Characterization of different magnetospheric and ionospheric contributions at mid-latitude magnetic observatories

Yvelice Castillo[1 2 4], Maria Alexandra Pais[1 2], João Fernandes[1 3], Paulo Ribeiro[1], Anna Morozova[1], Fernando J. G. Pinheiro[1]

(1) CITEUC, Geophysical and Astronomical Observatory, University of Coimbra, 3040-004 Coimbra, Portugal. (2) Department of Physics, University of Coimbra, 3004-516 Coimbra, Portugal.
(3) Department of Mathematics, University of Coimbra, 3004-516 Coimbra, Portugal. (4) Department of Astronomy and Astrophysics, National Autonomous University of Honduras, Boulevard Suyapa, Tegucigalpa, Honduras.

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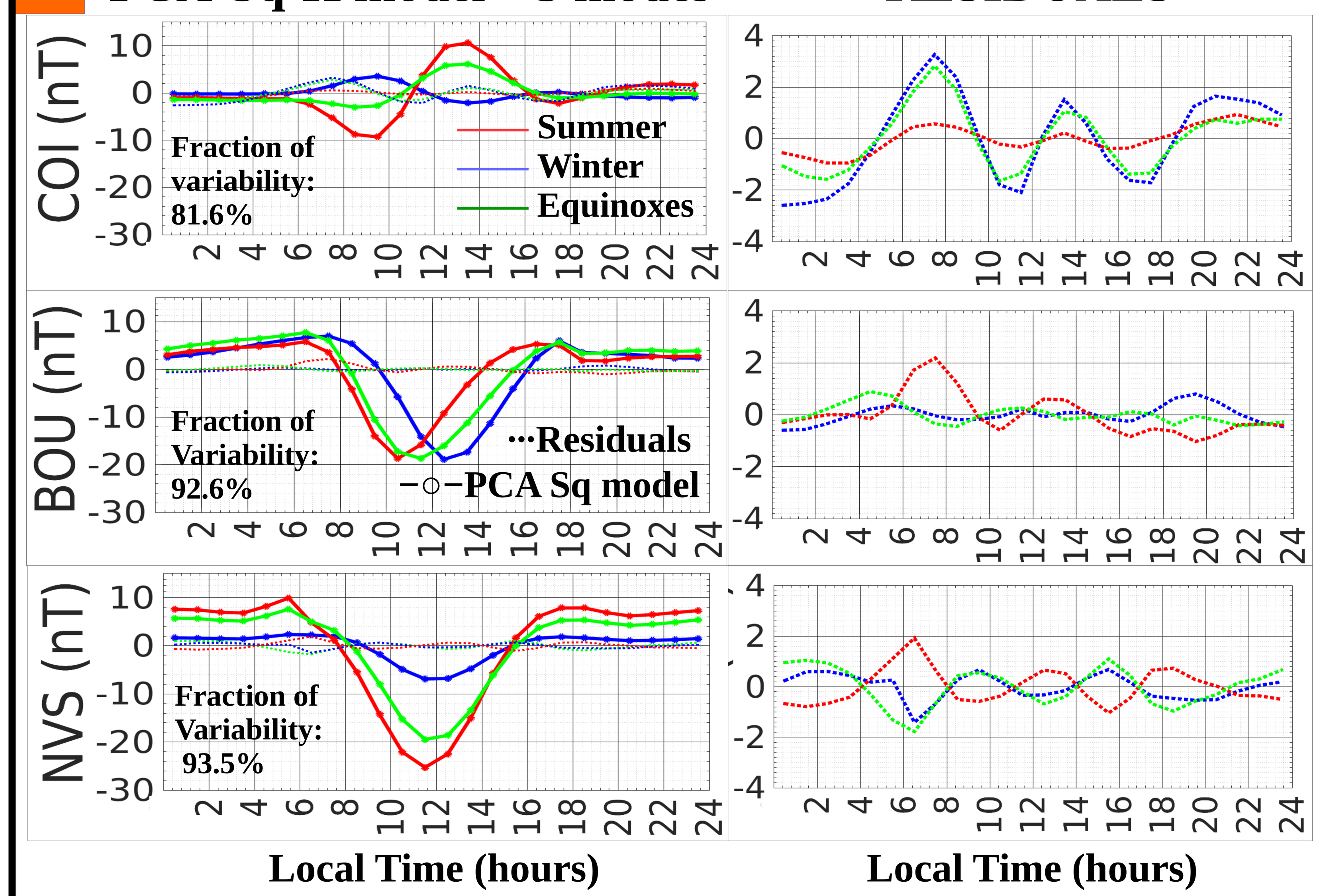
1 INTRODUCTION

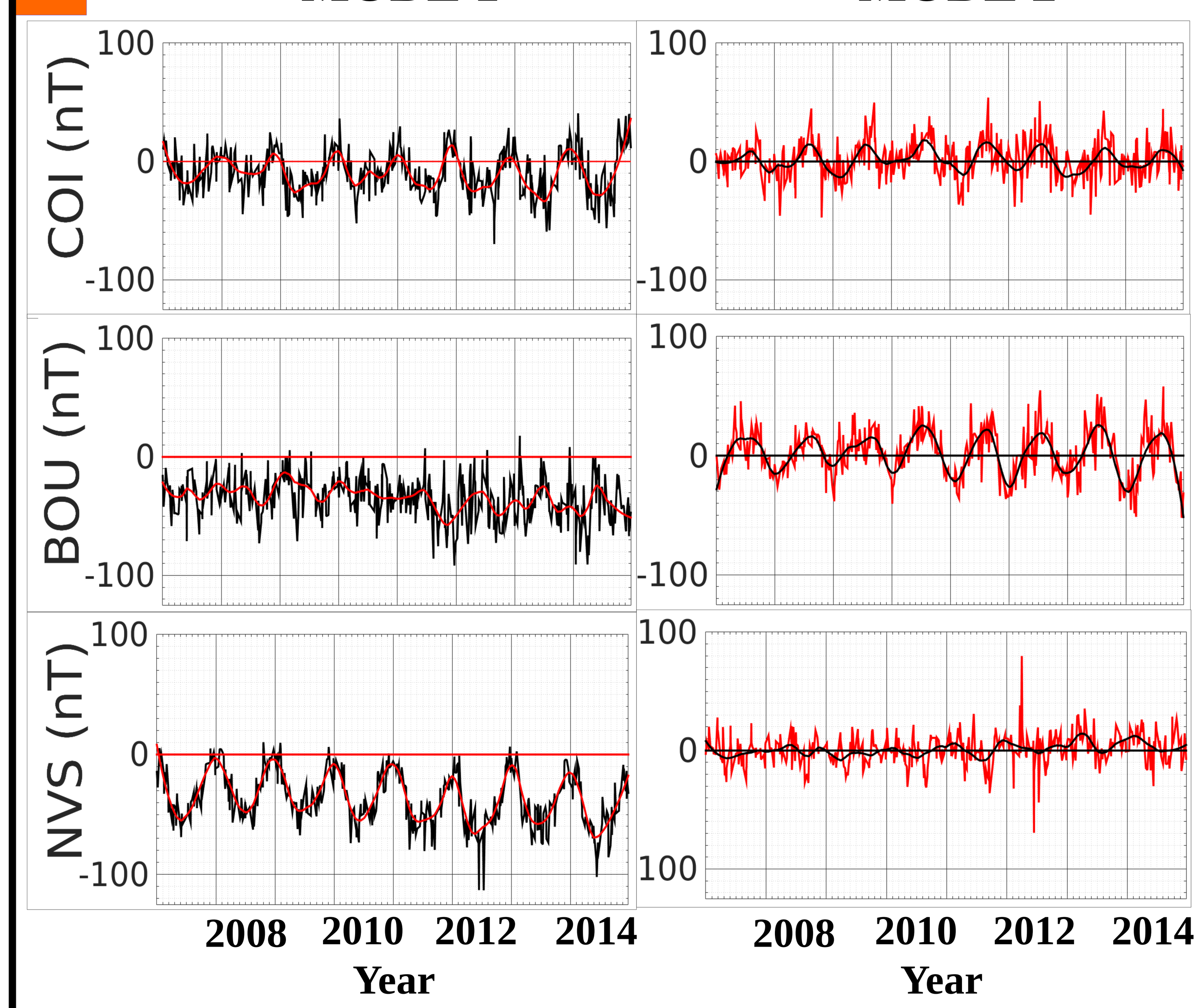
The main goal of space weather (SW) research is to produce reliable forecasts and nowcasts of the space environment and to evaluate the risks for technological infrastructures and human safety. Most of SW studies concern high and equatorial latitudes, because of well-known and significant effects of field-aligned currents and the equatorial electrojet at those latitudes. Less studies are made at mid-latitudes, resulting in an incomplete understanding of the local effect of magnetospheric and ionospheric currents. We compare the performance of global indices of geomagnetic activity such as Dst and RC[1], with simulations of the Tsyganenko semi-empirical model (TSY) of storm-time geomagnetic field[2], during years 2007-2014, in predicting the irregular geomagnetic activity observed at three magnetic observatories sparsely distant in longitude, but with similar geomagnetic latitudes: Coimbra (COI, 40.22 N, 351.58 E), Boulder (BOU, 40.14 N, 254.76 E) and Novosibirsk (NVS, 54.85 N, 83.23 E). We use principal component analysis (PCA) to model the geomagnetic quiet daily variation (Sq) for the years 2007-2014. Then we analyse the performance of indices RC and Dst and of TSY simulations, in explaining series of the geomagnetic horizontal component (H) observed at ground.

2 PCA-Sq-H model – 3 modes RESIDUALS



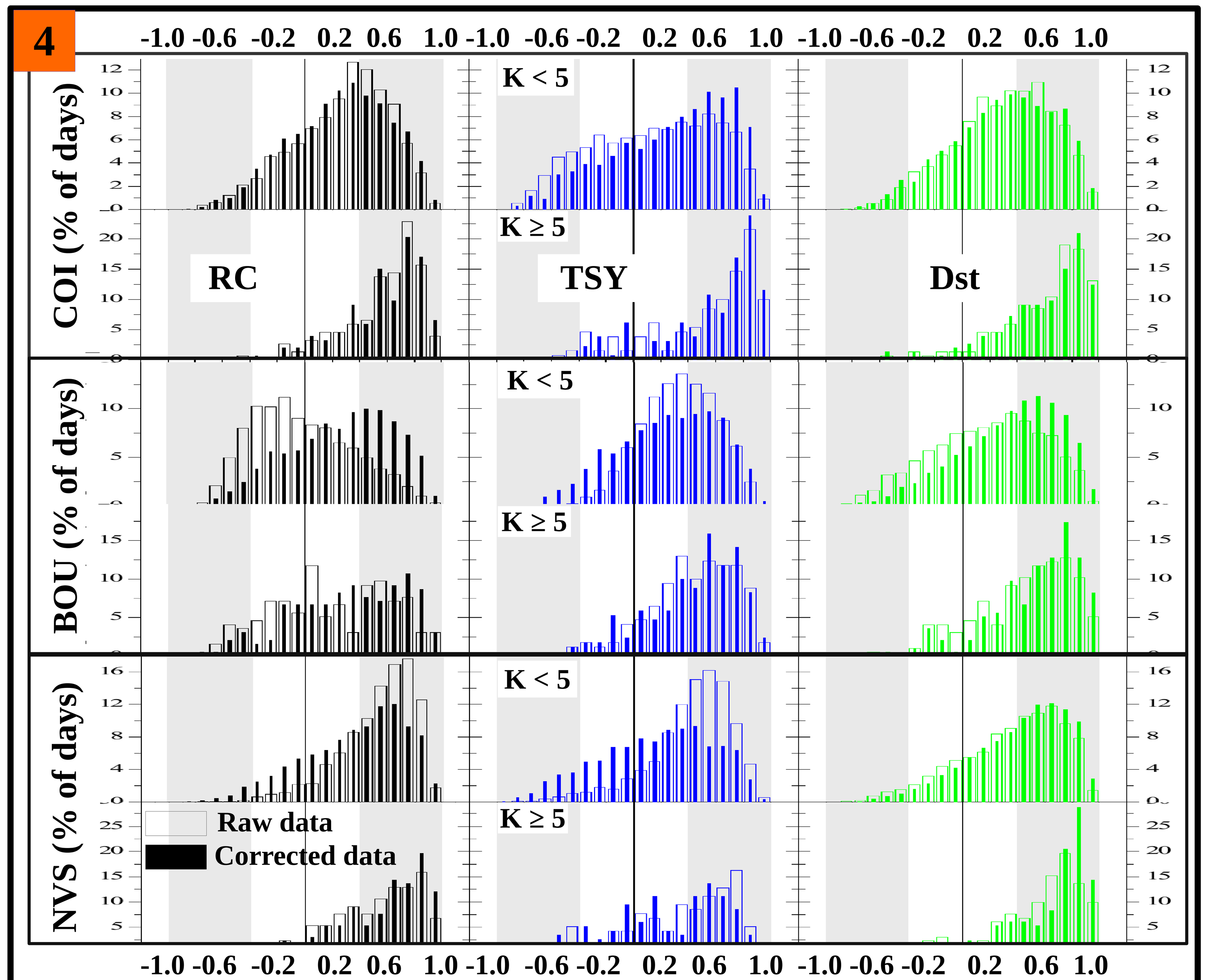
Left: PCA model of quiet-time H-component of the local field (PCA-Sq-H model) with 3 modes, for Winter, Summer and Equinoxes seasons, calculated from the quietest days data of years 2007-2014, for COI, BOU and NVS. Right: Residuals of PCA-Sq-H model, amplified.

3 MODE 1 MODE 2



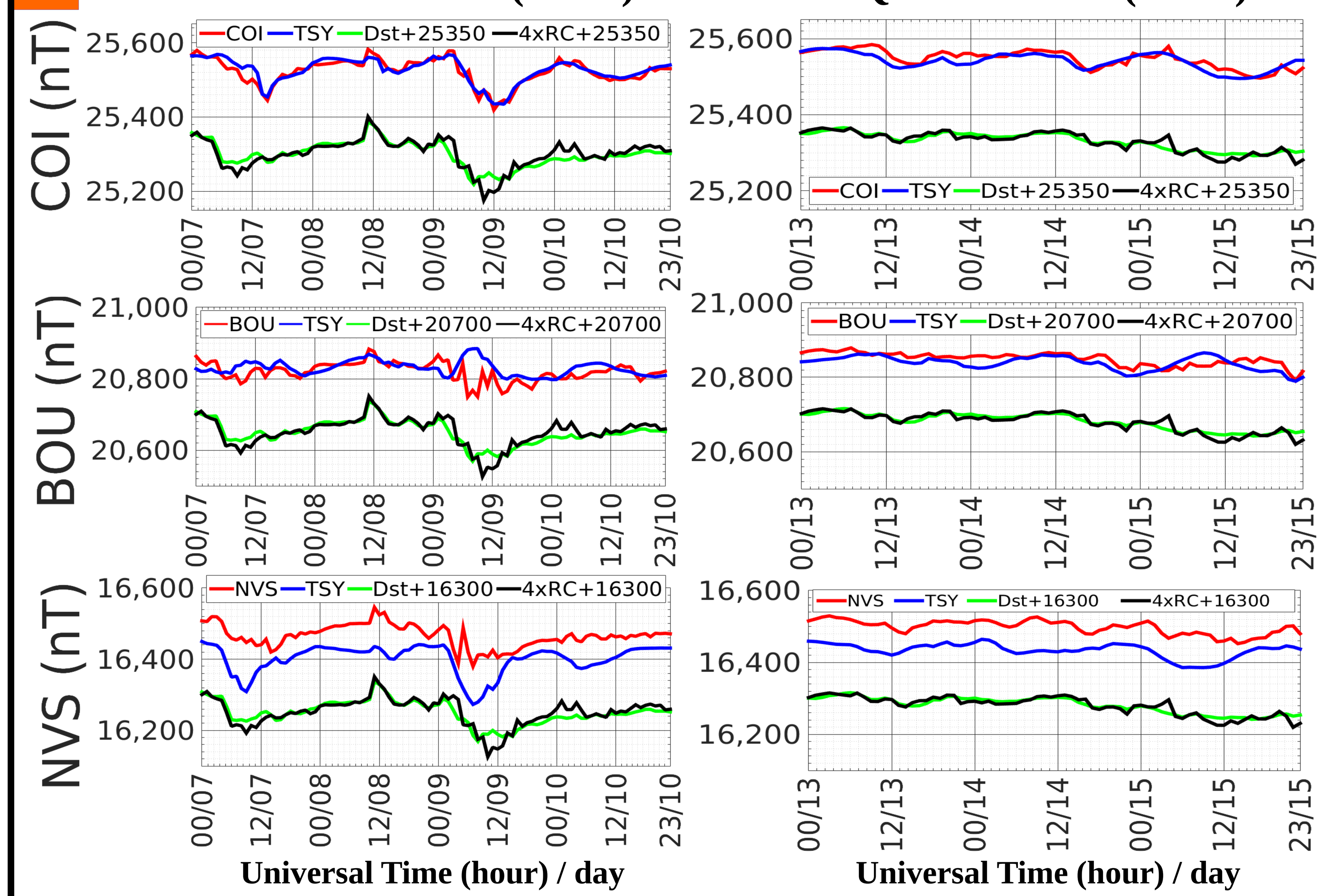
Amplitudes of the first and second PCA modes for the studied observatories. Note the seasonal variation in Sq H-component.

4



CORRELATION COEFFICIENTS DISTRIBUTION. Correlation coefficients (r) were calculated between the observed geomagnetic series, and geomagnetic indices (RC–black, Dst–green) and TSY simulations (blue) separately for days with low (local K < 5) and high (K ≥ 5) geomagnetic activity. White (raw geomagnetic series) and colored (raw data minus PCA model) bars show per cent of the days with r in a specific range. Shaded areas mark r with the statistical significance p ≤ 0.05.

5 ACTIVE DAYS (K ≥ 5) QUIET DAYS (K < 5)



Curves of H raw data minus PCA-Sq-H model (red) and corresponding Tsyganenko simulations (blue), Dst series (green) and RC series (black) for the three observatories. Left: March 7-10, 2012. Right: February 13-15, 2012.

6 CONCLUSIONS

1. **Correlations of H data vs. any of Dst, RC or TSY series are globally worse for quiet days (K< 5) than for active days (K≥5).**
2. **For K≥5, correlations of H data vs. any of Dst, RC or TSY series are globally high, with mean significant values between 0.60 and 0.75.**
3. **Removing Sq-H to data tends to improve correlations of H data vs. Dst series, for both K< 5 and K≥ 5.**
4. **Removing Sq-H to data improves correlations of H data vs. TSY simulations for COI (both K< 5 and K≥ 5) but not for BOU nor NVS.**
5. **Except for BOU where we observe some peculiar effects, correlations with RC tend to behave similarly to correlations with Dst.**

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For questions and comments: Yvelice Castillo, uc2014168023@student.uc.pt

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