

Atmospheric composition in the Asian monsoon from 2003-2017 in the Copernicus Atmosphere Monitoring Service global reanalysis

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CAMS production team

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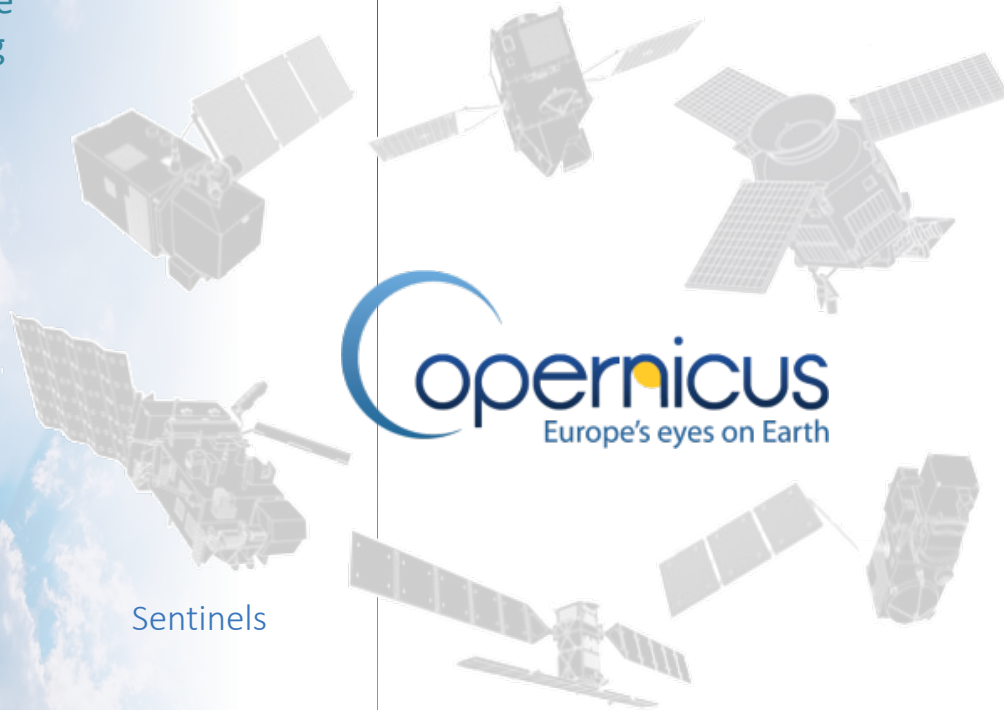


Atmosphere Monitoring



Atmosphere
Monitoring

COPERNICUS AND ECMWF



Observations
feeding into
value-added
Services



Atmosphere



Climate



Land



Marine



Emergency



Security

Copernicus is the European Union's operational Earth Observation and Monitoring programme, looking at our planet and its environment for the ultimate benefit of all citizens.

User-driven with free and unrestricted data access



Service is implemented by ECMWF

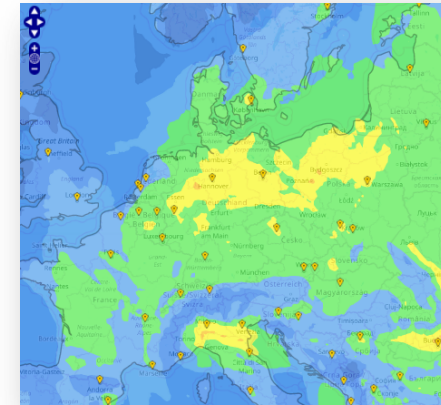


ECWMF is contributing to the Service



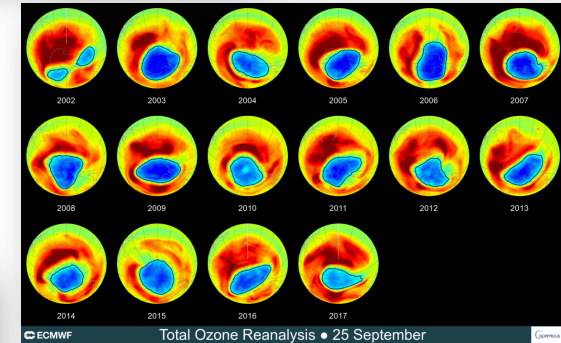
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CAMS: COPERNICUS ATMOSPHERE MONITORING SERVICE

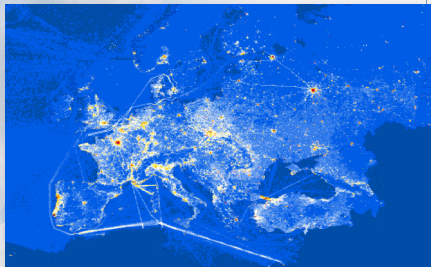


*European
Air Quality*

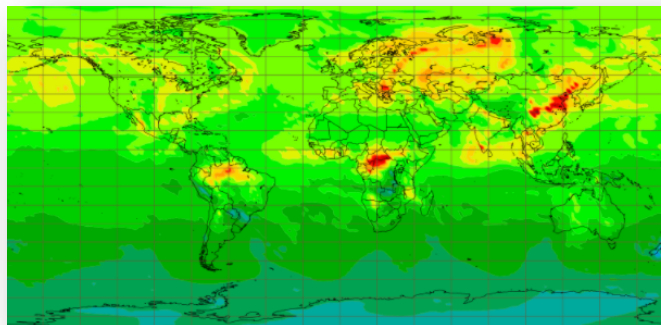
*LBCs for
regional
models*



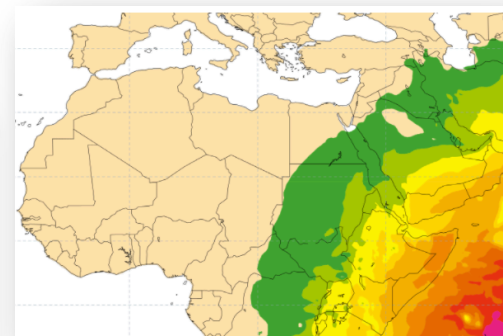
Ozone layer



*Emissions and
surface fluxes*



Global analyses, forecasts and reanalyses



*Solar radiation and
UV index*



Atmos
Monit

Near-real-time satellite data usage

Species	Instruments
Global system	
O ₃	OMI, SBUV, GOME-2, MLS, OMPS S5p
CO	IASI, MOPITT, S5p
NO ₂	OMI, GOME-2, S5p
SO ₂	OMI, GOME-2, S5p
Aerosol	MODIS, PMAp, VIIRS, S3
CO ₂	GOSAT, OCO-2
CH ₄	GOSAT, IASI, S5p
GFAS fire emissions	MODIS, GOES-E/W*, SEVIRI*, S3, VIIRS, HIMAWARI-8*

Assimilated **Monitored** Planned future

*Geostationary platform

Composition data additional to thousands of assimilated meteorological data.

40 km horizontal resolution, 60 model levels; two 5-day forecasts (00z and 12z UTC) each day

- Aerosols (AOD and concentration): biomass burning, dust, sea salt, sulphate
- Reactive gases: CO, NO₂, O₃, SO₂, HCHO

9 km horizontal resolution, 137 model levels; one 5-day forecast per day

- CO₂, CH₄, linear CO

Control runs (with no data assimilated) are also available.

CAMS data used for field campaign planning and evaluating special events.

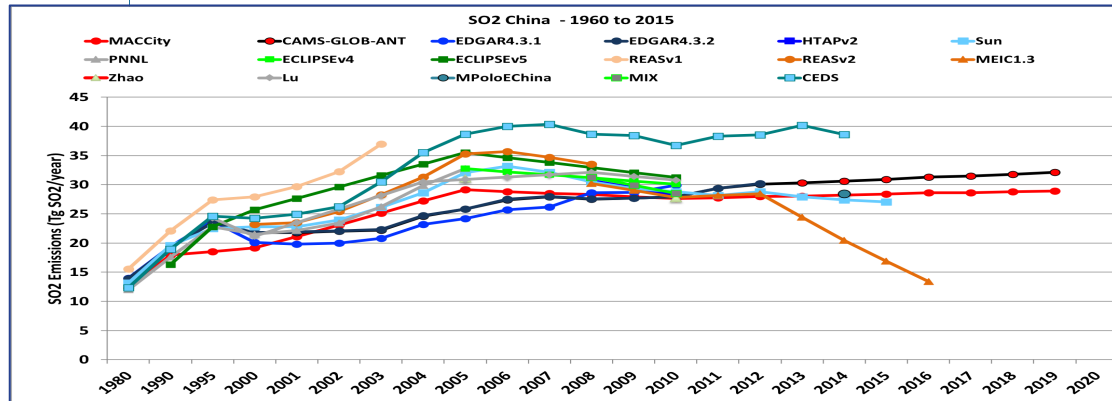
- Stratoclim in 2017
- ACCLIP in 2020
- ~30 others since 2010



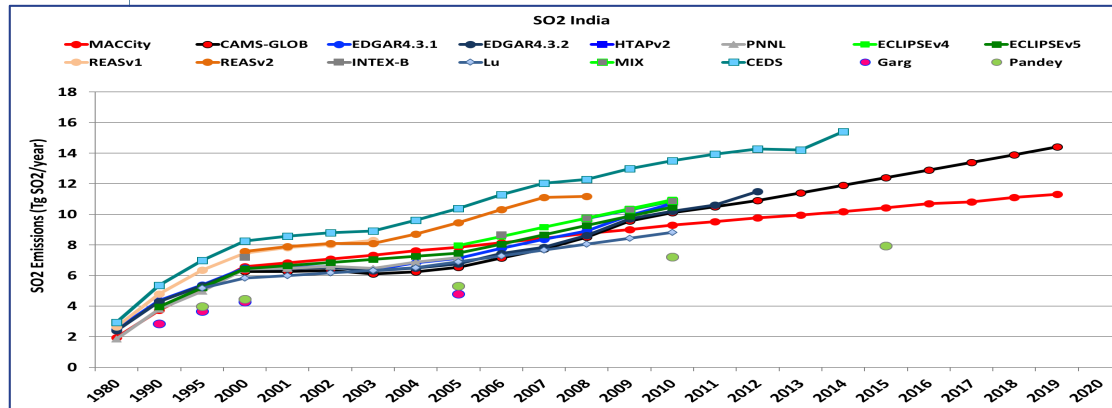
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CAMS emissions inventories

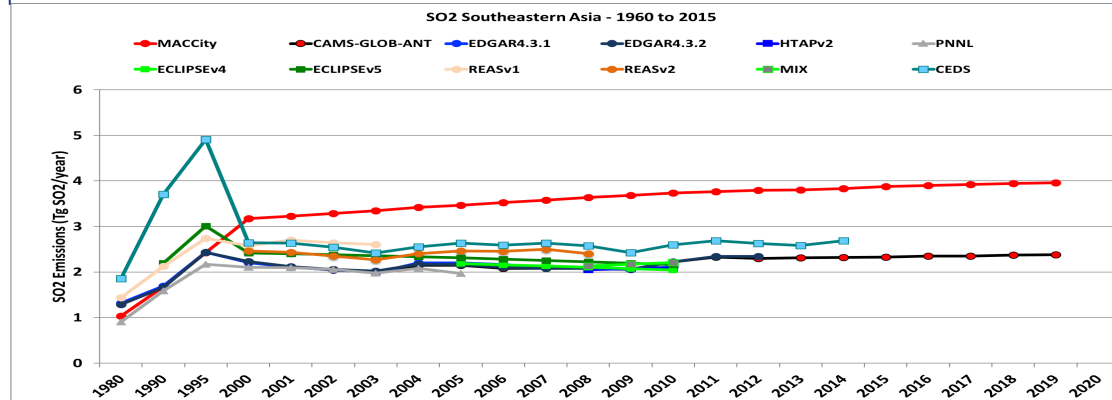
SO₂ China



SO₂ India



SO₂ SE Asia



- Global emissions inventories for anthropogenic, biogenic, shipping, volcanic outgassing, soil NO.
 - Geographical and sectoral temporal profiles.
- Regular updates to include, e.g., specific information on regional (including China, India & SE Asia) emissions
- Public releases and documentation available via ECCAD
 - <https://eccad3.sedoo.fr>

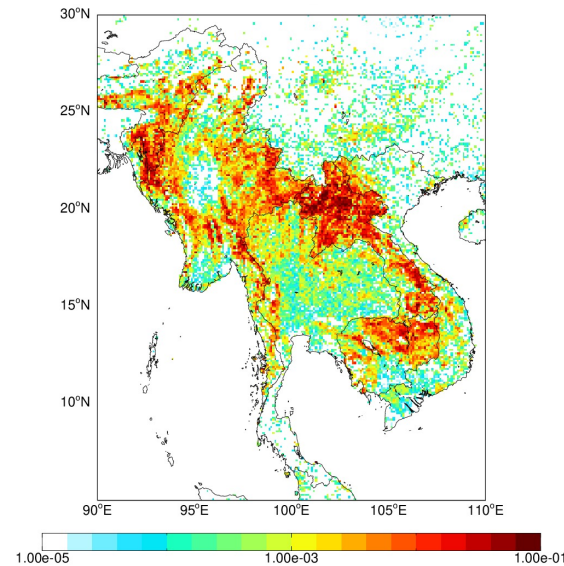


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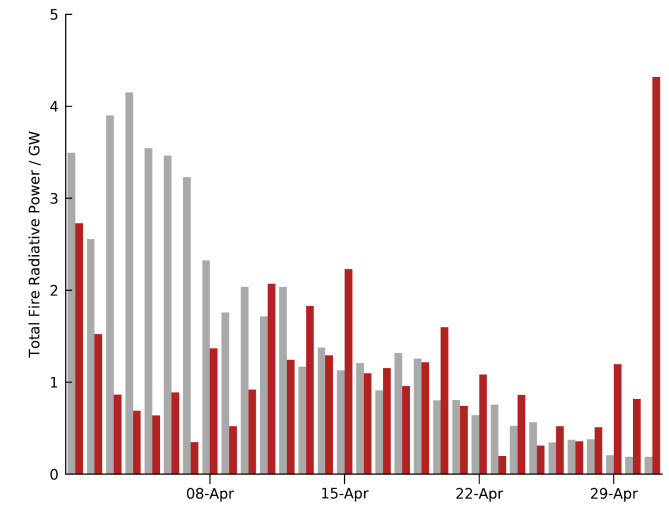
CAMS Global Fire Assimilation System

- **Global Fire Assimilation System (GFAS)**
 - <http://apps.ecmwf.int/datasets/data/cams-gfas/>
- **Uses satellite observations of Fire Radiative Power (FRP)**
 - Currently Aqua and Terra MODIS FRP observations
- **Daily global coverage at ~10km resolution**
 - 1-day behind NRT (diurnal cycle/hourly output coming operational later in 2019)
- **Emissions of aerosols and gases are estimated using factors dependent on vegetation type.**
 - Injection heights calculated with Plume Rise Model and IS4FIRES.

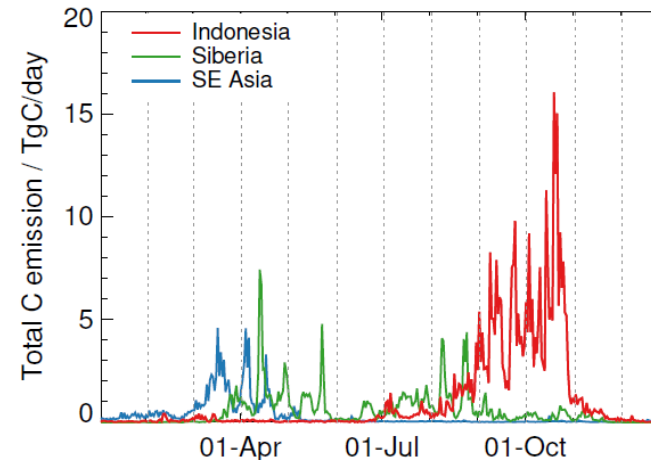
Jan-Apr 2019 total wildfire carbon flux



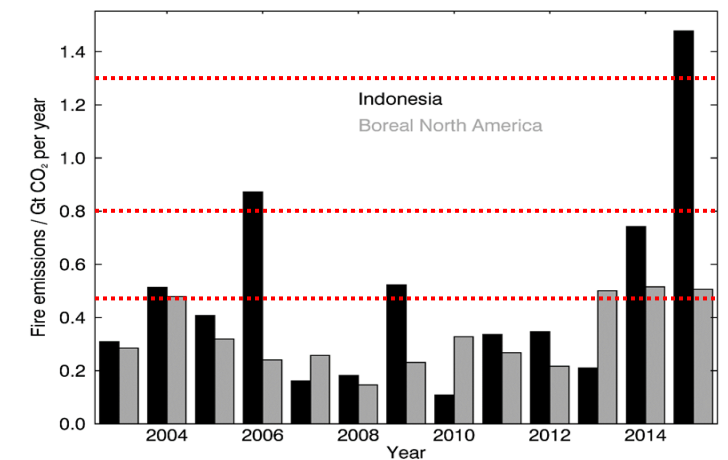
April 2019 daily total FRP for Thailand



Jan-Dec 2015 daily total wildfire C for Asia



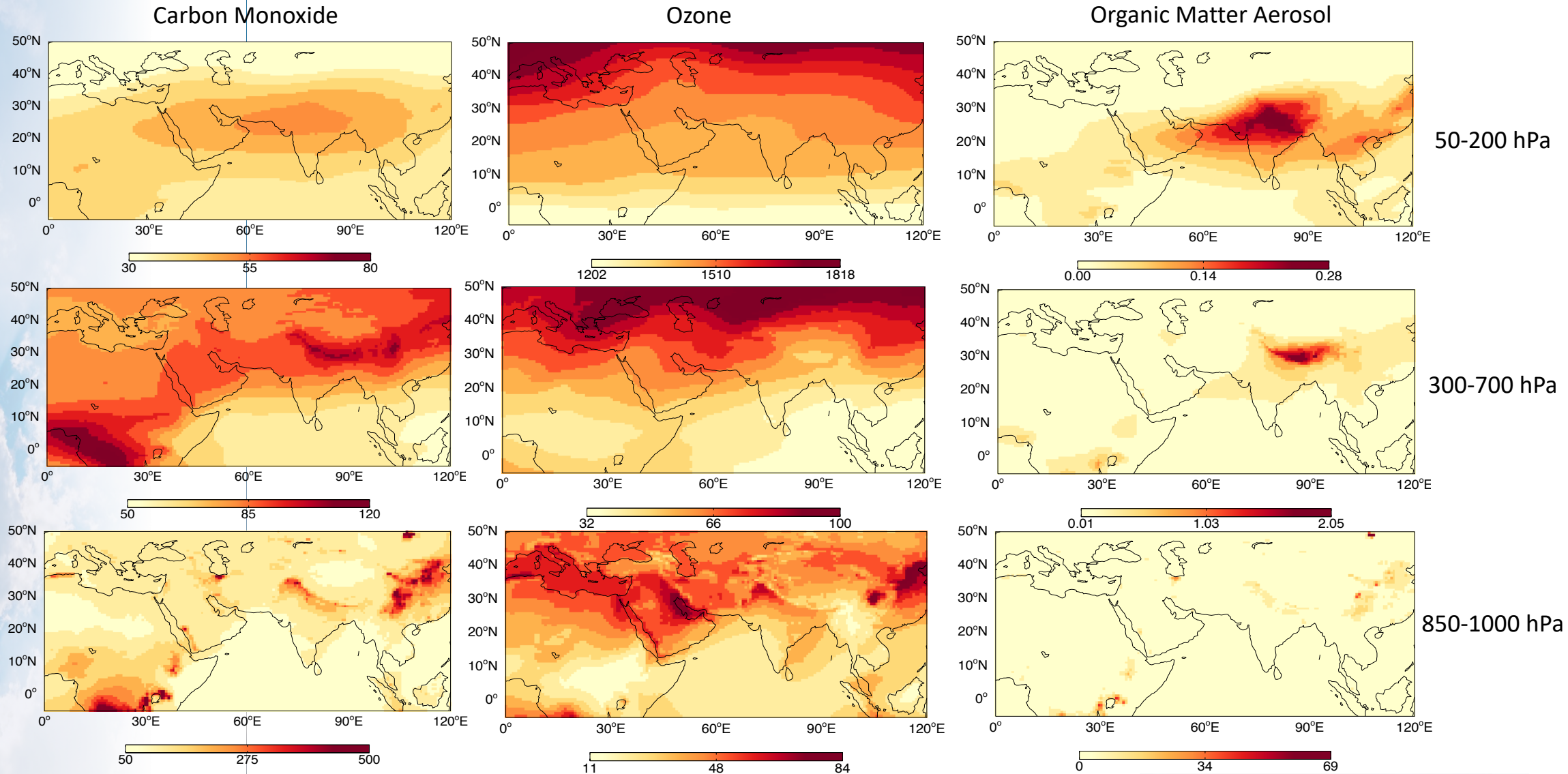
2003-2015 annual total wildfire CO2 for Indonesia





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CAMS products in relation to the Asian Monsoon



July-August 2017 mean

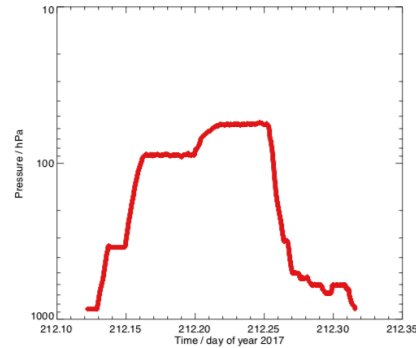


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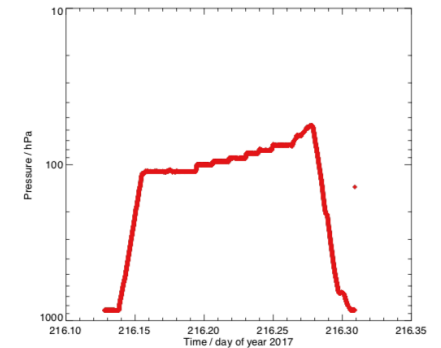
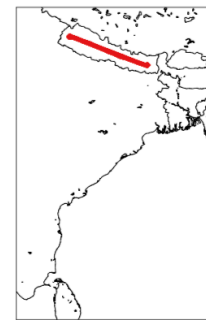
CAMS data in the Asian Monsoon vs. Stratoclim aircraft observations

Geophysica location and
altitude

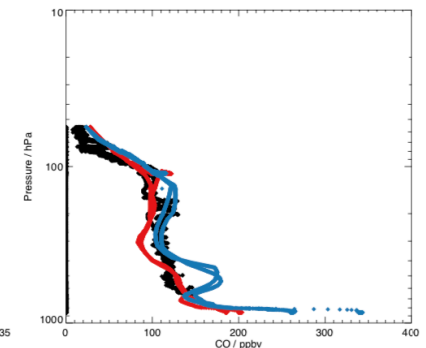
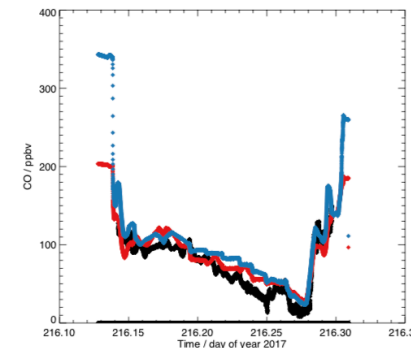
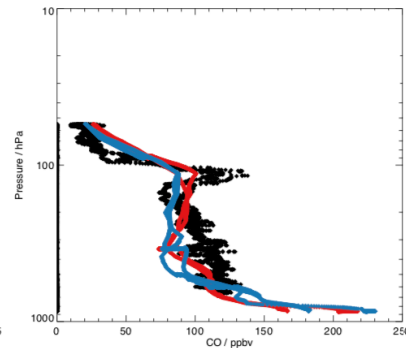
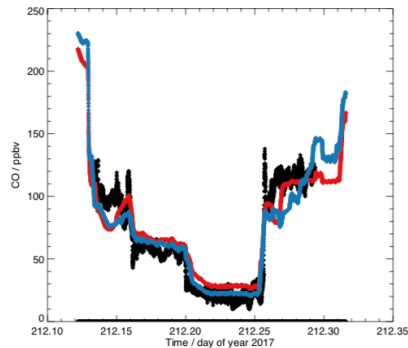
31 July 2017



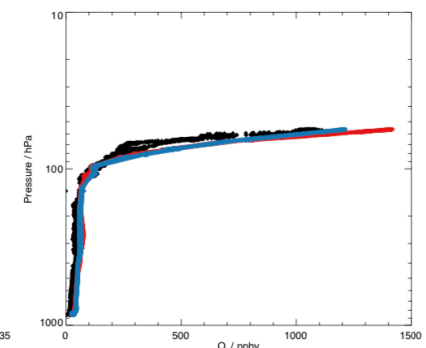
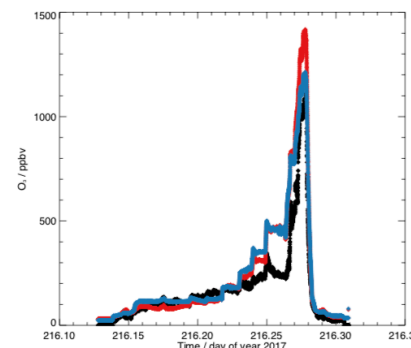
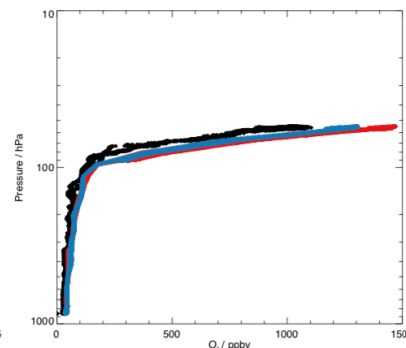
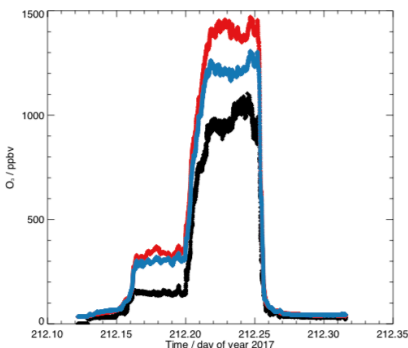
4 August 2017



Carbon Monoxide



Ozone



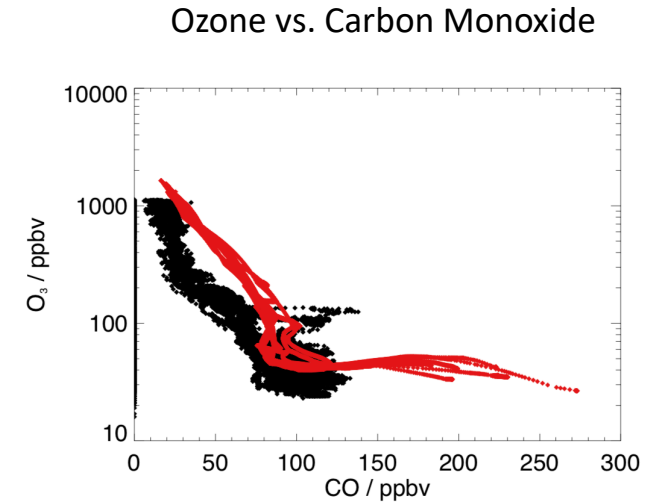
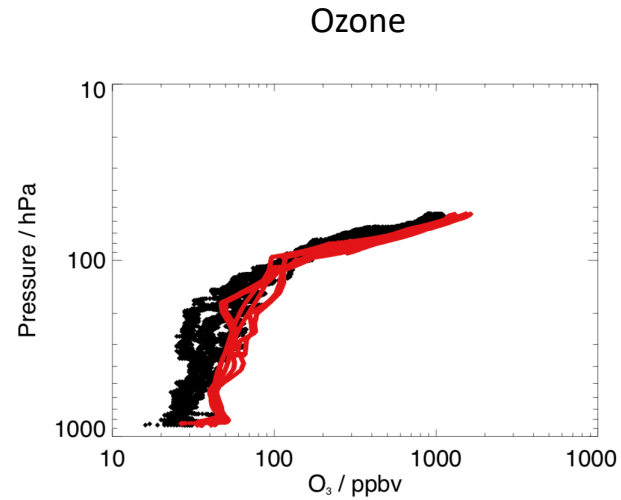
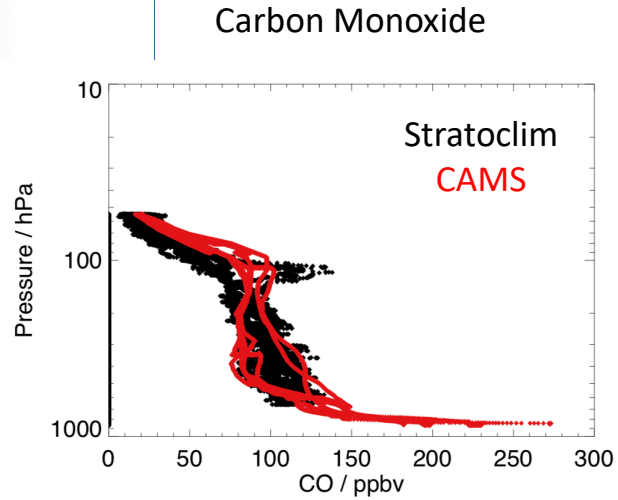
Stratoclim
CAMS NRT
CAMS REAN



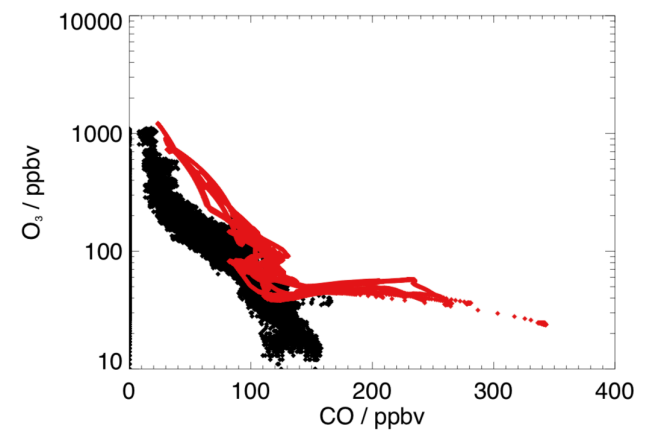
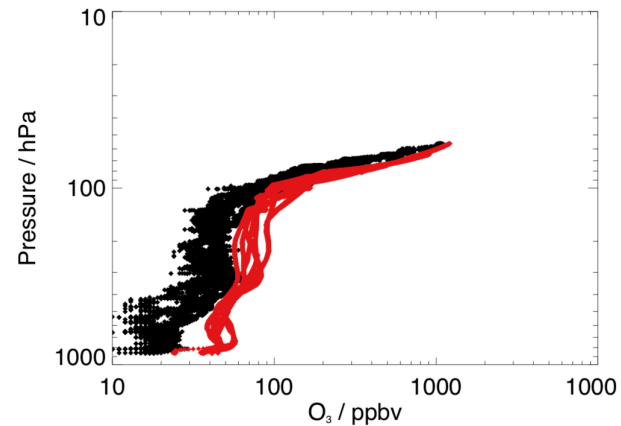
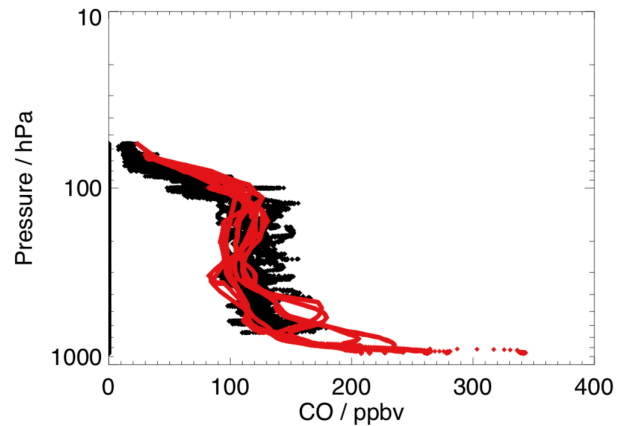
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CAMS data in the Asian Monsoon vs. Stratoclim aircraft observations

1st Phase
27-31 July



2nd Phase
6-10 August

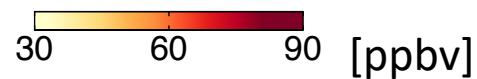
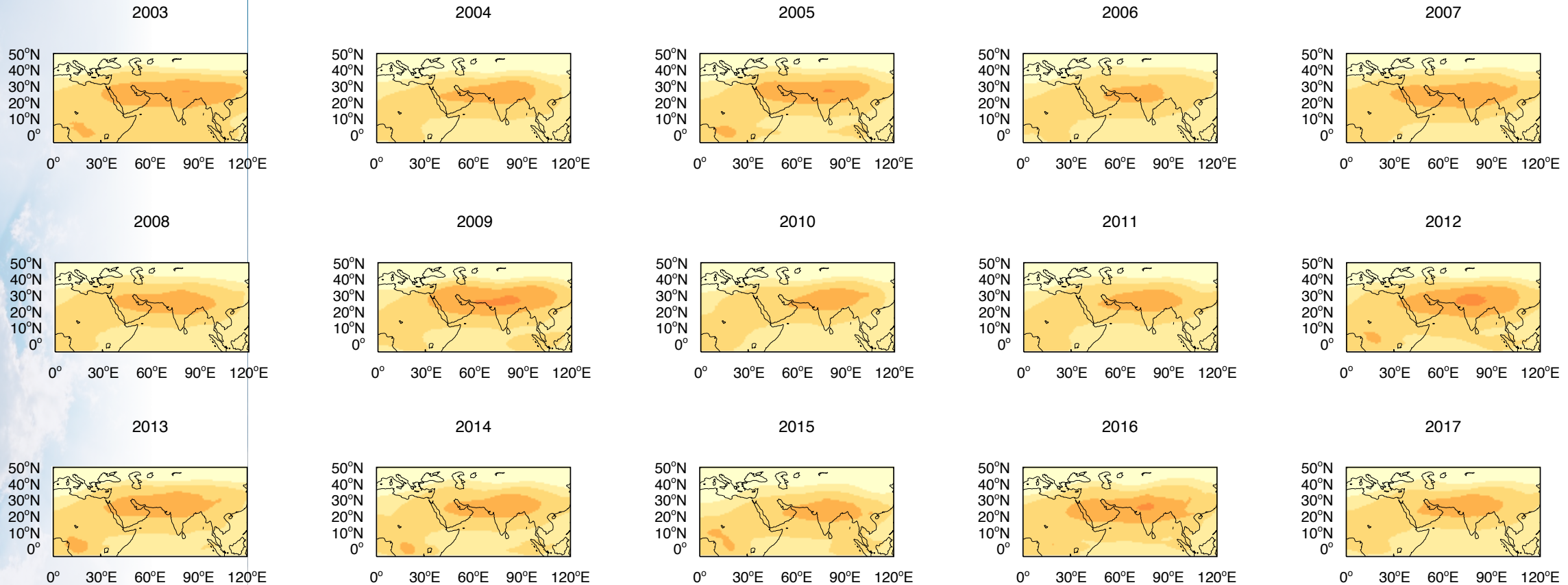




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CAMS Reanalysis: 15 years of global atmospheric composition

July 50-150 hPa mean CO, 2003-2017

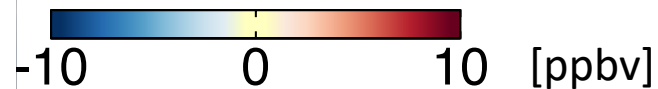
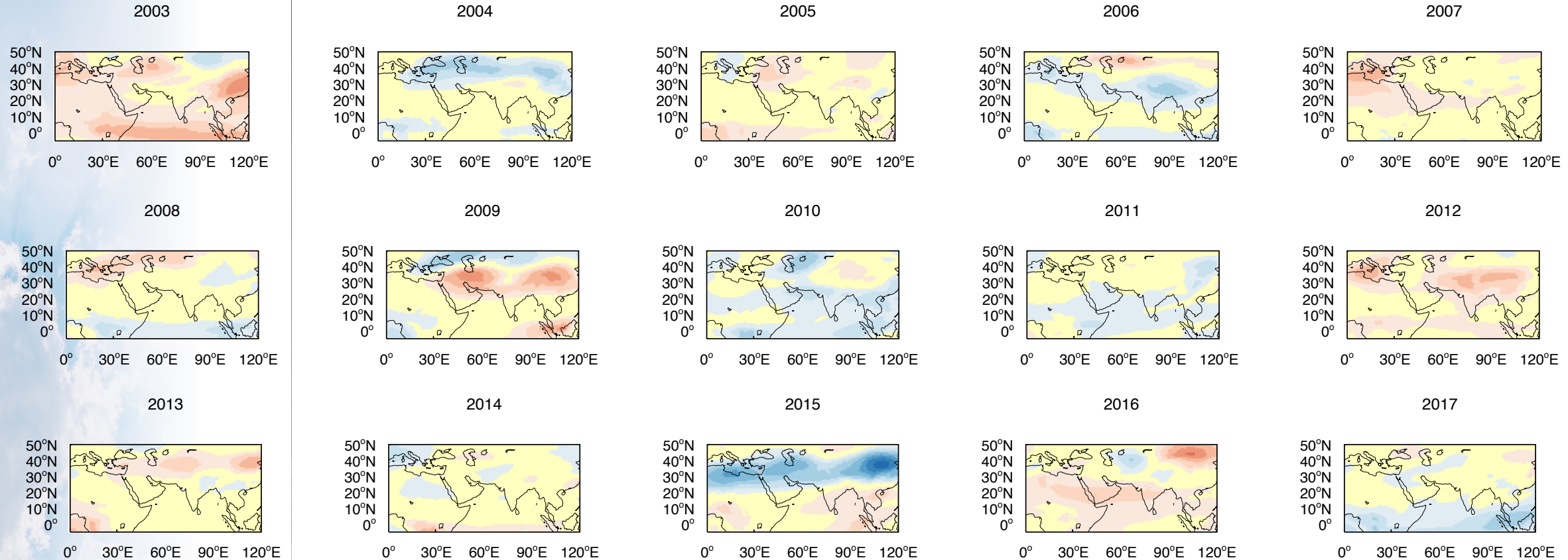




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CAMS Reanalysis: 15 years of global atmospheric composition

July-August 50-150 hPa mean CO anomalies (cf 2003-2017 climatology)

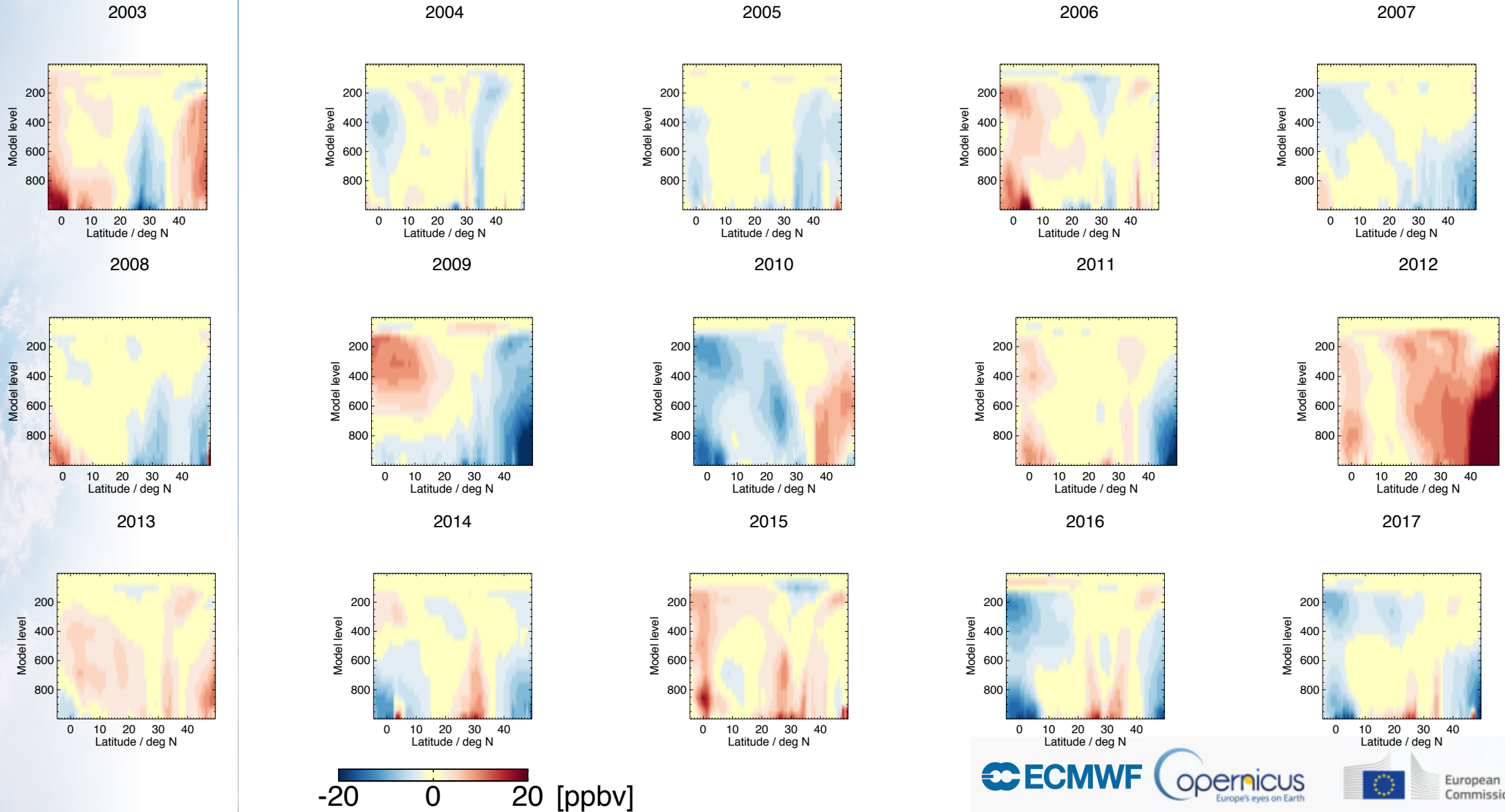




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CAMS Reanalysis: 15 years of global atmospheric composition

July-August 70-100 deg E zonal mean CO anomalies (cf 2003-2017 climatology)

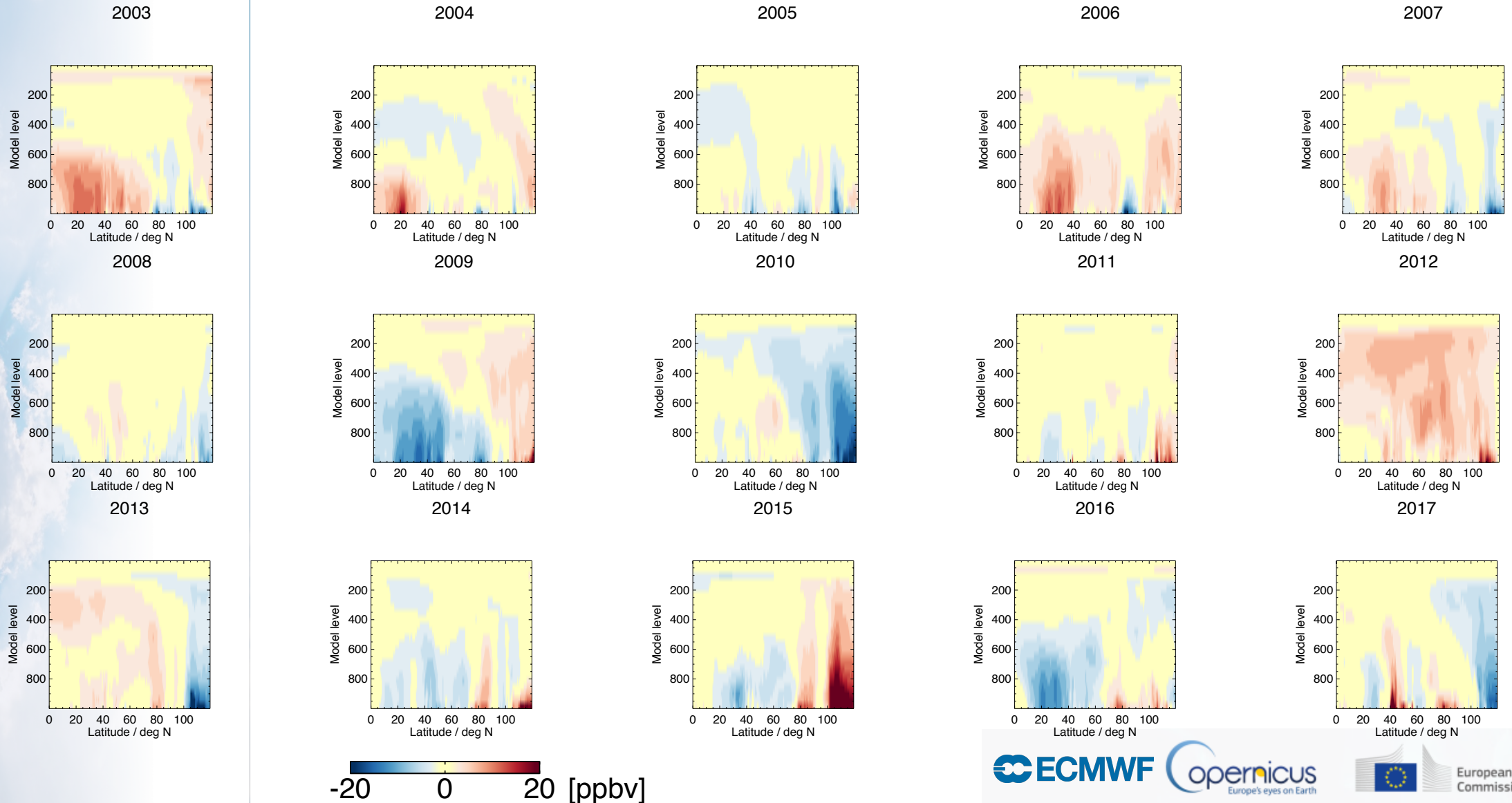




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CAMS Reanalysis: 15 years of global atmospheric composition

July-August 5-35 deg N meridional mean CO anomalies (cf 2003-2017 climatology)





Summary

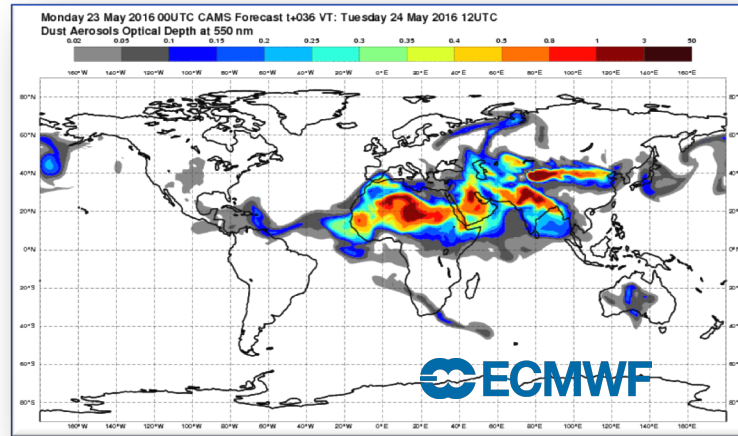
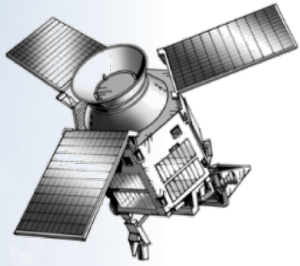
- CAMS provides a wide range of global data products of relevance to research and operational activities in the Asian Monsoon region.
 - Completely free and open access
 - User support <https://atmosphere.copernicus.eu/cams-user-service-desk/>
- Main features of the summer Asian Monsoon captured in the CAMS forecasts
 - High CO in UT matches location and concentrations observed by MLS
 - Clear signal of ATAL in organic matter aerosols
- Comparison of CAMS data against Stratoclim aircraft observations shows generally very good agreement for CO and O3.
 - First (preliminary) evaluation in the Asian Monsoon region gives confidence in the quality of the data for wider applications in the .
 - Generally good agreement with independent data based on routine quarterly validation of CAMS data.
- Operational 5-day forecasts at ~40 km spatial resolution allow NRT monitoring of surface air quality and evolution of atmospheric composition changes during the Asian Monsoon.
- CAMS reanalysis spans 2003-2017 to provide consistent globally resolved dataset of global atmospheric composition for evaluating interannual variability, relative changes and trends in the Asian Monsoon.



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CAMS SERVICE CHAIN

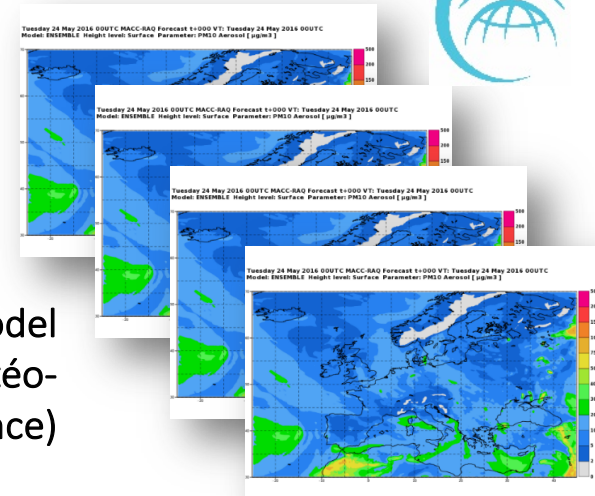
Space Agencies



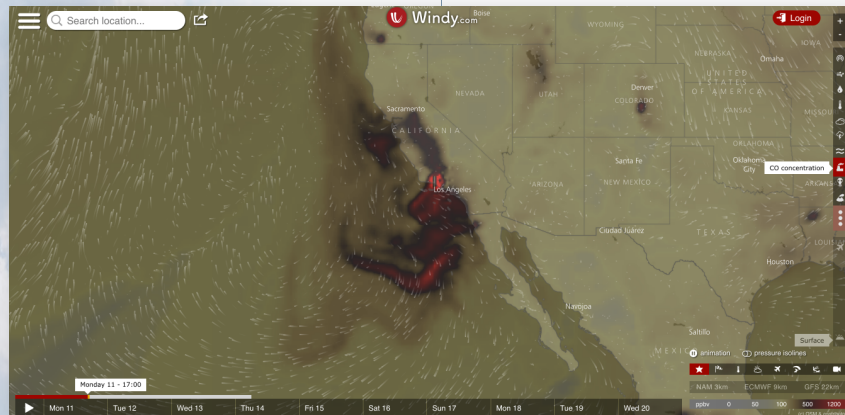
ECMWF Integrated Forecasting System (IFS)



Regional multi-model
ensemble (lead: Météo-
France)



In-situ observations



Users