NextGen Weather

WMO AVRDP

August 20th, 2019

South Africa

Matt Strahan

International Operations Chief

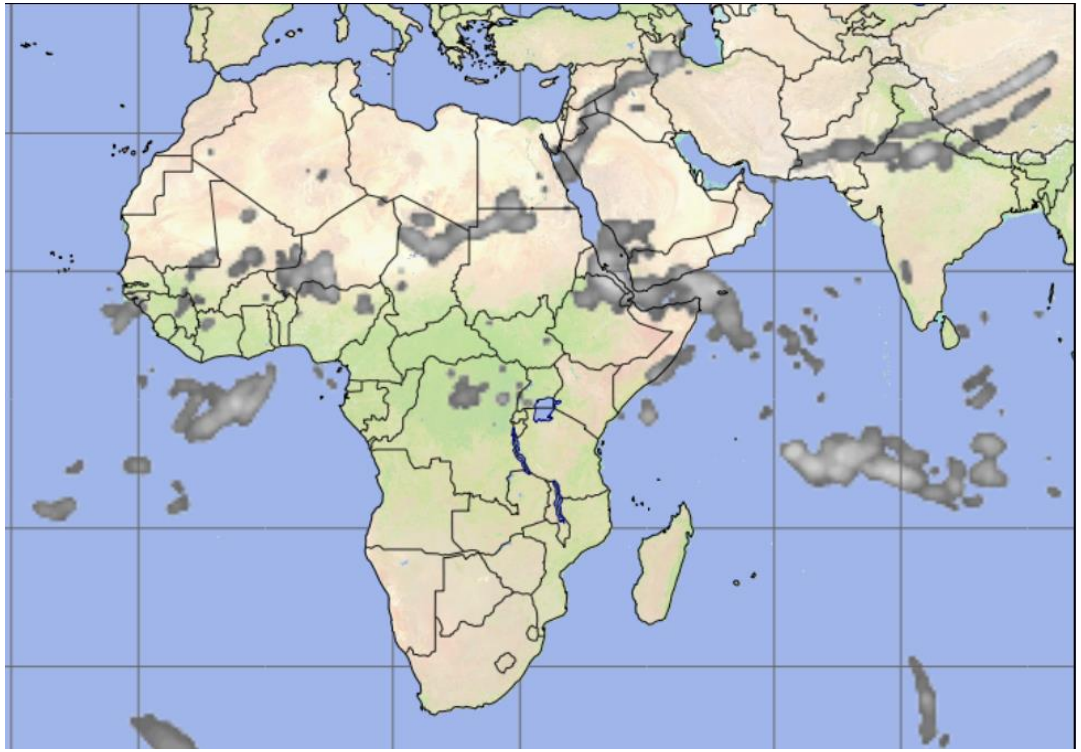
NOAA, Aviation Weather Center

Digital Weather Support
for Machine to Machine and the humans that live with it

- Trajectory Based Operations – foundation of NextGen
  - Gridded Data – GRIB2 and NetCDF
    - Winds, temps, RH, Geopotential Height, Turbulence, Icing and Cb
  - IWXXM – OPMET and geo-located objects

- Managing Air Space
  - Turbulence, Icing and Cb information

- Integrated Decision Support Services
  - Dashboards
  - Risk Matrices
  - Briefings

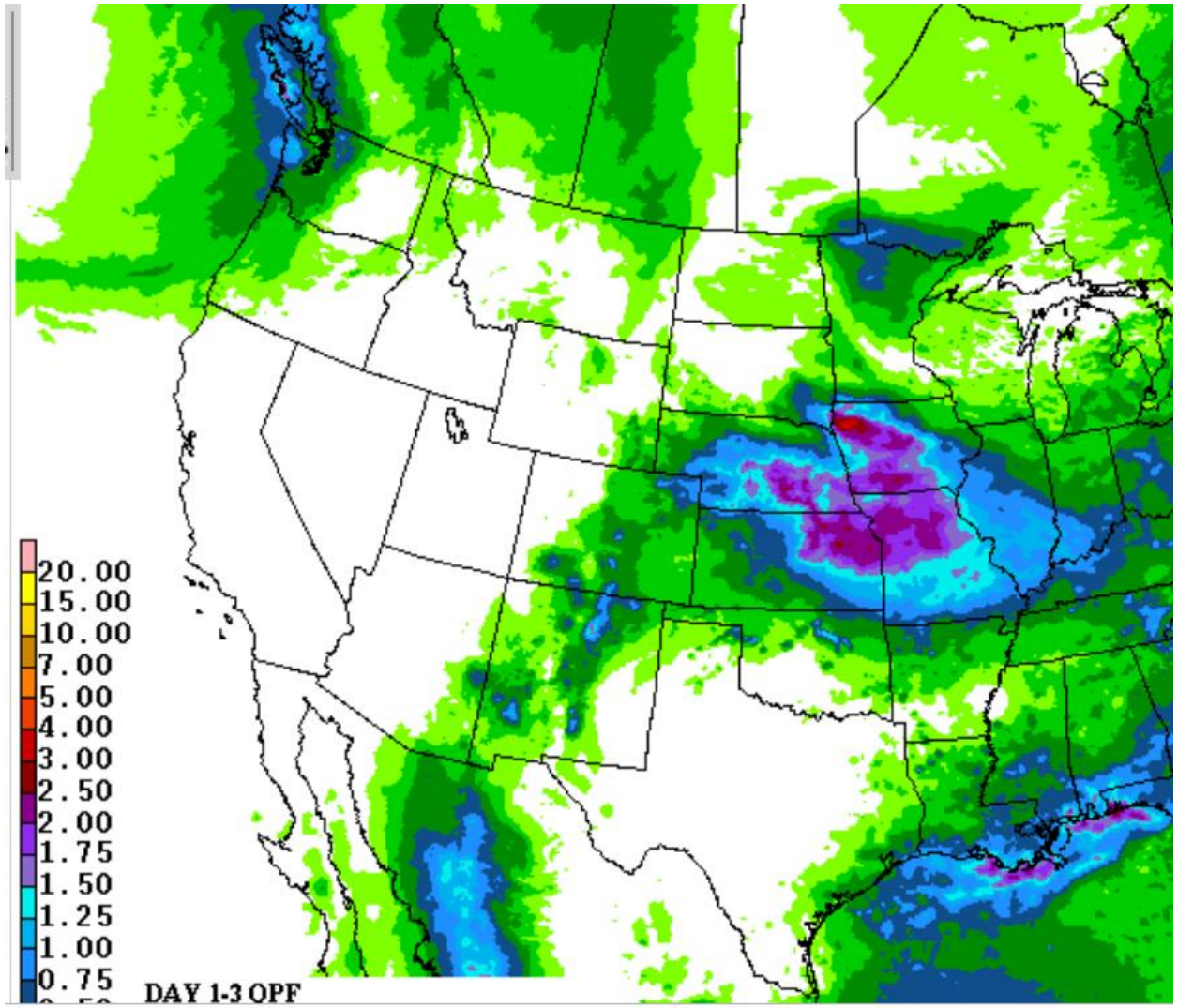


New WAFS 06hr prob Of Cb Tops Exceeding 30,000 ft.

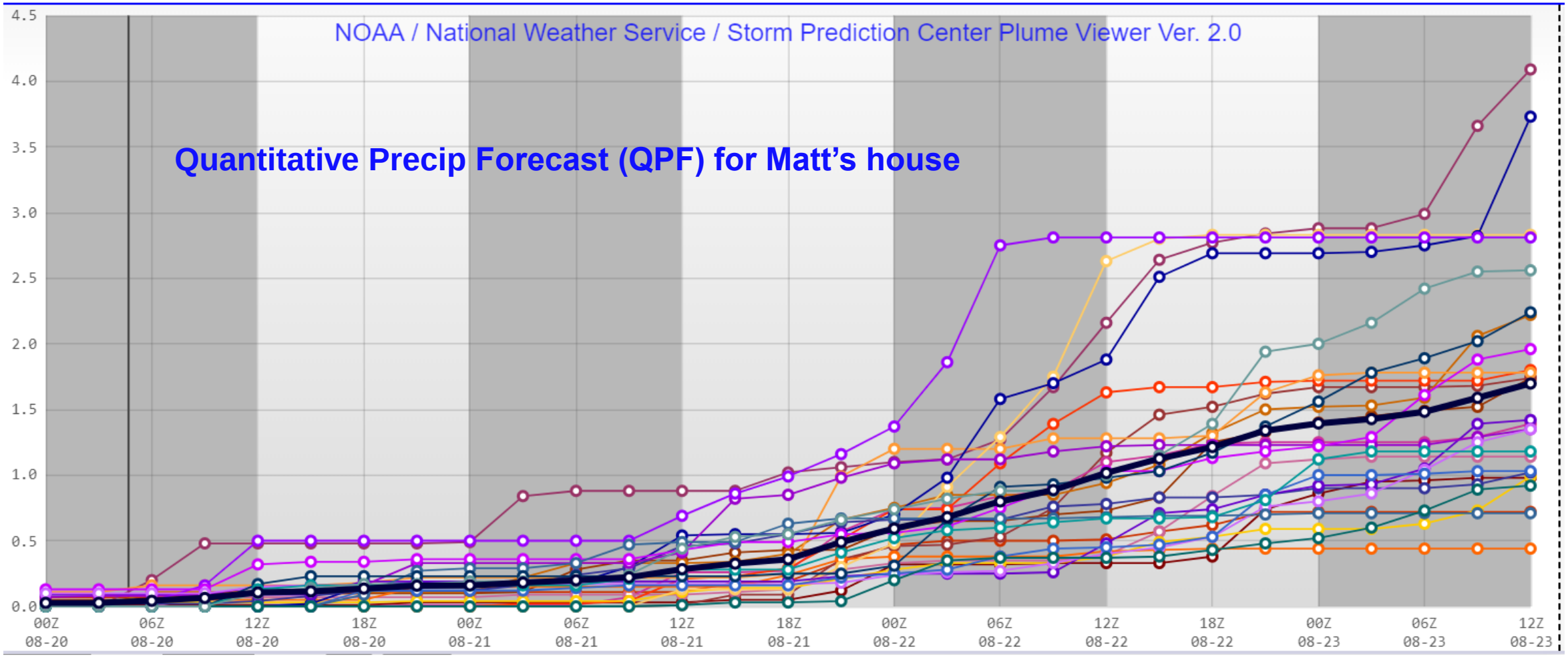
Expressions of Uncertainty

- Probabilities – Must be reliable to be useful
- Percentage of Normal – identification of outlier forecasts
- Confidence Factors – Automated or manual?
- Risk Matrices – Combines likelihood and impact to help decision makers

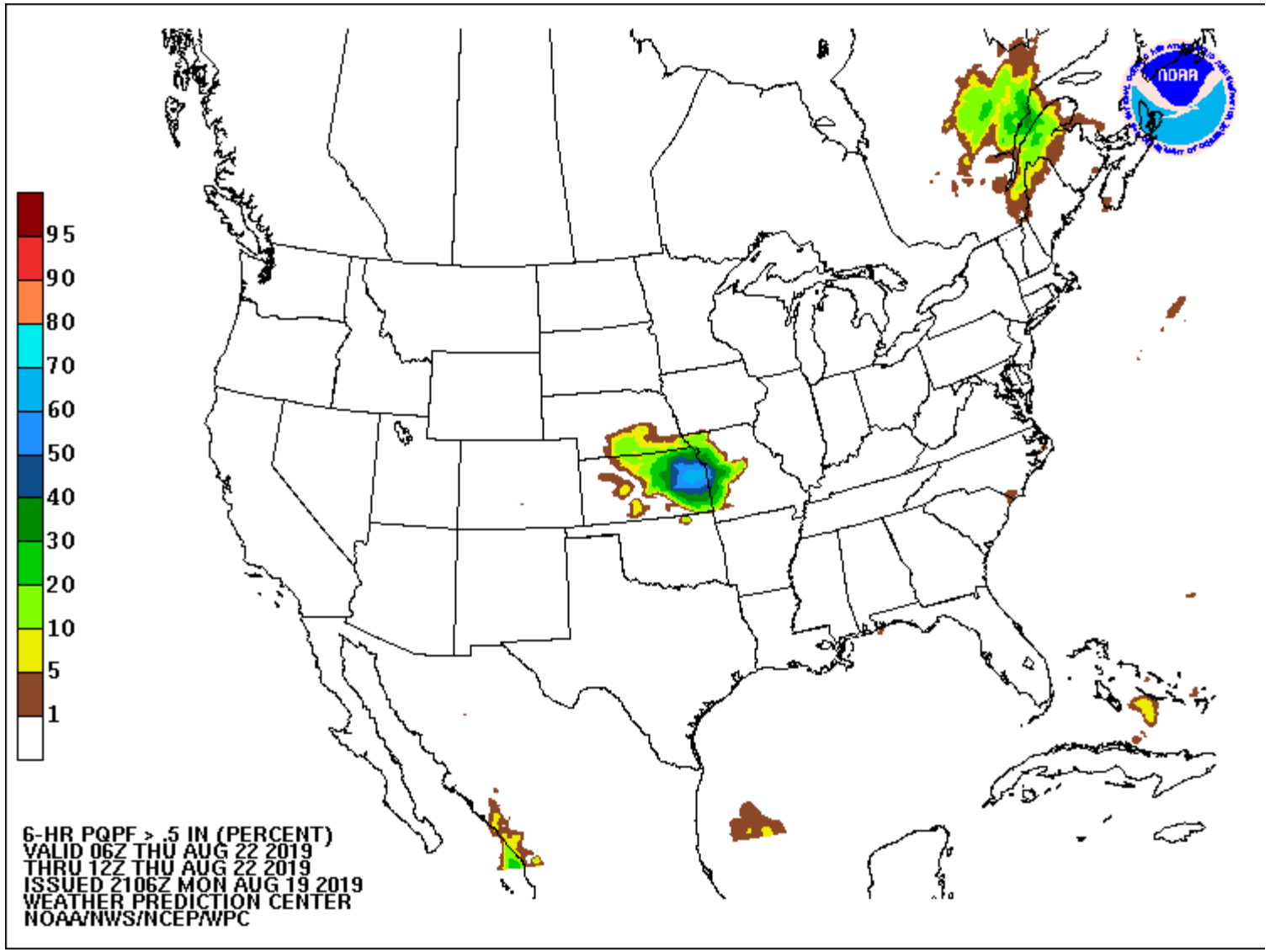
Deterministic Precip Forecast



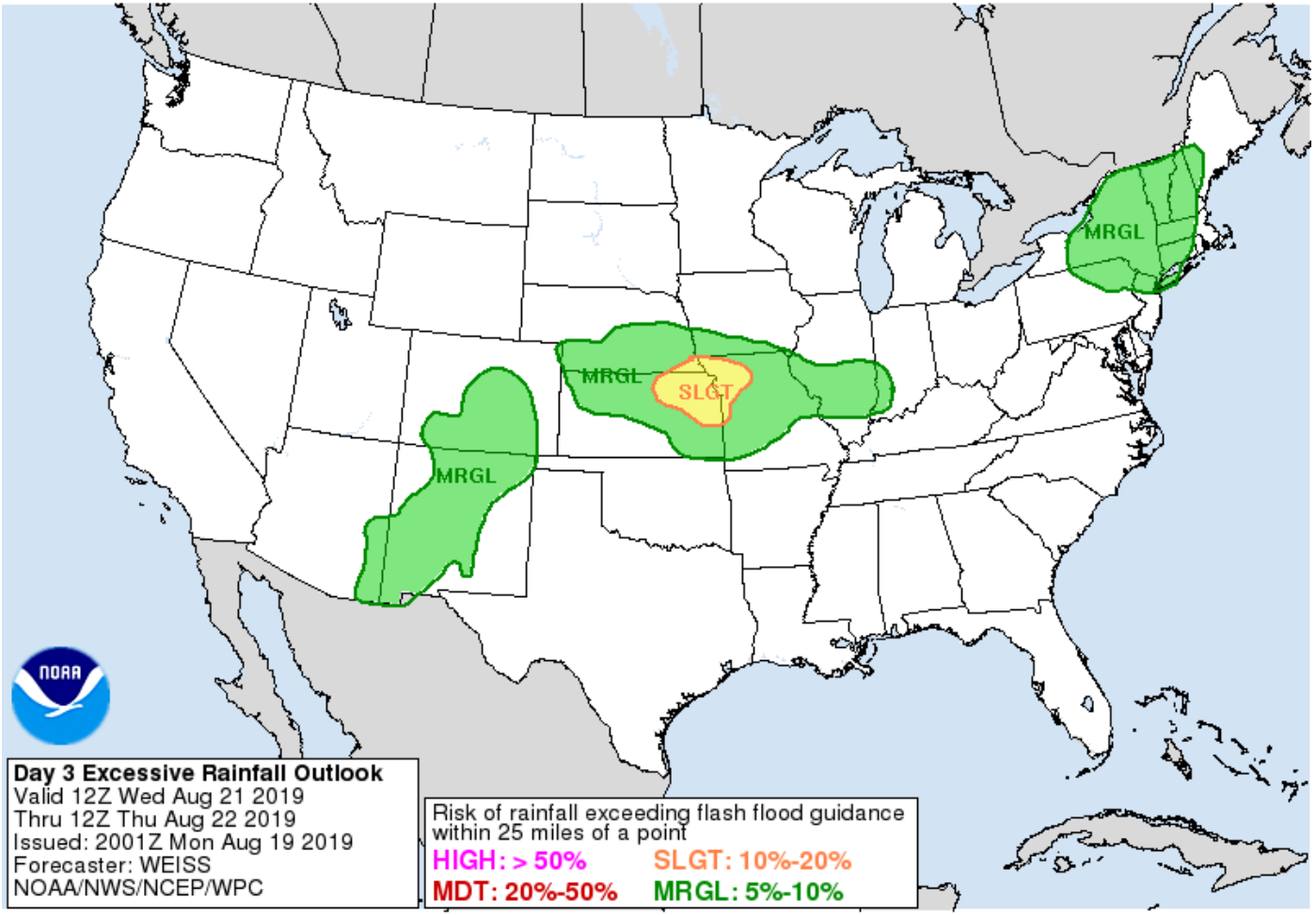
Ensemble Based Uncertainty



Probability of Threshold Exceedance



Impact Based Risk Analysis



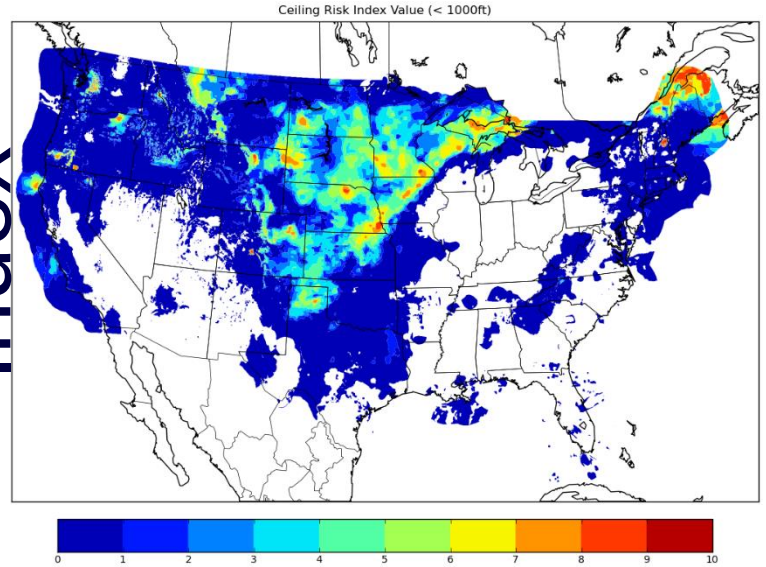
A Ceiling Risk Concept

Likelihood CIG < 010	010	005	002	000
100%	3	3	6	9
75%	2	2	5	8
50%	1	1	4	7
25%		0	3	6
0%				

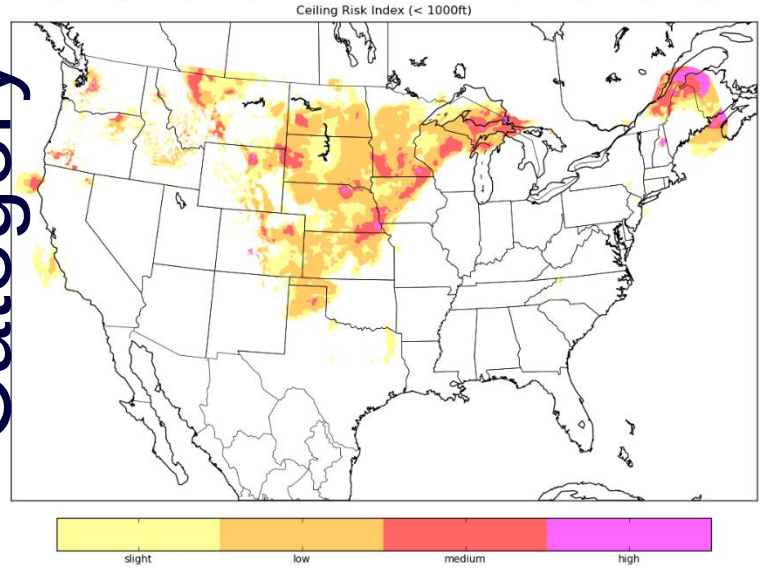
Ceiling Height AGL

Slight	Low	Medium	High
1-3	4-5	6-7	8-9

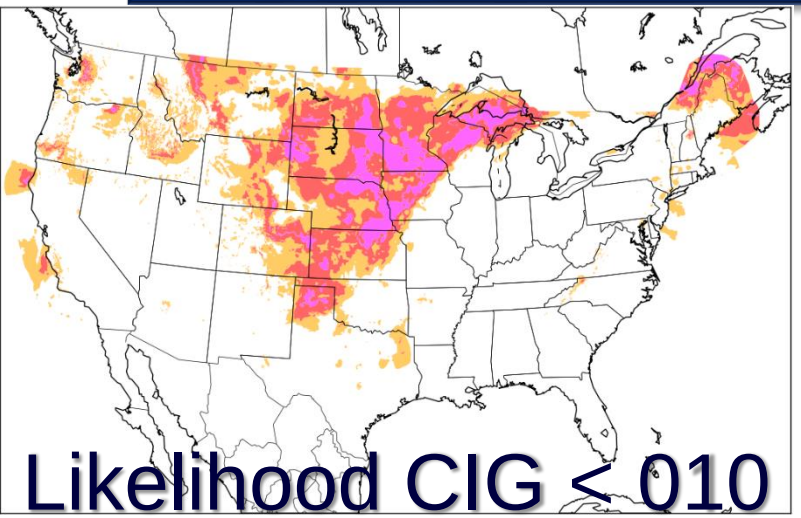
Index



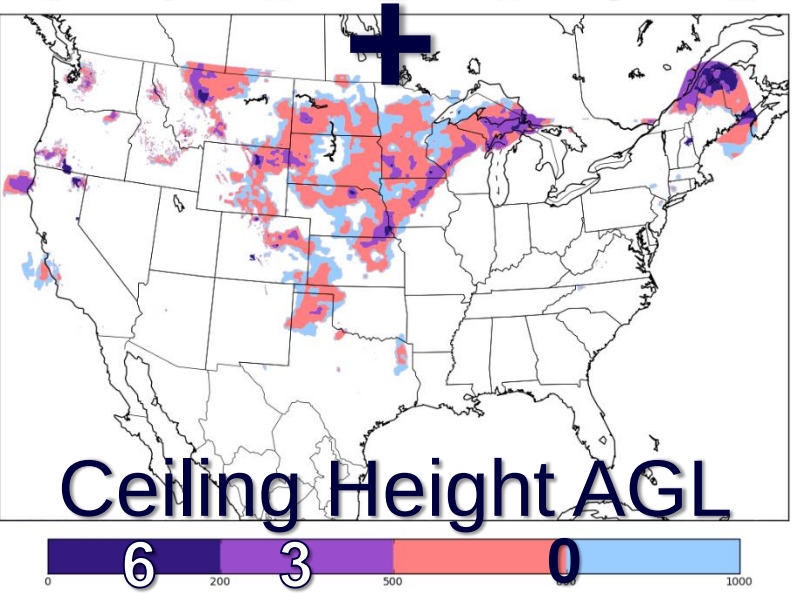
Category



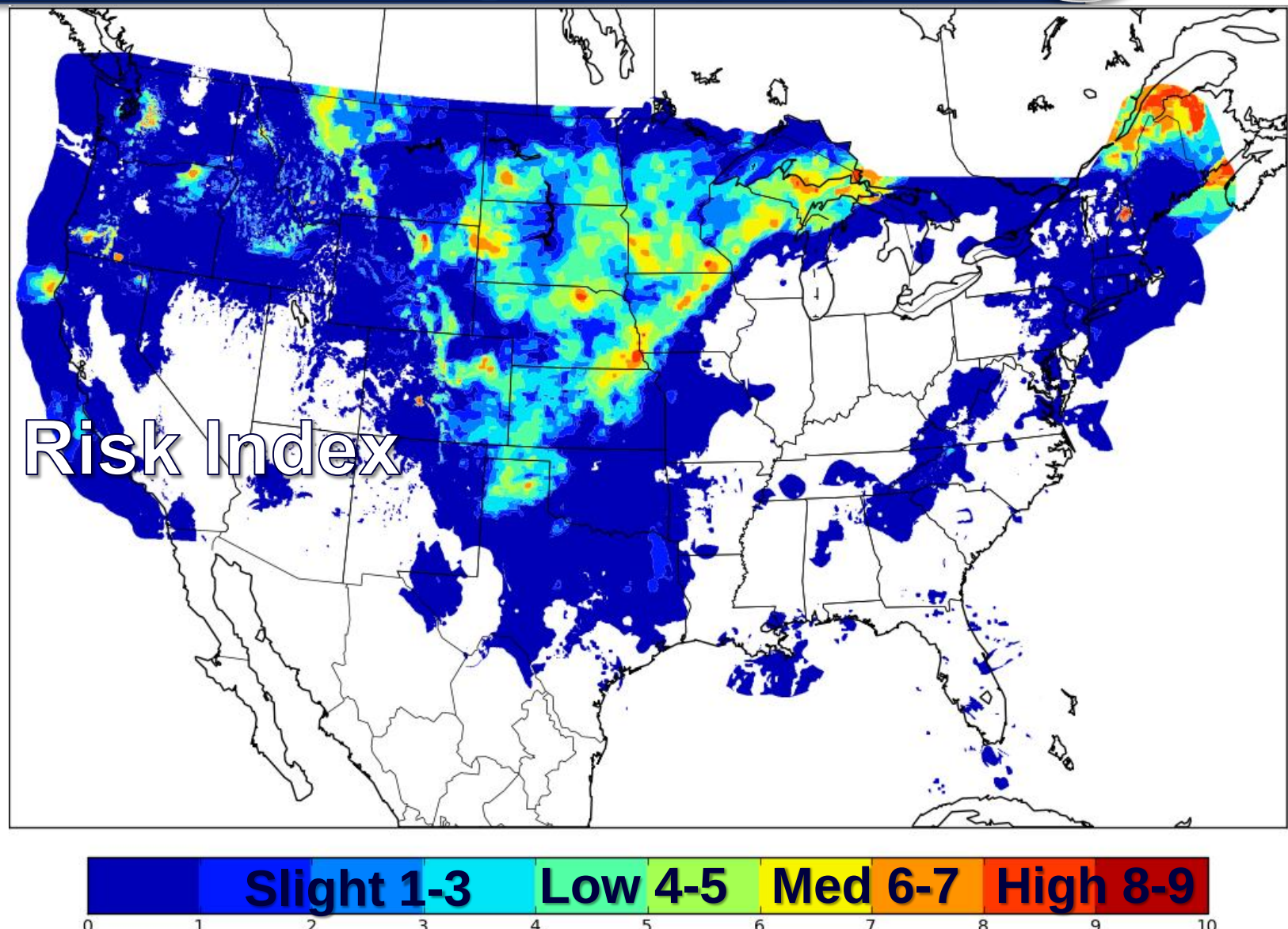
A Conceptual Ceiling Risk Example



+



=



Cost/Loss De-Icing Example

Cost/Loss Ratio (α)

- The **cost** of the preventative measure and the **loss** averted
- The optimum threshold for a user to minimize cost occurs anytime forecast P > cost/loss ratio

For example,

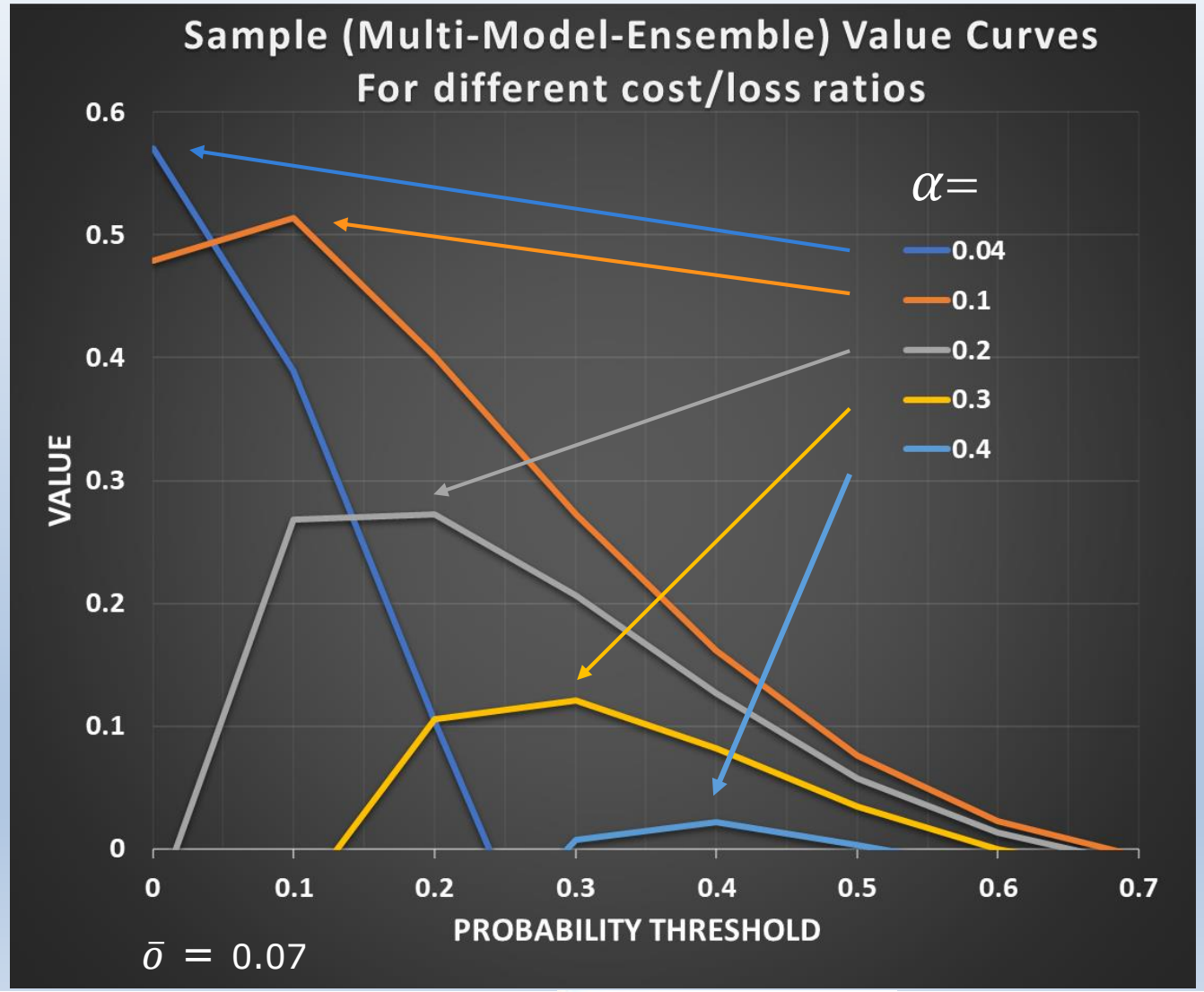
Cost to proactively de-ice = $50K

Cost to reactively de-ice = $1M

Cost/Loss (α) = 0.05

Thus, ideally any forecast > 5% calls for taking action.

Example: Large Value Increase possible for Ensemble System Particularly as Cost/Loss Decreases



Maximum value follows $P_T = \alpha$

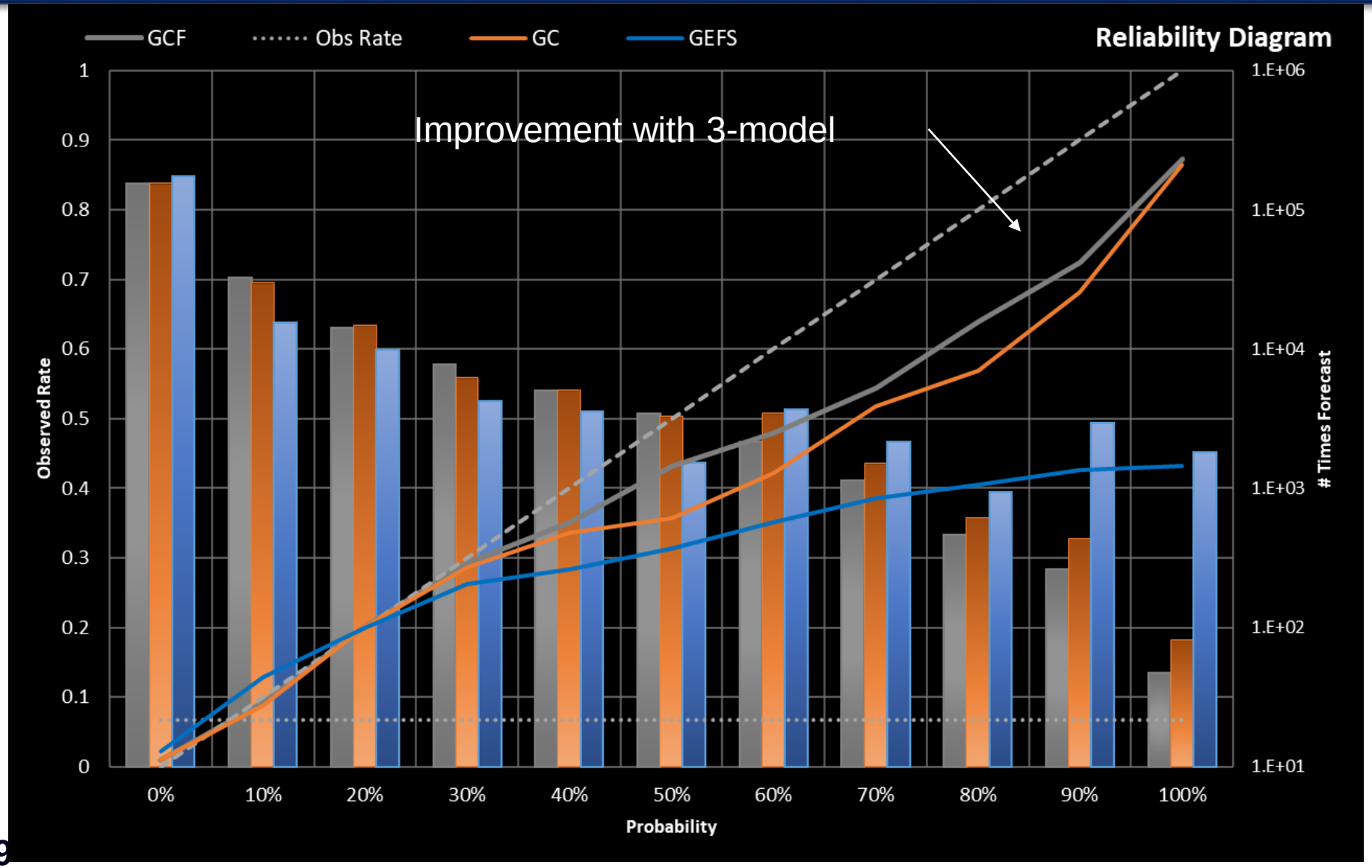
Value decreases as P_T deviates from α, rapidly in some cases.

Maximum overall value occurs when $P_T = \alpha = \bar{o}$

As α gets smaller, more precision is required to take advantage of ensemble.

Relative Value w.r.t climate, 24h 0Z forecast, APCP6hr, CMORPH > 4.0 mm
Caribbean region, April-July 2018

Reliability (Cb example)



Resolution vs Reliability/Calibration

Calibration is required for good decision-making.

Resolution is fundamental to accuracy.

The best probabilistic forecasts are calibrated with the highest possible resolution.

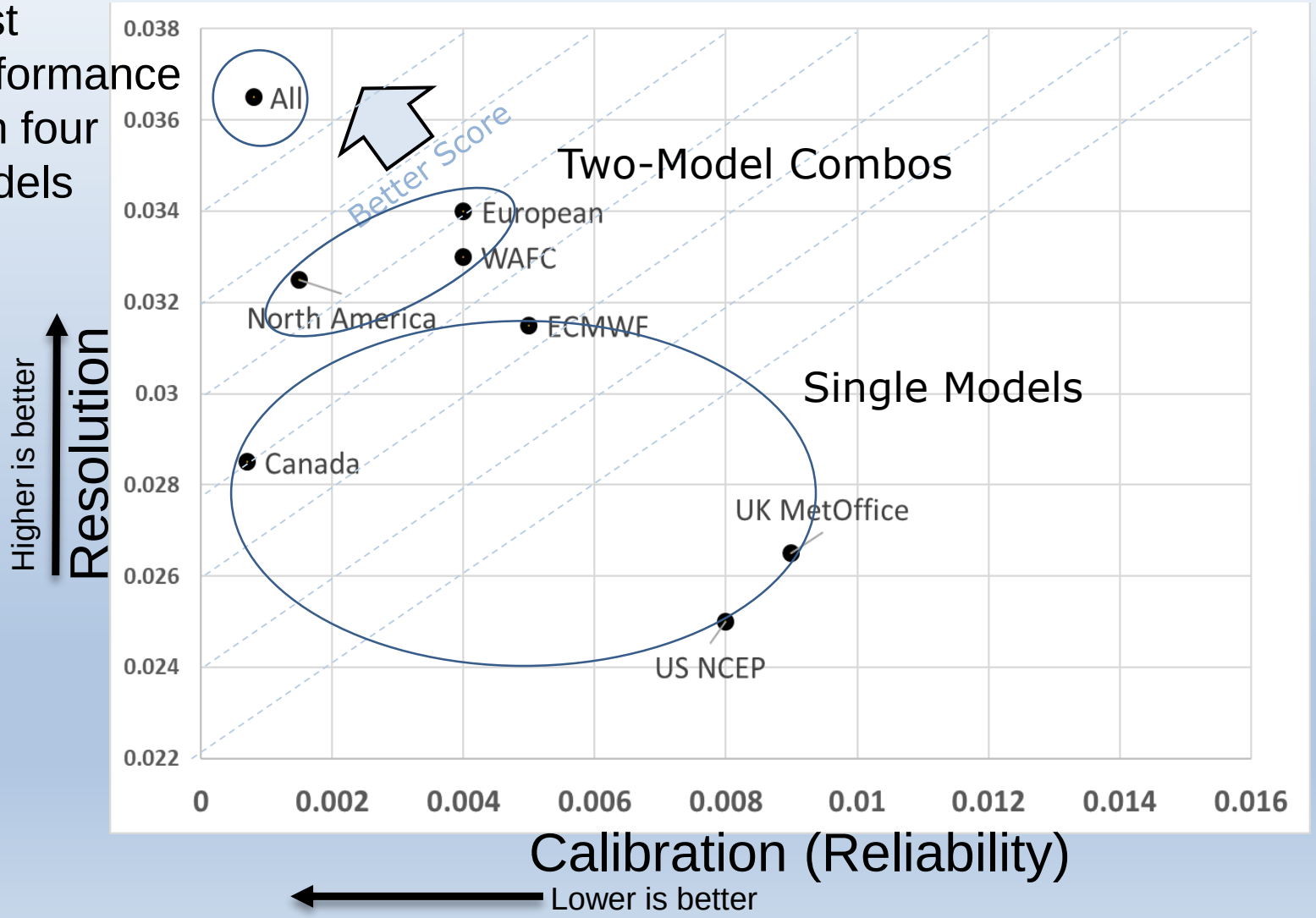
Example: A deterministic forecast (0 or 100% chance) that is perfectly accurate all the time. Upper limit of resolution => no uncertainty.

Example: Climatological event occurrence (say we forecast 15% all the time). Calibrated, but lower limit of resolution => much uncertainty.

Potential Benefits from Multi-model Ensemble

24-hour forecast in comparison to CMORPH 2mm APCP 6hr – UB correction

Best performance with four models



Linear Opinion Pool
Caribbean JJA 2013

Supporting Humans

Impacts TAF Board

Potential Impact	None	Slight	Moderate	High

Valid at: 0600 UTC 20 Aug 2019

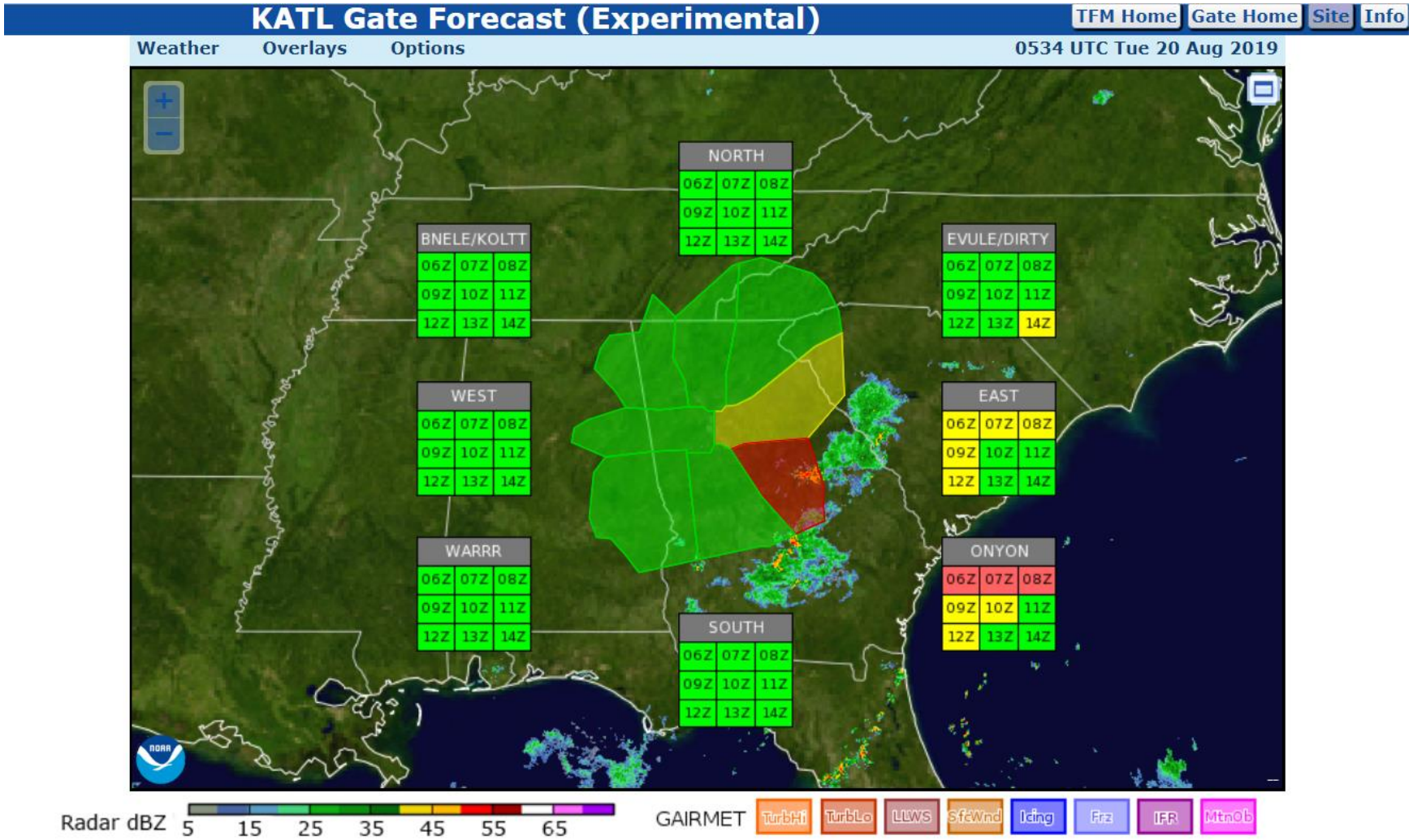
Time	OBS	20/06Z	20/07Z	20/08Z	20/09Z	20/10Z	20/11Z	20/12Z	20/13Z	20/14Z	20/15Z	20/16Z	20/17Z	20/18Z >>
@TOPE														
KBOS														
KCLE														
KLGA						WSpd	WSpd	WSpd	WSpd	WSpd	WSpd	WSpd	WSpd	WSpd
KEWR														
KJFK														
KPIT														WX
KPHL				[VIS]	[VIS]	[VIS]	[VIS]							
KBWI														WX
KIAD														WX
KDCA														WX
KCLT														[WX]
KATL														[WX]
KMCO													WX	[WX]
KTPA														
KFLL											[WX]	[WX]	[WX]	[WX]
KMIA											[WX]	[WX]	[WX]	[WX]

ID: KCLT **Date:** 20/18Z

WX	VIS	CIG	WDir	WSpd	WGst
-- [TSRA]	>6 [3]	40 [40]	200 [200]	7 [7]	-- [--]

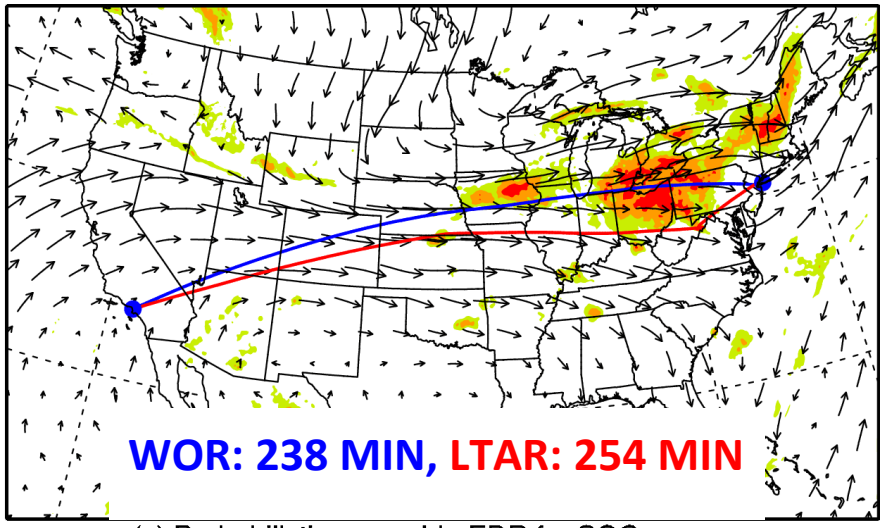
Supporting Humans w/Probabilistic Cb for Terminals

https://testbed.aviationweather.gov/trafficflowmgmt/gate/site?id=KATL

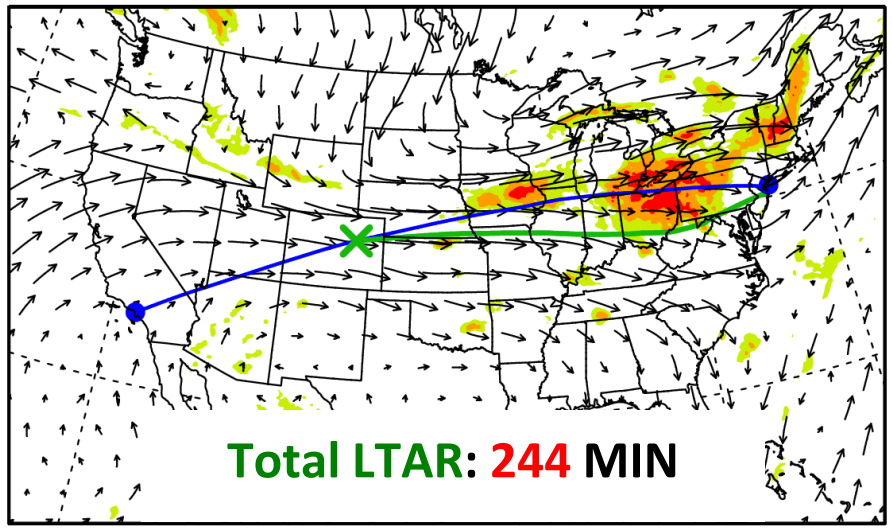


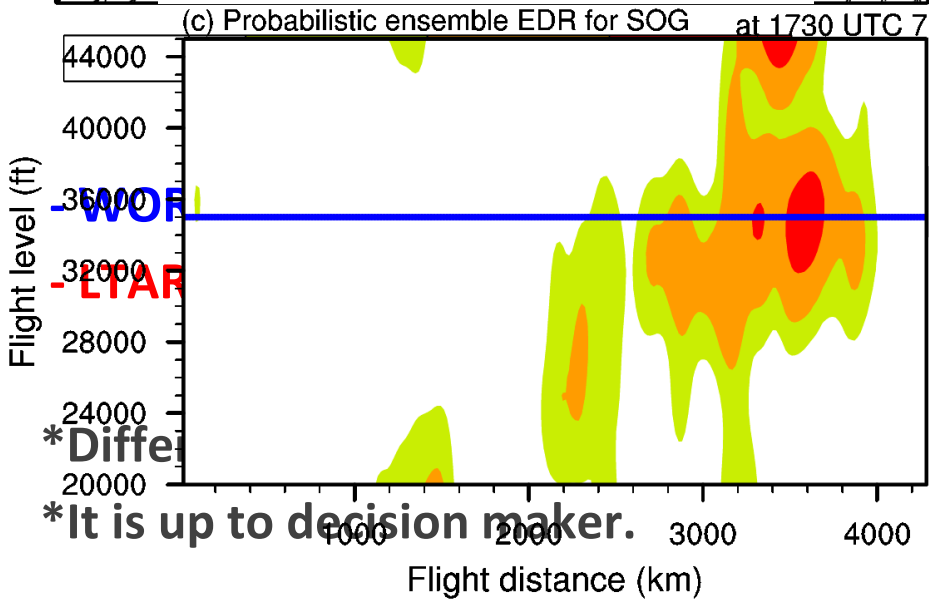
Integrated application to ATM

3-5-hrs turb prob. fcst at FL350



2-4-hrs turb prob. fcst at FL350

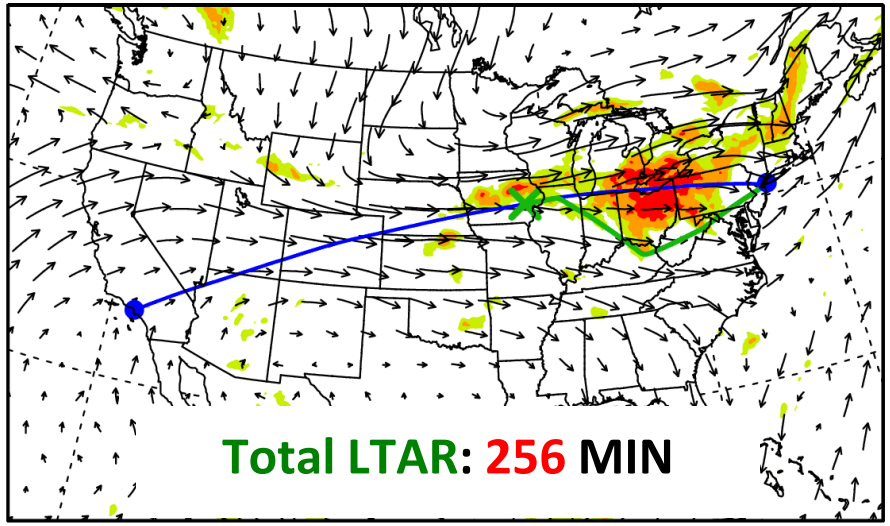




*Diffe

*It is up to decision maker.

1-3-hrs turb prob. fcst at FL350



Rare, Poorly Observed Events

- Turbulence and Icing
- Cannot guarantee reliability or resolution
- What to do, besides ask airlines for more observations?
- Maybe relate the forecast to normal values.
  - Example: This forecast is higher than 95% of forecasts for this location and time
  - Example: 50% of the ensemble members exceed their 98% value

Use a time/space "neighborhood" for the event?

Example: There is a 30% probability of turbulence exceeding 0.2 EDR for this 30 minute section of flight path