Development Plans for the TROPOMI Aerosol Index

Koninklijk Nederlands Meteorologisch Instituut
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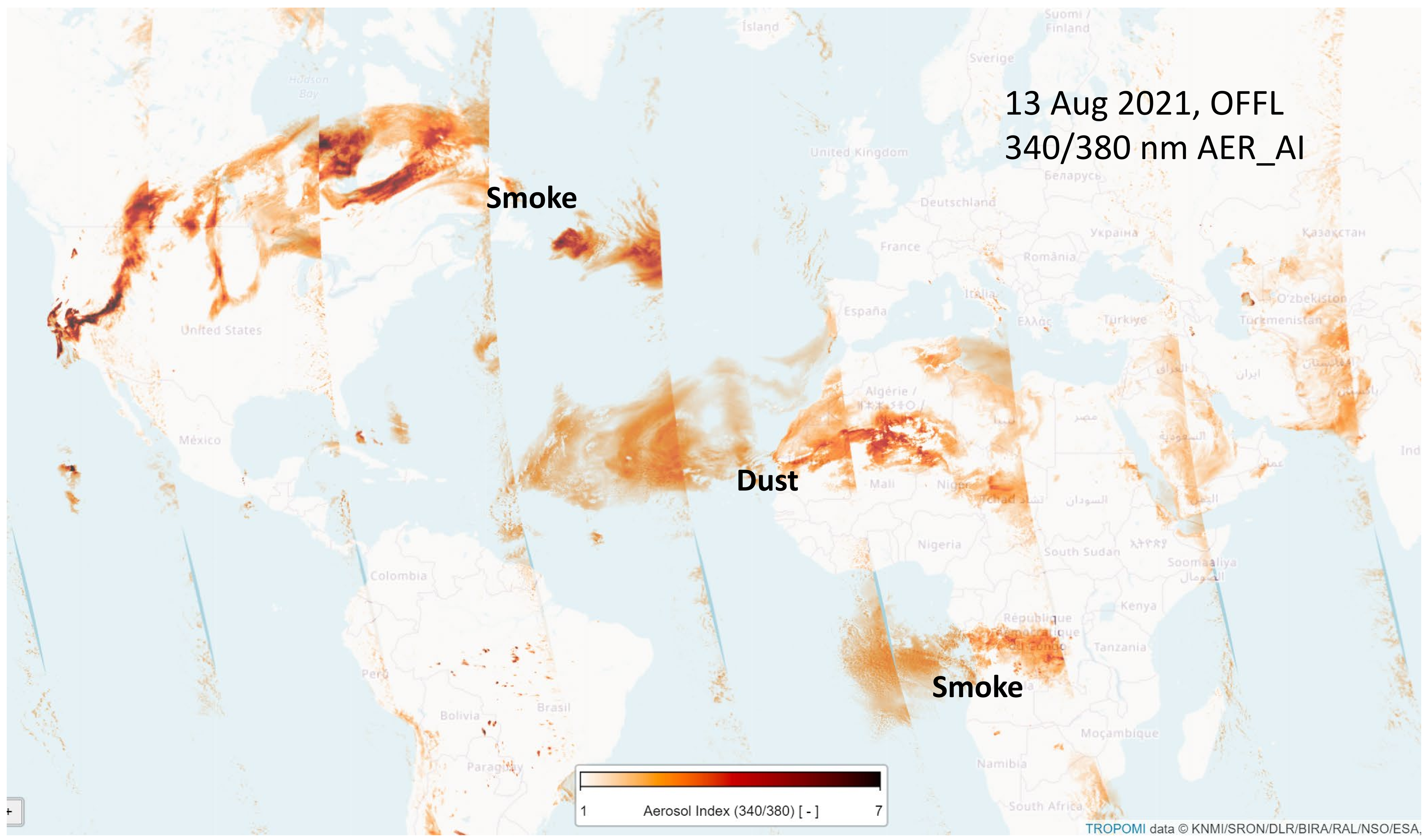
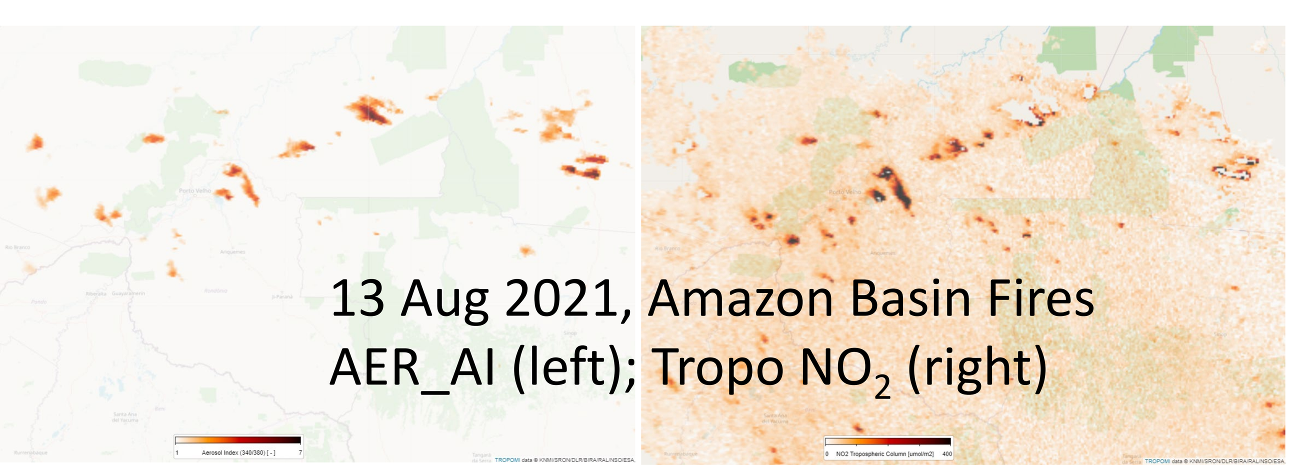
Aerosol Index: Ideal for global plume tracking

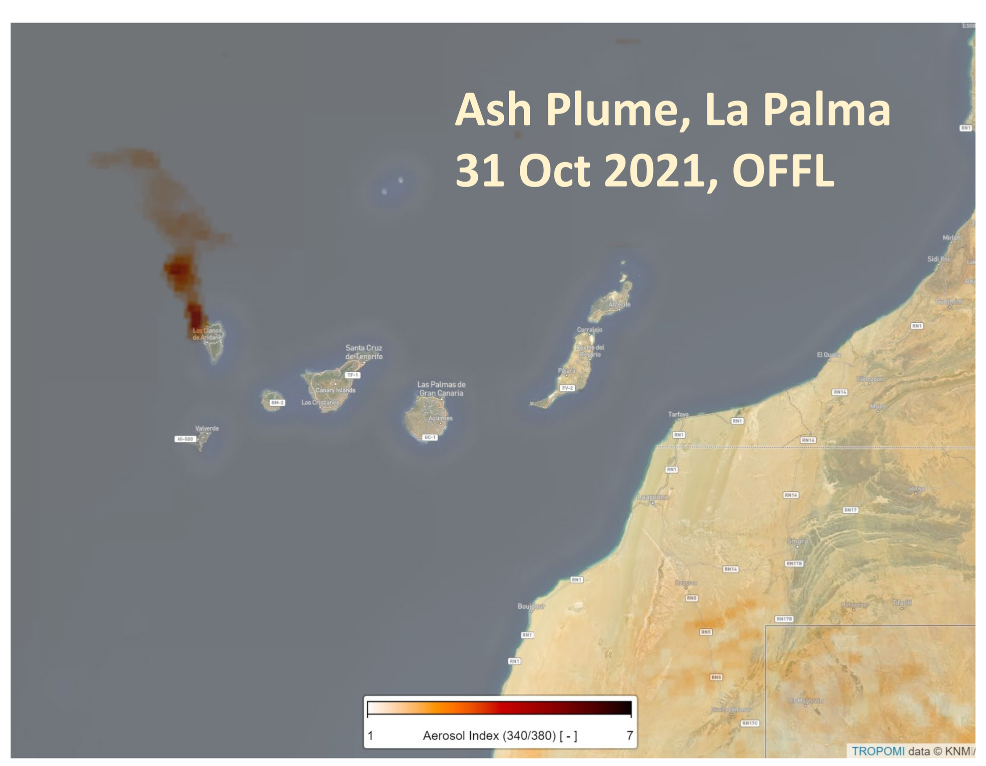
The TROPOMI Aerosol Index (AER_AI) is designed to indicate the presence of **UV-absorbing aerosols** including **dust, smoke and volcanic ash.** The operational data record for TROPOMI AER_AI is available starting form May 2018 and since Aug 2019 nadir **pixel size is approx. 3.5 x 5.5 km** with daily global coverage. These aspects make the data ideal for tracking aerosol plume events from biomass burning, desert dust outbreaks, and ash-yielding volcanic eruptions. The image below show fresh and transported smoke and dust plumes traveling over the Atlantic Ocean from both North America and Africa.



Suitable for small plumes:

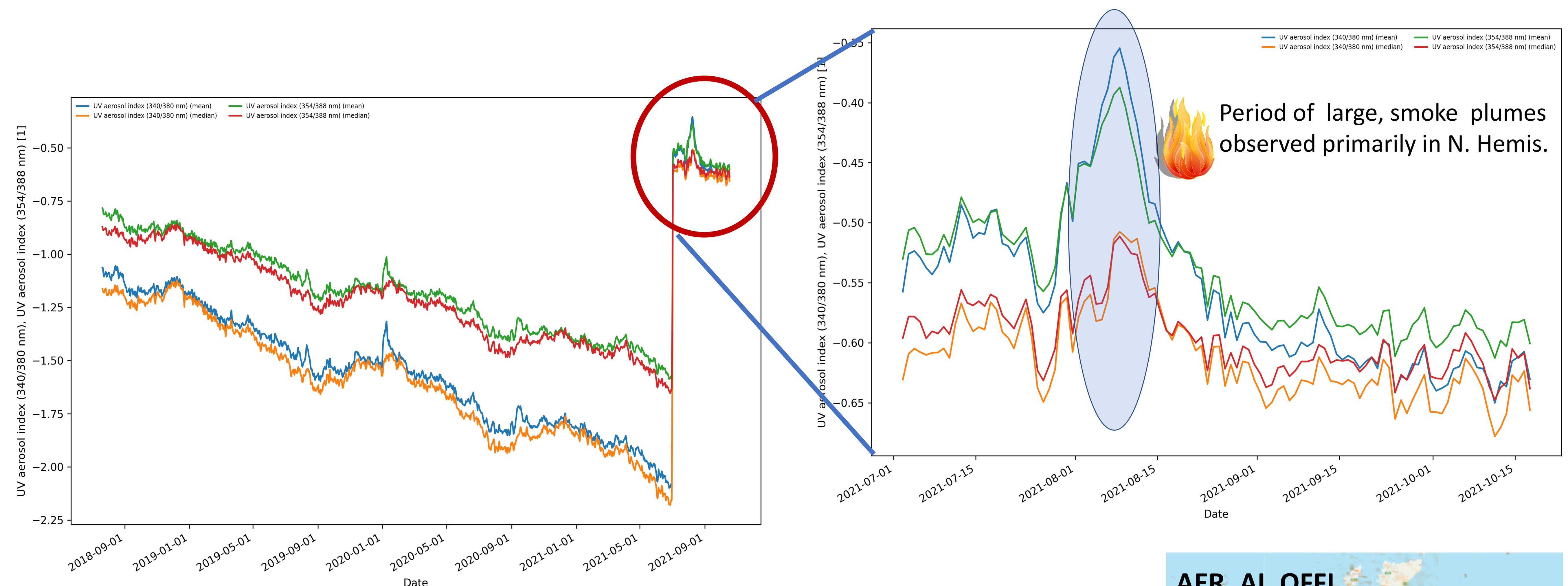
TROPOMI's high spatial resolution allows for detection of small smoke and ash plumes, provided the aerosols are UV-absorbing and sufficiently elevated in the atmosphere (> 1km)





Reprocessing: Setting the record straight

In the figure below, the left panel shows daily, global averages from the TROPOMI Operational AER_AI data record from July 2018 to late-Oct 2021. **What caused the decreasing trend and the discontinuity jump**?-- these features are caused by changes in the irradiance and radiance data (or Level 1). The AER_AI data product is very sensitive to any change in these values. As a result of **wavelength-dependent degradation in both irradiance and radiance**, a steadily increasing negative bias was present until a correction in the L1 data was applied (July 2021) for the irradiance degradation. After this update, AER_AI appeared to be subject to "overcorrection" (still under investigation) and so an offset (negative) was applied to bring the **global average to the expected value of -0.5 AI points**. Due to these biases in the data record, it is not recommended to conduct trend analysis using TROPOMI AER_AI data in its current form. However, once the data is **reprocessed** (planned mid-to-late 2022), the L1b data and offsets applied to AER_AI will be uniform, so that only a seasonal cycle will remain. The panel on the right zooms in on the period after the corrected irradiance data is used. Here (right panel), initial results indicate that the correction has susscessfully accounted for the previously observed decreasing trend.



Cloud & other effects: the way forward

Due to the small pixel size, the assumption that the "surface" behaves in a Lambertian way breaks down for detailed cloud structures and cloud shadows (see work of V. Trees). One of the strengths of AER_AI is that it can be quickly calculated with a relatively low processing effort so that it can be used to quickly flag aerosol layers in other TROPOMI trace gas retrievals. Thus, it is important not to introduce dependencies on external data sources or complicated a priori information.

The plots of AER_AI and cloud fraction over the UK and Ireland from 2 Nov 2021 illustrate how patchy cumulus fields lead to **positive aerosol index values driven by cloud *not* aerosol.** A swath position dependency is also visible in the AER_AI plot, where features on the East side of the swath exhibit relatively higher AI values.

Based on the work of G. Tilsta, a first step will be to introduce an additional aerosol index data field where the AI is calculated with a bi-reflector model, making use of two Lambertian reflectors instead of one to describe the scene reflectance at the top-of-atmosphere (TOA). The scene reflectance is then constructed as a mixture of a surface/clear-sky reflectance and a cloud reflectance.