More than just a verification package

Andrew Singleton (MET Norway), Alex Deckmyn (RMI), Christoph Zingerle (ZAMG), Bent Hansen Sass (DMI)

So, is this HARPv3?

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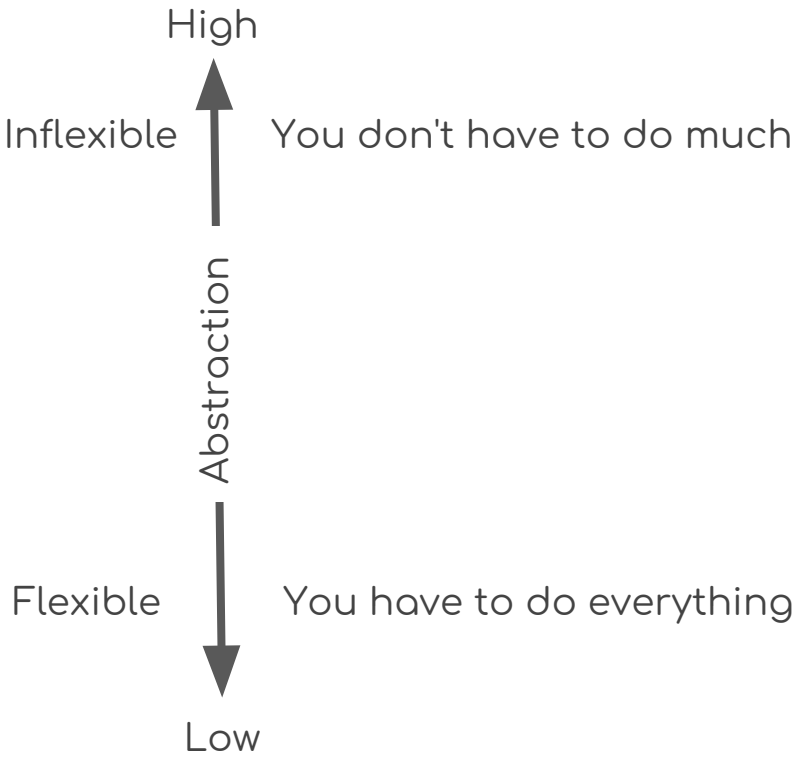
It's harp [as in not HARP]

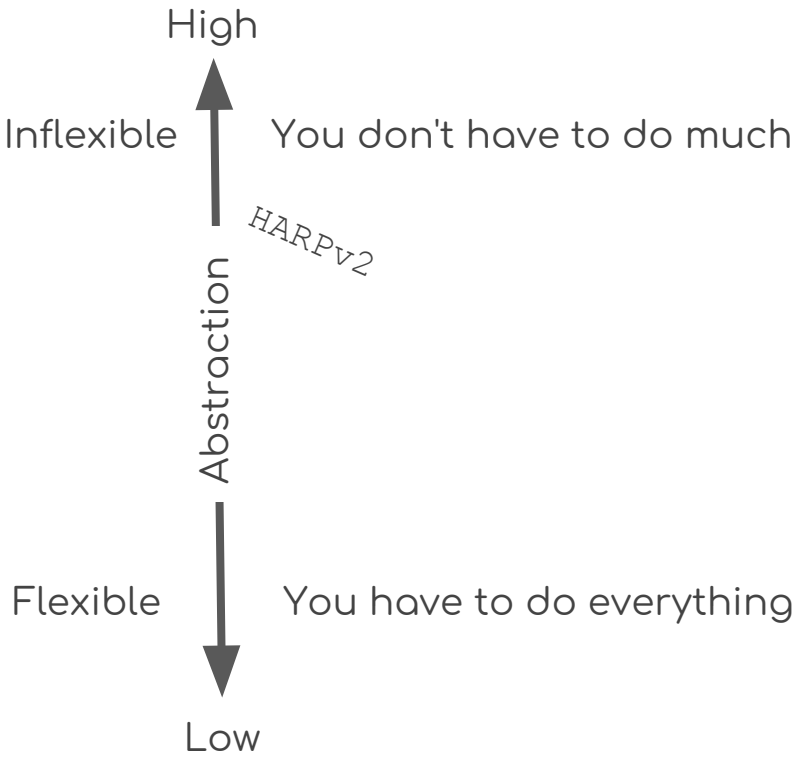
harp refers to a set of R packages that are designed to fulfill tasks related to specific themes. Each harp package has its own version control. harp itself is a collection of packages or an **ecosystem**.

What's different from HARPv2 ?

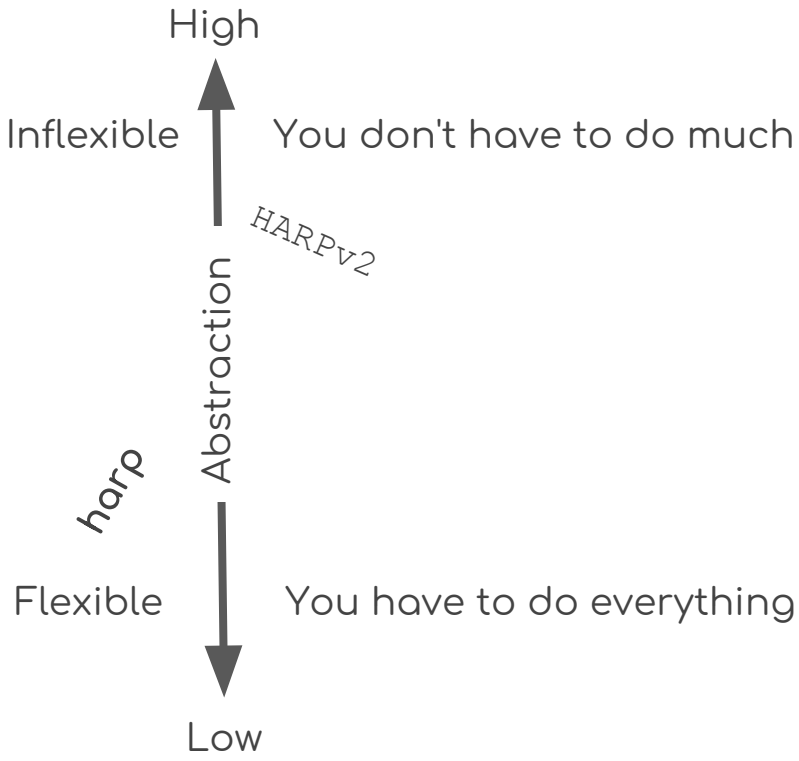
Abstraction Continuum / Spectrum



Abstraction Continuum / Spectrum



Abstraction Continuum / Spectrum




harp

Data IO & interpolation

Data IO & interpolation

Data IO & interpolation

Point
verification and wrangling

Data IO & interpolation

Point
verification and wrangling

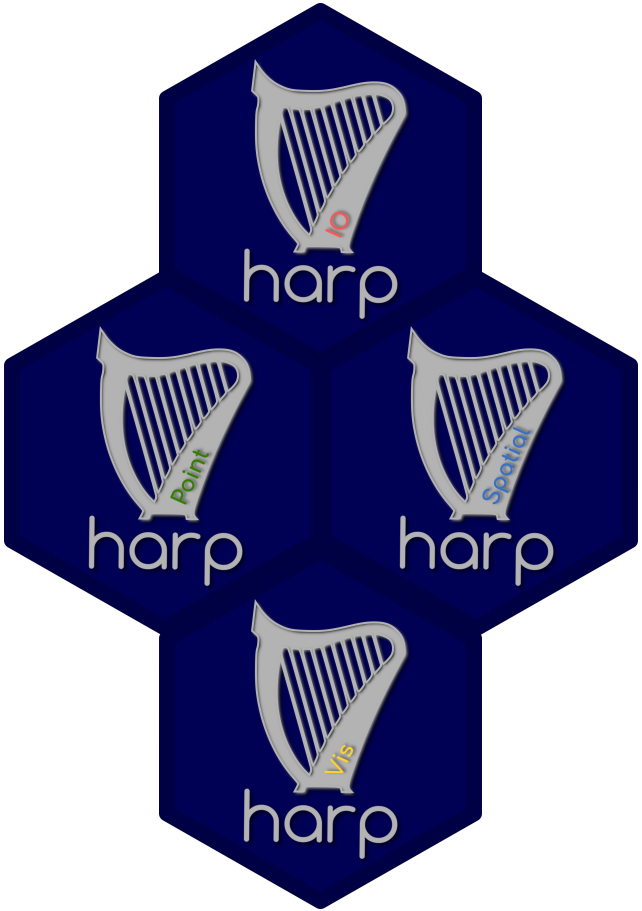
Data IO & interpolation

Point
verification and wrangling

Spatial
verification and wrangling

Data IO & interpolation

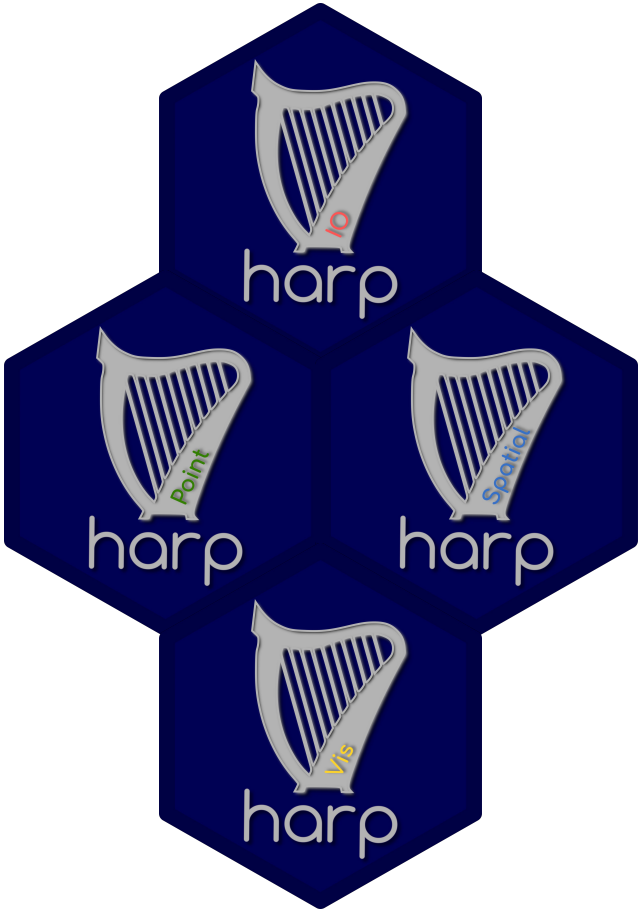
Point
verification and wrangling



Spatial
verification and wrangling

Data IO & interpolation

Point
verification and wrangling



Spatial
verification and wrangling

(Interactive) data visualisation


io
harp

Forecast formats

Grib (1 & 2)

FA

netCDF (currently MET Norway only for interpolating)

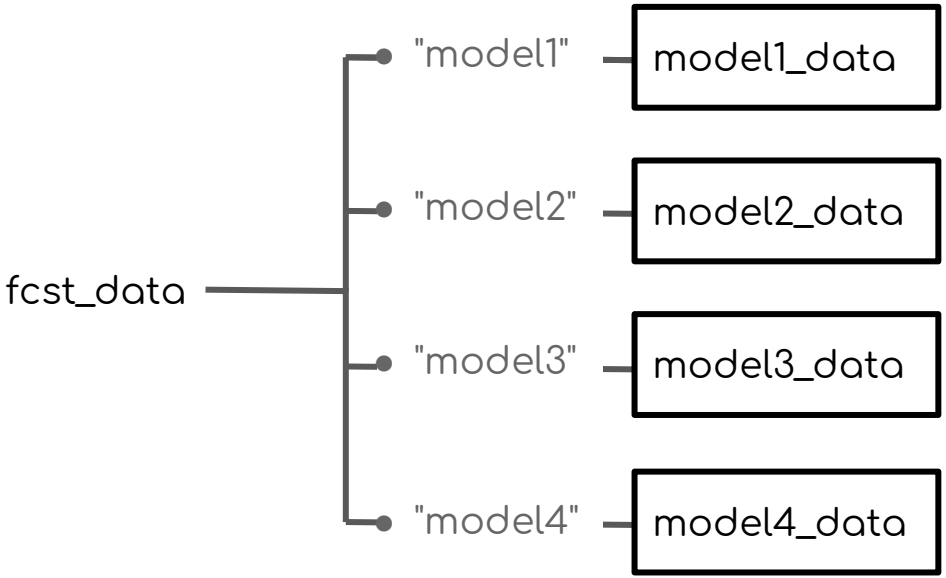
vfld

SQLite

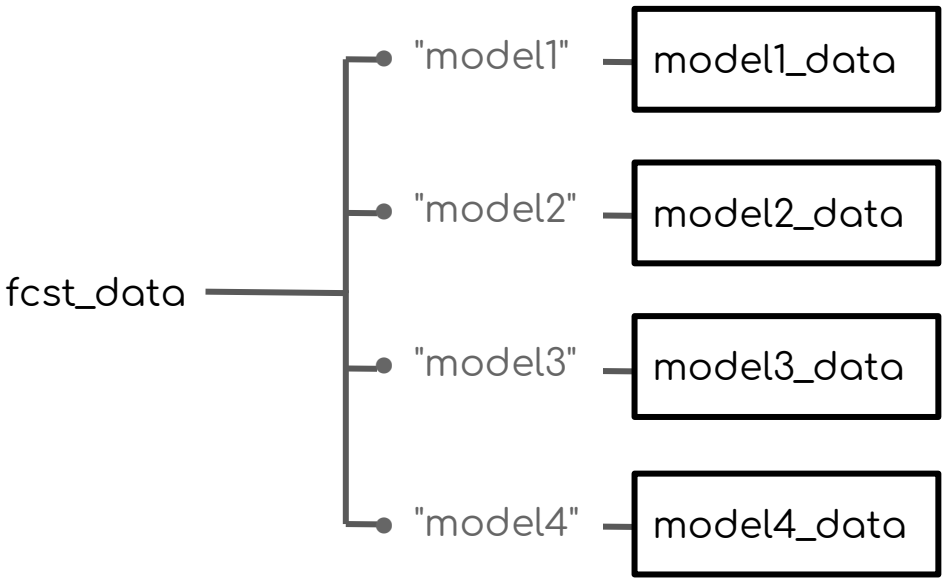
Generic read/write functions


```
read_eps(...) / read_eps_interpolate(...) / read_eps_profile(...)

read_det(...) / read_det_interpolate(...) / read_det_profile(...)

read_point_forecast(...) / read_profile_forecast(...)
```

Data structure



Data structure



Methods

- ❏ filter
- ❏ select
- ❏ mutate
- ❏ transmute
- ❏ arrange
- ❏ join

- ❏ select_members
- ❏ lag_forecast

Observation formats

Point observations	Spatial observations
vobs	HDF5
SQLite	INCA
BUFR (currently MET Norway only)	netCDF

Generic read/write functions


```
read_obs_convert(...) ##For point observations

read_point_obs(...) / read_profile_obs(...)

read_???(...) ##For spatial observations
```


Point
harp

Point verification


```
ens_verify(...)

det_verify(...)
```

Point verification

```
ens_verify(...)

det_verify(...)
```

Get categorical scores by adding thresholds

```
ens_verify(..., thresholds = seq(-10, 20, 5))

det_verify(..., thresholds = seq(-10, 20, 5))
```

Point verification

```
ens_verify(...)

det_verify(...)
```

Aggregate scores in any way using groupings

```
ens_verify(..., groupings = c("leadtime", "fcst_cycle", "SID"))

det_verify(..., groupings = c("leadtime", "fcst_cycle", "SID"))
```

Take account of errors

Error bars and statistical significance of differences by bootstrapping

```
bootstrap_score(..., ens_crps)
```

Observation errors

```
jitter_fcst(..., function(x) x + rnorm(1, 0, 0.5))

check_obs_against_fcst(...)
```

Take advantage of parallel processing


```
library(furrr)

parameters <- c("T2m", "RH2m", "Pmsl", "AccPcp3h")

plan(multiprocess)

verif <- future_map(
    parameters,
    ~ens_read_and_verify(
        ...,
        parameter = .x
    )
)
```


Vis
harp

Forecast time series for EPS

Spaghetti plots

Ribbon plots

Box whisker plots

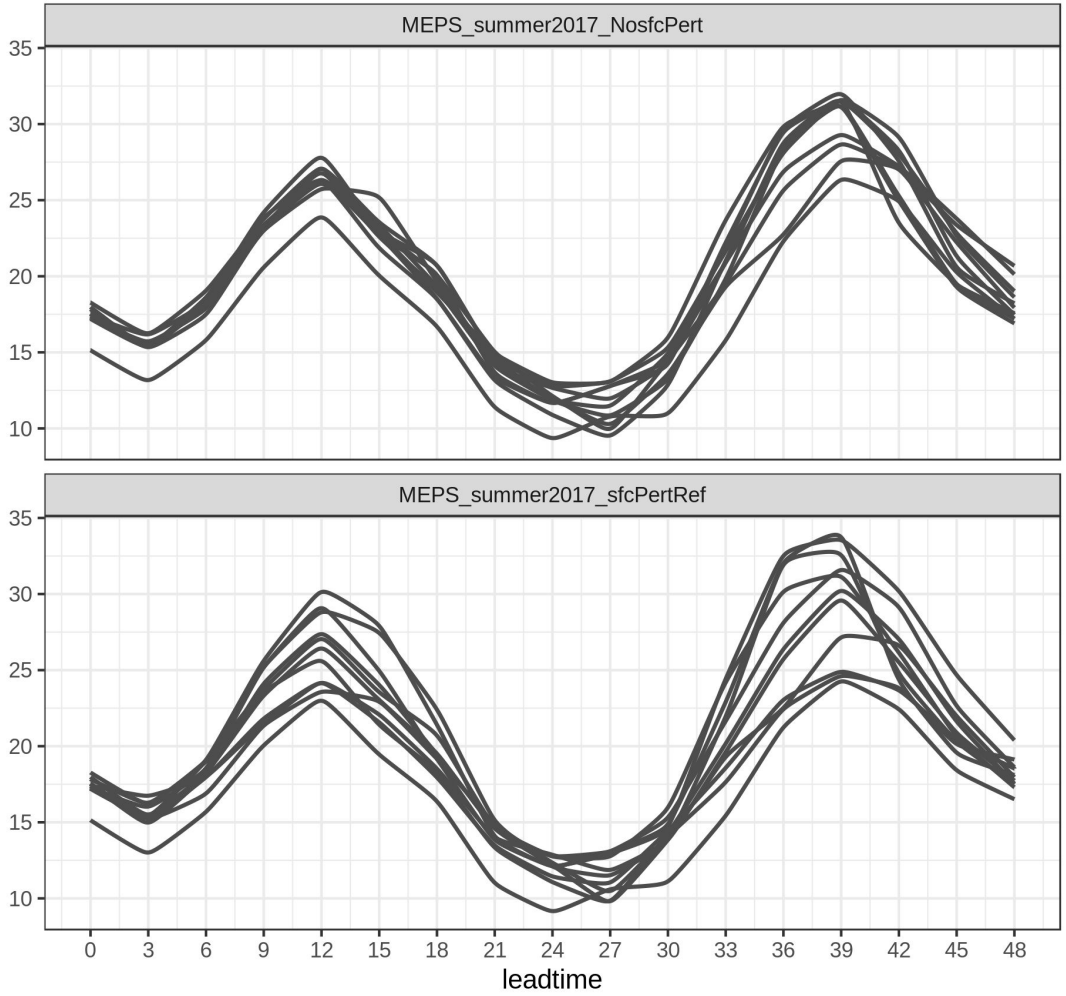
Violin plots

HOPs

Ridgeline plots

Stacked probability (bar / area)

```
plot_station_eps(..., type = "...")
```


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
35
30
25
20
15
10
0
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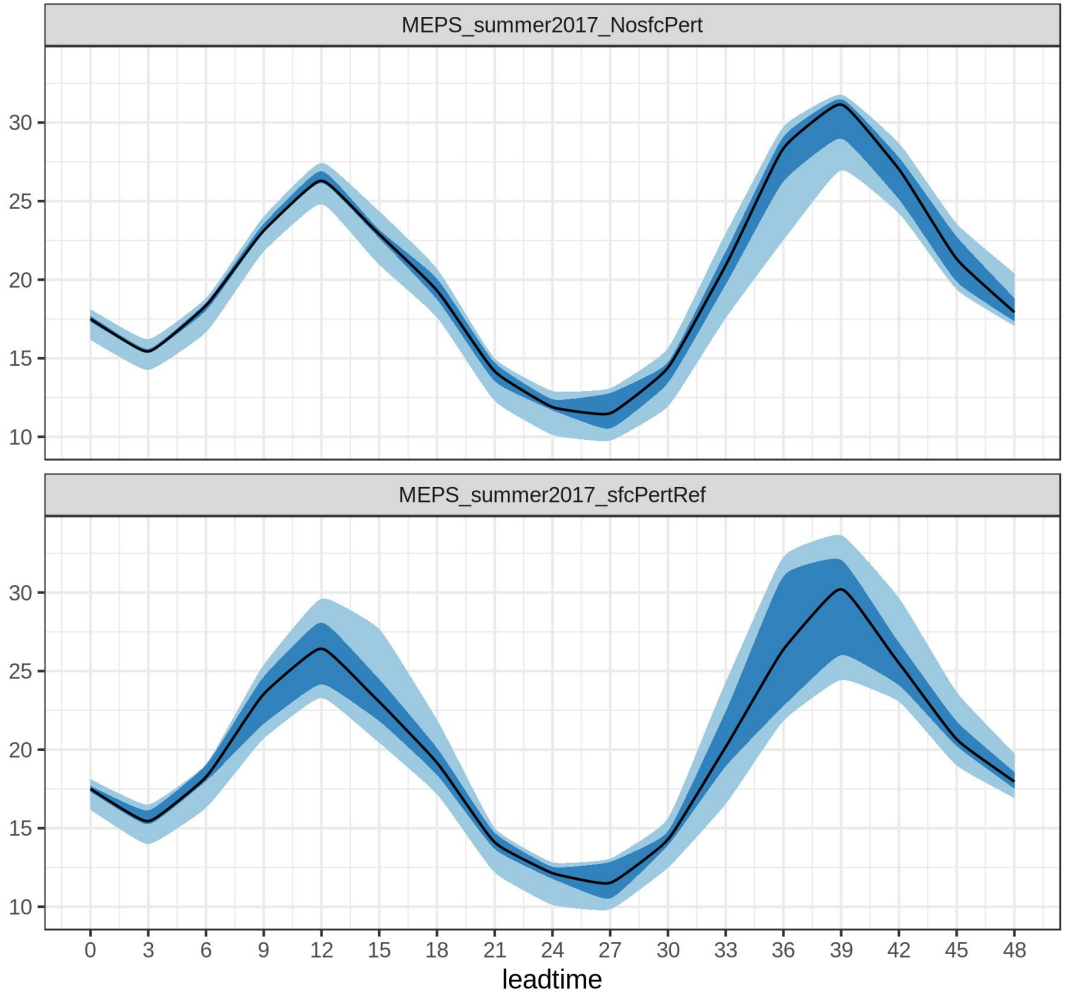
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
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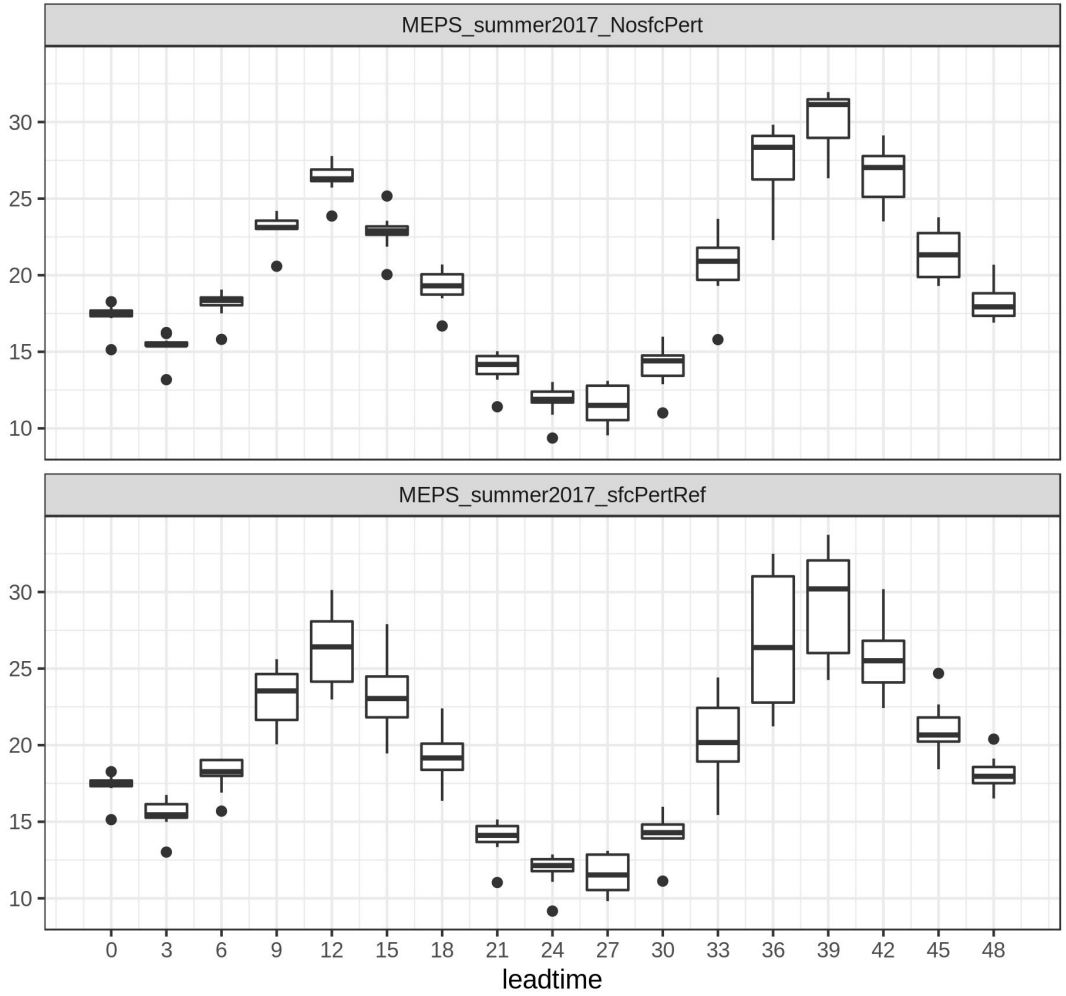
42
45
48
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
30
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36
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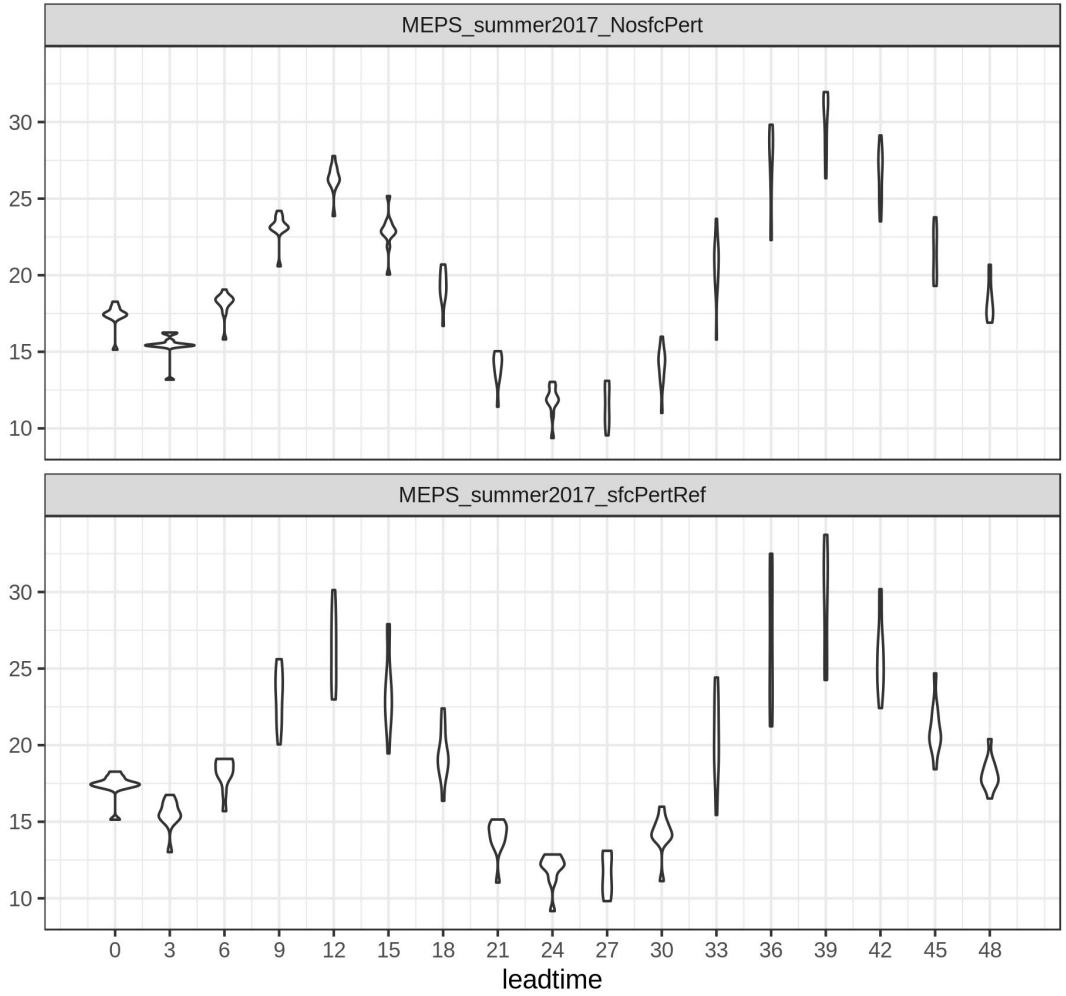
42
45
48
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
30
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15
18
21
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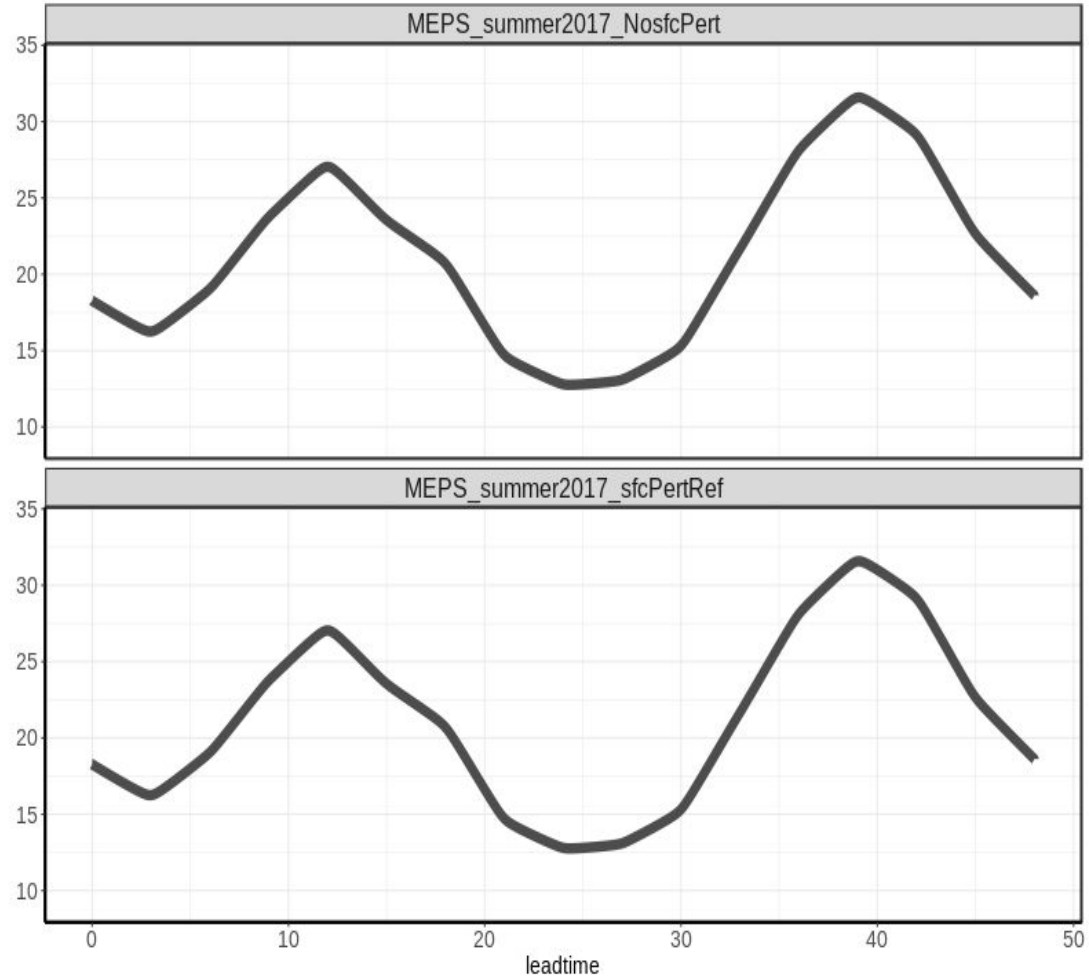
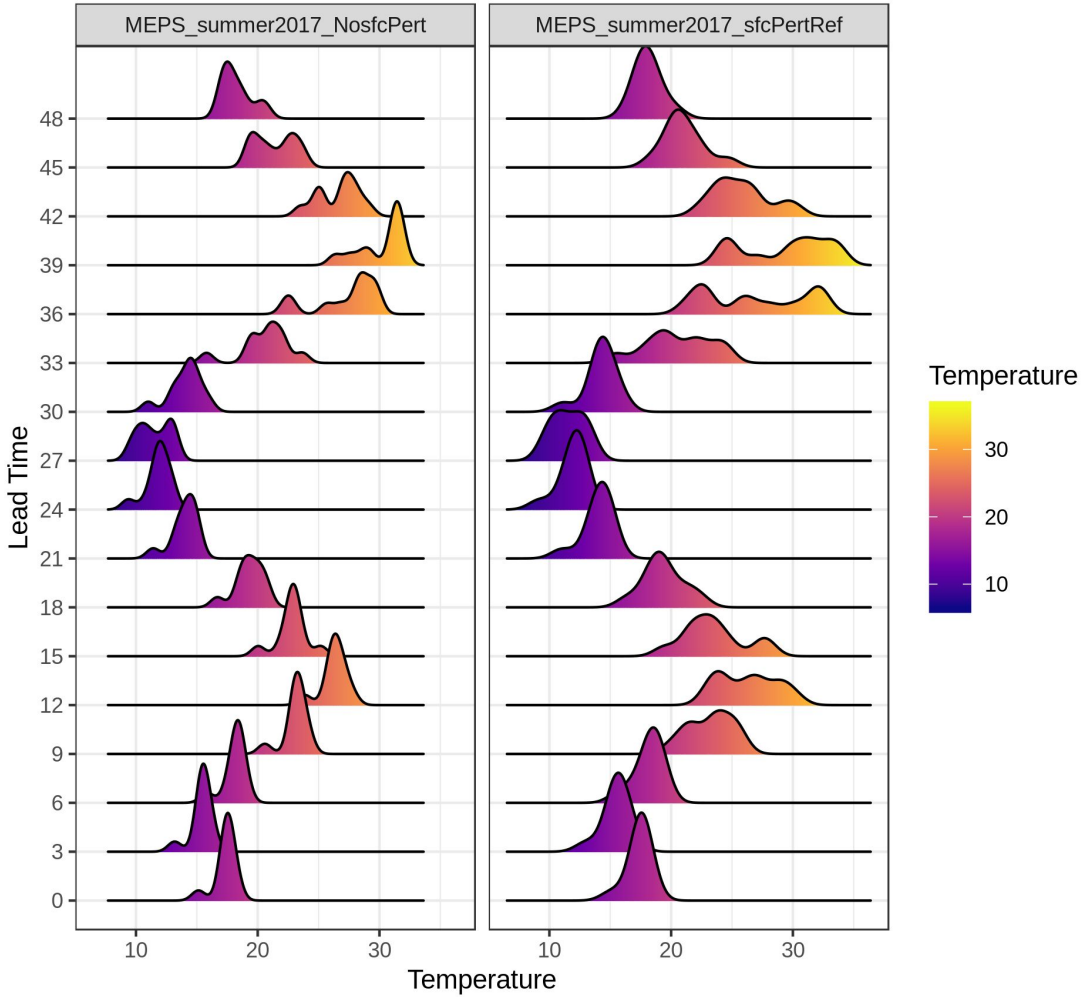
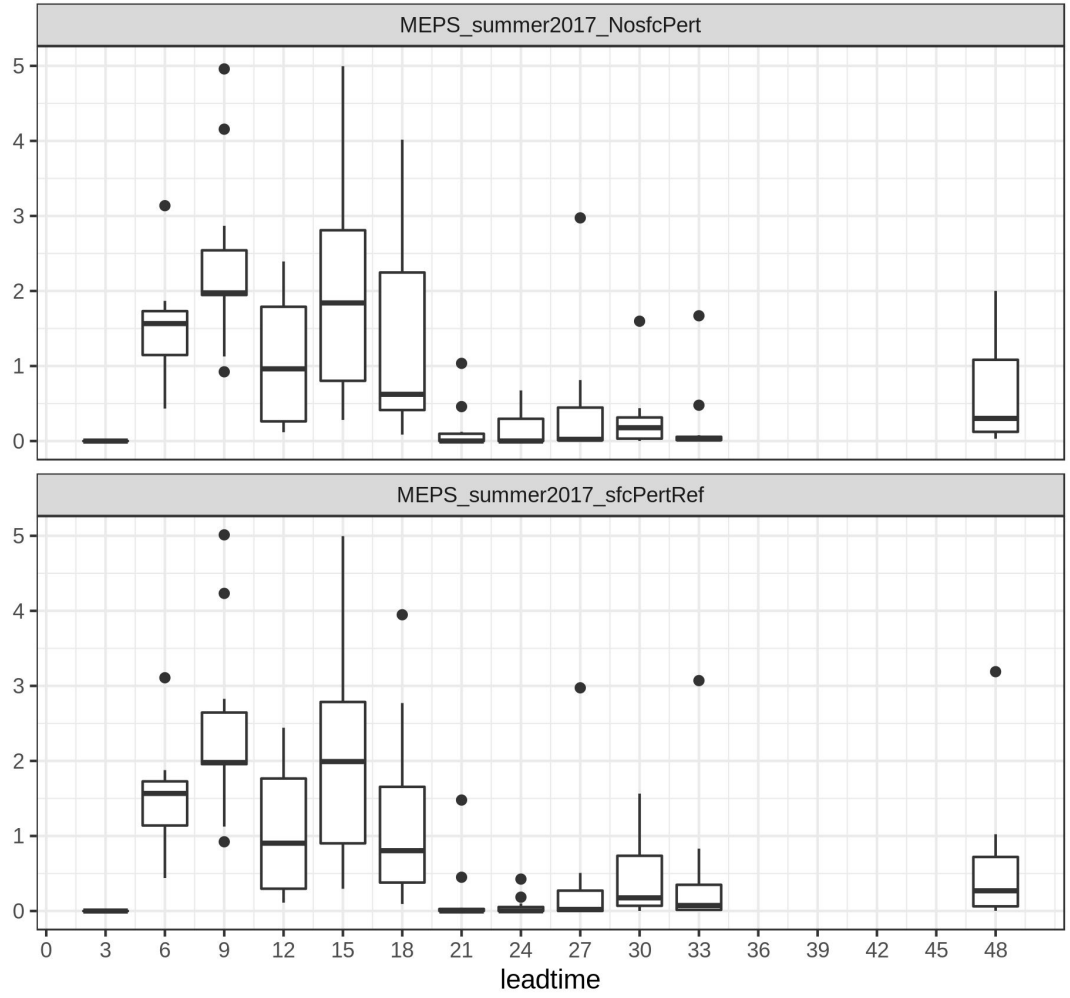
33
36
39
42
45
48
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
35
30
25
20
15
10
0
10
20
30
40
50
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
Lead Time
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
10
20
30
Temperature
Temperature
30
20
10


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
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3
4
5
0
3
6
9
12
15
18
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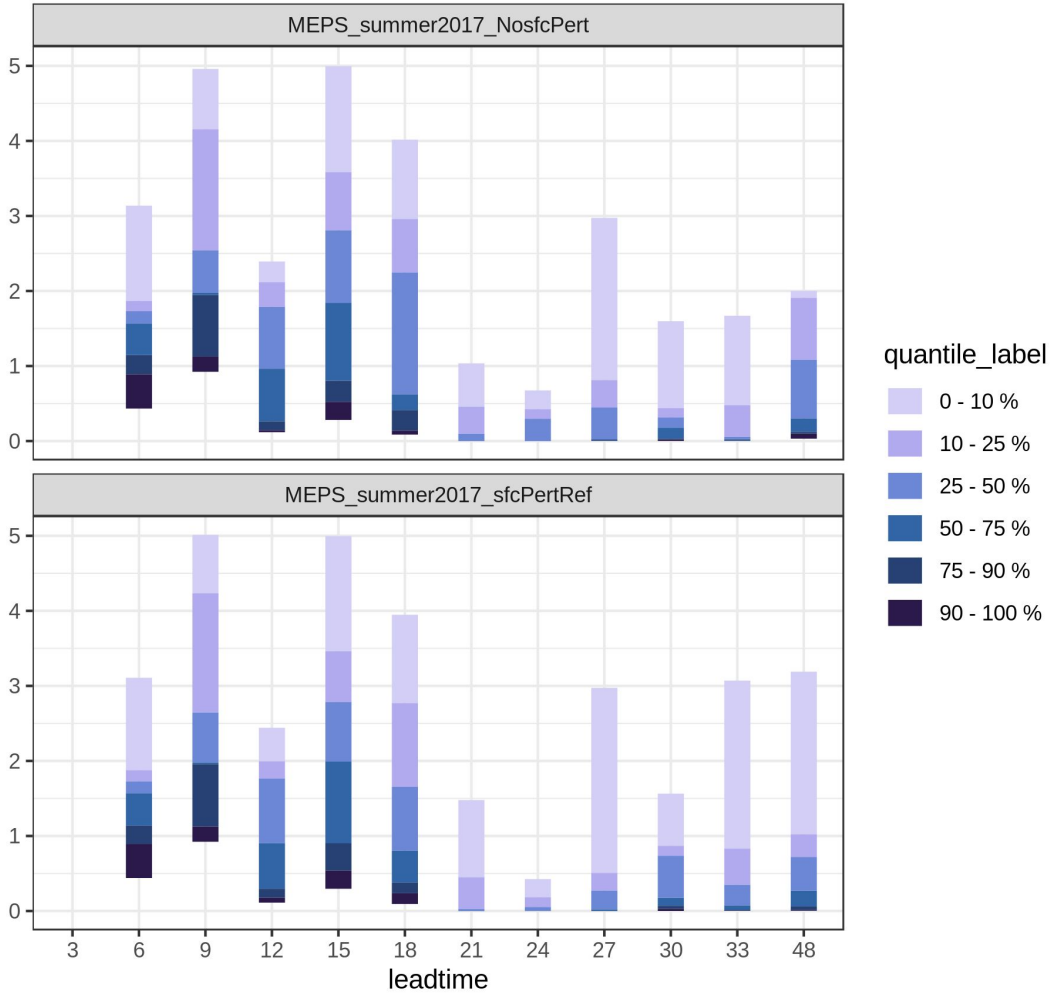
27
30
33
36
39
42
45
48
leadtime


MEPS_summer2017_NosfcPert
MEPS_summer2017_sfcPertRef
0
1
2
3
4
5
3
6
9
12
15
18
21
24
27
30
33
48
leadtime
quantile_label
0 - 10 %
10 - 25 %
25 - 50 %
50 - 75 %
75 - 90 %
90 - 100 %

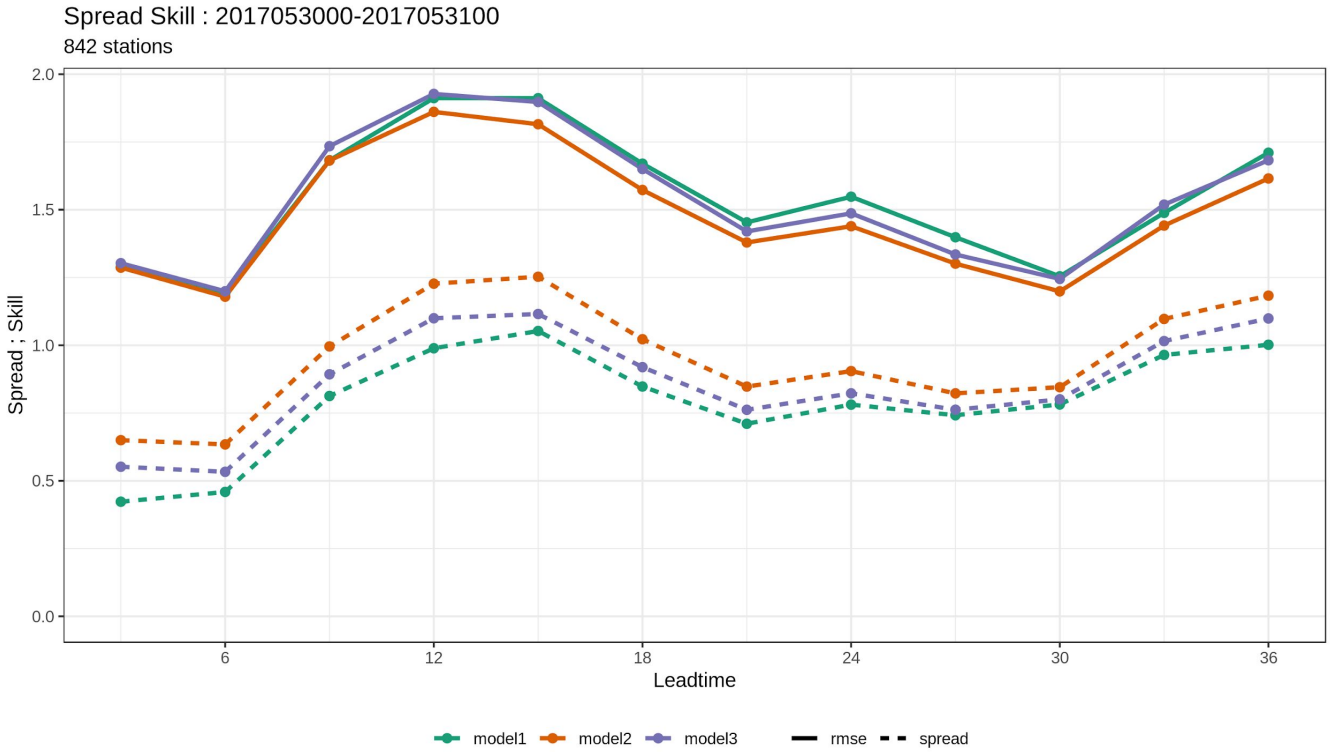
Plotting verification scores


```
plot_point_verif(...)

plot_spatial_verif(...)

plot_scatter(...)
```

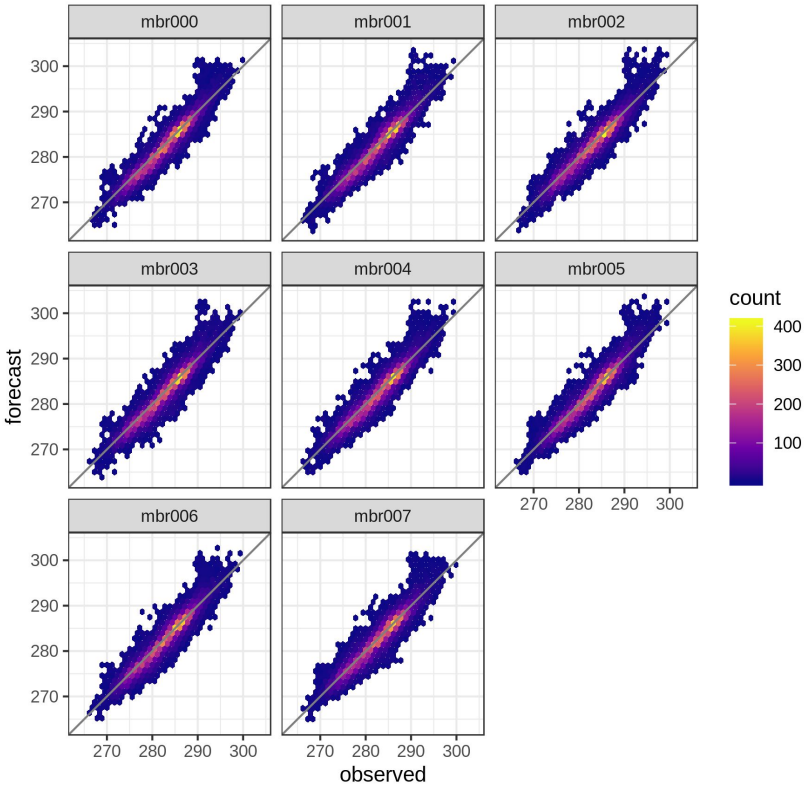
```
plot_point_verif(..., spread_skill)
```



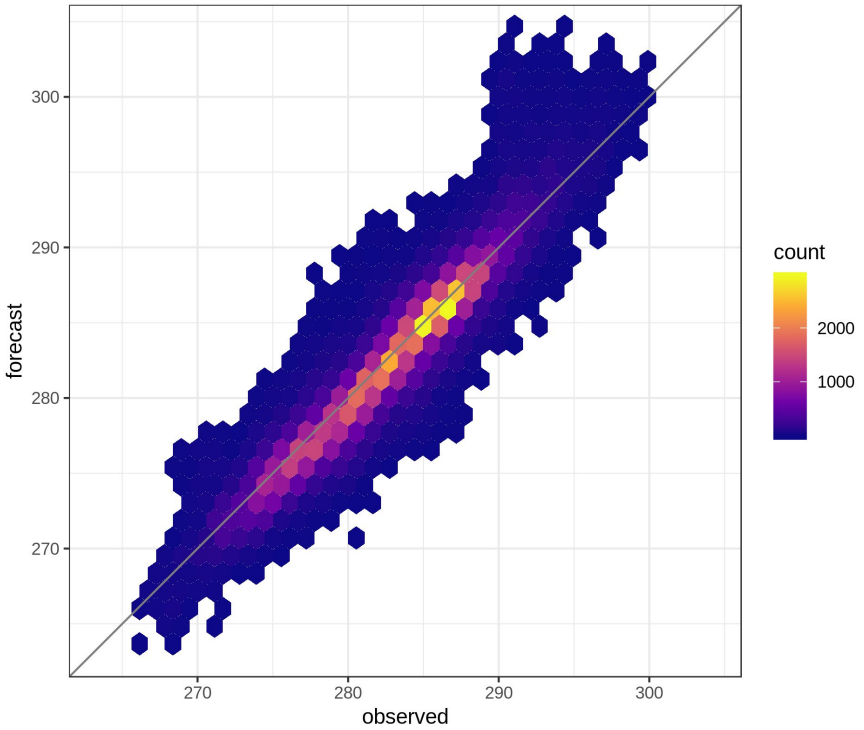
Verification for T2m

```
plot_point_verif(..., rank_histogram, facet_by = vars(leadtime))
```

```
plot_scatter(...)
```

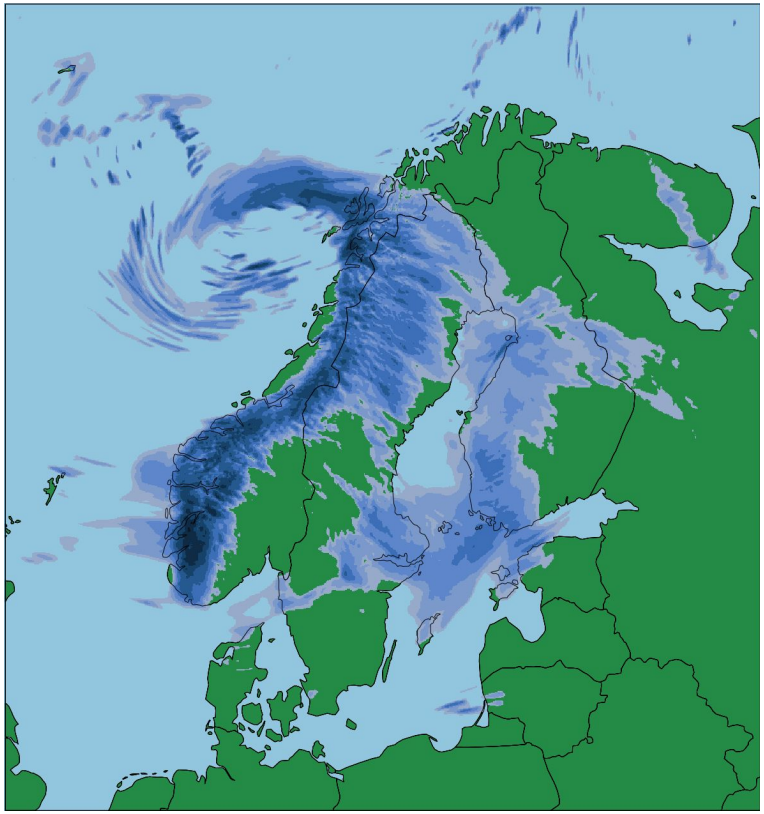


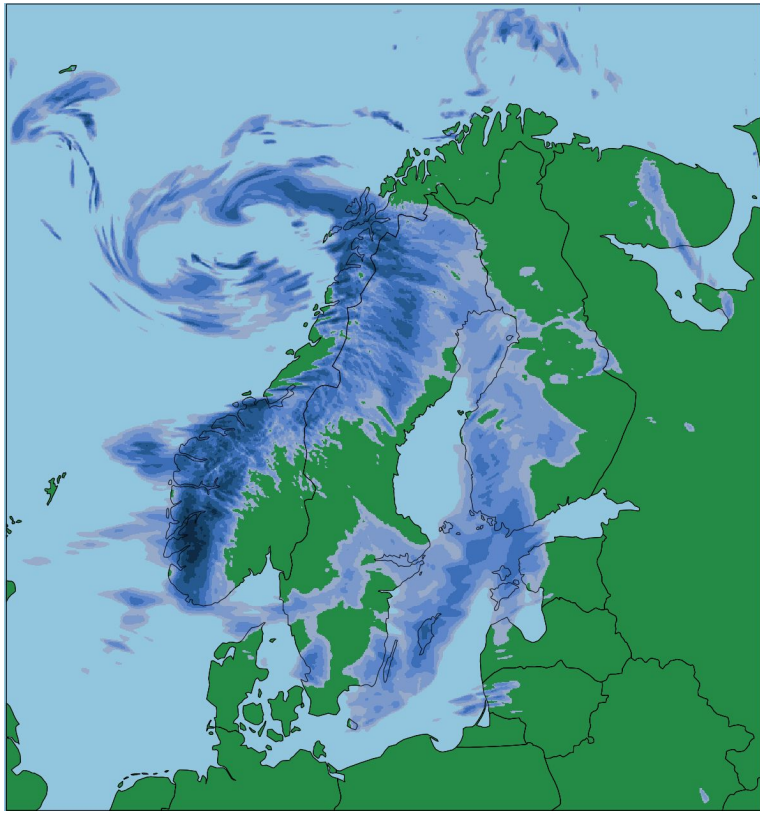
```
plot_scatter(..., facet_members = FALSE)
```



Maps*

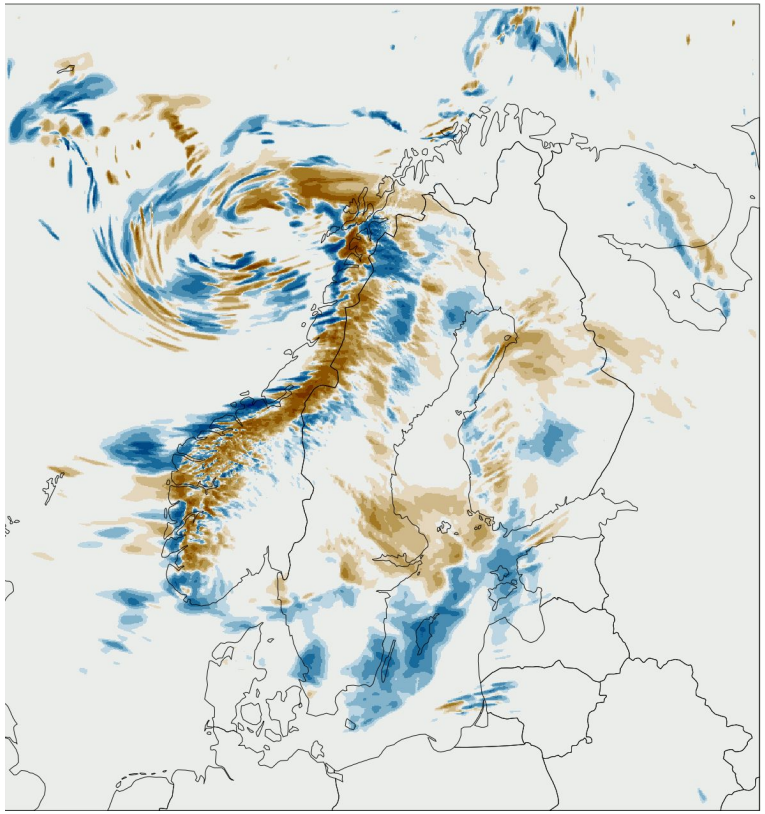
```
plot_field(..., member = c(0, 3))
```





Maps*

```
plot_field(..., member = c(0, 3), diff = TRUE)
```



Cross sections*

```
plot_x_section(..., point1 = ..., point2 = ...)
```

Interactive visualisation

```
shiny_plot_point_verif(options_bar = "all_dates")
```

127.0.0.1:4448

harp : : Point Verification

Select Verification Directory

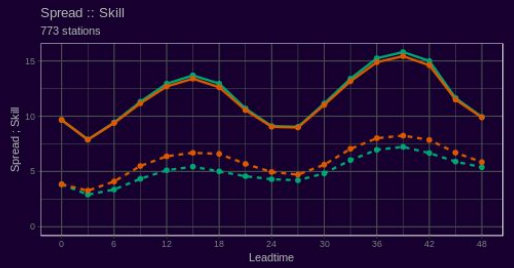
Model combination: MEPS_summer2017_NosfcPert + MEPS_summer2017_sfcPertRef

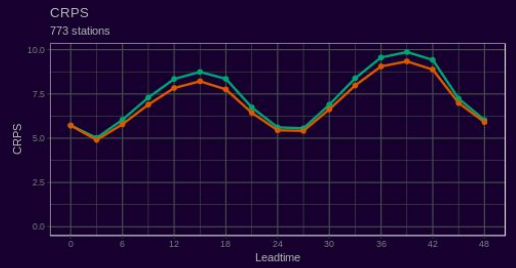
Dates: 2017052600-2017061300

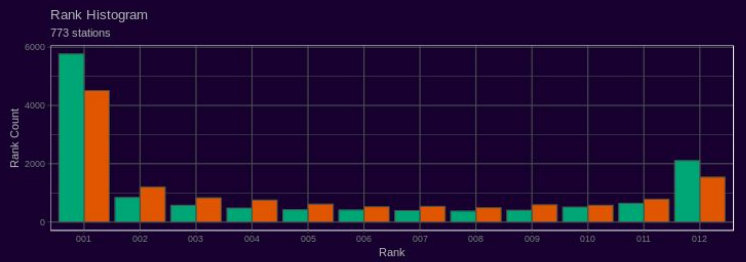
Parameter: RH2m

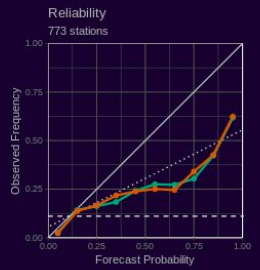
Load

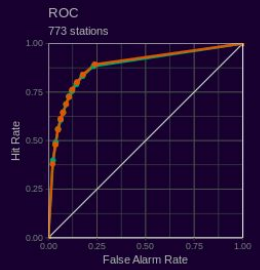
Dashboard | Interactive

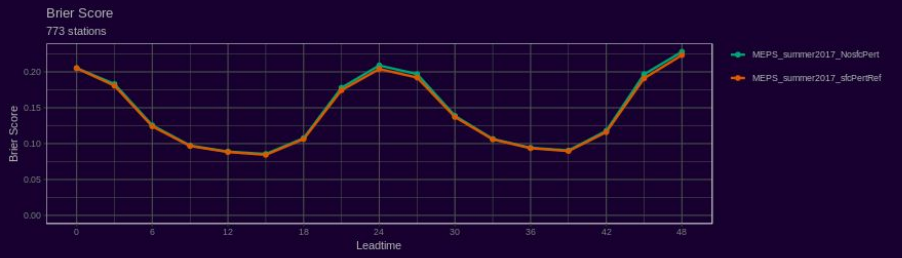












Do I need to know R?

- A tiny bit will help, but just learning how to use the harp functions should be enough. Becoming proficient opens up many more possibilities.
- harp documentation mainly through examples.
- Excellent free online materials for learning R
- harp training course in Autumn(?)