Examining Trends in Satellite-Detected Tropical Overshooting Tops as a Potential Predictor of Tropical Cyclone Genesis

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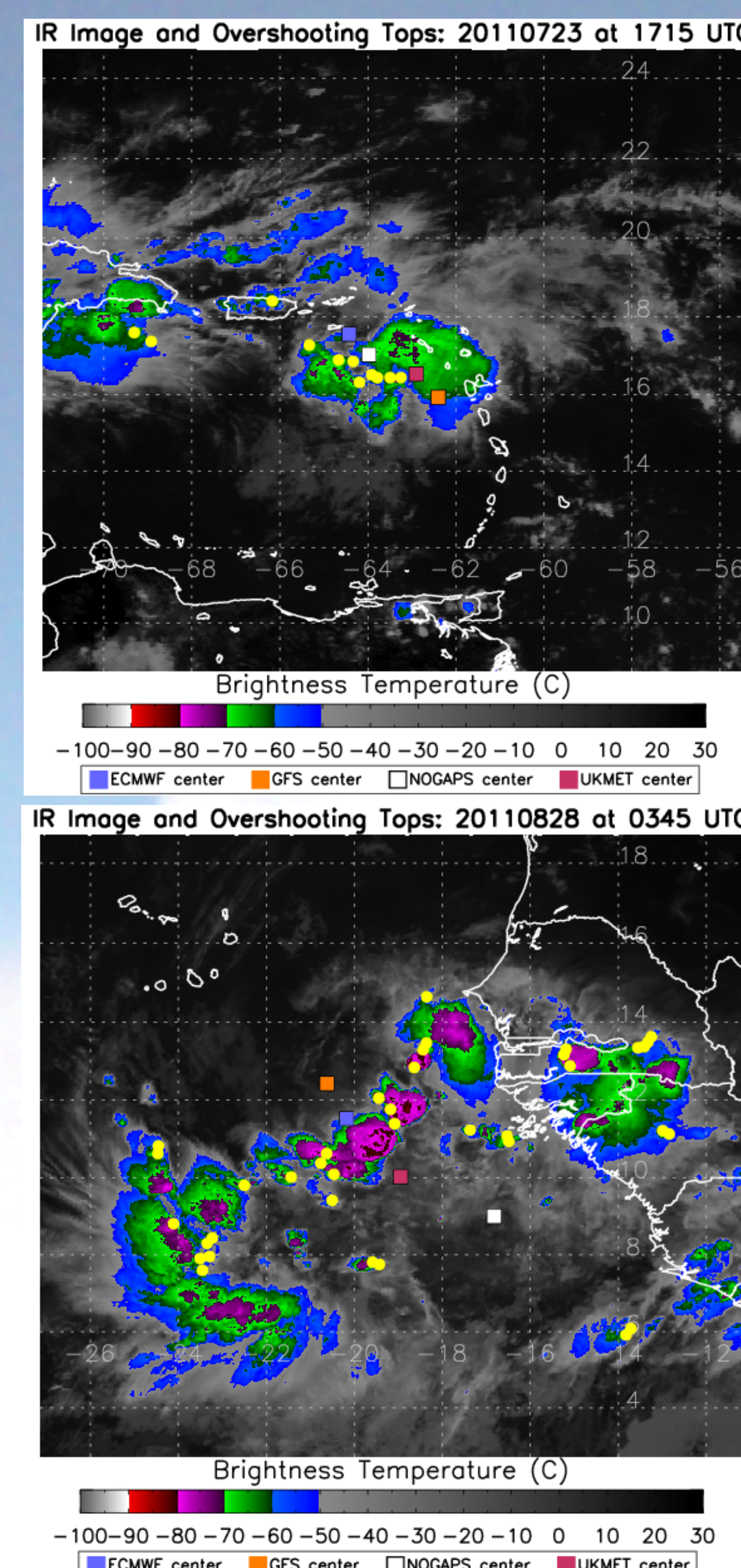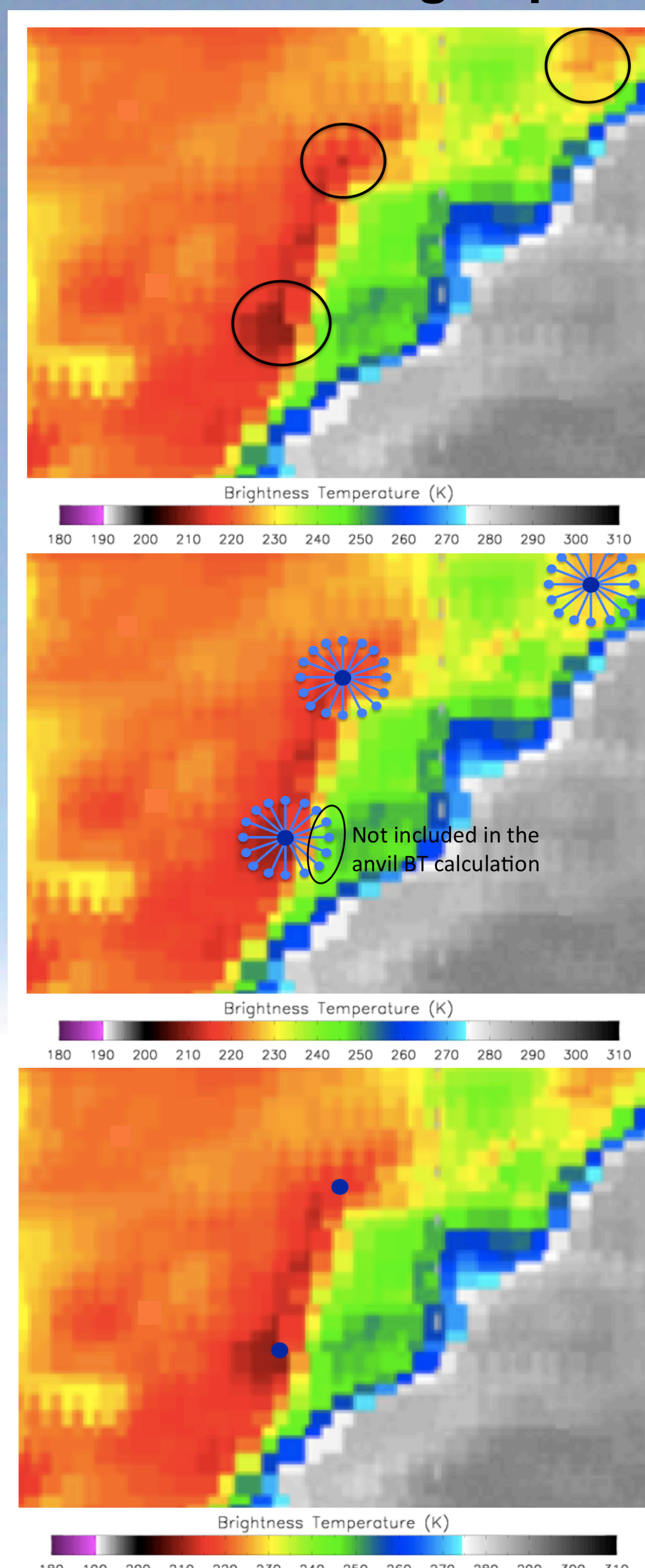[#] sarah.monette@ssec.wisc.edu

1. Introduction

- Research suggests that the presence of deep, concentrated vortical hot towers (VHTs) in tropical easterly waves acts to build vorticity upwards, and enhances the probability of tropical cyclone (TC) genesis.
- We investigate if 1) VHT activity/trends can be observed with a satellite-based Tropical Overshooting Top (TOT) detection algorithm, and 2) if the observed VHT trends could be a potential predictor of TC genesis.

2. About the Objective Tropical Overshooting Top (TOT) Detection Algorithm

Employing geostationary satellite imagery, find relative minima in the 11 μm (IR) brightness temperature (BT) field colder than 215 K.

Sample the surrounding anvil at an ~8 km radius in 16 radial directions. At least 9-of-16 anvil cloud pixels must be colder than 225 K. Compute the mean BT of these pixels.

Cloud pixel minima at least 9 K colder than the surrounding anvil are flagged as an overshooting top.

Not included in the anvil BT calculation

IR Image and Overshooting Tops: 20110723 at 1715 UTC

TOTs (yellow dots) during pre-TC Don (2011).

IR Image and Overshooting Tops: 20110828 at 0345 UTC

TOTs (yellow dots) during pre-TC Katia (2011).

3. Proof of Concept

Confirm TOTs can act as proxy-VHTs:

TOTs are detected and counted along the tracks of a "marsupial pouch," a region of low-level closed circulation in a Lagrangian framework within an easterly wave (Dunkerton et al., _Atmos. Chem. Phys._, 2009). Atlantic pouch tracks were provided by Mark Boothe (NPS).

Good correlation is found between average TOTs day[-1] and model-analyzed relative vorticity at 700 hPa averaged over the pouch region, with best correlations found at 4.5 days after initial pouch identification in at least one model. **Most pouches with high TOT counts eventually became named TCs.**

Correlation between the average TOTs day[-1] within 200 km of the UKMET model pouch center and pouch relative vorticity at 4.5 days as analyzed by the same model.

2009–2011 Pouch Relative Vorticity vs TOTs per day within 200 km after 4.5 Days

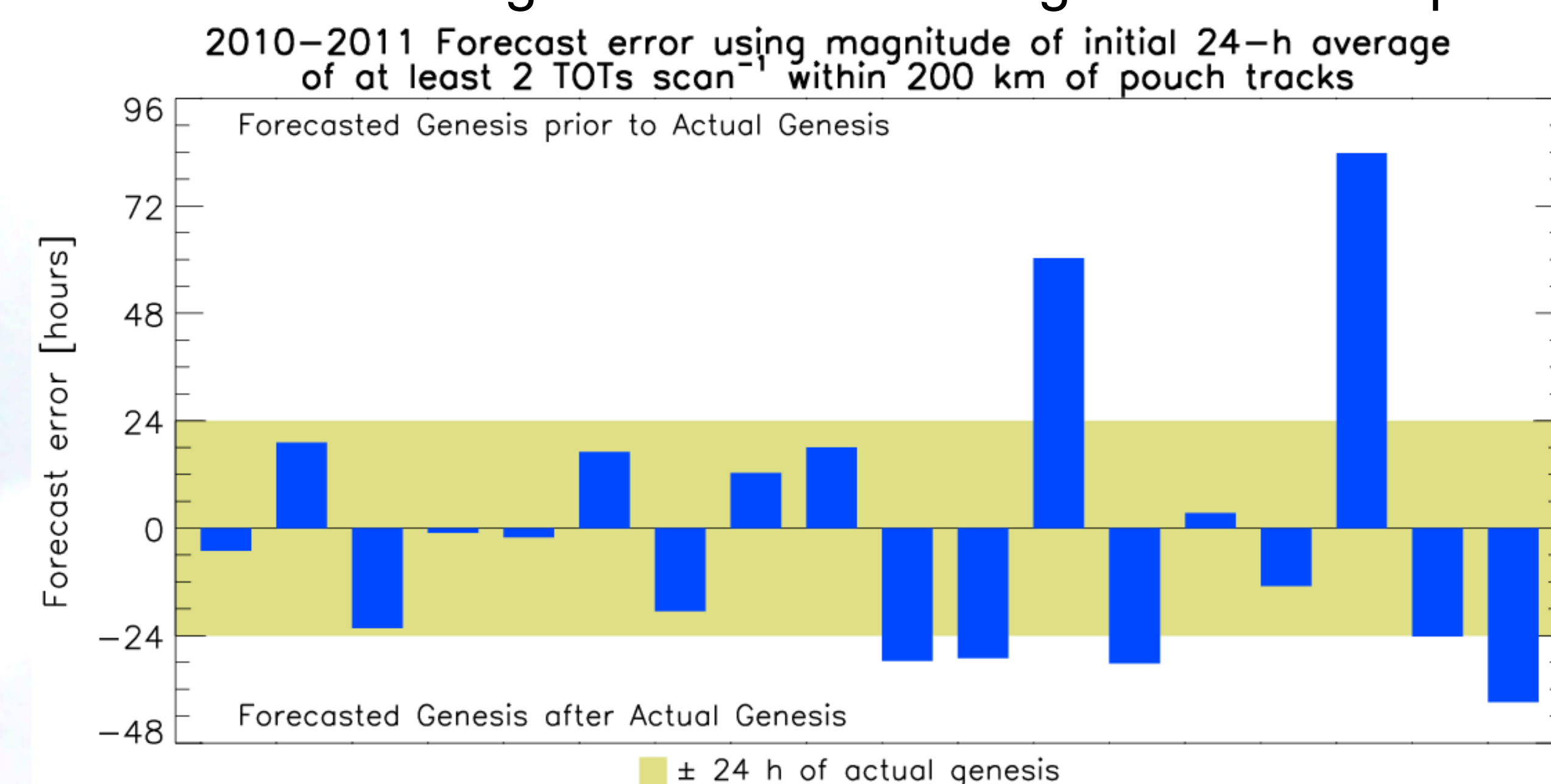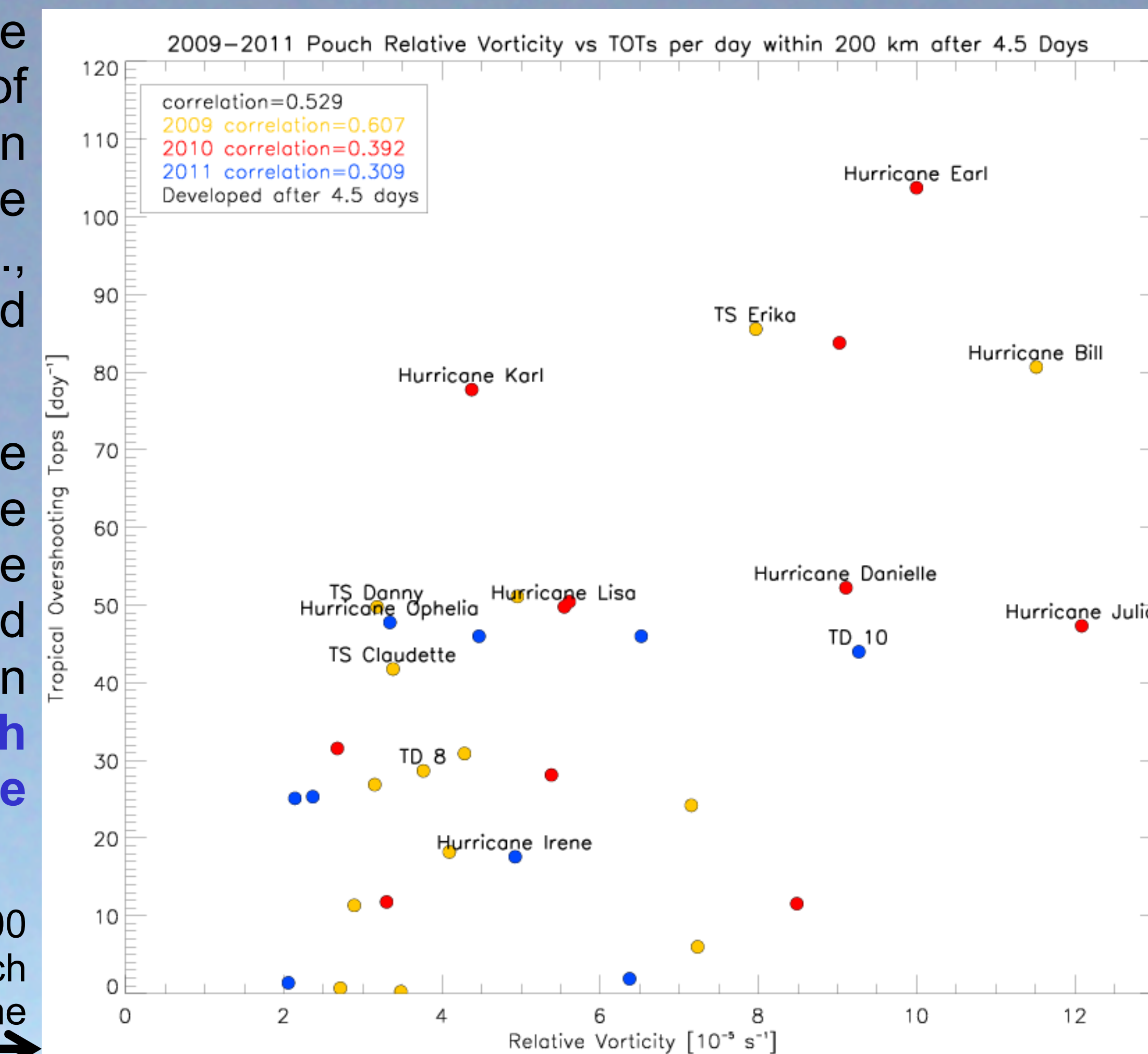## 4. Predicting Tropical Cyclone Genesis

IF _a pouch will undergo tropical cyclogenesis:_
Empirically-determined optimal TOT parameters for predicting a pouch to develop:
- 24-h average of at least 2.0 TOTs scan[-1] is observed within 200 km of at least one of the available global model pouch tracks (ECMWF, GFS, UKMET or NOGAPS).

TC Genesis Forecast Skill	
Probability of Detection	82.6% (19 out of 23)
False Alarm Ratio	20.8% (5 pouches)
Probability of False Detection	15.2%
Peirce Skill Score	0.675

WHEN _a pouch will undergo tropical cyclogenesis:_
Based on a linear regression between the value of the first 24-h average of at least 2.0 TOTs scan[-1] and the days between exceeding that threshold and genesis development.

2010–2011 Forecast error using magnitude of initial 24-h average of at least 2 TOTs scan[-1] within 200 km of pouch tracks

Forecasted Genesis prior to Actual Genesis

Forecasted Genesis after Actual Genesis

± 24 h of actual genesis

Timing error in the TOT-forecasted genesis of 2010-2011 TCs.

5. Test TOTs as a Predictor in the Objective Tropical Cyclone Formation Probability Model

Average TOTs scan[-1] prior to synoptic time from 2009 and 2010 pouches were provided by CIMSS to Andrea Schumacher (CIRA), and tested as a predictor in the objective Tropical Cyclone Formation Probability (TCFP) Guidance Product, developed by RAMMB/CIRA.

Highest Brier Skill Scores (BSS) are found when including the TOT information as a 3-h average of TOTs within 300 km of the UKMET pouch center. However, the impact compared to the BSS without the TOTs is neutral. Increasing the size of the dataset may be necessary.

3-h Average TOTs within 300 km of the pouch center

With OTs
Without OTs
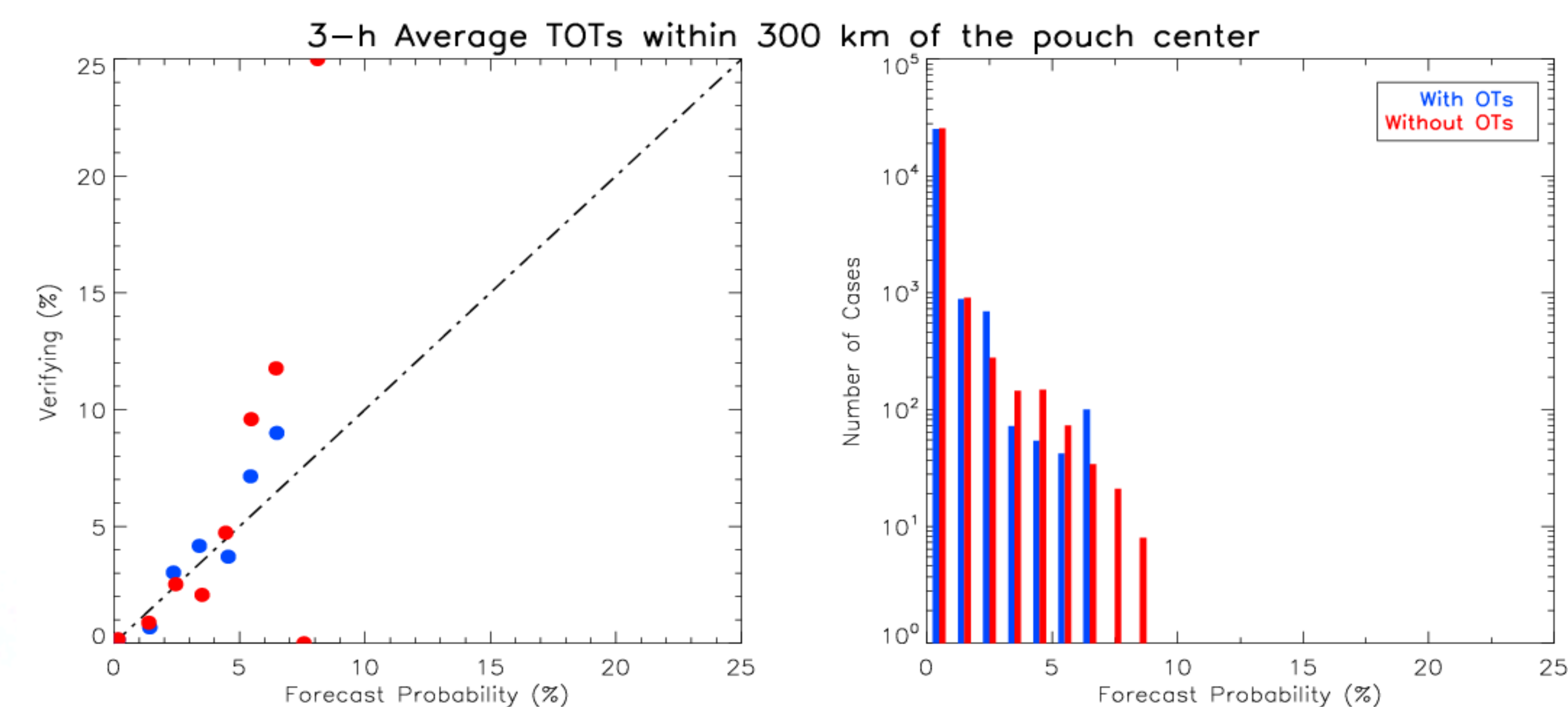
TCFP experiment performance: dot-dashed line represents perfect reliability for all forecast probabilities.

Addition of the TOTs increases the accuracy of the TCFP at middle probabilities (3-7%)

6. Future Work

- Conduct a real-time demonstration of the TOT product for potential use by NHC/TAFB, and test TC genesis prediction during the 2012 Atlantic hurricane season.
- Further explore the addition of TOT information into the TCFP model.