



Übersicht Copernicus Atmosphären Dienst

Johannes Flemming
ECMWF



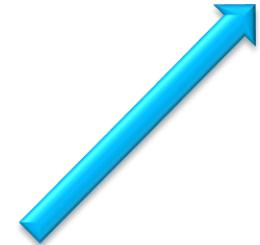
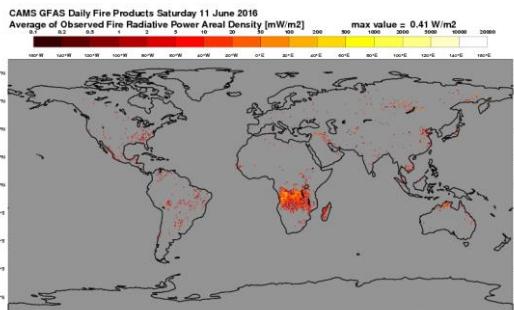
Space Agencies



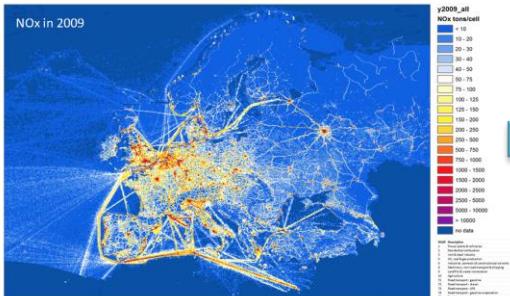
DA



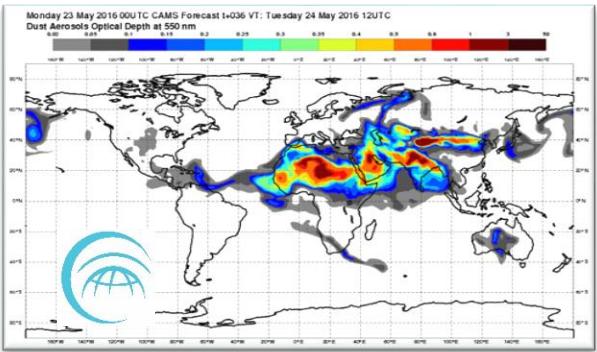
Fire emissions



Anthropogenic emissions



Global System at ECMWF



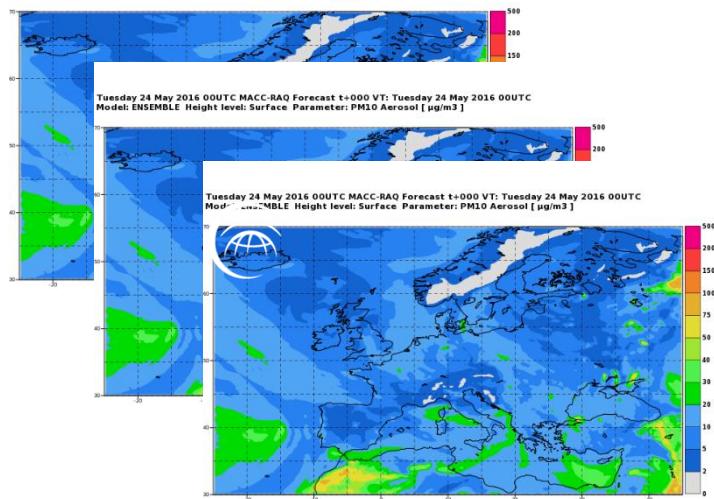
In-situ component



DA

Regional Ensemble

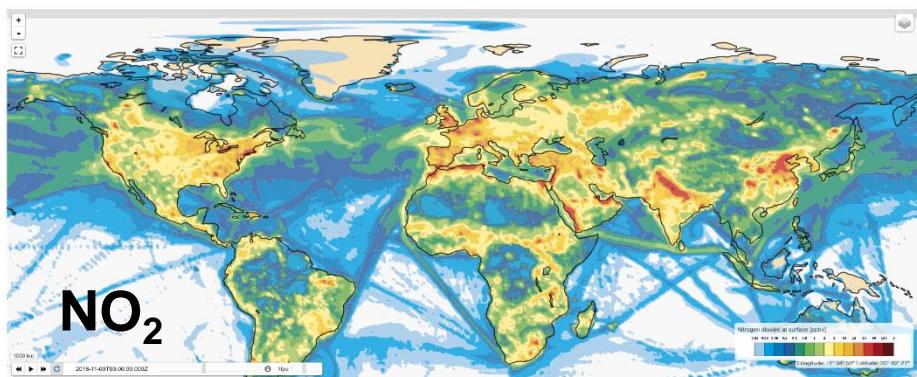
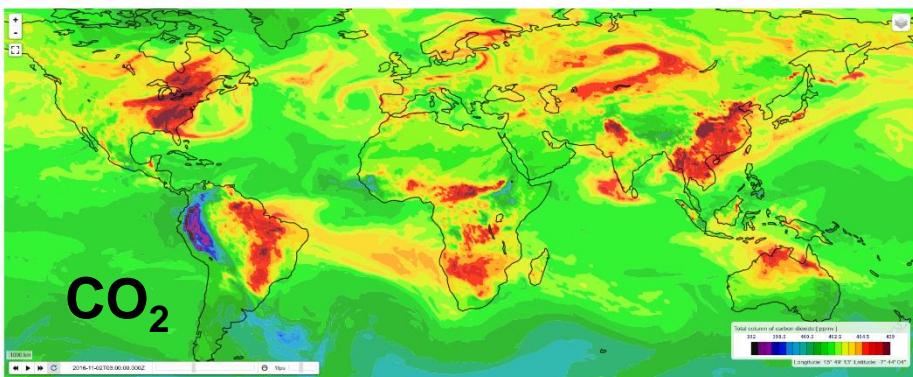
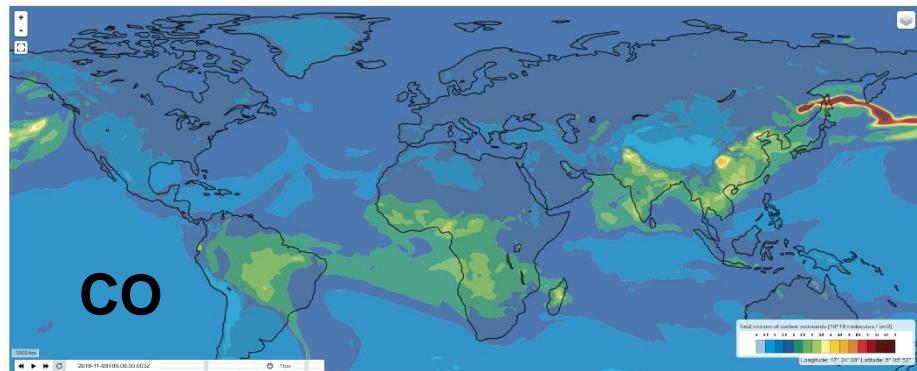
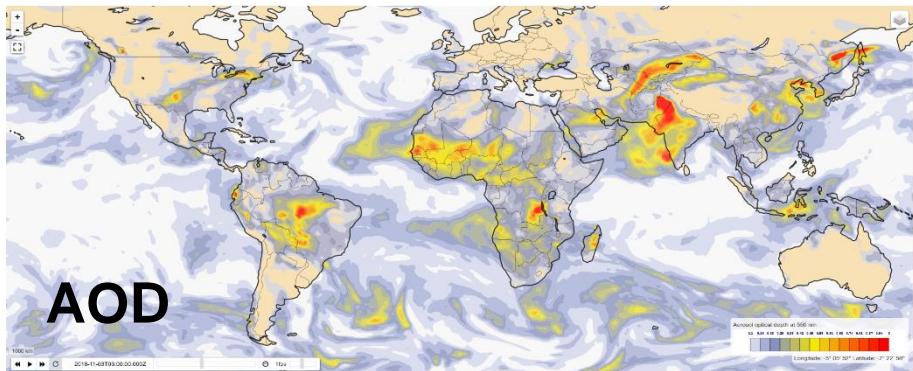
Tuesday 24 May 2016 00UTC MACC-RAQ Forecast t=000 VT: Tuesday 24 May 2016 00UTC
Model: ENSEMBLE Height level: Surface Parameter: PM10 Aerosol [µg/m³]



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, SEVIRI, VIIRS

CAMS also produces data sets without data assimilation. These can be used as control, for field campaigns, or specific events.

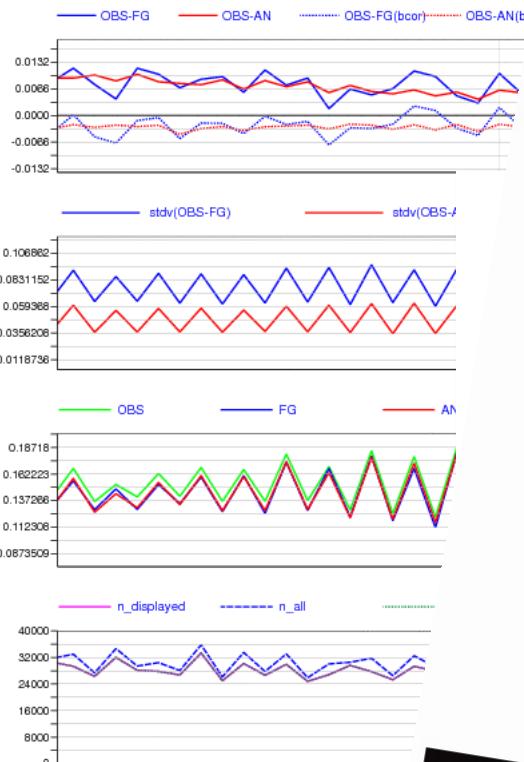
CURRENT FORECAST CONFIGURATION



- 40 km horizontal resolution at 60 model levels; two 5-day forecasts per day (chemistry and aerosols)
- 16 km horizontal resolution at 137 model levels; one 5-day forecast per day (CO₂, CH₄, linear CO)
- Re-analyses data set at 80 or 110 km resolution (2003-2016)



STATISTICS FOR AEROSOL FROM AQUA/MODIS
 LEVEL =0.00 - 1013.25 HPA, USED DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 0.0, lon_e= 360.0, lat_s= -90.0, lat_n= 90.0 (over All_surface)
 EXP = GL1Q (LAST TIME WINDOW: 2016050203)



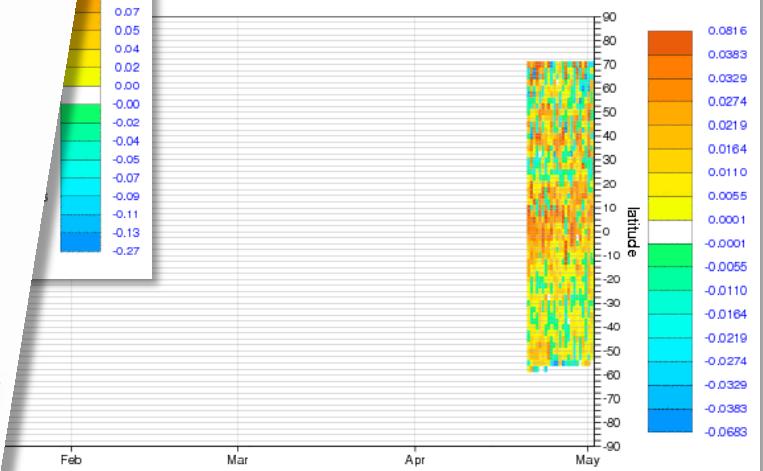
Validation report of the CAMS near-real time global atmospheric composition service

System evolution
and performance statistics
Status up to 1 June 2016

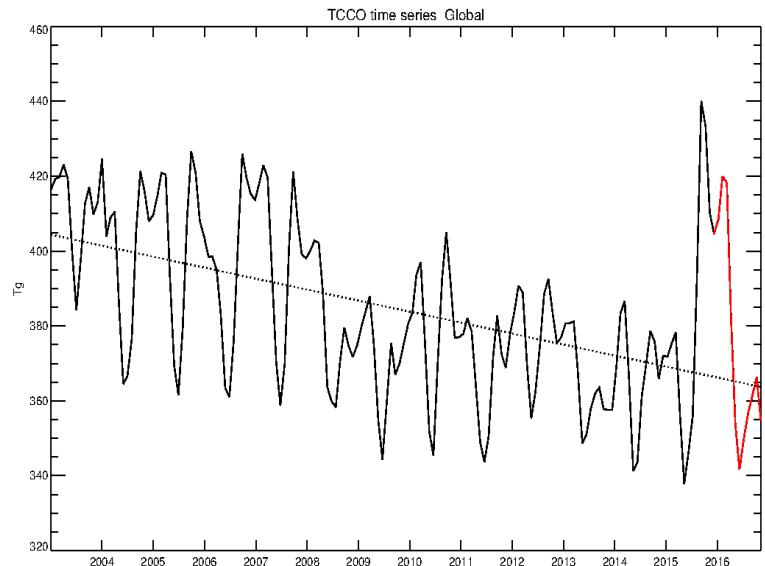
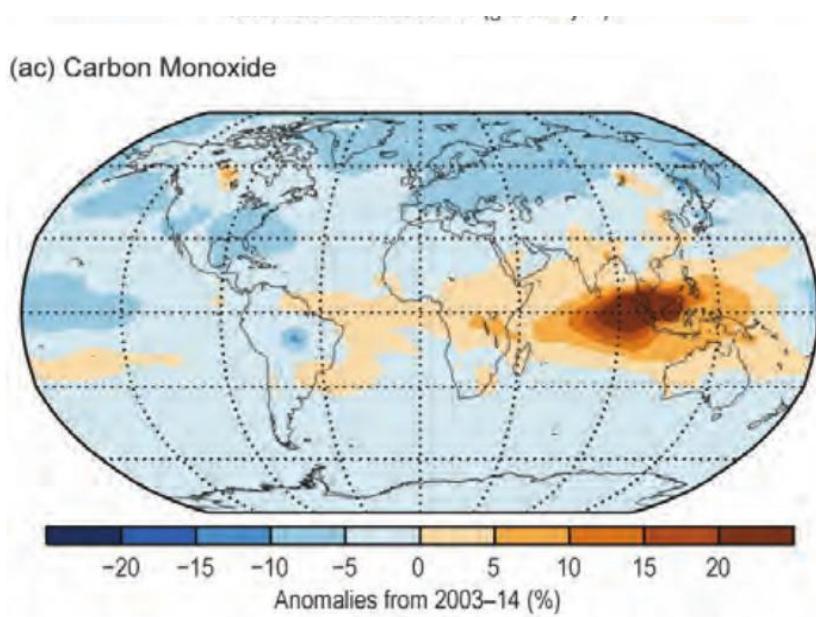
Issued by: KNMI
 Date: 21/09/2016
 REF.: CAMS84_2015SC1_D.84.1.4_201609

Obs-model statistics are
calculated for instruments that are
monitored.

STATISTICS FOR AEROSOL FROM AQUA/MODIS
 LEVEL =0.00 - 1013.25 HPA [TIME STEP = 12 HOURS]
 FIRST GUESS DEPARTURE (OBS-FG) , USED
 EXP = GL1Q, DATA PERIOD = 2016010218 - 2016050206
 -0.068 Max: 0.082 Mean: 0.008



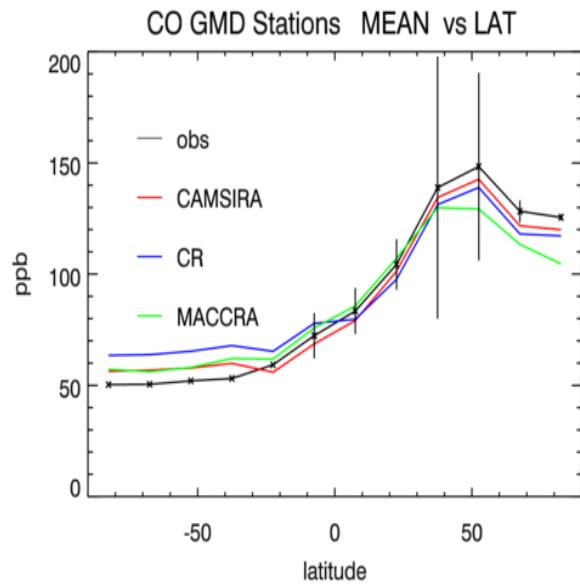
Monitoring of Atmospheric Composition - CAMS interim (re-)analysis



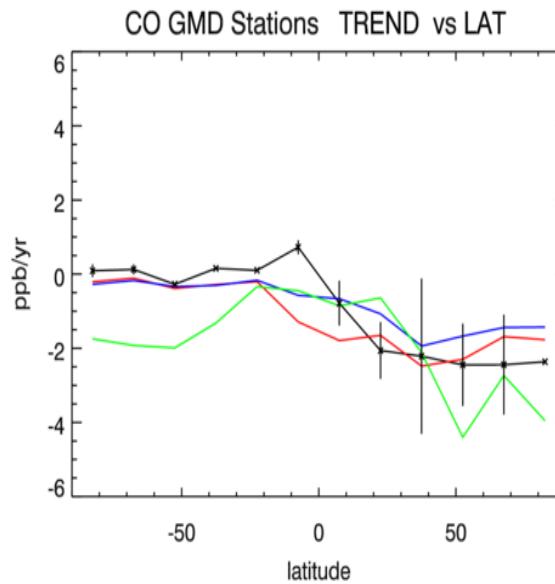
Flemming and Inness, BAMS State of Climate 2015

CAMS interim re-analyse 2003-2016

CO Trends Surface



Mean



Trend

Modelling atmospheric CH₄ in the ECMWF Integrated Forecasting system

CH₄ synoptic variability: 25 to 29th of March 2010

Average total column CH₄ [ppb]

TRANSPORT

High resolution
IFS (16km, L137)

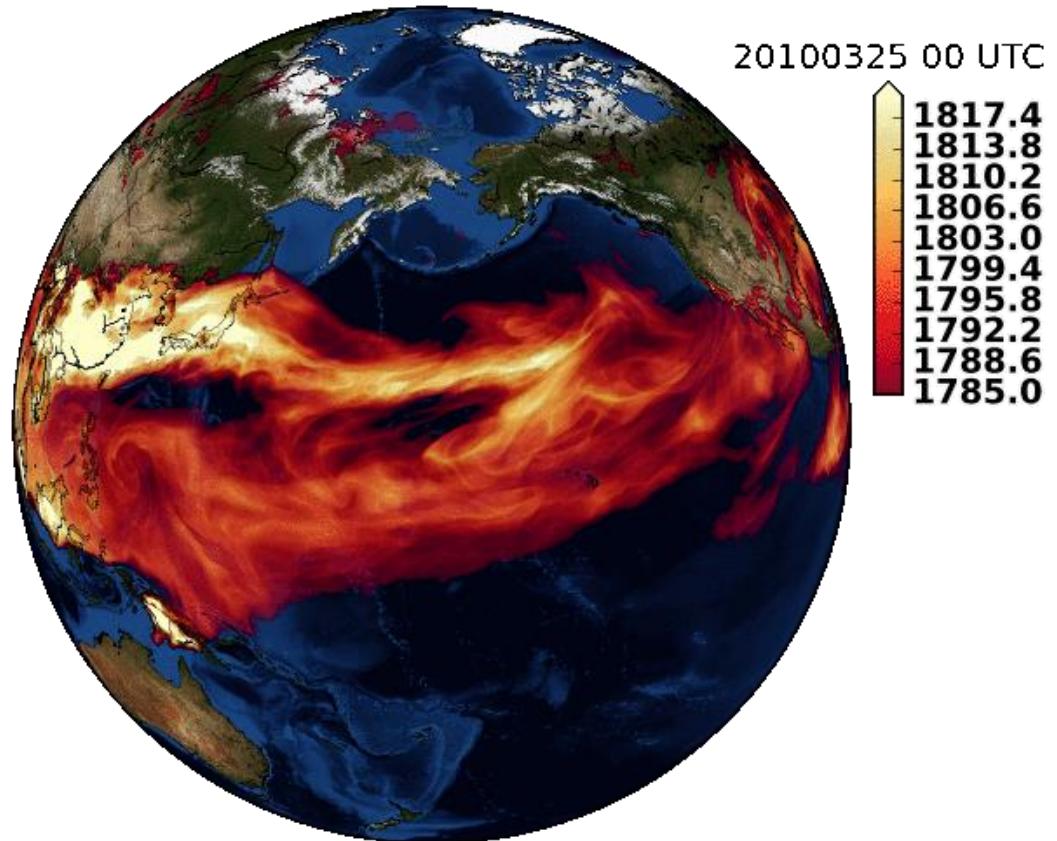
SURFACE FLUXES

- Anthropogenic : EDGARv4.2
2008
- Near-real-time GFAS biomass
burning
- Climatologies for other fluxes

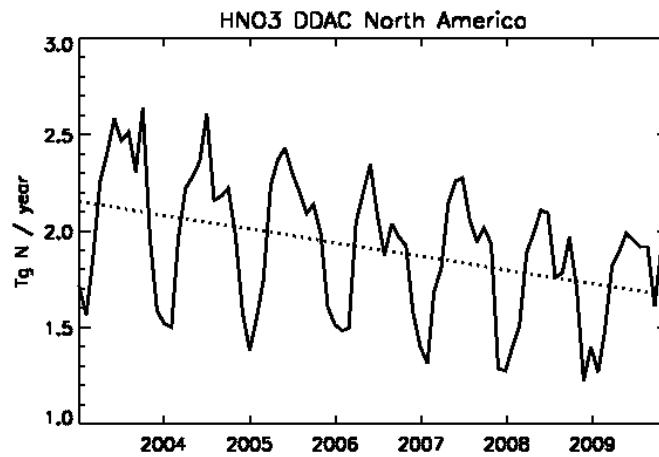
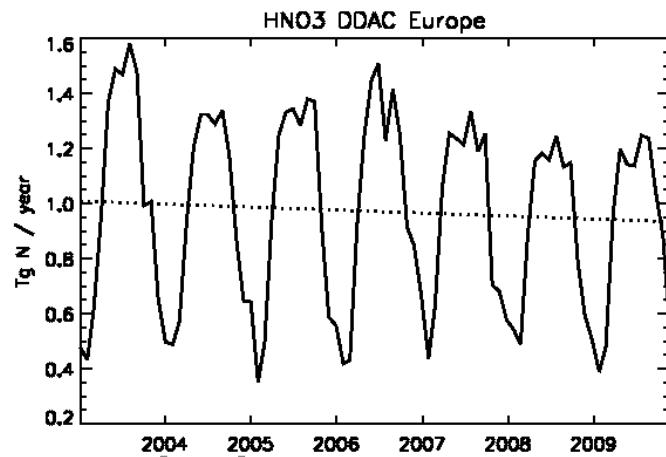
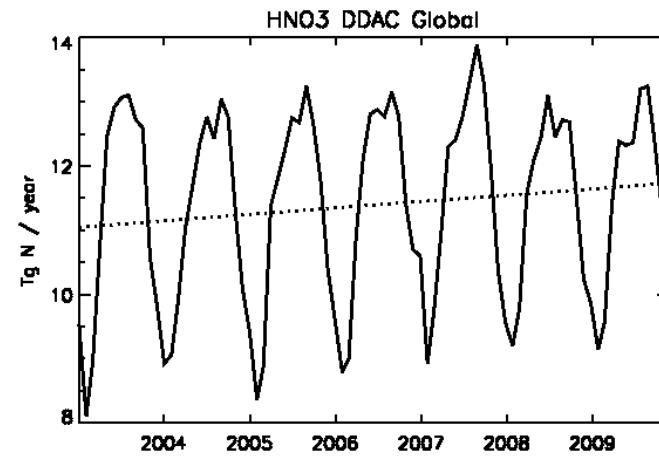
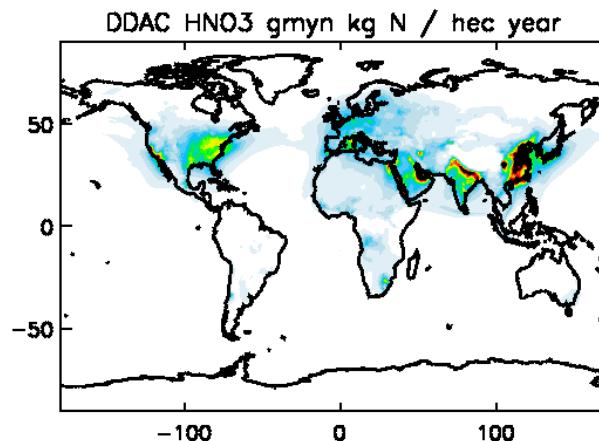
COSAT's

CHEMISTRY

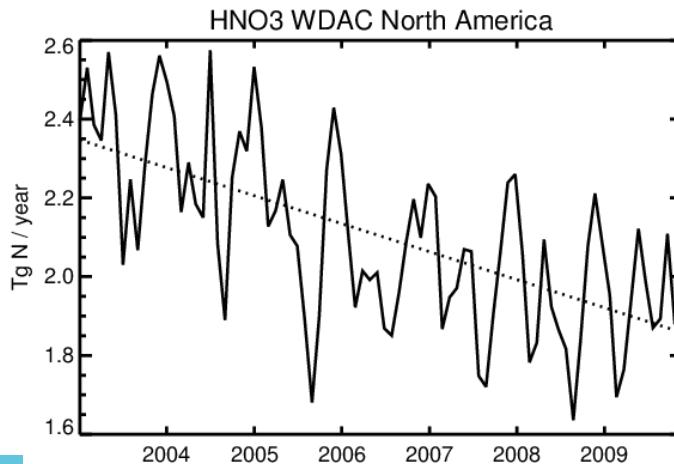
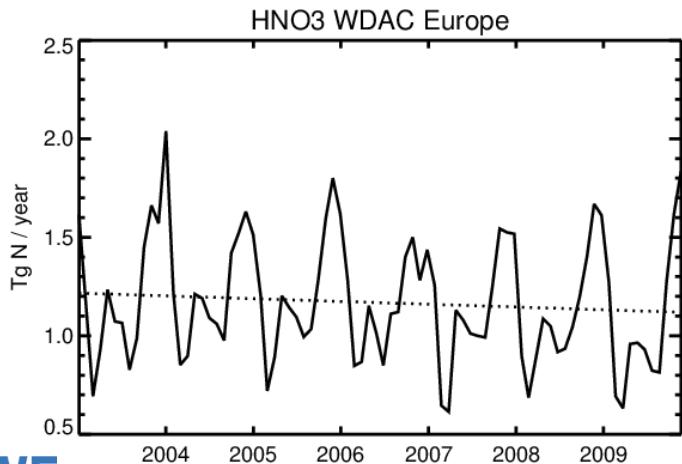
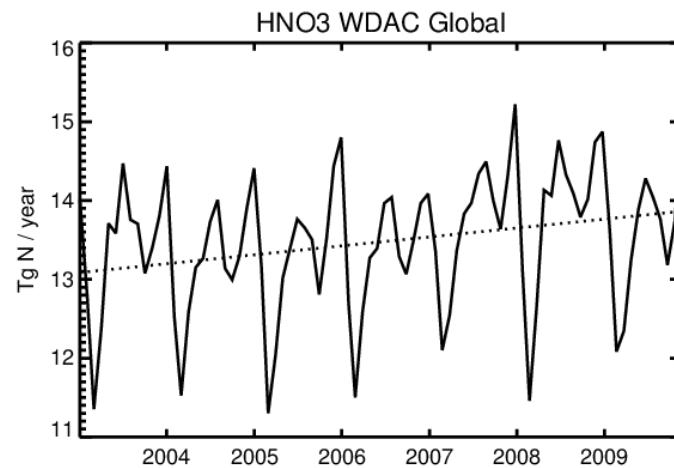
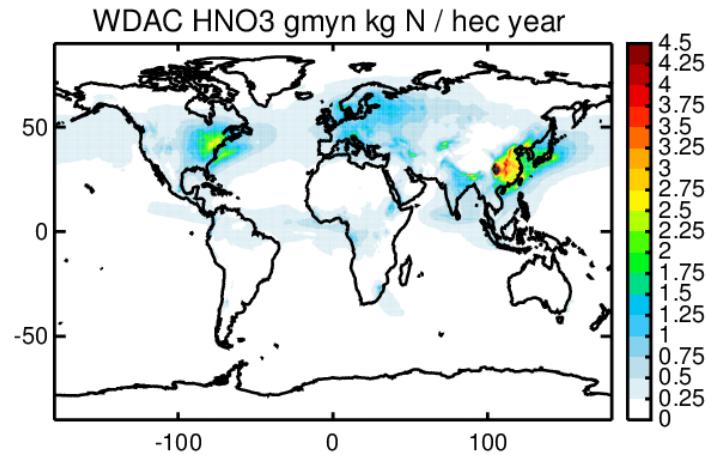
Monthly mean
loss rate
climatology



Dry Deposition HNO_3 2003-2009



Wet deposition HNO₃



Dry Deposition

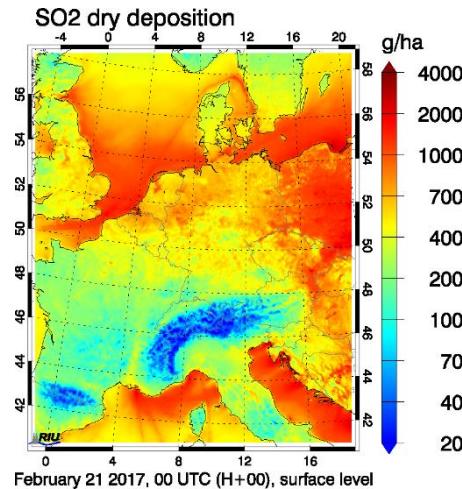
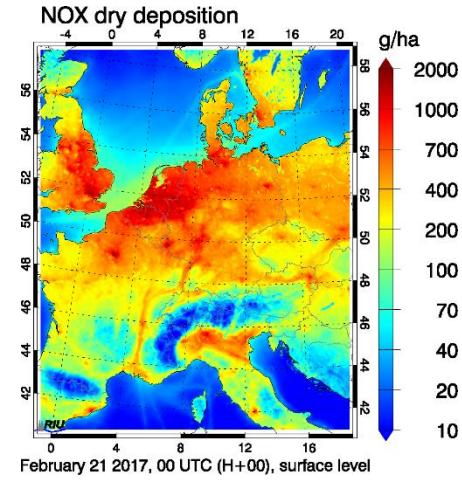
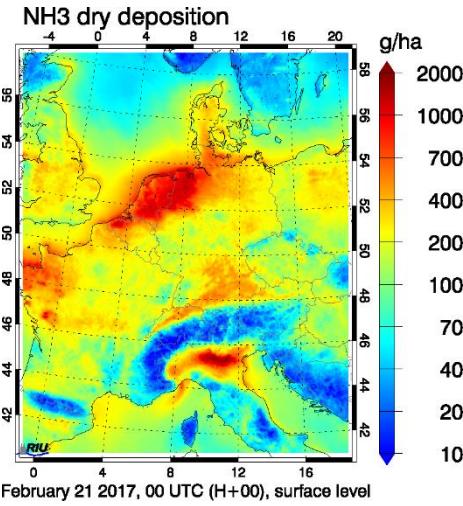
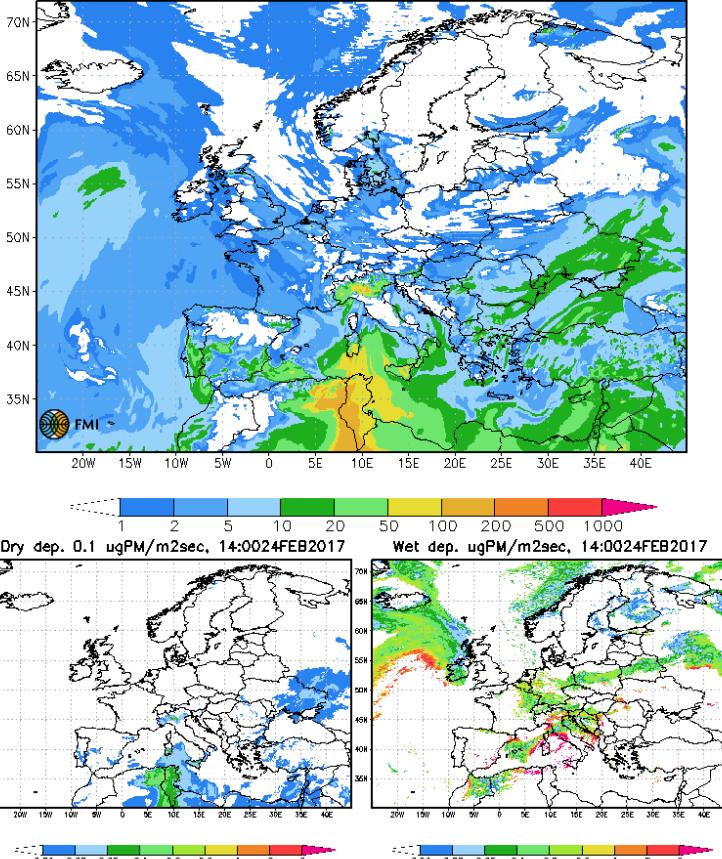


<http://silam.fmi.fi>

M. Sofiev

Forecast for PM2.5. Last analysis time: 20170223 00

Concentration, ugPM/m³, 14:0024FEB2017

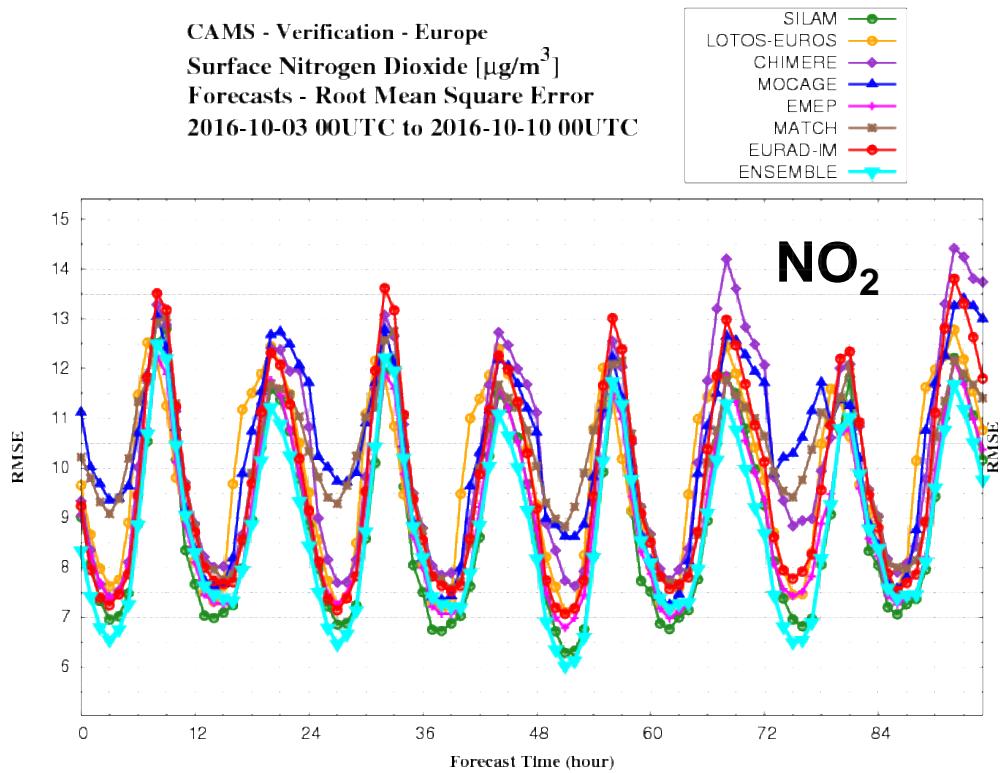


A CAMS50 downstream service for the Northrhine-Westfalian EPA (LANUV) from RIU with EURAD-IM by 5x5 km² resolution (E. Friese and H. Elbern)

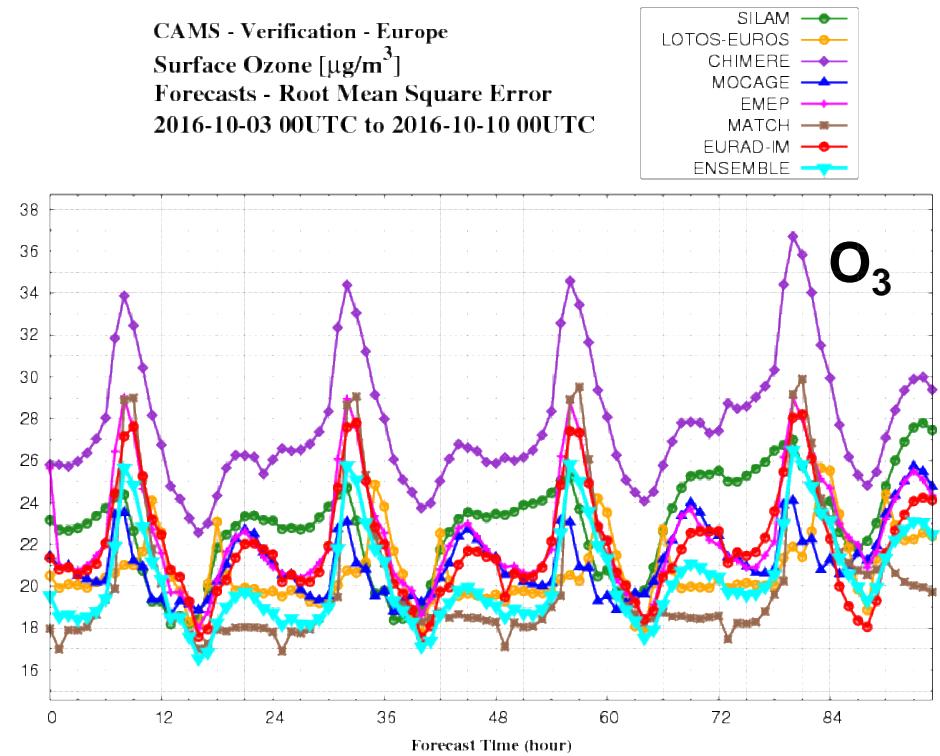
Copernicus
Europe's eyes on Earth

Why an ensemble?

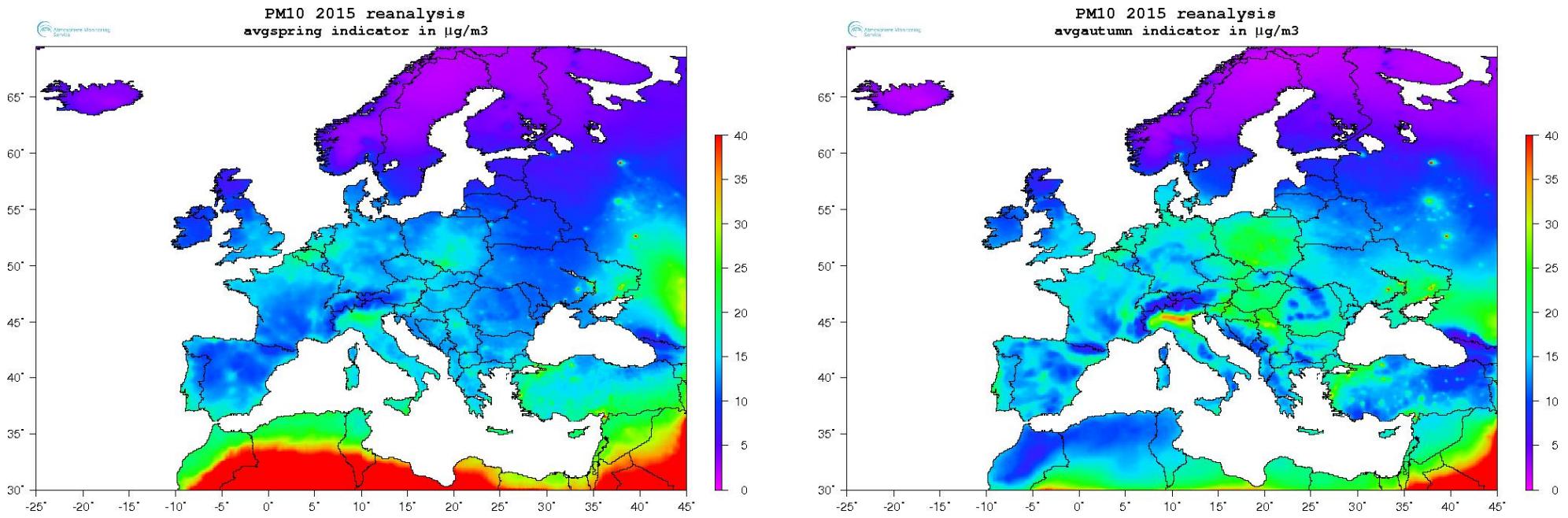
CAMS - Verification - Europe
Surface Nitrogen Dioxide [$\mu\text{g}/\text{m}^3$]
Forecasts - Root Mean Square Error
2016-10-03 00UTC to 2016-10-10 00UTC



CAMS - Verification - Europe
Surface Ozone [$\mu\text{g}/\text{m}^3$]
Forecasts - Root Mean Square Error
2016-10-03 00UTC to 2016-10-10 00UTC



The ensemble median consistently outperforms any individual model!!!

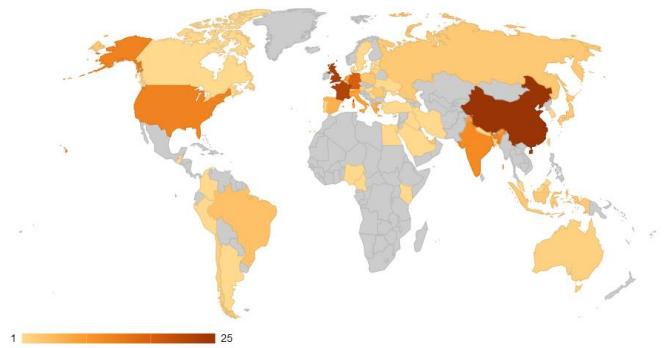
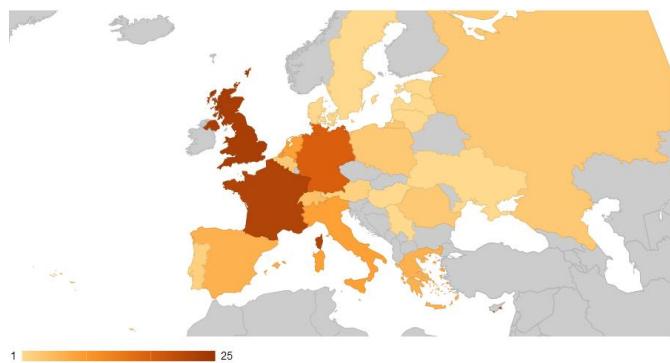


Two annual reanalyses are produced each year: one using validated and one using non-validated air quality observations.

Hourly output for O_3 , NO_2 , $\text{PM}_{2.5}$ and PM_{10}

Geographical coverage of CAMS users in Q4 2016

Global NRT forecast



Regional NRT forecast



T.Popp (DLR)

- ★ Copernicus Atmosphere Monitoring Service (CAMS) erstellt operationell globale und regionale 3D Daten von atmosphärischen Spurengasen, Treibhausgasen und Aerosolen
 - ★ Globale und regional zeitnahe Vorhersagen
 - ★ Globale and regionale Re-analysen
- ★ Das globale CAMS system assimiliert Satelliten Daten mit dem ECMWF model
- ★ Es gibt ein Ensemble von regionalen Modellen, die hauptsächlich in-situ Beobachtungen assimilieren.
- ★ Die CAMS Daten sind frei verfügbar
- ★ Es CAMS gibt user support
- ★ CAMS ist sehr an Nutzer Feedback interessiert



Vielen Dank

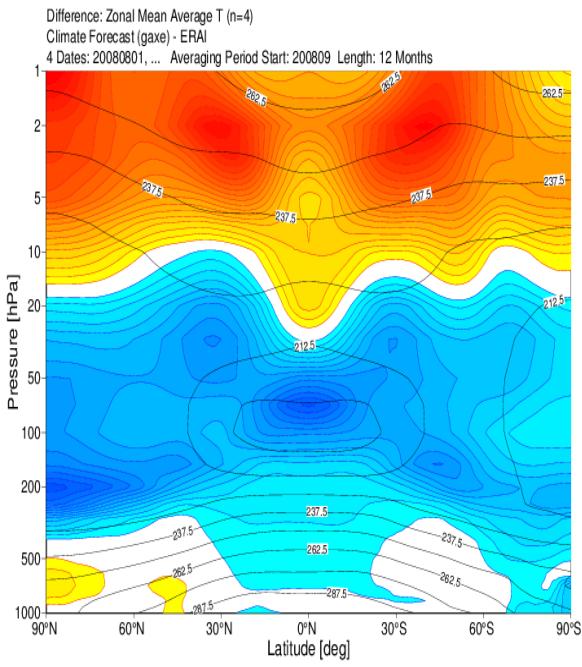
<http://atmosphere.copernicus.eu>

copernicus-support@ecmwf.int

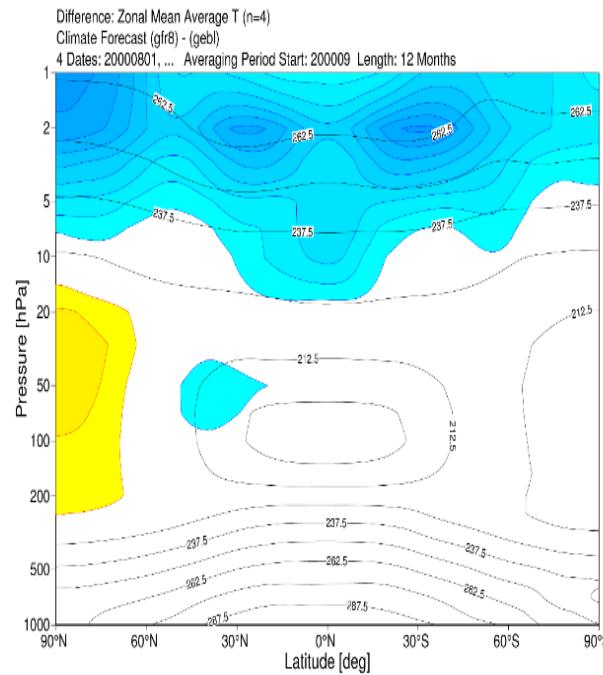


New ozone climatology ECMWF model (43R1) based on CAMS products

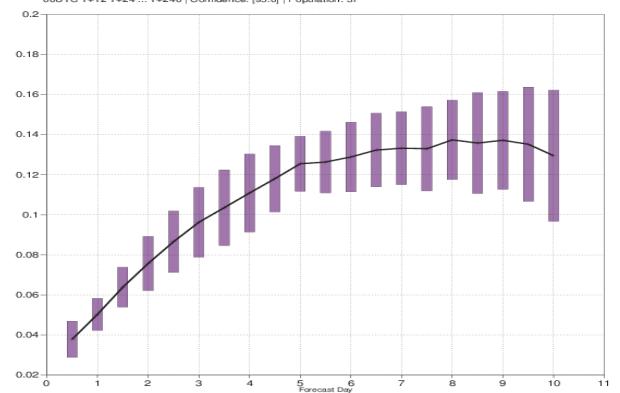
T bias (12 month) of 1-year climate run (MACCRA O3) vs. ERA interim



1yr “climate” runs T Bias vs Era-Interim MACC vs CAMSiRA O3 Clim



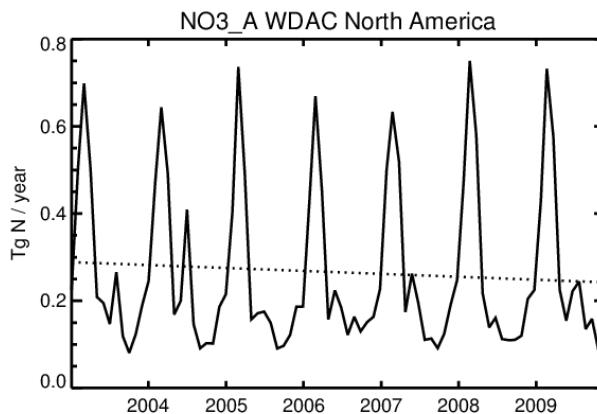
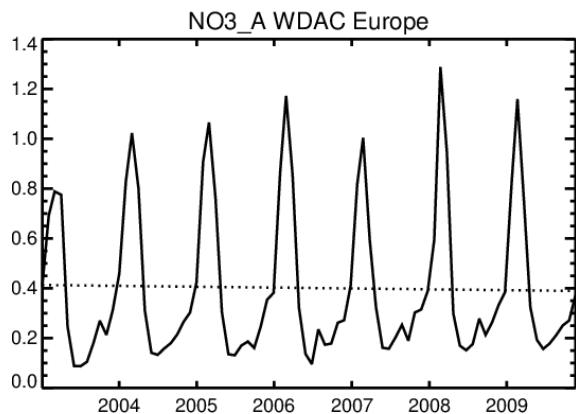
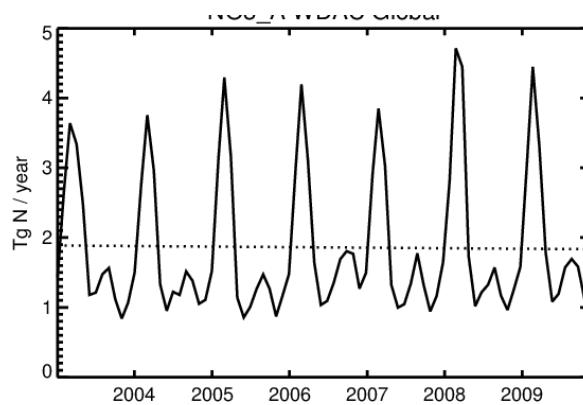
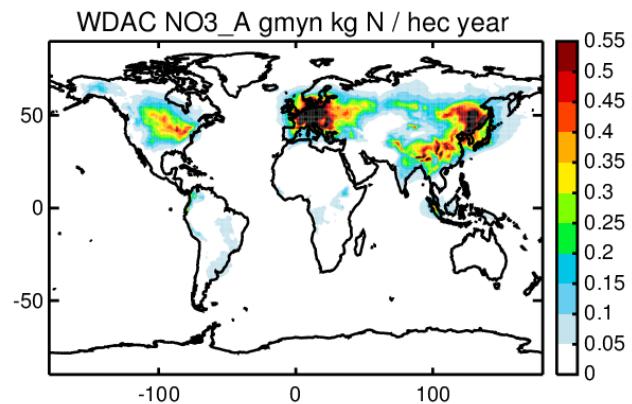
control-normalised gdil minus gfrb
 5hPa temperature
 Root mean square error
 NHem Extratropics (lat: 20.0 to 90.0, lon: -180.0 to 180.0)
 Date: 20120101 00UTC to 20121226 00UTC
 00UTC T+12 T+24 ... T+240 | Confidence: [95.0] | Population: 37



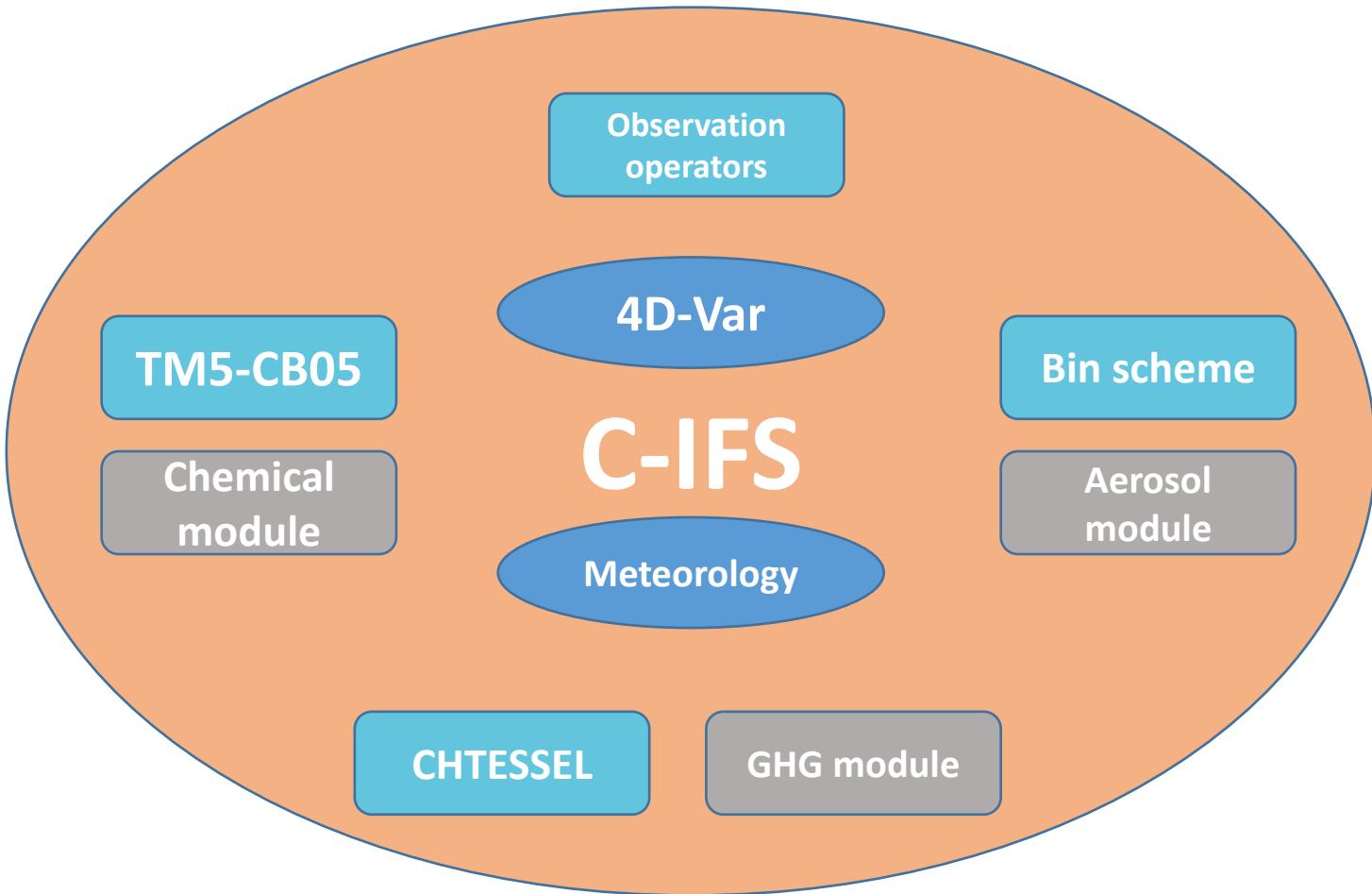
Improved 10-day Temperature forecast in upper stratosphere

A. Bozzo & J. Flemming

Wet Deposition NO₃ aerosol 2003-2009



CAMS global system is integrated ECMWF weather forecasting system IFS.



IFS is NWP forecasting and data assimilation system of ECMWF