Interactive INFERNO

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Overview

1. Why is fire important
2. Introduction to INFERNO
3. Modifications
4. Results
Why is fire modelling so important?

1. Fire effects vegetation dynamics, atmospheric chemistry, carbon cycle, hydrological cycle
2. Increased risk of fire with hotter, drier conditions
3. Continued pressure of land-use change, using fire
4. Fire modelling is in it’s infancy ->
   Low agreement and high uncertainty around future fire frequency

Worldwide, annual burned area reaches approximately 350 million hectares per year, and resultant CO₂ emissions can exceed 50% of fossil fuel emissions (Jolly et al, 2015)
Currently fire is represented as a constant disturbance in most ESMs.
INFERNO

INteractive Fire and Emission algoRithm for Natural envirOnments
INFERNO (INteractive Fire and Emission algoRithm for Natural envirOnments)

Fire model implemented into JULES Vn4.5 as a diagnostic of burnt area
Functional dependencies

- Flammability vs. Temperature (K)
- Flammability vs. Precipitation (mm s\(^{-1}\)\times 10\(^{-5}\))
- Flammability vs. Relative Humidity (%)
- Flammability vs. Soil Moisture (fraction of saturation)
- Flammability vs. Fuel Density (kg C m\(^{-2}\))
- Ignitions km\(^{-2}\) month\(^{-1}\) vs. Population Density (ppl km\(^{-2}\))
Fig. 2. 1997-2010 mean yearly burnt fraction (above) and emitted carbon (below, in kg m\(^{-2}\)). Shown for INFERNO on the left (with CRUNCEP meteorology and interactive ignitions: mode 3) and for GFED on the right.
INFERNO (INteractive Fire and Emission algoRithm for Natural envirOnments)

- Vn 4.8 now includes interactive fire, with dynamic vegetation
Output from INFERNO

Diagnostics
- Flammability
- Burnt area (fraction of gridbox)
- Emitted Carbon (KgC/m2/s)
- Carbon Dioxide (KgC/m2/s)
- Carbon Monoxide (KgC/m2/s)
- Methane (KgC/m2/s)
- Nitrogen Oxides (KgC/m2/s)
- Sulphur Dioxide (KgC/m2/s)
- Organic Carbon (KgC/m2/s)
- Black Carbon (KgC/m2/s)

For:
- PFTs
- GB aggregate
- DPM
- RPM

Interactive
- Fire disturbance (fraction of gridbox)
- Fire disturbance (per pft)
- Burnt carbon DPM
- Burnt carbon RPM
- Fire emissions from vegetation (fraction of gridbox)
- Fire emissions from vegetation (per pft)
- Burnt vegetation carbon
TRENDY runs, fraction of broadleaf tree

- S2 (CO2 & climate)
- S3 (CO2, climate & LUC)
- S3 + fire

Years: 1860, 1880, 1900, 1920

Legend:
- Amazon Forest
- Cerrado
- Atlantic Forest
- WWF Biome and ecoregions

www.metoffice.gov.uk
TRENDY runs, fraction of broadleaf tree

S2 (CO2 & climate)

S3 (CO2, climate & LUC)

S3 + fire

1950

1960

1970

1980

WWF Biome and ecoregions
TRENDY runs, fraction of broadleaf tree

S2 (CO2 & climate)

S3 (CO2, climate & LUC)

S3 + fire

1990

2000

2010

2015

WWF Biome and ecoregions

Amazon Forest

Caatinga

Cerrado

Atlantic Forest

S2 + fire 2015

Legend

Tropical and subtropical grasslands, savannas, and shrublands

Tropical and subtropical forest

Tropical Broadleaf and Broadleaf Mixed Forest

Terrestrial Broadleaf and Mixed Forest

Temperate Broadleaf and Mixed Forest

Savannas, Grasslands, and Shrublands

Polar, Alpine, and永久冻土

Mediterranean Forest, Woodlands, and Shrublands

Deserts and Arid Shrublands

Wetlands

Lakes

Rock and ice
Summary

- Fire impacts many parts of the Earth system
- INFERNO now coupled to vegetation
- Needs tuning
- Good in some areas, too high in others
- More work to understand processes & response in PFTs