The Deviation Angle Variance technique:

Pre-genesis cloud cluster tracking for Genesis detection and prediction

by

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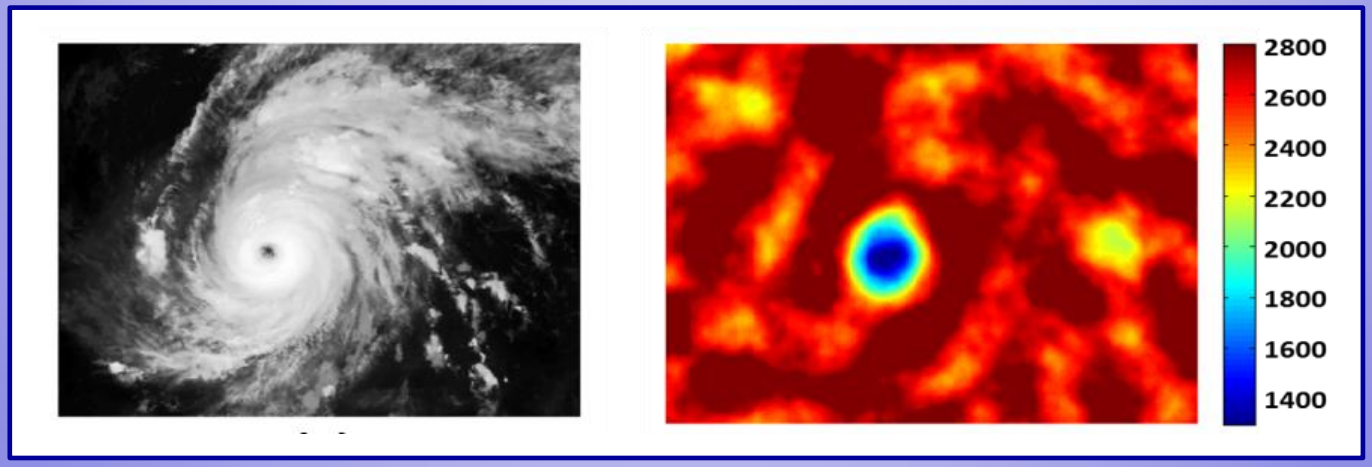

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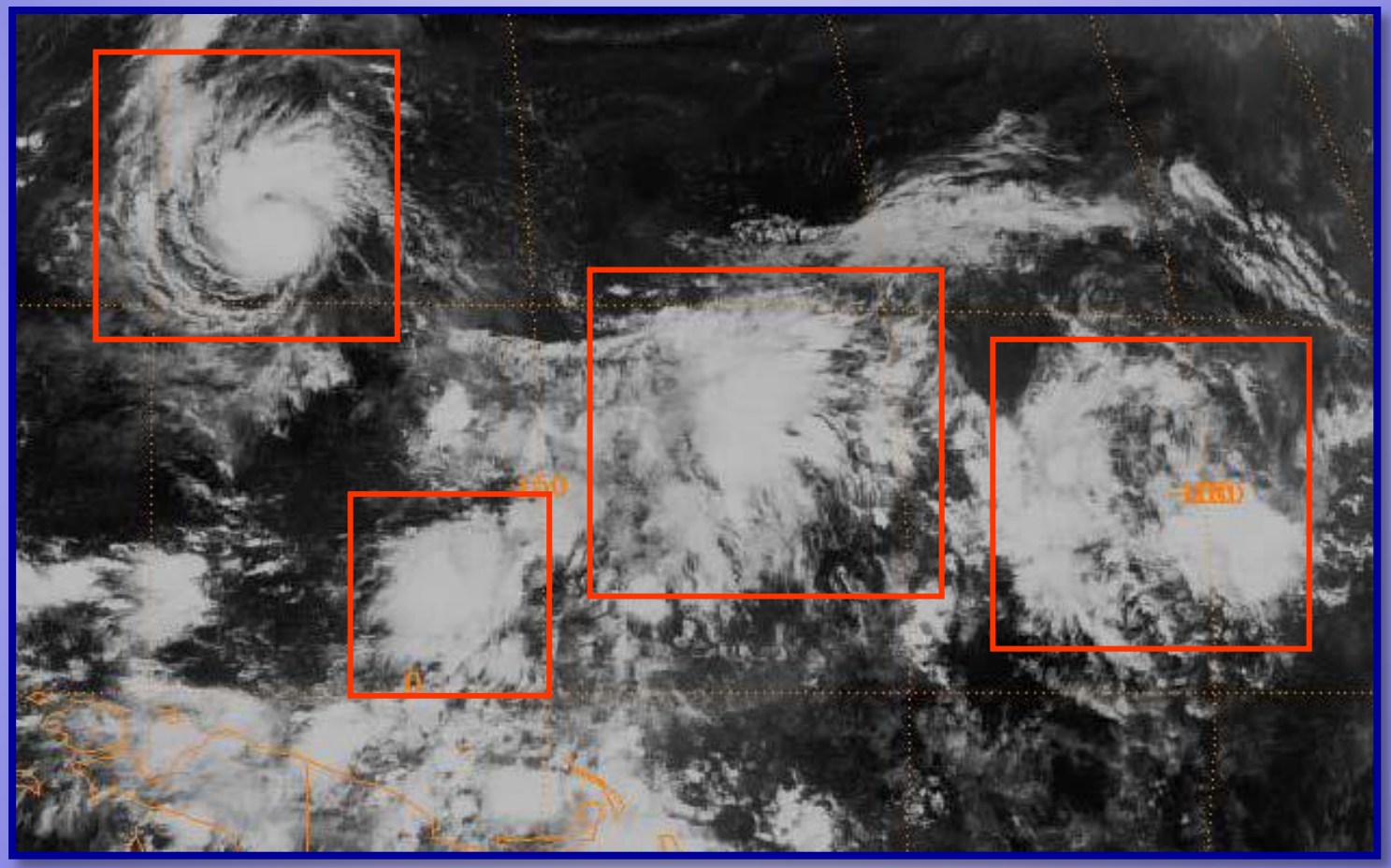
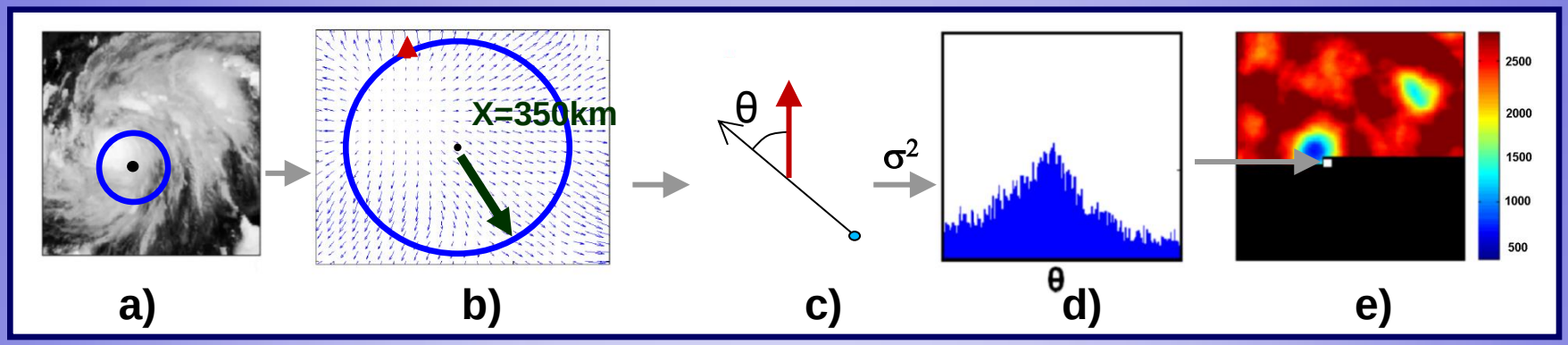
The Challenge …

Western North Pacific

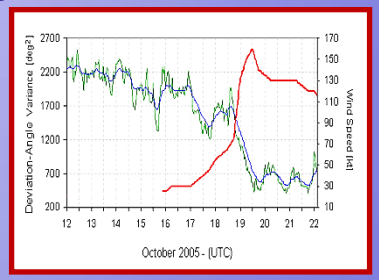


The DAV Technique …



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

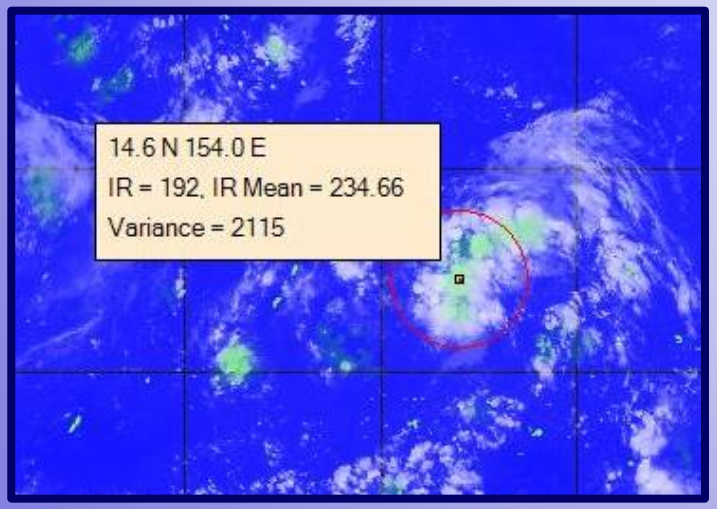


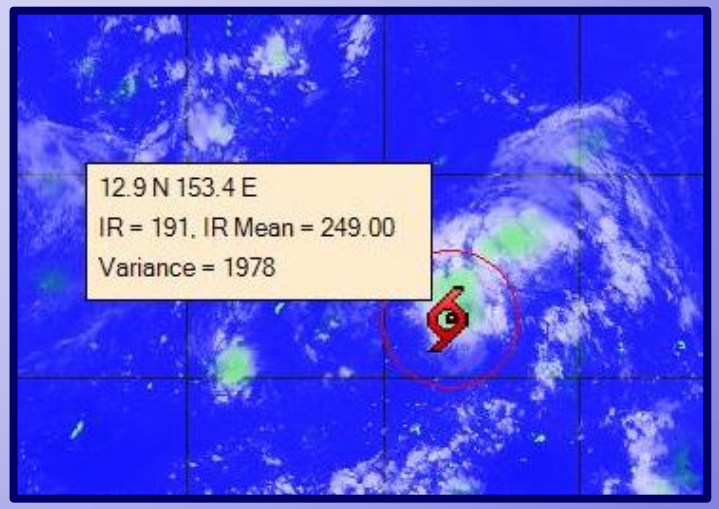
Intensity: require 9 pixels around a specified center location (9-pixel average)

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

Automatic Tracking (AT) …

a) Initial detect using a DAV threshold of 2000 deg^2
b) Next detect must occur within 24 hr and 500 (350) km of previous to be related
c) CC exist for at least 48 (72) hours
d) Detect (invest) is dropped if DAV goes above 2000 deg^2 for > 24 hour
e) A minimum average T_B threshold must also be met
f) Two-threshold requirement: detect is considered positive if DAV subsequently falls below a 2nd threshold of 1750 deg^2





Automatic Tracking (AT) …

Validation in western North Pacific

Tracking System	JTWC		Auto Tracking		# that correspond	
Season	# DEV	# NDEV	# DEV	# NDEV	# DEV	# NDEV
2009	23	44	23	49	23 (100%)	15
2010	19	77	17	49	17 (89%)	15
2011	20	44	19	30	19 (95%)	7
2012	20	39	16	23	16 (80%)	8

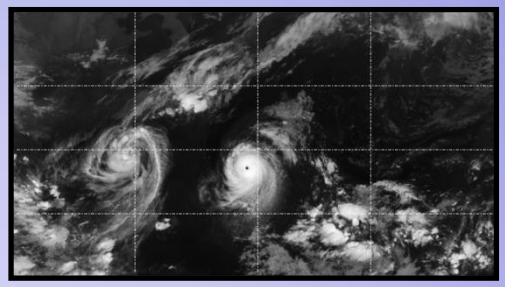
- Comparison with JTWC invest and best-track databases 2009-2012
- 75 of 82 developing TCs were correctly identified
- JTWC identified 204 non-developing CCs
- Automated tracking identified 151 non-developing CCs
- 45 corresponded between JTWC and DAV.

AT for Genesis

Automatic Tracking and Genesis – two threshold system

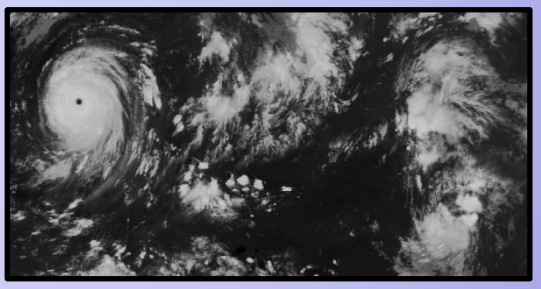
**Atlantic and Gulf of Mexico (GOES-E)

- original development using this basin
- Manually tracked
- reported on at previous IHC



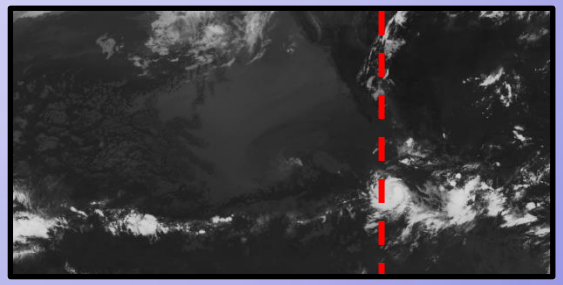
Western North Pacific (MTSAT)

- 3 years: 2009-2011
- hourly images
- 59/61 TCs detected
- 128 non-developing CCs



Eastern North Pacific (GOES E/W)

- 3 years: 2009-2011
- ½-hourly images
- 40/42 TCs detected
- 187 non-developing CCs



Detecting Genesis

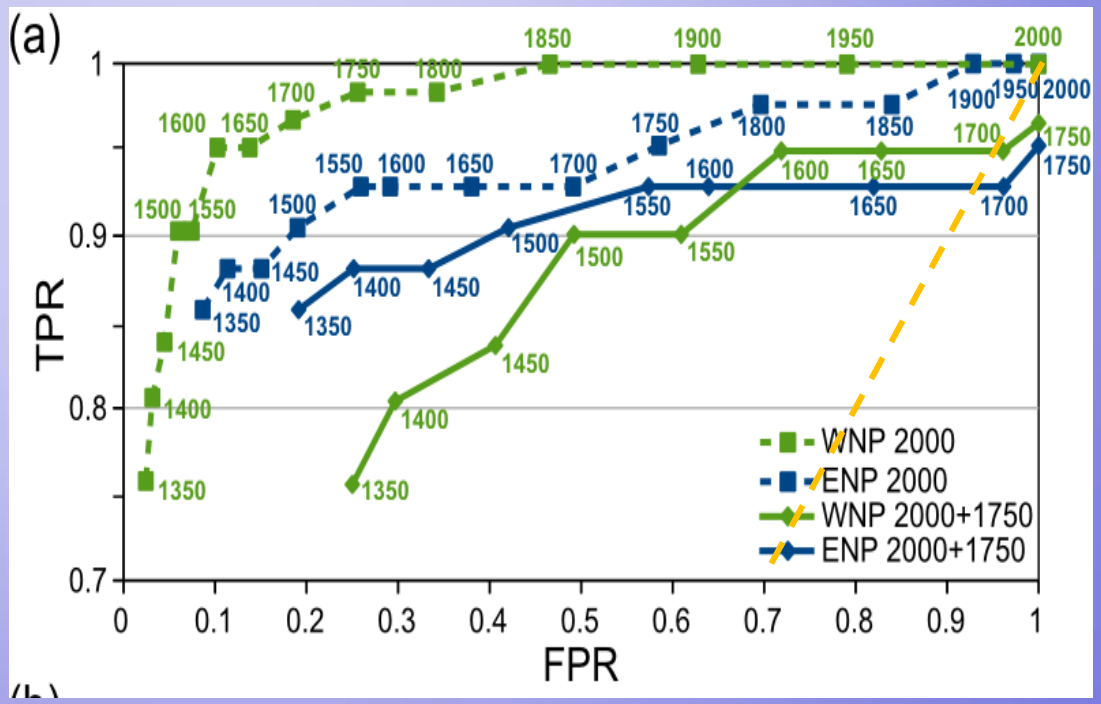
west NPAC and east NPAC – 1- and 2-threshold results

- Single threshold: DAV=2000 deg^2
- Double threshold: DAV = 2000 deg^2 and 1750 deg^2
- All CCs that meet 2nd threshold are "positive". All others are "negative".
- Check if correct – "True/False positive True/False negative"

- Plot:

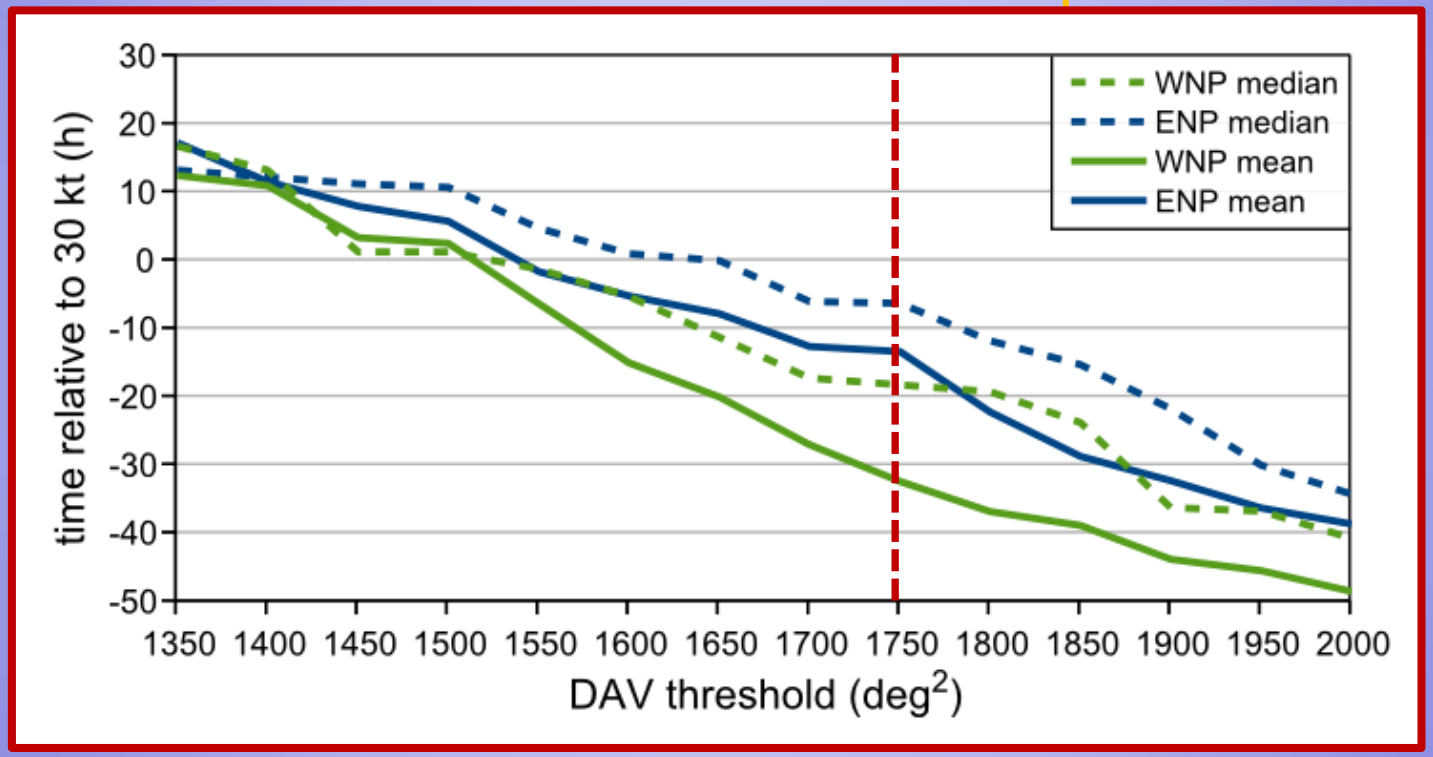
$$PoD = \frac{\#TP}{\#TP+\#FN}$$

$$FAR = 1 - \frac{\#TN}{\#TN+\#FP}$$



Detecting Genesis

Also accumulate the detection times of the "true detects" and compare to first entry of "30-kt" in the best track archive. Chosen for better consistency …



- **Western North Pacific: -32 hr**
- **Eastern North Pacific: -10.6 hr**

- **Earlier detection times for higher thresholds with higher false alarm rates.**

Work in Progress

Probabilistic Genesis

- A large amount of DAV information can be processed to calculate relative frequencies develop probability of genesis in XX hours given values of DAV have been met.

- Compute the % of CCs detected by the tracking system that develop into a TC as a function of the DAV threshold and the time spent below this threshold

- Compute the conditional relative frequency of development, for a set time to detection at each DAV threshold for:
    - tropical depression
    - tropical storm
    - typhoon

  given that the disturbance developed into a TC according to the JTWC best track.
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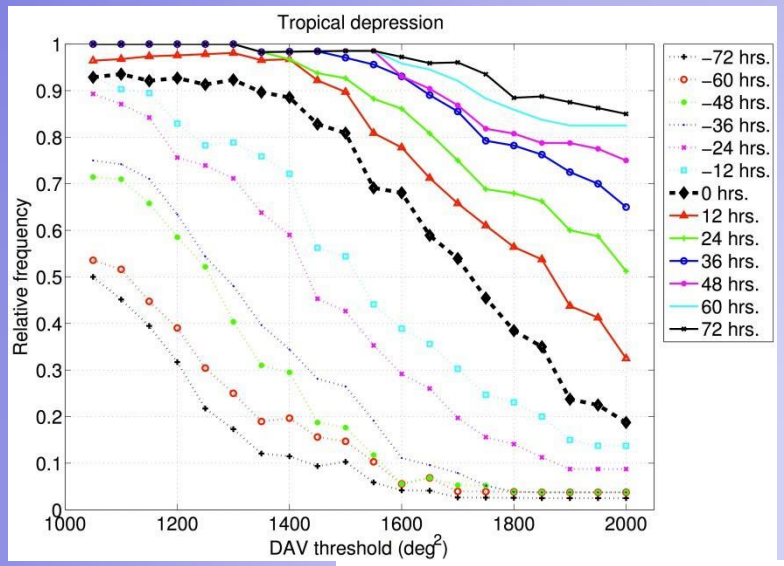
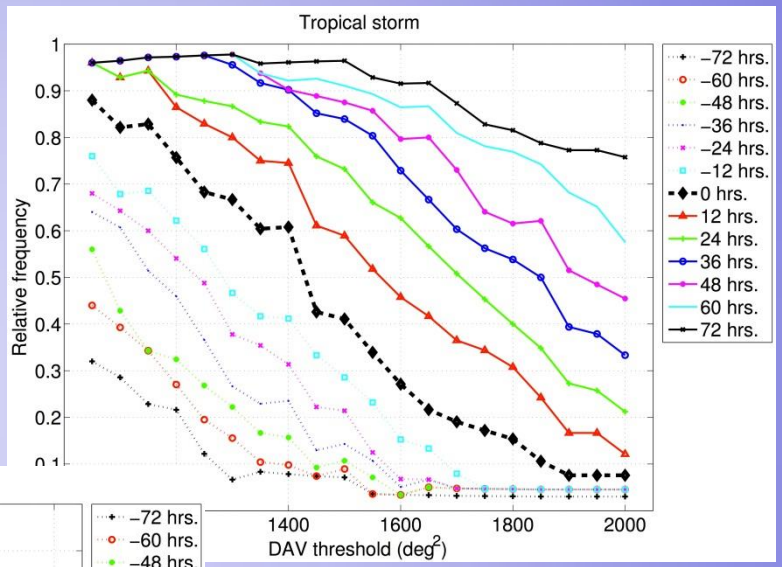
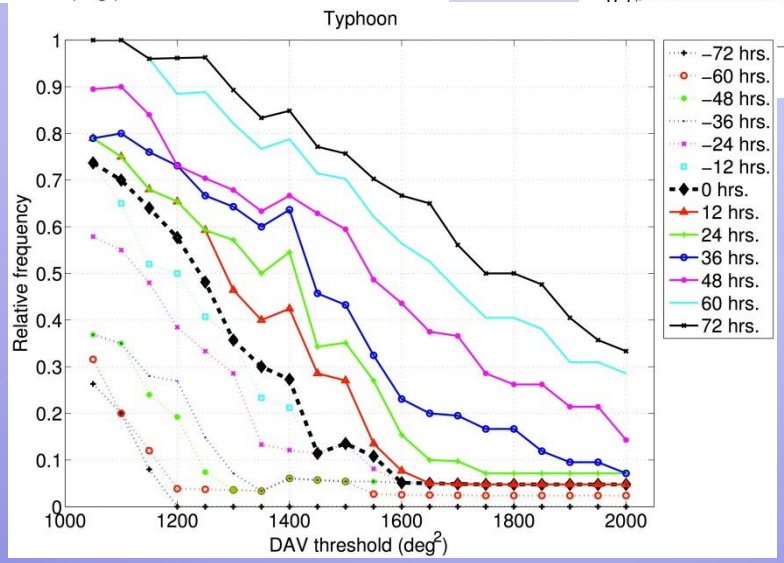
Probabilistic Genesis







Detecting Genesis - summary

- Can use minimum DAV within a disturbance to determine whether it is developing or not based on a pre-determined threshold value
- Currently deterministic “yes/no” decision
- Are developing a probabilistic approach, e.g.,
  - 50% chance of developing into a TD/TC/STC within X amount of time based on reaching certain threshold DAV values.
  - These values are determined by determining the conditional relative frequency of development into a TD/TC/STC given a certain DAV value (lots of number crunching)


THANK YOU