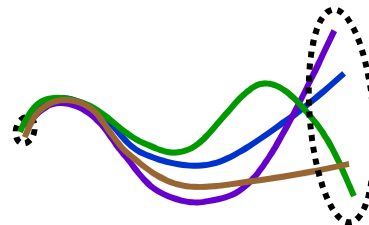


# COSMO-DE-EPS forecasts using KENDA for initial conditions

-- WG 1 / WG7 / PP KENDA-O / PP SPRED joint session --



Christoph Gebhardt, Tobias Tröndle  
developers of KENDA, ICON-EPS, ICON-EDA, verification

Deutscher Wetterdienst, DWD



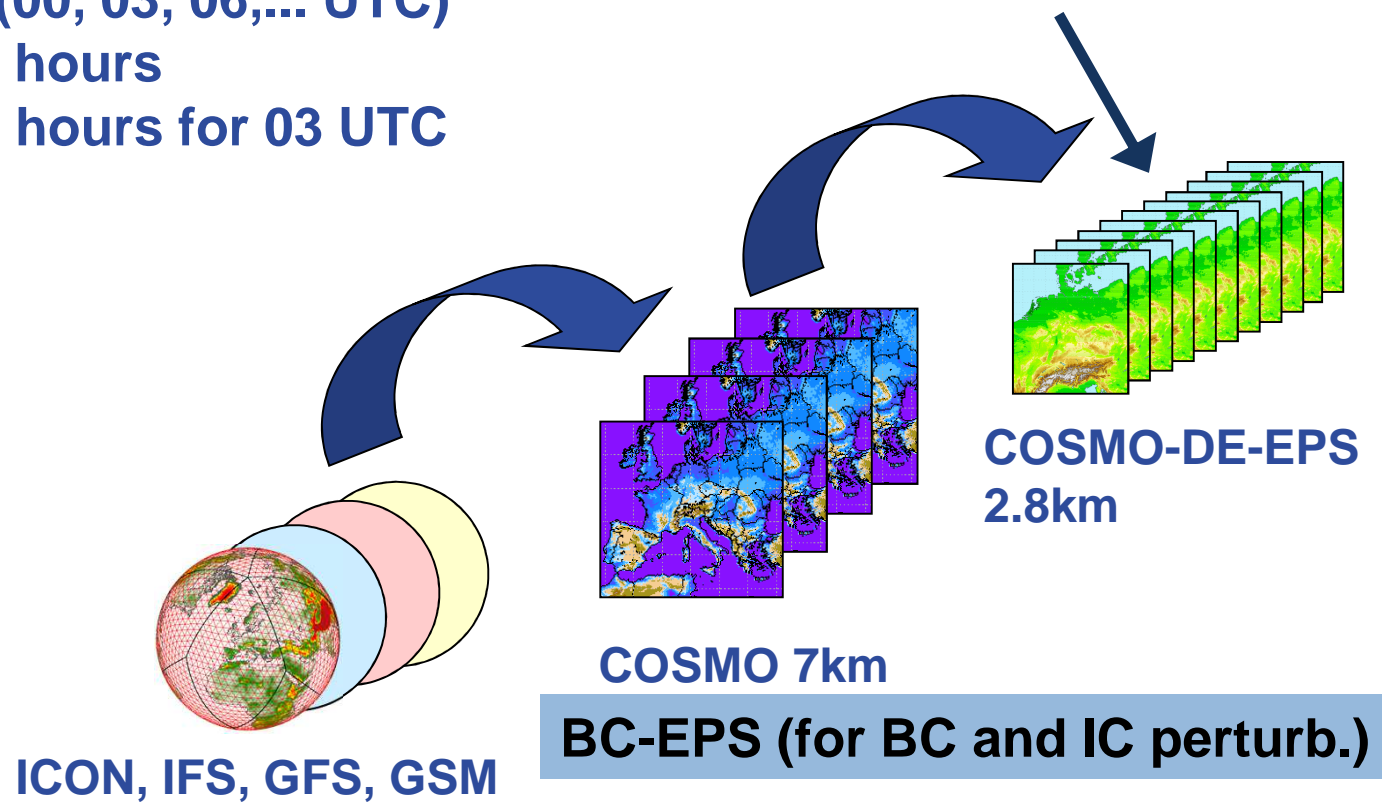
## Outline

- operational set up & changes since last COSMO GM
- Use of KENDA in pre-operational COSMO-DE-EPS (probabilistic verification)
- ICON-EPS as boundary conditions for COSMO-DE-EPS (highlights)

# COSMO-DE-EPS operational set-up

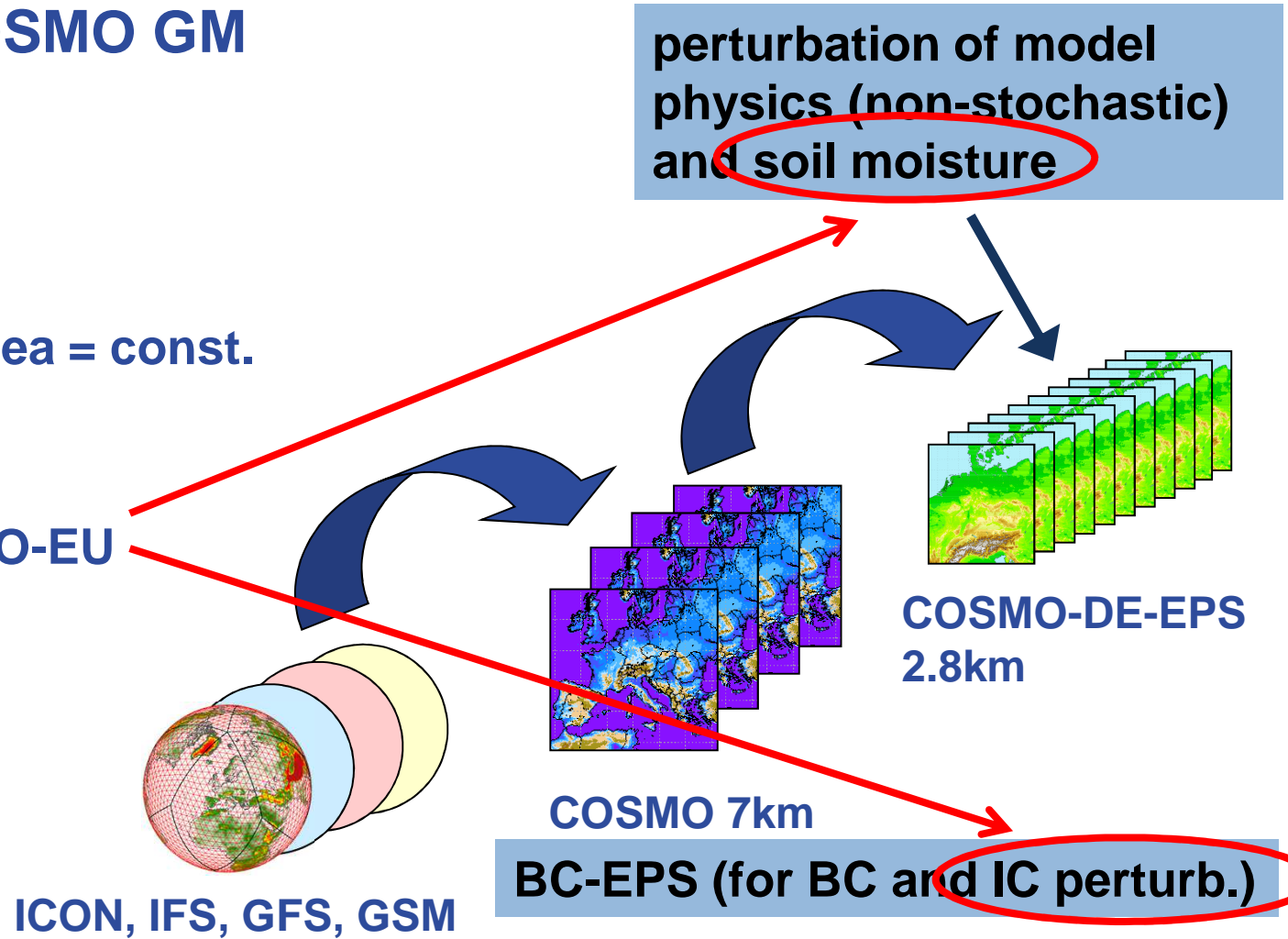
- 20 members, grid size: 2.8 km
- 8 starts per day (00, 03, 06,... UTC)  
lead time: 0 - 27 hours  
0 - 45 hours for 03 UTC

perturbation of model physics (non-stochastic) and soil moisture



# main changes in operations since last COSMO GM

- $rlam\_heat*rat\_sea = const.$   
(Apr 16)
- **ICON-EU**  
replaces **COSMO-EU**  
(Jul 16)



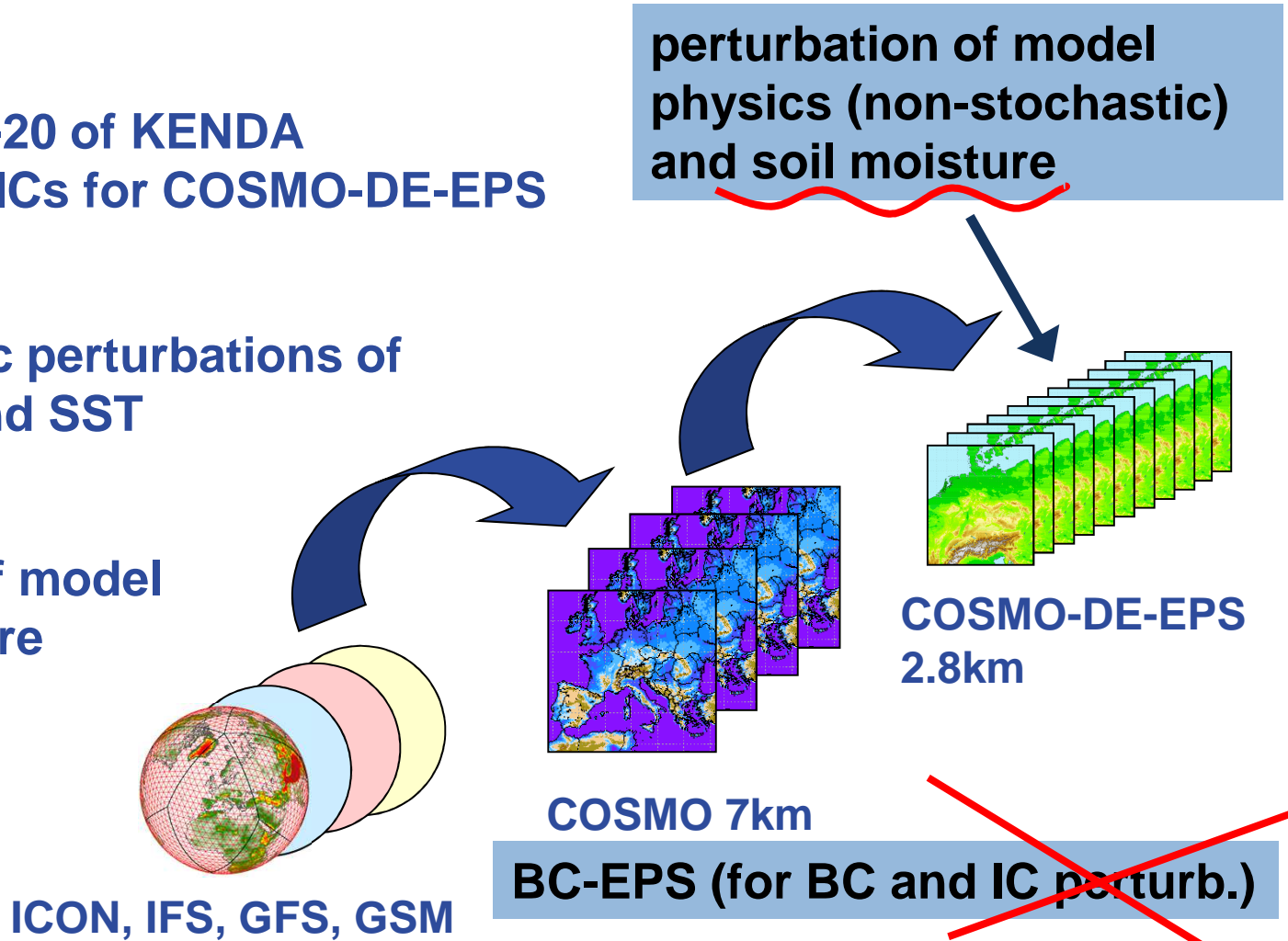
# KENDA in COSMO-DE-EPS

→ use members 1-20 of KENDA assimilation as ICs for COSMO-DE-EPS

→ apply stochastic perturbations of soil moisture and SST

→ perturbations of model physics as before

→ BC-EPS as BCs



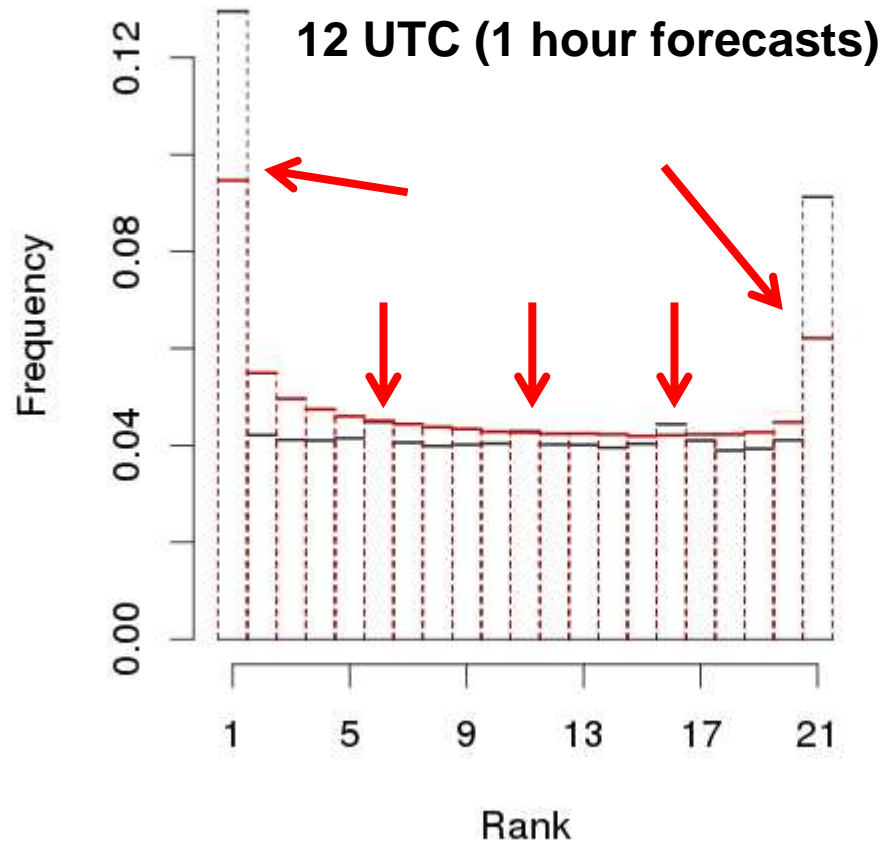
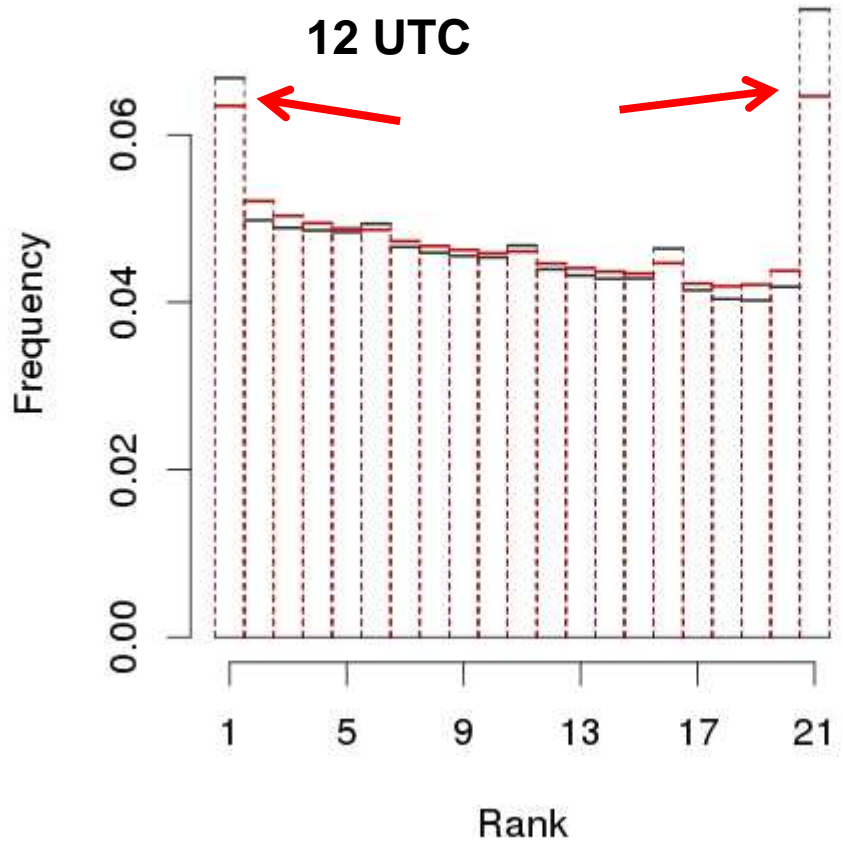
ICON, IFS, GFS, GSM



## KENDA in COSMO-DE-EPS (verification)

- verification period: 26.7.- 25.8. / 31.8.
- 00 and 12 UTC runs with 27 hours forecast range
- probabilistic scores
- hourly precipitation vs radar (rain gauge adjusted )
- hourly 10m gusts vs SYNOP
- 2m temperature vs SYNOP

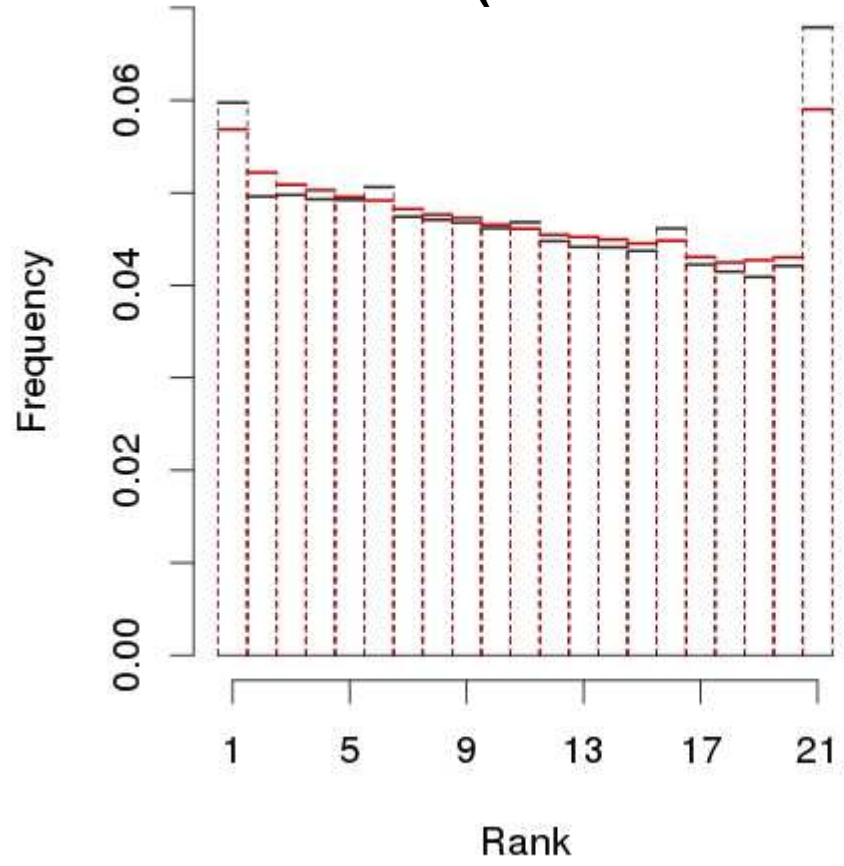
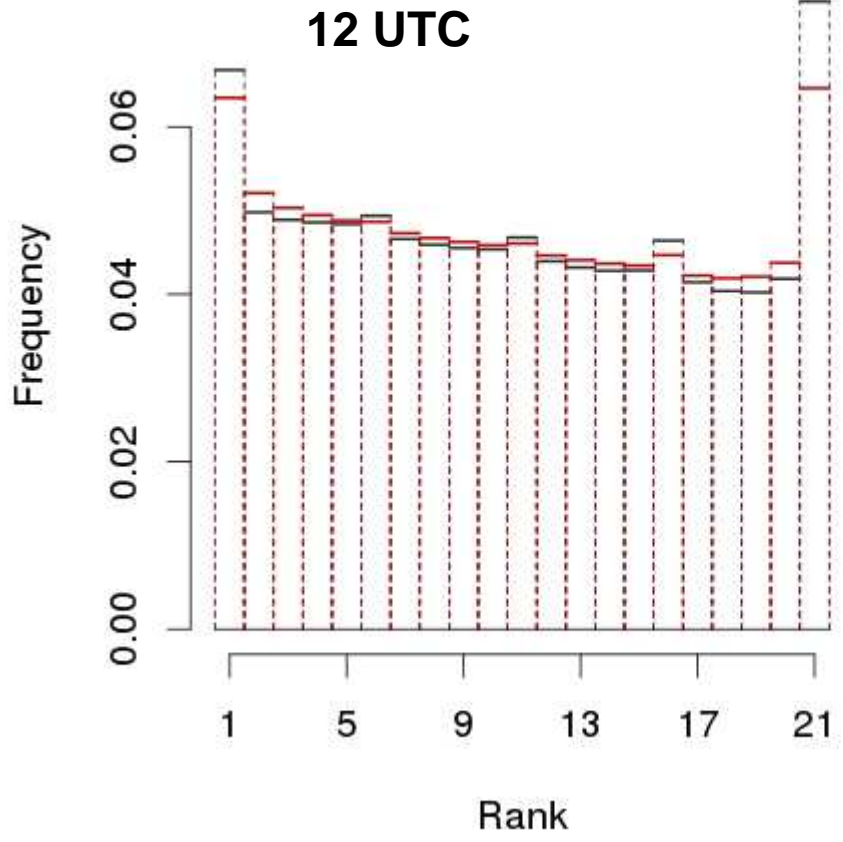
Rank histogram (hourly precipitation) **KENDA + BCEPS boundary operational**



Rank histogram (hourly precipitation)

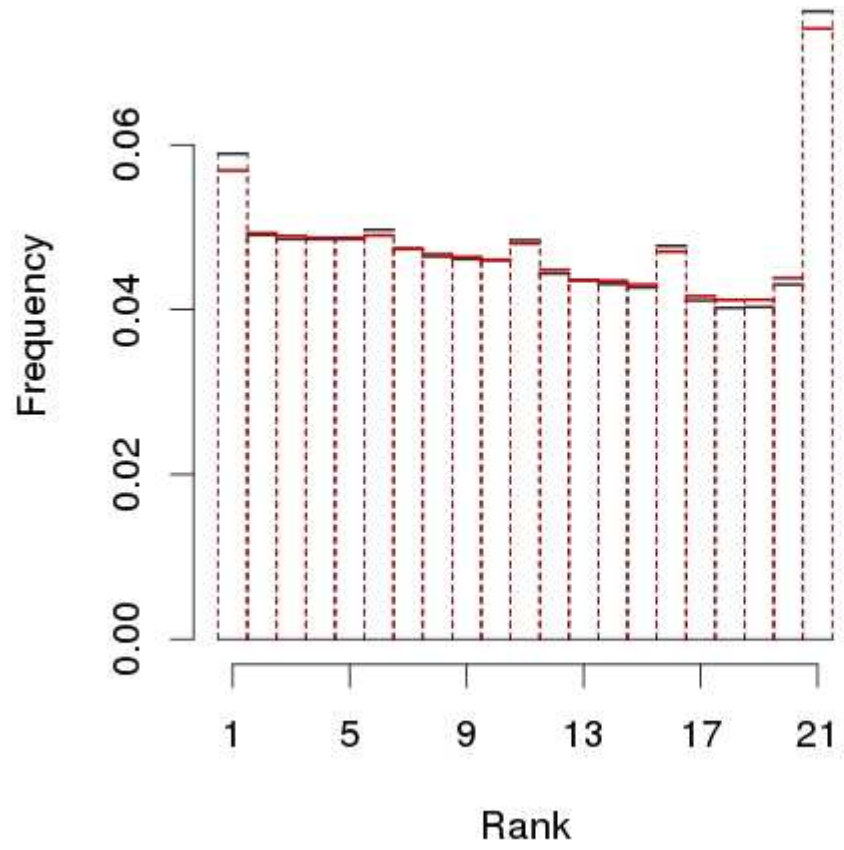
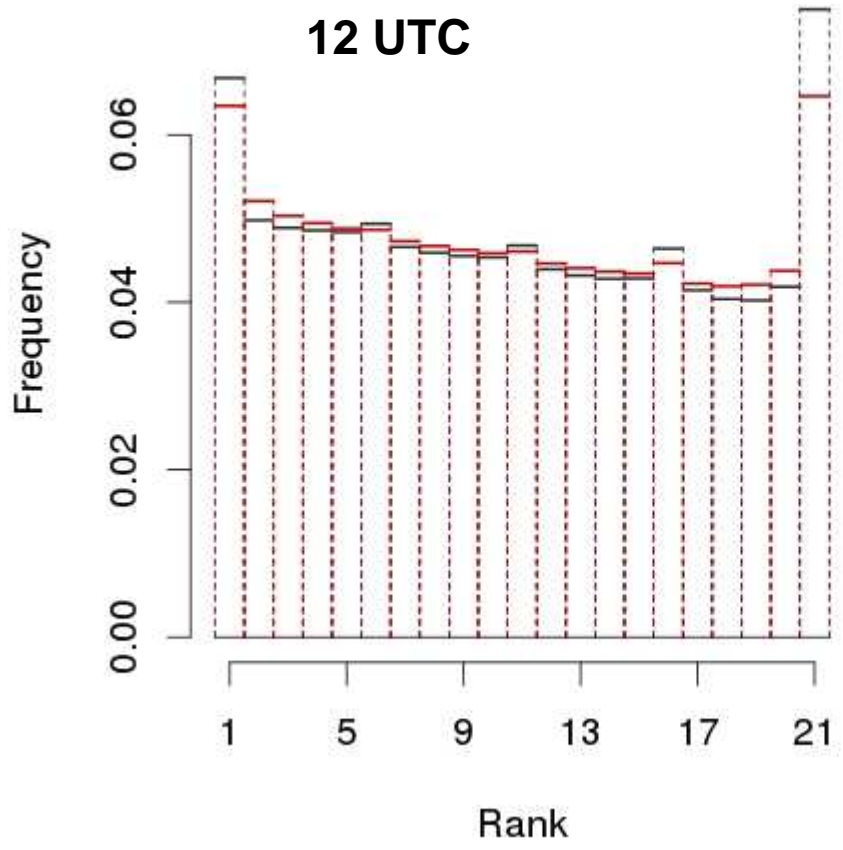
**KENDA + BCEPS boundary**  
operational

12 UTC (12 hours forecasts)

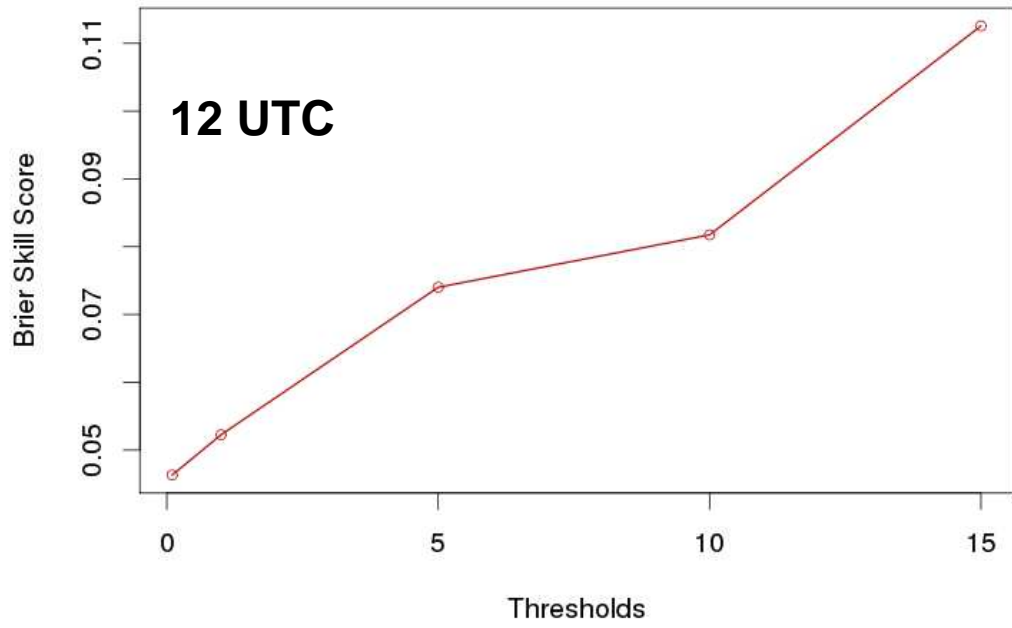
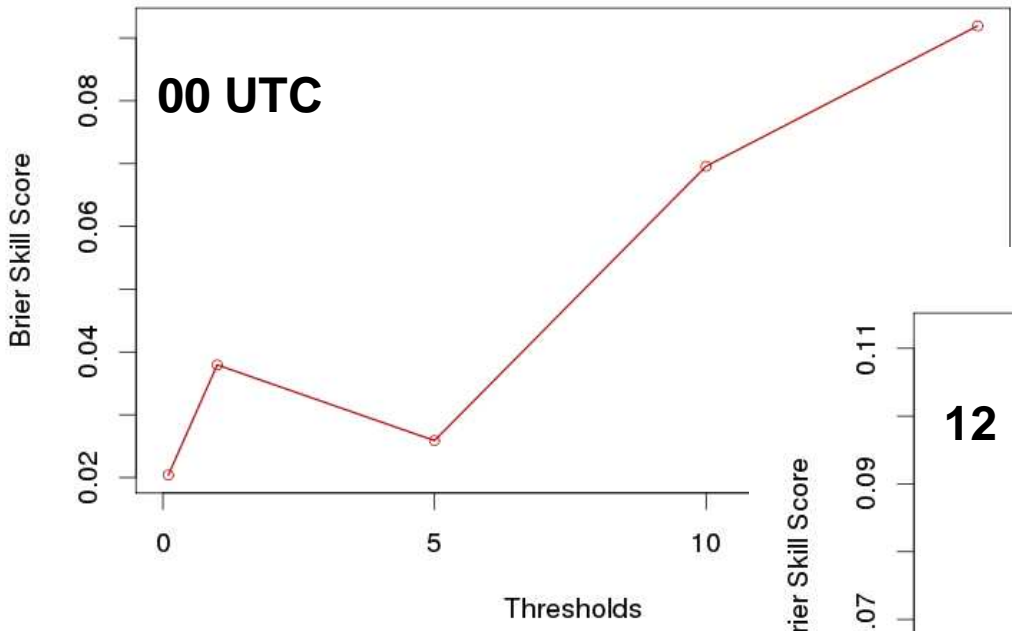




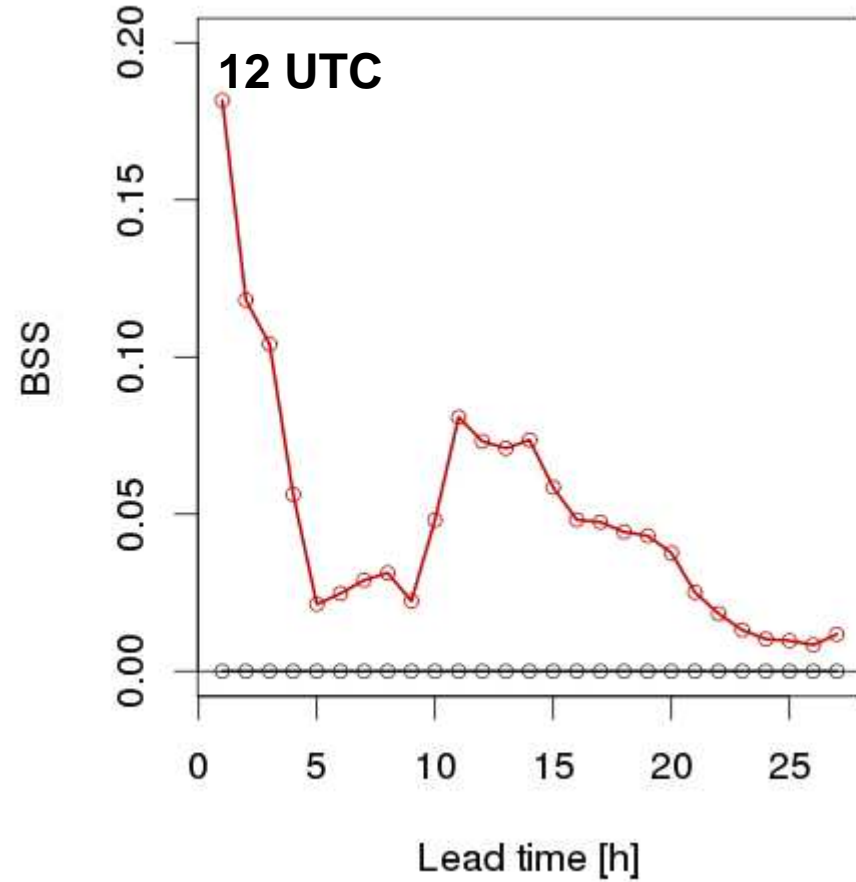
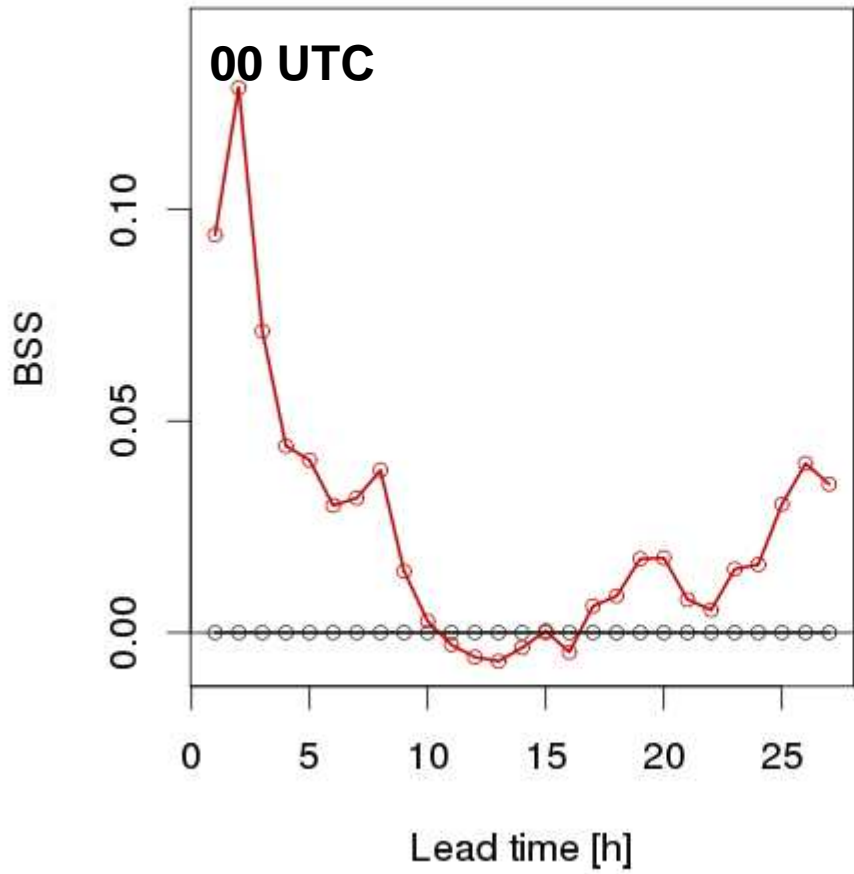
Rank histogram (hourly precipitation) **KENDA + BCEPS boundary**  
operational  
12 UTC (27 hours forecasts)



**Brier Skill Score (hourly precipitation) KENDA + BCEPS boundary (vs. operational)**

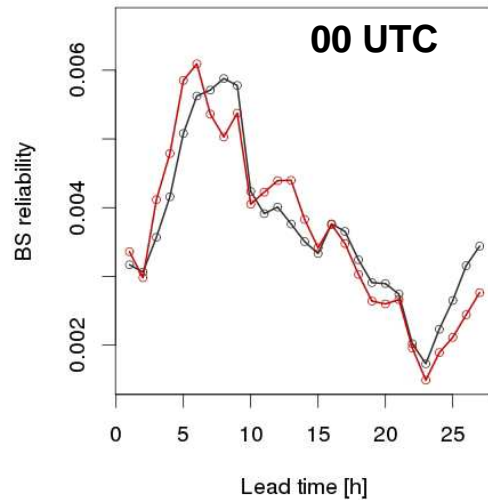


**Brier Skill Score (hourly precipitation) > 0.1 mm /h**    **KENDA + BCEPS boundary (vs. operational)**

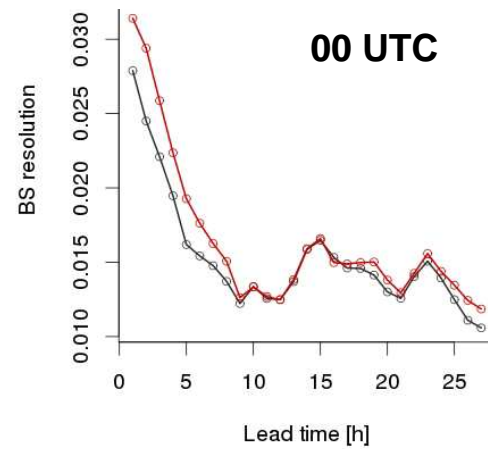
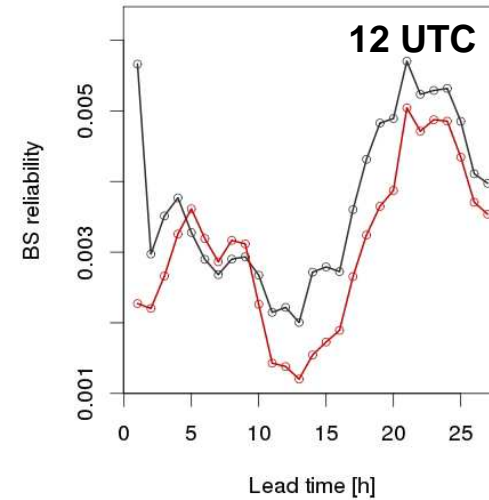


**BS Rel. & Res. (hourly precipitation)  
> 0.1 mm /h**

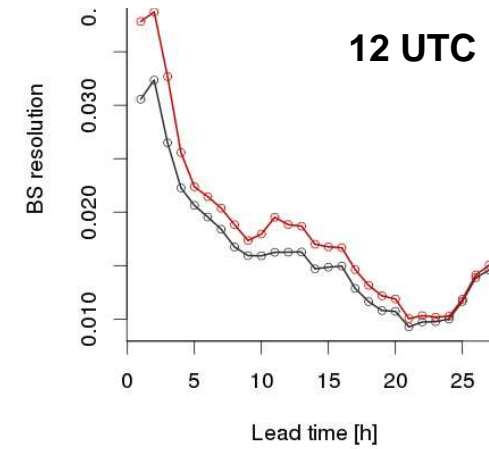
**KENDA + BCEPS boundary  
operational**



**reliability  
(lower is better)**

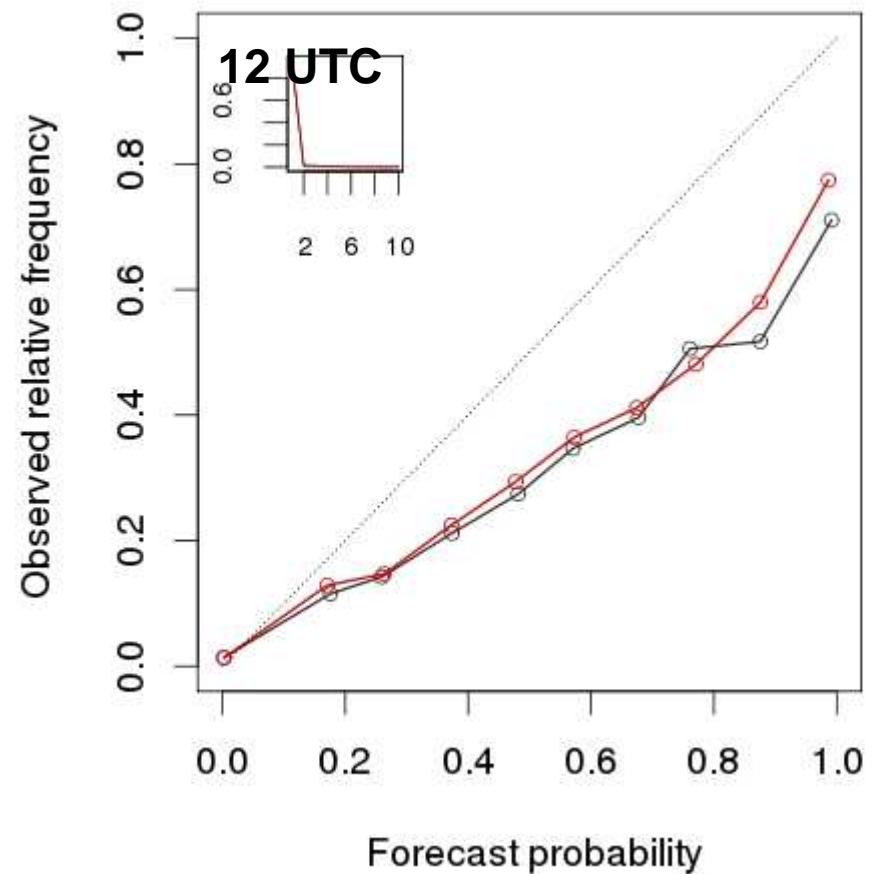
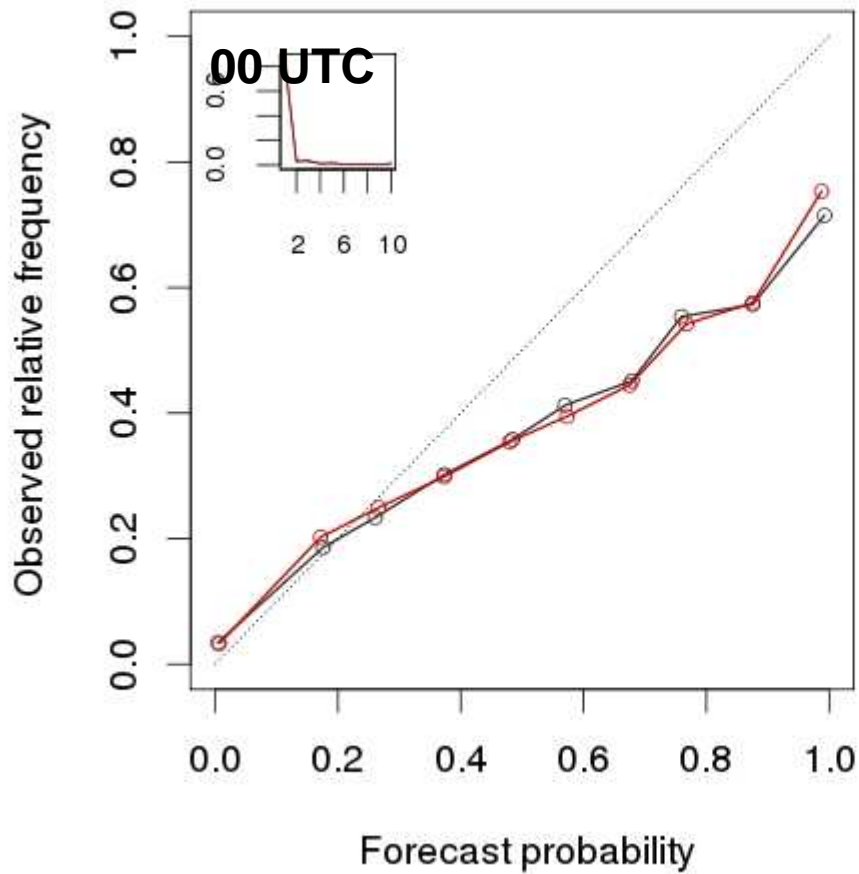


**Resolution  
(higher is better)**

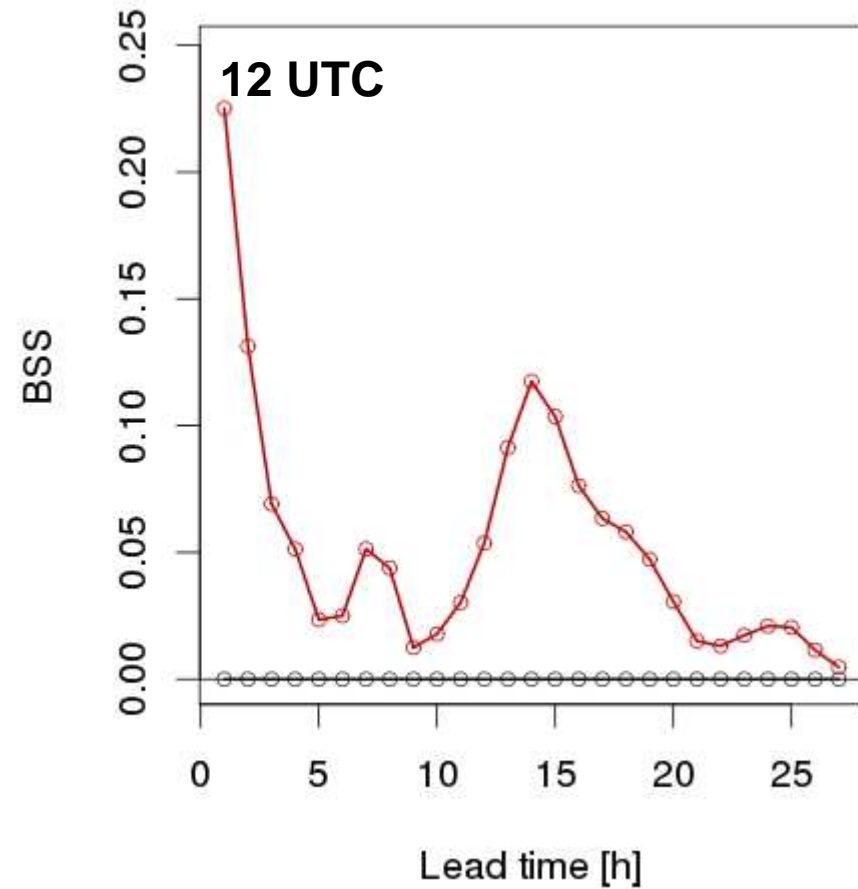
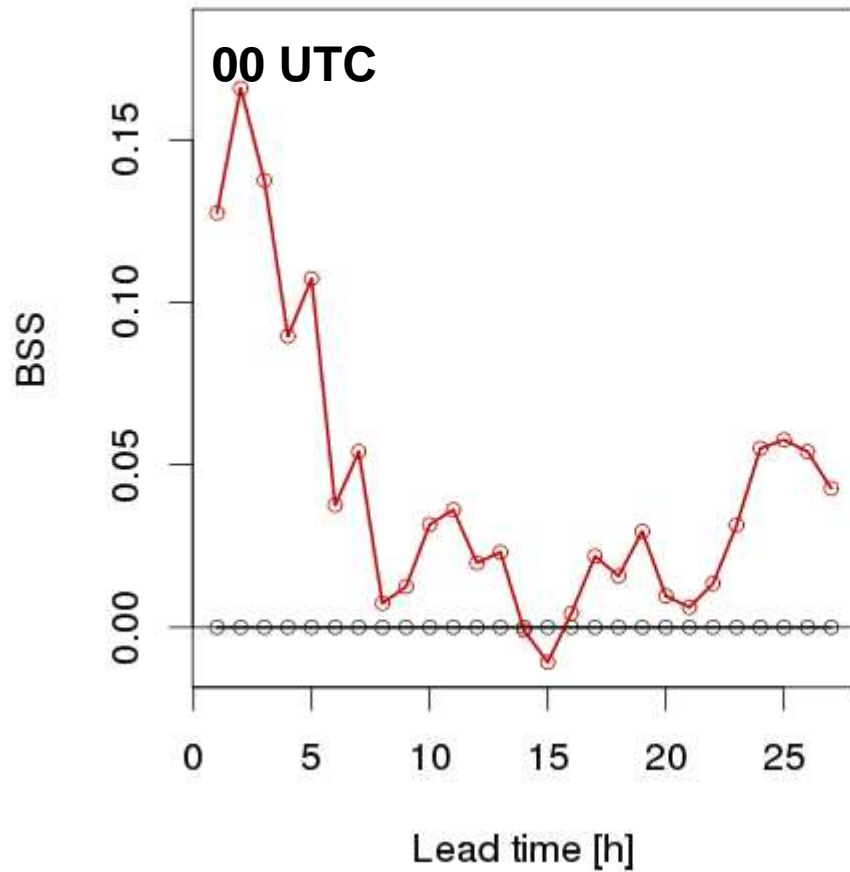


**Reliability diagram (hourly precipitation)  
> 0.1 mm /h**

**KENDA + BCEPS boundary  
operational**

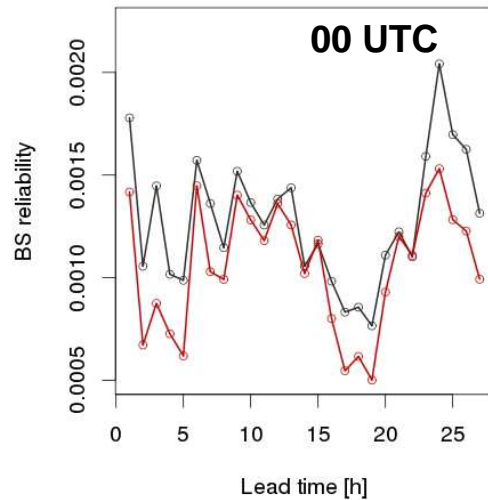


**Brier Skill Score (hourly precipitation) > 1 mm /h** **KENDA + BCEPS boundary (vs. operational)**

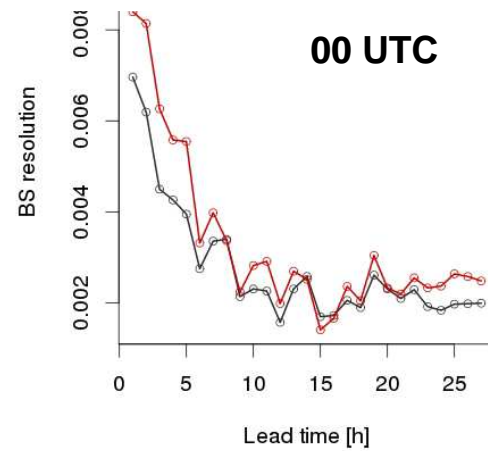
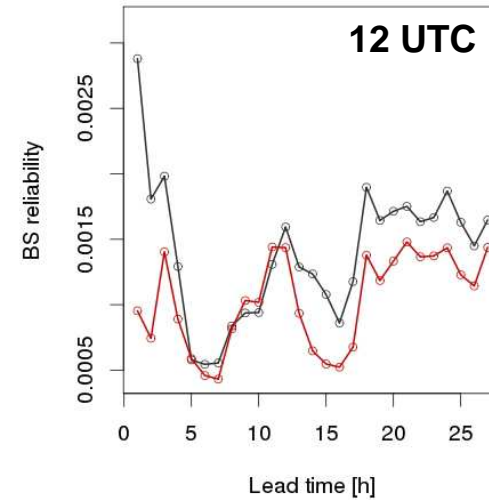


**BS Rel. & Res. (hourly precipitation)  
> 1 mm /h**

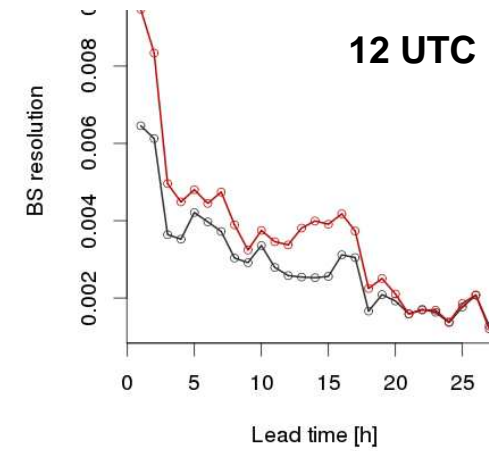
**KENDA + BCEPS boundary  
operational**



**reliability  
(lower is better)**

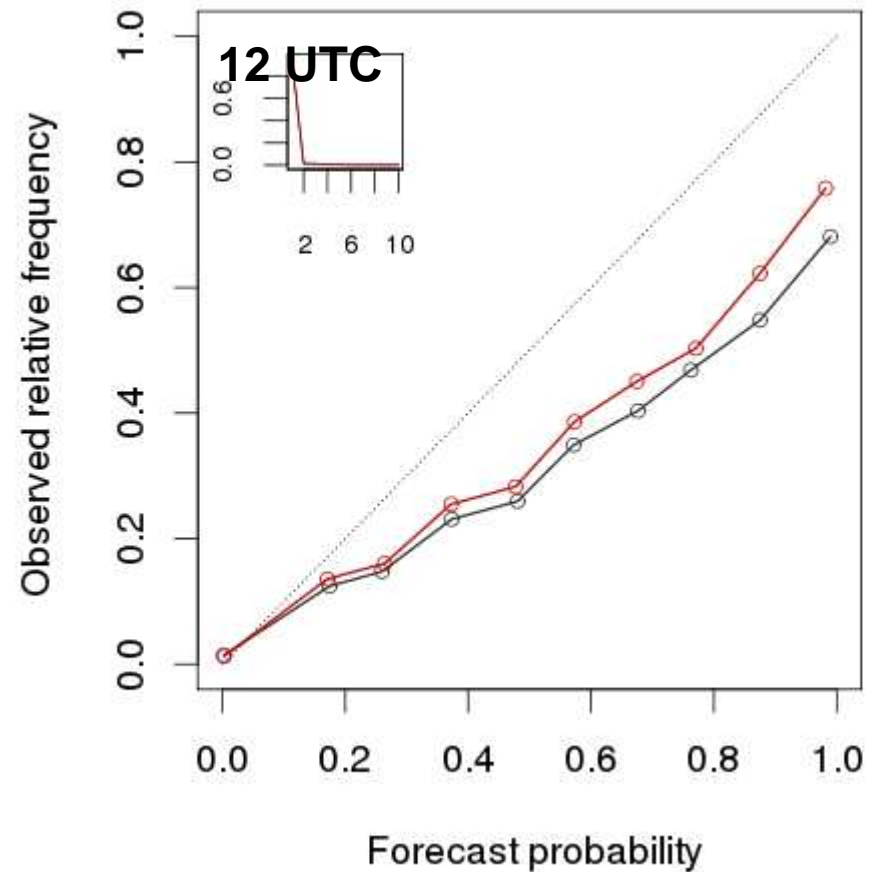
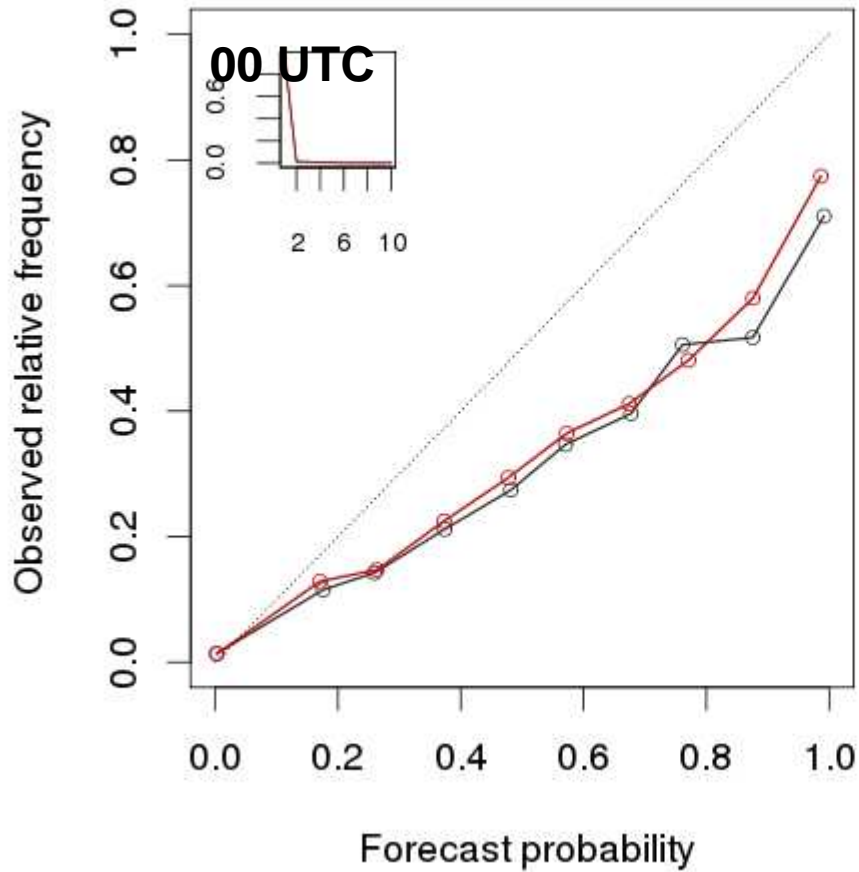


**Resolution  
(higher is better)**



**Reliability diagram (hourly precipitation)  
> 1 mm /h**

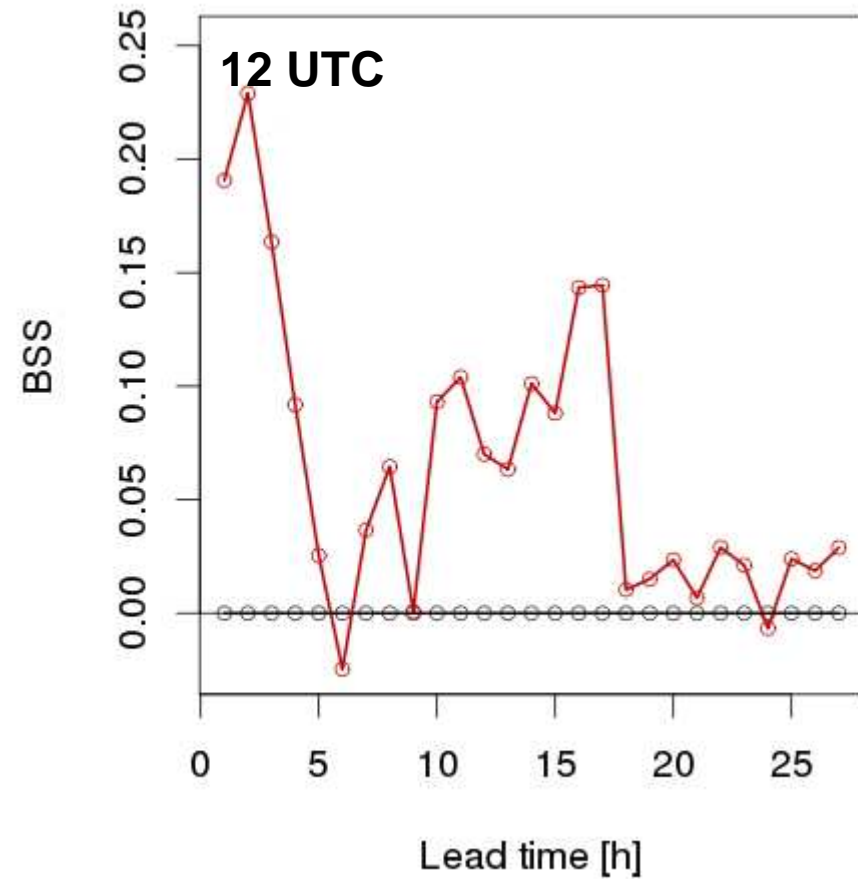
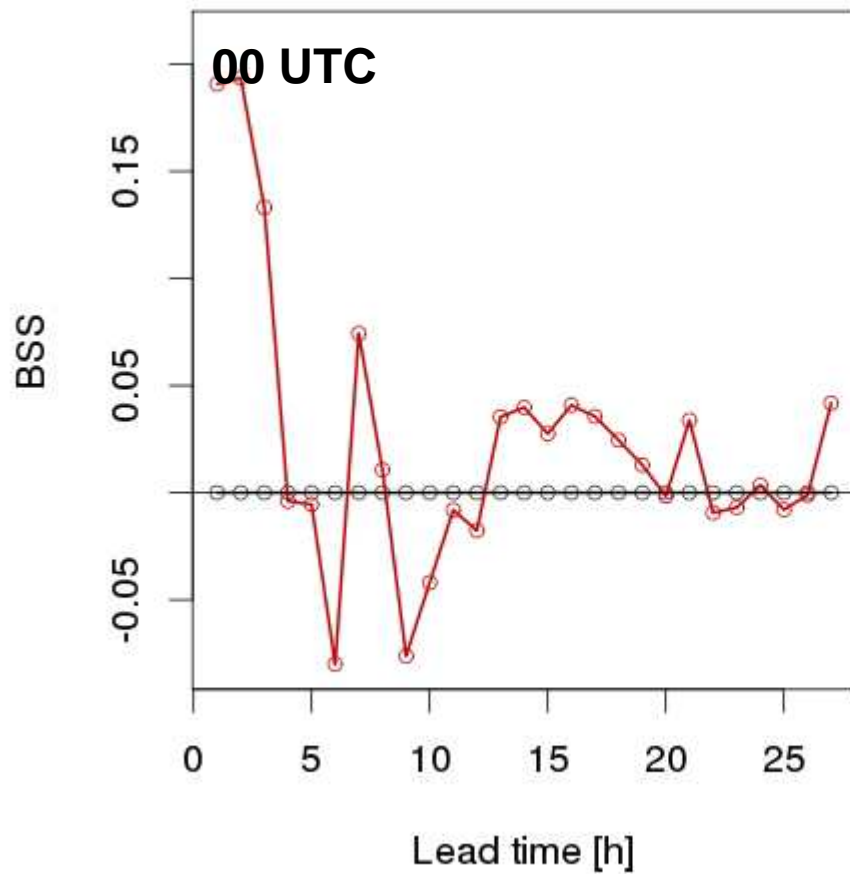
**KENDA + BCEPS boundary  
operational**





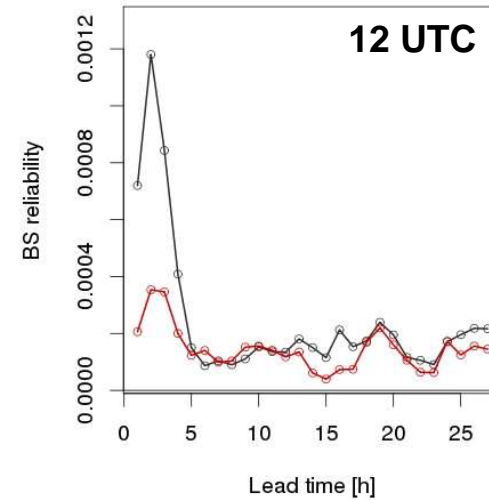
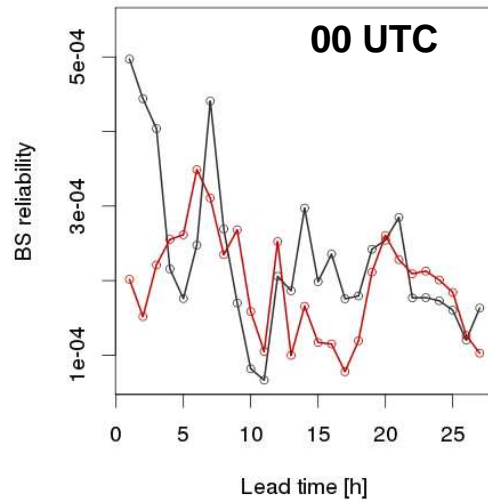
**Brier Skill Score (hourly precipitation)  
> 5 mm /h**

**KENDA + BCEPS boundary  
(vs. operational)**

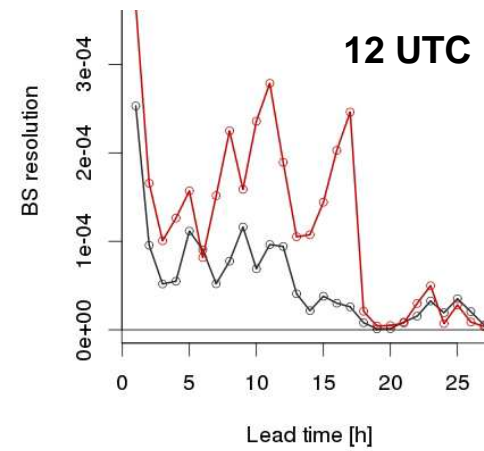
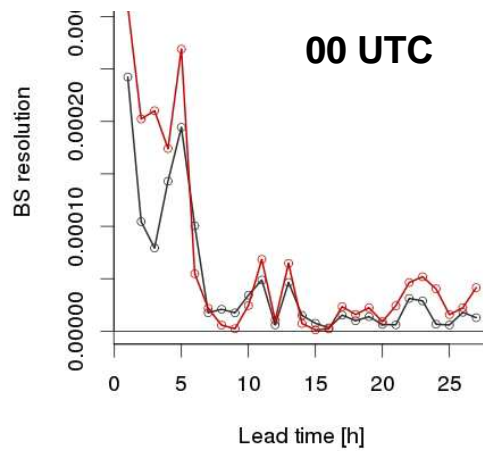


**BS Rel. & Res. (hourly precipitation)  
> 5 mm /h**

**KENDA + BCEPS boundary  
operational**



**reliability  
(lower is better)**

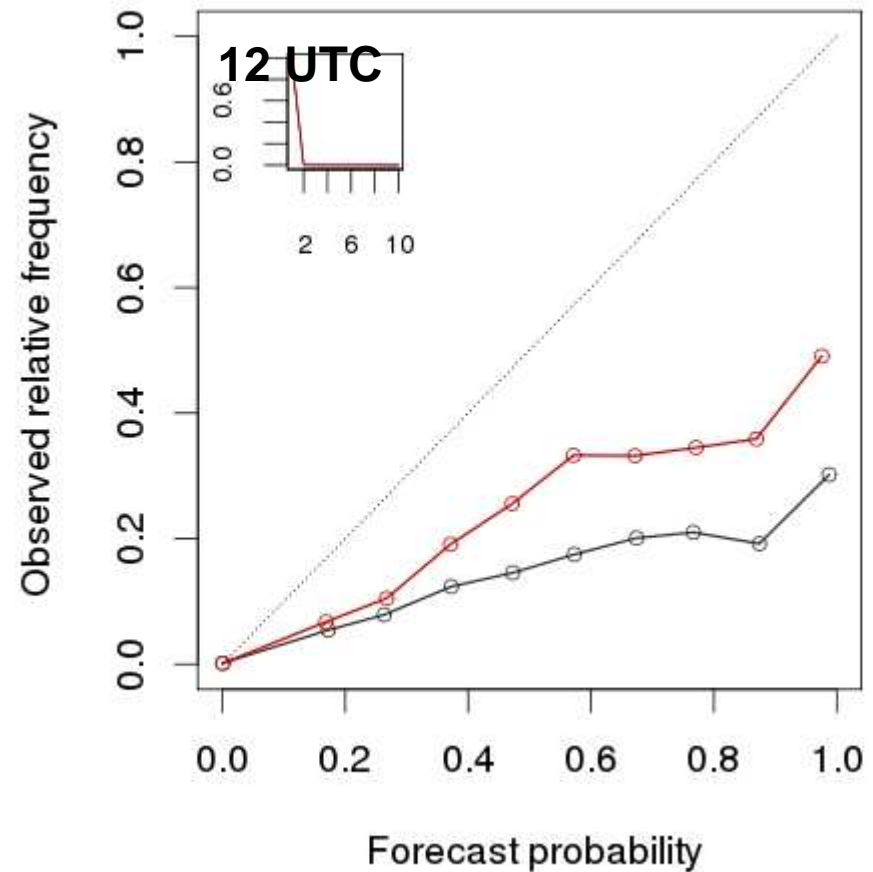
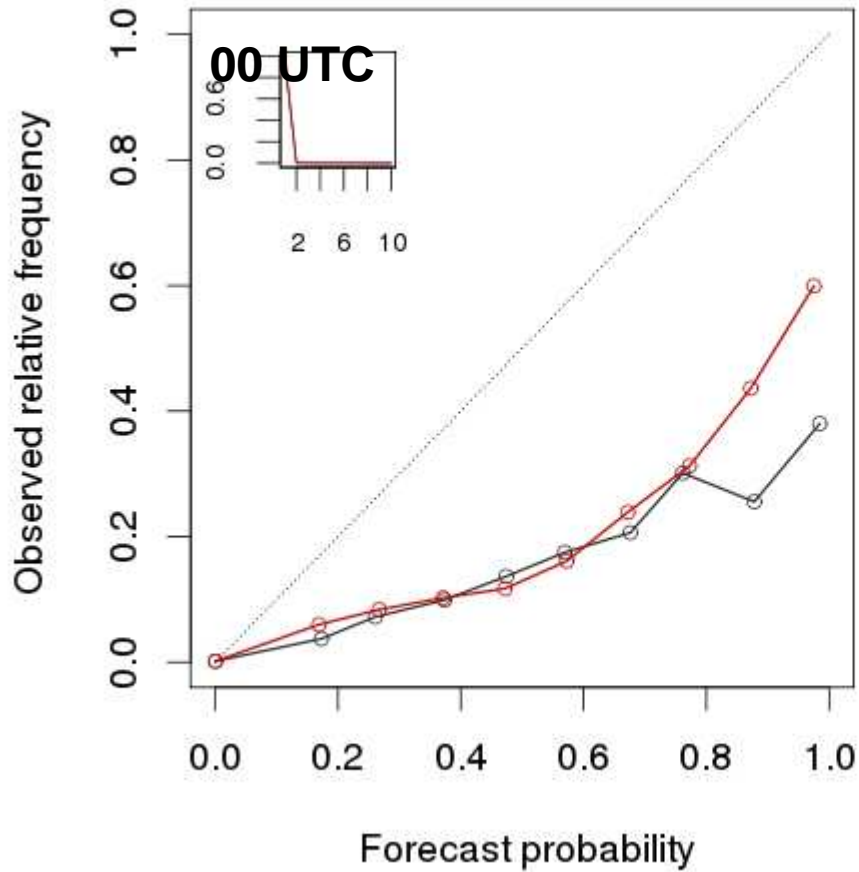


**Resolution  
(higher is better)**



**Reliability diagram (hourly precipitation)  
> 5 mm /h**

**KENDA + BCEPS boundary  
operational**



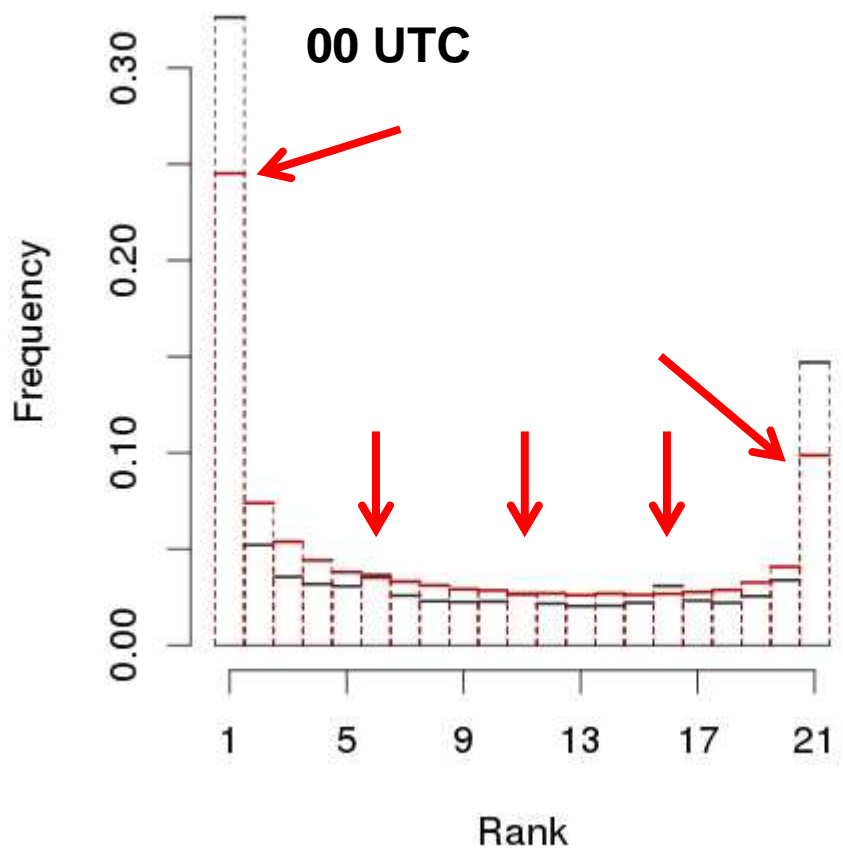
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## Summary for hourly precipitation

- less underdispersive (mainly in the first forecast hours)
- slightly positive BSS increasing with threshold
- improvement in BSS is highest in the early forecast hours and lasts until 27 hours for „yes/no“ and 1mm/h
- most striking feature is the improvement in resolution over a range of thresholds lasting for 10 – 27 forecast hours

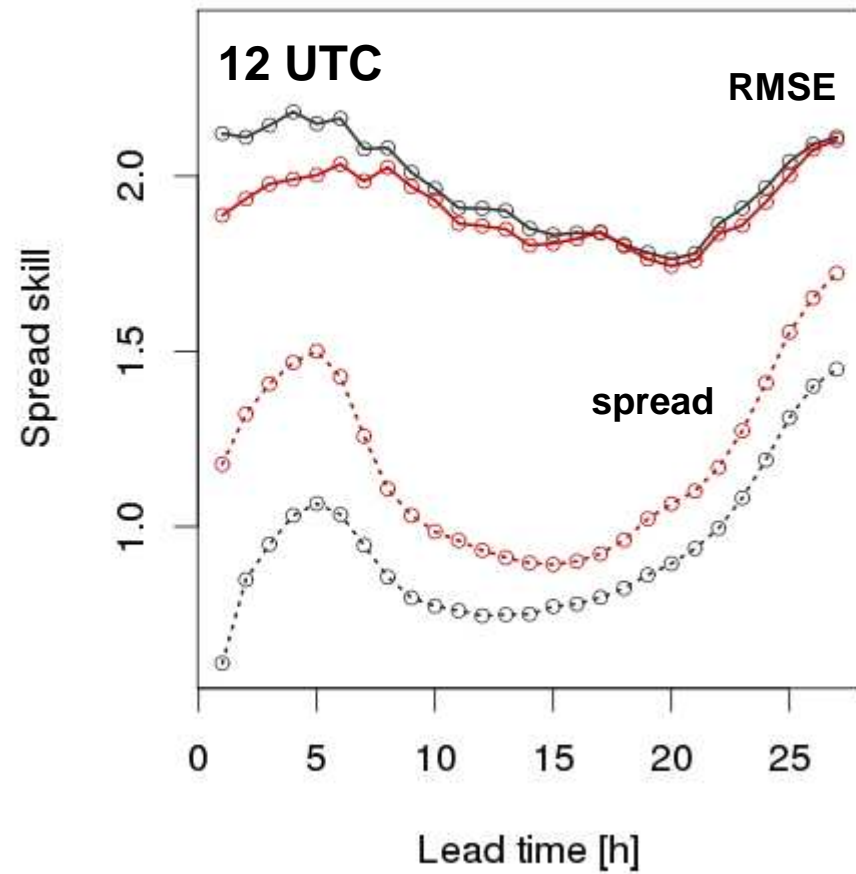
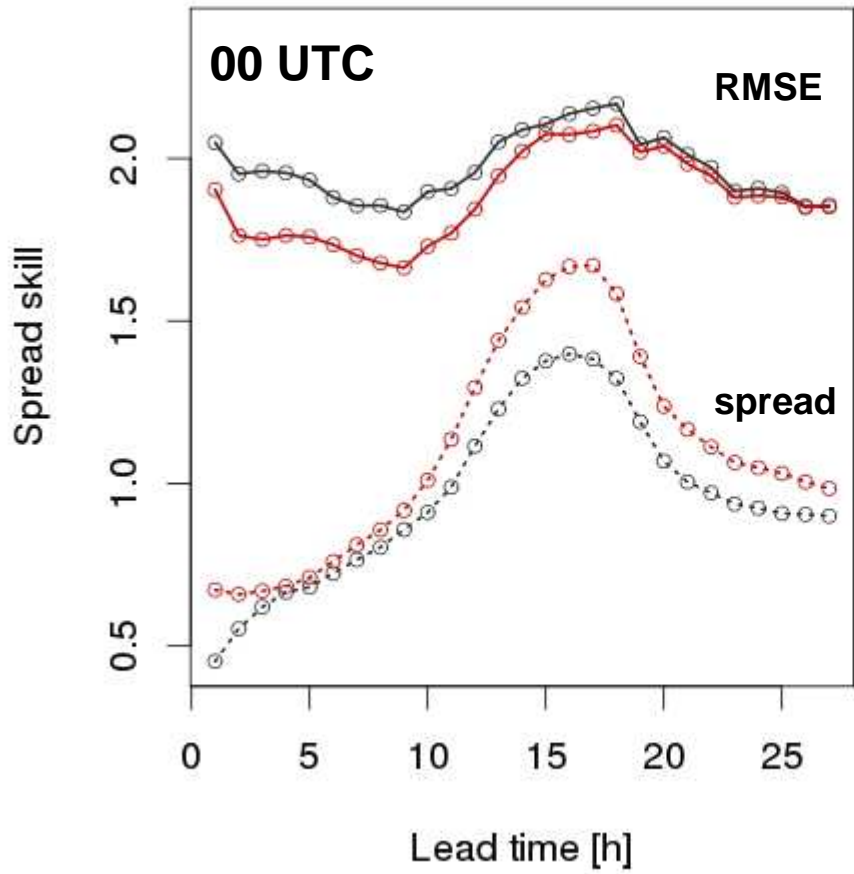
### Rank histogram (wind gusts)

### KENDA + BCEPS boundary operational



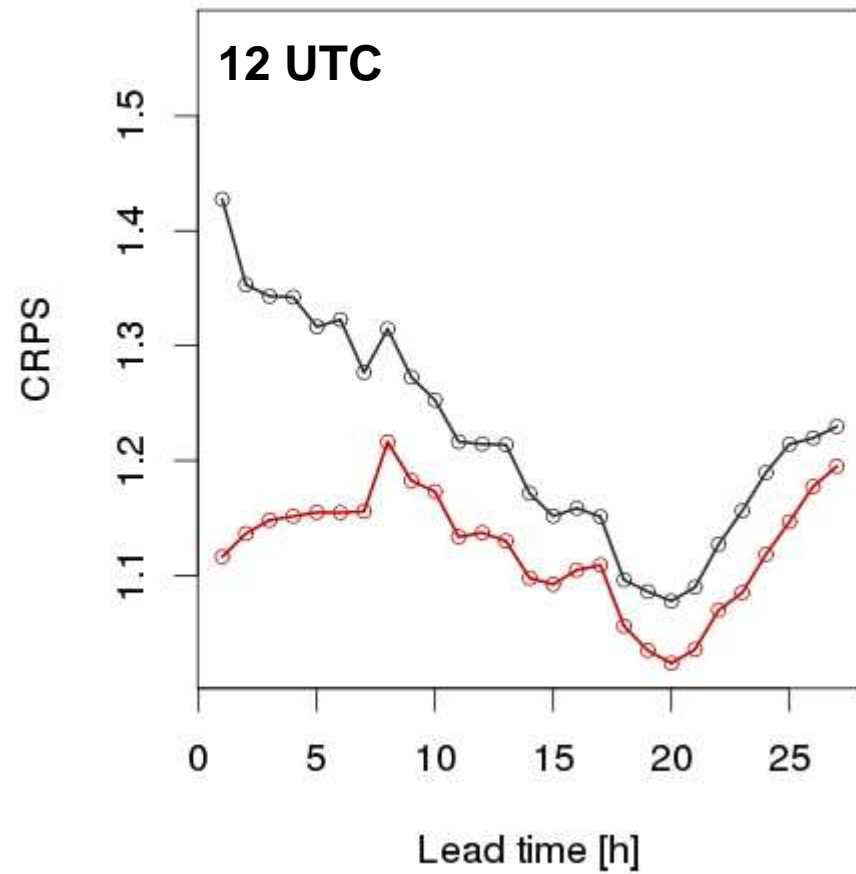
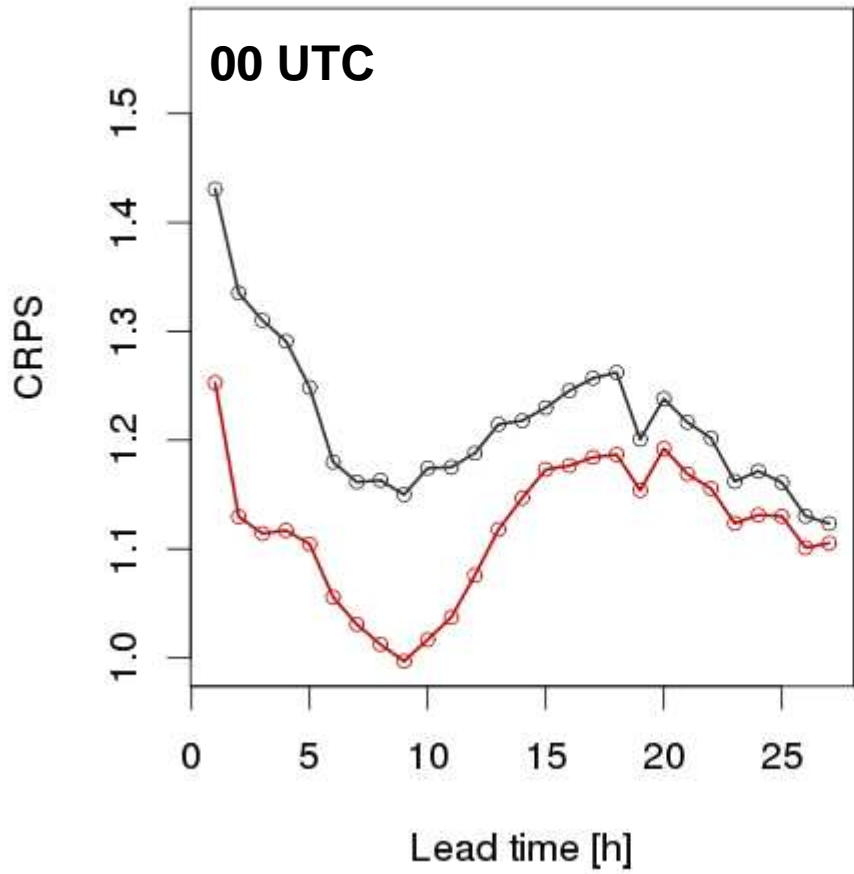
### RMSE & spread (wind gusts)

### KENDA + BCEPS boundary operational



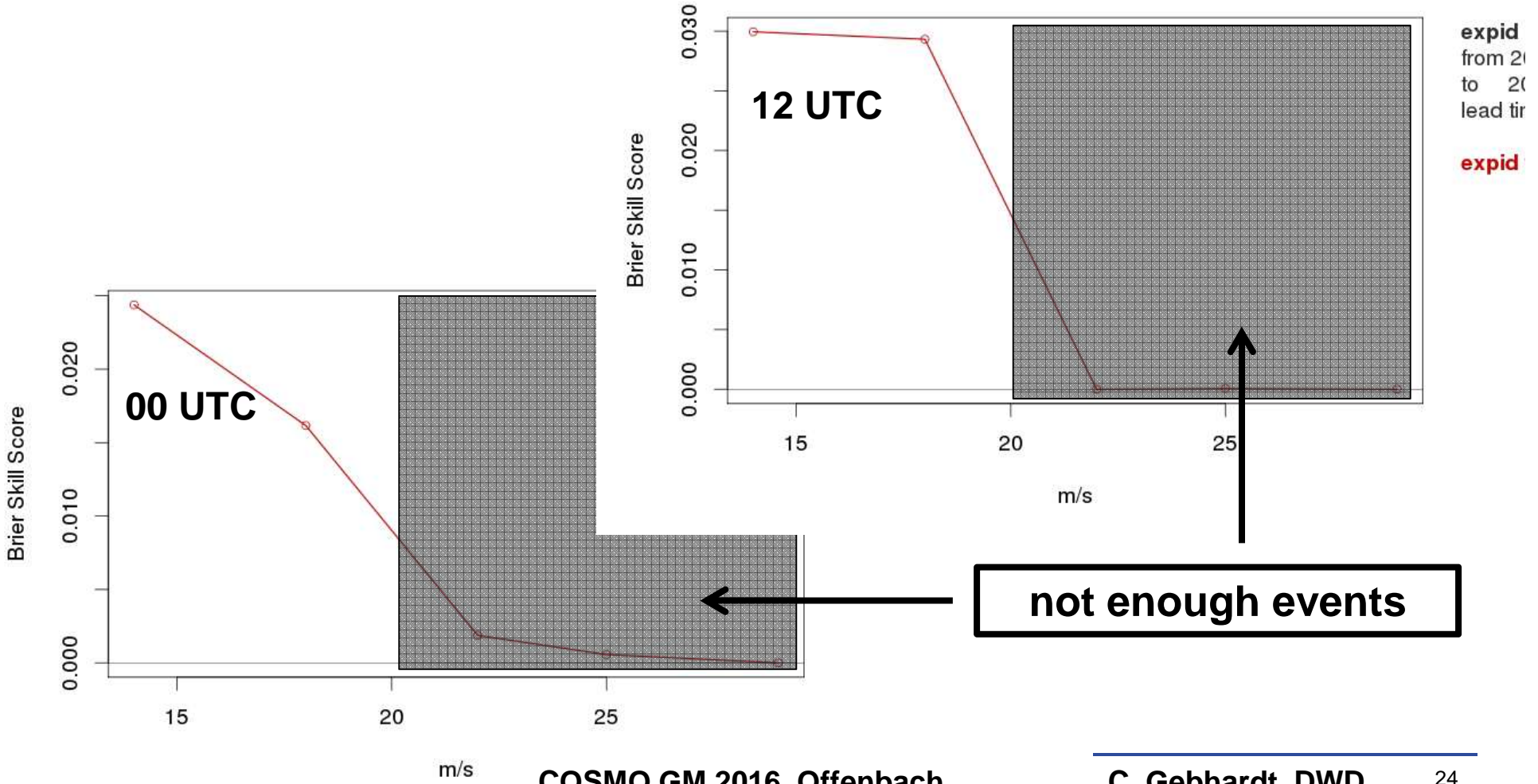
CRPS (wind gusts)

**KENDA + BCEPS boundary**  
operational



## Brier Skill Score (wind gusts)

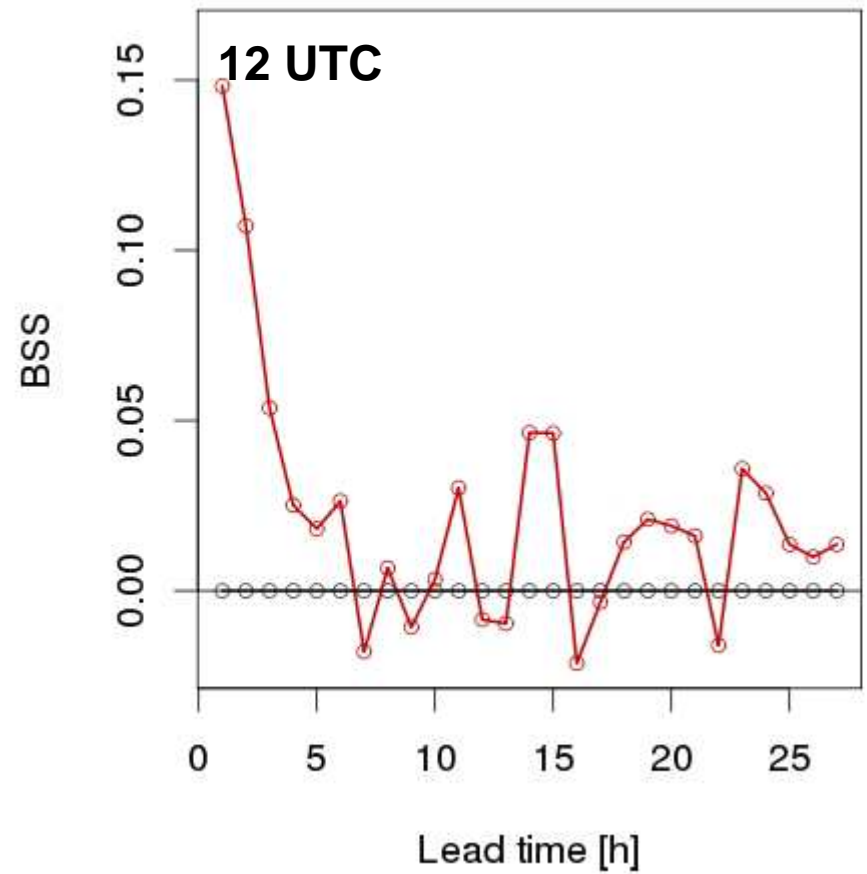
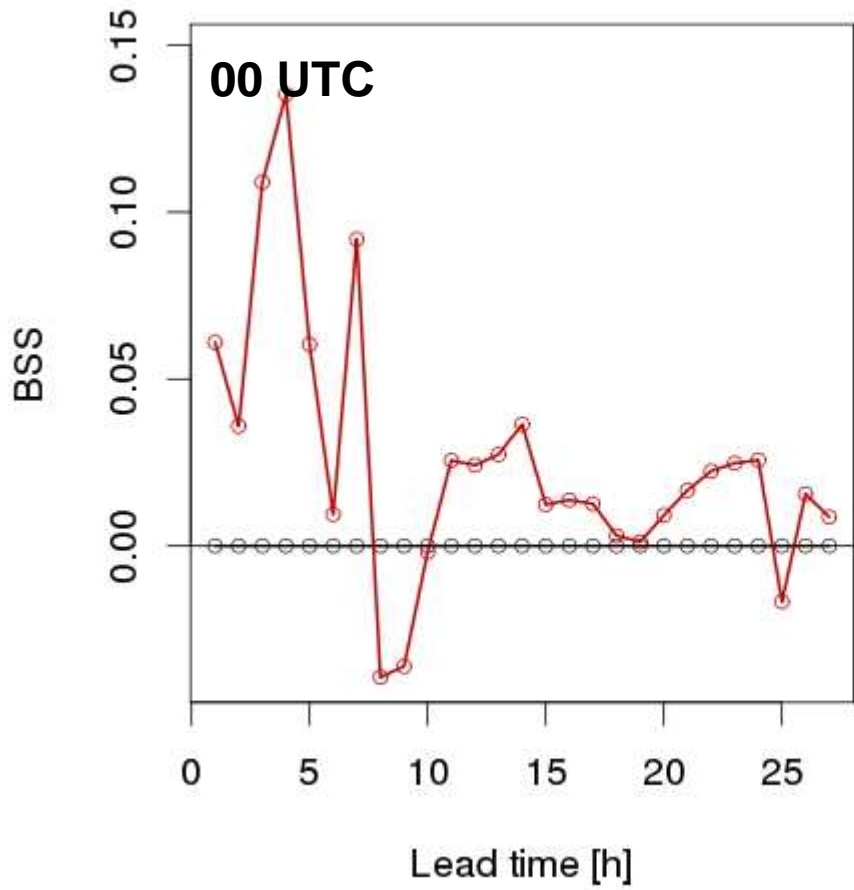
## KENDA + BCEPS boundary (vs. operational)





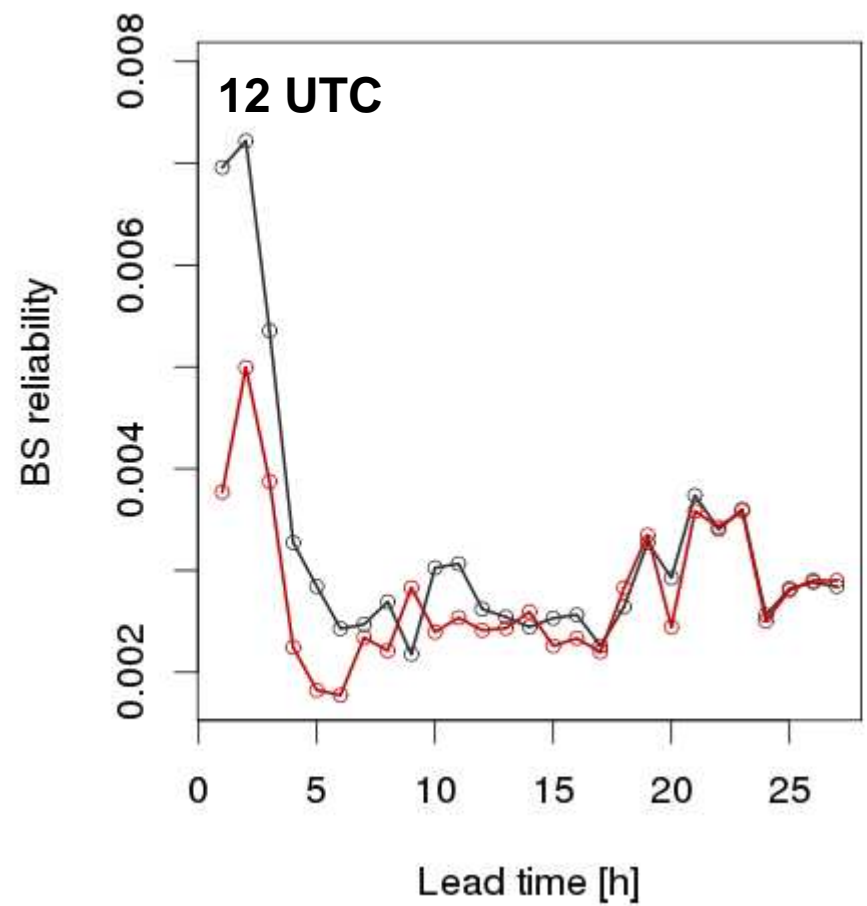
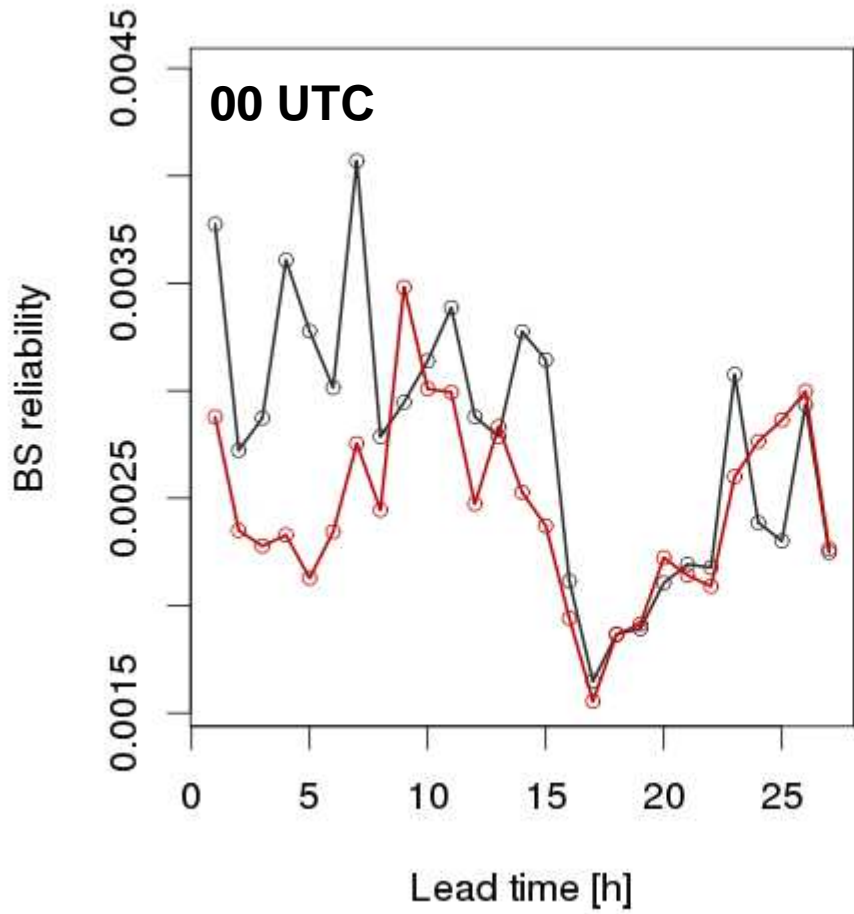
**BSS for 14 m/s (wind gusts)**

**KENDA + BCEPS boundary operational**



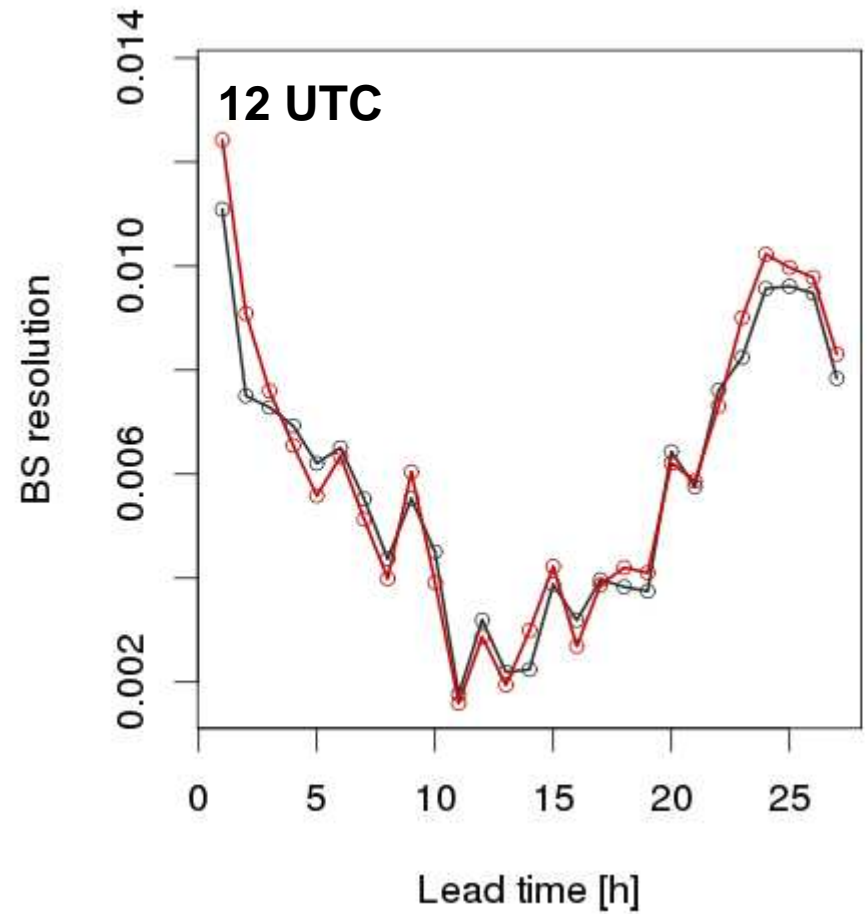
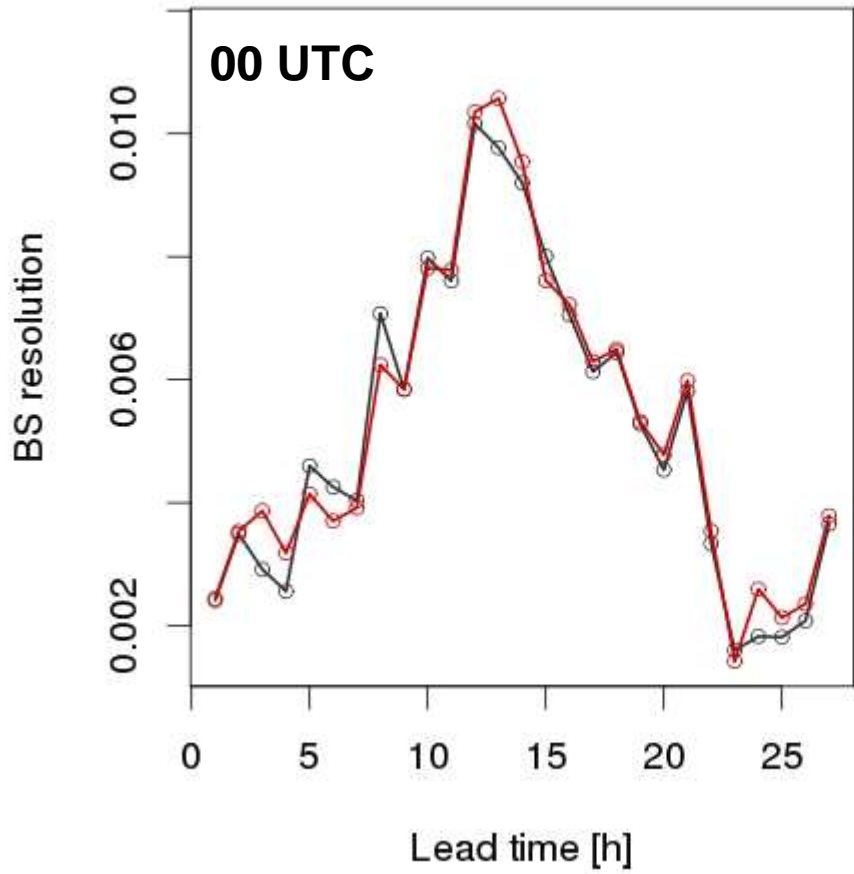
**BS reliability for 14 m/s (wind gusts)**

**KENDA + BCEPS boundary operational**



**BS resolution for 14 m/s (wind gusts)**

**KENDA + BCEPS boundary operational**

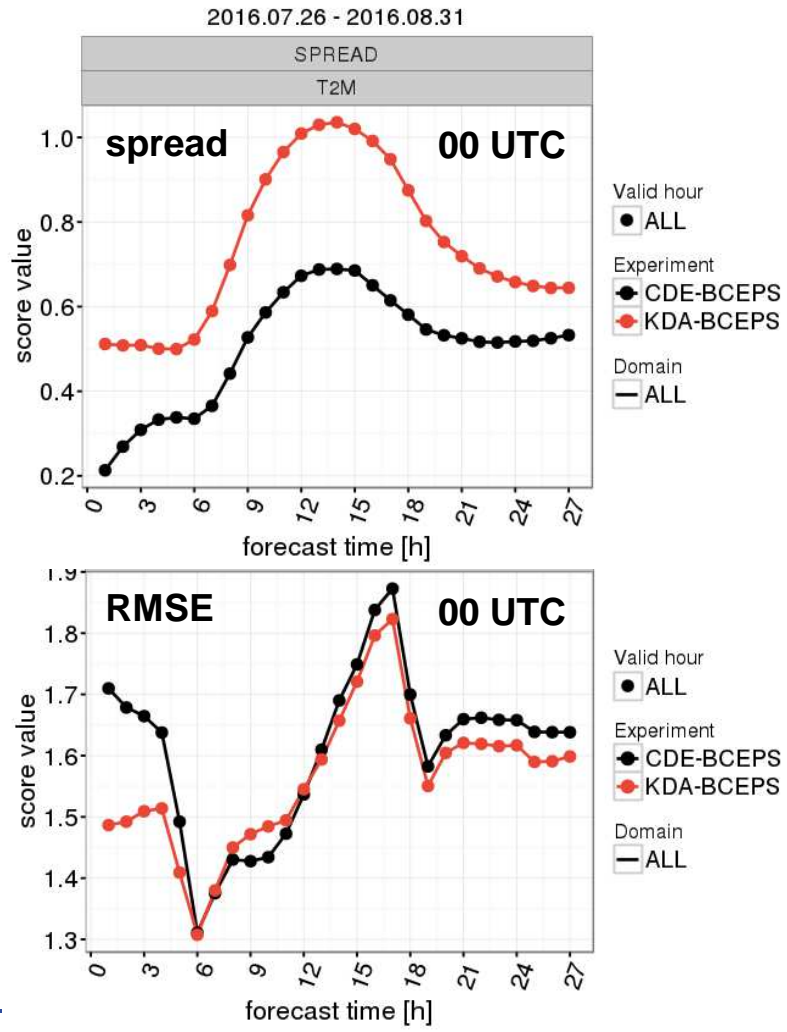


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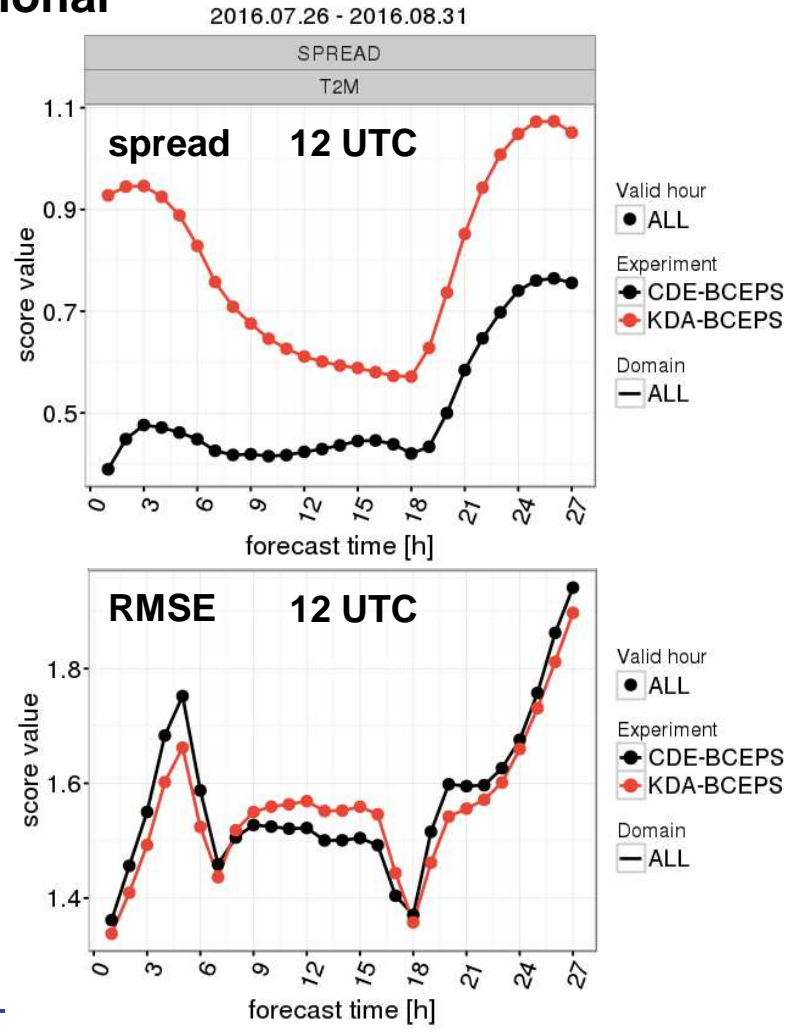
## Summary for hourly wind gusts

- still underdispersive, but less
- increased spread throughout the full forecast range
- decreased RMSE up to ~ 12-15 hours
- clearly decreased CRPS, particularly for early forecast hours (but includes the low wind gusts!)
- slightly positive BSS for 14 m/s and 18 m/s for first 6 hours
- improvement in reliability component of BS

## RMSE & spread (T<sub>2M</sub>)

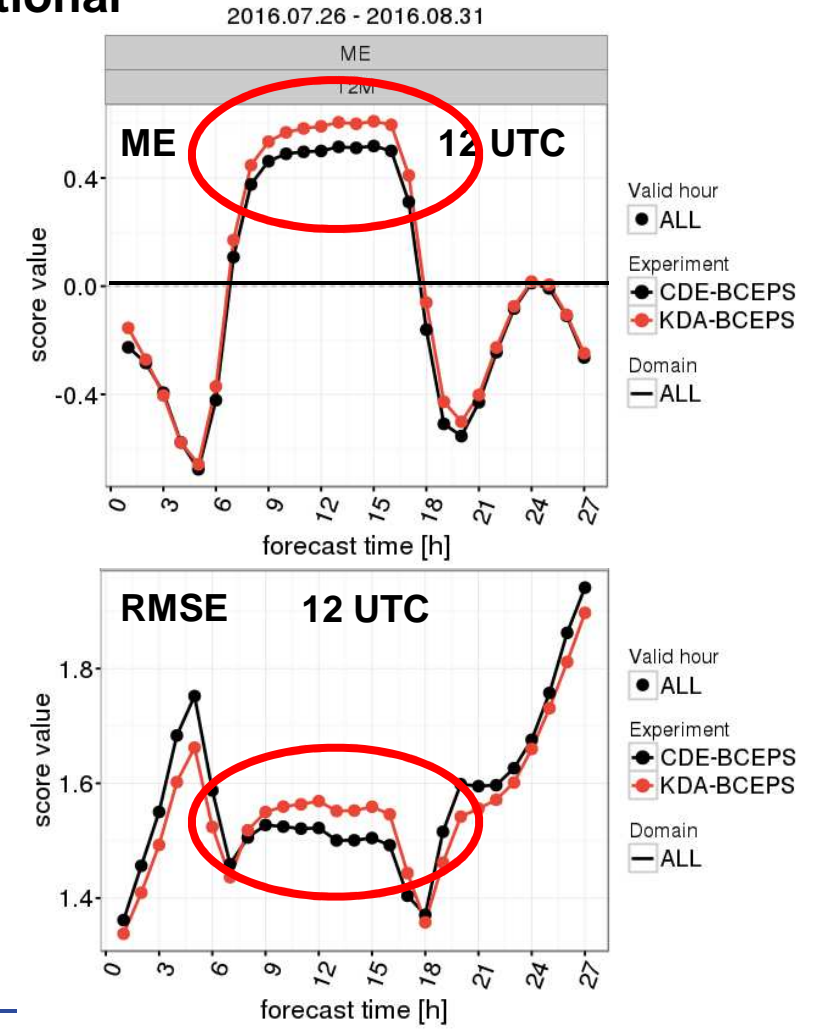


## KENDA + BCEPS boundary operational



## RMSE & Mean error (T<sub>2M</sub>)

## KENDA + BCEPS boundary operational

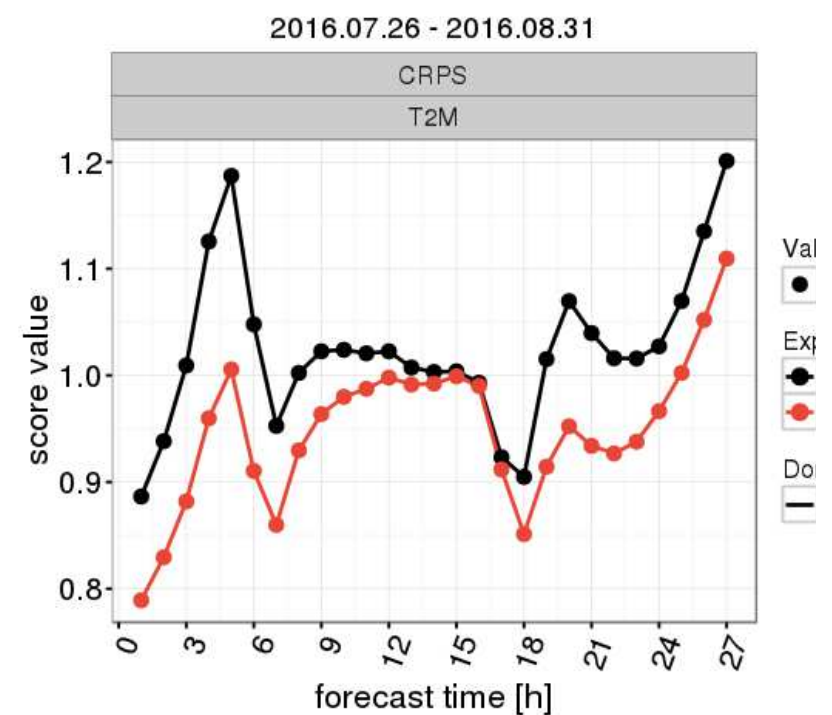
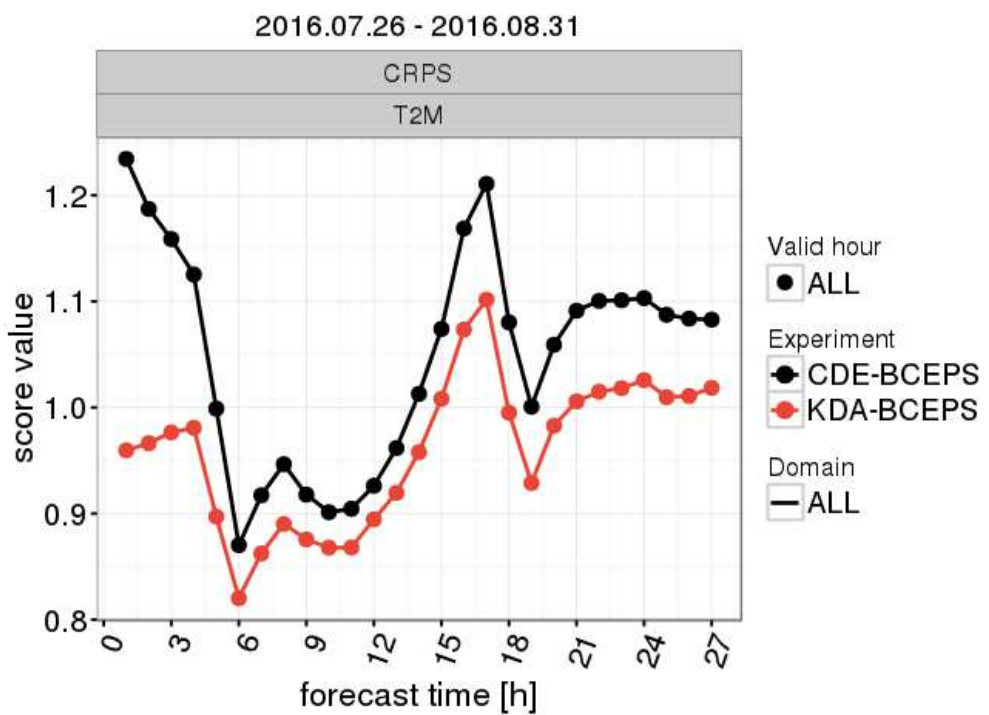


# CRPS (T<sub>2M</sub>)

# KENDA + BCEPS boundary operational

00 UTC

12 UTC



---

## Summary for 2m temperature

- still underdispersive, but less
- increased spread throughout the full forecast range
- decreased RMSE except during the night of 12 UTC run (influenced by bias)
- clearly decreased CRPS, particularly for early forecast hours in 00 UTC run



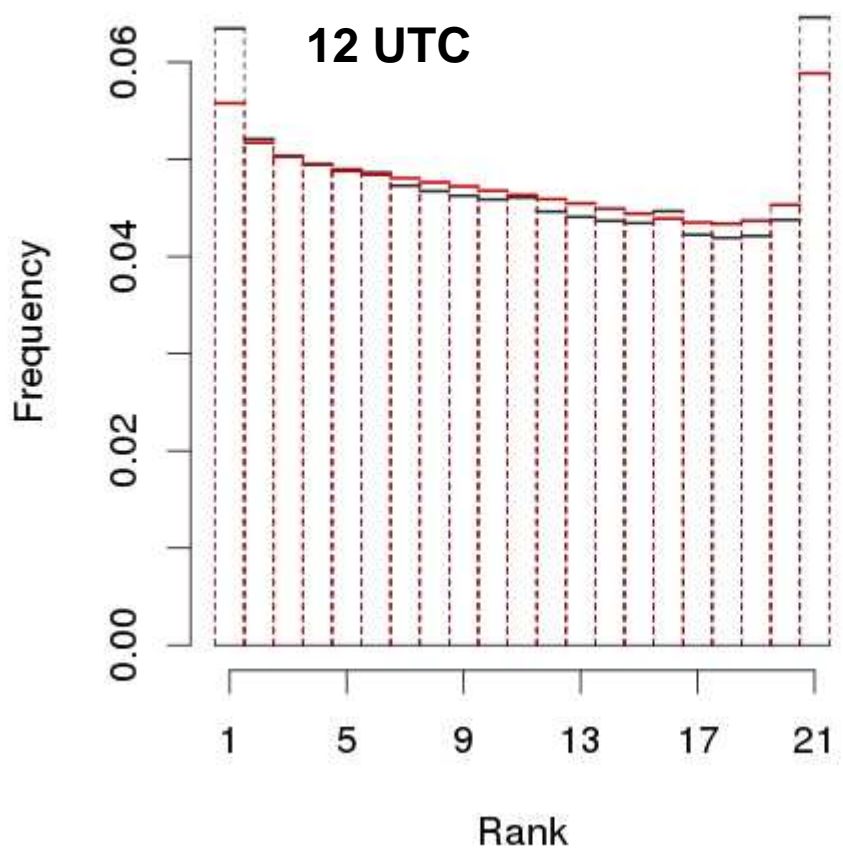
# ICON Ensemble

**Pre-operational suite** ( start October 2015 )

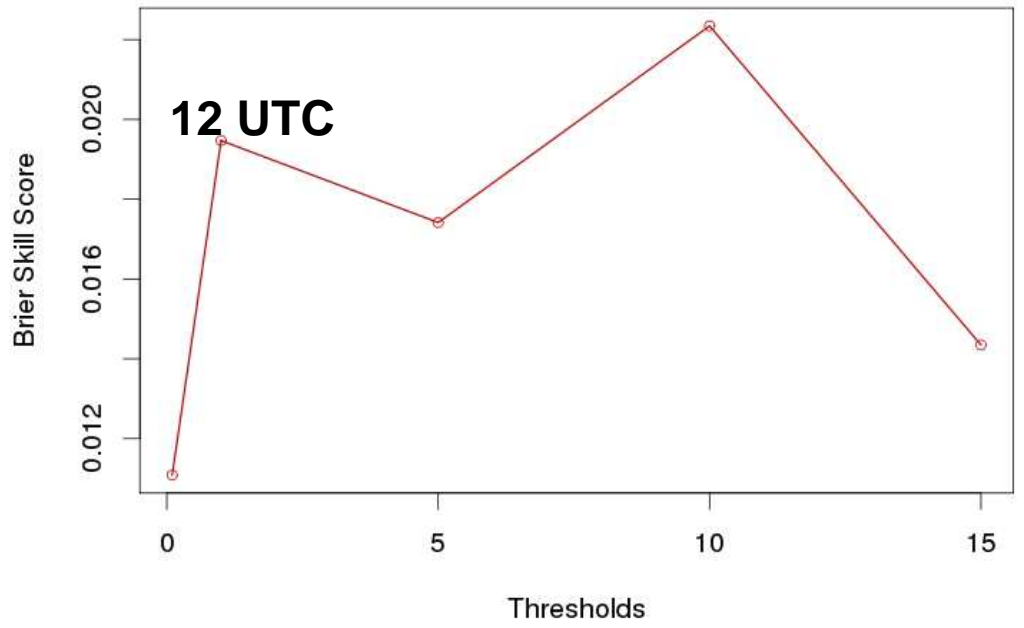
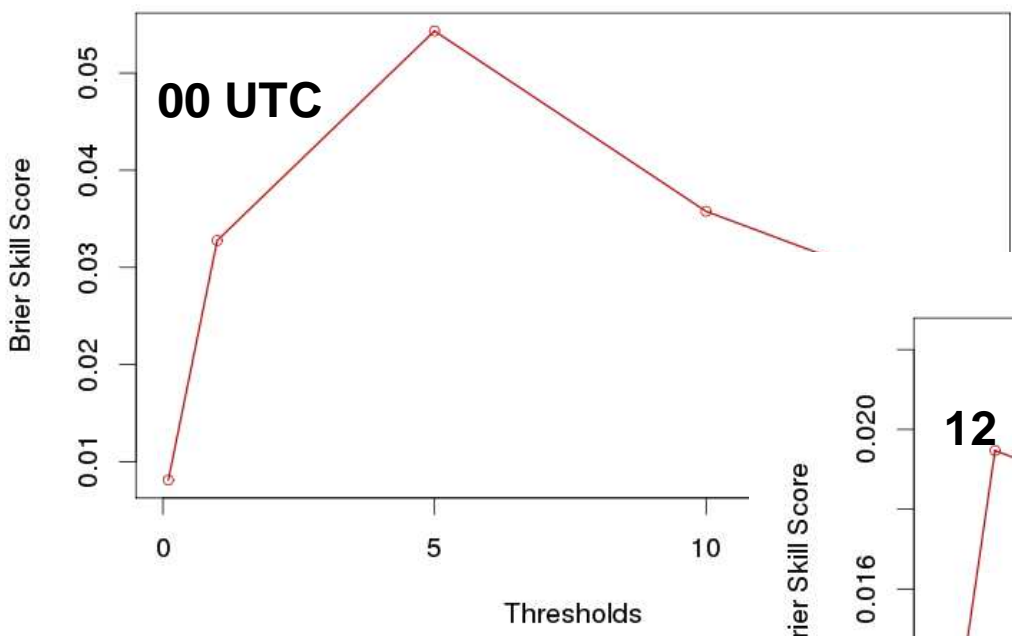
- 40 Member
- Global, 40 km ( -> +180h)
- ICON-EU Nest, 20 km (-> +120h)
- 00 und 12 UTC
- Ensemble Data Assimilation
- Boundary Conditions for COSMO-DE-EPS

*Andreas Rhodin, Harald Anlauf, Alexander Cress, Thomas Hanisch,  
Michael Buchhold, Michael Denhard*

Rank histogram (hourly precipitation) **KENDA + ICON-EPS boundary**  
**KENDA + BCEPS boundary**

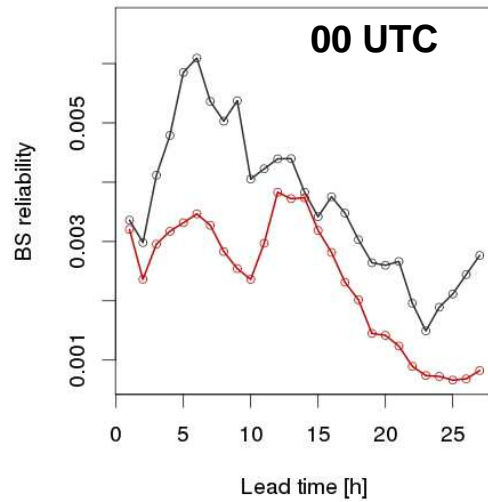


**Brier Skill Score (hourly precipitation) KENDA + ICON-EPS boundary (vs KENDA + BCEPS boundary)**

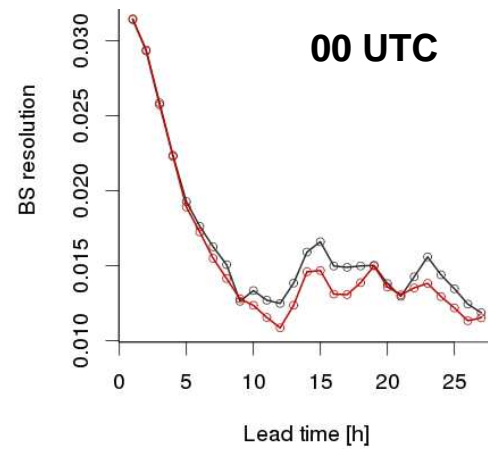
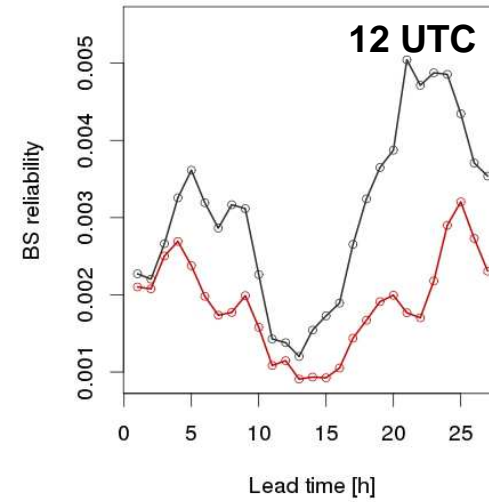


**BS Rel. & Res. (hourly precipitation)  
> 0.1 mm /h**

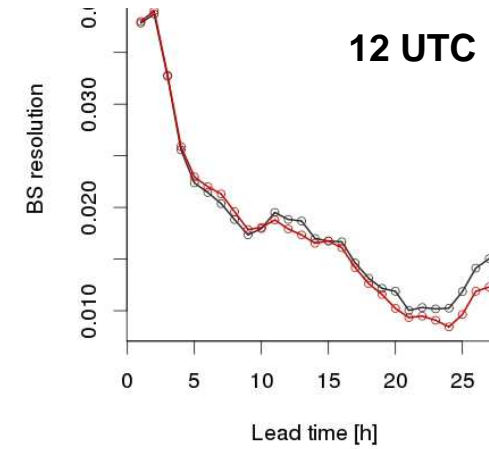
**KENDA + ICON-EPS boundary  
KENDA + BCEPS boundary**



**reliability  
(lower is better)**

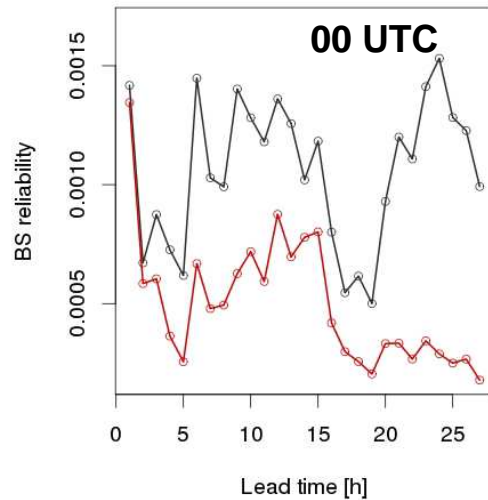


**Resolution  
(higher is better)**

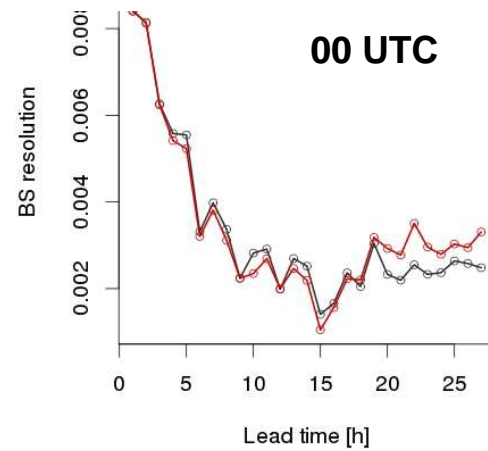
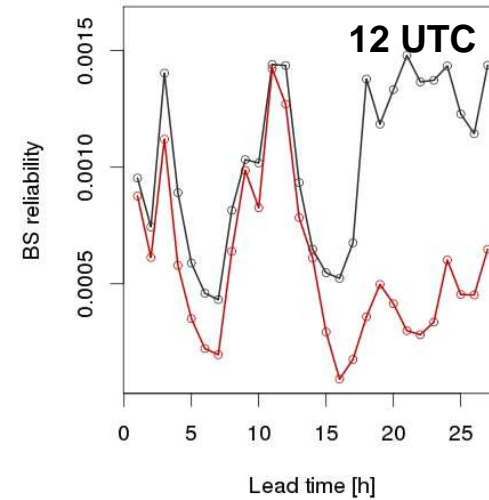


**BS Rel. & Res. (hourly precipitation)  
> 1 mm /h**

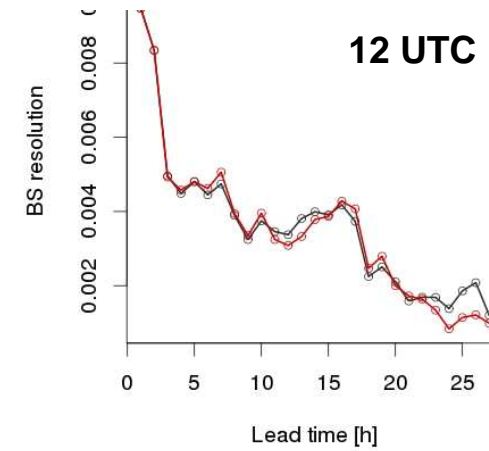
**KENDA + ICON-EPS boundary  
KENDA + BCEPS boundary**



**reliability  
(lower is better)**

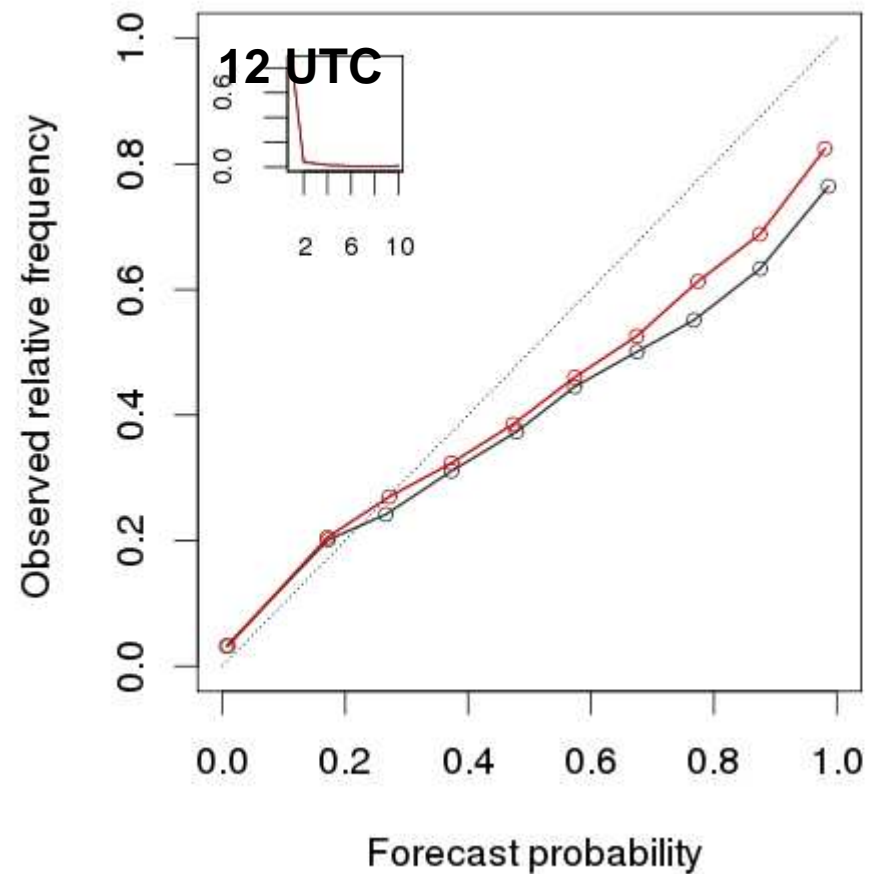
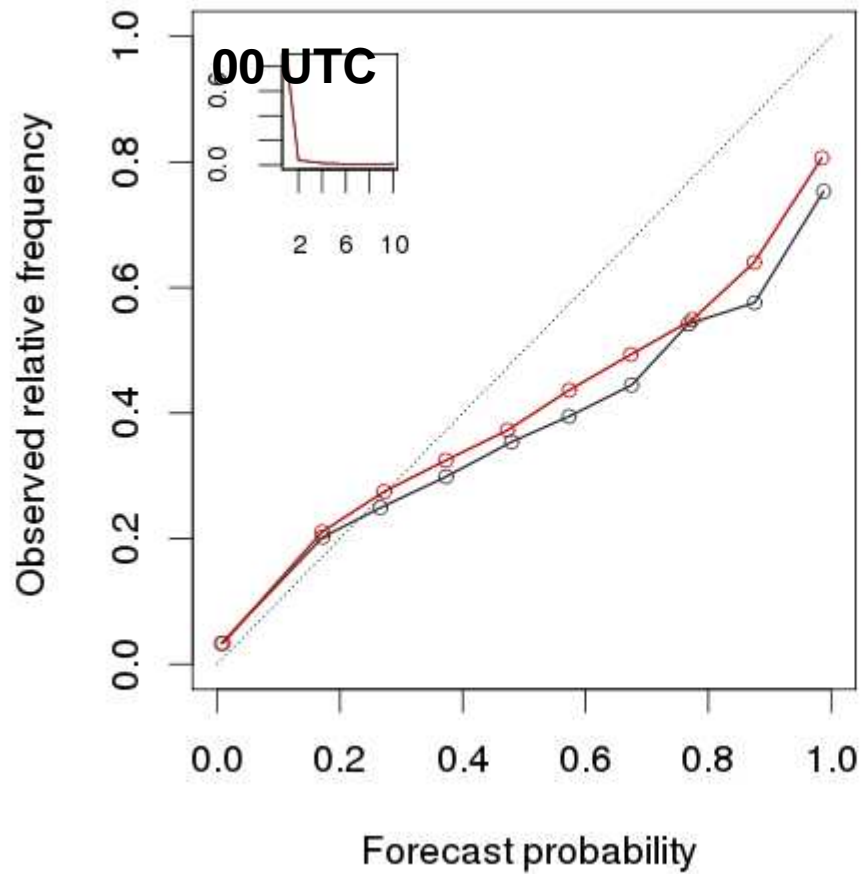


**Resolution  
(higher is better)**



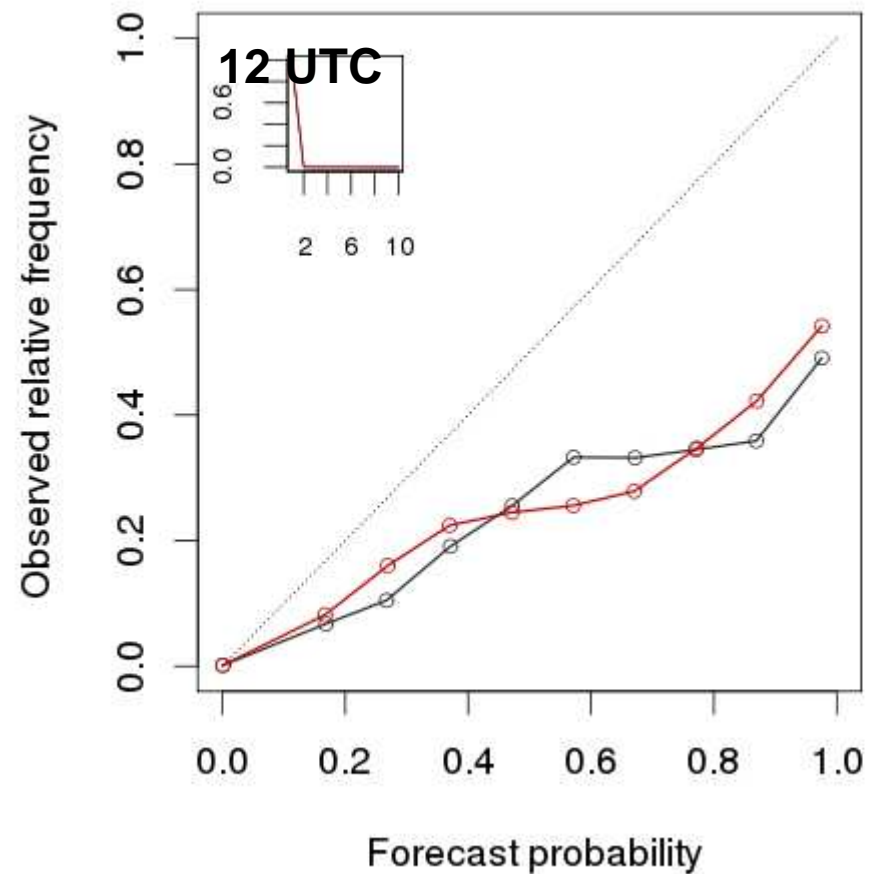
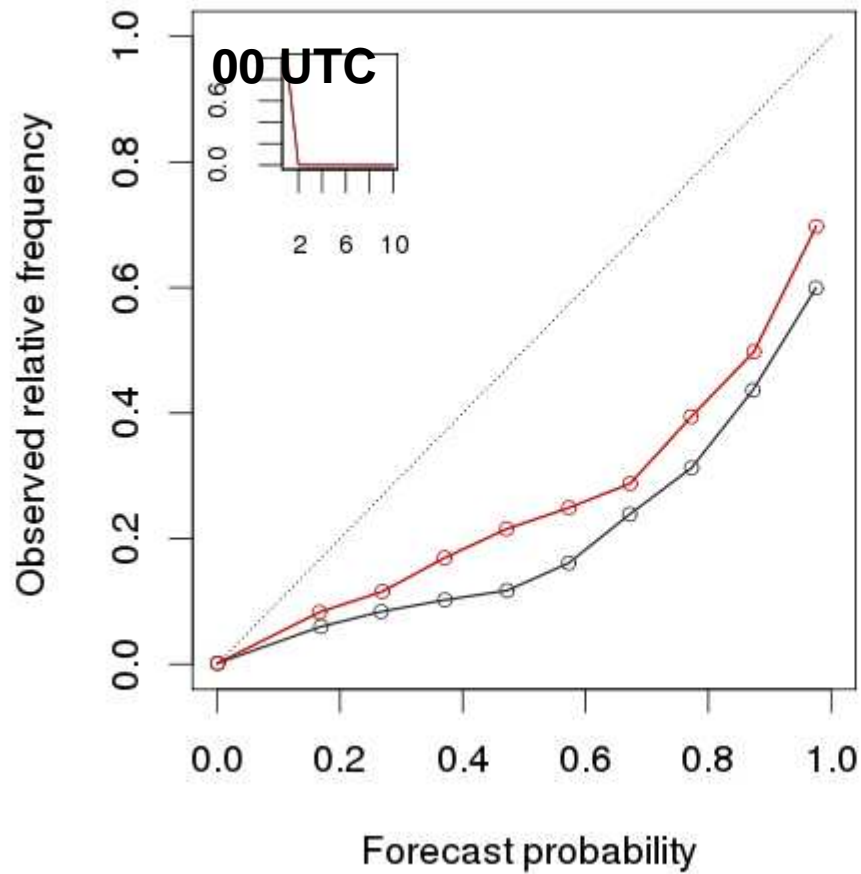
**Reliability diagram (hourly precipitation)  
> 0.1 mm /h**

**KENDA + ICON-EPS boundary  
KENDA + BCEPS boundary**



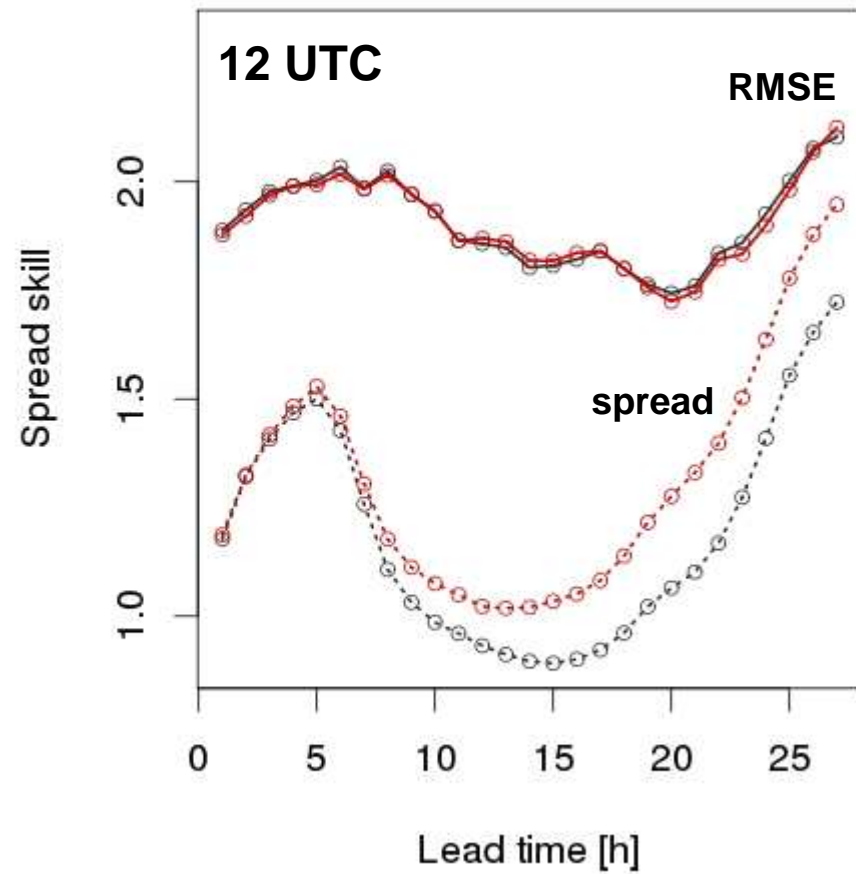
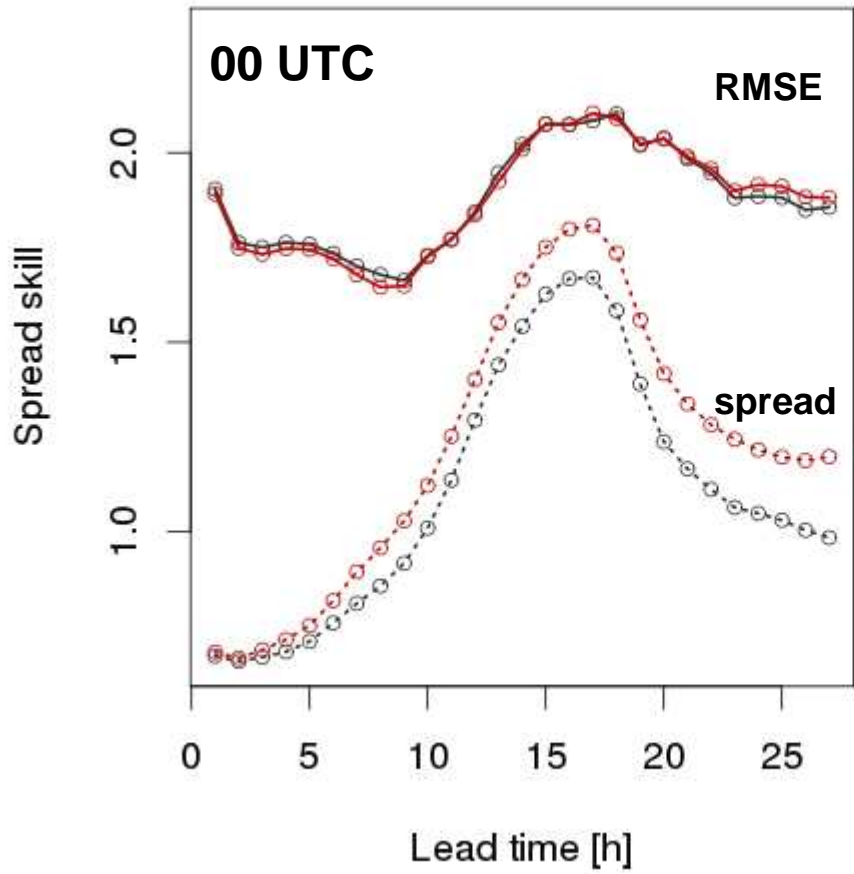
**Reliability diagram (hourly precipitation)  
> 5 mm /h**

**KENDA + ICON-EPS boundary  
KENDA + BCEPS boundary**



RMSE & spread (wind gusts)

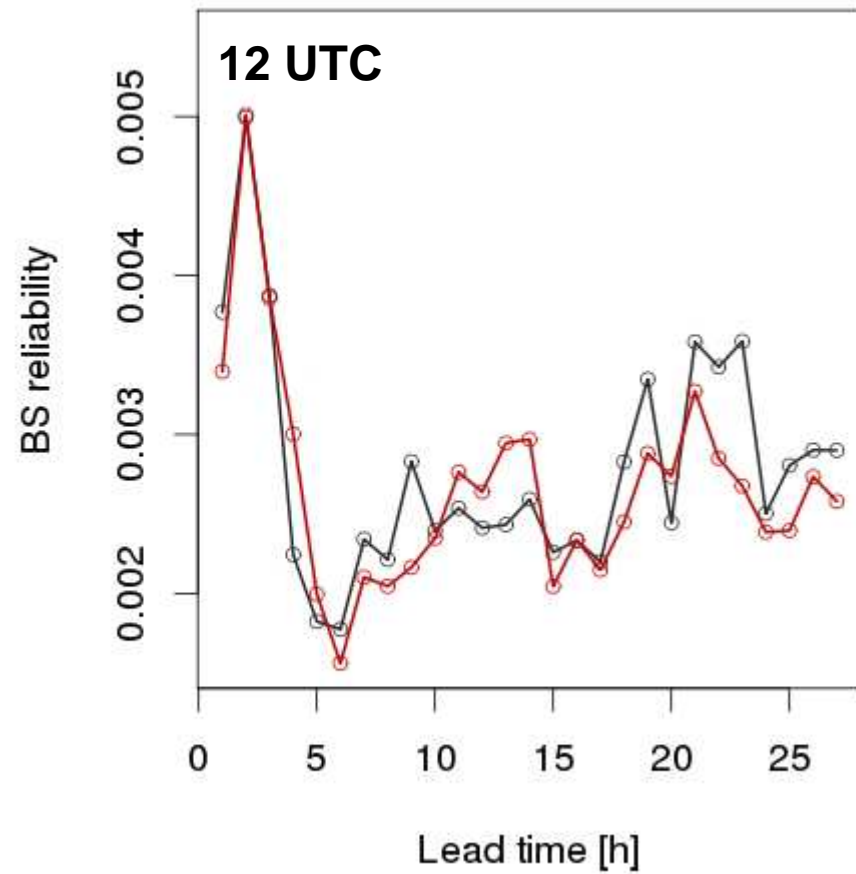
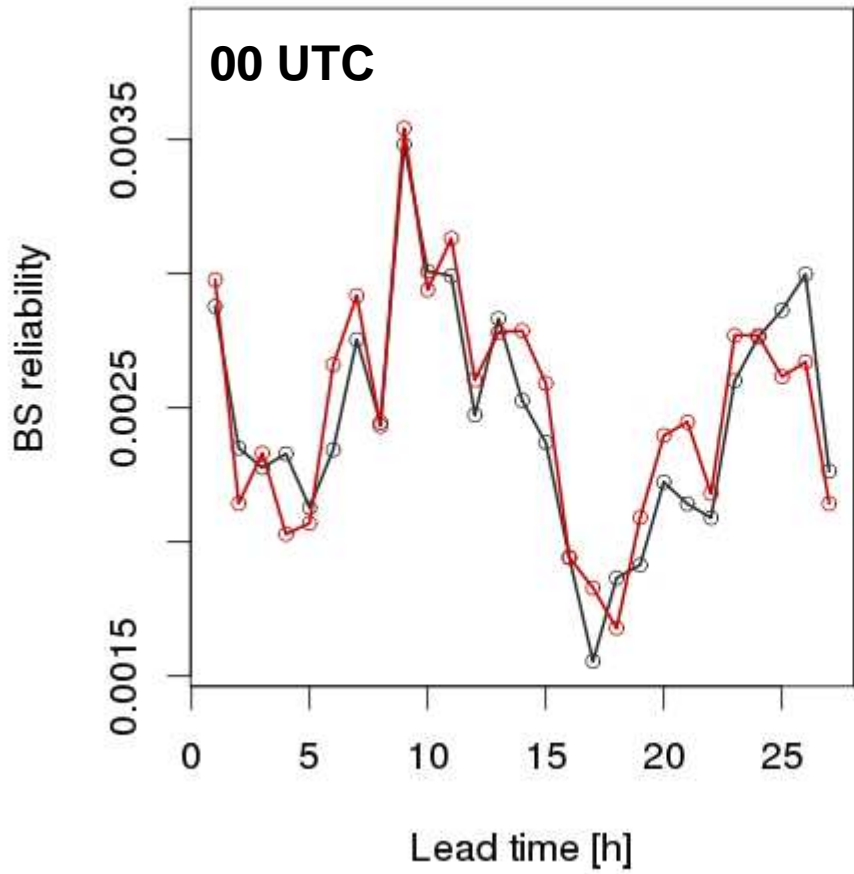
**KENDA + ICON-EPS boundary**  
**KENDA + BCEPS boundary**



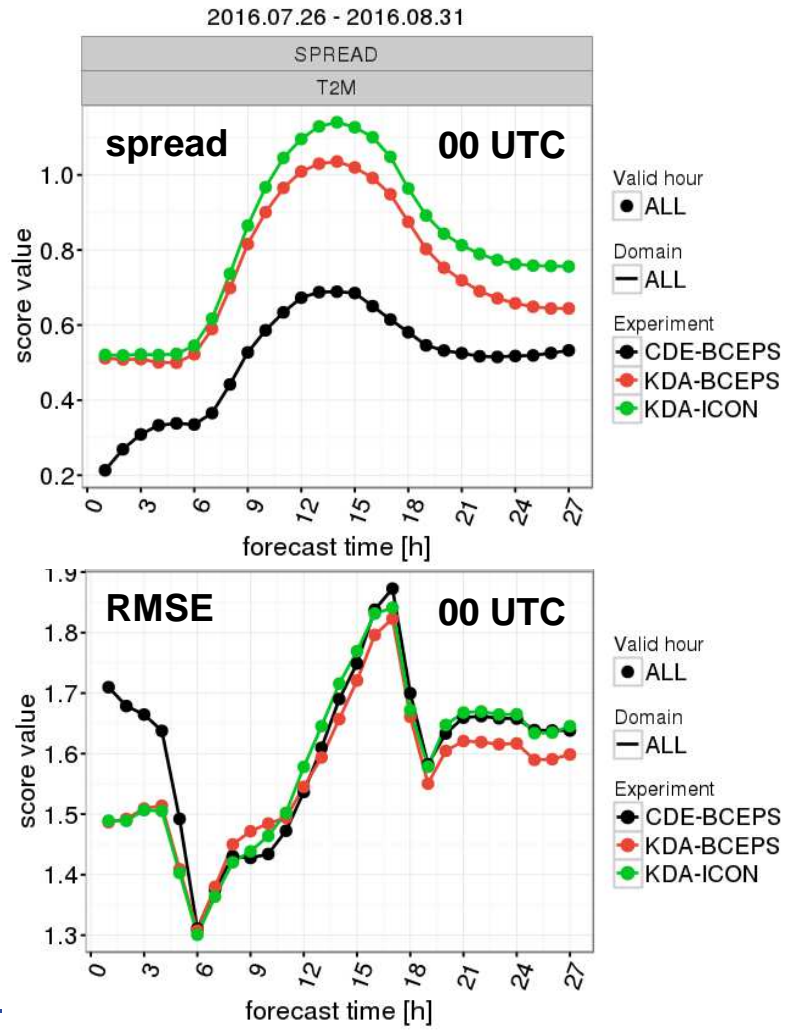


**BS reliability for 14 m/s (wind gusts)**

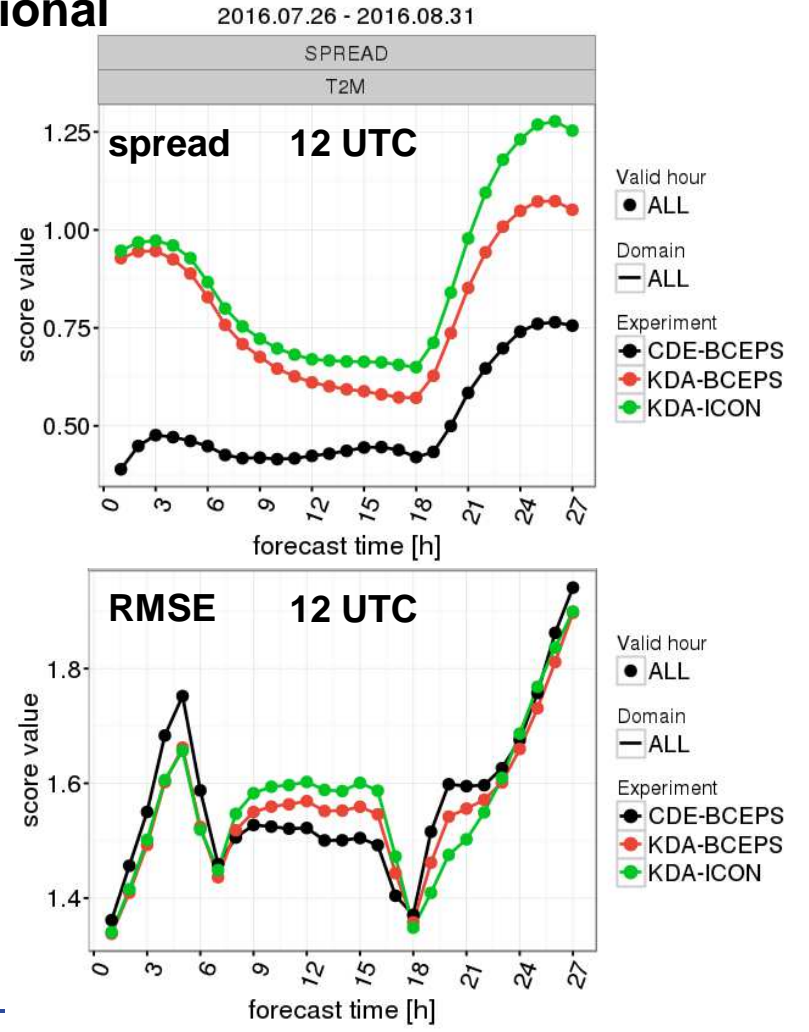
**KENDA + ICON-EPS boundary**  
**KENDA + BCEPS boundary**



## RMSE & spread (T<sub>2M</sub>)

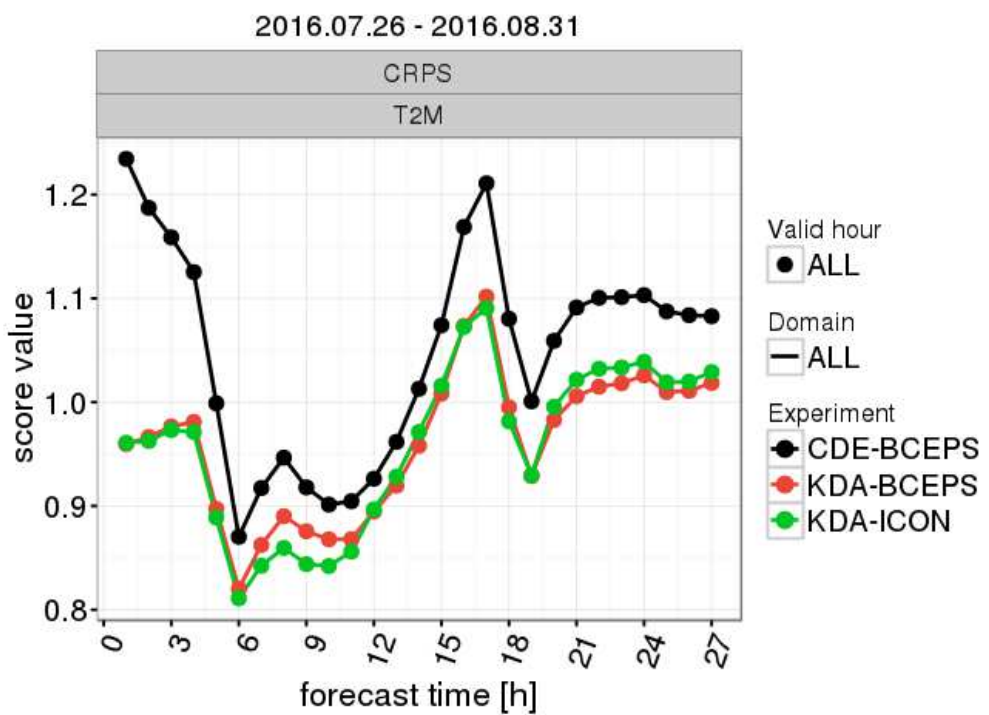


## KENDA + BCEPS boundary KENDA + ICON-EPS boundary operational



# CRPS (T\_2M)

00 UTC



# KENDA + BCEPS boundary KENDA + ICON-EPS boundary operational

12 UTC

