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Global trace gas distributions from the extended Infrared and Microwave Scheme for studies of Atmosphere – biosphere interaction

Richard Siddans

STFC – Rutherford Appleton Laboratory

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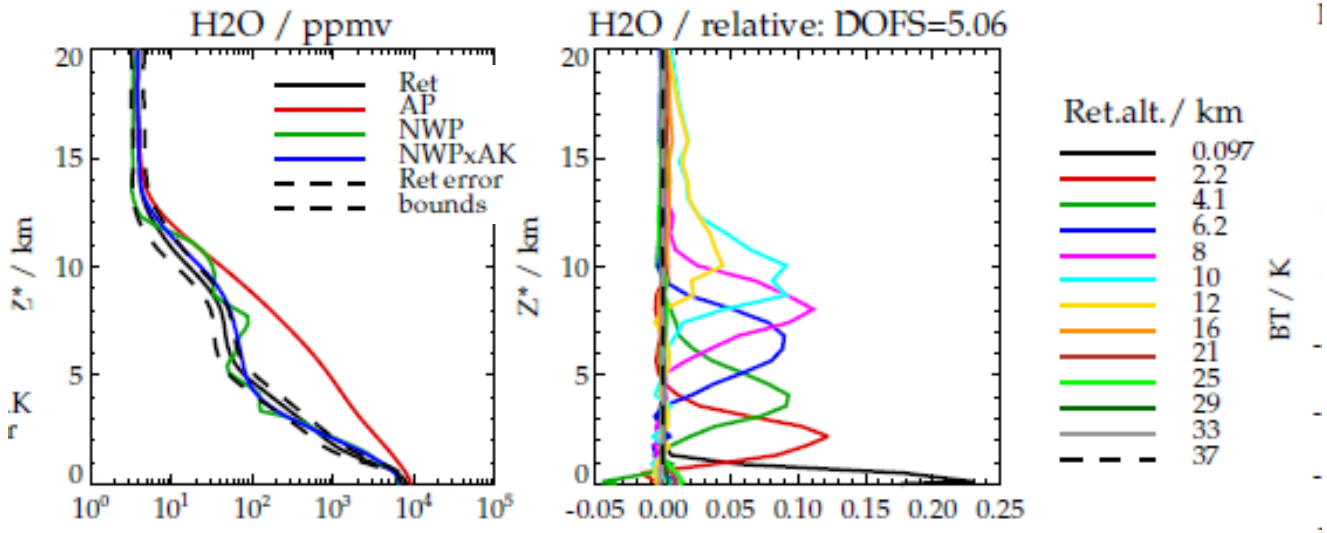
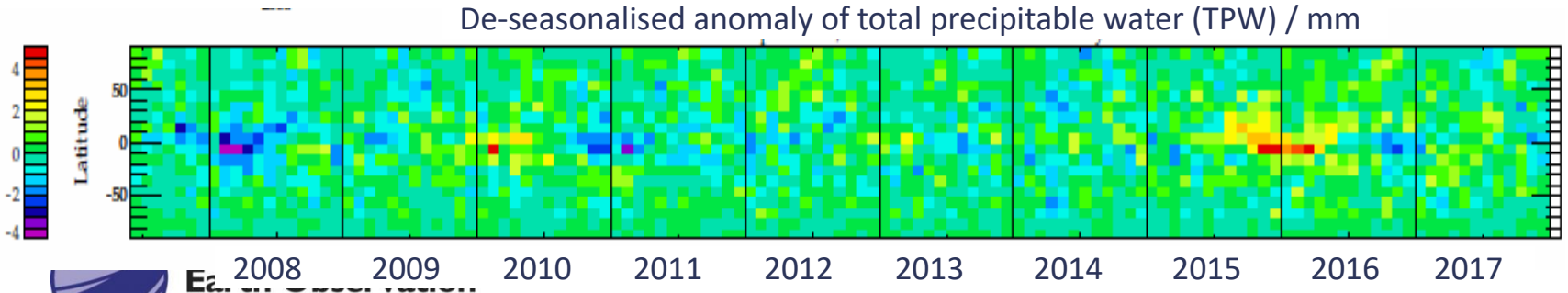
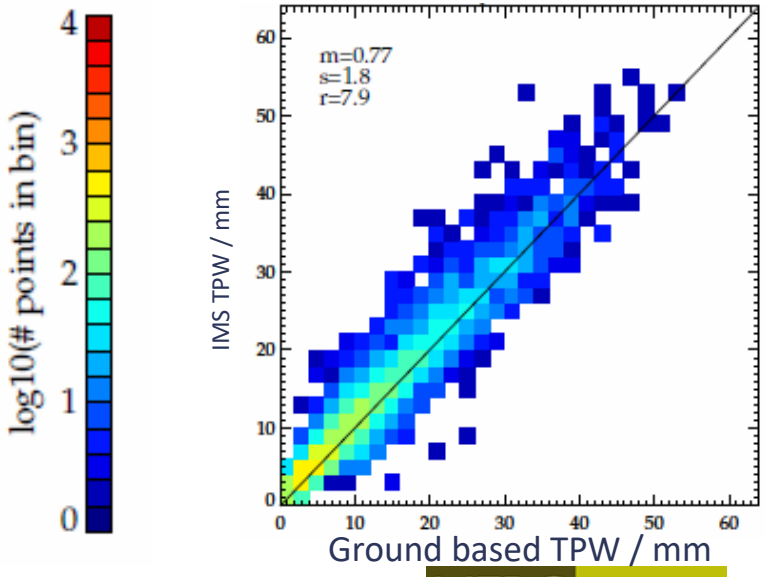
Overview of IMS "version 1" scheme

- Infra-red / Microwave sounder scheme developed by RAL starting from Eumetsat operational optimal estimation scheme for IASI temperature, humidity and ozone
- IMS adds use of microwave sounders + joint retrieval of surface spectral emissivity and effective cloud parameters
- Uses simple time independent a priori.
- Full Metop A mission (to 2017) processed and on CEDA
- Used by Leicester+Oxford and in ESA CCI+ Water vapour







m = mean difference
s = half difference between 16 & 84%ile
r = half difference between 1 & 99%ile

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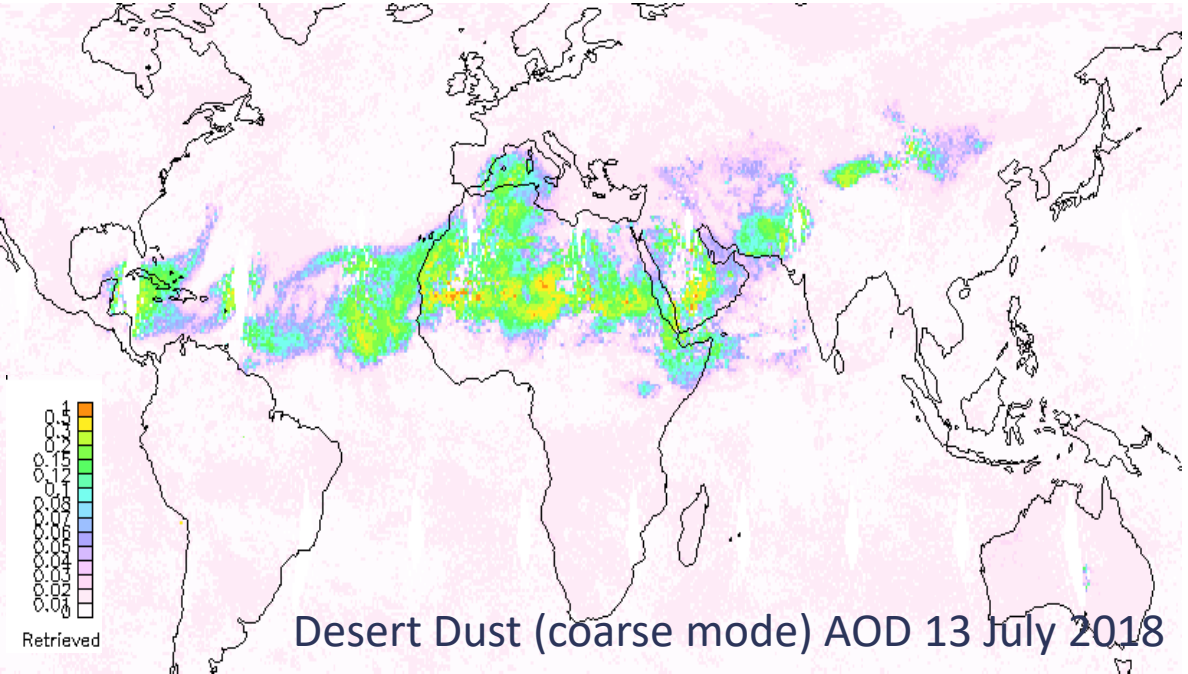
Advances for IMS Version 2

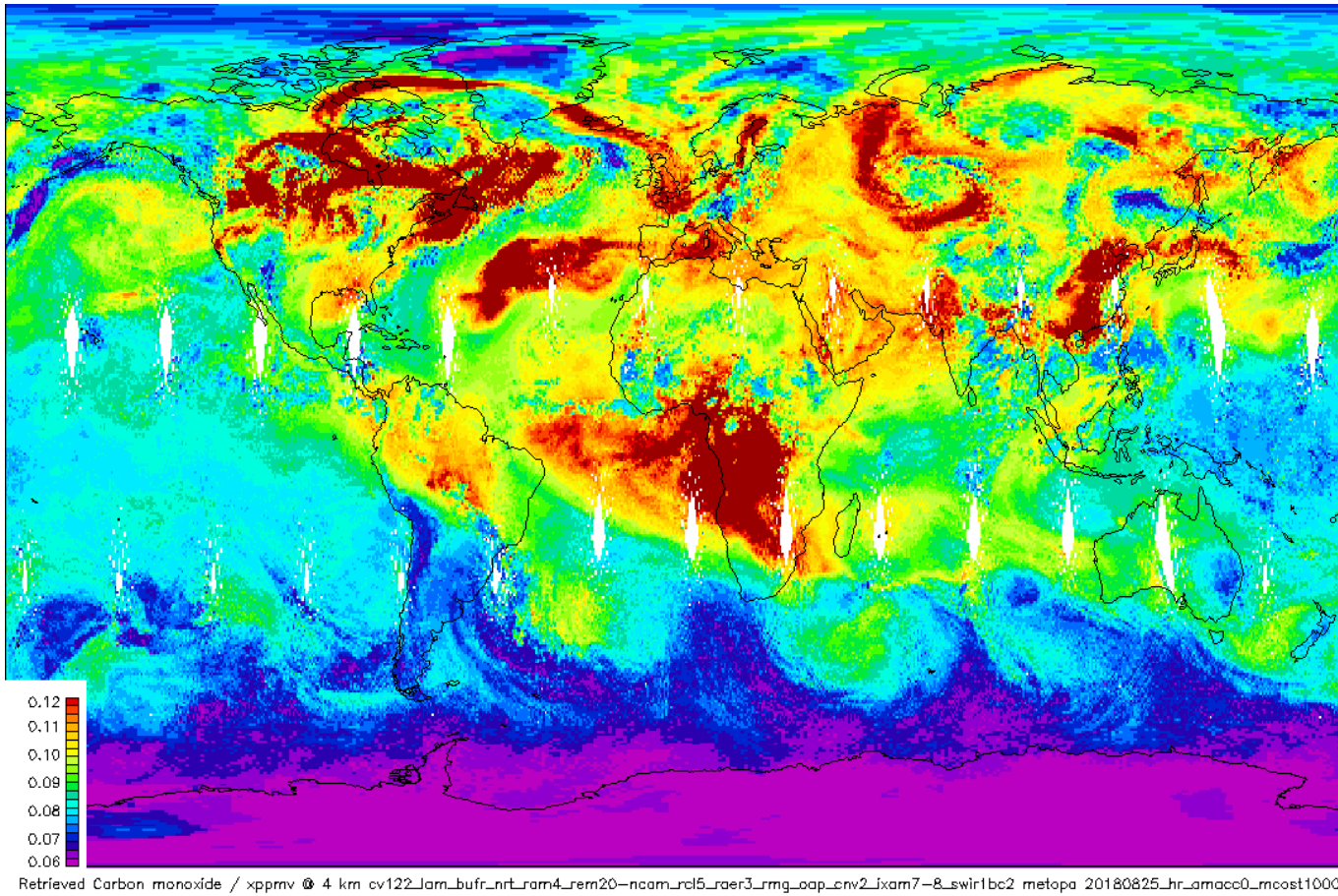
Recent release of RTTOV 12.2 exploited to enable

- Inclusion of IASI channels with solar contribution
- Cloud modelled as (DOM) scattering layer with retrieved optical depth, height + effective radius
- CO and short-wave emissivity added to the state vector
- Joint-retrieval of desert dust + H2SO4 aerosol
- Better representation of land surface reflection
- Added minor gas scale factors:
  NH3, CH3OH, HNO3, SO2, HCOOH (***with AKs***)
- Ozone retrieval improved



Desert Dust (coarse mode) AOD 13 July 2018

Total column average Carbon Monoxide (ppmv) 25 Aug 2018



- Inclusion of dust improves emissivity retrieval (and ozone)
- Scheme moved into Metop ***near-real time*** system
- Scheme successfully transferred to ***NPP CrIS for combination with S5P***

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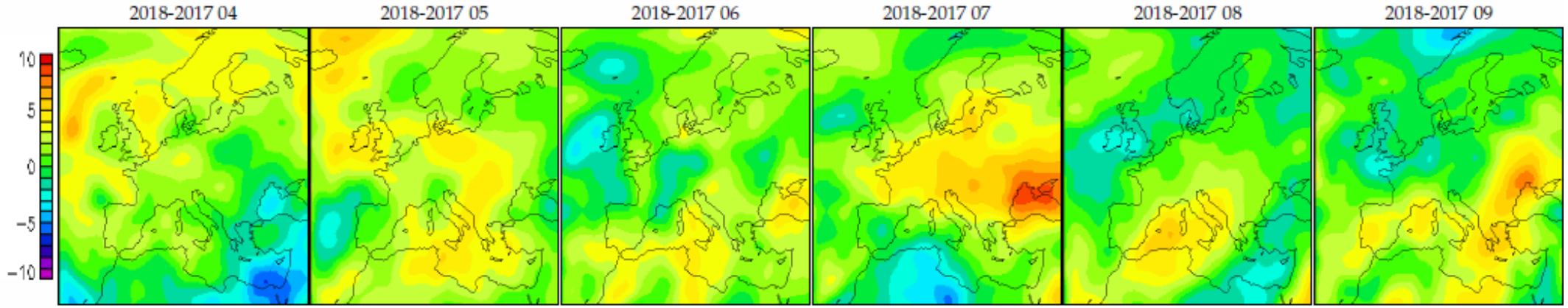
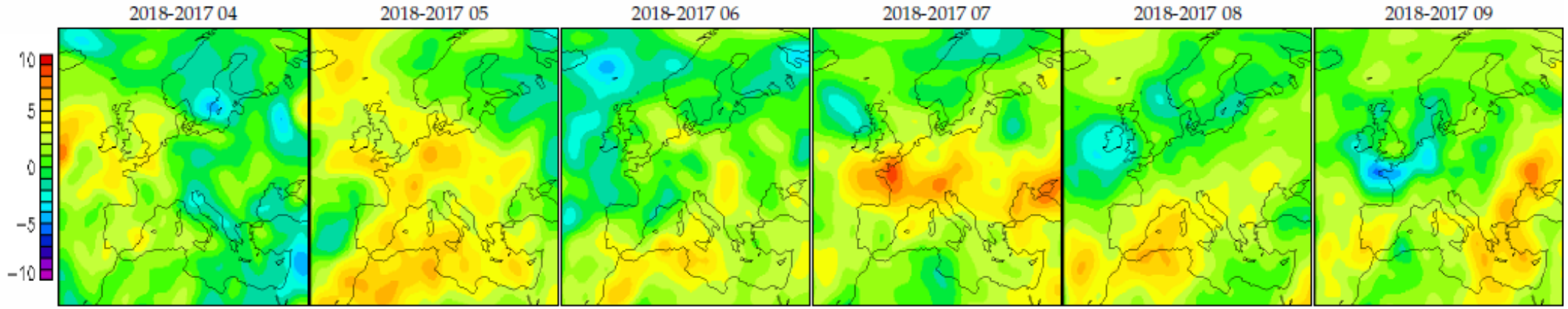
Summer 2018-2017 Trop Ozone differences: IASI and GOME-2



IASI: Co-located GOME-2 (Metop A): 1.5 deg smoothed

O3 0-6km / DU mk_1718_multipanel_ao3p_sm6



GOME-2 (Metop A): 1.5 deg smoothed

Next step: Combined uv+IR retrieval (also CO+CH4)

O3P O3 0-6km / DU mk_1718_multipanel_ao3p_sm6

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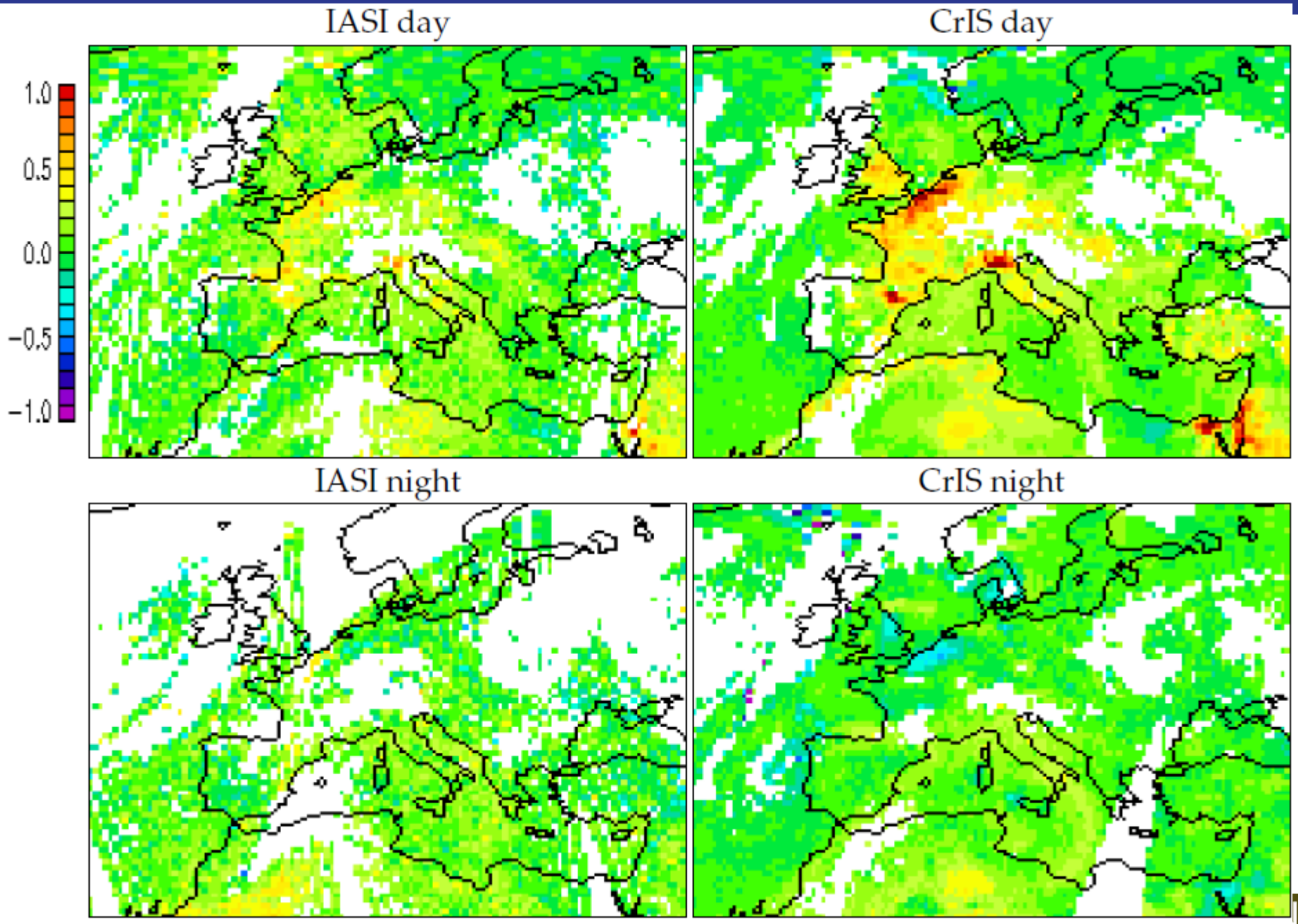
Total xNH3 (ppb)

15 July 2018



Retrieved NH3 mk_cris_comp_20180715_region3

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Raikoke Volcano: SO2 + H2SO4

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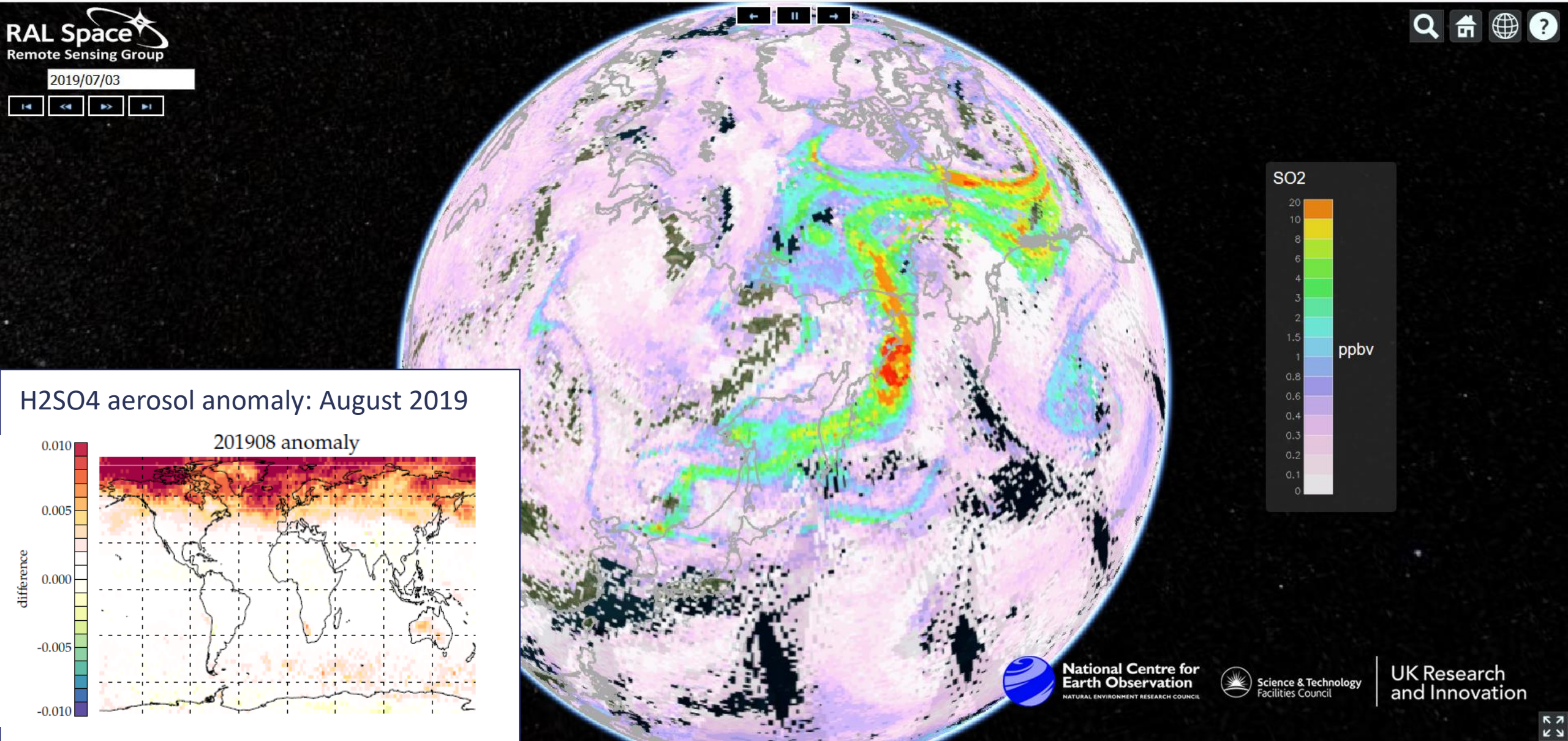
gws-access.ceda.ac.uk/public/rsgnceo/web_internal/rsg_data_viewer/



H2SO4 aerosol anomaly: August 2019

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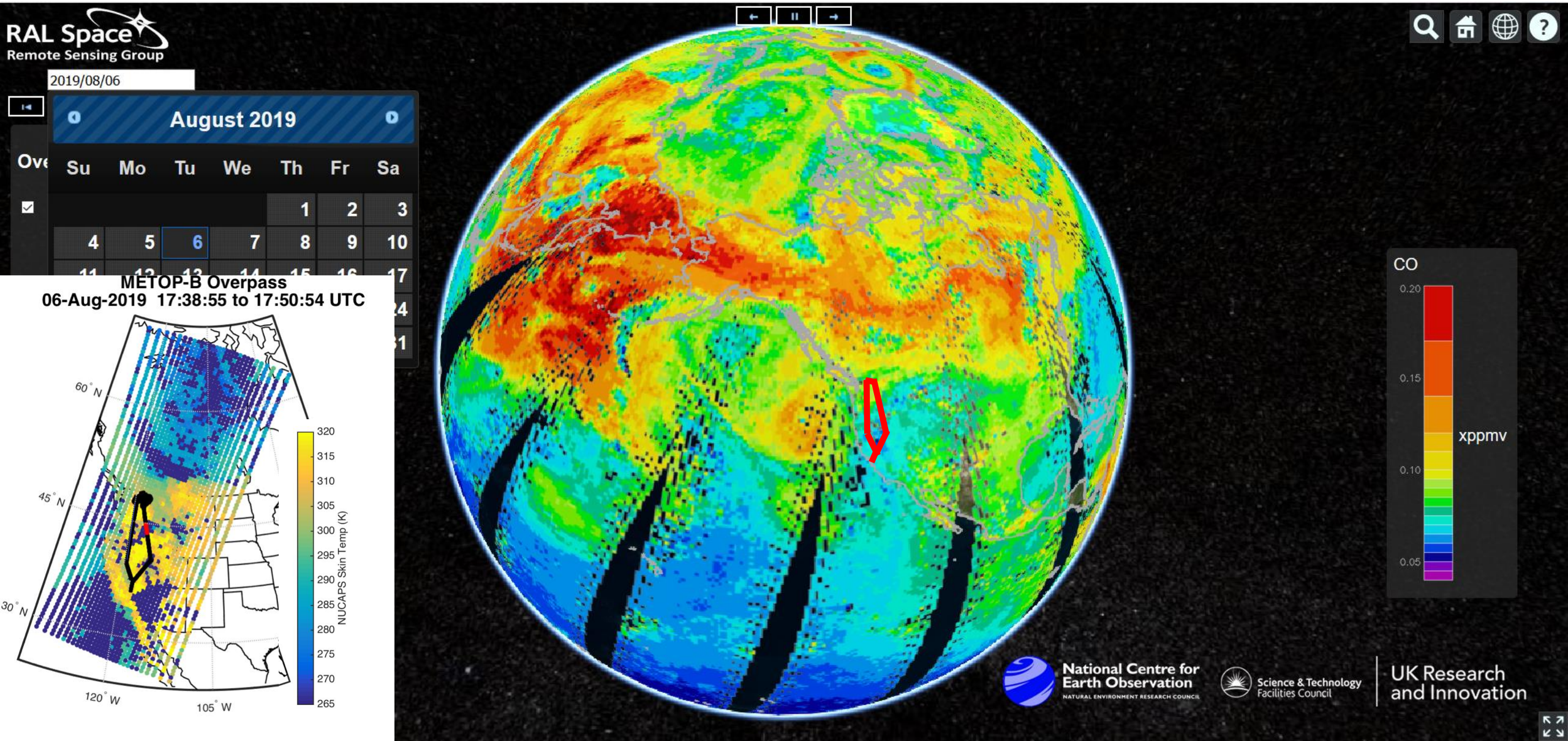
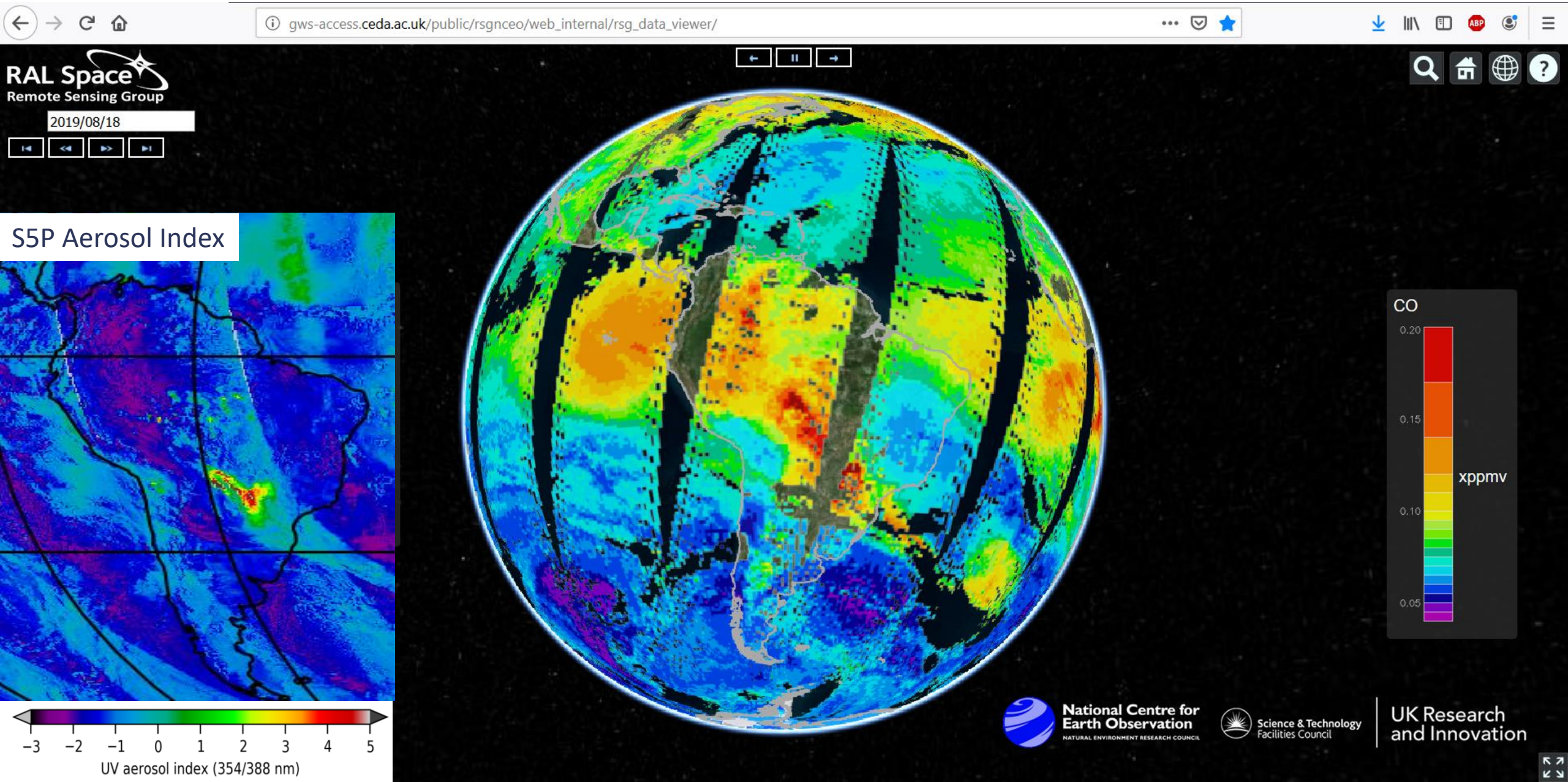
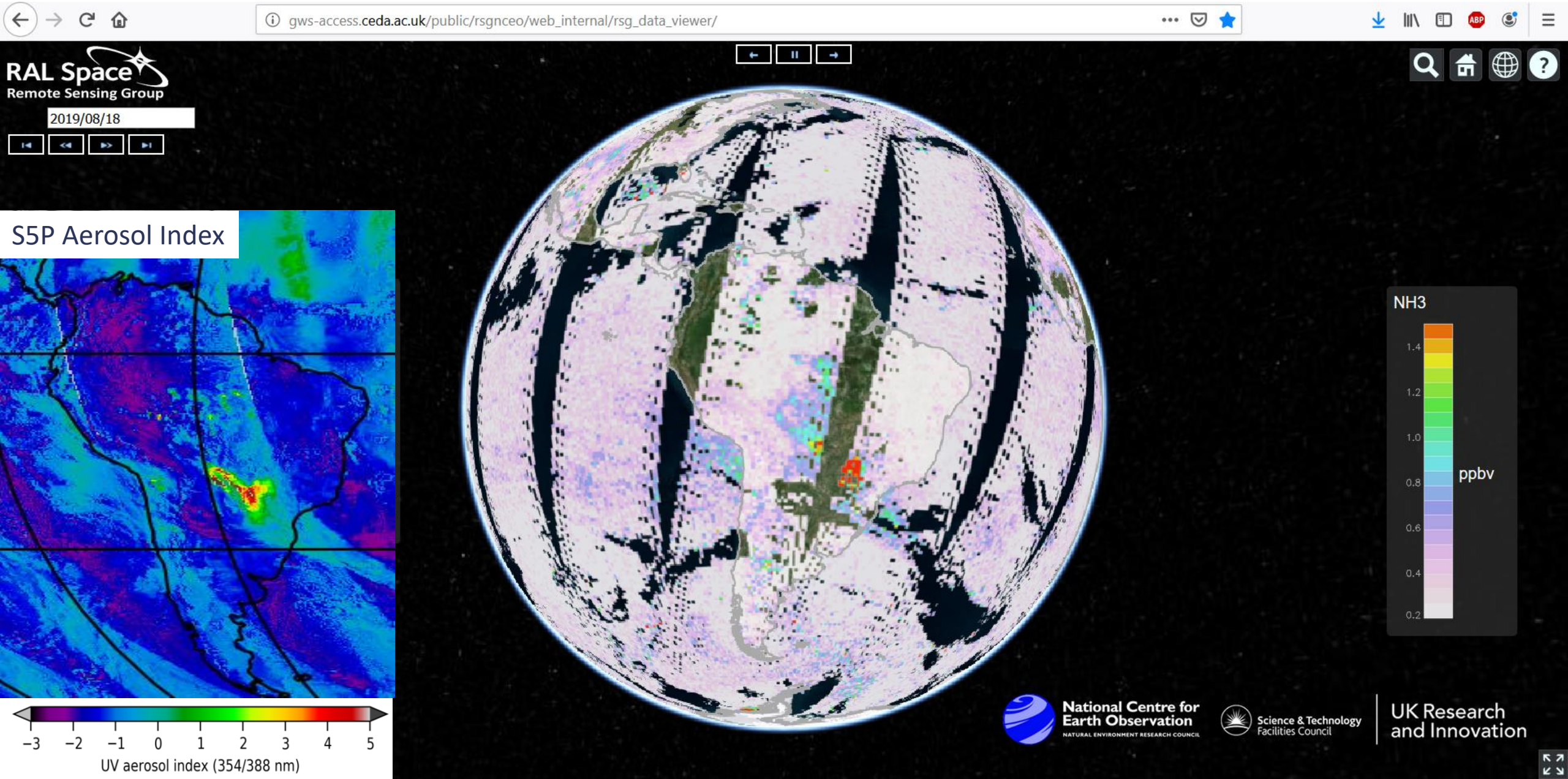
Support for FIREX-AQ ER2 Campaign on North America Fires



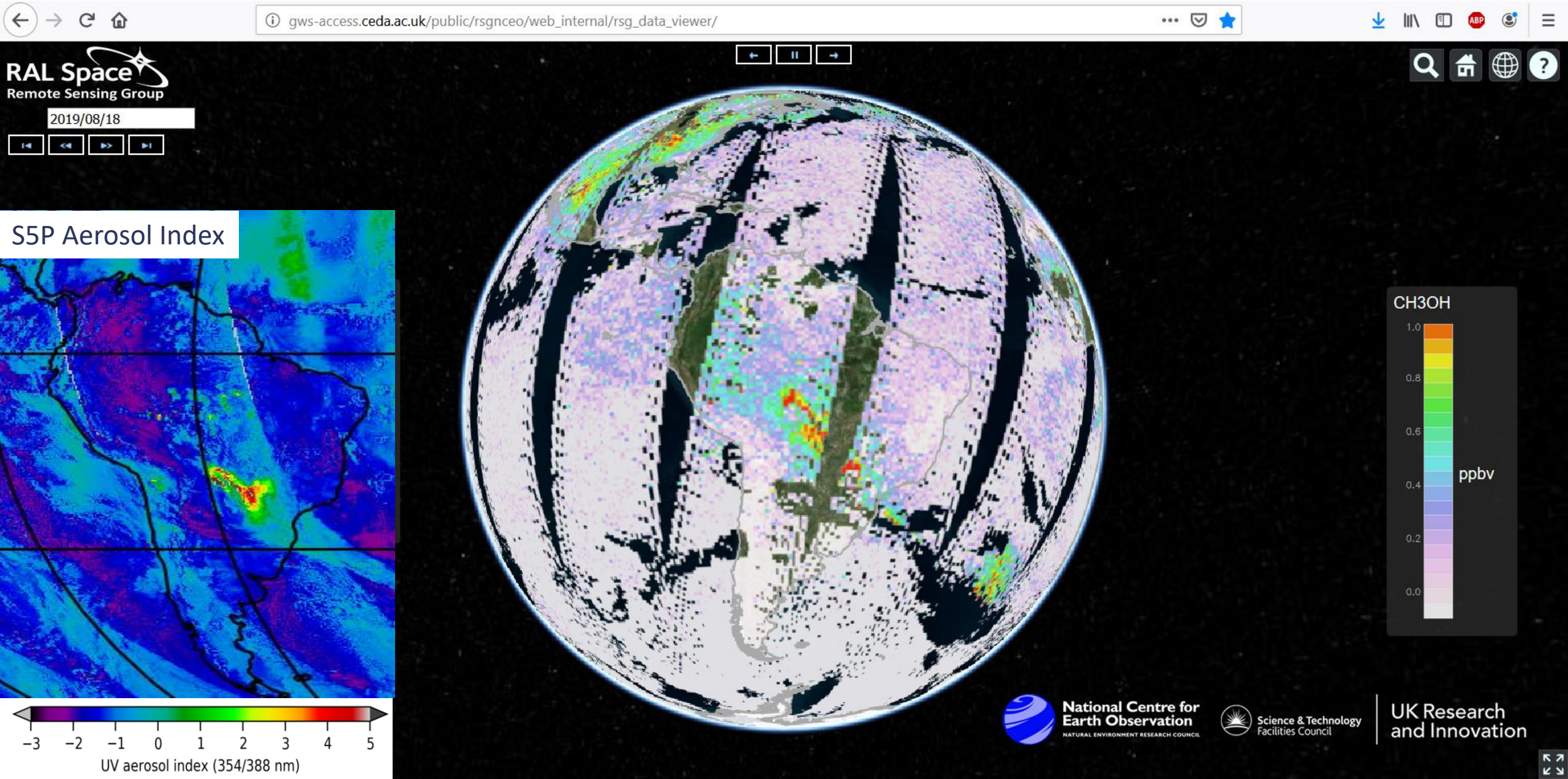
Amazon Fires 2019: Near-real Time CO: 18 August



Amazon Fires 2019: Near-Real Time Ammonia: 18 August



Amazon Fires 2019: Near-real time Methanol: 18 August



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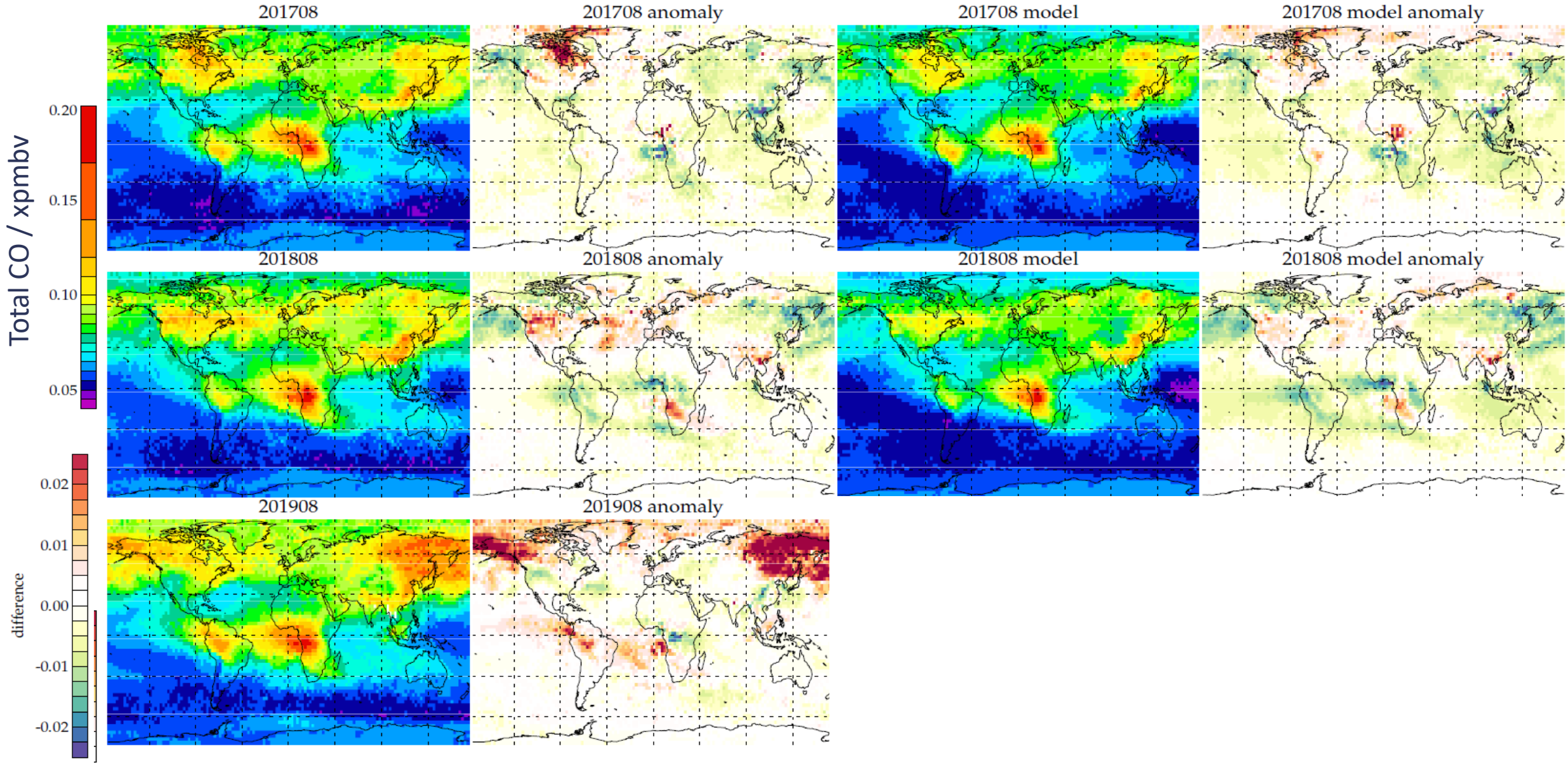
CO August 2017,2018,2019

IMS Retrievals

ECMWF/CAMS



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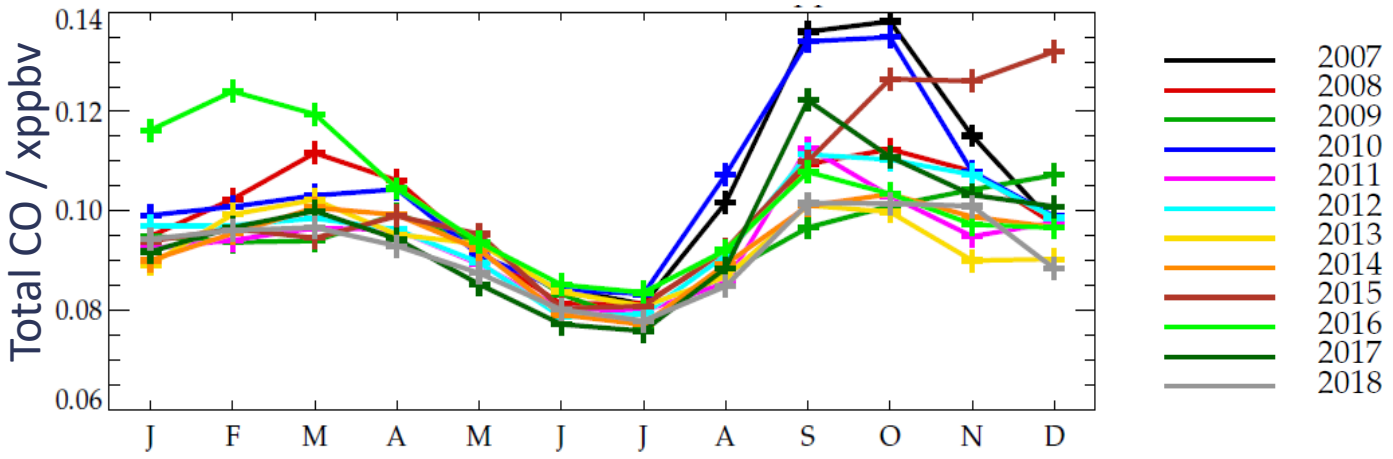
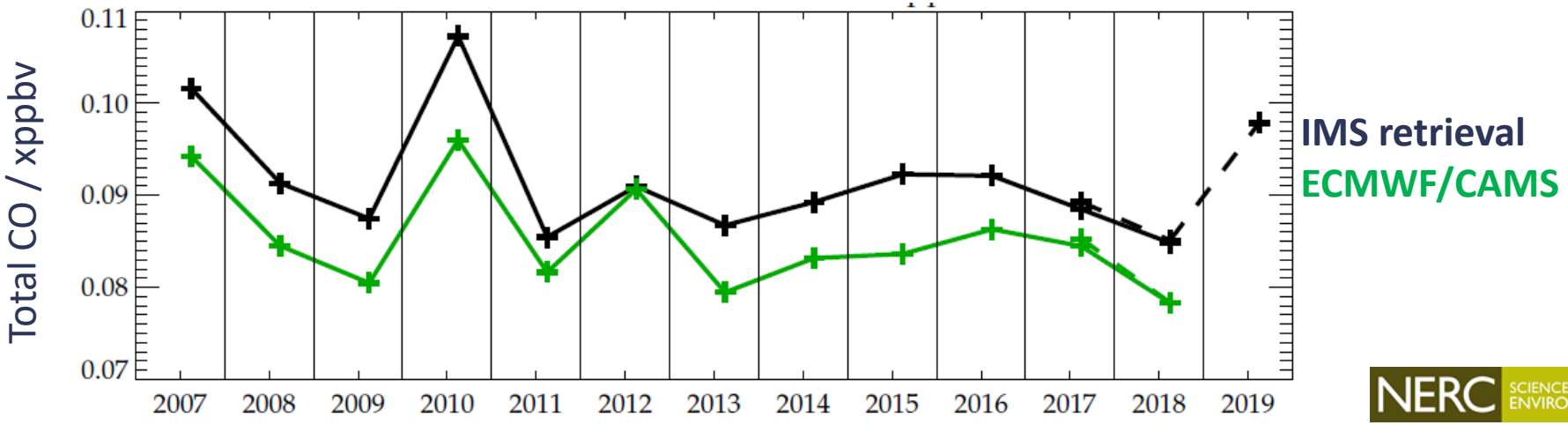
CO Timeseries: Tropical South America

Metop A results 2017-2018



Metop A+B (dashed) for August 2017-2010



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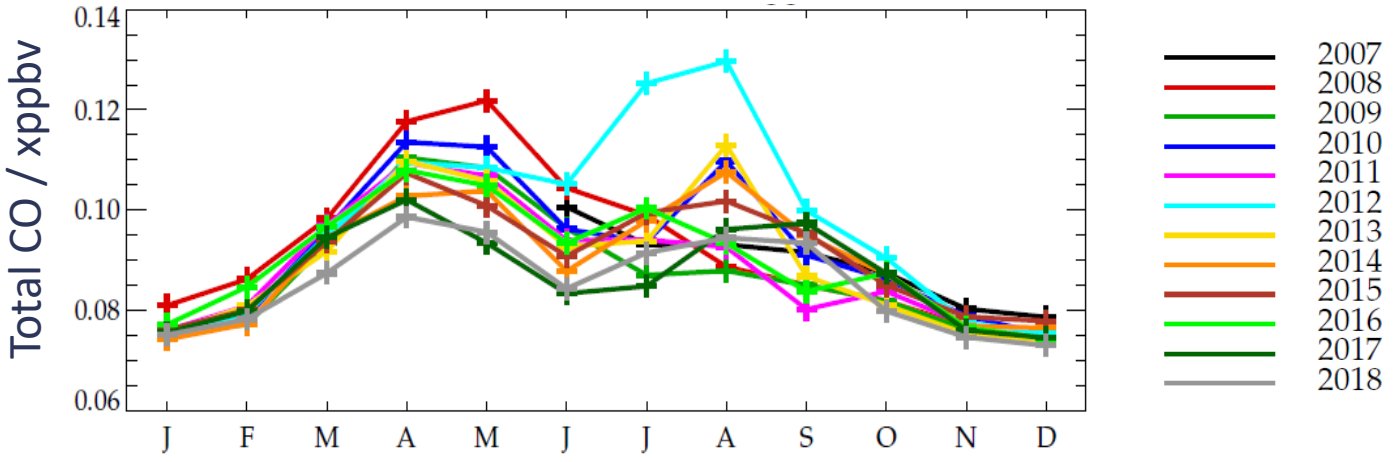
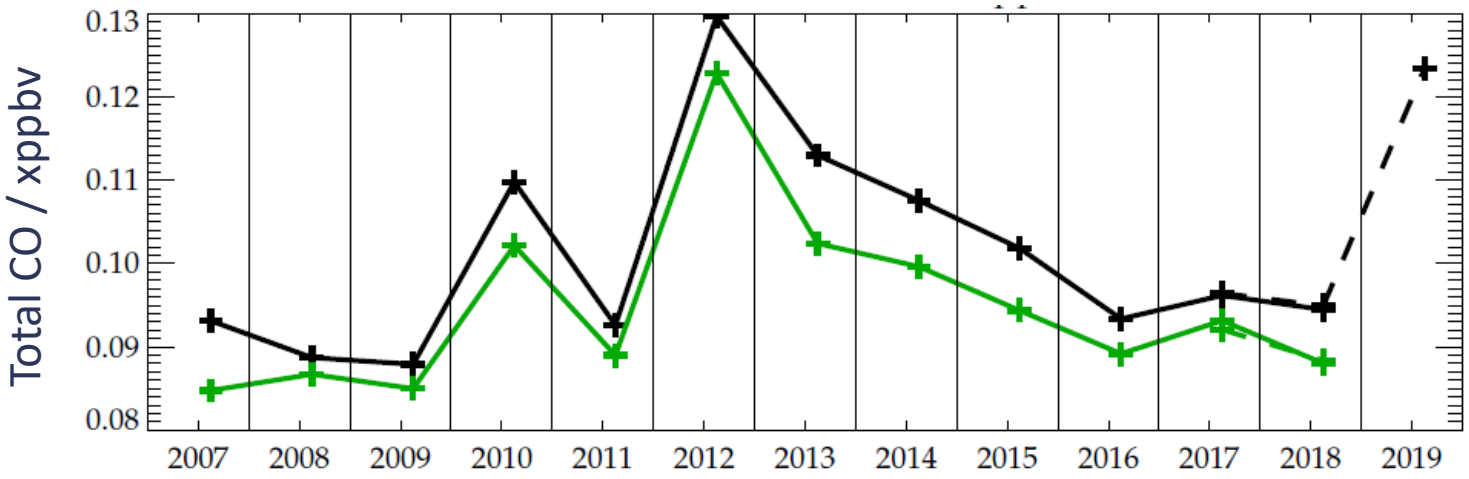
CO Timeseries: Boreal Eurasia

Metop A results 2017-2018



Metop A+B (dashed) for August 2017-2010



IMS retrieval
ECMWF/CAMS

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Summary

- Infra-red + Microwave Sounder (IMS) “v1” scheme applied to whole Metop-A mission
  - Results used by RAL, Leicester + Oxford as backround for other trace-gas retrievals
  - Within CCI+ water vapour
- Advances implemented in “v2” building on RTTOV12:
  - Extension to SWIR channels including joint fit of CO
  - Joint fit of aerosol + additional minor gases
  - Ozone greatly improved, paving way to joint GOME-2/IASI
- IMS successfully transferred to Suomi-NPP (CrIS,ATMS) paving way for joint CO + CH4 retrievals with S5P – to be taken forward via D. Knappett ESA fellowship
- Advanced scheme functioning in prototype near-real-time system
- Areas for further work include
  - Continued axploitation of data in collaboration with NCEO colleagues
  - Full processing of IASI with IMS v2 (then CH4 v2); Depends on Eumetsat re-processed L1
  - Re-processing of CH4 with improved IMS (NB H2SO4 aerosol impact)
  - Application to geostationary TIR spectrometers including recently launched GIIRS

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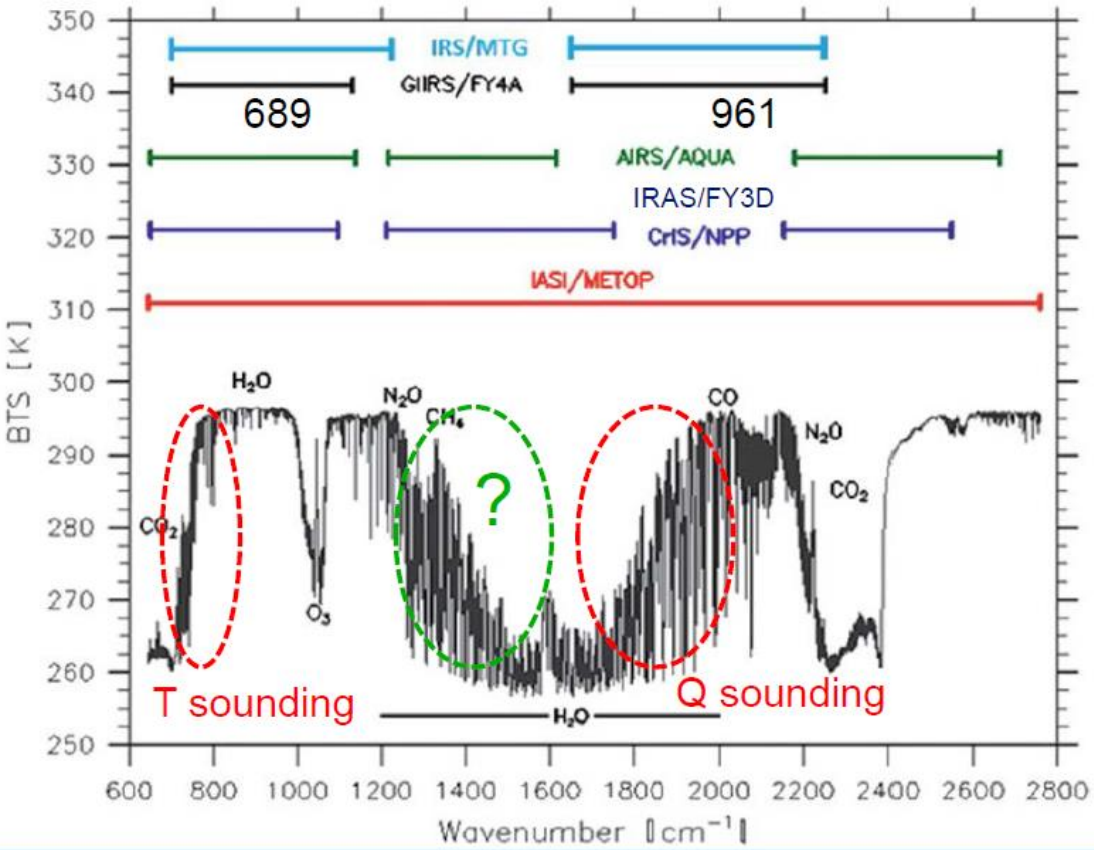
Interest in new geostationary TIR sounder ?

- Data from Chinese Geostationary FTIR sounder GIIRS now available via Eumetsat
- Similar spectral resolution to CrIS but Misses CH4 and SO2

GIIRS spectral coverage and comparisons with others



Yang J, Zhang Z, Wei C, Guo Q. : 2017,
Introducing the new generation of Chinese geostationary weather satellites – FengYun 4 (FY-4) [J]. Bulletin of the American Meteorological Society. DOI:10.1175/BAMS-D-16-0065.1

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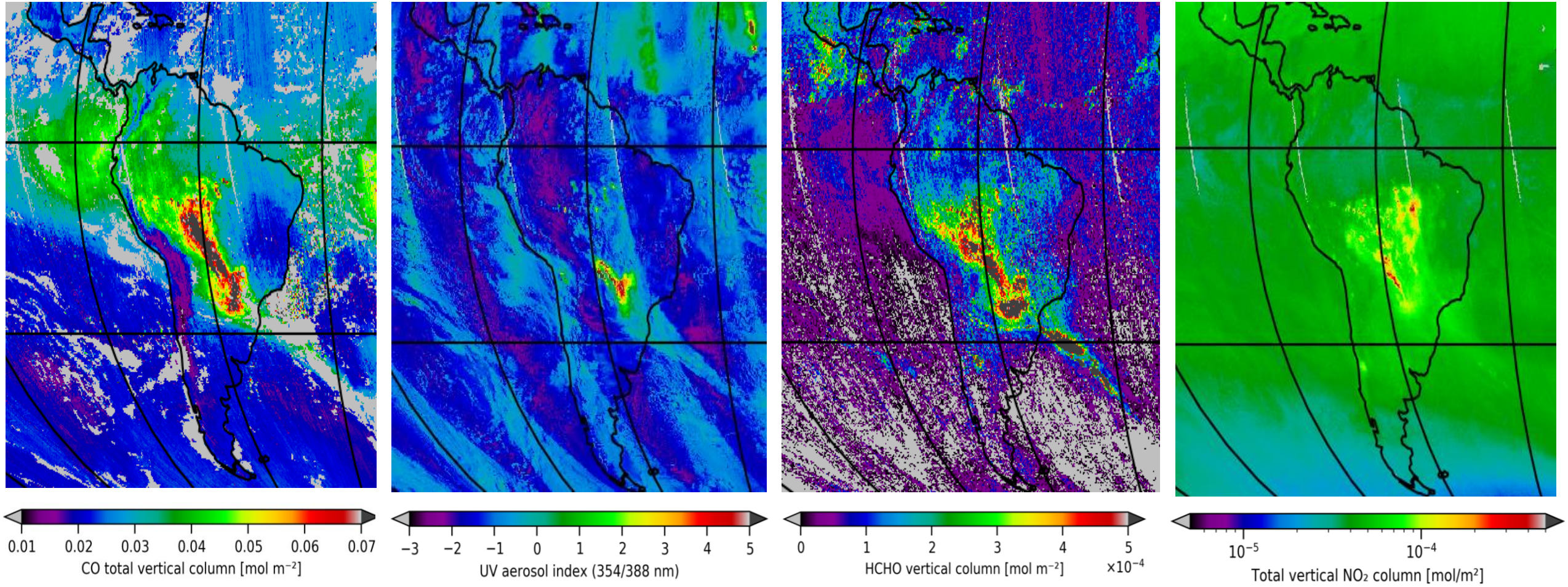
S5P measurements 18 Aug 2019



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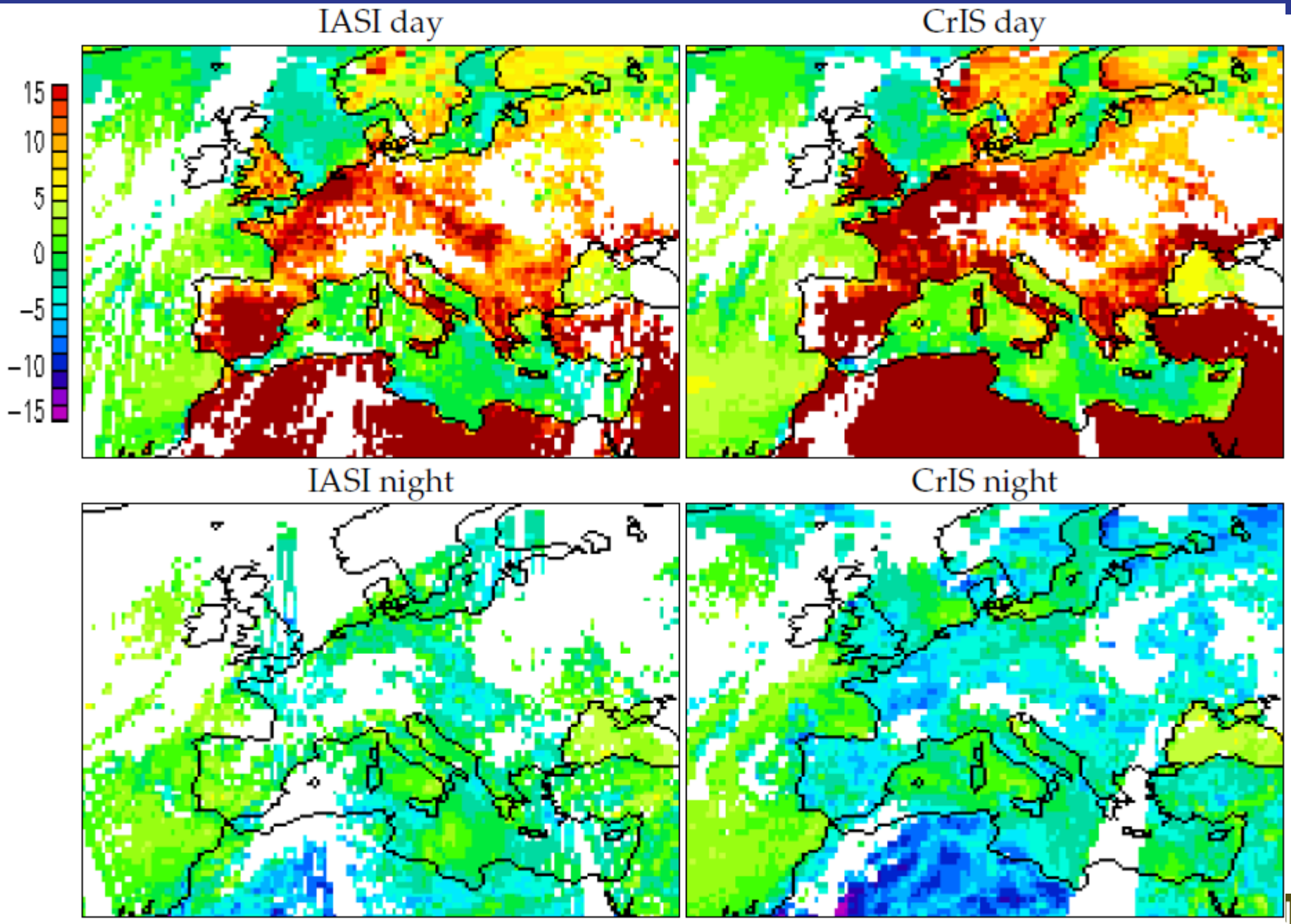
Surface – atmosphere T contrast (K)

15 July 2018



Retrieved Surface-air T contrast / K mk_cris_comp_20180715_region3

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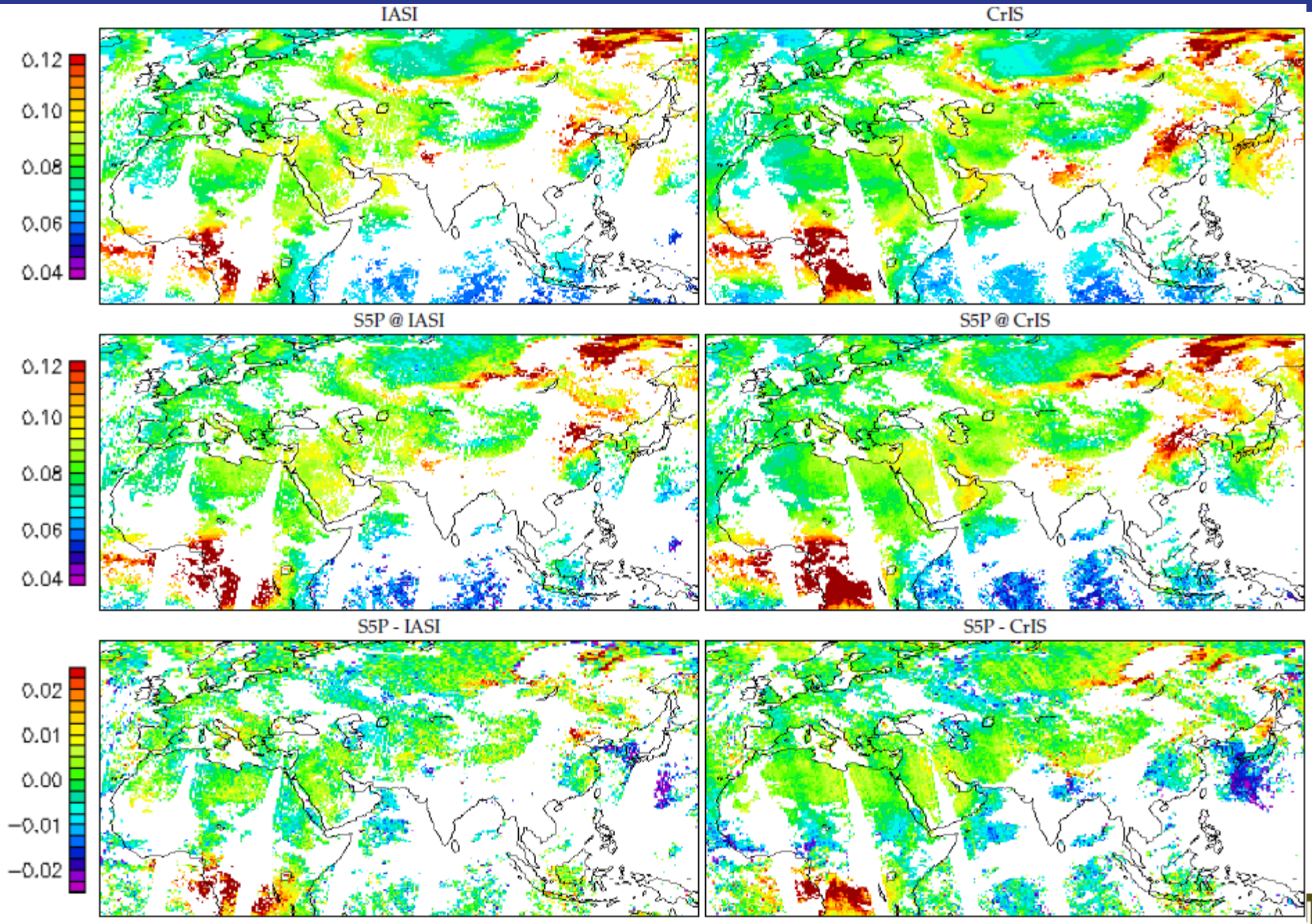
Total xCO (ppmv)

15 July 2018



Retrieved Carbon monoxide / xppmv S5PDIFF04 mk_cris_comp_20180715_region5_co

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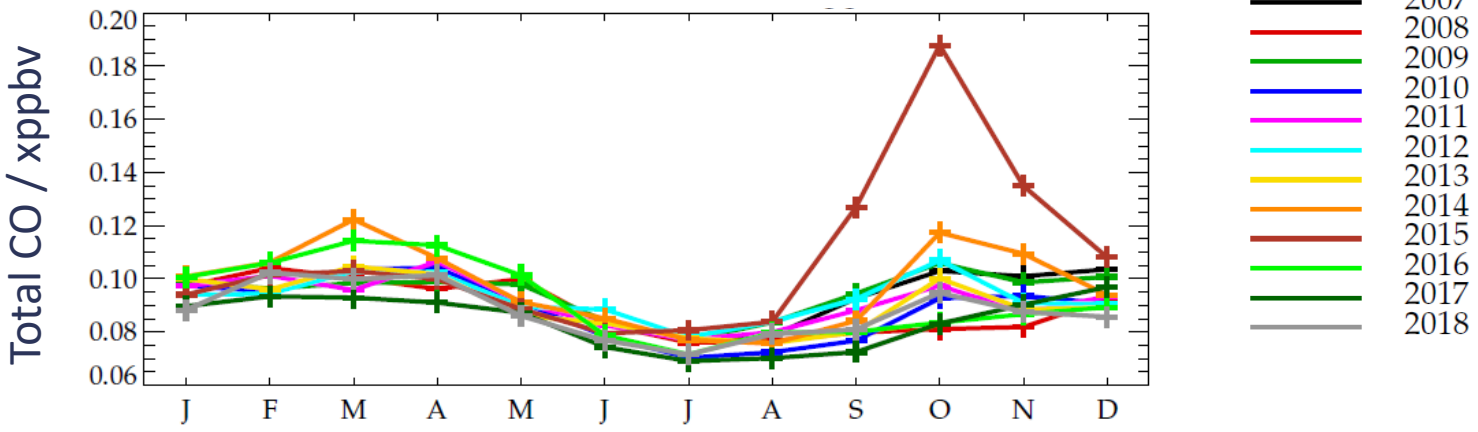
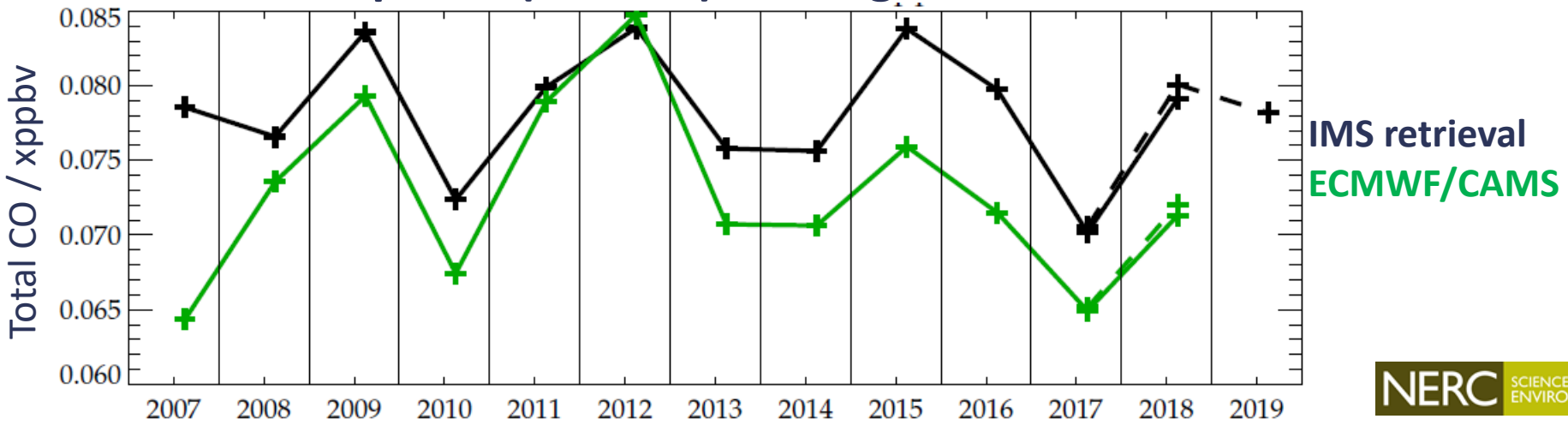
Tropical Asia timeseries

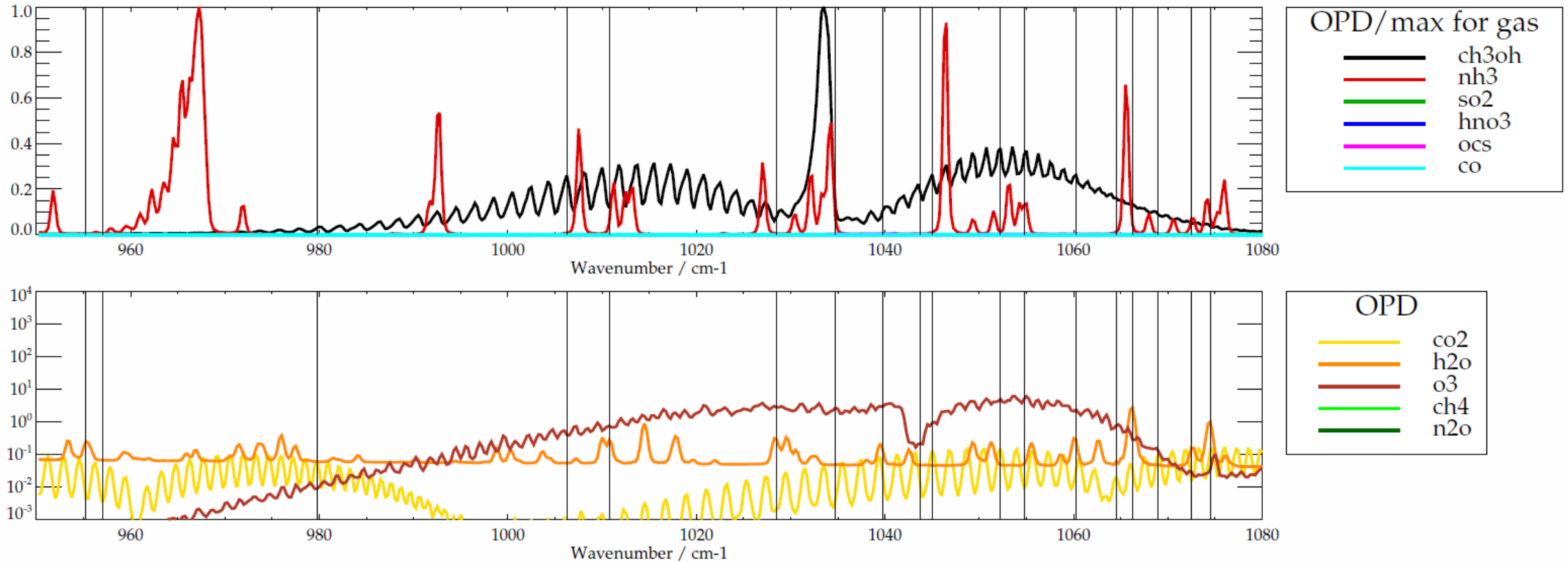
Metop A results 2017-2018



Metop A+B (dashed) for August 2017-2010



Original channels in O3 range



- Transmission spectra from Oxford
- Vertical lines indicate IASI channels used (Eumetsat original selection)

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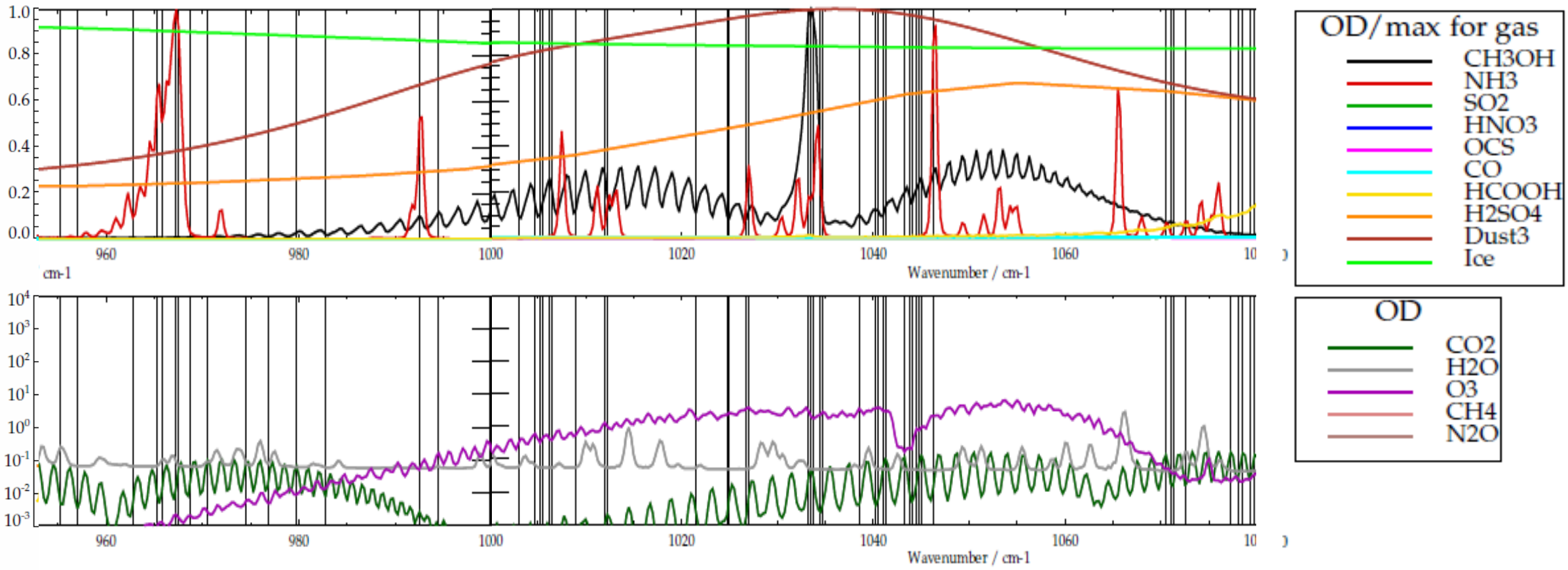
Optimised channels in O3 range



- Gas transmission + aerosol spectra from Oxford
- Vertical lines indicate new optimised channels

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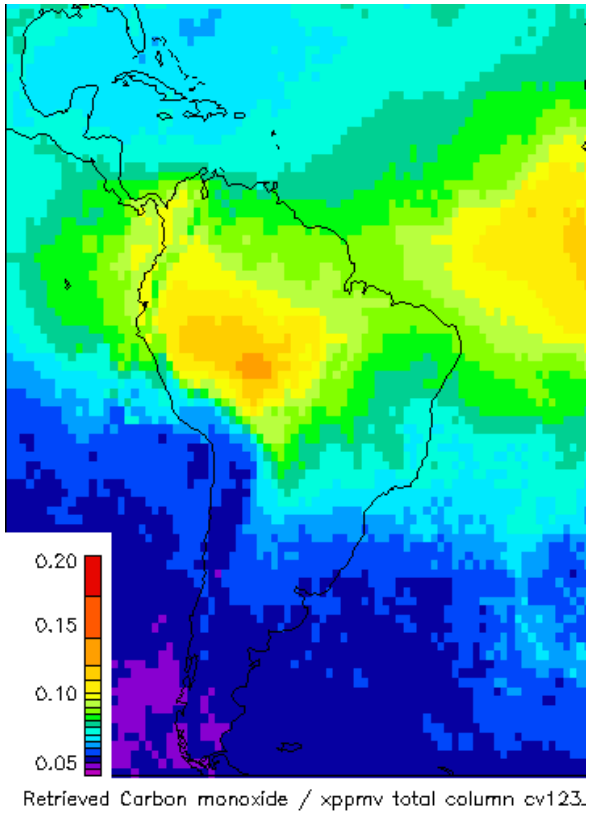

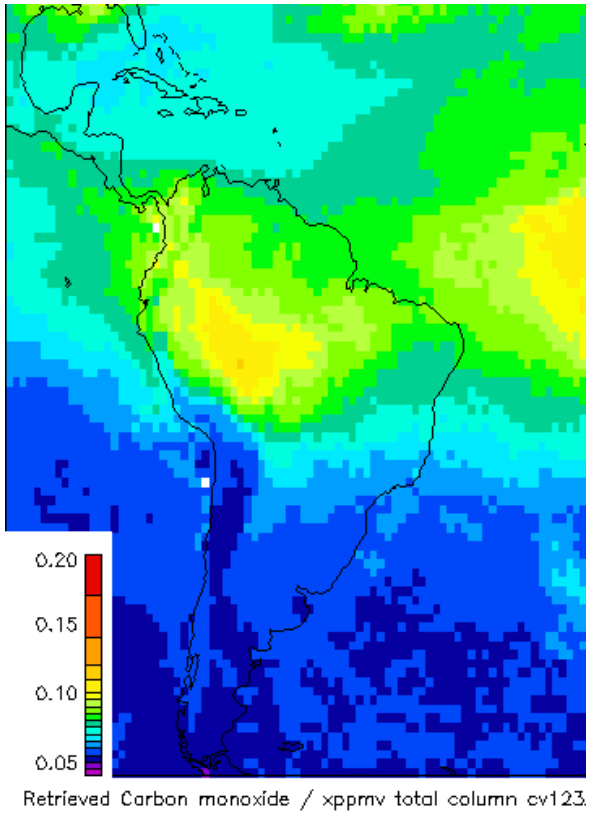

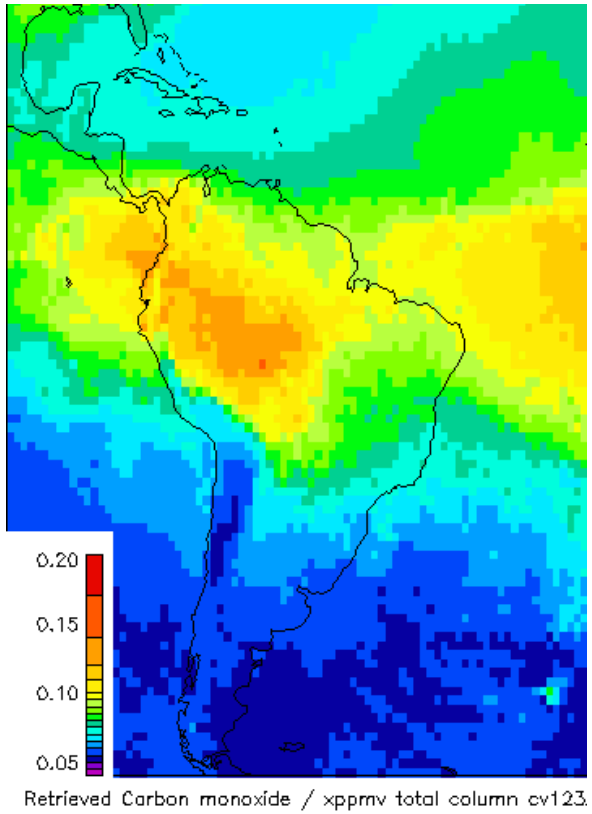

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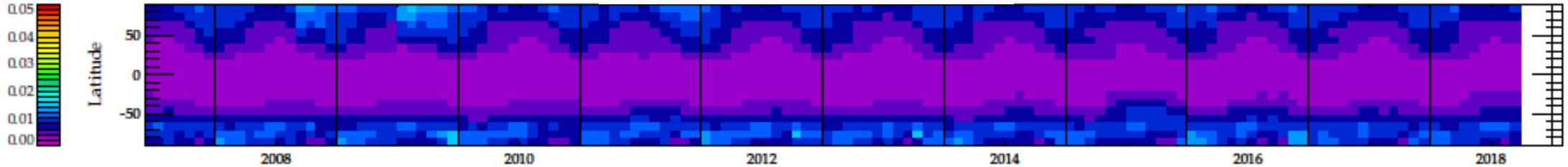
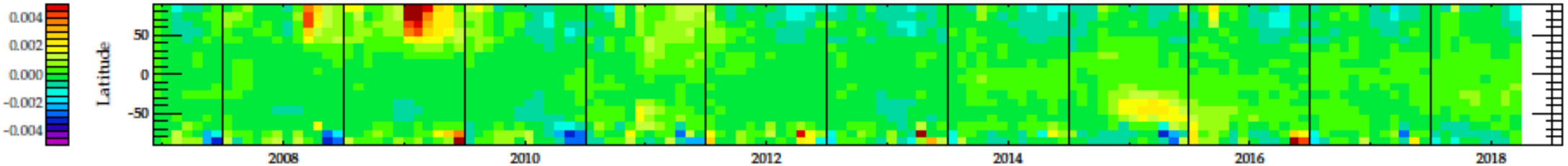
Sulfate aerosol IR optical depth

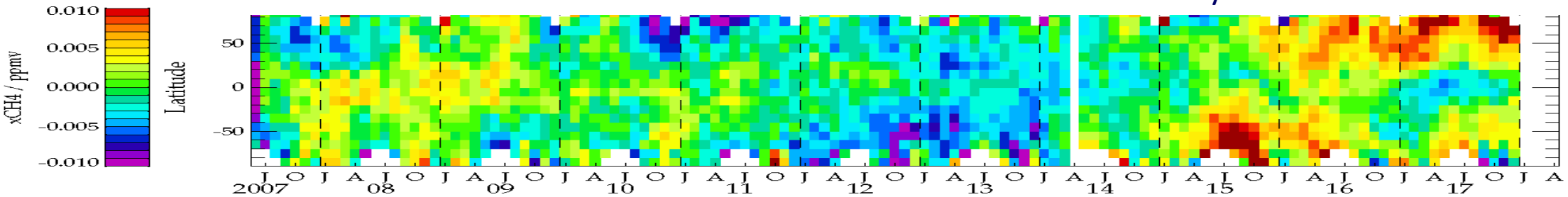
Retrieved IR AOD



De-deasonalised anomaly



Detrended v2.0 *interim* IASI methane anomaly



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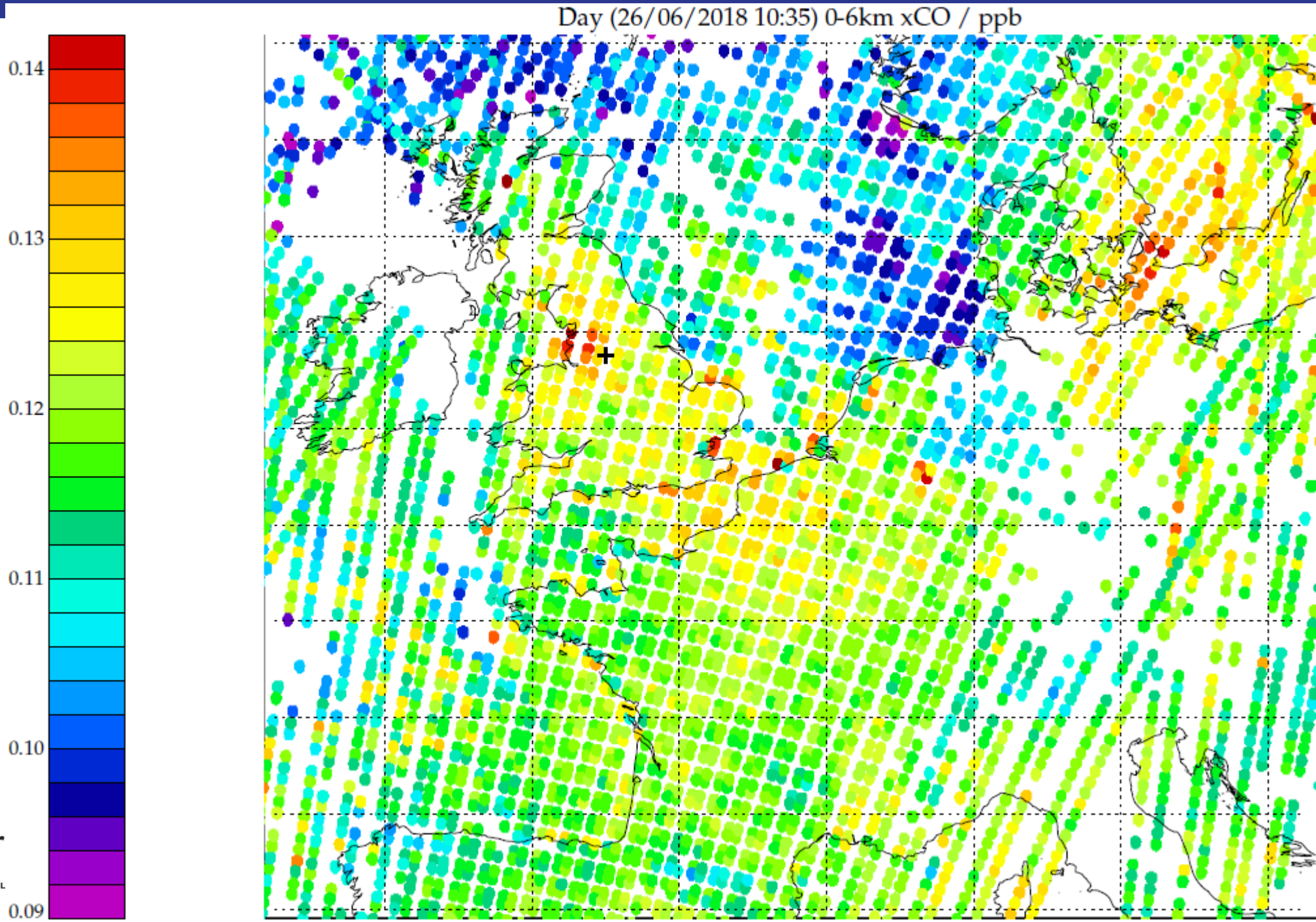
IMS CO
26 June 2018



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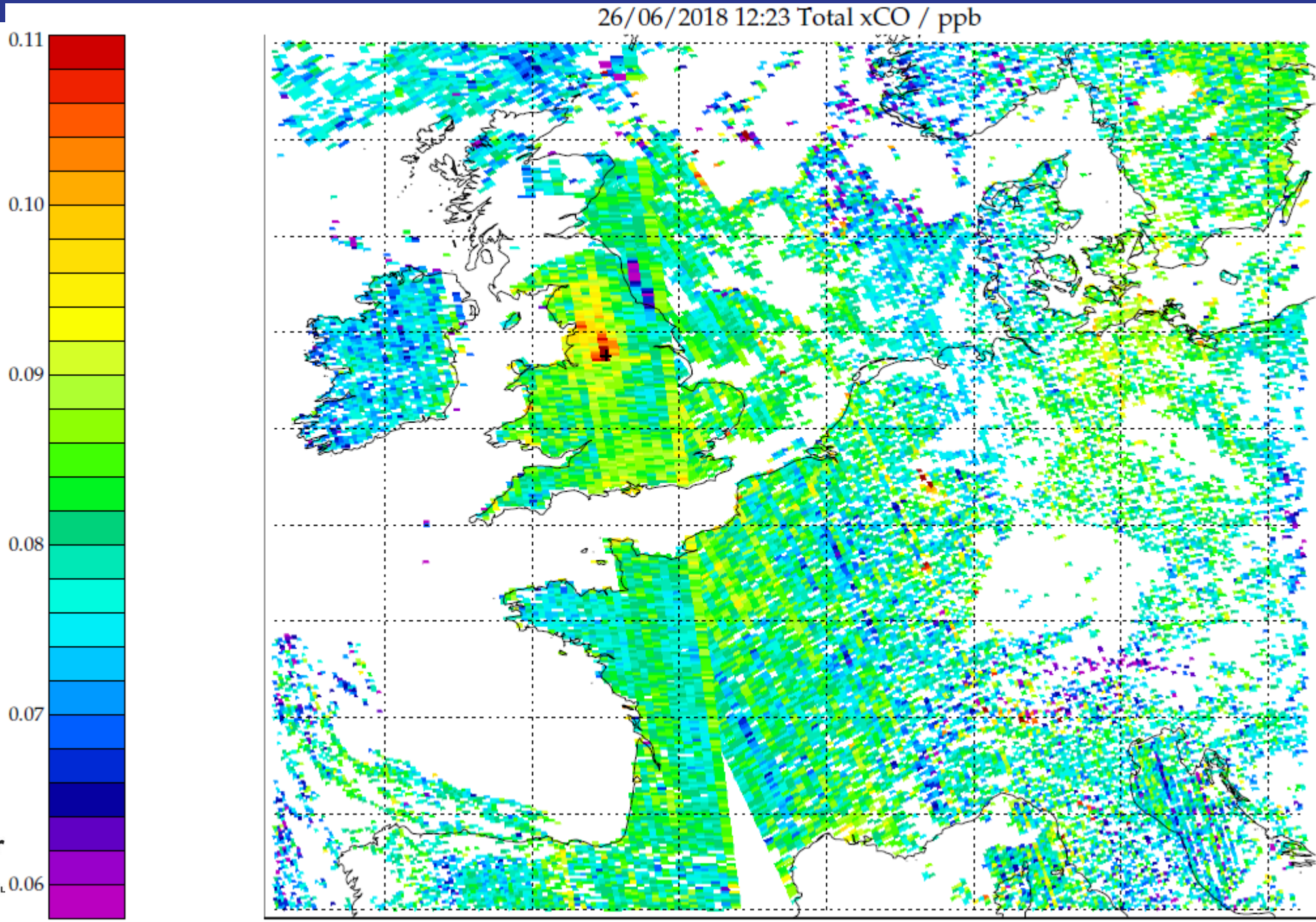
S5P CO
26 June 2018



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