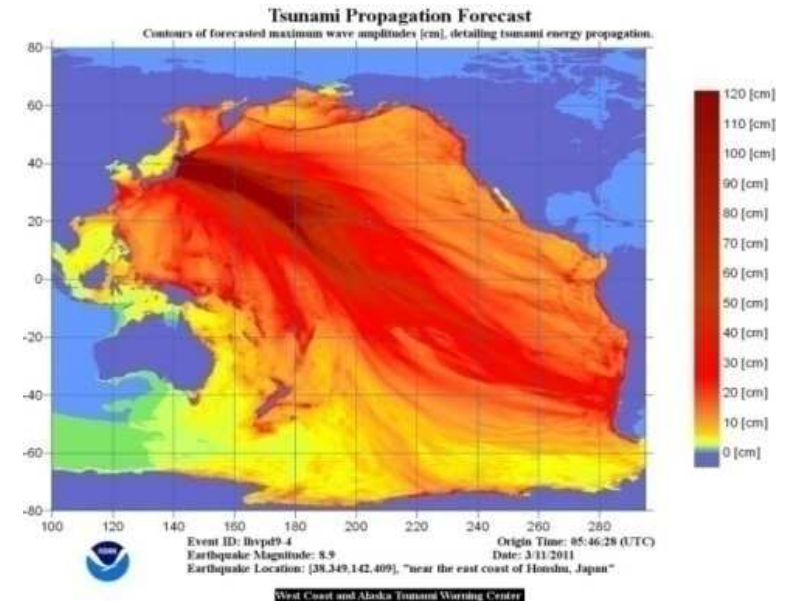
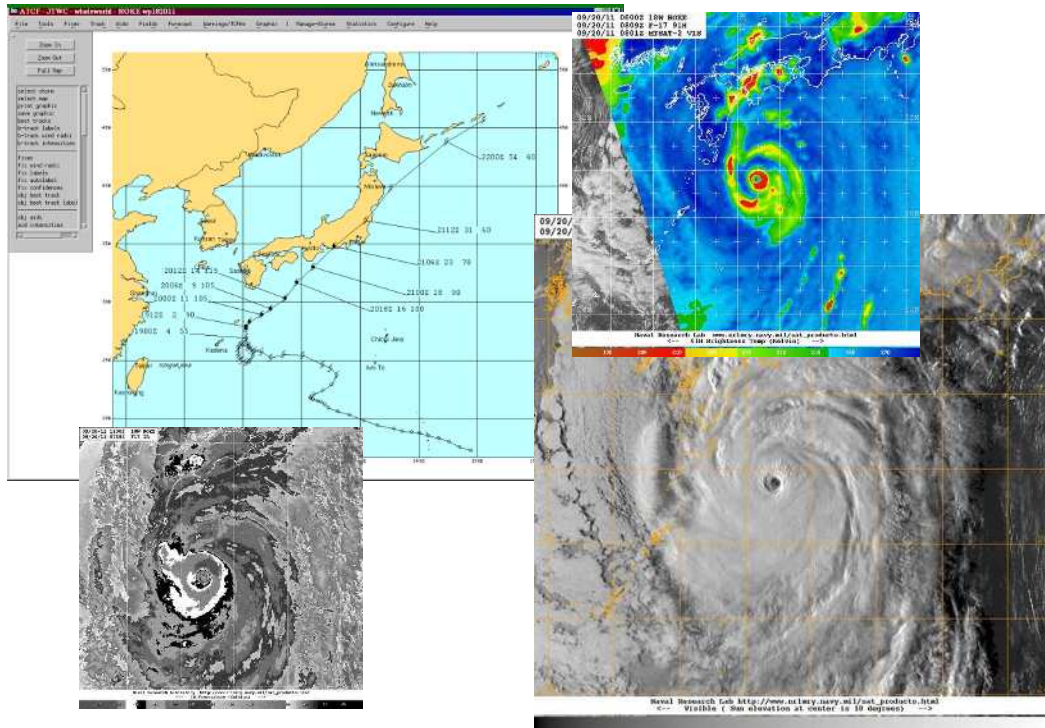


# JTWC Operations Overview & Tropical Cyclogenesis Monitoring

E. M. Fukada  
JTWC Technical Adviser



# Joint Typhoon Warning Center Mission



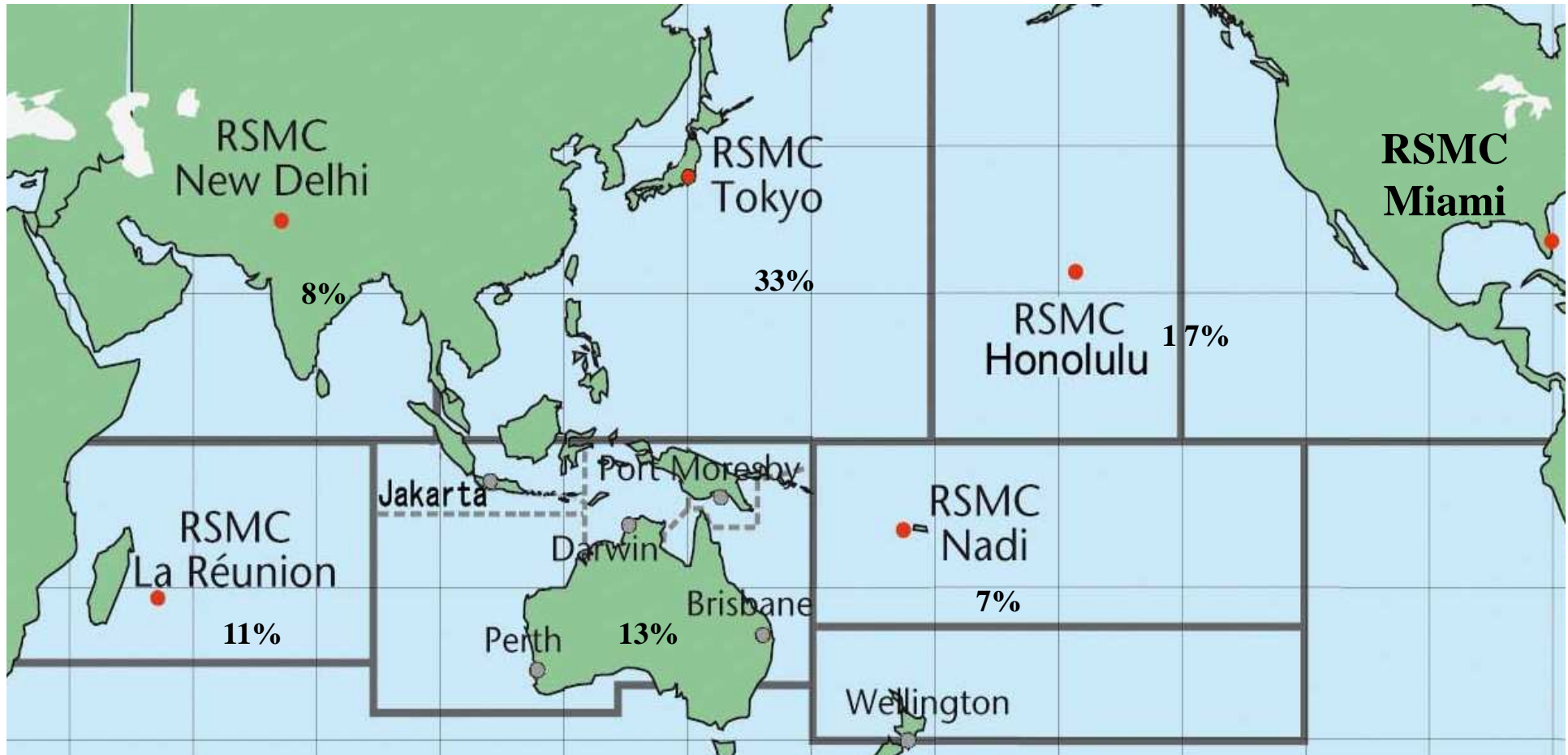
- Provide tropical cyclone reconnaissance, forecast, warning, and decision support to the United States Government agencies for the Pacific and Indian Oceans as directed by Commander, United States Pacific Command.
- Provide tsunami decision support to Department of Defense - U.S. Navy shore installation and fleet assets as directed by Commander, Fleet Forces Command.

UNCLASSIFIED



# JTWC Tropical Cyclone AOR

## West coast of Americas to east coast of Africa



\* Including WMO-sponsored Regional Specialized Meteorology Centers (RSMC) and percent of tropical cyclones by region

UNCLASSIFIED

# JTWC Personnel Responsible for 24hr/day Monitoring and Forecasting “Watch Section”

- Typhoon Duty Officer
  - the focal point
    - USN & USAF (civilian) with graduate degree in Meteorology
    - USN (military), 3year tour
- Satellite Analyst/Forecaster
  - USAF journeyman forecaster
- Geophysics Technician
  - USN forecaster in-training

USN – United States Navy  
USAF – United States Air Force

# Watch requirements

- Analyze existing situation (synoptic & mesoscale)
- Locate and assess all tropical disturbances/tropical cyclones in AOR
- Review numerical model output
- Make TC track and intensity forecast
- Communicate analyses and forecasts to U. S. DoD weather and NWS personnel

# Tropical Cyclone Warning Content

- “Strategic” parameters provided by JTWC
  - TC winds over open ocean/waters
  - No forecasts for precipitation
  - No forecasts for seas, surf, waves or surge
- “Tactical” forecast parameters provided by U. S. military and/or U. S. National Weather sites for specified areas/region
  - U.S. Navy weather provides forecasts for Japan
  - NWS WFO Tiyan provides forecasts for Guam

# TC Operations

- Multiple “fixes” are utilized to determine tropical disturbance location and intensity
  - Multiple sensors
  - Multiple sites
- Remotely sensed data analysis/interpretation conducted by Sat Analyst who is co-located with the Typhoon Duty Officer
  - Co-location optimizes interaction between analyst and forecaster

*Fix* - Tropical cyclone position and intensity determined through specified reconnaissance datas



# TC Reconnaissance

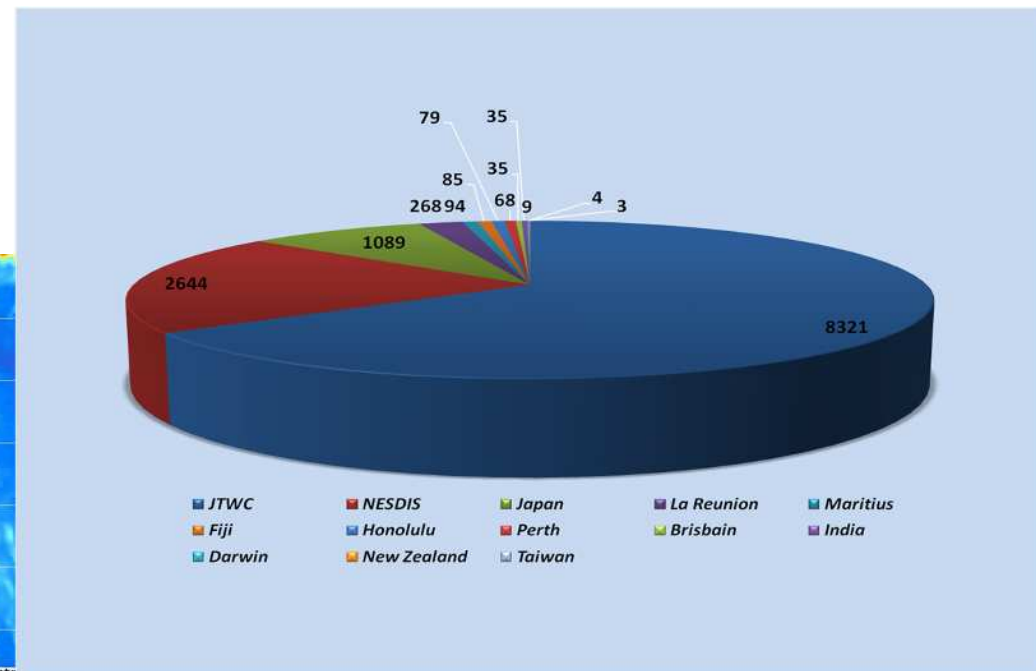
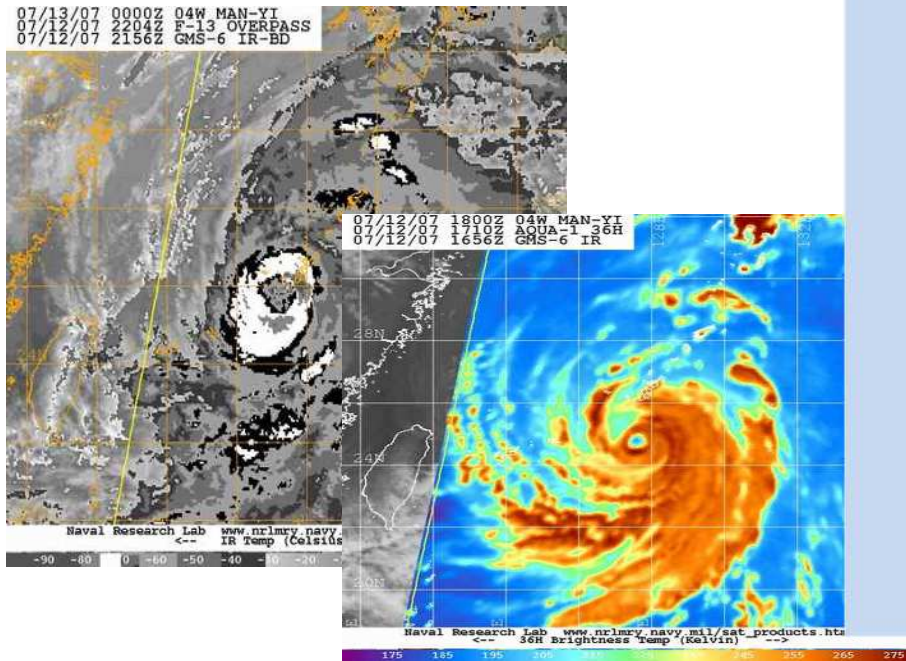


## Position/Intensity Fixes

- Exclusively remotely sensed data – satellite/radar
  - A/C recon ended 1987
- Infrared/Visible Imagery Fixes every 3 hours
- Microwave Imagery fixes as imagery is available

## Satellite Fixes by Agency

- 2012 Total 12,734 fixes
- 8,321 completed at JTWC
- Multiple fixes aids in TC position & intensity estimation



UNCLASSIFIED

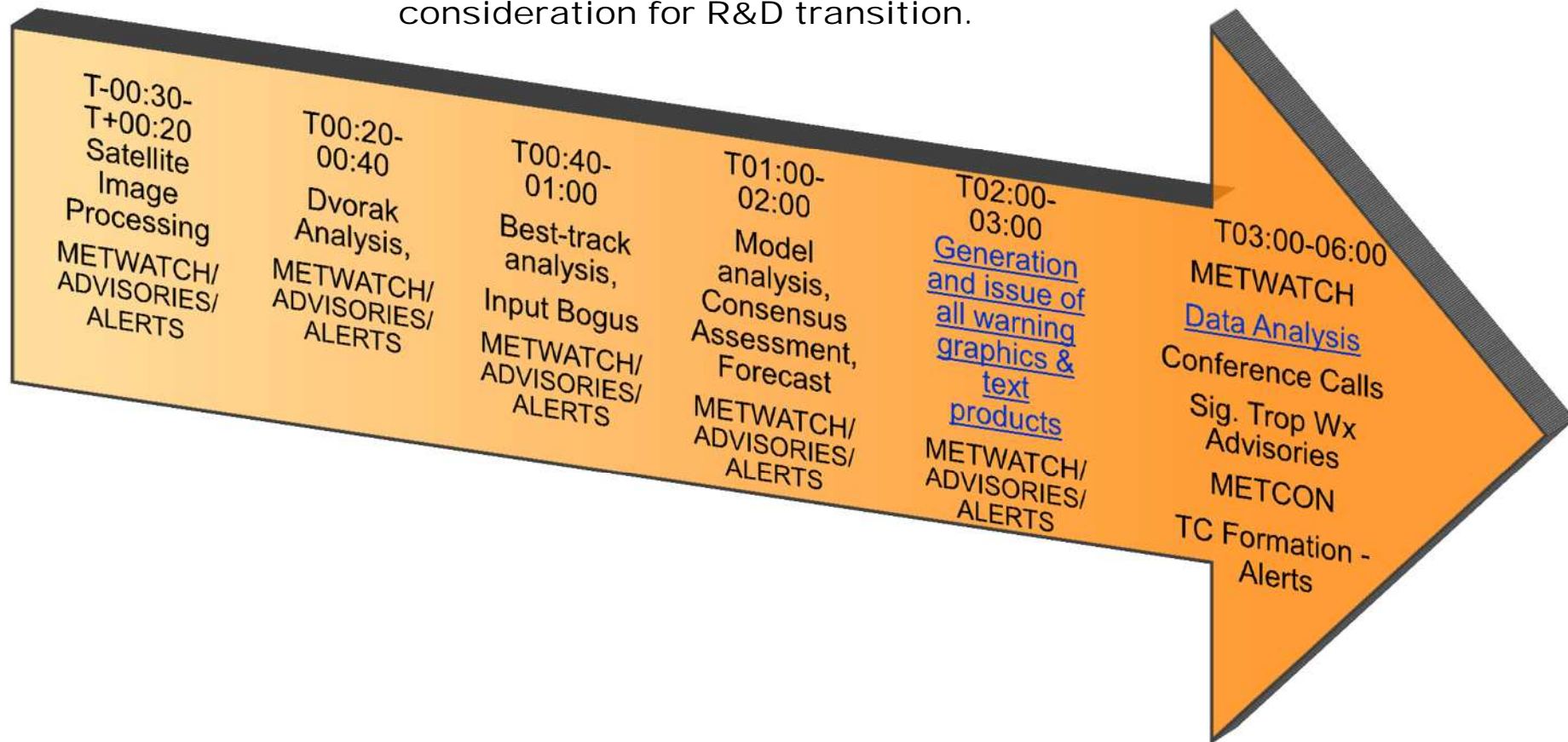




# JTWC WATCH TIMELINE



The JTWC AOR encompasses over 110 million sq. miles and nearly 89% of global TC activity. Process efficiency must be a critical performance parameter consideration for R&D transition.

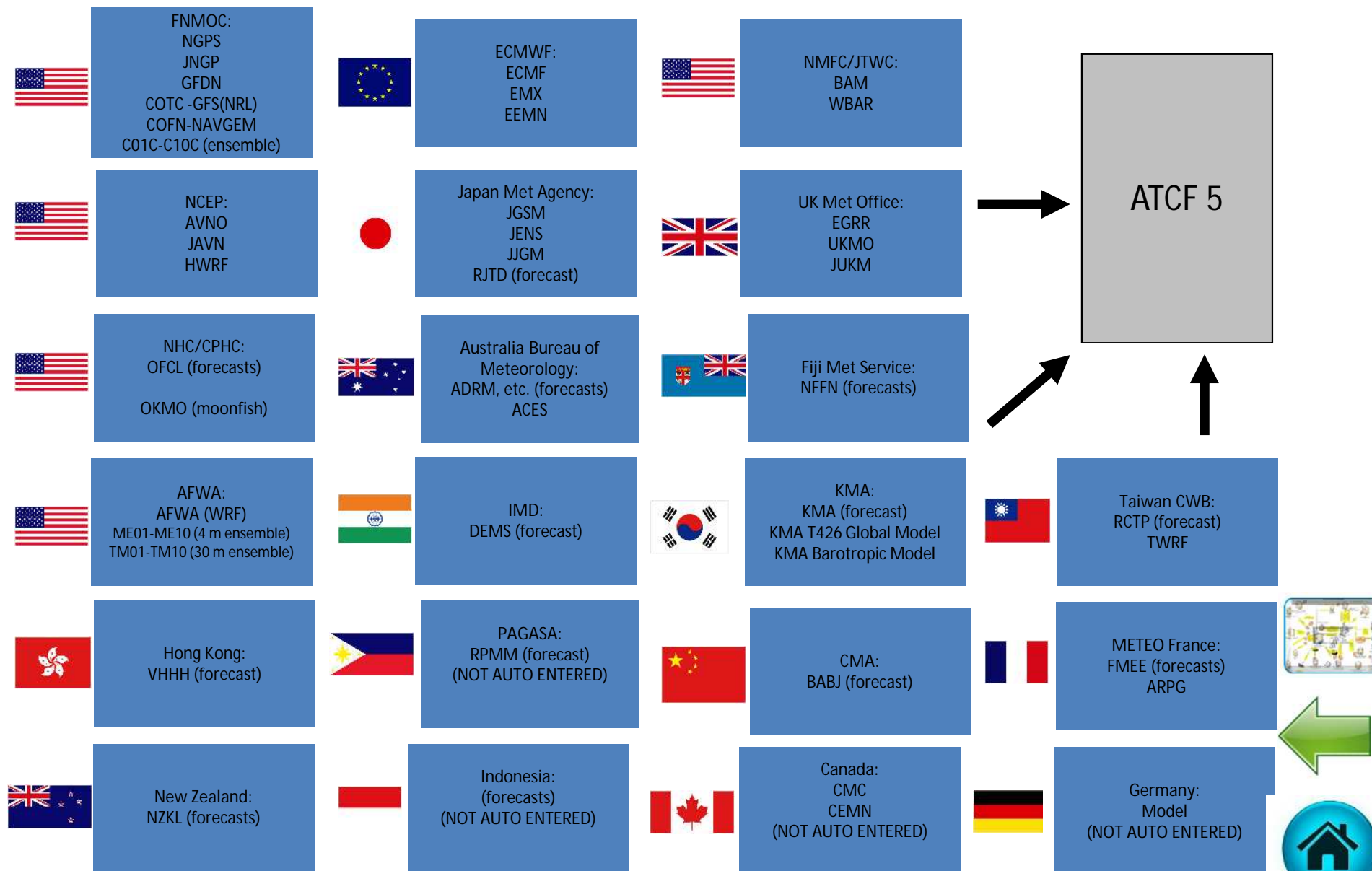


UNCLASSIFIED

# Automated Tropical Cyclone Forecasting System (ATCF)

- A product of more than 15 years of Navy / NHC collaboration
- Used in all the U.S. tropical cyclone forecasting centers and their support agencies
- Provides a common framework and common data formats, facilitating coordination among operational sites
- Major functions performed
  - Fix entry and display
  - Best tracking
  - Objective aid computation and display
  - Forecast creation and dissemination

# Model and Forecast Trackers



12 March 2014

JMA/WMO Workshop on Effective TC Warning SEASIA

# Tropical Cyclogenesis Monitoring

# Terms Used

- METWATCH
  - “Meteorological watch”; monitoring of area/region for which a SUSPECT AREA or INVEST has been determined
- SUSPECT AREA
  - Area or region for which the possibility of TC development exists
- INVEST
  - “Investigative Area”; location for which best tracking is conducted and “SAT Windows” are produced.
- SAT Window
  - @ 16 deg lat X 16 deg lat area centered over disturbance or TC
- TDO
  - JTWC Typhoon Duty Officer

# NRL & FNMOC Tropical Cyclone Pages

- METSAT data windows made from JTWC, NHC and CPHC best track positions
- Data available for review from websites [www.nrlmry.navy.mil/TC.html](http://www.nrlmry.navy.mil/TC.html) or [https://www.fnmoc.navy.mil/tcweb/cgi-bin/tc\\_home.cgi](https://www.fnmoc.navy.mil/tcweb/cgi-bin/tc_home.cgi)
- Data also available for review via the ATCF
- JTWC primarily uses the Microwave data from the TC page

# Sat Window Website

## FNMO Satellite Data Tropical Cyclone Page

2014 Storms

[All](#) [Active](#) [Year](#)

[Atlantic](#)

[East Pacific](#)

[Central Pacific](#)

[West Pacific](#)

[93W.INVEST](#)

[Indian Ocean](#)

[Southern Hemisphere](#)

[92P.INVEST](#)

Display [Latest](#) [Prev.](#) [Track&Image](#) [Pass](#) [Mosaic](#) Info: [General](#) [Tutorial](#) [Disclaimer](#)

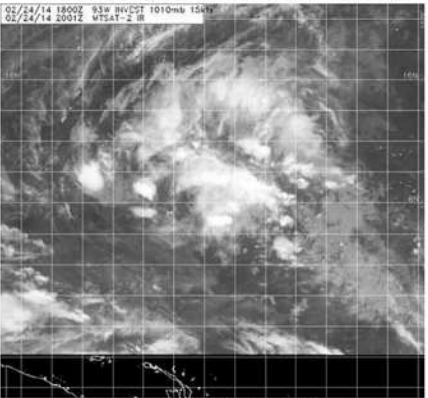
Environment [TPW](#) [TPW&NAVGEM](#) [TPW](#) [TPW&NAVGEM](#) [850 Winds](#)

[SSMI](#) [SSMIS](#) [TRMM](#) [AMSU](#) [ATMS](#) [AMSR](#) [WindSat](#) [ASCAT](#) [MODIS](#) [VIS](#) [IR](#) [OLS](#)

[Age <= 6hrs old](#) [Age <= 12hrs old](#) [Age >12hrs old](#) 20:49:25 [UTCZ](#)

93W.INVEST 24 FEB 2014 2001Z

Half-sized, (34 K) click image to get full-size (242 K).



Sensor	Latest	Upcoming Passes <a href="#">(more)</a>
SSMI	02/24 1634Z f15 379	02/25 16:20Z F-15 806
SSMIS	02/24 0859Z f18 839	02/25 06:41Z F-16 197
		02/25 07:38Z F-17 101
TMI	02/24 1516Z trmm 0	02/24 21:42Z F-18 13
		02/25 01:56Z TRMM 277
MHS	02/24 1606Z pass19 005	02/25 17:31Z N-18 264
		02/25 03:14Z N-19 255

- Invest Area Sat Window centered based on JTWC, NHC or CPHC input best track position
- Invest Area designated as a 90-series cyclone in ATCF

# Sat Window Website #2

[Privacy Policy](#)   [Disclaimer](#)   **NRL Tropical Cyclone Page**   [Development Team](#)

**2014 Season Storms**

All **Active** Year

**Atlantic**

**East Pacific**

**Central Pacific**

**West Pacific**

93W.INVEST

**Indian Ocean**

**Southern Hem.**

15S.GUITO

[Latest](#)   [Pass\\_Mosaic](#)   [ATCF](#)   [Track+Image](#)   [WindVectors](#)

**Environment**   TPW   TPW+NOGAPS\_TPW   TPW+NOGAPS\_850\_Winds   Wind\_Shear   **COAMPS\_TC**

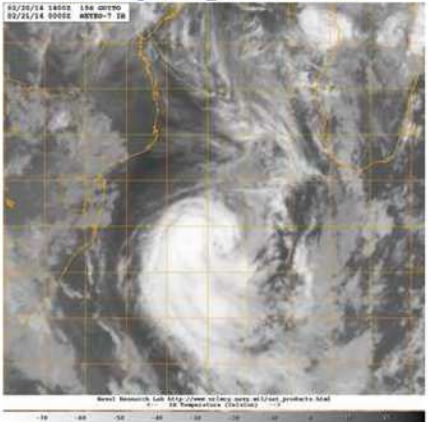
Sensor	% Cor	VIS	IR	IR-BD	Multi Sens.	85GHz H	85GHz weak	85GHz PCT	Color	Rain	Wind	37GHz Color	37GHz V	37GHz H	SSM/I Vapor
SSM/I	48														
SSMIS	60														
TMI	42														
AMSR2	85														
WINDSAT	39														
AMSUB	50														

15S.GUITO, TRACK\_VIS, 21 FEB 2014 0000Z 21:02:22 UTC (Z) [Overview](#)

Tutorials: [COMET](#)

Satellite Pass Info				
Sensor	Latest	Next (View All)		
SSM/I	02/20 1317 Z, F-15	0851	02/20 1425 Z, F-16	0321
TC_SSMIS	02/20 1808 Z, F-18	0849	02/21 0142 Z, F-16	0606
TMI	02/20 2144 Z, TRMM	0289	02/21 1415 Z, TRMM	0073
AMSR2	02/19 2201 Z, GCOMW-1	0281	02/20 1040 Z, GCOM-W1	0808
WINDSAT	02/20 1510 Z, CORIOLIS	0060	02/20 2051 Z, OCEANSAT	0418
AMSUB	02/20 2208 Z, N-19	1194	02/20 2348 Z, N-19	1315
SCATT	02/20 1511 Z, WINDSAT	0060	02/20 1824 Z, METOP-A	1151

**Latest ir/geo/1km\_bw/20140221.0000**



(Click product for full sized image)

[Sat\\_Home](#)   [East\\_Pacific+WestCoast](#)   [Global](#)   [CONUS](#)   [ModelOver](#)   [RainRate](#)   [CloudTops](#)   [Training](#)

**TropCyclones**

[NexSat](#)   [VIIRS](#)   [ColorComposite](#)   [SSM-I-Comp2](#)   [Tropics](#)   [CloudWinds](#)   [ScattWinds](#)   [CloudClass](#)



# Monitoring Overview

## Constant metwatch conducted for AOR

- 24hr/day, 7-day/week looping of water vapor geostationary data
  - MET-7
  - MTSAT <http://www.ssd.noaa.gov/mtsac/twpac/wv-animated.gif>
  - GOES Eastern Pacific Ocean
- 12 hourly manual streamline analysis produced for 200mb (hPA) and surface levels
- Numerical forecast fields reviewed 6/12 hourly
  - [GFS](#), NAVGEM, JGSM, out to 120hrs.

# Conditions Required for Formation

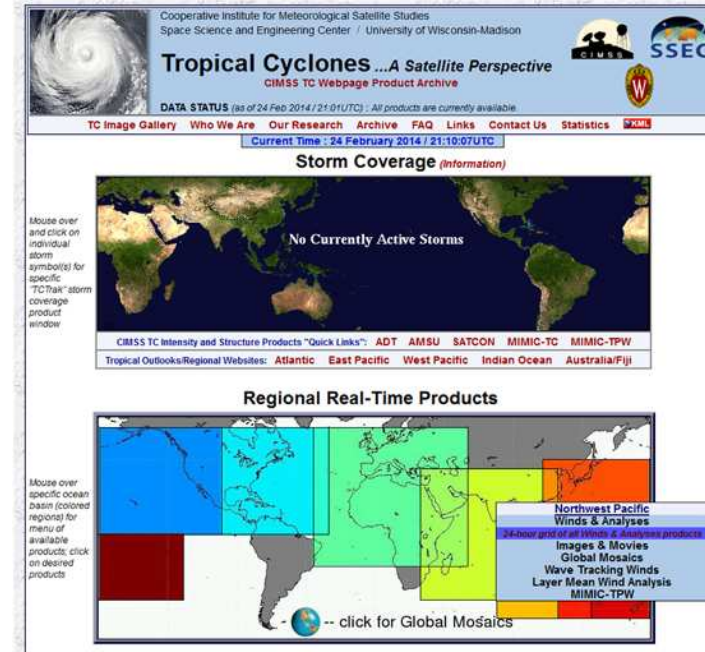
- Warm SST ( $> 78$  F)
- Pre-existing sfc disturbance
- Upper level divergence
- Lack of vertical shear
- Coriolis parameter above a minimum value
  - Excludes belt between 5 - 8 deg either side of Equator

# Genesis Potential or Status Determination Guidelines

- Metwatch constantly conducted throughout AOR for convective maxima and/or areas of turning
- Suspect Area or Invest can be designated at Typhoon Duty Officer discretion to monitor location or region for development
  - Example: Invest area set when GFS model calls for TD to form near Guam and this forecast was made for 2 days of model runs
  - Example: Invest area set near Guam when one model run indicated TD to present close to island in 36 hours.

# Data/Websites Used in Genesis Monitoring

- [CIMSS](#)\* Data Website
  - Regional data coverage used to help determine synoptic scale environment
- [RAMMB](#)+ Data Website
  - Cyclone or disturbance centric data used to determine structure or structure change



\* [CIMSS](#) – Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison

+ [RAMMB](#) – Regional and Mesoscale Meteorology Branch, NOAA, co-located with the Cooperative Institute for Research in the Atmosphere, Colorado State University



Site Map  
 10/2006/Commercial/NOAA/NO20/04/2014/Call  
 This page verified on 02/24/2014 21:10:07 UTC



Cooperative Research Program | Office of Research and Applications/Center for Satellite Applications and Research

## Currently Active Tropical Cyclones

### Atlantic

No Currently Active Cyclones

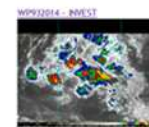
### Eastern Pacific

No Currently Active Cyclones

### Central Pacific

No Currently Active Cyclones

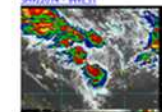
### Western Pacific



### North Indian Ocean

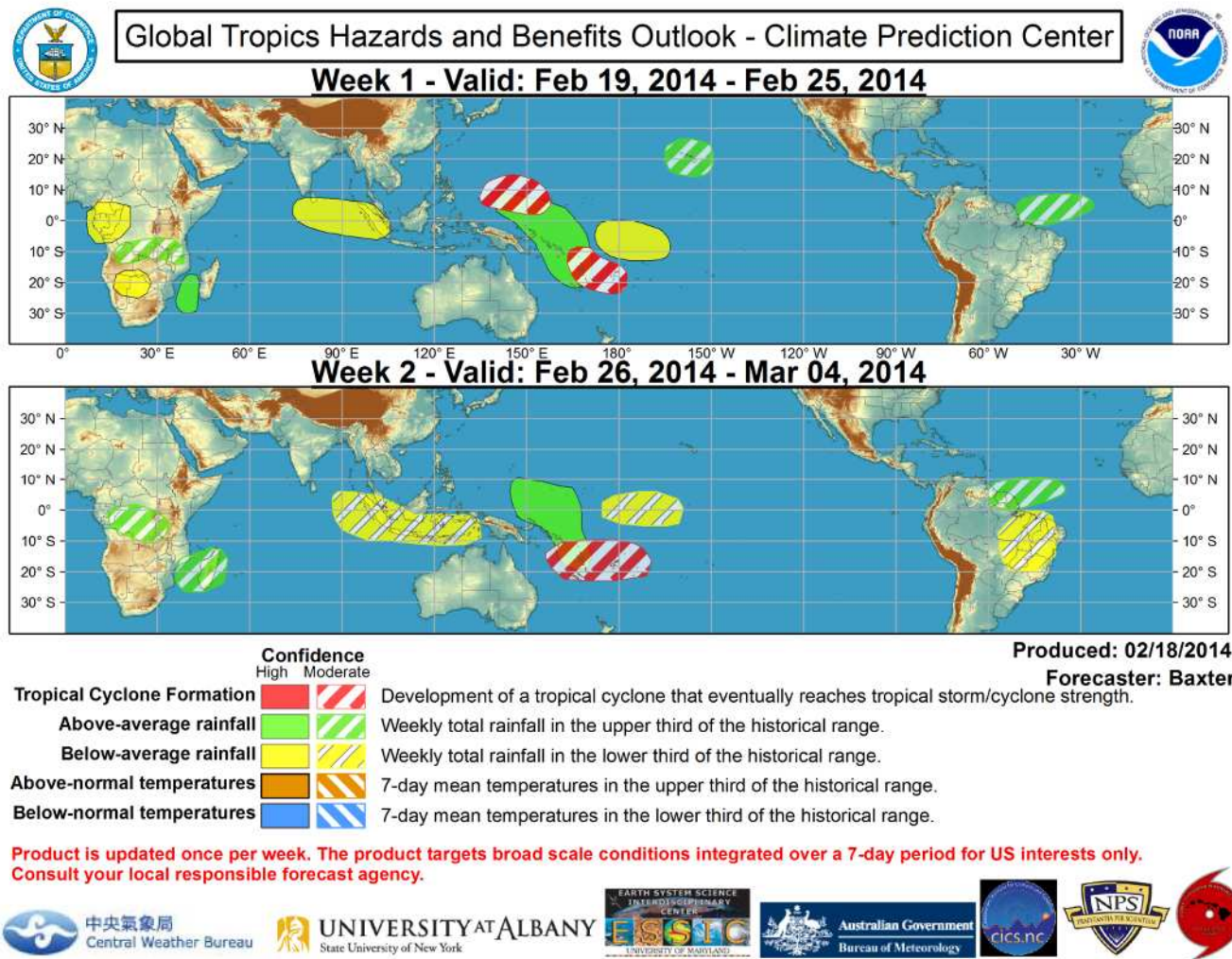
No Currently Active Cyclones

### Southern Hemisphere



Privacy Policy / Disclaimer / Information Quality  
 Problems or questions? Contact the webmaster  
 RAMMB Home | NOAA | University of Colorado Boulder

# Additional Data Used in Genesis Monitoring



# JTWC Effort to Increase Objectivity in Genesis Forecast Process

- [The low/medium/high \(LMH\) worksheet](#) is used to assess the potential for development of an invest area into a significant tropical cyclone.
- The worksheet is an attempt utilize a systematic forecasting process to classify low, medium, and high tropical cyclogenesis potential from regularly observable factors.
- Genesis factors used in the worksheet
  - Symmetry of the low level circulation center
  - 850mb vorticity
  - Dvorak final T-numbers
  - Global model development
  - Status of the Madden-Julian Oscillation
  - Vertical wind shear
  - Upper-level outflow pattern.
- A completed classification worksheet provides "trigger-based" recommendations for classifying genesis potential.
  - If certain factors or combinations of factors exist, the worksheet advises the forecaster to upgrade or downgrade development potential on the appropriate analysis bulletin.
- Results from the worksheet are used as a guide to the TDO in determining appropriate invest classification levels.
  - If the TDO does not follow (upgrade or downgrade) the worksheet results he/she will log the reasoning/explanation in the TDO E-log.

The screenshot shows the 'Operational Low/Medium/High Worksheet' interface. It is a yellow-themed web form with several sections:

- Step 1:** A section for entering 'invest/TC number, basin and year (ex: 93W / 2011)', with a 'Create Worksheet' button.
- OPERATIONAL LOW/MEDIUM/HIGH WORKSHEET FOR 90W:** A section for 'Date and Time (ex: 08/01/2011 18Z)' and 'Most Recent ATCF Best Track Location (ex: 10.0N 130.0E)'. It includes dropdown menus for date and time.
- LOW LEVEL STRUCTURE (3 CRITERIA):** A section with dropdown menus for 'Symmetry (long/short axis diameter)', 'CIMSS 850mb vorticity value', and a radio button for 'If no circ, w/ies eqward of disturbance?'.
- DVORAK FIX VALUES:** A section with input fields for 'Most recent PGTW FT (within past 6 hours)' and 'Most recent KNES FT (within past 6 hours)', both showing 'N/A'.
- MODEL DEVELOPMENT:** A section with 'References: WxMap, WxMapII' and two columns of dropdown menus for 'Development within 48 hours' and 'Development within 24 hours'. Each column includes options for NOGAPS, GFS, JGSM, UKMET, and ECMWF.
- MJO STATUS:** A section with a dropdown menu for 'QLR anomaly'.
- VERTICAL WIND SHEAR:** A section with a dropdown menu for 'Vertical wind shear value'.
- UPPER LEVEL OUTFLOW:** A section with a dropdown menu for 'Upper level outflow pattern'.
- EXPERIMENTAL PARAMETERS:** A section with a dropdown menu for 'ST11 24 hour intensity forecast'.
- GENESIS POTENTIAL INDEX:** A section with a dropdown menu for 'Most recent GPI value'.

At the bottom of the form, there are buttons for 'Assess Low-Med-High' and 'Reset'.

# Low, Medium & High Criteria/Definition

- “Low” formation potential describes an area that is being monitored for development, but is unlikely to develop within the next 24 hours.
- “Medium” formation potential describes an area that is being monitored for development and has an elevated potential to develop, but development will likely occur beyond 24 hours.
- “High” formation potential describes an area that is being monitored for development and is either expected to develop within 24 hours or development has already started, but warning criteria have not yet been met.
  - All areas designated as “High” will be accompanied by a Tropical Cyclone Formation Alert.

# Genesis Monitoring Example

## JTWC WP012013 (Sonamu)

- Looped metsat data not recreated but is a fundamental part of the metwatch effort
- Continuity on the metwatch effort effected through use of logs (records) to ascertain TDO actions.
- Primary log is known as the TDO log
  - Following slide is excerpt of TDO log for @ 24hrs starting at watch (shift start) 1500Z (UTC), 1 Jan 2013



Date: 1/02/2013 2155Z

Description: **UPGRADED 92W TO HIGH** AND ADDED SUBTROPICAL LOW AREA (REMNANTS OF TC 05P)...REISSUED AT 2200Z.

Date: 1/02/2013 2122Z

Description: Issued at 2130Z based on 1.5 dvoraks and improved consolidation and banding...JMA at TD with cone...notified JTWC CDO and also approved by JTOPS / JTDIR at METCON.

Date: 1/02/2013 1653Z

Description: Updated Bruce on 07S...on track...65 knots at 18Z...models indicate SSW track, ~ 170nm west of Mauritius at 03/06Z...ensembles tight and SSW...not likely to have major impact on Mauritius.

Date: 1/02/2013 1551Z

Description: Assumed the watch with:

Remnants of TC 05P

TC 07S

97S HIGH 01/2330Z

**92W MED**

No sig comm issues.

Date: 1/02/2013 1321Z

Description: Upgraded 92W to MED. See 021300z ABPW for details. Updated SRO.

Date:

1/02/2013 0319Z

Description: Assumed the watch with:

TC 07S - Warning #3

97S - TCFA

TC 05P - Final warning

**92W - INV only**

Wxmap incomplete. See related entry.

Subject: REISSUED ABIO FOR THE TCFA AT 020000Z

Date: 1/02/2013 0237Z

Date: 1/02/2013 0235Z

Description: Based on the decreasing wind speeds in the available SCAT data, dvoraks below 2.5 over the past few hours, and MSI showing a degenerating LLCC, I called JTOPS to inform him that this system was dropping below the warning criteria. I dissipated the system by tau 12 and extended the warning for 24 hours to give more coverage for New Caledonia.

Date: 1/02/2013 0233Z

Description: Called JTOPS to inform him that I would be issuing the TCFA. I also informed the CDO and asked him to call San Diego.

Date: 1/01/2013 1522Z

Description: Assumed the watch with: TC 05P (FREDA) - Warning #9, 45 kts

TC 07S (DUMILE) - Warning #2, 45 kts

97S - Medium

**92W - Invest Only**

Excerpt from JTWC TDO log for 92W (later Sonamu) with TDO names removed

# Genesis Monitoring Continuity Through Best Track Log – WP012013 (Sonamu)

01/00Z:

C. 4.4N 141.0E, 15 kts. A 0032z ascat pass suggests the llcc is located within the easterly wave feature, but is not well defined. ADL

D. 5.0N 140.7E bsd on 0032Z ASCAT AMB and 2352Z TRMM 37H. Concur 15kt DB. EMF

\*\*\*Looked like Broad wave prior to this. Recommend deleting posits. JDC\*\*\*

01/06Z:

A. 4.4 139.3E 15kts

B. 4.8N 138.4E BO 0537Z AMSU image. JDC

C. Concur with B. ADL

D. 5.0N 138.5E bsd on 0516Z N18 IRBD and 0537Z AMSU. Concur 15kt DB. EMF

01/12Z:

A. 4.5N 137.3E 15kts

B. 5.0N 136.3E BO extrap from 0854 SSMIS 37GHZ and 1612Z AMSU image. JDC

C. Concur with B as the VIS/IR imagery available does not improve this posit. ADL

D. Concur posit and int based on very sparse data. EMF

01/18Z:

A. 5.1N 134.0E 15kts.

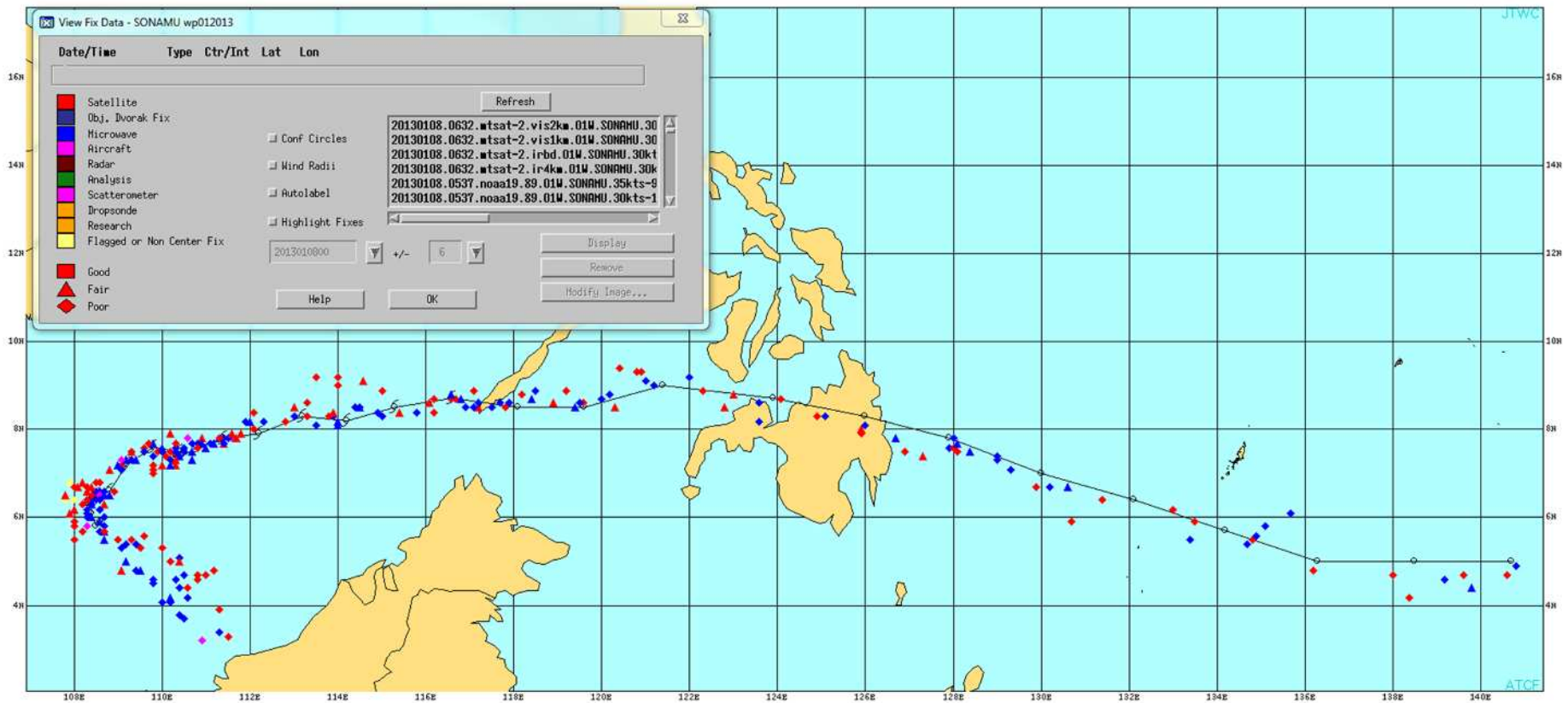
B. 5.7N 133.8E BO 1622Z AMSU with weakest turning. JDC

C. Concur with B, as an 1818z f15 vis2km suggests the center is near this posit BO the observed banding features meeting in this vicinity. ADL

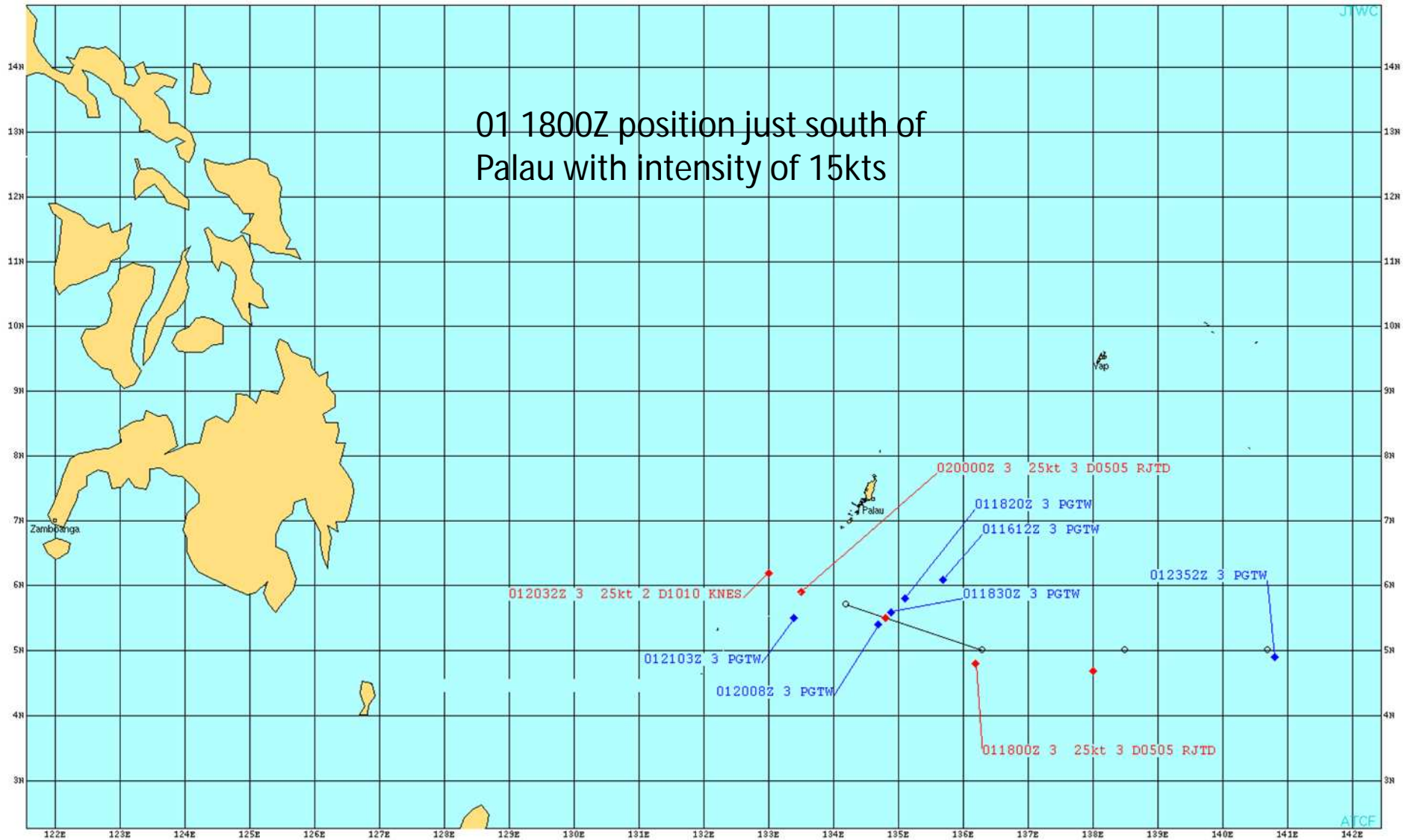
D. 5.7N 134.2E bsd on 1818Z F15 2km vis & 1830A SSMI. Concur 15kt DB. EMF

# WP012013 Total Best Track

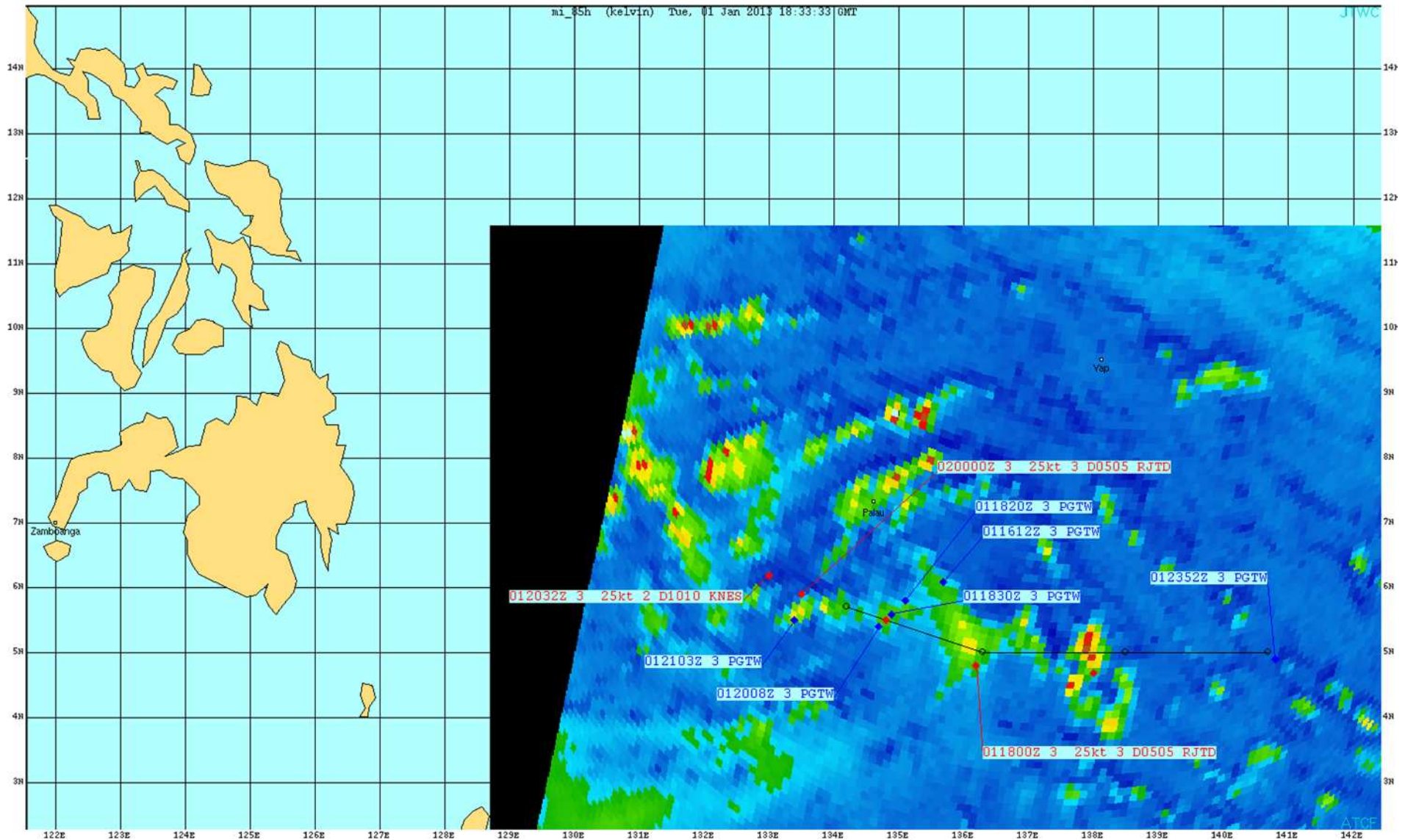
Note common occurrence that fix scatter decreases as intensity/organization increases



# WP012013(Sonamu) 01 Jan 1800Z



# WP012013 (Sonamu) 1830Z SSM/I 85H

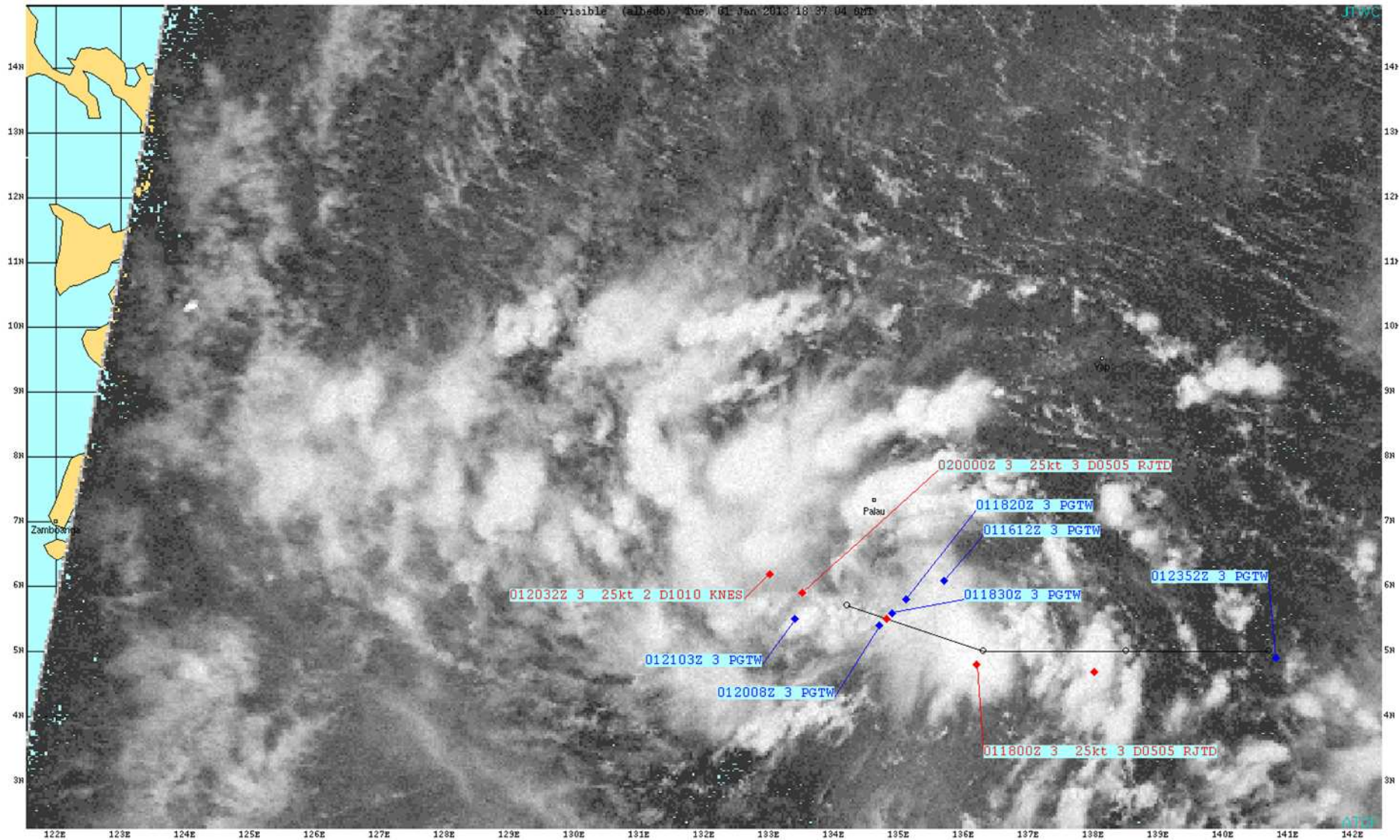


12 March 2014

JMA/WMO Workshop on Effective TC  
Warning SEASIA

29

# Sonamu 011818Z DMSP F15 2km VIS



12 March 2014

JMA/WMO Workshop on Effective TC  
Warning SEASIA

30

# In Addition to Previously Noted Analysis Data – Following Data Review

- Full disk water vapor loop
  - JTWC routinely monitors water vapor for upper tropospheric convergence/divergence and convective [patterns](#).
- Numerical model forecasts (two model output provided as example)
  - [NAVGEM](#)
    - U. S. Navy global spectral model
  - [GFS](#)
    - U. S. NWS global spectral model

# Example of JTWC Cyclogenesis Monitoring

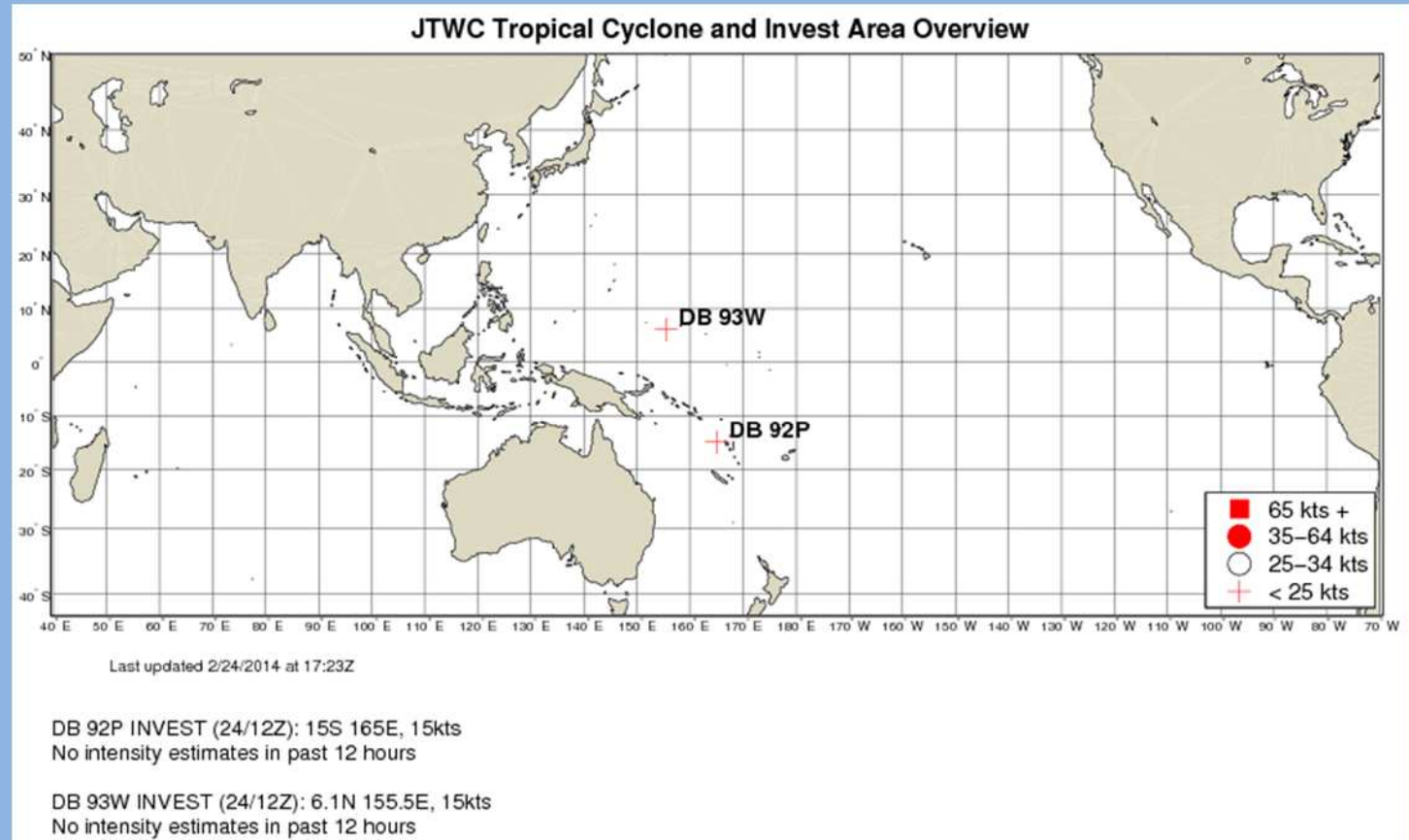
4 Power Point Slides from JTWC  
Morning Discussion

24 Feb 2014

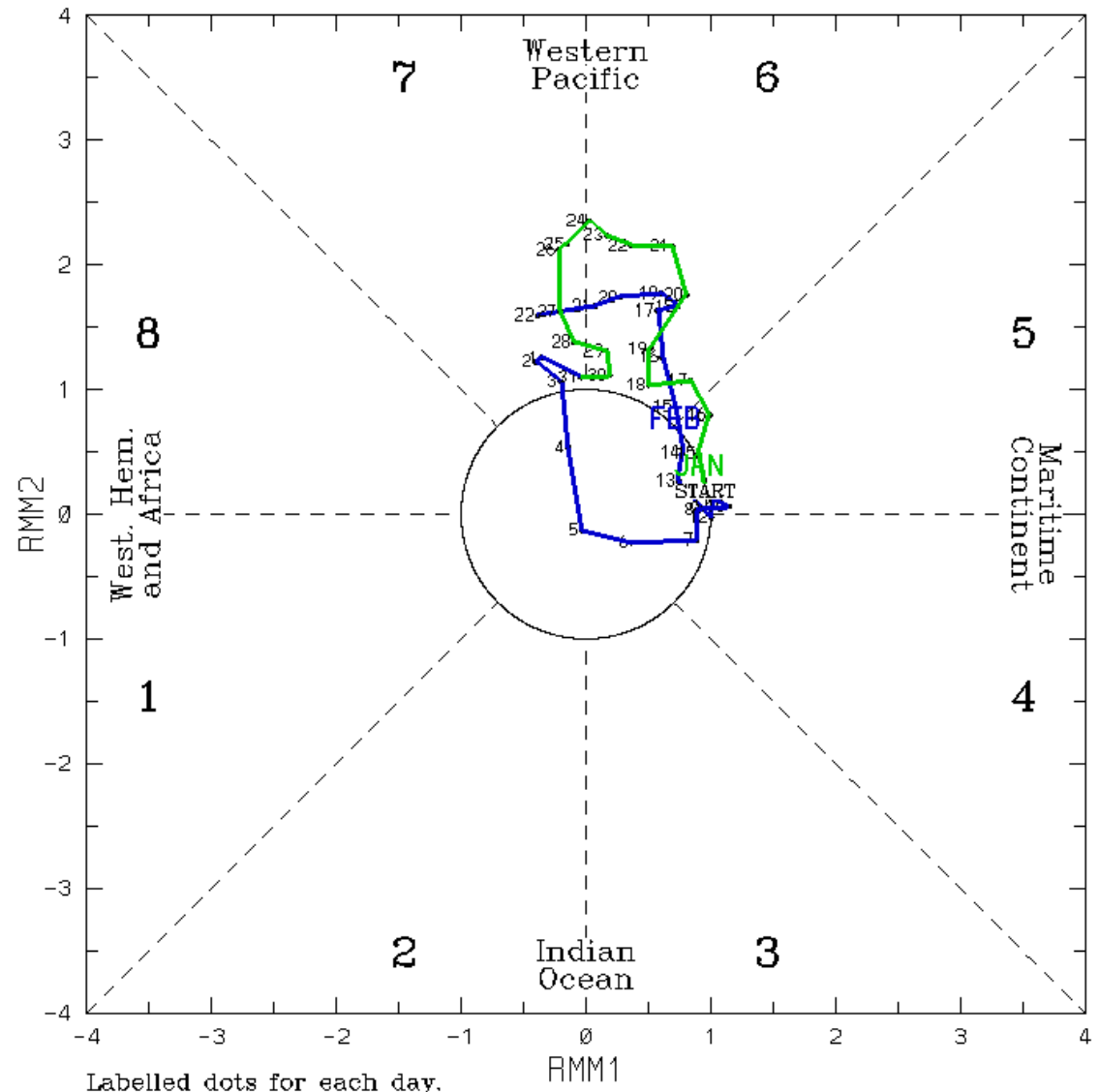


# Updates:

- 93W – Low
- 92P – New invest



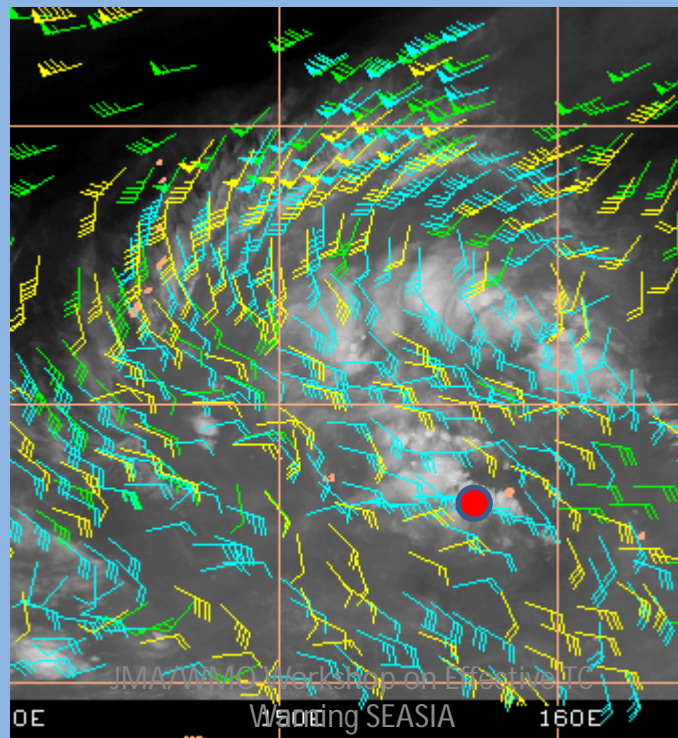
(RMM1,RMM2) phase space for 14-Jan-2014 to 22-Feb-2014



Labelled dots for each day.  
Blue line is for Feb, green line is for Jan, red line is for Dec.

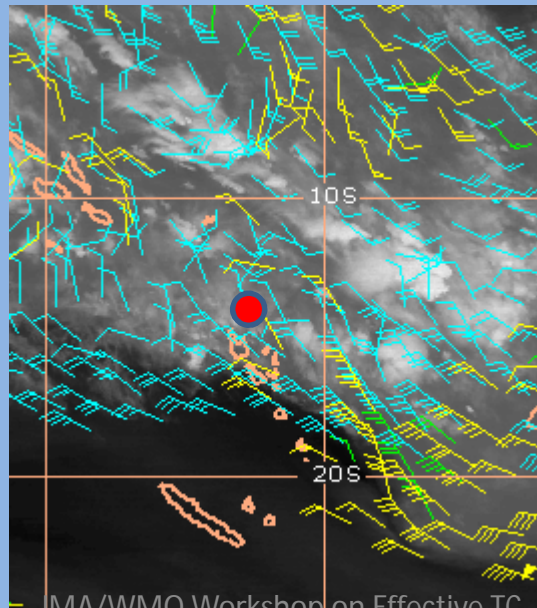
## 93W

- Broad LLCC, 10-15 knots on periphery
- Persistent easterly VWS
- Most convection removed to NW of center
- 28°C + SSTs
- Multiple model development (~ 96 hrs +)

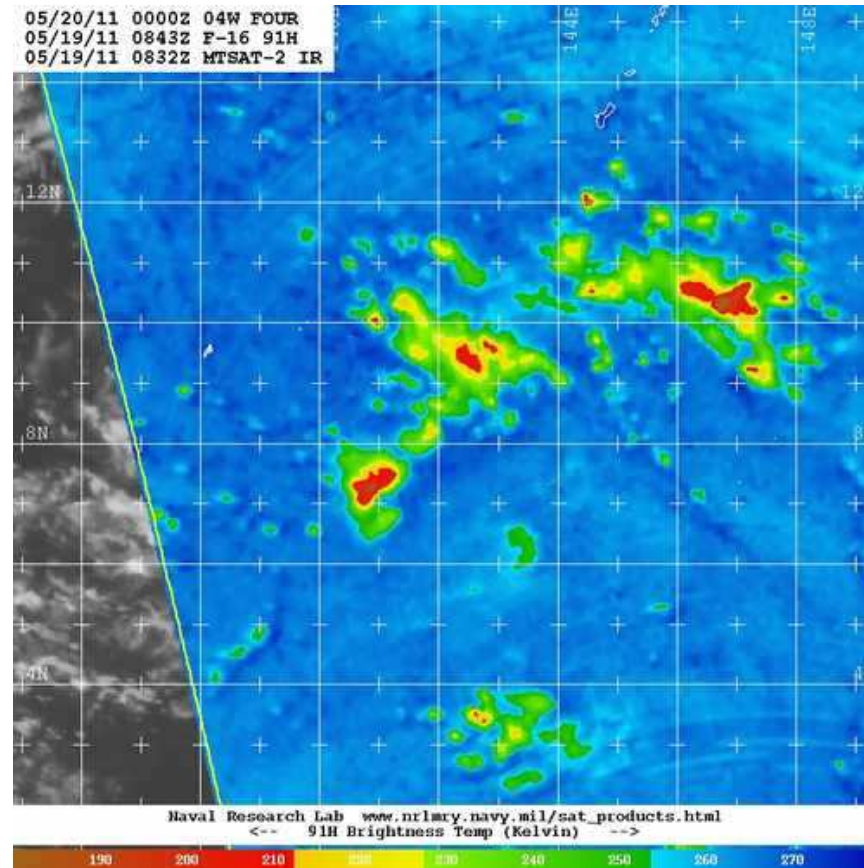


## 92P

- Low VWS, favorable outflow
- Limited deep convection
- SST  $\sim 30^{\circ}\text{C}$
- Multiple model development ( $\sim 72$  hrs)



# Forecasting Tropical Cyclogenesis: Development Efforts at JTWC



*Mr. Matthew Kucas – JTWC Techniques Development Team Chief*

# Focus on TC genesis: Low/Medium/High Worksheet

- Goals:
  - 1) Develop a realistic, quantitative framework for low, medium, and high development potential
  - 2) Provide forecasters a repeatable method to determine low, medium, and high development potential from available observational data
- Developed list of data and observable phenomena that influenced subjective poor/fair/good determinations
- Recorded values (binned) for eight “development factors” – 48 hour period prior to first warning for 17 developers and prior to invest closure for 17 non-developers
- Identified logical relationships between development factors to determine low, medium, and high classification recommendations

Development factor	Dataset referenced	Value “bins”
LLCC symmetry	ASCAT, visible and microwave satellite imagery, radar	Long axis diameter divided by short axis diameter: Between 1.5 and 2 Between 1.2 and 1.5 Less than 1.2 (~ symmetric)
850 mb vorticity	CIMSS vorticity product	< 25 /s x 10 <sup>-6</sup> 25-50 /s x 10 <sup>-6</sup> , 50-75 x 10 <sup>-6</sup> /s x 10 <sup>-6</sup> >75 /s x 10 <sup>-6</sup>
Dvorak T numbers	PGTW and KNES final T-numbers	1.0 1.5 or greater
Global model development	NOGAPS, GFS, UKMET, JGSM, and ECMWF surface wind fields	Development Yes/No within 24 hours and within 48 hours
MJO OLR anomaly	Australian CAWCR OLR anomaly “waterfall” diagram	No or positive anomaly < -4 W/m <sup>2</sup> < -12 W/m <sup>2</sup>
Vertical wind shear	CIMSS vertical wind shear product	< 15 kts 15-20 kts 20-30 kts 30+ kts
Upper level outflow pattern	CIMSS upper-level feature track winds	Weak to no diffluence Moderate to strong diffluence, but no trough interaction Moderate to strong diffluence, with trough interaction
Core temperature anomaly	CIMSS AMSU	0-0.5 C 5.- 1 C 2.C >2C

# Logical relationships (version 1)

Classify as low if any of the following bulleted criteria are met:

- Long axis diameter divided by short axis diameter  $< 2 > 1.5$
- 850 mb vorticity  $> 25 < 50 /s \times 10^{-6}$
- PGTW AND KNES final T = 1.0
- 2 or more global models indicate development within 48 hours
- Vertical wind shear less than 30 kts AND no convergence over LLCC AND MJO-associated OLR anomaly  $< -4 W/m^2$
- Medium criteria met

Classify as medium if any of the following bulleted criteria are met:

- Long axis diameter divided by short axis diameter  $< 1.5 > 1.2$  AND 850 mb vorticity  $> 50 < 75 /s \times 10^{-6}$
- PGTW final T = 1.5 OR KNES final T = 1.5
- 3 or more global models indicate development within 48 hours
- Vertical wind shear 20-30 kts AND divergence aloft over LLCC AND MJO-associated OLR anomaly  $< -4 W/m^2$
- High criteria met

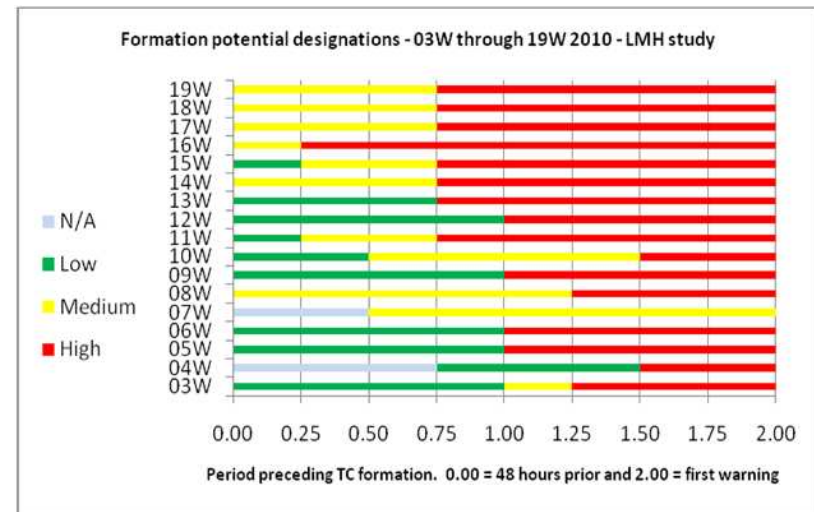
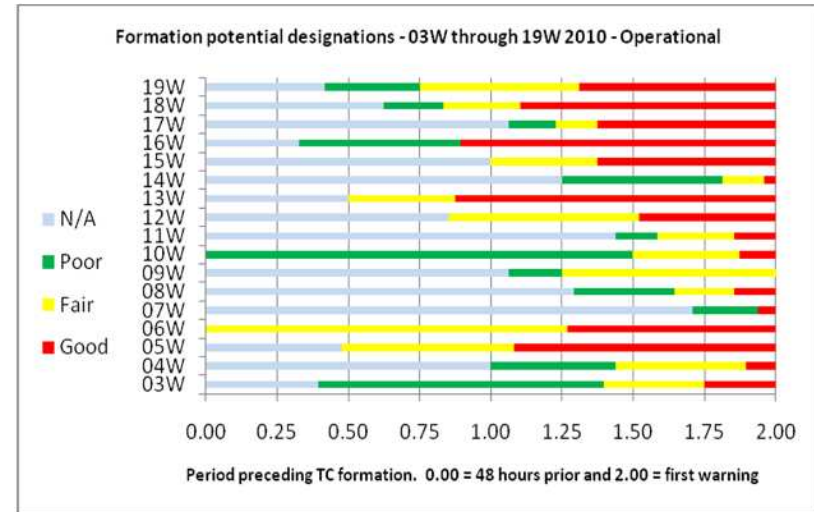
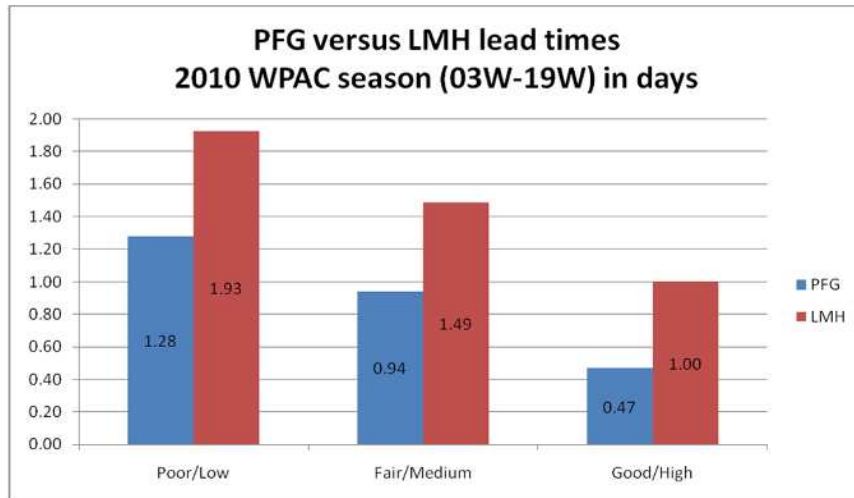
Classify as high if any of the following bulleted criteria are met:

- Long axis diameter divided by short axis diameter  $< 1.2$  AND 850 mb vorticity  $> 75 /s \times 10^{-6}$
- PGTW final T = 1.5 AND KNES final T = 1.5
- 5 global models indicate development within 48 hours
- 3 or more global models indicate development within 24 hours
- Long axis diameter divided by short axis diameter  $< 1.2$  AND vertical wind shear  $< 15$  knots AND divergence aloft with outflow into an upper level trough
- At least four of the following are true: Long axis diameter divided by short axis diameter  $< 1.5 > 1.2$ , 850 mb vorticity  $> 50 < 75 /s \times 10^{-6}$ , MJO-associated OLR anomaly  $< -12 W/m^2$ , vertical wind shear  $< 15$  knots OR divergence aloft with outflow into an upper level trough, Long axis diameter divided by short axis diameter  $< 1.2$ , 850 mb vorticity  $> 75 /s \times 10^{-6}$
- Long axis diameter divided by short axis diameter  $< 1.5 > 1.2$  AND 850 mb vorticity  $> 50 < 75 /s \times 10^{-6}$  AND EITHER PGTW final T = 1.5 OR KNES final T = 1.5

Classify as invest only if all low, medium, or high criteria remain unmet.

# Study results

- Increased lead-times and more consistency using LMH method compared to the control (subjective poor/fair/good method)





# Guided Worksheet

**JTWC Low-Medium-High Worksheet**

Step 1: Enter invest/TC number, basin and year (ex: 93W/2011), then click "Create Worksheet"

90W / 2012

Create Worksheet

---

**OPERATIONAL LOW/MEDIUM/HIGH WORKSHEET FOR 90W**

Date and Time (ex: 08/01/2011 18Z): 03 / 06 / 2012 00Z

Most Recent ATCF Best Track Location: (ex: 10.0N 130.0E)

**LOW LEVEL STRUCTURE (3 CRITERIA)**

Symmetry (long/short axis diameter)

CIMSS 850mb vorticity value

If no circ, w/lies eqward of disturbance?

**DVORAK FIX VALUES**

Most recent PGTW FT (within past 6 hours) N/A N/A

Most recent KNES FT (within past 6 hours) N/A N/A

Note: "N/A" indicates that fix information is not available in ATCF (agency is not fixing/cannot find/unable to classify) within 6 hours prior to the worksheet DTG.

**MODEL DEVELOPMENT**

References: WxMap, WxMapII

Development within 48 hours: Development within 24 hours:

NOGAPS GFS JGSM UKMET ECMWF

**MJO STATUS**

OLR anomaly

**VERTICAL WIND SHEAR**

Vertical wind shear value

**UPPER LEVEL OUTFLOW**

Upper level outflow pattern

**EXPERIMENTAL PARAMETERS**

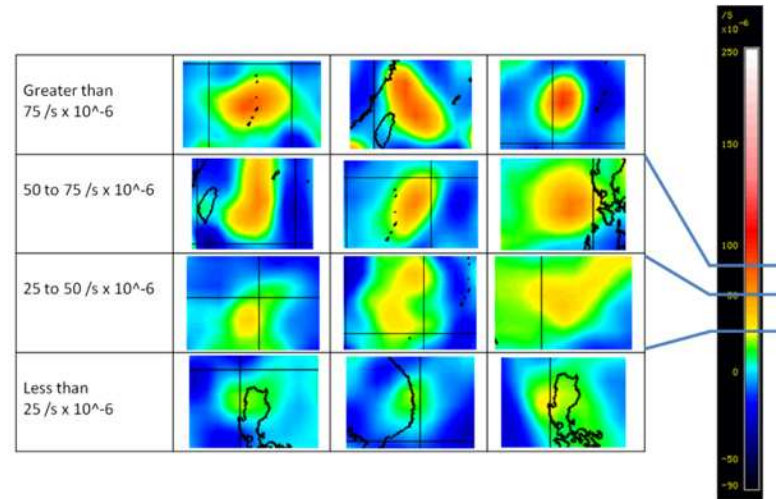
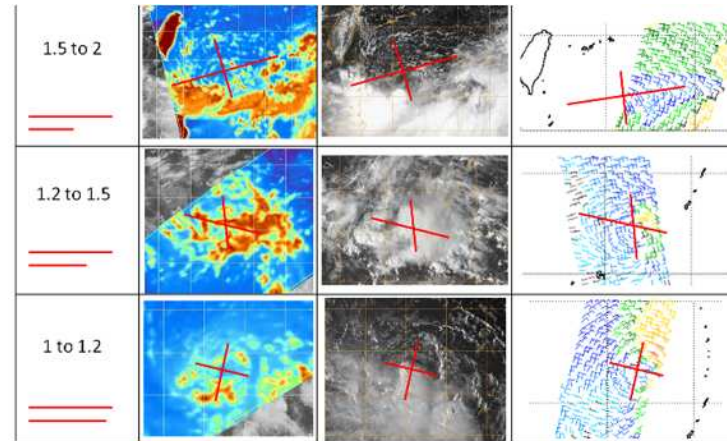
**STIPS FORECAST**

ST11 24 hour intensity forecast

**GENESIS POTENTIAL INDEX**

Most recent GPI value

Assess Low-Med-High Reset



# Genesis Potential Index

Peng et al. (2011) and Fu et al. (2011):

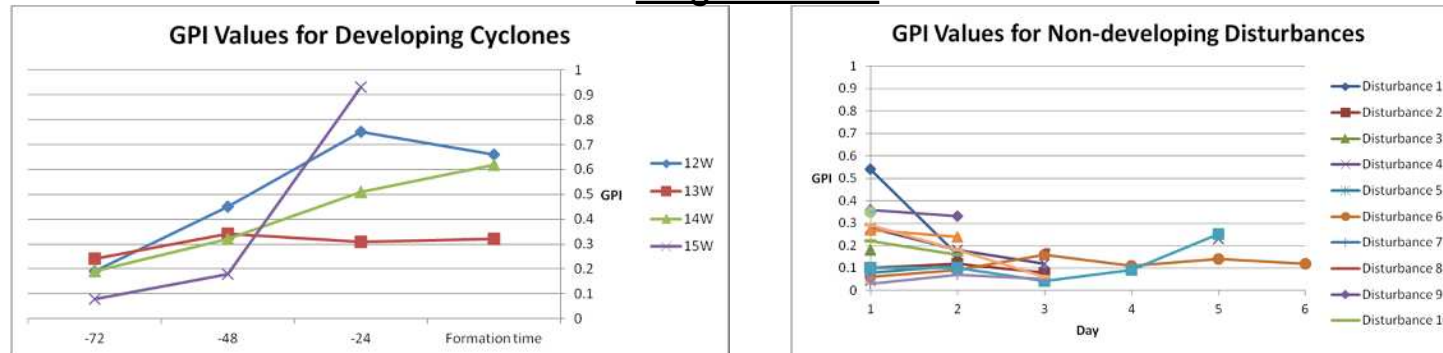
- Used TRMM satellite and NOGAPS analysis data to quantify key meteorological parameters related to TC genesis in the western North Pacific
- Applied nonlinear regression formulation to construct model to predict TC genesis in the 24 to 48 hour forecast period
- Trained model with 5 years worth of global analysis and TC best track data run in hindcast mode to derive Genesis Potential Index (GPI) applied in forecast mode
- Operational test for JTWC 2011 & 2012 - GPI parameters derived from NOGAPS analysis and TRMM combined satellite rainfall data:
  - 800 mb vorticity (maximum value associated with the disturbance)
  - 750 mb  $du/dy$
  - 3-hour rainfall

Peng, M.S., B. Fu, T. Li, and D.E. Stevens, 2011: Developing versus non-developing disturbances for tropical cyclone formation: Part I: North Atlantic. *Submitted to monthly weather review.*

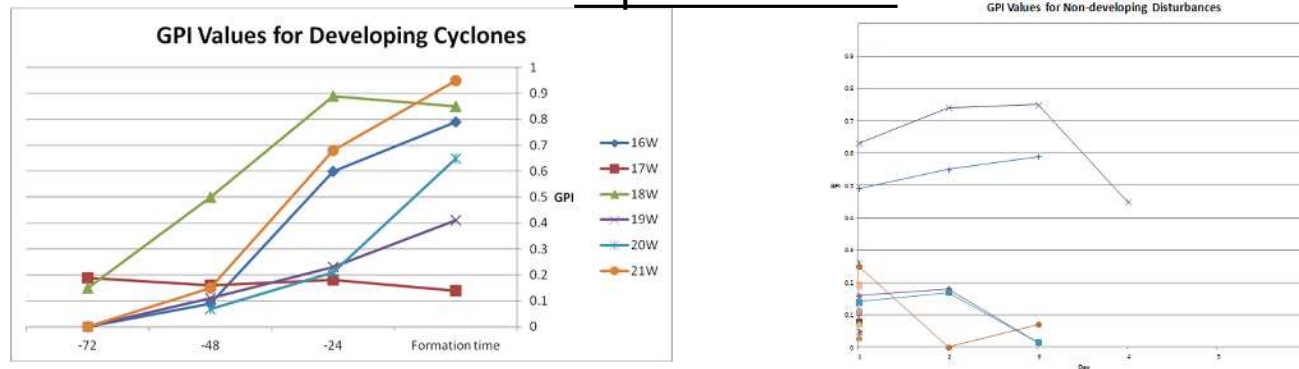
Fu, B., M.S. Peng, T. Li, and D.E. Stevens, 2011: Developing versus nondeveloping disturbances in the North Atlantic and Western North Pacific. Part II: the Western North Pacific. *Submitted to monthly weather review.*

# Genesis Potential Index Study

## August 2011



## September 2011

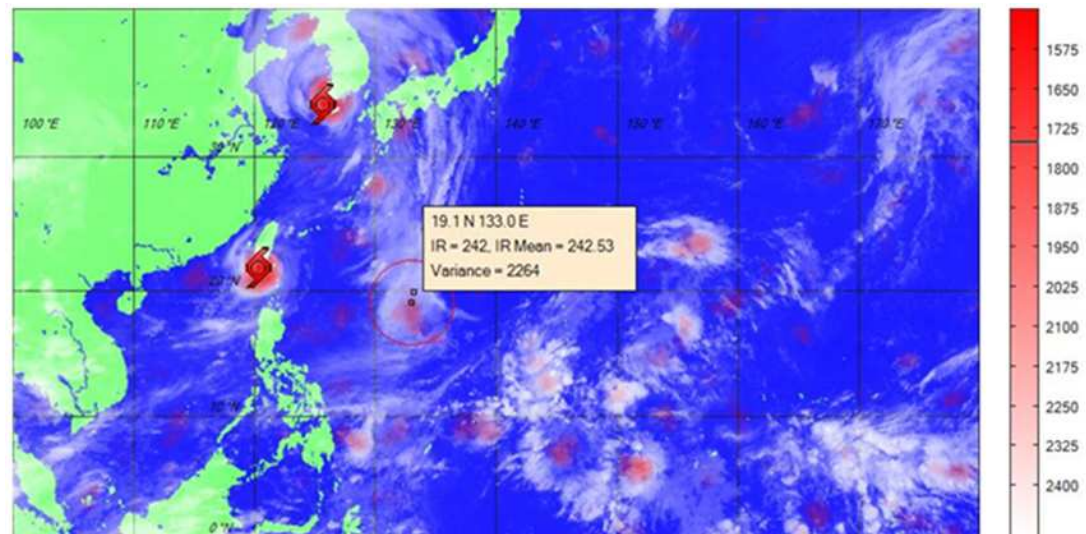


- Developing systems tended to show either a distinct increasing trend in GPI, particularly between 48 and 24 hours prior to formation, or a steady trend over several days at values exceeding the 0.2 development threshold
- Non-developing systems tended to maintain GPI values below 0.2 and, in the cases in which values exceeded 0.2, GPI tended to decrease

# Genesis Signals from Infrared Satellite Imagery

Piñeros et al. (2010):

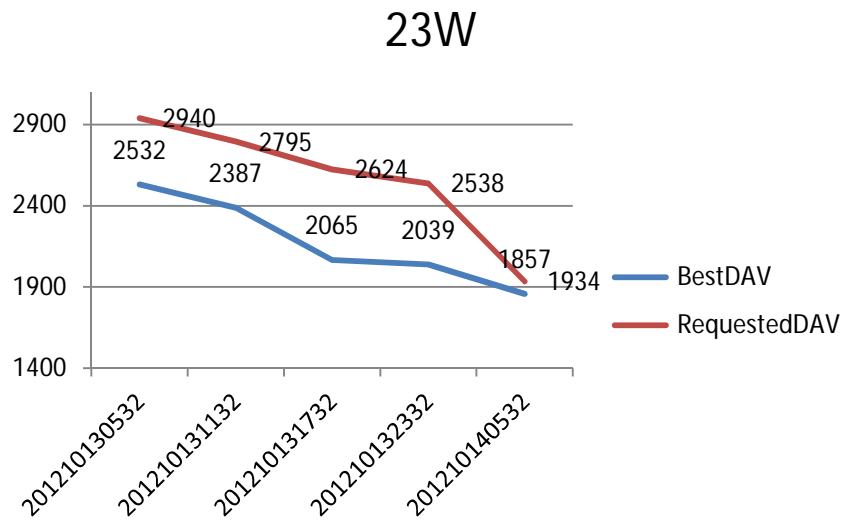
- Office of Naval Research (ONR)-funded research supported by National Oceanographic Partnership Program (NOPP)
- Applied procedure (from Piñeros et al. (2008)) to transform infrared imagery into “variance” data based on symmetry of convection distributed around cloud cluster center
- Lower variance values, associated with more symmetric cloud clusters, found to be directly correlated with tropical cyclogenesis potential
- Key variance thresholds determined by training algorithm with satellite data
  - Must provide reliable positive detection, low false alarm rate, and useful detection (lead) time



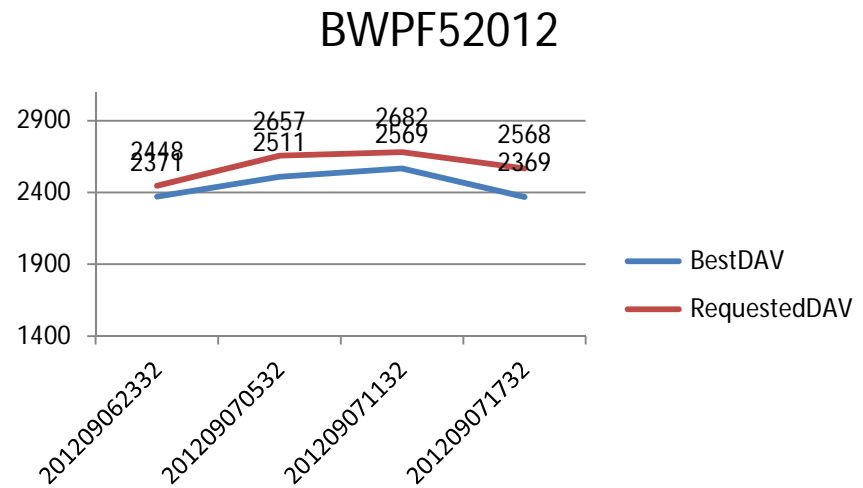
Piñeros, M.F., E.A. Ritchie, and J.S. Tyo, 2010: Detecting tropical cyclone formation from satellite infrared imagery. *Preprints, AMS 29<sup>th</sup> Conf. on Hurricanes and Tropical Meteorology*, Tucson, 9-14 May.

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 Transactions in Geoscience and Remote Sensing*, vol. 46, issue 11, part 1, pp. 3574-3580.

# DAV Study: 2012



DAV over time: Example developer

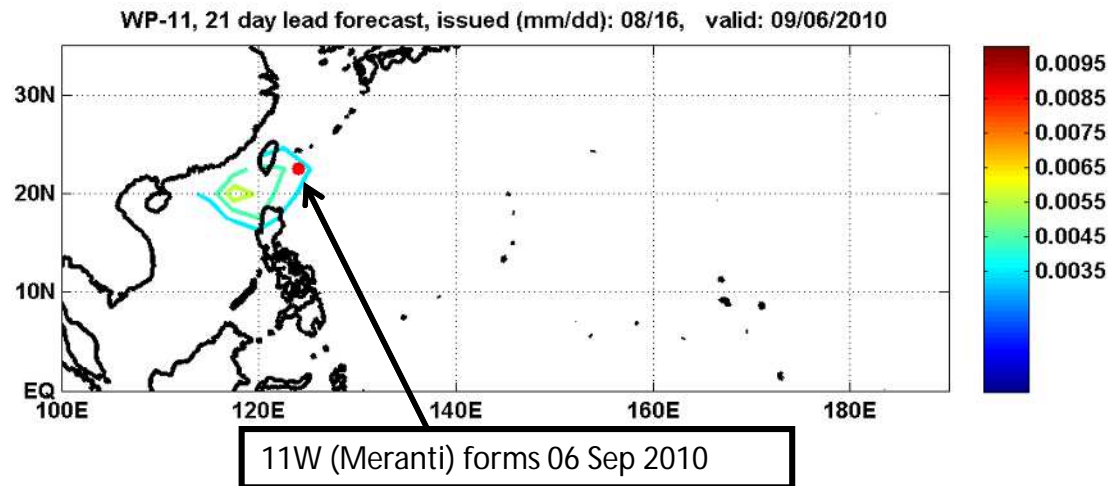


DAV over time: Example non-developer

- Threshold DAV value separated developers from non-developers (higher than previously-cited threshold – further study needed)
- Potential correlation between pre-genesis DAV and future storm intensity

# NPS Statistical-Dynamical Forecast System

- Developed by Dr. Tom Murphree and David Meyer, Naval Postgraduate School
- Statistical-dynamical predictions of tropical cyclone formations with up to 90 day lead
  - Ensemble of climate model runs used to determine expected values of Large-Scale Environmental Factors (LSEFs) associated with TC formation – LSEF values used to determine probability of TC formation in different areas

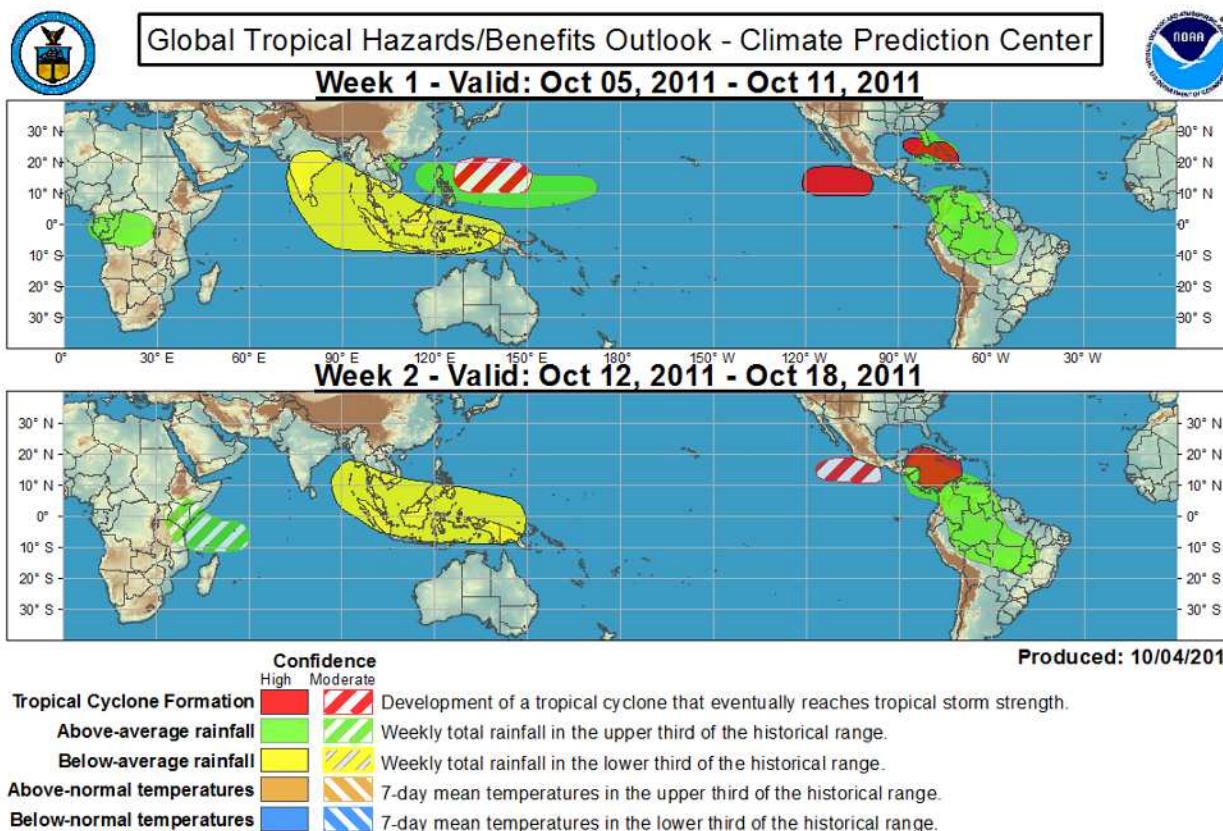




# Genesis Prediction: Cooperative Efforts Global Tropical Hazards/Benefits



- Actively involved in identifying potential TC formation areas during weekly Global Tropical Hazards/Benefits Outlook teleconference with Climate Prediction Center



Product is updated once per week. The product targets broad scale conditions integrated over a 7-day period for US interests only. Consult your local responsible forecast agency.

12 March 2014



47

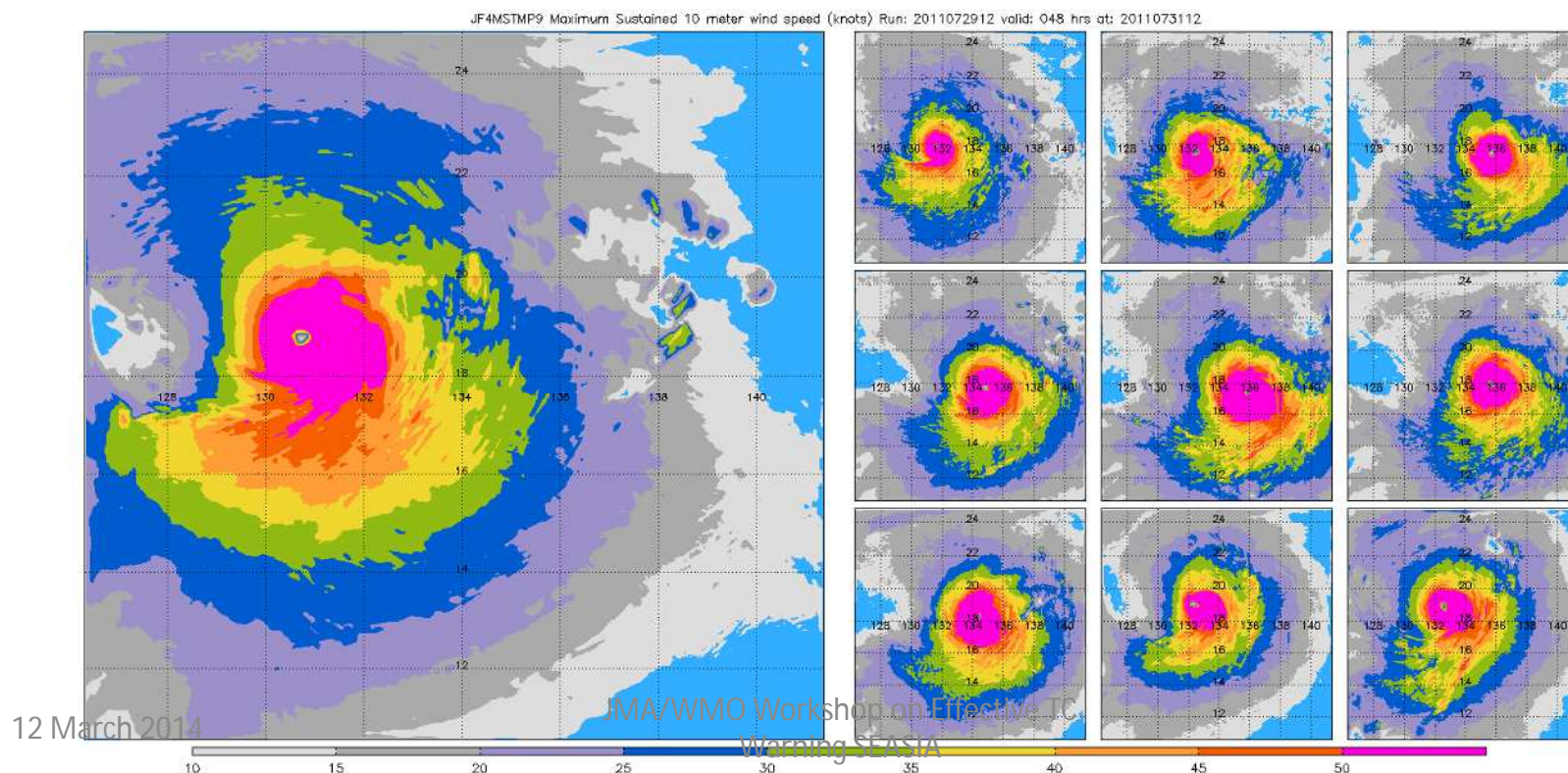


# Forecasting: Cooperative Efforts

## AFWA MEPS Ensemble



- Coordinating application of AFWA's MEPS ensemble to TC forecasting with the AFWA ensemble modeling group (20 km and 4 km resolution – 10 members each)
- Trackers in ATCF format now available for designated systems – evaluation ongoing





# ECMWF Ensemble Op Test 2012: Observations

- 15 day ensemble more useful than 32 day ensemble for short-lead forecasting due to daily frequency
- A few false alarms with large number of members developing, but mostly the exception
- Cases with multiple clusters in same area – perhaps same system?
- Number of developing members – distinct increase over time for classified TCs
- Subtropical cyclones included in storm cluster analysis

# ECMWF Ensemble Op Test 2013: Recommendations

- Provide “raw data” – number of tracks in cluster and average positions during forecast period
- Forecast continuity – label cyclone identified in subsequent runs with same number/designator
- Test “cyclone phase flag” to identify subtropical cyclones
- Flag instances when individual track cluster mean track is expected to outperform overall mean based on percentage of members present in cluster
- Proposals for evaluation/feedback:
  - Automatic integration of developing members and trends into LMH worksheet
  - Monthly reports

Questions?

# References

- Elsberry, R. L., M.S. Jordan, and F. Vitart, 2011: Evaluation of the ECMWF 32-day ensemble predictions during 2009 season of western North Pacific tropical cyclone events on intraseasonal timescales. *Asia-Pacific J. Atmos. Sci.*, **47**, 305-318.
- Fu, B., M.S. Peng, T. Li, and D.E. Stevens, 2011: Developing versus nondeveloping disturbances in the North Atlantic and Western North Pacific. Part II: the Western North Pacific. *Mon. Wea. Rev.*, in press.
- Peng, M.S., B. Fu, T. Li, and D.E. Stevens, 2011: Developing versus non-developing disturbances for tropical cyclone formation: Part I: North Atlantic. *Mon. Wea. Rev.*, in press.
- 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 Transactions in Geoscience and Remote Sensing*, vol. 46, issue 11, part 1, pp. 3574-3580.
- Piñeros, M.F., E.A. Ritchie, and J.S. Tyo, 2010: Detecting tropical cyclone formation from satellite infrared imagery. *Preprints, AMS 29<sup>th</sup> Conf. on Hurricanes and Tropical Meteorology*, Tucson, 9-14 May.