# Worksheet on climate change and model interpretation

In this worksheet you will try to get a feel of some of the tools that are out there to access climate data, including observations, reanalysis and climate projections. The list is by no means exhaustive, and in these exercises we will focus on the KNMI tool as it allows basic online analysis without needing knowledge of

## 1. KNMI Climate Explorer

http://climexp.knmi.nl/

The climate explorer is an informal non operational research tool maintained at KNMI. It allows for an easy analysis of a number of station data, models and even some reanalysis products.

### *Exercise 1*

Let's start with the CMIP5 models. Look at the top right and select "Monthly CMIP5 scenario runs". If you scroll down, you will find ensemble means of the CMP5 models, and also individual CMP5 models, labled in the left column.

Variables:
The variables are then listed to the right
tas = near surface (2m) temperature (this is commonly known as T2m)
pr = precipitation
A full list of variables names and units can be found here:
"http://www-pcmdi.llnl.gov/ipcc/standard_output.html"

Scenario:
"exp" refers to the experiment, which is usually referred to as the scenario – With CMIP5 there was a simplification of the naming convention, and so each scenario refers to a "representative concentration pathway (rcp)" that more or less stabilize at a top-of-atmosphere radiative forcing of XXX W/m2. These range from the low-end scenario of rcp2p6, with a scaling back of emissions to stabilize at 2.6 W/m2 to the high end scenario of 8.5 W/m2. These scenarios are not simply a linear scaling of one another; they are made with four separate impacts assessments models, each with its own array of land use, energy mix, population growth and GDP scenarios. For example, the land use change projections are actually quite similar between rcp2p6 and 8p5, since the former invokes significant deforestation for biofuels.

Ensemble member:
The number of ensemble members that go into the field is written below each radio button.

Let's look at the HADGEM model - "**HadGEM2-ES**". We will plot the present day run "**historical**". We can see that there are 4 ensemble members. Let's plot the precipitation, click on **"pr",** then scroll up to the top and click **"select field"**

Making a simple plot:
The server will now tell you it found ensemble members 0 to 3, and give you a lot of processing options. You can select sub-areas, make time-running averages, or select individual members. This is where people often get confused with climate explorer (including myself if I haven't used it for a while)!!! This is because, apart from the processing options on the left, you may not have noticed that there is also a new menu entry on the right titled "**investigate this field"**. There are a number of options. Click on "**Compute mean, s.d. or extremes**". This results in a lot of options, just ignore them an hit "**plot**" at the bottom. What happens?

Getting a plot right

You should get a plot with 12 panels, one for each month. The colours are weird though, as the colour bar is for an anomaly. Hit the back browser, and find “colours”, and select something reasonable like “grey-red-blue”. Hit “plot” again. Now the plot colours are better for some months, but there are still problems with the negative overshoot and also each month has a different maximum, making it difficult to compare. Hit “back” and set limits for the contours, say minimum of 5 and a maximum of 30 (make sure units are set to mm/day). Hit plot. Looks good no?

Getting the data.

Need the plot for a paper? There is a link about each panel offering to download the plot in several formats. Plot not to your liking and prefer to have the data in netcdf to use your own plotting software? Scroll down and you will find a link offering you the data in netcdf format.

***Exercise 2***

While the climate explorer is strong at field analysis (SVD, EOF, correlations) it is surprisingly clunky to make difference fields. In particular, the option to make a difference between a RCP future time-slice and present day does not seem to be presently possible (CMIP3 this is possible though).

But simple difference fields can be made of century long trends. For example, for the HADGEM fields, choose an RCP, say RCP4p5 – then you can now select the option on the right “**plot difference with a field**”

You can now choose a field to compare it to... this includes various observations, the entire CMIP3 database (but not the CMIP5 yet) or finally at the bottom of the list you can select the same field (i.e. You find the difference with itself!)

Then at the very bottom of the page there are options “area” and “difference options”. For the difference options we will examine the trend in June-July-August averages. So select “**starting month**” and select June, and then number of months=3.
First field = 2070-2099
Second field=2006-2035 (the RCP runs start in 2006)
then clik “plot difference” - you can play with the contours again (you may want to turn off the masking for significance). You should see see a general slowing down of the Hadley circulation marked with a reduction in tropical precipitation.

***Exercise 3:***

You can practise plotting some difference by looking at temperature and precipitation trends in other models or the ensemble mean. If you want to check out the difference between models for a given RCP, you will need to do this for CMIP3, where intercomparison options are richer. Look at temperature, try to see how difference between models compares to the difference between scenarios and the difference between individual ensemble members for example.

***Exercise 4: timeseries of daily data.***

Next week we will use daily data for VECTRI. For this, you will need to click on “select a field”-> “**daily fields**”. Not all models have Temperature and precipitation stored as daily fields, so choose a model that does. Once you click “select field”, this time we will use the grid point selection procedure. For example, if we want to extract the point for Niamey, under “Get grid points, average area or generate subset”, we will simply enter latitude 13.5N-13.5N and longitude 2.1E. Click on “**convert to mm/day”** and then “**make timeseries**”. Wait a little while and plots of the time-series should appear.

We will need to download these as netcdf, to do this, use the option “**raw data**” above the

timeseries plot, and then choose the option “**netcdf**”.

## 2. IRI data server

http://iridl.ldeo.columbia.edu/

The IRI data library holds a wide range of model and observations. It's observational datasets include a number of satellite products. The use of the library will be introduced in a separate lecture.

## 3. ECMWF datasets

The reanalysis server is presently being replaced. The old server required one to enter an email and click to accept user conditions on each usage, the new server required one to register with the organisation. The data server does not allow any real analysis, just simple plots, so for more complex analysis fields have to downloaded and processed offline.

An old ERAI server can be found here that does not need a registration:
Old server: http://data-portal.ecmwf.int/data/d/interim_full_daily

However, this will disappear soon so we suggest to move to the new server:
New server: http://apps.ecmwf.int/datasets/

Here there are a number of datasets. Probably for your uses you will need one of the following:

a. REANALYSIS – ERA-INTERIM
Long term database using the same (but old) system. Low resolution but consistent over time.

b. TIGGE database – Analysis and short-range forecast
High resolution analysis and forecast fields using the “state-of-the-art” system **at the time that forecast/analysis was made**.

c. GEMS/MACC database
Analysis and forecast of gases/aerosols, some of which may have significant health impacts.

**Exercise 1 :** Plot T2m over Africa from ERA-Interim for December 2011 from the analysis at 12Z

**Exercise 2**: Plot T2m over Africa from ERA-Interim for December 2012 from the 12 hour forecast.

**Exercise 3**: Plot the precipitation from the short-range forecasts at 24 hours for December 2012. What happens if you try to plot precipitation for the analysis? Why?

## 4. IPCC data

http://www.ipcc-data.org/maps/

Simple interface that allows for difference analysis between climate models output – Only AR4.

## 5. Malaria data:

http://www.map.ox.ac.uk

Malaria analysis based on survey data incorporated into a statistical model that accounts for environmental variables.