Karlsruher Institut für Technologie

High-resolution satellite-based cloud detection for the analysis of land surface effects on boundary layer clouds

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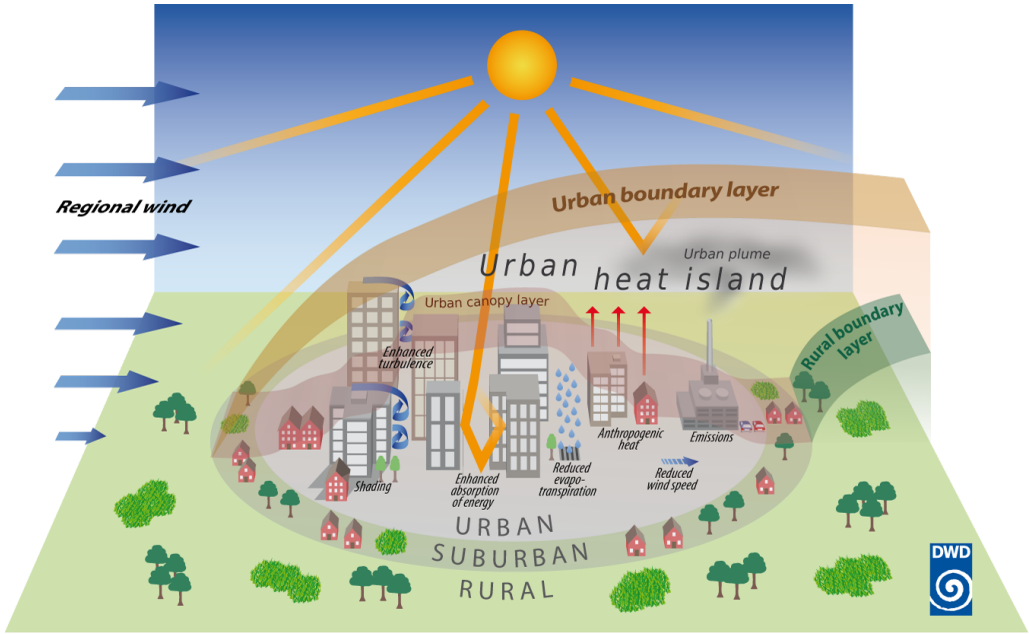
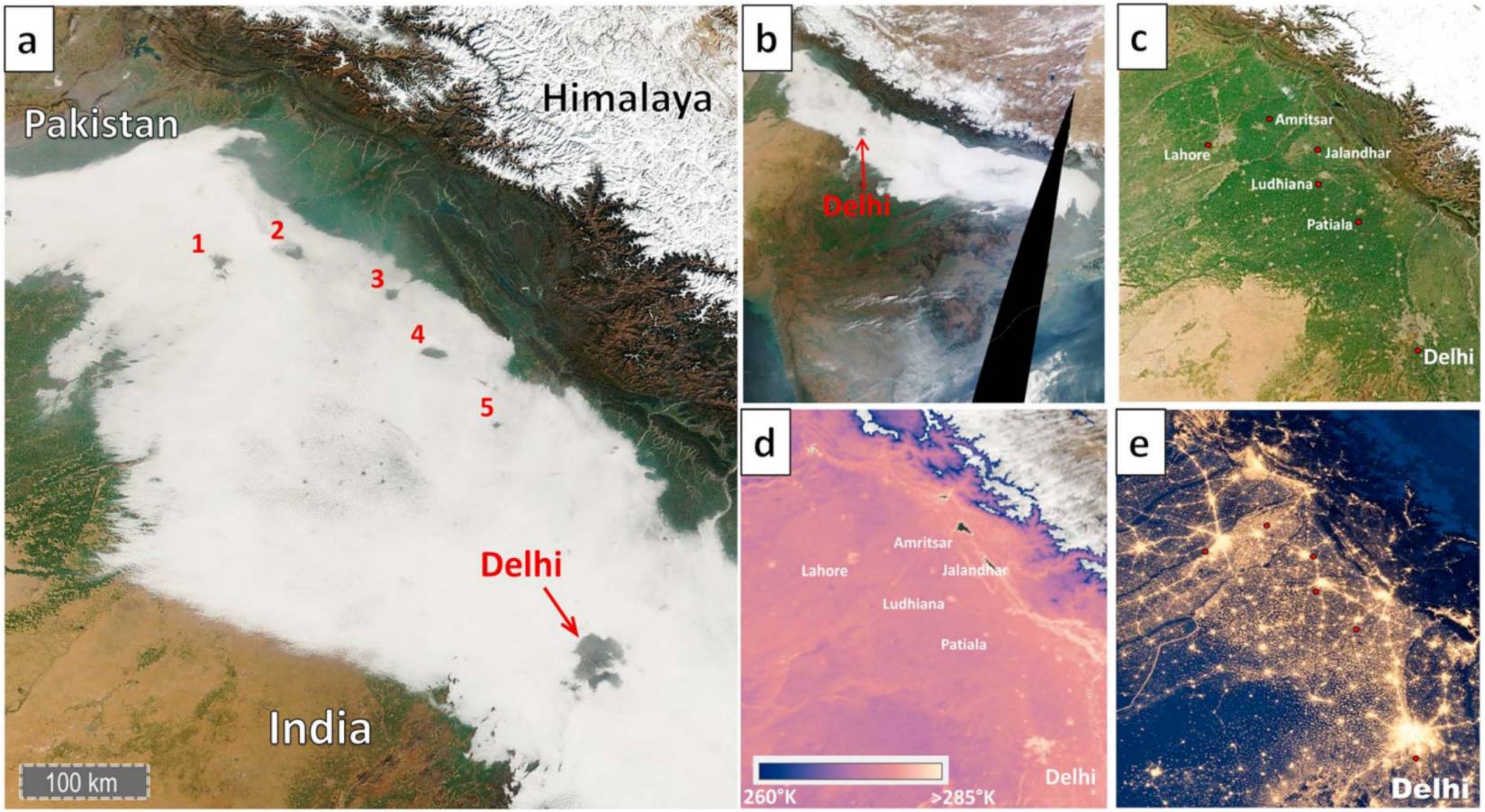
Motivation: Urban impacts on clouds

- Urban heat island effect, emission of anthropogenic aerosols, and increased roughness length of cities shape atmospheric processes in complex ways →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)

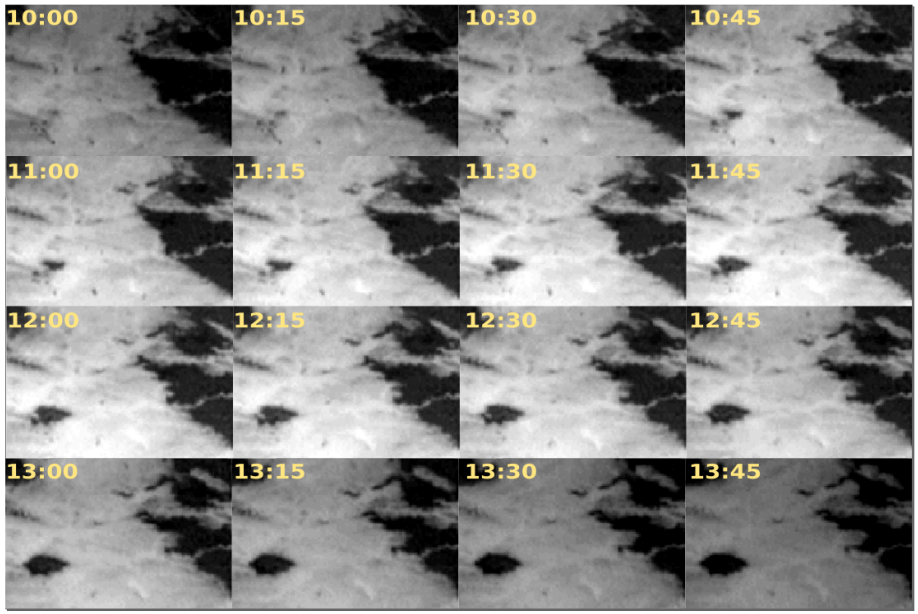
Holes in fog



Gautam & Singh 2018

Data: Spinning Enhanced Visible and Infrared Imager (SEVIRI) onboard MSG, Nov. 2004-2019

- Low resolution channels, $\sim$ 3km at nadir: snow and ice cloud filter (Cermak 2006, Westerhuis et al. 2020)
- High Resolution Visible (HRV), $\sim$ 1km at nadir –> cloud mask



A hole in the low stratus is evolving above the urban region of Paris (December, 30th 2016)

2 Goals

High-resolution satellite-based cloud detection

Understanding land surface effects on boundary layer clouds

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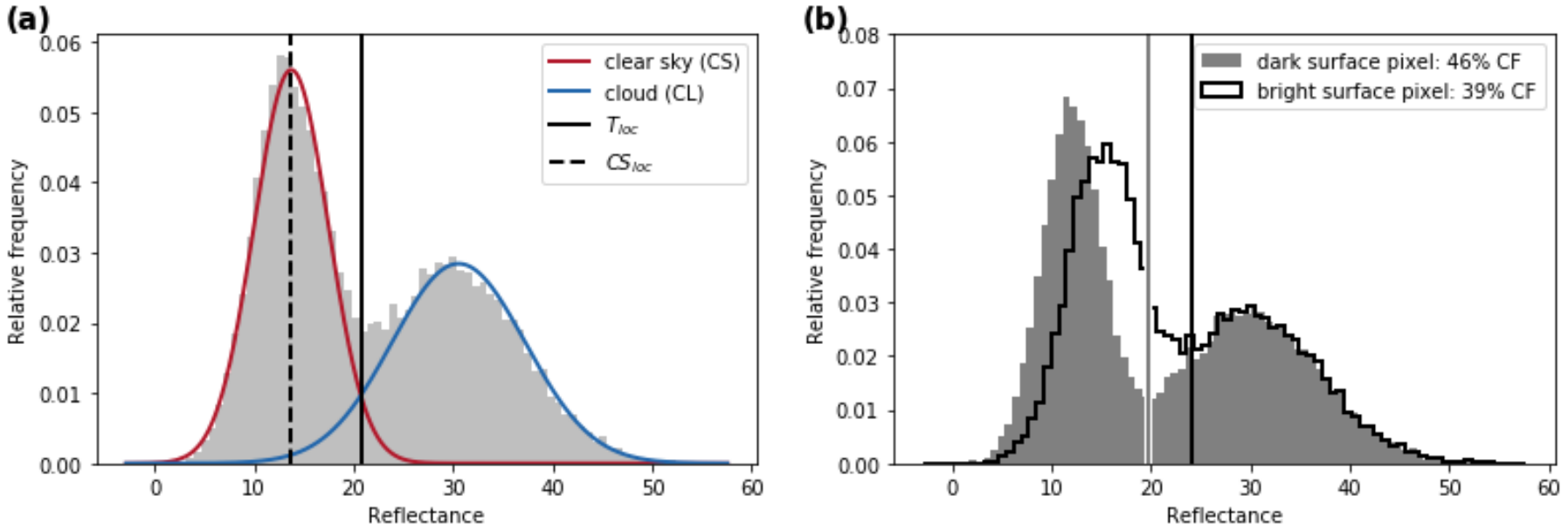
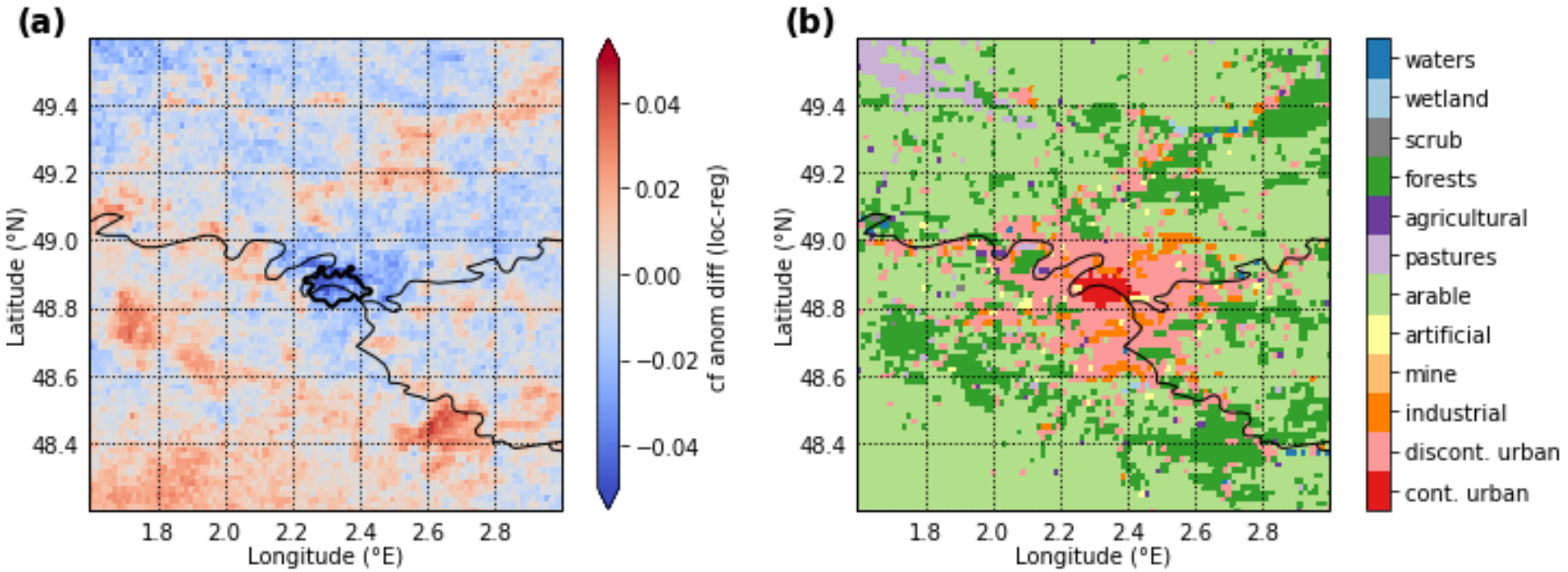
Cloud masking approaches: clear vs. cloudy



Bimodal distribution of HRV pixel counts for one SZA bin (reflectance [%])

- **Local** Empirical Cloud Detection Approach –> threshold per pixel dependent on surface albedo
- **Regional** Empirical Cloud Detection Approach –> one regional threshold for all pixels of the study area (Fuchs et al. 2022, preprint)

Influence of land cover on cloud detection approaches



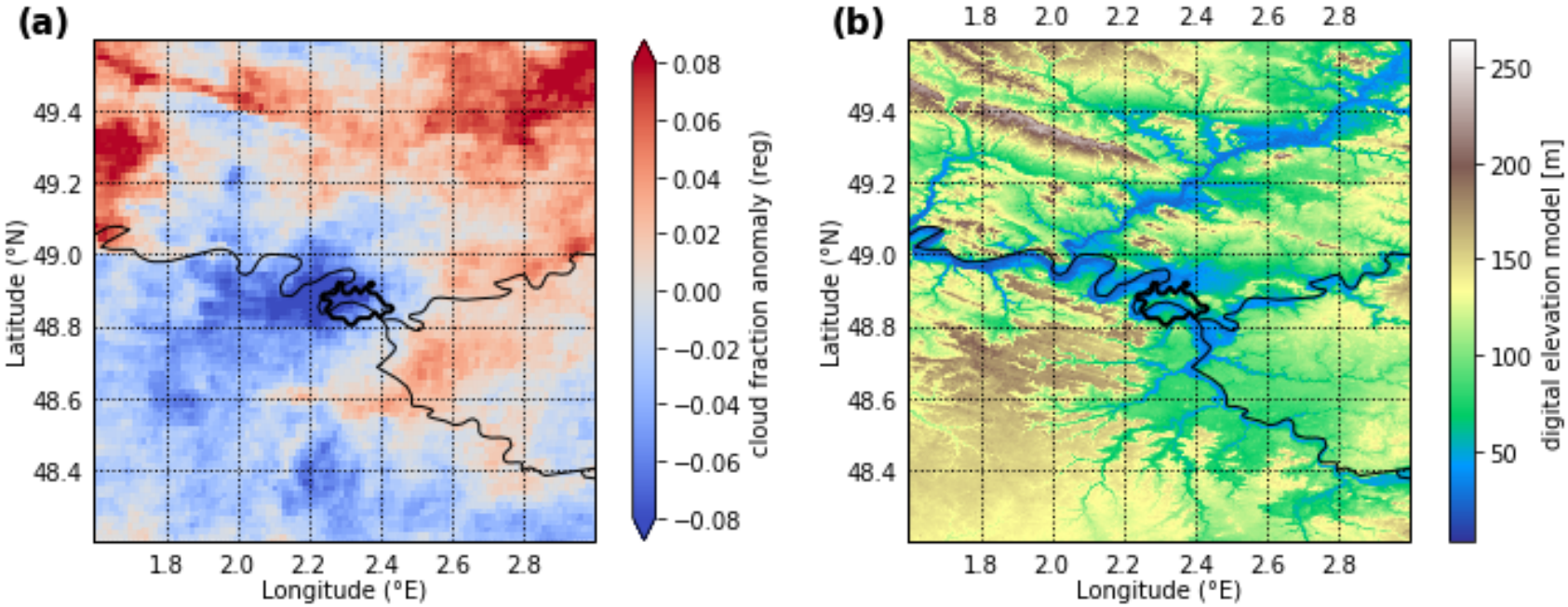
a) Difference of cloud fraction from Local and Regional Cloud Detection Approaches. b) Corine Land Cover (Fuchs et al. 2022, AMT, preprint).

2 Goals

High-resolution satellite-based cloud detection

Understanding land surface effects on boundary layer clouds

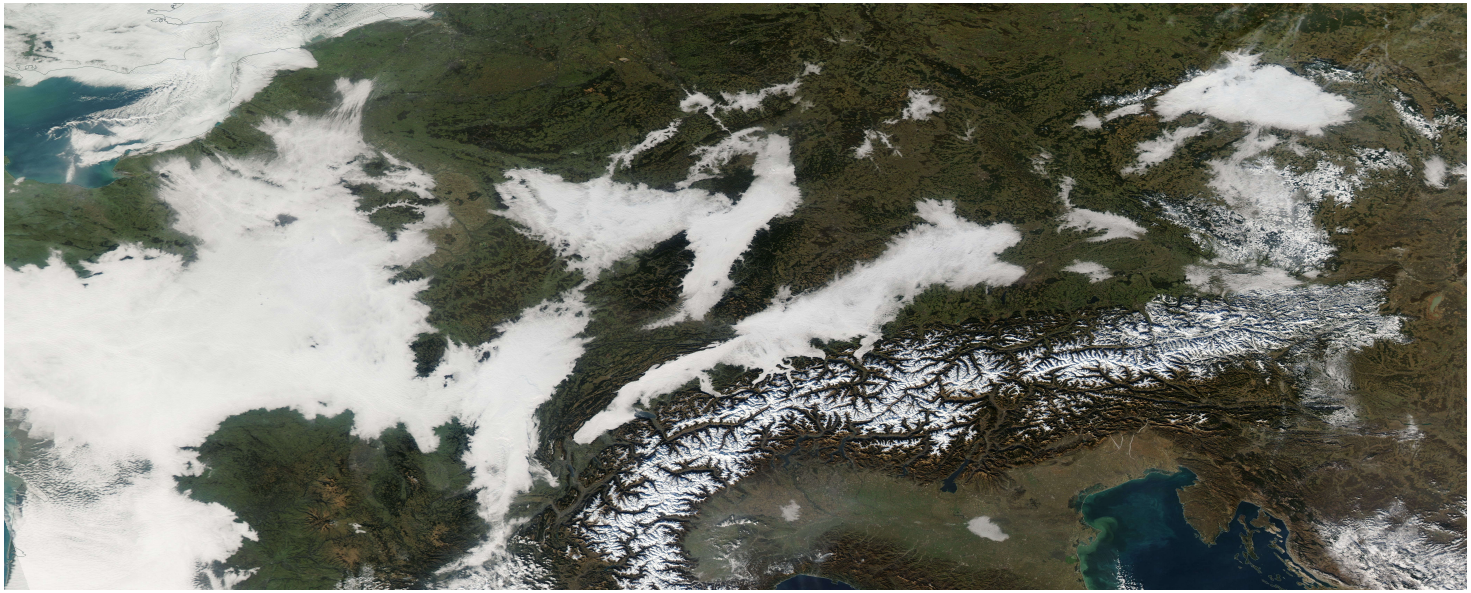
Influence of land cover and terrain height on clouds



Cloud fraction anomaly (Nov. 2004-2019): low wind speed (<3m/s), low blh (<300m), high msl (>1020hPa). b) European Digital Elevation Model (Fuchs et al. 2022, AMT, preprint).

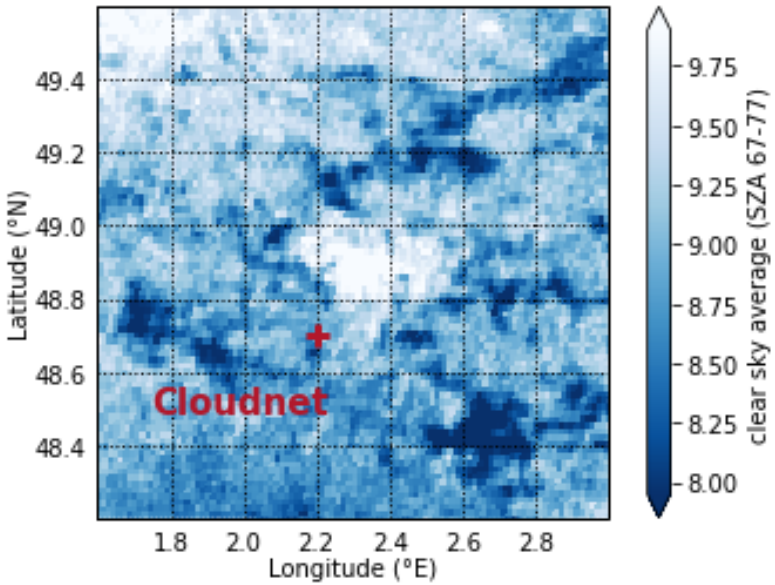
Outlook

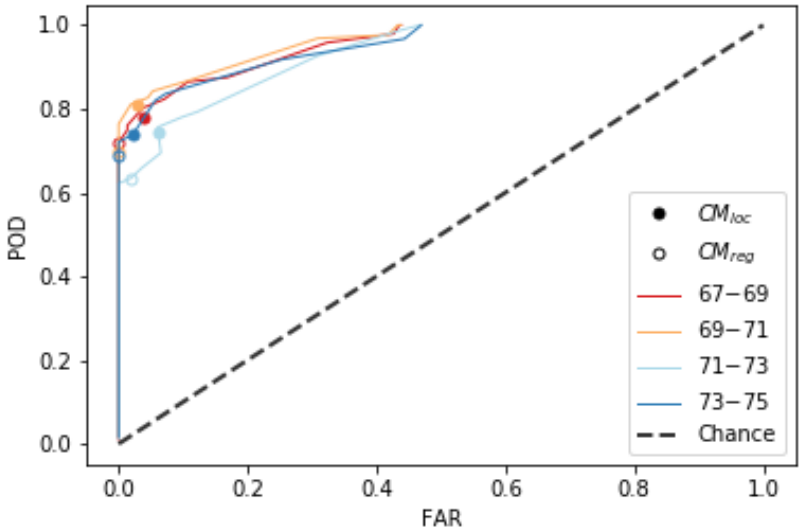
- Spatial and temporal quantification of urban cloud patterns and their main influences using satellite observations over Europe



Aqua/MODIS, December, 30th 2016, (https://worldview.earthdata.nasa.gov/, accessed: 04-05-2020)

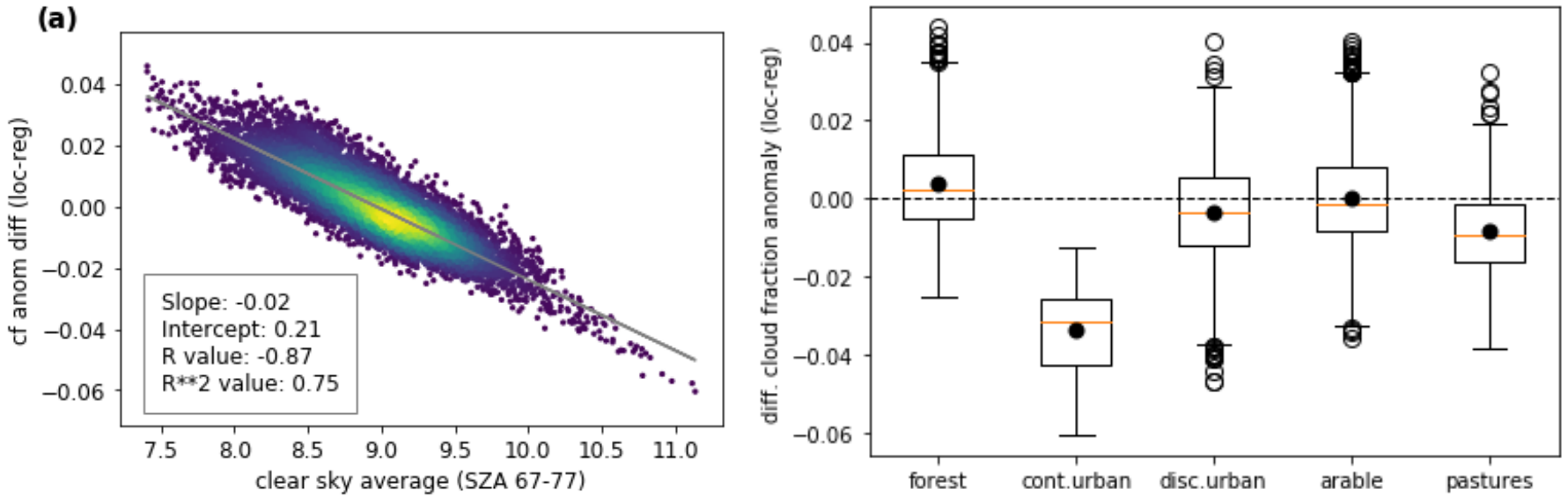
Validation with ground-based cloud fraction





Relationship of POD and FAR for local and regional cloud masks for different HRV threshold values and 4 Solar Zenith Angle bins (Fuchs et al. 2022, AMT, preprint).

Influence of land cover and surface reflectance on cloud detection approaches



a) Linear regression: Difference of cloud fraction anomalies (LECDA-RECDA) vs. clear sky reflectance (average of SZA bins 67-77).b) Difference of cloud fraction anomalies (CF_{loc}*anomaly*-CF_{reg}*anomaly*) from Local and Regional Empirical Cloud Detection Approaches grouped by 5 main Corine Land Cover types.

References

Cermak, J.: SOFOS – A New Satellite-based Operational Fog Observation Scheme. PhD Thesis, Philipps-Universität Marburg, (March). Retrieved from http://archiv.ub.uni-marburg.de/diss/z2006/0149/, 2006.

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German Weather Service (Deutscher Wetterdienst, DWD), url: https://www.dwd.de/EN/research/climateenvironment/climate_impact/urbanism/urban_heat_island/urbanheatisland_node.html; accessed: 04-05-2020.

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