MEMORANDUM FOR:	The JPSS Program Record
SUBMITTED BY:	JPSS NUCAPS Products Team Lead, Ken Pryor
CONCURRED BY:	JPSS Product Portfolio Manager, Lihang Zhou
	JPSS STAR Lead Scientist, Alisa Young
APPROVED BY:	JPSS Program Scientist, Satya Kalluri (Acting)

SUBJECT:	SNPP Validated maturity status
DATE:	12/17/2020

Validated maturity status declaration for CO_2

Maturity Review Date:	**12/17/2020**
Effective Date:	**12/17/2020**
Operational System:	**NUCAPS, Version # HEAP 2.3**

Beta maturity level effective date: 5/23/2018
Validated maturity level effective date: 12/17/2020
JPSS Validation Maturity Review artifacts available (hyperlink)

1. Maturity stage definition (http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php)
2. Algorithm Description:
   List of Products (Collection Short Name (CSN):'NUCAPS-EDR')
   - Carbon Dioxide (CO_2)

   Product requirements/Exclusions (L1RDS): see artifact at TBD
   Quality flags (Table): See artifact at TBD
   Product evaluation/validation: See artifact at TBD
   Product availability/reliability

3. Changes from CO_2 Beta maturity (HEAP 2.1) to the version CO_2 Validated maturity version (HEAP 2.3):
   - Inclusion of updated CO_2 QC flags
     The trace gas retrieval product QA/QC criteria are based on many acceptance checks associated with cloud-cleared radiances (CCRs). In addition, retrieval quality, chi-square (χ^2), and degrees-of-freedom-for-signal (DOFS) associated with each carbon trace gas (CO, CH_4, and CO_2) are applied in optimizing trace gas product quality.
   - Changes to the carbon trace gas climatological *a priori* profiles (CO, CH_4, and CO_2)
     The CO_2 *a priori* is derived using NOAA CarbonTracker model and includes latitudinal and seasonal variability. The NOAA Global Monitoring Laboratory (GML) surface measurement anomalies derived from observations from 2002 through 2020 are used to define the CO2 linear climatological trend.
   - NOAA STAR anticipates operational implementation of HEAP 2.3 by May 2021. NOAA STAR is also preparing for Mission-long reprocessing of SNPP NUCAPS products using HEAP 2.3, and reprocessed NUCAPS products should be available to users by December 2021.

Validation

A hierarchy of data sets was used to validate the products and achieve validated maturity for all of the operational SNPP NUCAPS atmospheric profile EDR products (viz., temperature, H_2O, O_3, CO, CH_4, and CO_2) derived from the current version. Figure 1 shows the SNPP NUCAPS carbon trace gas profile error statistics (CO, CH_4, and CO_2) versus NOAA/GML *in situ* measurements obtained from Atmospheric Tomography (ATom) aircraft campaigns.
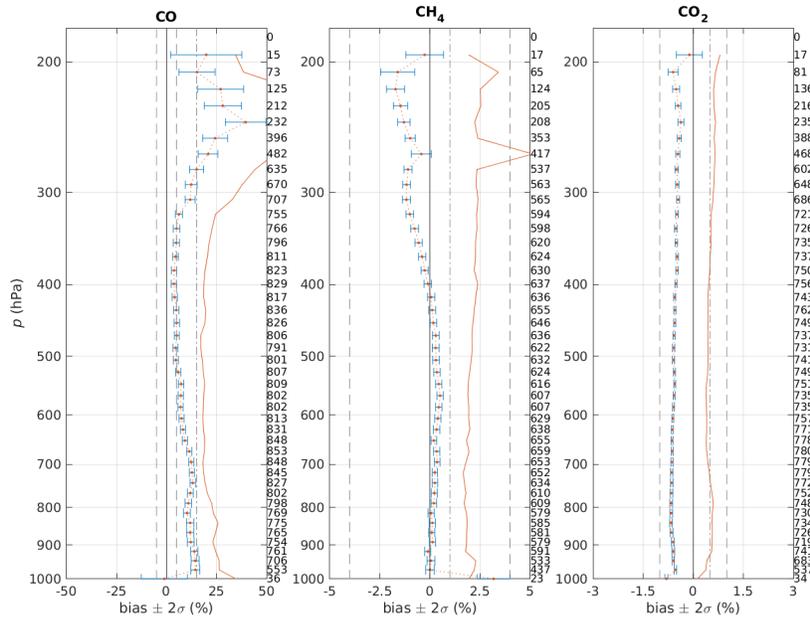

Figure 1. SNPP NUCAPS carbon trace gas profile retrieval statistics (cf. Nalli et al. 2020). Shown are bias (dotted red line) and precision (1σ variability; solid red line) versus ATom-4 *in situ* aircraft data (NOAA/GML measurements): (left) carbon monoxide, (center) methane, and (right) carbon dioxide. Layer sample sizes are indicated on the right margins. More details can be found in the NUCAPS validated maturity review from the STAR JPSS - Algorithm Maturity Matrix.

NUCAPS SNPP CrIS CO_2 products agree with OCO-2 v9 to within approximately 2.5 ppm or 0.5%, as shown in Figure 2 (SNPP vs OCO-2) using 11 focus days spanning 1 year period. In comparison, however, CrIS measurements provide twice daily nearly global coverage owing to its broad swaths and cloud-clearing.
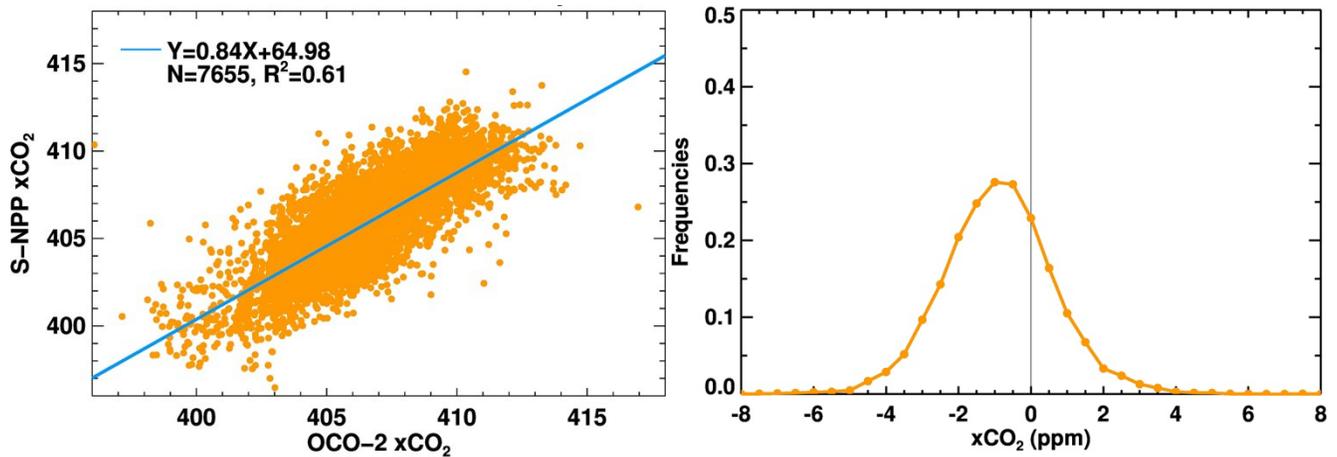
Figure 2. (Left panel) correlations of CO_2 between SNPP CrIS and OCO-2, and (right panel) histogram of the differences (SNPP CrIS − OCO-2) with the current operational (blue) and the improved new version (orange).

Algorithm performance dependence: None
Known errors/issues/limitations: TBD

4. Changes since last maturity stage: Provisional to Validated
5. Review board recommendations: The review board suggested an update to the CLASS webpage and notify subscribers that the current operational CO2 EDR available through CLASS is of beta maturity and should not be used by users/subscribers for research purposes. The review board also recommended that the CLASS webpage and the README file be updated once the validated CO2 EDR product becomes operational (May 2021) and available to the users/subscribers.
6. Path Forward/Future Plan: Planned Enhancements include upgrades to the NUCAPS output files through the inclusion of averaging kernels (AKs), NUCAPS algorithm improvements to include Ammonia retrievals, improvements in land/snow/ice surface emissivity retrievals using CAMEL and physical model *a priori* spectral emissivities, and potential improvements towards swath edges using local angle corrections. Collaboration with NOAA/GML in the implementation of the CO_2 product in numerical weather prediction model data assimilation.
7. Additional Items to note

Additional information is available in the NUCAPS algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

http://www.star.nesdis.noaa.gov/jpss/Docs.php

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