

The Reprocessed Suomi NPP Satellite Observations

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With contribution from the STAR Reprocessing Working Group,
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Outline

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- Reprocessing Activities at NOAA/STAR
- Benefit from Reprocessing
- Quality Assessment of Reprocessed Sensor Data Records (SDRs)
 - Compare with operational SDRs
 - Compare with similar instrument channels onboard other satellites
 - Check ICVS for engineering/science support of assessment results
- Summary and Perspective



Reprocessing Activities at NOAA/STAR

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- Operational calibration algorithms update and improve over time
- Use most recently updated, unified calibration algorithms to generate consistent SDRs for each JPSS/SNPP instruments through their life cycle
- Calibration accuracy for reprocessed SDRs achieves those from the latest operational calibration algorithms
- Completed a baseline version of the SNPP reprocessing for ATMS, CrIS, OMPS, and VIIRS: from SNPP launch time to 8 March 2017
- Ongoing Activities: Reprocess individual instruments as needed if changes in calibration algorithms are significant enough to warrant a new reprocessing; including both S-NPP and NOAA-20



Benefits

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- Allow stability assessment after removal of bias jumps due to operational calibration changes— quantify SDR quality in the time dimension
- Support consistent satellite retrievals
- Improve environmental data record (EDR) products
- Building blocks for development of climate data record (CDR)
- Improve climate reanalysis products as input datasets
- Climate trends analyses



Assessment of Consistency and Stability of Reprocessed SDRs

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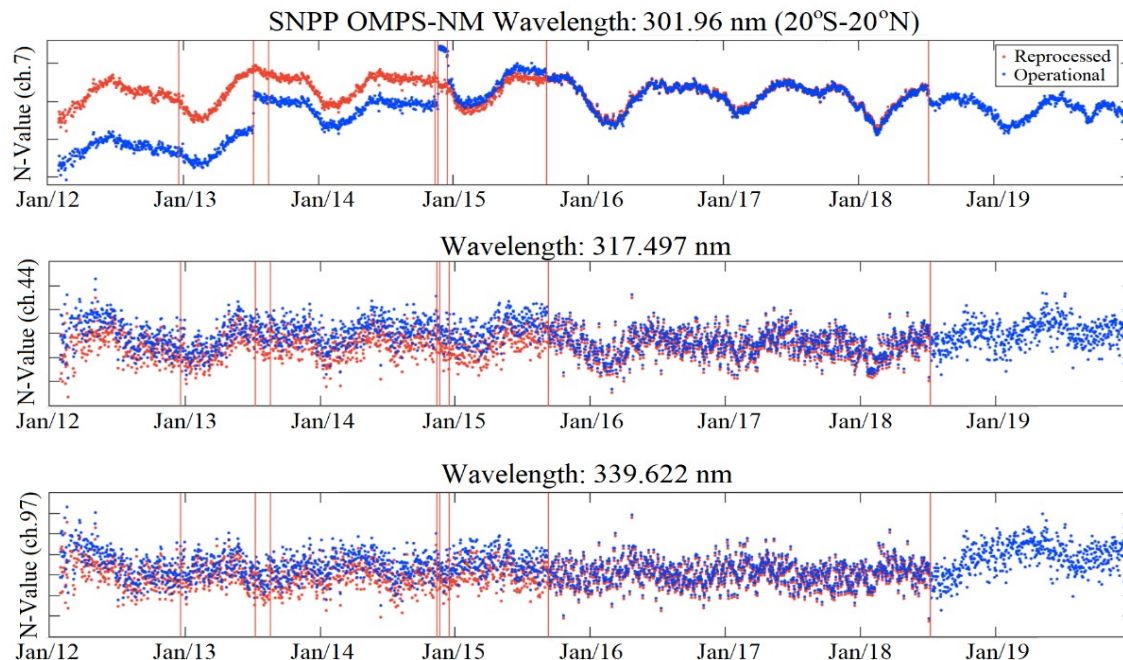
- Compare with operational SDRs
- Compare with similar instrument channel observations onboard other satellites
- Check ICVS for engineering/science support of assessment results



Compare Operational and Reprocessed SDRs—SNPP/OMPS

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- Changes in operational calibration caused bias jumps in the operational time series (blue curves)
- Timing of bias jumps matches with known times when updates of calibration coefficients occurred

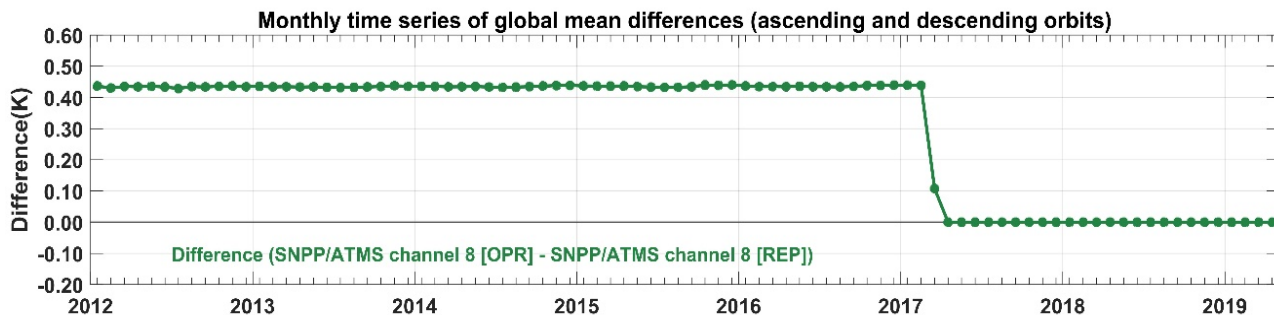
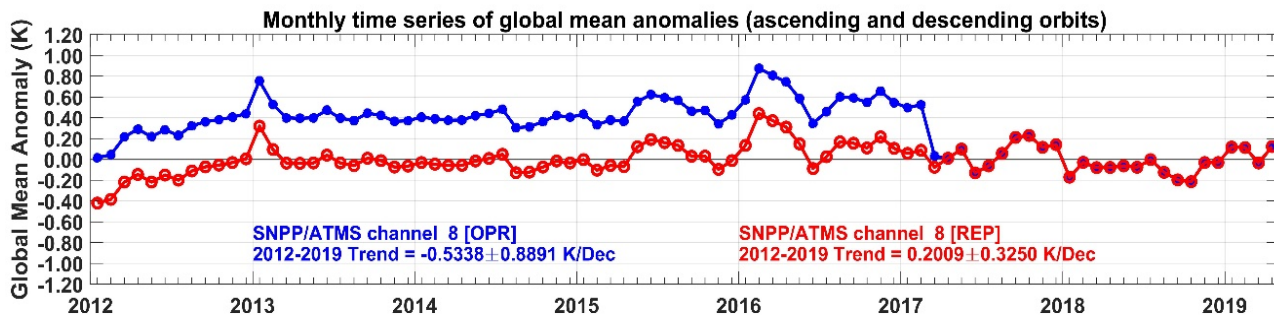


Daily N-value ($-100 \log_{10}(\text{Normalized Radiance})$) time series for data over the tropical region (20 S–20 N) for the Nadir Mapper (NM) instruments at selected channels. Update events of calibration look up tables (LUTs) are marked by the red vertical lines. Note that the channel wavelengths have errors as large as 0.1 nm for the operational SDRs due to improvement in wavelength scale calibration over time, and of less than 0.02 nm for the reprocessed SDRs (Plot from Zou et al. 2020).



Compare Operational and Reprocessed SDRs—SNPP/ATMS

- The bias jump found in March 2017 was caused by the calibration update for the operational calibration on 8 March 2017
- After that date, the two datasets are identical since they use the same calibration algorithm

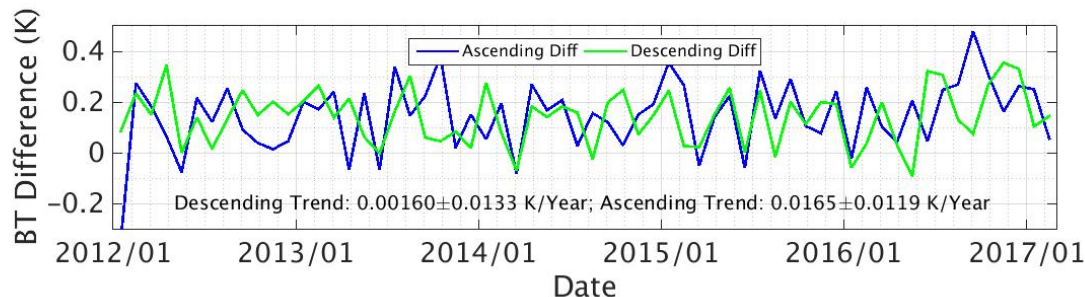
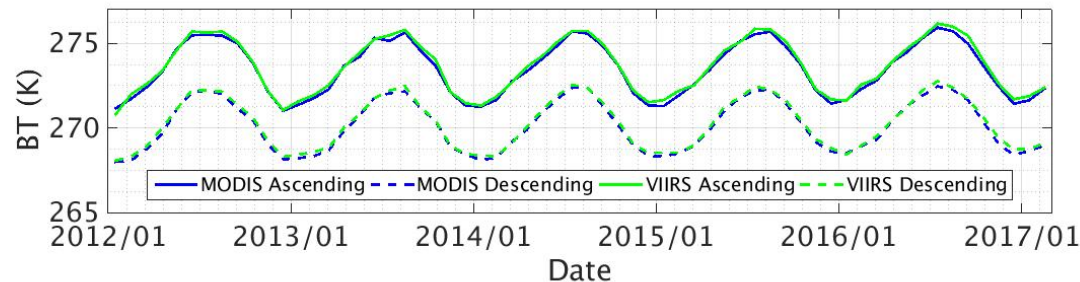


Monthly global mean anomaly T_b time series for ATMS channel 8 from operational calibrated (blue, top) and reprocessed (red, top) sensor data records and their differences (green, bottom). The global means are calculated using limb-adjusted scan positions from 29 to 68 for both operational calibrated and reprocessed datasets (plot from Zou et al. 2020).



Stability Assessment of Reprocessed SDR—SNPP/VIIRS

- The VIIRS channel M15 and MODIS channel B31 are both used for SST retrievals with similar channel frequencies
- Aqua and SNPP are both on stable afternoon orbits; there are no diurnal drifting errors between the two observations
- The reprocessed VIIRS M15 shows excellent agreement with the MODIS B31 in global means
- Trend difference in their descending orbits is only 0.0016K/Year, demonstrating high radiometric stability for both instruments

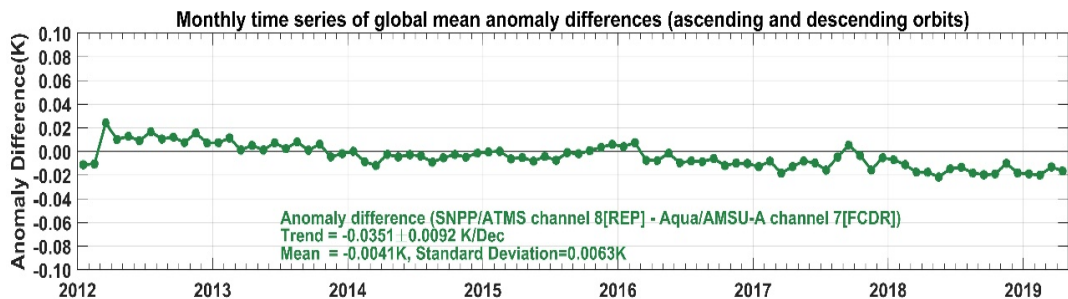
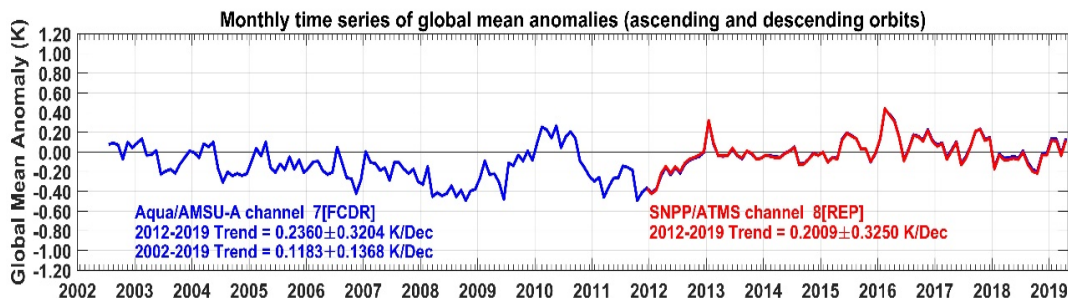


Monthly global mean time series of brightness temperatures for S-NPP VIIRS M15 and Aqua MODIS B31 bands (upper panel) and their difference (VIIRS-MODIS) time series (lower panel). Ascending and descending orbits are plotted separately. To minimize limb effects due to a large scan angle, only near-nadir pixels within a distance of 180 km were used for both MODIS and VIIRS. VIIRS data on 01/2012 were excluded due to insufficient observations (plot from Zou et al. 2020).



Stability Assessment of Reprocessed SDR—SNPP/ATMS

- SNPP/ATMS are compared with Aqua/AMSU-A for their companion channels
- Diurnal sampling difference is absent
 - they are naturally removed by satellites with stable orbits with the same overpass time
- Time series from different satellites match with each other nearly perfectly without applying any diurnal drift corrections or time-dependent inter-calibration
- Calibration drifts could be estimated quite accurately
- Small trend differences suggest high radiometric stability for either instrument



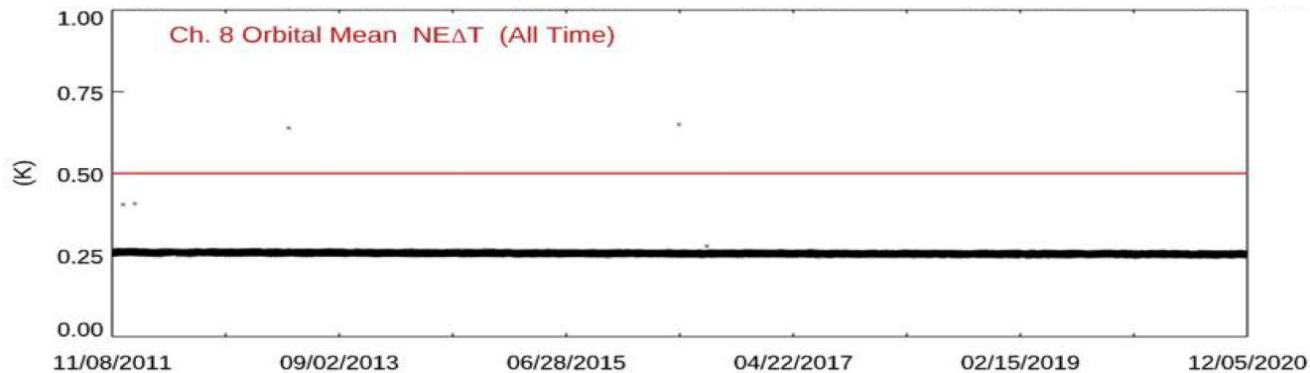
Monthly global mean T_b anomaly time series for AMSU-A channel 7 onboard Aqua (blue, top) versus ATMS channel 8 onboard SNPP (red, top) and their difference time series (green, bottom). The AMSU-A and ATMS data are from June 2002 and December 2011 to December 2018, respectively. The AMSU-A anomaly time series are overlaid by ATMS during their overlapping period, with their differences shown as nearly a constant zero line in the same temperature scale. Amplified scale of temperature is used in the bottom panel to show detailed features in the anomaly difference time series. Both ATMS and AMSU-A data are from limb-adjusted scan positions of 29-68 and averaged over ascending and descending orbits. Uncertainties in trends represent 95% confidence intervals with autocorrelation adjustments (plot from Zou et al. 2018).



Check ICVS for Instrument Performance

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- The NEDT has been below the specification all the time from the SNPP launch time to present
- The NEDT has been absolutely stable from the SNPP launch time to present



SNPP ATMS noise equivalent differential temperature (NE Δ T) time series from the SNPP launch time to present (Plot taken from ICVS website).



Summary and Perspective

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- NOAA/STAR had completed a baseline version of the SNPP reprocessing for ATMS, CrIS, OMPS, and VIIRS from its launch time to 8 March 2017
- Preliminary assessments on the quality of the reprocessed SNPP SDRs were performed by comparing them with operational SDRs and similar instrument channels but onboard other satellites, and by checking ICVS for engineering and science support of the assessment results
- Updated reprocessing is being conducted for individual instruments in an ‘as needed’ fashion when changes in calibration algorithms are significant enough to warrant a new reprocessing
- Reprocessing for NOAA-20 is being planned



- **The reprocessed datasets are publically available at:** ftp://jlrdata.umd.edu/pub/SNPP_Reprocessing/
- **Reference:** Zou, C.-Z.; Zhou, L.; Lin, L.; Sun, N.; Chen, Y.; Flynn, L.E.; Zhang, B.; Cao, C.; Iturbide-Sanchez, F.; Beck, T.; Yan, B.; Kalluri, S.; Bai, Y.; Blonski, S.; Choi, T.; Divakarla, M.; Gu, Y.; Hao, X.; Li, W.; Liang, D.; Niu, J.; Shao, X.; Strow, L.; Tobin, D.C.; Tremblay, D.; Uprety, S.; Wang, W.; Xu, H.; Yang, H.; Goldberg, M.D. The Reprocessed Suomi NPP Satellite Observations. *Remote Sens.* 2020, **12**, 2891.

Thank You!