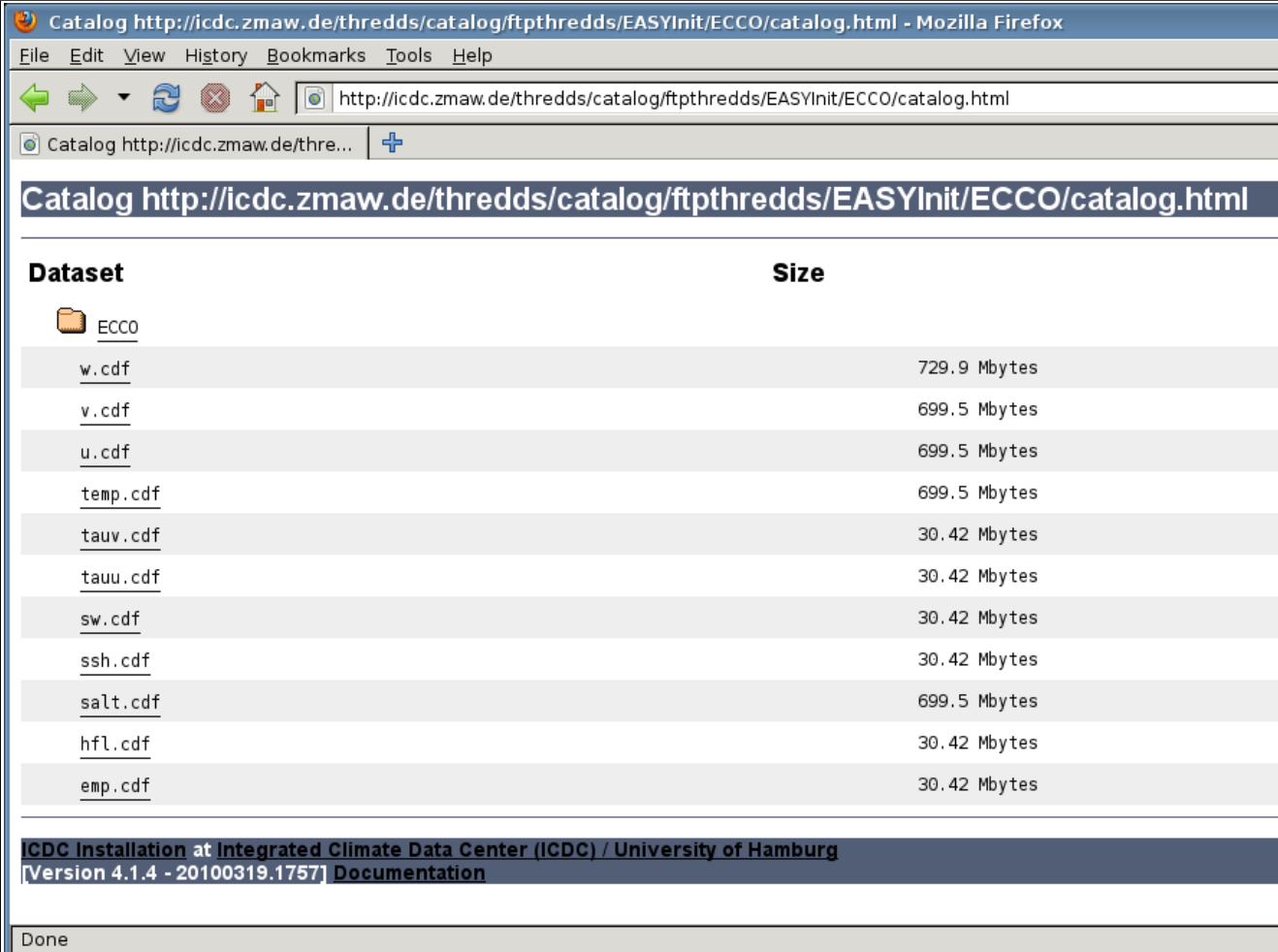# THREDDS / OPeNDAP Tutorial

What is THREDDS?

The THREDDS Data Server provides data access for scientific datasets, especially for geo-referenced data (netCDF, HDF, GRIB, etc.). Via THREDDS you can download datasets with your web browser or use subsets without downloading the datasets (OPeNDAP).

How to use THREDDS and OPeNDAP?

This short tutorial shows step by step how to access datasets via THREDDS and OPeNDAP:

1. Datasets Overview

If you click on a THREDDS or OPeNDAP link in our data center, you will get an **overview** of these datasets. E.g. if you choose ECCO-SIO, you will get a list of files with information about size and modification date: http://icdc.cen.uni-hamburg.de/thredds/catalog/ftpthredds/EASYInit/ECCO/catalog.html
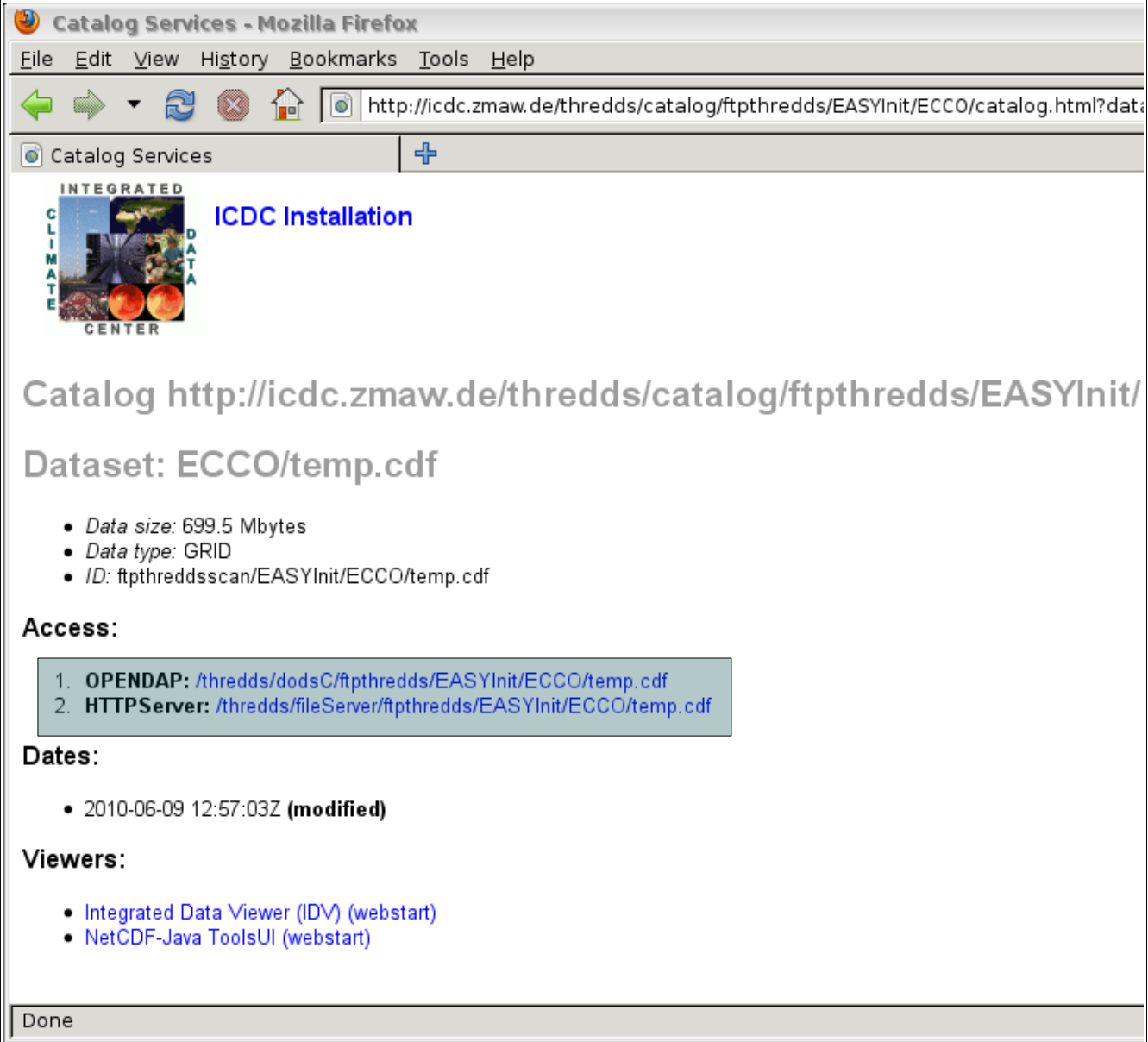
2. Dataset View

If you click on one dataset, e.g. on temp.cdf (Temperature), you will get the next screen. The most important section is **Access**, where you can choose between downloading this file (via the HTTPServer link) or accessing it via OPeNDAP.

3. OPeNDAP Data URL

If you click on the OPENDAP link, you will get the OPeNDAP Dataset Access Form. Via OPeNDAP you can work on a subset of the dataset file without the need to download it to your computer. Simply copy the **Data URL** and use it with your favorite software like Ferret, GrADS, NCO, CDAT, Matlab with OPeNDAP Toolkit, etc.

4. Using OPeNDAP with Ferret

In your favorite software you can now use the OPeNDAP Data URL. E.g. in Ferret you can use it with `set data` and plot it via the `shade` command - like in the following example:

```
> ferret
        NOAA/PMEL TMAP
        FERRET v6.71
        Linux 2.6.32-131.6.1.el6.x86_64 64-bit - 08/08/11
        19-Sep-11 15:25


yes? use "http://icdc.cen.uni-hamburg.de/thredds/dodsC/ftpthredds/EASYInit/ECCO/temp.cdf"
yes? show data
    currently SET data sets:
   1> http://icdc.cen.uni-hamburg.de/thredds/dodsC/ftpthredds/EASYInit/ECCO/temp.cdf  (default)
 name     title                             I      J       K       L
 TEMP     POTENTIAL TEMPERATURE          1:360   1:160    1:23    1:132

yes? shade/k=1/l=1 temp
```
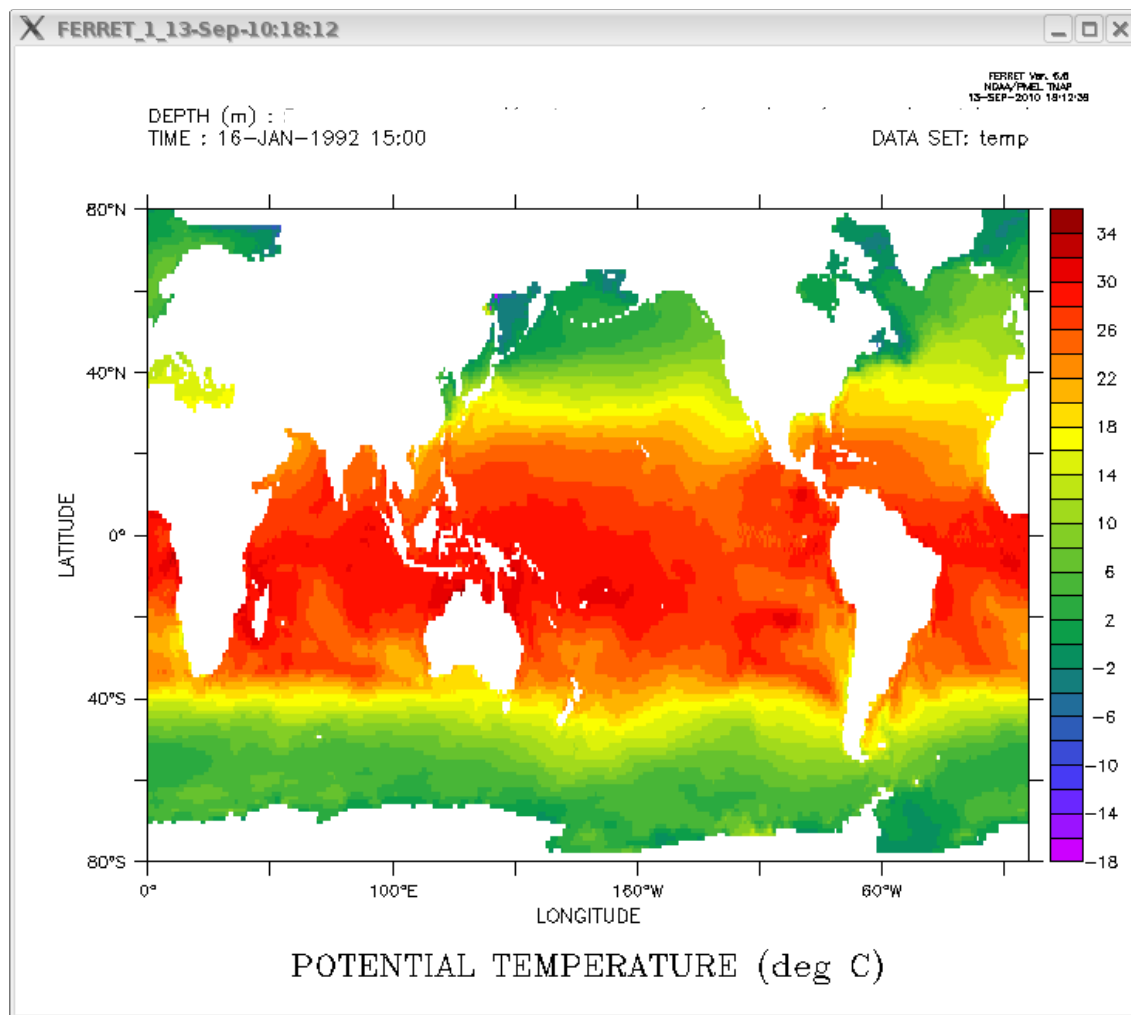
5. OPeNDAP Data Access Form

There is also a way to get data subsets via OPeNDAP directly in your browser. If you once again take a look at the OPeNDAP Data Access Form, you will see all variables of this dataset below the Data URL (see screenshot on page 6). The form is a bit confusing, but you can get used to it.

5.1 How to select a subset

In the case of ECCO-SIO Temperature we are interested in the TEMP-Variable. If you want a subset of Temperatures of this dataset, check the box in front of TEMP (form on page 6, bottom). The default values [0:1:0] will appear in the form fields TIME, DEPTH_T, LATITUDE_T and LONGITUDE_T.

The syntax [x:y:z] means: Return all values from x to z with step size y. So [0:1:0] in the Time field means: Return the first Time-value (the values from 0 to 0 step size 1, 0 means the first one). [0:1:0] in the fields Time, Depth, Latitude and Longitude of the TEMP variable means: Return the Temperature value at the first Time step, the first Depth value and the first Lon-Lat-grid-point.

Click on the "Get ASCII" button at the top of the page and you will get this result:

```
TEMP.TEMP[1][1][1][1]
[0][0][0], -1.0E23

TEMP.TIME[1]
1314000.0

TEMP.DEPTH_T[1]
5.0

TEMP.LATITUDE_T[1]
-79.5

TEMP.LONGITUDE_T[1]
0.5
```

The first Time value is 1314000.0 (seconds since 1992-01-01 10:00:00), the first Depth value is 5.0, the first Lat value is -79., the first Lon value is 0.5. The requested Temp value is -1.0E23.

5.2 Modified Data URL

Now please take a look at the Data URL: The constraints you specified were also added to the URL:
`http://icdc.cen.uni-hamburg.de/.../temp.cdf?TEMP[0:1:0][0:1:0][0:1:0][0:1:0]`

So you can also use this modified URL in your favorite software and will get the desired subset.

Global Attributes:
```
history: "FERRET V5.70    9-Jun-10"
Unlimited_Dimension: TIME
```

Variables: ☐ LONGITUDE_T: Array of 64 bit Reals [LONGITUDE_T = 0..359]
LONGITUDE_T: _____
```
units: "degrees_east"
modulo: 360.0
point_spacing: "even"
axis: "X"
```

☐ LATITUDE_T: Array of 64 bit Reals [LATITUDE_T = 0..159]
LATITUDE_T: _____
```
units: "degrees_north"
point_spacing: "even"
axis: "Y"
```

☐ DEPTH_T: Array of 64 bit Reals [DEPTH_T = 0..22]
DEPTH_T: _____
```
units: "meters"
positive: "down"
point_spacing: "uneven"
axis: "Z"
bounds: "DEPTH_T_bnds"
```

☐ DEPTH_T_bnds: Array of 64 bit Reals [DEPTH_T = 0..22][bnds = 0..1]
DEPTH_T: _____   bnds: _____

☐ TIME: Array of 64 bit Reals [TIME = 0..131]
TIME: _____
```
units: "seconds since 1992-01-01 10:00:00"
time_origin: "01-JAN-1992 10:00:00"
axis: "T"
bounds: "TIME_bnds"
```

☐ TIME_bnds: Array of 64 bit Reals [TIME = 0..131][bnds = 0..1]
TIME: _____   bnds: _____

☑ TEMP: Grid
TIME: 0:1:0   DEPTH_T: 0:1:0   LATITUDE_T: 0:1:0   LONGITUDE_T: 0:1:0
```
missing_value: -1.0E23
_FillValue: -1.0E23
long_name: "POTENTIAL TEMPERATURE"
history: "From iter69ts"
units: "deg C"
```

5.3 Further examples

You can change the [x,y,z] constraints according to the ranges that are specified at the variables. E.g. the DEPTH_T values must be between 0 and 22, so [21:1:22] would be an allowed constraint that means: Return the last two Depth values. The LONGITUDE_T and LATITUDE_T variables indicate that there is a grid of 360 x 160 values (LONGITUDE_T = 0...359, LATITUDE_T = 0...159).

If you would like to get a **time series** of the first 10 Temperature values at first Depth level over the entire data field (360 x 160), fill out the fields below TEMP in the following way:
```
TIME 0:1:9   DEPTH_T 0:1:0   LATITUDE_T 0:1:159   LONGITUDE_T 0:1:359
```

You can get the data subset by clicking on "Get ASCII" or use the Data URL that has changed to:
```
http://icdc.cen.uni-hamburg.de/.../temp.cdf?TEMP[0:1:9][0:1:0][0:1:159][0:1:359]
```

If you only want **every third value** of the data field, you can change the content of the LATITUDE_T and LONGITUDE_T fields to:
```
TIME 0:1:9   DEPTH_T 0:1:0   LATITUDE_T 0:3:159   LONGITUDE_T 0:3:359
```

If you want to get the Temperature values of the **last two Depth levels**, change the form fields to:
```
TIME 0:1:9   DEPTH_T 21:1:22   LATITUDE_T 0:3:159   LONGITUDE_T 0:3:359
```

5.4 "Get Binary" button

You can also use the "Get Binary" Button to download the subset. The content is then encoded using XDR (an architecture independent data format standard) with an ASCII metadata header.
The header called Dataset Descriptor Structure (DDS) gives some information about the dataset followed by the keyword "Data:". After that header the binary data part starts. An example of this ASCII header is shown here:

```
Dataset {
    Grid {
     ARRAY:
        Float32 TEMP[TIME = 10][DEPTH_T = 1][LATITUDE_T = 160][LONGITUDE_T = 360];
     MAPS:
        Float64 TIME[TIME = 10];
        Float64 DEPTH_T[DEPTH_T = 1];
        Float64 LATITUDE_T[LATITUDE_T = 160];
        Float64 LONGITUDE_T[LONGITUDE_T = 360];
    } TEMP;
} ftpthredds/EASYInit/ECCO/temp.cdf;

Data:
```

5.4 OPeNDAP suffixes

If you got an OPeNDAP Data URL and you do not want to use the OPeNDAP Access Form, you can append different suffixes to that URL in your browser to get more information about the data.

Take a look again at our ECCO Temperature Data URL. If you append the suffix `.dds` to it, you will get the Dataset Descriptor Structure (DDS):
http://icdc.cen.uni-hamburg.de/thredds/dodsC/ftpthredds/EASYInit/ECCO/temp.cdf.dds

By appending the suffix `.das`, you will get the Data Attribute Structure (DAS):
http://icdc.cen.uni-hamburg.de/thredds/dodsC/ftpthredds/EASYInit/ECCO/temp.cdf.das

If you append the suffix `.info` to it, you will get an info view, which combines the information of DDS and DAS:
http://icdc.cen.uni-hamburg.de/thredds/dodsC/ftpthredds/EASYInit/ECCO/temp.cdf.info

Instead of clicking the "Get ASCII" Button in the OPeNDAP Access Form, you can also use the `.asc` or `.ascii` suffix to get the data, e.g.:
http://icdc.cen.uni-hamburg.de/thredds/.../ECCO/temp.cdf.ascii?TEMP[0:1:10][0:1:0][0:1:159][0:1:359]

6. Conclusion

You can find further details about THREDDS on:
http://www.unidata.ucar.edu/projects/THREDDS/tech/TDS.html

If you want to know more about OPeNDAP, visit this site:
http://www.opendap.org

You can always contact the ICDC team, too:
http://icdc.cen.uni-hamburg.de/beratung.html

Your ICDC team,
Hamburg, 5.10.2016

Integrated Climate Data Center
KlimaCampus Hamburg
http://icdc.cen.uni-hamburg.de