# Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

# Online Proceedings

## Session 1M

### Environmental Monitoring and Modeling: Atmosphere, Mountains, and Ocean

*Session Moderator: Andrea Ogston, Oceanography*
**MGH 287**
*12:30 PM to 2:15 PM*
* Note: Titles in order of presentation.

**The Normalization of Anomalous Southern Ocean Sea Surface Temperatures for Analysis of Severe Storm Systems**
*Thomas S. Lamb, Junior, Atmospheric Sciences: Meteorology*
*Jonathan Chriest, Sophomore, Atmospheric Sciences: Climate, Atmospheric Sciences: Meteorology*
*Kallista Angeloff, Fifth Year, Atmospheric Sciences: Climate*
*Mentor: Dargan Frierson, Atmospheric Sciences*

Strong storms originating over the Southern Ocean just North of Antarctica have impacted the lives of many people in the coastal regions of Africa, South America, and Australia. These storms have been studied and observed since at least the end of the 17th century, most notably by Edmond Halley on a voyage to the South Atlantic; however, the causes of these storms are still not fully understood. The lack of land friction in this region plays a large part, but does not explain why these winds have increased in recent years. This recent wind phenomena, along with Halley's observations and coastal impacts for humans, led us to develop our research question: How do cold sea surface temperatures (SSTs) impact storm systems and winds originating from the Southern Ocean region? We posit that the extreme coldness of this region relative to the rest of the planet is a significant contributory factor to the strength of winds and storms in the Southern Ocean. To explore this hypothesis, we ran the Atmospheric Model 2 (created by the Geophysical Fluid Dynamics Laboratory at the National Oceanic and Atmospheric Administration) with SSTs symmetrized by zonal means to reduce the steep temperature gradient between the Southern Ocean and its bordering regions. This normalized the oceanic region, and made Southern Hemisphere SSTs more similar to SSTs in the Northern Hemisphere. We will present analysis of the changes in surface winds, kinetic energy, and precipitation in these simulations, and compare with theoretical predictions based on baroclinic instability theory.

## Session 1P

### Astronomy and Atmospheric Sciences

*Session Moderator: Suzanne Hawley, Astronomy*
**JHN 022**
*12:30 PM to 2:15 PM*
* Note: Titles in order of presentation.

**Southern African Topography Impacts on Low Clouds and the Atlantic ITCZ in a Coupled Model**
*Eliza Dawson, Senior, Atmospheric Sciences: Climate*
*Mentor: Dargan Frierson, Atmospheric Sciences*

We examine the influence of the Southern African mountain ranges on the Namibian stratocumulus deck, the South Atlantic ocean-to-atmosphere energy transport, and the Intertropical Convergence Zone (ITCZ), using an atmosphere-only model and a coupled atmosphere-ocean model. For both models, a control simulation with realistic topography is compared to a simulation where the mountains in Southern Africa are removed. As in previous studies, the removal of topography results in thinning of the Namibian stratocumulus deck. In the coupled model, the increased sea surface temperature in the southern Atlantic due to the reduction of low clouds forces the Atlantic ITCZ to shift southward towards the warmer hemisphere. However, changes in the ocean circulation cool the South Atlantic atmosphere, lessening the ITCZ shift and changing the structure of precipitation. These results show the importance of topography on shaping Atlantic rainfall, and highlight the role of dynamical ocean processes in atmospheric dynamics.

## Poster Session 2

**Commons West, Easel 13**
*1:00 PM to 2:30 PM*

**Life of Pika: A Science-Based Environmental Video Game**

*Kurt Blancaflor, Senior, Human Centered Design & Engineering, Computer Engineering*
*Amara Lynn (Amara) Kitnikone, Sophomore, Interdisciplinary Visual Arts*
*Benjamin Daniel (Ben) Celsi, Sophomore, Pre-Sciences*
*Sally Siyuan (Sally) Wei, Junior, Computer Science*
*Mentor: Dargan Frierson, Atmospheric Sciences*

Video games are seldom used for environmental science education, despite the variety of compelling lessons that they could be used to teach. We designed, built and tested a video game about the effects of climate change on a charismatic local animal, the pika. Native to North America and Asia, pikas are sensitive to changes in climate because they are covered with thick fur and get heat stroke even under modest temperatures (77 F). Pikas have to gather food throughout the summer, enough for them to make it through the long winter in their burrows. When temperatures warm, pikas do not have as much time to forage for food during their day. We decided to take these ideas and turn it into the major mechanics of a game that we developed. The resulting project, *Life of Pika*, is a runner game in which players need to collect flowers to survive while managing their temperature to avoid overheating. We have taken inspiration from other runner games such as *Frogger*, *Crossy Road*, and *Sonic the Hedgehog*, but this game is unique in that player vulnerability centers around their temperature bar, rather than around avoiding obstacles. The game is divided into seven levels to represent the pika's seven year lifespan. As one advances from level to level we make the game progressively harder by increasing the rate at which the player's temperature increases to simulate increasing global temperatures. Developed with industry-standard software for implementation in classroom and museum settings, we aim to promote empathy in the player about the pikas' struggle against climate change. We hope that players will become more thoughtful about their impact on the world and its inhabitants.

## POSTER SESSION 2

**Commons West, Easel 14**

*1:00 PM to 2:30 PM*

**The Cause of Western Europe's Mild Climate**

*David (Dave) Bonan, Sophomore, Atmospheric Sciences: Climate*
*UW Honors Program*
*Mentor: Dargan Frierson, Atmospheric Sciences*

The cause of Western Europe's mild climate has been under discussion for many years. Among the general public, heat transport by warm ocean currents is often given as an explanation. A prominent scientific study, Seager et al 2002, instead claimed that roughly fifty percent of the wintertime temperature difference across the North Atlantic is caused by the eastward atmospheric transport of heat released by the ocean that was absorbed and stored in the summer; another roughly fifty percent is caused by the stationary waves of the atmospheric flow; and that ocean heat transport only contributes a small magnitude of warming across the basin. Seager states that, "the next step of inclusion of a fully interactive mixed layer is unlikely to change the main results presented here". We test whether the transport of heat northward by the Atlantic Meridional Overturning Circulation (AMOC) and its ensuing release into the mid-latitude westerlies is indeed a small contributor to Western Europe's mild climate using simulations with two different fully coupled climate models. A model simulation where the Rocky Mountains were eliminated is used to test the effect of stationary waves on heat transport. Another simulation where the ocean heat flux of the Northern Hemisphere and the Southern Hemisphere is eliminated through symmetrization is used to test the effect of heat transport northward by the AMOC. In this simulation, land topography—such as the Rocky Mountains—was kept intact. In these simulations we examine temperature variations over Western Europe and the reasons for the changes using energy budget decompositions. An understanding of these climate system controls allows for an understanding of what controls future changes in climate.