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Patterns of urban cloud modifications

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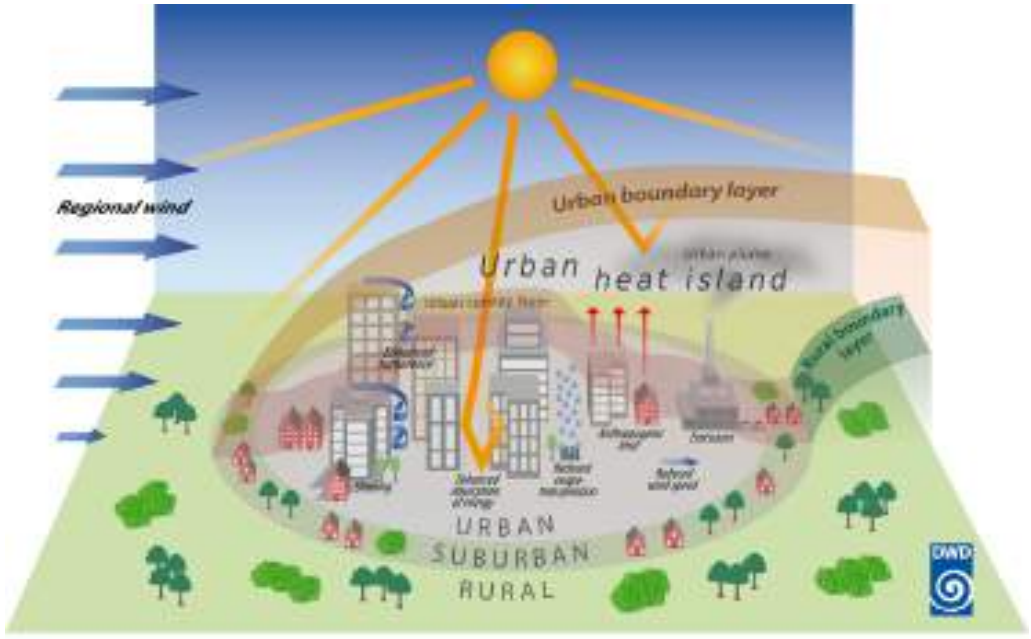
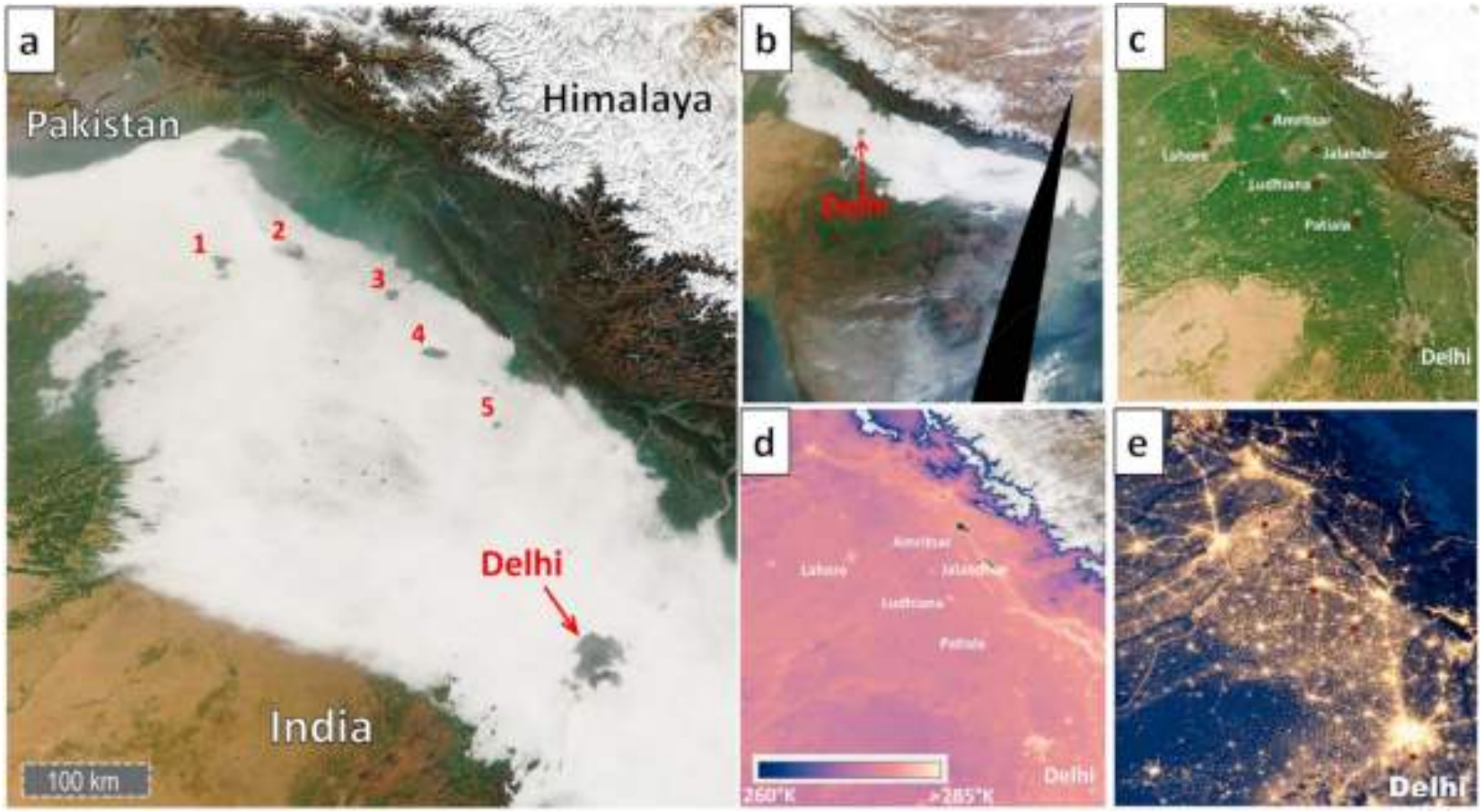
Motivation: Urban impacts on clouds

- Urban heat island effect, emission of anthropogenic aerosols, and increased roughness length of cities shape atmospheric processes in complex ways $\rightarrow$dominant processes still not understood
- Need for a complete understanding of all factors impacting urban cloud modifications



German Weather Service (DWD, accessed: 04-05-2020)

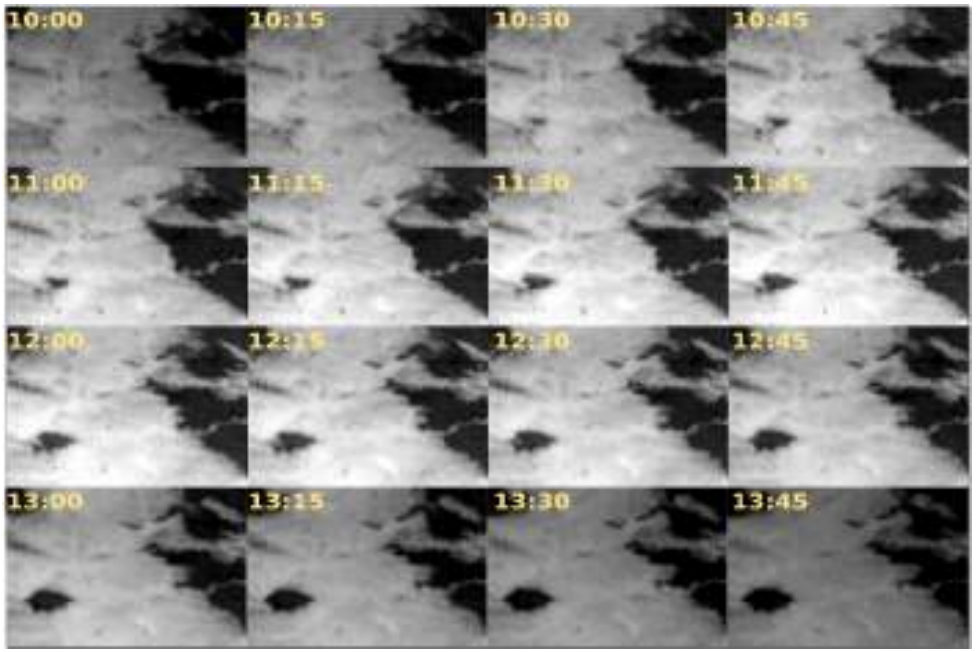
Example of urban impacts on clouds from satellite perspective



Gautam & Singh 2018

Research aim and data

- Goal: Spatial and temporal quantification of urban cloud patterns and their main influences using satellite observations over Europe
- Satellite data: High-resolution visible (HRV) channel of the Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard MSG

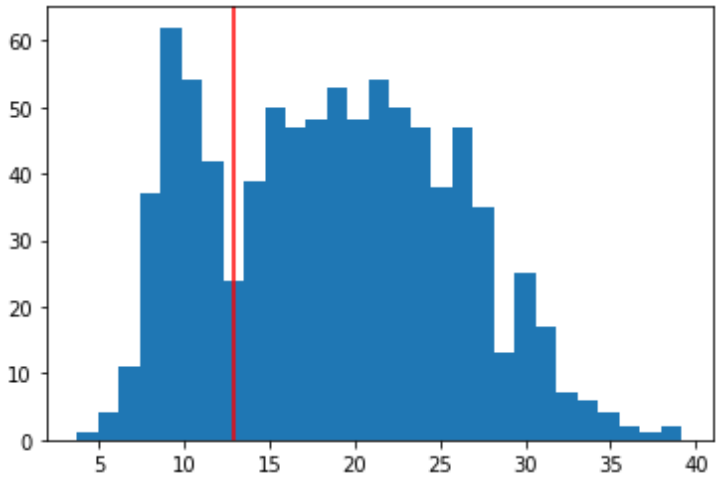


A hole in the low stratus is evolving right above the metropolitan region of Paris in the morning hours of December, 30th 2016

Method: Satellite-based analysis of urban cloud spatiotemporal patterns

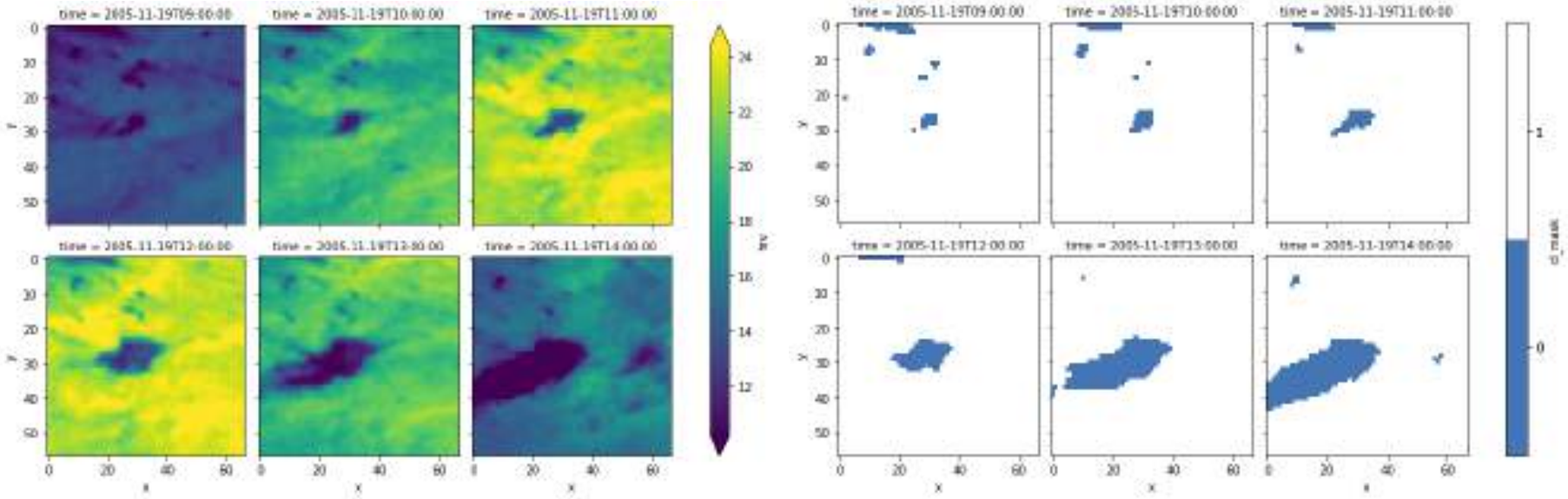
Computing SEVIRI HRV cloud mask (2004-2019; 1km at nadir):

- Divide dataset into bins of the Solar Zenith Angle (SZA)
- Find the optimal threshold for the HRV counts in each SZA bin maximizing (minimizing) the inter-class (intra-class) variance using Otsu's automatic image thresholding method (Otsu 1979)



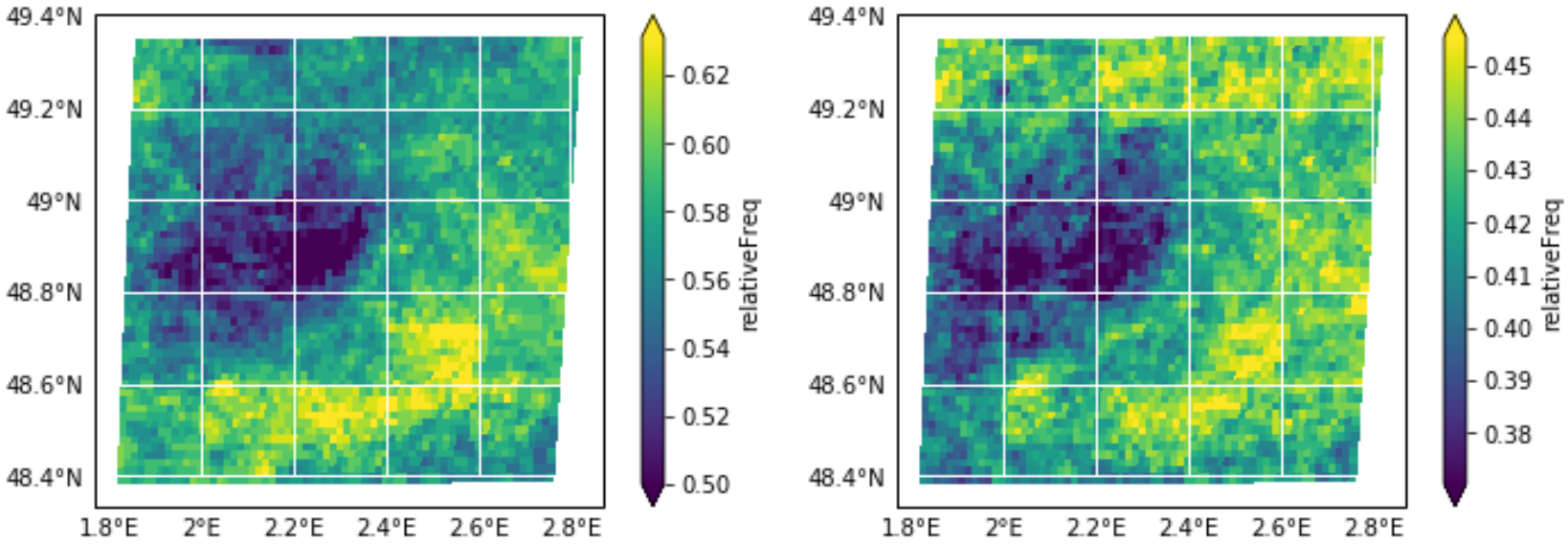
Examplary bimodal distribution of HRV counts found in one SZA bin and threshold (in red) delimiting clouds from clear sky

HRV cloud mask over the urban area of Paris



left: SEVIRI HRV; **right**: cloud mask (1: cloud, 0: clear sky); 19-11-2005

Preliminary results: Spatiotemporal occurrence of urban cloud modifications

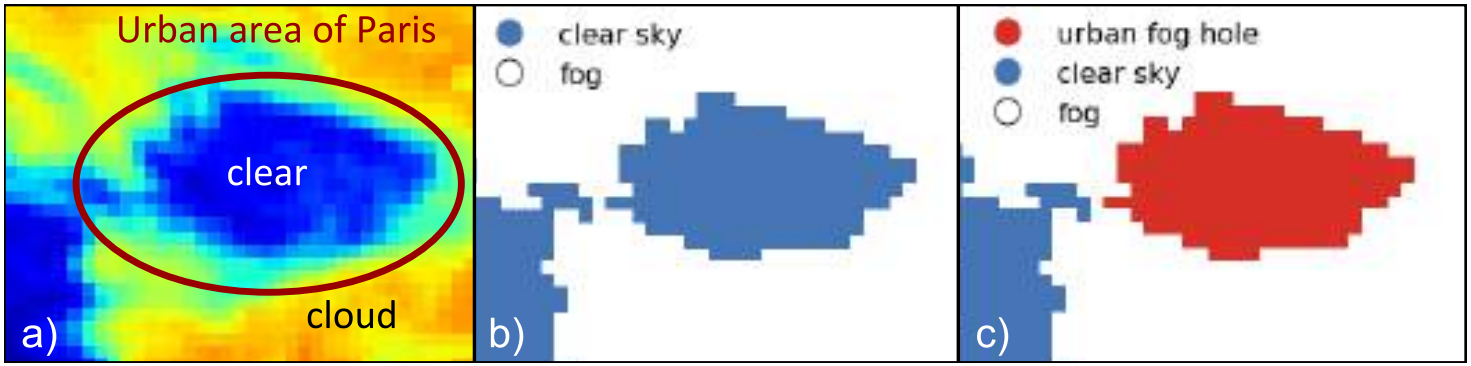


Relative frequency of cloud occurrence for the month of November (left) and during Sept/Oct/Nov (right) 2004-2019 during high pressure conditions (>1020hPa)

⇒ Less frequent cloud occurrence over Paris during high-pressure conditions in November and SON

Outlook

- Classification of ”urban fog hole” by density-based spatial clustering (DBSCAN) of spatially contiguous pixels (Ester et al. 1996)
- Diurnal and seasonal analysis of fog hole size and occurrence
- Spatiotemporal analyses for European urban areas



a) High Resolution Visible channel (SEVIRI HRV) radiance on January, 20th 2016 at 10:15 (blue: low, red: high). b) Binary cloud mask based on a). c) Density-based spatial clustering produces classes: urban fog hole, fog and clear sky over non-urban areas

Do you have questions or comments? Collaborations are welcome!

References

Ester, M., Kriegel, H. P.,Sander, J., and Xu, X.: A Density-Based Algorithm for Discovering Clusters in Large Spatial Databases with Noise, in: Proceedings of the 2nd International Conference on Knowledge Discovery and Data Mining, vol. OR, pp. 226-231, AAAI Press, Portland, 1996.

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