NESDIS DSUP Projects

Planned UFS Contributions

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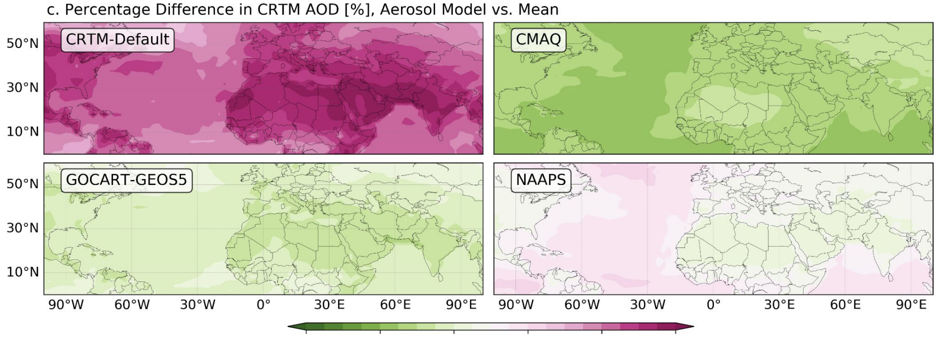
Components of NESDIS DSUP Projects
Relevant to UFS-R2O (Overview and CRTM AOD)

Project/subtask	Outcome
FY18: Contributions to JEDI development	
Improvements to CRTM for aerosol and short-wave (IR)	More flexible/accurate AOD calculation
FY19: Increasing satellite data use and impacts leveraging AI	
Satellite products for fire and smoke forecasting	Enhanced fire emissions, AOD, and NOx products
Intelligent data selection and QC	Improve impact of satellite observations in NWP
AI-based radiative transfer model	Improve speed and accuracy of radiance forward operator
Ultra-high resolution scatterometer winds in TC regions	Assimilated high res scatterometer winds in MRW/HWRF/HAFS
3D-winds from GOES AGI imagery	Assimilated 3D winds in HWRF/HAFS

Improvements to CRTM for aerosol and shortwave IR

- Motivation: Assimilation of aerosol observations in UFS air quality applications (MRW/global, RRFS)
- Objective: Improve CRTM AOD calculation for current/future IR imagers and polarimeters
  - Extend support of CRTM aerosol to CMAQ and other chemistry models (done) and optimize mapping of species to optical properties (in progress) (RL 4)
  - Improve/diversify aerosol optical properties (in progress) (RL 3)
  - Implement a generic/flexible CRTM interface for aerosol optical properties (partially completed) (RL 5)
- Iterative approach needed to assess CRTM AOD performance and impact working closely with UFS community on implementation



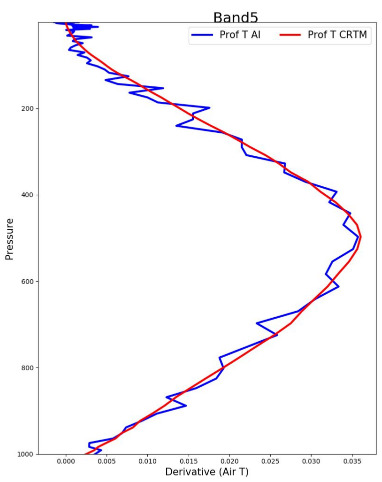
Comparison of CRTM AOD calculations for various chemistry models versus the mean AOD of the models (courtesy D. Cheng, JCSDA)

Components of NESDIS DSUP Projects
Relevant to UFS-R2O (FCDN-CRTM)

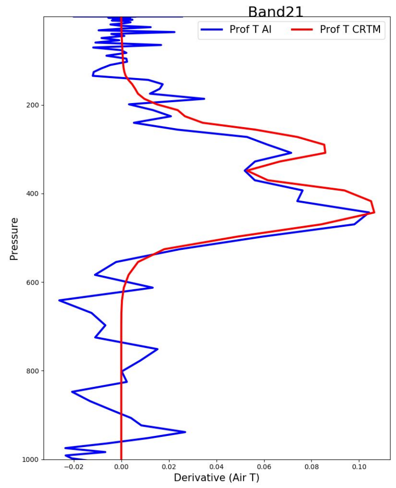
Develop AI-based Radiative Transfer Model

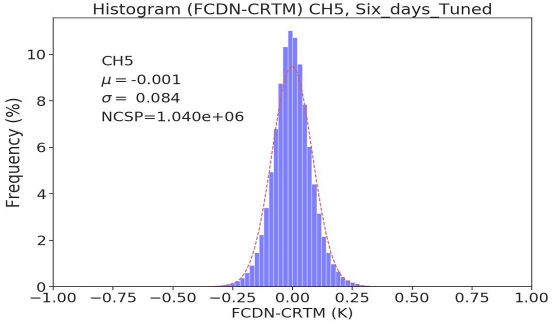
- Motivation: Improve the assimilation of all-sky satellite radiances through improved forward/TL/AD operator accuracy and efficiency
- Objective: Develop an AI-based radiative transfer model using machine learning architectures to simulate all-sky passive microwave radiances and Jacobians, matching or exceeding CRTM performance
  - Developed FCDN to emulate ATMS (RL 5).
  - Simulation performance is < ~0.1K for all channels (clear-sky, over ocean) compared to CRTM. Jacobians are mainly consistent with CRTM.
  - FCDN-CRTM reduces computational time for 1 day of ATMS data from 25m to 30s (no scattering)
- Current effort focusing on improving Jacobians, and extending to all-sky/all-surface, followed by testing in physical inversion (MiRS 1DVAR, global 4DEnVAR).
- Further effort will be required particularly for all-sky radiance assimilation due to complexity of model microphysics and consistency with model training data.

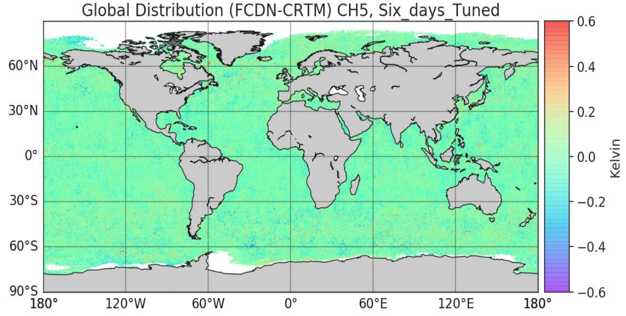
ATMS Ch. 5
Temperature Jac.



ATMS Ch. 21
Humidity Jac.







Left: Distribution and global map of ATMS channel 5 (52 GHz) FCDN-CRTM - CRTM for six days of ATMS simulation, and Top: FCDN-CRTM (blue) and CRTM (red) Jacobians for ATMS channel 5 (52 GHz) and channel 21 (183 GHz).