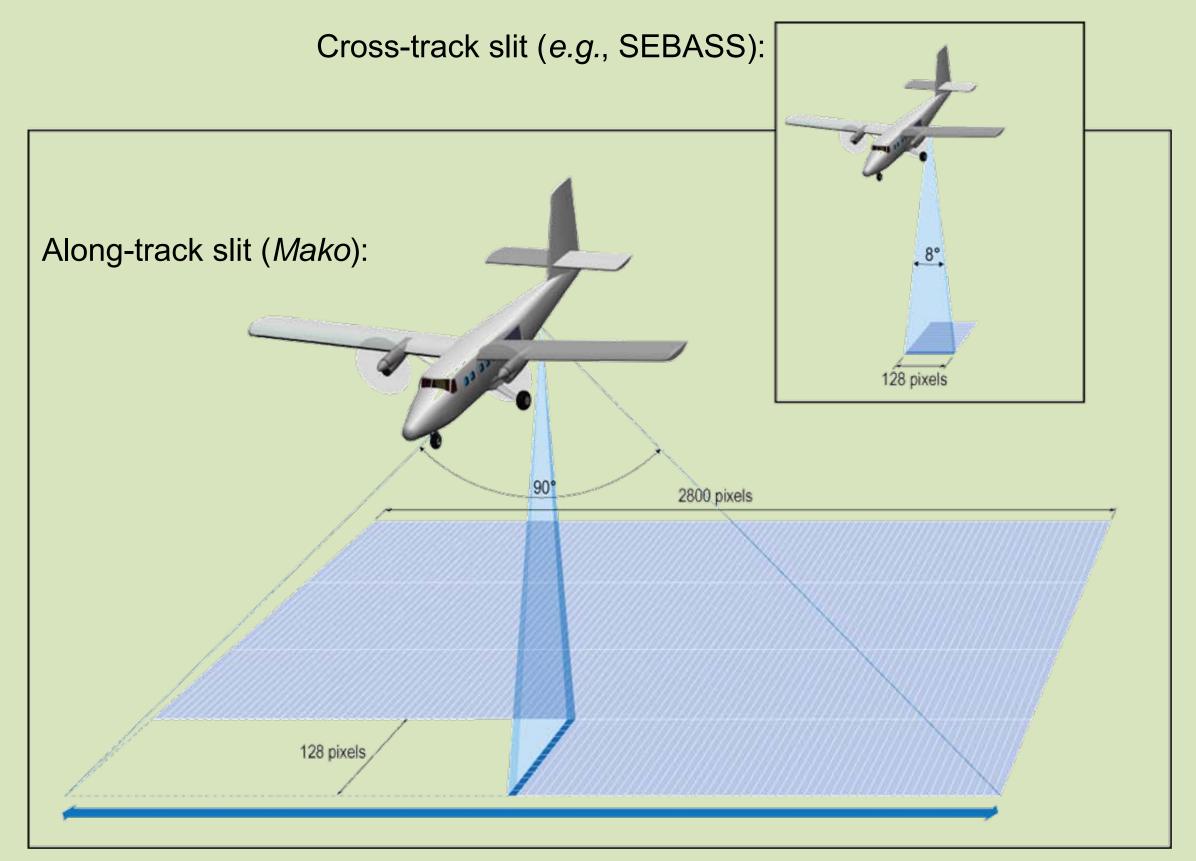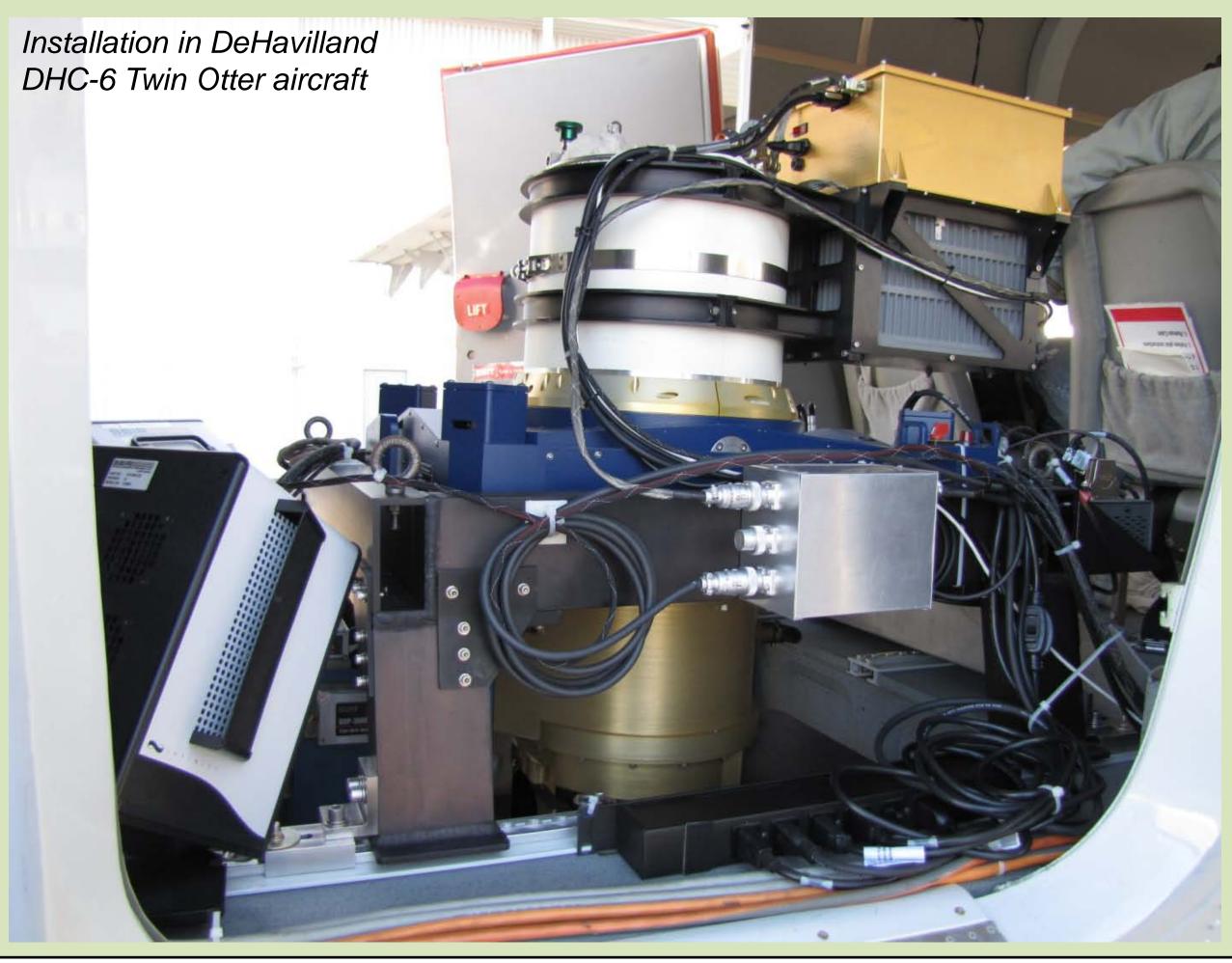# Airborne LWIR Hyperspectral Imager with High Spatial Resolution and Wide Area Coverage: A New Tool for Environmental and Ecosystem Studies

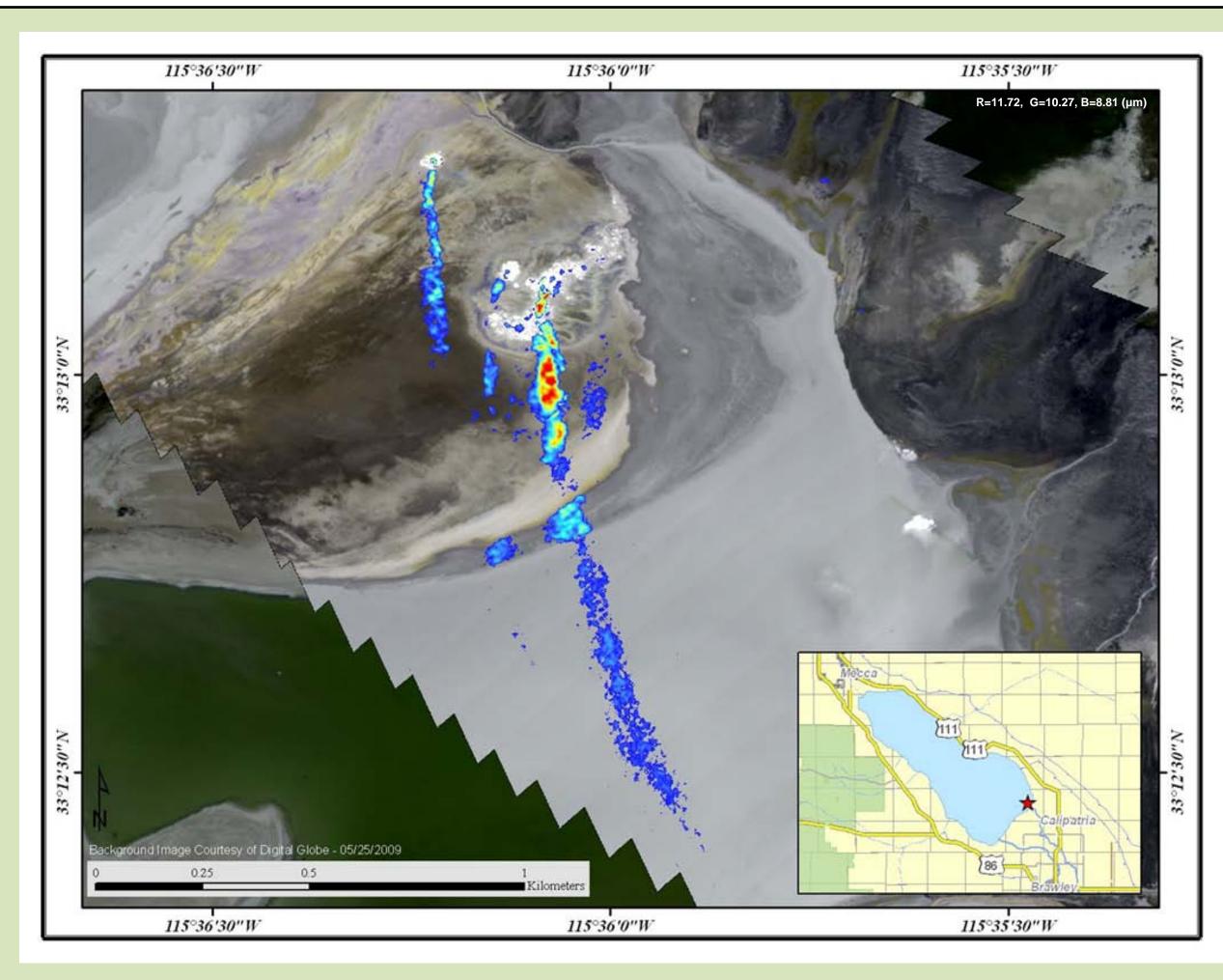David M. Tratt*, Jeffrey L. Hall, and the Mako Team† (The Aerospace Corporation, USA)

Mako is a wide-swath, three-axis-stabilized, whiskbroom airborne hyperspectral imager that operates across the wavelength range 7.6-13.2 µm in the longwave-infrared (LWIR) spectral region. Its fast (f/1.25) innovative spectrometer design enables low-noise performance (NEΔT ≲ 0.1 K @ 10 µm) despite the small pixel IFOV (0.55 mrad) and high frame rates, making possible ±45° nadir angles that enable an area-coverage rate of 20 km² per minute at 2-m GSD from 12,500 ft (3.8 km) AGL (Warren *et al.*, 2010; Hall *et al.*, 2011).

Cross-track slit (*e.g.*, SEBASS):
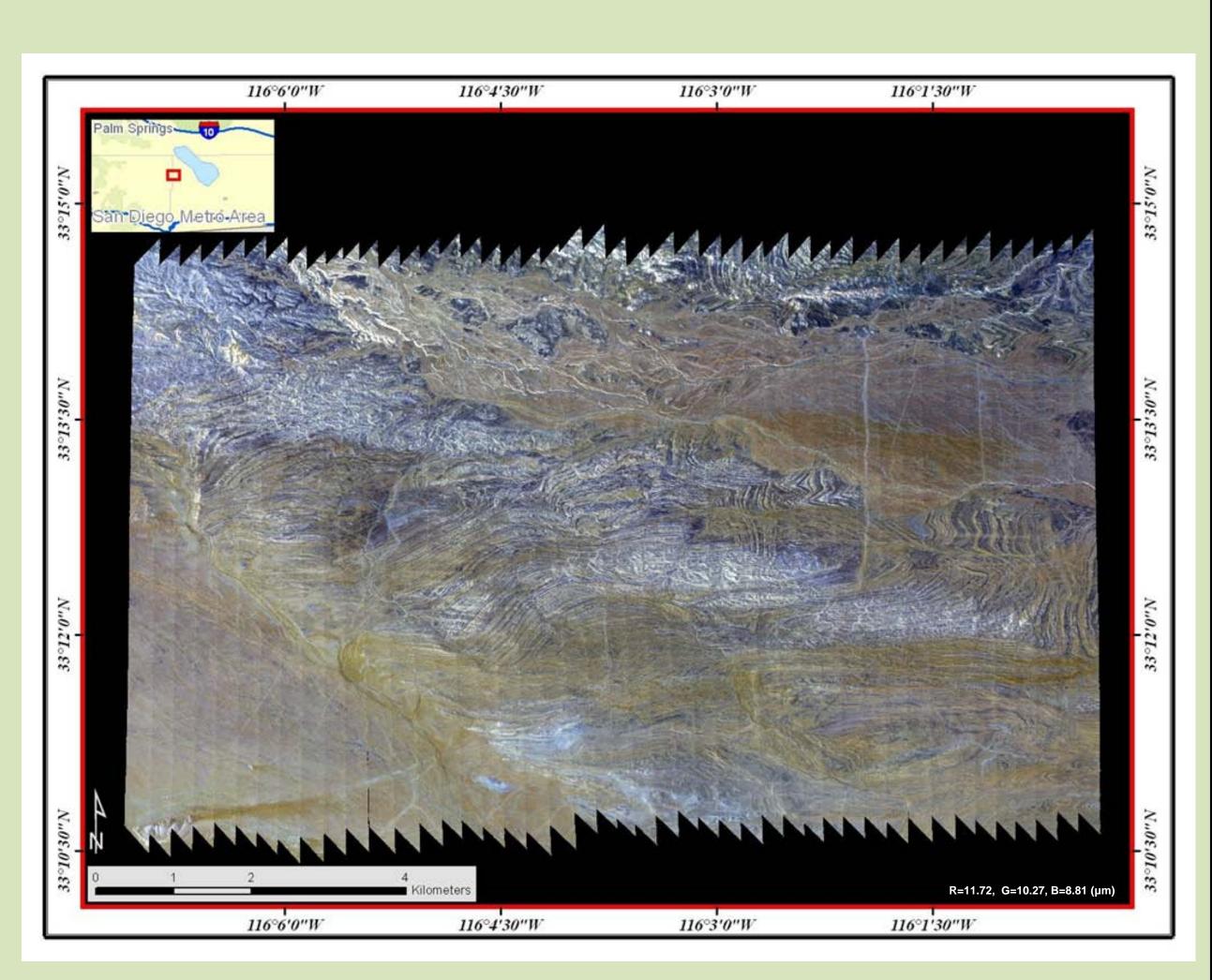
Along-track slit (*Mako*):

Mako has now undergone two comprehensive flight campaigns during which its full functionality has been verified against both natural and built environments. The sensor is available to participate in science investigations and calibration/validation operations that require the use of high spatial, spectral, and radiometric resolution LWIR imagery.
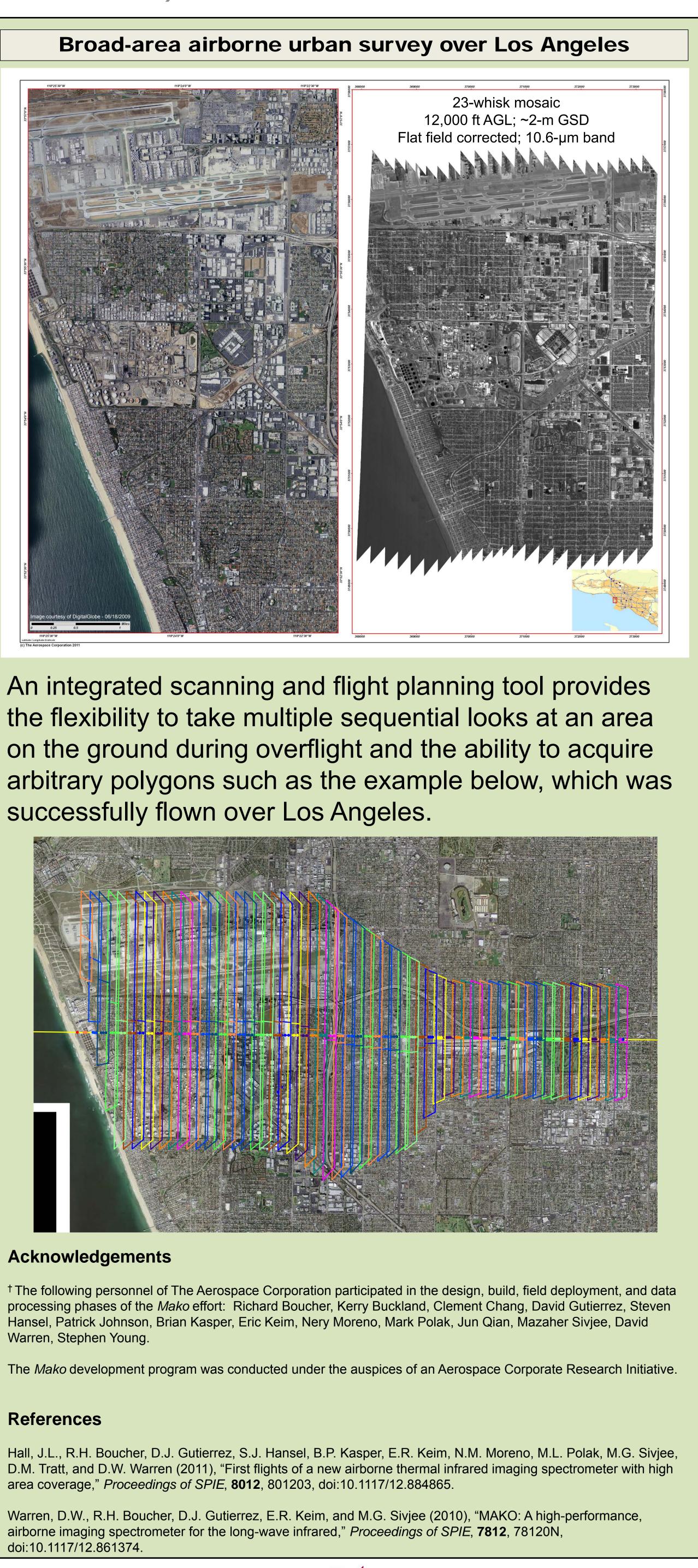
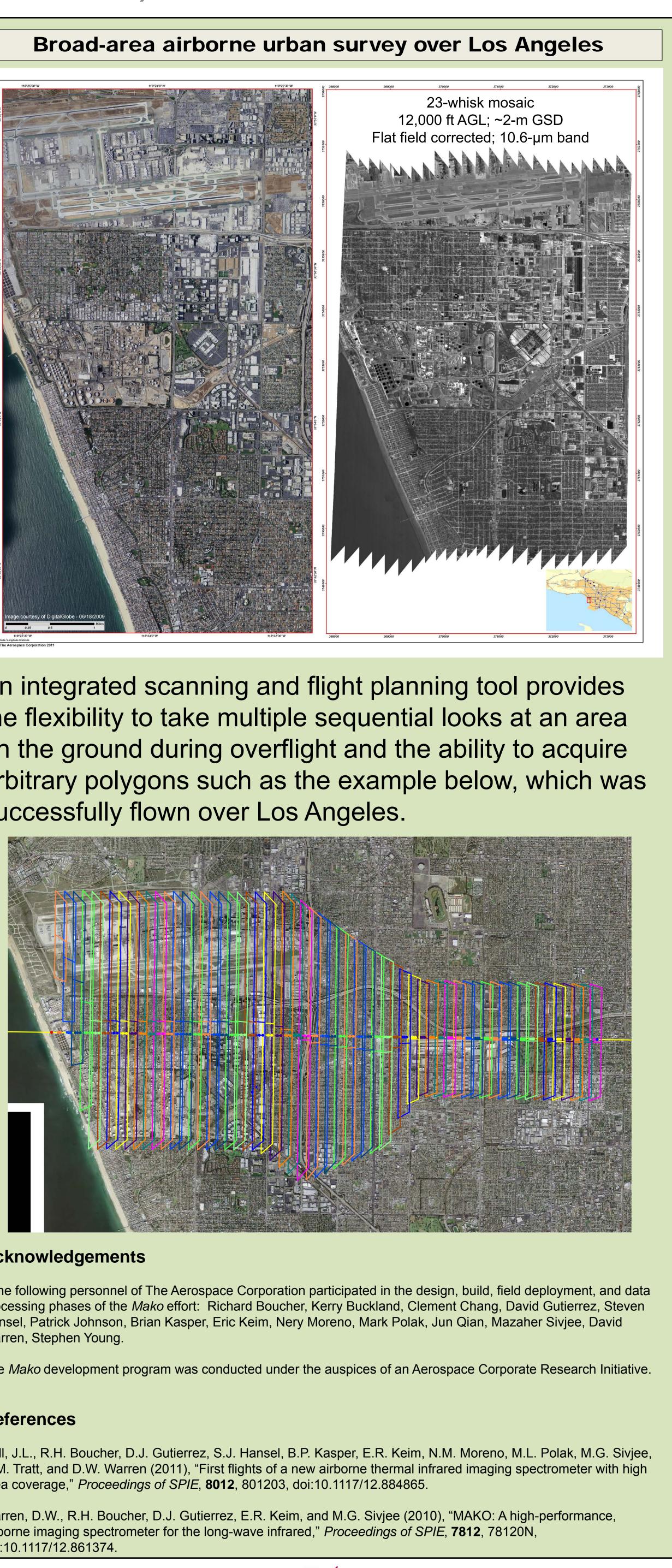*Installation in DeHavilland DHC-6 Twin Otter aircraft*

Nighttime LWIR radiance imagery of a segment of the Calipatria Fault as it crosses the southeast shore of the Salton Sea in southern California. The false-color features denote ammonia plumes being emitted from a cluster of hot fumaroles exposed on a sandbar near the shoreline. The ammonia is thought to arise from geothermally-induced pyrolytic decomposition of the nitrogen-rich agricultural runoff that permeates the lake water and sediments. The longest plume visible here is detected to a distance of ~1.3 km from its source.

False-color LWIR radiance image mosaic acquired by *Mako* in a single 4-minute pass over an area of exposed complex geological structure in California's Imperial Valley. The area acquired is ~90 km².

Broad-area airborne urban survey over Los Angeles

23-whisk mosaic
12,000 ft AGL; ~2-m GSD
Flat field corrected; 10.6-µm band

An integrated scanning and flight planning tool provides the flexibility to take multiple sequential looks at an area on the ground during overflight and the ability to acquire arbitrary polygons such as the example below, which was successfully flown over Los Angeles.

References

Hall, J.L., R.H. Boucher, D.J. Gutierrez, S.J. Hansel, B.P. Kasper, E.R. Keim, N.M. Moreno, M.L. Polak, M.G. Sivjee, D.M. Tratt, and D.W. Warren (2011), "First flights of a new airborne thermal infrared imaging spectrometer with high area coverage," *Proceedings of SPIE*, **8012**, 801203, doi:10.1117/12.884865.

Warren, D.W., R.H. Boucher, D.J. Gutierrez, E.R. Keim, and M.G. Sivjee (2010), "MAKO: A high-performance, airborne imaging spectrometer for the long-wave infrared," *Proceedings of SPIE*, **7812**, 78120N, doi:10.1117/12.861374.

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