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

by

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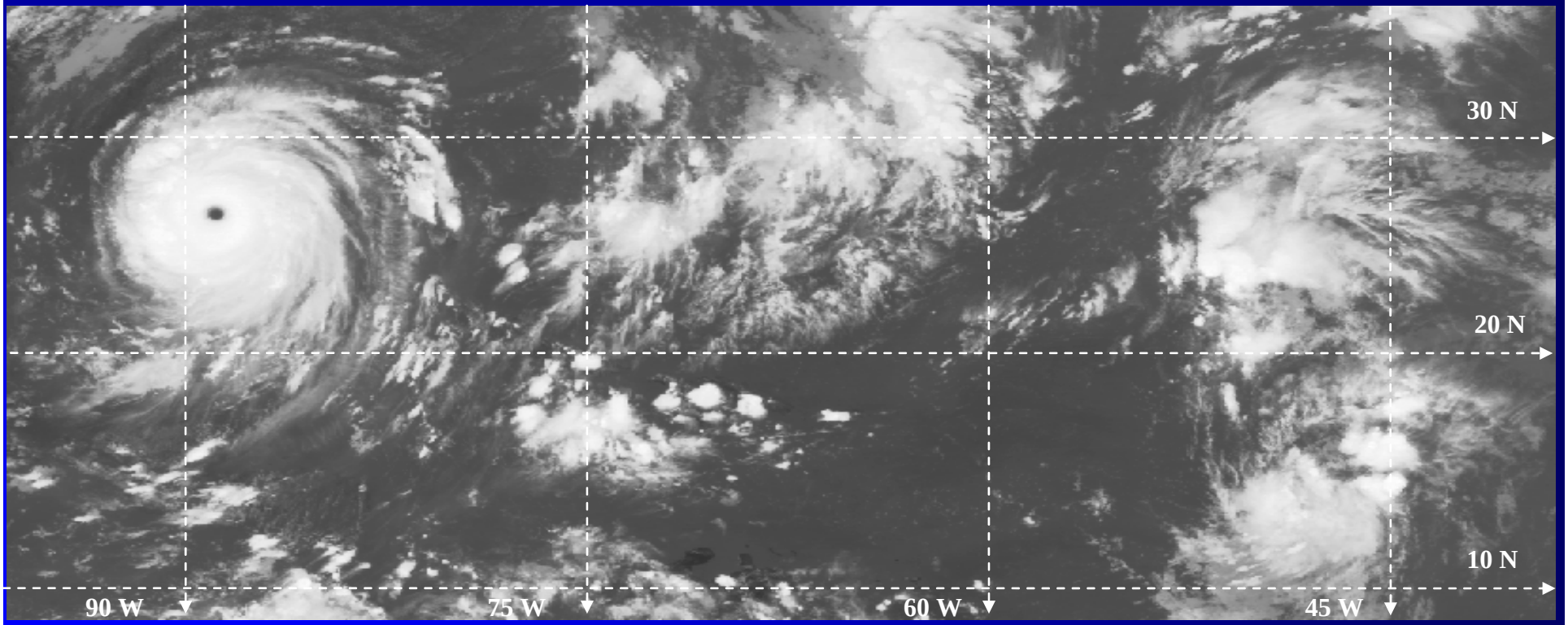
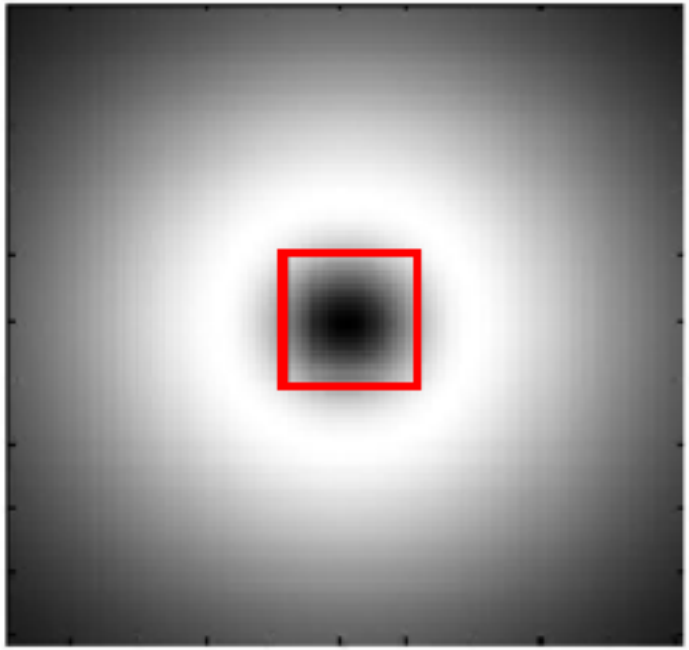


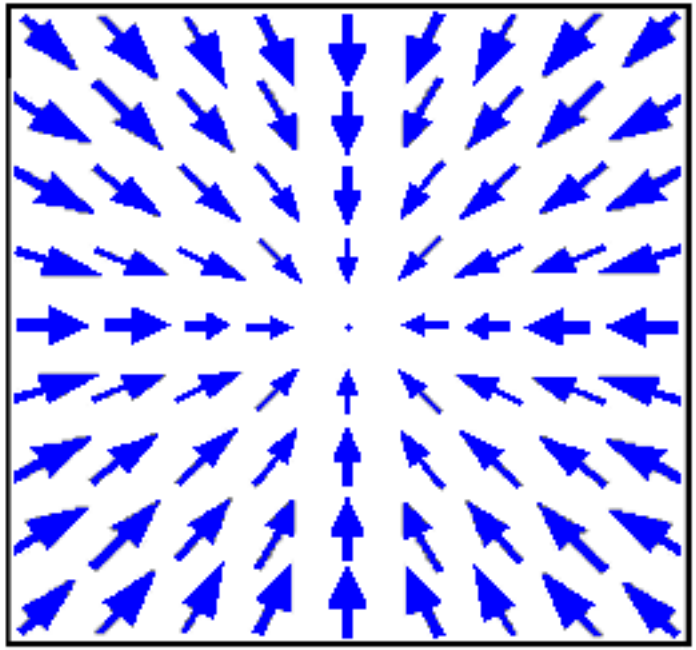
Acknowledgements: Office of Naval Research Marine Meteorology Program
TRIF – image processing fellowship

Idealised Vortex:-

Radiances

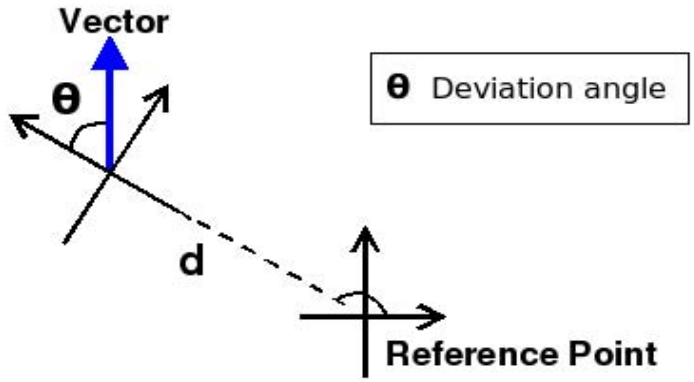
Radiance Gradient Vectors

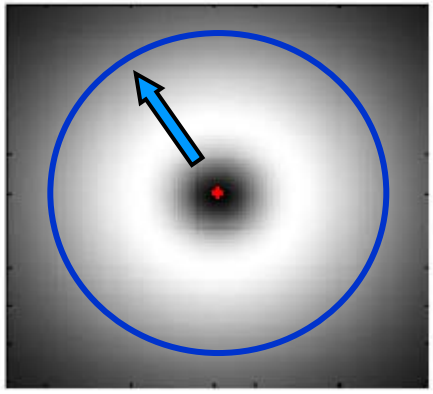




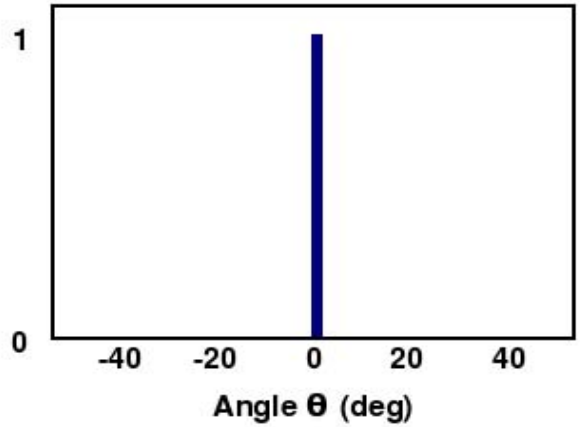
The deviation angle θ from a perfect radial is calculated for every pixel within 350 km of the reference point.

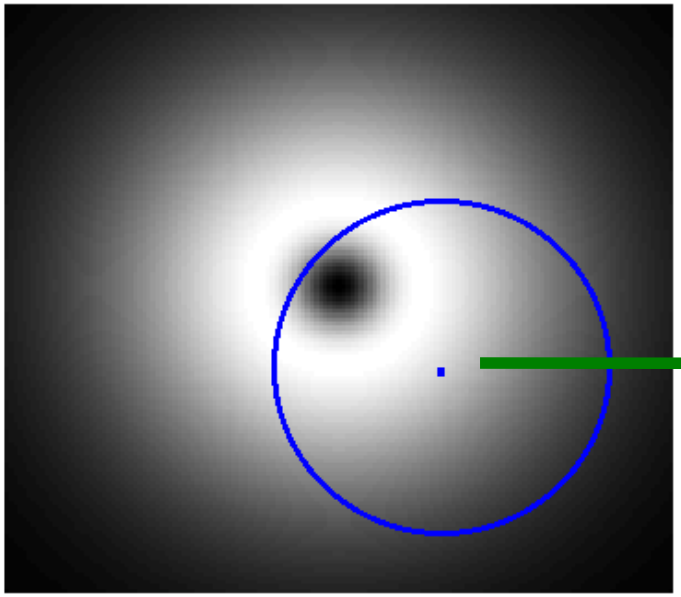
A histogram of angles is plotted. The variance is calculated.

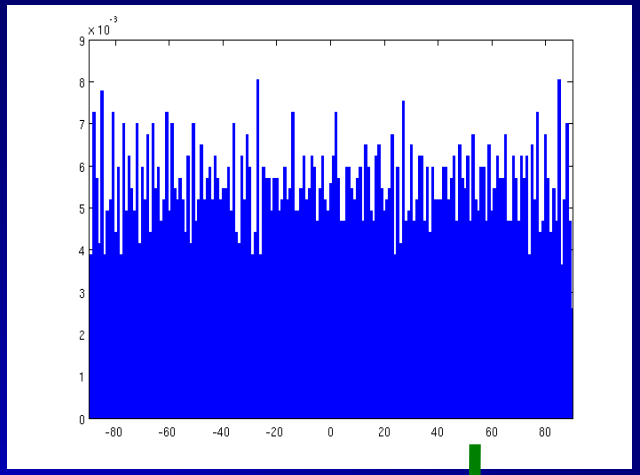


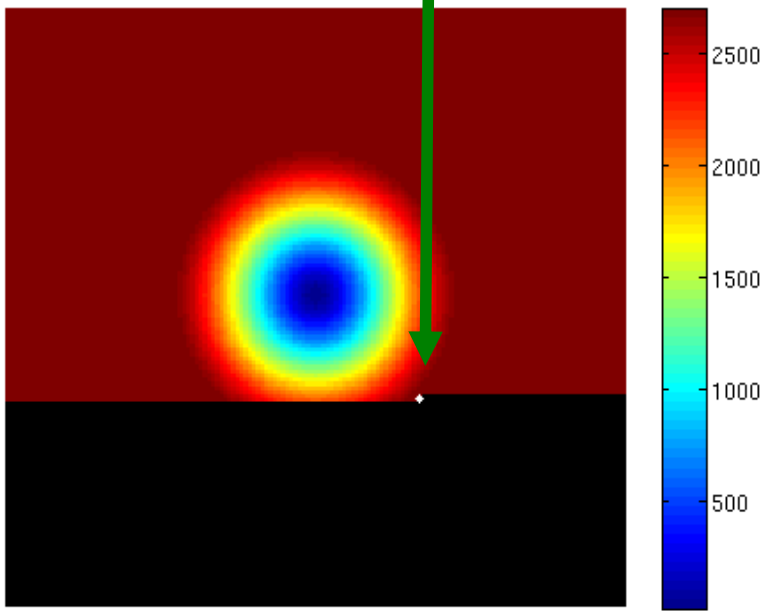


Gradient vector
θ = 0.0



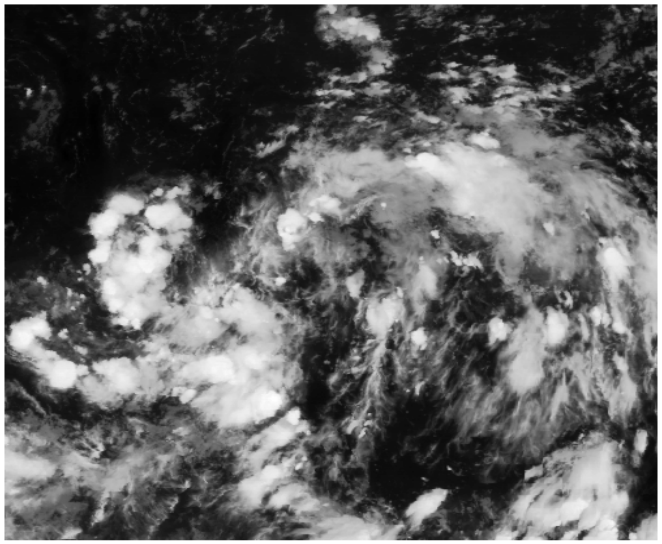


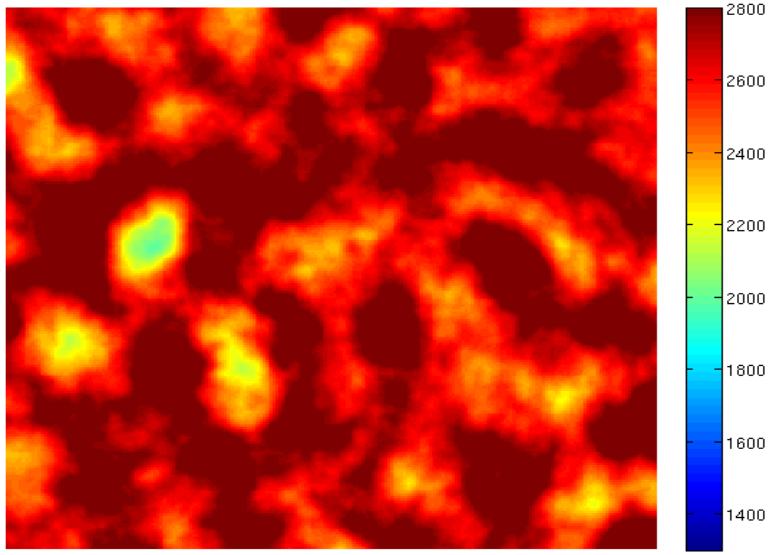




Repeated using every pixel in the scene in sequence as the reference point.

Hurricane Wilma 2005

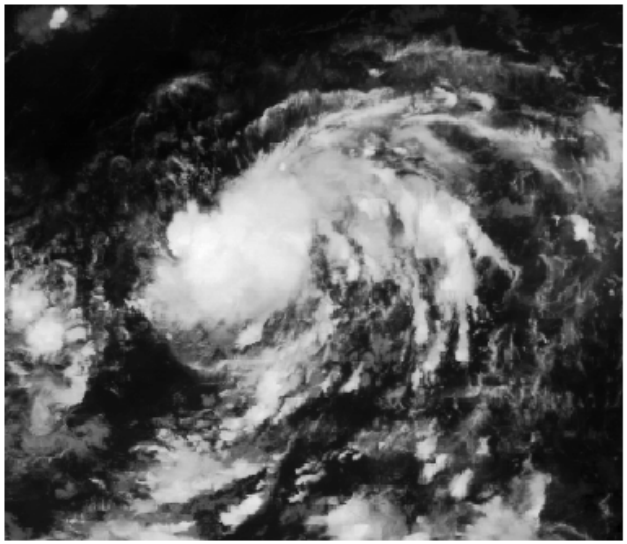


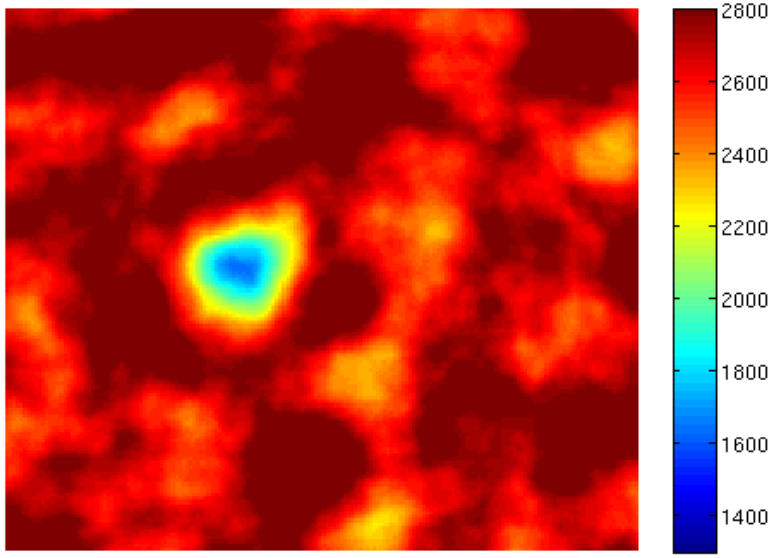


Intensity: not reported

Minimum Variance: 2094

Hurricane Wilma 2005

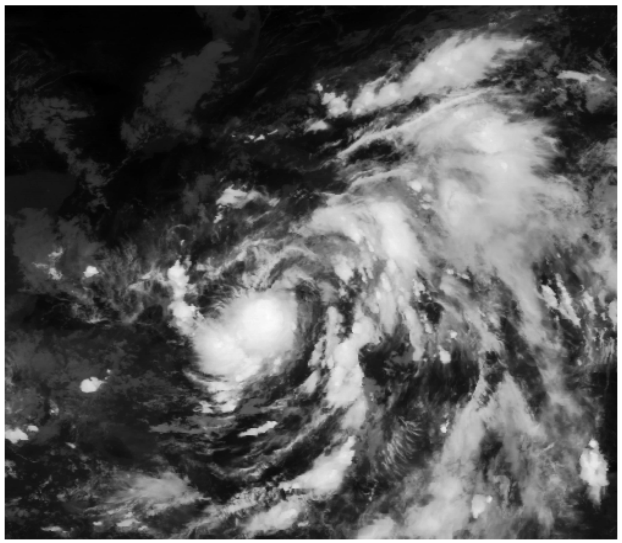


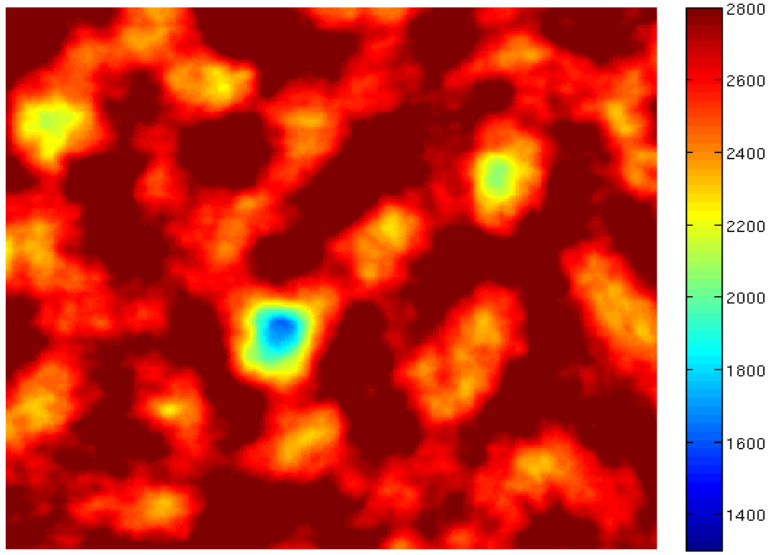


Intensity: 25 kt

Minimum Variance: 16

Hurricane Wilma 2005





Intensity: 35 kt

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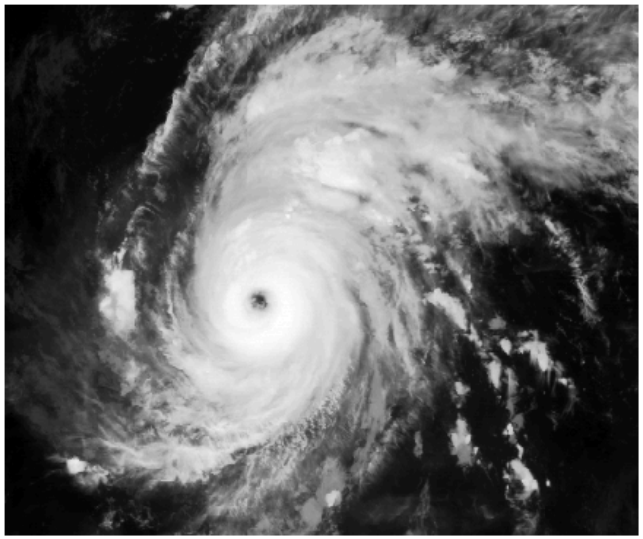
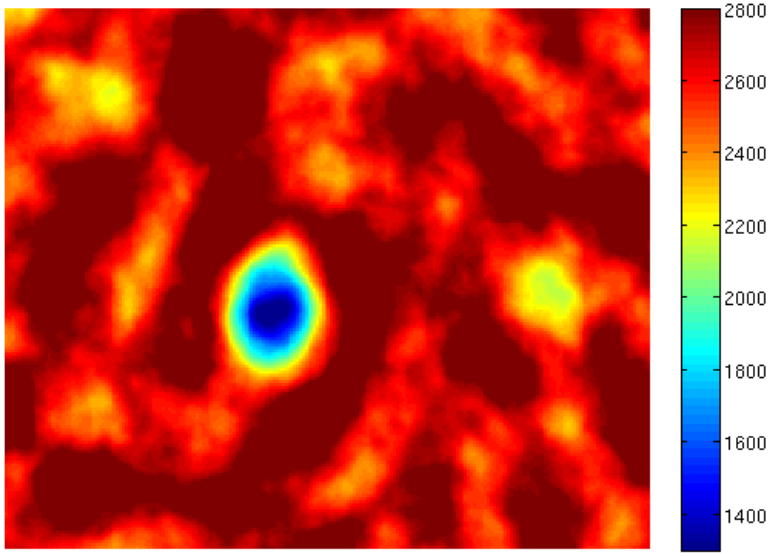
Hurricane Wilma 2005

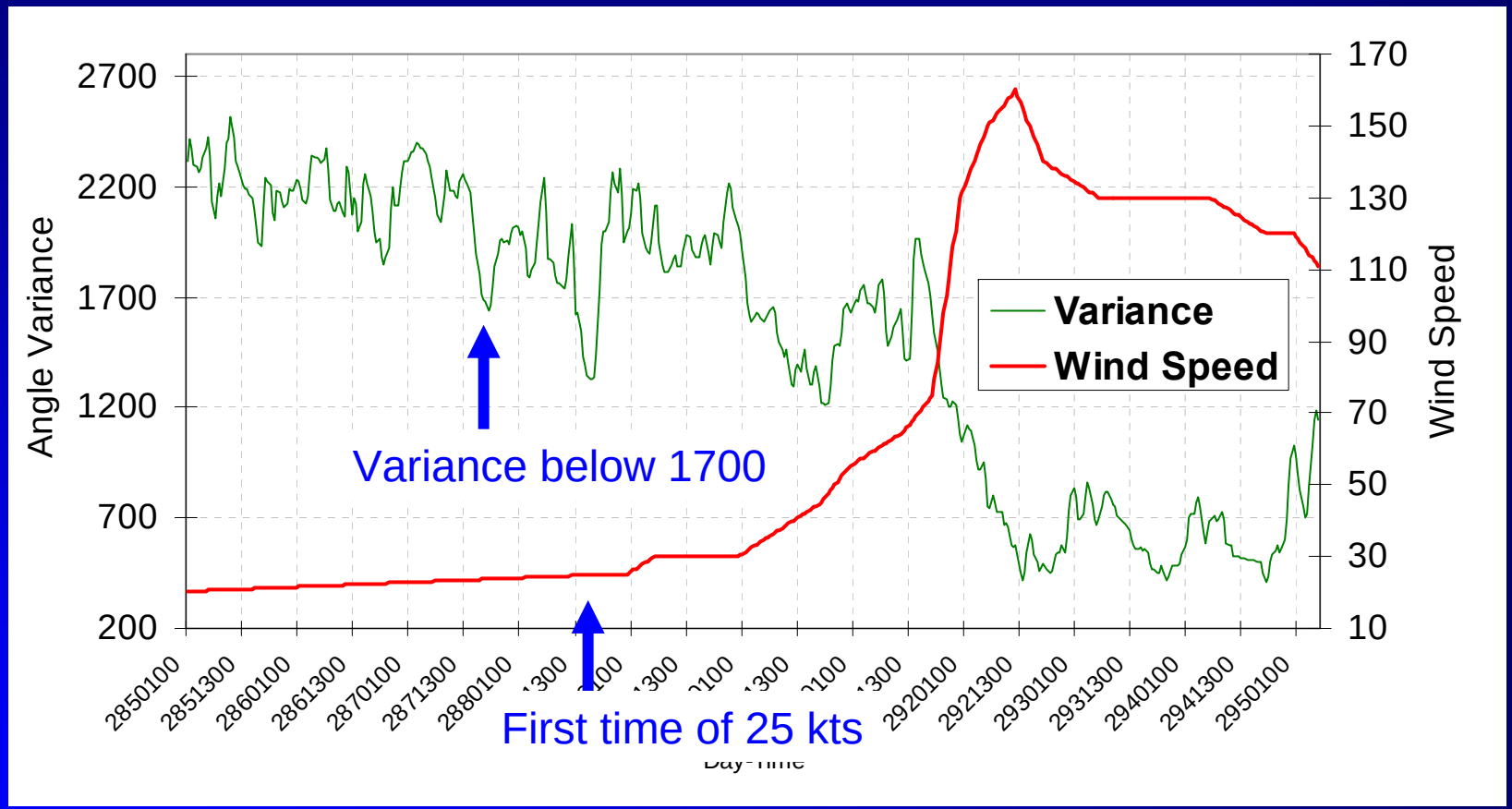




Intensity: 130 kt

Minimum Variance: 13

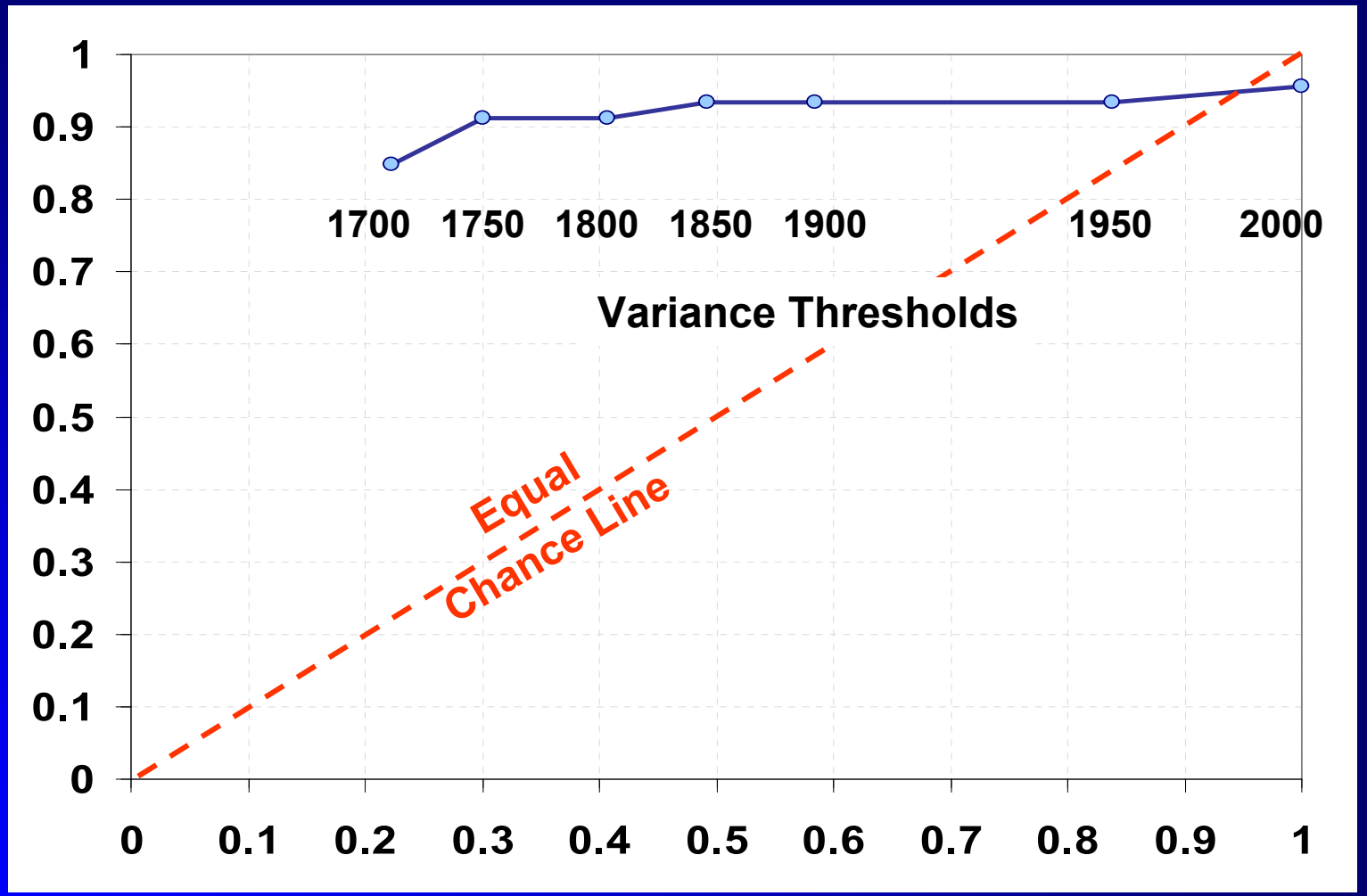
Hurricane Wilma 2005



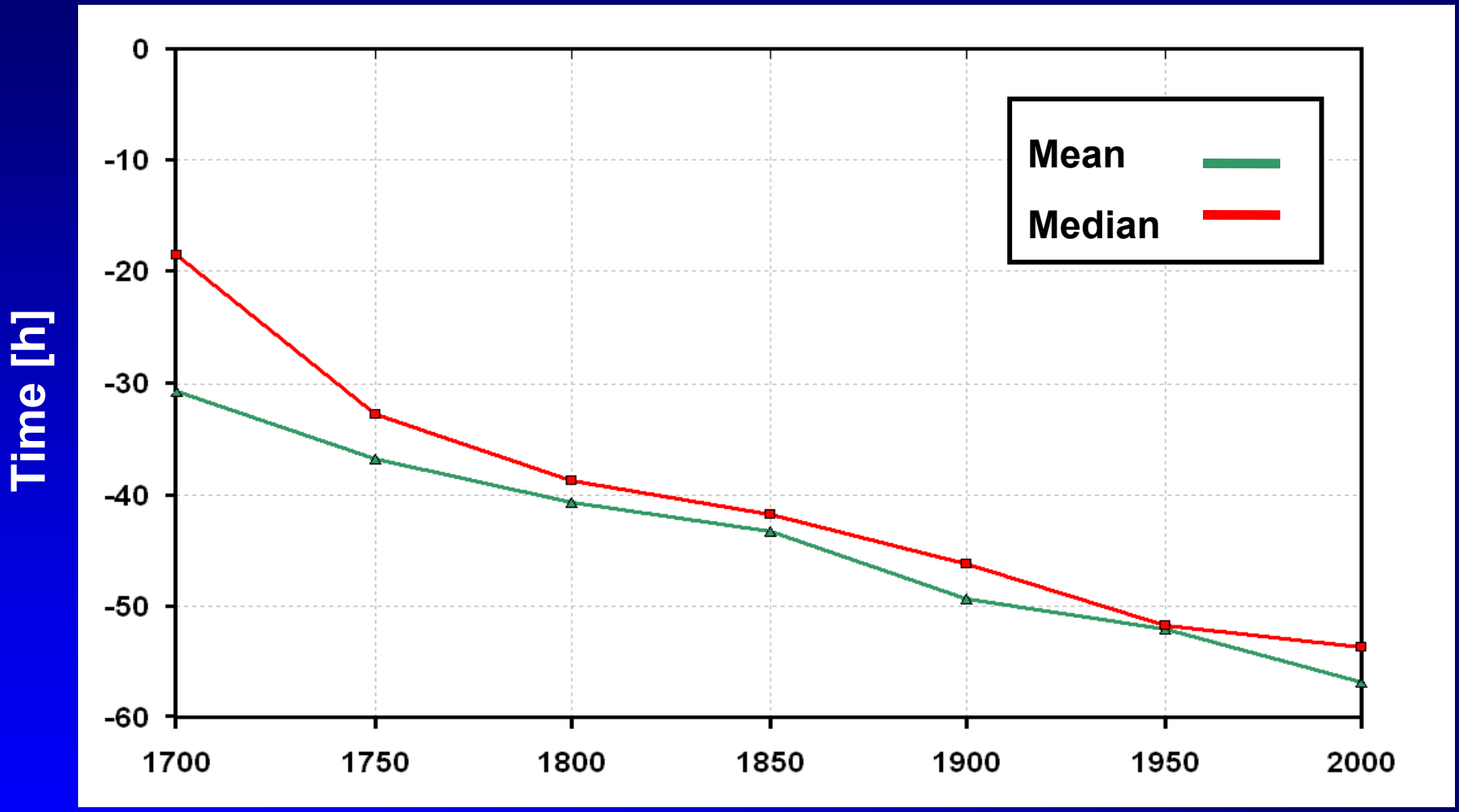
Correlation: **Total time series** **-0.93**

From 25 kts on **-0.92**

ROC


Probability of Detection
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1700
1750
1800
1850
1900
1950
2000
Variance Thresholds
Equal
Chance Line
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
False Alarm Rate

Detection Time



Conclusions

- A completely objective technique to determine whether a cloud system will develop into a TC.
- Threshold of 1700 gives P_D = 85% for pre-genesis cloud systems for F_R = 22%
- Mean detection of 30 hours in advance of first warning by NHC:
  - Best case: -100 hours Worst case: +20 hours
- There is a lot of potential uses with this technique:
  - good correlation between variance and intensity through system's lifetime – provide "intensity fix"
  - potential to provide early "position fixes"
- There are several ways to improve the system:
  - add a minimum "existence" criteria for every cloud system that is tracked – remove many "false alarm" systems
  - add more years of training
  - add more sources of remote-sensed data

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)