Cross Track Infrared and Microwave Sounding Suite (CrIMSS) EDR Algorithm

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Algorithm Overview

EDR Algorithm Products

The CrIMSS EDR algorithm produces three EDRs: Temperature Profile, Moisture Profile and Pressure Profile (derived from the retrieved Temperature and Moisture EDRs)

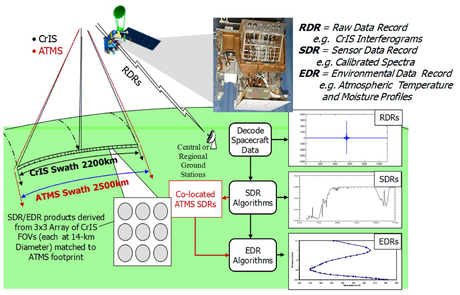
The CrIMSS EDR retrieval algorithm was developed by Atmospheric Environmental Research (AER) for the CrIS sensor contractor (ITT), and was integrated into IDPS by NGAS. NGAS provided several code enhancements during the integration process.

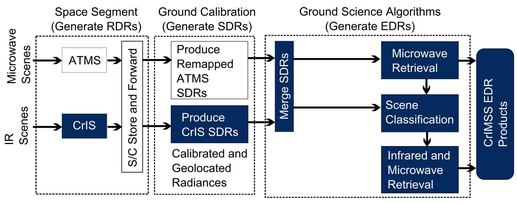
The CrIMSS EDR algorithm is based on a joint infrared and microwave physical retrieval and cloud-clearing methodology, similar to EOS AIRS algorithm, but otherwise deviates with some significant improvements:

(1) Performs simultaneous retrieval of atmospheric temperature, moisture, pressure and ozone profiles and surface skin temperature and spectral emissivity, using both IR and MW radiances

(2) Incorporates very fast and accurate Optimal Spectral Sampling (OSS) Radiative Transfer Model for IR and microwave

(3) Uses Empirical Orthogonal Functions (EOFs) to characterize and measure the retrieved geophysical parameters; the retrieval is done in the EOF space





Calibrated Radiance Spectra to Retrieved Atmospheric Parameters in Seven Steps

Algorithm Input Data

CrIS SDRs
Re-Mapped ATMS SDRs
Surface Pressure from NCEP
Surface Temperature from NCEP
Land Fraction

EDR Algorithm Steps

1. Initialization
2. Input and Pre-processing
3. Microwave-only (MW) Retrieval
4. Scene Classification
5. Microwave/Infrared Retrieval (MW+IR)
6. Quality Control
7. Output and Post-processing

Retrieved Surface and Atmosphere Parameters

Temperature Profile 42 Layers (reconstructed from 20 temperature EOFs)
Moisture Profile 22 Layers (reconstructed from 10 moisture EOFs)
Surface Temperature
Surface MW Emissivity (reconstructed from 5 MW emissivity EOFs)
Surface IR Emissivity (at 12 frequency hingepoints)
Surface IR Reflectance (at 12 frequency hingepoints)
MW Cloud Top Pressure and Cloud Liquid Water Path
Ozone Profile (reconstructed from 7 EOFs)

CrIMSS EDR Algorithm Description

Step 1 — Initialization

Load: Instrument Specification (Noise, Frequencies, etc.), NCEP Surface Pressure Database, Digital Elevation Map (static ancillary), Background Climatology and associated-co-variance, VIIRS Quarterly Surface Type (static ancillary)

Load Coefficient Files: Instrument Noise Co-Variance Matrices, Local Angle Adjustment, Infrared Optical Depth File, IR Channel Selection File, Microwave Optical Depth, Microwave Channel Selection Table, Emissivity Hinge Points, Ozone Co-Variances, Emissivity EOFs, NWP State Vector Co-Variances

Step 2 — Pre-Processing

Input: CrIS SDR and ATMS re-mapped SDR; NWP surface temperature and surface pressure, atmospheric temperature profile, water vapor mixing ratio, geopotential surface height.

QC and Precipitation Tests Flag Setting

Compute average elevation on footprint and adjust NCEP surface pressure
Determine land fraction from QST

Choose background by surface type
(8 different surface types)

Microwave Available? — No / Yes

Step 3 — Microwave Only Retrieval

Perform first physical inversion using background climatology as first guess and also as constraint with assosciated covariance (global apriori field)

All ATMS re-mapped SDR channels used for simultaneous retrieval of temperature, moisture, skin temperature, surface emissivity, cloud liquid water path, and cloud top pressure. Retrieves temperature profile and surface emissivity in EOF representations, and skin temperature cloud top pressure and cloud liquid water.

Update apriori field using appropriate covariance field based on simple air mass classification scheme (8 different stratifications, 2 global, 4 land, 2 ocean)

Perform second physical inversion

Converged? — Yes / No

IR Available? — Yes / No

Step 4 — IR Scene Classification

Identify Clear FOVS
Based on threshold of rms differences between clear specturm, determined from microwave first guess parameters, and observed IR spectrum.

Estimate number of cloud formations for cloud-clearing spectral region (eg. a data matrix containing 9 radiances spectra between 709.5 and 746 cm^{-1}). Uses larger eigenvalues in PCA to identify cloud signatures; this number used as number of cloud formations in cloud-clearing.

Group FOV clusters within FOR that are clear, partly cloudy or cloudy, based on thermal contrast and surface type (for NPP, all clusters contain 9 FOVs)

Step 5 — Joint Microwave/Infrared Retrieval

Cloud-clearing? — No / Yes

If partly cloudy, compute η (cloud-clearing parameter)
Calculate cloud cleared radiances

If clear, average radiances within cluster

If cloudy, perform cloud retrievals

Set noise error covariance

Map derivatives into EOF domain
Perform 101 level physical inversion
Temperature and moisture profiles, MW and IR emissivities, IR solar reflectivities, MW cloud parameters and skin temperature retrieved simultaneously
Update guess profiles (MW or NWP)
Project into geophysical parameters domain
Calculate new radiances

Maximum Interations? — No / Yes

Converged? — No / Yes

Compute Residuals

All clusters Processed? — No / Yes

Get Next Cluster

Step 6 — Quality Control

Final QC tests (report MW only, MW/IR or first guess)

Interpolation of T(p) and Q(p) to output pressure levels

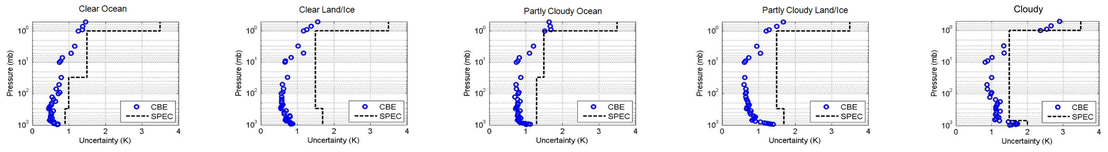
Step 7 — Output and Post-Processing

Compute pressure levels

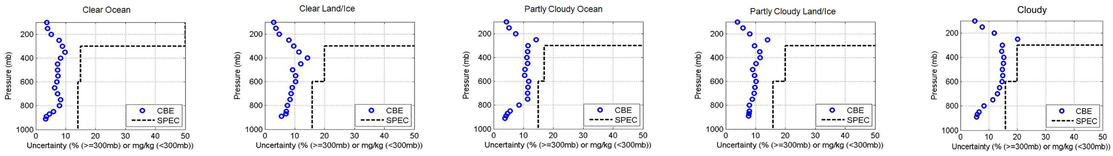
Output CrIMSS EDRs and IPs with quality flags

Performance

Expected Atmospheric Vertical Temperature Profile Performance Based on As-Built Instruments (black dotted line is EDR performance requirement)



Expected Atmospheric Vertical Moisture Profile Performance Based on As-Built Instruments (black dotted line is EDR performance requirement)



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