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Horizontal Wind Speed motion-induced error assessment on a floating Doppler Wind lidar

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A wind retrieval simulator of a floating Doppler Wind Lidar (DWL) with six Degrees of Freedom (DoF) in its motion is presented. The simulator considers a continuous-wave, conically scanning, floating DWL which retrieves the local wind profile from 50 line of sight (LoS) radial velocity measurements per scan. Rotational and translational motion effects over horizontal wind speed (HWS) measurements are studied parametrically. The 6 DoF motion framework as well as the most important buoy motion equations are based on the model presented in [1].

Each rotational and translational motion is simulated as 1 second sinusoidal signal defined by an amplitude, frequency and motion phase. In order to study the problem of motion-induced error on the retrieved HWS, a dimension reduction is needed (22 variables). A consideration followed in the literature [2] to alleviate the problem is to set the same motional frequency (f=0.3 Hz) for all DoF, a wind vector with constant HWS and null vertical wind speed (VWS). Moreover, the parametric study is carried out under certain constraints in order to finally reduce the problem dimensionality to three, which enables the generation of tri-dimensional colorplots of the error on the retrieved HWS.

Simulation results show that in the presence of motion, HWS error has a strong dependency on FDWL initial scan phase. Moreover, the directions of the rotation axis and translational velocity vector (with respect to wind direction, WD) show great impact on HWS error. For translational motion, a 3 DoF superposition principle is corroborated.

The simulator is as a useful tool for understanding particular lidar motion scenarios and their contributions to HWS measurements error. However, further analysis of the effect of lidar initial scan phase is needed. Additionally, these simulations are conducted under idealized assumptions of horizontally homogeneous wind profiles in the vicinity of the FDWL. Simulations using non-homogeneous wind fields (e.g., turbulence, air mass boundaries) would give insights on how well floating lidars can be expected to retrieve the wind profile in these common scenarios.

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