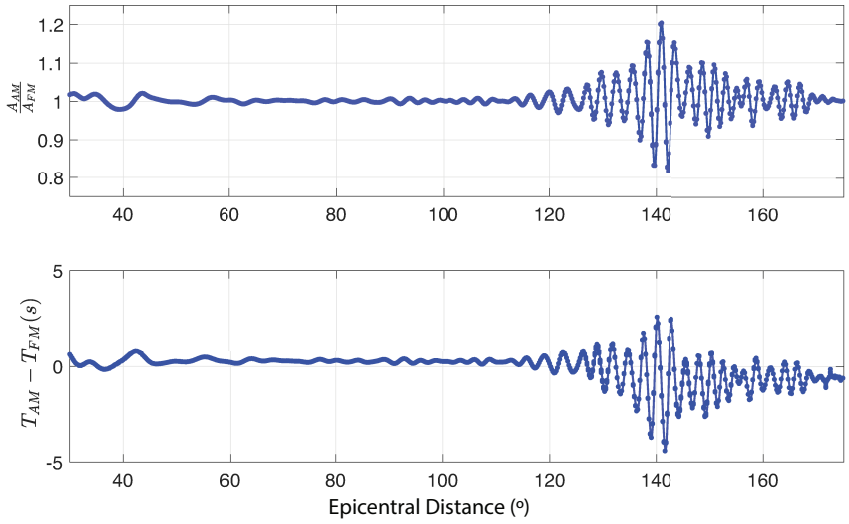
Overtone Interference in Fundamental-Mode Rayleigh Wave Phase and Amplitude

We show that measurements of minor-arc fundamental-mode (FM) Rayleigh waves are impacted by major-arc overtone interference. Measurements of Rayleigh wave travel times and amplitudes made on synthetic seismograms with multiple techniques oscillate along a ray path. The absence of the oscillations in normal-mode synthetics that contain only the FM indicates that the oscillations originate from higher modes interfering with the FM.

Contamination from interference is largest at epicentral distances greater than around 125˚, where record sections show the major-arc overtone intersecting the minor-arc FM Rayleigh wave. Different mode branches contribute to the interference pattern at different distance ranges. We explore how the earthquake source parameters and velocity structure affect the amplitude, wavelength, and distance dependence of the interference pattern.

Interference is also present and discernible in real data. The short-wavelength nature of the interference pattern means it is only observable with dense station spacing and high data quality, which may explain why it has not been previously recognized. Its overall impact on Rayleigh wave phase-velocity maps is minor due to the large number of measurements from shorter path lengths that are less prone to interference bias. However, phase-velocity maps constructed only from measurements at path lengths prone to the interference exhibit significant noise and poor agreement with maps constructed from measurements including all path lengths.

Constraining and accounting for this interference may diminish a noise source in measurements, improve the accuracy of seismic images of the upper mantle, and allow the measurement of overtone phase velocities. We show that the wavelength of the interference pattern is well-described using simple models for the interference of two waves and apply techniques based on the interference of multiple plane waves to measure FM phase velocities for Rayleigh and Love waves when overtone interference is present.



Rayleigh wave amplitudes (top) and phase (bottom) measured at 100s. Measurements are made on synthetic seismograms including all mode branches relative to synthetic seismograms including only the Fundamental mode. Amplitude and Phase measurements show evidence of major-arc interference at distances between 120-160 degrees.