Estimation of sporadic E layer parameters from GPS radio occultation measurements

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Sporadic E characteristics

- regions of enhanced electron density
- altitude range: 90 and 120 km
- thickness: ~1 bis 5 km
- horizontal extent: max. 1000 km
- Es formation depends on ionization rates, zonal wind shears, H-component of Earth’s magnetic field

Electron density profile measured by CHAMP
Sporadic E formation at midlatitudes

Chemistry
- Metallic ions from meteor ablation

Shears in zonal wind
- Wind reversal mainly produced by atmospheric tides

Magnetic field
- Inclination, H-component
GPS RO data: electron density vs SNR profiles
Data analysis – Es detection

- SNR profiles (50 Hz) of GPS L1 signal (high vertical resolution of ~50 m)
- Normalise profiles
- Calculate standard deviation in 2.0 km running windows
- Identify vertically thin structures by applying a band pass filter
- Calculate S4 index around the point of max deviation (51 values)

Information on:
- altitude
- latitude/longitude
- local time
- intensity
Comparison of ionosonde sporadic E parameters (Pruhonice, Prague, Czech Republic) with coinciding radio occultation measurements 2009/2010, N=29

\[ y = 0.80x + 23.14 \]

altitude off set of 3.4km at 100km
Sporadic E layer occurrence 2011 - 2016

- Sporadic E is a phenomenon of the summer hemisphere
- Low Es rates at high latitudes
- Earth's magnetic equator is clearly visible
Sporadic E layer intensity 2011 - 2016

- Highest S4 values found at midlatitudes
- Summer maximum is even more pronounced
- Very weak Es events in South Africa/South Atlantic → magnetic field
Sporadic E occurrence and intensity show a pronounced annual cycle.

At low latitudes, sporadic E is present almost throughout the year.

Highest intensities are found at midlatitudes during summer.
Interannual behaviour 2008-2016

- Alternating summer maximum between SH and NH
- Stable at midlatitudes
- Trend at low latitudes
Measurements of FORMOSAT-3/COSMIC provide an excellent data base for global sporadic E layer investigations

It is possible to extract information on sporadic E layer intensities from RO data

Global distribution of Es intensities shows a clear annual cycle of sporadic E occurrence and its intensity

Arras et al., GRL, 2008
Arras et al., Ann. Geo., 2009
Arras et al., Springer, 2013
Fytterer et al., EPS, 2014
Arras and Wickert, JASTP, 2017
Global Es distribution – lat/local time 2011 - 2016

**NH Summer**

- Es occurs mainly during daytime
- Pronounced semidiurnal structure at midlatitudes
- Diurnal structure at low latitudes

**NH Winter**

- Es occurs mainly during daytime
- Pronounced semidiurnal structure at midlatitudes
- Diurnal structure at low latitudes
7th IAGA/ ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System

When? 2 – 6 July 2018
Where? GFZ Potsdam, Germany

Topic? principle mechanisms of vertical coupling processes between the neutral atmosphere, the ionosphere, and the magnetosphere

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