Provisional Maturity Assessment of CrIMSS EDRs
(On Going Efforts with NPP-Aqua Matches and Dedicated RAOBs)

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NOAA/STAR, JPSS

*Core group for CrIMSS-EDR algorithm Implementation, evaluation, Improvements through Discrepancy Reports to JPSS, user support, and, data source for Focus-Day(s) correlative data sets

# STAR in-house Aqua-AIRS retrieval key consultant and data sets
@Initial help on CrIS/ATMS bias-tuning data set
§Coordinator for AEROSE and other ARM/CART dedicated RAOB campaigns

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1. Provisional Maturity assessment of CrIMSS EDR Products
   1. Chronology of CrIMSS EDR evaluations from Pre-Launch to Post-Launch and Beta Maturity (Quick Scan)
   2. On going efforts and future plans on validations
      - CrIMSS /Aqua-Matches (Focus Day 05/15/2012)
      - Dedicated RAOBs (Example for the Focus Day 05/15/2012)
   2. Evaluation of two different algorithms, the AIRS –Science Team heritage algorithm, and the CrIMSS official EDR Algorithm
      - The attempt here is to present one such example - effect of dust on two different retrieval algorithms – How it was perceived with proxy data, and how it is seen with real observations.
   3. Discrepancy Report (DR) Process
      - Algorithm evaluation process, updates, fixes, path way to realization
First-Light CrIMSS ‘MW-only’ Retrievals
Using SDRs/TDRs, ‘the Day-1 Bias Tuning’ - Day 11/11/2011
Advantages at NOAA/STAR (from Murty, AMS2012)

Thanks to Kevin Garrett for providing MIRS Bias Tuning, and Antonia for providing NUCAPS Bias tuning
Evaluate CrIMSS EDR Algorithm Versions
- Off-line EDR Algorithm to emulate exact IDPS EDR versions
- CrIMSS EDRs – Past MX5.3, Present-MX 6.3 (Oct. 2012), and Future (MX7)
- Updates to CrIMSS EDR algorithm through ADL/G-ADA
- Evaluate CrIMSS EDRs with truth measurements, identify fixes, suggest EDR algorithm updates through Discrepancy Reports (DRs)

Validations with Focus Day Data Sets (05/15/2012, 09/20/2012) data sets, ECMWF/GFS Fields, and Heritage Algorithm (AIRS) Products.
- Matched AIRS/CrIS SDRs and EDRs – A viable path for Provisional Maturity
  - Results Presented are for the Focus Day: 05/15/2012
- Validations with Dedicated RAOBs once a substantial sample is reached (Example with AEROSPACE RAOB - 05/15/2012)
- Global RAOB collocations as we have done for AIRS/IASI Validations
AIRS Radiances, and AIRS retrievals, especially $T(p)$, $q(p)$ (and O3) went through Stage-3 validations with a variety of truth data sets. (Murty, JGR-2006, 2008; Dave Tobin, JGR-2006).

AIRS V6 (with Pbest $\Delta T$ Assimilation QC meets 1K/1Km standard even for cloud-cleared cases. The AIRS defined ‘clear’ cases (QC = 30hPa down to 750 hPa) RMS difference is pretty close to 0.8K/Km or less (figures follow)

Matched Aqua-AIRS retrievals, CrIMSS retrievals and other correlative data sets (ECMWF) can be used to

- Verify CrIMSS EDR Statistics and Aqua-EDR statistics using ECMWF as the reference (177,000 Matches for the Focus Day 05/15/2012)
- Globally about 4000 clear cases can be obtained from the AIRS Retrievals, and corresponding matches of Aqua-AIRS/AMSU and CrIS/ATMS SDRs at 3 x3 FOVs, and matched retrievals at FOR resolution can be extracted.

This can be further substantiated with validations using ‘dedicated RAOBs’ and/or global RAOB match-up of truth data sets once we achieve a reasonable number of ascents.
500mb Temp (K) Map (Descending)
CLM-2002 NPP-CrIMSS, Aqua-AIRS (V5.9), and ECMWF
(Used in Beta Maturity of CrIMSS)
CrIMSS EDRs and Aqua-AIRS Retrievals

**Focus Day 05/15/12**
- AIRS RET V5.9
- IDPS MX5.3 Past
- IDPS MX6.3 Current
- IDPS MX7 Future

**Matched AIRS/CrIMSS EDRs**
- T(p)
- q(p)
- AIRS-V6
- AIRS-V5.9
- CrIMSS EDRs

**Directly to**
- CrIMSS EDR Evaluation/Statistical Metrics
  With ECMWF, AIRS V5.9, AIRS6.0

**Indirectly to**
- CrIMSS EDRs/SDRs
- AIRS RET V6 QCs for Data Assimilation And Climate
- AIRS V5.9 Emulation at NOAA/STAR (Eric Maddy)
- NASA-DAAC Aqua-AIRS AMSU SDRs
- NASA-JPL AIRS-V6 (Evan Manning)
- STAR-SCDR CrIS/ATMS SDRs/IDPS-EDRs
- CrIMSS EDR Emulations at STAR Offline/ADL

**Data Sources**
- ECMWF NCEP-GFS
- Dedicated RAOB(s)
Aqua-AIRS and NPP-CrIMSS Versions

» Aqua-AIRS Retrievals
  – Version 5.9 uses regression based on PCs trained with ECMWF as the first guess for the final physical retrieval.
  – Version 6 uses Neural Network (NN) regression trained with ECMWF as the first guess for the final physical retrieval.
    - Uses pressure dependent QC for each profile, (1) high thresholds for data assimilation applications (pbest), (2) loose thresholds for climate applications (pgood). The yield is higher with pgood, and yield is lower for pbest.
    - We don’t have exact QC, but we did somewhat similar
      » QC = 0 or 1 30 hPa to 750 hPa (higher yield, pgood must be at least 750 hPa)
      » QC = 0 30hPa to 750 hPa (lower yield, pbest must be at least 750 hPa)
      » Used T(p) QC control for both T(p) and q(p)

» CrIMSS Retrievals.
  – Past (MX5.3), Present (MX6.3), Upcoming (MX7)
    - Retrievals used here are some what MX7 equivalent.
AIRS Ret. Versions and RMS Diff (05/15/2012) V5.9, V6(Pgood), V6(Pbest) Global (L+S+C; D+N); Ocean (D+N)

T(p) RMS (K) Q(p) RMS (%)
## Global ALL (L+S+C; D +N) Clear Cases

### AIRS Clear Cases - Daytime

<table>
<thead>
<tr>
<th>Daytime - Land</th>
<th>Daytime - Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Daytime Land Map" /></td>
<td><img src="image2" alt="Daytime Ocean Map" /></td>
</tr>
</tbody>
</table>

### AIRS Clear Cases - Nighttime

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<tr>
<th>Nighttime - Land</th>
<th>Nighttime - Ocean</th>
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<tbody>
<tr>
<td><img src="image3" alt="Nighttime Land Map" /></td>
<td><img src="image4" alt="Nighttime Ocean Map" /></td>
</tr>
</tbody>
</table>
CrIMSS IR+MW vs. ECMWF
AIRS V5.9 vs. ECMWF
Global Ocean – CLDCLR, Clear, RMS

Solid Lines
CrIMSS IR+MW

Dashed Lines
AIRS V5.9 RET

Blue Ocean
N= 116,000 - CLDCLR
AIRS:76% dashed
CrIMSS:58% solid

Clear
N= 5,540
AIRS: 3% dashed
CrIMSS solid

T(p) RMS (K)

Q(p) RMS (%)
CrIMSS IR+MW vs. ECMWF
AIRS V6 Pgood vs. ECMWF
Global Ocean – CLDCLR, Clear, RMS

Solid Lines
CrIMSS IR+MW

Dashed Lines
AIRS V6 RET pgood

Blue Ocean
N= 116,000 - CLDCLR
AIRS: 93% dashed
CrIMSS: 58% solid

Clear
N= 5,520
AIRS: 3% dashed
CrIMSS solid

T(p) RMS (K)

q(p) RMS (%)
CrIMSS IR+MW vs. ECMWF
AIRS V6 Pbest vs. ECMWF
Global Ocean – CLDCLR, Clear, RMS

T(p) RMS (K)  q(p) RMS (%)
CrIMSS IR+MW vs. ECMWF
AIRS V6 pbest vs. ECMWF
Global (D+N) : (L+S+C); CLDCLR, Clear RMS

Solid Lines
CrIMSS IR+MW

Dashed Lines
AIRS V6 RET
pbest

Global ALL
N=177,000
AIRS: 38% dashed
CrIMSS: 53% solid
CLDCLR

Clear
N: 5,277
AIRS: (3%) dashed
CrIMSS: solid
5331
Global Ocean – ± 60 LAT, Night Time
AIRS V6(pbest), CrIMSS CLDCLR, Clear, STDEV
Clear: N:3,308 ‘Dedicated’ Matches (pg.

T(p) RMS (K)  Q(p) RMS (%)
Results

» EDR Evaluations with ECMWF
  – First Stage CrIMSS-MW RET (ATMS) vs. AMSU-MIT Ret
    ● ATMS Retrievals are better than AMSU Retrievals (Plots not shown)
  – IR+MW Stage CrIMSS RET vs. AIRS-PR
    ● Clear (6326; 5520 ocean; 3308 ocean, night) and CLDCLR cases
      » Very encouraging results for matched clear/cloud-cleared cases
      » EDR Evaluations of clear cases are similar to AIRS
      » CrIMSS QC flags – A revisit and a DR in the process.
    ● Retrieval ability over dust-free/dusty areas
  » This Matched AIRS-CrIS data set is very useful and can lead us to provisional maturity very easily and can be considered as ‘Dedicated Matches’ synonymous to Dedicated RAOBs that are very sparse.
» Improve CrIS/ATMS empirical bias tuning with clear cases as defined by AIRS algorithm and AIRS/MODIS clear matches
Aerospace RAOB (Kauai, Hawaii) Location Specifics with ATMS BTs

### ATMS - Sub-Pixel FOV Variability with in FOR

<table>
<thead>
<tr>
<th>Example Region</th>
<th>ATMS (CH#1) Field of Regard BT Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Example Region" /></td>
<td><img src="image2.jpg" alt="ATMS (CH#1) Field of Regard BT Difference" /></td>
</tr>
</tbody>
</table>

### Field of Regard (Sub-Pixel Variability)

<table>
<thead>
<tr>
<th>ATMS-TDRs</th>
<th>CH #1 BT Difference (FOR) (obs-cal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.jpg" alt="ATMS-TDRs" /></td>
<td><img src="image4.jpg" alt="CH #1 BT Difference (FOR) (obs-cal)" /></td>
</tr>
</tbody>
</table>
Aerospace RAOB (Kauai, Hawaii) Location Specifics with ATMS BTs CH#3
Aerospace RAOB (Kauai, Hawaii)
Location Specifics Total PCW ECMWF
Aerospace RAOB (Kauai, 22.05N, 159.78W, Hawaii) Location Specifics with ATMS BTs CH#1
Aerospace RAOB (Kauai, 22.05N, 159.78W, Hawaii) Location Specifics with ATMS BTs CH#1
CrIMSS Ozone and OMPS Ozone
(Provided by Jianguo Niu, Larry Flynn, STAR)

October 2, 2012 (Top); October 16, 2012 (Bottom)
Towards TOAST of CrIMSS and OMPS Ozone
(TOAST: Total Ozone Analysis from SBUV and TOVS)
Aqua-AIRS Ozone Validation, (Murty - JGR, 2008)
WOUDC O3(p), TO3 BD Measurements
Synergetic Use of A-Train Satellite Data Sets (Aura-OMI, N16-SBUV)


Joint Publication in Collaboration with NASA (Murty Divakarla, ...Larry Flynn et al., ...)

Matched WOUDC BD Measurements Used in Validating AIRS Total Ozone N-4096 Bias (4%), OMI (3%), RMS (8%)

AIRS TO3 vs. BD
Global
8% RMS
4% Bias

AIRS Total Ozone
February 2005

OMI Total Ozone
February 2005

Annual Cycle
AIRS - 2005

Annual Cycle
OMI - 2005

AIRS 1800 Km Swath

OMI 2600 Km Swath

SBUV Nadir

http://www.agu.org/pubs/crossref/20082007JD009317.shtml
Summary

» We are in the process of optimizing MX-7 CrIMSS EDR Algorithm Emulation and going through a thorough evaluation/implementation of many Discrepancy Reports. Results shown here will be improved substantially with all the anticipated changes.

» This AIRS/CrIS matches provide a simple pathway for CrIMSS EDR Provisional Maturity. The AIRS-CrIMSS SDR/EDR Matches (Ocean, Night Time, ±60 Lat, N: 3,300 for 05/15/2012) can be considered as ‘Dedicated Aqua Matches’ synonymous to ‘Dedicated RAOBs’. Extending this to other Focus Days could provide Set of ‘Golden Focus Day Data Sets’ to

- Validate CrIMSS vis-à-vis AIRS Retrievals with Matched ECMWF/Dedicated RAOBs
- Refine and enhance CrIS/ATMS empirical bias tuning
- Provide the best possible evaluation of two different algorithms, the AIRS –Science Team heritage algorithm, and the CrIMSS official EDR Algorithm) - Slides Follow -

» The attempt here is to present one such example - effect of dust on two different retrieval algorithms – How it was perceived with proxy data, and how it is seen with real observations.
On-Going STAR Activities
In Collaboration with Cal/Val Team Members

Topic:
Discrepancy Reports Generation
Coordinated Efforts to Expedite
Algorithm Change Process

Degui Gu, Xia L Ma, and Denise Hagan
Northrop Grumman Aerospace Systems

Xu Liu and Susan Kizer
Langley Research Center

Mike Wilson, Murty Divakarla, Bigyani das, Changyi Tan, and Xiaozhen Xiong,
STAR, NOAA/NESDIS

Wael Ibrahim
Raytheon

Other Cal/Val Teams
Other Teams (Richard Cember)

As Directed by:
Chris Barnet, CrIMSS Cal/Val Team Lead
How Do We Move forward

- "what and how" of proposed changes can be expedited through Algorithm Change Process
- Make sure the DR submitted is worthy of consideration
  - Scientific evaluation of the DR.
  - Provide preemptive answers to the queries expected in the implementation process
<table>
<thead>
<tr>
<th>DR #</th>
<th>Files Affected</th>
<th>LUT Affected</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4926</td>
<td>calcCrimssProfiles.f set_irmw_invert.f</td>
<td>calcCrimssProfiles.f</td>
<td>This change fixes handling of forward model errors. The current code has errors in computing total error in radiance residuals.</td>
</tr>
<tr>
<td>4942</td>
<td>fovsel.f</td>
<td></td>
<td>The current code identifies scenes as clear when they are actually partly cloudy. This change causes tighter scene detection for clear scenes.</td>
</tr>
<tr>
<td>4943</td>
<td></td>
<td>CrIMSS-IR-NOISE</td>
<td>This change upgrades the sensor and forward model LUTs for the CrIS instrument. The current LUTs are pre-launch values.</td>
</tr>
<tr>
<td>4945</td>
<td>calcCrimssProfiles.f</td>
<td></td>
<td>This change allows the difference between skin temperature and surface temperature to be larger for daytime land.</td>
</tr>
<tr>
<td>4946</td>
<td>setCovBack.f</td>
<td></td>
<td>This change optimizes the climatology LUT. The criteria for choosing warm ocean is loosened through this change, resulting in the warm ocean climatology being chosen more frequently.</td>
</tr>
<tr>
<td>4958</td>
<td></td>
<td>CrIMSS-EDR-AC</td>
<td>This change optimizes the QC flags. Currently, the QC flag for the microwave portion of the combined run is too strict. This change increases the threshold for this flag from 2 to 4, making values pass more frequently.</td>
</tr>
</tbody>
</table>
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1. **Chronology of CrIMSS EDR evaluations from Pre-Launch to Post-Launch and Beta Maturity (Quick Scan)**

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3. **Discrepancy Report (DR) Process**
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• **Thank You.**
End of Presentation