FACCE-MACSUR

# D-C.2.2 Local-scale CMIP5-based climate scenarios for MACSUR2

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## Selection of GCMs

Climate sensitivity of GCMs was used to select 5 GCMs from the CMIP5 ensemble for impact studies in MACSUR2. Table 1 shows changes calculated over land for N.Europe (NEU) and S.Europe (MED) in annual mean temperatures (C) and relative changes in precipitation (%) between future 2081-2100 (RCP85) and baseline climate (1985-2005) for 19 GCMs currently incorporated in LARS-WG (see Table 1; regions defined in (Giorgi & Francisco 2000). Selected GCMs for MACSUR2 are EC-EARTH (7), GFDL-CM3 (8,) HadGEM2-ES (10), MIROC5 (13), and MPI-ESM-MR (15). These GCMs are evenly distributed among CMIP5 (Fig 1) and should capture, in principal, climate uncertainty of the CMIP5 ensemble. Using 5 GCMs will enable us to assess uncertainties in impacts related to uncertainty in climate projections. The selection of GCMs in MACSUR2 has a good overlap with selections of GCMs used in CORDEX and AgMIP projects (Table 1).

## Climate Scenarios

We used the LARS-WG generator to construct local-scale CMIP5-based climate scenarios for Europe (Semenov & Stratonovitch, 2015). Fifteen sites were selected in Europe for MACSUR2 (see Fig 2). For each site and each selected GCM, 100 yrs climate daily data were generated by LARS-WG for RCP4.5 and RCP8.5 emission scenarios and for baseline and 3 future periods: near-term (2021-2040), mid-term (2041-2060) and long-term (2081-2100). Daily weather is stored as a text dat-file. For example, RR_HadGEM2-ES[RR,RCP85,2081-2100]WG.dat is dat-file for the site RR, GCM HadGEM2-ES, emission RCP85 and period 2081-2100; RRWG.dat is for the baseline scenario. Each dat-file has a corresponding st-file that describes data format, e.g. RR_HadGEM2-ES[RR,RCP85,2081-2100]WG.st. Below is an example of a st-file:

```
[SITE]
RR_HadGEM2-ES[RR,RCP85,2081-2100]WG
[LAT, LON and ALT]
51.80  -0.35  128.00
[CO2]
844.0
[WEATHER FILES]
RR_HadGEM2-ES[RR,RCP85,2081-2100]WG.dat
[FORMAT]
YEAR  JDAY  MIN  MAX  RAIN  RAD  PET
[END]
```

The line under [FORMAT] describes the format of weather data, YEAR – year, JDAY – day of the year, MIN, MAX – minimum and maximum daily temperature (C), RAIN – daily precipitation (mm), RAD – solar radiation (Mj/m2 per day), PET – potential evapotranspiration (mm) calculated using the Priestley-Taylor equation (a derived variable). The line under [CO2] is the CO2 concentration in ppm corresponding to this scenario.

| CMIP5.CORDEX | MACSUR | AgMIP | ISI-MIP | Tem.MED | Tem.NEU | Rain.MED | Rain.NEU |
|---|---|---|---|---|---|---|---|
| ACCESS1-3 | 1 | 1 | 1 | 5.1 | 4.9 | -8.4 | 14.3 |
| BCC-CSM1-1 | 2 | 2 | 2 | 4.2 | 4.8 | -20.2 | 6.7 |
| CanESM2 | 3 | 3 | 3 | 5.5 | 5.5 | -10.1 | 14.7 |
| CMCC-CM | 4 | 4 | 4 | 5.8 | 6.4 | -27 | 18.5 |
| CNRM-CM5 | 5 | 5 | 5 | 4.1 | 4.4 | 2.5 | 17.1 |
| CSIRO-MK36 | 6 | 6 | 6 | 4.8 | 4.9 | -21 | 9.4 |
| EC-EARTH | 7 | 7 | 7 | 4.2 | 4.3 | -10.4 | 11.3 |
| GFDL-CM3 | 8 | 8 | 8* | 6.7 | 6.8 | -27 | 18.5 |
| GISS-E2-R-CC | 9 | 9 | 9 | 3.4 | 3.9 | -14.6 | 10.7 |
| HadGEM2-ES | 10 | 10 | 10 | 5.8 | 6.1 | -22.2 | 1.6 |
| INMCM4 | 11 | 11 | 11 | 3.1 | 3.3 | -24.9 | 4.3 |
| IPSL-CM5A-MR | 12 | 12 | 12 | 5.5 | 5.9 | -36.2 | 12.9 |
| MIROC5 | 13 | 13 | 13 | 5.0 | 5.5 | -8 | 10.2 |
| MIROC-ESM | 14 | 14 | 14 | 6.4 | 6.6 | -12 | 24.9 |
| MPI-ESM-MR | 15 | 15 | 15 | 4.3 | 3.8 | -25 | 5.9 |
| MRI-CGCM3 | 16 | 16 | 16 | 3.7 | 4.2 | -5.3 | 17.1 |
| NCAR-CCSM4 | 17 | 17 | 17 | 4.2 | 4.2 | -16.2 | 3.4 |
| NCAR-CESM1-CAM5 | 18 | 18 | 18 | 5.1 | 4.6 | -11.4 | 8 |
| NorESM1-M | 19 | 19 | 19 | 4.1 | 4.3 | -13.7 | 7 |

Table 1. Absolute changes in annual mean temperatures, C, and relative changes in precipitation, %, for 2081-2100 (RCP85) compared with baseline for 19 GCMs from CMIP5 calculated for N.Europe (NEU) and S.Europe (MED). Highlighted GCMs were selected in CMIP5.CORDEX, MACSUR, AgMIP and ISI-MIP projects.

*GFDL-ESM2M was used in ISI-MIP.

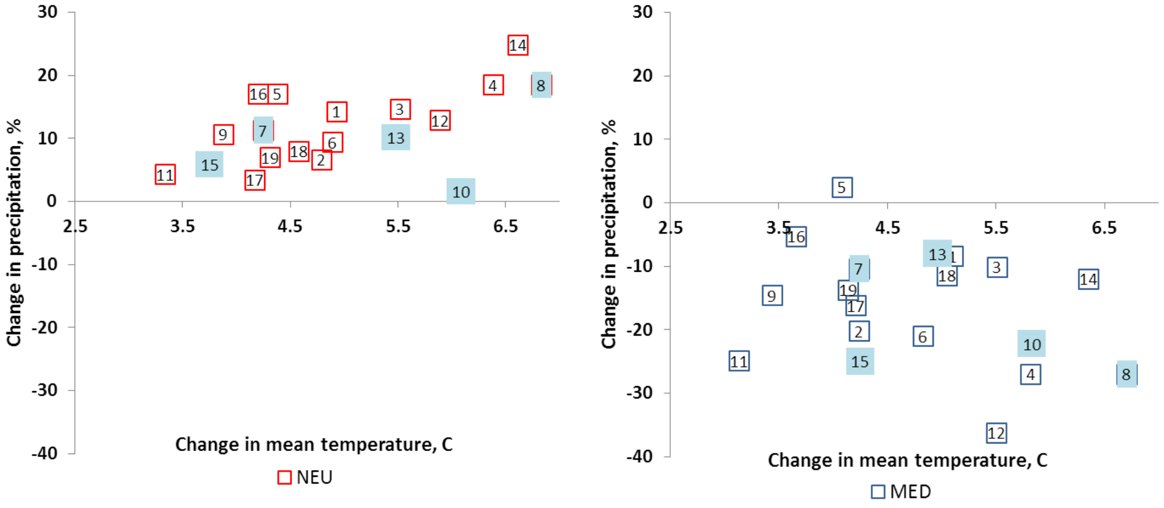

Figure 1. Climate sensitivity of 19 GCMs from CMIP5 for N.Europe (NEU, left) and S.Europe (MED, right). GCMs selected for MACSUR2 highligted in blue.

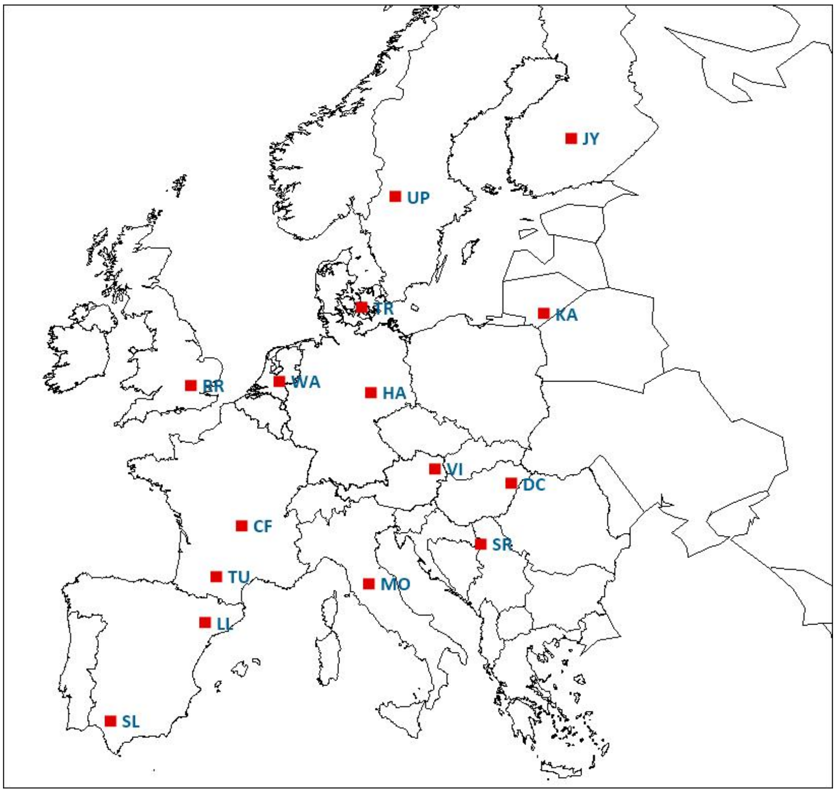

Figure 2. Locations of 15 sites for impact studies in MACSUR2.

| Site | Nick | Lat | Lon | Alt, m |
|---|---|---|---|---|
| Jyvaskyla | JY | 62.40 | 25.68 | 141 |
| Uppsala | UP | 59.90 | 13.60 | 24 |
| Tylstrup | TR | 55.15 | 11.33 | 13 |
| Kaunas | KA | 54.88 | 23.83 | 77 |
| Wageningen | WA | 51.97 | 5.67 | 7 |
| Rothamsted | RR | 51.80 | -0.35 | 128 |
| Halle | HA | 51.51 | 11.95 | 93 |
| Vienna | VI | 48.23 | 16.35 | 198 |
| Debrecen | DC | 47.60 | 21.60 | 114 |
| Clermont-Ferrand | CF | 45.80 | 3.10 | 329 |
| Sremska | SR | 45.00 | 19.51 | 84 |
| Toulouse | TU | 43.62 | 1.38 | 151 |
| Montagnano | MO | 43.30 | 11.80 | 250 |
| Lleida | LL | 41.63 | 0.60 | 190 |
| Seville | SL | 37.42 | -5.88 | 34 |

## References

Semenov, M.A., Stratonovitch, P., 2015. Adapting wheat ideotypes for climate change: accounting for uncertainties in CMIP5 climate projections. Climate Research 65, 123-139. Doi 10.3354/cr01297