Direct Estimation of Emissions from High Latitude Fires via the FREM Approach

LEVERHULME
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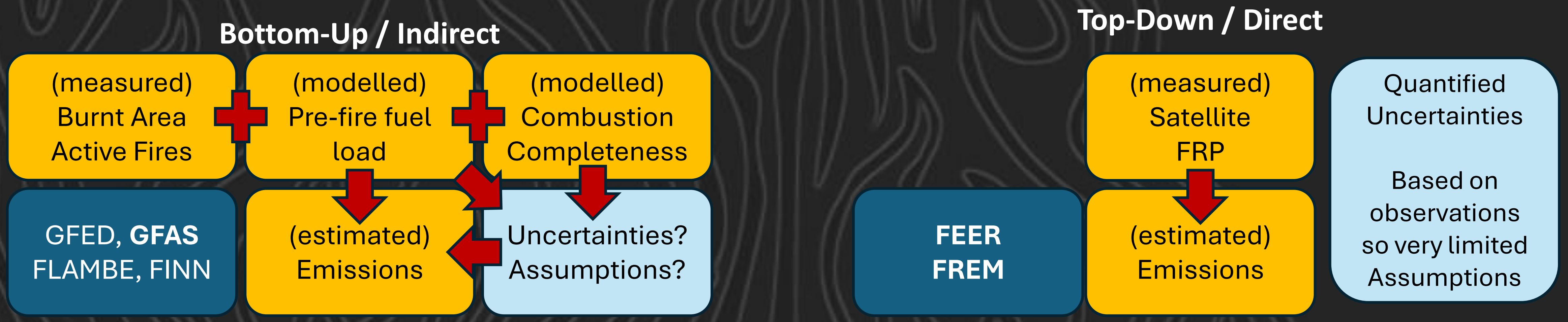
Background and Motivation

Landscape fires are amongst the largest contributor of gaseous and particulate emissions into the atmosphere.

- 25 Megatonnes of CO from High Latitudes (≥60°N)
- CO is 2nd largest emitted (CO_2 is first)
- CO is easily measurable (background CO is low)

Different ways of estimating fire activity and associated emissions of gases and aerosols using Earth Observation

- Only way to effectively get information at regional / national / global scales consistently, at the temporal resolutions needed



FREM Approach: Method and Data

Fire Radiative Energy eMissions (FREM)

- Based on FRP timeseries
- v1: relates Geostationary FRE to TPM (Africa)
- v2: method improved, also relates Geostationary FRE to CO (Africa)

High Latitude FREM (≥60°N)

- Swap Geostationary FRP for Polar Orbiter FRP
- Orbital convergence provides many samples per day

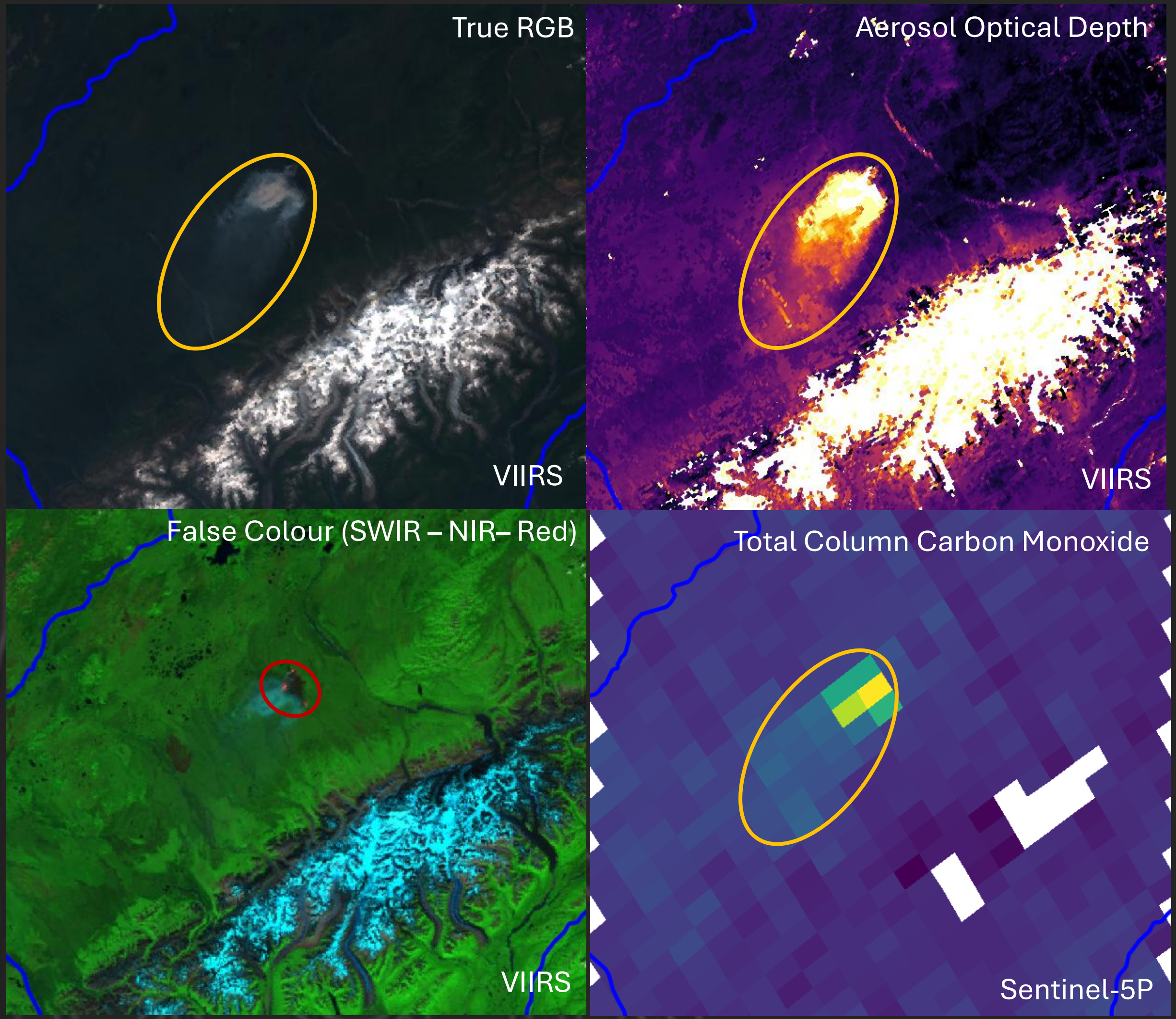
Data Used

VIIRS (S-NPP)
Plume and Fire Identification

GFAS v1.4
MODIS Hourly FRP

CCI 2018 Land Cover
Köppen-Geiger Classes
Aggregated Biomes

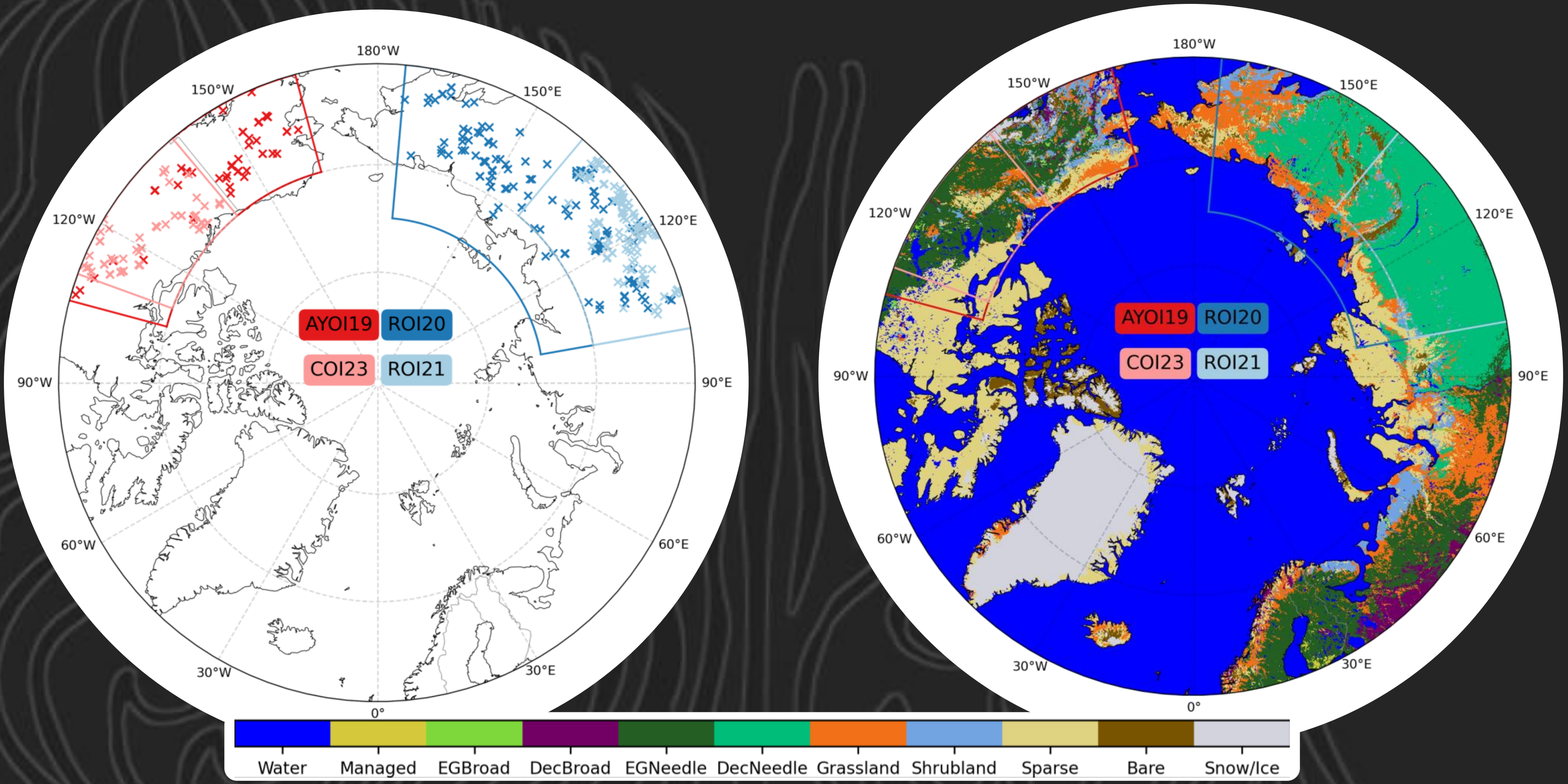
Sentinel-5P
Carbon Monoxide Observations



Regions of Interest

833 CO Plumes Manually Digitized (Parallel Work on AI Automation: Session 5 [tomorrow!]

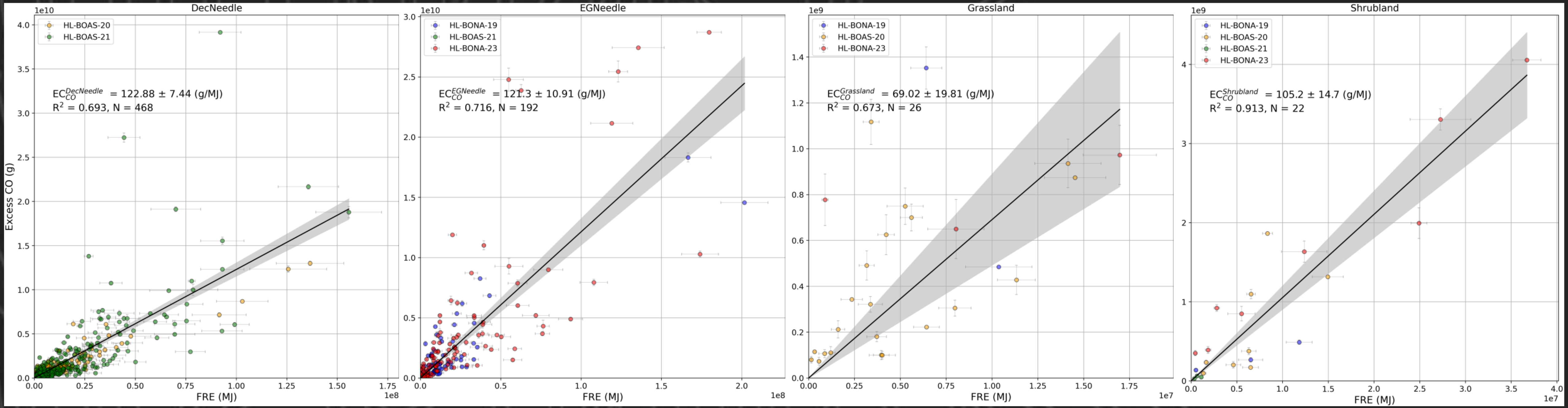
Alaska + NW. Canada JJA 2019 | Siberia JJA 2020 + 2021 | NW. Canada 2023



HL FREM Emission Coefficients

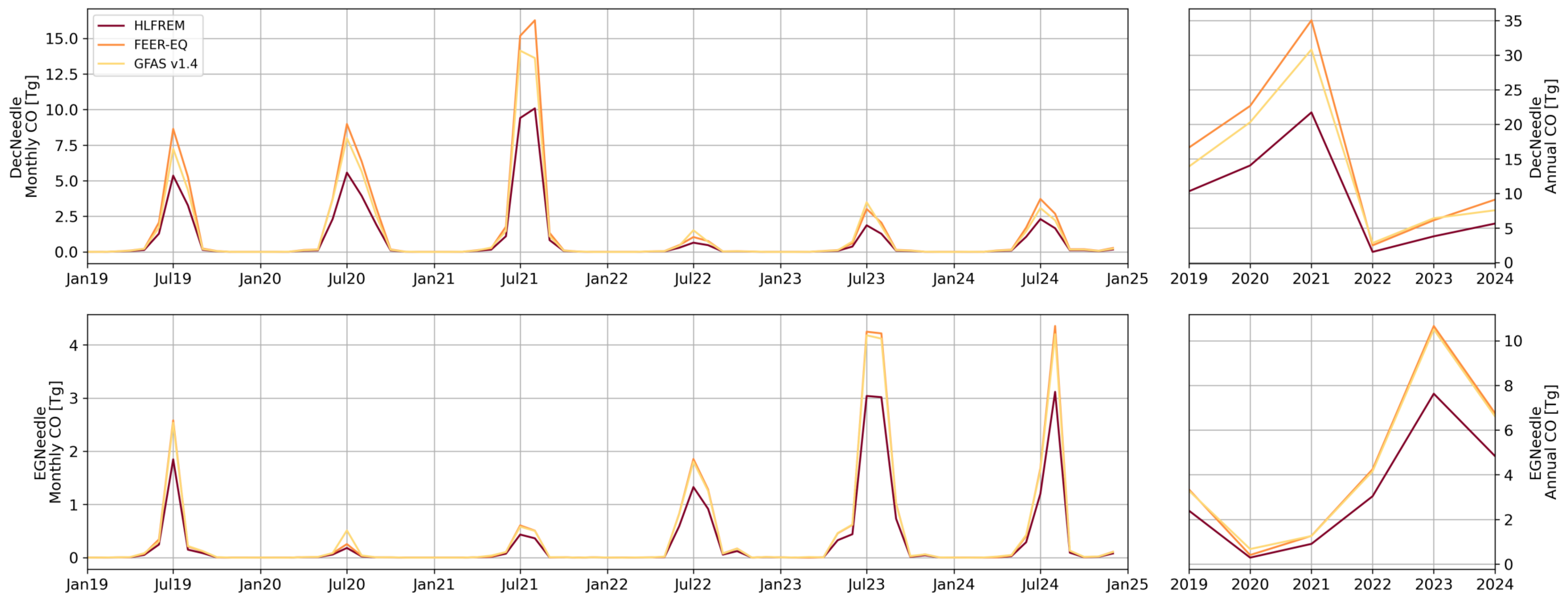
Four biomes analysed across the combined Regions of Interest (covers 95% of the HL Emissions)

- Deciduous Needleleaf Forests (DecNeedle)
- Evergreen Needleleaf Forests (EGNeedle)
- Grasslands
- Shrublands



DecNeedle **EGNeedle** **Grassland** **Shrubland**

CO Inventory Comparison (Forested)



Using EC_{CO}^{biome} and Emission Factors, can generate EC_{x}^{biome}

$$EC_x^{biome} = \frac{EF_x^{biome}}{EF_{CO}^{biome}} EC_{CO}^{biome}$$

What’s Next?

GFAS v1.4 underestimates FRE at the HL compared to publicly available GFAS v1.2

- Currently looking into reasons why

Long timeseries comparison (2003 to present!)

- Compare with GFED4

Use FREM with Burnt Area → Fuel Consumption per unit area

- Relationship between FCUA and other observations

Joined up Global Emission Inventory from EO alone

- Geostationary + Polar Orbiting FRP data

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Thank you

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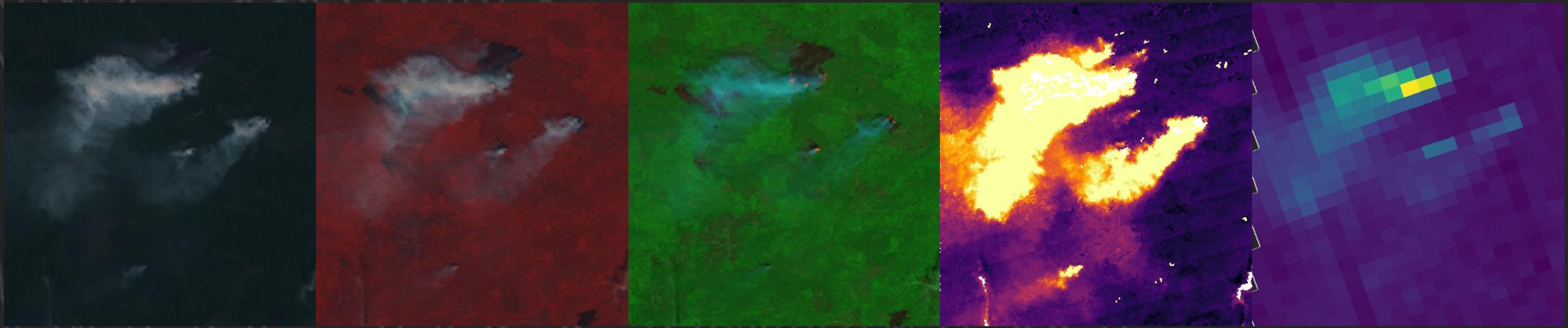

Help from: King's Earth Observation and Wildfire Research Group

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