

Prediction, Validation, and Calibration of Coastal Storms and Associated High Impact Weather in Ensemble Regional Climate Simulations over the Northeast U.S.

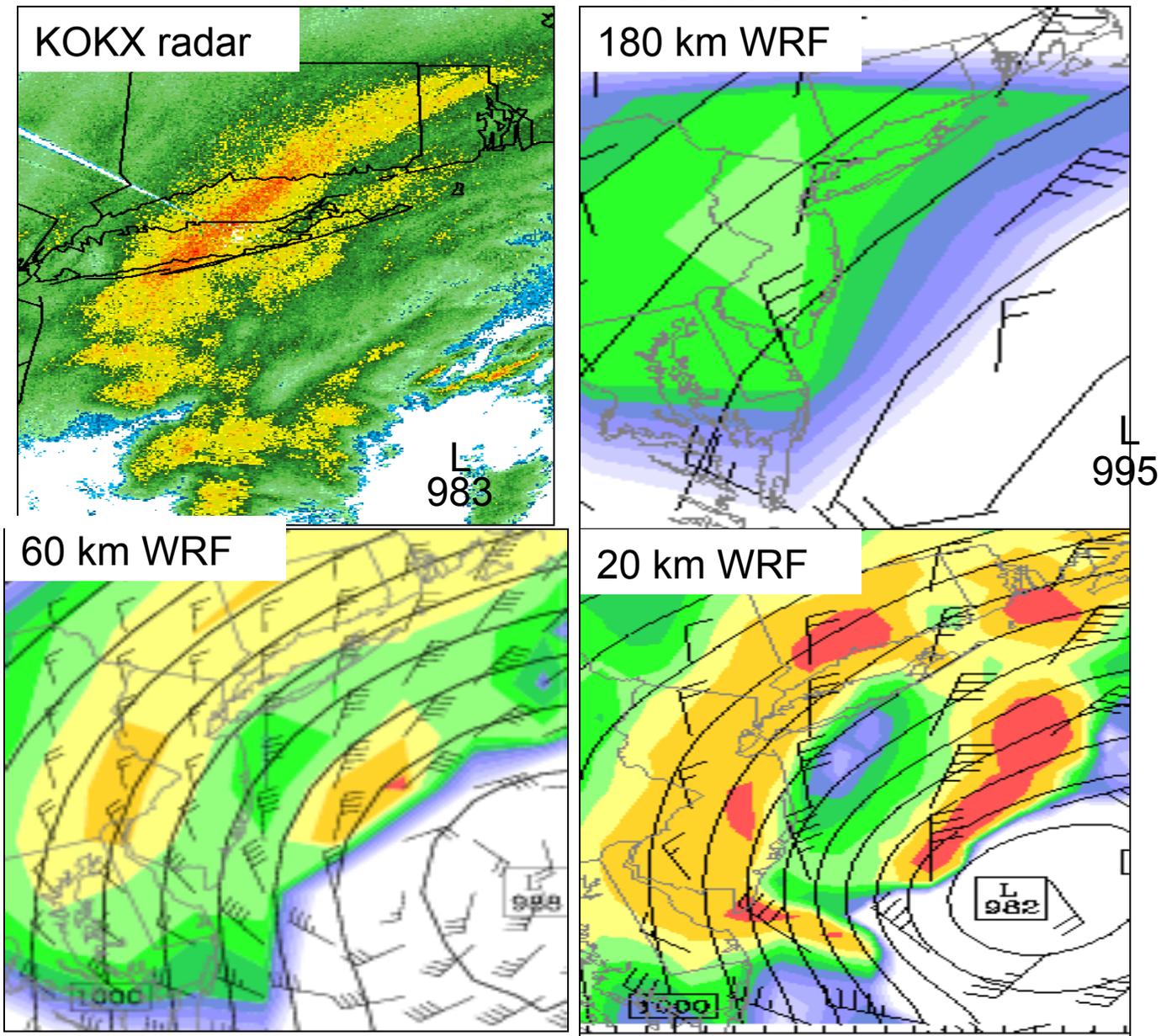


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*Observed and Simulated Snowband (shaded in dBZ) Around Long Island, NY
at 0500 UTC 20 December 2009*

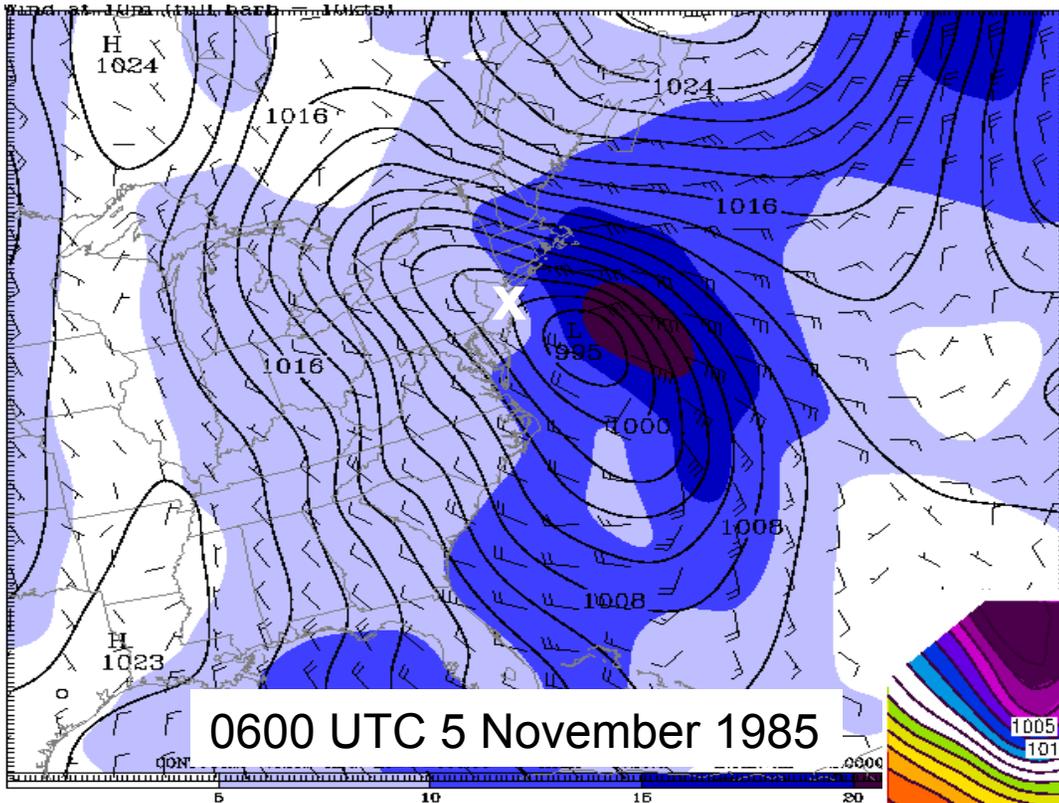


Motivation

- Many human, industrial, commercial, and marine ecosystem impacts along the U.S. East Coast are influenced by extreme precipitation, temperature, wind, and coastal flooding associated with winter storms.
- There have been only a few dynamically-downscaled model studies of winter mid-latitude cyclones (MLCs) over eastern North America.
- Can an ensemble of moderate resolution WRF simulations nested within the CCSM ensemble be calibrated to improve the climate predictions of MLCs?
- We also hypothesize that the prediction of MLCs in RCMs is dependent on what SST resolution is used and how it changes in the forecast.

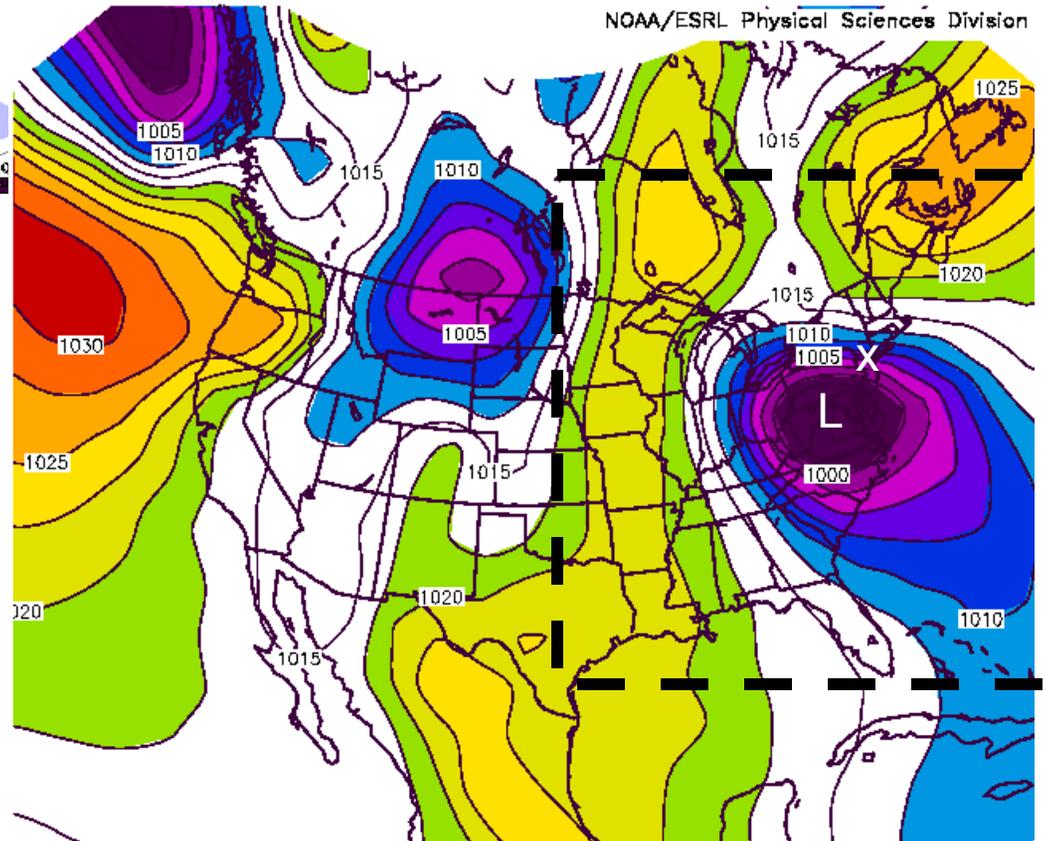
Approach

- Integrate 8-12 ensemble of coupled CCSM-WRF simulations from 1984-2004 by varying physics, SST, and land-surface models.
- Also run WRF ensemble within the NCEP2 analysis from 1984-2004. Verify cyclones to determine model performance. Also test Climate WRF (CWRF) member?
- Use historical runs to bias correct and weight the CCSM-WRF members. Test impact of SST, and one-way vs two-way nesting, and compare with NARCCAP.
- Use calibration and ensemble member weights for 2040-2070 runs; statistics will be calculated for cyclone density and tracks, extreme temperatures, heavy precipitation, snow banding events over the Northeast U.S., and coastal storm surge events



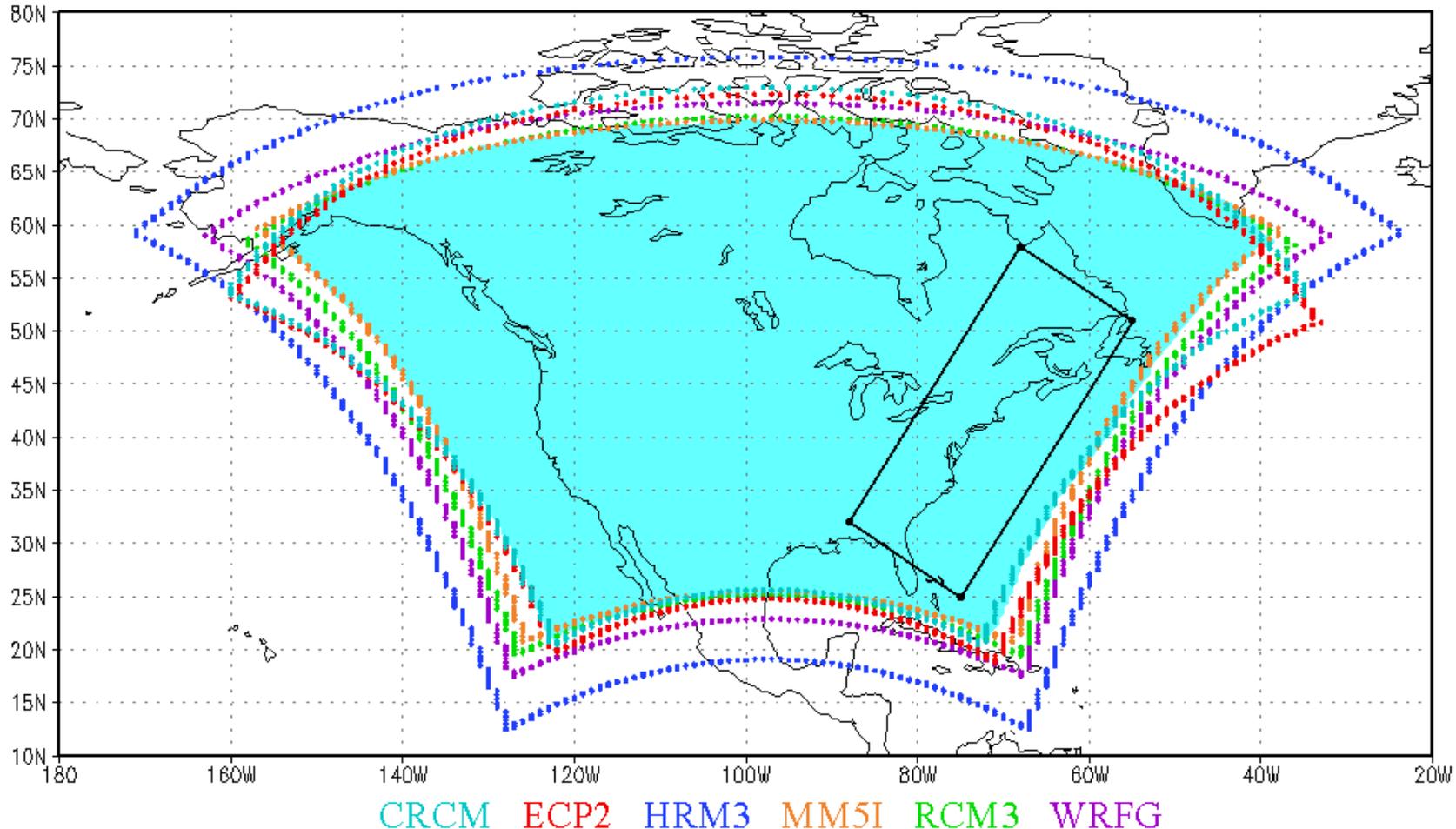
**20-km WRF
domain**
(forced by NCEP2 analysis on
boundary)

**NCEP2
Reanalysis**



Compare Cyclone Results with North American Regional Climate Change Assessment Program (NARCCAP)

NARCCAP RCM Domains



<http://www.narccap.ucar.edu/> (RCMs ~50 km grid spacing)

<http://narccap.ucar.edu/data/rcm-characteristics.html>

NARCCAP Members (all interpolated to 0.5 degree grid)

	NCEP	GFDL	CGCM3	HADCM3	CCSM
CRCM	1979-2003		1968-2000 2038-2070		1968-1999 2038-2069
HRM3	1979-2004			1968-2000 2038-2070	
MM5I					1968-1999 2038-2070
RCM3	1979-2003	1968-2000 2038-2070			
WRFG	1979-2004		1968-2000 2038-2070		1968-1999 2038-2070

Red members: will show some East coast cyclone predictions from these members later

1. Cyclone Tracker Procedure

Hodges (1994) TRACK Scheme

(Hodges, 1994: A General Method For Tracking Analysis And Its Application To Meteorological Data)

Part I: data preprocessing - Spectral Bandpass Filter the MSLP field

a: Use Discrete Cosine Transform (DCT) for spectral decomposition on a limited-area domain (Denis, 2002)

b: Remove planetary scale background (i.e. total wavenumber ≤ 5) and small scale waves (i.e. total wavenumber > 42)

Part II: Cyclone tracking

1. Flag cyclone centers:

- a. Segmentation: Identify objects around minimum in the SLP field.
- b. Store the objects for tracking.

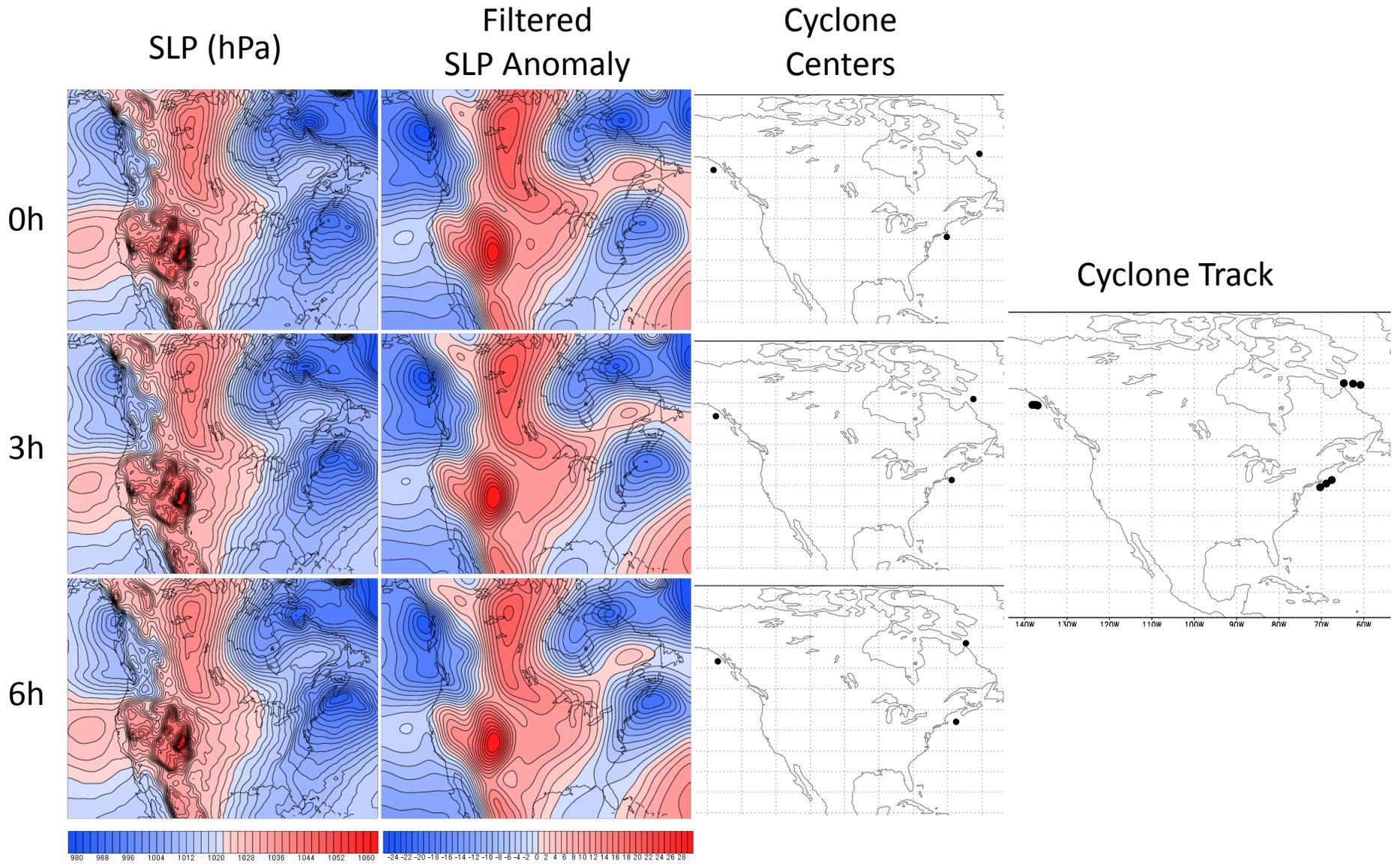
2. Tracking:

- a. Use a constrained optimization of a cost function to determine the next potential cyclone center position (based on the algorithm of Salari and Sethi 1990.)
- b. Label these connected cyclone centers with a unique storm ID

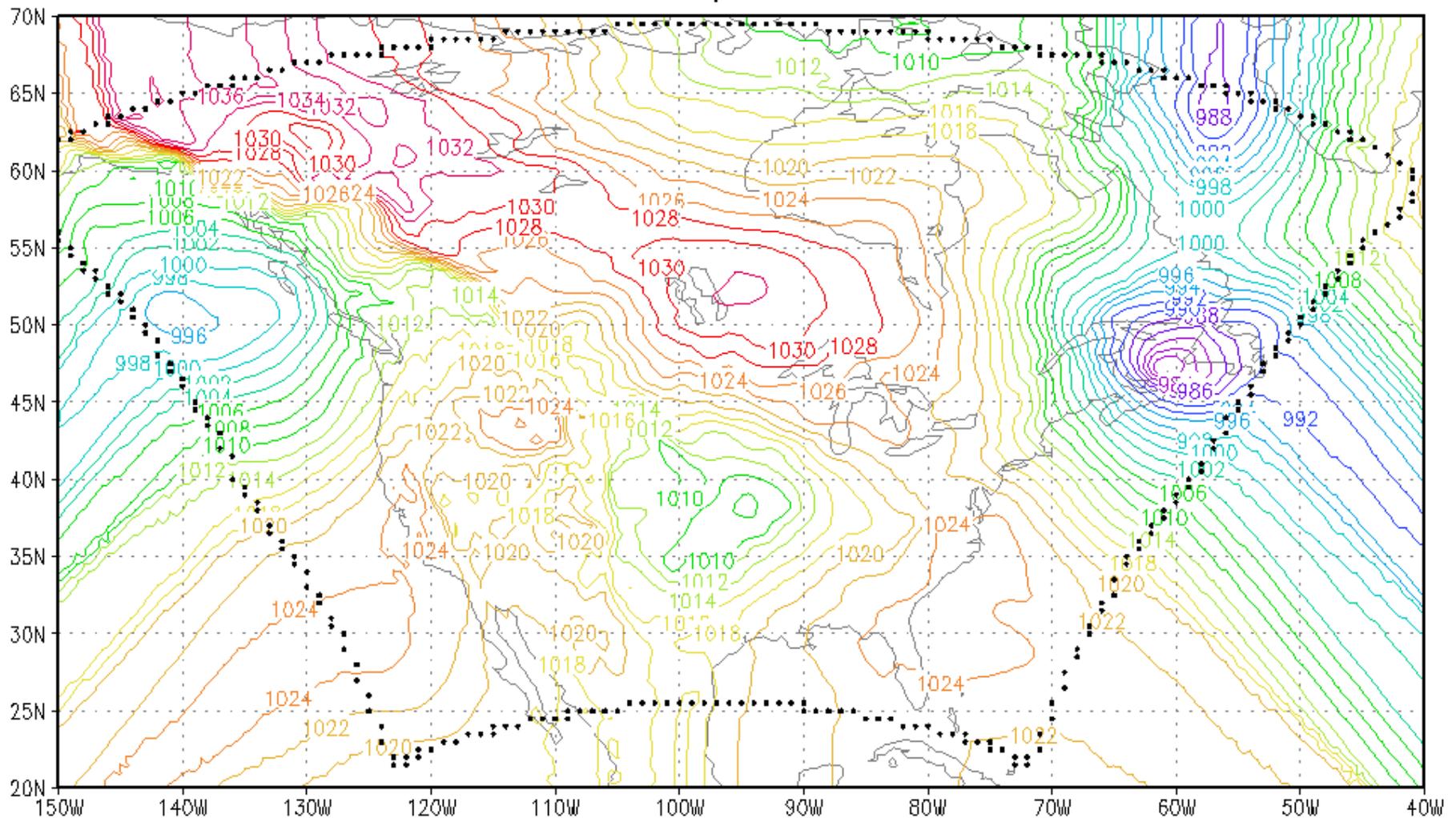
2. Parameters Explored

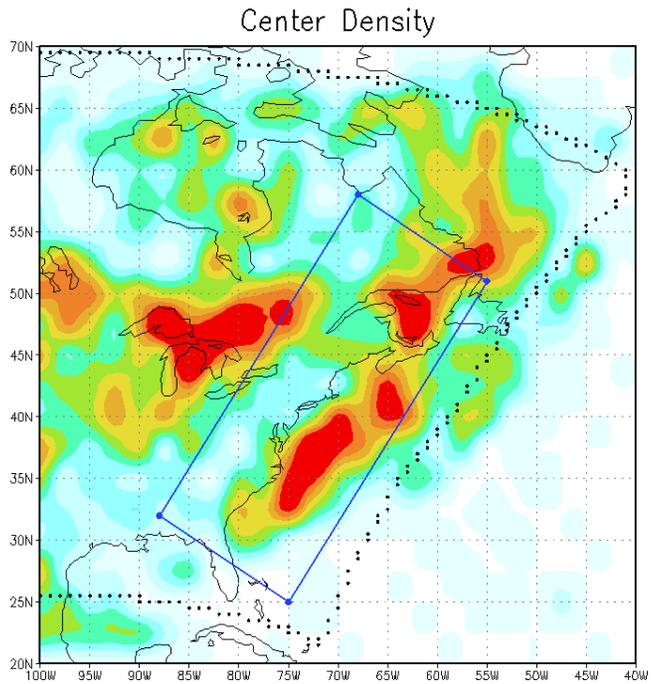
- Wavelength (600 – 10000km)
 - removes the planetary scales and too small scales
- Minimum Lifetime (i.e. 1 day)
- Minimum moving distance (i.e. 1000 km)
 - filtering centers exist for too short time or remain too stationary

3. Example case



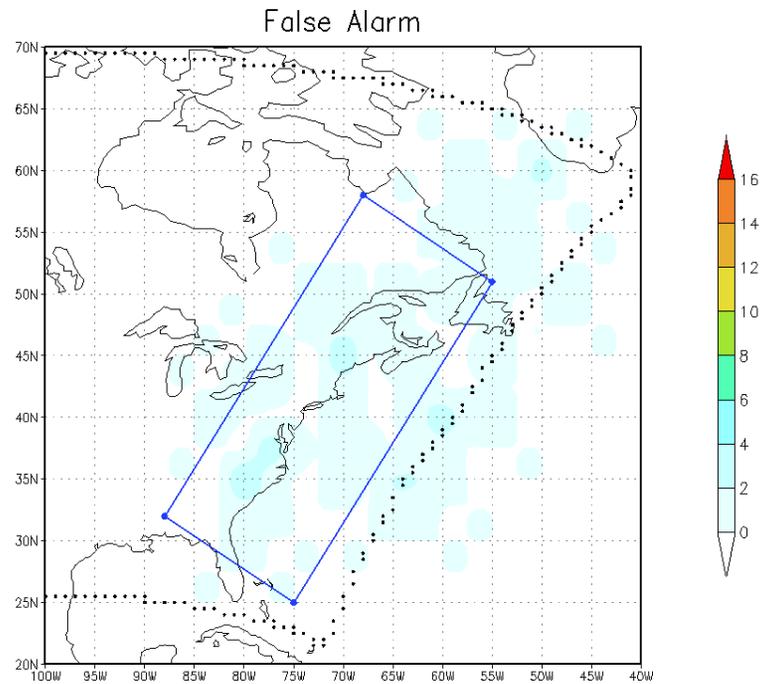
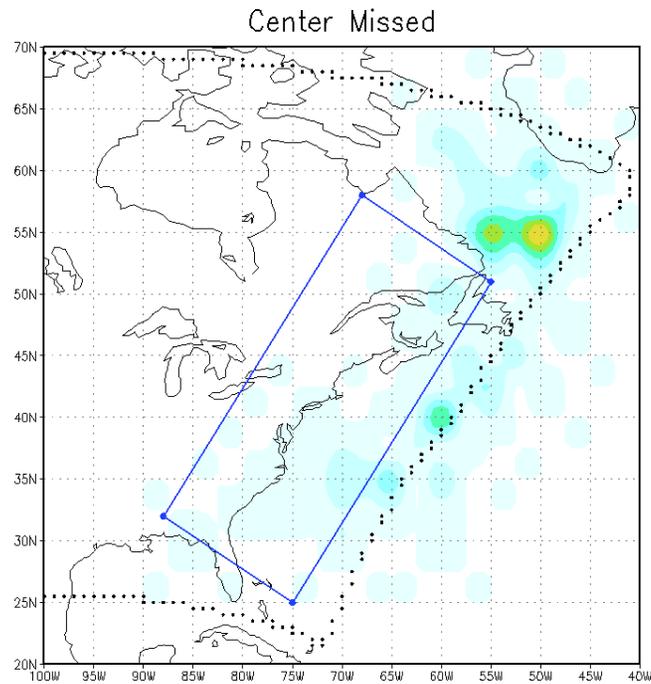
Interpolate NARCCAP Runs and CFSR on a common 0.5 deg grid + outer extrapolation for Hodges tracker



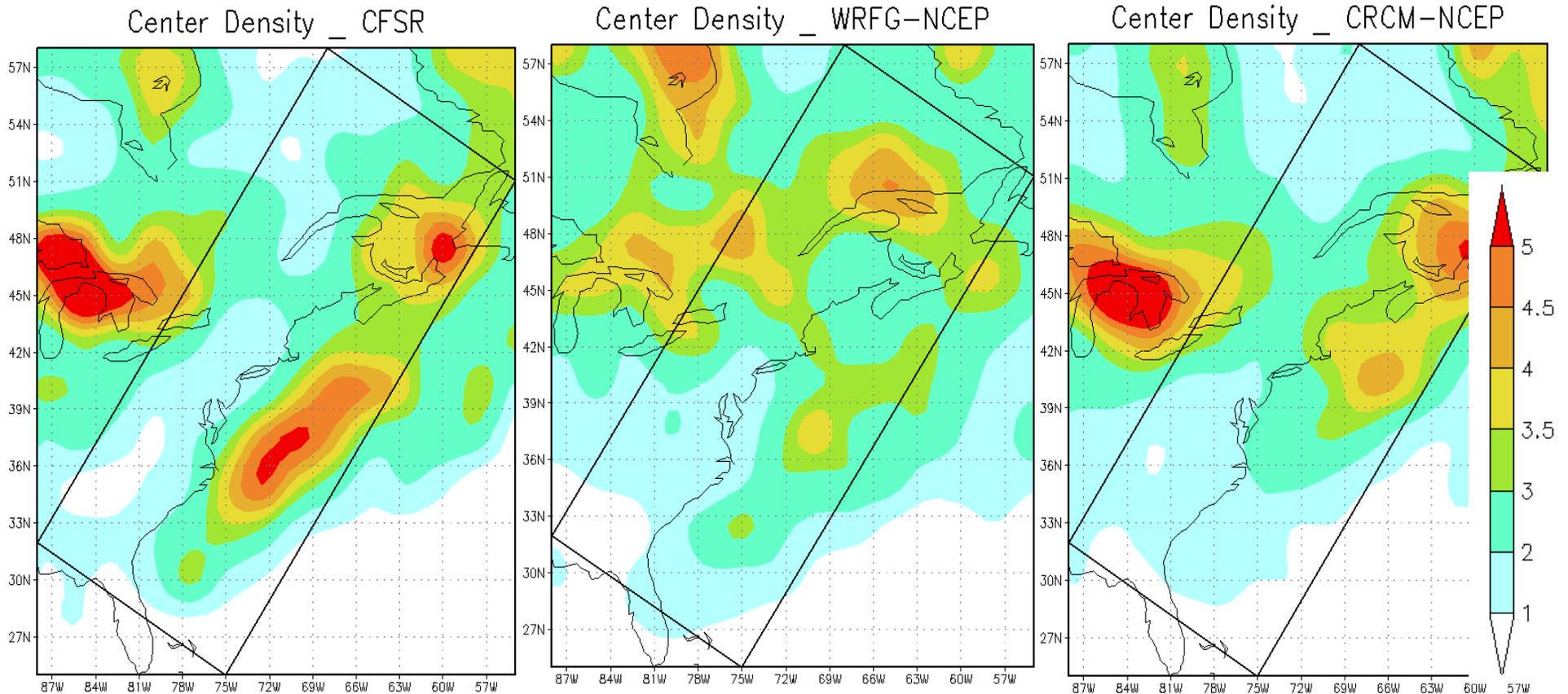


Tracker Verification using CFSR and manual inspection of every other January from 1979-1998 Over East Coast Box

total centers	centers missed	false alarm
617	29	34
rate	4.7%	5.5%

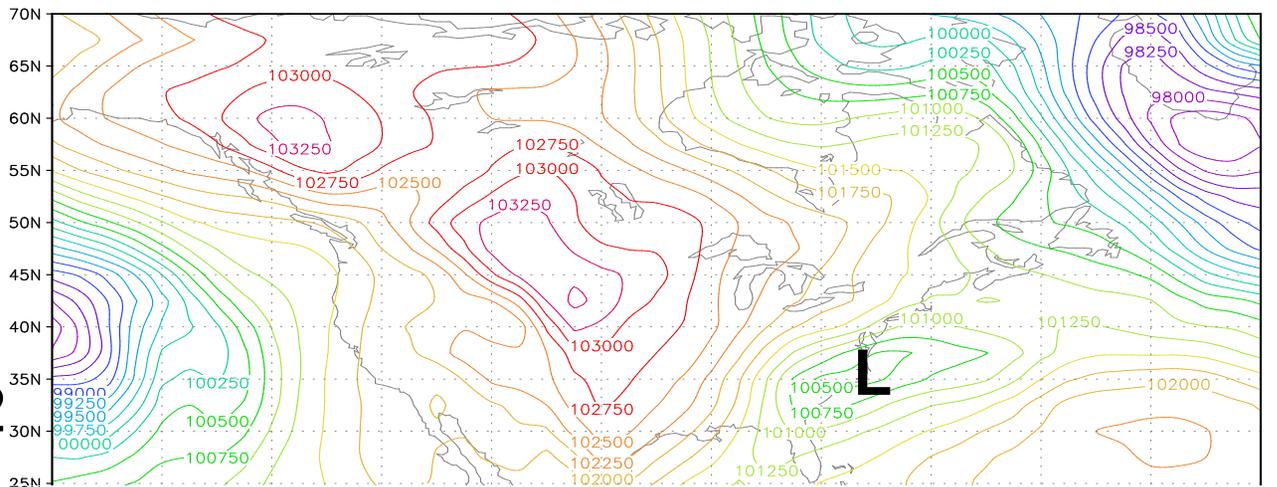


Average DJF Cyclone density (# Cyclones per 2.5 deg) from 1979-1998 (CRCM and WRFG nested within NCEP)

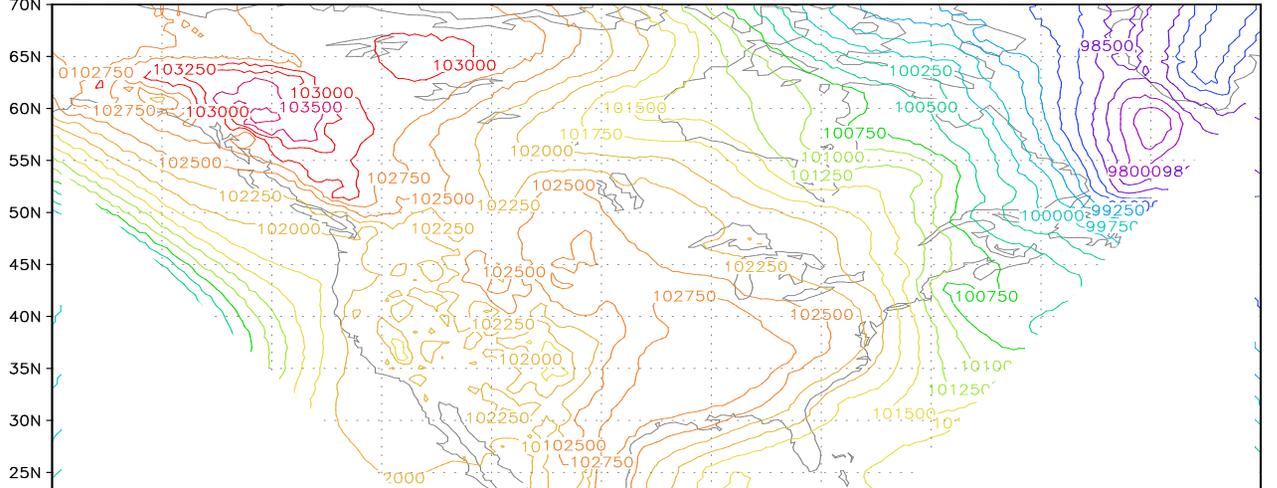


East Coast Cyclone Event (1200 UTC 11 February 1986)

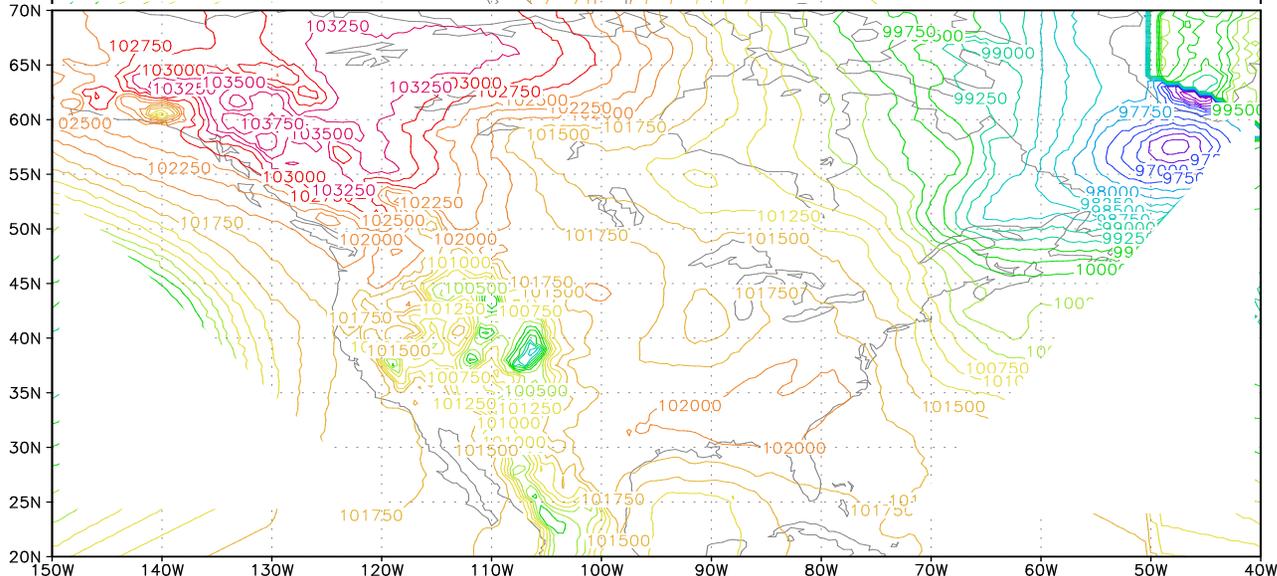
NCEP2



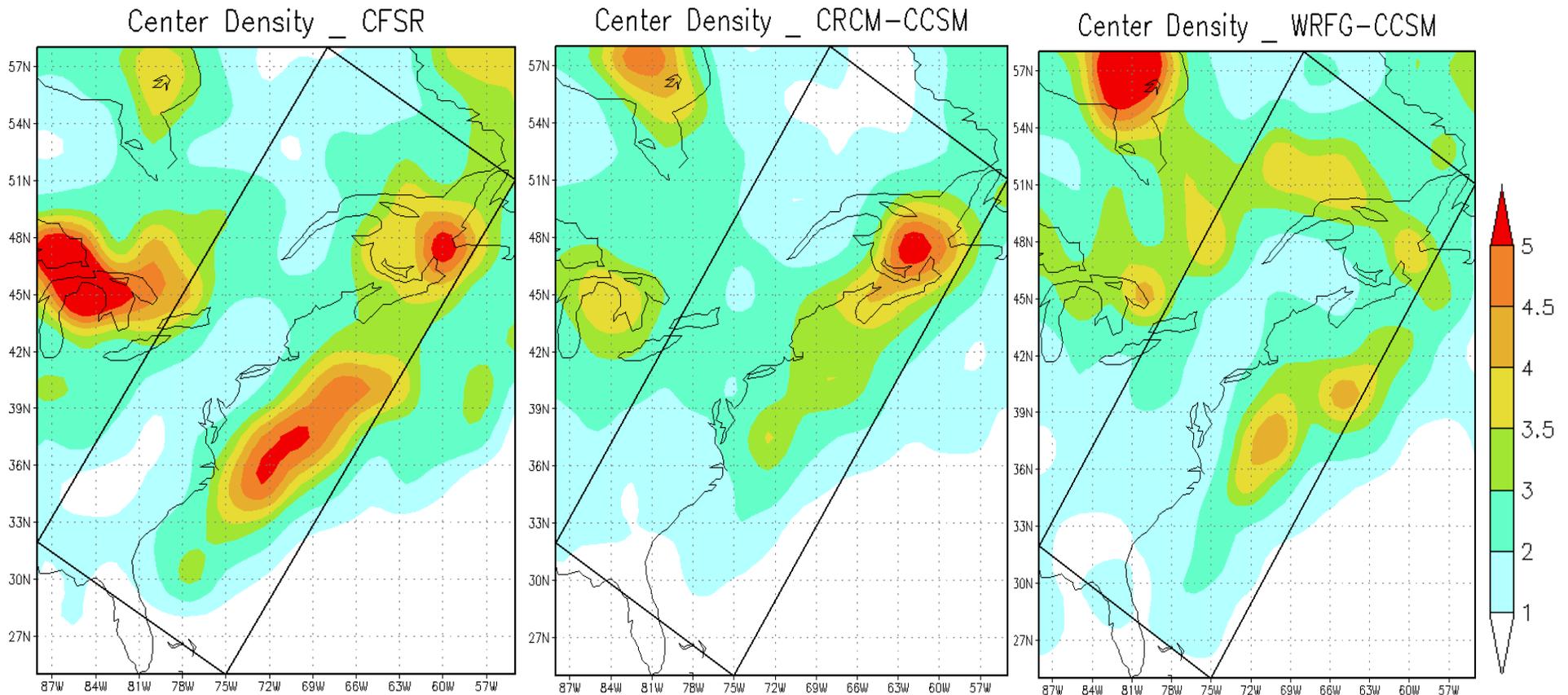
CRCM-NCEP



WRFG-NCEP



Average DJF Cyclone density (# Cyclones per 2.5 deg) from 1979-1998 (CRCM and WRFG nested within CCSM)



Summary

- An 8-12 member ensemble of one-way CCSM-WRF is being completed for 1984-2005 down to 20-km grid spacing.
- The ensemble results will be calibrated and weighted before completing a similar set of runs for the future.
- The Hodges (1994) cyclone tracker has been implemented and tested using the CFSR and NARCCAP grids.
- Preliminary results suggest that the CRCM and WRF NARCCAP models may underpredict the number (and intensity) of winter cyclones over the western Atlantic.