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Urban boundary layer structure of Stuttgart observed by ground-based remote sensing

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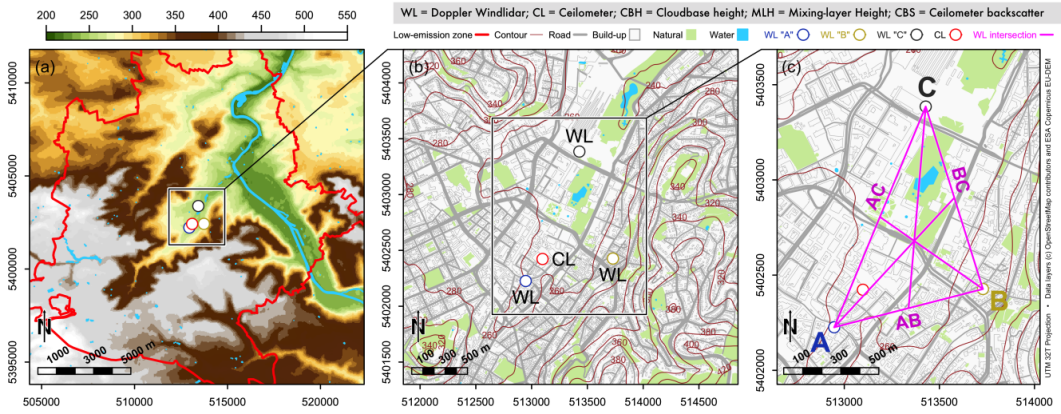
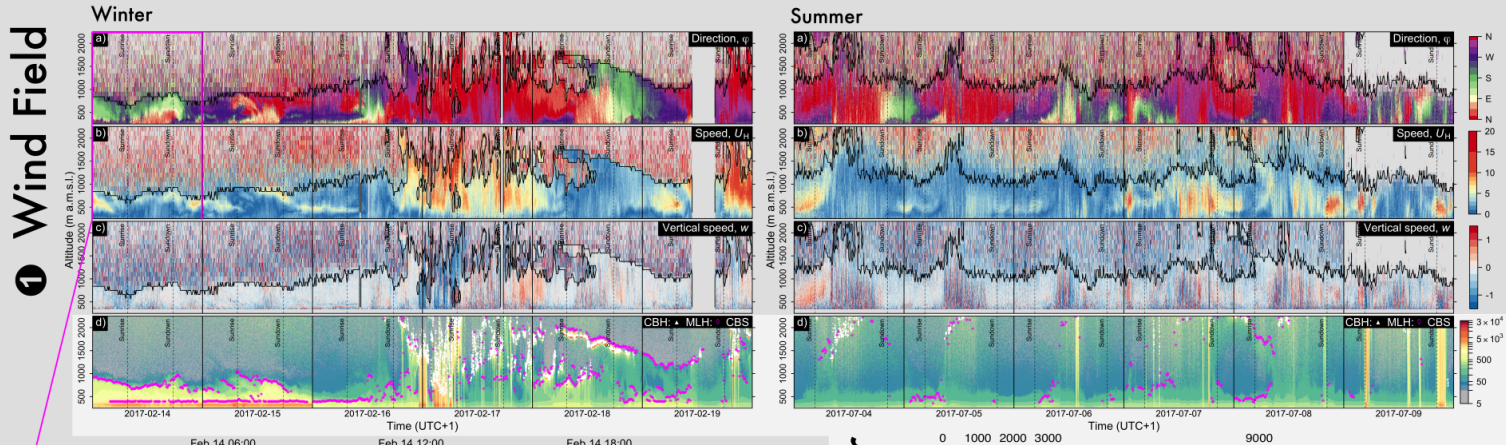
Stuttgart, a city situated in a bowl-shaped basin, is troubled by the accumulation of pollutants during weak-wind conditions; the reduced air quality prompts costly emission regulations.

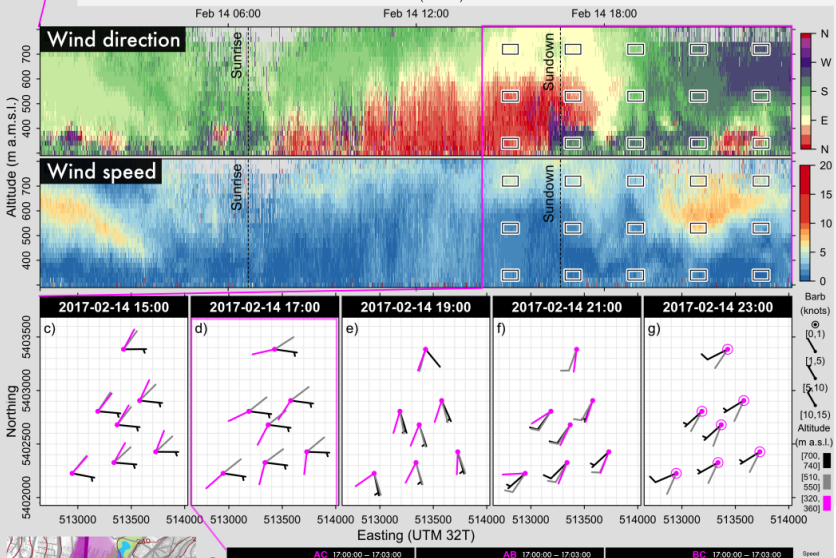
District-level regulation would require advanced monitoring and forecasting skills, which in turn require detailed knowledge about the development and structure of the atmospheric boundary layer (ABL).

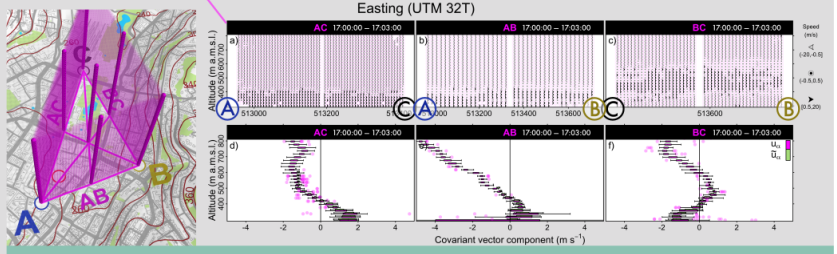
To this end, wind field (❶), backscatter, cloud (❷) & surface (❸) properties were observed, contrasting winter & summer.



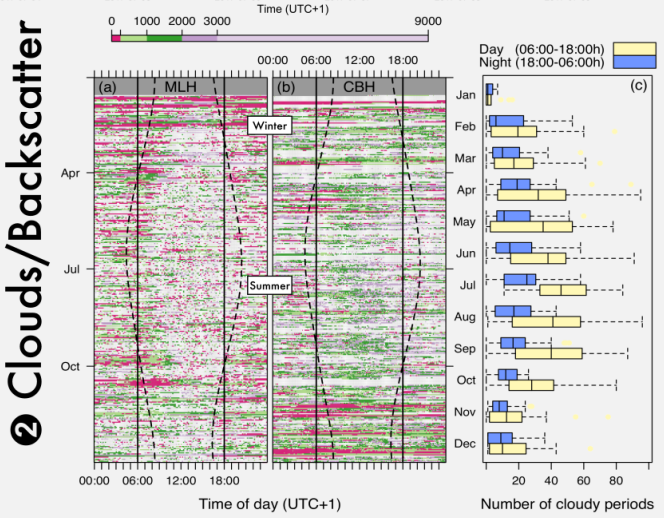
❶ Wind Field







❷ Clouds/Backscatter



❸ Surface

Local ABL development revealed reoccuring patterns, and interaction with the landscape

Regional – Seasonal:

❶ Typically, a shallower ABL in winter vs summer; Nocturnal low-level jets, more pronounced in summer, likely correlated to regional (alpine) forcing;
❷ Periods of persistent and low (<500 m) clouds (fog) in winter; Convective clouds dominant during summer daytime, with cloud base rising until late afternoon (>1000 m depth);

Local – Diurnal:

❶ Substantial directional shear (>60°) in the lowest 500 m, follows hypsography/topography of the surrounding area; Convergence/divergence patterns show indications of local circulation, particularly in the evening transition;
❷ Relevant layers detected below 500 m depth in CL and WL;
❸ Temperature gradients correlated to landuse at street/valley scale;

Universal – Other

❶ Summer daytime MLH maximum only just in range of the wind obervations (HP Streamline); Tripple WL adds only limited detail below 80 m depth;
❷ Layer detection below 500 m requires our attention;
❸ Ground-based sensing cannot fully subsititute airborne sensing – affected by recent legislation – in urban areas.

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