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Aerial imagery and structure-from-motion based DEM reconstruction of region-sized areas (Sierra Arana, Spain and Namur Province, Belgium) using an high-altitude drifting balloon platform.

Christian Burlet (1), Rosa María Mateos (3), Jose Miguel Azañón (2), José Vicente Perez (2), and Yves Vanbrabant (1)

(1) Royal Belgian Institute of Natural Sciences, Geological Survey of Belgium, Brussels, Belgium (christian.burlet@naturalsciences.be), (2) Universidad de Granada, Departamento de Geodinámica, Granada, Spain, (3) Instituto Geológico y Minero de España, Peligrosidad y Riesgos Geológicos, Granada, Spain

A new type of untethered balloon based mapping platform allows affordable remote sensing applications from higher altitudes and with a greater range and payload capacity than common motorized UAV's. The airborne device, called "Stratochip", is based on a dual helium balloons configuration. At a defined altitude (comprised between 1000 and 30000m), the first balloon is released, drastically reducing the platform climbing rate. The payload (up to 10kg) can then drift in a sub-horizontal trajectory until it leaves a pre-defined area of interest. Leaving the pre-defined area, the second balloon is released and the payload is recovered after a parachute landing.

The predicted flight path of the Stratochip, launch site and surveyed area are calculated using both forecasted (NOAA model) and real-time (inborne instruments) meteorological data, along with the physical parameters of the balloons and parachute. The predicted recovery area can also be refined in real-time to secure and facilitate equipment retrieval.

In this study, we present the results of two cartographic campaigns made in Belgium (Famennian outcrops near Beauraing, Namur Province) and Spain (karstic field in the Eastern part of Sierra Arana, Granada region). Those campaigns aimed to test the usability of the Stratochip to survey a large area at medium altitudes (3000m-8000m) and produced an updated Digital Elevation Model and orthophoto mosaic of those regions. For that purpose, the instrument installed in the Stratochip payload was constituted of a digital camera stabilized with two IMU's and two brushless motors. An automated routine then tilted the camera at predefined angles while taking pictures of the ground. This technique allowed to maximize the photogrammetric information collected on a single pass flight, and improved the DEM reconstruction quality, using structure-from-motion algorithms.

Three sets of data (DEM + orthophoto) were created from those campaigns, using pictures sets collected a different elevations. A 1m/pixel ground resolution set covering an area of about 200km^2 and mapping the eastern part of the Sierra Arana (Andalucía, Spain) includes a kartsic field directly to the south-east of the ridge and the cliffs of the "Riscos del Moro". A 4m/pixel ground resolution set covering an area of about 900km^2 includes the landslide active Diezma region (Andalucía, Spain) and the water reserve of Francisco Abellan lake. The third set has a 3m/pixel ground resolution, covers about 100km^2 and maps the Famennian rocks formations, known as part of "La Calestienne", outcropping near Beauraing and Rochefort in the Namur Province (Belgium).

The DEM and orthophoto's have been referenced using ground control points from satellite imagery (Spain, Belgium) and DPGS (Belgium). The quality of produced DEM were then evaluated by comparing the level and accuracy of details and surface artefacts between available topographic data (SRTM- 30m/pixel, topographic maps) and the three Stratochip sets. This evaluation showed that the models were in good correlation with existing data, and can be readily be used in geomorphology, structural and natural hazard studies.