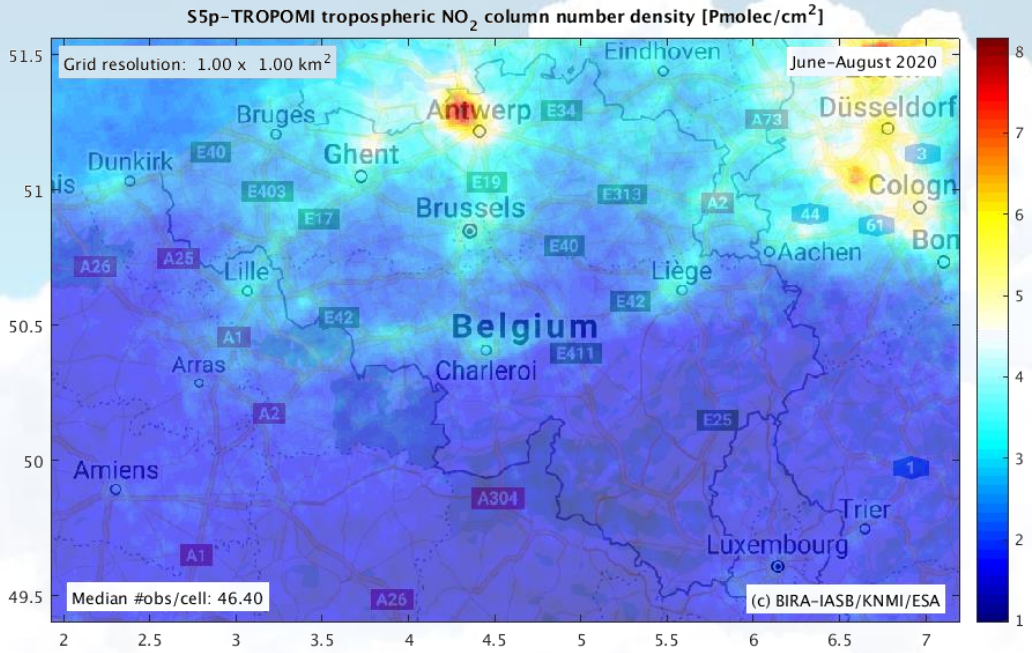
LEGO-BEL-AQ

Low-Earth and Geostationary Observations of BELgian Air Quality

Exploiting the full spatio-temporal resolving power of the Copernicus atmospheric Sentinels to support air pollution policies in Belgium



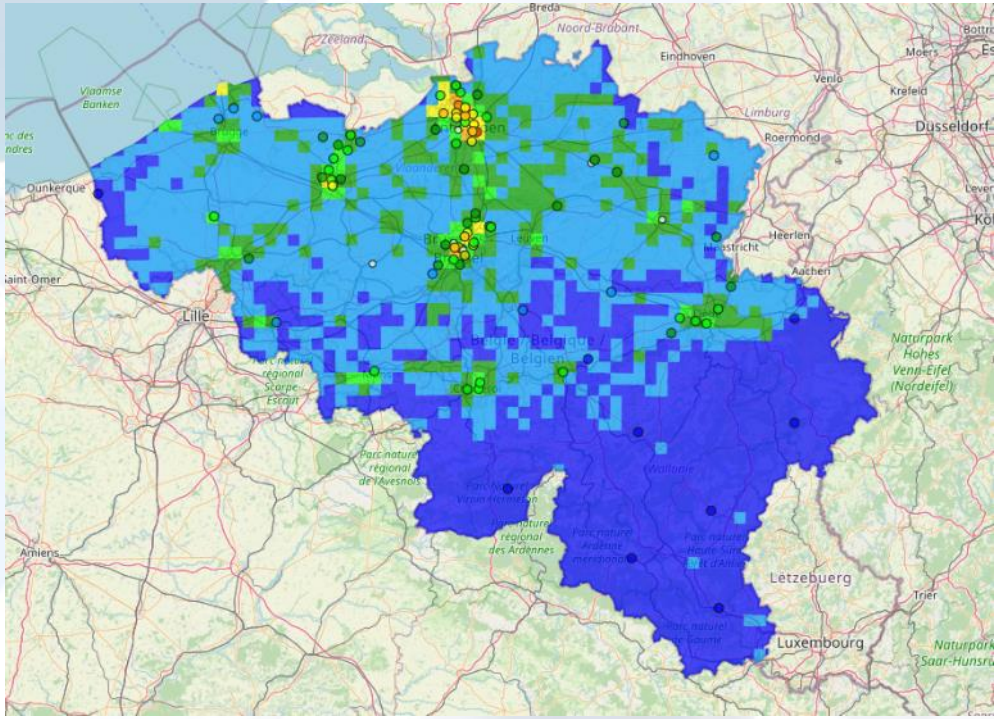
Tijl Verhoelst, Steven Compernolle and Jean-Christopher Lambert , BIRA-IASB
Frans Fierens and Charlotte Vanpoucke, IRCEL-CELINE

Outline

- Context: Regional Air Quality monitoring from space
- The (emerging) LEO+GEO Air Quality Constellation
- LEGO-BEL-AQ:
  - Tailoring Sentinel-5p data for users and policy-makers in Belgium
  - Preparing for the LEO+GEO AQ Constellation
- Implementation
- Appetizers: NO_2 over major Belgian cities
- Feedback and user consultation

Context: Regional Air Quality monitoring from space

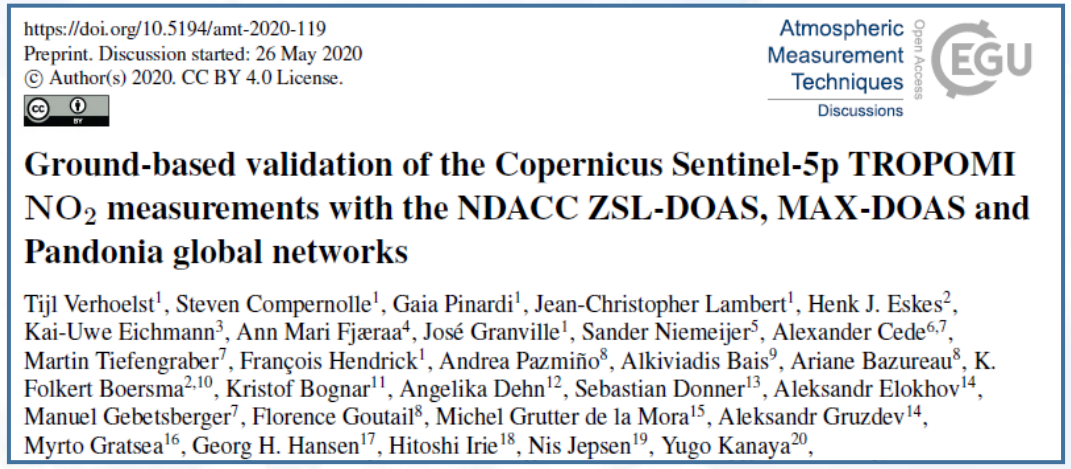
- International Air Quality framework: EU Ambient Air Quality Directives, EU National Emission Reduction Commitments Directive (NEC), UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP)…
- Increasing number of local regulations put into place to improve AQ, often on a city scale. E.g., the gradually tightening LEZ in Antwerp (2017), Brussels (2018), Ghent (2020), and Wallonia (2023).
- SARS-CoV-2 related reduction of human activities offers a low emissions test case (especially in summer).
- In-situ measurements of NOx, O_3, PM10, PM2.5 and BC are the standard for AQ monitoring ⇨ sparse data sets, made contiguous by (model-based) interpolation, e.g., CAMS-regional, RIO, CHIMERE…



Annual mean (2019) NO_2 concentration, in-situ data interpolated (4x4km^2) (RIO model, IRCEL-CELINE)

Context: Regional Air Quality monitoring from space

- Emerging constellation of AQ satellites with enhanced sensitivity to pollutants, at ~3 km ground resolution.
- Low-Earth Orbits (LEO): daily global coverage.
- Geostationary Orbits (GEO): hourly regional coverage.
- Complementarities but also differences ⇨ scientific challenges to develop integrated use of the constellation and make it fit-for-purpose for policy makers and end users.
- Current “baseline”: extensive LEO data sets (e.g. S5p) with detailed understanding of data quality and measurement intricacies.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Atmospheric Measurement Techniques Discussions

Ground-based validation of the Copernicus Sentinel-5p TROPOMI NO_2 measurements with the NDACC ZSL-DOAS, MAX-DOAS and Pandonia global networks

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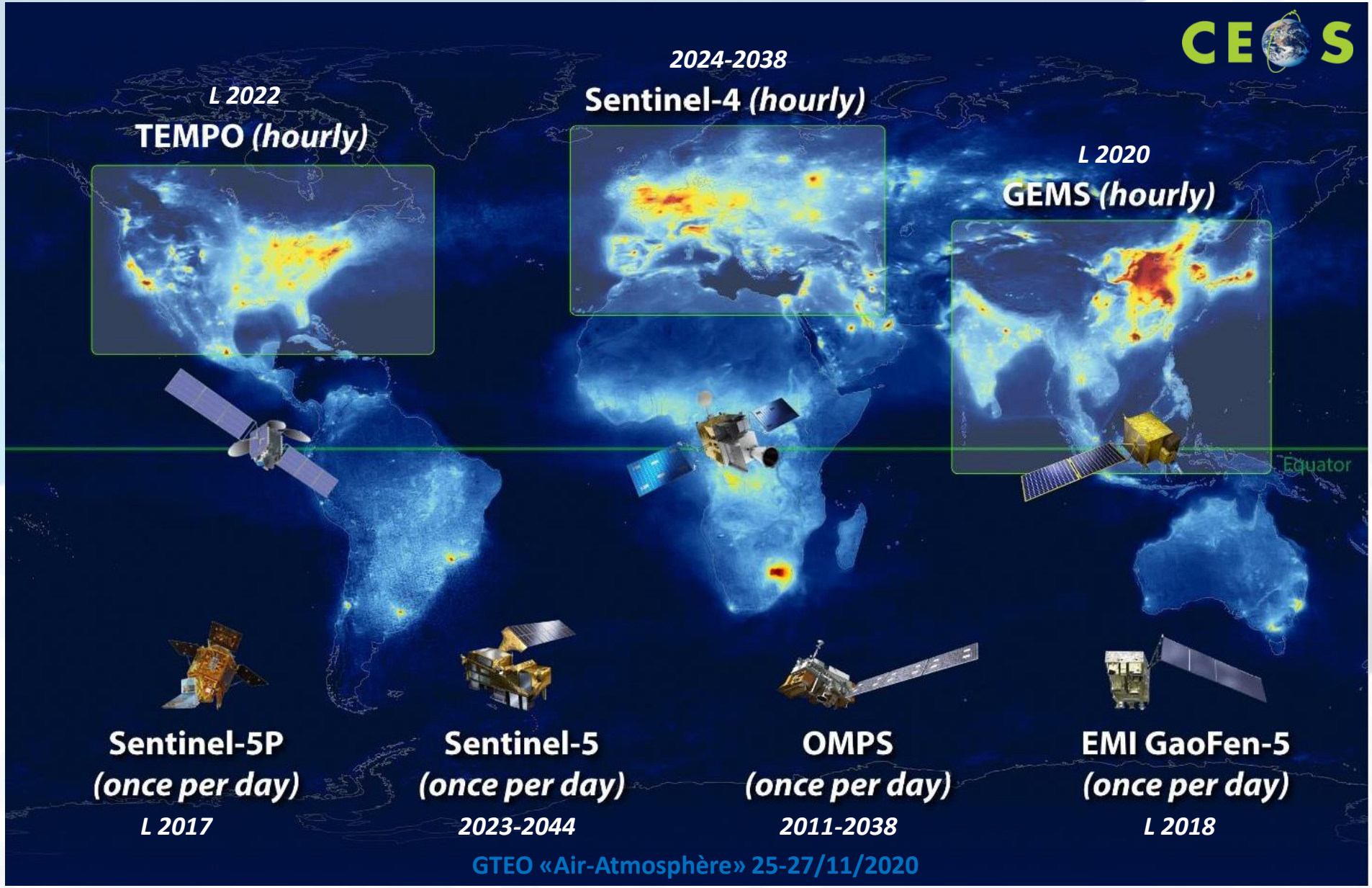
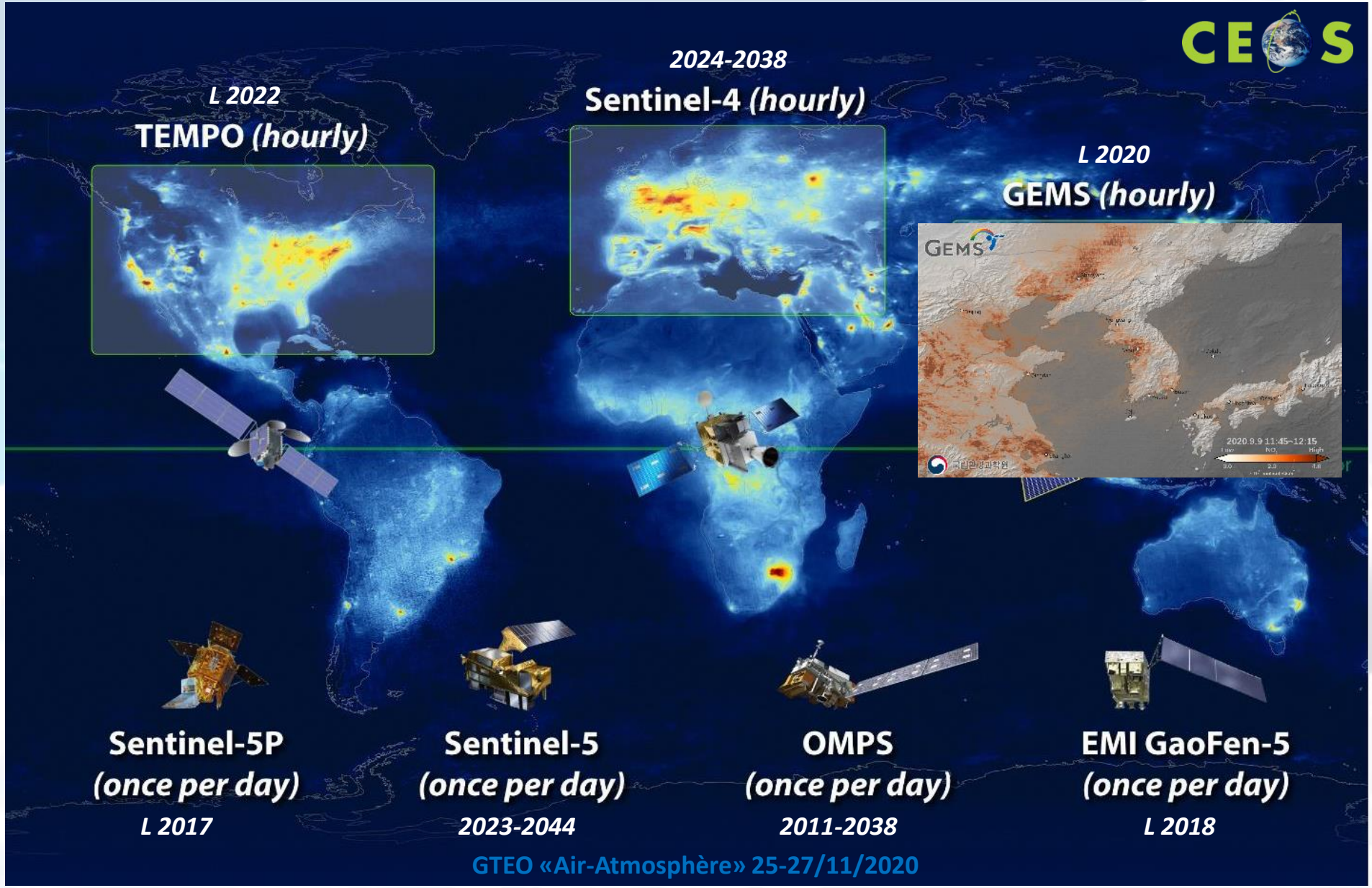
The LEO+GEO Constellation of Air Quality satellites



The LEO+GEO Constellation of Air Quality satellites



GTEO «Air-Atmosphère» 25-27/11/2020

GEMS press release 18/11/2020

LEGO-BEL-AQ

- BELSPO BRAIN-be 2.0 project, 12/2019 – 3/2024
- BIRA-IASB and IRCEL-CELINE partnership
- Focus: NO_2 over Belgium
- Advisory Board: EU and USA experts in NO_2 observations, air quality, geo-statistics + a delegate from EC DG-Environment (Clean Air unit)
- Three challenges:
  - ❖ The need for high horizontal resolution and accuracy to monitor local policy effects,
  - ❖ The non-trivial relation between surface concentration and tropospheric column,
  - ❖ The differences in observation sensitivity and features between the LEO and GEO vantage points.
- LEGO-BEL-AQ aims at inter-plugging high-resolution satellites (R&D) to bring EO Air Quality data closer to Belgian stakeholders (service).

Implementation plan: Science & Service

I. Spatio-temporal mapping and downscaling toolbox for satellite data sets

   Aggregation, interpolation, uncertainty propagation

II. Application to Sentinel-5p TROPOMI NO_2 data over Belgium and comparison to in-situ network data

   City-level maps and time series; comparison to in-situ and RIO-modelled surface concentrations

III. Developments for the specific viewing geometry of the geostationary sounders:

   3D LEO and GEO observation operators to asses spatial smearing and potential obscuration effects along the measured optical path + impact on perceived diurnal cycle

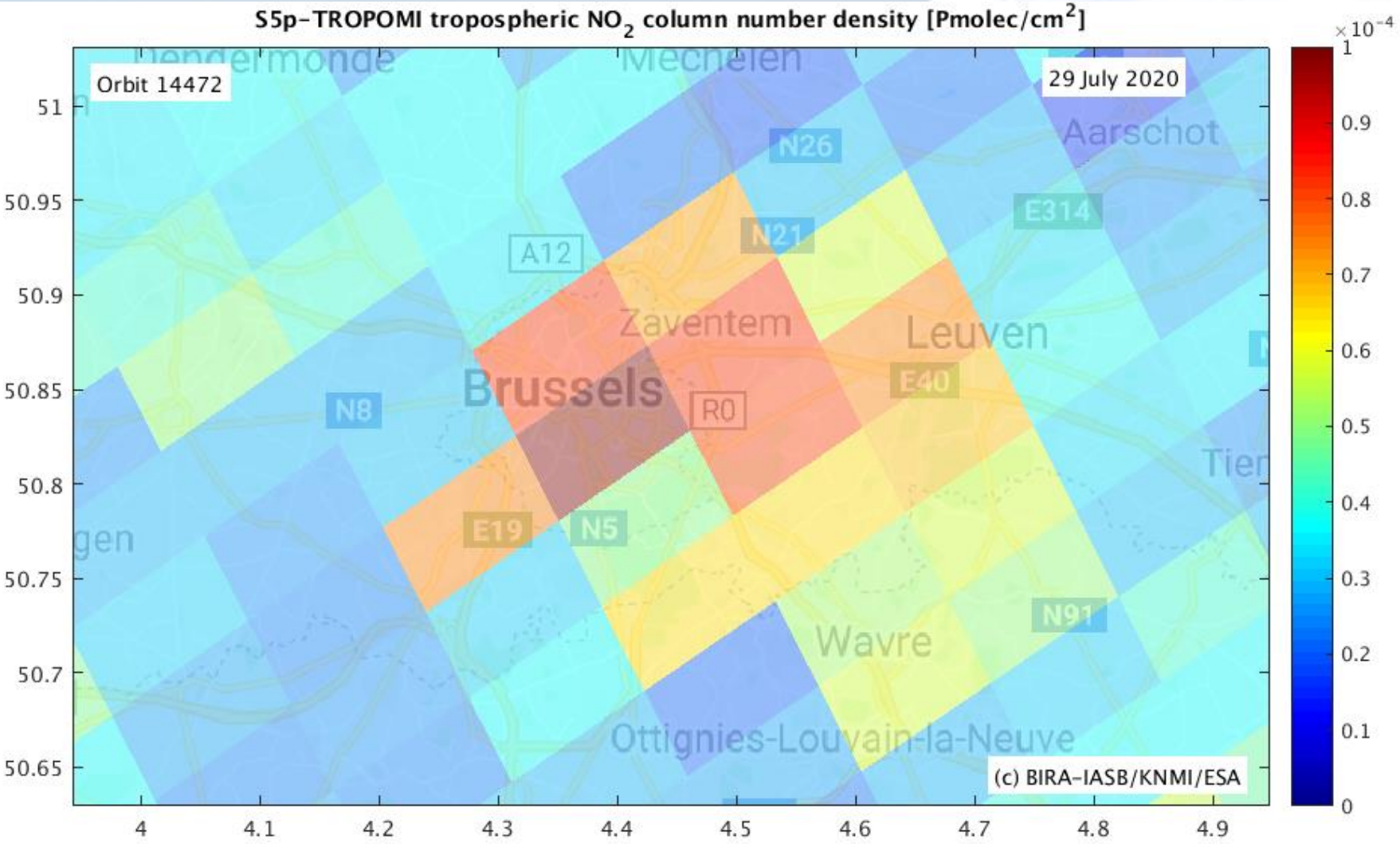
IV. Outreach and valorisation

   Liaison with identified stakeholders, both in AQ policy and in the data retrieval communities

Appetizers: Brussels (low emissions test case)

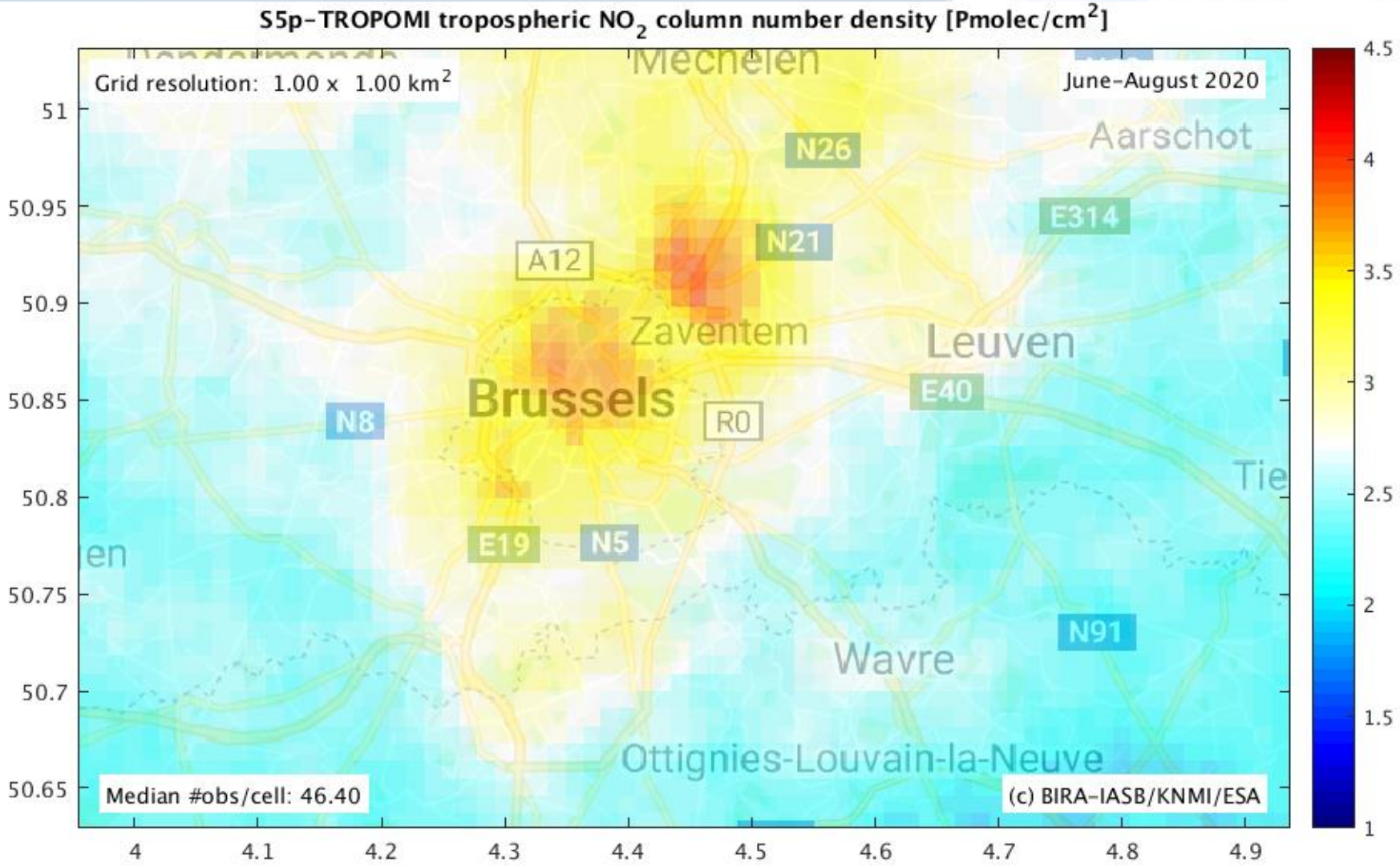
A single Sentinel-5p overpass over Belgium

Nominal ground resolution: 3.5 x 5.5 km^2



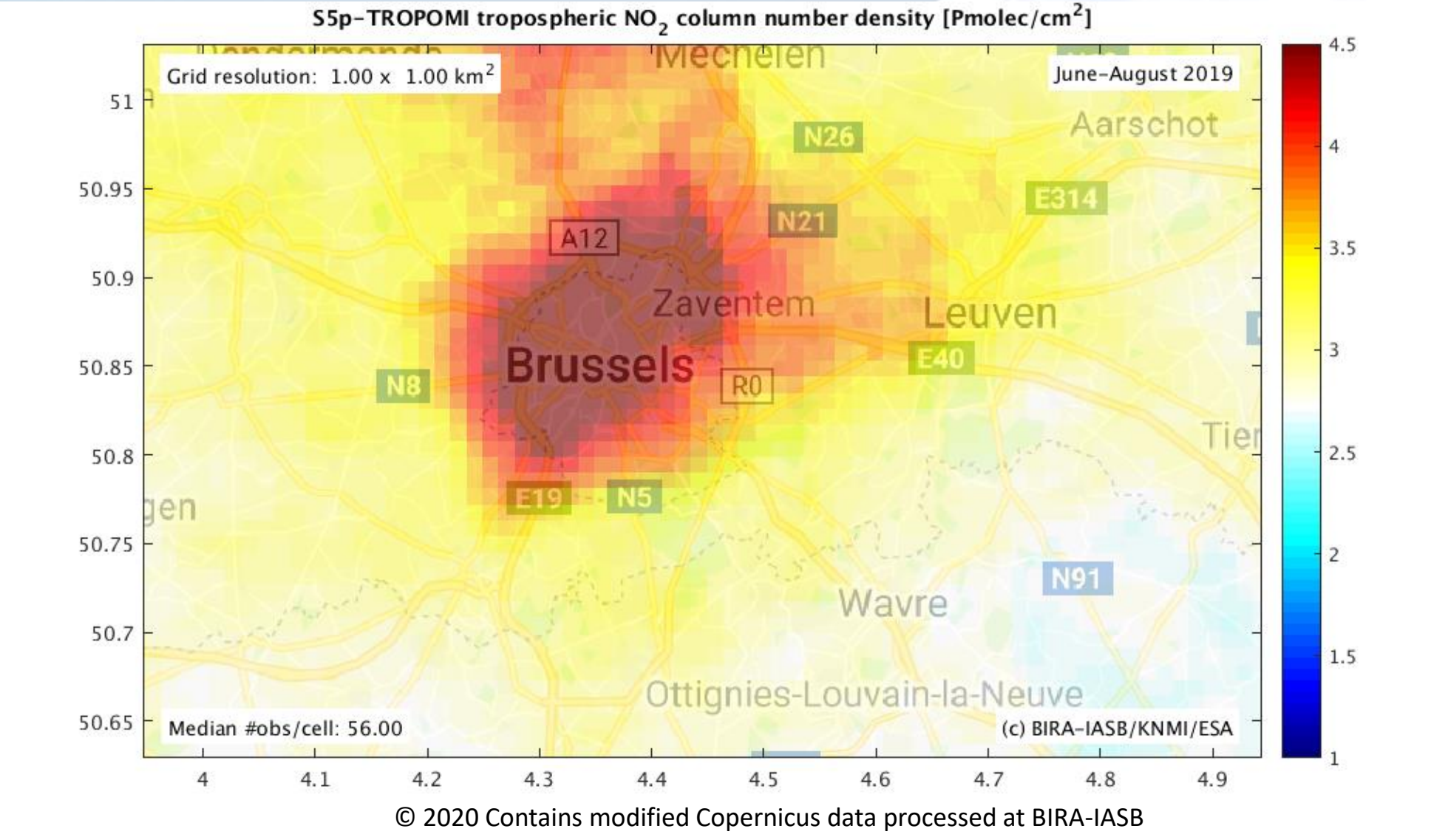
Appetizers: Brussels (low emissions test case)

- **Temporal aggregation** (from days to months, here: 3 months)
- **Filtering** (on quality and winds)
- **Spatial oversampling** with area-overlap weighting
- **Uncertainty propagation**

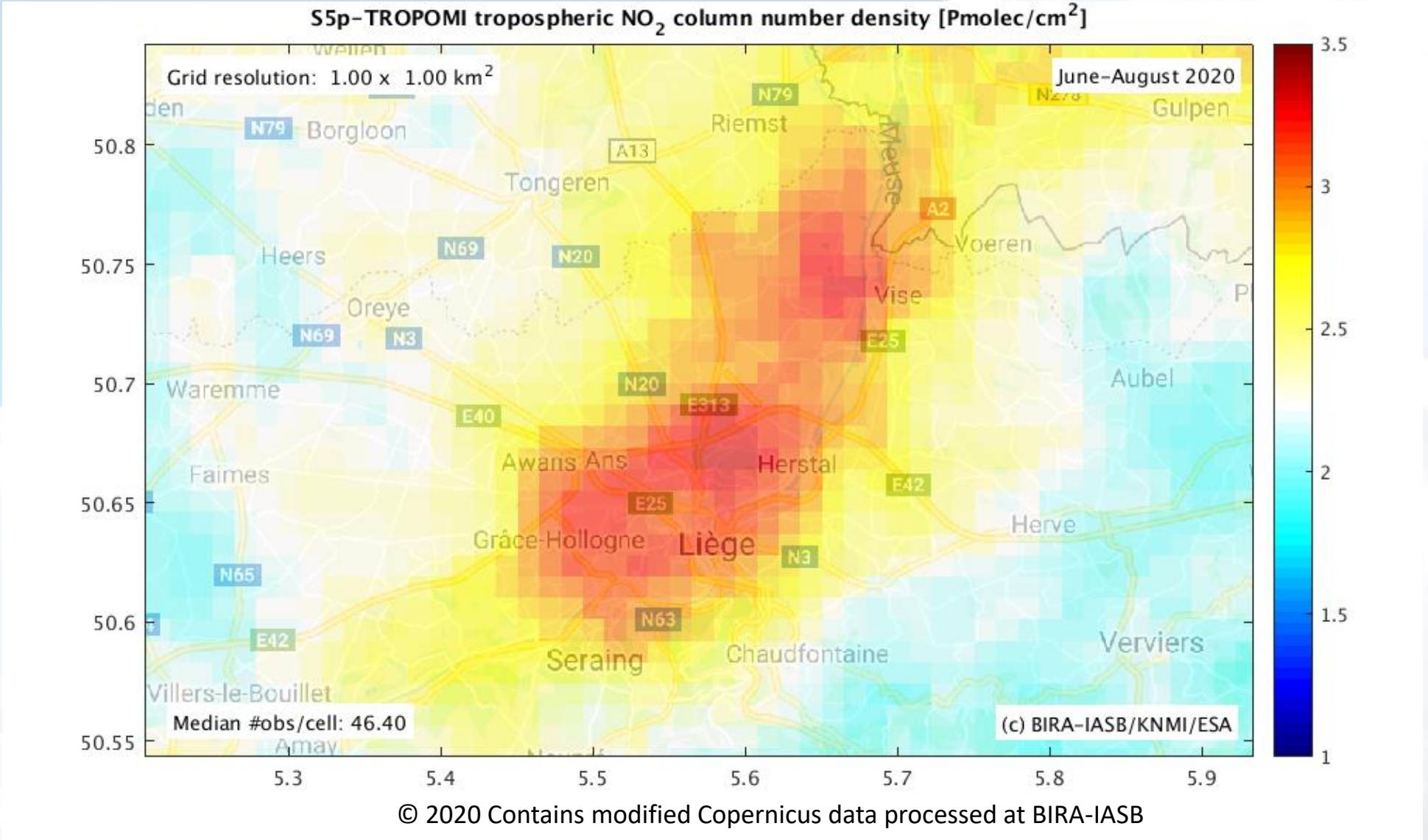


Appetizers: Brussels (normal emissions test case)

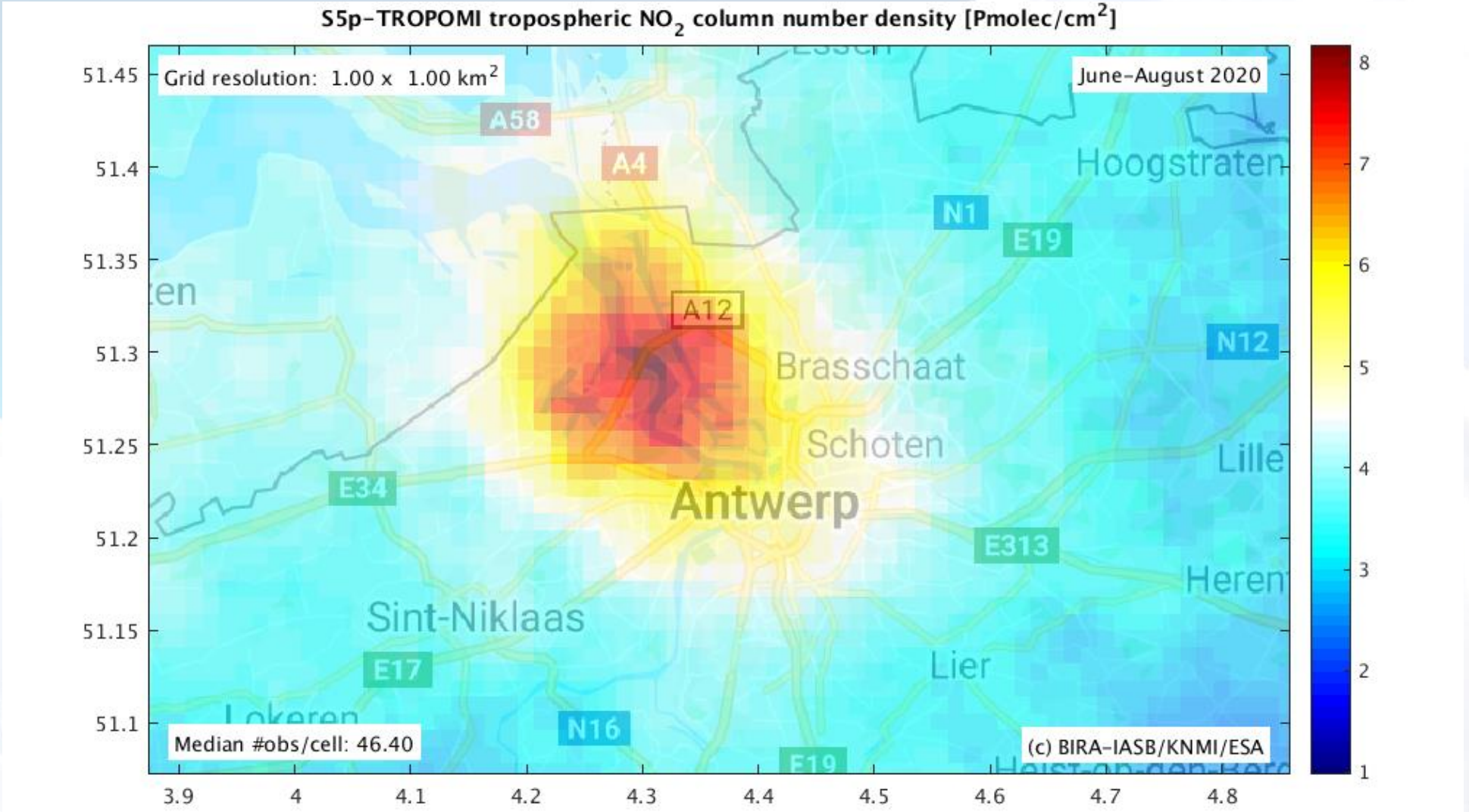
- **Temporal aggregation** (from days to months, here: 3 months)
- **Filtering** (on quality and winds)
- **Spatial oversampling** with area-overlap weighting
- **Uncertainty propagation**



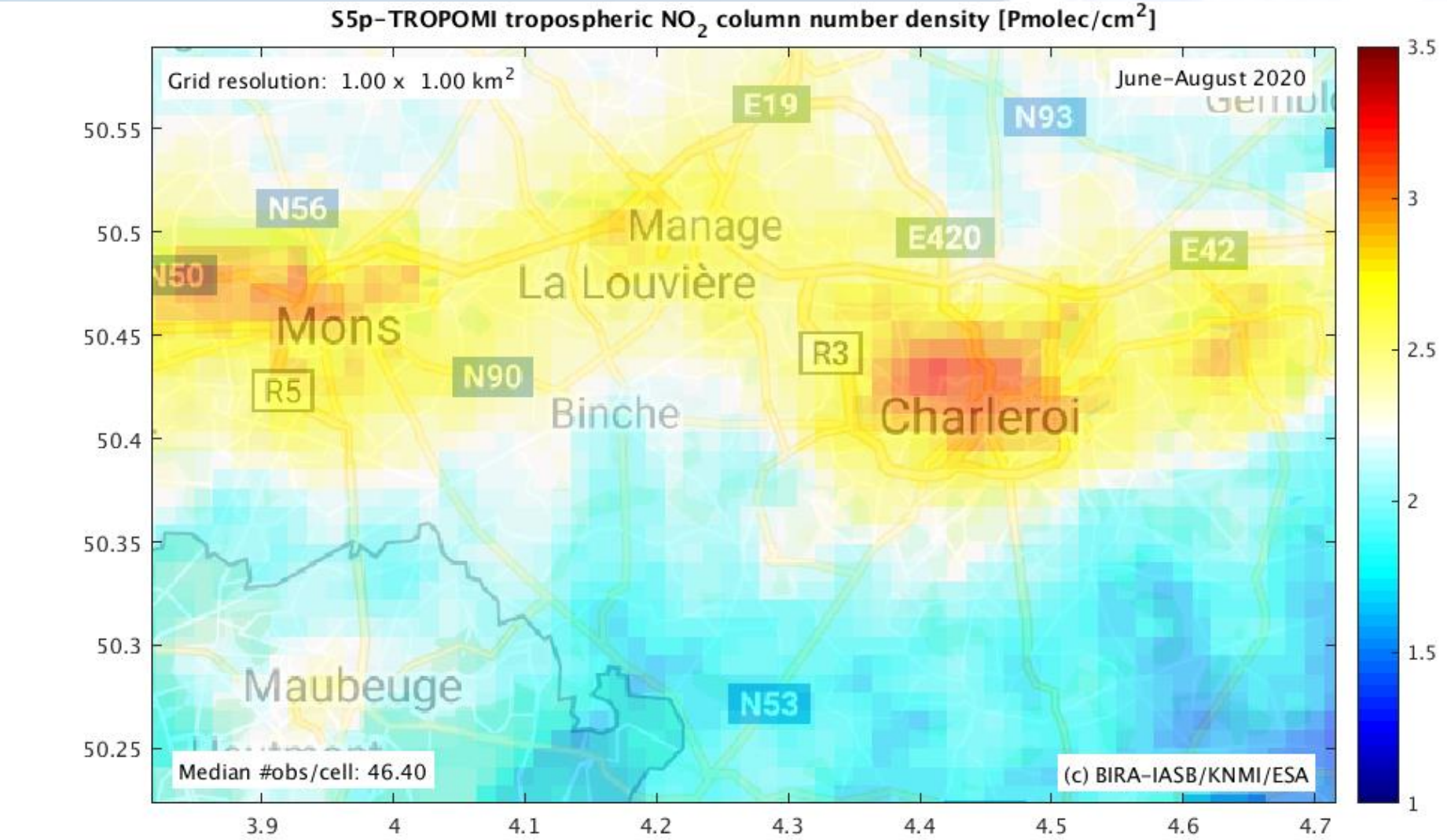
Appetizers: Liège (low emissions test case)



Appetizers: Antwerp (low emissions test case)



Appetizers: Mons & Charleroi (low emissions test case)



Visit our web site and get in touch !

https://lego-bel-aq.aeronomie.be

User feedback is highly appreciated (and consultation is part of the project).

Sentinel-5p data are being processed now:

- Requests for data format
- Requests for specific areas
- Requests for specific temporal and spatial aggregation and filtering
- …

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