Sentinel-4 and Sentinel-5 Mission Status Update

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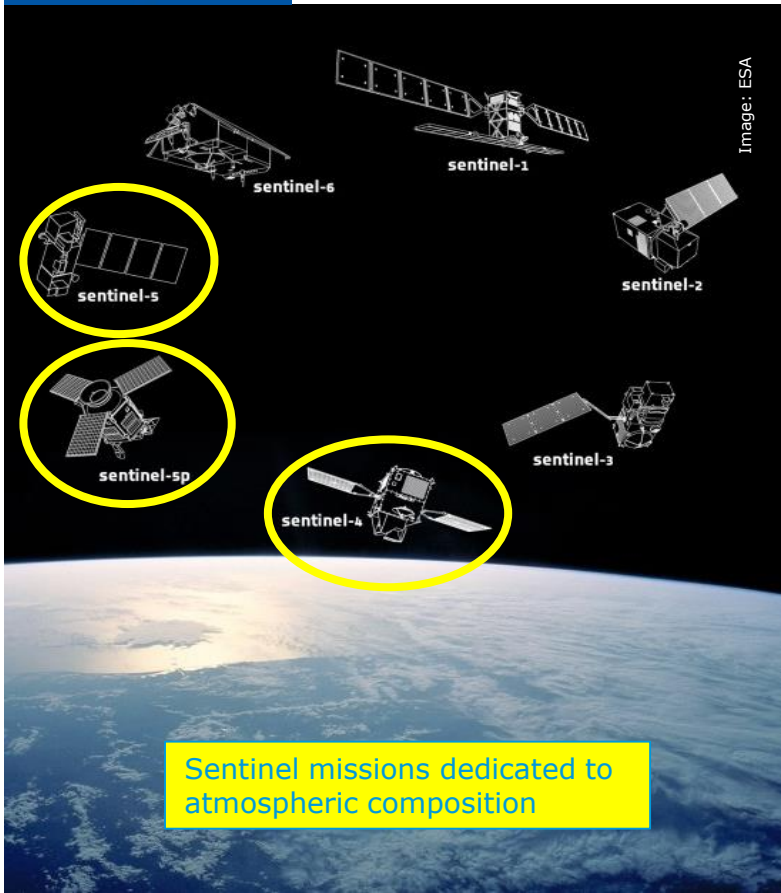
Acknowledgements: ESA Sentinel-4 and Sentinel-5 project teams, industrial consortia lead by ADS, L2 consortia lead by DLR and S&T

Supplement to Agenda Item 2.04
AC-VC#16 virtual meeting, 8-12 June 2020

- European system for monitoring
  land, marine, atmosphere, climate change, emergency management, security
- Observations from
  satellites, ground-based, air-borne sensors
- Information service for
  policymakers, public authorities, …, citizens
- Space Component:
  Sentinel missions by European Space Agency

Copernicus Atmosphere Monitoring Services



Copernicus Missions for Atmospheric Composition

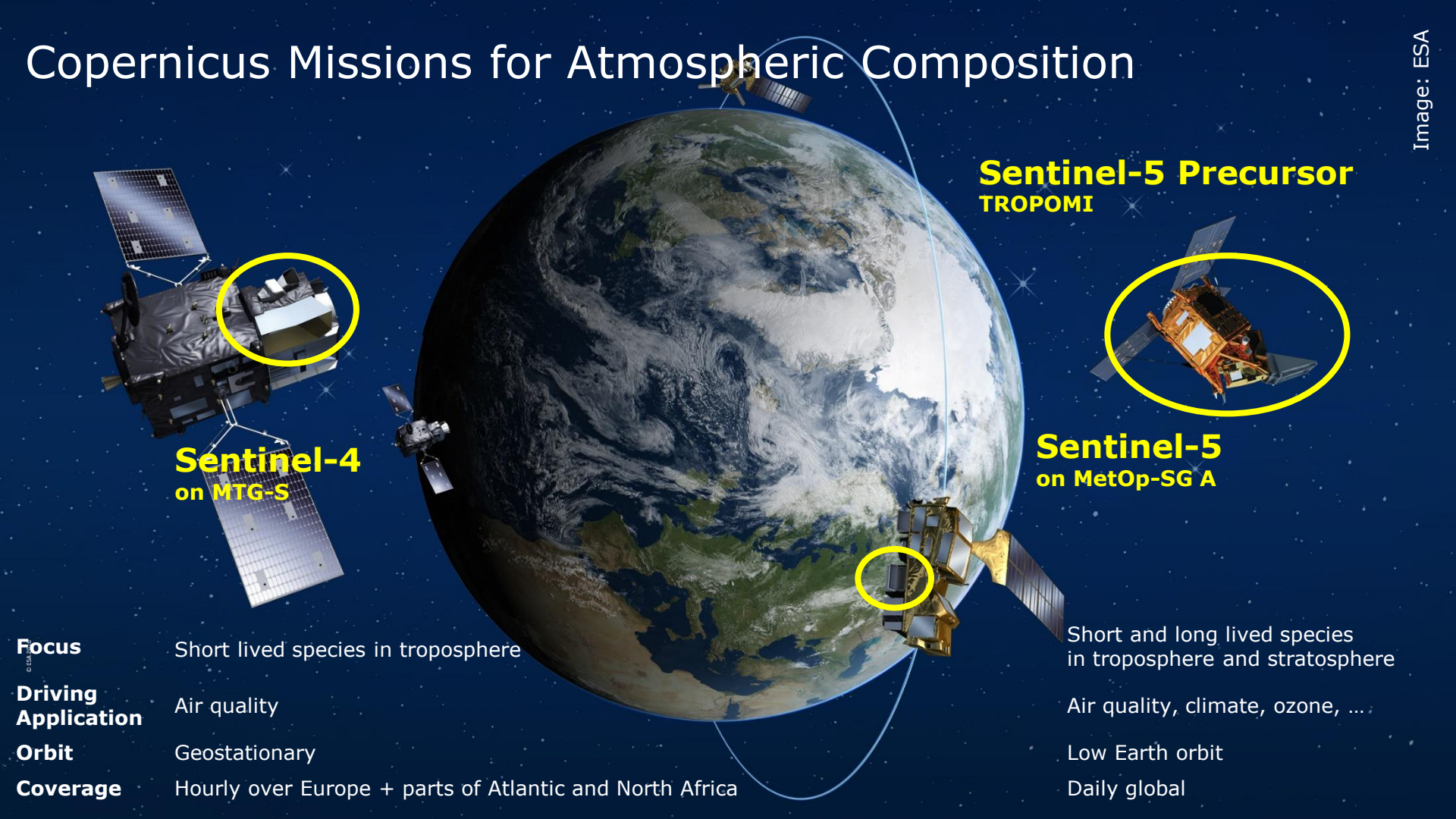
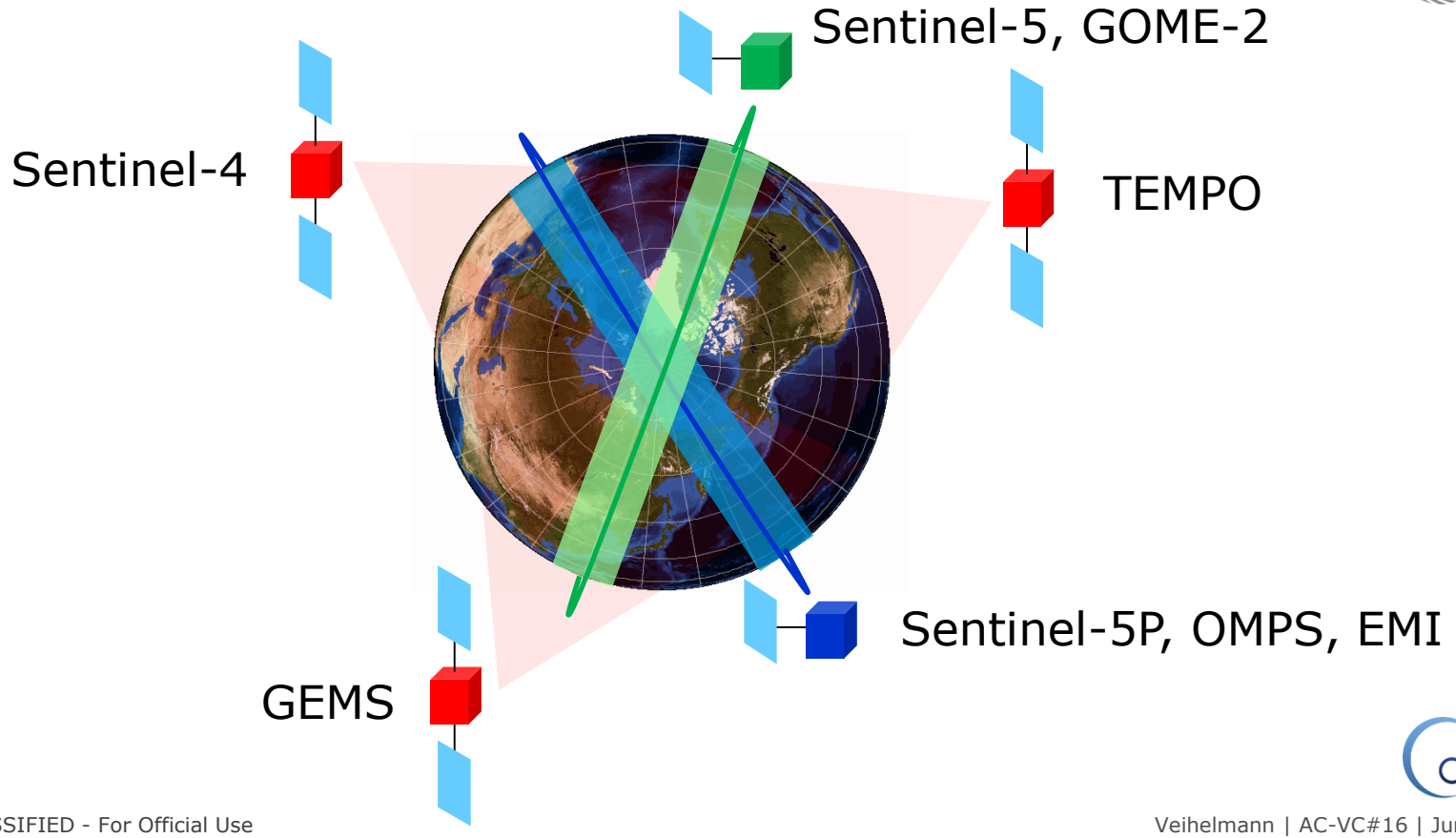


Image: ESA

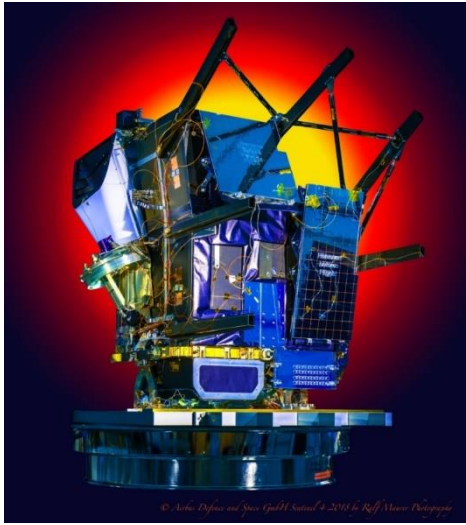
	Sentinel-4 on MTG-S	Sentinel-5 on MetOp-SG A
Focus	Short lived species in troposphere	Short and long lived species in troposphere and stratosphere
Driving Application	Air quality	Air quality, climate, ozone, …
Orbit	Geostationary	Low Earth orbit
Coverage	Hourly over Europe + parts of Atlantic and North Africa	Daily global

Global Atmospheric Composition Constellation



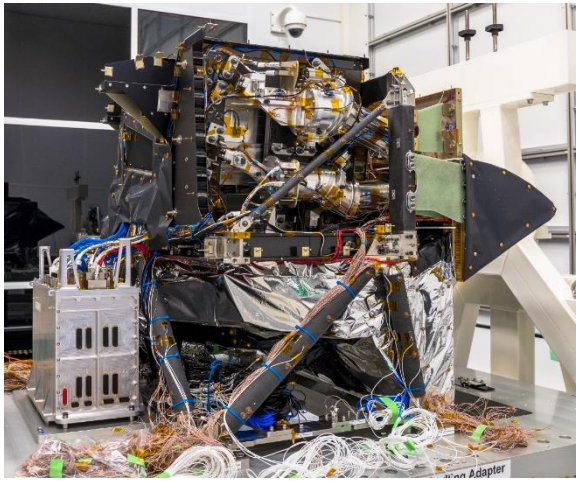
Copernicus Sentinel-4
UV-Vis-NIR (UVN) Imaging Spectrometer

- Built under the responsibility of ESA
  - Instruments and Level-1b prototype processor by a consortium led by ADS
  - L2 operational processor by a consortium led by DLR
- Will be operated by EUMETSAT
- Geostationary
- Two S4/UVN in sequence → mission lifetime of 15 years
- Embarked on Meteosat Third Generation-Sounder S1 and S2 satellites
- Synergy with FCI and LI on MTG-I, IRS on MTG-S
- Proto-Flight Model integration and testing
- L1 and L2 processor implementation
- On-ground calibration & characterization planning
- Launch expected 2023

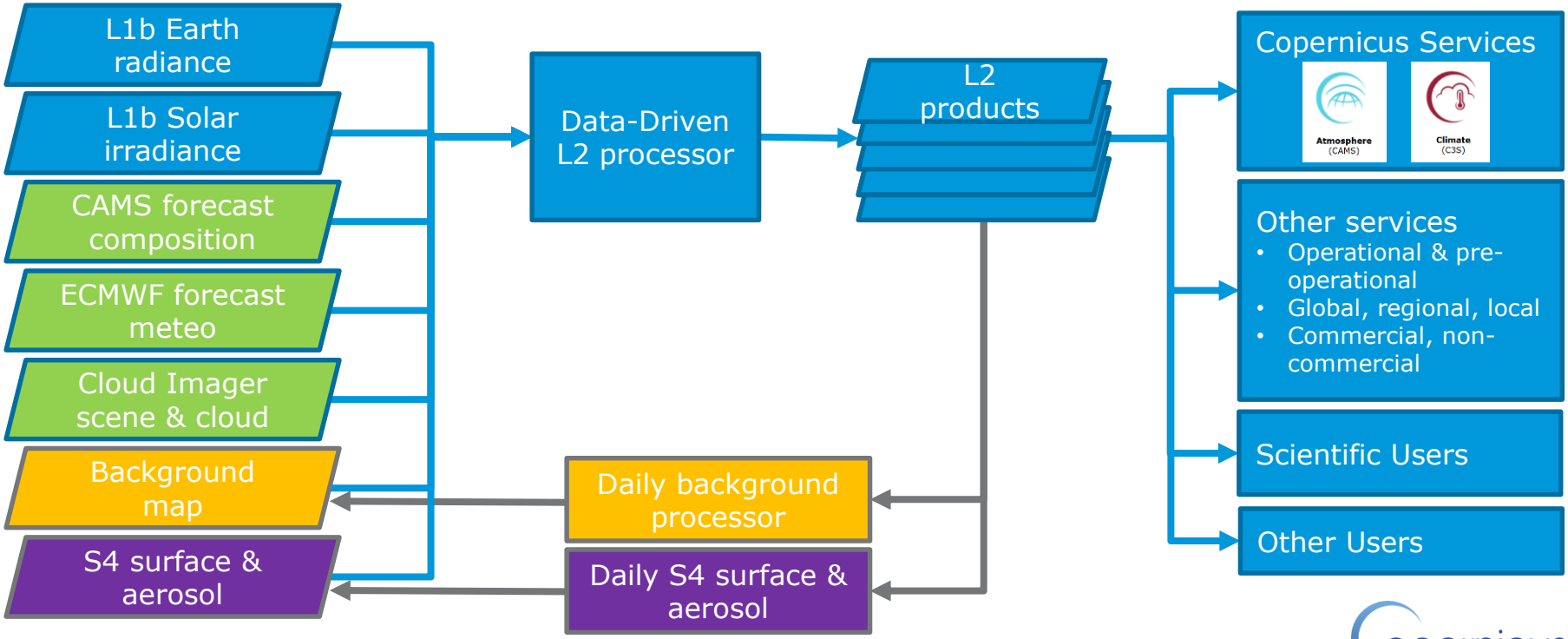


Copernicus Sentinel-5
UV-Vis-NIR-SWIR (UVNS) Imaging Spectrometer

- Built under the responsibility of ESA
  - Instruments and L1b prototype processor by a consortium led by ADS
  - L2 prototype processor by a consortium led by S[&]T
- Will be operated by EUMETSAT
- Low Earth Orbit ~9h30 local solar time
- Three S5/UVNS in sequence → mission lifetime 21 years
- Embarked on MetOp Second Generation A1, A3 and A3 satellites
- Synergy with MetImage, IASI-NG, and 3MI on MetOp-SG-A
- Proto-Flight Model integration and testing
- L1 and L2 processor implementation
- On-ground calibration & characterization planning
- Launch expected 2023



Copernicus Sentinel-4/-5 Level-2 Processing



Copernicus Sentinel-4 and -5 Level-2 Products

Species	Relevance				Observed by	
	Air quality	Climate	Ozone/UV	Varia	S4	S5/5P
O_3	Toxic, irritates lung and soft tissue, regulated*	Greenhouse gas	Surface UV, stratosphere	Oxidising capacity of atmosphere, damages plants	Total & troposph.	Total & profile
NO_2	Toxic, nitrate aerosol, regulated*	Nitrate aerosol	O_3 production	Acid rain	X	X
SO_2	Toxic, sulphate aerosol, regulated*	Sulphate aerosol		Acid rain, tracer for volcanic emissions	X	Total & layer height
HCHO	O_3 and CO production	Tracer for VOC emissions	O_3 production	Understanding VOC oxidation	X	X
CHOCHO	O_3 and CO production	Tracer for non-methane VOC emissions	O_3 production	Understanding VOC oxidation	X	X/TBC
Aerosol	Pulmonary & cardiovascular diseases, regulated*	Direct and indirect effect		Aviation control (volcanic ash), cloud formation	Layer height, index, AOD	Layer height, index, AOD
CH_4	O_3 production	Greenhouse gas	O_3 production	Source stratospheric H_2O		X
CO	Toxic, regulated*, O_3 production	CO_2 precursor	O_3 production	Tracer for long-range transport of pollutants		X
Cloud				Auxiliary for other products	X	X
Surface				Auxiliary for other products	Hourly BRDF daily generated	LER climatology
Surface UV			Erythemal & vitamin-D dose			Downwelling irradiance and dose rates

*) by European Standards: http://ec.europa.eu/environment/air/quality/standards.htm

Sentinel-4 Level-2 Performances

	goal / threshold	SZA<60°, VZA<60°, cloud fraction < 0.2, unless specified otherwise
O_3 total column	3% / 4%	All cloud conditions
O_3 troposphere	25% / 40%	
NO_2 troposphere	1.5×10^{15} molec/cm² or 30% / 50%	
SO_2	3×10^{16} molec/cm² or 60% / 100%	Pollution cases
HCHO	1×10^{16} molec/cm² or 50% / 100%	
CHOCHO	1.5×10^{15} molec/cm² (random) 2.5×10^{14} molec/cm² or 50% (systematic)	$>5 \times 10^{14}$ molec/cm²
Aerosol Optical Depth	0.05 or 15%	Cloud free
Aerosol Layer Height	1 km	>1.5 km, cloud free, $AOD_{760}>0.3$
UV Aerosol Index	0.3 / 0.5	All cloud conditions
Surface	first BRF parameter k: 0.02 (k≤0.03) 0.01 or 5% (k>0.03)	cloud-free, homogeneous

Sentinel-5 Level-2 Performances

	goal / threshold, (stability/decade)	SZA<80°, VZA<66°, unless specified otherwise
O_3 total column	3%, (1%)	all cloud conditions
O_3 profile	Surface-300 hPa: 8% / 16%, (3%) 300- 50 hPa: 8% / 16%, (3%) 50-0.1hPa: 4% / 8%, (2%)	SZA<65°, effective cloud fractions < 0.1 for troposphere
NO_2 troposphere	1.3 × 10^{15} molec/cm² or 20%, (2.6 × 10^{14} molec/cm² or 4%)	SZA<77°, cloud radiance fraction < 0.5
SO_2	3 / 6 × 10^{16} molec/cm² or 50%, (2.6 × 10^{14} molec/cm² or 6%)	SZA<77°, cloud radiance fraction < 0.5
SO_2 Layer Height	1 / 2 km	SO_2>25 DU, cloud radiance fraction < 0.5
HCHO	1.2 × 10^{16} molec/cm² (rand.), 5 × 10^{15} molecules.cm^{-2} or 50% (sys.), (2.6 × 10^{14} molec/cm² or 6%)	SZA<70°, effective cloud fraction < 0.3
CHOCHO	1.5 × 10^{15} molec/cm² (rand.), 2.5 × 10^{14} molec/cm² or 50% (sys.), (2.6 × 10^{14} molec/cm² or 6%)	SZA<70°, effective cloud fraction < 0.3
Aerosol Optical Depth	340-390 nm: 0.05/0.1 or 10%/25%, (0.016 or 2%) 390-500 nm: 0.02/0.1 or 10%/25%, (0.01 or 2%) 760 nm: 0.05/0.1 or 10%/25%, (0.01 or 2%)	cloud free
Aerosol Layer Height	0.5 / 1 km, (0.2 km)	AOD>0.5 (land), AOD>0.1 (ocean), cloud-free,
UV Aerosol Index	0.25, (0.05)	all cloud conditions
CH_4	10 / 18 ppbv or 0.5% / 1%, (0.25%)	SZA<70°, Clear sky
CO	4×10^{17} molec/cm² or 5%, (8×10^{16} molec/cm²)	SZA<70°, excluding high and optically thick cloud

Copernicus Sentinel-4 and Sentinel-5 Data

- **Free, full, and open access**
  - Copernicus Sentinel Data Policy & EU Regulations
- Processed up to L2 in EUMETSAT's MTG and EPS-SG ground segments
- Dissemination of L2 products in NRT via **EumetCast**
- Access to L1b and L2 via **EUMETSAT Data Centre**
  - L1b and L2 via rolling archive (limited time horizon and bandwidth)
  - L1b and L2 via archive
- Cloud-based access to data and processing tools
  - **DIAS**: Copernicus Data and Information Access Services, funded by EC
  - Enable users to build applications and process large datasets easily
- Copernicus Services benefitting from the atmospheric Sentinels
  - **CAMS**: Copernicus Atmosphere Monitoring Service
  - **C3S**: Copernicus Climate Change Service