



SEEDS - Sentinel EO-based Emission and Deposition Service

SEEDS Approach to Bottom-up BVOC Emissions



NILU, Norway: Paul D. Hamer, Islen Vallejo, Miha Markelj, Sabine Eckhardt, Gabriela Sousa-Santos, Leonor Tarrason, BOKU, Austria: Heidi Trimmel

CNRM, France: Jean-Christophe-Calvet, Bertrand Bonan, Catherine Meurey,, Joaquim Arteta, Nicholas Frebourg, Virginie Marécal

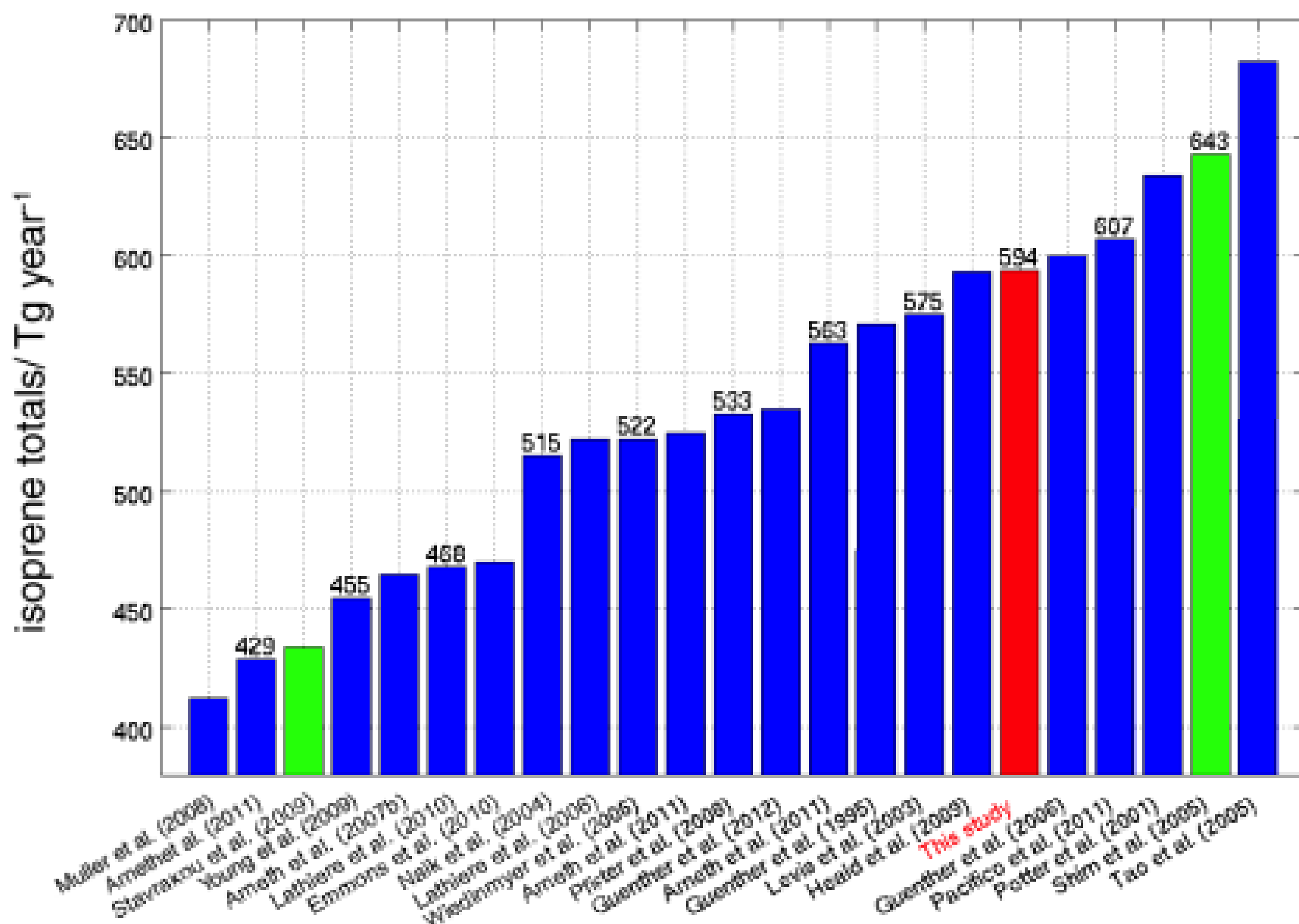
Charles University, Czech Republic: Kateřina Šindelářová

Meteorological Institute of Norway: David Simpson



Koninklijk Nederlands
Meteorologisch Instituut
Ministerie van Infrastructuur en Waters

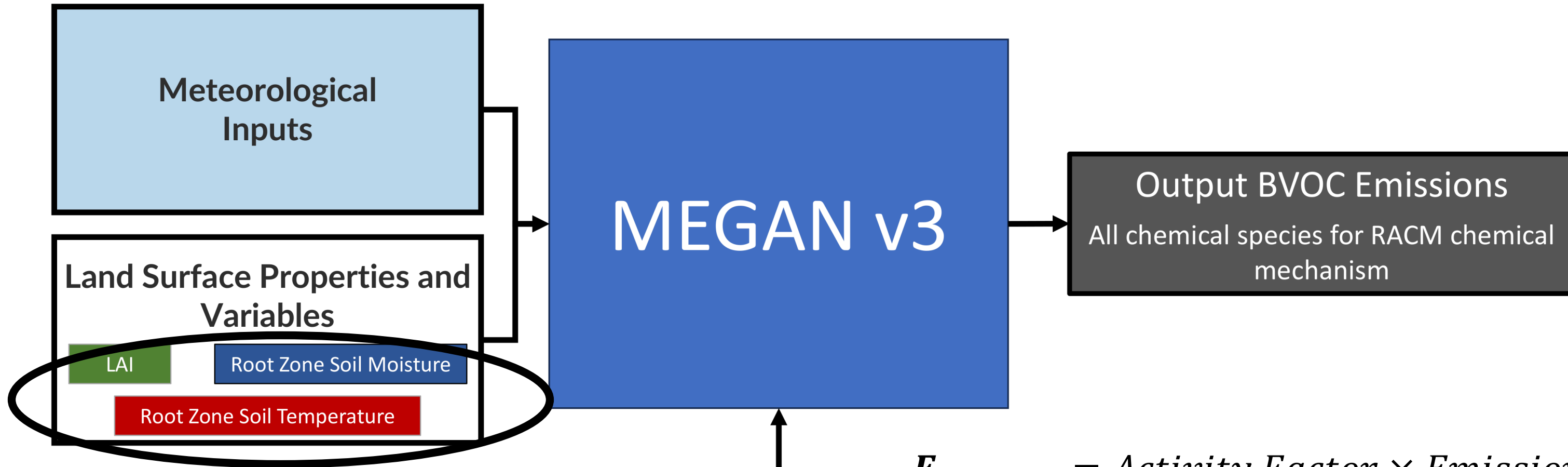




Sindelarova et al., Global data set of biogenic VOC emissions calculated by the MEGAN model over the last 30 years, Atmospheric Chemistry and Physics, 2014.

- Large range in global isoprene emissions in the published literature.
- High uncertainty in estimation of global isoprene emissions over the 1980-2010 period.
- Uncertainty arises from:
 - Different models
 - Different input datasets
 - Complex problem with insufficient direct measurement of BVOCs.

Motivation and Hypothesis

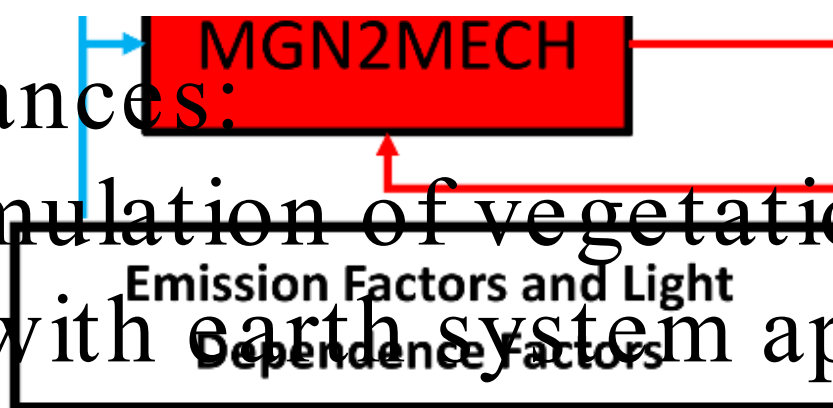


$$F_{isoprene} = Activity\ Factor \times Emission\ Factor$$

$$Activity\ Factor_{isoprene} = LAI \times g_{TP} \times g_{CO_2} \times g_{LA} \times g_{HW} \times g_{AQ} \times g_{HT} \times g_{LT} \times g_{SM} \times LDF$$

Emission Factors Derived from Mapping of Emitted Species

- Targetted advances:
- Dynamic simulation of vegetation supported by data assimilation of LAI couple with earth system approach
 - Attempt to increase spatial and temporal resolution relative to existing datasets.
 - Continuous data coverage for each hour and day in each year.

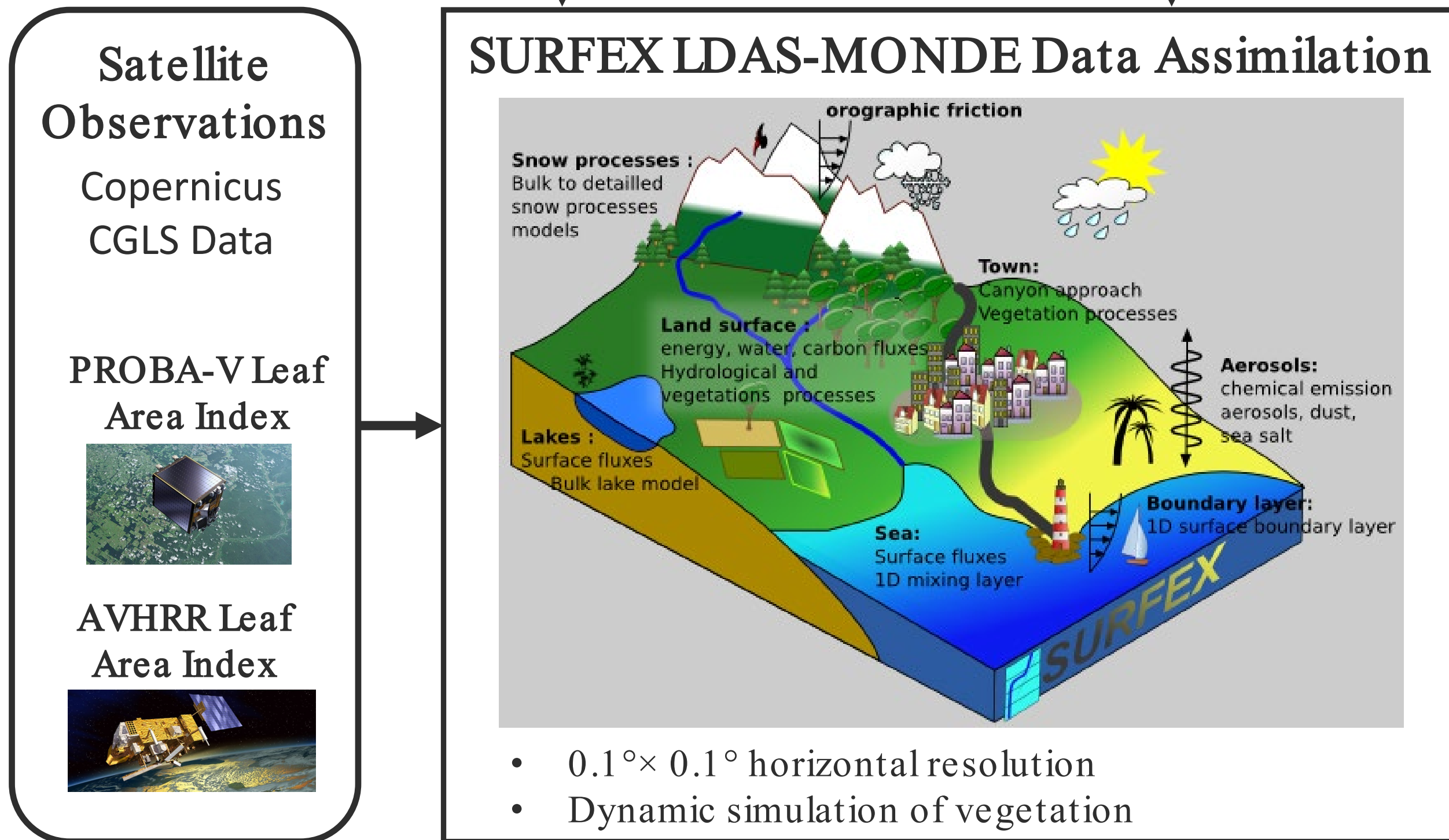


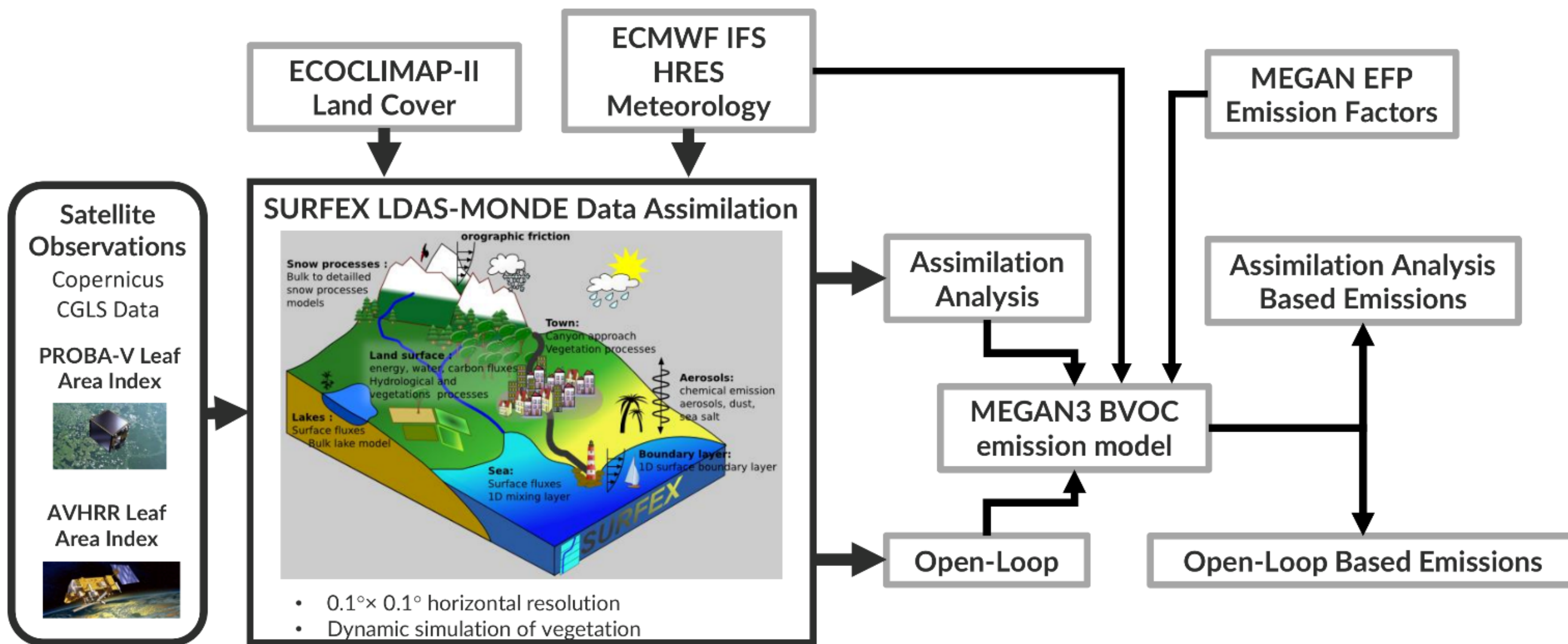
Temperature, humidity class activity factors

MEGAN_EF Python Code

Output BVOC Emissions
All chemical species for RACM chemical mechanism

SEEDS Land Surface Modelling Setup





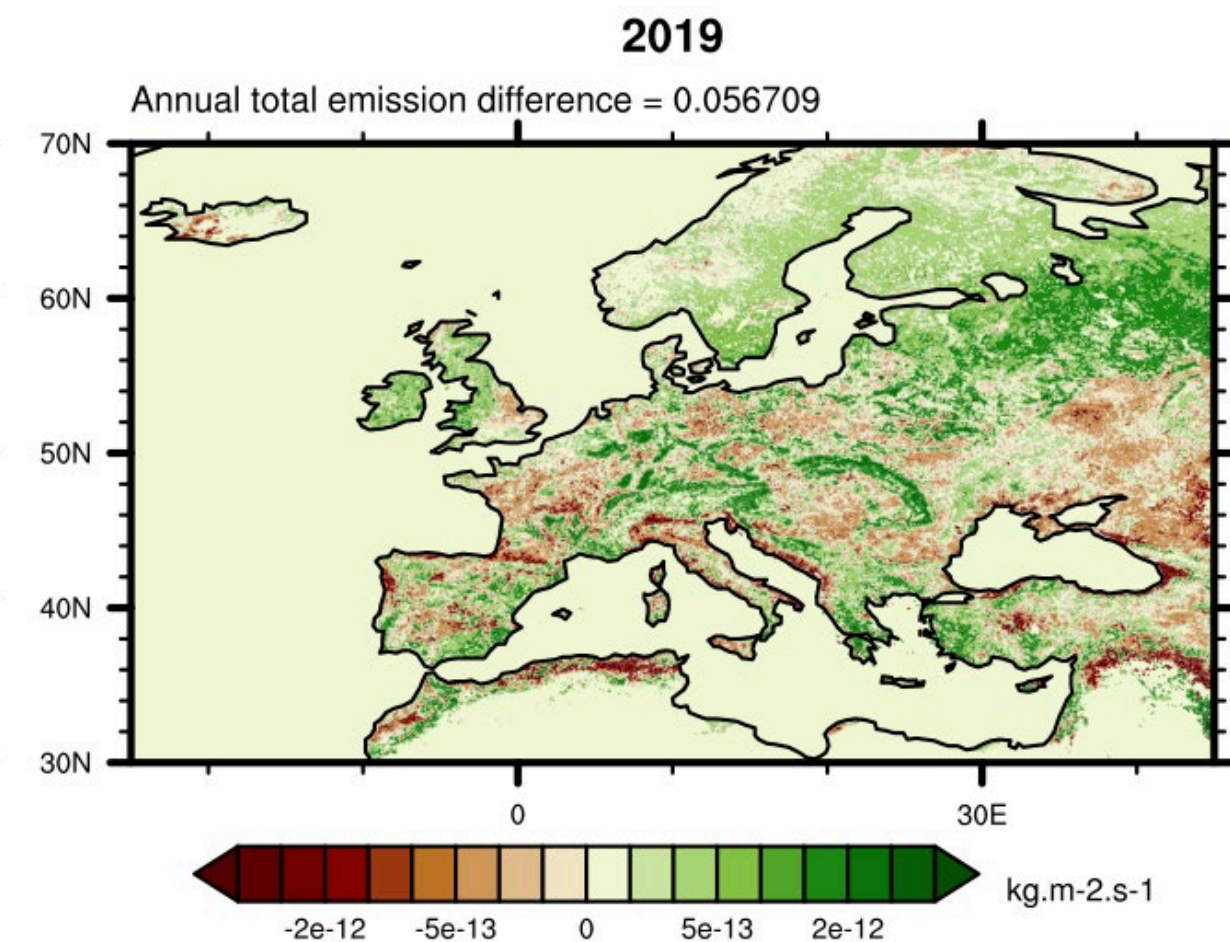
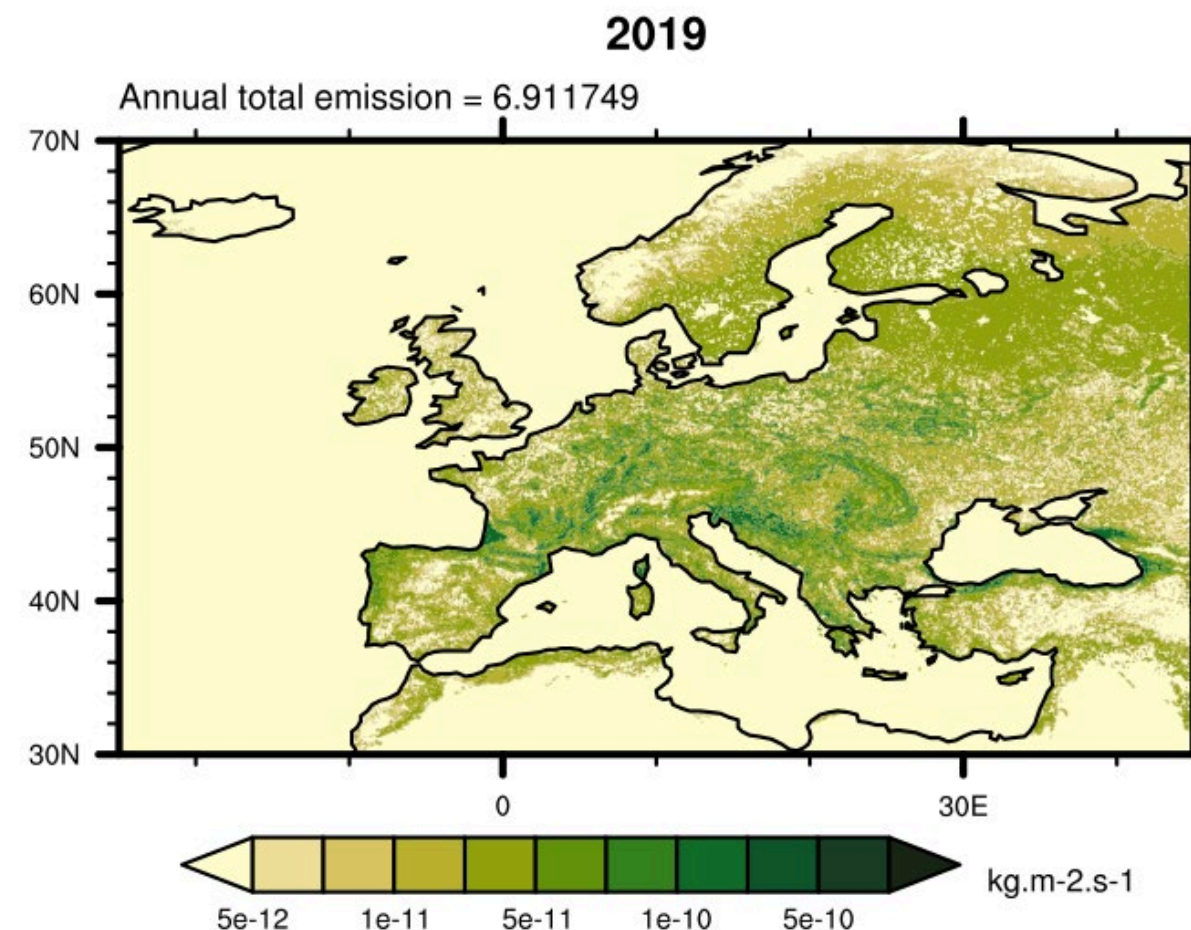
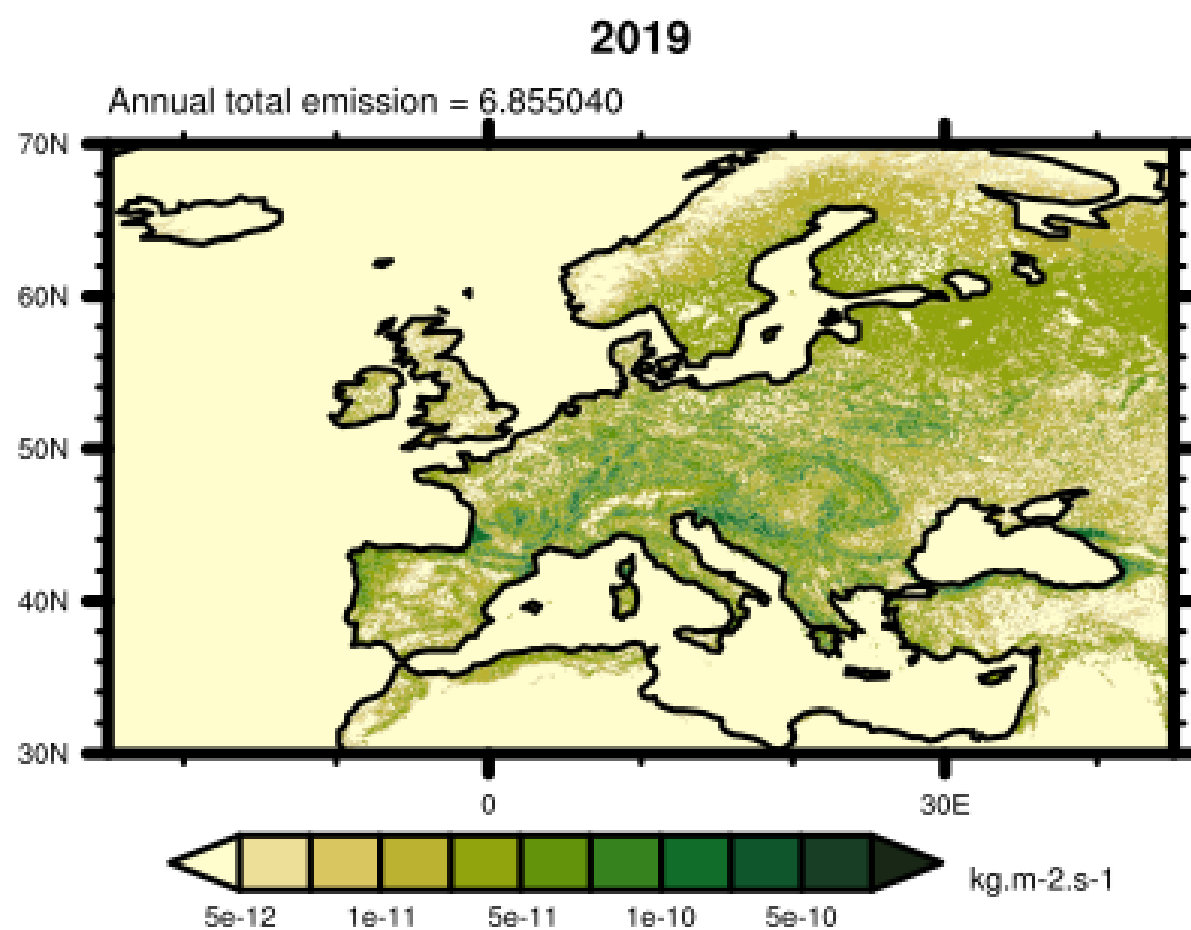
- Open-loop based emissions – 2018-2022.
- LAI assimilation analysis based emissions – 2018-2020.

Annual Mean Isoprene Maps

Open-Loop (No DA)

LAI Data Assimilation Analysis

LAI Analysis minus OL



- Assimilation analysis causes minor changes when averaged over the whole domain.
- Relative differences can be significant.
- Regional differences can be much more significant particularly on shorter timescale.

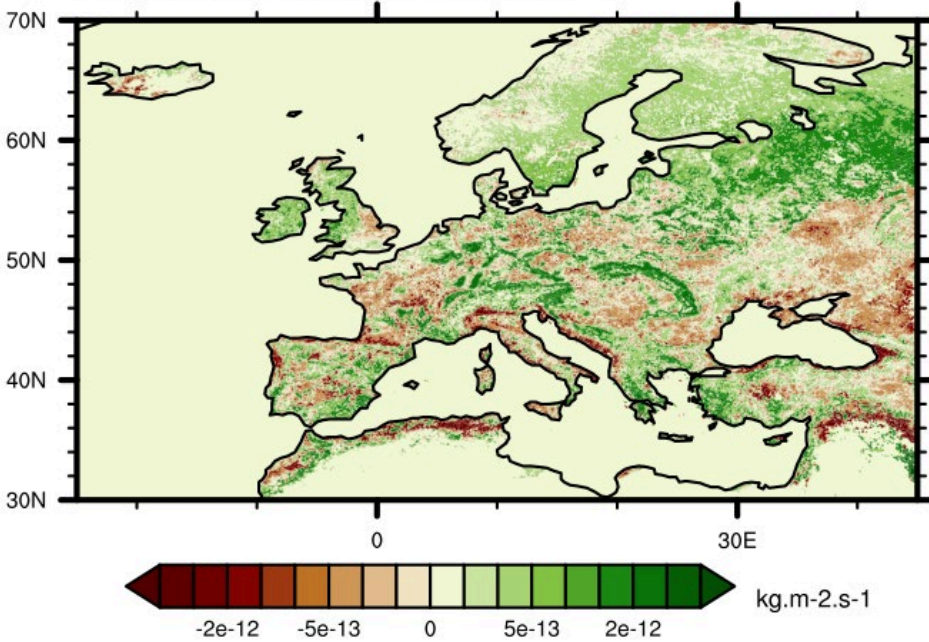
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

Isoprene Emission

2019

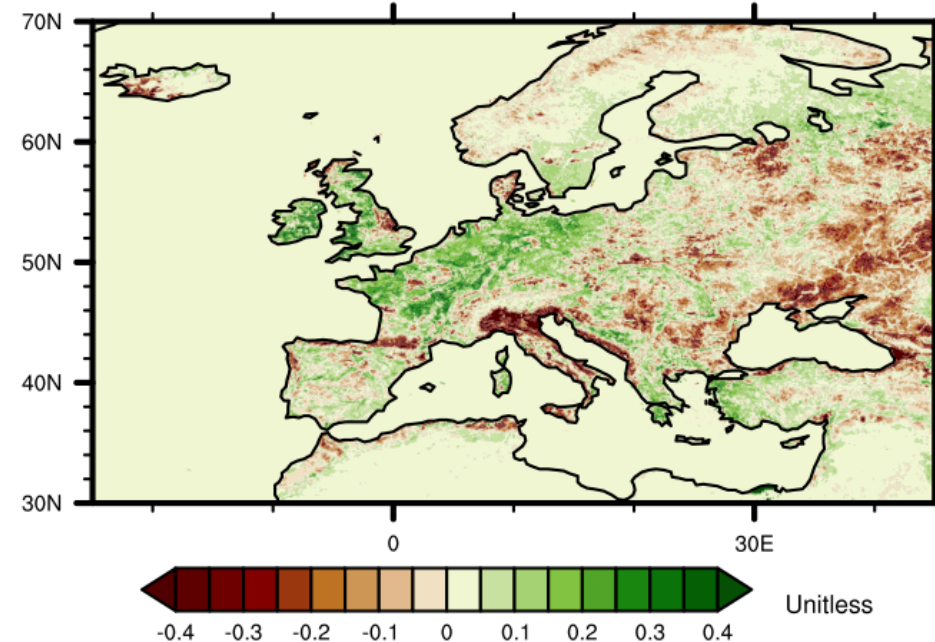
Annual total emission difference = 0.056709



LAI

2019

Monthly total emission = -0.000821



- Areas affected by LAI assimilation increments only partially correlate to net changes in emissions.
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 - Reduced surface temperature.
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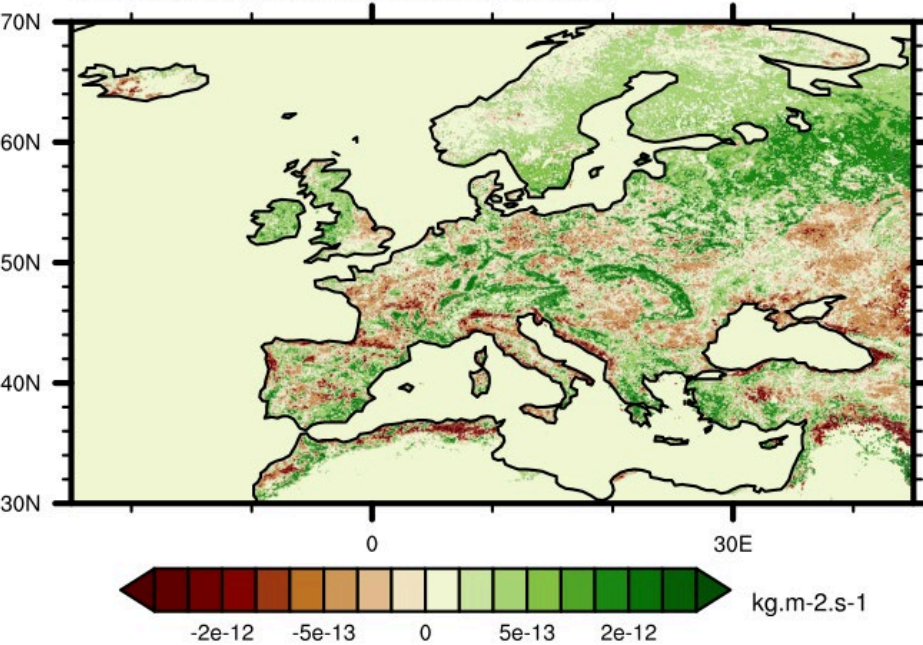
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

Isoprene Emission

2019

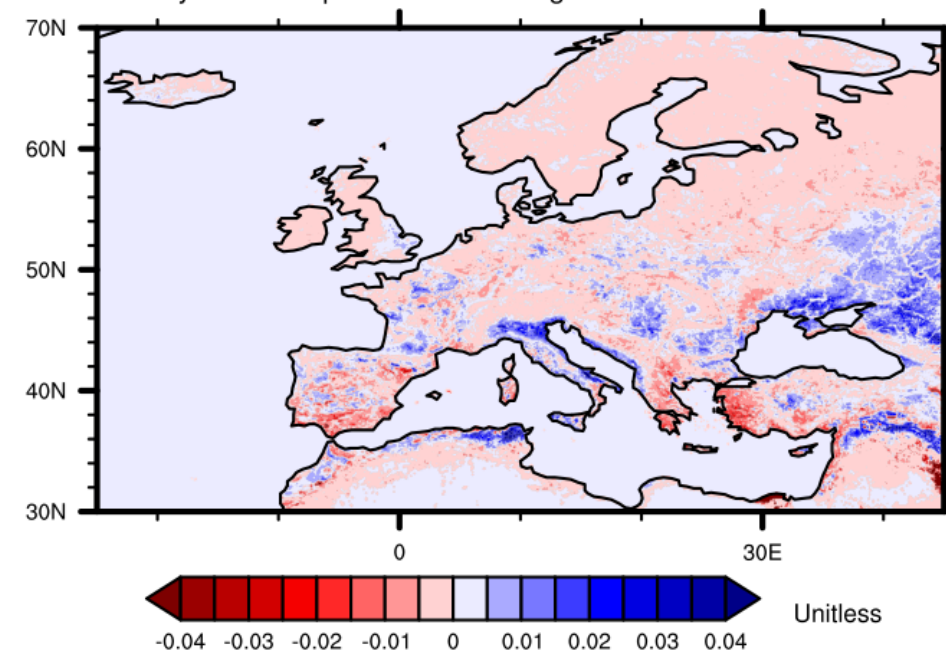
Annual total emission difference = 0.056709



Temp-Rad

2019

Monthly mean temperature-radiation gamma difference = -0.000024



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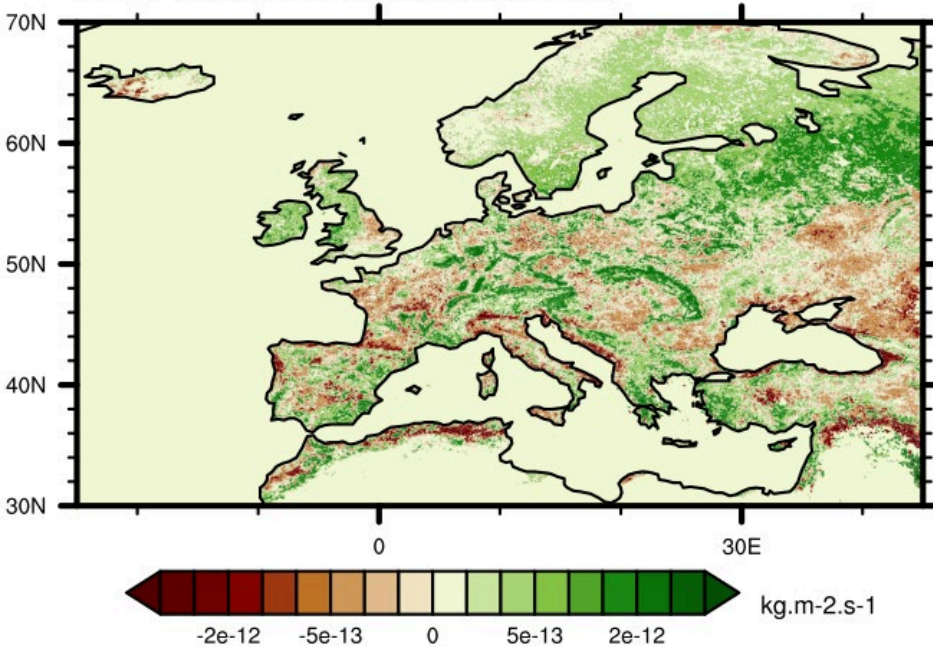
Annual Mean Isoprene Maps

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Isoprene Emission

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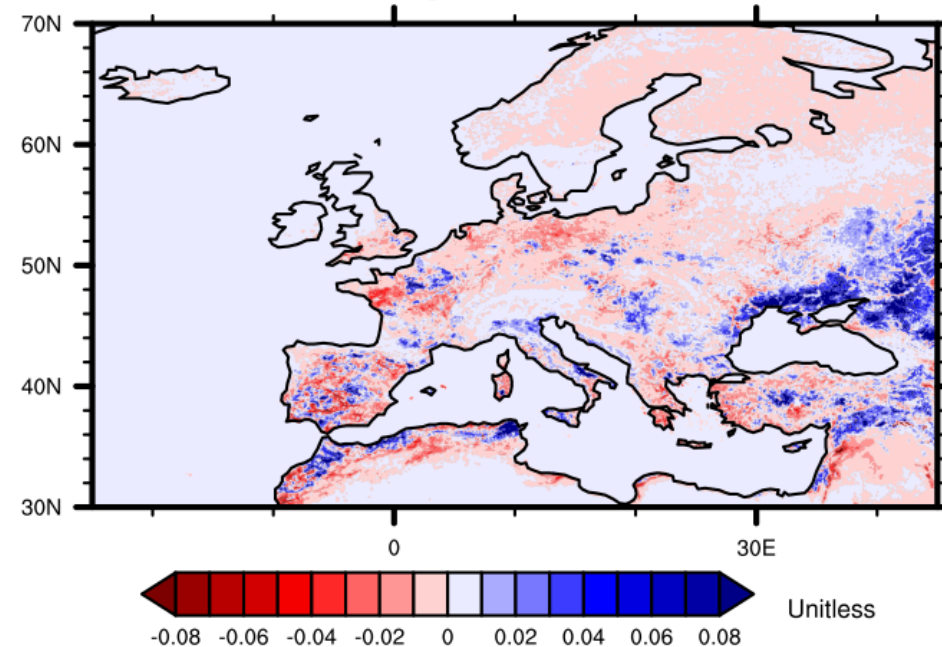
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Soil Moisture

2019

Annual mean soil moisture gamma difference = 0.001146



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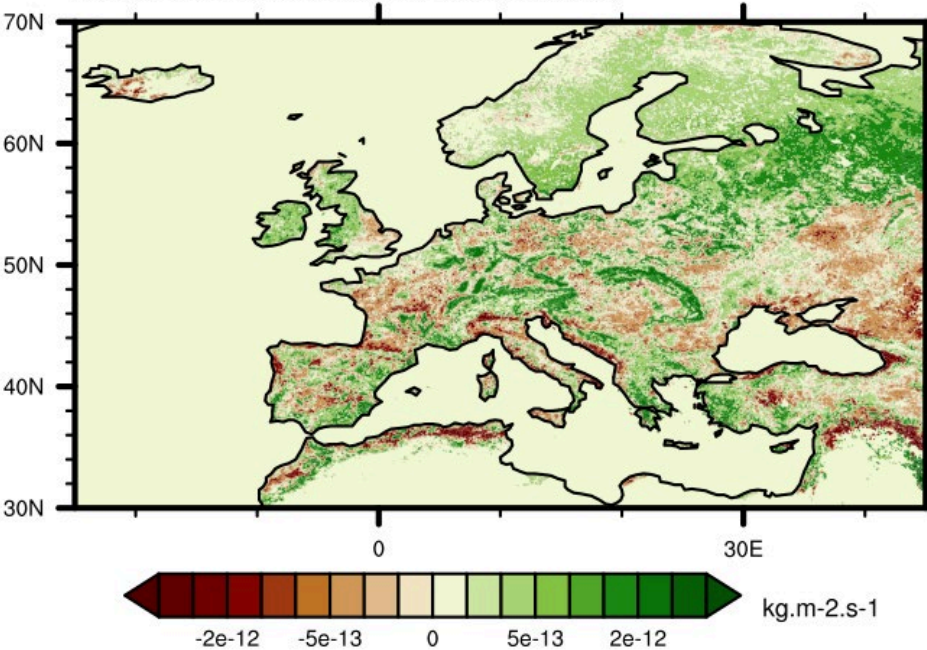
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

Isoprene Emission

2019

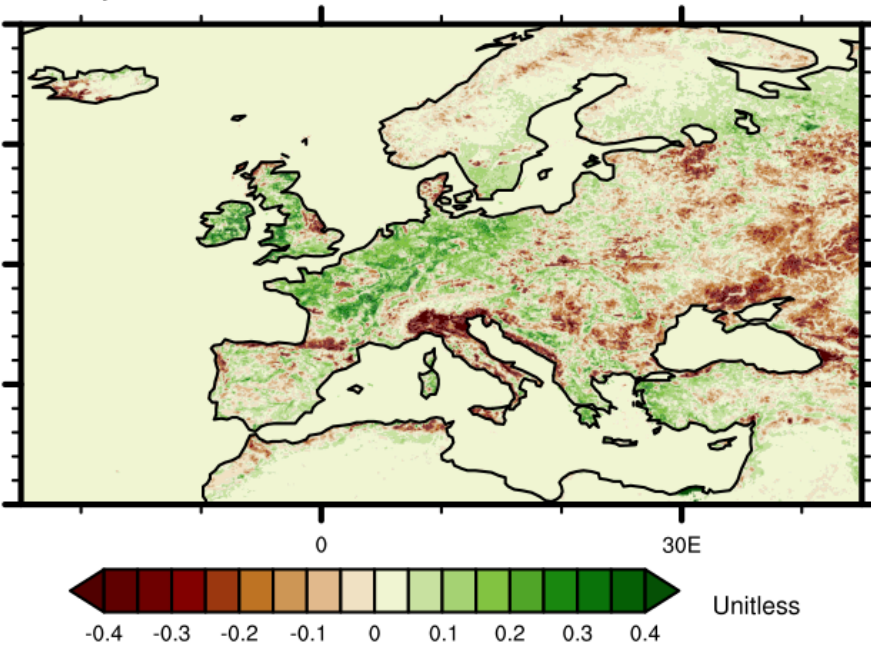
Annual total emission difference = 0.056709



LAI

2019

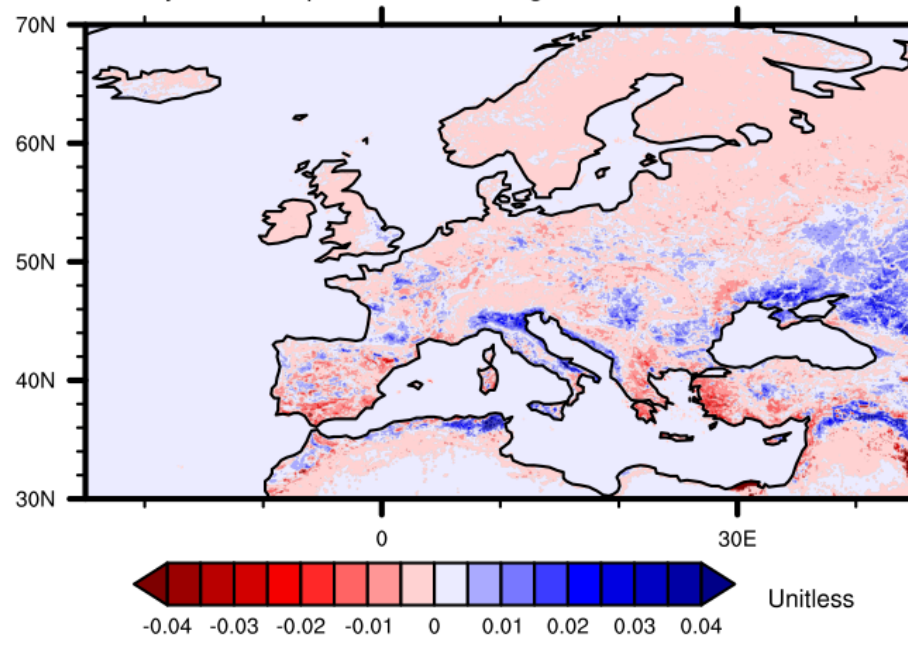
Monthly total emission = -0.000821



Temp-Rad

2019

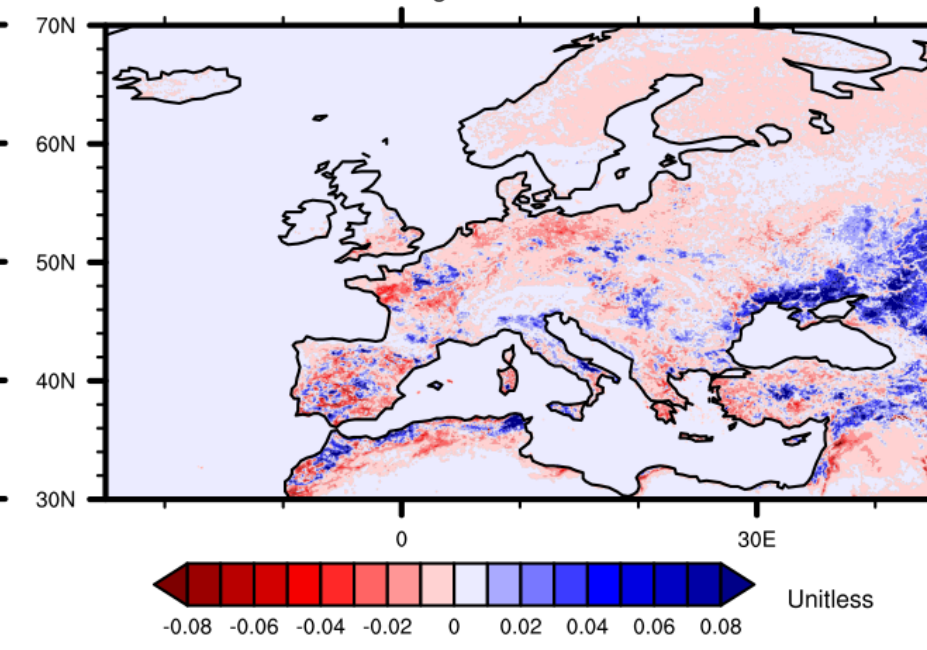
Monthly mean temperature-radiation gamma difference = -0.000024



Soil Moisture

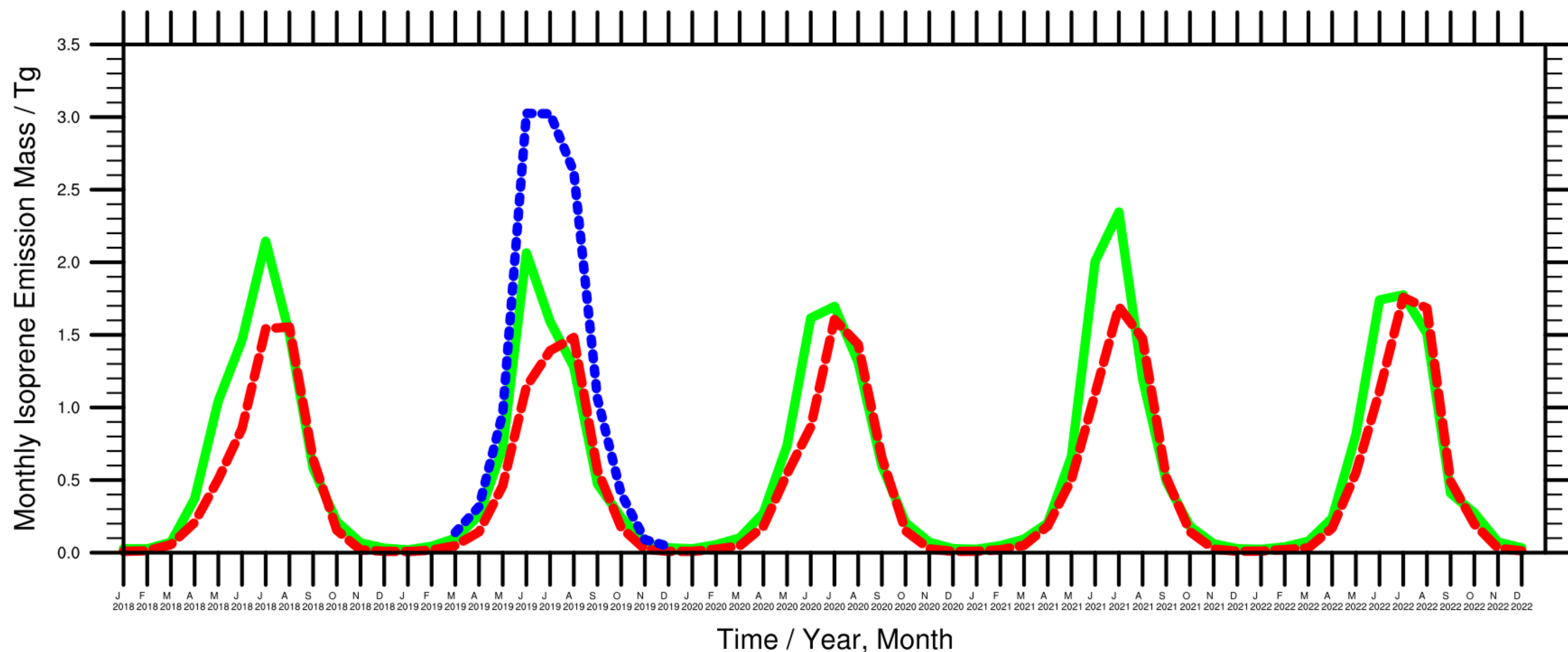
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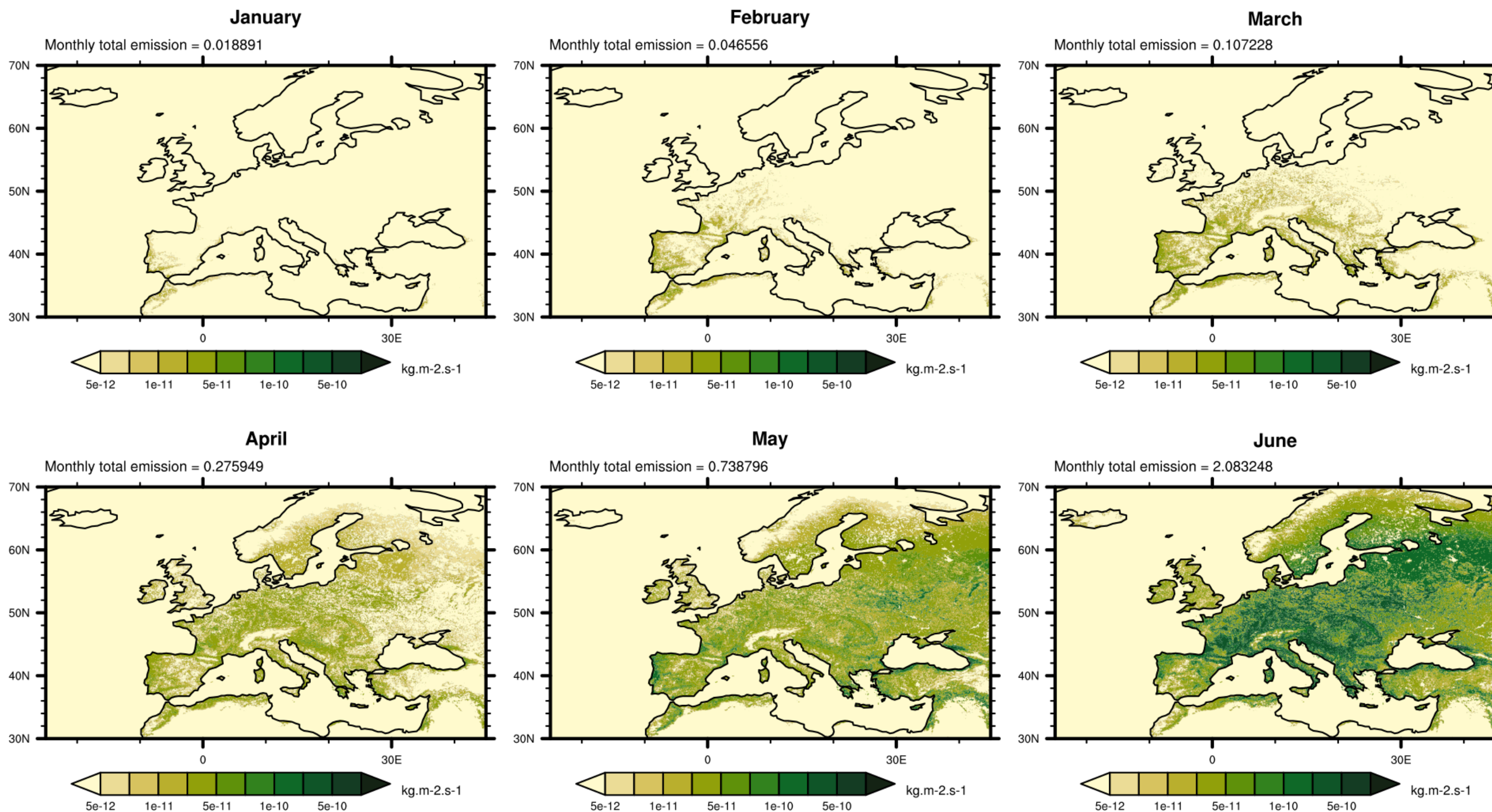
Monthly Mean Isoprene Emissions over Europe (CAM5) – MEGAN3 OL, CAM5-GLOB-BIOv3.1, SUMO (MOCAGE) – 2018-2022



— MEGAN3 Open Loop (SEEDS) - - - CAM5-GLOB-BIOv3.1
⋯ SUMO (MOCAGE) ➤ Some inter-annual variability in isoprene emissions: 6.76-7.5 Tg yr⁻¹

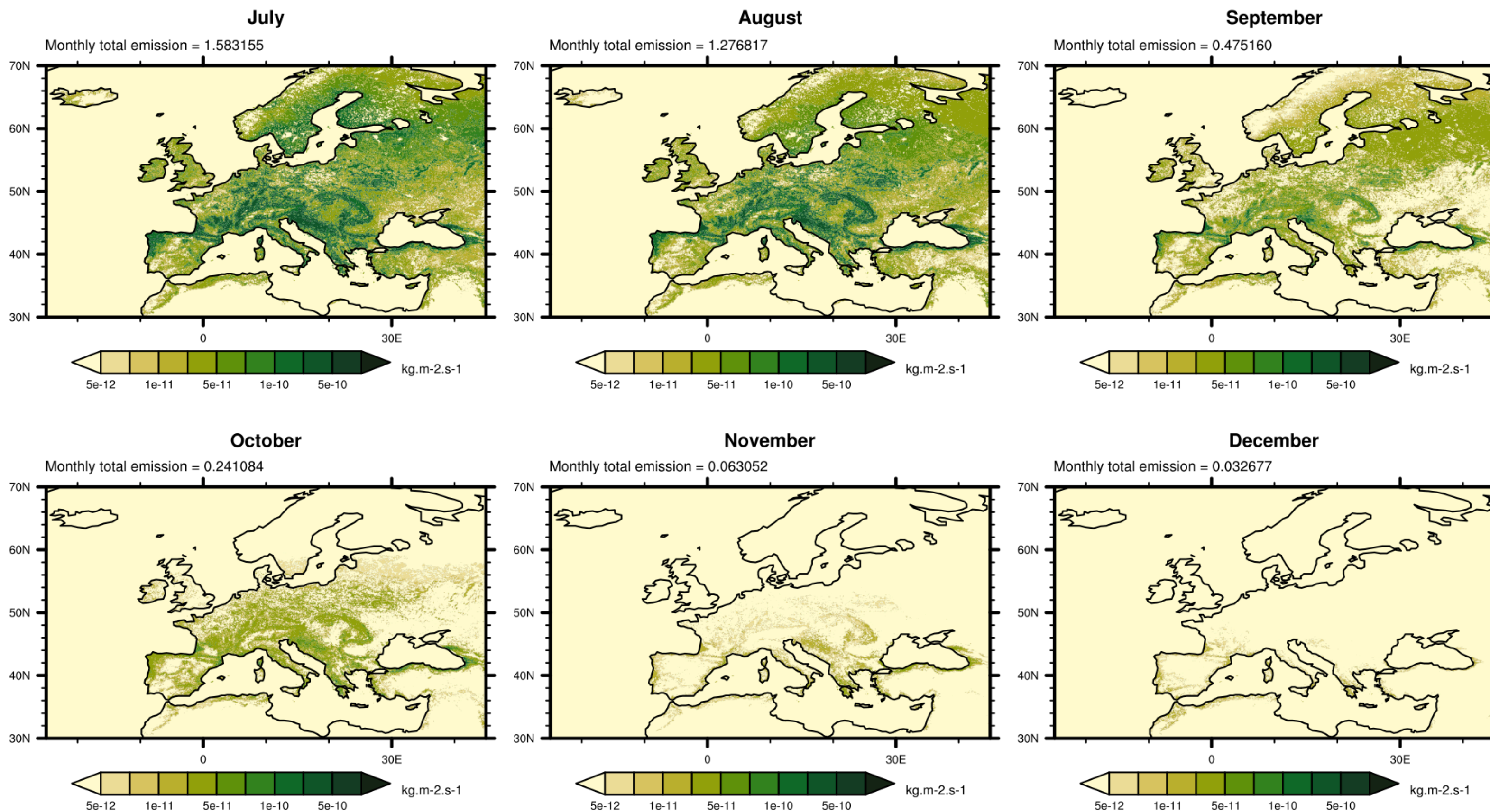
Monthly Mean Isoprene Maps

Monthly Mean Isoprene Emissions Over the CAMS European Domain for 2019 - LAI Analysis

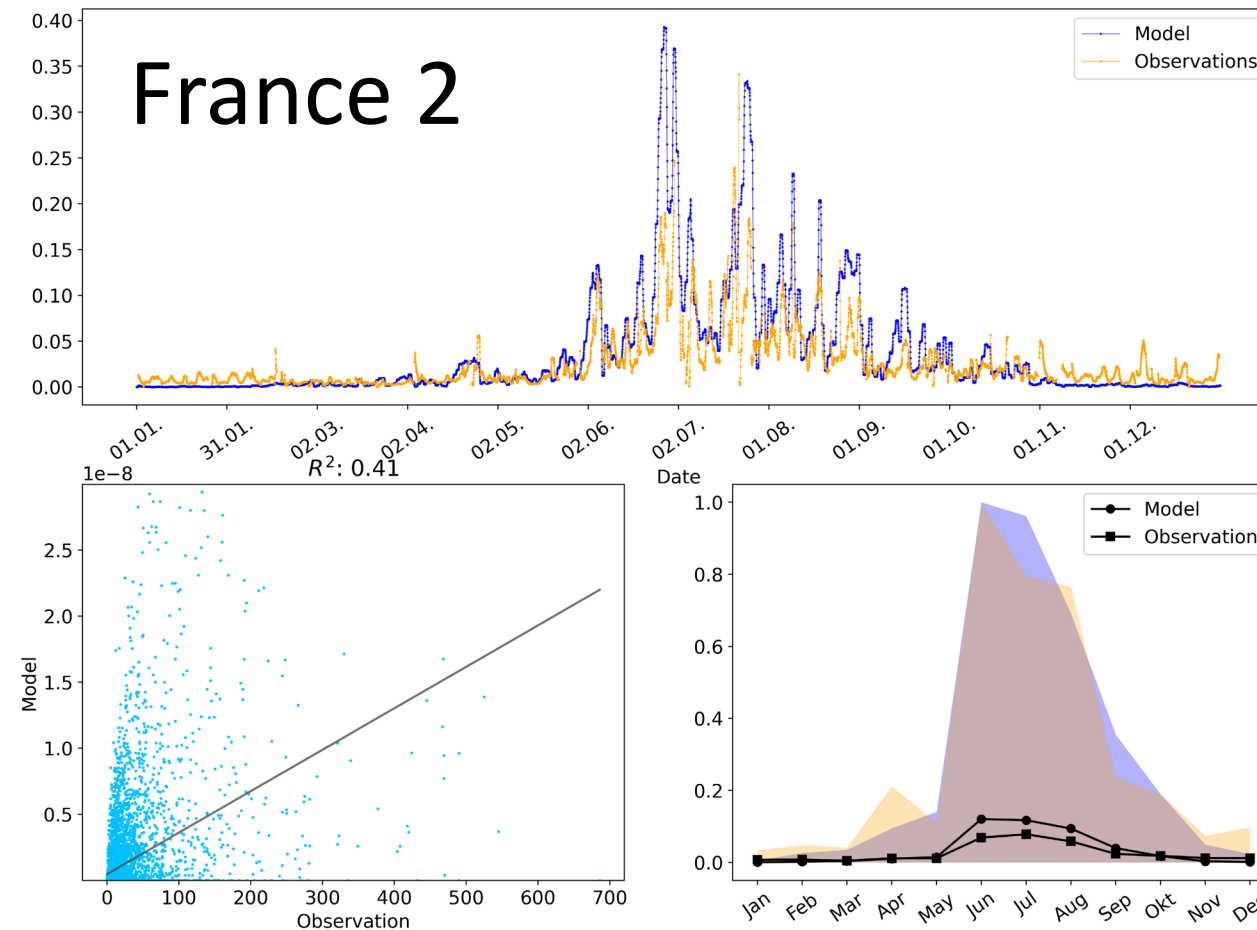
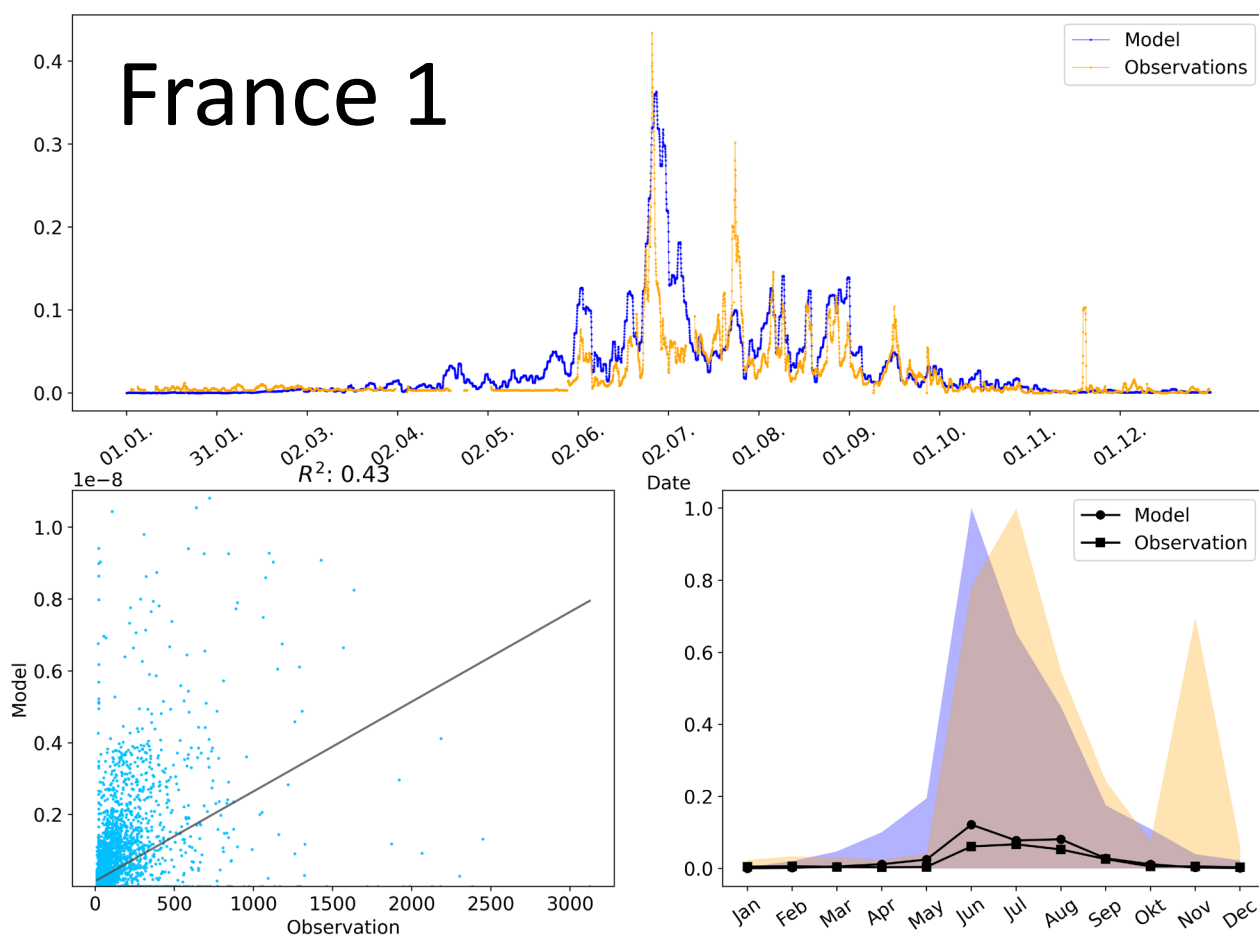
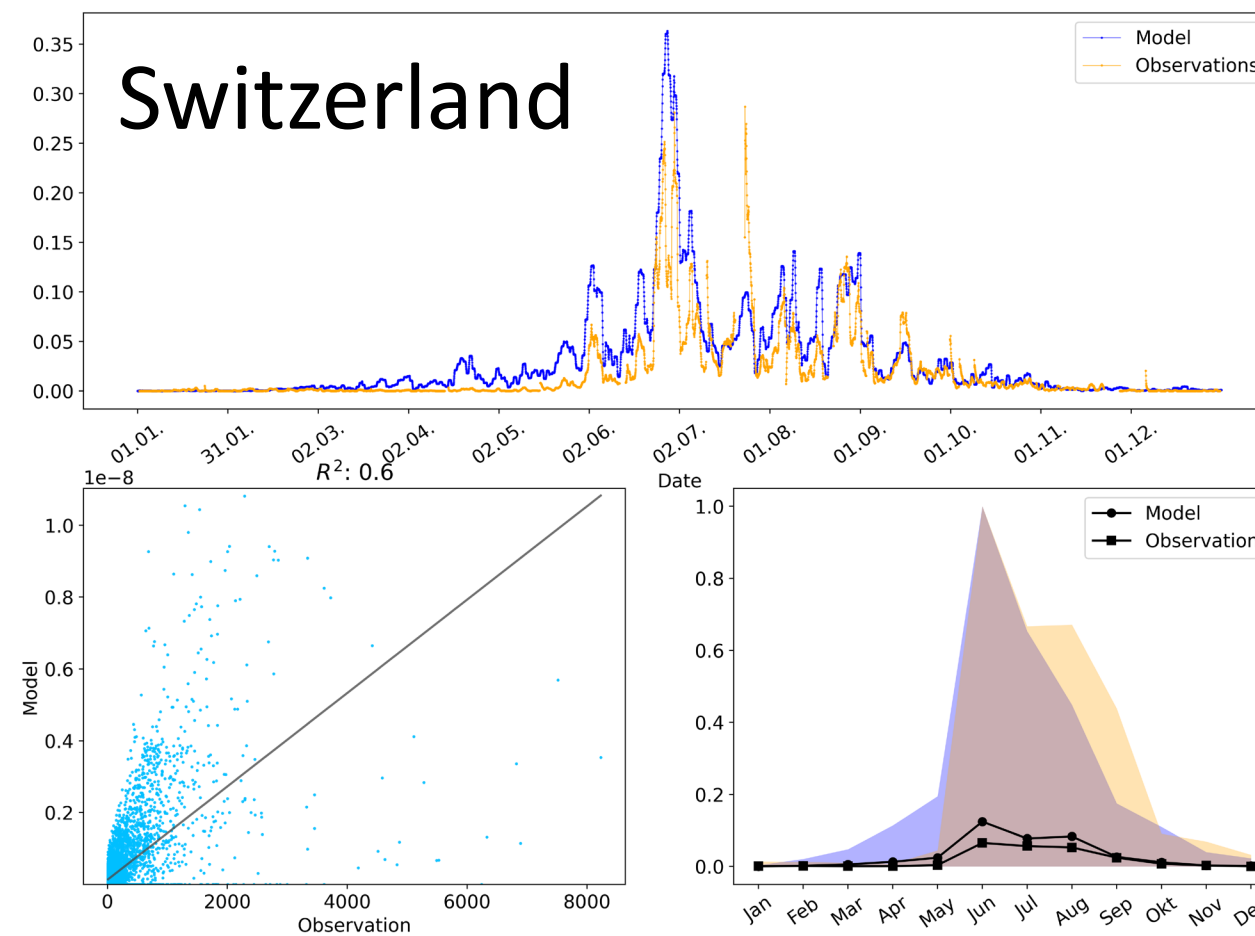
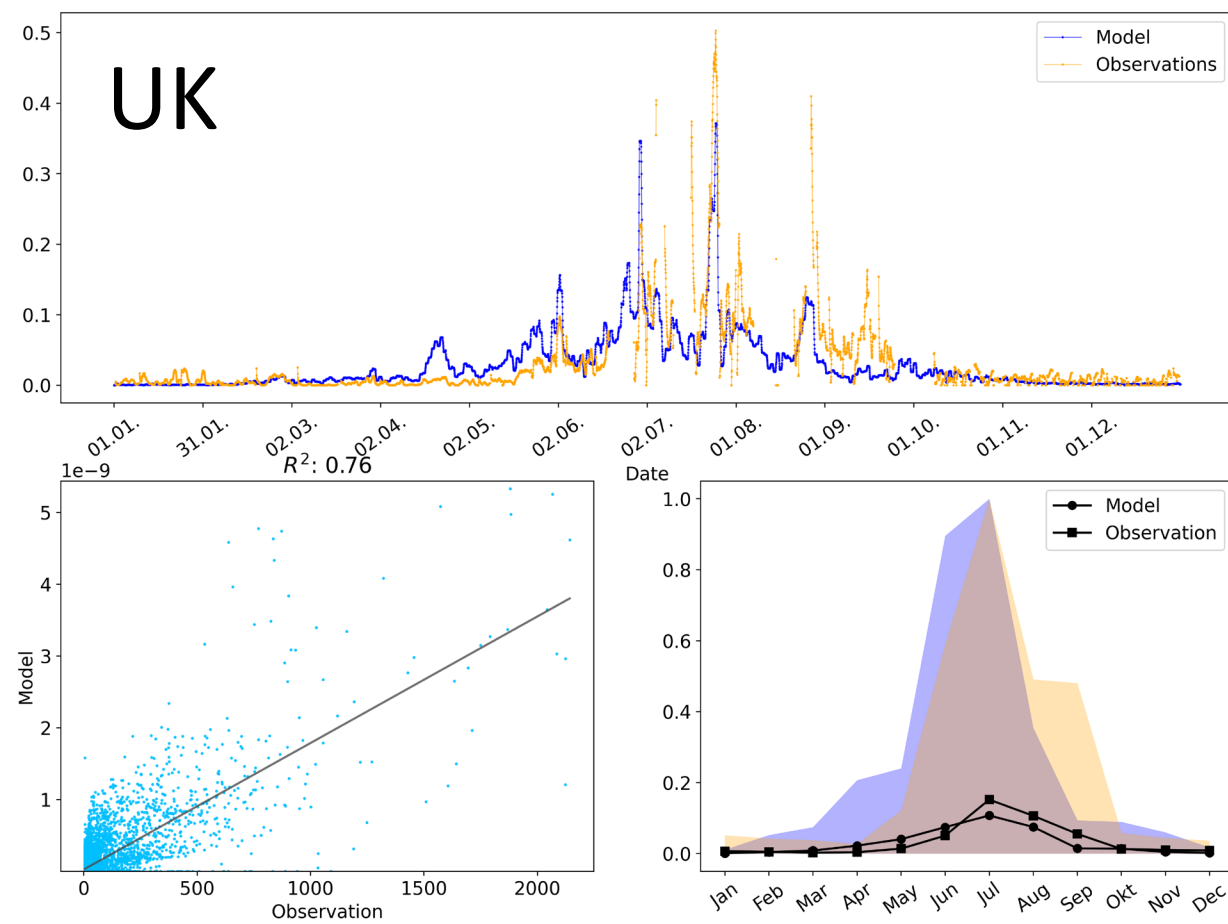


Monthly Mean Isoprene Maps

Monthly Mean Isoprene Emissions Over the CAMS European Domain for 2019 - LAI Analysis



Comparison with Isoprene Observations



Advances and advantages:

- Higher spatial resolution.
- Higher temporal resolution – important for more extreme events.
- Continuous temporal coverage for each day.
- Dynamic LAI supported by data assimilation.
- Land surface model permits earth system approach allowing vegetation-meteorology feedbacks.

Disadvantages, weaknesses, and areas where we need more work:

- We have used a ‘black box’ for our emission factors. More work needed to improve this with respect to state of the art.
- We have used a somewhat crude parameterization for the soil moisture gamma. Early work implies this causes too large decreases in emissions. More work needed.

Supplementary Material

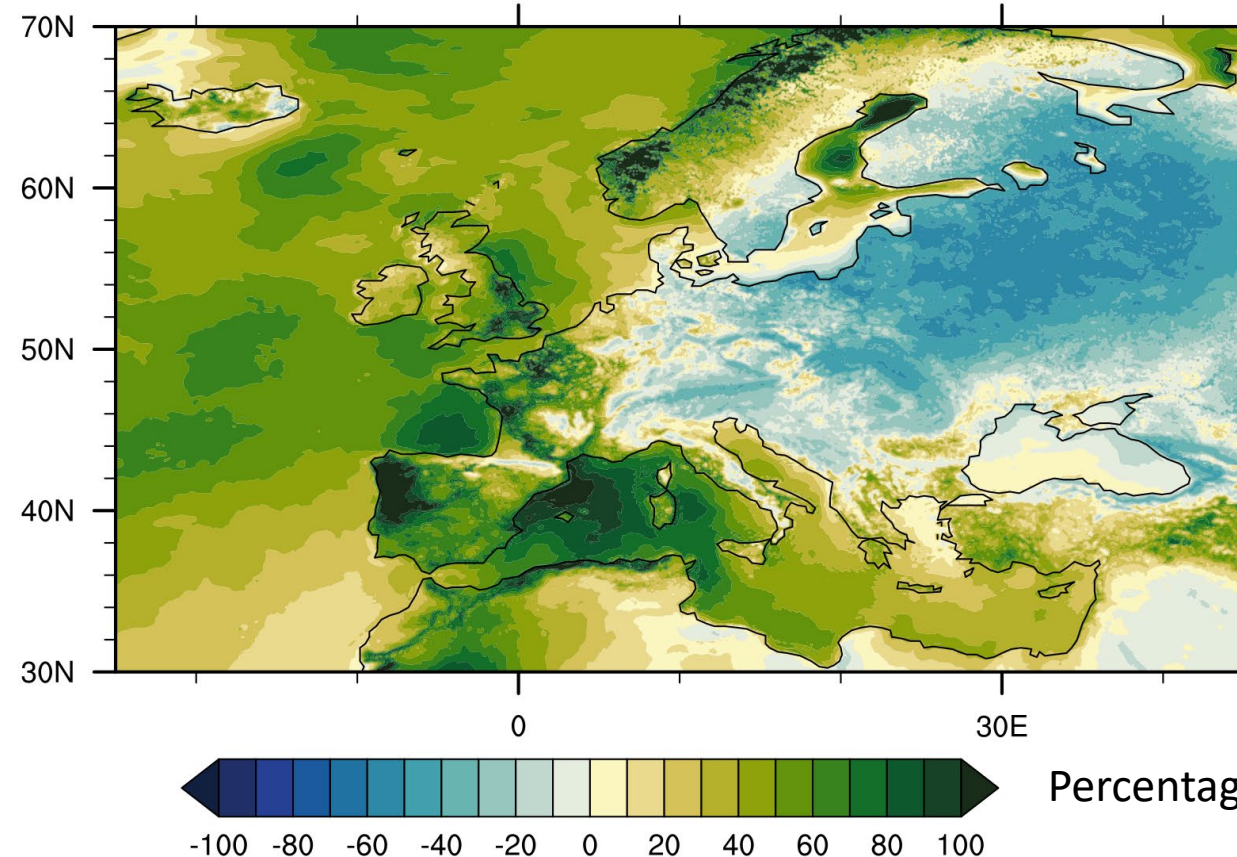
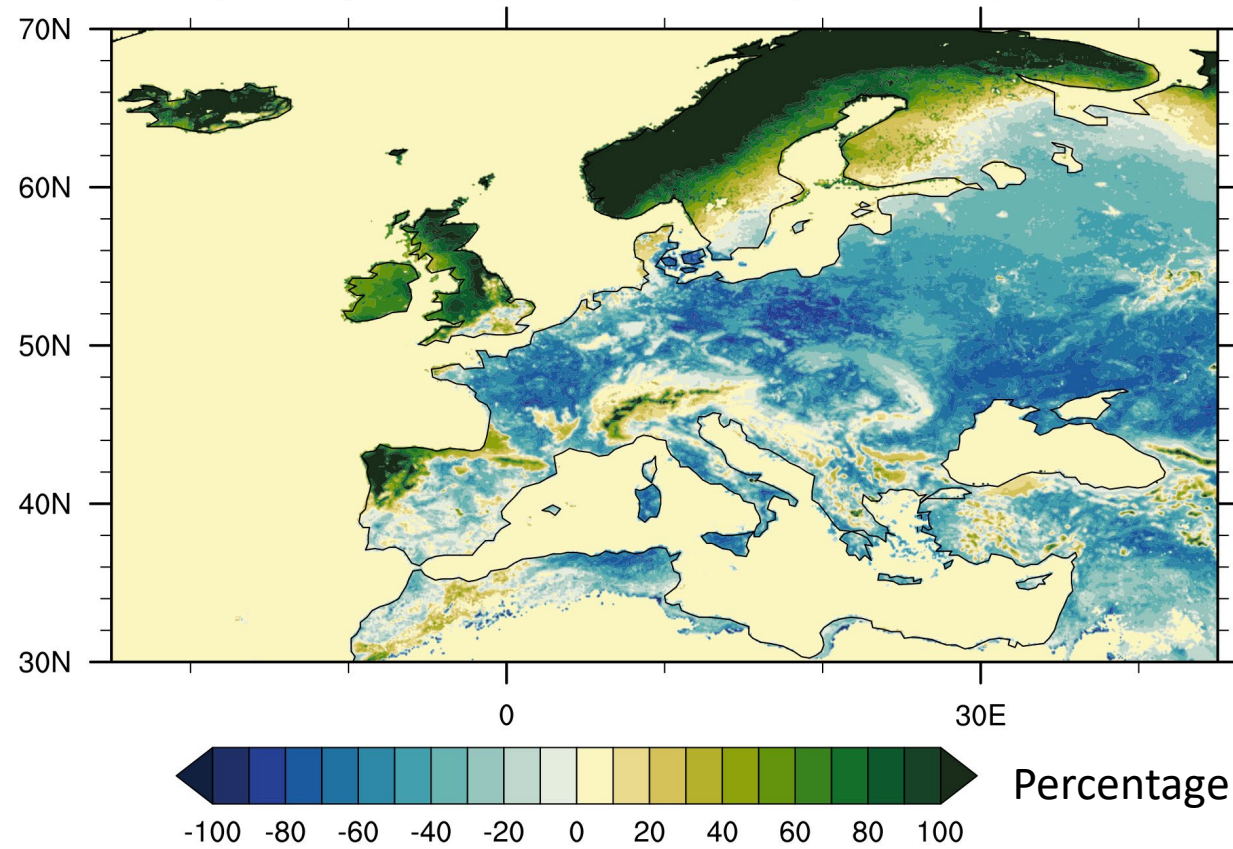
June 2019 minus July 2019

Isoprene Activity Factor

Temperature-Radiation Activity Factor

Monthly mean percentage difference in isoprene activity factor = 0.969255

Monthly mean percentage difference in temperature-radiation gamma factor = 23.283759

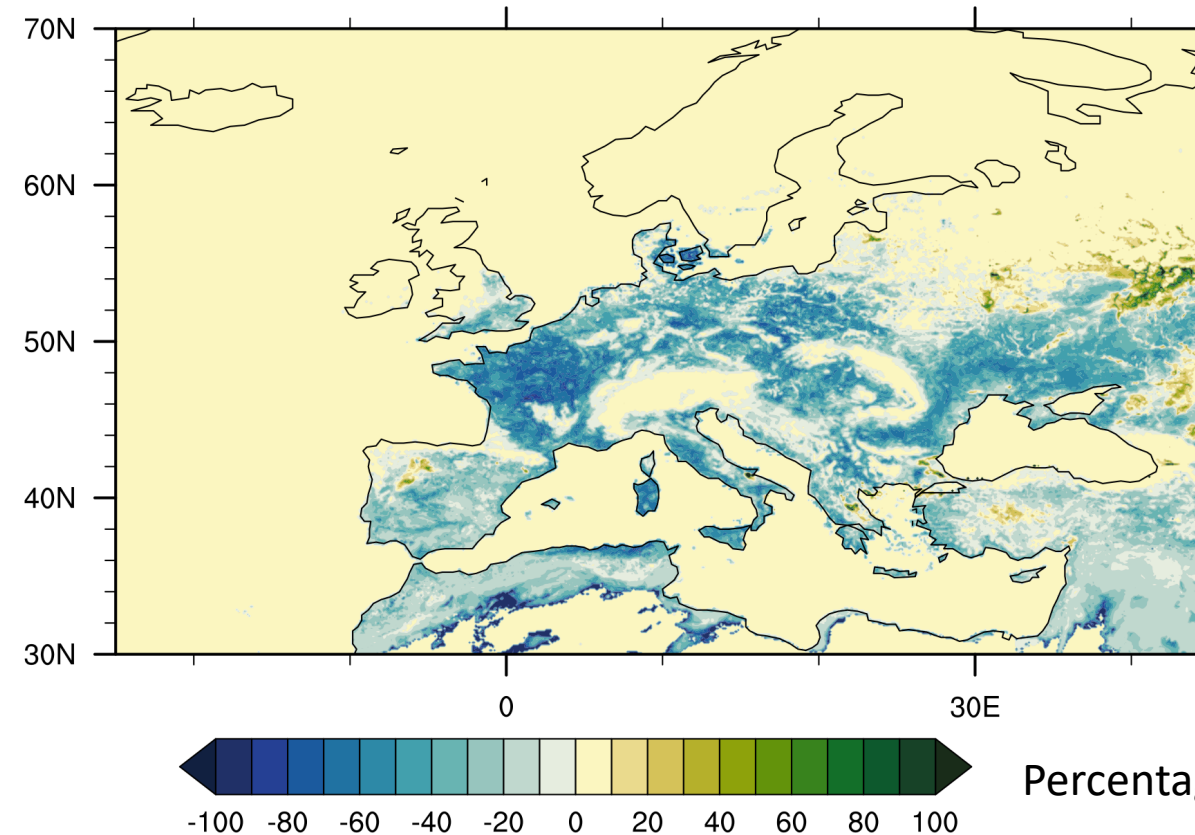
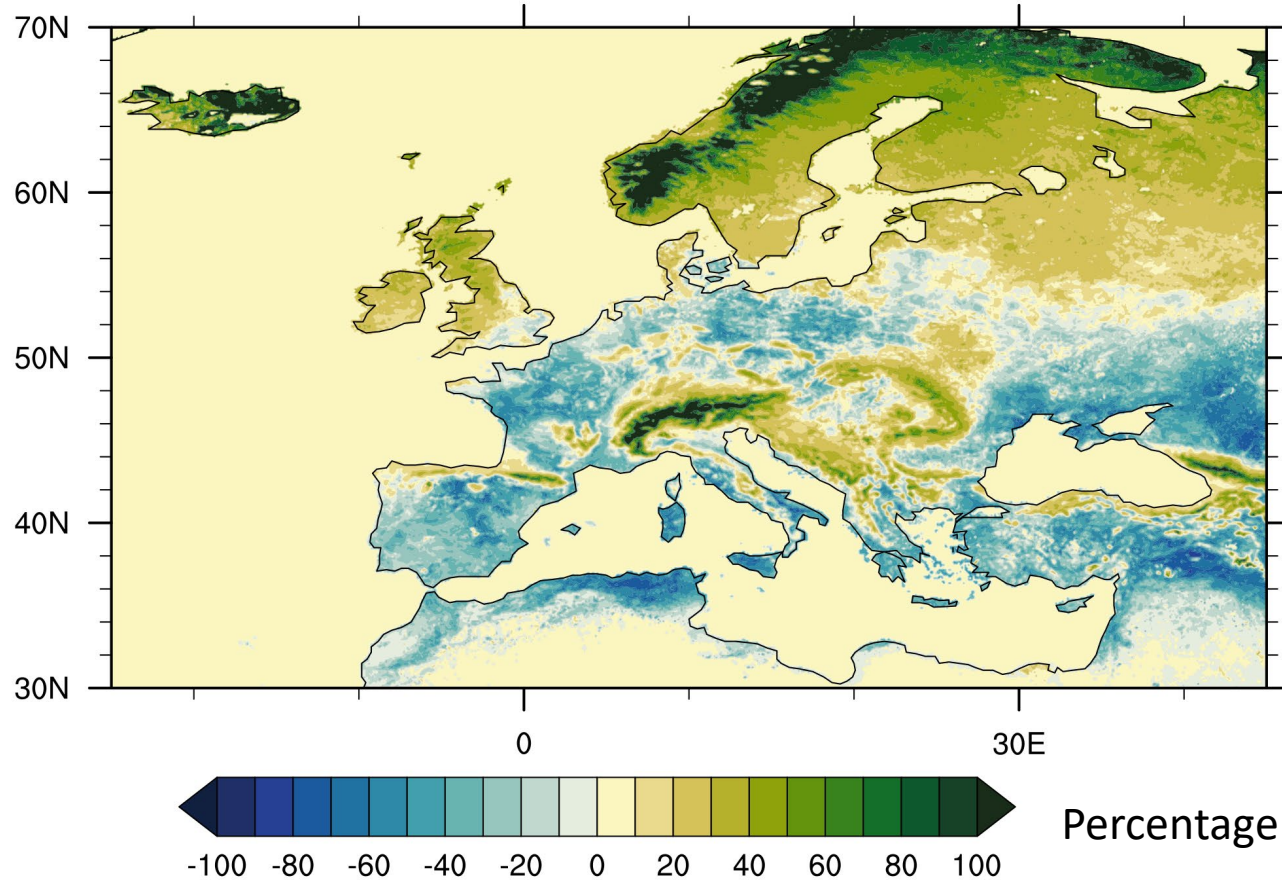


LAI Activity Factor

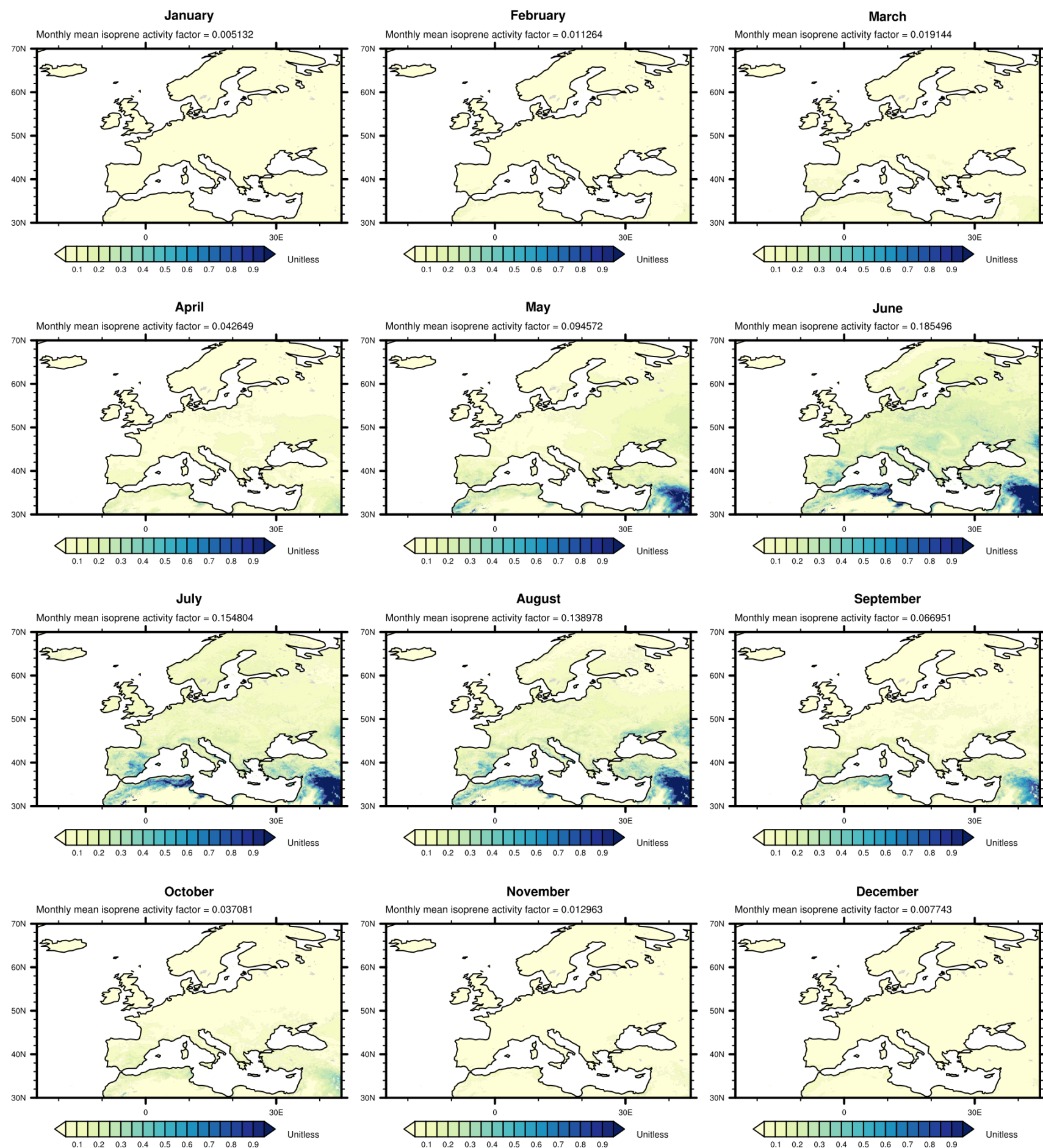
Soil Moisture Activity Factor

Monthly mean percentage difference in LAI = 4.108488

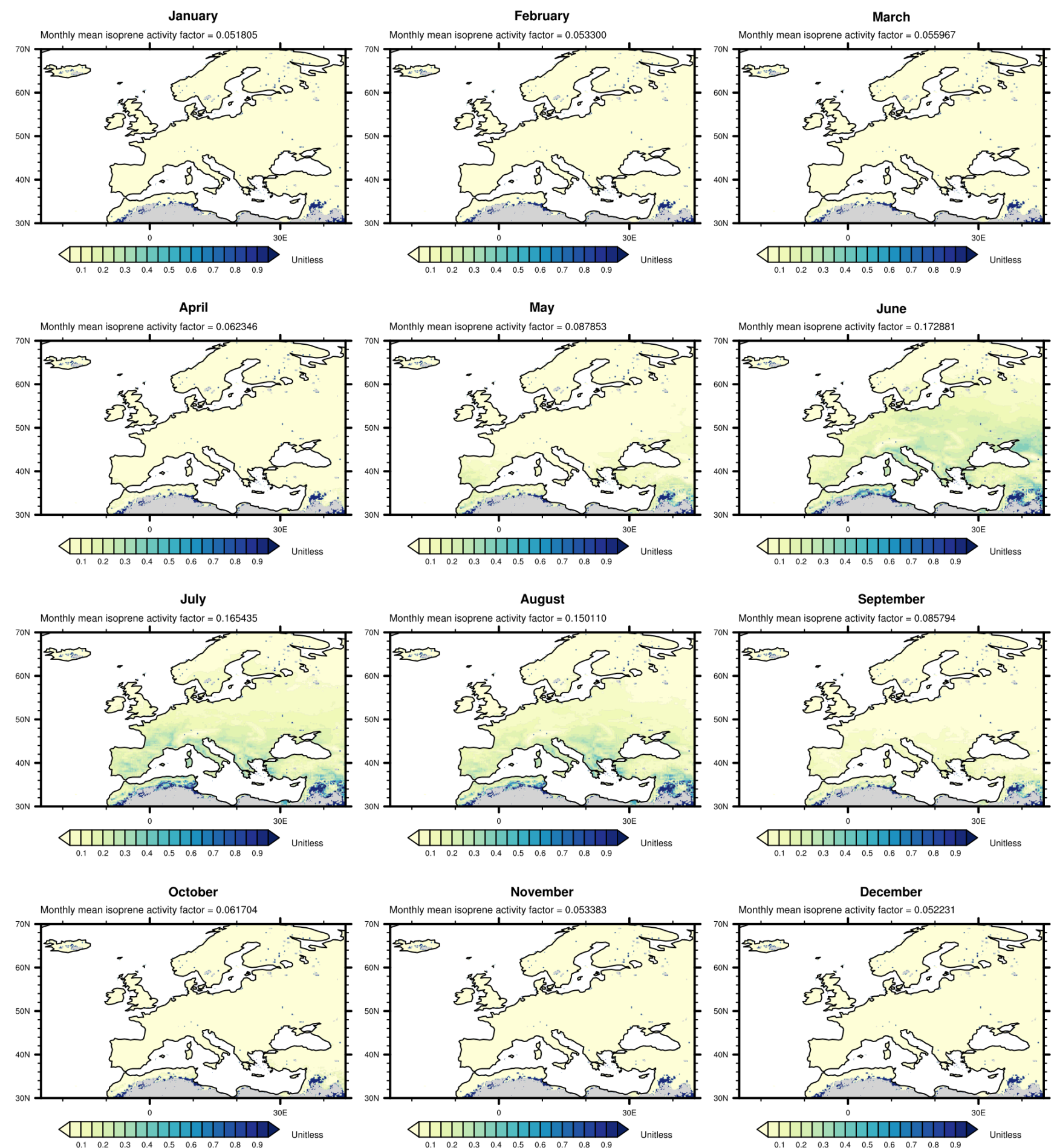
Monthly mean percentage difference in soil moisture gamma factor = -7.320259



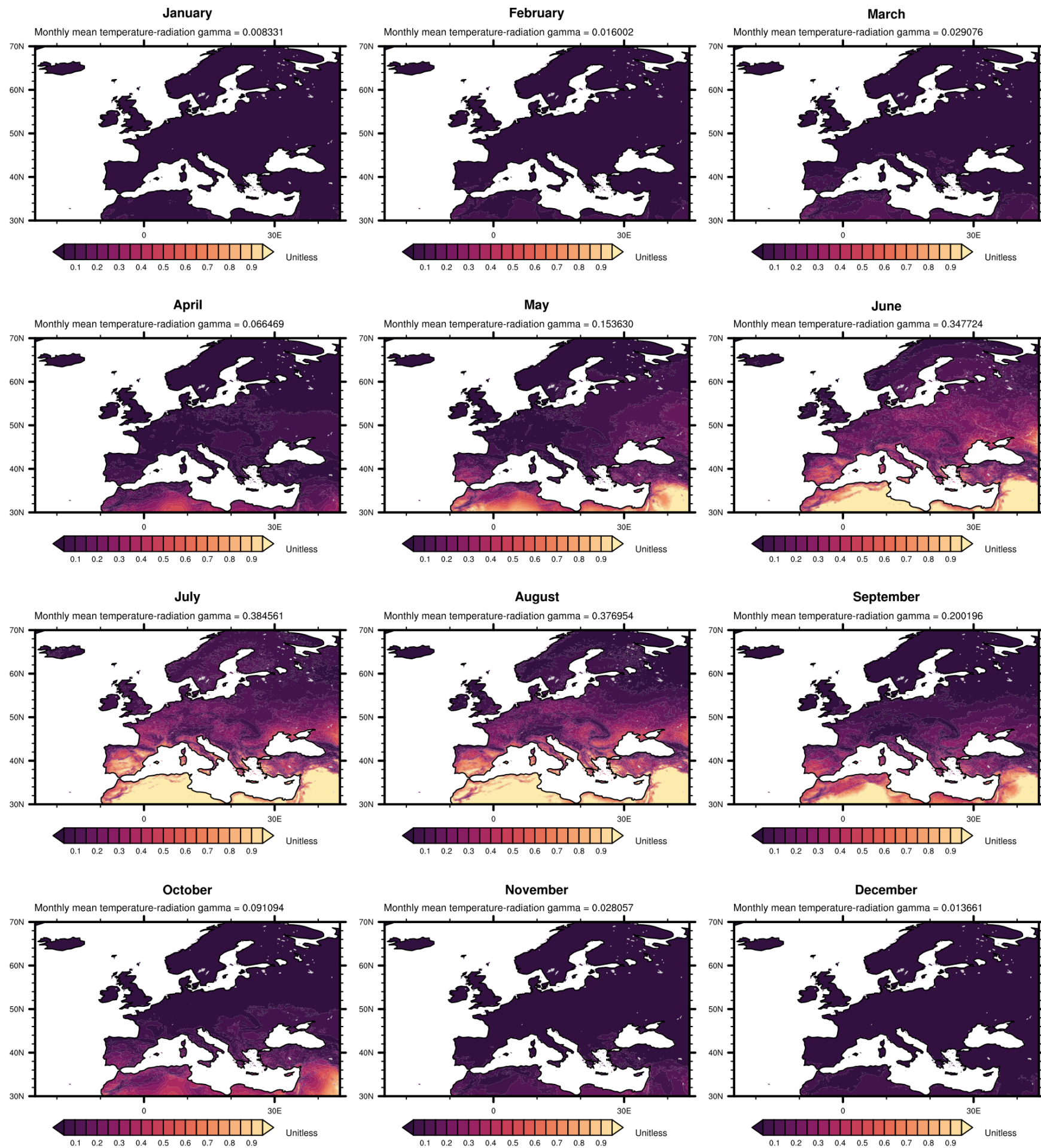
Monthly Mean Isoprene Activity Factor Over the CAMS European Domain for 2019 - LAI Analysis



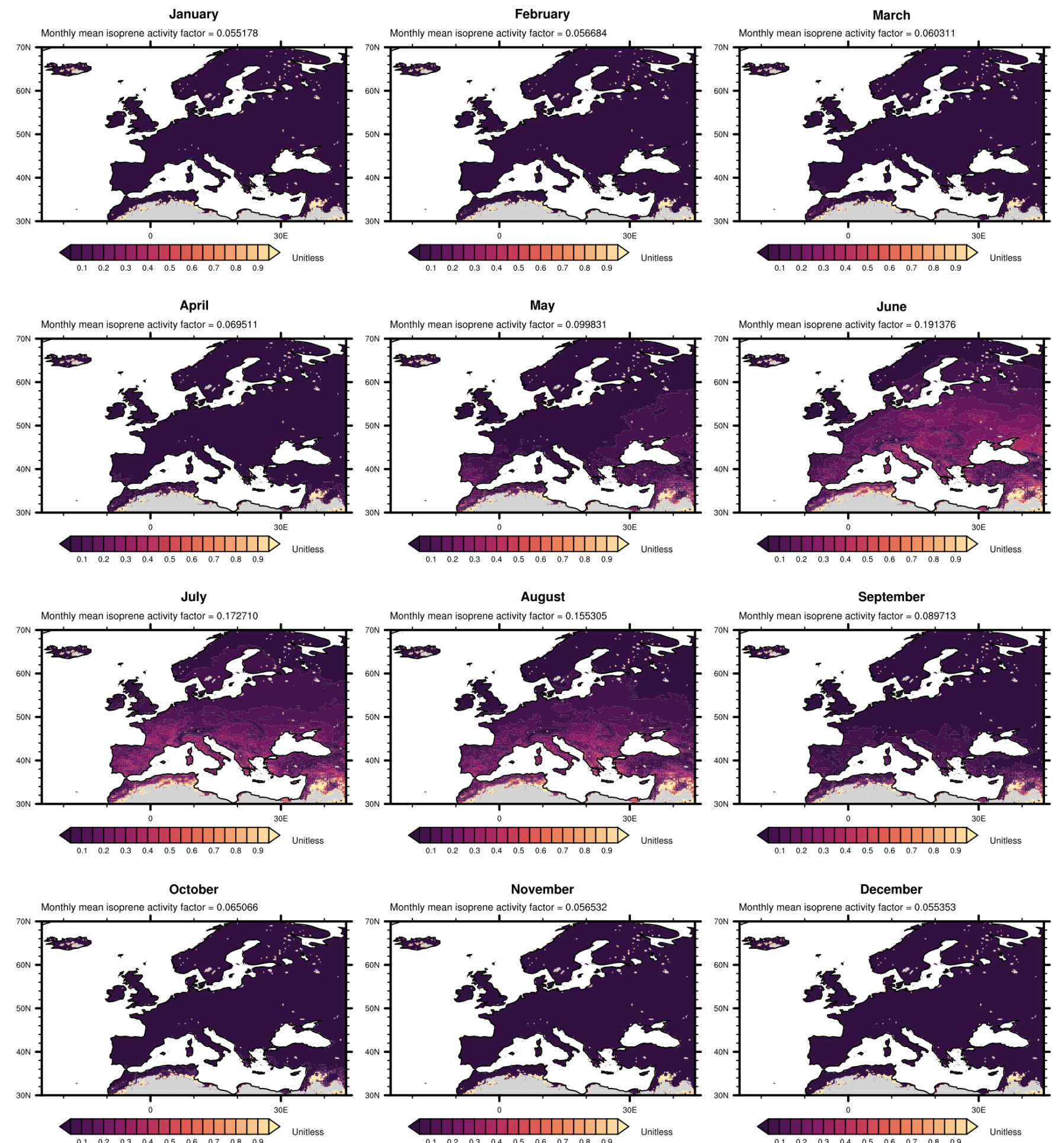
Monthly Mean Isoprene Activity Factor Over the CAMS European Domain for 2019 - CAMS-GLOBAL-BIOv3.1



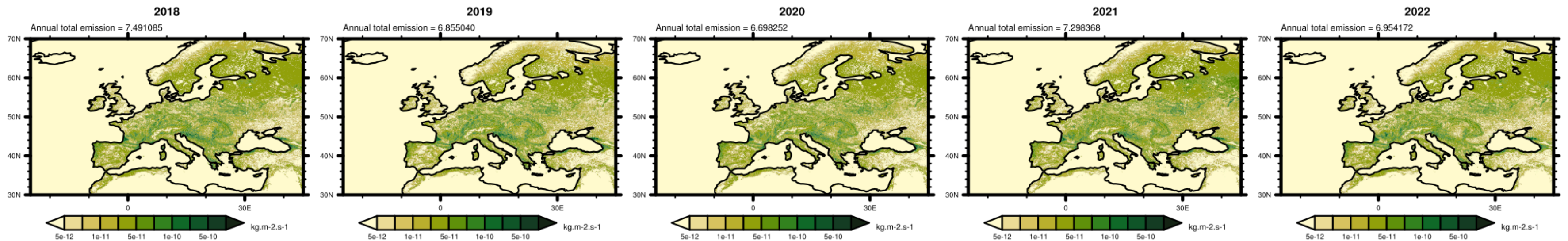
Monthly Mean Temperature-Radiation Gamma Over the CAMS European Domain for 2019 - LAI Analysis



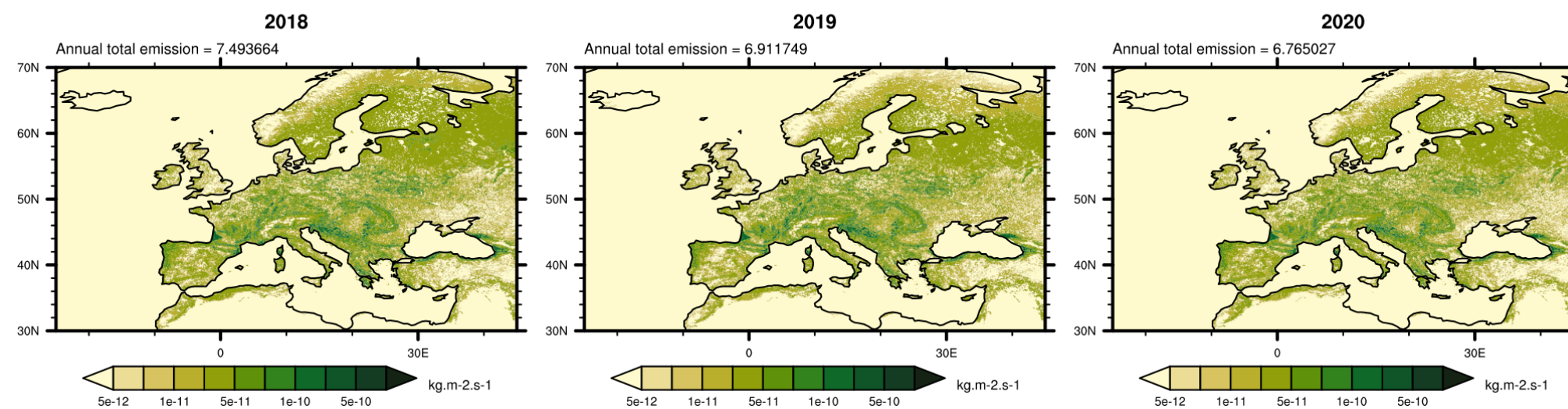
Monthly Mean GAMMATP Activity Factor Over the CAMS European Domain for 2019 - CAMS-GLOBAL-BIOv3.1



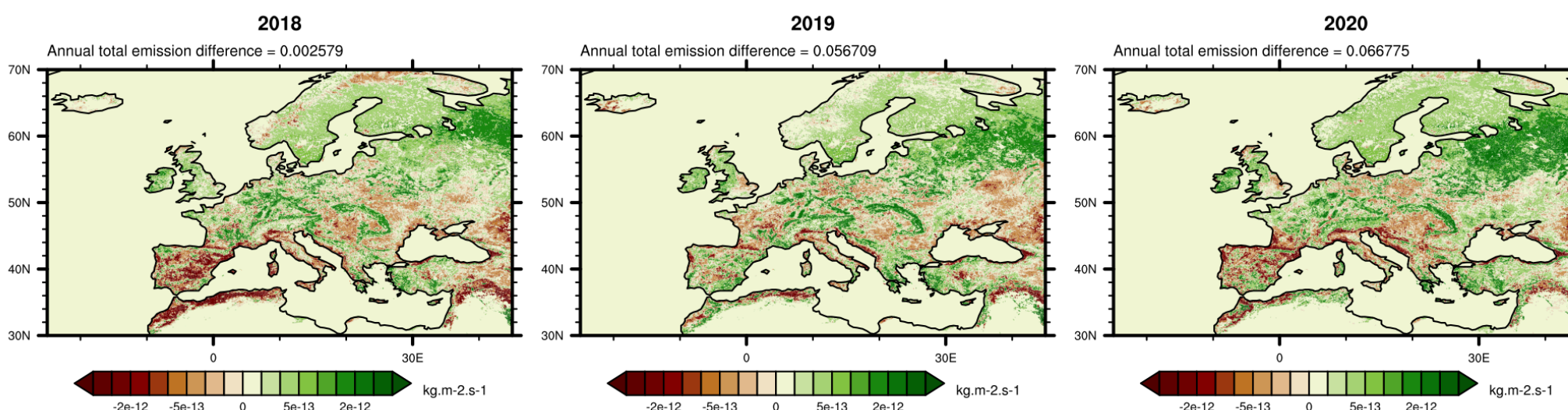
Annual Mean Isoprene Emissions Over the CAMS European Domain for 2018-2022 - Open Loop



Annual Mean Isoprene Emissions Over the CAMS European Domain for 2018-2020 - LAI Analysis



Annual Mean Isoprene Emissions Over the CAMS European Domain for 2018-2020 - LAI Analysis minus Open Loop

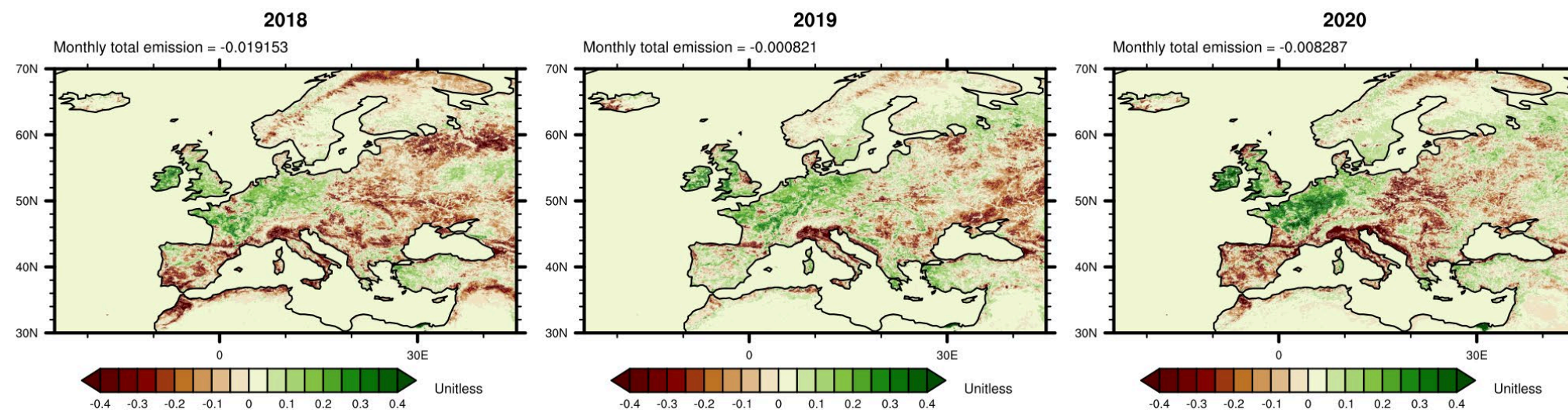


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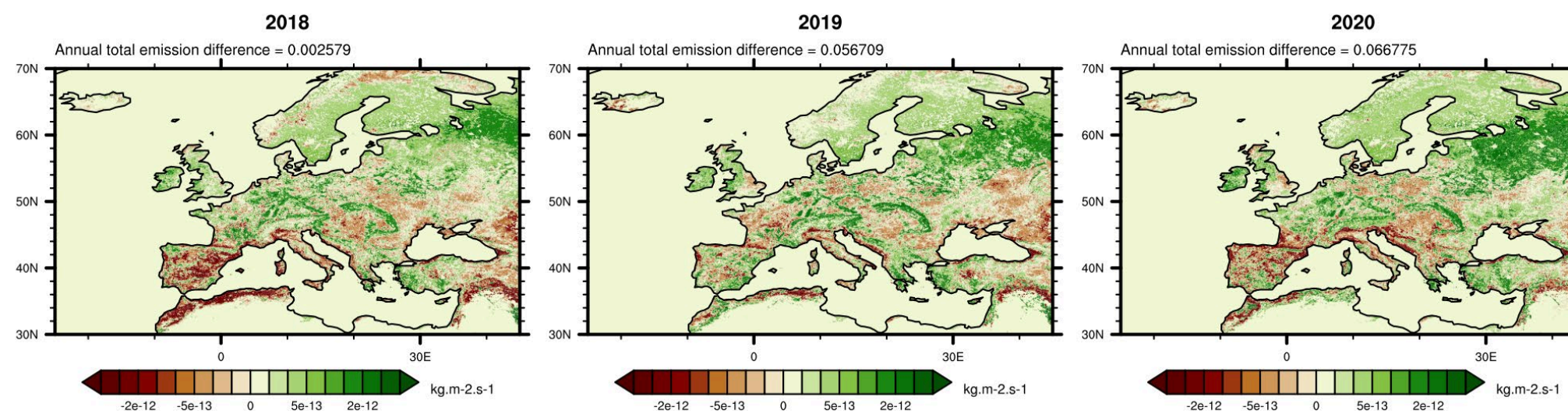
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

LAI



Isoprene Emission

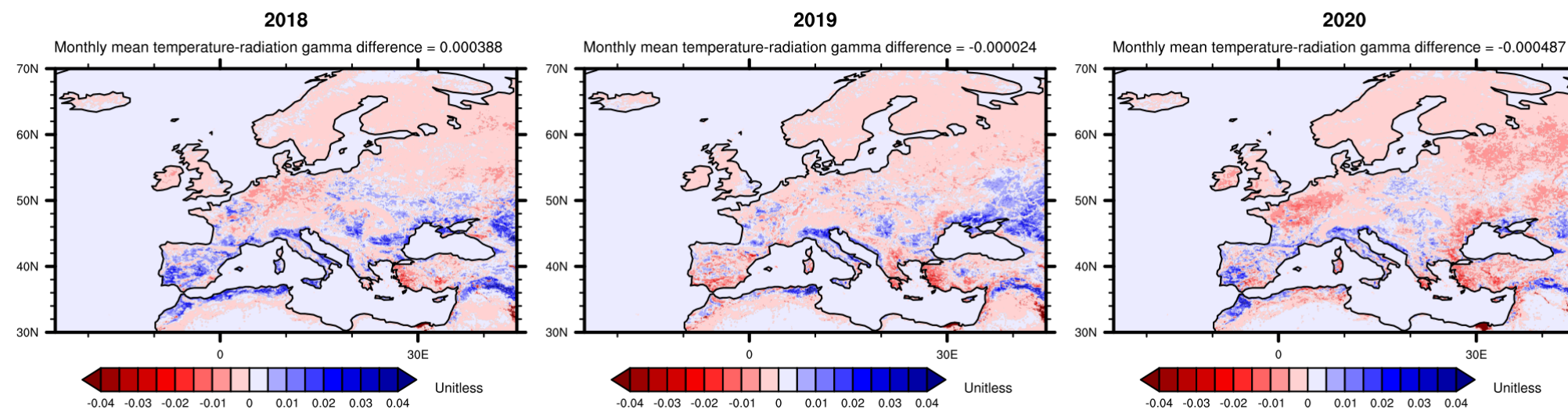


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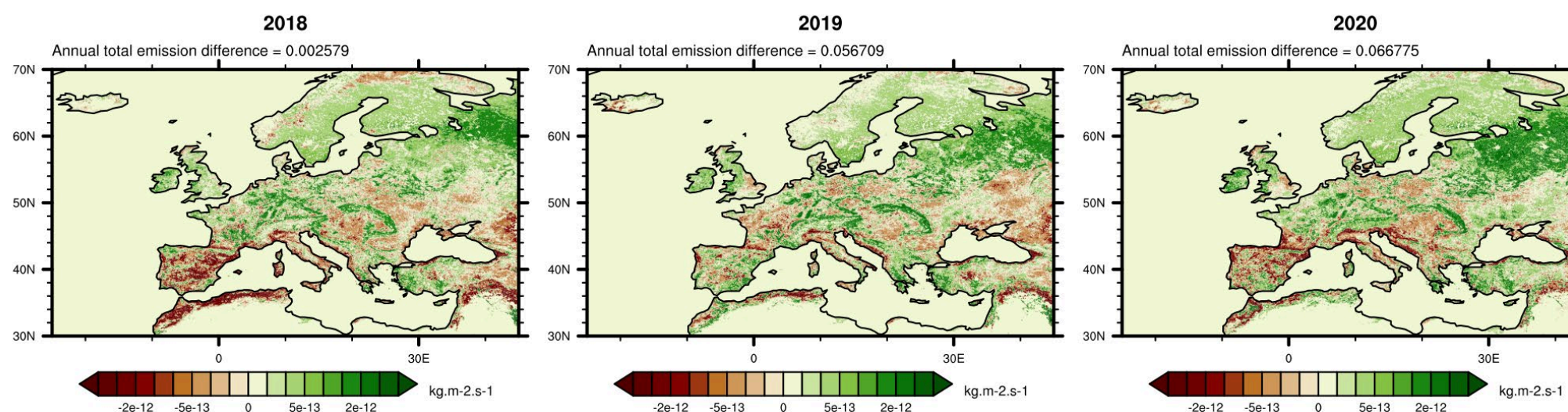
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

Temp-Rad



Isoprene Emission

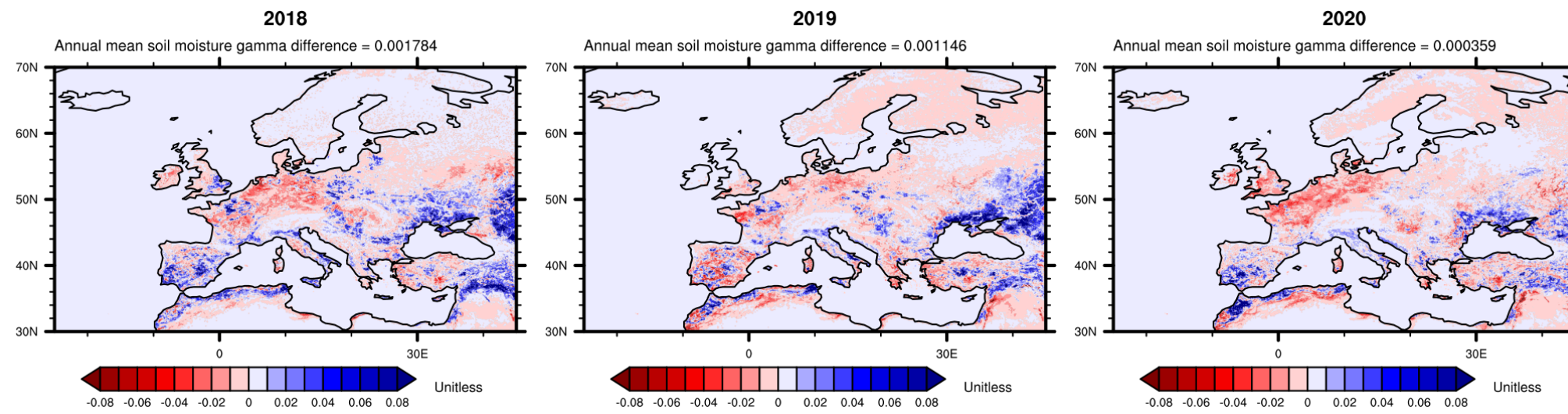


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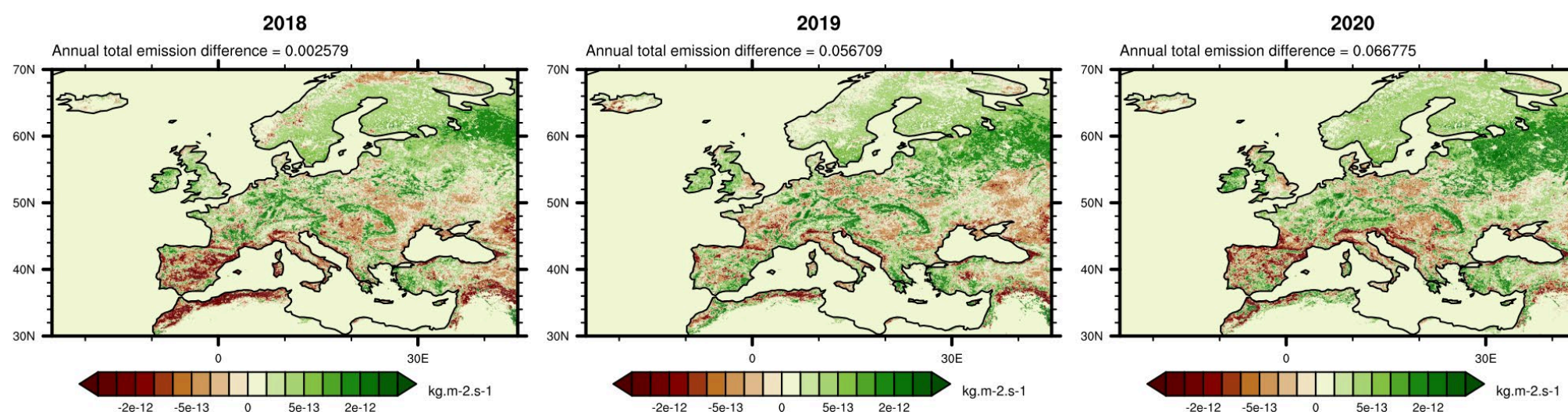
Annual Mean Isoprene Maps

Annual mean LAI Analysis minus Open Loop

Soil
Moisture



Isoprene
Emission

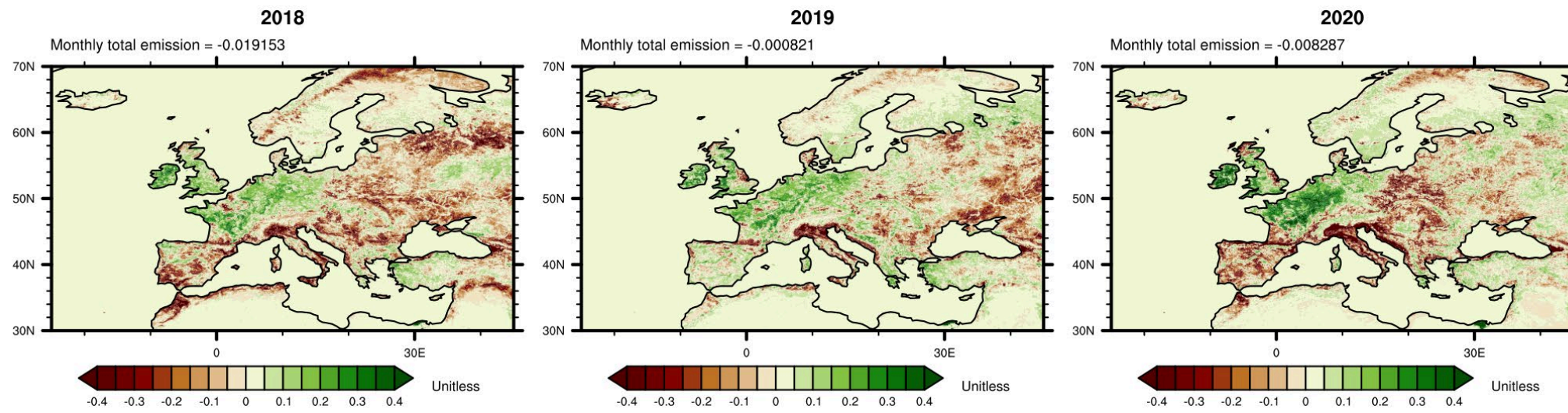


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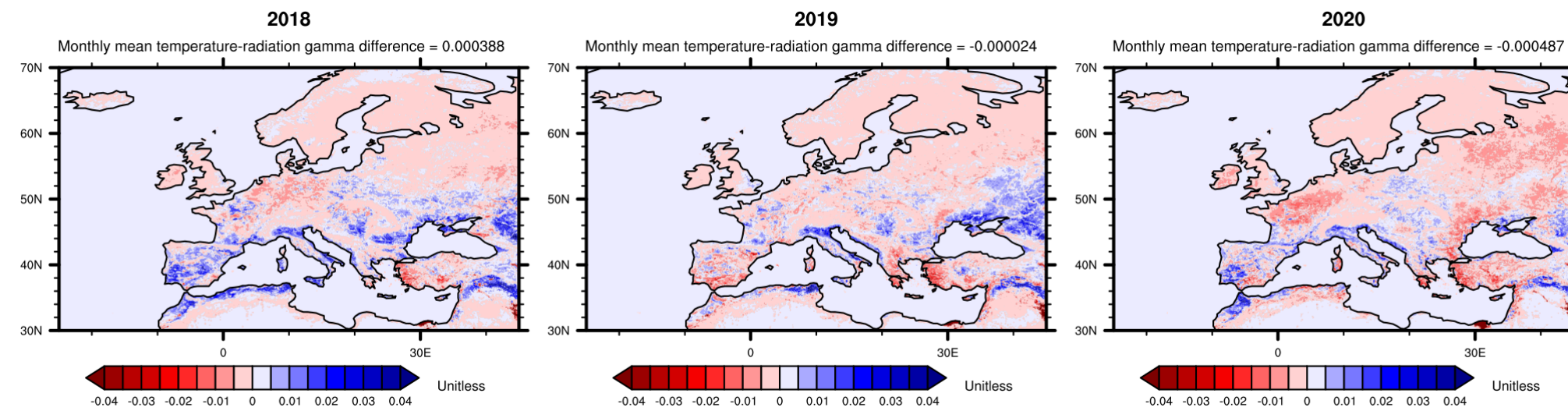
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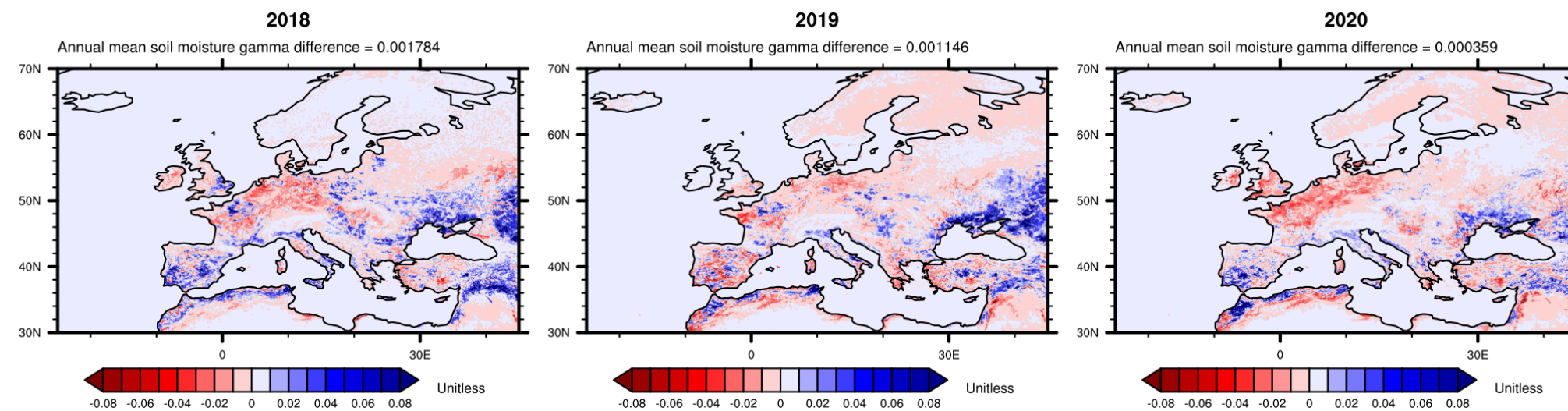
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Temp-Rad



Soil Moisture



Isoprene Emission

