WRF Forecasts Over Southeast United States: Does a Larger Domain Lead to Better Forecasts?

Preliminary Results

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Coastal Storms Initiative

- Goal of NOAA's Coastal Storms Initiative (CSI) project: Lessen impacts of storms on coastal communities

- Installation of WRF-ARW at Jacksonville, FL (JAX) NWS WFO in 2003 (Shaw et al. 2003) has helped to improve forecasts of precipitation, visibility, and sea breeze transition and convection compared to the Eta 12 km (Bogenschutz et al. 2005)

- *Question Proposed: Can a larger (CONUS) domain provide improved forecasts compared to a small (JAX) domain?*

Domains

WRF-CONUS

WRF-CSI

Experiment Setup

- Core Utilized: Non-hydrostatic Mesoscale Model (NMM)
- Both domains have 5 km horizontal grid spacing with 38 vertical levels
- Initialized at 00 UTC and run for 48 hours
- Physical parameterizations used:
  - Land-surface model: NOAH unified 5-layer
  - Microphysics: Ferrier
  - Cumulus parameterization: none
  - Planetary Boundary Layer (PBL): Mellor-Yamada-Janjic 2.5
  - Shortwave radiation: Lacis-Hansen
  - Longwave radiation: Fels-Schwartzkopf

Verification Methods

- Surface and upper air verification performed using the WRF verification system, developed at NCEP and FSL

- METAR and conventional radiosondes are used as the surface and upper air observations, respectively

- Precipitation verification performed using the Ebert & McBride technique (Ebert & McBride 2000)

- Sea breeze verification also to be examined, utilizing Contour Error Mapping technique (Case et al. 2004)

- Preliminary results presented from April 1st – June 15th, 2005

Ebert & McBride Verification

- Ebert & McBride technique utilized to overcome limitations of traditional QPF scores
- Introduces concept of Contiguous Rain Area (CRA) defined as the union between the forecast and observation bounded by a user specified threshold (0.25" for this study)
- Forecast entities are shifted across the grid to maximize the correlation coefficient with observations.
- Systematic errors can be computed for each CRA (displacement, pattern, and volume)
- 24 hour accumulations verified, using NCEP Stage IV precipitation observations
- For a CRA to count as a 'hit' for a model, the shifted forecast entity must be correlated at the 95% confidence interval
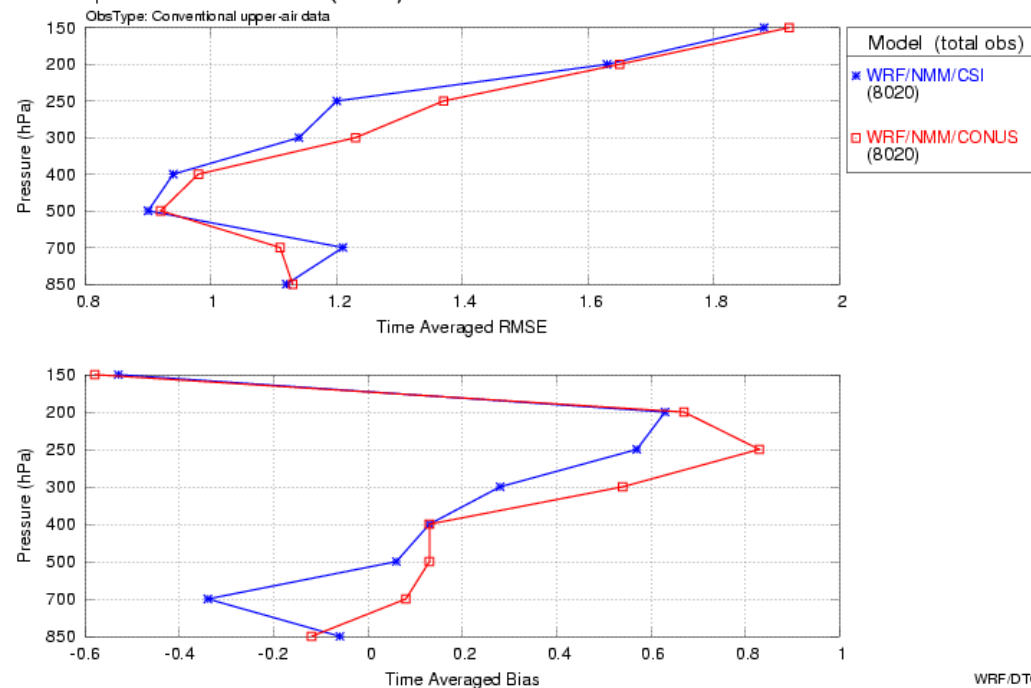
Temperature

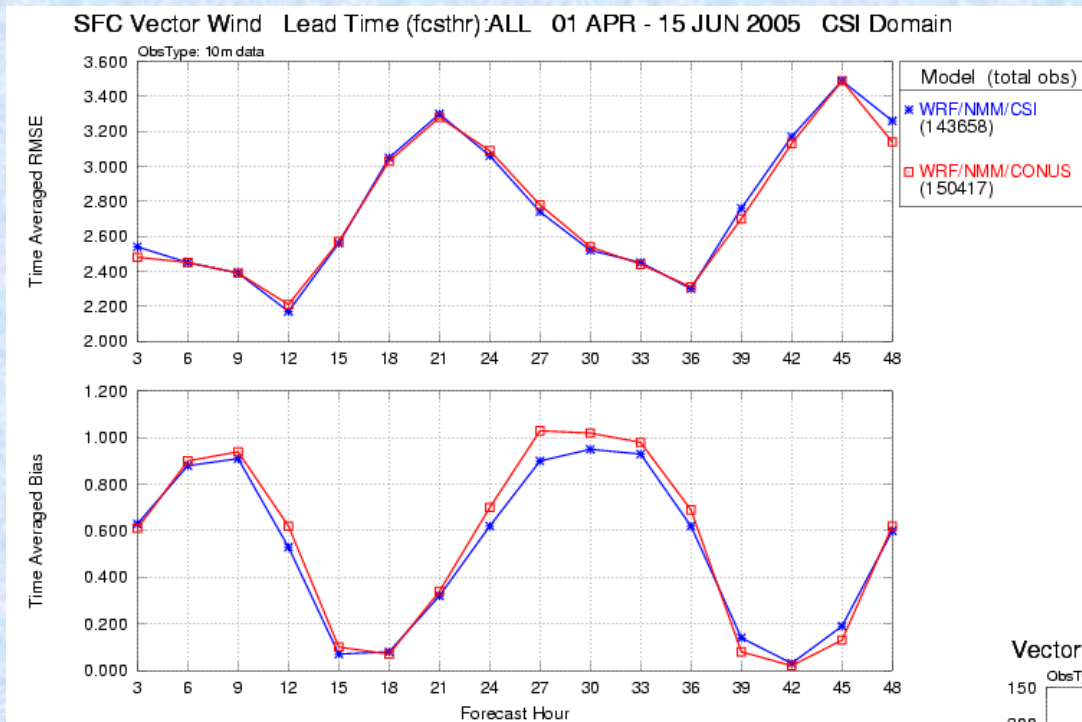SFC Temperature   Lead Time (fcsthr):ALL   01 APR - 15 JUN 2005   CSI Domain
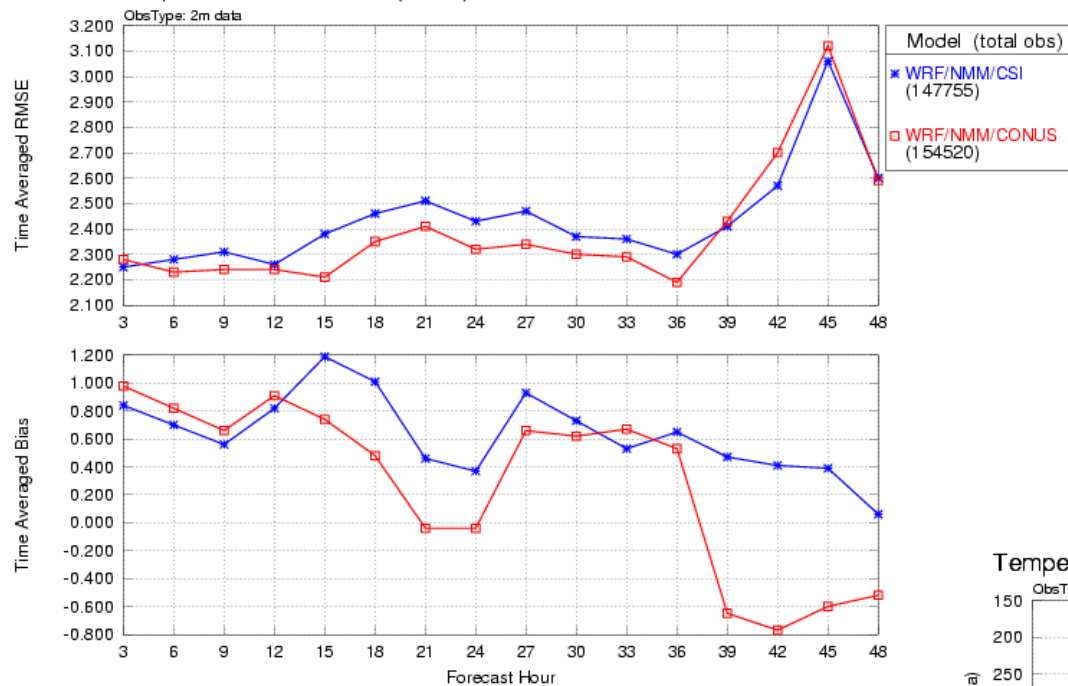
Surface (2 meter)

Temperature   Lead Time (fcsthr):ALL   01 APR - 15 JUN 2005   CSI Domain

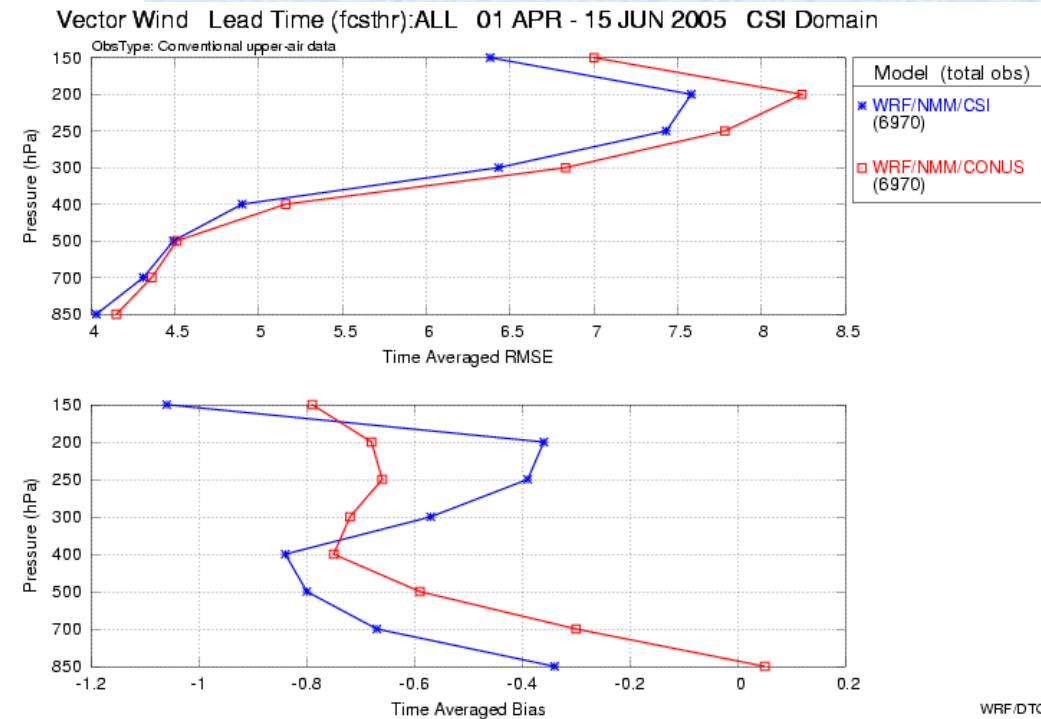Upper Air (All forecast hours)

WRF/DTC

Vector Wind

Surface (10 meter) ←

Upper Air (All forecast hours) ↘

Precipitation

- From April 1st – June 15th, 2005 a total of 468 CRAs detected through observations
- Total hit rates:
  - WRF-CSI: 268/468 = <u>0.57</u>
  - WRF-CONUS: 242/468 = 0.51
- False alarms:
  - WRF-CSI: <u>97</u>
  - WRF-CONUS: 126
- Critical Success Index:
  - WRF-CSI: <u>0.473</u>
 - WRF-CONUS: 0.406

Precipitation (Cont.)

❑ Most of the missed events (82% for WRF-CSI, 83% for WRF-CONUS) was a failure to forecast CRAs with fewer than 100 grid points (very small pop up convection).

❑ Mid-range, or mesoscale, entities (101 – 1200 grid points):

<u>210 Observed</u>

   ❑ WRF-CSI: 154 detections

   ❑ WRF-CONUS: <u>164</u> detections

❑ Large, or synoptic, entities (greater than 1200 grid points):

<u>57 Observed</u>

   ❑ WRF-CSI: <u>54</u> detections

   ❑ WRF-CONUS: 45 detections

Precipitation (Cont.)

ALL CRAS	WRF-CONUS	WRF-CSI
- Unshifted Correlation	0.205	0.169
- Shifted Correlation	0.416	0.428
- Displacement	0.42°	0.51°
- RMSE(in)	0.447	0.501
- Avg Rain Rates (0.323 in/24 hr observed)	0.692	0.780

	CONUS	CSI
Bias	1.15	1.25
ETS	0.45	0.38

WARNING: These stats are for CRAs only, not entire grid

Systematic Error Decomposition
April 1st - June 15th, 2005
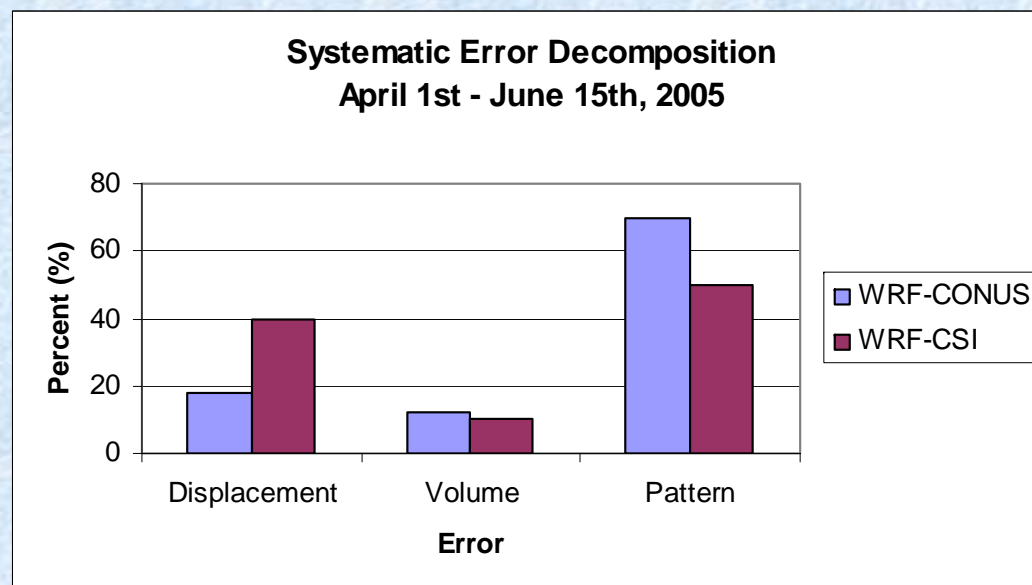
Sea Breeze Case
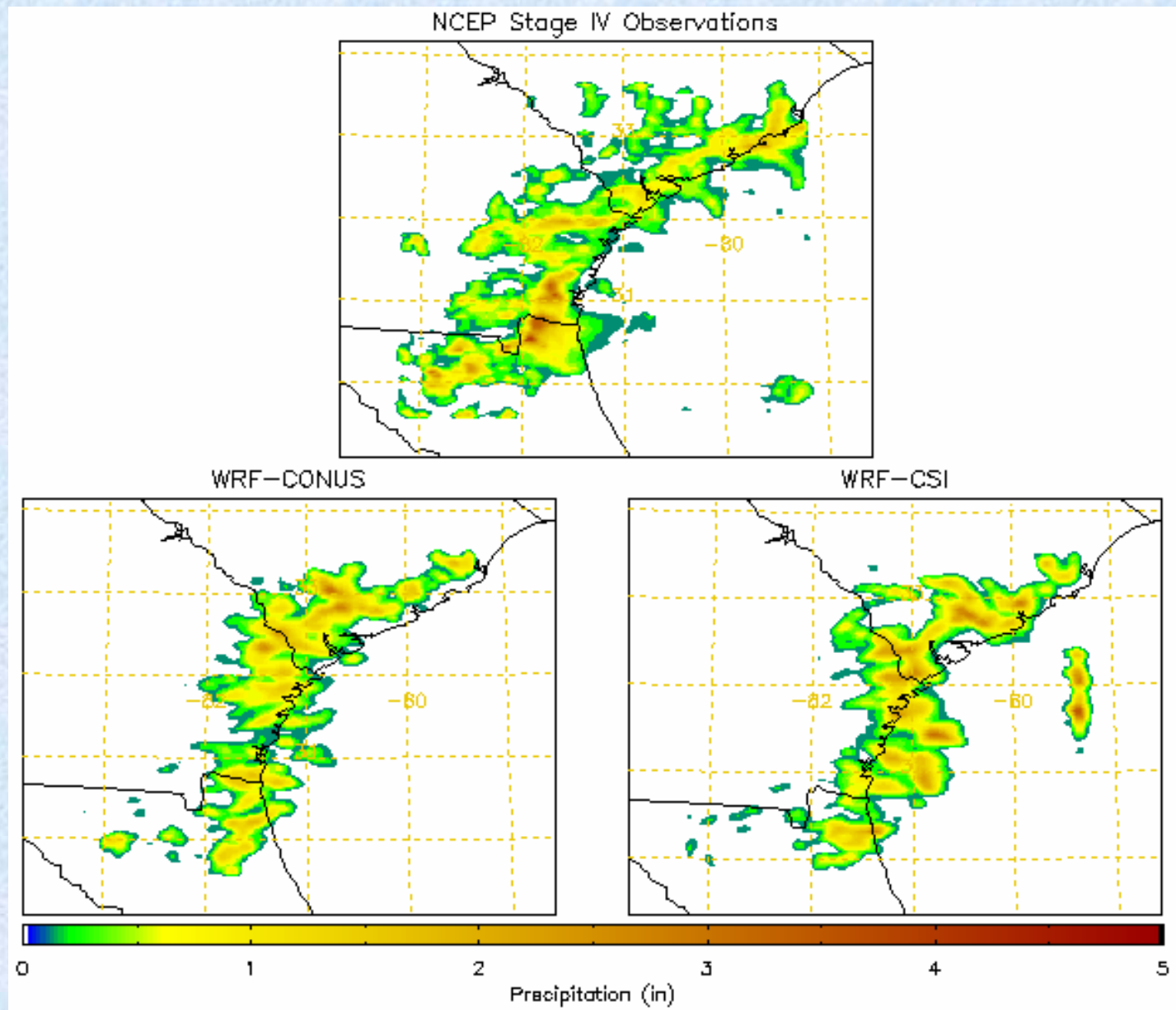
Summary & Future Work

- Preliminary results show no substantial advantages found in running a CONUS domain over a regional domain
- More warm season verification warranted (case verification)
- WRF-CONUS and CSI runs extended through July and possibly further
- Sea breeze verification
- Tropical cyclone verification
- Comparisons with WRF-ARW currently run at JAX NWS WFO