New air quality observations from Sentinel missions

Impact on science and society

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Member Sentinel-4 and Sentinel-5 Mission Advisory Group, ESA

Outline

- Copernicus space component
- Mission advisory group
- Atmospheric Sentinels
- Synergy with other missions

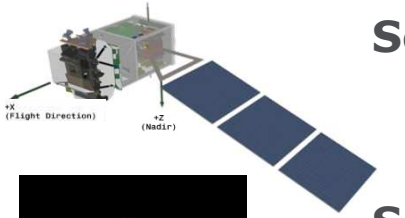
- Scientific issues
- Social issues
- Policy-relevant science

- Participation in
  - Copernicus Atmospheric Monitoring Services (CAMS)
  - Copernicus Climate Change Services (C3S)

Background: Copernicus Space Component

Sentinel-1: SAR imaging

Land surface properties, sea-ice, all weather, day/night

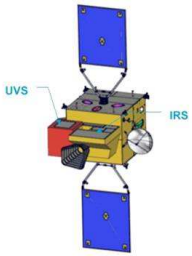


Sentinel-2: Multispectral imaging

Land applications: urban, forest, agriculture, etc.

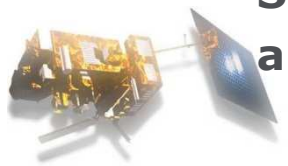
Sentinel-3: Ocean and global land monitoring

Ocean color, vegetation, sea/land surface temperature, altimetry



Sentinel-4: Geostationary imaging

Atmospheric composition monitoring



Sentinel-5Precursor and -5: Low Earth orbit imaging

Atmospheric composition monitoring

2014

2015

2015

2020

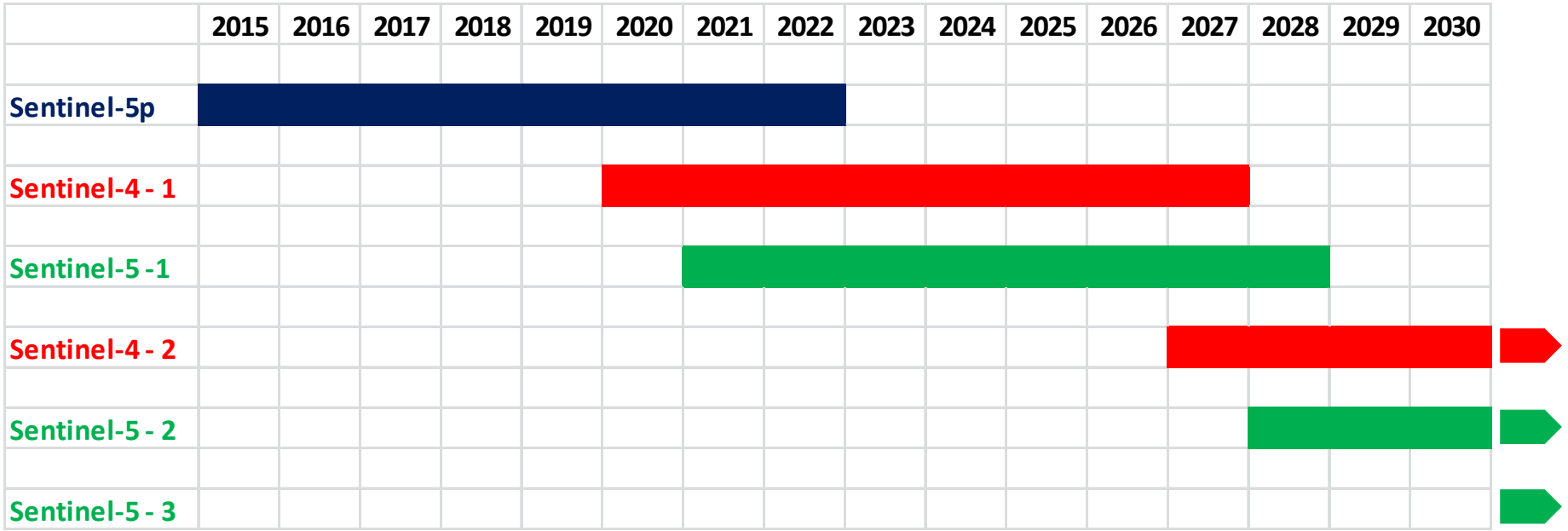
2015

2020+

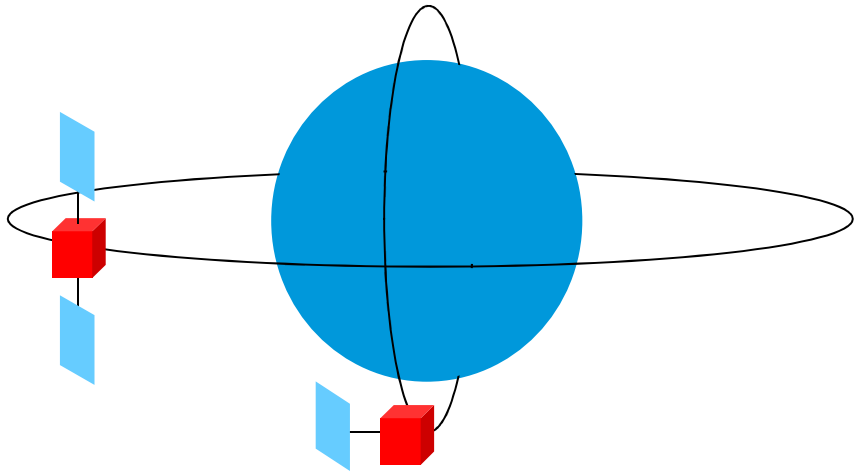
Role of Mission Advisory Group: advise on

- Fitness for purpose of Sentinel-4/-5 data for Copernicus Atmospheric Services
- Compatibility of system specifications with mission requirements
- Instrument calibration
- Specification of Level-1/-2 products, quality requirements and quality indicators
- Study and campaign requirements, end-to-end product calibration/validation, retrieval algorithms and quality indicator verification and validation
- Data quality requirements for Level-1/-2 interface
- Data processing, archiving and product delivery
- Promoting the mission

Launch Schedule of Atmospheric Sentinels



Identified Elements: LEO + GEO



Low Earth Orbit (LEO)

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

→ Sentinel-5 Precursor (S5p)

→ Sentinel-5 (S5)

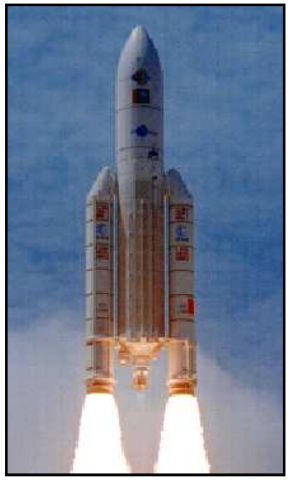
GEOstationary (GEO)

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

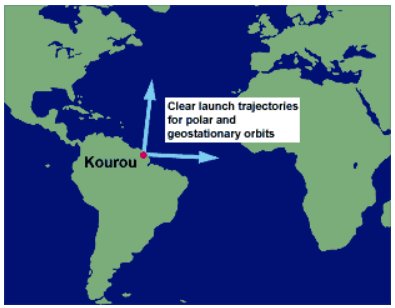
→ Sentinel-4 (S4)

MTG – S4 Mission Architecture

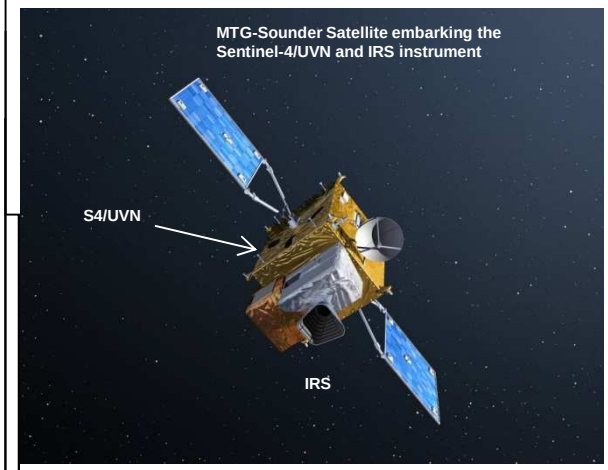
Launch Segment



Launch Vehicle
(A5, Soyuz, Proton)



Observatory Segment

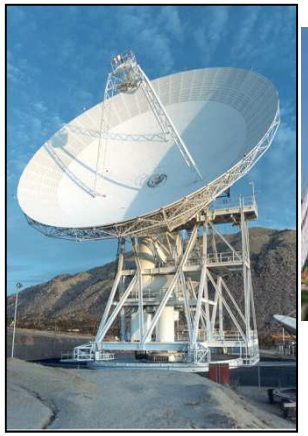


Two MTG-Sounder (MTG-S) S/Cs

Four MTG-Imager (MTG-I) S/Cs

Payload
1- Flexible Combined Imager, on MTG-I
2- Lightning Imager, on MTG-I;
3- Infra-Red Sounder on MTG-S;
4- Sentinel-4/UVN, on MTG-S

Ground Segment

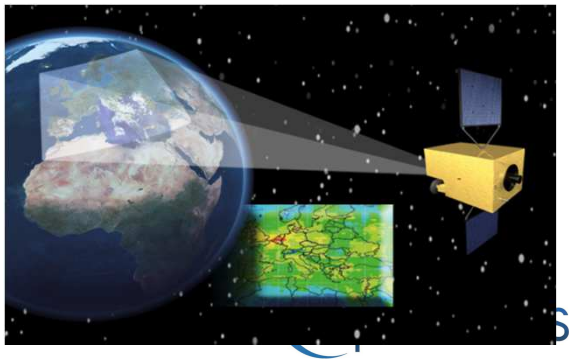


Flight Operations Segment

P/L Data Ground Segment

Ground Station(s)

Orbit: Geostationary

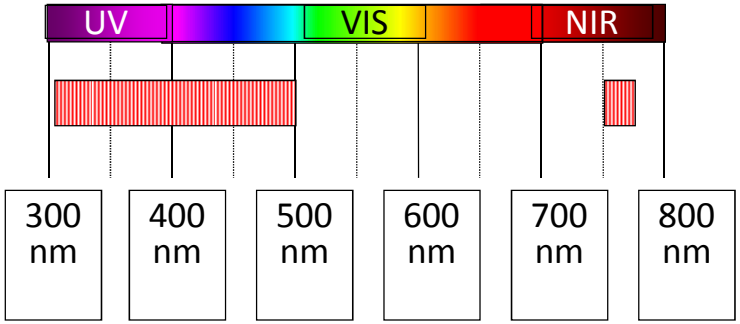


Sentinel-4 / UVN Mission Objective: Continuous monitoring of the atmospheric composition and air quality of Europe (O_3, NO_2, SO_2, HCHO and aerosol optical depth at a fast revisit time of ~1 hour.

Sentinel-4/UVN: Key Requirements

Instrument Spectral Coverage

Band ID	Wavelength range [nm]	Spectral resolution [nm]	Spectral sampling ratio
UV	305 - 400	0.5	3
VIS	400 – 500	0.5	3
NIR	750 – 775	0.12	3



Spatial Sampling: 8 km at 45° N

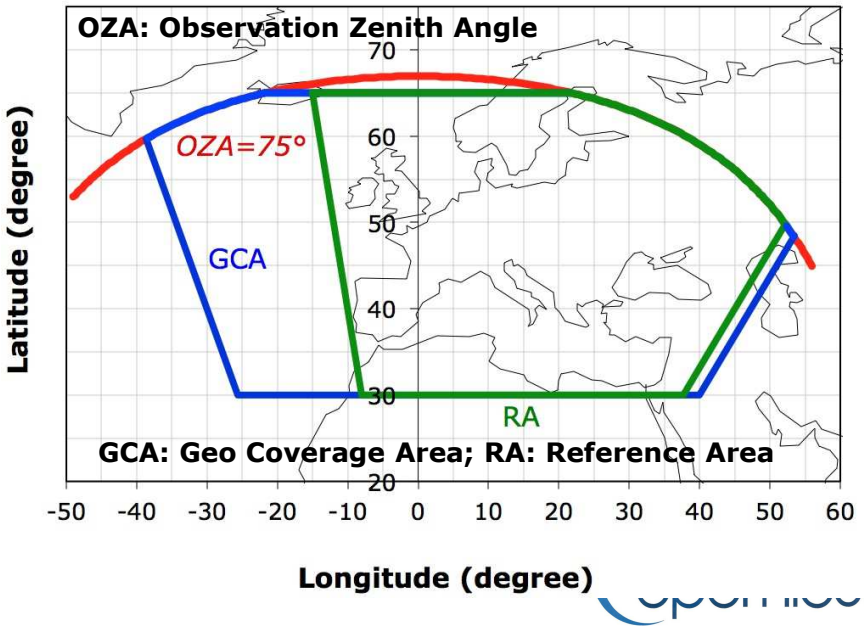
Coverage: Europe + part of Sahara

Repeat Cycle: 1 hour

Low sensitivity to polarisation (1%)

Low level of spectral features (0.05%)

High radiometric accuracy: 3% (2%, goal)



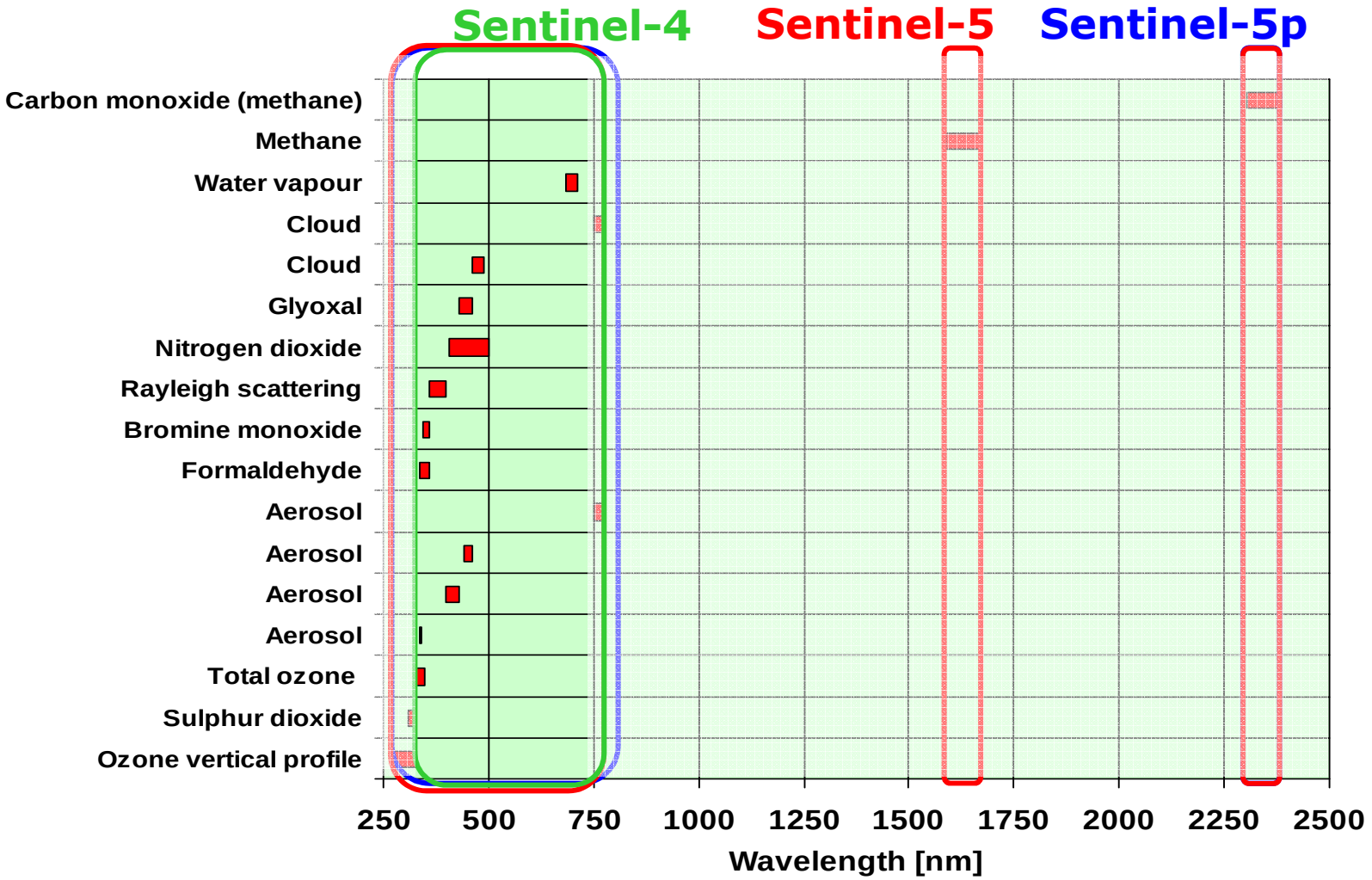
Sentinel-4 Level-2 Products [targeted by ESA]

Product	Application			Comment
	Air Quality	Climate	Surface UV	
O_3 total & trop. column	X		X	
O_3 profile	X		X	**Synergy with infrared data from IRS**
NO_2 total & trop. column	X			
SO_2 total column	X			Also for volcanic eruption monitoring
CHOCHO total column	X			By-product
CH_2O total column	X			
Aerosol extinction coeff. profile, column optical depth / type / index	X	X		Also for volcanic eruption monitoring Also auxiliary for other S4 products **Synergy with imager data from FCI**
Cloud optical thickness, fraction, altitude			X	Mainly auxiliary for other S4 products **Synergy with imager data from FCI**
Surface reflectance daily map			X	Mainly auxiliary for other S4 products

Sentinel-5p Level-2 Products

Product	Application			Comment
	Air Quality	Climate	Surface UV	
O_3 total & trop. column	X		X	
O_3 profile	X		X	
NO_2 total & trop. column	X			
SO_2 total column	X			Also for volcanic eruptions
CHOCHO total column	X			
CH_2O total column	X			
CO total column	X	X		
CH_4 total column		X		
Aerosol extinction coeff. profile, column optical depth / type / index	X	X		Also auxiliary for other S5p products Also for volcanic eruptions **Synergy with VIIRS**
Cloud optical thickness, fraction, altitude			X	Mainly auxiliary for other S5p products **Synergy with VIIRS**

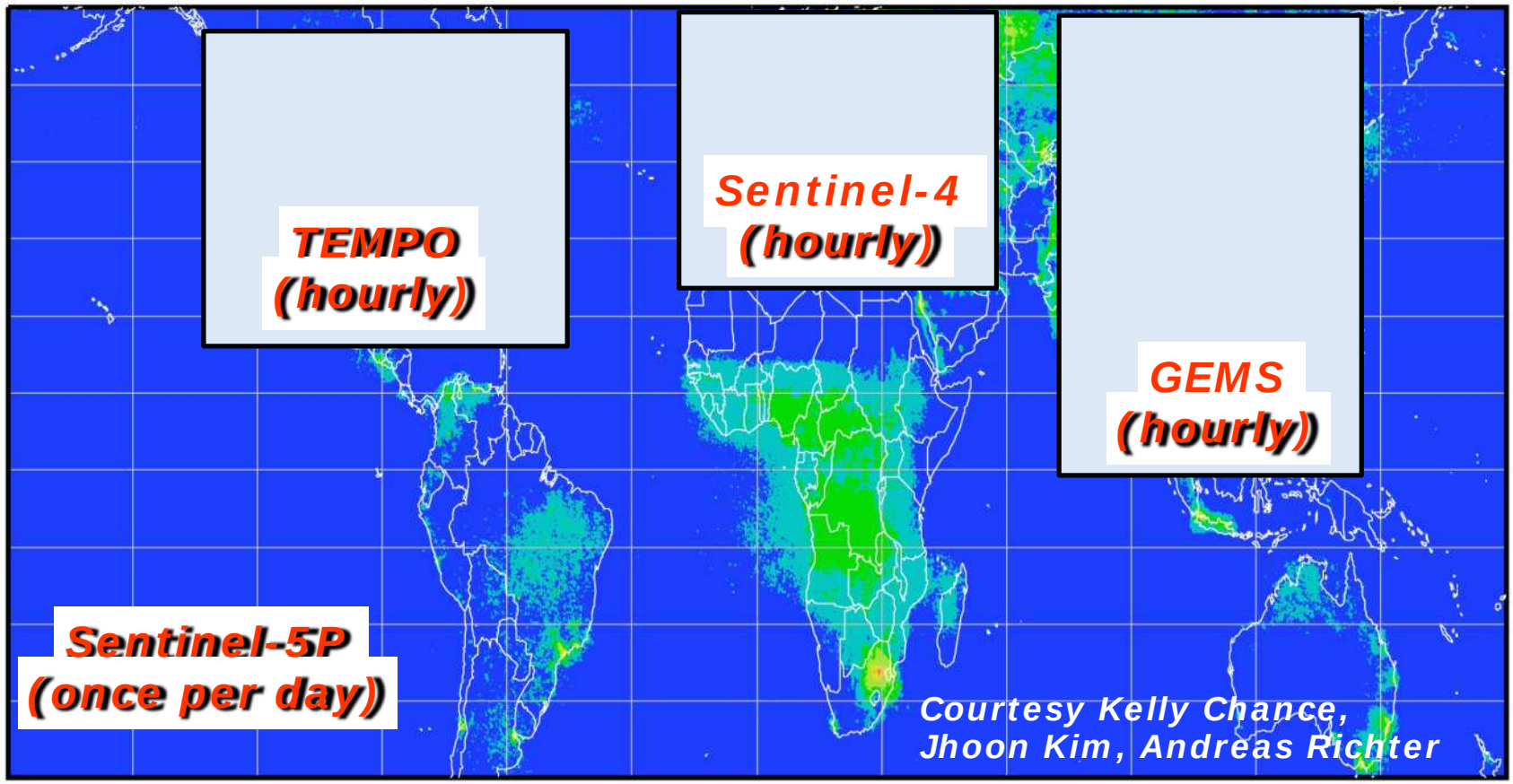
Mission Elements: Summary of Observation Requirements - UV-Vis-NIR-SWIR Bands



S-4/S-5 Summary

- Sentinel 4/5/5p missions will provide continuous monitoring of the composition of the Earth's atmosphere at high temporal and spatial resolutions
- The observed data will be used to support operational services covering air-quality near-real time applications, air-quality protocol monitoring and climate protocol monitoring over Europe
- Availability of high spatial and temporal resolution data will provide new opportunities and challenges for data assimilation, air quality forecasting and environmental impact assessments
- Impact on science
- Impact on society

Synergy with other missions



Important scientific issues

Observations from S4 and S5 will allow to address:

- Interface between atmospheric chemistry and meteorology, land and ocean processes across scales
- Trends in chemical composition of the atmosphere
- Atmospheric physics – water cycle, aerosols and clouds
- Chemical weather monitoring and prediction
- Climate science including air quality under climate change

Important social issues

Observations from S4 and S5 will allow to address:

- Climate change and adaptation
- Health, urbanization, bioaerosols, disease vectors
- Water supply and quality
- Agriculture – food security
- Energy supply and security – renewable resources

- Geo- engineering
- Emission trading

- New technologies
- Weather and environmental derivatives – financial instruments

Policy-relevant science

Observations from S4 and S5 will lead to:

- Improved emissions, at common confidence levels, over industrialized Northern Hemisphere
- Improved air quality forecasts and assimilation systems
- Improved environmental impact assessments
  - Air quality in Europe
  - Emission trading
  - Observations to support United Nations Convention on Long Range Transboundary Air Pollution

Participation in Copernicus Services

Copernicus Atmospheric Monitoring Services (CAMS)

- Air quality modelling – chemical weather forecasting
- Emission estimates and verification

An advanced and comprehensive air-quality modelling system GEM-AQ is used as a forecasting tool at Warsaw University of Technology and the EcoForecast Foundation.

Copernicus Climate Change Services (C3S)

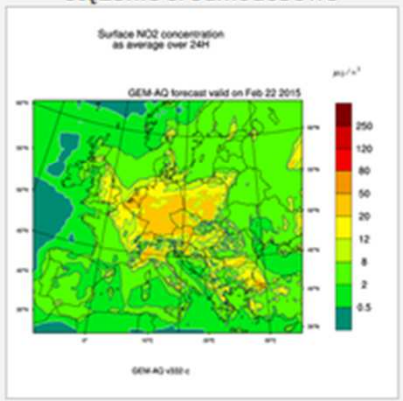
- Climate modelling
- Seasonal forecasting

The GEM-Climate model with atmospheric chemistry and aerosols was used under a grant from the National Science Centre at Warsaw University of Technology.

Home page
Ozone
Nitrogen dioxide
Sulphur dioxide
Carbon monoxide
PM10
PM2.5

Nitrogen dioxide Europe

22.02.2015
stężenie średniodobowe



23.02.2015
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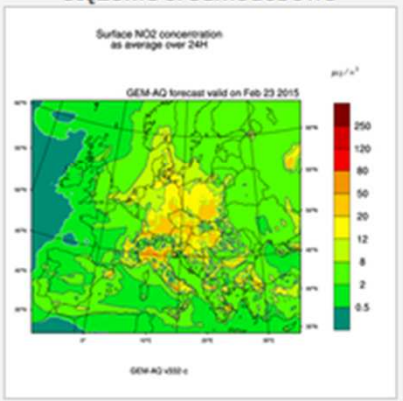

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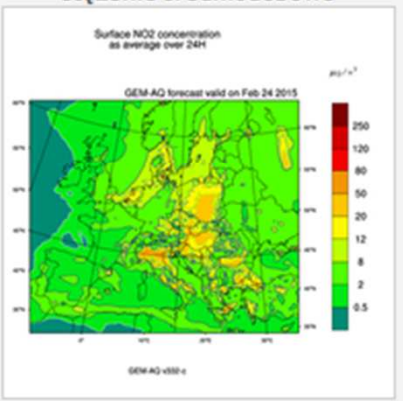

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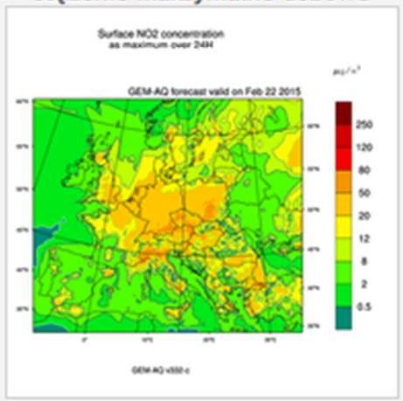
stężenie maksymalne dobowe



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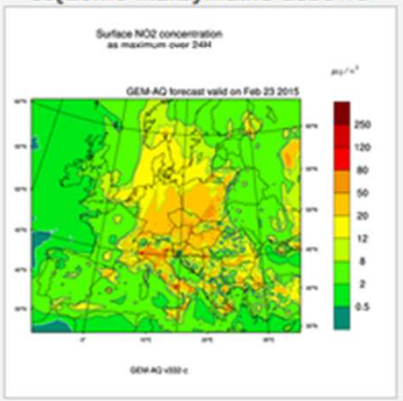

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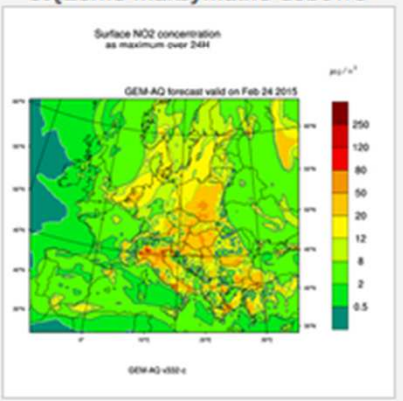
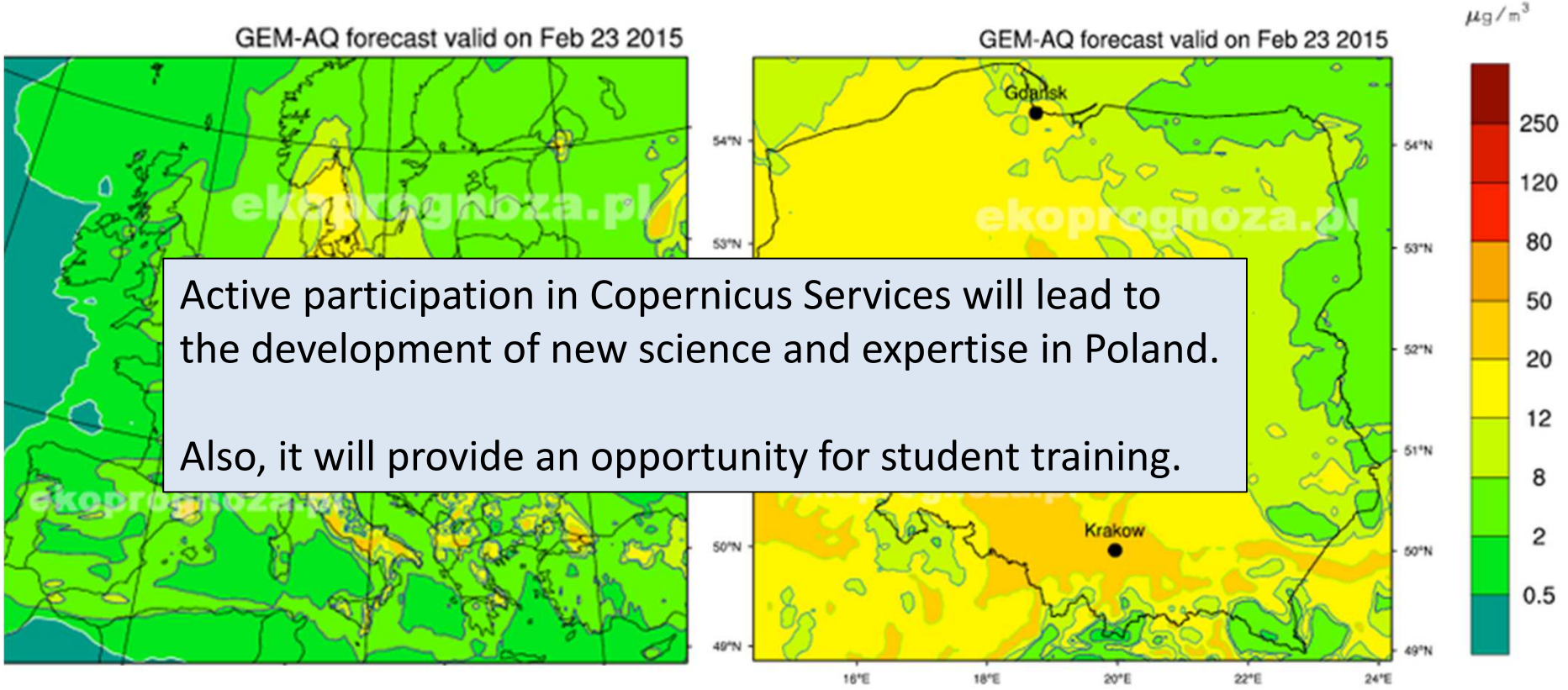


Air quality modelling- EcoForecast

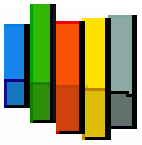
Observations from S4 and S5 will be used for

- Air Quality modelling
- Emission verification
- Environmental impact assessments



Active participation in Copernicus Services will lead to the development of new science and expertise in Poland.

Also, it will provide an opportunity for student training.



Thank you

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