Validating an Improved LEO POD Strategy in the CDAAC Processing

Teresa Van Hove, Yoke Yoon, Jan Weiss
COSMIC Program, University Corporation for Atmospheric Research, Boulder, CO

Abstract

An improved low Earth orbiter (LEO) precise orbit determination (POD) strategy has been developed and implemented in the CDAAC processing system in preparation for COSMIC-2. This strategy includes RINEX observation smoothing, cycle slip detection, and an iterative dynamic and reduced dynamic approach. We apply this new strategy to the KOMPSAT-5, satellite, which serves as COSMIC-2 testbeds. Internal orbit assessment methods, such as GPS measurement residuals and orbit overlap statistics, are used to validate the precision of the new orbit solutions. Initial results show more days pass our quality checks for KOMPSAT-5 POD, and noticeable improvement in the 3D RMS orbit overlap over a year of data. In this poster, we will present detailed description of our improved LEO POD strategy and results for KOMPSAT-5.

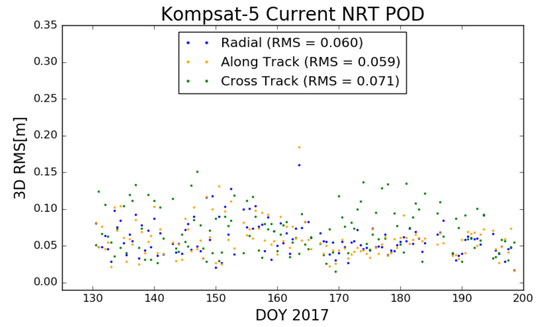
POD Strategy Summary

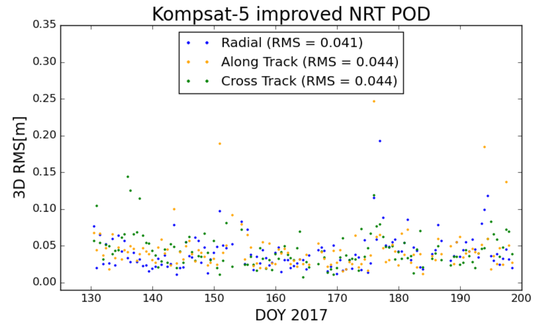
	Current method	Improved method
Cycle slip detection	Use triple difference phase	Use of WL and GF linear combination Use triple difference phase
Dynamic orbit generation	• Non-iterative • Periodic empirical acceleration in radial, along- and cross-track direction • Stochastic pulse in along-track directions every 12 min	• Iterative • Constant and periodic empirical acceleration in radial, along- and cross-track direction • Stochastic pulse in along-track direction every 15min
Reduced dynamic orbit generation	Not implemented	• Iterative • Constant empirical acceleration in radial, along- and cross-track directions • Piece-wise constant acceleration in radial, along-and cross-track direction every 10min

- Current operational LEO POD system uses non-iterative method. It does not include a reduced-dynamic orbit determination step
- The improved POD strategy has been under evaluation on our development and test operational system since May 10, 2017

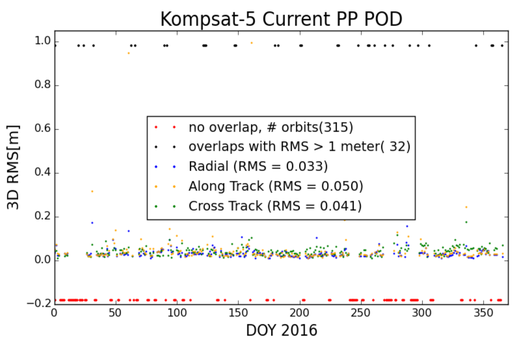
POD Solution Comparison

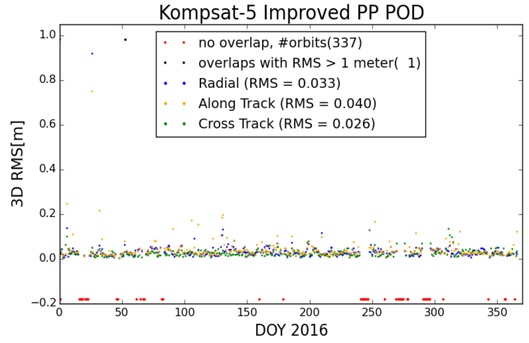
- The improved POD strategy has been implemented for the Kompsat-5 in near-real time (NRT) and post-processing (PP)
- Results below show orbit overlap statistics between the two POD strategies since May 10, 2017
- Each NRT overlap statistic between consecutive orbits consists of ~2hour of data





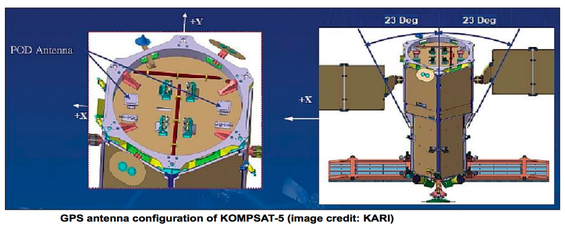
- PP POD consists of a 27-hour arc with 3-hour of overlap statistics



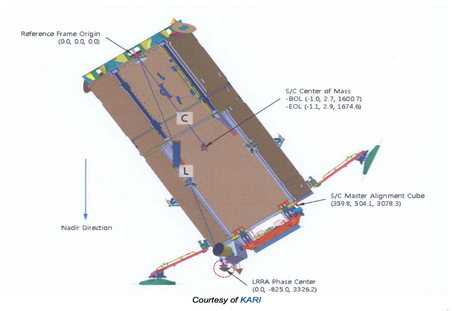


- Overlap statistics from the improved POD strategy demonstrate better consistency in the overall orbit solution
- Replacement of the old NRT POD system is foreseen by end of 2017
- The improved POD strategy will also be implemented and tested (NRT, post-processing and reprocessing) for other RO missions such as Metop, GRACE, TerraSar-X, CHAMP, etc.

Brief Description of the Kompsat-5 Satellite and Instruments Location



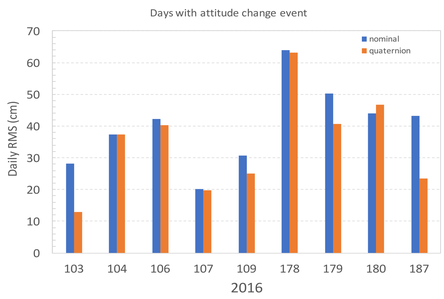
GPS antenna configuration of KOMPSAT-5 (image credit: KARI)

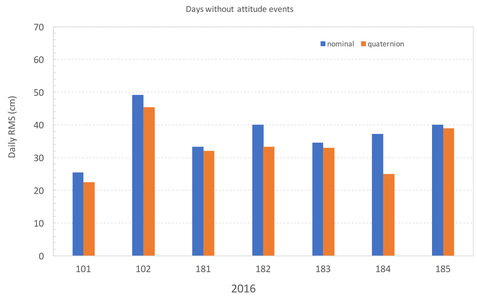


Courtesy of KARI

- Kompsat-5 was launched on August 22, 2013
- Kompsat-5 attitude model in the POD is based on nominal attitude model with POD and LRR antenna location configured in nominal flight mode (right figure)
- The nominal flight orientation varies in roll angle between -33.4 and -34, 0.35 deg peak-to-peak variation in pitch, and ~8 deg peak-to-peak variation in yaw angle
- Antenna locations are currently based on beginning of life (BOL) coordinates. An update to the coordinates will be implemented soon.

Impact of Attitude Quaternion on Orbit Quality





- Orbit analysis covers 20 days of Kompsat-5 data (DOY 101-110 and 178-187 of 2016)
- Days with no attitude change event show on average a 11.4% improvement
- Days with attitude change/event show on average a 15.5 % improvement
- Large station measurement bias exists in the daily statistics which needs further investigation
- Most of the laser measurements are not in the vicinity of attitude events, thus improvement is minimal
- 4 out of the 20 days are excluded due to data gap, orbit maintenance maneuver and anomalies