Status of Forward Algorithm

and

AIRS-RTA/AIRS-Ref-RTA

L. Larrabee Strow
Scott E. Hannon
Sergio De Souza-Machado
Howard E. Motteler

Department of Physics
University of Maryland Baltimore County (UMBC)
Baltimore, MD 21250

AIRS-RTA Deliveries

- JPL now has 3 RTA coefficient sets. Sets separated by $\approx$ 16% of a SRF width, so max interpolation is $\approx$ 8% of a SRF width.
- We plan to compute a new set of RTA coefficients once the AIRS spectral calibration settles. We can do this in about 2 weeks.
- The Standalone AIRS Radiative Transfer Algorithm (SARTA) is just a way to run the AIRS fast model without being in the PGE environment. SARTA will be used to test updates to the AIRS-RTA. SARTA will be delivered to JPL in the next few weeks.
- The AIRS Reference Radiative Transfer Algorithm (AIRS-Ref-RTA) is effectively a line-by-line RTA (kCARTA) that also performs convolutions with the AIRS SRFs. We can deliver this code in maybe 2 months.

Delivery Schedule for SRFs and AIRS-RTA

Date	Version	Comments
August 2000	FM V 5.0a	At launch frequencies, no fringes
November 2000	SRFs V1.0	At launch frequencies, no fringes
January 2001	FM V 5.0 b,c	2 more V 5.0 models for 3x finer grid
Launch + 3m	SRFs V2.0	Correct frequencies, fringes?
Launch + 4m	FM V 6.0	Correct frequencies, fringes?
Launch + 7m	SRFs V3.0	If required.
Launch + 8m	FM V 7.0	"Final" frequencies, fringes, improved parameterization and spectroscopy
Launch + 8m + 1yr	FM V 8.0	Con't improvements from V 7.0, plus any req'd variable gases

- Generally SRFs will be available 1 month before a new fast model is delivered to JPL
- The convolved layer-to-space transmittances (on the 100 AIRS layers) will be available, for our gas breakdowns, near the time period when a new FM is delivered to JPL.
- Delivery times assume special validation period starts by Launch + 2 months, which is unlikely.

SARTA and the RTP Data Format

- We need a data format to hold validation profiles and observed, calculated radiances
- Howard Motteler has developed the RTP format (Radiance Temperature Profile) in HDF4. Can store thousands of profiles/radiances in one file. Simple FORTRAN, Matlab interfaces are available.
- SARTA is actually a combination of our layering program (klayers) and the fast RTA.
- Interface of RTP to SARTA nearly finished. Data flow is:
  1. Produce RTP-level file with level quantities from matchups, NWP model data, etc. (Must include sufficient coverage of profile, klayers does not fill in missing values accurately.)
  2. klayers reads the RTP-level file and outputs a RTP-layer file on the AIRS 100 layers. (Could supply RTP-layers directly.)
  3. SARTA reads this RTP-layers file and outputs either the relevant RTP-layer/level file that also contains computed (and observed) radiances.

AIRS-Ref-RTA

- The AIRS-Ref-RTA is more accurate than the AIRS-RTA/SARTA, no parameterization errors, but takes 30-60 minutes to compute an AIRS radiance spectrum.
- AIRS-Ref-RTA can handle variable: gas concentrations, layering, SRF shapes, SRF centroids.
- Changes to spectroscopy in the AIRS-Ref-RTA handled by UMBC supplying updated look-up tables for the compressed transmittances.
- Interface of RTP to kCARTA just starting.
- During next 2 months will build convolution package for kCARTA.
- When done, kCARTA + convolution package becomes AIRS-Ref-RTA. NOTE: AIRS-Ref-RTA will only read and write RTP files, so it's only output is a radiance.
- Our in-house version of kCARTA can vary water continuum easily, and can also do simple small particle scattering.

Supplementing MatchUp Profile Information

- Sea surface emissivity model (Masuda looks OK).
- Land surface emissivity model. Looking into CERES approach, also implemented by T. Kleespies at NOAA/NESDIS. Possible input is the weekly NDVI product. Eventually use retrieved emissivities as well.
- Upper tropospheric water. Looking at quality/variability of ECMWF climatology (12,000 profiles). Not sure if these profiles contain assimilated HIRS channel 12. MLS climatologies available?
- Initially we should not modify profiles too much, and instead determine expected errors as a function of channel and refer to these errors in any analysis of radiance residuals.
- Potential validation sites (Mauna Loa) may help with UTH.
- Minor gas abundances. This will be one of the first things UMBC looks at once AIRS is stable; can we use constant gas amounts? We know that even CO_2 is a problem.

Assimilation and the AIRS-RTA

- We have delivered convolved layer-to-space transmittance sets to UK Met. Office and to L. McMillan. This set only contains fixed gases and variable water and ozone. Not optimal, but follows methods used now for TOVS RTA.
- Helping NEDIS/NCEP (L. McMillan) run kCARTA so they can develop better forward models that are usable by NCEP for radiance assimilation. AIRS SRF's also available (web page) for nominal channel set.
- Canadian Meteorological Service (DORVAL) have potentially agreed to monitor AIRS radiance bias, std. dev. using SARTA. They are now working on integration of SARTA into their system. I believe this is the only NWP group that will use the AIRS Science Team forward model for radiance monitoring.
- Haven't heard from the DAO.
- Still uncertain if UMBC will be supplying ECMWF with the required layer-to-space convolved transmittance or if they are going to use their own spectroscopy. Our CO_2 channel transmittance are quite different (1-5 K) than other codes.
- UMBC plans to monitor AIRS radiances using the ECMWF model (and maybe NCEP's as well). Practiced this during the last simulation.

Validation of AIRS*RTAs

- We need bias and variance for *most* channels, for a variety of conditions.
- Examination of the radiance residuals for the almost continuous spectra produced by AIRS will be essential for differentiating between instrument, parameterization, and spectroscopy errors.
- UMBC will initially concentrate on special validation sites
- ECMWF model data will also be used to monitor radiance biases and variances for a wider range of profiles. Note: ECMWF is not planning to do AIRS monitoring with the AIRS RTA, plus they only plan on ingesting a small subset of channels.
- As UMBC develops new AIRS-RTAs we will need to re-do bias/variance calculations, so must save both model data and AIRS radiances. Estimate that we need data for a 1-2 month time period to observe enough clear FOVs for accurate statistics. (Later use Level 2 cloud-cleared radiances for monitoring.)
- I believe we are going to be re-doing clear flags a lot after launch. Might be easier to run pre-Level 2 clear "indicator" software at UMBC once L1b product is stable and can be downloaded.
- Can NOAA/NESDIS (Mitch) or JPL supply 1-2 months of complete L1b data? Simulation: only 185 "clear" spots per day!

Forward Models Used for AIRS Research

Our interest: validation and improvement of AIRS-RTA

Organization	Spectroscopy	Parameterization
AIRS Project	kCARTA	AIRS-RTA
*DAO	kCARTA (via NCEP?)	"Optran (via NCEP?)"
NCEP	kCARTA?	"Optran"
ECMWF	GENLN2	RT-TOVS/IASI-A?
UKMO	kCARTA?	RT-TOVS/IASI-B?

* Only for radiance assimilation? AIRS-RTA for retrieval assimilation.

Software Development Questions

- Should SARTA/AIRS-RTA be optimized for vector processing environments. Presently it is *not* optimized.
- Will NWP centers run into trouble with variable gas concentrations that are not in their forward models (CO_2, CH_4, CO)?
- Do we (UMBC) need to develop variable N_2O in the RTA?
- Should the AIRS-RTA tangent linear model and adjoint be produced? Can't really do a proper job without "user" specifications .
- How important is it for UMBC to make sure we can supply various NWP users with layer-to-space transmittance data for their own fast model development?