Retrieval Algorithm Development for the Cross-track Infrared Sounder (CrIS)

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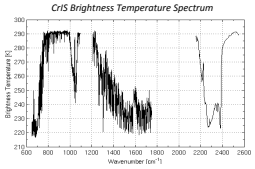
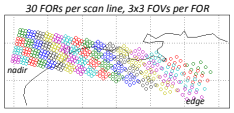
CrIS on Suomi NPP

- CrIS (Cross-Track Infrared Sounder) on the NASA's Suomi NPP (NPOESS Preparatory Project) satellite was launched on Oct 28, 2011.
- CrIS is a Michelson Interferometer with an unapodized spectral resolution of 0.625, 1.25, and 2.5 cm^{-1} in the LW, MW, SW bands respectively covering a spectral range from 650 to 2550 cm^{-1} in 1305 spectral channels. NEDT ranges from 0.05 to 0.5 K.
- The CrIS swath is 2200 km with 30 FORs (field-of-regards) per scan line. Each FOR contains 9 FOVs (field-of-views) each with an 14 km diameter at nadir.

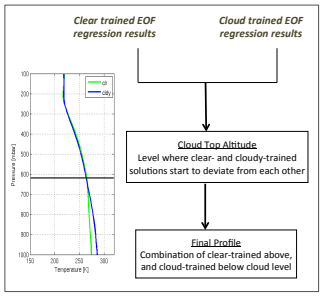
CrIS Brightness Temperature Spectrum



30 FORs per scan line, 3x3 FOVs per FOR



Dual Regression Algorithm Flowchart



DR Retrieval Parameters
Surface Temperature [K]
Temperature [K] at 101 pressure levels
TPW (total precipitable water) [cm]
PW (precipitable water) at three layers [cm]
Humidity [g/kg]] at 101 pressure levels
Relative Humidity [%]] at 101 pressure levels
Dew Point Temperature [K]] at 101 pressure levels
Ozone [ppmv]] at 101 pressure levels
Total Ozone Amount [Dobson Units]
CO_2 amount [ppmv]
Lifted Index [°C]
CAPE (Convective Available Convective Energy) [J/K]
Surface Emissivity at full spectrum
Cloud Mask (0/1)
Cloud Top Pressure 1 [hPa]
Cloud Top Pressure 2 [hPa]
Cloud Top Temperature 1 [K]
Cloud Top Temperature 2 [K]
Cloud Optical Thickness
Quality Flags

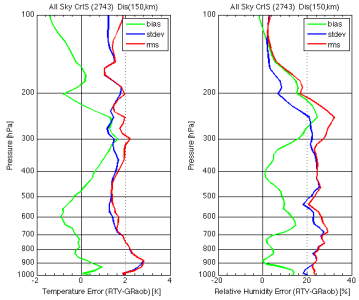
The Dual-Regression Retrieval Algorithm

- This algorithm is part of the **Community Satellite Processing Package (CSPP),** which provides the scientific community with software packages and tools to process measurements for various satellites (NPP, JPSS, POES, Metop) and their instrumentation.
- The Dual-Regression (DR) retrieval algorithm retrieves atmospheric profiles, surface and cloud products at single FOV resolution from hyper-spectral IR measurements.
- Two sets of regression coefficients are derived from global training data sets and their simulated radiances.
- Training sets are classified by scanning angle, CO_2 concentration, BT (brightness temperature) in window region, cloud top pressures (8 overlapping cloud classes from 100 to 900 hPa in 200 hPa increments) and land cover (land/ocean).
- These two sets of regression coefficients (clear, cloudy) are separately applied to real observed unapodized CrIS radiances to obtain a clear-trained and cloudy-trained solution. Then the following steps are performed to obtain the final retrieval.
- The highest level cloud top pressure (CTP) is found by examining the temperature differences between the cloudy and clear profiles. The cloud top altitude is defined as the highest level where the cloud-trained stays warmer than the clear-trained profile below that altitude.
- The levels from the top of the atmosphere to the cloud top are set to the clear-trained retrievals. For high clouds (CTP < 300 hPa) the cloud-trained solution is used.
- Below the highest cloud top level a secondary cloud level is defined where there is little deviation between the clear and cloudy solutions, indicating a small influence of the highest cloud on the profile solutions below. The clear- or cloudy-trained solution between the highest cloud top and this level is retained, or both solutions are rejected, based on various thresholds.
- If the derived CTP is at the surface, and the temperature profile as well as the surface skin temperature differences between the clear-trained retrieval and NCEP (National Centers for Environmental Prediction) GDAS (Global Data Assimilation System) values are smaller than a certain threshold then the entire sounding is set to the clear-trained retrieved values.
- A second (upper level cirrus) cloud top (CTP 2) is determined if the relative humidity in higher levels (above 300 hPa) is larger than a certain threshold.
- For the results below *preliminary* radiances provided by the CSPP ADL CrIS SDR Team at UW-Madison have been used.
- Details are described in Smith, W. L., E. Weisz, S. Kirev, D. K. Zhou, Z. Li, and E. E. Borbas, 2012: Dual-Regression Retrieval Algorithm for Real-Time Processing of Satellite Ultraspectral Radiances. *J. Appl. Meteor. Clim*. In press.

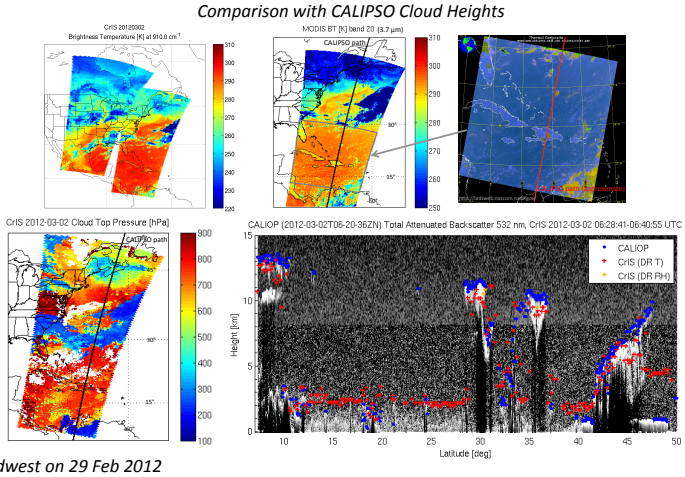
First Dual-Regression Retrieval Results

Comparison with GDAS profiles

(2743 profiles over North America, 2 March 2012)



Comparison with CALIPSO Cloud Heights



CrIS and AIRS: Severe Weather Case Study over the U.S. Midwest on 29 Feb 2012