Présentation du service de surveillance atmosphérique Copernicus (CAMS): le système, les produits, les opportunités

Head User Engagement Copernicus Services

Présenté par: Simon Chabrillat

Remerciements: V.-H. Peuch, R. Engelen and other colleagues and service providers of CAMS team

ISSeP Groupe de Travail en Observation de la Terre (GTEO) Matinée de présentation et d'échanges virtuels 25/11/2020







Atmosphere Monitoring



The EU Copernicus programme

Atmosphere Monitoring



Sentinels

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





Atm Mo

The Copernicus Sentinels

os	phere			
nit	oring	SENTINEL-1: 4-40m resolution, 3 day revisit at equator	S1A and 1B in orbit	
		SENTINEL-2: 10-60m resolution, 5 days revisit time	S2A and 2B in orbit	
		SENTINEL-3: 300-1200m resolution, <2 days revisit	S3A and S3B in orbit	
		SENTINEL-4: 8km resolution, 60 min revisit time	1st Launch 2022	
		SENTINEL-5p: 7-68km resolution, 1 day revisit	S5P in orbit	
		SENTINEL-5: 7.5-50km resolution, 1 day revisit	1st Launch 2023	
		SENTINEL-6: 10 day revisit time	1st Launch 2020	

Key Features

Polar-orbiting, all-weather, day-and-night radar imaging

Polar-orbiting, multispectral optical, high-resolution imaging

Optical and altimeter mission monitoring sea and land parameters

Payload for atmosphere chemistry monitoring on MTG-S

Mission to reduce data gaps between ENVISAT, and Sentinel 5

Payload for atmosphere chemistry monitoring on MetOp 2ndGen

Radar altimeter to measure seasurface height globally





Why information services are needed?



Example: NO₂ tropospheric column from Copernicus Sentinel-5P (07/10/2018)

Observations are essential, but **direct use** is generally **limited**:

- gaps in space and time
- observed quantities may not be directly relevant (vertical column vs nose-level concentration)
- Complex and numerous

What services do:

- blend observations (satellite and nonsatellite) with model to provide a consistent "picture"
- forecasts, some days ahead
- reanalyses over past years, decades



http://atmosphere.copernicus.eu















CAMS provides operational information products based on Earth Observation about:

- past, current and nearfuture (forecasts) global atmospheric composition;
- the ozone layer;

•

.

- European air quality;
- emissions and surface fluxes of key pollutants and greenhouse gases;
- solar radiation; •
- climate radiative forcing.





CAMS INFORMATION FLOW

Atmosphere Monitoring



Earth Observation from satellite (>75 instruments) and insitu (regulatory and research)





40km Globe (twice daily, d+5)

CAMS main operational data assimilation and modelling systems







COPERNICUS: EUROPE'S EYES ON EARTH

Atmosphere Monitoring



CAMS aerosol forecasts initialized on 13 October 2017. Storm Ophelia transported a mixture of smoke, dust and sea salt aerosol across Europe leading to the sun appearing red and to yellow skies.



PA/Neil Pugh, BBC

PRODUCTS: Past global atmospheric composition

Atmosphere Monitoring

AERONI

Evaluation of Aerosol Optical Depth

The CAMS global reanalysis covers the period 2003 to end 2019.

It is a marked improvement over our previous datasets (MACC reanalysis and CAMS interim reanalysis).

CAMSRA (2003-2016)







PRODUCTS: Ozone layer

Atmosphere Monitoring





The anomalous 2019 ozone hole has closed. It has been the smallest since the early 80s. This possibility was mentioned by CAMS to the press in mid-September already.



BIRA-IASB contribution: Ozone layer - validation + development

Atmosphere Monitoring

(BASCOE)

analysis

MLS

IFS Linear schemes

IFS-CARIOLLE

GO3 [ppbv] at 475.00 [K] GO3 [ppbv] at 475.00 [K] rd.h7c4_240x121x137_202003241200.grhdim_240x121x137_202003241200.gr O3 [ppbv] at 475.00 [K] 1LS_05.07E_202003241200_L137.nc1 3629 2911 2192 O3 [ppbv] at 475.00 [K] nl.b27e_192x97_202003241200 O3 [ppbv] at 475.00 [K] nl.b27b 192x97 202003241200 - 1474 - 756 - 37 **IFS** detailed schemes IFS-CB05/BASCOE **IFS-MOCAGE**

Detailed representation of stratospheric composition is a repeated user requirements.

Developments have been essentially completed and the next step is transferring to operations.

Opportunity to assimilate certain satellite observations, which are not used today.

Users: academia (ozone hole, climate...) and NWP.

IFS-HLO





PRODUCTS: Emissions inventories

Atmosphere Monitoring



1000.0

10000

10.0



1000 0

10000 0

100.0

Emissions are both an input to CAMS global and regional systems and a popular product. Entirely new datasets have been released covering 2003 to 2020 (extrapolation). Example: CO₂ emissions from shipping activities. (lead provider: TNO, NL)

10.0



100000.0

GLOBAL PRODUCTS: DAILY ANALYSES AND FORECASTS

Atmosphere



- Twice daily global analyses (00, 12UT) and forecasts up to +5 days, 40km resolution
- CAMS site provides all data (and many charts)
- GHG products CO₂ and CH₄: global analyses in delayed mode (4 day behind) at 9km resol.

Methane forecast on 2020/11/25 (today) at 18UT from analysis on Sunday at 00UT





AIR QUALITY PRODUCTS: DAILY ANALYSES AND FORECAST

Atmosphere Monitoring



- Over Europe, a multi-model ensemble is used to deliver forecasts (with uncertainty).
- It has now 9 operational members (CHIMERE, DEHM, EMEP, EURAD, GEM-AQ, LOTOS-EUROS, MATCH, MOCAGE, SILAM) and 2 more are ramping up (MONARCH, MINNI).
- These are the leading air quality models in Europe, leveraging on national efforts and expertise in 10 EU Member States.
- 10km by design.





AIR QUALITY PRODUCTS: EXAMPLE viz & outreach: windy.com

Atmosphere Monitoring



Subset available for viz on Windy (in addition to weather):

- NO₂
- PM2.5
- Aerosols
- O₃
- SO₂
- CO
- Dust
- Fires

CAMS global and regional forecasts seen in the highly successful Windy app and website. Here: NO2 forecast by AQ ensemble on 2020/11/20 (Wednesday) at 16UT from analysis on Monday at 0UT





PRODUCTS FOR POLICY USERS: reports

Atmosphere Monitoring

- Annual Air Quality interim assessment reports based on ensemble reanalysis of UTD E2 datasets: available July year N for year N-1. Includes analysis of key episodes and effect of natural contributions for supporting reporting activities in MS.
- Annual Air Quality assessment reports based on ensemble reanalysis of validated datasets: available Q3 of year N for year N-2.

In collaboration with

European Environment Agency





http://policy.atmosphere.copernicus.eu





PRODUCTS FOR POLICY USERS: Air Control Toolbox (ACT)

Atmosphere Monitoring



Co-designed with EU Member States and operated using one of the ensemble members (CHIMERE, Ineris, FR).

The CAMS ACT has been recently adjusted to support European Member States with the management of air quality during the COVID-19 crisis.





PRODUCTS for Air Quality managers

Atmosphere Monitoring

For the European capitals, daily analysis of local versus large scale contribution to air pollutant concentrations. Where does pollution come from? What is the chemical composition of PM?





EXAMPLE

Atmosphere Monitoring On Sunday 10 May evening, strong sulphurous smell are experienced in Paris area. CAMS was used to bring first insights about the situation.



Régis Crépet / M @RegisCrepet

#Odeur de soufre en IDF ? c'est lié au changement de masse d'air et de l'arrivée brutale de l'air froid de mer du Nord, rabattant aussi les odeurs vers Paris. Quant au ciel "orange" au-dessus de la Capitale, c'est dû à la réflexion des lumières de la ville sur les nuages bas **twitter.com/m_parrington/s...**

Mark Parrington @m_parrington

Cold front clearing surface PM2.5 #airpollution across UK & NW Europe on 10 May continues across Europe through coming days. @CopernicusECMWF Atmosphere Monitoring Service @ECMWF regional ensemble forecast visualized by @windyforecast windy.com/-PM2-5-pm2p5?c... @CopernicusEU



2067 23:12 - 10 mai 2020
1202 personnes parlent à ce sujet



Une odeur de soufre inquiétante s'étend de Lille jusqu'à Nantes : on vous explique ce qui se passe

Depuis la nuit dernière, une forte odeur de soufre règne sur une partie du pays, des Hauts-de-France jusqu'aux Pays de la Loire, <u>INTERAMENT</u>-sant par l'Ile-de-France. Ce phénomène inquiétant tire son origine de plusieurs facteurs, certains naturels, d'autres liés <u>INTERAMENT</u>-sur l'ivités humaines. On vous explique.



Or, la France a connu ce week-end une violente activité électrique. Pas des milliards d'éclairs, bien sûr, mais en nombre suffisant pour produire des oxydes d'azote, comme l'explique Mark Parrington dans un tweet (en anglais) :

Cold front clearing surface PM2.5
#airpollution across UK & NW Europe on 10 May continues across Europe through coming days.
@CopernicusECMWF Atmosphere Monitoring Service @ECMWF regional ensemble forecast visualized by @windyforecast https://t.co//Erlw4r6Fm7 @CopernicusEU
pic.twitter.com/LrOWsh5YBO— Mark Parrington (@m_parrington) May 10, 2020 99

- Une onde de pollution

(j)

>

On l'a vu ce week-end, et on ne peut que le remarquer depuis ce lundi matin : après des flux de sud-ouest qui ont fait remonter sur la France des orages puissants et durables, un immense front froid, venu du nord-est, a rapidement repoussé cet air chaud et humide pour apporter ses températures fraîches jusqu'au sud de la Loire.



Supplementary products

Atmosphere Monitoring

4

Greenhouse gas fluxes (CO₂, CH₄, N₂O)



Climate forcings

MACC Aerosol Forcing derived from MACC reanalysis Global Monthly Mean January 2003 Anthropogenic SW direct forcing at TOA allsky [Wm-2] min=-6.602 max=0.813 mean=-0.537





Solar radiation

DOCUMENTATION & QUALITY CONTROL

Atmosphere Monitoring

<u>https://atmosphere.copernicus.eu/index.php/quality-assurance</u> Large efforts by international consortia of *external* experts using *independent* observations provide extensive validation, e.g. :

- 3-monthly validation reports of NRT products (global, AQ/EU, ...)
- Annual validation report of reanalysis
- Automatic monitoring plots:

CAMS provides detailed info about how its products are produced and their quality

https://global-evaluation.atmosphere.copernicus.eu/

BIRA-IASB contributions:

Validation of ozone layer using independent satellite obs

Validation of global reactive gases with ground-based remote-sensing observations (NDACC)

OPENING OF THE ATMOSPHERE DATA STORE

http://ads.atmosphere.copernicus.eu

Atmosphere Monitoring

Start:	Fill-in	ill-in form			
5 0 000	0 50 0 2000	⊂ 250 ⊂ 3000	500 5000	Select all	Clear a
Level 3					
Ensemble median MATCH DEHM	CHIMERE MOCAGE GEM-AQ	a EMEP a SILAM	CLOTOS-EUROS EURAD-IM		Clear al
Dust Nitrogen monoxide Ozone PM2.5, anthropogenic fossil fuel carbon or Perophyr dioxide	Gran	s pollen nættane VOCs iculate matter < 2.5 µm (PM2.5) 15, anttropogenic wood burning carbon only weed pollen	Nitrogen dioxide Olive polien Particulate matter < 10 µm (PM10) PM10, wildfires only Secondary inorganic aerosol	Select all	Clear a

CAMS IN ACTION : CAMS COVID-19 MINISITE

Atmosphere Monitoring

https://atmosphere.copernicus.eu/european-air-quality-information-support-covid-19-crisis

Maps and animations of the latest situation in Europe.

Forecast model estimate of reduction in air pollution is expected on a daily basis accounting for weather effects.

concentration map

rin NO2 CAMS Surface (12:30 UTC) and S5P Total Columns 202

Air pollution across Europe compared to 2017-2019 and as a function of lockdown measures.

How consistent are surface and satellite measurements?

CAMS currently contributes to a number of epidemiological studies trying to evaluate the links between air pollution and COVID-19 (effects of long- and short-term exposure; fine particulate matter as a potential vector in air for the virus?...)

· 2020-05-11

NO2

Reference Air Quality Simulati

Covid lockdow

Reset cache

CAMS regional air quality forecasts: Météo-France, Ineris (FR) CAMS COVID-19 scenario forecasts: Ineris (FR) CAMS website: ECMWF

CAMS:

a mainstream information source on air quality

free and open source of big data for local applications

Atmosphere Monitoring

opernicus

Copernicus EU

Copernicus ECMWF

@CopernicusEU@CopernicusECMWF@VHPeuch

@copernicusecmwf

Copernicus EU Copernicus ECMWF

www.copernicus.eu atmosphere.copernicus.eu

