Evaluating trends in TROPOMI aerosol index

Deborah Stein Zweers[1], Maarten Sneep[1], and Martin de Graaf[1]
*deborah.steinzweers@knmi.nl 1 – KNMI, De Bilt, The Netherlands

Royal Netherlands Meteorological Institute
Ministry of Infrastructure and Water Management

Quick Summary: **The Aerosol Index (AER_AI) is a ratio of two radiances and can tell us about the presence of climate-relevant UV-absorbing aerosols from wildfire smoke, desert dust and volcanic ash. Also, the AER_AI is very sensitive to the calibration of both radiance and irradiance for the TROPOMI satellite instrument. Therefore, we monitor trends and seasonal cycling in this data and present them here using the full operational mission dataset covering 5 full years.**

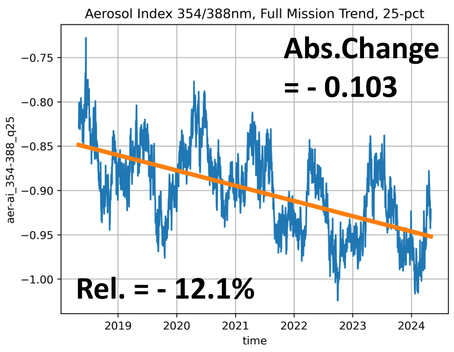
On this poster:

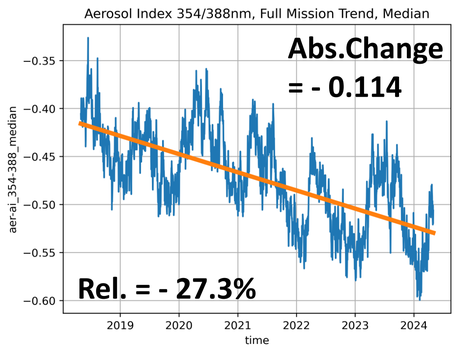
1) **Evaluate** the observed trends of TROPOMI aerosol index for the period **30 April 2018 – 30 April 2024**
2) **Discuss** implications of trends using analyses aimed at separating aerosol & instrument-driven effects
3) **Explore, Analyze & More:** TROPOMI sites for data access, mapping, download & analysis

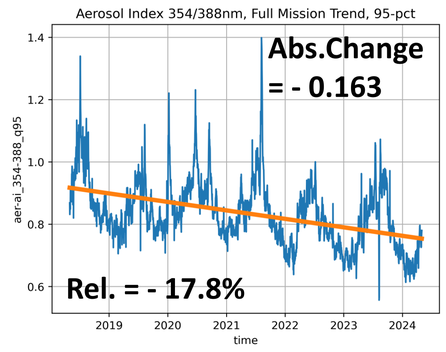
Evaluate trends in TROPOMI AER_AI

Data used: AER_AI daily, global averaged, reprocessed (RPRO) + (OFFL) data (from 30 April 2018-2024). Using the PyCAMA software, daily Level 2 data fields are binned & stored as histograms to evaluate trends for specific thresholds*, note differences in scale*:

AER_AI 354/388nm pair: (**left**) 25%-tile background values, calibration indicator; (**middle**) median; (**right**) 95%-tile aerosol events

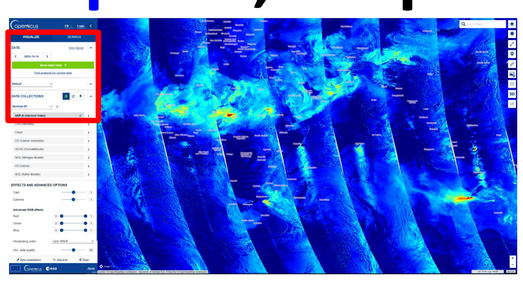






Discussion: There is a **downward trend** for all monitored thresholds including 1%, 10%, 25%, median, mean, 90%, 95%, and 99%. The lowest thresholds serve as indicators of background, non-aerosol affected pixels and are more closely related to (irr)radiance and therefore the state of the instrument and calibration. The relative change is largest for the mean (-33.5%, not shown) and the magnitude of the absolute change over time increases with higher thresholds (mean = -0.122, 99%-tile = -0.268). Interestingly, there is a slight *increase over time* in the maximum values (rel. change = + 11.0%). However, since the trends are generally larger with for higher AI-values, this suggests an aerosol-driven change, which may mean less UV-absorbing aerosol is being observed over the span of the TROPOMI mission. The latest **RPRO+OFFL data includes corrections for degradation in radiance and irradiance.** Trend analysis of Level 1 radiances at wavelengths relevant for AER_AI, as shown in the work from van der Plas et al., **poster P9.1** suggest no trend is present over the mission. Therefore, while some degree of degradation *may* still be present in the data it is *not* a driver for AER_AI trends observed and presented here.

Explore, Map & Analyze TROPOMI data:



https://www.tropomi.eu

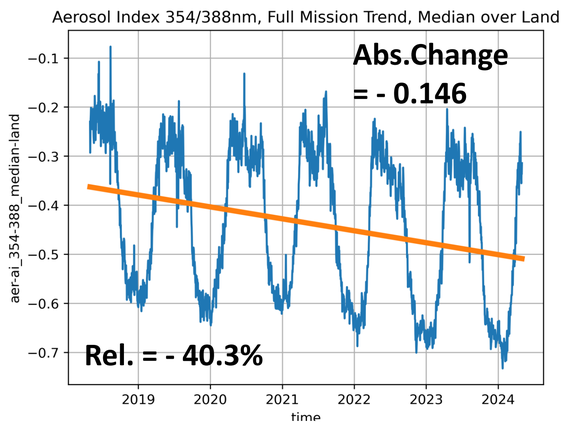
Data Access via:

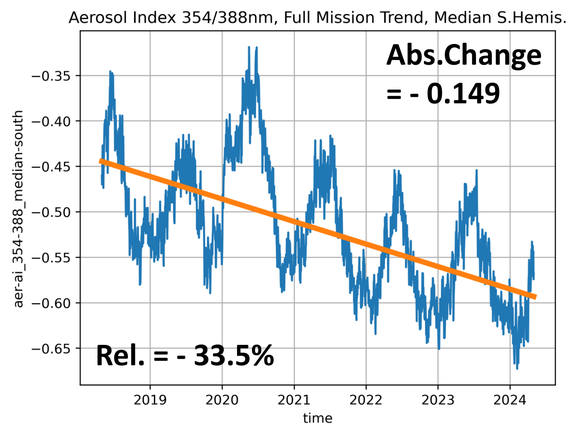
https://dataspace.copernicus.eu

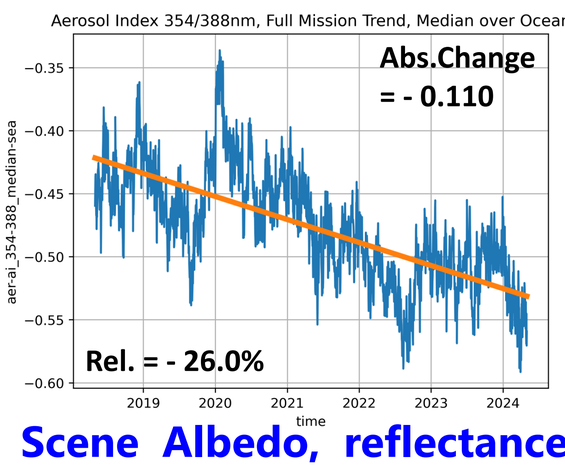
Questions? EOSupport@Copernicus.esa.int

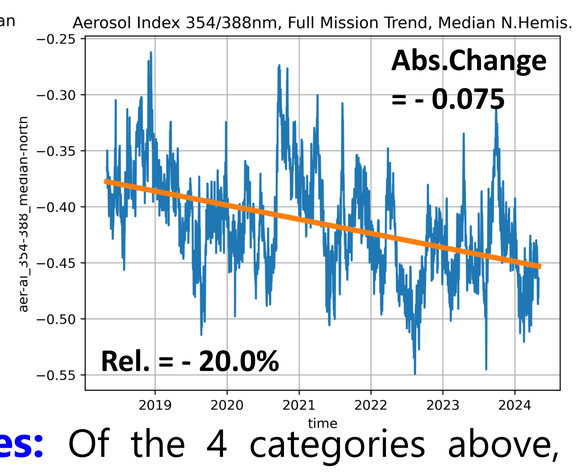
Disentangling Trends

Delineation: Where is the trend most prominent? Here, the dataset is filtered: **Land (top L), Ocean (bottom L), North (bottom R) and South Hemisphere (top R)**. This separation indicates an aerosol-driven trend is strongest for pixels over land in the southern Hemisphere and therefore suggests that longer-term changes in biomass burning emissions may be driving the observed trends.



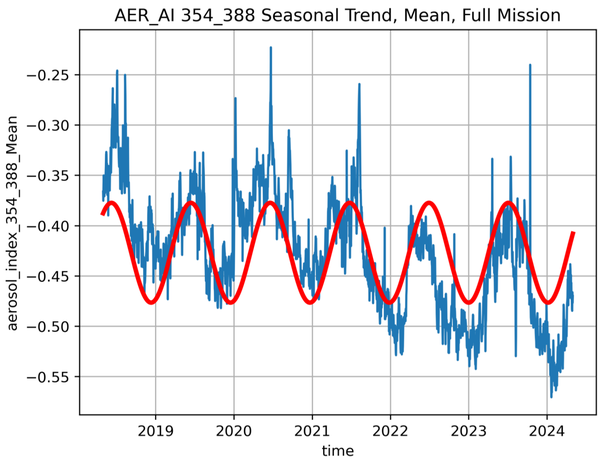


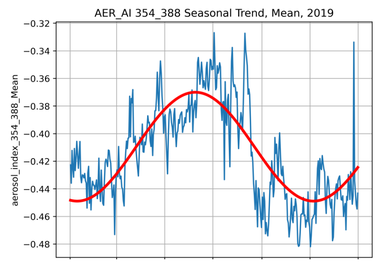


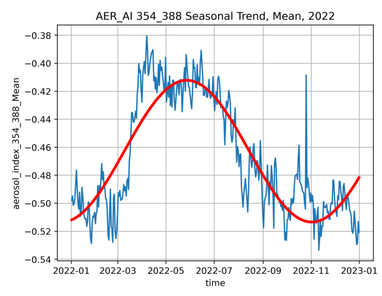


Scene Albedo, reflectances: Of the 4 categories above, corresponding trends in scene albedo at 388nm, reflectance at 354 & 388nm all show most pronounced increases over **LAND** further suggesting physical driver(s) of observed AER_AI trends.

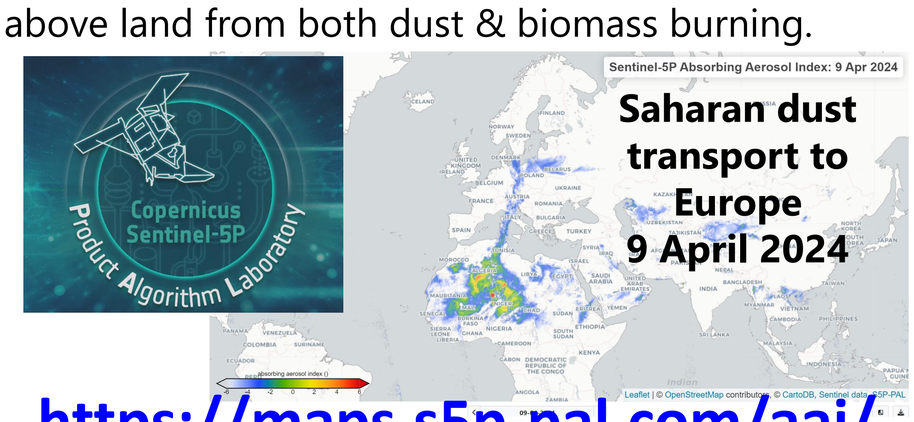
Seasonal Cycles







Evaluating the seasonal cycle (full mission, 2019, 2022 as shown above): the amplitude of annual variability is quite small, similar to the magnitude observed with OMI OMAERO aerosol index. The timing of the seasonal cycle peak corresponds to annually-observed, persistent aerosol plumes present above land from both dust & biomass burning.



https://maps.s5p-pal.com/aai/

- **Download & Map L3 Gridded Data:** You can map any operational TROPOMI dataset at S5P-PAL using daily, monthly or yearly data; & you can also download the Level 3 gridded data. Gridded data is needed for time-series analysis.