

Operational atmospheric chemistry monitoring,

European developments

2010 - 2030

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on behalf of
Capacity consortium and Eumetsat post-EPS study team

KNMI, University of Technology Eindhoven

Outline

Results ESA CAPACITY study

EUMETSAT Post-EPS study

Other developments

Outlook

the CAPACITY study

Mission concepts for operational atmospheric chemistry monitoring 2010-2020

Objectives:

- User requirements for operational atmospheric composition sounding
- Quantitative observational requirements
- Possible contributions of current and planned missions
- Mission concepts and instrument requirements for future missions
- Performance assessment with respect to user requirements

Study consortium

Prime : KNMI (H. Kelder, M. van Weele, A. Goede)

Core team : Rutherford-Appleton Lab (B. Kerridge, J. Reburn)
Univ. Leicester (P. Monks, J. Remedios)
Univ. Bremen (H. Bovensmann)
EADS-Astrium (R. Mager)
Alcatel Space (H. Sassier)

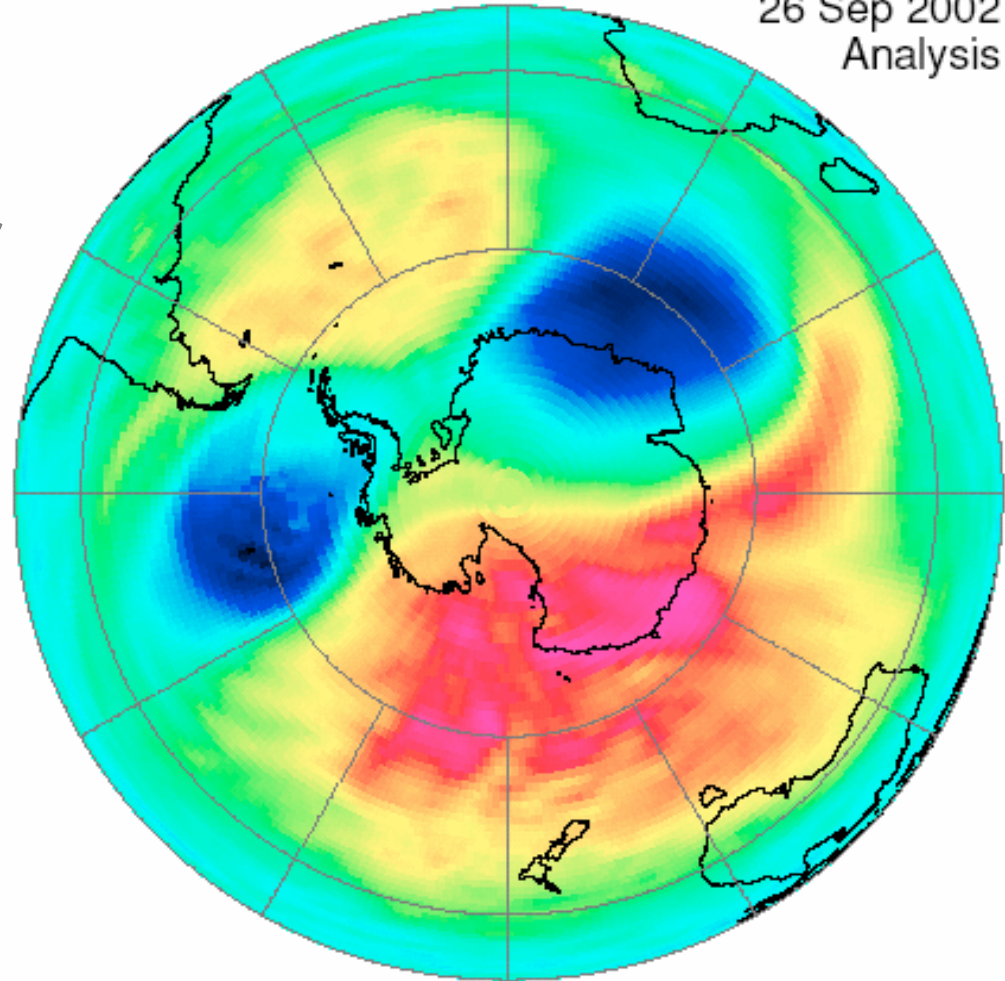
Consultants: *Requirements* – WMO, JRC, 5 weather and environmental agencies,
Eurocontrol, 11 research institutes and universities
Space instrumentation – 10 research institutes and universities,
1 company
Ground instrumentation – 1 research institute

ESA Joerg Langen

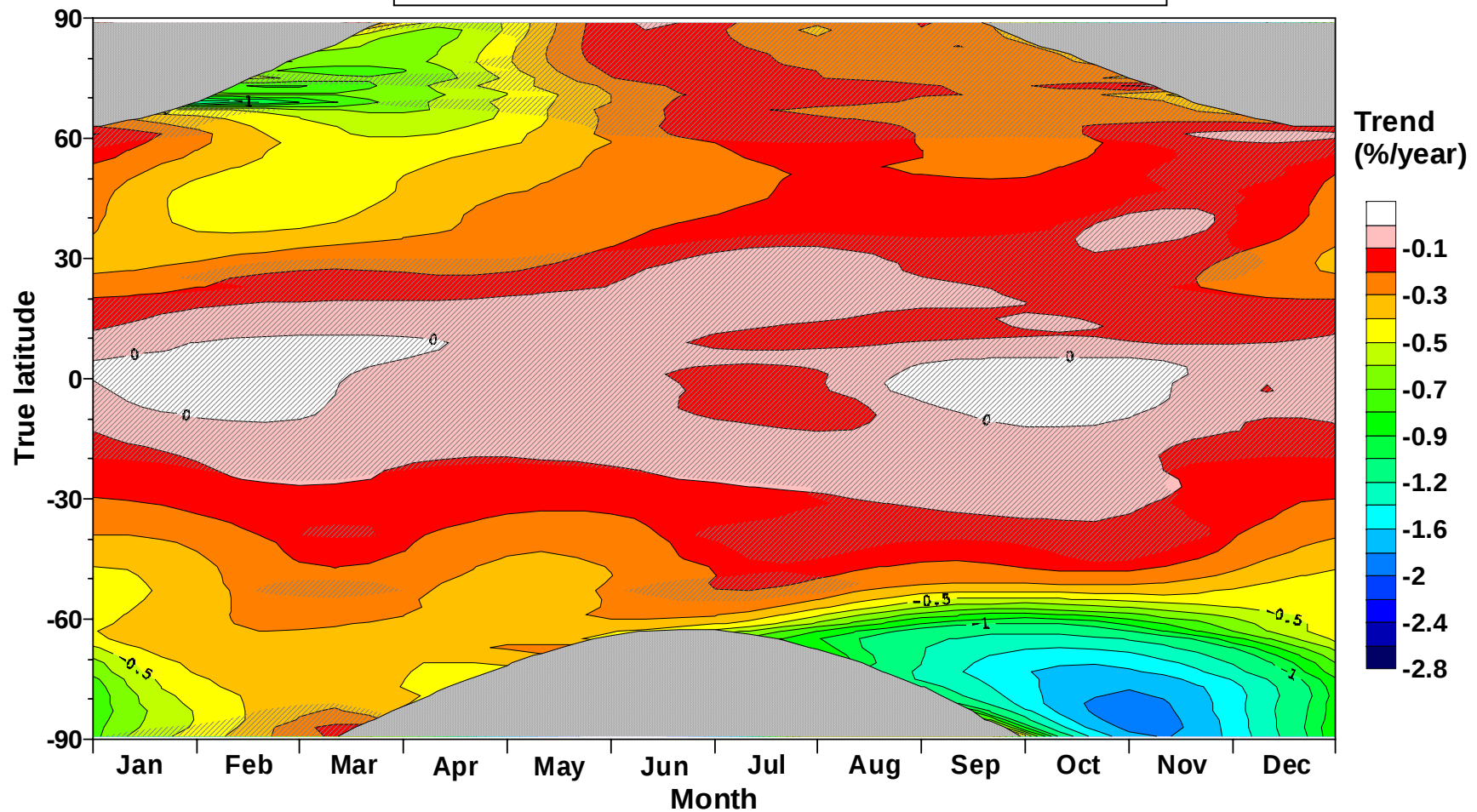
CAPACITY theme

Operational monitoring and
forecasting the ozone layer

26 Sep 2002
Analysis

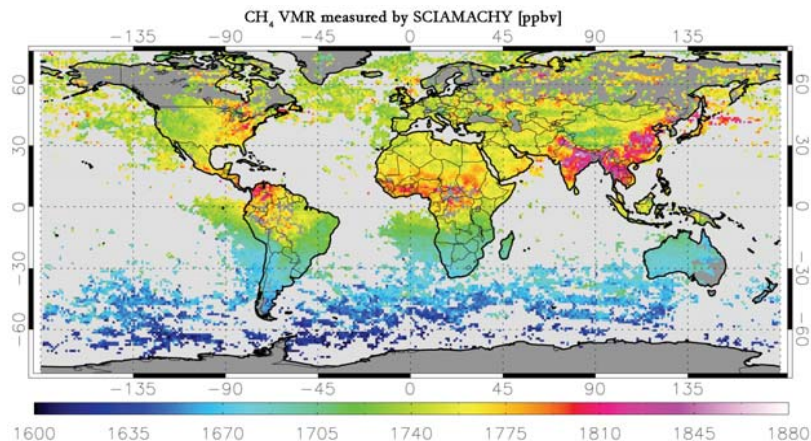
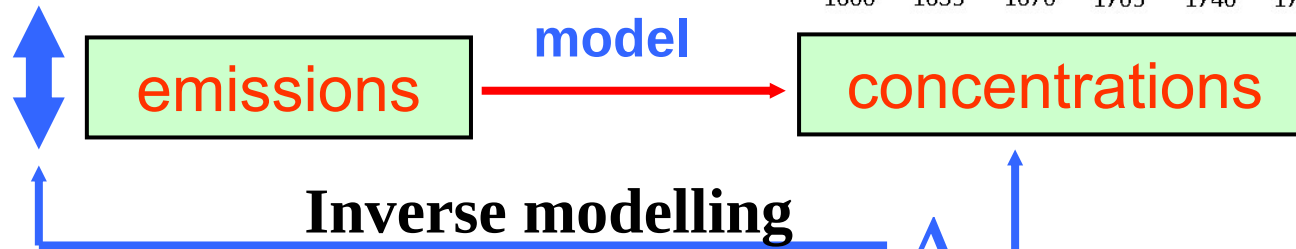
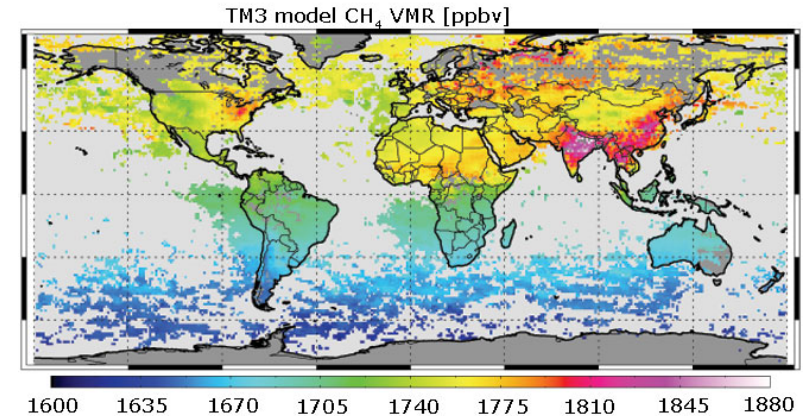
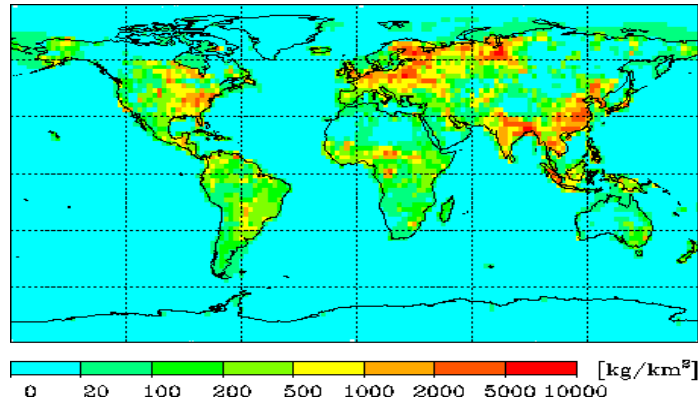


Vortex breakup, September 2002



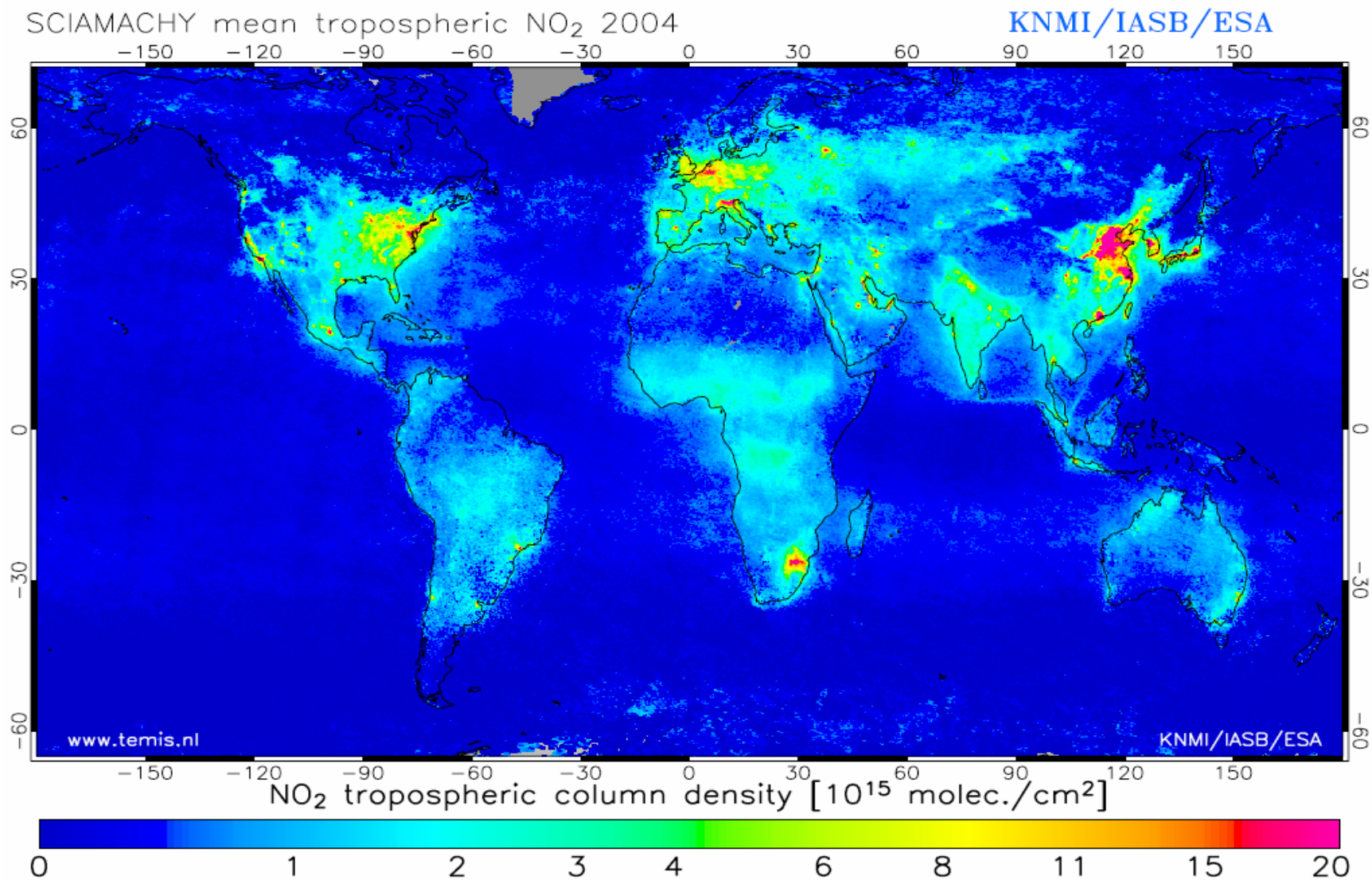
- Total ozone trend in NIWA assimilated data set for Nov'78 – Dec'02, based on Bodeker et al., 2005

CAPACITY theme Monitoring greenhouse gases



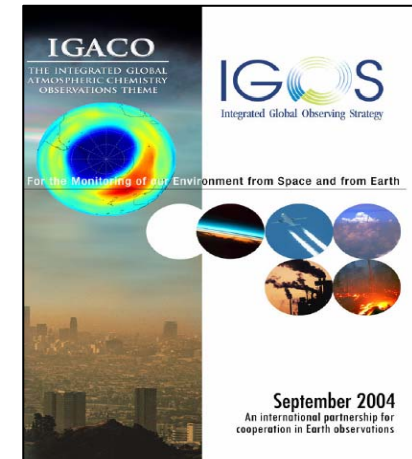
SCIAMACHY methane

Pollution Monitoring: Global Tropospheric NO₂ from SCIAMACHY



Sources of user and observational requirements

- **IGOS-IGACO Theme report, 2004**
- **EU GMES-GATO report**
- EU FP projects, e.g. Create-Daedalus, Evergreen
- Environment and climate protection Protocols, Directives etc. (EU, international)
- GCOS implementation plan, WCRP-SPARC long-term observation requirements
- GMES service element PROMOTE
- ESA studies on CO₂ monitoring
- ESA study on atmospheric chemistry observation requirements (research)
- **CAPACITY workshop Jan. '04 and final presentation June '05**



Environmental themes, data usage, applications

Environmental Theme	Ozone Layer & Surface UV radiation	Air Quality	Climate
Data usage			
Protocols	UNEP Vienna Convention; Montreal and subs. Protocols CFC emission verification Stratospheric ozone, halogen and surface UV distribution and trend monitoring	UN/ECE CLRTAP; EMEP / Göteborg Protocol; EC directives EAP / CAFE AQ emission verification AQ distribution and trend monitoring	UNFCCC Rio Convention; Kyoto Protocol; Climate policy EU GHG and aerosol emission verification GHG/aerosol distribution and trend monitoring
Services	Stratospheric composition and surface UV forecast NWP assimilation and (re-) analysis	Local Air Quality (BL); Health warnings (BL) Chemical Weather (BL/FT) Aviation routing (UT)	NWP assimilation and (re-) analysis Climate monitoring Climate model validation
Assessment	Long-term global data records WMO Ozone assessments Stratospheric chemistry and transport processes; UV radiative transport processes Halogen source attribution UV health & biological effects	Long-term global, regional, and local data records UNEP, EEA assessments Regional & local boundary layer AQ processes; Tropospheric chemistry and long-range transport processes AQ source attribution AQ Health and safety effects	Long-term global data records IPCC assessments Earth System, climate, rad. forcing processes; UTLS transport-chemistry processes Forcing agents source attribution Socio-economic climate effects

Measurement strategy - example: climate protocol monitoring, integrated approach

Role of Satellite Measurements

- Concentration monitoring for inverse modeling of CH₄, CO₂, CO and NO₂ emissions
- Global concentration distributions of the mentioned gases, O₃ and aerosols

Role of Surface network

- Greenhouse gases trend monitoring (CO₂, CH₄, N₂O, SF₆, CF₄, HFCs)
- Weekly surface concentrations and total columns from a representative network.
- Validation of satellite measurements
- Concentration monitoring for inverse modeling of CH₄, CO₂, CO and NO₂ emissions
- Tropospheric O₃: sondes, lidar and surface data;
- Tropospheric aerosol optical depth and aerosol absorption optical depth
- Trend monitoring for ozone depleting substances with climate forcing: (H)CFCs.

Auxiliary data

- Meteorology from NWP centers including surface data
- Emission inventories and estimates on sinks

Recommendations CAPACITY

In line with the IGACO recommendations the consortium has proposed to implement a system of GEO and LEO satellites and has suggested the following steps

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

**EUMETSAT:
Operational monitoring atmospheric composition in
time frame 2019-2030**



EUMETSAT Post-EPS 2020-2030 Atmospheric Chemistry Monitoring Study

Atmospheric Chemistry Expert Group 2005/2006

B. Carli, I. Isaksen, N. Harris, E. Hilsenrath, H. Kelder, B. Kerridge, M. van Weele and R. Munro (EUMETSAT)

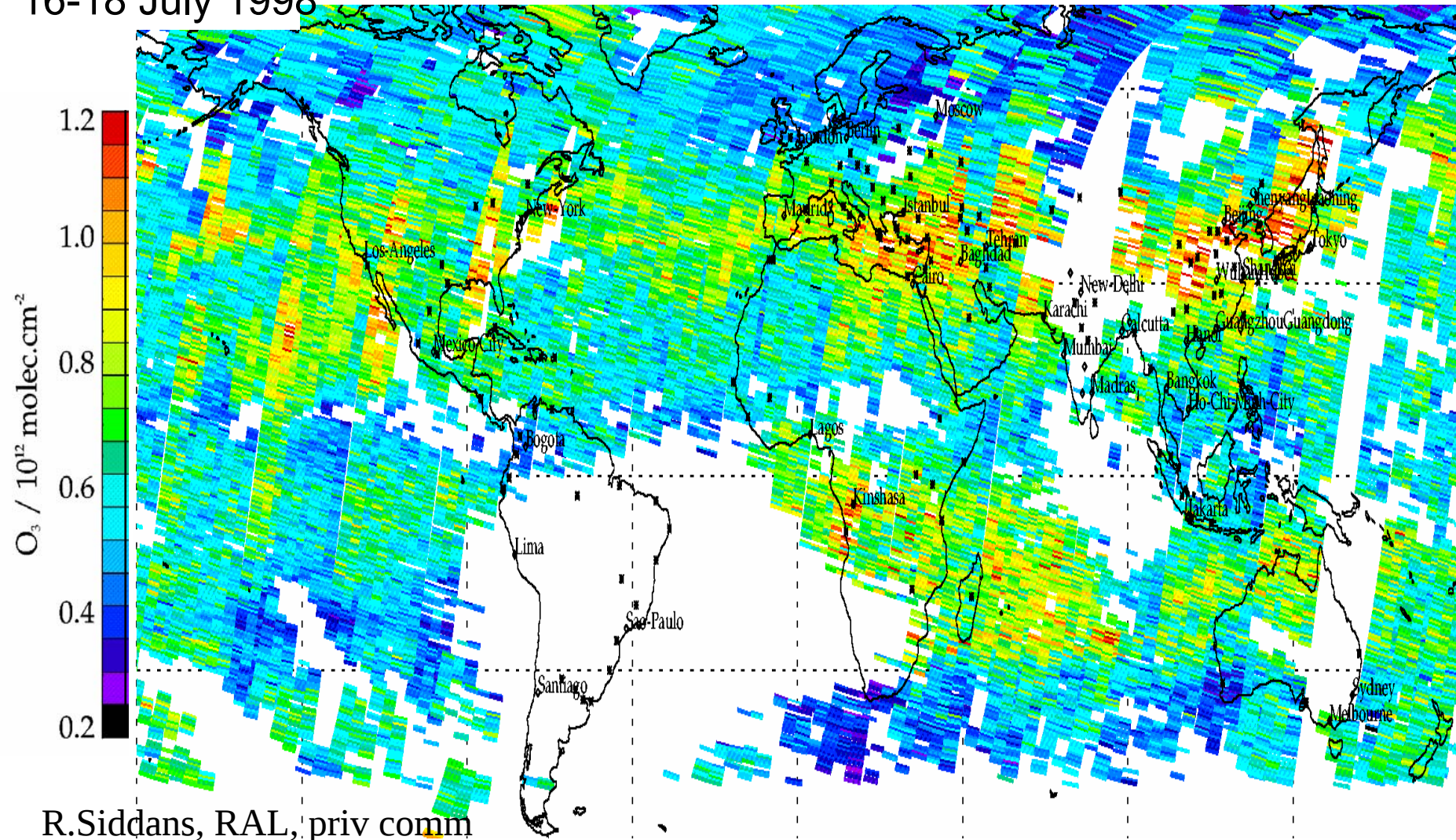
Position Paper on Operational Atmospheric Chemistry Monitoring in the Post-EPS Time Frame beyond 2020

Based on CAPACITY study and IGACO report

1. CURRENT STATUS OF ATMOSPHERIC CHEMISTRY MONITORING MISSIONS
2. TARGET USER GROUPS within and outside EUMETSAT
3. APPLICATION AREAS & USER REQUIREMENTS
4. POINTS FOR MISSION CONCEPT
5. SYNERGY WITH OTHER POST-EPS MISSIONS

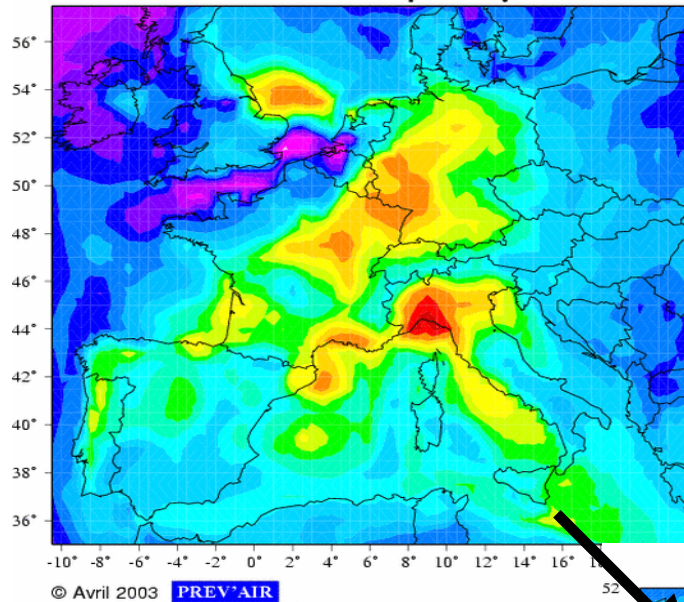
Pollution Monitoring: Global Tropospheric O₃ from GOME-1

16-18 July 1998

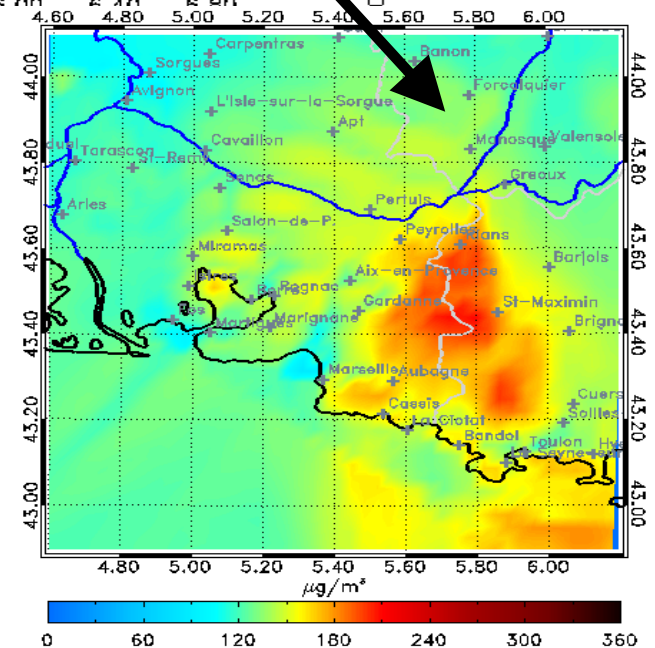
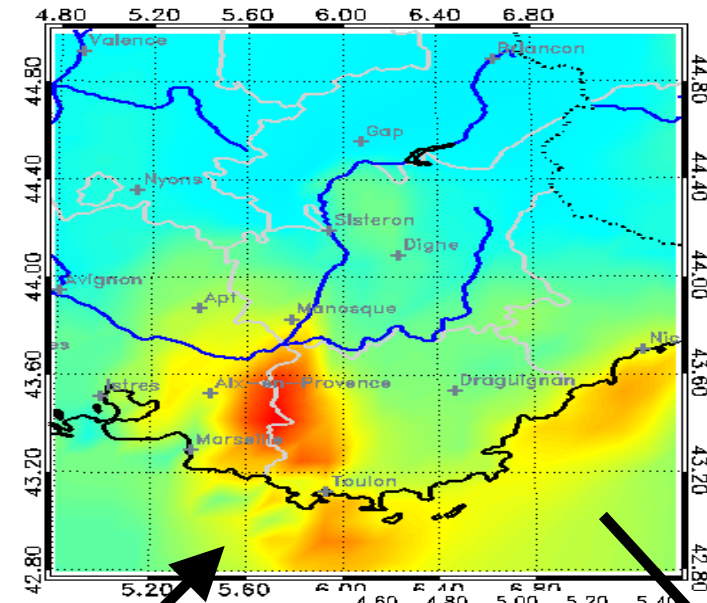
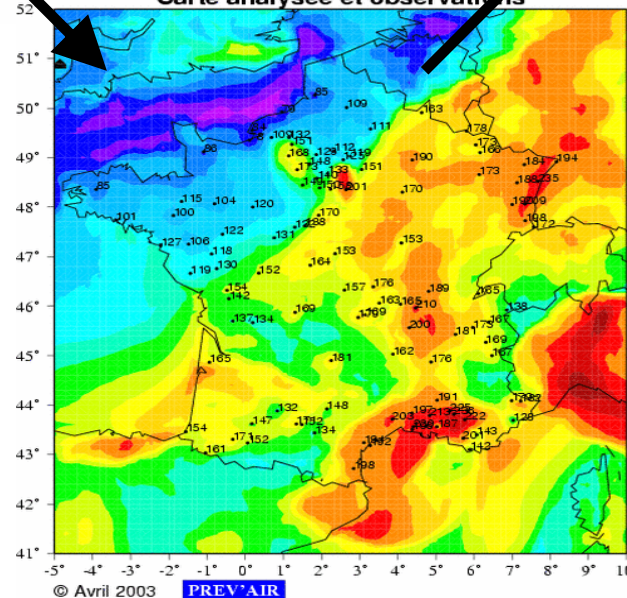


Regional AQ forecast

Ozone , pic en $\mu\text{g}/\text{m}^3$
Prévision du 31/07/2004 pour le jour-même



Ozone , pic
Carte analysée et observée



AQ forecast on several scales
employing CHIMERE model
by LISA/AirParif/Airimax

Netherlands: information for
dynamic traffic management

Atmospheric Chemistry Monitoring Applications

1. Ozone Layer and Surface UV Monitoring and Forecasting
2. Composition – Climate Interaction
3. Air Quality Monitoring and Forecasting

Points for Mission Concept

- Considering data requirements for the three applications and drawing on the extensive assessment of observing techniques for CAPACITY, several points can be noted for mission concept:
 1. **Nadir-viewing *uv-swir* and *ir* spectrometers** complementary in (a) near-surface sensitivity and (b) detectable constituents
 - Requirements for *near-surface* observations of trace gases and aerosol addressed by this combination
 2. **Limb-viewing *mm-wave* and *ir* spectrometers** complementary in (a) cirrus sensitivity and (b) detectable constituents
 - Requirements for *vertical profiling* addressed optimally by combination of limb- and nadir-sounding
- Specified requirements anticipated to be viable for mission deploying advanced instrumentation in the post-EPS (2020-2030) time-frame.
- Concept identified for GMES polar-orbit offers possible starting point also for post-EPS



1st Post-EPS User Consultation Workshop, 29-30th March 2006

Atmospheric chemistry mission team formed, May 2006

J. Burrows, J. Gleason, N. Harris, H. Kelder, B. Kerridge and
R. Munro(EUMETSAT)

EUMETSAT Post-EPS schedule

- | | | |
|--------------|---------------------------------|-----------|
| • Phase 0 | Mission analysis | 2006-2008 |
| • Phase A | Feasibility | 2008-2010 |
| • Phase B | Preliminary Definition | 2010-2012 |
| • Phase C, D | Detailed definition, Production | 2012-2018 |
| • Phase E | Utilisation | from 2019 |

Other developments

ESA /EU, Global Monitoring Environment and Security, **GMES**
Sentinels 4 and 5

GEO and LEO missions respectively for atmospheric chemistry

GEOSS, User Interface Committee: air quality monitoring
and forecasting, priority

WMO, 2007, Strategy 2008-2015, Global Atmosphere Watch,
Implementation IGACO recommendations, integrated approach
ground, in situ data and satellite data, models, data assimilation,

Outlook

Atmospheric chemistry monitoring and explorer missions,
beyond METOP 1,2 and 3

Opportunities in:

- ESA Earth Explorer program, atmospheric chemistry priority
- ESA/EU GMES sentinels 4 and 5 and GEOSS
- 2019 onwards , EUMETSAT Post-EPS framework

3 satellites at 900 km, 125° inclination (two consecutive orbits)

