Stable isotope variations in monsoon precipitation related to atmospheric moisture transport in southern Peru

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Motivation

- 70% of tropical glaciers globally are located in the tropical Andes
- Improving stable isotope model performance can enhance interpretation of tropical ice core records
- High-frequency observations of precipitation can help improve forecast models of rainfall

Objective

Identify controls on sub-seasonal spatiotemporal variability in stable isotope values of precipitation

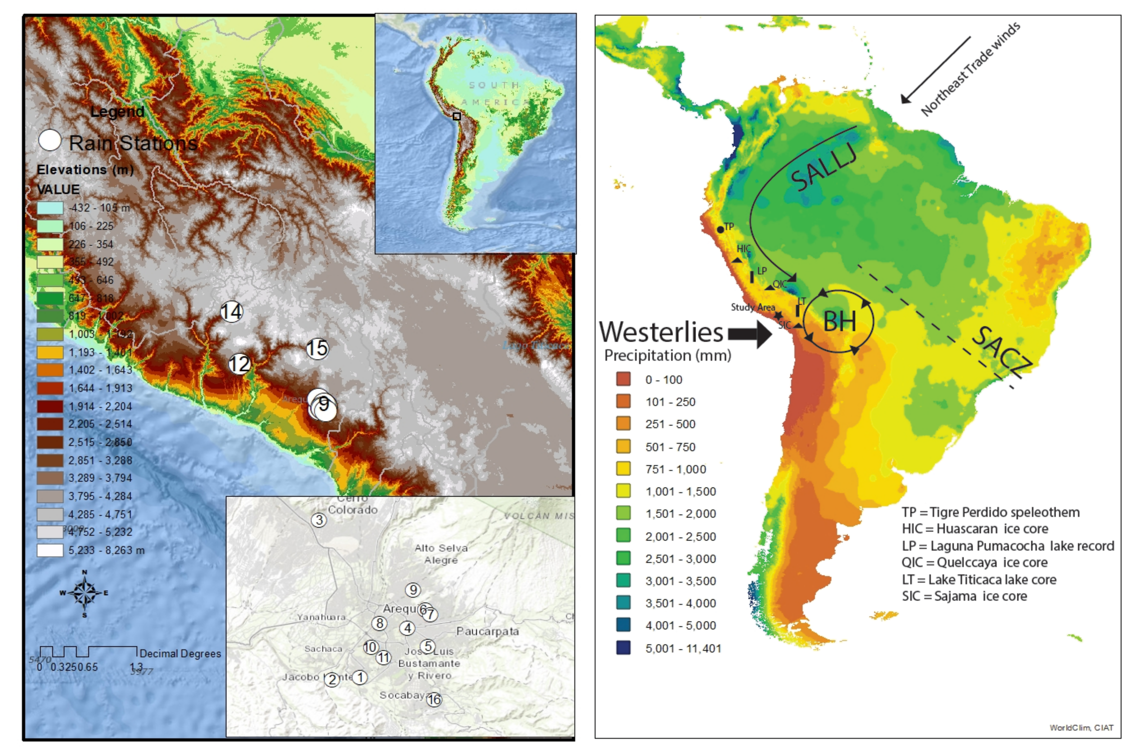

Figure 1. Map of study area. SACZ = South Atlantic Convergence Zone, SALLJ = South American Low Level Jet, Bolivian High, and location of high-resolution paleoclimate isotope records.

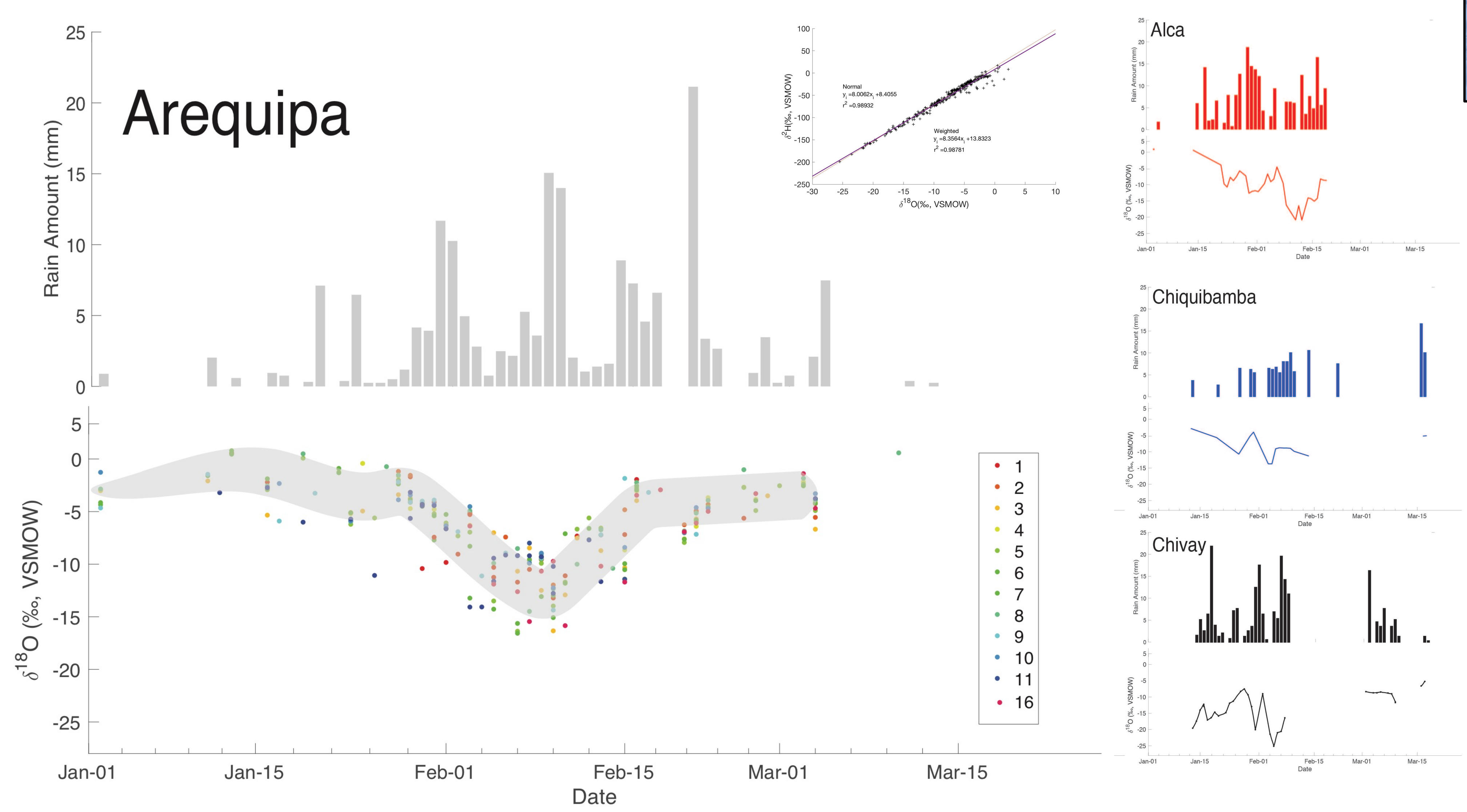

Figure 2. Daily precipitation amount and isotope measurements at each site. Inset $\delta^{18}O$ and δD of all sample stations with local meteoric water line (LMWL). Difference between normal and weighted LMWL calculations shows minimal influence of amount effect. A pronounced decrease in February 1-15[th] isotope values is observed at all sites.

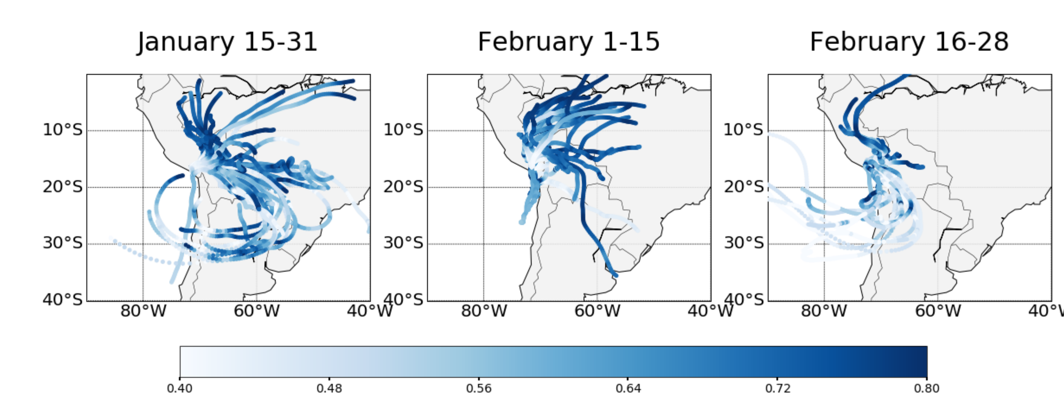

Figure 4. Hysplit back trajectories and specific humidity, showing moisture source is dominated by Amazonian SALLJ transport from the east.

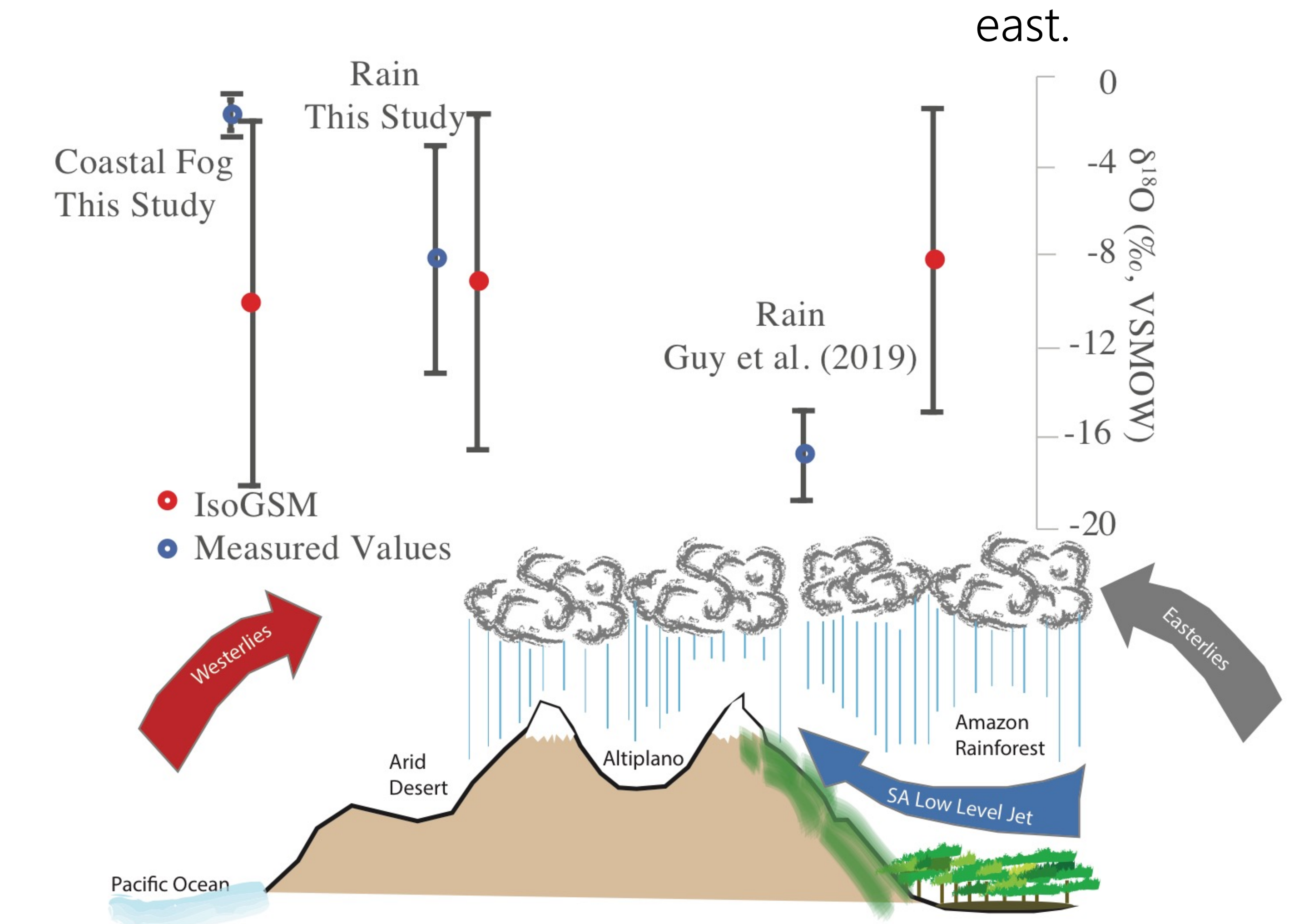

Figure 5. Precipitation and fog isotope values of measured samples compared to IsoGSM model results for $\delta^{18}O$-vapor along east-west transect of the south central Andes. Western Andean rain values are higher than expected given Amazonian source suggesting vapor mixing with Pacific moisture.

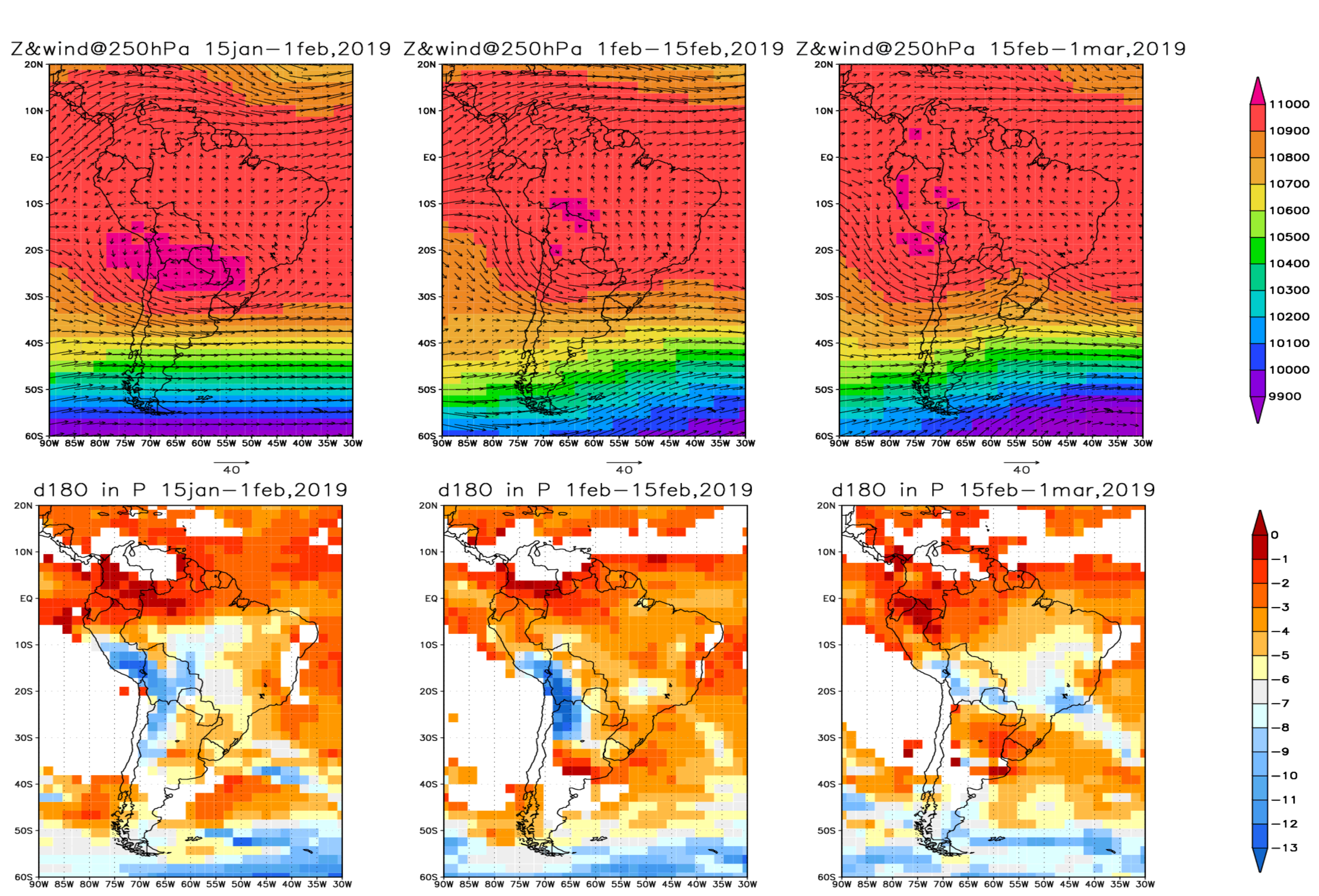

Figure 3. NCEP reanalysis data show decrease in upper atmosphere wind speed and a change in direction over the study period. IsoGSM model results showing decrease in $\delta^{18}O$ isotope values in southern Peru when a decrease is observed in measured precipitation in early February.

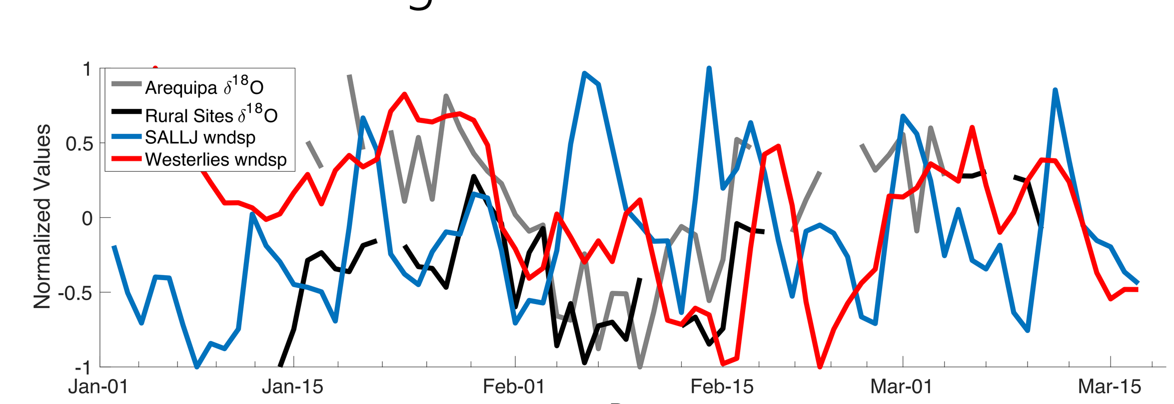

Figure 6. Precipitation isotope anomalies correlate to strength of surface westerlies wind speed at 17°S and mid-level wind speeds of SALLJ (index based on Guy et al.,2019).

	SALLJ	Westerlies
Arequipa	-0.27	**0.38***
Rural Sites	**-0.38***	**0.45***

Table 1. Correlations between $\delta^{18}O$ isotopes and wind speed measures of SALLJ (u_850hPa) and Westerlies (v_surface). Bold * values $p < 0.01$.

Methods

- Citizen scientists volunteers collected precipitation in southern Peru (Jan – Mar '19). Coastal fog was collected from passive net samplers at 6 coastal sites (May – Sep '19).
- Isotope analysis via LGR liquid water isotope analyzer for oxygen and deuterium normalized to VSMOW-VSLAP.
- Temporal variability in isotope values is compared to ERA5 (global atmospheric reanalysis model), NCEP and IsoGSM model data for variables.

Conclusions

Strength of westerlies and mid-level convective moisture transport from the Amazon (SALLJ) control stable isotope values in western Andean rain.

References and Acknowledgements

Kei Yoshimura for IsoGSM output
Funding from NEXUS Institute Purdue University

Guy, H., Seimon, A., Perry, L.B., Konecky, B.L., Rado, M., Andrade, M., Potocki, M. and Mayewski, P.A., 2019. Subseasonal Variations of Stable Isotopes in Tropical Andean Precipitation. Journal of Hydrometeorology, 20(5), pp.915-933.