World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:10, No:08, 2016

Subtropical Potential Vorticity Intrusion Drives Increasing Tropospheric Ozone over the Tropical Central Pacific

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Abstract : Drawn from multiple reanalysis datasets, an increasing trend and westward shift in the number of Potential Vorticity (PV) intrusion events over the Pacific are evident. The increased frequency can be linked to a long-term trend in upper tropospheric (UT, 200 hPa) equatorial westerly wind and subtropical jets (STJ) during boreal winter to spring. These may be resulting from anomalous warming and cooling over the western Pacific warm pool and the tropical eastern Pacific, respectively. The intrusions brought dry and ozone rich air of stratospheric origin deep into the tropics. In the tropical UT, interannual ozone variability is mainly related to convection associated with El Niño/Southern Oscillation. Zonal mean stratospheric overturning circulation organizes the transport of ozone rich air poleward and downward to the high and midlatitudes leading there to higher ozone concentration. In addition to these well described mechanisms, we observe a long-term increasing trend in ozone flux over the northern hemispheric outer tropical (10–25°N) central Pacific that results from equatorward transport and downward mixing from the midlatitude UT and lower stratosphere (LS) during PV intrusions. This increase in tropospheric ozone flux over the Pacific Ocean may affect the radiative processes and changes the budget of atmospheric hydroxyl radicals. The results demonstrate a long-term increase in outer tropical Pacific PV intrusions linked with the strengthening of the upper tropospheric equatorial westerlies and weakening of the STJ. Zonal variation in SST, characterized by gradual warming in the western Pacific–warm pool and cooling in the central–eastern Pacific, is associated with the strengthening of the Pacific Walker circulation. In the Western Pacific enhanced convective activity leads to precipitation, and the latent heat released in the process strengthens the Pacific Walker circulation. However, it is linked with the trend in global mean temperature, which is related to the emerging anthropogenic greenhouse signal and negative phase of PDO. On the other hand, the central-eastern Pacific cooling trend is linked to the weakening of the central–eastern Pacific Hadley circulation. It suppresses the convective activity due to sinking air motion and imports less angular momentum to the STJ leading to a weakened STJ. While, more PV intrusions result from this weaker STJ on its equatorward side; significantly increase the stratosphere-troposphere exchange processes on the longer timescale. This plays an important role in determining the atmospheric composition, particularly of tropospheric ozone, in the northern outer tropical central Pacific. It may lead to more ozone of stratospheric origin in the LT and even in the marine boundary, which may act as harmful pollutants and affect the radiative processes by changing the global budgets of atmospheric hydroxyl radicals.

Keywords : PV intrusion, westerly duct, ozone, Central Pacific
Conference Title : ICECC 2016 : International Conference on Environment and Climate Change
Conference Location : Venice, Italy
Conference Dates : August 08-09, 2016