The Version 2 VIIRS+CrIS Fusion Radiance products

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**Retired

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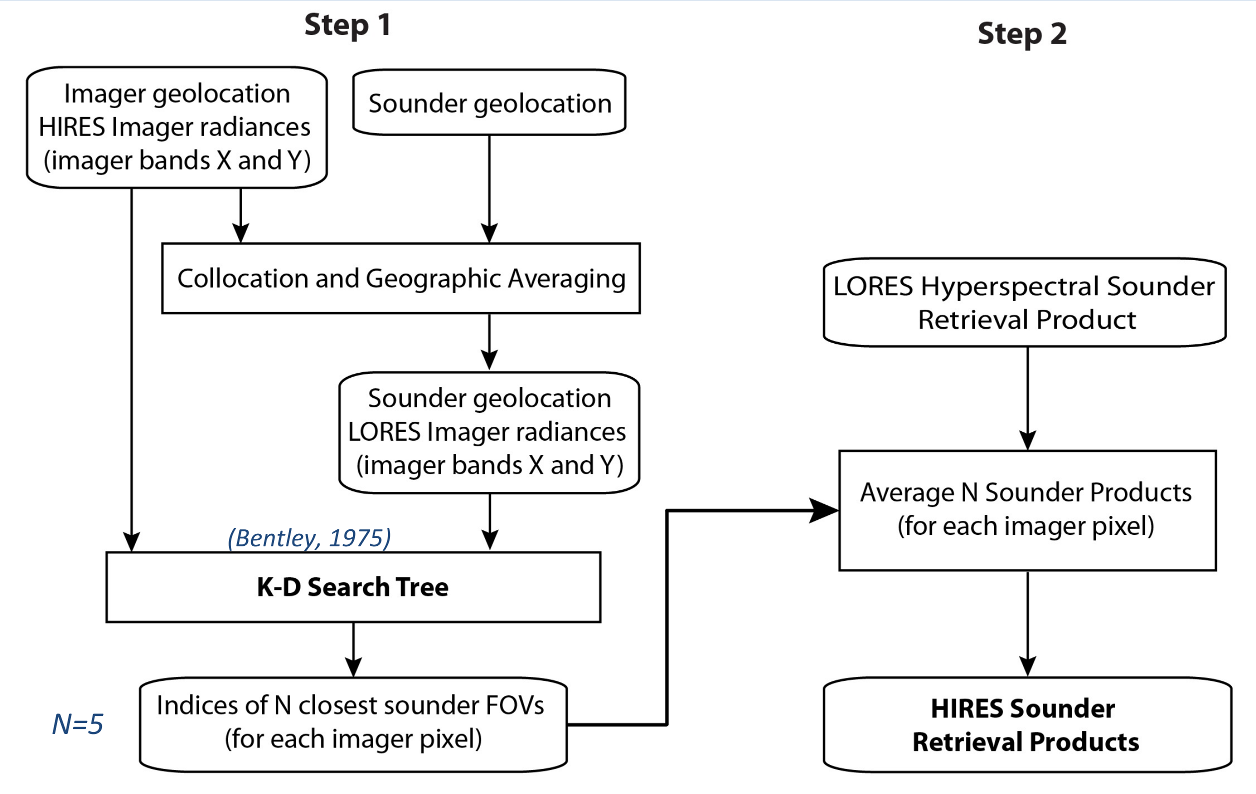
Goal

- The VIIRS+CrIS Fusion Radiance (FSNRAD) products have been created to provide a path for continuity of products based on the Terra, Aqua, SNPP, and NOAA-20 platforms.

- *Why is this work important?* MODIS has three channels sensitive to CO_2 in the 4.5 µm CO_2 band, four channels in the broad 15 µm CO_2 band, 2 channels sensitive to H_2O near 6.7 µm, and an ozone channel near 9 µm. VIIRS has none of these IR absorption bands. The lack of the CO_2 and H_2O channels results in a degradation of the accuracy of the cloud mask especially at night in high latitudes, other cloud products (cloud top pressure/height and thermodynamic phase) and the moisture products (total precipitable water vapor, upper tropospheric humidity).

- We addressed this restriction by constructing similar Aqua MODIS IR band radiances for VIIRS based on a fusion method that uses collocated VIIRS and CrIS data.

Imager+Sounder Spatial Fusion Schematics



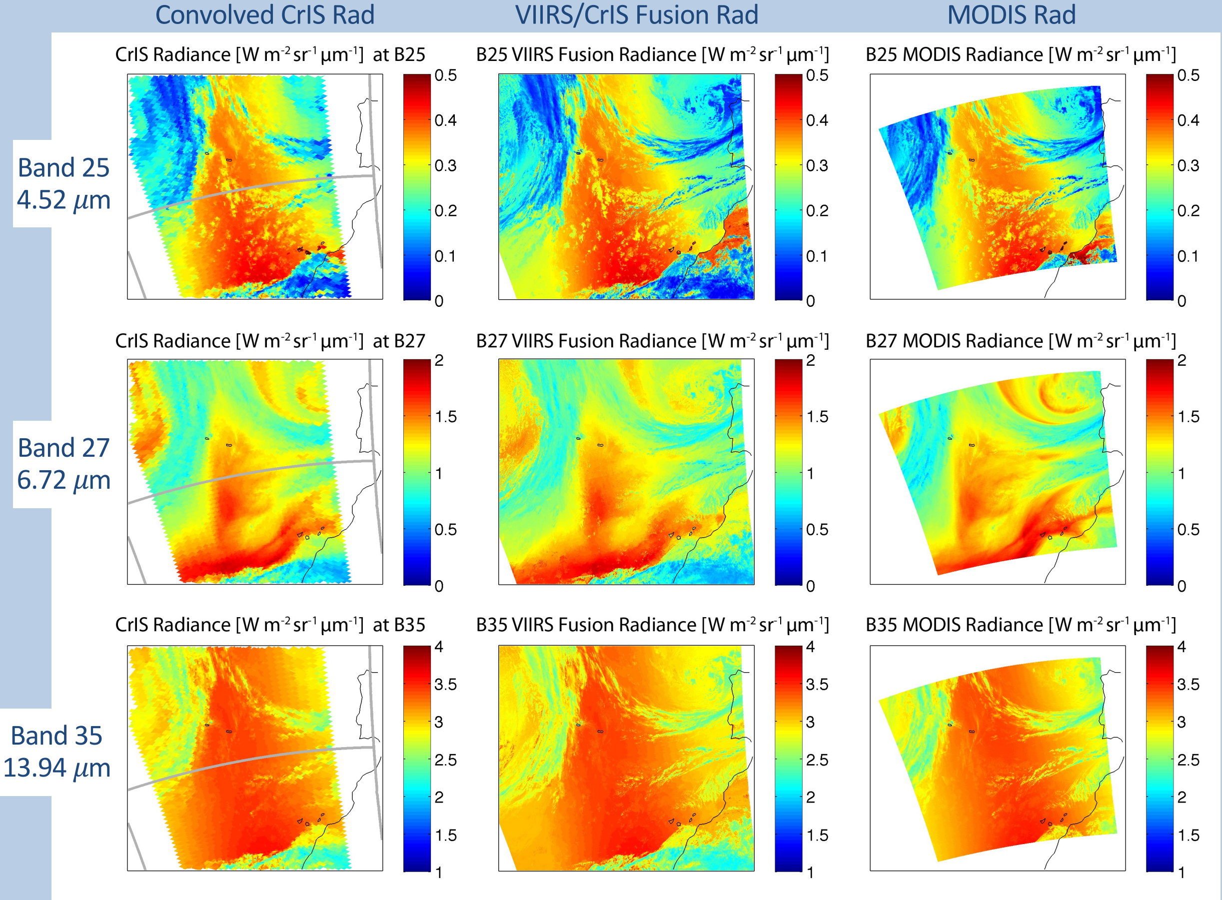
LORES/HIRES … low/high spatial resolution

Imager+Sounder Radiance Fusion Example

- Imager+sounder radiance fusion (Ref 1) applied to VIIRS+CrIS to construct missing VIIRS CO_2 and H_2O absorption bands (i.e., MODIS-like bands).

- Can be applied to various instrument pairs (e.g., AVHRR+IASI, AVHRR+HIRS, VIIRS+TROPOMI, ABI+CrIS)

Ref. 1. Weisz, E., B. Baum, and W. P. Menzel, 2017: Fusion of satellite-based imager and sounder data to construct supplementary high spatial resolution narrowband IR radiances, *J. of Appl. Remote Sens.*, 11(3). DOI: 10.1117/1.JRS.11.036022



Status of the VIIRS+CrIS FSNRAD products

- **V2 (2.0.0dev3) released at NASA LAADS DAAC**: March 8, 2022
- DOI: 10.5067/VIIRS/FSNRAD_L2_VIIRS_CRIS_SNPP.002
- https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/products/FSNRAD_L2_VIIRS_CRIS_NOAA20
- https://ladsweb.modaps.eosdis.nasa.gov/missions-and-measurements/viirs/VIIRS+CrIS_DataFusion_UG_v2.0_Dec_2021.pdf

- **Subsetter** products are available at A-SIPS: https://sips.ssec.wisc.edu/#/products/availability;id=14372

Product Name	Description	Available at
FSNRAD_L2_VIIRS_CRIS_SNPP	S-NPP/VIIRS Fusion Radiances	LAADS DAAC
FSNRAD_L2_VIIRS_CRIS_NOAA20	NOAA20/VIIRS Fusion Radiances	LAADS DAAC
FSNRAD_L2_VIIRS_CRIS_SS_SNPP	S-NPP/VIIRS Subsetted Fusion Radiances	Atmosphere-SIPS
FSNRAD_L2_VIIRS_CRIS_SS_NOAA20	NOAA20/VIIRS Subsetted Fusion Radiances	Atmosphere-SIPS

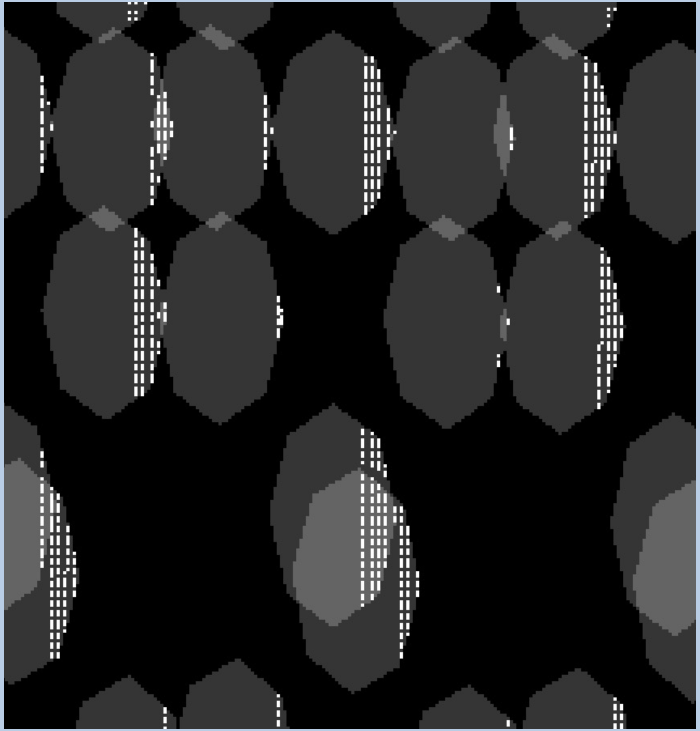
- **Note for SNPP:** CrIS anomaly in LW data
  - May 21 –July 12, 2021: fill value for Band 30-36 (anomaly of CrIS LW channels)
  - July 14, 2021 - fill value for Band 27, 28, B30-36 restored (Side 1 -> Side 2)

FSNRAD Version 2 updates:

- Updated to current VIIRS & CrIS calibration (V3.0.0)
- **New K-D tree**: MU (empirical, band-specific scaling factor) is eliminated by scaling radiances (additionally to lat and lon) in the KD tree search
- **Radiance is replaced with the BTdiff** (11-12 micron) for Band 27 and Band28 (differences are more sensitive for the atmospheric layer instead of the surface (individual channels).
- **QC improvement**: VIIRS granule quality check is done by scanline now, so partially good granules can be processed. Before the whole granule was checked at once, and only fully best quality granule was processed.
  - Granules with BB WUCD operation and lunar calibration are processed now.
- A **new CrIS-VIIRS collocation implementation** has been developed that provides two main improvements:
  - scans with missing geolocation data are now simply ignored instead of causing whole-granule failures.
  - False negative allocation of VIIRS pixels in the AIRS FOV is fixed.

The yield for the fusion radiance product is now greater than 99.9% for NOAA20.

Collocation fix



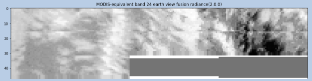
The old collocation code missed VIIRS pixels that should have been identified as residing within a CrIS FOV (false negatives).

The image shows an area where the false negative problem was especially prominent. Each small white rectangle is a VIIRS pixel that was not identified in the old collocation code.

Overall, an average granule was missing a bit under 1% of collocated VIIRS pixels (for a sense of scale the new code has 189 false negatives for all of August 2020, while the old code had about 286 million).

SNPP Geolocation error

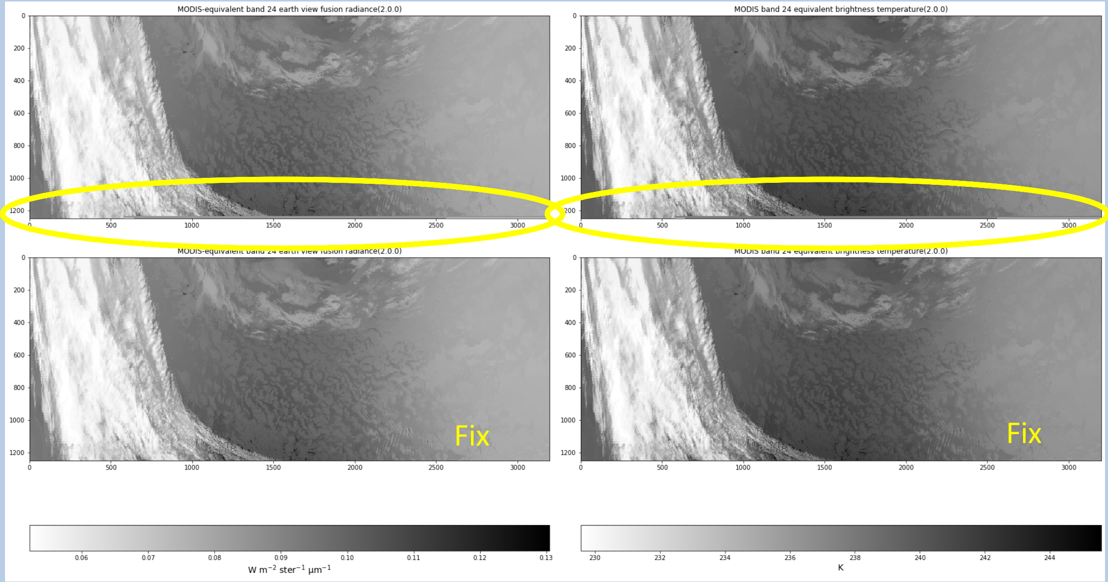
- Currently the VIIRS geolocation (V002 (viirs L1_version=3.1.0) for the last scan in each 2-hour block is failing, meaning the granule timestamps: 01:54, 03:54 05:54 …

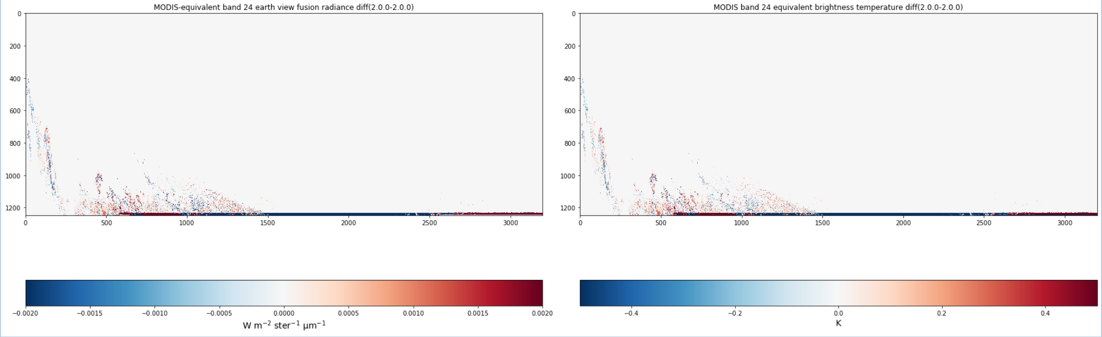


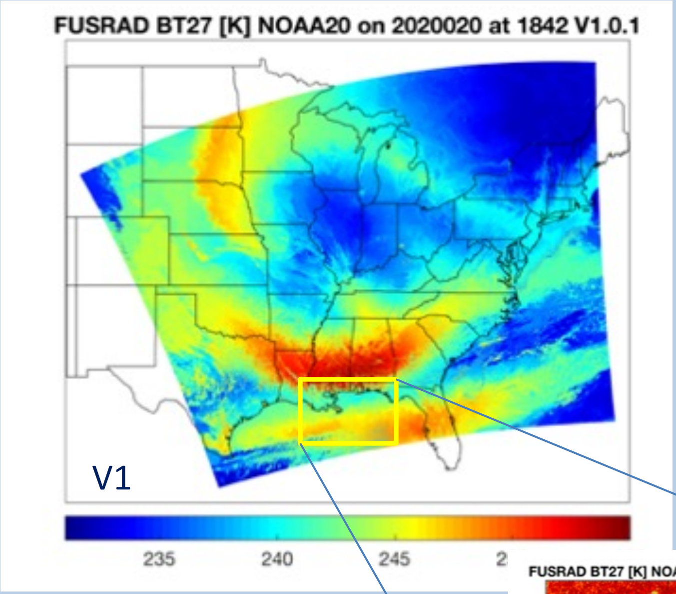
- A buffer is being added to the end of the L0 input for the Kalman filter to fix this.
- V2 Fusion still meets quality expectations.

Fusion B24 Radiances

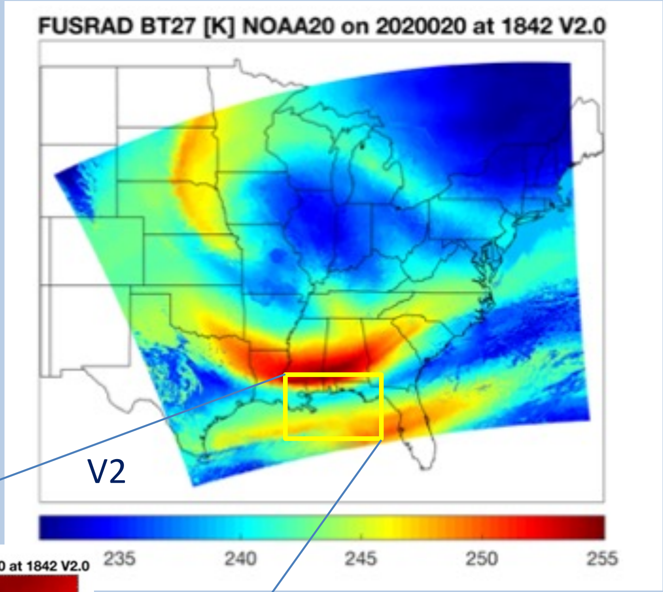
Fusion B24 BTs

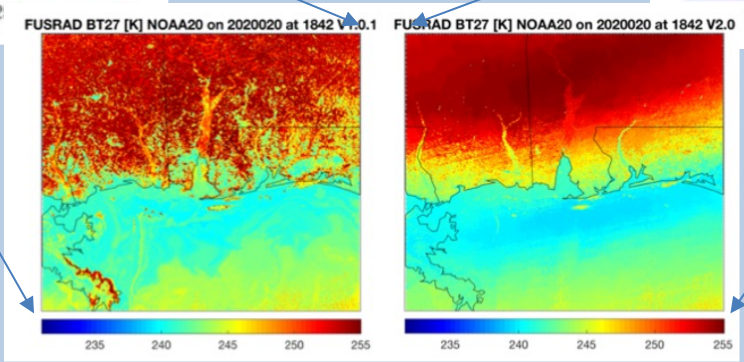


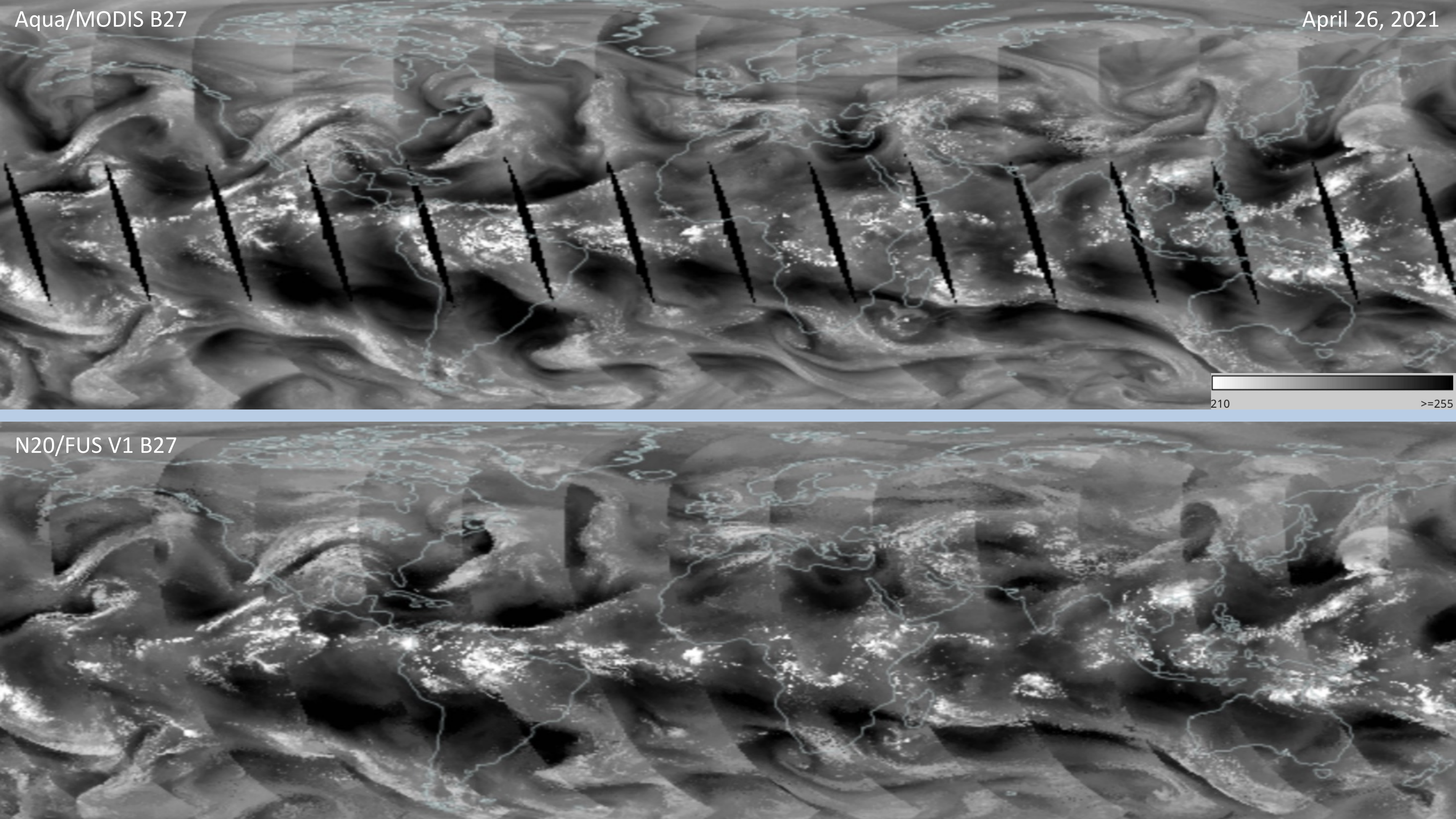


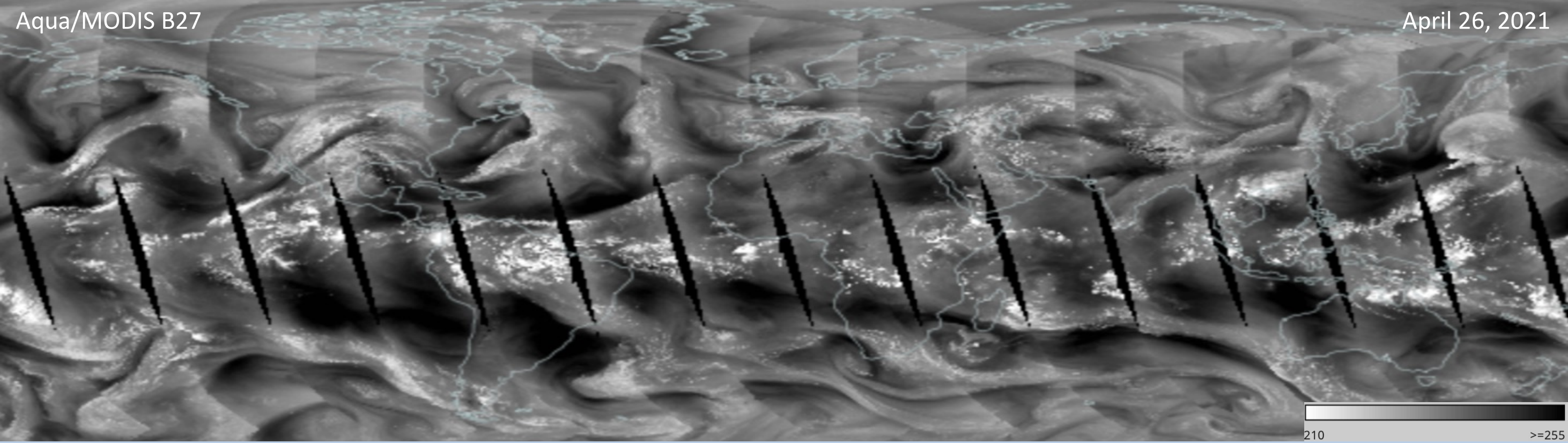


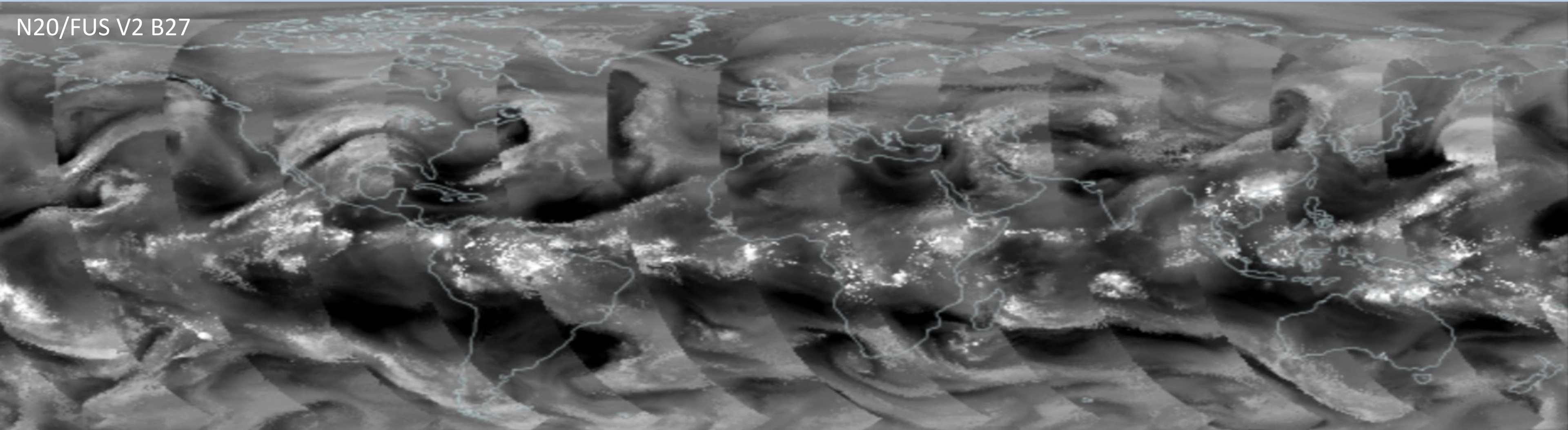
Decreasing surface effect in WV bands

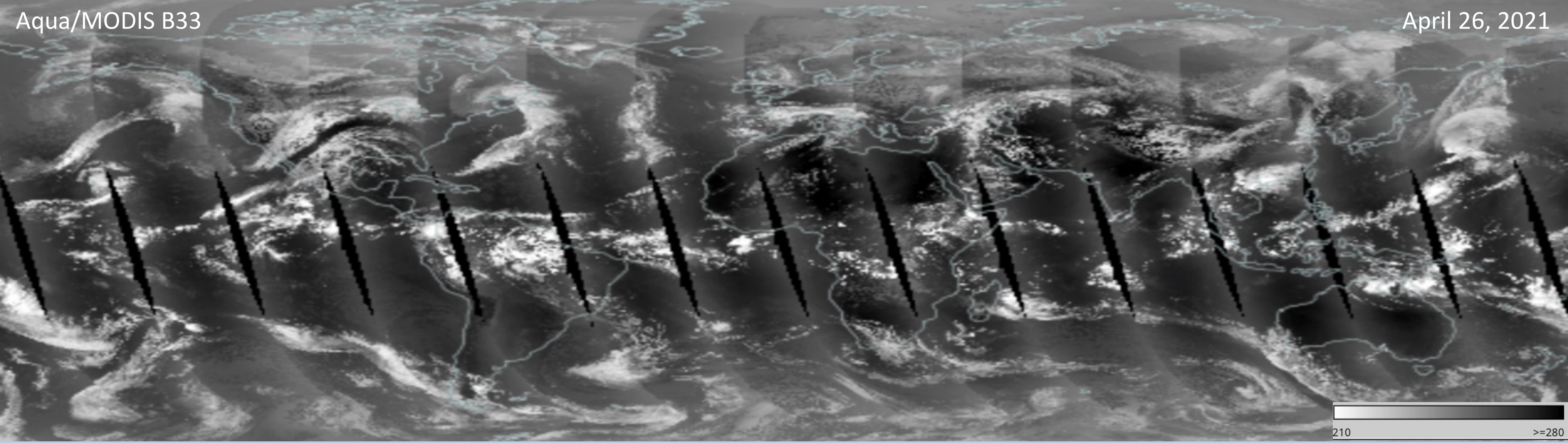


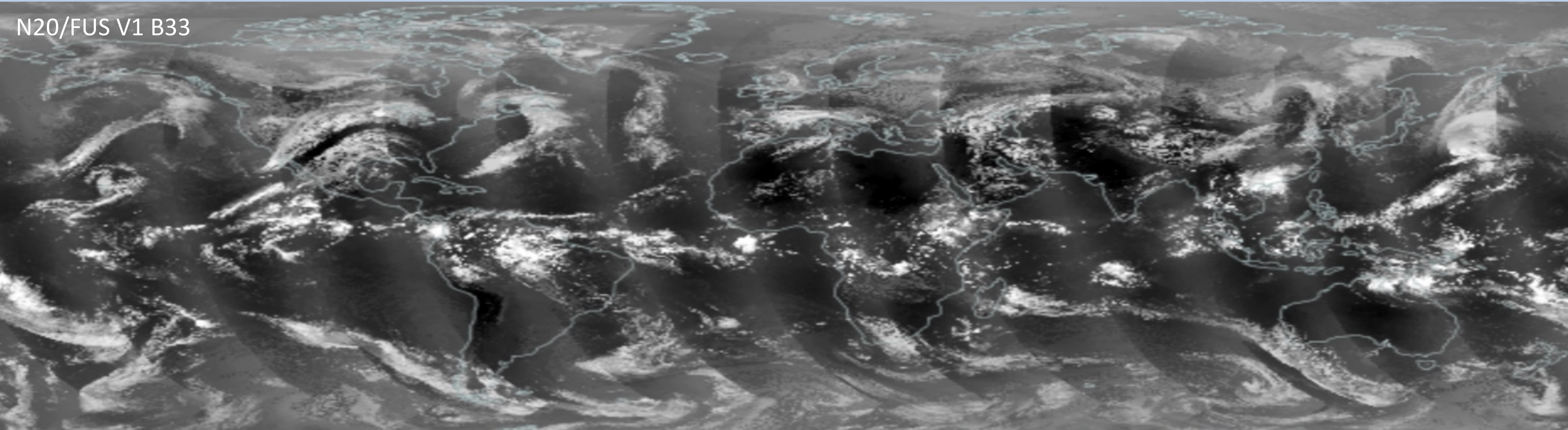


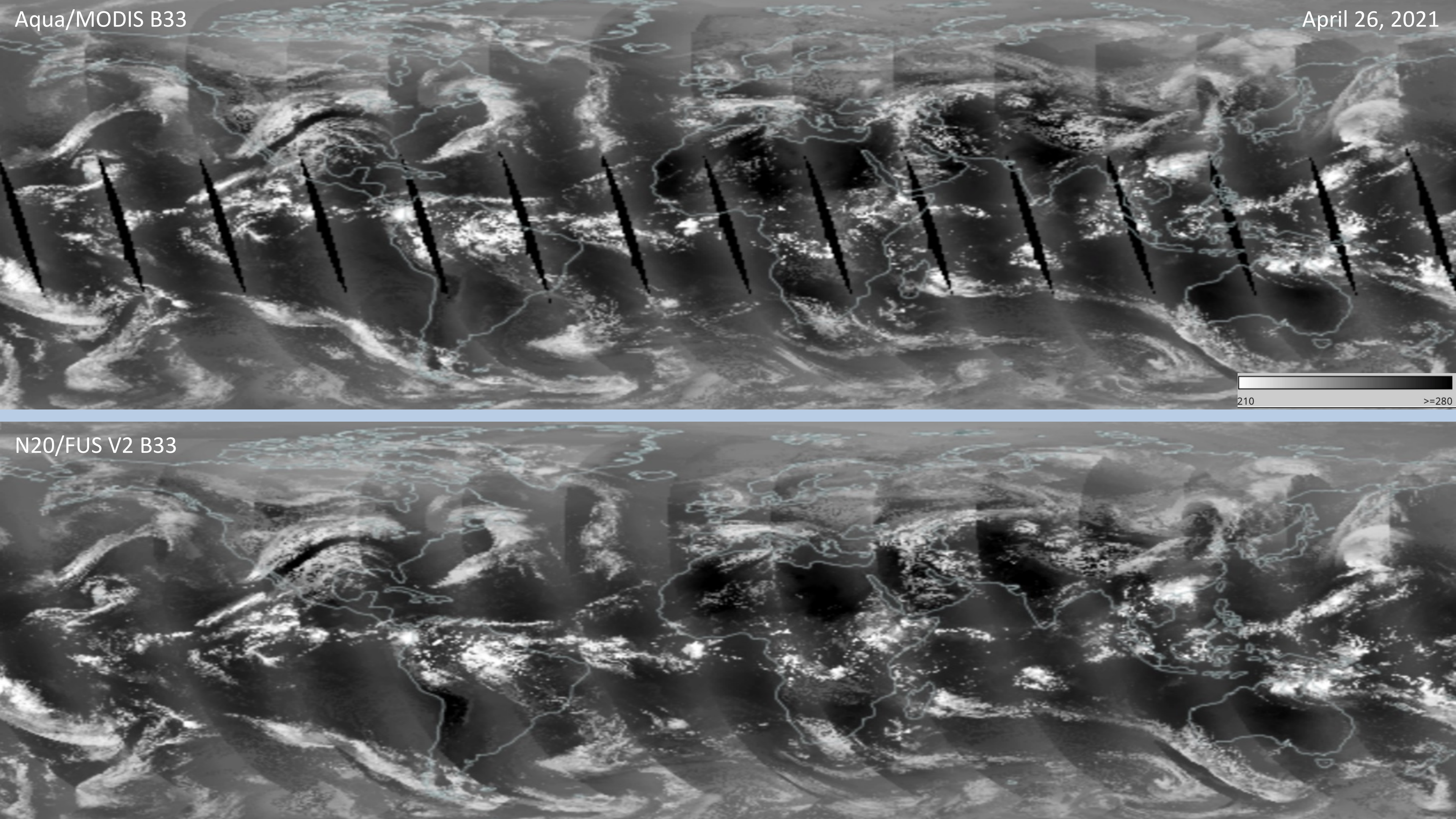

Aqua/MODIS B27
April 26, 2021
210
>=255
N20/FUS V1 B27


Aqua/MODIS B27
April 26, 2021
210
>=255


N20/FUS V2 B27


Aqua/MODIS B33
April 26, 2021
210
>=280


N20/FUS V1 B33


Aqua/MODIS B33
April 26, 2021
210
>=280
N20/FUS V2 B33

Assessment of Product Quality

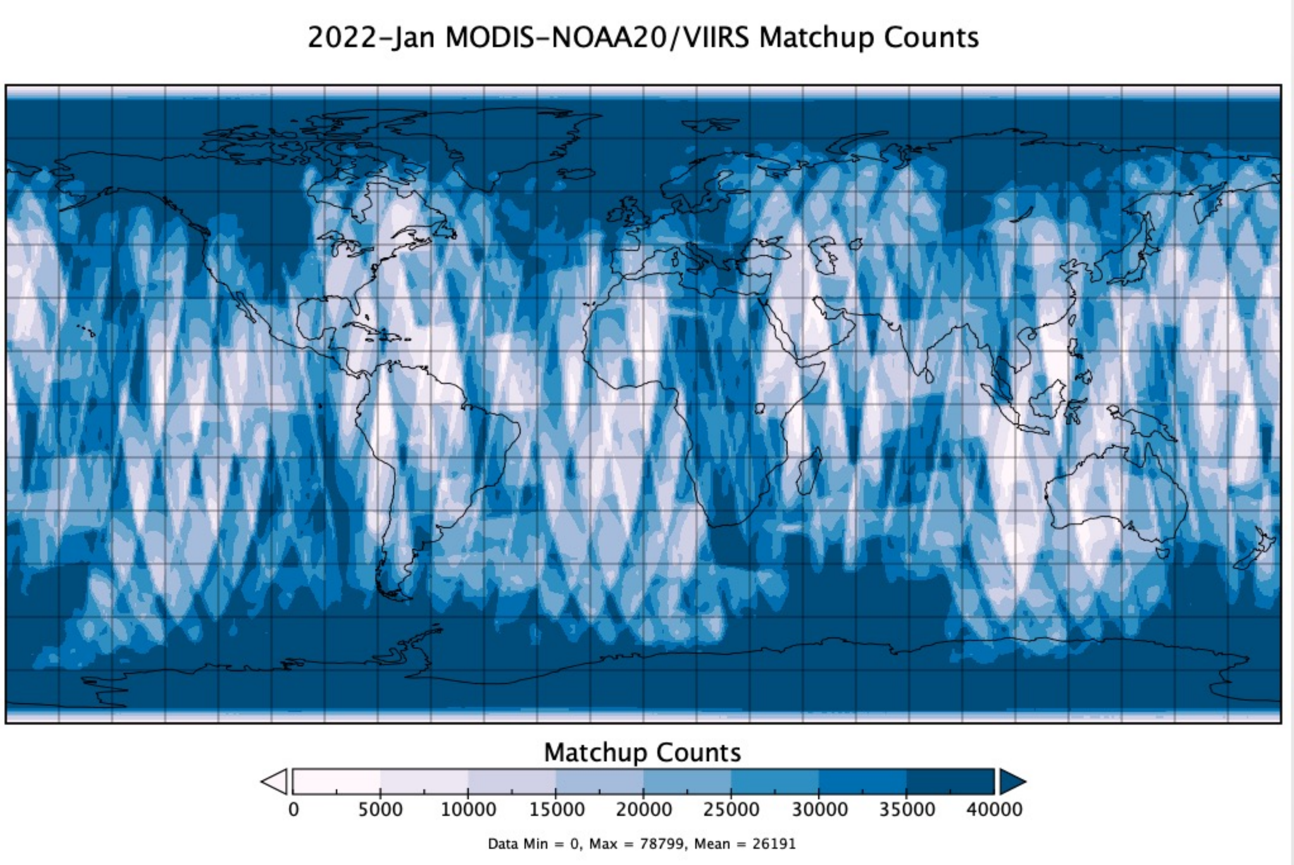
SNPP and NOAA20 fusion radiance products are compared directly with Aqua/MODIS measured radiances.

Provide:

- Sanitiy check
- uncertainty

SNO requirements:

- Scan angle < 50
- VIIRS fully contain within the MODIS
- Looking the same ground point within 20 min
- High confidence clear

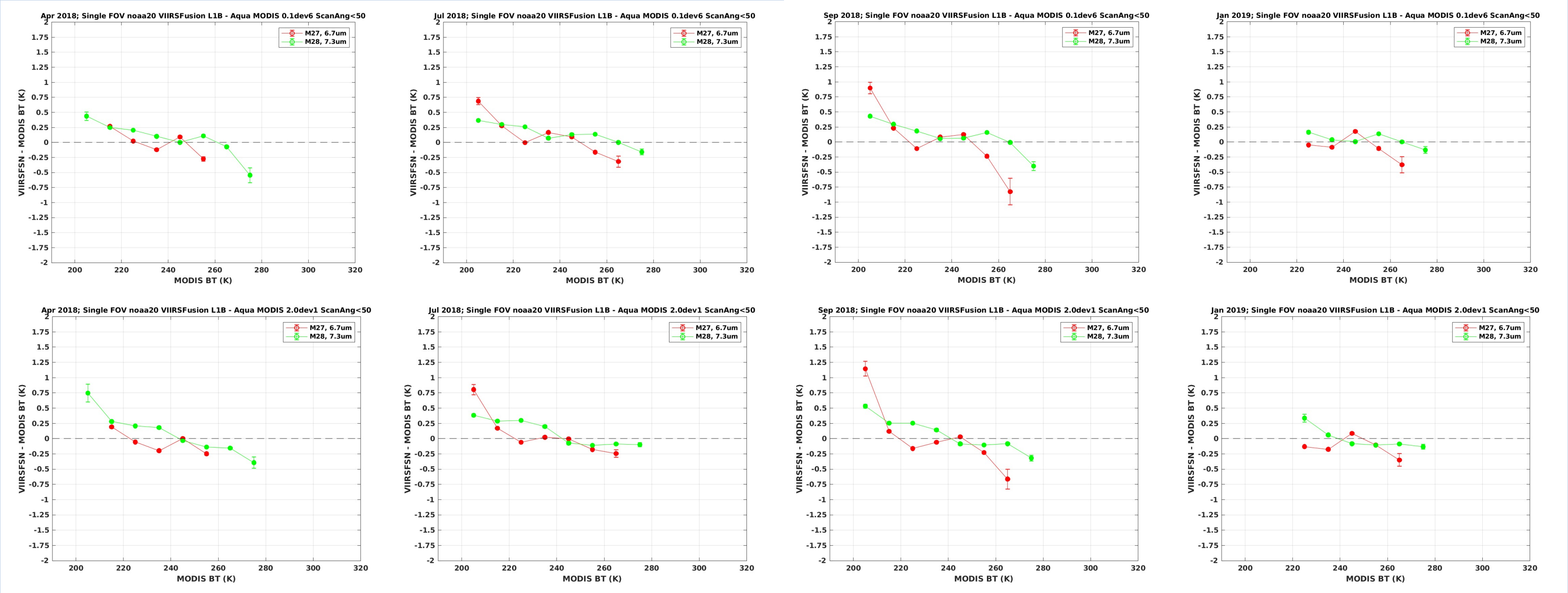


NOAA20 FSNRAD - Aqua/MODIS SNOs
Band 27, 28

April 2018 | July 2018 | Sept 2018 | Jan 2019

V1

V2

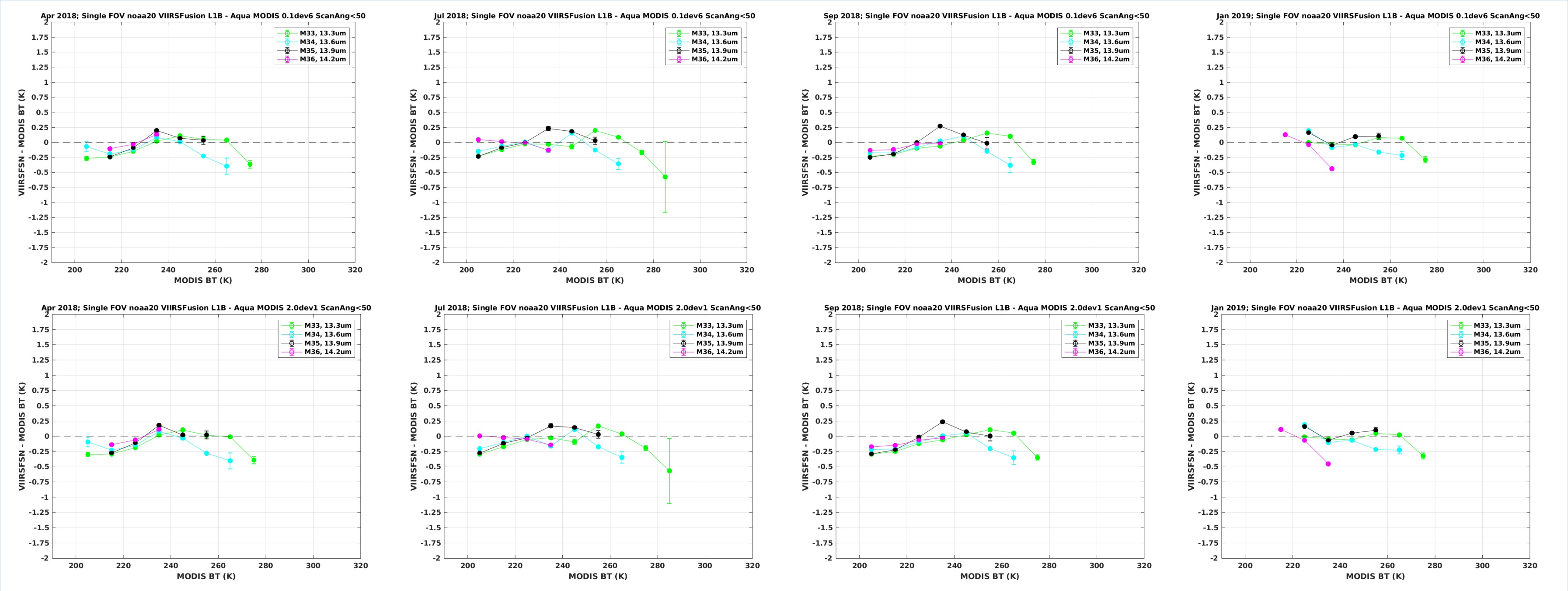


NOAA20 FSNRAD - Aqua/MODIS SNOs
Band 33-36

April 2018 | July 2018 | Sept 2018 | Jan 2019

V1

V2



Future plans:

- Adjust band 28 –no effect on the FSNRAD SS subsetter products
- Continue monitoring fusion radiance quality with MODIS SNOs

Next Presentation:

August 8-12, 2022, Madison , WI

Joint 2022 NOAA Satellite Conference and the 25th Conference on Satellite Meteorology, Oceanography

References:

- **Borbas**, E. E., E. Weisz, C. Moeller, W. P. Menzel, and B. A. Baum, 2021: Improvement in tropospheric moisture retrievals from VIIRS through the use of infrared absorption bands constructed from VIIRS and CrIS data fusion, *Atmospheric Measurement Techniques*, 14, 1191–1203, doi.org/10.5194/amt-14-1191-2021.
- **Li**, Y., B. A. Baum, A. K. Heidinger, W. P. Menzel, and E. Weisz, 2020: Improvement in cloud retrievals from VIIRS through the use of infrared absorption channels constructed from VIIRS-CrIS data fusion, *Atmospheric Measurement Techniques*, 13, 4035–4049, doi.org/10.5194/amt-13-4035-2020.
- **Weisz**, E., and W. P. Menzel, 2020: An Approach to Enhance Trace Gas Determinations through Multi-Satellite Data Fusion, *J. Appl. Remote Sens.*, 14(4), 044519 (2020), doi: 10.1117/1.JRS.14.044519.
- **Weisz**, E., B. A. Baum, and W. P. Menzel, 2017: Fusion of satellite-based imager and sounder data to construct supplementary high spatial resolution narrowband IR radiances. *J. Appl. Remote Sens.,* 11(3), 036022, doi: 10.1117/1.JRS.11.036022.