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Supporting Information for

Tropical west Pacific moisture dynamics and climate controls on rainfall isotopic ratios in southern Papua, Indonesia

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Contents of this supporting information

Text S1

Rain sample collection

The collectors used for sampling rain were designed and manufactured at BPCRC. They are composed simply of 1-liter polyethylene bottles (21 cm in height), each with a polyethylene funnel (11 cm in height) connected by a narrow soft polypropylene plastic tube (0.6 cm inner diameter and 26 cm in length). In order to protect the collectors from the weather, each was placed within a standing frame composed of a dark grey PVC tube (10 cm in diameter and 3.9 cm in height) fastened to a PVC plate. The height of the entire apparatus is approximately 41 cm and its empty weight is about 4 kg. The rain sample collection was conducted on a daily basis between 7 and 9 AM local time by PTFI personnel before they reported to work. During the collection, the rainwater in the collector bottle was immediately poured into 30-ml polyethylene sample bottle with a small air gap for water expansion due to possible

temperature increase and decrease below the freezing point. The bottles were secured and capped tightly as soon as possible to avoid evaporation. Each was labeled with station ID and collection time/date before it was stored in a cool and dark container. The collector bottle was dried with dry cloth or tissue before being returned to its position. Normally, the collection process took less than five minutes. The first collection period was from January 2013 to February 2014 which represents an ENSO-normal condition. In this period, 923 samples were collected at five locations in close proximity to AWSs operated by PTFI (PORT, TMK, KK, TPR and GRS). Only 899 samples were used in this study because 16 samples lacked proper documentation of the collection dates, and 8 samples from TMK were invalidated by sampling errors. The second collection period was conducted from December 2014 to September 2015 which represents an El Niño condition. 439 samples were collected at three stations (PORT, TPR and GRS) with 1 sample from TPR and 5 samples from GRS invalidated by sampling errors.

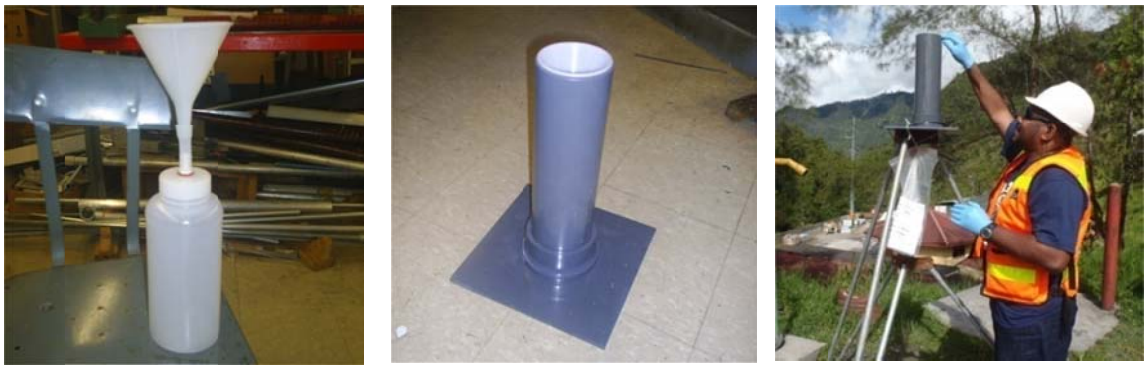

Figure S1. (Left) an assembled rain sampler. (Middle) a rain sampler within a PVC tube with a plate installed. (Right) an installed rain sampler. PTFI personnel conducted the sample collection at the TPR station. Left and middle photographs were taken by Donaldi Permana. Right photograph was taken by PTFI personnel.

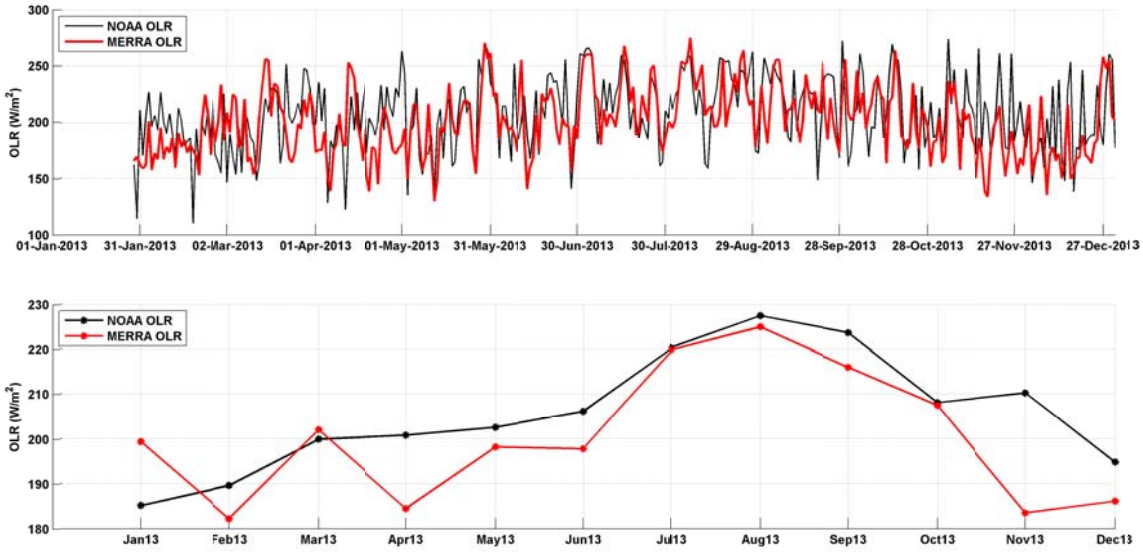

Figure S2. Comparison of daily and monthly NOAA OLR data at 5°S, 137.5°E and MERRA mean OLR data at 4.5-5.0°S, 136.67°E during 2013. The correlation coefficient of monthly comparison data is 0.75 (p = 0.005).

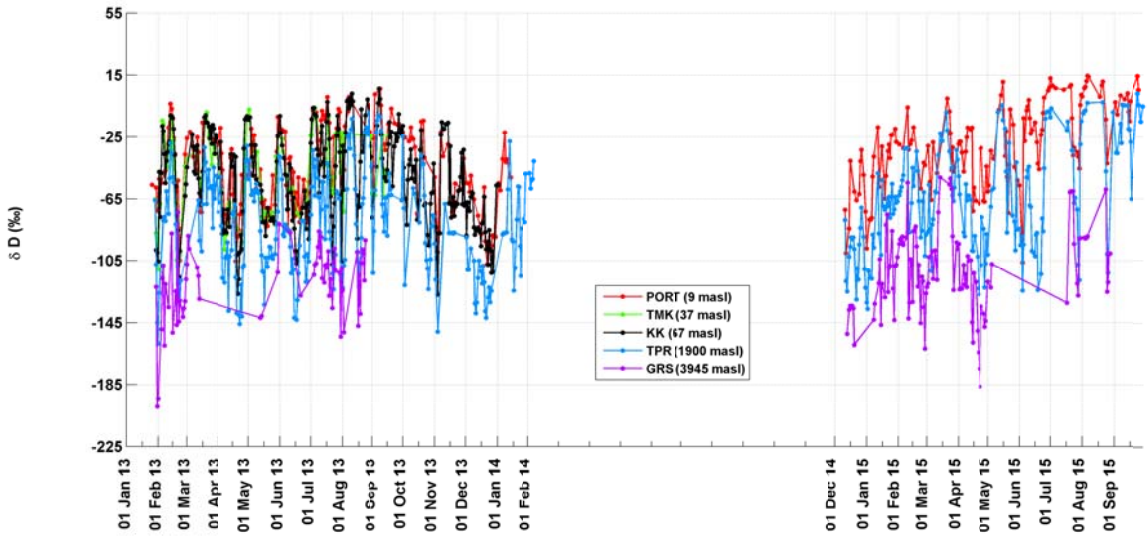

Figure S3. Timeseries of daily δD values for all stations.

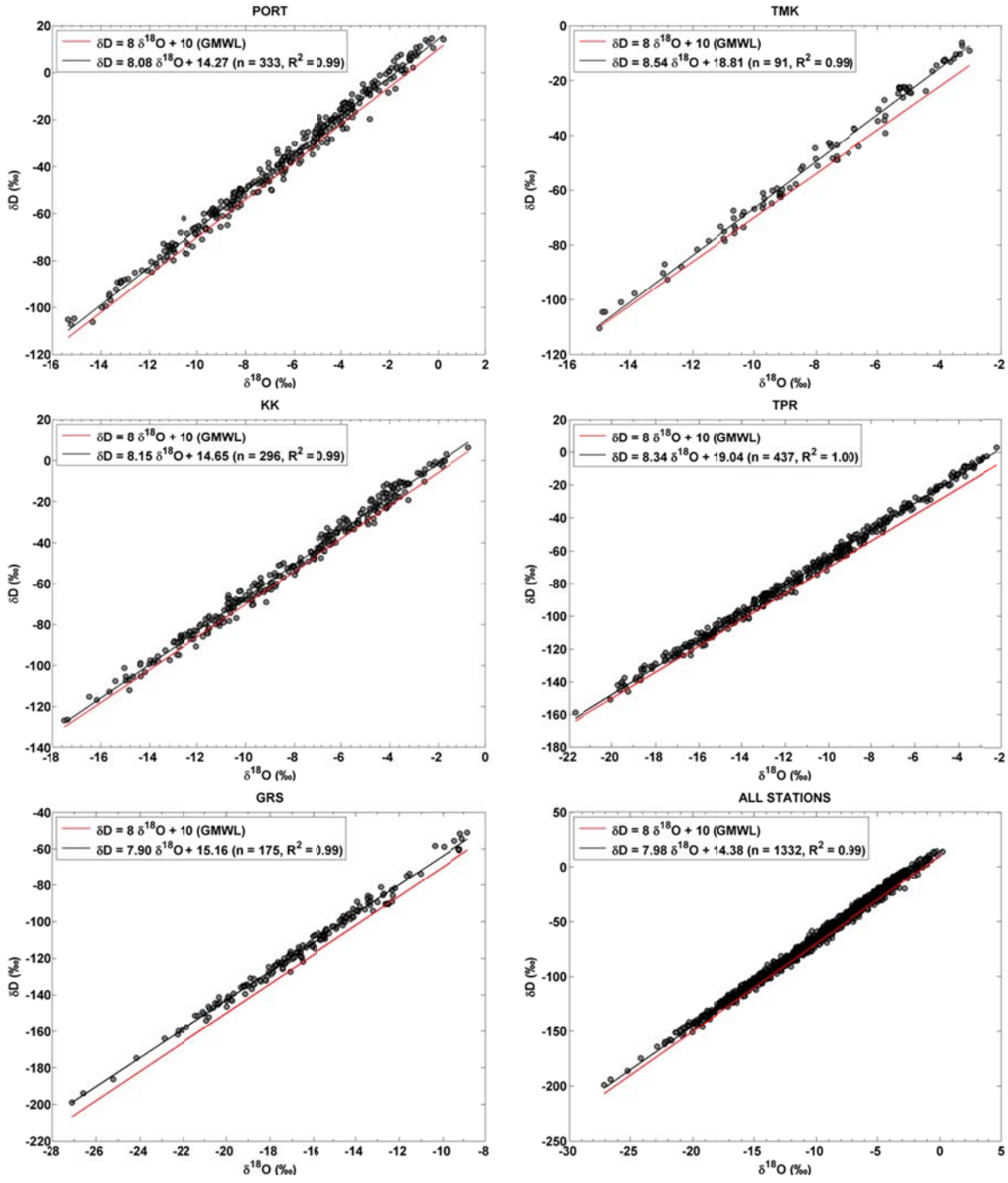

Figure S4. Linear relationships between $\delta^{18}O$ and δD values at each station, and from all stations. Black and red lines represent the LMWL and GWML, respectively.

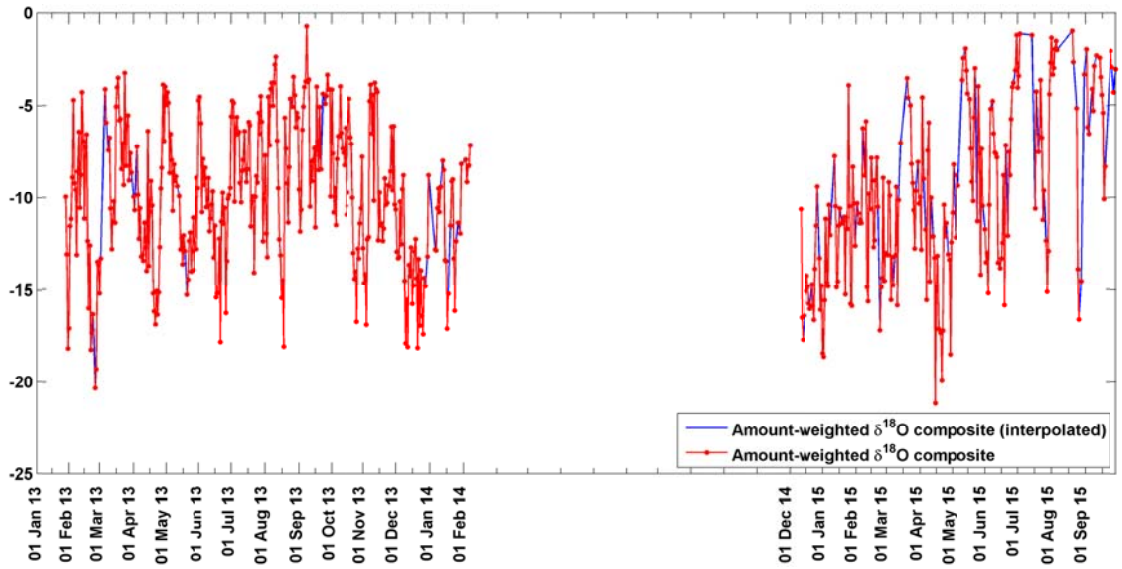

Figure S5. The composite of daily rainfall $\delta^{18}O$ during the two collection periods. The interpolated daily rainfall $\delta^{18}O$ composite (blue) represents the daily regional rainfall $\delta^{18}O$ in this study.

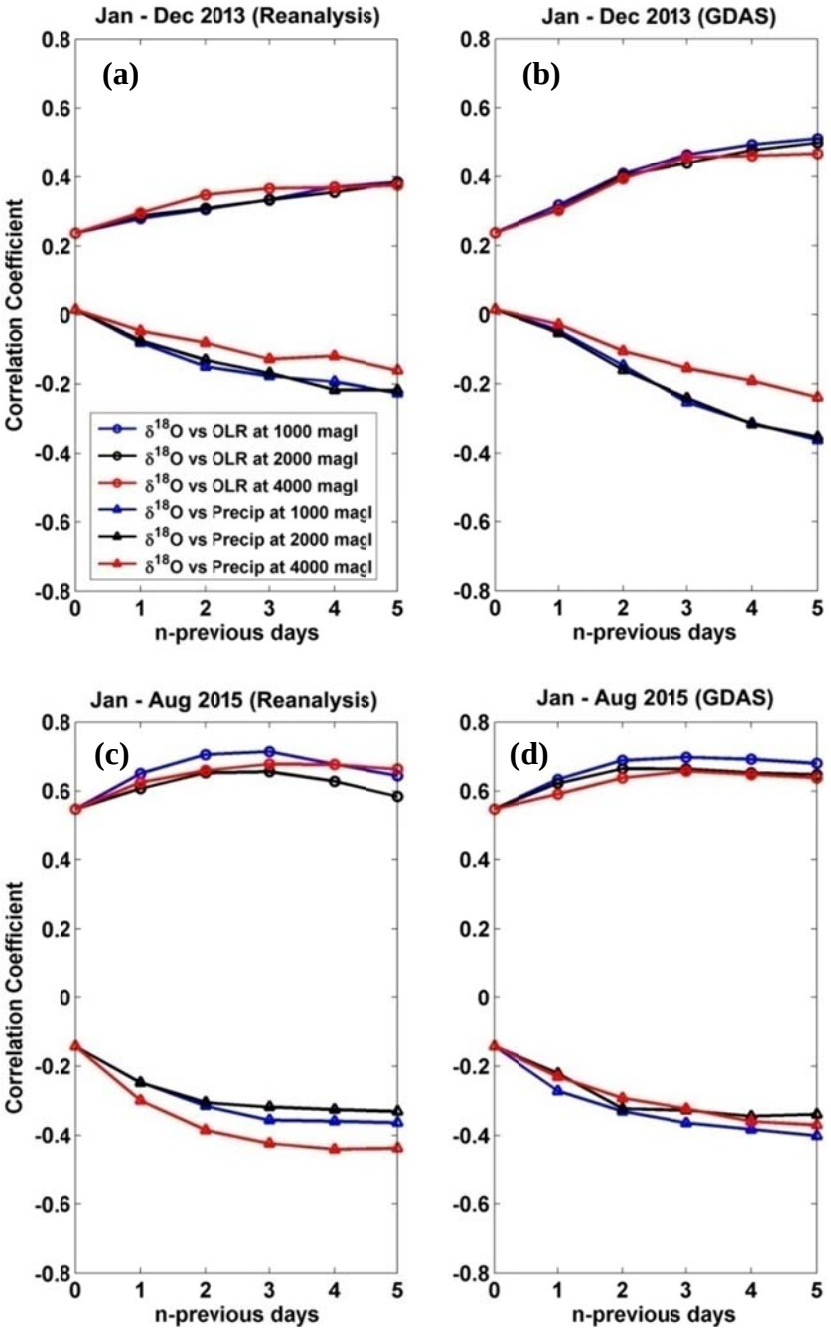

Figure S6. Correlation coefficients between daily regional rainfall $\delta^{18}O$ and mean daily OLR (MERRA), and with cumulative precipitation (TRMM) along the back trajectories over '*n*'-previous days with different starting elevations during 2013 using (a) NCEP Reanalysis and (b) GDAS data. (c) As in (a) and (d) as in (b), but during 2015.

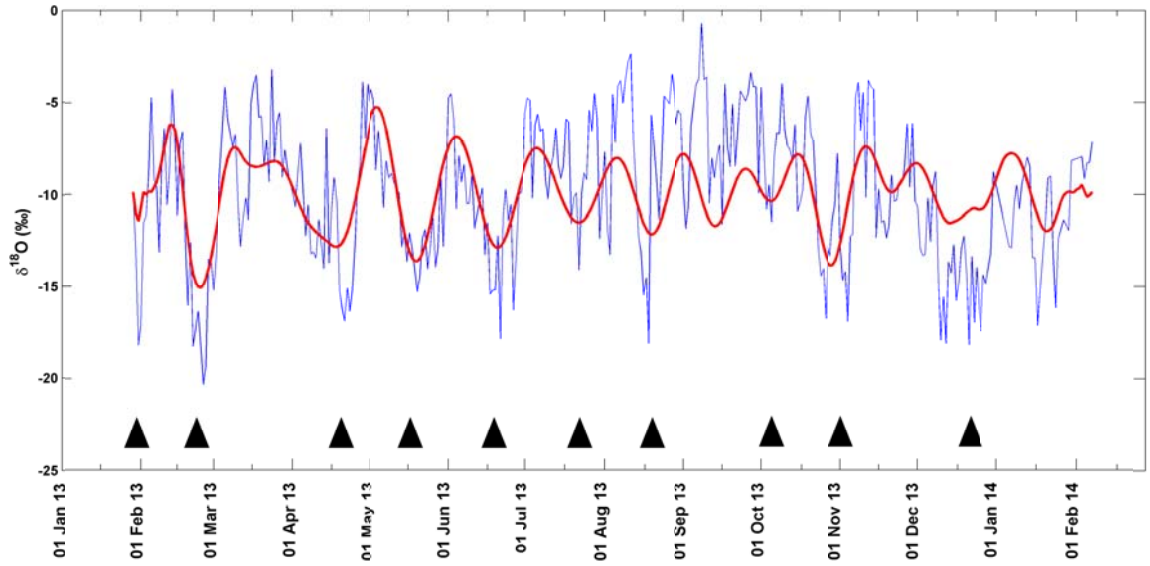

Figure S7. Daily regional $\delta^{18}O$ time series (blue, thin line) and after filtering with a 20–60 day bandpass filter (red, thick line) during the first collection period. Black triangles indicate major regional $\delta^{18}O$ depletion events occurring during the period.

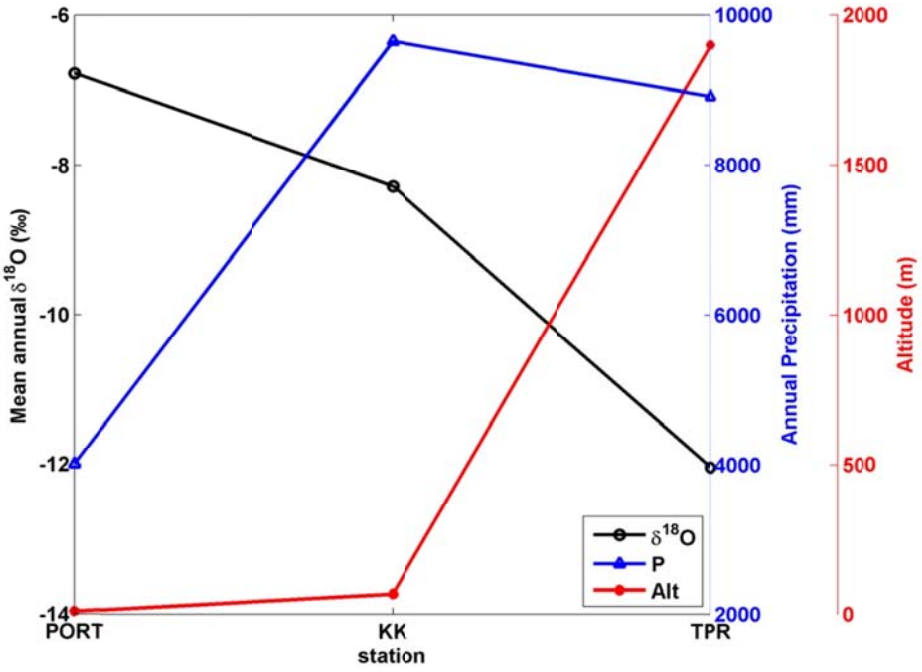

Figure S8. Distribution of mean annual rainfall $\delta^{18}O$, annual precipitation and altitude at PORT, KK, and TPR stations in 2013.

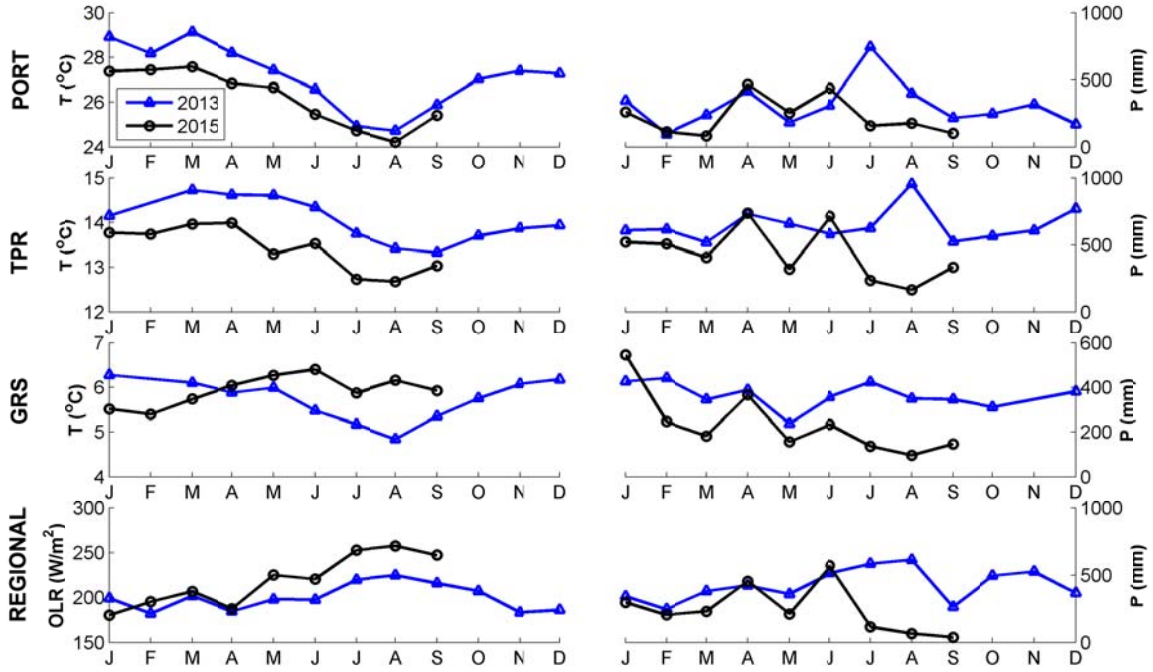

Figure S9. Monthly meteorological data comparison between 2013 (ENSO-Normal period) and 2015 (El Niño period) at stations at different elevations, and at the regional scale (bottom).

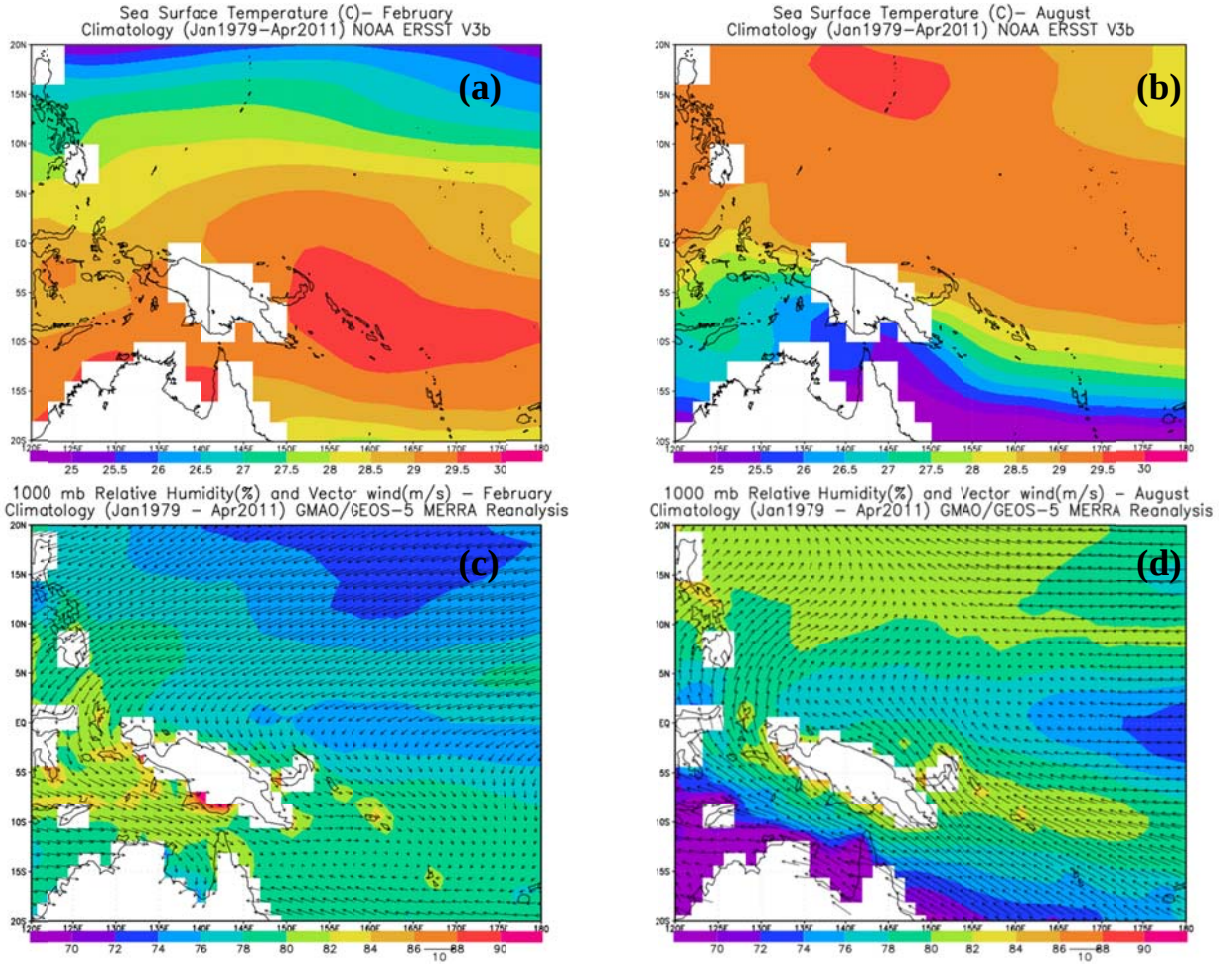

Figure S10. The long term mean sea surface temperatures (°C) at the WPWP for (a) February and (b) August from NOAA Extended Reconstructed SST (ERSST) V3b (January 1979 – April 2011). The climatology of relative humidity (shaded, %) and wind (vector, ms^{-1}) at 1000 mb for (c) February and (d) August from NASA MERRA Reanalysis (January 1979 – April 2011).

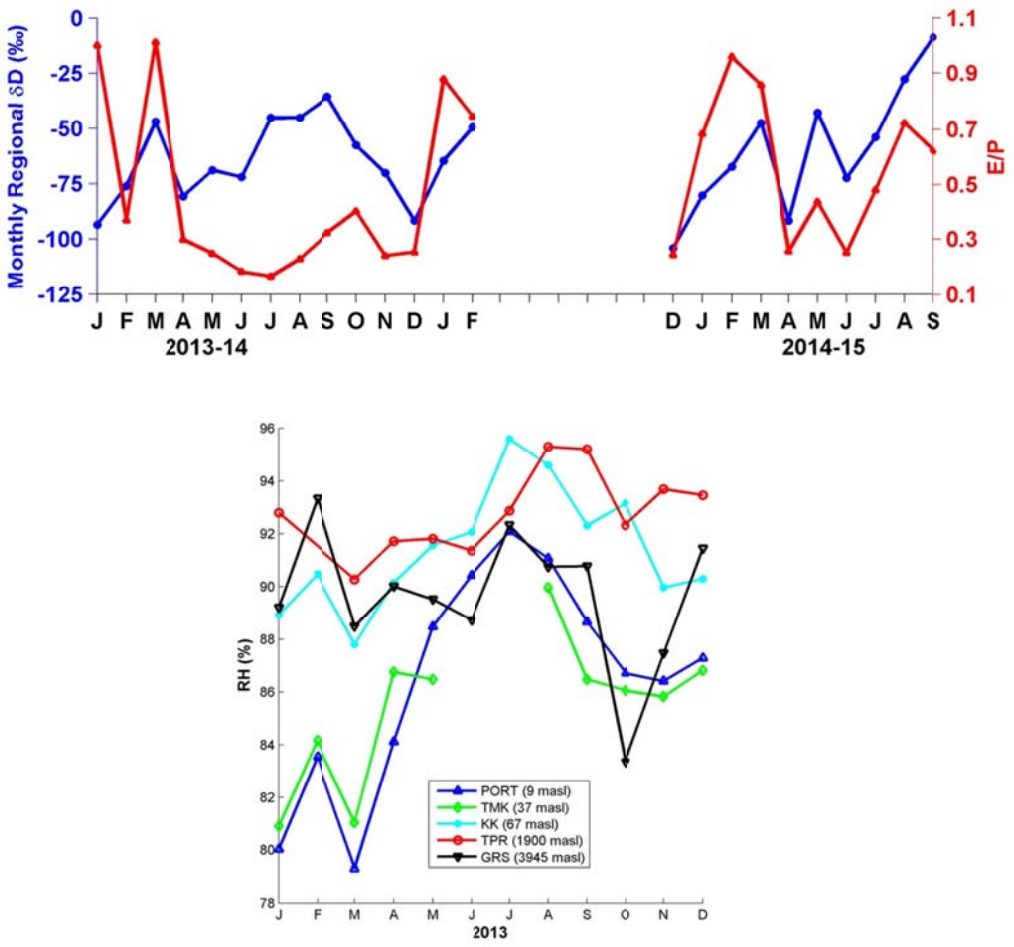

Figure S11. (Top) Comparison of monthly regional rainfall δD and mean E/P parameter (moisture convergence parameter) derived from MERRA at 4.5-5.0°S, 136.67°E during the two collection periods. (Bottom) Monthly mean relative humidity at sample collection stations at different elevations during 2013.

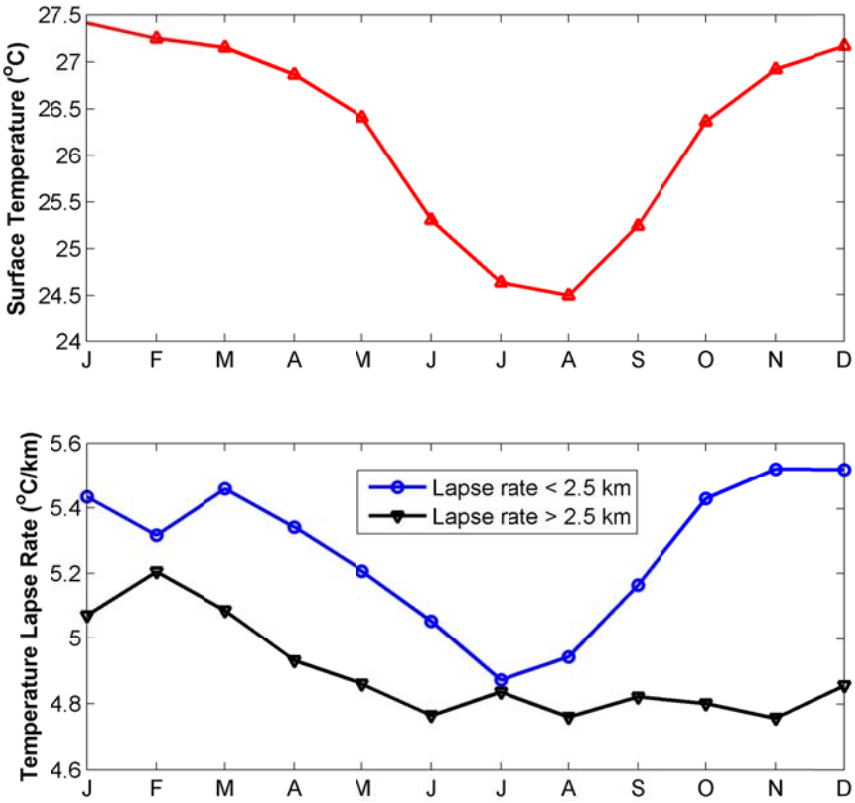

Figure S12. The mean surface temperatures and monthly temperature lapse rates below and above 2.5 km (mean cloud base altitude) from PTFI meteorological data.