S-NPP VIIRS SDSM Screen Transmittance Determined from both Yaw Maneuver and Regular On-orbit Data

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Introduction: S-NPP VIIRS uses an on-board solar diffuser (SD) to carry out radiometric calibration of its reflective solar bands (RSB). The SD bidirectional reflectance distribution function (BRDF) degrades over time. An on-board solar diffuser stability monitor (SDSM) is used to determine the degradation coefficient. The SDSM observes the sun through a pinhole screen and the SD at almost the same time and thus is able to determine the SD BRDF degradation. As a result, accurate knowledge of the SDSM screen transmittance is essential to allow the SDSM to determine the degradation coefficient accurately. Yaw maneuver data has large step size in the projected solar horizontal angle and therefore is not able to yield details of the transmittance. We use yaw maneuver data determined SDSM screen transmittances as anchors and use a portion of regular on-orbit data (~ 3 months) data to determine the SDSM pinhole screen transmittance at very fine angular step sizes. The BRDF degradation coefficient versus time curve determined with the new SDSM screen transmittance is much smoother than that computed with yaw maneuver data determined SDSM screen transmittance.

Theory

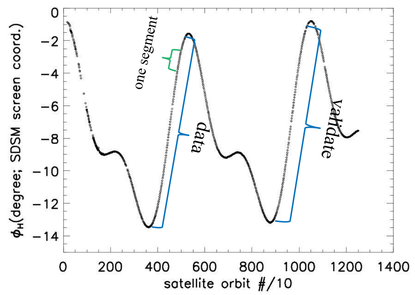
For an SDSM detector *d* per unit time:

$$\frac{\tau_{SDSM\ \ eff}(\phi_h(t),\phi_v(t);t)}{\tau_{SDSM\ ,eff}(\phi_h(t_0),\phi_{v_0}(t_0);t_0)} = \left[1+b_1(t-t_0)+b_2(t-t_0)^2\right] * \frac{dc_{sun}(t)R^2(t)}{dc_{sun}(t_0)R^2(t_0)}$$

t_0 ~ middle time in the yaw maneuver data or a small segment (in time) of on-orbit data
(change in RSR is negligible over the yaw data or a small segment)

Detector 8 has the largest b_1 and $|b_2|$.
At orbit 1570 (~ yaw maneuvers):
$b_1 = 6.6\times10^{-5}$/orbit, $b_2 = -2.16\times10^{-8}$/orbit^2
(solar spectral power drift is folded in b_1 and b_2)

Regular on-orbit data

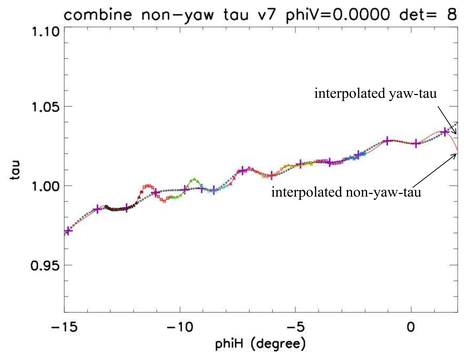


Very fine step size in ϕ_H, able to resolve transmittance in detail.

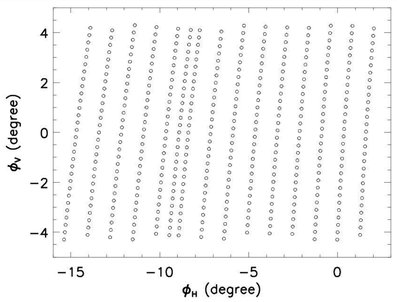
Procedure

(1) Divide the regular on-orbit data (~3-month) into segments with each covers one yaw maneuver orbit in solar angles.
(2) Compute transmittance for each segment and interpolate the transmittance at the yaw maneuver solar angles.
(3) Tau(yaw) and Tau(non-yaw) differ by a scale factor due to drifts in solar power and the SDSM detector gain, find the scale factor through a least-square fit; multiply Tau(non-yaw) by the scale factor.
(4) Combine tau(non-yaw) with linear adjustments.

Combine non-yaw tau from the segments

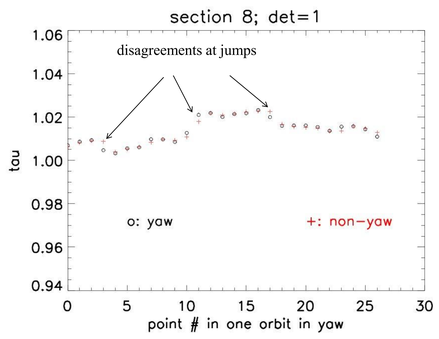


Yaw maneuver data

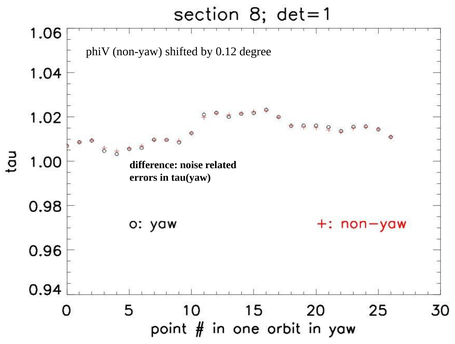


Large step size in ϕ_H, not able to resolve transmittance in detail.

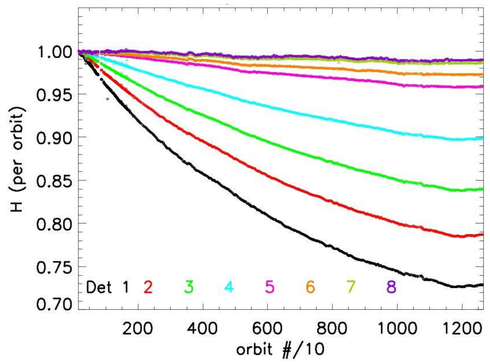
Mismatch at the jumps



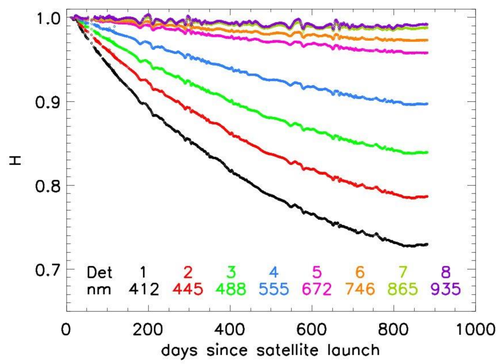
Shift in phiV to make a better match



Smoother BRDF degradation coefficients

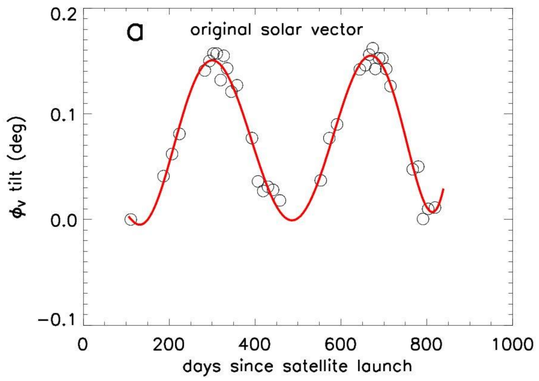


BRDF degradation coefficient

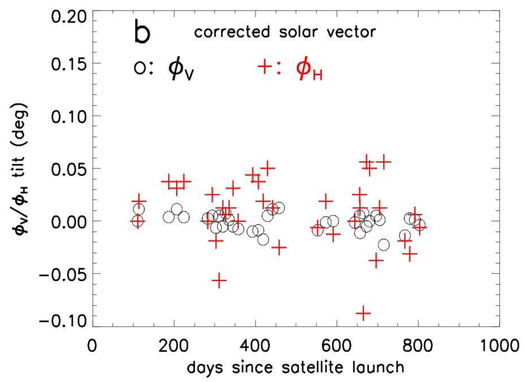


Degradation coefficient curves are not smooth.

phiV shift over time: solar vector error



Solar angle shift with corrected solar vector



Summary

(1) SDSM screen transmittance is computed more accurately with 3-month of regular on-orbit data.
(2) Relative transmittance error standard deviations are computed with the help of validation data at:
0.00059, 0.00045, 0.00039, 0.00035,
0.00033, 0.00033, 0.00058, 0.00099,
for SDSM detectors 1 to 8, respectively.
(3) SDSM screen is stable over time.

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