THE VARIATION DEPENDING ON SOLAR PARAMETERS OF ELECTRICAL CONDUCTIVITY TENSOR AT MID-LATITUDE IONOSPHERE

Ramazan Atici, Selçuk SAĞIR, Ali YEŞİL, Hafız ALISOY

Outline

1. Ionospheric conductivity
2. Solar impact on ionosphere
3. Results and discussions
4. Conclusions

1. Ionospheric conductivity

- As discussed the previous presentation, the ionospheric conductivity is divided into two as AC and DC according to current type.
- Also, the ionospheric conductivity is divided into three parts as Pedersen, Hall and Parallel according to the angle made by Eart's magnetic field.

- When considering the behavior of high frequency wave through ionospheric plasma, taking into account that $m_e << m_{i,}$ then only the equation of motion for electrons can be considered. Besides, if the thermal motion of particles is neglected and the cold plasma approximation is done, then the equation of motion for electrons can be written as follow:
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- $$m_e \frac{d\mathbf{V}_e}{dt} = -e\left(\mathbf{E} + \mathbf{V}_e \times \mathbf{B}\right) - m_e \nu_e \mathbf{V}_e \qquad (1)$$

- We assumed that the z-axis of the coordinate system with its origin located on the ground is vertical upwards. The x and y-axis are geographic eastward and northward in the northern hemisphere, respectively. The Earth’s magnetic field direction is z-axis and according to Ohm law , Eq.(1) is a tensor equation where the conductivity is as follows:

$$\sigma = \begin{bmatrix} \sigma_1 & \sigma_2 & 0 \\ -\sigma_2 & \sigma_1 & 0 \\ 0 & 0 & \sigma_0 \end{bmatrix}$$

The components of conductivity tensor are given by as follows:

$$\left(\sigma_0 = \frac{e^2 N_e}{m_e(\nu_e - i\omega)}\right)$$ the longitudinal conductivity,

$$\left(\sigma_1 = \frac{e^2 N_e(\nu_e - i\omega)}{m_e\left[\omega_{ce}^2 + (\nu_e - i\omega)^2\right]}\right)$$ pedersen conductivity,

$$\left(\sigma_2 = \frac{e^2 N_e \omega_{ce}}{m_e\left[\omega_{ce}^2 + (\nu_e - i\omega)^2\right]}\right)$$ Hall conductivity,

2. Solar Activity Impact On the Ionosphere

- Solar activity can effect on the ionosphere two different ways including the intensity of solar electromagnetic radiation, particularly notable at wavelengths of solar X-rays and the extreme ultraviolet (EUV) (XUV) radiations and the solar activity events; e.g. coronal mass ejection and solar proton events.

- Solar radiation penetrated the Earth’s upper atmosphere leads to heating, dissociation and ionization by absorbing via particles in the medium, and thus the ionosphere is primarily formed via the ionization effect of solar XUV. The features of the ionosphere during solar activity events change importantly and may have critical conclusions on the geospace environment.

- Enormous variations in the neutral density and temperature, ion and electron densities and temperatures, neutral winds, and electric fields in the ionosphere are initiated by the variability of the solar activity [Gorney, 1990; Forbes et al., 2006; Liu et al., 2011].

- A minute current of ~2 pA/m^2 permanently flows down from the ionosphere through the troposphere to the terrestrial surface.
- This current responds to internal but also to solar forcings, providing a mechanism by which solar activity affects various atmospheric parameters.
- In the present study, we investigate the relationship between the ionospheric electrical conductivity and sunspot numbers and F10.7 cm solar flux as solar parameters.

3. Results and Discussions

- The relation between the ionospheric conductivities given at section 1 and the solar parameters (SSN and F10.7 cm solar flux, in 1 sfu=$10^{-22}.m^{-2}.Hz^{-1}$) obtained from OMNIWeb internet address is investigated for 12:00 and 24:00 UT during March 1990 at mid-latitude region (39,2 N; 32,76 E).

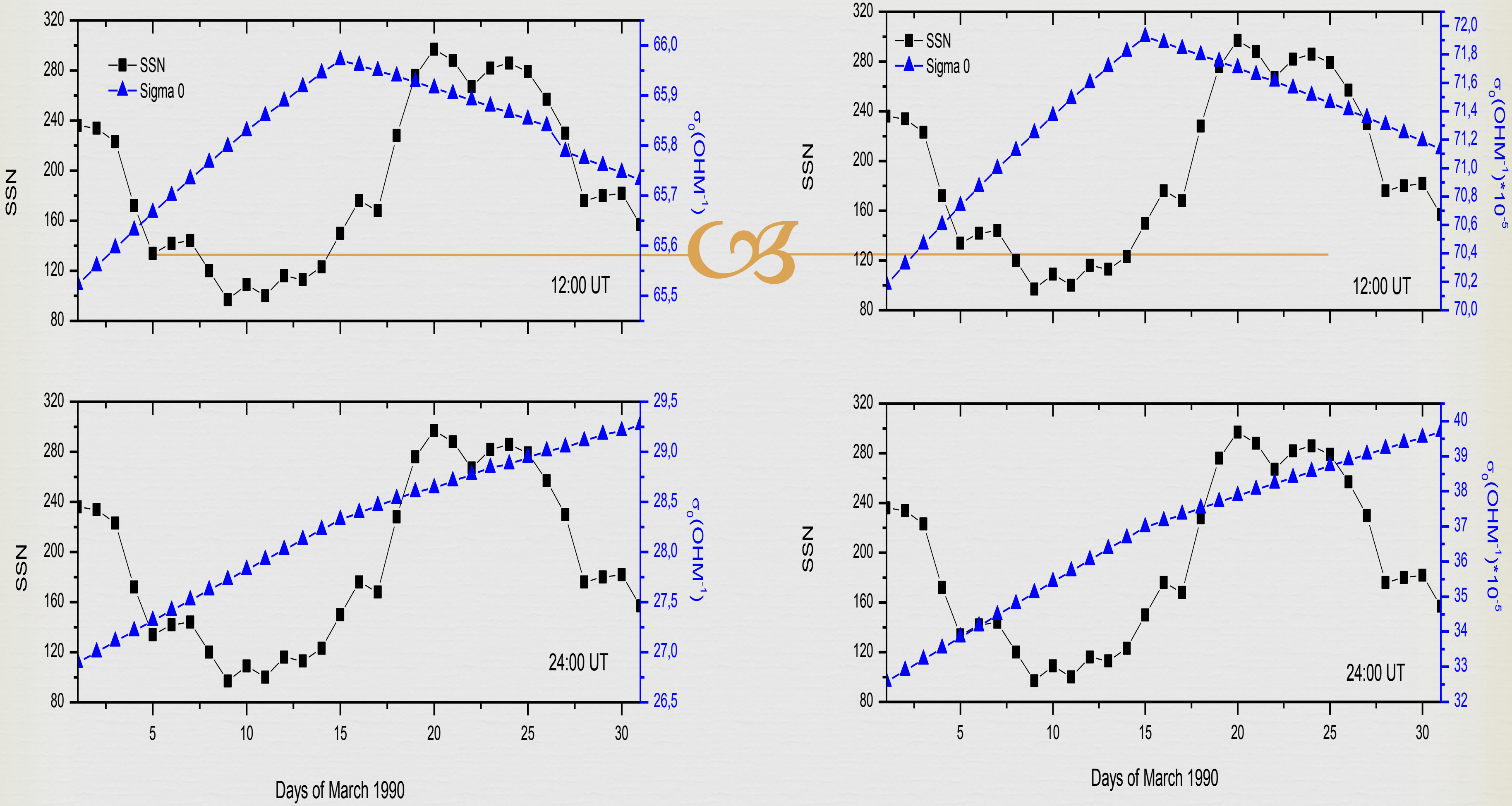

Figure 1. The variation depending on sunspot numbers (SSN) of DC and AC ionospheric longitudinal conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

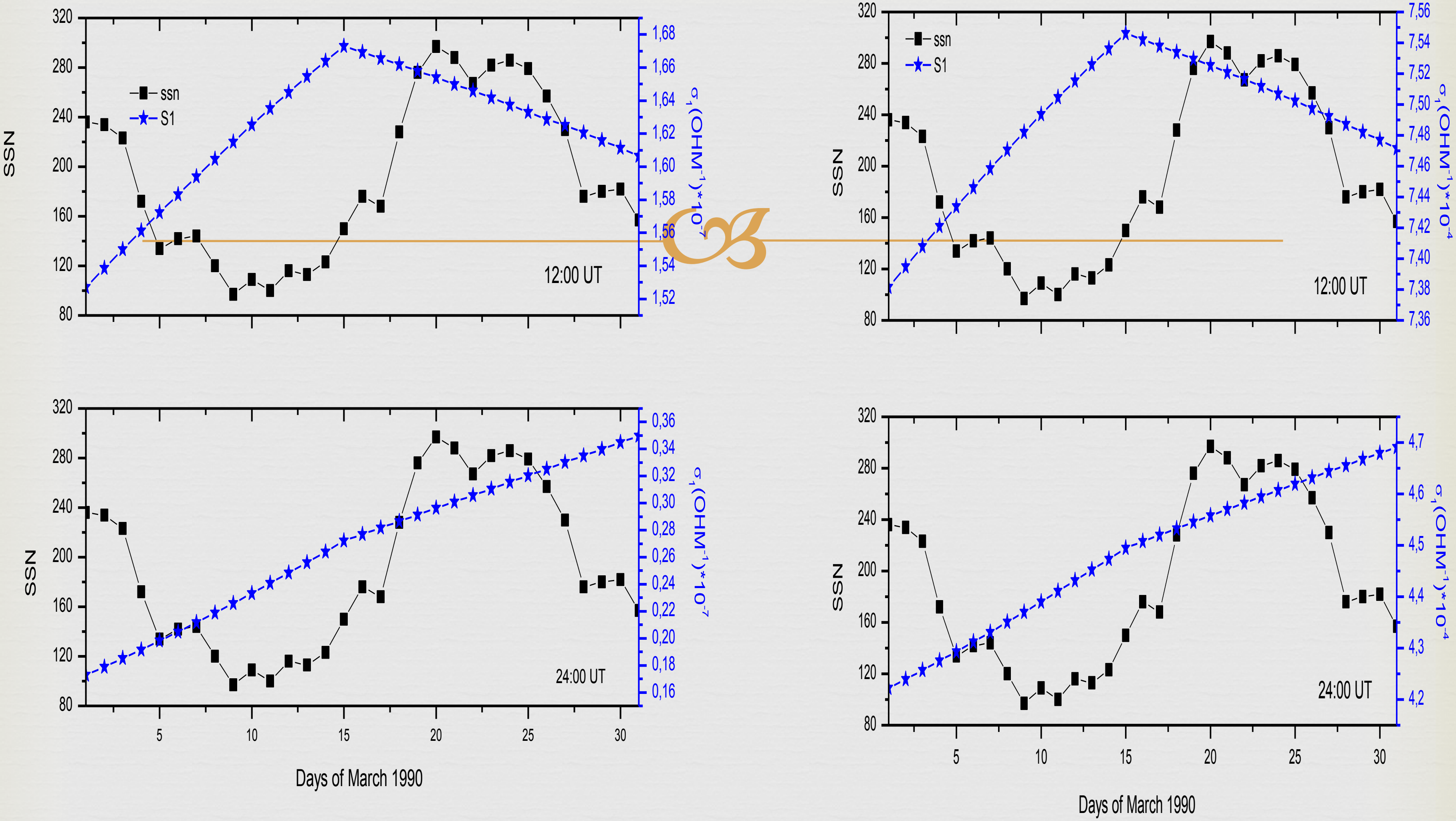

Figure 2. The variation depending on sunspot numbers (SSN) of DC and AC ionospheric pedersen conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

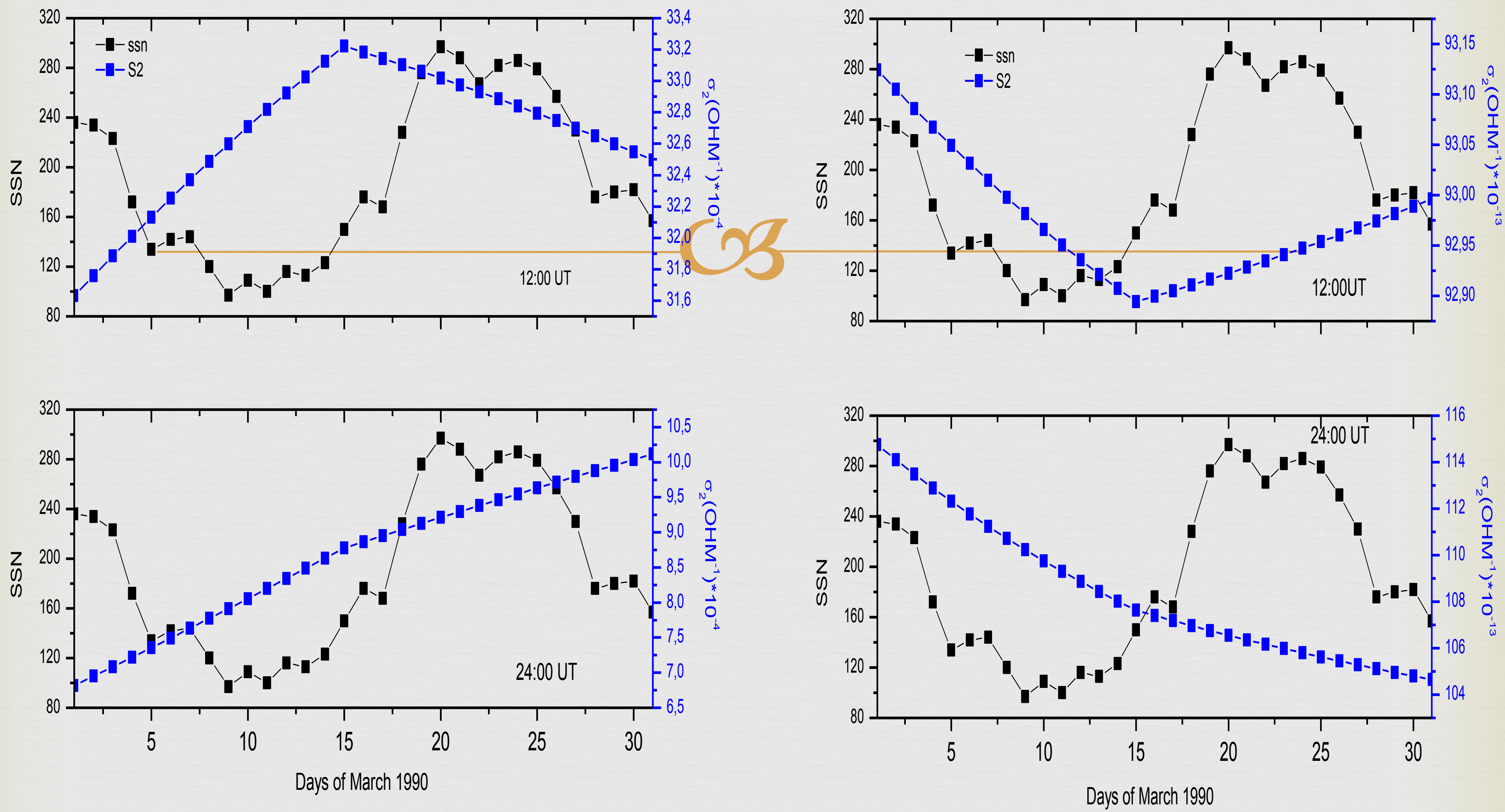

Figure 3. The variation depending on sunspot numbers (SSN) of DC (Left panel) and AC (Right panel) ionospheric Hall conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

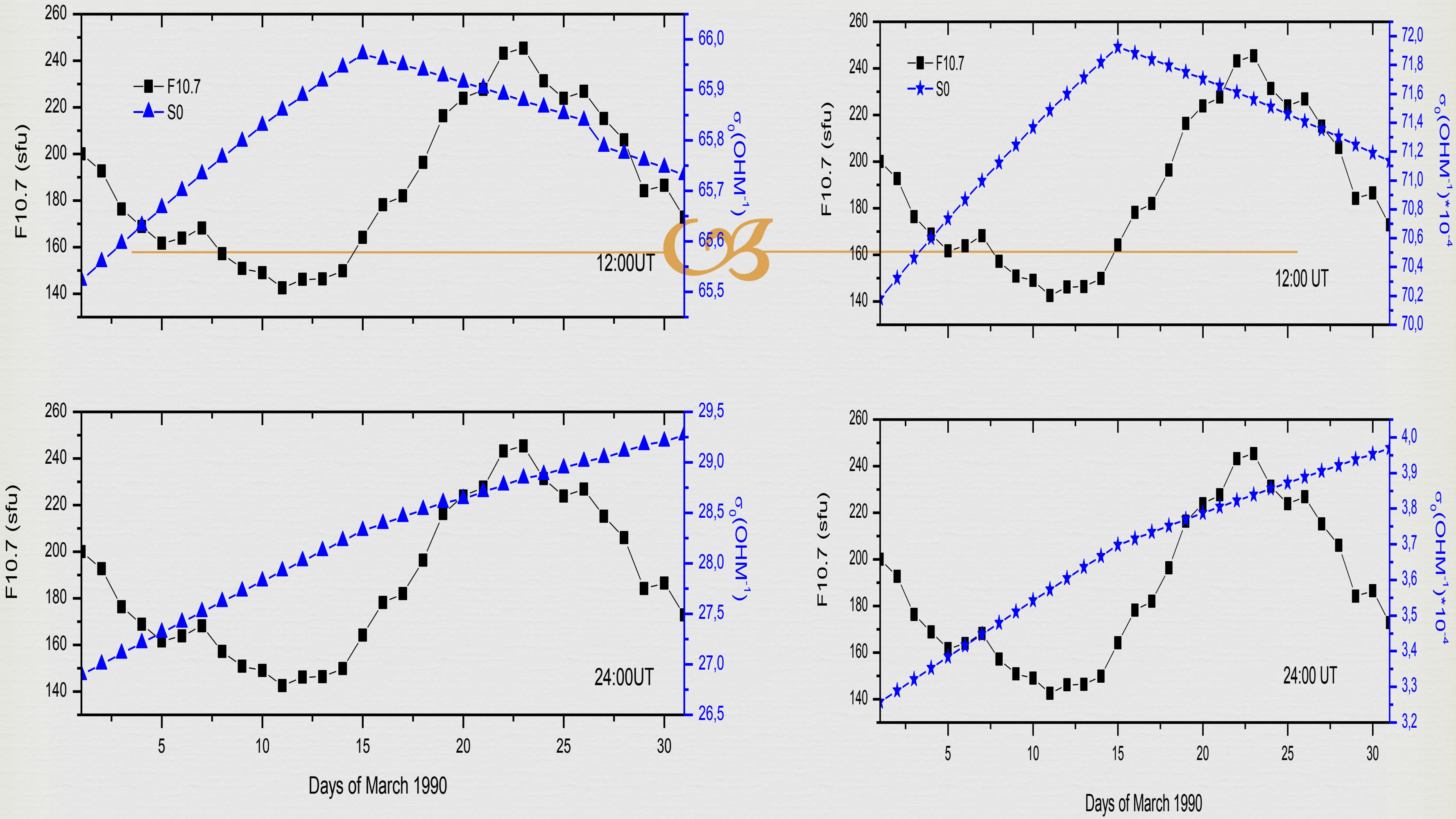

Figure 4. The variation depending on F10.7 cm solar flux (F10.7) of DC (Left panel) and AC (right panel) ionospheric longitudinal conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

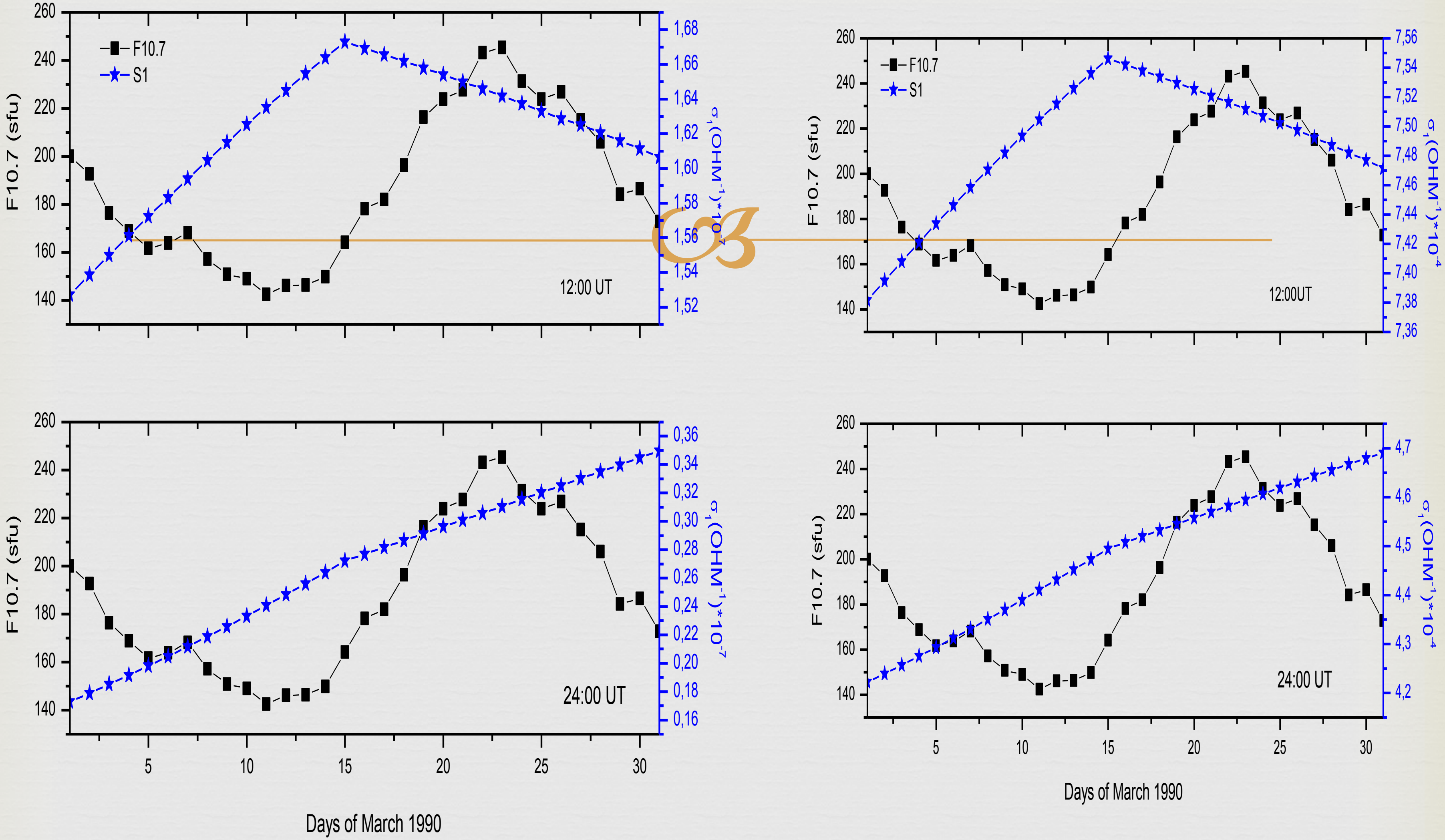

Figure 5. The variation depending on F10.7 solar flux (F10.7) of DC and AC ionospheric pedersen conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

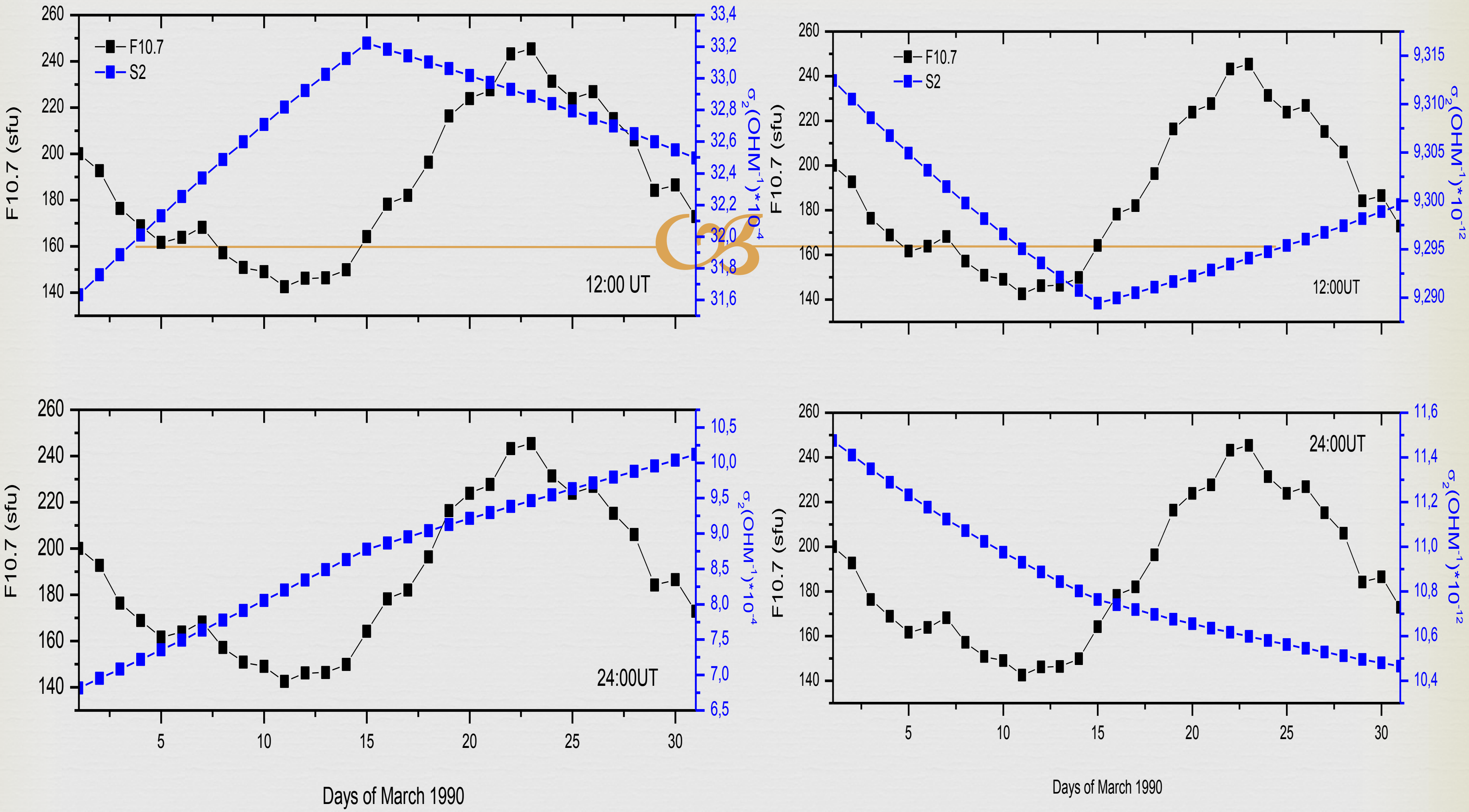

Figure 6. The variation depending on F10.7 cm solar flux (F10.7) of DC (Left panel) and AC (Right panel) ionospheric Hall conductivity at mid-latitude region on March 1990 at 12:00 UT and 24:00 UT.

Table 1. The correlation coefficiens between electrical conductivities and solar parameters.

Solar parameters	DC-current			AC-current		
	Sigma 0	Sigma 1	Sigma 2	Sigma 0	Sigma 1	Sigma 2
	For 12:00 UT time					
SSN	0,059813	0,057622	0,063086	0,055954	0,056075	-0,0537
F10.7	0,125153	0,138035	0,136634	0,136824	0,136865	-0,13652
	For 24:00 UT time					
SSN	0,371537	0,382764	0,374029	0,364396	0,380218	-0,32331
F10.7	0,519735	0,529232	0,521291	0,511867	0,526665	-0,47224

Conclusions

- In this study, we investigated the relationship between solar parameters and ionospheric electrical conductivities. As a result, we can say that there is a relationship between variables and this relationship is greater at 24:00 UT than at 12:00 UT. Also, we can say that the relationship between F10.7 solar flux and ionospheric conductivities is greater than those SSN.
- More studies are necessary to determine the direction and magnitude of this relationship.

THANK YOU FOR YOUR ATTANTION