GLAMEPS: what contribute to the added values?

- GLAMEPS performance skills as measured by HARP
- Behind added values...
- Derived conclusions

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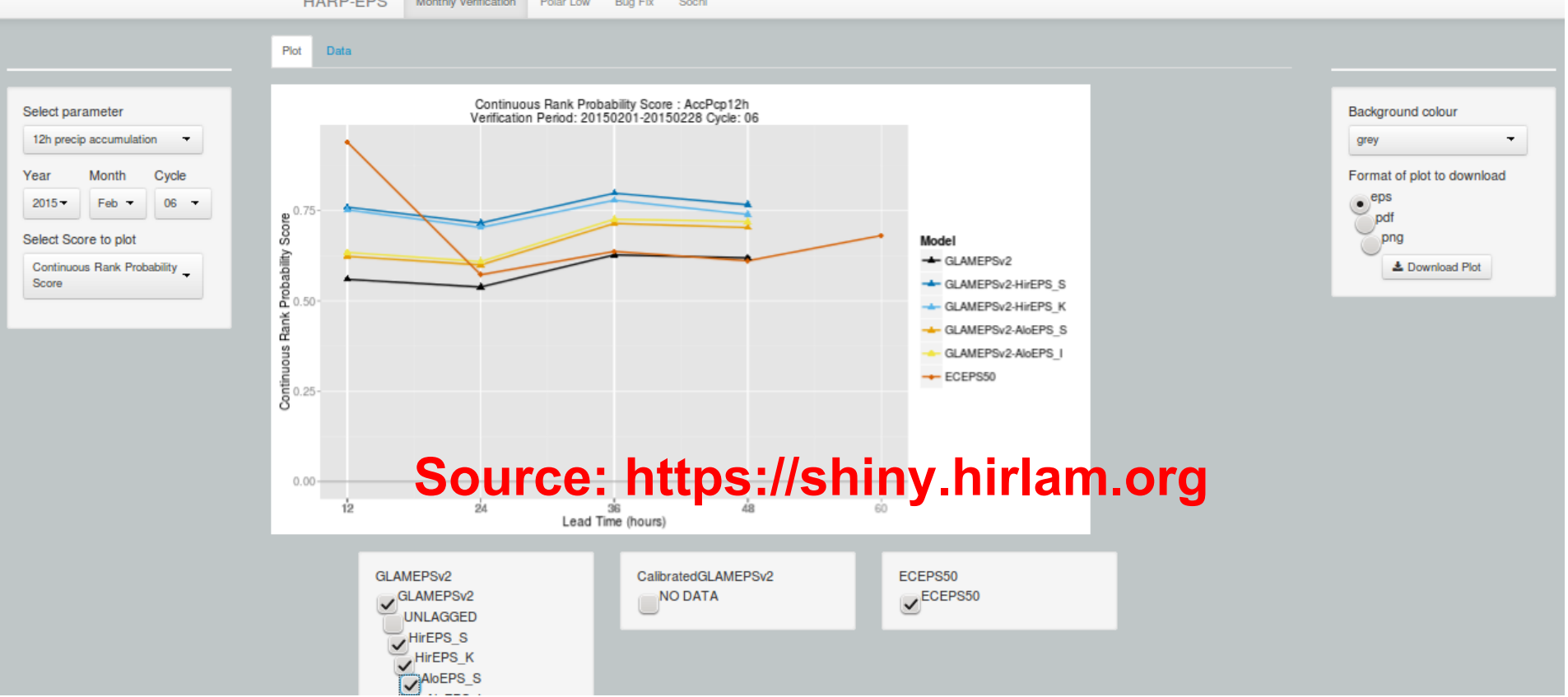
Acknowledgement: GLAMEPS & HARP & Hirlam MG

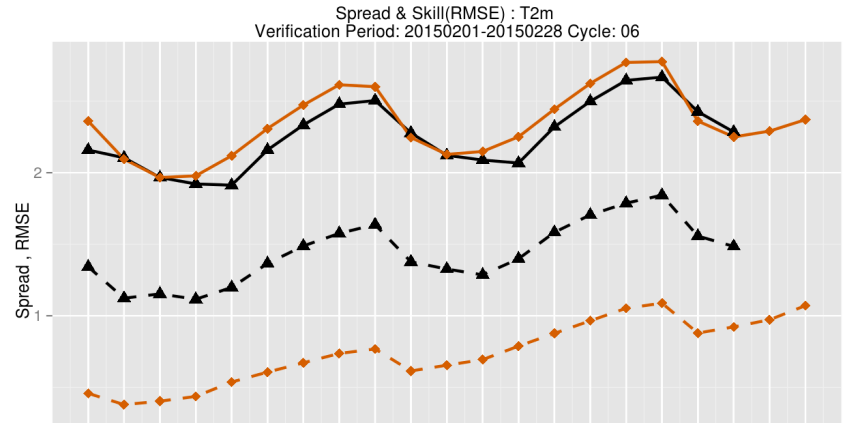
Outlines/Summary

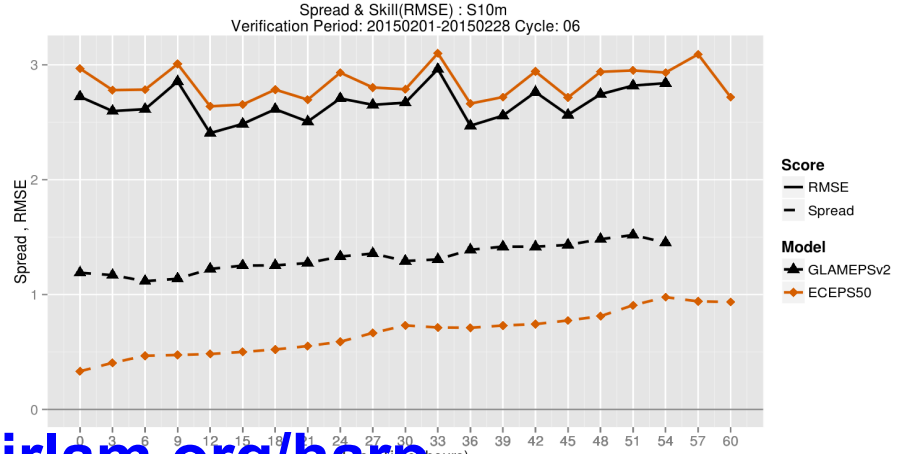
- GLAMEPS has a clear added values over the ECMWF ENS
- Evidence of sensitivity to configuration features via HARP tool
  -> resolution? -> multi-model? -> size of ensemble ? -> lagging?
  - main source of skills: multi-model
  - HIRLAM sub-ensembles contribute more to scores
  - skills of ALARO & HIRLAM controls equivalent
  - representation of model errors important
  - size of sub-ensemble in GLAMEPS not crucial
  - current single model ensembles generally under-dispersive
- GLAMEPS V3: finer resolution; reduced sub-ensemble size; enhanced representation of model errors



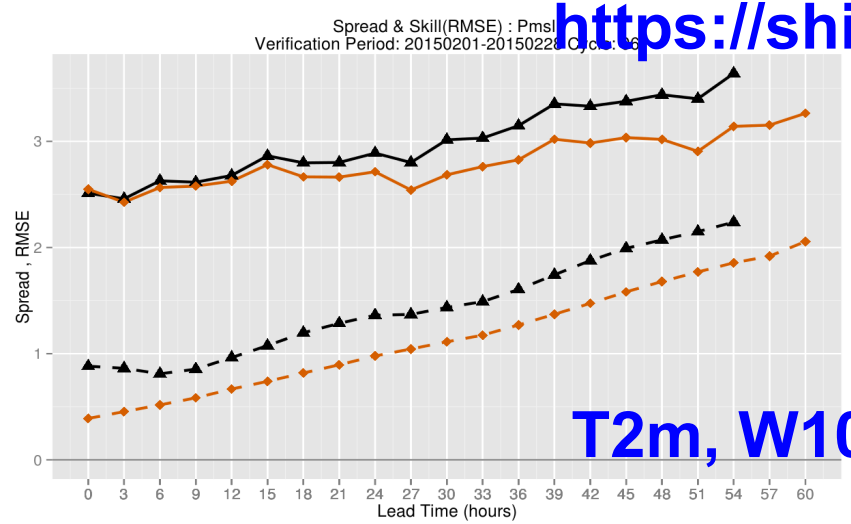
With HARP and shiny interface, it is convenient to examine relative contributions from sub-ensembles of the GLAMEPS...

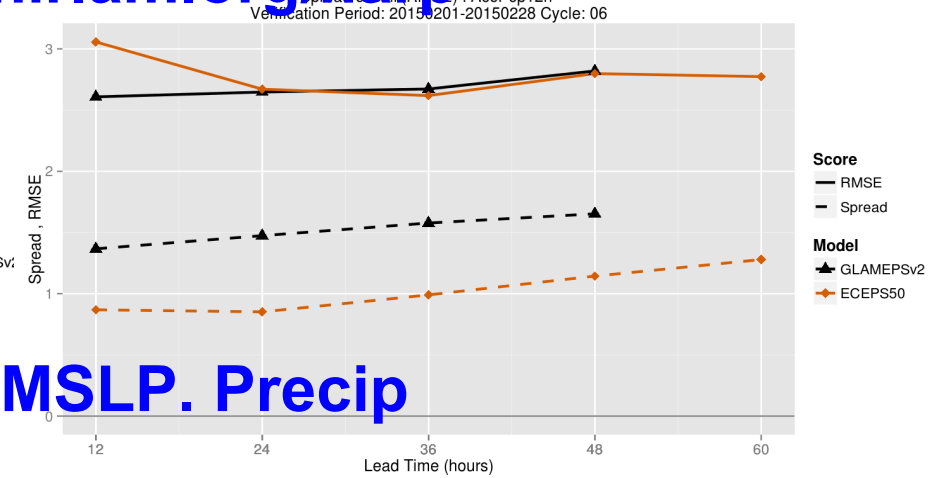
GLAMEPS vs ECMWF ENS: spread-skill Feb 2015





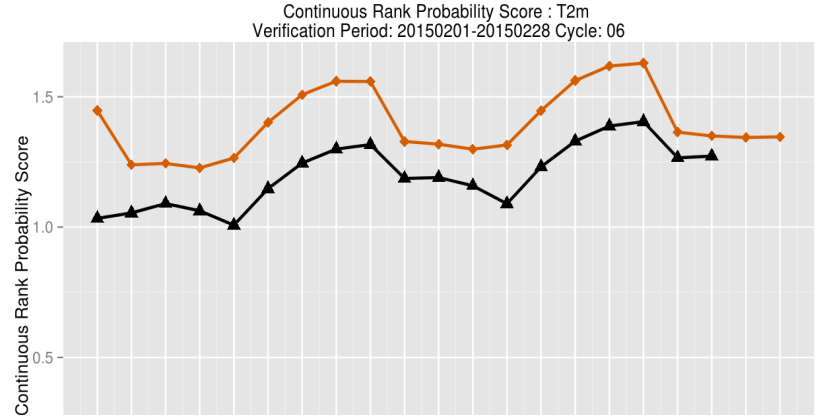
https://shiny.hirlam.org/harp

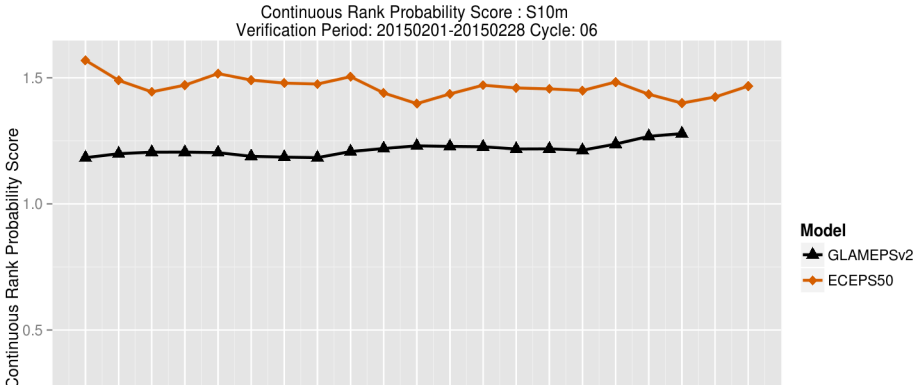


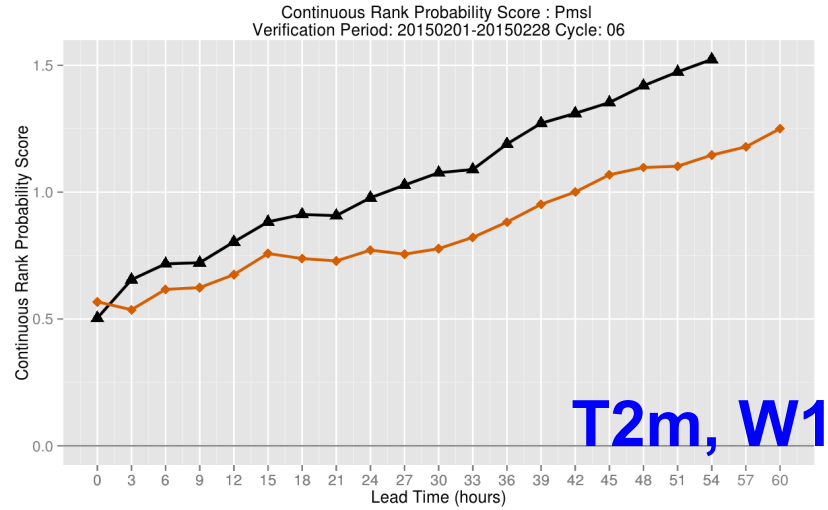


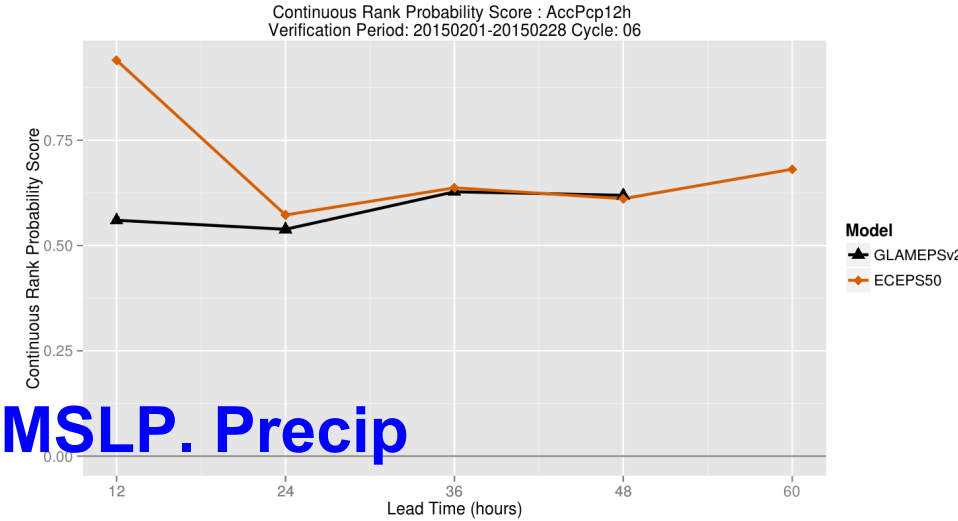
T2m, W10m, MSLP. Precip

GLAMEPS vs ECMWF ENS: CRPS



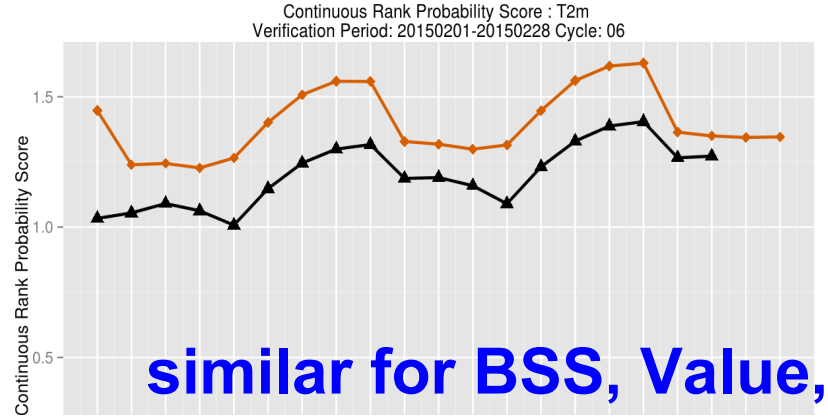


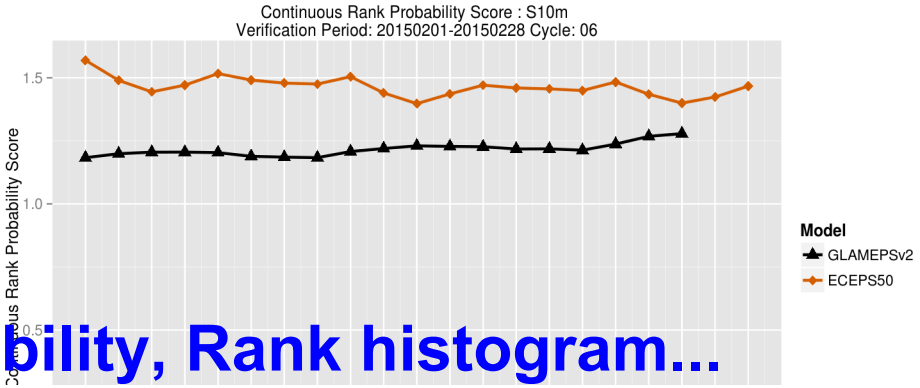




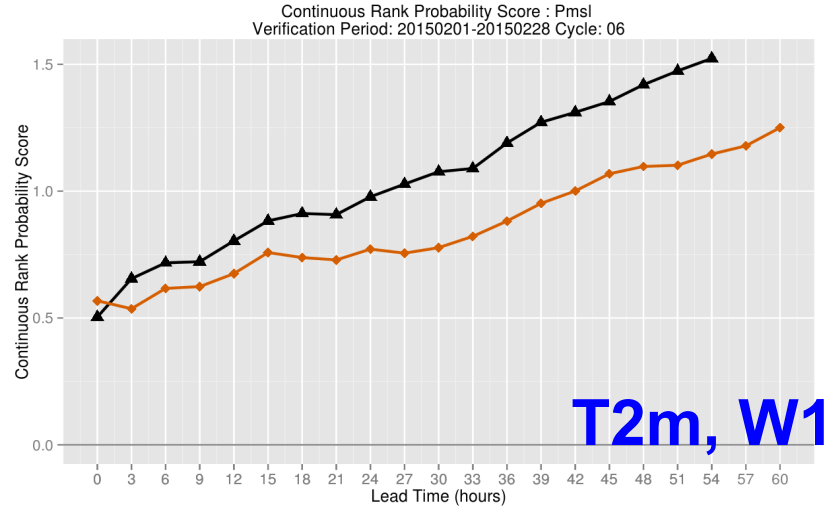
T2m, W10m, MSLP. Precip

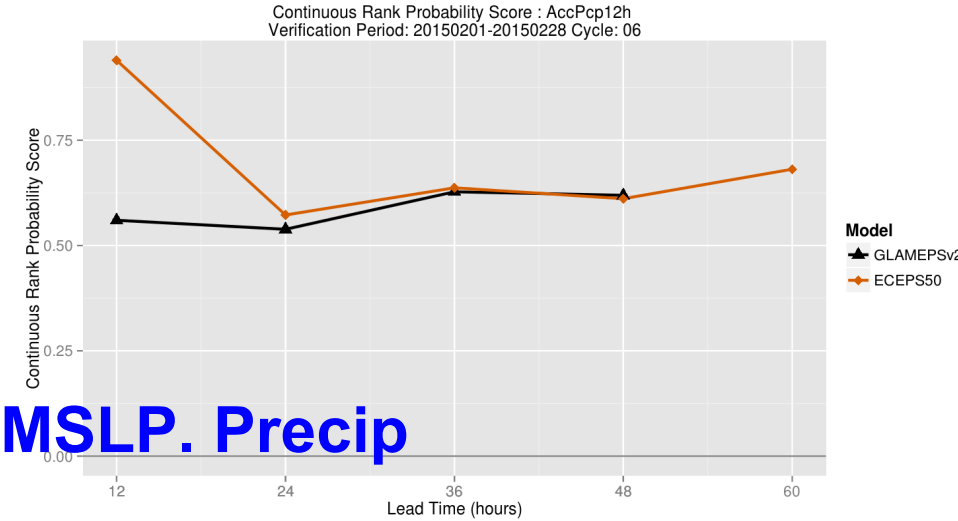
GLAMEPS vs ECMWF ENS: CRPS





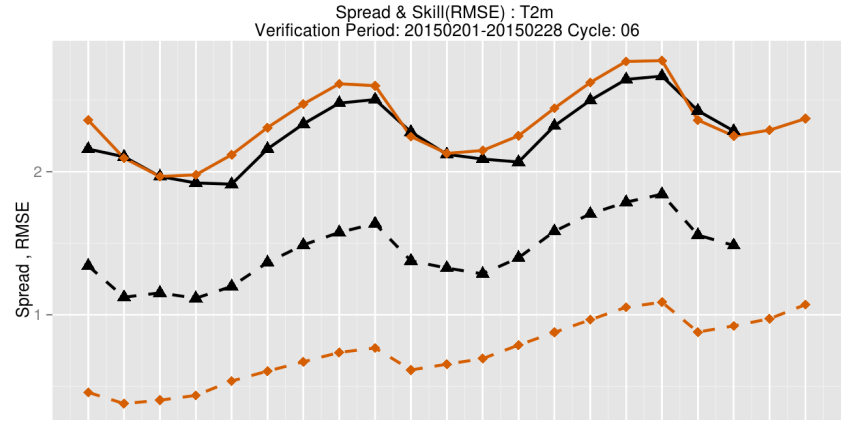
similar for BSS, Value, Reliability, Rank histogram...

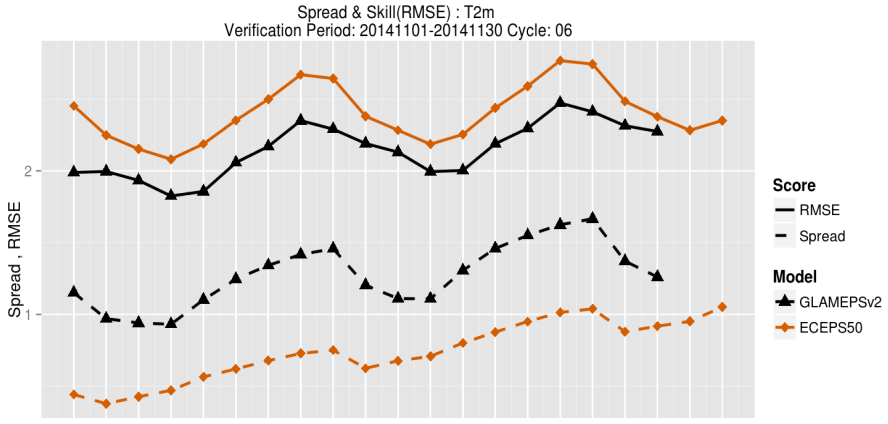


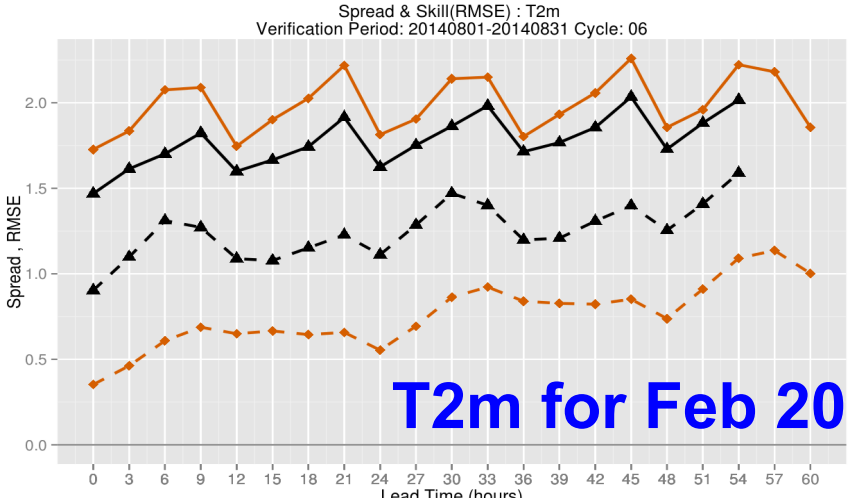


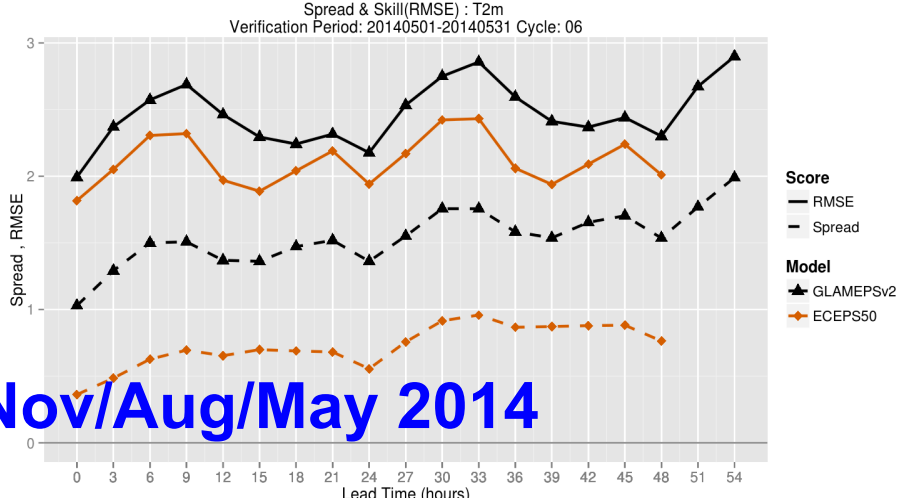
T2m, W10m, MSLP. Precip

GLAMEPS vs ECMWF ENS: spread skill



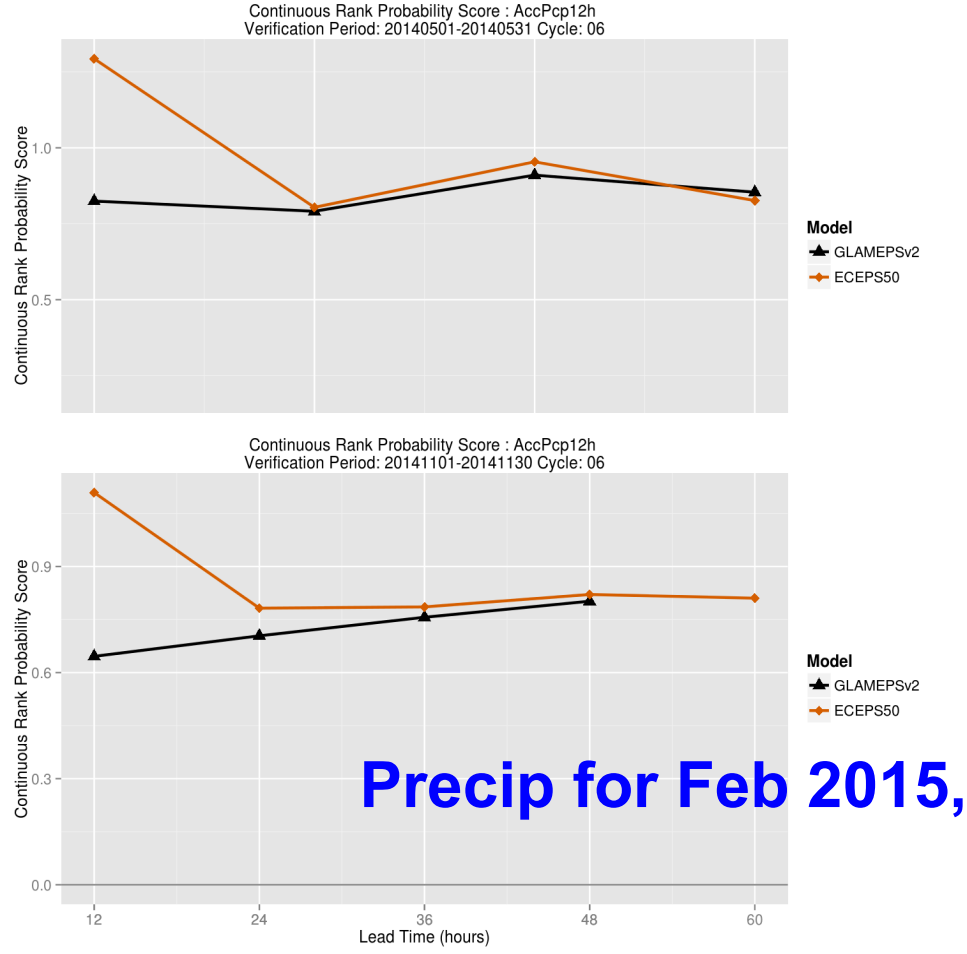


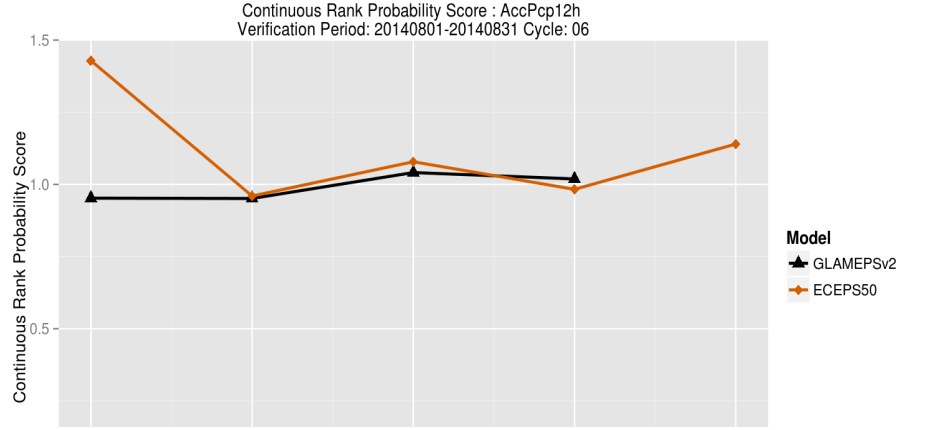


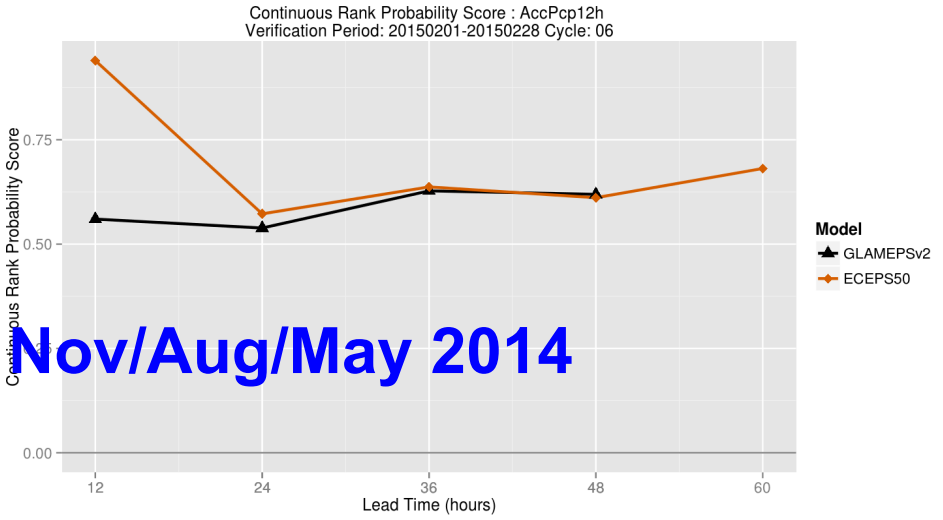


T2m for Feb 2015, Nov/Aug/May 2014

GLAMEPS vs ECMWF ENS, CRPS







Precip for Feb 2015, Nov/Aug/May 2014

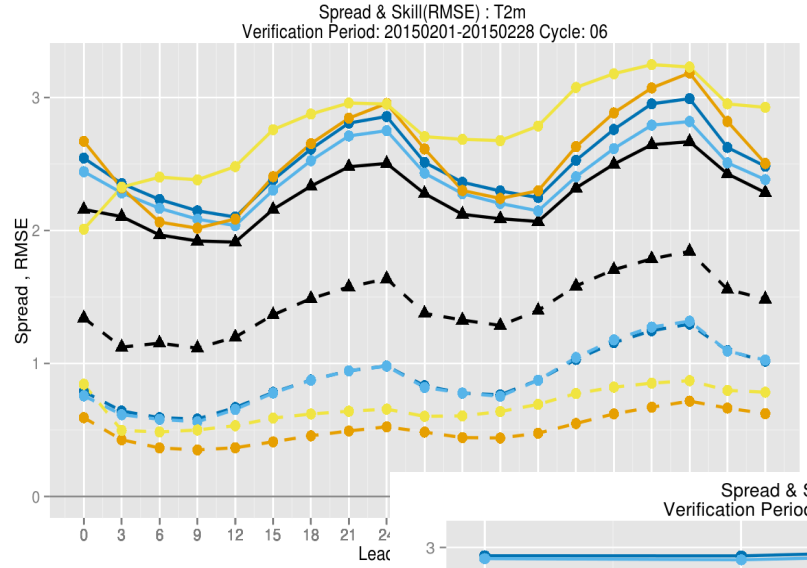
GLAMEPS vs ECMWF ENS: Summary

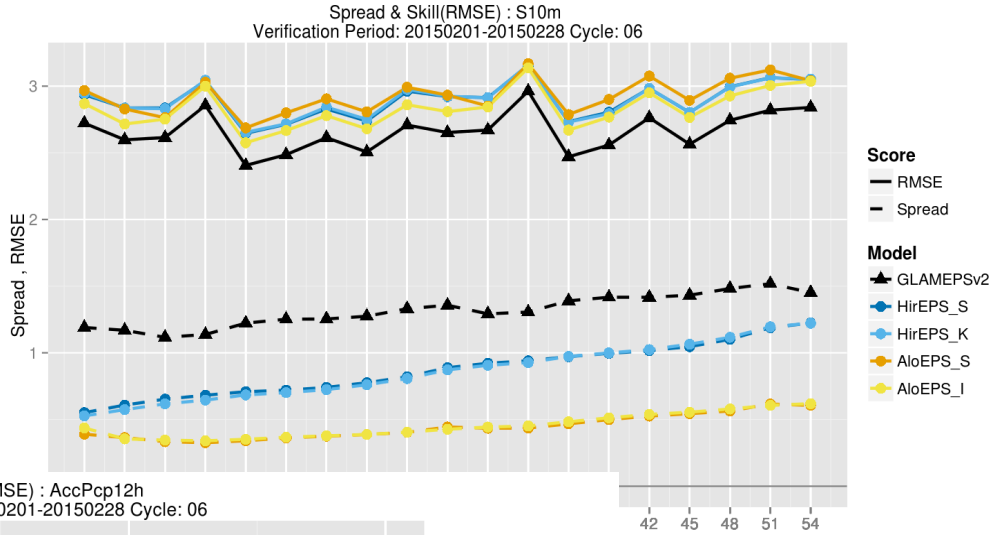
- Overall, GLAMEPS consistently outperform ECMWF ENS in probabilistic forecast skills for main synoptic parameters
  - benefit on T2m, W10m significant
  - benefit on precipitation mostly in Day 1
  - ENS still has advantage in MSLP scores
- Relative trend in score comparison between GLAMEPS and ENS consistent throughout seasons

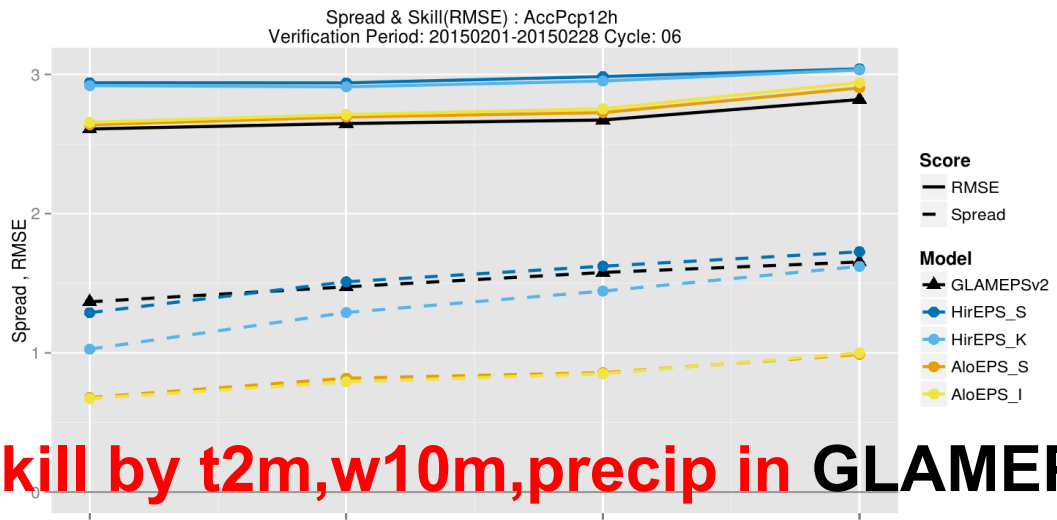
https://shiny.hirlam.org/harp

What contributes to the added values?

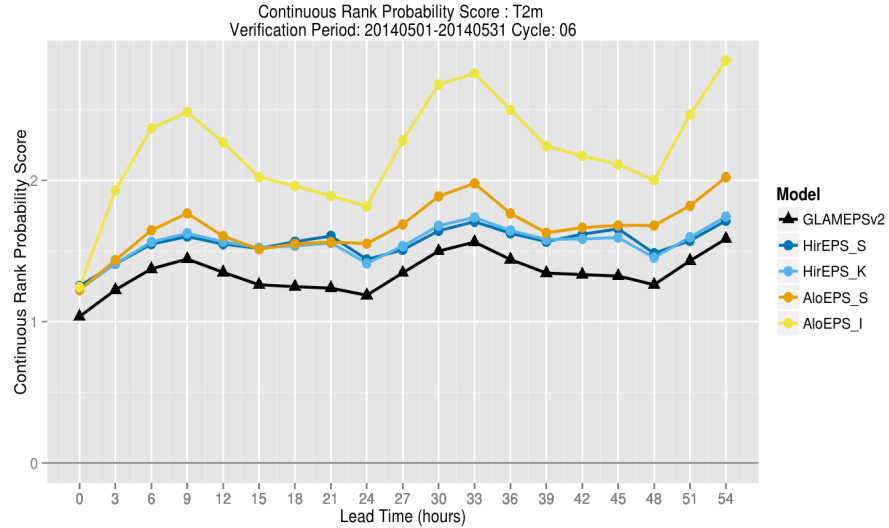
--- Skill contributions from components as shown by the HARP/shiny interface

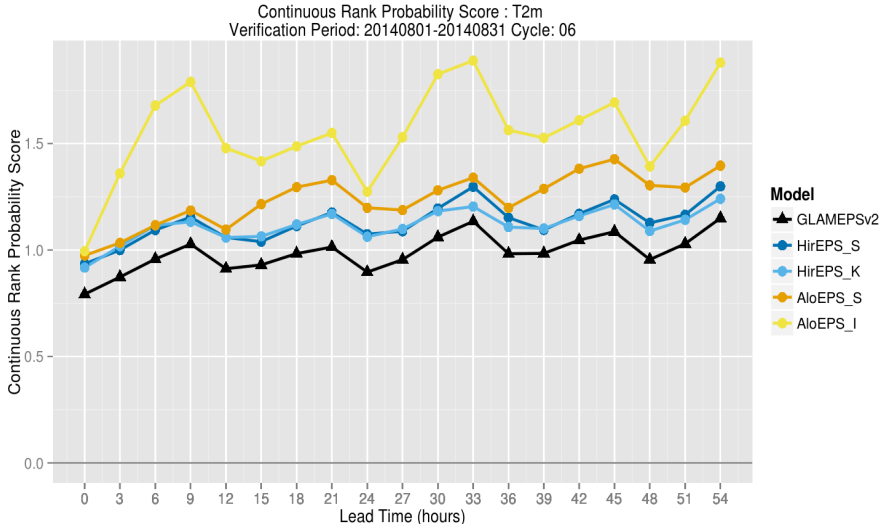


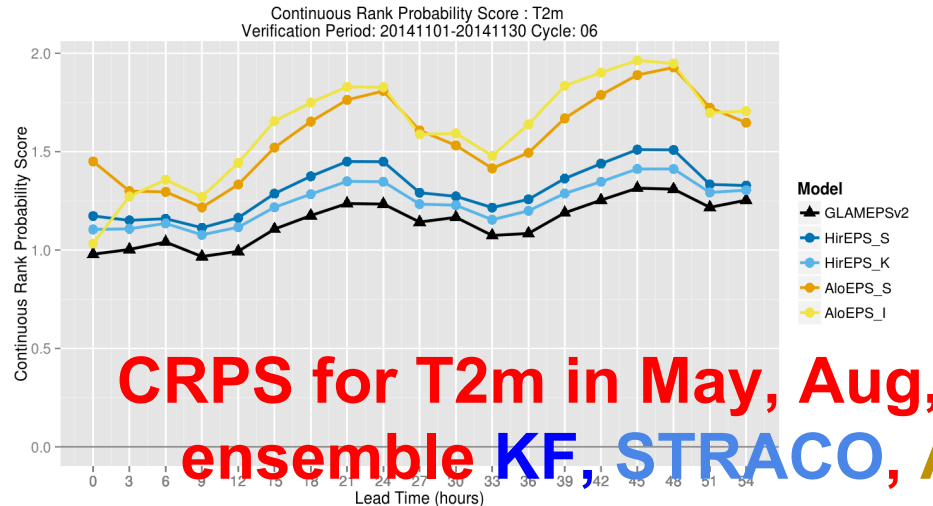


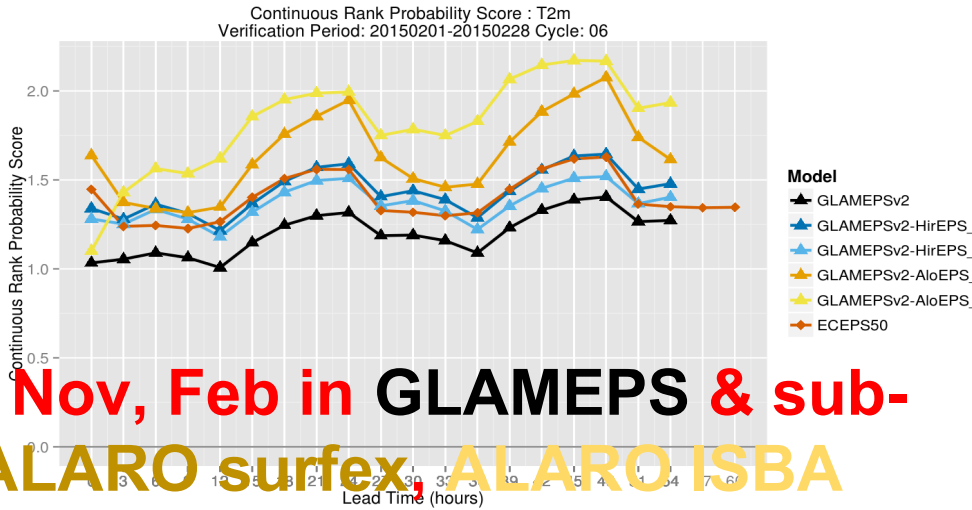


spread-skill by t2m,w10m,precip in GLAMEPS & sub-ensemble KF, STRACO, ALARO surfex, ALARO ISBA

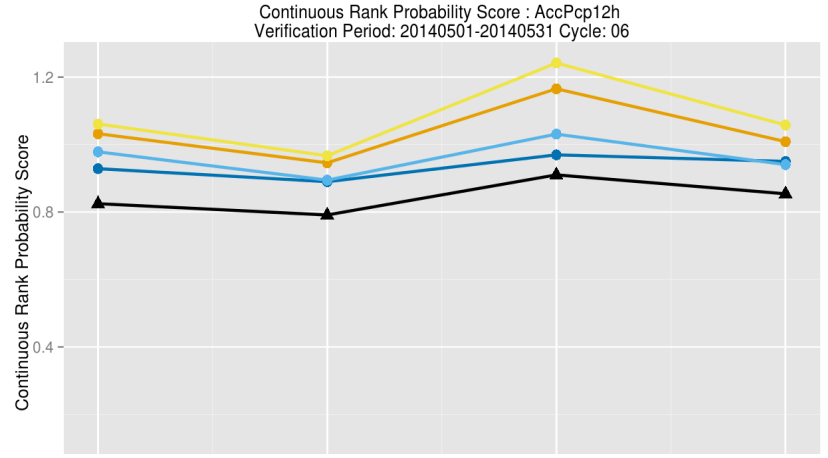


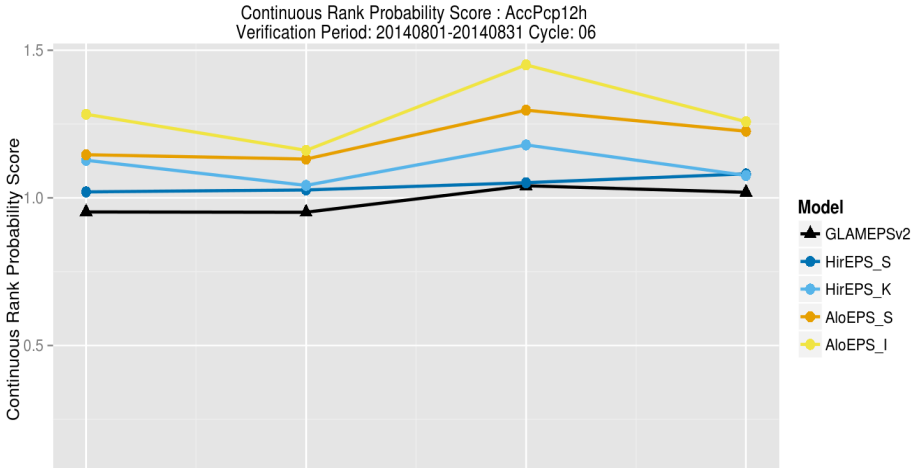


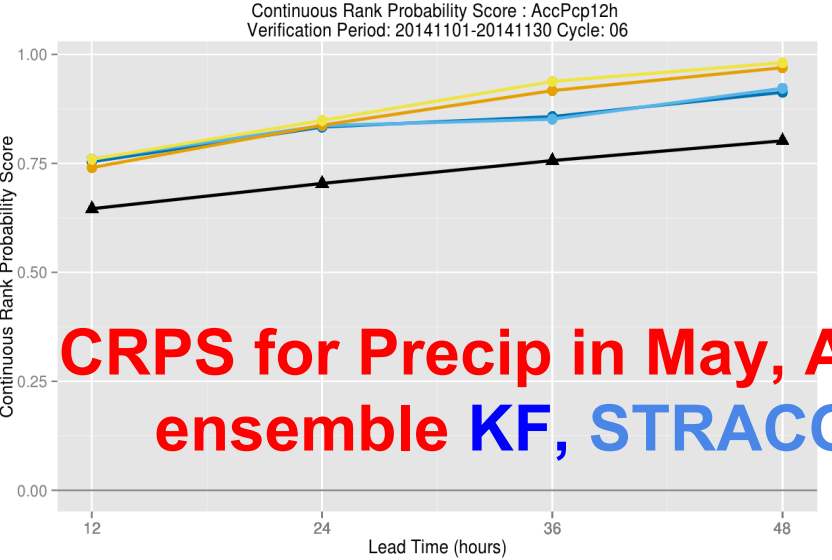


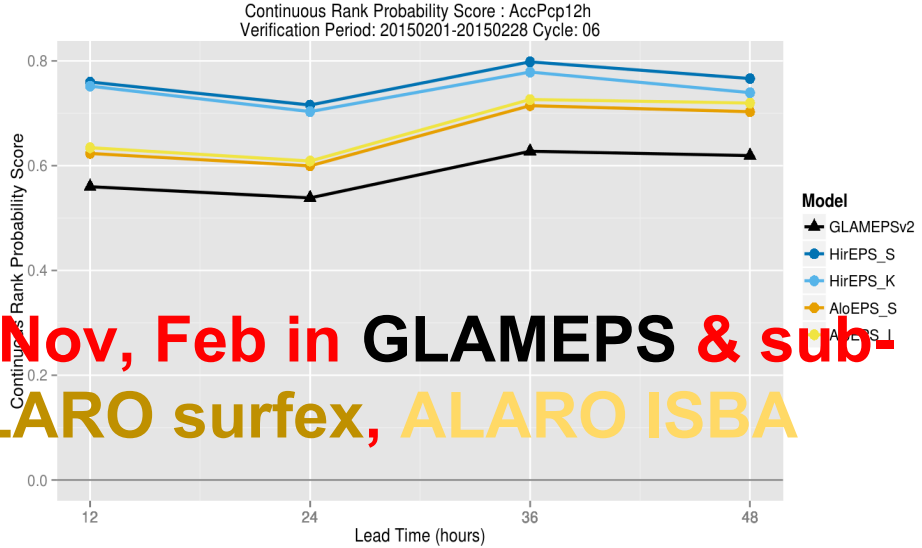


CRPS for T2m in May, Aug, Nov, Feb in GLAMEPS & sub-ensemble KF, STRACO, ALARO surfex, ALARO ISBA





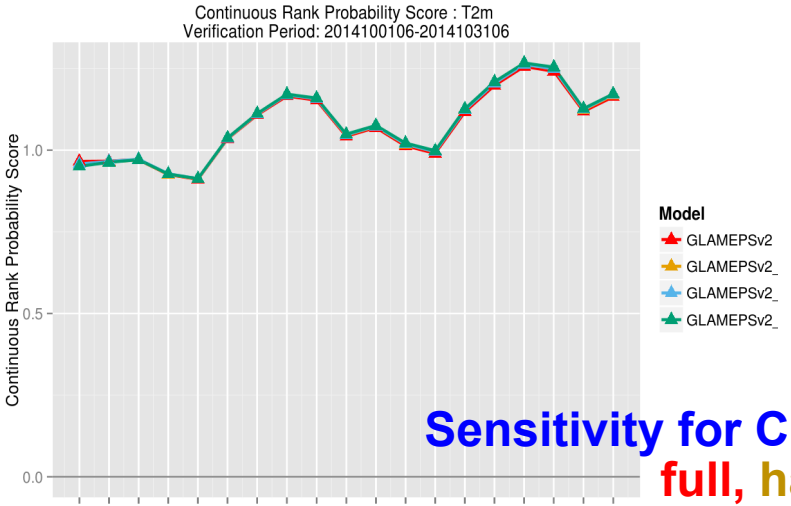


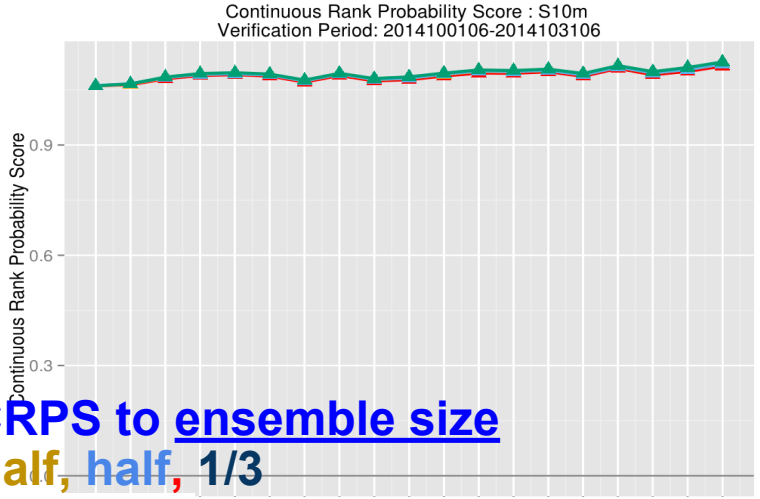


CRPS for Precip in May, Aug, Nov, Feb in GLAMEPS & sub-ensemble KF, STRACO, ALARO surfex, ALARO ISBA

Skill contributions from components

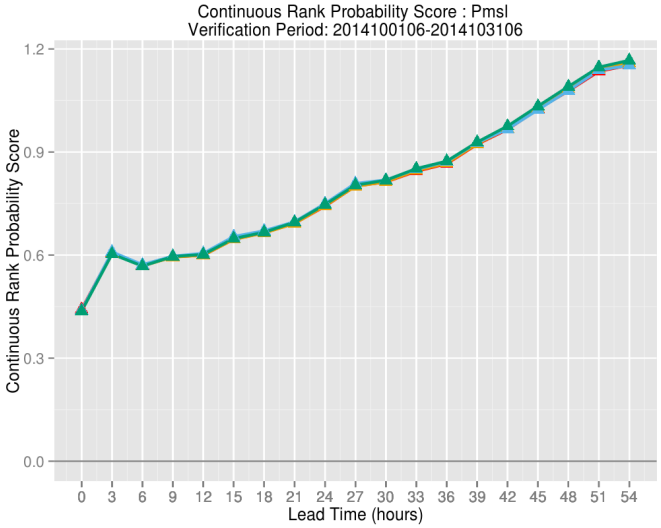
https://shiny.hirlam.org/glaemps_test

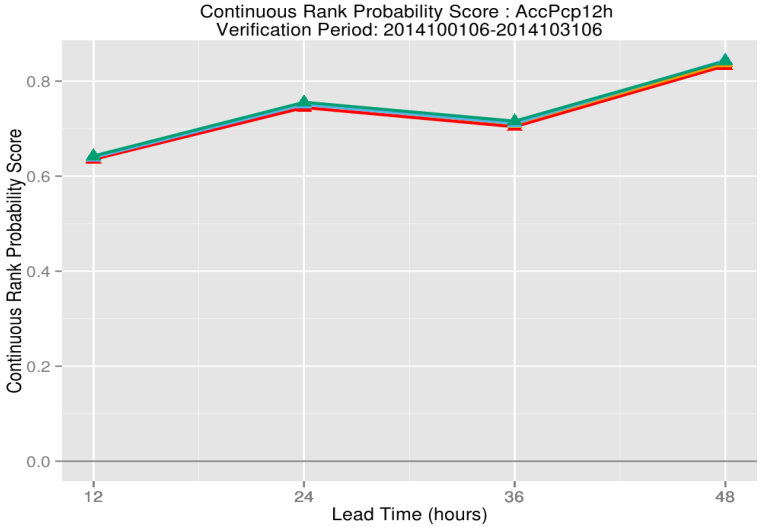


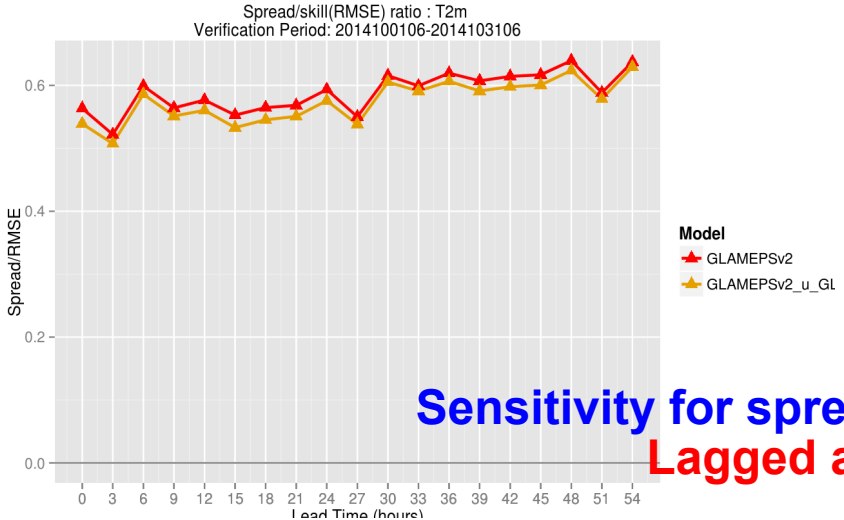


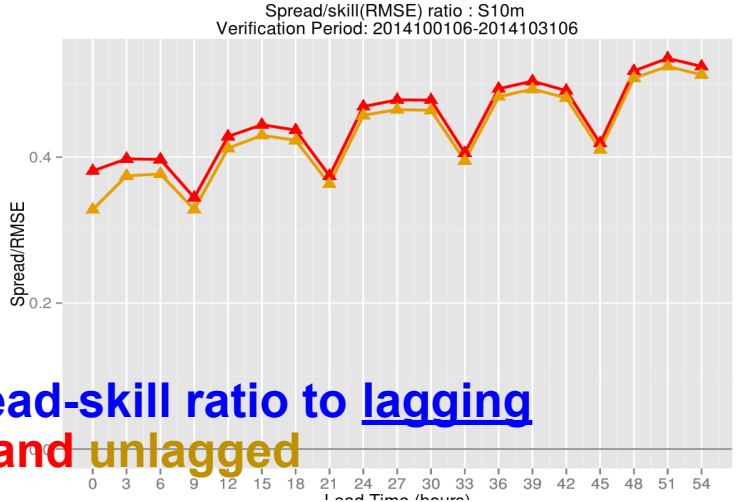
Sensitivity for CRPS to ensemble size

full, half, half, 1/3



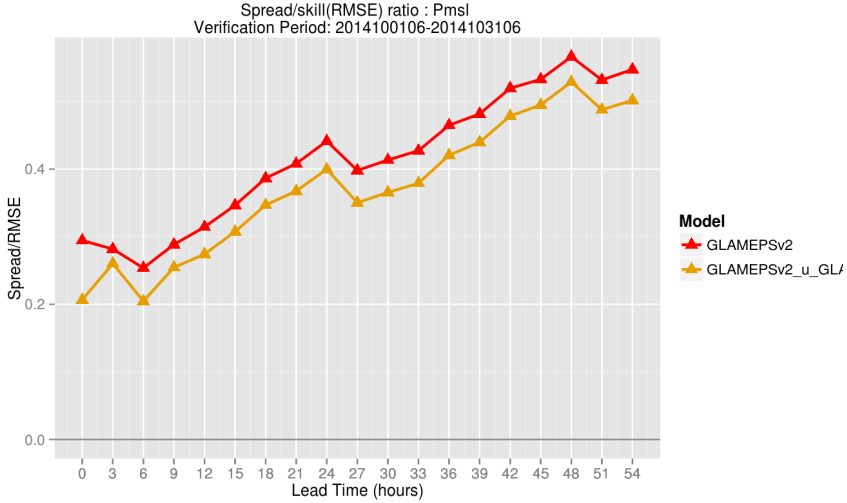


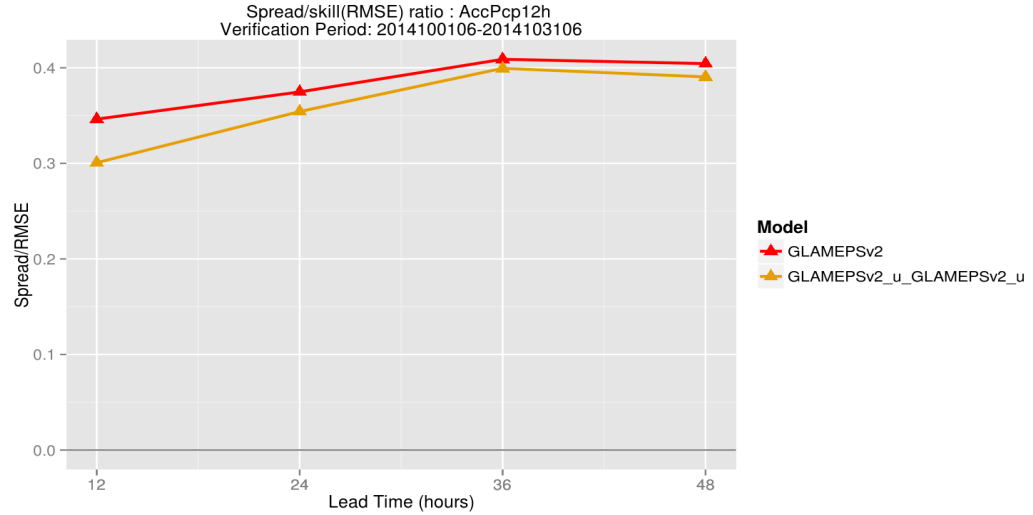


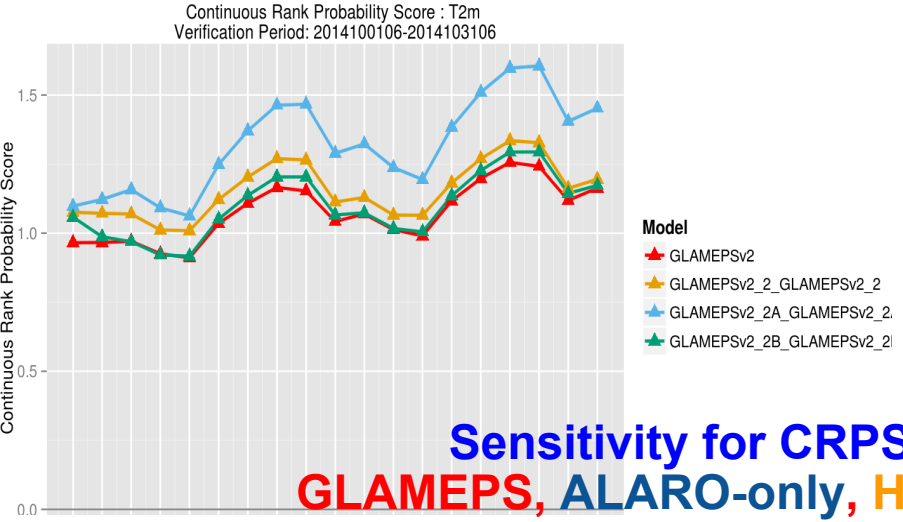


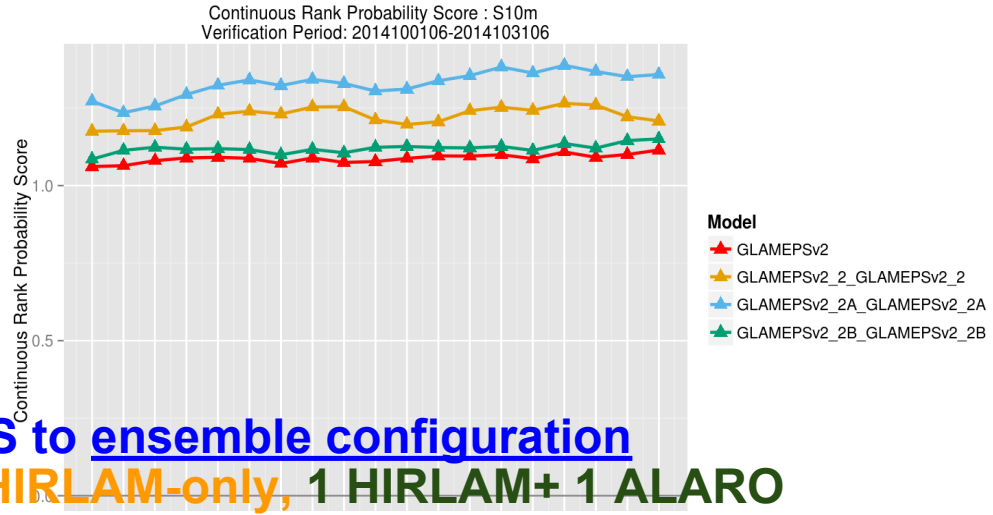
Sensitivity for spread-skill ratio to lagging

Lagged and unlagged



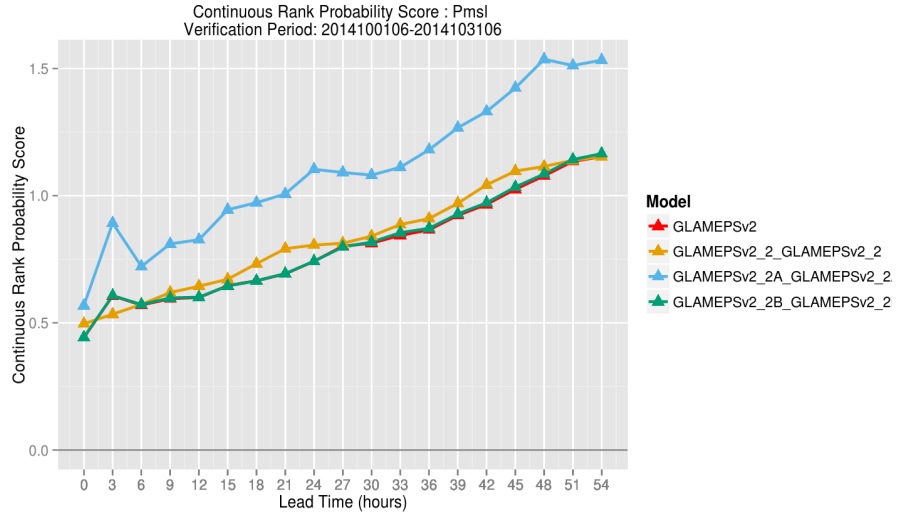


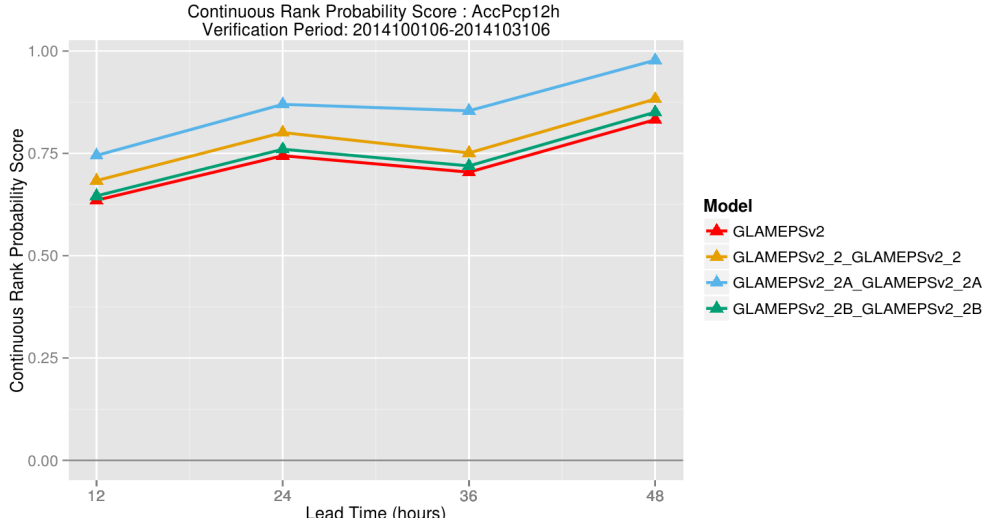


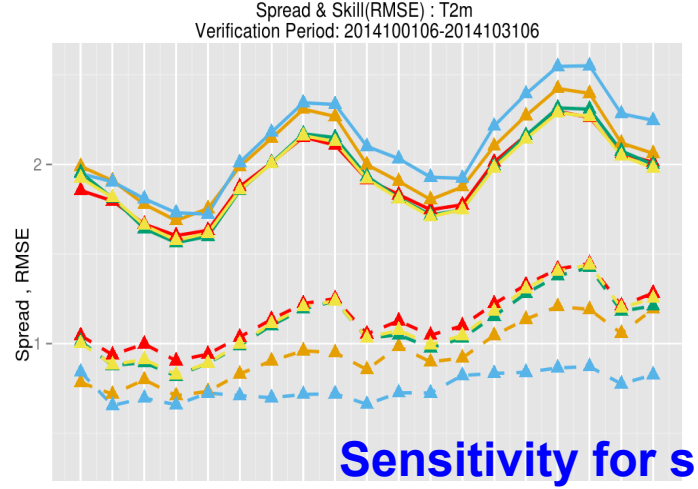


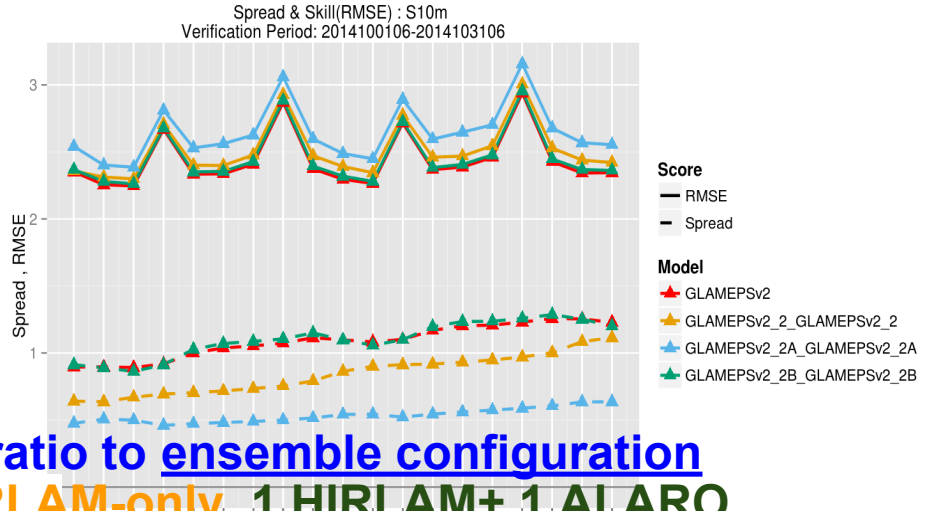
Sensitivity for CRPS to ensemble configuration

GLAMEPS, ALARO-only, HIRLAM-only, 1 HIRLAM+ 1 ALARO



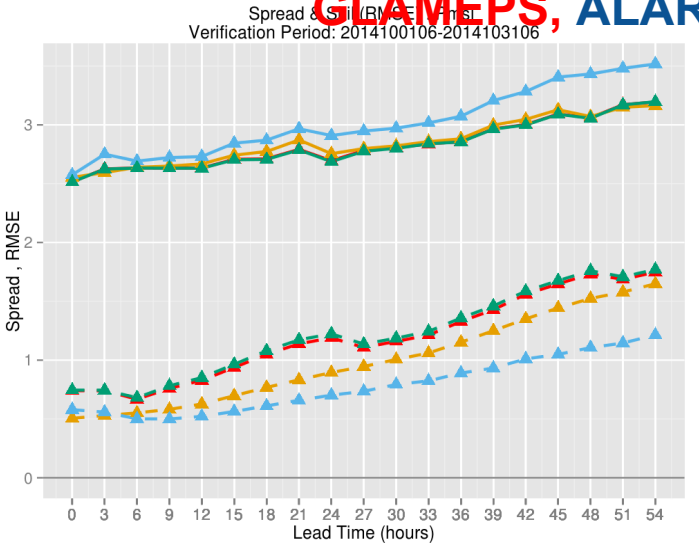


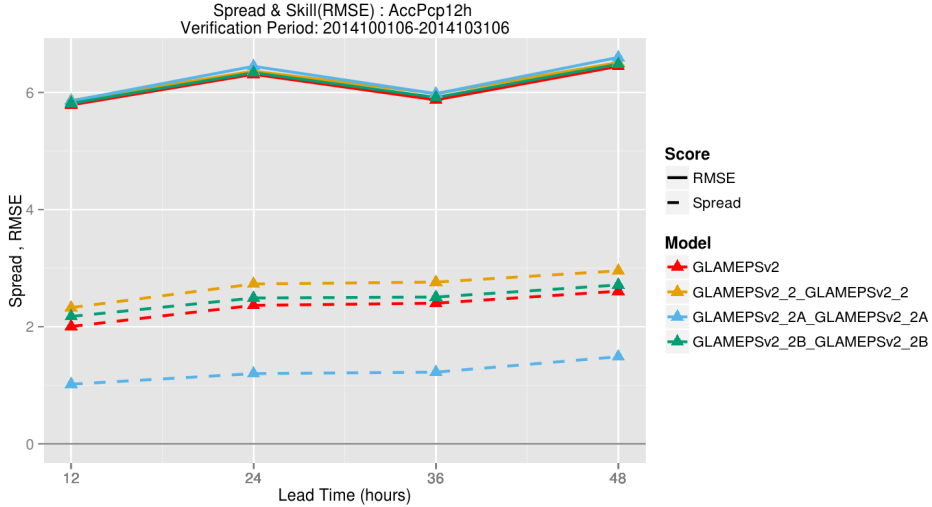




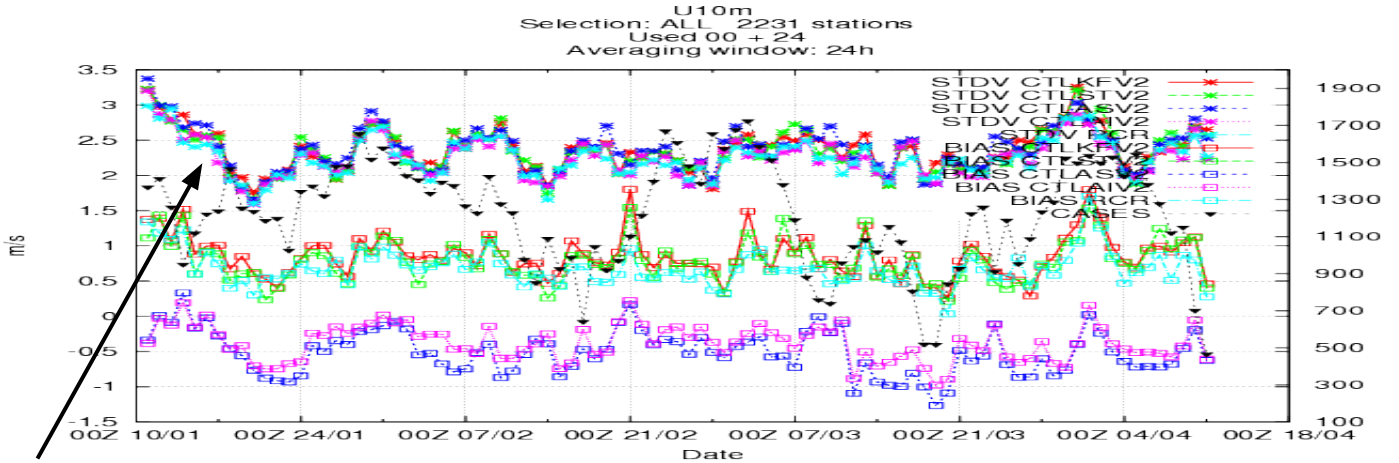
Sensitivity for spread-skill ratio to ensemble configuration

GLAMEPS, ALARO-only, HIRLAM-only, 1 HIRLAM+ 1 ALARO

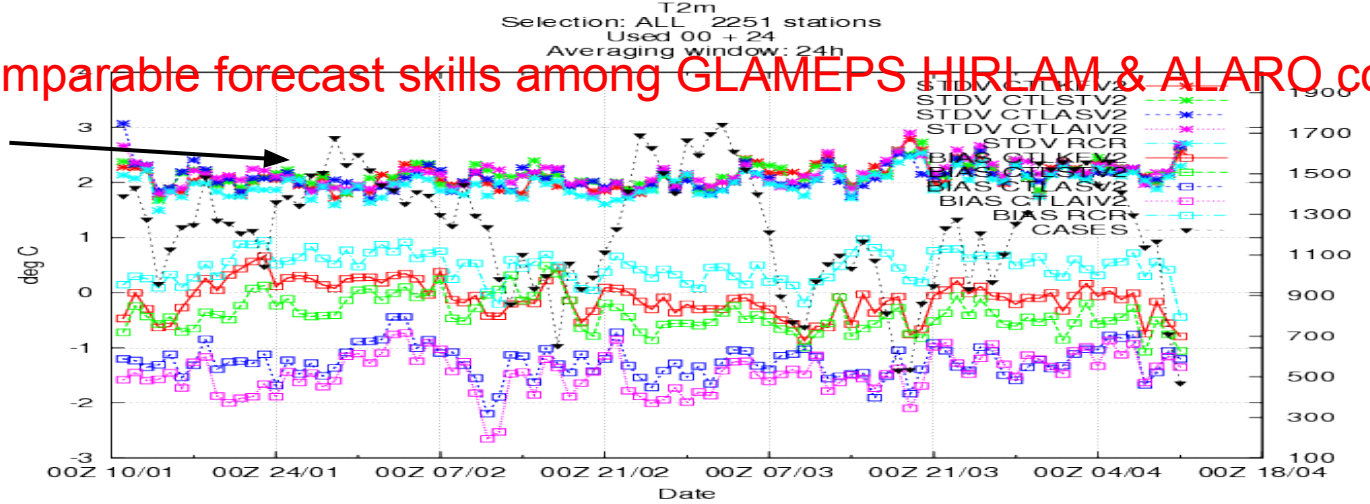




Daily forecast error (std, bias) time series in 2015



U10



T2

Comparable forecast skills among GLAMEPS HIRLAM & ALARO controls

Summary

- GLAMEPS has clear added values compared to ECMWF ENS
  - T2m, W10m, Precip (most pronounced in day 1)
- Most of the GLAMEPS skills come from multi-model configuration
- Larger sub-ensemble sizes does not add much value
  - Presently, single model EPS tends to be severely under-dispersive
- Lagging appears effective to add skills
- GLAMEPS model components (control and perturbed) appear to behave normal from deterministic point of view
- HIRLAM components in GLAMEPS provide more spread
  - stochastic physics, 3DVAR control
- ALARO members in GLAMEPS need enhanced representation about model error
  - good model does not automatically offer added values without adequate perturbation
  - downscaling alone insufficient to provide spread
- ECMWF EPS members is under-dispersive for short range
  - not so beneficial to use full ENS ensemble for LBC!

Outlook for GLAMEPS

Need to add for ALARO models representation of model error

Assume higher horizontal resolution is still beneficial to forecast skills, one may consider a further resolution increase

- Main candidates to GLAMEPS V3: ~5 km grid size; reduced size of sub-ensembles; model error for ALARO members.