The cause of the seasonal variation in the oxygen isotopic composition of precipitation along the western U.S. coast

Nikolaus Buenning1, Lowell Stott1, Max Berkelhammer2, Kei Yoshimura3

1Department of Earth Sciences, University of Southern California; 2Department of Atmospheric and Oceanic Sciences, University of Colorado; 3Department of Natural Environmental Studies, University of Tokyo

For further information contact at: buenning@usc.edu

Introduction and Motivation

Climate change is the 21st century’s principal challenge. A climate change throughout most of California and the American southwest. This poses a major problem for the western U.S., where there is an already inadequate supply of water and a growing demand. The western U.S. is also a region that has experienced prolonged periods of drought. Figure 1 shows two 20th century records from northern California: rainfall (Figure 1a) and Sacramento rainfall anomaly (Figure 1b). Both show that the seasonal variation in the oxygen isotopic composition of precipitation along the western U.S. coast is of clear importance. This study aims to understand the controls on the seasonal variations in δ18O.

Model

The primary tool for investigating isotopic variability is the isotopic incorporated Global Spectral Model (IsoGSM) [Yoshimura et al., 2008]. The atmospheric general circulation model is forced with prescribed sea surface temperatures and sea-ice conditions, although the dynamical wind and temperature fields are spectrally nudged to the NCEP/NCAR reanalysis version 1. The global simulations were performed with a horizontal resolution of approximately 1.85° x 1.85°. In addition to a control simulation, we performed a suite of model experiments to see how the seasonal cycle in δ18O is influenced by different factors.

Model Results

We validate the model by comparing simulated seasonal δ18O cycles with measured cycles from 16 different locations in western coastal states. Both modeled and measured values reveal a drop in δ18O during the winter months (Figure 5). This drop is primarily driven by equilibrium fractionation during condensation, as can also be seen from the model experiments (Figure 6). Figure 7 shows that the model experiment (NOFRAC1) removes the reservoir-specific gradient in δ18O values, thus, the seasonal δ18O cycle could be related to mid-latitude moisture transport. Figure 8 reveals that the NOFRAC2 simulation also removes the reservoir-specific gradient in δ18O values, so the observed seasonal δ18O cycle might also be due to seasonal changes in condensation height. Vapor tagging simulations were used to test this hypothesis.

Tagging Simulations

For further information contact at: buenning@usc.edu

Tagging Simulations

We validate the model by comparing simulated seasonal δ18O cycles with measured cycles from 16 different locations in western coastal states. Both modeled and measured values reveal a drop in δ18O during the winter months (Figure 5). This drop is primarily driven by equilibrium fractionation during condensation, as can also be seen from the model experiments (Figure 6). Figure 7 shows that the model experiment (NOFRAC1) removes the reservoir-specific gradient in δ18O values, thus, the seasonal δ18O cycle could be related to mid-latitude moisture transport. Figure 8 reveals that the NOFRAC2 simulation also removes the reservoir-specific gradient in δ18O values, so the observed seasonal δ18O cycle might also be due to seasonal changes in condensation height. Vapor tagging simulations were used to test this hypothesis.

ImPLICATIONS

...