**2019 NOAA/AOML/HRD Hurricane Field Program - IFEX**

**SATELLITE VALIDATION EXPERIMENT**
***Science Description***

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**Experiment/Module:** NESDIS JPSS Satellite Validation Experiment

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**Requirements:** No requirements: flown at any stage of the TC lifecycle

**Science Objective(s):**

1) Validate NOAA Unique Combined Atmospheric Processing System (NUCAPS) atmospheric profiles of temperature and moisture derived from the NOAA-20 and Suomi-NPP satellites in a variety of environments using G-IV GPS dropsonde data.

**Motivation:** NUCAPS atmospheric soundings (temperature and moisture) produced from the NOAA-20 and Suomi-NPP polar orbiting satellites provide global coverage and have been extensively validated using ground-based and ship-launched rawinsondes (Nalli et al. 2013). However, the performance of NUCAPS in tropical environments with strong horizontal and vertical gradients in temperature and moisture [e.g., the Saharan Air Layer and the environments of tropical disturbances (e.g., African easterly waves (AEWs), invests, and TCs] has not been extensively assessed. The validation (NUCAPS) and evaluation (forecast models) efforts proposed in this experiment are motivated by two factors: 1) NUCAPS can provide thousands of atmospheric soundings in the environments of TCs globally; and 2) thermodynamics can be an important factor governing the intensity and structure of AEWs, invests, and TCs.

**Background:** The NOAA Unique Combined Atmospheric Processing System (NUCAPS) provides atmospheric soundings of temperature, water vapor, cloud fraction, cloud top pressure, trace gases, dust, and volcanic emissions. NUCAPS is a heritage algorithm based upon the Atmospheric Infrared Sounder (AIRS) Science Team algorithm (Susskind et al. 2003), implemented operationally at NOAA since 2002. These soundings are derived from the CrIS (1,305 IR channels; 3.9-15 μm) and ATMS (22 microwave channels; 23-183 GHz) instruments flying onboard the Suomi-NPP & NOAA-20 polar orbiting satellites. NUCAPS provides ~324,000 soundings per day with 20-30 min latency and is also now available in a gridded format in AWIPS. NUCAPS grids are geolocated and provide two-dimensional views of temperature, humidity, stability metrics, and trace gases.

**Hypotheses:**

1. NUCAPS soundings can generally detect the low humidity and warmth of the Saharan Air Layer (SAL) throughout its depth (~550-850 hPa).
2. NUCAPS may not fully detect dryness in the SAL when its top (~550 hPa) is capped by a moist layer and may not completely capture the strong temperature inversions (~1-5ºC) found at its base (~850 hPa).

3. NUCAPS retrievals may be less skillful in areas with high horizontal gradients of temperature and moisture, including the periphery and especially leading edges of SAL outbreaks and the periphery of tropical disturbances [e.g., AEWs, invests, and TCs].
4. NUCAPS soundings will be more robust in the (near) cloud-free environment outside the TC inner core (R≥80 n mi/150 km), but may be less skillful in areas where TC outer rainbands and cirrus clouds associated with the TC outflow layer are present.

**Aircraft Pattern/Module Descriptions (see *Flight Pattern* document for more detailed information):**

**G-IV Pattern 1/Module 1:** This can be a stand-alone pattern or a break-away module that samples the environment of the SAL. Targets will include sampling the SAL's thermodynamics (warmth and low to mid-level dry air) for satellite validation, as well as the SAL's mid-level easterly jet. Although not a requirement, the SAL would preferably be interacting with a tropical disturbance (e.g., AEW, invest, or TC). For SAL-only sampling, a standard (or modified) Lawnmower pattern will be flown. For targets with a tropical disturbance interacting with the SAL, the following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, G-IV Circumnavigation, G-IV Star, or G-IV Star with Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits (e.g., R~90 n mi/165km) and legs should extend out to the (near) cloud free region in the periphery of the storm (e.g., R=80-215+ n mi/150-400+ km) to sample regions where NUCAPS soundings will experience less cloud contamination and therefore likely to be more robust. Take-off times will be adjusted to maximize temporal and spatial overlap with overpasses by the NOAA-20 and Suomi-NPP satellites. Targets of interest can also be sampled during ferries to/from the main flight pattern.

**G-IV Pattern 2/Module 2:** This can be a stand-alone pattern or a break-away module that samples the peripheral environment (e.g., R~90-215 n mi/165-400 km) of a tropical disturbance (e.g., AEW, invest, or TC). Depending on the intensity of the target of interest, the following standard patterns can be flown: Figure-4, Rotated Figure-4, Butterfly, Lawnmower, Square Spiral, G-IV Circumnavigation, G-IV Star, or G-IV Star with Circumnavigation. For TC targets, circumnavigations will be flown as close to the inner core as safety permits (e.g., R≥60-90 n mi/110-165km). Take-off times will be adjusted to maximize temporal and spatial overlap with overpasses by the NOAA-20 and Suomi-NPP satellites. Targets of interest can also be sampled during ferries to/from the storm.

**Links to Other Mature Stage Experiments/Modules:** The NESDIS JPSS Satellite Validation Experiment and Modules can generally be flown in conjunction with AIPEX, the TDR Experiment, SEF Experiment, TC in Shear Experiment, TCDC Experiment, Gravity Wave Module, and ADM-Aeolus Satellite Validation Experiment.

**Analysis Strategy:** Guidance for G-IV take-off times will be determined by the timing and location of NOAA-20 and Suomi-NPP satellite overpasses in the area of the target(s) of interest.

The GPS dropsonde sampling strategy will be determined by the tropical disturbance and/or SAL outbreak locations relative to the satellite overpass times and locations. Retrospective analyses will be conducted to assess the skill of NUCAPS and numerical model analyses (e.g., GFS and FV3-GFS) to represent the environments that are sampled by GPS dropsondes.

**References:**

Nalli, N. R., Barnet, C. D., Reale, A., Tobin, D., Gambacorta, A., Maddy, E. S., Joseph, E., Sun, B., Borg, L., Mollner, A. K., Morris, V. R., Liu, X., Divakarla, M., Minnett, P. J., Knuteson, R. O., King, T. S., & Wolf, W. W, 2013: Validation of satellite sounder environmental data records: Application to the Cross-Track Infrared Microwave Sounder Suite. *Journal of Geophysical Research-Atmospheres*, **118 (24)**, 13628-13643.

Susskind, J., C. Barnet, and J. Blaisdell, 2003: Retrieval of atmospheric and surface parameters from AIRS/AMSU/HSB data in the presence of clouds." *IEEE Transactions on Geoscience and Remote Sensing*, **41 (2)**, 390-409.