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Department of Atmospheric Sciences Seminar Announcement

Department of Atmospheric Sciences, S.O.E.S.T., University of Hawai'i at Mānoa
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ATMO Student Symposium 2022

You are invited to our weekly online Atmospheric Sciences Spring 2022 seminars via Zoom meeting.

When: April 27, 2022 at 3:30PM HST

Meeting admission: 3:15PM HST

Register in advance for this meeting:

<https://hawaii.zoom.us/join/joinmeeting/register/tJcof--qqjMiEtXX9J8yHV3K8NrAjdJsakyN>

After registering, you will receive a confirmation email containing information about joining the meeting.

Please save this information for future seminars.

****20 minutes presentation for each student****

Leeside Circulations of the Hawaiian Islands Under Trade Wind Conditions – A Literature Review

Rachael Eichelberger-Iga, MS Candidate

Adviser: Prof. Yi-Leng Chen

Abstract

Trade winds blowing from the east-northeast are interrupted by the complex topography of the Hawaiian Islands. With a trade wind inversion at approximately 1.9 km, the low-level trade winds either flow over or are deflected around the individual islands. This results in the formation of island wakes over the leeside of the islands. Conditions of island leeside wakes may affect air quality, local weather, turbulence, and optical ray propagation. Leeside wakes can generally be placed into two categories based on atmospheric stability, upstream wind speed, and the height of the island's terrain. Low Froude numbers ($Fr < 1$), with mountain tops above the trade wind inversion, indicate the incoming trade winds will be decelerated, blocked, and deflected around the island. In this case, a leeside wake containing counterrotating vortices separated by a westerly reverse flow may form. The leeside wakes of the Big Island and of Haleakalā on Maui fall into this category. Conversely, high Froude numbers ($Fr \geq 1$), with mountain tops below the trade wind inversion, indicate the incoming trade winds have the ability to flow over the terrain. In this case, a leeside wake without counterrotating vortices may form. The leeside wakes of Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lāna'i, Kaho'olawe, and western Maui fall into this category. Additionally, the lee-side wake circulations are also affected by the diurnal heating cycle. The leeside wakes of some Hawaiian Islands have been studied to varying degrees, but a comprehensive study of all island wakes, including the airflow through the island channels, is needed.

Impacts on El Niño Flavors on Northern Hemisphere Wintertime Atmospheric Blocking in Reanalysis and Models

Madeline McKenna, PhD Candidate
Adviser: Assoc. Prof. Christina Karamperidou

Abstract

Atmospheric blocking is a synoptic-scale weather pattern often indicated as a positive geopotential height anomaly that blocks or diverts the eddy-driven jet stream from its climatological path. Blocking events are persistent, making them influential to extreme weather events, such as summertime heat waves or heavy precipitation and flooding. Prior studies of blocking response to interannual climate variability have found a mixed bag of responses to the warm phase of the El Niño–Southern Oscillation, El Niño, but none have considered the spatial diversity of El Niño. We first investigate the effects of Central Pacific (CP) and Eastern Pacific (EP) flavors of El Niño on the characteristics of wintertime (December–February) atmospheric blocking in 42 years (1979–2020) of the ERA5 reanalysis dataset. Blocks are identified from the geopotential height field at 500 hPa using a two-dimensional index. In the North Pacific, blocking frequency is almost completely reduced in EP years compared with the seasonal climatology, and blocks that do occur are significantly smaller and weaker in intensity. By contrast, the preferred region of blocking occurrence is shifted northeastward in CP years, while overall blocking frequency and characteristics in the Pacific sector are not significantly reduced or altered. Across Europe, the blocking frequency increases considerably in EP years, but not in CP years. Blocks occurring during winter in the Euro-Atlantic region tend to be slightly stronger and last longer in EP than CP years. The modifications in blocking characteristics between EP and CP years occur due to their dissimilar teleconnection patterns and impacts on the jet stream. ENSO indices that disregard El Niño flavors blur and soften the significant relationships between ENSO-related variability, ENSO teleconnections, and synoptic weather phenomena such as blocking. Recognizing these relationships in reanalysis data provides insight that will reduce uncertainty in future projections of blocking. We further investigate the relationships between El Niño flavors and blocking in CMIP6 climate models, which have historically had difficulty simulating observed blocking frequency.

Moist baroclinic instability along the subtropical Meiyu front

Guang Yang, PhD Candidate
Adviser: Prof. Tim Li

Abstract

Different from classic mid-latitude dry baroclinic instability theory, atmospheric motion over the subtropical Meiyu front in boreal summer is dominated by synoptic-scale disturbances coupled with precipitation and moisture under a weaker background vertical shear. This moisture-precipitation-circulation interactive feature, along with a preferred zonal wavelength of about 3400 km and eastward phase propagation, is explained by a moist baroclinic instability theoretical framework. The new framework is an extension of a traditional 2-level model by considering a prognostic moisture equation, the moisture-precipitation-circulation feedback and an interactive planetary boundary layer. An eigenvalue analysis of the model shows that the most unstable mode has a preferred zonal wavelength of 3400 km, a westward tilted vertical structure, and a phase of maximum moisture and precipitation anomalies located slightly to the east of lower-tropospheric trough, all of which are in good agreement with the observations. Both anomalous horizontal and vertical moisture advection processes contribute to the moistening increase. Further sensitivity tests show that the instability and the zonal scale selection primarily arise from the moisture-convection-circulation feedback, while the vertical shear provides an additional energy source for the perturbation growth. The current moist baroclinic instability theory explains well the observed characteristics of the development of synoptic-scale disturbances along the Meiyu front.

Using a high-resolution global climate model (MPAS-A) to analyze regional and global ENSO impacts

Zachary M. Menzo, PhD Candidate
Adviser: Assoc. Prof. Christina Karamperidou

Abstract

The spatial pattern of SST anomalies during an El Nino Southern Oscillation (ENSO) event - or ENSO “flavor” - influences regional weather and climate. Whether the relative frequency of ENSO flavors may change as the planet continues to warm remains an open question leading to uncertainty in projections of regional ENSO impacts. Regional and local ENSO signals may deviate from large-scale signals, which are resolved in the typical grid scales of general circulation models used for past and present climate projections. Thus, there is a need for high resolution downscaling of climate projections. To address this issue, we present a series of contemporary simulations under various ENSO flavors using the global climate model Model for Prediction Across Scales – Atmosphere (MPAS-A). MPAS-A represents mesoscale variability with a high-resolution regional mesh (15km) and smoothly transitions to a lower global resolution (60km), capturing synoptic features. We demonstrate that the model can accurately represent the response of temperature and precipitation extremes to ENSO forcing in historical simulations and can be used for future paleoclimate and climate change research.