Van Allen Probe measurements of the electric drift $\mathbf{E \times B/B^2}$ at Arecibo's L = 1.4 field-line coordinate

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INTRODUCTION

Our goal is to explore **the limit of the corotational electric drift model** at low L values (L< ~3).

Motivated by mid and low latitude incoherent scatter radar observations, we investigate in particular on possible modulations of ExB/B² as a function of magnetic local time (MLT) due to the **ionosphere dynamo**.

This poster presents an analysis of **two years of electric and magnetic measurements by Van Allen Probe B at one field-line coordinate** set to Arecibo's incoherent scatter radar location (L=1.43).

MOTIVATION

Where does the corotational electric field *model* come from?

In an **Earth-centered rotation-aligned magnetic dipole,**

the conducting ionosphere is assumed to be pushed into corotation with the Earth by the drag of the neutral atmosphere.

These charged particles that move in a B field generate an electric field by *dynamo effect*.

Under the assumption that the magnetic field lines are equipotential, the electric field is transmitted to space ($\mathbf{E} \cdot \mathbf{B} = \mathbf{0}$).

Csq: There exists an ExB/B² drift that adds to the magnetic drift of charged particles and which is equivalent to corotation with the Earth.

But what about the winds?

DATA

We use electric and magnetic measurements by Van Allen Probe B for the years 2013 and 2014 (EFW + EMFISIS) to examine **ExB/B² at Arecibo's L.**

DATA Processing: E// = 0 + angular corrections for the magnetometer axes (Δu = -0.035⁰, Δv = 0.08⁰ and Δw = 0.8⁰, where w is the axial component)

RESULTS

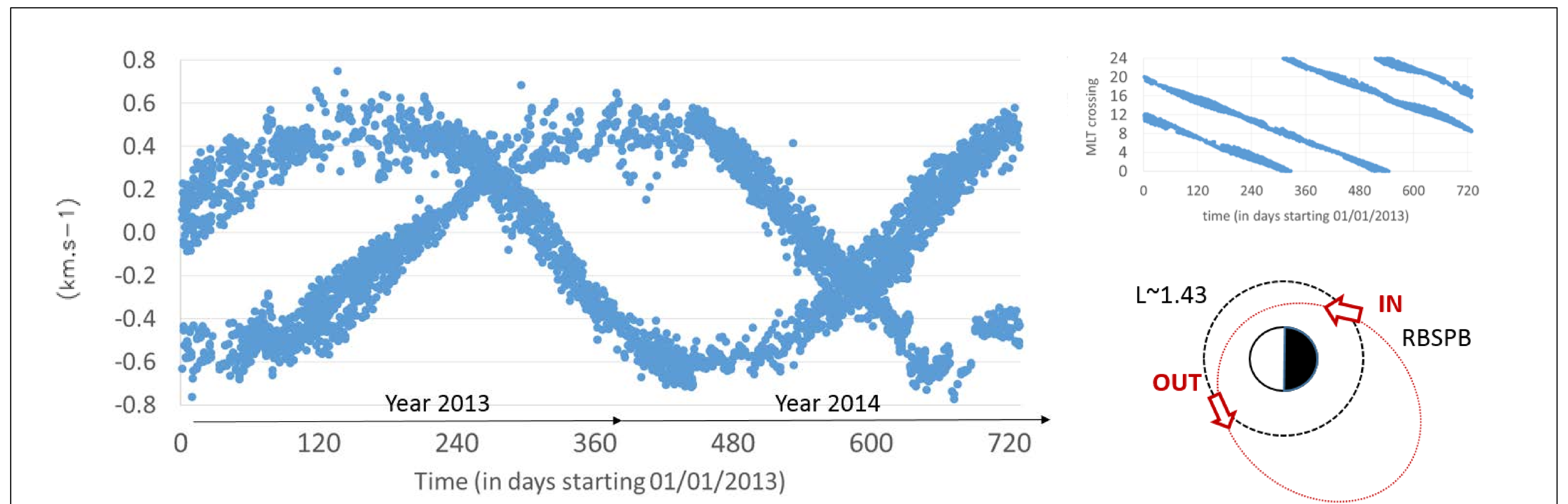


Fig.1 – 2 years of ExB / B² by Van Allen Probe B (GSE X component – Earth/Sun Line). The inbound and outbound crossings are slowly drifting in MLT.

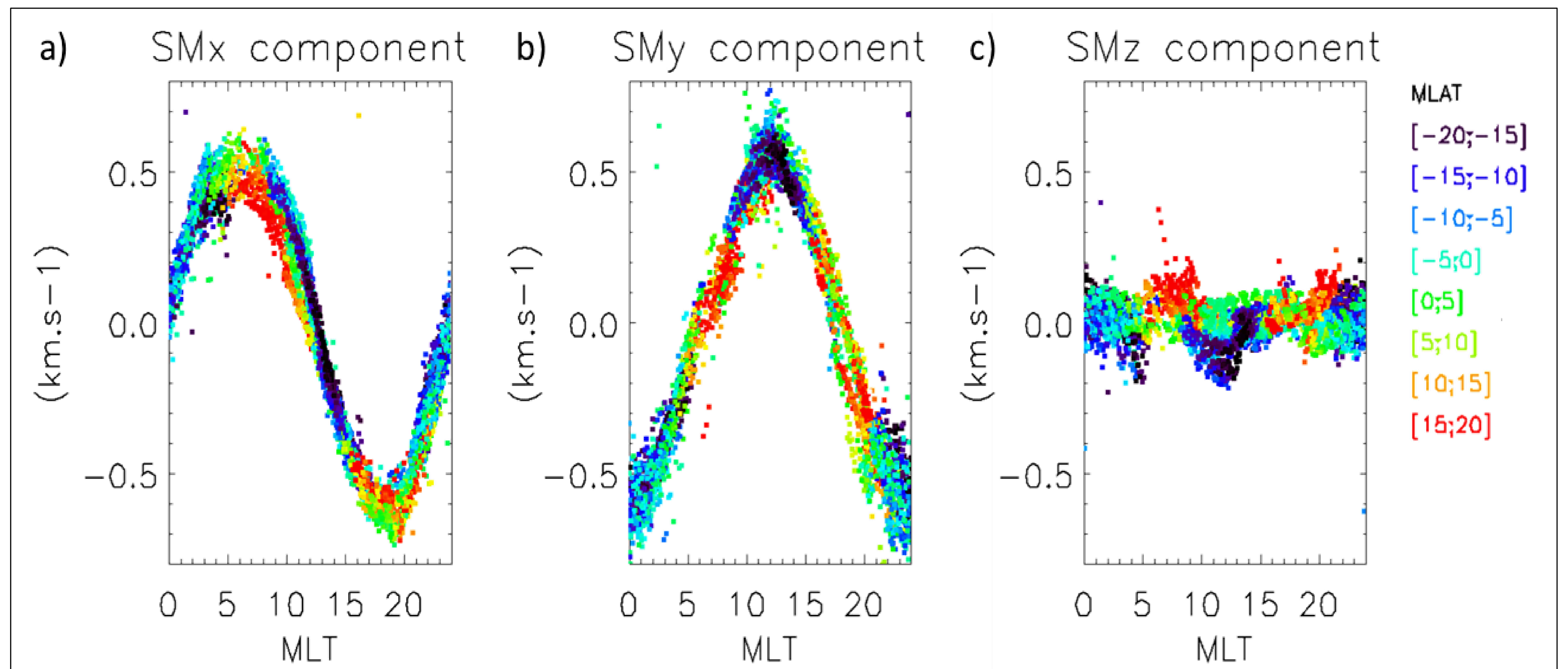


Fig.2 - Solar magnetic components of ExB/B² measured by Van Allen Probe B at Arecibo's L coordinate. The magnetic latitude (MLAT) of the spacecraft at the time of sampling is color-coded.

REMOVING THE MAGNETIC LATITUDE DEPENDENCE, MAPPING EXB/B² TO THE MAGNETIC EQUATOR

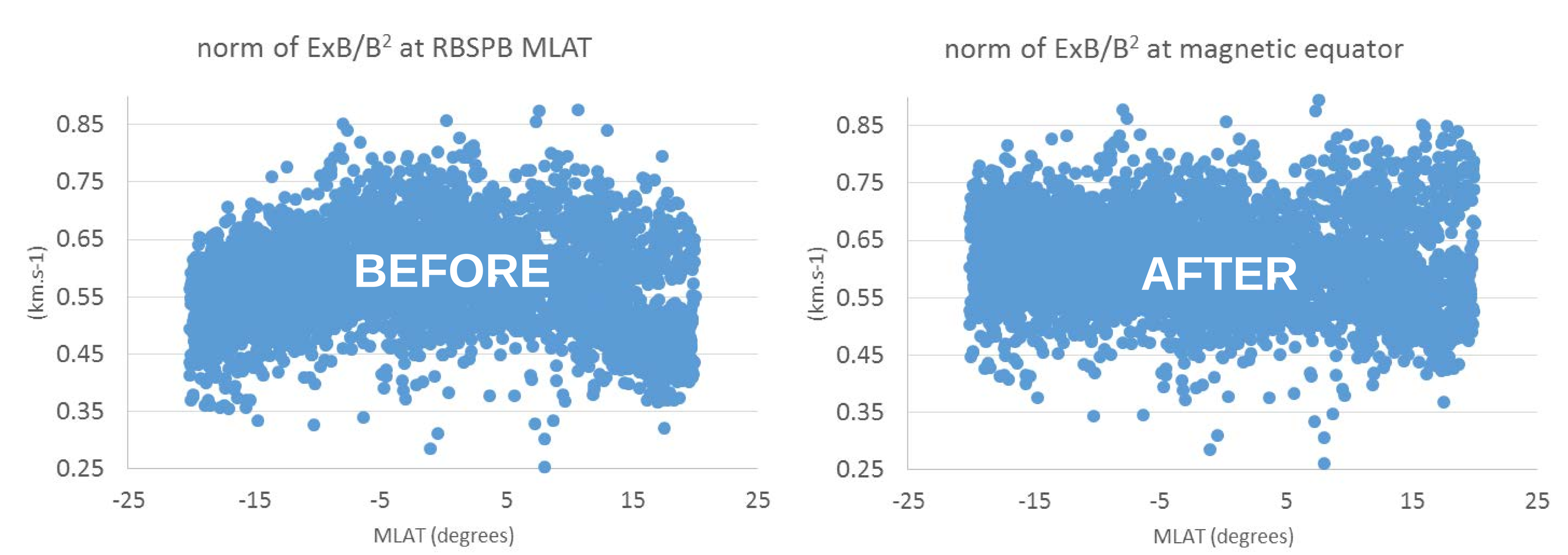
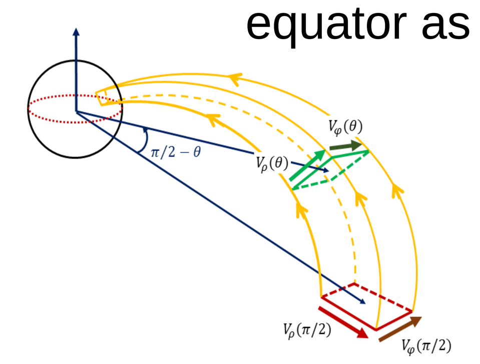


Fig.3 – Norm of ExB/B² before and after projection at the magnetic equator as a function of the *initial* magnetic latitude



In a dipole:

$$V_\varphi(\pi/2) = \frac{V_\varphi(\theta)}{\sin^3\theta} \qquad V_\rho(\pi/2) = \frac{\sqrt{1+3\cos^2\theta}}{\sin^3(\theta)} V_\rho(\theta)$$

STATISTICAL ANALYSIS

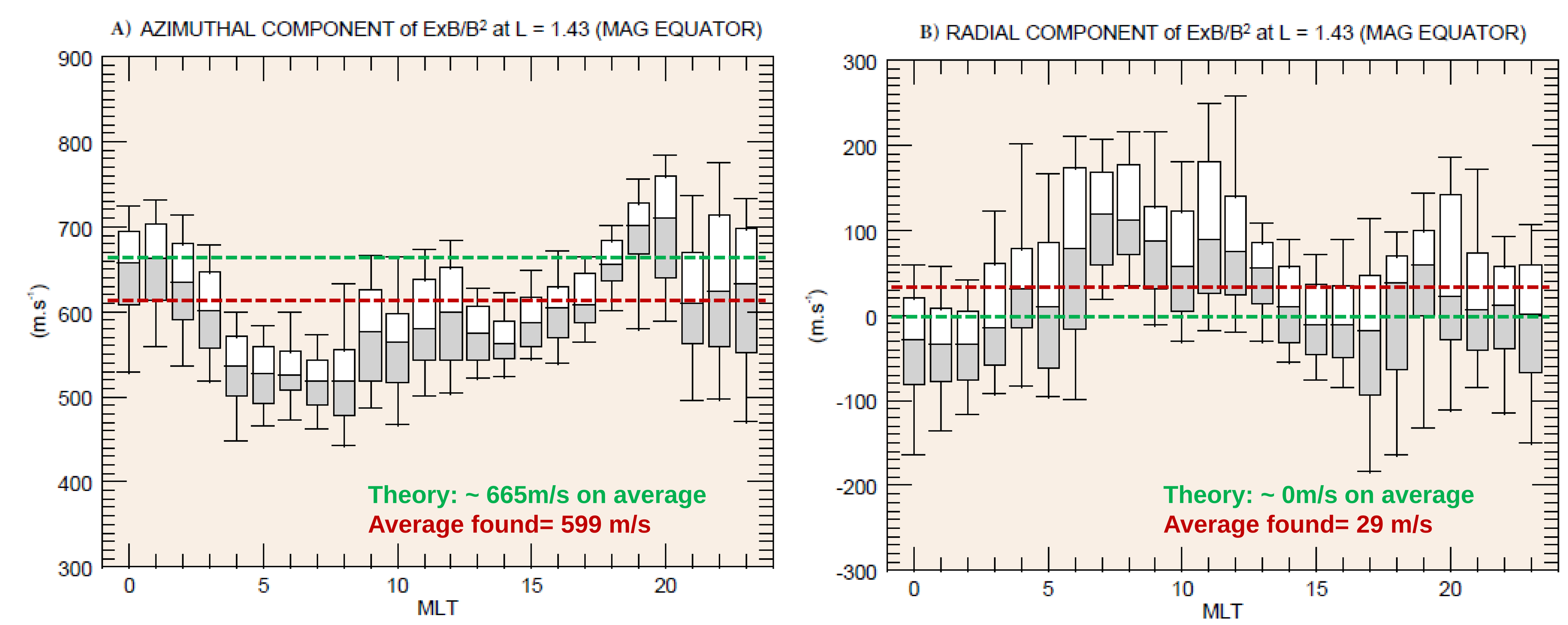


Fig.4 - Amplitudes of the equatorial ExB/B² at Arecibo's L coordinate in the azimuthal (a) and radial (b) directions. The ends of the whiskers indicate the 1st and 9th deciles.

COMPARISON WITH ION DRIFT MEASUREMENTS FROM ARECIBO INCOHERENT SCATTER RADAR

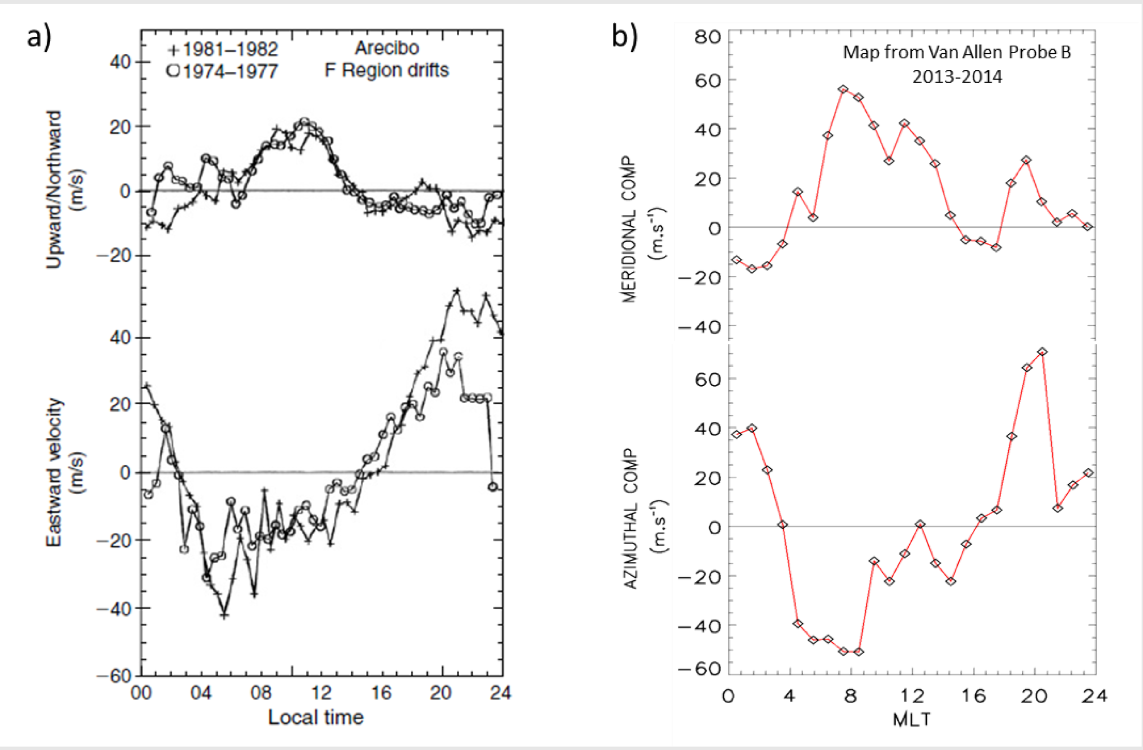


Fig.5 - A comparison of the average drifts over Arecibo during solar minimum and solar maximum [*Fejer*,1991] (a) with the average drifts mapped up to the ionosphere from Van Allen Probe measurements (b).

CONCLUSIONS

Van Allen Probes can detect the **electric fields due to the quiet-time ionosphere dynamo as they propagate along equipotential magnetic field lines**.

We found departures from the traditional picture of corotational motion with the Earth in 2 ways:
(1) ExB/B² has **a rotational angular speed 10% smaller** than the theoretical corotational rate;
(2) the quiet-time ionospheric dynamo results in a **MLT-dependence** of ExB/B² in both radial and azimuthal directions.

At such low altitudes, asymmetric variations of ExB/B² on time scales of a few hours or shorter are enough to transport most trapped particles through L shells. Therefore, the electric fields from the ionosphere dynamo are **most likely the main drivers of radial diffusion at low L values**. It would also explain why radial diffusion coefficients in the inner belt do not display the same ~ L^{10} dependence as the outer belt diffusion coefficients.

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