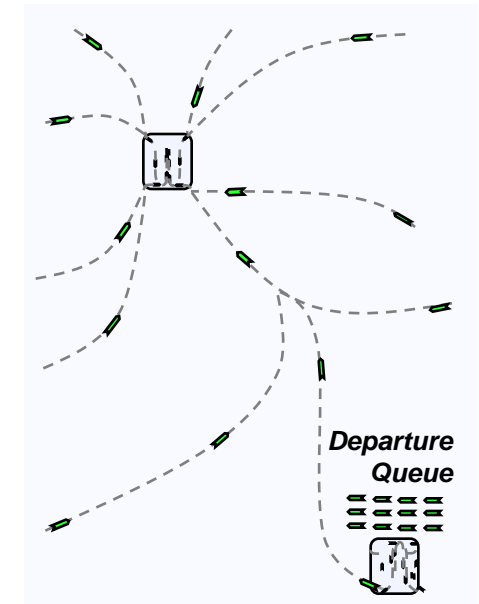
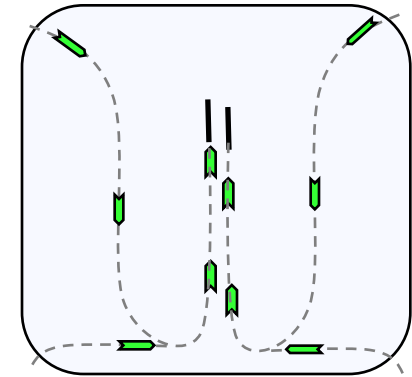
- Wind-dependent procedures for reduced separations on departure
- Wind forecast requirements
 - 20-minute wind forecast with *3-minute safety criticality*
 - Forecast from surface to 1000 feet
- Wind Forecast Algorithm: Predicts “Lower bound” crosswind separately for surface and aloft
 - Surface crosswind: Statistical forecast based on 1-minute 10m ASOS wind
 - Aloft : derived from RUC model profiles surrounding airport





WTMA-S Design Concept

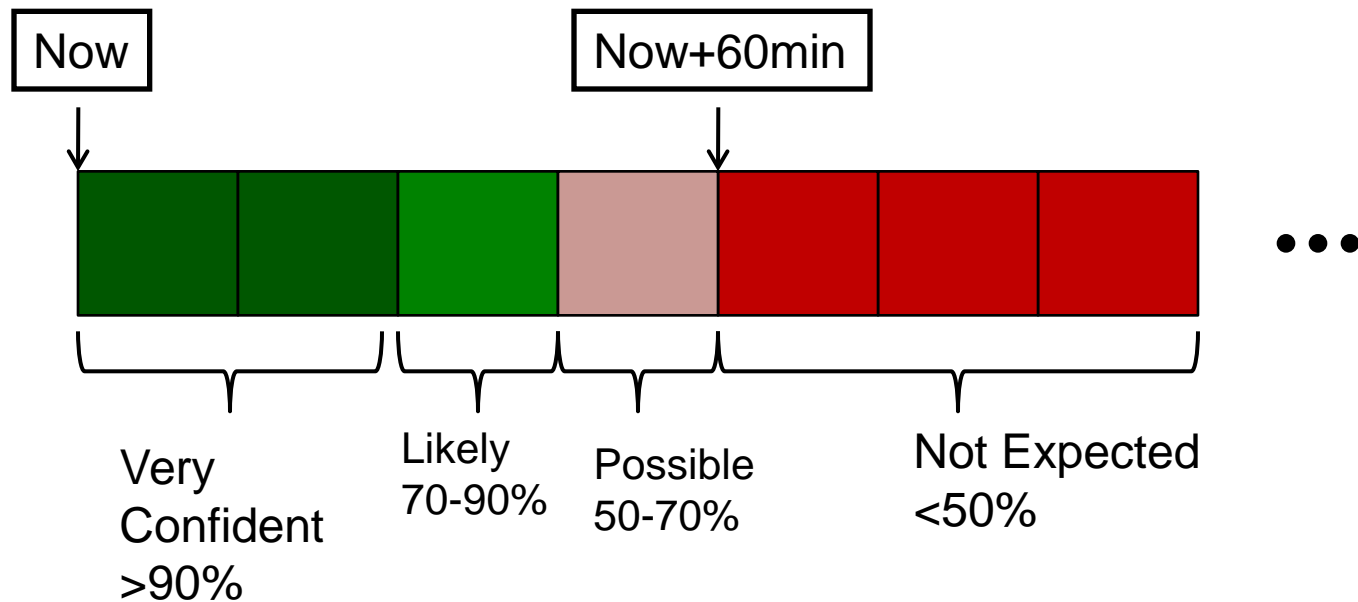
- **WTMA-S “Nowcast” (~20 minutes)**
 - Analogous to WTMD (departures)
 - Increase arrival throughput via compression within TRACON
 - Benefit to limited number of aircraft
- **WTMA-S “Outlook” forecast (1-6 hours)**
 - Predicts WTMA-S availability at longer time horizon, for planning purposes
 - Risk is excess throughput into TRACON if WTMA becomes unavailable (operational, not safety)
 - Increases “beneficiaries” beyond TRACON





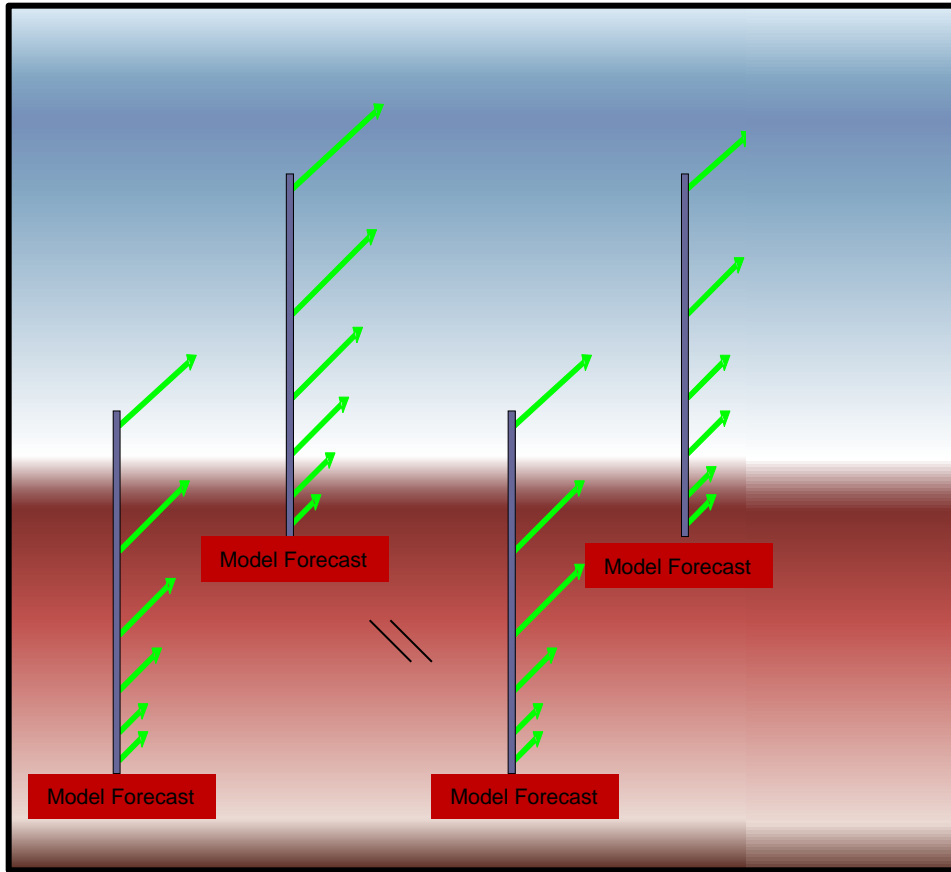
Probabilistic Concept

Provide categorical forecast of future WTMA-S availability as a planning aid out several hours





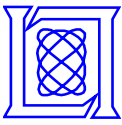
Likelihood Computation



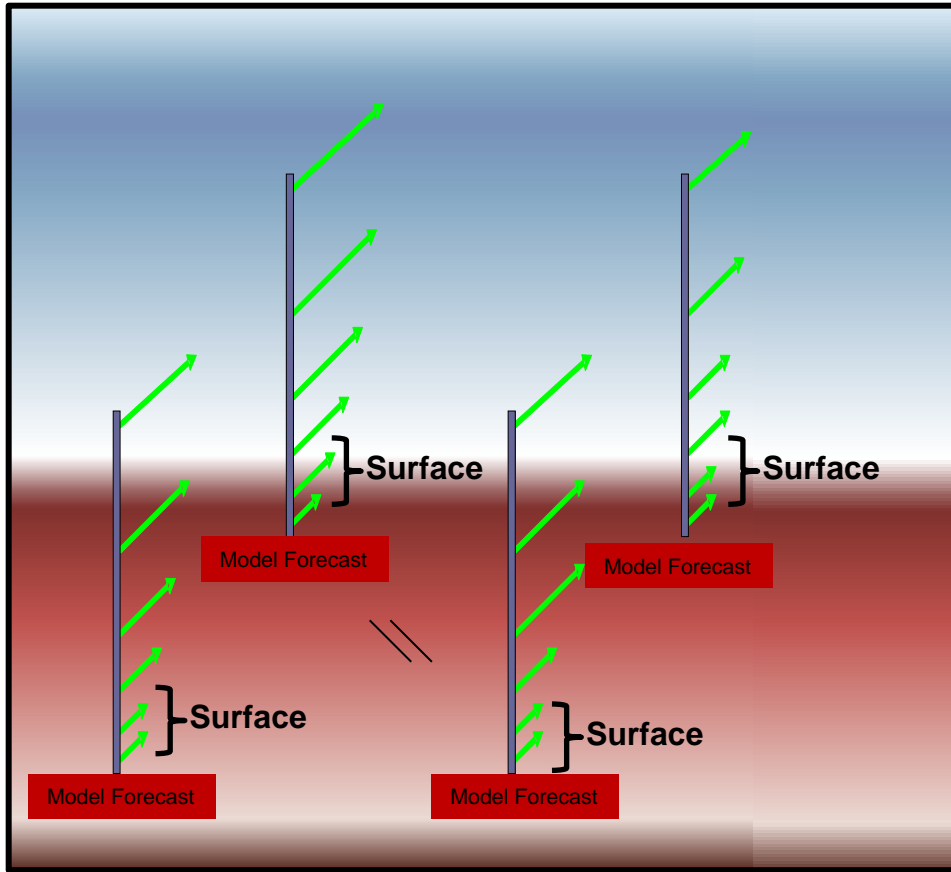
Long forecast horizons
required input to be
based solely on
numerical model
input.

Development based on
current operational
model (RUC 13km
grid spacing)

Model forecasts run every
hour with forecast
horizons past 12
hours



Likelihood Computation



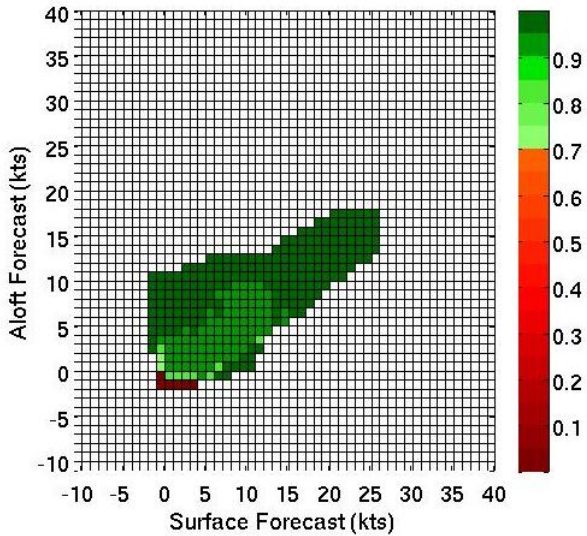
1. Interpolate each wind profile linearly in time to produce unique set of profiles for each minute
2. Isolate “surface” and “aloft” wind components
3. Empirically derive likelihood of availability lookup tables indexed by these forecast quantities and forecast horizon
4. Create a lookup table for each current state, i.e. available or unavailable
5. Convert likelihood for each 15 minute block to a categorical forecast



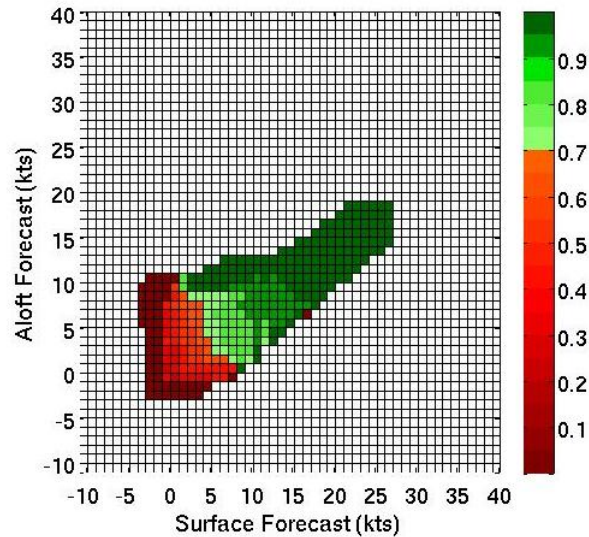
BOS-04R/22L Likelihoods WTMA Currently Available

Increasing Forecast Horizon

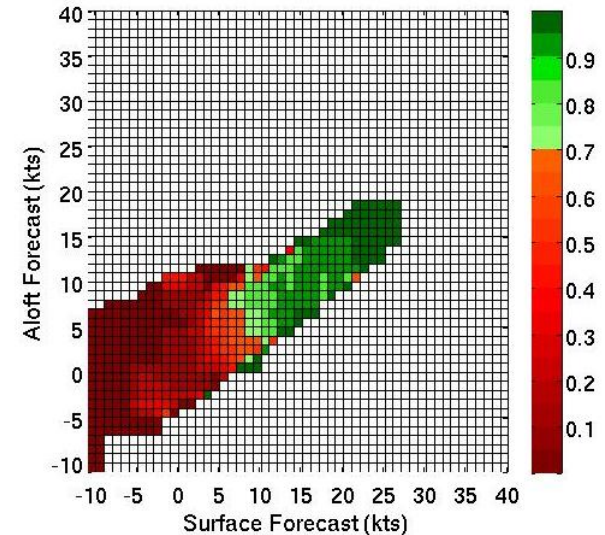
30 Minute Horizon



60 Minute Horizon



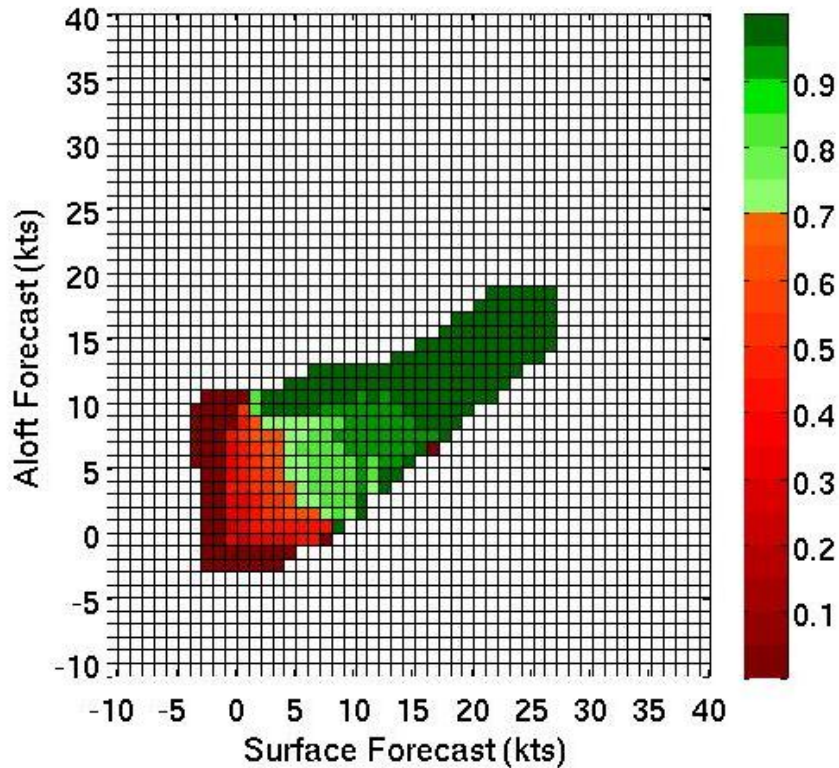
240 Minute Horizon



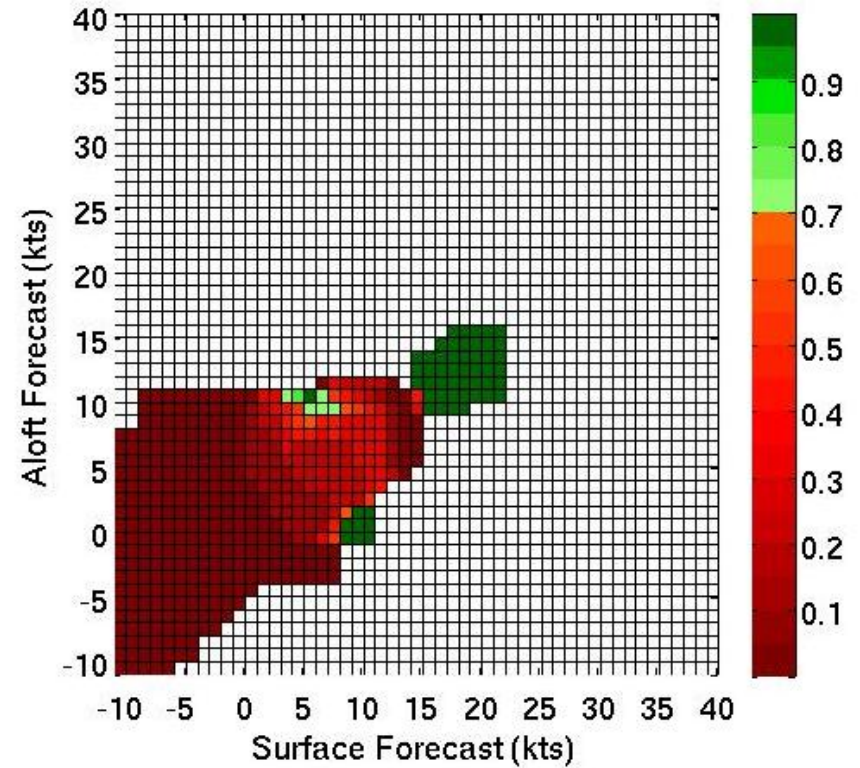


Likelihood at 60 Minute Horizon (BOS 04R/22L)

WTMA-S Available



WTMA-S NOT Available





Scoring Measures

1. **Confidence**: actual probability by category
2. **Capture Rate**: amount of correctly forecast availability
3. **Lead Time**: time difference between forecast start of available period and actual start
4. **End Time**: time difference between forecast end of available period and actual end
5. **Flicker**: the number category changes from max horizon to current time



Working Idea for Display

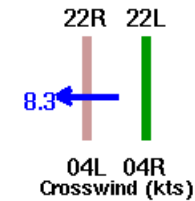
Wake Turbulence Mitigation for Arrivals (WTMA) Boston Logan International Airport (BOS)

28-Feb-2011
14:00 UTC

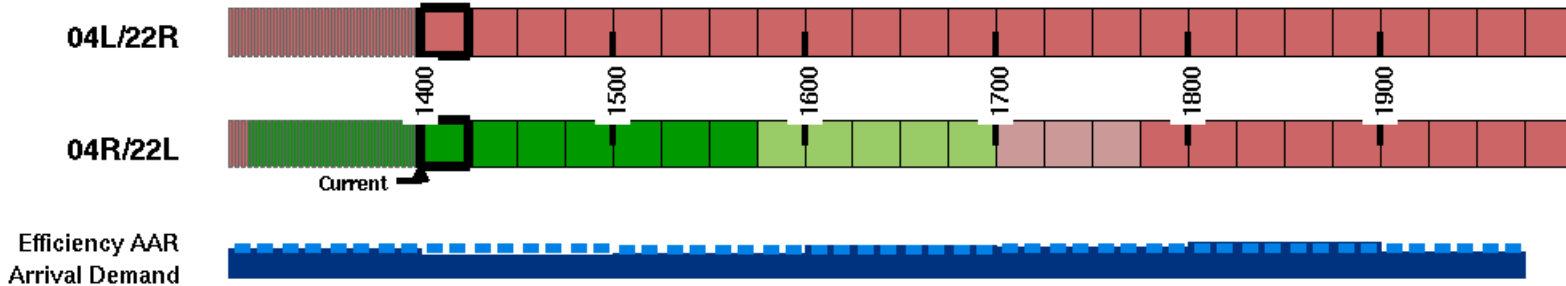


Current WTMA Availability

- 04L **Not Avail** -----
- 22R **Not Avail** -----
- 04R **Available** -----
- 22L **Available Enabled**



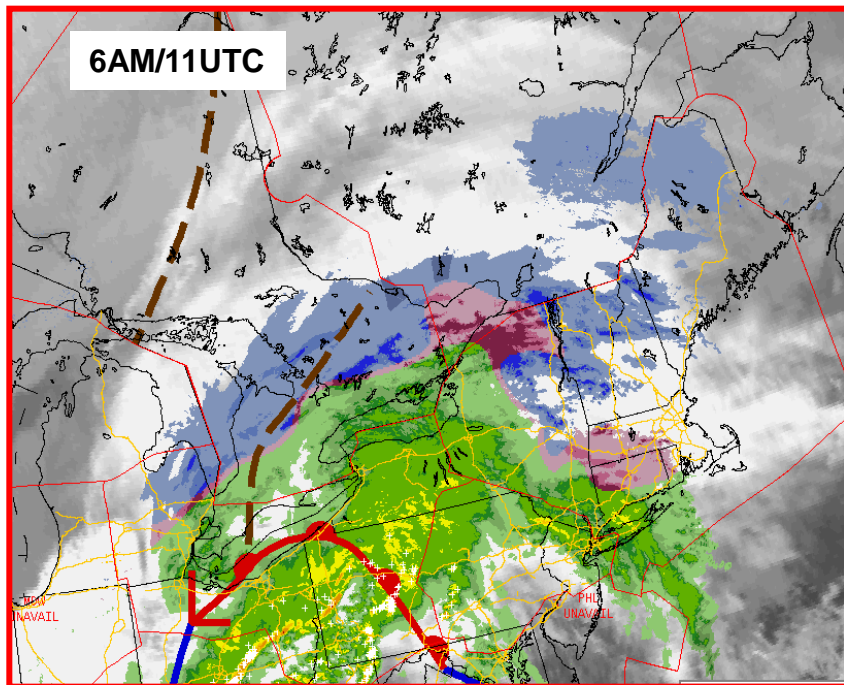
WTMA-S Availability Outlook



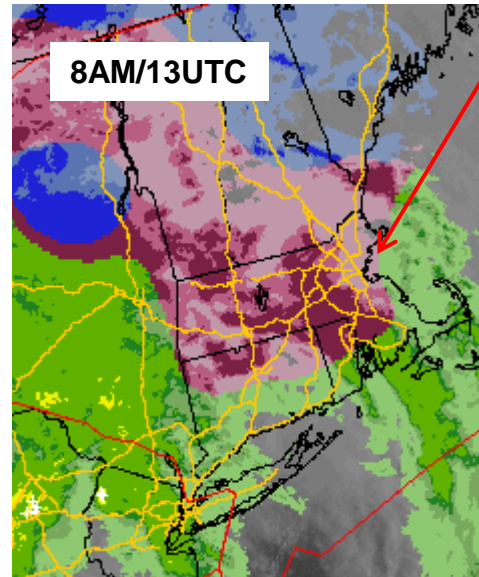


BOS

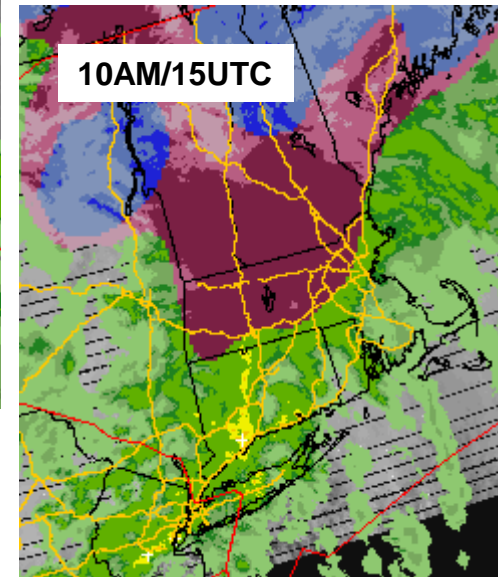
Feb 28, 2011



Winds from the southwest at 5-10kts



**BOS-Logan Airport
Departures on 22R
Arrivals on 22L**



Color	Weather
Blue	Snow
Magenta	Ice
Green	Rain
Yellow	Heavy Rain



BOS Feb 28, 2011 Synopsis

Airport Runway Configuration 6am-11am and (12pm):

- *Departures on 22R (33L)*
- *Arrivals on 22L (27)*

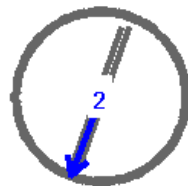
Local Time	Universal Time	Arrival Rate	Arrival Demand	Weather	WTMA-S Available on 22L?
6 AM	11z	32	6	Overcast	No
7AM	12z	30	28	Freezing Rain	No
8AM	13Z	30	32	Rain	Yes
9AM	14Z	30	25	Rain	Yes
10AM	15Z	30	27	Rain	Yes
11AM	16Z	30	35	Rain	First ½
12PM	17Z	32	34	Rain	No



WTMA-S Outlook 6AM (11UTC)

Wake Turbulence Mitigation for Arrivals (WTMA) Boston Logan International Airport (BOS)

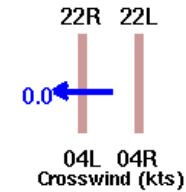
28-Feb-2011
11:00 UTC



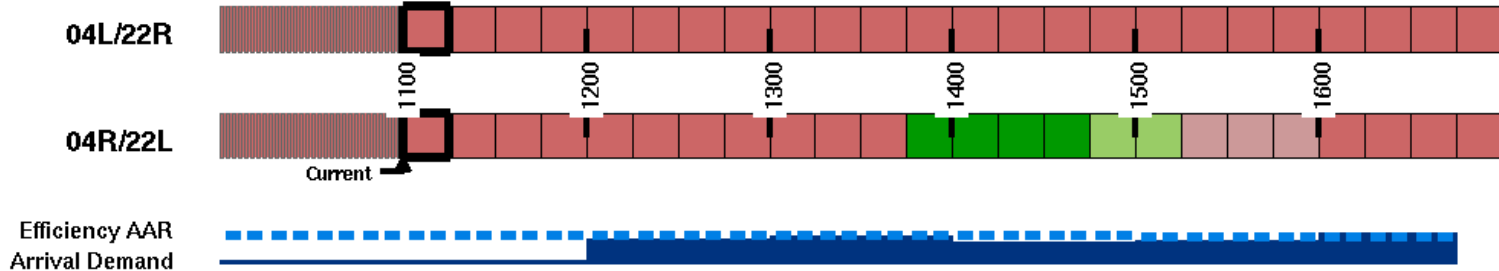
ASOS Wind
(knots)

Current WTMA Availability

04L Not Avail ----
22R Not Avail ----
04R Not Avail ----
22L Not Avail ----

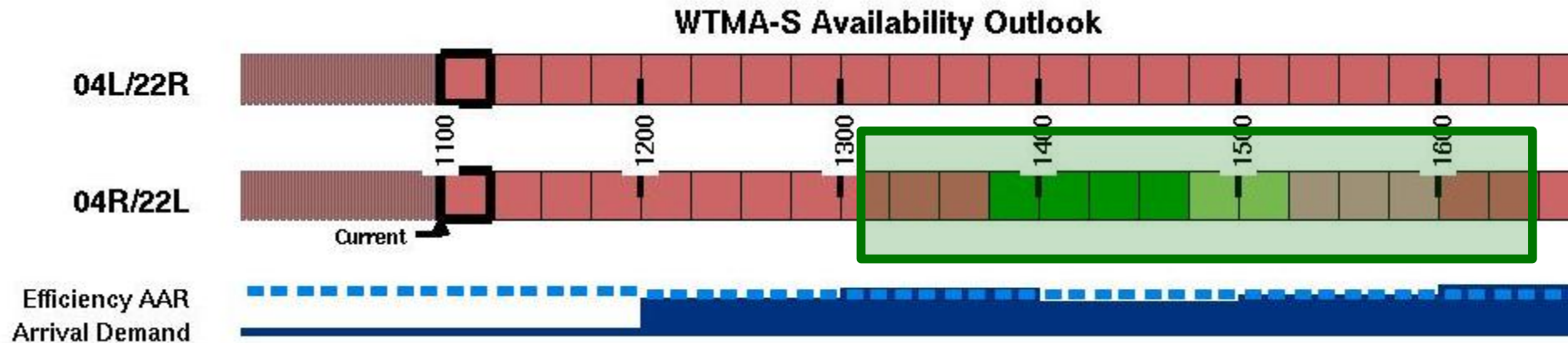


WTMA-S Availability Outlook





Outlook Forecast 6AM (11UTC)

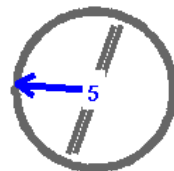




WTMA-S Concept Display Demonstration

Wake Turbulence Mitigation for Arrivals (WTMA) Boston Logan International Airport (BOS)

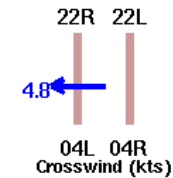
28-Feb-2011
12:54 UTC



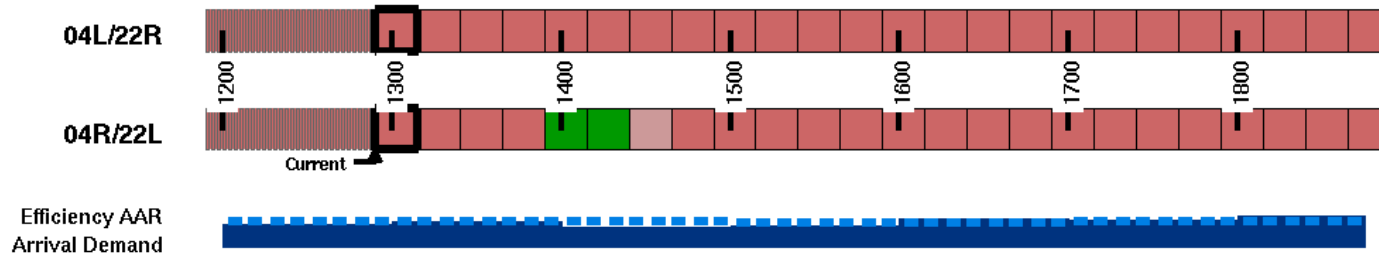
ASOS Wind
(knots)

Current WTMA Availability

04L Not Avail -----
22R Not Avail -----
04R Not Avail -----
22L Not Avail -----



WTMA-S Availability Outlook





Performance

- **Confidence matches desired performance for most time horizons**
- **Capture the bulk of most available time periods**
- **Conservative (late) lead times**
- **Overforecast (late) end times**
- **Acceptable flicker levels**

Performance based on 7 candidate airports for 8 months in 2011
utilizing probabilities based on 8 months in 2010



Summary

- **Input is numerical model wind forecasts for grid points nearby airport and ASOS sensor (Nowcast only)**
- **Nowcast analogous to WTMD; very conservative for safety**
- **Probabilistic Outlook for planning**
 - **Gives heads up for planning purposes of longer available time periods**
 - **Self-adjusting to different forecast models/locations**
- **Display Concept developed for evaluation, expect this to change as needs of user become apparent**
- **Forthcoming performance requirements needed to determine effectiveness and benefits**
- **Future work will focus on algorithm development (leveraging increased quantity of input data), real-time system development, and response to emerging needs and requirements**