A High resolution dataset of reference evaporation based on the WFDEI forcing

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11/30/15

Background

- The EU FP7 project eartH2Observe – construction of a global Water Resources Re-analysis dataset (model and EO data)
- Of value to large scale / global analysis and local applications in data sparse regions
- Based on the EU WATCH WFDEI forcing dataset ~ ERA-interim corrected with GPCP
- 3-hourly meteorological dataset for the period 1979 to 2012 at 0.5 degrees spatial resolution
- For local scale hydrological model application need for high resolution *reference evaporation*. (and precipitation and etc...)
- First set of downscaling actions using DEM information only

GLOBAL: Consistent but course	⟷	LOCAL: Detailed but sparse

Reference evaporation equations

- **Hargreaves** - temperature based

$$ET_o = 0.0023 \cdot R_a \cdot (\overline{T} + 17.8) \cdot TR^{0.50}$$

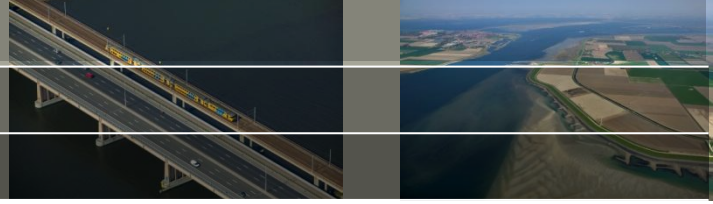
- **Priestley-Taylor** - temperature and radiation based

$$ET_o = \alpha \frac{\Delta R_n}{\lambda_v (\Delta + \gamma)}$$

- **Penman-Monteith** – physically based – (FAO Parameters)

$$ET_o = \frac{\Delta (R_n - G) + \rho_a c_p \frac{(e_s - e_a)}{r_a}}{\lambda_v \Delta + \gamma (1 + \frac{r_s}{r_a})}$$

Elevation based down-scaling



DEM based Elevation Correction: ΔH (m)
difference between high and low resolution DEM for each high resolution grid-cell (m)

- Temperature (lapse rate)

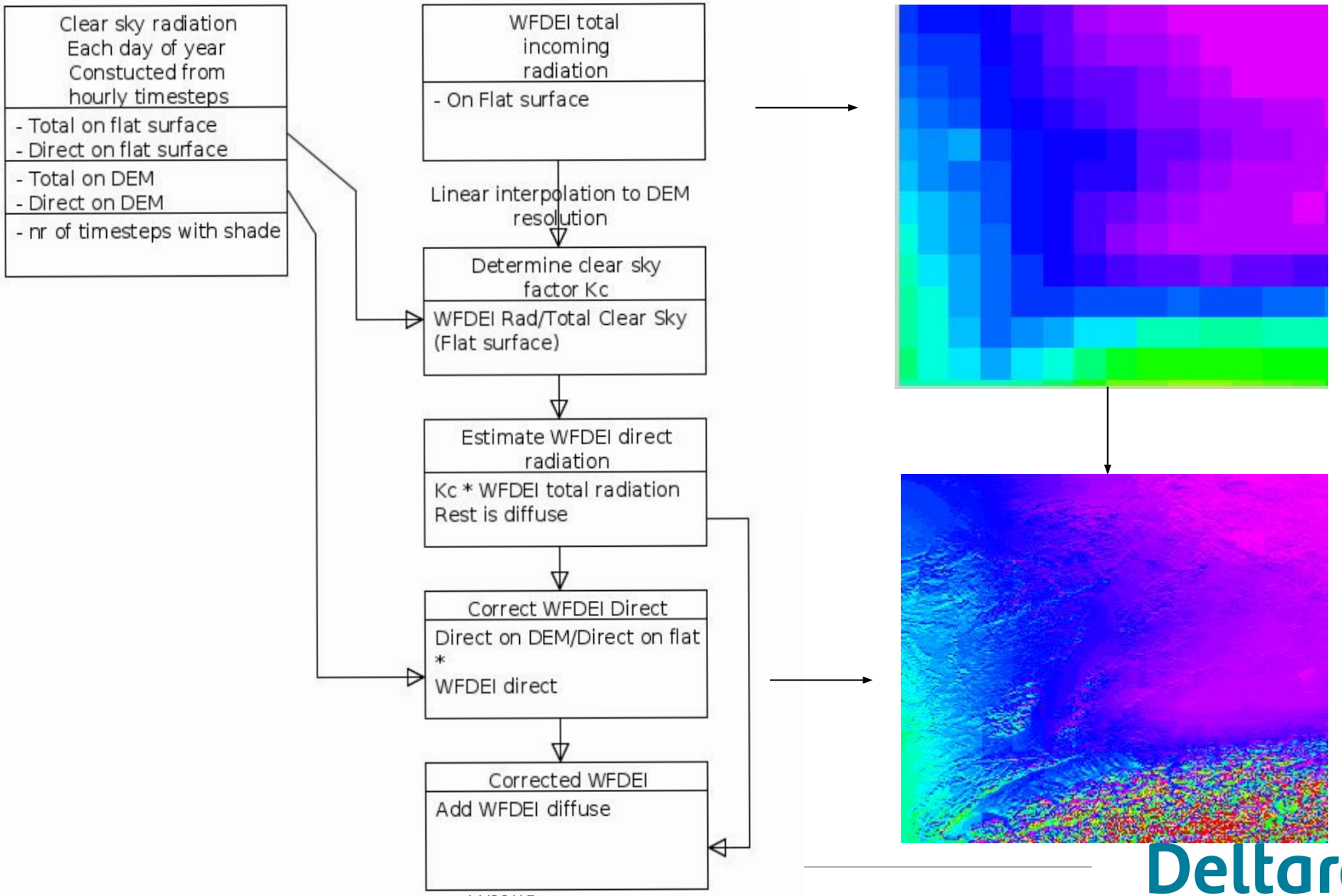
$$T_{downscaled} = T - L\Delta H$$

- Pressure (hydrostatic pressure assumption)

$$P_{cor} = P\left(\frac{\overline{T}}{\overline{T} + L\Delta H}\right)^{\frac{gM_0}{LR}}$$

g = gravitational constant (m s-2), R = specific gas constant for dry air (J mol-1 K-1), Mo = molecular weight of gas (g mol-1), L = lapse rate (k m-1)

Radiation down-scaling and correction



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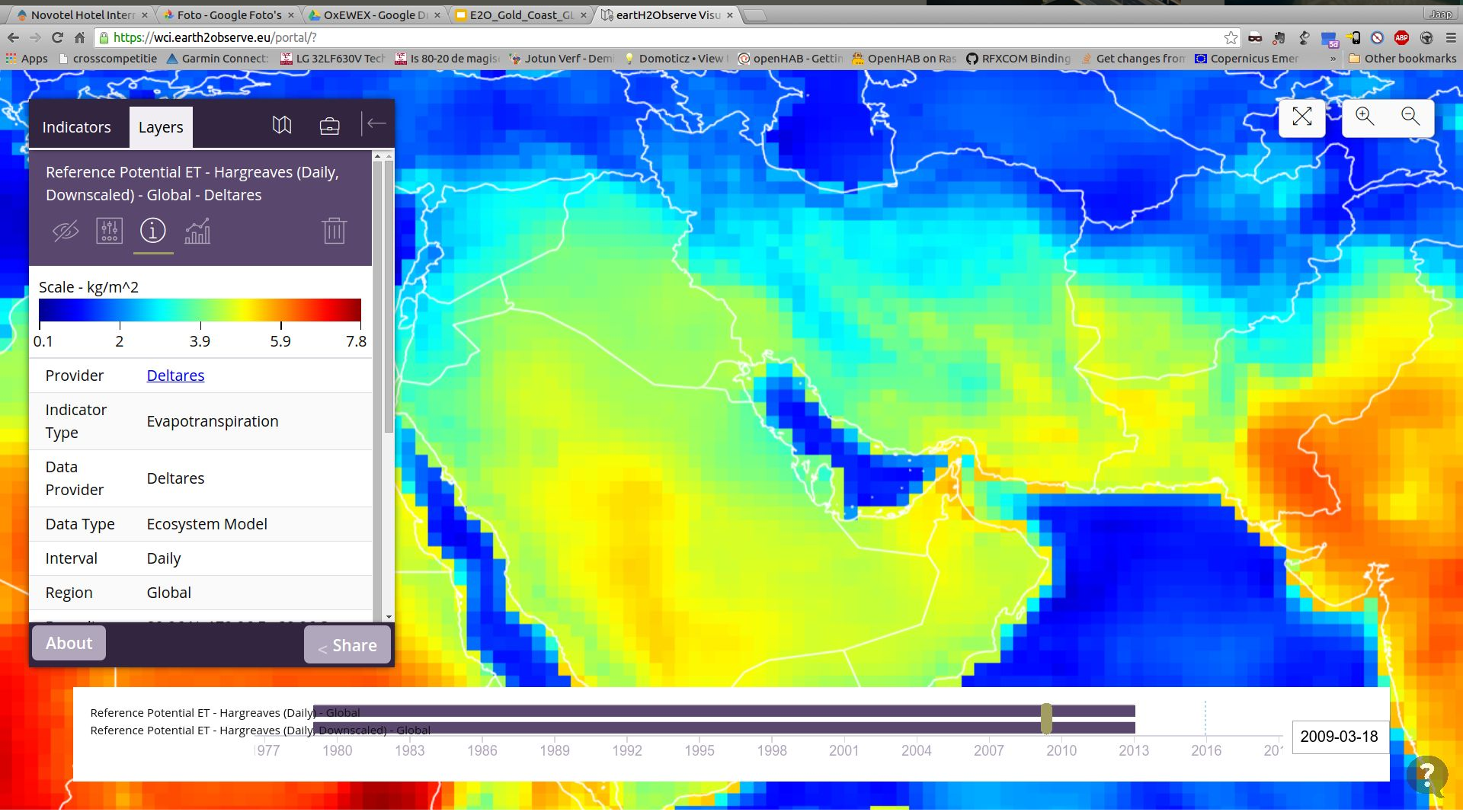
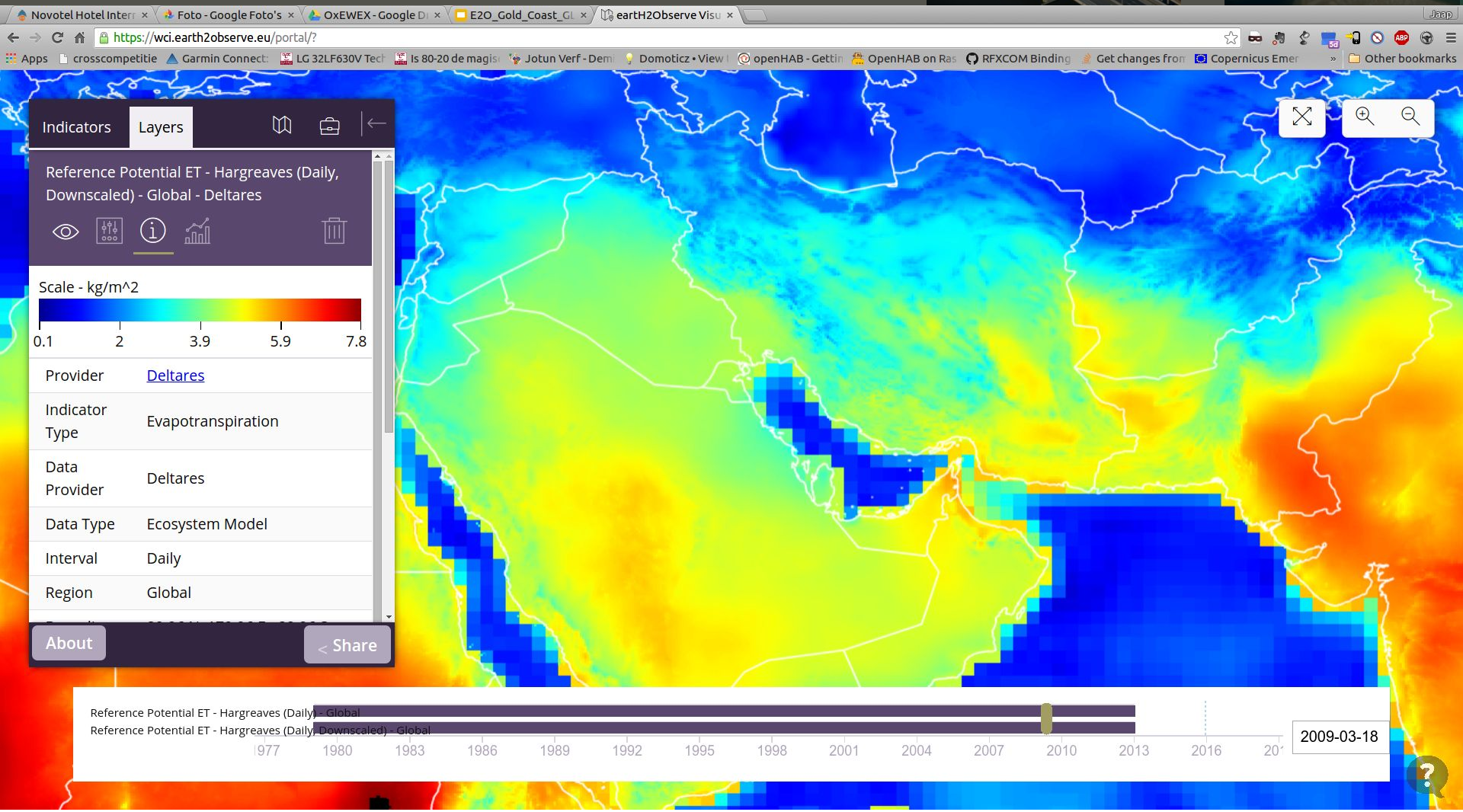
Radiation down-scaling and correction

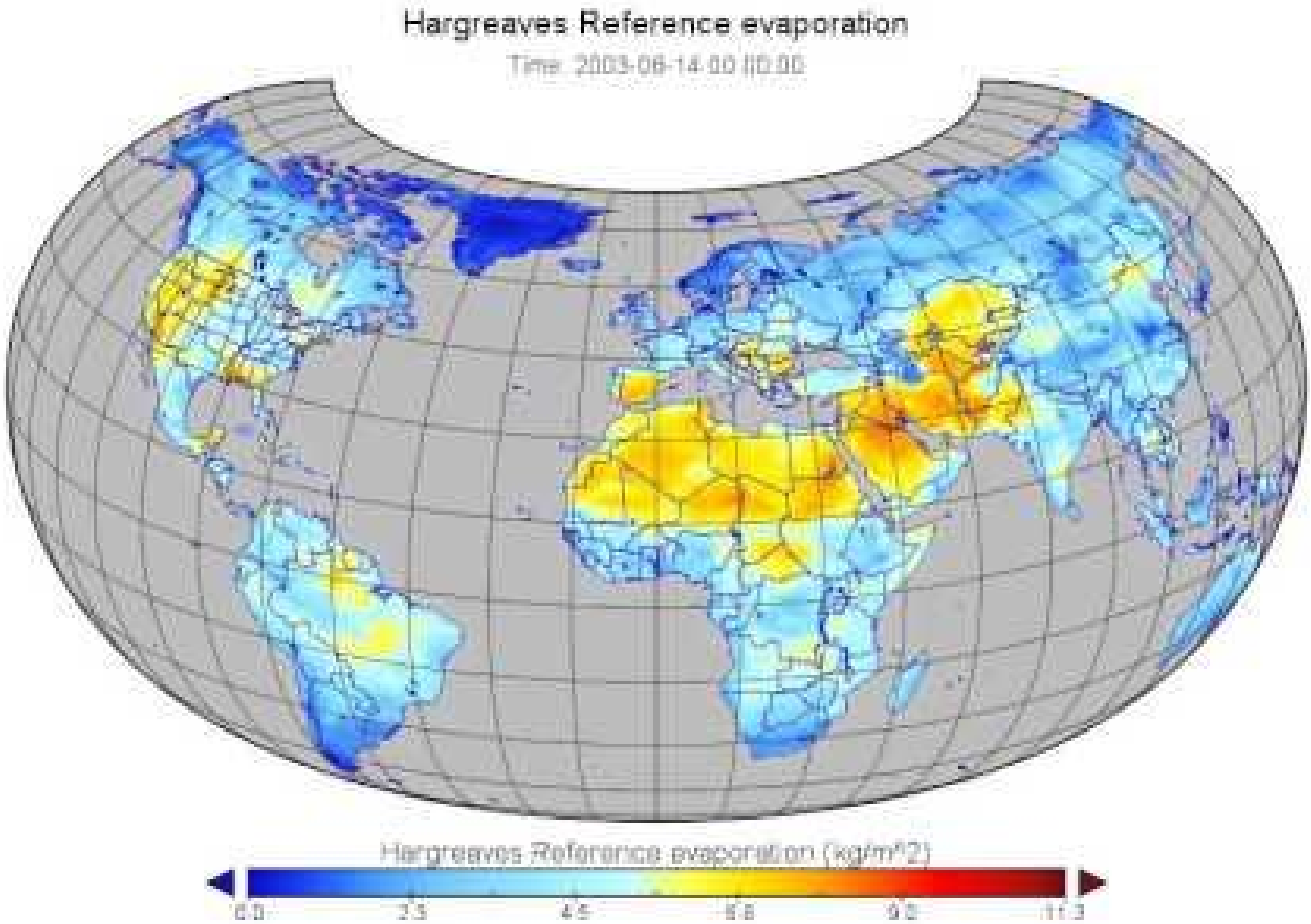


Radiation down-scaling and correction



Radiation down-scaling and correction

[redacted]



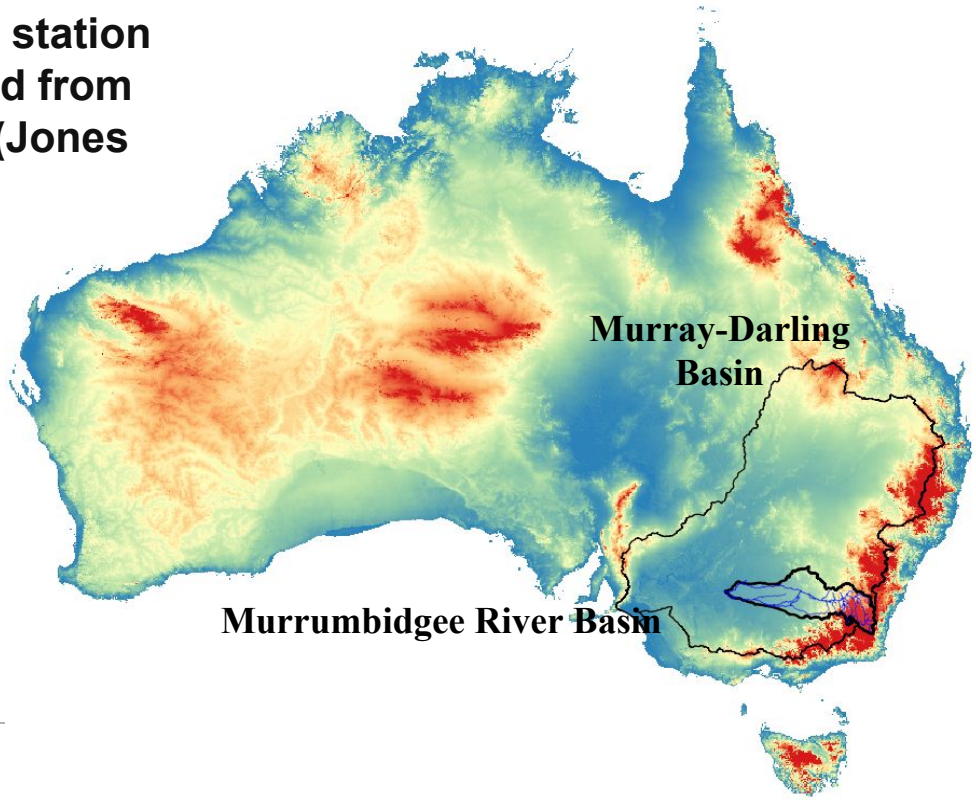
[redacted]

Case-study Murumbidgee (Australia)

- Topography: 2,000 m east – 50 m west
- Area: 84,000 km^2
- Rainfall: 1,700 mm/y east – 350 mm/y west
- Evaporation: 1,000 mm/y south-east – 1,800 mm/y west
- Average annual flow at Wagga Wagga ≈ 123 m^3/s
- Direct Runoff dominated

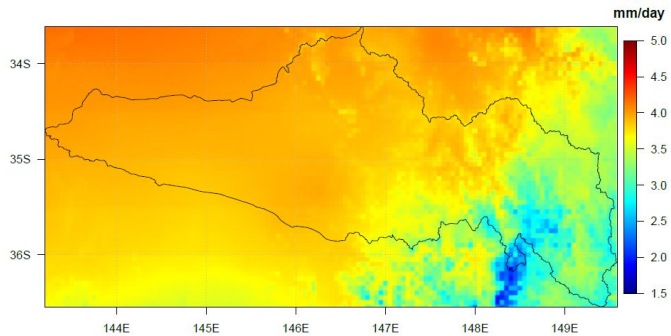
Reference : Local high resolution gauging station based gridded datasets (0.05º), sourced from the Australian Bureau of Meteorology (Jones et al., 2009).

Comparison for the years 1979 - 2010



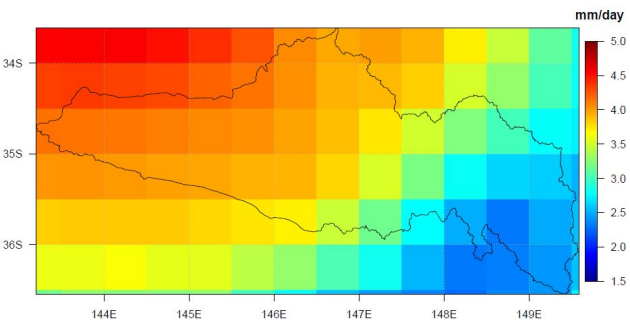
earthH_2Observe

Long-term average reference evaporation

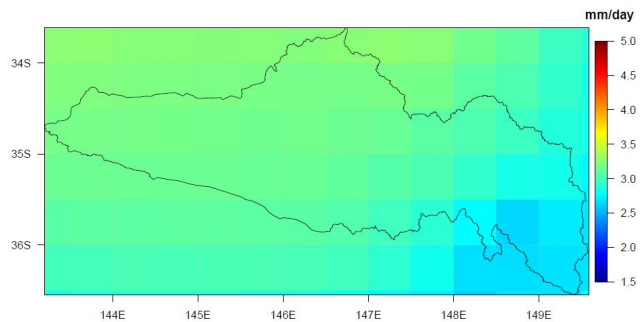


Local Hargreaves

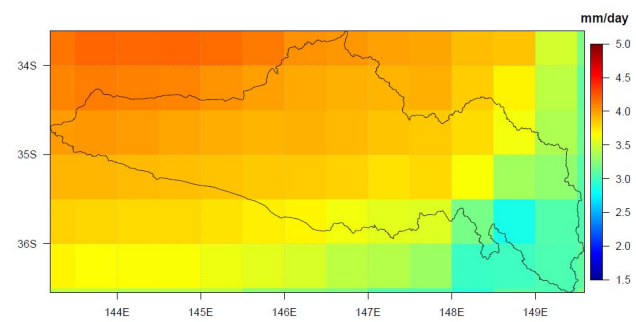
Top: local reference
Middle: non down-scaled
Bottom: down-scaled



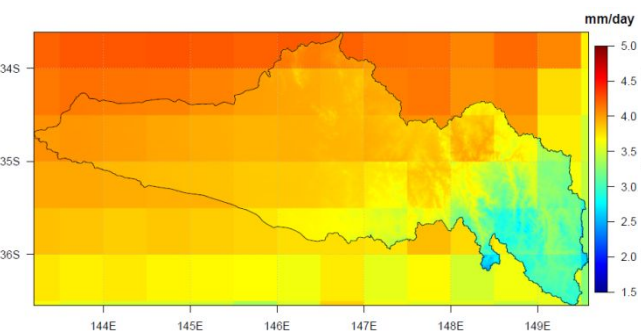
Penman-Monteith



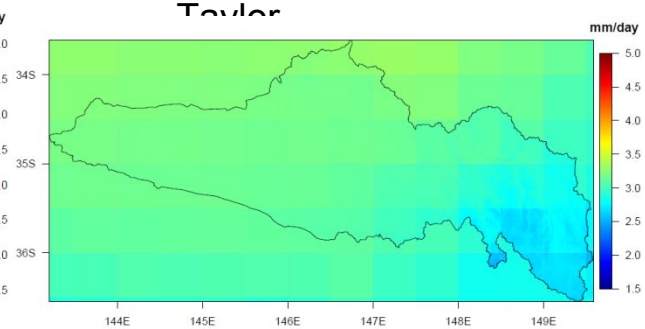
Priestley-Taylor



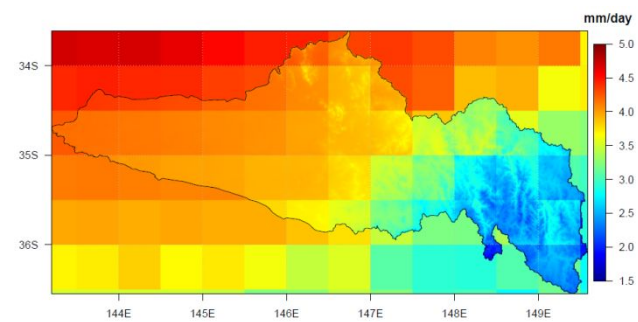
Hargreaves



Penman-Monteith

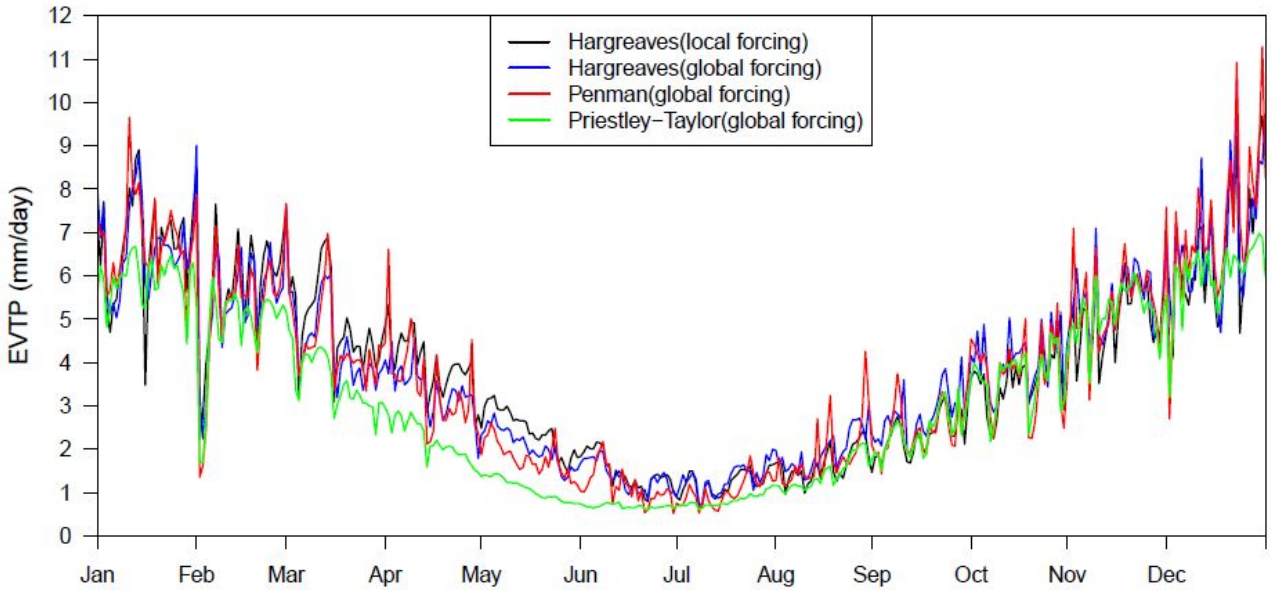


Priestley-Taylor

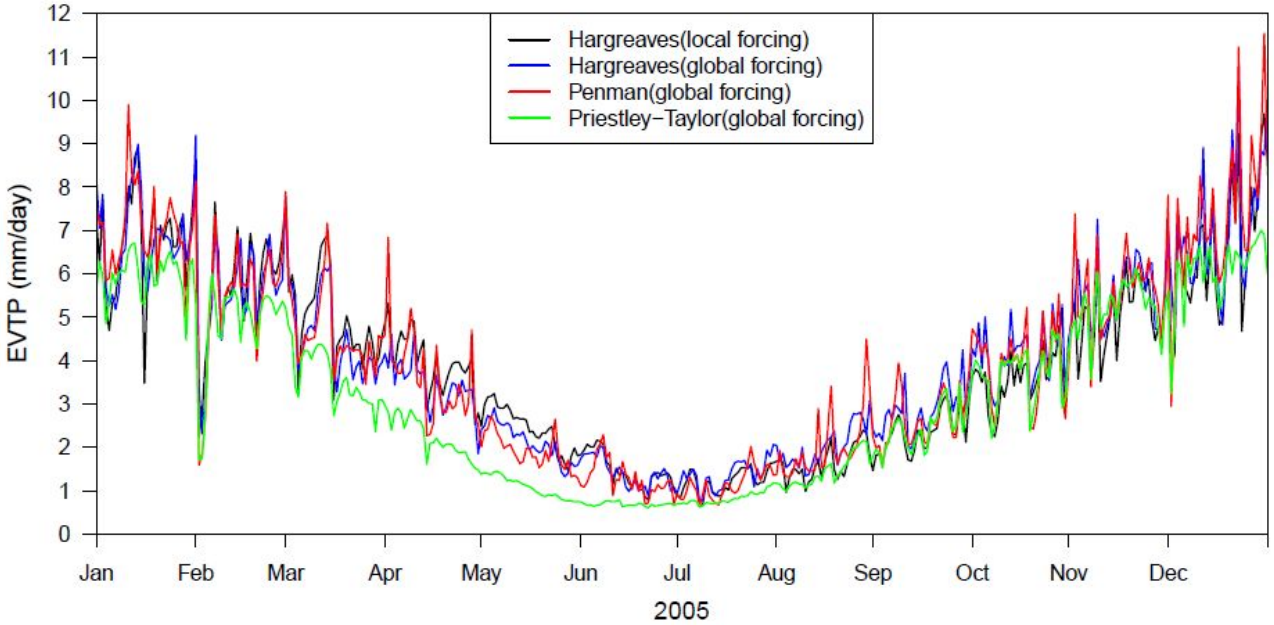


Hargreaves

Daily time-series for the Murumbidgee



Non down-scaled



Down-scaled

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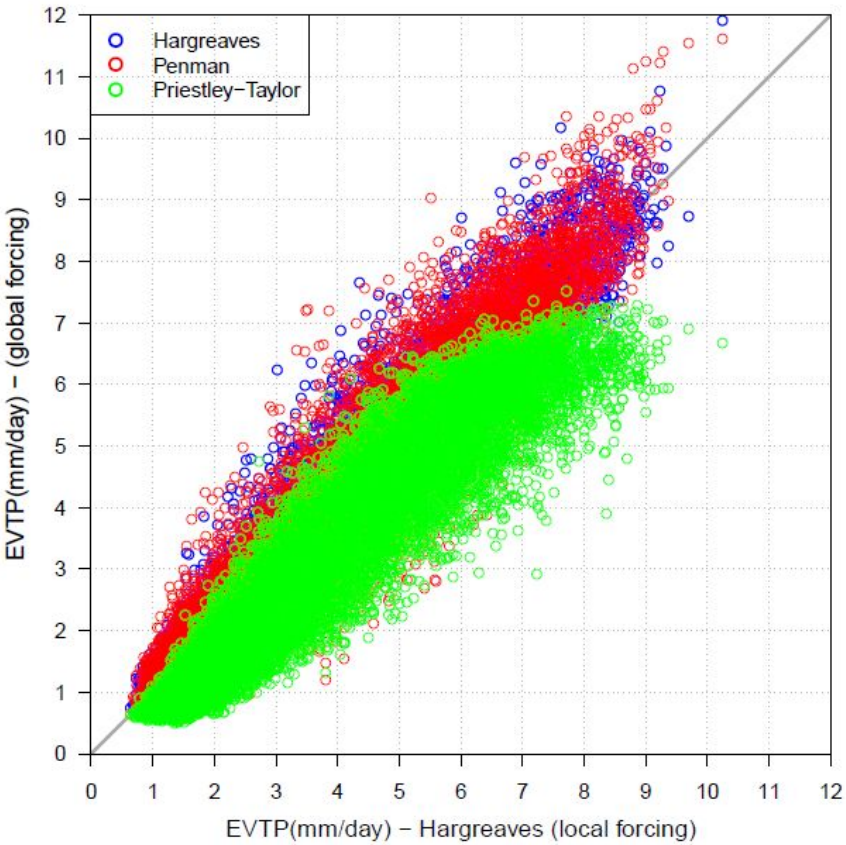
Evaporation time-series Canberra airport

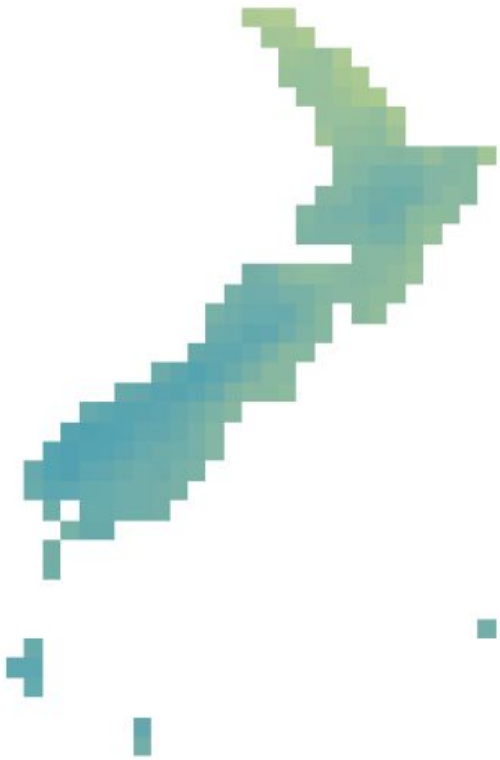


Scatter plot with down-scaled evaporation
and local reference

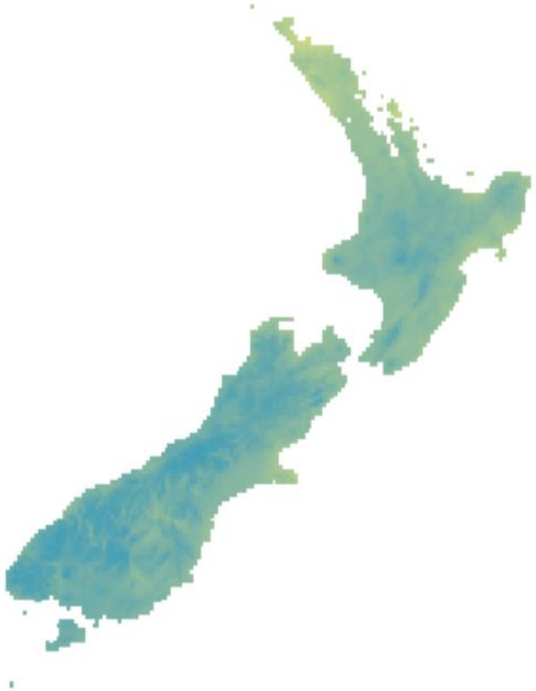
Correlation between daily reference evapo-
ration time-series derived from the global dataset and reference Hargreaves evapo-ration derived from the local Australian dataset for Canberra airport.

Corre-lation	Penman-Monteith	Priestley-Taylor	Hargreaves
0.5 degrees	0,9325	0,9259	0,9592
1 km	0,9324	0,9258	0,9592

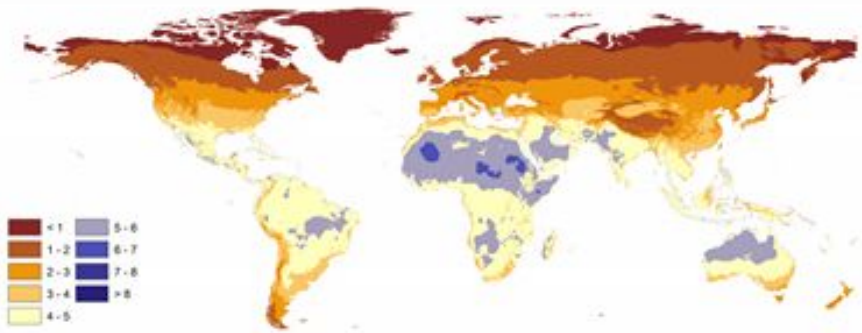
Global Penman-Monteith evaporation (1979-1984)



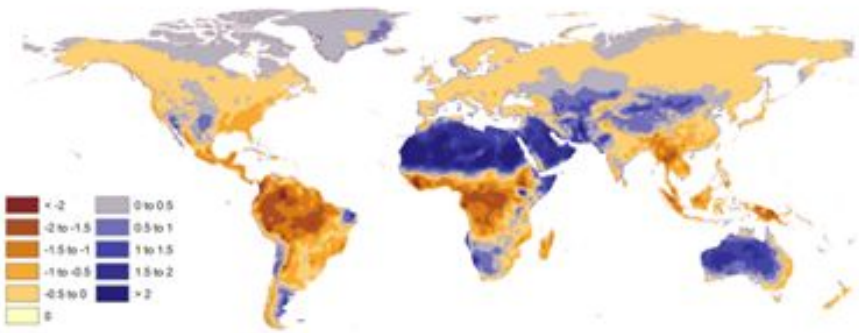
Five year average daily evaporation at the original 0.5 degrees resolution



Five year average daily evaporation
with radiation correction and down-scaling to 10 km



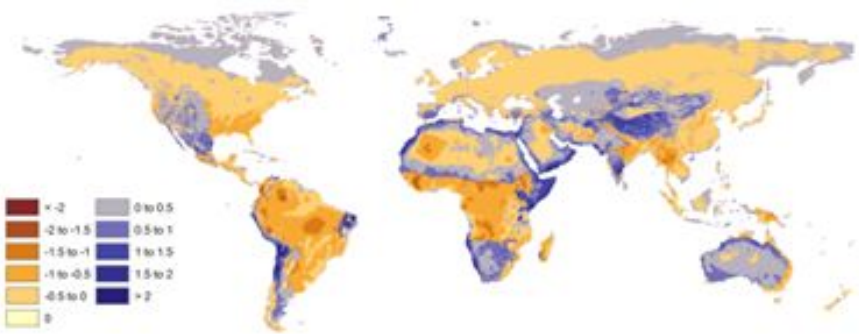
HG Worldclim



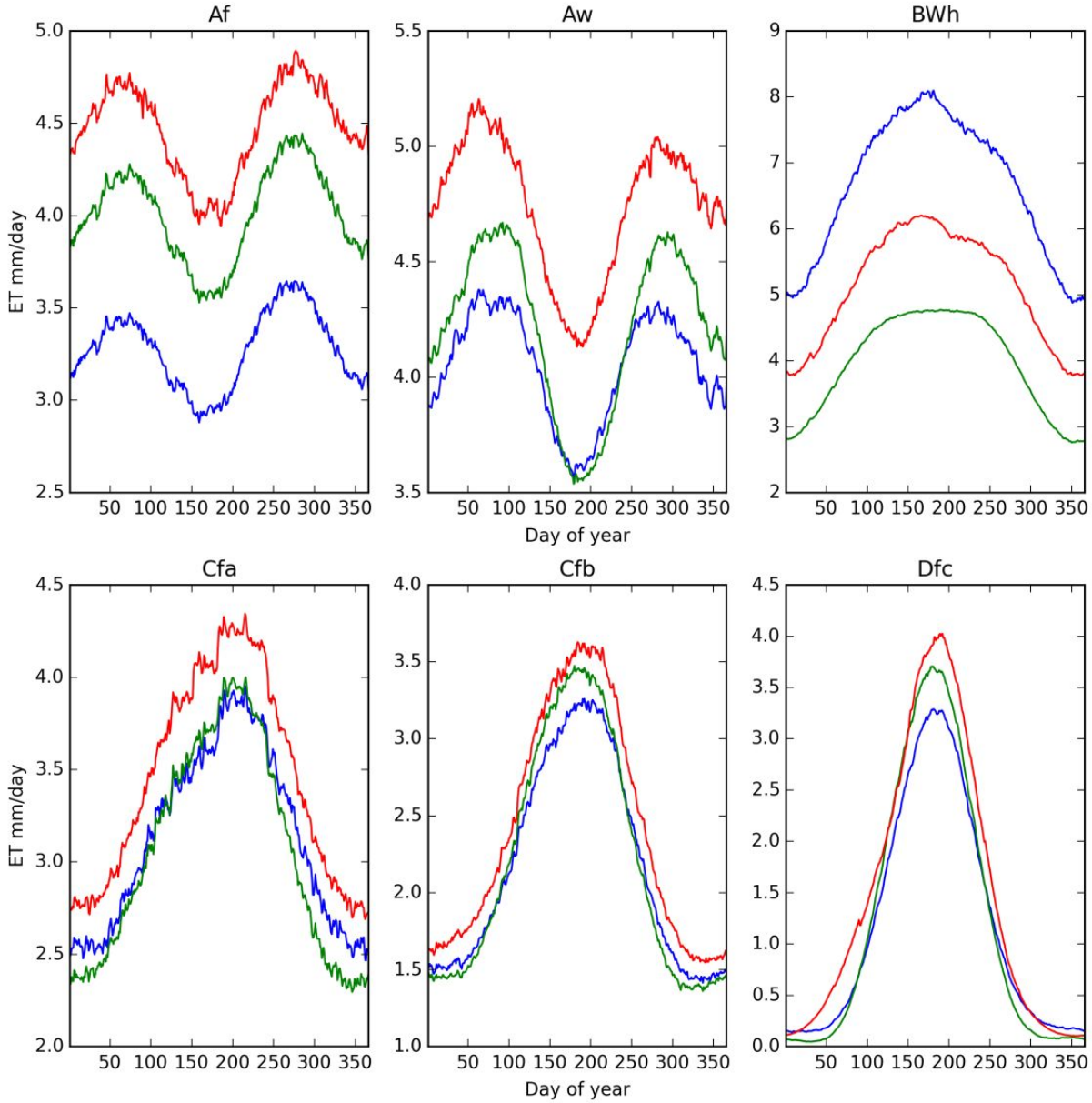
PM Bias

HG Bias

PT Bias



Top-left: HG reference potential evaporation derived from the WorldClim dataset (mm/day). Remaining maps: bias from the WorldClim estimate (mm/day) for HG (bottom-left), PM (top-right) and PT (bottom-right).



Climatology for a number of selected Köppen climate zones. Blue: PM, Green: PT and Red: HG

Differences large in the more extreme climate zones. (simplification)

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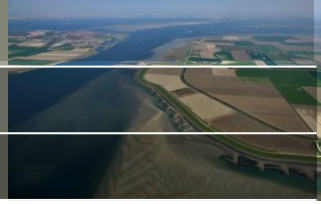
Conclusion



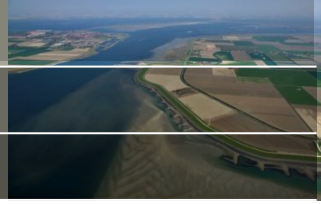
The presented reference potential evaporation estimates resemble the WorldClim dataset quite well.

Largest differences are found over the Saharas, Amazon and desert region of Australia. This suggests that the global results should be used with caution in the more extreme climate zones.

Results per climate zones suggest that the differences between the WordClim dataset and the present results originate from the three different equations.

The global and downscaled global reference evaporation estimates show high similarity with the local Hargreaves evaporation in local testing.

Outlook



A global reference evaporation dataset for the period 1979-2012 at a resolution of 10 km (1km may happen later) is available at the eartH2Observe data portal: https://wci.earth2observe.eu

Further evaluation of the dataset will at least be carried out in case-studies in Colombia, Bangladesh and the Mediterranean region

Next in line: precipitation (easy ;-))

DIY: Get the tools from GitHub

Analysis of water da | Upcoming Events | 2 | Programme | earth2observe/dow | Inbox (153) - jaapsch

GitHub, Inc. [US] https://github.com/earth2observe/downscaling-tools

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earth2observe / downscaling-tools

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Automatically exported from code.google.com/p/e2o-downscaling-tools

147 commits | 2 branches | 1 release | 1 contributor

Branch: master | New pull request | New file | Find file | HTTPS | https://github.com/earth2 | Download ZIP

Jaap Schellekens doc update — Latest commit 0bbfb04 on Oct 9

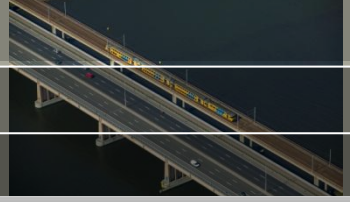
data	Added linke dem to correct for altitude differences	6 months ago
doc	doc update	2 months ago
e2o_dstools	doc	5 months ago
examples	doc typo	4 months ago
LICENSE.rst	Update LICENSE.rst	5 months ago
README.rst	Update README.rst	2 months ago
make_exe.py	doc	5 months ago
setup.py	doc update	2 months ago

README.rst

e2o-downscaling-tools

PanoplyJ-4.3.2.tgz | Show all downloads...

DIY: Documentation



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e2o-downscaling-tools.readthedocs.org/en/latest/

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eartH2Observe Downscaling tools

Note

This documentation is for version 0.1 of e2o_dstools, release 2015 This documentation was generated October 09, 2015

Introduction

e2o_downscaling-tools consists of a number of python programs and procedures that facilitate local application of the earth2observe global water resources reanalysis. The tools can connect directly to the project's data server and save (resampled) data to a local computer for further analysis or direct application. The current first versions of the tool focusses on downscaling the global forcing dataset used in the project :cite:`weedonwfdei2014`.

Quick start using the examples

The steps below should allow you to run the examples on a windows

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Next topic v: latest

e2o_getvar - retrieve

PanoplyJ-4.3.2.tgz | Show all downloads... ×

DIY: Start...

```
[url]
serverroot = http://wci.earth2observe.eu/thredds/dodsC/
wrrsetroot = ecmwf/met_forcing_v0/


[selection]

latmax = 55.25
latmin = 44.25
lonmin = 4.25
lonmax = 14.75
startyear = 1979
endyear= 2012
startmonth = 1
endmonth = 12
startday = 1
endday = 31

# Add any of the following variables here
Temperature=True
#DownwellingLongWaveRadiation=True
#SurfaceAtmosphericPressure=True
#NearSurfaceSpecificHumidity=True
#SurfaceIncidentShortwaveRadiation=True
#SnowfallRate=True
#NearSurfaceWindSpeed=True
Rainfall = True
resampling=True
```

```
/home/jaap/repos/dow
```

```
    e2o_getvar.py -I inifile [-l loglevel][-h]

    -I inifile - ini file with settings which data
    -l loglevel (must be one of DEBUG, WARNING, ERR

jaap@jaap-XPS13-9333:~/repos/downscaling-tools/exam
_dstools/e2o_getvar.py  -I examplerun1.ini
2015-11-29 23:30:18,840 - e2o_getvar - DEBUG - File
2015-11-29 23:30:18,840 - e2o_getvar - DEBUG - Read
run1.ini
2015-11-29 23:30:18,841 - e2o_getvar - INFO - returning defaul
ction:downscaling
2015-11-29 23:30:18,841 - e2o_getvar - INFO - returning defaul
r downscaling:lowResDEM
2015-11-29 23:30:18,841 - e2o_getvar - DEBUG - Done reading se
WARNING: Unable to read min val in CSF.
WARNING: Unable to read max val in CSF.
True
2015-11-29 23:30:25,319 - e2o_getvar - DEBUG - <type 'netCDF4.
root group (NETCDF3_CLASSIC data model, file format UNDEFINED)
    id: Tair_E2OBS_197901
    naming_authority: ecmwf.int
    Metadata_Conventions: Unidata Dataset Discovery v1.0
```