What's happening in harp

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Brief Overview

harp is a set of R packages for reading, analysing and visualizing NWP data

- **harpIO** for reading and writing data
- **harpPoint** for analysing point data (verification)
- **harpSpatial** for analysing spatial data (verification)
- **harpVis** for visualization
- **harp** attaches everything

Initial thinking

- Point data and spatial data are very different...
  - Point data are stored as vectors
  - Spatial data are stored as (multi dimensional) arrays
- It makes sense to have separate packages

New thinking

- Point data and spatial data can exist as columns in a data frame
  - Point data as a vector
  - Spatial data as a list of 2d «geofields»
    - «geolist» class with many basic mathematical operations
  - All data frame operations can be done on spatial data
    - Mutating
    - Filtering by other columns
    - Grouping and summarizing
    - Pivoting

Refactored packages

- Many methods for point data now work spatial data as well so it no longer makes sense to have them in separate packages
  - **harpCore** - class definitions and methods, common operations and math
  - **harpIO** - as before
  - **harpVerif** - point and spatial verification
  - **harpVis** - as before (web app part may be abstracted out into a separate package)
  - **harp** - attaches everything + wrapper scripts read › operation › (write)
    - "automated " verification
    - Score cards

Upcoming changes with user impact

- read_<...> functions have new date_times argument
- The Old Way

```
read_forecast(
  start_date = 2022040400,
  end_date   = 2022040818,
  …,
  by = "6h"
)
```

Upcoming changes with user impact

- read_<...> functions have new date_times argument
- The Old Way

```
read_forecast(
  2022040400,
  2022040818,
  …,
  by = "6h"
)
```

Upcoming changes with user impact

- read_<...> functions have new date_times argument
- The New Way

```
read_forecast(
  date_times = seq_dates(2022040400, 2022040818, by = "6h")
  …,
)
```

Upcoming changes with user impact

- read_<...> functions have new date_times argument
- The New Way

```
read_forecast(
  seq_dates(2022040400, 2022040818, by = "6h")
  …,
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```

Upcoming changes with user impact

- read_<...> functions have new date_times argument
- The New Way

```
read_forecast(
  seq_dates(2022040400, 2022040818, by = "6h")
  …,
)
```

- Allows for specification of irregularly spaced date-times
- No longer need to supply the same date-time twice for only one date-time

Upcoming changes with user impact

New parameter definitions (*not linked to FA yet)

```
t2m = list(
  description = "Air temperature at 2m above the ground",
  min = 223,
  max = 333,
  grib = list(
    name       = c("2t", "t"),
    level_type = c("heightAboveGround", "surface"),
    level      = 2
  ),
  netcdf = list(
    name = "air_temperature_2m"
  ),
  v = list(
    harp_param  = "T2m",
    name        = "TT",
    param_units = "K",
    type        = "SYNOP"
  ),
  wrf = list(
    name = "T2"
  ),
  fa = list(
    name  = pad_string("CLSTEMPERATURE", 16),
    units = "K"
  ),
  obsoul = list(
    name      = 39,
    units     = "K",
    harp_name = "T2m"
  )
)
```

Upcoming changes with user impact

New parameter definitions with possibility to apply a function at read time

```
ws10m = list(
  description = paste(
    "Wind speed at 10m above the ground calculated",
    "from U and V winds at 10m above the ground"
  ),
  .
  .
  .
  netcdf = list(
    name = list(u = "x_wind_10m", v = "y_wind_10m")
  ),
  .
  .
  .
  func = function(u, v) sqrt(u ^ 2 + v ^ 2)
)
```

Upcoming changes with user impact

New read functions

- **`read_obs()`** - replaces **`read_obs_convert()`** and more consistent with **`read_forecast()`**
- **`read_obs_file()`** - reads a single observations file (like **`read_grid()`** but for observations)
- **`read_analysis()`** - reads gridded analyses

Upcoming changes with user impact

New transformations

`"xsection"`	Vertical cross section between two user defined points (in long lat)
`"subgrid"`	Subset of gridded from user defined (i, j) locations of corners
*`"zoom"`	Zoom into a grid from user defined grid centre (long, lat) and radius of grid squares
*`"upscale"`	Upscale the grid by a user defined integer factor

Upcoming changes with user impact

Sub hourly lead times

- Specify lead times in different units of time in read functions
  - *Only tested for netcdf so far

Upcoming changes with user impact

*Faster score computation

- Huge speed up for bootstrapping

*Verification of cyclic variables (e.g. wind direction)

- Not entirely clear what to do for some scores

Upcoming changes with user impact

Compatibility with ggplot2 for 2d fields

- New geoms for «geolist» columns
  - **`geom_georaster()`** with data thinning for faster plotting
  - **`geom_geocontour()`**
  - **`*geom_geovector()`**
- New coordinates - will automatically add map background / overlay
  - **`**coord_geo()`**
- New plot theme for gridded data
  - **`theme_harp_map()`**

Upcoming changes with user impact

Compatibility with ggplot2 for 2d fields

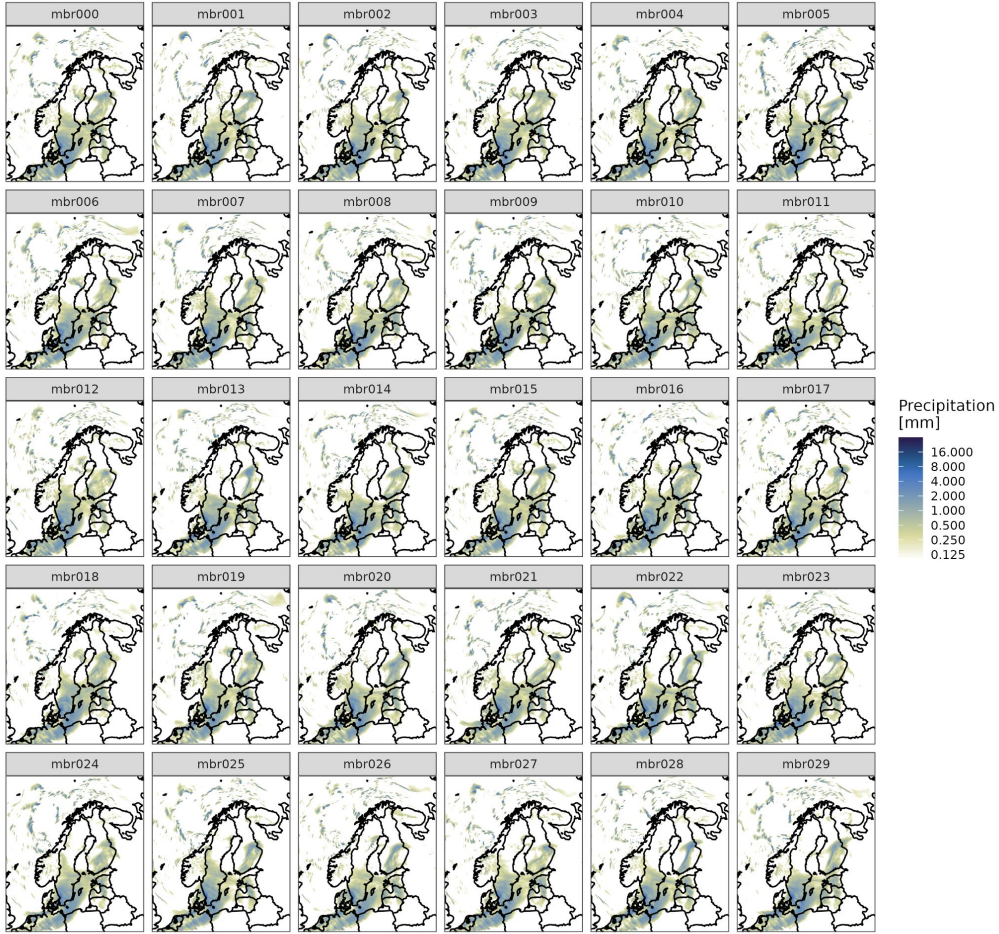
- New colour scales
  - `*scale_fill_precip()`
  - `*scale_fill_temp()`
  - `*scale_fill_wind()`

- *Data thinning to speed up raster plotting

Upcoming changes with user impact

Postage stamp plot example

```
ggplot(meps) +
  geom_georaster(aes(geofield = forecast)) +
  scale_fill_precip() +
  facet_wrap(vars(member)) +
  coord_geo(add_map = TRUE) +
  theme_harp_map() +
  labs(fill = "Precipitation\n[mm]")
```


mbr000
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Precipitation [mm]
16.000
8.000
4.000
2.000
1.000
0.500
0.250
0.125

Upcoming changes with user impact

Better handling of groups in web app

- Group dropdowns are automatically generated from the data
- Selection from each group should now influence what can be chosen from other groups
- *Different x-axis data (e.g. valid date-time / lead time) to be detected and a radio button created

*Automatic vertical profile plotting in web app

- When vertical profile verification is detected plots will automatically switch to having vertical level in the y axis and facetting by lead time / valid date-time

Time scale of new releases

- Aiming for end May 2022
  - Only items marked with an asterisk are not fully implemented in development versions
  - All packages will be tagged and become more stable
  - Development versions will be easily installable / forkable

Longer term plans

- Fractions skill score for ensembles (already in testing)
- Fractions skill score using point observations and gridded forecasts (following UK Met Office)
- **harpSat** package for dealing with satellite data***
  - Resample swath data to model grid
  - Resample gridded data to swath
- On the fly scores using web app
- Wind into / along cross sections***
- Cross sections for long-lat projections following great circles***
- Spatial verification coding weeks in Autumn

(Default verification set for ACCORD)

***Seeking collaborators