How do terrestrial vegetation emissions change under the changing climate and human pressures?

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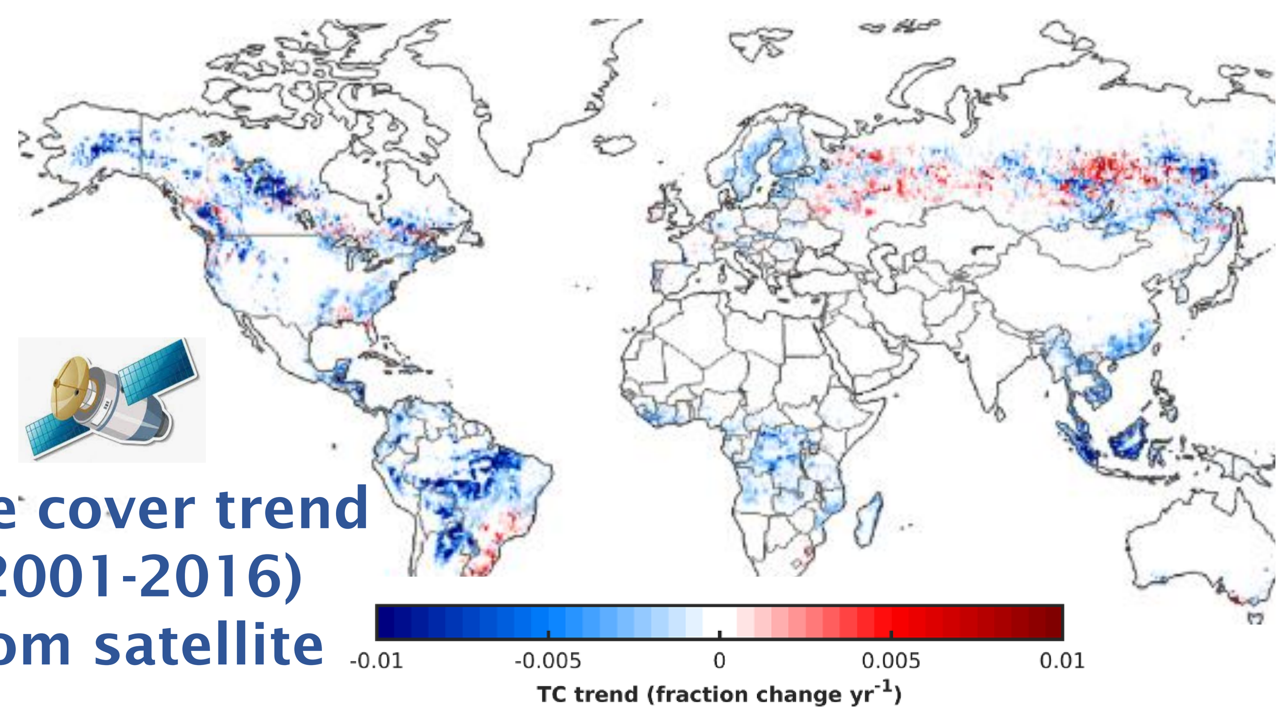
Introduction

- **The terrestrial vegetation emits** substantial amounts of hydrocarbons into the atmosphere with **isoprene (C_5H_8)** being the most prominent.
- Isoprene reduces the oxidizing power of the atmosphere and therefore **increases the lifetime of methane.** It contributes to the **formation of ozone and aerosols**, prime agents of Earth's radiative forcing.
- Because of their role in air quality and climate, **isoprene emissions and how they are affected by the warming climate and land use changes** are issues of prime importance addressed at BIRA-IASB.

Methods

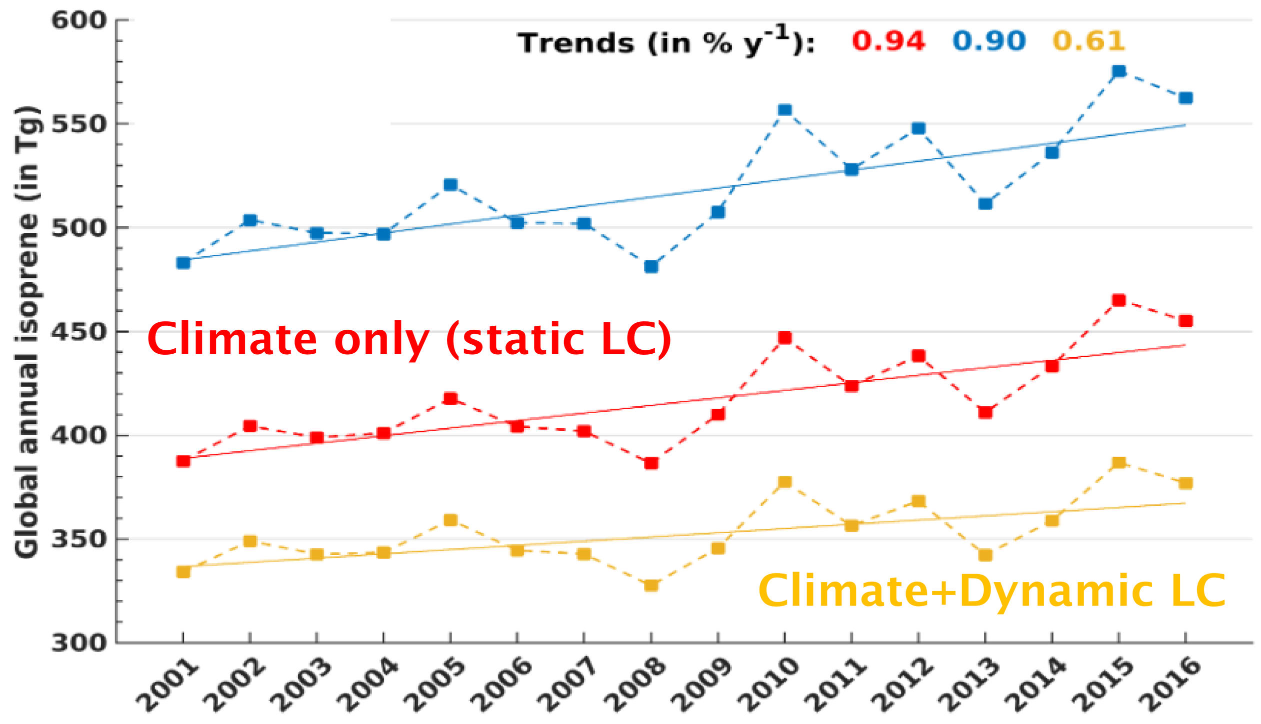
- **Biogenic emission models** (MEGAN-MOHYCAN, Opacka et al. 2021)
- **In-house atmospheric models** at regional/global scale (IMAGES/MAGRITTE, Muller et al. 2018)
- **Inverse models** to assess the evolution of isoprene emissions based on satellite data (Bauwens et al. 2016)
- **Satellite data of formaldehyde (HCHO).** HCHO is formed in the oxidation of isoprene in the atmosphere, and can be used as a proxy for isoprene fluxes (Stavrakou et al. 2018)
- **Satellite land cover (LC)** to help assess the effects of deforestation (Opacka et al. 2021)

What drives the isoprene emissions and their trends?



Tree cover trend (2001-2016) from satellite

Evolution of global total isoprene emissions (Opacka et al. 2021)

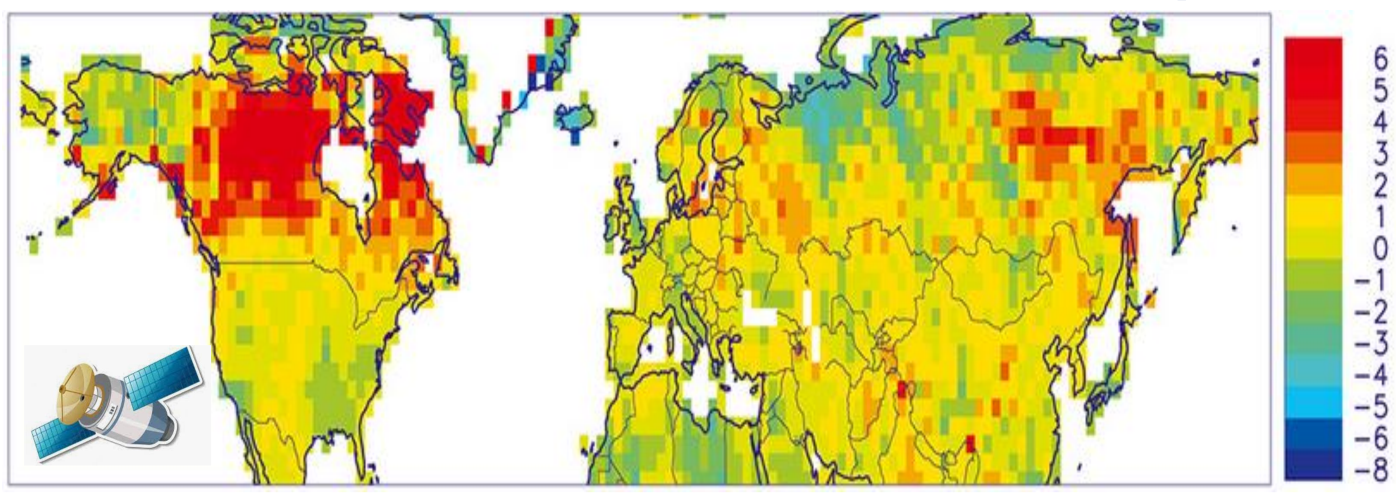


- **Strong positive trends of isoprene emissions (0.94 %/yr) driven by the warming climate.**
- **The impact of land cover changes is a mitigating effect (0.61%/yr).**
- **The difference is due to the negative trends in tree coverage, esp. for tropical broadleaf trees.**

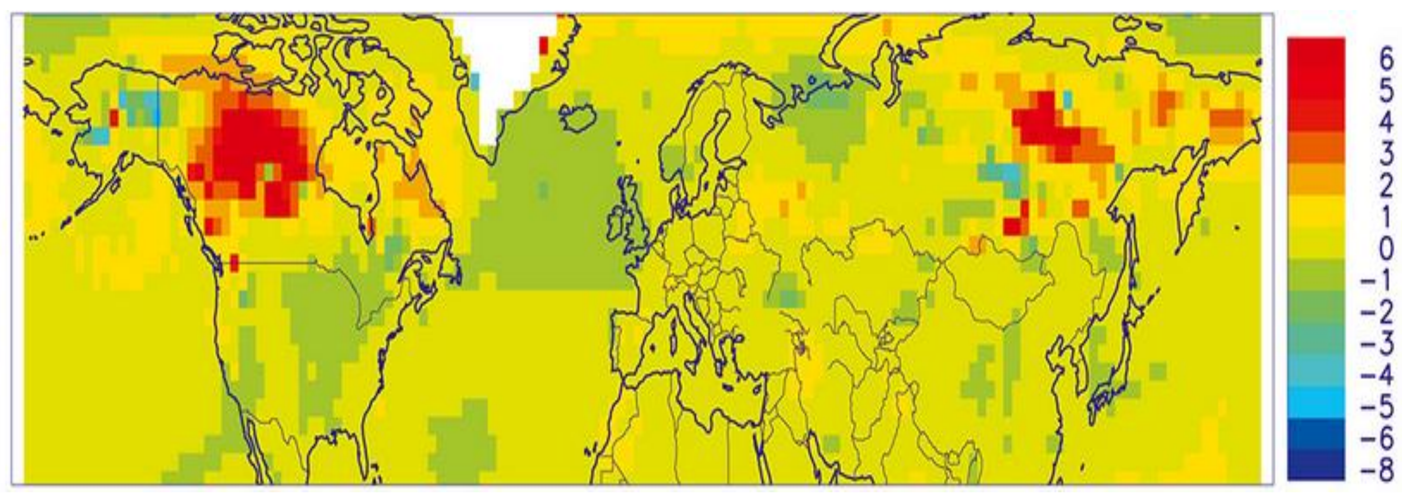
Do models reproduce the response of biogenic fluxes to changing climate?

Long-term satellite data reveal clear evidence that HCHO observations reflect climate variability and its trends over forested areas (Stavrakou et al. 2018)

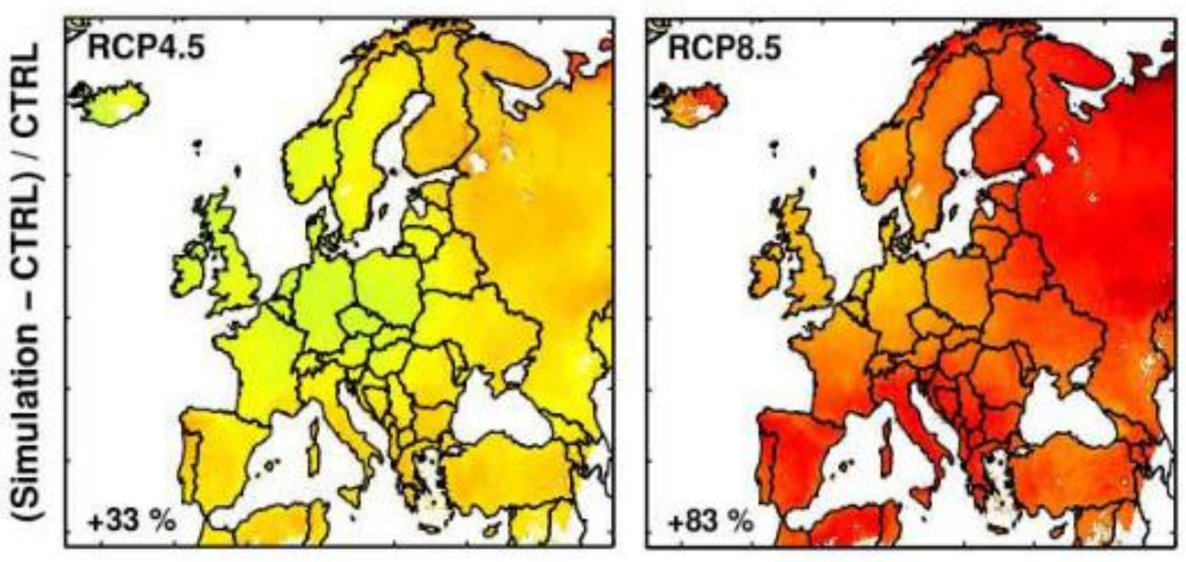
Satellite HCHO trend 2005-2015 (%/yr)



Modelled HCHO trend (%/yr)



How do biogenic fluxes evolve under different climate scenarios?



Bauwens et al. 2018

- **Meteorology from ALARO climate model**
- **Isoprene emissions increase by +33 % (RCP4.5), +83 % (RCP8.5), compared to the control run**
- **Even stronger increases when considering the impact of CO_2 fertilization: +141 % (RCP8.5)**

Conclusions and ongoing work

- **Large increases in biogenic fluxes due to global warming**
- **Long-term satellite data (e.g. ESA CCI projects) and models allow to assess the evolution of biogenic fluxes, a key uncertainty in climate models**
- **Particular focus on tropical forests, where 80% of the global biogenic emissions occur (BRAIN-be EQUATOR project)**

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