GLOBAL PRECIPITATION MEASUREMENT (GPM) AND INTERNATIONAL SPACE STATIONS (ISS) COORDINATION FOR CUBESAT DEPLOYMENTS

James H. Pawloski , Earth Science Mission Operations, NASA/GSFC, Maryland, USA
Jorge Aviles, Ralph Myers, GPM Flight Operations Team, Honeywell Technical Services, NASA/GSFC, Maryland, USA
Joshua Parris, Bryan Corley, Garrett Hehn & Joseph Pascucci (SGT), International Space Station (ISS), Houston, Texas, USA

WHAT PROTECTS YOUR SPACECRAFT FROM A CONJUNCTION WITH A DEPLOYED CUBESAT?
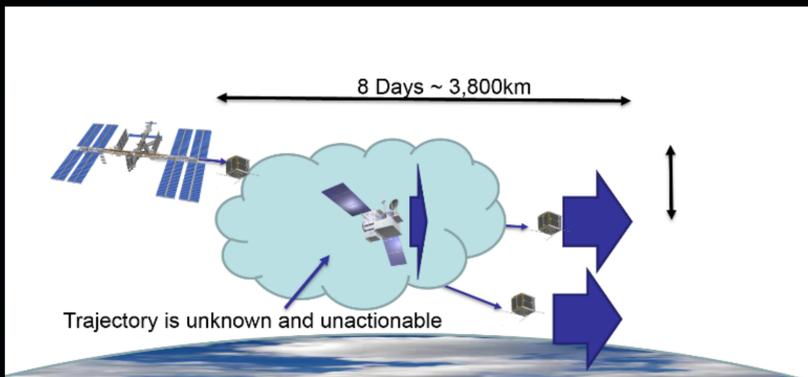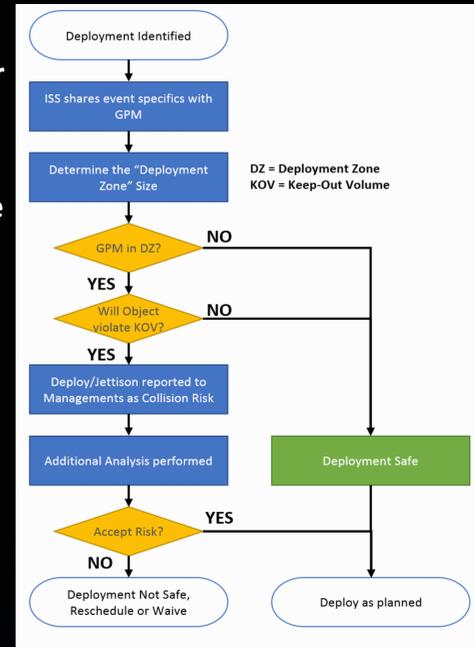

https://secure.flickr.com/photos/nasa2explore/12801808743/in/set-72157629601396498

Several days can pass from deploy until cataloged by JSpOC. Assuming 6 days for JSpOC and 2 for GPM reaction time...

8 Days ~ 3,800km

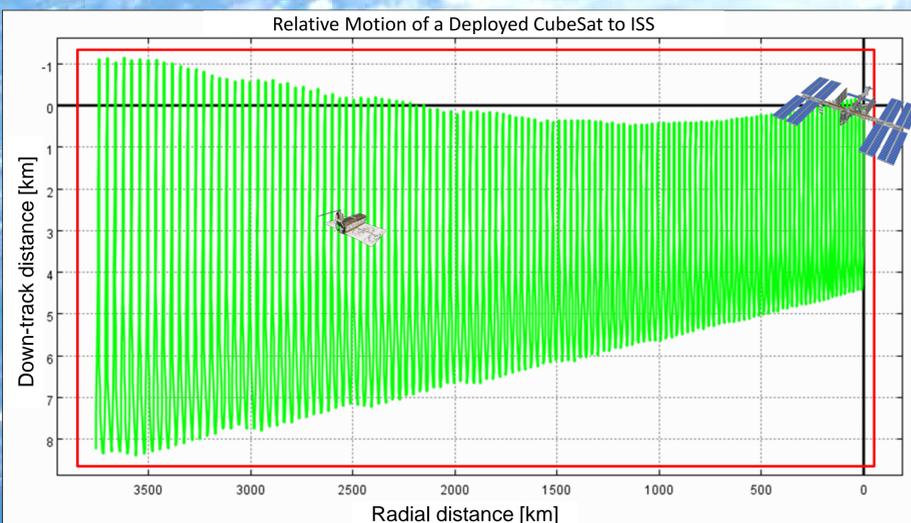Trajectory is unknown and unactionable

STEP 1: COMMUNICATIONS

- ISS alerts GPM for planned deployments & jettisons at least a month in advance
- ISS alerts GPM within 24 hours following successful deployments and jettisons.
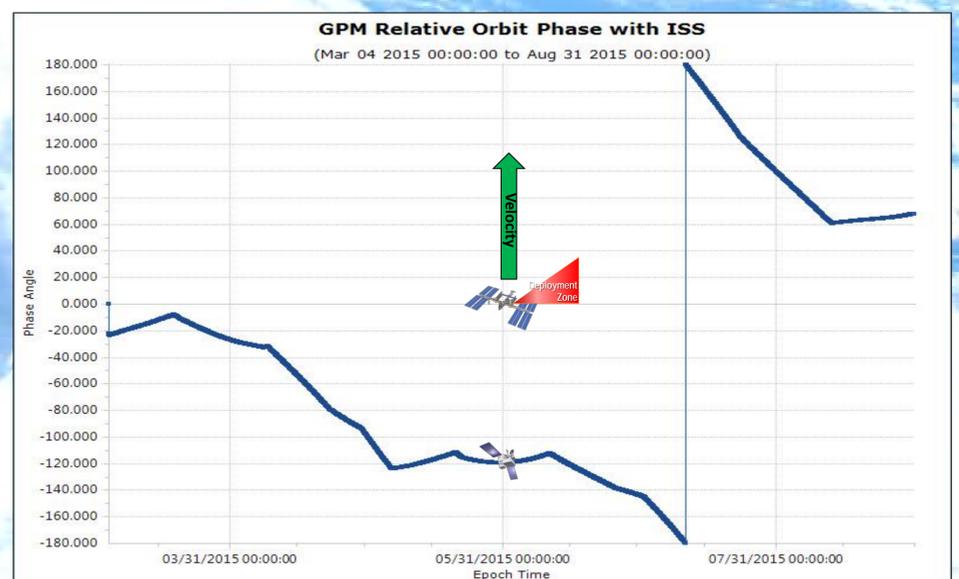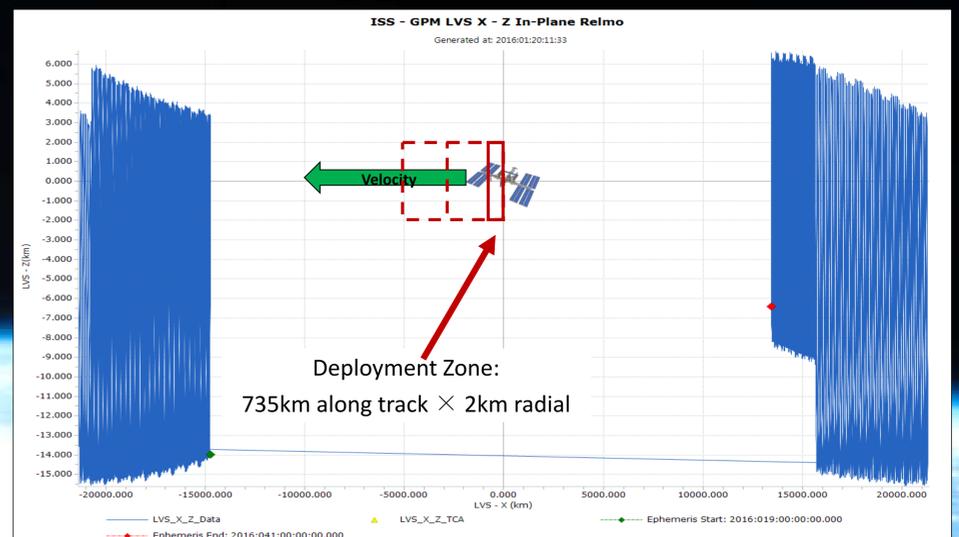
STEP 2: TRAJECTORY SHARING

- ISS Trajectory Team provides a weekly predicted ephemeris (8-week span) to the GPM FOT for predicting GPM/ISS separation distance and Drag Make-Up Maneuver (DMUM) plans and monthly 6-month long term predicted ephemeris.
- GPM provides ISS Trajectory Team a weekly predicted ephemeris (30-day span) for predicting GPM/ISS separation distances.

CubeSat relative motion analysis over time was used to bound expected CubeSat motion.

Relative Motion of a Deployed CubeSat to ISS

GPM AND ISS HAVE SOLVED THIS CHALLENGE BY INSTITUTING A SIMPLE PROCESS THAT ALLOWS QUICK VERIFICATION OF POTENTIAL PROBLEMS

STEP 1: Enable communications between operations teams for situational awareness

STEP 2: Share predicted trajectory to allow relative motion & phase analysis

STEP 3: Reduce the problem to one dimension, along track, to determine if a conjunction is possible. Try to keep GPM out of the Deployment Zone.

STEP 4: If needed, conduct more sophisticated analysis to determine if a conjunction is possible

DZ = Deployment Zone
KOV = Keep-Out Volume

STEP 3: FIRST ORDER DEPLOYMENT ZONE

- ISS deployments are safe if GPM flies outside of the Deployment Zone
- GPM will try to alter their burns to minimize time in the Deployment Zone

ISS - GPM LVS X - Z In-Plane Relmo

Deployment Zone:
735km along track × 2km radial

GPM Relative Orbit Phase with ISS
(Mar 04 2015 00:00:00 to Aug 31 2015 00:00:00)

STEP 4: CONDUCT MORE ANALYSIS FOR WHAT'S LEFT

- ISS Trajectory Team conducts further nodal analysis to prove that the deployment will not pose a collision risk to GPM.
- ISS & GPM will discuss the deployment risk if deployments cannot meet the requirements of these analyses.

GPM and ISS instituted a simple process to clear most deployments. The problem is reduced to a single dimension without performing excessive analysis of trajectories and covariances, and focusing analysis effort to more concerning deployments.