Tropical Cyclone intensity Estimation and Formation Detection using the Deviation Angle Variance Technique

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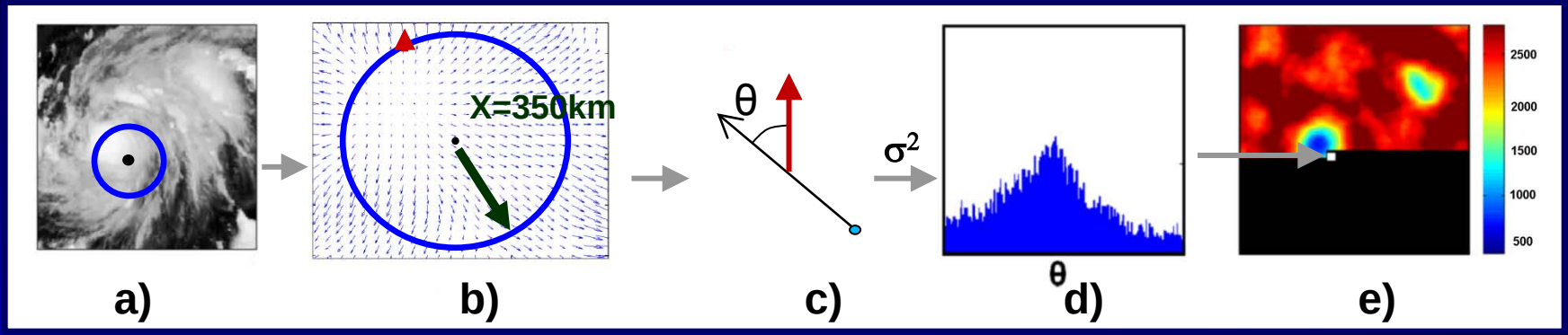
Summary of the DAV technique



a) **Calculate gradient of the brightness temperatures of IR image of interest**
b) **For a chosen center point draw radials to all pixels within a radius X.**
c) **Calculate the angle between the radial and the gradient at all pixels**
d) **Plot a frequency histogram of the angles and calculate the variance**
e) **Map the variance back to the center pixel location.**

Note: higher variance → greater disorganization → lower intensity
lower variance → greater organization → higher intensity

Intensity: require 9 pixels around a specified center location (9-pixel average)

Genesis: require the full map of variances – locate regions where the variance falls below a statistically-determined threshold value for a detect.

Summary of achievements for 2011

Data: 30-m GOES or 60-m MTSAT 10.7 μm infrared band.

- Atlantic basin (GOES-E):

Intensity	- 7 years (2004-2010)
	- employed “operational centers” for intensity
Genesis	- 2 years (2004-2005) to build statistics

- Added western North Pacific basin (MTSAT) (with NRL and JTWC):

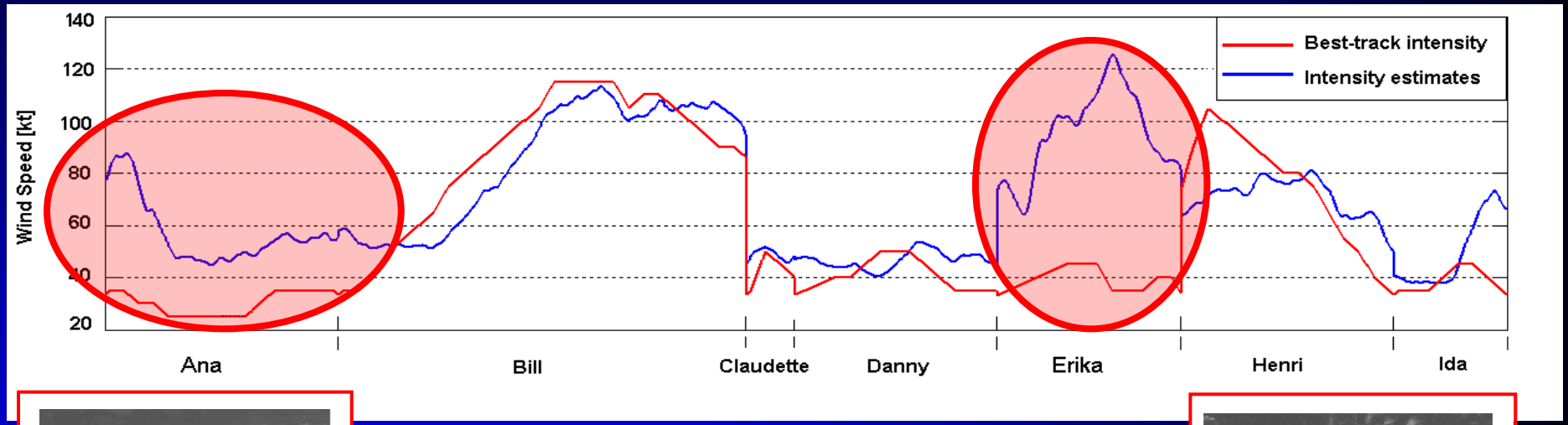
Intensity	- 3 years (2007-2009)
Genesis	- 2 years (2009-2010)

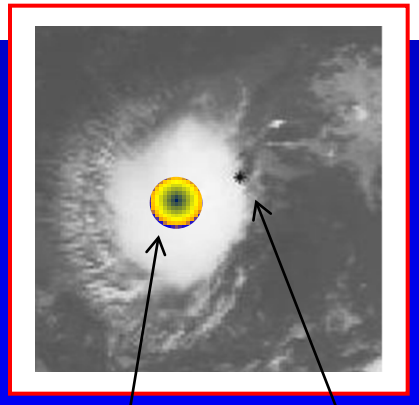
- Added eastern North Pacific basin (GOES-W & GOES-E):

Intensity	- 6 years (2005-2010)
Genesis	- in progress

New "Operational" Center technique

Training: 2004-2008 Testing: 2009, **RMSE: 24.8kt**





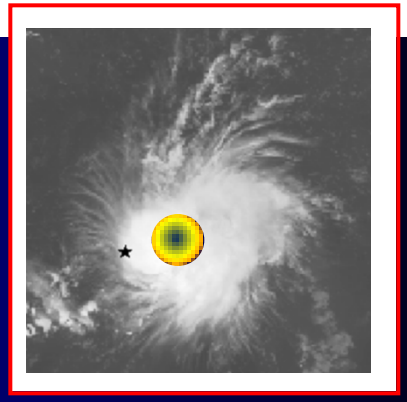
Automated DAV center

Circulation center

Old Method: use lowest DAV value in cloud cluster for intensity estimation – usually fairly close to "real" circulation center.

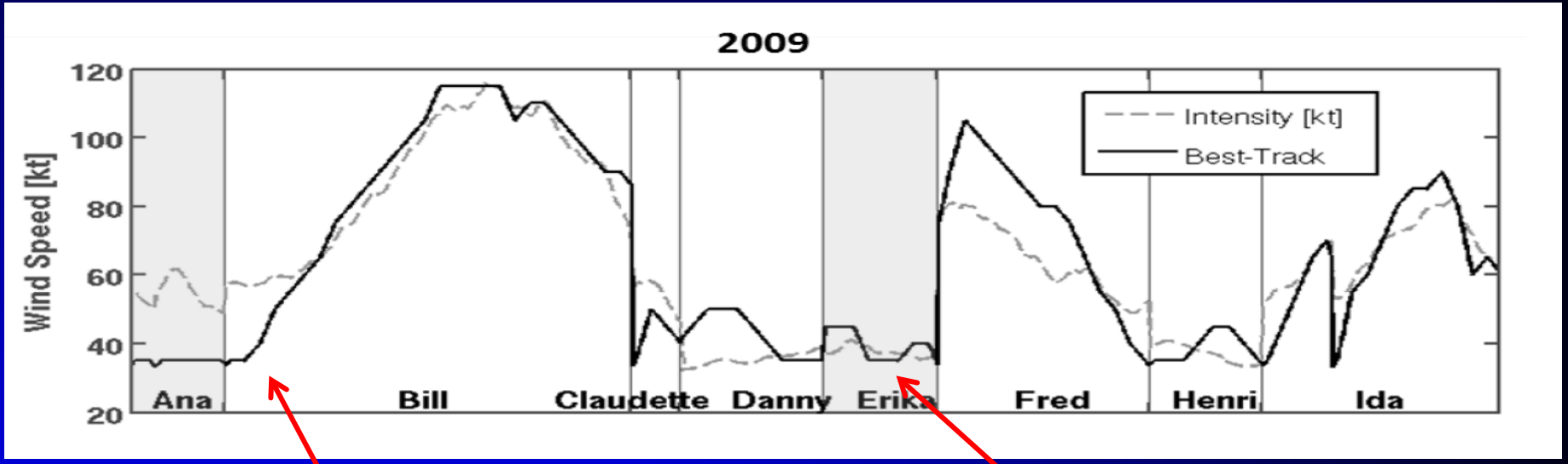
Problem: Real center is outside a very circular but highly sheared cloud system.

Solution: Use "operational center fix" as the center pixel for the DAV calculation.



New “Operational” Center technique

Using “operational” center (in this case best track since it’s retro-active)



Ana: from 29 kt to 19 kt

Erika: from 58 kt to 6 kt

New “Operational” Center technique

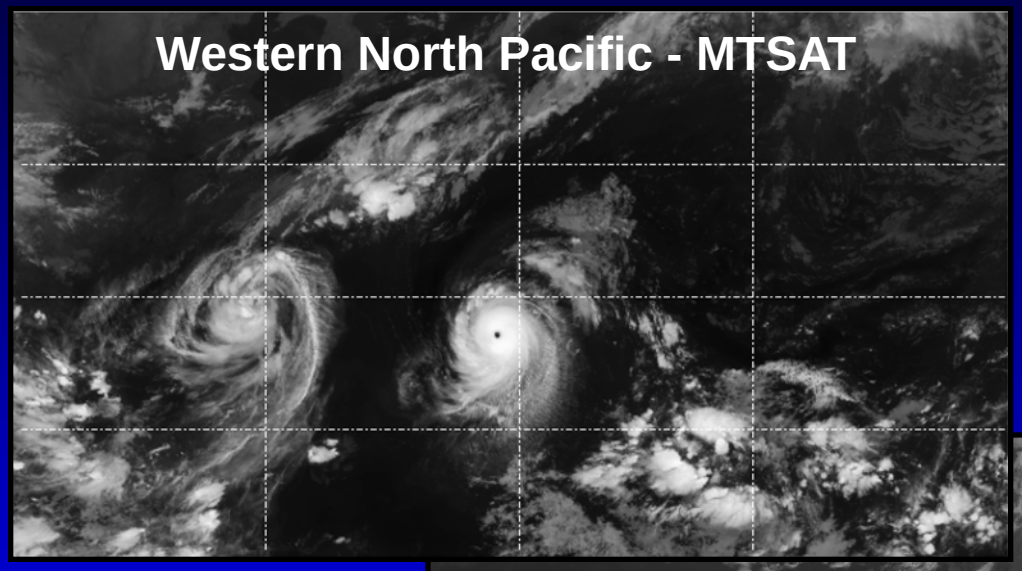
Direct comparison of RMSE between two years for the Atlantic basin.

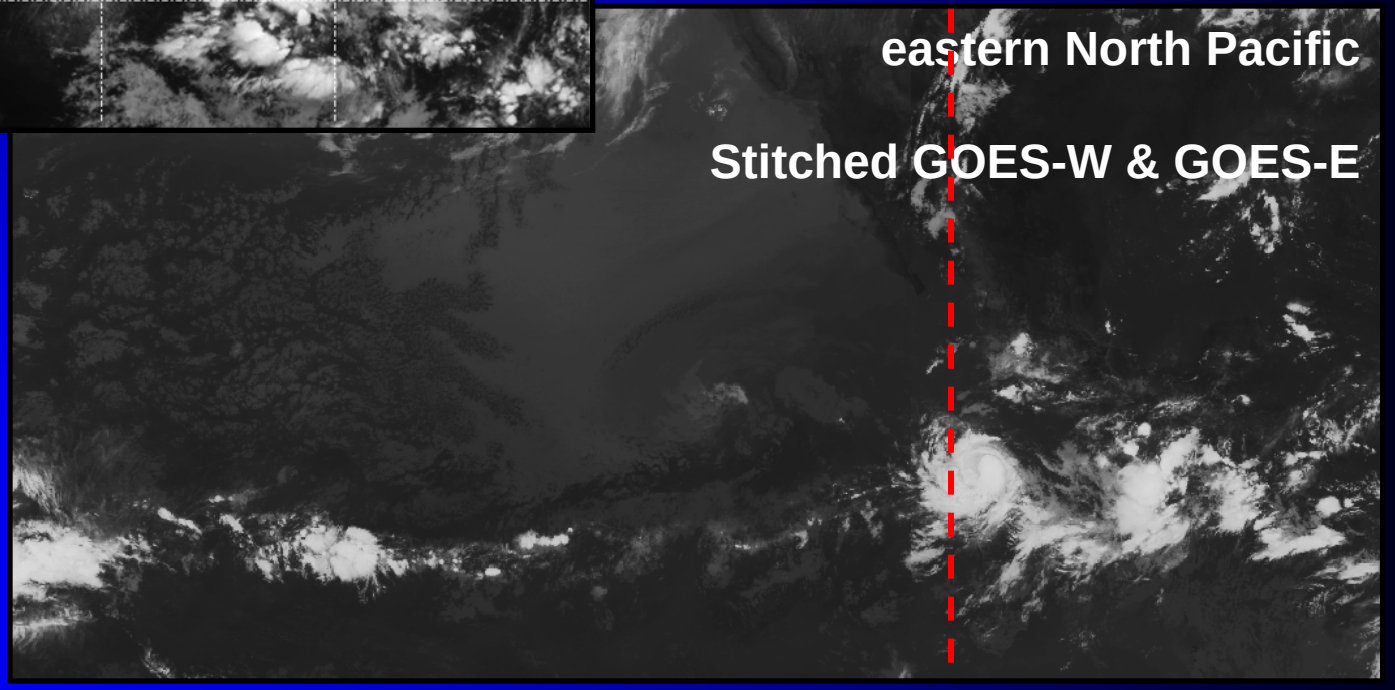
	Old Technique	New Technique
2009	24.8 kt	10.6 kt
2010	14.7 kt	11.8 kt

Appears to provide consistent improvement

*** Now use this new technique for the new basins ***

Data – added 2 basins

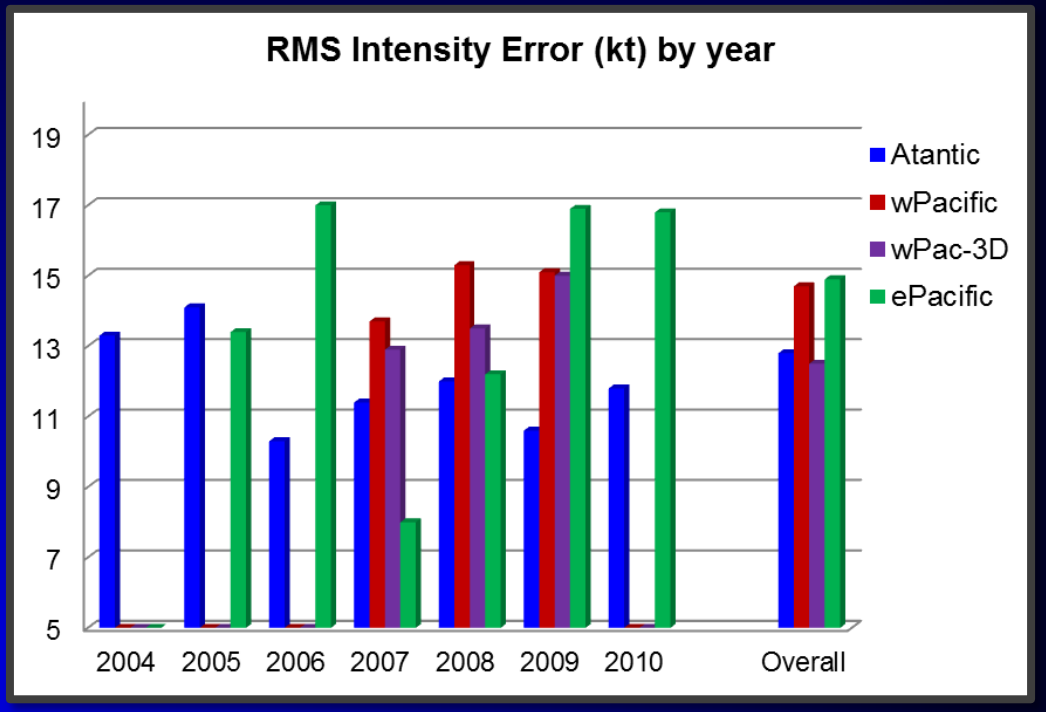




Images are 15 minutes apart

New “Operational” Center technique

Results for all basins



Basin	Overall RMSE	Best Year	Latest Year
Atlantic (7 years)	12.8 kt	2006 10.3 kt	2010 11.8 kt
w-Pacific (3 years)	14.7 kt	2007 13.7 kt	2009 15.1 kt
e-Pacific (6 years)	14.9 kt	2005 13.4 kt	2010 16.8 kt

New "Operational" Center technique

Atlantic binned by intensity categories:-

Bin	# of Samples	RMSE (kt)	# Overestimated	#Underestimated
Tropical Storms	9896	10.9	5666 (57%)	4230 (43%)
Hurricane Cat 1	2892	12.5	1620 (56%)	1272 (44%)
Hurricane Cat 2	1522	12.5	676 (44%)	845 (56%)
Hurricane Cat 3	1453	12.6	532 (37%)	920 (63%)
Hurricane Cat 4	1513	17.7	309 (20%)	1204 (80%)
Hurricane Cat 5	347	32.4	0 (0%)	347 (100%)

**** Similar trend for other basins**

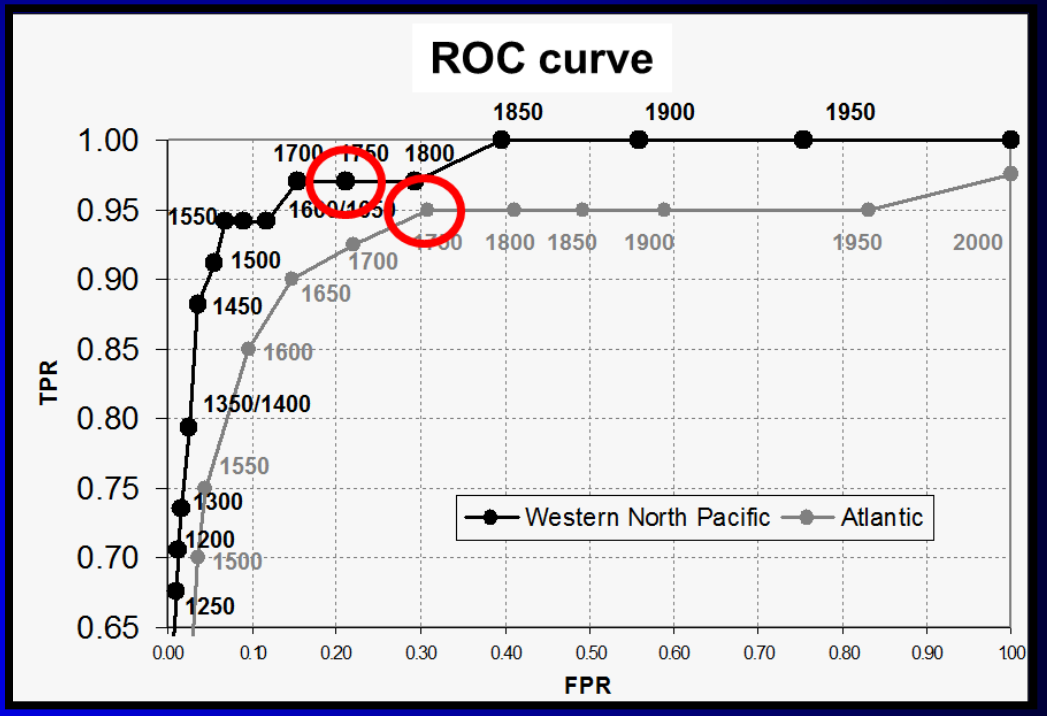
**** Correlating by Vertical wind shear from SHIPs showed little trend.**

Genesis Detection – ROC curve

Western North Pacific: 2009 and 2010 *Atlantic: 2004 and 2005.*

Choose a threshold DAV value - 1750 deg^2 –
All cloud systems that meet that criteria are "positive". All others are "negative".
Check if correct – build statistics for ROC curve

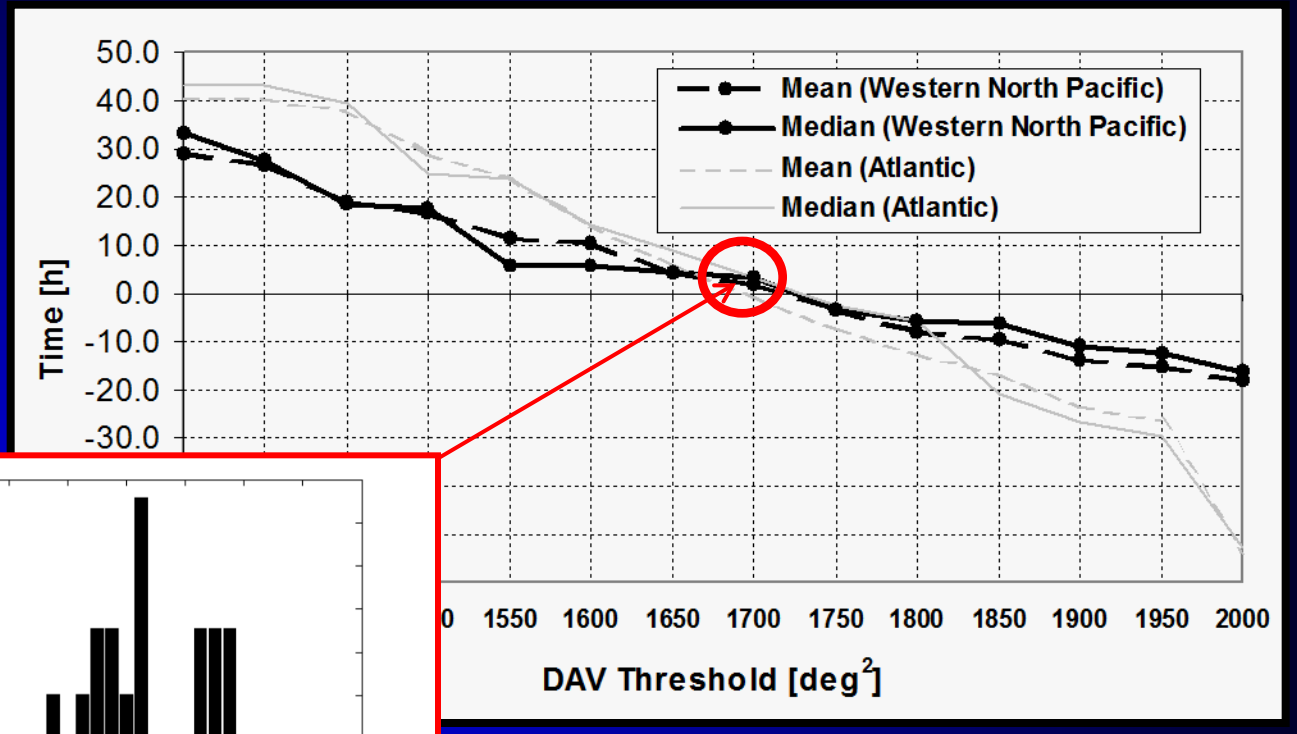
True positives are named systems that were detected at a given DAV threshold

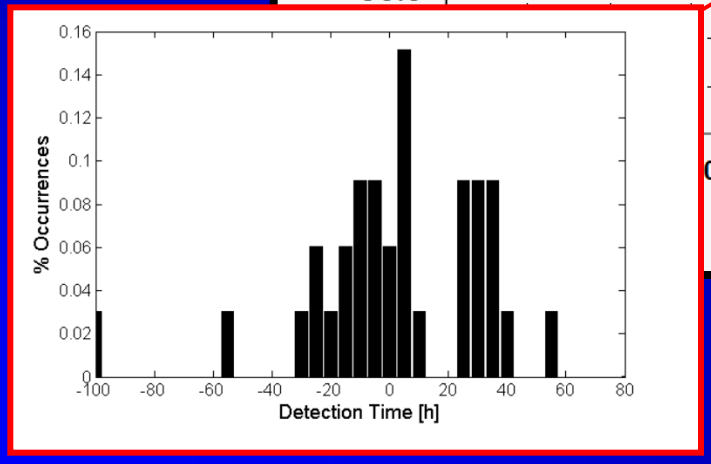


False positives are systems fell below a given DAV threshold but did not develop

Genesis Detection – Detection time

Also accumulate the detection times of the "true detects" and compare to best track





Westpac Distribution

Mean and median time of detection of tropical cyclones (relative to Best Track TD designation) during 2009 and 2010 in the Western North Pacific basin and for the Atlantic during 2004 and 2005.

Next Steps

- General:
  - Develop “probability of TD/TS in 24/48/72 h” prediction.
  - Explore the DAV signal for wind structure and prediction information.

- Atlantic basin:
  - Add 2011 when Best track is available (or obtain operational center information)
  - Test in “real time” in 2012 season

- Western North Pacific basin:
  - Add 2010/2011 for intensity estimation
  - Explore 3-D parametric surface instead of 2-D sigmoid (good results)
  - Test in “real time” in 2012 season (exploring obtaining MTSAT in real tine)

- Eastern North Pacific:
  - Add 2011
  - Develop the genesis statistics

- Add Australian region:

- User Interface – poster in Gold Room:
  - Add eastern North Pacific, automatic tracker of cloud clusters
  - Add intensity page

Thank you

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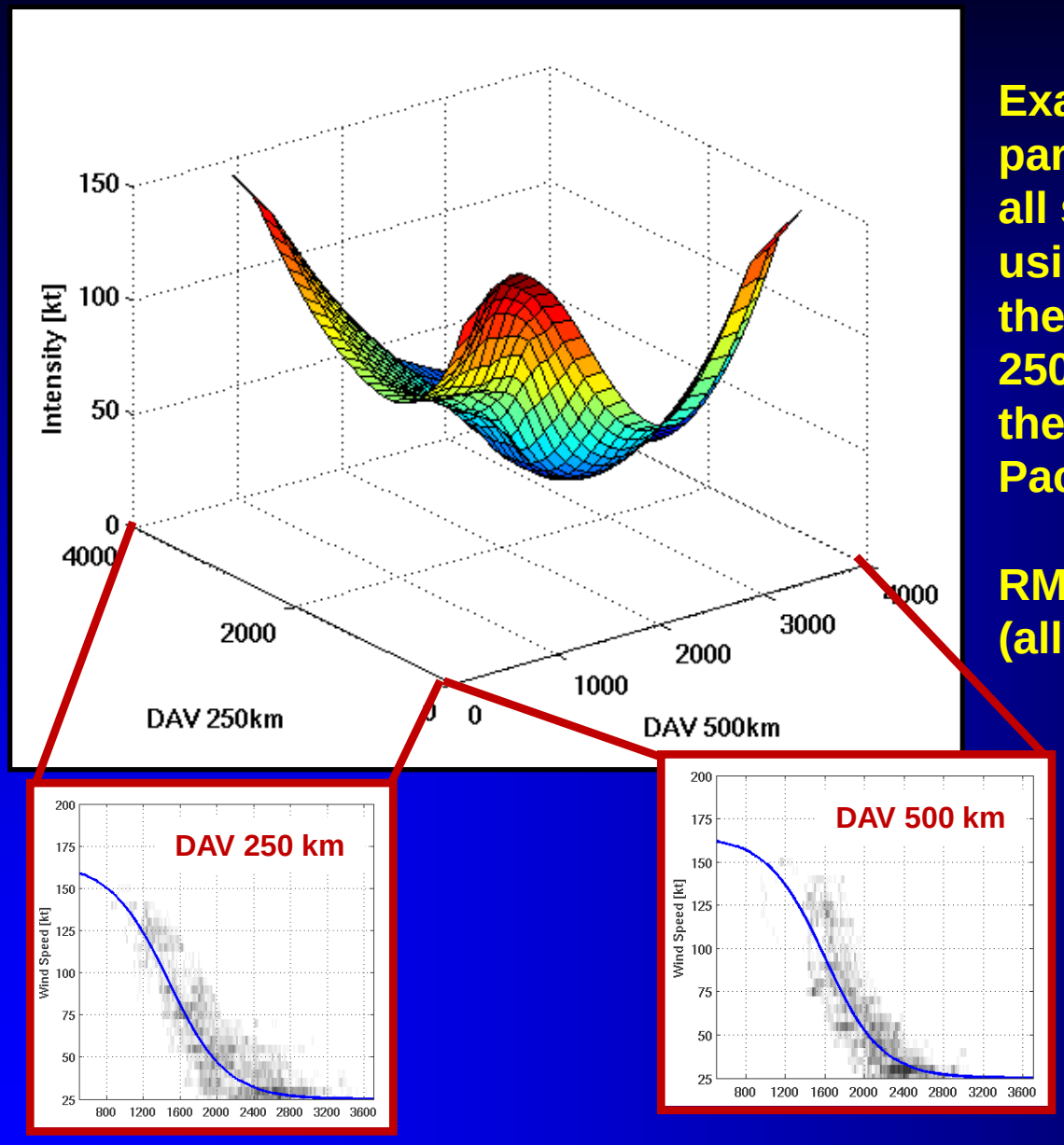

Example of a 3-D parametric surface for all samples (2007-2009) using a combination of the two "best" radii – 250 km and 500 km for the western North Pacific.

RMSE: 12.5 kt (all storms train-test)