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Computation of synthetic seismograms in a 3 dimensional Earth and inversion of eigenfrequency and Q quality factor datasets of normal modes

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The 26 December 2004 Sumatra-Andaman event is the third biggest earthquake that has never been recorded but the first recorded with high quality broad-band seismometers. Such an earthquake offered a good opportunity for studying the normal modes of the Earth and particularly the gravest ones (frequency lower than 1 mHz) which provide important information on deep Earth. The splitting of some modes has been carefully analyzed. The eigenfrequencies and the Q quality factors of particular singlets have been retrieved with an unprecedented precision. In some cases, the eigenfrequencies of some singlets exhibit a clear shift when compared to the theoretical eigenfrequencies. Some core modes such as the 3S2 mode present an anomalous splitting, that is to say, a splitting width much larger than the expected one. Such anomalous splitting is presently admitted to be due to the existence of lateral heterogeneities in the inner core. We need an accurate model of the whole Earth and a method to compute synthetic seismograms in order to compare synthetic and observed data and to explain the behavior of such modes. Synthetic seismograms are computed by normal modes summation using a perturbative method developed up to second order in amplitude and up to third order in frequency (HOPT method). The last step consists in inverting both eigenfrequency and Q quality factor datasets in order to better constrain the deep Earth structure and especially the inner core. In order to find models of acceptable data fit in a multidimensional parameter space, we use the neighborhood algorithm method which is a derivative-free search method. It is particularly well adapted in our case (non linear problem) and is easy to tune with only 2 parameters. Our purpose is to find an ensemble of models that fit the data rather than a unique model.