EGU22-719
https://doi.org/10.5194/egusphere-egu22-719
EGU General Assembly 2022

Response of a small river plume on wind forcing

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Wind forcing is the main driver of river plume dynamics. Direction and magnitude of wind determine position, shape, and size of a river plume. The response of river plumes on wind forcing was simulated in many numerical modeling studies; however, in situ measurements of this process are still very scarce. In this study, we report the first direct measurements of frontal movement of a small river plume under variable wind forcing conditions. Using quadcopters, we performed nearly continuous daytime aerial observations of the Bzyb river plume located in the non-tidal Black Sea. The aerial remote sensing was accompanied by synchronous in situ measurements of wind forcing. We assessed spreading patterns of the plume and evaluated movement velocity of its outer border with unprecedentedly high spatial (~ 10 m) and temporal (~ 1 minute) resolution, which was not available in previous studies based on in situ measurements and satellite observations. Based on the collected data, we evaluated the time of response of plume spreading dynamics on changes in wind forcing conditions. The advection velocity of the outer plume border shows linear relation to wind speed with very small response time (10-20 minutes). The reversal between upstream/downstream plume spreading occurs during several hours under moderate wind forcing conditions. These reversals involve only near-field part of the plume, which cause detachment of the far-field part of the plume. The obtained results are crucial for understanding and simulating spreading dynamics of small river plumes worldwide.