HarmonEPS and GLAMEPSv1 for the Sochi Olympic Games

- and a little bit on CA in HarmonEPS

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and

GLAMEPSv1: Kai Sattler
HarmonEPS: Ole Vignes, Ulf Andrae, Andrew Singleton
Calibration: Thomas Nipen, John Bjørnar Bremnes
Verification: Andrew Singleton, Alex Deckmyn
CA: Lisa Bengtsson

With thanks to MET Norway obs-department and IT-department

Bucharest April 2014

International project FROST-2014 (FROST = Forecast and Research in the Olympic Sochi Testbed)

Probabilistic forecasting in FROST-2014

Goal:
- Regional meso-scale ensemble forecast products in winter complex terrain environment
- To deliver probabilistic forecasts in real time to Olympic weather forecasters and decision makers

Contributing probabilistic systems:
- FDP: COSMO-S14-EPS, Aladin LAEF, GLAMEPS, NNMB-7km EPS,
- RDP: COSMO-RU2-EPS, HARMON-EPS, KMA's downscaling of probabilistic forecasts, Poor man's ensemble of deterministic high-resolution models

HIRLAM contribution:
- Raw GLAMEPSv1 - FDP
- Calibrated GLAMEPSv1 for venues – RDP *but delivered in real time*
- HarmonEPS – RDP *but run in real time*

OLYMPIC TEST PERIOD: 20140115 - 20140331

HIRLAM (EPS) contribution to FROST

2011:
•GLAMEPS semi operational (FDP). Technical work in setting up Harmonie to run in ensemble mode (RDP)

2012:
•Providing GLAMEPS results routinely (FDP) – Delivery of GLAMEPS to FROST from September 2012.
•Run HarmonEPS experiments for the area of Sochi.
•Calibration of EPS forecasts (RDP).

2013:
•Run HarmonEPS for the area of Sochi and provide output
•Calibrated forecasts for venues

GLAMEPS_v1 for the "synoptic" scales:

54 ensemble members:

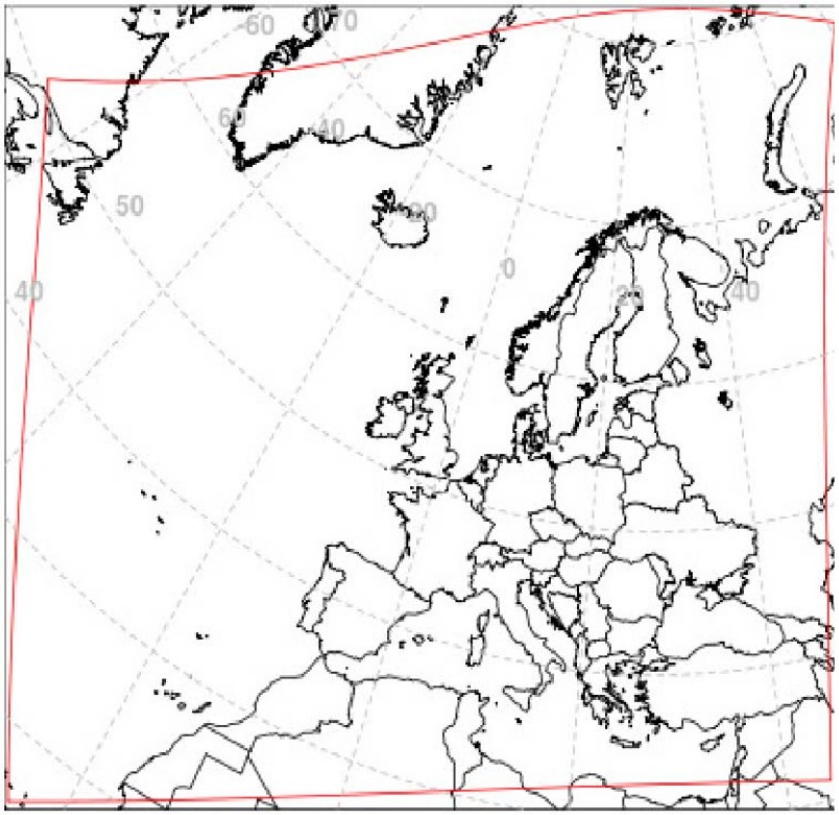
- EC DET (1) +
- HirEPS_S (12+1) +
- HirEPS_K (12+1) +
- AladEPS (13) +
- EC EPS (14) = 54

Forecast range: 54h

- 06 and 18 UTC (EC 00 and 12 UTC)

~11 km resolution
Aladin: 629x529, 11.8 km, L37
Hirlam: 646x492, 0.10° (11,1 km), L40

Runs as Time-Critical Facility at ECMWF



Black frame: Aladin domain
Red domain: Hirlam domain and common output domain

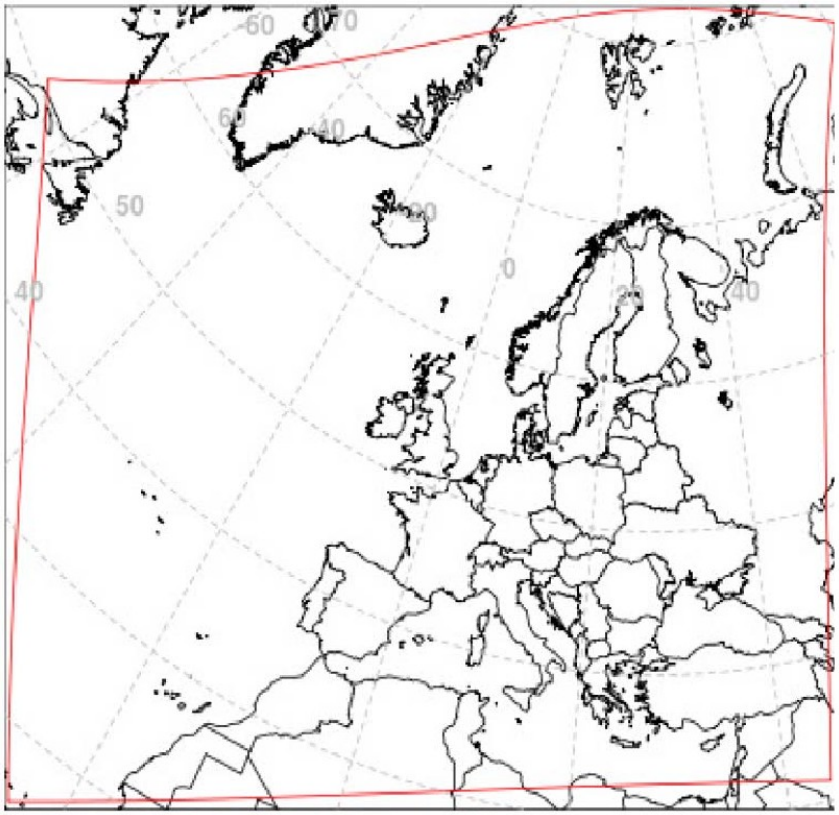
GLAMEPS_v1 for the "synoptic" scales:

Alaro component:

- 6h CANARI-cycle with conventional data
- 3D fields uppdated 00h and 12h

HIRLAM component:

- Two different choises for parameterization scheems:
  - HirEPS_S (STRACO)
  - HirEPS_K (Kain-Fritsch/Rasch-Kristjansson)
  - Two controls with 3d-Var
  - Other members have surface assimilation cycle
  - Stochastic physics since 6. February 2013
  - Perturbed surface observations since 29. January 2013



Black frame: Aladin domain
Red domain: Hirlam domain and common output domain

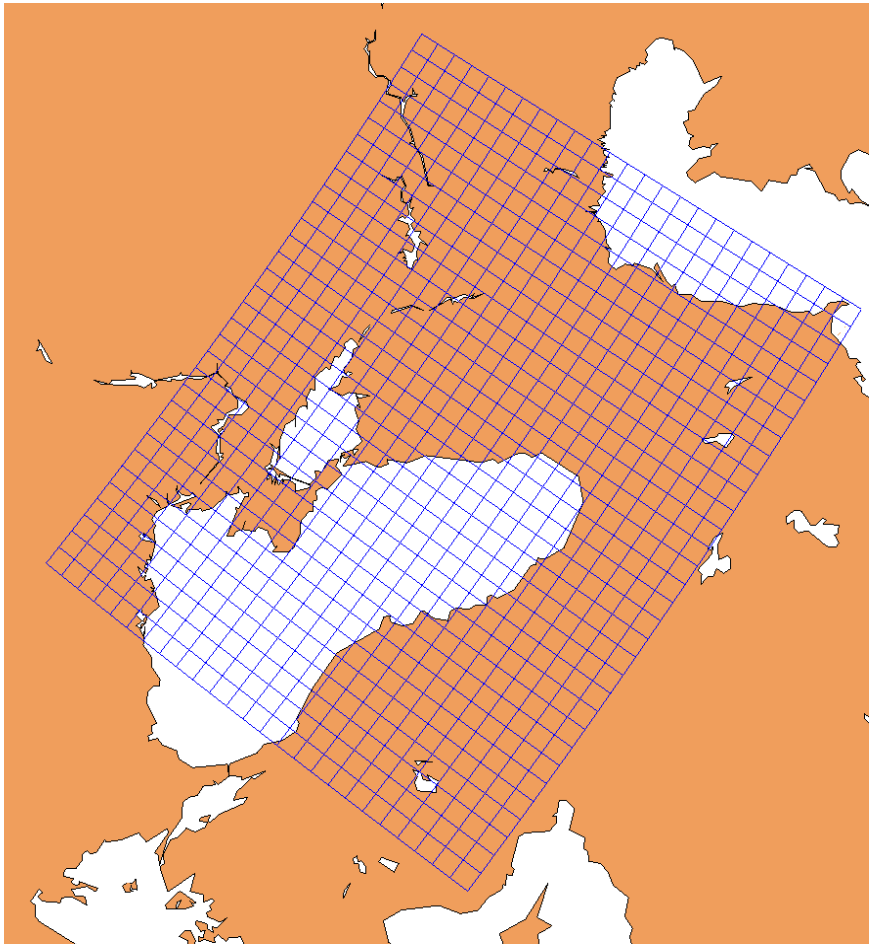
HarmonEPS: set-up

- A convection-permitting EPS, ~2.5 km for Sochi-area
- 2.5 km resolution
- +36 h lead time.
- 3D-Var and 6 h cycling for the control,
- HarmonEPS every 12 h, main hours 06UTC and 18UTC.
- Surface assimilation included for every member.
- 12 + 1 members, all with AROME
- Boundaries from IFS ENS, 6h old for 06UTC and 18UTC, fresh for 00UTC and 12UTC

- 2 week spinup of control before start of period

HarmonEPS

Integration area



640 x 500 points

HarmonEPS - runtime characteristics

- Total runtime 06- and 18 UTC (+36h) ~ 42-43 min. Total number of nodes: 301 (max).
- forecast part ~ 30 min., rest is assim., boundaries. etc.
- Each forecast on 22 nodes (each with 16 physical, 32 logical CPU's).
- nprocx=14, nprocy=25, and 2 OpenMP threads per MPI task
- (=hyperthreading, meaning 32 logical tasks per node, -> 16 MPI * 2 OpenMP).
- Forecast for each member using dedicated I/O server
- In addition one Listener-node (Listen4Makegrib) for each member.

FROST-2014: Forecast and Research in the Olympic Sochi Testbed

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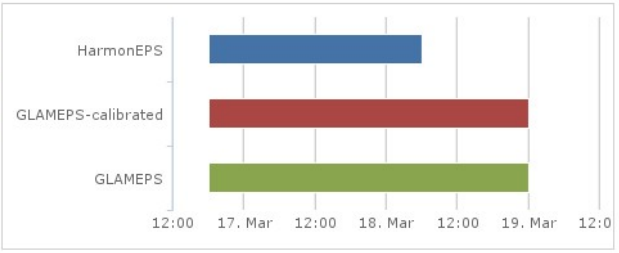
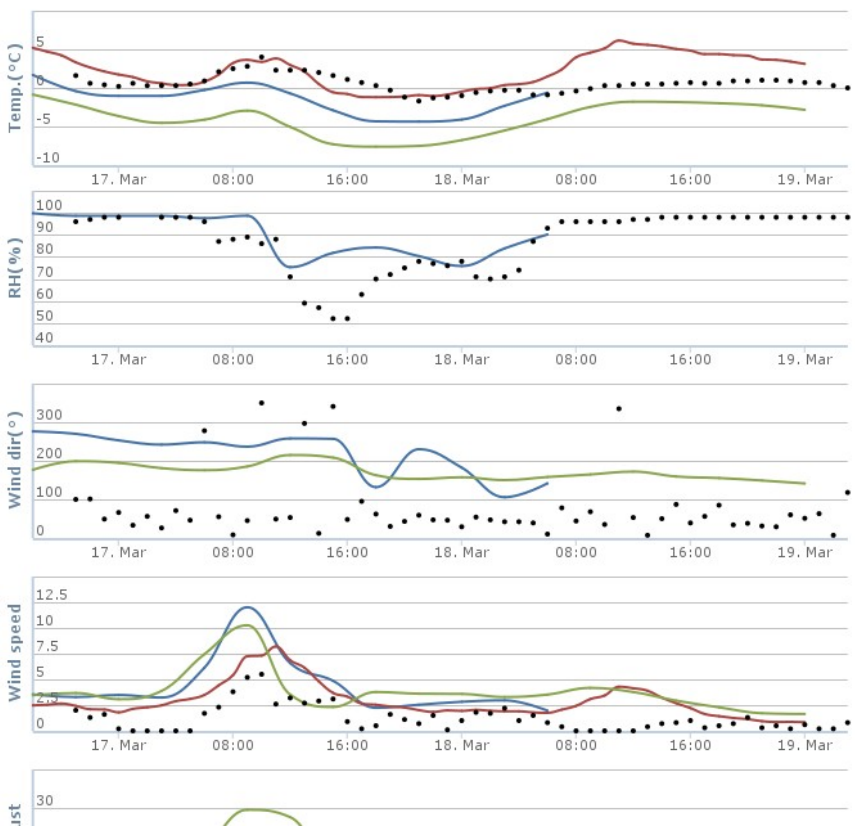
- Multi-system point forecasts
- Online monitoring of forecast quality
- Forecast maps for Sochi region (.png - version)
- Forecasts and observations for Sochi region on Google map
- COSMO-RU Deterministic Forecasts
- COSMO-RU2-EPS Meteograms
- COSMO-S14-EPS probabilistic forecasts (ARPA - SIMC)
- HIRLAM GLAMEPS forecast EPSgrams
- ALADIN-LAEF Epsgrams
- CARDS Nowcasts (Env. Canada)
- INTW Nowcasts (Env. Canada)
- ABOM Nowcasts (Env. Canada)
- Description of participating forecasting systems
- Other forecasts (in Russian)
- Forecast Bulletins Archive

Forecasts

Abbrevations used for the Forecasting Systems | **Locations of the AMSs** | **AMSs on Google Maps**

Model	Init time
HarmonEPS	2014-03-16 18:00:00
GLAMEPS-calibrated	2014-03-16 18:00:00
GLAMEPS	2014-03-16 18:00:00





- RKHU-1 (2320m)
- RKHU-3 (2043m)
- RKHU-8 (1740m)
- RKHU-4 (1580m)
- RKHU-7 (Finish, 980m)
- Snowboard-1025
- Freestyle-1080
- Biathlon-1500
- Biathlon-1400
- Biathlon Stadium
- Ski Stadium
- Nordic Combination-675
- Nordic Combination-615
- Ski Jump-650
- Ski Jump-800
- Sledge-830
- Sledge-700
- Krasnaya Poliana (Roshydromet)
- Kordon Laura (Roshydromet)
- Gornaya Karusel-1500 (Roshydromet)
- Gornaya Karusel-1000 (Roshydromet)
- Aibga (Roshydromet)
- Solokh-Aul (Roshydromet)
- Kichmai
- Imeretinka (Roshydromet)
- Agrostation Sochi (Roshydromet)
- Kepsha (Roshydromet)
- Lazarevskoye (Roshydromet)
- Adler-AMSG
- Magry (Roshydromet)

LOG OUT

Multi-system point forecasts
Online monitoring of forecast quality
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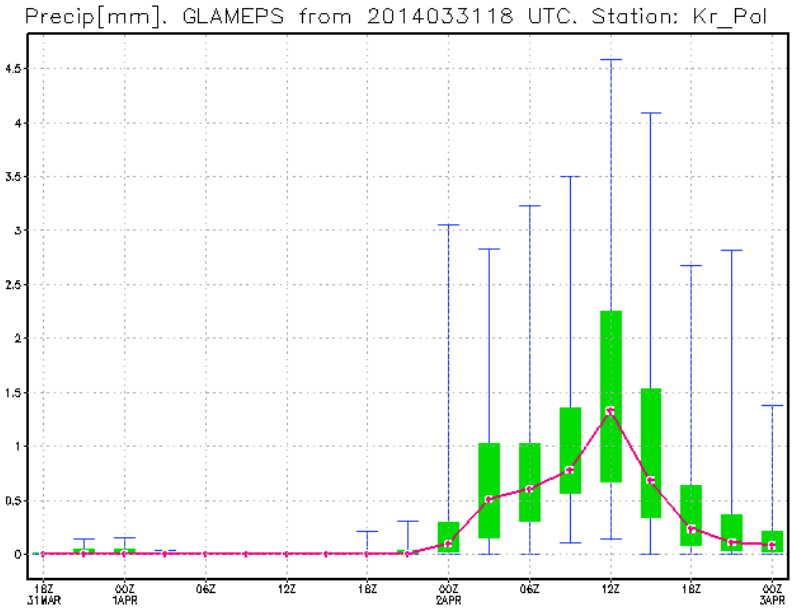
HIRLAM GLAMEPS forecast meteograms

Meteorological Element and Station Precipitation [mm/3hours] Krasnaya Polyana



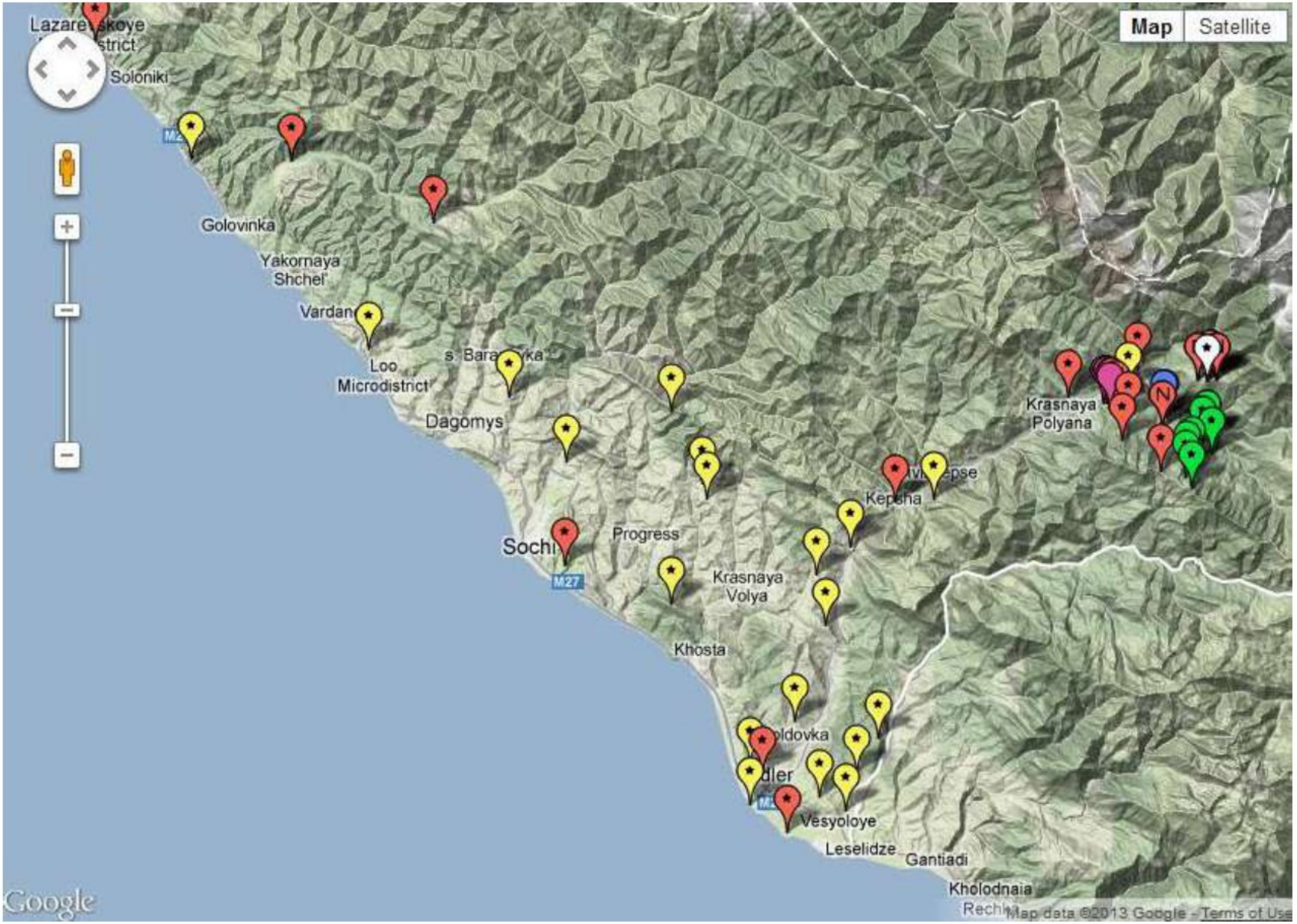
Red curve - forecast ensemble median;
Green bars - 50% confidence intervals (from 25% to 75% percentiles).

Performance of operational raw GLAMEPSv1 and prototype HarmonEPS for Sochi Winter Olympic Games

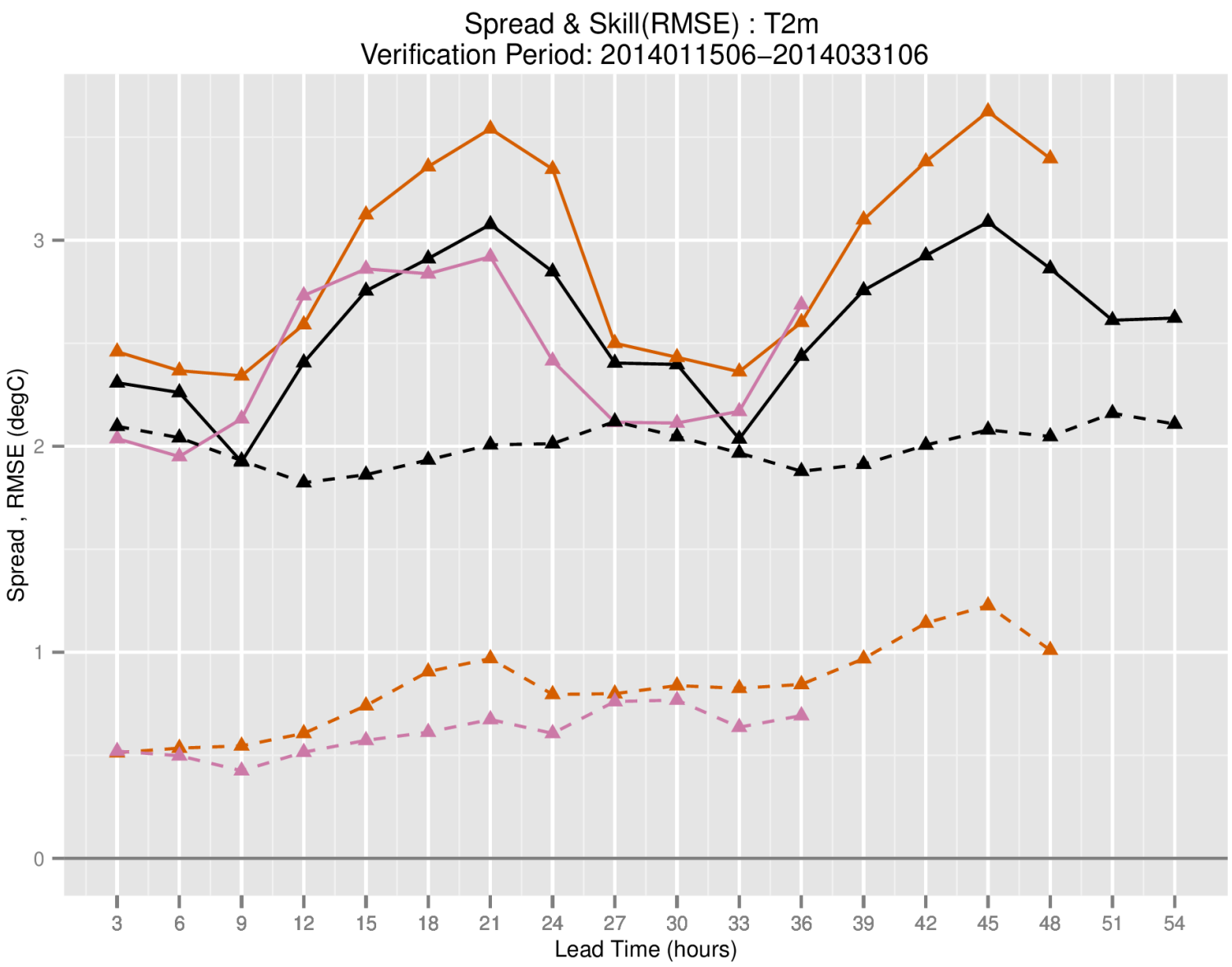
Computed against observations
and compared to IFS ENS

Using HARP

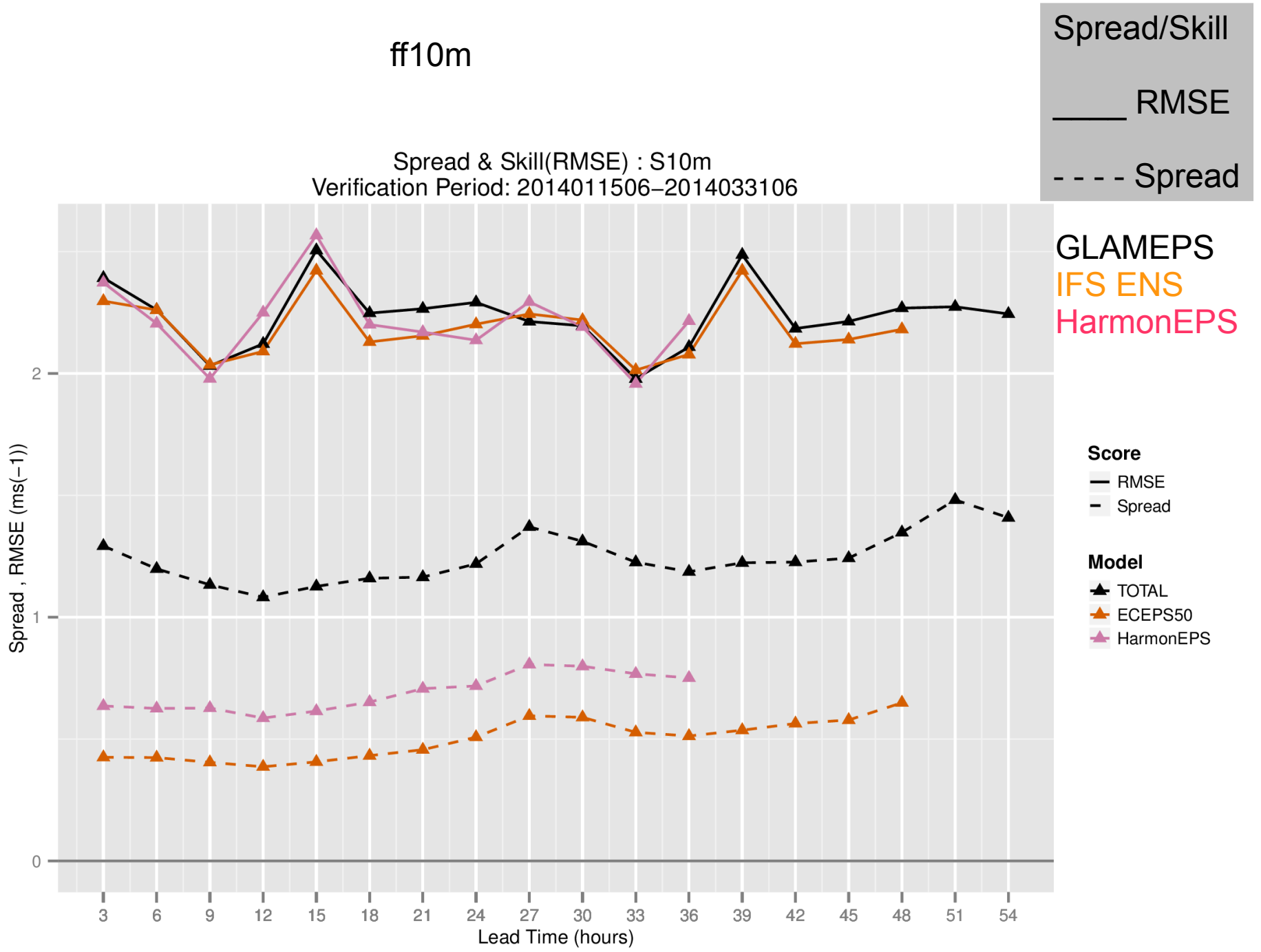
Today's network of meteorological stations in the region of Sochi

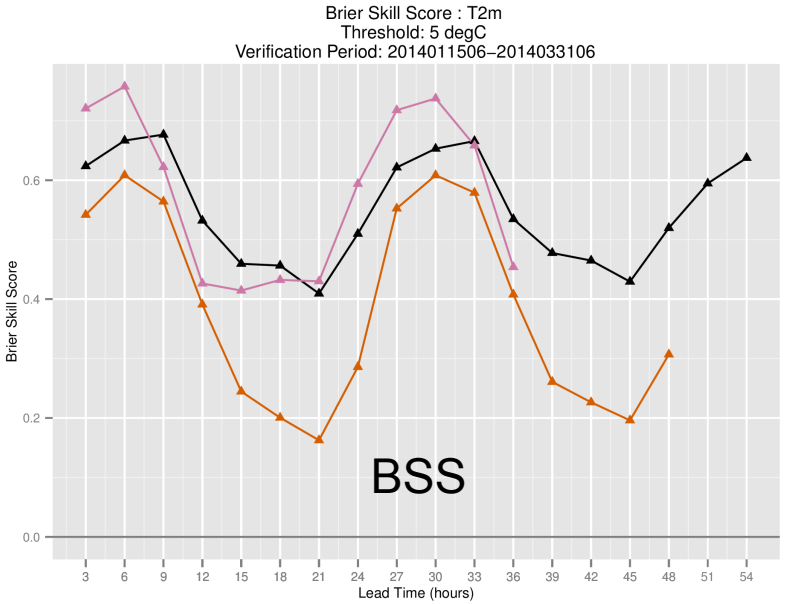


T2m


Spread & Skill(RMSE) : T2m
Verification Period: 20140115O6–20140331O6
Spread , RMSE (degC)
0
1
2
3
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
51
54
Lead Time (hours)
Spread/Skill
____ RMSE
- - - - Spread
GLAMEPS
IFS ENS
HarmonEPS
Score
RMSE
Spread
Model
TOTAL
ECEPS50
HarmonEPS

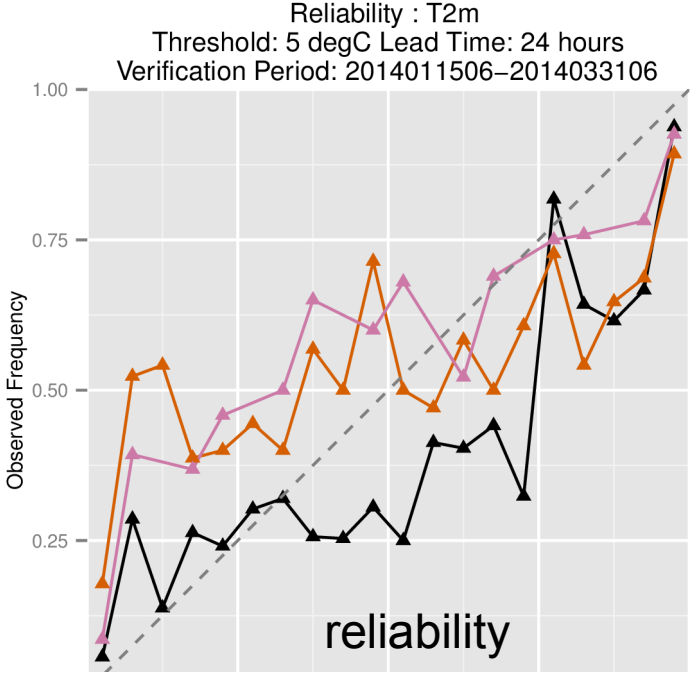
ff10m

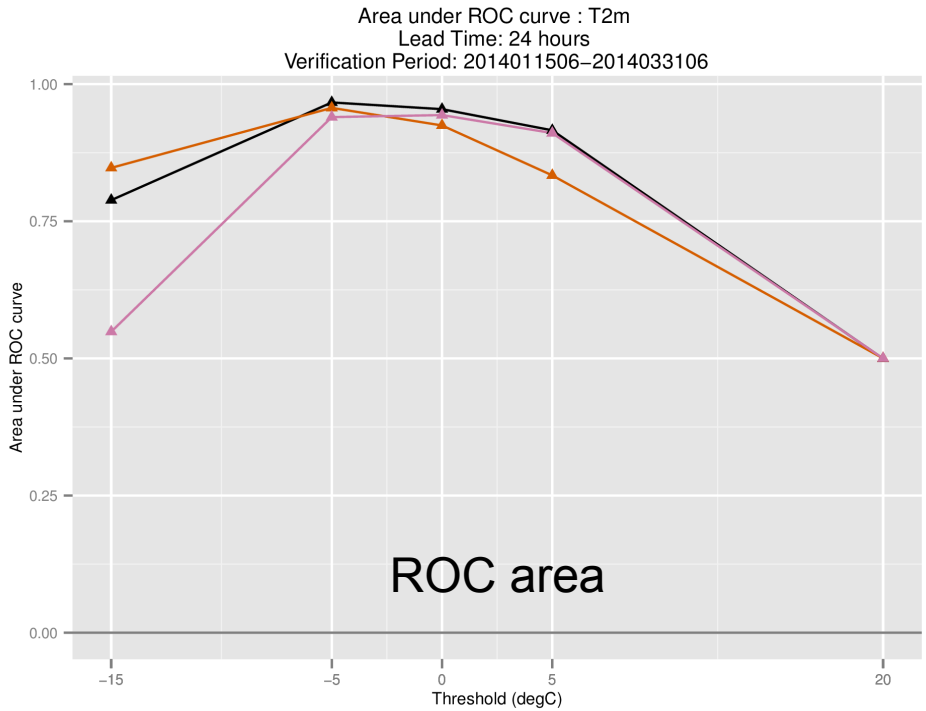

Spread/Skill
____ RMSE
- - - - Spread
Spread & Skill(RMSE) : S10m
Verification Period: 2014011506–2014033106
GLAMEPS
IFS ENS
HarmonEPS
Spread , RMSE (ms(−1))
0
1
2
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
51
54
Lead Time (hours)
Score
RMSE
Spread
Model
TOTAL
ECEPS50
HarmonEPS

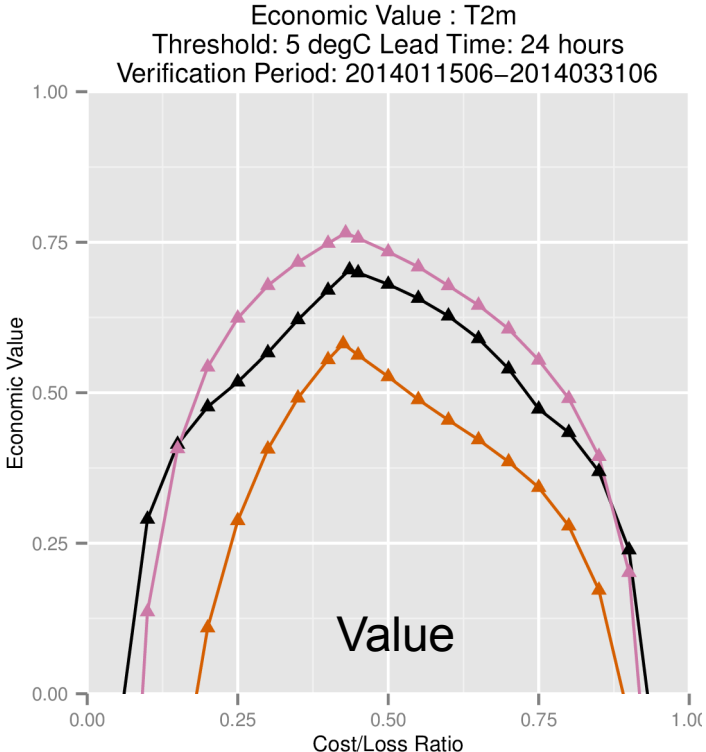


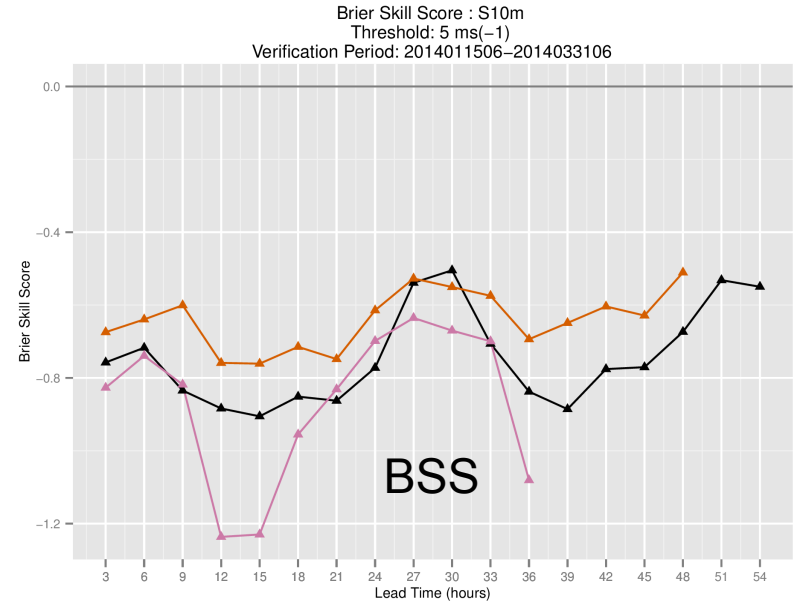
T2m
5 deg
+24h

GLAMEPS
IFS ENS
HarmonEPS



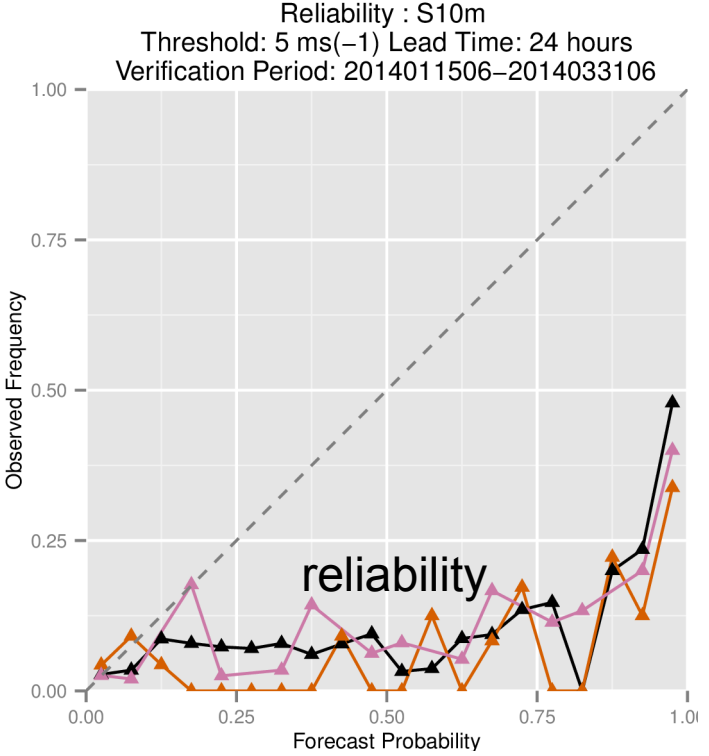


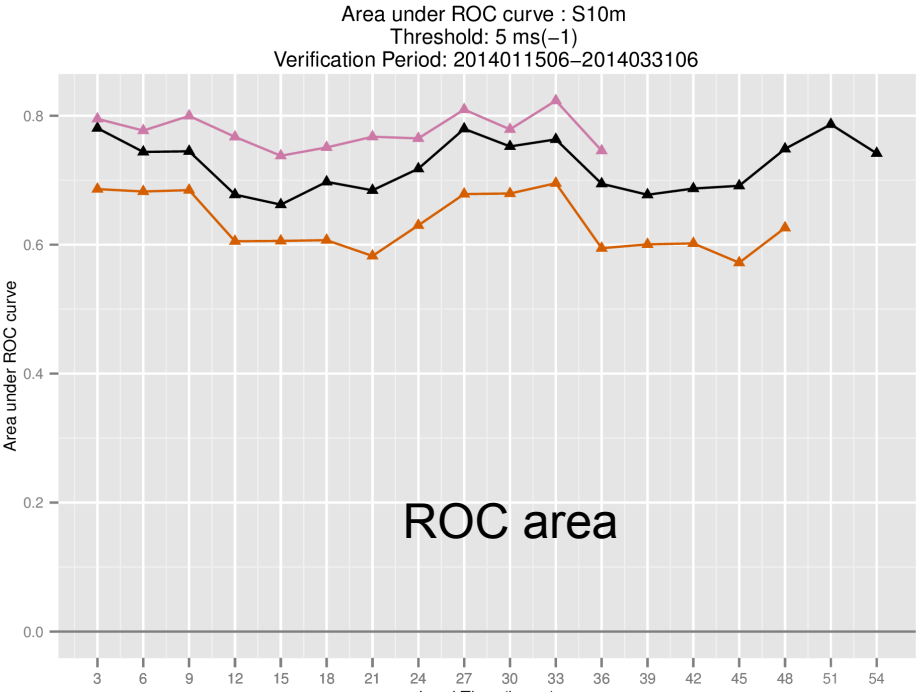


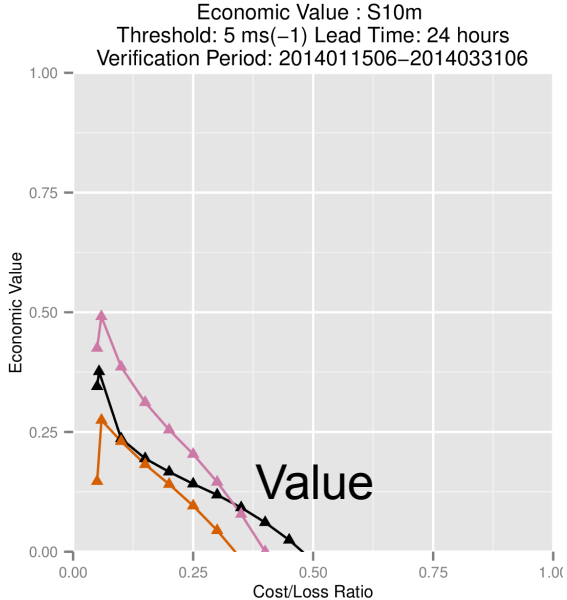


ff10m
5 m/s
+24h

GLAMEPS
IFS ENS
HarmonEPS

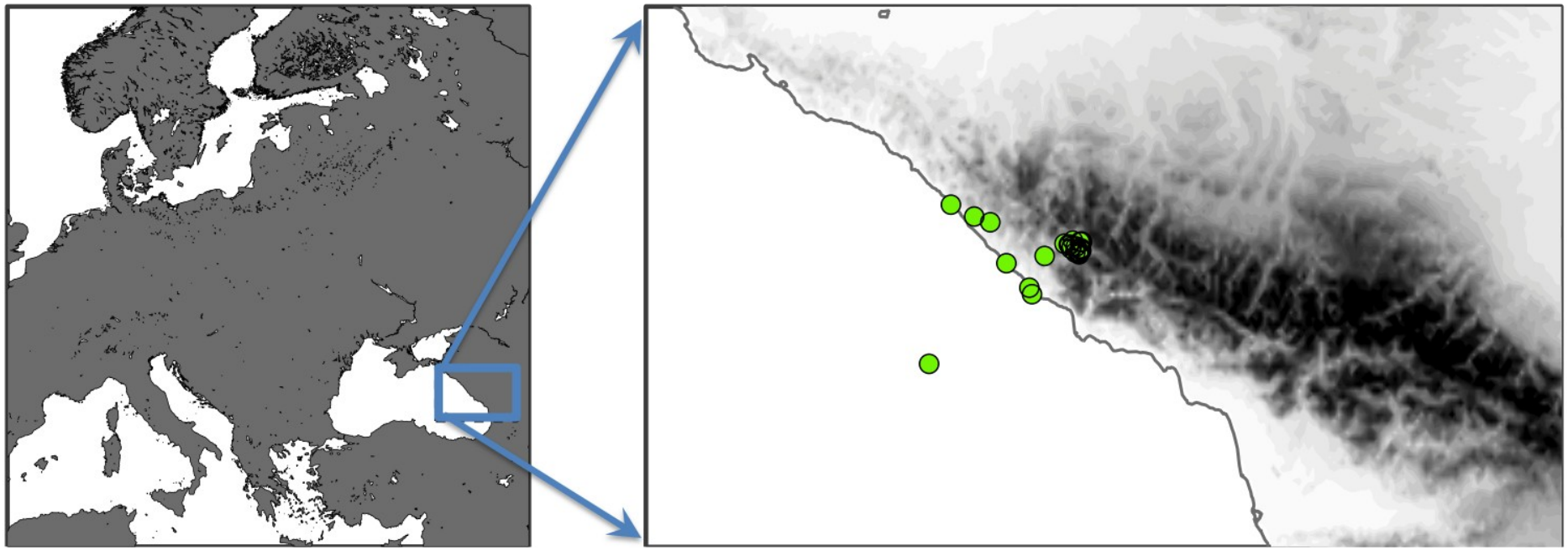






Calibrated GLAMEPSv1 for the Sochi Olympics

- Probabilistic forecasts for 31 locations
  - Temperature, winds, precipitation
  - Goal: Frequently updated forecasts - every hour!
  - 06 UTC runs, 20140115 - 20140331



Calibration method temperature:

- Correct bias by weighting the bias from the last couple of days
- Update with latest observation
- Adjust ensemble spread to be in line with RMSE

Calibration method wind:

- Correct by scaling up or down

Calibration method precipitation:

- Correct by scaling up or down

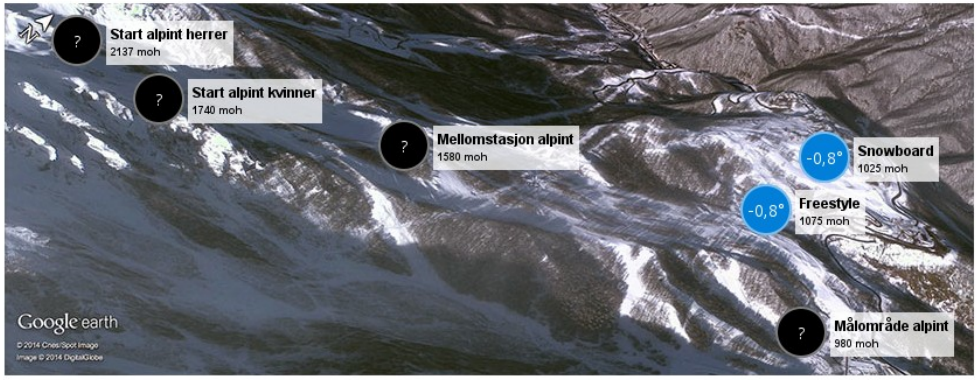
Calibrated GLAMEPSv1 on yr.no

YR.no

Langrenn/skiskyting – Laura skisenter

Tilbake til toppen av siden

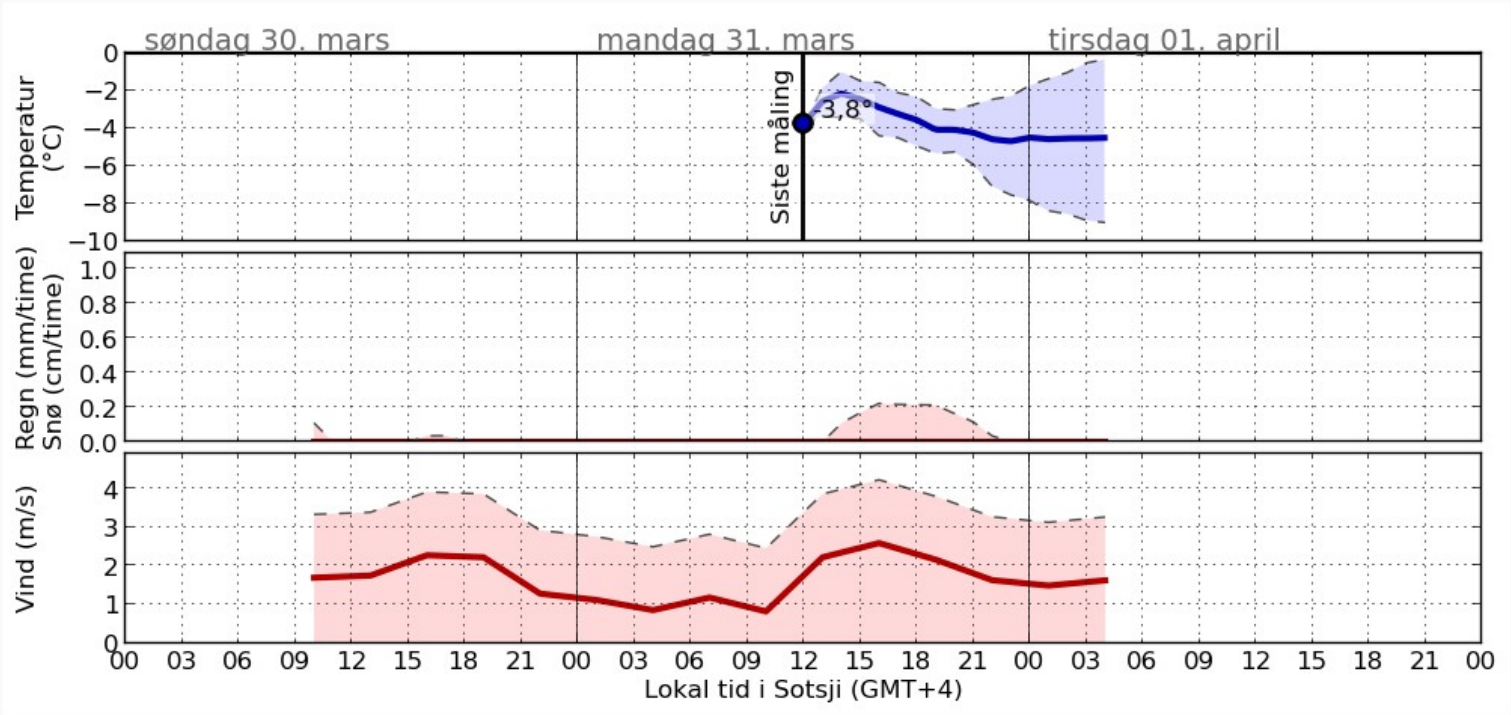
Alpine øvelser – Roza Khutor



Tilbake til toppen av siden

Hopp og kombinert – RusSki Gorki

Langrenn/skiskyting – Laura skisenter

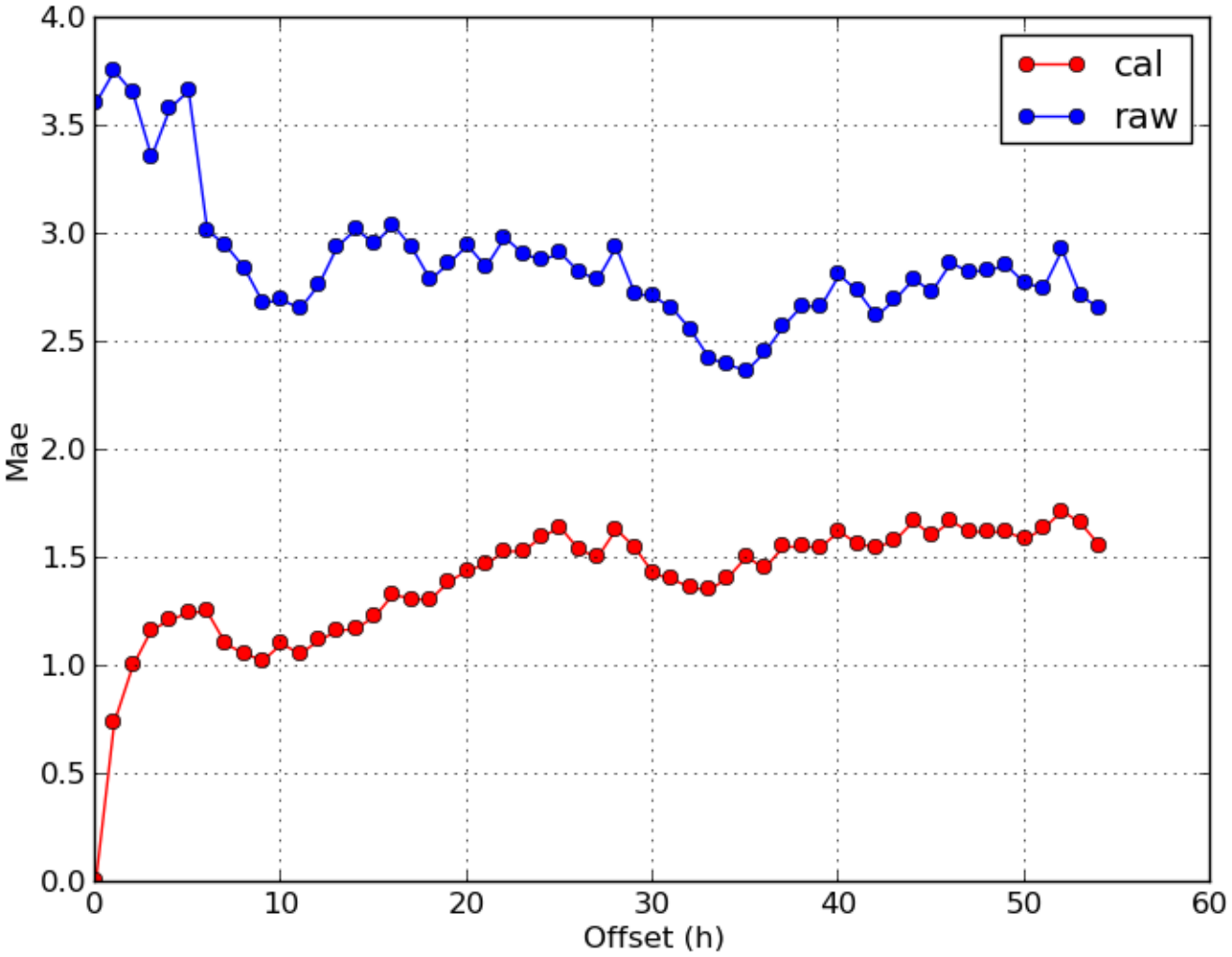


Langrenn/skiskyting – Laura skisenter – værvarsel for Løypepunkt 1 (1420 moh) :

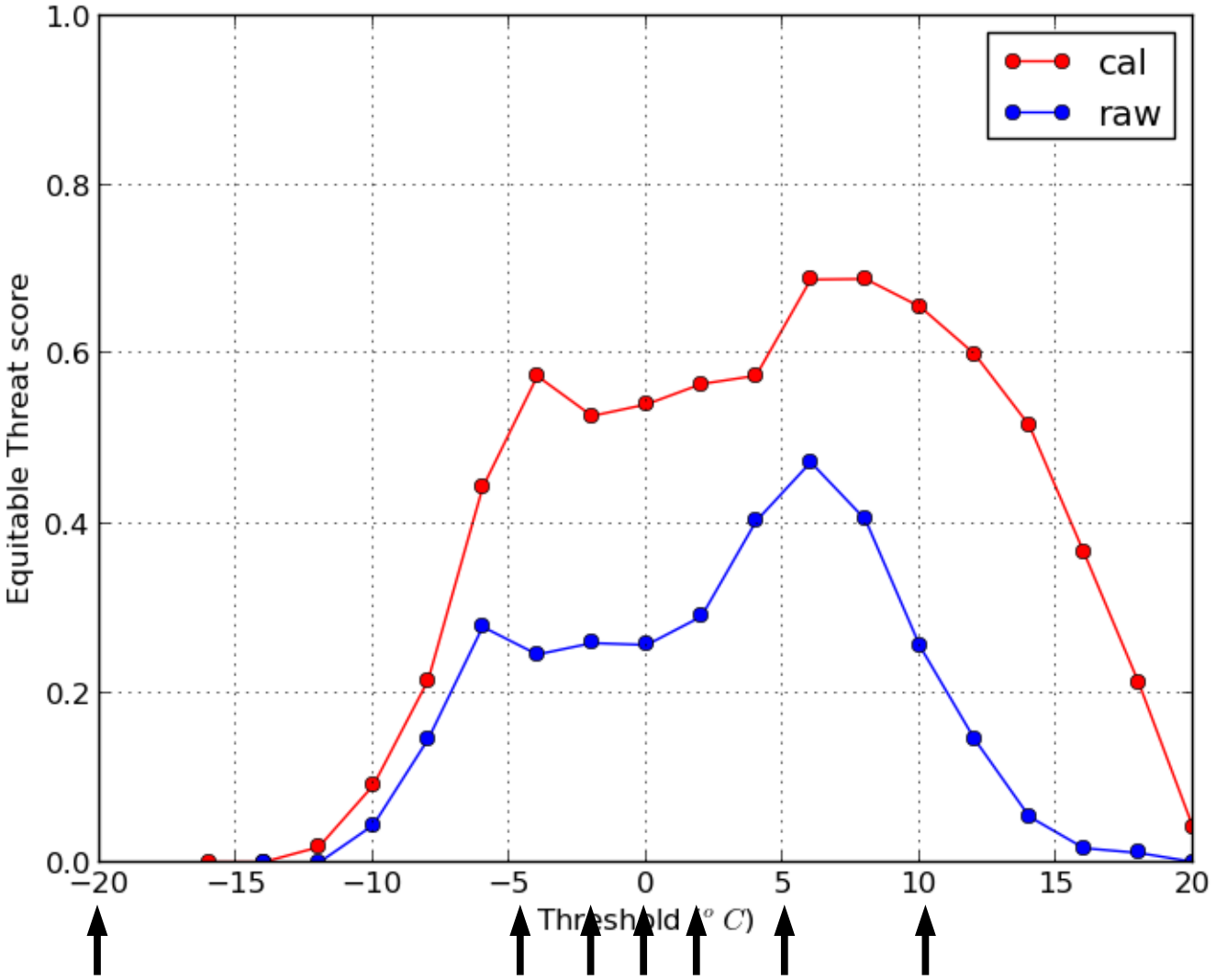
Grafene viser varsel for temperatur, nedbør og vind. Værmodellene oppdateres to ganger i døgnet, og i tillegg blir temperaturvarslene justert hver time basert på siste temperaturmåling.

Varselet er gitt med en heltrukken strek. Usikkerheten kan leses av grafen ved å sjekke de to tynne røde strekene/det lyserøde feltet. Systemet varsler at temperaturen vil havne mellom de to verdiene de tynne strekene angir med 90 % sannsynlighet.

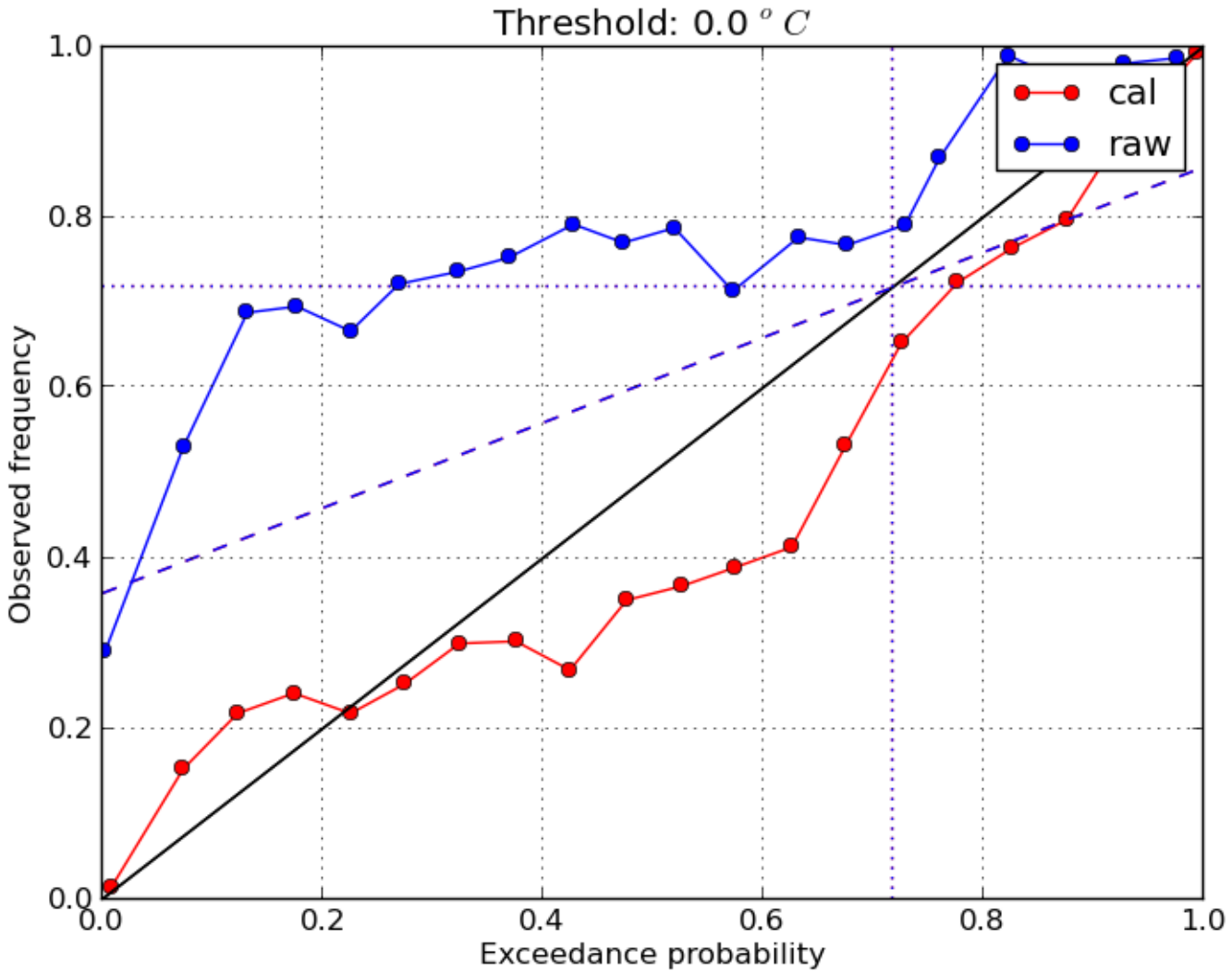
Temperature - mae



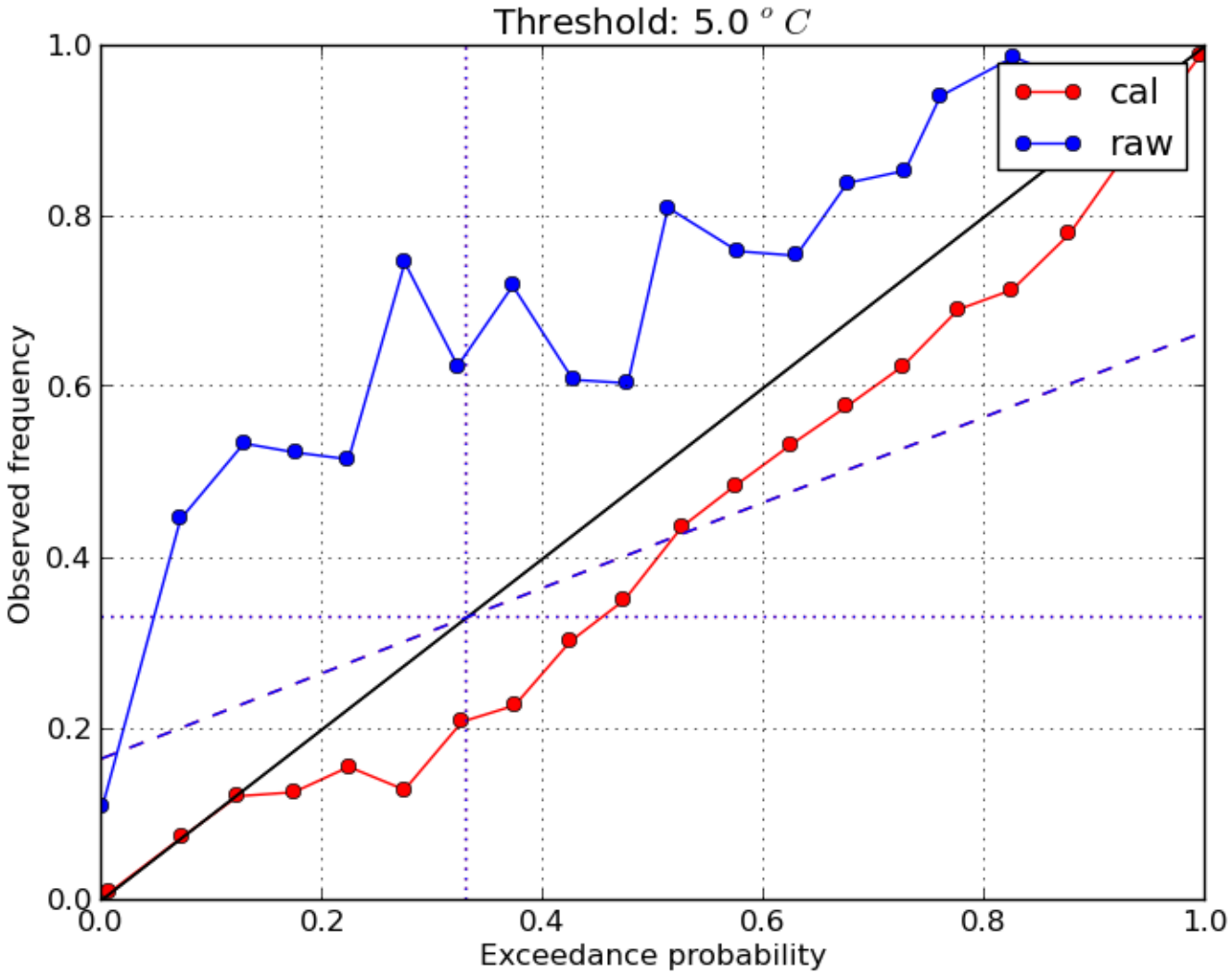
Temperature - ETS



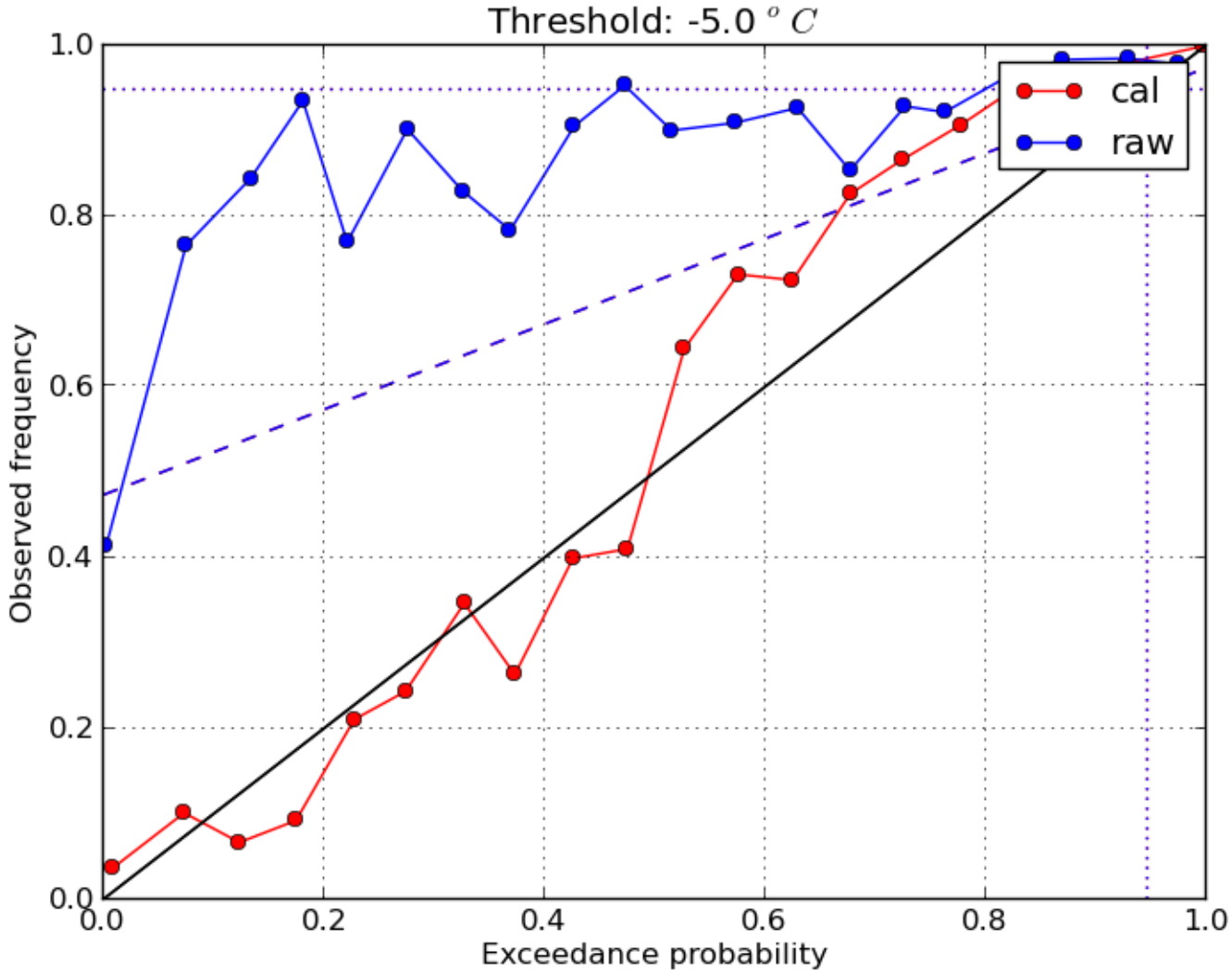
Temperature – reliability 0



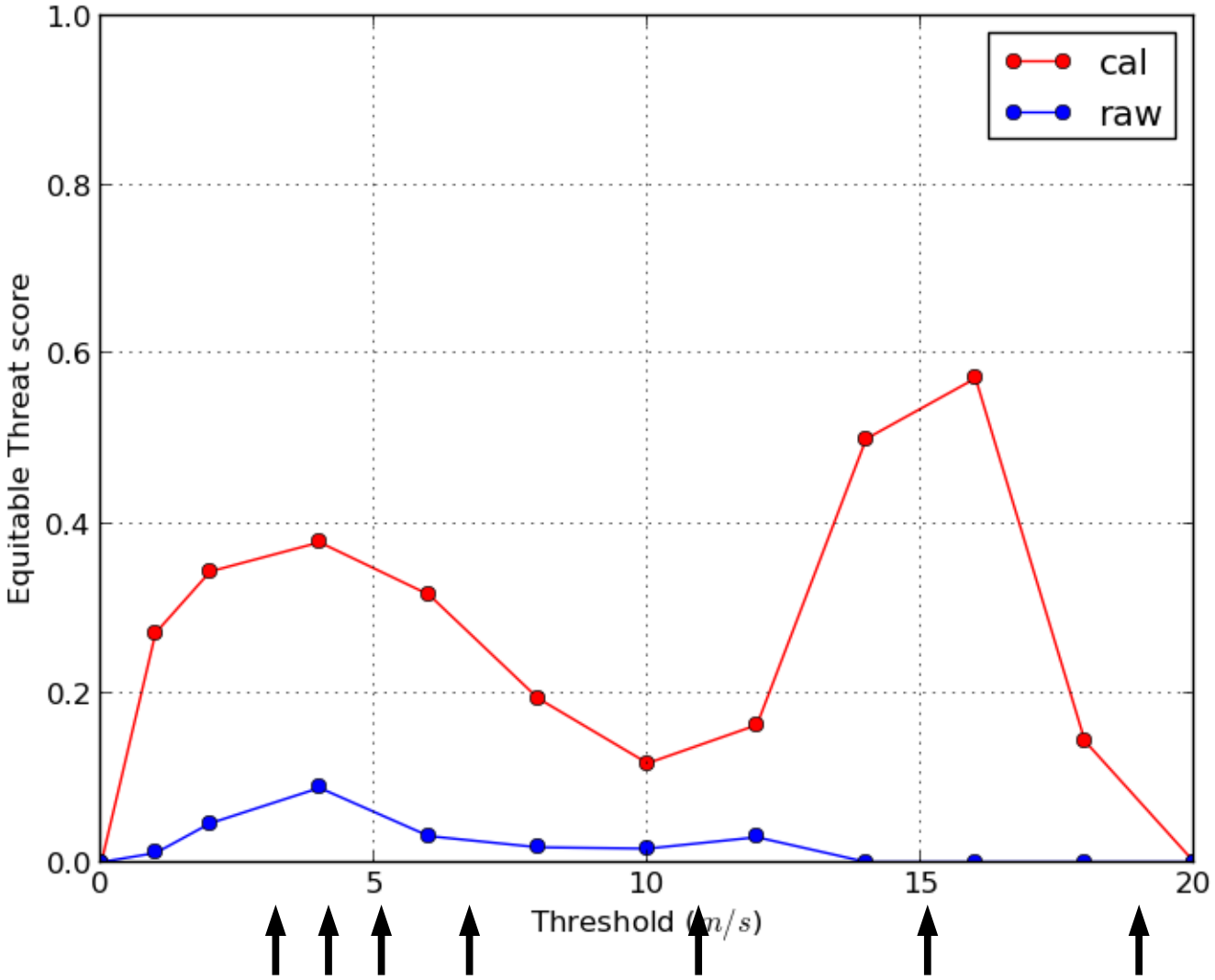
Temperature – reliability 5



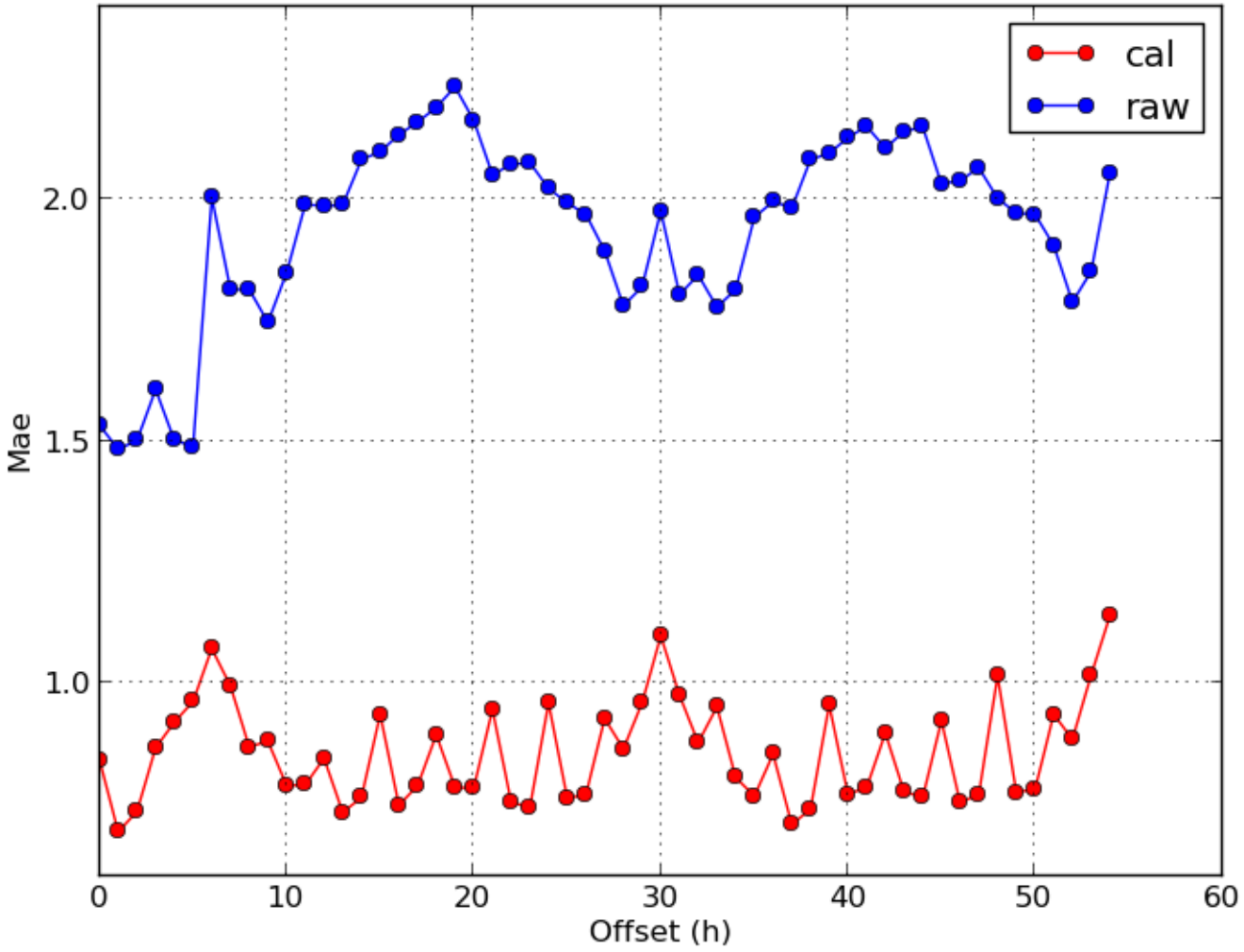
Temperature – reliability -5



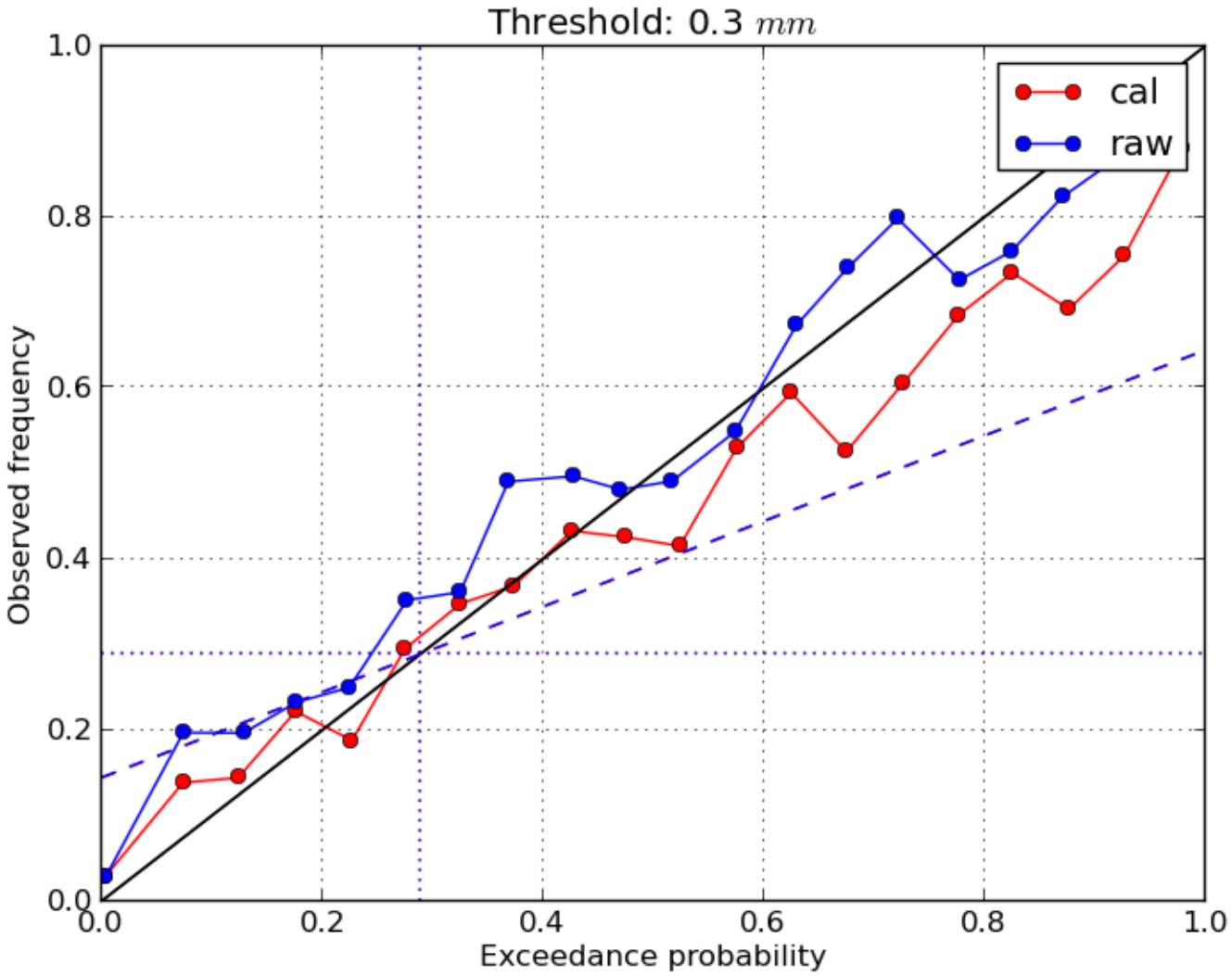
Wind speed – ETS



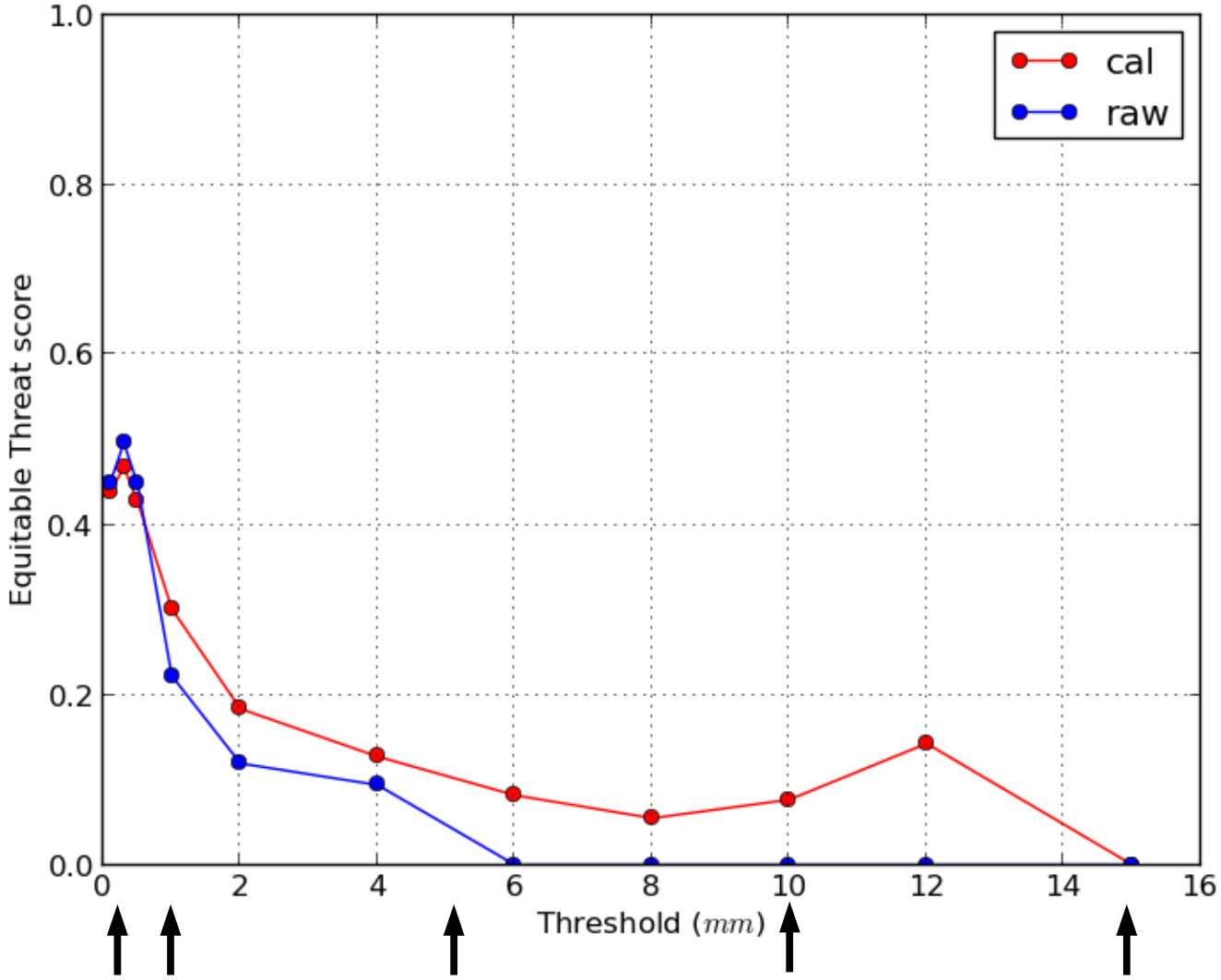
Wind speed – mae



Precipitation – reliability



Precipitation – ETS



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2012:
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•Calibration of EPS forecasts (RDP).

DONE!

2013:
•Run HarmonEPS for the area of Sochi and provide output
•Calibrated forecasts for venues

HIRLAM (EPS) contribution to FROST

But still to do:

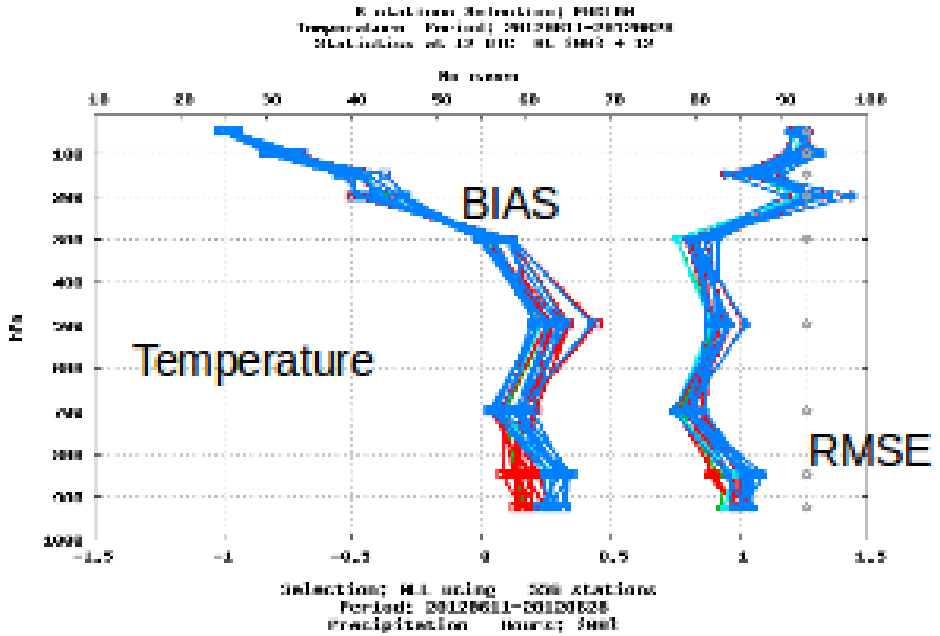
- Run Alaro component
- Rerun with surface perturbations
  - Idea: use difference between HarmonEPS 2.5 km and Harmonie 1km (Sami) field of eg soil moisture as perturbation (– but area is smal).
- And last but not least: Analyze results

HarmonEPS: status of CA development

The challenge with cumulus param. Addressed with a cellular automata scheme

- Need to describe the upward transport of heat, water vapour and momentum in terms of the grid column profile of wind, temperature and humidity - IMPOSSIBLE!
- Can only hope to represent the average effect of many cloud lifecycles
- Maybe use random numbers to mimic statistical fluctuation in cloud numbers and intensities?
- Spatial organization extends across many grid-boxes. How could we represent that? And does it matter to the forecast model?
- A stochastic parameterization with lateral communication using cellular automata has been developed to address the above challenges. (Bengtsson et. al, 2013)

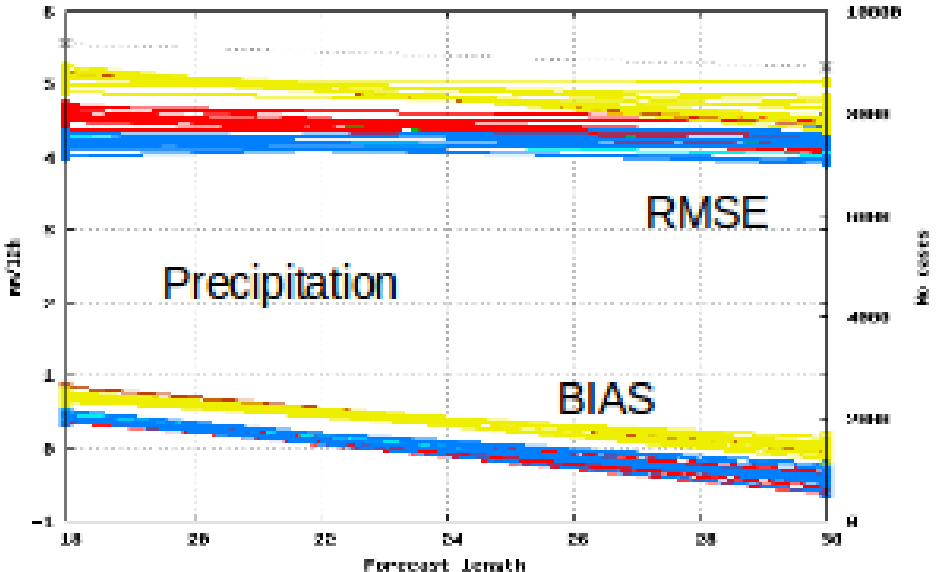
HARMON-EPS with CA-scheme



ALARO members

ALARO members + CA

CA scheme reduces warm bias of all the members in the boundary layer, while maintaining the spread.



ALARO members

AROME members

ALARO members + CA

HARMON-EPS with CA-scheme

- The CA-scheme improves temperature and humidity profiles in the boundary layer, while maintaining good spread.
- The CA-scheme degrades the total precipitation compared with the reference. Could further tuning help? Is the scheme needed at 2.5 km?

Thank you

HarmonEPS: Perturbation strategies

Initial condition perturbations:

- Perturbations from EC EPS
- Humidity perturbations: humidity in SVs, use of MSG cloud mask
- hybrid 3D-VAR: end 2014. Exps with nr of ens members, domain size.
- => 4DEnVAR

Lateral boundary perturbations:

- Tested EPS (T639) vs EPS (T1279)
- Difference between deterministic runs / SLAF

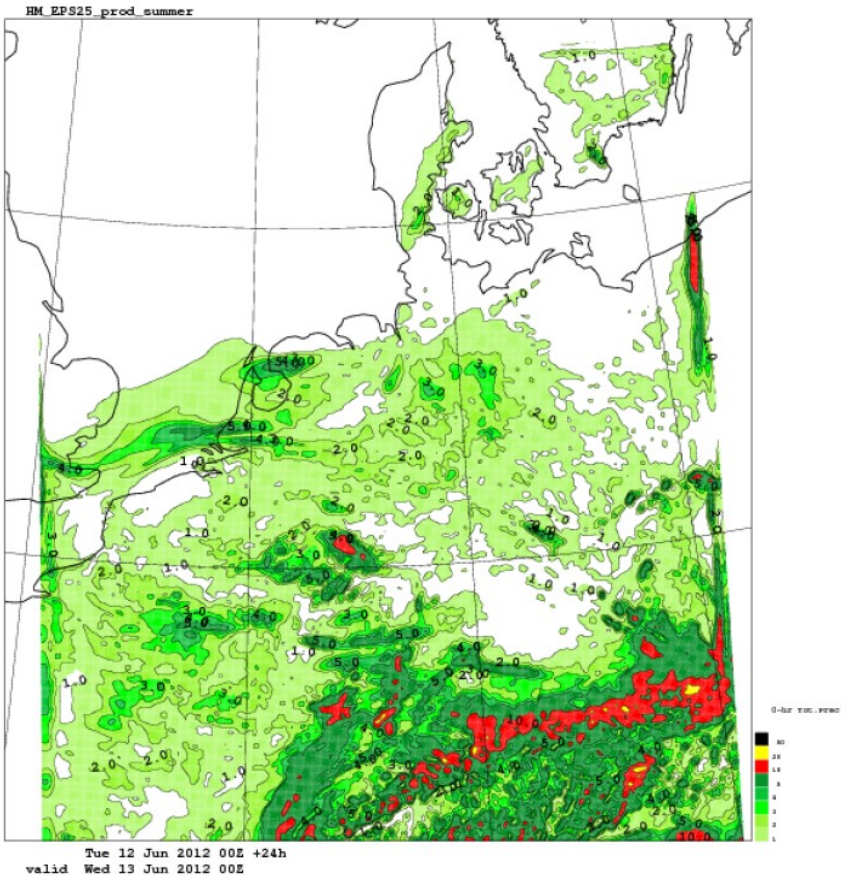
Model error

- Multi-physics
- SPPT
- physics parameter perturbations: learn from experiences LAEF
- stochastic perturbations in several (microphysics, cloud) parametrizations
- Introduce "stochastic physics" on process level, rather than multiplying the total physical tendencies
- Use Cellular Automata (CA)

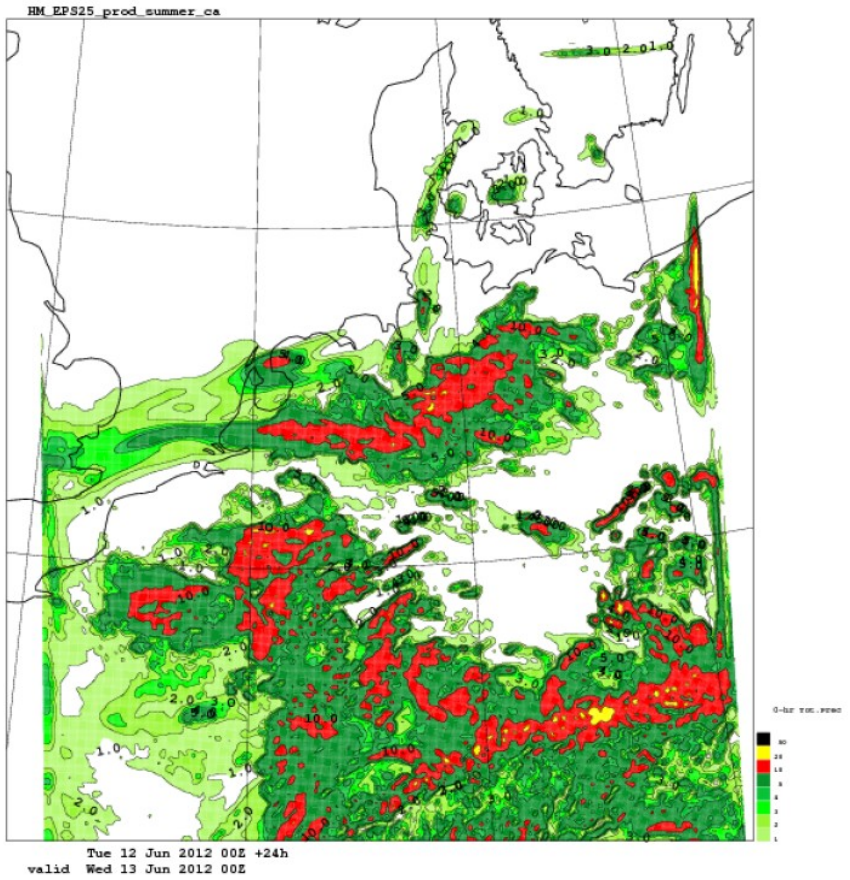
Surface perturbations: soil moisture, snow, SST, exchange coefficients

SPREAD 24 h acc. precip

Reference



With CA scheme



CA seems to be too active at 2.5 km, needs tuning of time/space scales and CAPE threshold