

KrigR — A Tool for Downloading and Statistically Downscaling Climate Reanalysis Data.

Efficient Data Retrieval and Processing of ECMWF C3S Products for Your Research



SCAN ME

KrigR
GitHub



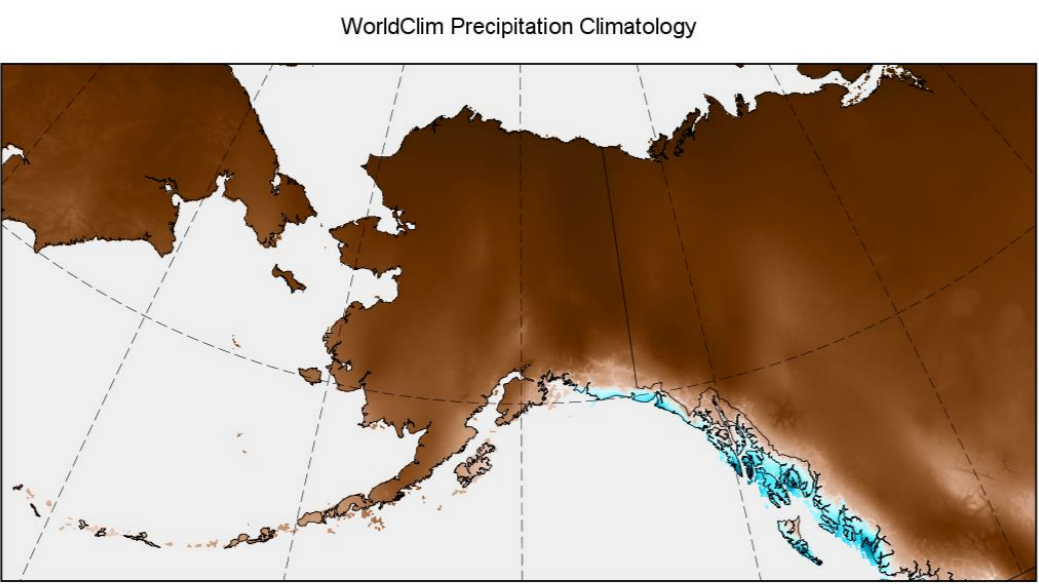
Find me around the venue if I'm not here. I'd love to chat.

Erik Kusch¹, Richard Davy²
¹Aarhus University, ²Nansen Environmental and Remote Sensing Center,

CLIMATE DATA NEEDS FOR THE 21ST CENTURY

1. Data Accuracy

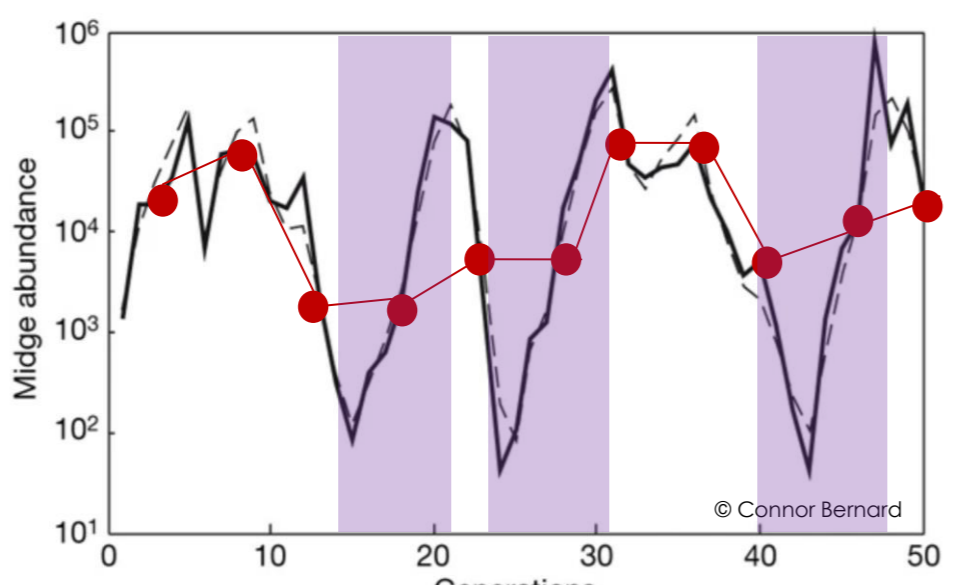
- Global legacy climate data sets (e.g., CRU, WorldClim) offer subpar accuracy
→ Macroecology relies on climate data at global scales



Climate Reanalyses (e.g.; ERA5/ERA5-Land) offer higher accuracy and data uncertainty flags.

2. Temporal Resolution

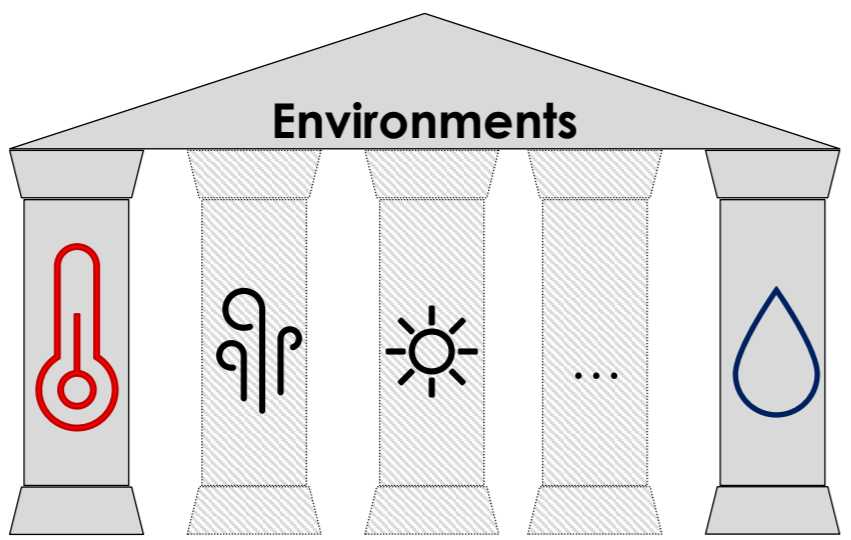
- Legacy data sets rarely report data at sub-monthly intervals
→ Biological processes (●) and extreme events (■) operate at finer temporal resolutions



ERA5(-Land) offer data at hourly intervals.

3. Range of Variables

- Legacy data follows a temperature (●) – precipitation (○) paradigm
→ Neglecting other essential climate variables (ECVs) like wind (⌘), radiation (⊗), etc. (...)



ERA5(-Land) offers up to 83 ECVs.

ROADBLOCKS FOR CLIMATE REANALYSES

1. Accessibility

- Climate Data Store (CDS) interface can be overwhelming and downloads hard to reproduce
- CDS APIs (e.g., ecmfr) download specification can be unintuitive and don't offer data manipulation

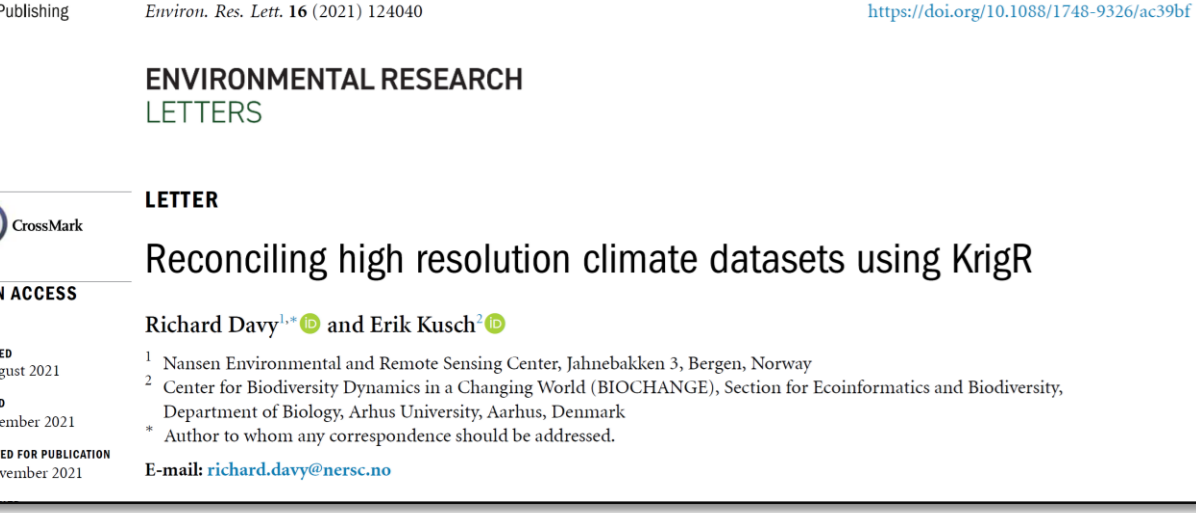
Practitioners need an intuitive, reproducible R-interface for data retrieval and handling.

2. Spatial Resolution

- Native spatial resolution of climate reanalyses is coarser than that of legacy data
→ Practitioners have become accustomed to these fine spatial resolutions

Practitioners require a workflow for creation of high-spatial-resolution data products.

IMPLICATIONS OF KrigR-DERIVED PRODUCTS



ENVIRONMENTAL RESEARCH LETTERS

LETTER

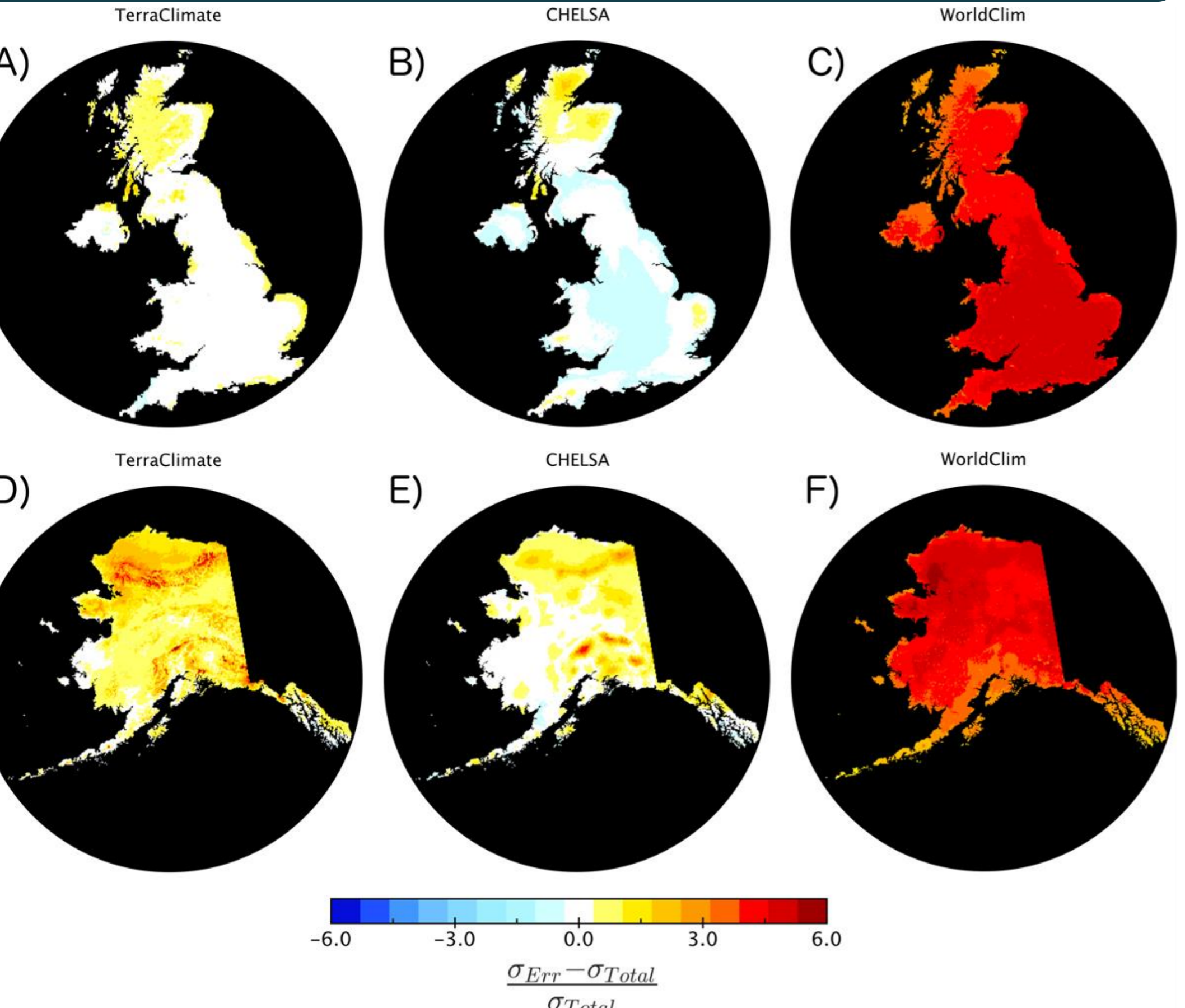
Reconciling high resolution climate datasets using KrigR

Richard Davy¹ and Erik Kusch²

¹ Nansen Environmental and Remote Sensing Center, Sherholmen 3, Bergen, Norway
² Center for Biodiversity Dynamics in a Changing World (BIOCHANGE), Section for Ecotoxicology and Biodiversity, Department of Biology, Aarhus University, Aarhus, Denmark
* Author to whom any correspondence should be addressed.
E-mail: richard.davy@ner-sc.no

Kriging is highly accurate for a variety of ECVs.

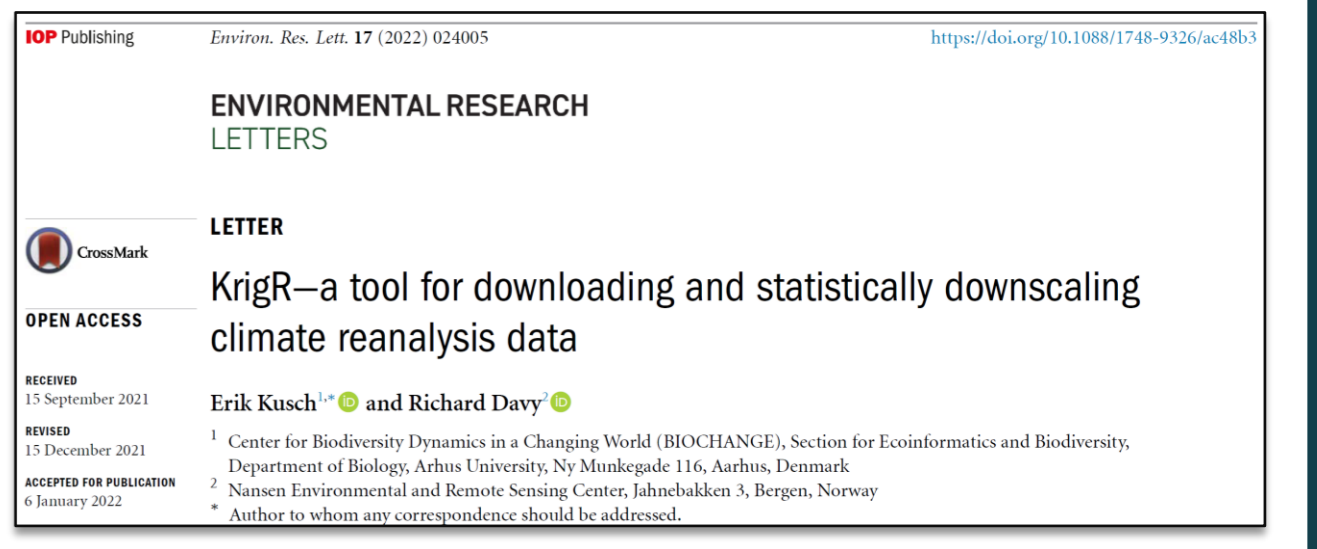
Legacy products largely fall outside of KrigR predictions ± uncertainty.



THE KrigR-TOOLBOX

R-internal functionality for retrieval of climate data matching requirements:

- Downloading & handling of ERA5(-Land) products
- Provision and preparation of interpolation covariates
- Statistical interpolation of climate data via Kriging



ENVIRONMENTAL RESEARCH LETTERS

LETTER

KrigR—a tool for downloading and statistically downscaling climate reanalysis data

Erik Kusch¹ and Richard Davy²

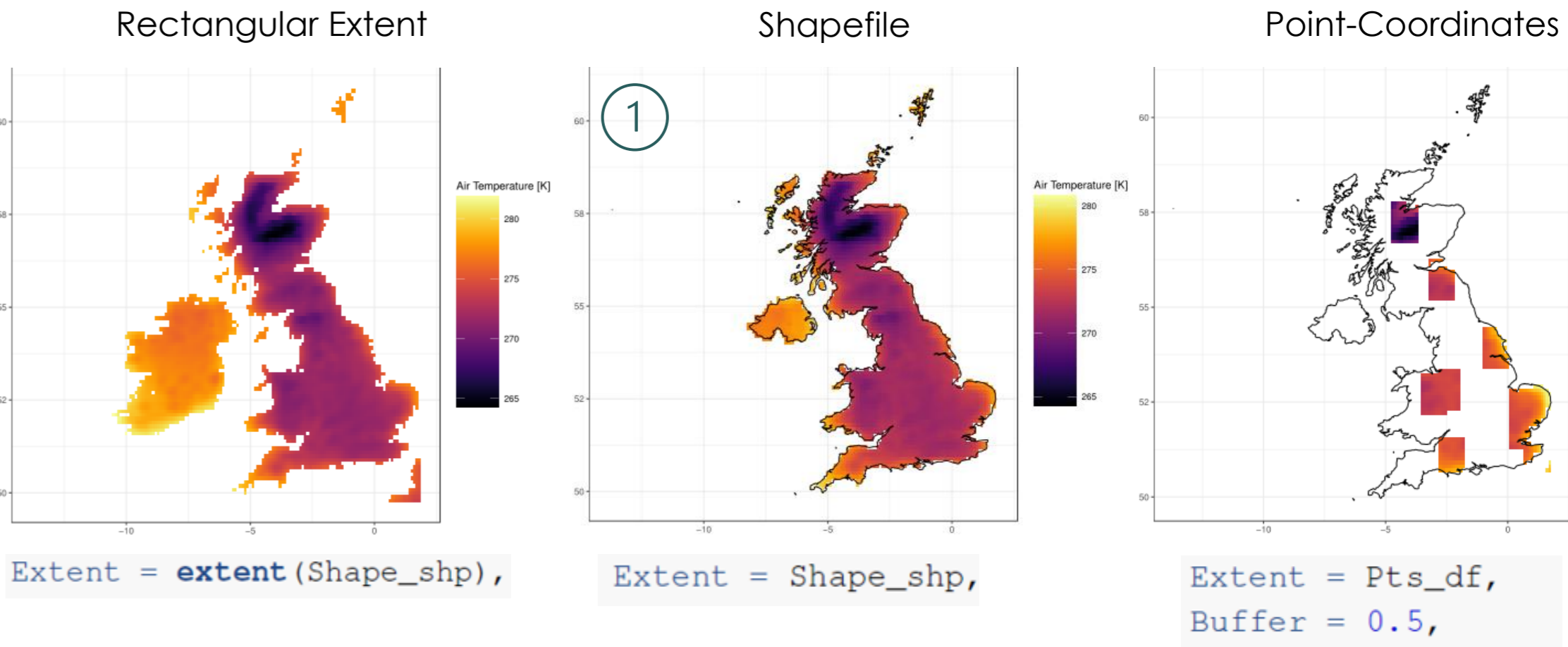
¹ Center for Biodiversity Dynamics in a Changing World (BIOCHANGE), Section for Ecotoxicology and Biodiversity, Department of Biology, Aarhus University, Ny Munkegade 116, Aarhus, Denmark
² Nansen Environmental and Remote Sensing Center, Sherholmen 3, Bergen, Norway
* Author to whom any correspondence should be addressed.

Climate Data Retrieval

```
download_ERA(
  Variable = "2m_temperature", # Climate Variable
  DataSet = "era5-land", # Reanalysis Data Product
  DateStart = "1995-01-03", # Time-Window
  DateStop = "1995-01-03",
  Resolution = "day", # Temporal Resolution
  TStep = 1,
  Extent = extent(Shape_shp), # Geographical Region
  Dir = Dir.Data, # Directory for NETCDF
  FileName = "ExtentRaw", # Name for NETCDF
  API_User = API_User, # CDS API Credentials
  API_Key = API_Key
)
```

All subsequent steps in KrigR can handle third-party data.

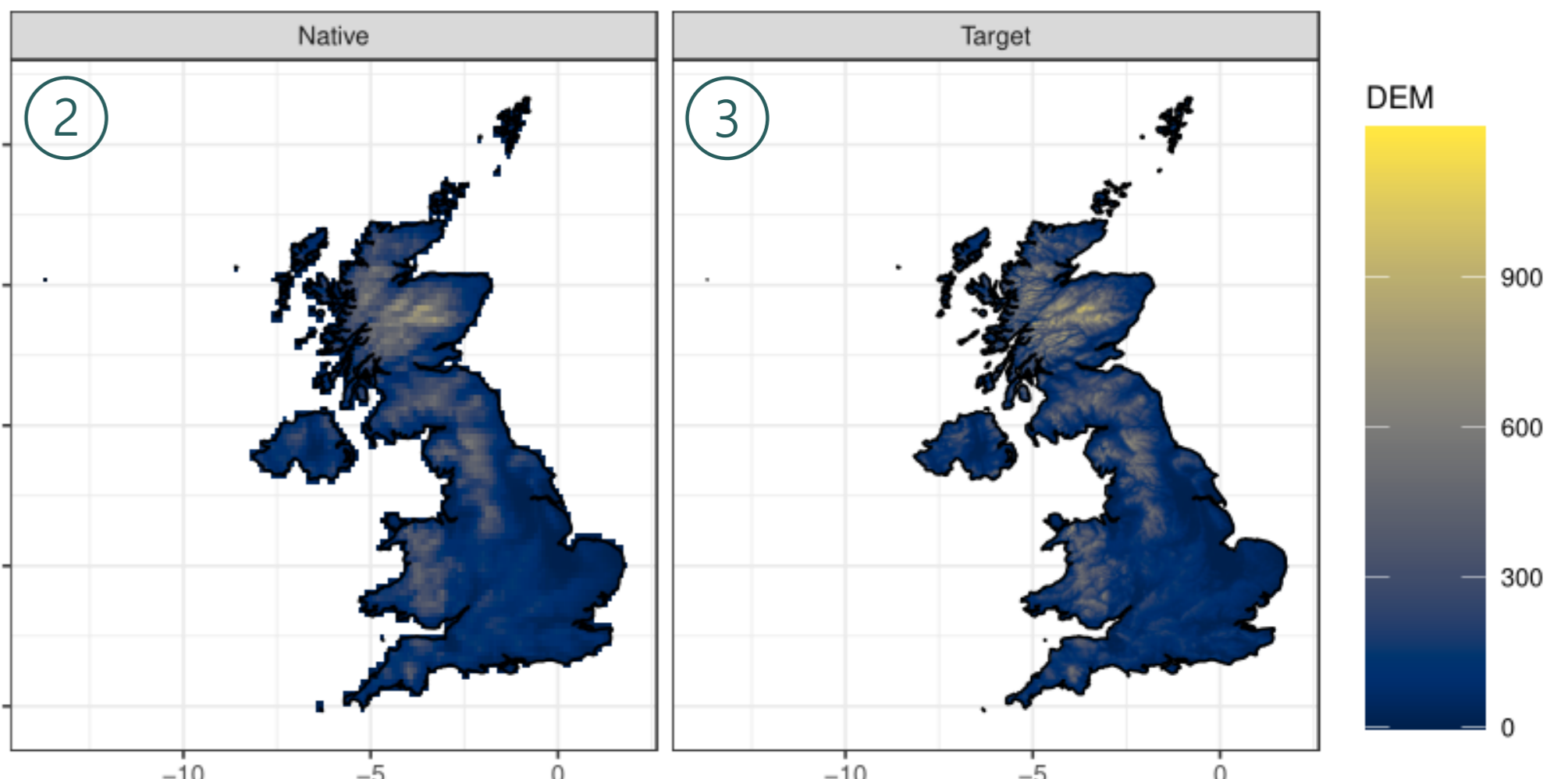
Extent controls spatial limits of the data.



Covariates

```
download_DEM(
  Train_ras = Demo_Raw, # Data you want to downscale (i.e.: 1)
  Target_res = .02, # Target resolution or a raster object whose resolution to match
  Shape = Shape_shp, # Optional, shapefiles or points like specified in download_ERA()
  Keep_Temporary = TRUE # Whether to keep the GMTED 2010 data set on your hard drive
)
```

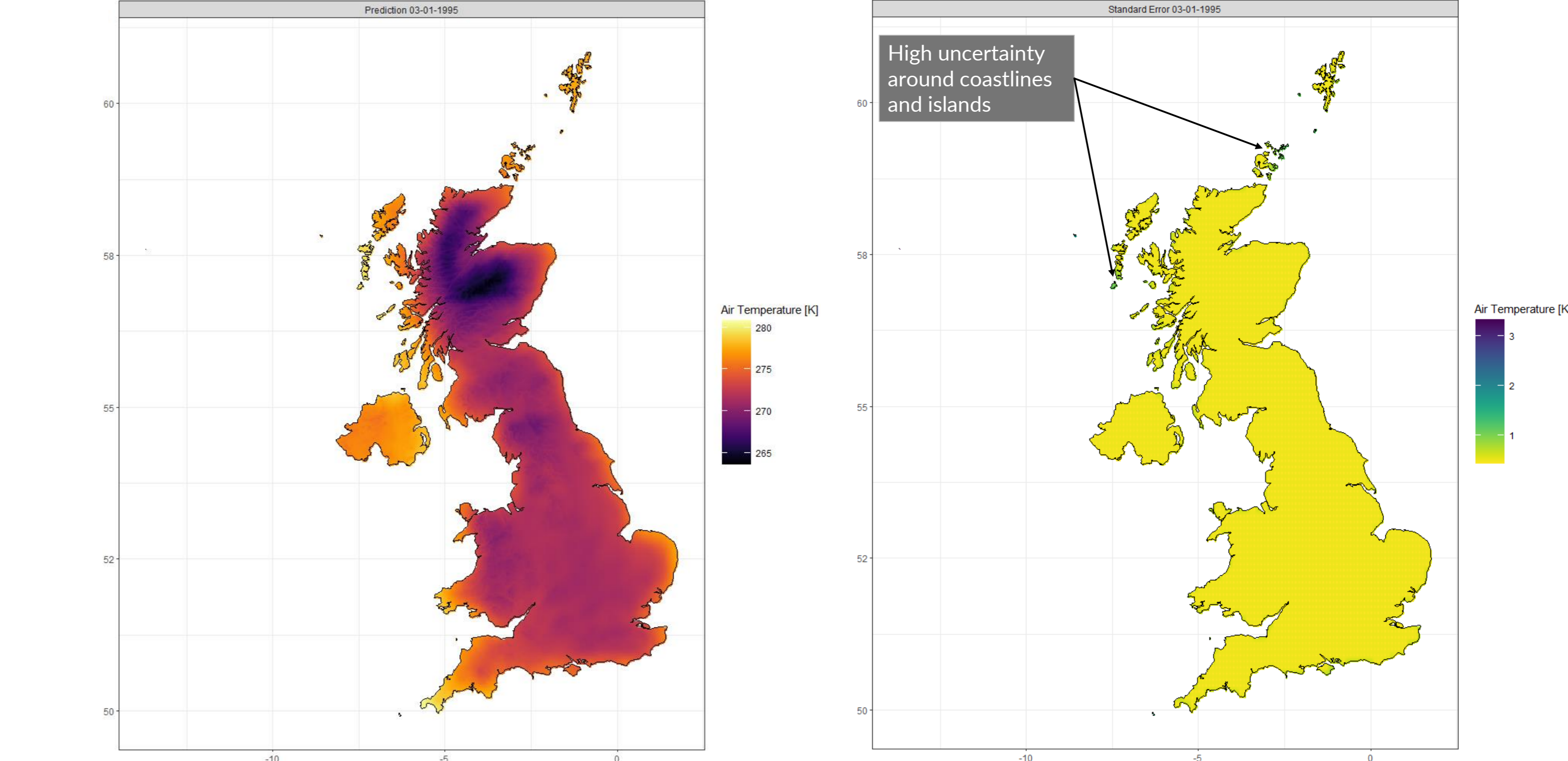
The default DEM won't be a suitable covariate for all ECVs.



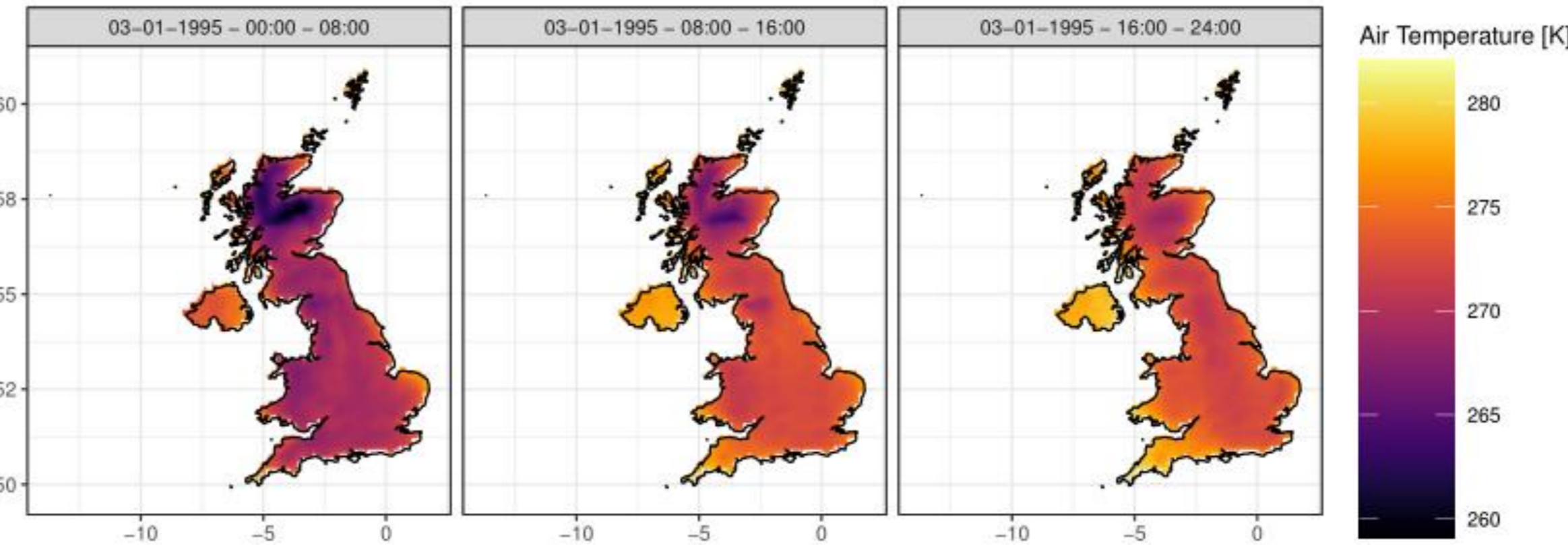
Interpolation uncertainty is an output unique to Kriging.

Computational costs depends on user-specifications and statistical relationships.

Kriging



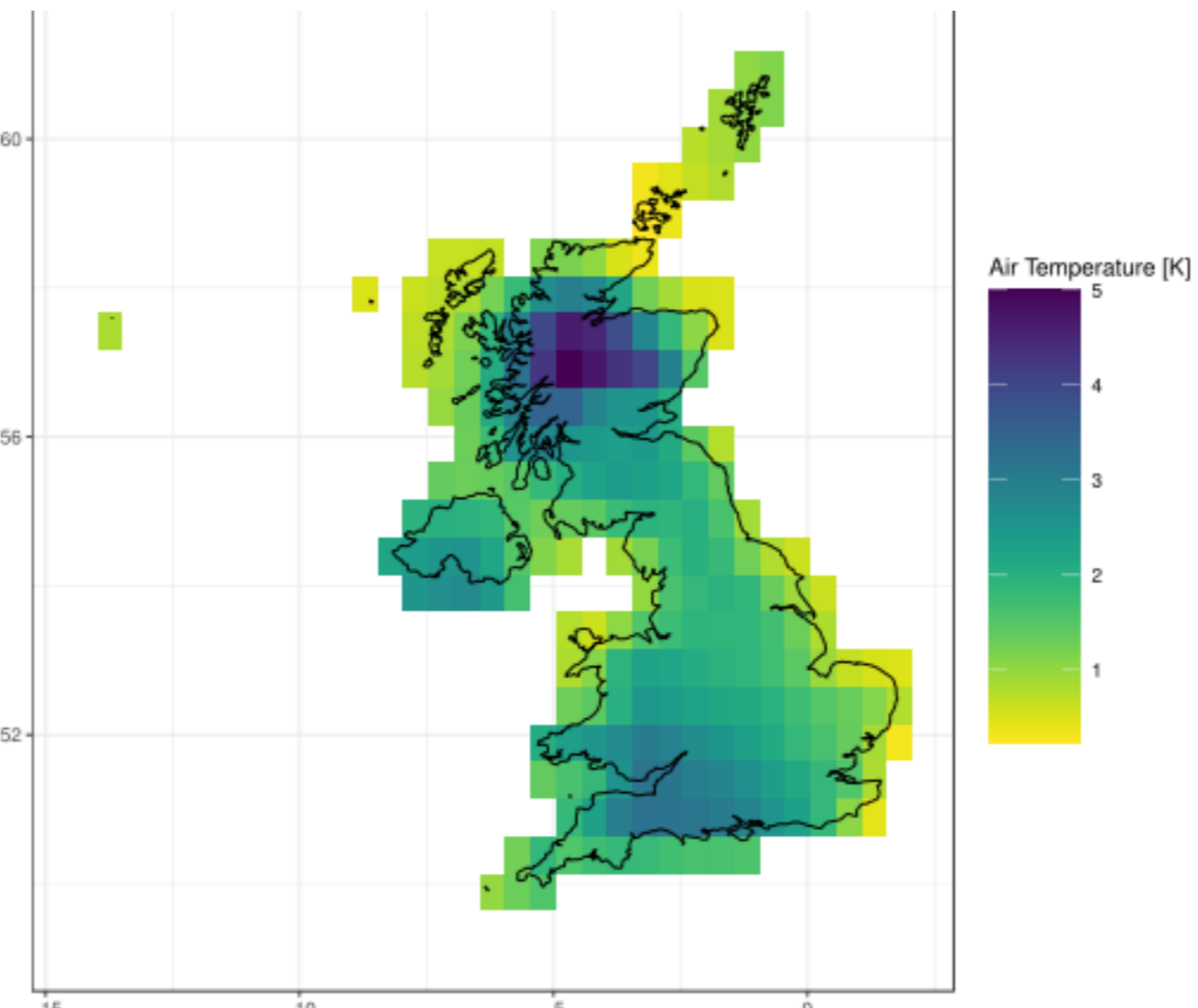
TResolution and TStep control temporal resolution of the data.



```
TResolution = "hour",
TStep = 8,
```

FUN controls aggregate metrics.

Considerations in download_ERA()



The standard deviation of the underlying reanalysis ensemble members gives the dynamic data uncertainty.

```
DataSet = "era5",
Type = "ensemble_members",
FUN = sd,
```

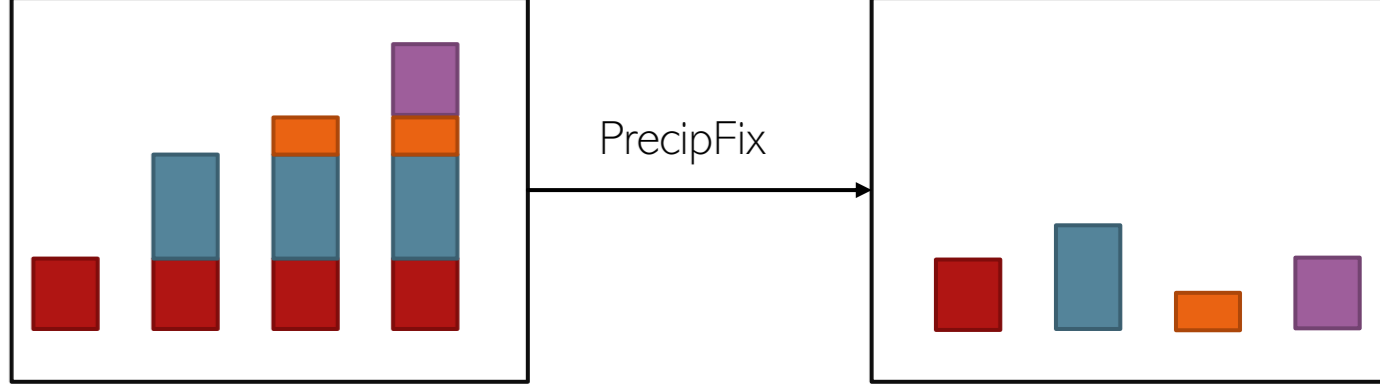
Downloads are automatically broken into individual months of data.

Cores controls how many downloads to stage in parallel.

SingularDL allows staging of a maximum of 100.00 layers of data as one download.

Some ECVs are stored cumulatively.

PrecipFix enables back-calculation.



KrigR doesn't support all ECMWF C3S products.

We are planning to expand KrigR functionality & ECMWF has voiced interest in us doing so.