GPS Signal and Auroral Activity in Perspective Coupling between the Upper and Lower Levels of the Atmosphere

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The sun is the source of energy that causes motion of the atmosphere, drives the Earth's climate and controls the weather. One key element that is extremely taken as evidence of this response is the similarities between the periodicity of solar activity indices and different meteorological parameters. Usually, this similarity is often in the form of coherence, which requires the analysis of large quantities of data and is hard to obtain significant results in the presence of unrelated periodic variability. In other words, the physical mechanism involved of how the sun affects terrestrial weather/climate changes is remained proving difficult. Previous work has shown that by using the ionospheric total electron content (TEC) as a measure of solar activity and precipitable water vapor (PWV) in the lower atmosphere as the terrestrial response which both derived from the propagation delays in GPS signal, the connection between the upper and the lower atmosphere during transient events associated with intense geomagnetic storms of 2003 have been conducted within the Antarctic polar cap. Both are showing a high correlation, although the physical mechanism between them is still incapable to be explained. Based on their correlation, auroral activity in the auroral zone is proposed as a buffer to explain the possible occurrence of the clutches. In this paper, we will study the aurora and its relation with the TEC and PWV from the GPS signal propagation perspective. With the argument that the auroral activity clearly influences on the communication systems, especially on GPS signals (shown in TEC), and the same signals propagate toward the lower atmosphere layers (shown in PWV), a reasonable coupling process between the upper and the lower levels of the atmosphere can be explained. The ability to capture or visualization the coupling mechanism will clarify the reliable relationship between solar activity and terrestrial weather/climate changes that further benefit for space weather and meteorological applications. The future plan of this project includes modeling of electrodynamics tropospheric-ionospheric coupling with take into account the auroral effects in the model of solar-terrestrial climate.