Development of an OSS version of the CRTM (CRTM-OSS)

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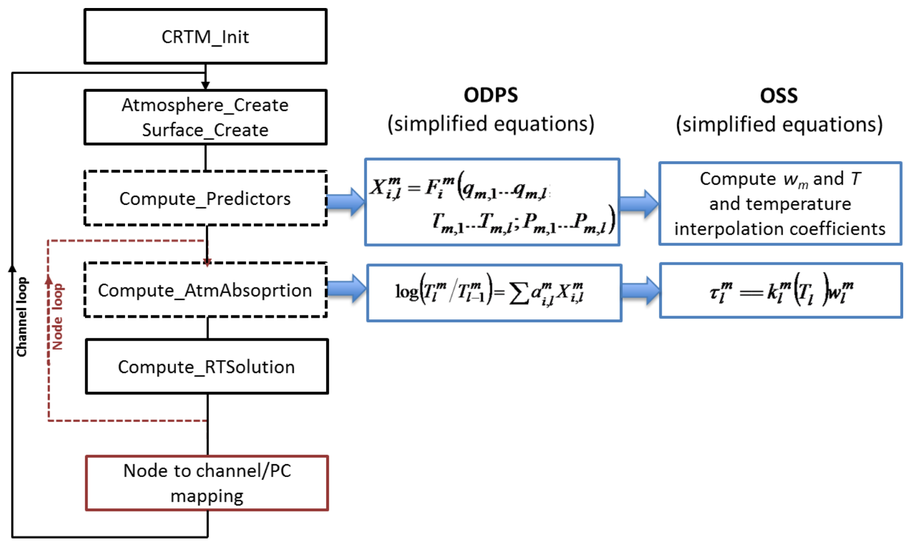
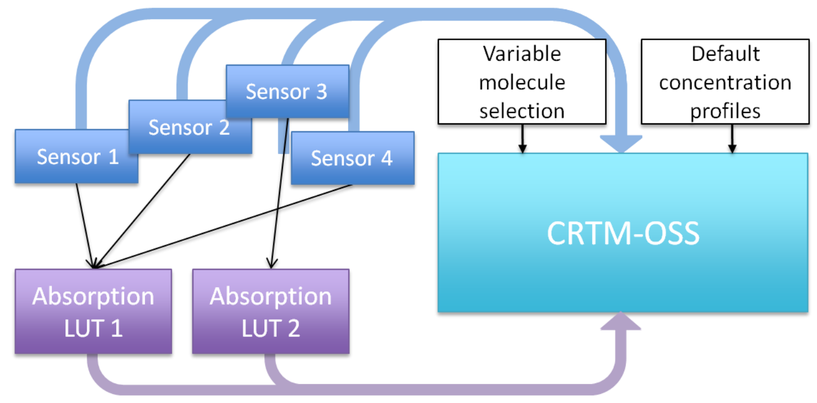
Background

- Current CRTM built around ODAS/ODPS (similar to OPTRAN/RTTOV) channel transmittance parameterizations
- OSS models observations as weighted sum of monochromatic radiances (Moncet et al. 2008) at selected frequencies (nodes)
  - Model requires node loop within channels loop
  - Important differences in the way atmospheric parameters are used (tau-predictors as opposed to amount computation in OSS)
- For maximum computational efficiency it was decided not to merge the capabilities into a single model but build separate version



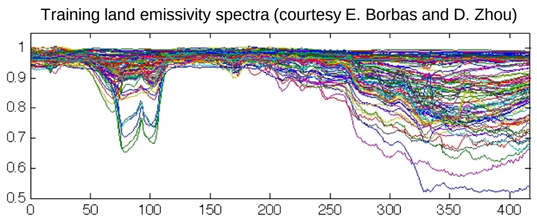
- **Sensor file:** node-to-channel (or PC) mapping information and weights
- **Absorption look-up table size may reach up to 85 Mbytes for 3 variable molecules (185 for 20 species) in 640 to 2780cm-1 range (full IASI spectrum)**
- **Reduced to 13 and 6 Mbytes with global training for 20 and 3 species, respectively**
- **Fix/variable species partitioning selectable at run time**



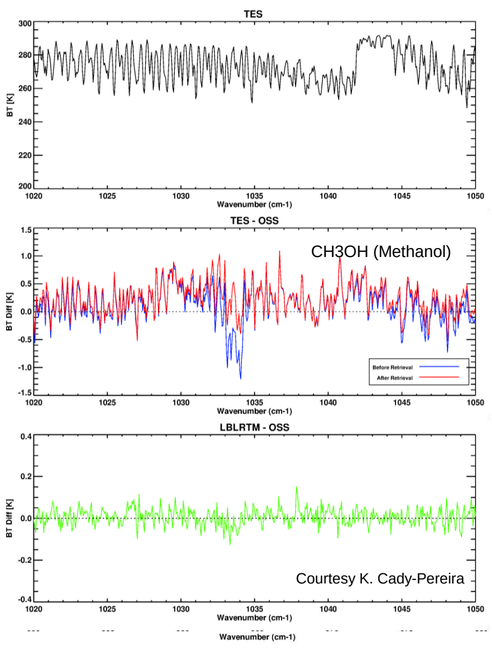
OSS vs. LBLRTM (reference)

- OSS trained to meet specified accuracy in clear and cloudy conditions for each emissivity sample
- Same training approach applicable to apodized, non-apodized ILS or PC
- Global training reduces number of nodes (forward model monochromatic loop execution and LUT size) by an order of magnitude

Training land emissivity spectra (courtesy E. Borbas and D. Zhou)



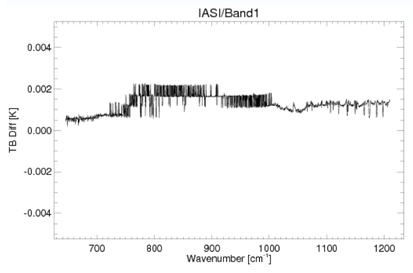
- **Numerical errors small compared to spectroscopic errors**
- **Robust**
- **Adding new variable species done through training (no change in CRTM code)**
  - Information contained in OSS look up tables
- **For current TES application: handles up to 20 variable species**
  - number of retained variable species selected at run time for each application
- **Not necessarily for retrieval but could be used for bias adjustment**



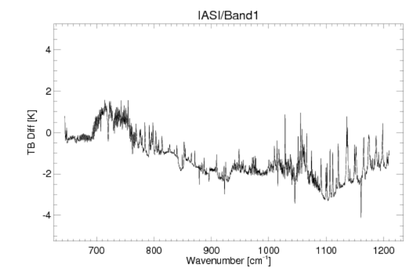
CRTM-OSS testing

D_{eff} rms error (MODIS)

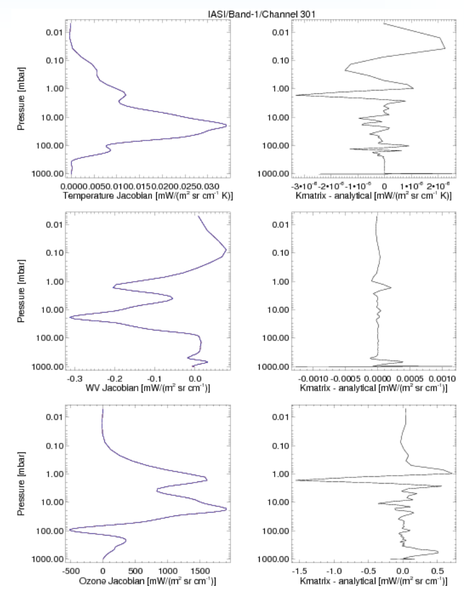
CRTM-OSS vs. Standalone OSS model



CRTM vs. Standalone OSS model

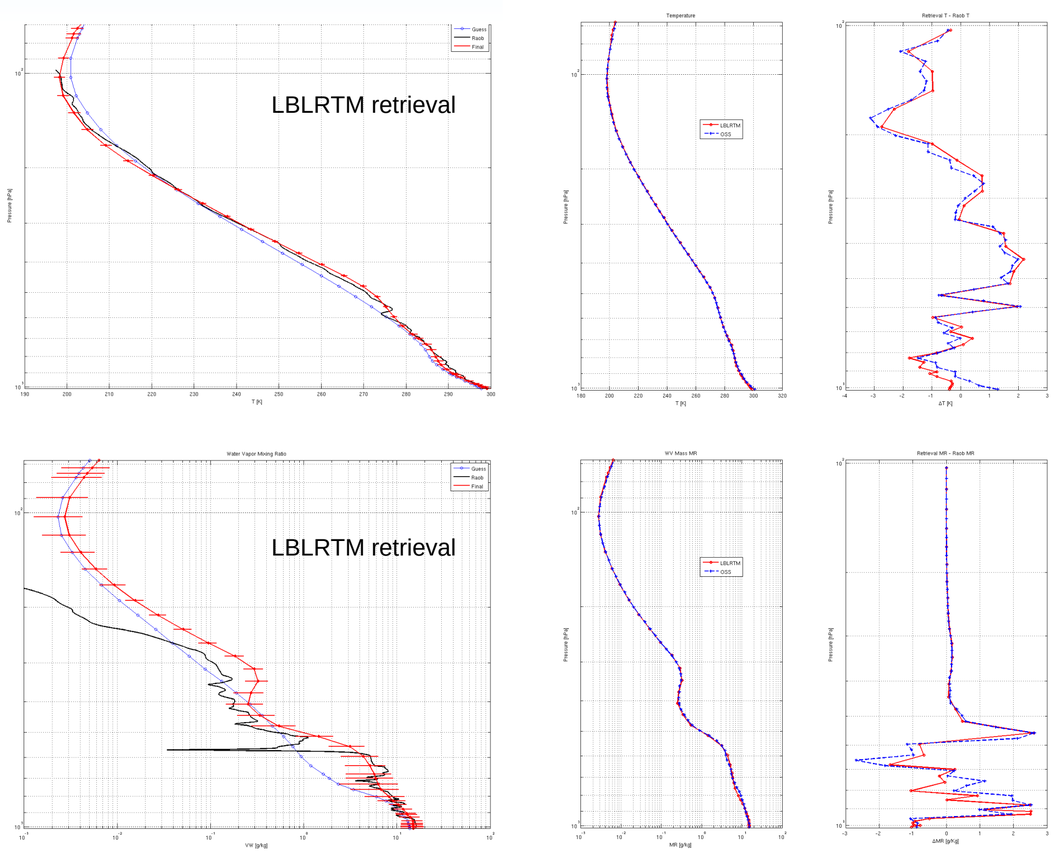


CRTM-OSS vs. Standalone OSS model (Jacobian testing)



Example of retrieval from airborne unapodized S-HIS observations

(Courtesy of Paolo Antonelli – U. Wisc.)



CRTM-OSS vs. CRTM Timing Comparisons (IASI Band 1 - 2260 channels - clear sky)

Clear-sky results (channel space):

1) Localized training: 1998 nodes (~1node/channel)

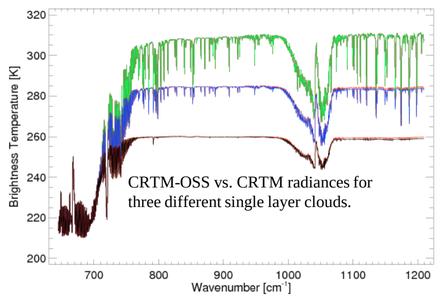
	AER Stand alone OSS	CRTM-OSS	CRTM
Radiance calculations	0.050	0.051	0.090
Tangent linear	NA	0.077	0.142
Adjoint	NA	0.076	0.141
Radiance calculations + Jacobians	0.115	0.145	0.260

2) Global training: 137 nodes (acceleration ~14)

Fwd Model	TL	AD	K-Matrix**
0.004	0.006	0.005	0.120

** K-matrix includes expensive loop for mapping Jacobians from node to channel space (uses ~90% of computation time). Faster in PC space. Not invoked if working in node space.

Scattering atmosphere (single cloud layer, 4 streams) – channel space:



	CRTM-OSS		CRTM
	Local	Global	
Forward	0.65	0.05	0.7
K-Matrix	1.66	0.3	1.7

CRTM-OSS capabilities

- **Modes:**
  - Channel radiances
  - PCs (from OSS or PCRTM)
  - Monochromatic node radiances (for node-based representation of incoming observations)
- **Multiple sensor capability**
- **Applicability: clear and cloudy conditions over ocean and land**

Summary and Future Work

- CRTM-OSS delivered to JCSDA for testing and evaluation of NL, TL, AD and K-Matrix codes
- Supports channel, PC and node-based modeling
- Compares favorably to ODPS/ODAS version both timing wise and in terms of accuracy
- OSS testing:
  - TES
  - Independently tested at U. Wisconsin (part of UWPHYSRET package) and EUMETSAT (acquisition process started for generation of MTG Level 2 product)
- Future work:
  - Complete MW capability
  - Port to CRTM V2.1
  - Incorporate “scattering accelerator”