Copernicus Atmosphere Monitoring Service

Technical User Guide

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Abstract

The abstract.

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Tables

1. Introduction

Some of today's most important environmental concerns relate to the composition of the atmosphere. The increasing concentration of the greenhouse gases and the cooling effect of aerosol are prominent drivers of a changing climate, but the extent of their impact is often still uncertain.

At the Earth's surface, aerosols, ozone and other reactive gases such as nitrogen dioxide determine the quality of the air around us, affecting human health and life expectancy, the health of ecosystems and the fabric of the built environment. Ozone distributions in the stratosphere influence the amount of ultraviolet radiation reaching the surface. Dust, sand, smoke and volcanic aerosols affect the safe operation of transport systems and the availability of power from solar generation, the formation of clouds and rainfall, and the remote sensing by satellite of land, ocean and atmosphere.

To address these environmental concerns there is a need for data and processed information. The Copernicus Atmosphere Monitoring Service (CAMS) has been developed to meet these needs, aiming at supporting policymakers, business and citizens with enhanced atmospheric environmental information.

The Copernicus Atmosphere Monitoring Service (CAMS, atmosphere.copernicus.eu/) is establishing the core global and regional atmospheric environmental service delivered as a component of Europe's Copernicus programme.

2. Study Area, Data & Materials

{Introduction}

2.1. Pollutants

2.1.1. Surface Ozone (O_3)

Ozone (O_3) in the troposphere (the lowermost part of the atmosphere, from the surface to 6-15 km height depending on the latitude) is highly relevant for the Earth's climate, ecosystems, and human health. Tropospheric ozone is the third largest contributor to greenhouse radiative forcing after carbon dioxide and methane (Forster et al., 2007). It is part of the Earth's shield against ultraviolet radiation, particularly when there is stratospheric ozone depletion (Sabziparvar et al., 1998).

Ozone plays a crucial role in tropospheric chemistry as the main precursor for the OH radical which determines the oxidation capacity of the troposphere (Seinfeld and Pandis, 2006). It is a toxic air pollutant affecting human health (Bell et al., 2006) and agriculture (Royal Society 2008). Furthermore, through plant damage, it impedes the uptake of carbon into the biosphere (Sitch et al., 2007).

Accurate long-term measurements of ozone in the troposphere, including near the earth surface in unpolluted and polluted environments, are needed in order to assess the impacts of tropospheric ozone on the earth system, human health and ecosystems, and to detect changes in the atmospheric composition which could aggravate or reduce these impacts because of changing ozone precursor emissions or climate change.

2.1.2. NO_x: Nitric Oxide (NO) + Nitrogen Dioxide (NO_2)

NO_x is a generic term for the mono-nitrogen oxides (Mollenhauer and Tschöke, 2010; Omidvarborna et al., 2015), nitric oxide (NO) and nitrogen dioxide (NO_2). They are produced from the reaction among nitrogen, oxygen and even hydrocarbons (during combustion), especially at high temperatures (Omidvarborna et al., 2015; Annamalai, 2007).

2.2. Study Areas

2.2.1. Global

2.2.2. European-scale

The regional forecasting service provides daily 4-day forecasts of the main air quality species and analyses of the day before, from 7 state-of-the-art atmospheric chemistry models and from the median ensemble calculated from the 7 model forecasts. The regional service also provides posteriori reanalyses using the latest validated observation dataset available for assimilation.

2.3. Available Files

2.4. Data Access Methods

3. Models

3.1. Global

3.2. European-scale

3.2.1. CHIMERE

CHIMERE is an Eulerian chemistry-transport model able to simulate concentration fields of gaseous and aerosols species at a regional scale (Menut et al., 2013a). The model is developed under the General Public License licence[1]. CHIMERE is used for analysis of pollution events, process studies, (Bessagnet et al., 2009; Beekmann and Vautard, 2010), experimental and operational forecasts (Rouïl et al., 2009), regional climate studies and trends (Colette et al., 2011), among others.

CHIMERE runs over a range of spatial scale from the regional scale (several thousand kilometres) to the urban scale (100-200 Km) with resolutions from 1-2 Km to 100 Km. The model runs over the GEMS-MACC domain with a 0.1° resolution and 8 vertical levels extending from the surface up to 500 hPa, covering the whole troposhphere.

CHIMERE reproduces nicely the day to day O_3 variation similarly at urban and rural sites with an overestimation which is higher during the winter at urban sites. CHIMERE reproduces the daily NO_x variability along the year but underestimates significantly the concentration especially during the cold season.

3.2.2. EMEP

The EMEP/MSC-W model has been developed at the EMEP Meteorological Synthesizing Centre-West at the Norwegian Meteorological Institute. The model has been publicly available as open-source code since 2008, and a detailed description is given in Simpson et al. (2012).

[1] Official website: http://www.lmd.polytechnique.fr/chimere/

	Forecast	Analysis
Altitudes	Surface, 50m, 250m	Surface
	500m, 1000m, 2000m	
	3000m, 5000m	
Available at	6:00 UTC	09:45 UTC for the day before
Species	O_3, NO, NO_2	O_3, NO, NO_2
Timespan	0-96h, hourly	0-24h for the day before, hourly

Table 1. Products of CHIMERE model

One strength of the EMEP model is that its domain extends throughout the whole troposphere, thus taking accurate account of long-range transport of pollutants in the free troposphere. As the model is designed mainly for background concentrations, urban increments have not been implemented as in some other models with equally coarse resolution, leading to somewhat lower performance in urban and sub-urban areas. However, being one of the main research tools under the UN LRTAP (Long-range Transboundary Air Pollution) convention, the EMEP model is evaluated continuously against measurements of a large range of chemical parameters (including air concentrations, depositions, and trends) ensuring modelling capability with very good overall performance (e.g. Jonson et al., 2006; Fagerli and Aas, 2008; Genberg et al., 2013).

3.2.3. EURAD-IM

EURAD-IM is an Eulerian meso-scale chemistry transport model involving advection, diffusion, chemical transformation, wet and dry deposition and sedimentation of tropospheric trace gases and aerosols (Hass et al., 1995, Memmesheimer et al., 2004). It includes 3DVar and 4DVar chemical data assimilation (Elbern et al., 2007) and is able to run in nesting mode. EURAD-IM has been applied on several recent air pollution studies (Monteiro et al., 2013;Zyryanov et al., 2012; Monteiro et al., 2012; Elbern et al., 2011; Kanakidou et al., 2011).

3.2.4. LOTOS-EUROS

The 3-D chemistry-transport model LOTOS-EUROS (Schaap et al., 2008) is developed by the Dutch institutes TNO [2], RIVM [3] and, more recently, KNMI [4]. It is used for regional-scale air quality forecasts in Europe and the Netherlands (De Ruyter de Wildt et al., 2011).

[2] www.tno.nl
[3] www.rivm.nl
[4] www.knmi.nl

3.2.5. MATCH

3.2.6. MOCAGE

3.2.7. SILAM

3.2.8. ENSEMBLE

To process the ensemble median, all seven individual models are first interpolated to a common $0.1^{\circ}\times 0.1^{\circ}$ horizontal grid. For each grid point, the ensemble model value is calculated as the median value of the individual model forecasts or analyses available. The median is defined as the value having 50% of individual models with higher values and 50% with lower values. This method is rather insensitive to outliers in the forecasts or analyses and is very efficient computationally. These properties are useful from an operational point of view. The method is also little sensitive if a particular model forecast or analysis is occasionally missing.

For the forecasts, the ENSEMBLE is produced for all levels and all species. For the analyses, the individual assimilation systems provide only analyses at the surface level and do not produce analyses for all species yet.

4. Examples

5. Conclusions

References

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Mollenhauer, K., and H. Tschöke (2010), *Handbook of diesel engines*, Springer.

Omidvarborna, H., A. Kumar, and D.-S. Kim (2015), NOx emissions from low-temperature combustion of biodiesel made of various feedstocks and blends, *Fuel Processing Technology*, *140*, 113 – 118, doi:10.1016/j.fuproc.2015.08.031.