Zachary Ian Espinosa

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PUBLICATIONS & PROJECTS

A Machine Learning Parameterization of Gravity Wave Momentum Fluxes Coupled to an Atmospheric Global Climate Model | *In Preparation* | **Geophysical Research Letters**

- Authors: Zachary I. Espinosa, Aditi Sheshadri, Gerald R. Cain, Edwin P. Gerber, Kevin J. DallaSanta.
- We performed a novel investigation into the efficacy of using machine learning to emulate a Gravity Wave Parameterization. (GWP). We demonstrated that the drag due to breaking atmospheric gravity waves can be faithfully represented using an artificial neural network (ANN) that is trained using data from a global atmospheric model embedded with an existing gravity wave model. When coupled with a GCM, the ANN generates a Quasi-Biennial Oscillation (QBO) with a realistic amplitude and period and is stable for multidecadal timescales, and when forced by increasing concentrations of CO2, the ANN's climatological response is similar to that generated by the physics-based GWP. This work constitutes a significant step towards obtaining observationally validated, computationally efficient GWPs in GCMs.

Drivers of the Seasonal Delay of Rainfall in the Amazon Rainforest

- Authors: Zachary I. Espinosa, Lai-yung Ruby Leung, Fengfei Song
- Tropical precipitation has a distinct annual cycle characterized by an amplitude, the range between wet and dry seasons, and phase, their onset timing. Previous studies have reported a seasonal delay in the onset of precipitation in observations over the northern tropical land driven by changes in greenhouse gases (GHG) and anthropogenic aerosols (AER). Here, we use multi-model output of historical and individual forcing simulations to show that the seasonal delay of precipitation in the Amazon rainforest cannot be fully explained by changes in GHG and AER. We examine the impact of land use and land cover change, and we perform an atmospheric energy budget analysis for the Amazon Basin.

NetQuil: A Quantum Playground for Distributed Quantum Computing Simulations | *Publicly Accessible* | **NetQuil**

- Contributors: Zachary I. Espinosa, Matthew Radzihovsky, Yewon Gim
- We built and published an open-source Python framework designed for simulating quantum networks and distributed quantum protocol. NetQuil is built on the quantum computing framework pyQuil, by Rigetti Computing, and is useful for extending current quantum computing experiments and testing ideas in quantum network topology and distributed quantum protocol.

Henry's Fork Foundation Water Quality Monitoring Site | *Publicly Accessible* | **HFF WQM**

- Contributors: Melissa Muradian, Zachary I. Espinosa, and Justin Appleby
- We built an automated data-collection network of sensors in the Henry's Fork Water Shed near Yellowstone National Park. We then built and published a water quality monitoring website that is updated in real-time and used by local scientists to study the health of the hydrological system. This project has also served as the cornerstone of HFF's scientific communication mission.

PRESENTATIONS & POSTER SESSIONS

Speaker | **EGU General Assembly** | Machine Learning Emulation of Parameterized Gravity Wave Momentum — Apr 2021

Speaker **| AGU Fall meeting |** A Data-Driven, Single-Column Gravity Wave Parameterization in an Idealized Model — Dec 2020

Speaker **| MSCAR |** A Data-Driven, Single-Column Gravity Wave Parameterization in an Idealized Model — Sep 2020

Speaker **| CalGFD |** A Data-Driven, Single-Column Gravity Wave Parameterization in an Idealized Model — Aug 2020

Poster **| APS March Meeting (Canceled) | N**etQuil: A playground for quantum networking simulations — Mar 2020

Poster **| Stanford Deep Learning Poster Session |** Distracted Driver Detection — Jun 2018

• Used ensembled model of ResNet-18, DenseNet-121, and Inception-V3 to detect distracted drivers through dashboard camera.

Poster **| Stanford Artificial Intelligence Post Session |** Tracking Schistosomiasis with Computer Vision — Mar 2018