The Low-Latitude Ionosphere: Spatio-Temporal Characterization of the Equatorial Electrojet from Satellite Measurements

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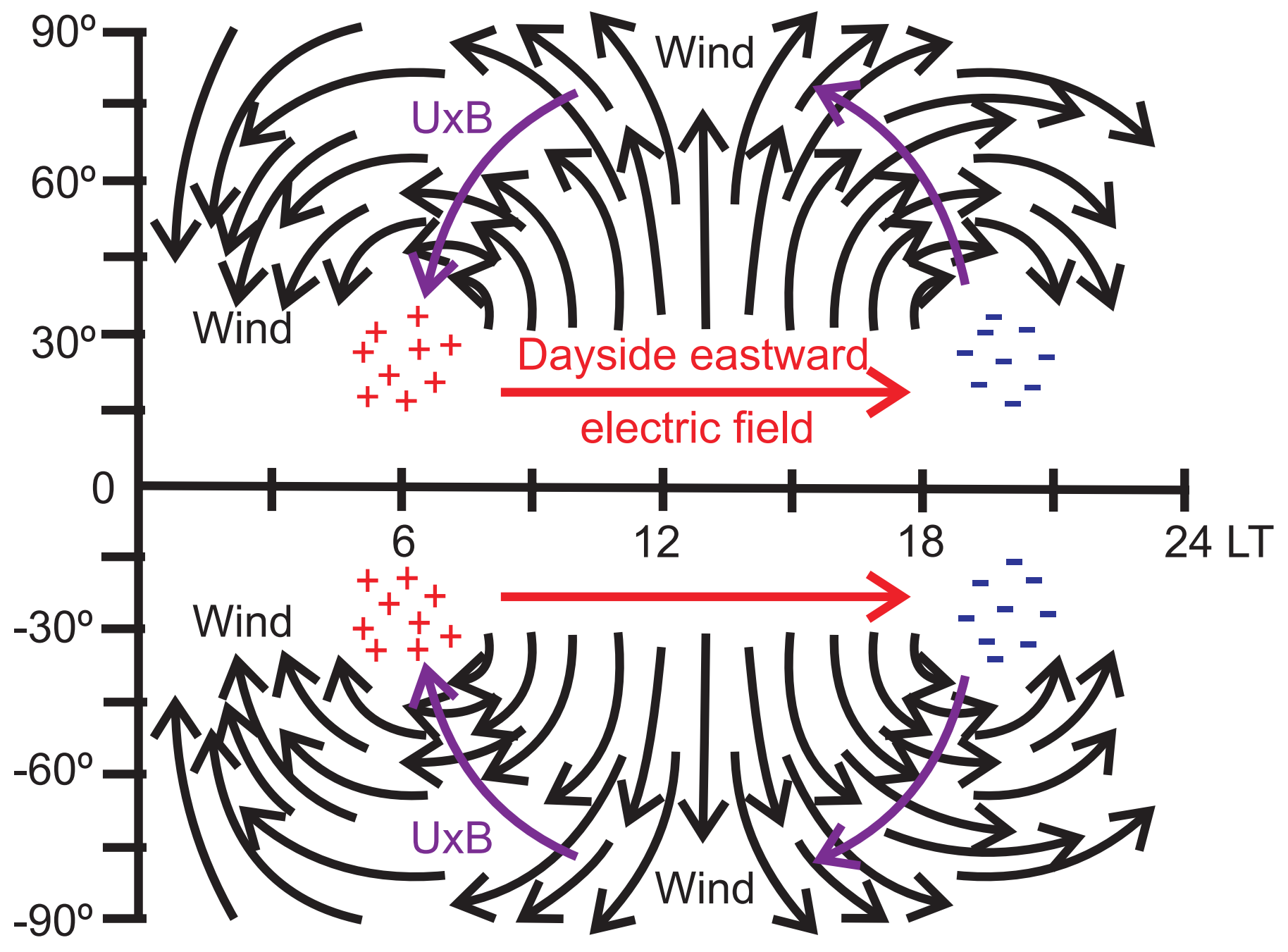
The day-side eastward electric field drives the equatorial electrojet (EEJ) current. We have created a climatological model of this current using satellite magnetic measurements from the CHAMP, Oersted, and SAC-C satellites. Our model includes the mean EEJ current as well as the daily variance of the EEJ.

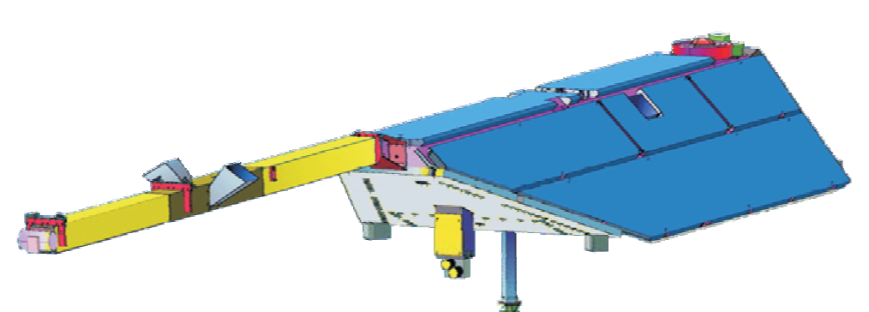
The model has been verified using vertical drift data from the JULIA radar at Jicamarca. We show that our model can predict mean drifts at JULIA to within 2 m/s. We also investigate the self-correlation of the EEJ and find a short spatial correlation length.

The day-side eastward electric field driving the equatorial electrojet

Diurnal tidal winds give rise to a UxB drift of ions in the E-region. This results in a buildup of charges at the dawn and dusk terminators, giving rise to a day-side eastward electric field.

This electric field drives an eastward current along the magnetic equator.



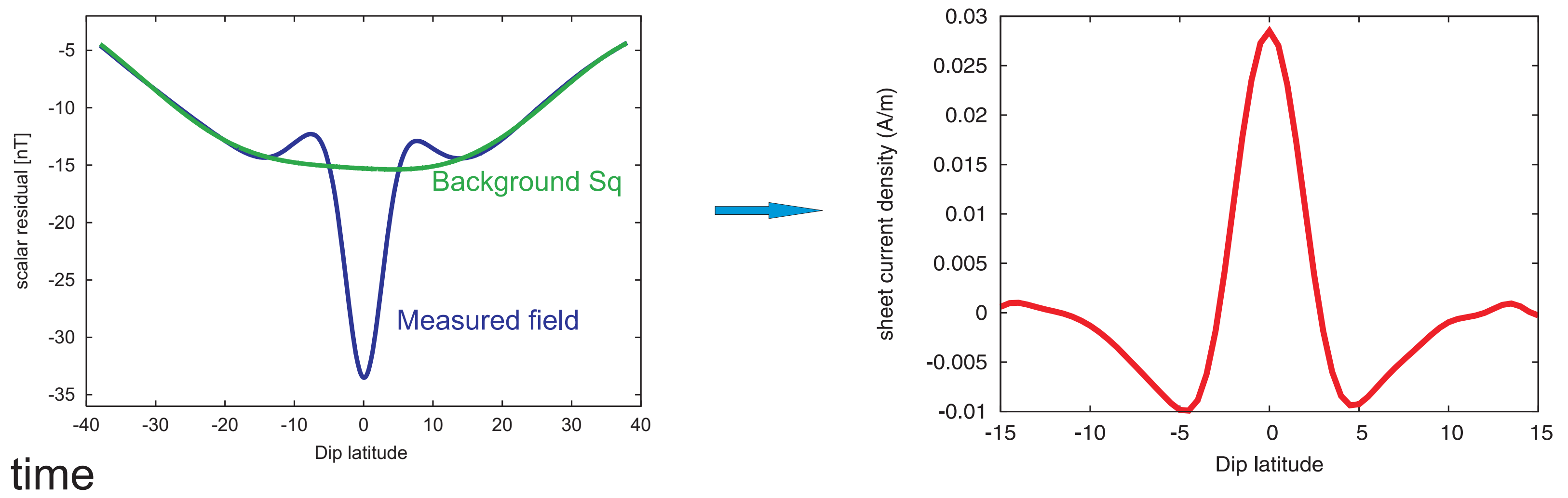


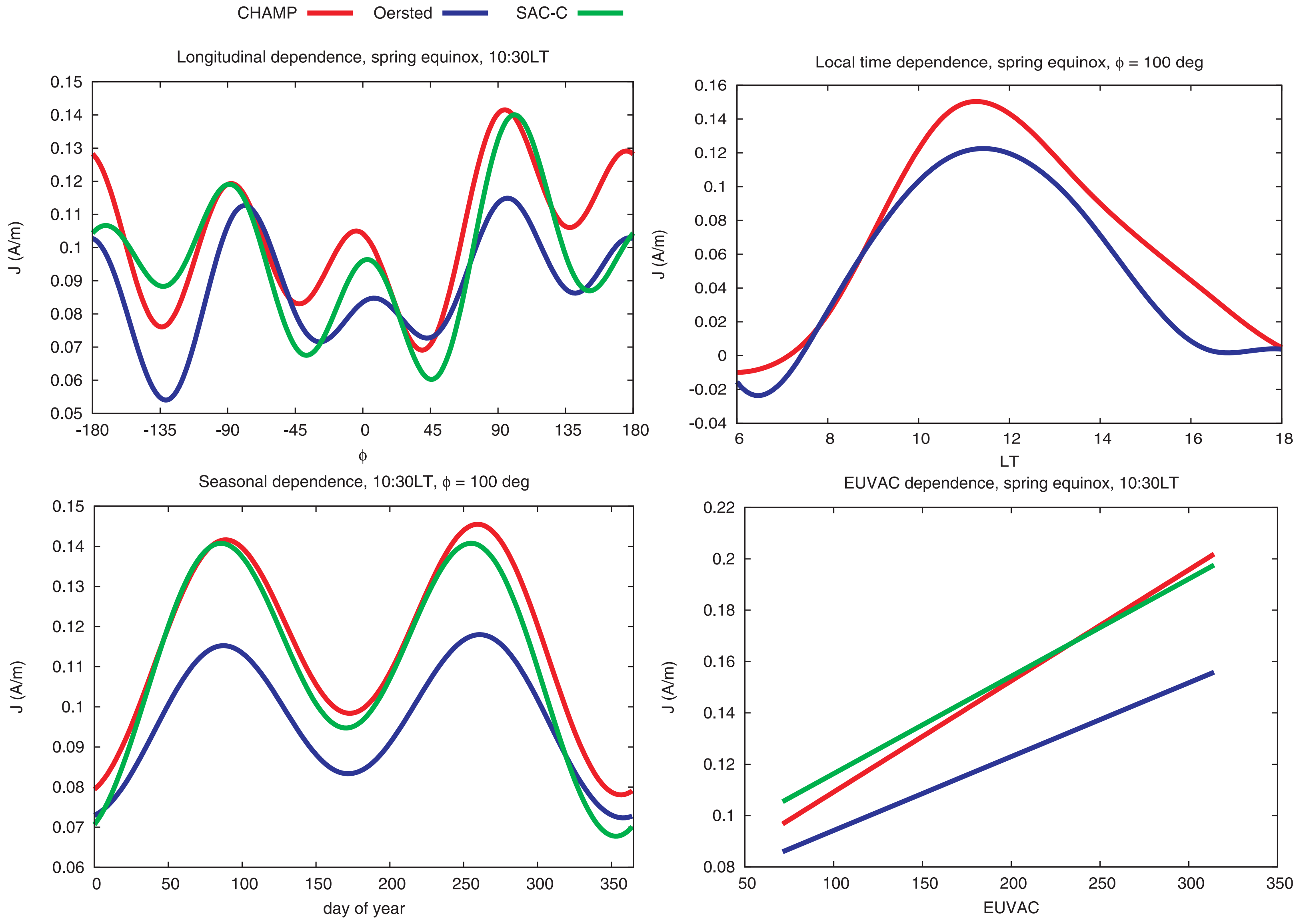
CHAMP (since 2000)
450 km altitude, descending
Drifts rapidly in local time

SAC-C (2000-2004)
700 km altitude
Sun-sync noon-midnight orbit

Oersted (since 1999)
600-800 km altitude, drifts slowly in local time

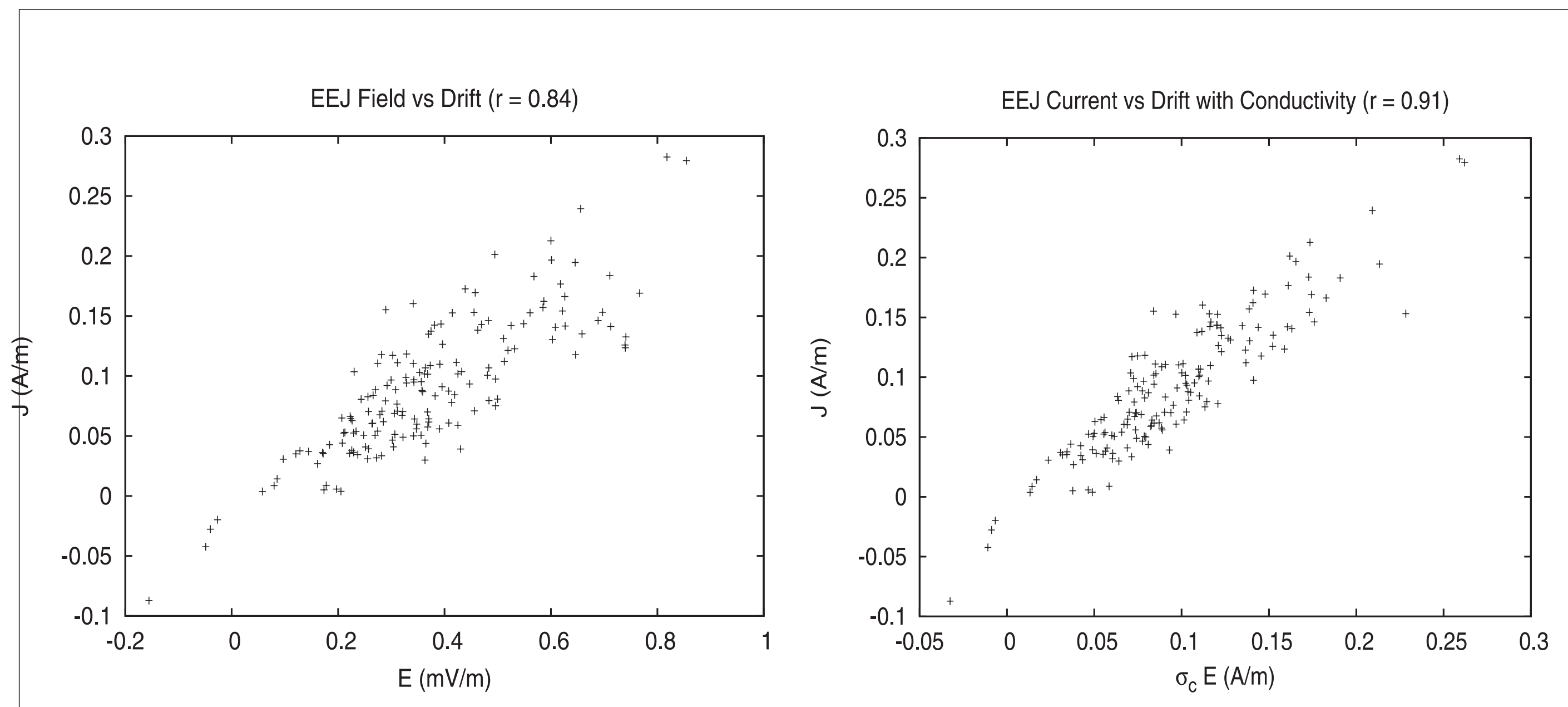
Satellite magnetic measurements





Climatological Model Plots

Our climatological EEJ model has four parameters: longitude, local time, season, and EUVAC. Above are one dimensional sample plots from the four dimensional model for each parameter. The wavenumber-four structure in the longitudinal dependence is due to the diurnal tide. In local time, the EEJ rises sharply to a peak around 10:30-12LT and gradually decreases and dies out around 18:00LT. Seasonally, the EEJ contains peaks at equinox and is significantly lower during solstice. The EUVAC dependence has been found to be approximately linear.

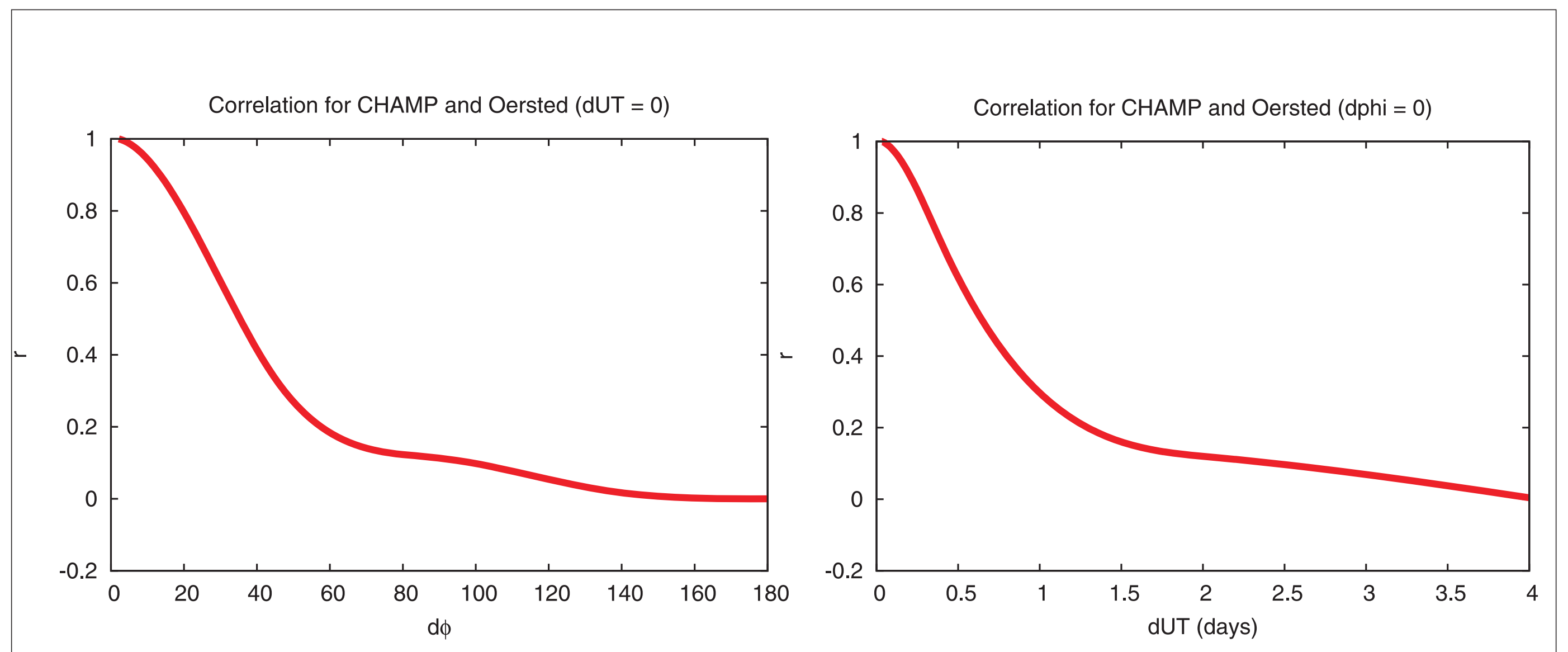


Verifying the model with drifts

To verify the model, we took vertical drift data from the JULIA radar at Jicamarca and compared it to values predicted by our model using $J = \sigma E$. The conductivity was computed using a model $\sigma = a(\mathrm{EUVAC} \times \cos(\chi))^b$. The parameters (a,b) were estimated directly from the JULIA drift and CHAMP current data. This conductivity model improved the correlation of J and E from 0.84 to 0.91 as shown above. Also, using this correlation, we predicted mean electric fields using our climatological EEJ model and compared them with a mean electric field model derived directly from the JULIA data. We found a RMS error of 53.5 uV/m between the two models.

Results

- We have constructed a climatological model of the EEJ mean and variance. The model will be made available online soon.
- The model has been verified against independently measured vertical drift data from JULIA.
- The model has been used to construct the self-correlation of the EEJ. We find a short correlation in longitude, and a significant correlation in time over a period of about a week.



EEJ Self-Correlation

With the models of the climatological mean and variance, we can compute the correlation of the EEJ with itself using two different satellites. Above, we have correlated the EEJ currents from the CHAMP and Oersted satellites over both longitudinal and temporal separation. In longitude, we find a short correlation length (correlation drops significantly after about 30 deg). In time, we find a sharp drop in correlation over the first 10-12 hours, and then a gradual decline over a period of about a week. This shows that a strong EEJ current on one day will produce strong EEJ signals on subsequent days.

References

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