Authors: Yurong Zhang[1], Joseph Byrnes[2], S. Shawn Wei[1], Dongdong Tian[1], Fan Wang[1], Maximiliano Bezada[3]

[1] Michigan State University
[2] Northern Arizona University [3] University of Minnesota

Title: P-wave attenuation tomography of the Tonga-Lau mantle wedge improved by a Bayesian Monte Carlo approach and independently constrained source spectra

Abstract:

The Tonga subduction zone and the adjacent Lau back-arc basin form a complex subduction system where large amounts of melts and water are expected in the mantle wedge. A detailed investigation of the seismic attenuation structure of the Tonga-Lau subduction system can provide critical constraints on the temperature, material transportation, and melting processes in the mantle wedge. Previous studies of this region (Wei & Wiens, 2018; 2020) imaged the highest P-wave attenuation known in the upper mantle and attributed this attenuation to high temperature and hydrous partial melts in the mantle wedge. In this study, we utilize a series of new techniques and complementary results to better constrain the P-wave attenuation structure of the Tonga- Lau subduction system. First, we analyze 1163 P-wave displacement spectra of seismograms between December 2009 and October 2010, which were recorded by 49 ocean-bottom seismographs (OBSs) and 17 temporary stations on land in the Tonga-Lau-Fiji region. Raypaths are calculated by 3D ray tracing with a pseudo-bending algorithm based on a newly developed 3D velocity structure of the Tonga subduction zone (Wang et al., 2021). To minimize the trade-off between source and path effects, we invert for t* using earthquake source spectra that are independently constrained by a spectral decomposition method (Tian et al., 2021). Finally, with the newly determined t* measurements, we utilize a Bayesian Markov chain Monte Carlo technique to image the 3D P-wave attenuation structure. This tomographic approach allows for a robust estimate of the peak Q_p^{-1} reached, along with formal uncertainties, at this apparent maximum in upper mantle attenuation. This new attenuation tomography model of the Tonga-Lau subduction system will contribute a critical constraint, possibly an endmember, to the global database of body wave attenuation in subduction zones.