

› TNO EARTH OBSERVATION

Satellite Information
& Instruments to Mitigate
Climate Change, Air Pollution
and Biodiversity Loss

TNO innovation
for life

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› TNO

Mission

TNO's mission is to create impactful innovations for the sustainable wellbeing and prosperity of society

Key facts

- › Technology development and consultancy
- › Independent, not-for-profit organization
- › Founded in 1932
- › Annual Turnover over 500MM EUR: 2/3 from industry
1/3 from Dutch Government
- › Over 4,000 employees, scientists and engineers (MsC, PhD)
- › TNO stands for Netherlands Organization for Applied Scientific Research



› ROLES OF TNO

Independent advisory

- › Fact based
- › For governments and industry

Innovation

- › Applied R&D
- › Prototyping and pilot testing

Knowledge transfer

- › Academic partnerships
- › Licensing of solutions to companies

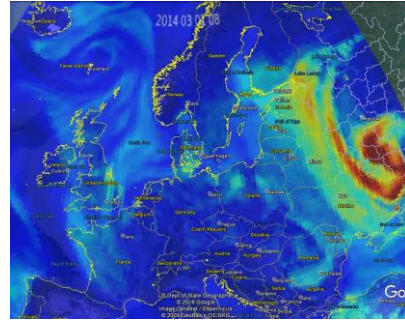


› TNO EMISSION REDUCTION



EMISSIONS

- › Inventories
- › Modelling
- › Space- based localisation



TRANSPORT

- › LOTOS-EUROS chemistry and transport model
- › Source Apportionment (TOPAS)



MONITOR

- › Satellites
- › Ground
- › Airborne
- › Maritime



REDUCTION

- Advisory
- › Hotspots detection
- › Verification
- › Mitigation options

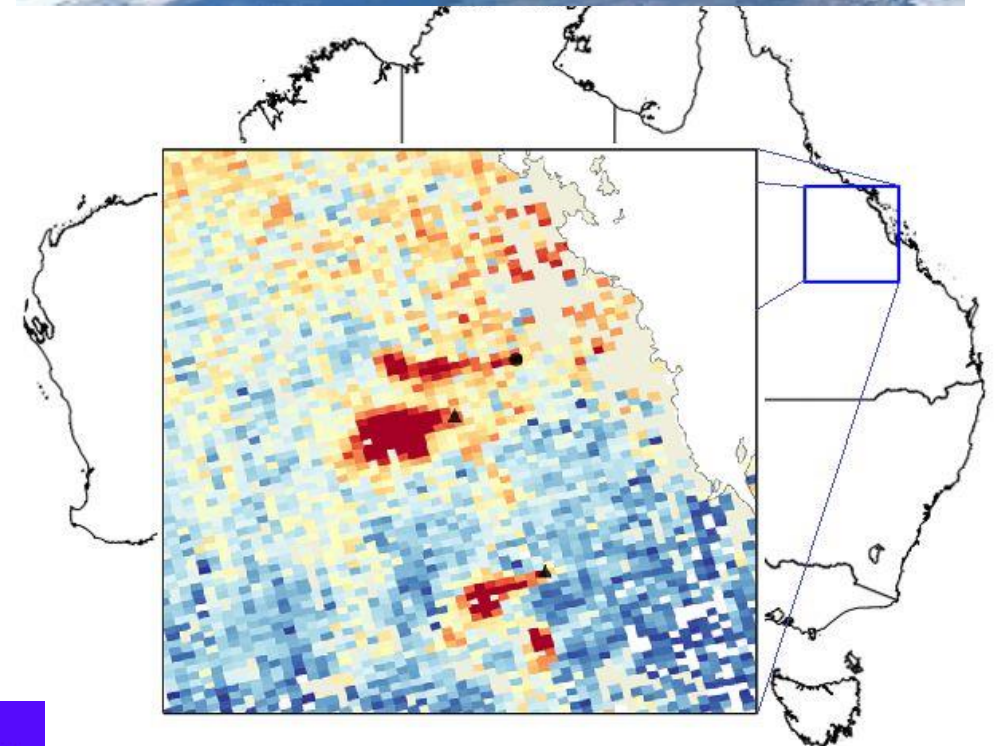
› IMPACT: EXAMPLE

TNO designed and manufactured key optical systems of the TROPOMI satellite instrument that is used to globally monitor methane emissions



Case study

- › TROPOMI on board Sentinel-5p mission (ESA)
- › Consortium of Dutch researchers monitored methane emissions of Australian coal mines
- › Measurements show 6 mines accounting for 7% of the national coal production emit around 55% of reported coal emission (Dec' 21)
- › Australian government taking action to reassess reported emissions



Pankaj Sadavarte et.al. (2021) Environmental Science & Technology

The New York Times



› TNO EARTH OBSERVATION

TNO has over 40 years of heritage in earth observation, contributes to major ESA and NASA satellite missions, and has a team of over 300 researchers and engineers

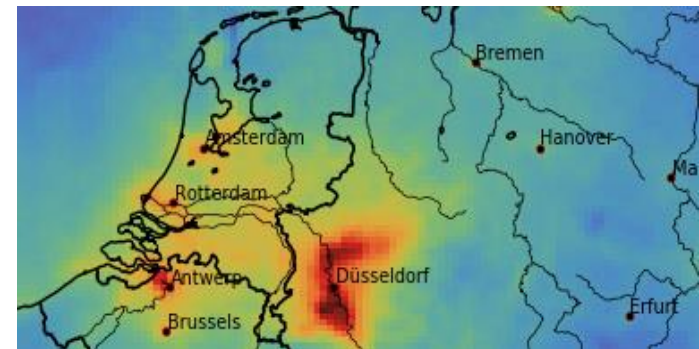
Development of satellite instruments

- › Air pollution
- › Green house gases
- › Water pollution



Development of satellite information products

- › Reduce global warming
- › Health
- › Preservation of nature
- › Economic activities



› TNO SATELLITE INSTRUMENTS

Capabilities

Designs, manufactures, integrates and tests satellite instruments, subsystems and components

Value earth observation instruments

- › Global reach
- › Datasets of comparable measurements
- › Cover large area
- › Frequent measurements and revisits (e.g. daily)

Uniqueness

- › TNO has over 40 years of heritage developing instrument for ESA and NASA
- › Proven ability to innovate
- › Design and manufacturing under a single roof
- › Major heritage in atmospheric science



TROPOMI satellite instrument in TNO lab (TNO)

TNO CUSTOMERS

Satellite instruments

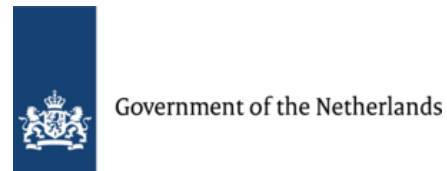


Satellite information products



Europe

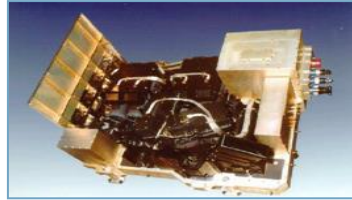
Governments



Companies



40 YEARS OF HERITAGE IN INSTRUMENTS



GOME / GOME-2

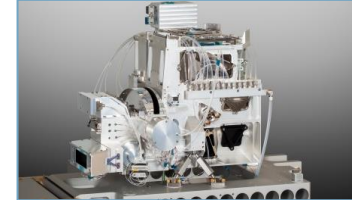
1995 ERS-2
 2006- METOP1, 2, 3
 2020+



SCIAMACHY



OMI



TROPOMI

Netherlands
 Space
 Office



SENTINEL 5



1995

2002

2004

2017

2021

2020+

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AIRBUS NL

Koninklijk Nederlands
 Meteorologisch Instituut
 Ministerie van Verkeer en Waterstaat

SRON
 Netherlands Institute for Space Research

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NEW DEVELOPMENT: TANGO

TNO is part of the core team that develops the TANGO greenhouse gas monitoring satellite mission

Mission

- › Facility level emission measurements at high precision
- › Emissions of CO₂, CH₄ and NO₂
- › Open source data
- › Complements global observations of Copernicus CO2M mission
- › Go-Ahead provided by ESA

Role TNO

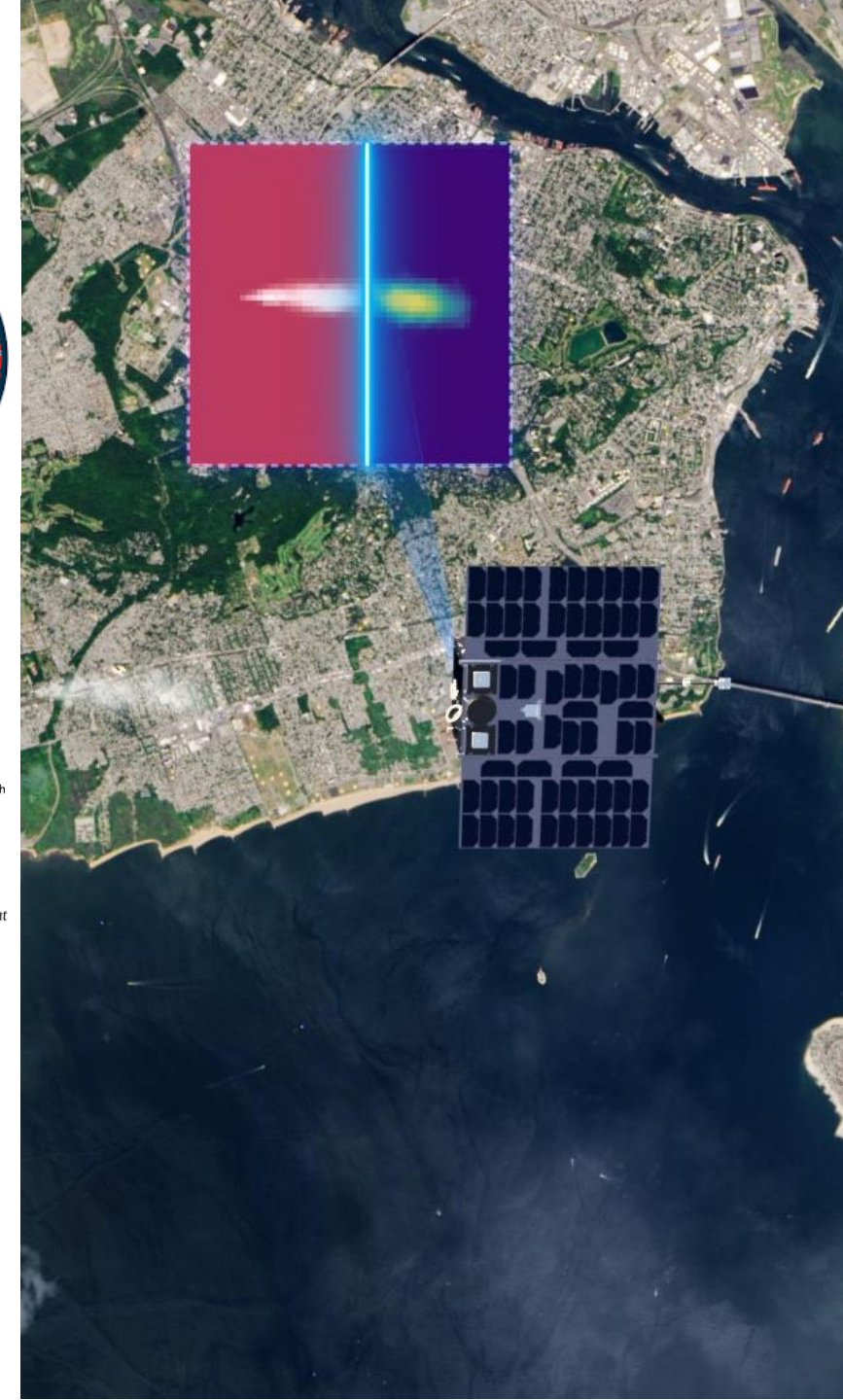
- › Leads the development of mission satellite instruments
- › Member integrated mission team (science-platform-instrument)
- › TNO Spectrolite technology (free form mirror spectrometers optimized to cost, volume and mass)



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SRON
Netherlands Institute for Space Research



› TNO EMISSION ATLAS

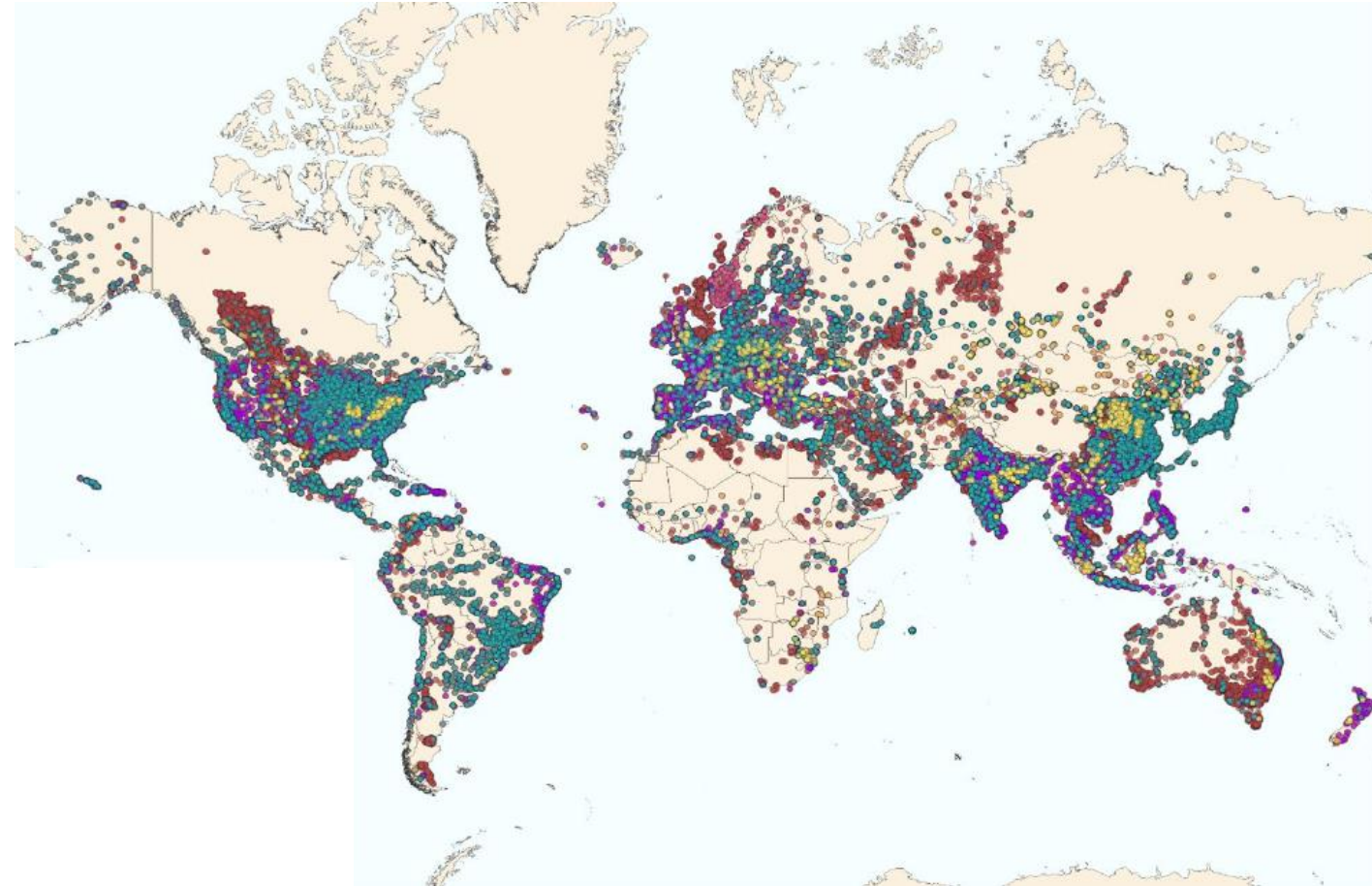
Atlas of greenhouse gas emissions that are geo-located to specific locations. It is complimentary to conventional inventories that contain data at sector- (e.g. steel, power) and country-level.

Powerful tool to combine with earth observation

- › Verification of asset emissions
- › Asset level insights for mitigations
- › Means to target satellite observations

Uniqueness

- › Presents best available science
- › Global CO₂, methane and NO_x emissions
- › Complete: 100.000 asset emissions, remainder of emissions grided
- › Possibility to keep improving it with TNO science team having decades of experience in emissions research



TNO global facility level greenhouse gas emission database (TNO)

› IN SUMMARY

TNO develops innovations that supports governments, scientists and companies to prevent climate change, air pollution and biodiversity loss

- › Works worldwide, with the EU, government agencies and the private sector
- › 40 years heritage in designing and building satellite instruments for ESA and NASA
- › Key role in the next generation European satellite mission to globally measure emission (TANGO)
- › Makes available methods to ensure satellite data can be turned into actionable information
 - › Independent verification of greenhouse gases emission
 - › Real-time management of air pollution at national level, including setting of health alert
 - › Monitoring ammonia and nitrogen emission and their harmful deposition in nature

› **THANK YOU FOR
YOUR TIME**

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