



Royal Netherlands  
Meteorological Institute  
Ministry of Infrastructure and the  
Environment



PUSAIR



## JOINT COOPERATION PROGRAMME

### Component D1:

### Droughts Early Warning System

#### Document D1.3

#### Manuals for the training on *Use of PCRaster, NetCDF and grib data*

BMKG, Jakarta

1-4 August 2011

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Royal Netherlands  
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# **JCP training**

**Implementation SPI Pemali Comal**

Ronald Vernimmen

# **Preliminary**

Prepared for:  
PusAir, BMKG

## **JCP training**

**Implementation SPI Pemali Comal**

Ronald Vernimmen

Report

August 2011

<b>Client</b>	PusAir, BMKG							
<b>Title</b>	JCP training							
<b>Abstract</b>								
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## 1 Introduction

The Pemali-Comal catchment is chosen as a pilot area by PusAir for which SPI (Standardized Precipitation Index) drought maps are created on a monthly basis. So far this has been done manually, by calculating the SPI in Excel for each individual station after which from the calculated SPI values maps were created by the Thiessen interpolation method?. Currently the SPI is also implemented in the DEWMS where the SPI is calculated using a Python script. The whole process of importing precipitation data, calculation of SPI and generation of the SPI maps is done within one single workflow which will save a lot of time in generating the drought maps in the future. This training manual discusses the implementation of the SPI in the DEWMS.

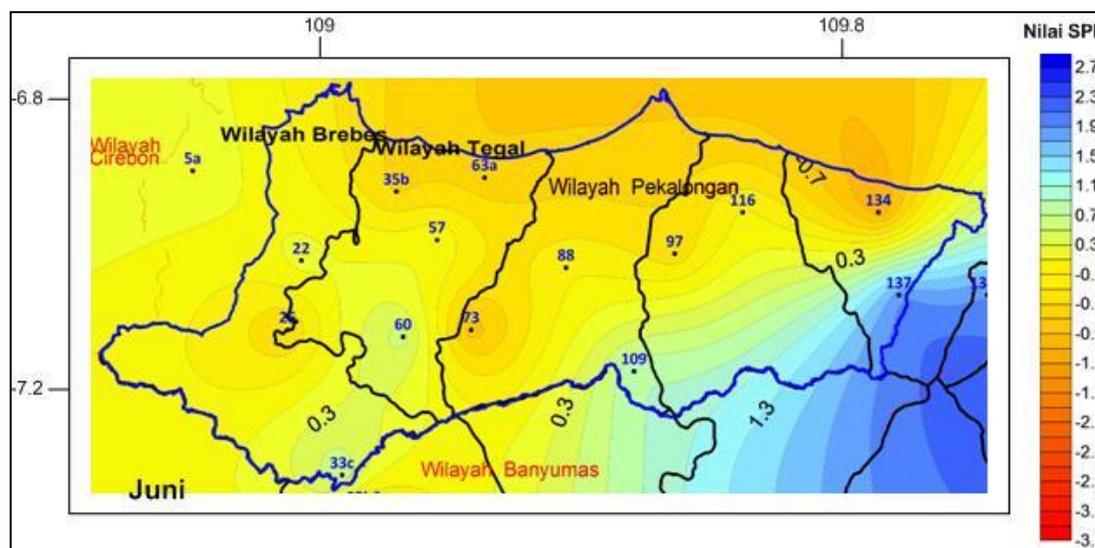


Figure 1.1 SPI-01? map for Pemali-Comal for June 2011.

## 2 Precipitation input

The SPI is an index which uses monthly precipitation data. The Python script which is written however expects daily precipitation which will be aggregated to monthly values prior to calculating the SPI. The precipitation data can be imported in the DEWMS database via either the Data Editor (Section 2.1) or via a CSV file (Section 2.2).

### 2.1 Import via Data Editor

First we need to select a location and parameter for which we like to add new data (Figure 2.1). Once both location and parameter are selected press the Data Editor icon (Figure 2.2). A table and figure will appear (Figure 2.3). Go to the table and click on the column with the correct date for which you have data and start entering the data. It is also possible to copy-paste a whole time series from Excel. The data automatically appears in the graph to the right of the table. **Note:** when using the data editor the missing value is NaN instead of -999. When entering -999 this will be stored in the database as a value!

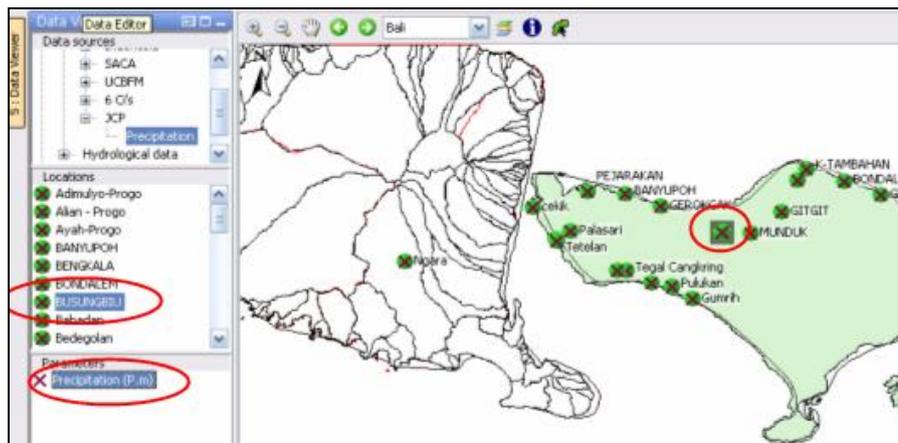


Figure 2.1 Select a location and parameter via the Data Viewer tab.

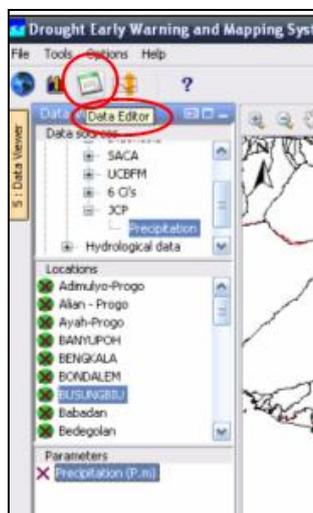


Figure 2.2 Data Editor icon.

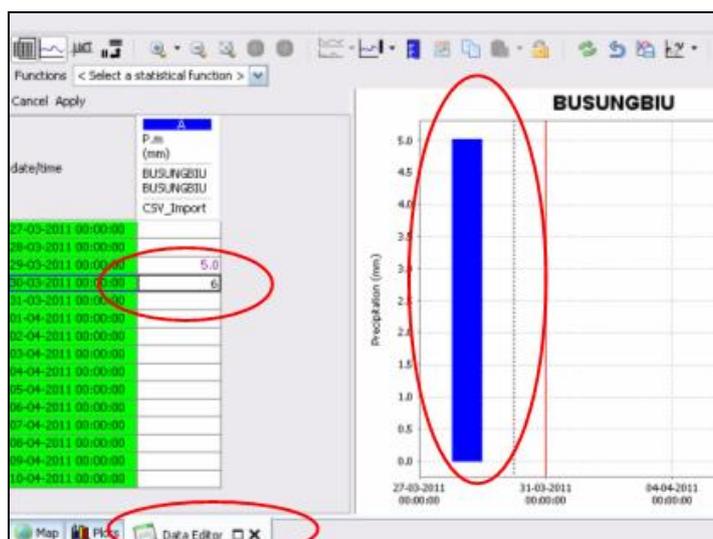


Figure 2.3 Table and figure in data editing mode.

If the table has no empty cells anymore and you have more recent data, you can extend the table by zooming out on the graph (using scroll button) until the period for which you have data appears on the axis (Figure 2.4). When you are finished and you want to store the data in the database click the Apply button. You will be asked if you really want to save the changes to the database (Figure 2.5).

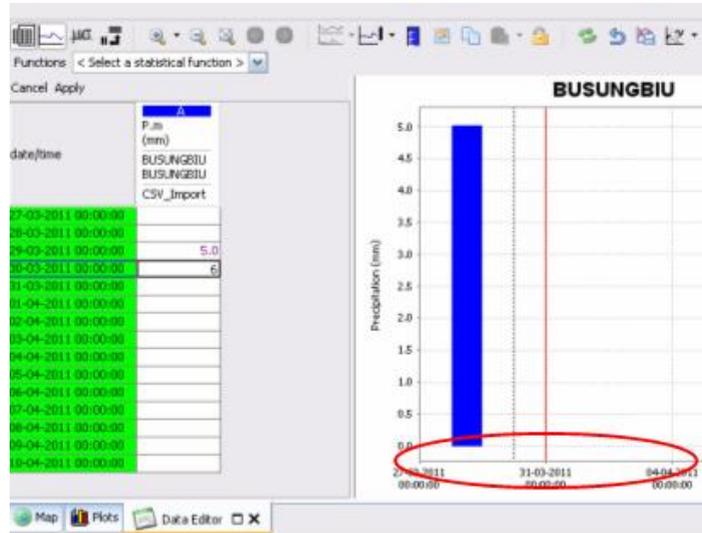


Figure 2.4 Zoom out if you have data out of the period shown on the date axis.



Figure 2.5 Save changes permanently in the database.

## 2.2 Import via CSV files

If you have much data it will be quicker if you import the data through CSV files. Comma Separated Value (CSV) files can be created from Excel and can be opened with any text editor. However the CSV file needs to follow a specific format:

- The cell format of the first column should be yyyy-mm-dd hh:mm:ss otherwise the Delft-OMS software will not be able to import the data and will return an error.
- The format is set by right clicking on the selected cells and select the 'Format Cells' format option and change to the required format via the Category: Custom and Type: General, in which you can type yyyy-mm-dd hh:mm:ss (Figure 2.6).
- Nodata values should be -999.
- The separator between data should be comma (',') instead of semicolon (';'). If this is not the case check the language settings via (in Windows XP) Settings - Control Panel – Regional and Language Options and change it to English instead of i.e. Indonesian.
- Make sure that the first 3 lines of the first column begin with the words: Location Names, Location Ids and Time.

- Each column with data then starts with on the first row the LocationName and on the second row the LocationId. If the LocationId does not exist yet make sure to include it in both the Metadata file but also in the IdMapping file. The Metadata file is located in the <DEWMS/Config/MapLayerFiles> directory and at the moment of writing it is the following file: MetadataHydroMeteoStationsIndonesia-LL-RV110728.dbf. The IdMapping file (the file that couple external (in this case CSV file) location id's and parameter id's to the internal (DEWMS database) id's. For convenience it is recommended to keep both external location id's and parameter id's the same as the internal id's. The IdMapping file for the CSV import is the IdCSV\_Import.xml which is found in the <DEWMS/Config/IdMapFiles> directory.
- On the third row the ParameterId which is recognized by DEWMS is expected. Available parameters can be found in the Parameters.xml file which is found in the <DEWMS/Config/RegionConfigFiles> directory. Should you want to add a new parameterId which is not yet defined in the Parameters.xml make sure you add this ParameterId not only in the CSV file but also in the Parameters.xml.

An example of a correct formatted csv file is shown in [Figure 2.7](#).

Save the csv file in Excel via File – Save As and select the CSV (Comma delimited) (\*.csv) type ([Figure 2.8](#)). Click OK when you get a message that "The selected file type does not support workbooks that contain multiple sheets." And yes when the message is: "<Filename> may contain features that are not compatible etc."

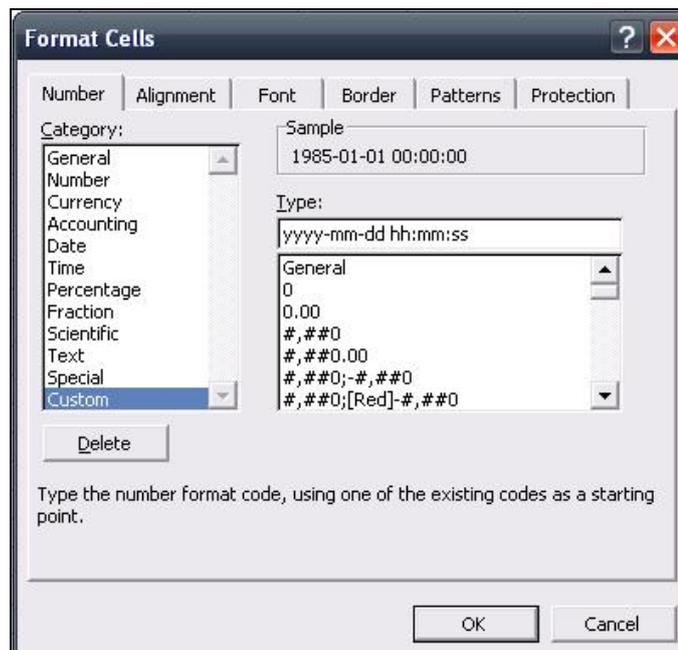


Figure 2.6 Setting the correct cell format for dates in the CSV file.



Once a '.csv' file is created it should be stored in for instance the <DEWMS/Import/Precipitation/Daily> directory. It depends on what type of data (Precipitation or Discharge) and the timestep (Daily, Hourly) the csv file contains.

The import of the csv files is arranged in the CSV\_Import.xml which is stored in the <DEWMS/Config/ModuleConfigFiles> directory. At the moment the following parameters and timesteps are already included:

1. Q.m – daily (daily discharge)
2. Q.m – hourly (hourly discharge)
3. H.m – hourly (hourly waterlevels)
4. P.m – hourly (hourly precipitation)
5. P.m – daily (daily precipitation)

If you want to import the 'csv' data in the database you go to the manual forecast display in DEWMS (either by clicking on the icon, via CTRL-M, or via the Tools menu and selecting Manual Forecast). Select the workflow "Import measurements (CSV format) (T0: 1 Jan 2012)" and press Run.

### 2.3 Exercise 1: Conversion of BMKG dataset to CSV timeseries

For each Kabupaten of the Pemali-Comal catchment a database in Excel format from BMKG is available. These data need to be transformed into a timeseries format. A selection is made of the locations which have priority (see the file Timeseries list - RV110727.xls). This priority is related to the next exercise (**Section X**) where the station data of BMKG will be compared with the precipitation data from the PusAir dataset. Each participant will transform data of five stations and create a 'csv' file formatted as explained in **Section 2.2**.

For your convenience a template in Excel is available which converts data in the BMKG database format to a timeseries format. See file Template conversion to timeseries - RV110801.xls. Please read the Notes included in the file.

As an example in the <Exercise 1> directory a timeseries for the Bandar station is included, both in the template format as well as already transformed in csv format. Note: the LocationName and LocationId to be used are found in the Timeseries list - RV110727.xls.

You can either create 5 separate 'csv' files or just one with all 5 locations in one file. Once you have finished the csv file, copy the file to the <DEWMS/Import/Precipitation/Daily> directory and import the data using the workflow explained in **Section 2.2**. Inspect the log messages. No errors? Check if all 5 timeseries have been imported correctly by going to the filters and select the correct LocationNames and parameter from the Locations and Parameters panel.

### 2.4 Exercise 2: compare BMKG vs PusAir timeseries

- (1) Go to filters (Data Viewer tab)
- (2) Go to folder Pemali Comal Data

- (3) Select one of the 5 locations assigned to you from Pemali Comal (BMKG) [day] and the same location (or almost the same LocationName) from Pemali Comal (BMKG) [day] and click on the plot diagram. Do you see differences?
- (4) Repeat 3 for all the locations you imported

### 2.5 Exercise 3: calculate SPI using Excel method

- (1) first export monthly data for any of the locations for which SPI in Pemali Comal is currently calculated. (Folder SPI Data – SPI (input) [month]). Do you have data? If not you need to rerun the “import measurements” workflow
- (2) select the location and parameter and go to File and Export Timeseries. Select the period (make it 01-01-1990 until 01-01-2010) select original and reliable, select the module instance and export the file, save as csv
- (3) note that the data stored at the months are one month shifted. This has to do with the new Transformation Module. It will be corrected later. For the moment values stored with timestamp 01-02-1990 is actually the monthly value of January 1990.
- (4) Copy the monthly data exported from DEWMS into the SPI formula - exercise 3 - RV110802.xls file and create a timeseries of the SPI-01

### 2.6 Exercise 4: compare SPI Excel method with SPI Python method

- (1) export the SPI-01 timeseries from DEWMS calculated by the Python script for the location for which you calculated SPI using the Excel method. (Folder SPI Data – SPI (output)). Similarly to step 2 in Exercise 3.
- (2) compare the output by Python with your own Excel calculation. Create a graph and see if the results are significantly different.

### 2.7 Interpolation method

***Still to be included/discussed in this manual:***

data filling method

Thiessen interpolation method (other methods)

# **JCP training**

**Working with NetCDF and grib**

Ronald Vernimmen

# **Preliminary**

Prepared for:  
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# 1 Introduction

To be completed later

# 2 Software

NetCDF and grib files can be visualized with free NASA software Panoply (<http://www.giss.nasa.gov/tools/panoply/>). No need to install the software. Panoply uses the same libraries as Delft-OMS to read the files. So if you are able to visualize the grids with Panoply you will also be able to import the data in Delft-OMS as well. You need Java installed. It's probably already installed but if not you can get it here: <http://www.java.com/en/download/>.

# 3 NetCDF

The TRMM 3B43 product is one of the TRMM products which is created using the same satellite information as the TRMM 3B42RT data. However, the 3B43 product corrects the precipitation with a gridded field of measurements on the ground (GPCP product). However, in Indonesia not much stations are used for this correction and as such the hypothesis is that the 3B43 product will differ significantly with the bias corrected TRMM 3B42RT product. The latter which is validated with 6 validation areas in Indonesia (Vernimmen et al. 2011).

The TRMM 3B43 product (as are most? other TRMM products) are available in NetCDF format and can be downloaded for free via the following website: <http://mirador.gsfc.nasa.gov/cgi-bin/mirador/presentNavigation.pl?tree=project&project=TRMM&dataGroup=Gridded&CGISESSID=2052192e9ddbdf85f37ed2f3d86c25f>

The data have been downloaded in full and can be found in the NetCDF folder. Let's open a file with Panoply and see how it looks like. General information on the dimensions and variables is provided on the right (**Figure 3.1**).

At the bottom of the page there is a box (List only plottable variables). When you tick this box only the variables which can be plotted by the software are shown. In the case of TRMM 3B43 this is the relative error and precipitation. Double click on the precipitation variable and an image will appear showing the world with the precipitation projected on it (**Figure 3.2**). The values of each grid cell are also available when you click on the Array 1 tab. Standard format is %.1f (or 1 digit float). You can change this format to increase the numbers behind the dot (**Figure 3.3**).

The general information shown in **Figure 3.1** is used to prepare Delft-OMS software for importing the data.

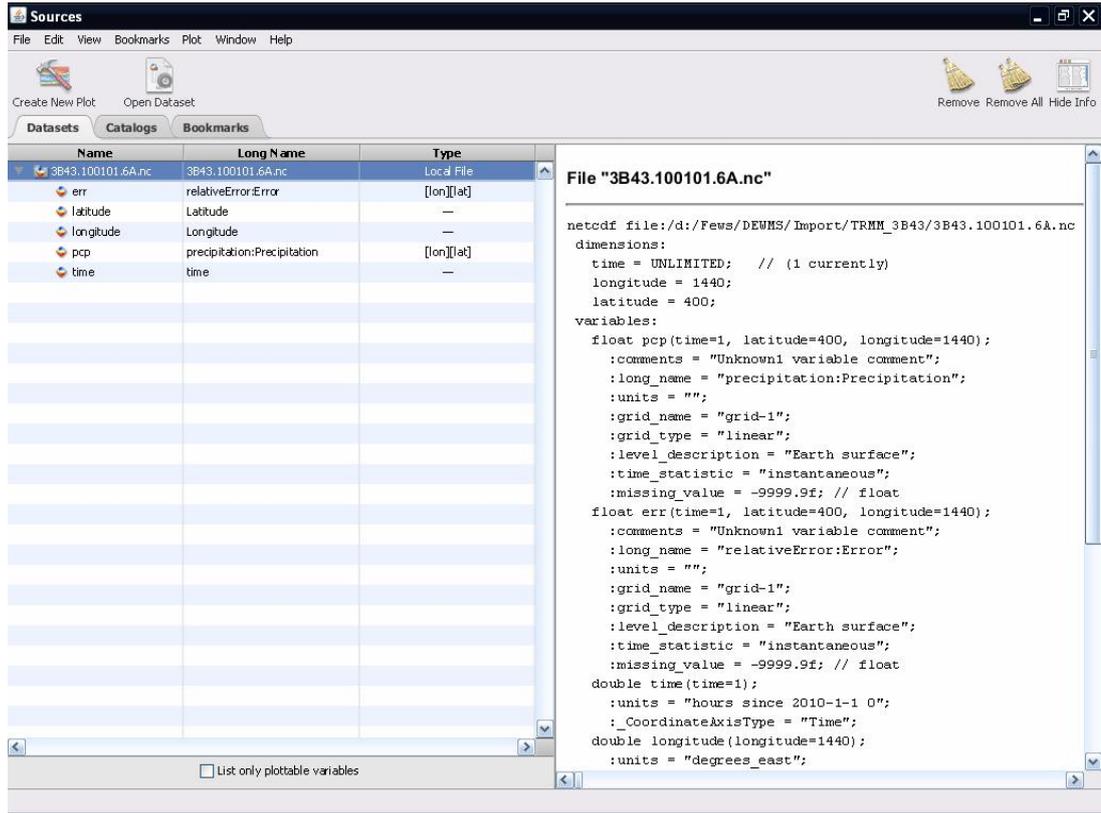


Figure 3.1 Contents of the TRMM 3B43 NetCDF file for January 2010.

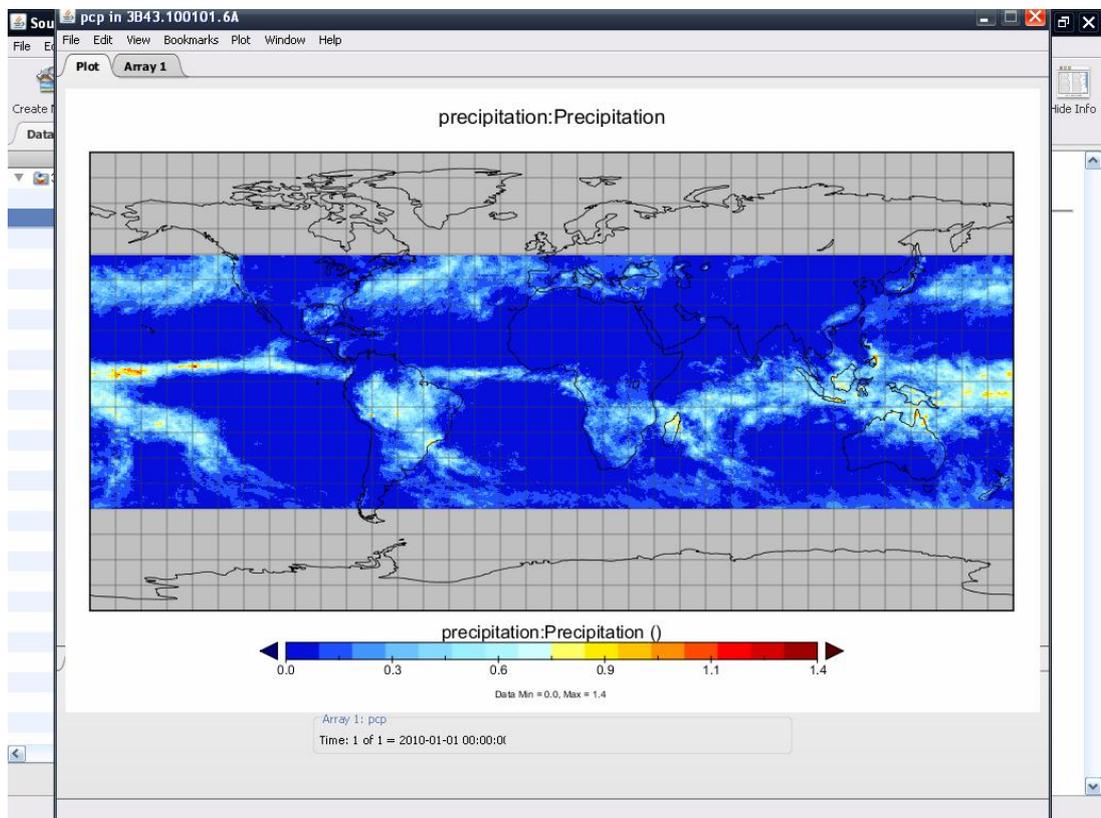
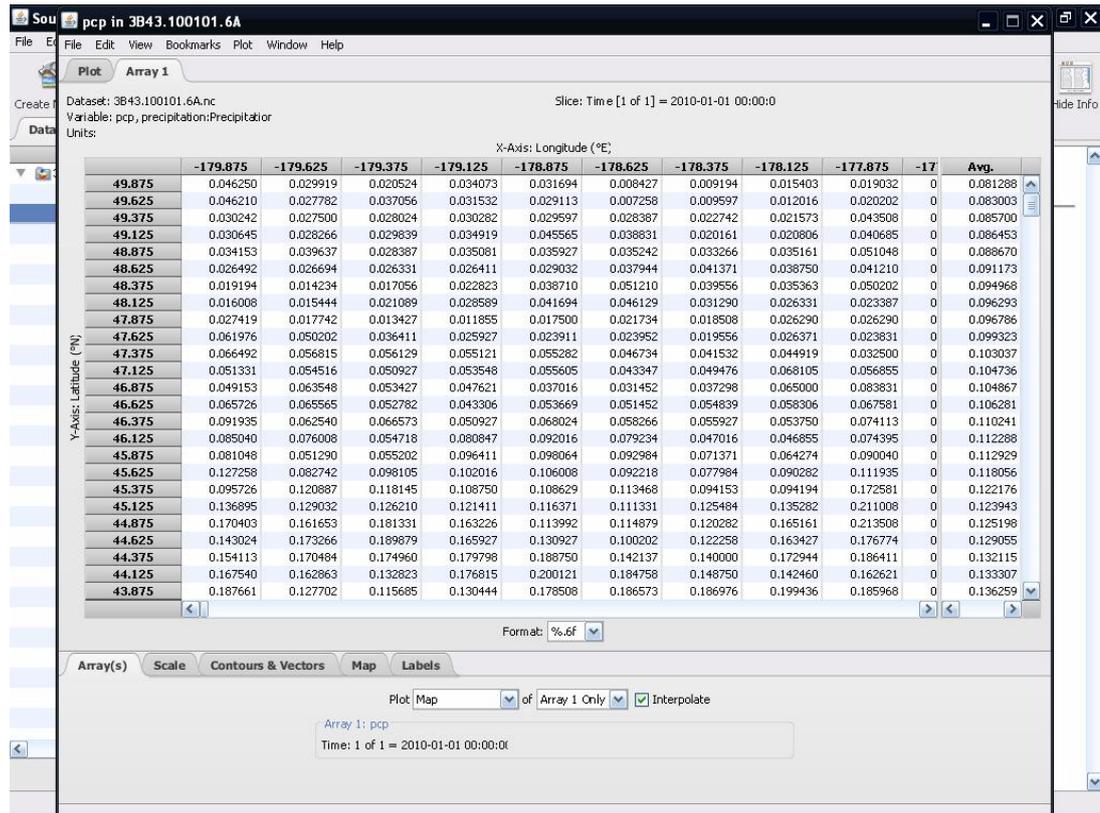


Figure 3.2 Precipitation variable from the NetCDF TRMM 3B43 file visualized for January 2010.



(3) Import file: 3B43\_Import.xml (in the <DEWMS/Config/ModuleConfigFiles/TRMM 3B43> directory). An import is divided into two sections, a general section (<general>) with information on the importType (in this case NETCFD-CF\_GRID), the location of the Import, ImportBackup and ImportFailed folders as well as the reference to the IdMapping file (see above). A UnitConversions file is also needed which will be discussed further below. Missing value is given (can be retrieved from the general information shown in [Figure 3.1](#)). Below the general section is the <timeSeriesSet> section. Which uses again the LocationId and ParameterId defined before. One more item which is (sometimes) needed is the externUnit. The unit of the variable in the import file. When this is set (in this case using the ImportUnitType id (see below) "mm\_hr\_3B43"), the software will convert the external unit to a unit which is preferred internally.

(4) Unit conversion file: Import3B43Units.xml (in the directory: <DEWMS/Config/UnitConversionsFiles>). Usually the unit should also be included in the NetCDF file and thus can be retrieved from the General information shown in [Figure 3.1](#). Unfortunately, the unit is not provided in the TRMM 3B43 file. So find it on the internet. The unit turns out to be mm/hr ([http://disc.sci.gsfc.nasa.gov/precipitation/documentation/TRMM\\_README/TRMM\\_3B43\\_readme.shtml](http://disc.sci.gsfc.nasa.gov/precipitation/documentation/TRMM_README/TRMM_3B43_readme.shtml)) and will be converted to mm by multiplying by 24 (see the Import3B43Units.xml)

The problem however is that we now will import a monthly grid with the unit of mm/day. If we want to have the monthly total we need to do some transformations. The details of these transformations **will not be discussed at this moment**, however briefly the steps will be described:

- a. the monthly data (nonequidistant timeStep unit, see 3B43\_Import.xml) is disaggregated instantaneously to a daily timestep (see the 3B43\_DisaggregateToDayInstantaneous.xml file). What thus happens is that data stored at 1 January 2010 (with timeStep unit = nonequidistant) is now also stored at 1 January 2010 with timeStep unit = day.
- b. the daily data created under a. is then block filled for each of the other days with missing values until a day with a non missing value is found (see the 3B43\_BlockFillDayInstantaneous.xml file). Thus all days from 2 – 31 January 2010 will be given the value of 1 January 2010.
- c. Finally the data created under b. are aggregated again to monthly values (see file: 3B43\_AggregateToMonth.xml)

Now, that the configuration files that are needed are discussed we can start importing the data in our database.

First however, we need to make sure the 3B43\_Import, 3B43\_DisaggregateToDayInstantaneous, 3B43\_BlockFillDayInstantaneous and 3B43\_AggregateToMonth ModuleConfigFiles are registered. Registration of these files is done in the ModuleInstanceDescriptors.xml (found in the following directory: <DEWMS/Config/RegionConfigFiles>

Import of the TRMM 3B43 NetCDF file is organized in the 3B43\_Import.xml workflow file (in the <DEWMS/Config/WorkflowFiles> directory). When you open this file you see the 4 moduleInstanceId's again.

The workflow file needs to be registered as well which is done in the WorkflowDescriptors.xml (in the <DEWMS/Config/RegionConfigFiles> directory).

Summarizing you thus need the following files which you either need to create or extent when you receive a NetCDF file you haven't imported yet before:

1. Locations.xml (extent, new LocationId, <RegionConfigFiles>)
2. Grids.xml (extent, new grid definition, <RegionConfigFiles>)
3. Parameters.xml (extent, new ParameterId, <RegionConfigFiles>)
4. IdMapping.xml (create new, <IdMapping>)
5. Import.xml (create new, <ModuleConfigFiles>)
6. Unit conversion.xml (create new, <UnitConversionsFiles>)
7. ModuleInstanceDescriptors (extent, new ModuleConfigFile, <RegionConfigFiles>)
8. Workflow.xml (create new, <WorkflowFiles>)
9. WorkflowDescriptors (extent, new WorkflowFile, <RegionConfigFiles>)

We are now ready to import the data. Copy the NetCDF data to the <DEWMS/Import/TRMM\_3B43> directory. **Note:** the import data can be stored in a zip file (only Winzip, not Winrar or gzip!), there is no need to have each file extracted within the import directory. Delft-OMS will extract the files internally prior to importing the data.

Import the data via the Manual Forecast display (either by clicking on the icon or using CTRL-M) and run the workflow "Import TRMM 3B43 (T0: 1 January 2012)". Prior to running make sure the current system time is set to 1 January 2012.

Inspect the log messages. If the import was successful you can see the result in the Spatial Display. Go to the Spatial Display by either pressing on the globe icon, CTRL-G or via Tools menu – Spatial Data. Open the Precipitation (TRMM 3B43) [mm] folder and select either the monthly or daily data. You will notice that each day of the same month has exactly the same values. This is the result of the 3B43\_BlockFillDayInstantaneous.xml explained briefly above under b.

### 3.1 Exercise 1: Compare TRMM 3B43 with bias corrected TRMM 3B42RT

In this exercise you are going to compare the monthly map of TRMM 3B43 with the bias corrected TRMM 3B42RT monthly map.

Choose a month for which data is available both in TRMM 3B43 and TRMM 3B42RT but also ECMWF seasonal forecast data (see Section 4) (so: between January – May 2010). Export both the TRMM 3B43 and bias corrected TRMM 3B42RT maps from the Spatial Display to ascii format. Remember: right click on the map, Save Frame As ASCII grid file.

Convert both files to PCRaster format (.map files). Remember via:

```
Gdal_translate -ot Float32 -of PCRaster -mo  
PCRASTER_VALUESCALE=VS_SCALAR <FILENAME>.asc <FILENAME>.map
```

Whereby <FILENAME> is the name of the file you exported. Run this command from the command prompt in the directory where you have stored your asc file. Note: You need to have the program FWTools 2.4.7 installed.  
Use your PCRaster skills to create a difference map!

## 4 Grib

ECMWF Seasonal forecast data are provided in the grib1 data format which can be visualized by Panoply as well and can be imported by Delft-OMS as well.

Steps are the same as for NetCDF.

The main difference is the importtype which is ***grib1*** instead of ***NETCDF-CF\_GRID*** (see file ImportECMWF-Seasonal.xml in <DEWMS/Config/ModuleConfigFiles/ECMWF-Seasonal> directory).

The Seasonal forecast data have a cell size which is different from TRMM 3B42RT. 0.5 degree instead of 0.25 degree. We can 'downscale' the Seasonal forecast data to this same resolution. For the moment we use the closest distance method.

### 4.1 Exercise 2: Compare ECMWF with TRMM 3B43 and with TRMM 3B42RT

Similarly to Exercise 1 export for the same month as you have already exported the TRMM 3B43 and TRMM 3B42RT data the ECMWF data.

Create difference maps using PCRaster

### 4.2 Exercise 3: Import different ECMWF seasonal forecast parameter

Using the example of the precipitation data. Import the evaporation grib data.

### 4.3 Exercise 4: Import your own NetCDF example

Using the example of the 3B43 NetCDF file import this file as well.

# **JCP training**

**Catchment water balance as check for quality discharge data**

Ronald Vernimmen

# **Preliminary**

Prepared for:  
PusAir, BMKG

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## 1 Introduction

As a first quality check of discharge data it is useful to convert the discharge (Q) data from  $\text{m}^3/\text{s}$  to mm and compare the Q in mm with precipitation (P) in mm. On an annual basis when difference storage is assumed 0,  $Q = P - ET$ , whereby ET is evapotranspiration. In other words, Q can never be higher than P. Should this be the case the discharge data need critical evaluation. One of the first things which then should be checked is the used rating curve.

In this manual the use of rating curves and the conversion to mm is explained.

## 2 Rating curves

Water levels are converted into discharge via rating curves. A rating curve is typically of the form  $a * (H+b)^c$ , whereby a, b and c are coefficients and H is the waterlevel. The application of this equation can be configured in the Transformation Module.

See the file LevelToFlow.xml (in the <DEWMS/Config/ModuleConfigFiles/Import\_CSV> directory). Within the transformation a simple user expression is used to convert the waterlevels (Variable: Level) into discharge (Variable: Flow). The coefficients a,b, and c are retrieved from the Metadata file (MetadataHydroMeteoStationsIndonesia-LL-RV110803.dbf in the <DEWMS/Config/MapLayerFiles> directory). The id's @RATINGCURVE\_COEFFICIENT\_A@, @RATINGCURVE\_COEFFICIENT\_B@ and @RATINGCURVE\_COEFFICIENT\_C@ are defined in the LocationSets.xml (in the <DEWMS/Config/RegionConfigFiles> directory):

```
<attribute id="RATINGCURVE_COEFFICIENT_A">
  <number>%RC_COEFF_A%</number>
</attribute>
```

**Note:** instead of a text attribute the attribute type for the RATINGCURVE\_COEFFICIENT\_A is number.

For each HydroStation where a rating curve is available (whenever the RATINGCURV column in the Metadata file indicates Yes (see LocationSets.xml in <DEWMS/Config/RegionConfigFiles> directory):

```
<locationSet id="RatingcurvesAvailable" name="RatingcurvesAvailable">
  <locationSetId>Metadata</locationSetId>
  <constraints>
    <attributeTextEquals id="RATINGCURV" equals="Yes"/>
  </constraints>
</locationSet>
```

### 3 Conversion from $m^3/s$ to mm

Discharge in  $m^3/s$  is converted into mm using the upstream catchment area of the hydro station. See the file Discharge\_m3s\_mmday (in the directory <DEWMS/Config/ModuleConfigFiles/CSV\_Import>).

```
<transformation id="m3stomm">
  <user>
    <simple>
      <expression>1000* ((86400 * InputM3S) / (AreaKM2 * 1000000))</expression>
      <coefficientSetFunctions>
        <coefficient id="AreaKM2" value="@CATCHMENTAREA@"/>
      </coefficientSetFunctions>
      <outputVariable>
        <variableId>OutputMM</variableId>
      </outputVariable>
    </simple>
  </user>
</transformation>
```

The mathematical equation is found between <expression> and </expression>.

Input in  $m^3/s$  to  $m^3/day$  is 86,400 seconds in a day times the Input:

$86400 * InputM3S$

Divide by the area in  $m^2$ . Area is for instance  $1000 km^2 * 1000000 = 1,000,000,000 m^2$

Result of the division is in  $m$  times 1000 to get the result in  $mm/day$ .

Note: the @CATCHMENTAREA@ again uses information retrieved from the Metadata file (see also [Section 2](#)).

#### 3.1 Exercise 1: Calculate annual discharge and precipitation in mm

Now that we have daily discharge in mm it is time to aggregate the discharge to annual discharge. Change the AggregateToYear.xml file (in the directory <DEWMS/Config/ModuleConfigFiles/CSV\_Import>) so that apart from the annual precipitation for the LocationSet PrecipitationStations also annual Discharge in mm is calculated.

Do this for the precipitation as well. **Tip:** Check the 3B42RT\_GridToLocations.xml (in the directory <DEWMS/Config/ModuleConfigFiles/TRMM 3B42RT>) to obtain the correct ModuleInstancelD's and other relevant information which is needed.

**Note:** the precipitation is currently an extract to point from the daily uncorrected TRMM 3B42RT data. Later, when we are going to derive upstream catchment areas automatically, using PCRaster and a DEM based on the location of the hydrological station, we can actually calculate areal average precipitation using a polygon representing the upstream catchment area.

Include the results in the Filters (see Filters.xml in directory <DEWMS/Config/RegionConfigFiles>). **Tip:** Look for the "Waterbalance" string in the file.