



Using remotely-sensed observations to describe and predict tropical cyclone formation

# Tropical B----- De-intensification

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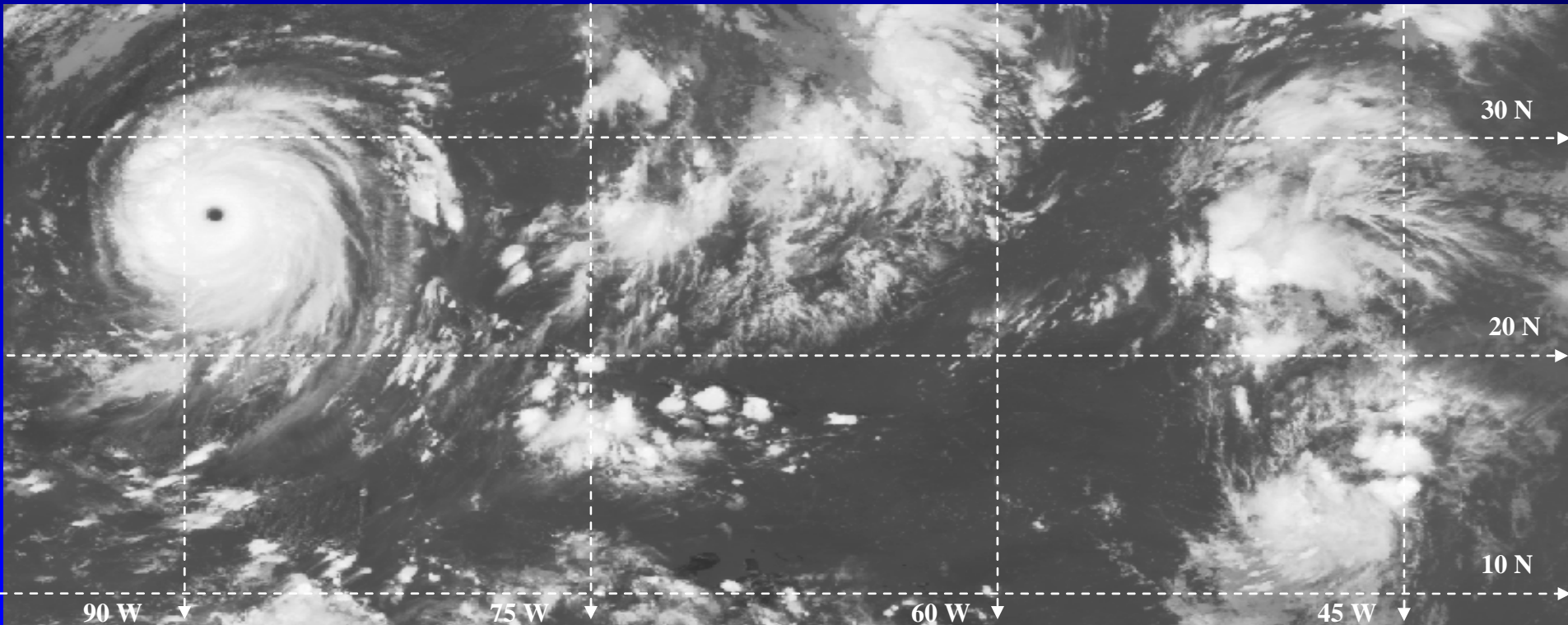
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Lesley Leary

J. Scott Tyo

(TBD) or...

University of Arizona



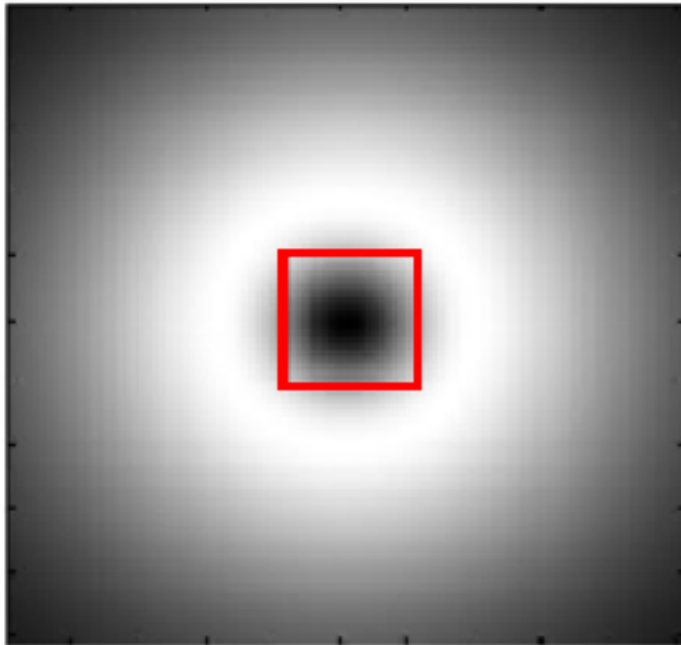
Acknowledgements: Office of Naval Research Marine Meteorology Program  
TRIF - image processing fellowship

# Deviation Angle Variance Technique (DAVT):-

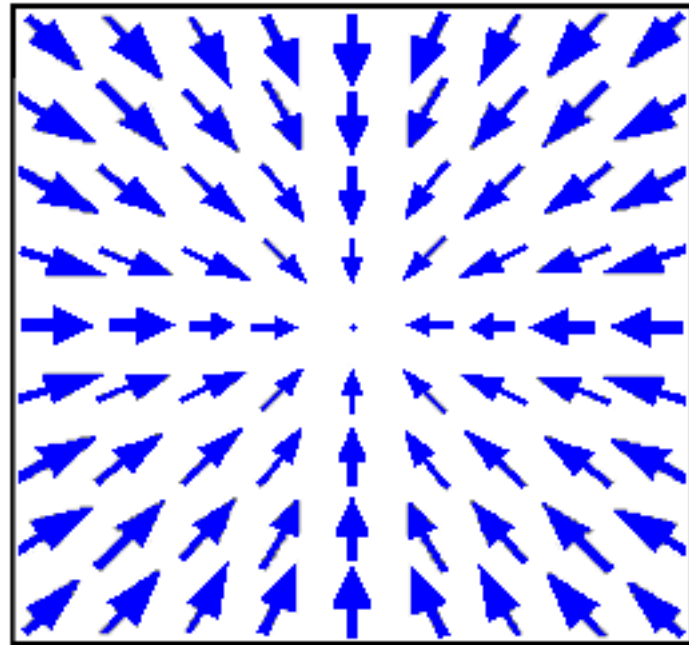


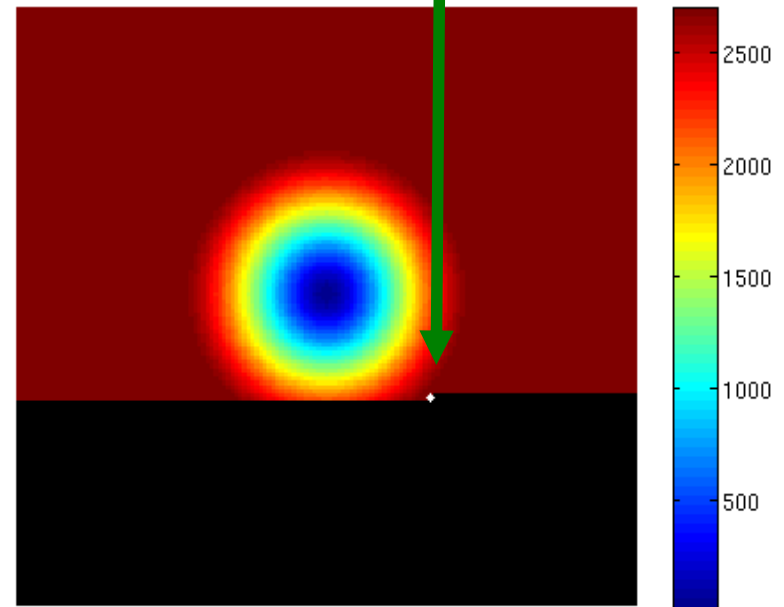
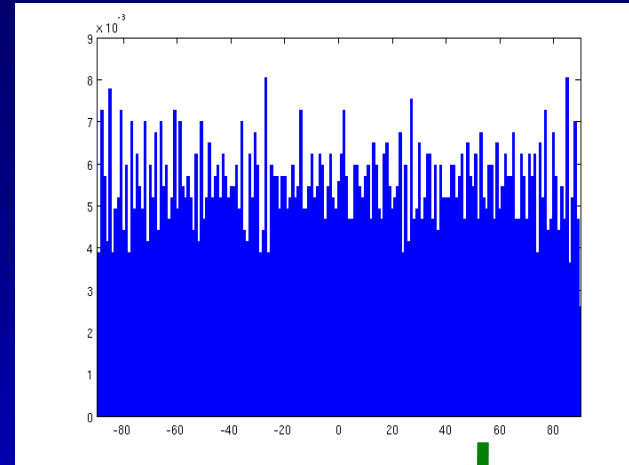
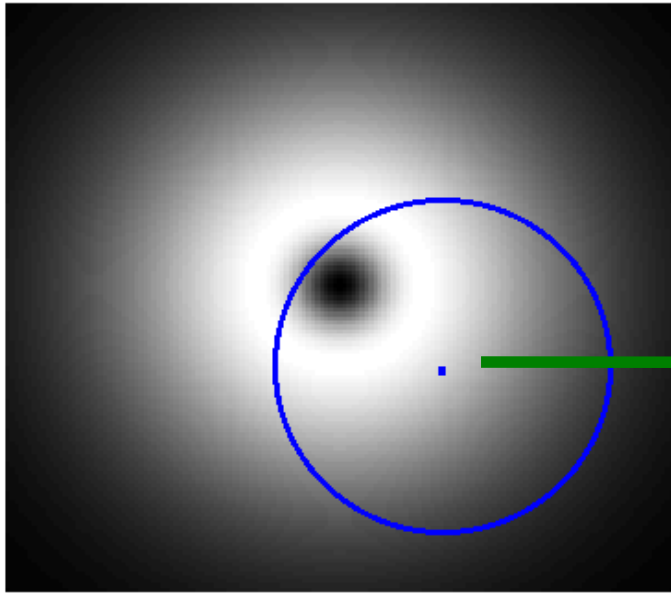
## Idealised Vortex:-

Radiances



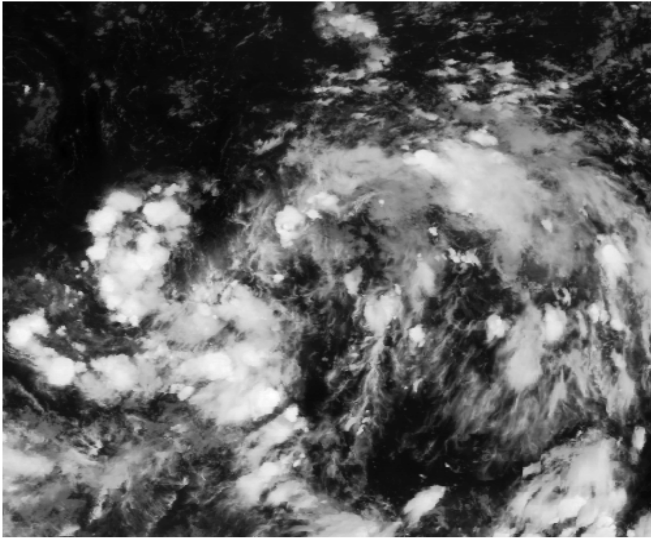
Radiance Gradient Vectors



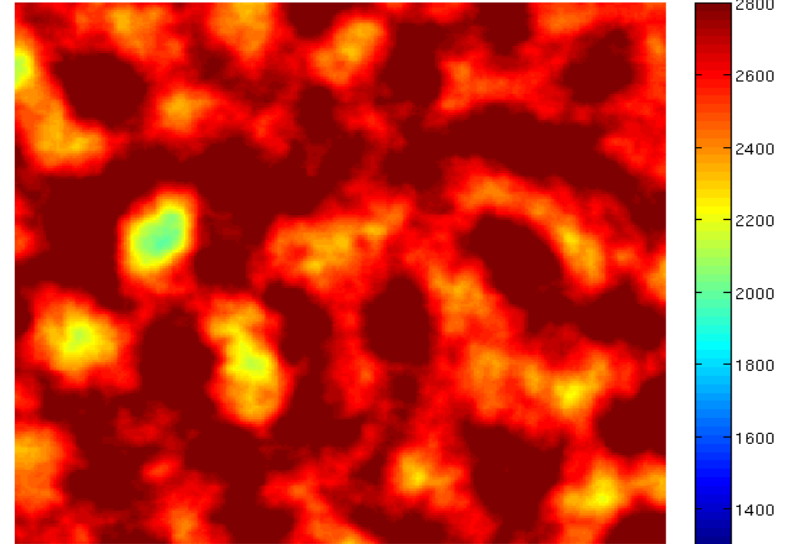


Repeated using every pixel in the scene in sequence as the reference point.

# Hurricane Wilma 2005



Intensity: not reported

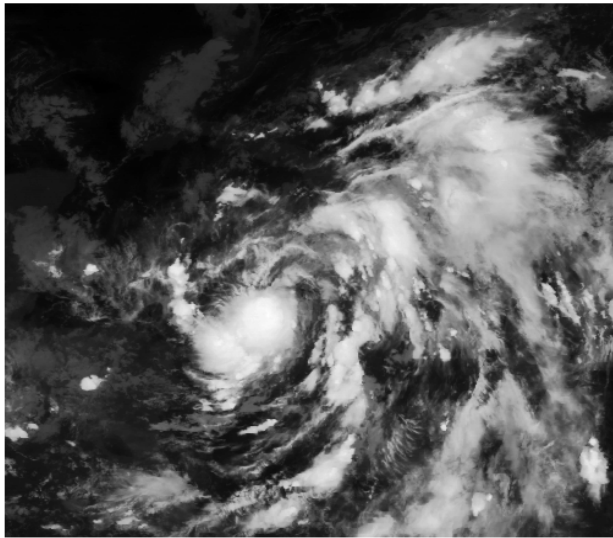


Minimum Variance: 2094

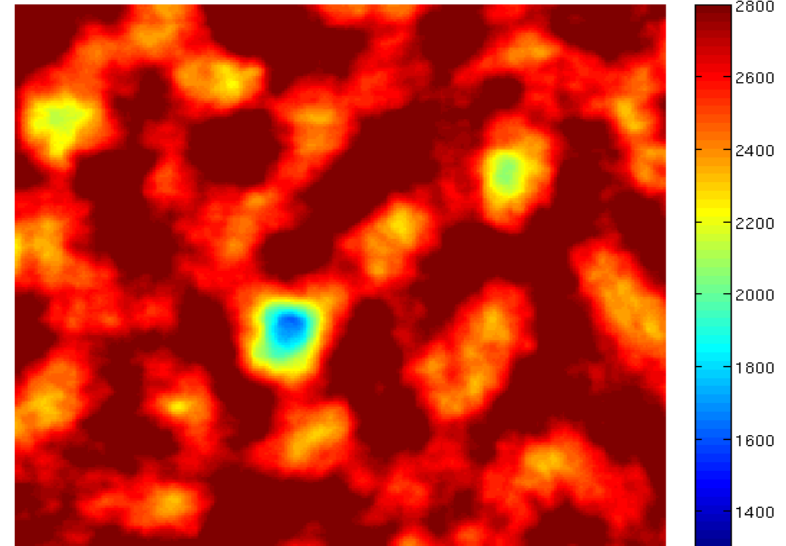
Deviation variance technique:



# Hurricane Wilma 2005



Intensity: 35 kt

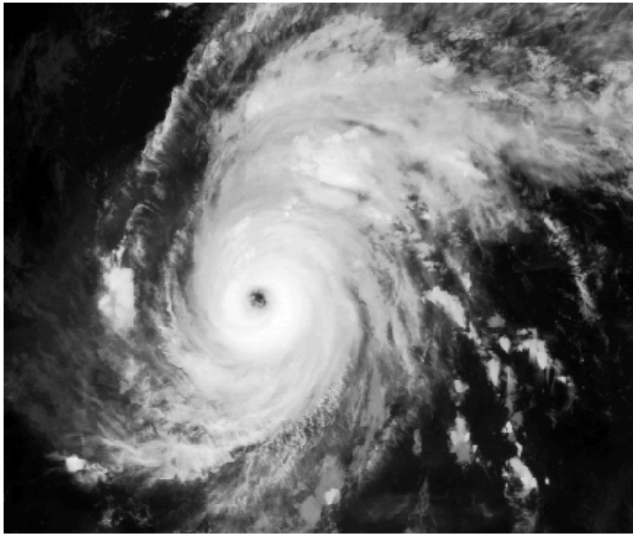


Minimum Variance: 1616

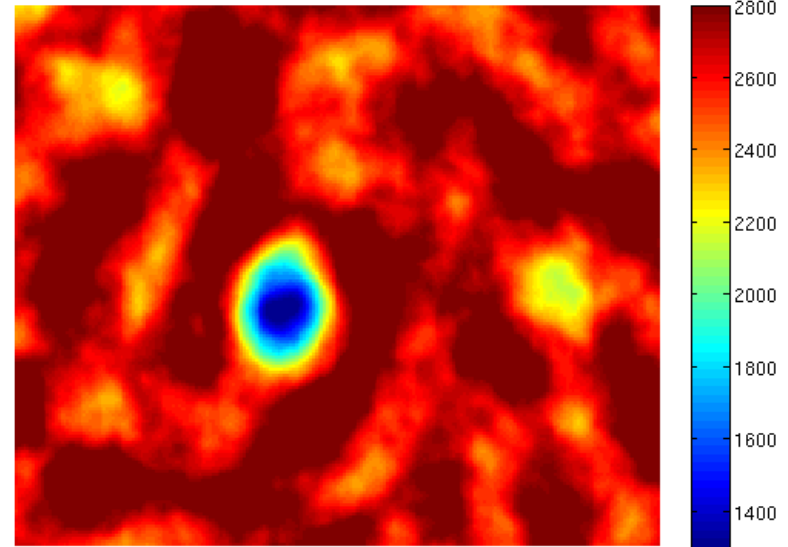
Deviation variance technique:



# Hurricane Wilma 2005



Intensity: 130 kt



Minimum Variance: 1330

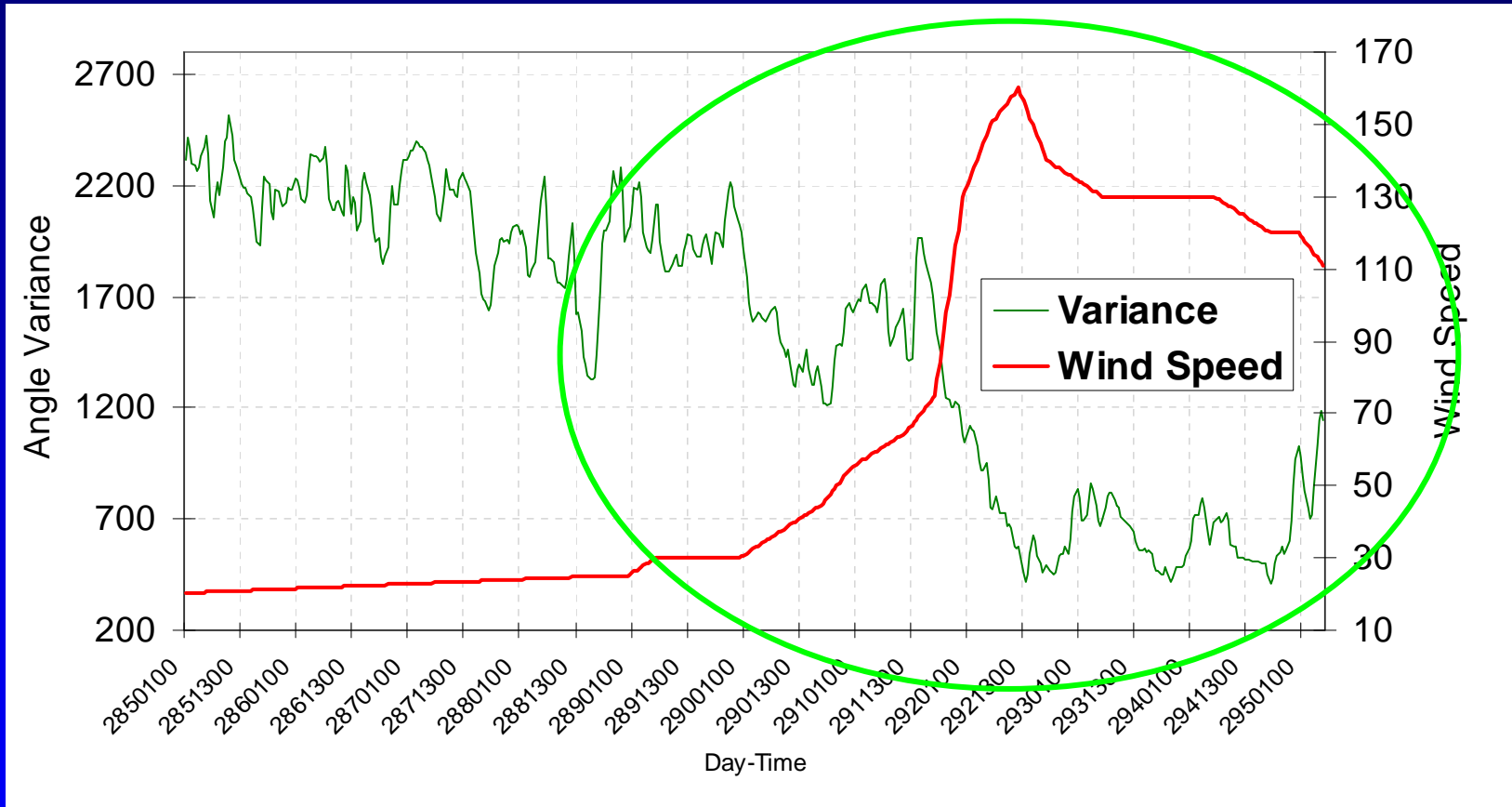
Deviation variance technique:





# Hurricane Wilma 2005

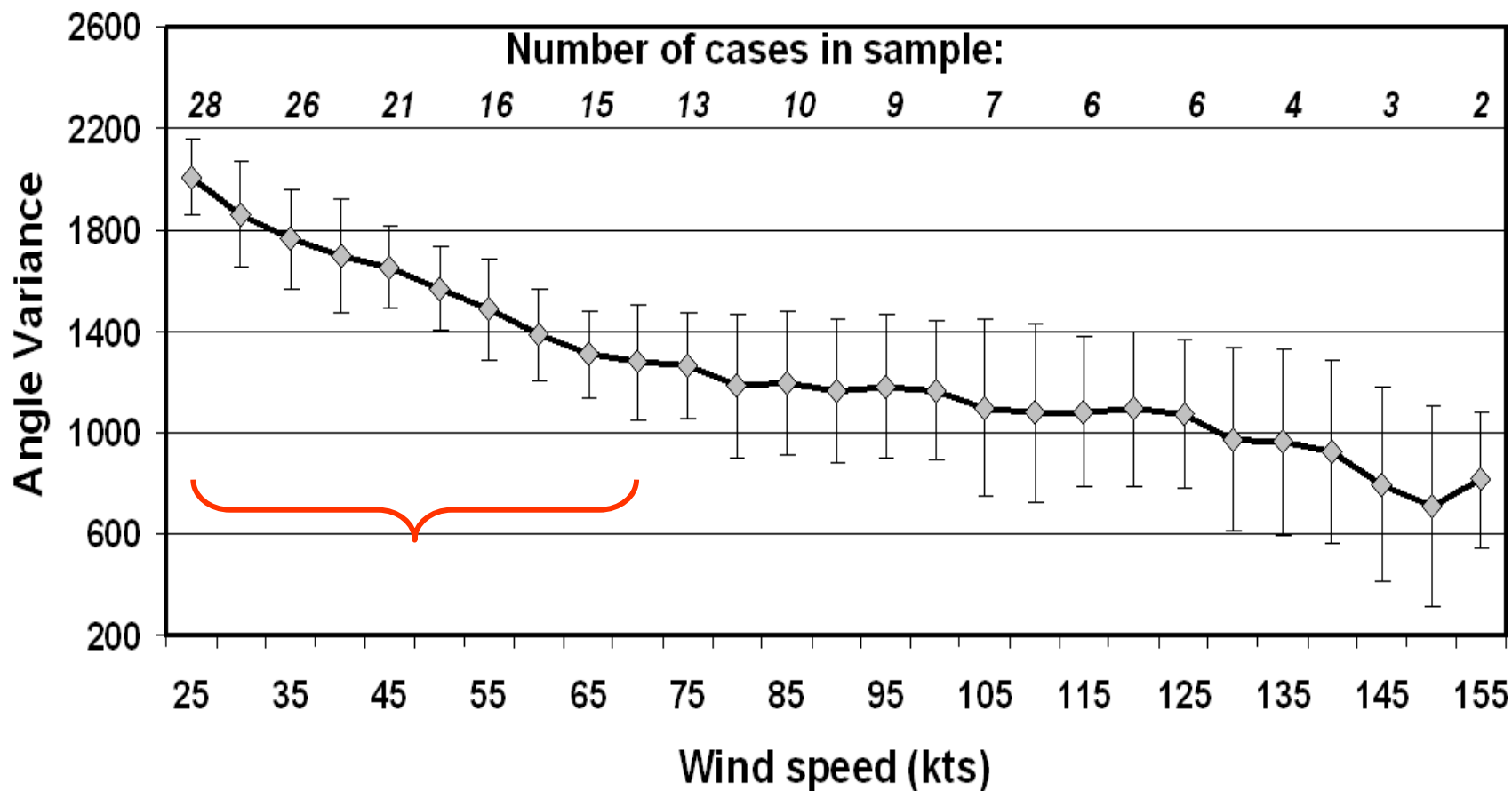
## Intensity???



**Correlation: - 0.93**



## 2005 cases – intensifying periods only

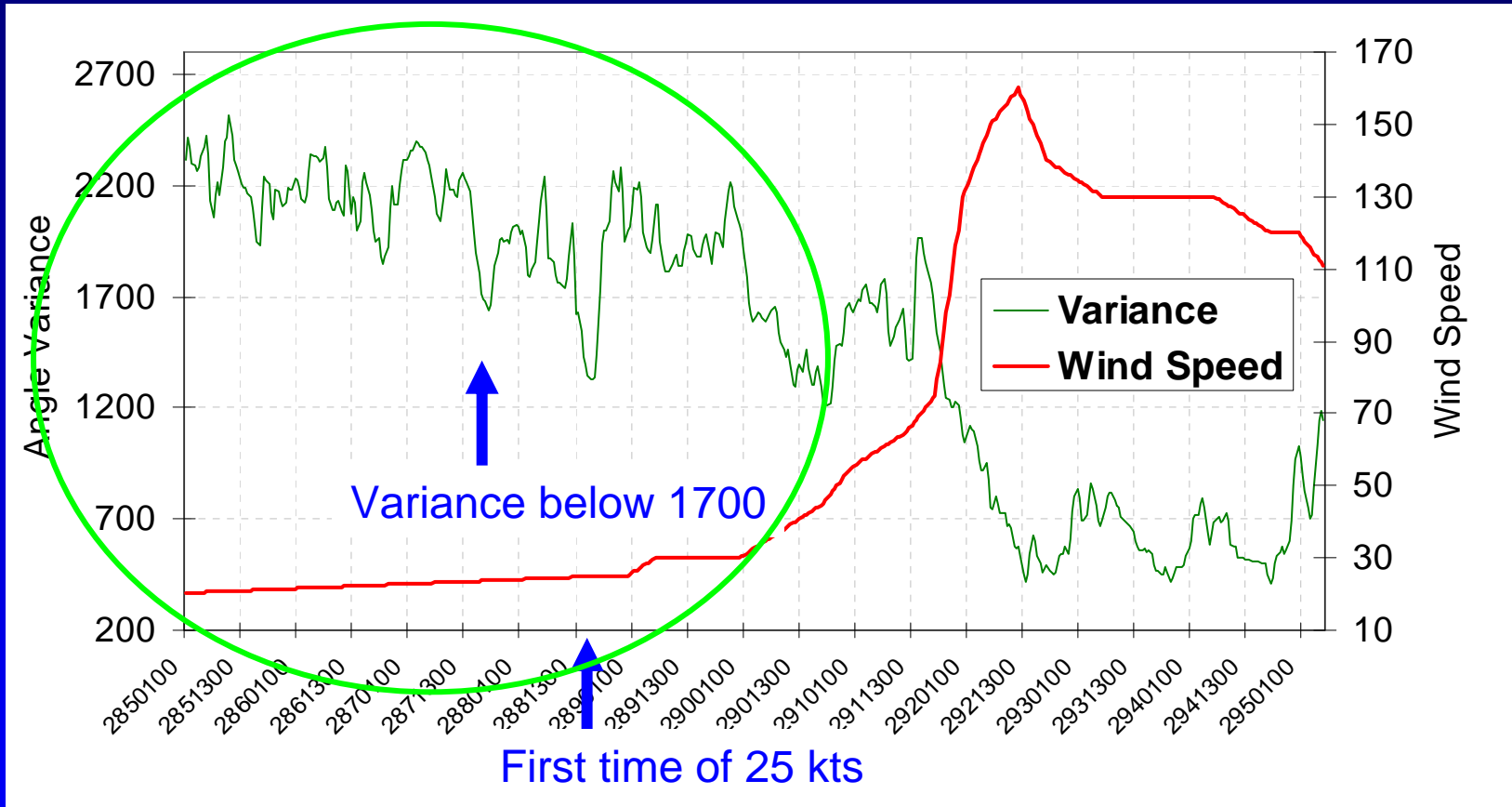






# Hurricane Wilma 2005

## Genesis???

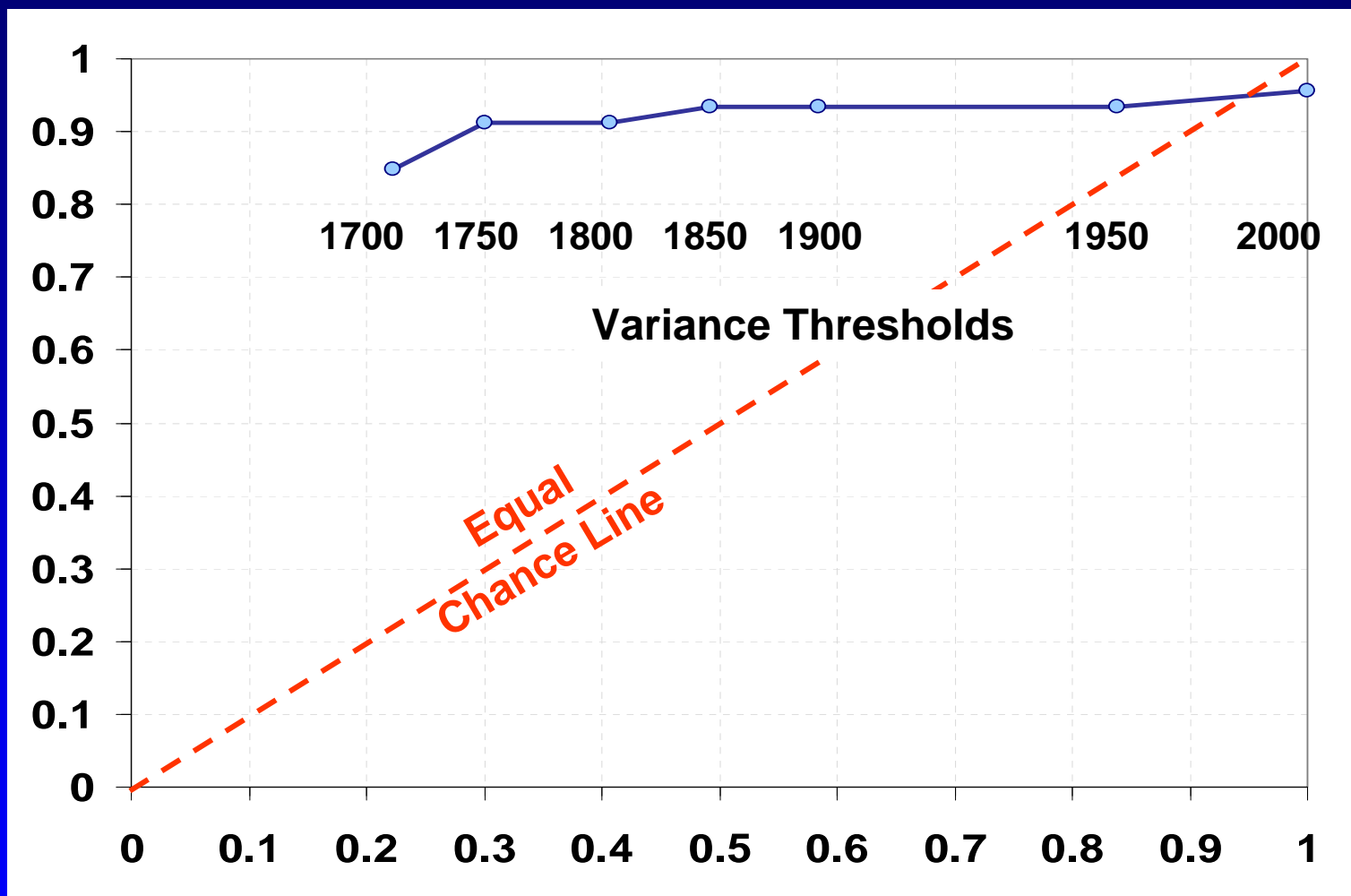


Correlation: - 0.93



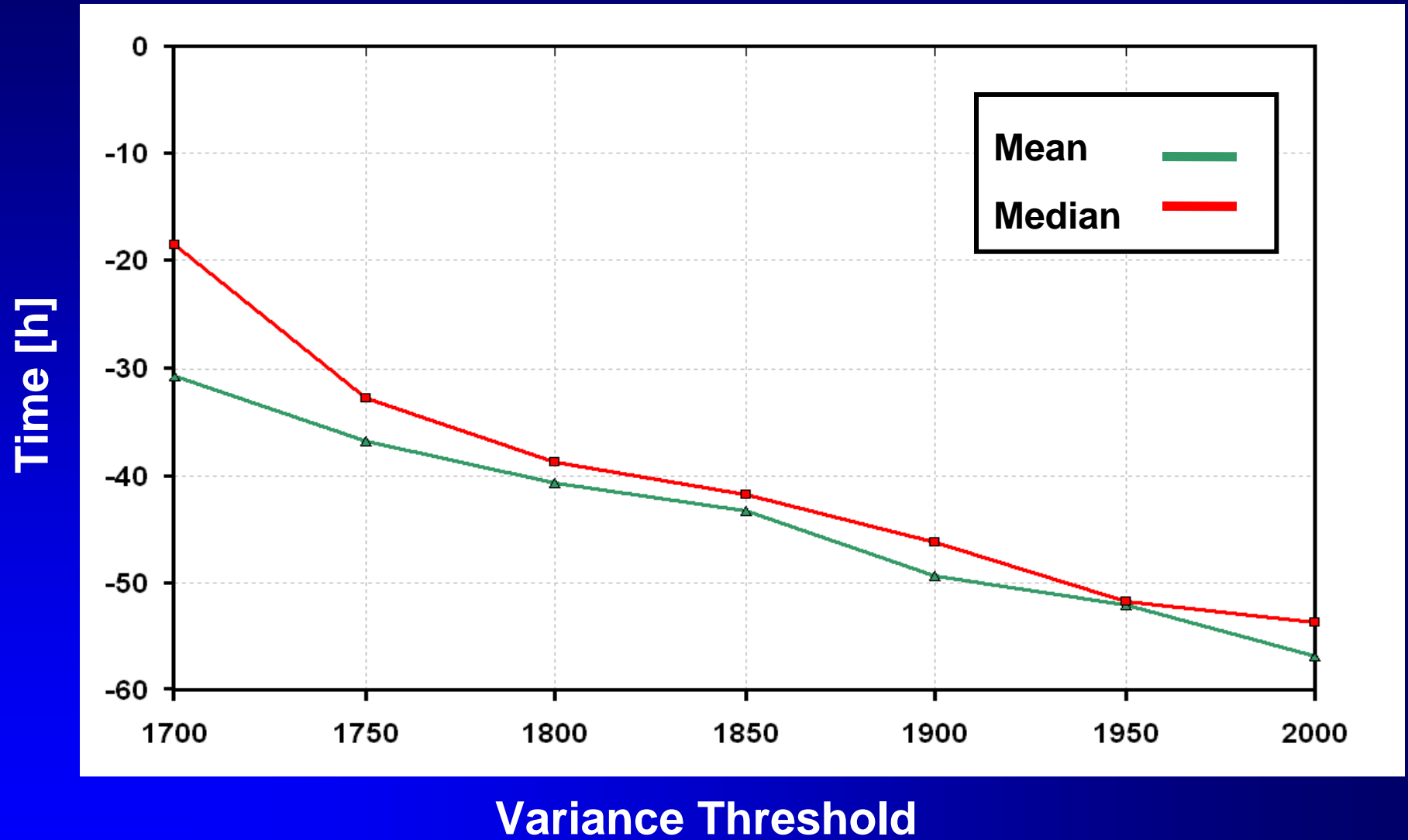
# ROC (2004 & 2005)

Probability of Detection



False Alarm Rate

# Detection Time



# Why Lightning is Interesting

- Lightning requires deep convection
- Intensity of convection may indicate development of the cloud cluster into a TC
- Frequency of lightning can imply intensity of convection

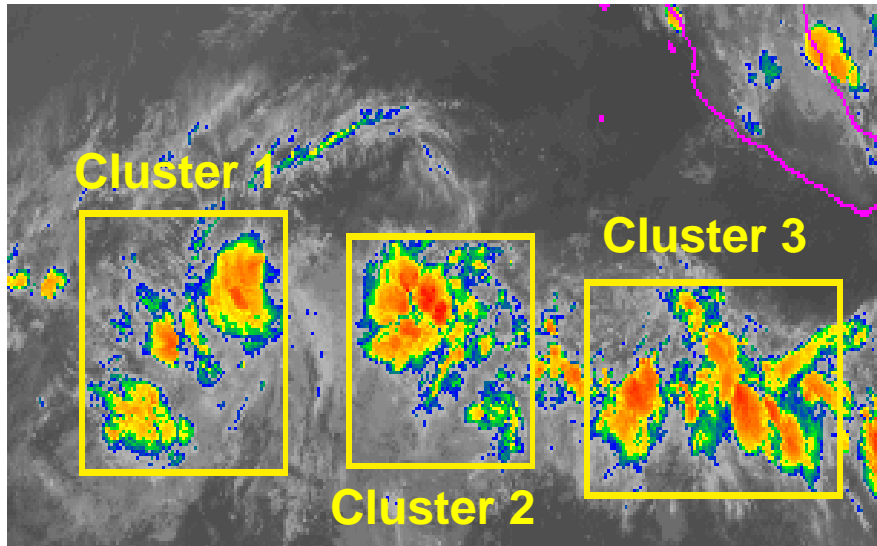


# Long-Range Lightning Detection Network

- Extension of NLDN
- Detects VLF signals trapped by ionosphere
- Efficiency of network decreases with
  - Distance from coast
  - Time of day
- Using data from JAS 2006 in the “lonely, forgotten basin”



# Methodology: Tracking Clusters



7/1/06 three clusters  
between 100 W and 130 W

- Track persistent clusters within the region
  - Exclude clusters lasting less than 72 hrs unless:
    - Out of range
    - Joins another cluster



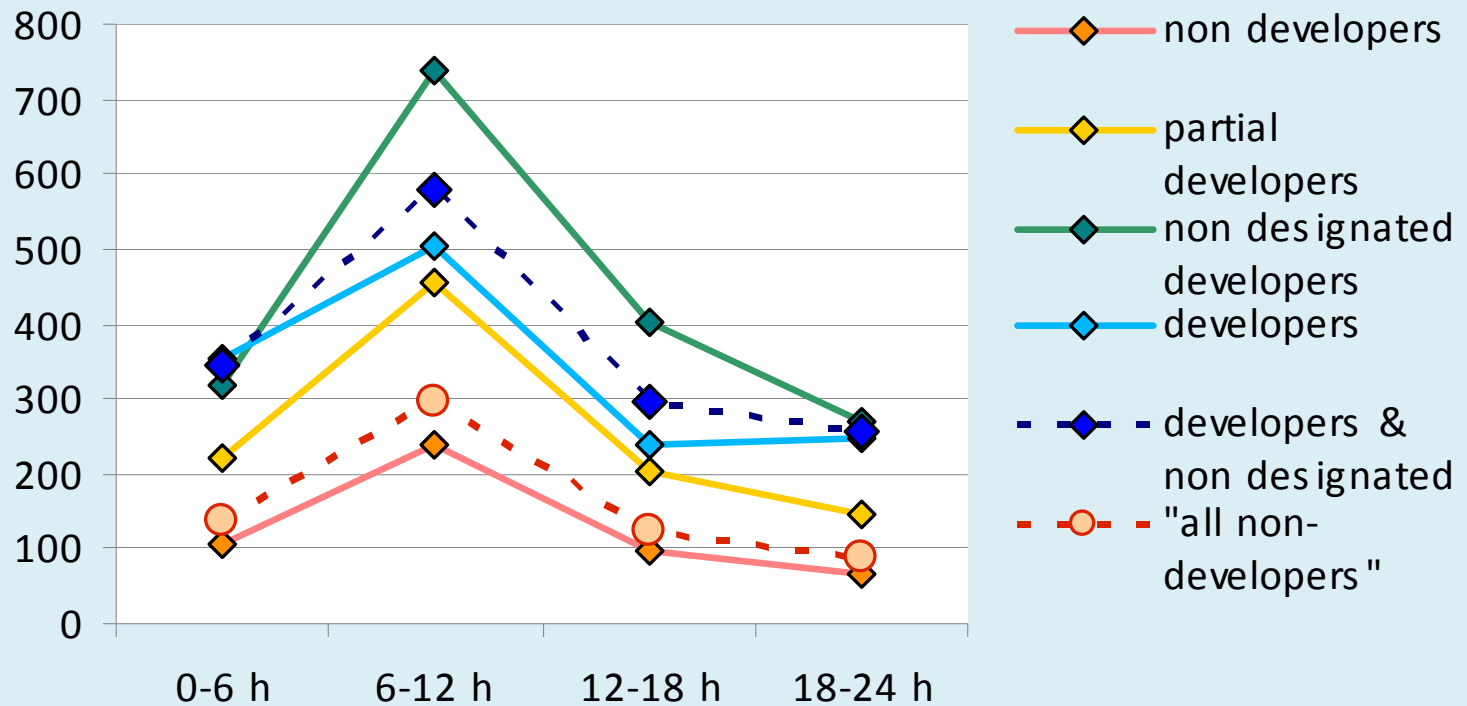
# 4 category classification

- 1. NHC Designated Developers:** systems designated as a tropical depression (or higher) by the NHC
- 2. Non-Designated Developers:** systems with winds above 30 kts and closed circulation
- 3. Partial Developers:** systems with winds above 30 kts imbedded in an open-wave pattern
- 4. Non-Developers:** all other systems persisting for at least 72 hrs



# Threshold of development

2006 season: average flash count per 6 hr



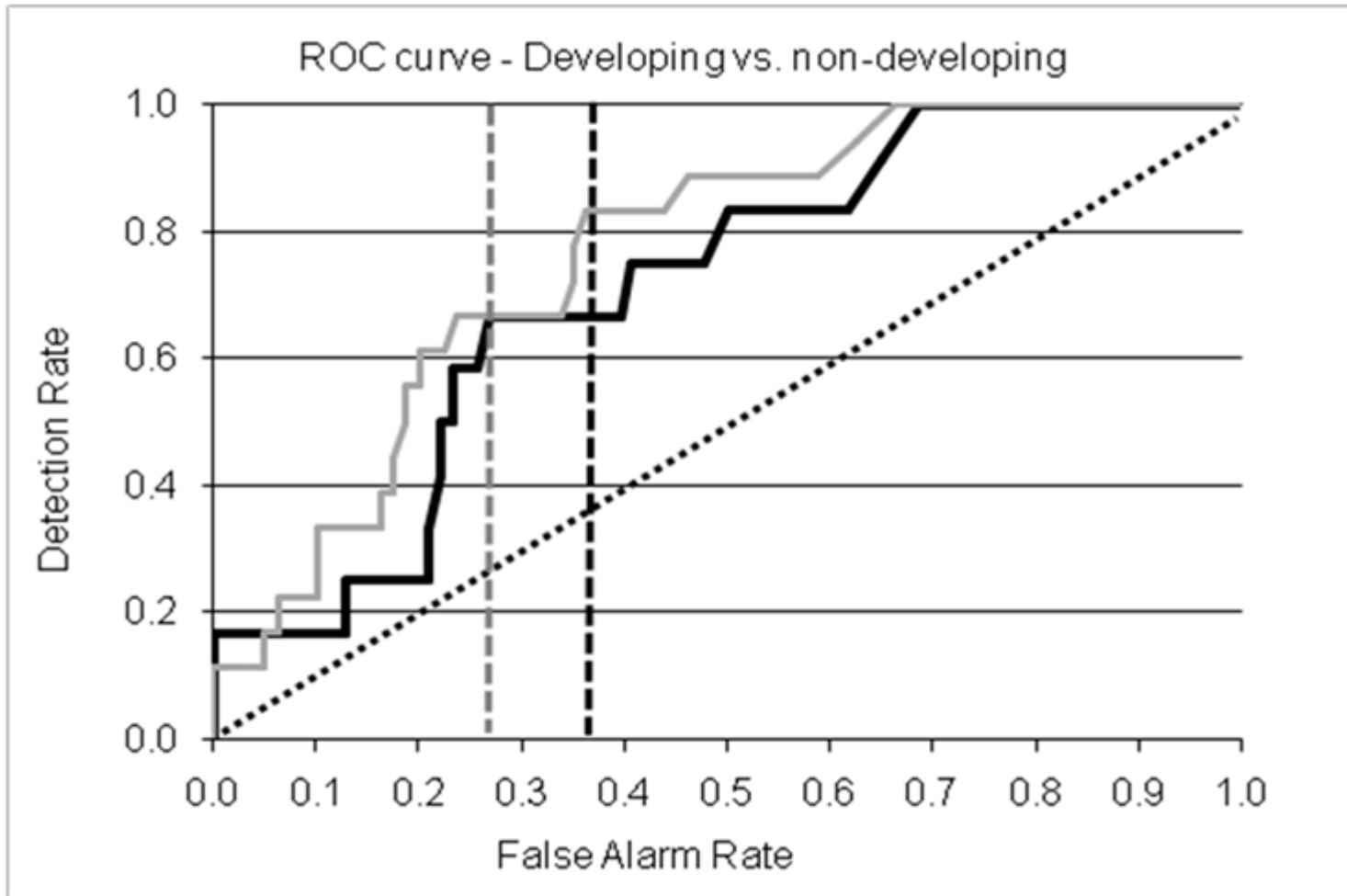


# Results:

2006	# of cases	Avg. per storm	Avg. per 6 hrs
NHC designated developers	6	10935	<b>479</b>
Non-designated developers	4	6988	<b>424</b>
Partial developers	7	8932	<b>294</b>
Non-developing clusters	39	2303	<b>149</b>
total of all cases	56	3465	<b>215</b>



# ROC Curve:



# Conclusions

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- The DAVT is a fully automated technique that characterizes the structure of a cloud cluster relative to an idealised vortex.
  - Correlates with intensity - provide intensity estimation
  - Provides a position estimate from early times
  - Provides a threshold for development ahead of NHC's first warning
  - Potential to characterise intensification rates for short-term prediction
- Lightning also provides a way to separate developing from non-developing cloud clusters

# On-going Work

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- There are several ways to improve the DAVT. We are:
  - adding a minimum “existence” criteria for every cloud system that is tracked - remove many “false alarm” systems
  - adding more years of training (help separate out the higher intensity storm to DAVT relationship) and other basins
  - adding more sources of remote-sensed data
    - in particular, we wish to “solve the problem” of incorporating non-regular spatial and temporal data such as microwave imagers and satellite-borne radar
- Lightning: using other remote-sensed imagery to characterise the microphysical differences between developing and non-developing systems



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# Thank you

Piñeros, M. F., E. A. Ritchie, and J. S. Tyo 2008: Objective measures of tropical cyclone structure and intensity change from remotely-sensed infrared image data. *IEEE Trans. Geosciences and remote sensing*. **46**, 3574-3580.

Piñeros, M. F., E. A. Ritchie, and J. S. Tyo 2009: Detecting tropical cyclone genesis from remotely-sensed image data. (In Preparation)

# Simulated Hurricane Emily 2005

