Effects of geomagnetic storms on plasma bubbles over South America

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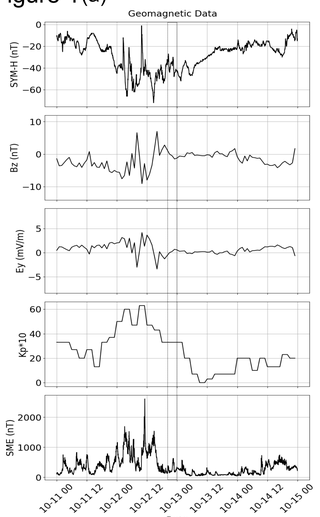
Abstract

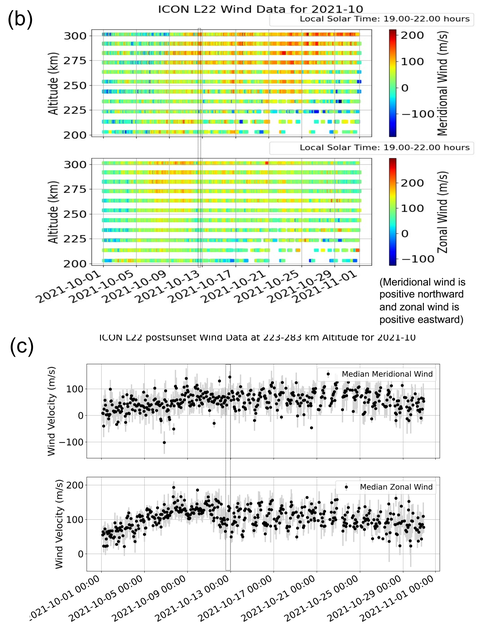
The generation and development of ionospheric irregularities is an important topic of study in space weather, particularly due to their adverse effects on navigation positioning systems and trans-ionospheric communications. To improve our prediction capabilities, a comprehensive understanding of their variability during different geomagnetic conditions is important. **The purpose of this research is to analyze the inhibition of post-sunset plasma bubbles over South America during geomagnetic storms**. To conduct the analysis, we used the moving standard deviation (std), to characterize the occurrence of ionospheric irregularities in ICON IVM ion density data, std ⩾10000 indicates the presence of irregularities. We also used the peak electron density (NMAX) from GOLD night disk scan measurements to identify bubbles. Additionally, we consider ICON MIGHTI wind data (red line emission) to study the role of the neutral wind. We examine the presence of irregularities during three storms: October 12, 2021; November 3, 2021; and February 3, 2022.

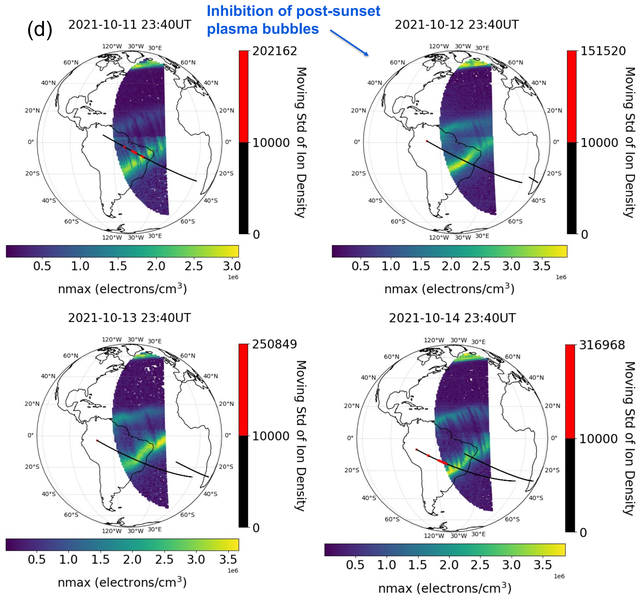
Observations

October 2021

Figure 1(a)





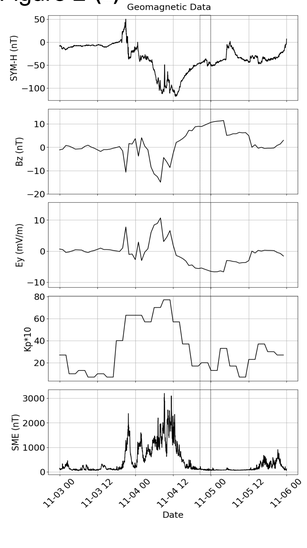


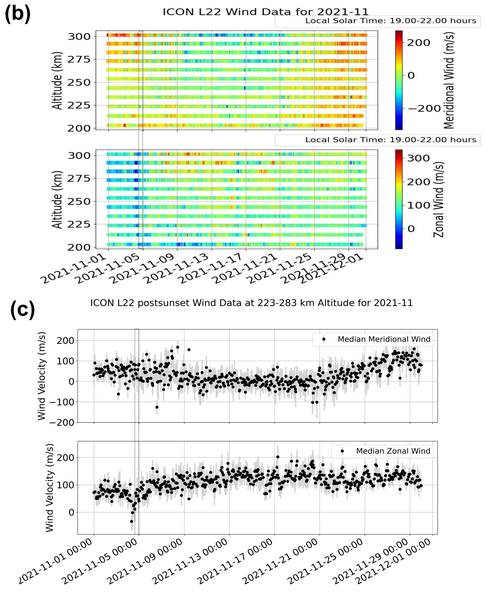
(a)Geomagnetic data for oct 11-14, 2021. (b) Wind data from ICON MIGHTI during Oct 2021 (c)Median postsunset wind data for Oct 2021 (d) GOLD NMAX and moving standard deviation of ICON IVM ion density for Oct 11-14, 2021 at 23:40UT.

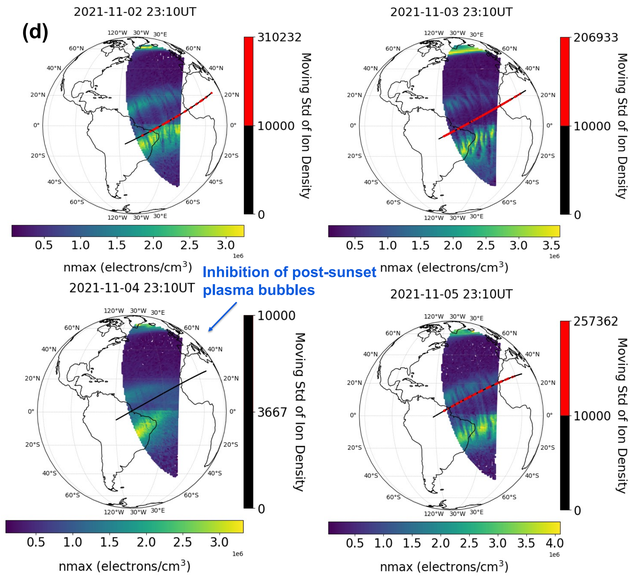
Plasma bubbles are usually observed at postsunset over the Brazilian sector, but on postsunset Oct 12 the bubbles were not detected (fig 1d). This was during the recovery phase of the geomagnetic storm occurred on Oct 12 (Fig 1a). Zonal wind (Fig 1b and c) turned eastward before the inhibition of the bubbles on Oct 12. The dotted lines indicate the period when the bubbles were inhibited.

November 2021

Figure 2 (a)





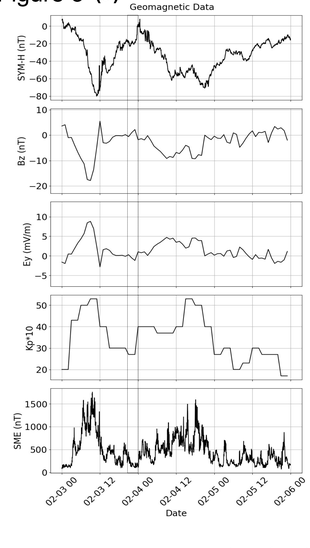


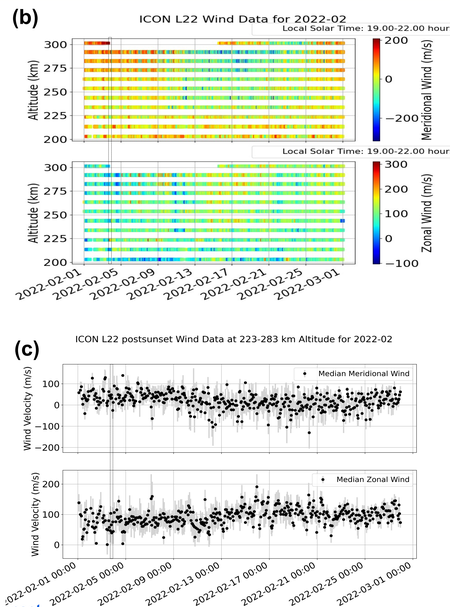
(a)Geomagnetic data for Nov 3-5, 2021. (b) Wind data from ICON MIGHTI during Nov 2021 (c)Median postsunset wind data for Nov 2021 between 223-283km (d) GOLD NMAX and moving standard deviation of ICON IVM ion density for Nov 2-5, 2021 at 23:10UT.

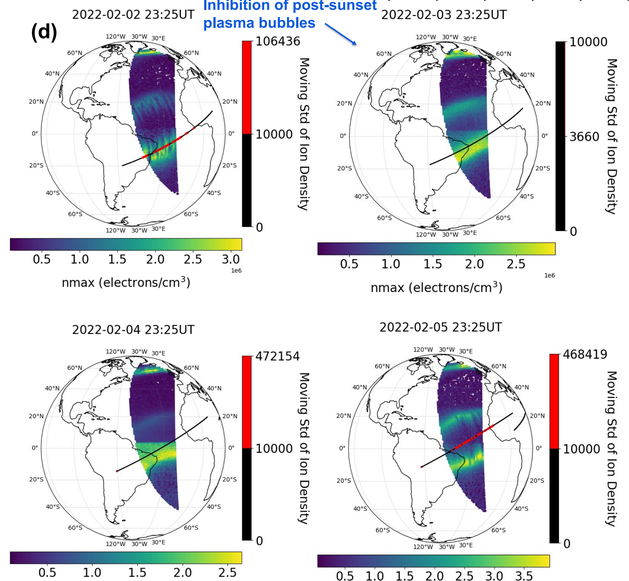
This storm shows a similar effect; plasma bubbles over the Brazilian sector on Nov 2,3 and 5 but not on Nov 4 (fig 2d), during the recovery phase of the geomagnetic storm (Fig 2a). A strong westward zonal wind (Fig 2b and c) is observed before the inhibition of the bubbles. The same behavior is observed during the February 3, 2022 (Fig 3), geomagnetic storm, when the generation of plasma bubbles was suppressed during the recovery phase.

February 2022

Figure 3 (a)







a)Geomagnetic data for Feb 3-5, 2022. (b) Wind data from ICON MIGHTI during Feb 2022 (c)Median postsunset wind data for Feb 2022 between 223-283km (d) GOLD NMAX and moving standard deviation of ICON IVM ion density for Feb 2-5, 2022 at 23:25UT.

Summary

- **Post-sunset plasma bubbles over South America disappear during the recovery phases of the three storms analyzed.**
- Zonal wind in the F region turned westward before bubble inhibition occurs
- The DDEF might play an important role in the inhibition of the irregularities

Acknowledgement

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