Radiative Transfer Algorithm Updates

AIRS Virtual Science Team Meeting

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Introduction

- Current and upcoming set of SARTA builds
- Possible future improvements
- Minor fitting improvements
- RTA/HITRAN intercomparisons and tuning issues

Current Spectroscopy

- HITRAN 2016
- CO2, CH4 line mixing from LBLRTM12.8
- MT CKD3.2
- CO2 CIA from WV and N2 by Hartmann (4.3 um)
- Single parameter surface emissivity.
- Used in IASI, AIRS L1c, and CHIRP RTAs.

Current SARTAs at ASL

- The following SARTAs are in use at ASL: Dates are release dates.
  - AIRS L1B (2008): Used in AIRS V6, V7 Level 2
  - AIRS L1C (2019): Possible use by Bill Irion, CLIMCAPS
  - CrIS NSR v2012, & v2016
  - CrIS FSR v2016
  - IASI v2008 and v2016
  - CHIRP v2020

Future Improvements/Activities

- HITRAN 2020, should be out this year.
- Line Mixing package from the HITRAN (Iouli Gordon, Harvard-Smithsonia).
- Currently use kCARTA at 0.0025 cm-1 steps, can move to 0.0005 cm-1 step in 15 μm m region
- Interpolation improvements in kCARTA
- Nalli surface emissivity parameterization? Under study.
- Improved non-LTE, the extreme solar angles. Not yet started.
- RTA tuning in collabortion with Chris Barnet and Bill Irion (more later in talk)
- Hope to perform major re-validation on new RTAs using HITRAN 2020, probably last time...

Validation: Fitting Accuracy

- Fast coefficients are checked by comparing top-of-atmosphere (TOA) radiances predicted by SARTA and kCARTA.

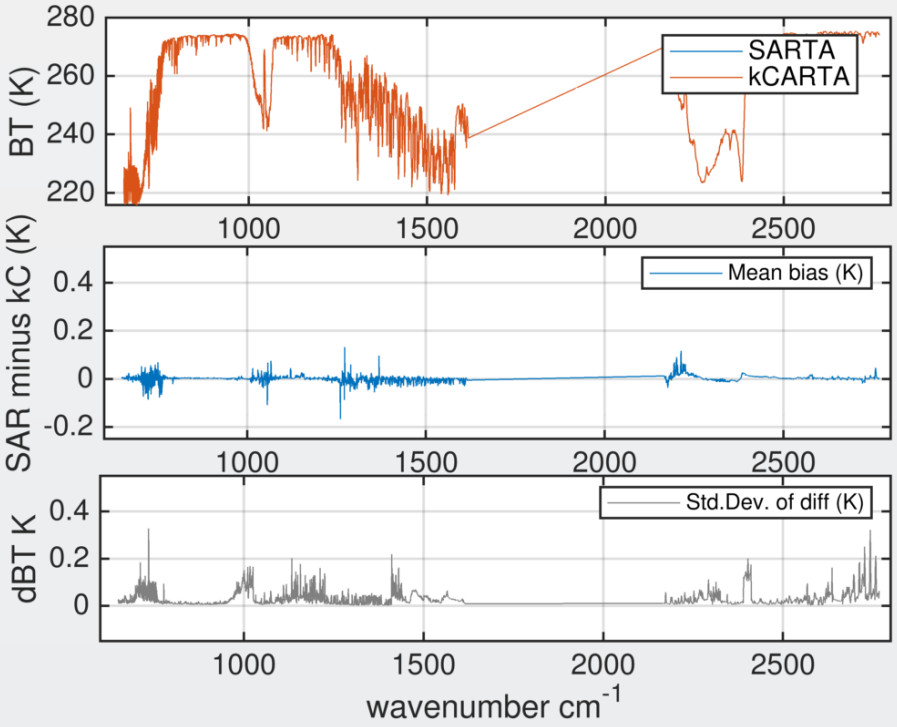

Figure 1: AIRS bias relative to kCARTA.

Improved bias & std.dev relative to kCARTA

- kCARTA monochromatic layer-so-space optical depths are convolved to the sensor grid.
- For AIRS (and any spectrometer) convolution with the spectral response functions (SRF) is well behaved. Transmittance approaches zero for opaque channels.
- For interferometers (IASI, CrIS, CHIRP) convolution with the instrument line shape (ILS) produces tau that goes -ve and +ve into the opaque region.
- Regression of the fast coefficients is controlled down to a minimum transmittance which is set by inspection of these 'wings'.
- Sarta builds for IASI, CrIS version 2019 and CHIRP 2020 included some fits in strong (CO2) bands that were not optimal. (See next slides).

Example of optimization: CHIRP 640 cm-1

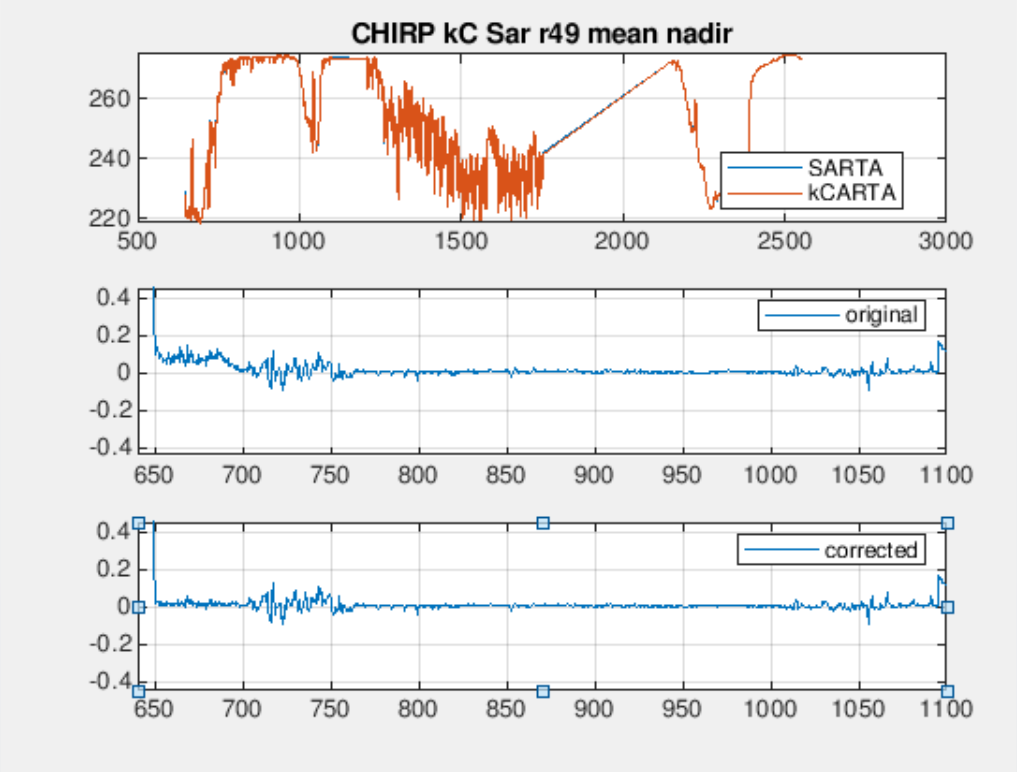

Figure 2: CHIRP SARTA bias compared to kCARTA, with and without improved regression.

Example of optimization: IASI $2300 cm^{-1}$

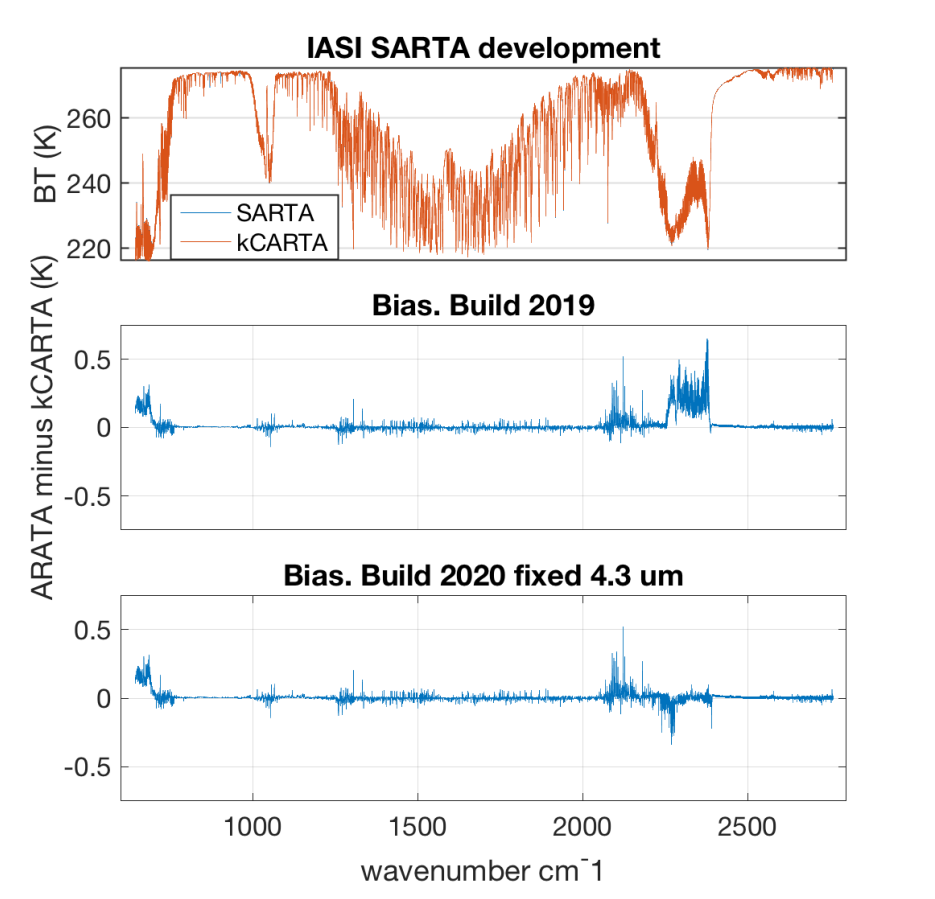

Figure 3: IASI SARTA bias compared to kCARTA, with and without improved regression at 4.3 um.

Tuning

Retrieval and NWP assimilation require Obs - Fit bias removal, via "tuning" Bias can occur because of:

- AIRS radiometric calibration.
- AIRS spectral calibration and instrument line shape.
- AIRS fast model parameterization.
- Spectroscopy (including continuum and lineshape)
- Cloud contamination in fields of view selected as clear
- Validation data, including time/space mismatches and uncertainties in minor gas abundances.

Two approaches: (a) Tune the spectroscopy (optical depths), (b) Tune the (Obs - Calc) B(T)'s.

Tuning: Case study

- Selection of June 25 talk

Conclusions

- RTA (kCARTA and SARTA) development and maintenance continues at UMBC/JCET.
- SARTA for AIRS, CrIS (NSR FSR), IASI and CHIRP have been or are being developed, tested and verified.
- CHIRP SARTA is in progress.
- Tuning for builds from 2019 are either partial or pending.