Results from the Ørsted-GPS Occultation Experiment

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The Ørsted satellite

- Launched February 1999
- Orbit altitude: 650–865 km
- Inclination: 96.5°
- Mass: 60.7 kg
Atmosphere profiling
Data processing and products

Ørsted orbit determination
- Position
- Velocity

Neutral atmospheric profiling
- Refractivity
- Pressure
- Temperature

Ionospheric profiling
- Total Electron Content
- Electron density
Data quality

- L1 - L2 difference can not generally be trusted
- 1–2 second data gaps every 10 second
- Noise on C/A (0.3–1 m) limits the accuracy
- Smoothed L1 - C/A difference used for ionosphere correction
- Orbit accuracy: 2–50 m (2–50 mm/s)
Data processing

Input data

- Ørsted phase and pseudo-range (L1 and C1)
- Ground-station phase and pseudo-range (L1, L2, and C1)
- Ørsted position and velocity fix (every 10 sec)

Pre-processing

- Data de-compression and formatting
- Orbit determination using GIPSY
- Cycleslip detection and correction (only on 1 Hz data)
- Filtering, interpolation and data gap filling

Orbit arc construction

- Interpolation to 10 Hz
- Correction for signal travel time

Phase corrections

- Double differencing (clock correction)
- Tropospheric correction
- Relativistic correction
- Ionospheric correction

Bending angle calculation

- Bending angle bias correction (model constrained)

Abel transform and hydrostatic integration
Comparison of temperature profiles with ECMWF analysis

Temperature profiles at 38°N, 115°E
Comparison of temperature profiles with ECMWF analysis

Temperature profiles at 69°N, 111°W

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Oersted
ECMWF
Distribution of \(\sim500\) profiles (11 days in February 2000)
Statistics for \(~500\) profiles (11 days in February 2000)

ECMWF data reduced to refractivity and "dry" temperature for comparison

- Mean difference \(~1\) K between 500 and 30 mb (5–25 km)
- Standard deviation 2–4 K in same interval
- “Negative N-bias” probably due to spurious tracking in the lower troposphere
Example of spurious tracking in the lower troposphere

Temperature profiles at 38°N, 102°W
Comparison of electron density profiles with MU radar and digisonde observations over Japan

- Good agreement above F-layer peak
- Vertical resolution limited by sampling rate (~30 km)
- Bias below F-layer due to spherical symmetry assumption
Conclusions

Main problem: poor L2 data quality
- Affects orbit determination
  - accuracy $\sim 50 \text{ m}$ at present—but can be improved
  - Mitigated by bending angle bias correction
- Affects ionosphere correction
  - Mitigated by smoothing L1 - C/A difference
  - limits accuracy of bias correction
- Limits accuracy of retrieved profiles

Minor problems: high-rate data gaps; spacecraft attitude; power limitations
- Data gaps affects resolution in the neutral atmosphere
- Attitude problems affects quantity and quality of occultations

Neutral atmospheric profiles
- Individual profiles can be significantly biased
- Mean accuracy as good as GPS/MET between 5 and 25 km
- Standard deviation is a little larger than GPS/MET

Electron density profiles
- Good accuracy above F-layer—but low resolution
- Bias below F-layer should be minimized using constraints