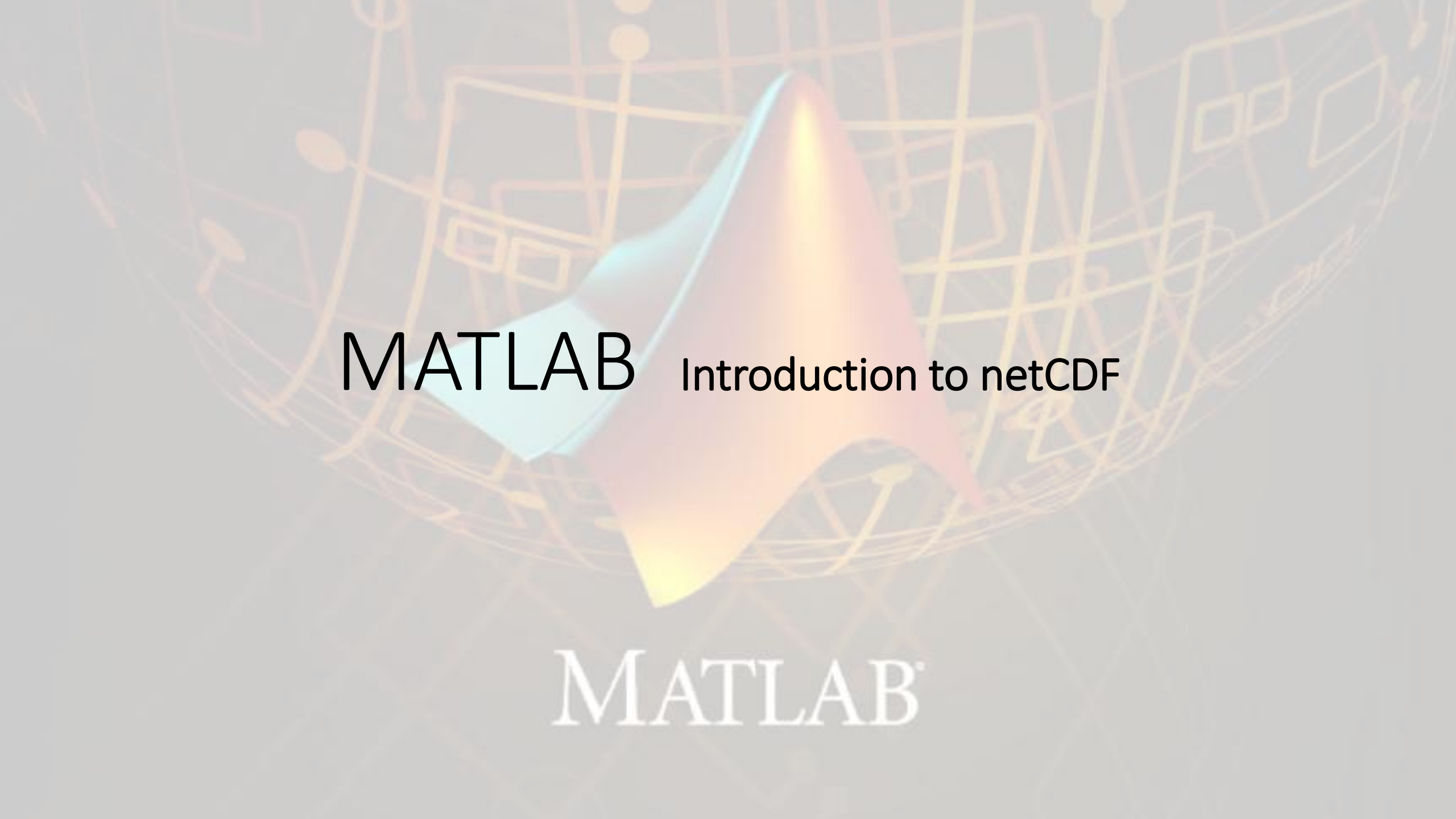


The background features a large, stylized MATLAB logo in the center, which is a 3D surface plot with a color gradient from blue to red. The logo is surrounded by a network of thin, orange lines and dots, resembling a complex graph or neural network. The overall background is a light gray with a subtle grid pattern.

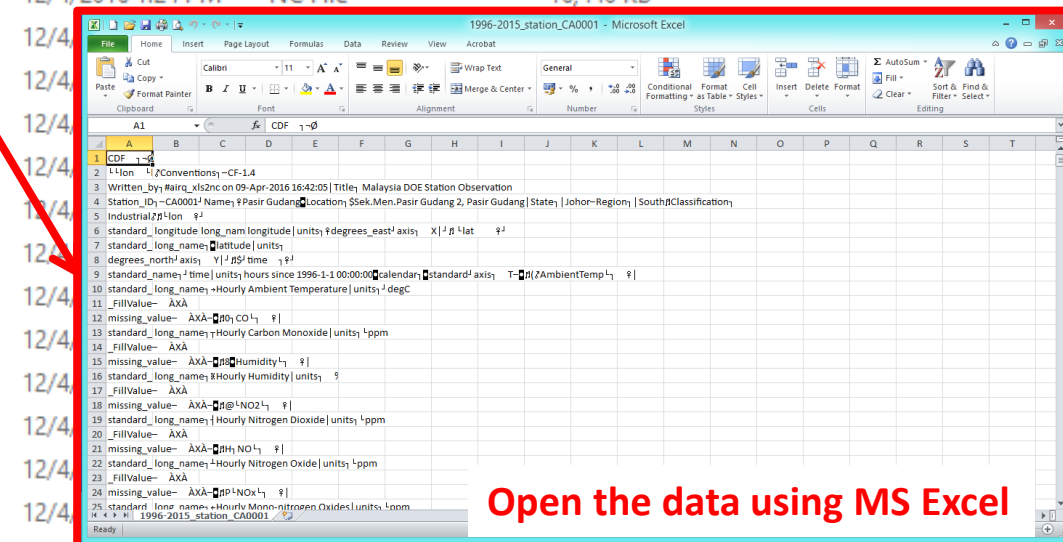
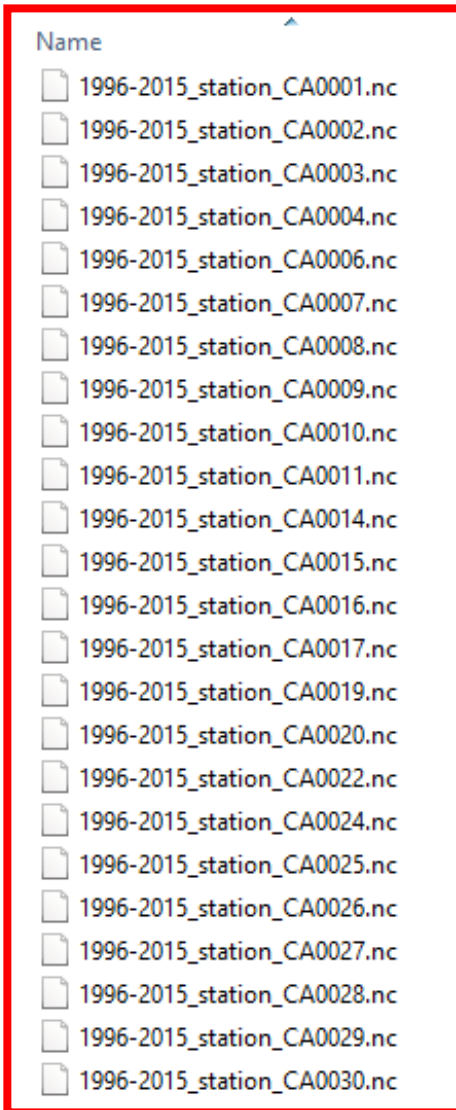
MATLAB Introduction to netCDF

MATLAB

What is netCDF?

- Developed and maintained by Unidata, University Corporation for Atmospheric Research (UCAR).
- Usually self describing (having embedded information in the data)
- Machine independent
- Can store multidimensional data
- Some common tools we used here to processed/visualized netCDF:
 - i. **Climate Data Operators (CDO)**
 - ii. Grid Analysis Display System (GrADS)
 - iii. **MATLAB**
 - iv. R
 - v. Panoply

What is netCDF?



netCDF is a **binary data**,
it cannot be read as if it
is ASCII data!

When asked to work with netCDF data ...

It is **complicated**

I am **not good** in
technical



... but is it?

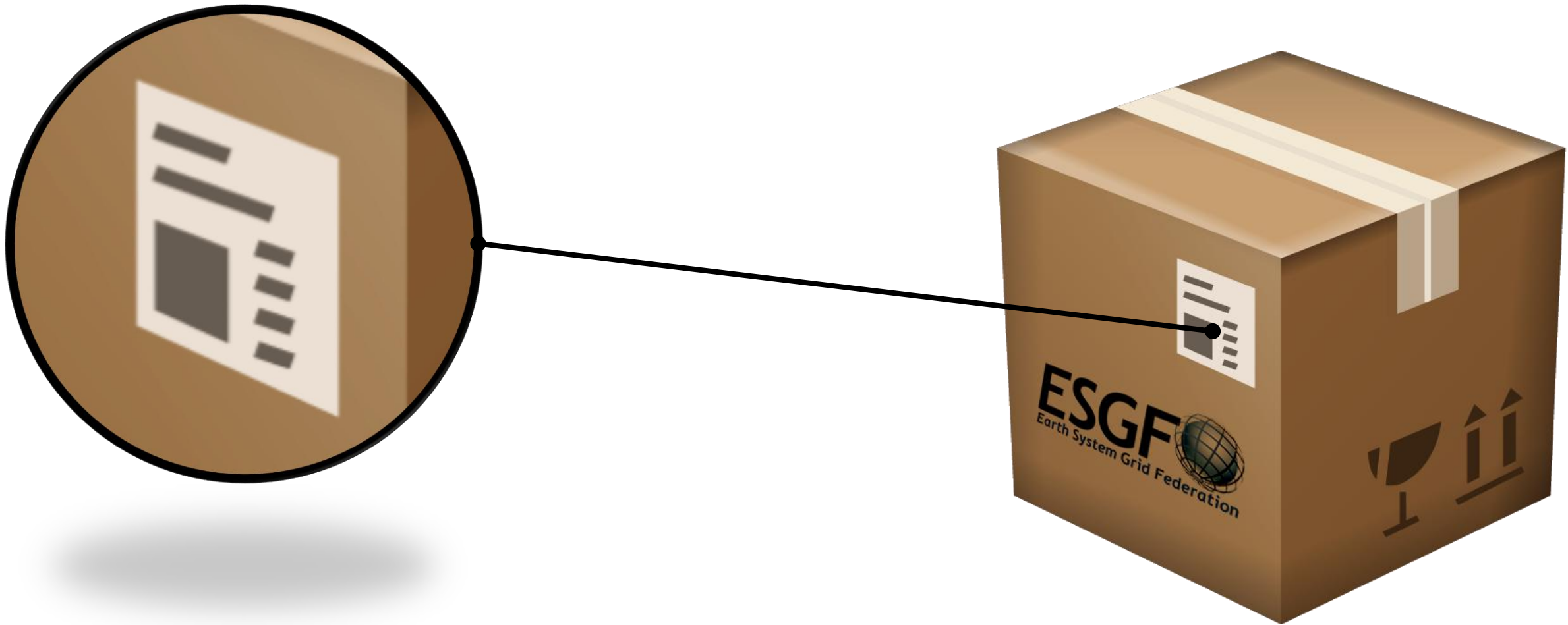
Concept: Data in netCDF, A Sealed Box with Hidden Treasure

- Data in .nc is like a “**sealed box**” with “**treasure**”.
(binary data)
(information we want to extract)
- To access its content “a **pair of scissor**” is needed to “**cut open the box seal**”.
(specific software)
(read this binary data and extract the information we want)



Before we get work with netCDF data

Read the “information sticker”!





```
netcdf file:pr_EC-EARTH_RegCM4_historical_SRF.nc {
  dimensions:
    lon = 227;
    lat = 164;
    time = UNLIMITED; // (672 currently)
    bnds = 2;
  variables:
    double time_bnds(time=672, bnds=2);

    float pr(time=672, lat=164, lon=227);
      :standard_name = "precipitation_flux";
      :long_name = "Total precipitation flux";
      :units = "kg m-2 s-1";
      :_FillValue = -9.0E33f; // float
      :missing_value = -9.0E33f; // float
      :cell_methods = "time: mean";

    float lon(lon=227);
      :standard_name = "longitude";
      :long_name = "longitude";
      :units = "degrees_east";
      :axis = "X";
      :_CoordinateAxisType = "Lon";

    float lat(lat=164);
      :standard_name = "latitude";
      :long_name = "latitude";
      :units = "degrees_north";
      :axis = "Y";
      :_CoordinateAxisType = "Lat";

    double time(time=672);
      :standard_name = "time";
      :long_name = "time";
      :bounds = "time_bnds";
      :units = "hours since 1950-1-1 12:00:00";
      :calendar = "standard";
      :axis = "T";
      :_CoordinateAxisType = "Time";

  // global attributes:
  :CDI = "Climate Data Interface version 1.7.2 (http://mpimet.mpg.de/cdi)";
  :Conventions = "CF-1.4";
}
```

“header”

netCDF “Information Sticker”

(metadata)

Getting the Metadata

- If your computer has netCDF library installed (refer supplementary information section) , type in terminal/command prompt: `ncdump -h ifile.nc`
- If MATLAB: **ncinfo**, or **nc_dump** (3rd party function from snctools)
- If CDO: too many to list down, refer CDO User's Guide section 2.1 (<https://code.mpimet.mpg.de/projects/cdo/embedded/cdo.pdf>)

```
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  dimensions:
    lon = 227;
    lat = 164;
    time = UNLIMITED;    // (672 currently)
    bnds = 2;
  variables:
    double time_bnds(time=672, bnds=2);
```

```
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  :standard_name = "precipitation_flux";
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```

```
float lon(lon=227);
  :standard_name = "longitude";
  :long_name = "longitude";
  :units = "degrees_east";
  :axis = "X";
  :_CoordinateAxisType = "Lon";
```

```
float lat(lat=164);
  :standard_name = "latitude";
  :long_name = "latitude";
  :units = "degrees_north";
  :axis = "Y";
  :_CoordinateAxisType = "Lat";
```

```
double time(time=672);
  :standard_name = "time";
  :long_name = "time";
  :bounds = "time_bnds";
  :units = "hours since 1950-1-1 12:00:00";
  :calendar = "standard";
  :axis = "T";
  :_CoordinateAxisType = "Time";
```

```
// global attributes:
:CDI = "Climate Data Interface version 1.7.2 (http://mpimet.mpg.de/cdi)";
:Conventions = "CF-1.4";
```

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float pr(time=672, lat=164, lon=227);
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  :cell_methods = "time: mean";
```

```
float lon(lon=227);
  :standard_name = "longitude";
  :long_name = "longitude";
  :units = "degrees_east";
  :axis = "X";
```

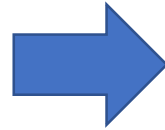
```
float lat(lat=164);
  :standard_name = "latitude";
  :long_name = "latitude";
  :units = "degrees_north";
  :axis = "Y";
  :_CoordinateAxisType = "Lat";
```

```
double time(time=672);
  :standard_name = "time";
  :long_name = "time";
  :bounds = "time_bnds";
  :units = "hours since 1950-1-1 12:00:00";
  :calendar = "standard";
  :axis = "T";
  :_CoordinateAxisType = "Time";
```

Contain important information
describing the data

Getting the Metadata

```
netcdf \1996-2015_station_CA0001 {
dimensions:
    lon = 1;
    lat = 1;
    time = UNLIMITED ; // (175320 currently)
variables:
    float lon(lon) ;
        lon:standard_name = "longitude" ;
        lon:long_name = "longitude" ;
        lon:units = "degrees_east" ;
        lon:axis = "X" ;
    float lat(lat) ;
        lat:standard_name = "latitude" ;
        lat:long_name = "latitude" ;
        lat:units = "degrees_north" ;
        lat:axis = "Y" ;
    double time(time) ;
        time:standard_name = "time" ;
        time:units = "hours since 1996-1-1 00:00:00" ;
        time:calendar = "standard" ;
        time:axis = "T" ;
    double AmbientTemp(time, lon, lat) ;
        AmbientTemp:standard_name = "Ambient Temperature" ;
        AmbientTemp:long_name = "Hourly Ambient Temperature" ;
        AmbientTemp:units = "degC" ;
        AmbientTemp:_FillValue = -99. ;
        AmbientTemp:missing_value = -99. ;
        .....
// global attributes:
    :Conventions = "CF-1.4" ;
    :Written_by = "airq_xls2nc on 09-Apr-2016 16:42:05" ;
    :Title = "Malaysia DOE Station Observation" ;
    :Station_ID = "CA0001" ;
    :Name = "Pasir Gudang" ;
    :Location = "Sek.Men.Pasir Gudang 2, Pasir Gudang" ;
    :State = "Johor" ;
    :Region = "South" ;
    :Classification = "Industrial" ;
}
```



This is a sample of metadata of a netCDF, what does it tell you about the data?

- i. Data stored here is **hourly ambient temperature**
- ii. The unit of the data is **°C**
- iii. This data has **175320** hourly data in it
- iv. It is a point data, because **lat & lon = 1**
- v. The data is a **Malaysia DOE station observation**
- vi. The station ID is **CA0001**
- vii. The station name is **Pasir Gudang**
- viii. It is located at **SM Pasir Gudang 2**
- ix. The state this station located is in **Johor**
- x. The region this station located is the **southern region**
- xi. The classification of this station is **industrial**