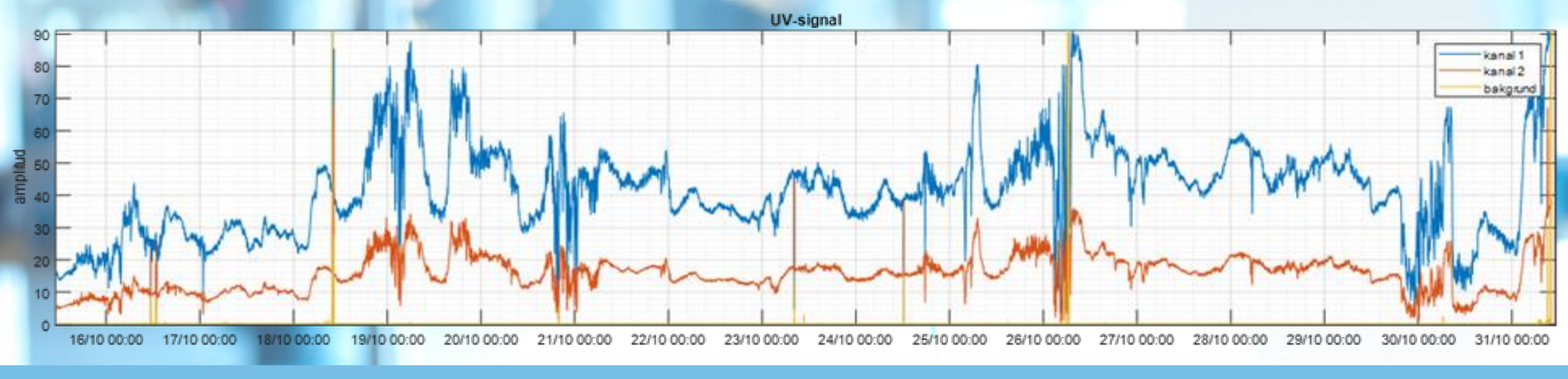


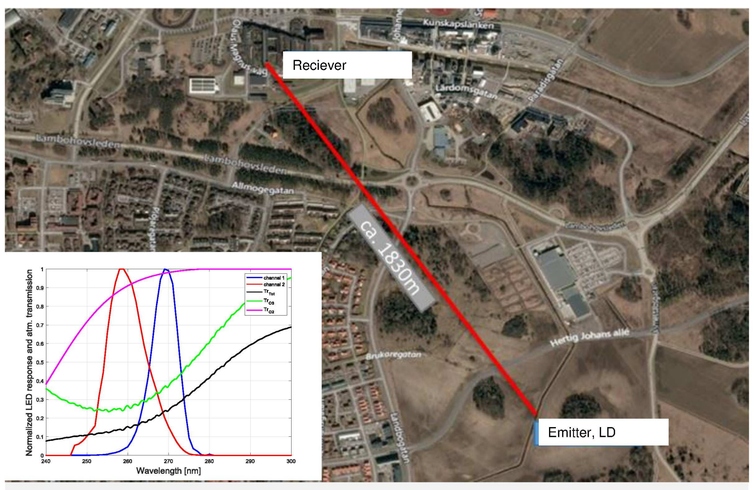
Ground-level ozone impact on optical propagation in the ultraviolet wavelength range

In the UV (UVC) wavelength range are aerosol, precipitation, oxygen and ozone the strongest dampening factors of radiation. Ozone is continuously formed at the ground level in photolysis of the nitrogen molecule but is consumed equally rapidly in a reaction series. But in the presence of sunlight and volatile organic compounds (VOCs) is ozone formed which is not consumed as rapidly and therefore increases the concentration. The ozone content is generated locally and varies with local wind fields and is there more difficult to predict.

Authors

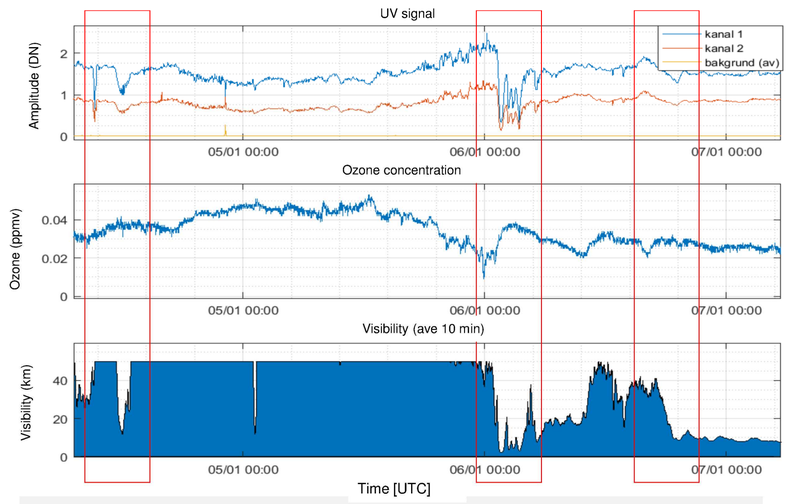
Ove Gustafsson, Johan Eriksson and Sebastian Möller at
Swedish Defence Research Agency

ove.gustafsson@foi.se



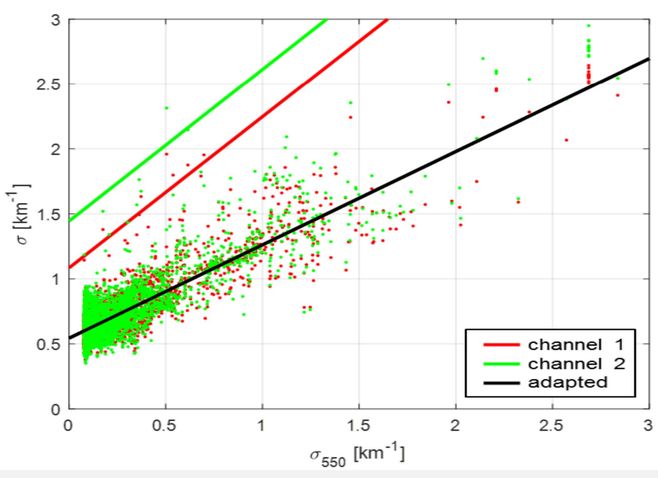
Transmission measurement

During November-January 2018-19, continuous measurements of UV transmission, ozone content and other atmospheric parameters have been carried out. During the period, the weather has been predominantly autumn-like with plus degrees and short periods of freezing.



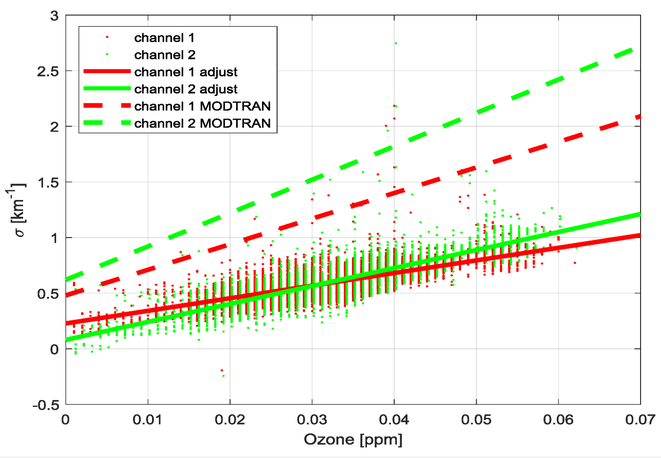
Examples of data

A section from these recordings with UV signal from the three channels, the Ozone content and the visibility value collected with the weather station. All registered data have been used as a basis for analysis.



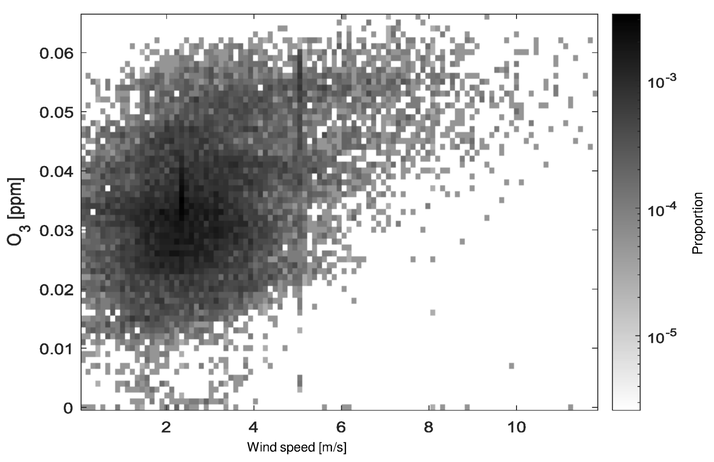
UV versus visual extinction

Comparison of UV extinction dependence on visual extinction from MODTRAN (solid red and green lines) and measurements (dots and solid black line) respectively. The difference in offset is probably related to calibration errors in the measurement setup.



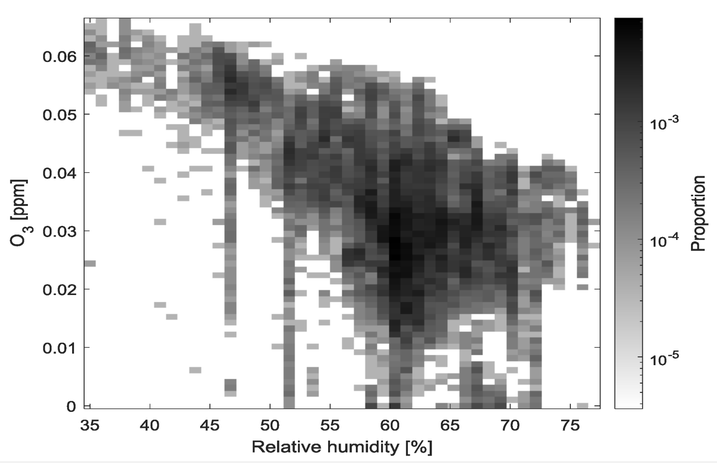
UV extinction versus Ozone

The extinction calculated from the signal levels in the UV channels versus measured ozone values is shown together with custom linear curves with another inclination than simulations performed with MODTRAN.



Ozone versus wind speed

Ozone concentration as a function of wind speed. Here it can be noted that higher wind speeds also result in higher Ozone concentrations. Darker areas mean more data points, white means no data points



Ozone versus relative humidity

Dry air has significantly higher ozone content than moist air. When the humidity is above 65% the Ozone concentration is rarely over 40 ppb. But if RH is below 45%, it is almost guaranteed that the ozone concentration is above 50 ppb.

Conclusion

The collected measured data as well as the SMHI and the Swedish Environmental Protection Agency data, as well as other research reports shows variations in the atmospheric ground-level Ozone content that are not easily explained by weather parameters alone. Theories around this indicate that it is volatile hydrocarbons and other molecules, both natural and anthropogenic, that cause this variation along with solar radiation.

The measured transmission data for the UV wavelengths showed small or no significance for the UV extinction at visibility values above about 15 km.

In the relation between the extinction for UV wavelengths and the corresponding for the visual wavelength range, the Modtran and the measured carried out in the project show different slope conditions, i.e. different relationships.

K. O. S. Gustafsson, J. Eriksson, and S. Möller, “Ultraviolet transmission measurements along horizontal near ground path in Nordic environment,” Proc. SPIE 11153, Environmental Effects on Light Propagation and Adaptive Systems II, 1115305 (9 October 2019); doi: 10.1117/12.2533449.