Relationship between solar wind and atmospheric circulation

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More than four decades have passed since the discovery of a relationship between solar wind magnetic sector boundary structure and the winter mid-latitude upper-tropospheric vorticity/circulation [1,2]. These results have been later confirmed and various physical mechanisms proposed [3,4]. Solar wind to magnetosphere - ionosphere - atmosphere (MIA) coupling process generates internal atmospheric gravity waves propagating upward and downward from the lower thermosphere sources at high latitudes [5]. If ducted over long distances in the lower atmosphere they can reach troposphere [6,7]. Despite significantly reduced wave amplitude, but subject to amplification upon over-reflection in the upper troposphere, the gravity waves can trigger moist instabilities to initiate convective bursts [4]. The latent heat release is the source of energy leading to intensification of extratropical storms and convective bursts have been linked to rapid intensification of tropical cyclones. Recent studies [8,9,10] showed that explosive extratropical cyclones and rapid intensification of tropical cyclones tend to follow arrivals of solar wind high-speed streams and interplanetary coronal mass ejections. The solar wind MIA coupling is most intense during the arrivals of co-rotating interaction regions and interplanetary shocks at the leading edge of high-speed solar wind when the amplitudes of aurorally-generated gravity waves are largest. If these gravity waves trigger moist instabilities in extratropical and tropical cyclones to initiate convective bursts the intensification of cyclones leads to enhanced atmospheric circulation.

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