Characterization and prediction of the Mid Summer Drought in the Tempisque river basin, North of Costa Rica, Central America, using ENSO and AMO relationships.

Eric J. Alfaro: *Centre for Geophysical Research, School of Physics & Marine Sciences and Limnology Research Centre - University of Costa Rica.*

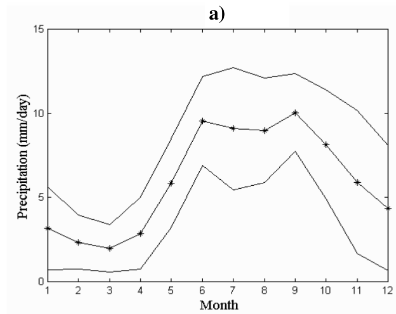
Abstract: On the Pacific slope of Central America, the precipitation annual cycle is characterized by two rainfall maxima in June and September-October, an extended dry season from November to May, and a shorter reduced precipitation period during July–August known as Mid-Summer Drought (MSD) or "veranillo" (**Fig. 1a**) , during July, the magnitude of trade winds increase and this is associated also with the Caribbean Low Level Jet (**Fig. 1b**) (Amador, 2008). Four daily gauge stations records, e.g. Nicoya, Santa Cruz, Liberia and Bagaces, located in the Tempisque river basin, province of Guanacaste, North Pacific slope of Costa Rica, were studied to characterize the MSD from 1937 to 2010 (**Fig. 2**). Among the aspects considered are the MSD start (**July 3**), end (**August 15**), duration (**45 days**), intensity (**6.6 mm/day**), deep of the minimum (**2.7 mm**), timing (**July 21**) and seasonal predictability (**Fig. 3 and Table 1**). The modulation of these aspects by climate variability sources as Equatorial Eastern Pacific (ENSO) and Atlantic (AMO) was lately explored, including their interannual and decadal variability (**Fig. 4**). The MSD signal strongly impact social and economic life in the region like energy, human consumption and the agriculture sector (**Fig. 5**).

Some references

-Amador, J., 2008. The Intra-Americas Seas Low-Level Jet (IALLJ): Overview and Future Research. *Ann. N. Y. Acad. Sci.*, 1146(1), 153-188.

-Magaña V., J. Amador and S. Medina. 1999. The Midsummer Drought over Mexico and Central America, *Journal of Climate*, 12, 1577-1588.

-Taylor, M. and E. Alfaro, 2005. Climate of Central America and the Caribbean. In: *Encyclopedia of World Climatology*. John E. Oliver (ed.), Springer, Netherlands. 183-189.



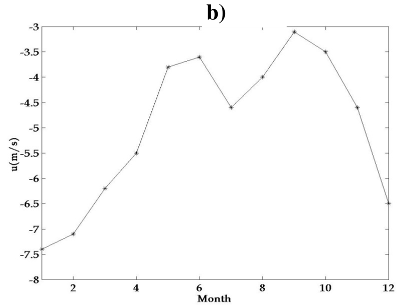


Fig. 1 – **a)** Line with asterisk is the first (dominant) EOF of rainfall annual cycle pattern from 337 points over or very close to land in Central America, covering 78.0-95.0°W, 7.5-21.5°N. Bands show one standard deviation (solid lines). The sources of these data are described in Magaña *et al.* (1999). **b)** Zonal Wind annual cycle at surface, *u*(m/s), Juan Santamaria airport, synoptic station located in the Costa Rican Central Valley (Taylor y Alfaro, 2005).

a)

b)

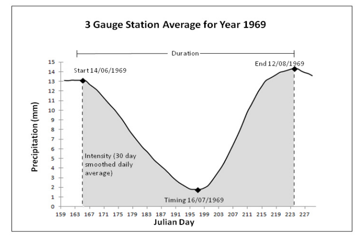


Fig. 2 – **a)** Location of the four gauge stations used, province of Guanacaste, Costa Rica. **b)** Individual records were smoothed with a triangular moving average of 30 days, then, the daily average using the three records was calculated to produce a precipitation index. The figure shows the characteristics that were considered using 1969 as an example. 63 cases were studied, from 1937 to 2010. 11 years were considered as missing data.

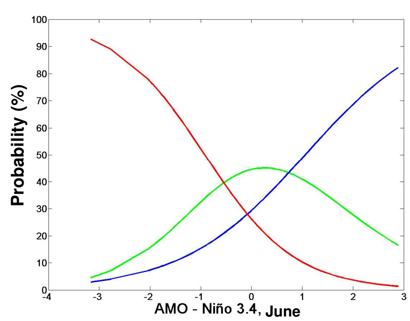
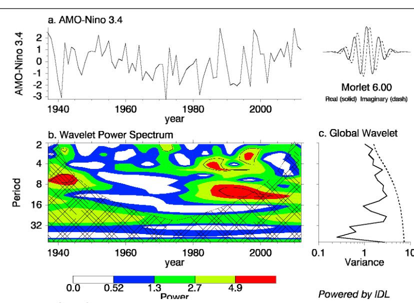


Fig. 3 – *Logit* models fixed for the MSD precipitation Minimum at the Tempisque basin, with *x* representing the June observed normalized anomaly in the AMO - Niño 3.4 index. Blue, green and red line are for the probability of the AN, N and BN scenarios, respectively of the models y_{AN}, y_N and y_{BN}.

AMO-Niño June	Minimum: BN (≤2.2mm)	Minimum: N	Minimum: AN (≥3.4mm)
BN (≤-0.59)	61(13)***	29(6)	10(2)***
N	29(6)	38(8)	33(7)
AN (≥0.63)	10(2)***	33(7)	57(12)***

Table 1. – Relative frequency (percentages) Contingency Tables between June AMO - Niño 3.4 index (rows) and the precipitation at the minimum of the MSD events (columns). *, **, and *** are for α = 0.1, 0.05 and 0.01, significance levels, respectively. Values in parenthesis are for absolute frequencies. According to **Fig. 3** and **Table 1**, Negative (positive) AMO - ENSO events tend to be associated with drier (wetter) MSD conditions.

a)



b)

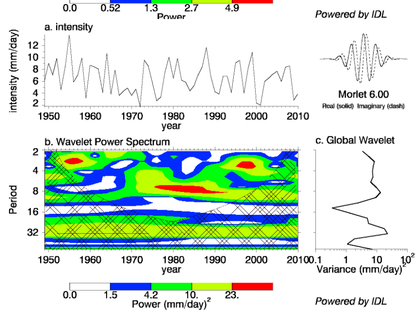
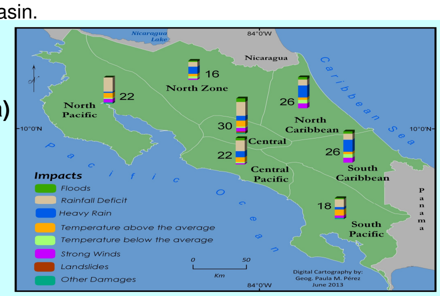


Fig. 4 – Wavelet analysis for **a)** AMO-Niño 3.4 index, and **b)** MSD intensity in the Tempisque basin.

a)



b)

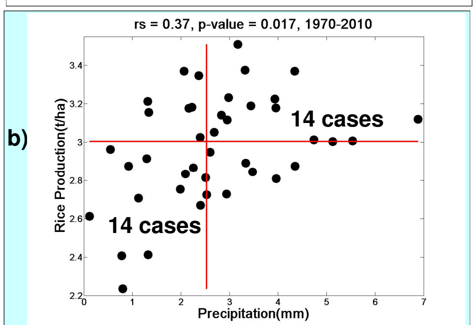


Fig. 5 – **a)** Spatial distribution of MSD climate impacts reported in the Monthly Meteorological Bulletins elaborated by the Costa Rican National Meteorological Institute for the years 1977, 1982, 1986, 1993, 2000, 2001, 2003, 2009 and 2012, according to the climate regions of Costa Rica. Years are identified in the BN category in **Table 1**. **b)** Rice annual production vs. precipitation in the Tempisque MSD minimum. Red lines are medians.

Acknowledgments. Projects: CRN2050 – IAI, and VI-805-A7-002, B0-810, UCR. Thanks also to Paula Pérez, Elsie Troyo, Aarón Vega and Francisco Jiménez for the data processing.

Based on the work: Alfaro, E., 2014. Caracterización del Veranillo en dos cuencas de la vertiente del Pacífico de Costa Rica, América Central. *Accepted in International Journal of Tropical Biology and Conservation.*

Poster available after the event in : http://kerwa.ucr.ac.cr/

Author e-mail: erick.alfaro@ucr.ac.cr