

# ***Interactive comment on “Evidence of vertical coupling: Meteorological storm Fabienne on 23 September 2018 and its related effects observed up to the ionosphere” by Petra Koucká Knížová et al.***

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On behalf of all authors, I would like to thank the reviewer for her/his valuable comments and suggestions that helped us to improve the paper significantly. Corrections made in the text are provided further together with corrected figures.

Sincerely, Petra Koucka Knizova

Here are all the requested corrections that we made in the text: 1. We have added text related to GLONASS/GPS:

GPS satellite measurements are promising tools for monitoring ionospheric changes connected with severe weather systems. Recently the analyses of scintillation S4 index in relation to four tropical cyclones (Yasi in 2011, Marcia in 2015, Debbie in 2017 and Marcus in 2018) were presented by Ke et al. (2019). They found intensification of scintillation effects mostly above the tropical cyclone path and attributed them to the electric field perturbation and consequent plasma bubble generation. Within COSMIC GPS data, Yang and Liu (2016) has found significant peak in radio occultation scintillation events during the passage of tropical cyclone Tembin (2012) during quiet geomagnetic or solar activity and attributed the observed effect to the gravity waves generated in the lower atmosphere by the cyclone. Afraimovich et al. (2013) published large review of GPS/GLONASS studies of the ionospheric response to natural and anthropogenic processes and phenomena. Paper focuses on wide range of ionospheric forcing and corresponding ionospheric variability detected in principle within Total Electron Content (TEC) and F2 layer critical frequency  $f_{0F2}$ . In relation to tropical cyclones (Katrina, Rita and Wilma) occurring in 2005 they reported increase of wave-like activity in gravity-wave period range mainly in the range 20 to 60 minutes and intensification of TEC variations along the satellite path close cyclone. The zones of disturbances were found to form during hurricane stage of the cyclone (Afraimovich et al., 2013).

## 2. Explanation of MERRA results:

Figure 6a shows zonal wind at 1 hPa for Europe region from 20 September at 00 UT to 27 September at 18 UT. On the sequence there is well seen weak eastward wind in middle Europe and westward wind in south Europe which is typical situation for this period. Shortly before storm Fabienne (23 Sep 00 and 6 UT) easterly wind became stronger and replace westerly wind in the south (because of incoming waves from troposphere) and remain easterly for the following several days in whole studied area. At 0.1 hPa we can see changes from westerly to easterly wind shortly after Fabienne (24.9. 00 and 06 UT). We do not register any significant changes before because wave from the troposphere need some time to reach 0.1 hPa. Strong easterly wind remains

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in whole Europe again for several days after storm. The stratosphere needs some time for changing/restoration dynamics to normal situation because of wave disturbances which remains in inversion condition (temperature increase with altitude) much longer than in other layers. That is why we can observe strong eastward wind not only during the storm but for several days after storm in whole Europe as well.

#### 4. Explanation text of the ionospheric measurement

An example of multi-beam ionograms measured by DPS-4D is shown in the Figure 8. There is a sequence of ionograms recorded during four consequent days around 23 UT. The receiving antenna system of the digisonde is able to identify the direction of the electromagnetic wave arrival. The information about the reflected wave arrival is included in the raw ionograms. Further, from sequence of raw ionograms the general plasma motion is constructed and presented as the directogram. Each color correspond to particular antenna beam, hence the direction of the arrival of oblique echo from large scale irregularities.

We have corrected all the figures as suggested.

Please also note the supplement to this comment:

<https://www.ann-geophys-discuss.net/angeo-2019-26/angeo-2019-26-AC4-supplement.pdf>

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Interactive comment on Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2019-26>, 2019.

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