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## The CUMULOS Payload on ISARA:

CUMULOS was built by the Aerospace Corporation as an experimental payload hosted on the JPL-managed NASA Integrated Solar Array and Reflectarray Antenna (ISARA) mission. The Aerospace Corporation also built the ISARA mission spacecraft bus and operates the spacecraft via a multi-station ground network. The primary reflect array mission left over 1U of spacecraft volume available. CUMULOS was inserted on a non-interference basis and was not turned on until 6-months after launch following the successful completion of the ISARA primary mission operations.

### CUMULOS Engineering Goals:

- 1) Develop appropriate ground calibration procedures for small CubeSat imaging payloads.
- 2) Develop in-space calibration procedures and CoNops, including stellar calibration, lunar measurements, dark scene correction, vicarious calibration and cross-satellite comparisons
- 3) Research streamlined imaging CoNops with a goal of automating data collection
- 4) Develop a radiometric and metric data pipeline using CubeSat imagery and star camera ADCS telemetry
- 5) Assess space worthiness and aging of compact payloads, electronics and optics

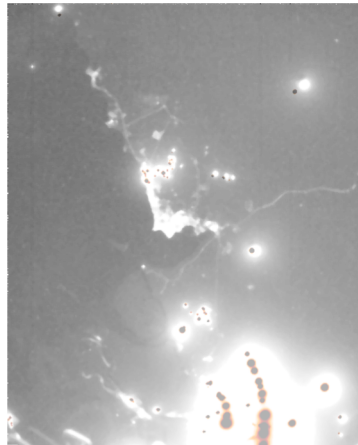

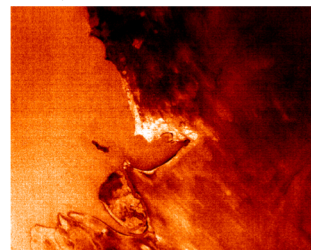
## Initial Performance:

- 1) The microbolometer is functioning very well on orbit, including the shutter. Calibration target collections and cross satellite comparisons will establish performance metrics. Clouds are well imaged, and very high cold clouds are being imaged and assessed to study system sensitivity limits.
- 2) The SWIR camera is tuned for nighttime performance and is meeting or exceeding our expectations. We believe we're detecting reflected airglow signals. Daytime performance is better than expected with auto modes enabled.
- 3) The visible camera compares very well to VIIRS imagery of nighttime scenes. We will be making more detailed comparisons of nighttime cloud imagery between VIIRS and our SWIR and VIS cameras soon.

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# Kuwait: Flares, Lights, Heat Islands in 3 bands

17 Sept 2018 19:20 UT  
Moon 12.5° elevation, 58% illum

**VIS** **SWIR**

< SWIR (high-gain + low-gain composite)

**Map of region imaged with flares**

The Kuwait/Iraq border region is imaged in a SWIR camera high gain + low gain composite. High-gain data saturates on signals from a double line of gas flares in the Rumaila oil field, detects waste light from Kuwait city and roadways, and sees weak, low elevation moonlight scattered from the desert. The low-gain data (shown in reverse contrast) pinpoints the gas flares. This high dynamic range data complements the VIS camera imagery and aids in distinguishing hot thermal emissions from lights. The LWIR camera provides cloud context and highlights urban heat islands which closely match the development mapped by the VIS camera in these scenes. The 300-m GSD microbolometer only detects the brightest flares, although it does readily detect larger area thermal sources (such as fires).



OTR number: 2019-00141

AGU Number: **A41K-3106**