WGNE Precipitation verification

Thanks to NCEP, JMA, ECMWF, RHMC, CPTEC, MF

Pan-WCRP Modelling Groups Meeting - WGNE32

UK Met Office, Exeter, United Kingdom, 9-13 October 2017

Outline

Contributions from :

1) NCEP
2) JMA
3) ECMWF
4) RHMC
5) CPTEC
6) Météo-France

NCEP

Contact person : Ying Lin
Ying.Lin@noaa.gov

QPF Verification at NCEP for Deterministic NCEP and International Models

- International models verified over ConUS: CMC (global and regional), DWD, ECMWF, JMA, METFR, UKMO. Mostly 24h verification only (contingency table-based scores; SL1L2 scores), plan to include more in 6h FSS verif (now have 6h QPF from CMC and JMA)
- Verified against CCPA (climate-calibrated radar+gauges analysis, 5km, 3/6/24h).
- Verifying grids: 80km/40km, for int'l models and most NCEP models (80km stats shown here). Some NCEP models also verified on 12km grid. Model QPF and verifying analysis are mapped to a common verifying grid before computation of scores.
- Contingency table-based scores including FB, POD, FAR, POFD, TS, ETS, HK, HSS, EDI, SEDS, SEDI and many others
- 24h and 6h fractions skill scores over ConUS

Future Plans

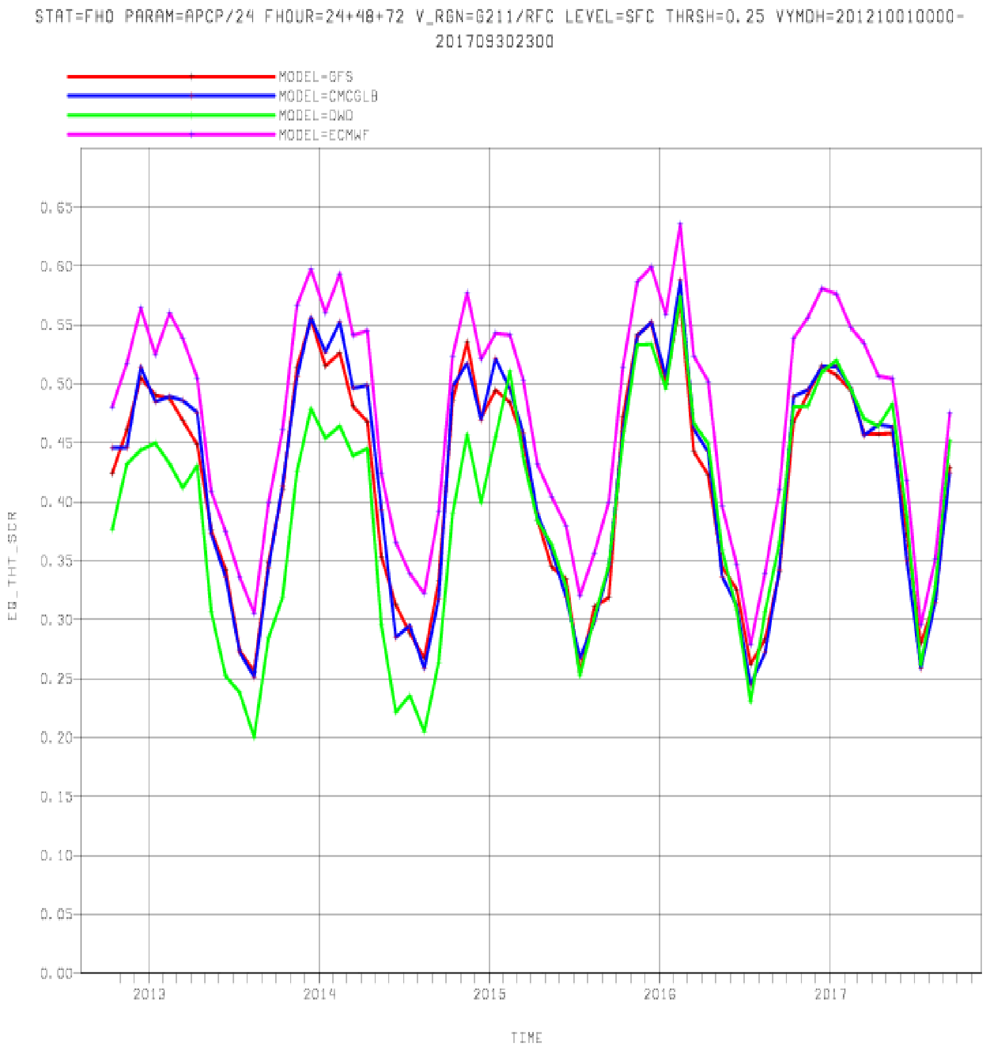
- Transition to MET+ based verification (https://www.dtcenter.org/met/users/)
- Add verification to nearest gauge locations; SEEPS
- Include more 6h verification for international models as their QPFs become available

Time series of monthly ETS/EDI scores for the past five years

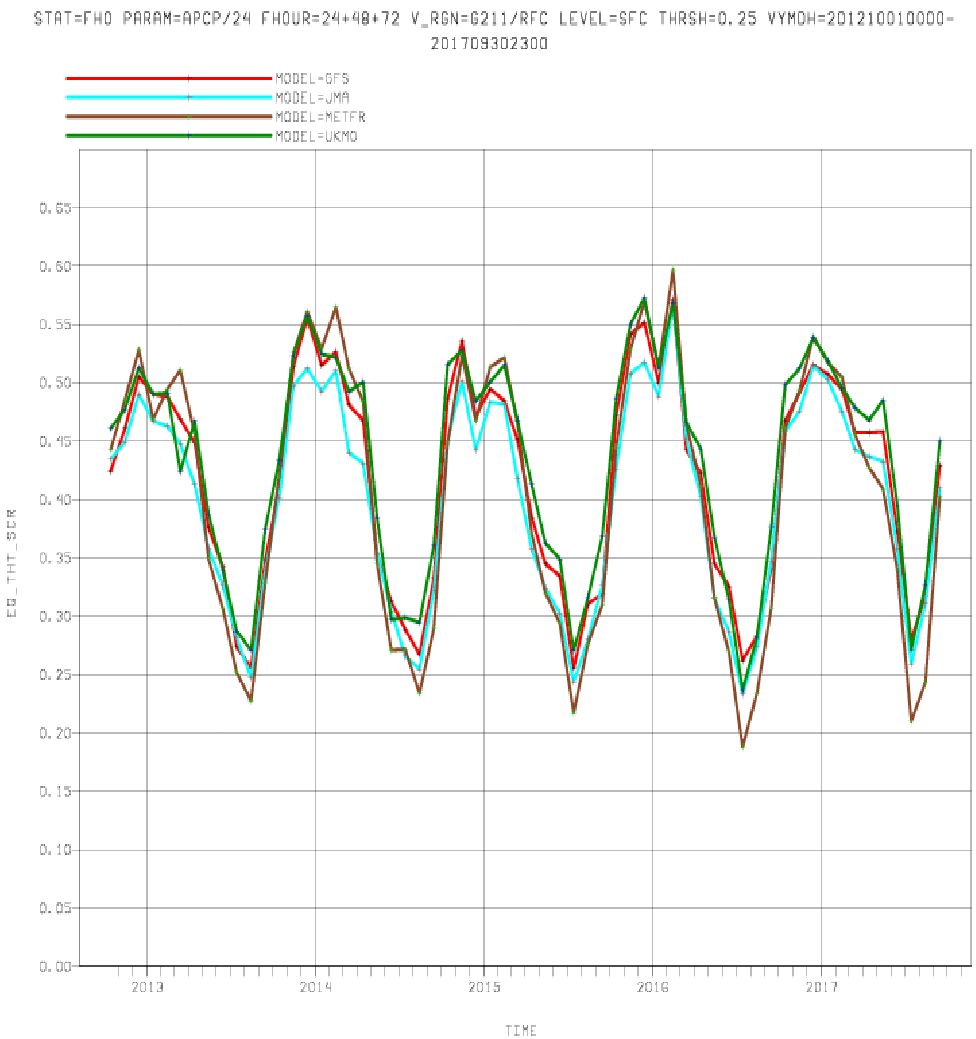
- 7 global models (separate out into two groups for easier viewing), 1/2/3-day lead time
- 4 N. Amer. models (GFS and CMCGLB are global), NAM and CMC are regional, 1&2-day lead time (CMC range is 48h)

Monthly ETS of global models, 1/2/3-day fcsts, Oct 2012-Sept 2017, 6.35mm/day threshold

GFS/CMCGLB/DWD/ECMWF

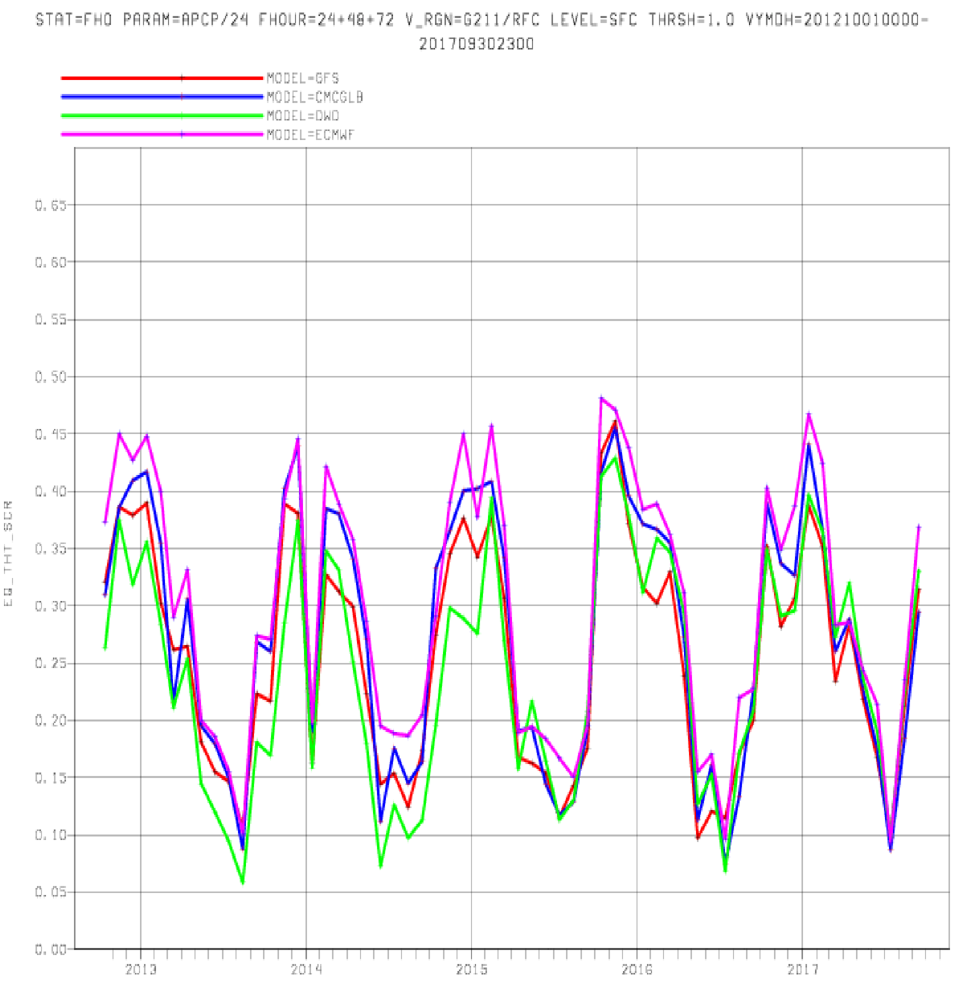


GFS/JMA/METFR/UKMO

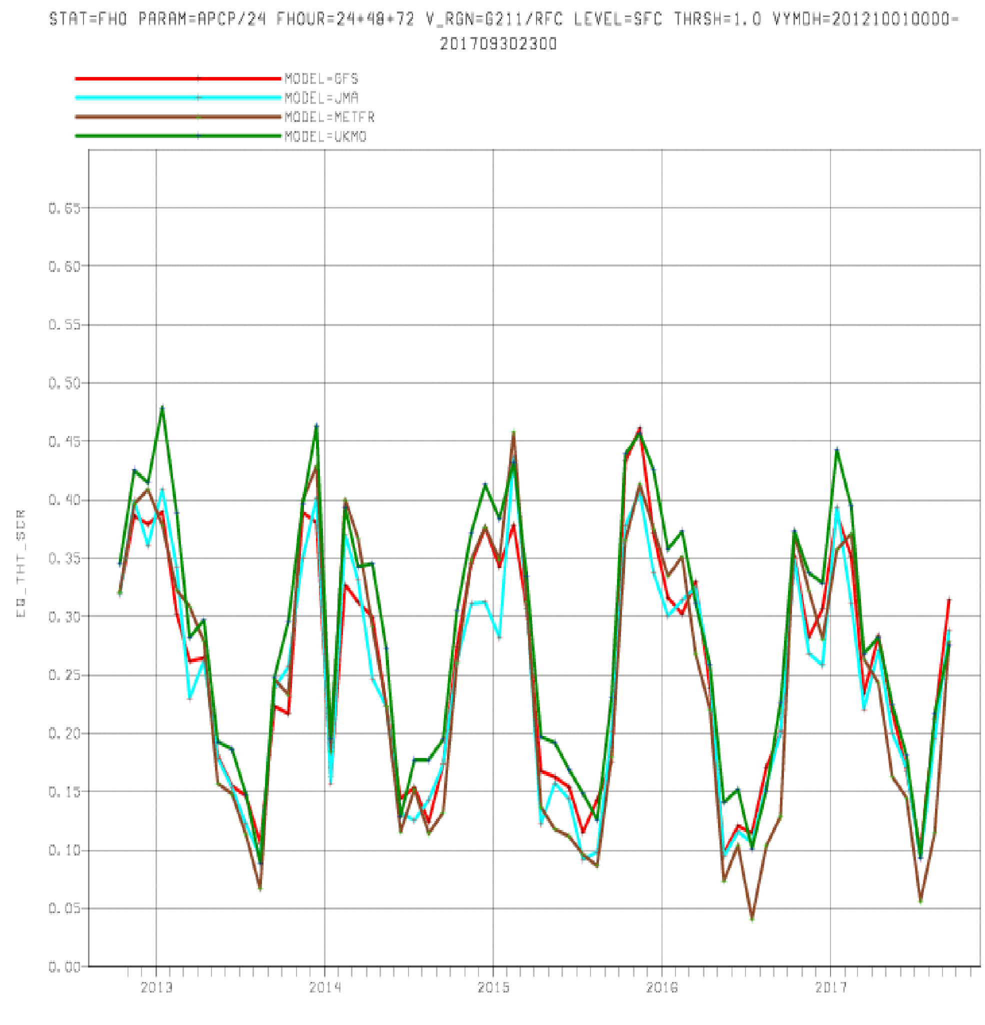


Monthly ETS of global models, 1/2/3-day fcsts, Oct 2012-Sept 2017, 25.4 mm/day threshold

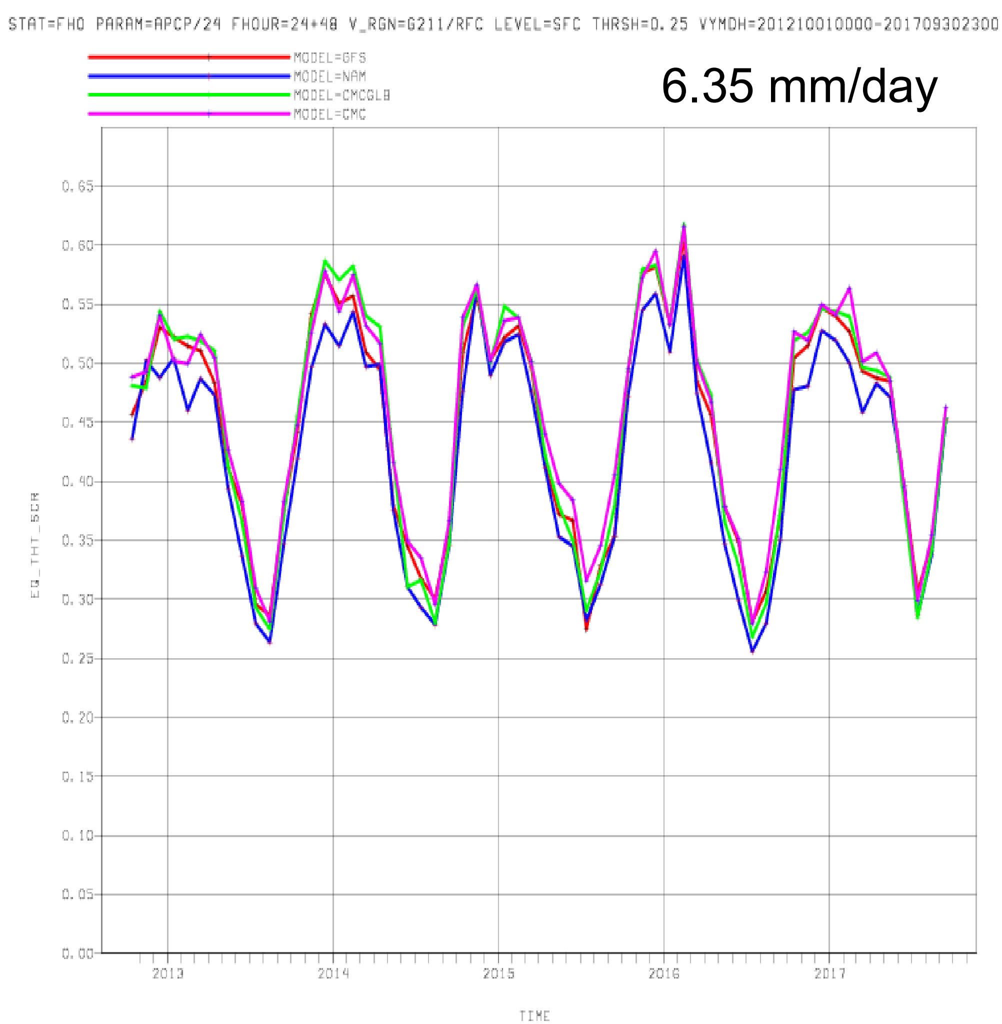
GFS/CMCGLB/DWD/ECMWF

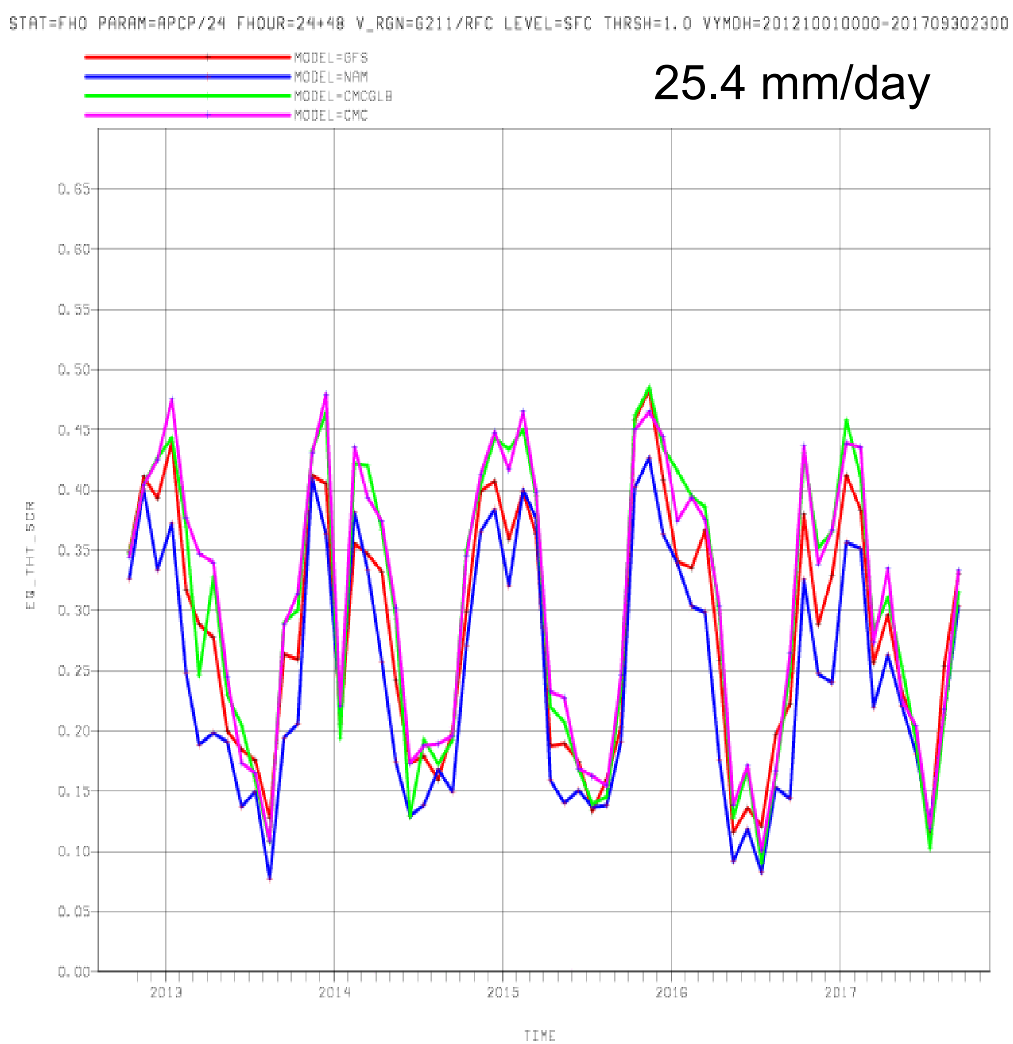


GFS/JMA/METFR/UKMO



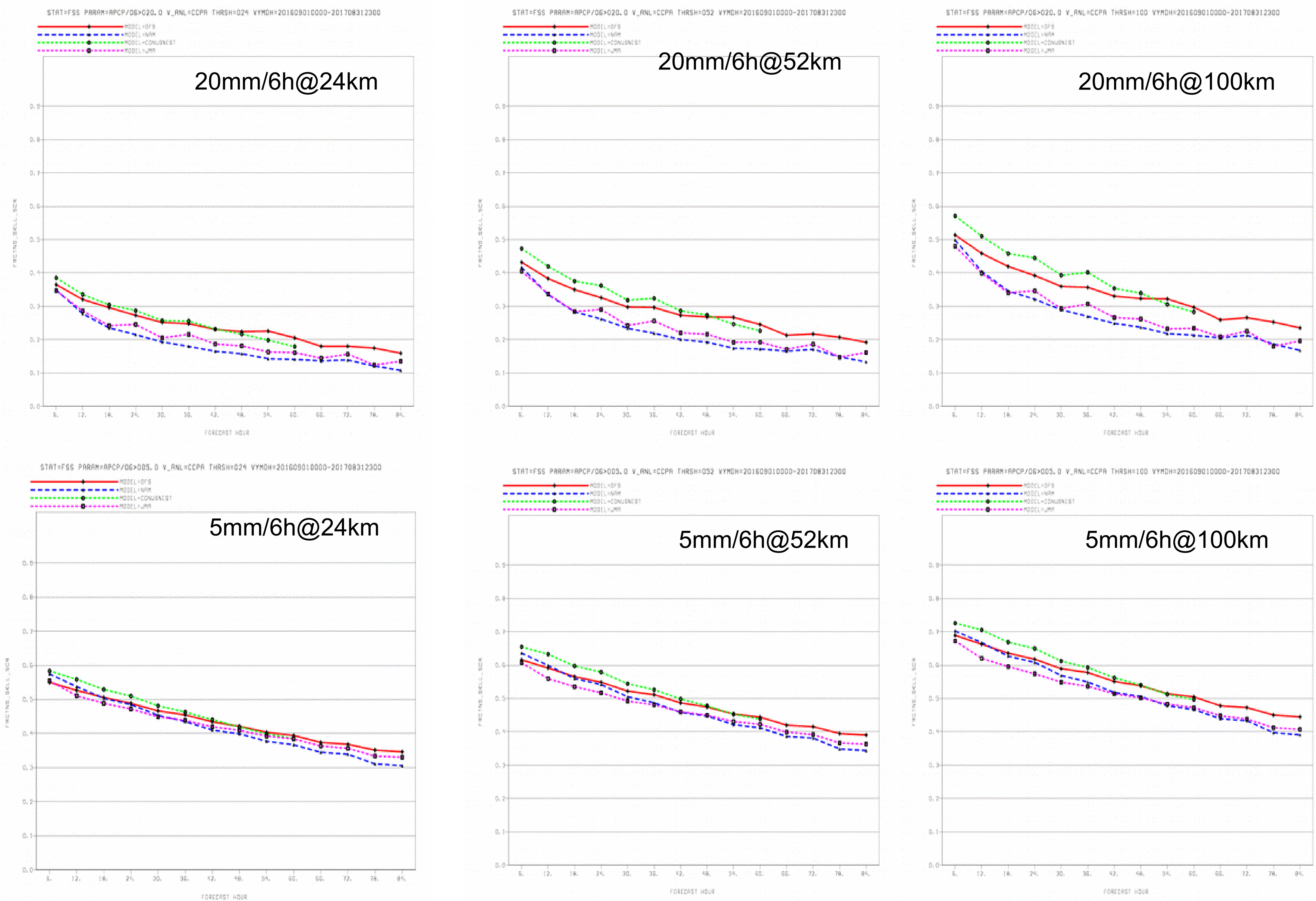
Monthly ETS of N. Amer models,1&2-day fcsts, Oct 2012-Sep 2017, GFS/NAM/CMCGLB/CMC(regional)





Example of 6h fractions skill scores:
Sep 2016 - Aug 2017 FSS06h *vs.* forecast lead time, for
3 NCEP models and JMA model

6h FSS *vs.* lead time, Sep 2016-Aug 2017, GFS/NAM/CONUSNEST/JMA



Seasonal ETS and EDI scores

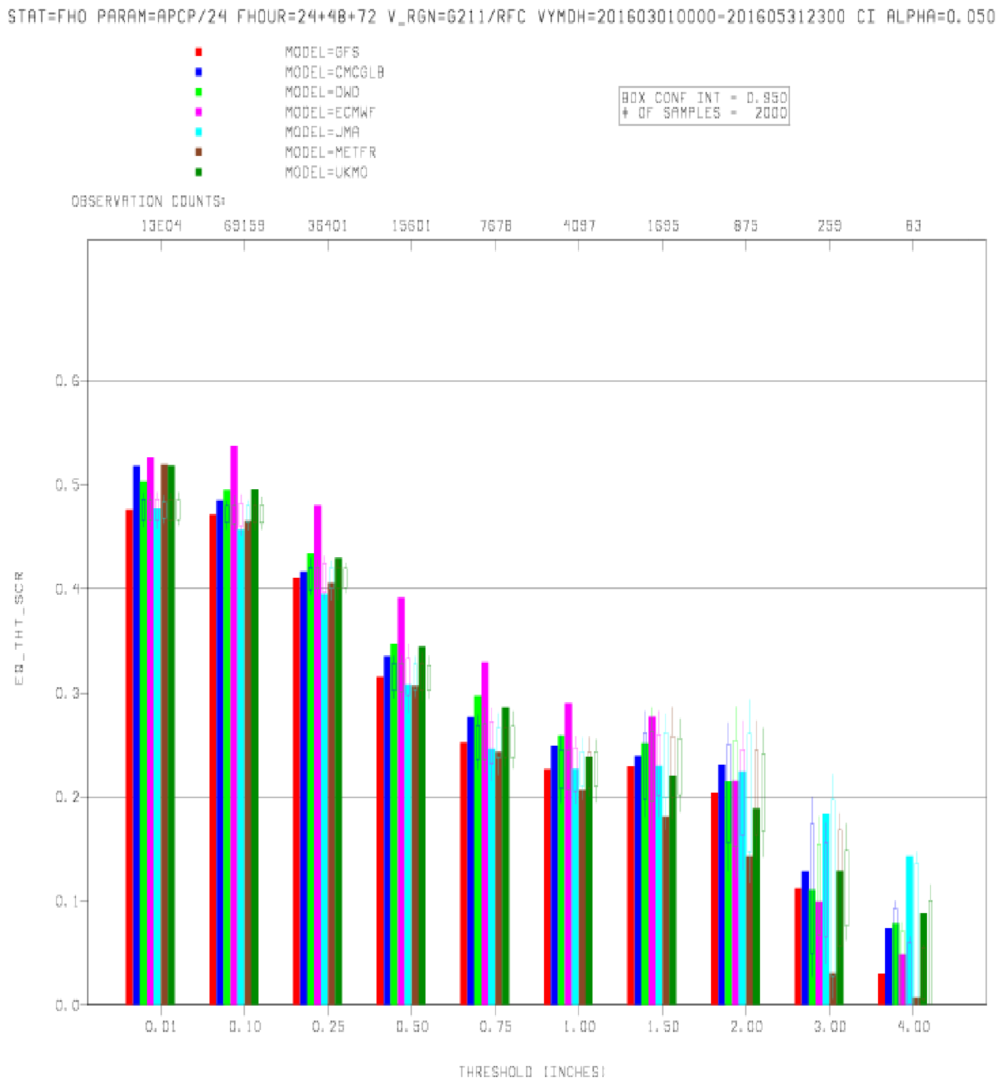
Covering 6 seasons (18 months):
Spring (Mar-May), summer (Jun-Aug), autumn (Sep-Nov) 2016,
winter (Dec-Feb) 2016-2017,
Spring (Mar-May), summer (Jun-Aug) 2017

Global models, 1/2/3-day forecasts

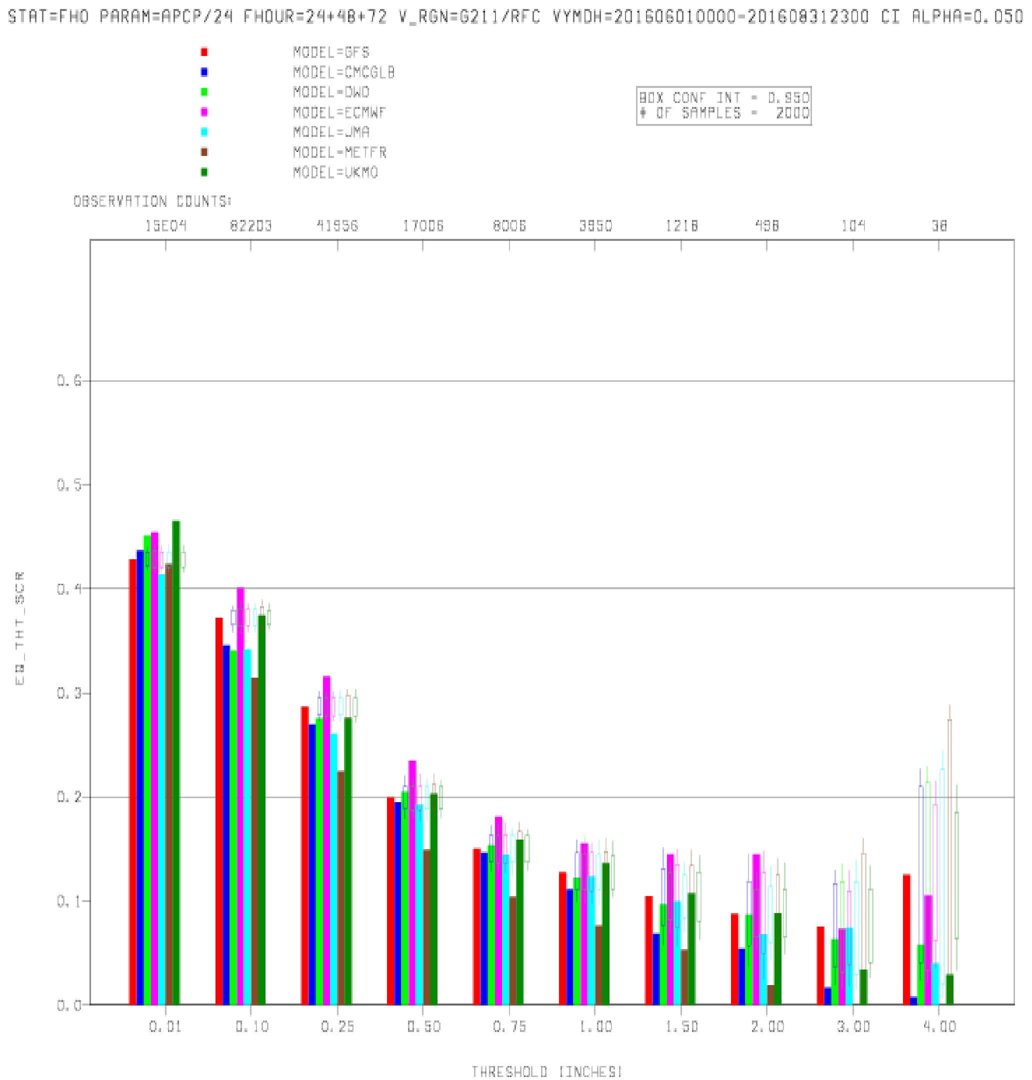
North American models (i.e. GFS and CMC Global models, NAM and CMC regional models. CMC regional's forecast range is 48h) 1&2 day forecasts

ETS over ConUS, 1/2/3-day fcsts of Global Models, 1 of 3
L to R: GFS/CMCGLB/DWD/ECMWF/JMA/METFR/UKMO

Mar-May 2016

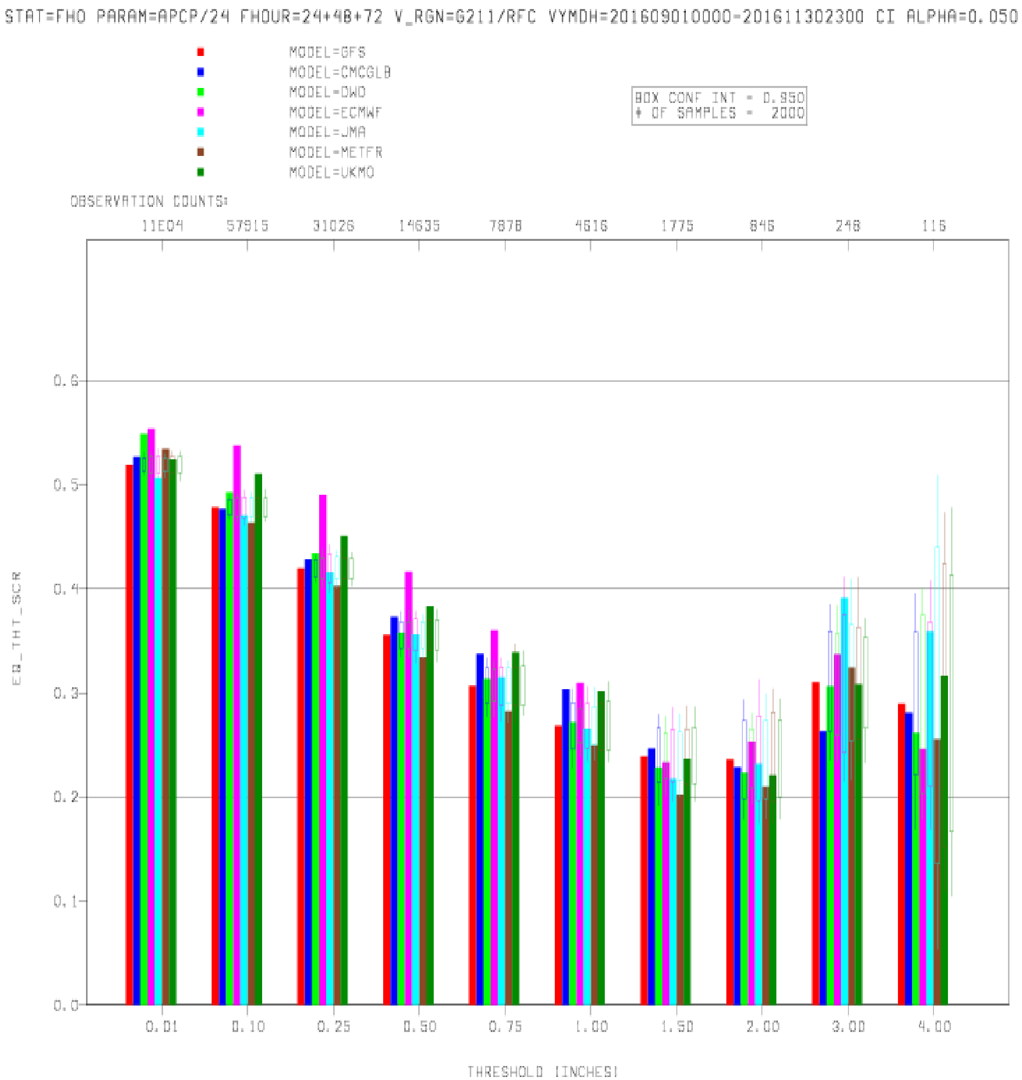


Jun-Aug 2016

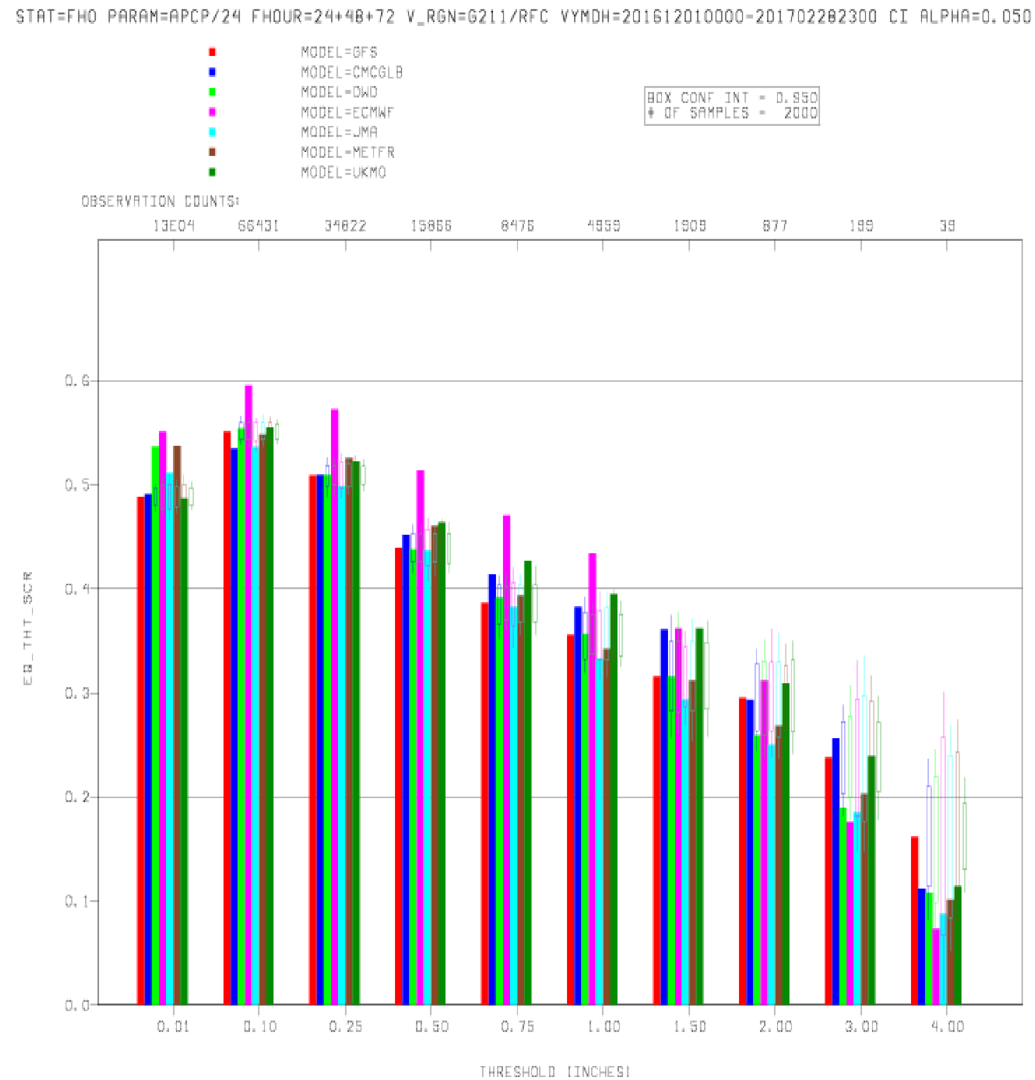


ETS over ConUS, 1/2/3-day fcsts of Global Models, 2 of 3
L to R: GFS/CMCGLB/DWD/ECMWF/JMA/METFR/UKMO

Sep-Nov 2016



Dec 2016-Feb 2017



ETS over ConUS, 1/2/3-day fcsts of Global Models, 3 of 3
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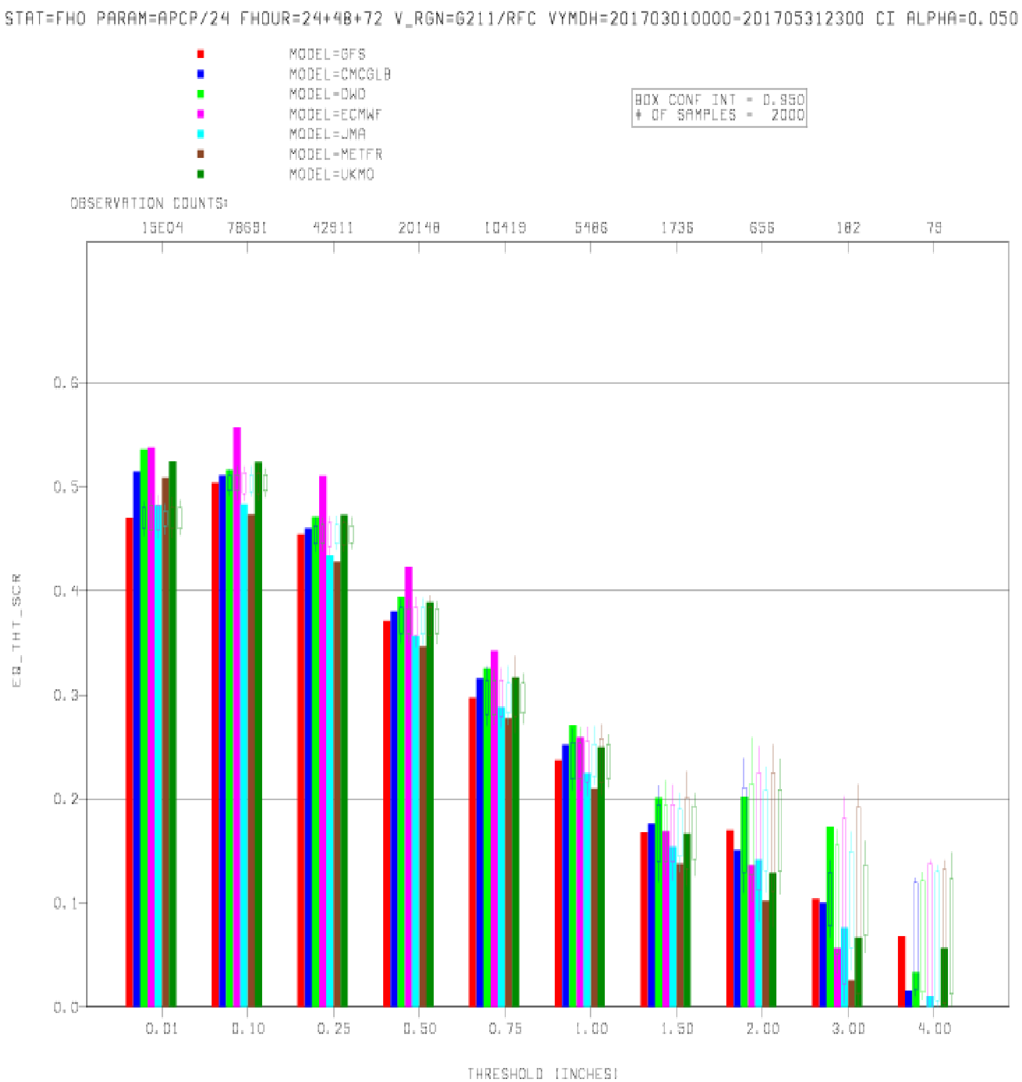
Mar-May 2017



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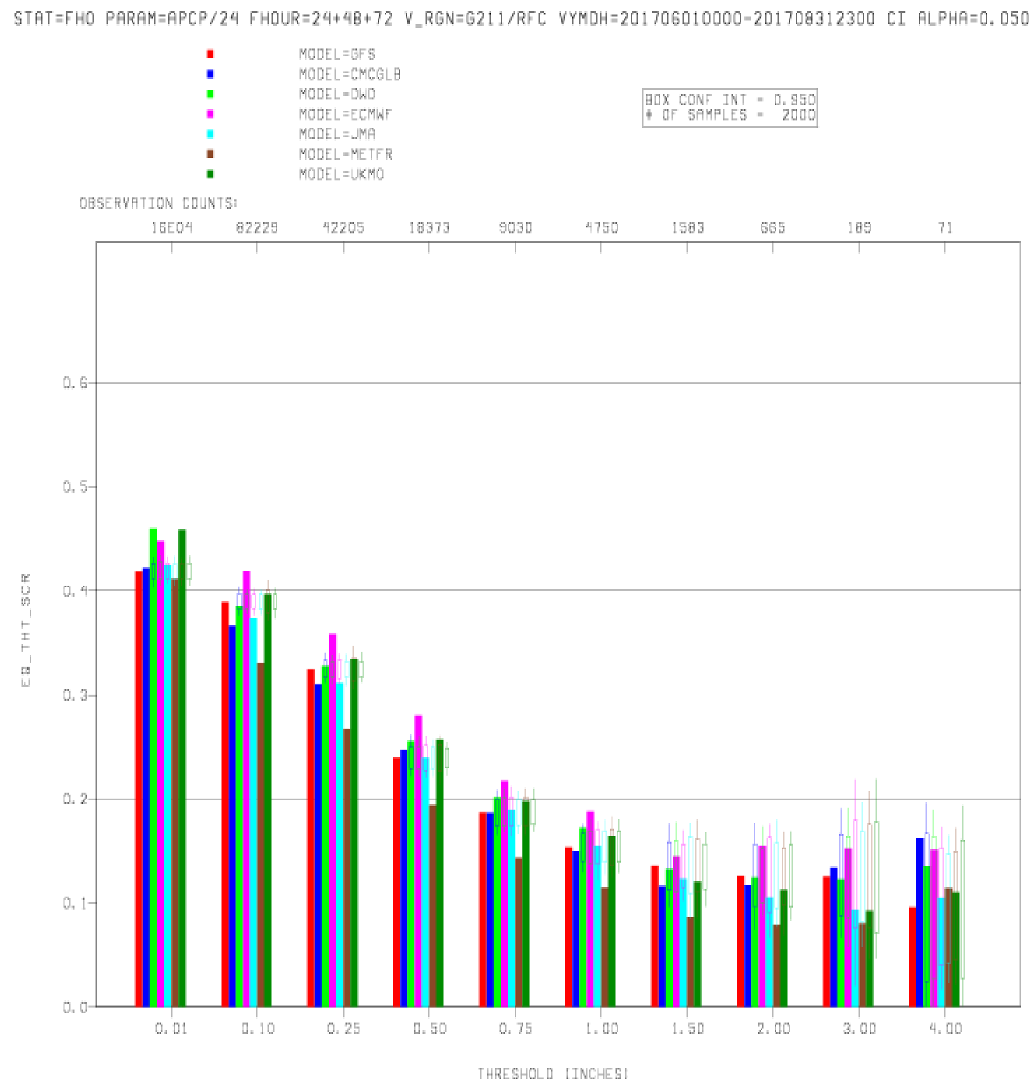

EDI over ConUS, 1/2/3-day fcsts of Global Models, 1 of 3
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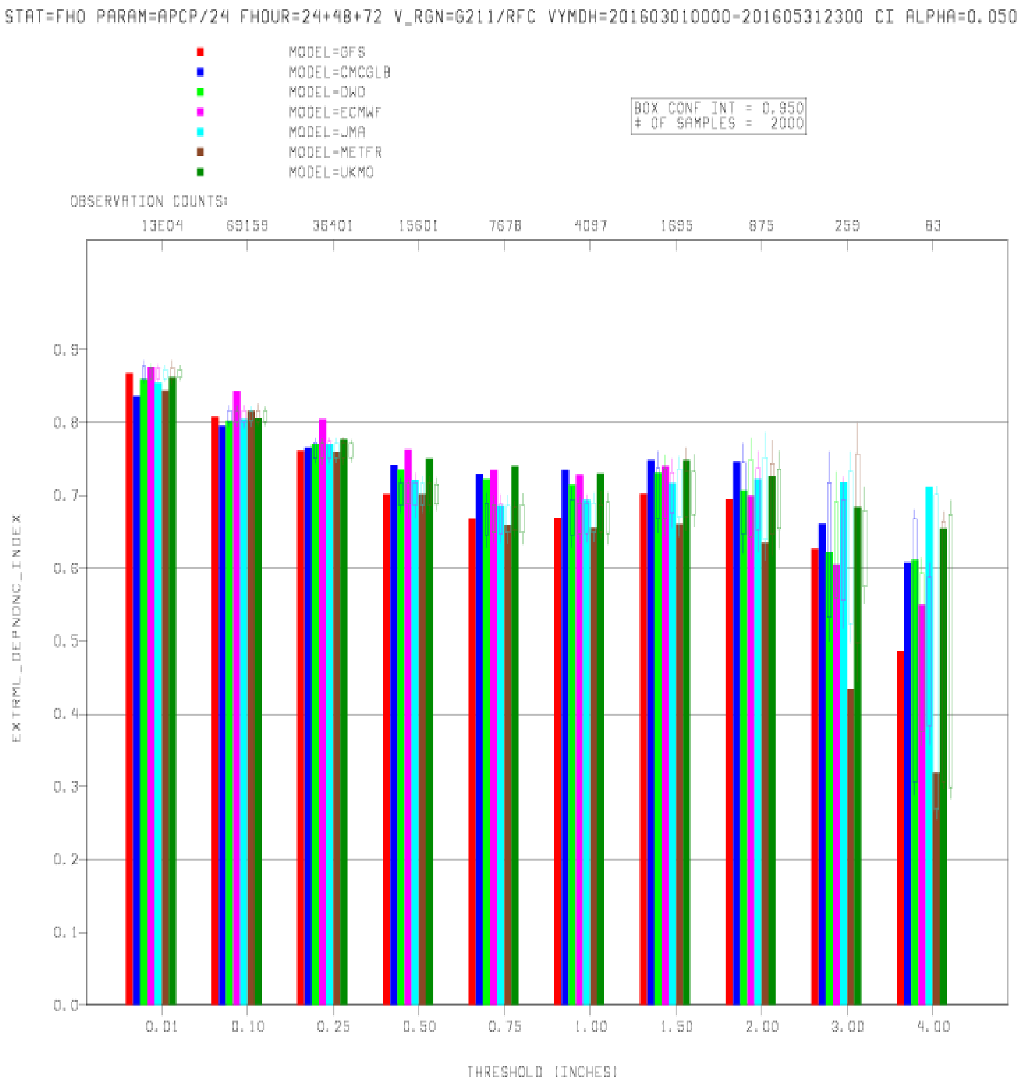

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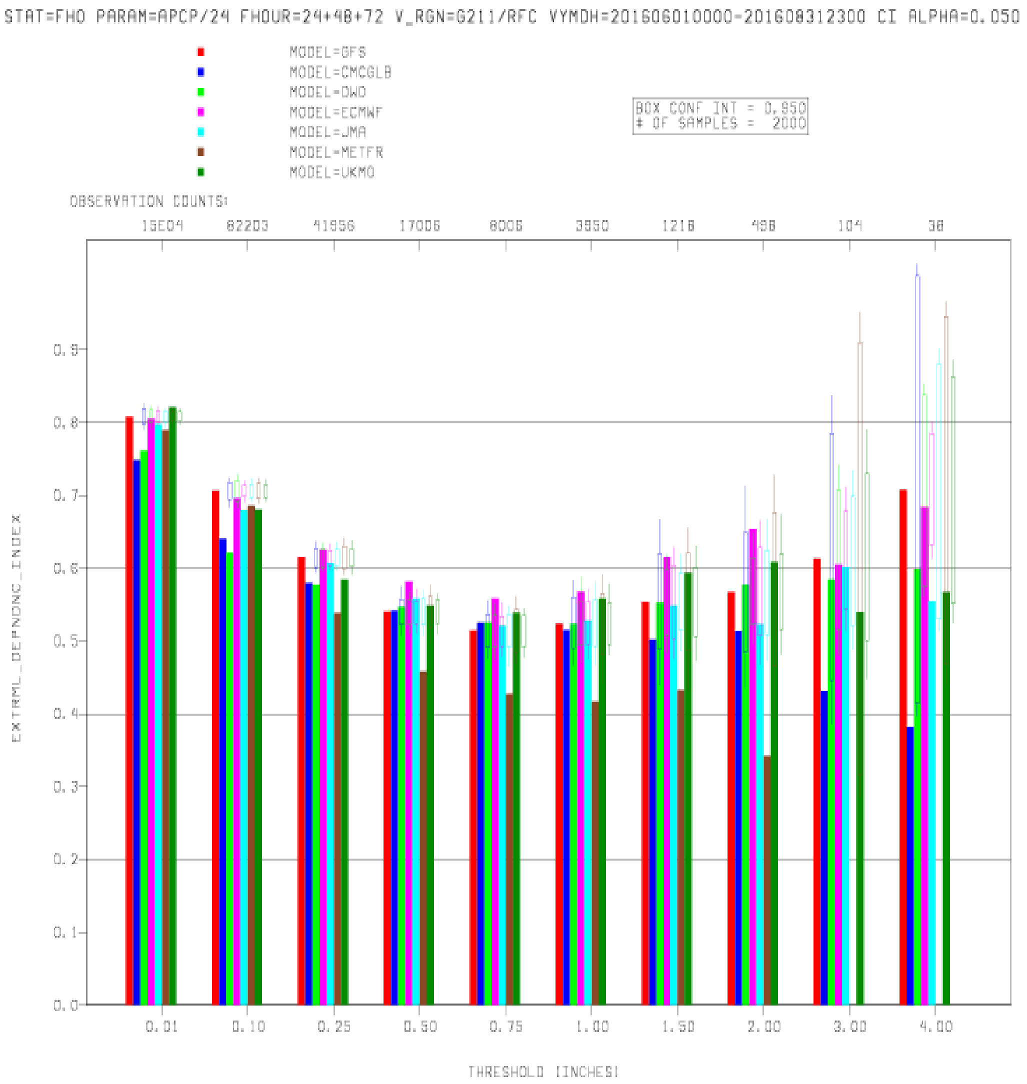

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L to R: GFS/CMCGLB/DWD/ECMWF/JMA/METFR/UKMO

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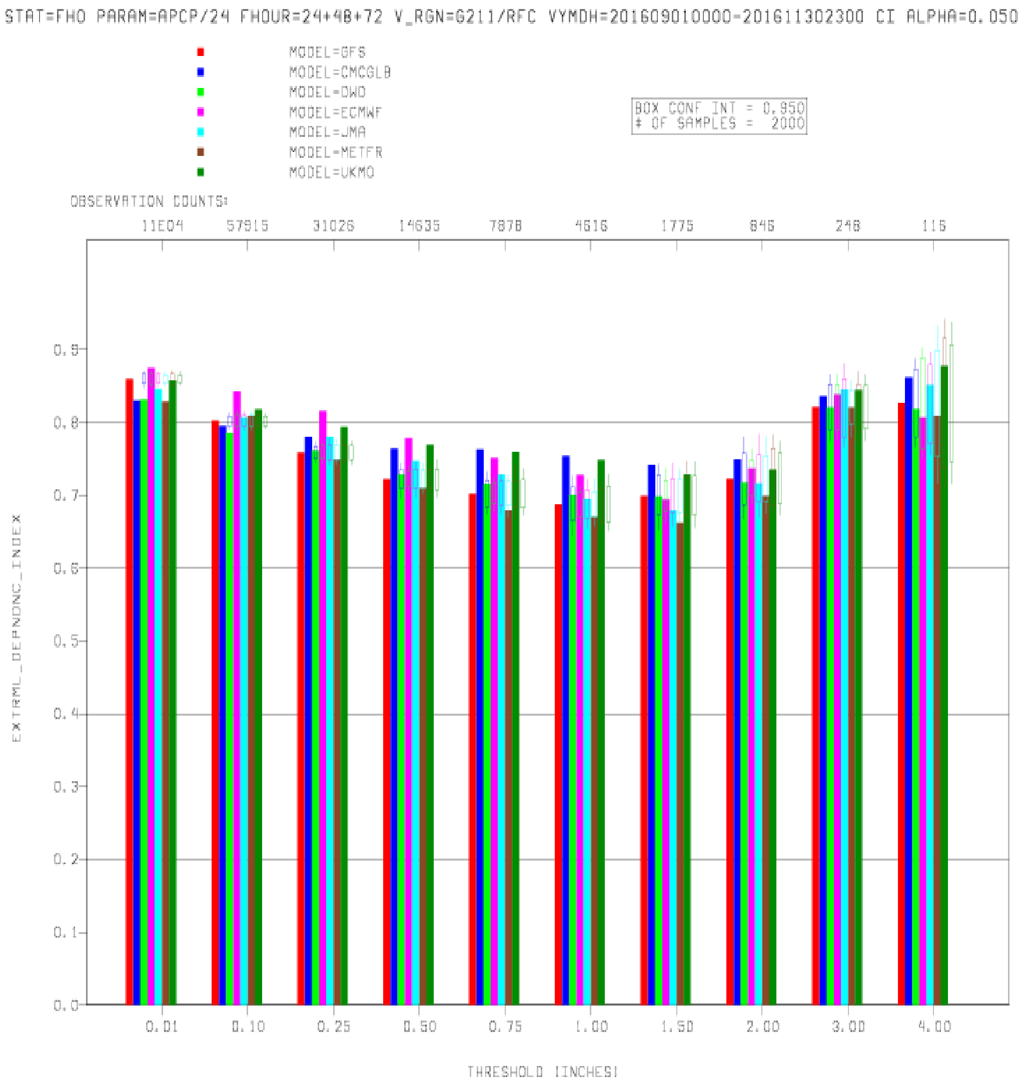

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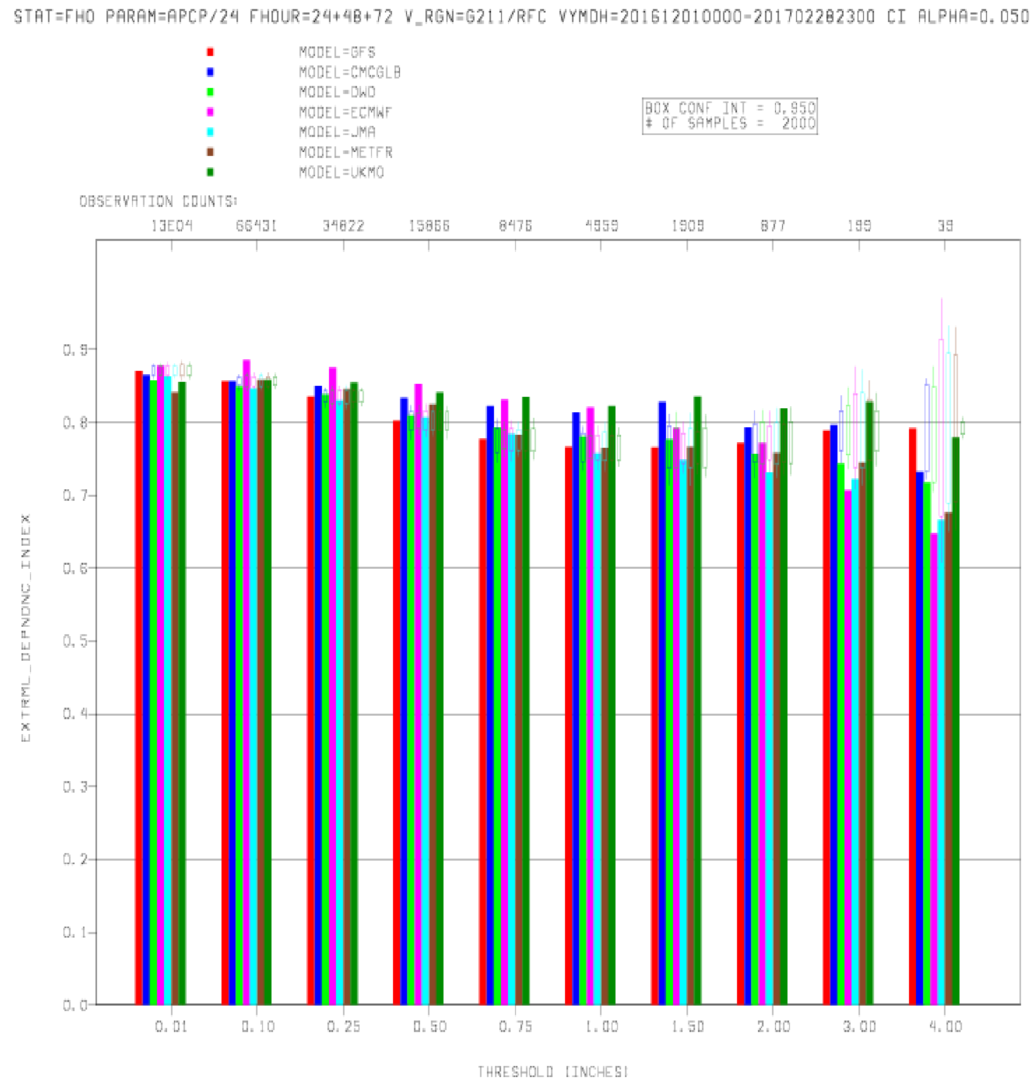

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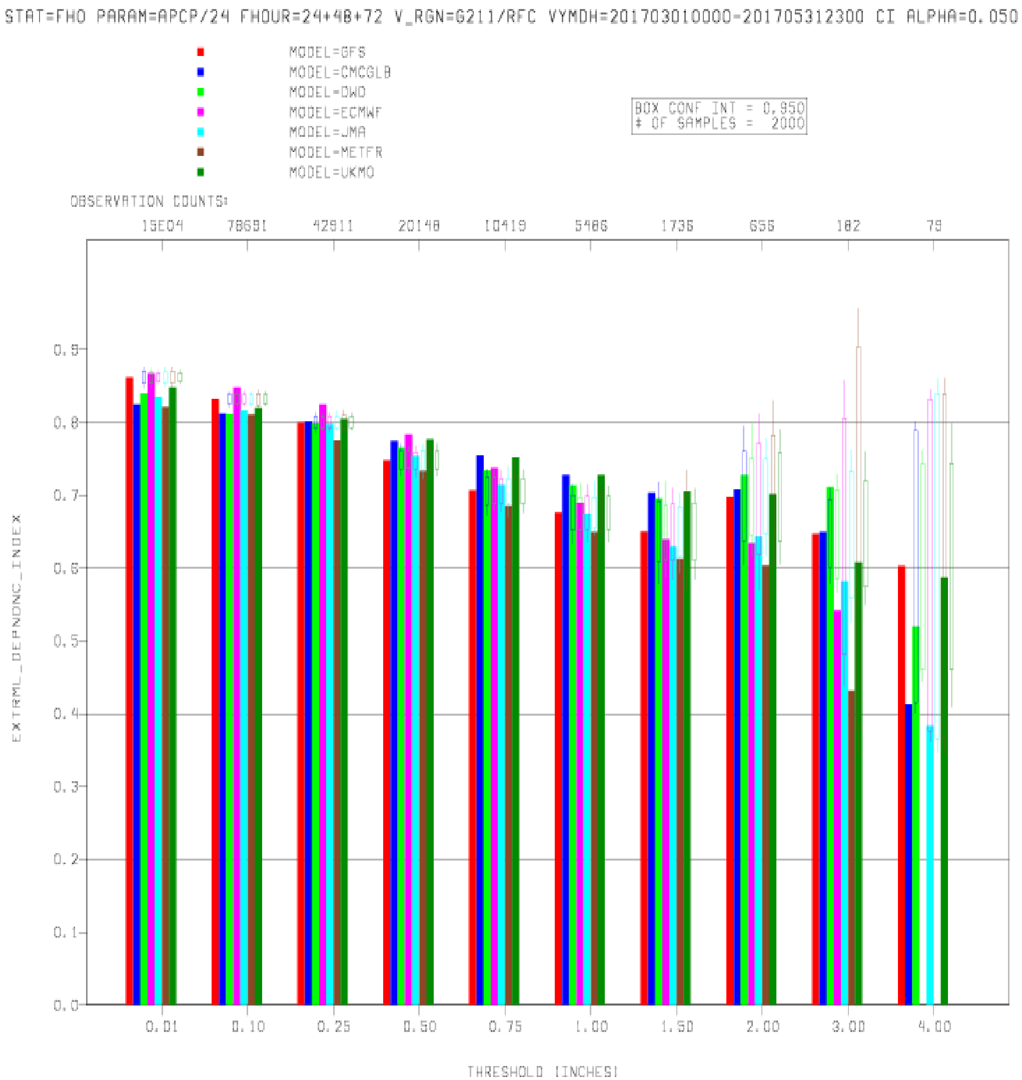

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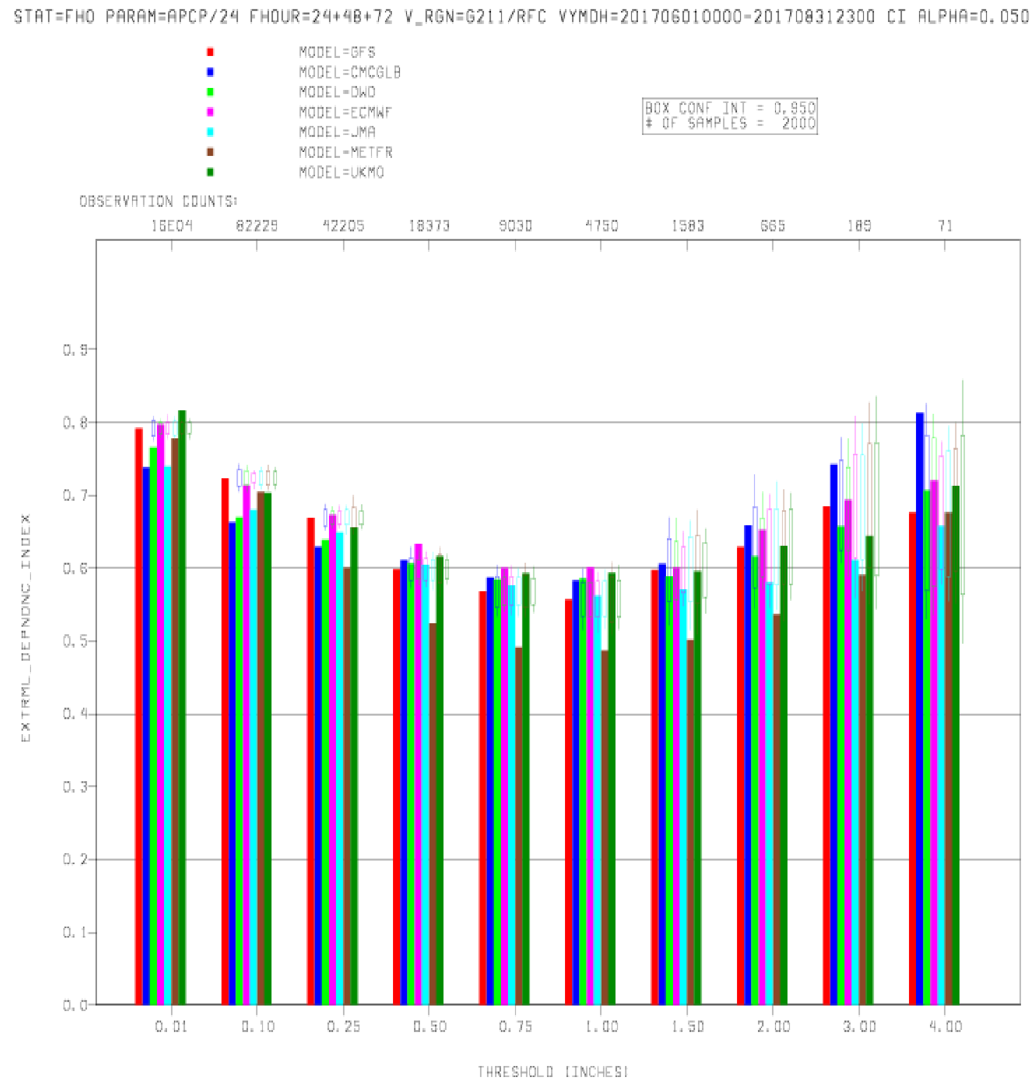

ETS over ConUS, 1&2-day fcsts of N. Amer. Models, 1 of 3
L to R: GFS/NAM/CMCGLB/CMC regional

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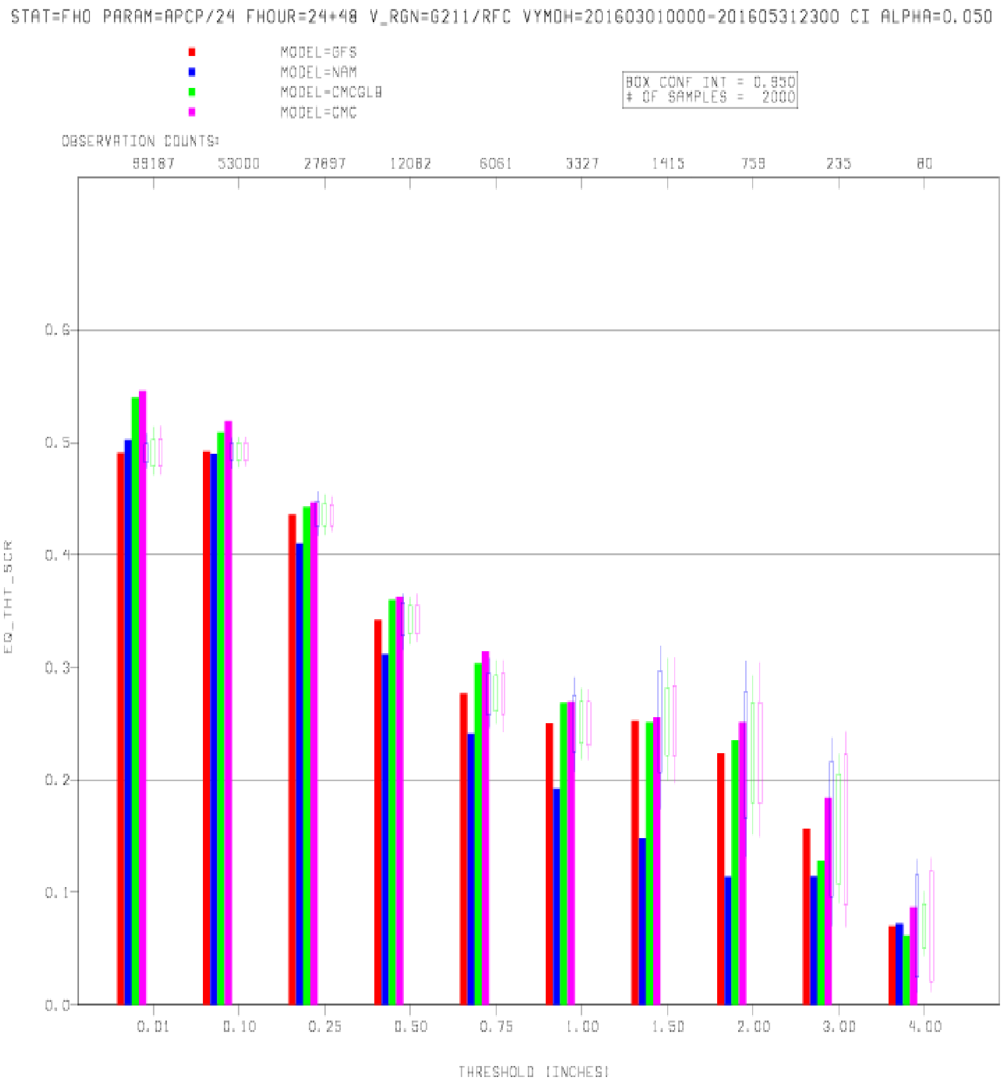

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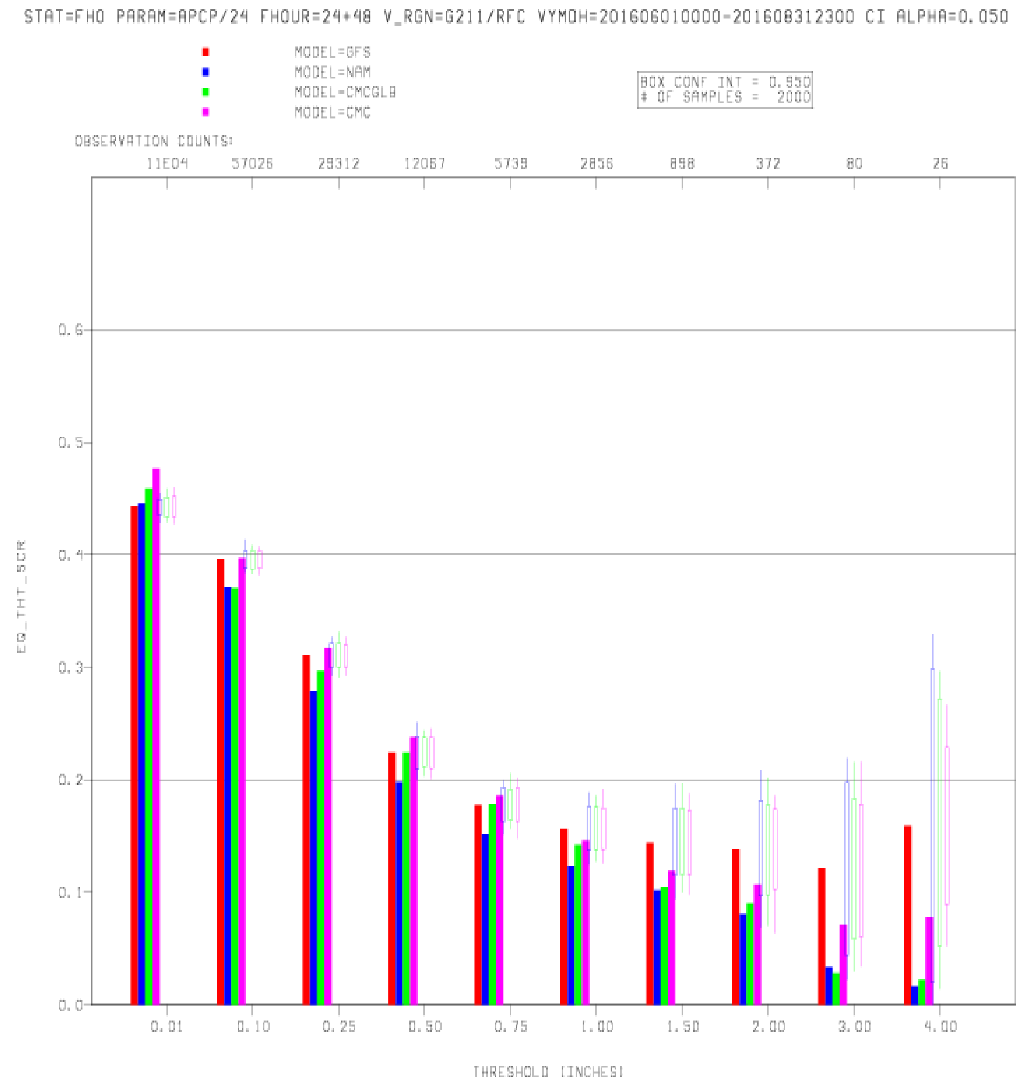

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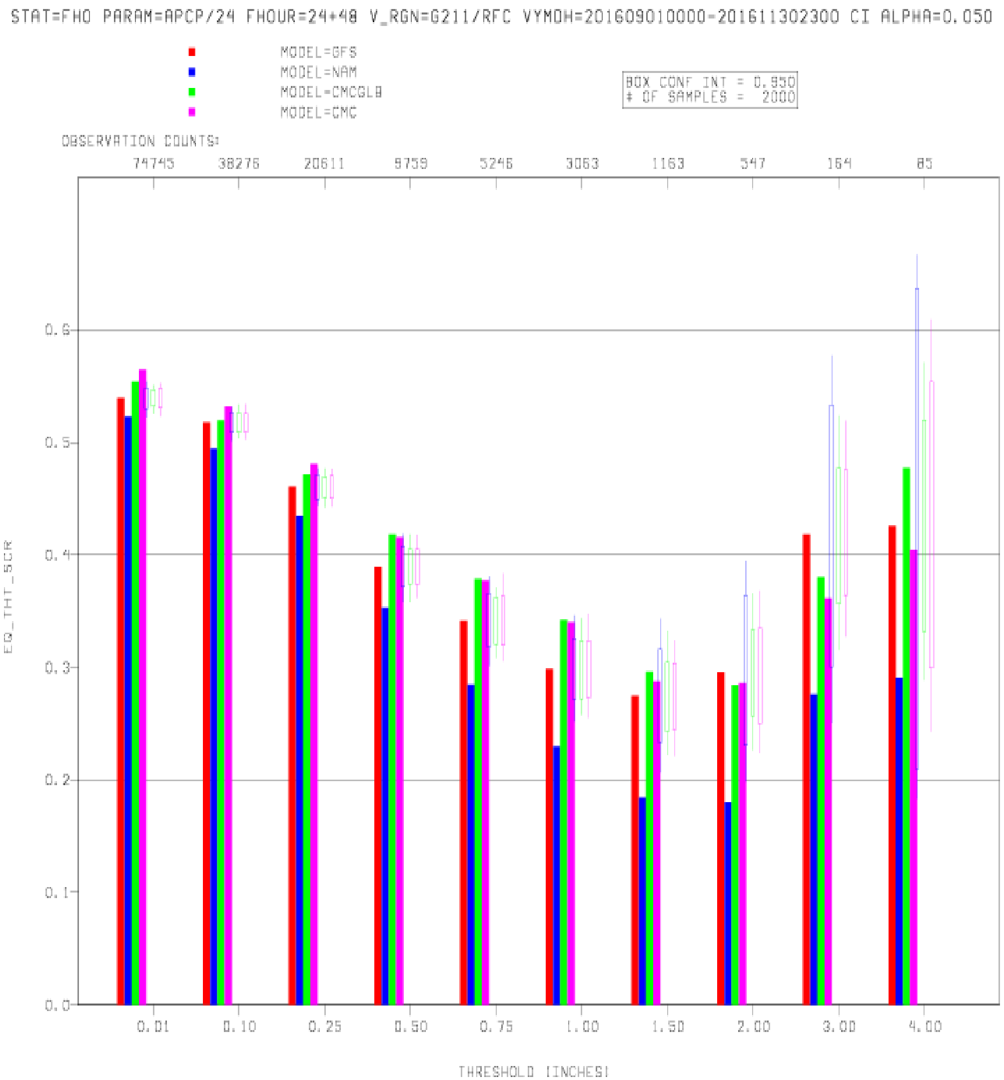
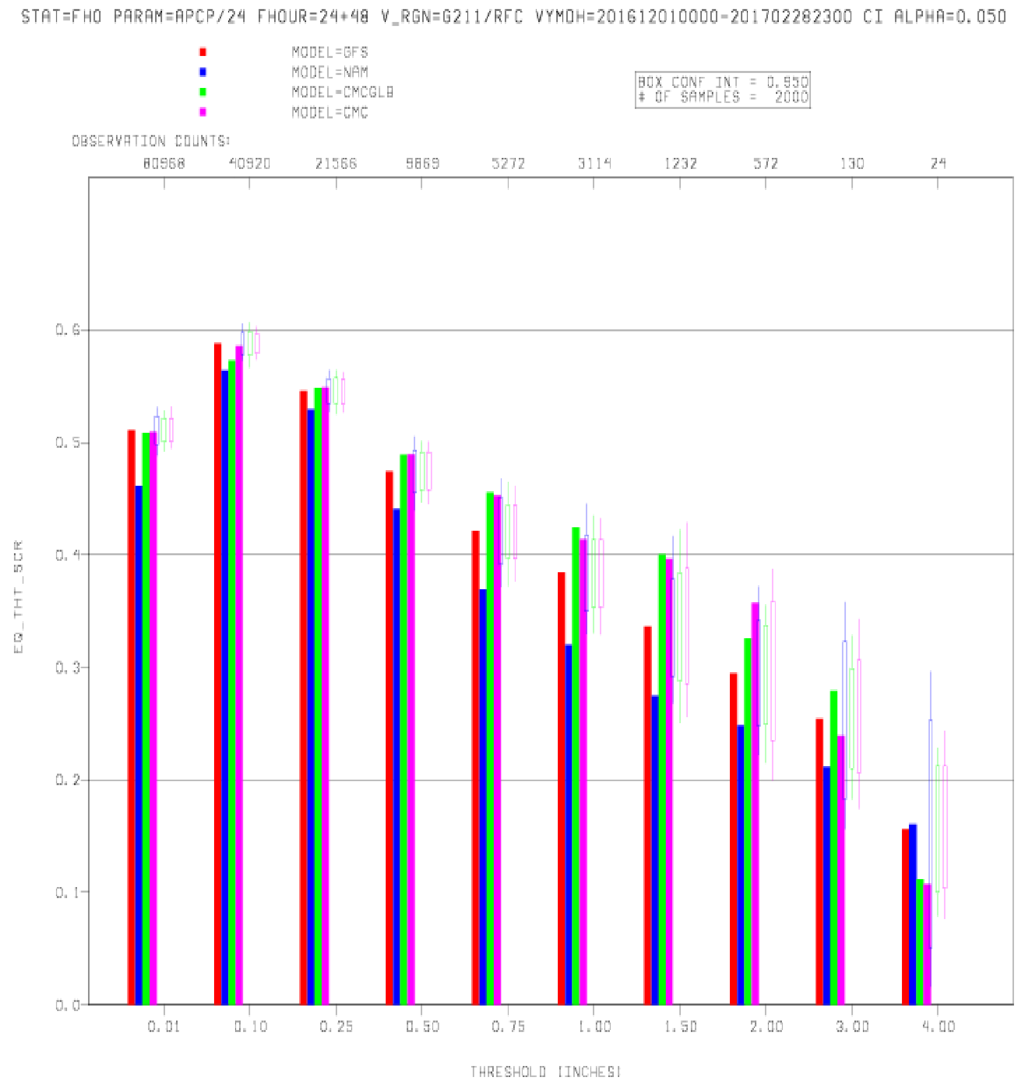


Dec 2016-Feb 2017



EDI over ConUS, 1&2-day fcsts of Global Models, 3 of 3
L to R: GFS/NAM/CMCGLB/CMC regional

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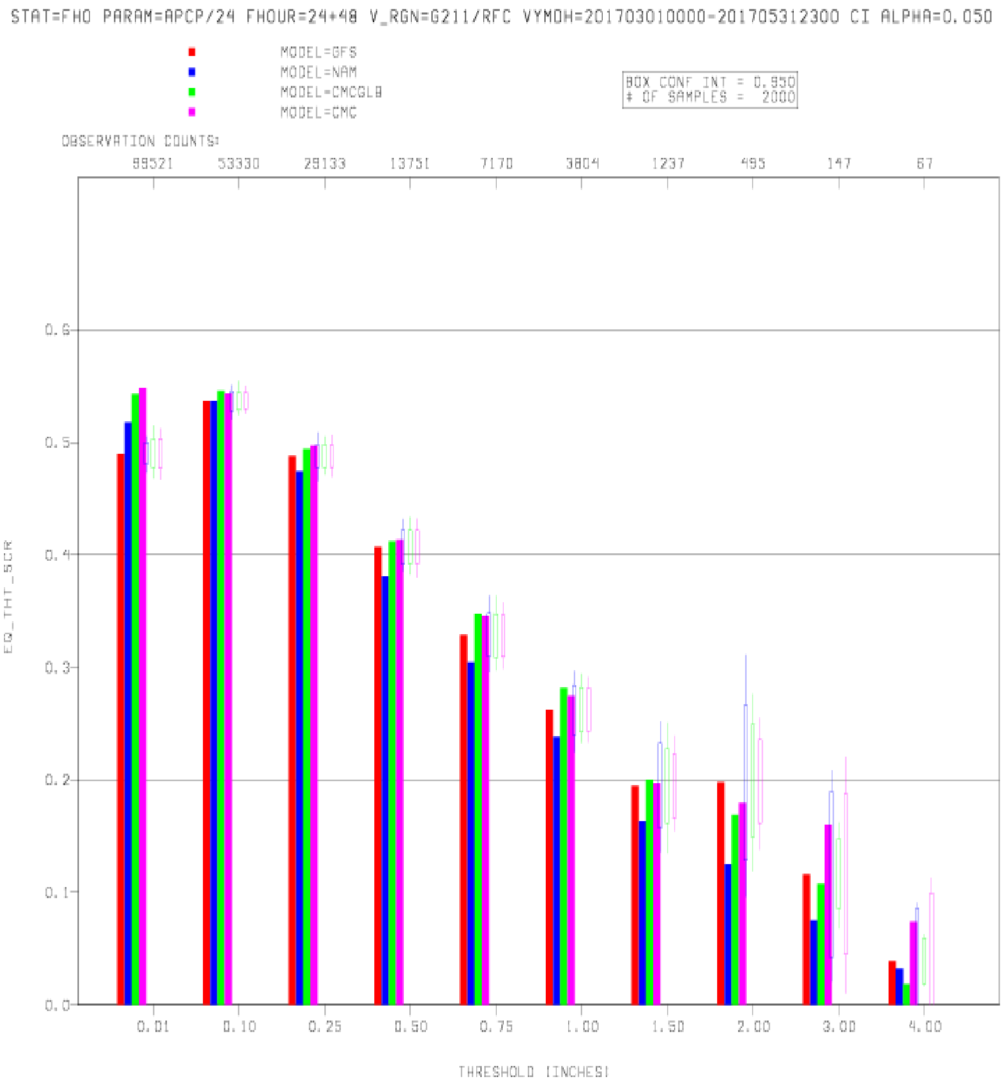

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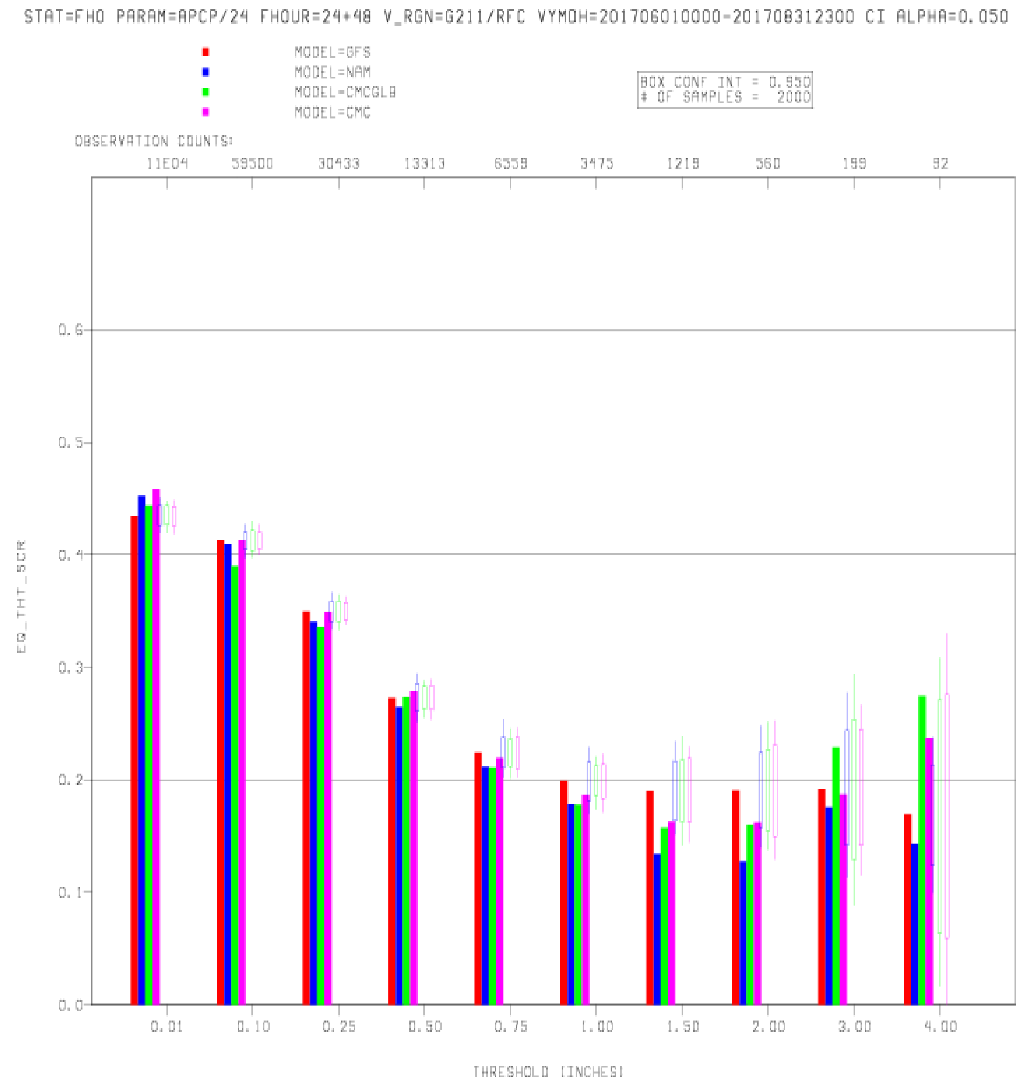

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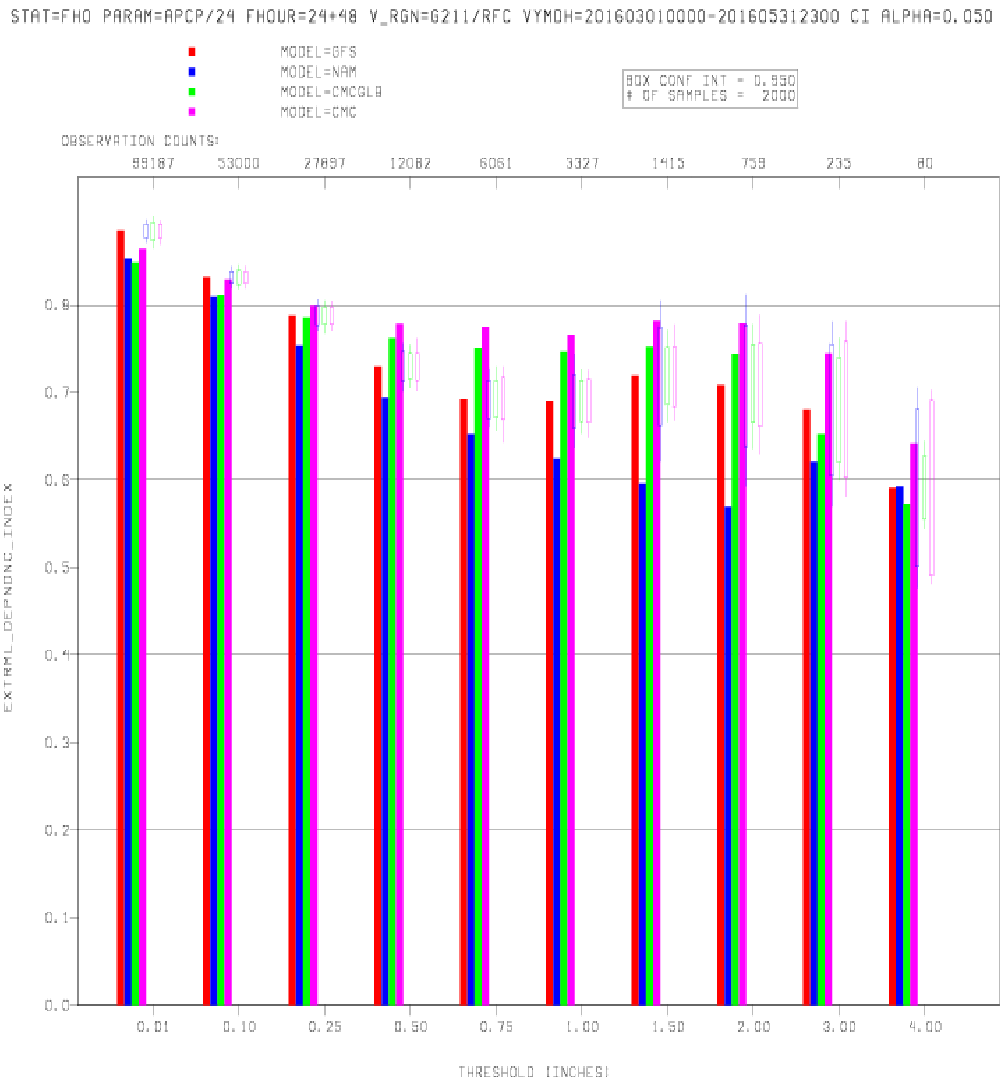

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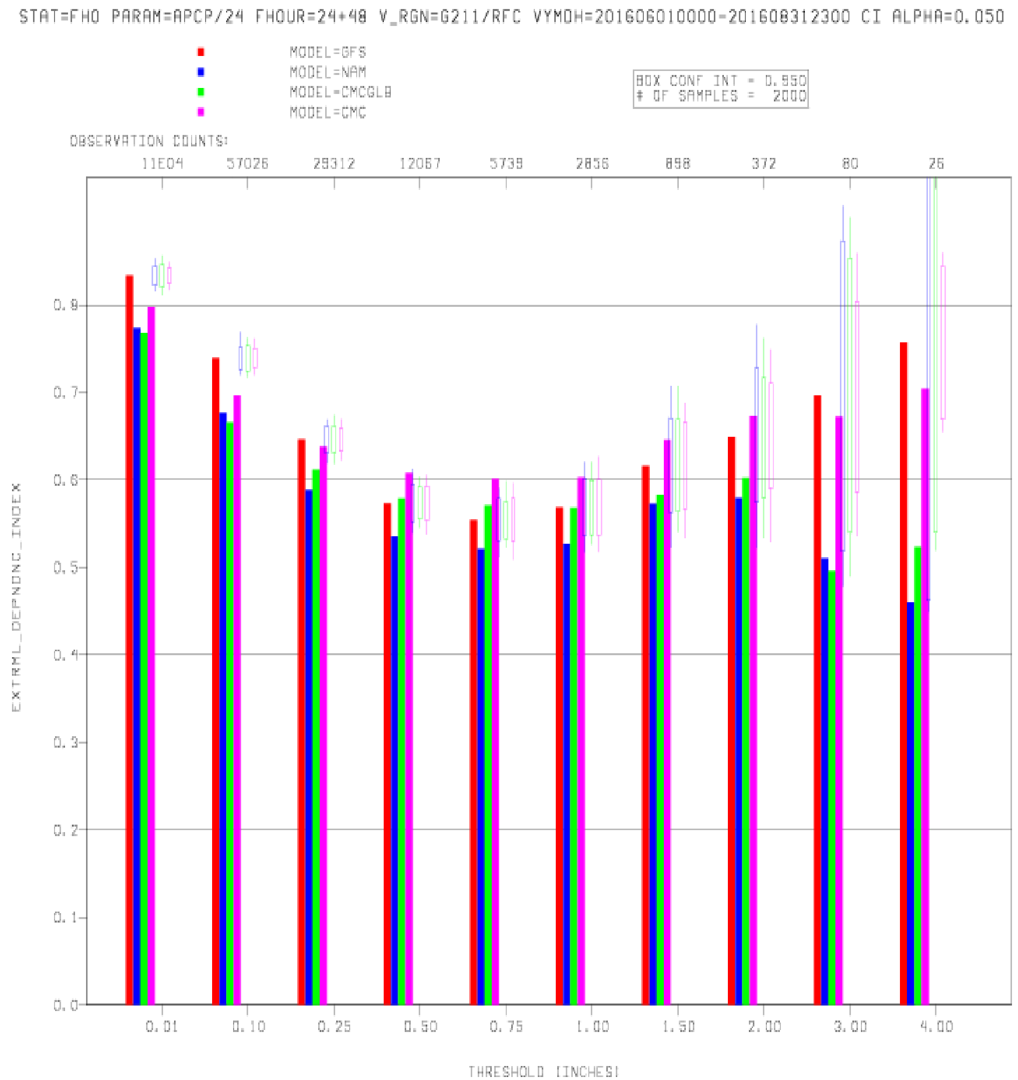

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L to R: GFS/NAM/CMCGLB/CMC regional

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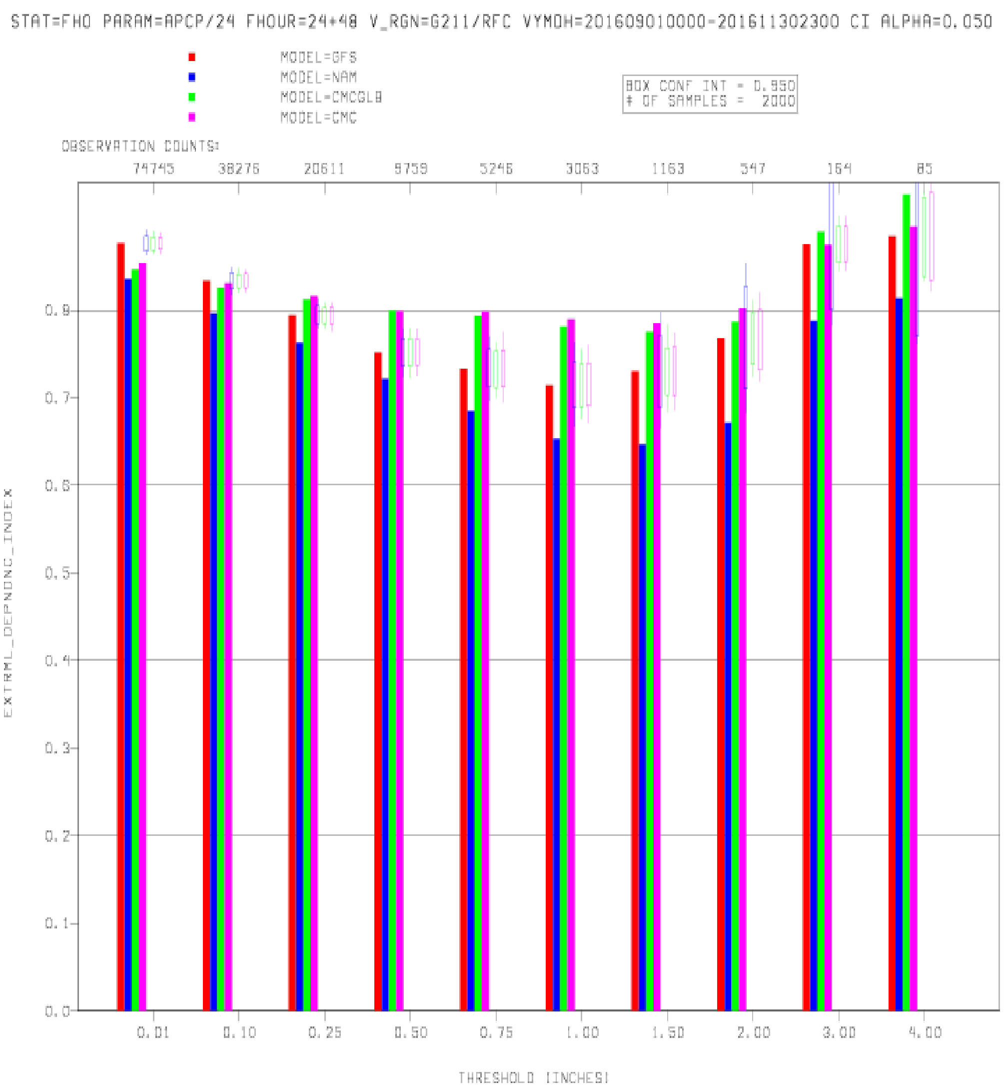

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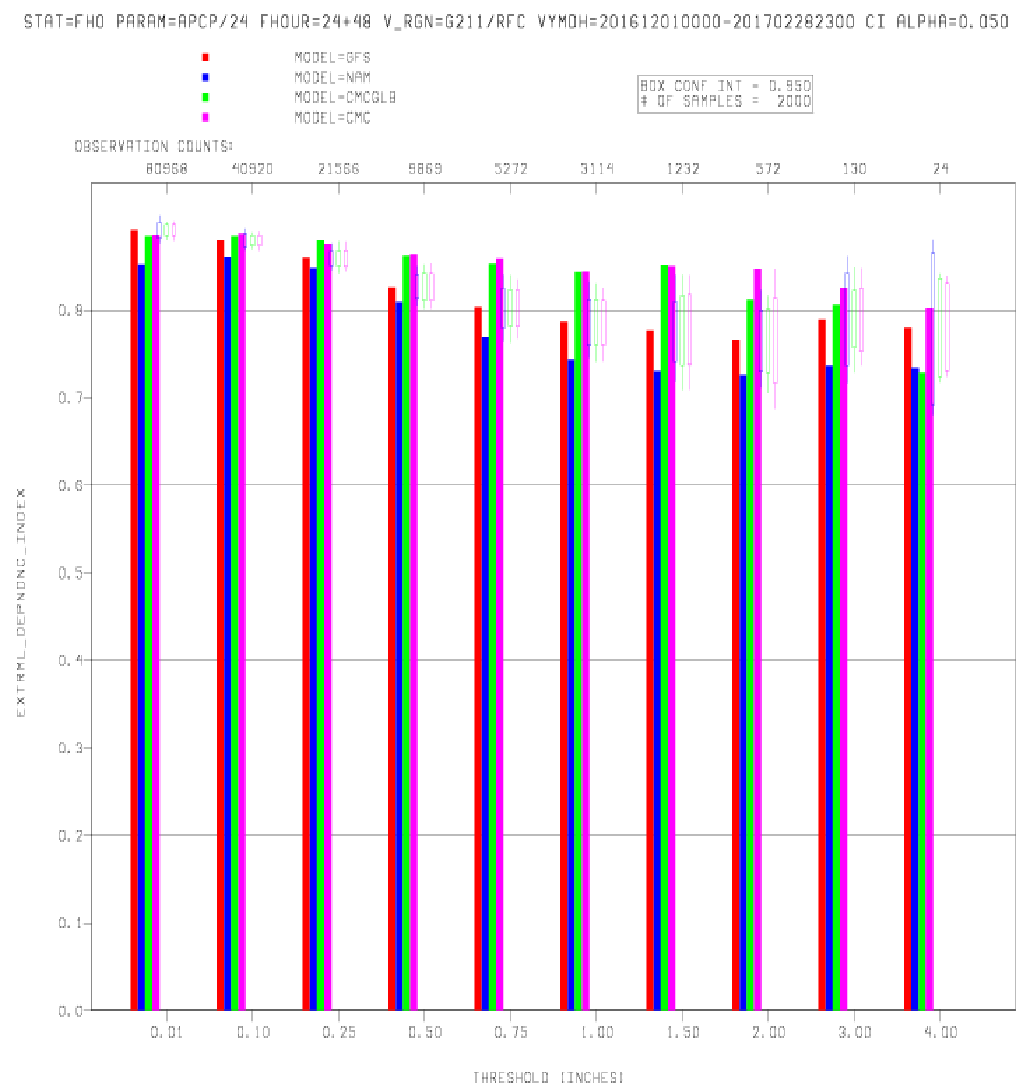

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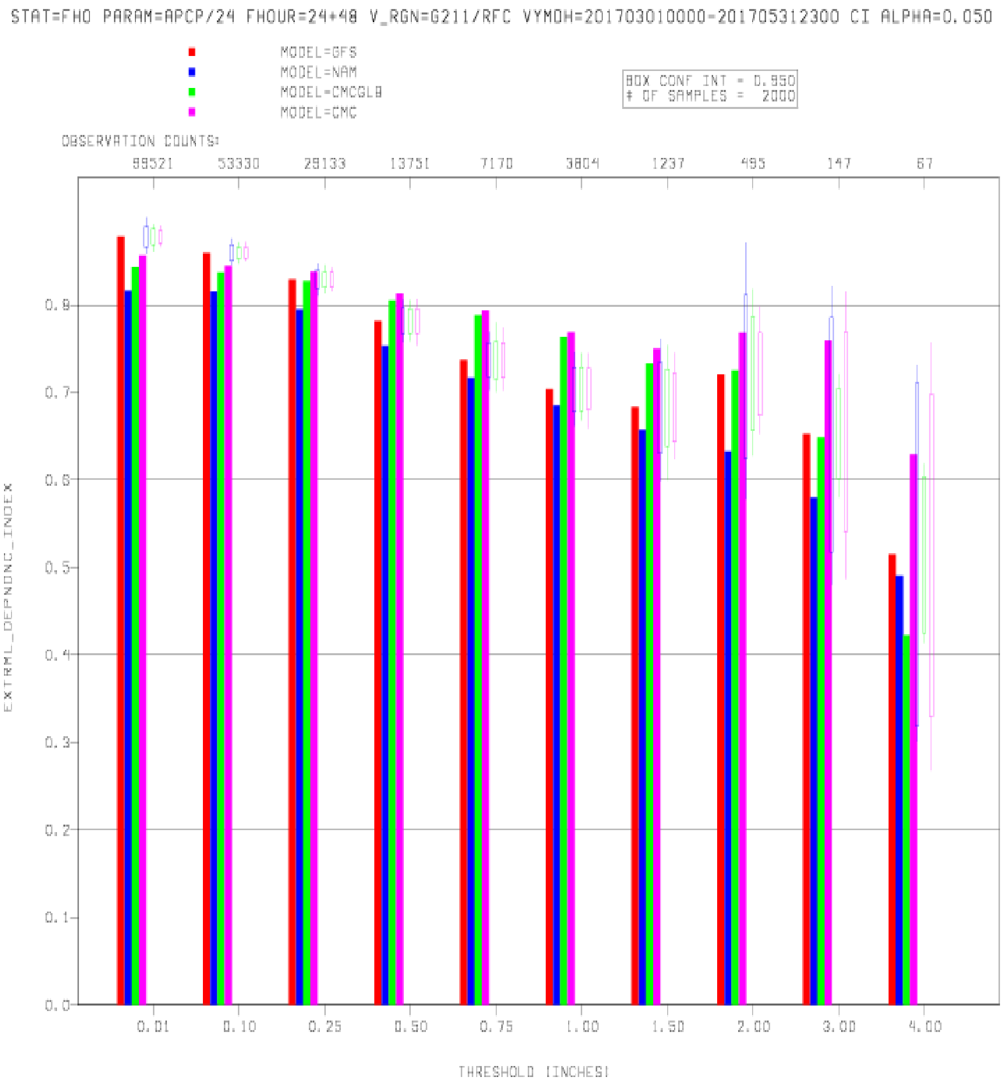

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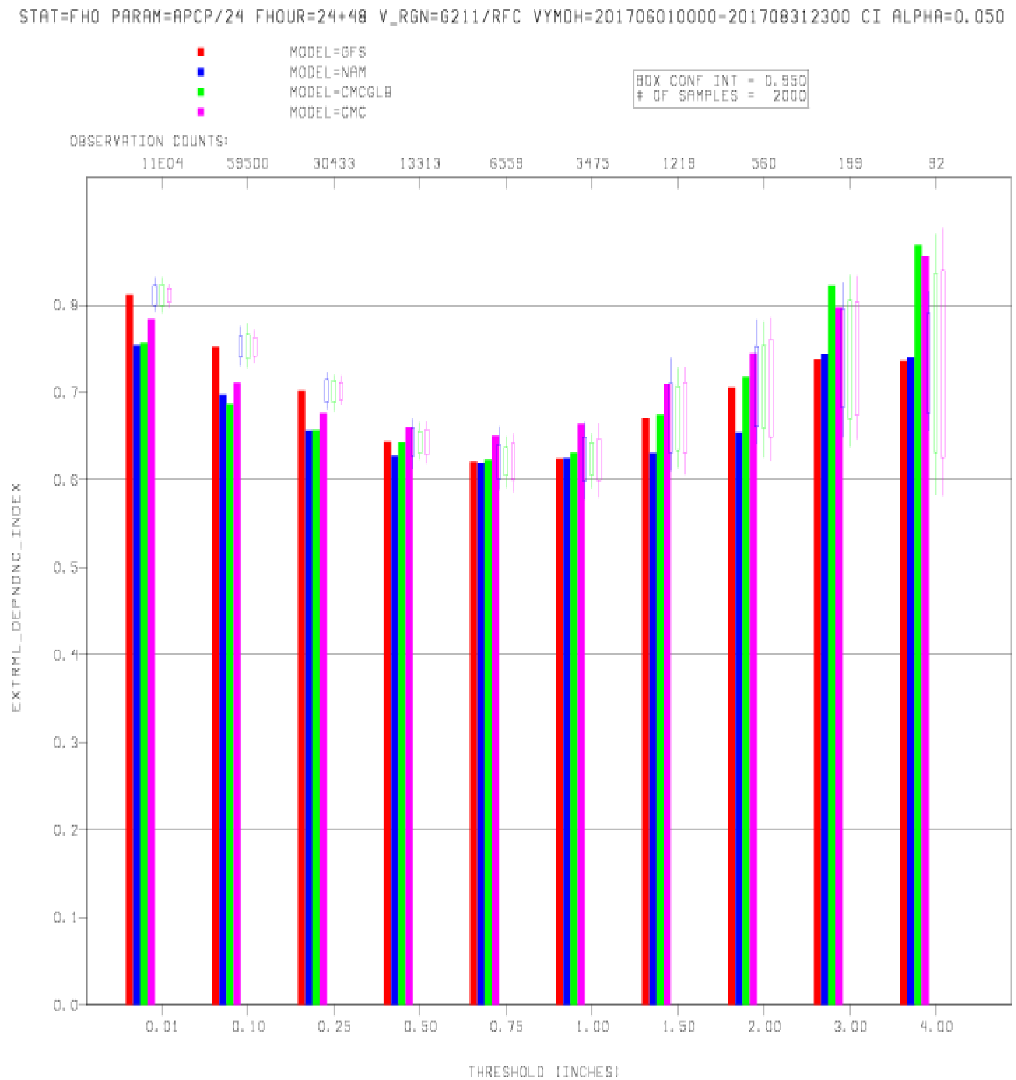


Additional Information

- GFS data made available to NCEP's international partners: http://nomads.ncep.noaa.gov/pub/data1/nccf/com/verf/prod/precip.yyyymmdd/
- Monthly precipitation scores of operational models: http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores/
- QPF scores for the experimental FV3GFS runs: http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores.fv3/
- Global experimental verification scores: http://www.emc.ncep.noaa.gov/gmb/STATS_vsdb/
- Daily side-by-side precipitation verification comparisons: http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/daily/

JMA

Contact person : Junichi Ishida
j-ishida@met.kishou.go.jp

WGNE QPF Verifications over Japan Dec 2015–Jun 2017

Japan Meteorological Agency

WGNE-32

Data and Verification Method

Verification grid

80 km×80 km

Converting method

Simple average or interpolation

Reference data (Observations)

Amount of precipitation observed by rain gauges

Verified data (QPFs data)

See next slide

Error bars

Estimated by bootstrap method

with 95% confidence intervals

Verification method

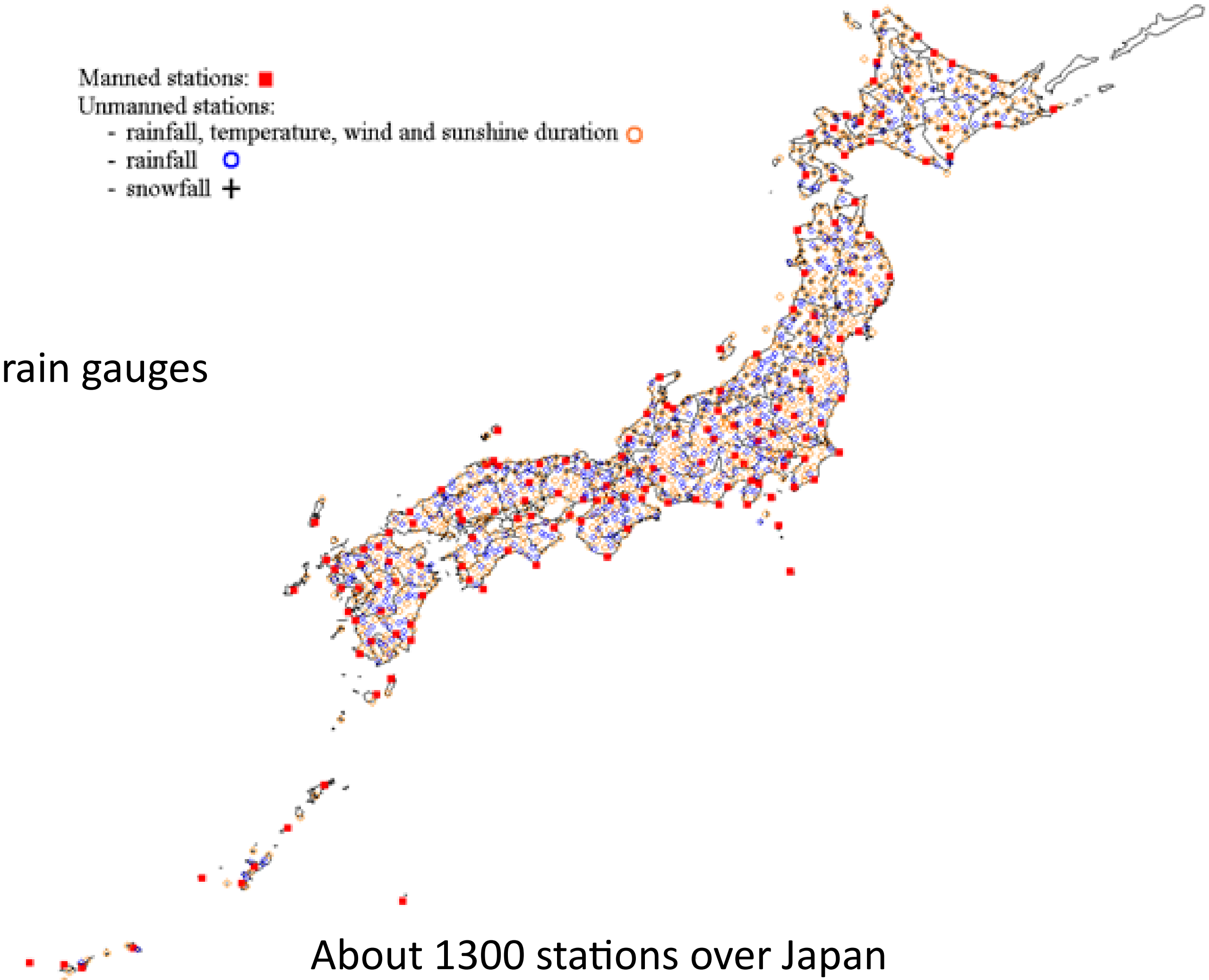
Equitable Thread Score (ETS)

Extremal Dependency Index (EDI)

Bias Score (BI, Optional)

Hit Rate (HR, Optional)

False Alarm Rate (FAR, Optional)



About 1300 stations over Japan

Average distance (among stations): ~17 km

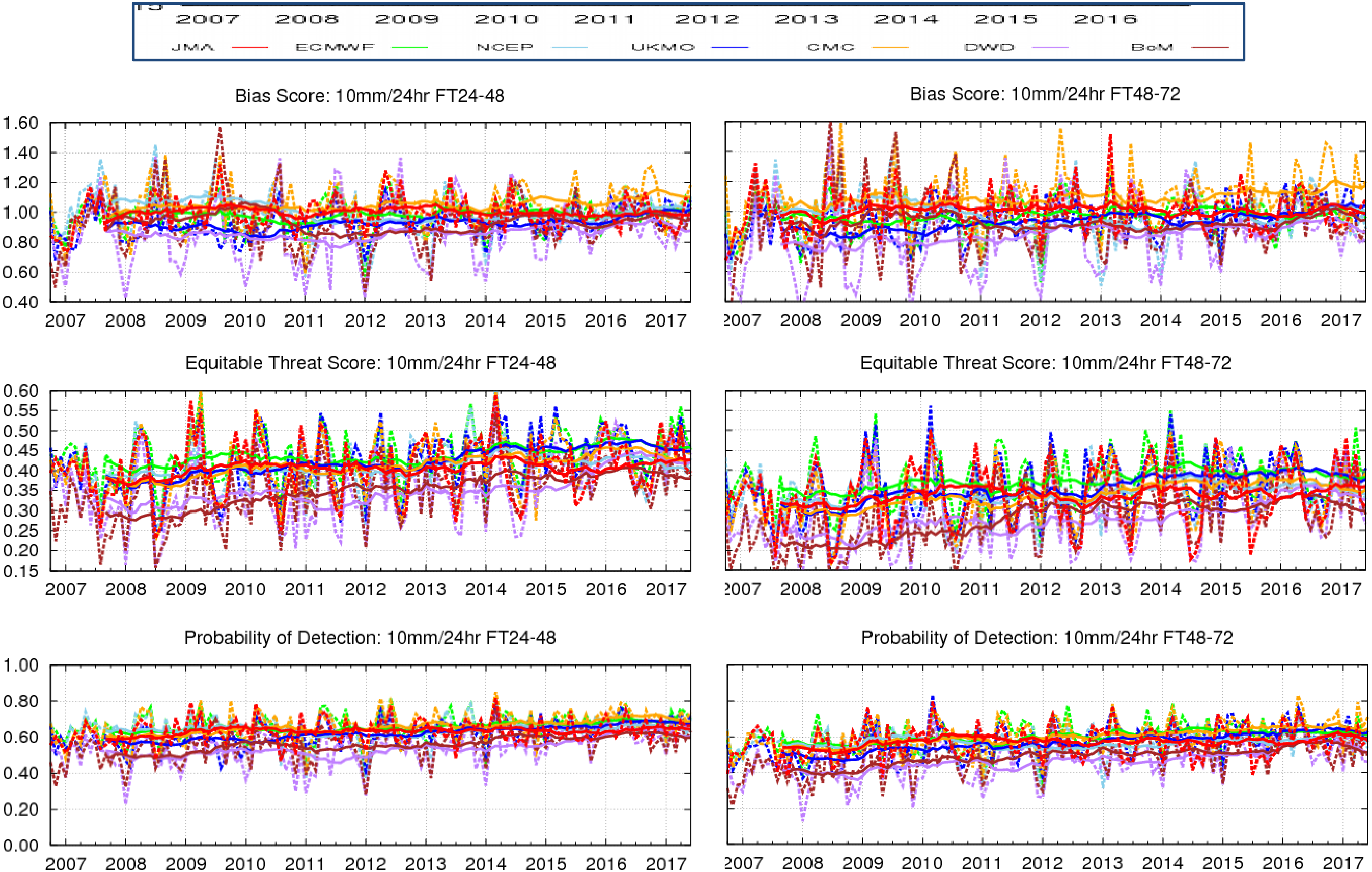
Verification with 80 km×80 km grid

NWP Center	horizontal resolution of verified data (degree)	forecast time (hour)	converting method in 80 km verification
BoM	0.5625 × 0.375 (*1) 0.3516 × 0.234	6, 12, ..., 144	average
CMC	1.00×1.00	6, 12, ..., 120	interpolation
DWD	0.25×0.25	6, 12, ..., 174	average
ECMWF	0.50×0.50	6, 12, ..., 72	average
NCEP	0.50×0.50	6, 12, ..., 84	average
UKMO	0.234×0.156	6, 12, ..., 96	average
JMA	0.25×0.25 (GSM[*2]) 5 km×5 km (MSM[*3])	6, 12, ..., 84 3, 6, ..., 39	average average
Observation	Corresponding to 17 km×17 km	-	average

(*1) before 2016/03/16

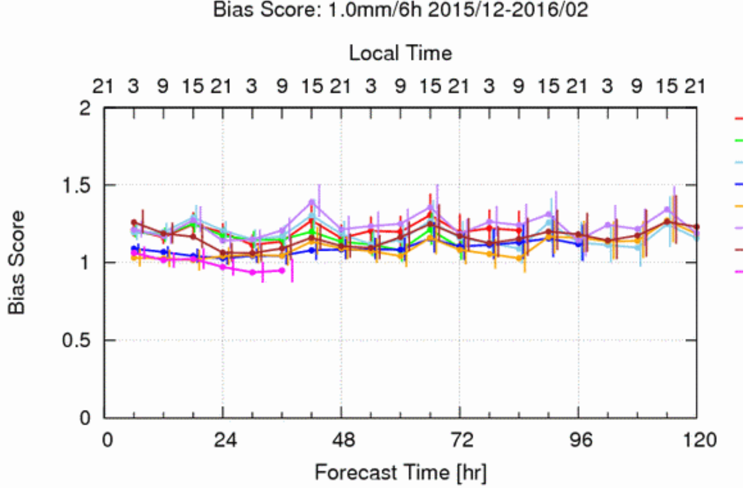
(*2) global model (*3) regional model

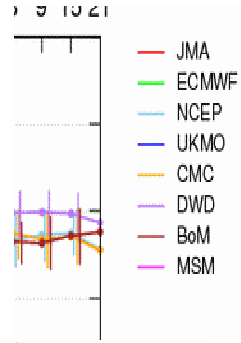
Time series from late 2006

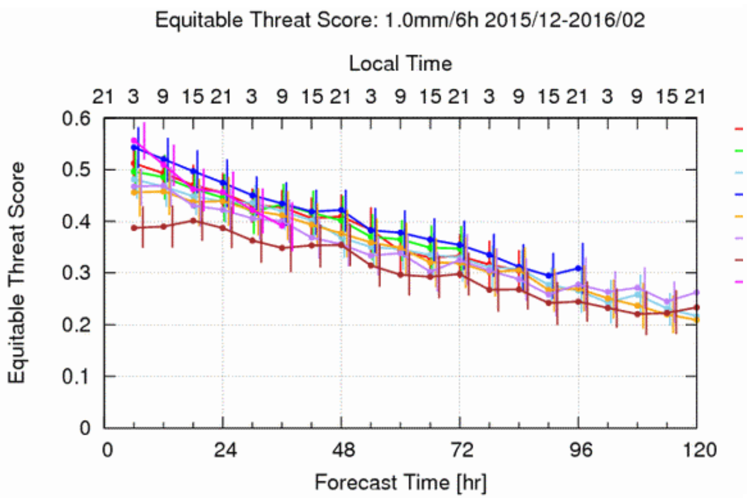


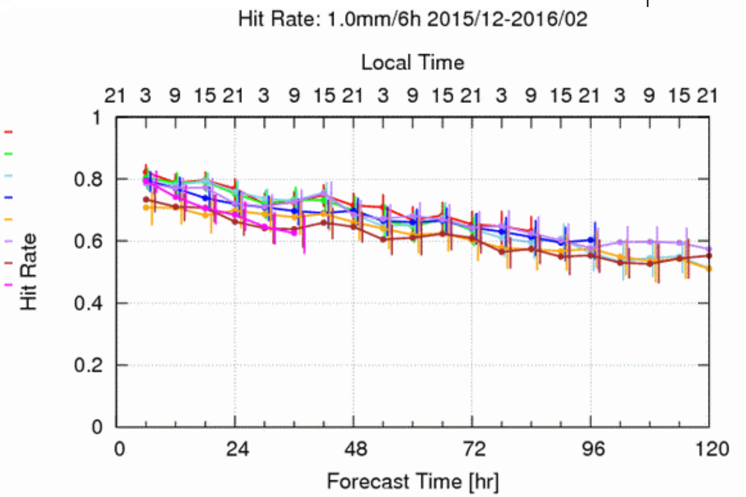
NOTE: Solid lines represent moving-average (12 months).

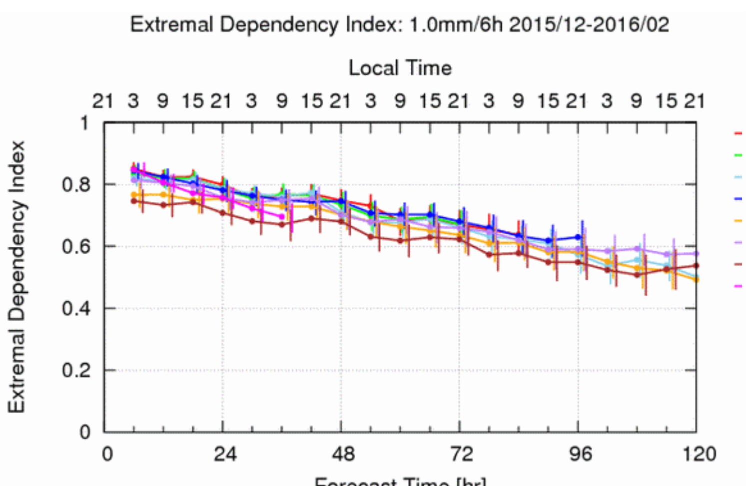
2015DJF

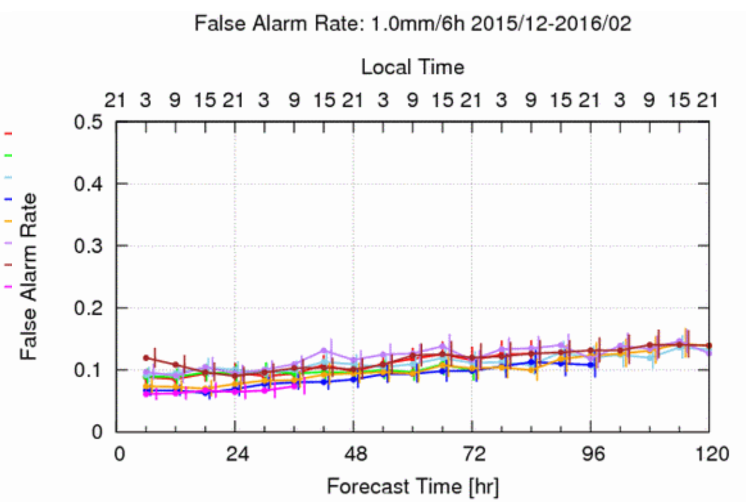


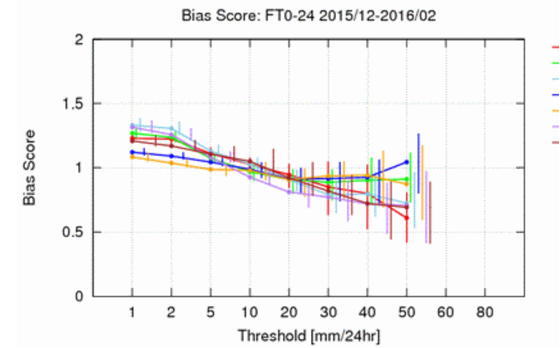


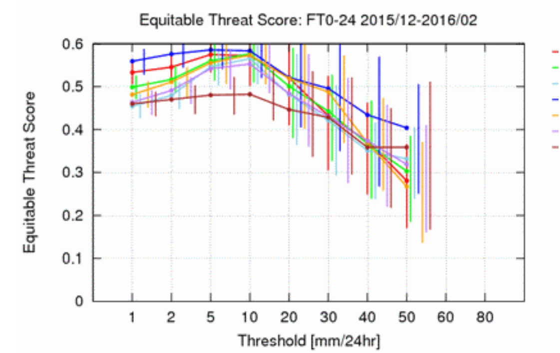


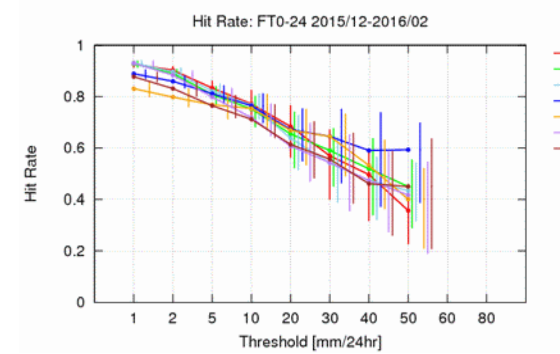


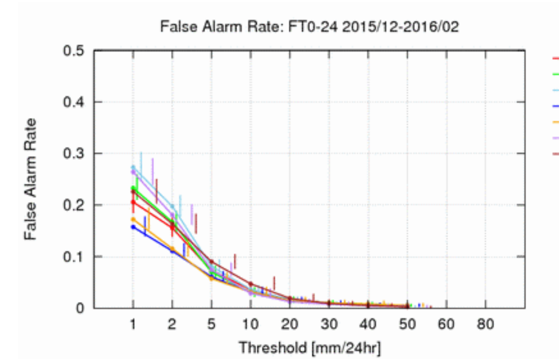






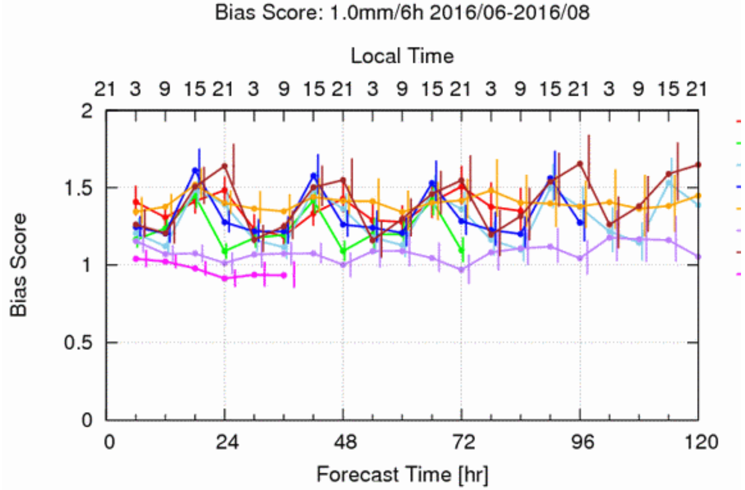


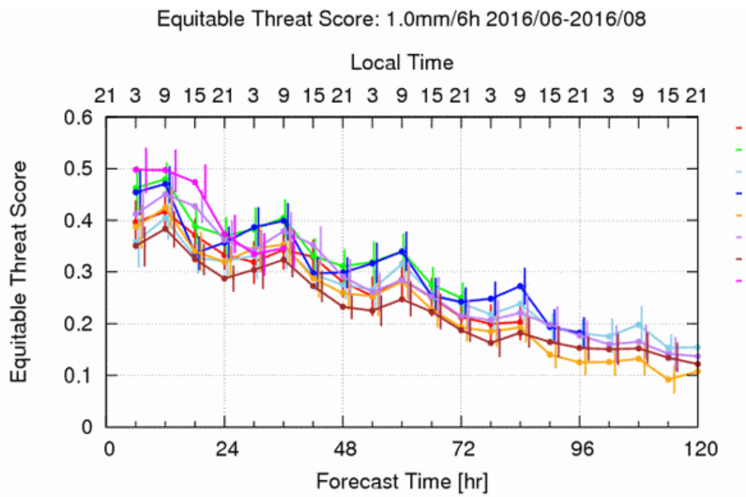


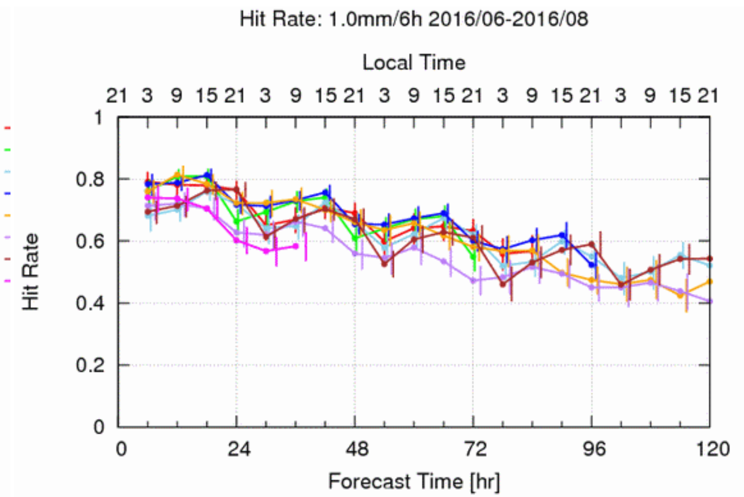


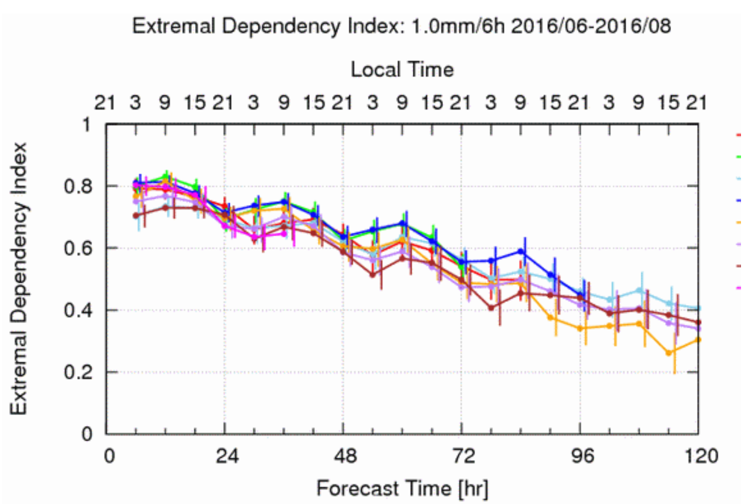
NOTE: Error bars are shifted slightly for clarification.

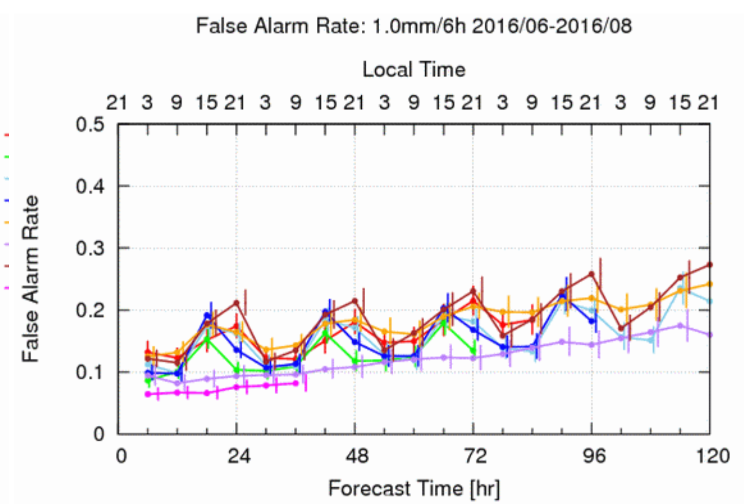
2016JJA

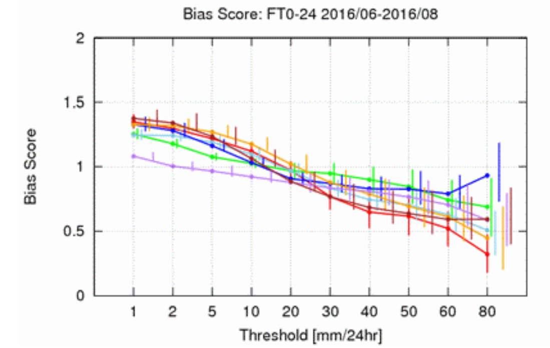


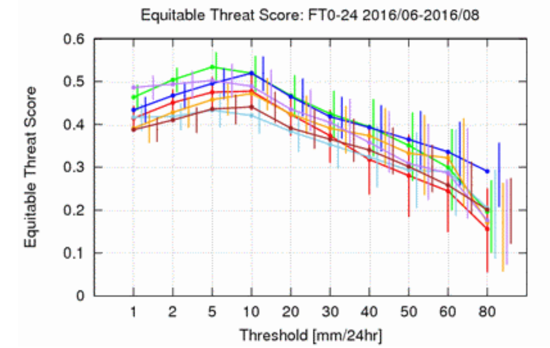


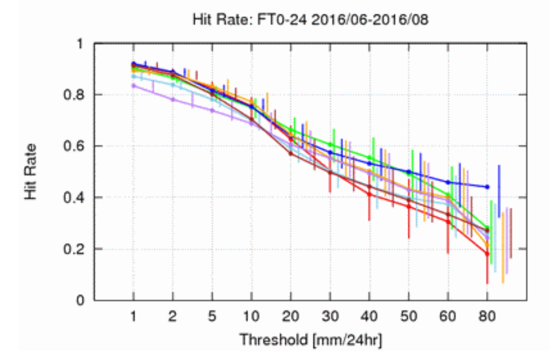


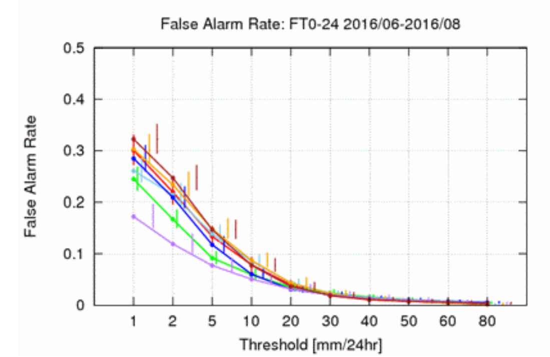












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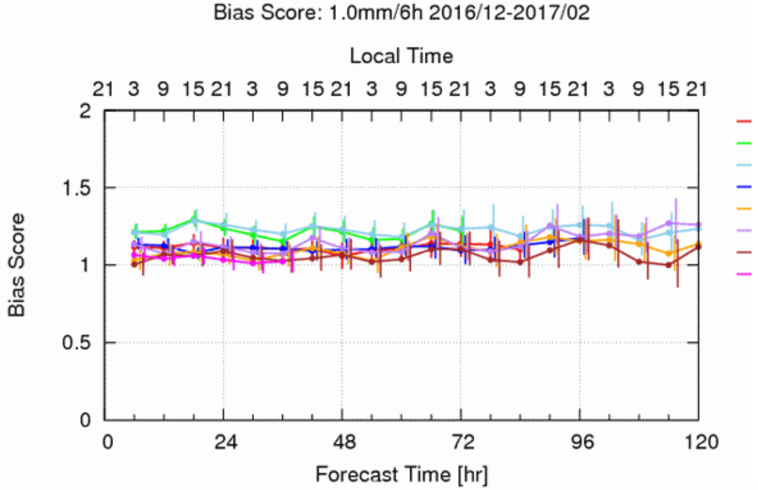
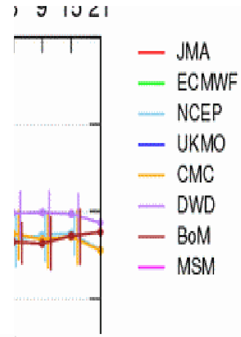
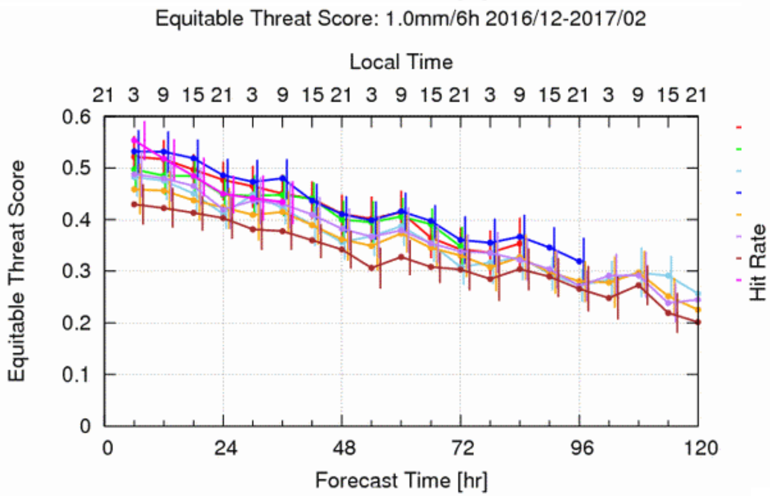
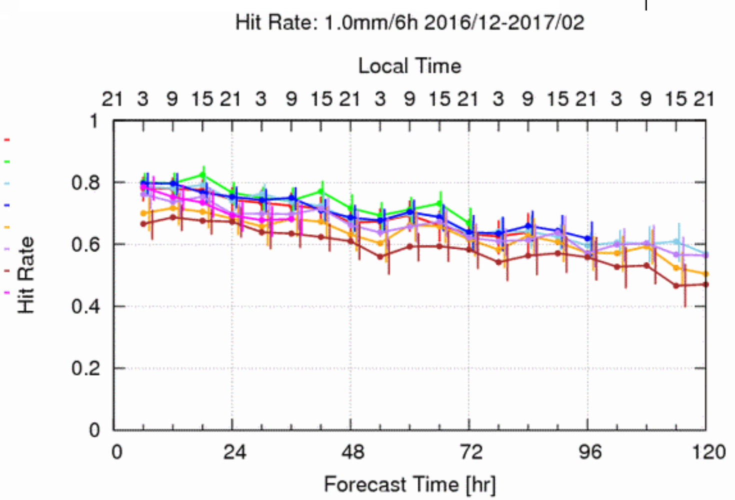
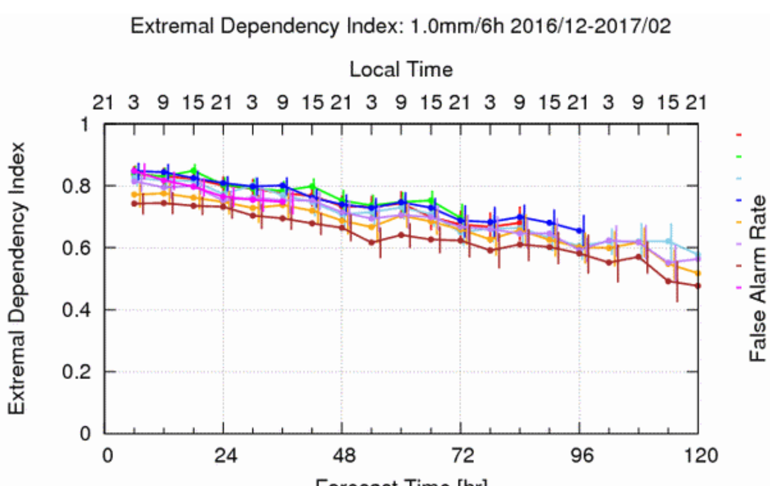
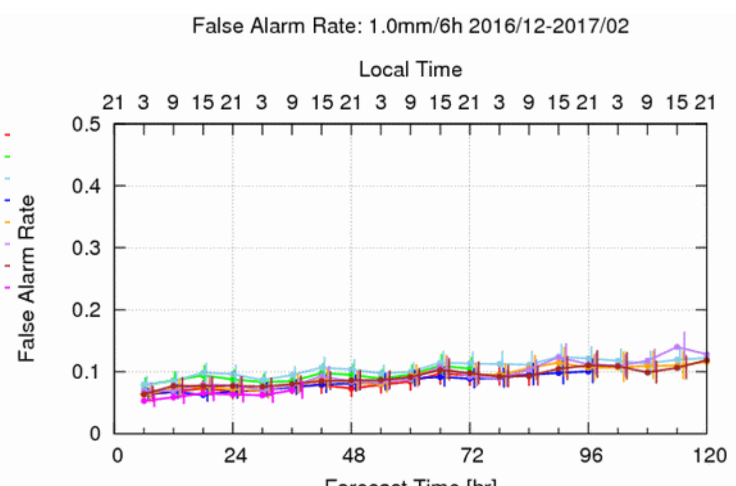


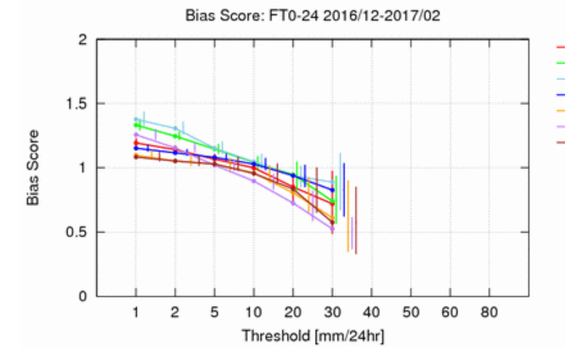


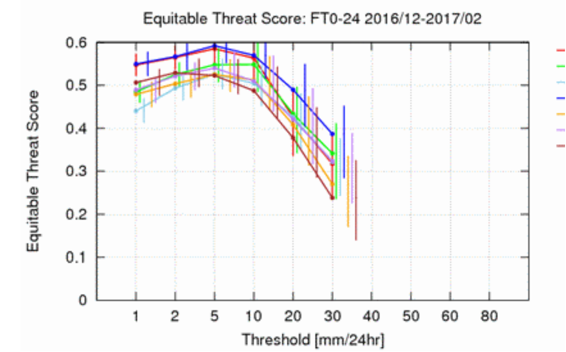


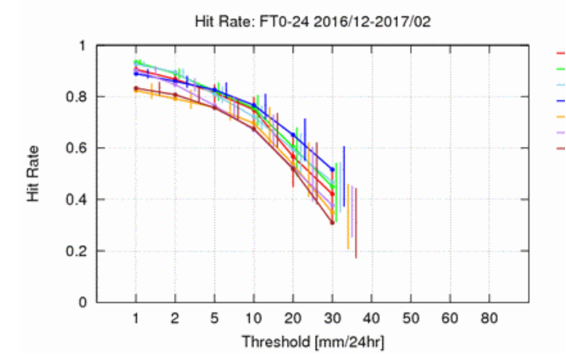


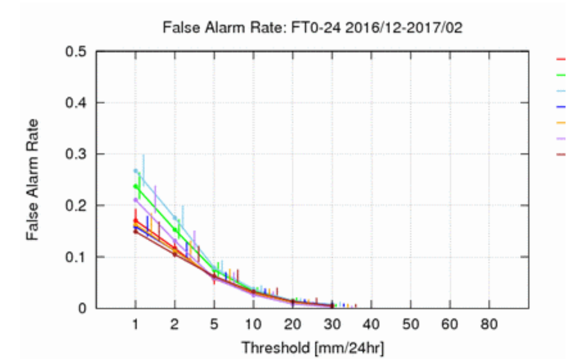












気象庁 Japan Meteorological Agency

NOTE: Error bars are shifted slightly for clarification.

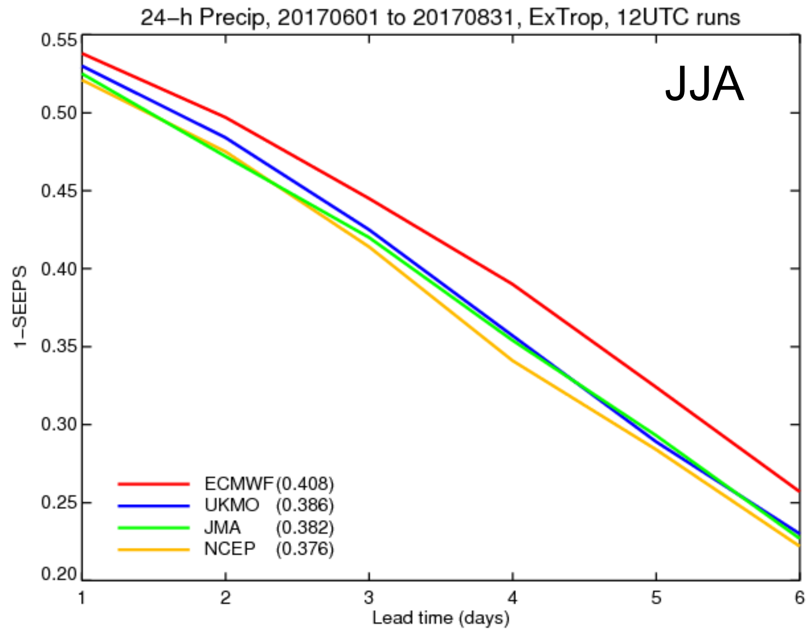
ECMWF

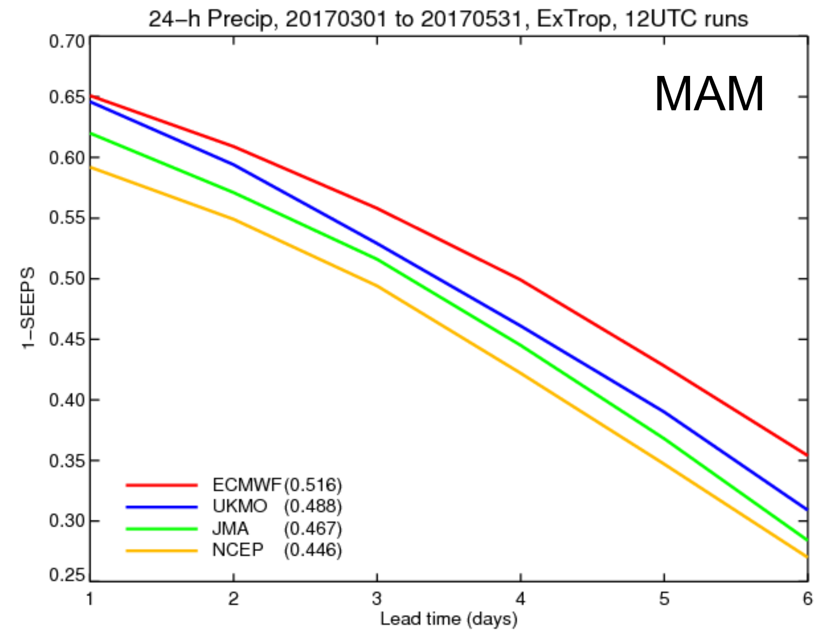
Contact person : Thomas Haiden
thomas.haiden@ecmwf.int

Verification using SYNOP

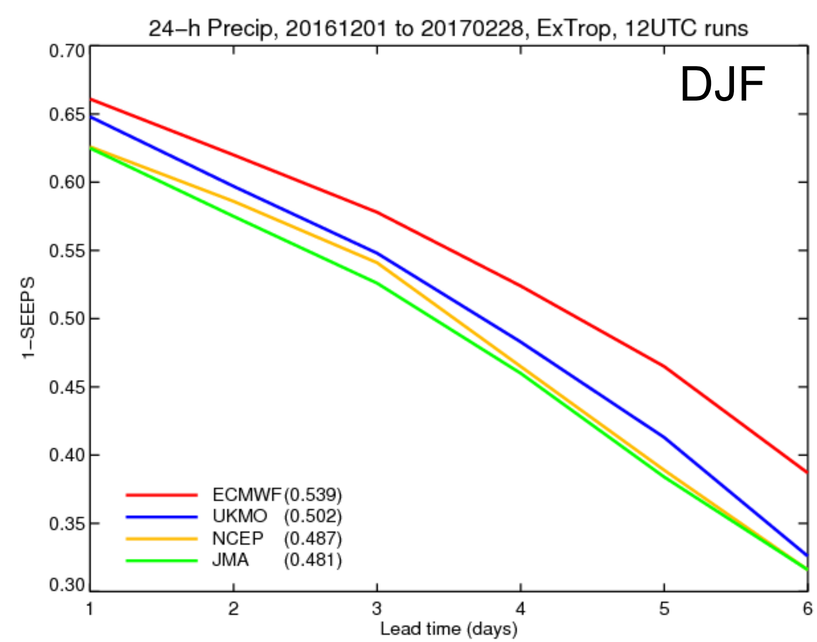
- Characteristics
  - 24-h precipitation
  - Forecast days 1 to 10
  - Aggregation over large domains (extra-tropics, tropics, europe)
- Verification of Deterministic Forecasts
  - Symmetric Equitable Error in Probability Space (SEEPS)
  - Peirce Skill Score (PSS)
- Verification of Ensemble Forecasts
  - Continuous Rank Probability Skill Score (CRPSS)

Model intercomparison – deterministic forecast



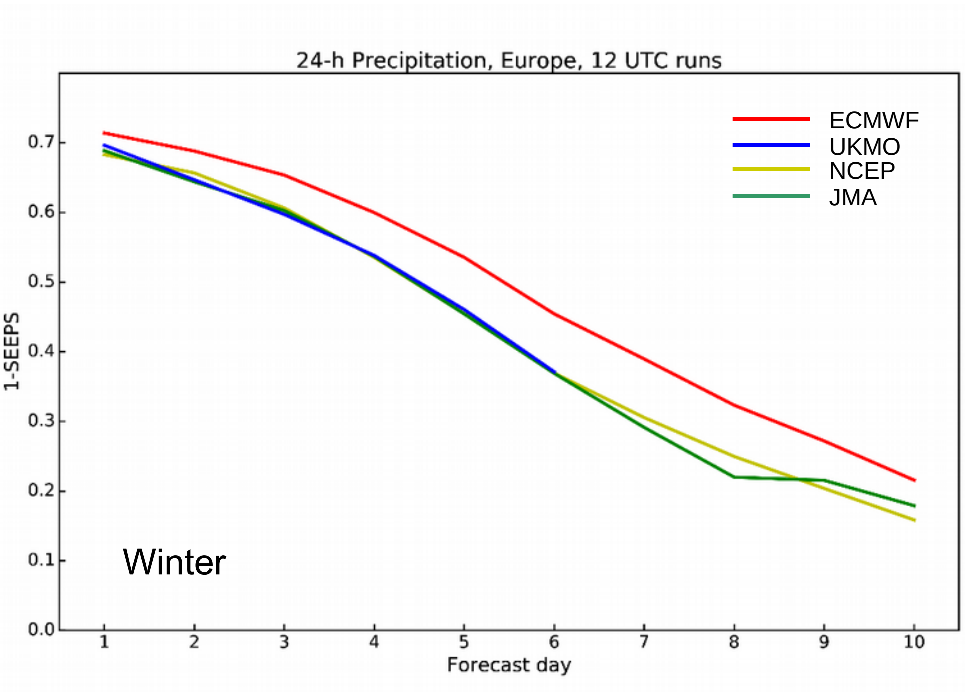


Extratropics

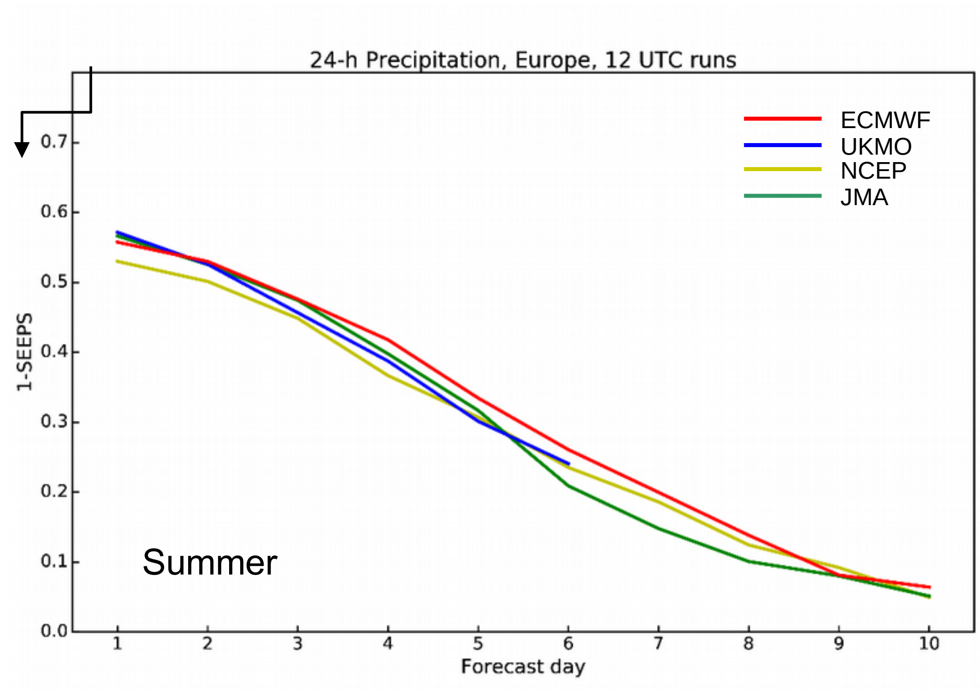


Model intercomparison – deterministic forecast

Europe



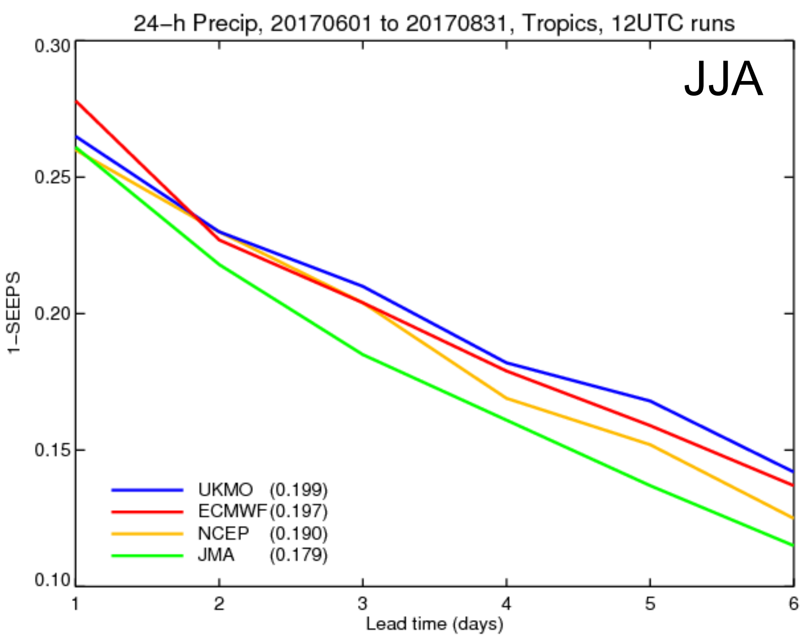
DJF 2016-17



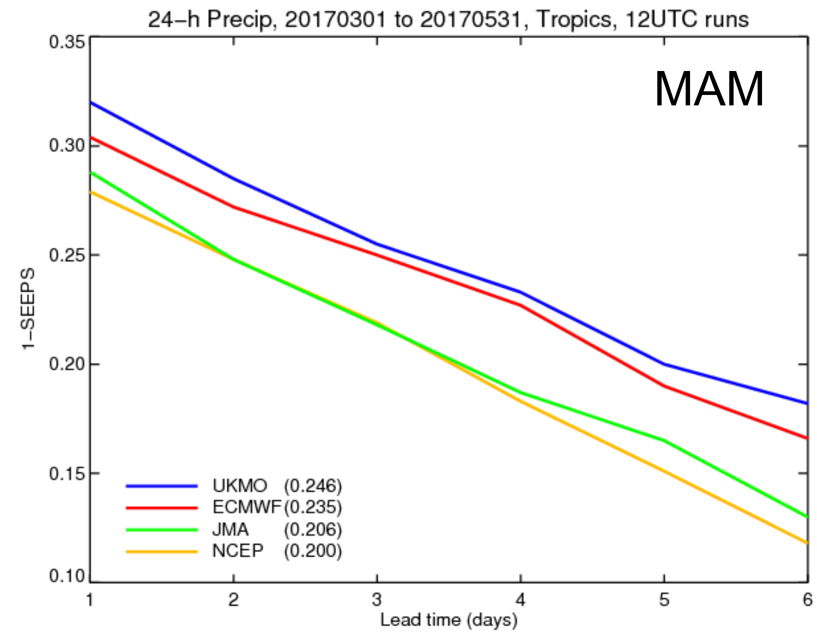
JJA 2017

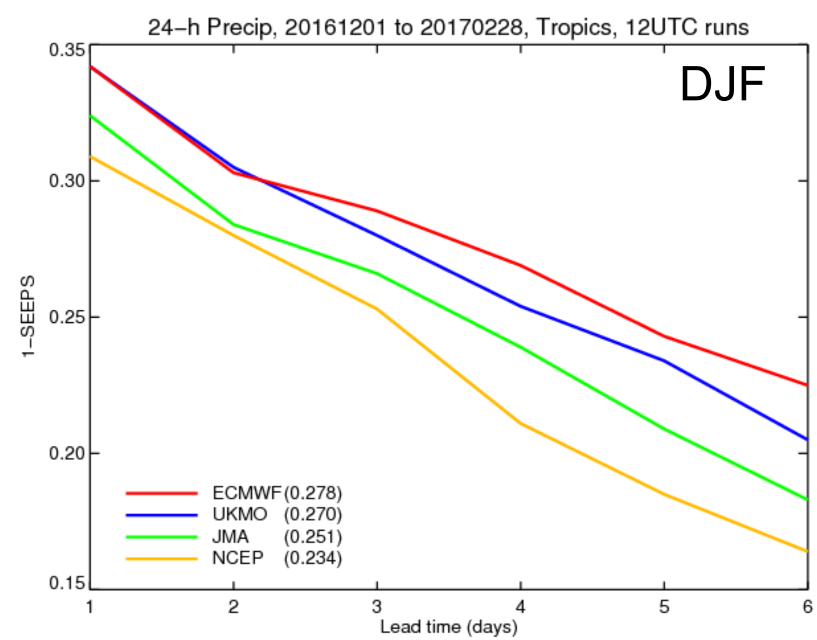
ECMWF

Model intercomparison – deterministic forecast

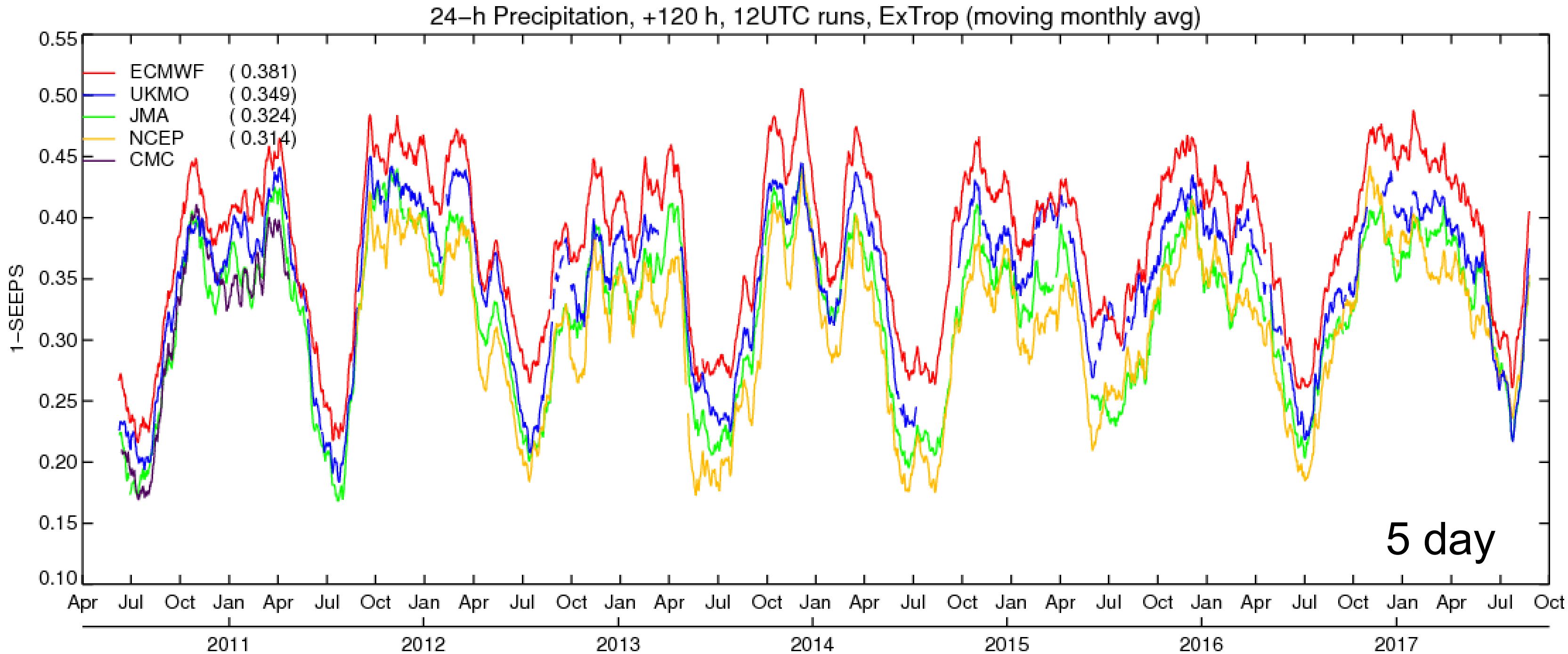


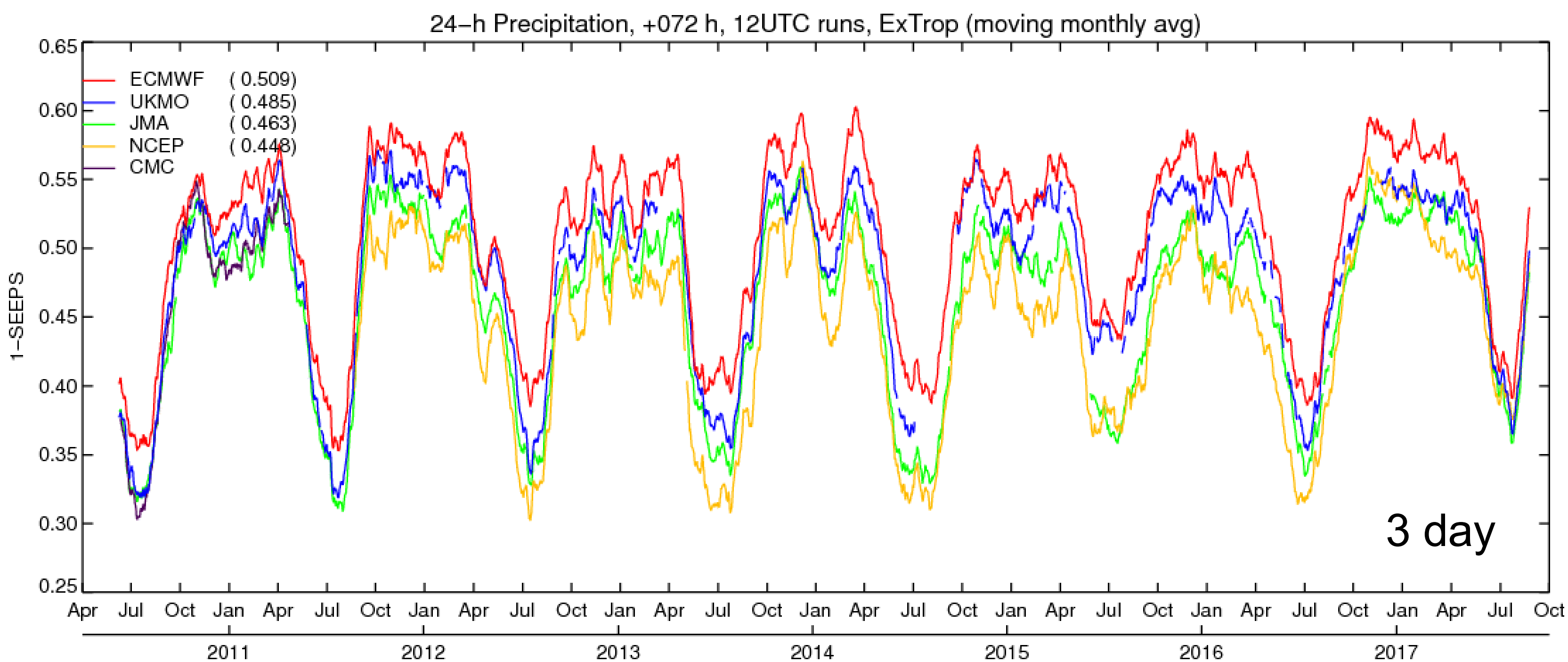
Tropics



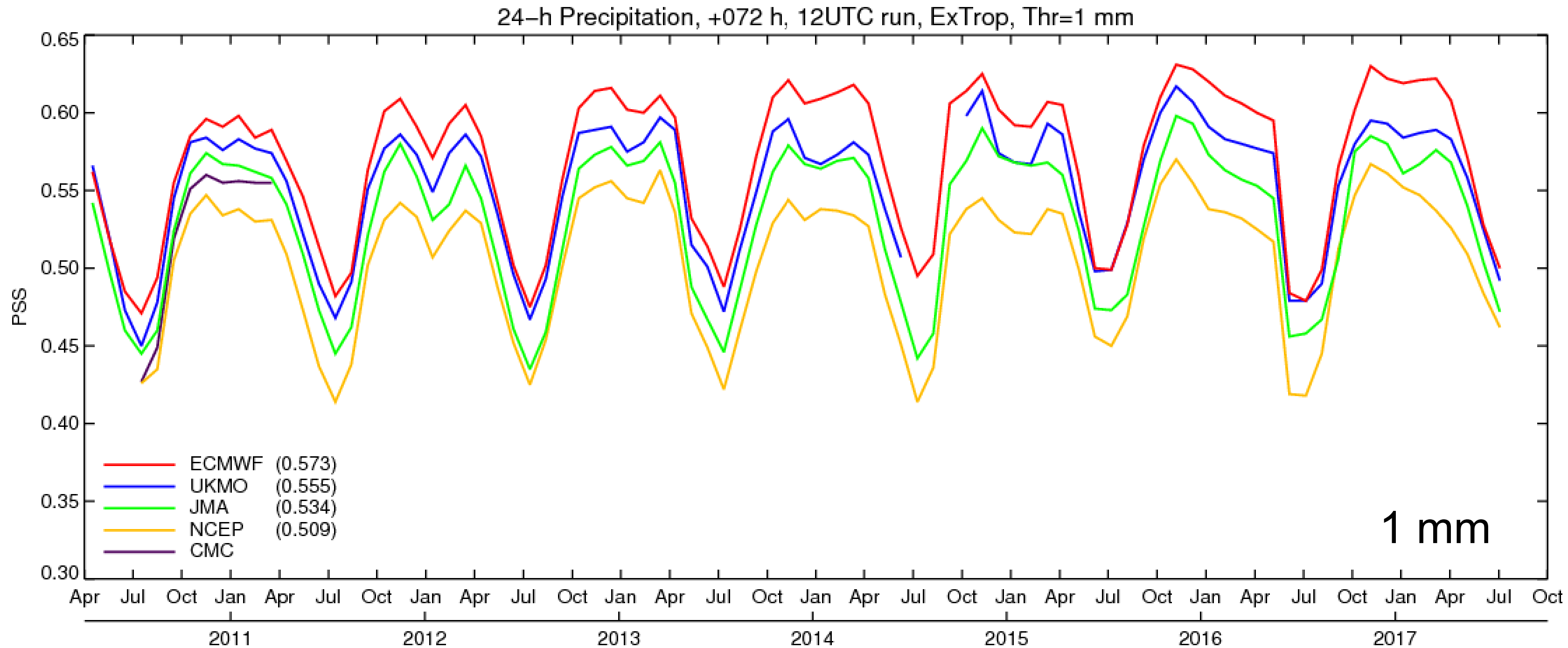


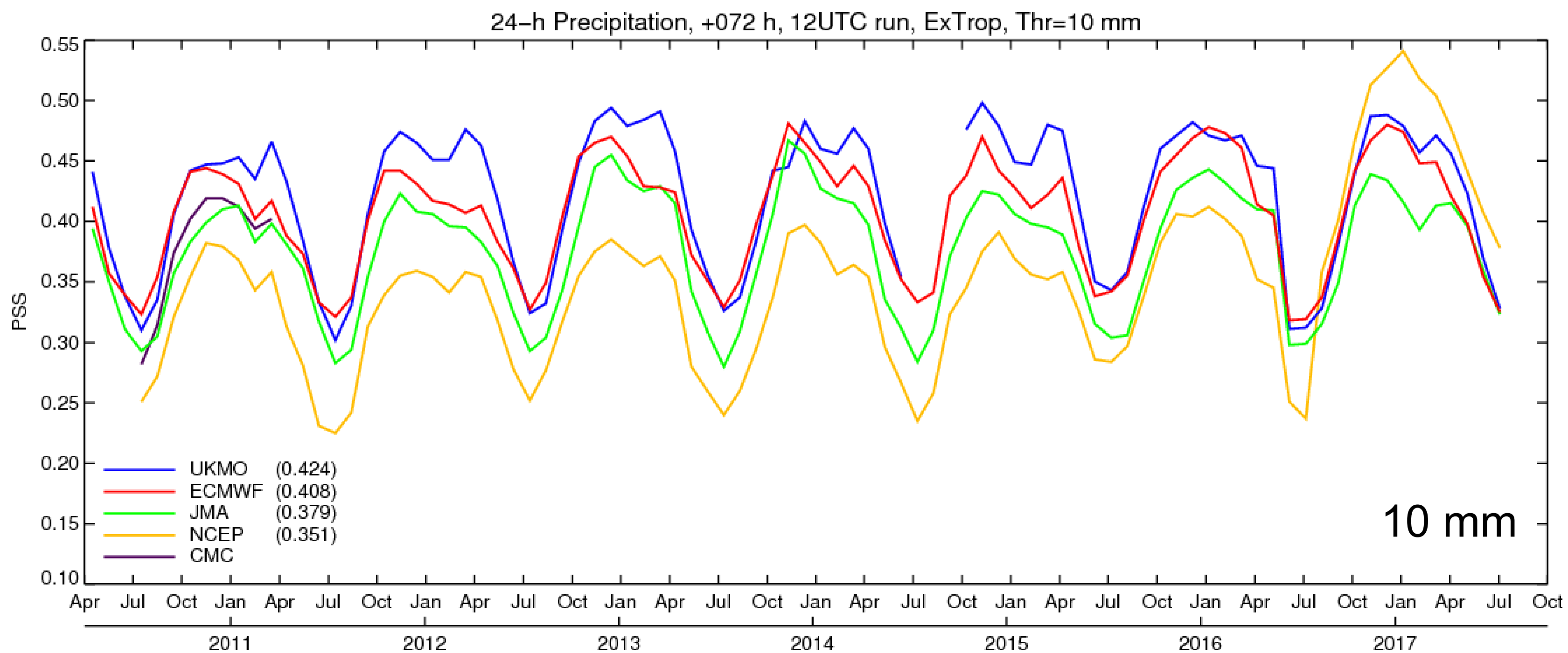
Model intercomparison – deterministic forecast



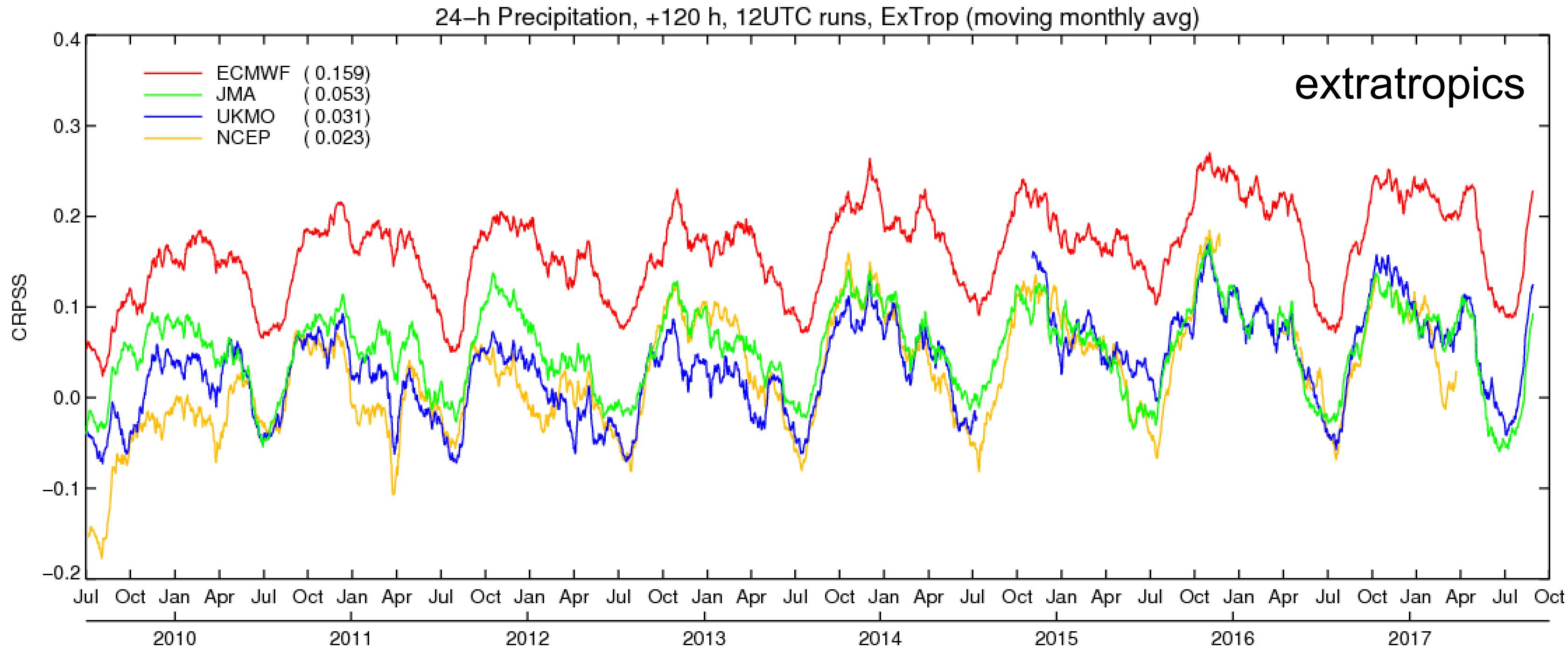


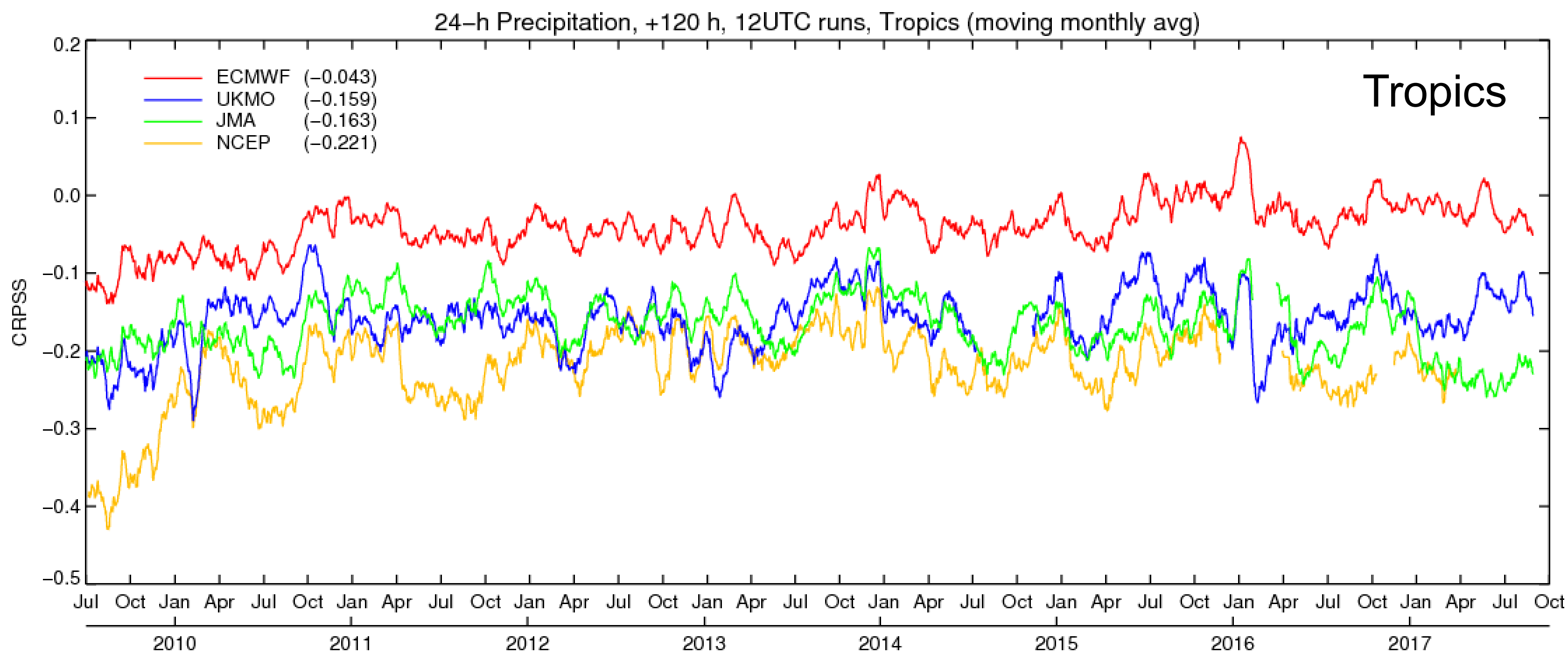
Model intercomparison – deterministic forecast



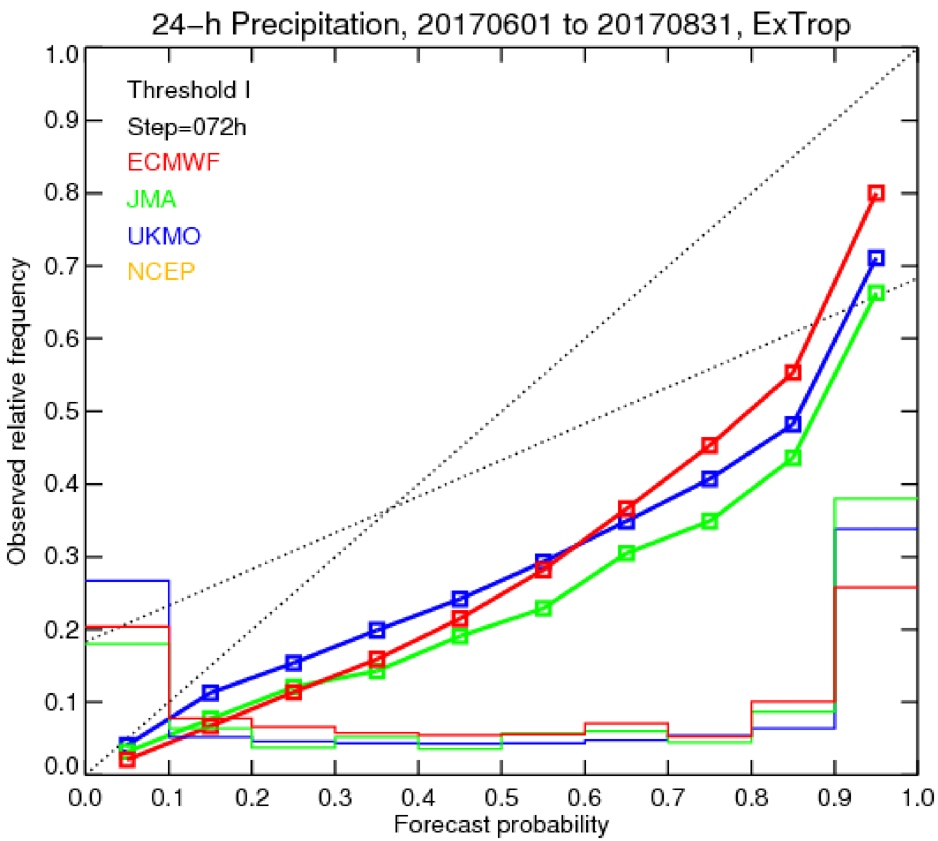


Model intercomparison – ensemble forecast

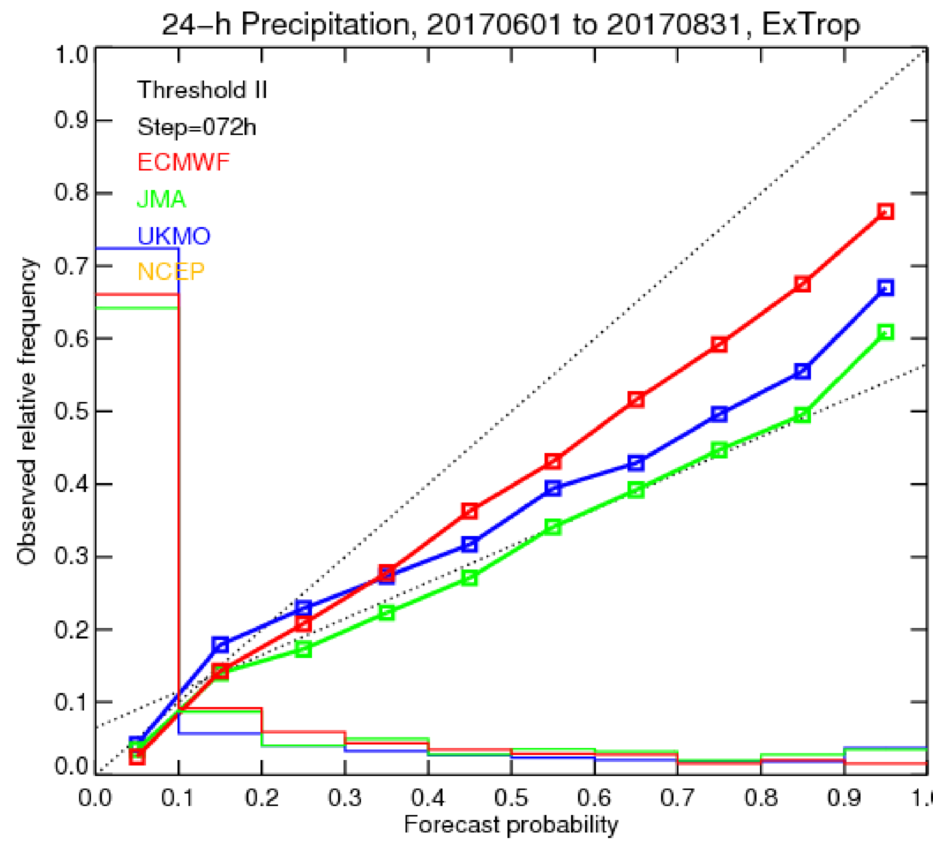




Model intercomparison – ensemble forecast



Light precipitation



Moderate-to-heavy precipitation

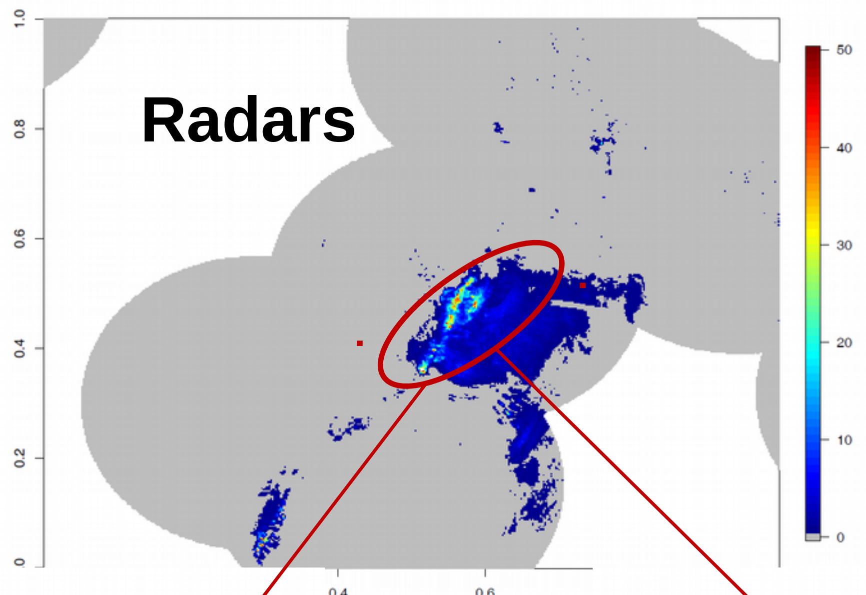
Roshydromet

Contact person : Anastasia Bundel
a.bundel@gmail.com

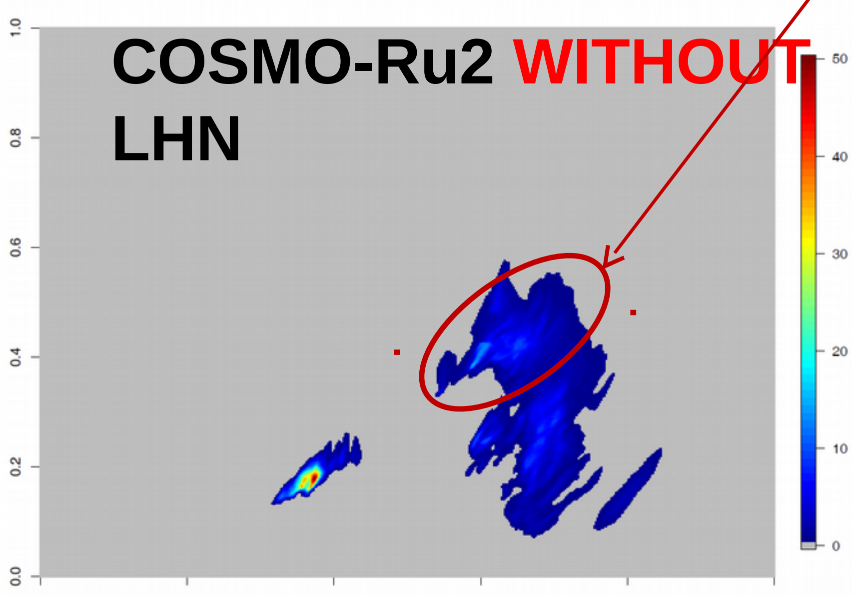
Spatial methods using R SpatialVx for assessing radar data assimilation performance at RHM: a framework

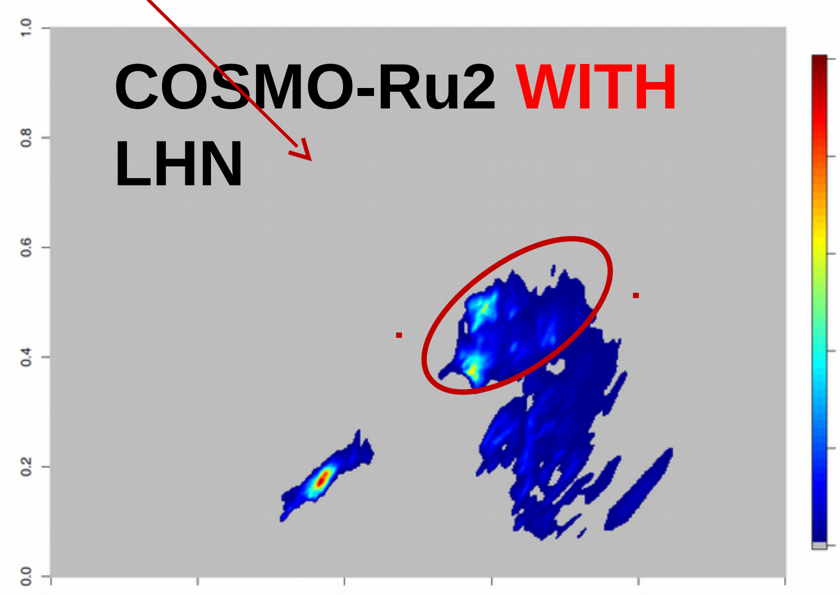
A. Bundel, A. Muraviev, D. Blinov, E. Finkelberg

1h precipitation totals (mm/h) from radar data and COSMO-Ru2, 13 July 2016 (heavy showers and thunderstorms), 19-20 UTC, initial data 2016071318 (2h lead time), Central



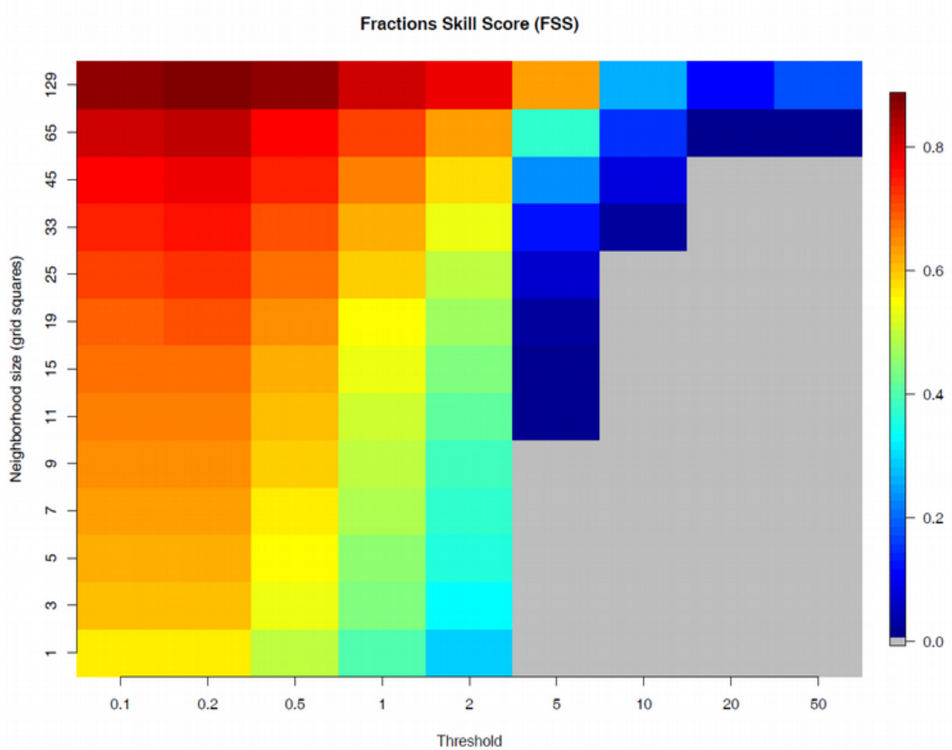
Latent Heat Nudging (LHN) assimilates precipitation intensities derived from radar composites over Central Russia

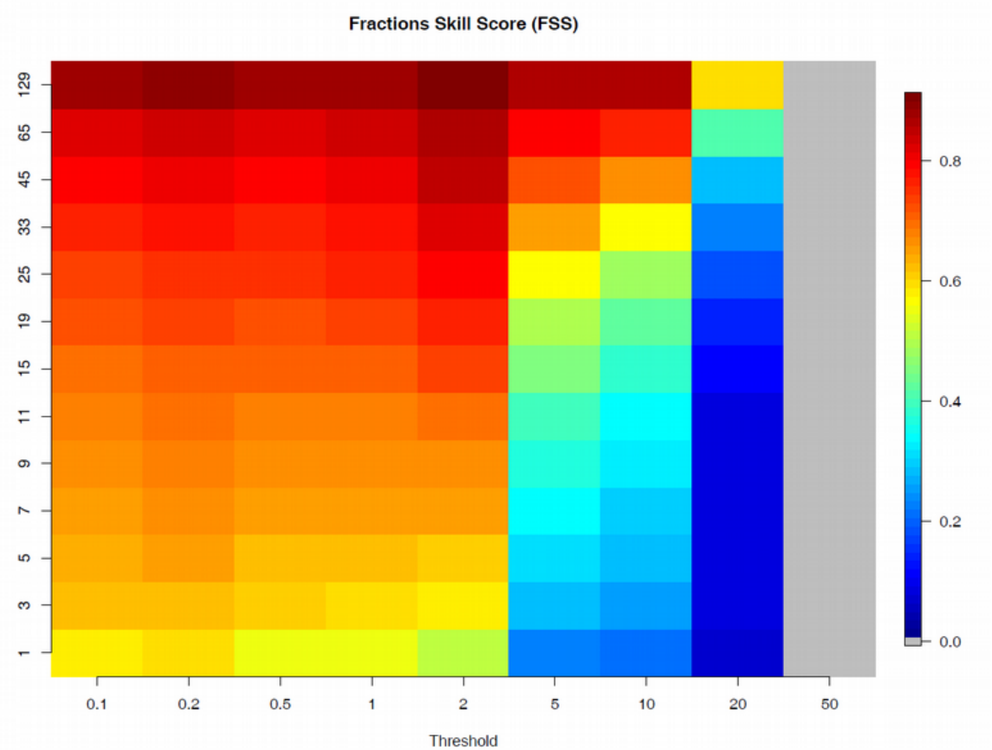




Fractions skill score (FSS) COSMO-Ru2
13 July 2016, 19-20 UTC, Central Russia

Neighborhood size, grid cells



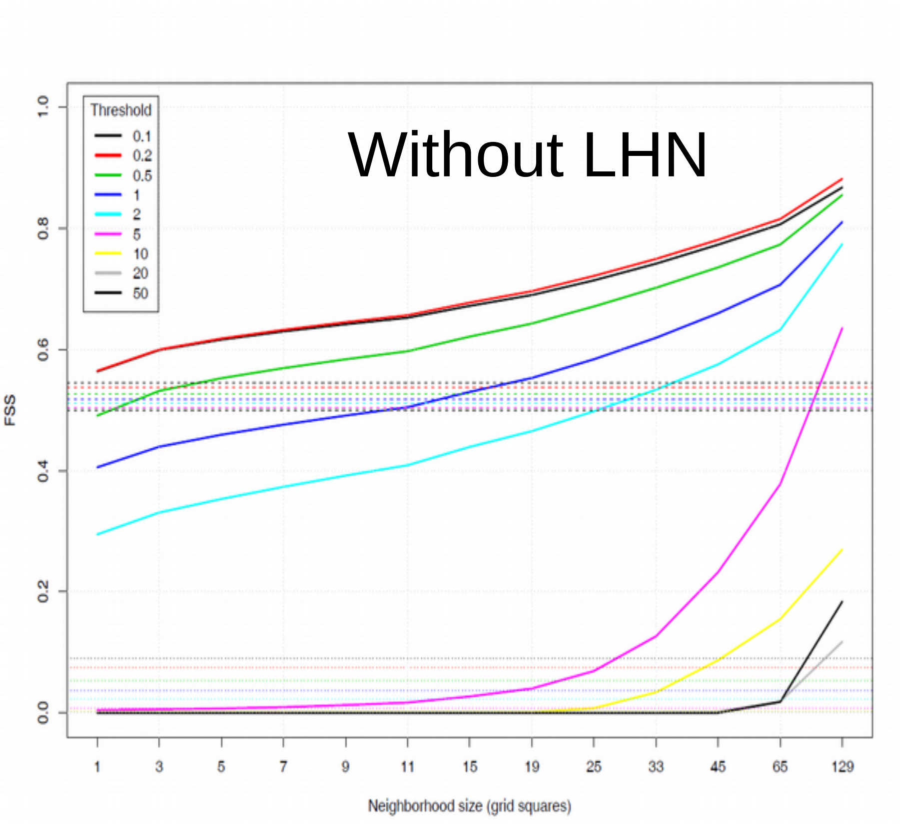


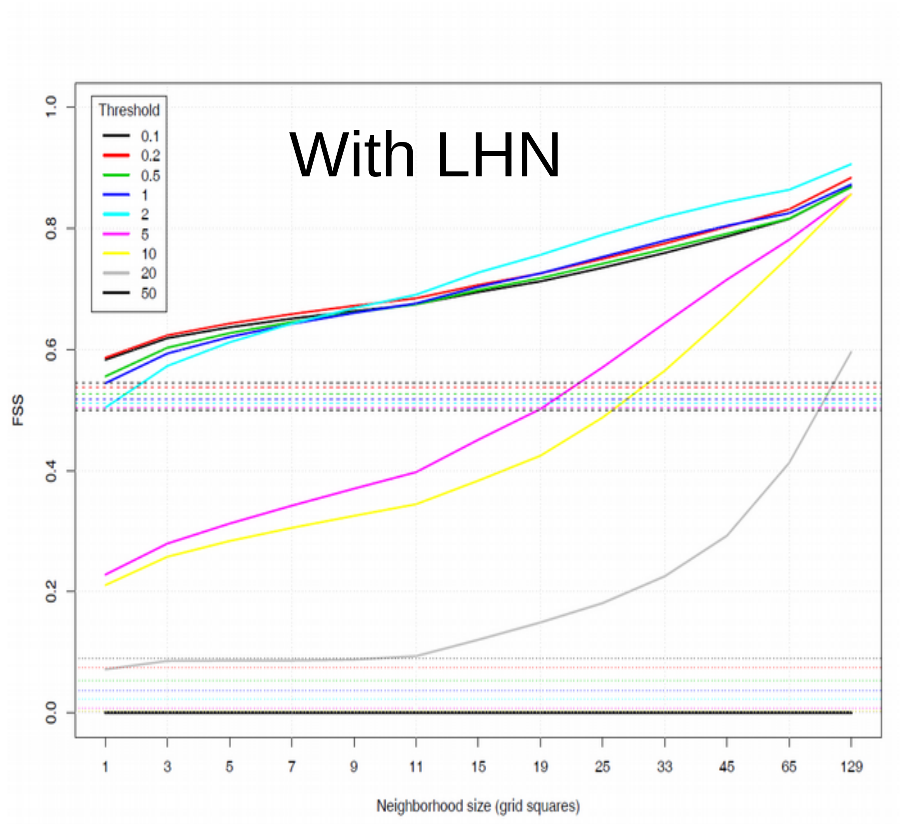
Precip thesholds

The “redder” the better.

LHN improves the forecast of precipitation, especially of intense one

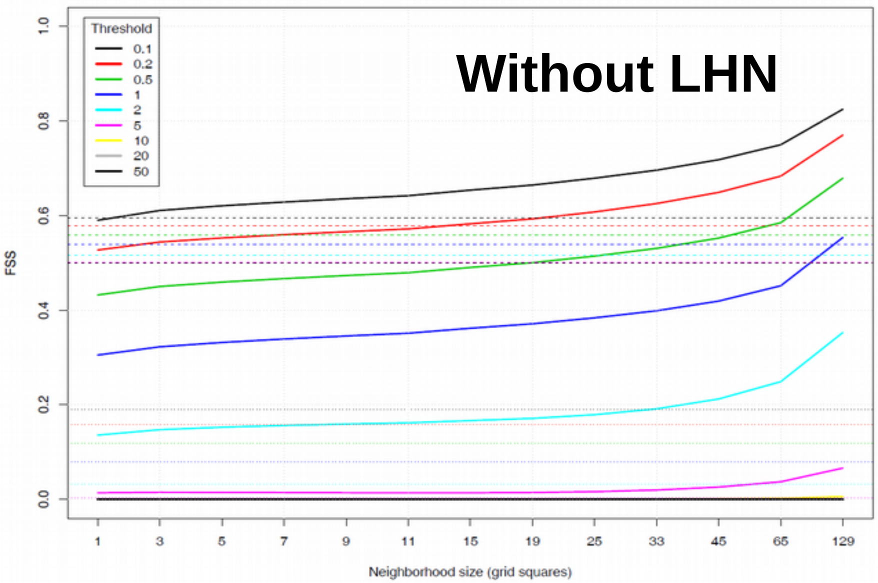
Fractions skill score (FSS) COSMO-Ru2
13 July 2016, 19-20 UTC, Central Russia

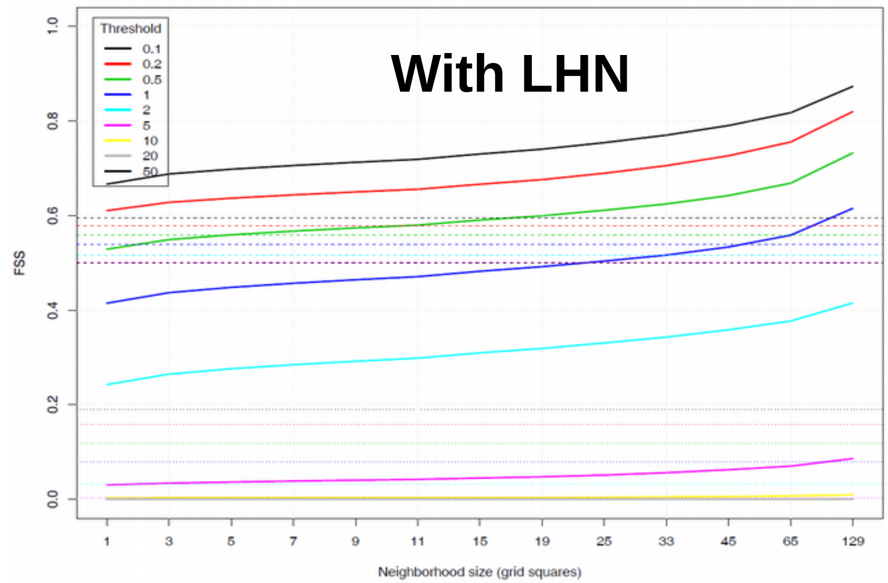




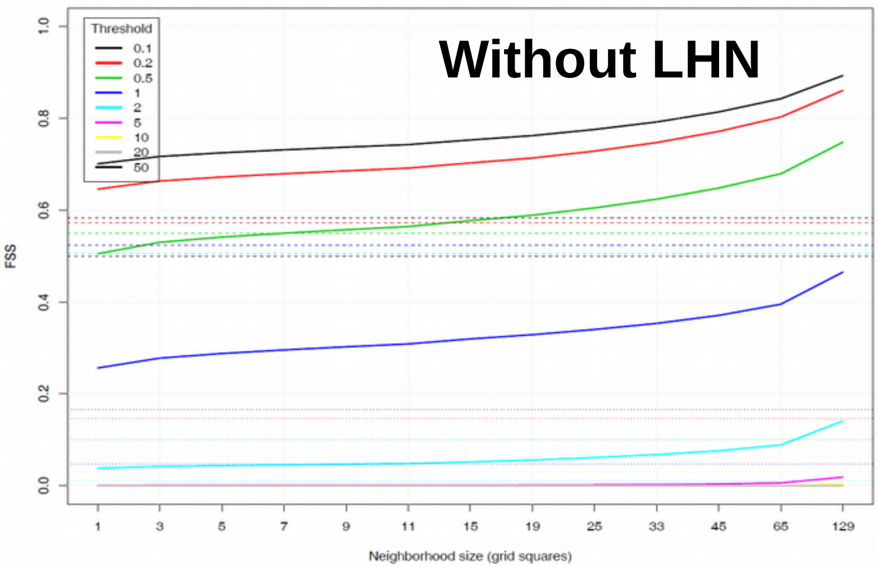
Starting from the threshold 0.5 mm/h, FSS is higher for the model with LHN

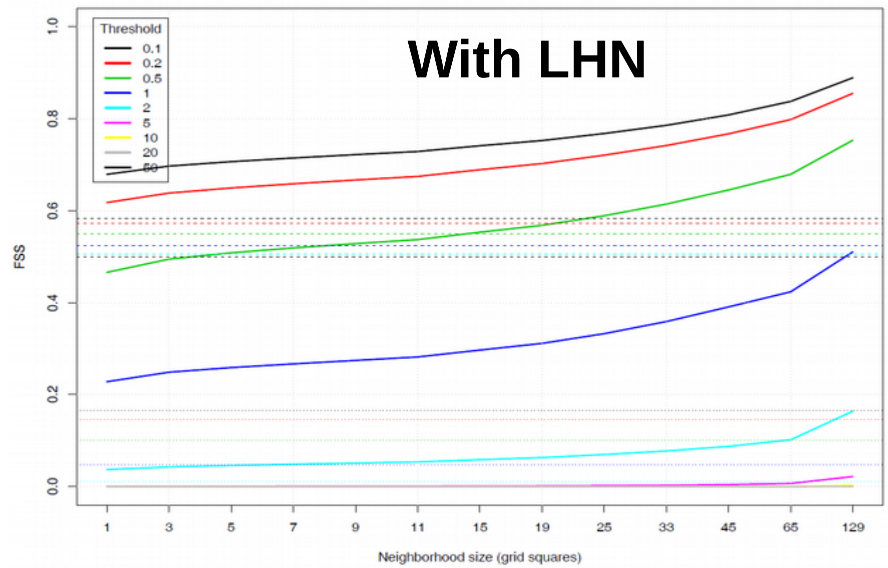
FSS of 6 h precip accumulations. 13 July 2016 18 UTC –
14 July 2016 00 UTC (first 6 hours of forecast period)





FSS of 6 h precip accumulations, 14 July 2016, 00-06 UTC (second 6 hours of forecast period)



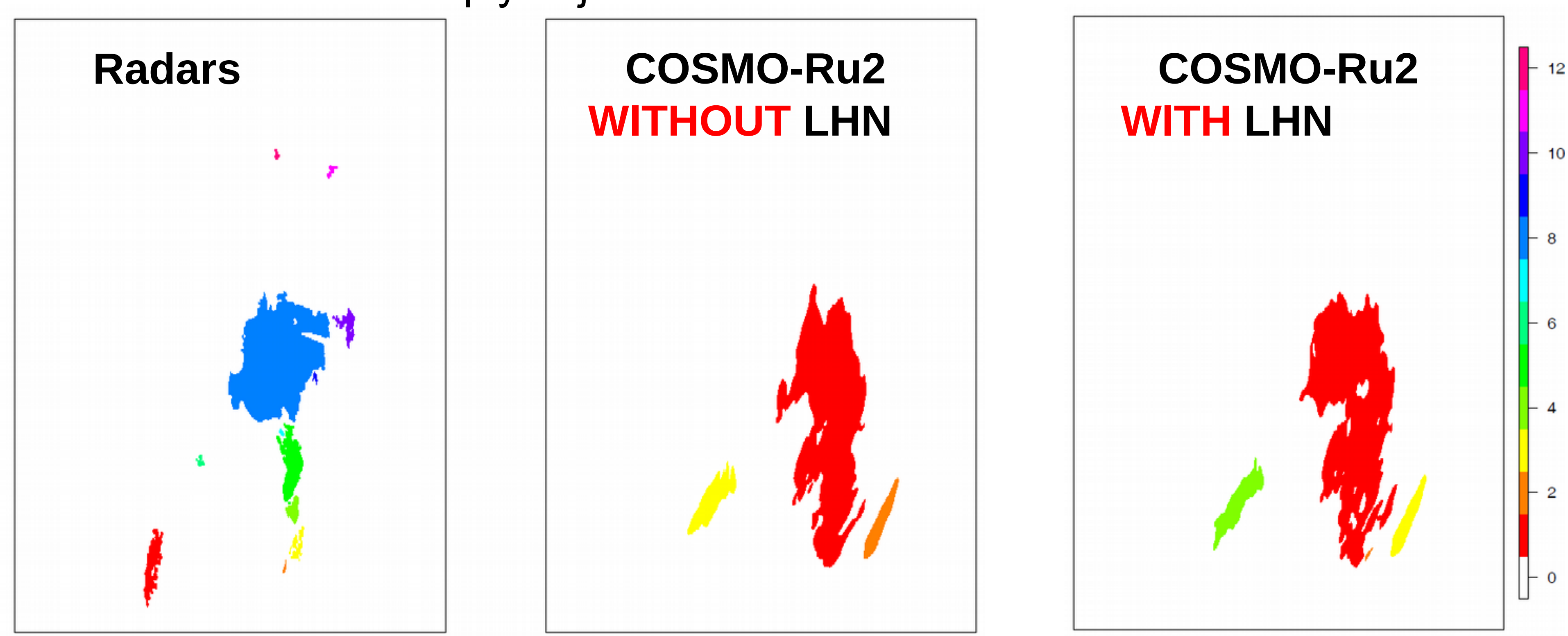


No improvement with LHN after the first 6 hours of forecast period

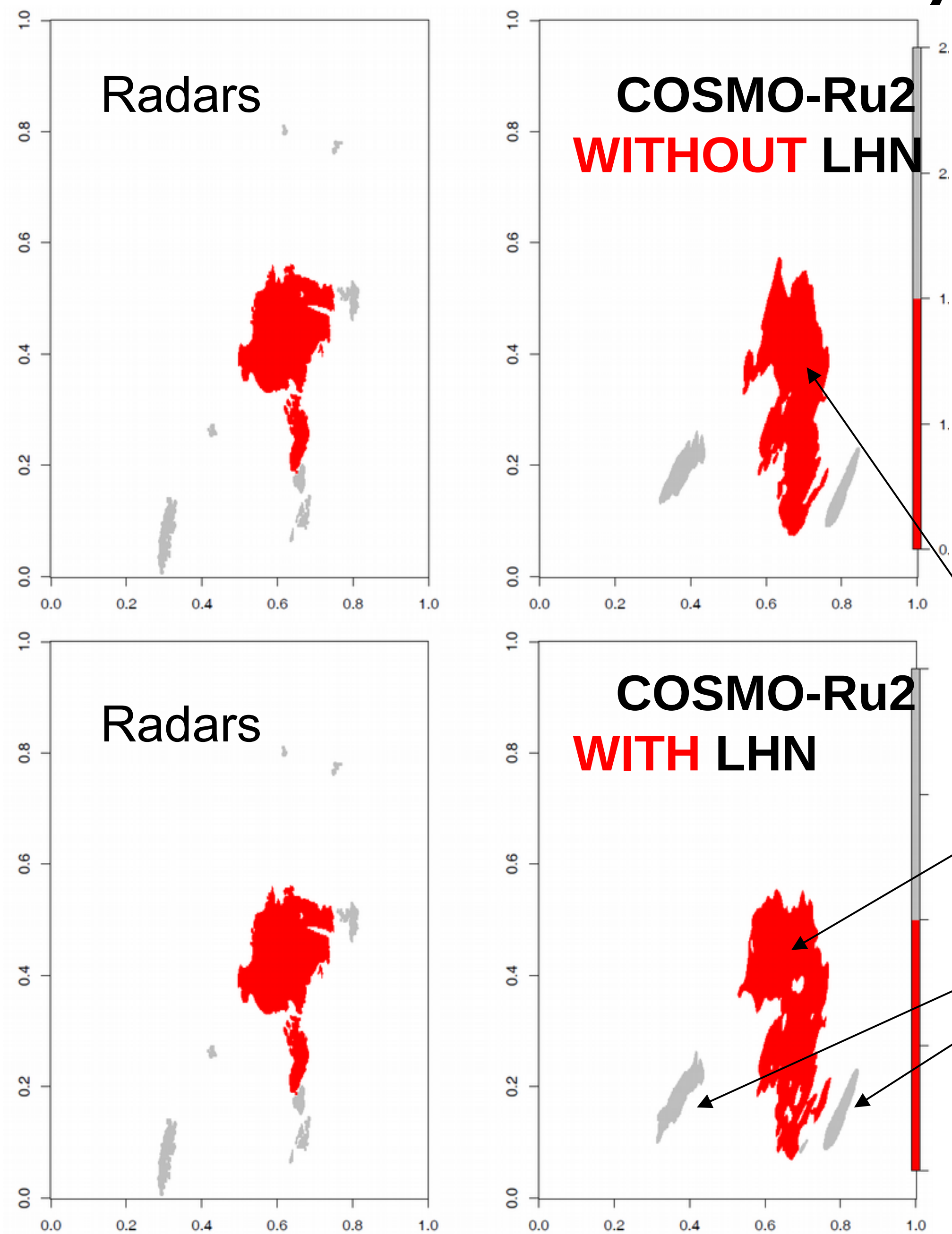
Experiments with object-based methods

Objects are contiguous areas with precipitation values greater than a certain threshold.

Objects for threshold > 0.5 mm/h, 13 July 2016, 19-20 UTC.
Colors indicate simply object order numbers



Matched object pairs
> 0.5 mm/h 13 July 2016, 19-20 UTC



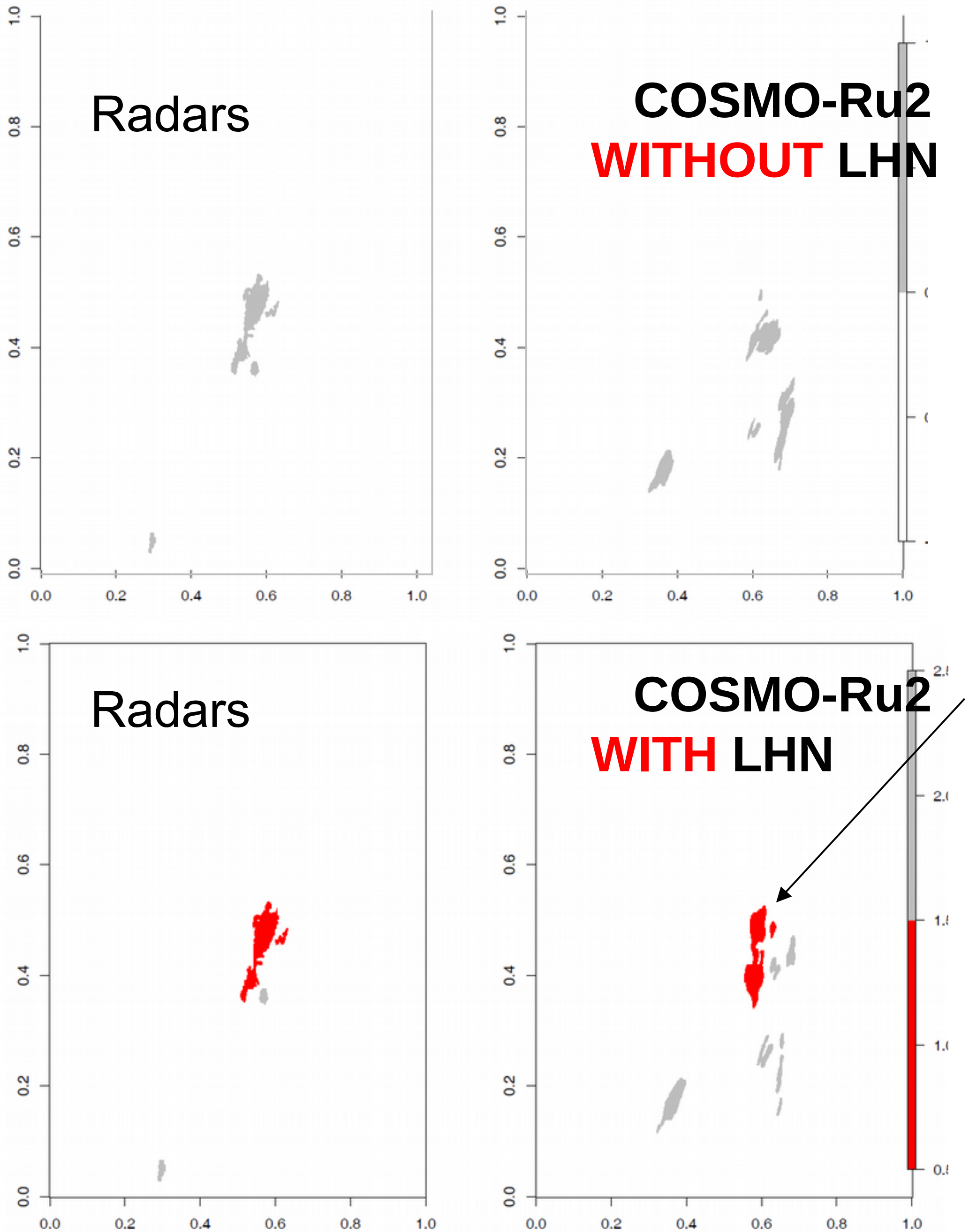
<u>Matching criterion:</u>
Centroid distance between forecast and observed objects is less than the average object size
(object size is the square root of object area)

Colors indicate matched pairs

These objects are considered forecasted

Grey objects are not matched

Matched object pairs
> 5 mm/h 13 July 2016, 19-20 UTC



No paired objects for the model without LHN

The area of intense precipitation is greater in the model with LHN, sufficiently to satisfy the matching criterion

Many unpaired objects

Conclusions

- An experiment was made on evaluating the effect of latent heat nudging (LHN) in COSMO-Ru2 using precipitation intensities derived from radar composites over Central Russia (heavy rainfalls and thunderstorms on 13-14 July 2016). The neighborhood and object-base approaches were applied using R SpatialVx. The LHN effect is positive if there are large areas of intense precipitation. More test cases are needed!
- FSS scores are sensitive to domain choice
- It is difficult to choose the best universal matching function for the object-based methods that require pair-wise matching of observed and forecast objects. The study is being continued.

CPTEC

Contact person : Ariane Frassoni
ariane.frassoni@inpe.br

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

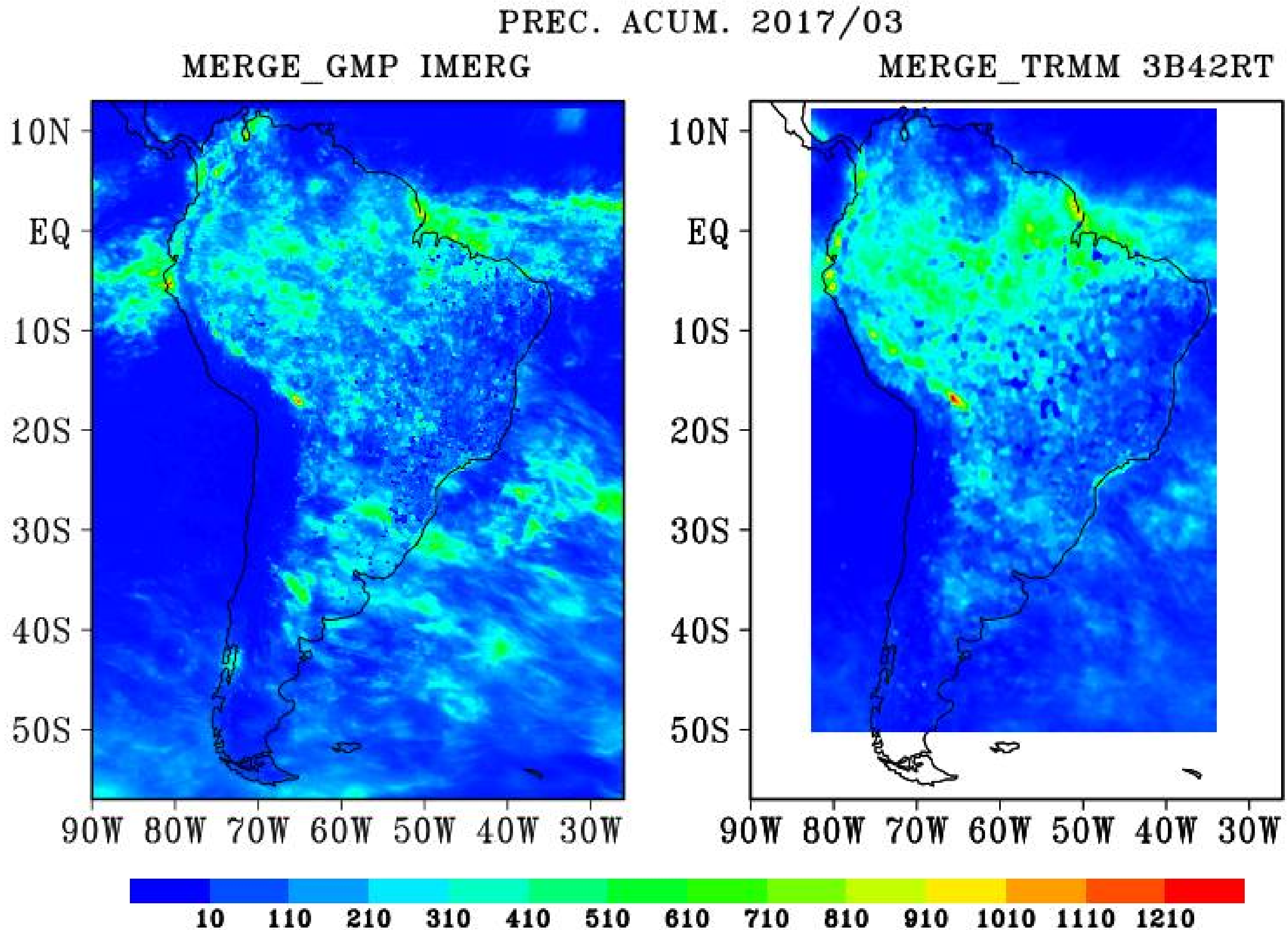
Operational verification of quantitative precipitation forecast at INPE/CPTEC

José R. Rozante

Center for Weather Forecasting and Climate Studies,
National Institute for Space Research, Brazil

October 2017

New MERGE (Rozante et al., 2010) – rain gauge and satellite precipitation estimation combination in 5km horizontal resolution, available daily for South America



Comparison between GPM_IMERG_V04 (5km resolution) and TRMM_3B42RT (20km resolution)

Description

GPM_IMERG_V04 – the product is generated using Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG) (Huffman et al., 2015 a,b,c)

Format: grib2

Horizontal resolution: 5km resolution

Temporal resolution: daily (24h) for South America and hourly for Brazil

Variables: precipitation accumulation in 24h and number of observations per grid point

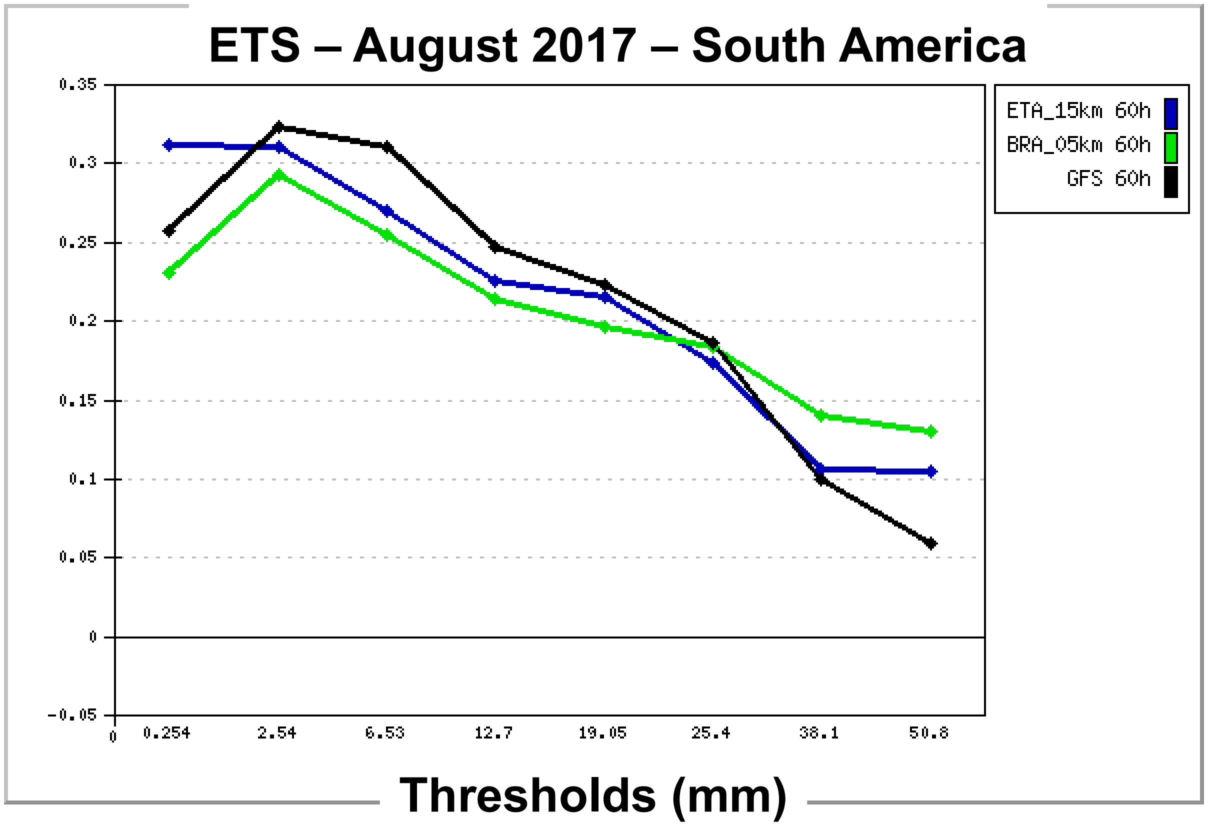
Research version: IMERG GPM_Final (GPM_F) and TMPA TRMM_V7 – Late release of 2 months

Operational version: IMERG GPM-Early, TMPA TRMM_RT – release each 4 hours; IMERG GPM-Late – release each 12 hours

Description

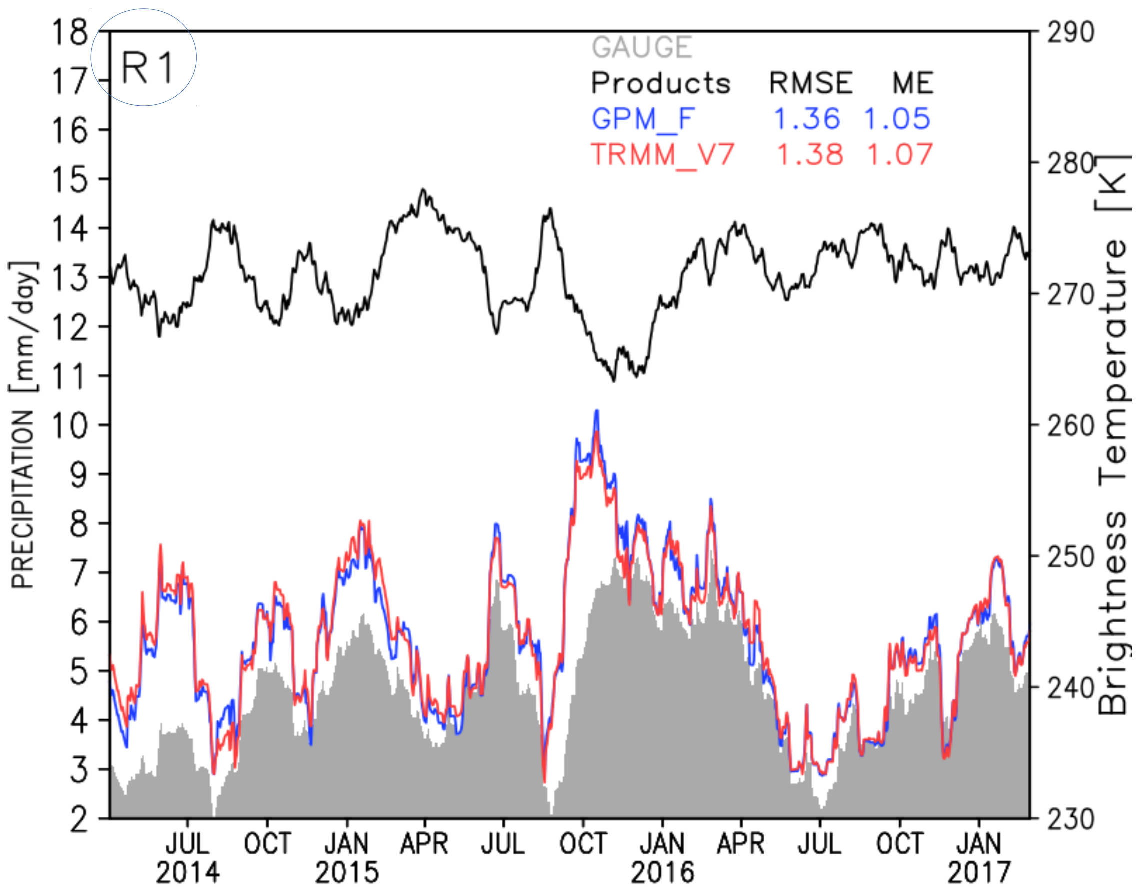
New MERGE dataset using IMERG is available from March 2014

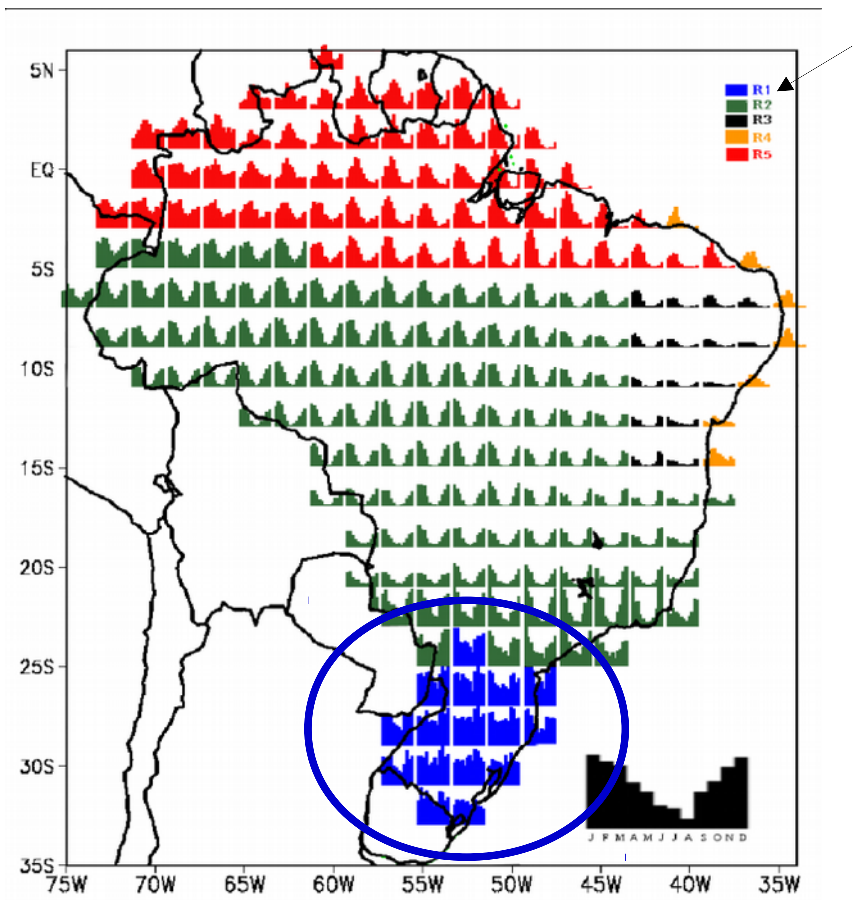
MERGE products are used in the routine process of QPF verification at CPTEC/INPE



Product validation
Comparison between two different sources of satellite data used in MERGE product

Region 1 – Southern Brazil (blue)



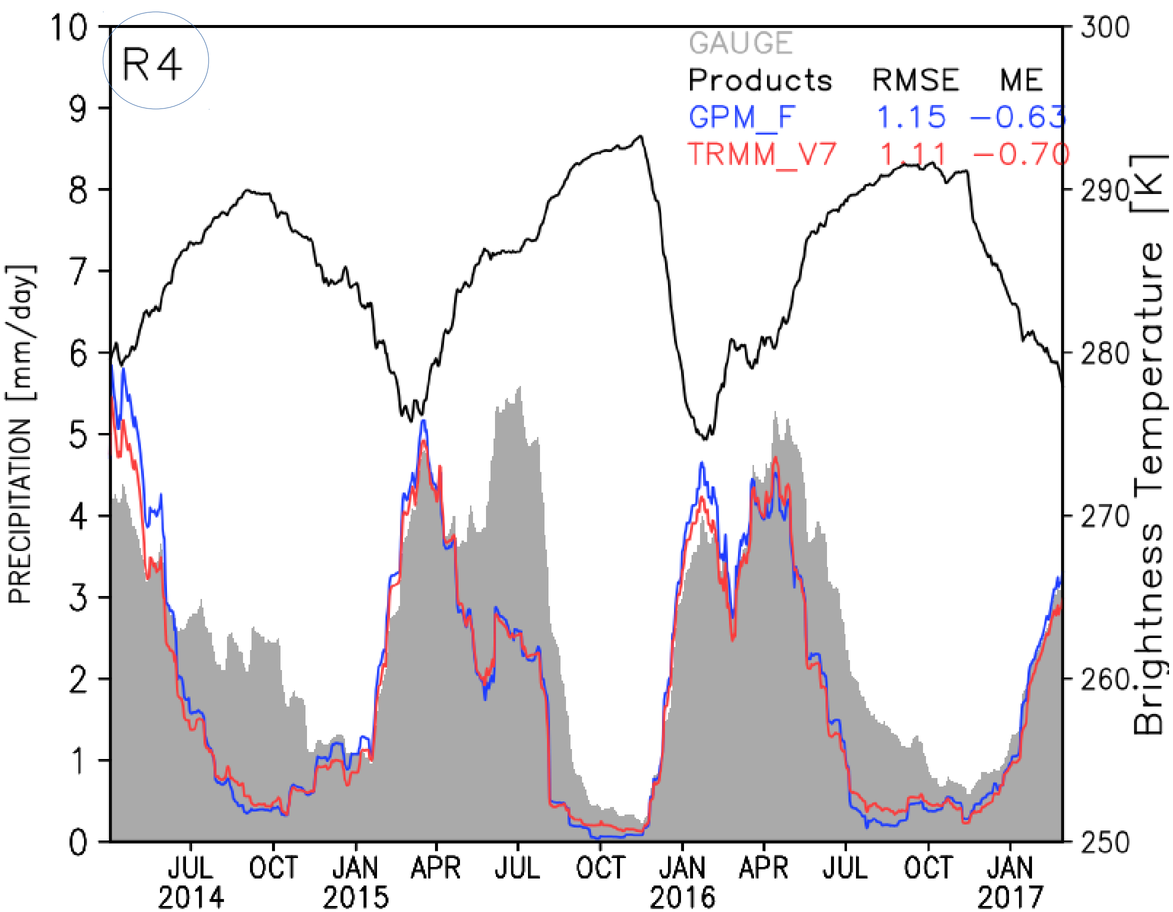


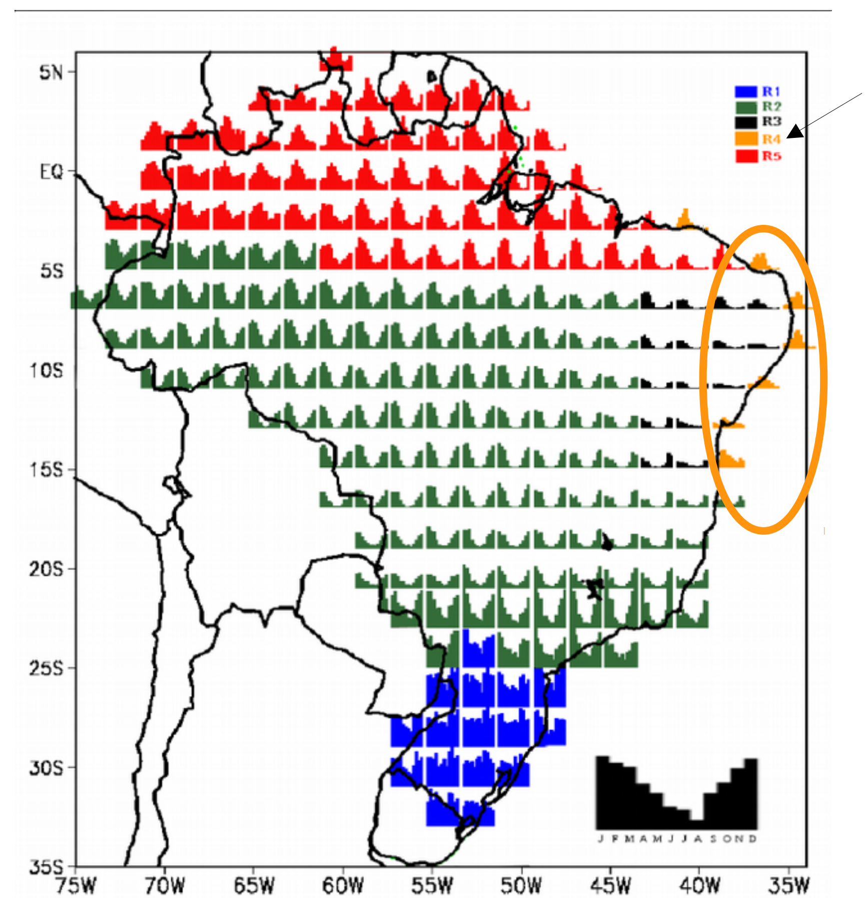
Precipitation overestimation in R1 is due to cold clouds

Product validation

Comparison between two different sources of satellite data used in MERGE product

Region 4 – East Northeast Brazil (orange)





Precipitation underestimation in R4 is due to warm clouds

Final remarks

TMPA (TRMM) and IMERG (GPM) estimations are comparable, even with different horizontal resolutions

The new MERGE increases the details of precipitation spacial distribution with 5km resolution over South America

References

Huffman, G.J., R.F. Adler, D.T. Bolvin, G. Gu, E.J. Nelkin, K.P. Bowman, E.F. Stocker, D.B. Wolff The TRMM multi satellite precipitation analysis (TMPA): quasi-global, multi-year, combined-sensor precipitation estimates at fine scales J. Hydrometeorol., 8 (2007), pp. 38-55

Huffman, G. J., D. T. Bolvin, D. Braithwaite, K. Hsu, R. Joyce, C. Kidd, E. J. Nelkin, and P. Xie, 2015a: NASA Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG). Algorithm Theoretical Basis Doc., version 4.5, 26 pp. [Available online at http://pmm.nasa.gov/sites/default/files/document_files/IMERG_ATBD_V4.5.pdf.]

Huffman, G. J., D. T. Bolvin, and E. J. Nelkin, 2015b: Integrated Multi-satellitE Retrievals for GPM (IMERG) technical documentation. NASA Doc., 47 pp. [Available online at http://pmm.nasa.gov/sites/default/files/document_files/IMERG_doc.pdf.]

Huffman, G. J., D. T. Bolvin, and E. J. Nelkin, 2015c: Day 1 IMERG final run release notes. NASA Doc., 9 pp. Available online at http://pmm.nasa.gov/sites/default/files/document_files/IMERG_FinalRun_Day1_release_notes.pdf

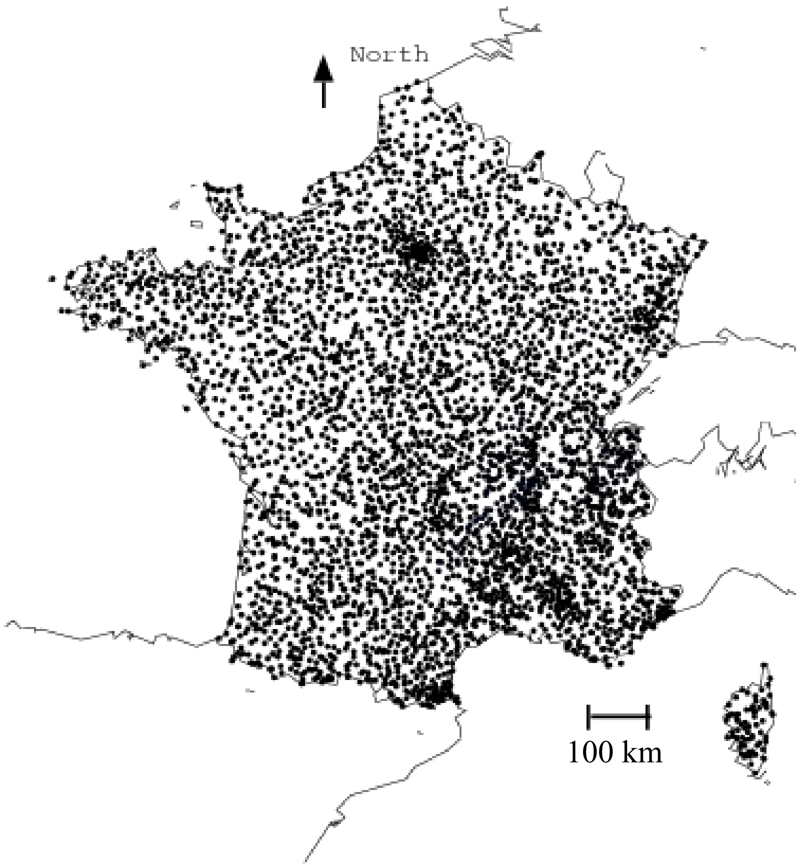
Rozante, J. R.; Moreira, D. S. ; Gonçalves., L. G. G.; Vila, Daniel A.. Combining TRMM and Surface Observations of Precipitation: Technique and Validation Over South America. Weather and Forecasting, v. 25, p. 885-894, 2010.DOI: http://dx.doi.org/10.1175/2010WAF2222325.1

Météo-France

Contact person : Véronique Lion
veronique.lion@meteo.fr

QPF verification

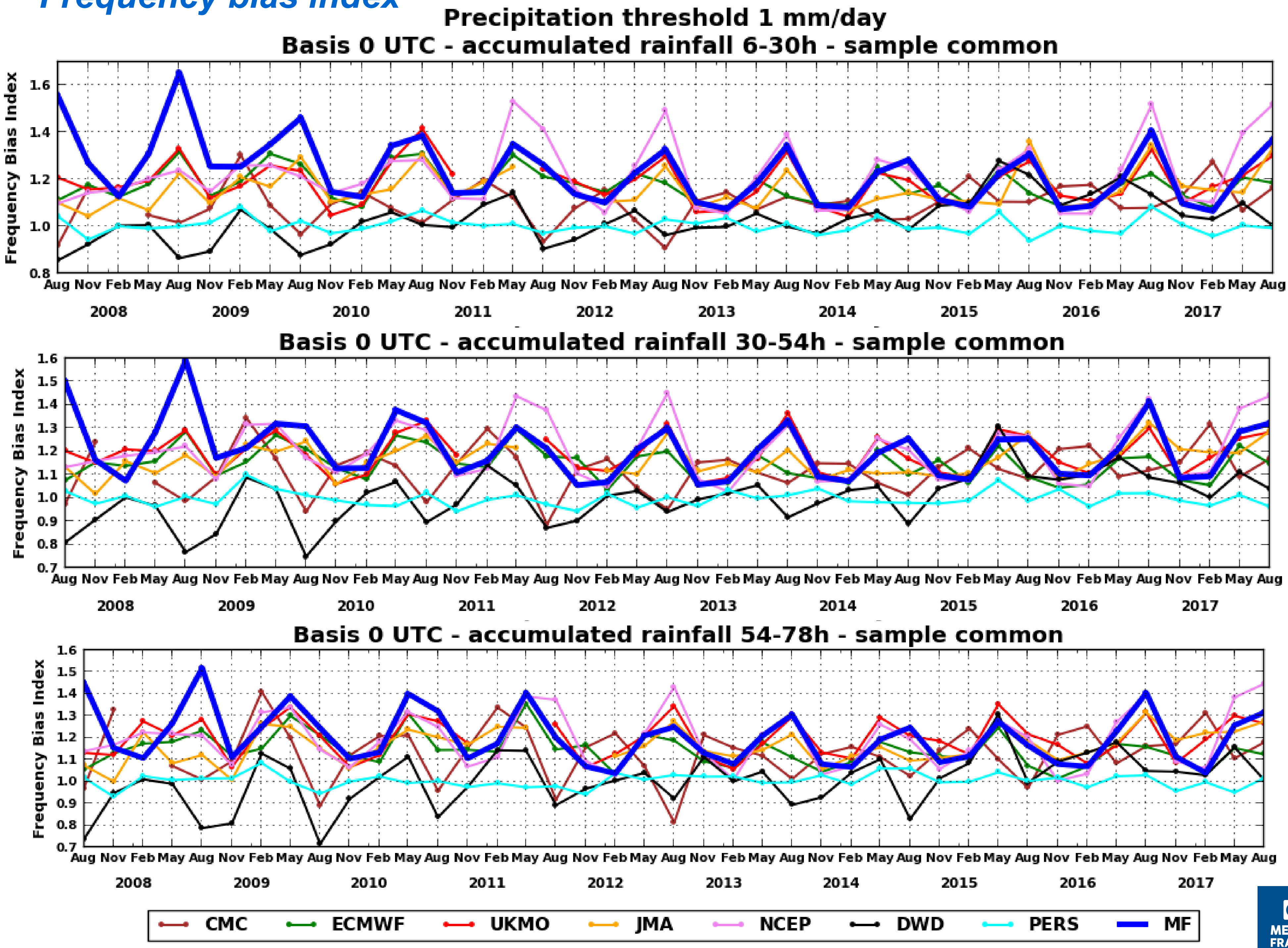
- Average the data and the models QPF at 0.5°x0.5°



Climatological state network

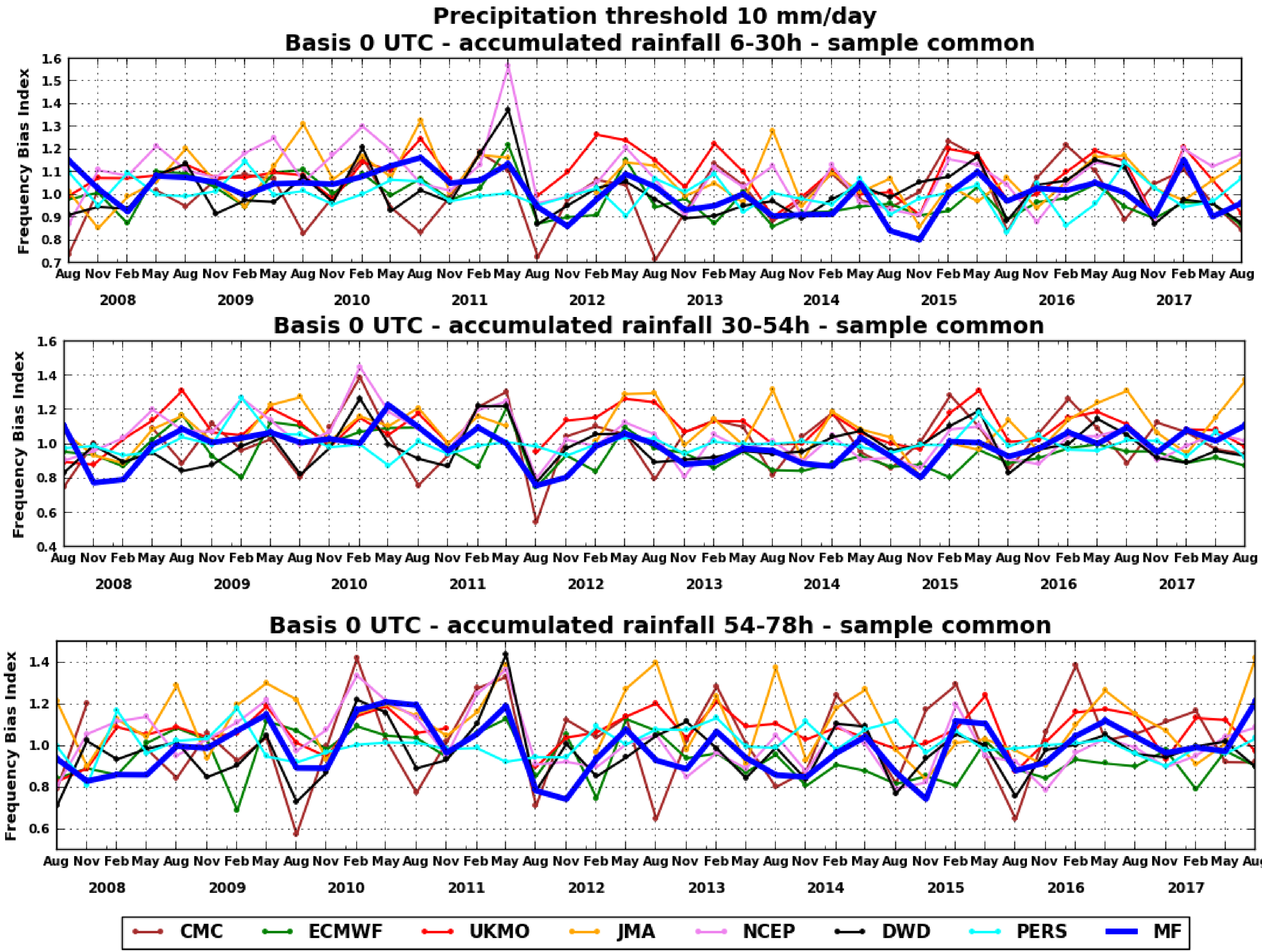
~4000 raingauges giving 24 hours accumulated rain every day

Frequency bias index

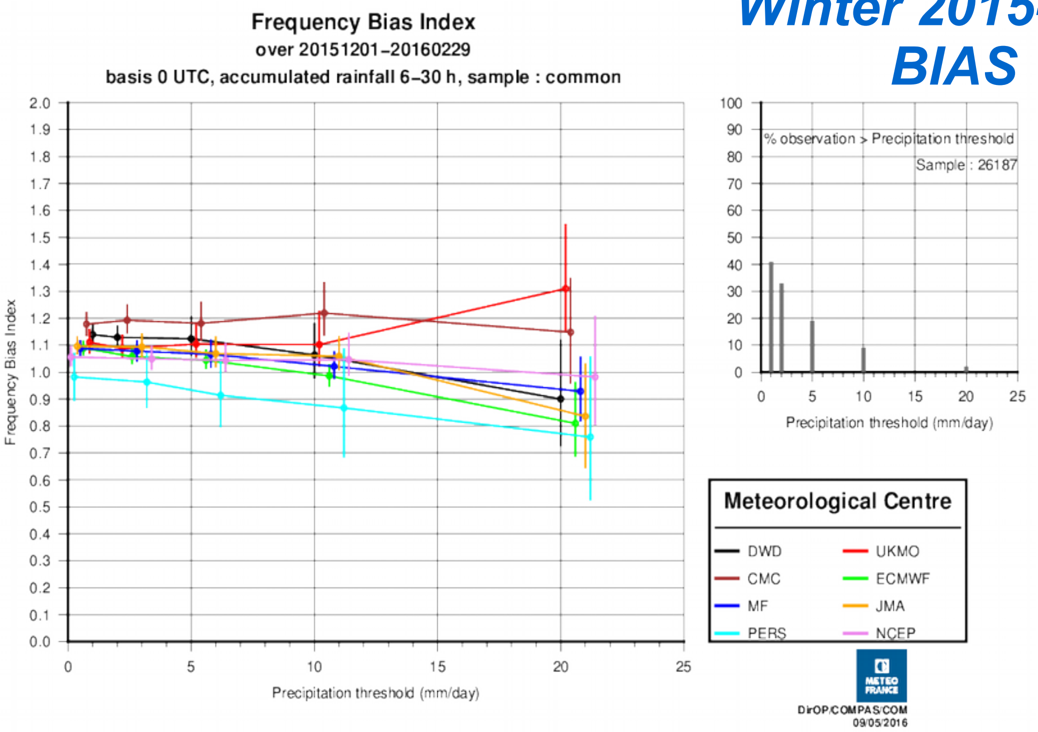


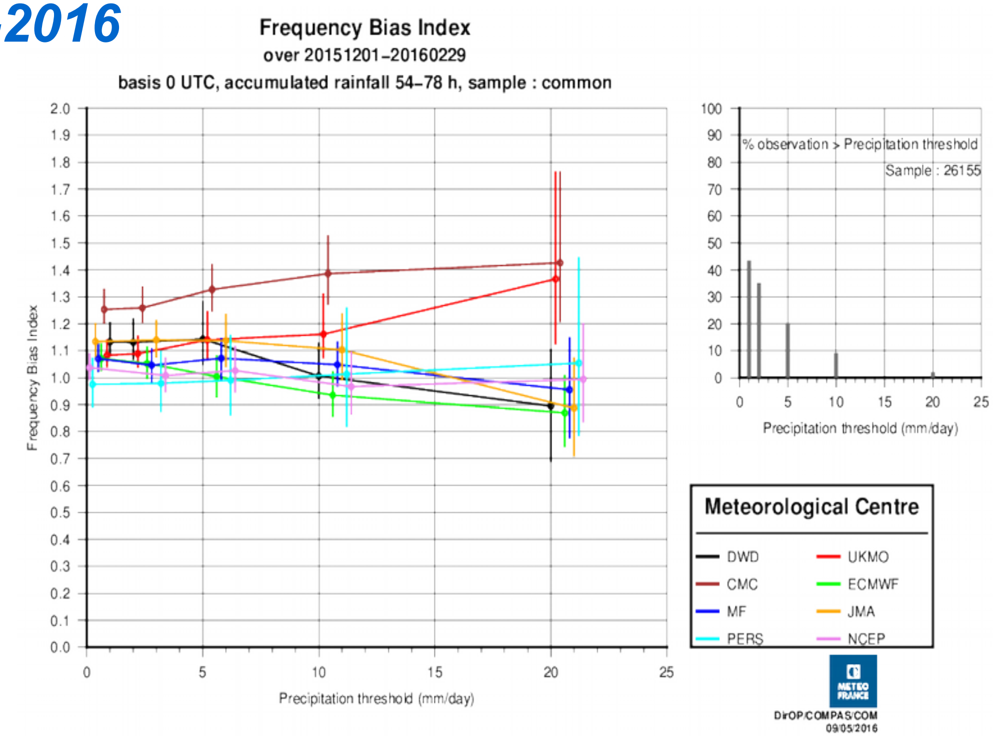
METEO FRANCE

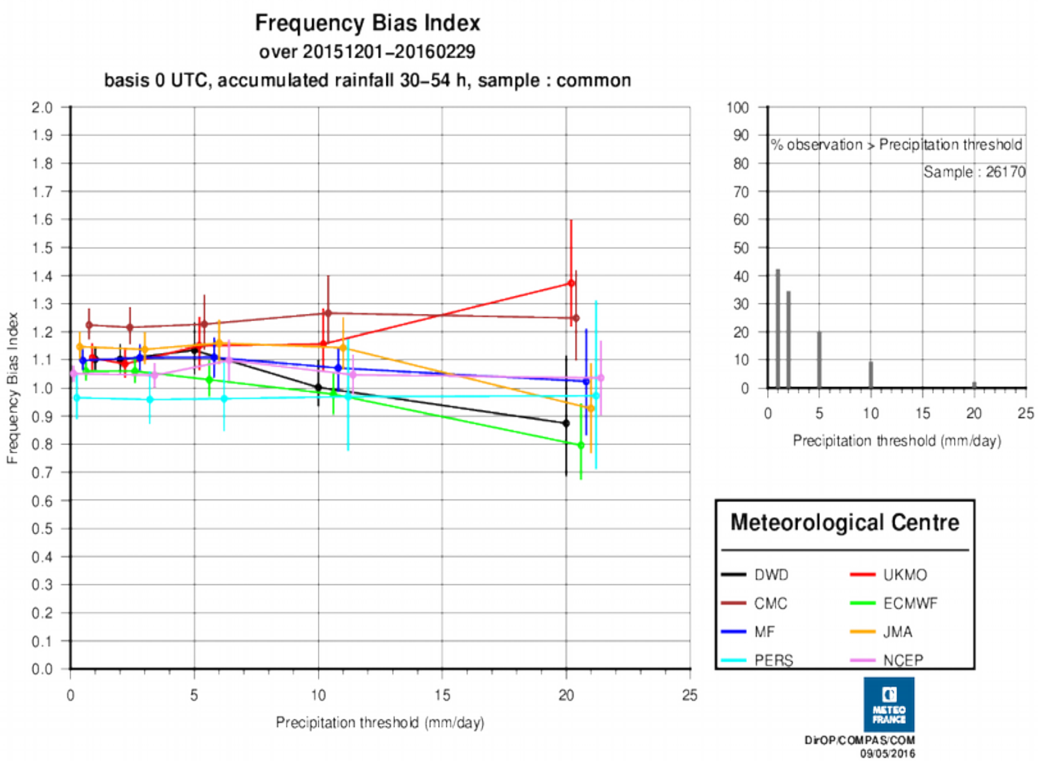
Frequency bias index



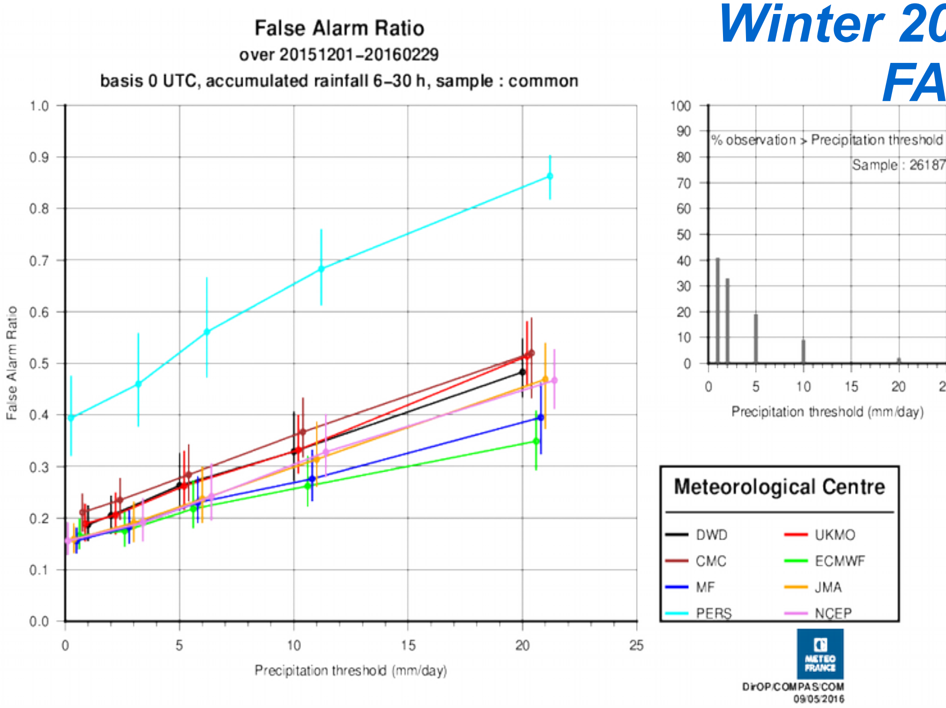
Winter 2015-2016
BIAS

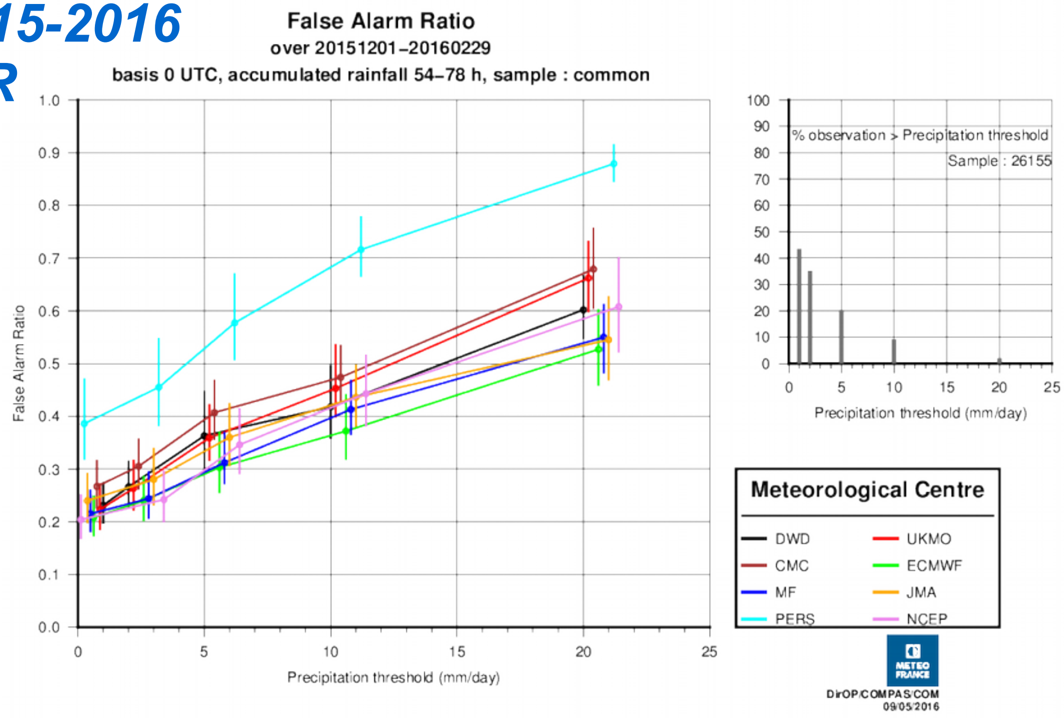


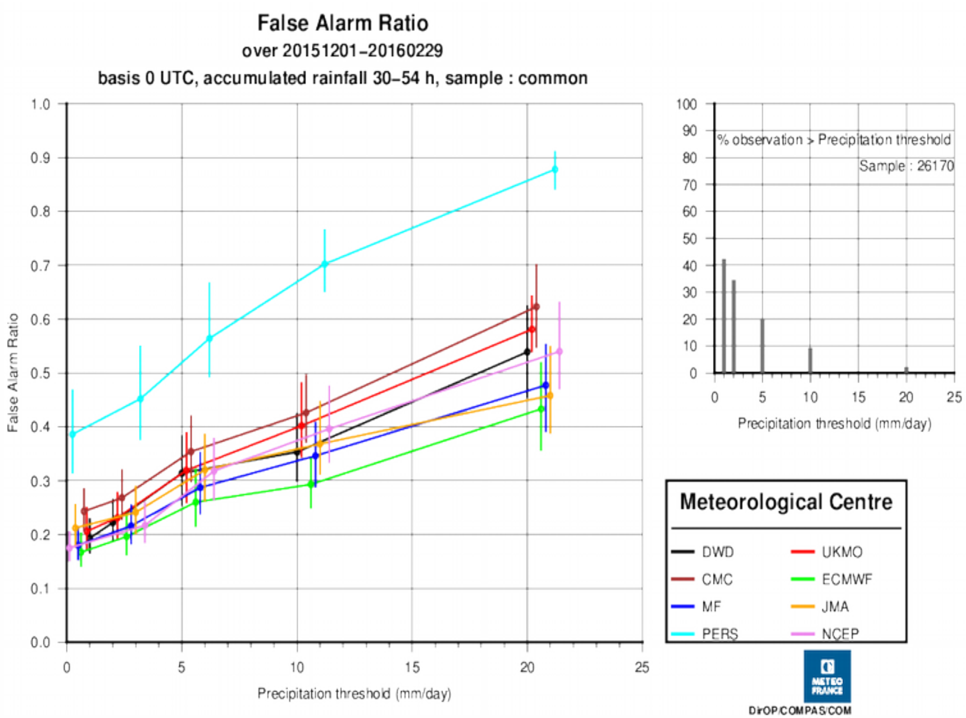




Winter 2015-2016
FAR

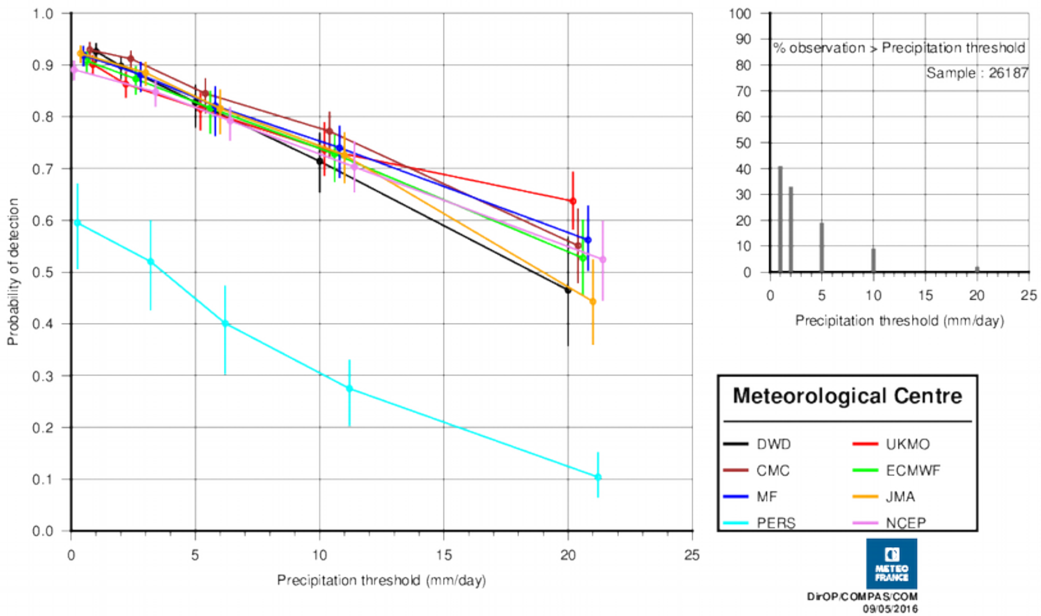




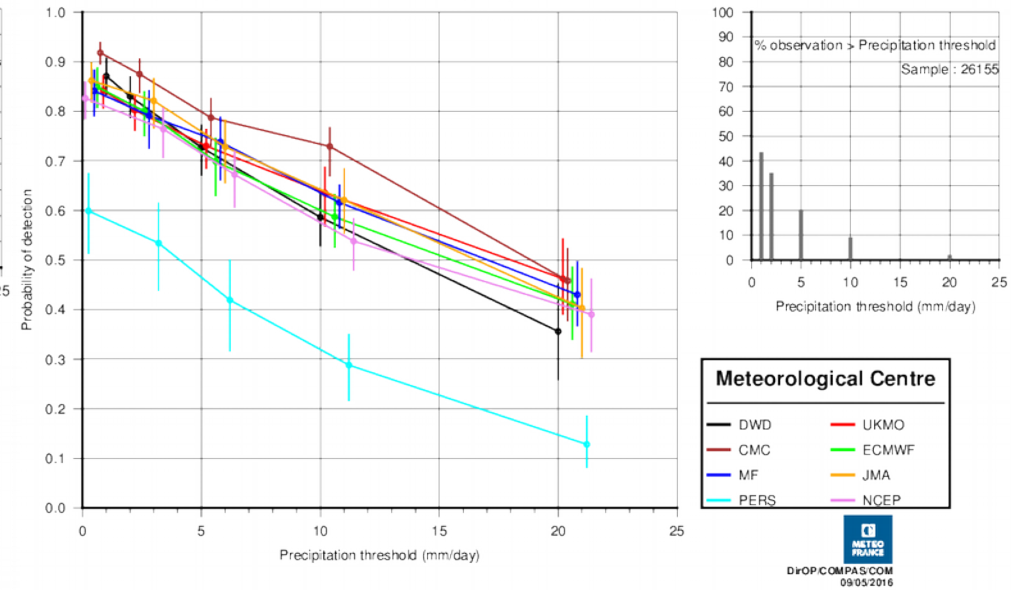


Winter 2015-2016
POD

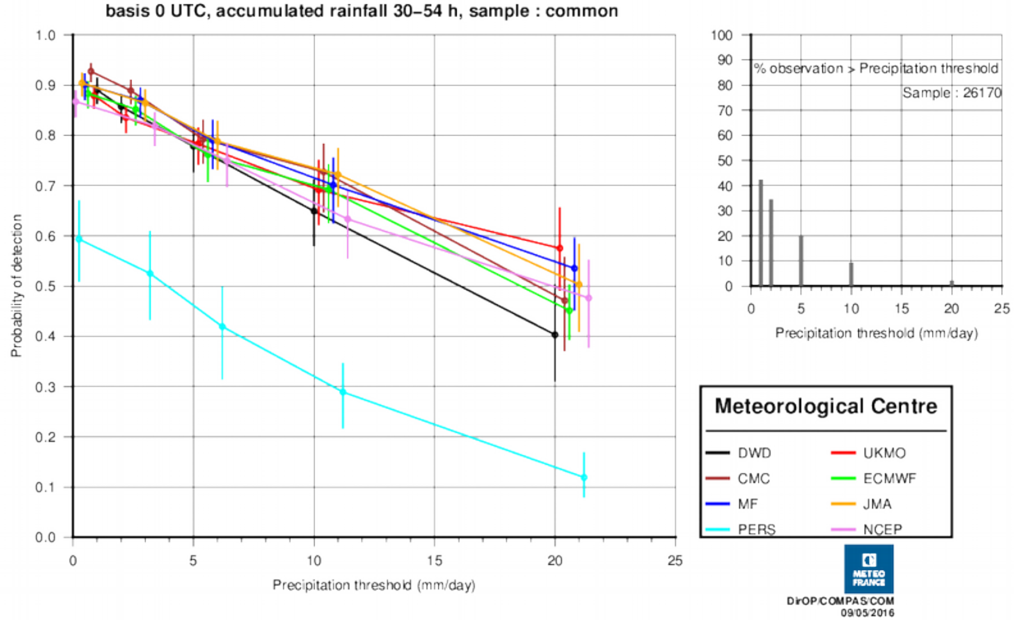
Probability of detection
over 20151201–20160229
basis 0 UTC, accumulated rainfall 6–30 h, sample : common



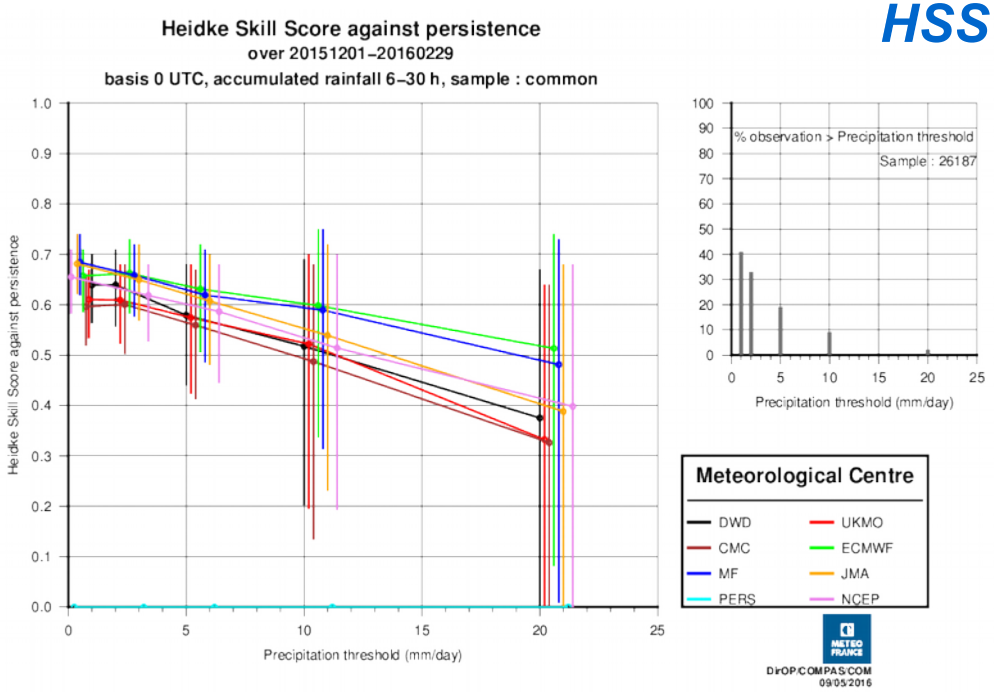
Probability of detection
over 20151201–20160229
basis 0 UTC, accumulated rainfall 54–78 h, sample : common

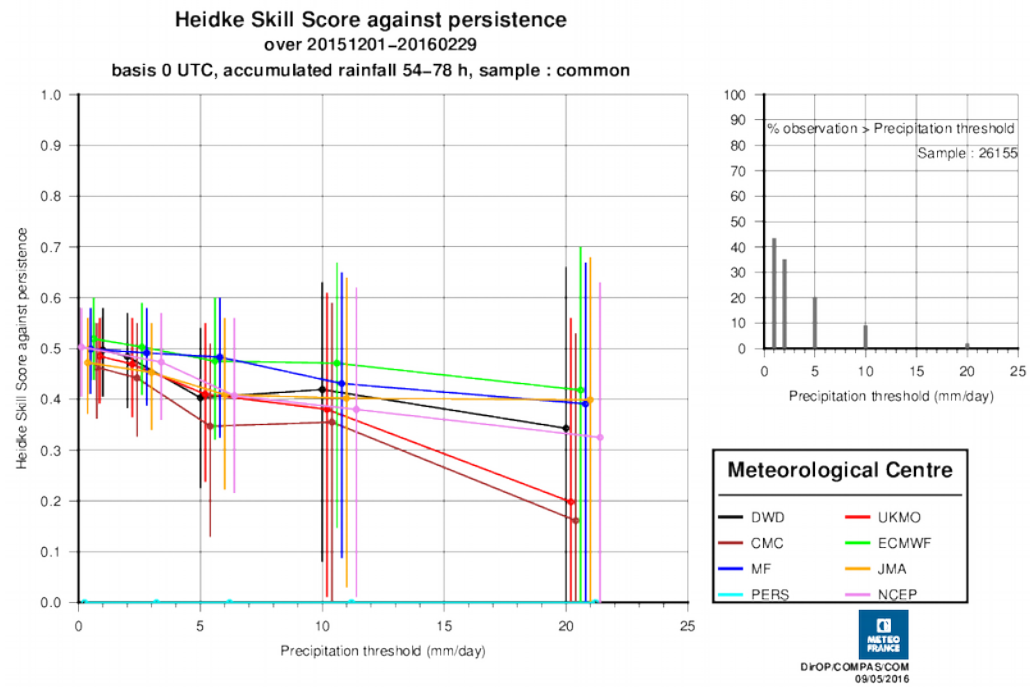


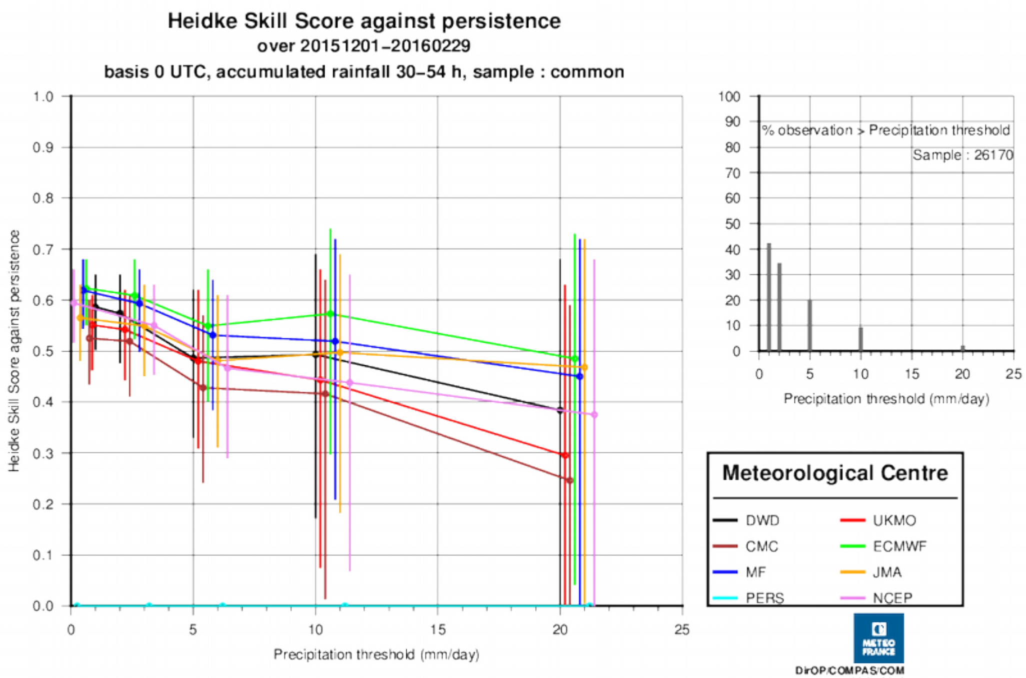
Probability of detection
over 20151201–20160229
basis 0 UTC, accumulated rainfall 30–54 h, sample : common



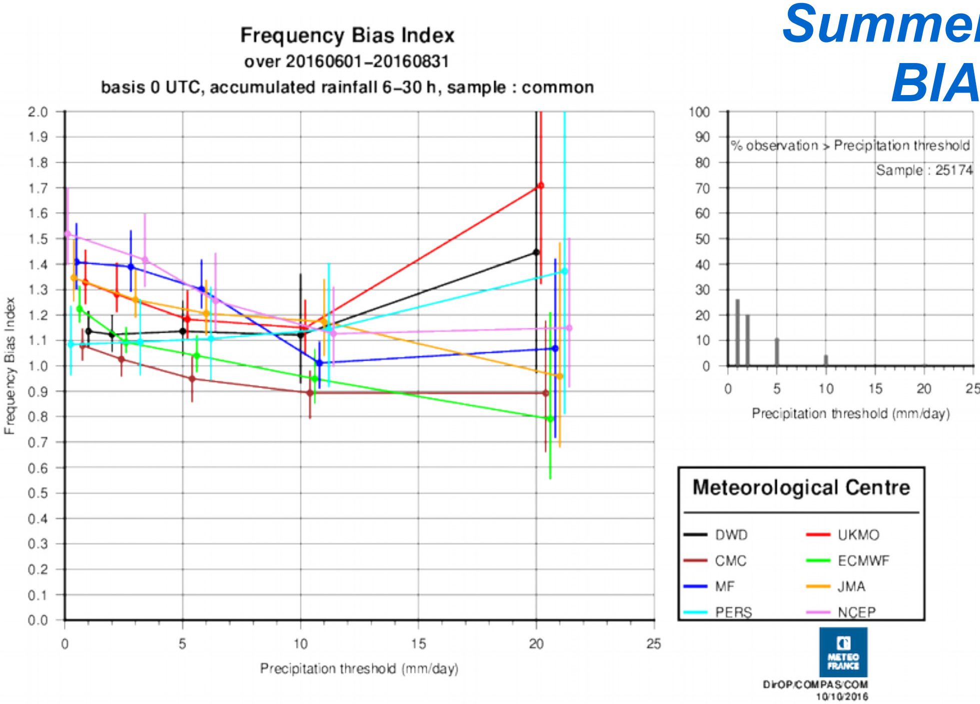
Winter 2015-2016
HSS

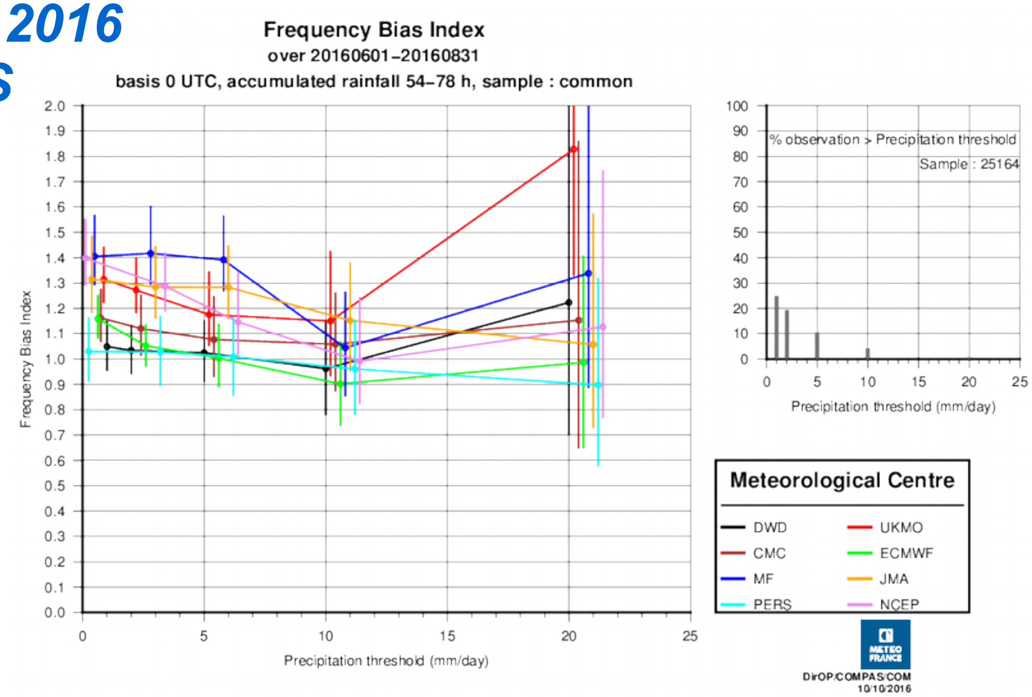


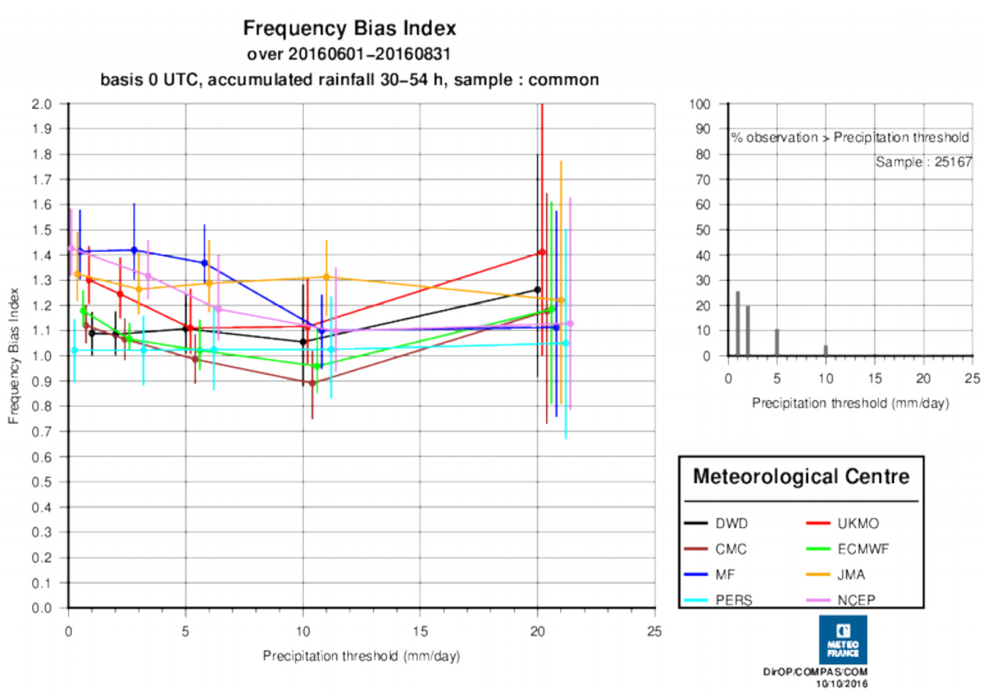




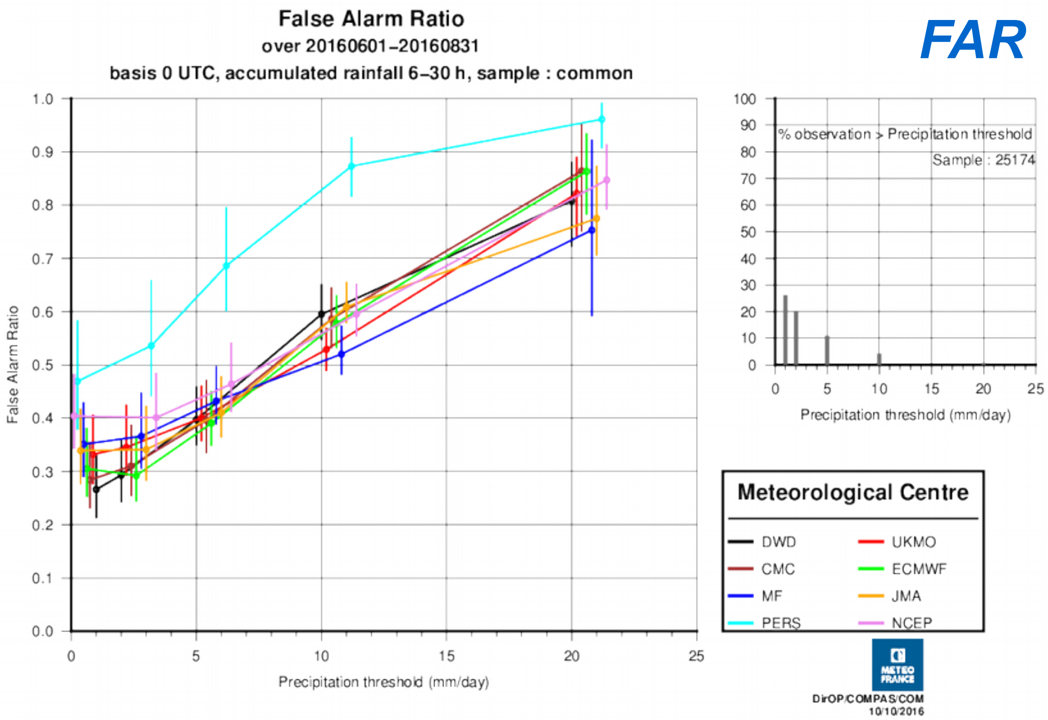
Summer 2016 BIAS

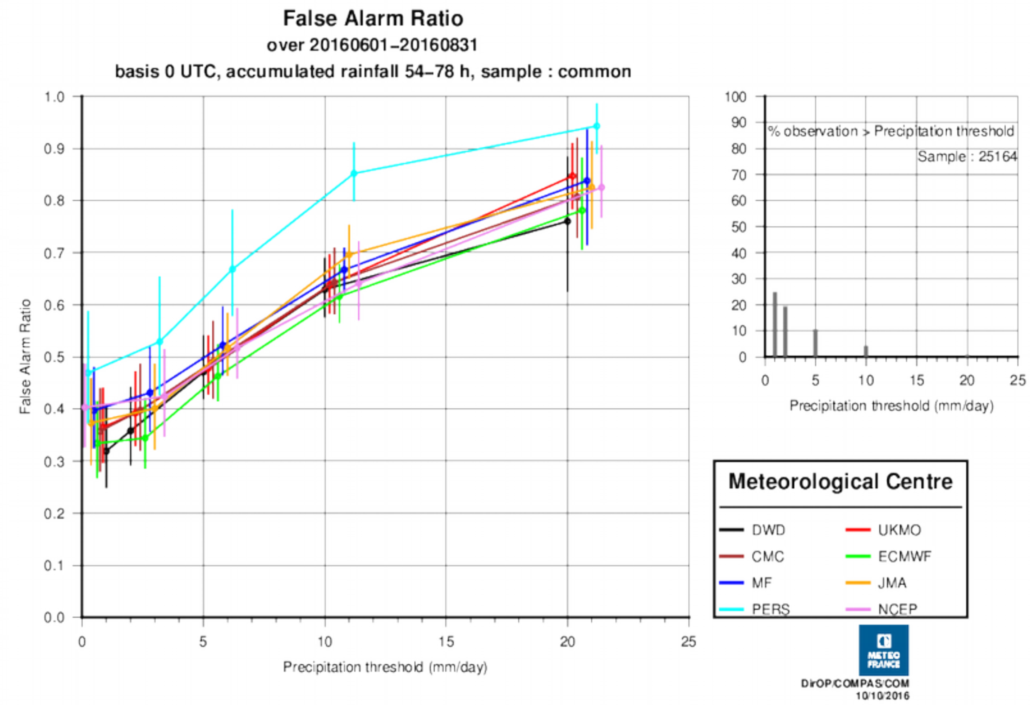


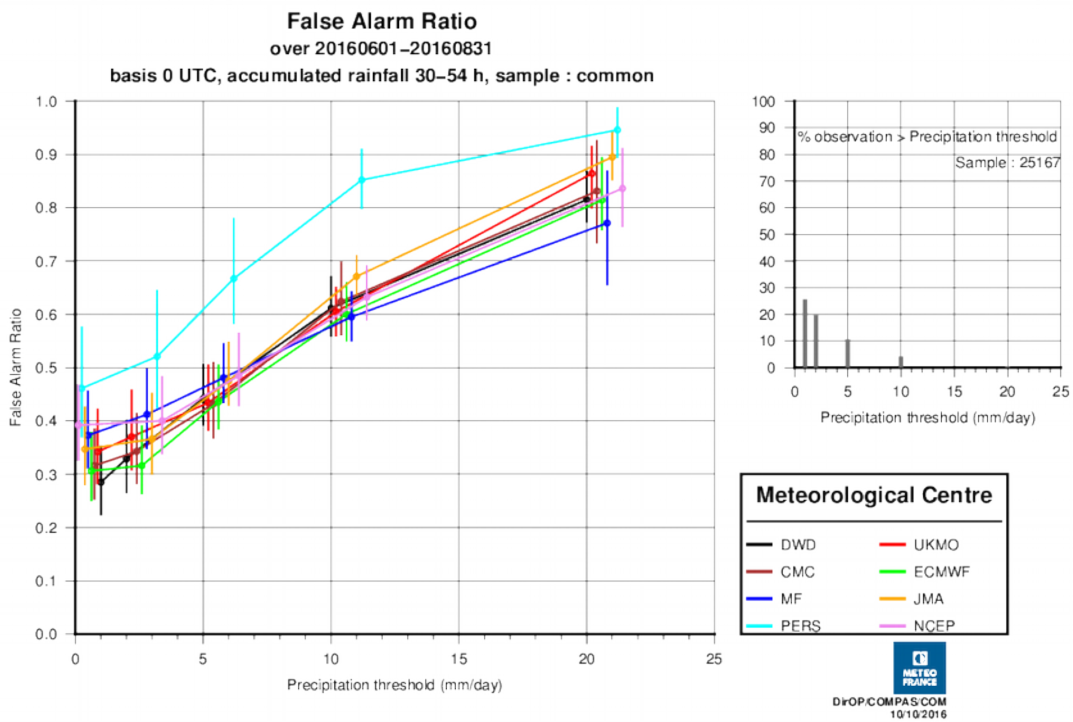




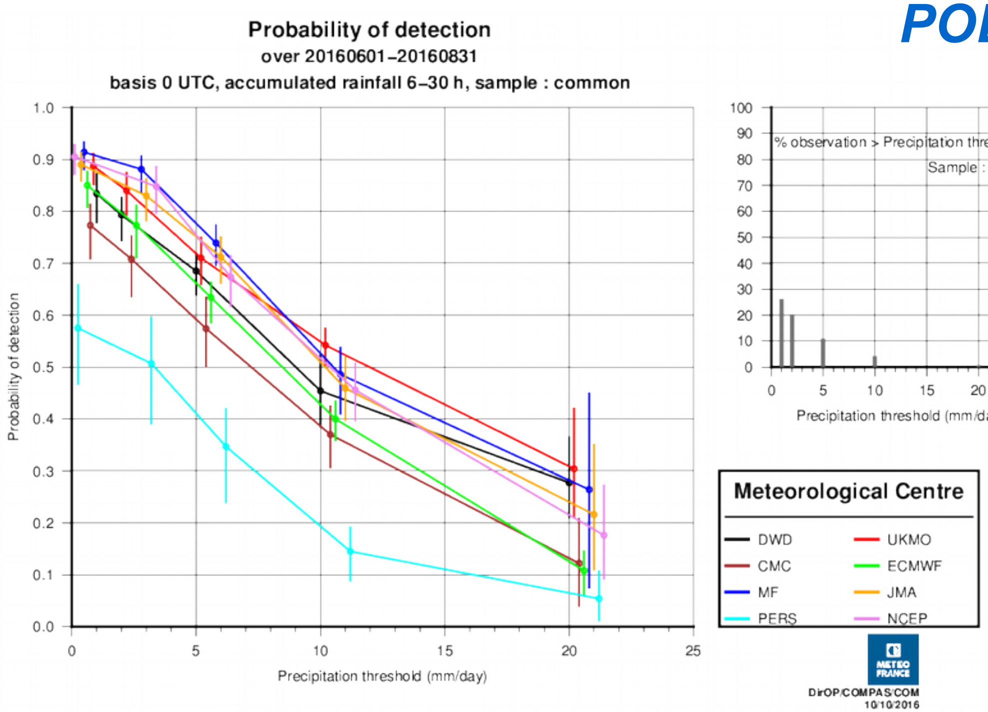
Summer 2016
FAR

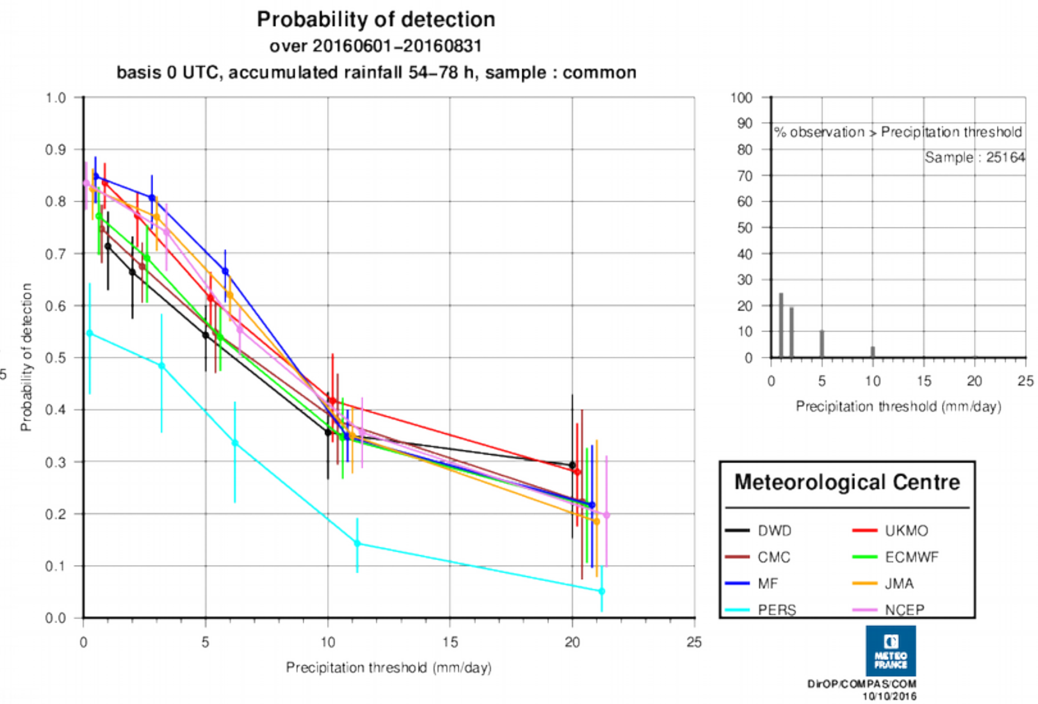


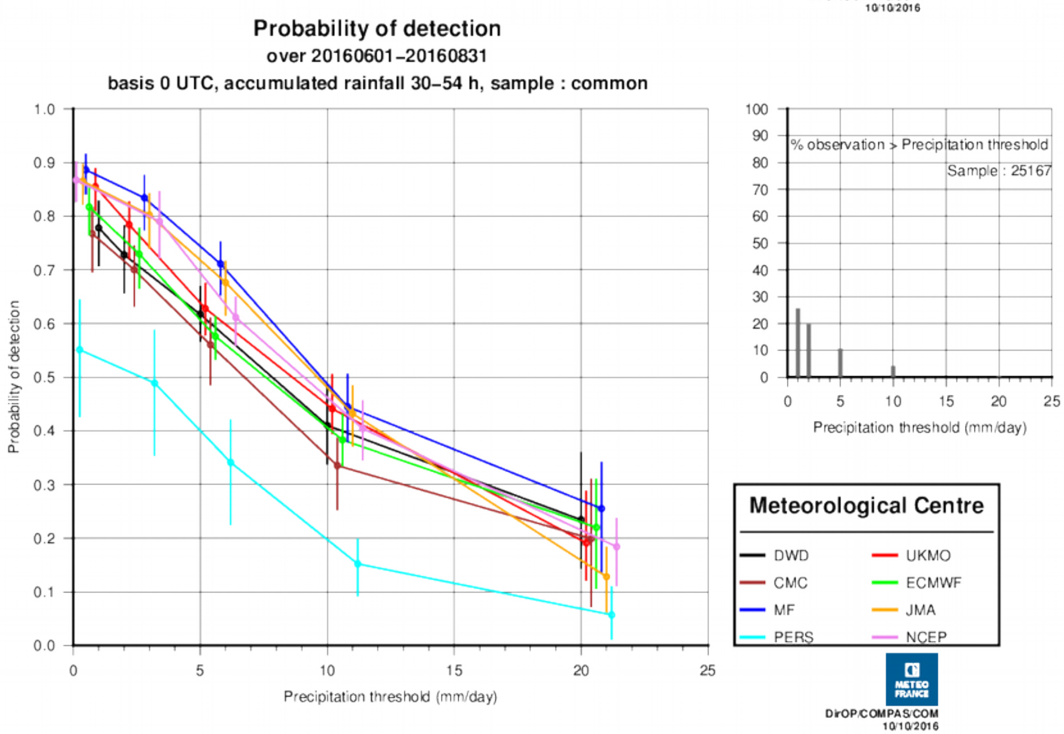




Summer 2016
POD







Summer 2016
HSS