

The Sentinel-4 Mission: Instrument Description and Atmospheric Composition Products

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Services Component – **led by EC**

- Produces information services in response to European policy priorities in environment and security
- Relies on data from in-situ and space component

In-situ Component – **led by EEA**

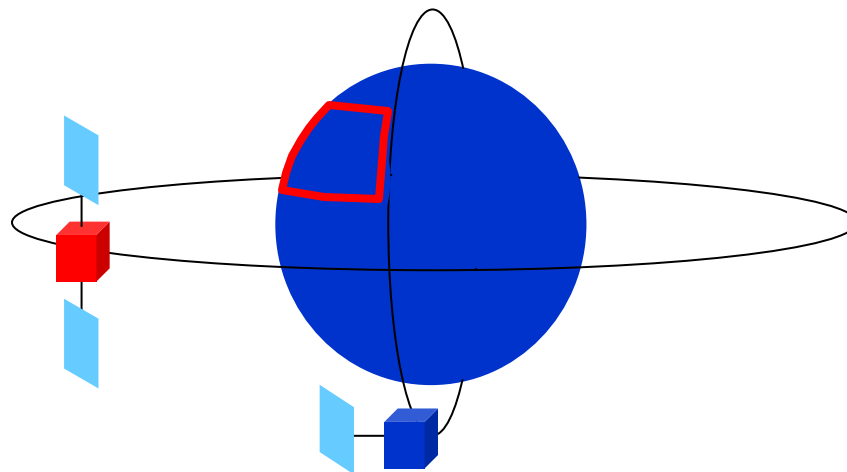
- Observations mostly within national responsibility, with coordination at European level

Space Component – **led by ESA**

- Sentinels - EO missions developed specifically for GMES

Plus **Contributing Missions** - EO missions built for purposes other than GMES but offering part of their capacity to GMES

Constellation of Sentinels for GMES Atmosphere Services



GEOstationary (GEO)

- Hourly revisit time over **Europe**
 - Mainly air quality
 - Diurnal cycle of tropospheric composition
- **Sentinel-4**

Low Earth Orbit (LEO)

- Daily revisit time **global coverage**
 - Climate, air quality, ozone & UV
 - Tropospheric & stratospheric composition
- **Sentinel-5**
- **Sentinel-5 Precursor**

- **Sentinel-4**

- **UVN spectrometer** on EUMETSAT's Meteosat Third Generation Sounder (MTG-S) platforms; launch of first platform **2019**;
- utilisation of data from the InfraRed Sounder (**IRS**) on MTG-S;
- utilisation of data from the Flexible Combined Imager (**FCI**) on the MTG Imager (MTG-I) platforms.

- **Sentinel-5**

- **UVNS spectrometer** on EUMETSAT Polar System Second Generation (EPS-SG) platforms; launch of first platform **≥2020**;
- implementation of atmospheric composition requirements in addition to NWP requirements for the **IRS** on EPS-SG;
- utilisation of aerosol data from the **3MI** instrument on EPS-SG.

- **Sentinel-5 Precursor**

- **UVNS spectrometer** on a dedicated platform; launch **2015**;
- utilisation of NPP/JPSS **imager** data;

UVN = Ultraviolet + Visible + Near infrared;

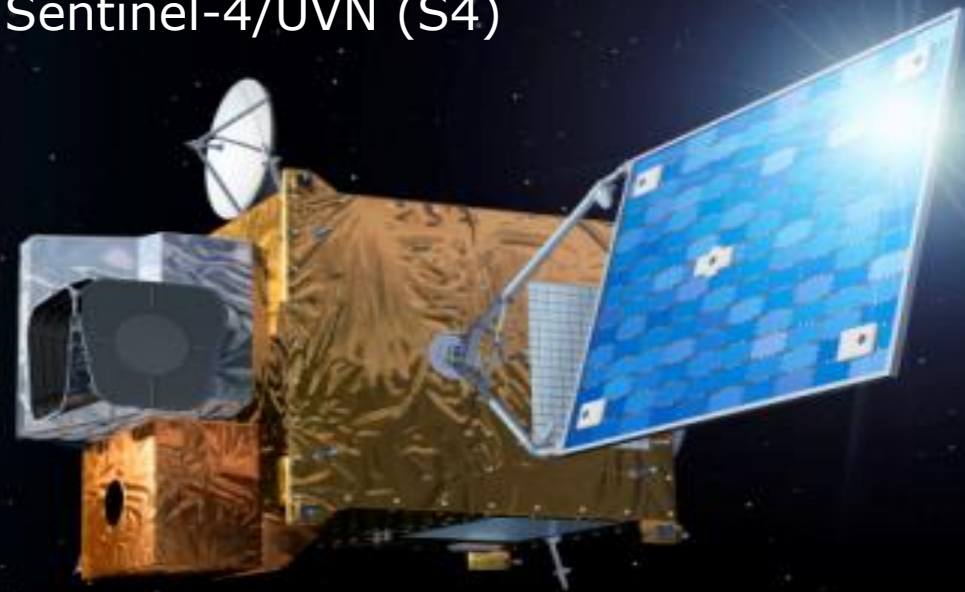
UVNS = UVN + Short wave infrared;

IR = Infrared

MTG-Sounder
InfraRed Sounder (IRS)
Sentinel-4/UVN (S4)



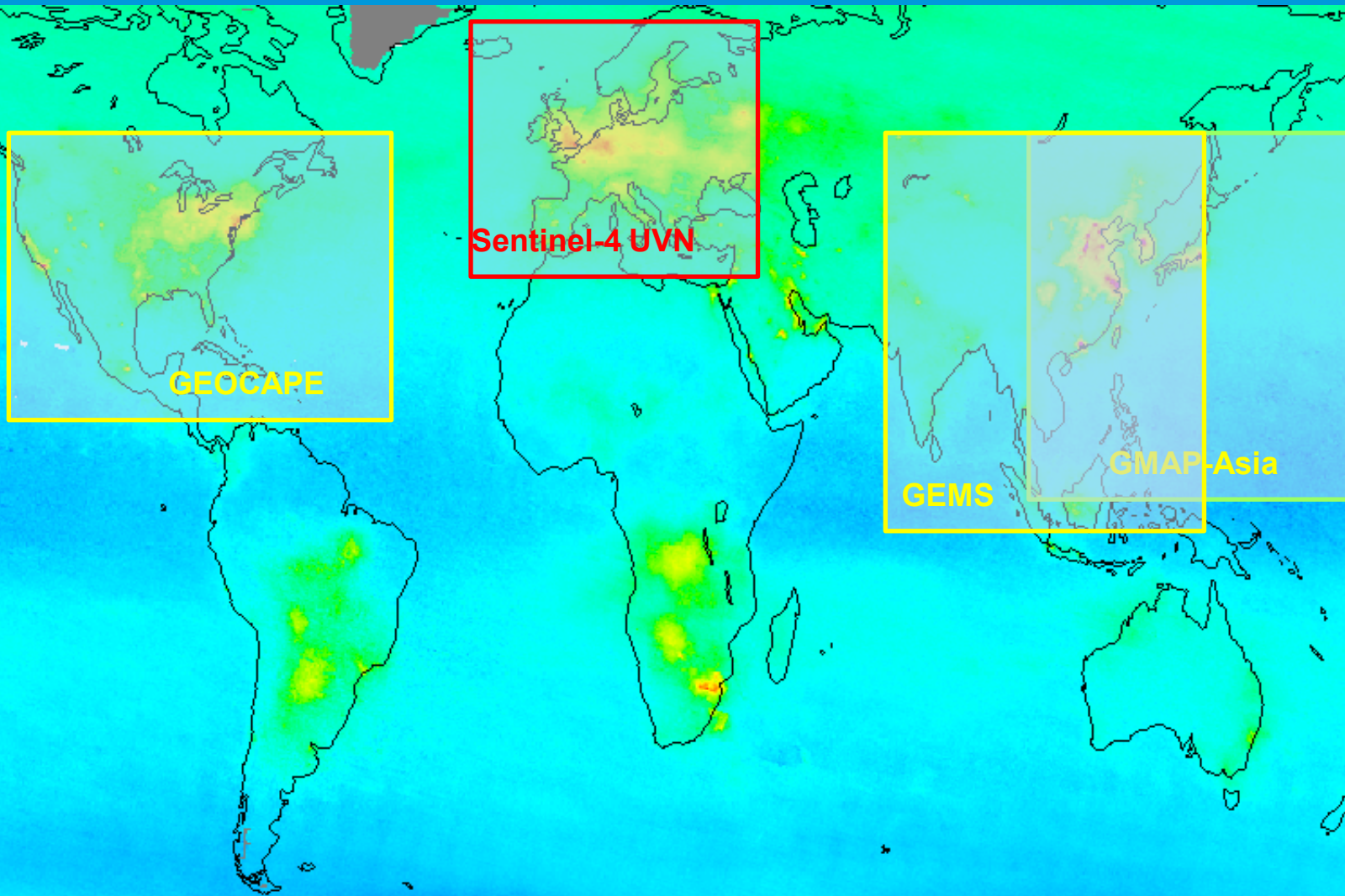
MTG-MTG-I
Flexible Combined Imager (FCI)
Lighting Imager (LI)



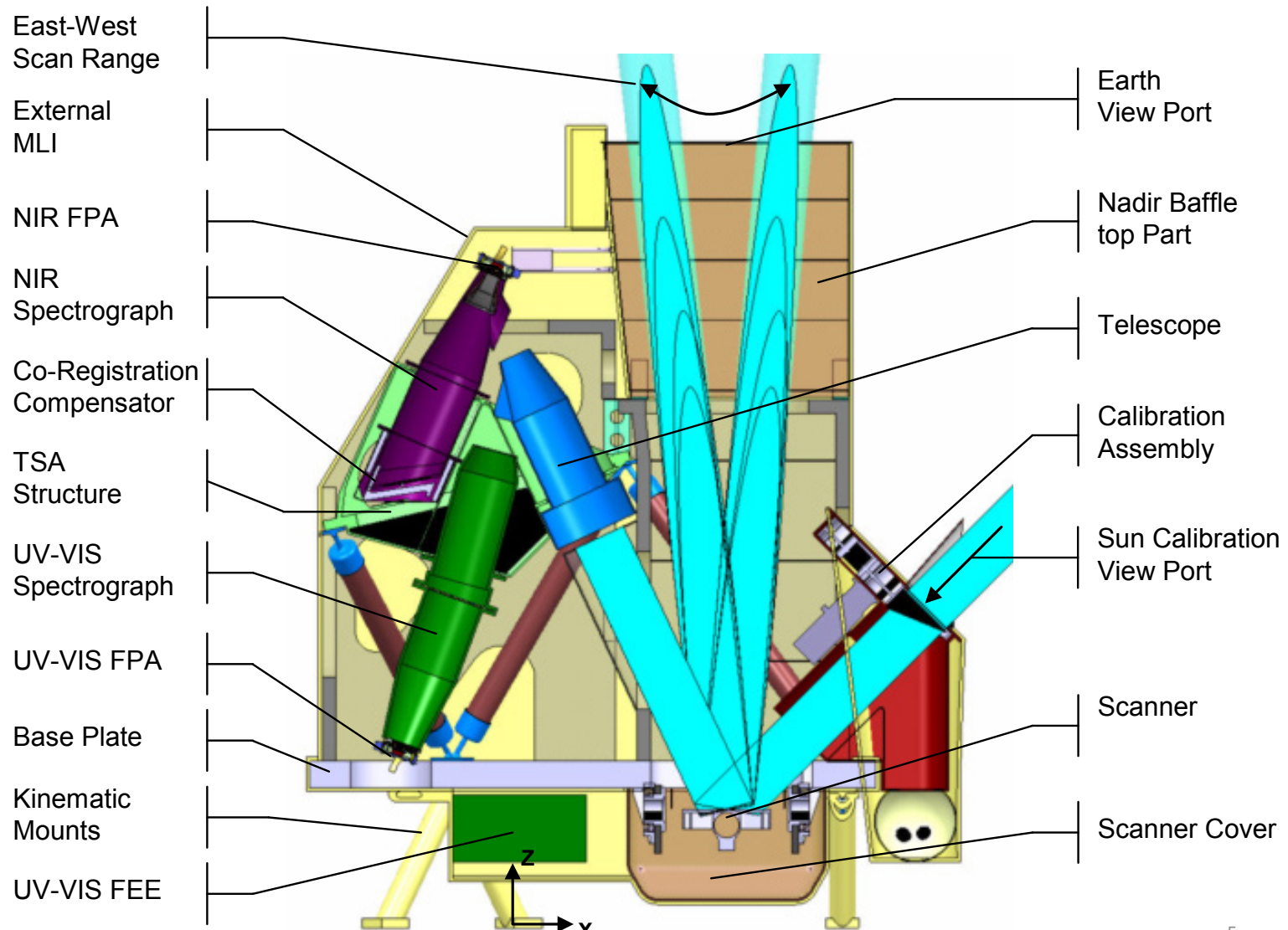
Current International Plans for Geostationary Atmospheric Missions



SCIAMACHY total NO₂ August 2006 KNMI/IASB/ESA

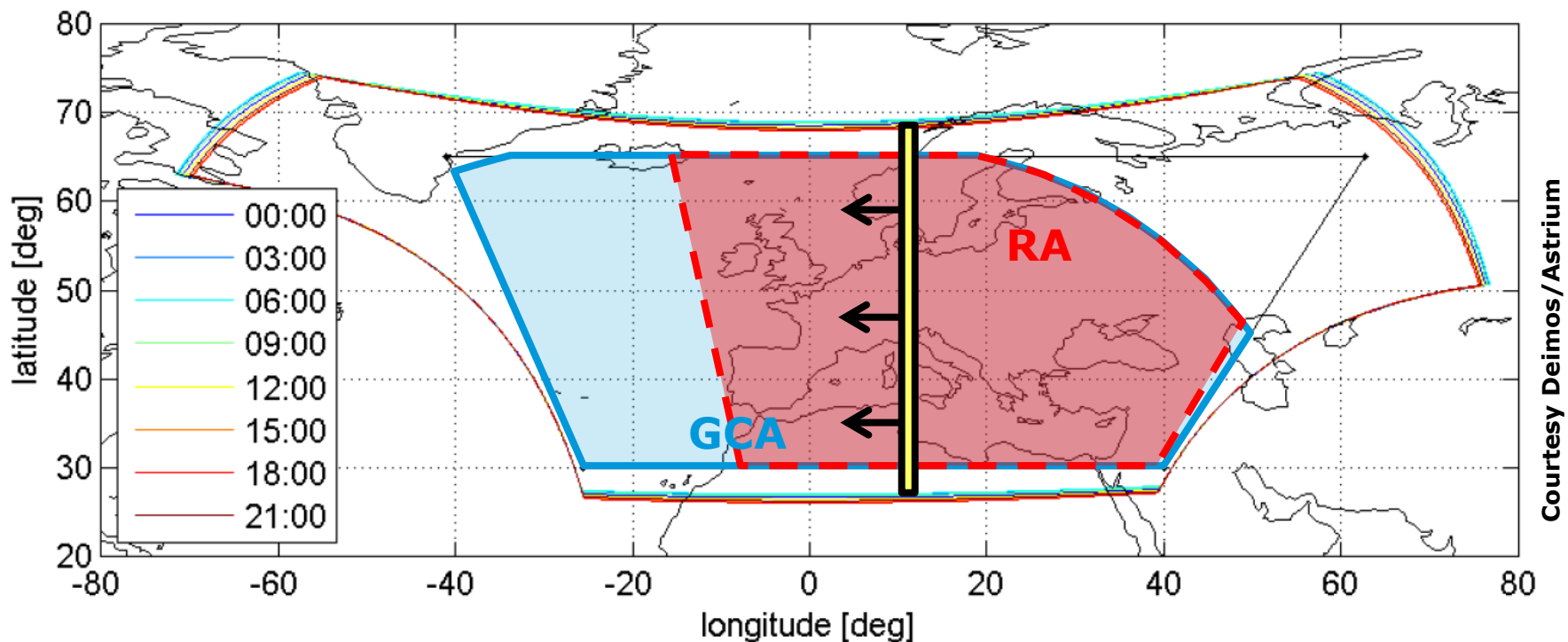


Sentinel-4/UVN Instrument



Courtesy Astrium

- Geographical Coverage Area (GCA): Europe + part of Sahara
- Reference Area (RA): revisit time 1h
- Spatial resolution 9 km E/W, 11 km N/S at 45° N
- Spatial sampling 8 km E/W and N/S at 45° N



- UV-VIS: 305 – 500 nm with 0.5 nm spectral resolution, 3 x oversampling
- NIR: 750 – 775 nm with 0.12 nm spectral resolution, 3 x oversampling
- Polarisation sensitivity: 0.6% (<315 nm), 0.7% (315-500 nm), 0.4% (NIR)
- Radiometric accuracy: 2.3% (<315 nm), 1.8%(315-500 nm), 2.3% (NIR)
- Low level of spectral features

Sentinel-4 Level-2 Products



Product	Application			Comment
	Air Quality	Climate	Surface UV	
O₃ total & trop. column	X		X	
O₃ profile	X		X	Synergy with infrared data from IRS
NO₂ total & trop. column	X			
SO₂ total column	X			Also for volcanic eruption monitoring
CHOCHO total column	X			By-product
CH₂O total column	X			
Aerosol extinction coeff. profile, column optical depth / type / index	X	X		Also for volcanic eruption monitoring Also auxiliary for other S4 products Synergy with imager data from FCI
Cloud optical thickness, fraction, altitude			X	Mainly auxiliary for other S4 products Synergy with imager data from FCI
Surface reflectance daily map			X	Mainly auxiliary for other S4 products

IRS-alone products (eg O₃, CO) assumed to be developed by EUMETSAT

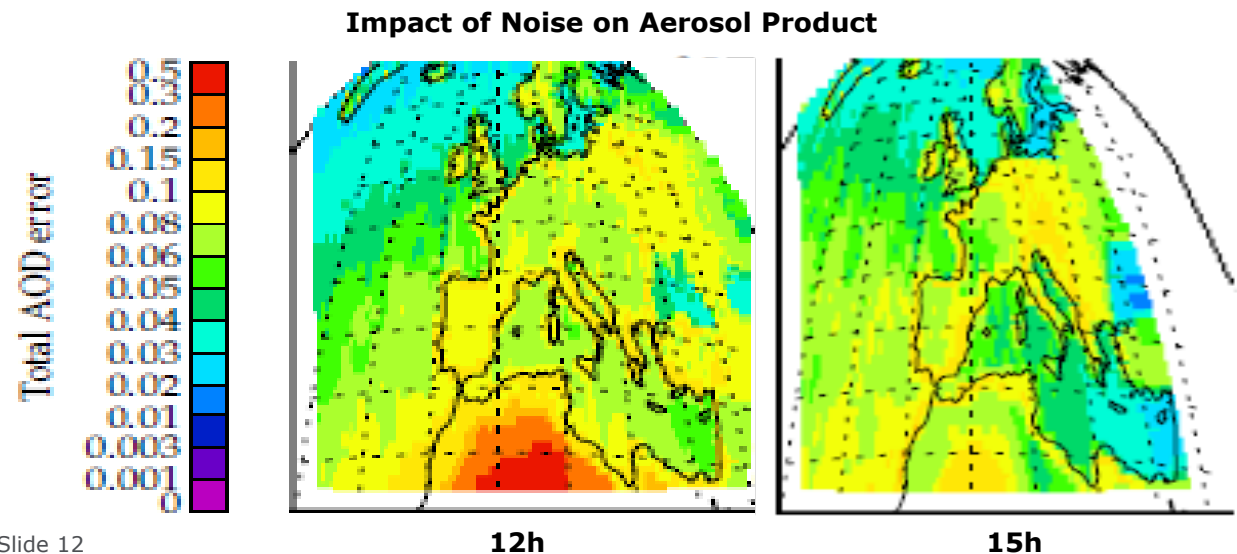
Sentinel-4 Level-2 Performance Estimate



- S4UVN3 study with IUP-Bremen, RAL, SRON, Noveltis
- Assumptions: polluted scenario at 50°N, 15h local time, radiometric offset error small, spectral calibration on, cloud fraction up to 20%

Tropospheric column	O ₃ [%]		NO ₂ [%]		CH ₂ O [%]		SO ₂ [%]		Aerosol [AOD]	
	Ran.	Sys.	Ran.	Sys.	Ran.	Sys.	Ran.	Sys.	Ran.	Sys.
Error type										
Instrument	3	3	7	3	13	3	5	10	0.2	0.2
Scene (clear)	9	20	10	21	7	27	12	20	0.03	0.05
Scene (cloudy)	9	22	11	26	9	34	19	36	-	-
Total (clear)	22		25		31		25		0.25	
Total (cloudy)	24		29		37		42		-	
User req.	10-25		15-25		20-50		20-50		0.05	

- Sentinel-4 well suited to meet user requirement for observations of NO_2 , O_3 , HCHO , SO_2 in clear or partially cloudy conditions
- Aerosol optical thickness user requirement achieved (at full spatial sampling) only in slant viewing and illumination conditions
- Several observations per day likely due to hourly revisit time
- Observation System Simulation Experiment LEO + GEO (ISOTROP study with KNMI, CNRS, TNO, FMI, NILU)



- Instrument Preliminary Design Review completed → Phase C/D
- L1 processor development in preparation
- L2 pre-development ongoing
 - aerosol profile retrieval from O₂A-band (AEROPRO study with KNMI)
 - surface reflectance map from temporally aggregated S4 data (SURMACED study with BIRA, GC, LOA, IM)
- L2 processor development in preparation
 - ITT end 2013
 - Kick-off early 2014

Backup slides

- S4UVN3 study with IUP-Bremen, RAL, SRON, Noveltis
- Pseudo-Noise (PN) due to
 - scene heterogeneity
 - non-uniform illumination of spectrometer slit
 - perturbation of Instrument Spectral Response Function (ISRF)
- PN mitigation in UV-vis
 - spectral calibration → sufficient
 - estimate ISRF using High Spatial Sampling (HSS) data → even better
- PN mitigation in NIR
 - estimate ISRF in continuum using HSS data → possibly sufficient
 - estimate ISRF across the NIR using HSS data → sufficient