Towards robust PROjections of European FOrests UNDer climate change (PROFOUND)

COST Action FP1304

Christopher Reyer, Potsdam Institute for Climate Impact Research
PROFOUND - aims & objectives
Aims of PROFOUND

to evaluate and improve our ability to project the consequences of environmental change for European forests

by addressing open questions regarding data needs, scaling, parameterization, and predictive accuracy of European forest models

to be able to better plan sustainable forest management issues under changing conditions such as adaptation, mitigation or bioenergy potentials.
<table>
<thead>
<tr>
<th>WG1: Data &amp; Models</th>
<th>WG2: Processes &amp; Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>- review of model data needs (eval, cal, param)</td>
<td>- inclusion of different processes</td>
</tr>
<tr>
<td>- data gaps &amp; additional observations to support models?</td>
<td>- scale of process description</td>
</tr>
</tbody>
</table>

Cross-cutting

- reference data set for benchmarking
- structured model comparisons

<table>
<thead>
<tr>
<th>WG3: Methods</th>
<th>WG4: Uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>- protocols for model parameterisation, evaluation &amp; comparison with multi-source data</td>
<td>- protocol for model comparisons &amp; climate change impact runs</td>
</tr>
<tr>
<td></td>
<td>- stakeholder preceptions &amp; uncertainty framing</td>
</tr>
</tbody>
</table>
PROFOUND Task Groups (TG)
<table>
<thead>
<tr>
<th>TG</th>
<th>Title</th>
<th>Lead</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG1</td>
<td>Review of available data for forest models</td>
<td>Zavala/Palacios</td>
<td>Review ongoing*, Meet in 2/3 2016</td>
</tr>
<tr>
<td>TG2</td>
<td>Reference Dataset</td>
<td>Dolos</td>
<td>Processing data*, Meet in 2/3/4 2016</td>
</tr>
<tr>
<td>TG4</td>
<td>Mortality modeling</td>
<td>Bugmann</td>
<td>Simulations finished, paper writing*</td>
</tr>
<tr>
<td>TG5</td>
<td>Allocation modeling</td>
<td>Merganicova</td>
<td>Meet in summer 2016 in Zvolen</td>
</tr>
<tr>
<td>TG6</td>
<td>Modelling forest structure</td>
<td>Collalti</td>
<td>Experiment in TG3 protocol</td>
</tr>
<tr>
<td>TG7</td>
<td>Landscape model comparison</td>
<td>Lischke</td>
<td>Meet in 5/2016 in Dischma</td>
</tr>
<tr>
<td>TG8</td>
<td>State-of-the-art of forest modeling</td>
<td>Huth</td>
<td>Active next GP</td>
</tr>
<tr>
<td>TG9</td>
<td>Forest management modeling</td>
<td>Fabrika</td>
<td>Meet in summer 2016 in Zvolen</td>
</tr>
<tr>
<td>TG10</td>
<td>Climate change and forest disturbance</td>
<td>Seidl</td>
<td>Review paper ongoing*</td>
</tr>
<tr>
<td>TG11</td>
<td>Genetics/adaptation/intra-specific</td>
<td>Kramer</td>
<td>Meet in GP3</td>
</tr>
<tr>
<td>TG12</td>
<td>Tree Rings &amp; Disturbances</td>
<td>Rammer</td>
<td>Active next GP</td>
</tr>
<tr>
<td>TG14</td>
<td>MCMC algorithm comparison</td>
<td>Minunno</td>
<td>Comparison ongoing*, meet in 5/2016</td>
</tr>
<tr>
<td>TG15</td>
<td>Fitting models to heterogeneous data</td>
<td>Cameron/Dietze</td>
<td>Simulations ongoing*, meet in 5/2016</td>
</tr>
<tr>
<td>TG16</td>
<td>Uncertainty Review</td>
<td>Petr</td>
<td>Review paper ongoing</td>
</tr>
<tr>
<td>TG17</td>
<td>Bridging the gap (stakeholders perspectives)</td>
<td>Blennnow</td>
<td>Questionnaire ongoing</td>
</tr>
<tr>
<td>TG18</td>
<td>The merits of multi constraints data sets for model parameter estimation</td>
<td>Ibrom</td>
<td>Meet February 2016 in Copenhagen</td>
</tr>
<tr>
<td>TG19</td>
<td>Model-comparison Nitrogen</td>
<td>Magnani</td>
<td>Active next GP?</td>
</tr>
<tr>
<td>TG20</td>
<td>Seed Masting Modelling</td>
<td>Vacchiano</td>
<td>Meet in 4/2016 or later?</td>
</tr>
<tr>
<td>TG21</td>
<td>Regeneration Modeling</td>
<td>Reinekeing/Bugm</td>
<td>Meet in GP3</td>
</tr>
<tr>
<td>TG22</td>
<td>Models and data providers</td>
<td>Martin Benito</td>
<td>Meet in GP3</td>
</tr>
<tr>
<td>TG23</td>
<td>Databases</td>
<td>Chikalanan</td>
<td>Aim to be refined</td>
</tr>
</tbody>
</table>

*have meet using PROFOUND funds, bold = actively working towards "product"
Task Group Work Flow
PROFOUND infrastructure

TG1: Data for forest models
Lead: Miguel Zavala, Alicia Palacios
- Review paper

TG2: Reference dataset
Lead: Klara Dolos
- Reference dataset for PROFOUND simulations
- Data paper describing the dataset

TG3: Multi-model projection protocol
Lead: Christopher Reyer, Santiago Sabaté
- Protocol for PROFOUND multi-model simulations

TG4: Mortality modeling reloaded
Lead: Harald Bugmann
- Synthesis paper based on "simple" model experiments for Novi Sad workshop
- Simulations: "TG4 reloaded" with harmonized mortality simulations

TG5: Allocation modeling
Lead: Katarina Merganicova
- Review paper
- Simulations: how different models with different allocation modules react to climate change?

TG6: Modelling forest structure
Lead: Alessio Collalti
- Simulations: mixed forests

TG7: Landscape model comparison
Lead: Heike Lischke
- Simulations: comparing landscape models

TG8: Multi constraints data sets
Lead: Andreas Ibrom
- Simulations using datasets from various sources

TG9: Forest management modelling
Lead: Marek Fabrika
- Review paper

TG10: Climate Change & Disturbances
Lead: Rupert Seidl
- Review paper

TG11: Genetics & Adaptation
Lead: Koen Kramer
- Review paper?

TG12: Uncertainties
Lead: Michael Petr
- Review paper

TG13: Model parameterization protocol
Lead: Florian Hartig, Björn Reineking
- Protocol for calibration and review paper on how to calibrate models to data

TG14: MCMC algorithm comparison
Lead: Francesco Minunno
- Simulations comparing different MCMC algorithms

TG15: Models & heterogeneous data
Lead: David Cameron, Michael Dietze
- Simulations comparing different datasets

TG16: Seed Maasting modelling
Lead: Giorgio Vacchiano
- Review paper?

TG17: Bridging the gap between stakeholders
Lead: Kristina Blennow
- Questionnaire & paper

Steering Group & Webmaster
Lead: n.a
- Homepage, Twitter, LinkedIn, Blogs

PROFOUND simulation studies

TG18: Multi constraints data sets
Lead: Andreas Ibrom
- Simulations using datasets from various sources

TG19: Model parameterization protocol
Lead: Florian Hartig, Björn Reineking
- Protocol for calibration and review paper on how to calibrate models to data

TG20: Seed Maasting modelling
Lead: Giorgio Vacchiano
- Review paper
- Simulations?

TG21: Recruitment Modelling
Lead: Björn Reineking, Harald Bugmann
- Simulations?

PROFOUND review papers

TG22: Modelers and data providers
Lead: Dario Martin
- Review paper?

TG23: Databases
Lead: Alexander Chikalanov
- Review paper?

PROFOUND Stakeholder

TG17: Bridging the gap between stakeholders
Lead: Kristina Blennow
- Questionnaire & paper

Steering Group & Webmaster
Lead: n.a
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Task Group relation to objectives
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<td>TG1</td>
<td>TG22</td>
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<table>
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<th>Cross-cutting</th>
<th>TG8</th>
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| TG2 |

| TG19 |

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<td>TG13</td>
<td>TG14</td>
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</tbody>
</table>

| TG3 |
COST PROFOUND reimbursement

• Sign the attendance list!
• Reimbursement is 80€/night, 20€/meal
• You can only claim a maximum of 2 meals/meeting or travel day minus the meals provided by the organisers.
• Never finish the claim before you attended the meeting („claim pending“)
SIGN THE LIST!
TG3 Objectives

- develop model protocols for multi-model simulations (climate change, ISI-MIP)
- develop advanced model protocols for more standardized model comparisons (parameter values, calibration techniques) with WG3
Goals ISI-MIP 2.1

Model evaluation/benchmarking:

➢ Are current vegetation models able to reproduce observed responses to climate variability and extreme events at global and regional scales?

➢ Comparison of regional and global vegetation models for selected sites?

➢ Multi-model climate change impact simulations

➢ Cross-sectoral analyses (e.g. heatwave 2013 across sectors)

➢ Do impacts on society add-up, multiply, cancel out?
The ISI-MIP2.1:
Representation of variability and extreme events

Observational climate input
- Princeton
- GSWP3
- WATCH
- WFDEI

Historical socioeconomic input data

Impact Models
Regional
- Water (14)
- Forestry

Global
- Water (13)
- Agriculture (14)
- Ecosystems (8)
- Infrastructure
- Health
- Fishery (5)
- Energy
- Permafrost (3)

Model evaluation and improvement
Cross-scale intercomparison

Protocol: Consistent scenario design according to a focus topic

Open repository of cross sectoral consistent impact projections
### ISI-MIP: Global vegetation models and available runs

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<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CARAIB*</td>
<td>X</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
<td>BE</td>
</tr>
<tr>
<td>DLEM*</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>USA</td>
</tr>
<tr>
<td>JULES</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>UK</td>
</tr>
<tr>
<td>Hybrid</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
<td>(X)</td>
<td>UK</td>
</tr>
<tr>
<td>LPJ-GUESS*</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>GER</td>
</tr>
<tr>
<td>LPJmL</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>GER</td>
</tr>
<tr>
<td>ORCHIDEE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>FR</td>
</tr>
<tr>
<td>VEGAS*</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>USA</td>
</tr>
<tr>
<td>VISIT</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>JP</td>
</tr>
</tbody>
</table>

*new groups in ISI-MIP 2.1
TG3 Status

- ISI-MIP/PROFOUND simulation protocol is ready!
- 3 modelling groups did test runs for first site (Peitz)
- Data available for more sites
- „Model Experiment Documentation“ available
Preliminary Results

The graph shows the growth of DBH (diameter at breast height) from 1940 to 2020. The x-axis represents the years, while the y-axis represents the DBH in centimeters. The graph compares measured data (Meas) with model predictions from Model_1 and Model_2. Other models included are PGMFD v.2, GSWP3, WFD, and WFDEI.GPCC. The models show a consistent increase in DBH over the years, with Model_2 showing a slightly steeper increase compared to Model_1.
Preliminary Results

The graph shows the trend in height (m) from 1940 to 2020. The data is categorized into different models and observations. The models include "Meas," "Model_1," "Model_2," and "Model_3." The observations include "4C_Obs," "PGMFD v.2," "GSWP3," "WFD," and "WFDEI.GPCC."
TG3 Paper ideas

1. Data paper (TG2) (MEE, PLOS ComBio, Geoscientific Model Development, BGS, ECOMOD, Ecological Archive ➔ indexed?, Naturedata) ➔ What we did with data to make it useful to modellers ➔ this is how to make data useful...
2. „Standard“ model comparison (TG3)
3. Compare GVM and local forests models (ISI-MIP cross-scale)
4. How does management affect forests across Europe (nat-runs vs. man-runs)? (Daniel Nadal)
5. Climatic turning point ➔ dominance of two species changes (Klara Dolos, needs meeting)
6. Uncertainty analysis: Decomposition of uncertainty (effect of management, climate, model type) (ask Maxime Cailleret about status)
7. Productivity combined with water balance wrt to extreme events (Thomas Rötzer)
8. Analysis of intra-annual anomalies and trends (Alessio) maybe overlap with „standard comparison“? Maybe not if focus is rightly shaped
9. Extra carbon paper: photosynthesis, allocation under Co2const and co2inc (Rüdiger) ➔ optional output
10. Disentanglic of drivers (management, co2, climate-experiments) under CC ➔ overlap with MAxime
11. Risk Analyses ➔ expectation of losses due to CC (vulnerability*hazard=risk) (David Cameron)

• TG3: once database is ready ➔ get models running using the data! ➔ discuss more paper ideas
TG3 Reasons to contribute

- Special Features (ERL, GCB)
- Funding (JPI Climate, Belmont Forum)
- EGU session: CL3.04 Modelling climate impacts: Intercomparison, validation, and improvement of impact models
  Convener: Jacob Schewe
  Co-Conveners: Rutger Dankers, Katja Frieler, Christopher Reyer, Carl-Friedrich Schleussner
  Link: http://meetingorganizer.copernicus.org/EGU2016/session/21107
TG3: PROFOUND/ISI-MIP protocol
Overview

1) Introduction
2) General design of ISI-MIP2.1
3) Motivation of experiment design
4) Common input data for all sectors
5) General Spin-up procedures
6) Reporting model results
7) Sector-specific input, output, experiments
   7.3 Forest Models
General design of ISI-MIP2.1

- **Focus Topic:** „Extreme events and variability“
- **Focus Regions:**

![Map showing different regions with numbers and markers](image)
# General design of ISI-MIP2.1

<table>
<thead>
<tr>
<th></th>
<th>Fast-track models</th>
<th>New sectors/models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISI-MIP2.1A</strong></td>
<td>Historical runs $\rightarrow$ validation and evaluation with focus on variability and extremes</td>
<td>Historical runs $\rightarrow$ validation and evaluation with focus on variability and extremes (this may, particularly for regional models, include calibration and validation for average conditions as a first step)</td>
</tr>
<tr>
<td><strong>ISI-MIP2.1B</strong></td>
<td>Strengthening cross-sectoral integration (e.g. by application of land-use (LU) patterns generated by the agro-economic models within the water and biomes sectors)</td>
<td>Run impact models driven by ISI-MIP fast-track climate data using fast track protocol (&quot;catch-up runs&quot;; with modifications for new sectors where necessary)</td>
</tr>
<tr>
<td><strong>ISI-MIP2.2</strong></td>
<td>Next generation future simulations (in particular with regard to &quot;extreme events and variability&quot;) based on newly bias-corrected RCP and SSP projections (improved bias correction, high resolution climate regional climate projections (CORDEX), improved model set-ups based on ISI-MIP2.1)</td>
<td></td>
</tr>
</tbody>
</table>
General design of ISI-MIP2.1

• Results and publications
  ➔ bottom-up: send ideas around / discuss today and ask for extra-simulations

• Data access and authorship
  “After submission deadlines, ISI-MIP archive only accessible for ISI-MIP participants for a period of approximately 6 months, to give modelling groups time for quality checks and first analyses. For all papers written during this period, at least one author from each model from which data is used should be offered co-authorship. The lead authors of the papers are responsible for contacting these potential co-authors. After this period, the data archive will be made publicly accessible, and modeling teams should be acknowledged when their data are used for a publication. “

• Data archive
  ➔ a central ISI-MIP data archive at the DKRZ (Hamburg, Germany). www.isi-mip.org > Data Archive. ➔ distribution point for the input data as well as the collection of the output data before they will be made publically available.
  ➔ ESG-server with all results open after embargo period
Common input data: 4 past forcings

Table 5: Historical (atmospheric) climate data sets to be used in validation runs. All data sets contain the variables tas, pr, rhs, rlds, rsds, ps, wind, and partly also tasmin and tasmax. Note that simulations should be conducted with each of these datasets.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Reanalysis</th>
<th>Years</th>
<th>Resolution, coverage</th>
<th>Bias target</th>
<th>Order of simulations; comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGMFD v.2 (Princeton)</td>
<td>NCEP/NCAR Reanalysis 1</td>
<td>1901-2012</td>
<td>0.5° Land + Ocean</td>
<td>CRU, SRB, TRMM, GPCP, WMO validated against GSWP2</td>
<td>1</td>
</tr>
<tr>
<td>GSWP3</td>
<td>20CR</td>
<td>1901-2010 (2011 and 2012 to be added soon)</td>
<td>0.5° Land + Ocean</td>
<td>GPCC, GPCP, CPC-Unified; CRU; SRB</td>
<td>2</td>
</tr>
<tr>
<td>WATCH (WFD)</td>
<td>ERA-40</td>
<td>1901-2001</td>
<td>0.5° Land</td>
<td>GPCC</td>
<td>3</td>
</tr>
<tr>
<td>WFDEI.GPCC</td>
<td>ERA-Interim</td>
<td>1901–2012 (with 1901-1978 taken from WFD, WFDEI.GPCC data starting in 1979)</td>
<td>0.5° Land</td>
<td>GPCC</td>
<td>4</td>
</tr>
</tbody>
</table>

➤ + locally observed meteorology for forest plots!
Common input data: 5 bias-corrected GCMs, 4 RCPs

Table 8 Climate input variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Unit format</th>
<th>(NetCDF format)</th>
<th>Frequency</th>
<th>Bias correction method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface air temperatures $T_{avg}$</td>
<td>tas, tasmin, tasmax</td>
<td>K (K)</td>
<td>daily &amp; monthly</td>
<td>Mean and range matched to WATCH data (1960-1999)</td>
<td></td>
</tr>
<tr>
<td>Tmin $T_{max}$ (24 hour values)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precipitation (sum of snowfall and rainfall)</td>
<td>pr</td>
<td>Kg/m²/s (kg m⁻² s⁻¹)</td>
<td>daily &amp; monthly</td>
<td>Statistical distribution matched to WATCH data</td>
<td></td>
</tr>
<tr>
<td>Surface radiation (short- and longwave downwelling)</td>
<td>rds</td>
<td>W/m² (W m⁻²)</td>
<td>daily &amp; monthly</td>
<td>Statistical distribution matched to WATCH data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rlds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near-surface wind speed (east- and north-ward)</td>
<td>uas</td>
<td>m/s (m s⁻¹)</td>
<td>daily &amp; monthly</td>
<td>Statistical distribution matched to WATCH data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near-surface wind speed (total)</td>
<td>wind</td>
<td>m/s (m s⁻¹)</td>
<td>daily &amp; monthly</td>
<td>Statistical distribution matched to WATCH data</td>
<td></td>
</tr>
<tr>
<td>Surface air pressure</td>
<td>ps</td>
<td>Pa (pa)</td>
<td>daily &amp; monthly</td>
<td>Statistical distribution matched to WATCH data</td>
<td></td>
</tr>
<tr>
<td>Near-surface relative humidity</td>
<td>rhs</td>
<td>% (%)</td>
<td>daily &amp; monthly</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>CO₂ concentration</td>
<td>co2</td>
<td>ppm (ppm)</td>
<td>annual</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
Common input data: CO2 & N

- Atmospheric CO2 concentration for past and all RCPs
- N not included but some models use it, maybe add?
Common input data: Simulation Logic
Common input data: Simulation Logic

Catch-up runs
(according to Fast Track protocol)

land-use
constant or none (see sectoral specifications)

CO₂
fixed at 1950 level

climate
spin-up dataset (30 years back-to-back)

SPIN-UP 1950 - 1951

historical

bias-corrected GCM data

REPORTING PERIOD 1971-2099

RCPs, GCM data
Reporting Model Results

- **Reporting period:**
  - Validation: 1971-200X but...
  - Future: 1971-2099
- **One variable** should be reported per file. The file naming convention:
  
  \(<modelname>\_<obs>\_<clim_scenario>\_<socio-econ-scenario>\_<sens-scenarios>\_<variable>\_<region>\_<timestep>\_<start-year>\_<end-year>\).nc4

- **Netcdf4**, Single (one-point) timeseries should be reported with the coordinates of the point included in the header information.
  - Example files and scripts that produce empty netcdf-files are available, python script to convert *.csv into netcdf, R-Scripts?
  - Let me know if you need support: reyer@pik-potsdam.de

- **Model Experiment Documentation to be filled in**
7.3 Forest models (regional, stand-level)

7.3 Forest models: Management & forest dynamics

- **business-as-usual (BAU) management** defined by data (e.g. stem numbers) and general management guidelines. Also for future runs.
- A “natural reference run (nat)” without any management has also been included in the experiments. The “nat”-run will help assessing the influence of forest management.

<table>
<thead>
<tr>
<th>Species</th>
<th>Thinning regime</th>
<th>Intensity [% of remaining basal area]</th>
<th>Interval [yr]</th>
<th>Stand age for final harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>pisy</td>
<td>below</td>
<td>20</td>
<td>15</td>
<td>140</td>
</tr>
<tr>
<td>piab</td>
<td>below</td>
<td>30</td>
<td>15</td>
<td>120</td>
</tr>
<tr>
<td>fasty</td>
<td>above</td>
<td>30</td>
<td>15</td>
<td>140</td>
</tr>
<tr>
<td>quro/qupe</td>
<td>above</td>
<td>15</td>
<td>15</td>
<td>200</td>
</tr>
<tr>
<td>pipi</td>
<td>below</td>
<td>20</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>eugl</td>
<td>below</td>
<td>30?</td>
<td>10</td>
<td>40?</td>
</tr>
</tbody>
</table>
7.3 Forest models: Management & forest dynamics

• running simulations until 2100 will result in very old forests.

➡️ If you harvest, please proceed after harvest as your model usually does, e.g. plant the same tree species again or allow for regeneration of the same species.
7.3 Forest models: „Calibration“

- alterations to the model should be reported in the model experiment documentation ➔ understanding of model results.
- model improvement driven by comparison to “PROFOUND TG2” data ➔ avoid & report
- manual or automatic site-specific “tuning” of parameters should be avoided. The same “model” (i.e. also with the same parameter values) should be used in all simulations.
- model development needed to run a model at specific sites is welcomed (e.g. adjustment of phenology model to include chilling effects; fixing parameters for a new species). ➔ document
7.3 Forest models: Disturbances

- If models simulate disturbances (bark beetle outbreaks or storm damage = “dist” runs) that can be switched on and off → experiments to tease out the influence of disturbances (“dist vs. nodist”)
7.3 Forest models: Co2-effects

- increasing CO2 („co2“) and constant CO2 („noco2“) run
### 7.3 Forest models: Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Climate</th>
<th>Scenario</th>
<th>Management</th>
<th>Other Settings</th>
<th>#runs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a) Historical, no disturbances</td>
<td>localclim, princeton, watch, gwsp3, watch+wfdei</td>
<td>-</td>
<td>man, nat</td>
<td>co2nodist</td>
<td>10</td>
</tr>
<tr>
<td>2a) Future, no disturbances</td>
<td>HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, GFDL-ESM2M, NorESM1-M</td>
<td>Rcp2.6, rcp4.5, rcp6.0, rcp8.5</td>
<td>man, nat</td>
<td>co2nodist noco2nodist</td>
<td>80</td>
</tr>
<tr>
<td>1b) Historical, disturbances</td>
<td>localclim, princeton, watch, gwsp3, watch+wfdei</td>
<td>-</td>
<td>man, nat</td>
<td>co2dist</td>
<td>10</td>
</tr>
<tr>
<td>2b) Future, disturbances</td>
<td>HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, GFDL-ESM2M, NorESM1-M</td>
<td>Rcp2.6, rcp4.5, rcp6.0, rcp8.5</td>
<td>man, nat</td>
<td>co2dist noco2dist</td>
<td>80</td>
</tr>
</tbody>
</table>

 ➤ **Large numbers of runs ➤ discuss what is minimum for paper plans**
7.3 Forest models: Input

- The database!
7.3 Forest models: Output

- 26 + 14 optional variables
  - Stand dynamics
  - Carbon stocks and fluxes
  - Water cycles

- per species, dbh_class
### 7.3 Forest models: Output

**Table 31** Variables to be reported by forest models. Abbreviations are provided in Table 33. Variables should be reported as documented in section 6.

<table>
<thead>
<tr>
<th>Long name</th>
<th>units</th>
<th>output variable name</th>
<th>frequency</th>
<th>comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Essential (mandatory) outputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean DBH</td>
<td>cm</td>
<td>per species and stand total</td>
<td>dbh_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Stand Height</td>
<td>m</td>
<td>per species and stand total</td>
<td>height_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Stand Density</td>
<td>Trees/ha</td>
<td>per species and stand total</td>
<td>density_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Basal Area</td>
<td>m²ha⁻¹</td>
<td>per species and stand total</td>
<td>ba_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Volume of Dead Trees</td>
<td>m³ha⁻¹</td>
<td>per species and stand total</td>
<td>mort_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Harvest by dbh-class</td>
<td>m³ha⁻¹</td>
<td>per species and stand total and dbh-class</td>
<td>harv_&lt;<em>species/total&gt;</em>&lt;_dbhclass&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Remaining stem number after disturbance and management by dbh class</td>
<td>Trees/ha</td>
<td>per species and stand total</td>
<td>stemno_&lt;<em>species/total&gt;</em>&lt;_dbhclass&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Stand Volume</td>
<td>m³</td>
<td>per species and stand total</td>
<td>vol_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Carbon Mass in Vegetation biomass (incl. Soil veg. ?)</td>
<td>kg C m⁻²</td>
<td>per species and stand total</td>
<td>cveg_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Carbon Mass in Litter Pool</td>
<td>kg C m⁻²</td>
<td>per species and stand total</td>
<td>clutter_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Carbon Mass in Soil Pool</td>
<td>kg C m⁻²</td>
<td>per species and stand total</td>
<td>csoil_&lt;_species/total&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Tree age by dbh class</td>
<td>yr</td>
<td>per species and stand total</td>
<td>age_&lt;<em>species/total&gt;</em>&lt;_dbhclass&gt;</td>
<td>year</td>
</tr>
<tr>
<td>Gross Primary Production</td>
<td>kg m⁻² s⁻¹</td>
<td>per species and stand total</td>
<td>gpp_&lt;_species/total&gt;</td>
<td>day</td>
</tr>
<tr>
<td>Net Primary Production</td>
<td>kg m⁻² s⁻¹</td>
<td>per species and stand total</td>
<td>npp_&lt;_species/total&gt;</td>
<td>day</td>
</tr>
<tr>
<td>Autotrophic (Plant) Respiration</td>
<td>kg m⁻² s⁻¹</td>
<td>per species and stand total</td>
<td>ra_&lt;_species/total&gt;</td>
<td>day</td>
</tr>
</tbody>
</table>
### 7.3 Forest models: Output

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterotrophic Respiration</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Net Ecosystem Exchange</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per stand</td>
</tr>
<tr>
<td>Mean Annual Increment</td>
<td>m$^3$ ha$^{-1}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Fraction of absorbed photosynthetically active radiation</td>
<td>%</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Leaf Area Index</td>
<td>m$^2$ m$^{-2}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Species composition</td>
<td>%</td>
<td>per ha</td>
</tr>
<tr>
<td>Total Evapotranspiration</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Evaporation from Canopy (interception)</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Water Evaporation from Soil</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per stand</td>
</tr>
<tr>
<td>Transpiration</td>
<td>kg m$^{-2}$ s$^{-1}$</td>
<td>per species and stand total</td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>kg m$^{-2}$</td>
<td>per stand</td>
</tr>
</tbody>
</table>

**Optional outputs**

<table>
<thead>
<tr>
<th>Removed stem numbers by</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trees ha$^{-1}$</td>
<td>per species and stand total</td>
</tr>
</tbody>
</table>
### 7.3 Forest models: Output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Time Unit</th>
<th>Specific in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removed stem numbers by size class by management</td>
<td>Trees/ha</td>
<td></td>
<td>Specific in Table 33</td>
</tr>
<tr>
<td>Volume of disturbance damage</td>
<td>m³/ha⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen of annual Litter</td>
<td>g N m⁻² a⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen in Soil</td>
<td>g N m⁻² a⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Production allocated to leaf biomass</td>
<td>kg m⁻² s⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Production allocated to fine root biomass</td>
<td>kg m⁻² s⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Production allocated to above ground wood biomass</td>
<td>kg m⁻² s⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Production allocated to below ground wood biomass</td>
<td>kg m⁻² s⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root autotrophic respiration</td>
<td>kg m⁻² s⁻¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Mass in Leaves</td>
<td>kg m⁻²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Mass in Wood</td>
<td>kg m⁻²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Mass in Roots</td>
<td>kg m⁻²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature of Soil</td>
<td>K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: If you cannot provide the data at the temporal or spatial resolution specified, please provide it the highest possible resolution of your model.

Please contact the coordination team (isi-mip@pik-potsdam.de) for any further clarification, or to discuss the equivalent variable in your model.
Timeline

• First simulations for Peitz, KROOF start immediatly
• Experiments 1a 2a are priority
• Finish database for 5-6 sites which are already close to be finished (end of march)
• Finish database for all sites until mid-may
• Simulations for other sites May/June
• Mid July deadline for submitting simulation results
• Meeting in September

• Use TG3 mailing list
• Send paper abstracts by 30march ➔ discuss overlap and which variables needed and send back to whole group in mid april requestion optional variables
• CR: prepare mail with all information (link to package, DB, presentations...)
Protocol comments

- P36 examples for forests
- Disturbances?
- Package include R-script for *.csv to netcdf4
- Spin-up for localclim

- Future experiments:
  - Disturbance scenarios
  - Management scenarios
  - Artificial climate extreme time series (check with Carbo extreme)
Database comments

- Nitrogen deposition? David to check if CEH could provide Nitrogen deposition data for each plot? CR to check at PIK
- Flux-data latest version?
- Fill Gaps
- Metadata/data description
- Rename pgfv2 ➔ Princeton
- Collelongo ➔ Alessio? Send to Ramiro for checking
Thank you and be prepared to participate actively!

More info:
reyer@pik-potsdam.de
http://www.cost.eu/domains_actions/fps/Actions/FP1304
http://cost-profound.eu/site/
http://www.isi-mip.org/