Photogrammetric Analysis of Rotor Clouds Observed during T-REX

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Introduction

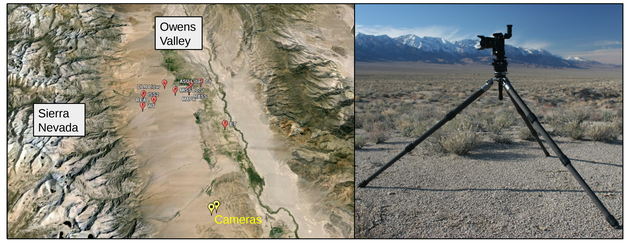
Digital stereo photgraphs collected during the T-REX field campaign are used to:

- Develop algorithms for camera calibration, automatic feature matching, and reconstruction of 3D cloud scenes.
- Track the 3D path of cloud fragments at the upstream edge of rotor clouds and monitor their growth and dynamics until their merger with the main cloud.

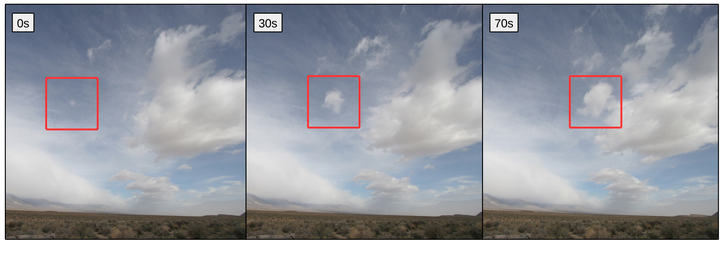
Data

The T-REX field campaign took place in Owens Valley, CA, in the lee of the Sierra Nevada.

- IOP 6: March 25, 2006, 08:40-16:50 PST
- Cameras: Cannon 20D digital 8 Mpixel
- Base line between cameras: 666m
- Shutter speed: ~10s



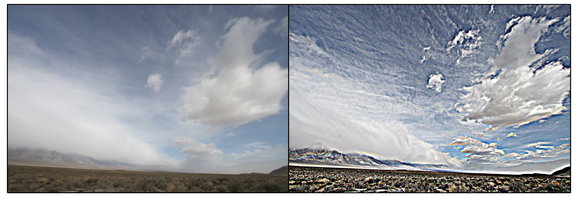
We study the evolution of cloud fragments which form upsteam of a largely stationary rotor cloud.



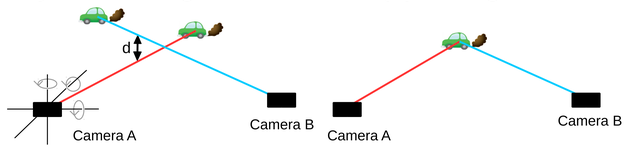
- Grubišić, V., and Coauthors, 2008: The Terrain-Induced Rotor Experiment: A field campaign overview including observational highlights. Bull. Amer. Meteor. Soc., 89, 1513–1533.
- Hu, J., A. Razdan, and J. A. Zehnder, 2009: Geometric calibration of digital cameras for 3D cumulus cloud measurements. J. Atmos. Oceanic Technol., 26, 200–214.

Camera calibration, feature matching, and 3D cloud reconstruction algorithms

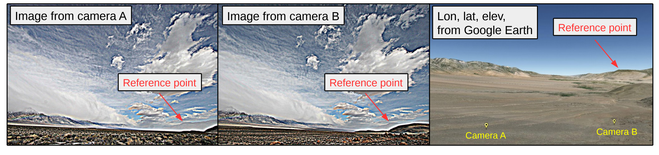
1. Lens distortion correction and image enhancement.



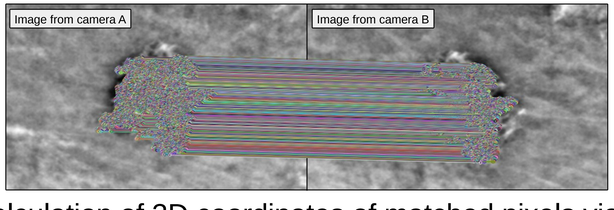
2. Calibration of all six camera angles relative to each other by minimizing the distances (d) of “sightlines”.



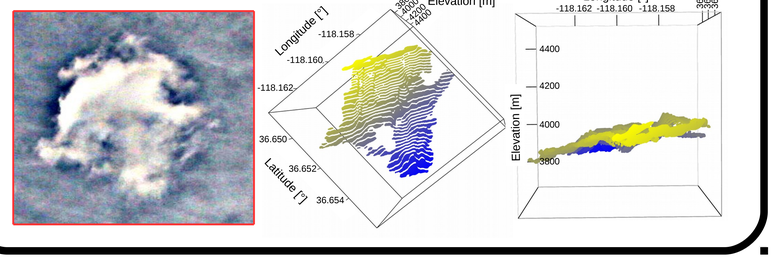
3. Transformation of camera coordinate system (x, y, z) to world coordinate system (longitude, latitude, elevation) using real world reference point visible in both images.



4. Automatic matching of left and right image pixels of selected cloud feature.



5. Calculation of 3D coordinates of matched pixels via triangulation, and reconstruction of 3D point cloud.



Conclusions

Algorithms have been developed for camera calibration, automatic feature matching, and reconstruction of 3D cloud scenes from stereo photographs. The resulting point clouds have:

- high spatial resolution (~m) which is only limited by the pixel size and the distance to the cameras
- high temporal resolution (~10s)

High resolution 3D point clouds allow detailed analysis of cloud evolution parameters such as growth, and horizontal and vertical movement.

Results: Statistics from 37 clouds