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NEWS Climatology Project: Comparing the effects of ENSO and volcanic eruptions on the global hydrological cycle during 1979-2008

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Using satellite- and station-based observations of precipitation, (surface and atmospheric) temperature, and tropospheric water vapor content, this study is focused on exploring how ENSO and two large tropical volcanic eruptions (El Chichón, March 1982; Mt. Pinatubo, June 1991) influence these water cycle components during the period of 1979-2008. By assessing the responses in the time series of tropical and global means over land, ocean, and land and ocean combined, we intend to further provide an observational comparison of the effects of these two phenomena, represented by Nino 3.4 and the tropical mean stratospheric aerosol optical thickness (τ), respectively. Strong same-sign ENSO signals appear in tropical and global mean (surface and tropospheric) temperature over both land and ocean as found in past studies. Nevertheless, ENSO only has very weak impact on tropical and global mean (land ocean) precipitation, despite intense anomalies being readily seen in the time series of precipitation averaged over either land or ocean. In contrast, the two volcanoes decreased not only tropical and global mean surface and tropospheric temperature, but also tropical and global mean (land ocean) precipitation. Lag-correlation analyses further indicate that the ENSO-related peak responses in oceanic precipitation and sea surface temperature (SST) have the same time lags with Nino 3.4, two (four) months for the tropical (global) means. Tropical and global mean tropospheric water vapor over ocean (and land) generally follows surface temperature. However, land precipitation responds to ENSO much faster than temperature, suggesting a certain time needed for surface energy adjustment there following ENSO-related circulation and precipitation anomalies. Weak ENSO impact on the tropical and global mean mid-lower tropospheric (dry) static instability are further discovered, tending to be consistent with weak ENSO responses in the tropical and global (land ocean) mean precipitation. For volcanic eruptions, tropical and global mean precipitation over either ocean or land responds faster than (surface and atmospheric) temperature and tropospheric water vapor averaged over the same areas, suggesting that precipitation tends to be more sensitive to volcanic-related forcing. It is further shown that the volcanic-related precipitation variations are related to the changes in the mid-lower tropospheric (dry) instability.