The Copernicus Sentinel-5 Mission: Daily Global Data for Air Quality, Climate and Stratospheric Ozone Applications

Yasjka Meijer
RHEA for ESA, Noordwijk, NL
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Co-Authors: Jörg Langen, Paul Ingmann, Didier Martin, Ben Veihelmann
ESA-ESTEC, Noordwijk, The Netherlands

Overview

- Background of Atmospheric Sentinel missions
- Sentinel-5 mission overview
- Sentinel-5 status
- Sentinel-5 product list
- Expectations

Background: Copernicus
The European contribution to GEOSS

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 – Earth Obs. missions developed specifically for Copernicus

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

Copernicus Atmosphere Monitoring Service

- Operational information services for policy makers, …, citizens
- Protocol compliance monitoring: ozone layer (Montreal, …), air quality (Göteborg, …), climate (Kyoto, …), emission verification
- Near-real-time services: Local air quality, health warning, aviation routing
- Assessments: Improve understanding of processes, validate chemical transport models, ground measurement networks
- Operational: CAMS, see **http://atmosphere.copernicus.eu**
- Uses observations from current satellites & in the future from **Sentinels**

Atmosphere Monitoring Service

Copernicus

Sentinel-5 in the Copernicus Programme

Initiative led by the European Commission (EC) in partnership with the European Space Agency (ESA)

Sentinel-1: Radar Imaging Mission for land and ocean services

Sentinel-2: High resolution wide swath Optical Mission for land

Sentinel-3: Medium Resolution Optical Imaging and Altimetry Mission

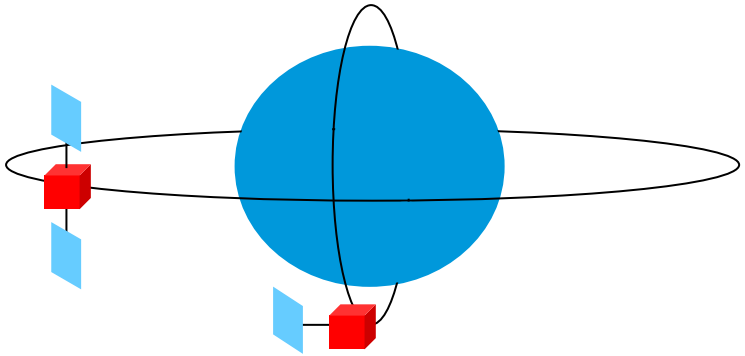
Sentinel-4: Geostationary Atmospheric Chemistry Mission

Sentinel-5p: Low Earth Orbit Atmospheric Chemistry Precursor Mission

Sentinel-5: Low Earth Orbit Atmospheric Chemistry Mission

Sentinel-6, Jason-CS: Altimetry Mission

Identified Elements: LEO + GEO



GEOstationary (GEO)

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

→ Sentinel-4 (S4)

Low Earth Orbit (LEO)

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

→ Sentinel-5 Precursor (S5p)

→ Sentinel-5 (S5)

Identified (Mission) Elements: Implementation of S-5p/-4/-5

- **Sentinel-5p** will consist of
  - a UVNS spectrometer embarked on a *dedicated platform* with utilisation of Suomi-NPP/JPSS imager data.

- **Sentinel-4** will be a realised as
  - an addition of a UVN spectrometer on the MTG-S platforms;
  - will utilise TIR data from the IR sounder onboard the same platform; and
  - will utilise imager data from the MTG-I platforms.

- **Sentinel-5** will consist of
  - a UVNS spectrometer to be embarked on the MetOp-SG platforms;
  - will utilise the IR sounder (IASI-NG), the imager (VII) and the 3MI imager all onboard the same platform

UVN = Ultraviolet + Visible + Near infrared
UVNS = UVN + Short wave infrared

Sentinel-5 on MetOp-SG

MetOp-SG

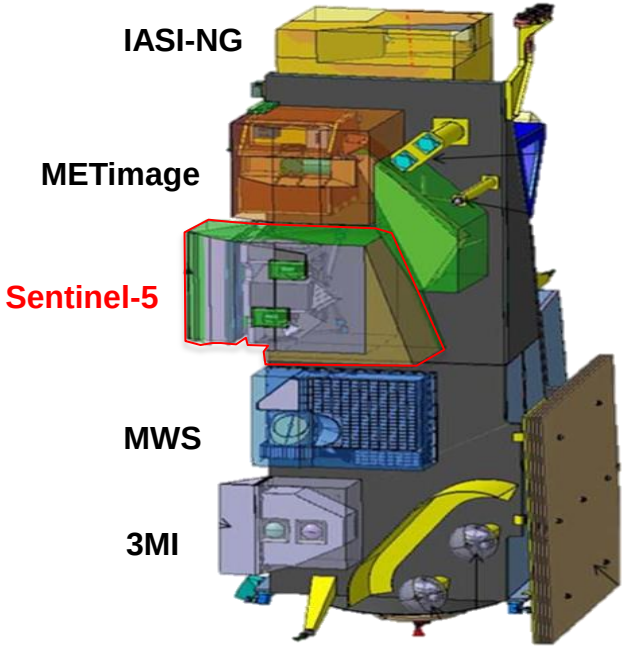
- 2 series of Satellites (A&B)
- 3 Satellites per series

Payload Complement:

- 10 different Instruments

Sentinel-5	270 kg 300 W 20 Mbit/s 1.1x1.0x1.0 m^3

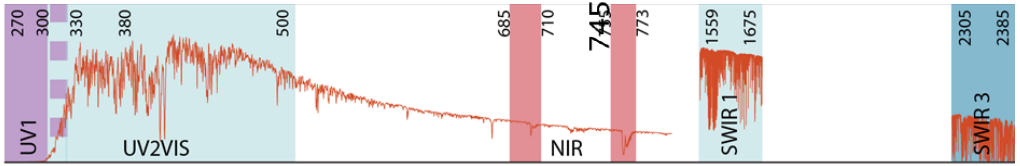
MetOp-SG Satellite A

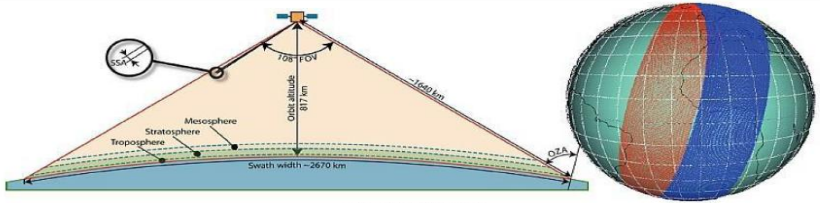


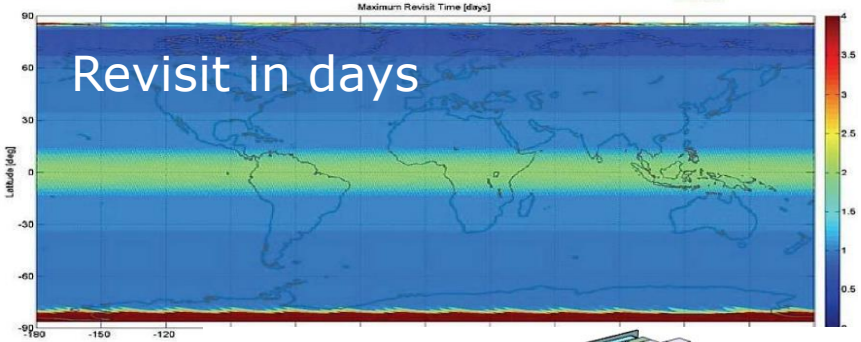
Satellite A	
IASI-NG	CNES via EUMETSAT
METimage	DLR via EUMETSAT
Sentinel-5	**ESA - Copernicus**
MWS	ESA – MetOp-SG
3MI	ESA – MetOp-SG
RO	ESA – MetOp-SG

Satellite B	
Argos-4	CNES via EUMETSAT
MWI	ESA – MetOp-SG
ICI	ESA – MetOp-SG
SCA	ESA – MetOp-SG
RO	ESA – MetOp-SG

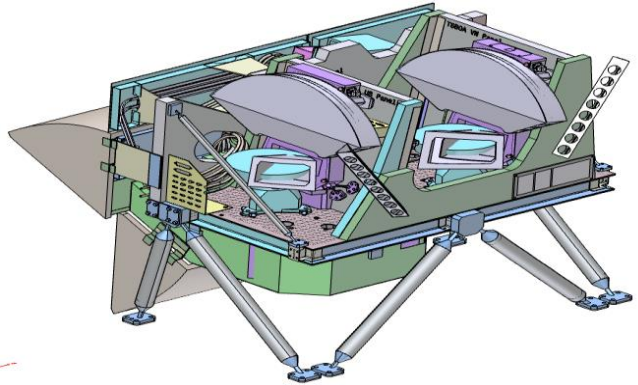
Sentinel-5 UVNS instrument



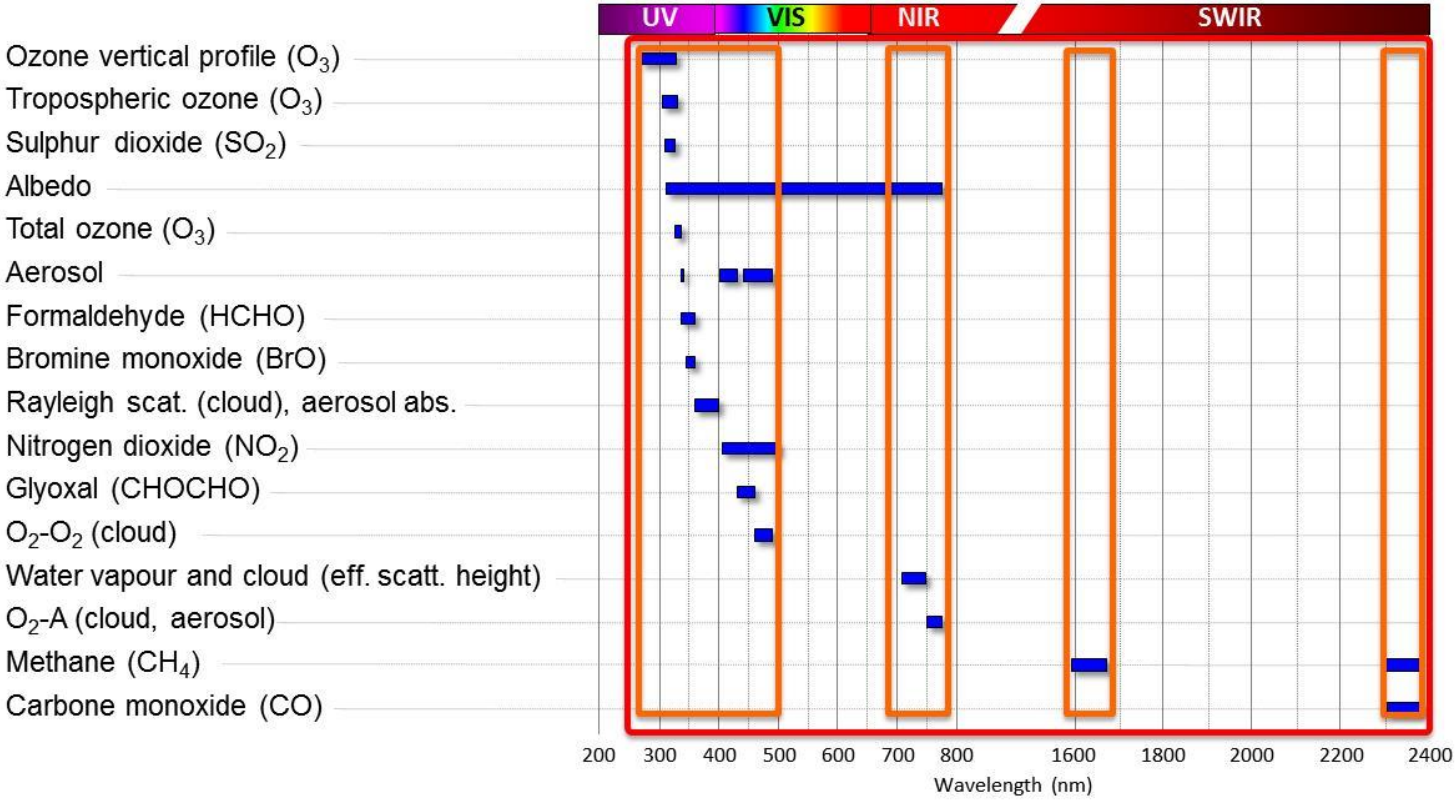




1. Daily global coverage
2. Spectral resolution: 1.0 nm UV1, 0.5 nm UV2VIS, 0.4 nm NIR and 0.25 nm SWIR
3. Spatial resolution 7.5 x 7.5 km^2 nadir
4. Pushbroom imaging spectrometer
5. High SNR (e.g., >1500 in VIS)



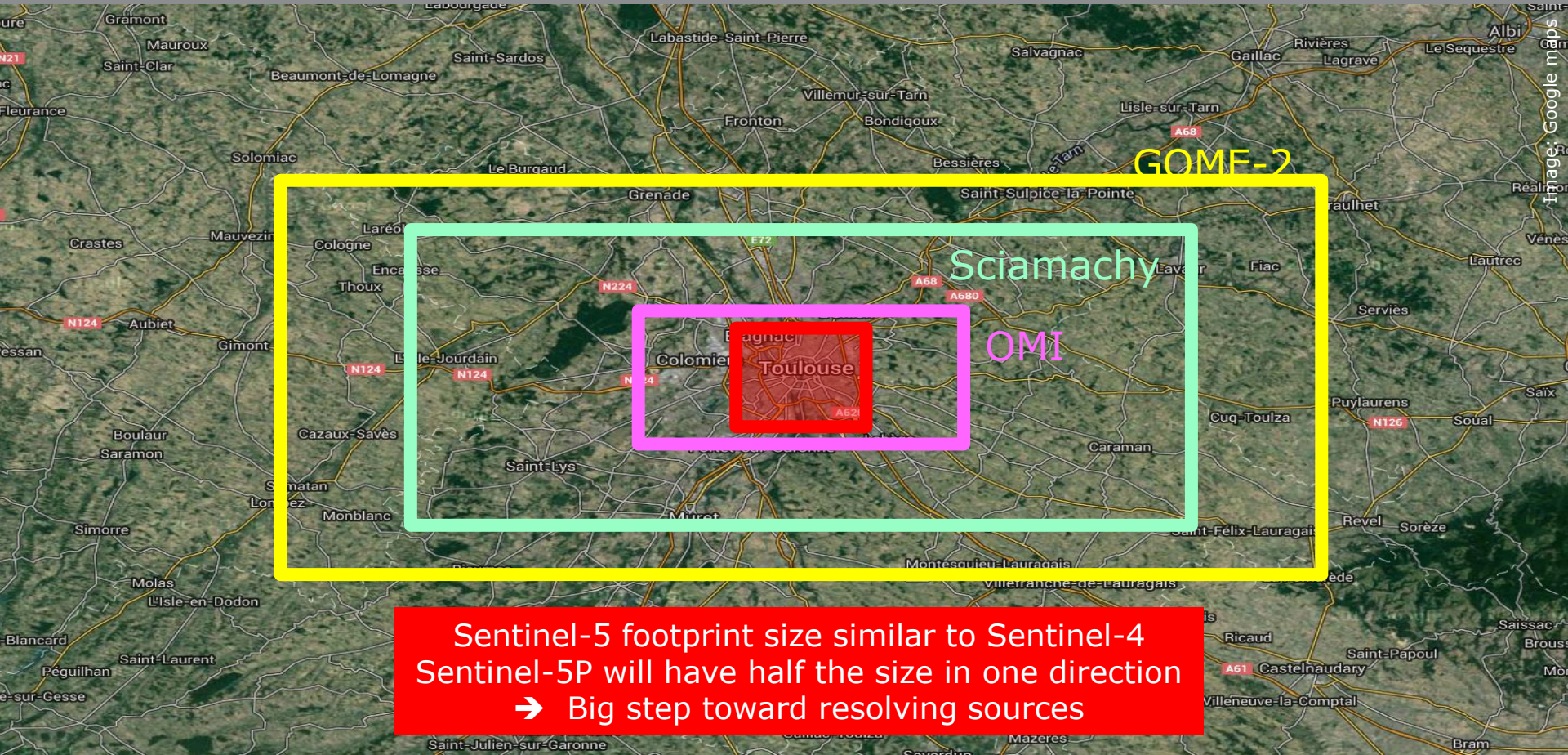
UVNS Level-2 Products 1/2



UVNS Level-2 Products 2/2

Product	Application			Comment
	Air Quality	Climate	Stratospheric Ozone and Solar Radiation	
O_3 total column	X		X	
O_3 stratospheric profile & trop. Column	X		X	**Synergy with IASI-NG**
NO_2 total & trop. Column	X			
SO_2 total column & (TBC) plume height	X			**Synergy with IASI-NG** Also for volcanic eruptions
CHOCHO total column	X			
CH_2O total column	X			
CO total column	X	X		**Synergy with IASI-NG**
CH_4 total column		X		**Synergy with IASI-NG**
Aerosol layer height, AOD at 4 wavelengths (TBC), index	X	X		Also auxiliary for other S5 products Also for volcanic eruptions **Synergy with VII and 3MI**
Cloud fraction, altitude			X	Mainly auxiliary for other S5 products **Synergy with VII and 3MI**
UV irradiance at surface, index			X	

Spatial sampling: Footprint size



Sentinel-5 footprint size similar to Sentinel-4
Sentinel-5P will have half the size in one direction
➔ Big step toward resolving sources

Sentinel-5 Implementation Status

1. UVNS instrument & Level-1b Prototype Processor developed by ESA with Airbus Defence & Space as prime
    a. Preliminary Design Review completed in December 2015
    b. Critical Design Review mid 2017
    c. Flight Acceptance Review early 2021
2. Level-1 **Operational** Processor developed by **EUMETSAT** kick-off in 2017
3. Level-2 **Prototype** Processor developed by ESA, kick-off mid 2016
4. Level-2 **Operational** Processor developed by **EUMETSAT** kick-off in 2018
5. EUMETSAT will operate the instruments and process the mission data up to Level-2

SENTINEL-5

EUMETSAT

Summary:
Sentinel S-5p/-4/-5 Implementation

	UV, VIS, NIR, SWIR			TIR	
Orbit	LEO		GEO	LEO	GEO
Temporal sampling	daily		hourly	daily	hourly
Instrument	TROPOMI	UVNS	UVN	**IASI-NG**	IRS
(Host) Satellite	S5P	MetOp/ EPS-SG	MTG-S	MetOp/ EPS-SG	MTG-S
Synergy	VIIRS[+OMPS+ CRIS]/NPP,/JPSS	VII, 3MI	FCI, LI/MTG-I	VII	FCI /MTG-I

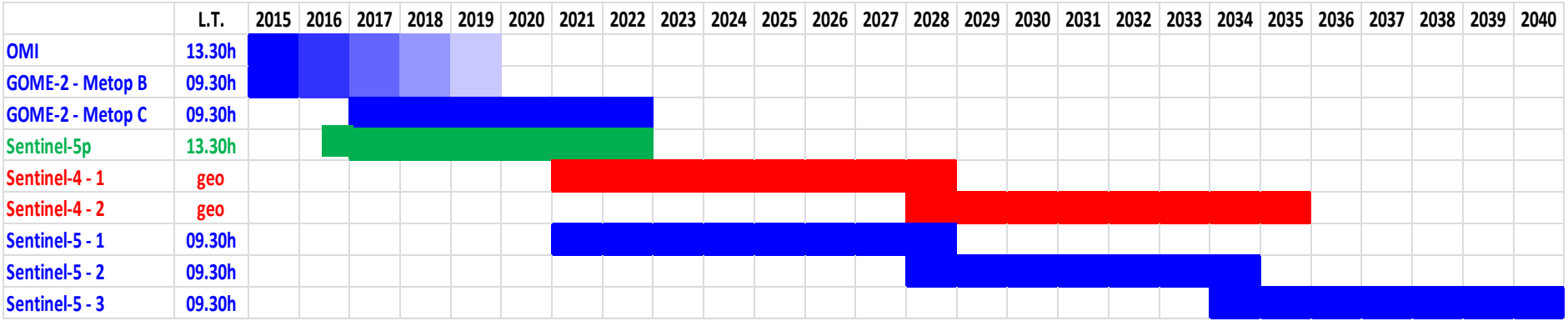
Sentinel-5p

Sentinel-4

Sentinel-5

In conclusion; a continuous data set

Launch Schedule of Atmospheric Sentinels



- GOME-2 (9.30h) and Sentinel-5 Precursor (13.30h) provide partial diurnal information, before geostationary missions takes over with hourly revisit over Europe
- Europe's long-term contribution to operational nadir-viewing atmospheric composition sounding
- Guaranteed provision of long-term datasets in synergy with meteorological payloads is based on identical instruments → continuity until 2035/40

Any questions?