The ISIMIP fire sector

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Outline

- Intro: FireMIP and reasons to join ISIMIP

- Plans for simulations within ISIMIP

    - Protocol

    - Fire sector specific output variables

    - Model documentation

- Open points in the protocol:

    - daily variables?

    - Extended simulations?

- Ideas for manuscripts

Fire Model Intercomparison Project (FireMIP)

- Initiated by Almut Arneth, Sandy Harrison, Stijn Hantson
- International initiative to compare and evaluate existing global fire models against benchmark data sets for present-day and historical conditions.
- Systematically understand and decrease uncertainty in fire model projections

Phase 1 provided simulations from 1700-2013

Major outcomes:

- Emission datasets for atmospheric modelling (van Marle et al. 2017, Li et al. 2019)
- Evaluation/Benchmarking (Forkel et al. 2019, Hantson et al. 2020)
- Sensitivity to forcing factors over the historical period (Teckentrup et al. 2019)
- Impact of fire on vegetation and the carbon cycle (Lasslop et al. 2020)

Reasons to join ISIMIP

- No fire regime projections with state of the art fire model ensemble exists

- Limited resources to prepare input data, bias correction of climate not trivial

ISIMIP:

- Availability of forcing data and experience with future projections

- Increased visibility and possibility to share data across sectors

- Future fate of fire regimes is important for various sectors

Simulations

- First focus on ISIMP 2b protocol

    - Reasons: Land use input is available, land use is a major uncertainty in fire simulations

- ISIMIP 3a would be interesting for attribution studies (counterfactual climate)

ISIMIP 2b fire sector protocol

Based on biome sector protocol

Simulations to separate out

1) effects of climate change (comparison to simulation with preindustrial climate and between different RCPs)

2) effects of CO2, in simulations with CO2 fixed at the value of 2005

3) effects of changes in socioeconomic factors (simulations with socioeconomic factors fixed at year 2005)

- **additionally to biome sector protocol:** simulations to separate out the effect of population density and land use change (fixed at 2005 level)
- no simulations for RCP8.5 as land use data not available (focus on RCP 2.6 and 6)
- do we need the extensions after 2100?

Fire sector specific output variables

Variable	Specifier	Unit	Resolution
Burnt Area Fraction	burntarea<pft/total>	%	0.5° grid daily, monthly
Burnt Area Fraction from Fire mediated land-cover change	burntareaLUC<total>	%	0.5° grid, monthly
Carbon Mass Flux into Atmosphere due to C Emission from Fire	ffire-<pft/total>	kg m-2 s-1	0.5° grid, monthly
Carbon Mass Flux into Atmosphere from Fire mediated land-cover change	ffireluc-<total>	kg m-2 s-1	0.5° grid, monthly
Fireline intensity	fireints-<total>	kW m^{-1}	0.5° grid, monthly
Carbon in different fuel classes	cfuelxxx-<total>	kg m-2	0.5° grid, monthly
Combustion completeness in different fuel classes	ccfuelxxx-<total>	1	0.5° grid, monthly
Fuel moisture for different fuel classes	mfuelxxx-<total>	1	0.5° grid, monthly

Fire sector specific output variables

Variable	Specifier	Unit	Resolution
Number of fires	firenr-<total>	km-2	0.5° grid monthly
Fire-caused tree mortality	Firemortality <pft/total>	1	0.5° grid, monthly
Mean fire size	firesize-<total>	km-2	0.5° grid, monthly
Mean fire duration	fireduration<total>	s	0.5° grid, monthly
Mean rate of spread	fireros-<total>	m s^{-1}	0.5° grid, monthly
Iginitions - human caused	ignhuman-<total>	km-2	0.5° grid, annual
Iginitions - lightning caused	ignlight-<total>	km-2	0.5° grid, monthly
Carbon emitted from peat fires	ffirepeat<total>	kg m-2 s-1	0.5° grid, monthly

Daily output

- Crucial for looking into

  - Extremes

  - Changes in fire season length

- But: large data volume, difficulties in postprocessing

- Updated protocol: daily output only for burned area fraction

  - Per PFT?

  - Or per natural vegetation, pasture+rangelands, croplands?

  - Only for 30 years present day and end of century?

- Emissions possible?

  - Resolution important for aerosols (Marlier et al. 2014) –> air quality or atmospheric modelling applications

  - Only per gridcell values needed

- Add monthly maximum fire size, rate of spread?

Model documentation

- What are the **main components of burned area computation**?

- Which **sources of ignition** are included?
- Is fire ignition implemented as a random process?
- Is human influence on fire ignition and/or suppression included? How?
- If human ignitions are included for which conditions are the ignitions highest/lowest?

- How does **fire spread**?
- How is **fire duration** computed?

- How does the model compute **fuel load**?
- List of fuel types
- **Fuel moisture** linked to soil moisture/air humidity/precip?
- Which carbon pools are **combusted**?
- Is the **combustion completeness** constant or depends on what (fuel type, moisture?)

Model documentation

- **Land-cover classes** allowed to burn

- Are **peatland** fires included?

- Are **deforestation** or land clearing fires included?

- If croplands and pastures/rangelands burn, how are they different from grasslands, does the fire model differ for this PFT?

- **Vegetation fire mortality**: is it constant/constant per pft/depends on (for instance fire intensity, bark thickness, veg height)

- What **input datasets** are used in the fire model and what are they used for?

- What is the **time step** of the fire model?

- What is the **time step** of the exchange between fire and vegetation model? e.g. are carbon pools and cover fractions updated every day?

- What is the **minimum/maximum burned area** fraction at grid cell level? Over which time period?

Ideas for manuscripts

- How will fire regimes change in future? What are the drivers?
- Future impact of fires on ecosystems (vegetation, carbon cycle)
- Fire impact on society
- Future fire emissions and their impacts on radiation and climate
- short-term (e.g. seasonal) impacts of future fires
- Extremes: can we simulate extremes? In which regions will extreme events become more frequent?
- Shrub/woody encroachment (Inter-sectorial with biomes sector?)
- Fire suppression? (additional simulations, simple technical solution 1 year no fire, 5 years no fire)
- Afforestation scenarios- resilience of carbon stocks in afforested regions to future fire (Inter-sectorial study with biomes sector?)
- Impacts of fire regime changes (prescribed present day fire regimes: possible for all modellig groups?)

Time plan

- Finalize protocol 2b until end of month

- First simulations until beginning of September?

- First preliminary analysis until FireMIP workshop 20-22 October, 2020

- Over the next weeks: get in touch with modelling groups outside FireMIP (also fire models without DGVM, statistical models: do they diverge from DGVM projections?)

- Over the next months: start advertise the simulations to find people who may want to use them

    - Atmospheric modeller

    - Ecologists

    - Pyrogenic carbon community

    - Paleo community?

    - Any more ideas?