Extended-range TC Forecasting: Opportunity and Challenge

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A Seamless TC Forecasting System

READY

Seasonal prediction:
Basin-wide seasonal total named TC number & Hurricane number

SET

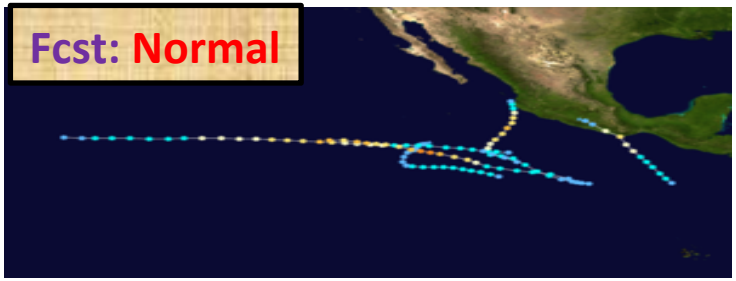
Extended-range Forecasting :
Weekly TC strike probability
Location & timing

GO

Weather Forecasting :
48-hr genesis, Intensity & track

2012 Hurricane Season (Jun 01 => Nov 30)

(http://www.cpc.ncep.noaa.gov/products)



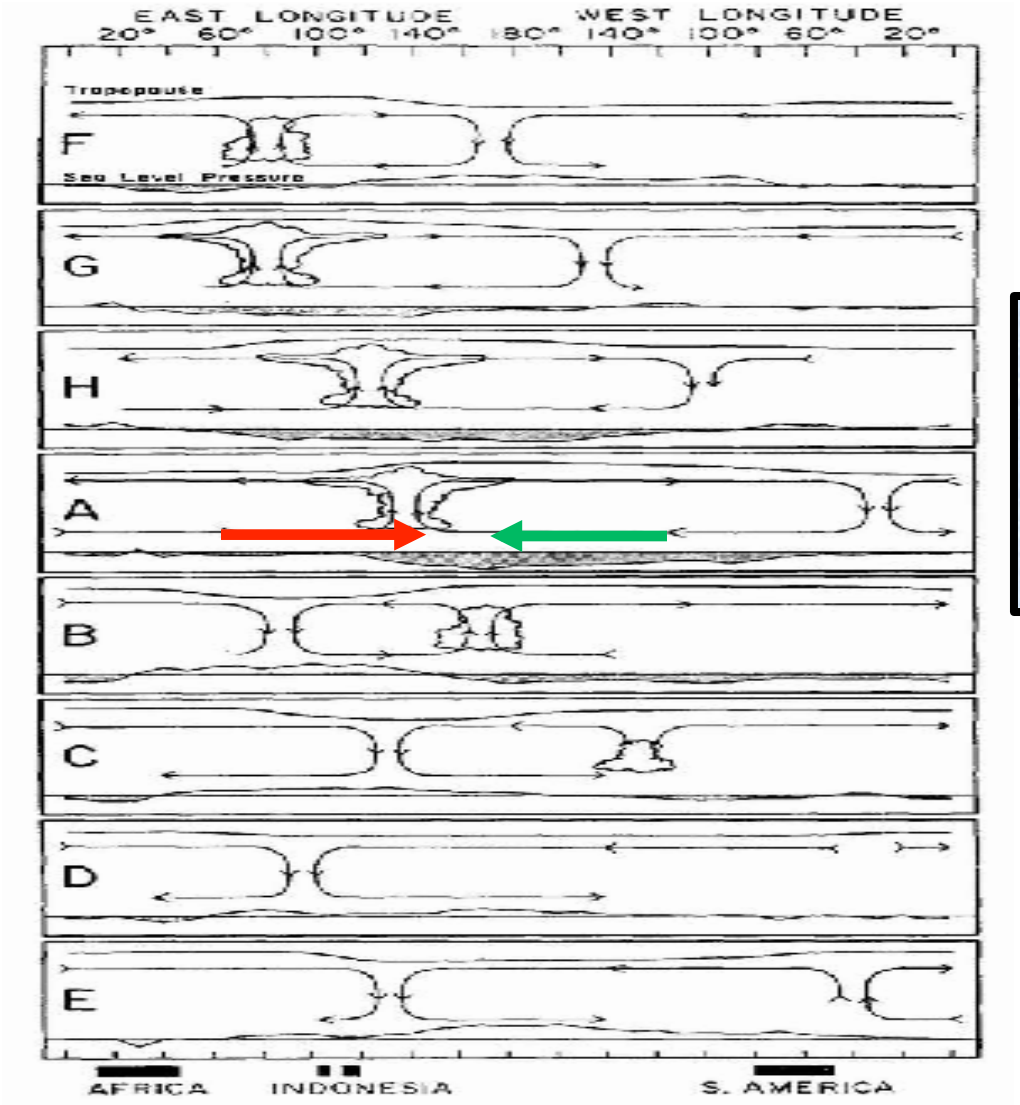
Current: 6 TC/5 HC (Forecasted: 15/8)

Current: 4 TC/1 HC (Forecasted: 13/5)

Sources of Extended-range TC Forecasting

- Madden-Julian Oscillation (MJO)
- Boreal-summer Intra-Seasonal Oscillation (BSISO)
- Sea Surface Temperature (or Air-Sea Coupling)
- Easterly Waves
- Convectively Coupled Equatorial Waves (e.g., ER, Kelvin, MRG et al.)

What is MJO: Madden-Julian Oscillation?



Baroclinic disturbance,

Coupled with convection,

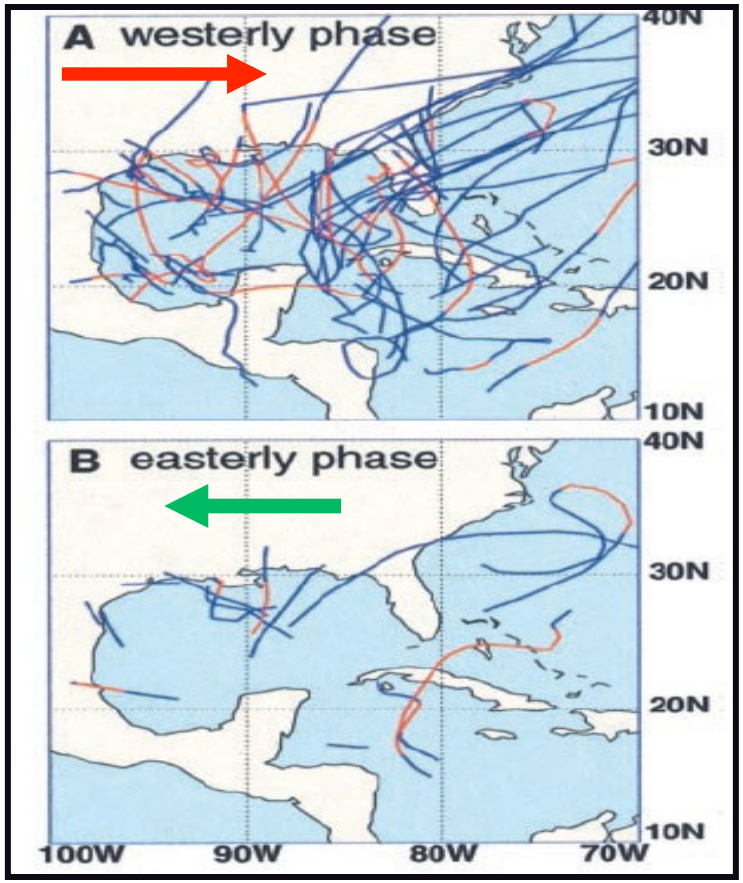
Eastward along the equator,

With a period of 30-60 days

Madden and Julian, 1972

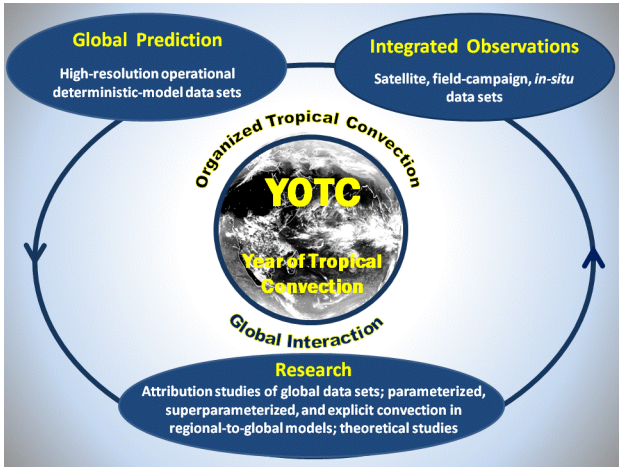
Modulation of the MJO on Tropical Cyclones

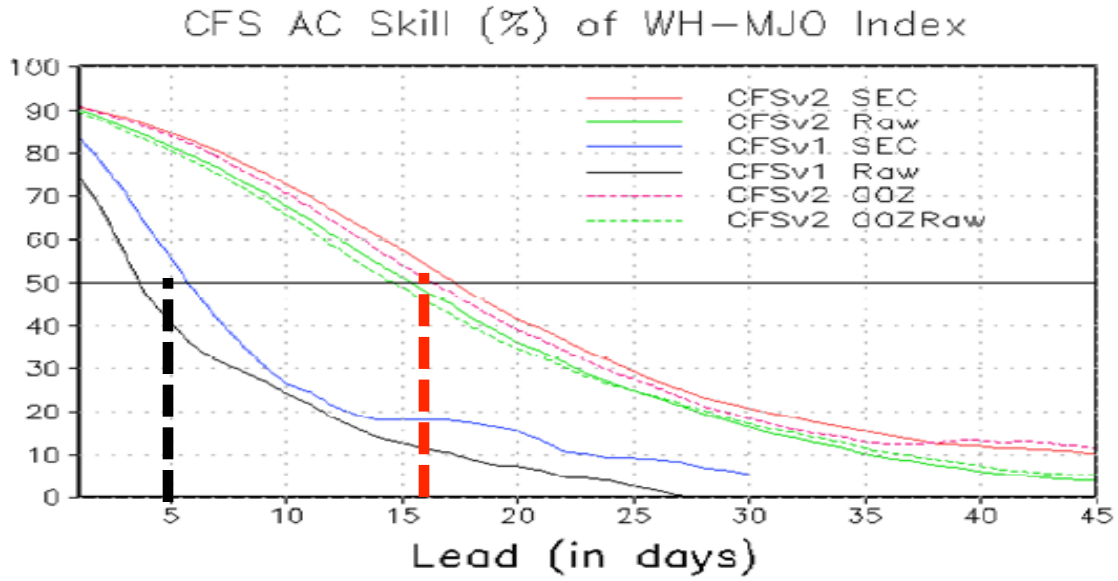
- **Western North Pacific**
  Nakazawa (1988); Liebmann et al. (1994)
- **Eastern North Pacific**
  Molinari et al. (1997); Maloney and Hartmann (2000)
- **Atlantic Basin**
  Maloney and Hartmann (2002); Mo (2002)
  Klotzbach (2010)
- **Indian Ocean**
  Bessafi and Wheeler (2006); Ho et al. (2002)
  Kikuchi and Wang (2009)
- **Australian Region**
  Hall et al (2001); Chand and Walsh (2010)



(Maloney and Hartman 2002, Science)

A National Effort to Advance MJO (or IS) Prediction

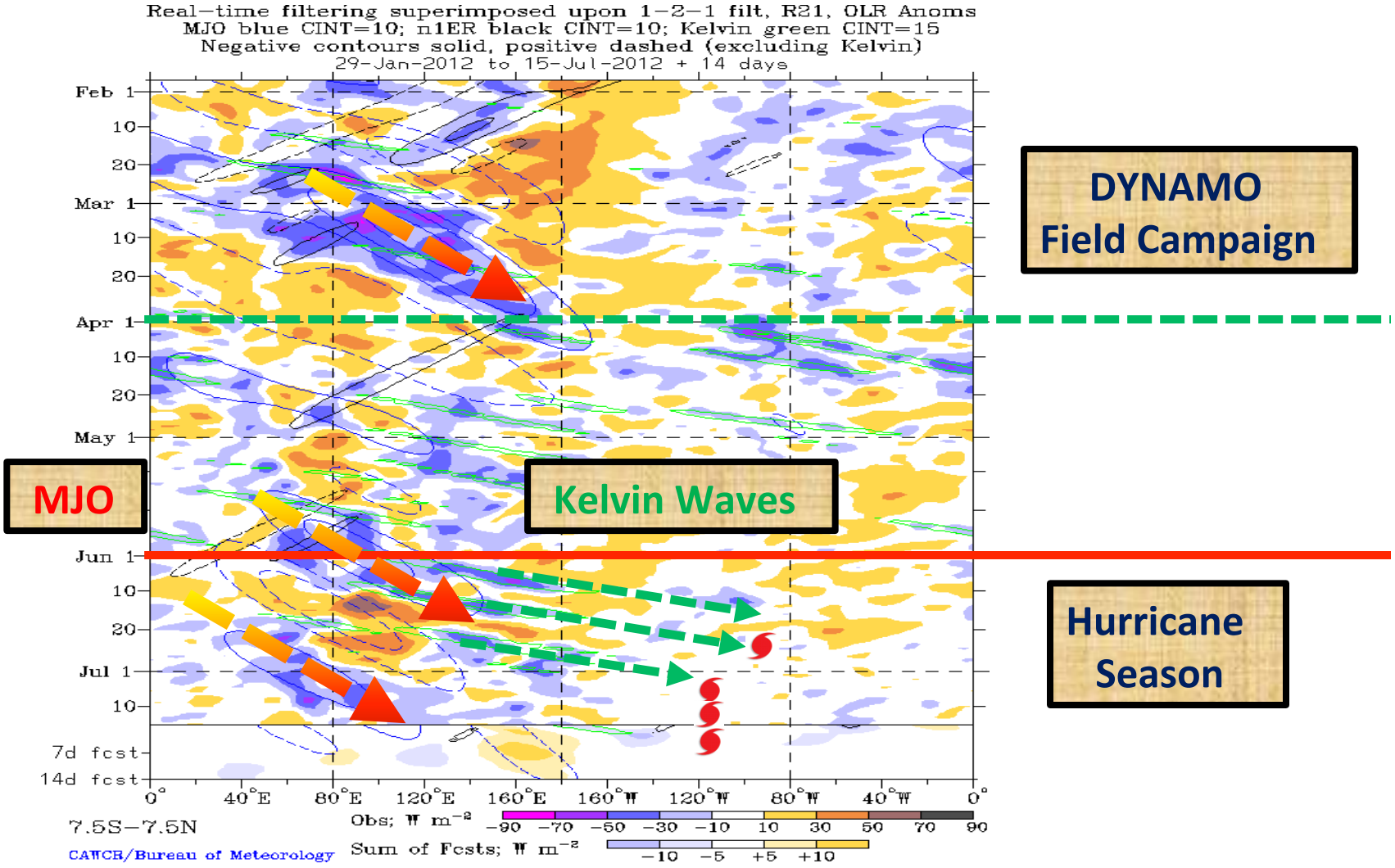




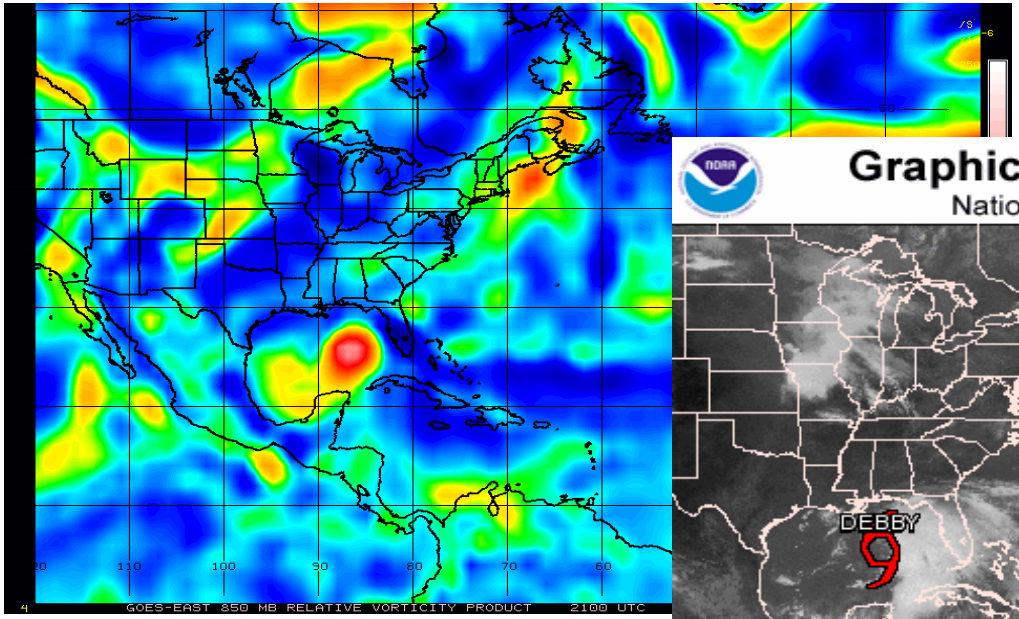
National (NOAA/NCEP CPC) MJO forecasting capability has been tripled from CFSv1 to CFSv2.

Zhang and Van Den Dool (WAF, 2012)

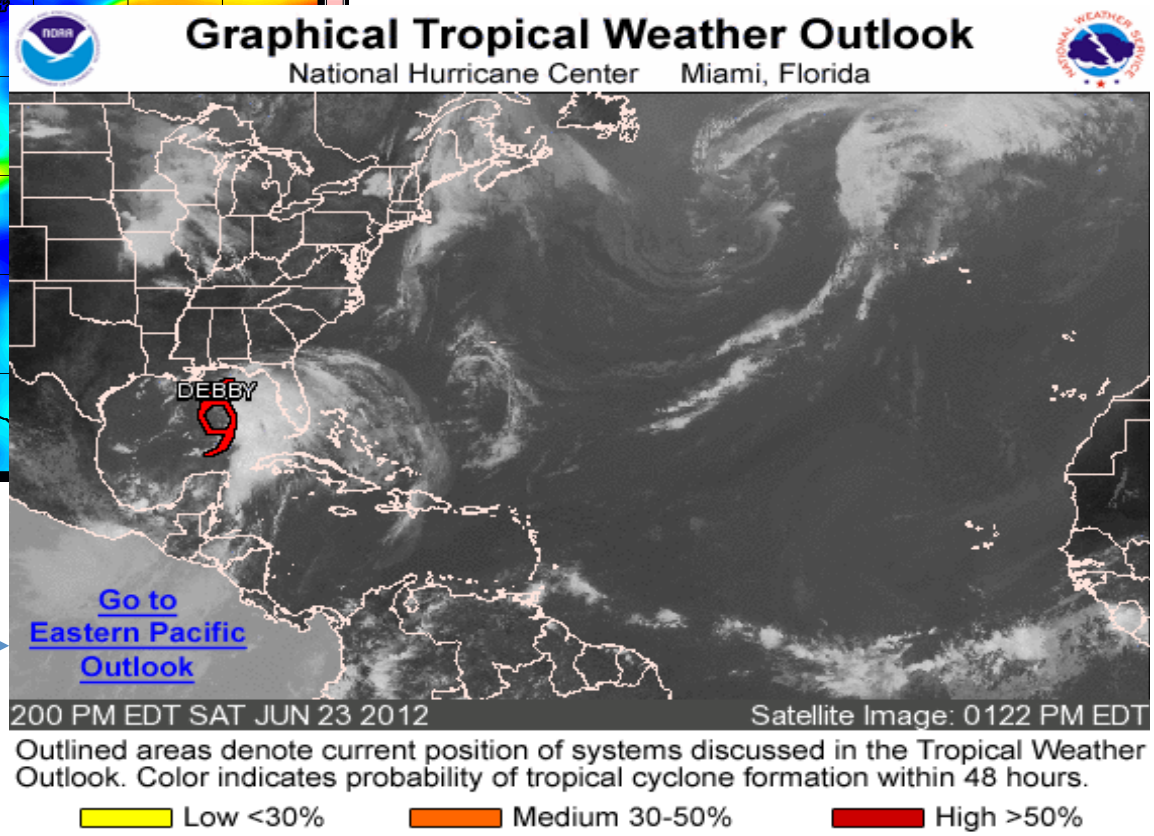
MJO and Convective-Coupled Equatorial Waves



CMISS Tropical Cyclones – University of Wisconsin-Madison



TS "Debby": June 23-27, 2012

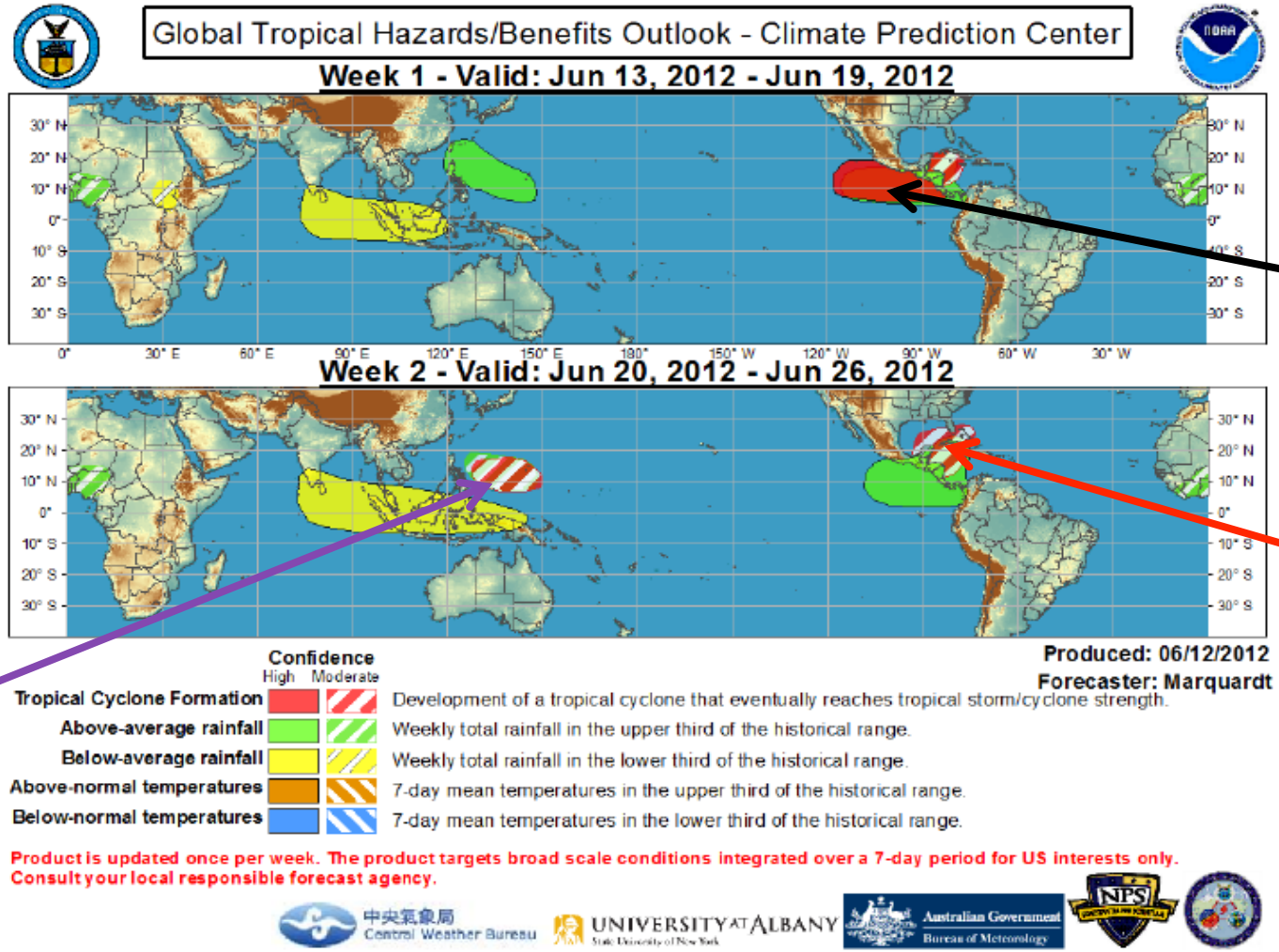


National Hurricane Center →

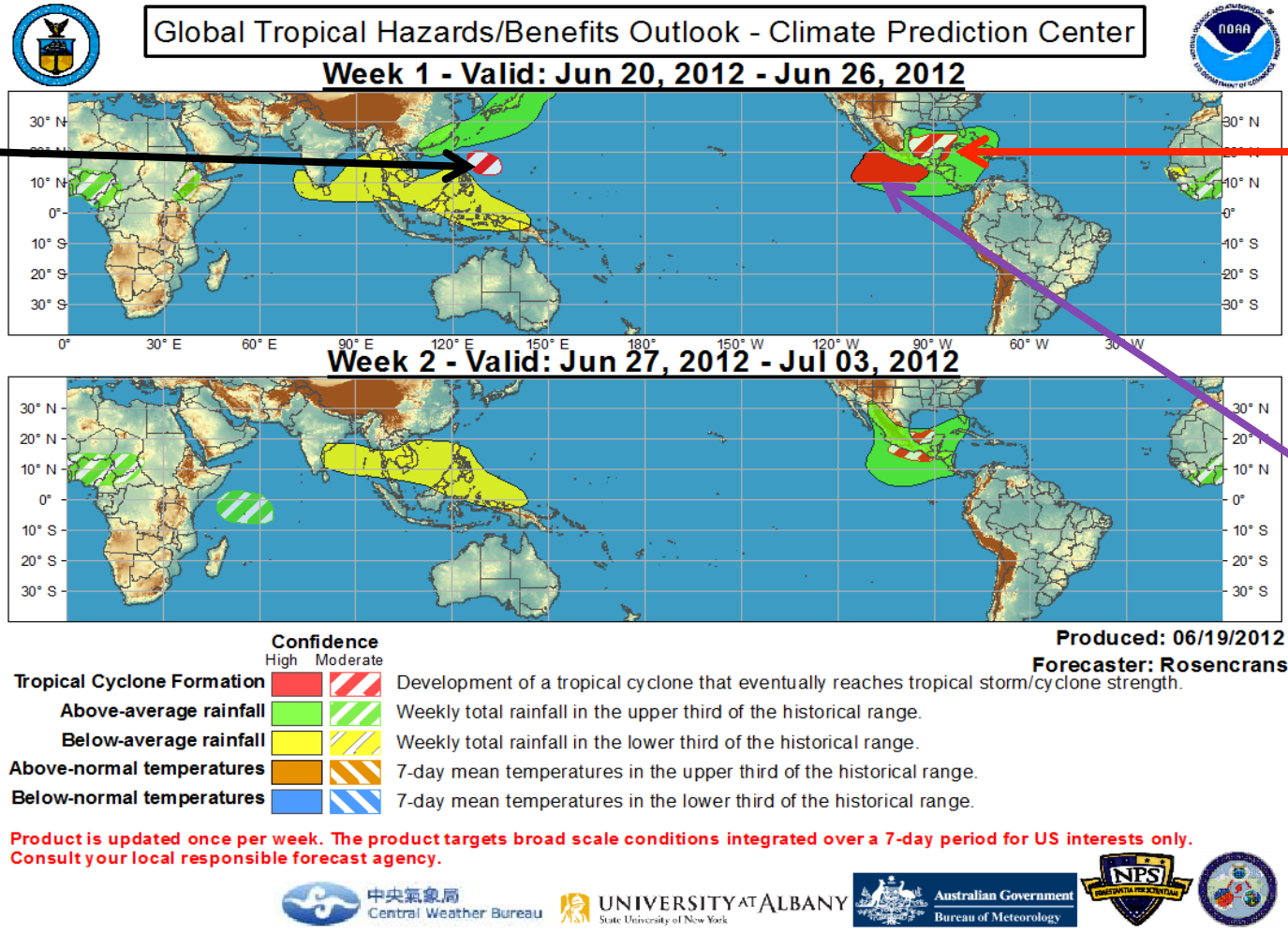
USA Today on June 23, 2012

Tropical Storm "Debby" disrupts Gulf oil, gas production

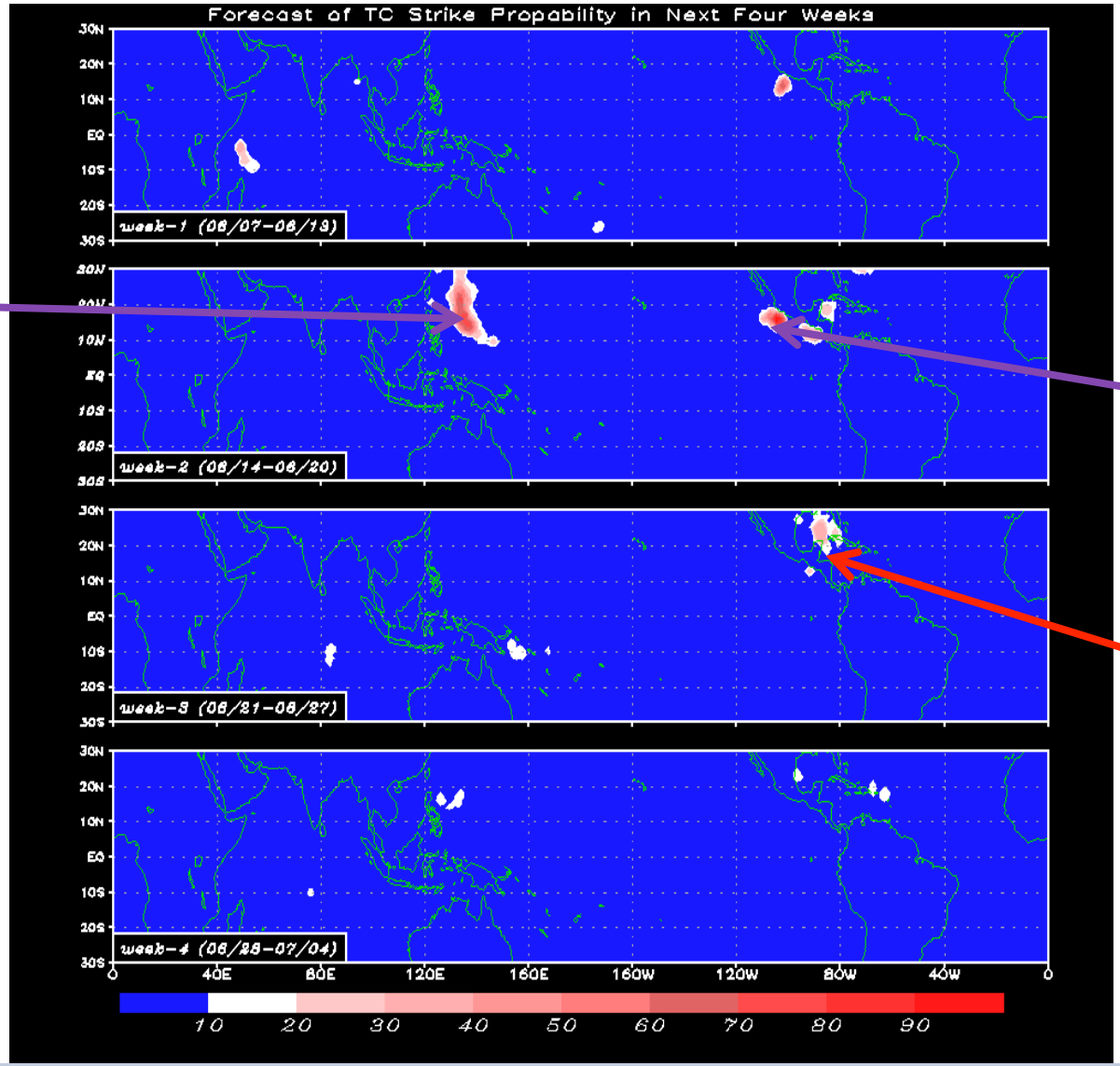
NOAA/NCEP CPC Global Hazards Outlook (IC: June 13)



NOAA/NCEP CPC Global Hazards Outlook (IC: June 20)



UH Weekly TC Strike Probability (IC: June 07)

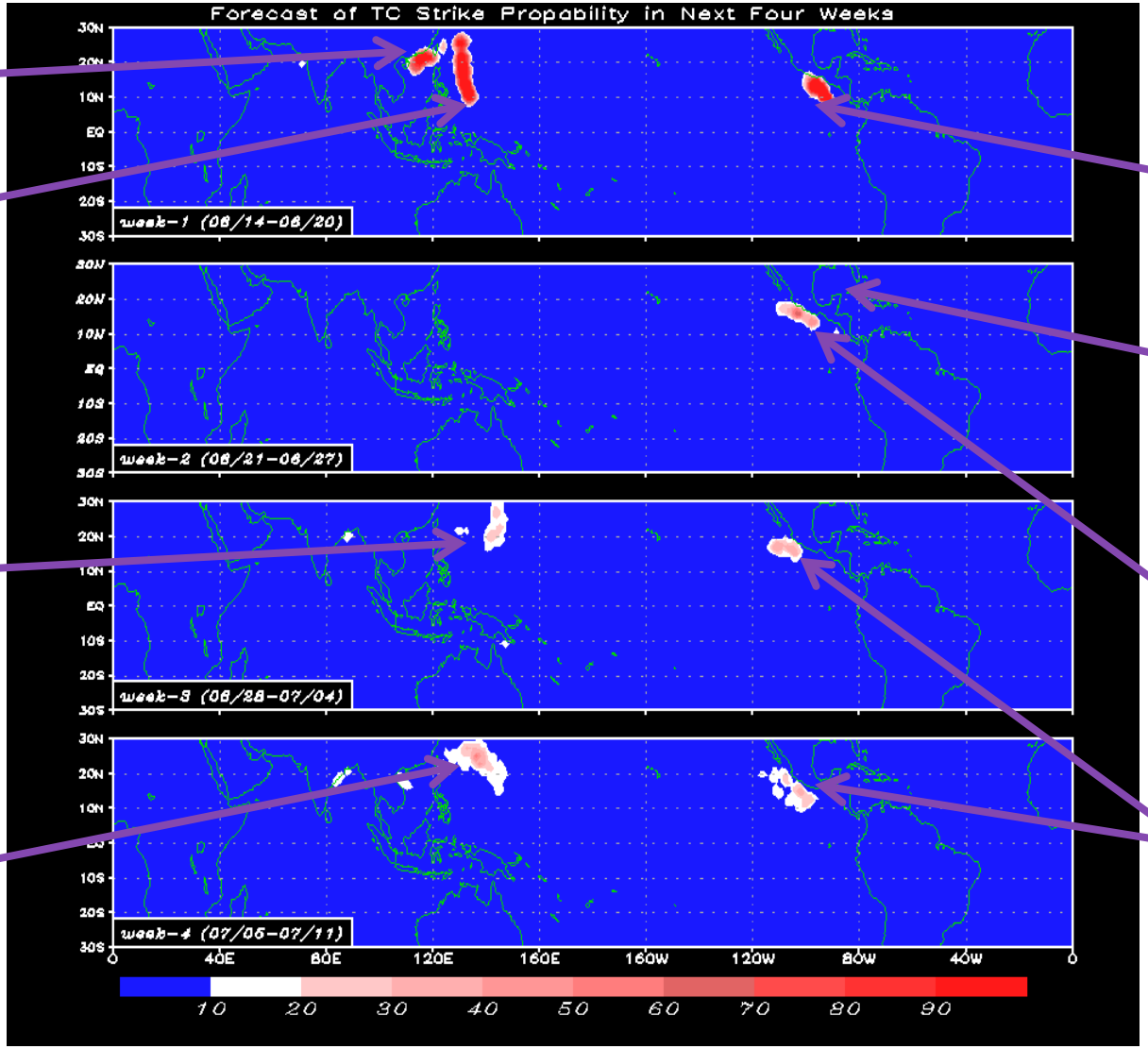


Guchol

Carlotta

Debby

UH Weekly TC Strike Probability (IC: June 14)



Talim

Guchol

Carlotta

Missing Debby

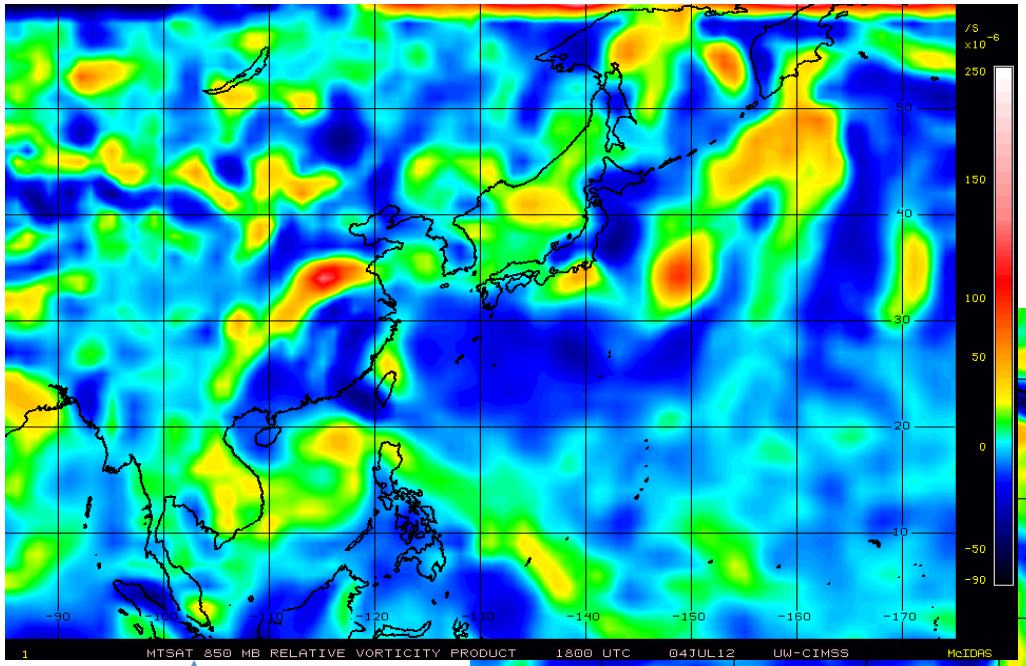
Doksuri

False Alarm

False Alarm

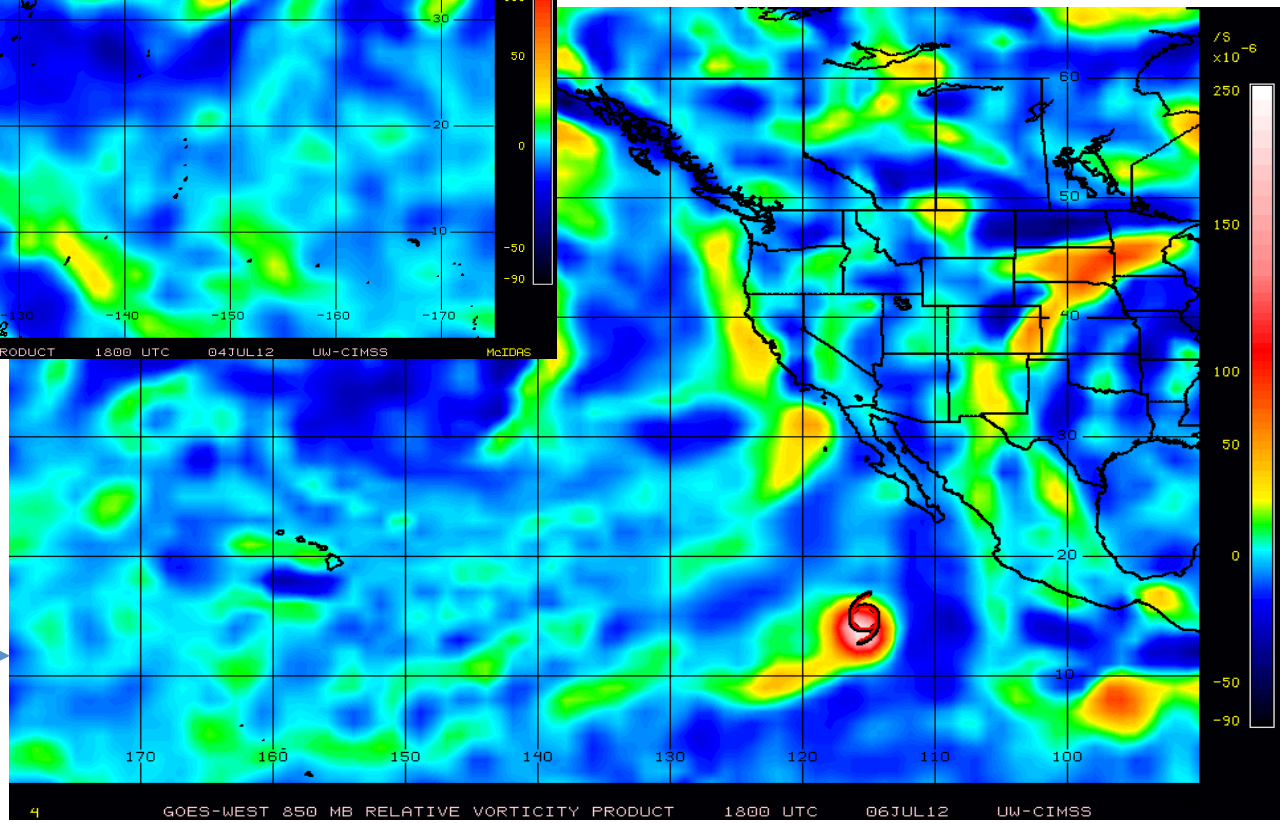
Daniel & Emilia

CMISS Tropical Cyclones – University of Wisconsin-Madison



July 4

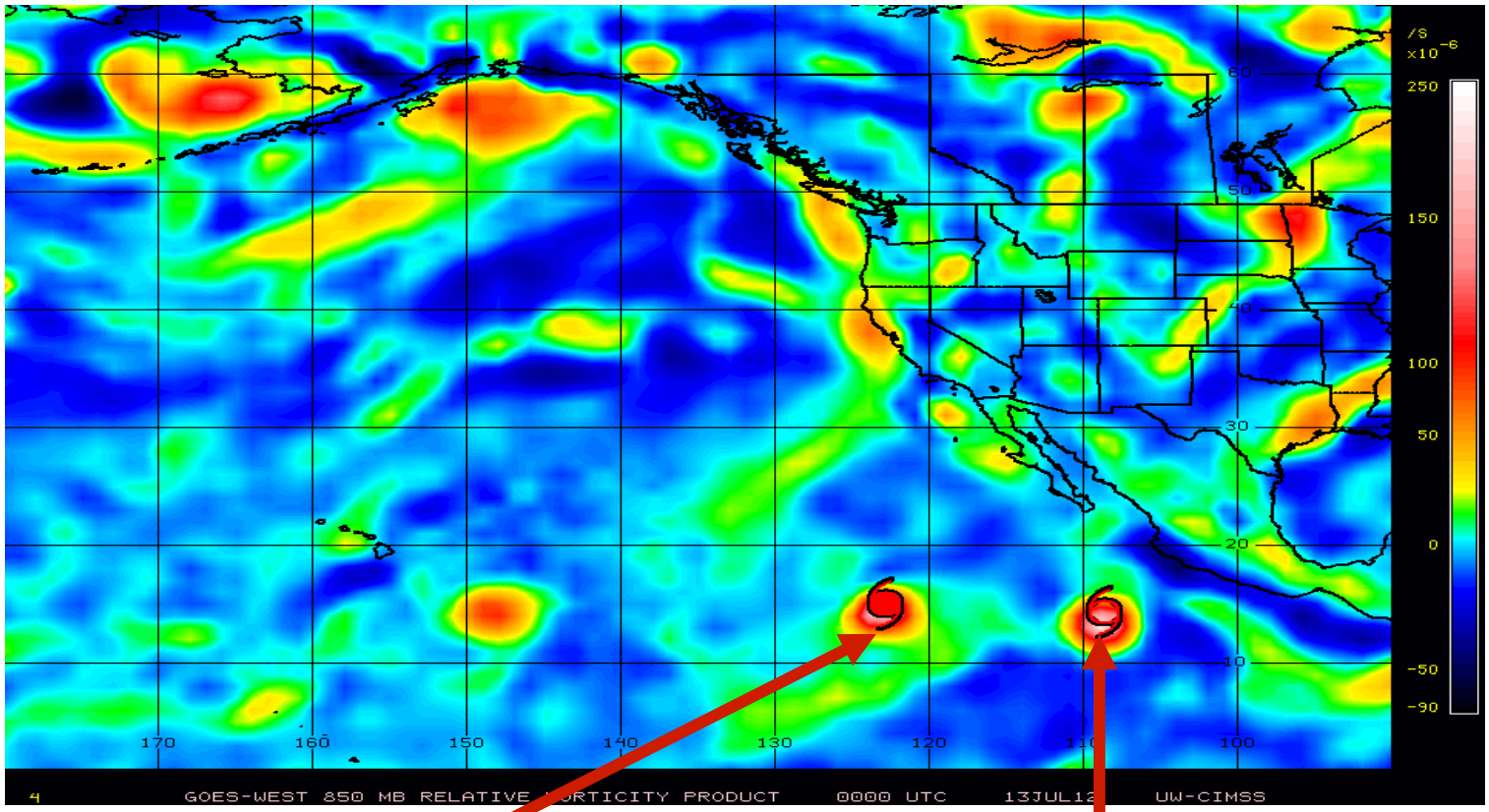
July 6



"Daniel": July 4-11, 2012

CMISS Tropical Cyclones – University of Wisconsin-Madison

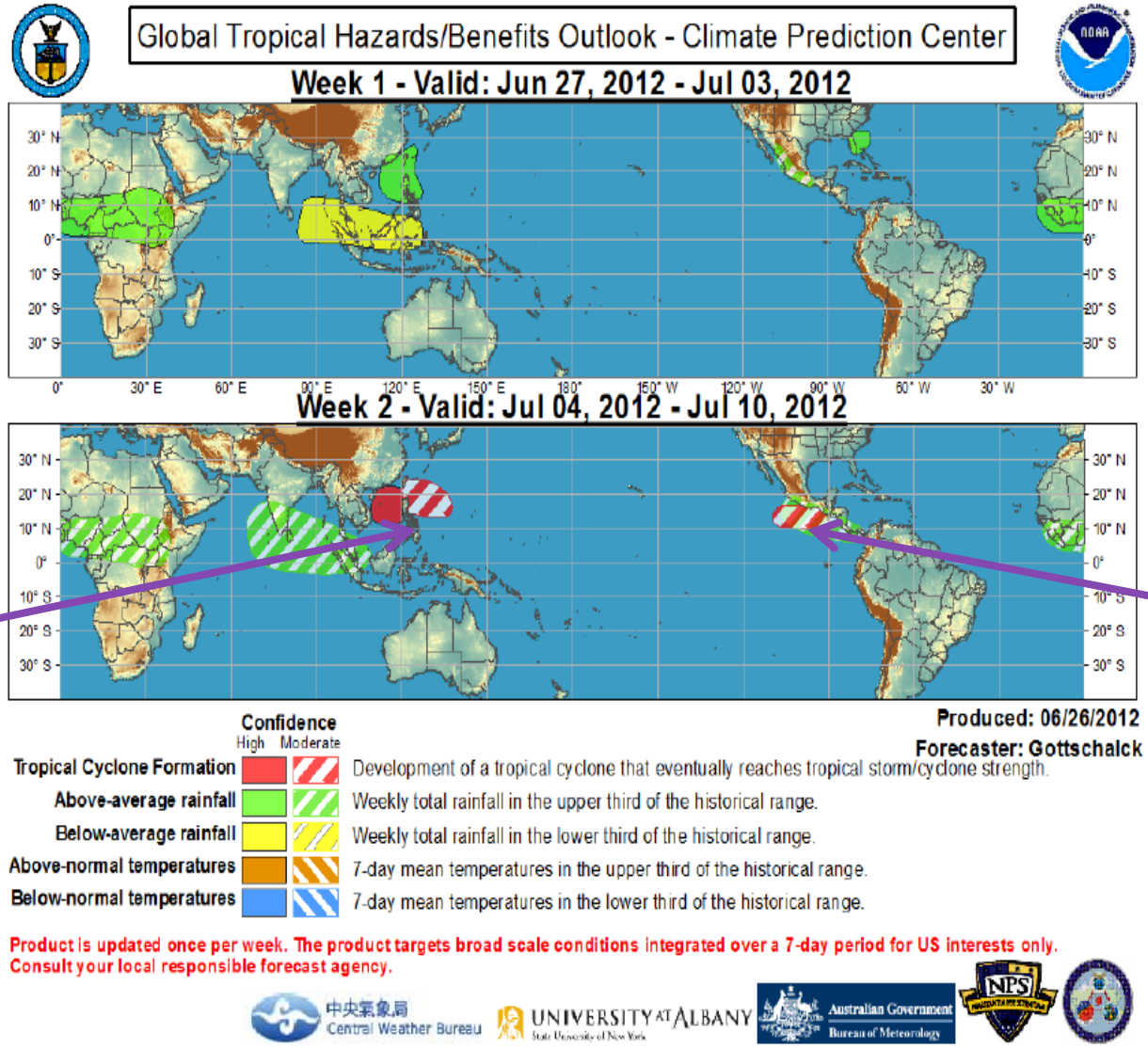
July, 13, 2012



"Emilia": July 7-15 , 2012

"Fabio": July 12-18 , 2012

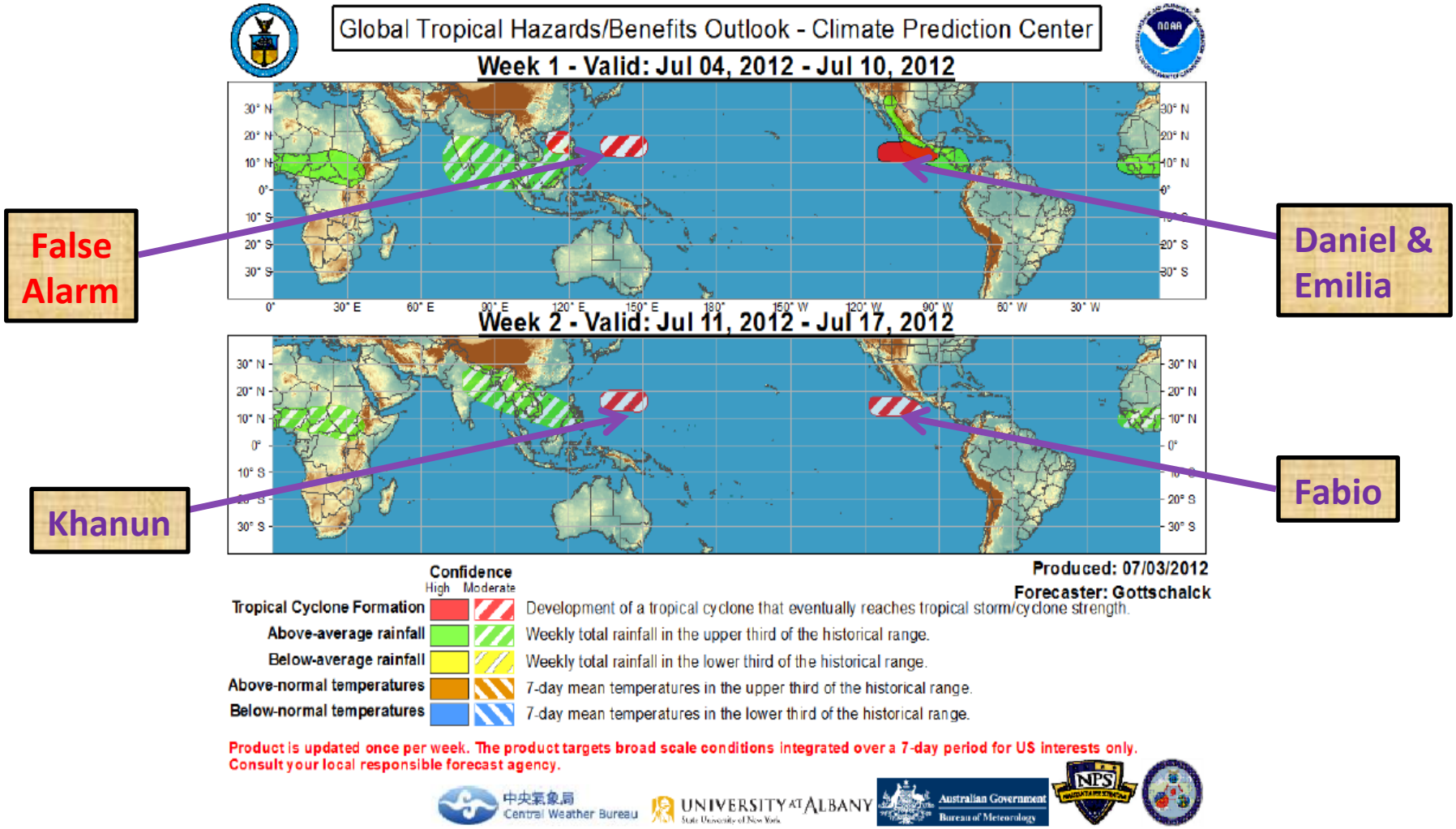
NOAA/NCEP CPC Global Hazards Outlook (IC: June 27)



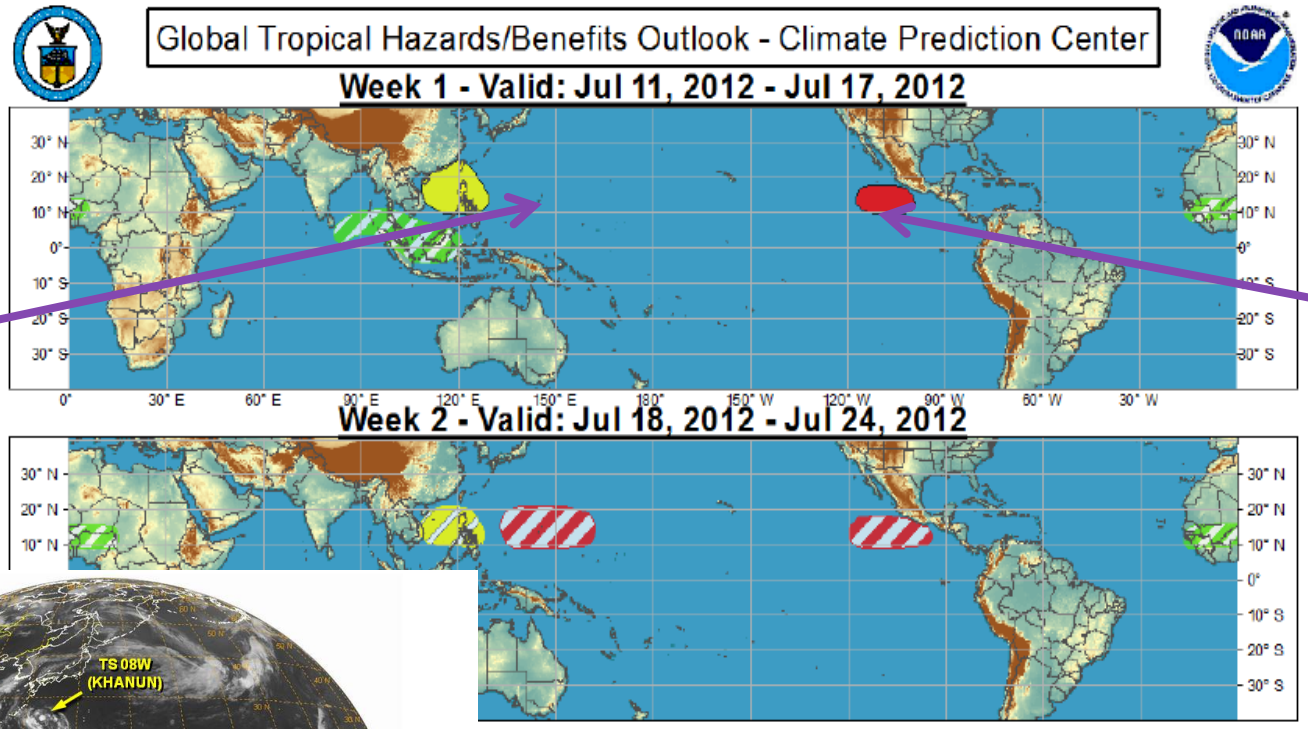
False Alarm

Daniel & Emilia

NOAA/NCEP CPC Global Hazards Outlook (IC: July 04)

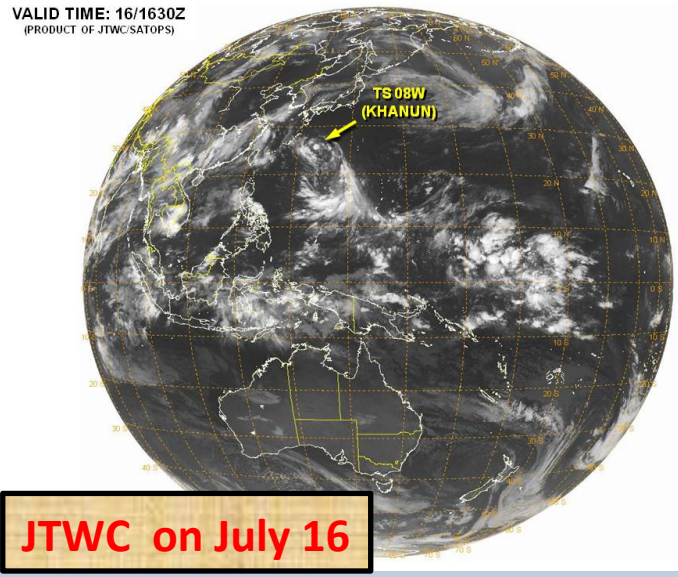


NOAA/NCEP CPC Global Hazards Outlook (IC: July 11)



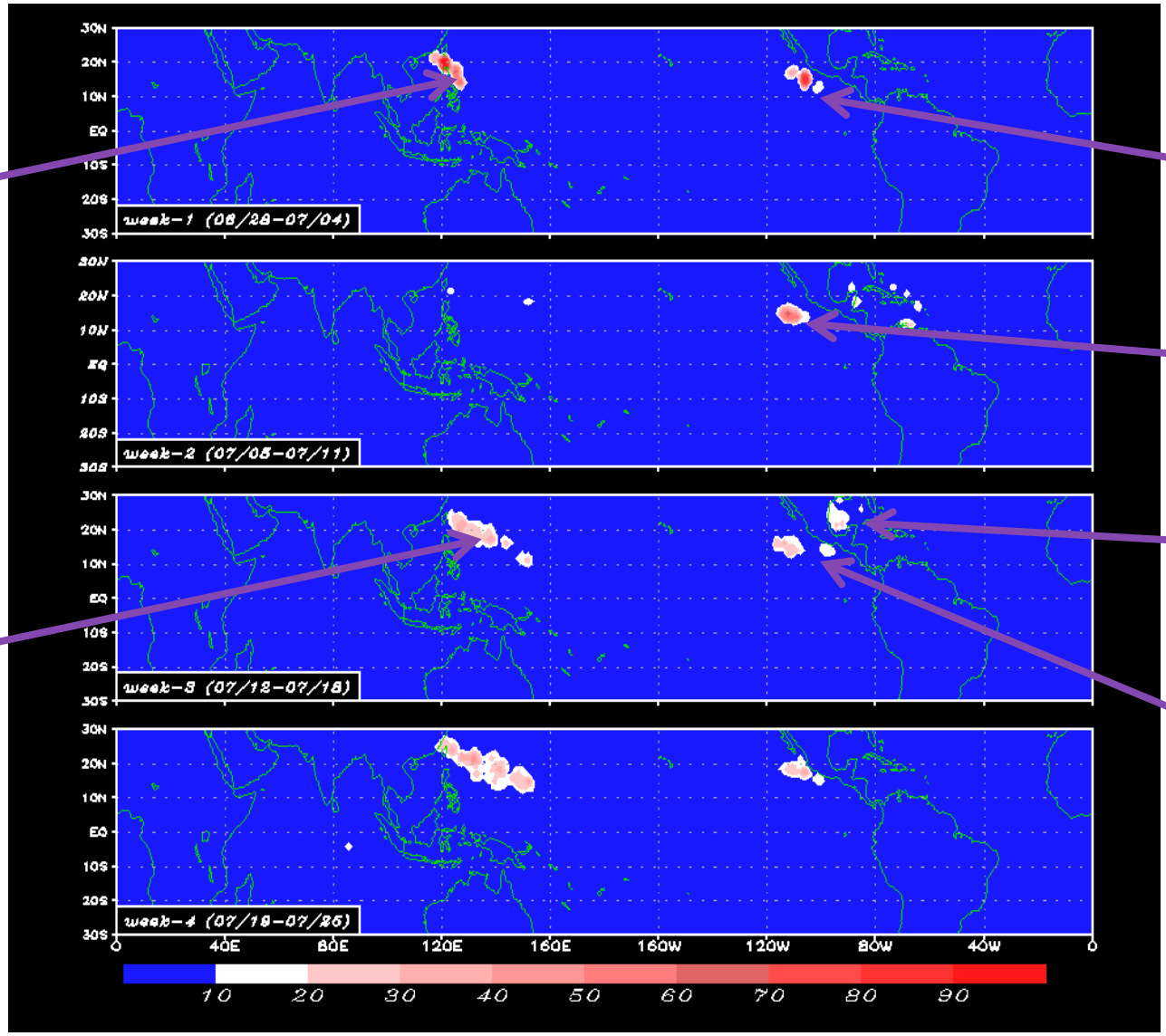
Missing Khanun

Fabio



JTWC on July 16

UH Weekly TC Strike Probability (IC: June 28)



Doksuri

Khanun

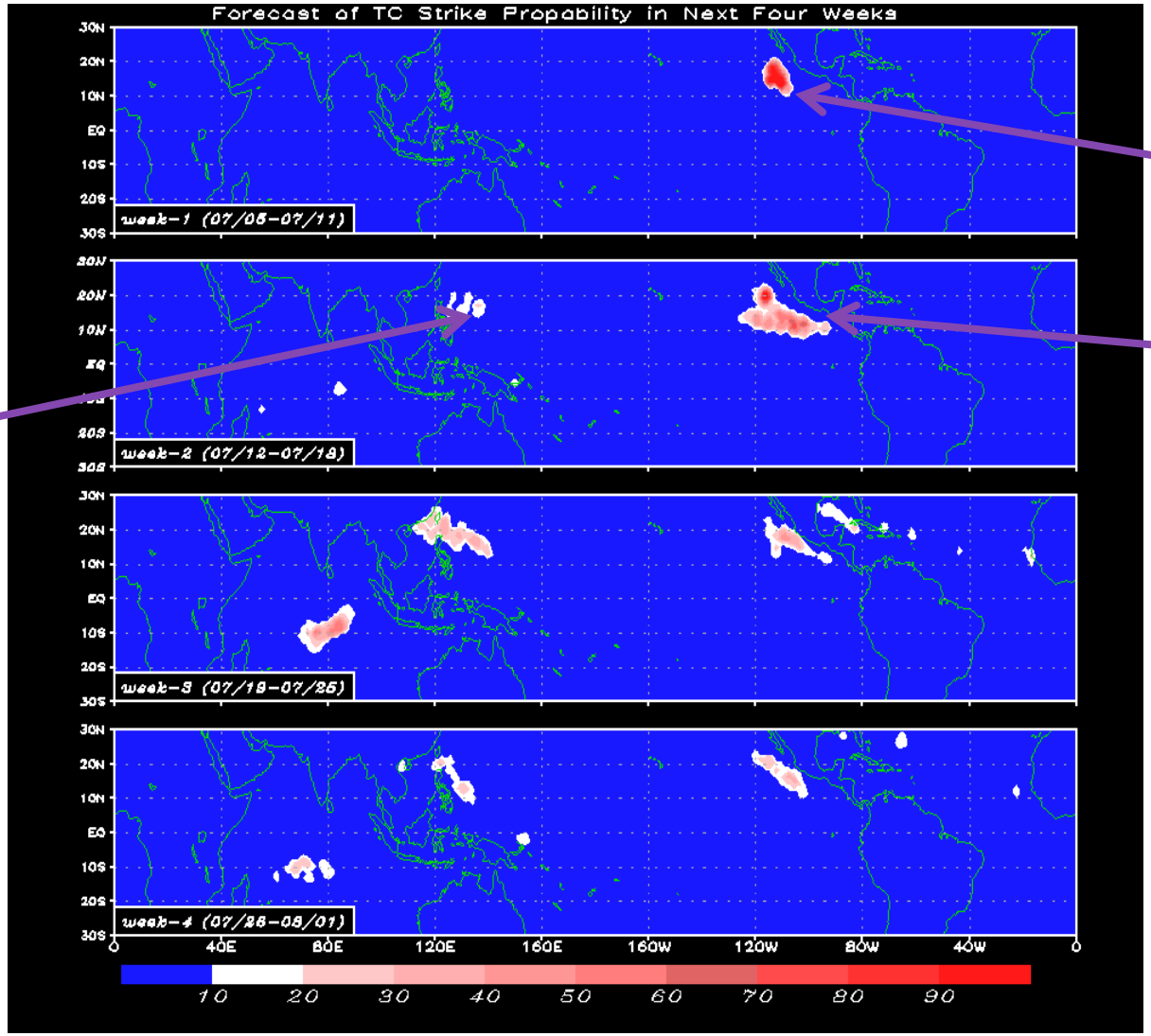
Daniel

Daniel & Emilia

False Alarm

Emilia & Fabio

UH Weekly TC Strike Probability (IC: July 05)



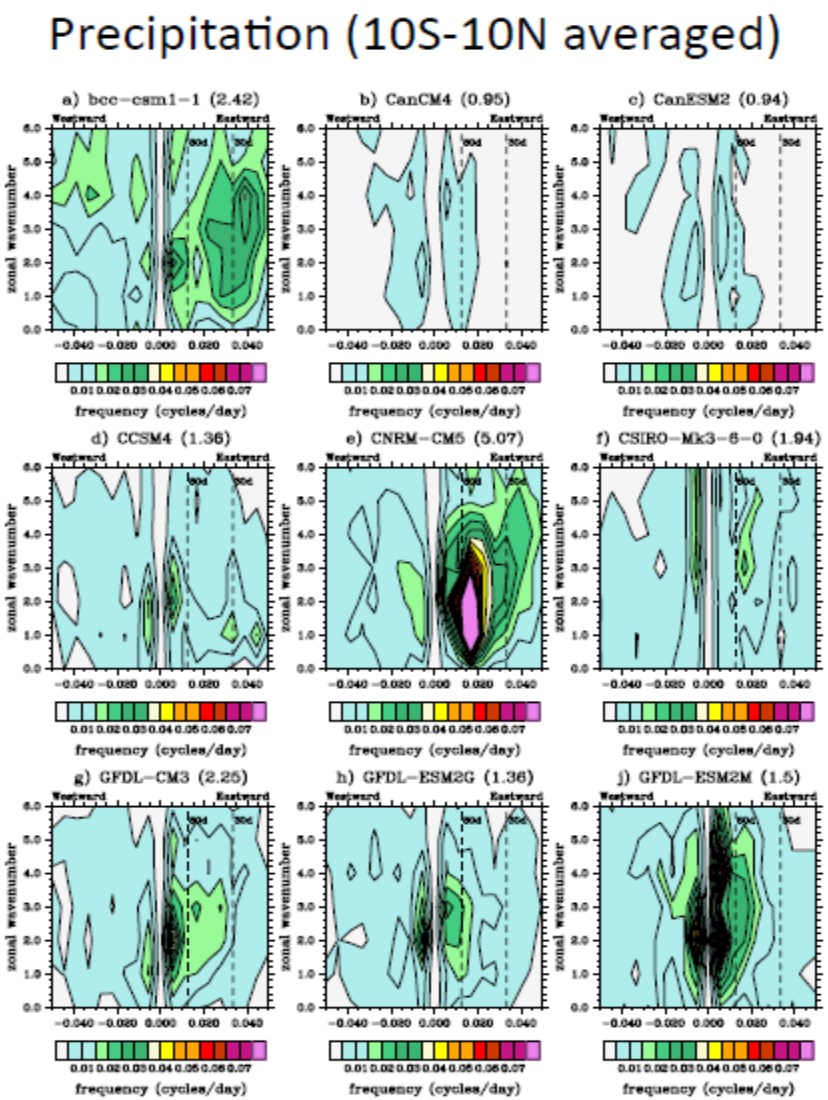
Daniel & Emilia

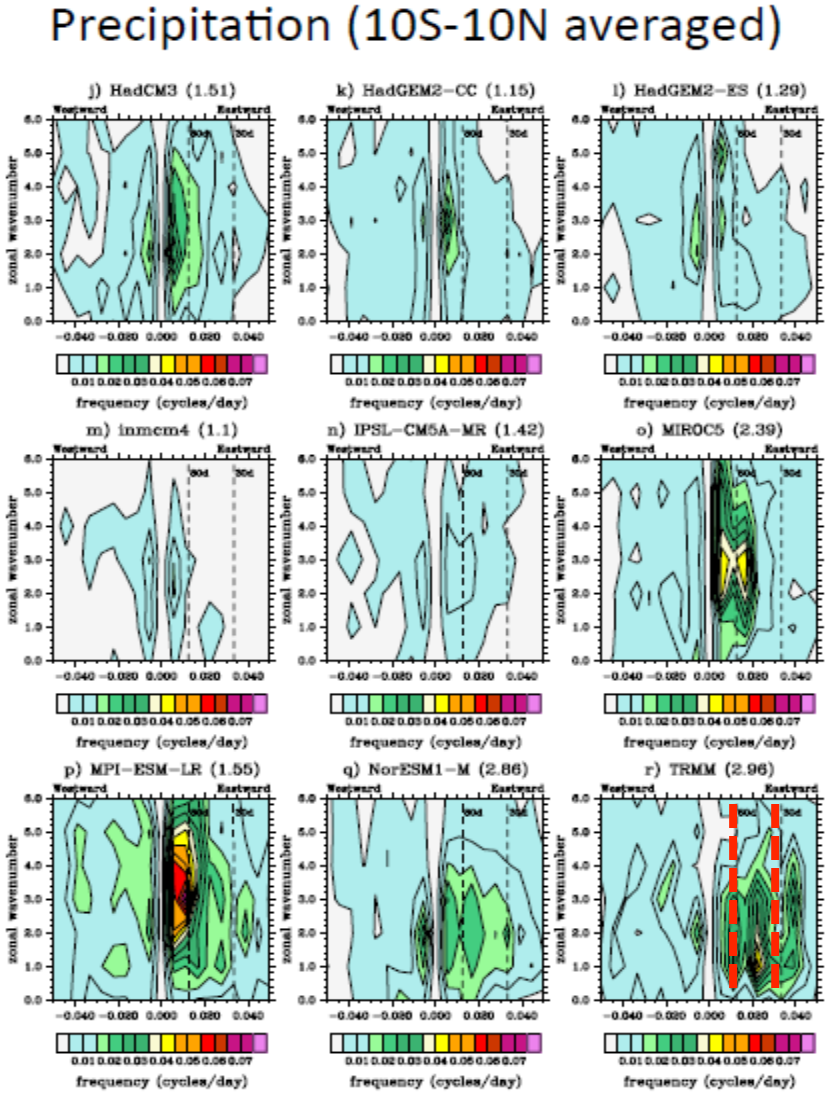
Emilia & Fabio

Khanun

MJO/BSISO/CCEW need to be better simulated

CMIP5





OBS

Scientific Issues and Questions

- **Major uncertainties on extended-range TC forecasting:**
  - **False alarms**
  - **Missing events**
  - **"Jumpy" forecasts at different lead times**
- **Questions:**
  - **What are the major factors leading to TC false alarms? And how to reduce TC false alarms in operational extended-range forecasting models?**
  - **What cause the "missing" events? How to make improvement?**
  - **What cause the "jumpiness" in extended-range TC forecasting?**
  - **What are the misrepresented model physical processes responsible for the afore-mentioned uncertainties?**
  - **Will multi-model approach significantly reduce the above uncertainties?**

THANK YOU VERY MUCH!