

› TNO EARTH OBSERVATION

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

TNO innovation
for life

Anton Leemhuis

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

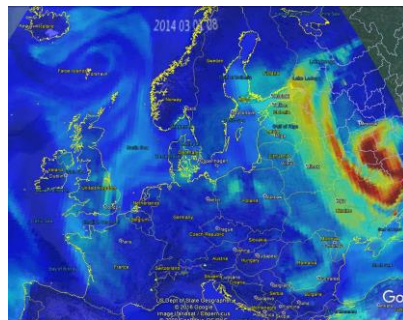


› TNO EMISSION REDUCTION



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

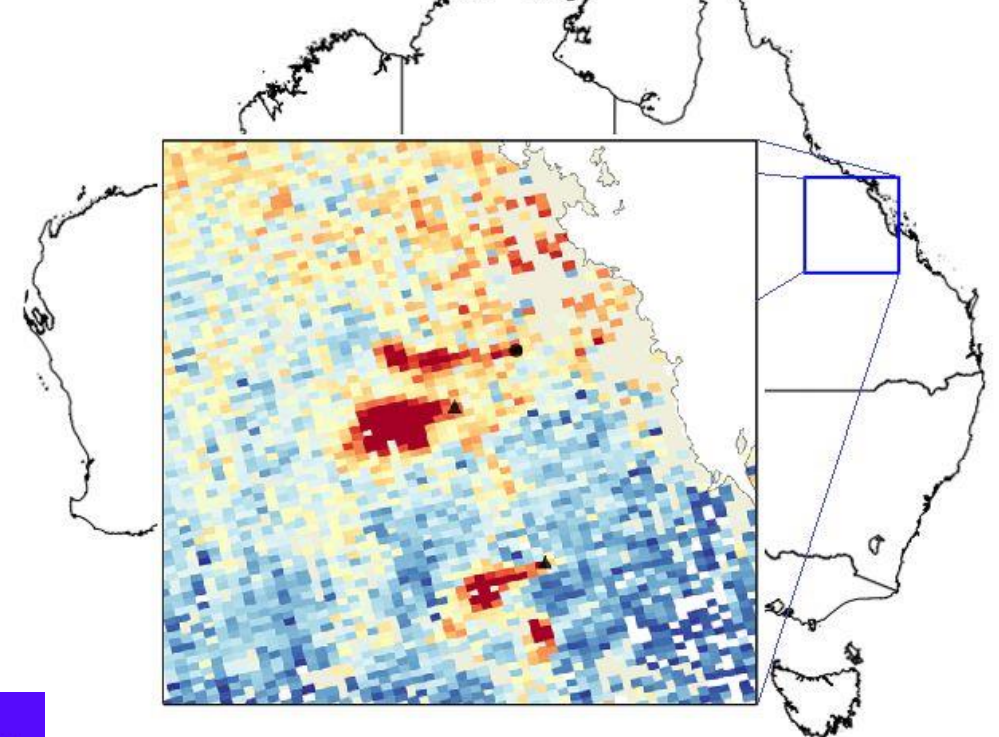
› IMPACT: EXAMPLE

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



Bloomberg

› 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

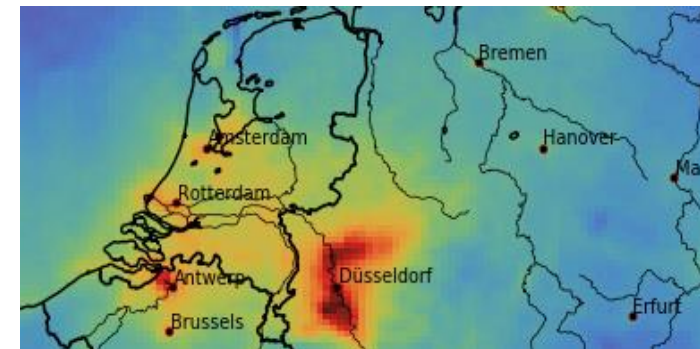
Development of satellite instruments

- › 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

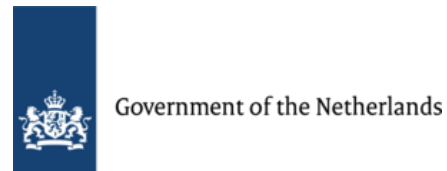


Satellite information products



Europe

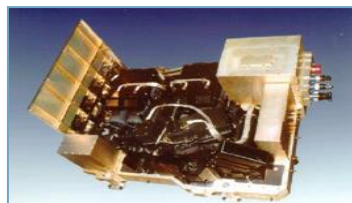
Governments



Companies



› 40 YEARS OF HERITAGE IN INSTRUMENTS



GOME / GOME-2

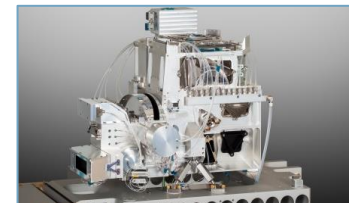
1995 ERS-2
2006- METOP1, 2, 3
2020+



SCIAMACHY



OMI



TROPOMI



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

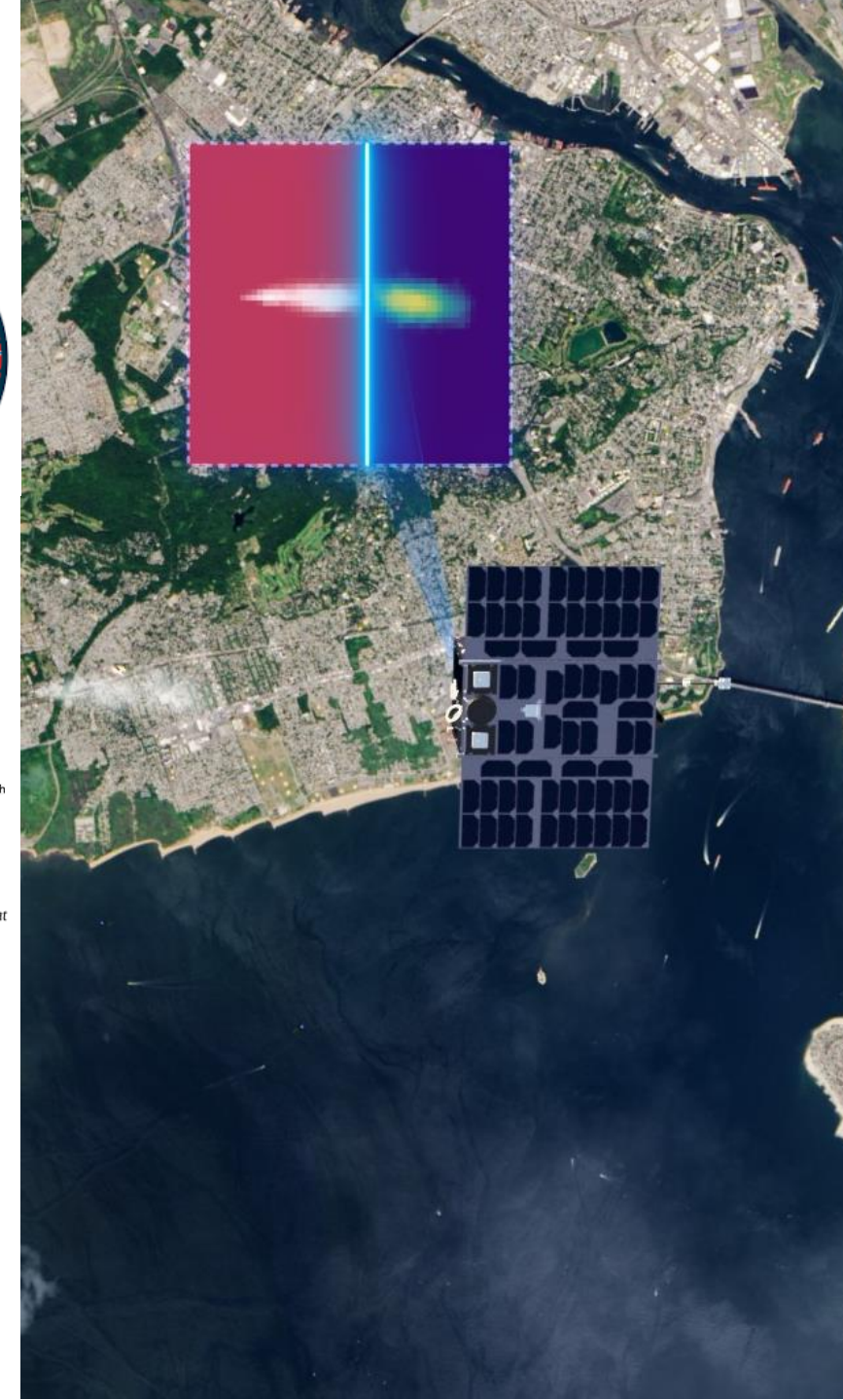
- › Leads the development of mission satellite instruments
- › Member integrated mission team (science-platform-instrument)
- › TNO Spectrolite technology (free form mirror spectrometers optimized to cost, volume and mass)



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SRON
Netherlands Institute for Space Research



› TNO EMISSION ATLAS

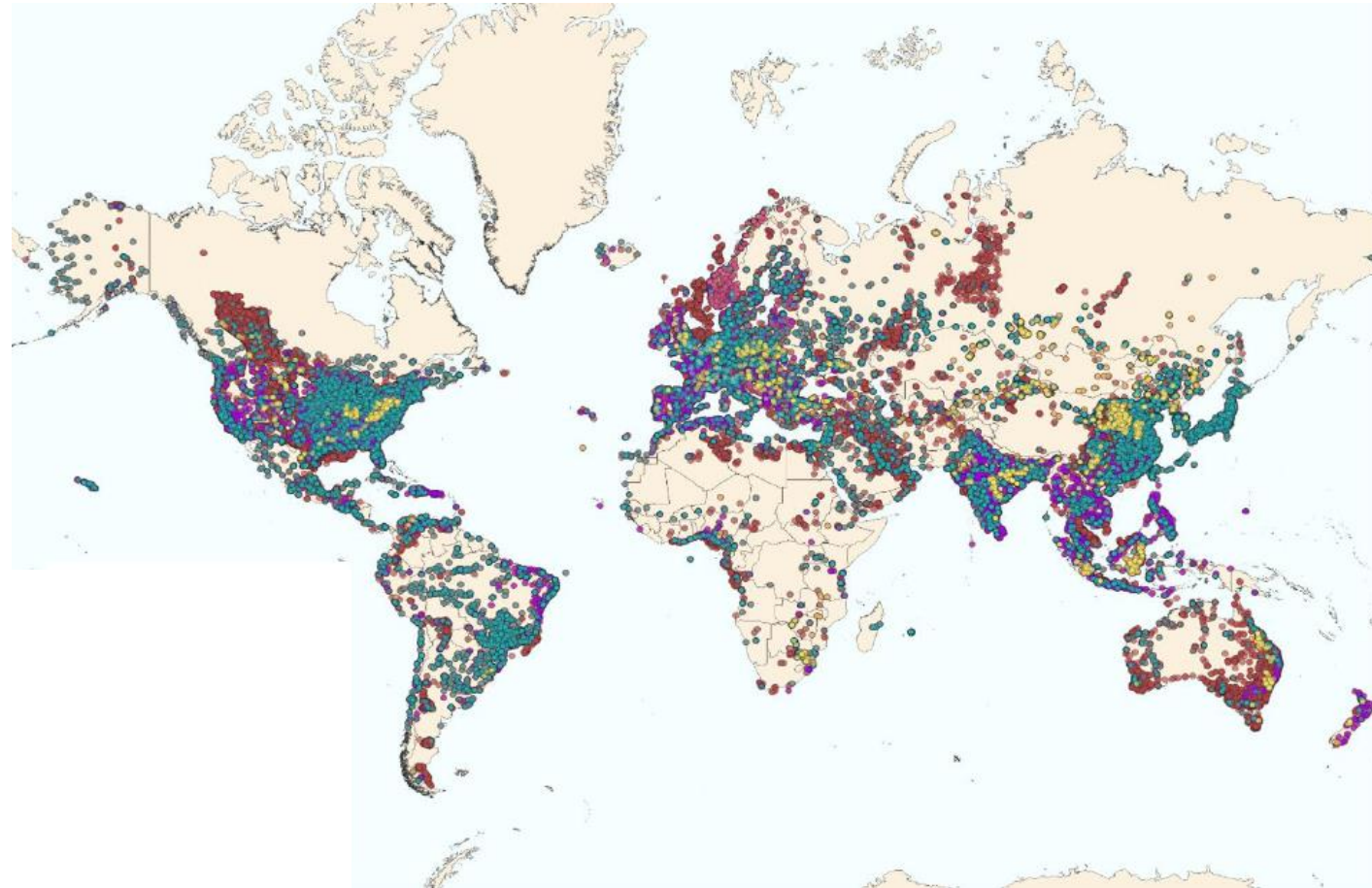
Atlas of greenhouse gas emissions that are geo-located to specific locations. It is complimentary to conventional inventories that contain data at sector- (e.g. steel, power) and country-level.

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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