CrIS L1b Project, Part 1

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NASA Sounder Science Team Meeting
2018-10-05

Outline

- Introduction
- Algorithm overview and theory
- Data quality assessment
- Current status and proposed tasks (L1b)
- Summary

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Introduction

Tuesday

- "A Long-Term Homogeneous Hyperspectral Radiance Time Series: AIRS2CrIS", Larrabee Strow

Friday

- "Hyperspectral IR Radiances (HIS, AERI, AIRS, IASI, CrIS, HIRAS, GIIRS, ARI)", Hank Revercomb
- "CrIS L1b Project, Part 1", Joe Taylor
- "CrIS L1b Project, Part 2", Graeme Martin
- "Can We Improve the AIRS ILS Functions Using CrIS?", Chris Hepplewhite
- "AIRS/CrIS Radiance Inter-Calibration and Tests of Trends Using Time Series that Combine Both Sensors", Chris Hepplewhite
- "NOAA20 CrIS Nonlinearity and Radiometric Calibration", D. Tobin
- "CrIS Polarization and Radiometric Uncertainty", Joe Taylor
- "CrIS/IASI/AIRS Intercalibration Results", Bob Knuteson

Introduction

- "CrIS L1b Project, Part 1", Joe Taylor
  - Focus: Introduction, L1b calibration algorithm

- "CrIS L1b Project, Part 2", Graeme Martin
  - Focus: Software, products, user interface

CrIS L1B Project Overview

- Funded by NASA to create software to generate a **climate quality** SNPP and NOAA-20 CrIS Level 1B mission data record
  - Supports reprocessing of the full mission datasets for the CrIS sensors, with a consistent calibration algorithm and consistent calibration coefficients and parameters
  - Transparent and accessible code base
- Joint effort at Univ. of Wisconsin – Madison and Univ. of Maryland – Baltimore County
- File formats, granulation and other conventions are common with the ATMS L1B product
- Underlying calibration equation and theory for NASA CrIS L1b Version 2.0/2.1 processing and current IDPS processing are similar but may diverge for future releases.

CrIS L1B Project Overview

- August 2015 – September 2018
  - Goal: Support NASA climate research by providing a climate quality Level 1B (geolocation and calibration) algorithm and long-term measurement record for CrIS
    - Create software that produces climate quality CrIS Level 1B data to continue EOS-like data records, and provide this software and associated documentation to the Sounder SIPS
    - Provide a) monitoring and validation of the CrIS Level 1B data record and b) maintenance and refinement of the Level 1B software

- September 2018 – August 2021
  - Goal: Produce climate quality radiance records from the CrIS sensors and continuity from EOS AIRS
    - Focus on providing continuity from EOS AIRS to CrIS and homogenous radiance records from the EOS timeframe through SNPP and into JPSS.
    - Important refinements to CrIS L1a and L1b software
    - AIRS to CrIS radiometric property conversion (AIRS2CrIS)
    - CrIS RTA

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L1b Calibration Algorithm Overview and Theory

- Complex calibration method (Revercomb, 1988) used for radiometric calibration
- Onboard neon source for spectral calibration
- Instrument self-apodization correction via inverse self apodization operator (Genest and Tremblay, 1999; Desbiens et al., 2006)

$$\tilde{L}^{es} = L^{ict} \cdot \frac{F \cdot f_{ATBD} \cdot SA_s^{-1} \cdot f_{ATBD} \cdot \left[\frac{\Delta S_1}{\Delta S_2} \left| \Delta S_2 \right| \right]}{F \cdot f_{ATBD} \cdot SA_s^{-1} \cdot f_{ATBD} \cdot \left| \Delta S_2 \right|}$$

$$\Delta S_1 = \tilde{S}_{es} - \left\langle \tilde{S}_{ds} \right\rangle$$

$$\Delta S_2 = \left\langle \tilde{S}_{ict} \right\rangle - \left\langle \tilde{S}_{ds} \right\rangle$$

F = *spectral resampling operator*

f_{ATBD} = *bandguard filter*

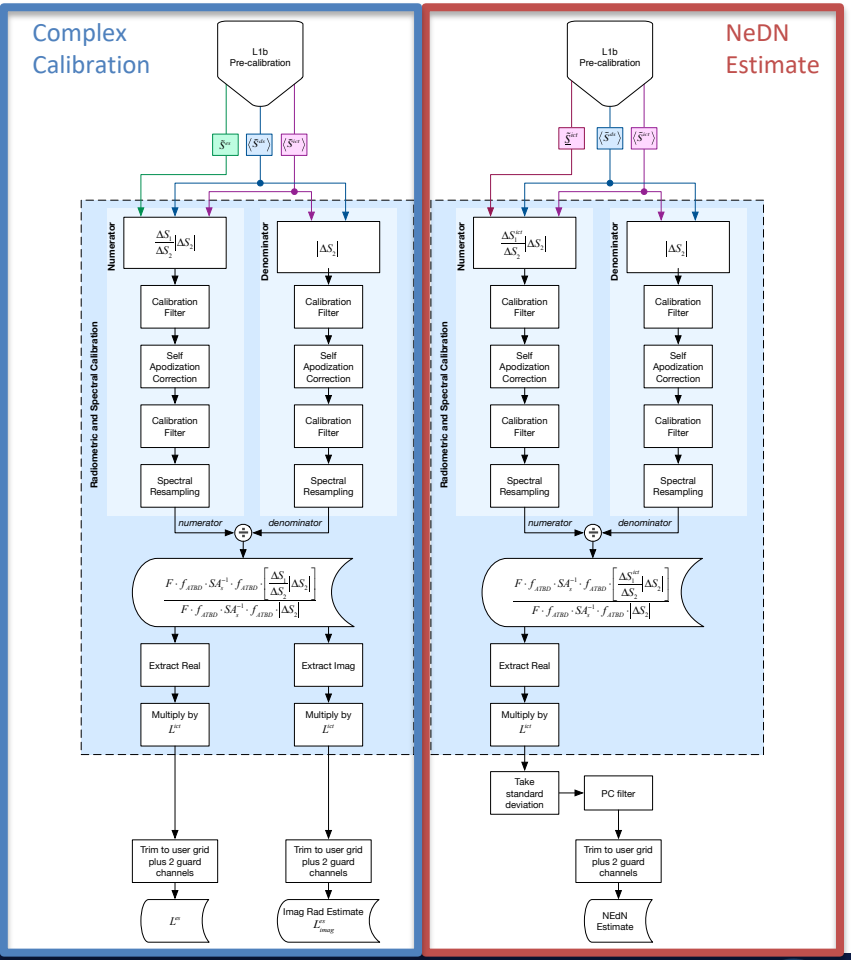
SA_S^{-1} = *Inverse Self Apodization Operator*

L^{ict} = *predicted ICT radiance*

L^{es} = *calibrated Earth scene radiance*

$\tilde{S}$ = *complex spectra*

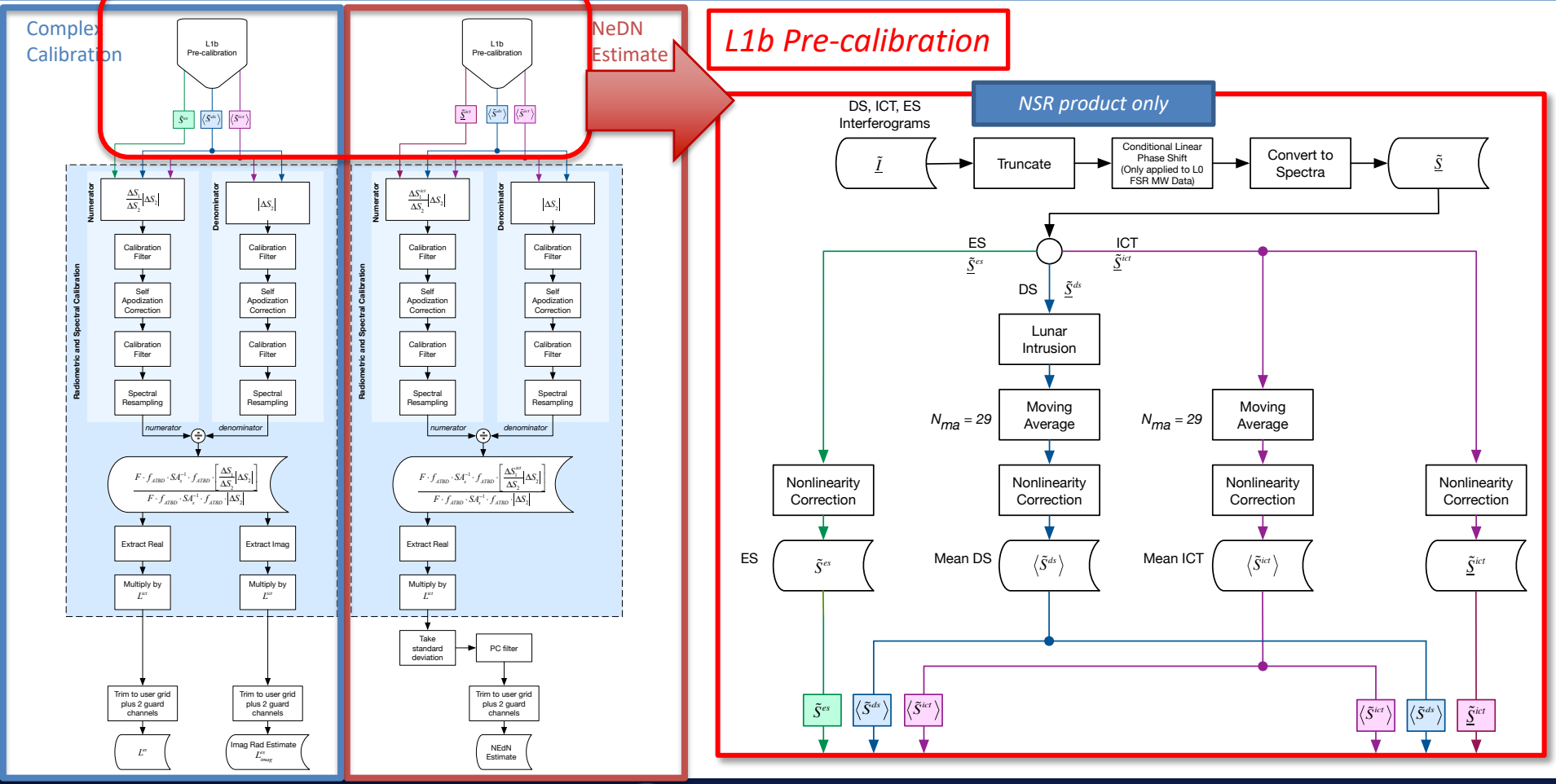
Algorithm Overview and Theory



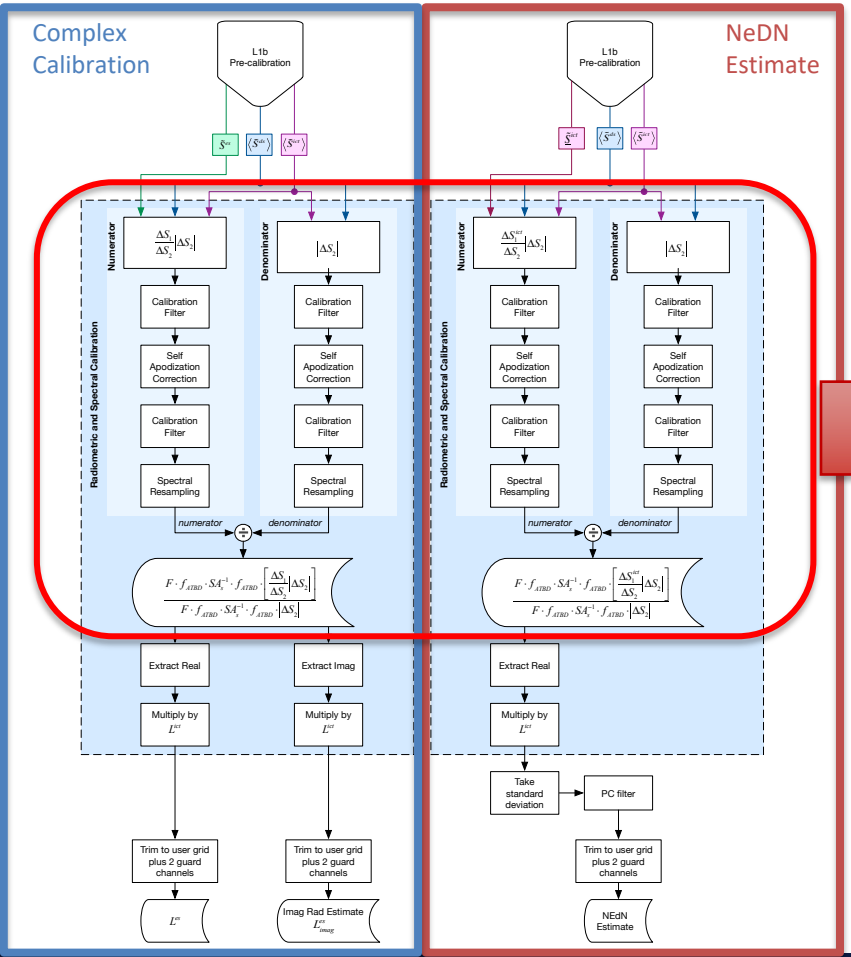
$$\tilde{L}^{es} = L^{ict} \cdot \frac{F \cdot f_{ATBD} \cdot SA_s^{-1} \cdot f_{ATBD} \cdot \left[\frac{\Delta S_1}{\Delta S_2} \left| \Delta S_2 \right| \right]}{F \cdot f_{ATBD} \cdot SA_s^{-1} \cdot f_{ATBD} \cdot \left| \Delta S_2 \right|}$$

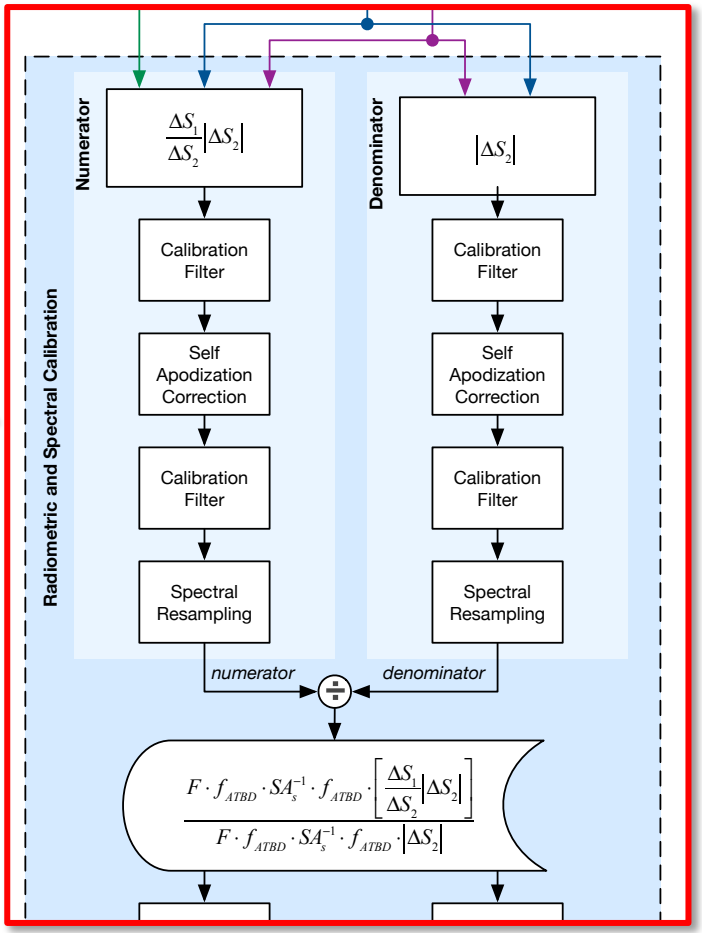
- Full calibration is applied to complex Earth scene spectra (real and imag output)
- Full calibration is used to produce NeDN estimate

Algorithm Overview and Theory

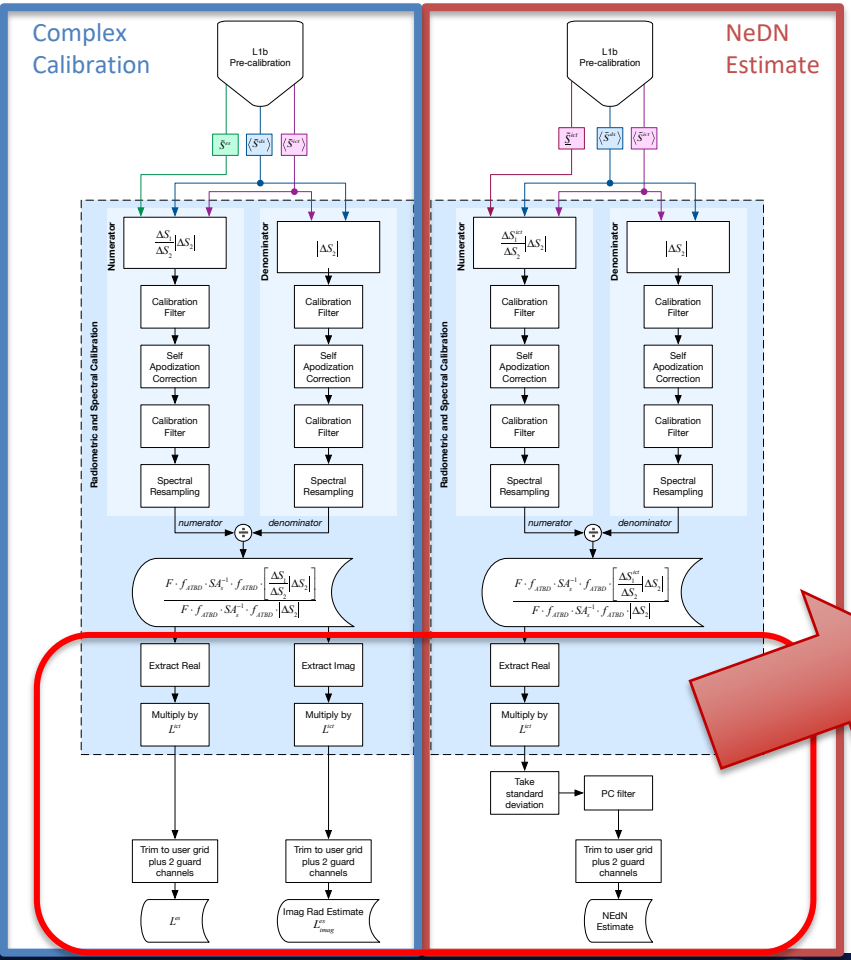


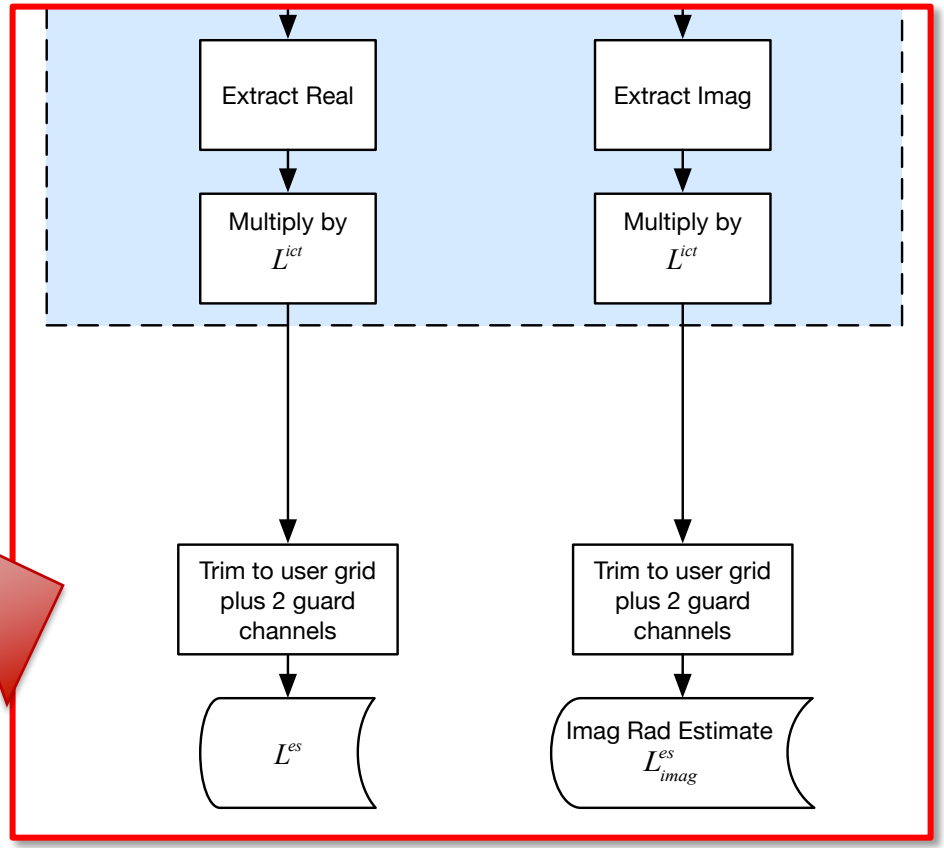
Algorithm Overview and Theory





Algorithm Overview and Theory





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Typical Data Quality Assessment Tasks

- QF, QC quicklooks
- Mission length metrics
  - Granule yield, product continuity
- Obs to Obs radiometric comparisons:
  - Previous L1b release(s)
  - IDPS
- FOV-to-FOV comparisons
  - Radiometric and spectral calibration
- Obs – Calcs
- SNOs and SONOs
  - IASI-A, IASI-B, AIRS
- SNPP CrIS to NOAA-20 CrIS
  - Via calculation as transfer standard (Double Obs – Calc)
  - Via AIRS or IASI as transfer standard (SNO Differences)

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Current Status, Accomplishments to Date (L1b; v2.0, v2.1)

- L1b algorithm and software development
  - Developed and delivered an operational, traceable, climate quality calibration software package (based on prototype research code developed at UW-SSEC and UMBC).
  - Calibration equation: The form of the basic calibration equation was changed to reverse the order of the spectral and radiometric calibration modules allowing for a more rigorous self-apodization correction.
  - Non-linearity correction: improved code performance and readability; optimal coefficients applied for life of mission.
  - Spectral calibration: provide optimal smoothing and use of the Neon lamp view data.
  - Polarization Correction: identified polarization correction parameters; prep and development of polarization correction code.
  - FIR Convolution Correction: prep and development of a correction to remove artifacts related to how the onboard data compression is performed.

Current Status, Accomplishments to Date (L1b)

- Development and validation of a new CrIS FSR RTA
- Documentation (Delta ATBD, Software User's Guide, Product User's Guide)
- Product Validation
- Sample L1b datasets
- Software releases
  - multiple software releases accomplished

Proposed Work (L1b)

- L1b refinements and development
  - Implement polarization correction
  - Implement FIR Convolution correction
  - Radiometric Uncertainty estimates
  - Improved Self Apodization Correction
  - Spectral calibration upgrades
  - Robustness improvements (improved lunar intrusion, IGM spike detection, etc.)
  - Additional ‘aux’ information in L1b output files

Proposed Work

- AIRS to CrIS radiometric property conversion (AIRS2CrIS)
  - Produce a homogenous hyperspectral radiance product that converts AIRS to the CrIS ILS, view angle, and radiometry
- Radiometric homogenization
  - Develop/refine existing software to produce AIR2CrIS + CrIS calibration subset data files.
  - External L1b calibration validation (obs-calc, SNOs, radiance trends)
  - Optimize the agreement between the radiances from the SNPP and NOAA20 CrIS instruments in a way that preserves the rigor of each calibration.
- CrIS RTA development

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Summary

- NASA funded project to develop and deliver software to generate a **climate quality** SNPP and NOAA-20 CrIS Level 1B mission data record
  - Supports reprocessing of the full mission datasets for the CrIS sensors, with a consistent calibration algorithm and consistent calibration coefficients and parameters
  - Transparent and accessible code base
- Focus for next phase of development:
  - Refinements and further development (CrIS L1a and L1b)
  - AIRS to CrIS radiometric property conversion (AIRS2CrIS)
  - Radiometric homogenization (AIRS, SNPP CrIS, J1 CrIS, ...)
  - CrIS RTA development
  - Documentation