Ionospheric Data Processing and Retrieval

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Total electron content data (podTec)

Number of TEC arcs processed in the past week

2006.283: 2541
2006.284: 2612
2006.285: 3369
2006.286: 2528
2006.287: 2599
2006.288: 3226
2006.289: 2930

Total: 19806
Absolute TEC processing

- Pseudo-range local multipath
- Phase cycle-slips & outliers (Blewitt, 1990)
- Phase-to-pseudorange leveling
- Differential code bias calibration
Pseudo-range local multipath calibration

C003.2006.284.04.46.0016.G11.00 --- without multipath calibration

C003.2006.284.04.46.0016.G11.00 --- with multipath calibration
Pseudo-range local multipath calibration

C003.2006.283.23.48.0014.G16.00 --- without multipath calibration

- P2 - P1 pseudo-range
- L1 - L2 phase levelled to P2 - P1

C003.2006.283.23.48.0014.G16.00 --- with multipath calibration

- P2 - P1 pseudo-range
- L1 - L2 phase levelled to P2 - P1
Phase-to-pseudorange leveling statistics

Without multipath calibration

With multipath calibration

levelingerr = \frac{\text{RMS}}{\sqrt{N}} \; (\text{TECU}), \quad N = \text{number of data points in arc}
LEO Differential Code Bias estimation

- Weighted average of paired observations

- Assumption:
  \[ \text{TEC}_A \mathcal{M}(\theta_A) = \text{TEC}_B \mathcal{M}(\theta_B) \]

- Foelsche-Kirchengast (2002) geometric mapping function:
  \[ \mathcal{M}(\theta) = \frac{\sin \theta + \sqrt{\tilde{r}^{-2} - \cos^2 \theta}}{1 + \tilde{r}^{-1}} \]

\[ \text{DCB}_{\text{leo}} = \frac{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A))(\widehat{\text{TEC}}_A \mathcal{M}(\theta_A) - \widehat{\text{TEC}}_B \mathcal{M}(\theta_B))}{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A))^2} \]
LEO Differential Code Bias estimation

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LEO Differential Code Bias estimation

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\[ DCB_{leo} = \frac{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A))(\widehat{TEC}_A \mathcal{M}(\theta_A) - \widehat{TEC}_B \mathcal{M}(\theta_B))}{\sum (\mathcal{M}(\theta_B) - \mathcal{M}(\theta_A))^2} \]
Near real-time DCB solution for FM5, POD 01

Daily average
Regularized solution
Near real-time DCB solution for all 12 POD antennas
Absolute TEC statistics

TEC at elevation angles $> 45^\circ$, latitude $> 60^\circ$, local time $< 7$ am

tecsinmax = $\text{TEC} \sin \theta$ at maximum elevation (TECU)
Number of electron density profiles processed in the past week:

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<td>2006.289</td>
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<td><strong>Total</strong>:</td>
<td><strong>13349</strong></td>
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</table>

Profiles collected within 10 minutes on Oct 12.
- Subtracting positive elevation angle data from negative elevation angle (Schreiner et al., 1999)
- Model independent estimate of upper boundary electron density (Syndergaard et al., 2006)
- Profile retrieval based on straight-line and spherical symmetry assumptions
Comparisons with ground-based data

Cosmic occultation on April 28, 2006  UT=20.5

- Occultation: (47.3N, 102.8W)
- ISR LP at MHR (42.6N, 72.5W)
- ISR AC at MHR
- Ionosonde at MHR
- Ionosonde at Boulder (40.0N, 105.3W)
Comparisons with ground-based data

Occultation: (42.7N,−72.0W) & Ground-based Observations

- COSMIC Occultation
- ISR AC at Millstone Hill
- ISR LP at Millstone Hill
- Ionosonde at Wallpos Ls

DAY: 214
UT: 13.1
Using GAIM to correct for gradients

Courtesy of Zhen Zeng
High-rate scintillation data (atmPhs)

Number of high-rate excess phase and amplitude profiles processed in the past week

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<tbody>
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<td>2006.289</td>
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Examples of large amplitude scintillations on Sep 22
Number of TIP dumps processed in the past week

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<td>2006.288</td>
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<tr>
<td>2006.289</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>89</strong></td>
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Tri-Band Beacon data (tbb???)
Problems and anticipated improvements

- Absolute TEC and DCBs seem biased by a few TECU (should be addressed soon – anticipating new version numbers 0001.0002 on real-time podTec and leoDcb files)

- Trying to resolve issue with NSPO regarding erroneous solar array drive angle data at times (h/w angles vs s/w angles) used in our multipath calibration

- Many ionospheric rising occultations start too late (working with JPL to lower the starting altitude for rising occultations)

- TIP data processing mostly working thanks to hard work from Scott Budzien (NRL) – a few remaining issues with timing and quality flag – radiances not yet calibrated

- Considering to make TIP level 1b data available from the CDAAC website
Absolute TEC latency

Latency of podTec data for the past week

Number of TEC arcs vs. Latency (minutes)

— this is where we are...
Absolute TEC latency

Latency of podTec data for the past week

— this is our goal!