Processing of FORMOSAT-3/COSMIC Ionospheric Data at CDAAC

Stig Syndergaard

UCAR COSMIC Project Office
COSMIC ionospheric data

- GPS
  - TEC
  - Profiles
  - Scint.
- TBB
  - TIP
    - UV Rad
  - TEC
  - Scint.
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

TEC arcs from one dump on June 1st, FM3 Aft-POD antenna (2006.152.003.02.01)
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

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

C003.2006.284.04.46.0016.G11.00 --- with multipath calibration

P2 - P1 pseudo-range
L1 - L2 phase levelled to P2 - P1
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 $= \frac{\text{RMS}}{\sqrt{N}}$ (TECU), \hspace{1cm} 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:
  \[ \mathcal{M}(\theta) = \frac{\sin \theta + \sqrt{\tilde{r}^{-2} - \cos^2 \theta}}{1 + \tilde{r}^{-1}} \]

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

DOY 2006
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

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

- 2006.283: 1710
- 2006.284: 1790
- 2006.285: 2222
- 2006.286: 1714
- 2006.287: 1885
- 2006.288: 2184
- 2006.289: 1844

Total: 13349
• 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
High-rate scintillation data (atmPhs)

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

\[
\begin{align*}
2006.283: & \quad 1530 \\
2006.284: & \quad 1635 \\
2006.285: & \quad 2114 \\
2006.286: & \quad 1664 \\
2006.287: & \quad 1807 \\
2006.288: & \quad 2061 \\
2006.289: & \quad 1830 \\
\text{Total:} & \quad 12641
\end{align*}
\]

Examples of large amplitude scintillations on Sep 22
Number of TIP dumps processed in the past week:

- 2006.283: 5
- 2006.284: 8
- 2006.285: 16
- 2006.286: 12
- 2006.287: 10
- 2006.288: 18
- 2006.289: 20

Total: 89
Tri-Band Beacon data (tbb???)
• Absolute TEC and DCBs seem biased by a few TECU (should be addressed soon – look out for new version numbers 0001.0002 on real-time podTec and leoDcb files)

• 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) – radiances not yet calibrated

• tipLv1 data files soon to be available from the CDAAC website

• Latency...
Absolute TEC latency

Latency of podTec data for the past week

Number of TEC arcs

Latency (minutes)

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

Latency of podTec data for the past week

— this is our goal!