Conditions for deriving air quality information from satellite data

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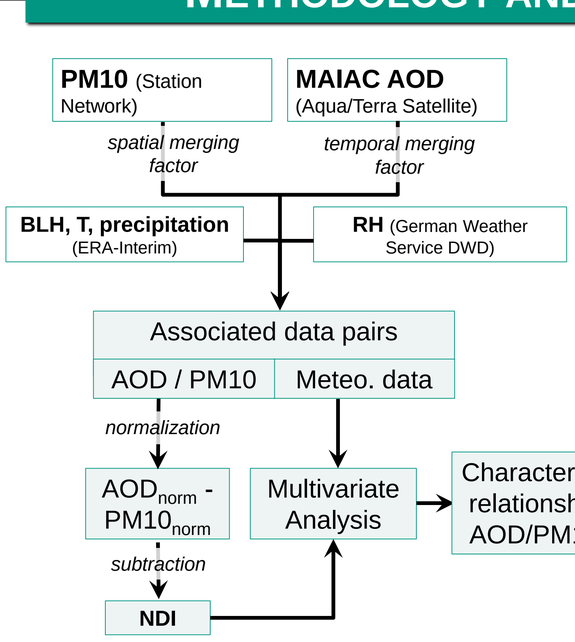
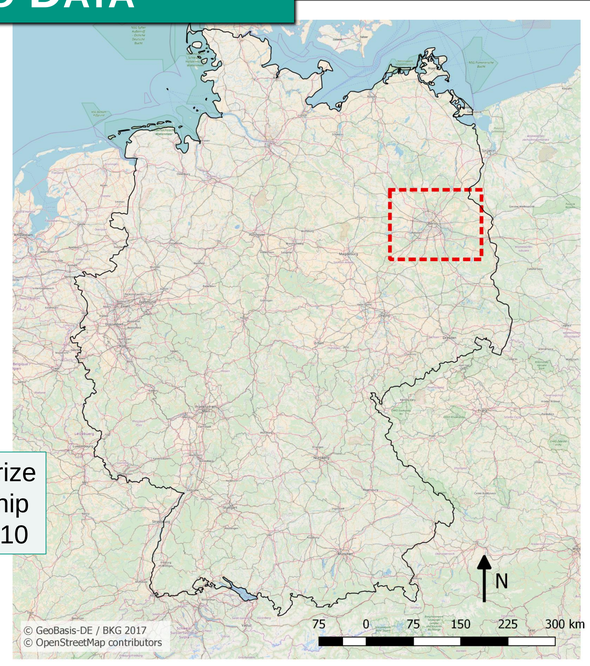
Motivation and Objective

- **Summary:** This contribution investigates the use of passive-sensor satellite data to infer on street-level air pollution
- **Motivation:** PM monitoring stations provide only limited spatial information. Satellite data can help gather information of the spatiotemporal distribution of pollutants
- **Objective:** To link street-level, station-based particulate matter concentrations (PM10) in an urban region to satellite-retrieved, vertically integrated atmospheric aerosol optical depth (AOD)
- **Approach:** The influence of meteorological parameters on the relationship AOD & PM10 is investigated. Situations, in which AOD is a reliable proxy for near ground PM10 are identified

Methodology and Data

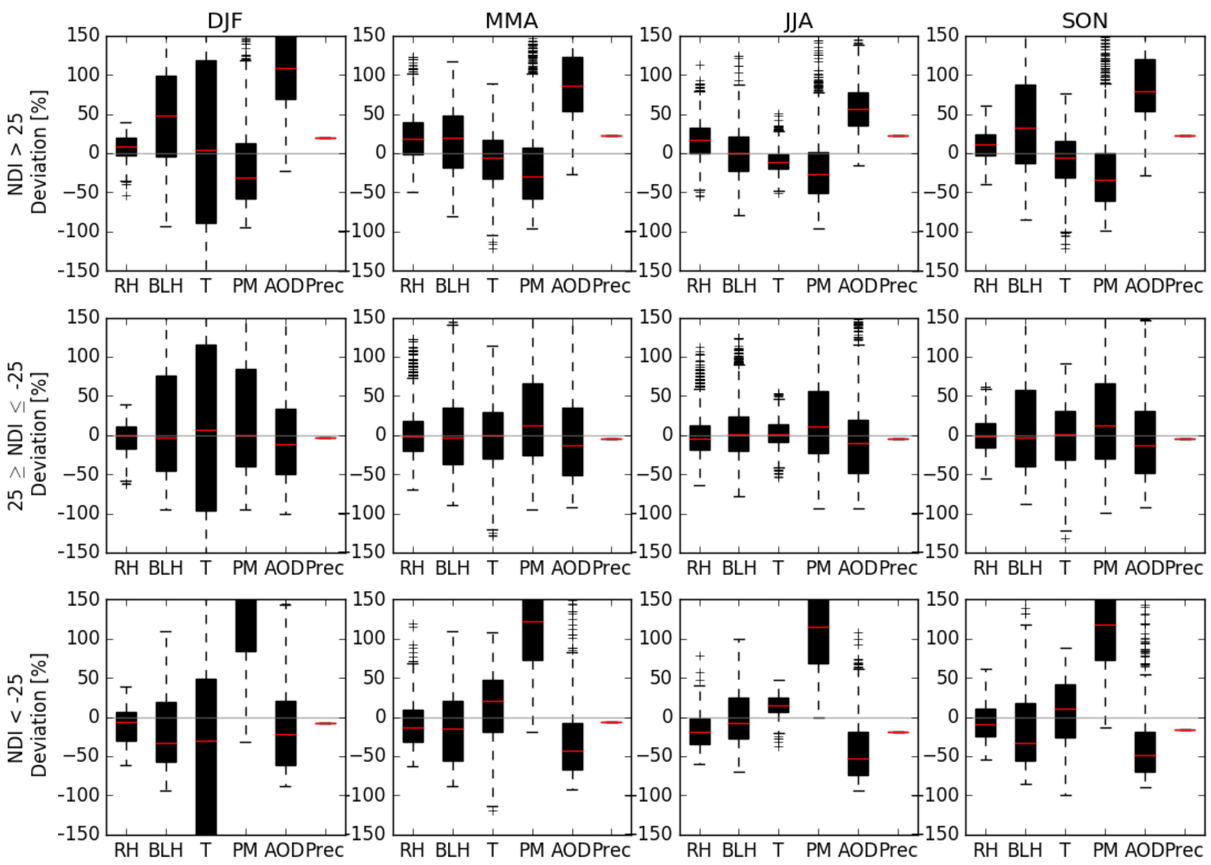




- Study area is Berlin with its rural surroundings, study period is 2001-2015. We use model output, satellite and in-situ data
- **Normalized Difference (NDI):** We normalize AOD & PM10 by monthly rank on a scale from 1-100. Subtracting this $PM10_{norm}$ from AOD_{norm} yields the **NDI**
- A positive (negative) NDI occurs, when relatively low (high) PM10 coincides with relatively high (low) AOD values. NDI close to zero indicates good agreement of AOD and PM10

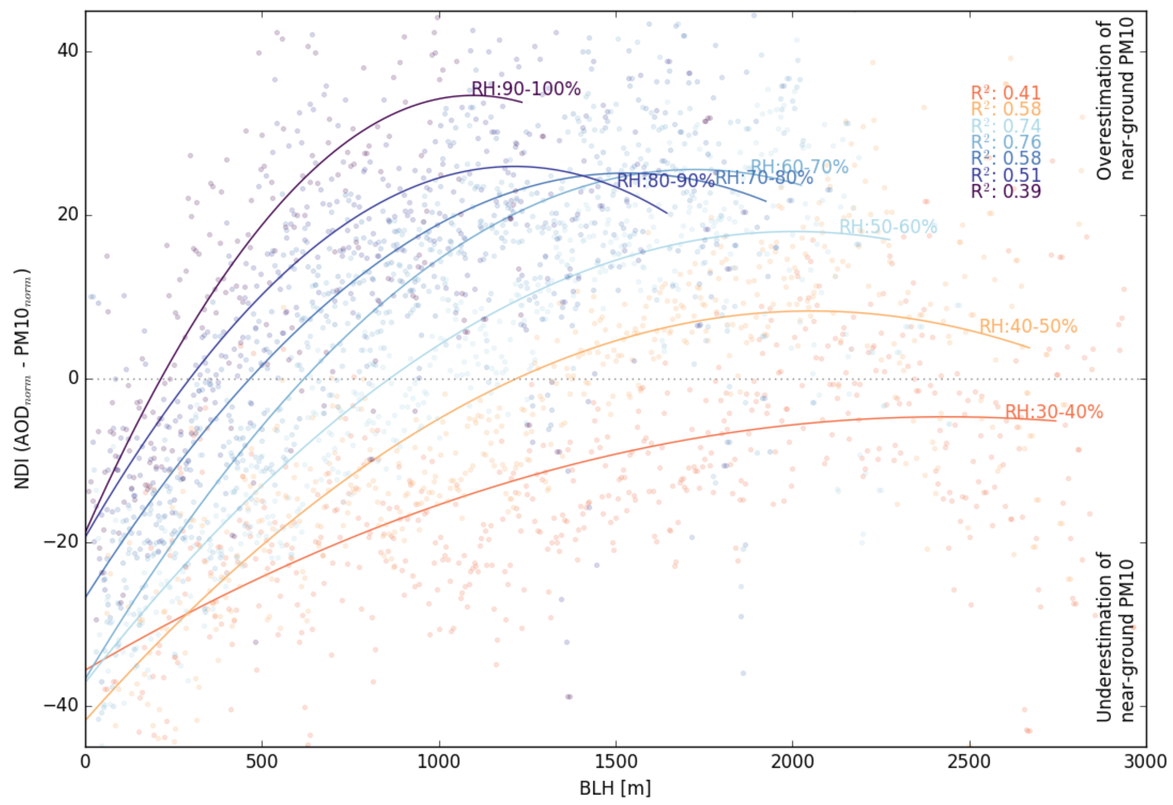
Characterizing the Relationship AOD/PM10

- We split our data in positive NDI values (>25), negative values (<-25) and values close to zero (-25 ≤ NDI ≥ 25)
- Possible factors explaining the variability of the relationship AOD/PM10 include relative humidity (RH), boundary layer height (BLH), Temperature (T) and the occurrence of precipitation (Prec)
- The boxplots show the relative deviation from each parameter's **seasonal mean** for a given NDI range



Mechanisms Behind the Relationship AOD/PM10

- High ambient RH is known to increase the AOD (Zieger et al., 2013); high BLH decreases PM10 concentrations near ground (Gupta & Christopher, 2009)
- We quantify these effects using the NDI. Favorable situations for predicting PM10 based on AOD appear when the atmosphere is dry (RH < 50%) and BLH > 1000 m



Conclusions

- AOD observations coinciding with high (low) ambient RH and high (low) BLH have a high probability to cause an overestimation (underestimation) of PM10
- The NDI proved to be a valuable tool to perform in-depth analyses on associated AOD & PM10 data pairs

Outlook

- In upcoming work, we will apply our results, using both satellite AOD measurements and meteorological parameters to estimate ground PM10
- These estimates will be used to investigate spatiotemporal patterns of high pollution events in urban areas

References

Gupta, P. & Christopher, S.A., 2009. Particulate matter air quality assessment using integrated surface, satellite, and meteorological products: Multiple regression approach. Journal of Geophysical Research Atmospheres, 114(14), pp.1–13.

Zieger, P. Fierz-Schmidhauser, R., Weingartner, E., Baltensperger, U., 2013. Effects of relative humidity on aerosol light scattering: Results from different European sites. Atmospheric Chemistry and Physics, 13(21), pp.10609–10631.