



CAMS activities for air quality monitoring and forecasting in Mediterranean

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What information will the Copernicus Atmosphere Monitoring Service provide?

- Daily production of near-real-time analyses and forecasts of global atmospheric composition
- Reanalyses providing consistent multi-annual global datasets of atmospheric composition with a frozen model/assimilation system
- Daily production of near-real-time European air quality analyses and forecasts with a multi-model ensemble system
- Reanalyses providing consistent annual datasets of European air quality with a frozen model/assimilation system, supporting in particular policy applications
- Products to support policy users, adding value to “raw” data products in order to deliver information products in a form adapted to policy applications and policy-relevant work
- Solar and UV radiation products supporting the planning, monitoring, and efficiency improvements of solar energy production and providing quantitative information on UV irradiance for downstream applications related to health and ecosystems
- Greenhouse gas surface flux inversions for CO₂, CH₄ and N₂O, allowing the monitoring of the evolution in time of these fluxes
- Climate forcings from aerosols and long-lived (CO₂, CH₄) and shorter-lived (stratospheric and tropospheric ozone) agents

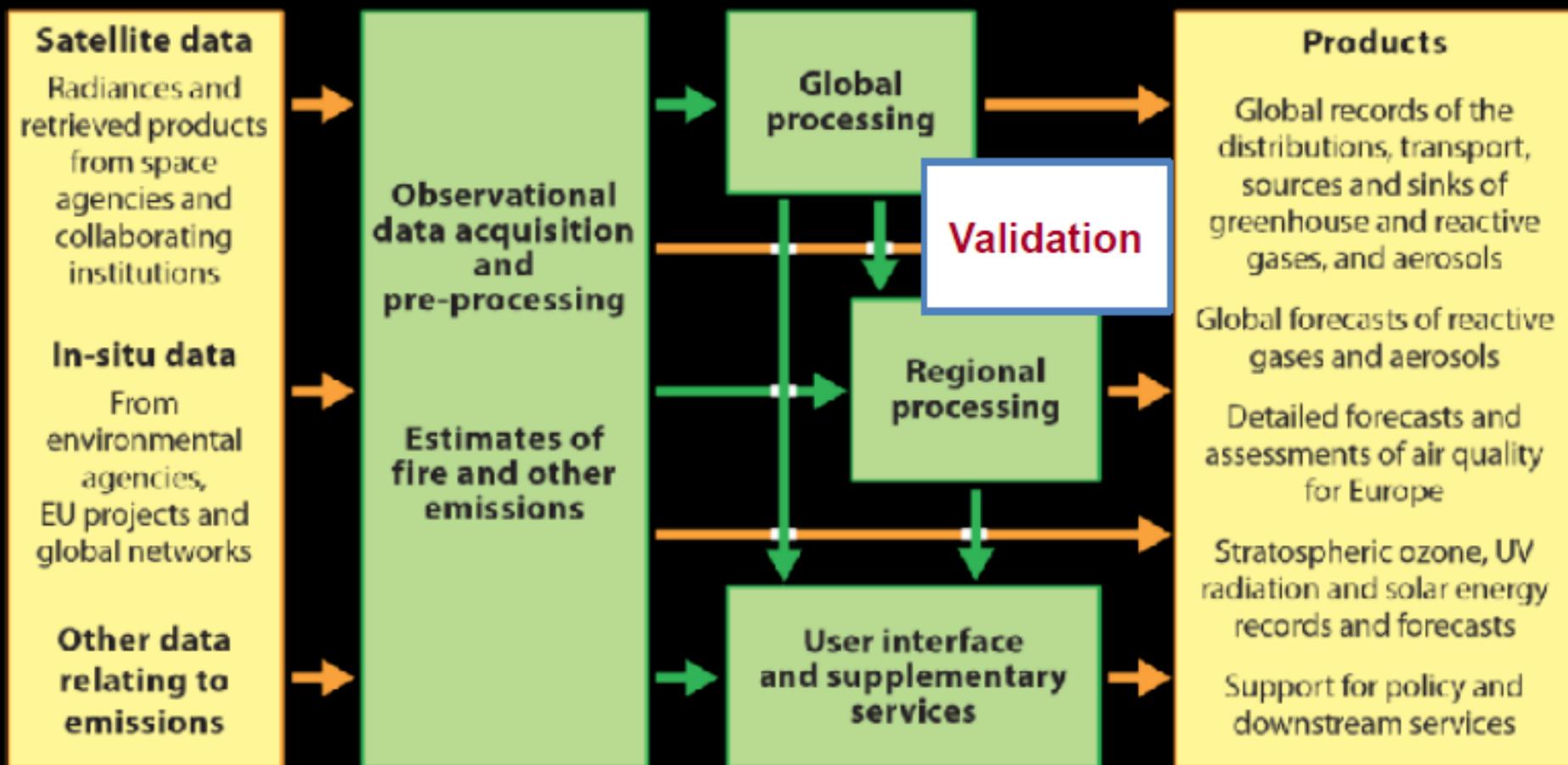
CAMS Global Atmospheric Composition

- The meteorological model is based on IFS version cy41r1, see also <http://www.ecmwf.int/en/forecasts/documentation-and-support/changes-ecmwf-model/cy41r1-summary-changes>; the model resolution is T255L60.
- The modified CB05 tropospheric chemistry is used (Williams et al., 2013), originally taken from the TM5 chemistry transport model (Huijnen et al., 2010)
- Stratospheric ozone during the forecast is computed from the Cariolle scheme (Cariolle and Teyssède, 2007) as already available in IFS, while stratospheric NO_x is constrained through a climatological ratio of HNO₃/O₃ at 10 hPa.
- Monthly mean dry deposition velocities are based on the SUMO model provided by the MOCAGE team.
- Data assimilation is described in Inness et al. (2015) and Benedetti et al. (2009) for chemical trace gases and aerosol, respectively
- Anthropogenic and biogenic emissions are based on MACCity (Granier et al., 2011) and a climatology of the MEGAN-MACC emission inventories (Sindelarova et al., 2014)
- NRT fire emissions are taken from GFASv1.2 (Kaiser et al. 2012).
- **The forecast length is 120 h**
- **Spatial resolution 40 km**

Species, vertical range	Assimilation	Validation
Aerosol, optical properties	MODIS Aqua/Terra AOD	AOD, Ångström: AERONET, GAW, Skynet, MISR, OMI, lidar, ceilometer
Aerosol mass (PM10, PM2.5)	-	European AirBase stations
O₃, stratosphere	MLS, GOME-2A, GOME-2B, OMI, SBUV-2	Sonde, lidar, MWR, FTIR, OMPS, BASCOE and MSR analyses
O₃, UT/LS	Indirectly constrained by limb and nadir sounders	IAGOS, ozone sonde
O₃, free troposphere	Indirectly constrained by limb and nadir sounders	IAGOS, ozone sonde
O₃, PBL / surface	-	Surface ozone: WMO/GAW, NOAA/ESRL-GMD, AIRBASE
CO, UT/LS	-	IAGOS
CO, free troposphere	IASI, MOPITT	IAGOS, MOPITT, IASI, TCCON
CO, PBL / surface	Indirectly constrained by satellite IR sounders	Surface CO: WMO/GAW, NOAA/ESRL
NO₂, troposphere	OMI, partially constrained due to short lifetime	SCIAMACHY, GOME-2, MAX-DOAS
HCHO	-	GOME-2, MAX-DOAS
SO₂	GOME-2A, GOME-2B (Volcanic eruptions)	-
Stratosphere, other than O₃	-	NO₂ column only: SCIAMACHY, GOME-2
CO₂, surface, PBL		ICOS
CO₂, column		TCCON
CH₄, surface, PBL		ICOS
CH₄, column		TCCON



CAMS INFORMATION FLOW



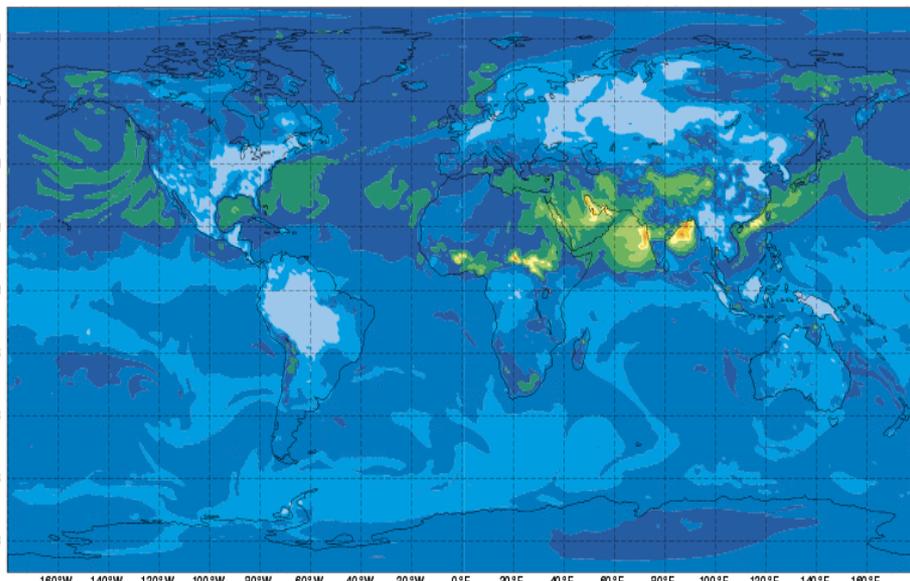
CAMS Global Atmospheric Composition

Available fields

- Meteorology (T, RH, Pre, Psl, Cloud Cover ...)
- Reactive gases (O₃, Nox, CO ...)
- Greenhouse gases (CO₂, CH₄)
- Aerosols (Dust, Sea Salt, Sulfate, Black Carbon)
- Radiation
- AOD

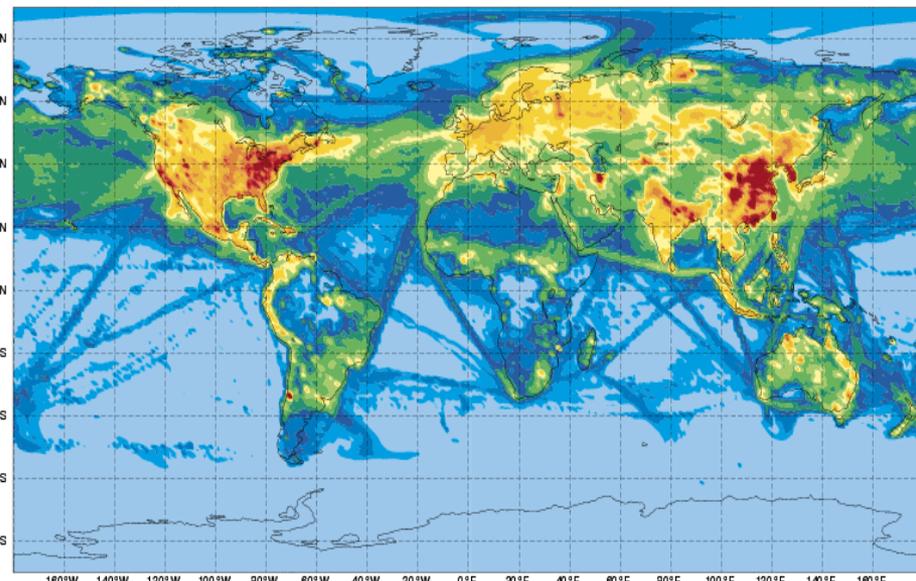
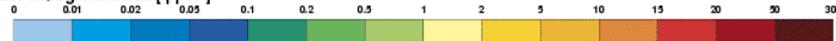
Tuesday 15 November 2016 00UTC CAMS Forecast t+012 VT: Tuesday 15 November 2016 12UTC

Surface ozone [ppbv]



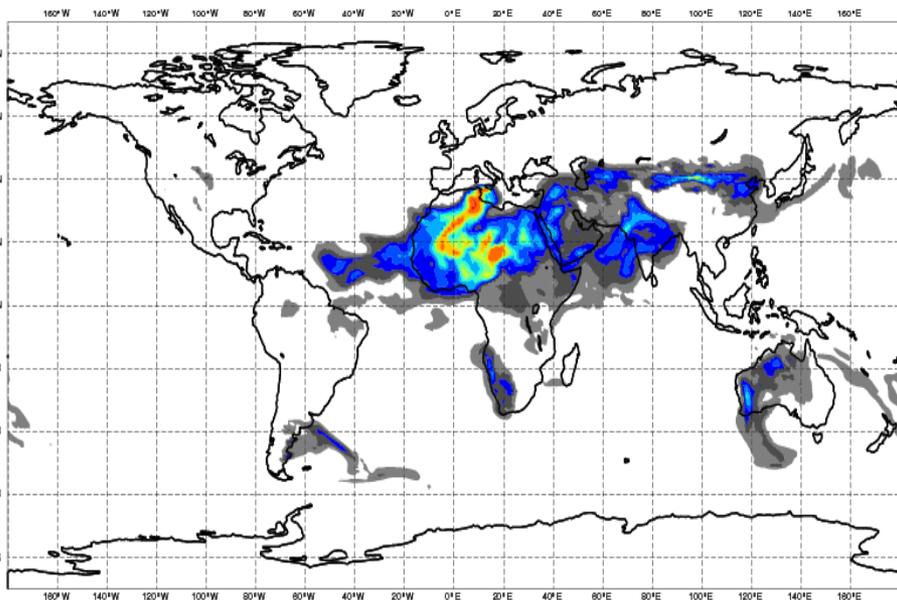
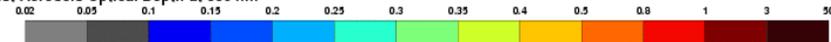
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Surface Nitrogen Dioxide [ppbv]



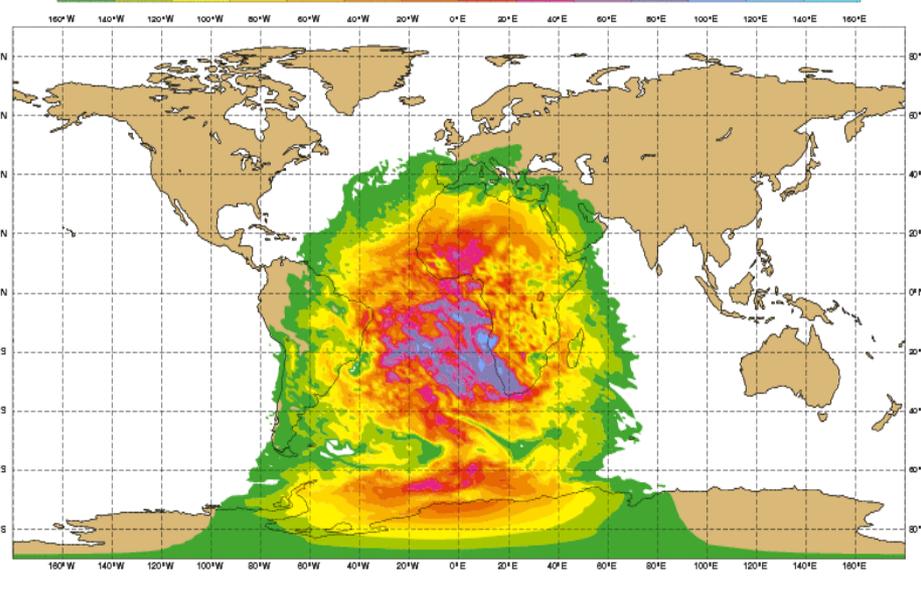
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Dust Aerosols Optical Depth at 550 nm

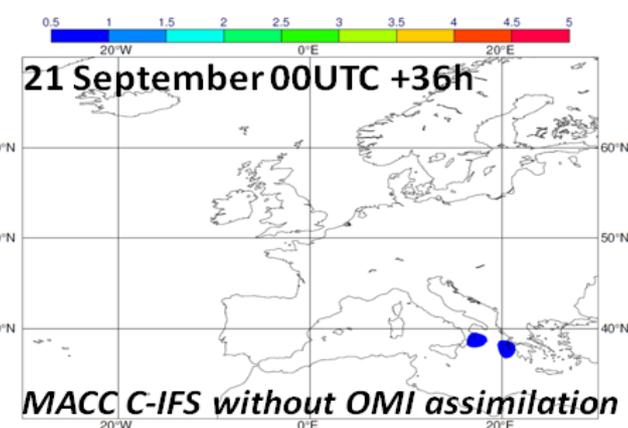
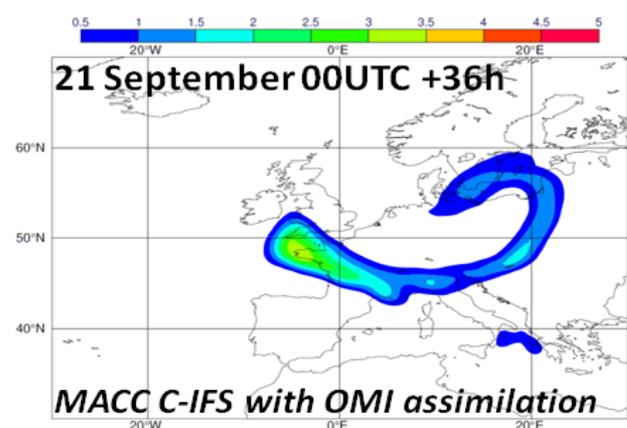
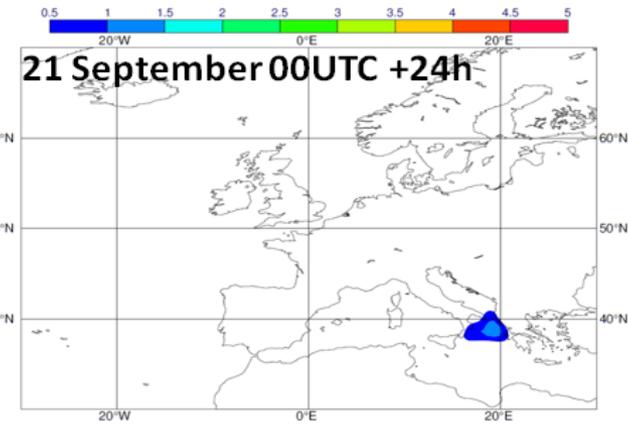
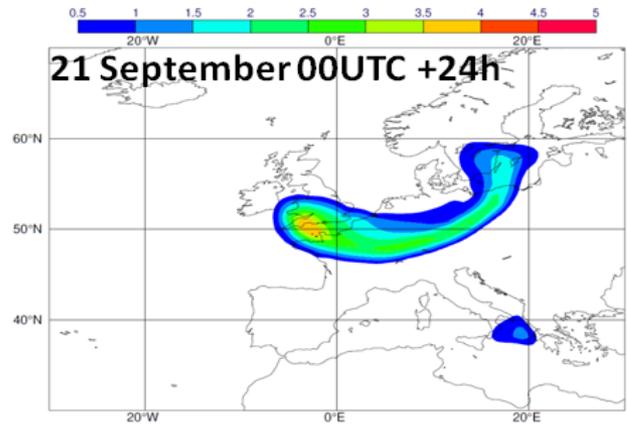
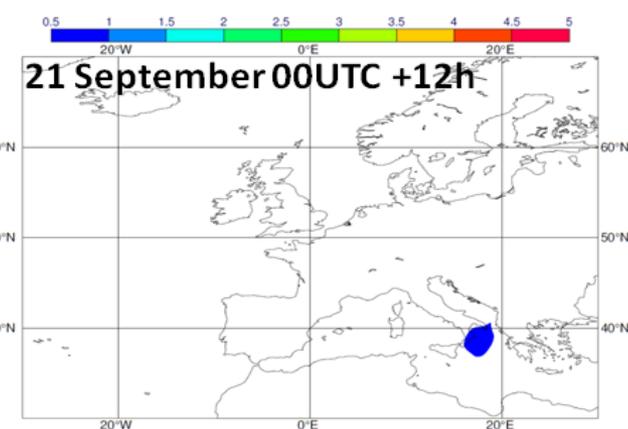
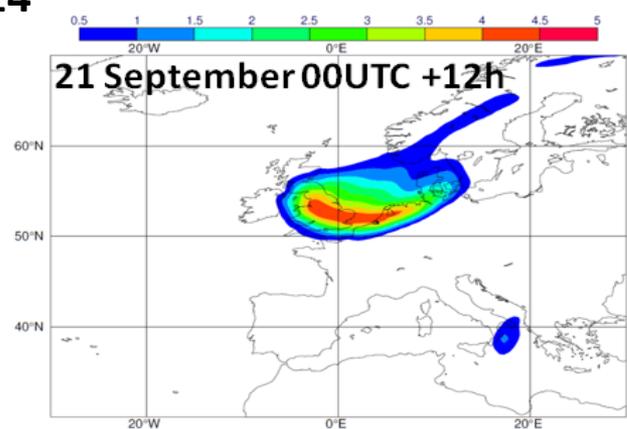


Tuesday 15 November 2016 00UTC CAMS Forecast t+012 VT: Tuesday 15 November 2016 12UTC

Total sky UV Index



Bárðarbunga, 2014 SO₂

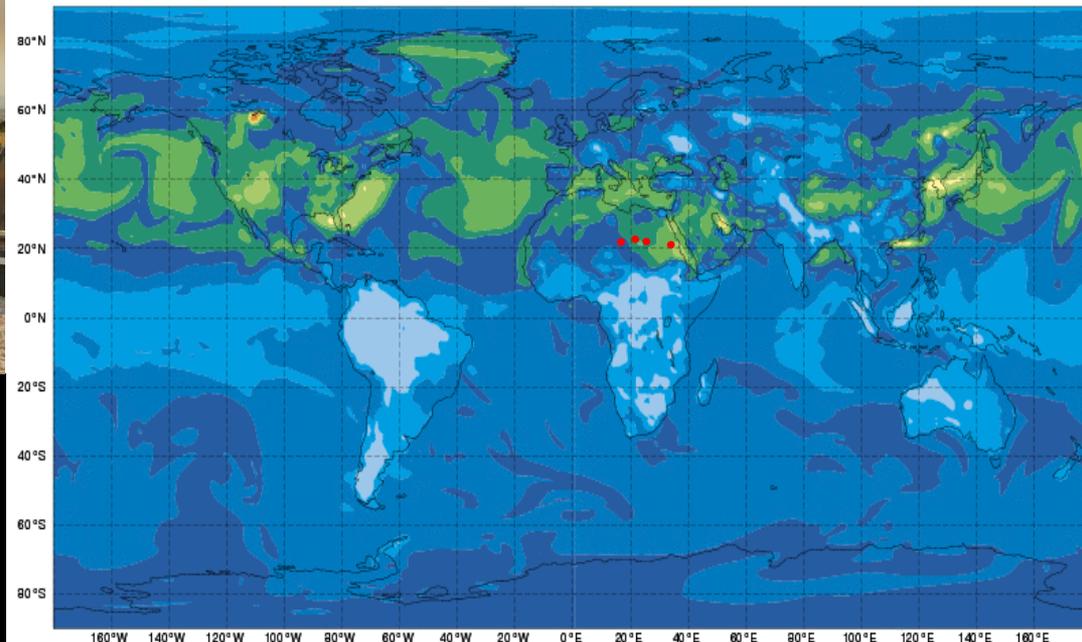


In situ Networks used for the CAMS validation over the Mediterranean

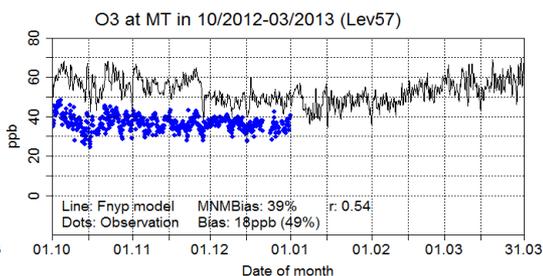
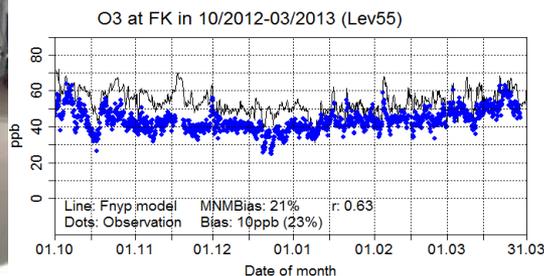
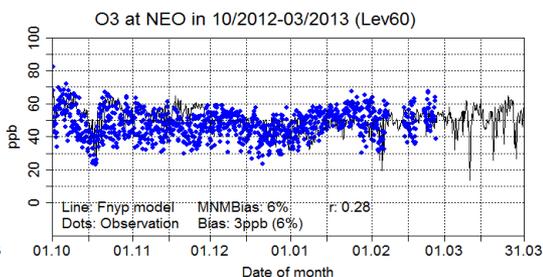
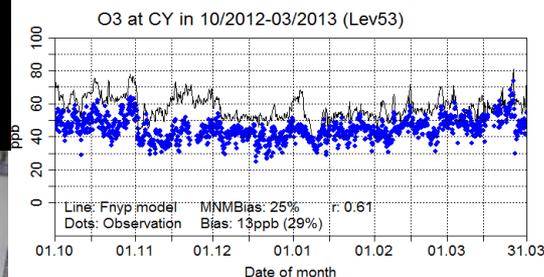
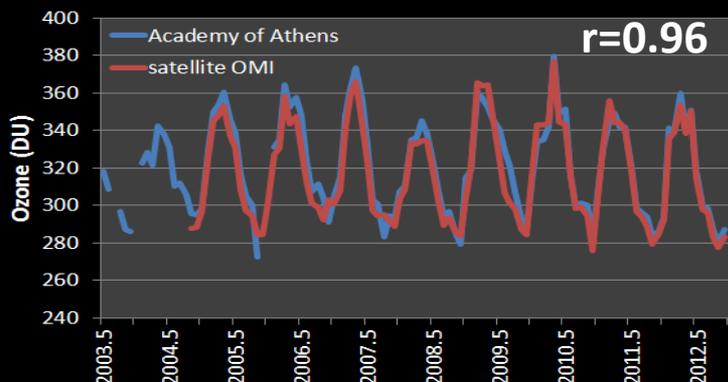
- GAW
- AirBase (Classes 1-2)
- Aeronet
- Department of Labour Inspection - Ministry of Labour and Social Insurance, of Cyprus
- Other Stations (NEO, Finokalia)

AoA air quality data platform- Validate and use CAMS data

Smoke over BRFAA during the forest fires event in Athens in August 2009

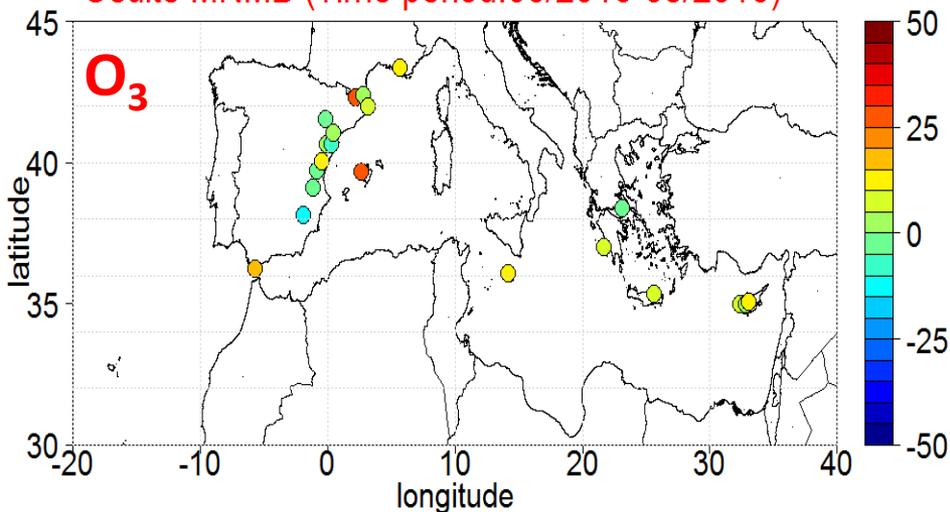


Athens monthly ozone 2003-2012

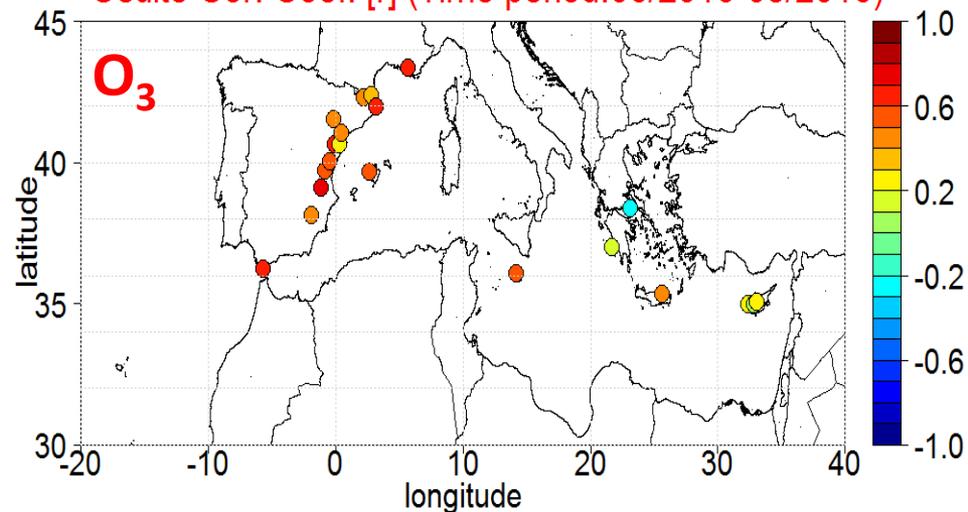


Validation over the Mediterranean

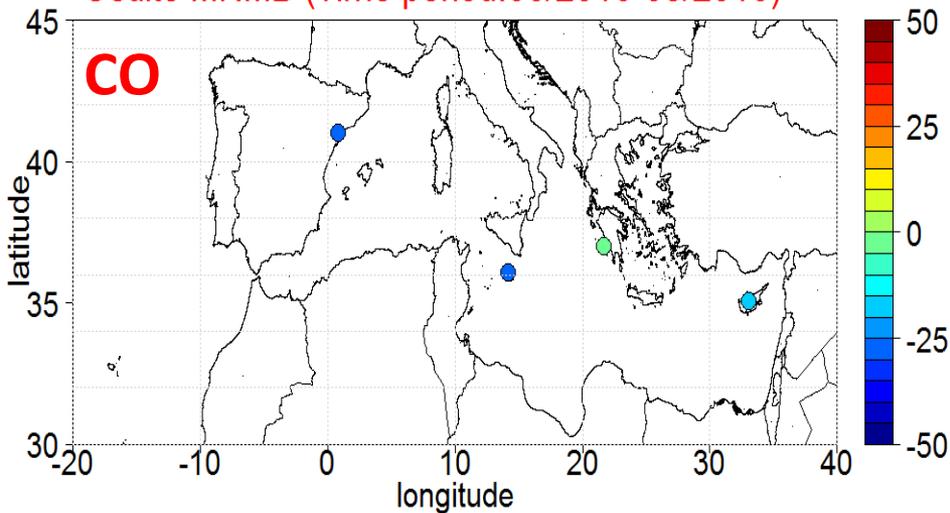
O₃ Osuite MNMB (Time period:06/2016-08/2016)



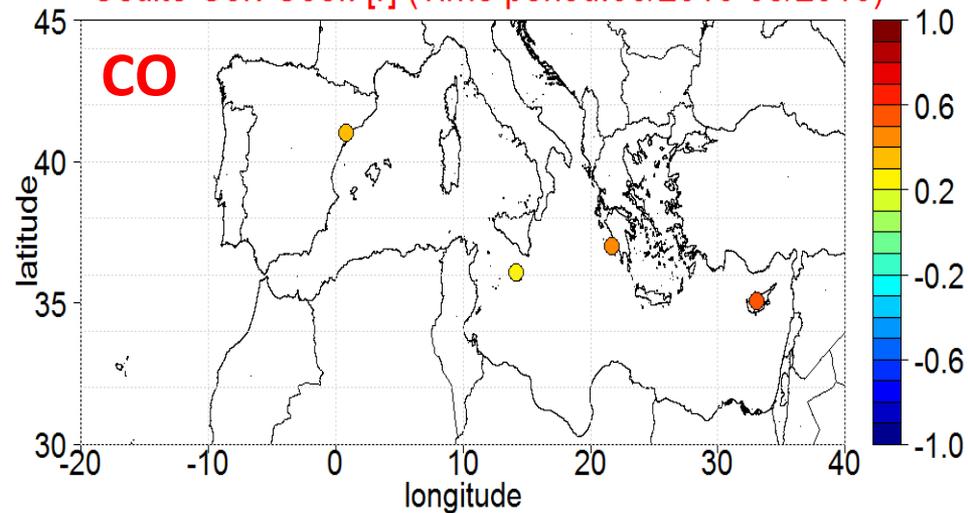
O₃ Osuite Cor. Coef. [r] (Time period:06/2016-08/2016)

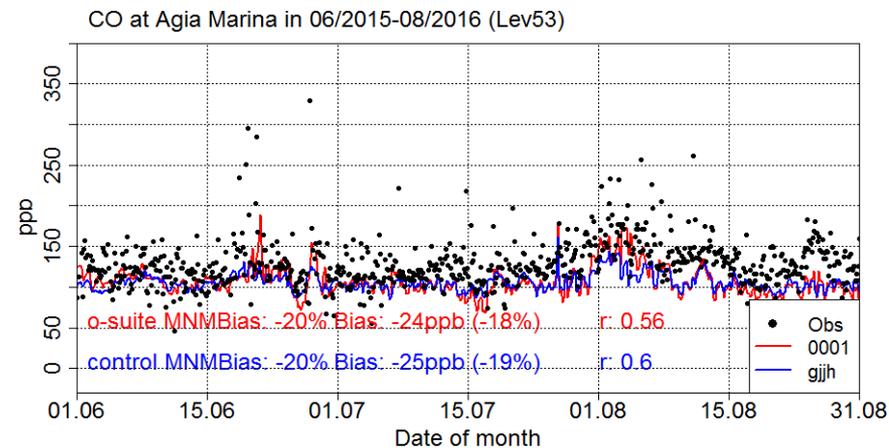
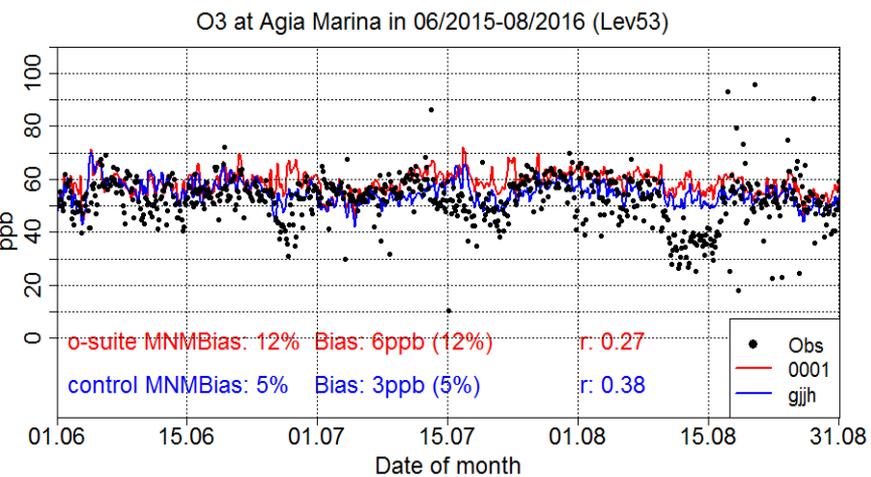
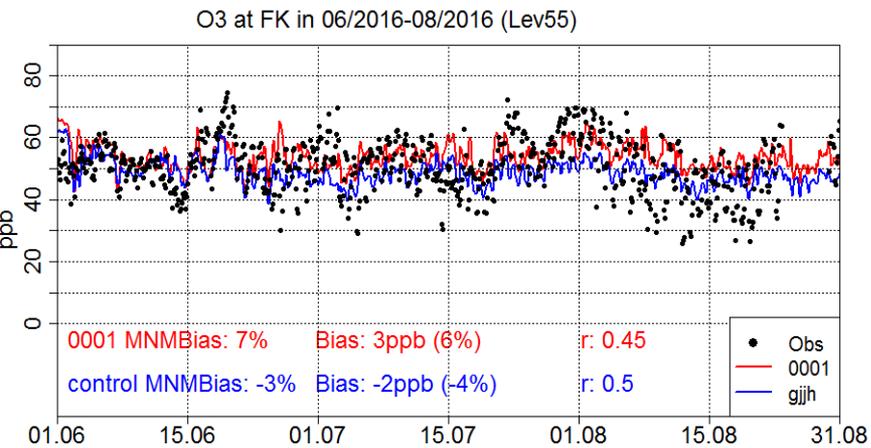
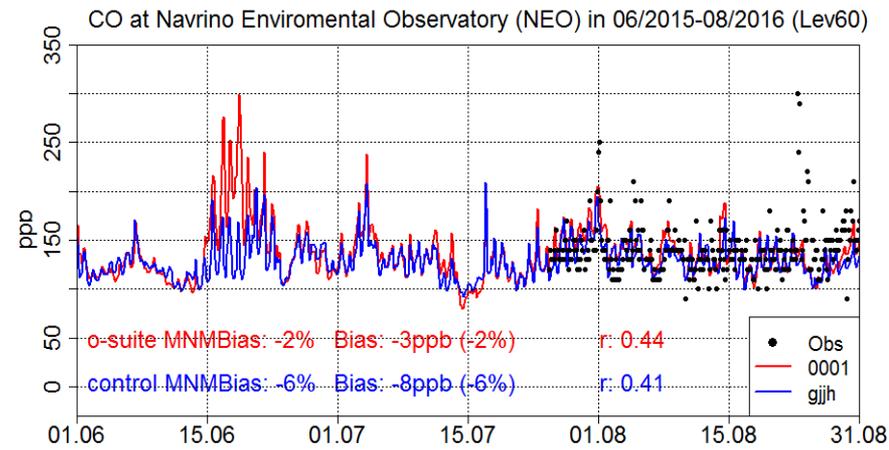
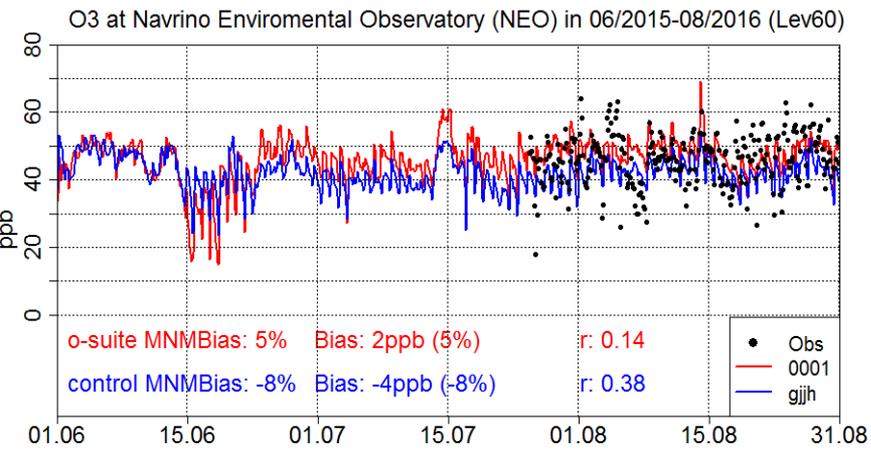


CO Osuite MNMB (Time period:06/2016-08/2016)



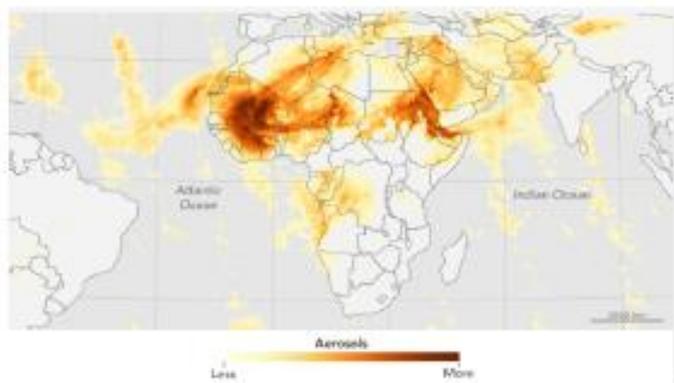
CO Osuite Cor. Coef. [r] (Time period:06/2016-08/2016)



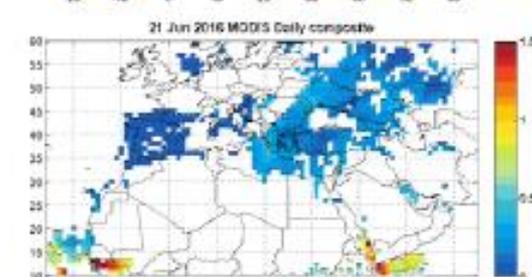
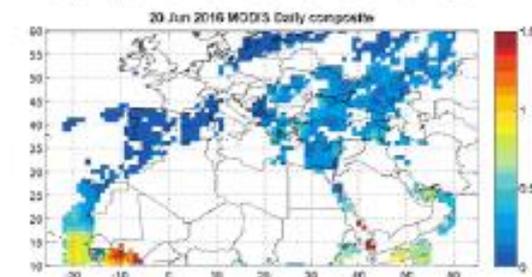
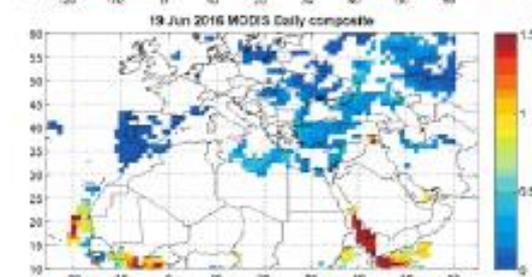
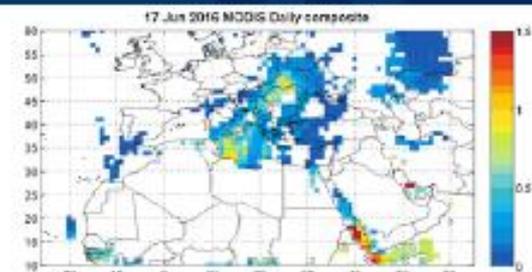
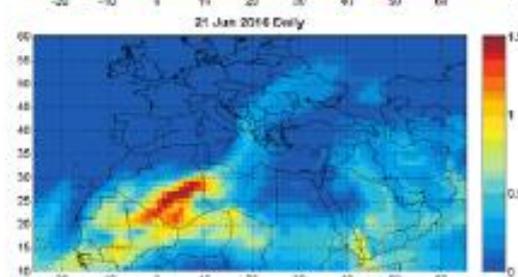
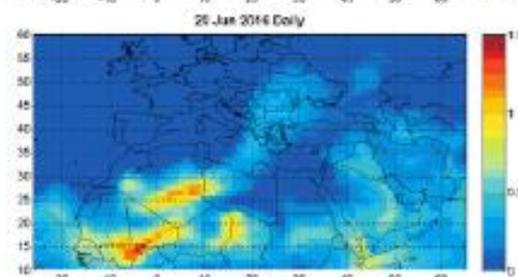
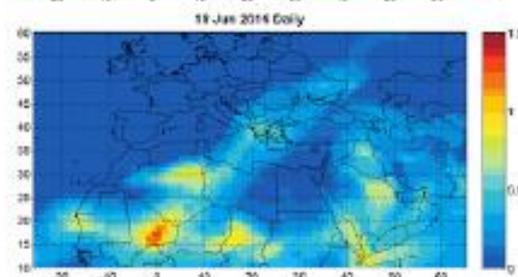
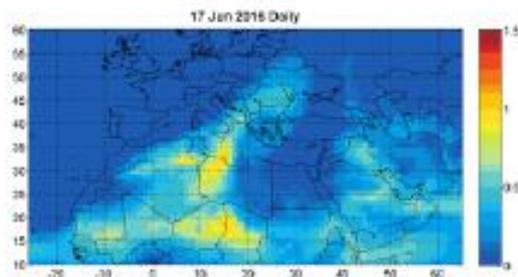


- Navarino Environmental Observatory stations is now providing NRT surface O3 and Co data
- The development of East Mediterranean web platform is under way

Events: A dusty period over NAMEE in mid-June 2016



Aerosol content on June 19, 2016 from the Ozone Mapping Profiler Suite (OMPS) on the Suomi-NPP satellite. Source: NASA Ozone Mapping and Profiler Suite.



CAMS Regional Air Quality (RAQ)

European Air Quality products

- **Available Chemical Species:**

O₃, NO₂, SO₂, CO, PM₁₀, PM_{2.5}, NH₃, NO, NMVOC, PANs, Birch pollen

- **Each day are provided 96h model forecasts, with hourly resolution**

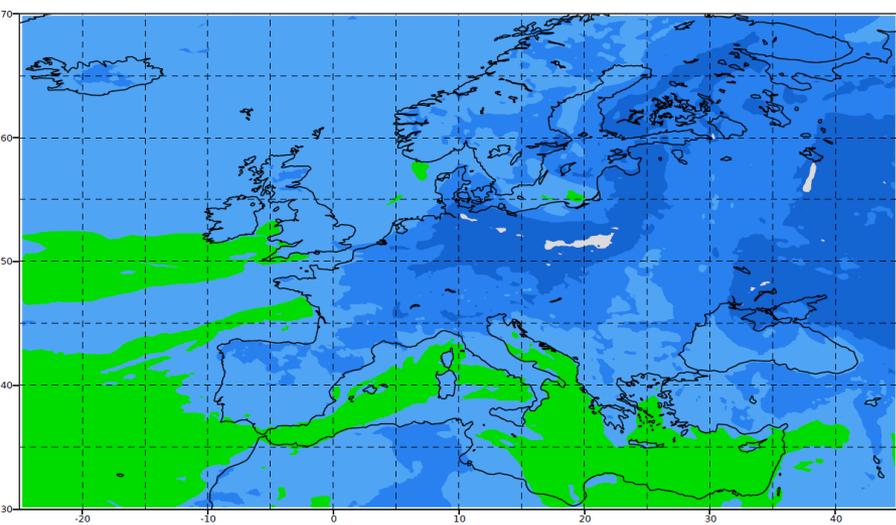
- **Spatial Resolution 0.1x0.1°**

- **Products are available at 8 vertical levels: surface, 50, 250, 500, 1000, 2000, 3000, 5000 m**

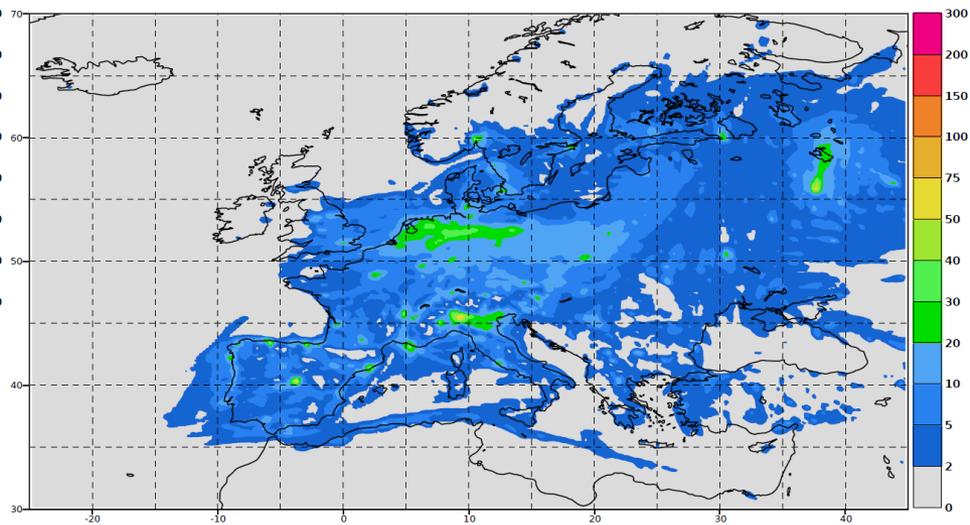
The ensemble mean is the median of the following 7 regional air quality models:
MOCAGE, LOTOS-EUROS, EMEP, MATCH, EURAD-IM, CHIMERE and SILAM.

(<http://atmosphere.copernicus.eu/>)

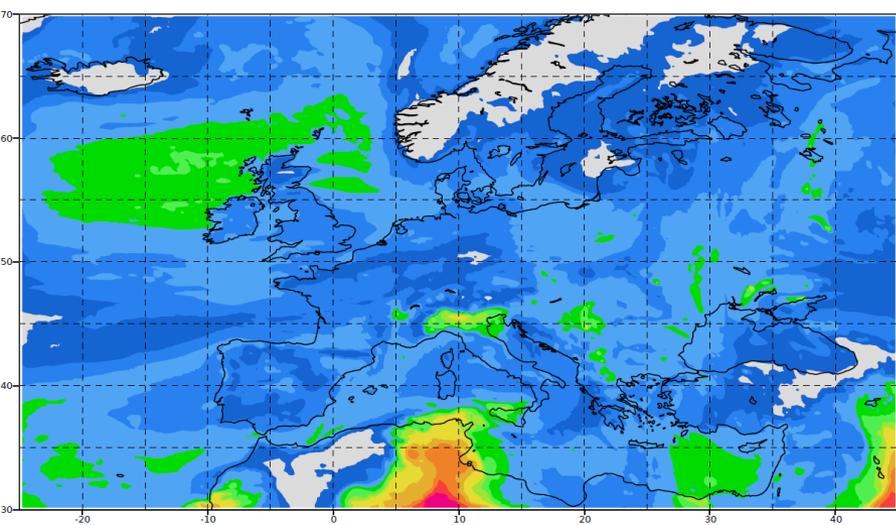
Tuesday 15 November 2016 00UTC CAMS Forecast t+038 VT: Wednesday 16 November 2016 14UTC
Model: ENSEMBLE Height level: Surface Parameter: Ozone [$\mu\text{g}/\text{m}^3$]



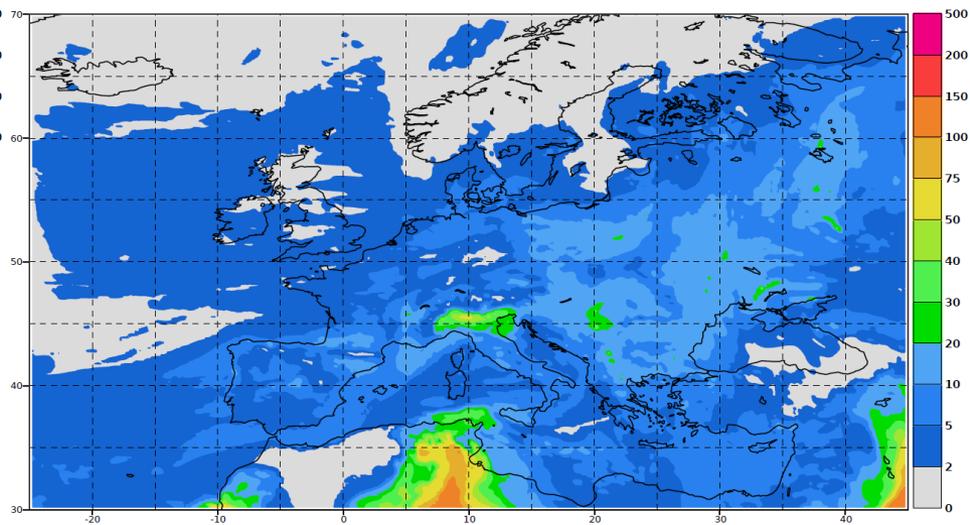
Tuesday 15 November 2016 00UTC CAMS Forecast t+032 VT: Wednesday 16 November 2016 08UTC
Model: ENSEMBLE Height level: Surface Parameter: Nitrogen Dioxide [$\mu\text{g}/\text{m}^3$]



Tuesday 15 November 2016 00UTC CAMS Forecast t+038 VT: Wednesday 16 November 2016 14UTC
Model: ENSEMBLE Height level: Surface Parameter: PM10 Aerosol [$\mu\text{g}/\text{m}^3$]



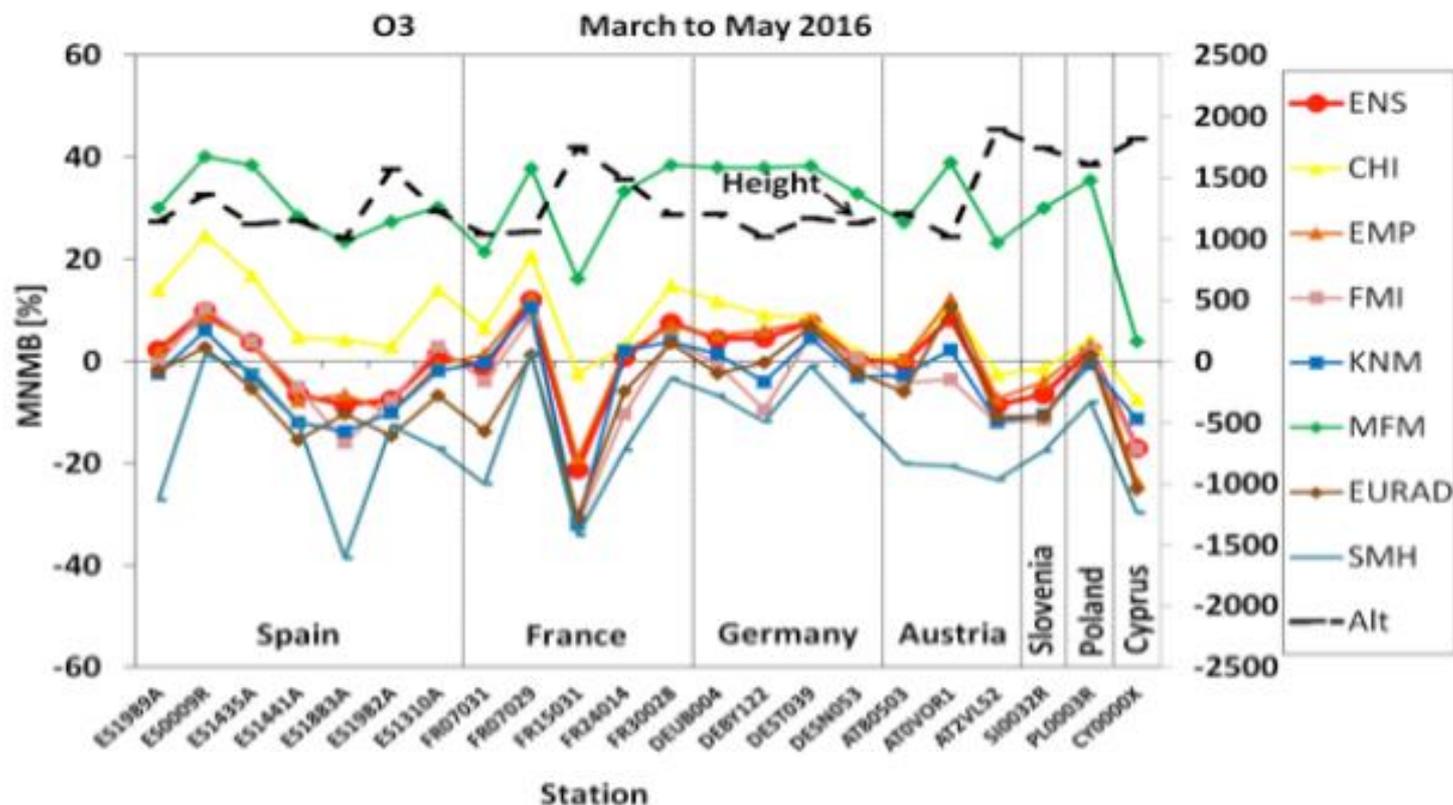
Tuesday 15 November 2016 00UTC CAMS Forecast t+038 VT: Wednesday 16 November 2016 14UTC
Model: ENSEMBLE Height level: Surface Parameter: PM2.5 Aerosol [$\mu\text{g}/\text{m}^3$]





EVALUATION REGIONAL FORECASTS ABOVE SURFACE

AIRBASE high altitude stations



John Kapsomenakis, Christos Zerefos

CAMS products are strongly linked with thematic areas such as :

- Air Quality
- Climate Change and adaptation
- Energy
- Bioclimatology
- Tourism
- Health