



Jet Propulsion Laboratory
California Institute of Technology

Overview of TOPEX Center of Mass Correction (s1038_cg_corr)

Phil Callahan

Jet Propulsion Laboratory, California Institute of Technology

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Overview

- Origin and basic physics of CG Correction
- Algorithm Structure
- Reasons for not including correction with instrument range corrections
 - While basic concept of algorithm was well-understood, the calculation of the amount bending was theoretical and not entirely trusted. For the accuracy expected at launch, the correction was not needed, and it was not thought that there was any way to verify it.
- From TOPEX GDR Handbook/SIS

4.4.91. S1038_CG_Corr

Correction to altimeter tracker range for center of mass movement caused by solar array motion and satellite roll and pitch. Value should be added by the data user to the reported instrument range to get corrected range (or subtracted from the reported Sea_Surf_Hght). This value is output by algorithm s1038, but is not included in the applied instrument corrections.



Overview

- Origin and basic physics of CG Correction
 - Sun side of solar array will be hotter than the other side, so there will differential expansion bending the array away from the sun
 - Solar array rotates approximately once per orbit, so the direction of the bend relative to nadir changes
 - TOPEX did yaw steering to keep the array normal pointed in the sun direction when the sun was more than ~ 30 deg from the orbit plane (so there is not really 1 rotation per rev). When the sun was $< \sim 30$ deg from the orbit plane, yaw was fixed in the orbit plane.
 - Solar array was offset in rotation around axis (varied over mission as solar cells aged) from normal to sun
 - Solar array was on s/c bus while altimeter was on instrument module → lever arm for offset
- Center of Mass is what moves on the orbit – it does not really move up and down; altimeter, tracking antennas, LRA move in opposite sense to solar array CM movement



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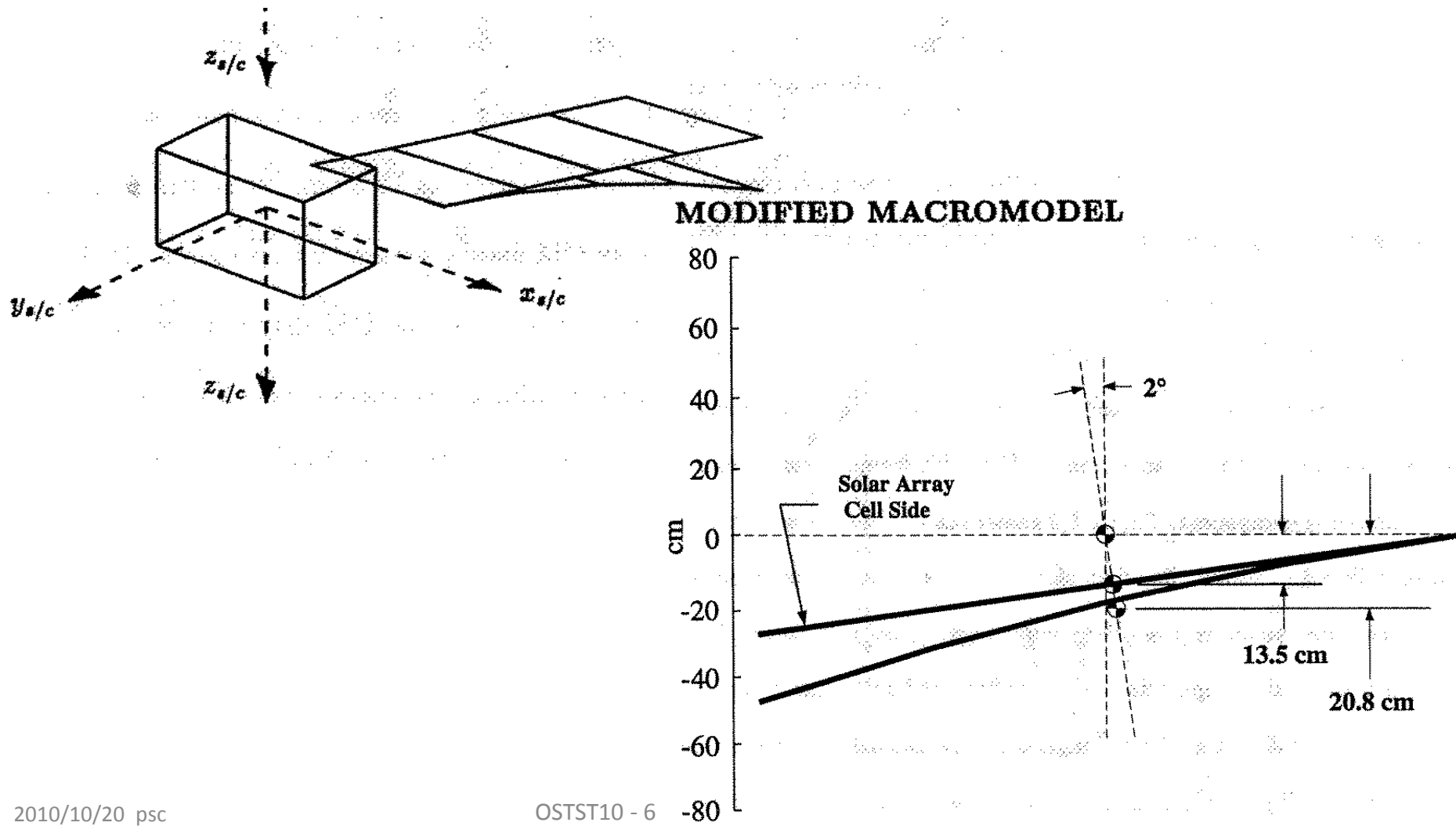
Algorithm Background

- C (code comments) Note: Offset of SA CM is based on deflection equation for thermal distortion of a cantilever beam. Information was derived from the CM_MOVE subroutine written by Paul Baird of Fairchild - 301-428-5397. (See Roark, Formulas for Stress and Strain, 5th Ed., Table 3:6a.)
 - CM offset is determined by calculating the CM of the parabolic shape by integrating the deflection equation and assuming the SA has a constant mass per unit length.
 - The factor obtained is 6.44 mm deflection per deg C temperature difference. This factor was obtained using the mass of the panels only. It must be modified by the ratio of the panel mass to the mass of the panel plus the yoke. This factor is 0.9.



Pictures

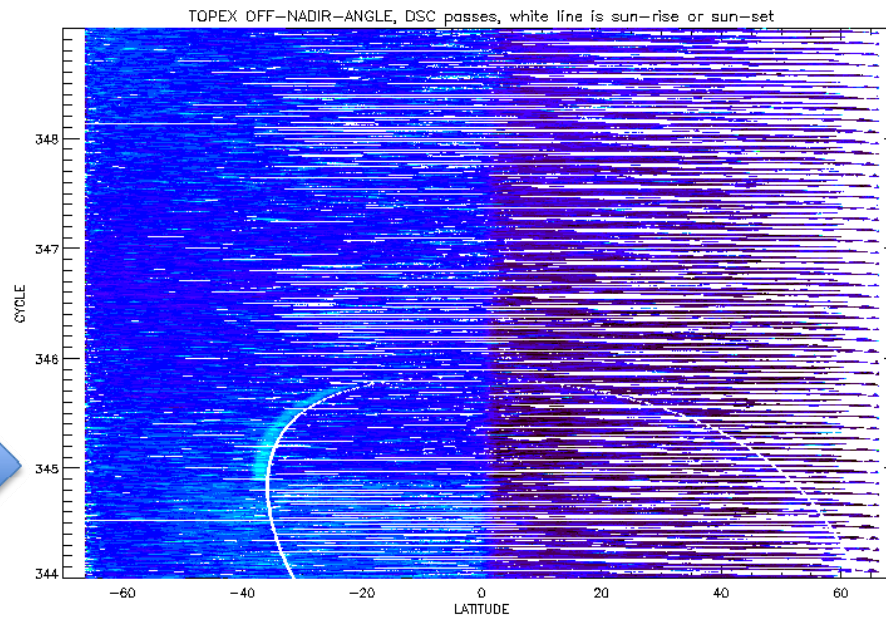
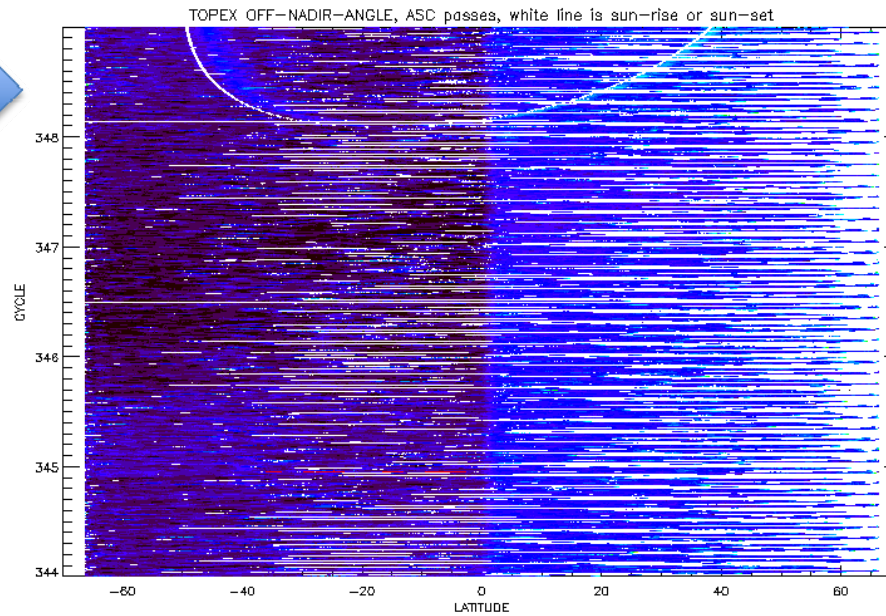
- From Daniel Kubitschek, U. Colorado, PhD Dissertation, 1997





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Solar Array “Snap”





Algorithm s1038 Structure

- Algorithm s1038 -- Center of Mass Correction to Height (Range).
- The algorithm computes the range correction due to the nadir component of the displacement between the center of mass and the altimeter zero reference point.
- C CALL INPUTS --
- C FLAG_Quaternion - Attitude interpolation quality
- C FLAG_Solar_Array_Pitch_Angle - SA pitch interpolation quality
- C FLAG_Solar_Array_Temperature - Temp diff interpolation quality
- C Mid_frame_UTC - Altimeter time tag - J2000
- C Roll_STR - Satellite roll angle in degrees
- C Pitch_STR - Satellite pitch angle in degrees
- C Solar_Array_Pitch_Angle_STR - Solar array pitch angle in degrees
- C Solar_Array_Temp_Diff - Solar array front-to-back temperature difference in deg C

- C CALL OUTPUTS --
- C CG_range_corr - CG range correction in mm (static part due to fuel usage and fixed geometry only)
- C Delta_range_corr - Variable part of correction, in mm
- C FLAG_CG_corr - Correction quality logical flag

- C INPUT COMMONS --
- C SDP_MASSCOM - Center of mass parameters input by SDP_RDSCM during program initialization
- C S1038COM - Constants for algorithm S1038 from algorithm constants file
- C T1310COM - Constants for algorithm T1310 from algorithm constants file

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- Output zero for solar array temp difference or attitude bad