Justification for CrIMSS EDR Provisional Maturity Presented: Jan. 17, 2013 (updated Jan. 18th, 2013)

(cover page only updated March 21, 2013)

ADR #: 7089

CCR # 474-CCR-13-0923

DRAT discussion: March 12, 2013

AERB presentation: March 27, 2013

Christopher Barnet, former CrIMSS EDR Validation and Algorithm Lead
Tony Reale, acting CrIMSS EDR Validation and Algorithm Lead

Significant inputs were made from the entire CrIMSS EDR Algorithm and Validation Team Members.

Outline of this presentation

- CrIMSS EDR Team (3-slides)
- Users of CrIMSS EDR (2-slides)
- Provisional EDR Maturity Definition (1 slide)
- Summary of CrIMSS EDR (4 slides)
- CrIMSS EDR requirements (3 slides)
  - SIDEBAR: Discussion on AVMP statistics definition (7 slides)
- History of Algorithm Changes, DR Summary (6 slides)
- Provisional Maturity Evaluation (35 slides)
- Known issues with the Provisional CrIMSS EDR (3 slides)
- Additional supporting documentation (2 slides)
- Provisional Justification Summary (2 slides)
- Future plans (1 slide)
- Conclusions (1 slide)

CrIMSS EDR Team Members' Roles and Responsibilities (part of CrIMSS EDR budget)

Lead for Activity	Organization	Task
Chris Barnet	NOAA/NESDIS/STAR	CrIS/ATMS EDR algorithm lead (Wilson) and validation (Nalli, Xiong)
Mitch Goldberg (C. Barnet)	NOAA/NESDIS/STAR	NGAS-code analysis (Divakarla, Tan)
Anthony Reale	NOAA/NESDIS/STAR	NPROVS operational RAOB comparisons
Ralph Ferraro	NOAA/NESDIS/STAR	Precipitation Flag

Lead for Activity	Organization	Task
Allan Larar	NASA/LaRC	Comparisons to aircraft (S-HIS, NAST-I) EDRs
Xu Liu	NASA/LaRC	CrIMSS EDR Algorithm Validation (Kizer)
Hank Revercomb	SSEC	AVMP/AVTP validation (Knuteson), AVTP/AVMP validation (Li)
Dave Tobin	SSEC	ARM-RAOBS at NWP, SGP, NSA
Larrabee Strow	UMBC	OSS validation and comparisons to SARTA

Brown=funding reduced in FY13, RED = not funded in FY13,
GREEN = FY13 funding removed from CrIMSS-EDR team

External CrIMSS EDR members of validation team (not funded by CrIMSS EDR budget)

SDR/EDR	Lead for Activity	Organization	Task
ATMS SDR, CrIS SDR, CrIMSS EDR	Degui Gu / Denise Hagan / Xia-Lin Ma	NGAS	EDR /SDR Validation, code integration
ATMS TDR/SDR	Sid Boukabara	NOAA/STAR	MiRS EDR
CrIMSS EDR	Lars Peter Riishojgaard	JCSDA	NCEP analysis
CrIMSS SDR	Steven Beck	Aerospace Corp.	RAOB,LIDAR
CrIMSS SDR	Steven English	UKMET	UKMET analysis
CrIMSS SDR	William Bell	ECMWF	ECMWF analysis
AVTP/AVMP	Steve Freidman	NASA/JPL	Sounder PEATE
CrIMSS SDR	Ben Rustin	NRL	NOGAPS/NAVDAS analysis

CrIMSS EDR Team (3/3)

- STAR coordinates the algorithm activities
  - ensures algorithm changes are consistent with algorithm architecture and the DPA/DPE change process.
  - provides datasets and methodologies to the team to ensure a consistent analysis.
- This presentation summarizes the work of the entire algorithm and validation team.
  - Individual team members have made significant contributions (figures and analysis) during telecons and meetings.
  - STAR has consolidated these contributions from individual team members into this document.
    - As a result, many of the figures and analysis shown are from STAR.
    - This should NOT be misconstrued as a lack of contribution by any individual member of the team.
  - See list of AMS presentations under "Additional Supporting Documentation" for *some* of the individual contributions.

Users of CrIMSS EDR (1/2)

ATMS/CrIS SDRs and Sounding EDR Products

- **U. S. Users:**
  - AWIPS-II – Advanced Weather Interactive Processing System (Brian Gockel)
  - NCEP- National Centers for Environmental Prediction (Jim Jung/Dennis Keyser)
  - GMAO- Global Modeling and Assimilation Office (Emily Liu)
  - NRL – Naval Research Laboratory (Ben Ruston)
  - FNMOC – Fleet Numerical Meteorology and Oceanography Center (Yiping Wang)
  - STAR – Center for Satellite Applications and Research (Tony Reale, Murty Divakarla)
  - CLASS - Comprehensive Large Array-data Stewardship System (John Bates)

- **Foreign Users:**
  - UK Met Office (Nigel Atkinson)
  - JMA- Japan Meteorological Agency (Yoshiaki Takeuchi)
  - ECMWF- European Center for Medium range Weather Forecasting (Tony McNally)
  - DWD- Germany's National Meteorological Service (Reinhold Hess)
  - Meteo-France- France's National Weather service (Lydie Lavanant)
  - CMC- Canadian Meteorological Center (Louis Garand)
  - EUMETSAT – Simon Elliott

Users of CrIMSS EDR (2/2)

In reality, CrIMSS EDR has a very limited user base

- NOAA-TOAST product considering use of CrIMSS O3-IP (within NDE)
- AWIPS has decided to use the NOAA-Unique CrIS/ATMS Processing System (NUCAPS) products
  - Desire 100 level product
  - Desire continuity with IASI product EDR formats
  - Desire rapid R2O environment
    - NUCAPS had a successful Alg. Readiness Review on Jan. 14, ready for operations
    - Product will be available to users from CLASS in summer 2013
- CrIMSS-EDR is a baseline operational product
  - Physical-only 1DVAR approach is unique for hyperspectral IR
  - Can explore capabilities for NWP applications.
    - Retrievals are a "test-bed" for exploitation of CrIS radiances.
    - These capabilities are usually imbedded directly into NWP
  - Other developers use it as a "standard" to explore trade-offs in methodologies
- Historically, the users of these kinds of products are varied (e.g., climate, air-quality, process studies, etc.)
  - Users tend to be access data as needed for their study, not a 24/7 user.
  - AIRS EDR products are used in ~30-40 publications/year in recent years.
  - AIRS project has identified 100's of unique users of it's EDR standard and support products; however, it is not clear how much volume of data they use.
  - NASA/AIRS team reprocesses the entire Aqua/AIRS dataset at maturity level transitions (v3 beta, v4 provisional, v5 stage.1, v6 stage.2, etc.) → could attract users.

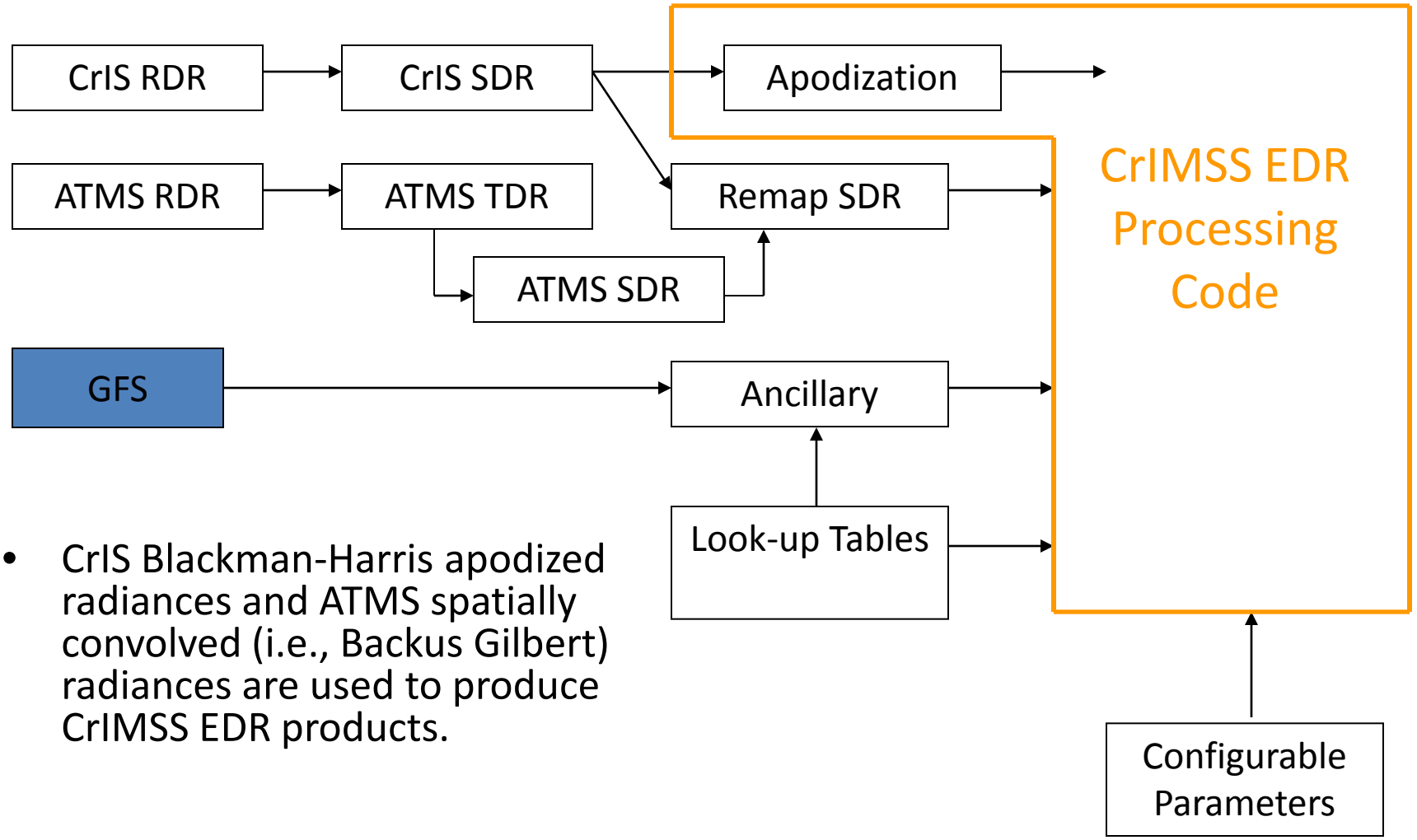
Provisional EDR Maturity Definition (1/1) (adapted from Dec. 18, 2012 ADP guidance)

- Product quality may not be optimal.
  - Product accuracy is determined for a broader (but still limited) set of conditions.
  - No requirement to demonstrate compliance with specifications.
- Incremental product improvements are still occurring.
- Narrative, listing and discussing known errors.
  - All DRs are identified and prioritized
  - Pathway towards algorithm improvements to meet specifications is demonstrated.
- Version control is in effect.
  - Description of the IDPS algorithm version and LUTs/PCTs versions used to generate the product validation materials.
  - ATBDs are accurate, up-to-date and consistent with the product running.
- General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing.
  - DPA will submit readme document to CLASS.
- Users are urged to consult the EDR product status document prior to use of the data in publications.
  - Identify known deficiencies regarding product quality.
- May be replaced in the archive when the validated product becomes available.
  - Technical evaluation of limited data reprocessing is presented.
- Ready for operational evaluation.
  - Key NOAA and non-NOAA end users are identified and feedback requested

Summary of the CrIMSS EDR (1/4)

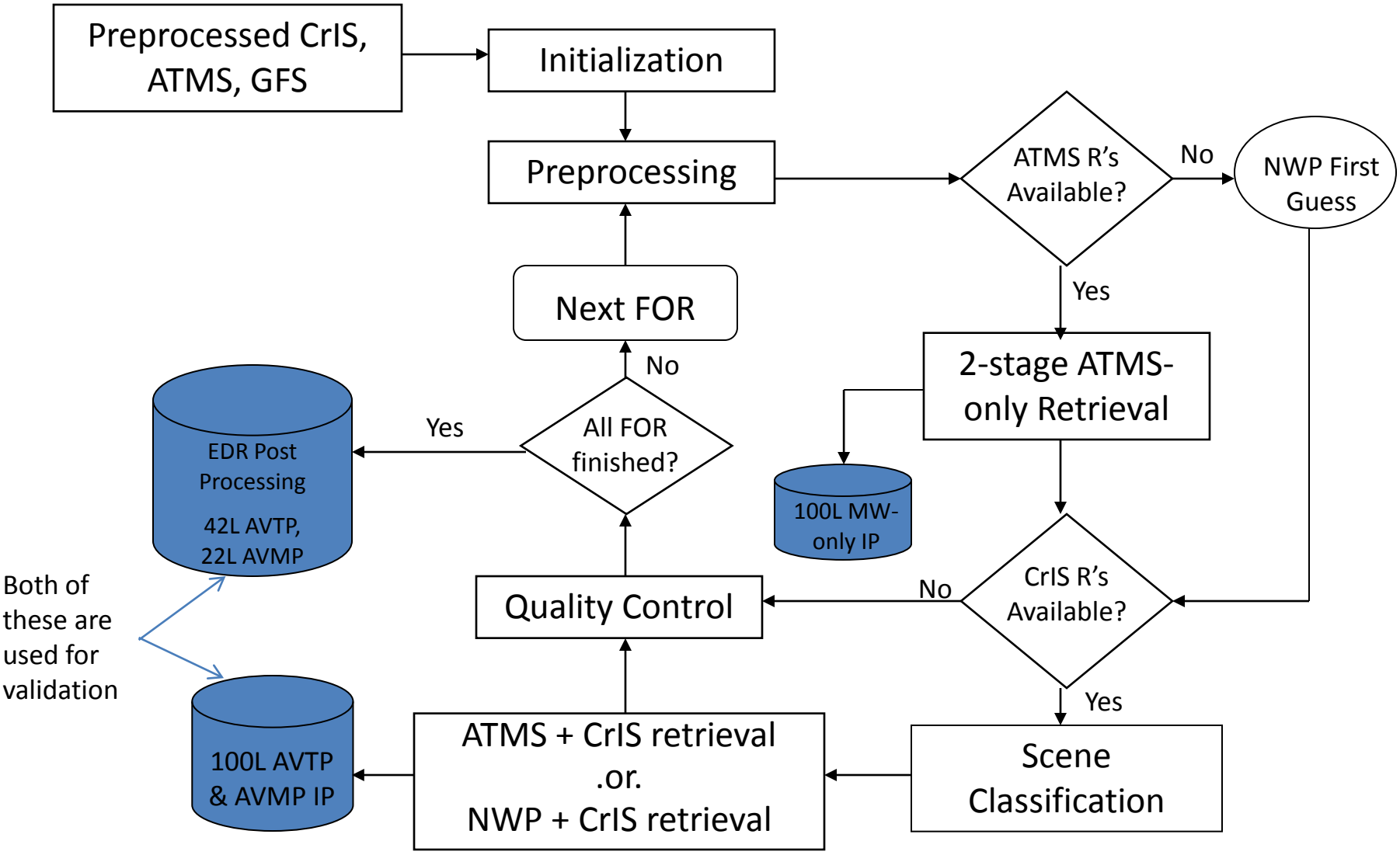
- The CrIMSS EDR algorithm utilizes all of the radiances from CrIS and ATMS within a CrIS field-of-regard (FOR) to produce a single sounding of the AVTP, AVMP, and O3-IP.
- The FOR is derived from ~25 ATMS fields-of-view (FOV) that are optimally averaged along with an optimal spatial combination of the 9 CrIS FOVs (called cloud clearing) within a single interferogram sweep.
- The AVPP product is derived from geopotential height computed from AVTP and AVMP.
- The CrIMSS EDRs are heavily dependent on the upstream SDRs as well as empirically derived bias corrections (a.k.a. tuning) with respect to the CrIMSS forward model (called the Optimal Spectral Sampling (OSS) model).
- As calibration of the CrIS or ATMS SDRs improves, so does the quality of the CrIMSS EDR.

Summary of the CrIMSS EDR (2/4)



- CrIS Blackman-Harris apodized radiances and ATMS spatially convolved (i.e., Backus Gilbert) radiances are used to produce CrIMSS EDR products.

Summary of CrIMSS EDR (3/4)



Summary of CrIMSS EDR (4/4)

- The CrIMSS EDR derives AVTP, AVMP, AVPP, O3-IP, surface temperature, surface emissivity simultaneously.
  - AVTP reconstructed from 20 EOF's, AVMP from 10 EOF's
  - Also 1 surface temperature, 5 MW EOF's, 12 IR emissivity and reflectivity hingepoints, MW cloud top pressure and cloud liquid water path
    - These products are not currently in HDF5 file(s)
  - There is an inter-dependence within products
  - Therefore, entire atmospheric state needs to be assessed in order to validate these products.
- Assumption for EDR validation is that CrIS and ATMS SDRs are calibrated.
  - Beta versions of SDR will be used to help algorithm and instrument assessments during EOC
  - Assessment is "hierarchal" using NWP model(s) and operational RAOBs for global assessment and dedicated radiosondes for detailed site characterization.
  - Characterization improves as more *in-situ* data is acquired.

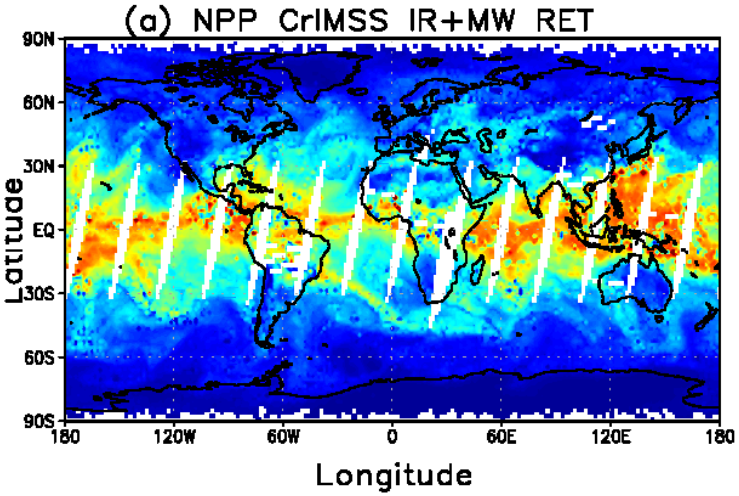
CrIMSS EDR Requirements (1/3)

Atmospheric Vertical Moisture Profile (AVMP).

Used for initialization of high-resolution NWP models, atmospheric stability, etc.

Lower tropospheric moisture layers are no longer Key Performance Parameters (KPPs) .

Parameter (KPP in Blue)	IORD-II, JPSS-L1RD
AVMP Partly Cloudy, surface to 600 mb	**Greater of 20% or 0.2 g/kg**
AVMP Partly Cloudy, 600 to 300 mb	Greater of 35% or 0.1 g/kg
AVMP Partly Cloudy, 300 to 100 mb	Greater of 35% or 0.1 g/kg
AVMP Cloudy, surface to 600 mb	**Greater of 20% of 0.2 g/kg**
AVMP Cloudy, 600 mb to 300 mb	Greater of 40% or 0.1 g/kg
AVMP Cloudy, 300 mb to 100 mb	Greater of 40% or 0.1 g/kg



Example of AVMP (shown as total precipitable water) on May 15, 2012 from the CrIMSS off-line EDR
Results are from the coupled algorithm without QC

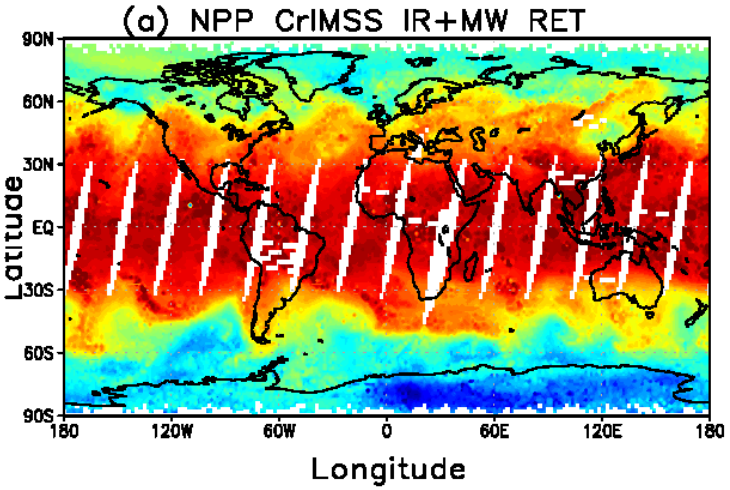
CrIMSS EDR Requirements (2/3)

Atmospheric Vertical Temperature Profile (AVTP).

Used for initialization of high-resolution NWP models, atmospheric stability, etc.

Lower tropospheric temperature are no-longer KPPs.

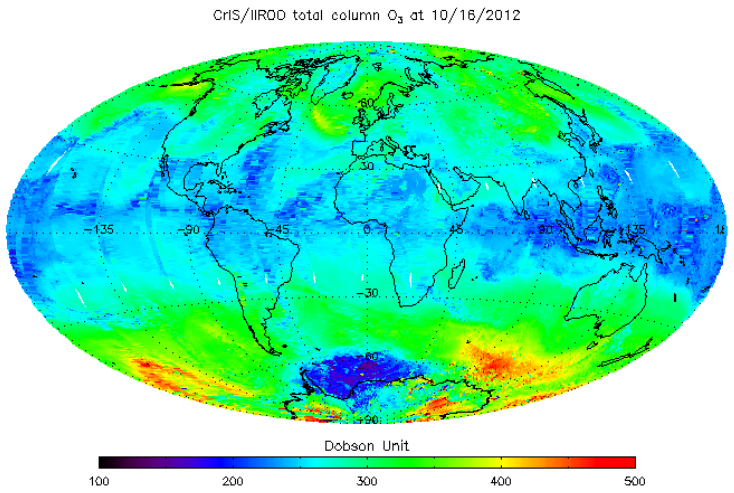
Parameter (KPP in Blue)	IORD-II, JPSS-L1RD
AVTP Partly Cloudy, surface - 300 mb	**1.6 K/1-km layer**
AVTP Partly Cloudy, 300 to 30 mb	1.5 K/3-km layer
AVTP Partly Cloudy, 30 mb to 1 mb	1.5 K/5-km layer
AVTP Partly Cloudy, 1 mb to 0.5 mb	3.5 K/5-km layer
AVTP Cloudy, surface to 700 mb	**2.5 K/1-km layer**
AVTP Cloudy, 700 mb to 300 mb	1.5 K/1-km layer
AVTP Cloudy, 300 mb to 30 mb	1.5 K/3-km layer
AVTP Cloudy, 30 mb to 1 mb	1.5 K/5-km layer
AVTP Cloudy, 1 mb to 0.05 mb	3.5 K/5-km layer



Example of AVTP at 500 hPa on May 15, 2012 from the CrIMSS off-line EDR
Results are from the coupled algorithm without QC

Overview of CrIMSS EDR Products

- Pressure product is a EDR derived product that requires validation.
- Ozone is an intermediate product (IP) used by the OMPS team.
- CO, CH4 and CO2 are pre-planned product improvements(P^{3}I)
  - SOAT has recommended full-resolution RDR's for CrIS SW and MW bands to support these products..



Example of CrIMSS total column ozone IP product (day+night) from CrIS for Oct. 16, 2012.

Parameter (P^{3}I in Blue)	IORD-II / JPSS-L1RD
Pressure Profile	4 mb threshold, 2 mb goal
Ozone IP	20% precision for ~5 km layers from 4 hPa to 260 hPa
CH4 (methane) column	1% ± 5% / 1% ± 4% (precison ± accuracy)
CO (carbon monoxide) column	3% ± 5% / 35% ± 25% (precision ± accuracy)

Discussion on AVMP statistic definition (1/7) How Statistics are computed

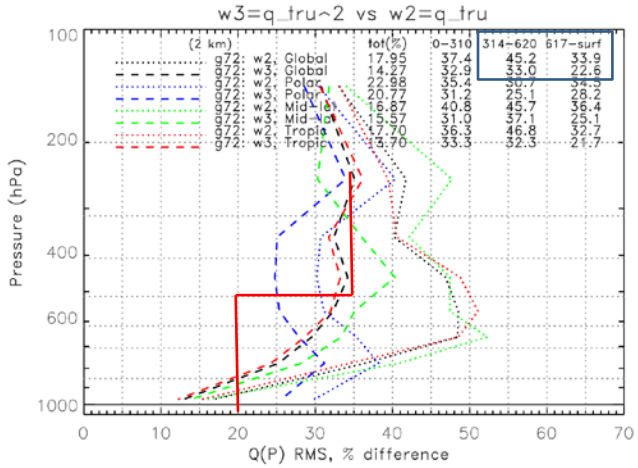
- In the following figures I used ECMWF as the truth water
  - q_tru, given as gm/cm^2 within 2-km statistical layers
    - Layer boundaries are shown as horizontal dotted line on figures
- The retrieval water, q_ret, is an old v5 AIRS run (Sep. 2008) on ~5000 accepted cases from Sep. 2, 2002 observations.
- Statistics of % water error, g = (q_ret-q_tru)/q_tru, are
  - %RMS = 100*SQRT{sum{w*g^2}} / SQRT{sum{w}}
  - %BIAS = 100*sum{w*g} / sum{w}
  - %SDV = SQRT{$\%RMS^2$ - $\%BIAS^2$}
- Historically, for %RMS w=$(q\_tru)^2$ and %BIAS used w=q_tru
  - This creates a mathematic inconsistency and %SDV is not well-behaved
  - Weighting by $(q\_tru)^2$ was originally proposed so that polar cases, presumed to have high errors, would not dominate the statistic

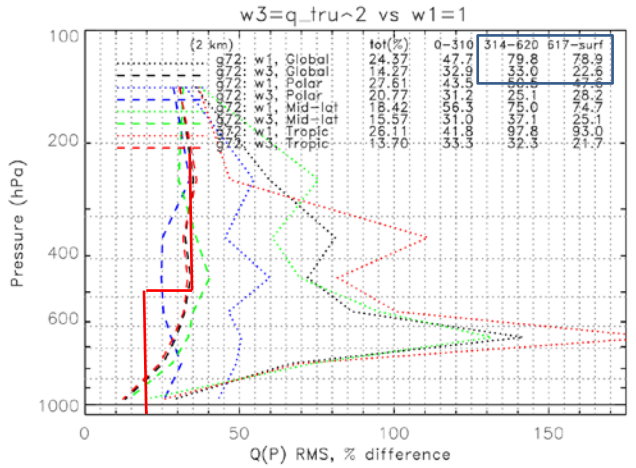
Discussion on AVMP statistic definition (2/7) Investigated 3 Methods of Weighting

- Ran an experiment in which 3 weights were used
  - W1 = 1
  - W2 = q_tru
  - W3 = $(q\_tru)^2$
- There is no change in the profiles themselves
  - Only difference in the figures on the next page are in the statistic itself
- Level-1 requirements document is sufficiently vague
  - Historically, these requirements were derived from the $w=q\_tru^2$ weighting for RMS from AIRS simulation experiments.

Discussion on AVMP statistic definition (3/7) Results from 3 Methods of Weighting

In the plots below the dashed lines are for w3=q_tru^2 for global (black), polar(blue), mid-latitudes (green), and tropical (red) cases.
Alternative weightings are shown as dotted lines. On the left are RMS statistics for w2=q_tru and on the right are for w1=1.
Statistics are computed for the "2-km" layering scheme (dotted horizontal lines)
Obviously, the w2=q_tru and w1=1 would cause us to not meet requirements.





In boxes at left are the average from 300-600 and 600-surf

Global statistic is Summarized below

	300-600	600-surf
L1RD	35%	20%
W1	80%	79%
W2	45%	34%
W3	33%	23%

As weight goes from w3 (dashed lines) to w2 (dotted on left) to w1 (dotted on right) the statistics get worse (see table)

Discussion on AVMP statistic definition (4/7) What are the implications?

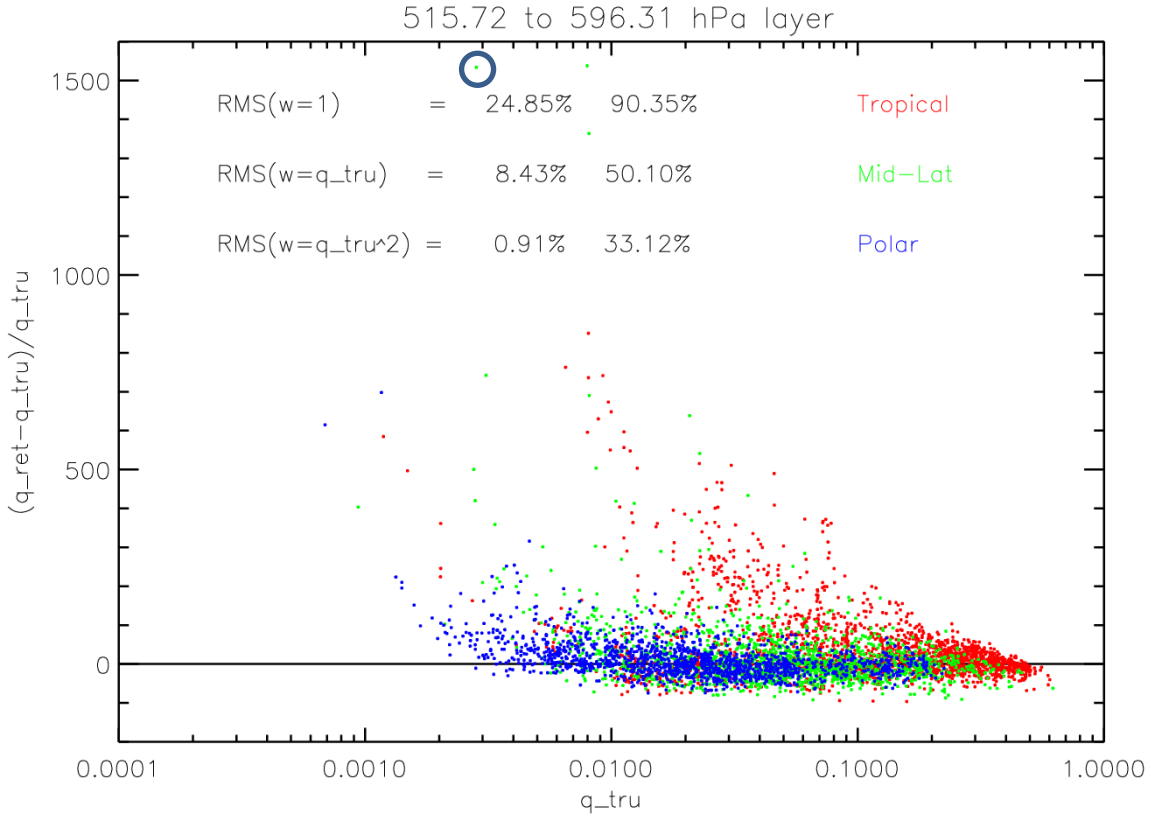
- These results were somewhat surprising and confirmed what Bomin Sun had showed with the RAOB statistics
  - But, the statistic for the polar cases is least sensitive to the choice of weighting than mid-latitude and tropical case.
  - The original thinking that the q_tru^2 weighting would lessen the impact of polar (i.e., very cold) cases is not the main contribution to higher statistics for w=q_tru or w=1 weighting
    - Polar cases don't seem to be a problem
  - But, since water decreases rapidly with altitude this effect is more in the middle troposphere
- Decided to take a closer look at the 500-600 hPa layer

Discussion on AVMP statistic definition (5/7)
A detailed look at 550 mbar region

Below is a scatter plot of (g vs q_tru) the individual retrievals for the 515-600 hPa layer. The three colors show cases for tropical (red), mid-latitude (green), and polar (blue).
Also shown is the %bias and %rms statistic for the 3 weighting schemes for the global ensemble.
Circled point will be looked in the next slide

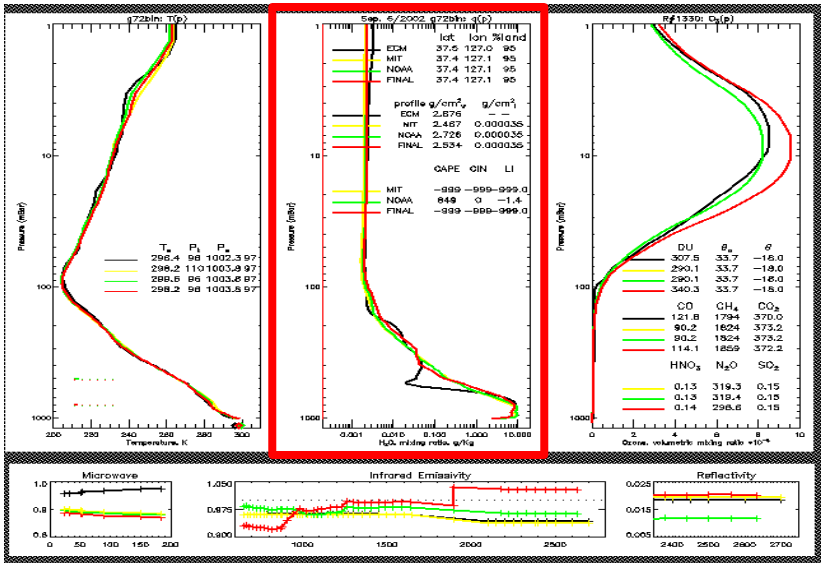
Note that in each latitude band (red, green, blue) there are large outliers, but these outliers and the overall error tends to increase for small q_tru in this layer.

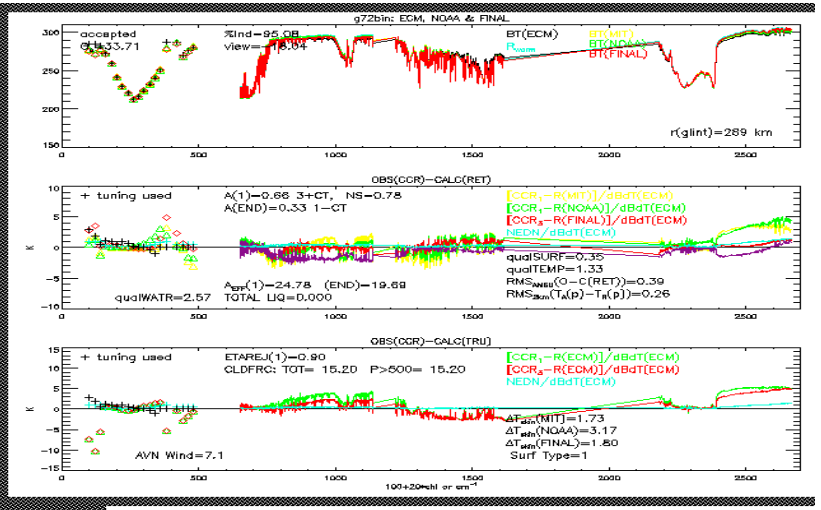
Also, there are more positive outliers (wet retrieval) than there are negative outliers.



Discussion on AVMP statistic definition (6/7)
A detailed look at one case with large error.

Here is a detailed diagnostic for one of the mid-latitude outliers. Lots of info on this plot, but if you look at the 2nd panel in the upper left profile plot (highlighted in red) you will see that ECMWF has a dry layer (NOTE: this is a log scale) that the smooth retrieval doesn't capture – but this is a "good" retrieval. This case is the one in previous plot with g=1533, q_tru=0.0028 g/cm^2 at latitude=37.4 (index = 1330 in granule 401)






```
HIT RETURN to continue (exit,...,eps,ps) ==> xwd
ETAREJ(1)=0.90, ETAREJ(1)=0.90  CLDFRC: TOT= 15.20  P>500= 15.20
qualSURF=0.35  qualTEMP=1.33  qualWATR=2.57
RMS(AMSU-C(RET))=0.39, RMS(TA(p)-TR(p))=0.26
A(1)=0.66 3+CT,  NS=0.78, A(END)=0.33 1-CT,  Aeff(1)=24.78, Aeff(END)=19.69
TOTAL LIQ=0.000  AVN Wind=7.1  Surf Type=1 (land)  Ts=298.2
DTskin(MIT)=1.73, DTskin(NOAA)=3.17, DTskin(PHYS)=1.80
George's Test=0.691  Tsurf(PHYS)-Tsurf(REG)=-1.373  NOAA_Diff_Test=-4.356
 OLR=0  h2o=0  TTp=0  TMd=2  TBt=2  Srf=2  CCR=2
 i  alat  alon %land  solz  glint R(sort)  eta %(516) %(801) Cij(850) Cij(2560)
 1  37.2 127.0 100.0  33.5  289.0  42.737  0.010  4.6  0.0  -0.26  -0.13
 2  37.2 127.1 100.0  33.6  289.0  42.168  0.010  2.5  6.6  0.05  -0.15
 3  37.3 127.3 100.0  33.7  291.0  41.459  0.005  3.4  20.0  -0.26  0.08
 4  37.4 126.9  99.8  33.6  290.0  42.059  -0.004  7.0  0.0  0.62  0.38
 5  37.4 127.1 100.0  33.7  291.0  41.230  0.001  1.6  30.5  -0.09  0.03
 6  37.4 127.3  97.1  33.8  293.0  41.621  -0.006  5.6  6.7  0.44  0.44
 7  37.5 126.9  83.7  33.7  292.0  42.116  -0.006  6.0  4.6  -1.19  0.65
 8  37.6 127.0  82.9  33.8  293.0  41.381  -0.004  8.9  7.5  -0.10  0.26
 9  37.6 127.2  92.2  33.9  295.0  41.036  -0.007  8.4  12.9  -0.38  0.27
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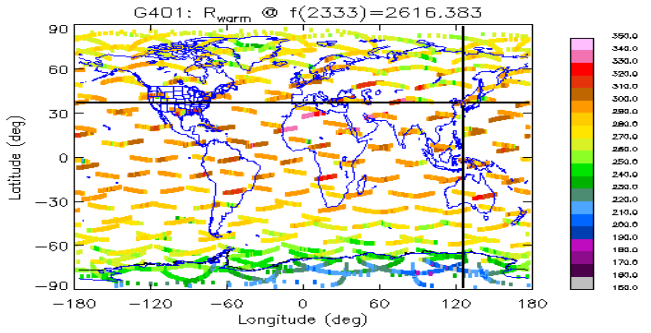


Discussion on AVMP statistic definition (7/7) What should the weighting be?

- The higher resolution level truth (ECMWF) has dry layers that the lower resolution retrieval cannot capture
  - ECMWF could be in error both in the sense of
    - Placing the dry layer in the wrong vertical bin
    - Or – the dry layer could be displaced spatially
      - When looking at many of the diagnostic plots you tend to see the retrieval capture the dry layer a few fields of regard to the east or west of where ECMWF sees it, albeit at lower resolution.
- This effect will be seen in all "truth" datasets.
- A mathematically correct procedure would be to adjust the truth datasets with the retrieval averaging kernal (AK)
  - This would not eliminate cases where the truth was in error (due to temporal or spatial differences between truth and retrieval)
  - Current CrIMSS EDR code does not compute or output AK's.

- Given the historical nature of AVMP statistics shown with $w=(q\_tru)^2$, all the figures in this presentation and future validation efforts will adopt this weighting for requirements assessment.
- Issue with bias and rms having different weighting will be fixed – both will use $(q\_tru)^2$ – which has the net effect of reducing previous estimates of bias (i.e., accuracy); however, these were not turned into requirements.
  - Figures in this document use the old AIRS methodology for BIAS – hence they cannot be used to infer standard deviation.

History of Algorithm changes (1/6)
DR's leading up to beta maturity

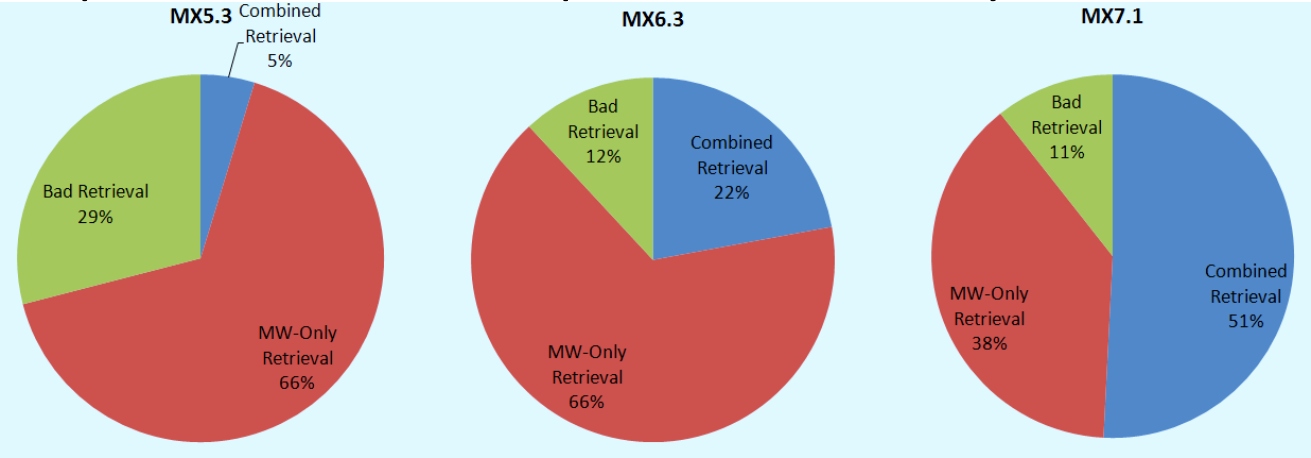
Date	Update/DR#	Reason	Completed
Nov. 2010	4068 & 4079	Precip flag is out of date	In-work, expect to install May 2013
Dec. 2010	4090 (same as 4045)	Derivatives w.r.t. emissivity	Cancelled
Feb. 2011	4207 & 4208	Interpolation of AVTP/AVMP is incorrect, bottom layer missing	Have not confirmed that this is a real problem
Mar. 2011	4233	Surface pressure has Gaussian Noise (for simulation)	Completed and closed
Mar. 2011	4234	State.2 (increased spatial resol.)	Deferred to J1
Aug. 2011	4325, CCR707	ATMS bias correction	LUT and code installed in Mx6.4
Aug. 2011	4334, CCR707	CrIS bias correction	Code completed pre-launch (Mx5.0), LUT updated in Mx6.4
Aug. 2011	4335, CCR707	Updates of post-launch LUTs	OSS (both IR and MW) completed in Mx5.3, emissivity covariance LUT installed in Mx6.4
Sep. 2011	4346	Pressure inconsistencies at TOA	Closed

History of Algorithm Changes (2/6)
Mx7.1 changes, in IDPS June 2013

Date	DR#/CCR#*	Description	Status
Sep 2012	4922/0707	Code bug: non-LTE & ozone channel indexing is off by 22 chl	Scheduled for Mx6.6
Oct. 2012	4923	Code Bug: Surface pressure exceeds reasonable values	In-work, Raytheon investigating
Oct. 2012	4926/0739	Code bug: Fix noise used by retrieval for clear scenes	Approved for Mx7.1
Oct. 2012	4942/0739	More conservative clear scene detection	Approved for Mx7.1
Oct. 2012	4943/0740	Replace CrIS sensor noise and forward model error LUTs with post-launch derived values	Approved for Mx7.1
Oct. 2012	4944	Replace CrIS and ATMS bias correction LUTs	In-work, current tables are reasonable
Oct. 2012	4945/0739	Modify surface constraint for daytime land scenes (current constraint too tight).	Approved for Mx7.1
Oct. 2012	4946/0739	Modify the selection criteria for warm ocean climatology (current code selects warm ocean too often)	Approved for Mx7.1
Oct. 2012	4958/0740	Optimize chi^2 threshold parameters to allow higher yield for IR retrieval	Approved for Mx7.1

History of Algorithm Changes (3/6)
Four "baseline" systems will be discussed

- Mx5.3, operational since April 1, 2012
  - This is the *beta* maturity system
- Mx6.4 (a.k.a. Mx6.3), operational since Oct. 12, 2012
  - Added empirical bias corrections for ATMS, updated CrIS
- Mx6.6, expected to be operational in Feb. 2012
  - Fixed an indexing bug for non-LTE and ozone channels
  - Significant improvements in daytime yield (from 4% to 50%)
- Mx7.1, expected to be operational in June 2012
  - Improvements in both performance and yield



History of Algorithm Changes (4/6)
Example of how we test changes

	a	b	c	d	e	f	g	h	i	j	k	l
E1												
E2	✓											
E3		✓										
E4			✓									
E5	✓	✓	✓									
E6	✓	✓	✓	✓								
E7	✓	✓	✓		✓							
E8	✓	✓	✓	✓	✓							
E9	✓	✓	✓			✓						
E10	✓	✓	✓	✓	✓	✓						
E11	✓	✓	✓	✓	✓	✓	✓					
E12	✓	✓	✓	✓	✓	✓		✓				
E13	✓	✓	✓	✓	✓	✓			✓			
E14	✓	✓	✓	✓	✓	✓				✓		
E15	✓	✓	✓	✓	✓	✓	✓		✓	✓		
E16	✓	✓	✓	✓	✓	✓					✓	
E17	✓	✓	✓	✓	✓	✓						✓
E18	✓	✓	✓	✓	✓	✓					✓	✓
E19	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

List of Changes

Changes made in MX6.4 (E5 is baseline):

a) MW Bias File
b) IR Bias File
c) CLIM-LUT File

Changes in Mx6.6 (E10 is baseline):

d) non-LTE issue (main program)
e) Indexing issue (ozone)

Changes proposed for Mx 7.1 (E19 is baseline)

f) Fix to SPLF (using Xiaozhen's SPLF as proxy)

DR Submissions for code:

g) Rtmerror bug (fix calculation of IR noise)
h) Turn off stratification
i) Change warm ocean constraint
j) Loosen Tskin-Tair constraint over land

New LUTs:

k) New IR-NOISE-LUT file.
l) New IR-ATM-NOISE file.

Note: h) and i) are two options for the same fix. (i) is the primary fix

NOTE: we are now up to E33 with many inter-combinations being tested.

History of Algorithm Changes (5/6)
How changes are packaged to DPA/DPE

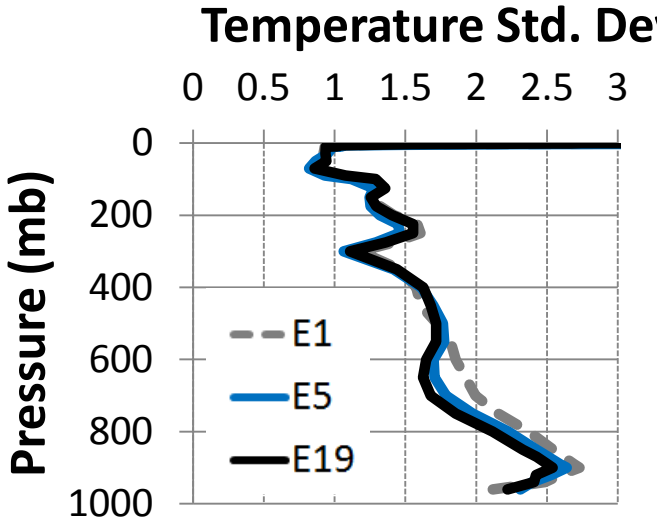
1. During telecons and e-mails the potential problems are identified by the algorithm team (mostly NGAS, LaRC and sounder PEATE members) and potential solutions are discussed.
2. Algorithm lead submits DRs based on a consensus of the problem.
3. STAR coordinates the analysis with significant contributions from the entire algorithm and validation team and decides on the best course of action as well as evaluate the interaction between proposed changes – package is then submitted to STAR AIT group.

	Temp. Bias	WV Bias	QC(1)	QC(4)	QC(5)	QC(1&4)
E1	1.55 K	30.05%	44.36%	5.23%	68.08%	4.03%
E5	1.31 K	30.39%	63.09%	30.02%	87.10%	22.06%
E19	1.25 K	33.88%	43.36%	24.63%	89.13%	13.60%

Example at right is an example of the metrics used and a sample of one plot used to decide what baseline systems should be proposed to the AERB.

List of Changes

- E1: Mimics Mx5.3
- E5: Mimics MX6.4 (bias and clim files)
- E19: Mimics candidate Mx7.1 (code + LUTs)



History of Algorithm Changes (6/6)
Example of metrics and evaluation

	a	b	c	d	e	f	g	h	i	j	k	l
E1												
E2	✓											
E3		✓										
E4			✓									
E5	✓	✓	✓									
E6	✓	✓	✓	✓								
E7	✓	✓	✓		✓							
E8	✓	✓	✓	✓	✓							
E9	✓	✓	✓			✓						
E10	✓	✓	✓	✓	✓	✓						
E11	✓	✓	✓	✓	✓	✓	✓					
E12	✓	✓	✓	✓	✓	✓		✓				
E13	✓	✓	✓	✓	✓	✓			✓			
E14	✓	✓	✓	✓	✓	✓				✓		
E15	✓	✓	✓	✓	✓	✓	✓		✓	✓		
E16	✓	✓	✓	✓	✓	✓					✓	
E17	✓	✓	✓	✓	✓	✓						✓
E18	✓	✓	✓	✓	✓	✓					✓	✓
E19	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓

QC Improvement	Temperature Improvement	Water Vapor Improvement
N/A	N/A	N/A
Worse	Worse	Better
Better QC(5): No Change	Worse	Better
Better	Better	Better
Better	Better	Worse
Better QC(5): No Change	Better	Better
No Change	No Change	No Change
Better QC(5): No Change	Better	Better
QC(4,1&4): Better QC(1,5): Worse	Worse	Better
Better QC(5): Worse	Better	Better
Better QC(5): No Change	No Change	Better
Better	Better	Worse
	Worse	Better
	Better	Worse
	Better	Worse
Worse QC(5): No Change	Worse	Worse
Worse QC(5): Better	Worse	Worse

Provisional Maturity Evaluation (1/35): Cal/Val Plan is Hierarchical

Dataset	Sampling	Characteristics
ECMWF/GFS	Global	±3 hour, model errors, select focus days
NUCAPS EDR	Global, exact match	Different algorithm approach using CrIS/ATMS Significant diagnostic capability
AIRS EDR Products	Nearly global	Orbits are aliased, 16d repeat, different algorithm and instrument
IASI EDR Products	Polar SNO's, global DD	4 hour orbit difference, different algorithm and instrument
GPS	~1000 matchup/day	Limb vs. nadir, mid- to upper-trop
Op. RAOB	~200 matchup/day	±3 hours, ±100 km, regional w.r.t. op.systems
Dedicated RAOB	~600 matchup/year	Only a handful of locations

CrIMSS EDR cal/val Team has maintained an "off-line" capability to provide reprocessing for these data sets on many systems (e.g., Mx5.3, 6.4, 6.6, 7.1) including individual changes made for each DR

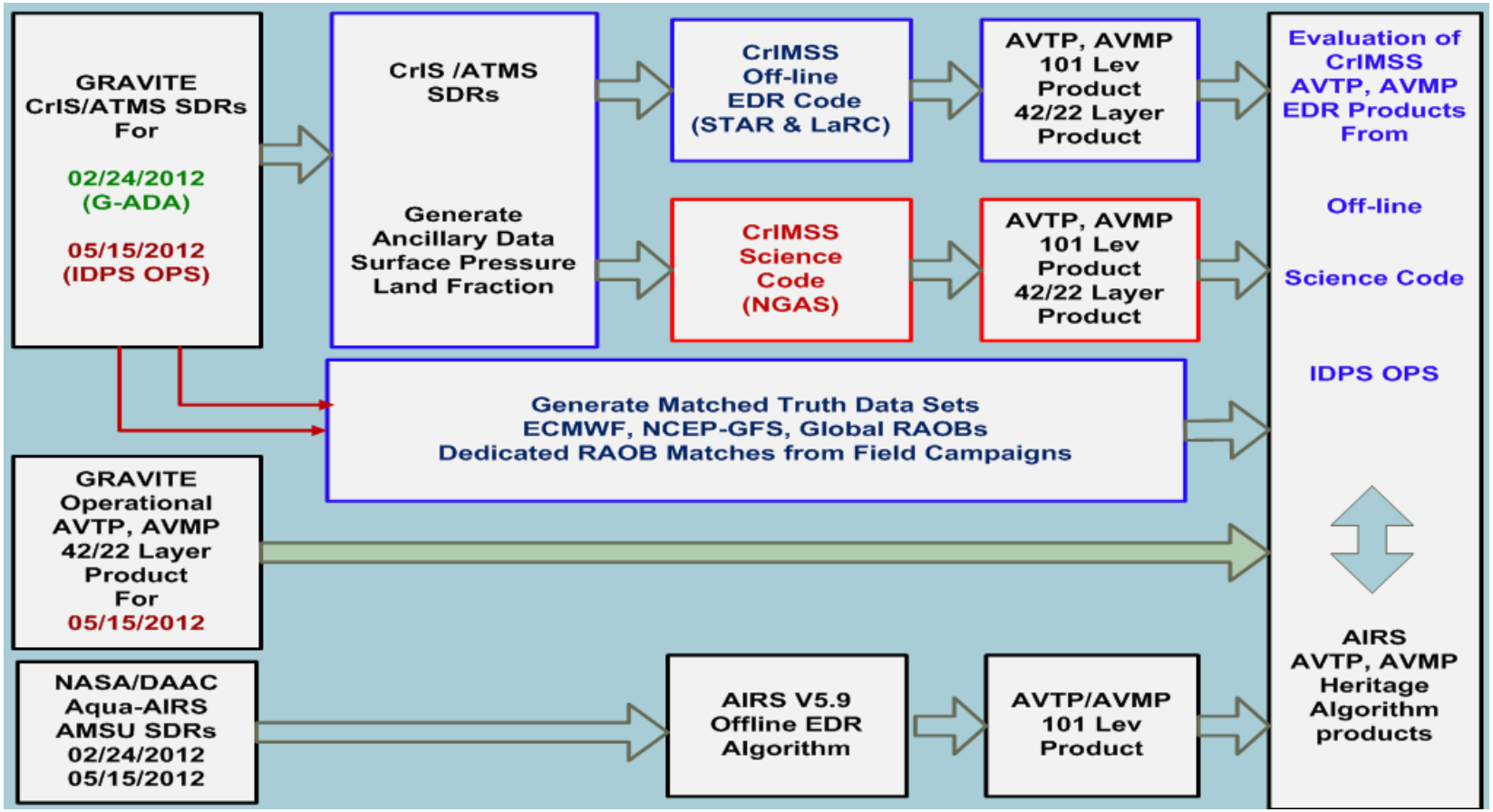
- Allows demonstration of improvements on historical datasets
- Allows maximizing the impact of the investment in "truth" datasets

Provisional Maturity Evaluation (2/35) Definition of Systems

- The graphic on the next page shows the various pathways of data that have been used to analyze the CrIMSS EDRs
- Most of the analysis of the CrIMSS EDR has been done with the "Off-line" version of the *future* IDPS Mx7.1
  - This is our sand-box where we can make changes and run many granules (focus days, matchups, etc.).
    - Demonstrated that off-line, ADL, and IDPS get the same results.
    - Most validation is done with 100L IP's.
  - In Off-line version it is possible to do runs on large ensembles of cases.
  - Once a change packet is defined it is then tested with ADL (STAR AIT group) and submitted as change package to DPA/DPE.
- NGAS also uses their science code to do similar evaluations
  - Science code is the original source of the IDPS code.
  - We have confirmed that the NGAS science-code and off-line code get the same answers
    - In many instances, problems with the IDPS have been discovered using this process.
- IDPS (and ADL) versions lags the off-line capability by many months.
  - Most recent changes for CrIMSS EDR occurred in Oct. 2012 (Mx6.4)
  - CCR739/740 took 3 full months to get through regression testing
  - AERB approved these changes on Jan. 16, 2013 for implementation in Mx7.1 (scheduled for IDPS in June 2013)

Provisional Maturity Evaluation (3/35)
Origin of Comparison Datasets

- Graphic to illustrate CrIMSS EDR data pathways (discussed on previous slides)

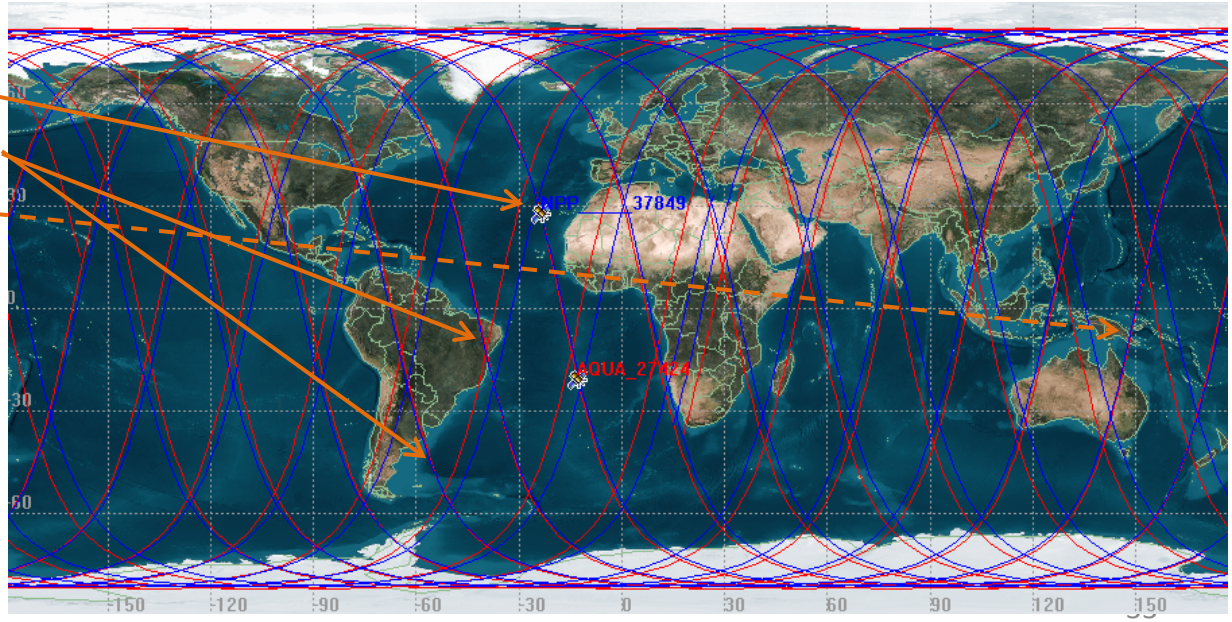


Provisional Maturity Evaluation (4/35) CrIMSS EDR Datasets

- Focus days Comparison to other products
  - ECMWF is used as a proxy for "truth"
    - It is also used as a "transfer standard" for other retrieval systems such as AIRS and NUCAPS
  - May 15, 2012 and Sep. 20, 2012 are the primary focus days because both ATMS and CrIS were calibrated and at the beta maturity level.
    - Subset of globally representative 108 granule set is used for evaluations of individual DRs
  - Feb. 24th and 25th was also used
    - NOTE: Feb. 25th is same orbit configuration as May 15th)
  - We plan on collecting ≈4 focus days per year
    - Focus day collections include Aqua, Metop SDRs and EDRs, ECMWF, GFS, etc.
- Comparisons to GPS RO Products
  - Large number of days were used in May, to get reasonable statistics.
- Primary validation is dedicated radiosondes
  - Very few radiosondes have been launched to date
    - ~500 sondes were purchased by the JPSS project office and most have been launched at 3 sites (Alaska, Oklahoma, Tropical Pacific) in support of provisional and stage.1 validation.
    - 33 radiosondes were launched by Aerospace Corp. from Hawaii in May.

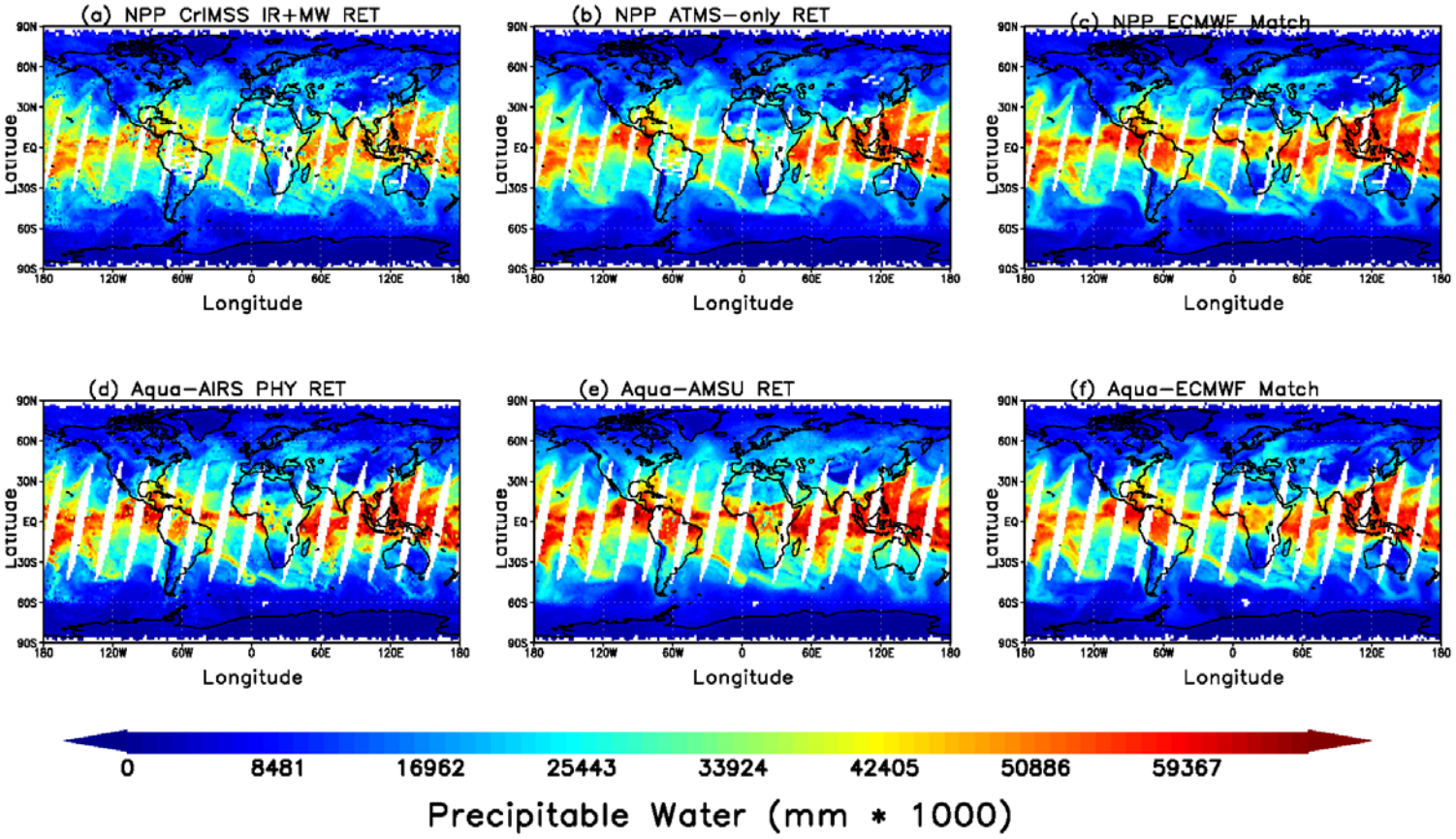
Provisional Maturity Evaluation (5/35)
Selection of Focus Days

- May 15 focus day was chosen because:
  - It had very good overlap between NPP and Aqua satellites
  - It was same the orbital configuration as other focus days (Feb. 25, 2012, Sep. 20, 2012)
  - Simultaneous nadir overpasses with Aqua occurred in many places:
    - west coast of Africa
    - East coast of S.America
    - Northeast of Australia
    - Many polar cases



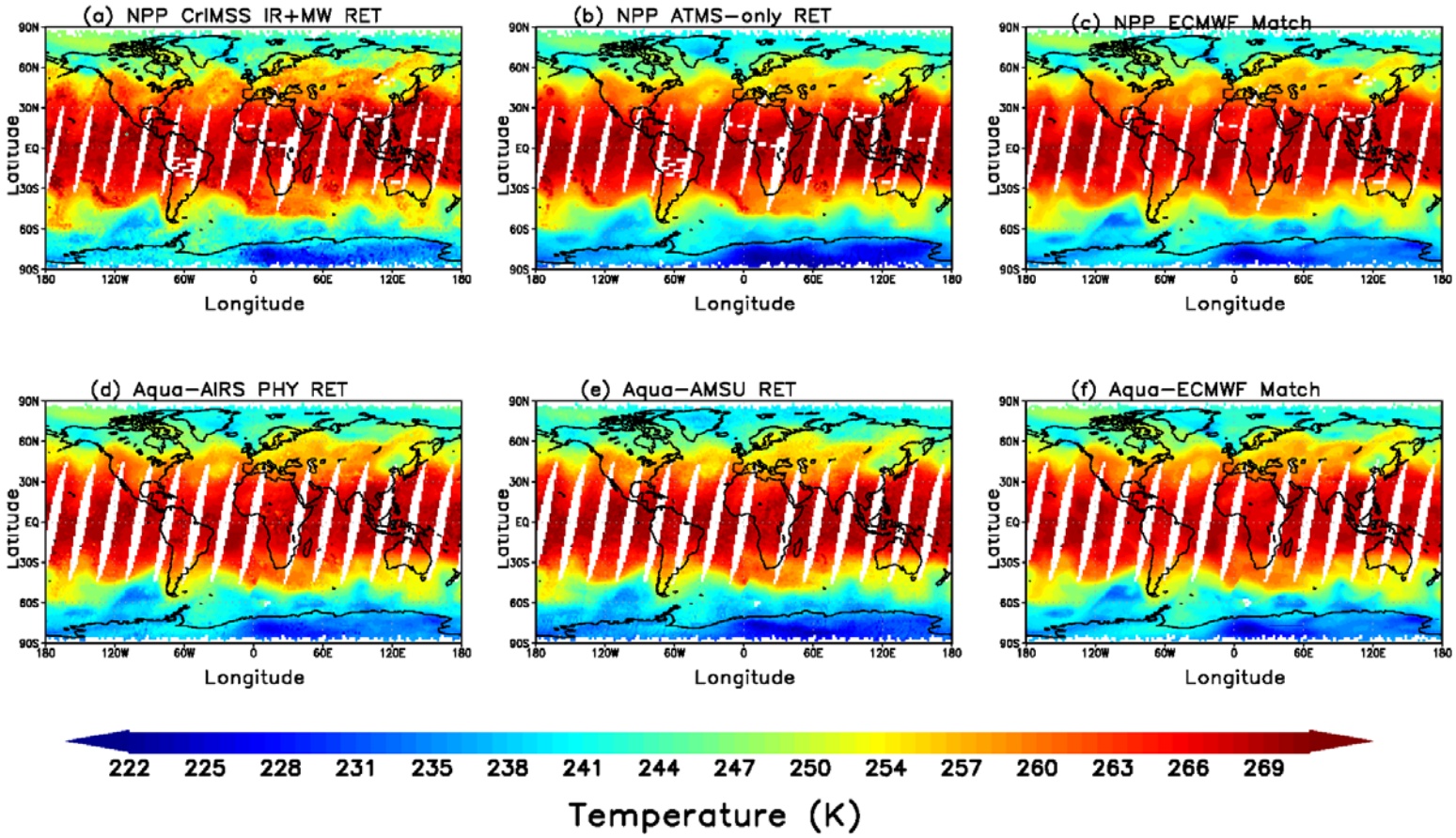
Provisional Maturity Evaluation (6/35) First look at a Focus Day AVMP Dataset

- AVMP total precipitable water (integral of AVMP) for May 15, 2012
  - CrIMSS IR+MW (upper left) and MW-only (upper middle)
  - AIRS IR+MW (lower left) and AMSU-only (lower middle)
  - Co-located ECMWF for CrIS (upper right) and AIRS (lower right)



Provisional Maturity Evaluation (7/35) Example of a Focus Day AVTP Dataset

- AVTP (850 hPa-surface layer) temperature product for May 15, 2012
  - CrIMSS IR+MW (upper left) and MW-only (upper middle)
  - AIRS IR+MW (lower left) and AMSU-only (lower middle)
  - Co-located ECMWF for CrIS (upper right) and AIRS (lower right)



Provisional Maturity Evaluation (8/35)
T(p), q(p) Global RMS for May 15, 2012

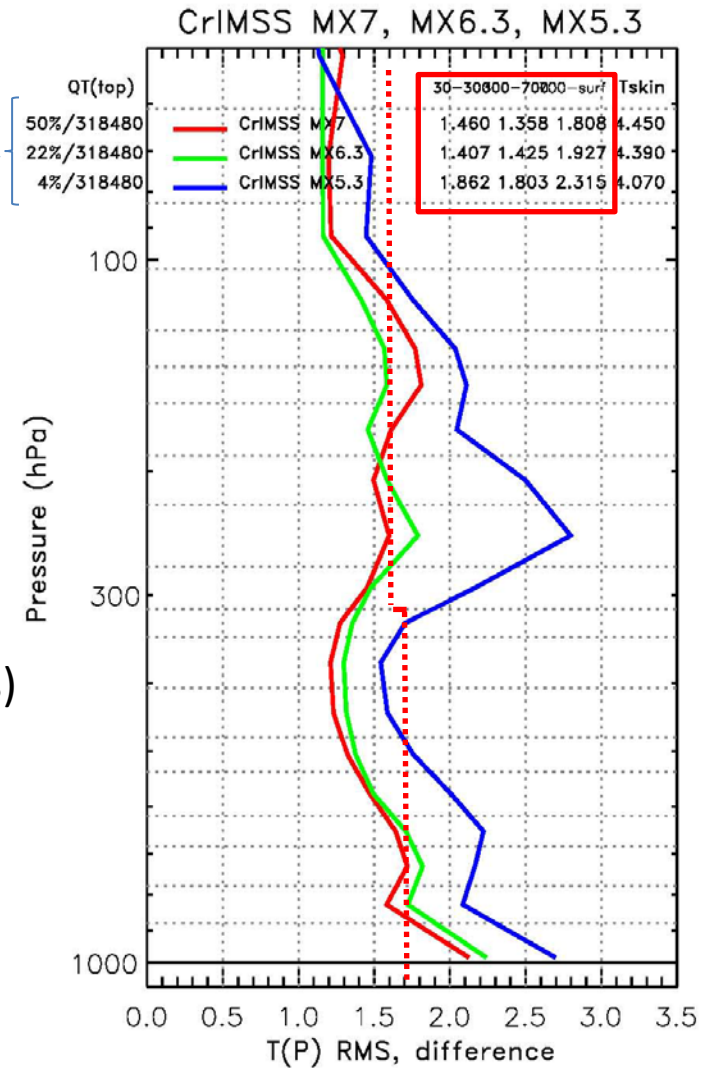
IDPS 5.3 (Past), IDPS 6.4 (Present) and IDPS 7.1 (future) Yield : IR+MW

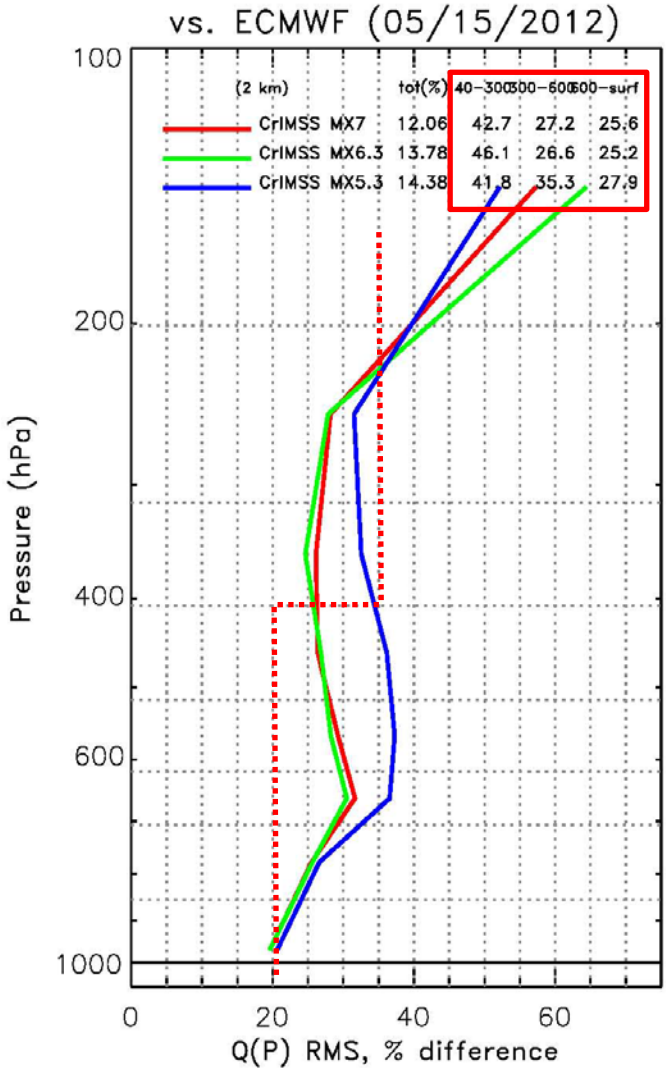
Yield has increased from 4% (Mx5.3) to 50% (Mx7.1)

Results are shown w.r.t. ECMWF

Specifications shown as dotted red line (only relevant for GLOBAL RMS) and numerical (red boxes)

Performance has improved with IDPS version (will be summarized in table later)

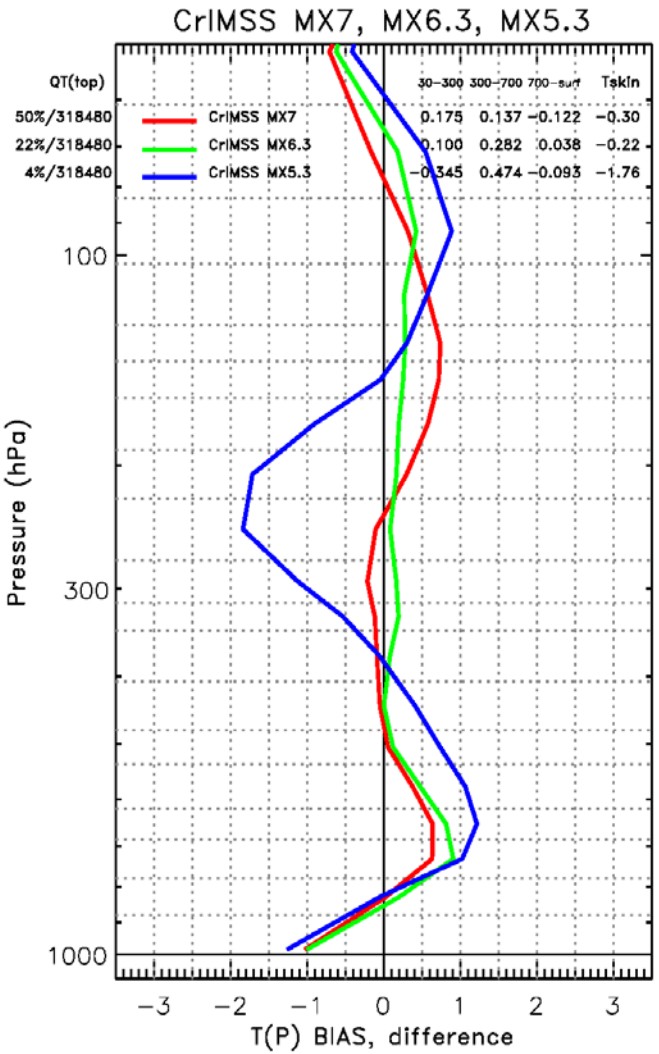


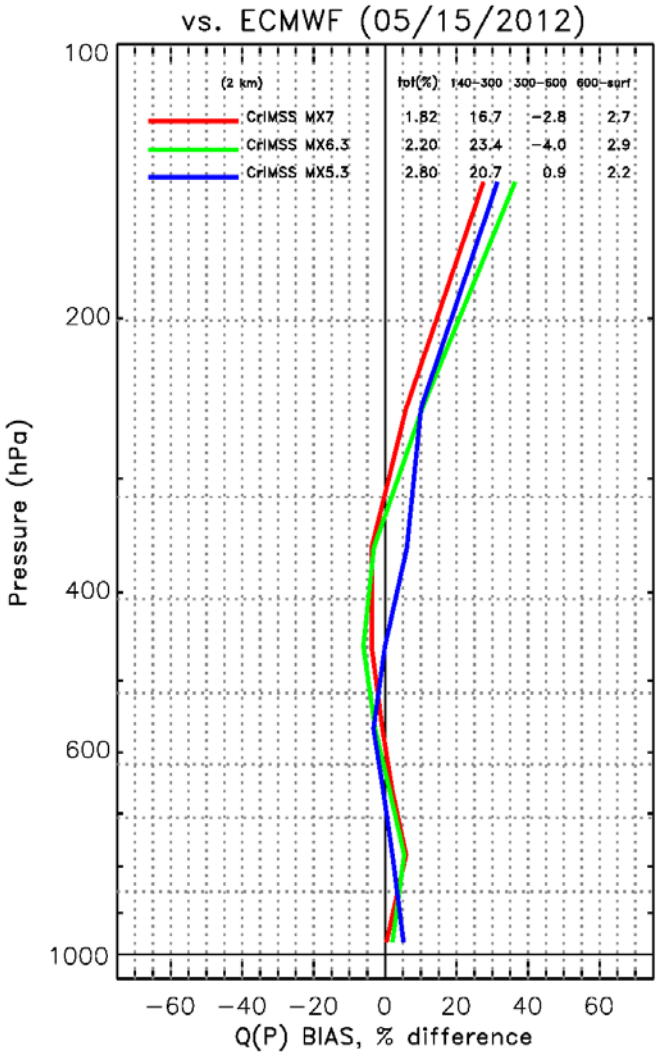


Provisional Maturity Evaluation (9/35)
T(p), q(p) Global BIAS for May 15, 2012

IDPS 5.3 (Past), IDPS 6.4 (Present) and IDPS 7.1 (future) Yield : IR+MW

Same as previous figure, except BIAS w.r.t. ECMWF is shown.





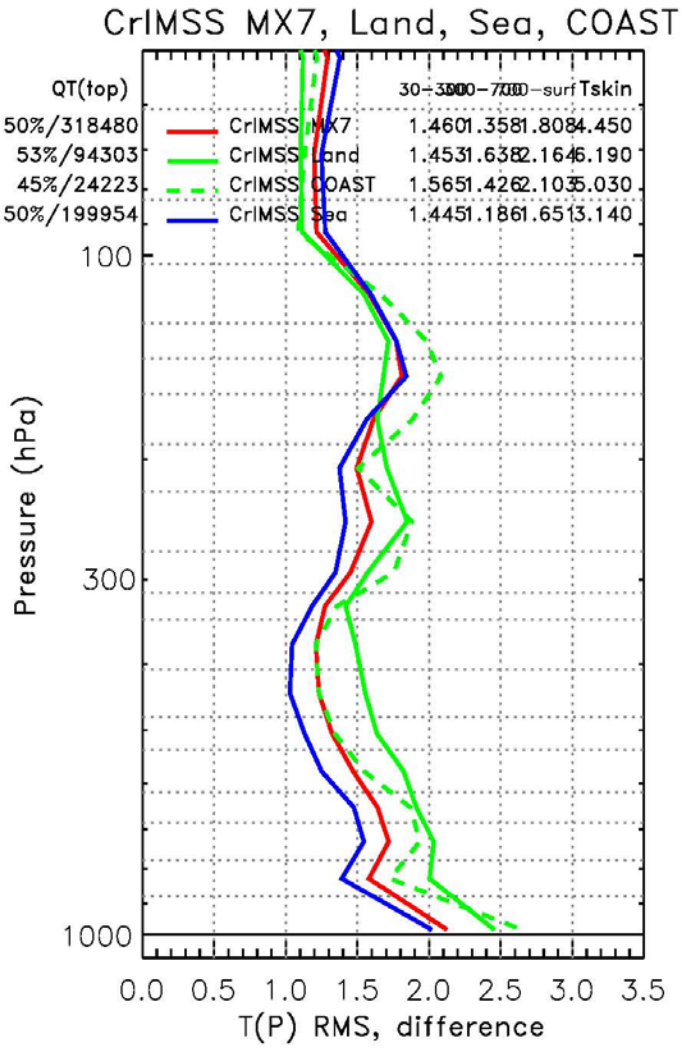
Provisional Maturity Justification (10/35)

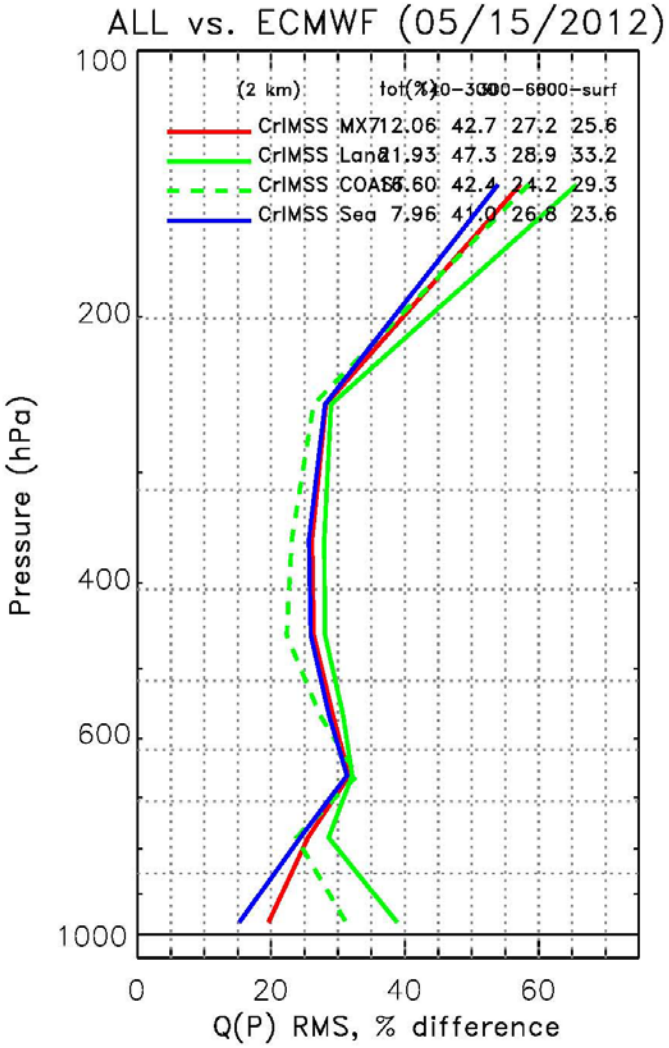
T(p), q(p) RMS Global, Land, Sea, Coast for May 15, 2012: IR+MW

Performance is better over ocean than land or coastlines

This is expected from previous experience with HIRS, AIRS, and IASI.

Requirements not drawn, since these RMS's are not GLOBAL.





Provisional Maturity Justification (11/35)

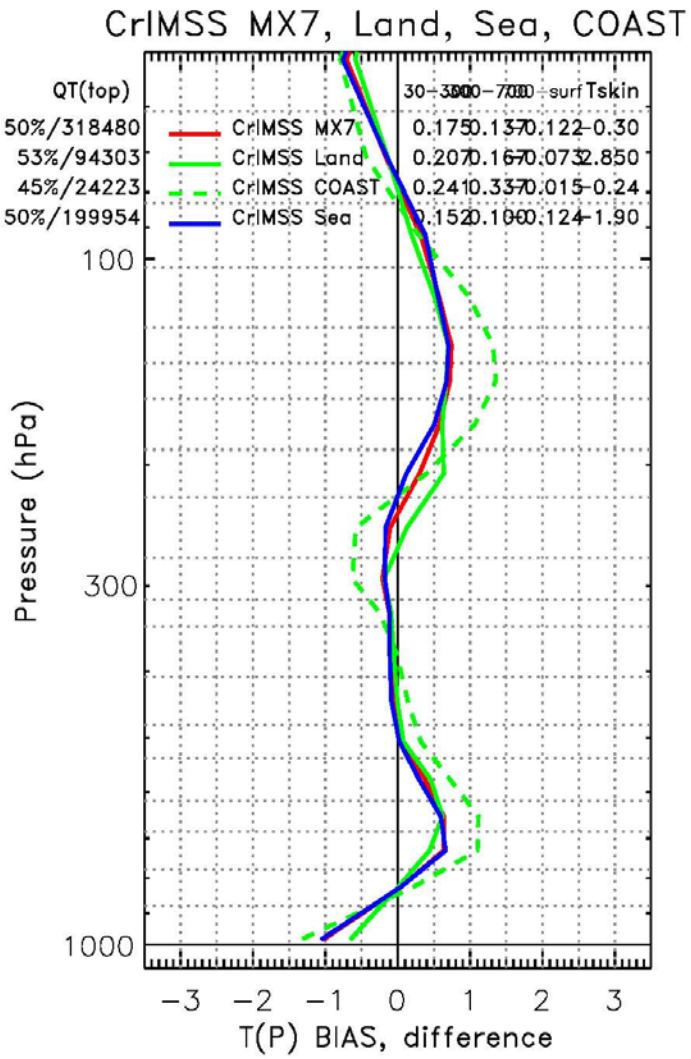
T(p), q(p) BIAS Global, Land, Sea, Coast for May 15, 2012: IR+MW

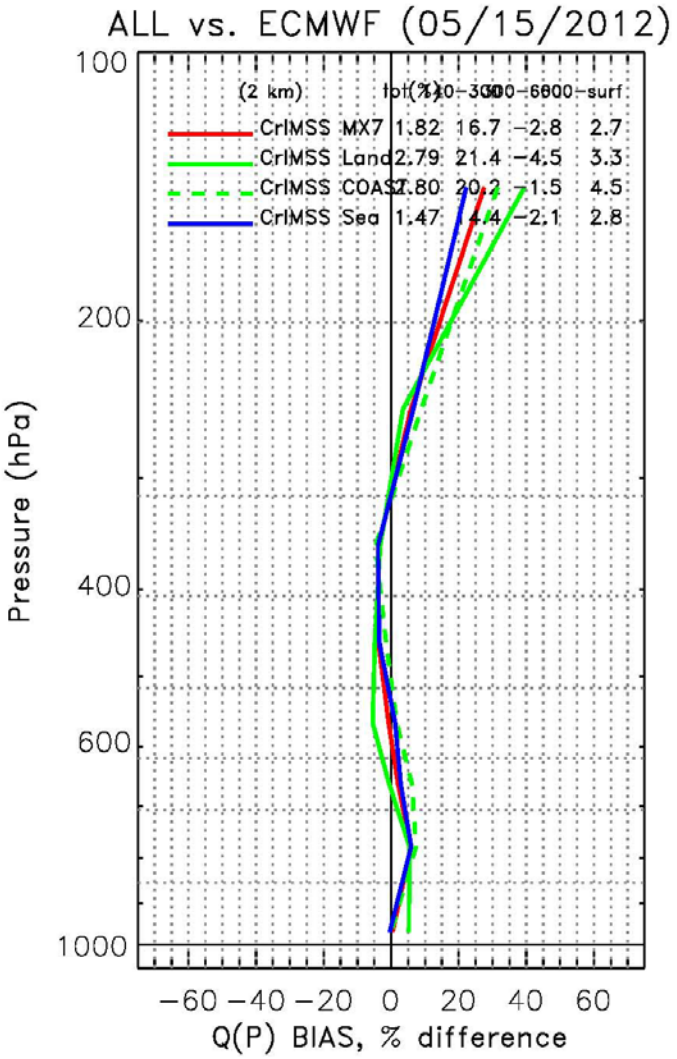
Same as previous slide except BIAS is shown.

No requirements (at this time for BIAS).

Our desired is to have BIAS be as small as possible.

Given that this is w.r.t. ECMWF we are not yet certain if the bias shown at right is in our product or ECMWF.





Provisional Maturity Justication (12/35)
Yield is stable: May 15 versus Sept. 20, 2012

Offline Mx7.1 configuration for full focus day

	% of Profiles in Category		% Passing QC(1) (IR ChiSq Test)		% Passing QC(4) (MW ChiSq Test in combined retr.)		% Passing QC(5) (MW ChiSq Test in MW-only retr.)		% Passing BOTH QC(1) and QC(4)	
	May 15	Sept 20	May 15	Sept 20	May 15	Sept 20	May 15	Sept 20	May 15	Sept 20
All Profiles	100%	100%	79.76%	81.10%	53.38%	53.05%	89.36%	89.82%	50.81%	51.15%
Day Profiles	49.17%	49.31%	77.69%	80.37%	53.16%	54.18%	91.08%	90.93%	49.74%	51.74%
Night Profiles	50.83%	50.69%	81.76%	81.82%	53.60%	51.95%	87.71%	88.74%	51.85%	50.58%
Clear Profiles	9.21%	8.31%	75.47%	85.23%	48.35%	60.99%	89.32%	93.62%	45.64%	58.14%
Partly Cloudy Profiles	80.11%	80.58%	79.11%	79.70%	53.31%	51.77%	89.32%	89.05%	50.75%	50.01%
Cloudy Profiles	10.67%	11.11%	88.34%	88.21%	58.22%	56.43%	89.75%	92.58%	55.74%	54.19%
Ocean Profiles	62.60%	62.52%	80.95%	82.08%	51.01%	50.89%	91.46%	91.97%	50.10%	50.21%
Land Profiles	29.25%	29.33%	77.77%	80.47%	60.12%	60.26%	87.67%	88.88%	53.77%	55.55%
Coast Profiles	8.14%	8.15%	77.76%	75.91%	47.41%	43.65%	79.36%	76.68%	45.65%	42.52%

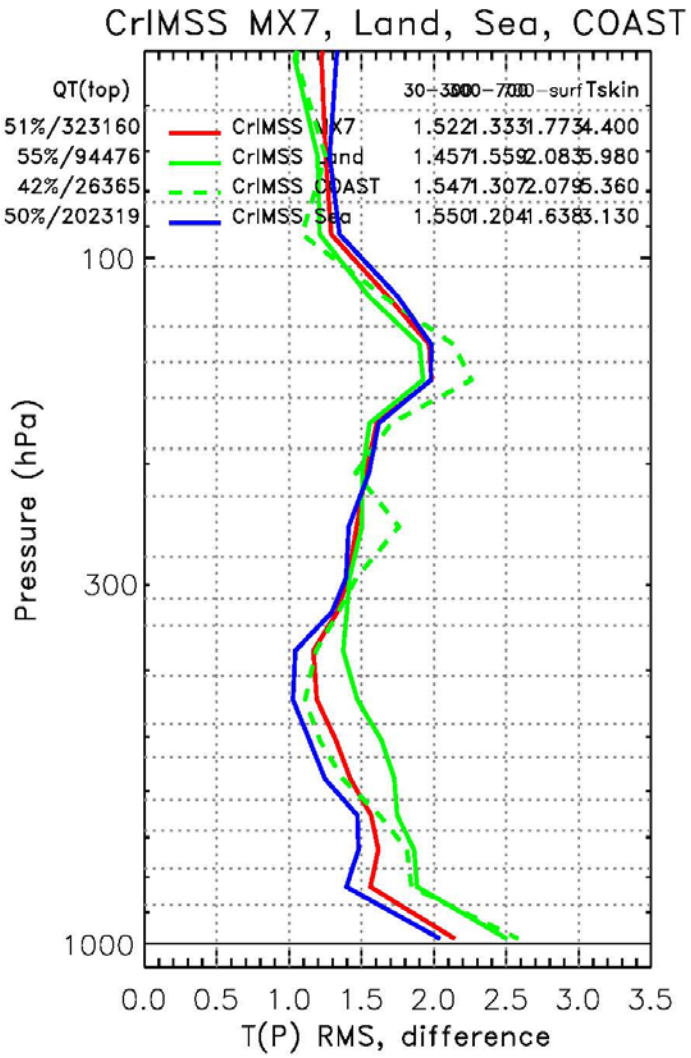
Provisional Maturity Justification (13/35)

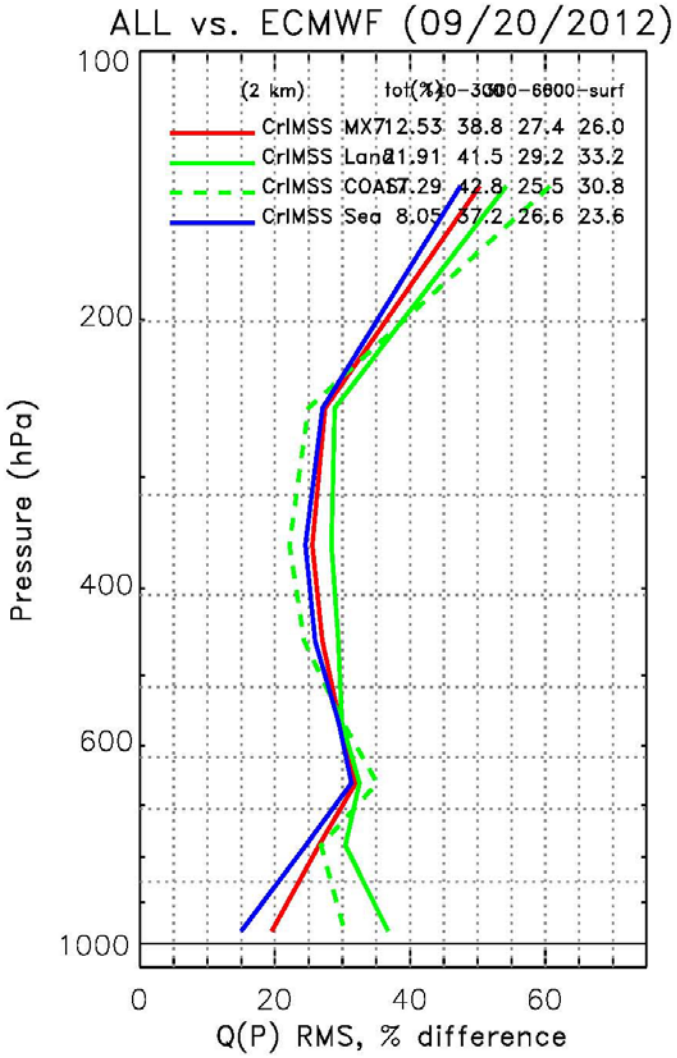
T(p), q(p) RMS Global, Land, Sea, Coast for Sep. 20, 2012: IR+MW

Here we repeat the analysis for the Sep. 20 focus day.

If you compare this figure to the May 15th figure there is very little difference.

CrIMSS EDR is stable over 2 seasons.





Provisional Maturity Justification (14/35)

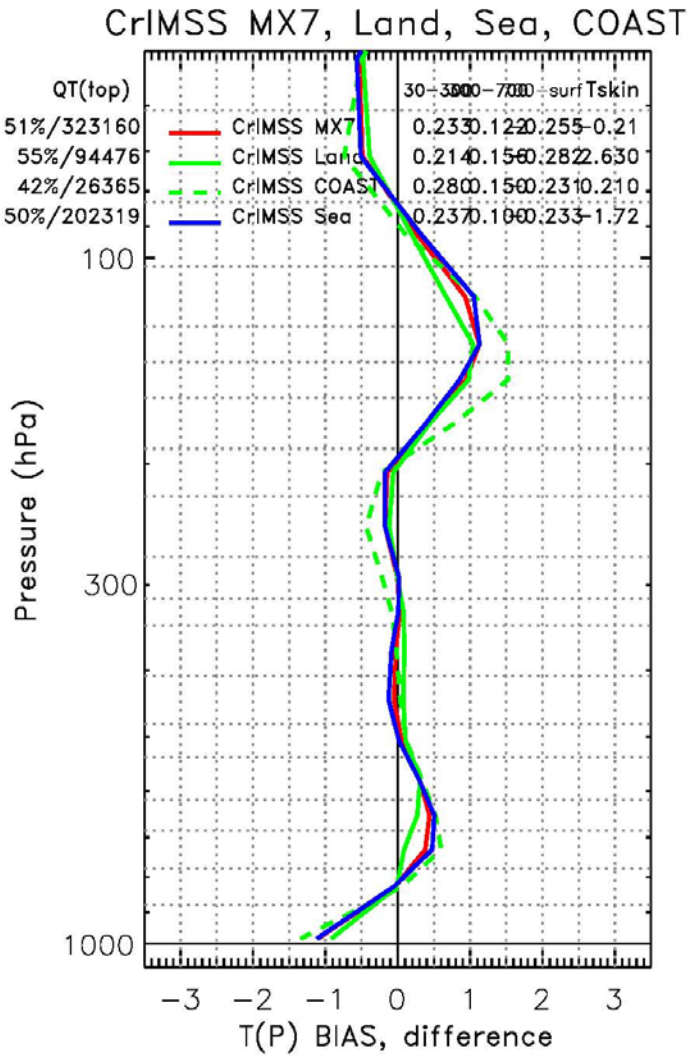
T(p), q(p) BIAS Global, Land, Sea, Coast for Sep. 20, 2012: IR+MW

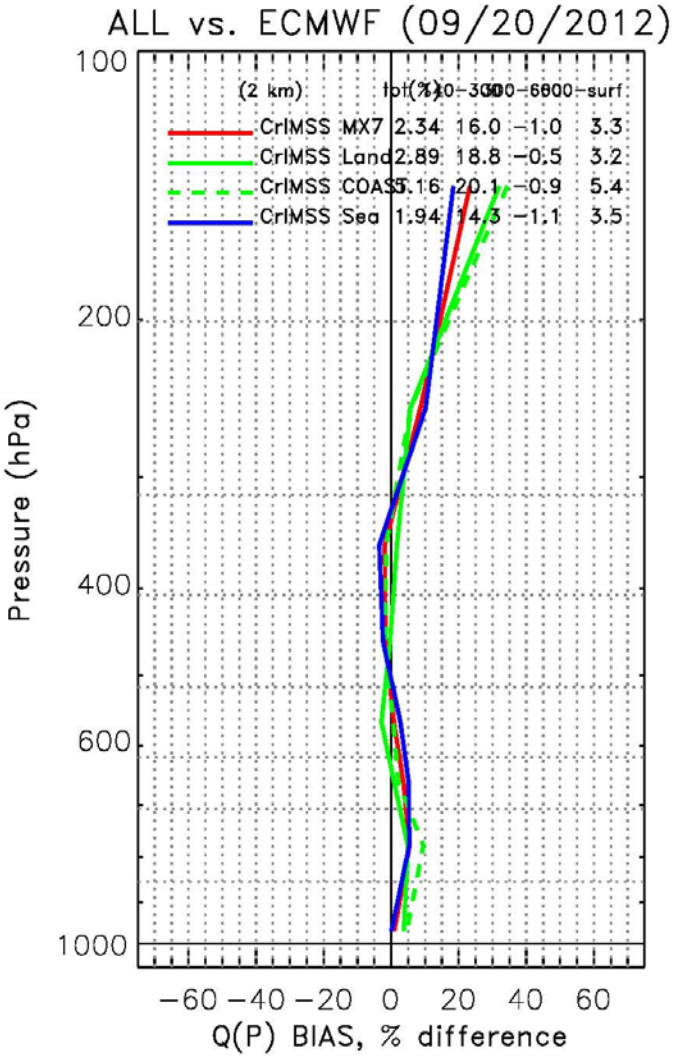
Here we repeat the analysis for the Sep. 20 focus day.

If you compare this figure to the May 15th figure there is very little difference.

May 15th clear scenes were used for tuning (bias correction).

This day was not used in any manner to optimize the algorithm.





Provisional Maturity Justification (15/35)

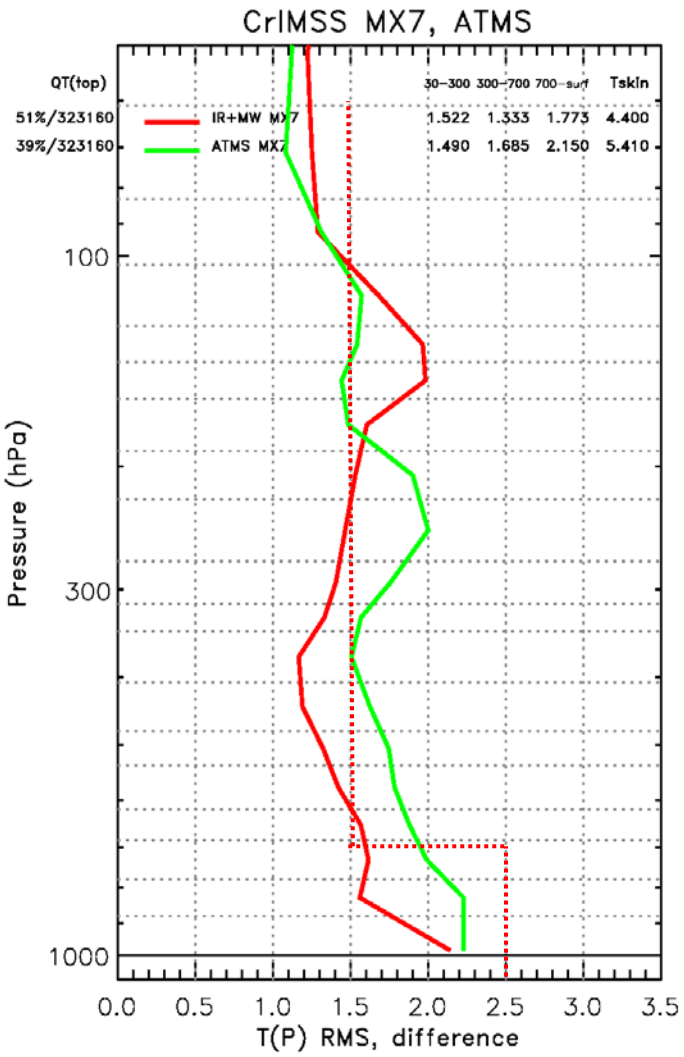
T(p), q(p) RMS for Sep. 20, 2012: MW-only vs. IR+MW

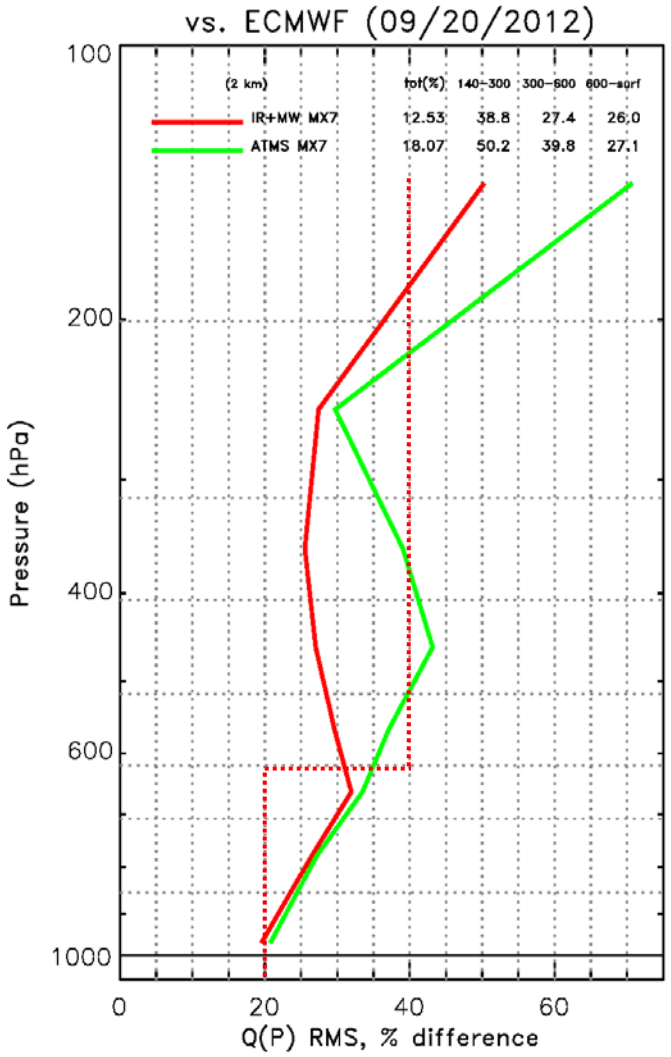
The MW-only (green line) is shown versus the IR+MW (red line)

It is close to meeting requirements.

Dotted Red line are the cloudy requirements.

Note: In 300-700 hPa region the MW-only requirements are actually more difficult than the IR+MW requirement

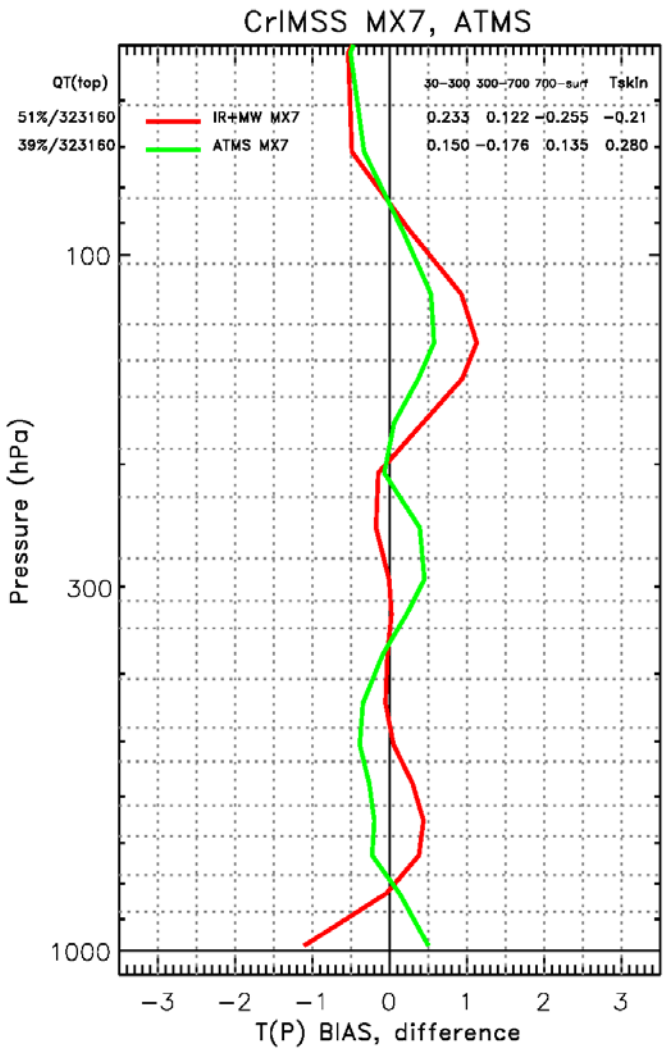


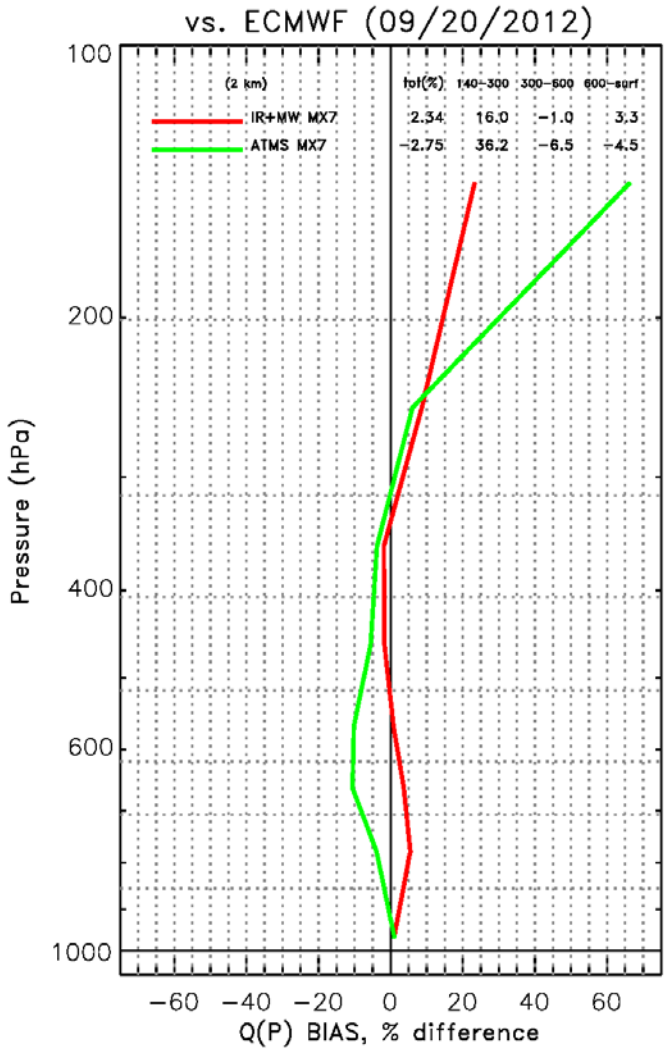


Provisional Maturity Justification (16/35)

T(p), q(p) BIAS for Sep. 20, 2012: MW-only vs. IR+MW

Same as previous figure except BIAS is shown





Provisional Maturity Justification (17/35)

Summary of Statistics from Previous Slides

- In the table below we show how the provisional CrIMSS EDR compares to requirements using ECMWF
  - Some error exists in ECMWF itself, hence real error is less
    - This will be assessed with dedicated radiosondes in the future.

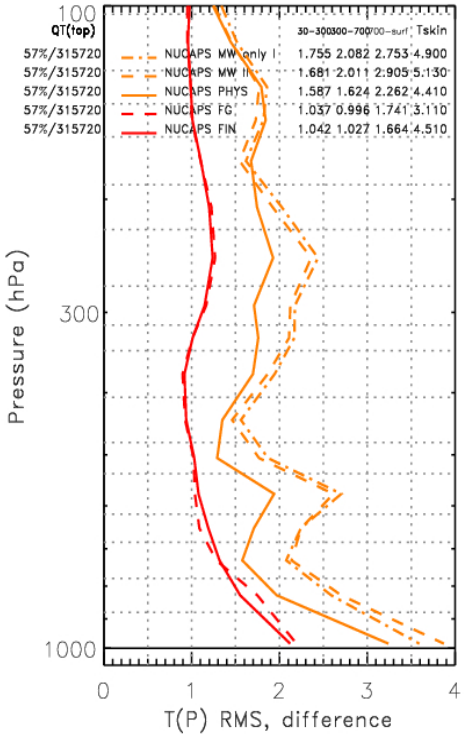
IR+MW (pt.cloudy)	yield	AVTP(p) 30-300	AVTP(p) 300-srf	AVMP(p) 300-600	AVMP(p) 600-srf
Mx5.3	4%	1.86 K	2.1 K	35.3 %	27.9 %
Mx6.4	22%	1.41 K	1.7 K	26.6 %	25.2 %
Mx7.1	50%	1.46 K	1.6 K	27.2 %	25.6 %
Rqmts	~50%	1.5 K	1.6 K	35 %	20 %

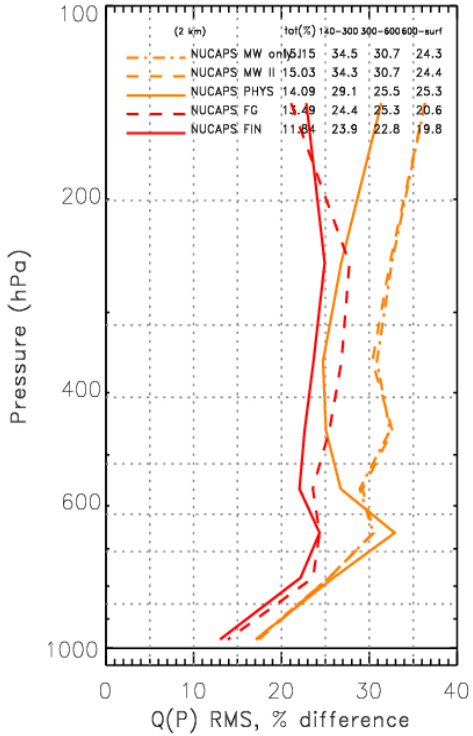
MW-only (cloudy)	yield	AVTP(p) 30-300	AVTP(p) 300-700	AVTP(p) 700-srf	AVMP(p) 300-600	AVMP(p) 600-srf
Mx7.1	39%	1.5K	1.7K	2.2K	40%	27%
Rqmts	~50%	1.5 K	1.5 K	2.5 K	40%	20 %

Provisional Maturity Justification (18/35)

NUCAPS: Analysis of Physical Only vs. Regression Systems

- Statistics shown at each step
  - MIT AMSU-only (gold dash-dot)
  - GSFC AMSU-only (gold dash)
  - Cloud cleared regression (red dash)
  - Final physical (red solid)
- Physical-only a system (gold-solid) is also shown (no statistical operator, uses AMSU-only as 1st guess).
- Note that regression is trained on 5/15/2012 and 9/20/2012 (evenly weighted).
  - Independent focus day (July 13, not shown) show this is not the case.



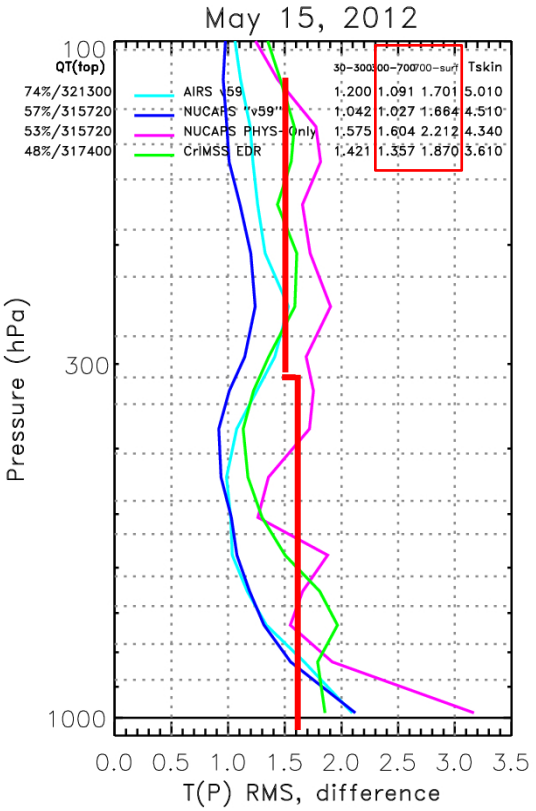


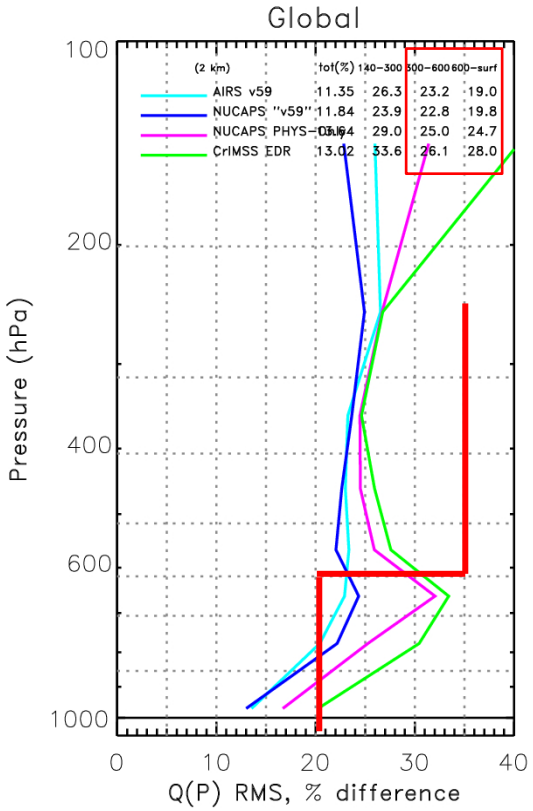
- AMSU-only results are quite reasonable and shows that physical retrieval improves on that state (CrIS adds information content)
- Very little improvement is seen between regression and final physical retrieval.

Provisional Maturity Justification (19/35)

Comparison of CrIMSS-EDR, NUCAPS, AIRS

- AIRS/AMSU v5.9 (CYAN) is AIRS v5 with correction for instrument changes.
- NUCAPS “v5.9” uses CrIS/ATMS and the same spectroscopy and retrieval methodology as AIRS v5.9.
- NUCAPS PHYS-only has no statistical operators
- CrIMSS-EDR (GREEN) results have all changes installed (it is an emulation of Mx7.1 (May 2013) system).





- Statistics for May 15, 2012 focus day in which Aqua and NPP orbits has high coincidence.
- NUCAPS -PHYS(Magenta) and CrIMSS EDR (GREEN) have similar yield and performance
- AIRS v5.9 and NUCAPS statistics are remarkably close
  - However, yield of NUCAPS is significant lower

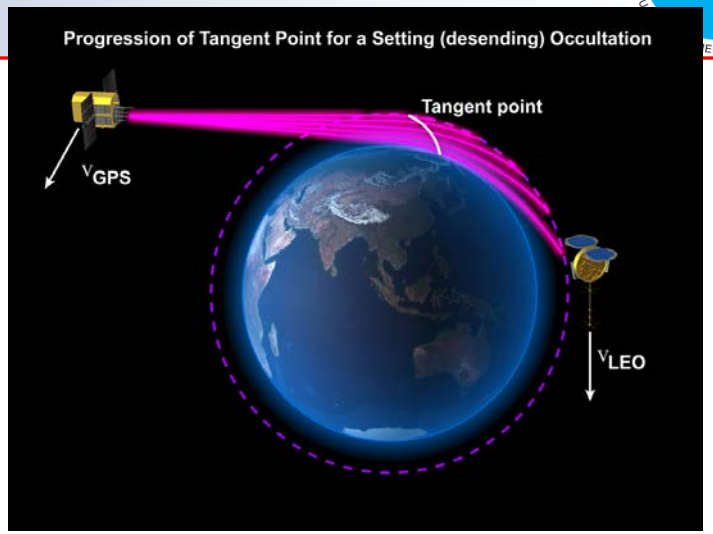
Provisional Maturity Evaluation (20/35) Introduction to COSMIC Comparison

- Next Set of slides (courtesy of Bob Knuteson and Michelle Feltz, Univ. of Wisconsin) show IDPS CrIMSS EDR products relative to co-located GPS sondes
  - AIRS results are shown in top panels
  - CrIMSS results from Mx5.3 and Mx6.4 are shown in bottom panels
- GPS comparisons are only valid from ~300 hPa to 30 hPa
  - In general, GPS results are an independent confirmation of what we have shown relative to ECMWF
  - Statistics are similar to the heritage AIRS EDR products
    - CrIMSS EDR has larger biases
      - Because IDPS system does not have ATMS bias corrections
    - CrIMSS EDR has slightly larger standard deviation (SDV)
      - IDPS code is not fully optimized

Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (21/35)

Matchups were found between COSMIC and CrIMSS retrievals of temperature (collocated and within 1 hour). The COSMIC data is used a common reference to compare CrIMSS and AIRS retrievals on a daily basis. The COSMIC dry temperature is valid in the range 30 – 300 mb.



http://www.cosmic.ucar.edu/launch/GPS_RO_cartoon.jpg

COSMIC Dry Temperature Profile

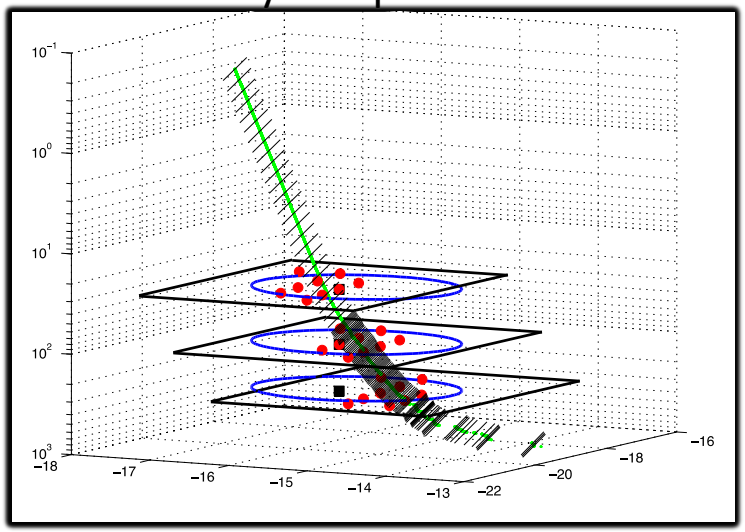
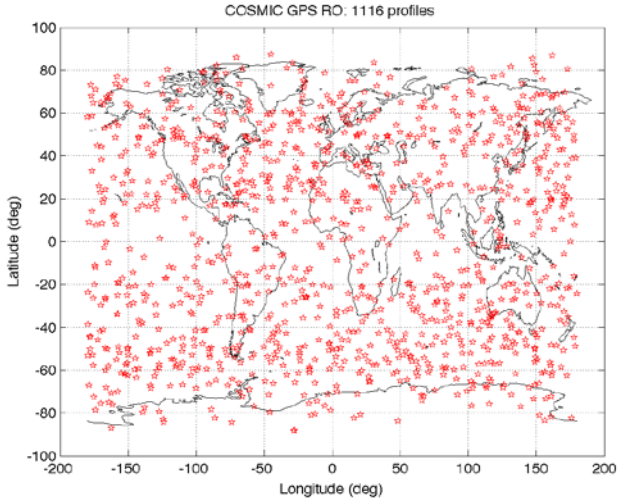


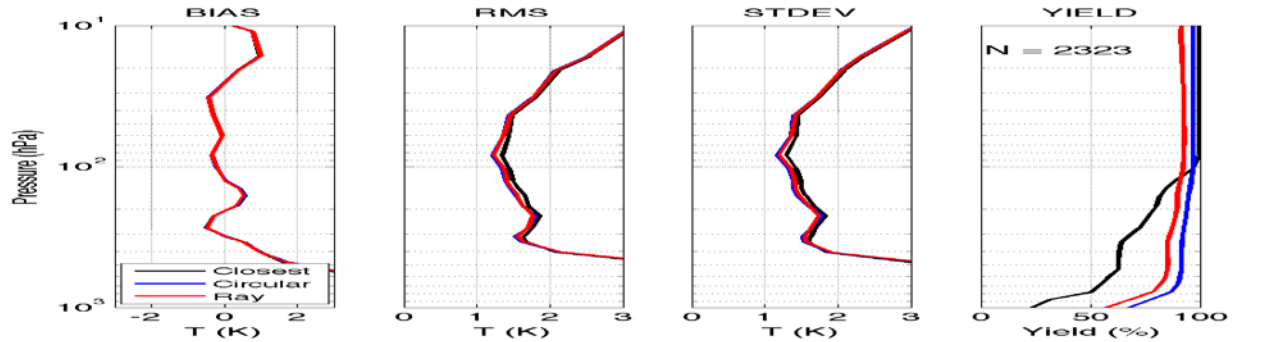
Illustration of the closest (black square), circular (blue circle), and ray path (red dots) methods for a single GPS profile (green) for the circle centered at the GPS RO level of 100 hPa



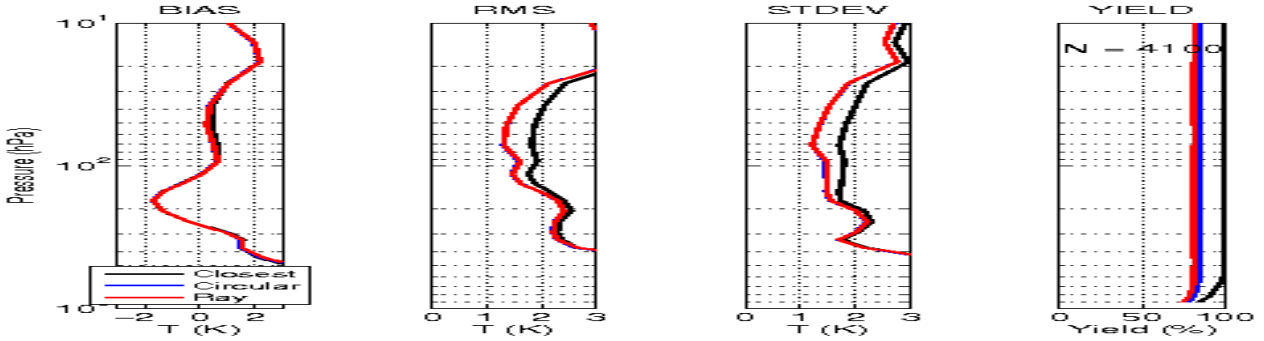
One Day of COSMIC Profiles

Provisional Maturity Evaluation (22/35)
GPS comparisons: Global (90S-90N)

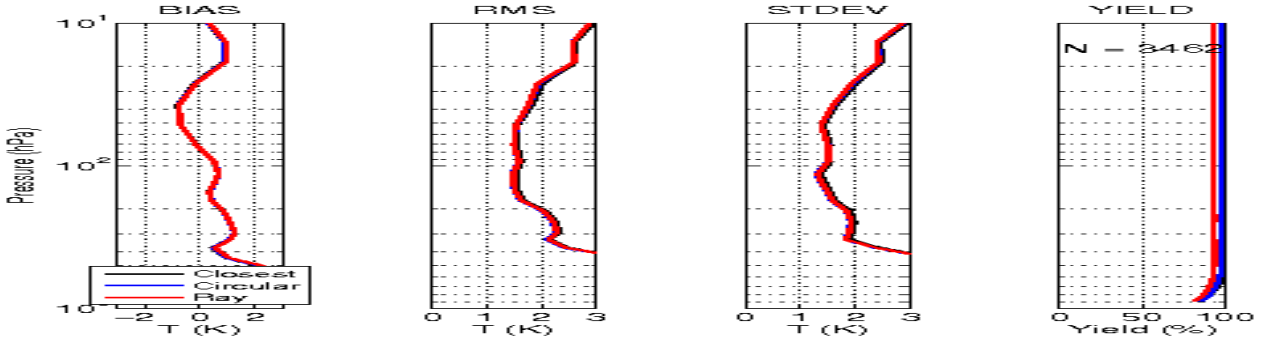
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



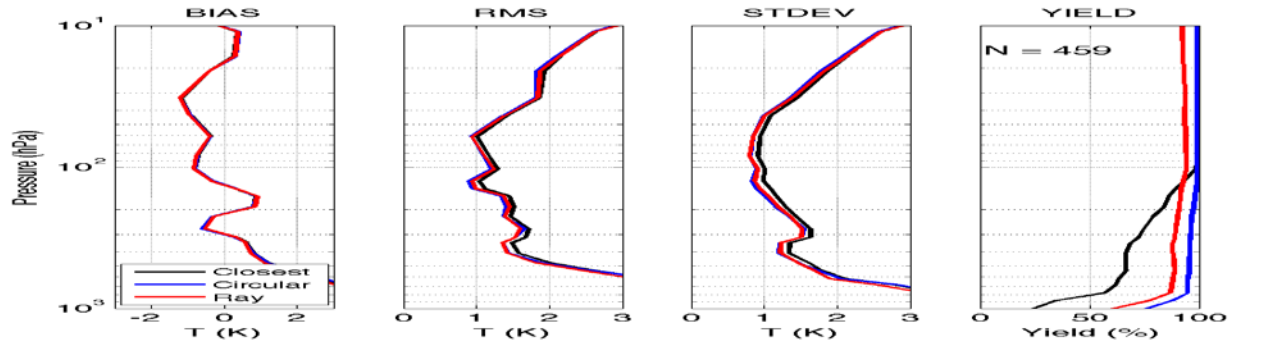
CLASS
Mx 6.4
Product
Oct. 22-31



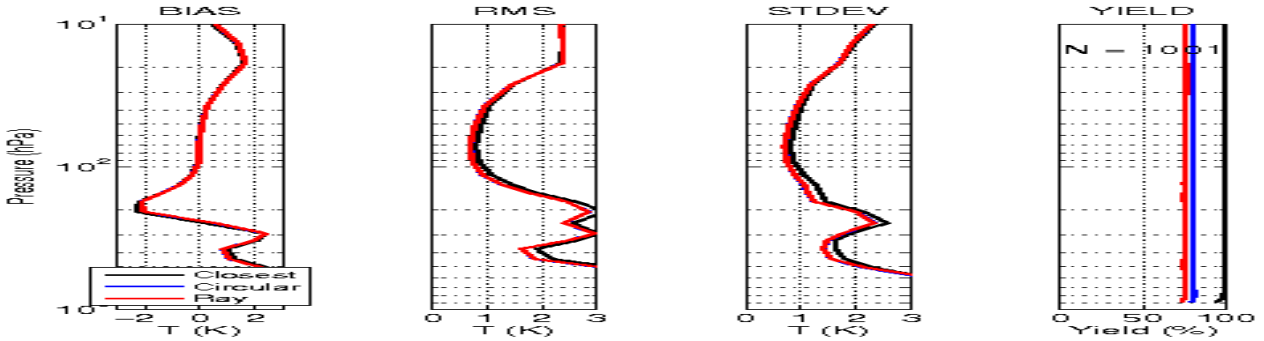
Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (23/35)
GPS comparisons: N.H. Polar (60N-90N)

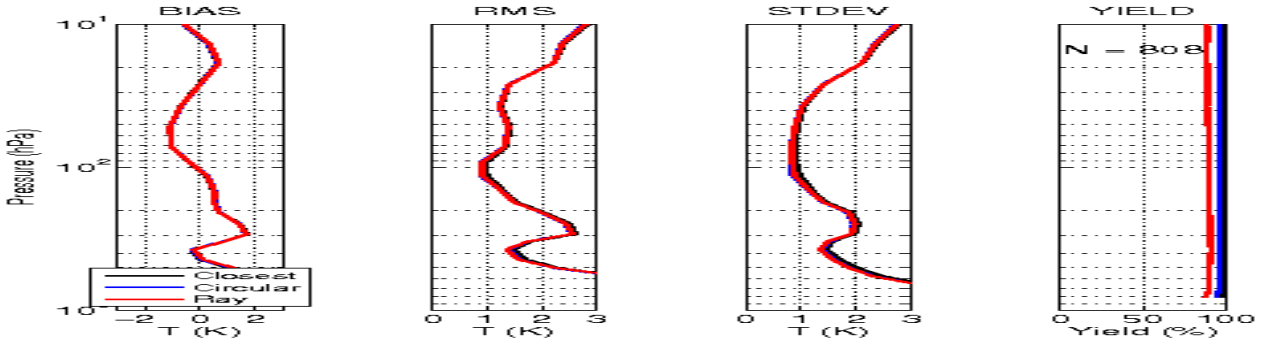
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



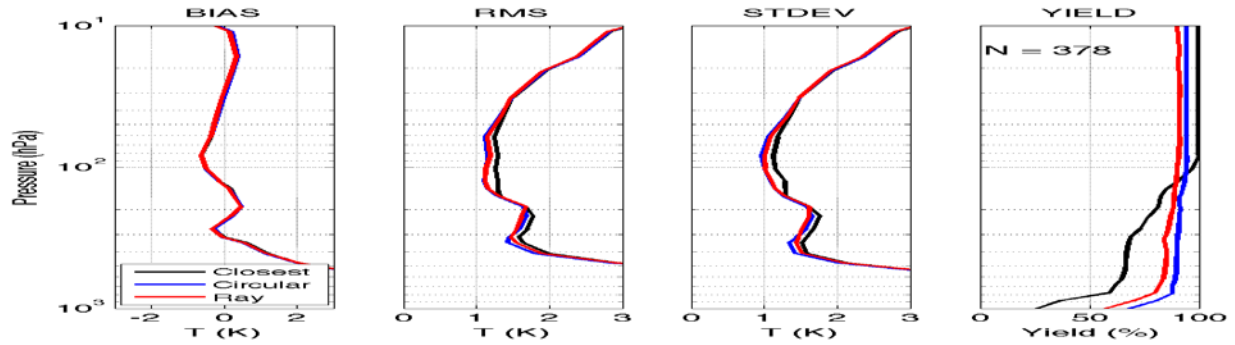
CLASS
Mx 6.4
Product
Oct. 22-31



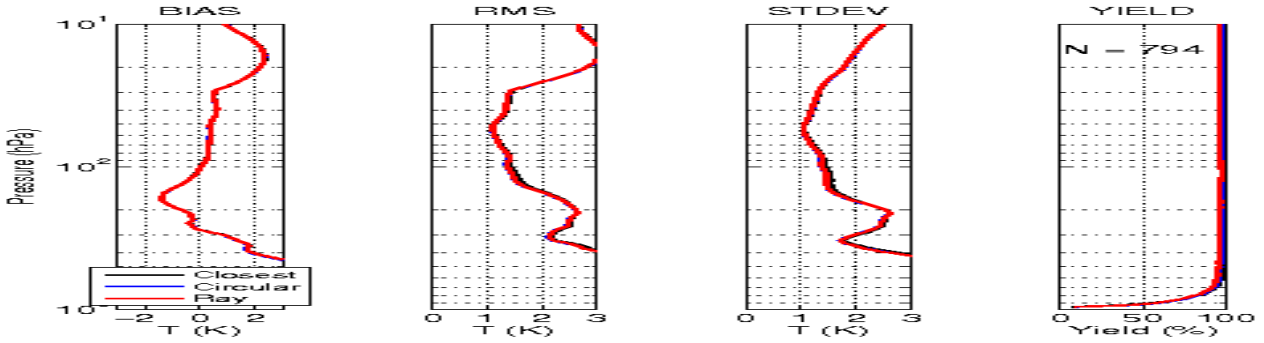
Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (24/35)
GPS comparisons: N.H. Mid-Lat (30N-60N)

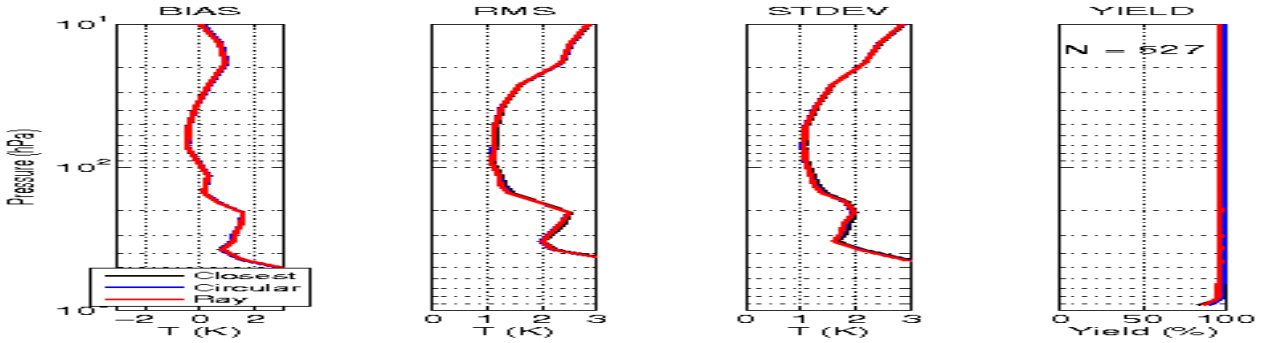
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



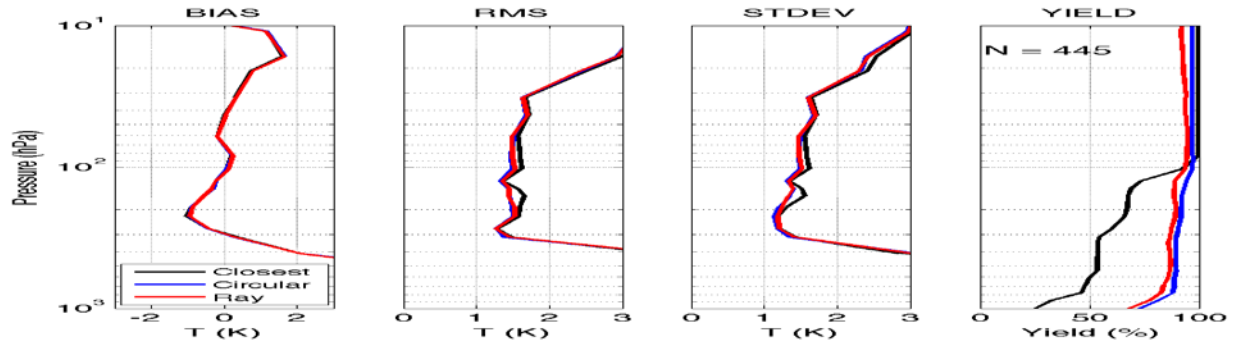
CLASS
Mx 6.4
Product
Oct. 22-31



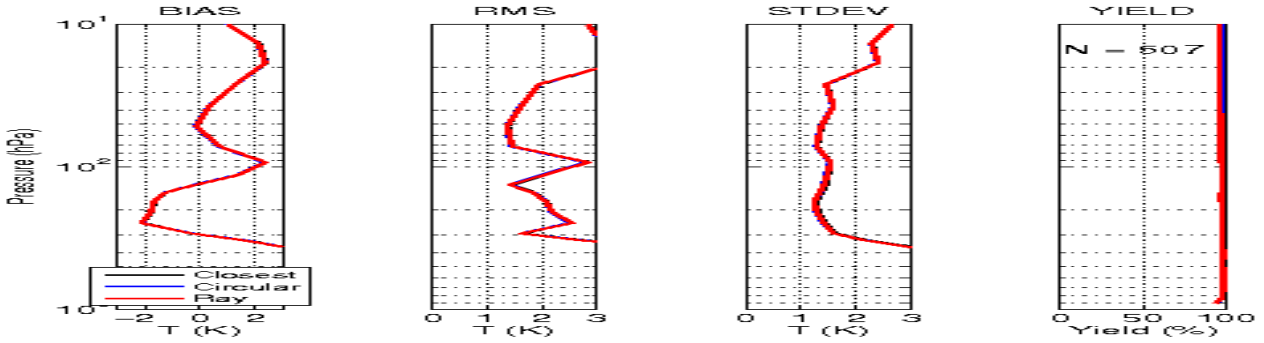
Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (25/35)
GPS comparisons: Tropical (30S-30N)

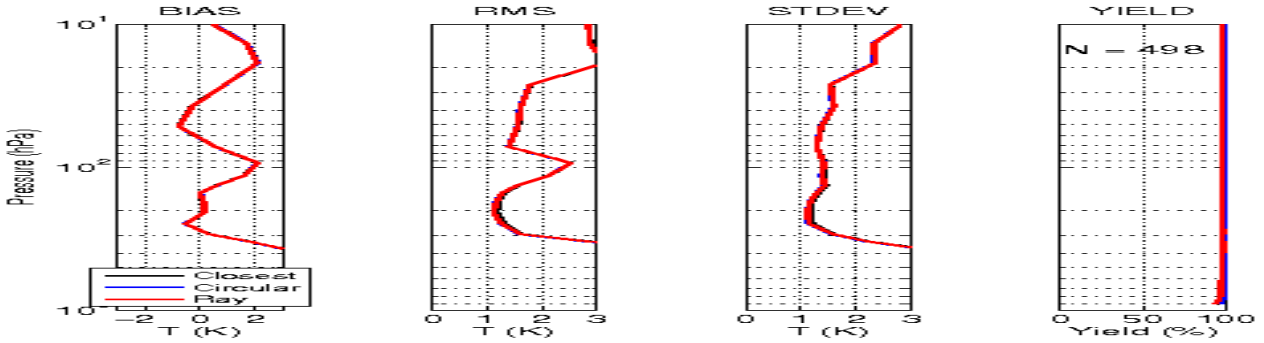
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



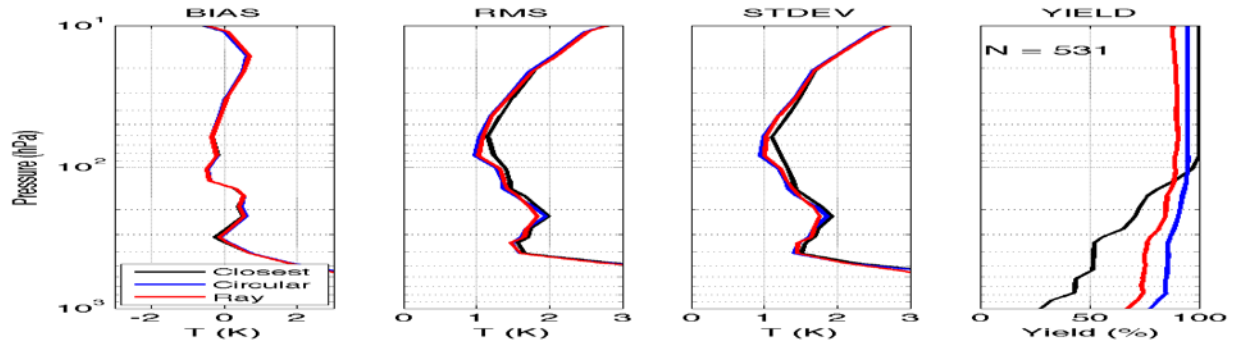
CLASS
Mx 6.4
Product
Oct. 22-31



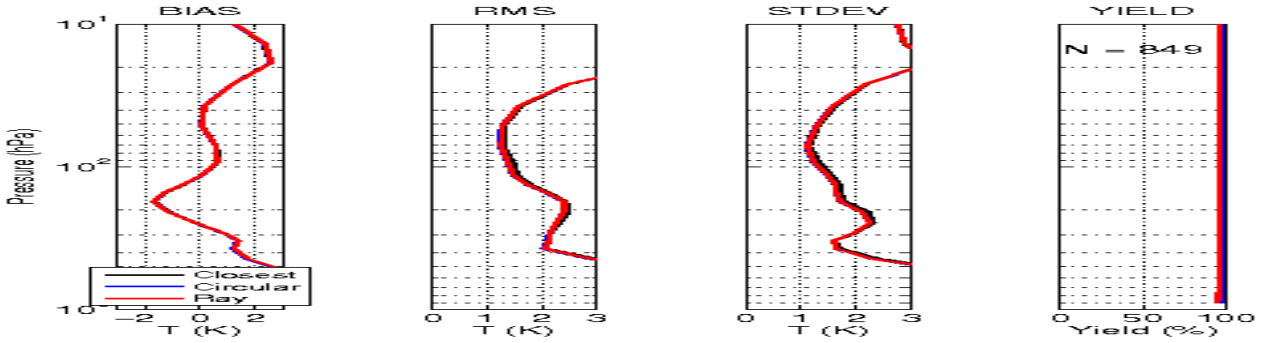
Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (26/35)
GPS comparisons: S.H. Mid-Lat (30S-60S)

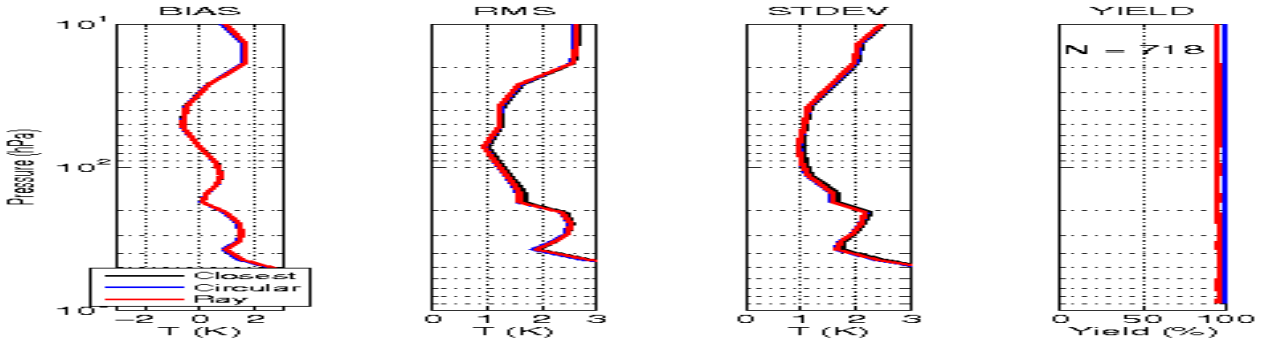
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



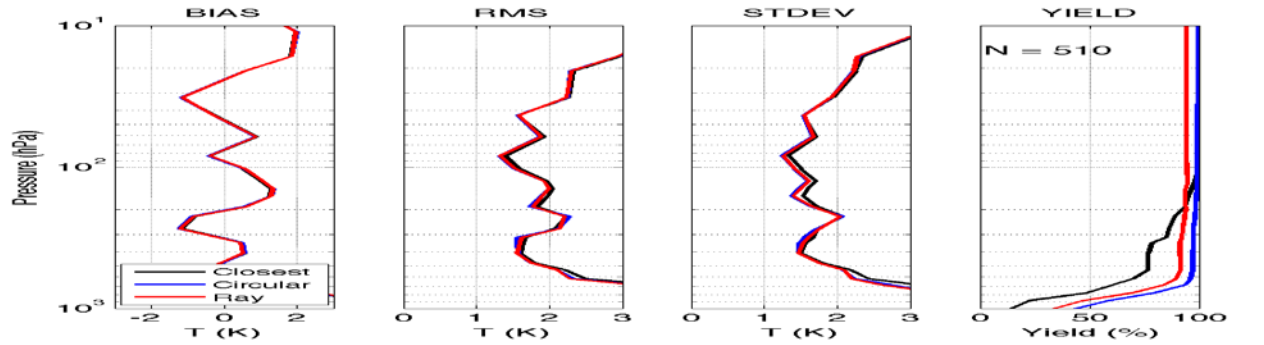
CLASS
Mx 6.4
Product
Oct. 22-31



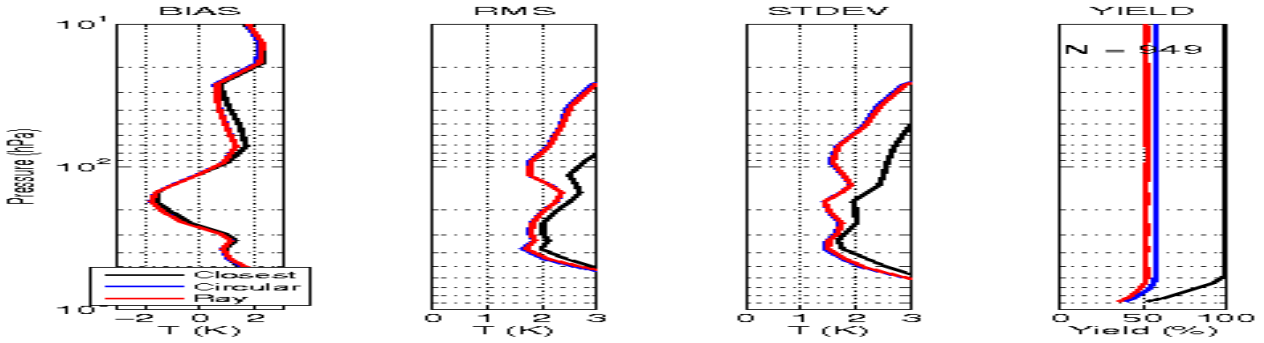
Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (27/35)
GPS comparisons: S.H. Polar (60S-90S)

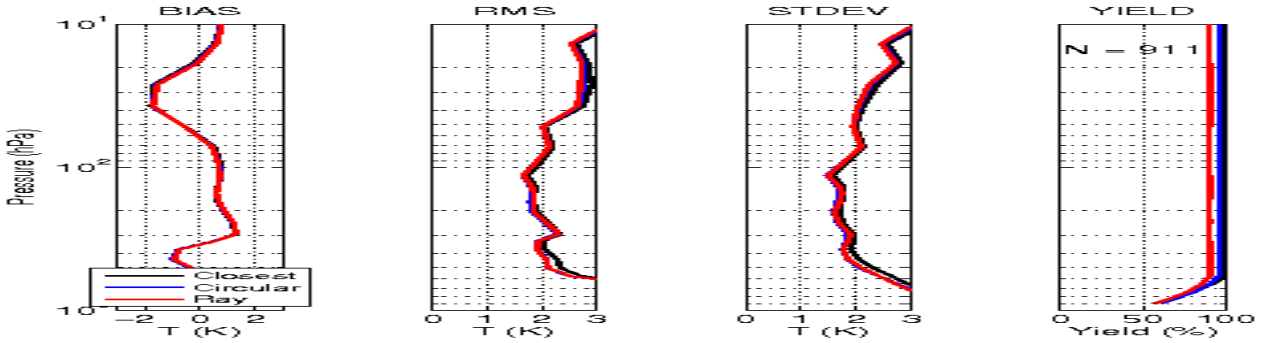
AIRS - COSMIC



CLASS
Mx 5.3
Product
Oct. 1-10



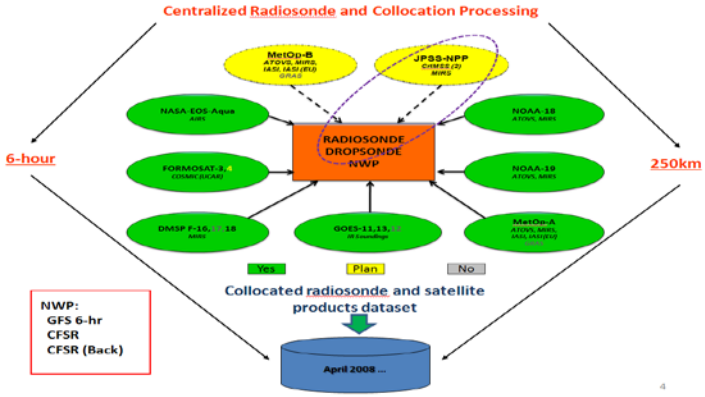
CLASS
Mx 6.4
Product
Oct. 22-31

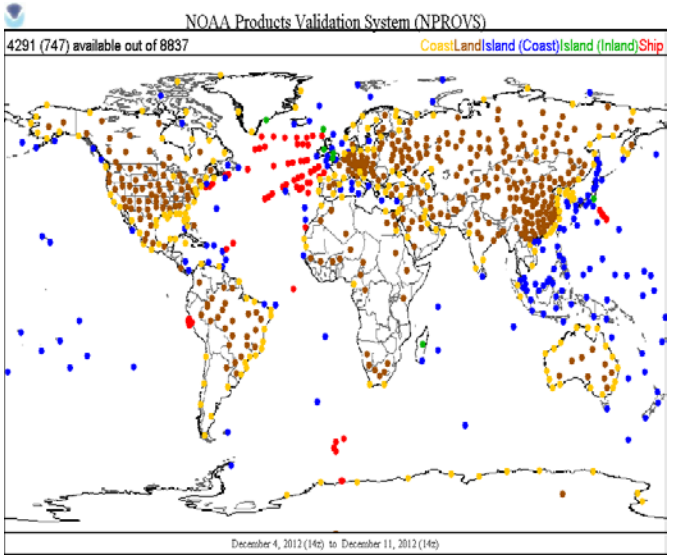


Slide courtesy of Michelle Feltz and Robert Knuteson (see AMS presentation for details).

Provisional Maturity Evaluation (28/35) Introduction to NPROVS (Tony Reale)

- NOAA Products Validation System (NPROVS) is a powerful interactive system.
  - Can compare a number of operation systems to the operational radiosonde database
  - Lower right: Locations of matchups (6 hour, 250 km) between NPP soundings and operational radiosondes during the week of Dec. 4-11, 2012.
    - 4291 potential soundings

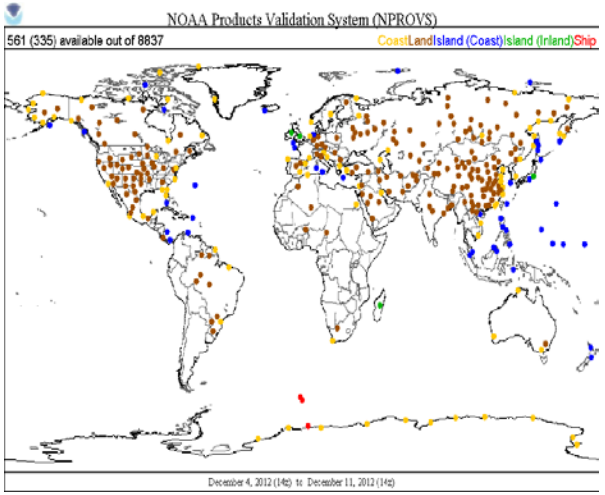


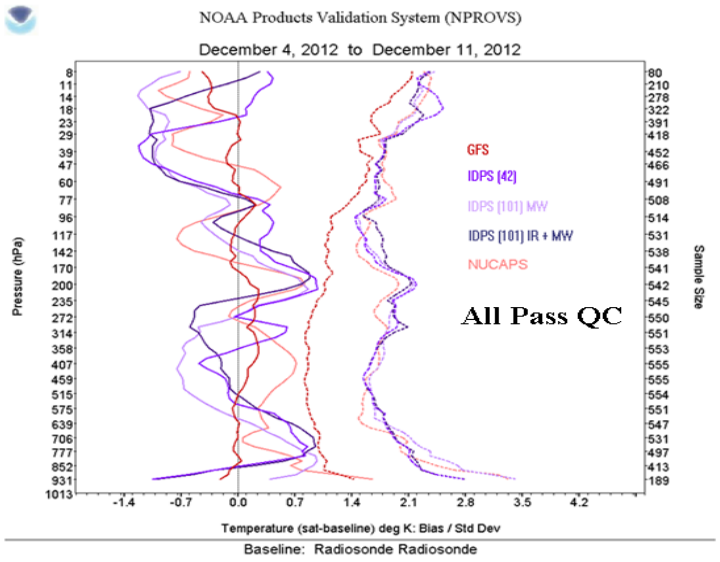


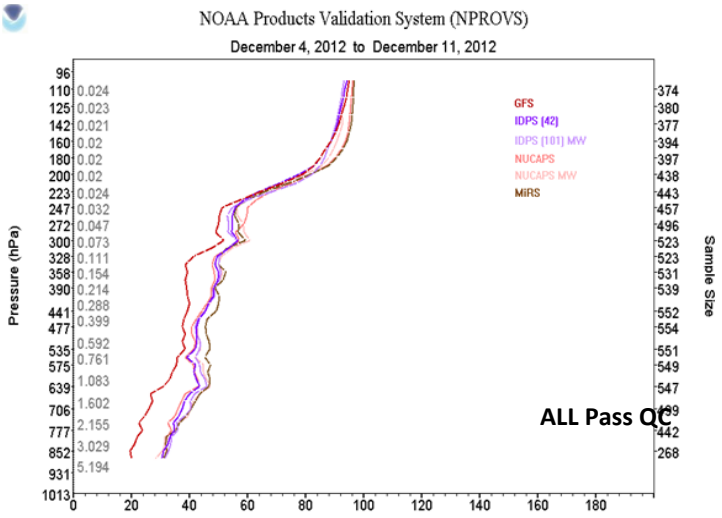
Provisional Maturity Evaluation (29/35) NPROVS evaluation of Mx6.4

- The subset of 561 radiosondes where there is a successful Mx6.4 CrIMSS EDR and a successful pre-op NUCAPS sounding is shown in upper right.

- Statistics of differences with radiosondes are shown below for AVTP (left) and AVMP (right).

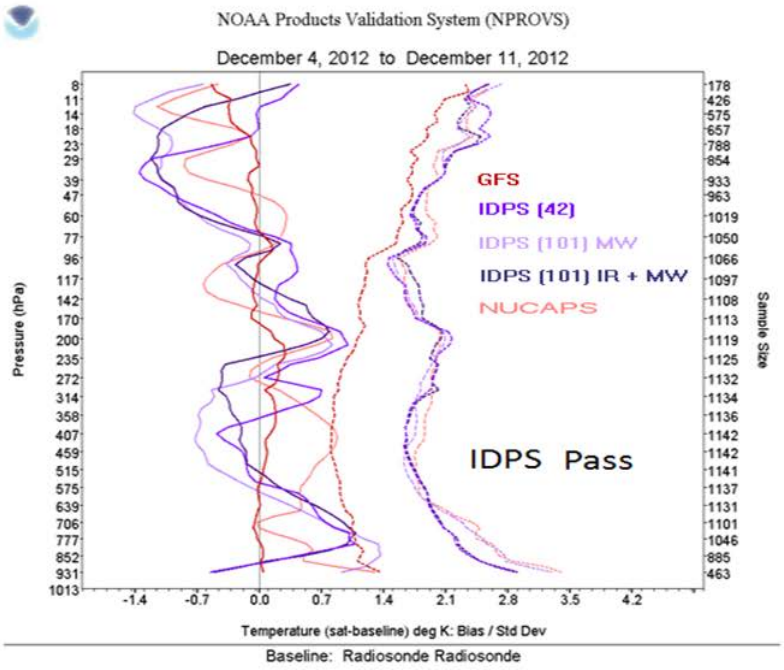


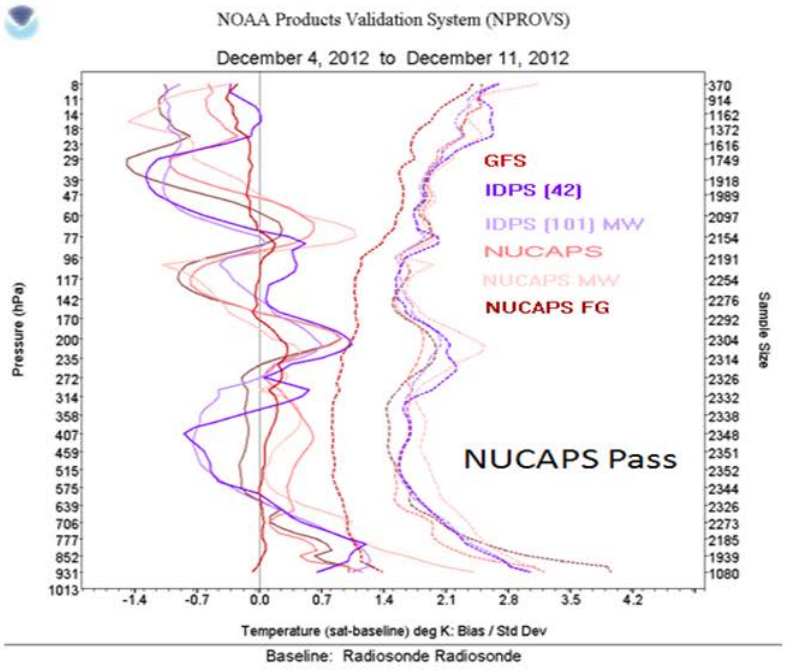




Provisional Maturity Evaluation (30/35)

- In Mx6.4 the IDPS is still rejecting many cases (fix will be in place in Mx6.6)
- Below is shown the AVTP statistics for both CrIMSS EDR and NUCAPS if CrIMSS EDR QC is used (left, ≈1150 cases) and if NUCAPS QC is used (right, ≈2350 cases)
- The fact that the CrIMSS EDR statistic doesn't change significantly is an indication that the performance of provisional CrIMSS EDR will not be degraded with higher yield.

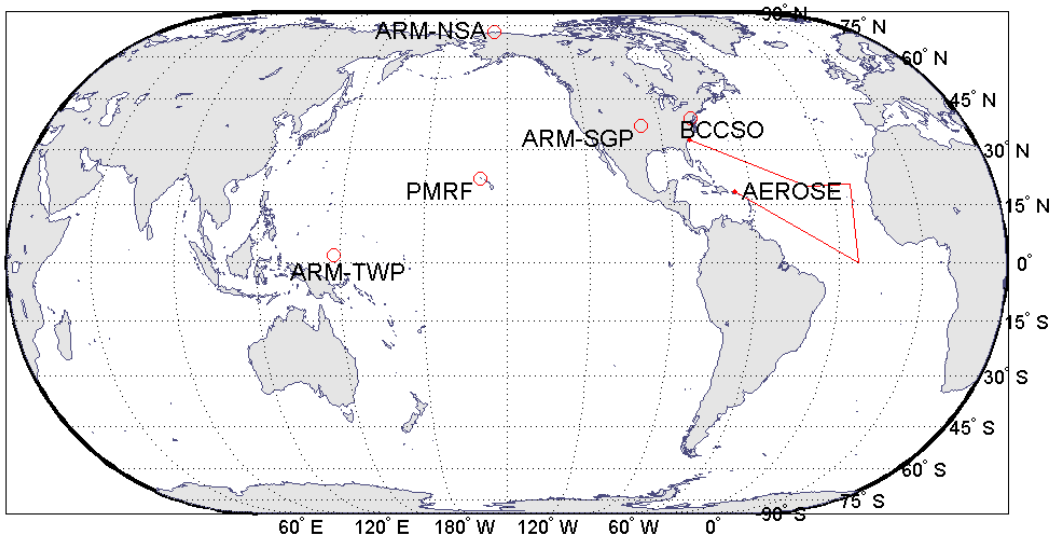




Provisional Maturity Justification (31/35)
Coordinated Dedicated RAOB Campaign Status

	ARM-TWP	ARM-SGP	ARM-NSA	PMRF	BCCSO	NOAA AEROSE
Location	Manus Island, Papua New Guinea	Ponca City, Oklahoma, USA	Barrow, Alaska, USA	Kauai, Hawaii, USA	Beltsville, Maryland, USA	Tropical North Atlantic Ocean
Regime	Tropical Pacific Warm Pool, Island	Midlatitude Continent, Rural	Polar Continent	Tropical Pacific, Island	Midlatitude Continent, Urban	Tropical Atlantic, Ship
Planned *N*	90	180	180	40	—	≈ 60–120 (partitioned between NPP+IASI)
Launched n_1	**47**	**93**	**93**	**40**	**23**	**23 (NPP + IASI) (in progress)**
Launched n_2	—	**89**	**90**	—	—	**0**
Time Frame	Aug–present	Jul–present	Jul–present	May, Sep	Jun–Jul, Sep–present	Jan–Feb 2013

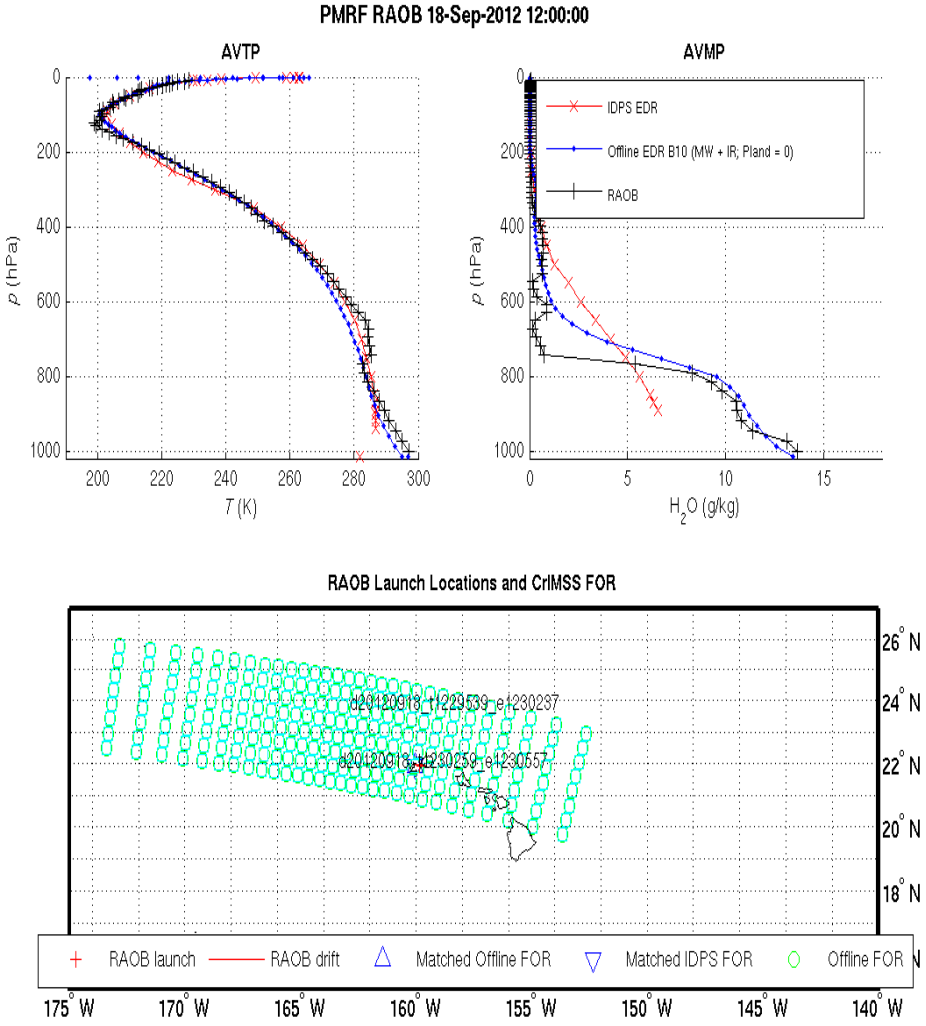
NPP CrIMSS EDR ICV Dedicated RAOB Sites



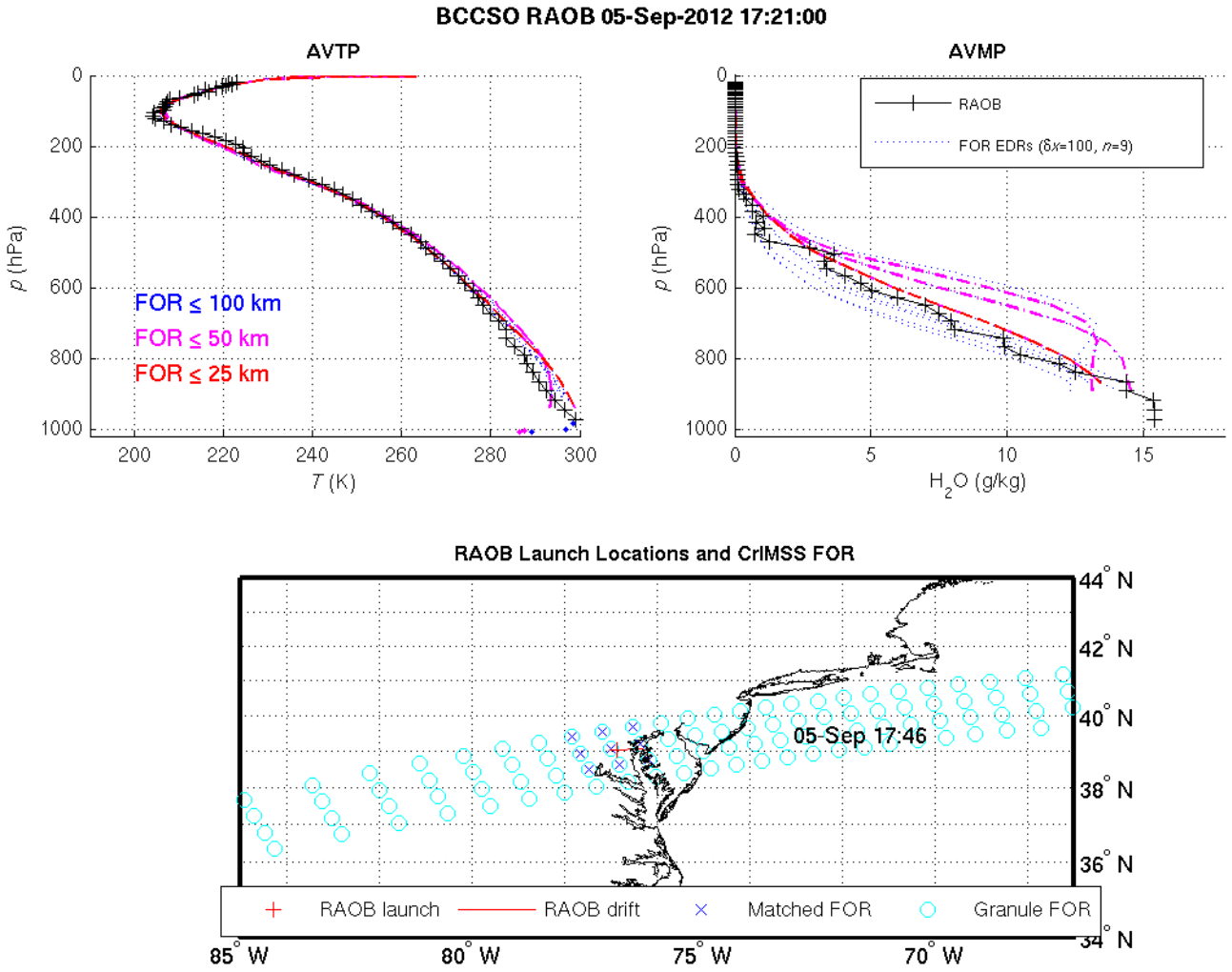
NOTE: we will use other GRUAN sites if data are provided – however, we do not have a commitment for those.

Provisional Maturity Evaluation (32/35) Example of PMRF Radiosonde

- In May 2012, Aerospace Corp. launched 20 sondes from Hawaii.
  - Add'l 20 in Sep. 2012
- At right is one sonde (black), the Off-line optimized CrIMSS EDR result (blue), the IDPS EDR (red), and NUCAPS EDR (cyan) for ATVP (left) and AVMP (right)
- While these results are preliminary, we are investigating the possibility that the EDR product, which is reported on coarse layers, is offset (DR4207/4208) .



Provisional Maturity Justification (33/35)
Example of Beltsville comparison

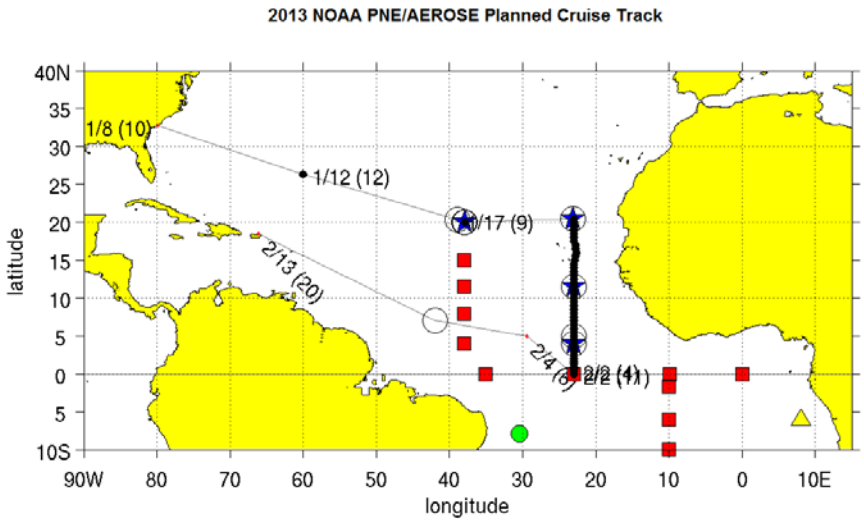


Provisional Maturity Justification (34/35)
AEROSE "2012"

- Aug. 2012 campaign was postponed due to propulsion problems with R.H. Brown
- Campaign is now underway (Jan. 8-Feb.13)
  - ~60-100 RS-92
    - Partitioned between Metop and NPP overpasses
  - ~20-25 ozone sondes
- After the usual problems getting shipboard systems to function (including fire in engine room), 1st radiosonde launched Jan. 9th.
- As of Jan. 15, 23 RS-92's and 5 O3 sondes have been launched

AEROSE provides unique measurements in under-sampled region

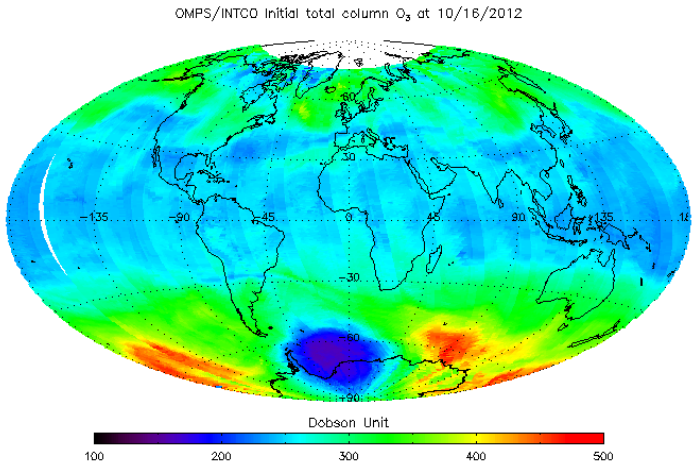
- Allows assessment of impacts due to dust and smoke.
- These sondes and "site" statistics never entered NWP analysis
  - Allows unique assessment of ECMWF/GFS errors

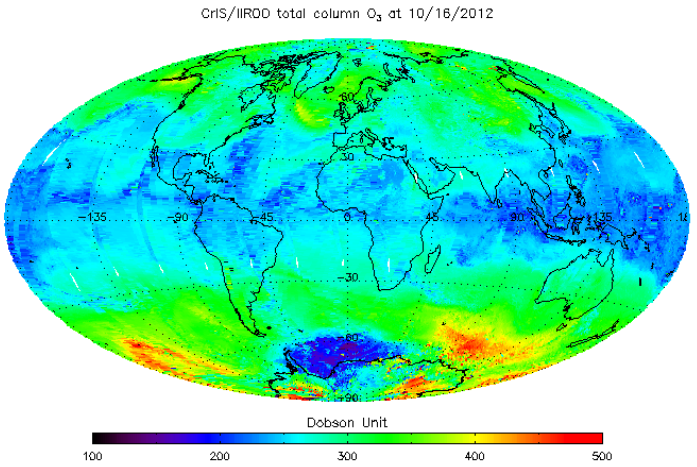


Provisional Maturity Justification (35/35)
Ozone: OMPS vs CrIMSS-EDR

OMPS nadir
mapper beta EDR

CrIMSS Mx6.4 O3-IP





Total column ozone (integral of CrIMSS ozone IP profile)
Quick Look slides and analysis by OMPS team
Slides courtesy of OMPS team (P.I. Larry Flynn, Jianguo Niu, Eric Beach)

Known Issues with the Provisional CrIMSS EDR (1/3): General Issues

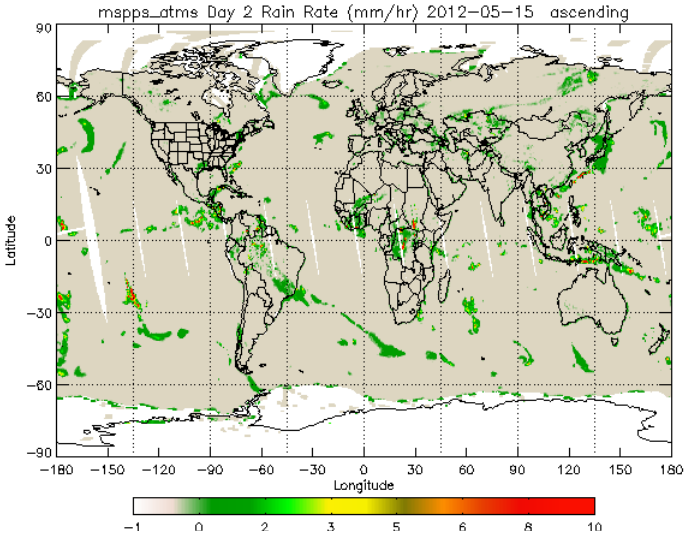
- Known problem with surface pressure exceeding reasonable values (DR4923)
  - Has negligible impact on product performance.
- Amplification factor value in EDR file has incorrect value for ATMS-only retrievals.
  - Can be screened out using QC flags
- Earth scenes during maneuvers should be marked invalid
  - If satellite is not in nadir configuration, but is still viewing Earth scene the LUTs for local angle correction are invalid and will cause subtle errors.
- AVMP super-saturation test sometimes causes unrealistic structure in UTH profiles.

Known Issues with the Provisional CrIMSS EDR (2/3): Precip Flag

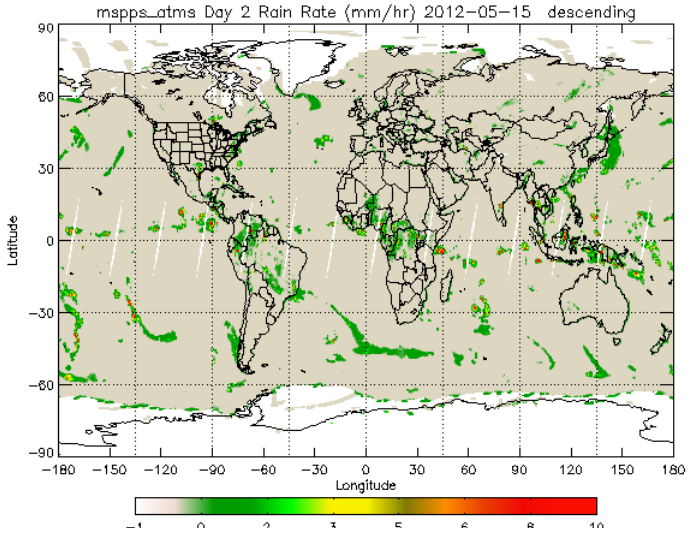
- Precipitation flag is sub-optimal (DR4068 and 4069)
  - Precipitation flag is needed for excluding cases from the performance statistics.
  - Current flag is using out of date algorithm (1998) and incorrect coefficients (AMSU coefficients used)
    - Has a high failure rate (both false positives and negatives).
    - Does not impact quality of CrIMSS EDR directly.
      - Flag is unreliable.
      - Mostly affects performance assessment
        - » Bad cases can be included with false negative, making statistics worse
        - » Good cases can be excluded, making yield appear lower than it is.
  - New algorithm is being tested now (with 6 months of rain estimates) and being compared with MiRS products over CONUS.
    - Current approach converts ATMS into AMSU-like channels.
    - New code and coefficient's will be installed into the off-line code in April-May 2013.

Known Issues with the Provisional CrIMSS EDR (3/3): Precip Flag

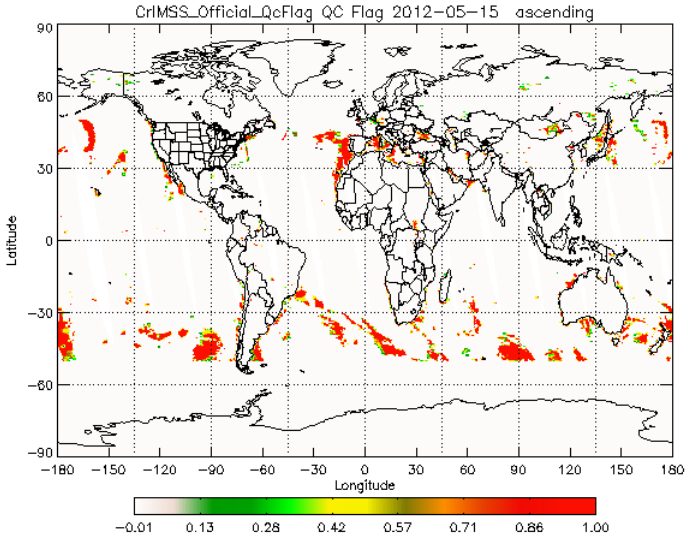
Ascending Orbit

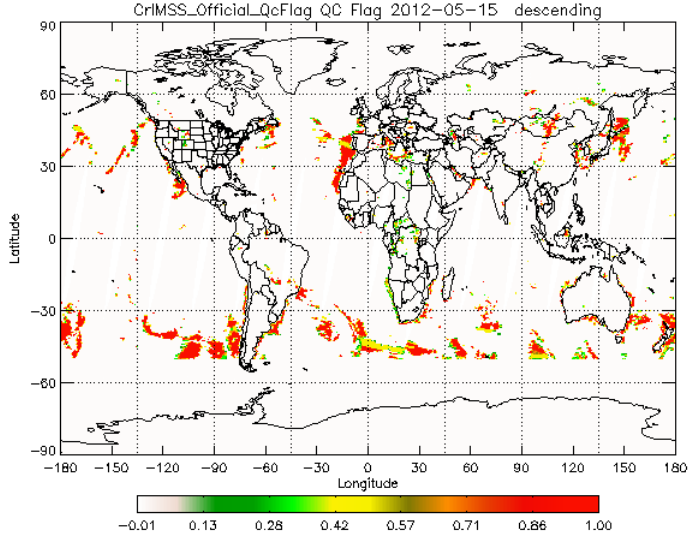


Descending Orbit



MSPPS





Mx5.3 CrIMSS EDR

Additional Supporting Documentation (1/2)

Presentations at the 93rd Annual AMS Meeting (Jan. 6-10, 2013)

- Murty Divakarla, STAR, “Evaluation of CrIS/ATMS Proxy Data Generation Algorithms with Observed Radiances and Retrieval Products”
- Murty Divakarla, STAR, “Provisional Maturity Assessment of Cross Track Infrared Sounder (CrIS) Temperature and Moisture Profile Products “
- Poster: Tony Reale, STAR, “Validation of pending Suomi-NPP Operational Sounding Retrievals Using Global Radiosondes and Future Plans”
- Poster: Xu Liu, NASA/LaRC, “Atmospheric Temperature and Moisture Profiles Retrieved from Suomi NPP CrIMSS Data”
- Poster: Susan Kizer, NASA/LaRC, “Suomi NPP CrIMSS EDR Operational Code Porting and Algorithm Validation”
- Poster: Mike Wilson, STAR, “A Global Perspective of the Current and Future CrIMSS EDR Algorithm”
- Poster: Changyi Tan, STAR, “On Empirical Bias Corrections of the NPP CrIMSS OSS Forward Model “
- Poster: Ralph Ferraro, STAR, “Evaluation and Improvement of the NPP CrIMSS Rain Flag”
- Zhenglong Li, CIMSS, “NPP sounding validation and evaluation”
- Feltz and Knuteson, CIMSS, “Validation of Temperature Profile Environmental Data Records (EDRs) from the Cross-Track Infrared Microwave Sounding Suite (CrIMSS) Using COSMIC Dry Temperature Profiles”
- Denise Hagan, NGAS, “Performance of the ATMS Intermediate Product Suite”
- Denise Hagan, NGAS, “CrIMSS Single FOV EDR Retrieval”

Additional Supporting Documentation (2/2) (Published papers related to CrIMSS EDR)

- Gambacorta, A. and C. Barnet 2012. Methodology and information content of the NOAA NESDIS operational channel selection for the Cross-Track Infrared Sounder (CrIS). IEEE TGARS, In-Press, June 2012
  - Discusses methodology of selection of CrIS channels sent to NWP centers
  - More details in published NOAA Technical Report v.133
- Maddy, E.S., S. DeSouza-Machado, N.R. Nalli, C.D. Barnet, L.L. Strow, W.W. Wolf, H. Xie, A. Gambacorta, T.S. King, E. Joseph, V. Morris, S.E. Hannon and P. Schou 2012. On the effect of dust aerosols on AIRS and IASI operational level 2 products. Geophys. Res. Lett. v.39 L10809 doi:10.1029/2012GL052070, 5 pgs.
  - Direct result of analysis of AEROSE data
- Nalli, N.R., C.D. Barnet, E.S. Maddy and A. Gambacorta 2012. On the angular effect of residual clouds and aerosols in clear-sky infrared window radiance observations: Sensitivity analyses. J. Geophys. Res. v.117 D12208 doi:10.1029/2012JD017667, 19 pgs.
  - Direct result of analysis of AEROSE data
- Reale, T., B. Sun, F.H. Tilley and M. Pettey 2012. The NOAA Products Validation System (NPROVS). J. Atmos. Oceanic Tech. v.29 p.629-645.
  - Demonstration of the NOAA CrIMSS EDR validation system
- Nalli, N., Joseph, E., Morris, V.R., Barnet, C.D., Wolf, W.W., Wolfe, D., Minnett, P.J., Szczodrak, M., Izaquirre, M.A., Lumpkin, R., Xie, H, Smirnov, A., King, T.S., Wei, J. 2011. Multi-year observations of the tropical Atlantic atmosphere: Multidisciplinary applications of the NOAA Aerosols and Ocean Science Expeditions (AEROSE). Bull. Amer. Meteor. Soc. v.92, p.765-789 doi:10.1175/2011BAMS52997.1 (June 2011 and was cover of that issue)

Provisional Justification Summary (1/2)

- Criteria: Product accuracy is determined for a broader (but still limited) set of conditions
  - Majority of evaluation is based on 2 focus days using off-line code
    - CrIS and ATMS SDRs were both at beta maturity
    - Demonstration of improvements is based on understanding of code theoretical basis and architecture.
  - Product has been enhanced: yield has increased substantially with significant improvement in performance
- Criteria: All DRs are identified and prioritized
  - Known bugs have been fixed
  - Priority has been given to improving yield and performance.
  - Outstanding issues are mostly related to file format and quality control during rare events.

Provisional Justification Summary (2/2)

- Criteria: General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing
  - CrIMSS EDR team has evaluated IDPS EDR products available from CLASS now (Mx6.4) and in the future.
    - Yield is reasonable (both IR+MW and MW-only) and product quality is high.
  - Provisional release will allow other users within the community to gain experience with the parameters.
    - This is important to allow users to complement the validation activity.

Future Plans and Issues

- We are working to get these changes into the IDPS
  - IDPS version is significantly behind the off-line and ADL versions.
  - Change process has been a learning process, but they have been approved for implementation in Mx7.1 (to be available June 2013).
  - Once implemented in IDPS, we will verify performance.
  - At that time, product can be declared provisional.
- In the meantime: detailed performance characterization will be done w.r.t. dedicated radiosondes
  - Hopefully, we will have completed a successful AEROSE campaign
  - The ARM-CART radiosonde launches from North Slope of Alaska (NSA), Southern Great Plains (SGP), and Tropical Western Pacific TWP) are continuing.
    - ~90 overpasses at each site (SGP and NSA have 2 sondes/overpass)
  - Aerospace PMRF sondes complement the ARM TWP sondes
  - Beltsville sondes complement the ARM SGP sondes
- Radiosonde analysis will be basis of the stage.1 validated maturity justification scheduled for Nov/Dec 2013.

Conclusion

- Many issues were uncovered during validation and solutions were evaluated, change packages submitted (and accepted by AERB)
- Proposed Mx7.1 CrIMSS EDR has met the Provisional stage based on the definitions and the evidence shown
  - It exceeds the definition of provisional in most cases
    - Lower troposphere AVTP and AVMP still need work.
  - Off-line EDR product performance is close to meeting requirements at this time (and continuing to improve).
- Once Mx7.1 is running on IDPS the analysis will be repeated to ensure performance is the same as described in this document.
  - Open question: Do we submit provisional DR/CCR now or wait until the analysis is completed using the IDPS EDR products?