

## 7 Biomes

### 7.1 Scenarios

5 Since the pre-industrial simulations are an important part of the experiments, the spin-up has to finish before the pre-industrial simulations start. The spin-up should be using pre-industrial climate (**picontrol**) and year 1860 levels of “other human influences”. For this reason, the pre-industrial climate data should be replicated as often as required. The precise implementation of the spin up will be model specific, the description of which will be part of the reporting process.

| Climate & CO <sub>2</sub> scenarios    |  |
|--|--|
| <b>picontrol</b>                       | Pre-industrial climate and 286ppm CO <sub>2</sub> concentration. The climate data for the entire period (1661-2299) are unique – no (or little) recycling of data has taken place. |
| <b>historical</b>                      | Historical climate and CO <sub>2</sub> concentration.  |
| <b>rcp26</b>                           | Future climate and CO <sub>2</sub> concentration from RCP2.6   |
| <b>rcp60</b>                           | Future climate and CO <sub>2</sub> concentration from RCP6.0   |
| <b>2005co2</b>                         | CO <sub>2</sub> concentration fixed at 2005 levels at 378.81ppm.   |
| Human influence and land-use scenarios |  |
| <b>1860soc</b>                         | Constant pre-industrial (1860) land use, nitrogen deposition, and fertilizer input.  |
| <b>histsoc</b>                         | Varying historical land use, nitrogen deposition and fertilizer input.   |
| <b>2005soc</b>                         | Fixed year-2005 land use, nitrogen deposition and fertilizer input.  |
| <b>rcp26soc</b>                        | Varying land use, water abstraction, nitrogen deposition and fertilizer input according to SSP2 and RCP2.6.  |
| <b>rcp60soc</b>                        | Varying land use, water abstraction, nitrogen deposition and fertilizer input according to SSP2 and RCP6.0.  |
| <b>2100rcp26soc</b>                    | Land use, nitrogen deposition and fertilizer input fixed at year 2100 levels according to RCP2.6 in 2100.  |

**Table 13** ISIMIP2b scenarios for the global biomes simulations.

| Experiment |   | Input                     | Pre-industrial<br>1661-1860 | Historical<br>1861-2005 | Future<br>2006-2099   | Extended future<br>2100-2299 |
|------------|---|---------------------------|-----------------------------|-------------------------|-----------------------|------------------------------|
| <b>I</b>   | no climate change, pre-industrial CO <sub>2</sub>                                       | Climate & CO <sub>2</sub> | <b>picontrol</b>            | <b>picontrol</b>        | <b>picontrol</b>      | <b>picontrol</b>             |
|            | varying LU & human influences up to 2005, then fixed at 2005 levels thereafter          | Human & LU                | <b>1860soc</b>              | <b>histsoc</b>          | <b>2005soc</b>        | <b>2005soc</b>               |
| <b>II</b>  | RCP2.6 climate & CO <sub>2</sub>  | Climate & CO <sub>2</sub> | Experiment I                | <b>historical</b>       | <b>rcp26</b>          | <b>rcp26</b>                 |
|            | varying LU & human influences up to 2005, then fixed at 2005 levels thereafter          | Human & LU                |                             | <b>histsoc</b>          | <b>2005soc</b>        | <b>2005soc</b>               |
| <b>Ila</b> | RCP2.6 climate, CO <sub>2</sub> after 2005 fixed at 2005 levels                         | Climate & CO <sub>2</sub> | Experiment I                | Experiment II           | <b>rcp26, 2005co2</b> | <b>rcp26, 2005co2</b>        |
|            | varying LU & human influences up to 2005, then fixed at 2005 levels thereafter          | Human & LU                |                             |                         | <b>2005soc</b>        | <b>2005soc</b>               |
| <b>III</b> | RCP6.0 climate & CO <sub>2</sub>  | Climate & CO <sub>2</sub> | Experiment I                | Experiment II           | <b>rcp60</b>          | not simulated                |
|            | varying LU & human influences up to 2005, then fixed at 2005 levels thereafter          | Human & LU                |                             |                         | <b>2005soc</b>        |                              |
| <b>IV</b>  | no climate change, pre-industrial CO <sub>2</sub>                                       | Climate & CO <sub>2</sub> | Experiment I                | Experiment I            | <b>picontrol</b>      | <b>picontrol</b>             |
|            | varying human influences & LU up to 2100 (RCP2.6), then fixed at 2100 levels thereafter | Human & LU                |                             |                         | <b>rcp26soc</b>       | <b>2100rcp26soc</b>          |
| <b>V</b>   | no climate change, pre-industrial CO <sub>2</sub>                                       | Climate & CO <sub>2</sub> | Experiment I                | Experiment I            | <b>picontrol</b>      | not simulated                |
|            | varying human influences & LU (RCP6.0)  | Human & LU                |                             |                         | <b>rcp60soc</b>       |                              |

|            |   |                           |              |               |          |               |
|------------|---|---------------------------|--------------|---------------|----------|---------------|
| <b>VI</b>  | RCP2.6 climate & CO <sub>2</sub>  | Climate & CO <sub>2</sub> | Experiment I | Experiment II | rcp26    | rcp26         |
|            | varying human influences & LU up to 2100 (RCP2.6), then fixed at 2100 levels thereafter | Human & LU                |              |               | rcp26soc | 2100rcp26soc  |
| <b>VII</b> | RCP6.0 climate & CO <sub>2</sub>  | Climate & CO <sub>2</sub> | Experiment I | Experiment II | rcp60    | not simulated |
|            | varying human influences & LU (RCP6.0)  | Human & LU                |              |               | rcp60soc |               |

**Table 14** Additional sector-specific simulations for the biome sector.

| Experiment  |  | Input                     | Pre-industrial<br>1661-1860 | Historical<br>1861-2005 | Future<br>2006-2099 | Extended future<br>2100-2299 |
|-------------|--|---------------------------|-----------------------------|-------------------------|---------------------|------------------------------|
| <b>Ia</b>   | no climate change, pre-industrial CO <sub>2</sub>                              | Climate & CO <sub>2</sub> | picontrol                   | picontrol               | picontrol           | picontrol                    |
|             | LU & human influences fixed at 1860 levels                                     | Human & LU                | 1860soc                     | 1860soc                 | 1860soc             | 1860soc                      |
| <b>Iib</b>  | RCP2.6 climate & CO <sub>2</sub>   | Climate & CO <sub>2</sub> | Experiment I                | historical              | rcp26               | rcp26                        |
|             | LU & human influences fixed at 1860 levels                                     | Human & LU                |                             | 1860soc                 | 1860soc             | 1860soc                      |
| <b>IIia</b> | RCP6.0 climate, CO <sub>2</sub> after 2005 fixed at 2005 levels                | Climate & CO <sub>2</sub> | Experiment I                | Experiment II           | rcp60, 2005co2      | not simulated                |
|             | varying LU & human influences up to 2005, then fixed at 2005 levels thereafter | Human & LU                |                             |                         | 2005soc             |                              |
| <b>IIib</b> | RCP6.0 climate & CO <sub>2</sub>   | Climate & CO <sub>2</sub> | Experiment I                | Experiment II           | rcp60               | not simulated                |

|  |  |            |  |  |         |  |
|--|--|------------|--|--|---------|--|
|  | LU & human influences fixed at 1860 levels | Human & LU |  |  | 1860soc |  |
|--|--|------------|--|--|---------|--|

## 5 7.2 Output data

**Table 15** Variables to be reported by biomes models. Variables marked by \* are also relevant for the permafrost sector and also listed in **Table 21**. **Note:** If you cannot provide the data at the temporal or spatial resolution specified, please provide it the highest possible resolution of your model.

| long name                                      | units              |                            | output variable name      | resolution | comment   |
|--|--------------------|----------------------------|---------------------------|------------|---|
| <b>Essential outputs</b>                       |                    |                            |                           |            |   |
| Pools  |                    |                            |                           |            |   |
| *Carbon Mass in Vegetation biomass             | kg m <sup>-2</sup> | per pft and gridcell total | <b>cveg-&lt;pft&gt;</b>   | annual     | Gridcell total cveg is essential. Per PFT information is desirable.   |
| *Carbon Mass in aboveground vegetation biomass | kg m <sup>-2</sup> | per pft and gridcell total | <b>cvegag-&lt;pft&gt;</b> | annual     | Gridcell total cvegag is essential. Per PFT information is desirable. |
| *Carbon Mass in belowground vegetation biomass | kg m <sup>-2</sup> | per pft and gridcell total | <b>cvebg-&lt;pft&gt;</b>  | annual     | Gridcell total cvebg is essential. Per PFT information is desirable.  |
| *Carbon Mass in Litter Pool                    | kg m <sup>-2</sup> | per gridcell total         | <b>clitter</b>            | annual     | Info for each individual pool.  |
| *Carbon Mass in Soil Pool                      | kg m <sup>-2</sup> | per gridcell total         | <b>csoil</b>              | annual     | Info for each individual pool.  |

| Fluxes   |                                   |                |                        |                 |  |
|--|-----------------------------------|----------------|------------------------|-----------------|--|
| *Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land      | $\text{kg m}^{-2} \text{ s}^{-1}$ | gridcell total | <b>gpp</b>             | monthly (daily) |  |
| *Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land      | $\text{kg m}^{-2} \text{ s}^{-1}$ | per pft        | <b>gpp-&lt;pft&gt;</b> | annual          |  |
| *Carbon Mass Flux into atmosphere due to Autotrophic (Plant) Respiration on Land | $\text{kg m}^{-2} \text{ s}^{-1}$ | gridcell total | <b>ra</b>              | monthly (daily) |  |
| *Carbon Mass Flux out of atmosphere due to Net Primary Production on Land        | $\text{kg m}^{-2} \text{ s}^{-1}$ | gridcell total | <b>npp</b>             | monthly(daily)  |  |
| *Carbon Mass Flux out of atmosphere due to Net Primary Production on Land        | $\text{kg m}^{-2} \text{ s}^{-1}$ | per pft        | <b>npp-&lt;pft&gt;</b> | annual          |  |
| *Carbon Mass Flux into atmosphere due to Heterotrophic Respiration on Land       | $\text{kg m}^{-2} \text{ s}^{-1}$ | gridcell total | <b>rh</b>              | monthly(daily)  |  |
| *Carbon Mass Flux into atmosphere due to total Carbon emissions from Fire        | $\text{kg m}^{-2} \text{ s}^{-1}$ | gridcell total | <b>fireint</b>         | monthly(daily)  |  |

|   |                                    |                  |                        |                               |   |
|---|------------------------------------|------------------|------------------------|-------------------------------|---|
| *Carbon Mass Flux out of Atmosphere due to Net biome Production on Land (NBP) | kg m <sup>-2</sup> s <sup>-1</sup> | gridcell total   | <b>ecoatmflux</b>      | monthly(daily)                | This is the net mass flux of carbon between land and atmosphere calculated as photosynthesis MINUS the sum of plant and soil respiration, carbon fluxes from fire, harvest, grazing and land use change. Positive flux is into the land.                                      |
| Structure   |                                    |                  |                        |                               |   |
| *Leaf Area Index  | 1                                  | per pft          | <b>lai-&lt;pft&gt;</b> | annual                        |   |
| *Leaf Area Index  | 1                                  | gridcell average | <b>lai</b>             | monthly (daily)               |   |
| *Plant Functional Type Grid Fraction  | %                                  | per gridcell     | <b>pft-&lt;pft&gt;</b> | annual<br>(or once if static) | The categories may differ from model to model, depending on their PFT definitions. This may include natural PFTs, anthropogenic PFTs, bare soil, lakes, urban areas, etc. Sum of all should equal the fraction of the grid-cell that is land.<br><br>Value between 0 and 100. |
| Hydrological variables  |                                    |                  |                        |                               |   |
| Total Evapo-Transpiration   | kg m <sup>-2</sup> s <sup>-1</sup> | gridcell total   | <b>evap</b>            | monthly (daily)               |   |
| Evaporation from Canopy (interception)  | kg m <sup>-2</sup> s <sup>-1</sup> | gridcell total   | <b>intercep</b>        | monthly (daily)               | the canopy evaporation+sublimation (if present in model).   |
| Water Evaporation from Soil   | kg m <sup>-2</sup> s <sup>-1</sup> | per gridcell     | <b>esoil</b>           | monthly (daily)               | includes sublimation.   |
| Transpiration   | kg m <sup>-2</sup> s <sup>-1</sup> | per gridcell     | <b>trans</b>           | monthly (daily)               |   |

|                                      |                                   |              |                      |                   |   |
|--------------------------------------|-----------------------------------|--------------|----------------------|-------------------|---|
| *Runoff                              | $\text{kg m}^{-2} \text{ s}^{-1}$ | per gridcell | <b>qtot</b>          | monthly (daily**) | total (surface + subsurface) runoff (qtot = qs + qsb).<br><br>**for models also participating in the water sector<br><br>If daily resolution not possible, please provide monthly. If storage issues keep you from reporting daily data, please contact the ISIMIP team to discuss potential solutions. |
| *Soil Moisture                       | $\text{kg m}^{-2}$                | per gridcell | <b>soilmoist</b>     | monthly (daily)   | If possible, please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m. Otherwise, provide soil moisture of entire column.   |
| Surface Runoff                       | $\text{kg m}^{-2} \text{ s}^{-1}$ | per gridcell | <b>qs</b>            | monthly (daily)   | Total surface runoff leaving the land portion of the grid cell.   |
| *Frozen soil moisture for each layer | $\text{kg m}^{-2}$                | per gridcell | <b>soilmoistfroz</b> | monthly           | Please provide soil moisture for all depth levels and indicate depth in m.  |
| *Snow depth                          | m                                 | per gridcell | <b>snd</b>           | monthly           | Grid cell mean depth of snowpack.   |
| *Snow water equivalent               | $\text{kg m}^{-2}$                | per gridcell | <b>swe</b>           | monthly           | Total water mass of the snowpack (liquid or frozen), averaged over a grid cell.   |
| *Annual maximum thaw depth           | m                                 | per gridcell | <b>thawdepth</b>     | annual            | calculated from daily thaw depths<br><br>Please provide for purposes of permafrost sector.  |
| <b>Other outputs</b>                 |                                   |              |                      |                   |   |

|   |                                    |                |                  |                 |  |
|---|------------------------------------|----------------|------------------|-----------------|--|
| *Temperature of Soil                        | K                                  | per gridcell   | <b>tsl</b>       | daily (mon)     | Temperature of each soil layer. Reported as "missing" for grid cells occupied entirely by "sea".<br><br>Also needs depths in meters. Daily would be great, but otherwise monthly would work. |
| Burnt Area Fraction                         | %                                  | per gridcell   | <b>burntarea</b> | monthly (daily) | Area percentage of grid cell that has burned at any time of the given day/month/year (for daily/monthly/annual resolution)   |
| Albedo                                      | 1                                  | per gridcell   | <b>albedo</b>    | monthly         | average of pfts, snow cover, bare ground and water surfaces, range between 0-1   |
| *N <sub>2</sub> O emissions into atmosphere | kg m <sup>-2</sup> s <sup>-1</sup> | gridcell total | <b>n2o</b>       | monthly         | From land, not from industrial fossil fuel emissions and transport   |
| *CH <sub>4</sub> emissions into atmosphere  | kg m <sup>-2</sup> s <sup>-1</sup> | gridcell total | <b>ch4</b>       | monthly         | From land, not from industrial fossil fuel emissions and transport   |