psyplot: The interactive python analysis framework

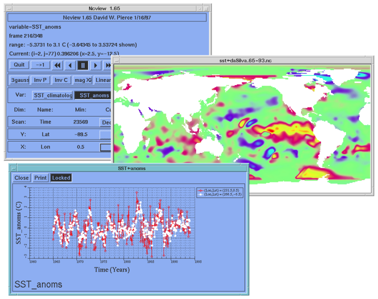
Philipp S. Sommer
Helmholtz-Zentrum Geesthacht, February 4th 2020

Motivation

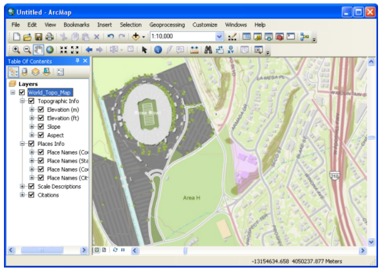
Current tools either focus on

- Data visualization (ncview, Panoply, Paraview, etc.)
- data processing (Python, R)

ncview



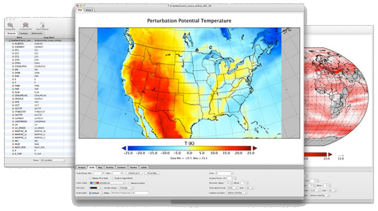
ArcGIS



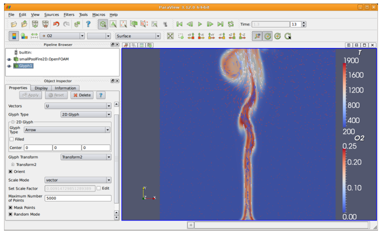
No solution available that

- Is (easily) scriptable
- And has a Graphical User Interface
- Treats data processing and visualization hand in hand

Panoply

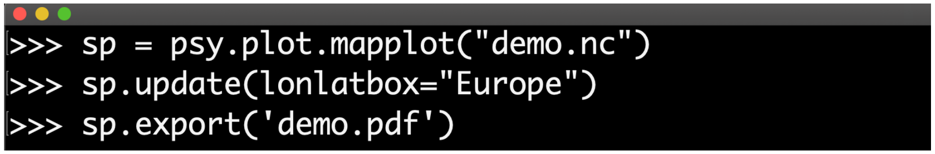


Paraview



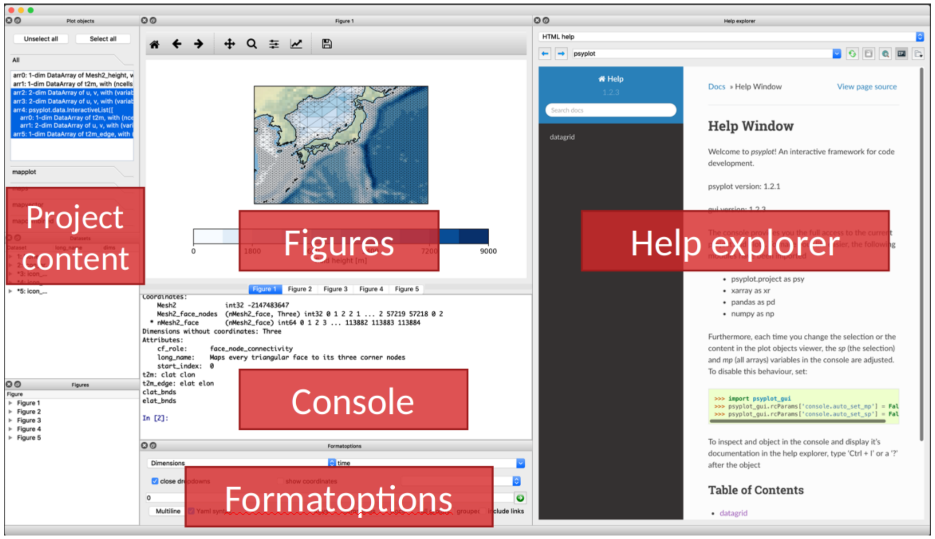
Motivation

Interactive data visualization with Python



```
>>> sp = psy.plot.mapplot("demo.nc")
>>> sp.update(lonlatbox="Europe")
>>> sp.export('demo.pdf')
```

- Scriptable
- Graphical user interface (with built-in command line)
- Publication-ready and reproducible figures
- Flexible and extensible framework



```
Coordinates:
    Mesh2             int32 -2147483647
    Mesh2_face_nodes  (nMesh2_face, Three) int32 0 1 2 2 1 ... 2 57219 57218 0 2
  * nMesh2_face       (nMesh2_face) int64 0 1 2 3 ... 113882 113883 113884
Dimensions without coordinates: Three
Attributes:
    cf_role:      face_node_connectivity
    long_name:    Maps every triangular face to its three corner nodes
    start_index:  0
t2m: clat clon
t2m_edge: elat elon
clat_bnds
elat_bnds

In [2]:
```

Dimensions: time

☑ close dropdowns

Docs » Help Window   View page source

Help Window

Welcome to *psyplot*! An interactive framework for code development.

psyplot version: 1.2.1

- psyplot.project as psy
- xarray as xr
- pandas as pd
- numpy as np

Furthermore, each time you change the selection or the content in the plot objects viewer, the *sp* (the selection) and *mp* (all arrays) variables in the console are adjusted. To disable this behaviour, set:

```
>>> import psyplot_gui
>>> psyplot_gui.rcParams['console.auto_set_mp'] = Fal
>>> psyplot_gui.rcParams['console.auto_set_sp'] = Fal
```

To inspect and object in the console and display it's documentation in the help explorer, type 'Ctrl + I' or a '?' after the object

Table of Contents

- datagrid

The psyplot data model

Let’s code and work on some data!

In [1]:

```
cd data
```

```
/home/psommer/Documents/code/docs/psyplot-hzg-presentation-20200204/data
```

Low-level interface

In [2]:

```
from psyplot.plotter import Formatoption, Plotter
```

In [3]:

```
class MyFormatoption(Formatoption):
    default = 'my text'

    def update(self, value):
        self.ax.text(0.5, 0.5, value, fontsize='xx-large')
```

In [4]:

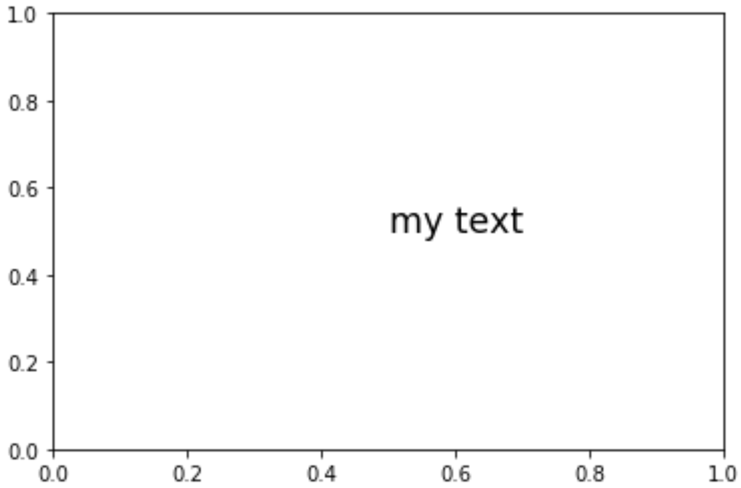
```
class MyPlotter(Plotter):
    my_fmt = MyFormatoption('my_fmt')
```

In [5]:

```
import psyplot.project as psy

ds = psy.open_dataset('demo.nc')

data = ds.t2m

plotter = MyPlotter(data)

project = psy.Project([data])
project
```

Out[5]:

```
1 Main psyplot.project.Project([    arr0: 4-dim DataArray of t2m, with (time,
lev, lat, lon)=(5, 4, 96, 192), ])
```



High-level interface

In [6]:

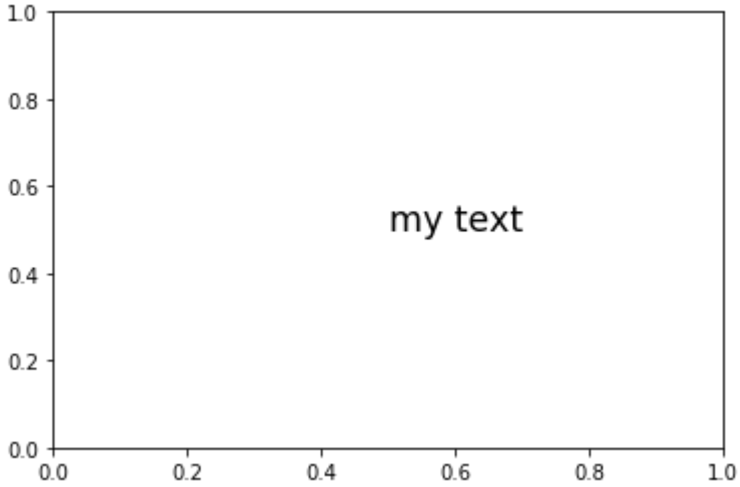
```
psy.register_plotter('my_plotter', MyPlotter.__module__,
                     'MyPlotter', MyPlotter)
```

In [7]:

```
psy.plot.my_plotter('demo.nc', name='t2m')
```

Out[7]:

```
psyplot.project.Project([    arr0: 4-dim DataArray of t2m, with (time, lev, la
t, lon)=(5, 4, 96, 192), ])
```



Plugins for visualization

psyplot is the core that defines the framework (Plotter, Formatoption, Project, CFDecoder), the plot methods are implemented by plugins:

- `psy-simple`: for standard 1D and 2D plot
    - e.g. lineplot, plot2d, vector, barplot
- `psy-maps`: for georeferenced plots (i.e. maps)
    - e.g. mapplot, mapvector, etc.
- `psy-reg`: for regression analysis
    - linreg, densityreg

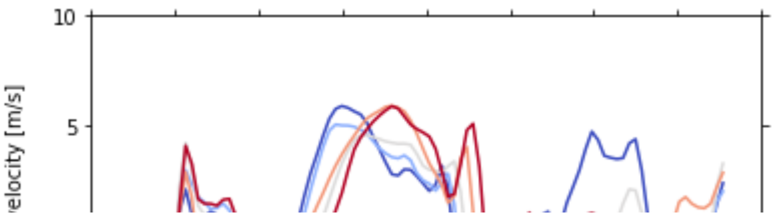
psy-simple

In [8]:

```
lines = psy.plot.lineplot(
    'demo.nc',        # netCDF file storing the data
    name='v',         # variable name
    t=range(5),       # one line per timestep
    z=0,              # first vertical level (dimension lev)
    x=0,              # first longitude step (dimension lon)
    ylabel="{desc}",  # use the longname and units on the y-axis
    color='coolwarm', # use the coolwarm colormap for the lines
    yticks=range(-10, 11, 5),  # explicitly set ticks on y-axis
    legend=False
)
lines
```

Out[8]:

```
psyplot.project.Project([arr1: psyplot.data.InteractiveList([
    arr0: 1-dim DataArray of v, with (lat)=(96,), lon=0.0, lev=100000.0, time=
1979-01-31T18:00:00,
    arr1: 1-dim DataArray of v, with (lat)=(96,), lon=0.0, lev=100000.0, time=
1979-02-28T18:00:00,
    arr2: 1-dim DataArray of v, with (lat)=(96,), lon=0.0, lev=100000.0, time=
1979-03-31T18:00:00,
    arr3: 1-dim DataArray of v, with (lat)=(96,), lon=0.0, lev=100000.0, time=
1979-04-30T18:00:00,
    arr4: 1-dim DataArray of v, with (lat)=(96,), lon=0.0, lev=100000.0, time=
1979-05-31T18:00:00])])
```



Formatoptions

In [9]:

```
lines.keys()
```

```
+----------------+----------------+----------------+----------------+
| axiscolor      | color          | coord          | error          |
+----------------+----------------+----------------+----------------+
| erroralpha     | figtitle       | figtitleprops  | figtitlesize   |
+----------------+----------------+----------------+----------------+
| figtitleweight | grid           | labelprops     | labelsize      |
+----------------+----------------+----------------+----------------+
| labelweight    | legend         | legendlabels   | linewidth      |
+----------------+----------------+----------------+----------------+
| marker         | markersize     | maskbetween    | maskgeq        |
+----------------+----------------+----------------+----------------+
| maskgreater    | maskleq        | maskless       | plot           |
+----------------+----------------+----------------+----------------+
| post           | post_timing    | sym_lims       | text           |
+----------------+----------------+----------------+----------------+
| ticksize       | tickweight     | tight          | title          |
+----------------+----------------+----------------+----------------+
| titleprops     | titlesize      | titleweight    | transpose      |
+----------------+----------------+----------------+----------------+
| xlabel         | xlim           | xrotation      | xticklabels    |
+----------------+----------------+----------------+----------------+
| xtickprops     | xticks         | ylabel         | ylim           |
+----------------+----------------+----------------+----------------+
| yrotation      | yticklabels    | ytickprops     | yticks         |
+----------------+----------------+----------------+----------------+
```

Formatoptions

In [10]:
```
lines.docs('ylabel')
```

```
ylabel
======
Set the y-axis label

Set the label for the y-axis.
You can insert any meta key from the :attr:`xarray.DataArray.attrs` via a
string like ``'%(key)s'``. Furthermore there are some special cases:

- Strings like ``'%Y'``, ``'%b'``, etc. will be replaced using the
  :meth:`datetime.datetime.strftime` method as long as the data has a time
  coordinate and this can be converted to a :class:`~datetime.datetime`
  object.
- ``'%(x)s'``, ``'%(y)s'``, ``'%(z)s'``, ``'%(t)s'`` will be replaced
  by the value of the x-, y-, z- or time coordinate (as long as this
  coordinate is one-dimensional in the data)
- any attribute of one of the above coordinates is inserted via
  ``axis + key`` (e.g. the name of the x-coordinate can be inserted via
  ``'%(xname)s'``).
- Labels defined in the :class:`psyplot.rcParams` ``'texts.labels'`` key
  are also replaced when enclosed by '{}'. The standard labels are

  - tinfo: ``%H:%M``
  - dtinfo: ``%B %d, %Y. %H:%M``
  - dinfo: ``%B %d, %Y``
  - desc: ``%(long_name)s [%(units)s]``
  - sdesc: ``%(name)s [%(units)s]``

Possible types
--------------
```

Plot methods

In [11]:

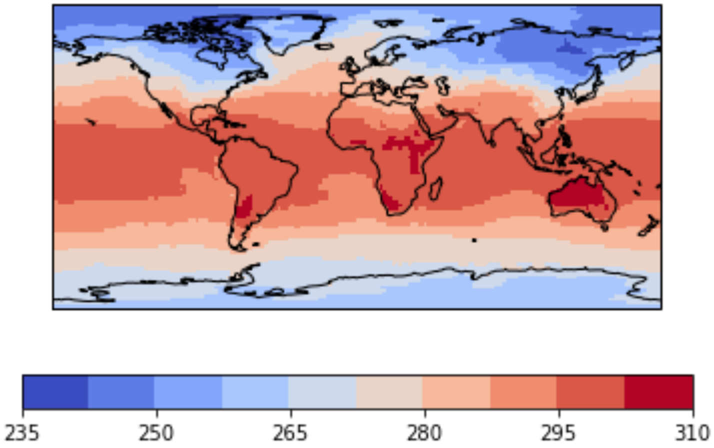
```
psy.plot.show_plot_methods()
```

```
barplot
    Make a bar plot of one-dimensional data
combined
    Plot a 2D scalar field with an overlying vector field
density
    Make a density plot of point data
densityreg
    Make a density plot and draw a fit from x to y of points
fldmean
    Calculate and plot the mean over x- and y-dimensions
lineplot
    Make a line plot of one-dimensional data
linreg
    Draw a fit from x to y
mapcombined
    Plot a 2D scalar field with an overlying vector field on a map
mapplot
    Plot a 2D scalar field on a map
mapvector
    Plot a 2D vector field on a map
my_plotter
    Open and plot data via :class:`__main__.MyPlotter` plotters
plot2d
    Make a simple plot of a 2D scalar field
vector
    Make a simple plot of a 2D vector field
violinplot
    Make a violin plot of your data
```

Maps

```
In [12]: ds.psy.plot.mapplot(name='t2m')
```

```
Out[12]: psyplot.project.Project([    arr2: 2-dim DataArray of t2m, with (lat, lon)=(9
6, 192), lev=100000.0, time=1979-01-31T18:00:00])
```



Maps

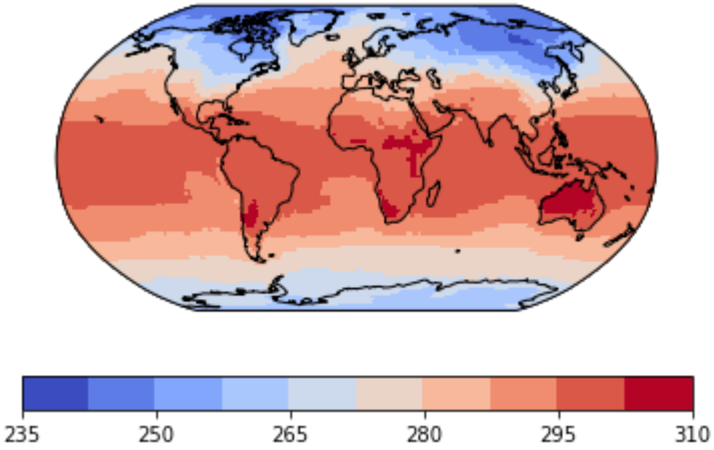
(Some) Special Formatoptions for Maps

- **lonlatbox**: Specify the longitude-latitude box (via numbers, or countries/continents, etc.). Data outside this region will be masked in the array.
- **map_extent**: Same as *lonlatbox* but without masking
- **projection**: Projection for the plot. Can be `'ortho'`, `'cyl'`, etc. or anything from https://scitools.org.uk/cartopy/docs/latest/crs/projections.html (https://scitools.org.uk/cartopy/docs/latest/crs/projections.html)
- **lsm**: Draw a land-sea-mask from a natural earth shapefile
- **stock_img**: Draw a colored image on the map to distinguish ocean and continents

Maps

In [13]:
```
ds.psy.plot.mapplot(
    name='t2m', projection='robin')
```

Out[13]:
```
psyplot.project.Project([    arr3: 2-dim DataArray of t2m, with (lat, lon)=(9
6, 192), lev=100000.0, time=1979-01-31T18:00:00])
```



Grid structures

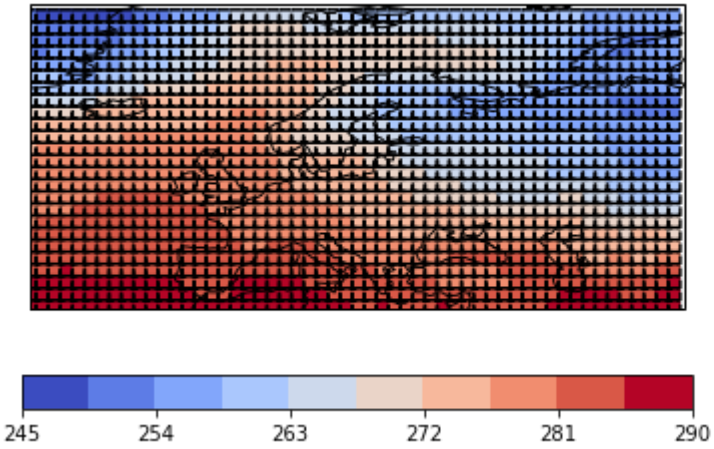
Rectilinear

In [14]:

```
ds = psy.open_dataset('demo.nc')
ds
ds.psy.plot.mapplot(
    name='t2m', lonlatbox='Europe', datagrid='k--')
```

Out[14]:

```
psyplot.project.Project([    arr4: 2-dim DataArray of t2m, with (lat, lon)=(9
6, 192), lev=100000.0, time=1979-01-31T18:00:00])
```



Grid structures

Circumpolar (2D coordinates)

In [15]:

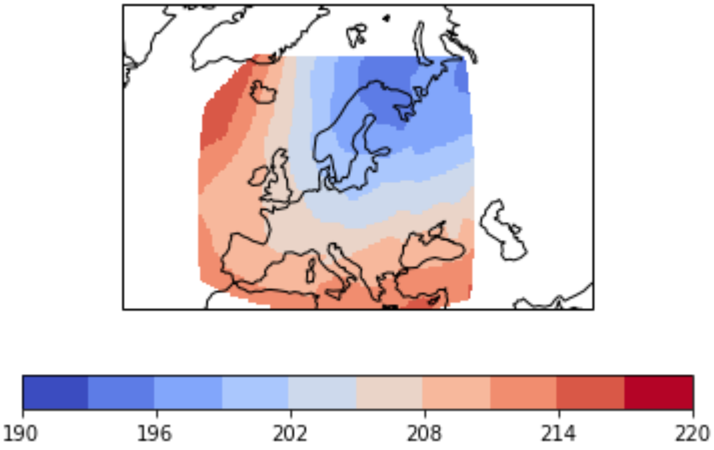
```
import warnings
warnings.filterwarnings('ignore', '.*')
```

In [16]:

```
ds = psy.open_dataset('T.nc')
ds
ds.psy.plot.mapplot(
    name='T', projection='ortho',
    lonlatbox='Europe')
```

Out[16]:

```
psyplot.project.Project([    arr5: 2-dim DataArray of T, with (rlat, rlon)=(11
1, 101), time=1983-12-01T21:00:00, level=0])
```

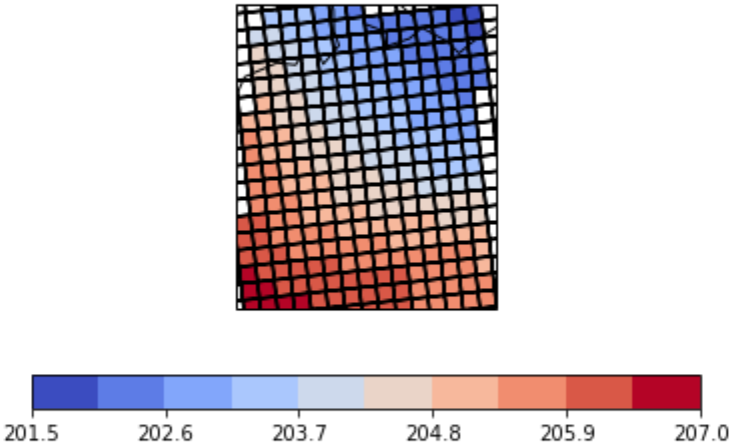


In [17]:

```
ds = psy.open_dataset('T.nc')
ds
ds.psy.plot.mapplot(
    name='T', projection='ortho',
    lonlatbox='Germany', datagrid='k-')
```

Out[17]:

```
psyplot.project.Project([    arr6: 2-dim DataArray of T, with (rlat, rlon)=(11
1, 101), time=1983-12-01T21:00:00, level=0])
```



Grid structures

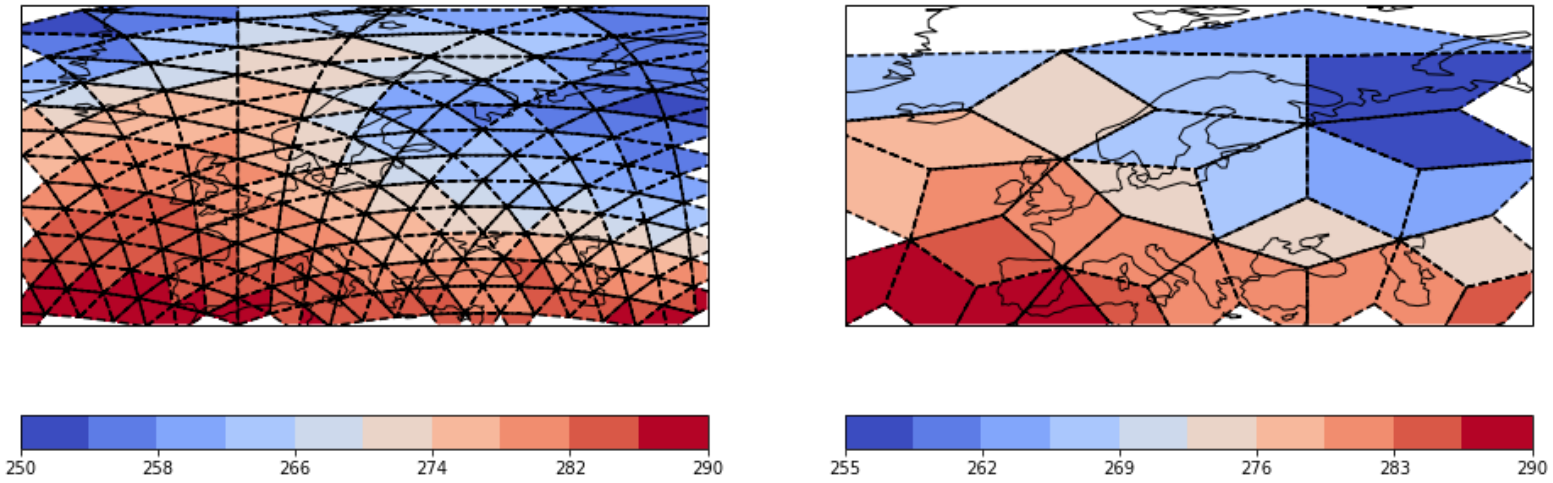
ICON (triangular, hexagonal, etc.)

In [18]:

```
ds = psy.open_dataset('icon_grid_demo.nc')
ds
ds.psy.plot.mapplot(
    name=['t2m', 't2m_edge'], ax=(1, 2),
    lonlatbox='Europe', datagrid='k--')
```

Out[18]:

```
psyplot.project.Project([
    arr7: 1-dim DataArray of t2m, with (ncells)=(5120,), time=1979-01-31T18:0
0:00, lev=100000.0,
    arr8: 1-dim DataArray of t2m_edge, with (edge)=(480,), time=1979-01-31T18:
00:00, lev=100000.0])
```



Grid structures

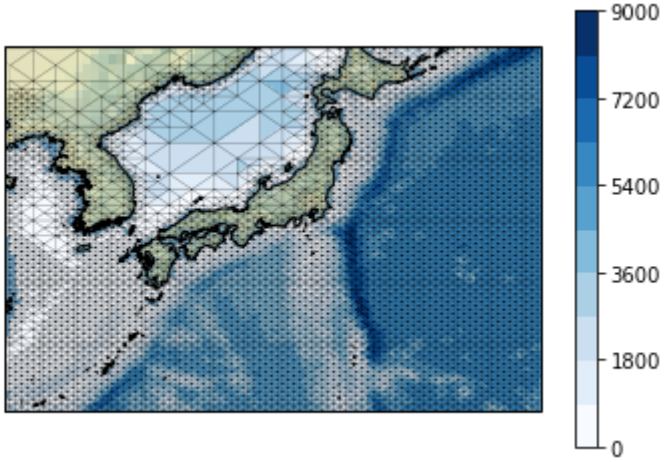
Unstructured (UGRID)

In [19]:

```
ds = psy.open_dataset('ugrid_demo.nc')
ds
ds.psy.plot.mapplot(
    name='Mesh2_height', load=True,
    maskleq=0, lonlatbox='Japan', cmap='Blues',
    cbar='r', stock_img=True, lsm='10m',
    datagrid={'c': 'k', 'lw': 0.1})
```

Out[19]:

```
psyplot.project.Project([    arr9: 1-dim DataArray of Mesh2_height, with (nMes
h2_face)=(113885,), Mesh2=-2147483647, time=1950-01-01T04:11:59.999742507])
```



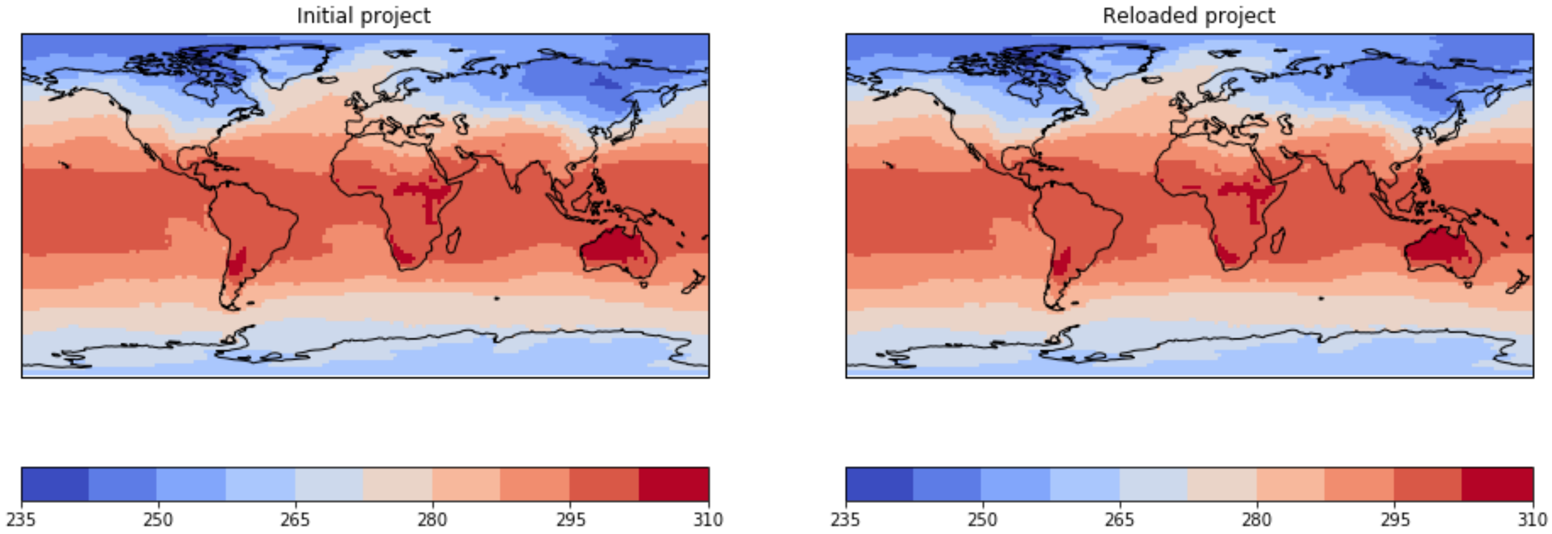
Other features

Save and load projects

In [20]:

```
axes = psy.multiple_subplots(1, 2, n=2, for_maps=True)
initial = psy.plot.mapplot('demo.nc', name='t2m', ax=axes[0], title='Initial project')
initial.save_project('my-project.pkl')
print('-------------------------------------------------')
!ls -hl my-project.pkl
print('-------------------------------------------------')

reloaded = psy.Project.load_project('my-project.pkl', alternative_axes=[axes[1]])
reloaded.update(title='Reloaded project')
```

```
-------------------------------------------------
-rw-r--r-- 1 SommerP psommer 3.7K Feb  5 19:07 my-project.pkl
-------------------------------------------------
```



Other features

The graphical user interface

In [21]:

```
#!psyplot -p my-project.pkl
```

Other features

Export plots

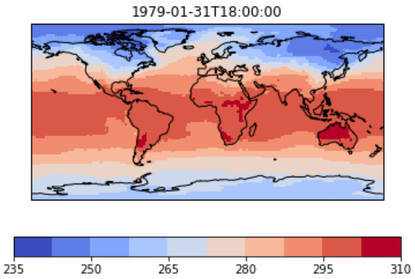
In [22]:

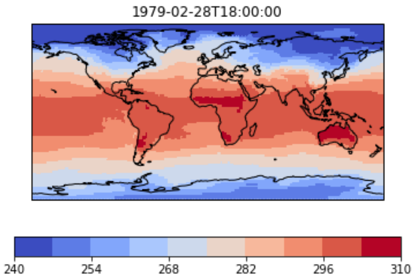
```
sp = psy.plot.mapplot('demo.nc', name='t2m', time=[0, 1, 2],
                      title='%(time)s')
sp.export('step-%i.png')
psy.close('all')
!ls step-?.png
```

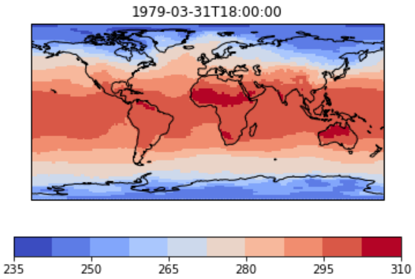
```
step-1.png  step-2.png  step-3.png
```

In [23]:

```
from IPython.display import display, HTML, Image
s = '<table><tr><td><img src="data/step-1.png"></td><td><img src="data/step-2.png"></td><td><img src="data/step-3.png"></td></tr></table>'
display(HTML(s))
```







Other features

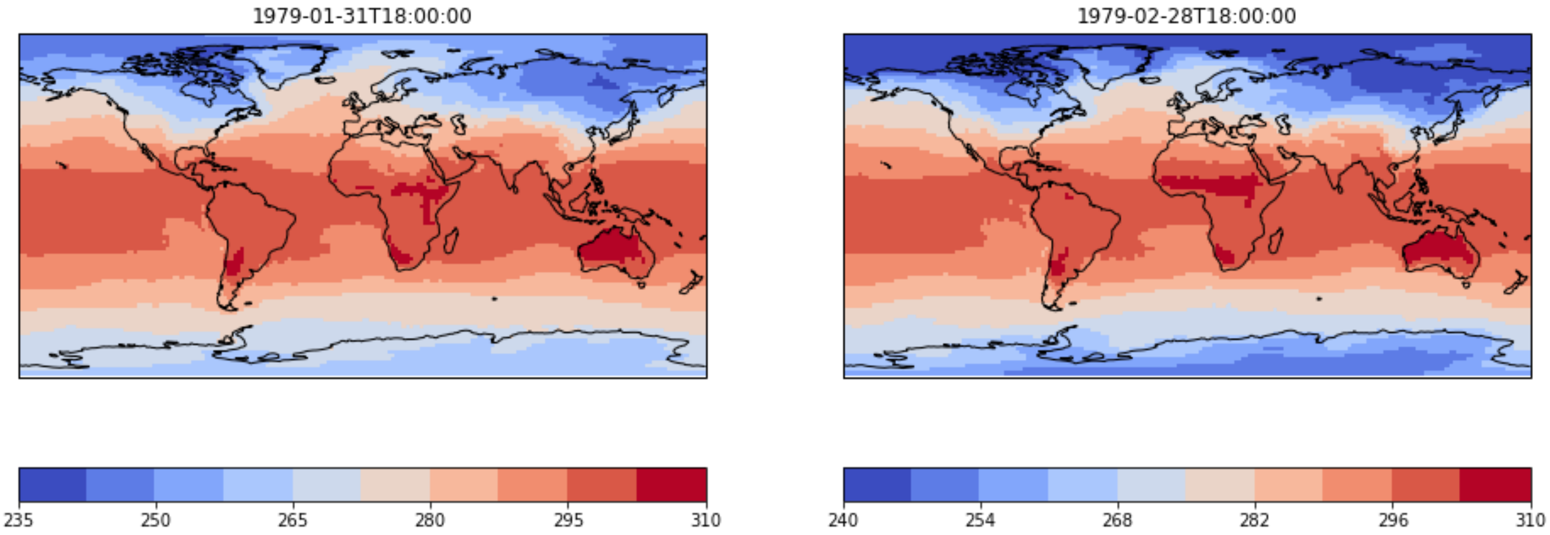
Update plots

In [24]:

```
# make some jupyter specific config
%config InlineBackend.close_figures = False
psy.rcParams['auto_show'] = True
```

In [25]:

```
psy.close('all')
sp = psy.plot.mapplot('demo.nc', name='t2m', time=[0, 1],
                      ax=(1, 2), title='%(time)s')
```



In [26]:

```
psy.plot.mapplot.keys()
```

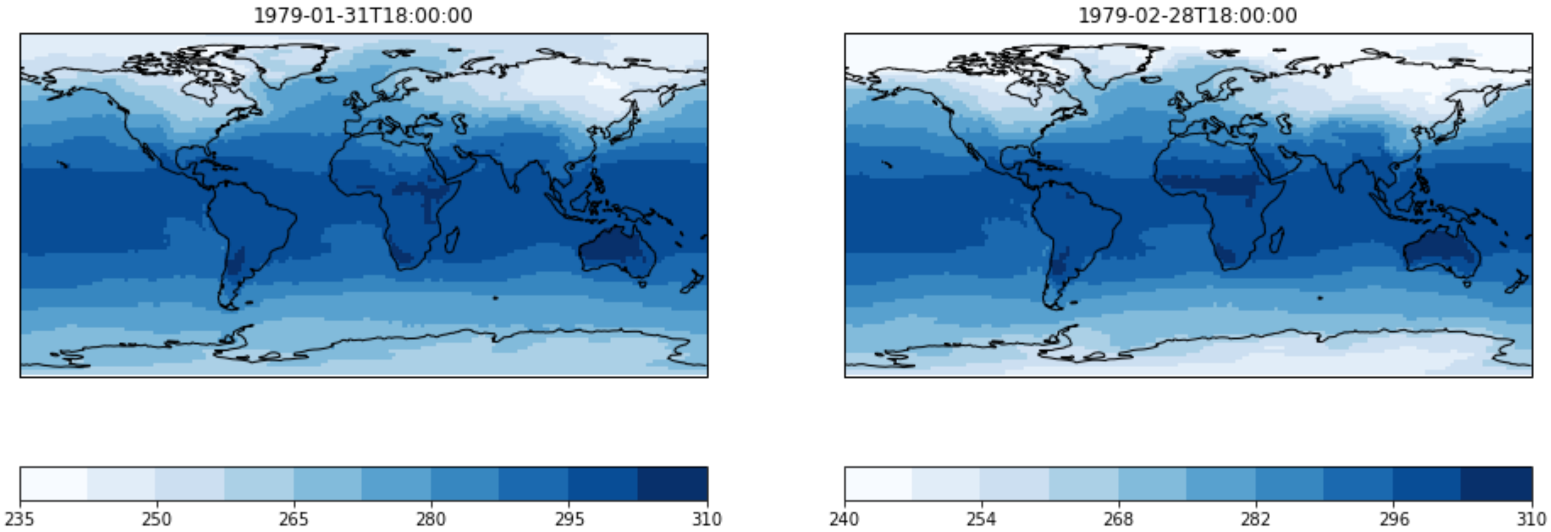
```
+----------------+----------------+----------------+----------------+
| bounds         | cbar           | cbarspacing    | clabel         |
+----------------+----------------+----------------+----------------+
| clabelprops    | clabelsize     | clabelweight   | clat           |
+----------------+----------------+----------------+----------------+
| clip           | clon           | cmap           | cticklabels    |
+----------------+----------------+----------------+----------------+
| ctickprops     | cticks         | cticksize      | ctickweight    |
+----------------+----------------+----------------+----------------+
| datagrid       | extend         | figtitle       | figtitleprops  |
+----------------+----------------+----------------+----------------+
| figtitlesize   | figtitleweight | grid_color     | grid_labels    |
+----------------+----------------+----------------+----------------+
| grid_labelsize | grid_settings  | interp_bounds  | levels         |
+----------------+----------------+----------------+----------------+
| lonlatbox      | lsm            | map_extent     | mask_datagrid  |
+----------------+----------------+----------------+----------------+
| maskbetween    | maskgeq        | maskgreater    | maskleq        |
+----------------+----------------+----------------+----------------+
| maskless       | miss_color     | plot           | post           |
+----------------+----------------+----------------+----------------+
| post_timing    | projection     | stock_img      | text           |
+----------------+----------------+----------------+----------------+
| tight          | title          | titleprops     | titlesize      |
+----------------+----------------+----------------+----------------+
| titleweight    | transform      | xgrid          | ygrid          |
+----------------+----------------+----------------+----------------+
```

Other features

Update plots

In [27]:

```
sp.update(cmap='Blues')
```



In [28]:

```
# make some jupyter specific config
%config InlineBackend.close_figures = True
psy.rcParams['auto_show'] = False
psy.close('all')
```

Other features

Generate plots from the command line

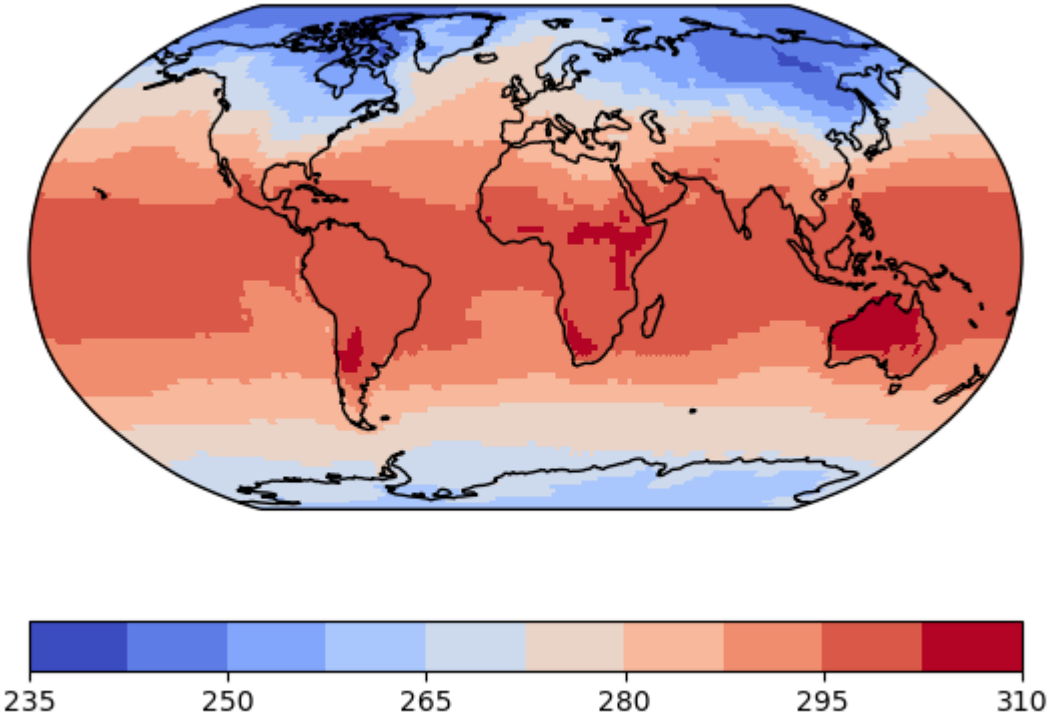
In [29]:

```
!echo 'projection: robin' > fmt.yml
!psyplot demo.nc -n t2m -pm mapplot -fmt fmt.yml -o output.png
```

```
/home/psommer/miniconda3/envs/psyplot-presi/lib/python3.7/site-packages/psyplo
t/data.py:2028: FutureWarning: In xarray version 0.15 the default behaviour of
`open_mfdataset`
will change. To retain the existing behavior, pass
combine='nested'. To use future default behavior, pass
combine='by_coords'. See
http://xarray.pydata.org/en/stable/combining.html#combining-multi

  decode_coords=False, **kwargs)
/home/psommer/miniconda3/envs/psyplot-presi/lib/python3.7/site-packages/xarray
/backends/api.py:941: FutureWarning: The datasets supplied have global dimensi
on coordinates. You may want
to use the new `combine_by_coords` function (or the
`combine='by_coords'` option to `open_mfdataset`) to order the datasets
before concatenation. Alternatively, to continue concatenating based
on the order the datasets are supplied in future, please use the new
`combine_nested` function (or the `combine='nested'` option to
open_mfdataset).
  from_openmfds=True,
```

In [30]:

```
display(Image('output.png'))
```



3D visualization (not matplotlib, VTK)

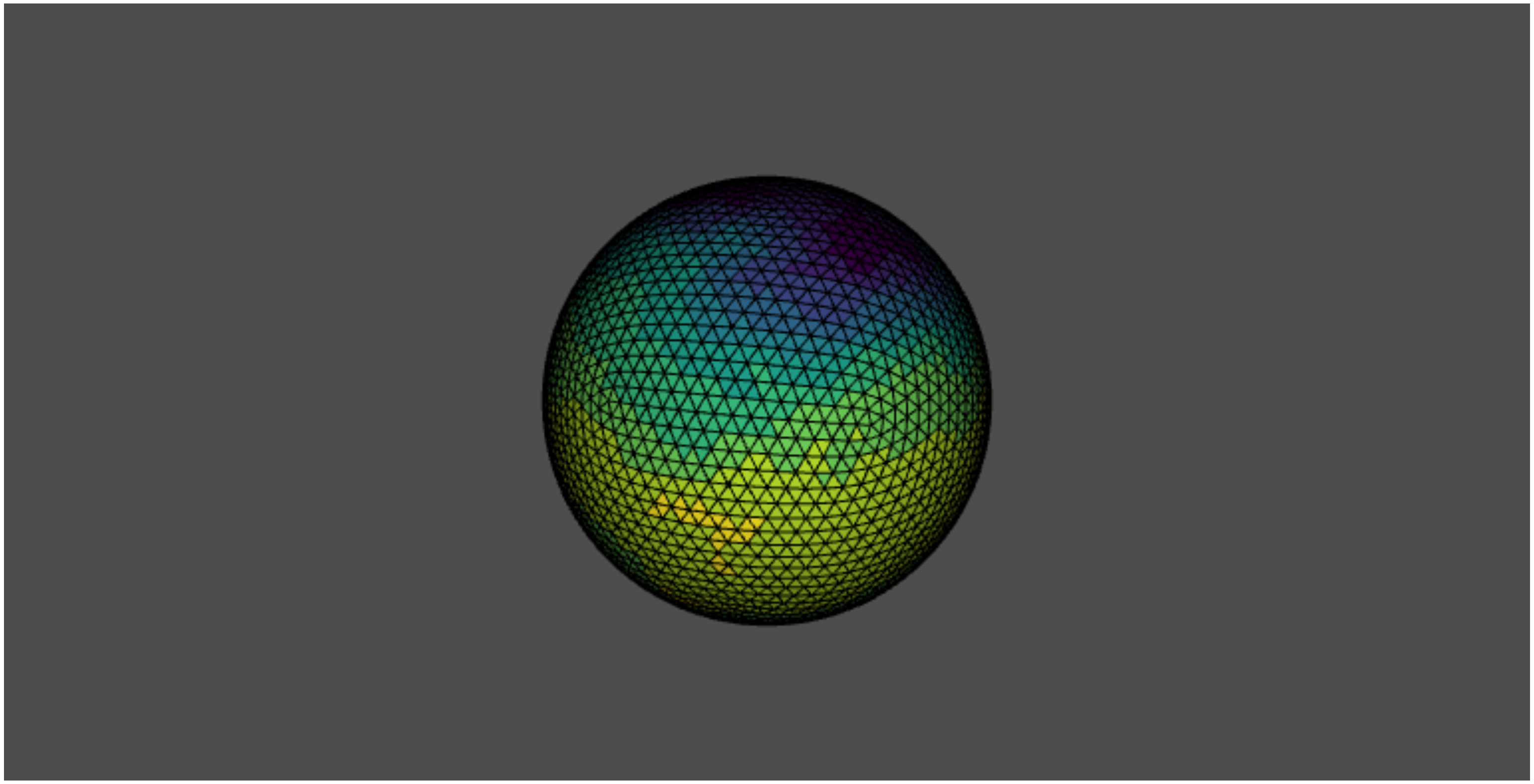
In [31]:

```
import psy_vtk.plotters as pvtk
```

In [32]:

```
ds = psy.open_dataset('icon_grid_demo.nc')
data = ds.psy.t2m.psy[0, 0]

globe_plot = pvtk.GlobePlotter(data, cmap='viridis', datagrid=True)
disp = globe_plot.ax.show()
disp
```

Out[32]:

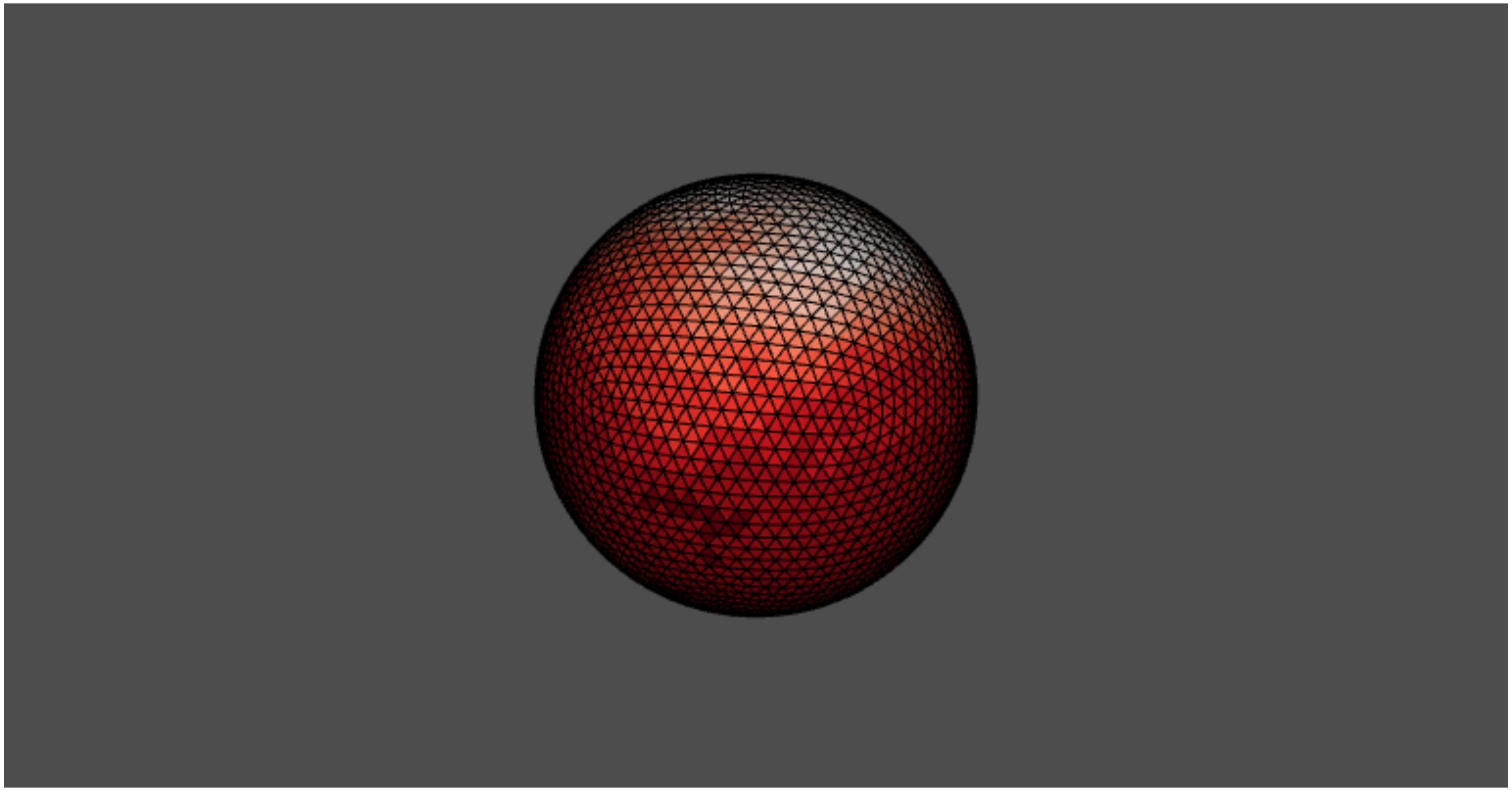


3D visualization (not matplotlib, VTK)

In [33]:

```
globe_plot.update(cmap='Reds')
disp.clone()
```

Out[33]:



3D visualization (not matplotlib, VTK)

Support for all grids (out-of-the-box!)

In [34]:

```
data
```

Out[34]:

```
<xarray.DataArray 't2m' (ncells: 5120)>
array([268.0231 , 267.82184, 270.76376, ..., 284.9598 , 281.40765, 285.71848],
      dtype=float32)
Coordinates:
    time     datetime64[ns] 1979-01-31T18:00:00
    clon     (ncells) float64 ...
    clat     (ncells) float64 ...
    lev      float64 1e+05
Dimensions without coordinates: ncells
Attributes:
    long_name:                     Temperature
    units:                         K
    code:                          130
    table:                         128
    CDI_grid_type:                 unstructured
    number_of_grid_in_reference:   1
```

In [35]:

```
ds = psy.open_dataset('T.nc')
data = ds.T[0, 0]

globe_plot = pvtk.GlobePlotter(data, cmap='viridis', datagrid=True)
globe_plot.ax.show()
```

Out[35]:

Advanced implementation: Transect through your data

Extract the data along a line and plot the vertical profile with respect to the underlying orography.

In [36]:

```
temperature = psy.open_dataset('T.nc').psy.T.psy[0]
orography = psy.open_dataset('lffd1980010100c.nc').psy.HHL.psy[0]
```

In [37]:

```
temperature
```

Out[37]:

```
<xarray.DataArray 'T' (level: 40, rlat: 111, rlon: 101)>
[448440 values with dtype=float32]
Coordinates:
    lat      (rlat, rlon) float32 ...
    lon      (rlat, rlon) float32 ...
  * rlat     (rlat) float32 -24.09 -23.65 -23.21 -22.77 ... 23.43 23.87 24.31
  * rlon     (rlon) float32 -25.13 -24.69 -24.25 -23.81 ... 17.99 18.43 18.87
    time     datetime64[ns] 1983-12-01T21:00:00
Dimensions without coordinates: level
Attributes:
    standard_name:  air_temperature
    long_name:      temperature
    units:          K
    grid_mapping:   rotated_pole
    cell_methods:   time: point
```

In [38]:

```
orography
```

Out[38]:

```
<xarray.DataArray 'HHL' (level1: 41, rlat: 111, rlon: 101)>
[459651 values with dtype=float32]
Coordinates:
    time     datetime64[ns] 1980-01-01
  * rlon     (rlon) float32 -25.13 -24.69 -24.25 -23.81 ... 17.99 18.43 18.87
  * rlat     (rlat) float32 -24.09 -23.65 -23.21 -22.77 ... 23.43 23.87 24.31
    lon      (rlat, rlon) float32 ...
    lat      (rlat, rlon) float32 ...
Dimensions without coordinates: level1
Attributes:
    standard_name:  altitude
    long_name:      height
    units:          m
    grid_mapping:   rotated_pole
    positive:       up
    cell_methods:   time: point
```

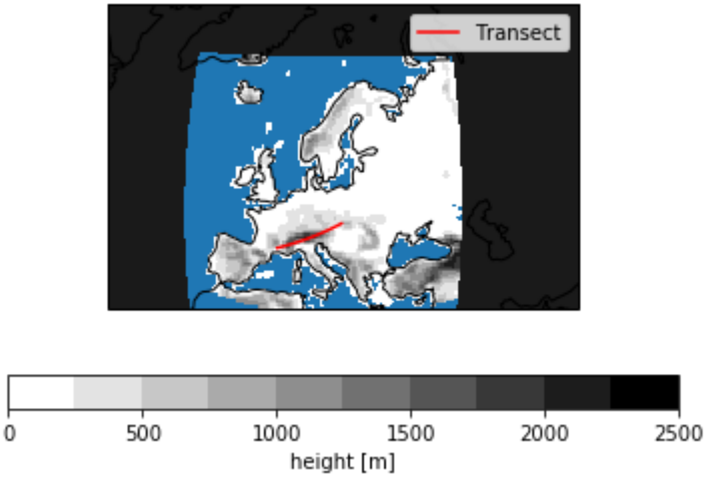
The transect

In [39]:

```
import numpy as np
import matplotlib.pyplot as plt
```

In [40]:

```
min_orog = orography.min('level1', keep_attrs=True)
min_orog.encoding['coordinates'] = orography.encoding['coordinates']
plotter = min_orog.psy.plot.mapplot(
    cmap='binary', maskleq=0, miss_color='#1f77b4',
    projection='ortho', lonlatbox='Europe', clabel='{desc}');
plotter.ax.background_patch.set_facecolor('0.1')

points = np.vstack([np.linspace(4, 18, 200), np.linspace(44, 49, 200)]).T

line = plotter.ax.plot(
    points[:, 0], points[:, 1], color='r', transform=plotter.transform.projecti
on)
plt.legend(line, ['Transect']);
```



The transect formatoption

In [41]:

```
from psyplot.plotter import START
from sklearn.neighbors import BallTree
from psyplot.utils import unique_everseen
import xarray as xr

class Transect(Formatoption):
    priority = START  # first phase for psyplot, data manipulation

    @property
    def default(self):  # placeholder
        return None

    def update(self, value):
        data = self.data[0]

        lon = self.decoder.get_x(data, data.coords)
        lat = self.decoder.get_y(data, data.coords)

        if lon.shape != data.shape[1:]:
            lon, lat = np.meshgrid(lon, lat)
        lon = np.ravel(lon)
        lat = np.ravel(lat)

        # find the closest grid cell using some efficient machine learning libr
ary
        tree = BallTree(np.vstack([lon, lat]).T)
        indices = np.array(list(unique_everseen(tree.query(
            value, return_distance=False, sort_results=False)[:, 0])))

        # select the closest grid cells in orography and scalar variable (T)
        arrays = self.data
        new_arrays = []
        for da in arrays:
            nlev = da.shape[0]
            arr = da.values.reshape((nlev, -1))[:, indices]
            coords = {key: val for key, val in da.coords.items() if val.dims ==
da.dims[:1]}
            new_arrays.append(xr.DataArray(
                arr, dims=(da.dims[0], '_cell'),
                coords=coords))
```

The transect plotter

In [42]:

```
from psy_simple.plotters import Simple2DPlotter, SimplePlot2D, Ylim2D, DataGrid


class TransectPlot2d(SimplePlot2D):

    @property
    def raw_data(self):
        return self.data

class TransectYlim(Ylim2D):

    @property
    def raw_data(self):
        return self.data

class TransectDataGrid(DataGrid):

    @property
    def raw_data(self):
        return self.data

class TransectPlotter(Simple2DPlotter):
    transect = Transect('transect')
    plot = TransectPlot2d('plot')
    ylim = TransectYlim('ylim')
    datagrid = TransectDataGrid('datagrid')

    allowed_dims = 3

    def get_enhanced_attrs(self, arr, *args, **kwargs):
        return getattr(arr, 'attrs', {})
```

Combining temperature and orography into one InteractiveList

In [43]:

```
import psyplot.data as psyd
data = psyd.InteractiveList([
    temperature,
    orography
])
for da in data:
    da[da.dims[0]] = (da.dims[0], np.arange(da.shape[0]))
data
```

Out[43]:

```
arr0: psyplot.data.InteractiveList([
    arr0: 3-dim DataArray of T, with (level, rlat, rlon)=(40, 111, 101), time=
1983-12-01T21:00:00,
    arr1: 3-dim DataArray of HHL, with (level1, rlat, rlon)=(41, 111, 101), ti
me=1980-01-01])
```

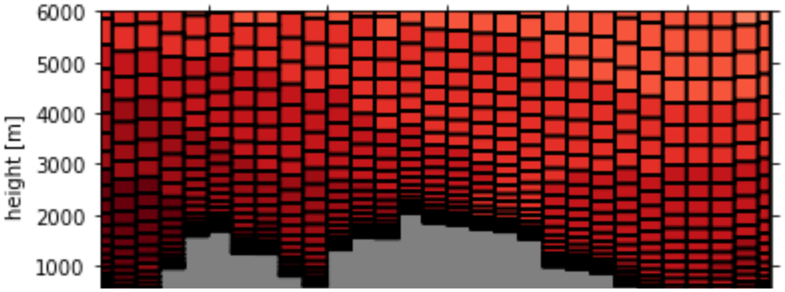
That’s it!

In [44]:

```
plotter = TransectPlotter(
    data, transect=points.tolist(), xlim='minmax', plot='poly',
    ylim='minmax', cmap='Reds', clabel='{desc}', ylabel='height [m]')
plotter.ax.set_facecolor('0.5')
plotter.update(datagrid='k-', mask_datagrid=False, ylim=(0, 6000))
plotter.plot_data.psy.base
```

Out[44]:

```
<xarray.Dataset>
Dimensions:          (_bnds: 2, _cell: 29, level: 40)
Coordinates:
  * level            (level) int64 0 1 2 3 4 5 6 7 8 ... 32 33 34 35 36 37 38 3
9
    orography        (level, _cell) float32 21750.0 21750.0 ... 305.6878 402.29
65
  * _cell            (_cell) int64 0 1 2 3 4 5 6 7 8 ... 21 22 23 24 25 26 27 2
8
    _cell_coord      (level, _cell) float64 0.5 1.5 2.5 3.5 ... 26.5 27.5 28.5
    orography_bnds   (level, _cell, _bnds) float32 22700.0 20800.0 ... 392.6400
5
Dimensions without coordinates: _bnds
Data variables:
    T                (level, _cell) float32 207.45358 207.35056 ... 263.18335
```



Summary

The framework

- the psyplot core for the data model, and plugins for various visualizations
- designed to be flexible and sustainable
- equipped via flexible graphical user interface

The data model

- based on a netCDF-like infrastructure and interpretes CF- and UGRID conventions
- support for multiple grids: rectilinear, circumpolar and unstructured

Scriptability

- close to the data with a minimum of visualization overhead (compared to Paraview or something else)
- can easily be enhanced by other powerful libraries, such as scipy, scikit-learn, etc.

Roadmap for 2020

General features

- Transfer psyplot repositories to https://github.com/psyplot (https://github.com/psyplot)
- 3D visualization using vtk (see https://github.com/Chilipp/psy-vtk (https://github.com/Chilipp/psy-vtk))
- Exporting psyplot projects as scripts (see https://github.com/Chilipp/psyplot/issues/4 (https://github.com/Chilipp/psyplot/issues/4))
- add animation features (see https://github.com/Chilipp/psyplot/issues/10 (https://github.com/Chilipp/psyplot/issues/10) and https://github.com/Chilipp/psyplot-gui/issues/7 (https://github.com/Chilipp/psyplot-gui/issues/7))

GUI

- A more intuitive widget for updating central formatoptions in the GUI (e.g. colorbar, colormap, etc.). This could be implemented as plugins for the GUI in the individual package (psy-simple, psy-maps, etc.) (see https://github.com/Chilipp/psyplot-gui/issues/7#issuecomment-562529774 (https://github.com/Chilipp/psyplot-gui/issues/7#issuecomment-562529774))
- Generate time-series (or any other dimension) by clicking on a grid cell in a map (such as ncview does it, see https://github.com/Chilipp/psyplot-gui/issues/7#issuecomment-562529774 (https://github.com/Chilipp/psyplot-gui/issues/7#issuecomment-562529774))

Technical issues

- The sharing of formatoptions needs to be improved. The strategy within the `Project.update` method (currently it is using one `Thread` per array in the project) needs to be revised. My suggestions is to rather update all formatoptions (and dimensions) in one single thread using some kind of dependency graph