www.scienceinschool.org

Eyes in the sky: tracking air pollution with satellites

Activity 2 answer sheet

Mapping NO_2 emissions with Copernicus Browser

- **Where are the main European NO_2 hotspots? Did you expect these results?**
  Central Europe, especially Belgium and the Netherlands, often show persistent NO_2 hotspots due to dense traffic and heavy industry. The Po Valley in Northern Italy is another major hotspot, driven by traffic and industrial emissions, and further exacerbated by the surrounding mountains, which trap pollutants and limit air circulation. Yes, these results are expected, as they correspond to regions with high population density, industrial activity, and unfavourable meteorological conditions for pollutant dispersion.

- **What type of human activity generates NO_2?**
  - Road transport (cars, trucks, diesel engines)
  - Power plants burning coal, oil or gas
  - Industrial processes and refineries
  - Domestic heating systems
  - In much smaller levels, biomass burning (forest fires, agriculture)

- **Use the Copernicus Browser to check NO_2 maps for different days over the same region. Do you notice changes? Why might this happen?**
  Nitrogen dioxide (NO_2) doesn't stay in the air for long, usually only a few hours to a couple of days. Its levels change with traffic, weather and sunlight. Wind can move or spread pollution, carrying NO_2 away from cities or mixing it with cleaner air. This makes hotspots shift from day to day. Scientists use weekly or monthly averages of Sentinel-5P data to see overall pollution patterns instead of short-term changes. These measurements were averaged over several months in 2018.[1]

- **Why do some areas (e.g. Spain) appear blank on the NO_2 map?**
  Some areas on the Sentinel-5P NO_2 map, such as over Spain (where it was probably cloudy that day), appear blank because the TROPOMI instrument needs sunlight to detect gases. It measures how light is absorbed and scattered in the atmosphere, a bit like how a camera captures reflected light. When clouds, dust, or aerosols block sunlight, the satellite can't "see" through them and records no data for that region. Scientists combine data from multiple satellite overpasses to fill these gaps and to build a complete picture of air quality in a given area.

- **Satellites show where NO_2 is in the atmosphere, but ground stations also measure it. Why do scientists use both?**

  Satellites measure NO_2 in the troposphere, the lowest atmospheric layer, providing a global perspective on air pollution. In contrast, ground-based stations measure NO_2 at surface level, where people actually breathe, offering local precision. By combining both types of data, scientists can gain the most accurate understanding of air quality and improve forecasts, like those available on Copernicus Atmosphere Monitoring Service. [2]

References

[1] Nitrogen dioxide pollution mapping with TROPOMI.: https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-5P/Nitrogen_dioxide_pollution_mapped

[2] Copernicus Atmosphere Monitoring Service – nitrogen dioxide forecast: https://atmosphere.copernicus.eu/charts/packages/cams/products/nitrogen-dioxide-forecasts