Geophysical Research Abstracts
Vol. 21, EGU2019-15553, 2019
EGU General Assembly 2019

Assessing North Atlantic winter climate response to energetic electron precipitation and solar UV irradiance

Ville Maliniemi (1,2), Timo Asikainen (1), Antti Salminen (1), and Kalevi Mursula (1)

(1) ReSoLVE Centre of Excellence, Space Climate Research Unit, University of Oulu, Finland, (2) Birkeland Centre for Space Science, Department of Physics and Technology, University of Bergen, Norway

There is increasing evidence that solar-related forcing mechanisms can influence climatic conditions in the North Atlantic winter. A solar wind driven energetic electron precipitation (EEP) can influence high-latitudinal upper-atmospheric chemistry by creating nitrogen and hydrogen oxides, which can destroy ozone. Ozone destruction in winter at high latitudes can lead to thermal and dynamical changes, affecting the state of the polar vortex. As a result, tropospheric pressure pattern is altered in the North Atlantic, leading to changes in storm track and surface conditions. Solar UV irradiance has been shown to modulate the ozone amount and thermal conditions in the low-latitudinal middle atmosphere. This can lead to zonal wind anomalies by thermal-wind balance, which moves poleward and downward to the high-latitudinal troposphere as the winter progresses. Both of these two mechanisms are so-called top-down forcings. In this study, we assess the relative variability of these two forcings since 1940s using re-analysis data, and geomagnetic activity and sunspot activity as proxies for EEP and solar UV irradiance, respectively. We find that the two mechanisms independently and simultaneously produce a significant signal in both the stratosphere and the troposphere, which clearly differ from each other. EEP signal in zonal wind is seen in both early and late winter in the high-latitudinal stratosphere and troposphere, whereas solar UV irradiance signal in zonal wind reaches the troposphere only in late winter. Our results suggest that both solar wind related EEP and solar UV irradiance can lead to significant atmospheric circulation anomalies in the North Atlantic winter.