Precipitation verification

Thanks to CMC, CPTEC, DWD, ECMWF, JMA, MF, NCEP, NRL, RHMC, UKMO

WGNE - 31
Council for Scientific and Industrial Research
South Africa
26 - 29 April 2016

WCRP World Climate Research Programme

World Meteorological Organization

CSIR our future through science

Outline

1) Status of WGNE QPF intercomparisons

2) Overview of the use of recommended methods for the verification of precipitation forecasts against high resolution limited area observations (JWGFVR, Nov 2013)

1) WGNE QPF intercomparison

WGNE began verifying quantitative precipitation forecasts (QPFs) in the mid 1990s.

In 1995, NCEP and DWD began verifying QPFs from a number of global and regional operational NWP models against data from their national rain gauge networks.

BOM joined in 1997, followed by UKMO in 2000, MF in 2001, JMA in 2002 and CMA in 2013.

These intercomparisons have evolved to take into account increased spatial resolution of NWP models and research advances on QPF verification methods.

WGNE QPF intercomparisons have been very useful over these years to evaluate QPF improvements of operational global NWP models.

A survey was proposed to :
i) summarize current characteristics of the WGNE QPF intercomparisons,
ii) collect suggestions for improving further these intercomparisons

WGNE QPF intercomparison survey

- Geographical domain of verification
- Observations (type, sample size, etc.)
- Observation processing (interpolation, quality control, etc.)
- Models evaluated (data characteristics)
- Model output processing
- Precipitation accumulation period (in hours)
- Precipitation thresholds
- Stratification (lead time, season, region, etc.)
- Operational QPF scores
- Confidence intervals
- Web site with WGNE QPF verification
- Contact person

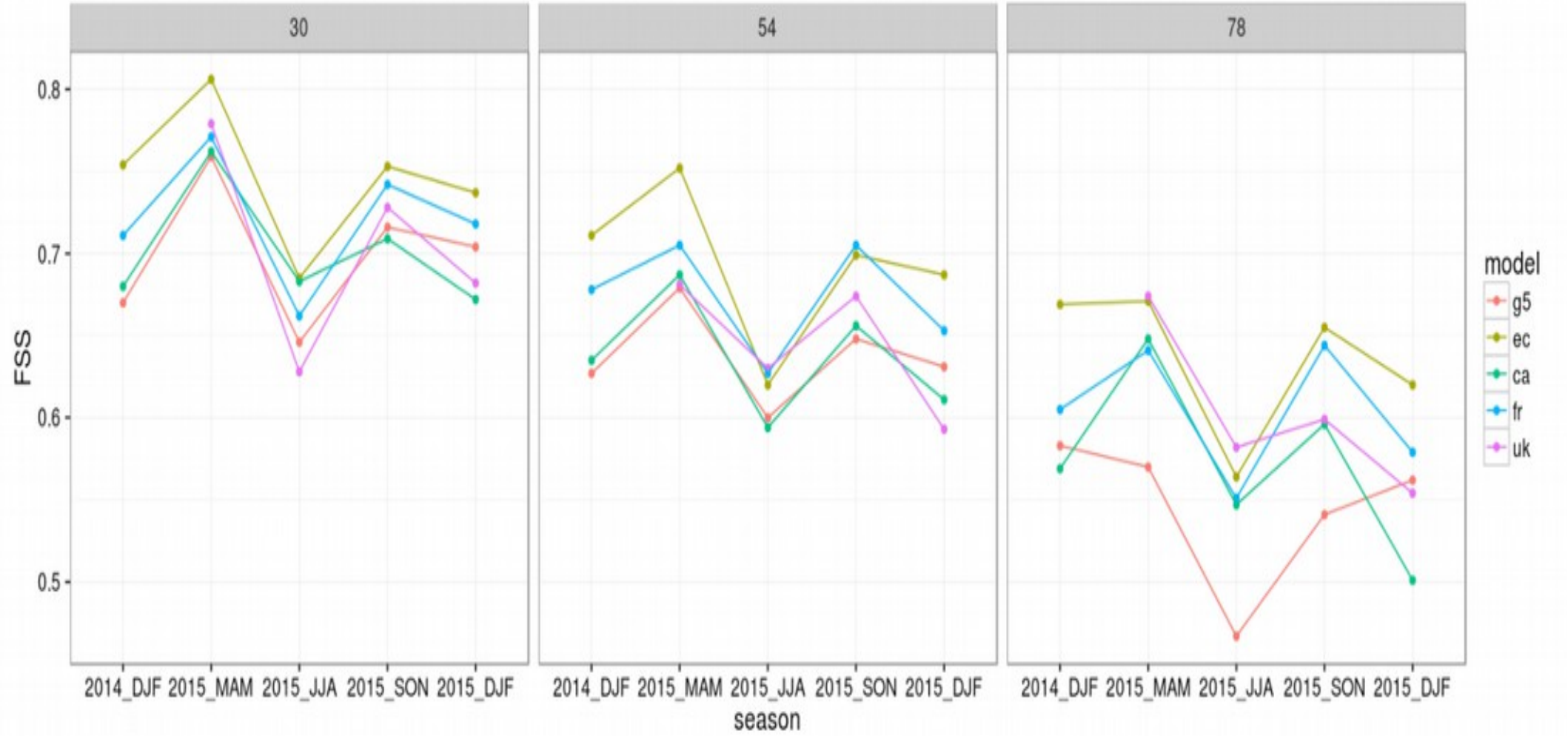
Some examples:

Forecast Centre	Models evaluated (data characteristics)	Observations (type, sample size, etc.)	Precipitation accumulation period (in hours)	QPF scores
NCEP	NCEP, CMC, DWD, ECMWF, JMA, MF, UKMO	1) 24h/6h/3h 5km polar-stereographic grid radar+hourly gauge-based analysis, with climate calibration 2) ~8,000 daily rain gauge over contiguous U.S.	24h	FB,POD,FAR,POFD,TS,ETS,HK,HSS,OR,EDI,SEDS,SEDI
DWD	NCEP, CMC, DWD, ECMWF, MF, UKMO	Calibrated radar composite over Germany	24h	ETS, FBI, FSS, BSS
MF	NCEP, CMC, DWD, ECMWF, JMA, MF, UKMO	French climatological rain-gauges network. ~4000 stations (1obs/(12km)2)	24h	FB, FAR, POD, POFD, HSS, CSI, ETS, EDS, SEDS
JMA	NCEP, CMC, DWD, ECMWF, JMA, UKMO, BoM	Japanese climatological rain-gauges network. ~1300 stations (1 obs/(17 km)^2)	6, 12, 24h	FB, POD, POFD, TS, ETS, EDI

<u>Suggestions of improvements:</u>

Improve spatial (0.25° or 0.2° or 0.1°) and temporal resolution (6h)
Verification against precipitation analysis
Move further to recommended scores

Fractions Skill Score
Scale: 9x9 GP

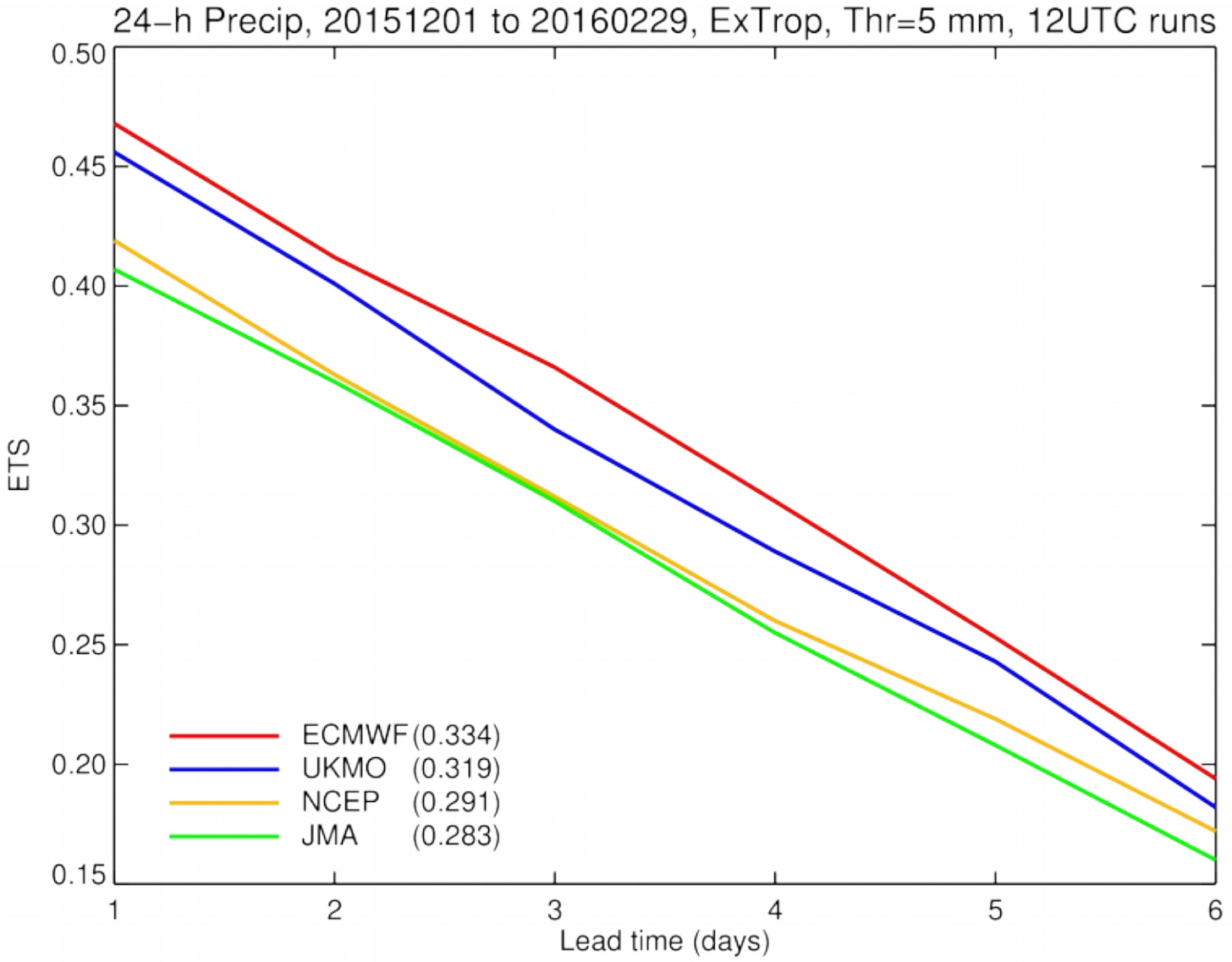


5 mm/24h

Problem with NCEP data!

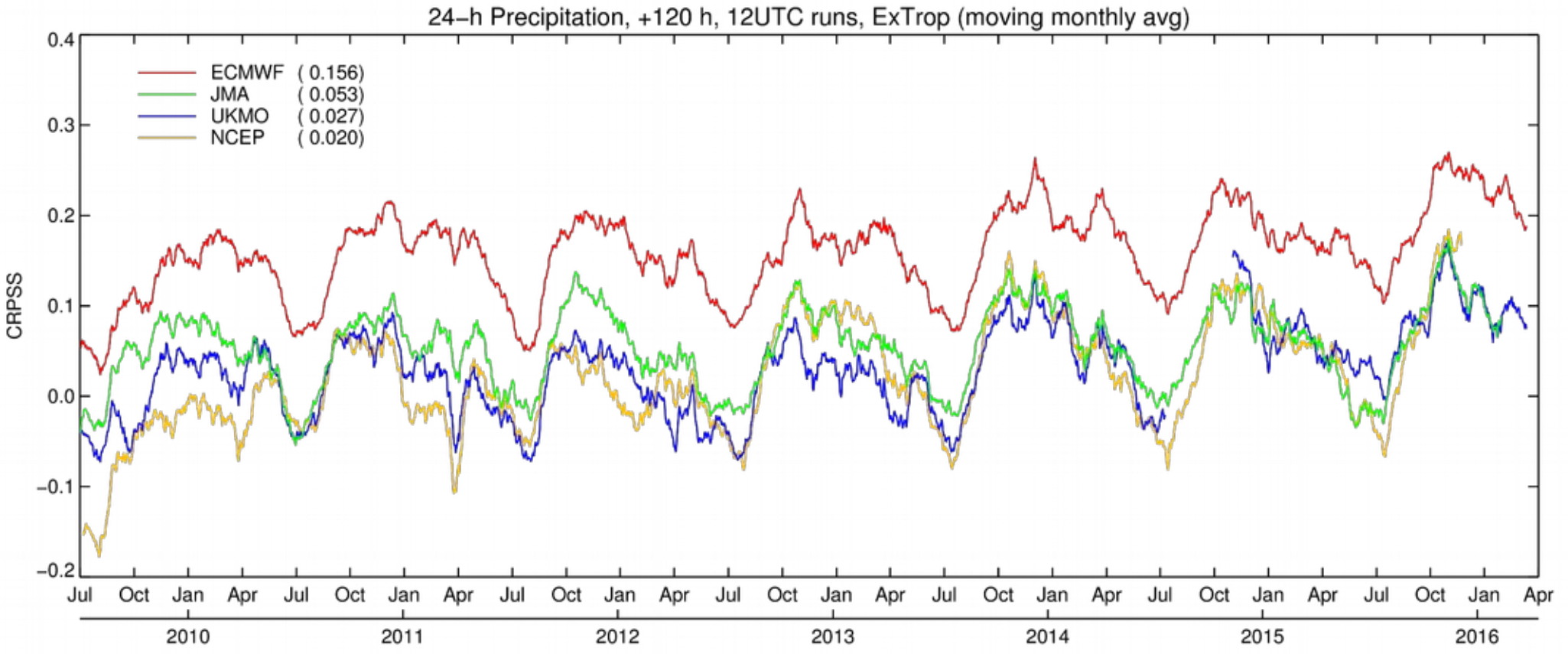
DWD

Model intercomparison – deterministic forecast



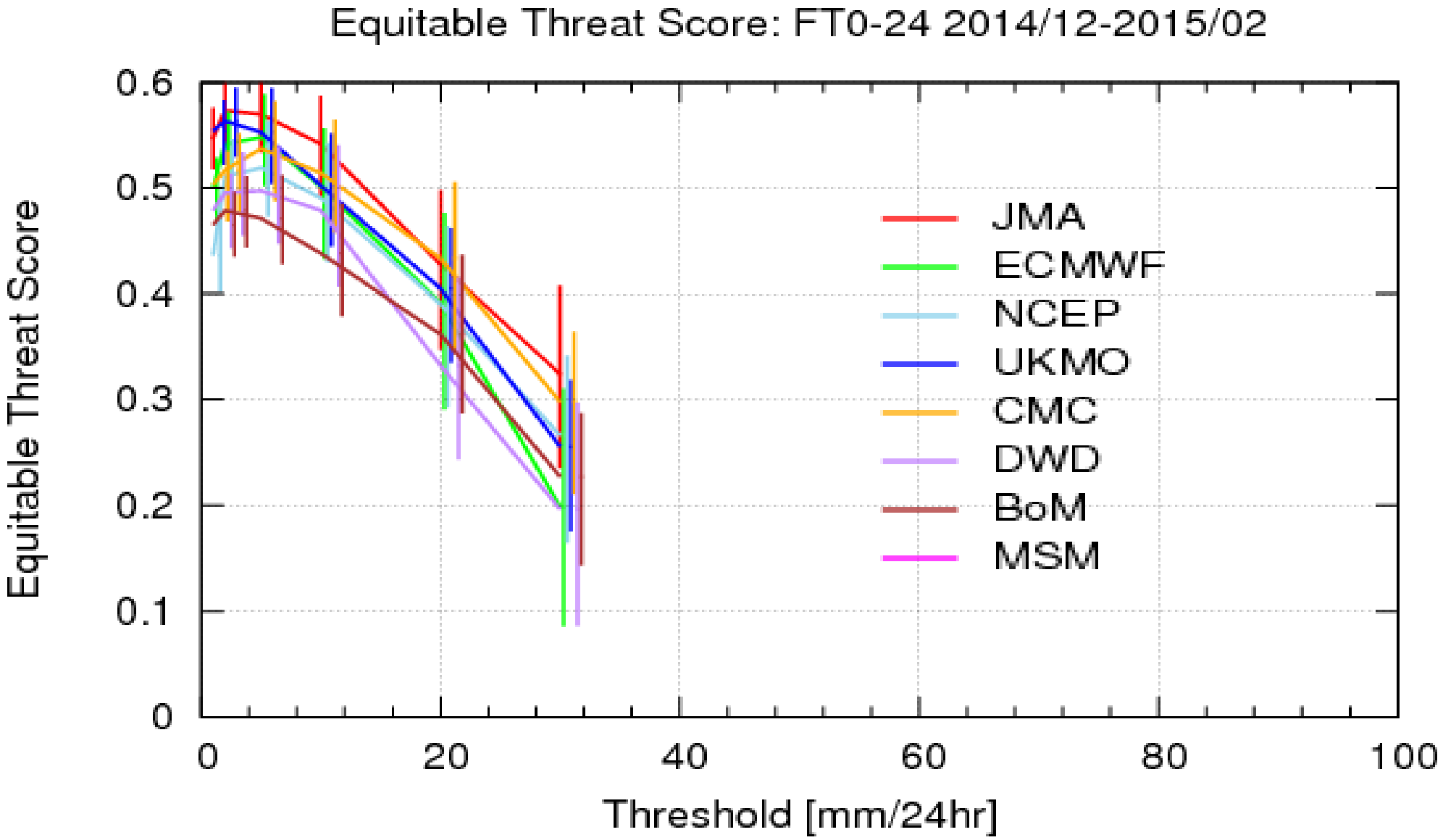
ECMWF

Model intercomparison – ensemble forecast



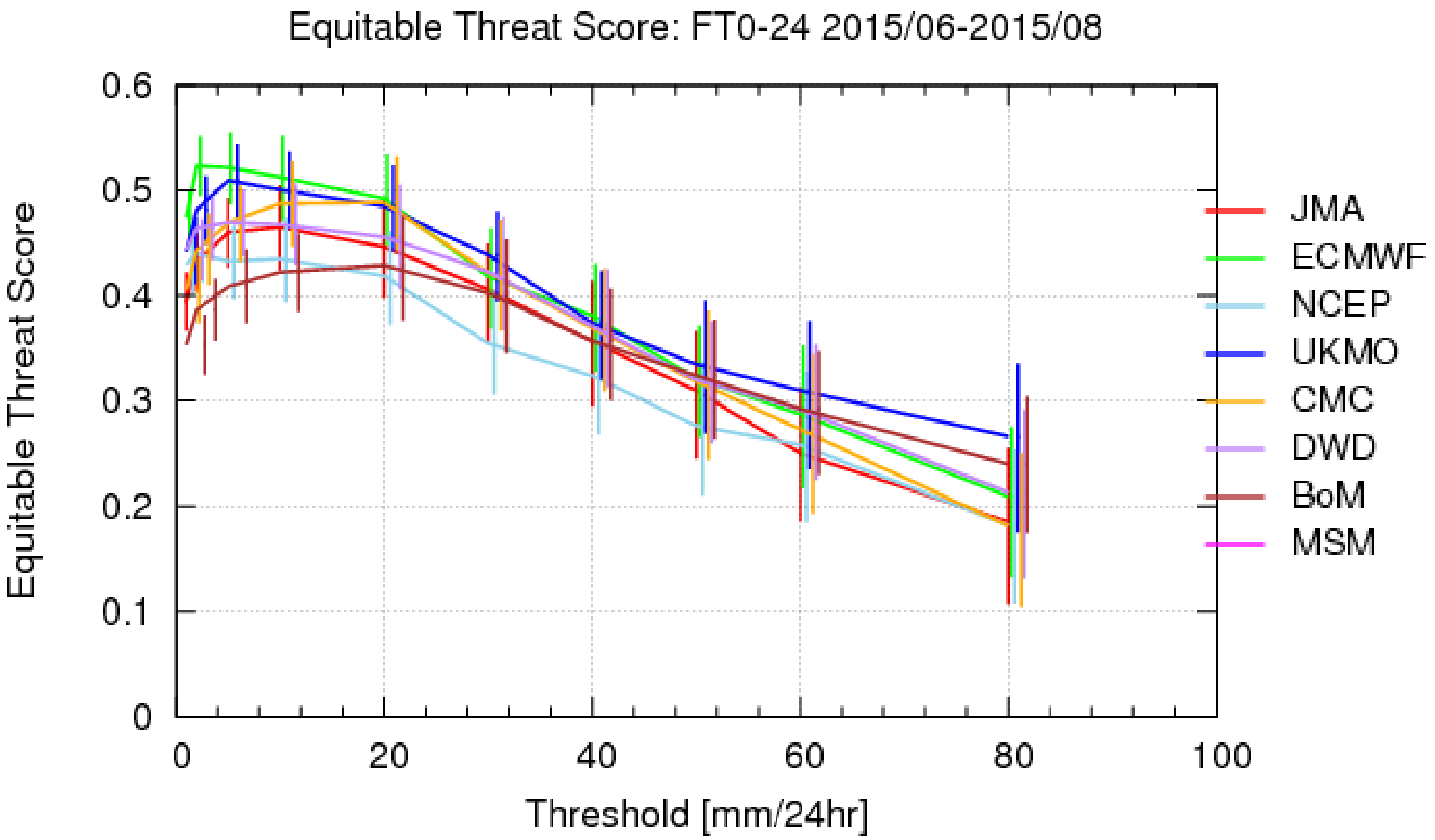
ECMWF

2014DJF


Equitable Threat Score: FT0-24 2014/12-2015/02
Equitable Threat Score
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
Threshold [mm/24hr]
JMA
ECMWF
NCEP
UKMO
CMC
DWD
BoM
MSM

JMA

2015JJA

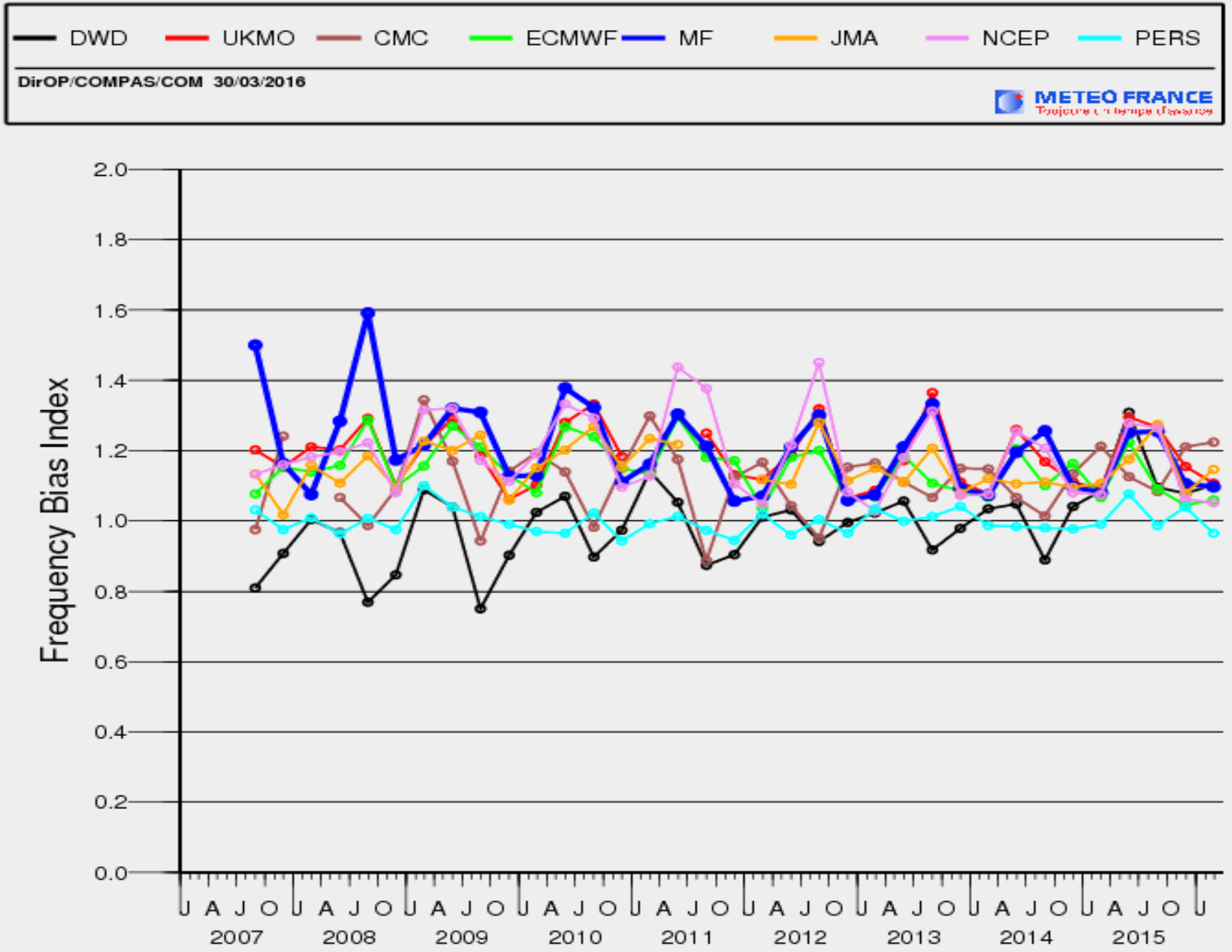

Equitable Threat Score: FT0-24 2015/06-2015/08
Equitable Threat Score
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
Threshold [mm/24hr]
JMA
ECMWF
NCEP
UKMO
CMC
DWD
BoM
MSM

JMA

Frequency Bias Index

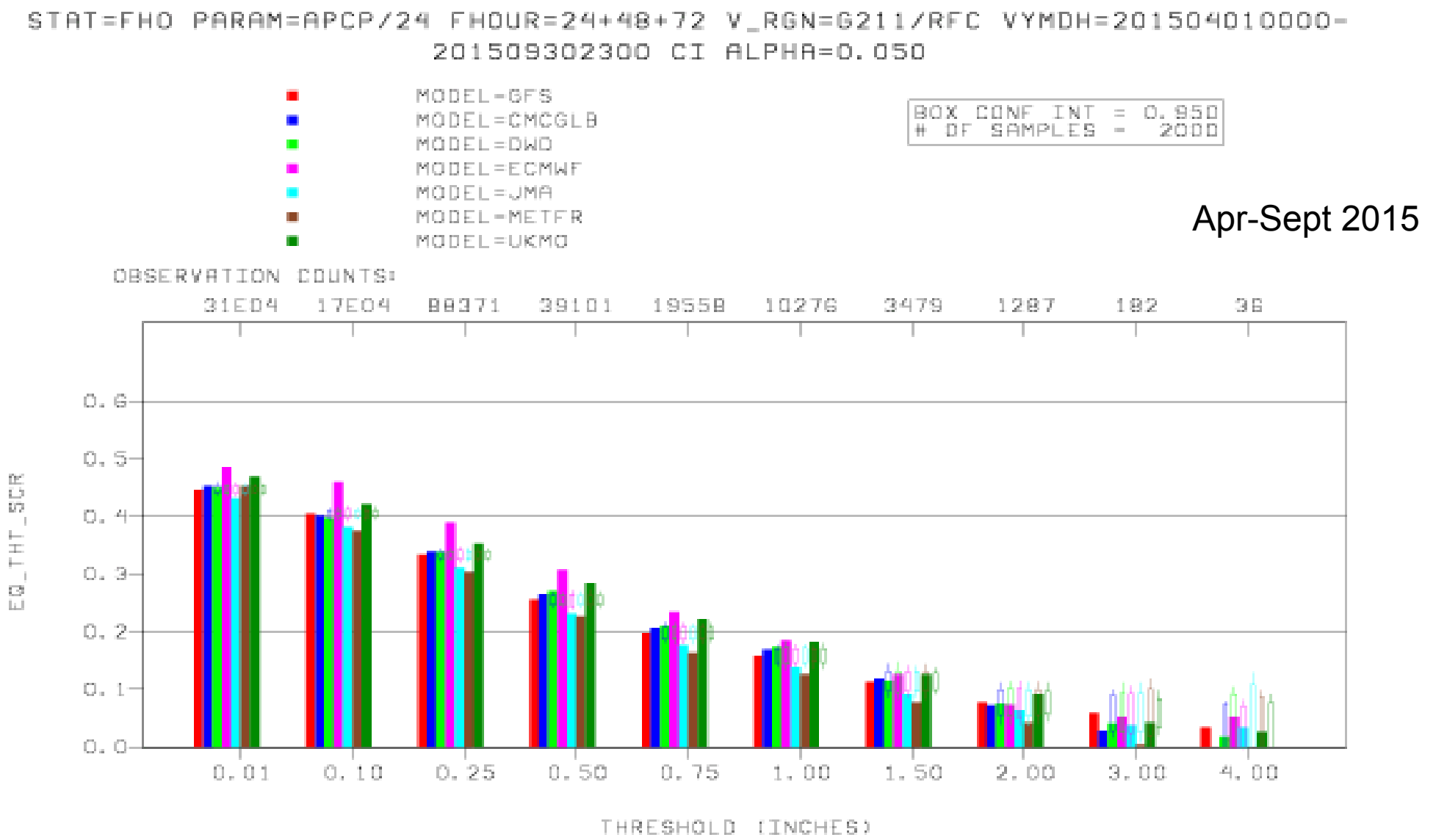
Precipitation threshold 1 mm/day

Basis 0 UTC. accumulated rainfall 30–54 h. sample common



MF

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



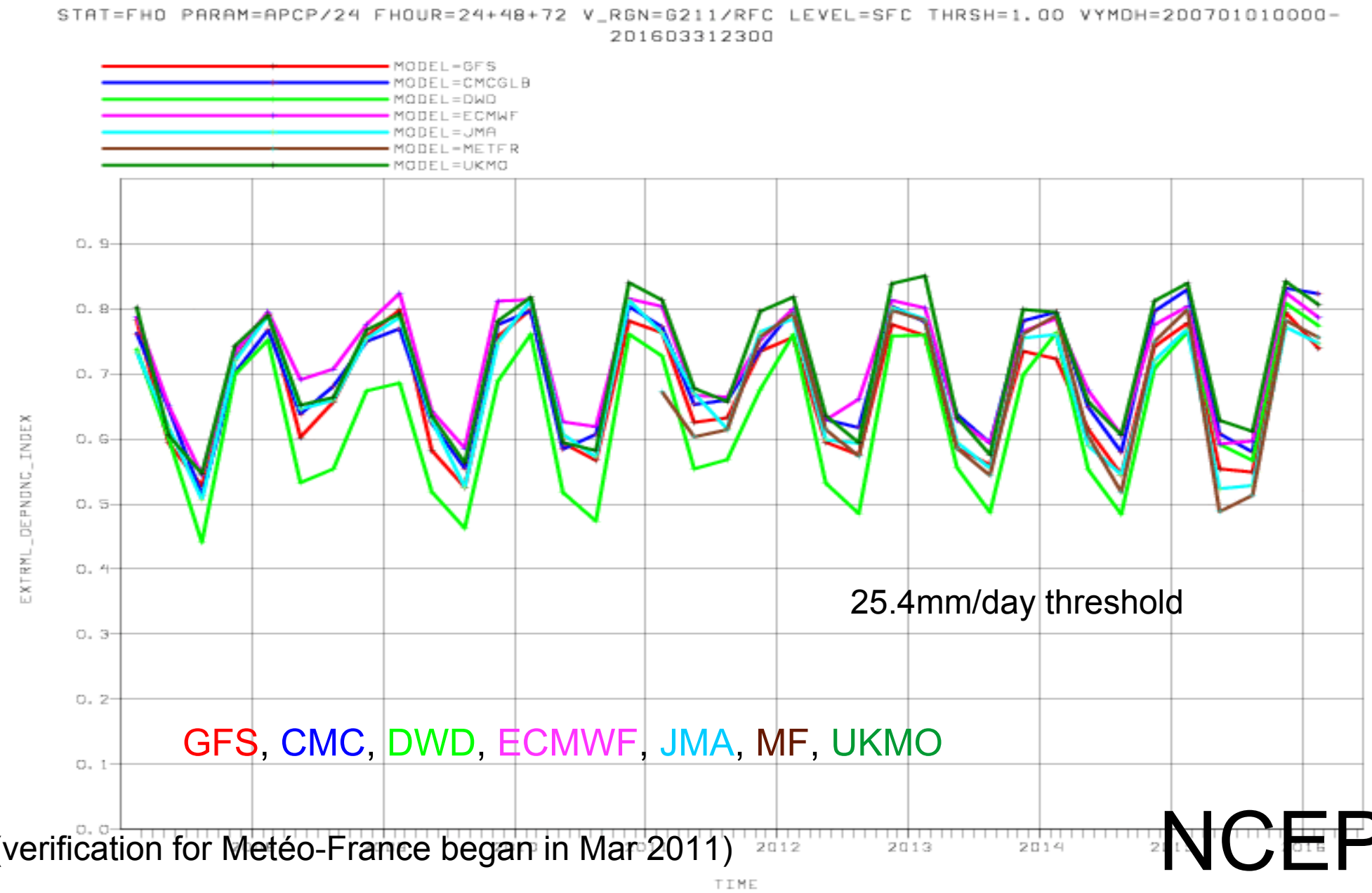
Apr-Sept 2015

GFS, CMC, DWD, ECMWF, JMA, MF, UKMO

NCEP

Quarterly time series of Extremal Dependence Index

all global models



(verification for Metéo-France began in Mar 2011)

NCEP

2) QPF recommendations

Reference note: Suggested methods for the verification of precipitation forecasts against high resolution limited area observations (JWGFVR, Nov 2013)

Primary temporal resolution (6h)
Thresholds (1, 2, 5, 10, 20, 50 mm per 6h)
Stratification (lead time, season, region, observed intensity threshold, …)
Comparison against station observation or gridded observations
Aggregate verification scores should be accompanied by 95% confidence intervals

For deterministic model forecasts:

- Equitable threat score (ETS)
- Extremal dependency index (EDI)
- Fractions skill score (FSS) (where gridded observations are available)
- (Additional diagnostics: HR, FAR, FBI)

For probabilistic forecasts interpreted from ensembles, or by statistical post-processing

- Brier skill score BSS (and components)
- ROC area
- Continuous ranked probability skill score (CRPSS)

Survey on the use of recommended methods for the verification of NWP-based QPF against “high resolution limited area observations”

- Characteristics of high resolution precipitation observations used?
- Scores used for deterministic model
- Scores used for EPS
- QPF verification methods used for regional EPS
- Plans to move further towards suggested scores
- Any comments on the suggested methods?

Most centers are using climatological rain-gauges network and gridded precipitation analysis (combined raingauge-radar ; combined raingauge-satellite)

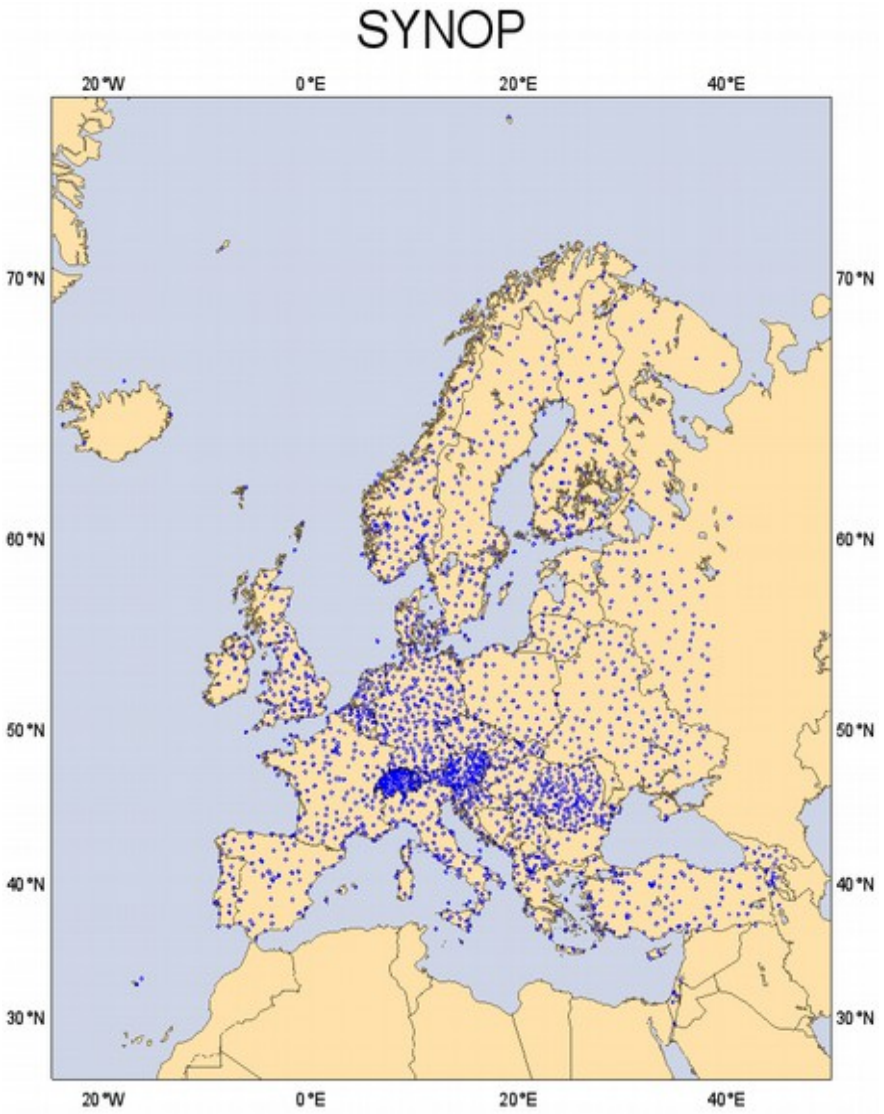
Most centers have implemented recommended scores for deterministic model evaluation

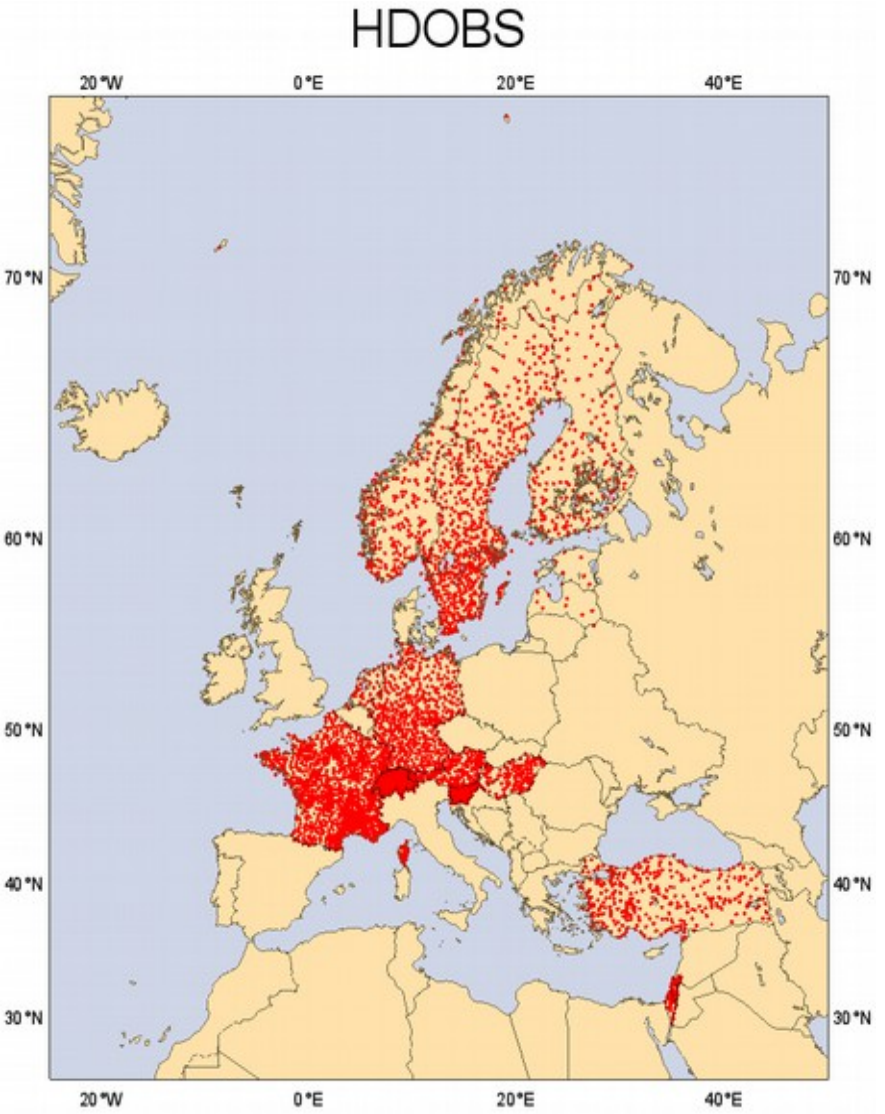
Few centers are computing recommended scores on EPS but many have plans to do so.

Lack of station climatology for BSS and CRPSS scores.

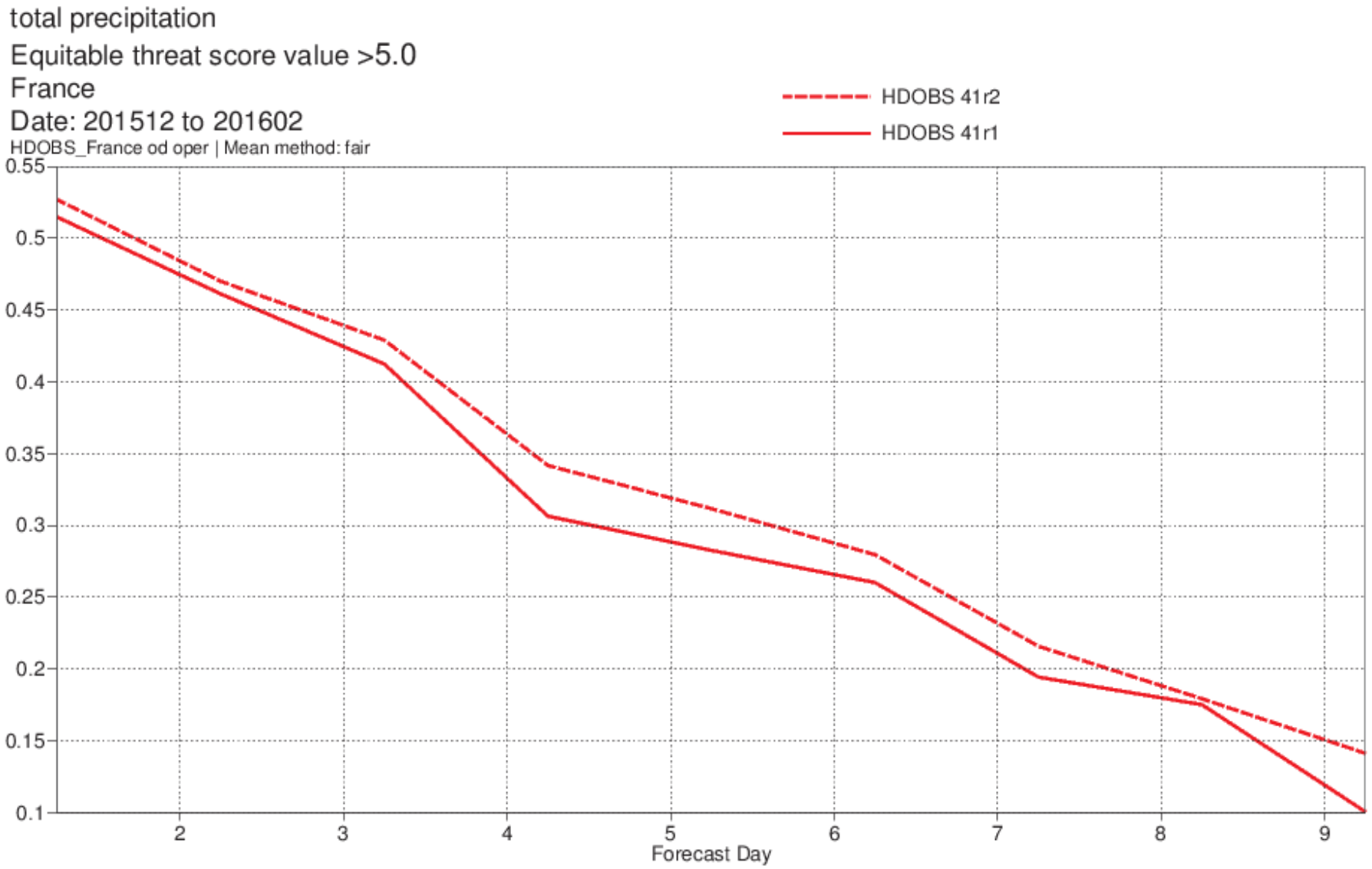
MF uses BSS_NO rather than FSS, which differ from the normalization. In BSS_NO, the persistence forecast is used for the reference.

Surface Observations – Daily Precip to 06Z

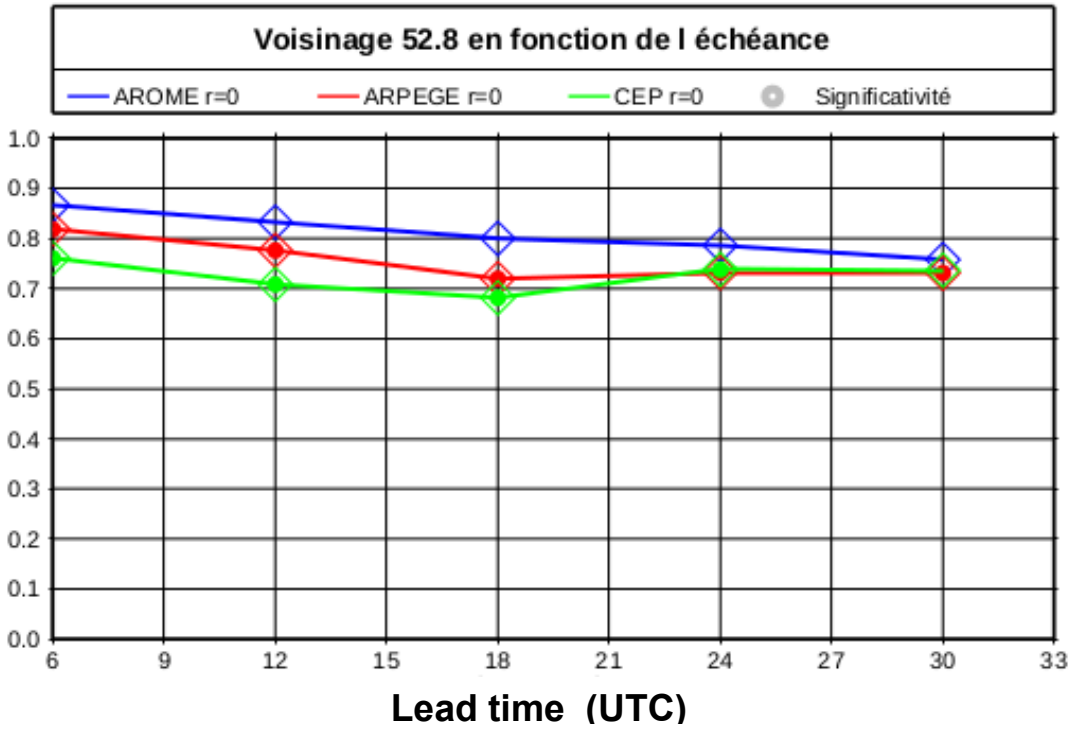


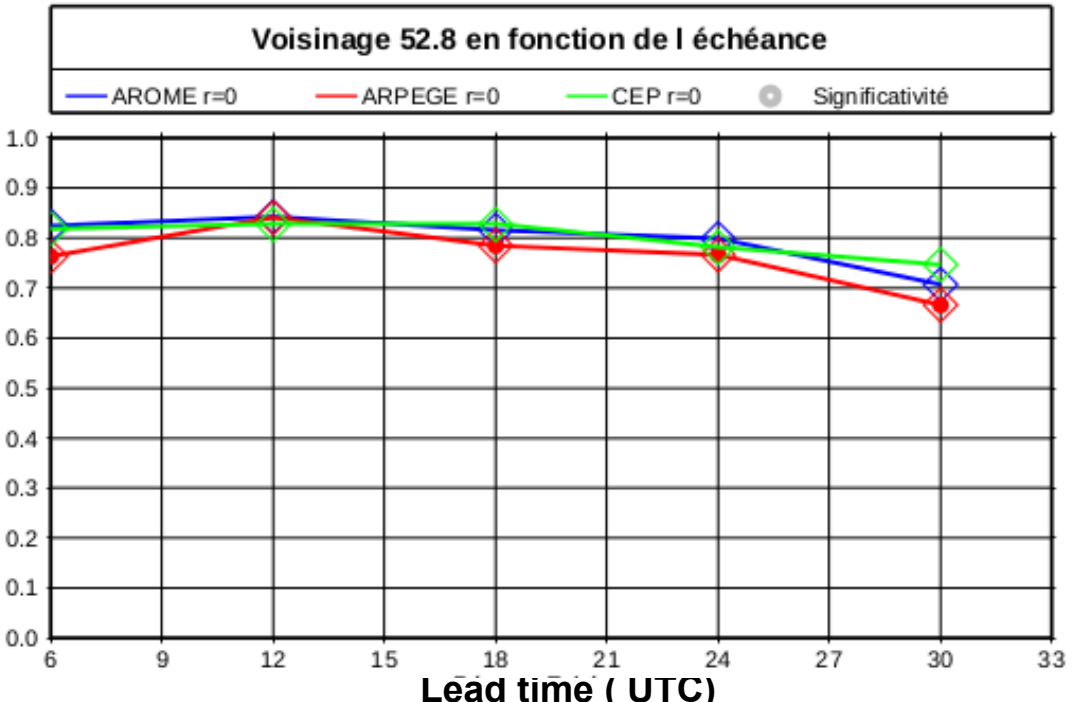


HDOBS 41r1-v-41r2 for France, DJF 2015/16



6 hours accumulated rainfall BSS_NO





Neighbourhood 50 km

Winter 2014-2015

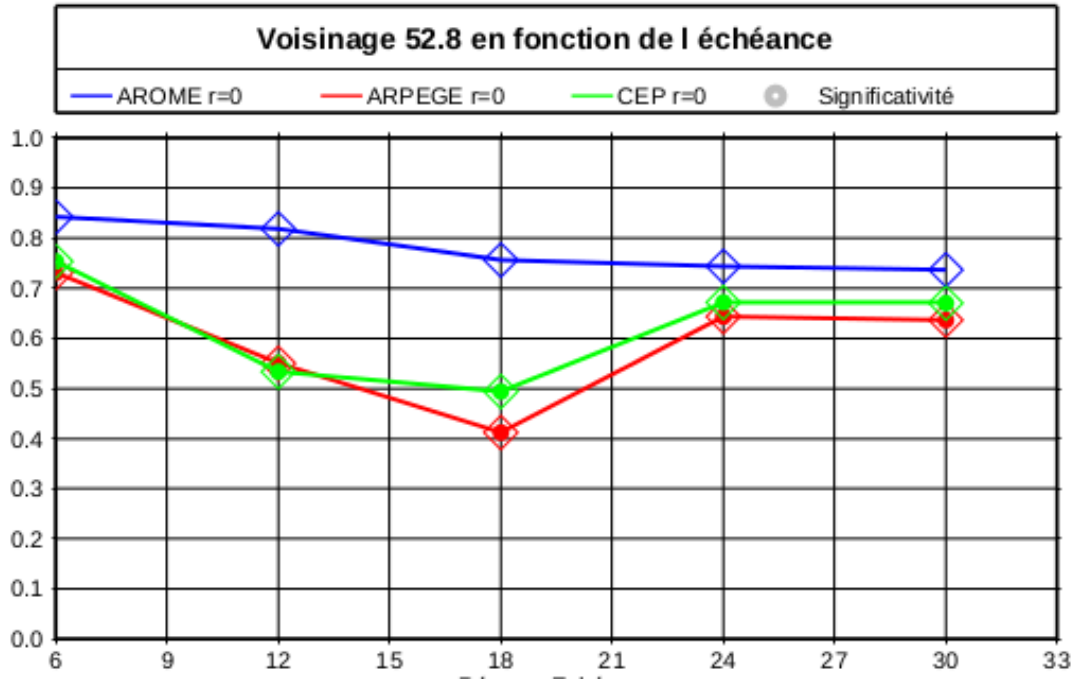
Threshold 0.5 mm

AROME
ARPEGE
IFS

Threshold 5 mm

MF

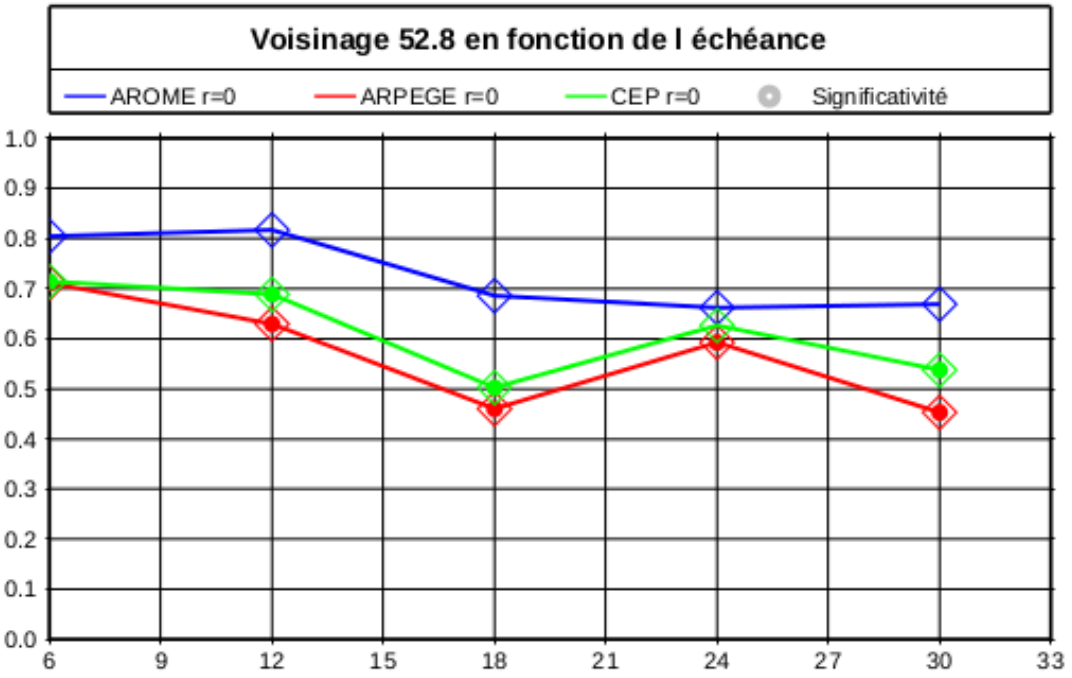
6 hours accumulated rainfall BSS_NO



Neighbourhood 50 km

Summer 2015

Threshold 0.5 mm



Threshold 5 mm

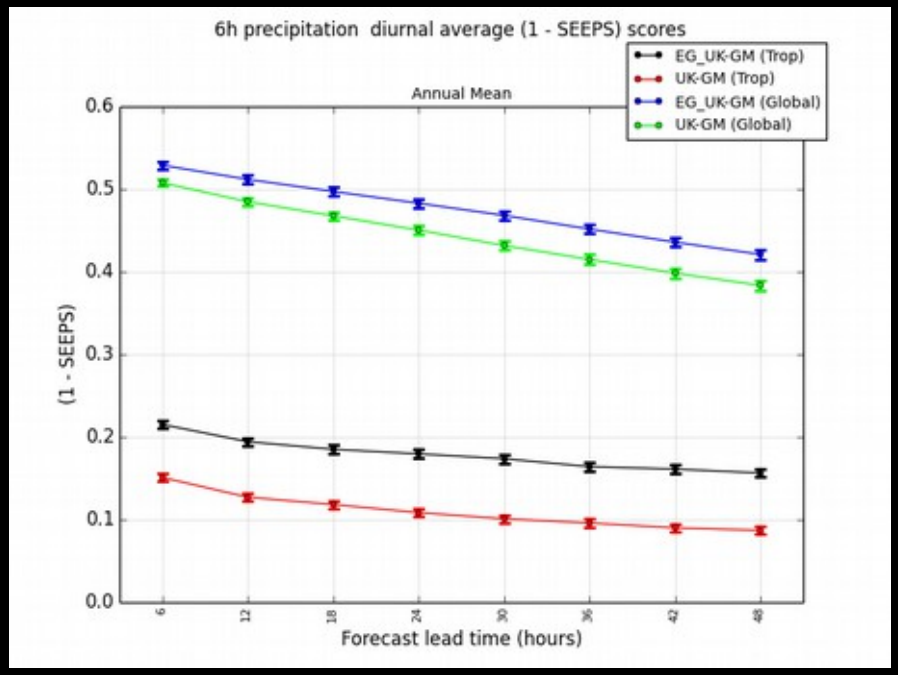
MF

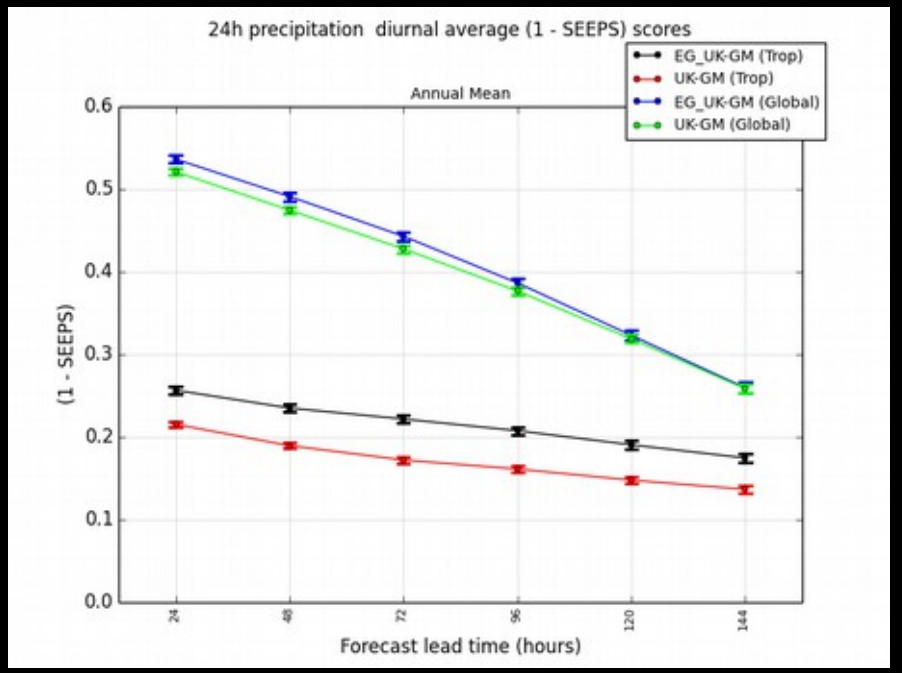
Verification of QPF using SEEPS

Score with forecast lead time, April 2012 to February 2016

SEEPS skill score from UM
Global
6-hour accumulations
(6h to 48h)

Diurnal averages
Tropics: red & black
Global: blue & green





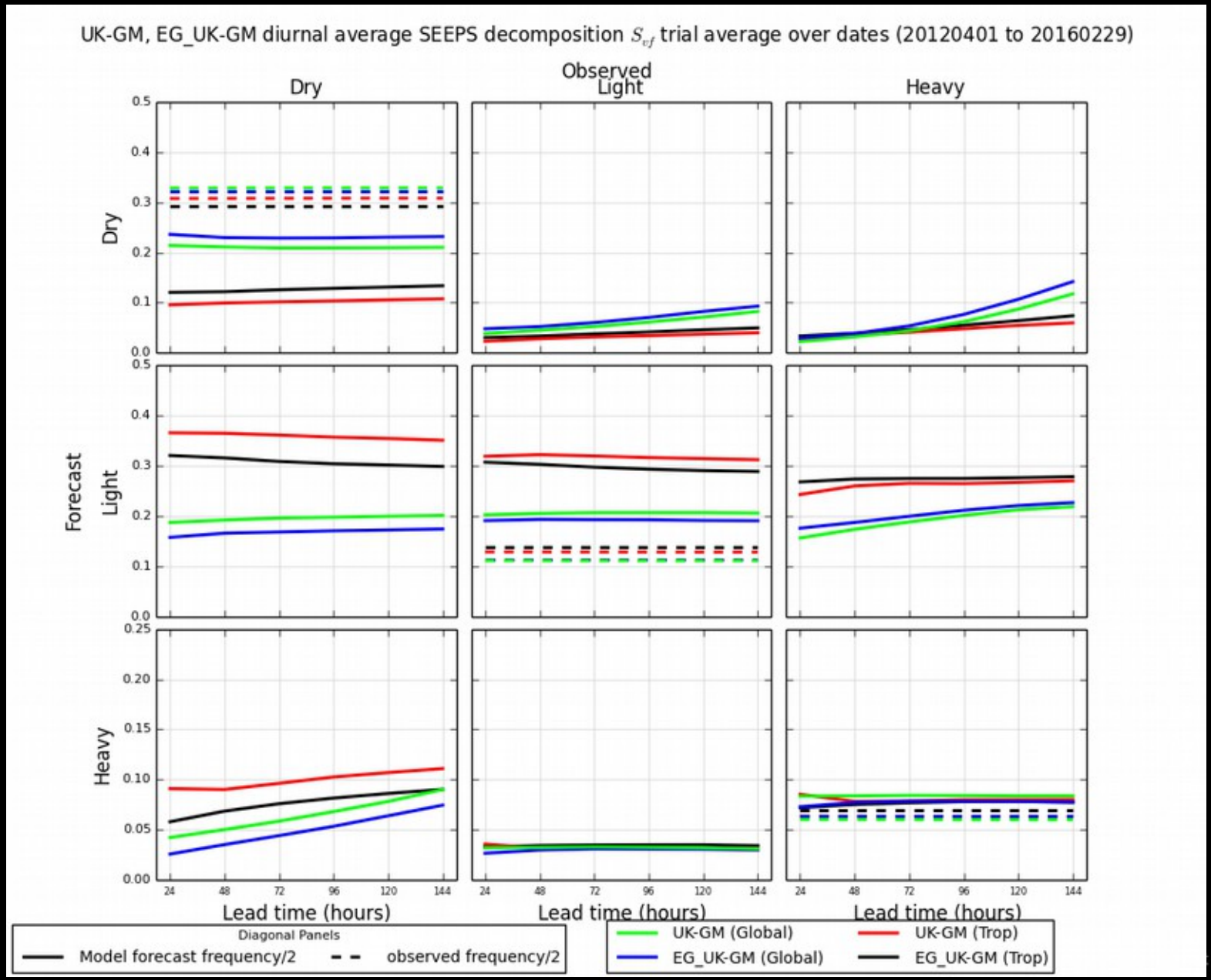
SEEPS skill score from UM
Global
24-hour precipitation
accumulations (day 1 to 6)

Verification of QPF using SEEPS

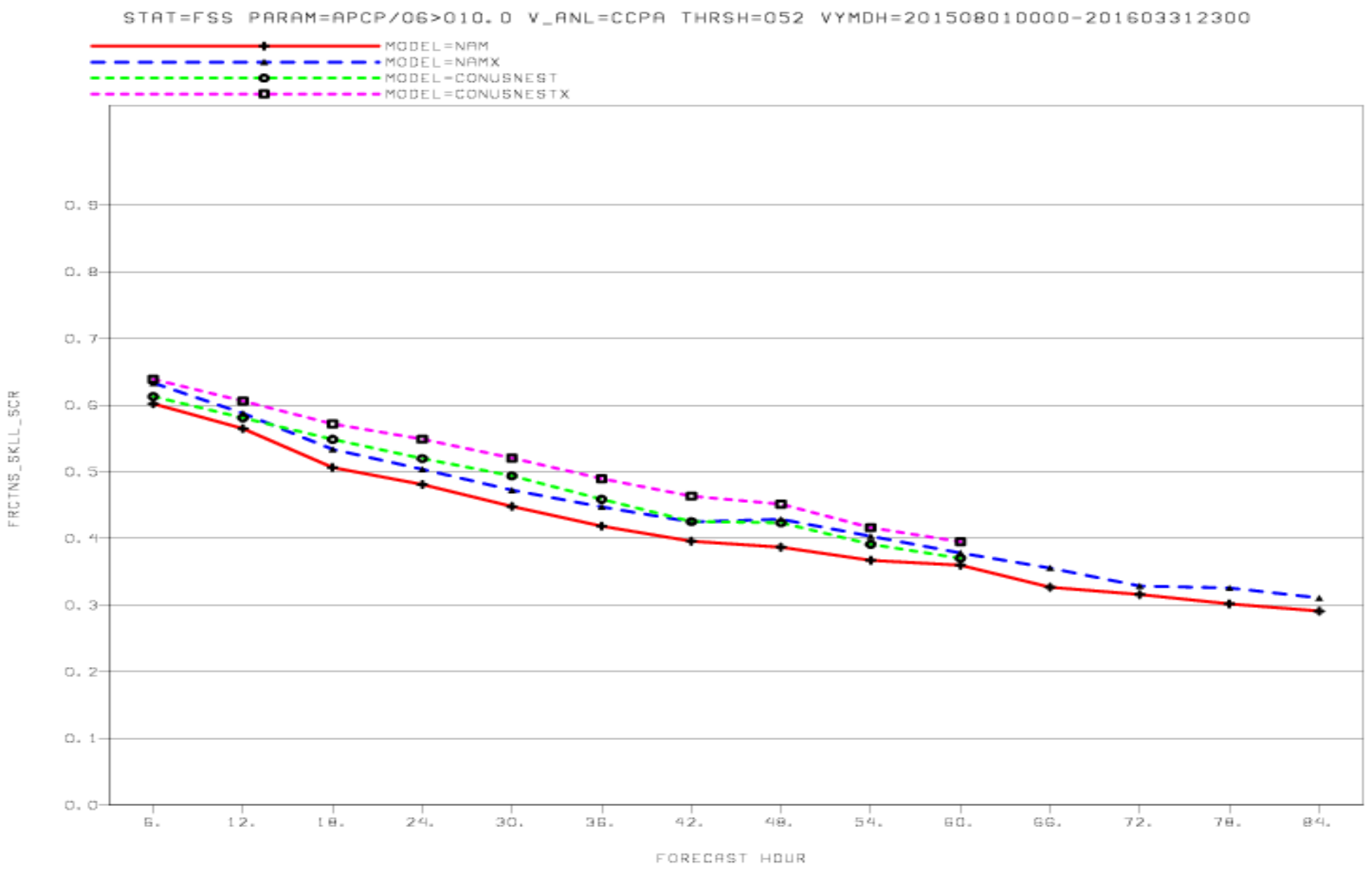
Decomposition into constituent error sources

Diurnal Average 2012-2016

24-hour totals



NAM/NAMX/CONUSNEST/CONUSNESTX Aug 2015 – Mar 2016, 6h FSS

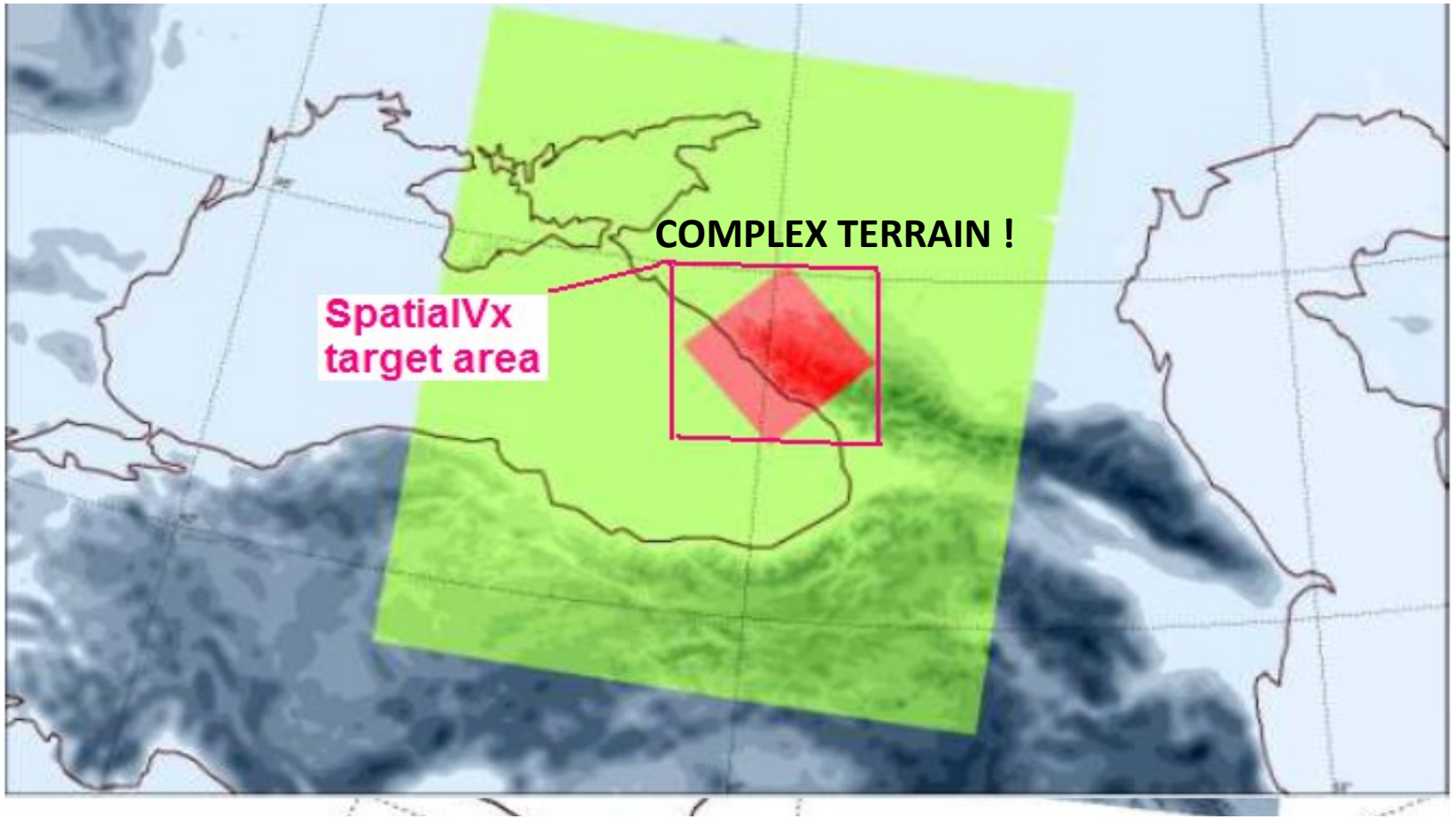


10mm/6h @52km

NCEP

Area of the study

349 lon points * 481 lat points with **0.00833** lat-lon increments.
1 grid size by **longitude** = 111*0.00833 = **930 m**,
1 grid size by **latitude** = cos(43°35')*930 m = 0.72*930 = **~ 670 m**

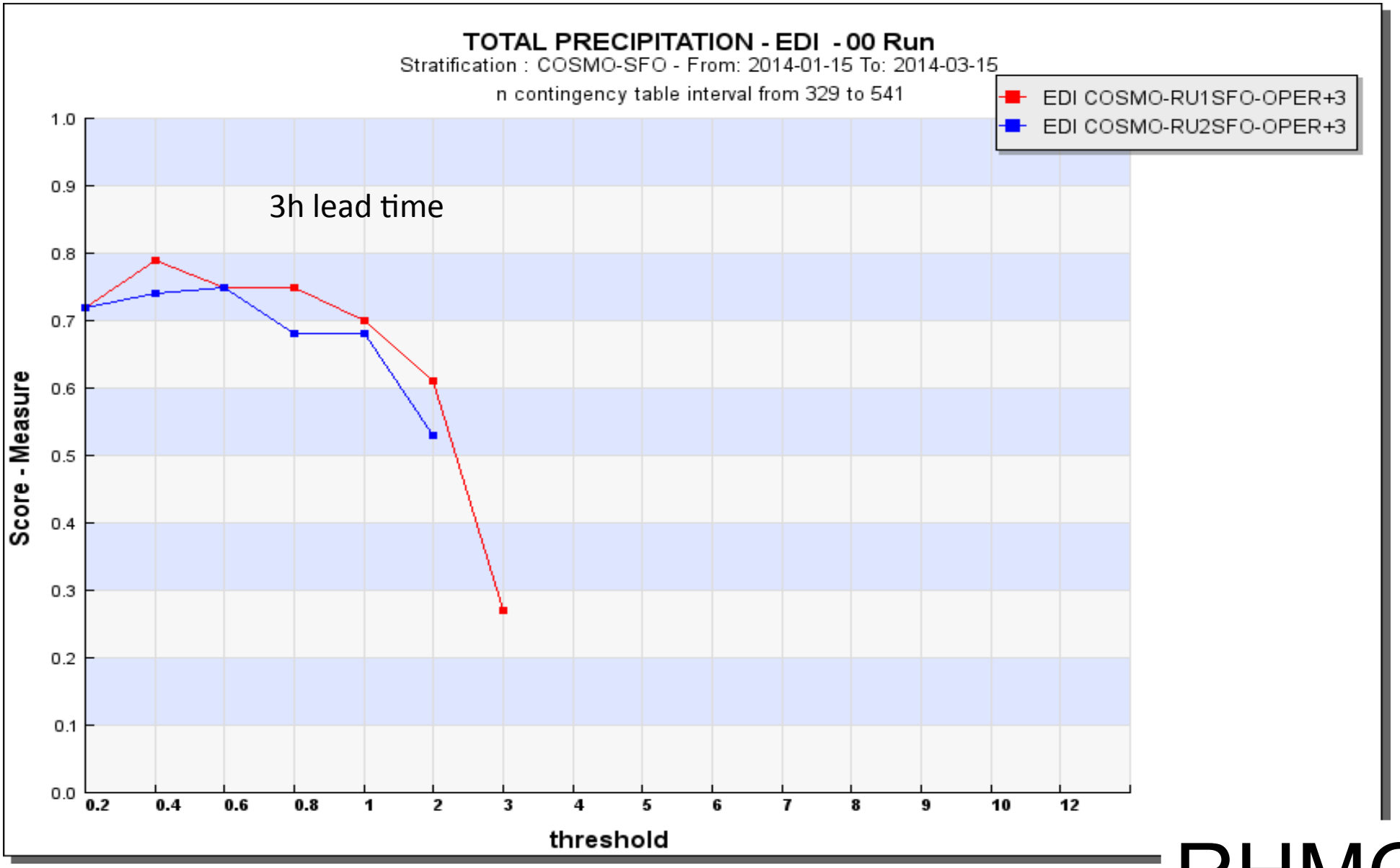


COSMO-Ru2 domain (2.2-km resolution)

COSMO-Ru1 domain (1.1-km resolution)

RHMC

EDI of 1h precipitation, Sochi region, Comparison with the station data (~23 stations) as a function of threshold, COSMO-Ru1 and COSMO-Ru2



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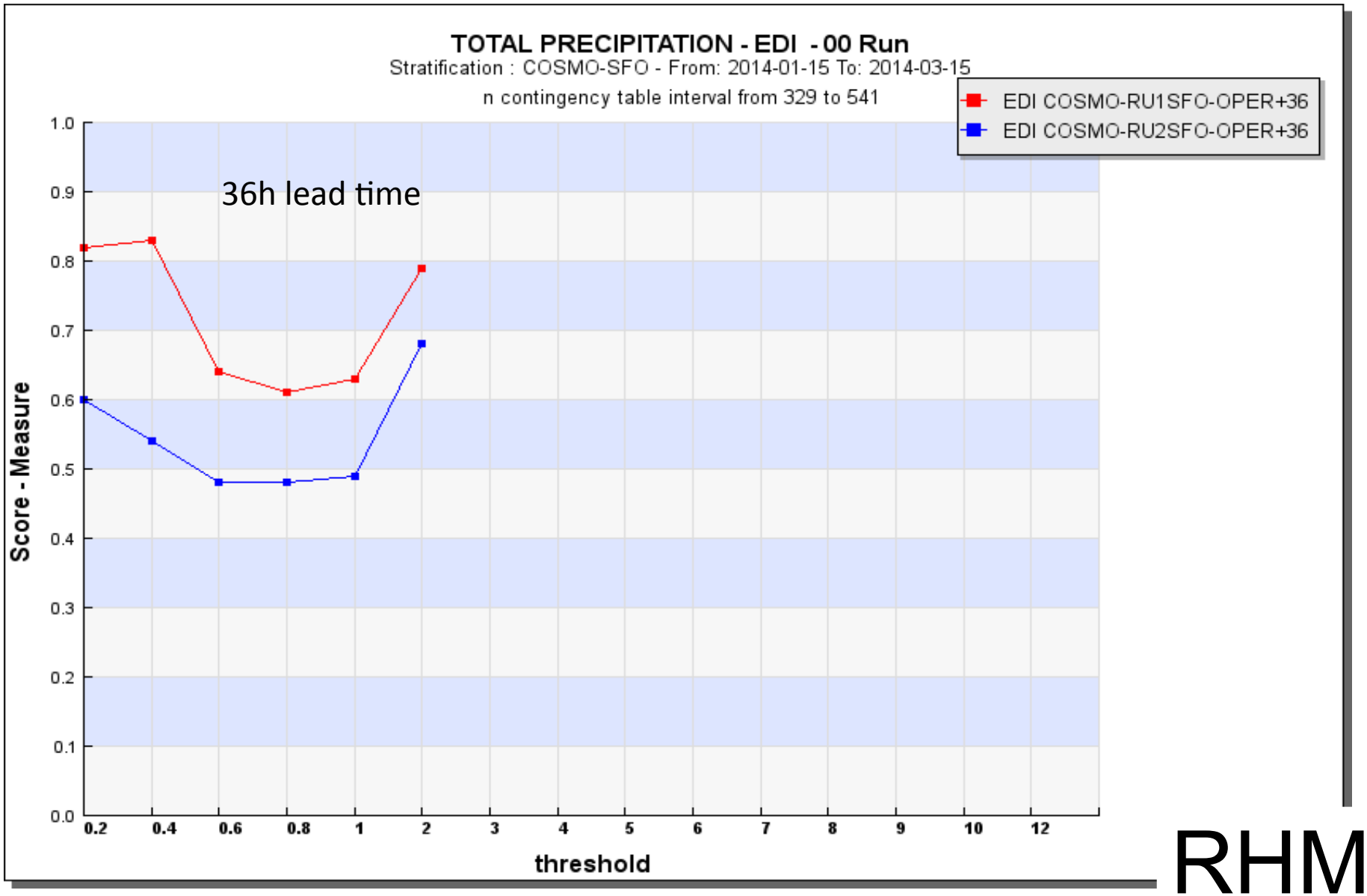

RHMC

Conclusions and perspectives

Many contributions on QPF verification from centers to WGNE-31: ~140 slides

10 contributions on QPF survey

There is a clear move towards recommended methods for the verification of precipitation forecasts against high resolution limited area observations (JWGFVR, Nov 2013).

QPF verification of global models with high resolution national observation network is very useful:
- a lot of scores are produced (types, thresholds, period, etc.) and should be ideally available on Web site (password if necessary) like NCEP or MF
- some interest to increase forecast data resolution in time (at least 6h) and space (?)
- QPF intercomparison on EPS ?

Weaknesses:
- Inter-comparison of a limited number of models
- Inter-comparisons are done in several centers with similar but not identical methodologies. This does not a provide a very comprehensive overview of QPF verification all over the world, like for instance for TC verification.
- Lack of station climatologies for computing BSS, CRPSS