PROMCOM

Production of lower tropospheric methane and carbon monoxide distributions through combined use of ESA Sentinel-5 Precursor shortwave infrared and IASI/CrIS thermal infrared satellite data

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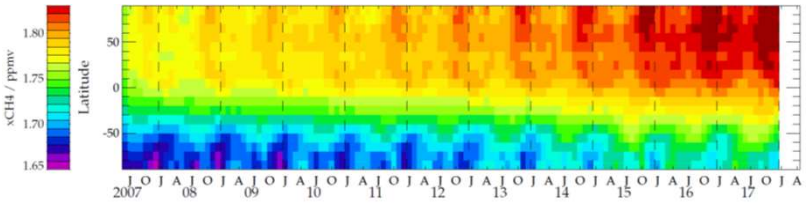
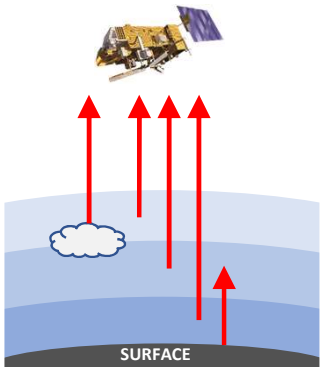
Project Background

- Studying methane (CH_4) and carbon monoxide (CO)
  - CH_4: Potent greenhouse gas. Concentrations rising globally.
  - CO: Effective pollutant tracer. Precursor for tropospheric ozone.

IASI xCH_4



- Satellite remote sensing in thermal infrared (TIR) or shortwave infrared (SWIR)

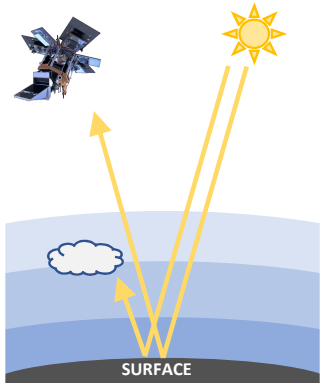


TIR (IASI/CrIS)

- Measurement: Thermal emission (from Earth/atmosphere)
- Measurement type: Height-resolved (reduced sensitivity towards surface)
- Coverage: Day+night, land+ocean

SWIR (Sentinel-5P)

- Measurement: Surface reflected sunlight
- Measurement type: Total column
- Coverage: Day only, land (+ocean, over low altitude cloud)



- RAL Shortwave Thermal InfraRed (RASTIR) retrieval
  - ➢ Combined Level-2 SWIR-TIR retrieval (S5P+IASI *or* S5P+CrIS)

Scientific Objectives

Exploit synergy between S5P and IASI/CrIS satellite measurements to resolve CH_4 and CO in the lower troposphere, where emissions peak

- Apply RAL TIR IASI retrieval scheme to CrIS
  - CrIS overpass is~5 minutes from S5P (IASI is ~4 hours)
- Develop a synergistic SWIR-TIR retrieval algorithm
- Produce a 1-year SWIR-TIR dataset of lower tropospheric CH_4 and CO
- Demonstrate methodology in preparation for co-located Sentinel-5 and IASI-NG on MetOp-SG

Status at Mid-Term

Instrument	IASI	CrIS	S5P	S5P+IASI/CrIS
CH4 retrieval	RAL CH4	RAL CH4	RemoTeC-S5P	RASTIR
CO retrieval	RAL IMS	RAL IMS	SICOR	RASTIR

Pre-existing algorithms at RAL

S5P official L2 algorithms

L2 products pre-exist

L2 products developed

L2 products to be developed

- IMS CO retrieval applied to CrIS
- Comparisons of IASI, CrIS, and S5P CO retrievals to CAMS NRT data
- Updating the IASI CH_4 retrieval for application to CrIS
- Algorithm to combine SWIR and TIR Level-2 (L2) products set up mechanically

Comparisons – CO (I)

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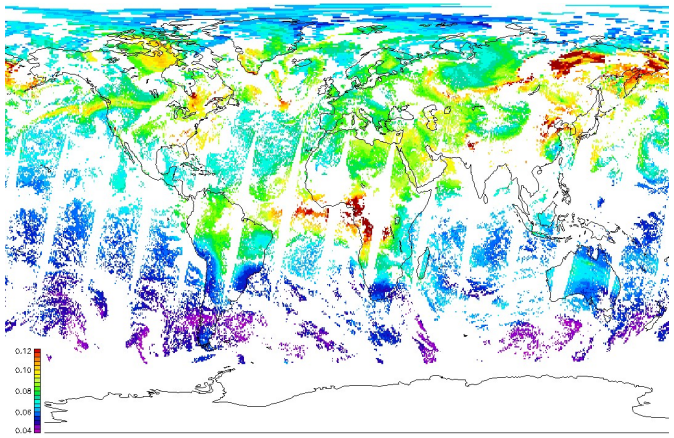
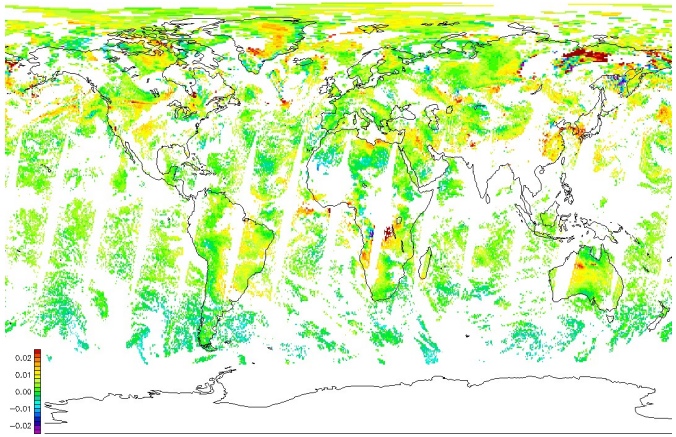
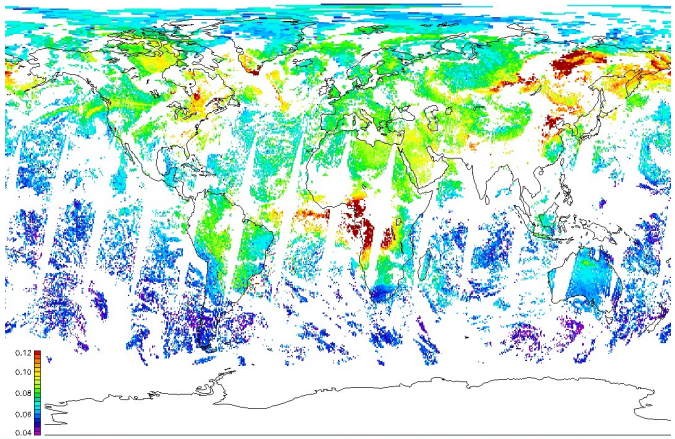
IASI



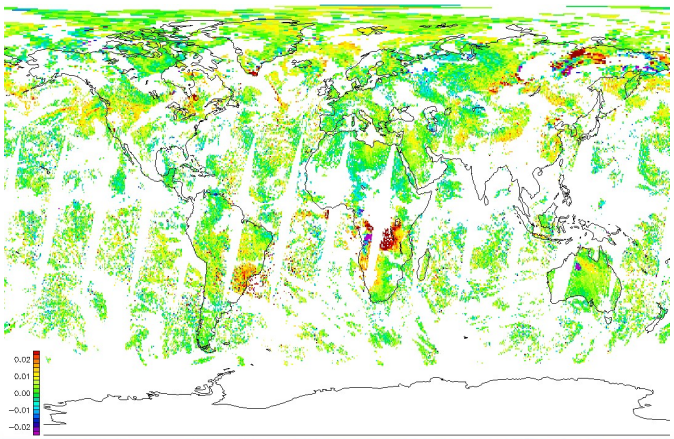
IASI – CAMS



S5P



S5P – CAMS



- Generally good agreement with CAMS
- Red/yellow areas indicate where satellite is higher
  - Features missing in CAMS?
  - Retrieval artefacts?

- Biomass burning in Central Africa and Siberia underestimated in CAMS

Comparisons – CO (II)

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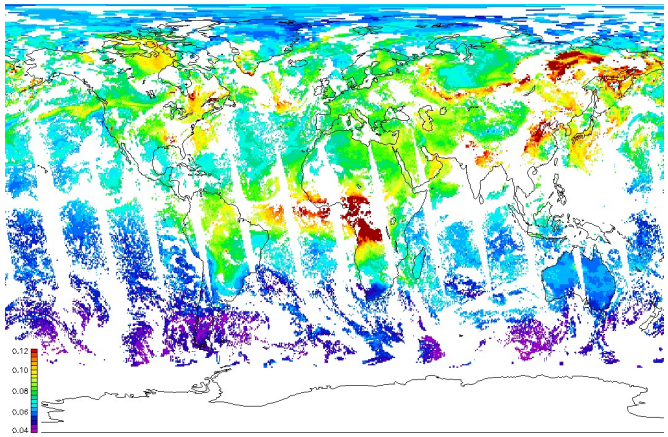
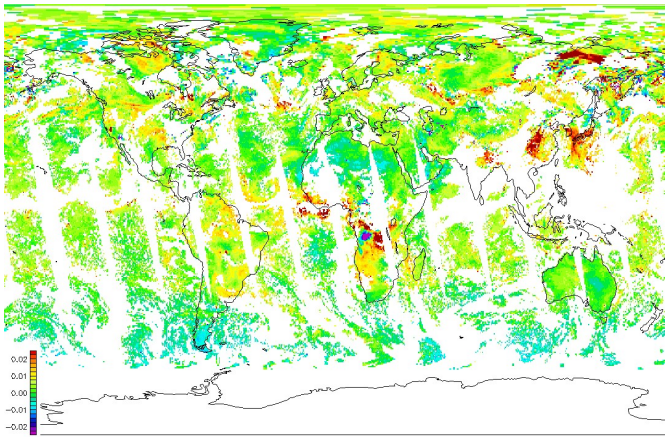
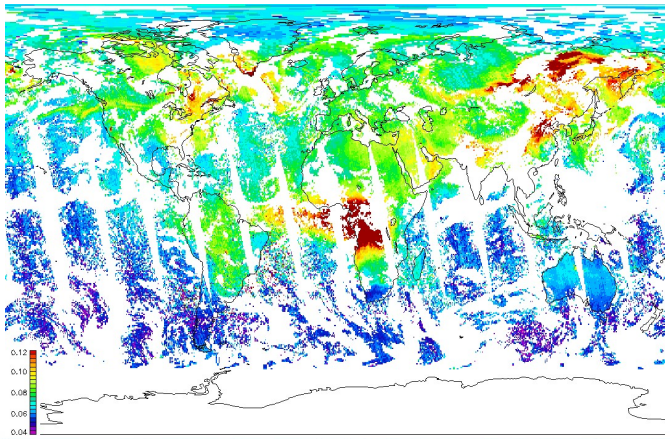
CrIS



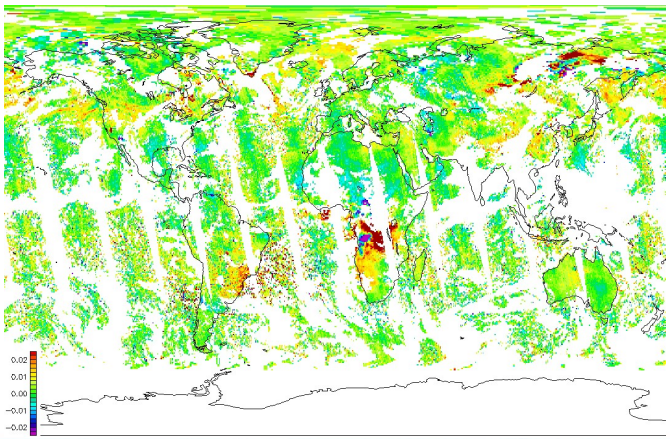
CrIS – CAMS



S5P

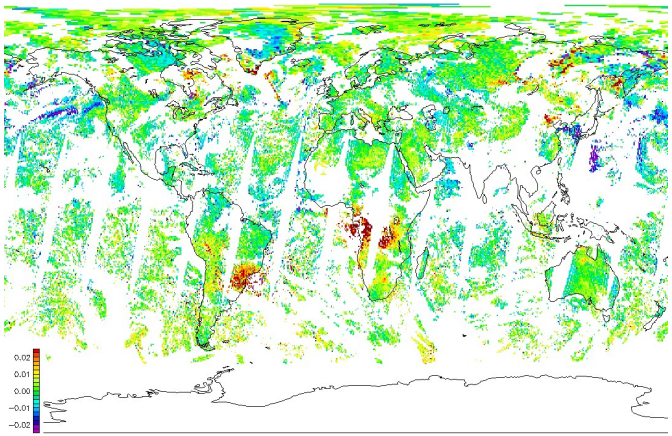


S5P – CAMS

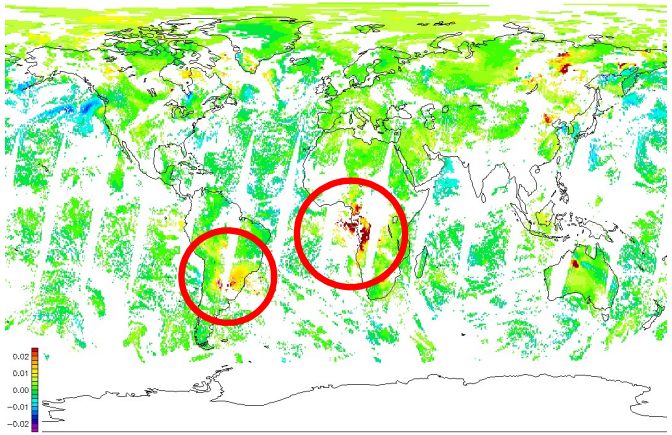


Comparisons – CO (III)

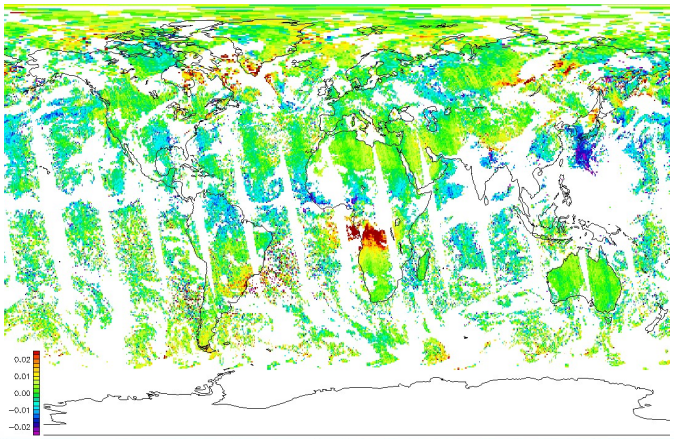
S5P – IASI



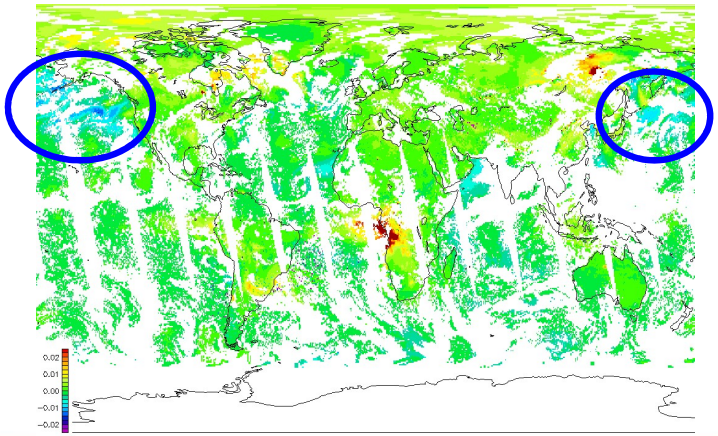
CAMS [S5P] – CAMS [IASI]



S5P – CrIS



CAMS [S5P] – CAMS [CrIS]



- CAMS difference plots indicate differences in SWIR/TIR sensitivity alone
  - Red : CO near surface
  - Blue : CO uplifted
- Generally differences as expected

Initial L2-L2 SWIR-TIR combinations

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Before combination

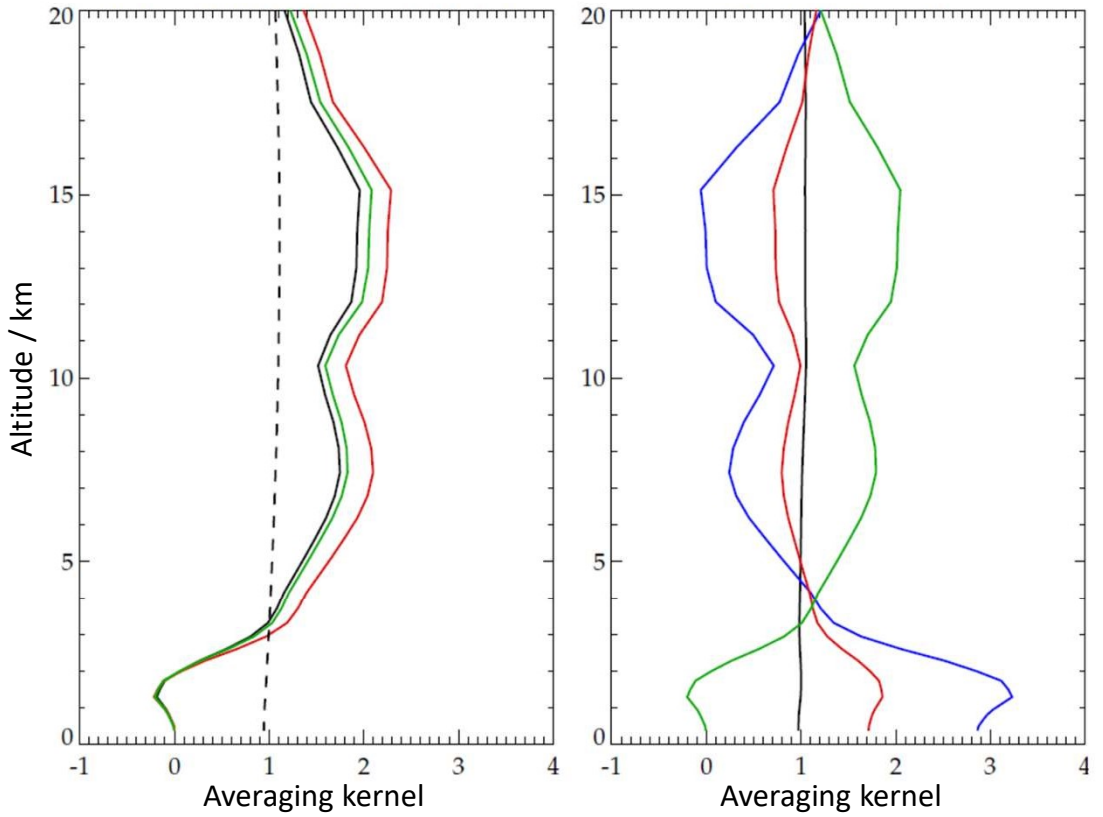
CrIS DOFS: 0.902 , S5P DOFS: 0.999

After combination

CrIS + S5P DOFS: 1.69

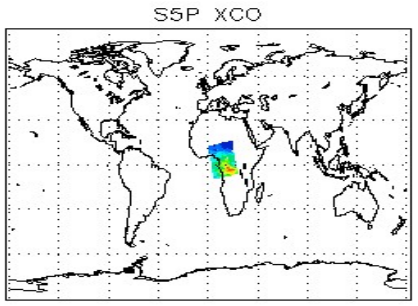
CrIS
- Total column
- 0 – 6 km
- 6 – 12 km

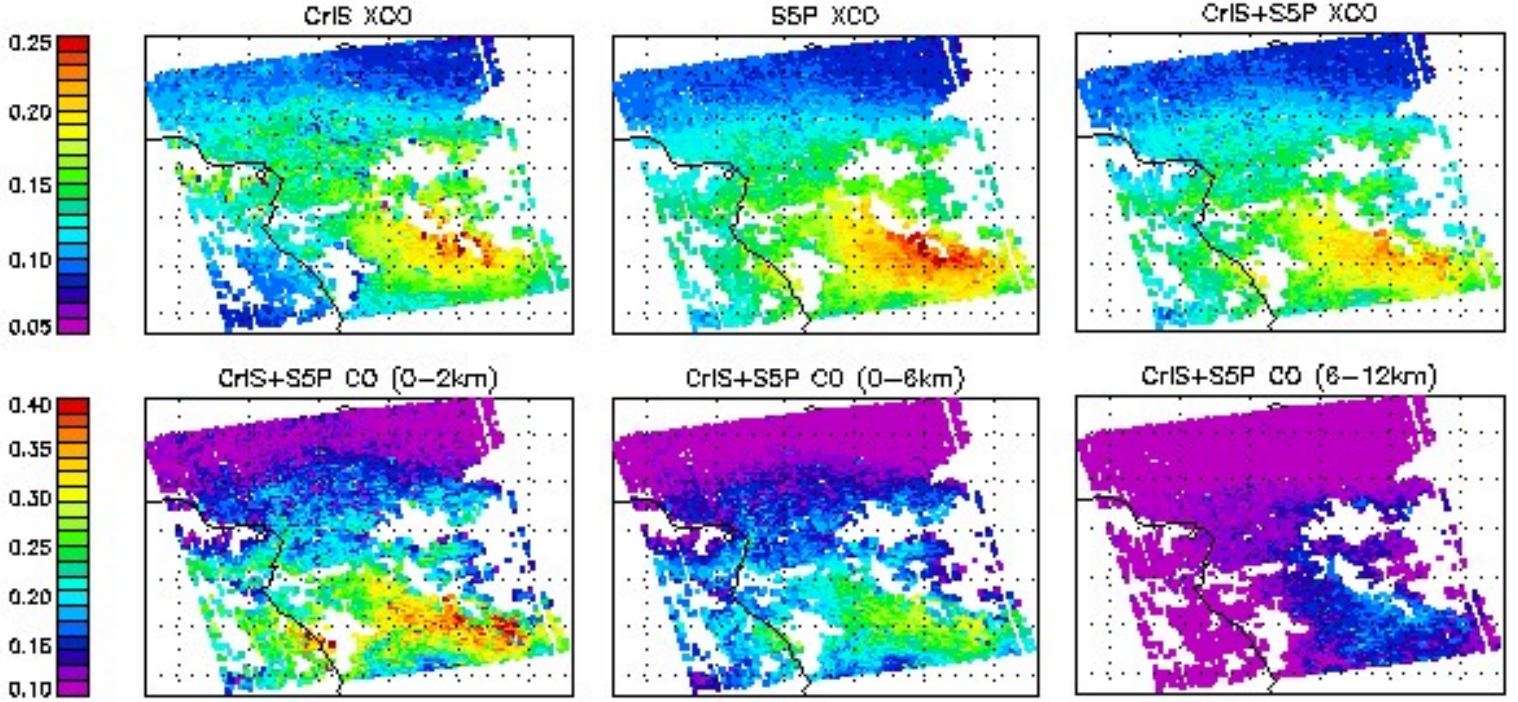
S5P
- Total column



CrIS + S5P
- Total column
- 0 – 2 km
- 0 – 6 km
- 6 – 12 km

Initial L2-L2 SWIR-TIR combinations





Next Steps

- Fine tuning of L2-L2 retrieval
- Improvement of TIR CH_4 scheme and application to CrIS
- L2-L1 retrievals – S5P + IASI/CrIS
- Comparison of joint retrieval schemes and dataset production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