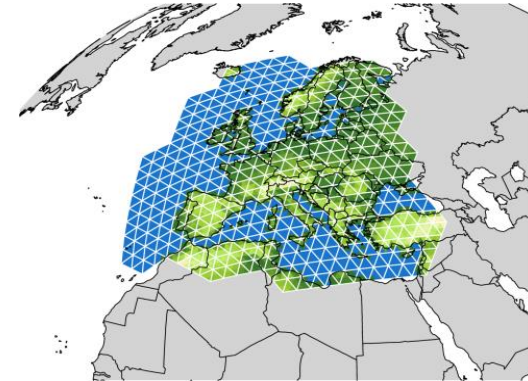


Extending the skin-temperature scheme to snow-covered grid points



Günther Zängl

COSMO-GM 2026, Rome, September 14, 2026

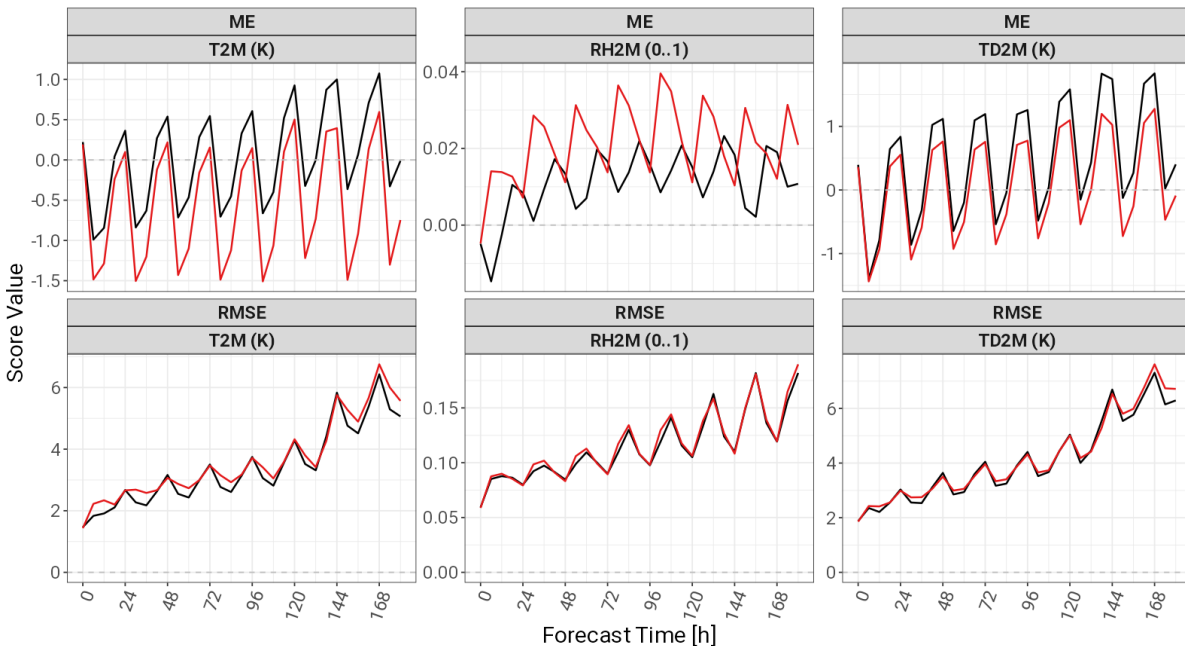
- So far, the skin-temperature scheme is restricted to snow-free grid points
- In the context of the NIX implementation, the idea came up to test extending the skin-temp to snow-covered grid points
- Indeed, significant improvements can be achieved for the diurnal temperature amplitude, particularly over deep snow layers
- Moreover, the improved diurnal temperature cycle allows changing the predictor for the adaptive snow albedo, giving daytime temperature biases a larger weight (3x) than nocturnal ones
- Namelist changes:
 - `itype_canopy = 3` (oper. 2)
 - `icpl_da_snowalb = 4` (oper. 3)

Specific changes

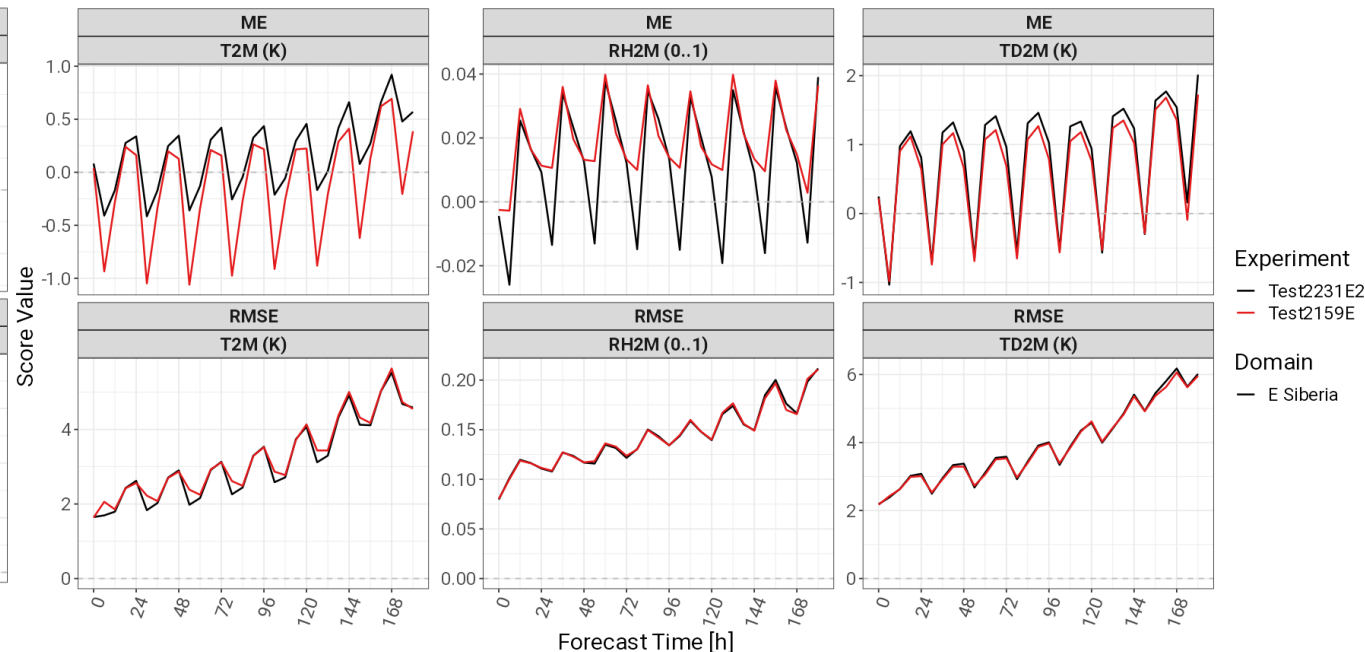
- Rather than discriminating between snow-free and snow-covered grid points, the weighted average of t_s and t_{snow} enters into the calculation of t_{sk}
- As a consequence, t_g equals t_{sk} over all land points
- The skin conductivity is parameterized based on snow depth rather than land-cover class
- Reason: the single-layer snow scheme underestimates the diurnal temperature cycle over snow primarily for deep snow layers (due to their large heat capacity)
- Moreover, minor adaptations were made to the transfer coefficient limiter and to the calculation of evaporation over snow
- Beyond that, the algorithm of the skin-temperature scheme remains unchanged
- Experiment period: January – June 2025; global ICON with full DA cycle including EPS forecasts; verification split into two-month sub-periods

→ Strong dependence on amount of insolation (not surprising, because both the diurnal temperature amplitude and the sensitivity to surface albedo depend on solar radiation input)

2025/03/01-00UTC - 2025/04/17-00UTC
INI: 00 UTC, DOM: N-W Siberia , STAT: ALL



2025/03/01-00UTC - 2025/04/17-00UTC
INI: 00 UTC, DOM: E Siberia , STAT: ALL



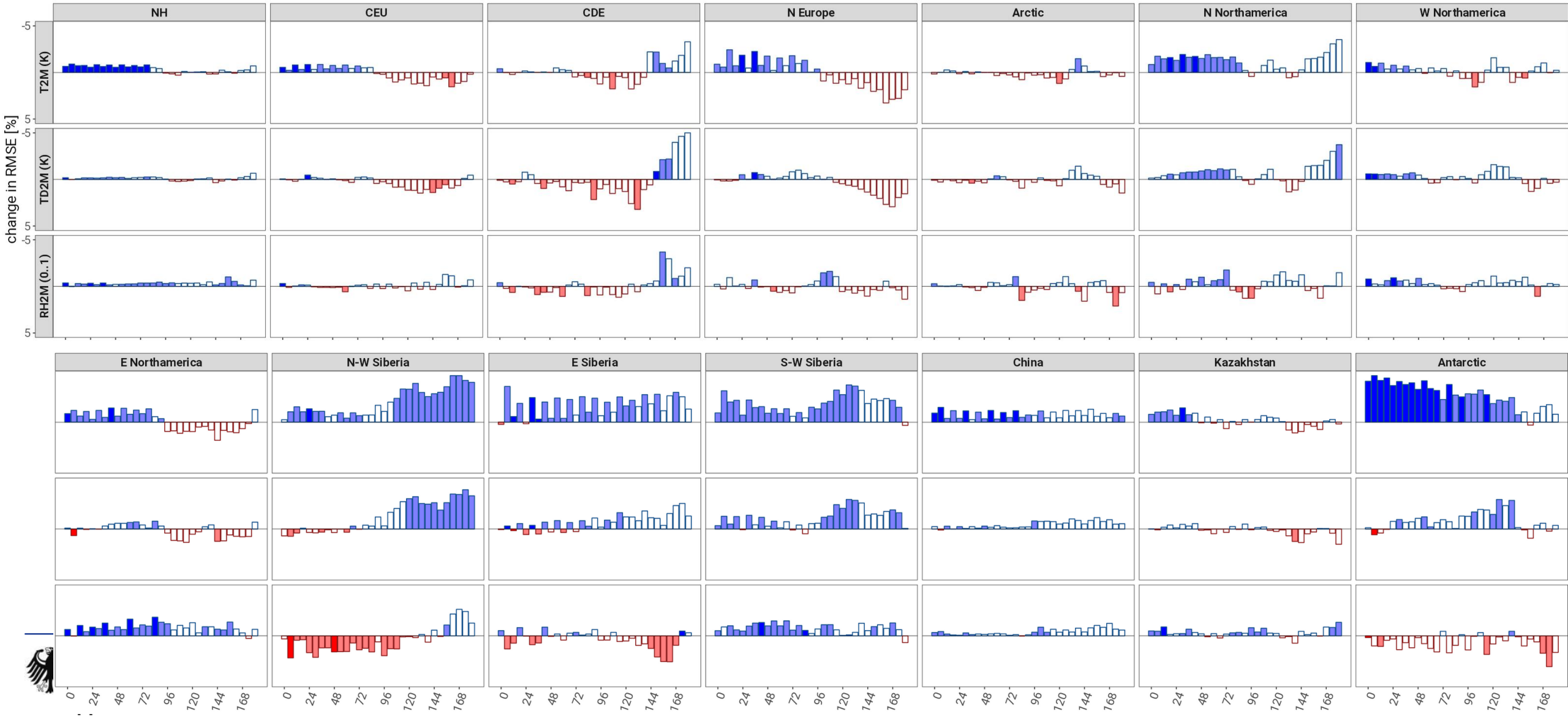
Score changes of RH2M/TD2M are not always positive, but T2M is consistently improved;
changes of daytime mean bias primarily originate from the revised predictor for albedo tuning



Synop-Scorecard DET (Jan-Feb)

Forecasts initialized from 2025/01/01 to 2025/03/08
Reduction of RMSE [%], INI; 00, 12UTC, SIGTEST: TRUE

Significance 0.00 0.25 0.50 0.75 1.00 Test2159E better Test2231E better

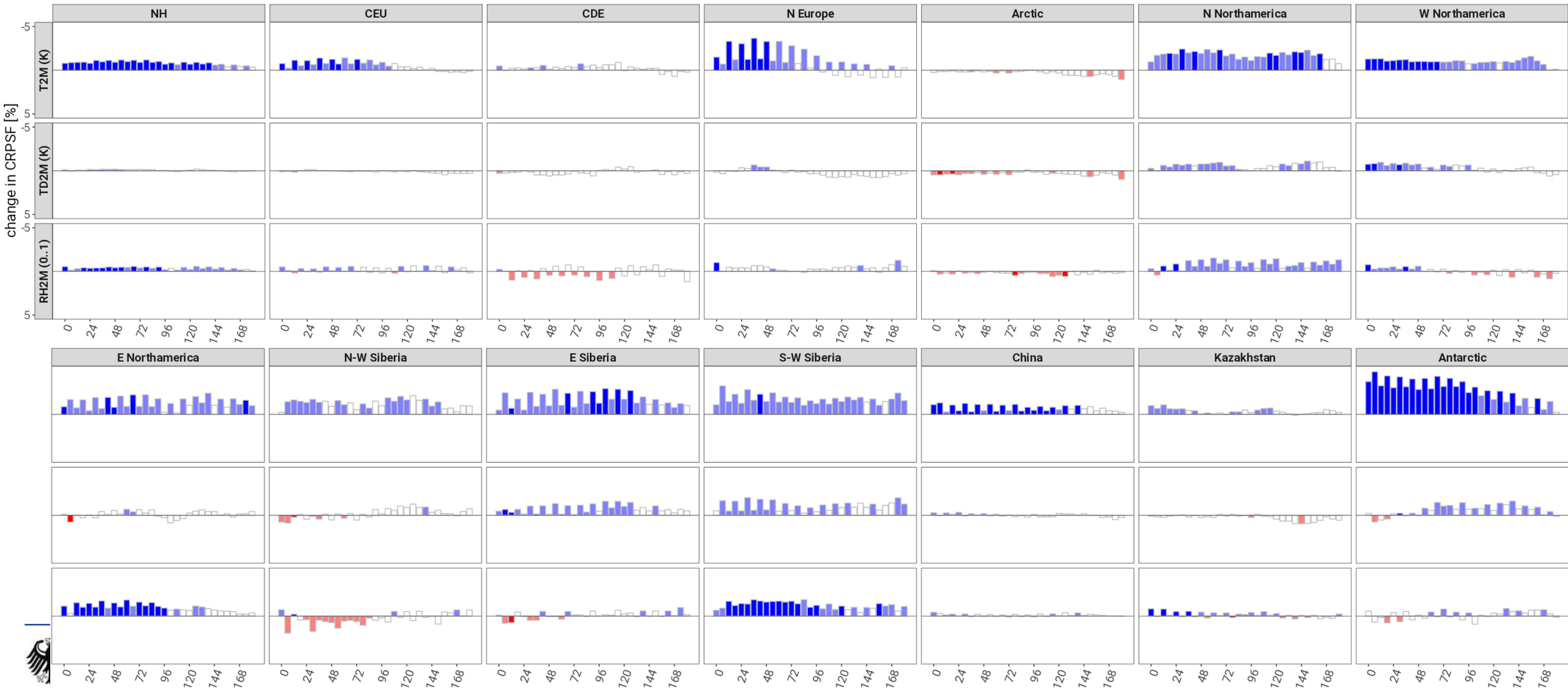


Synop-Scorecard EPS (Jan-Feb)

Forecasts initialized from 2025/01/01 00UTC - 2025/03/08 00UTC

Change in CRPSF [%],
INI; 00, 12UTC, SIGTEST: TRUE, STATIONS: ALL

Significance 0.00 0.25 0.50 0.75 1.00 Test2159EPS-E lower Test2231EPS-E lower



TEMP-Scorecard EPS (Jan-Feb)

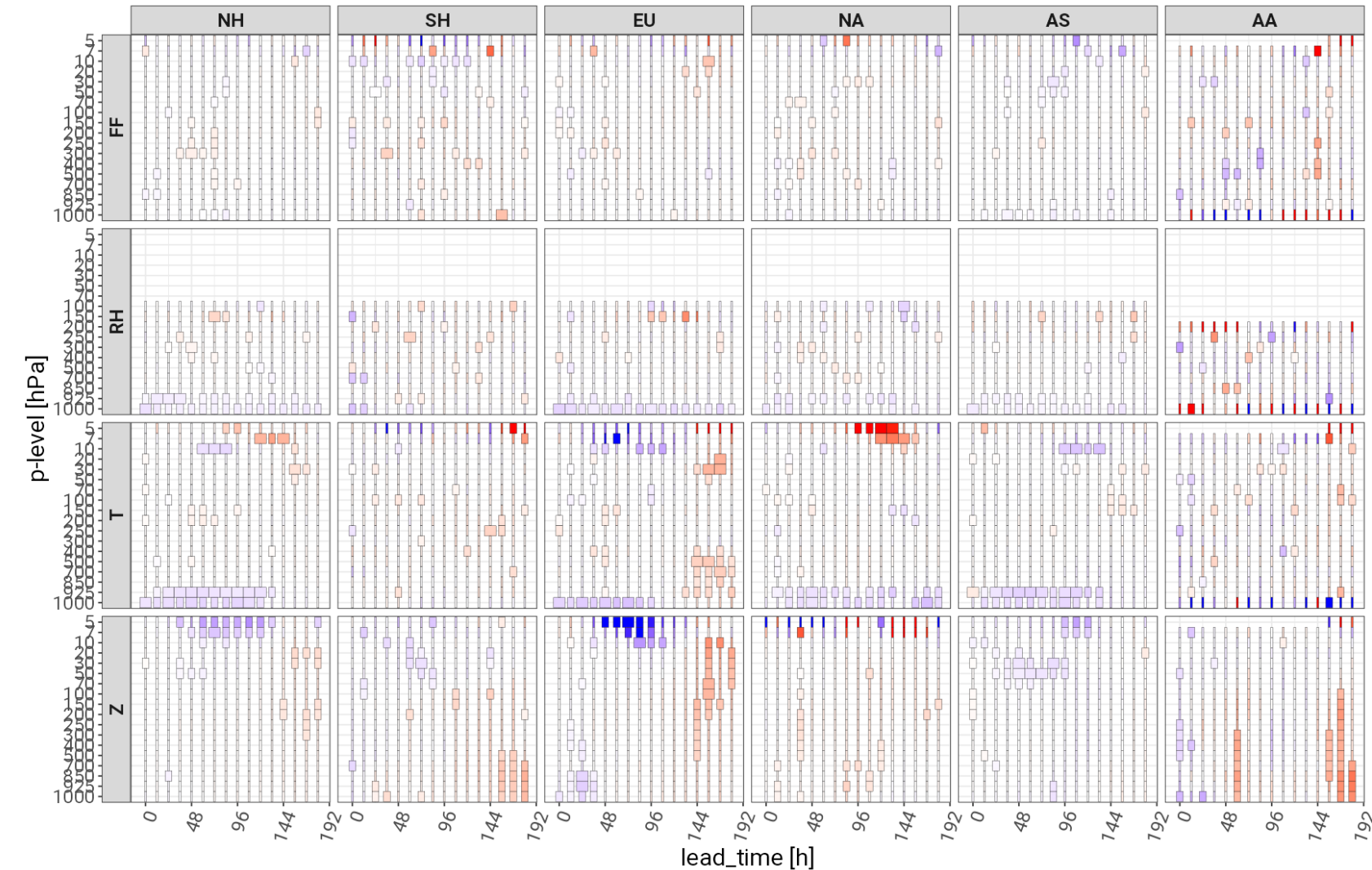
Verification period: 2025/01/01 - 2025/03/08

INI: 00, 12UTCUTC, SIGN. TEST: TRUE

Data selection by initial-date

Change in CRPSF [%]

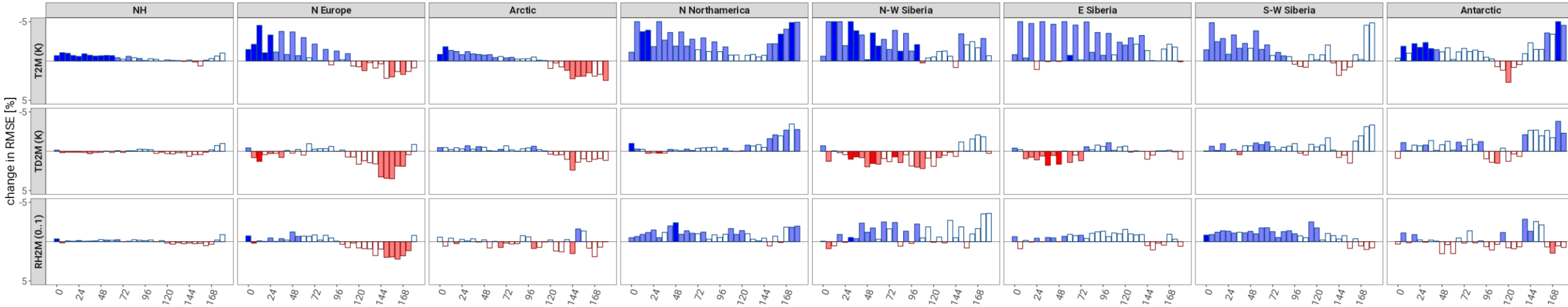
Improvements at 1000 and 925 hPa
are more significant in EPS than in
DET



Synop-Scorecard DET+EPS (Mar-Apr)

Forecasts initialized from 2025/03/01 to 2025/05/08
Reduction of RMSE [%], INI; 00, 12UTC, SIGTEST: TRUE

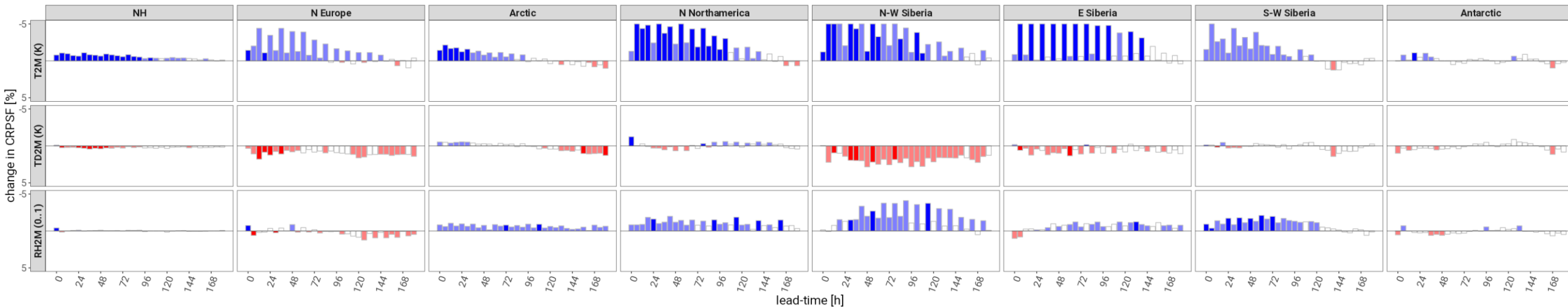
Test2159E better Test2231E2 better Significance 0.00 0.25 0.50 0.75 1.00



Forecasts initialized from 2025/03/01 00UTC - 2025/05/08 00UTC

Change in CRPSF [%],
INI; 00, 12UTC, SIGTEST: TRUE, STATIONS: ALL

Test2159EPS-E lower Test2231EPS-E2 lower Significance 0.00 0.25 0.50 0.75 1.00



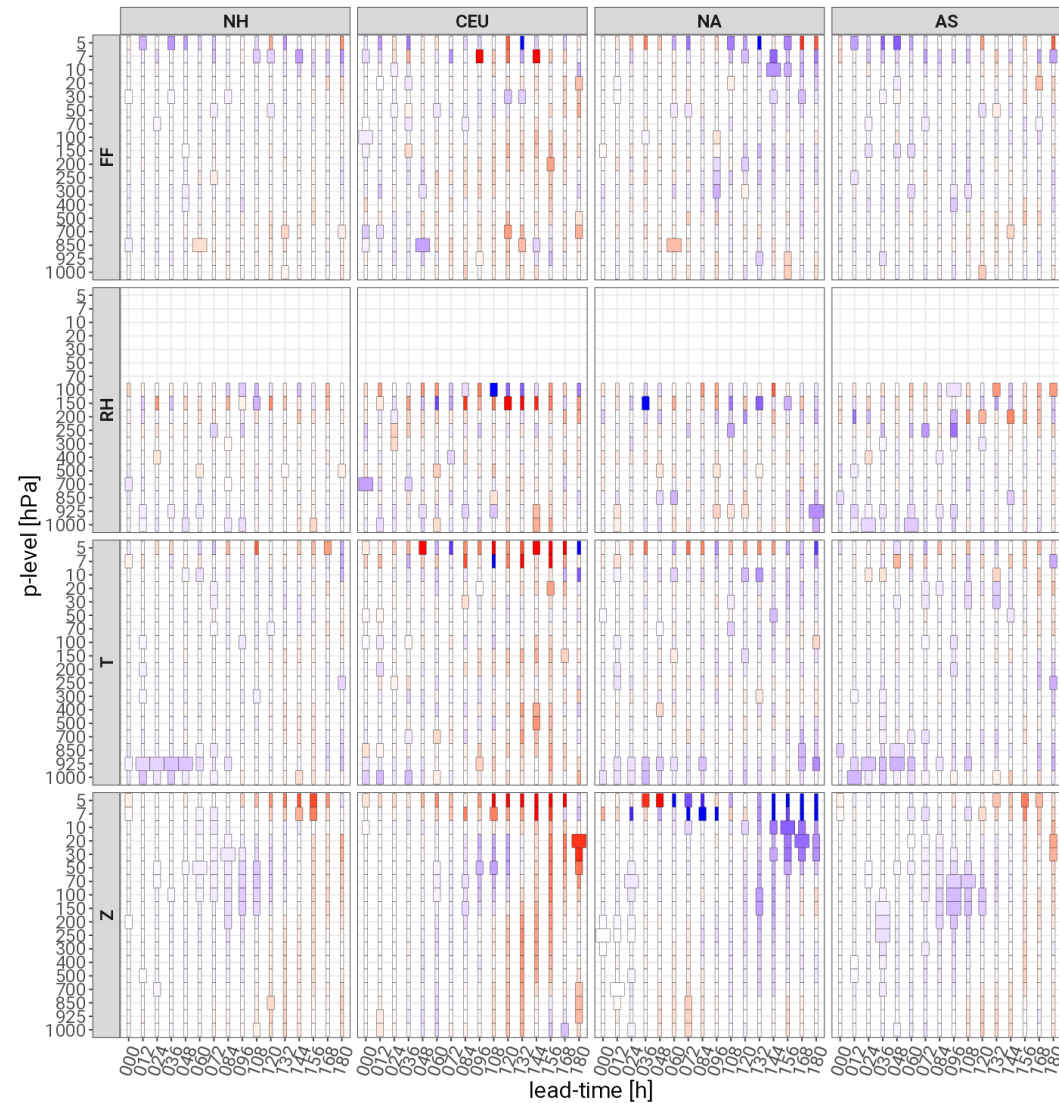
TEMP-Scorecard DET+EPS (Mar-Apr)

Verification period: 2025/03/01 - 2025/05/08

INI: 00, 12UTC, SIGN. TEST: TRUE

Data selection by initial-date

Reduction of RMSE [%]

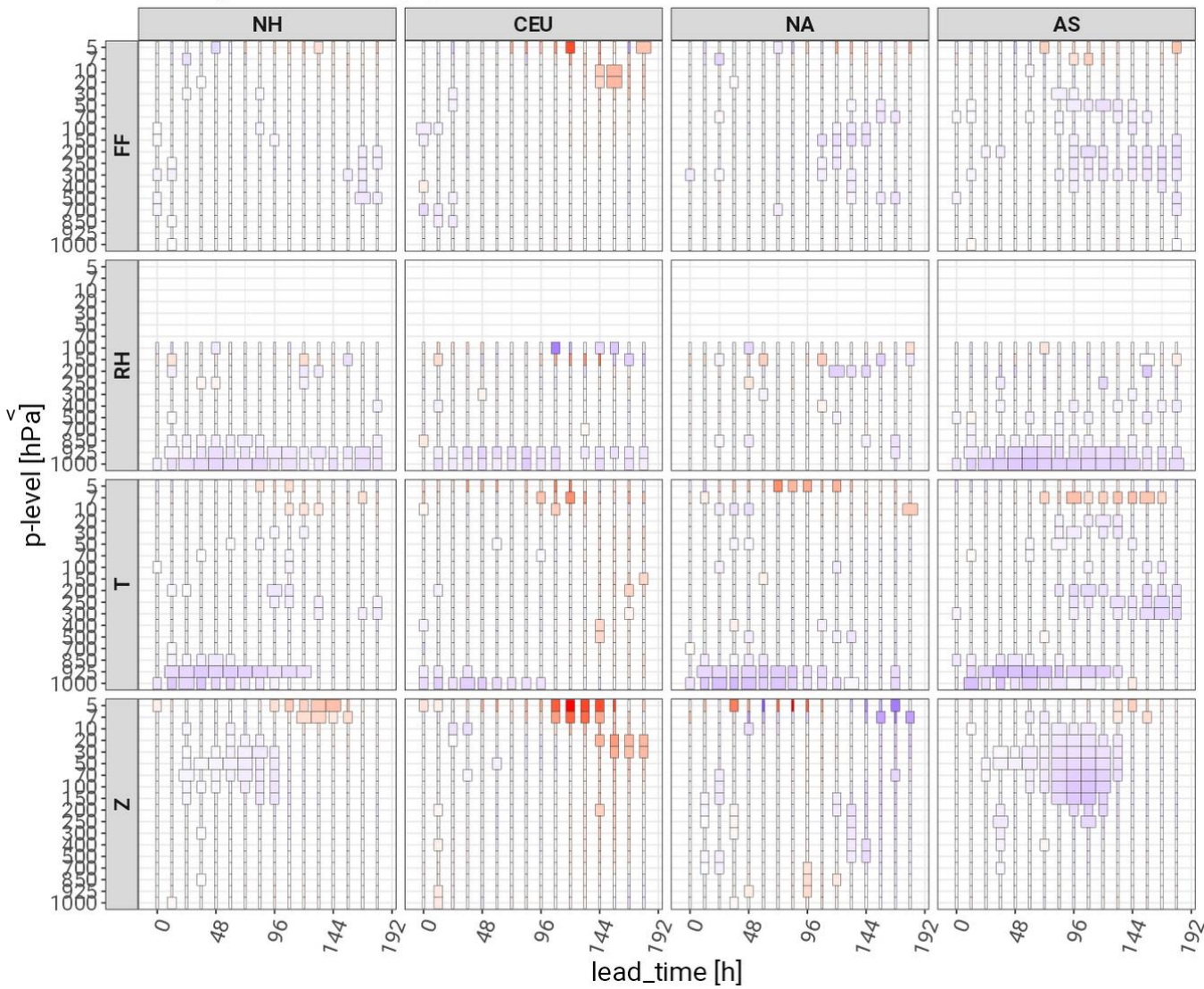


Verification period: 2025/03/01 - 2025/05/08

INI: 00, 12UTC, SIGN. TEST: TRUE

Data selection by initial-date

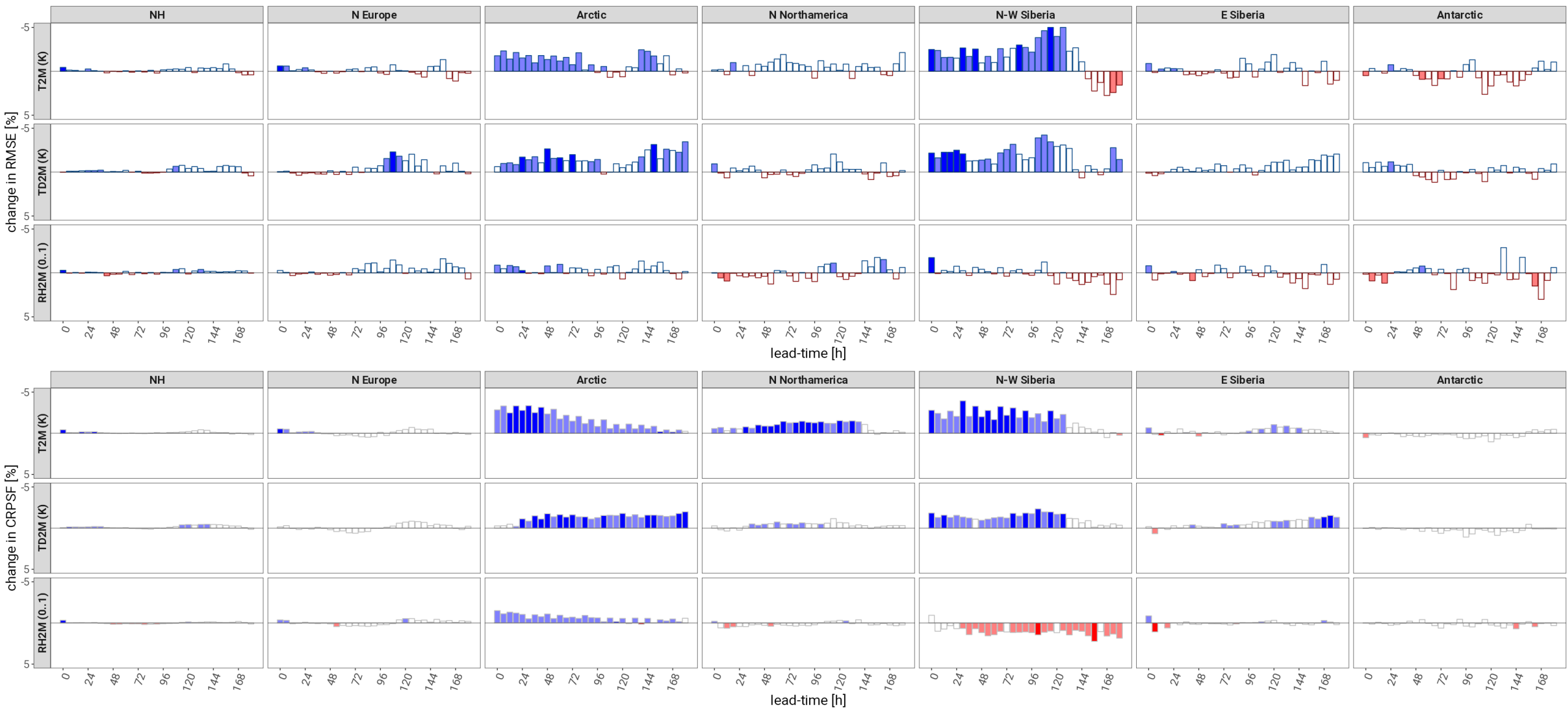
Change in CRPSF [%]



Synop-Scorecard DET and EPS (May-June)

Forecasts initialized from 2025/05/01 to 2025/07/08
Reduction of RMSE [%], INI; 00, 12UTC, SIGTEST: TRUE

Test2160E better Test2232E better Significance 0.00 0.25 0.50 0.75 1.00



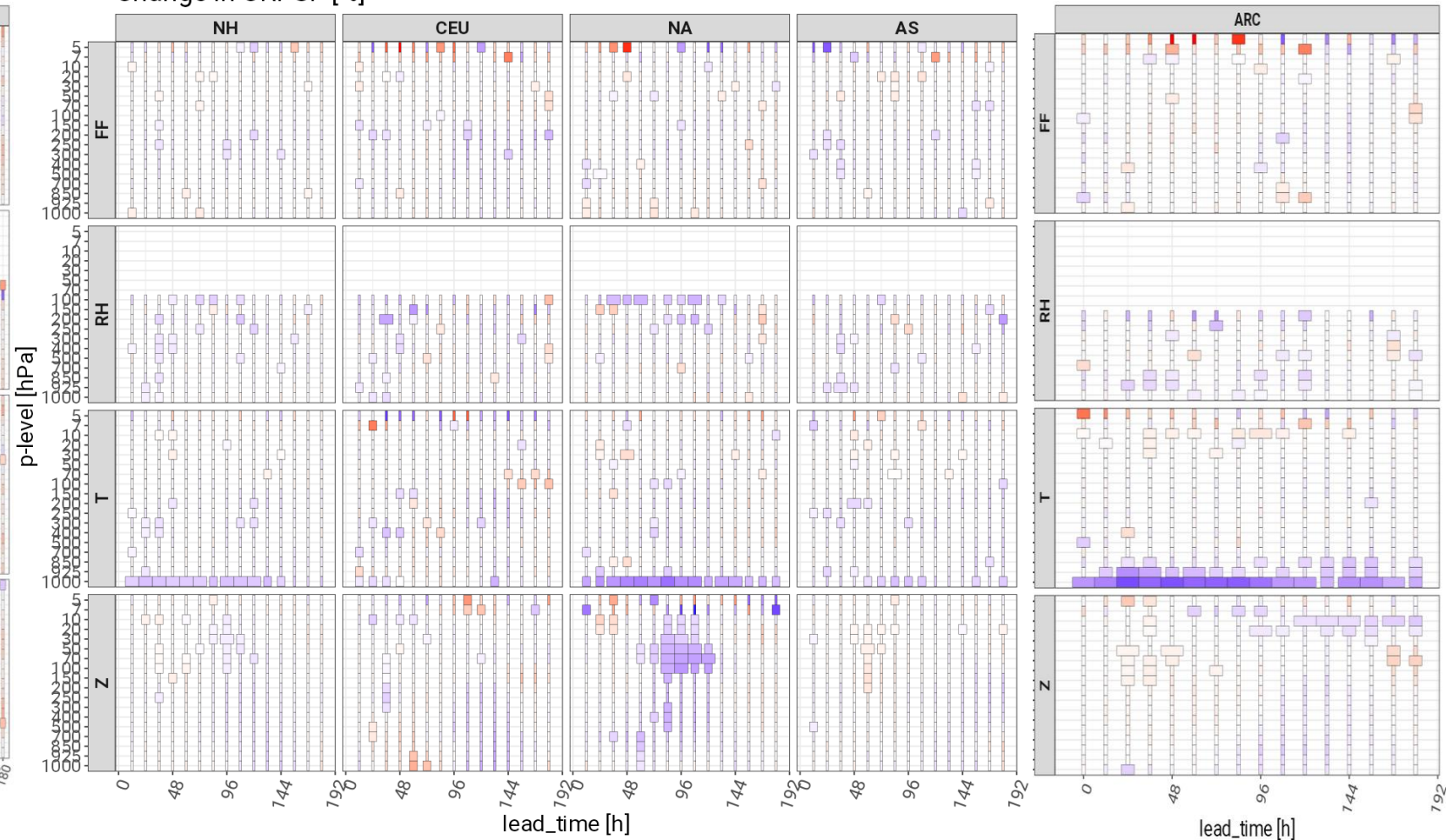
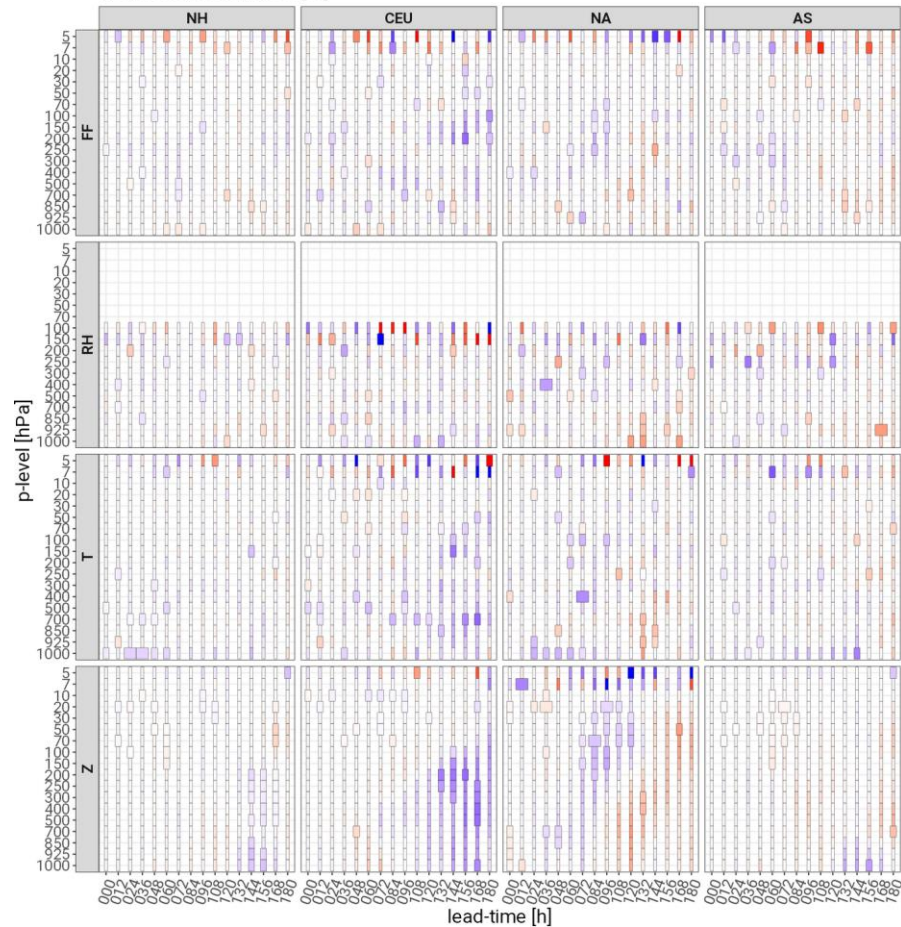
TEMP-Scorecard DET and EPS (May-June)

EPS shows unexpectedly large improvements in the Arctic region

Verification period: 2025/05/01 - 2025/07/08
INI: 00, 12UTC, SIGN. TEST: TRUE
Data selection by initial-date
Reduction of RMSE [%]

Verification period: 2025/05/01 - 2025/07/08
INI: 00, 12UTC, SIGN. TEST: TRUE
Data selection by initial-date
Change in CRPSF [%]

> 65°N



- Extending the skin-temperature parameterization to snow-covered grid points significantly improves the diurnal temperature amplitude over thick snow layers
- Combined with an adapted predictor for the adaptive snow albedo, T2M scores are improved in most snow-covered regions
- The differences strongly depend on the amount of incoming solar radiation. They are negligible during the polar night and extend into the lower troposphere in spring and (in the Arctic) early summer