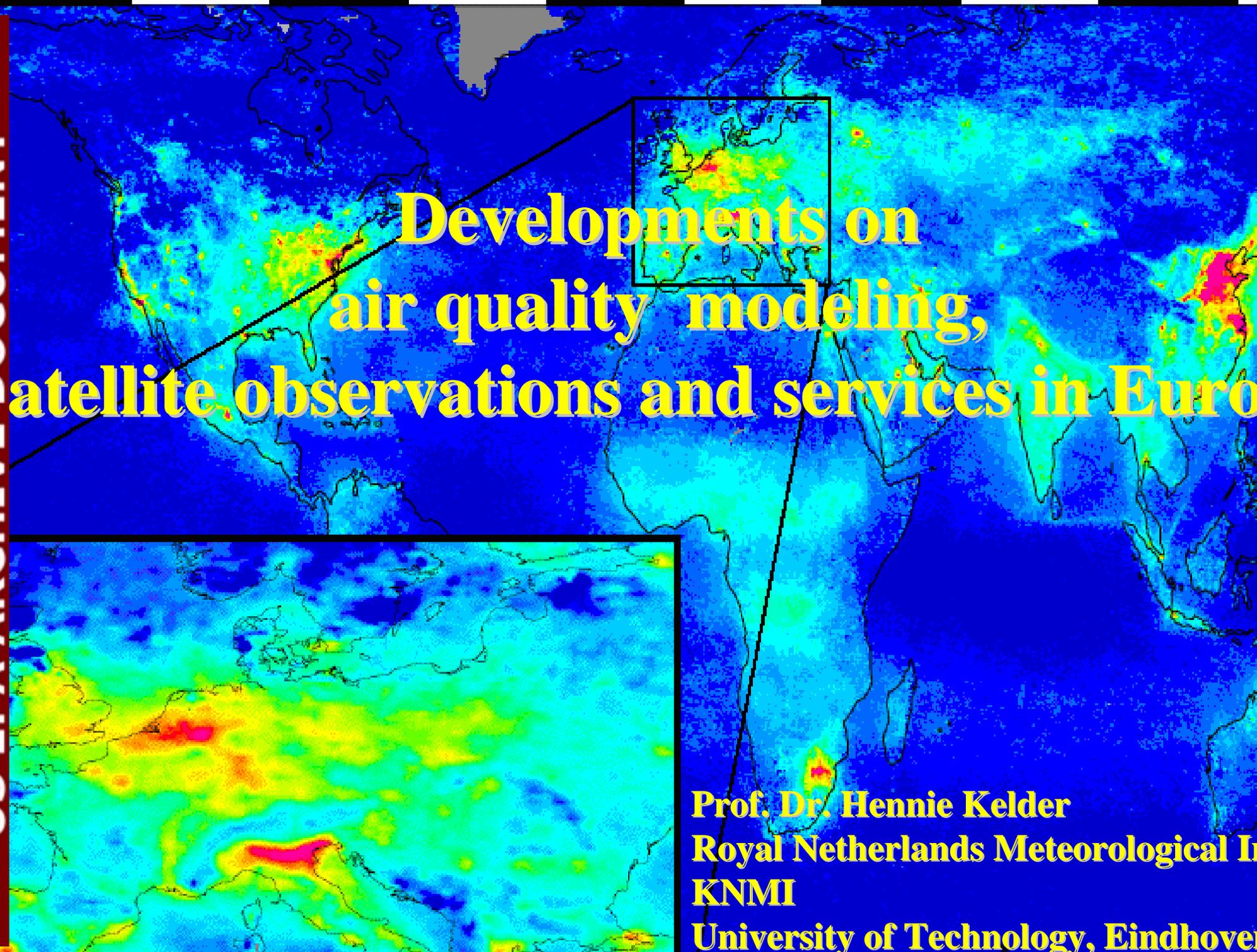


US EPA ARCHIVE DOCUMENT



Developments on air quality modeling, satellite observations and services in Europe

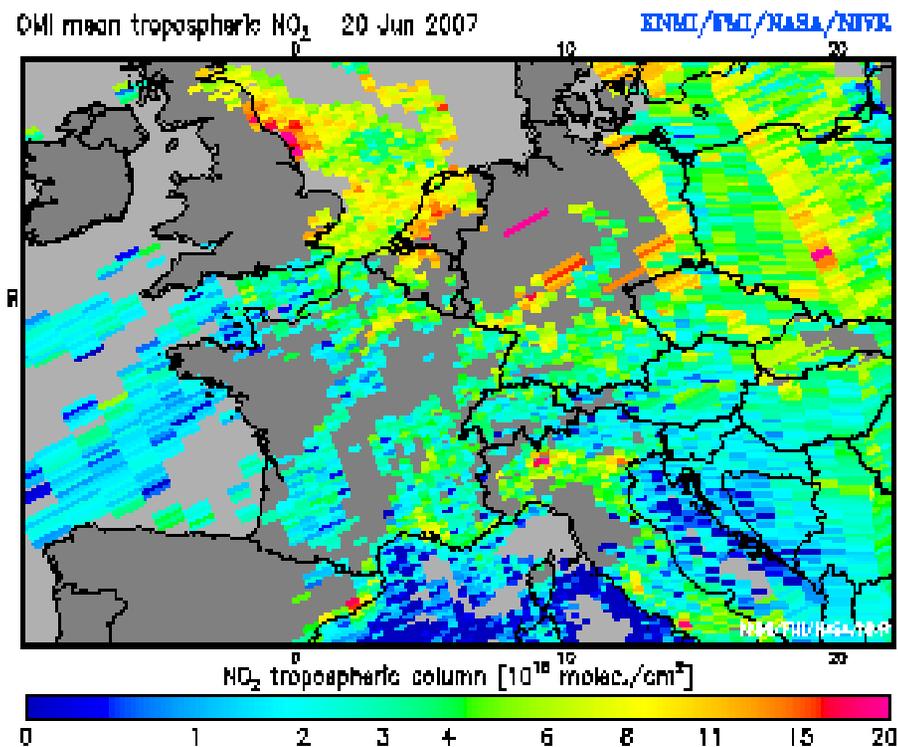
Prof. Dr. Hennie Kelder
Royal Netherlands Meteorological Institute
KNMI
University of Technology, Eindhoven

GMES: Global Monitoring of the Environment and Security

European contribution to GEO

Integrated approach (satellite and ground-based data, models and assimilation):

- Infra structure and use of data for Atmospheric Service
EU: GEMS and GAS
ESA: GSE, PROMOTE
EUMETSAT: Ozone SAF
- Provision of future satellite data for operational monitoring of the atmosphere



OMI NRT NO₂ June 20, 2007



Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft



Global and regional Earth-System (atmosphere) Monitoring using Satellite and in-situ data (GEMS)

- Integrated Project of the 6th EC Framework Programme
- part of the GMES (EC&ESA) Atmosphere theme
- 31 consortium members
- 4 years (started in March 2005)
- coordinated by the European Centre for Medium-Range Weather Forecasts



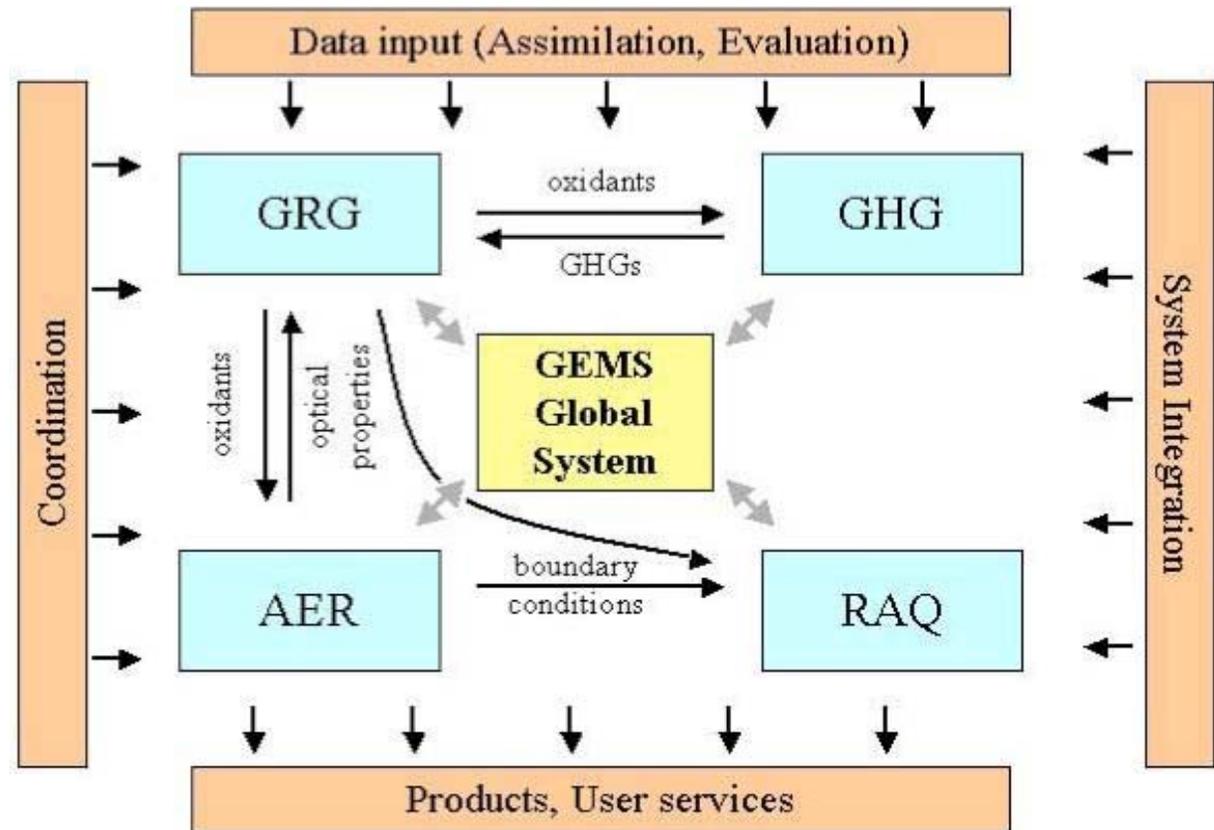
The GEMS Project

Global & regional Earth-system Monitoring using Satellite and in-situ data

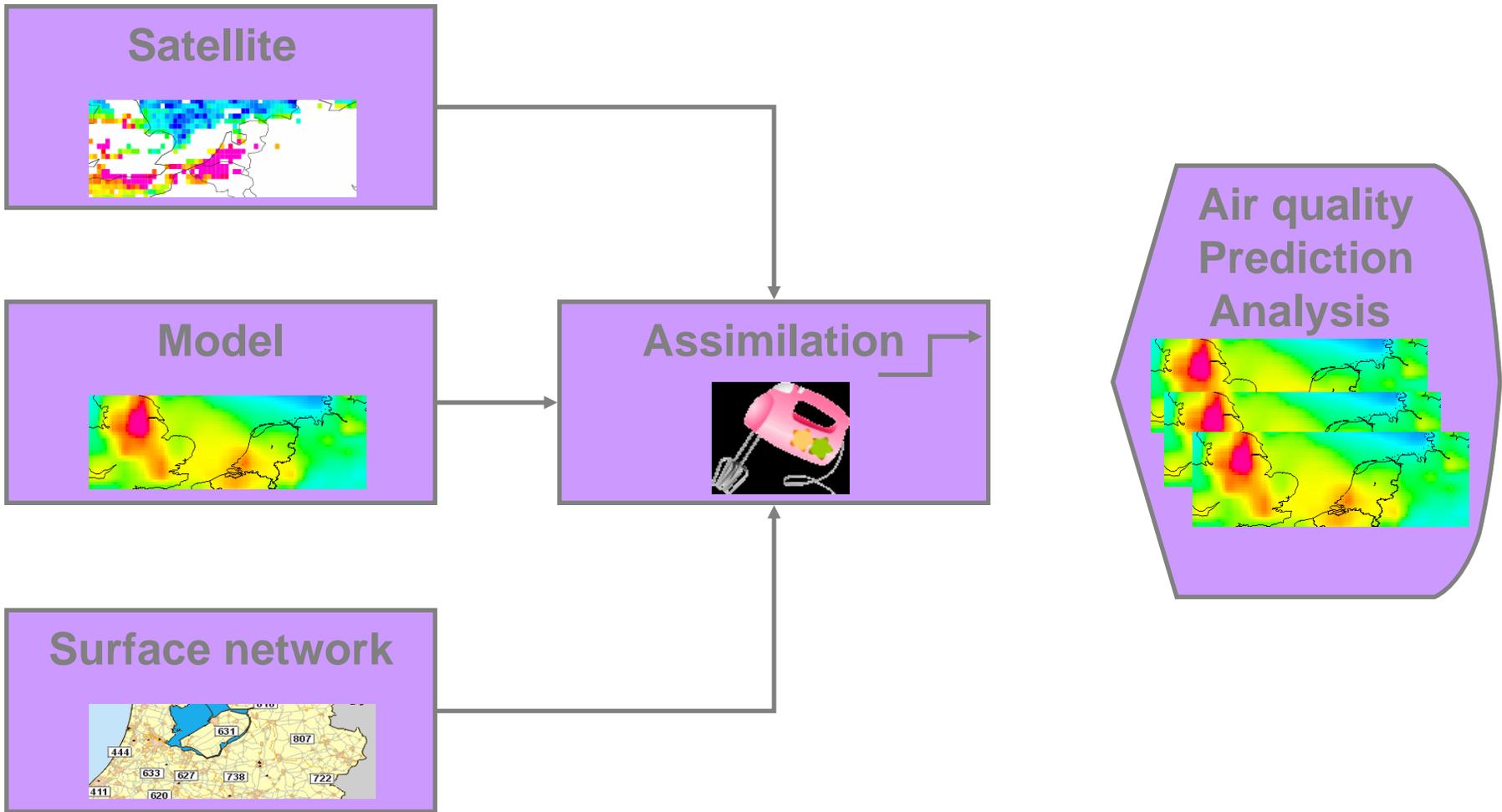
Subprojects:

- Greenhouse gases
- Reactive gases
- Aerosols
- Regional air quality

First (trial) reanalysis
(period 2003/2004)



The aim



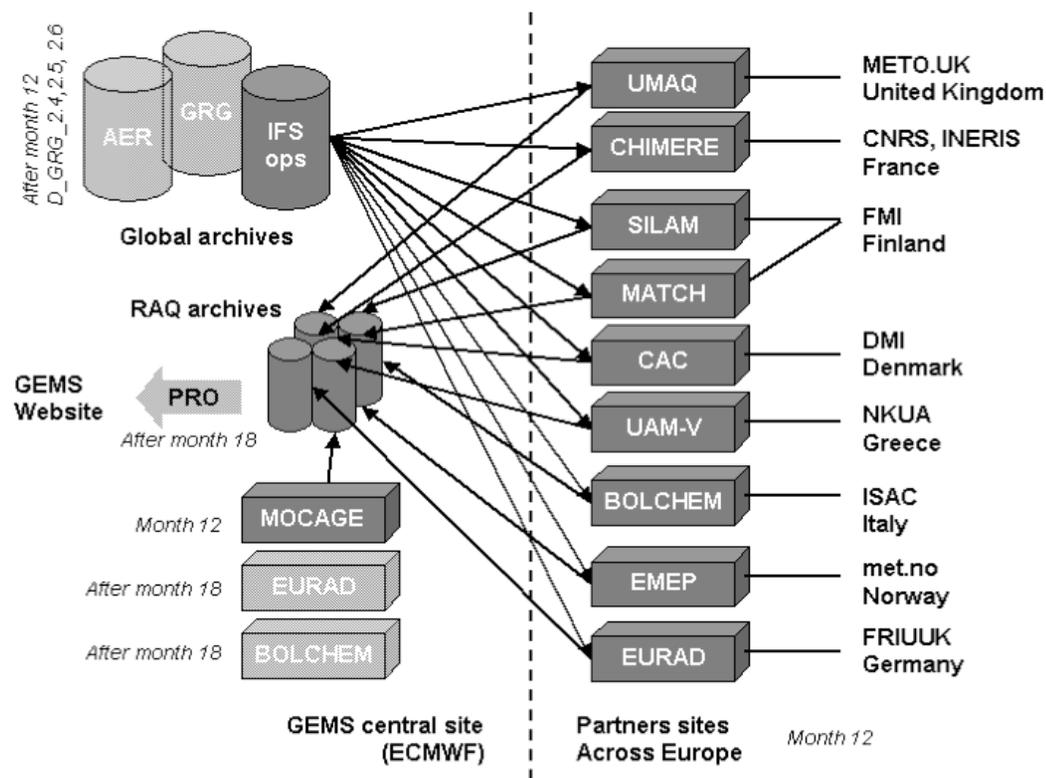
GEMS: Regional air quality subproject

Aspects:

- Many of the European regional AQ modelling groups involved
- Intercomparison of 11 European RAQ models on GEMS website
- Chemical assimilation at regional scale(surface observations)
- NRT access to surface data
- Ensemble forecasts

Satellite data of SCIAMACHY, GOME, OMI and GEMS-RAQ:

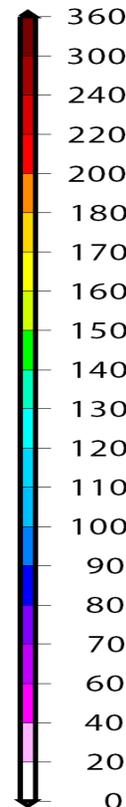
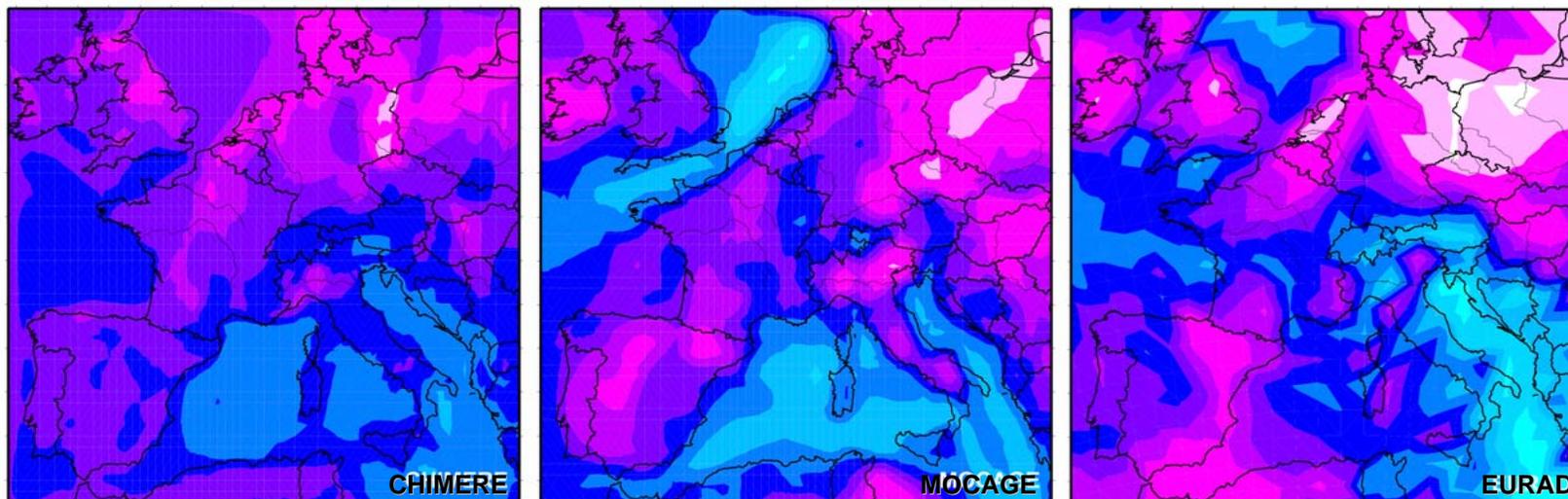
- nrt NO₂ etc. will be included in intercomparison



Forecast from three European air quality model systems



daily maxima of surface ozone [$\mu\text{g}/\text{m}^3$] for 20/10/2006



CHIMERE (CNRS-INSU and INERIS)

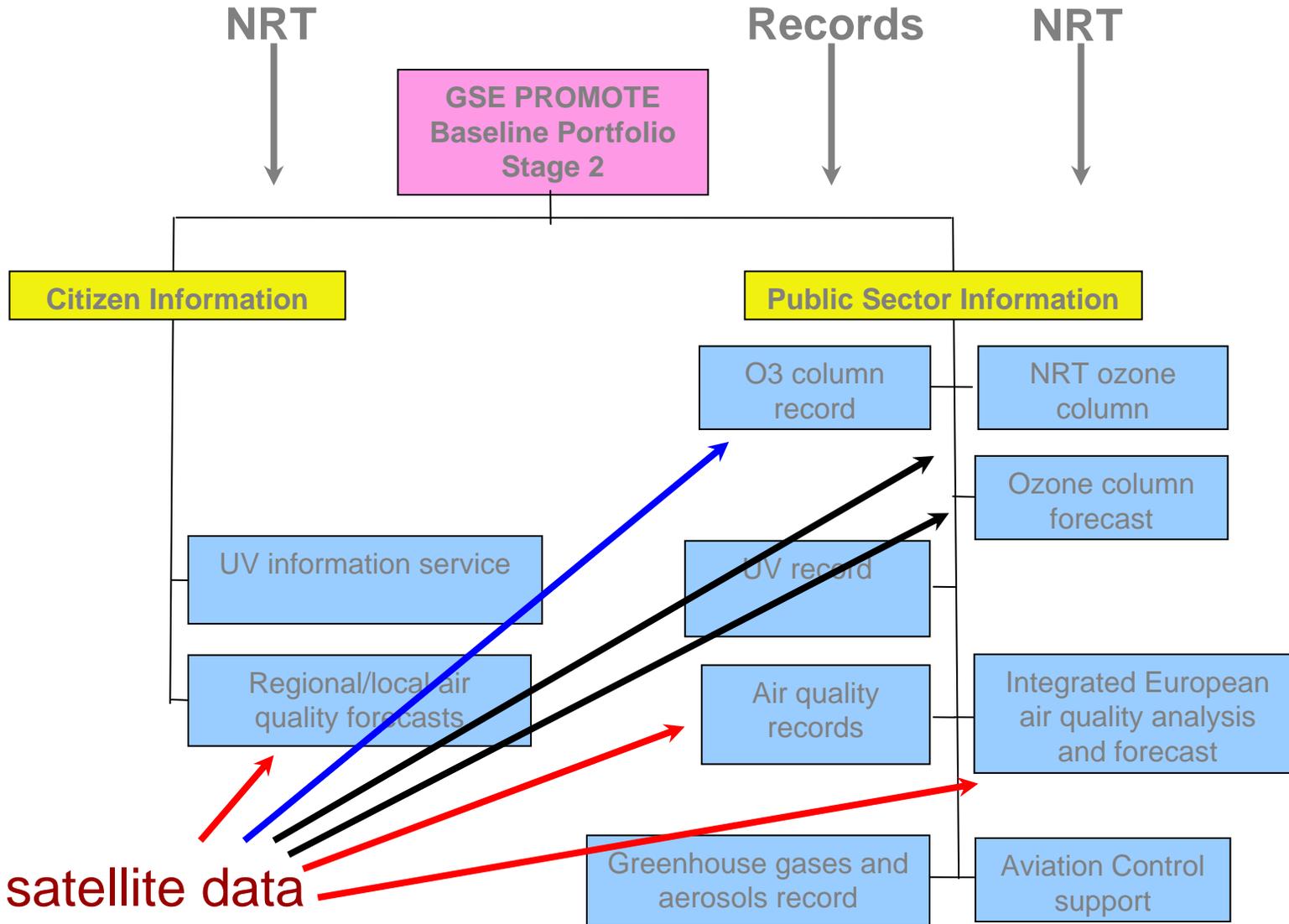


MOCAGE (Météo-France)



EURAD (Rhenish Institute for Environ. Research, Univ. Köln)

ESA PROMOTE



GMES Atmospheric Service

December 5/6, 2006, EU workshop on GAS in Brussels

Results:

- European contribution to Atmospheric services
- Implementation team to be installed
- Issue a space call including GAS

Subject: Activity 9.1.2 GMES Atmospheric Services

- **Developing pre-operational service capabilities in new application field **Atmosphere****

– **pre-operational service capabilities in application field Atmosphere**

GEMS and **PROMOTE** prepared **MACC** proposal, lead ECMWF infrastructure for atmospheric services, submitted to EU on 19 June 19th, 2007
Budget 15 M€

Implementation team installed in 2007

Working group of 5 European experts on satellite data

First meeting sept 20, 2007

Analysis of present and future needs for data and corresponding requirements on satellite missions

Analysis of needs for infrastructure for provision and use of data

Workshops on user requirements

Recommendations

Overview recent European satellite instruments for tropospheric measurements

GOME

Launched April 1995 (ESA ERS-2)

*First total ozone data, 11 Jan 07
courtesy Eumetsat / DLR*

SCIAMACHY

Launched February 2002 (ESA ENVISAT)

OMI

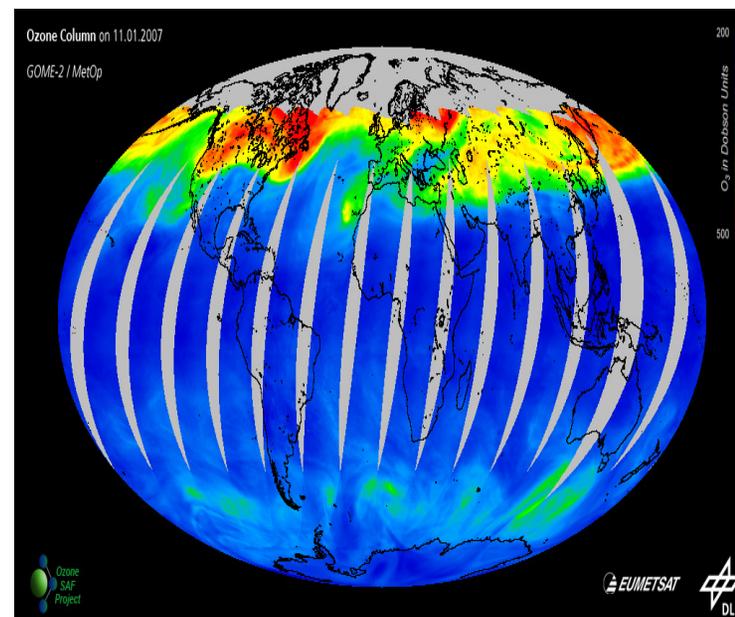
Launched July 2004 (NASA EOS-Aura)

GOME-2

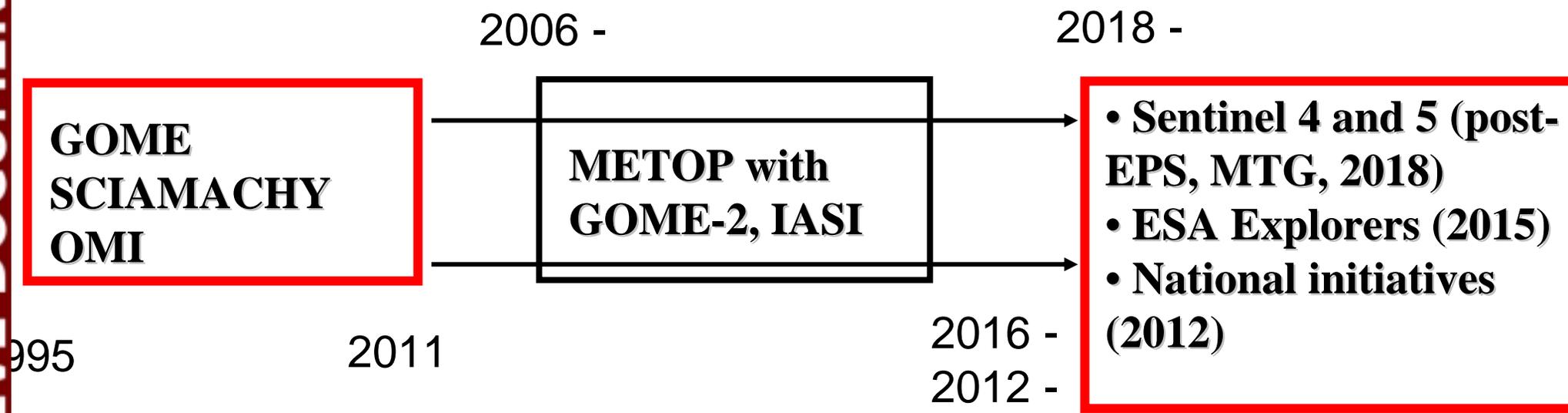
Launched October 2006, EUMETSAT METOP 1

IASI

Launched October 2006, EUMETSAT's METOP 1



European satellite instruments for air quality



Red = present or planned European missions with air quality data

Black = European atmospheric composition missions
not optimal for air quality and greenhouse gases

Initiatives and plans for air quality/climate exploring and monitoring satellite missions

ESA

- Earth Explorer program
- Sentinels 4 and 5: Capacity study 1 and 2, operational monitoring atmospheric chemistry based on user requirements.

EUMETSAT

- Post EPS and MTG

National initiatives

- Air quality and climate monitoring : NL, Fi, Belgium, UK, etc.
- **TROPOMI/TROPI (Dutch led initiative):**
Nadir looking UV/VIS/NIR/SWIR instrument on small platform

**ESA EOEP Program (EE7, estimated Launch 2014/2015):
Six Candidate Core Missions for phase 0 study**

**BIOMASS: A BIOMASS Monitoring Mission for Carbon
Assessment**

TRAQ: TRopospheric composition and Air Quality

**PREMIER: PRocess Exploration through Measurements of
Infrared and millimetre-wave Emitted Radiation,**

FLEX: FLuorescence Explorer

**A-SCOPE: Advanced Space Carbon and Climate Observation of
Planet Earth**

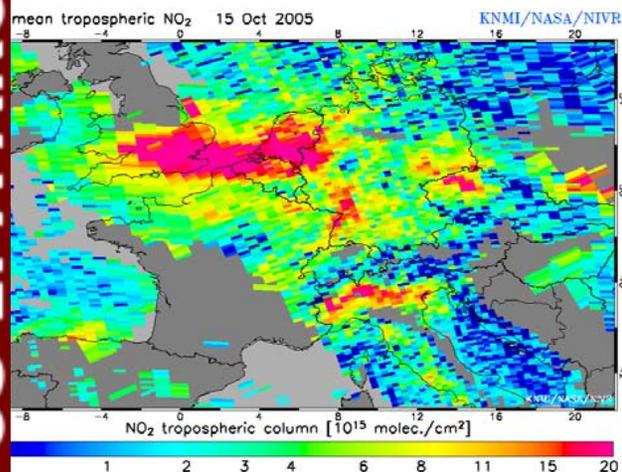
Core-H2O: Cold Regions Hydrology High-resolution Observatory

TRAQ Science Questions

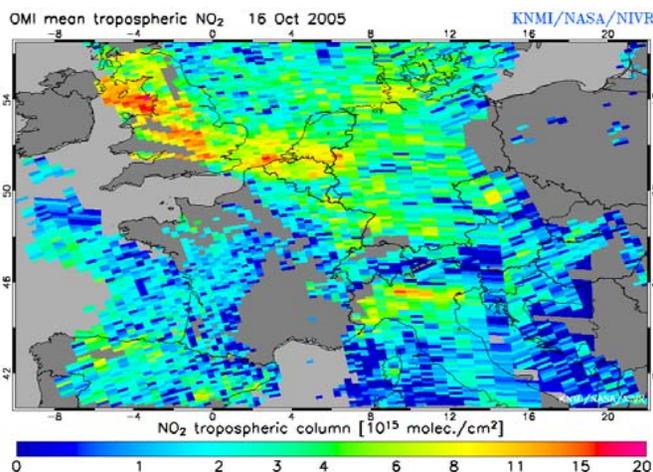
How fast is air quality changing on a global and regional scale?

What are strengths and distributions of sources and sinks of trace gases and aerosols influencing air quality and climate?

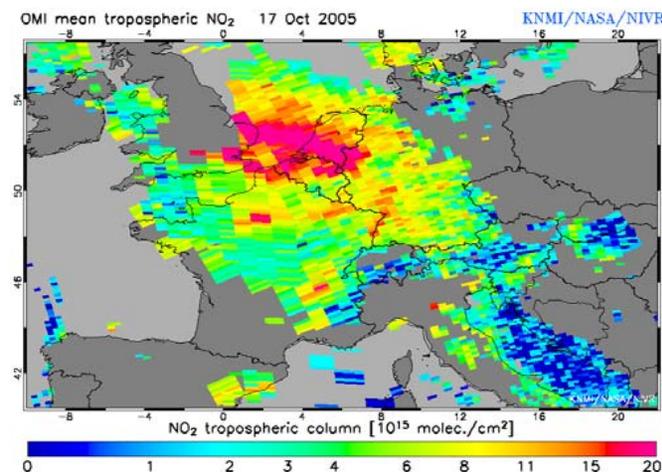
What is the role of tropospheric composition in global change?



Saturday 15 October 2005



Sunday 16 October 2005



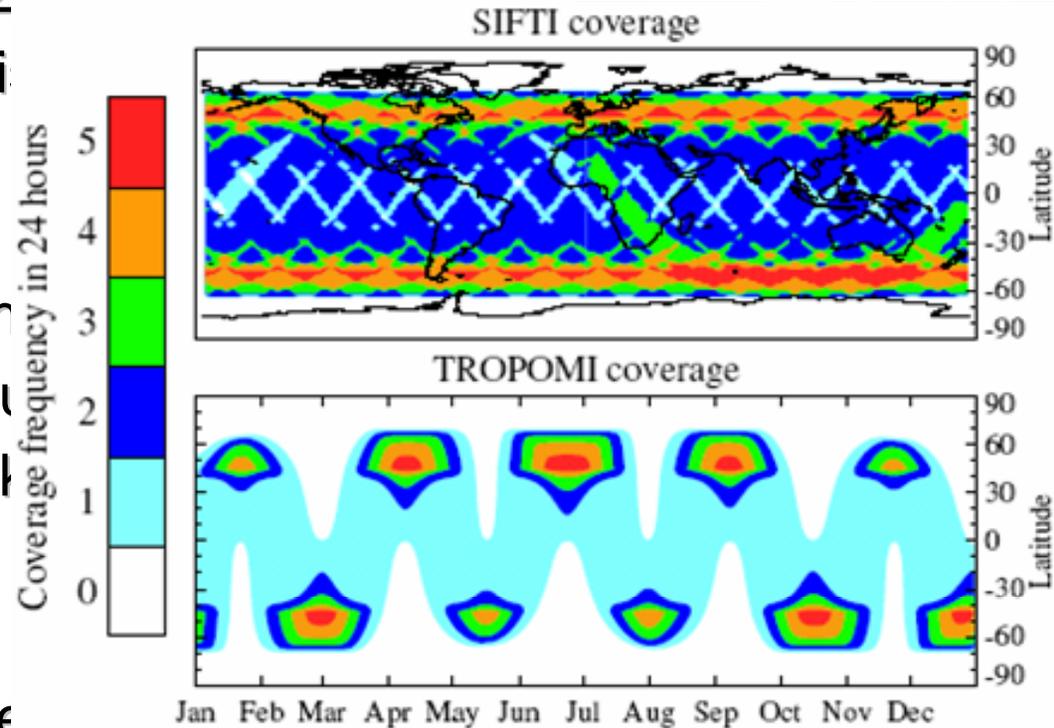
Monday 17 October 2005

ESA explorer mission candidate TRAQ Payload

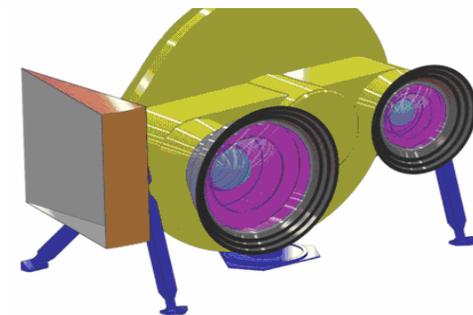
TROPOMI: Backscatter instrument (trop) columns of O₃, NO₂, SO₂, HCHO, aerosols & CO and CH₄.
Swath 2600, 10 x 10 km²
Heritage: Aura-OMI, Envi



SIFTI (FTIR): O₃, CO, CH₄: trop column
intelligent pointing for cloud
Swath 2000 km, 10 x 10 km²
Heritage: IASI



CAPI: POLDER type of instrument
AOD, single scattering albedo (ω_0), Air quality index (AQI), aerosol sizes and aerosol type.
Swath 2000 km, 5 x 5 km²
Heritage: POLDER, PARASOL



GMES Sentinels 4&5

Eumetsat

Meteosat Third Generation

- Detailed UV-VIS instrument studies during phase 0
- Instrument not considered at system level
- Will not be followed in phase A

Post-EPS

- Several atmospheric composition instruments considered
- Highest priority : UV-VIS-NIR-SWIR and TIR spectrometers

Eumetsat – ESA cooperation

- It is planned to merge Sentinels 4&5 with Eumetsat atmospheric composition programme.
- Funding is open.

Goals:

- Operational monitoring of the atmosphere in preparation of Sentinel missions 4 & 5
- Integrated approach in line with IGACO, ground-based, in situ and satellites

CAPACITY 1: 2004 – 3006 (KNMI lead, ESA J. Langen)

- Main goal : to identify gaps in current / planned operational system and identify system/instrument requirements

Recommendations from CAPACITY 1

In line with IGACO to implement a system of GEO and LEO satellites:

1. Implement 1 LEO satellite with UV-VIS-SWIR payload for **global air quality and climate protocol monitoring** with small pixel sizes as soon as possible
2. Perform trade-off between GEO + LEO and LEO constellation in inclined orbit, and implement complete air quality & climate protocol monitoring mission
3. Consolidate choice and requirements of instruments for UT/LS mission for climate and ozone NRT and assessment applications, and implement the mission

ESA CAPACITY studies 1 and 2

CAPACITY 2: 2007 - 2009 ESA (J. Langen) KNMI | (H. Kelder) | RAL | U. Leicester | SRON | FMI, BIRA-IASB | CNR-IFAC | Noveltis (LPMAA, ULB) | U. Koeln

Main goal: perform sensitivity and retrieval studies for several operational systems and perform trade-offs, including user's perspective (workshop).

Key issues:

Identification and quantification of **meteorological and possibly other auxiliary data requirements** and their priority compared to chemical data requirements

Trade-offs between **different observation strategies** (spectral ranges, polarisation, direction etc.) for aerosol and several gaseous species

Quantitative mapping of geophysical observation requirements onto instrument performance requirements and a review of the implementation-critical requirements

Quantitative assessment of requirements for **spatio-temporal sampling** taking into account contamination of nadir-viewing observations by clouds

Contribute from **user's perspective** to trade-off between different orbit options

TROPOMI (TROPI)

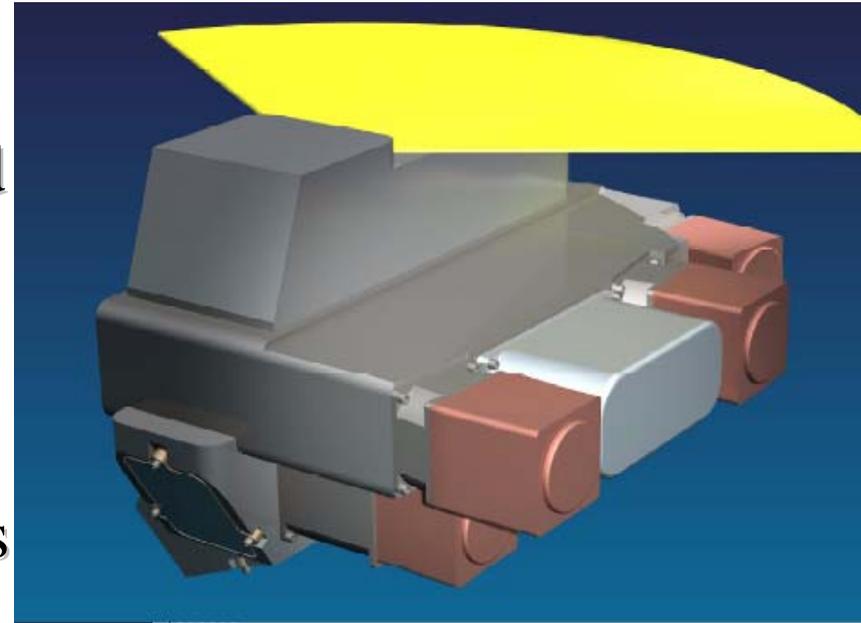
Successor of OMI en SCIAMACHY

Collaboration between KNMI, SRON, TNO and DS.

Consists of the OMI channels and added to that channels for CO, CH₄ and the O₂-A band (cloud detection and surface albedo)

Due to TROPOMI's

- smaller ground pixel size than OMI's and
- improved correction for clouds the troposphere can be measured with improved accuracy



< 10 x 10 km² ground pixel

- **TROPOMI type of instrument part of TRAQ, Sentinels, National initiative for a precursor mission**
- **TROPOMI also Called TROPI in USA (decadal survey)**

WMO

**Commission on Atmospheric Sciences,
CAS**

**2006, Establishment of a
Joint Scientific Steering Committee(JSSC) on
atmospheric chemistry**

Conclusions

European satellite instruments : key information on ozone/UV, climate and air quality

Infrastructure and user services (ESA Promote, Eumetsat Ozone SAF and EU funded project GEMS, MACC ?, GAS): will result in more users.

Next decade: Gome 2 and IASI on METOP, reduction in capacity in Europe compared to present decade. Better perspectives after 2018. National initiatives for precursor/bridging mission.

Shared European responsibility for GMES/GEO and hence for a mature satellite component & user services - decisions in near future to be taken by ESA, EU, EUMETSAT and national agencies.

Cooperation within GEO, across the Atlantic etc - ?