waves and therefore the mean wave height. The annual rainfall cycle was the typical bimodal pattern from the Central America Pacific, with maxima in May and October, except for the midsummer interruption, and minimum rain was on February. Golfo Dulce is a unique environment in the Eastern Tropical Pacific, shows healthy environmental conditions, and is threatened; therefore we urge the establishment of zoning policy for human activities, and to improve protection under the principles of sustainable use.

5. Publications (under both CRN2050 and SGP-CRA-2050, 2006-2015)

Journal Publications

(Our IAI funding is mentioned in the acknowledgments. The pdf version of the published papers is attached to this annual report)

Year 1 (2006-2007)

Liu, K.B., 2007. Uncovering prehistoric hurricane activity, American Scientist 95: 126-133.

Mora, C.I., Miller, D.L. and Grissino-Mayer, H.D., 2007. Tempest in a tree ring: Paleotempestology and the record of past hurricanes, The Sedimentary Record, 4: 4-8.

Year 2 (2007-2008)

Alfaro, E., 2007a. Escenarios climáticos para temporadas con alto y bajo número de huracanes en el Atlántico (Climate scenarios for years with high and low number of Hurricanes in the Atlantic basin). Revista de Climatología, 7, 1-13. (Available at: http://webs.ono.com/reclim/, last visit 25/07/2008)

Alfaro, E., 2007b. Uso del análisis de correlación canónica para la predicción de la precipitación pluvial en Centroamérica (Use of CCA for the Central American rainfall prediction). Revista Ingeniería y Competitividad, 9 (2), 33-48. (Available at: http://revistaingenieria.univalle.edu.co/, last visit 25/07/2008)

Alfaro, E., D. Hernández y A. Bezanilla, 2007: Uso de un modelo de aguas someras para analizar la influencia del Atlántico Tropical Norte y del Pacífico Ecuatorial del Este sobre la circulación atmosférica en los mares Intra-Americanos (Use of a shallow water model to analize the influence of the Tropical North Atlantic and the Eastern Tropical Pacific on the Intra Americas Seas atmospheric circulation). Revista de Climatología, 7, 15-26. (Available at: http://webs.ono.com/reclim/, last visit 25/07/2008)

Frappier, A. B., Knutson, T., Liu, K.-b., Emanuel, K., 2007. Perspective: Coordinating Paleoclimate Research on Tropical Cyclones with Hurricane-Climate Theory and Modeling Tellus A. doi: 10.1111/j.1600-0870.2007.00250.x

Frappier, A. B., 2008. Masking of inter-annual climate proxy signals by residual tropical cyclone water from Hurricane Mitch: Observations and challenges for low-latitude speleothem paleoclimatology. Geochimica et Cosmochimica Acta, v. 72, n.12: A282-A282 Suppl.

Landsea, C.W., D.A., Lenn, W. Bredemeyer, M. Chenoweth, R. Ellis, J. Gamache, L. Hufstetler, C. Mock, R. Perez, R. Prieto, J. Sánchez-Sesma, D. Thomas, And L. Woolcock. 2008. A Reanalysis of the 1911–20 Atlantic Hurricane Database, Journal of Climate, 21, 2138-2168. (a copy was sent to IAI, 24 July 2008)

Mora C.I., Miller D.M., and Grissino-Mayer H.D. (2007) Oxygen isotope proxies in tree ring cellulose: tropical cyclones, drought and climate oscillations. in Dawson, T.E. and Siegwolf, R.T.W. (eds.) Stable Isotopes as Indicators of Ecological Change p. 63-76. Terrestrial Ecology Series, Elsevier. (The format of this book did not allow for acknowledgements to be published.)

Rivera, E. y J. A. Amador, 2008. Predicción Estacional del Clima en Centroamérica mediante la reducción de escala dinámica. Parte I: Evaluación de los Modelos de Circulación General CCM3.6 y ECHAM4.5. Revista de Matemática: Teoría y Aplicaciones, 15(2), 131-173.

Year 3 (2008-2009)

Alfaro, E. y J. Soley, 2009. Descripción de dos métodos de rellenado de datos ausentes en series de tiempo meteorológicas (Description of two methodologies for filling gaps in meteorological time series). Revista de Matemáticas: Teoría y Aplicaciones. 16(1), 59-74. (Available at http://revista.emate.ucr.ac.cr/index.php/revista, last visit 29/06/2009) (X)

Amador, J. A., 2008. The Intra-Americas Sea Low-Level Jet (IALLJ): Overview and Future Research, Trends and Directions in Climate Research, Annals of the New York Academy of Sciences, 1146: 153–188. (*)

Amador J. A., E. Alfaro, E. Rivera y B. Calderón, 2009a. Central America. In: State of the Climate in 2008, Special Supplement, Bulletin of the American Meteorological Society Vol. 90, No. 7, July 2009. (*)

Grissino-Mayer H.D., Miller D.L., and Mora C.I. (in press) Dendrotempestology and the Isotopic Record of Tropical Cyclones in Tree Rings from the Southeastern United States. In: Stoffel M., Bollschweiler M., Butler D., and Luckman B.H., eds., Tree-Ring Reconstructions in Natural Hazards Research: A State-of-the-Art. Springer-Verlag, Berlin

Lam, N.S.N., Arenas, H., Li, Z., and Liu, K.B.. 2009. An estimate of population impacted by climate change along the U.S. coast. Journal of Coastal Research, Special Issue 56: 1522-1526.

Mann, M.E., J.D. Woodruff, J.P. Donnelly, and Z. Zhang, 2009, Atlantic hurricanes and climate over the past 1500 years: Nature 460: 880-883.

Rivera, E. y J. A. Amador, 2008. Predicción Estacional del Clima en Centroamérica mediante la reducción de escala dinámica. Parte I: Evaluación de los Modelos de Circulación General CCM3.6 y ECHAM4.5. Revista de Matemática: Teoría y Aplicaciones, 15(2), 131-173.

Rivera, E. y J. A. Amador, 2009. Predicción Estacional del Clima en Centroamérica mediante la reducción de escala dinámica. Parte II: Aplicación del modelo MM5v3. Revista de Matemática: Teoría y Aplicaciones, 16(1), 76-104.

Saenger, C., Cohen, A. C., Oppo, D. W. Halley, R. B. and Carilli, J. E.: 2009. Surface temperature trends and variability in the low-latitude North Atlantic since 1552. Nature Geoscience. 2, 492-495, doi: 10.1038/NGEO552.

Year 4 (2009-2010)

Amador, J. y E. Alfaro, 2009. Métodos de reducción de escala: Aplicaciones al clima, variabilidad y cambio climático. Revista Iberoamericana de Economía, 11, 39-52. (Available at http://www.redibec.org/, last visit Jun. 6Th, 2010)

Amador J. A., E. Alfaro, E. Rivera y B. Calderón, 2009. Central America. In: State of the Climate in 2008, Special Supplement to the Bulletin of the American Meteorological Society, 90(8), S130. (Available at http://journals.ametsoc.org/doi/abs/10.1175/BAMS-90-8-StateoftheClimate, last visit Jun. 6Th, 2010)

Amador, J. A., & A. Bonilla, 2009: Ciclones tropicales y sociedad: Una aproximación al enfoque científico de estos fenómenos atmosféricos como referente para la investigación social en desastres. En: Concepciones y Representaciones de la Naturaleza y la Ciencia en América Latina (R. Viales, J. Amador y F. Solano eds.), 159-179. Editorial de la Universidad de Costa Rica.

Bonilla, A., & J. A. Amador, 2009: El temporal de enero 2000: sus características e impactos socio-económicos sobre las comunidades próximas a la cuenca de la Laguna de Arenal y de la región Huetar Norte. En: Concepciones y Representaciones de la Naturaleza y la Ciencia en América Latina (R. Viales, J. Amador y F. Solano eds.), 243-253. Editorial de la Universidad de Costa Rica.

Lam N.S.N., Arenas, H., Liu, K.B., and Brito P.L., 2009. Assessing the coastal population at risk to sea level rise in the Caribbean Region. Proceedings of the 24th International Cartographic Conference. Santiago, Chile. November 15-21, 2009.

Torrealba, E., y J. Amador, 2010. La corriente en chorro de bajo nivel sobre los Llanos Venezolanos de Sur América. Revista de Climatología, 10, 1-20. (Available at http://webs.ono.com/reclim/, last visit Jun. 6Th, 2010)

Year 5 (2010-2011)

Alfaro, E., A. Quesada and F. Solano, 2010. Análisis del impacto en Costa Rica de los ciclones tropicales ocurridos en el Mar Caribe desde 1968 al 2007 (Analysis of Caribbean Sea tropical cyclones occurrences from 1968 to 2007 and their impact in Costa Rica), Revista Diálogos, 11(2), 22-38. (available at: http://historia.fcs.ucr.ac.cr/) (In Spanish).

Amador J. A., E. Alfaro, H. Hidalgo, E. Rivera and B. Calderon, 2010. Central America. In: State of the Climate in 2009, Special Supplement to the Bulletin of the American Meteorological Society, 91(7), S143-144. (available at http://globalfundexchange.com/press/wp-content/uploads/2010/07/climate-assessment-2009-lo-rez.pdf, last visit April 26th, 2011)

Amador J. A., E. Alfaro, E. Rivera and B. Calderon, 2010. Climatic Features and Their Relationship with Tropical Cyclones over the Intra-Americas Seas. In: J.B. Elsner et al. (eds.), Hurricanes and Climate Change: Volume 2, DOI 10.1007/978-90-481-9510-7 9 (pp. 149-173). New York: Springer.

Year 6 (2011-2012)

Alfaro, E. y A. Quesada, 2010. Ocurrencia de ciclones tropicales en el Mar Caribe y sus impactos sobre Centroamérica (Tropical cyclone ocurrences in the caribbean sea and their impact on Central America). Revista Intersedes, 11(22), 136-153. (http://www.intersedes.ucr.ac.cr/ojs/index.php/intersedes/issue/archive) In Spanish.

Amador, J. A., 2011. Socio-economic impacts associated with meteorological systems and tropical ciclones in Central América in 2010. In: State of the Climate in 2010, Special Supplement to the Bull. Amer. Met. Soc., 92(6), S184.

Amador, J. A., E. J. Alfaro, H. Hidalgo & B. Calderon, 2011. Central America. In: State of the Climate in 2010, Special Supplement to the Bull. Amer. Met. Soc., 92(6), S182-183.

Lewis, D., Finkelstein, D.B., Grissino-Mayer, H.D., Mora, C.I., and Perfect, E. (in press) A multi-tree perspective of the tree ring tropical cyclone record from longleaf pine (Pinus

palustris Mill.), Big Thicket National Preserve, Texas, U.S.A. Journal of Geophysical Research – Biogeosciences. 116, G02017, doi:1029/2009JG001194

Liu, K.B., Li, C.Y., Bianchette, T.A., McCloskey, T.A., Yao, Q., and Weeks, E., 2011. Storm deposition in a coastal backbarrier lake in Louisiana caused by Hurricanes Gustav and Ike. Journal of Coastal Research, SI 64: 1866-1870.

Maldonado, T. y E. Alfaro, 2011. Predicción estacional para ASO de eventos extremos y días con precipitación sobre las vertientes Pacífico y Caribe de América Central, utilizando análisis de correlación canónica (Seasonal prediction of extreme precipitation events, and frequency of rainy days for ASO over the Pacific and Caribbean slopes of Central America using Canonical Correlation Analysis). Revista Intersedes. 13 (24), 78-108. (http://www.intersedes.ucr.ac.cr/ojs/index.php/intersedes/issue/archive) In Spanish.

Maldonado, T. y E. Alfaro, 2010. Propuesta metodológica para la predicción climática estacional de eventos extremos y días con precipitación. Estudio de caso: Sur de América Central (Seasonal climate prediction of extreme precipitation events and frequency of rainy days in the South of Central America as a study case. A methodological proposal). Revista Intersedes, 11(21), 182-214. (http://www.intersedes.ucr.ac.cr/ojs/index.php/intersedes/issue/archive) In Spanish.

Solano, F., E. Alfaro, & A. Quesada, 2011: Impacto de los Ciclones Tropicales del Atlántico en Centroamérica, Temporadas de 1968 y 1969 (Impact of the Atlantic Tropical cyclones in Central America. 1968 and 1969 seasons). Revista Diálogos, 12(1), 78-100. (http://historia.fcs.ucr.ac.cr/). In Spanish.

Vargas, J., E. Alfaro y J. Gómez, 2011. Tres Colón en Cariay (1502): reflexiones sobre marinos, el mar y la flora (Three Columbus in Cariay (1502): Reflections on the fleet, the sea, the land, and the flora). Revista Reflexiones, 90(1), 105-120. (http://reflexiones.fcs.ucr.ac.cr/index.php/ediciones-anteriores/127-edicion-90-1-2011). In Spanish.

Year 7 (2012-2013)

Amador, J. A., E. J. Alfaro, B. Calderón, A. M. Durán-Quesada, H. G. Hidalgo and I. L. Rivera, 2013. Central America. In: State of the Climate in 2012, Special Supplement to the *Bull. Amer. Met. Soc*., **94**(8), S232-23 4.

Fallas-López B, Alfaro E, 2012a. Uso de herramientas estadísticas para la predicción estacional del campo de precipitación en América Central como apoyo a los Foros Climáticos Regionales. 1: Análisis de tablas de contingencia. *Revista de Climatología*, **12**, 61-79.

Fallas-López B, Alfaro E, 2012b. Uso de herramientas estadísticas para la predicción estacional del campo de precipitación en América Central como apoyo a los Foros Climáticos Regionales. 2: Análisis de Correlación Canónica. *Revista de Climatología*, **12**, 93-105.

Farfán, L., E. Alfaro and T. Cavazos, 2013. Characteristics of tropical cyclones making landfall on the Pacific coast of Mexico: 1970-2010. *Atmósfera*, **26**(2), 163-182.

Frappier, A. B., 2013. Masking of interannual climate proxy signals by residual tropical cyclone rainwater: Evidence and challenges for low-latitude speleothem paleoclimatology, *Geochem. Geophys. Geosyst*., **14**, doi:10.1002/ggge.20218.

Maldonado, T., E. Alfaro, B. Fallas and L. Alvarado, 2013. Seasonal prediction of extreme precipitation events and frequency of rainy days over Costa Rica, Central America, using Canonical Correlation Analysis. *Advances in Geosciences,* **33**, 41-52.

McCloskey, T.A. and Liu, K.B., 2012. A sedimentary-based history of hurricane strikes on the southern Caribbean coast of Nicaragua. *Quaternary Research* 78: 454-464.

McCloskey, T.A. and Liu, K.B., 2013. A 7000 year record of paleohurricane activity from a coastal wetland in Belize, *The Holocene*, **23** (2): 278-291.

McCloskey, T.A. and Liu, K.B., 2013. Sedimentary history of mangrove cays in Turneffe Islands, Belize: Evidence for sudden environmental reversals, *Journal of Coastal Research*, **29** (4): 971-983.

McCloskey, T.A., Bianchette, T.A., and Liu, K.B., 2013. Track patterns of landfalling and coastal tropical cyclones in the Atlantic Basin, their relationship with the North Atlantic Oscillation (NAO), and the potential effect of global warming, *American Journal of Climate Change*, **2**: 12-22.

Year 8 (2013-2014)

Amador, J. A., E. J. Alfaro, H. G. Hidalgo, A. M. Durán-Quesada, B. Calderón, I. L. Rivera and C. Vega, 2014. Central America. In: State of the Climate in 2013, *Special Supplement to the Bull. Amer. Met. Soc*., 95(7), S164-166.

Alfaro, E. and P. M. Pérez-Briceño, 2014. Análisis del impacto de fenómenos meteorológicos en Costa Rica, América Central, originados en los mares circundantes. *Revista de Climatología*, 14, 1-11.

Amador, J. and E. Alfaro, 2014. Weather and climate socio-economic impacts in Central America for the management and protection of world heritage sites and the Diquis Delta culture in Costa Rica (a case study). *Advances in Geosciences,* 35, 157–167.

Denommee, K., Bentley, S.J., and Droxler, A.W., 2014. Climatic controls on hurricane patterns: a 1200-y near-annual record from Light House Reef, Belize. *Scientific Reports*, 4: 3876. DOI: 10.1038/srep03876

Fallas-López, B. and Alfaro E., 2014. Predicción estacional de las temperaturas máximas y mínimas en América Central. *Tópicos Meteorológicos y Oceanográficos*, 13(1), 5-26.

Farfan, L.M., D'Sa, E.J., Liu, K.B., and Rivera-Monroy, V.H., 2014. Tropical cyclone impacts on coastal regions: The case of the Yucatan and the Baja California peninsulas, Mexico. *Estuaries and Coasts*, 37: 1388-1402. (DOI: 10.1007/s12237-014-9797-2.

Frappier, A. B., J. Pyburn, A. D. Pinkey-Drobnis, X. Wang, D. R. Corbett, and B. H. Dahlin, 2014. Two millennia of tropical cyclone-induced mud layers in a northern Yucatán stalagmite: Multiple overlapping climatic hazards during the Maya Terminal Classic "megadroughts". *Geophysical Research Letters*, 41(14): 5148-5157, doi:10.1002/2014GL059882.

Lam, N.S.N., Arenas, H., Brito, P., and Liu, K.B., 2014. Assessment of vulnerability and adaptive capacity to coastal hazards in the Caribbean region. *Journal of Coastal Research, Special Issue* 66, 473-478.

Naquin, J.D., Liu, K.B., McCloskey, T.A., and Bianchette, T.A., 2014. Storm deposition induced by hurricanes in a subsiding coastal zone. *Journal of Coastal Research*, Special Issue 70: 308-313.

Serra, Y., Jiang, X., Tian, B., Amador, J., Maloney, E., and Kiladis, G., 2014. Tropical Intraseasonal Modes of the Atmosphere. *Annual Review of Environment and Resources*. 39 (5), 5-27. Doi: 10.1146/annurev-environ-020413-134219

Year 9 (2014-2015)

Alfaro, E., 2014. Caracterización del "veranillo" en dos cuencas de la vertiente del Pacífico de Costa Rica, América Central (Characterization of the Mid Summer Drought in two Pacific slope river basins of Costa Rica, Central America). *Revista de Biología Tropical*, 62 (Supl. 4): 1-15. *Spanish*.

Amador, J. & Muñoz, G. (2015). Moduladores climáticos de baja frecuencia y las plagas de langostas en Mesoamérica. In Peraldo, G. (Ed.). *Plagas de langostas en América Latina. Una perspectiva multidisciplinaria*. San José, Costa Rica: Editorial Nuevas Perspectivas. 57-97pp.

Amador, J. A., E. J. Alfaro, H. G. Hidalgo, Ana M. Durán, B. Calderón, I. L. Rivera, and C. Vega, 2015. Central America. [In State of the Climate 2014], *Bull. Amer. Met. Soc.*; 96(7), S. *In Press*.

Cid, L., S. Ramírez, E.J. Alfaro, D. Enfield, 2015. Analysis for the American west coast rainfall predictability using an ENSO index. *Revista Atmósfera. (in Press)*.

Hidalgo, H.G., Durán-Quesada, A.M., Amador J.A. and Alfaro, E.J., 2015. The Caribbean Low-Level Jet, the Inter-Tropical Convergence Zona and the precipitation patterns in the Intra-Americas Sea: A proposed dynamical mechanism. *Geografiska Annaler, Series A: Physical Geography*. 97, 41–59. doi:10.1111/geoa.12085

Lam NSN, Reams M, Li K, Li C, Mata L. 2015a. Measuring community resilience to coastal hazards along the Northern Gulf of Mexico. *Natural Hazards Review*. DOI: 10.1061/(ASCE)NH.1527-6996.0000193.

Lam NSN, Qiang Y, Arenas H, Brito P, Liu KB. 2015. Mapping and assessing coastal resilience in the Caribbean region. *Cartography and Geographic Information Science*. DOI: 10.1080/15230406.2015.1040999.

Lam NSN, Arenas H*, Brito P*, Liu KB. 2014. Assessment of vulnerability and adaptive capacity to coastal hazards in the Caribbean region. *Journal of Coastal Research, Special Issue* 66, 473-478.

McCloskey, T.A., Bianchette, T.A., and Liu, K.B., (*in review*). Geological and sedimentological evidence of a large tsunami occurring ~1100 yr BP from a small coastal lake along the Bay of La Paz in Baja California Sur, Mexico, *Journal of Marine Science and Engineering* (submitted 09/09/2015)

Morales-Ramírez, A., O. Lizano, J. Acuña, E. Alfaro y E. Gómez, 2015. Rasgos oceanográficos en el Golfo Dulce, Pacífico de Costa Rica: una revisión para la toma de decisiones en conservación marina (Oceanographic features of Golfo Dulce, Costa Rican Pacific: a review for decision-making in marine conservation). *Revista de Biología Tropical*, 63 (Supl. 1): 131-160. *Spanish*.

Smith, JE, Bentley, SJ, Snedden, G., and White, C, 2015, What role do hurricanes play in sediment delivery to subsiding river deltas? *Scientific Reports*, submitted for review June 2015.

Yao, Q., Liu, K.B., Platt, W.J., Rivera-Monroy, V.H., 2015, Palynological reconstruction of environmental changes in coastal wetlands of the Florida Everglades since the mid-Holocene. *Quaternary Research* 83(3): 449-458.

(B) Theses and Dissertations (2014-2015 only)

Kuklevich, Katherine B., 2015. *Principal Component and Time-Series Analysis of a Stalagmite Geochemical Record from Yucatán, Mexico.* Undergraduate Thesis, Skidmore College, 51 pp.

Naquin, J.D., 2014. Hurricane induced geological change and palynological assessment of a rapidly subsiding deltaic environment in coastal Louisiana. Master's Thesis: Department of Oceanography and Coastal Sciences, Louisiana State University, 85 p.