Cross-track Infrared Sounder (CrIS)
SDR Calibration/Validation Plan Status

Gail Bingham, Denise Hagan,
Sounder Science Team Meeting
16 October 2008

You may be tempted to ask, “Just which plan are we talking about?
Haven’t we done this about 15 times already?”
CrIS is 3rd Hyperspectral Sounder

CrIS follows two great, well calibrated instruments to orbit
SDR Cal/Val will utilize similar procedures
Co-existence allow direct comparison-good comparisons from GSCICS
Cal/Val team brings direct AIRS/IASI experience
Hence, today’s Cal/Val plan is significantly different than the first one
NPP CrIS SDR Cal/Val Plan

Objectives

• Develop up-to-date plan to guide the cal/val process implementation
  – Resource allocation, architecture development and communications
  – Coordinate previous planning, foster team building,
  – Optimize task assignments, resource utilization

• Unify cal/val planning, describe the joint government/industry effort
  – IPO-industry team consolidating and optimizing previous versions
  – Allocating anticipated resources, developing functional approaches
  – Preparing document section for near term SME and community review

• Incorporate heritage lessons (AIRS, IASI, TES calibration)
  – Cross calibration assets
  – Tools and techniques developed by team members

• Guide pre-launch SDR development using bench and TVAC tests
  – Guided by experienced industry, government and academic SMEs
  – Open process, with near real time data sharing, process guidance

• Provide detailed planning for post-launch activities
NPP CrIS SDR Calibration Strategy (1)

• Build a team of SMEs from government, industry and science communities with heritage knowledge and tools to assure mission success.
  – Provide the basis for resource allocation and justification
• Utilize two pronged pre-launch effort:
  – Development of formal software and instrument response functions utilizing ground test data to verify SDR accuracy and completeness
  – Develop post flight plan, team, support facilities and communications
• Pre-launch effort
  – Analysis of TVAC data
  – Evolve TVAC findings into improved operational algorithm
  – Verification of RDRs and ITT supplied engineering parameters (LUTs)
  – Test the SDR conversion from C++ into the IDPS system
  – Test the post launch software, tools and communication systems
NPP CrIS SDR Calibration Strategy (2)

• Post-launch effort lead by NGST, supported by government resources
  – IPO provided computer support, personnel resources
  – IPO contracted SMEs from government and academic associated laboratories
  – Distributed design utilizing teleconferencing, internet, distributed software
  – System exercised extensively pre-launch using proxy data

• Post-launch effort divided into three phases
  – Sensor activation and checkout
    > Lead by NGST and ITT
    > Data available to SME team for information and communication checkout
  – Intensive Calibration Period
    > Combined effort by NGST/ITT and government SME teams
    > Effort coordinated through IPO “Issue Tracker” and “DR Tracker” software
    > Linux based SDR software at SME and government team locations to process RDRs and make data available to local tools
    > IPO Linux and NGST’s IBM ADA system provide change suggestion verification

• Long term monitoring and trending
  – NGST and SME participation
  – Note: I do not see any Sounding Science funding included in the cal/val effort
Cal/Val Effort Summary

NPP Mission Phase

Pre-launch Sensor Characterization, SDR Algorithm Testing and Product Development

Launch and Sensor Activation

On-Orbit Check Out

ICV

Long-term Monitoring

Team Components

NGST, ITT, UWisc, SDL, U Maryland, MIT, IPO/NOAA Raytheon (RIS, IDPS), Aerospace

NGST, ITT, NASA

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NGST, ITT, UWisc, SDL, U. Maryland, NASA, JPL, Goddard, Langley, NOAA/IPO, Raytheon, AFWA, Aerospace

NGST, NOAA

Team Products

Sensor LUTs from FM Testing including SDR algorithm updates and analysis software, ROPs

First Light Spectra

Data Inventory RDR-SDR Verification, Calibrated spectra

Radiance Match-up Products, Sensor Trending Products, Visualization PGE Products

Trending Products
# NPP CrIS SDR C/V Team

<table>
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<tr>
<th>Function / Leads</th>
<th>NGST/Raytheon/ITT</th>
<th>IPO/Govt</th>
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<tr>
<td>Instrument Verification</td>
<td>Denise Hagan (NGST)</td>
<td>Gail Bingham (SDL)</td>
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<tr>
<td>Radiometric Cal</td>
<td>Denis Tremblay</td>
<td>SMEs</td>
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<tr>
<td>SST Comparisons</td>
<td>Chunming Wang</td>
<td>Dan Mooney (Lincoln Labs)</td>
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<tr>
<td>Radiosonde Comparisons</td>
<td>Denise Hagan</td>
<td>Hank Revercomb, Dave Tobin</td>
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<tr>
<td>Cross-Platform Comparison</td>
<td>Gene Kratz</td>
<td>and Bob Knuetson (UW SSEC)</td>
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<tr>
<td>Model-to-Instrument</td>
<td>Giovanni De Amici</td>
<td>George Aumann and Tom Pagano</td>
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<tr>
<td>Geolocation</td>
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<td>(JPL)</td>
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<td></td>
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<td>Larrabee Strow (UMBC)</td>
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<td></td>
<td></td>
<td>M. Esplin, C. Fish, G.</td>
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<td></td>
<td></td>
<td>Cantwell, V. Zavyalov, N.</td>
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<td>Pougatchev (SDL)</td>
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<td>Chris Barnet (NESDIS/STAR)</td>
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<td>ATMS Interface</td>
<td>Giovanni De Amici</td>
<td>Bill Blackwell (Lincoln Labs)</td>
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<td>Edward J. Kim (GSFC)</td>
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<td>Lynn Chidister (SDL)</td>
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<tr>
<td>Sensor Support</td>
<td>Joe Predina, Glenn White, Dave Jordan,</td>
<td>Mark Esplin, Greg Cantwell</td>
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<td>Lawrence Suwinski, Ron Glumb, Steve Wells</td>
<td>(SDL)</td>
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<td></td>
<td>and Nathan Funk (ITT)</td>
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<td></td>
<td>Farhang Sabet-Peyman,</td>
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<tr>
<td>SDR Operational Algorithm Change</td>
<td>Denis Tremblay and AM&amp;S</td>
<td>Larrabee Strow (UMBC)</td>
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<td>Support</td>
<td>(Degui Gu, Xia-Lin Ma)</td>
<td>Dean Ferguson, Mark Greenman</td>
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<tr>
<td>SDR ILS Updates</td>
<td>AER (Post-launch POC TBD)</td>
<td>(SDL)</td>
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SDR Design

- SDR is maturing as the instrument develops
  - Three EDUs proceeded FM1, but still learning things!
  - New releases of the SDR have accompanied the learning process.
  - Newest version will include non-linearity correction and improved ICT environment model. (Beta release imminent)
# Prelaunch SDR Tuning

<table>
<thead>
<tr>
<th>SDR Algorithm Parameter Specified in 4 min Engineering Data Packet</th>
<th>Populated Pre-launch</th>
<th>Post-launch Update</th>
<th>Task Network ID</th>
<th>On-Orbit Procedure/Method</th>
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<tr>
<td>Effective Neon wavelength</td>
<td>ITT</td>
<td>Cal-Val</td>
<td>855, 1333</td>
<td>Set Neon Lamp Calibration (ROP #8216134)</td>
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<td>ILS Fit Parameters</td>
<td>ITT</td>
<td>Cal-Val</td>
<td>910, 913, 926</td>
<td>DA Tilt Offset Determination (ROP #8216139) Likely requires adjustments</td>
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<td>Cal Target Geometric factor</td>
<td>ITT</td>
<td>Cal-Val</td>
<td>914, 927, 1341, 1374</td>
<td>May require tuning</td>
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<td>Cal Target Emissivities (Wavelength-dependent)</td>
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<td>Cal-Val</td>
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<td>May require tuning</td>
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<tr>
<td>Polarization Change (%) (Detector/FOV dependent)</td>
<td>ITT</td>
<td>Cal-Val</td>
<td>927</td>
<td>May require tuning</td>
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<td>Polarization Wavenumber</td>
<td>ITT</td>
<td>Cal-Val</td>
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<td>Determined pre-launch</td>
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<td>Ext Env ICT Model Parameters</td>
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<tr>
<td>Science TLM Coefficients</td>
<td>ITT</td>
<td>Cal-Val</td>
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<td>Determined pre-launch for ICT Radiance Model; may require tuning</td>
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<td>TLM Limits</td>
<td>ITT</td>
<td>Cal-Val</td>
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<td>Temp Drift limits determined pre-launch; may require tuning</td>
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<td>Mapping Parameters</td>
<td>ITT</td>
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<td>Bit Trim Masks</td>
<td>ITT</td>
<td>Cal-Val</td>
<td>911</td>
<td>Bit Trim and Impulse Mask Checks (ROP #8216136)</td>
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<td>OPD SampleJitter Correction Parameters</td>
<td>ITT</td>
<td>Cal-Val</td>
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<td>ITT Procedure TBD</td>
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<td>Spectral Calibration Data</td>
<td>ITT</td>
<td>Cal-Val</td>
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<td>Tuning</td>
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# Post Launch Cal/Val Task Summary

<table>
<thead>
<tr>
<th>Principal Category</th>
<th>Sub-Category</th>
<th>Task Network ID#(s)</th>
<th>Related Sensor Performance Requirement #s</th>
<th>Cal/Val Phase</th>
<th>Benefit from Air Campaign</th>
<th>Requires Sea &amp;/or Ground Campaign</th>
<th>Lead / Backup</th>
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<tr>
<td></td>
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<td>Sensor Activatio n</td>
<td>Sensor Checkou t</td>
<td>SDR Baseline</td>
<td>Long Term Monitoring</td>
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<td>Functional Performance</td>
<td>CrIS Diagnostic Mode</td>
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<td>Sensor Checkout Status and Trending</td>
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<td>CrIS Telemetry Parameters and RDR Status and Trending</td>
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<td>Absolute Radiometric Uncertainty</td>
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<td>Radiometric linearity</td>
<td>867, 870</td>
<td>CSS 835</td>
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<td>Cross Comparisons</td>
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<td>ICT Temperature Stability</td>
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<td>Spectral Calibration</td>
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<td>SDRP 7043, 884, 940, 944</td>
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<td>Geolocation</td>
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<td>CrIS FOV Coregistration</td>
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Government IV&V SDR Activities

- Government supported effort is designed to provide industry team capability gap filling and independent review
- Significant support to NGST/ITT from IPO supported SME’s with aircraft and space FTS sensor experience (GIFTS, MSX, NAST-I, S-HIS)
- Significant use of WMO GSICS and CEOS calibration procedures

**Graphs:**
- AIRS to NPP SNO time delta
- CrIS to IASA SNO time delta

< 3 days / SNO

> 80 days / SNO
• ITT developed Science Code is the basis for IDPS development – provides preflight SDR
• Our effort will validate the science and IDPS codes, before launch, using AIRS/AMSU and IASI/AMSU proxy data.
• A controlled, user friendly version of the SDR will be provided to the Cal/Val team to allow a distributed CrIMSS Cal/Val network.
GRAVITE Linux SDR Validation Tool

Sophisticated, flexible package available for team member use
Cal/Val Communications/Coordination

Team members linked by internet and teleconferencing links
Cal/Val Preflight Exercises

• The data and software interfaces required for Cal/Val effort are complex and cross many boundaries.

• Critical prelaunch steps to implement this plan include:
  – Completion of tool development and validation
  – Definition and EXERCISE of data interfaces and products
  – Specific cal/val tasks linked to specific SDR coefficients
  – EXERCISE the cal/val data to coefficient update procedure

• Pre-launch cal/val exercise plan is under consideration that would use proxy data collection to allow end-to-end verification of SDR performance and the EDR interface.
  – Use real time AIRS & IASI data collection as proxy data source
  – Utilize an aircraft campaign to provide benchmark absolute calibration of existing (heritage) assets.
  – Aircraft role has probably changed with AIR/IASI existence and GSICS efforts
  – Verify tools and ancillary data collection, access – utilization.
Plan Implementation Summary

• **CrIS SDR Cal/Val effort has 4 branches:**
  – **Thermal Vacuum performance assessment and SDR validation**
    > Team wide, biweekly data analysis telecom and result progress reviews
    > Exercise science SDR code with independent TV results
  – **Detailed “Task Network” item update and optimization**
    > Coefficient identification and CV task link assignment
    > Effort error and resource analysis
  – **CV system exercise plan development, budgeting and schedule**
    > Coordination and buy-in across agencies and sensors
    > Resource availability verification and schedule development
  – **CV personnel interfaces and network development / validation**
    > Completion of IDPS to Linux code conversion for GRAVITE
    > GRAVITE operations plan development and user team review

• **Careful, in depth coordination of CrIS SDR and CrIMSS EDR planning and development teams is critical to smooth function.**