Coupling interactive fire with atmospheric composition and climate in the UKESM

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Coupling framework

INFERNO

Fuel Density
Goff-Gratch saturation vapour pressure
Soil Moisture
Flammability
Ignition
Burnt Area
Emissions

Atlantic Composition
Chemistry
Aerosols
(aerosol-cloud interactions)

Fire weather conditions
Precipitation
Temperature
Relative Humidity
Cloud-ground Lightning

\[ CO, NO_x, C_2H_6, C_3H_8, HCHO, MeCHO, Me2CO, NH_3, DMS, OC \text{ and } BC \]
Burnt area fraction (%) mean annual average (1997 - 2010)

- Global pattern of the annual average burnt area fraction is well reproduced
- Global pattern correlation of 55.3 %
- Large (50%) underestimation of the fires over Africa (even more over Australia)
Biomass burning emissions (kg m⁻²) mean annual average (1997 - 2010)

- Global pattern well reproduced
- Large overestimation of the biomass burning emissions
  - NHAF
  - SHAF – emissions extend further south
  - SHSA – large bias on the eastern edge
- Underestimation over the peatland regions (e.g. Indonesia and boreal regions)
Summary

- Coupling a fire model to UKESM1 results in a similar performance in reproducing the distribution of aerosols and CO atmospheric column.

- Limitations of current set-up
  - No fire-vegetation feedbacks
  - Peat fires are not represented
  - Underlying vegetation bias can have a significant impact in modelled results

- This shows that we have developed a useful coupling framework that allows the representation of complex fire-composition-climate interactions and feedbacks in the Earth system

Future work

- Include fire-vegetation feedbacks - brings improvements to Africa and South America
- Include representation of peatland fires - impact in the northern hemisphere
- Study and quantify the impacts of fire in climate change scenario and on atmospheric composition-climate interactions