# EEJ Current Distributions from Philippine MAGDAS Data

C. L. Chan[1,2], Q. **SUGON** Jr.[1,2], C. D. Bennett[1,2], R. Otadoy[3], M. Cardinal[4] T. Uozumi[4], A. Yoshikawa[4], D. Mcnamara[1,2]

*1. Manila Observatory, 2. Ateneo de Manila University, 3. University of San Carlos, 4. ICSWSE, Kyushu University.*

## ABSTRACT

We study a finite linear current segment model for EEJ/CEEJ. We use Biot-Savart law to com-pute the magnetic field of the current distribution and use this to interpret the Philippine magnetic data obtained from ICSWSE's MAGDAS mag-netometers. We show that the data from three Philippine magnetometer stations in CDO, CEB, and LGZ for year 2010 yields the following para-meters for the EEJ: height of 923 km to 1,235 km, current intensity of -0.56 A to -1.24 A, and length of 1,385 km to 1,594 km.

## 1. INTRODUCTION

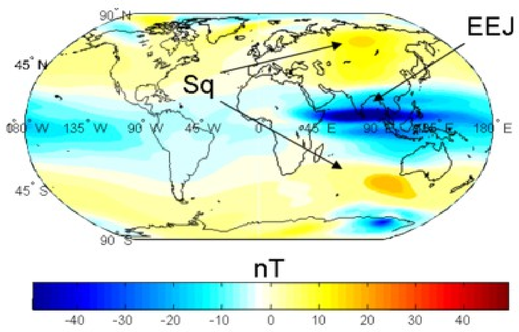


Fig. 1. A model of the Equatorial Electrojet (EEJ) as a band of current moving along the dip equator. (Source: http://en.wikipedia.org/wiki/ Equatorial_ electrojet)

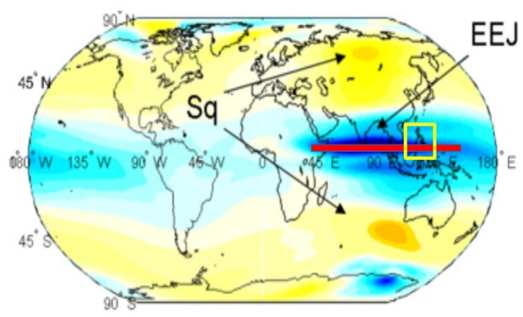


Fig. 2. An approximation of the EEJ as a line current segment (red band) of finite length and infinitesimal width. The yellow box describes the area surrounding the Philippines.


Fig. 3. The EEJ along the dip equator together with three Philippine MAGDAS magnetometer stations LGZ, CEB, and CDO.

**Problem:** Can we measure the height, intensity, and length of the Equatorial Electrojet (EEJ) current using data from three MAGDAS magnetometer stations in the Philippines?

## 2. THEORETICAL FRAMEWORK

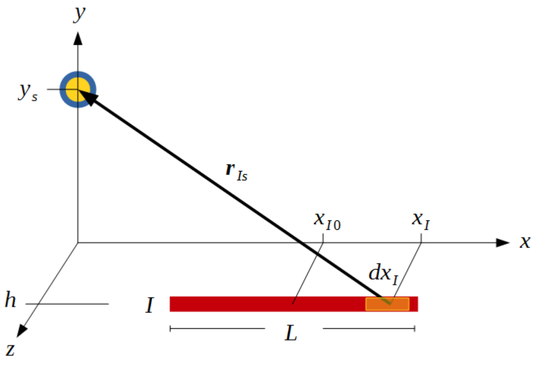


Fig. 4. The position of the current I of length L and height h with respect to a ground magnetometer at station s.

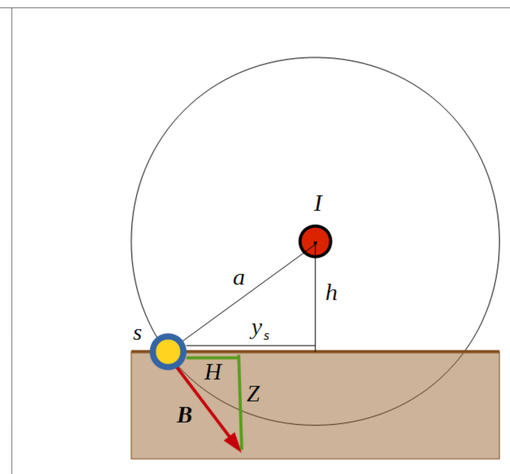


Fig. 5. The magnetic field B generated by the current I at station s. The components of B are the horizontal H and the vertical Z. The current is at a vertical height h and at a perpendicular distance a from the station.

### Biot-Savart Law

$$\boldsymbol{B} = \frac{\mu_0}{4\pi}\int \frac{I\, d\boldsymbol{r}_I \times \hat{r}_{Is}}{r_{Is}^2}$$

### Magnetic Field at the Station

$$\boldsymbol{B} = -\Delta H \boldsymbol{e}_2 + \Delta Z \boldsymbol{e}_3 = \frac{\mu_0 I}{4\pi a^2}(y_s \boldsymbol{e}_2 + h\boldsymbol{e}_3)\beta,$$

where

$$a = \sqrt{y_s^2 + h^2},$$

$$\beta = \frac{x_{I0} + \frac{L}{2}}{\sqrt{a^2 + \left(x_{I0} + \frac{L}{2}\right)^2}} - \frac{x_{I0} - \frac{L}{2}}{\sqrt{a^2 + \left(x_{I0} - \frac{L}{2}\right)^2}}.$$

### Determination of EEJ parameters

$$h = -\frac{\Delta H_0}{\Delta Z_0} y_s, \qquad I = \frac{4\pi a^2 \Delta H_0}{\mu_0 h \beta_0}$$

$$L = -\beta_{FWHM}$$

## 3. METHODOLOGY

### Filtering out the background magnetic field

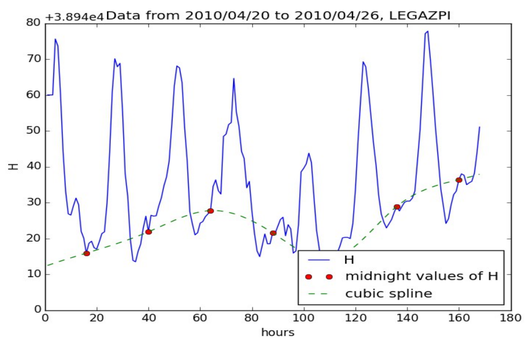


Fig. 6 How to find the background magnetic field by connecting the midnight values with a cubic spline.

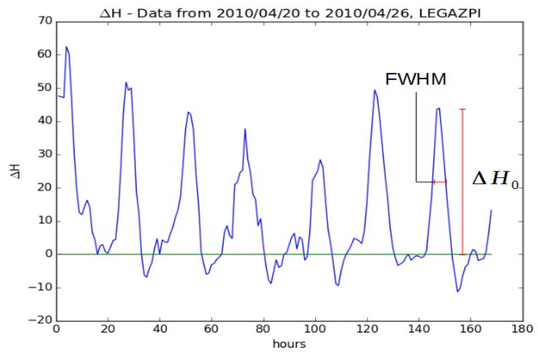


Fig. 7. How to find the magnetic field variation by subtracting the background magnetic field from the raw data. From this the peak magnetic field variation and the full-width half-maximum (FWHM) can then be obtained.

## 4. RESULTS AND DISCUSSION

### EEJ Height

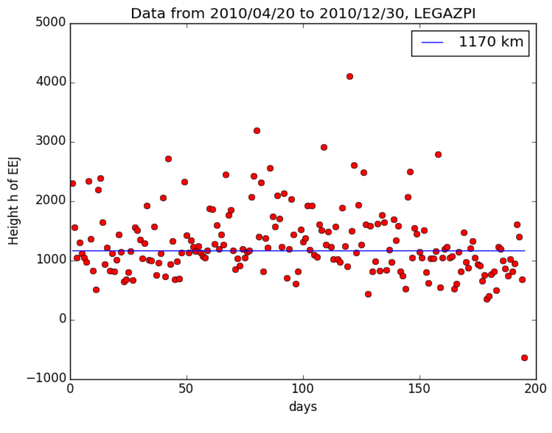


Fig. 8. The median EEJ height in LGZ station is 1,170 km.


Co-sponsored by

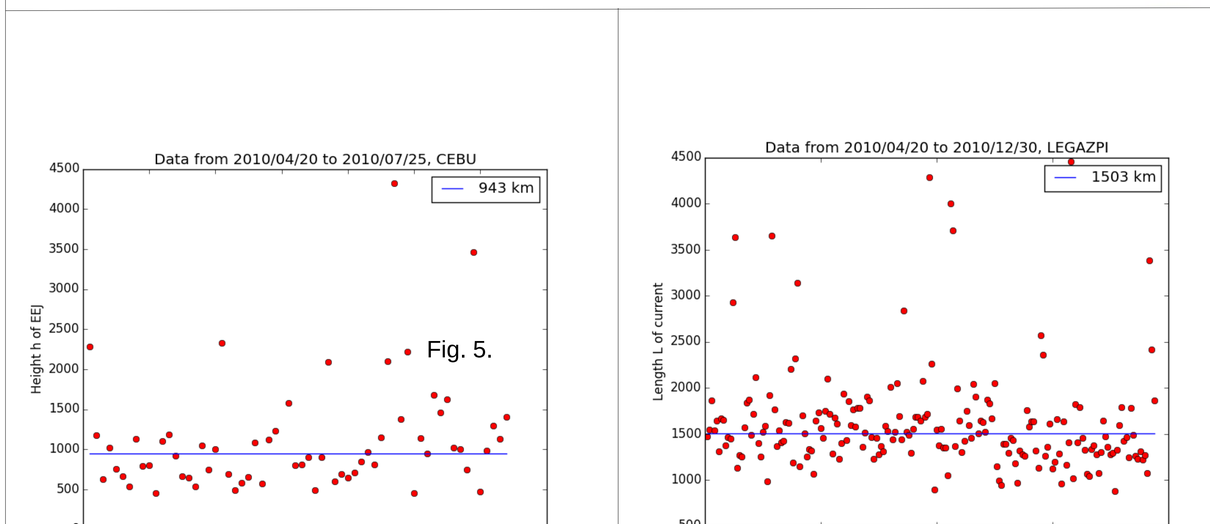


Fig. 8. The median EEJ height in CEB station is 943 km.

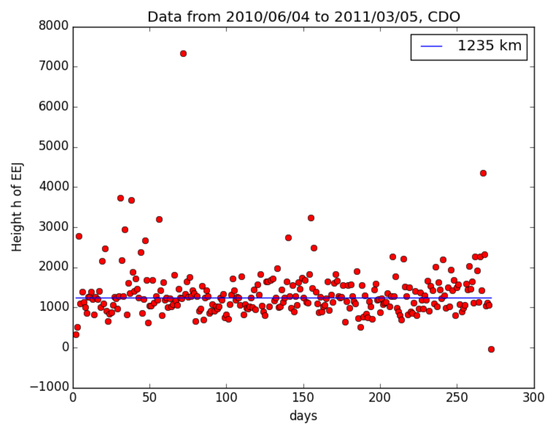


Fig. 9. The median EEJ height in CDO station is 1,235 km.

### EEJ Current Intensity

### EEJ Current Intensity

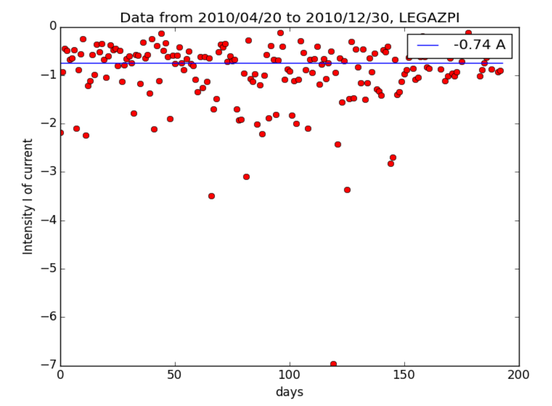


Fig. 10. The median EEJ current intensity in LGZ station is -0.74 A.

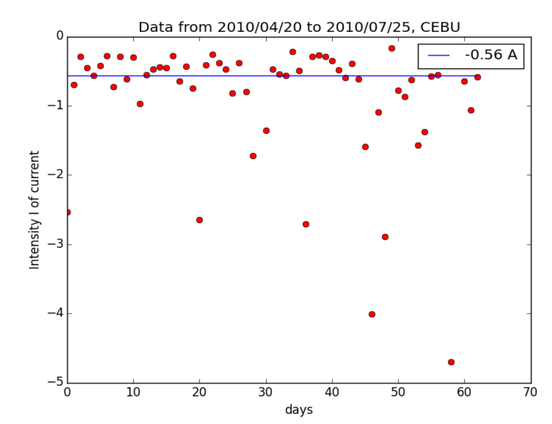


Fig. 11. The median EEJ current intensity in CEB station is -0.56 A.

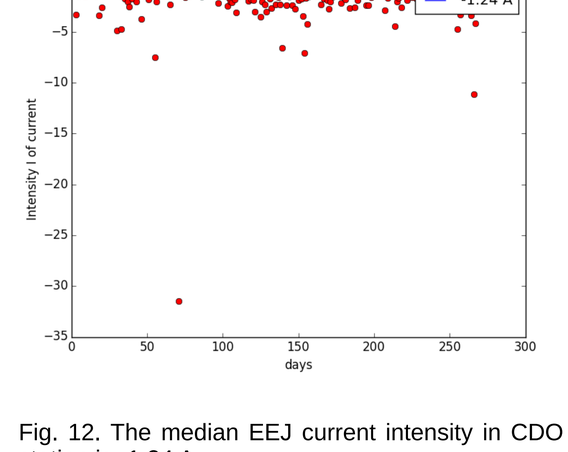


Fig. 12. The median EEJ current intensity in CDO station is -1.24 A.




Fig. 13. The median EEJ length in LGZ station is 1,503 km.

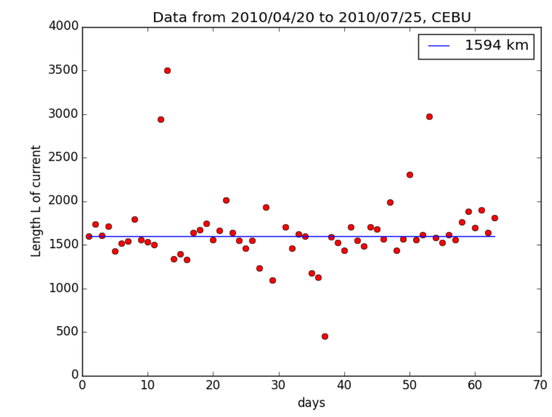


Fig. 14. The median EEJ length in CEB station 1,594 km.

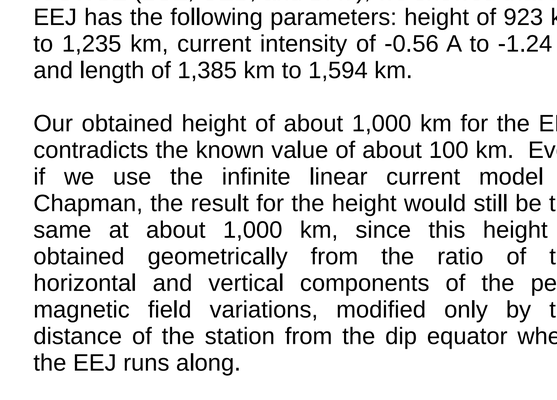


Fig. 15. The median EEJ length in CDO station 1,385 km.

## 5. CONCLUSIONS

We studlied a finite linear current segment model for the Equatorial Electrojet (EEJ). To do this, we used the Biot-Savart law to compute the magnetic field of this line current. This result would then allow us to compute the parameters of the electrojet: (1) height, (2) current intensity, and (3) length. Using the one-year data available for 2010 for three MAGDAS magnetometer stations of ICSWSE (LGZ, CEB, and DAV), we showed that the EEJ has the following parameters: height of 923 km to 1,235 km, current intensity of -0.56 A to -1.24 A, and length of 1,385 km to 1,594 km.

Our obtained height of about 1,000 km for the EEJ contradicts the known value of about 100 km. Even if we use the infinite linear current model of Chapman, the result for the height would still be the same at about 1,000 km, since this height is obtained geometrically from the ratio of the horizontal and vertical components of the peak magnetic field variations, modified only by the distance of the station from the dip equator where the EEJ runs along.

In the future work, we shall study two other current distributions: (1) finite linear current segment and (2) finite arc current segment. These models may hopefully lower down the 1,000 km height estimate for the EEJ to coincide with the known value of 100 km.

## Acknowledgments

We would like to thank ICSWSE of Kyushu University for providing the data for the Philippine MAGDAS stations for 2010 and for providing the travel support to attend the UN/Japan Workshop on Space Weather. We would also like to thank Manila Observatory and Ateneo de Manila University for financial grants for the hiring of research staffs for this project.