

Development of NCAR's Advanced Hurricane-research WRF (AHW): *Explicit Representation of Convection*

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Acknowledgements:

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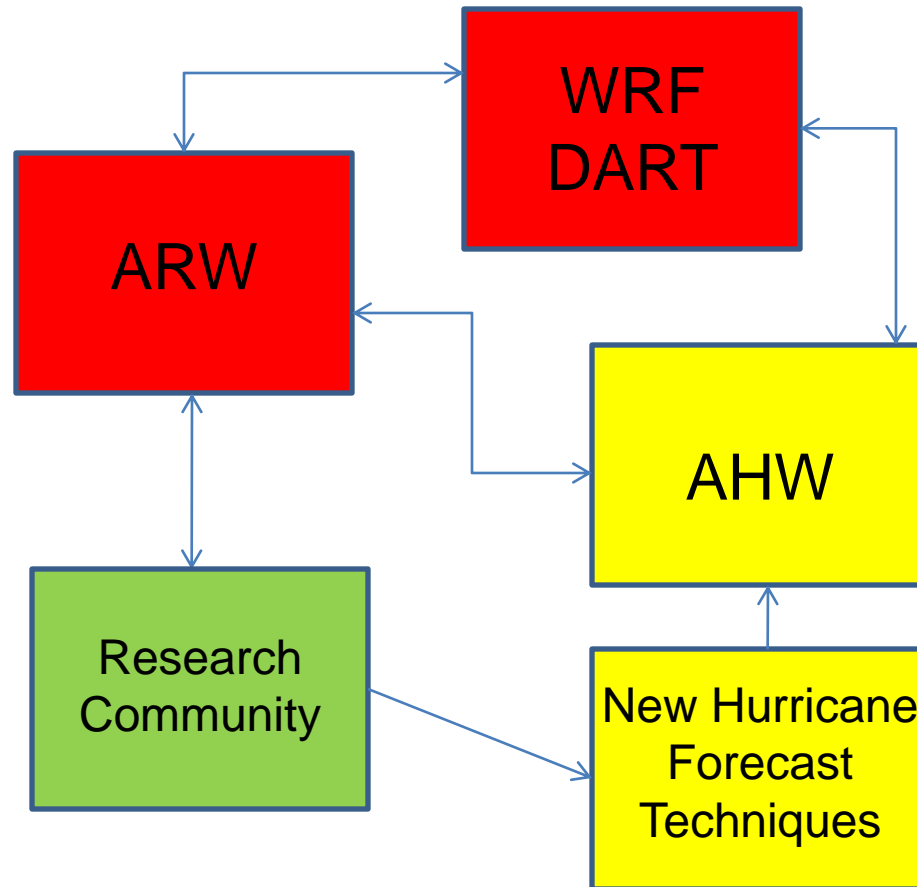
Ryan Torn (U. Albany SUNY)

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NOAA's Hurricane Forecast Improvement Project (HFIP)

WRF ARW and AHW

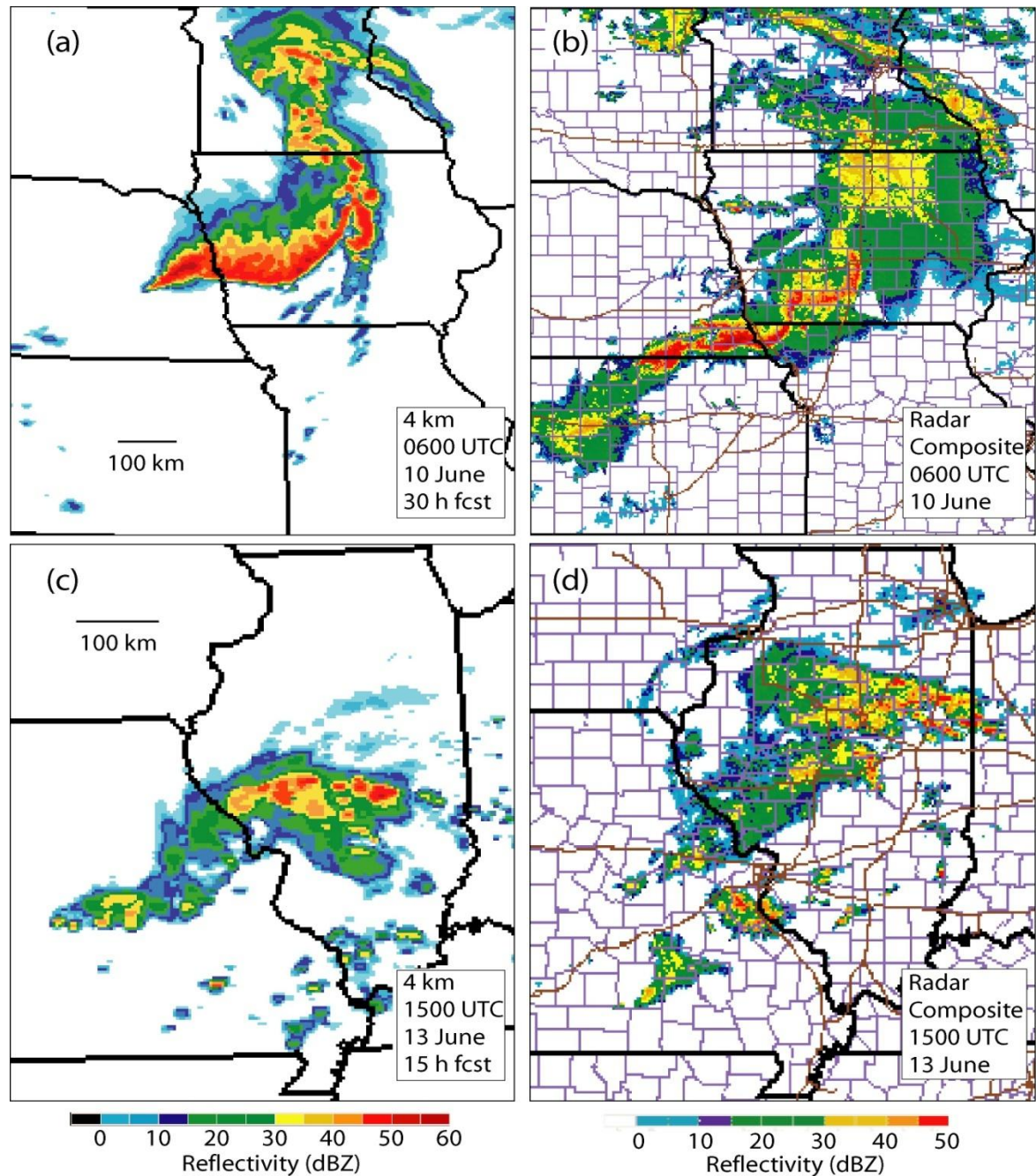


AHW is never much different from ARW

WRF and Convection Forecasting

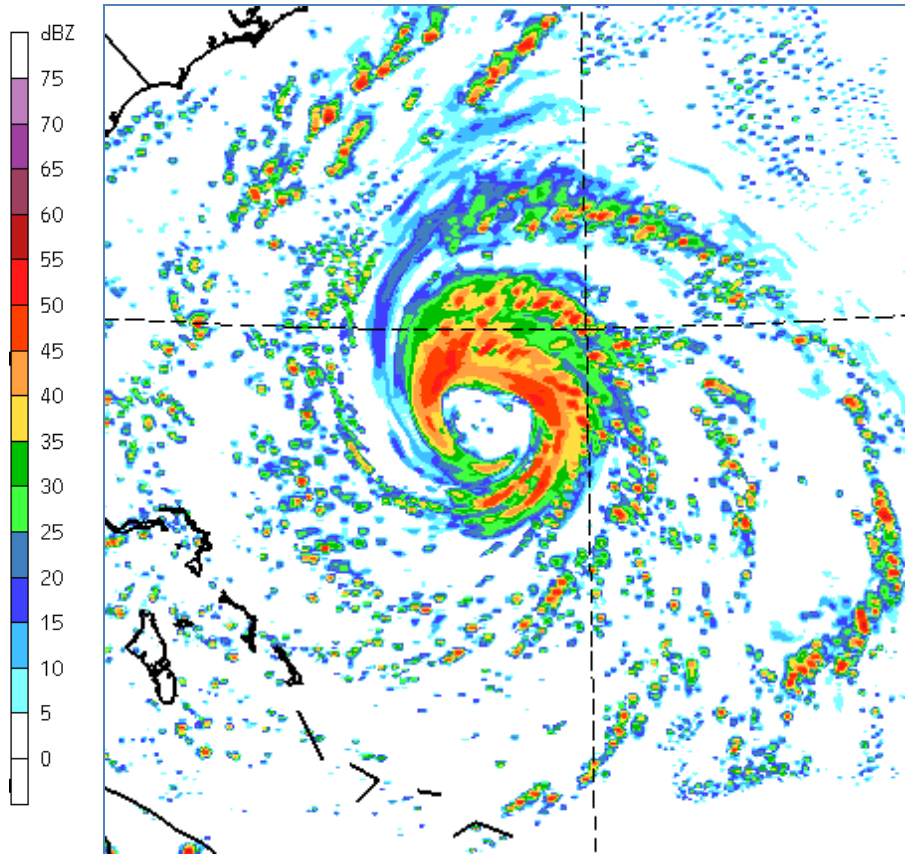
Explicit forecasts
of convection:
 $\Delta x = 4$ km

Done et al. (2004):
Atmos. Sci. Lett.

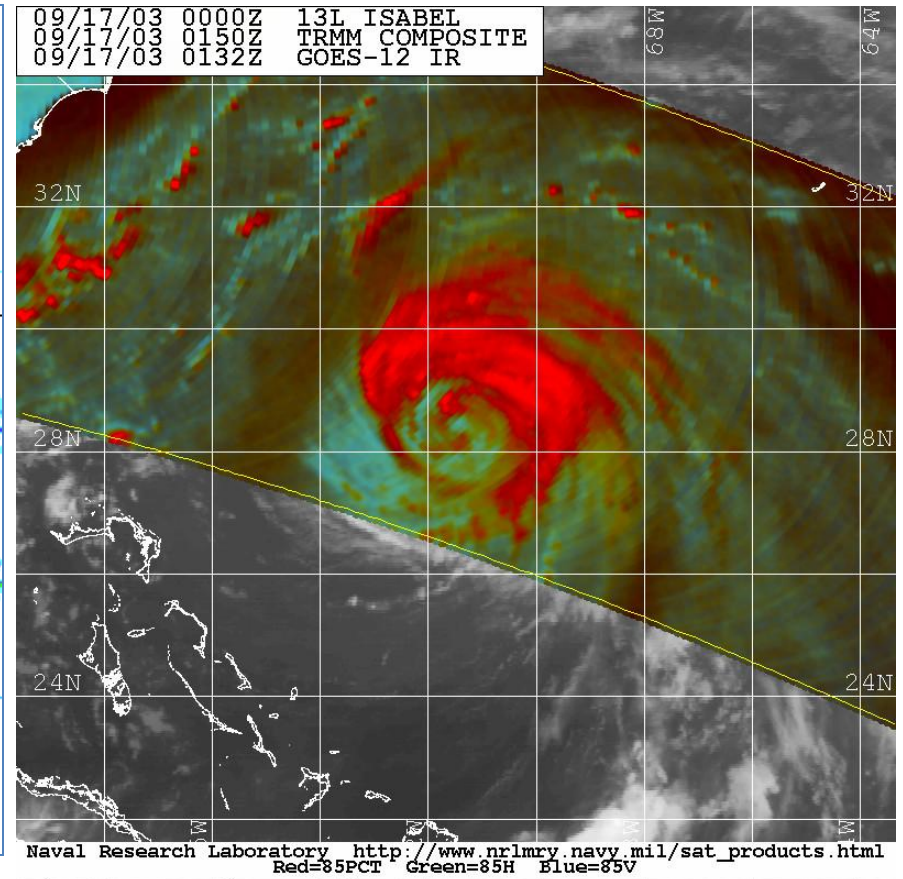


Isabel

$\Delta x = 4$ km, no cu scheme, GFS i.c.



38 h forecast valid
02 UTC 17 Sept. 2003



Developments since 2003

- Moving nest
- Various WRF upgrades
- Improved flux formulation
- 1-D ocean (3-D in progress)
- Advanced data assimilation (EnKF)

High-resolution Hurricane Test (HRH)

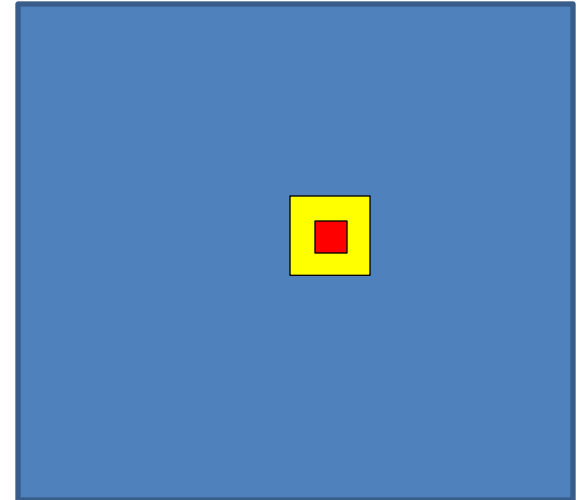
- Compare forecasts with different horizontal grid spacing
- Same initial and boundary conditions
- Same physical parameterizations (except cumulus)
- Selected cases were difficult for operational models
- All Atlantic storms; relatively well observed
- Statistically meaningful sample

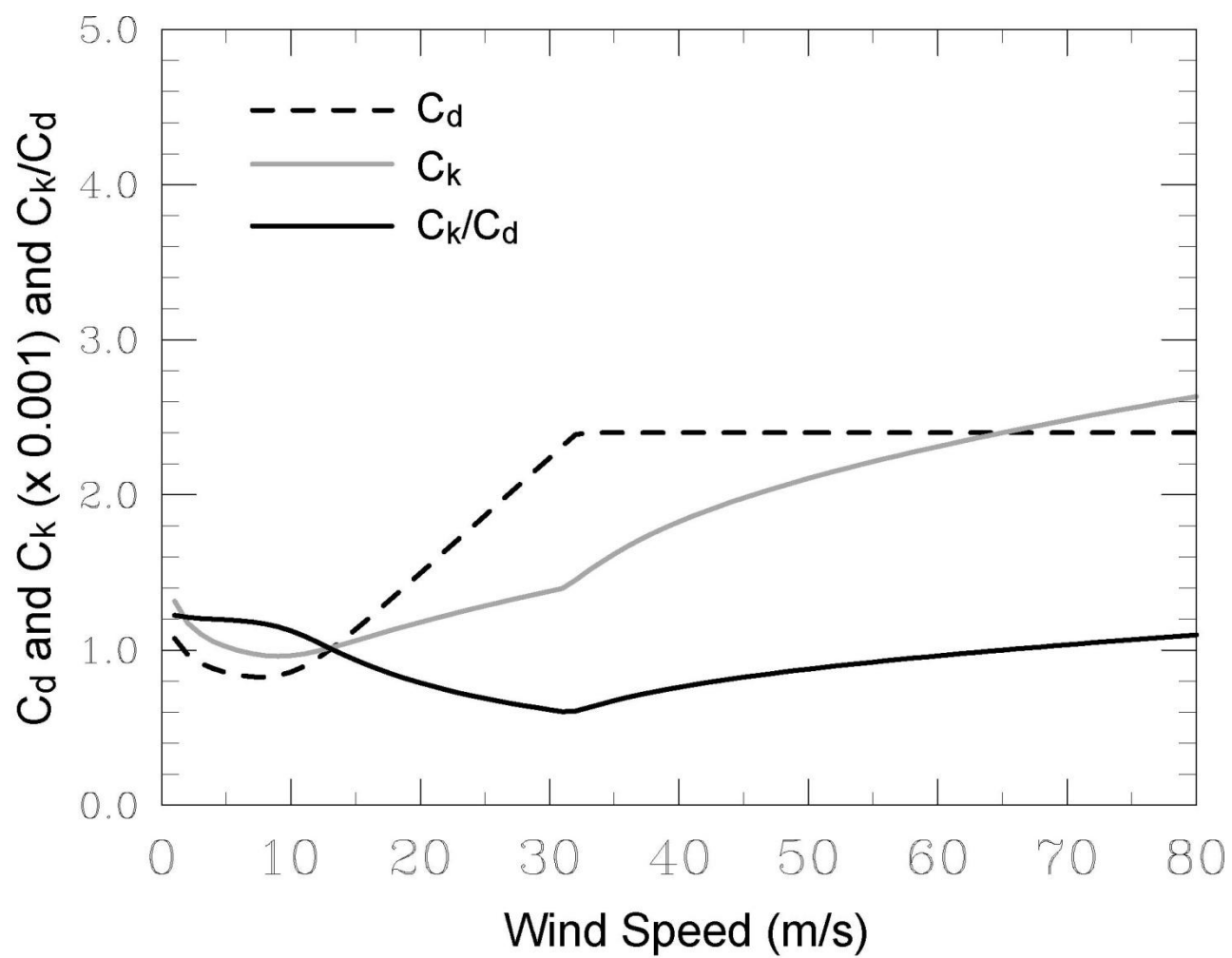
69 Forecasts for 2 Resolutions

Storm	# Forecasts	Initialization
Emily (2005)	10	00 UTC
Katrina (2005)	6	00 UTC
Philippe (2005)	6	12 UTC
Rita (2005)	7	00 UTC
Ophelia (2005)	11	12 UTC
Wilma (2005)	11	00 UTC (mostly)
Felix (2007)	8	6 hrly (mostly)
Humberto (2007)	2	Only 2 times
Ingrid (2007)	4	12 UTC
Karen (2007)	4	00 UTC
Table 2. Storms and # forecasts for each resolution for each storm.		

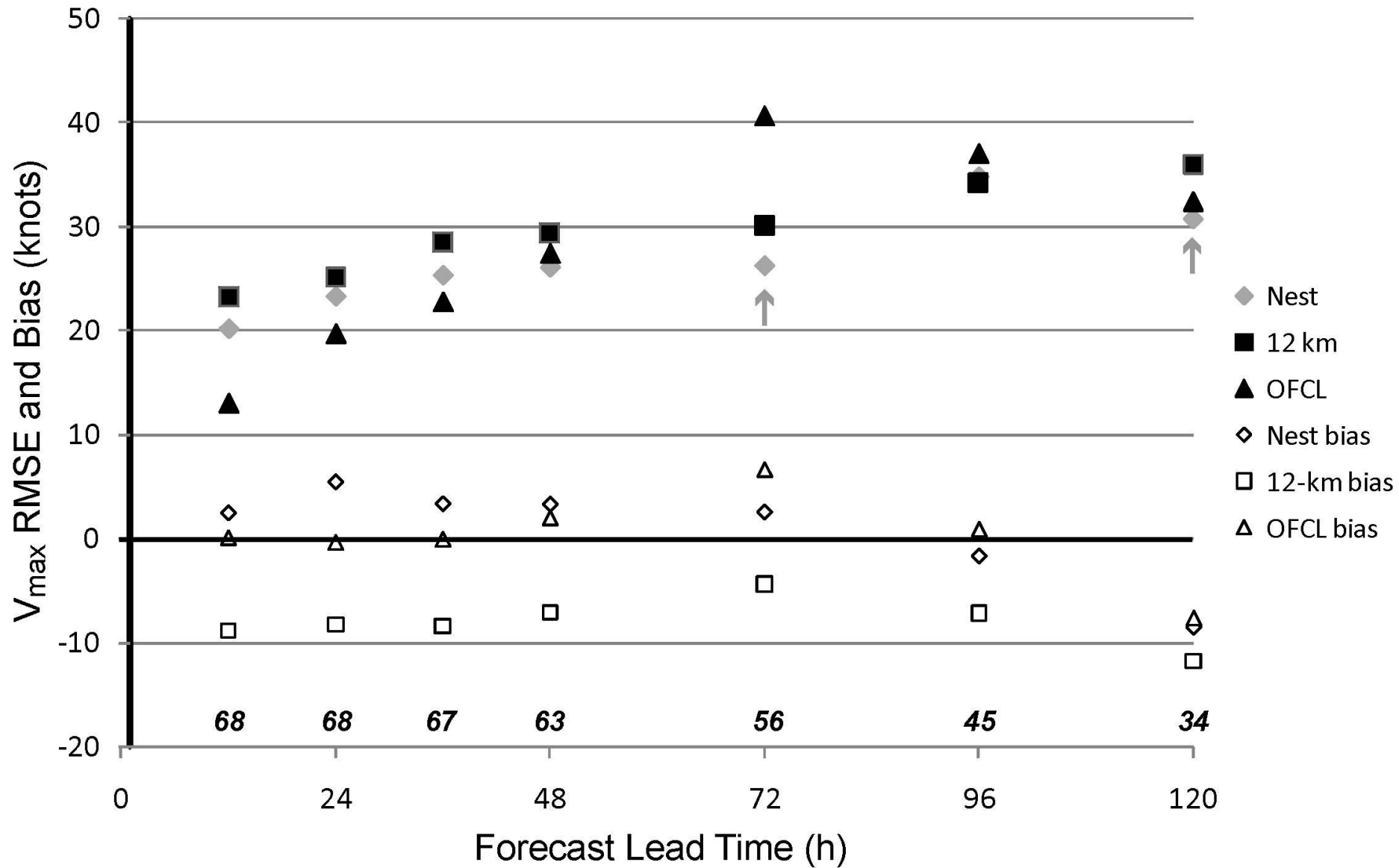
Model Configuration

- Model
 - Based on WRF ARW 3.0
 - (a) 12 km (469 by 424)
 - (b) Nests (no cumulus scheme)
 - 4 km (202 by 202)
 - 1.33 km (241 by 241)
 - 34 levels (stretched vertically)
 - 1-D ocean
 - EnKF for initialization
 - 96 members, 36-km grid spacing
 - Choose member closest to SLP obs.

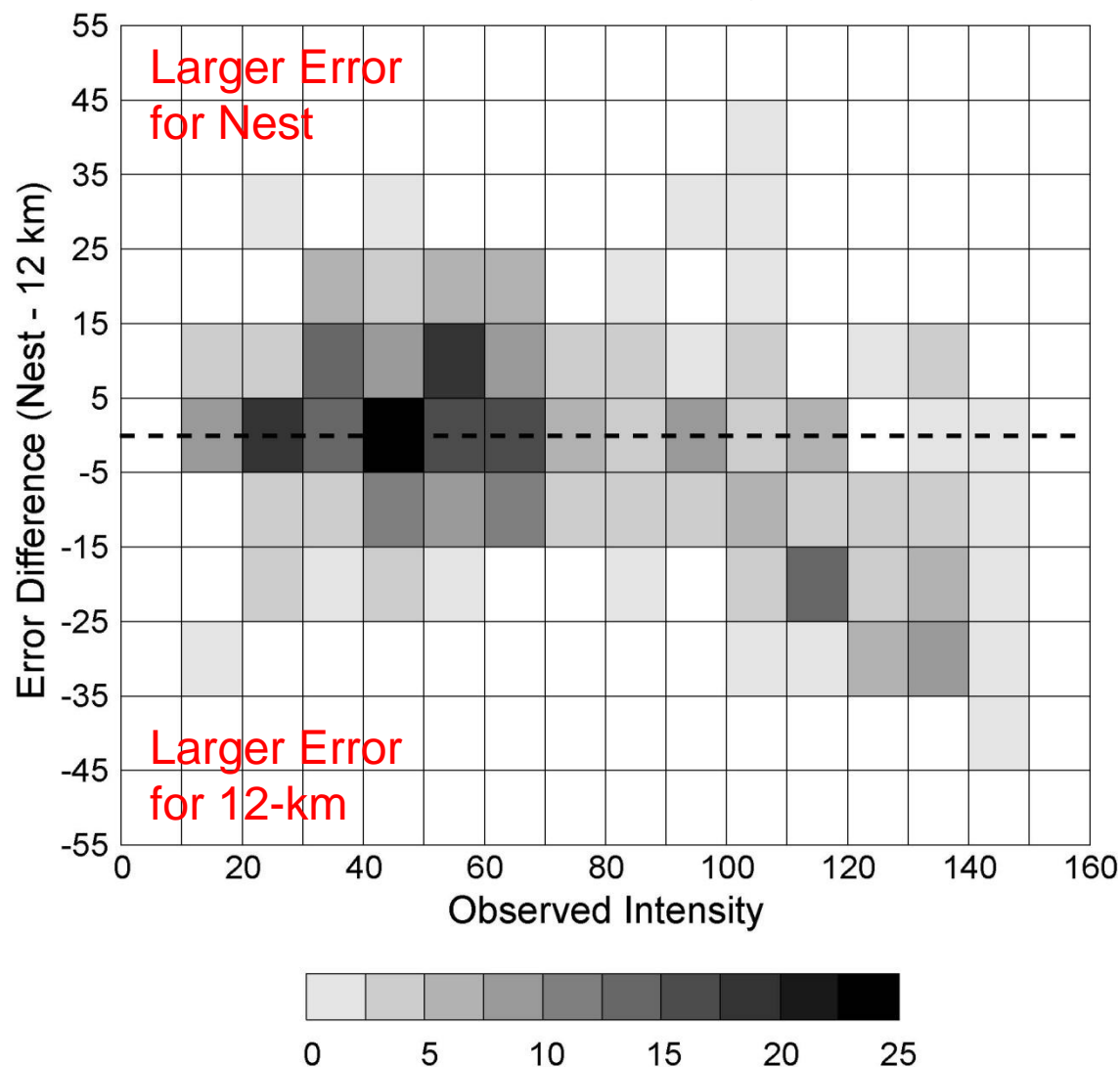




Intensity



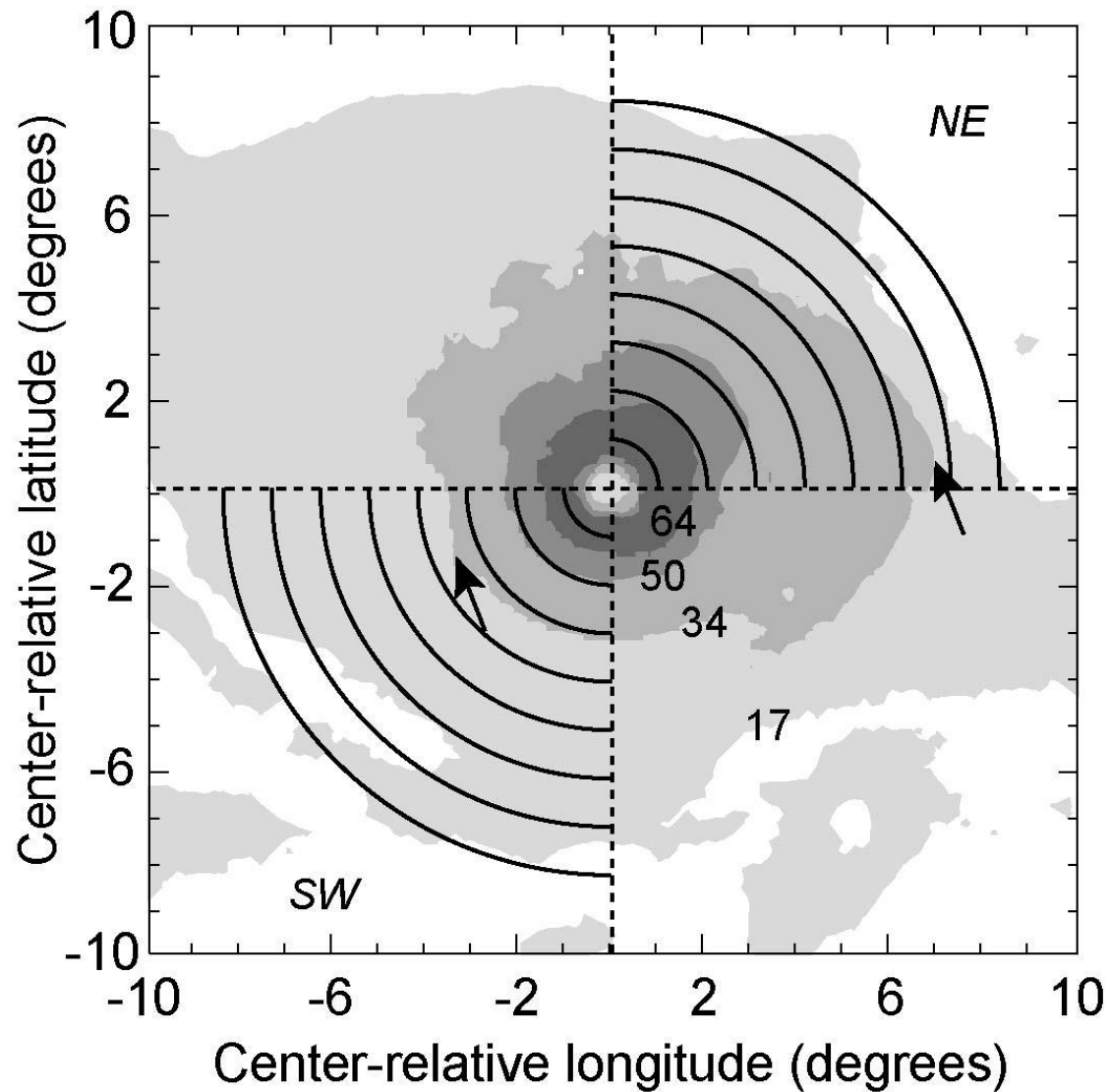
Intensity Error Difference (Nest – 12 km) vs. Observed Intensity (knots)



Rapid Intensification

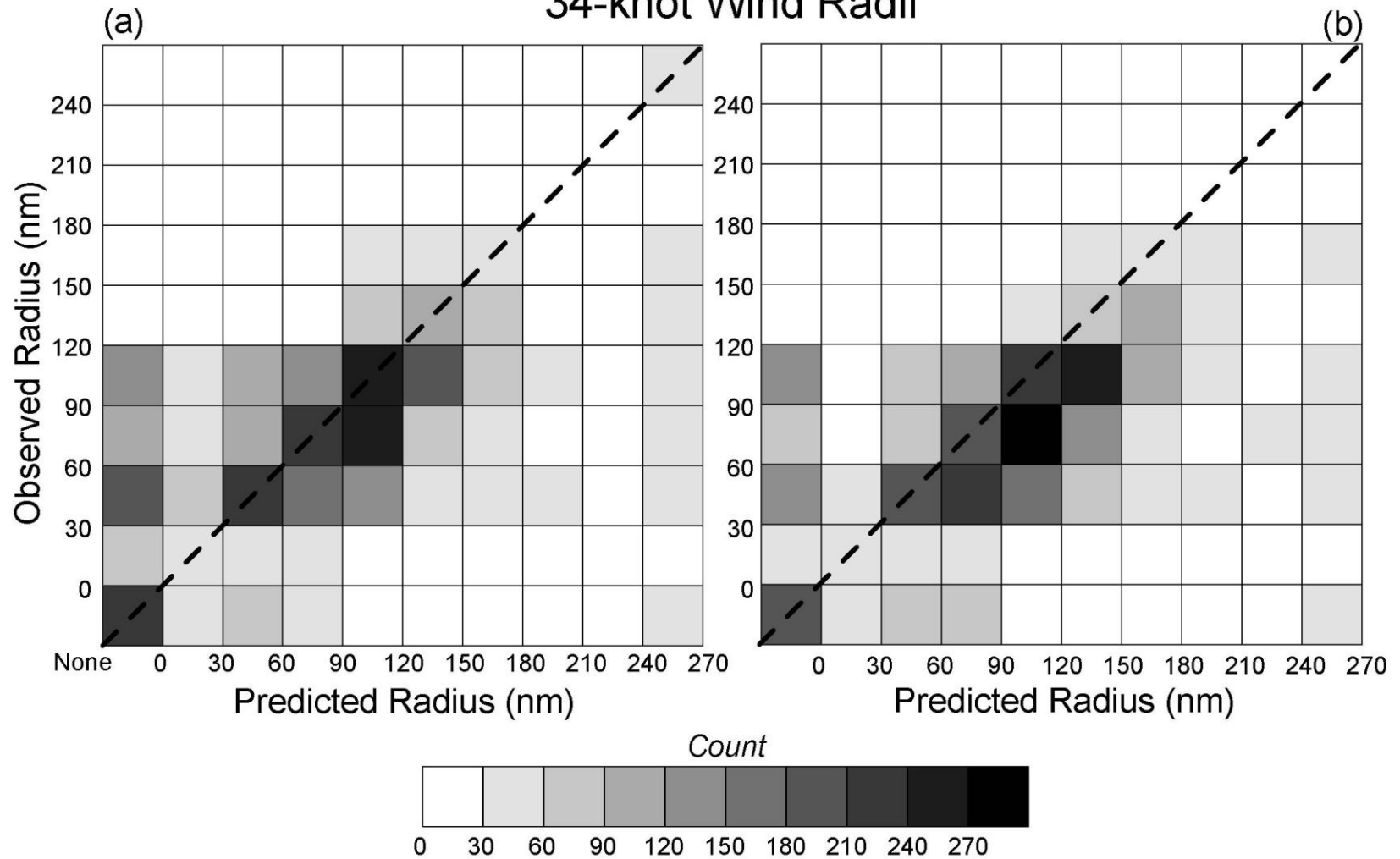
FCST	ETS for RI
OFCL	0.04
12 km	0.11
Nest	0.16
Equitable threat score for rapid intensification (RI) (defined here as 25 knots in 24 h, or more).	

Verification of Wind Radii



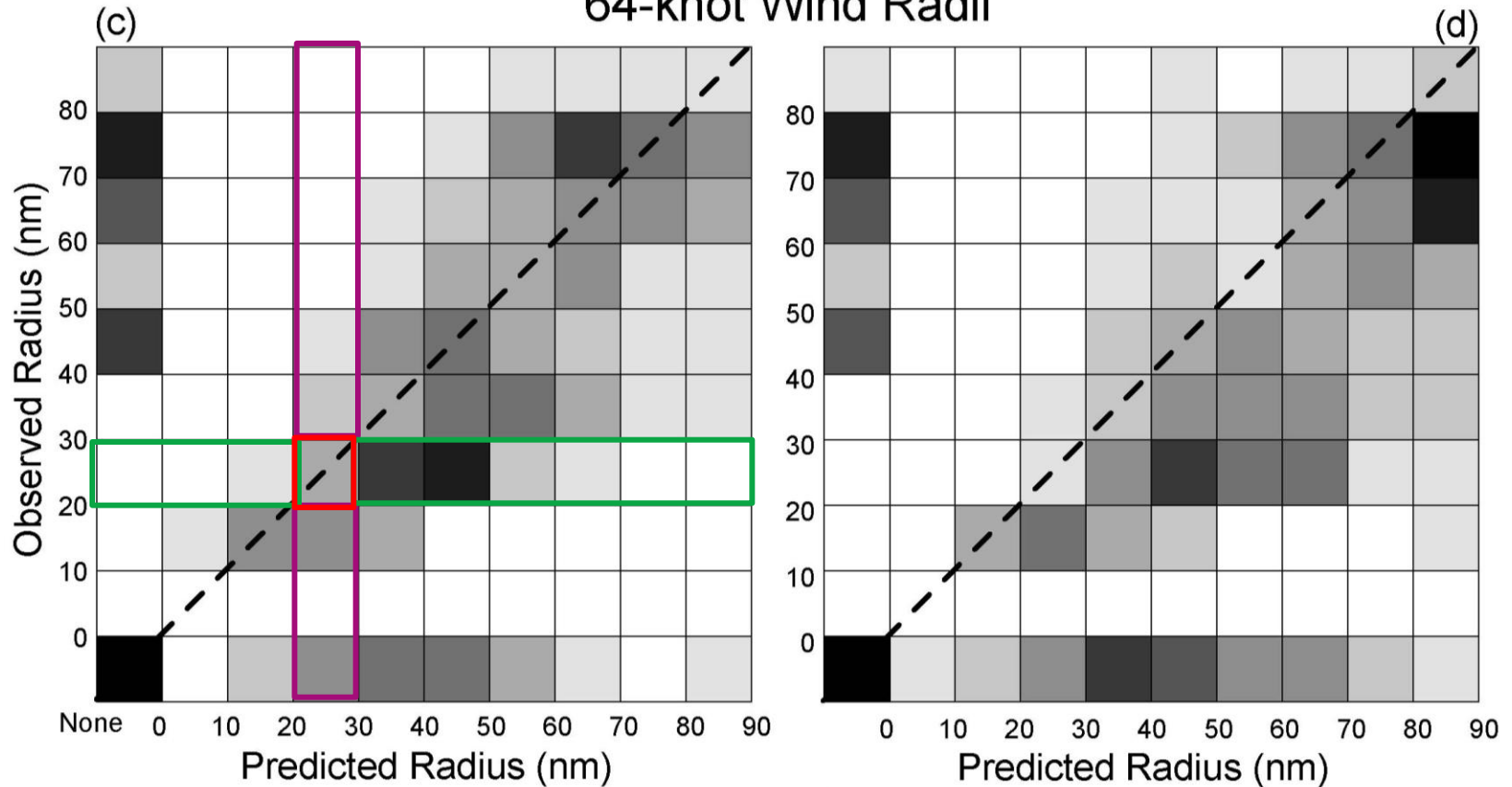
Wind Radii

34-knot Wind Radii



Wind Radii

64-knot Wind Radii



Hit

Miss

False Alarm

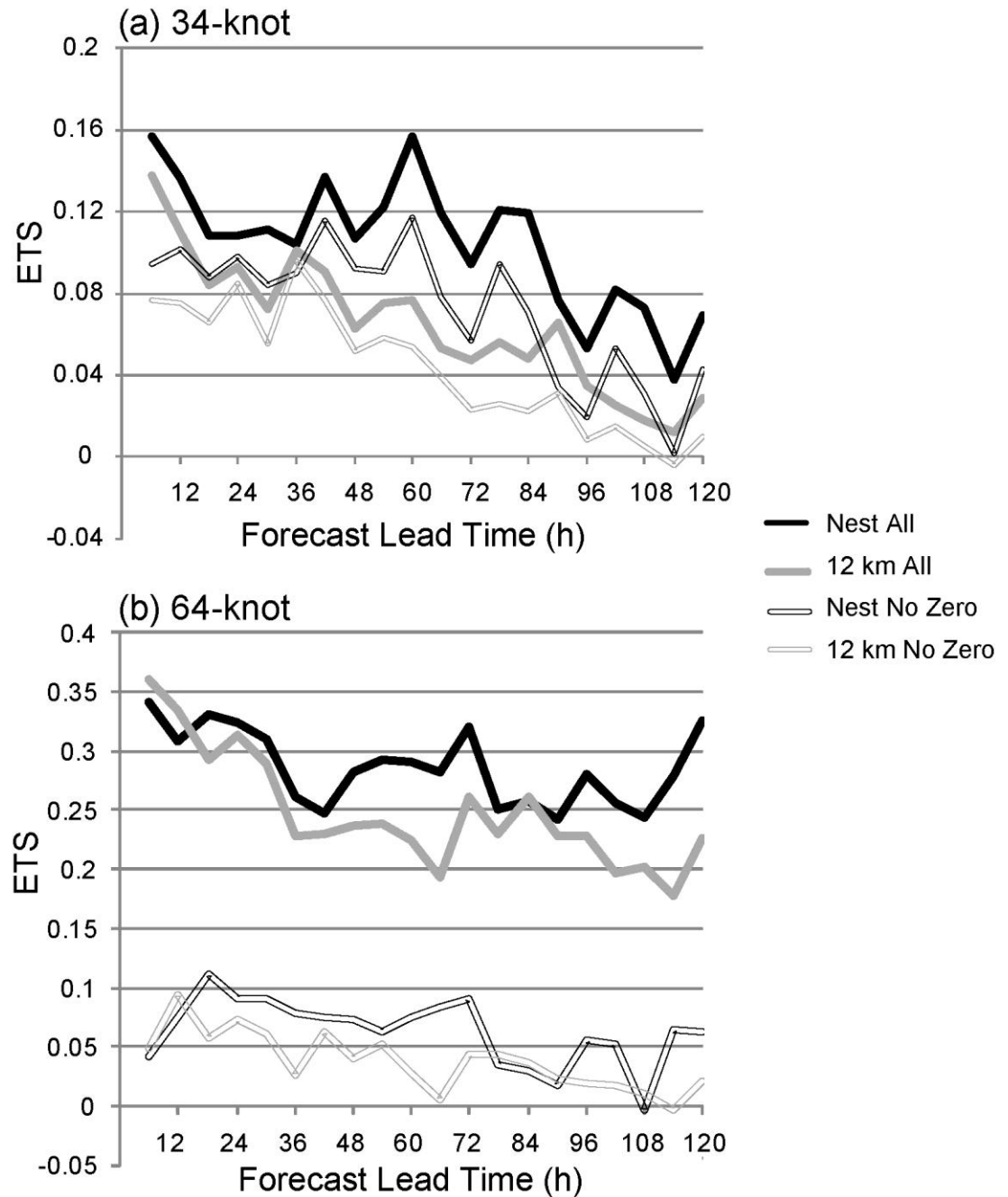
Wind Radii

$$ETS = \frac{H - \varepsilon}{\Sigma - \varepsilon}$$

$$\varepsilon = \Sigma / N,$$

H = # Hits

Σ = Total # of forecasts



Conclusions

- Resolution comparison
 - No significant track difference
 - Slightly improved intensity for Nest
 - Improved skill for RI and wind radii for Nest
 - Gale radius errors governed by “synoptic scale”
- Next steps
 - High-resolution data assimilation
 - Larger outer domain: global?
 - Data assimilation in vortex core: predictability?

Needed Advances for AHW

- 3-D Ocean model
- Idealized vortex initialization
- Moving nest in EnKF
- Improved surface-atmosphere exchange
 - Wave model
 - Sea Spray
- Detailed diagnostic analysis
 - 3-D wind comparisons vs. Doppler radar
 - Flight-level data comparisons
 - Satellite radiance comparisons