

→ ATMOS 2015

Advances in Atmospheric Science and Applications

Sentinel-5 Precursor: Exploitation of the first Copernicus Atmospheric Mission



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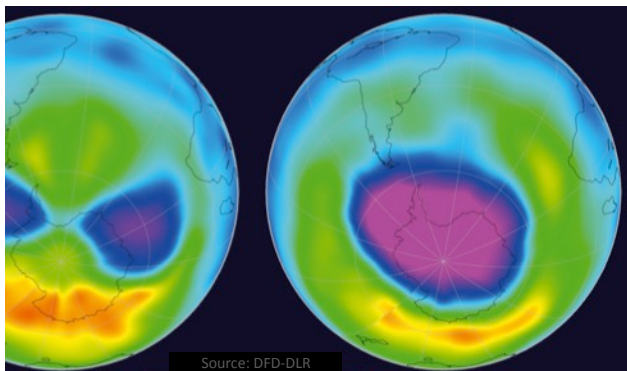
S5P Copernicus Themes



Stratospheric Ozone and
Surface UV Radiation

Air Quality

Climate Change











Support the Copernicus Atmospheric Core and Downstream services

- Current Sentinel-5 Precursor Data Access Solutions
 - Copernicus Services
 - Privileged Access to the Level 2 NRT
 - CSCDA interface implemented in the PDGS
 - Science/other Users
 - Rolling Access to Latest Data via Sentinel Data Hub
 - Already operational for Sentinel-1
 - Soon for Sentinel-2
 - S5P: Level 2 NRT and Off-line, Level 1b Off-Line
 - Open and free to any user via self registration



Level 2 Products



Parameter	Data Product	Vertical Resolution	Accuracy	Precision
Ozone	 Ozone Profile	6 km	10-30%	10%
	Total Ozone	total column	3.5-5%	1.6-2.5%
	Tropospheric Ozone (offline)	trop column		
NO ₂	 Stratospheric NO ₂	strat column	<10%	0.5e15
	Tropospheric NO ₂	trop column	25-50%	0.7e15
SO ₂	 SO ₂ enhanced	total column	30%	0.15-0.3 (0.06-0.12) DU
	Total SO ₂	total column	30-50%	1-3 (0.4-1.2) DU
Formaldehyde	 Total HCHO	total column	40-80%	1.2e16 (4e15)
CO	 Total CO	total column	15%	<10%
Methane	 Total CH ₄ (offline)	total column	1.5%	1%
Cloud	 Cloud Fraction	total column	<20%	0.05
	Albedo (Optical Thickness)	total column	<20%	0.05 (10)
	Cloud Height (Pressure)	total column	<20%	<0.5 km (<30hPa)
	SNPP VIIRS Cloud data			
Aerosol	 Aerosol Layer Height	total column	<100hPa	<50hPa
	Aerosol Type	total column	~1 AAI	<0.1 AAI

Source: S5P Level 2 Working Group

All ATBDs (L1 and L2) will be made available to the science community



Sentinel(-1) Scientific Data Hub



Sentinel-1 Scientific Data Hub



Welcome to the Sentinel-1 Scientific/Other use Data Hub

The [Sentinel-1](#) Scientific Data Hub provides free and open access to a Rolling Archive of Sentinel-1 [Level-0](#) and [Level-1](#) user products. Products are available for the following Sentinel-1 [acquisition modes](#):

- [Strip Map \(SM\)](#)
- [Interferometric Wide Swath \(IW\)](#)
- [Extra Wide Swath \(EW\)](#)

Level-0 products and Level-1 Ground Range Detected (GRD) products are available for all performed acquisitions. Level-1 Single Look Complex (SLC) products are available for acquisitions performed over specific regions of interest.

The S-1 Scientific Data Hub Rolling Archive maintains the latest 2 months of products for download via HTTP. During the initial operations period the complete data production, commencing from the in-orbit commissioning review (3rd of October 2014) is available online.

A maximum of 2 concurrent downloads per user is allowed in order to ensure a download capacity for all users.

The Sentinel-1 Level-1 products are preliminary qualified. Operational product qualification, including absolute radiometric calibration, will continue during the next period.

<https://scihub.esa.int>



Enter the HUB



User Guide



Roadmap

Data Distribution

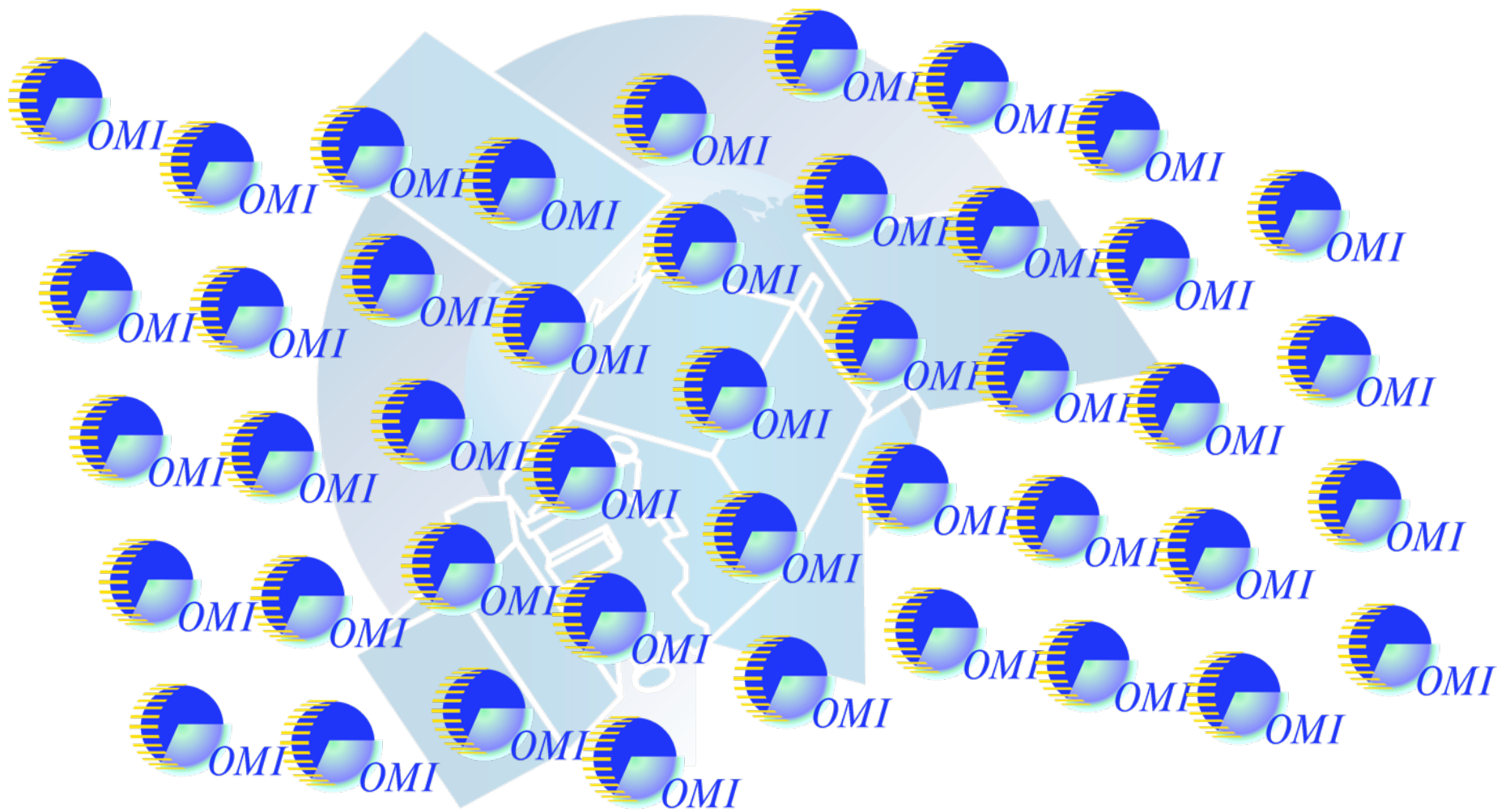


- Data Organisation
 - Level 1b radiance is provided as separate files for each of the 8 bands
 - UV-UVIS-NIR and SWIR solar irradiance product
 - Each geophysical Level 2 parameter is provided in a dedicated product
 - Data format is netCDF-4 using Climate and Forecasting Metadata Standards (see also M. Sneep, Poster#53, for Level 2 Format)
 - Harmonisation with GOME and SCIAMACHY products formats ongoing
 - Target to harmonise with Sentinel-4 and Sentinel-5

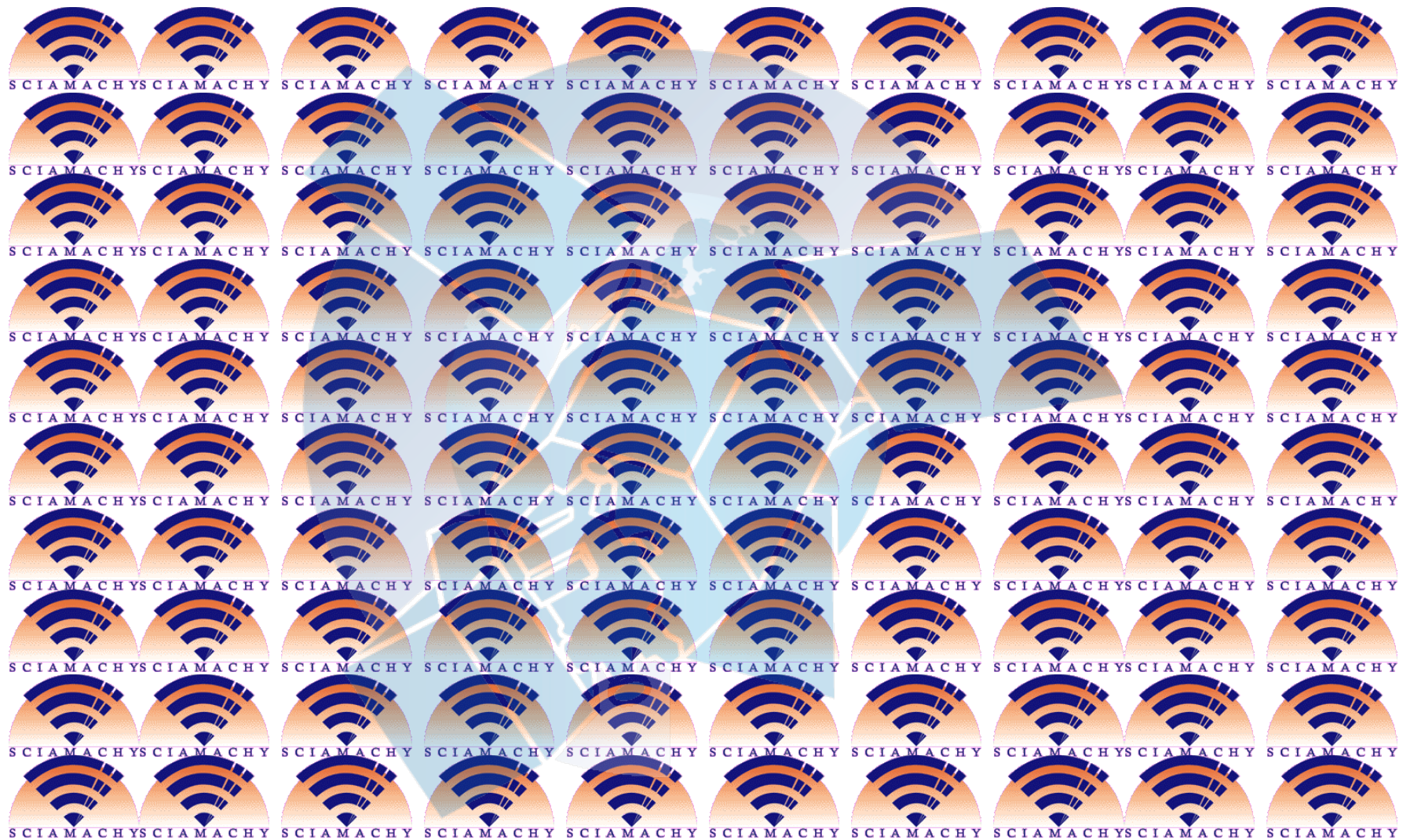
- Data Volume:

Product type	GB per Orbit	GB per day
Level 2 NRT	4.27	60.6
Level 1b Radiance OFL	35.6	504
Level 1b Irradiances OFL	0.03	0.42
Level 2 OFL	5.24	74.3
Total	45.1	639

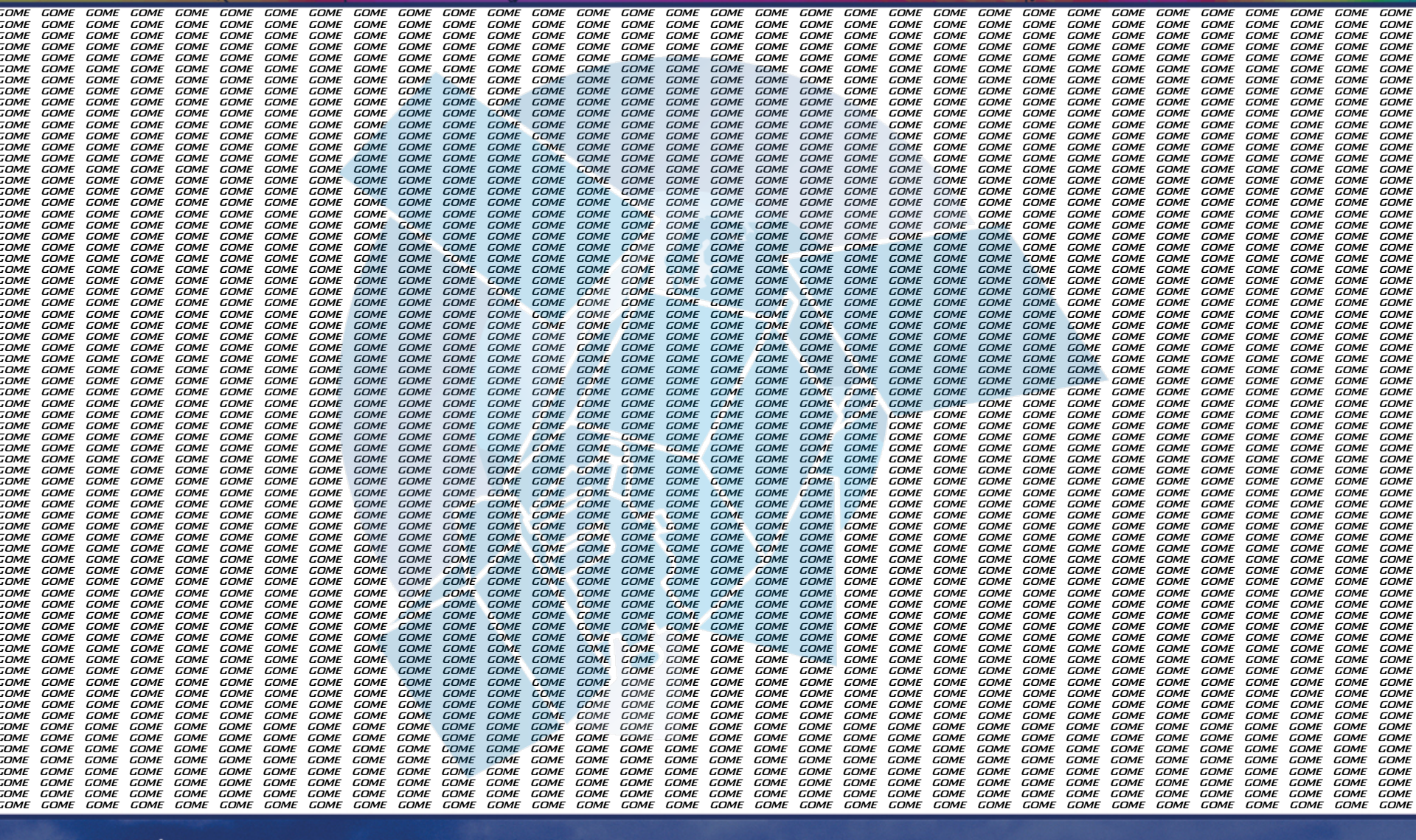
S5P ~ 44 x OMI



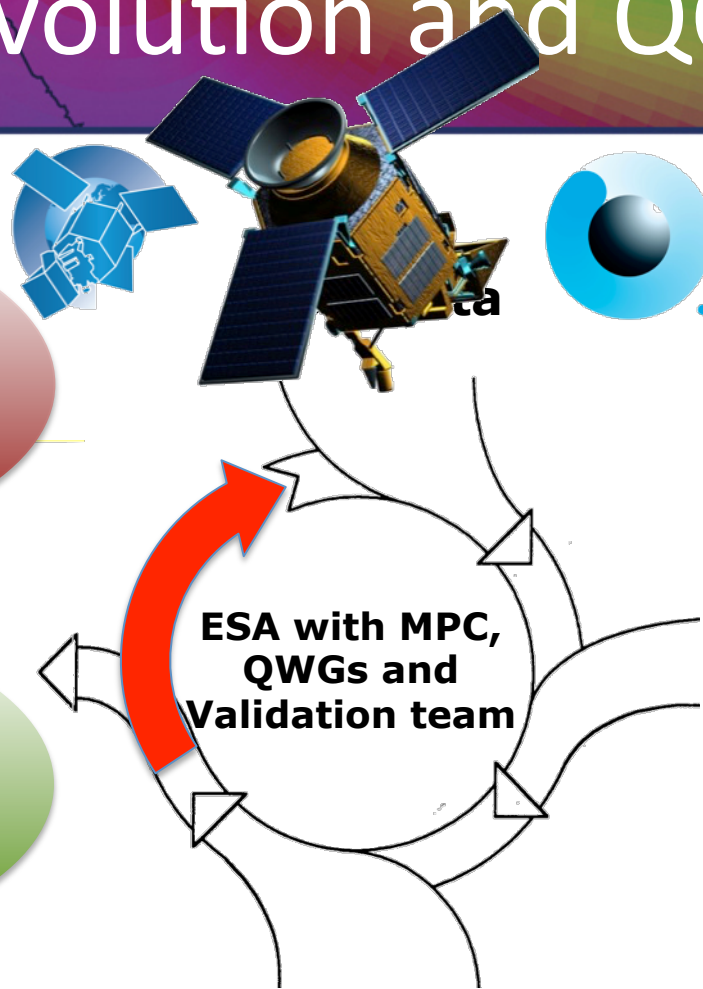
S5P ~ 100 x SCIAMACHY



S5P ~ 2916 x GOME



Product Evolution and QC



Mission Feedback

- Science community input
- Comparison with independent products
- Evolution of protocols (QA4EO)

Improved Products

- Reprocessing resulting from improved calibration and algorithms
- Interface to collaborative algorithms

Calibration Strategy

- Pre-launch (Phase A-D)
- Satellite Commissioning (Phase E1)
- Operations (Phase E2)
- Post-Operations (Phase F)

Reference Measurements

- Collection of data against well-defined requirements
- Inter-calibration of in-situ systems
- Data collection following community accepted protocols (QA4EO)
- Maintenance of Cal/Val information and data portals

ESA with MPC,
QWGs and
Validation team

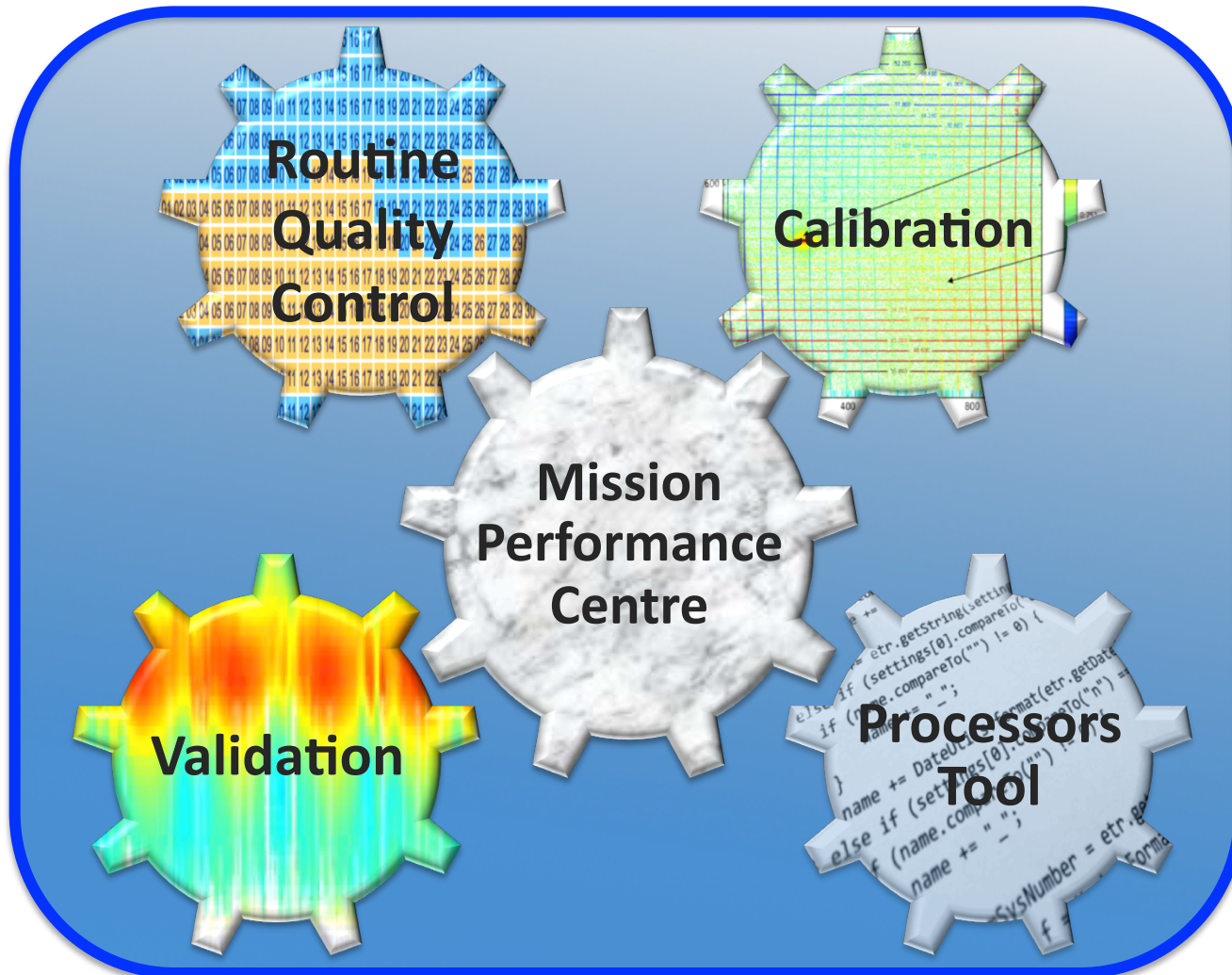
Product Validation

- Algorithm development and Validation
- Operational QC on products
- Match-up, long-loop evaluation, Sat-Sat

Tools

- Diagnostic data-sets (DDS)
- Cal/Val tools
- Algorithm breadboards
- Radiative Transfer Models

In cooperation with Dutch TROPOMI team and national partners



- Part of the the S5P Ground Segment
- Implemented by ESA as a Service Contract
- ITT to be released “before summer”

Validation Preparation



- Sentinel-5 Precursor Validation Team
 - complementary to the MPC (not funded by ESA Copernicus)
 - AOCall issued in September 2014
 - Validation using satellite, airborne or ground-based experiments providing independent measurements
 - Experiments to assess accuracy, resolution and stability of the TROPOMI
 - Assessment and validation of the S5P retrieval, processing and geophysical products

- Announcements of Opportunity

[Swarm SO](#) | [S3VT](#) | [G-POD](#) | [Previous AOs](#)

Welcome to the submission area for the Sentinel-5 Precursor Validation Team call.



Within the framework of its Copernicus missions, ESA is pleased to announce the Sentinel-5 Precursor Calibration and Validation Team Call (S5PVT) that aims to engage leading expertise for the Calibration and Validation of the Sentinel-5 Precursor (S5P) in the mission validation team, providing independent experimental data, analysis and recommendations to critically assess the end-to-end performance of the instrument and its products. The main payload of S5P is TROPOMI (TROPOspheric Monitoring Instrument), a push broom imaging spectrometer realized by ESA in collaboration with the [Netherlands Space Office \(NSO\)](#). S5P is expected to provide information on atmospheric variables in support of European policies and Copernicus services. It is planned to be launched in early 2016 and will provide over 7 years data to the user community.

- [Invitation Letter](#)
- [Sentinel-5P Validation Call main text](#)
- [Mission Requirements Traceability Document](#)
- [Sentinel-5P Commissioning & CalVal Plan](#)
- [Requirements for the Geophysical Validation of Sentinel-5P Products](#)
- [Sentinel-5 Precursor System Requirement Document](#)

- [ESA Copernicus website: Sentinel-5P](#)
- [European Commission Copernicus site](#)
- [Copernicus: Sentinel-5P on the eoPortal](#)
- [Free and Open Data Policy for Copernicus](#)

- [Scientific quality requirements document for the TROPOMI L01b data processor](#)
- [Algorithm theoretical basis document for the TROPOMI L01b data processor](#)
- [Input/output data specification for the TROPOMI L01b data processor](#)
- [Sentinel 5-precursor/TROPOMI KNMI and SRON level 2 Input Output Data Definition](#)
- [Sentinel 5-precursor Level 2 UPAS Processor](#)

- [Proposal submission form](#)
- [Guidelines for submission of proposals](#)

Proposal submission deadline was 10 October 2014.

Should you need more information about the Sentinel-5P Validation Team Call, you can contact the [Sentinel-5P Mission team](#).

Other information can be found on the [ESA Sentinel-5P Website](#) and the [ESA Earth Observation Pages](#)



<https://earth.esa.int/aos/S5PVT>

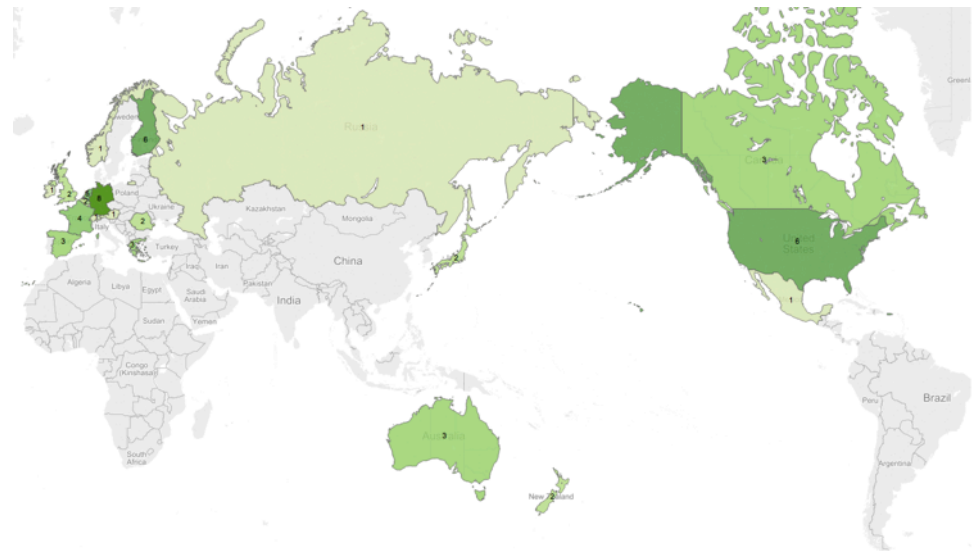
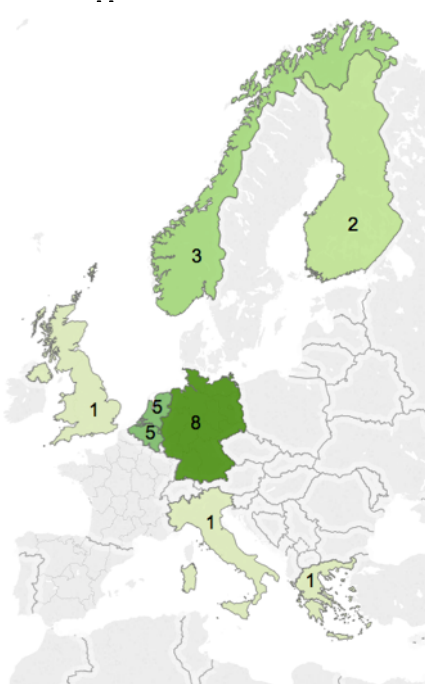
Proposals by Country



- 37 proposals received in total covering all products

PIs by Country

Co-PIs



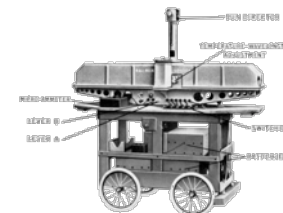
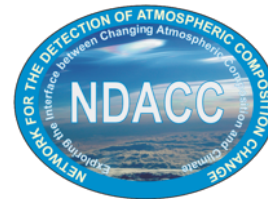
Proposed Systems (selection)



Satellite Systems

Networks

Ground-based Reference



In addition a number of campaigns have been part of the proposals.

S5PVT Call Conclusions



- Summary
 - A comprehensive set of projects have been proposed
 - All target products are addressed by the in the frame of the AO
 - Pis and Co-Pis covering Western Europe, USA and beyond
 - Excellent use of satellite data
 - Basically all standard ground based reference systems are proposed
 - Instrument networks and cooperation are well covered
 - A number of (non-ESA led) campaigns are proposed
- Some remaining issues
 - Still gaps for Air Quality measurements
 - Measurements in important hot spots potentially missing, S-E Asia, Biomass Burning, Megacities
 - Some proposed campaigns too early
- Validation teams interested to join the established S5PVT are invited to contact ESA

S5PVT Workshop



Sentinel-5 Precursor Validation Team Workshop

ESTEC, The Netherlands

29 September – 01 October 2015

Targets:

- Consolidation of information required for Cal/Val plan
- Gap analysis
- Fiducial Reference Measurements Concept
- Coordination between S5PVT Partners

<http://congrexprojects.com/2015-events/15m16/>

esa sentinel-5 precursor validation team (S5PVT) workshop
29 september - 1 oktober 2015
European Space Agency
List of events

Introduction
Objectives
Themes and Format
Abstract Submission
Author Instructions
Registration
Committee
Calendar of Events
Venue
Contact

Sentinel-5 Precursor Validation Team (S5PVT) Workshop
ESA-ESTEC, Noordwijk, NL
29 September until 01 October 2015

Preparation Campaigns



- Several airborne campaign opportunities have been identified in the Validation Call
- Preparatory and Cal/Val campaigns
 - AROMAT Campaign summer 2014, Romania
 - AROMAT-II Campaign summer 2015, Romania
 - [TBC] Ground based intercalibration campaign (“CINDI”-like), 2016, The Netherlands
- [TBC] Sentinel-5 Precursor Validation Campaign, 2017, Romania



Source: AROMAT Team

S5p-SNPP Formation Flight



Visible/Infrared Imager Radiometer with 22 bands

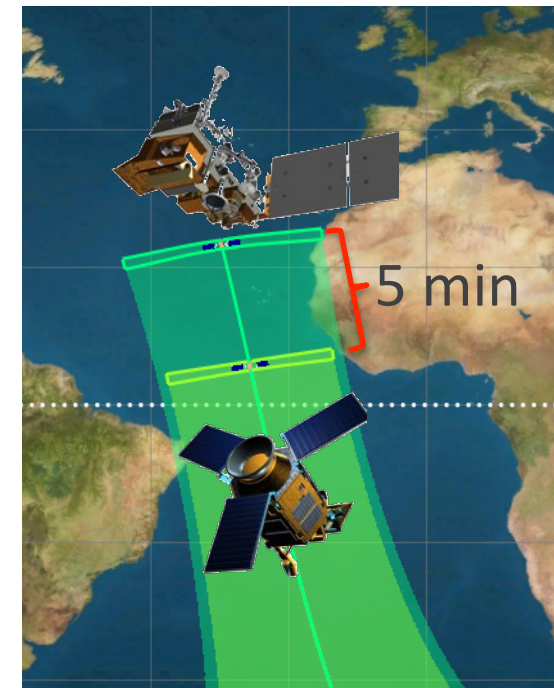
Cross-track Infrared Sounder (CrIS) using a Fourier transform spectrometer with 1305 spectral channels

Microwave Sounder using a cross-track scanner with 22 channels (profiles of atmospheric temperature and moisture)

Three-channel radiometer measuring both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the surface

Back-scattered UltraViolet (BUV) radiation sensors

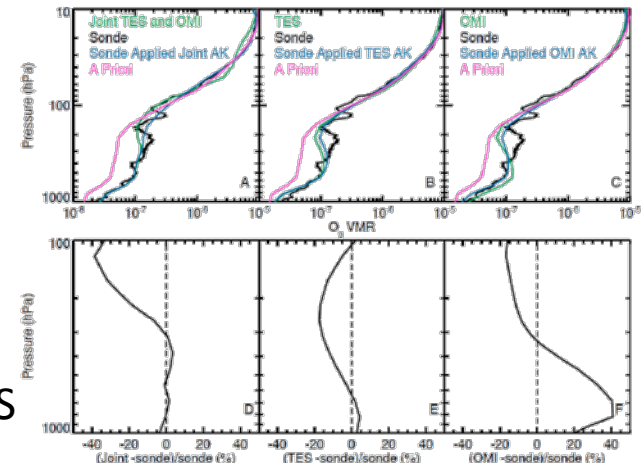
<http://npp.gsfc.nasa.gov/suomi.htm>



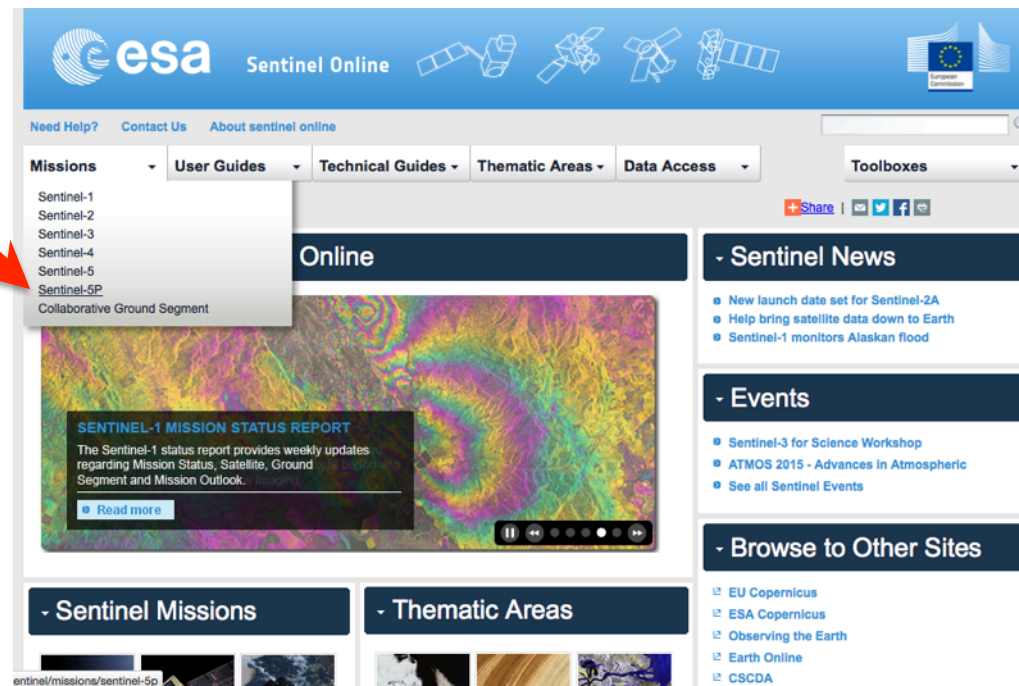
S5P-SNPP Synergy



- Main synergy application: Cloud screening of S5P using the VIIRS cloud information
 - S5P NPP Cloud Product based on the VIIRS Cloud Mask, Channels M7 (0.865 μ m), M9 (1.378 μ m) and M11 (2.25 μ m)
 - Improvement of S5P methane and other product
- Potential for synergistic research:
 - Combined analysis of co-located (time/space) S5P-SNPP observations
- Potential for inter-calibration
 - TROPOMI-OMPS /-VIIRS
- Potential for synergistic products
 - Combined retrieval for higher level products
 - Examples:
 - D. Fu et al., 2013, OMI/TES, Poster#73
 - J. Cuesta et al., 2013: GOME-2/IASI
 - Martin de Graaf, ATMOS2015, OMI/MODIS
 - Options: TROPOMI-CRIS, -VIIRS, -OMPS



- Sentinel-5 Precursor on the “Sentinel Online”
 - Mission Guide
 - User Guide
 - Technical Guide
 - <https://sentinel.esa.int/>



- TROPOMI: 
<http://www.tropomi.eu>

- Copernicus: 
<http://www.copernicus.eu/>

Thank you for your
attention!

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