

JEDI-MPAS: facilitating research to operation for all-sky radiance data assimilation

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Model for Prediction Across Scales (MPAS)

Current release – Version 7.3 **March 2022**

Version 1.0, June 2013

- Atmosphere and land only
- Open Source: <https://mpas-dev.github.io/>
- Global and regional, variable-resolution capabilities
- Annual tutorials; new releases as needed
- GPU-enabled for some configurations (V6.1, October 2020)
- DA – both DART and JEDI

Last major release June 2019 (V7) - What have we been doing?

Physics unification – see *Fowler et al* talk today, *Wong et al* talk Thursday

Deep-atmosphere extensions – see *Klemp* talk tomorrow.

LES extensions – not quite ready for a talk

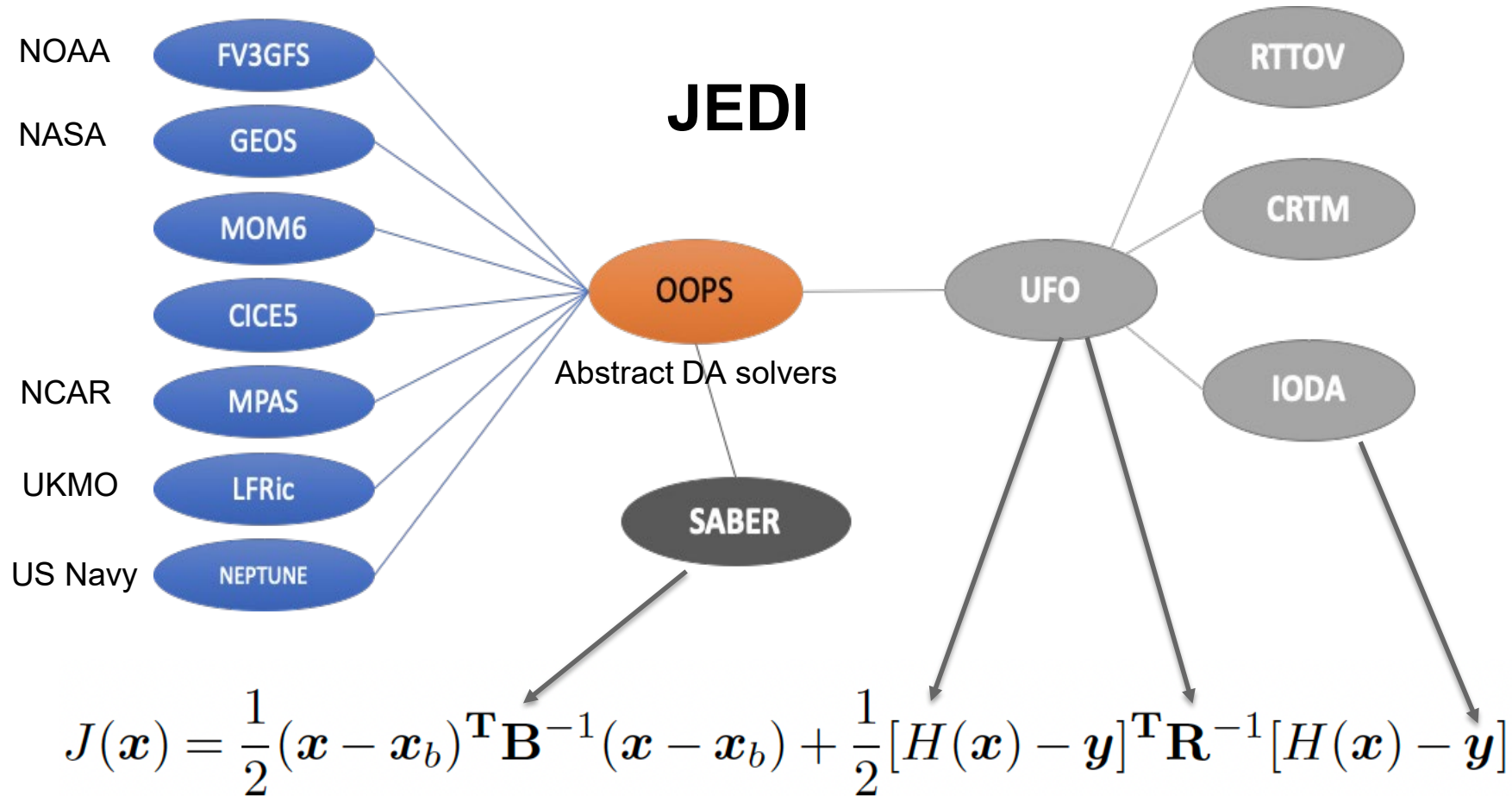
MPAS in an Earth System Model (ESM) – part of today's talk

GPU development – another part of today's talk

Many of these developments will become available in the coming year

Joint Effort for Data assimilation Integration (JEDI)

led by Joint Center for Satellite Data Assimilation (JCSDA)



JCSDA and all groups from its partner agencies contribute to JEDI's development

<https://www.jcsda.org/jedi-mpas>

Version	Download	Quick Start - Tutorials	Support	Date
1.0.0	Code	Build and Test JEDI-MPAS	Documentation	2021-09-24

[Release Notes](#)

[Simulating Observations with a JEDI-MPAS Application](#)

[Forums](#)

[Running the JEDI-MPAS Variational Application](#)

Model-agnostic components:
<https://github.com/JCSDA/oops>
<https://github.com/JCSDA/saber>
<https://github.com/JCSDA/ufo>
<https://github.com/JCSDA/ioda>

MPAS model and model-specific interfaces:
<https://github.com/JCSDA-internal/MPAS-Model>
<https://github.com/JCSDA/mpas-jedi>

Build mechanism based on cmake/ecbuild:
<https://github.com/JCSDA/mpas-bundle>

Liu Z et al., 2022: Data Assimilation for the Model for Prediction Across Scales - Atmosphere with the Joint Effort for Data assimilation Integration (JEDI-MPAS 1.0.0): EnVar implementation and evaluation, *Geosci. Model Dev.*, 15, 7859–7878.

Main Features in JEDI-MPAS

- Deterministic analysis: **3DVar**, **3D/4DEnVar**, and hybrid **-3D/4DEnVar**
- Ensemble analysis : Ensemble of EnVar (**EDA**), with perturbed observations or **LETKF** (under development, will be available in release 2.0)
- Analysis directly done on **MPAS unstructured grid** for uniform or **variable -resolution mesh**, **global** or **regional mesh** .
- Multivariate B model follows GSI/WRFDA, e.g., use variable transform from stream function and velocity potential to u/v wind components

All-sky radiance DA capability in JEDI-MPAS

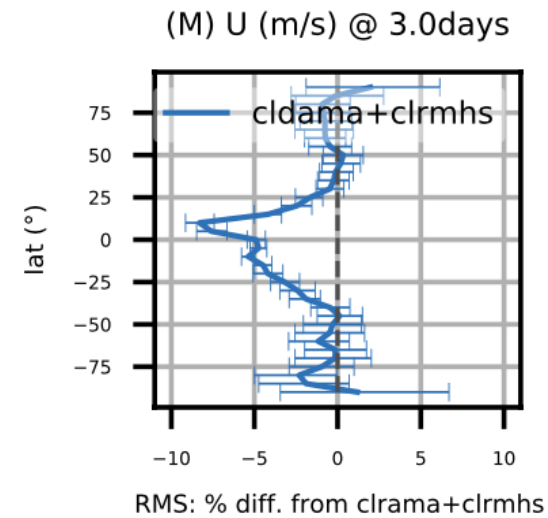
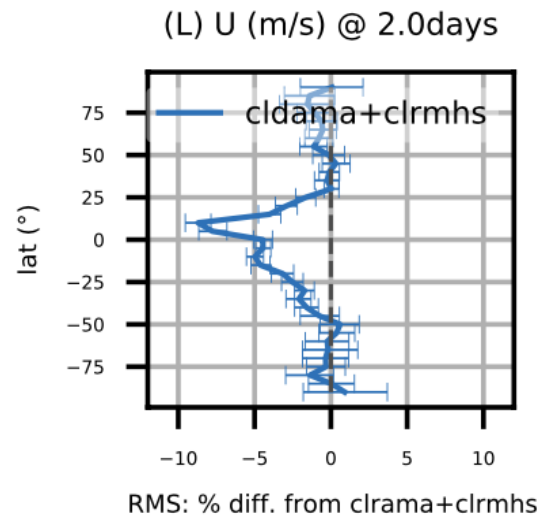
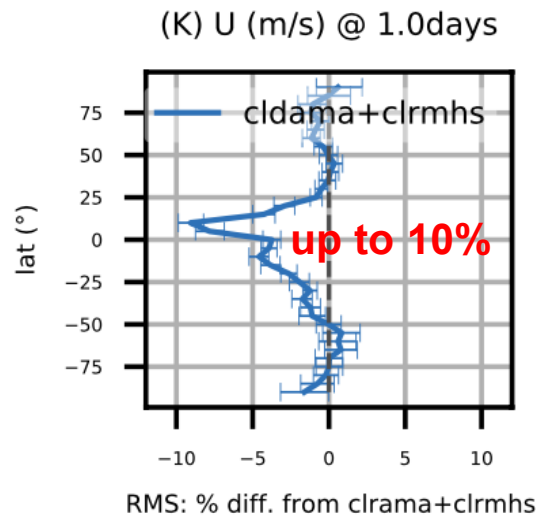
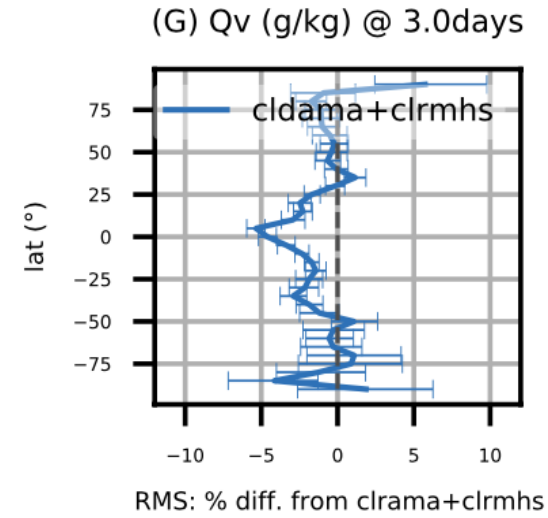
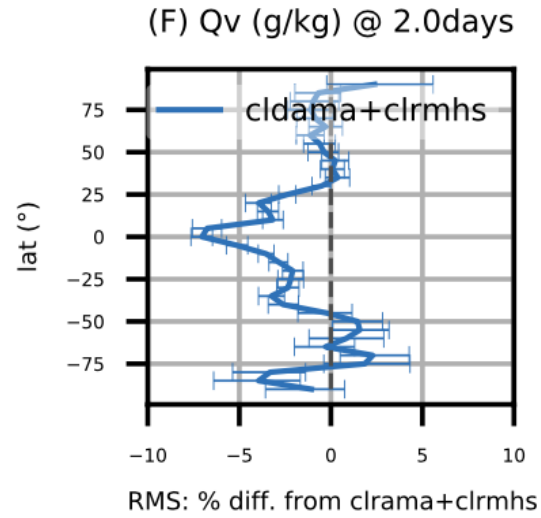
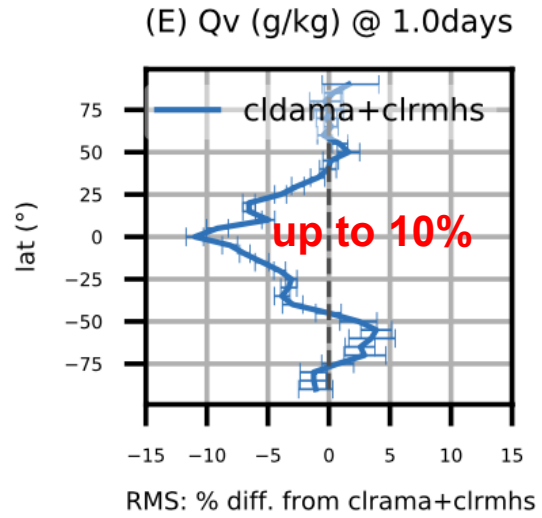
- UFO includes interface to both CRTM and RTTOV, and allows great flexibility of configurations for using either of two or even combination of two RTMs
- Mixing ratios of 5 hydrometeors (cloud water, cloud ice, rain, snow, graupel) as part of analysis variables
 - Currently two microphysics schemes (WSM6 and Thompson) available in MPAS, more to be added
- Evaluated all-sky DA impact for some of MW and IR sensors, using CRTM-v2.3 so far

A fully open-source model and DA system, a convenient R&D testbed for research community (usually have no access to operational NWP systems)

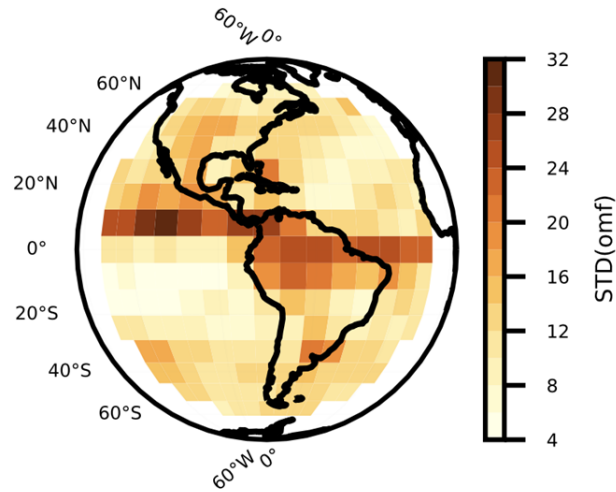
AMSU-A all-sky DA impact

- Two 6-hourly cycling experiments of 30km-60km dual-resolution **hybrid-3DEnVar**
 - **clrama+clrmhs** : non-radiance obs + 6 clear-sky AMSU-A (ch 5-9) + 4 clear-sky MHS (ch 3-5)
 - **cldama+clrmhs** : above + 5 all-sky window channel (ch 1-4, 15) AMSU-A over water
- One-month period from 15 April to 14 May, 2018.
- Configuration:
 - 75% weight in ensemble B and 25% weight in static B for non -cloud analysis variables
 - 100% weight on ensemble B for 5 cloud analysis variables
 - 1200km/6km localization scale in horizontal/vertical
 - **80-member** ensemble input from MPAS-JEDI's own EDA cycling at 60km mesh
 - Variational Bias Correction, CRTM-v2.3, situation-dependent obs error model

% RMSE change by adding AMSU -A window channels: verify against NCEP -GFS analyses

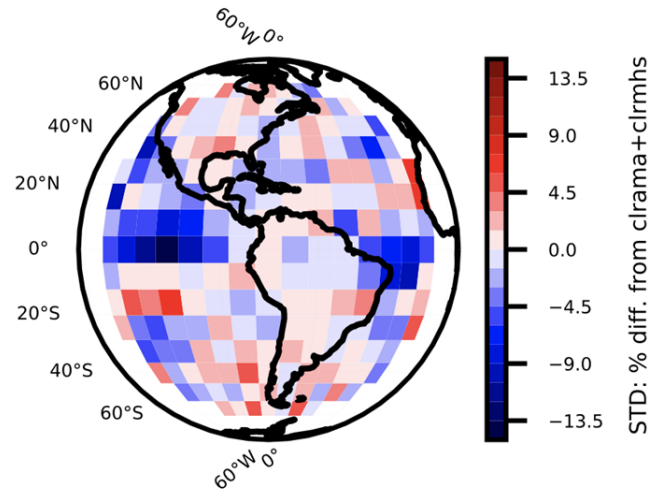


(g) clrama+clrmhs
BT13 (K)



ABI

(h) cldama+clrmhs
BT13 (K)

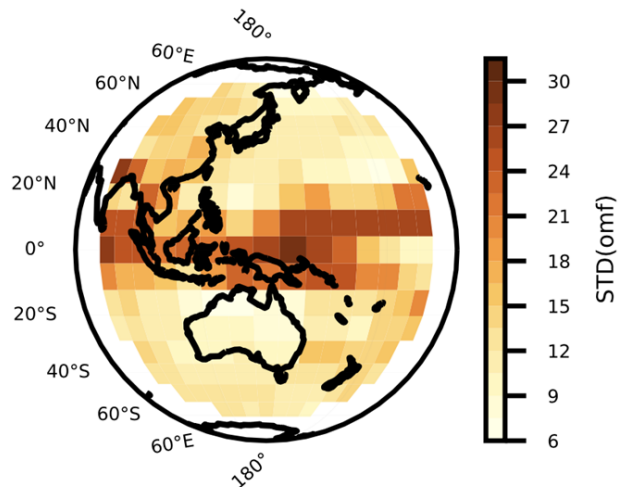


Impact of AMSU -A
window channels on
clouds in terms of
ABI/AHI ch13
radiances

Day-1 forecast

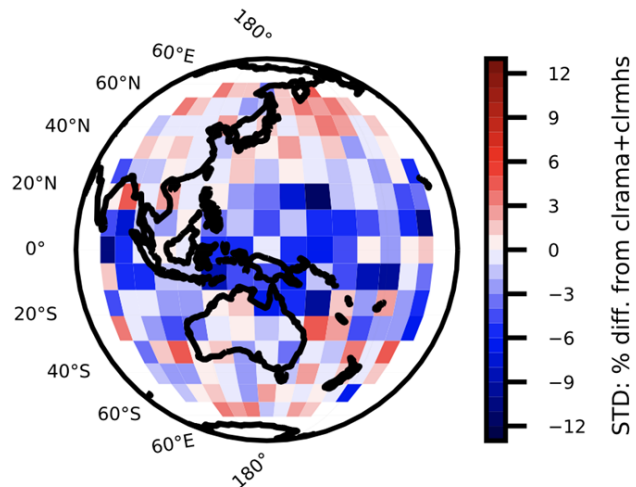
% STD reduction

(g) clrama+clrmhs
BT13 (K)



AHI

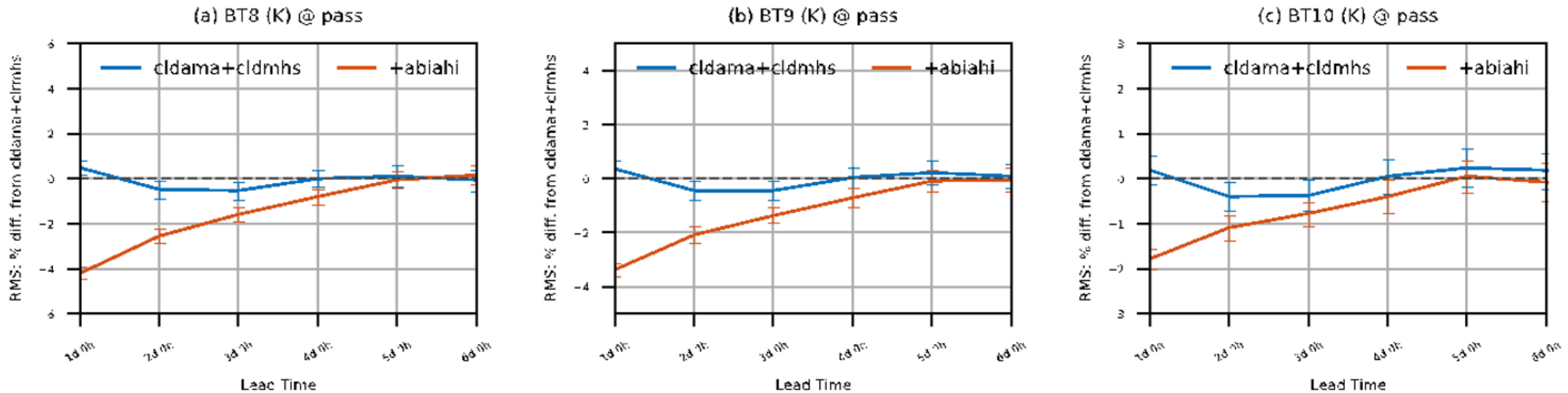
(h) cldama+clrmhs
BT13 (K)



Improvement concentrated in
tropical cloudy regions, with a
similar magnitude to Q and U
fields

What if we further add **all-sky ABI/AHI's** 3 WV channels or switch from clear-sky to **all-sky approach for MHS's** 3 WV channels?

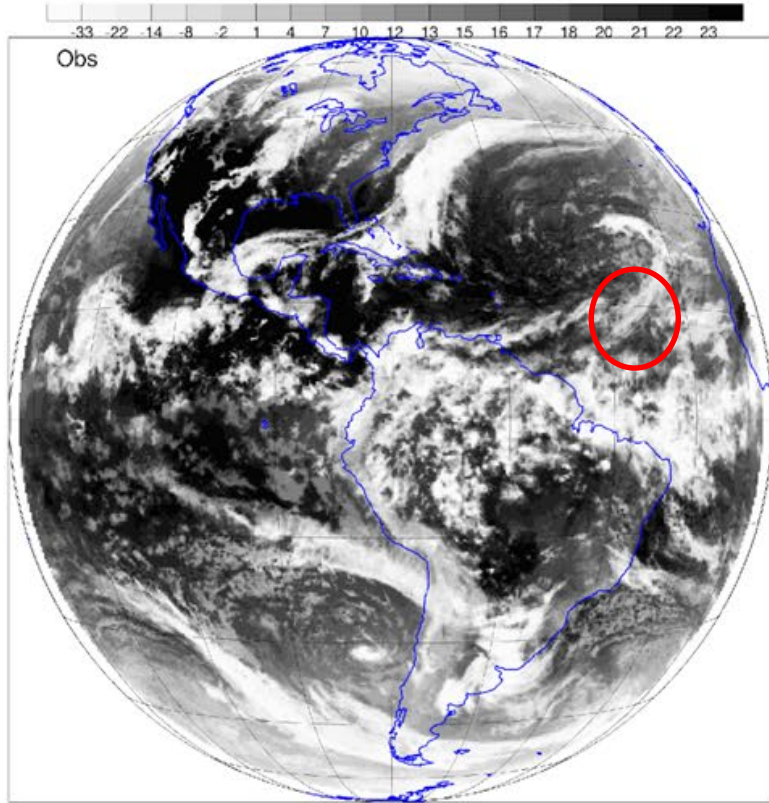
Verify against AHI 3 water vapor channels' radiances



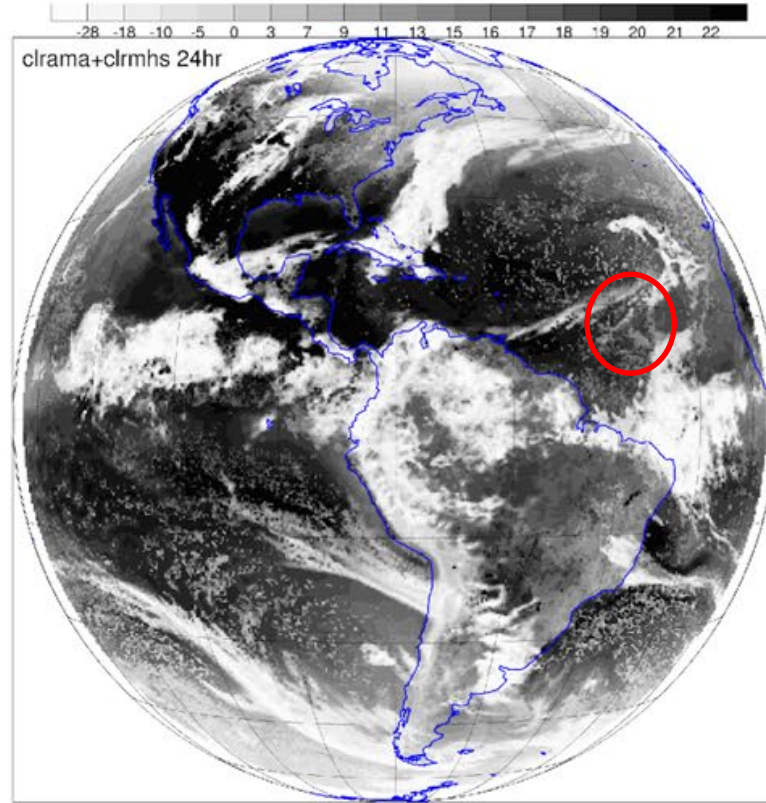
**Small impact from all-sky MHS is related to bad scattering LUT in CRTM-v2.3?
Will try updated LUT in CRTM-v2.4**

Observations vs. Day -1 forecast

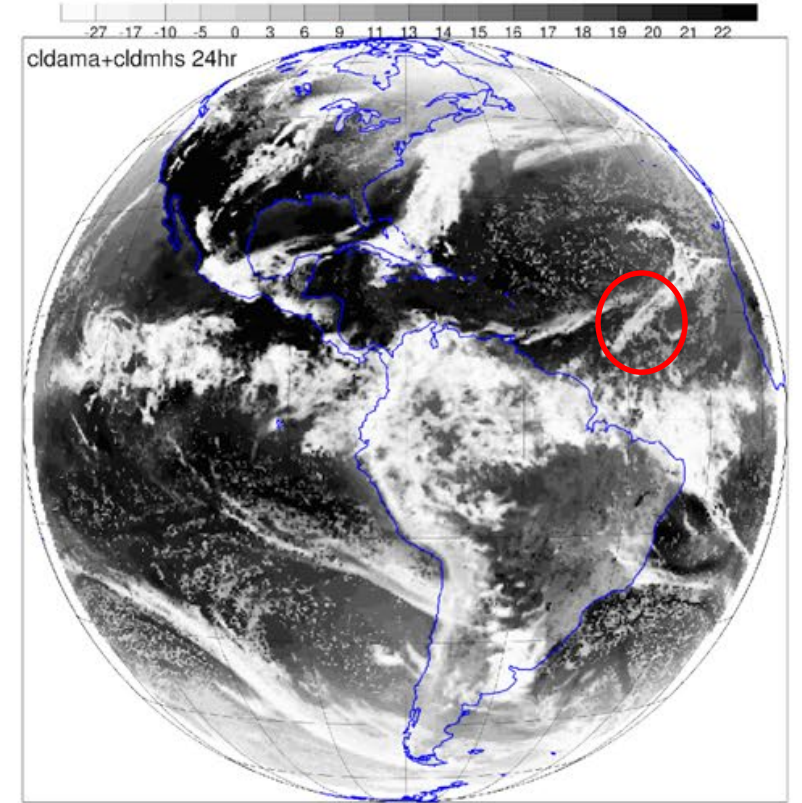
Observations



AMSUA+MHS clear-sky DA



AMSUA+MHS all-sky DA



ABI channel 13 BTs (degree C) valid at 00 UTC 9 May 2018

Concluding Remarks and Future Plan

- JEDI-MPAS is MMM's new -generation communication DA system for both global and regional applications
- Advanced feature available in JEDI-MPAS for all-sky radiance DA, a promising testbed for further R&D
- Plan to have a new release 2.0 this Spring/Summer and do the 1st tutorial this Fall.
- Evaluate performance in a more operational-like setting (e.g., hybrid-4DEnVar, more obs, higher resolution) with more all-sky radiance DA and CRTM-v2.4 (and RTTOV)