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SEEDS - Sentinel EO-based Emission and Deposition Service

SEEDS
Sentinel EO-based Emission and Deposition Service

Final SEEDS General Assembly

5th and 6th December 2023

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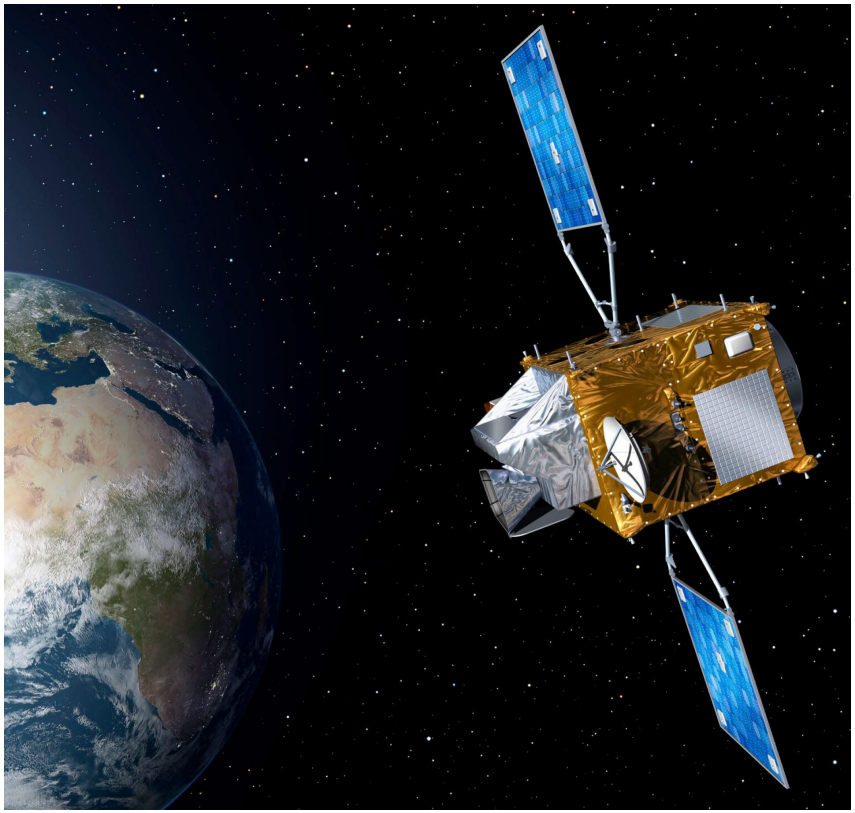
SEEDS

Sentinel EO-based Emission and Deposition Service

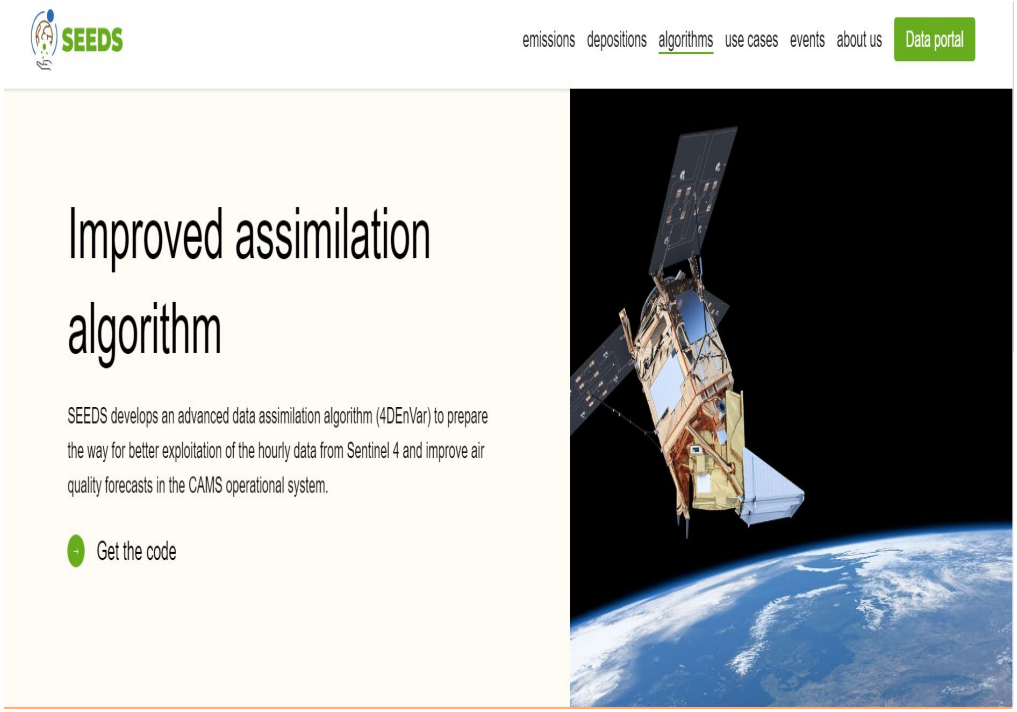


Sentinel 5P & Preparation for Sentinel 4

- The SEEDS project goal is to develop several top-down (satellite) inversion techniques to estimate European emissions of NOx, NH3, VOC, improve deposition flux modelling and develop advanced data assimilation techniques.
- The project is developing techniques that may eventually become part of the Copernicus Atmosphere Service (CAMS).
- SEEDS is now reaching its end and we have compiled a significant number of datasets in our portal for further evaluation.

SEEDS – New Products

Advanced data assimilation algorithm



SEEDS develops an advanced data assimilation algorithm (4DEnVar) to prepare the way for better exploitation of the hourly data from Sentinel 4 and improve air quality forecasts in the CAMS operational system

- **Open-source code** with the 4DEnVAr algorithm for use by a wide range of researchers and scientific experts.

SEEDS – H2020 project

Sentinel EO-based Emission and Deposition Service

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What makes TROPOMI unique?

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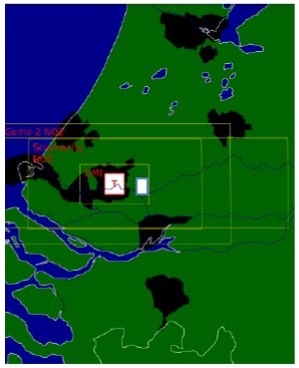
TROPOMI combines 4 unique features:

Large spectra range
(large # of trace gas species)
High signal-to-noise

High spatial resolution
(3.5 x 5.5 km)



Daily global coverage

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TROPOMI Operational Data products

Product	Application	
Ozone	Ozone layer monitoring, UV-index forecast, Climate monitoring	
NO_2	Air quality forecast and monitoring	SEEDS
CO	Air quality forecast and monitoring	
CH_2O	Air quality forecast and monitoring	SEEDS
CH_4	Climate monitoring	
SO_2	Air quality forecast and monitoring, Climate monitoring, Volcanic plume detection	
Aerosol	Air quality forecast and monitoring, Climate monitoring, Volcanic plume detection	
Clouds	Climate monitoring	
UV-Index	UV index forecast	

KNMI | DLR | BIRA-IASB | SRON | RAL |IUP-Bremen | MPIC | FMI | ESA

Development of supplementary products: SIF, AOD, CHOCHO, HONO, ALH

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SEEDS Surface Fluxes

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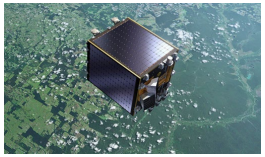
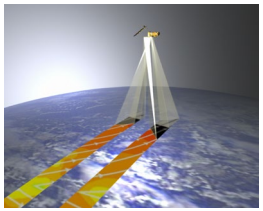
Satellite Observations

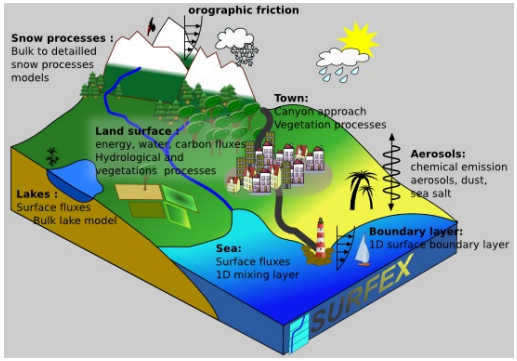
PROBA-V Leaf Area Index



Surface Soil Moisture



SURFEX LDAS-MONDE Data Assimilation



SURFEX dry deposition model

- Links to advanced vegetation model
- Uses assimilated LAI and soil moisture
- Dry deposition calculated for all surface types

- **Deposition velocities**
- **Dry deposition diagnostics**

- Land surface modelling (ISBA) and data assimilation to feed into calculation of dry deposition.
- LAI, soil moisture, and vegetation dynamics play key role in dry deposition modelling.

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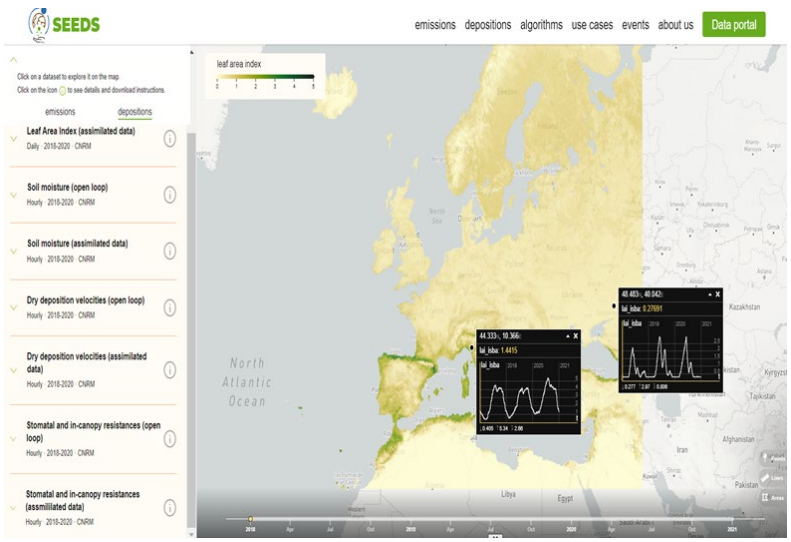
TD Emission products in SEEDS

Emission estimation method:	**Inversion technique using satellite observations and a chemical transport model:** DECSO (developed by KNMI) MAGRITTE (developed by BIRA-IASB)
Products:	**NO2 From TROPOMI** **NH3 emissions from CRIS** **CH2O from TROPOMI**

SEEDS – New Products



https://www.seedsproject.eu/data

SEEDS uses inverse modelling to produce up-to-date high-resolution estimates of NOx, NH_3 and biomass burning emissions.

- **NOx** – 2019,2020 -2022 Monthly anthropogenic NOx emissions at up to 5 km resolution
- **NH_3** – 2019, 2020 -2022 Monthly NH_3 emissions with 20 km resolution
- **Fires** – 2018-2020 -2022 Daily top-down biomass burning emissions at 10 km resolution
- **Soil NOx** – 2019, 2020 -2022 Agricultural soil NOx emissions at up to 5 km resolution
- **BVOC** – 2018-2020 -2022 Top-down and bottom-up estimates of Biogenic Organic Compounds with 10 km resolution
- **LAI** - 2018-2020 -2022 Leaf area index data sets at 10 km spatial resolution
- **Soil Moisture** – 2018- 2020 -2022 Soil moisture datasets at 10 km spatial resolution
- **Deposition** - 2018-2020, -2022 Deposition fluxes and diagnostics (e.g., stomatal resistance) for ozone and nitrogen at 10 km spatial resolution

SEEDS – Demonstration

Improved CAMS products

The added-value of the **SEEDS** emission and deposition products is demonstrated though their capabilities to improve the current **CAMS** operational type chain to prepare further production and use in downstream applications – MOCAGE model

The capabilities of

- SEEDS up-to date emission data
- SEEDS deposition and land surface data
- SEEDS 4DEnVar DA algorithm
- the combined SEEDS methods and data

to **improve current CAMS regional forecasting products** will be systematically evaluated in a part of the CAMS production chain

SEEDS – Demonstration

Stakeholder engagement

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Explore the possibilities

Agriculture and forestry

SEEDS products on soil moisture and leaf area index can support environmental management practices in precision agriculture while the SEEDS deposition products for ozone and nitrogen can inform control options for eutrophication and crop yield damage.

Urban planning

SEEDS products for urban planning include both anthropogenic and biogenic emissions products as well as improved air pollution forecast of NOx, ozone and PM that can support local administrations in cities develop sustainable zero-pollution city plans.

Industry

SEEDS anthropogenic emission products can be used by industry (metallurgy, cement, energy, oil and gas production sectors) as independent and scientifically sound data to validate monthly emissions from space.

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SEEDS – Final GA – Agenda – Day 1

Tuesday 5th December

(10:00-17:00)

Added value of SEEDS emission products

10:00 – 10:30	Introduction & algorithms
10:30 – 12:30	Block 1: Industrial emissions
12:30 – 13:30	*Lunch break*
13:30 - 14:10	Block 2: Emissions in cities
14:10 – 17:00	Block 3: Fire and Biogenic Emissions

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SEEDS Final General Assembly

5th – 6th December 2023 - Hybrid meeting in Toulouse, France

Final Agenda

Tuesday 5th December (10:00-17:00) - Added value of SEEDS emission products

10:00 - 10:15 The SEEDS project: achievements and lessons learnt (Leonor Tarrasón, NILU)
10:15 - 10:30 The SEEDS project and perspectives from CAMS (V-H Peuch, ECMWF)

10:30 – 10:45 Added-value of the SEEDS data assimilation scheme (Emanuele Emili, BSC)

Block 1: Industrial emissions

10:45 – 11:05 Lessons learnt for SEEDS NOx emissions from industrial plants (Ronald Van der A, KNMI)
11:05 – 11:15 Experiences with use satellite data for industrial emissions at EEA: strengths and limitations (Federico Antognazza, EEA)
11:15 – 11:30 Coffee break
11:30 – 11:50 Alternative approaches to derive industrial emissions from satellite data (Henk Eskes, KNMI)
11:50 – 12:10 The planned use of satellite data in CAMS for industrial emissions (Jeroen Keunen, TNO)
12:10 – 12:30 Panel discussion: Perspectives on use of EO products for industrial emissions

12:30 – 13:30 Lunch break

Block 2 – Emissions in cities

13:30 – 13:50 SEEDS NOx emissions in cities, links to CAMEO and further cooperation with CAMS (Ronald Van der A, KMNI)
13:50 – 14:10 Needs and expectations from different stakeholders to EO emission data - Summary from the SEEDS Stakeholder seminar from 28th November (Isadora Jimenez, Lobelia)

Block 3: Fire and Biogenic Emissions

14:10 – 14:35 Fire emissions in SEEDS (Jenny Stavrakou, BIRA-IASB)
14:35 – 15:00 Perspectives for European scale services on Fires (Johannes Keiser, NILU)
15:00 – 15:15 Coffee break
15:15 – 15:30 SEEDS top-down BVOC emissions: an outlook for CAMS (Glenn-Michael Oomen, BIRA-IASB)
15:30 – 15:45 Perspectives on BVOC emission estimates from CAMS (Kateřina Šindelářová, MFF CUNI)
15:45 – 16:00 SEEDS approach to Bottom -up BVOC emissions (Paul Hamer, NILU)
16:00 – 16:30 Added value of SEEDS emission products for daily forecasts (Joaquim Arteta, MFF)
16:30 – 17:00 Panel discussion: Perspectives on use of EO products for urban and biogenic emissions

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SEEDS – Final GA – Agenda- Day 2

SEEDS
Sentinel EO-based Emission and Deposition Service

Wednesday 6th December

(10:00-16:00)

Added value of SEEDS surface fluxes

10:00 – 12:00	Block 4: Agricultural emissions
12:00 – 13:00	*Lunch break*
13:00 - 14:00	Block 5: Deposition fluxes and yields
14:00 – 15:30	Block 6 : Physical information on SM and LAI
15:30 -16:00	Lessons Learnt

SEEDS Sentinel EO-based Emission and Deposition Service — Funded by the European Union

SEEDS Final General Assembly

5th – 6th December 2023 - Hybrid meeting in Toulouse, France

Final Agenda

Wednesday 6th December (10:00-16:00) - Added value of SEEDS surface fluxes

Block 4: Agricultural emissions

10:00 – 10:20 SEEDS NH3 emissions (Jieying Ding, KNMI)
10:20 – 10:40 SEEDS Soil emissions of NOx and comparison with CAMS (Ronald van der A, KNMI)
10:40 – 11:10 Evaluation of SEEDS agricultural emissions in Denmark (Camilla Geels, AU)

11:10 – 11:25 Coffee break

11:25 - 11:45 Experience in Northern Italy with ammonia (NH3): emissions, using in situ observations and satellite derived products (Alessandro Marongiu ARPA Lombardia)
11:45 – 12:00 Added value of SEEDS agricultural emission products for daily forecasts (Joaquim Arteta, MFF)
11:30 – 12:00 Panel discussion: Perspectives on use of EO products for agricultural emissions

12:00– 13:00 Lunch Break

Block 5: Deposition fluxes and yields

13:00 – 13:20 SEEDS Nitrogen and Ozone dry depositions (Paul Hamer, NILU)
13:20 – 13:40 Implementation of bidirectional flux in DEHM, MATCH and EMEP and links to SEEDS (Lise Marie Frohn Rasmussen, AU)
13:40 – 14:00 Dry Deposition perspectives in CAMS (David Simpson, MET NORWAY)

Block 6 : Physical information on SM and LAI

14:00 -14:20 SEEDS Soil Moisture and LAI products and links to CORSO (Jean-Christophe Calvet, CNRM)
14:20 - 14:40 Potential use of remote sensing data on canopy and soils to represent surface-atmosphere exchange of pollutants and GHG. (Benjamin Loubet, INRAE)
14:40 – 15:00 Added value of SEEDS deposition in CAMS (Joaquim Arteta, MeteoFrance)

15:00 – 15:30 Panel discussion Perspectives on SEEDS surface flux products for agriculture users

15:30 - 16:00 Closing remarks (Leonor Tarrason, NILU)

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Key messages - Emissions

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- Satellite AQ information through inverse modelling can be used to support the review and verification of emission data
    - Location/Resolution
    - Spatial resolution of EO-based emissions still a challenge
    - Locating sites - of very limited value in most European countries - Possibly applications in other parts of the world
    - Nox soil emission in summer identified from satellite
    - Timeseries checks
        - Verifying year to year variations -
        - Checking emissions from sources that drop below thresholds… and gap filling datasets
        - Estimating monthly/weekly emissions.
    - Emission outlier checks
        - Reported vs EO-based emissions – even if EO-based data is not specific to a point source, is still of value in identifying issues.
        - Possible additional analysis with pollutant ratio checks for instance with CO can be informative for QA/QC purposes

Key messages – Surface Fluxes

SEEDS
Sentinel EO-based Emission and Deposition Service

- Satellite AQ information through inverse modelling may support agricultural users through additional value creators
- The data portal from SEEDS provides access to a series of complete datasets that can be useful for further testing, benchmarking and uptake

  - Agricultural emission information – added value
    - Verifying year to year variations - ammonia and soil Nox from SEEDS
    - Estimating monthly/weekly emissions.
    - Fertiliser recommendations such as Nitrate action plan
  - Physical parameters and agricultural yields
    - SM and LAI products can be suitable for farmers and decision makers, as one more tool to take decisions but resolution is still a challenge
    - NDDVI and LAI from Sentinel 2 in higher resolution – 20m
    - Remote sensing and EO can't replace being in the field, but are a resource to support different agricultural practices, such as irrigation plans
  - Ozone effects on crop and vegetation yields
    - Stomatal conductance hourly data to develop and test POD
    - Additional deposition data and diagnostics to evaluate effects on vegetation and further risk assessment

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SEEDS Consortium team

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Sentinel EO-based Emission and Deposition Service

NILU - L. Tarrason, P. D. Hamer, J. Kaiser

KNMI - H. Eskes, R. van der A, J. Ding

BIRA- IASB - J. Stavrakou , G.M. Oomen, J-F Müller.

CERFACS - E. Emili, P. Piacentini

MF-CNRM - J. Arteta, J.-C. Calvet, N. Frebourg, V. Marécal

ISAT – Lobelia Earth - J. Calvin, I.Jimenez, Ch. Michel. P. Moreno, Th. Fontelle, A. Naranjo

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Thank you

https://seedsproject.eu

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