GREENHOUSE GAS COLUMN OBSERVATIONS FROM AN EM27/SUN PORTABLE SPECTROMETER IN UGANDA

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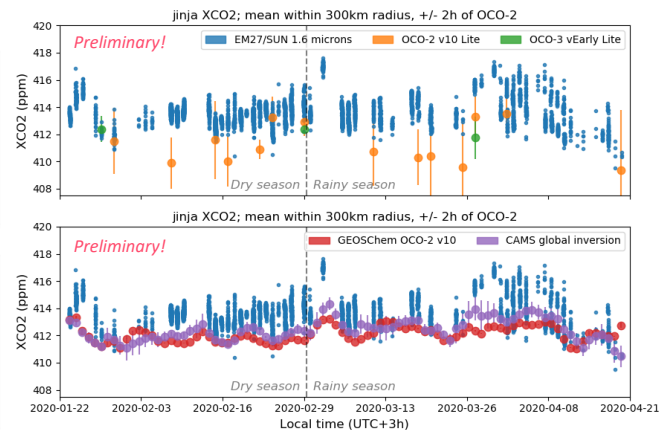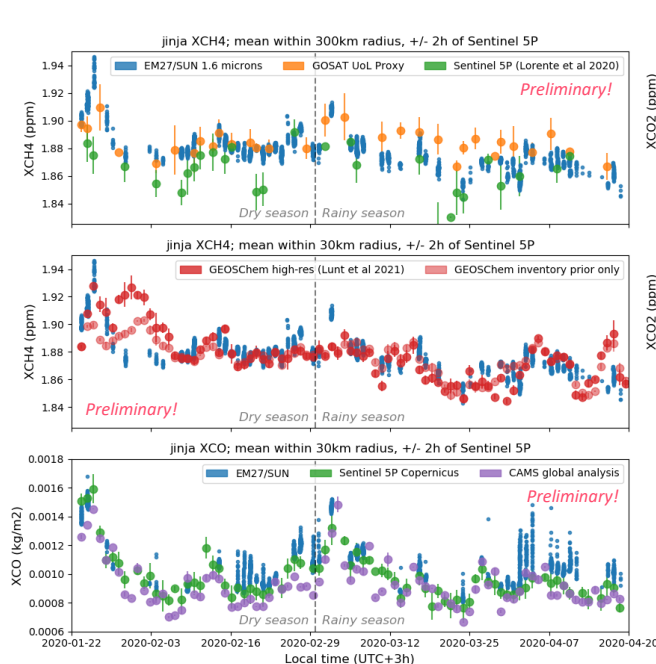
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- Part of NERC Global Methane project MOYA

- Leicester EM27/SUN spectrometer and TU Munich enclosure hosted by NaFIRRI in Jinja, Uganda

- Operated for an initial 3 month deployment from January to April 2020, data processed using COCCON tools – *returning to Jinja later this month for a 12 month deployment*

- Ideal location for methane emissions from wetlands and agriculture, GHGs and carbon monoxide from biomass burning

- Filling gap in satellite and model validation networks over tropical East Africa

jinja XCH4; mean within 300km radius, +/- 2h of Sentinel 5P — EM27/SUN 1.6 microns, GOSAT UoL Proxy, Sentinel 5P (Lorente et al 2020). Preliminary!

jinja XCH4; mean within 30km radius, +/- 2h of Sentinel 5P — GEOSChem high-res (Lunt et al 2021), GEOSChem inventory prior only. Preliminary!

jinja XCO; mean within 30km radius, +/- 2h of Sentinel 5P — EM27/SUN, Sentinel 5P Copernicus, CAMS global analysis. Preliminary!

jinja XCO2; mean within 300km radius, +/- 2h of OCO-2 — EM27/SUN 1.6 microns, OCO-2 v10 Lite, OCO-3 vEarly Lite. Preliminary!

jinja XCO2; mean within 300km radius, +/- 2h of OCO-2 — GEOSChem OCO-2 v10, CAMS global inversion. Preliminary!

MOTIVATION

- Many studies investigating greenhouse gas emissions in Tropical Africa are based on satellite and model datasets of atmospheric composition

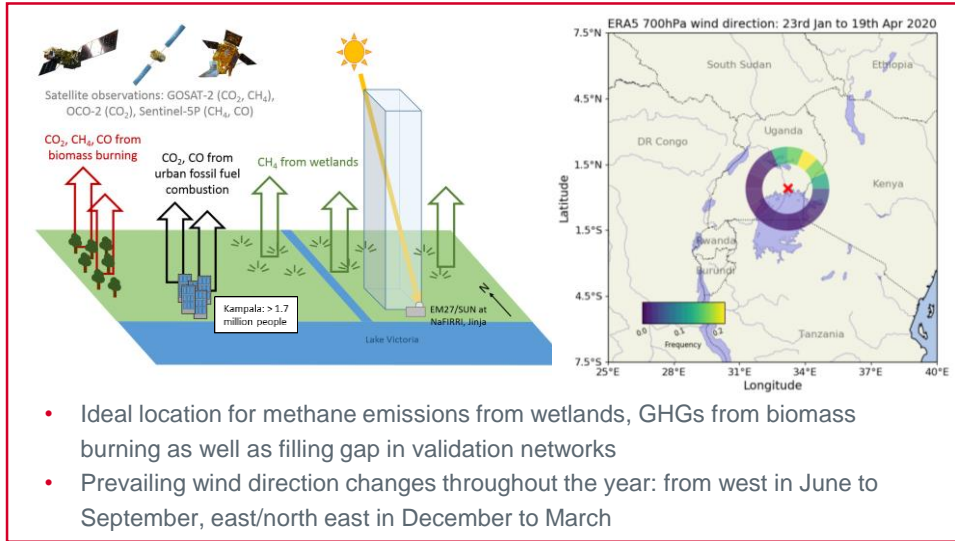Palmer et al (2019): Unexpectedly large net emissions from tropical Africa in 2015 and 2016
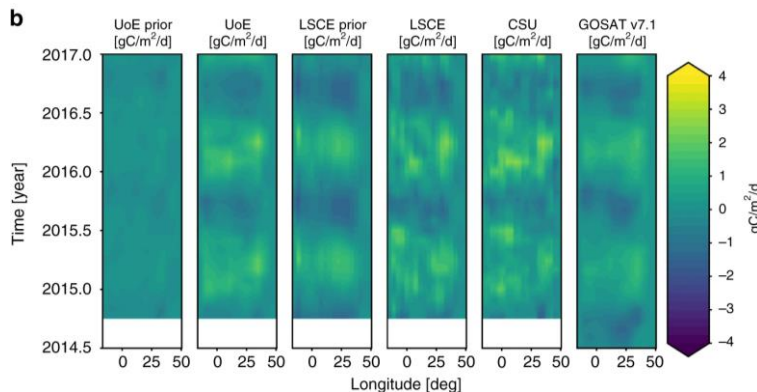
Lunt et al (2019): focus on methane, found robust positive linear trend in tropical African methane emissions over the period 2011 to 2016, consistent with increased wetland extent in the Sudd region
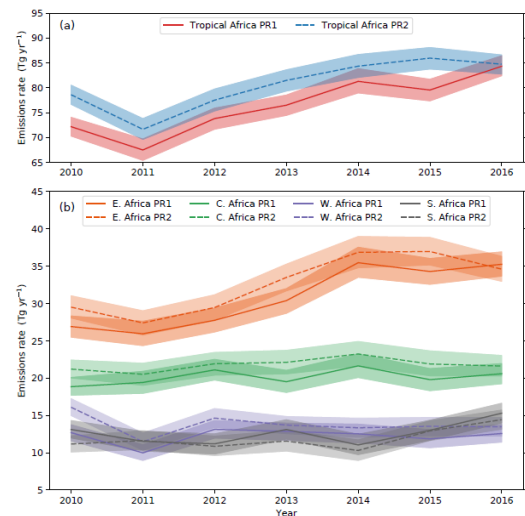

- *How well do these datasets represent what's happening in the atmosphere over the tropical Africa region?*

EM27/SUN DEPLOYMENT IN JINJA, UGANDA

- EM27/SUN and enclosure hosted at National Fisheries Resources Research Institute

- Ideal location for methane emissions from wetlands, GHGs from biomass burning as well as filling gap in validation networks
- Prevailing wind direction changes throughout the year: from west in June to September, east/north east in December to March

- Automated enclosure developed by TU Munich (see Dietrich et al 2021 in AMT) allows continuous remote operation via internet connection
- Environmental protection and stability provided by active cooling and heating, automatic retractable dome triggered by rain sensor
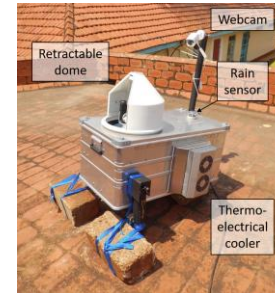

- *Initial deployment collected column greenhouse gas data from January to April 2020, processed using COCCON tools (PROFFAST)*

EM27/SUN OBSERVATIONS OF CH$_4$ AND CO

- Methane:

  - Satellite retrievals: University of Leicester GOSAT proxy (Parker et al 2020, ESSD), SRON Sentinel 5P TROPOMI (Lorente et al 2020, AMT)

  - Model data: high spatial resolution GEOSChem (0.25° x 3125°, Lunt et al 2021, ERL) with and without (i.e. inventory prior only) assimilation of S5P TROPOMI

  - GEOSChem used to infer surface fluxes from satellite data → essential to check that model captures observed variability and trends

- Carbon monoxide:

  - Satellite retrieval: Copernicus Sentinel 5P TROPOMI (Landgraf et al 2016, AMT)

  - Model data: Copernicus Atmospheric Monitoring Service (CAMS) global analysis (Inness et al 2019, ACP)

- Colocation criteria:

  - Time: ± 2 hours of Sentinel 5P overpass (1330 local time)

  - Space: < 30 km from Jinja for GEOSChem CH$_4$ and CO, extended to 300 km for satellite CH$_4$ to provide sufficient data for comparison
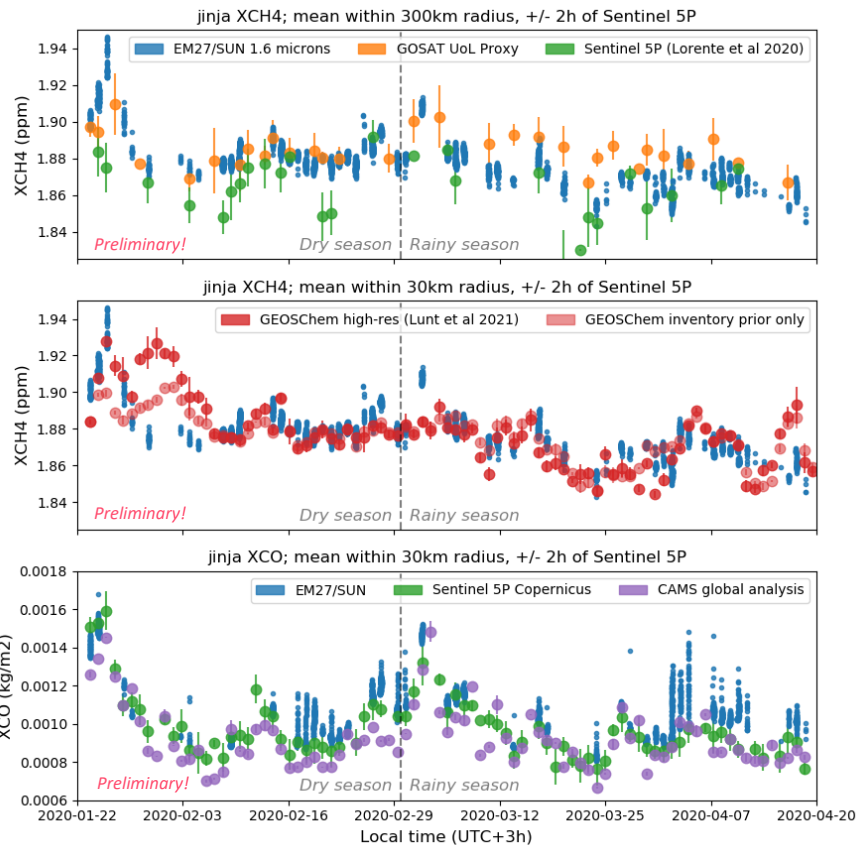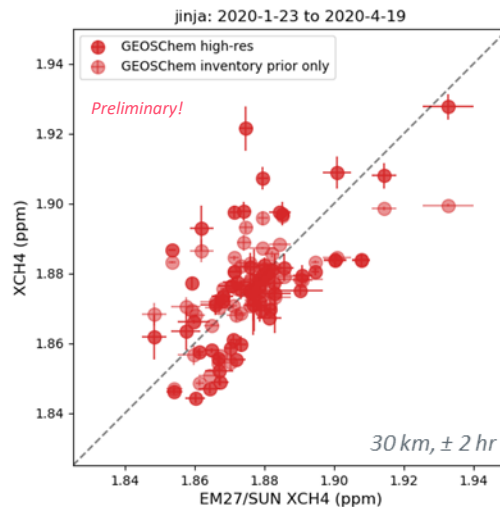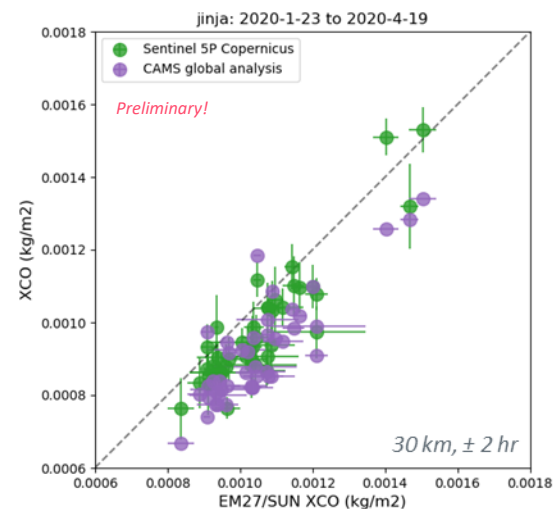
EM27/SUN OBSERVATIONS OF CH$_4$ AND CO
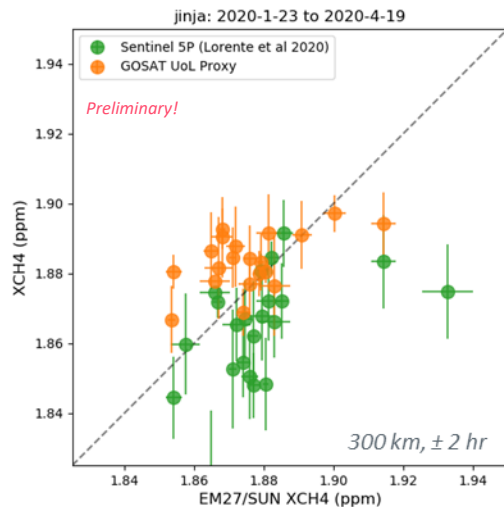
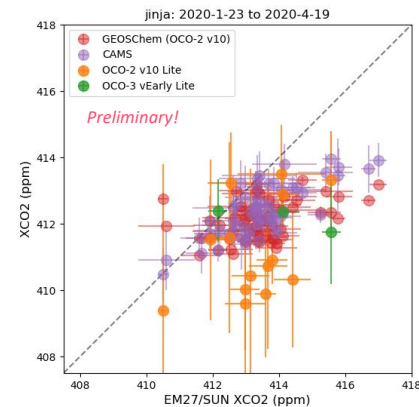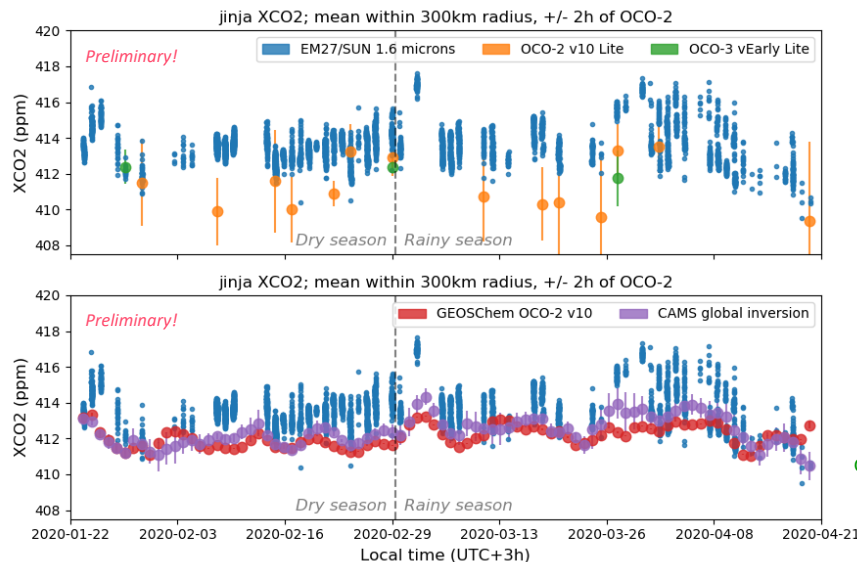Preliminary! Caveats: only 3 months of data, wider spatial colocation for CH$_4$ satellite retrievals vs. models

EM27/SUN OBSERVATIONS OF CARBON DIOXIDE

- Carbon dioxide:
  - Satellite retrievals: OCO-2 v10 Lite and OCO-3 vEarly Lite, data available from *https://ocov2.jpl.nasa.gov/oco-2-data-center/*
  - Model data: low spatial resolution global GEOSChem inversion (4° x 5°, Liang Feng, U. Edinburgh) and global CAMS inversion (1.9° x 3.75°)

- Colocation criteria:
  - Time: ± 2 hours of OCO-2 overpass (1335 local time)
  - Space: < 300 km from Jinja for both satellite and models to provide sufficient data for comparison (both models are low spatial resolution global inversions)

jinja XCO2; mean within 300km radius, +/- 2h of OCO-2

Preliminary!

Legend: EM27/SUN 1.6 microns | OCO-2 v10 Lite | OCO-3 vEarly Lite

XCO2 (ppm)

Dry season | Rainy season

jinja XCO2; mean within 300km radius, +/- 2h of OCO-2

Preliminary!

Legend: GEOSChem OCO-2 v10 | CAMS global inversion

XCO2 (ppm)

Dry season | Rainy season

Local time (UTC+3h)

jinja: 2020-1-23 to 2020-4-19

Legend: GEOSChem (OCO-2 v10) | CAMS | OCO-2 v10 Lite | OCO-3 vEarly Lite

Preliminary!

XCO2 (ppm)

EM27/SUN XCO2 (ppm)

OCO-2 v10 Lite (N=14) – EM27/SUN: **-2.04 (1.38) ppm**

OCO-3 vEarly Lite (N=3) – EM27/SUN: **-1.79 (1.66) ppm**

GEOSChem (N=61) – EM27/SUN: **-1.37 (1.12) ppm**

CAMS (N=61) – EM27/SUN: **-1.09 (0.80) ppm**

Preliminary! Caveats: only 3 months of data, wide spatial colocation, only three OCO-3 overpasses in same time window as OCO-2

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