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Theme 6



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1. Introduction

This document describes the steps necessary to make UERRA data available on ESGF (Earth Science Grid Federation). The goal is that UERRA data is findable and accessible on ESGF and usable in third party portals. To achieve this, a selected UERRA dataset is obtained from the ECMWF MARS system using the MARS API. This data is converted from GRIB to NetCDF using the FIMEX tool. For metadata, the NetCDF files conforms to both the Climate and Forecast conventions and the CLIPC Data Reference Syntax (DRS). The DRS makes sure that data is correctly indexed and available in the ESGF faceted search engine.

An ESGF data node is setup for UERRA at KNMI. Data is then stored on the UERRA ESGF node, published to the DKRZ index node and made findable/accessible through the whole federation. To demonstrate this, UERRA data was searched, previewed and used in the EU/FP7 IS-ENES2 climate4impact portal.

As the data required for publication was not available in the MARS archive on time, the D4.4 deliverable was delayed. Once the data was available the publication of the set was started.

The MARS work at ECMWF is going on very actively now and can be followed on the wiki UERRA pages (and in the Mars Catalogue).

The work on the UERRA ESGF node has progressed well. A contiguous 15 year temperature data set for the SMHI RRA has been extracted for every 6 hours and converted to NetCDF. The metadata follows the CLIPC metadata standard. This document describes the procedure used to publish EURRA data on ESGF. Intended readers are the UERRA data providers, wanting to publish data on ESGF.

2. What is ESGF?

The Earth System Grid Federation (ESGF) Peer-to-Peer (P2P) enterprise system is a collaboration that develops, deploys and maintains software infrastructure for the management, dissemination, and analysis of model output and observational data. ESGF's primary goal is to facilitate advancements in Earth System Science. It is an interagency and international effort led by the Department of Energy (DOE), and co-funded by National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), and international laboratories such as the Max Planck Institute for Meteorology (MPI-M) German Climate Computing Centre (DKRZ), the Australian National University (ANU) National Computational Infrastructure (NCI), Institut Pierre-Simon Laplace (IPSL), and the British Atmospheric Data Center (BADC). European contributions are united and coordinated in ENES (European Network for Earth System modelling). The ESGF mission is to:

- Support current CMIP5 activities, and prepare for future assessments
- Develop data and metadata facilities for inclusion of observations and reanalysis products for CMIP5 use
- Enhance and improve current climate research infrastructure capabilities through involvement of the software development community and through adherence to sound software principles
- Foster collaboration across agency and political boundaries
- Integrate and interoperate with other software designed to meet the objectives of ESGF: e.g., software developed by NASA, NOAA, ESIP, and the European IS-ENES community
- Create software infrastructure and tools that facilitate scientific advancements

ESGF Architecture

ESGF P2P is a component architecture expressly designed to handle large-scale data management for worldwide distribution. The team of computer scientists and climate scientists has developed an operational system for serving climate data from multiple locations and sources. Model simulations, satellite observations, and reanalysis products are all being served from the ESGF P2P distributed data archive.

The ESGF federation aims to provide observation and climate data to a large number of users and communities. KNMI / UERRA is a member of the ESGF federation, and contributes a data node and technical support. ESGF Federation data can be used via external portals, including Climate4Impact IS-ENES portal. ESGF search APIs and OpenDAP services give access to federation Data.

3. Installation of the UERRA ESGF node at KNMI

The UERRA ESGF node is installed and running at KNMI. The system is build up from a virtual machine with 8 Cpu's, 128Gb of memory and is linked to a 1Gb network. Network bandwidth to other ESGF nodes is monitored using PerfSonar. The data node can be reached via https://esgf.knmi.nl/thredds/, and is searchable / visible from any ESGF index node in the federation. A secure and valid SSL certificate issued by TERENA is installed, enabling the node to be available over secure and verified HTTPS connections.

The UERRA ESGF data node is a so called "data node only system". A data node is designed to just host data and publish its catalog to an ESGF index node. A data-node serves its data using the THREDDS data server, which enables various ways of accessing the data, like OpenDAP and HTTP download. To make its content and catalogs findable throughout the whole federation, its metadata catalog is published to the DKRZ index node.

Initially 50Tb of storage is available to the machine, but this amount can be increased as the storage system is capable of growing to larger volumes. KNMI will sustain this ESGF node in the future as KNMI will publish its own CMIP6 datasets on this ESGF node as well. During this period UERRA datasets will remain published.

A new project named UERRA was added to the federation. Under this project datasets are published and are findable in the faceted search system. The KNMI ESGF Data Node (K-DN) is active for a period of one and a half years. The installation workflow has seen several iterations, including a major security upgrade leading to a down-time of 8 months.

Visit the installation manual at: https://github.com/ESGF/esgf-installer/wiki/ESGF-Installation-From-scratch

4. Downloading data from the ECMWF MARS System

The UERRA datasets created by project partners are stored on the ECMWF Meteorological Archival and Retrieval System (MARS). MARS is the main repository of meteorological data at ECMWF. It contains petabytes of operational and research data, as well as data from Special Projects. Users can browse the Archive catalogue (describing archive data that ECMWF can distribute) or the complete MARS catalogue (authorization required) from dedicated servers. MARS exposes a Web API, which has been used to download the UERRA datasets.

Methods for access to data on the MARS archive are described on the ECMWF web site: https://software.ecmwf.int/wiki/display/WEBAPI/Access+MARS .

UERRA data in the MARS archive can be browsed manually with a web browser, for example by pointing your browser to http://apps.ecmwf.int/mars-catalogue/?class=ur. Data retrieval can also be scripted with Python scripts; this can be useful for large or complex retrievals.

As an example we will use a browser to search temperature model data for the HAR/V1 model analysis by SMHI for the period 2005-2010:

1. Select as version: **prod** for definitive data.
2. Select as origin: **SMHI**.
3. Select **Atmospheric model** from **Deterministic forecasts**.
4. Select **Analysis** from **Assimilations**.
5. Select the year **2005**
6. Select the month **January**
7. Select the type of level **Surface**
8. Select all Dates, all Times and Parameter **2m temperature**
9. Select **View the MARS request** to view the input needed to do a MARS request for the selected data. This information could be also used to help making a Python script for retrieving the same data.
   The MARS request for this data retrieval looks like:

```
retrieve,
class=ur,
date=2005-01-01/to/2005-01-31,
expver=prod,
levtype=sfc,
origin=eswi,
param=167,
stream=oper,
time=00:00:00/06:00:00/12:00:00/18:00:00,
type=an,
target="output"
```

Data can be extracted from the MARS Web API using a Python script. An example script for retrieving the same data, but for the period 2005-2011 is:

```
#!/usr/bin/env python
from ecmwfapi import ECMWFService
from datetime import date,timedelta
import calendar
```

```
server = ECMWFService("mars")

years=[y for y in range(2005,2011)]
months=[m+1 for m in range(12)]

for yr in years:
  for m in months:
    t_start=date(yr, m, 1)
    dt_start=t_start.strftime("%Y%m%d")
    weekday,monthlength=calendar.monthrange(yr,m)
    t_end=t_start+timedelta(days=(monthlength-1))
    dt_end=t_end.strftime("%Y%m%d")
    server.execute(
    {
      "class":"ur",
      "date":"%s/to/%s"%(t_start.isoformat(), t_end.isoformat()),
      "expver":"prod",
      "levtype":"sfc",
      "origin":"egrr",
      "param":"167",
      "stream":"oper",
      "time":"00:00:00/06:00:00/12:00:00/18:00:00",
      "type":"an",
    },
    "ta_UKMO_%s_%s.grib"%(dt_start, dt_end))
```

This python script will retrieve monthly GRIB files from the MARS-archive.

5. Making data ESGF publishable

To publish data in the ESGF, data needs to be in NetCDF and needs to conform to metadata standards. Firstly the data needs to conform to the climate and forecast conventions, secondly the data needs to conform to a Data Reference Syntax (DRS). The latter one is also about how the directory structure for storing the files should look like and how the files should be named.

More in depth information can be read in: https://drclimate.wordpress.com/2015/09/04/managing-your-data/.

Data reference syntax (DRS): Re-using CLIPC DRS

For UERRA we followed the existing CLIPC data reference syntax, as this DRS is suitable for both regional climate model data and climate indicators. Both types of data will be made available during the UERRA project.

Documentation on the CLIPC DRS for Climate Impact Indicators can be found at:
https://dev.knmi.nl/attachments/825/CLIPC_DRS_for_Climate_Impact_Indicators.pdf

Data conversion from Grib to NetCDF: FIMEX

The tool Fimex (http://fimex.met.no) is used to convert the grib files to NetCDF files. This tool can also be used to add metadata required for publishing files in the ESGF node at the same time as the NetCDF file is created.

Calling Fimex from command line:

fimex --input.file="glob:ta_2006*" --input.type=grib --input.config=cdmGribReaderConfig.xml --output.file=ta_2006_SMHI.nc

This Fimex call uses an XML configuration file, which specifies the conversion from GRIB to NetCDF.

An example of a Fimex configuration file used for conversion can be found in Appendix A:

Testing DRS compliancy: CLIPC DRS Checker

In the CLIPC project all published files needed to adhere to the CLIPC DRS standard. As data was provided by many partners, a tool was needed to check the quality of the metadata. All metadata needed to be filled out correctly. The tool is available via: https://dev.knmi.nl/projects/drschecker/wiki

The DRS checker was applied on the UERRA datasets published in the ESGF node as well.

6. Publishing the datasets on ESGF

The created datasets need to be published on the KNMI/UERRA data node. A detailed manual about this procedure can be found on the ESGF Confluence Wiki with filename ESGF-GuidetoESGFPublishingandBestPractices-260617-0038.pdf

For publishing files the following commands can be used:

1. from root on the node go to: 'su esgpub'

2. place data in /data/esgf/uerra/

3. myproxy-logon -T -s esgf-data.dkrz.de -p 7512 -l ESGFKNMI -o ~/.globus/certificate-file -b

3b. generate metadata at /usr/people/mihajlov/python/uerra
drs dir: UERRA.observations.EOBS.EUR-25.KNMI.day.tg.0.25deg.v14.0
drs name: tg_EOBS_KNMI_0.25deg_1950-2016.nc

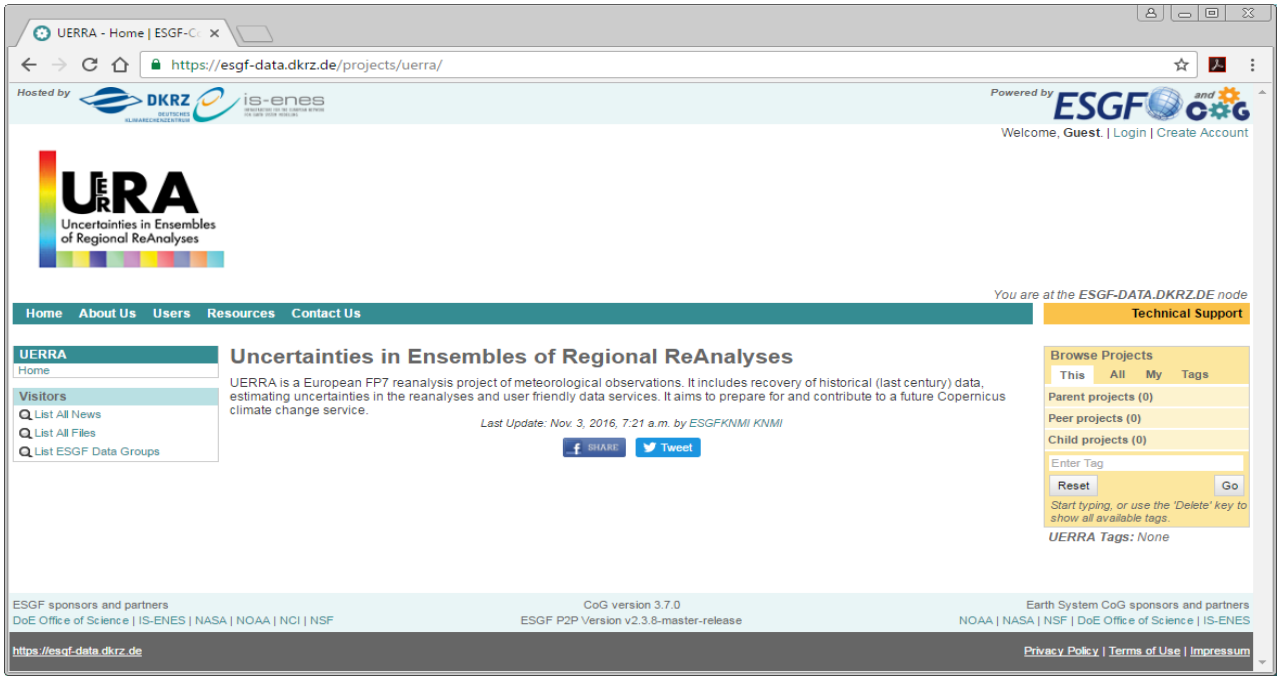
4. esgprep mapfile --dataset UERRA.observations.EOBS.EUR-25.KNMI.day.tg.0.25deg.v14.0 --project uerra /data/esgf/uerra/

5. esgpublish --service fileservice --map UERRA.observations.EOBS.EUR-25.KNMI.day.tg.0.25deg.v14.0.map --project uerra --p

UERRA datasets in the MARS archive are offered by the KNMI Data Node and indexed by the DKRZ index node. The relevant metadata and drs are delivered for publication of the datasets.

The UERRA project is available on ESGF via:

https://esgf-data.dkrz.de/projects/uerra/



The THREDDS catalog is accessible via https://esgf.knmi.nl/thredds/



7. Using the UERRA datasets in the climate4impact portal

To demonstrate that the UERRA datasets published on ESGF are accessible and findable, the climate4impact portal will be used. With climate4impact it is possible to search the complete ESGF federation, including UERRA datasets. A preview and some simple analysis will be performed in the climate4impact portal.

Creating an ESGF account and become member of UERRA

An account is needed to access the ESGF. It can be created at

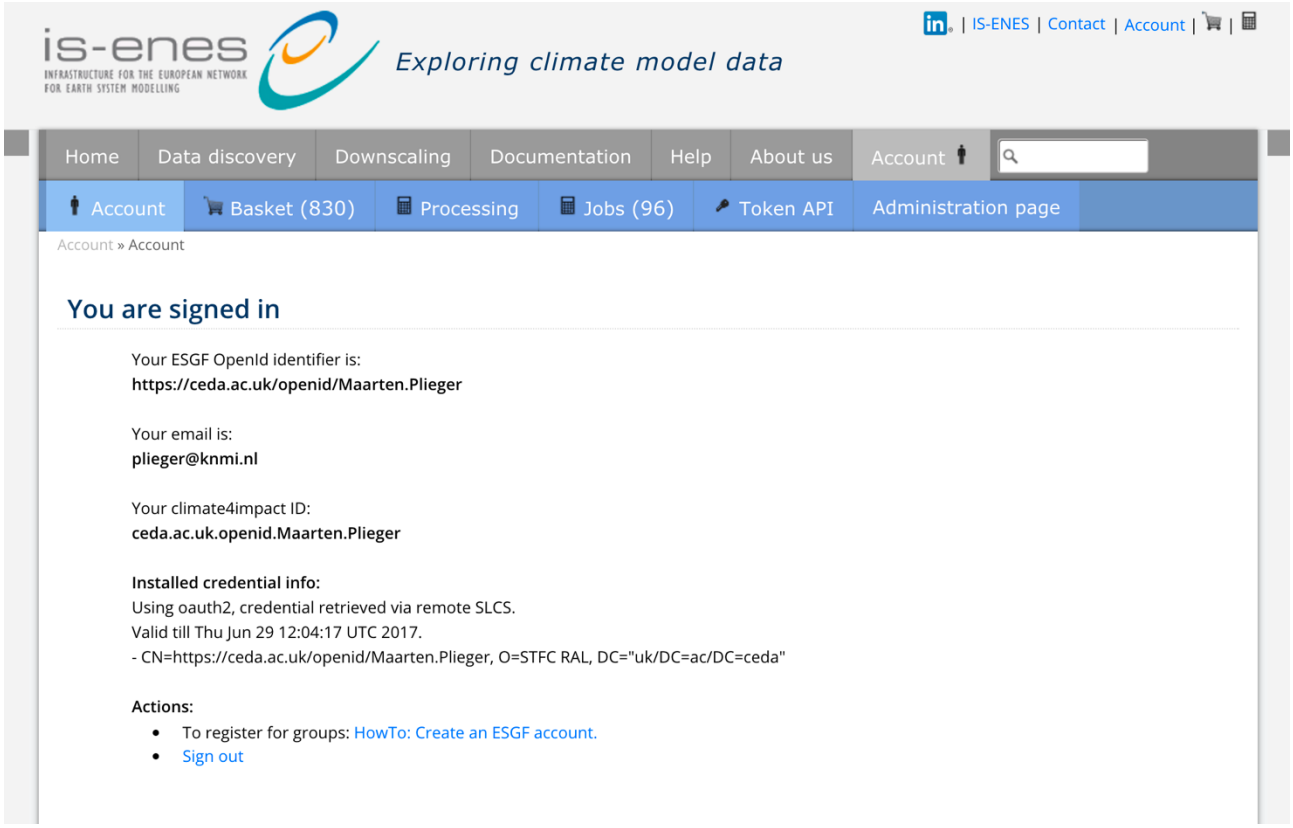
https://services.ceda.ac.uk/cedasite/register/info/

Make sure that you are registered to the UERRA group:

https://esgf-data.dkrz.de/projects/uerra/

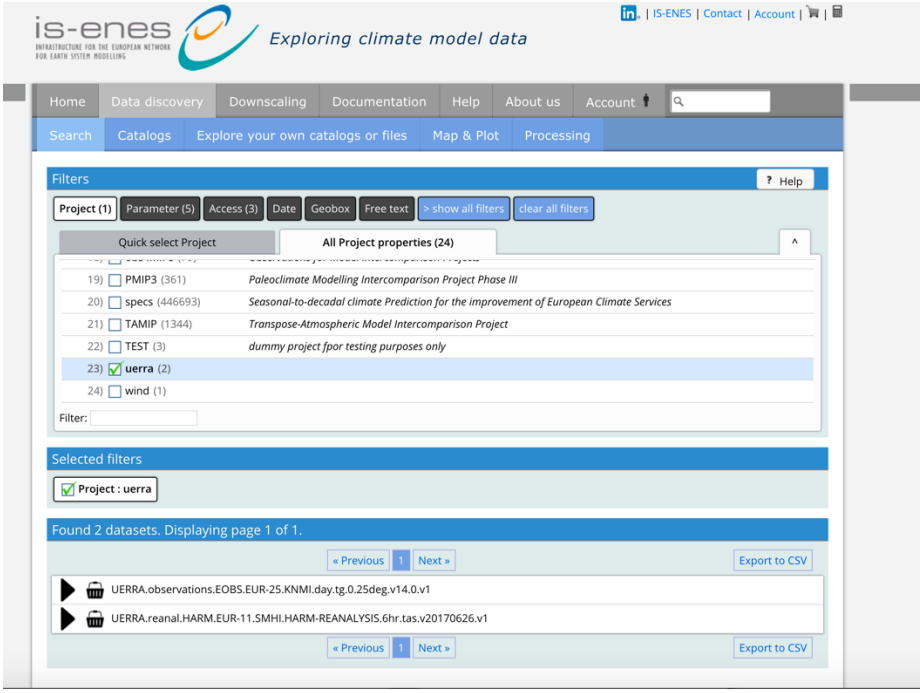
Sign in at Climate4Impact

Go to https://climate4impact.eu/impactportal/account/login.jsp and sign in. Once signed in you will see the following page:

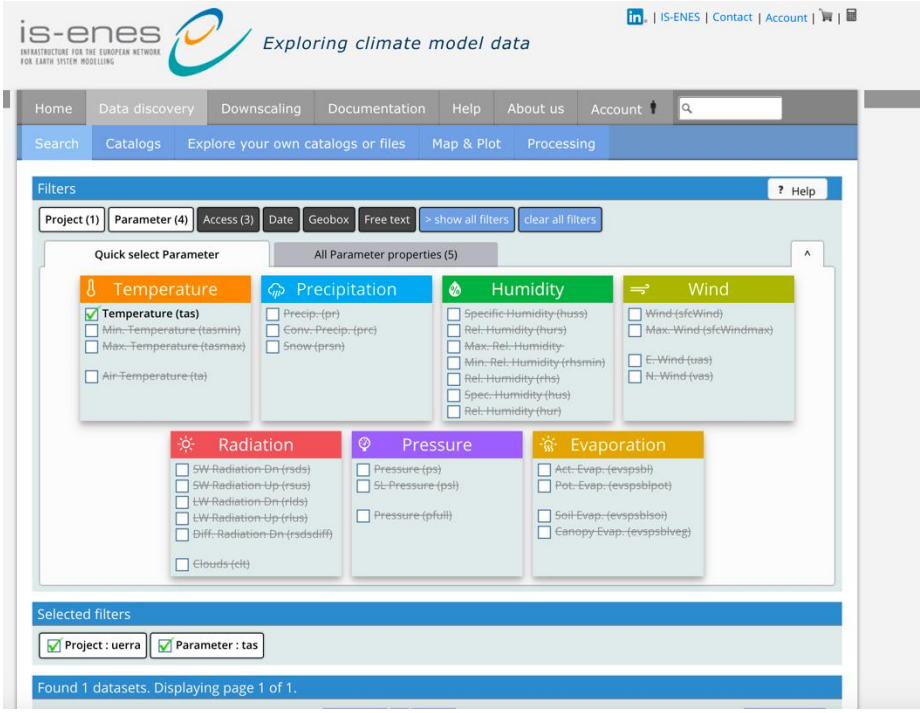


Search data under project UERRA

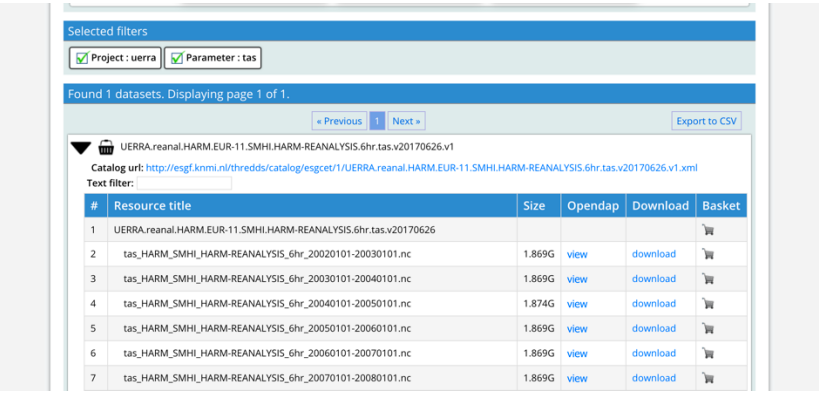
1) Now go to Search: https://climate4impact.eu/impactportal/data/esgfsearch.jsp
2) Click on the facet project
3) Click on the tab named "All project properties" and select "uerra":



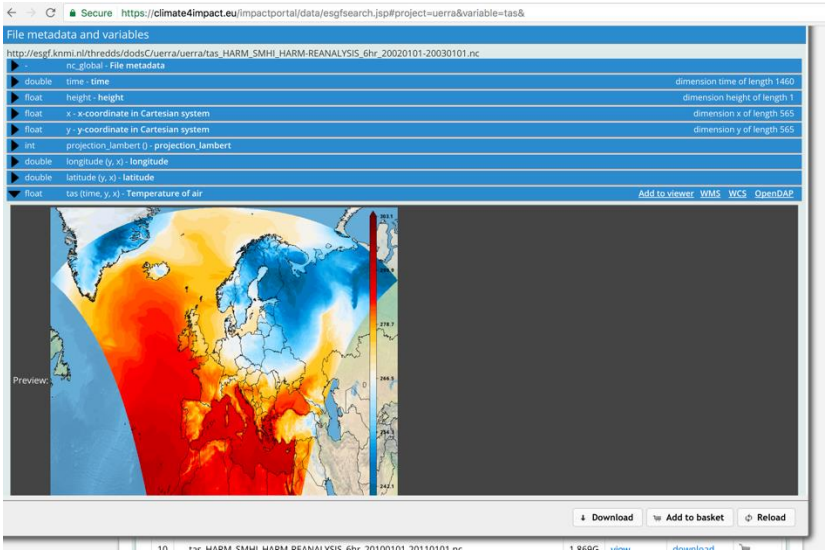
4) It is now possible to choose any search facet in any order, like parameter, access, etc..:



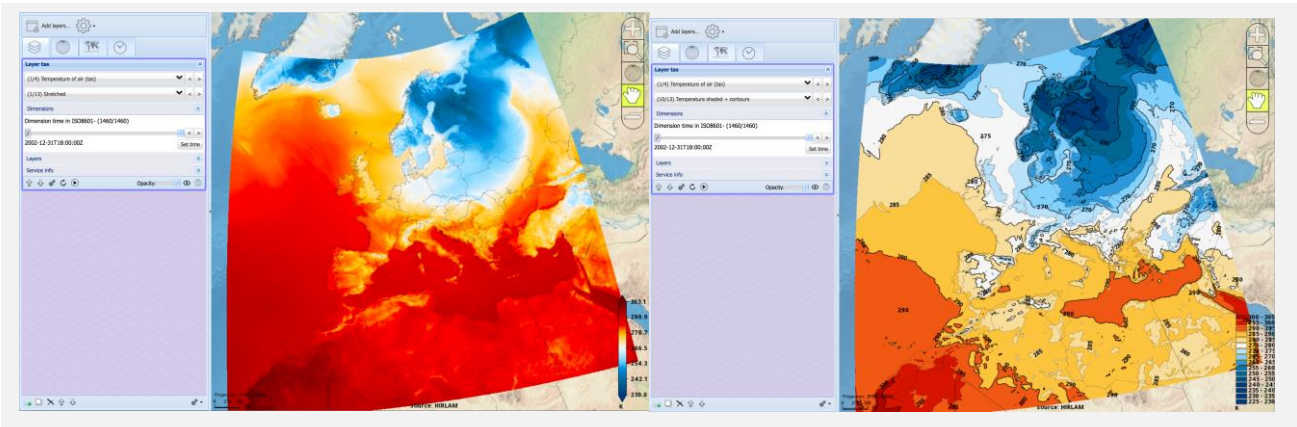
5) Now select the dataset "UERRA.reanal.HARM.EUR-11.SMHI.HARM-REANALYSIS.6hr.tas.v20170626.v1" and click on the triangle to expand the filelist:



6) Click on the basket icon to add the file to your basket. You can click view to preview the file:



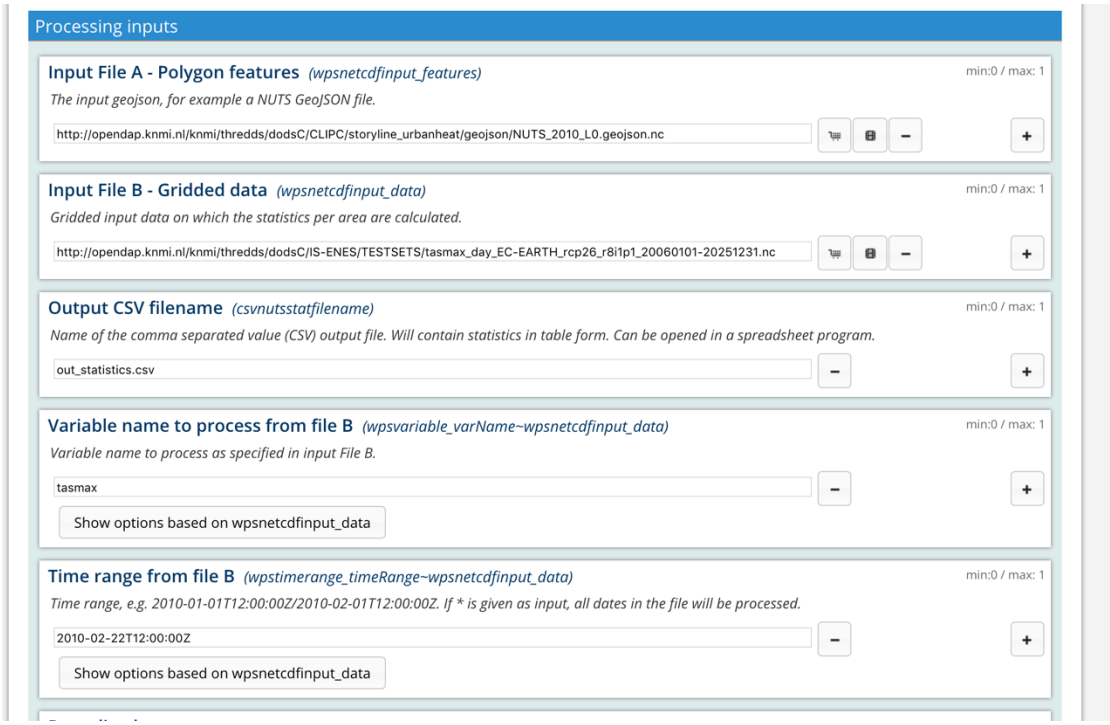
7) You can click "Add to Viewer" to display the complete file in the ADAGUC viewer:



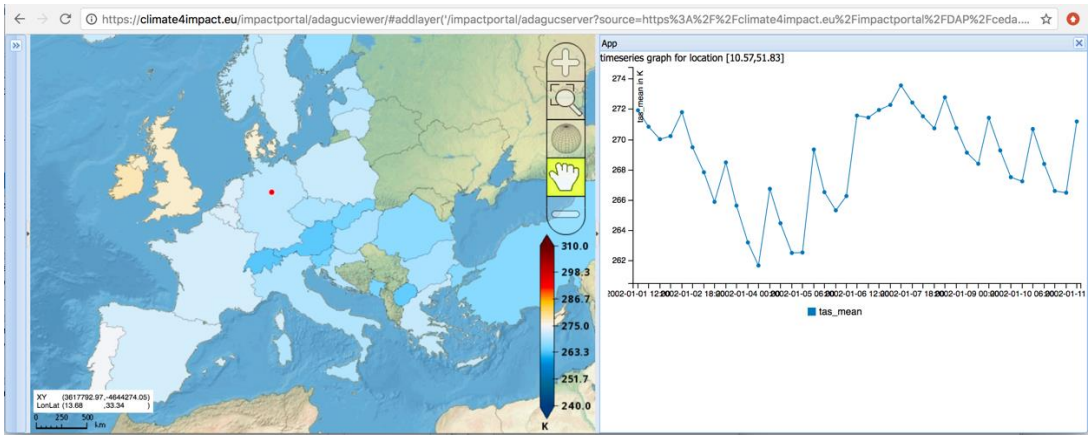
Analysis using OGC Web Processing Services in climate4impact

Climate4impact supports all kinds of processing options. To demonstrate this we will calculate the temperature averaged over an area specified by the area of a country. Polygon overlay is a function to calculate statistics for a gridded file by extracting geographical areas defined in a GeoJSON file. The statistics per geographical area include minimum, maximum, mean and standard deviation. The statistics are presented in a CSV table and a NetCDF file. Statistics can be calculated for several dates at once.

Go to Processing -> Polygon Overlay at
https://climate4impact.eu/impactportal/account/wpsuseprocessor.jsp?processor=is_enes_wps_polygonoverlay



For Input File B, select the UERRA dataset which was previousely added to your basket. For variable select tas instead of tasmax. Adjust the timerange accordingly. Once processed the result is stored in your basket and can be viewed in the viewer. In the viewer it is possible to make timeseries graphs like:





Summary

The UERRA ESGF data node was successfully installed and set-up at KNMI. A demonstrator dataset was retrieved from MARS, converted from GRIB to NETCDF and published on the data node. Corresponding metadata based on the CLIPC Data reference syntax was added to the files. The UERRA data node is linked to the ESGF federation through the DKRZ index node. Using the climate4impact portal it was demonstrated that UERRA data is indeed findable and usable in the ESGF federation.

The publication of a MARS catalog retrieved dataset is delivered to the ESGF Node.

Acronyms

ADAGUC	Atmospheric Data Access for the Geospatial User Community
API	Application Programming Interface
CF-Conventions	Climate and Forecast conventions
CLIMATE4IMPACT	EU FP7 IS-ENES portal for the climate impact research community
CLIPC	Climate Information Portal for Copernicus
CLIPC DRS	Data Reference Syntax as defined in the EU project CLIPC
DKRZ	Deutsche Klimarechenzentrum, Germany, Hamburg
ECMWF	European Center for Meteorological Weather Forecasting
ESGF	Earth System Grid Federation
FIMEX	File Interpolation, Manipulation and EXtraction library
GRIB	GRIdded Binary or General Regularly-distributed Information in Binary form
IS-ENES	Infrastructure for the European Network of Earth System Modelling
MARS	ECMWF Meteorological Archival and Retrieval System
NETCDF	Network Common Data Format
OGC	Open Geospatial Consortium
OPENDAP	Open-source Project for a Network Data Access Protocol
PERFSONAR	Network Performance and Troubleshooting (perfSONAR)
THREDDS	Thematic Real-time Environmental Distributed Data Services
UERRA	Uncertainties in Ensembles of Regional Re-Analyses
WCS	Web Coverage Services
WMS	Web Mapping Services
WPS	Web Processing Services

Reference Documents

Climate4impact portal: https://climate4impact.eu/

CLIPC DRS document: http://www.clipc.eu/media/clipc/org/documents/other/metadata_standards_for_climate_impact_indicators_v1.4.pdf

CLIPC DRS Metadata checker: https://dev.knmi.nl/projects/drschecker/wiki

ESGF Atlassian wiki: https://acme-climate.atlassian.net/wiki/display/ESGF/Manual

ESGF Installation Manual: https://github.com/ESGF/esgf-installer/wiki/ESGF-Installation-From-scratch

ESGF White Paper: https://esgf.llnl.gov/media/pdf/2017-ESGF-Brochure.pdf

Managing your data with DRS: https://drclimate.wordpress.com/2015/09/04/managing-your-data/

UERRA ESGF Project page: https://esgf-data.dkrz.de/projects/uerra/

UERRA ESGF Thredds data server: https://esgf.knmi.nl/thredds/

Appendices

Appendix A – Fimex configuration file for adding DRS Metadata to NetCDF files

```
<?xml version="1.0" encoding="UTF-8"?>
<cdmGribReaderConfig xmlns="http://www.met.no/schema/fimex/cdmGribReaderConfig"
                     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<!--                 xsi:schemaLocation="http://www.met.no/schema/fimex/cdmGribReaderConfig cdmGribReaderConfig.xsd"> --><processOptions>
    <!-- parameters to select: all, definedOnly -->
    <option name="selectParameters" value="all" />
</processOptions>
<overrule>
    <!-- use these values instead of the values in the grib-messages -->
    <!-- <earthFigure proj4="+ellps=WGS84 +towgs84=0,0,0" /> -->
</overrule>
<global_attributes>
    <attribute name="Conventions" value="CF-1.6" type="string" />
    <attribute name="Activity" value="uerra" type="string" />
    <attribute name="title" value="unknown" type="string" />
    <attribute name="min_time" value="%MIN_DATETIME(%Y-%m-%d %H:%M:%SZ)%" type="string" />
    <attribute name="max_time" value="%MAX_DATETIME(%Y-%m-%d)%" type="string" />
    <attribute name="time_coverage_start" value="%MIN_DATETIME(%Y%m%d)%" type="string" />
    <attribute name="time coverage end" value="%MAX DATETIME(%Y%m%d)%" type="string" />
    <attribute name="cdm datatype" value="grid" type="string"/>
    <attribute name="references" value="unknown" type="string" />
<!--    <attribute name="history" value="" type="string"/>-->
    <attribute name="comment" value="none" type="string" />
    <attribute name="institution" value="SMHI" type="string" />
    <attribute name="institution_url" value="http://www.smhi.se" type="string" />
    <attribute name="contact" value="per.unden@smhi.se" type="string" />
    <attribute name="contributor_name" value="" type="string" />
    <attribute name="contributor_role" value="" type="string" />
</global_attributes>
<axes>
<time id="time" name="time" type="double">
    <attribute name="long_name" value="time" type="string" />
    <attribute name="standard_name" value="time" type="string" />
<!-- adapt the time-unit as needed, i.e. -->
<!-- <attribute name="units" value="hours since 2007-05-16 00:00:00 +00:00" type="string" /> -->
    <attribute name="units" value="seconds since 1970-01-01 00:00:00 +00:00" type="string" />
</time>
<spatial_axis typeOfGrid="lambert" id="x" name="x" type="float">
    <attribute name="long_name" value="x-coordinate in Cartesian system" type="string" />
    <attribute name="standard_name" value="projection_x_coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="lambert" id="y" name="y" type="float">
    <attribute name="long_name" value="y-coordinate in Cartesian system" type="string" />
    <attribute name="standard_name" value="projection_y_coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="mercator" id="x" name="x" type="float">
    <attribute name="long_name" value="x-coordinate in Cartesian system" type="string" />
    <attribute name="standard_name" value="projection_x_coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="mercator" id="y" name="y" type="float">
    <attribute name="long name" value="y-coordinate in Cartesian system" type="string" />
    <attribute name="standard name" value="projection y coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="polar_stereographic" id="x" name="x" type="float">
    <attribute name="long_name" value="x-coordinate in Cartesian system" type="string" />
    <attribute name="standard_name" value="projection_x_coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="polar_stereographic" id="y" name="y" type="float">
    <attribute name="long name" value="y-coordinate in Cartesian system" type="string" />
    <attribute name="standard name" value="projection y coordinate" type="string" />
    <attribute name="units" value="m" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="regular_ll" id="x" name="longitude" type="float">
    <attribute name="long_name" value="longitude" type="string" />
    <attribute name="units" value="degrees_east" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="regular_ll" id="y" name="latitude" type="float">
    <attribute name="long_name" value="latitude" type="string" />
    <attribute name="units" value="degrees north" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="rotated_ll" id="x" name="rlon" type="float">
    <attribute name="long_name" value="rotated longitude" type="string" />
    <attribute name="standard_name" value="grid_longitude" type="string" />
    <attribute name="units" value="degrees" type="string" />
</spatial_axis>
<spatial_axis typeOfGrid="rotated_ll" id="y" name="rlat" type="float">
    <attribute name="long_name" value="rotated latitude" type="string" />
    <attribute name="standard_name" value="grid_latitude" type="string" />
    <attribute name="units" value="degrees" type="string" />
</spatial_axis>
<spatial_axis id="longitude" name="longitude">
    <attribute name="valid_max" value="180." type="float" />
    <attribute name="valid_min" value="-180." type="float" />
    <attribute name="long_name" value="longitude" type="string" />
    <attribute name="standard name" value="longitude" type="string" />
    <attribute name="units" value="degree east" type="string" />
</spatial_axis>
<spatial_axis id="latitude" name="latitude">
    <attribute name="valid_max" value="90." type="float" />
    <attribute name="valid_min" value="-90." type="float" />
    <attribute name="long_name" value="latitude" type="string" />
    <attribute name="standard_name" value="latitude" type="string" />
    <attribute name="units" value="degree_north" type="string" />
</spatial_axis>
<!-- grib2 code table 4.5; grib1 code table 3 / 3a -->
<vertical_axis id="surface" name="surface" grib2 id="1" grib1 id="1" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="description" value="ground or water surface" type="string" />
    <attribute name="long_name" value="surface" type="string" />
```

```
    <attribute name="positive" value="up" type="string" />
    <attribute name="units" value="m" type="string" />
</vertical_axis>
<vertical_axis id="isotherm_0C_level" name="isotherm_0C_level" grib1_id="4" grib2_id="4" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="description" value="level of 0degreeC isotherm" type="string" />
    <attribute name="long name" value="isotherm 0C" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="maximum_wind_level" name="maximum_wind_level" grib1_id="6" grib2_id="6" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="long_name" value="max wind level" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="tropopause" name="tropopause" grib1_id="7" grib2_id="7" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="long name" value="Tropopause" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="top_of_atmosphere" name="top_of_atmosphere" grib2_id="8" grib1_id="8" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="long_name" value="nominal top of atmosphere" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="isotherm_percK_level" name="isotherm_percK_level" grib1_id="20" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="description" value="level of 1/100K isotherm" type="string" />
    <attribute name="long name" value="isotherm %K" type="string" />
    <attribute name="units" value="1/100 K" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="mean_sea_level" name="mean_sea_level" grib2_id="101" grib1_id="102" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="description" value="mean sea level" type="string" />
    <attribute name="long name" value="mean sea level" type="string" />
    <attribute name="positive" value="up" type="string" />
    <attribute name="units" value="m" type="string" />
</vertical_axis>
<vertical_axis id="pressure" name="pressure" grib2_id="100" grib1_id="100" type="float">
    <!-- Isobaric level -->
    <attribute name="description" value="pressure" type="string" />
    <attribute name="long_name" value="pressure" type="string" />
    <attribute name="standard name" value="air pressure" type="string" />
    <attribute name="positive" value="down" type="string" />
    <grib1>
        <attribute name="units" value="hPa" type="string" />
    </grib1>
    <grib2>
        <attribute name="units" value="Pa" type="string" />
    </grib2>
</vertical_axis>
<vertical_axis id="height above msl" name="height above msl" grib2 id="102" grib1 id="103" type="float">
    <attribute name="description" value="height above MSL, altitude" type="string" />
    <attribute name="long name" value="height" type="string" />
    <attribute name="positive" value="up" type="string" />
    <attribute name="units" value="m" type="string" />
</vertical_axis>
<vertical_axis id="layer_between_altitudes" name="layer_between_altitudes" grib1_id="104" type="float">
    <attribute name="description" value="layer between two altitudes" type="string" />
    <attribute name="long_name" value="layer between two altitudes" type="string" />
    <attribute name="positive" value="up" type="string" />
    <attribute name="units" value="100m" type="string" />
</vertical_axis>
<vertical_axis id="height" name="height" grib2 id="103" grib1 id="105" type="float">
    <attribute name="description" value="height above ground" type="string" />
    <attribute name="long_name" value="height" type="string" />
    <attribute name="positive" value="up" type="string" />
    <attribute name="units" value="m" type="string" />
</vertical_axis>
<vertical_axis id="sigma" name="sigma" grib2_id="104" grib1_id="107" type="float">
    <attribute name="description" value="atmosphere sigma coordinate" type="string" />
    <attribute name="long_name" value="atmosphere_sigma_coordinate" type="string" />
    <attribute name="standard_name" value="atmosphere_sigma_coordinate" type="string" />
    <attribute name="positive" value="down" type="string" />
</vertical_axis>
<vertical_axis id="hybrid" name="k" grib2_id="105" grib1_id="109" type="double">
    <attribute name="standard_name" value="atmosphere_hybrid_sigma_pressure_coordinate" type="string" />
    <attribute name="formula" value="p(n,k,j,i) = ap(k) + b(k)*ps(n,j,i)" type="string" />
    <attribute name="formula_terms" value="ap: ap%EXT% b: b%EXT% ps: ps p0: p0%EXT%" type="string" />
    <attribute name="long name" value="atmosphere hybrid sigma pressure coordinate" type="string" />
    <attribute name="positive" value="down" type="string" />
    <values mode="hybridSigmaCalc(ap,b,p0)" />
    <!--  optional values, will otherwise be calculated -->
    <!-- <values mode="inline">0.01000025677 0.030167302165 0.0506574118 0.071450009935 0.09252333188 0.1138544163 0.13541913675 0.15719222585 0.17914733025
0.2012570937 0.2234932623 0.24582677445 0.2682278651 0.2906662383 0.31311114455 0.3355315966 0.35789645305 0.38017460195 0.40233509685 0.424347324 0.4461811847
0.4678071633 0.489196539 0.5103215403 0.5311554552 0.55167275145 0.5718492055 0.59166201445 0.61108997355 0.6301135343 0.6487148597 0.66687796335 0.6845887315
0.70183494755 0.71860654485 0.73489551425 0.75069577035 0.7660033971 0.78081677885 0.7951363129 0.80896444377 0.82230582149 0.83516716094 0.847557280535
0.859487003145 0.87096914209 0.882018498895 0.892651686215 0.90288721645 0.912745443885 0.92224845265 0.931419910746 0.9402852619265 0.9488715493425
0.9572073044055 0.96532265475235 0.97331471657385 0.981184395 0.98881774 0.996283525</values> -->
    <additional_axis_variable name="p0" type="double" axis="">
        <attribute name="units" value="Pa" type="string" />
        <values>101325</values>
    </additional_axis_variable>
    <additional_axis_variable name="ap" type="double" axis="k">
        <attribute name="units" value="Pa" type="string" />
        <values mode="extraHalvLevel1" scale_factor="1" />
        <!--  optional values, will otherwise be retrieved from level2 -->
        <!--  <values>1000.025677 3016.7302165 5053.90618 7087.0199935 9093.765188 11053.98013 12949.566675 14764.408585 16484.295025 18096.84587 19591.43773
20959.130445 22192.59551 23286.04683 24235.168455 25037.05066 25690.118305 26194.061695 26549.769185 26759.2609 26825.62347 26752.93383 26546.1954 26211.27253
25754.81752 25184.199145 24507.43255 23733.106445 22870.320355 21928.60293 20917.83697 19848.187335 18730.02765 17573.856255 16390.225985 15189.661425
13982.572535 12779.18721 11589.468885 10423.01579 9288.991377 8196.045649 7152.209594 6164.8270535 5240.4653145 4384.825709 3602.6483895 2897.6316215
2272.348645 1728.1508885 1265.082265 881.7835746 575.42419265 341.59793425 174.23244055 65.519475235 12.368657385 0 0 0</values> -->
    </additional_axis_variable>
    <additional_axis_variable name="b" type="double" axis="k">
        <attribute name="units" value="1" type="string" />
        <values mode="extraHalvLevel2" scale_factor="1" />
        <!--  optional values, will otherwise be retrieved from ident19 -->
        <!--  <values>0 0 0.00011835 0.00057981 0.00158568 0.003314615 0.00592347 0.00954814 0.01430438 0.020288635 0.027578885 0.03623547 0.04630191 0.05780577
0.07075946 0.08516109 0.10099527 0.118233985 0.136837405 0.156754715 0.17792495 0.200277825 0.223734585 0.248208815 0.27360728 0.29983076 0.32677488 0.35433095
0.38238677 0.410827505 0.43953649 0.46839609 0.497288455 0.526096385 0.554704285 0.5829989 0.610870045 0.638211525 0.66492209 0.690906155 0.71607453 0.740345365
0.763645065 0.78590901 0.80708235 0.827120885 0.845992015 0.86367537 0.88016373 0.895463935 0.90959763 0.922602075 0.93453102 0.94545557 0.95546498 0.96466746
0.97319103 0.981184395 0.98881774 0.996283525</values> -->
    </additional_axis_variable>
</vertical_axis>
<vertical_axis id="depth" name="depth" grib2_id="106" type="short">
    <attribute name="description" value="depth below land surface" type="string" />
    <attribute name="long_name" value="depth" type="string" />
    <attribute name="positive" value="down" type="string" />
    <attribute name="standard_name" value="depth" type="string" />
```

```
    <grib1>
        <attribute name="units" value="cm" type="string" />
    </grib1>
    <grib2>
        <attribute name="units" value="m" type="string" />
    </grib2>
</vertical_axis>
<vertical_axis id="specified pressure difference" name="specified pressure difference" grib2 id="108" type="float">
    <attribute name="description" value="Level at specified pressure difference from ground to level" type="string" />
    <attribute name="long_name" value="specified pressure difference from ground" type="string" />
    <attribute name="standard_name" value="air_pressure" type="string" />
    <attribute name="positive" value="up" type="string" />
    <grib2>
        <attribute name="units" value="Pa" type="string" />
    </grib2>
</vertical_axis>
<vertical_axis id="potential vorticity surface" name="potential vorticity surface" grib2 id="109" type="float">
    <attribute name="description" value="Potential vorticity surface" type="string" />
    <attribute name="long name" value="potential vorticity surface" type="string" />
    <attribute name="standard_name" value="ertel_potential_vorticity" type="string" />
    <attribute name="positive" value="up" type="string" />
    <grib2>
        <attribute name="units" value="K m^2 kg^-1 s^-1" type="string" />
    </grib2>
</vertical_axis>
<vertical_axis id="depth_between_layers" name="depth_between_layers" grib1_id="112" type="short">
<!-- ROBO, the 2 layers are not read correctly yet. I need a special function to extract the 2 levels from one grib-field
          like in  hybridSigma -->
    <attribute name="description" value="depth between layers below land surface" type="string" />
    <attribute name="long_name" value="depth between layes" type="string" />
    <attribute name="positive" value="down" type="string" />
    <attribute name="standard_name" value="depth" type="string" />
    <attribute name="units" value="cm" type="string" />
</vertical_axis>
<vertical_axis id="theta" name="theta" grib2 id="107" grib1 id="113" type="float">
    <attribute name="description" value="isentropic layer" type="string" />
    <attribute name="units" value="K" type="string" />
</vertical_axis>
<vertical_axis id="depth_below_sea" name="depth_below_sea" grib2_id="160" grib1_id="160" type="short">
    <attribute name="description" value="depth below sea surface" type="string" />
    <attribute name="long_name" value="depth_below_sea" type="string" />
    <attribute name="positive" value="down" type="string" />
    <attribute name="standard name" value="depth" type="string" />
    <attribute name="units" value="m" type="string" />
</vertical_axis>

<vertical_axis id="harmoniUnknown117" name="harmoniUnknown117" grib1_id="117" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>

<vertical_axis id="adiabatic condensation level" name="adiabatic condensation level" grib1 id="5" type="short">
    <attribute name=" FillValue" value="-32767" type="short" />
    <attribute name="long name" value="adiabatic condensation level (parcel lifted from surface)" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>

<vertical_axis id="harmoniUnknown10" name="harmoniUnknown10" grib1_id="10" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>


<vertical_axis id="total atmosphere" name="total atmosphere" grib1 id="200" type="short">
    <attribute name="_FillValue" value="-32767" type="short" />
    <attribute name="long_name" value="total atmosphere as single layer" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_200" name="local_vertical_level_200" grib2_id="200" type="float">
    <attribute name="description" value="vertical level 200, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 200" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="entire_ocean" name="entire_ocean" grib2_id="201" grib1_id="201" type="float">
    <attribute name="long_name" value="entire ocean as single layer" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_204" name="local_vertical_level_204" grib2_id="204" type="float">
    <attribute name="description" value="vertical level 204, defined locally, ask center" type="string" />
    <attribute name="long name" value="unknown vertical level 204" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_211" name="local_vertical_level_211" grib2_id="211" type="float">
    <attribute name="description" value="vertical level 211, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 211" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local vertical level 212" name="local vertical level 212" grib2 id="212" type="float">
    <attribute name="description" value="vertical level 212, defined locally, ask center" type="string" />
    <attribute name="long name" value="unknown vertical level 212" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_213" name="local_vertical_level_213" grib2_id="213" type="float">
    <attribute name="description" value="vertical level 213, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 213" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local vertical level 214" name="local vertical level 214" grib2 id="214" type="float">
    <attribute name="description" value="vertical level 214, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 214" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_222" name="local_vertical_level_222" grib2_id="222" type="float">
    <attribute name="description" value="vertical level 222, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 222" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local vertical level 223" name="local vertical level 223" grib2 id="223" type="float">
    <attribute name="description" value="vertical level 223, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 223" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_224" name="local_vertical_level_224" grib2_id="224" type="float">
    <attribute name="description" value="vertical level 224, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 224" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_232" name="local_vertical_level_232" grib2_id="232" type="float">
    <attribute name="description" value="vertical level 232, defined locally, ask center" type="string" />
```

```
    <attribute name="long_name" value="unknown vertical level 232" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_233" name="local_vertical_level_233" grib2_id="233" type="float">
    <attribute name="description" value="vertical level 233, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 233" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local vertical level 234" name="local vertical level 234" grib2 id="234" type="float">
    <attribute name="description" value="vertical level 234, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 234" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_242" name="local_vertical_level_242" grib2_id="242" type="float">
    <attribute name="description" value="vertical level 242, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 242" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local vertical level 243" name="local vertical level 243" grib2 id="243" type="float">
    <attribute name="description" value="vertical level 243, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 243" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>
<vertical_axis id="local_vertical_level_244" name="local_vertical_level_244" grib2_id="244" type="float">
    <attribute name="description" value="vertical level 244, defined locally, ask center" type="string" />
    <attribute name="long_name" value="unknown vertical level 244" type="string" />
    <attribute name="positive" value="up" type="string" />
</vertical_axis>

</axes>

<variables>
      <!-- Pressure () -->
      <parameter name="air_pressure_at_sea_level" type="float">
          <grib1 indicatorOfParameter="151" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="1" levelNo="0"/>
          <grib2 discipline="0" parameterCategory="3" parameterNumber="1" typeOfLevel="1"/>
          <attribute name="long_name" value="Mean Sea Level Pressure (MSLP)" type="string"/>
          <attribute name="standard_name" value="air_pressure_at_sea_level" type="string"/>
          <attribute name="units" value="Pa" type="string"/>
      </parameter>
      <parameter name="surface_air_pressure" type="float">
          <grib1 indicatorOfParameter="134" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="1" levelNo="0"/>
          <grib2 discipline="0" parameterCategory="3" parameterNumber="0" typeOfLevel="1"/>
<attribute name="long name" value="Surface air pressure" type="string"/>
          <attribute name="standard name" value="surface air pressure" type="string"/>
          <attribute name="units" value="Pa" type="string"/>
      </parameter>
      <!-- logarithmic surface_air_pressure -->
      <parameter name="surface_air_pressure" type="float">
          <grib2 discipline="0" parameterCategory="3" parameterNumber="25" typeOfLevel="105"/>
          <attribute name="long_name" value="Logarithmic surface air pressure (lnsp)" type="string"/>
          <attribute name="standard name" value="surface air pressure" type="string"/>
          <attribute name="units" value="1 ln(re 1Pa)" type="string"/>
      </parameter>

    <parameter name="geopotential_height_pl" type="float">
        <!-- multi-id for grib1 and grib2 -->
        <grib1 indicatorOfParameter="156" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" timeRangeIndicator="0"/>
        <!-- wmo -->
        <grib1 indicatorOfParameter="7" gribTablesVersionNo="1"/>
        <grib1 indicatorOfParameter="7" gribTablesVersionNo="2"/>
        <grib1 indicatorOfParameter="7" gribTablesVersionNo="3"/>
        <grib2 discipline="0" parameterCategory="3" parameterNumber="5" typeOfLevel="100"/>
        <attribute name=" FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="long_name" value="geopotential_height" type="string" />
        <attribute name="standard_name" value="geopotential_height" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>
    <parameter name="geopotential_pl" type="float">
        <grib1 indicatorOfParameter="156" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="100"/>
        <grib2 discipline="0" parameterCategory="3" parameterNumber="4" typeOfLevel="105"/>
        <attribute name="long_name" value="Geopotential pressure levels" type="string"/>
        <attribute name="standard_name" value="geopotential" type="string"/>
        <attribute name="units" value="m^2/s^2" type="string"/>
    </parameter>
    <parameter name="geopotential_ml" type="float">
        <grib1 indicatorOfParameter="129" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="109"/>
        <grib2 discipline="0" parameterCategory="3" parameterNumber="4" typeOfLevel="100"/>
        <attribute name="long_name" value="Geopotential model levels" type="string" />
        <attribute name="standard name" value="geopotential" type="string" />
        <attribute name="units" value="m^2/s^2" type="string" />
    </parameter>
    <parameter name="surface_geopotential" type="float" constantTime="true">
        <grib1 indicatorOfParameter="129" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="1"/>
        <grib2 discipline="0" parameterCategory="3" parameterNumber="4" typeOfLevel="103"/>
        <attribute name="long_name" value="Surface geopotential (fis)" type="string" />
        <attribute name="standard_name" value="surface_geopotential" type="string" />
        <attribute name="units" value="m^2/s^2" type="string" />
    </parameter>
    <parameter name="surface altitude" type="float">
        <grib2 discipline="0" parameterCategory="3" parameterNumber="5" typeOfLevel="1"/>
        <grib1 indicatorOfParameter="7" gribTablesVersionNo="253" identificationOfOriginatingGeneratingCentre="233" typeOfLevel="105" levelNo="0"/>
        <attribute name="long_name" value="Orography (ZS)" type="string" />
        <attribute name="standard_name" value="surface_altitude" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>

    <parameter name="cloud cover" type="float">
        <!-- multi-id for grib1 and grib2 -->
        <!-- high clouds -->
        <grib1 indicatorOfParameter="188" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <!-- medium clouds, sigma level-->
        <grib1 typeOfLevel="107" indicatorOfParameter="187" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <!-- below examples allow omission of identificationOfOriginatingGeneratingCentre or gribTablesVersionNo -->
        <!-- low clouds -->
        <grib1 indicatorOfParameter="186" gribTablesVersionNo="128" />
        <!-- fog -->
        <grib1 indicatorOfParameter="248" identificationOfOriginatingGeneratingCentre="98"/>
        <!--  <grib2 discipline="" parameterCategory="" parameterNumber=""/> -->
        <attribute name="long_name" value="cloud coverage" type="string" />
        <attribute name="units" value="%" type="string" />
    </parameter>
    <parameter name="total_precipitation" type="float">
        <grib1 indicatorOfParameter="61" gribTablesVersionNo="3"/>
        <attribute name="long_name" value="total_precipitation" type="string" />
        <attribute name="units" value="kg m^-2" type="string" />
    </parameter>

<!-- from metcoop -->
```

```
    <parameter name="x_wind_10m" type="float">
        <grib1 indicatorOfParameter="33" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="x_wind" type="string" />
        <attribute name="units" value="m s^-1" type="string" />
    </parameter>
    <parameter name="y_wind_10m" type="float">
        <grib1 indicatorOfParameter="34" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard name" value="y wind" type="string" />
        <attribute name="units" value="m s^-1" type="string" />
    </parameter>
    <parameter name="x_wind_10m" type="float">
        <grib1 indicatorOfParameter="33" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <grib2 discipline="0" parameterCategory="2" parameterNumber="2" typeOfLevel="103" level="10"/>
        <attribute name="standard_name" value="x_wind" type="string" />
        <attribute name="units" value="m s^-1" type="string" />
    </parameter>
    <parameter name="x wind pl" type="float">
        <grib2 discipline="0" parameterCategory="2" parameterNumber="2" typeOfLevel="100"/>
        <!-- <grib1 indicatorOfParameter="33" gribTablesVersionNo="253" identificationOfOriginatingGeneratingCentre="233" typeOfLevel="109"/> -->
        <attribute name="long_name" value="Zonal wind model levels" type="string" />
        <attribute name="standard_name" value="x_wind" type="string" />
        <attribute name="units" value="m/s" type="string" />
        <spatial_vector direction="x,longitude" counterpart="y_wind_ml" />
    </parameter>
    <parameter name="x_wind_ml" type="float">
        <grib2 discipline="0" parameterCategory="2" parameterNumber="2" typeOfLevel="105"/>
        <!-- <grib1 indicatorOfParameter="33" gribTablesVersionNo="253" identificationOfOriginatingGeneratingCentre="233" typeOfLevel="109"/> -->
        <attribute name="long name" value="Zonal wind model levels" type="string" />
        <attribute name="standard_name" value="x_wind" type="string" />
        <attribute name="units" value="m/s" type="string" />
        <spatial_vector direction="x,longitude" counterpart="y_wind_ml" />
    </parameter>

    <parameter name="y_wind_10m" type="float">
        <grib2 discipline="0" parameterCategory="2" parameterNumber="3" typeOfLevel="103" level="10"/>
        <grib1 indicatorOfParameter="34" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <attribute name="standard_name" value="y_wind" type="string" />
        <attribute name="units" value="m s^-1" type="string" />
    </parameter>
    <parameter name="y_wind_pl" type="float">
        <grib2 discipline="0" parameterCategory="2" parameterNumber="3" typeOfLevel="100"/>
        <grib1 indicatorOfParameter="132" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="100"/>
        <attribute name="long name" value="Meridional wind pressure levels" type="string"/>
        <attribute name="standard name" value="y wind" type="string"/>
        <attribute name="units" value="m/s" type="string"/>
        <spatial_vector direction="y,latitude" counterpart="x_wind_pl"/>
    </parameter>
    <parameter name="y_wind_ml" type="float">
        <grib2 discipline="0" parameterCategory="2" parameterNumber="3" typeOfLevel="105"/>
<!--         <grib1 indicatorOfParameter="34" gribTablesVersionNo="253" identificationOfOriginatingGeneratingCentre="233" typeOfLevel="105"/>
 -->        <attribute name="long_name" value="Meridional wind model levels" type="string" />
        <attribute name="standard name" value="y wind" type="string" />
        <attribute name="units" value="m/s" type="string" />
        <spatial_vector direction="y,latitude" counterpart="x wind ml" />
    </parameter>
      <!-- skin temperature -->
      <parameter name="surface_temperature" type="float">
        <grib2 discipline="0" parameterCategory="0" parameterNumber="0" typeOfLevel="1" level="0"/>
        <grib1 indicatorOfParameter="235" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="1" levelNo="0"/>
        <attribute name="long_name" value="Surface (skin) temperature (SKT)" type="string"/>
        <attribute name="standard_name" value="surface_temperature" type="string"/>
        <attribute name="units" value="K" type="string"/>
      </parameter>
    <parameter name="air temperature 2m" type="float">
        <grib2 discipline="0" parameterCategory="0" parameterNumber="0" typeOfLevel="103" level="2"/>
        <grib1 indicatorOfParameter="11" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105" levelNo="2"/>
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="air_temperature_pl" type="float">
        <grib2 discipline="0" parameterCategory="0" parameterNumber="0" typeOfLevel="100"/>
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="tk" type="float">
        <grib1 indicatorOfParameter="11" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
      <!-- 2m dew point temperature -->
      <parameter name="dew_point_temperature_2m" type="float">
        <grib1 indicatorOfParameter="168" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98" typeOfLevel="1" levelNo="0"/>
        <grib2 discipline="0" parameterCategory="0" parameterNumber="6" typeOfLevel="103" level="2"/>
        <attribute name="standard_name" value="dew_point_temperature" type="string"/>
        <attribute name="units" value="K" type="string"/>
      </parameter>

    <parameter name="fi" type="float" constantTime="true">
        <grib1 indicatorOfParameter="6" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="geopotential_height" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>
    <parameter name="fis" type="float">
        <grib1 indicatorOfParameter="6" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard name" value="geopotential height" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>
    <parameter name="q" type="float">
        <grib1 indicatorOfParameter="51" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <attribute name="standard_name" value="specific_humidity" type="string" />
        <attribute name="units" value="1" type="string" />
    </parameter>
    <parameter name="omega_ml" type="float">
        <grib1 indicatorOfParameter="40" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
        <attribute name=" FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standname name" value="omega" type="string" />
        <attribute name="units" value="Pa/s" type="string" />
    </parameter>
    <parameter name="relative_humidity_2m" type="float">
        <grib2 discipline="0" parameterCategory="1" parameterNumber="1" typeOfLevel="103" level="2"/>
        <grib1 indicatorOfParameter="52" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="relative_humidity" type="string" />
        <attribute name="units" value="1" type="string" />
    </parameter>
    <parameter name="relative_humidity_pl" type="float">
        <grib2 discipline="0" parameterCategory="1" parameterNumber="1" typeOfLevel="100"/>
        <grib1 indicatorOfParameter="52" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="100"/>
```

```
        <attribute name="standard_name" value="relative_humidity" type="string" />
        <attribute name="units" value="1" type="string" />
    </parameter>
    <parameter name="visibility_in_air" type="float">
        <grib2 discipline="0" parameterCategory="19" parameterNumber="0" typeOfLevel="1"/>
        <attribute name="standard_name" value="relative_humidity" type="string" />
        <attribute name="units" value="1" type="string" />
    </parameter>
    <parameter name="tcc" type="float">
        <grib1 indicatorOfParameter="71" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="cloud_area_fraction" type="string" />
        <attribute name="units" value="%" type="string" />
    </parameter>
    <parameter name="lcc" type="float">
        <grib1 indicatorOfParameter="73" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="low_type_cloud_area_fraction" type="string" />
        <attribute name="units" value="%" type="string" />
    </parameter>
    <parameter name="mcc" type="float">
        <grib1 indicatorOfParameter="74" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="medium_type_cloud_area_fraction" type="string" />
        <attribute name="units" value="%" type="string" />
    </parameter>
    <parameter name="hcc" type="float">
        <grib1 indicatorOfParameter="75" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard name" value="high type cloud area fraction" type="string" />
        <attribute name="units" value="%" type="string" />
    </parameter>
    <parameter name="lwe_thickness_of_stratiform_precipitation_amount" type="float">
        <grib1 indicatorOfParameter="62" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="lwe_thickness_of_stratiform_precipitation_amount" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>
    <parameter name="lwe thickness of convective precipitation amount" type="float">
        <grib1 indicatorOfParameter="63" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="lwe_thickness_of_convective_precipitation_amount" type="string" />
        <attribute name="units" value="m" type="string" />
    </parameter>
    <parameter name="air_pressure_at_sea_level" type="float">
        <grib1 indicatorOfParameter="1" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="103"/>
        <attribute name="standard_name" value="air_pressure_at_sea_level" type="string" />
        <attribute name="units" value="Pa" type="string" />
    </parameter>
    <parameter name="surface air pressure" type="float">
        <grib1 indicatorOfParameter="1" gribTablesVersionNo="1" identificationOfOriginatingGeneratingCentre="96" typeOfLevel="105"/>
        <attribute name="standard_name" value="surface_air_pressure" type="string" />
        <attribute name="units" value="Pa" type="string" />
    </parameter>

<!-- from MEE ensembles (ec) -->
    <parameter name="geopotential" type="float" constantTime="true">
        <grib1 indicatorOfParameter="129" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name=" FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="long_name" value="geopotential" type="string" />
        <attribute name="standard_name" value="geopotential" type="string" />
        <attribute name="units" value="m2/s2" type="string" />
    </parameter>
    <parameter name="lwe_thickness_of_percipitation_amount" type="float">
        <grib1 indicatorOfParameter="228" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard name" value="lwe thickness of percipitation amount" type="string" />
        <attribute name="units" value="kg/m2" type="string" />
    </parameter>
    <parameter name="lwe_thickness_of_snowfall_amount" type="float">
        <grib1 indicatorOfParameter="144" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="lwe_thickness_of_snowfall_amount" type="string" />
        <attribute name="units" value="kg/m2" type="string" />
    </parameter>
    <parameter name="cloud_area_fraction" type="short">
        <grib1 indicatorOfParameter="164" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="-32767" type="short" />
        <attribute name="scale_factor" value="0.0001" type="float" />
        <attribute name="standard_name" value="cloud_area_fraction" type="string" />
        <attribute name="units" value="1" type="string" />
    </parameter>
    <parameter name="air_temperature" type="float">
        <grib1 indicatorOfParameter="130" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name=" FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="dewpoint_2m" type="float">
        <grib1 indicatorOfParameter="168" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="air temperature 2m" type="float">
        <grib1 indicatorOfParameter="167" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="max_air_temperature_2m" type="float">
        <grib1 indicatorOfParameter="121" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name=" FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard name" value="air temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="min_air_temperature_2m" type="float">
        <grib1 indicatorOfParameter="122" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="air_temperature" type="string" />
        <attribute name="units" value="K" type="string" />
    </parameter>
    <parameter name="x wind 10m" type="float">
        <grib1 indicatorOfParameter="165" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98">
          <extraKey name="localDefinitionNumber" value="1" /> <!-- just for testing -->
        </grib1>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="x_wind" type="string" />
        <attribute name="units" value="m/s" type="string" />
    </parameter>
    <parameter name="y_wind_10m" type="float">
        <grib1 indicatorOfParameter="166" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="y_wind" type="string" />
        <attribute name="units" value="m/s" type="string" />
```

```
    </parameter>
    <parameter name="max_wind_speed_of_gust_10m" type="float">
        <grib1 indicatorOfParameter="123" gribTablesVersionNo="128" identificationOfOriginatingGeneratingCentre="98"/>
        <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
        <attribute name="standard_name" value="max_wind_speed_of_gust" type="string" />
        <attribute name="units" value="m/s" type="string" />
    </parameter>

    <!-- wave parameters -->
    <parameter name="significant_wave_height" type="float">
      <grib1 indicatorOfParameter="229" gribTablesVersionNo="140" />
      <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
      <attribute name="units" value="m" type="string"/>
      <attribute name="standard_name" value="sea_surface_wave_significant_height" type="string"/>
    </parameter>
    <parameter name="wave_direction" type="float">
      <grib1 indicatorOfParameter="230" gribTablesVersionNo="140"/>
      <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
      <attribute name="units" value="degree" type="string"/>
      <attribute name="standard_name" value="sea_surface_wave_to_direction" type="string"/>
    </parameter>
    <parameter name="peak_wave_period"  type="float">
      <grib1 indicatorOfParameter="231" gribTablesVersionNo="140"/>
      <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
      <attribute name="long_name" value="sea_surface_wave_peak_period" type="string"/>
      <attribute name="units" value="s" type="string"/>
    </parameter>
    <parameter  name="mean wave period"  type="float">
      <grib1 indicatorOfParameter="232" gribTablesVersionNo="140"/>
      <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
      <attribute name="units" value="s" type="string"/>
      <attribute name="standard_name" value="sea_surface_wave_mean_period_from_variance_spectral_density_first_frequency_moment" type="string"/>
      <attribute name="long_name" value="sea_surface_wave_significant_period" type="string"/>
    </parameter>
    <parameter name="cdww"  type="float">
      <grib1 indicatorOfParameter="233" gribTablesVersionNo="140"/>
      <attribute name="units" value="" type="string"/>
      <attribute name="long_name" value="sea_surface_wave_drag_coefficient" type="string"/>
    </parameter>
    <parameter name="wind_speed_10m"  type="float">
      <grib1 indicatorOfParameter="245" gribTablesVersionNo="140"/>
      <attribute name="_FillValue" value="9.9692099683868690e+36f" type="float" />
      <attribute name="units" value="m/s" type="string"/>
      <attribute name="standard name" value="wind speed" type="string"/>
    </parameter>
    <parameter name="137Cesium_concentration" type="float">
        <grib1 indicatorOfParameter="200" gribTablesVersionNo="133" identificationOfOriginatingGeneratingCentre="54">
            <extraKey name="isotopeIdentificationNumber" value="169"/>
        </grib1>
        <!--  <attribute name="standard_name" value="geopotential_height" type="string" /> -->
        <attribute name="units" value="Bq*h/m3" type="string" />
    </parameter>
    <parameter name="133Xenon concentration" type="float">
        <grib1 indicatorOfParameter="200" gribTablesVersionNo="133" identificationOfOriginatingGeneratingCentre="54">
          <extraKey name="isotopeIdentificationNumber" value="158"/>
        </grib1>
        <!--  <attribute name="standard_name" value="geopotential_height" type="string" /> -->
        <attribute name="units" value="Bq*h/m3" type="string" />
    </parameter>


</variables>
</cdmGribReaderConfig>
```