February Science Team Meeting
Early L1b Evaluation

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Overview

• Concentrate on model (ECMWF) data for “early” evaluation
• As sonde/lidar results come in, will evaluate as well
• Used V2.2.0 granules, matchup-files for this work (night/ocean)
• Assume do not know frequency scale
• Used our own clear flags (absolute and differential window B(T) tests, using model/obs SST). Haven’t implemented TMI SST yet.
• To lower volume and to improve detection of clear, only used warmest FOV per golfball.
• Main new software: kCARTA wrapper and large scale convolutions
• Can run ~ 1000+ AIRS profiles/day with kCARTA
• Software view of activity: produce RTP files
• Developed file organization scheme for these analyses
• Probably pre-process at JPL to produce RTP files with clear FOVS (need ECMWF files at TLSFC soon to test).
Radiance Covariance Analysis

- Determine if observed channel correlations match computed correlations
- Didn’t add noise to computed correlations for present simulation (reduced agreement between obs and calc correlation)
- Use to identify significant outliers
- If matchup files are available, can generate about 1 correlation matrix/day with kCARTA, assuming ~ 500-1000 clear FOVS over ocean/night.
- Limited utility for water channels using model data
- Assume others will work on this once fast model at correct frequencies is available.
- Software pretty much complete. Difficult to test with present simulations.
Obs vs Computed Correlations for $\nu=739 \text{ cm}^{-1}$
Spectral Calibration (before correct RTA available)

- Verify L1b provided frequency calibration set; (V2.2.0 didn’t have L1b-determined frequency data, correct?)

- Provide UMBC with AIRS frequency calibration during Launch+2 to launch+3 for kCARTA radiance calculations.

- Two approaches:
  - Single granule: generate mean clear B(T), mean profile from ECMWF
  - Single profile: single clear B(T), ECMWF closest profile

- Generate mean obs-calc B(T) curves for each module for a range of SRF offsets and find the minimum per array. Need to fine tune if need more than a single offset/array.

- Most of the time taken in running kCARTA (once) - 15 minutes.

- As expected, using mean profile is more accurate.

- Software needs about 1-2 weeks to be “turn-key” at UMBC, plus some documentation
Results of Frequency Fit per Module

7 Random Profiles from Synop/MU

10 Granule Stats, Using Mean Profile
Verify SRF’s in Orbit Same as in RTA: SRF Width

- Very difficult since uncertain temperature and water can mimic errors in SRF width.
- Requirement varies considerably with channel, nominally 1-5%
- Need to look at calibration data when AMA was de-focused.
  - What is relationship of SRF width to de-focus?
  - Can that relationship be determined from plate scale factor?
  - Has someone done this??
  - Low priority?
- During early validation, tests suggest that N₂O spectral region best suited for this test
- Sensitivity is quite low, chance of occurrence low as well
- Used synoptic matchup-files (cleared) for analysis
- Software specialized since must change SRF width, low priority test that Scott Hannon can perform if needed.
SRF Width Sensitivity

Label Error: should be kCARTA: +5% SRF Width

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SRF Width Sensitivity #2

Obs – Calc (+5% SRF)
Sensitivity
Sarta Error
Obs – Calc (+10% N2O, +5% SRF)
Obs – Calc (+10% N2O)
Verify the N\textsubscript{2}O Abundance is Correct

- Need to check abundances used for several RTA gases, but N\textsubscript{2}O main interference gas in retrieval channels

- Used synoptic matchup-files with kCARTA to evaluate ability to detect incorrect N\textsubscript{2}O column amount

- Lower troposphere variation maybe $\sim$1\%, stratospheric much higher, but AIRS insensitive to N\textsubscript{2}O there. Variability probably only a concern near 2200 cm\textsuperscript{-1}.

- Detection near 1\% possible?

- Software almost ready, needs documentation
Sensitivity to N$_2$O

Δ B(T) for Δ N$_2$O = 10%
Retrieval of N$_2$O
(Both curves are biases using the synoptic matchup files and ECMWF profiles)

![Graph showing retrieval of N$_2$O with two curves: Correct N$_2$O and +10% N$_2$O. The graph plots wavenumber (cm$^{-1}$) on the x-axis and ΔB(T) in K on the y-axis. The correct N$_2$O curve is blue, and the +10% N$_2$O curve is red. The graph highlights the spectral features of N$_2$O absorption bands.]
Evaluate Biases using ECMWF: kCARTA and SARTA

- Can do 1000+ profiles/day with kCARTA, sufficient for clear/night/ocean synoptic matchup
- Single granules might have up to 400 ECMWF grid points, could process several granules/day with kCARTA, more with subsetting
- Note: only used center FOV of matchup golfballs, picked warmest FOV
- Software in good shape, SARTA almost automated, kCARTA needs work on distributing to processor farm

Synoptic Matchup Locations
Synoptic Bias/Std Night/Ocean

Shortwave window STD about 0.1K larger than noise

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Synoptic Bias/Std Night/Ocean, Subsetted

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Synoptic Bias with Scan Angle

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Low Temperature Radiometry Verification using AMSU Channels

- No progress
- Need to make sure we are running microwave forward model properly with RTP
- Hope to work jointly with MIT on this
- Need to work out schedule
Fast Model Stats Using Independent Data Set (from TIGR)

B(T) in K

\[ B(T) \text{ in K} \]

\[ -0.1 \quad 0 \quad 0.1 \]

\[ \Delta B(T) \text{ in K} \]

TIGR Mean

Bias

Std

\[ \Delta B(T) \text{ in K} \]

220 240 260 280

800 1000 1200 1400 1600 1800 2000 2200 2400 2600

0 0.1 0.2 0.3

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Fast Model Stats Using Synoptic Matchups

- Since we ran kCARTA for the synoptic matchups, we can compare to SARTA calcs.

- Helped us ensure that kCARTA and SARTA were treating all RTP fields consistently (they weren’t at first)

- Uncovered issues with cld = 0 flag, default behavior if satellite height not set, solar zenith angle definitions, and SRF convolution issues (later).
kCARTA - SARTA Bias for Synoptic Matchups

Large ozone errors examined, histogram implies true bias error
Histogram of kCARTA - SARTA Bias Errors, All channels/FOVS

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SRF Accuracy Issue

- Based on estimated accuracy of measured SRF’s, our convolution routines cut off the SRF at $10^{-4}$ of SRF peak value.

- Estimates made using US Standard profile?

- Higher lapse rate profiles might need higher accuracy for a few channels in the $2380 \text{ cm}^{-1}$ region

- We will re-visit SRF accuracy for these channels, which are mostly high altitude temperature sounding channels.

- Example of highly correlated forward model errors

- May have to avoid some of the coldest channels in this region
B(T) Differences for 10-4 vs 10-5 SRF Cut-Off

![Graph showing B(T) differences]
Monochromatic Radiance vs SRF Shape

![Graph showing monochromatic radiance vs SRF shape](image-url)
Lessons Learned/To Do

- Had several incompatibilities between kCARTA and SARTA, now fixed
- Probably will save level profile in RTP so kCARTA can add gases
- Will always need special codes to supplement profiles. klayers will only do simple adjustments using US standard atmosphere, etc.
- Use ECMWF to supplement profile until AIRS retrievals are available for high-altitude T/water.
- Probably will produce clear FOV RTP files at JPL to reduce data transfer.
- Re-visit sea surface emissivity (wider wavelength range)
- Install surface emissivity model (CERES?)
- Can we get a good emissivity*B(T_s) product before retrievals are fully operational?
- Big item for us: Improved water spectroscopy in latest HITRAN. Need to re-do kCARTA tables and forward model.
- Need to practice generation of new forward model anyway.