The New Probabilistic Global Tropics Hazard Outlook at CPC: Weeks 2 and 3

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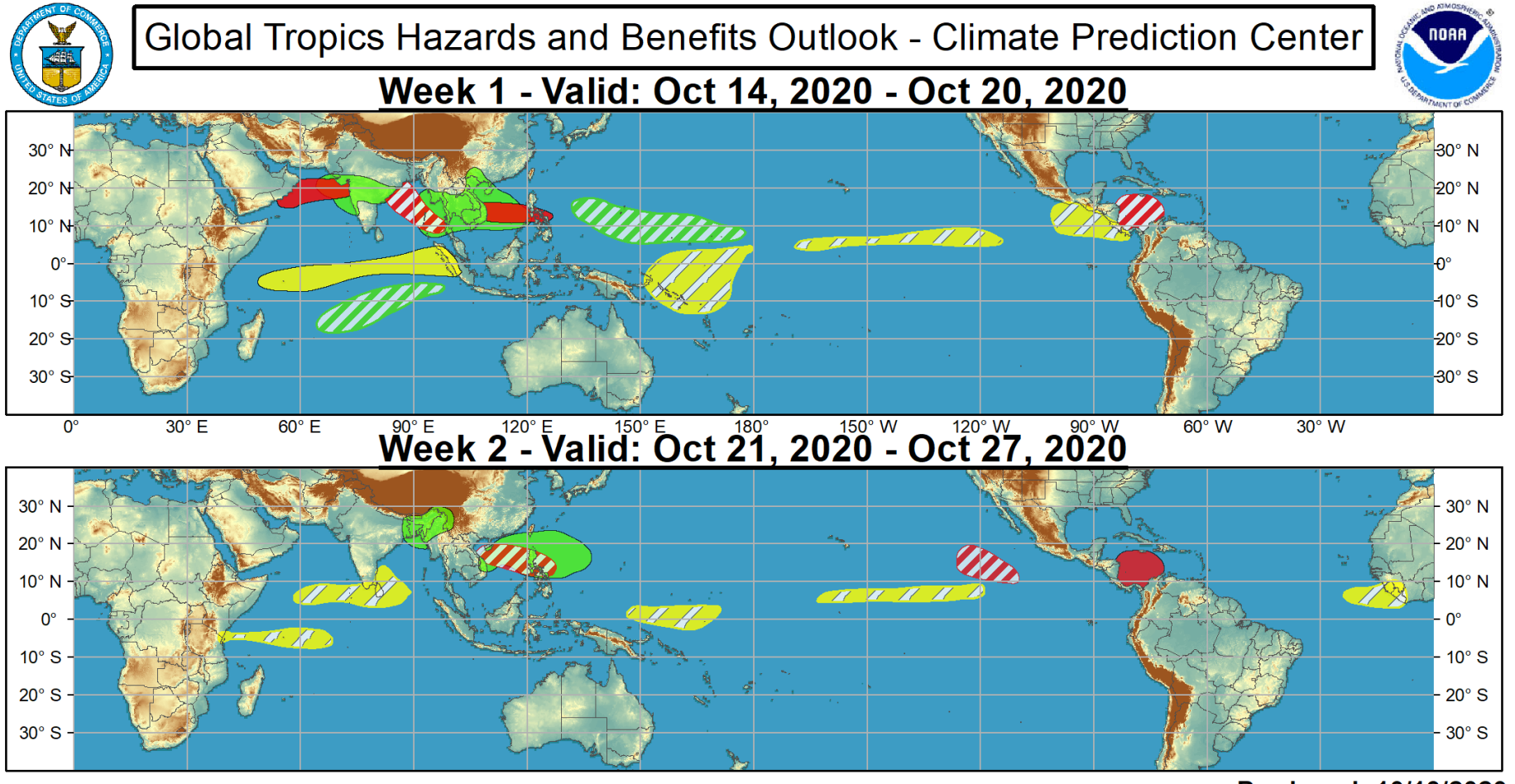
Outline

- Examples of the current and updated GTH
- Model Guidance Used
- Tropical Cyclone Tools and Skill Scores
- Precipitation Tools and Skill Scores (Nick Novella)
- Transition Timeline

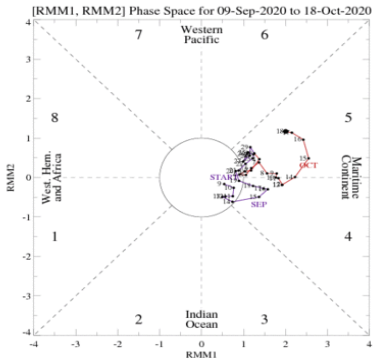
Current GTH

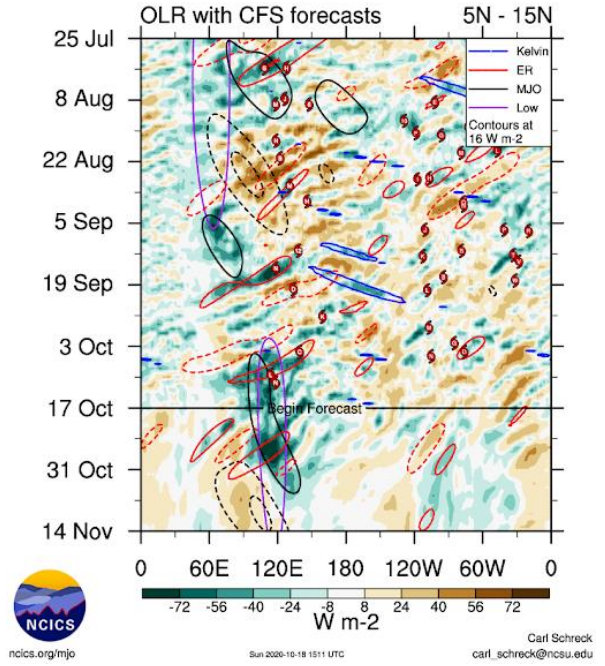
- Issued each Tuesday for Week 1 and 2
  - Includes graphic and detailed discussion, Live Briefing
  - Additional Friday update during peak NH TC season
    - 6/1 – 11/30 for 120E-0 and 0-40N
- Forecast moderate or high confidence of:
  - TS Formation
  - Above/Below Upper/Lower Tercile of Historic Rainfall
  - Above/Below Upper/Lower Tercile of Historic Temperature



Changes to the GTH Outlook

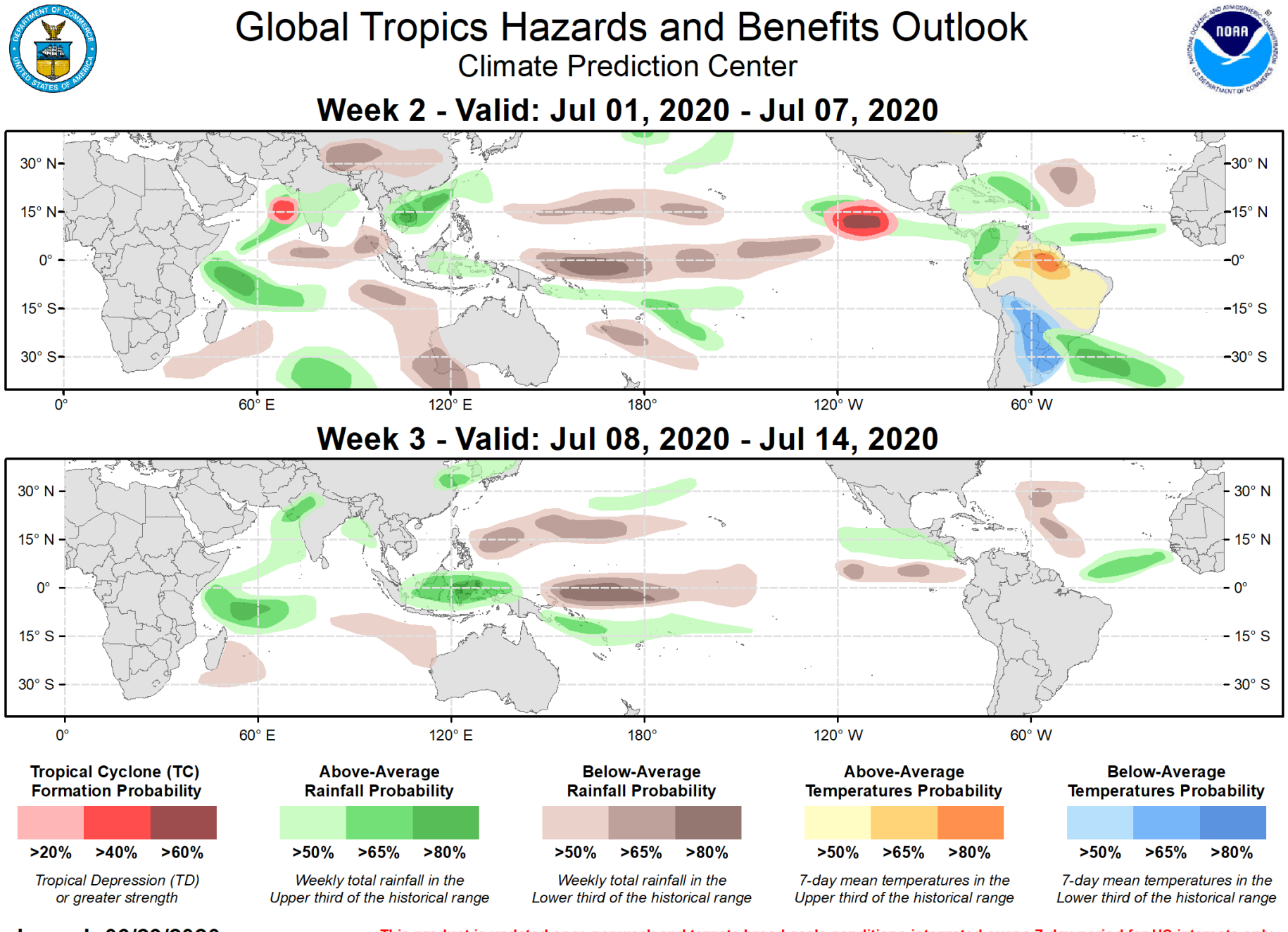
- Shifting the outlook from weeks 1-2 to weeks 2-3. Week 1 will be removed.
- Moving from Moderate/High Risk shapes to a Probabilistic Format
- With the shift out of week 1, the Friday Update will be removed
- Detailed discussion and Monday briefings will remain the same
- Forecasters will use a combination of model guidance (first guess) and tropical teleconnections (MJO, Kelvin Waves, Equatorial Waves, etc) to produce final forecasts.
  - ➢ This is not just a regurgitation of model guidance!





New GTH Template

- **EXAMPLE ONLY**
- New, cleaner look
- Three-tiered probability ranges.
- TC probabilities range from >20% to >60%.
- Precipitation and Temperature forecasts range from >50% to >80%.
- Shapes exported in .geotiff format to include as layers in GIS forecast tools.



Model Guidance

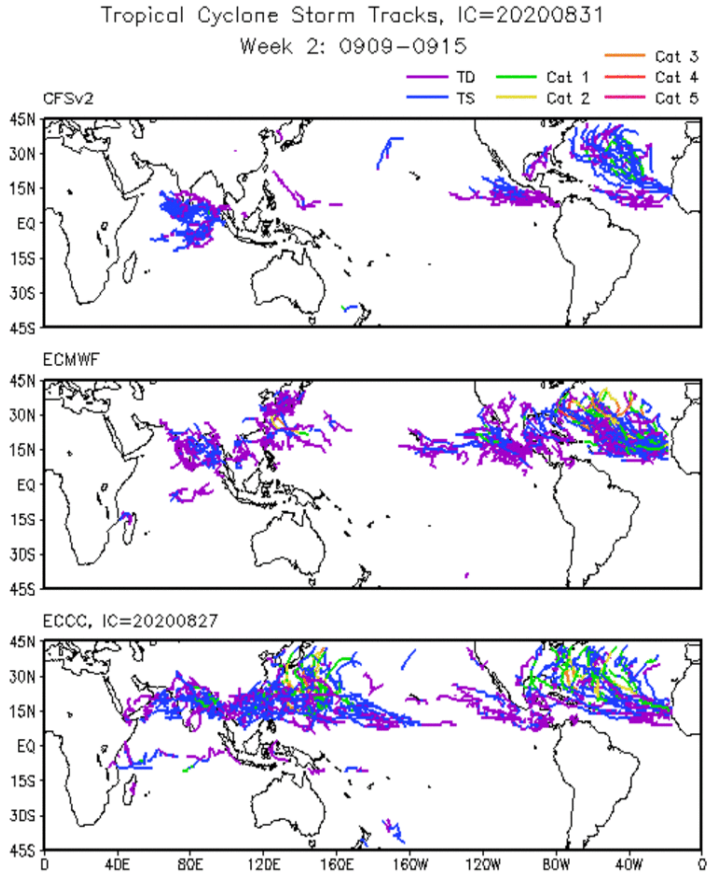
Model	Forecasts	Hindcasts	Resolutions
CFSv2	Daily 16 members	1999-2012 Daily 4 members Use 5 days prior=20 members	1ºx1º, 6-hrly
ECMWF	Mondays & Thursdays 51 members	1997-2018 Mondays & Thursdays 11 members	0.5ºx0.5º, 12-hrly
ECCC/CMC	Thursdays 20 members	1995-2014 Thursdays 4 members	0.45ºx0.45º, F: 6-hrly H: Daily
GEFSv12*	Daily 31 members	2000-2019 Daily 11 members	0.5ºx0.5º, 6-hrly

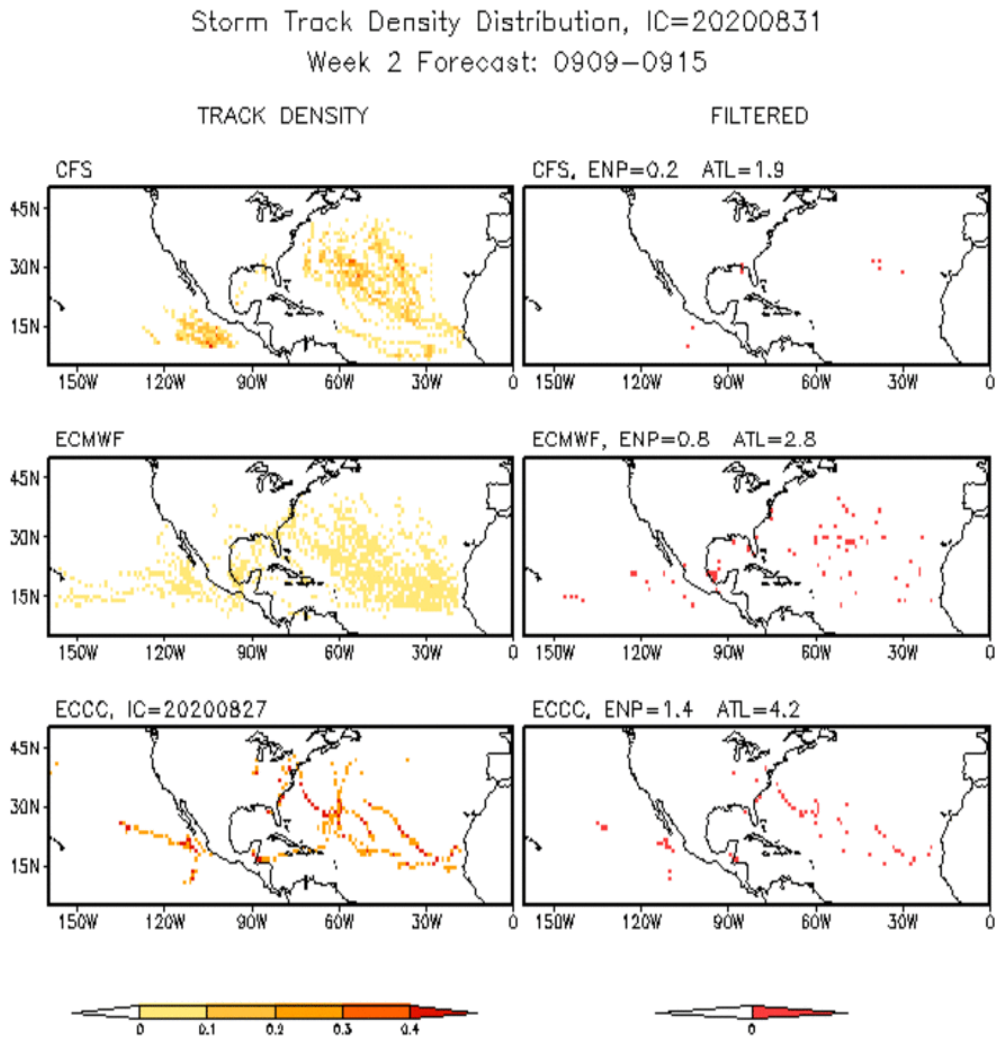
* GEFSv12 Coming Soon. Became operational on September 23rd and currently being added to product suite.

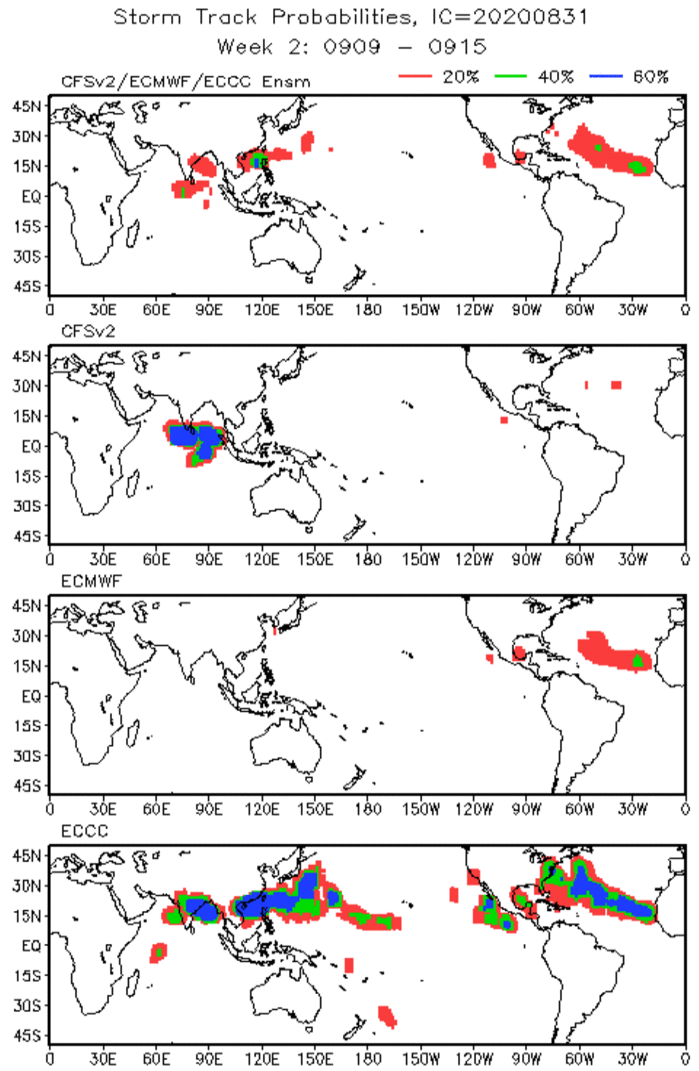
TC Detection & Tracking

- Method based on Camargo & Zebiak (2002)
  - Point must meet 7 criteria to be considered a storm
  - Tracked forward and backward in time following vorticity maxima
- Detection thresholds unique to each model based on hindcasts
- Verification
  - HURDAT and JTWC Best Track Datasets
- Tracks filtered using a False Alarm Climatology created from model hindcasts.
- Probabilities based on number of remaining storm points in a surrounding 7x7 grid box

Tropical Cyclone Tools





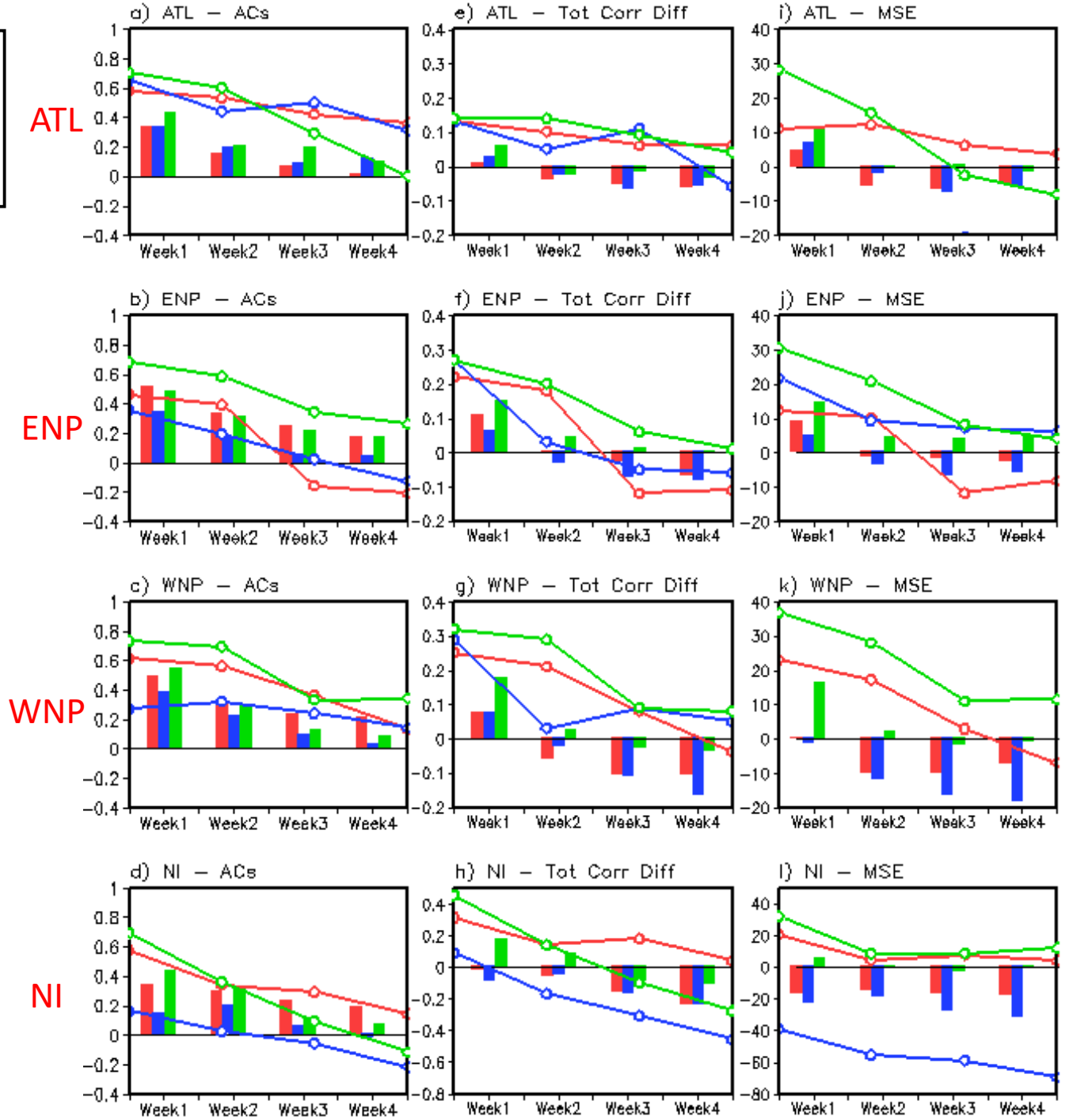


TC Skill - Count

CFSv2
ECCC
ECMWF

- Column 1: Anomaly Correlations
- Column 2: Difference in Correlations between Observation and Model (>0 beats fcst of observed)
- Column 3: Mean Square Error (MSE) Skill Scores (>0 beats fcst of obs)

- Bar Graph = Hindcast, only ECMWF shows skill in week 2/3
- Line Graph = Real-time, 2018, ECMWF and CFS show skill out to weeks 3 in most basins.



Tropical Cyclone Skill – Track Week 2

$$Hit\ Rate = \frac{a}{a+c}$$

$$False\ Alarm\ Rate = \frac{b}{b+d}$$

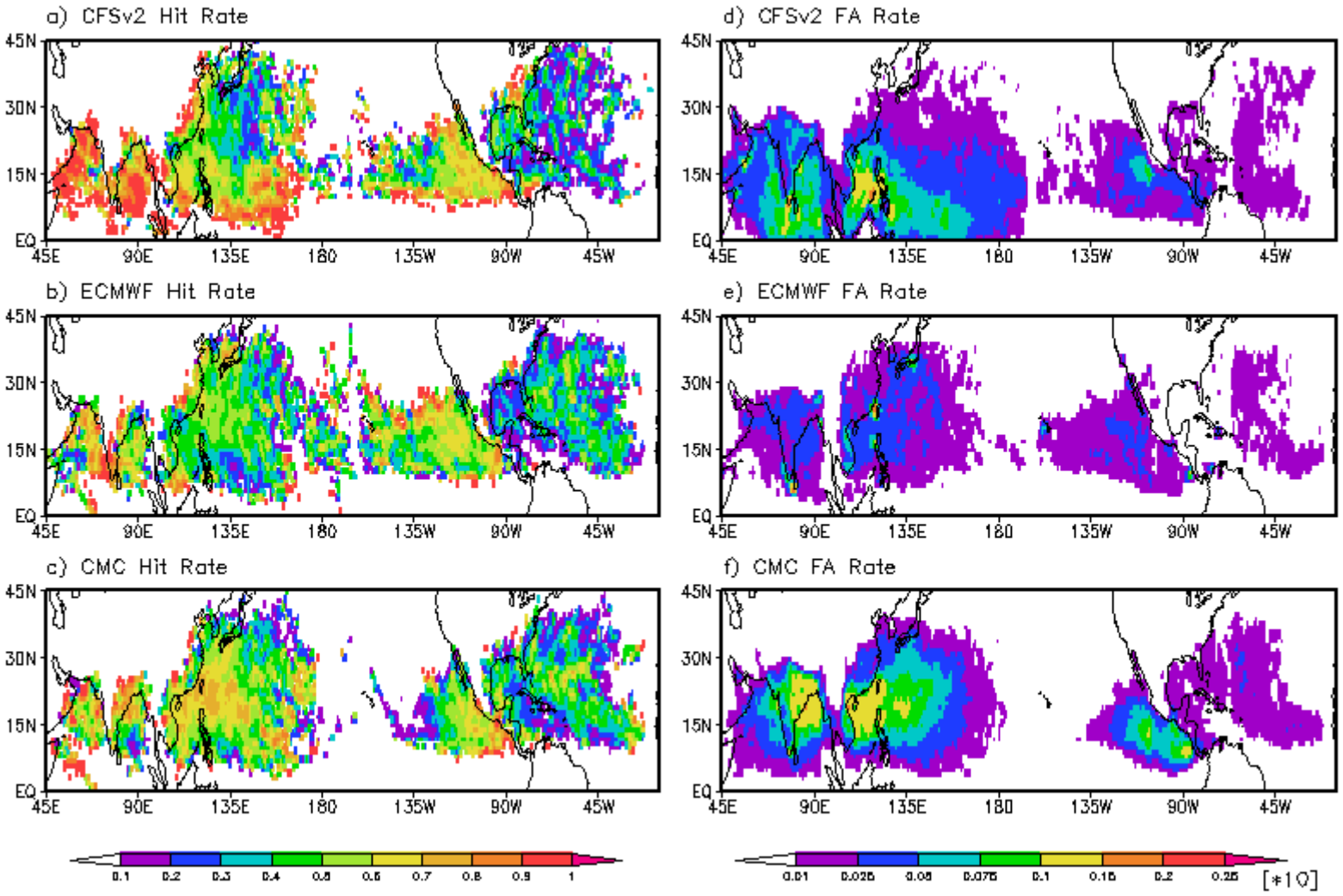
- Hit Rate and False Alarm (FA) Rate for each model hindcast.
- Based on a 2x2 contingency table:

Obs \ Model	**Yes**	**No**
Yes	"a" Hit	"c" Miss
No	"b" False Alarm	"d" Correct Null

CFS

ECMWF

ECCC



Tropical Cyclone Skill – Track Week 3

$$Hit\ Rate = \frac{a}{a+c}$$

$$False\ Alarm\ Rate = \frac{b}{b+d}$$

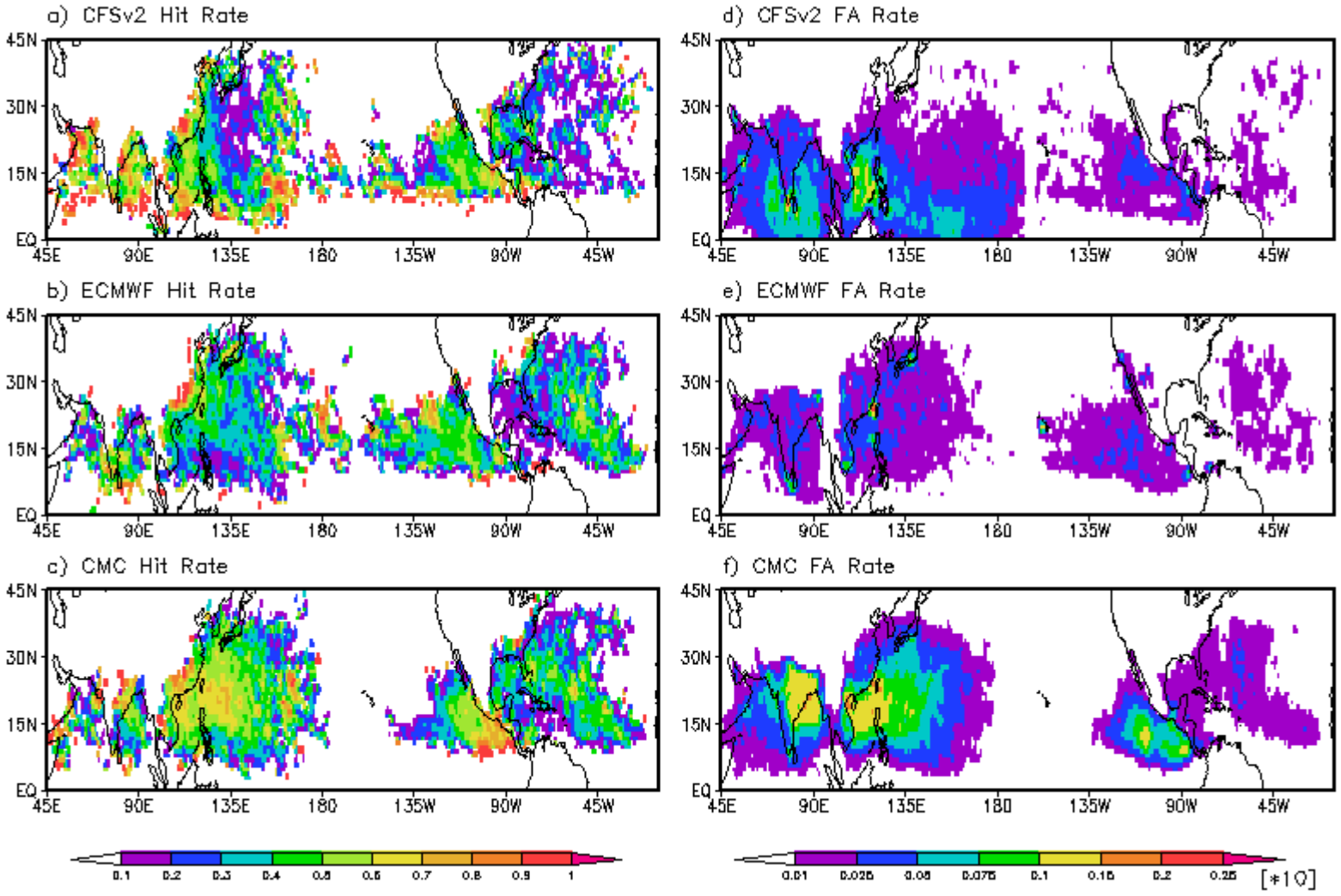
- Hit Rate and False Alarm (FA) Rate for each model hindcast.
- Based on a 2x2 contingency table:

Obs \ Model	**Yes**	**No**
Yes	"a" Hit	"c" Miss
No	"b" False Alarm	"d" Correct Null

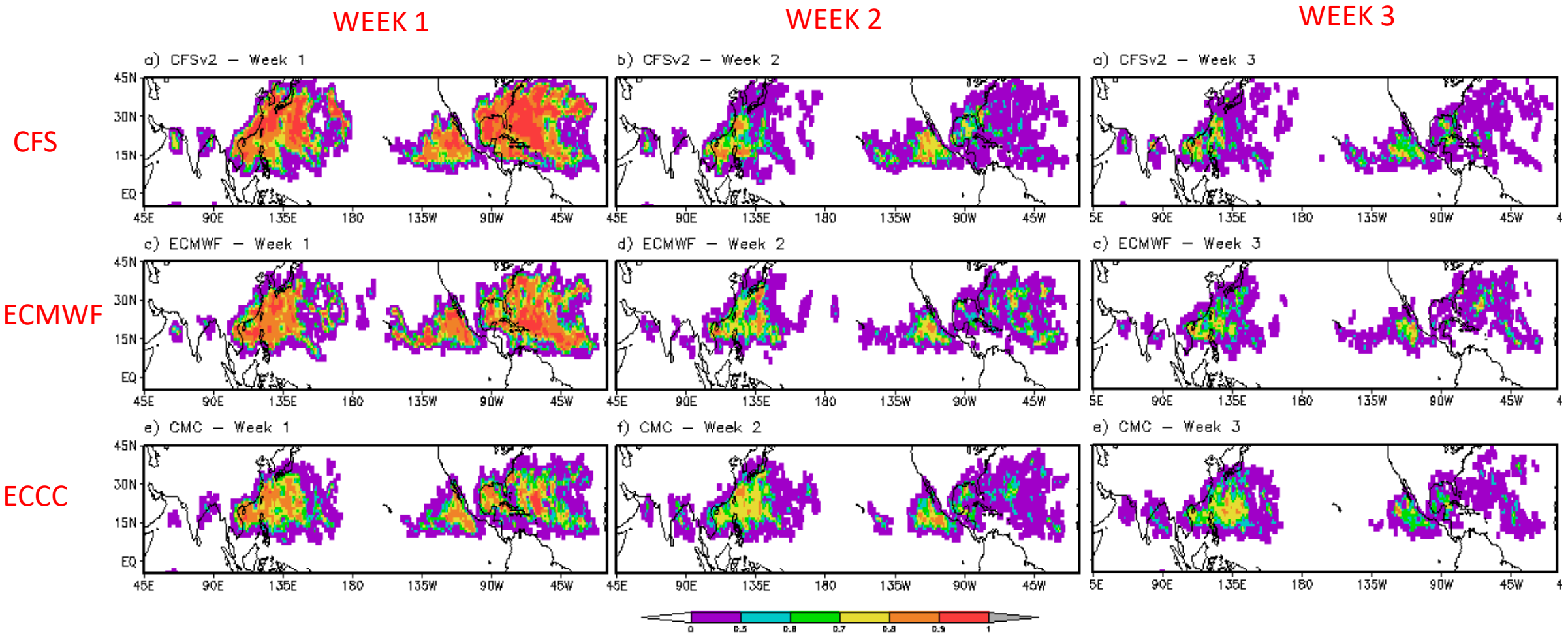
CFS

ECMWF

ECCC



Tropical Cyclone Skill – Track SEDS

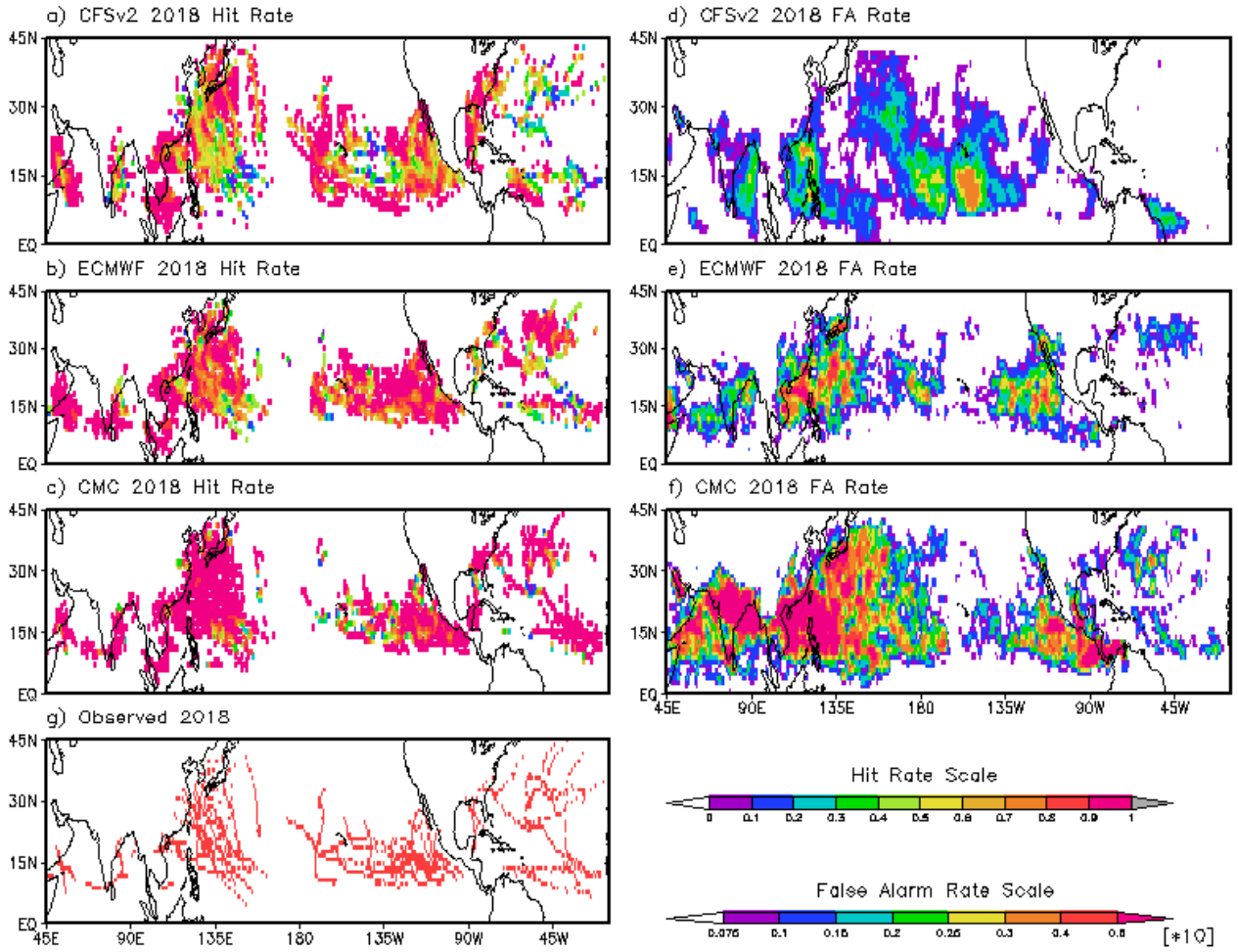


- Symmetric Extreme Dependency Score (SEDS) for September

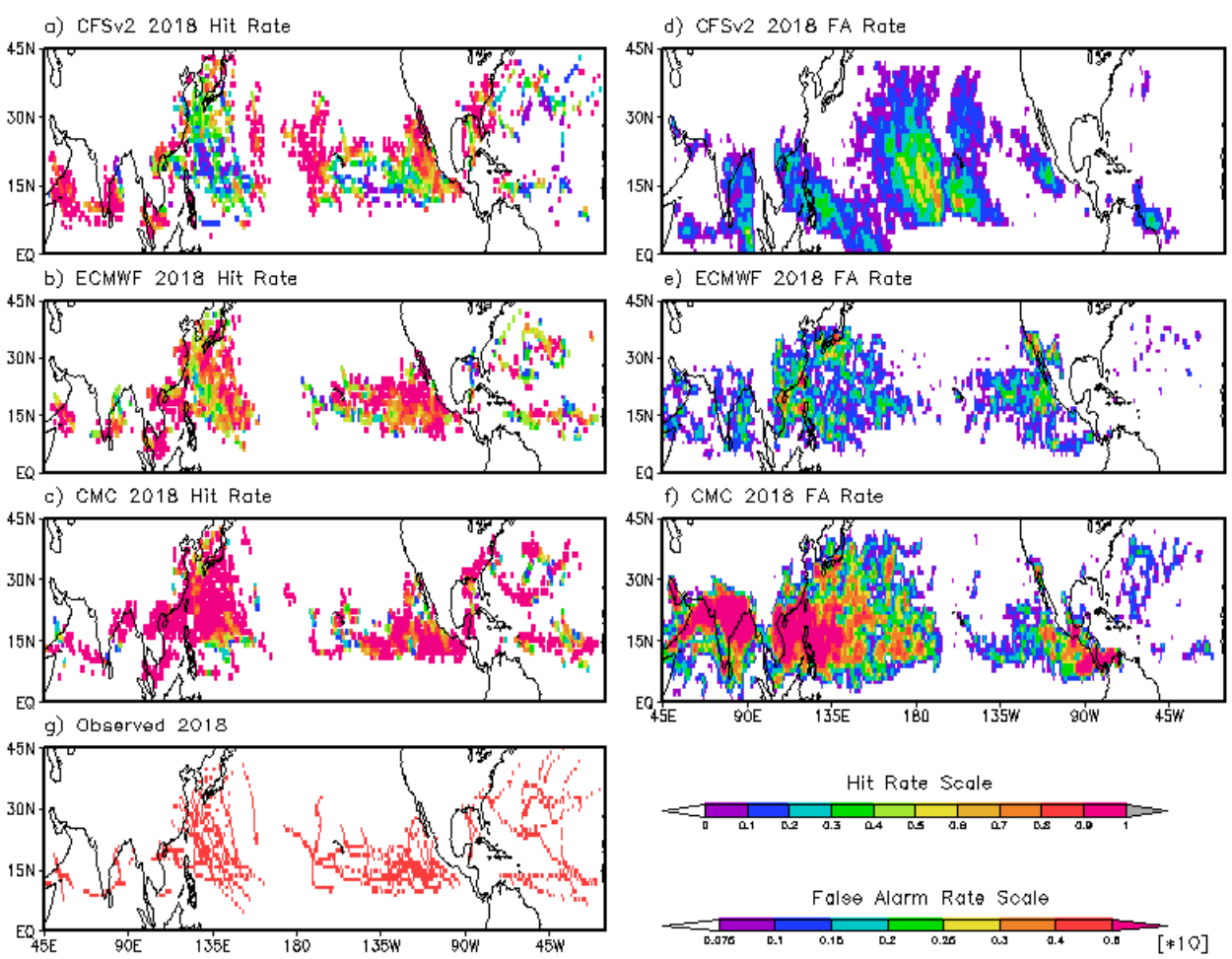
$$SEDS = \frac{\ln[(a+b)/n] + \ln[(a+c)/n]}{ln\,[a/n]} - 1$$

Tropical Cyclone – Real Time 2018 Rates

WEEK 2



WEEK 3

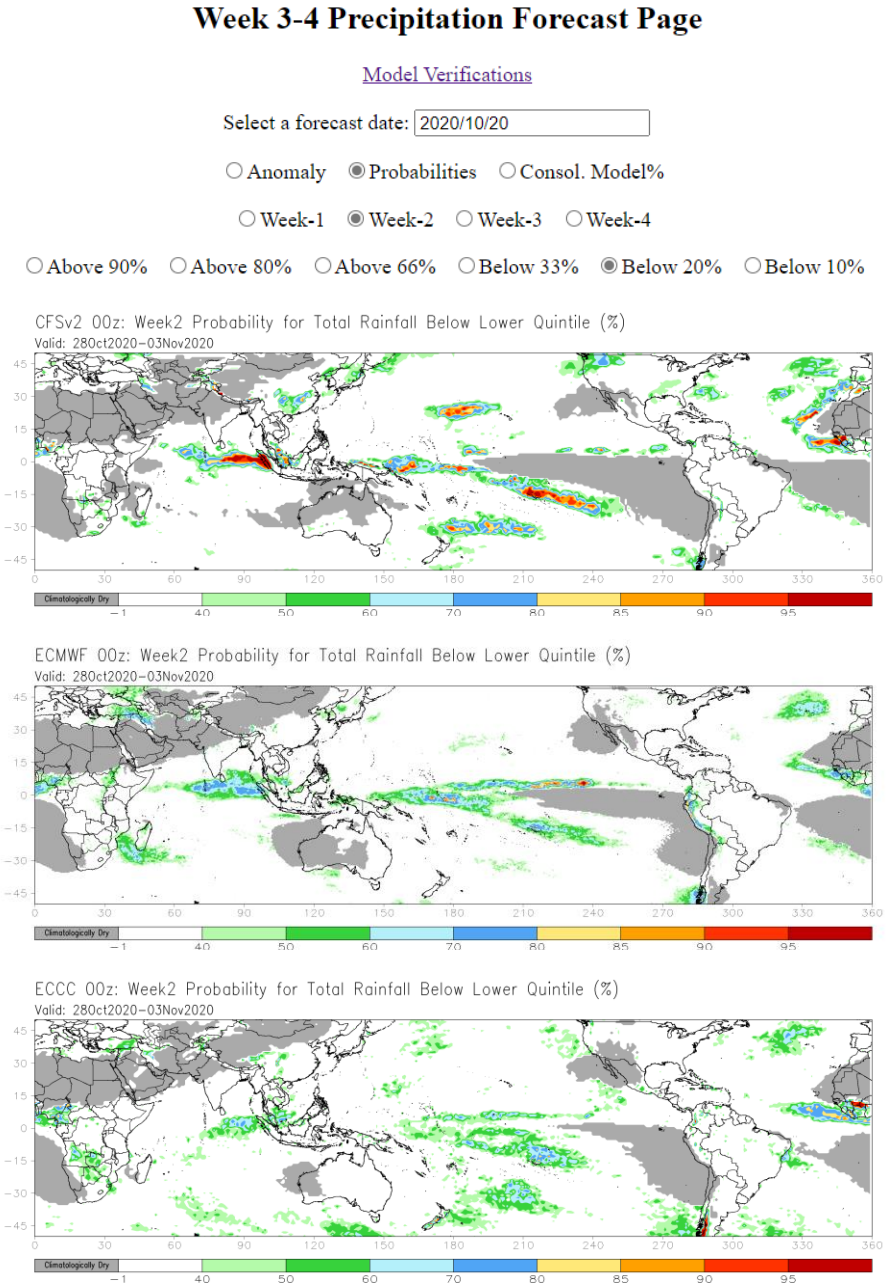


Precipitation Tool Overview

- Real-time, bias-corrected probabilistic maps of CFSv2, ECMWF, and ECCC precipitation and a historical correlation weight based consolidation (CONS) produced for weeks1-4.

- Probabilities are based on model real-time forecasts exceeding various percentile thresholds calculated from model hindcasts.
  - Thresholds: Upper/lower deciles (90/10), quintiles (80/20), and **terciles (66/33).**
  - Higher variances in climatological distribution of rainfall achieved by combining # of years and # of ensemble members from hindcast to increase total # of forecasts.

- Can identify regions where potentially impactful enhanced/suppressed precipitation are favored by the models.
  - Dry masking (grey) where precip <5mm for period. Allows focus on climatologically active areas for hazards, while omitting extreme values that can occur over arid regions.

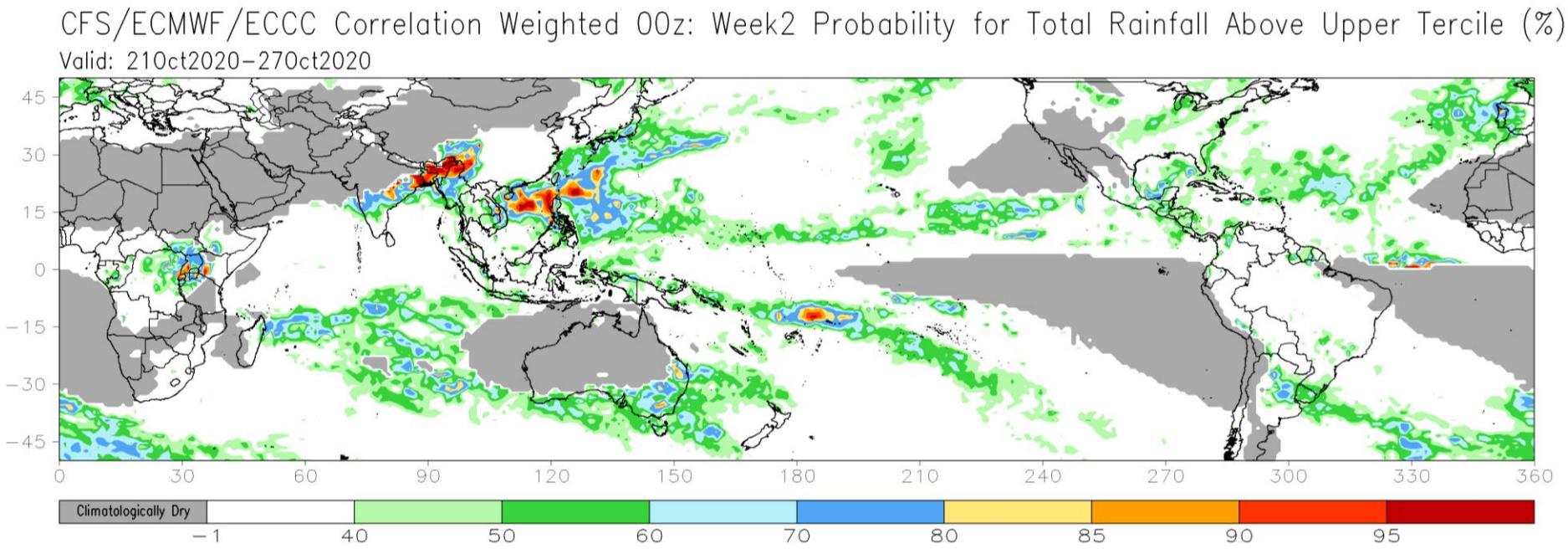


Courtesy of Nick Novella

Consolidated (CONS) Method

- Computes the spatial correlations between model reforecasts and historically observed precipitation (CMORPH). Anticipated to serve as first-guess for new GTH.
- Correlations applied as skill based weights in the model probability average.
  - Grants higher (lower) weights in models shown to historically perform well (poor) over various regions.
  - Used as weights for blending model probabilities of exceedance (and anomalies) via:

$$\frac{[\ (prob\_cfs * corr\_cfs^2) + (prob\_ecmwf * corr\_ecmwf^2) + (prob\_eccc * corr\_eccc^2)\ ]}{[\ corr\_cfs^2 + corr\_ecmwf^2 + corr\_eccc^2\ ]}$$



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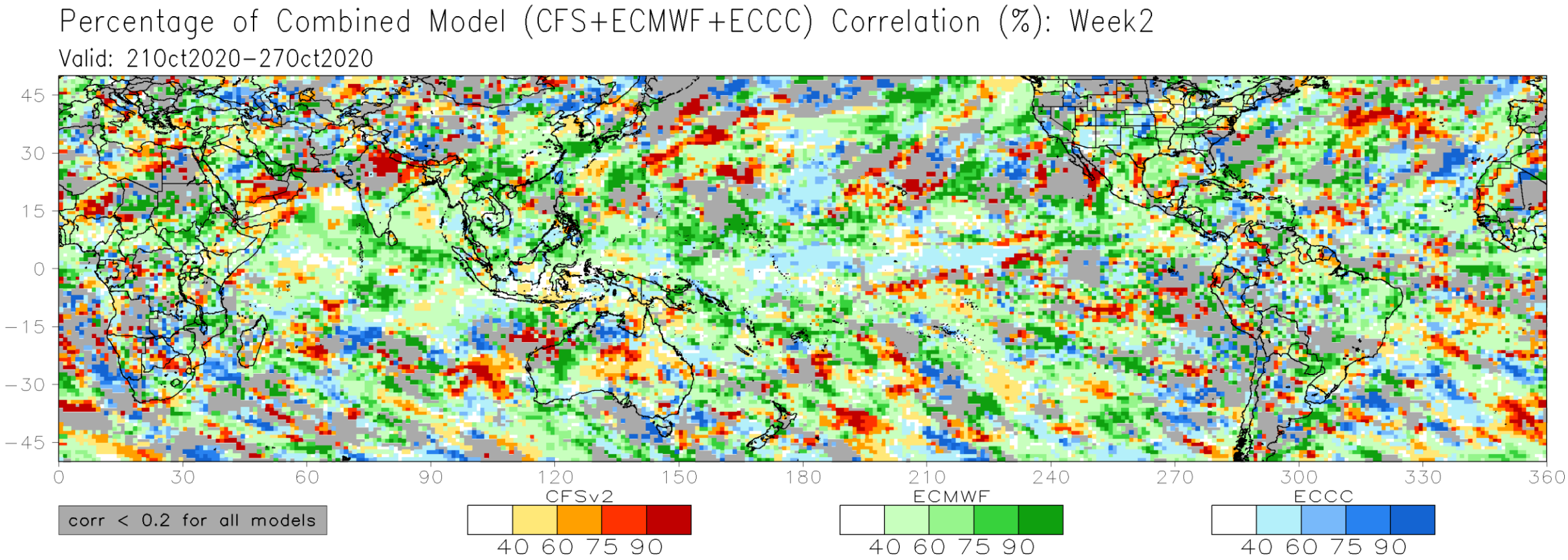
Consolidated (CONS) Method

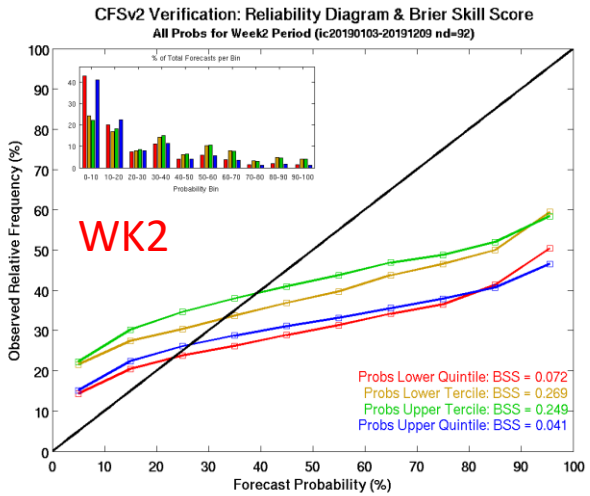


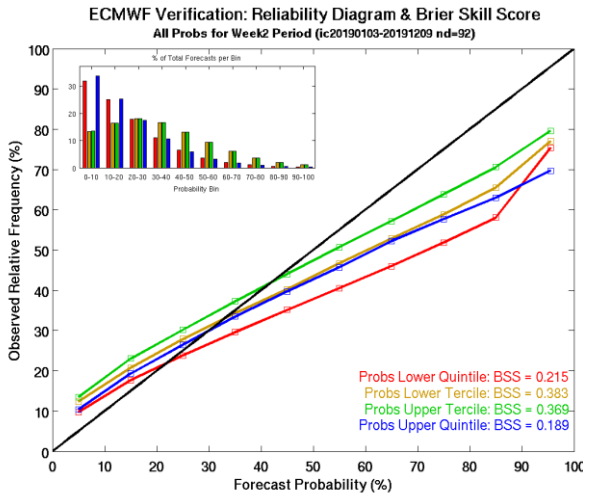
- In addition, a percentage of combined correlation analysis is regularly produced to illustrate which model contributes most/less towards the consolidated blend (answer=Euro).

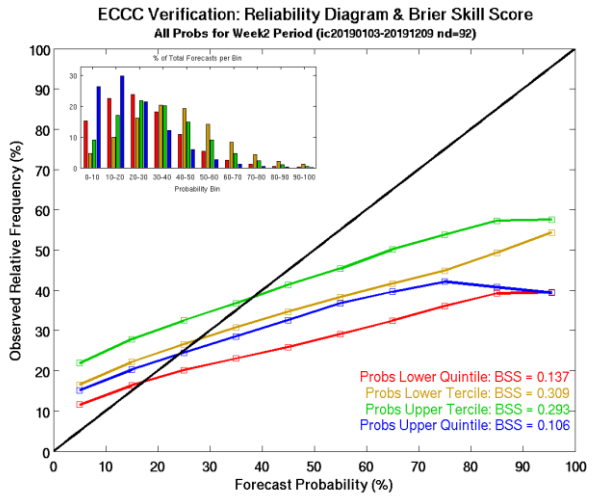
Courtesy of Nick Novella

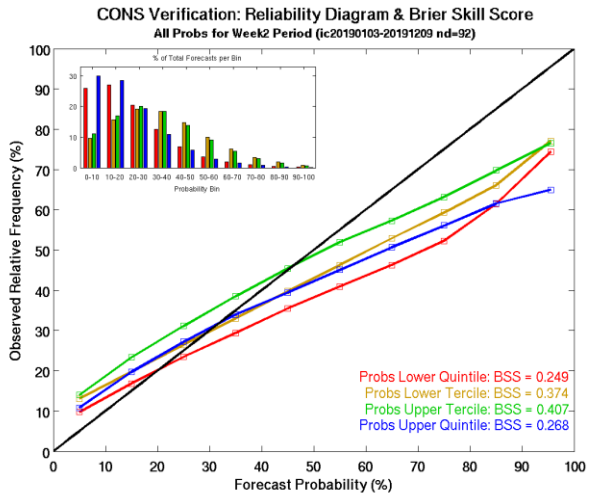
Precipitation Verification – 2019 Reliability Diagrams

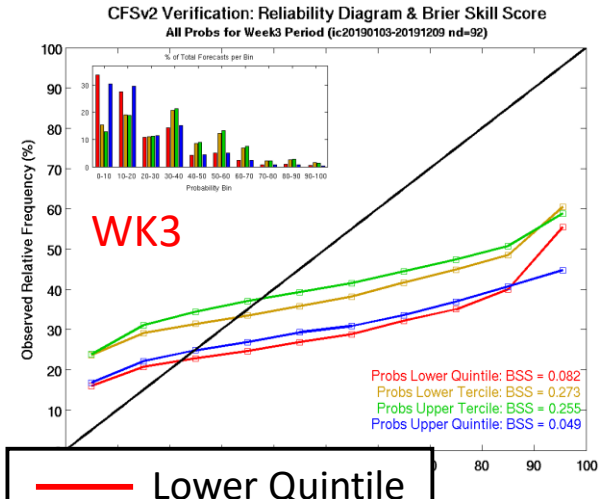
CFS | ECMWF | ECCC | CONS

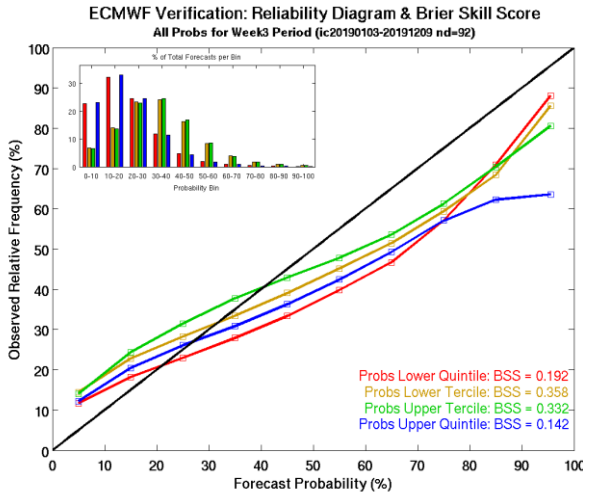


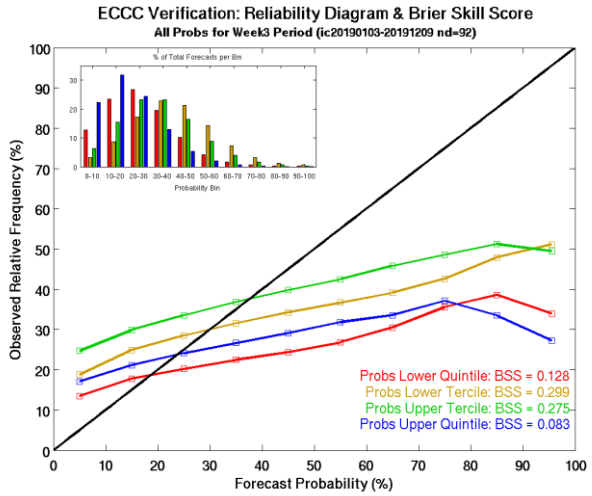


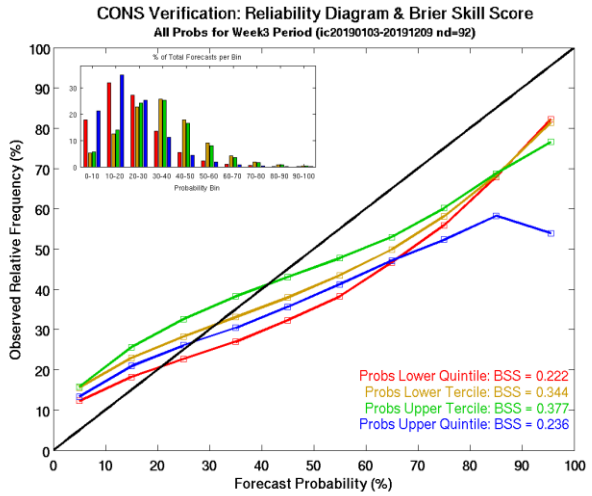










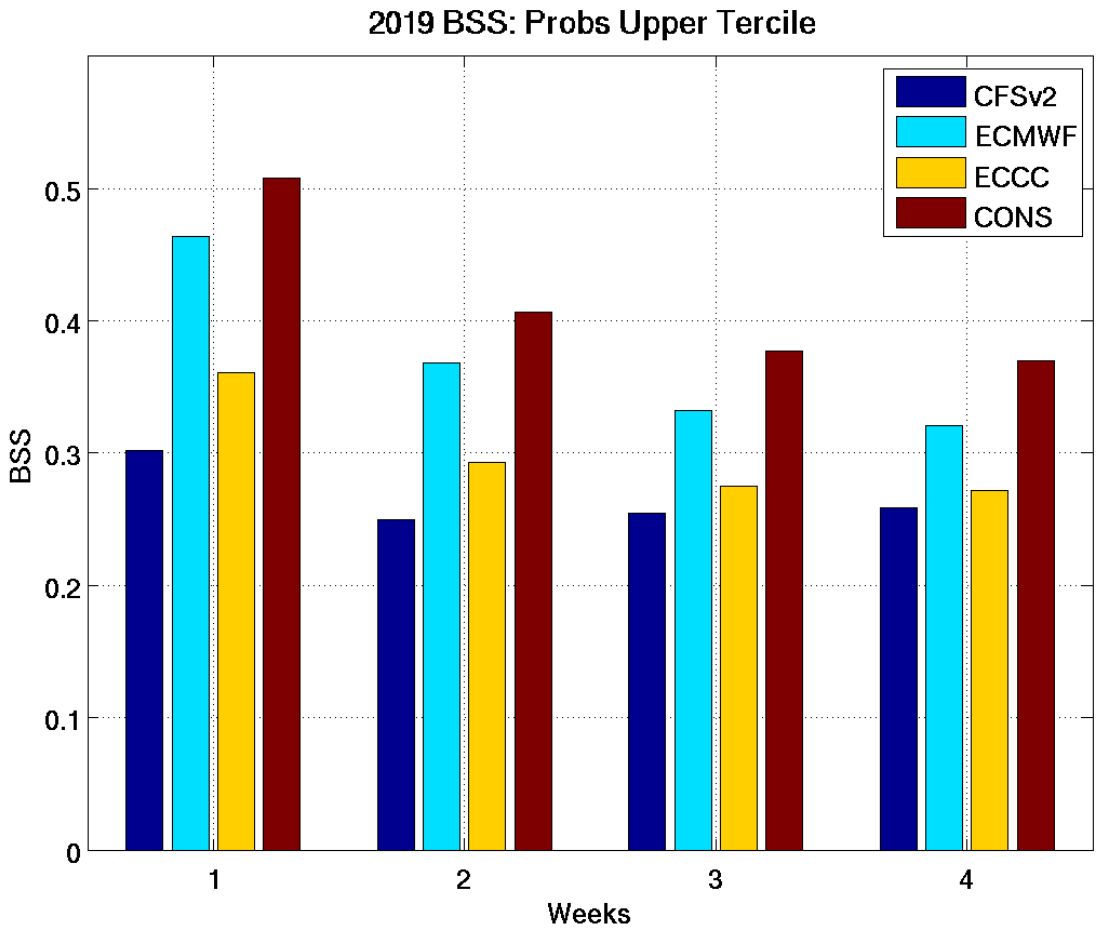


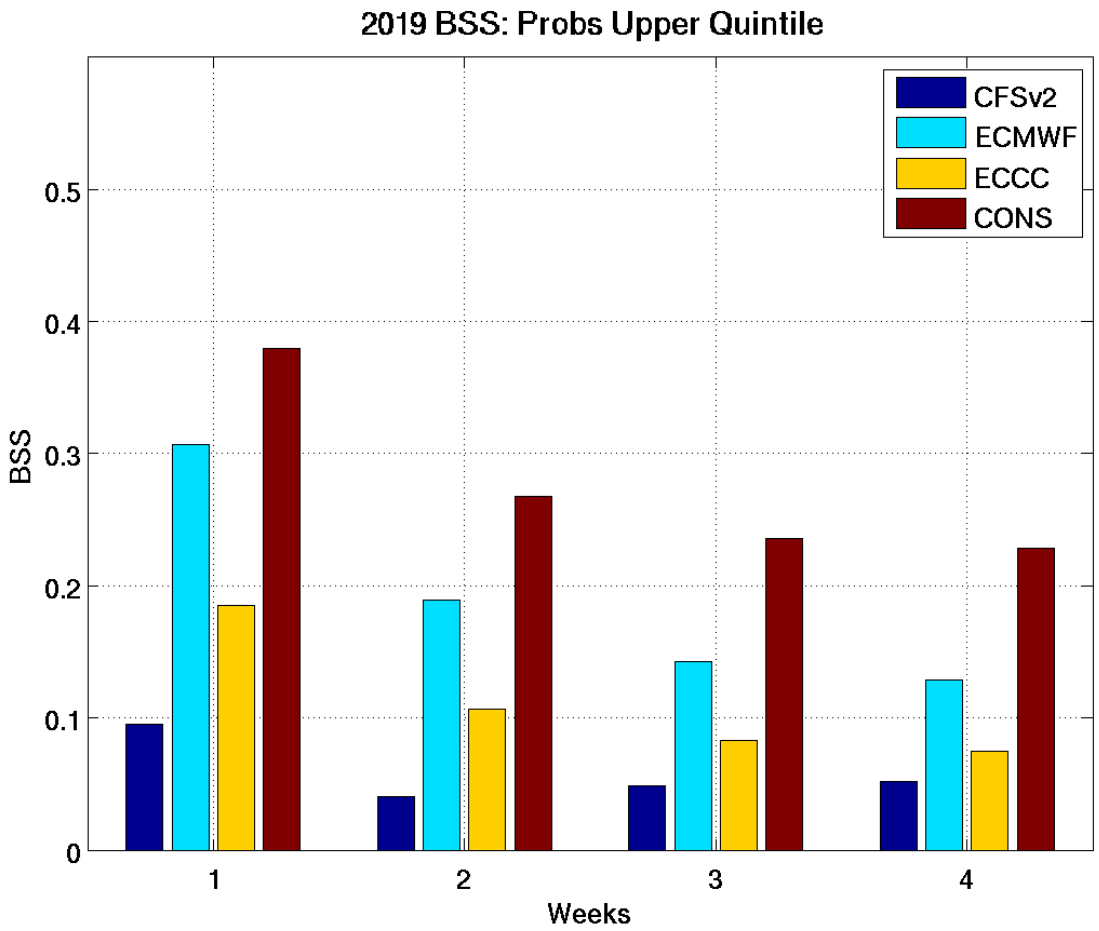
- Lower Quintile
- Lower Tercile
- Upper Quintile
- Upper Tercile

Models over-forecast probabilities of 30% chance and higher.
ECMWF has a much better reliability than CFS and ECCC.

Courtesy of Nick Novella

Precipitation Verification Summary





Brier Skill Score (BSS) for Weeks 1-4 upper tercile and quintile probability forecasts for 2019. ECMWF shows highest scores, but CONS shows other models do add value.

Courtesy of Nick Novella

Transition Status and Next Steps

- Proposed transition of the GTH to the new probabilistic format targeting the Week 2-3 outlook period in FY20 was delayed for a few reasons:

  ✓Onset of COVID-19 health crisis and the transition to 100% remote forecast operations. Initially determined to wait until more normal conditions returned.

  ✓Rapid development of short staffing during FY20 Q3 – FY20 Q4

  ✓Wanted to address comments and issues raised by the Climate and Tropical SPT's regarding the proposed changes in organized manner

  ✓Best not to introduce the change during the Atlantic and East Pacific Hurricane Season

Courtesy of Jon Gottschalck

Transition Status and Next Steps

(1) Complete preparation of materials to address comments and potential issues raised by the Climate and Tropical SPTs (~ November 27, 2020)

(2) Provide SPT response materials to NWS HQ Climate and Tropical Program Leads for distribution to SPT members for review (~ December 4, 2020)

(3) Based on and depending on SPT feedback, modify Standard Operating Procedure (SOP) information to outline collaboration and coordination regarding the proposed outlook with NHC, CPHC, JTWC, other NWS regions (~ December 18, 2020)

(4) Determine remaining needs before setting a proposed initial release date (TBD) for the Week 2-3 GTH product (~ January 15, 2021)

Courtesy of Jon Gottschalck