Photogrammetric analysis of rotor clouds observed during T-REX

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Stereo photogrammetric analysis is a rarely utilized but highly valuable tool for studying smaller, highly ephemeral clouds. In this study, we make use of data that were collected during the Terrain-induced Rotor Experiment (T-REX), which took place in Owens Valley, eastern California, in the spring of 2006. The data set consists of matched digital stereo photographs obtained at high temporal (on the order of seconds) and spatial resolution (limited by the pixel size of the cameras). Using computer vision techniques we have been able to develop algorithms for camera calibration, automatic feature matching, and ultimately reconstruction of 3D cloud scenes.

Applying these techniques to images from different T-REX IOPs we capture the motion of clouds in several distinct mountain wave scenarios ranging from short lived lee wave clouds on an otherwise clear sky day to rotor clouds formed in an extreme turbulence environment with strong winds and high cloud coverage. Tracking the clouds in 3D space and time allows us to quantify phenomena such as vertical and horizontal movement of clouds, turbulent motion at the upstream edge of rotor clouds, the structure of the lifting condensation level, extreme wind shear, and the life cycle of clouds in lee waves. When placed into context with the existing literature that originated from the T-REX field campaign, our results complement and expand our understanding of the complex dynamics observed in a variety of different lee wave settings.