

GMES Sentinels 4&5

Environmental themes, data usage, applications

Environmental Theme	Ozone Layer & Surface UV Radiation A	Air Quality B	Climate C
Data usage			
Protocols 1	UNEP Vienna Convention; Montreal and subs. Protocols CFC emission verification Stratospheric ozone, halogen and surface UV distribution and trend monitoring A1	UN/ECE CLRTAP; EMEP / Göteborg Protocol; EC directives EAP / CAFE AQ emission verification AQ distribution and trend monitoring B1	UNFCCC Rio Convention; Kyoto Protocol; Climate policy EU GHG and aerosol emission verification GHG/aerosol distribution and trend monitoring C1
Services 2	Stratospheric composition and surface UV forecast NWP assimilation and (re-) analysis A2	Local Air Quality (BL); Health warnings (BL) Chemical Weather (BL/FT) Aviation routing (FT) B2	NWP assimilation and (re-) analysis Climate monitoring Climate model validation C2
Assessment (lower priority for operational mission) 3	Long-term global data records WMO Ozone assessments Stratospheric chemistry and transport processes; UV radiative transport processes Halogen source attribution UV health & biological effects A3	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 B3	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 C3

Geographical coverage requirements

**Ozone Layer &
Surface UV radiation**

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

global

Air Quality

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

threshold : Europe + surrounding areas
(e.g. monitoring of EC directives and national AQ legislation, short-term air quality forecast)

target : global (monitoring, assessment and forecast of global air quality, the oxidising capacity, and the quantification of continental in/outflow)

Climate

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

global

Main gaps in current / planned operational system

- High temporal/spatial resolution space-based measurements of tropospheric (PBL) composition for application to **air quality**
- High vertical resolution measurements in the **UT/LS region** for ozone and climate applications
- **Climate gases** (CO₂, CH₄ and CO) and **aerosol monitoring** with sensitivity to the PBL

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

→ **in line with IGACO findings**

Mission concept for **climate protocol monitoring applications (lower troposphere)**

System: sun-synchronous LEO platform

Instrumentation: UV-vis-SWIR spectrometer for O₃, NO₂, CH₄, CO, aerosol

Mission concept for **ozone and climate applications in the UTLS**

System: sun-synchronous LEO platform with a limb-sounder, formation flying with Metop or other new mission with nadir-viewing instruments in order to support their tropospheric data products

Instrumentation options:

either mm-wave (MASTER derivative) or mid-IR (AMIPAS derivative)

Mission concept for **air quality**

Instrumentation options:

- 1) combined solar backscatter and thermal IR sounding
- 2) solar backscatter only

Mission concept for **air quality** - system options

Driving requirements (protocol monitoring, forecast) :

Revisit time **0.5 – 2 h (Eumetsat post-EPS: 0.5 – 4 h)**

Spatial resolution **5 – 20km**

System options:

- A 1 geostationary satellite to satisfy spatio-temporal sampling requirements over Europe, and
 1 LEO satellite in sun-synchronous orbit for global pollution transport (Convention on long-range transport of air pollutants, medium-range forecast)
- B a constellation of ~3 satellites in inclined LEO to satisfy spatio-temporal sampling requirements globally at mid-latitudes, with reduced sampling at low latitudes
- C a constellation of 3 satellites in sun-synchronous orbit to satisfy Eumetsat spatio-temporal requirements globally

Conclusions for Sentinels 4 and 5

1. **Implement 1 LEO satellite with UV-VIS-SWIR payload for global air quality and climate protocol monitoring as soon as possible**

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

2. **Perform trade-off between GEO+LEO and LEO constellations in inclined or sun-synchronous orbits**, and implement complete air quality & climate protocol monitoring mission

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

3. **Consolidate choice and requirements** of instrument for UTLS mission for climate and ozone NRT and assessment applications, and implement the mission

	A	B	C
1	A1	B1	C1
2	A2	B2	C2
3	A3	B3	C3

The programmatic situation of Sentinels 4&5

- **Current GMES planning horizon is 2013**
- **Sentinels 4&5 Phase 0 starting April 2007**
- **Funding for phase A available**

The relation to Eumetsat programmes

Common ESA – Eumetsat position (9/2006) :

“According to current plans Sentinels-4 and -5 will be implemented as additional payloads on the Eumetsat MTG and post-EPS missions, and will be operated by Eumetsat as part of the overall MTG and post-EPS management procedures.

...

As next steps, ESA and Eumetsat will establish a plan to identify requirements, a provisional funding scheme and operational implementation scheme for Sentinels-4 and -5.”

Discrepancies between requirements (Sentinels 4&5 vs. Eumetsat) have been identified.

Harmonisation to be finalised March 2007.

Consolidation of requirements for Sentinels 4&5 (1/2)

- **Generate “best estimate” MRD with identified priorities and alternatives, taking into account Eumetsat MTG and post-EPS requirements**
- **Two parallel trade-off studies (AQ and climate protocol monitoring mission) :**
 1. **Phase 0 system study (start April 2007)**
 - **On basis of MRD**
 - **Trade-offs on system and instrument level**
 - **design to cost**
 2. **Scientific study (“Capacity follow-on”, start March 2007)**
 - **Auxiliary requirements**
 - **Retrieval study ➡ observation principles, L1 requirements**
 - **Cloud contamination statistics**
 - **Orbit optimisation**
 - **Support to phase 0 study**
- **Combine results of both studies to consolidate MRD**

Consolidation of requirements for Sentinels 4&5 (2/2)

- **AQ OSSE study (assimilation, forecast) to close the loop to the user**
 ➡ iteration on Level 2 requirements possible

- **Inverse modelling study (CH₄, pollutants: sources and sinks) (TBC – funding open)**
 ➡ iteration on Level 2 requirements possible

- **UTLS climate and ozone applications : limb-sounder study**
 - **Impact on NWP and climate monitoring**
 - **Choice of mm-wave vs. infrared instrument**
 - **Retrieval study ➡ Level 1 requirements**