Radio Occultation From POD to Bending Angle

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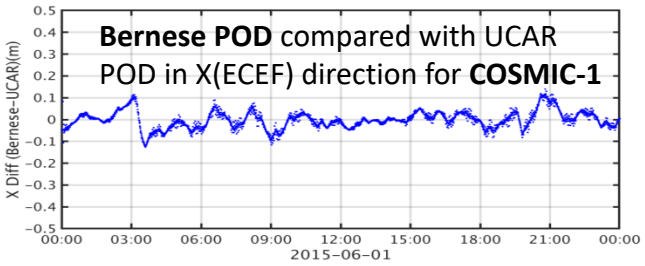
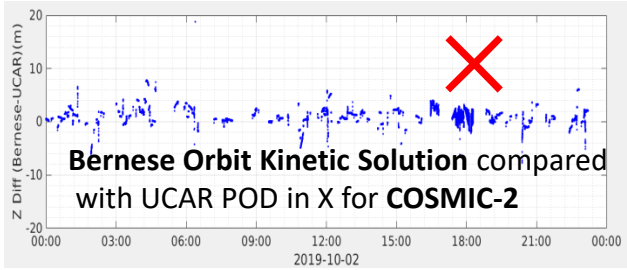
Statement of Work

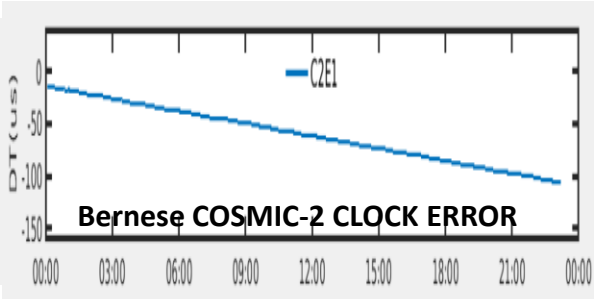
- Leo Precise Orbit Determination
  - Understand and run Bernese Software
  - Understand errors in orbital interpolation and coordinate transformation
  - Leo Receiver Clock error estimation
  - Understand LEO attitude (Quaternions , ECEF/ECI coordinates, Space Craft/Instrument)
- RO Event Determination
  - Readers for GPS observations as phase and pseudo range.
  - Determine observation intervals to separate each RO event in both OCC and POD antenna observations.
  - SNR check, phase scaling factor, cycle slip removal, phase model calculation
  - Pair RO event from OCC antenna with event from POD antenna (1Hz or high rate) for single differencing.
- Excess Phase Model
  - For each RO event
  - Calculate atmospheric path delay (excess phase) from raw observation
    Contributions from LEO/GNSS range, clock errors of Leo and GNSS, general relativity, phase windup etc.
  - Determine excess doppler shift
  - Cycle slip and Navigation Data Modulation removal.
- Bending Angle/refractivity Calculation
  - Using ROPP to do the integration
  - Using ROPP for internal bit correation to remove cycle slips
  - Decodeing GPS/GlONASS Navigation Bit time series
- RO data validation, inter-mission/inter center comparison, Climate monitoring using RO datasets

Current and Important Work

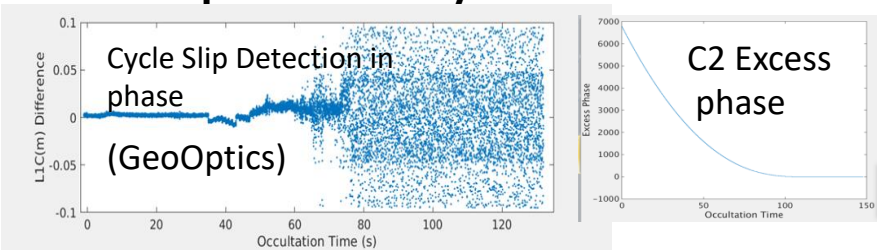
1. Bernese Software for POD and CLOCK error estimation



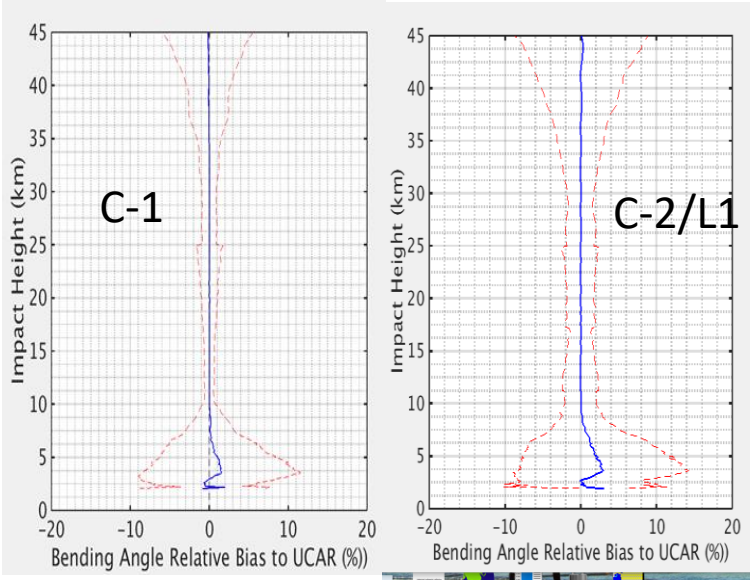




2. Excess phase model/calculation



3. ROPP Bending Angle/Refractivity calculation



4. Validation/Calibration RO Products from different missions

Papers/Presentations

- **Presentations**
  - **Zhang,B**., S. Ho, X.Shao and C.Cao, Using Radio Occultation observations to detect ATMS brightness temperature bias, International Radio Occultation Working Group (IROWG), Helsingør, Denmark, 09/19-09/25,2019 (poster).
  - Cao,C., E.M. Lynch, **B. Zhang**, T. Reale and Y. Bai. GNSS-RO Data Quality Assurance for Operational Weather Forecast Using the Integrated Calibration, Verification and Validation System, AMS, Phoenix, AZ, 2019 (poster)
  - **Zhang, B**., E. M. Lynch, C. Cao, X. Shao, and L. Lin. Recent Results in the Validation and Monitoring of COSMIC Radio Occultation Performance, AMS, Phoenix, AZ, 2019 (Talk)
  - **Zhang, B.,** SP Ho, X Shao and C Cao. Error Assessments in the GNSS Radio Occultation Excess Phase/Bending Angle Calculation, AMS, boston, MA, 2020 (talk)
- Papers (to be)
  - RO L1a to L1B processing
  - ATMS/RO inter-comparison (?)