Ultra Low Latency Reception and Processing of CrIS Data to Detect Atmospheric Instability

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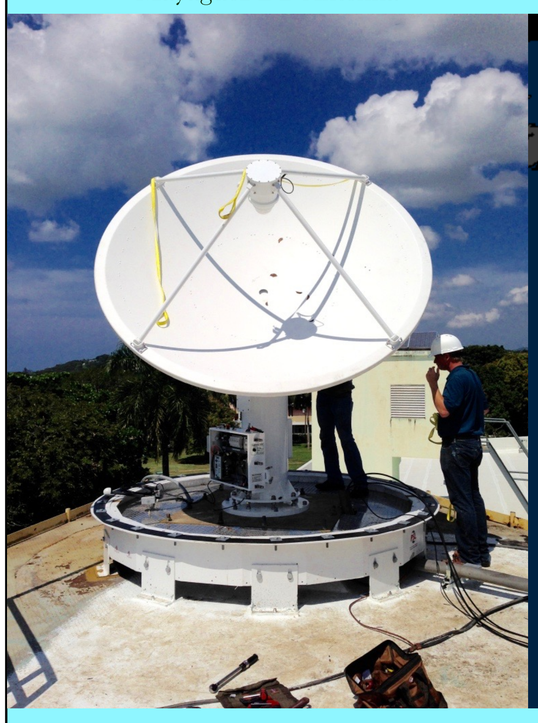
1. Project Overview

CIMSS/SSEC has developed an **Ultra Low Latency** (ULL) system that allows **SNPP and NOAA-20** data to be received via **direct broadcast (DB)** at multiple antenna sites covering North America, and then merged, de-duplicated, geolocated, and calibrated within **60 seconds** of earth observation. The system utilizes DB antennas at multiple locations to provide redundancy. For CrIS, individual **CrIS earth scans** are calibrated and geolocated by the **NASA CrIS Level 1 software**. The CrIS radiances are used in a **dual-regression (DR) retrieval** algorithm to obtain temperature and moisture profiles and **Convective Available Potential Energy (CAPE)**. CrIS FOVs where CAPE is greater than 500 J/kg are stored in a database and can be retrieved via a Web API. System enhancements in development include PC compression and reconstruction via the **EUMETSAT Hybrid Principal Component Analysis** approach, and detection of anomalous emissions (such as methane) via the PCA residuals.

2. Data Ingest and Processing

The ULL data ingest system relies on DB antennas at Madison WI, Hampton VA, Miami FL, and Mayaguez PR to receive SNPP and NOAA-20 (VIIRS, CrIS, ATMS) data in real-time. NOAA-21 will be added soon, along with coverage from two antennas on the US west coast.

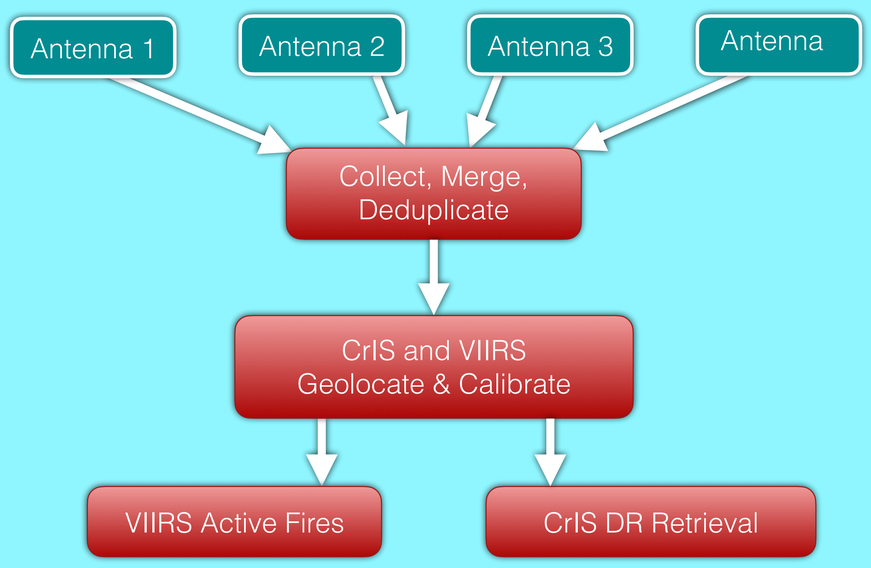
Mayaguez DB Antenna



Coverage Region

The received data are decoded to Level 0 CCSDS packets at each site, and the packets are streamed to SSEC by a sender application. A collector at SSEC receives, de-duplicates, and merges the Level 0 packets and collects them in 5-second micro-granules. A CrIS processor at SSEC waits until 3 consecutive CrIS earth scans have been collected before it starts processing the middle scan. The CrIS earth scan is decoded to Level 1A; each FOV is geolocated; and calibrated radiances are produced. VIIRS earth view data are processed similarly in groups of 2 or 3 scans (via the NASA VIIRS Level 1 software).

ULL Processing Data Flow for CrIS and VIIRS



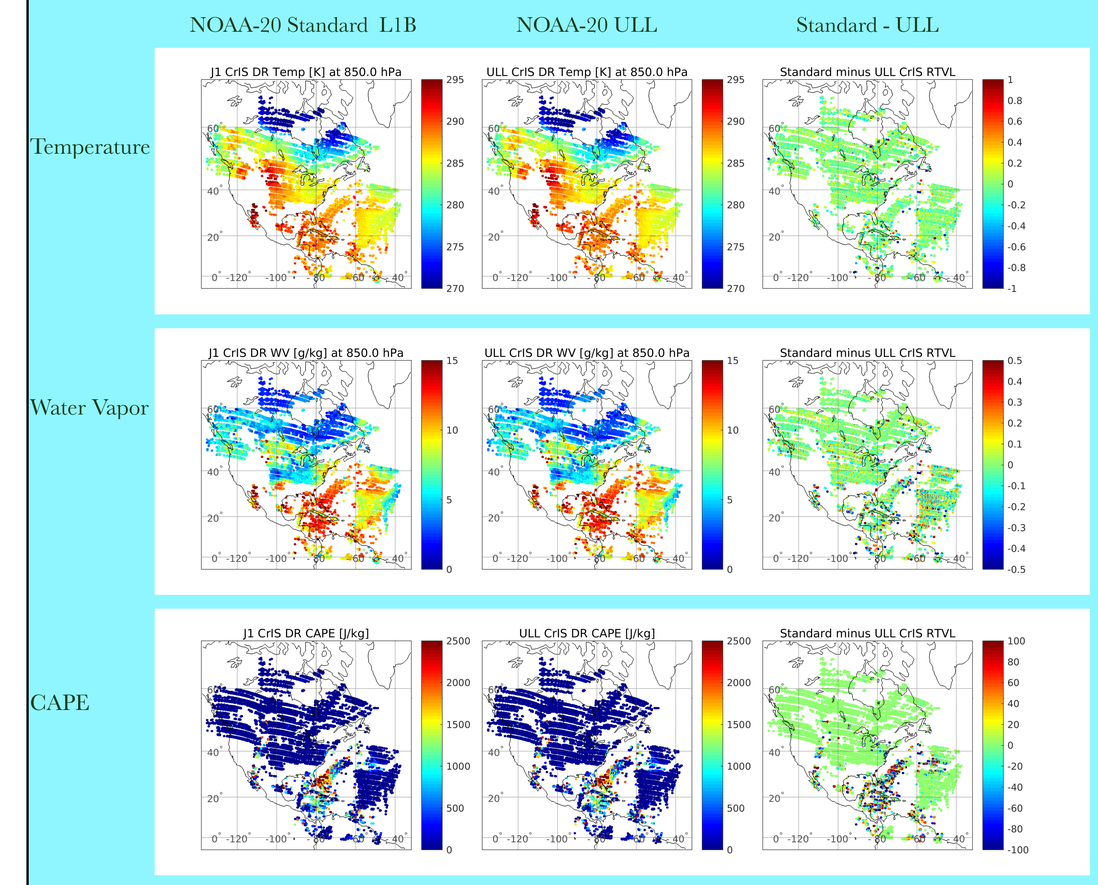
3. CrIS Latency

The timeline below shows the approximate timing for CrIS data acquisition, ingest and processing (in minutes and seconds). This example focuses on the latency for CrIS scan 1 (scan 0 has already been acquired).

00:00 Start of earth observation for Scan 1
00:08 Scan 1 complete; start of earth observation for Scan 2
00:16 Scan 2 complete
00:21 Scan 2 received and merged; start L1A processing for Scan 1
00:26 Scan 1 L1A processing complete; start L1B processing for Scan 1
00:44 Scan 1 L1B processing complete; start GEO processing for Scan 1
00:48 Scan 1 GEO processing complete; start DR processing for Scan 1
01:06 Scan 1 DR processing complete

4. Retrieval of CAPE

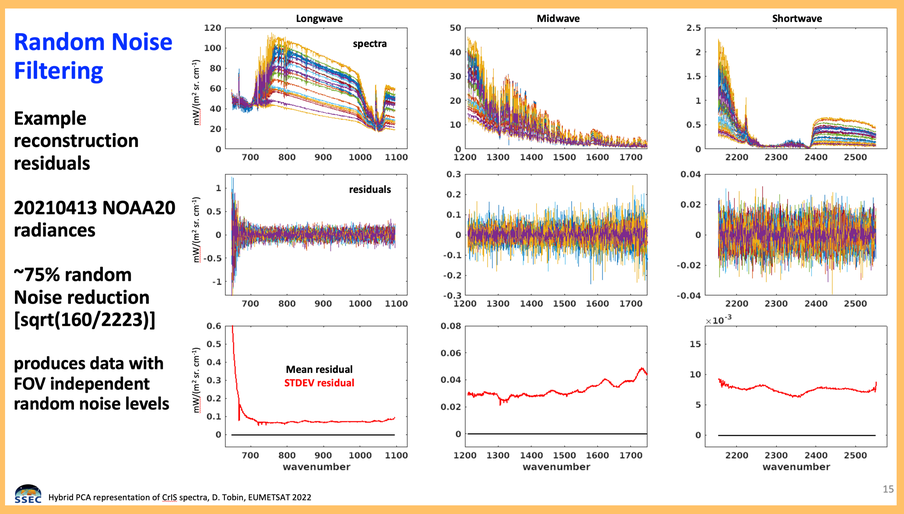
A research version of the dual regression retrieval algorithm, similar to the current CSPP HSRTV software (but without de-aliasing and minor trace gases) is applied to the NOAA-20 CrIS ULL Level 1B data. The figure below shows the resulting daytime temperature, water vapor, and CAPE retrievals for 08/23/2022.



Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. W. L. Smith et al, 2012. https://doi.org/10.1175/JAMC-D-11-0173.1

5. PCA Compression and Noise Reduction

The EUMETSAT Hybrid Approach for PCA compression and reconstruction will be applied in the next version to reduce noise and allow detection of anomalous emissions (e.g. methane) via PCA residuals.



Local or global? How to choose the training set for principal component compression of hyperspectral satellite measurements: a hybrid approach. Tim Hultberg et al, 2017. https://doi.org/10.1117/12.2278349