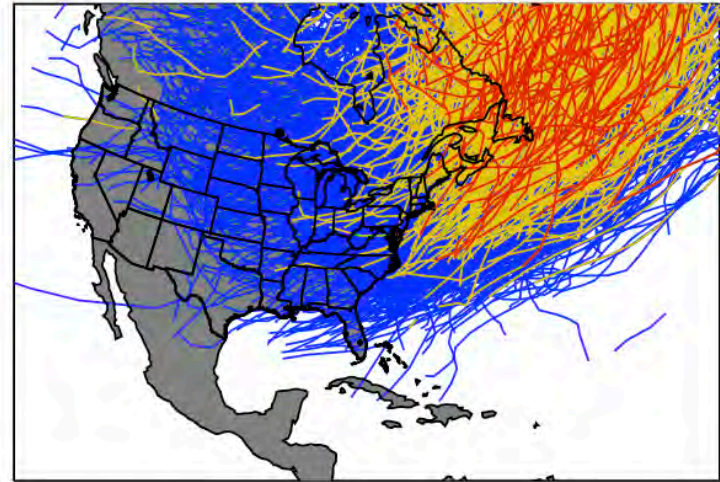
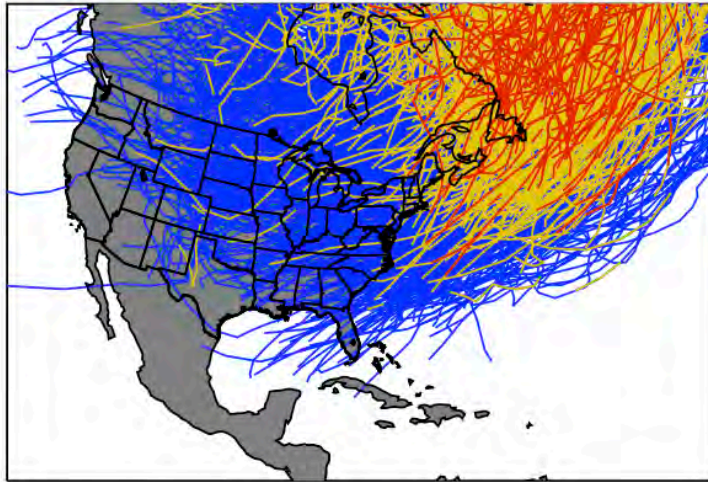
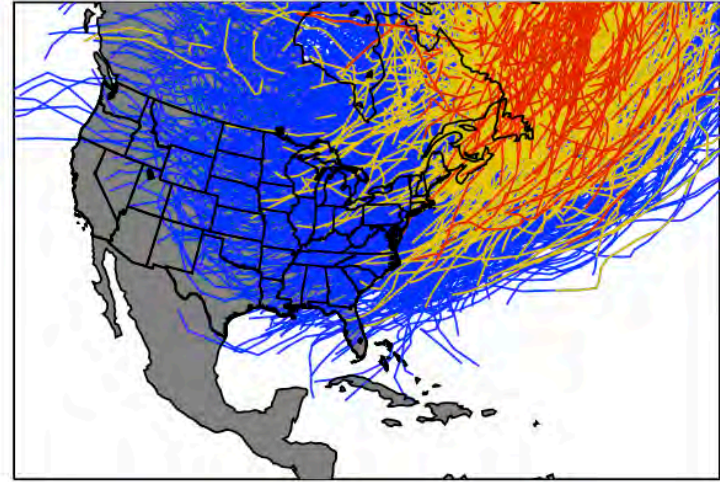
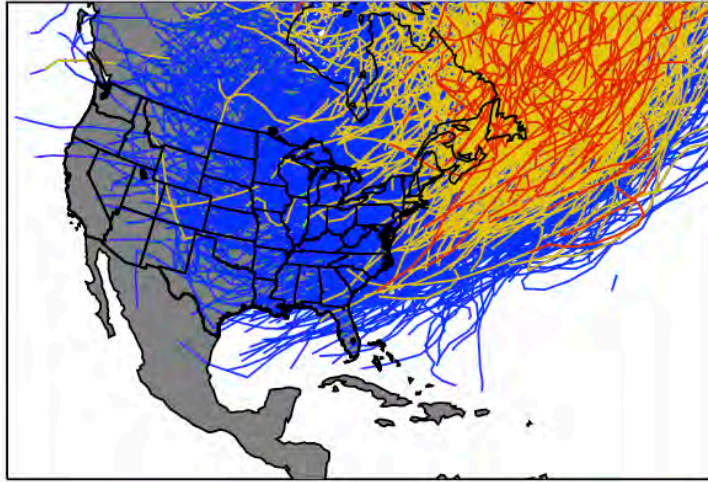


# *SynthETC*

A Stochastic Extra-Tropical Cyclone Model for US Winter Storm Hazard



## **SynthETC: A stochastic model that generates large ( $10^6$ - $10^7$ ) event sets of synthetic ETCs over the Eastern US whose statistical properties match history.**

Driven by ENSO, NAO, and annual cycle of 500mb steering winds. Trained on MCMS-tracker ETCs from 1979-2012 ERA-Interim reanalysis data.

### **Applications:**

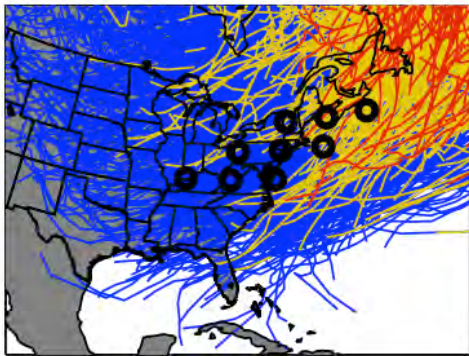
- Estimate local probabilities of extreme events that may have no historical precedent.
- Make probabilistic seasonal forecasts.
- Drive surge and precipitation models.

### **Operation Modes:**

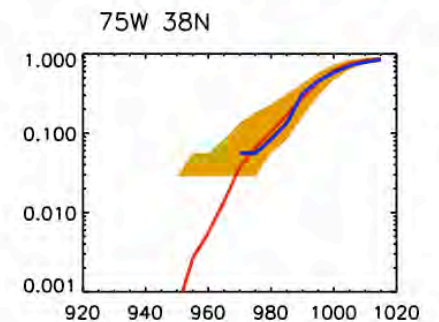
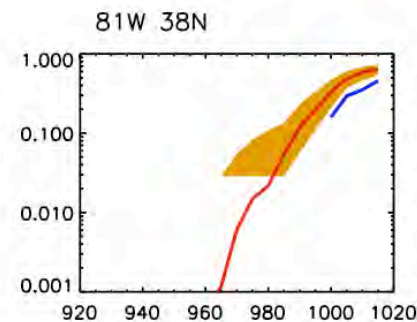
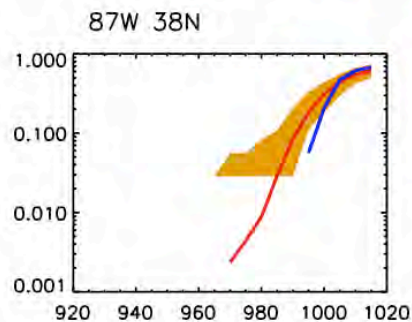
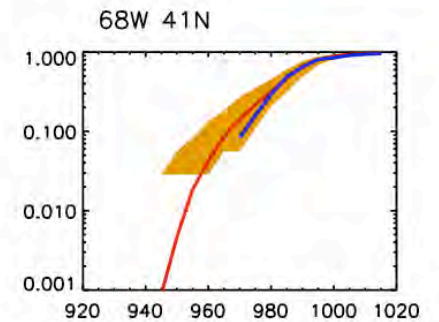
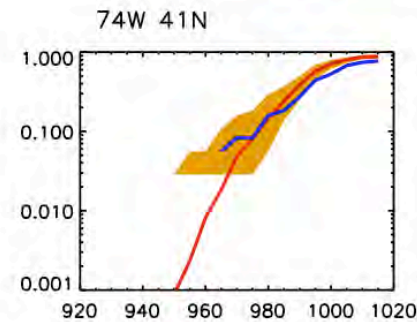
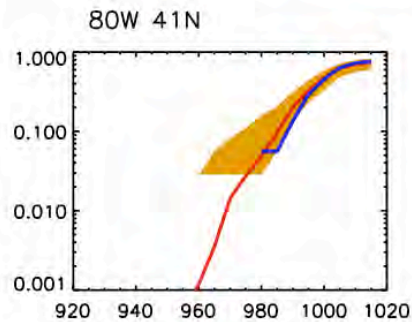
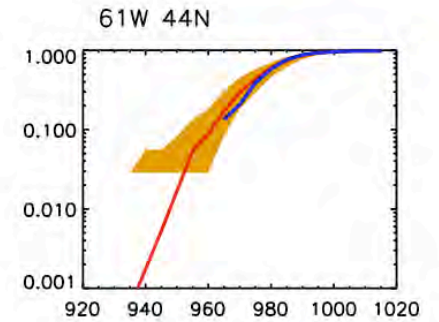
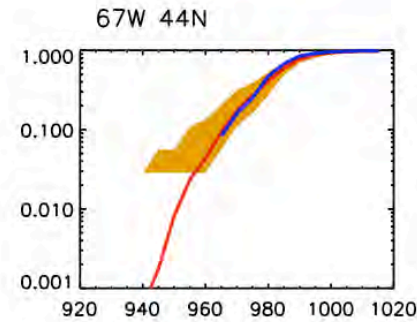
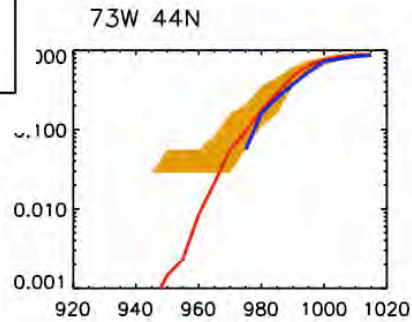
- Simulate historical period.
- Simulate range of fixed climate states (ENSO/NAO) to document sensitivities.
- Simulate using forecasts of ENSO/NAO to forecast ETC probabilities.

### **Model components:**

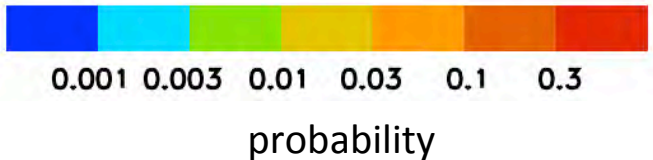
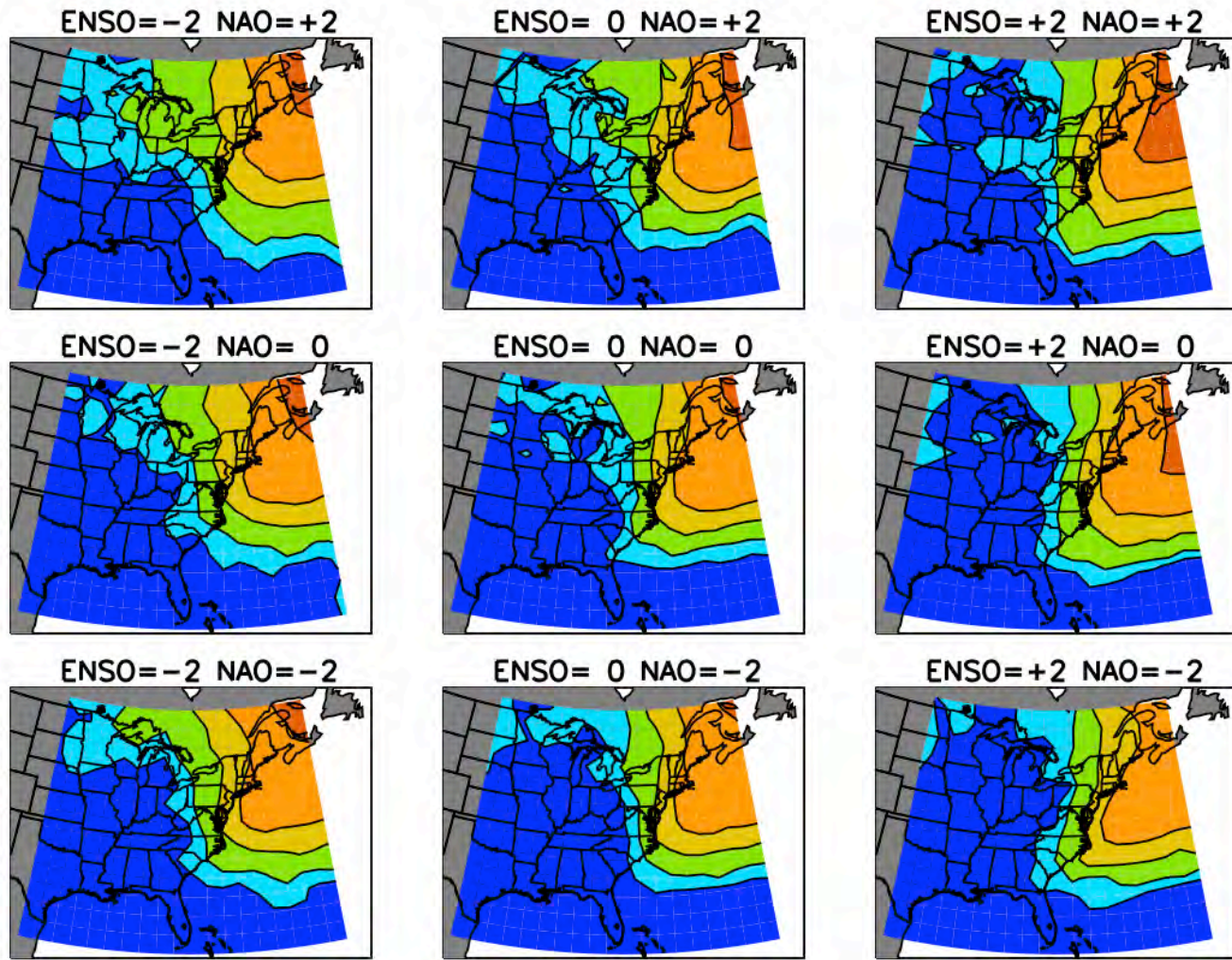
- Genesis (Poisson point process).
- Tracks (local regression with autoregressive noise).
- Central Pressure (weighted sampling with perturbation)
- Wind Field (rescaled composites from meteorological reanalyses)



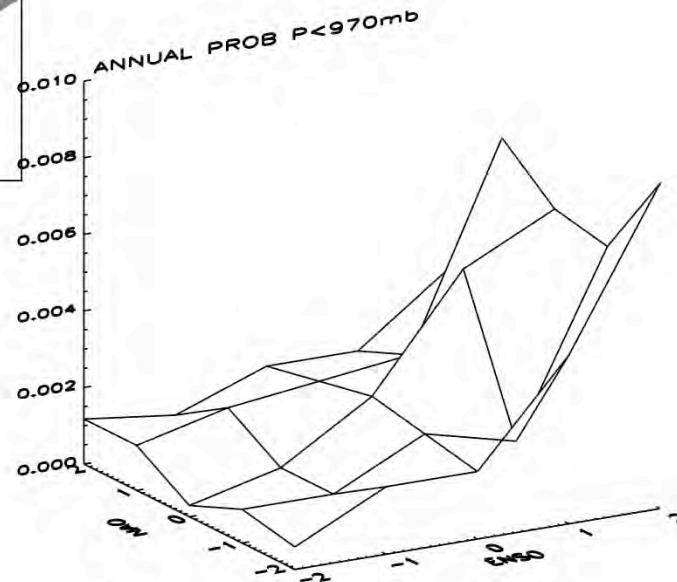
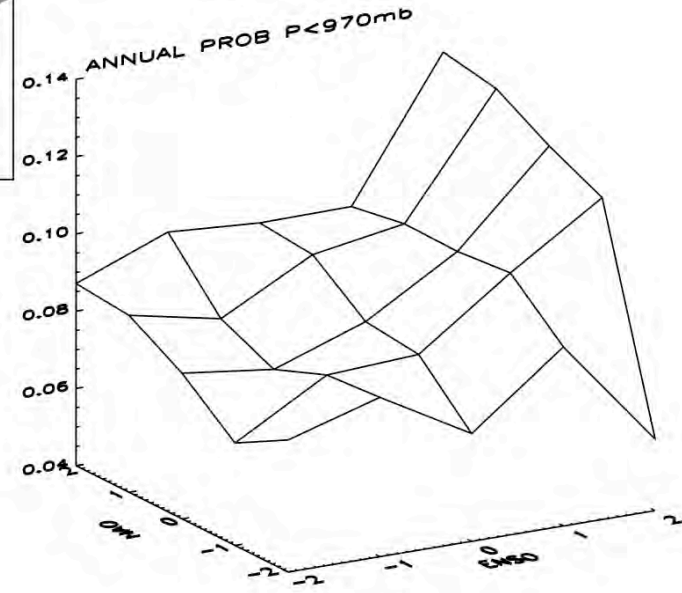
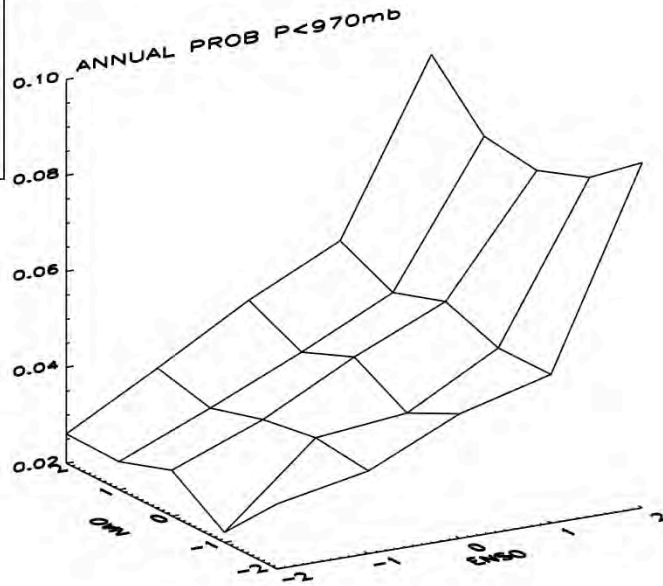
Validation: a stochastic model is unbiased to the extent that historical values of some statistic are a typical members of the larger simulated set. Simulate 1979-2012 many times. Compute local exceedance probabilities of storm CP. Compare to history.



ENSO/NAO dependence: Run ~3000 years in 25 fixed combinations, ENSO, NAO = -2,-1,0,+1,+2. Compute annual probability of CP<960mb within 100km.



# Annual probability of CP<970mb as function of ENSO/NAO at specific locations

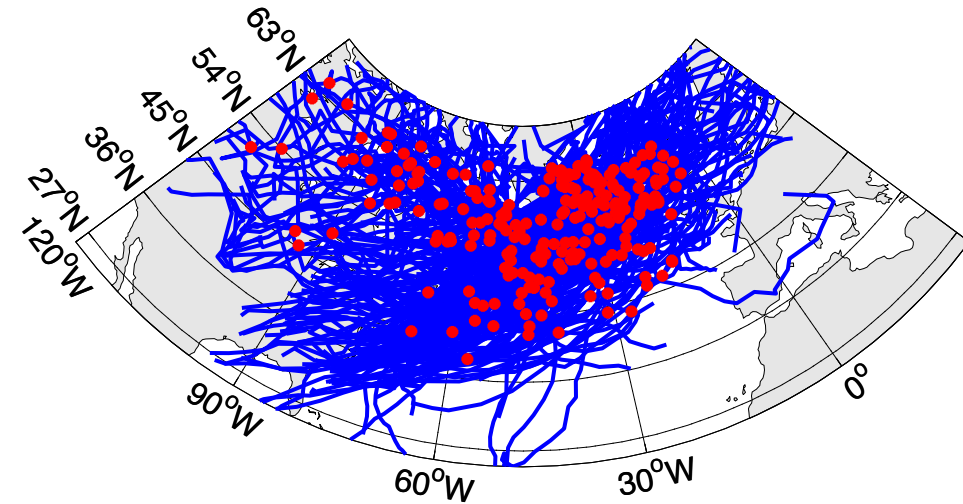


Note: based on 100 simulations for each ENSO/NAO state. Not enough for good convergence on low probability events. Currently running 1000 simulations.

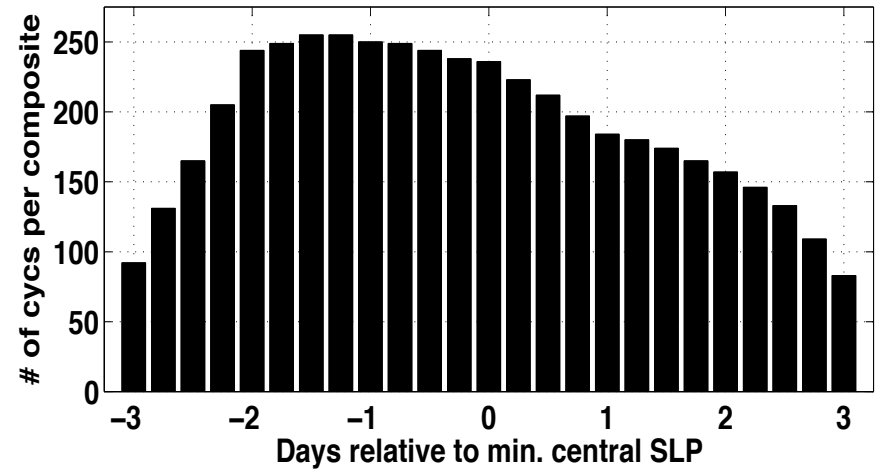
# Wind fields for SynthETC (Jimmy Booth)

Composite 10m winds with respect to time of minimum CP using ERA-Interim data along MCMS-tracked cyclones. Criteria for composite inclusion include: min CP < 980mb, points along track inside specified region, track duration at least 4.5 days. Total of 266 cyclone tracks (7370 scenes) employed.

Tracks with point at time of min. central pressure

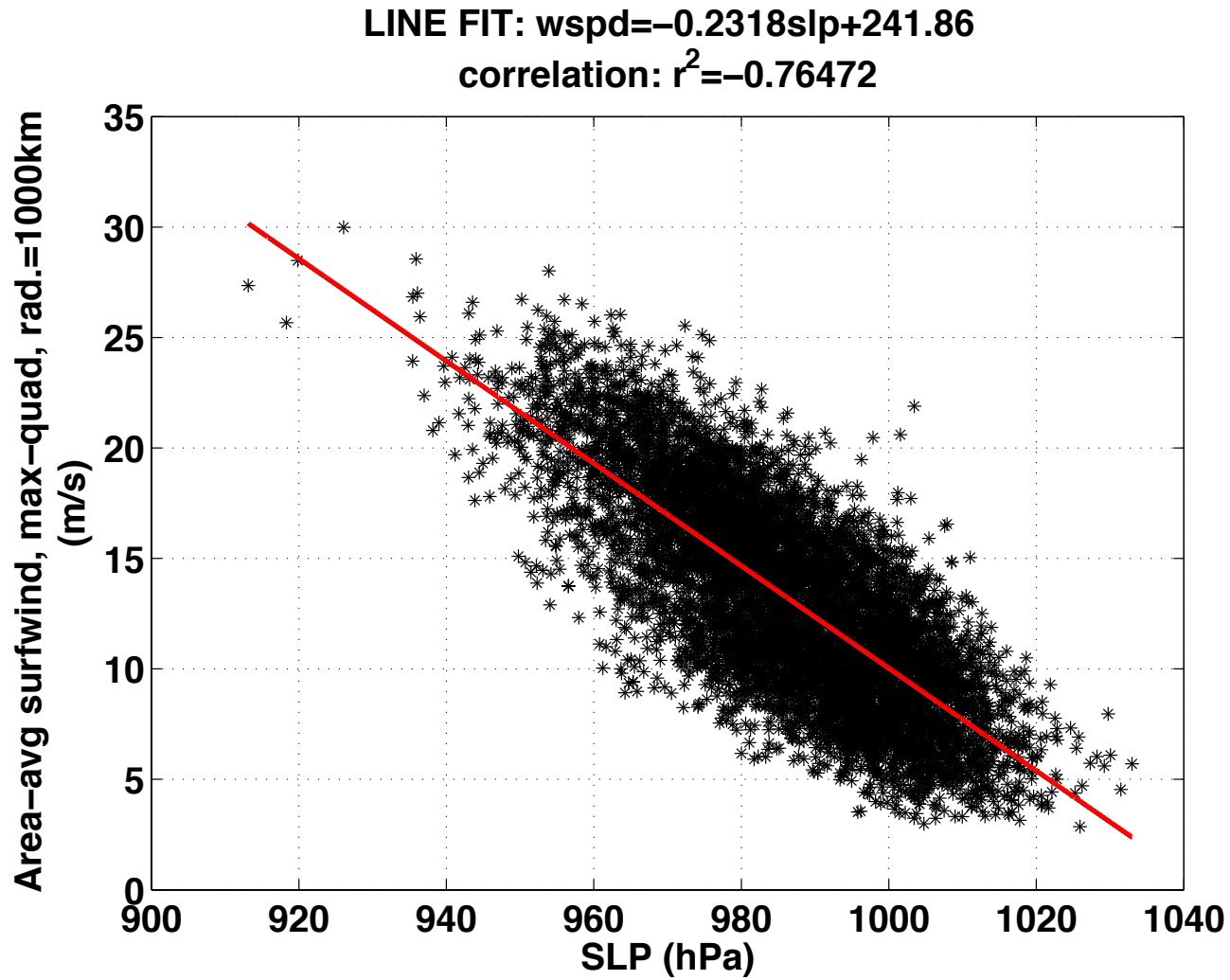


Histogram of cyclone scene count by composite 6-hr interval



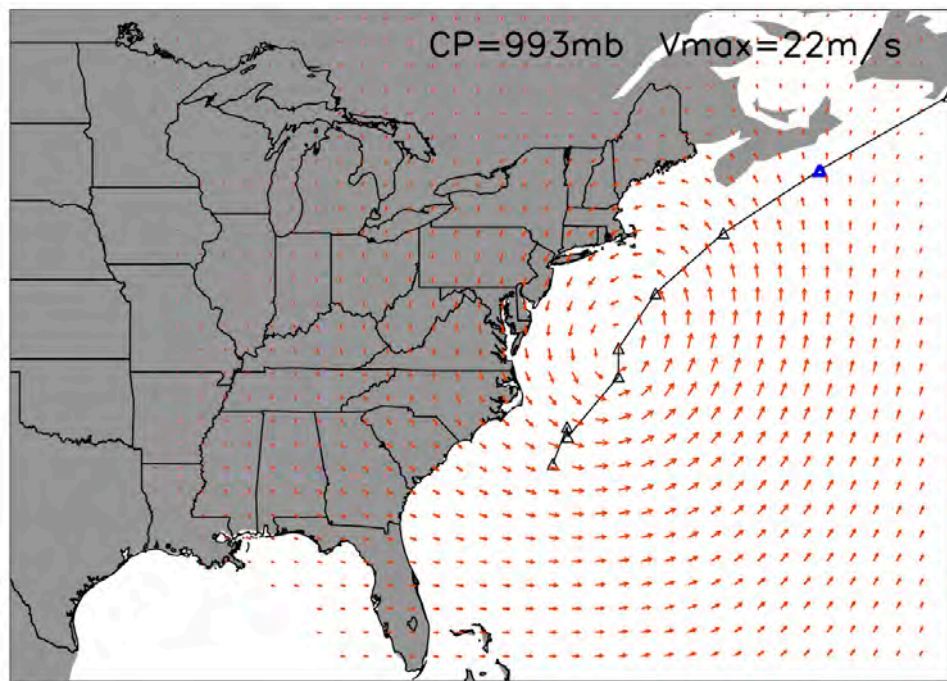


Wind speed-CP relationship used to rescale composites to simulated CPs.

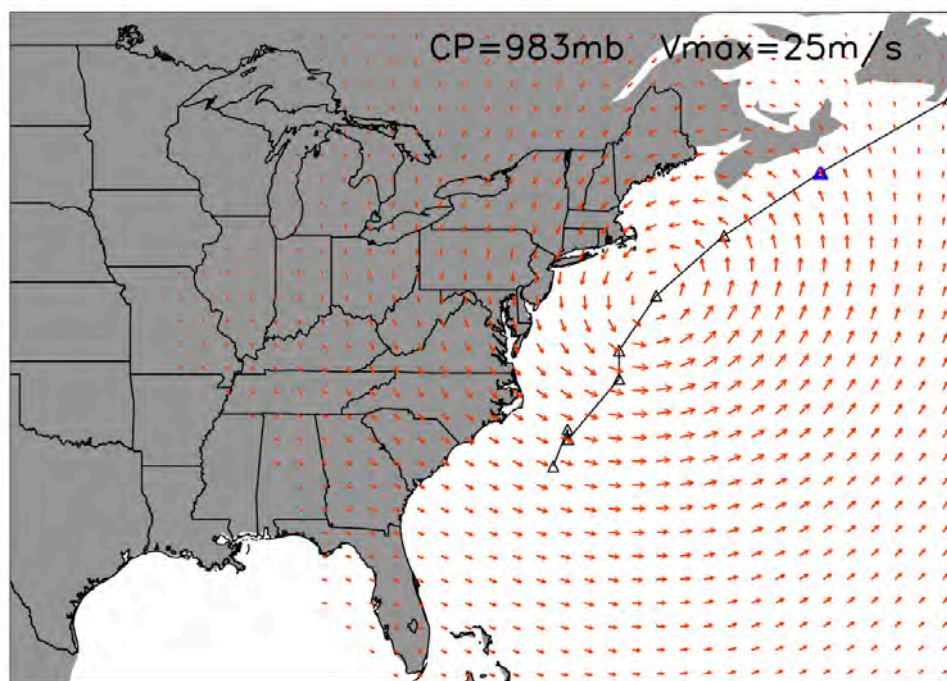




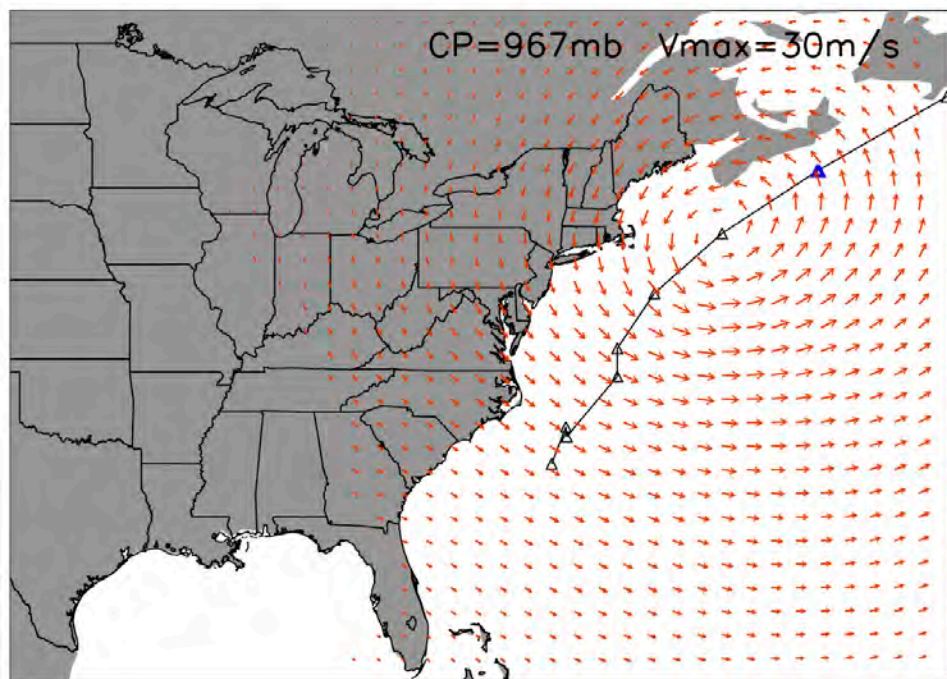
CP=993mb  $V_{max}=22\text{m/s}$



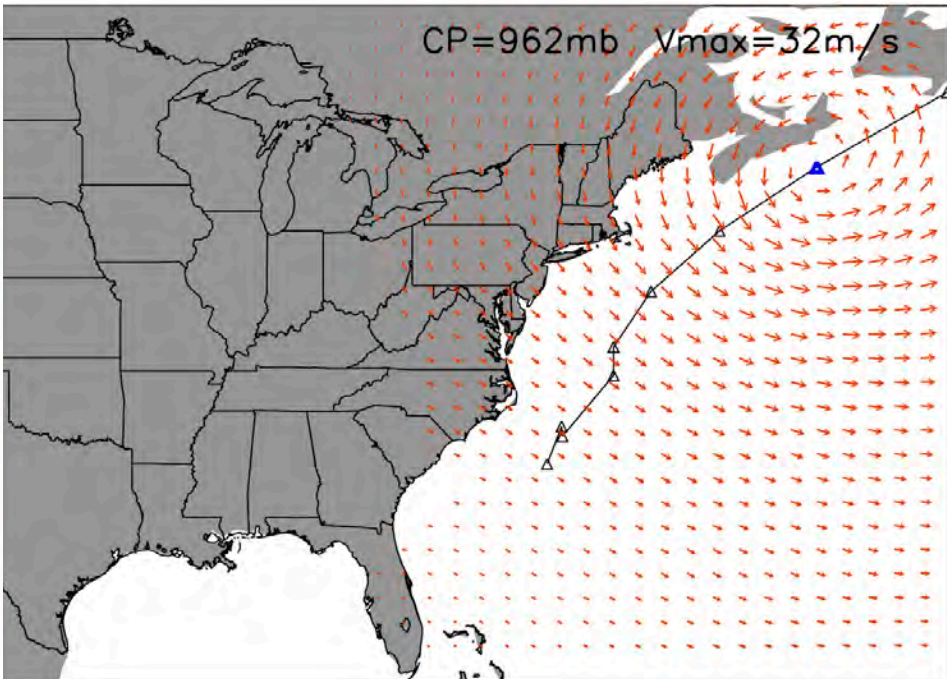
CP=983mb  $V_{max}=25\text{m/s}$



CP=967mb  $V_{max}=30\text{m/s}$



CP=962mb  $V_{max}=32\text{m/s}$



## Next Steps:

1. Place wind fields on full simulated track set.
2. Compute fields of wind speed exceedance probabilities for historic period and ENSO/NAO states.
3. Validate wind speed probabilities against historical occurrence.
4. Modify wind-field component if necessary; e.g., stochastic simulation the wind-speed-CP error term, explicit connection of asymmetry to track-speed.
5. Write-up a documenting paper!