Full waveform tomography of the South Atlantic upper mantle

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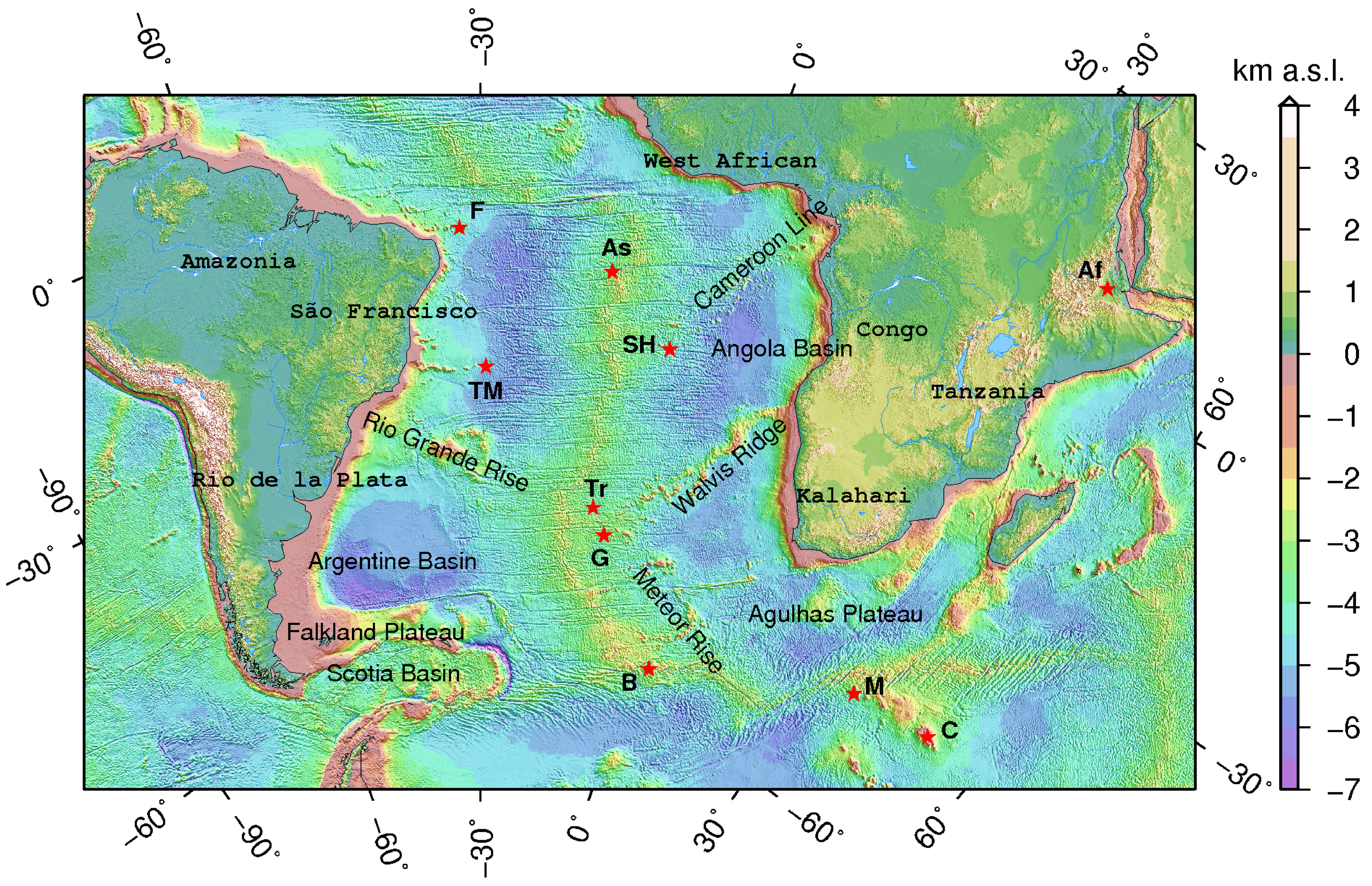
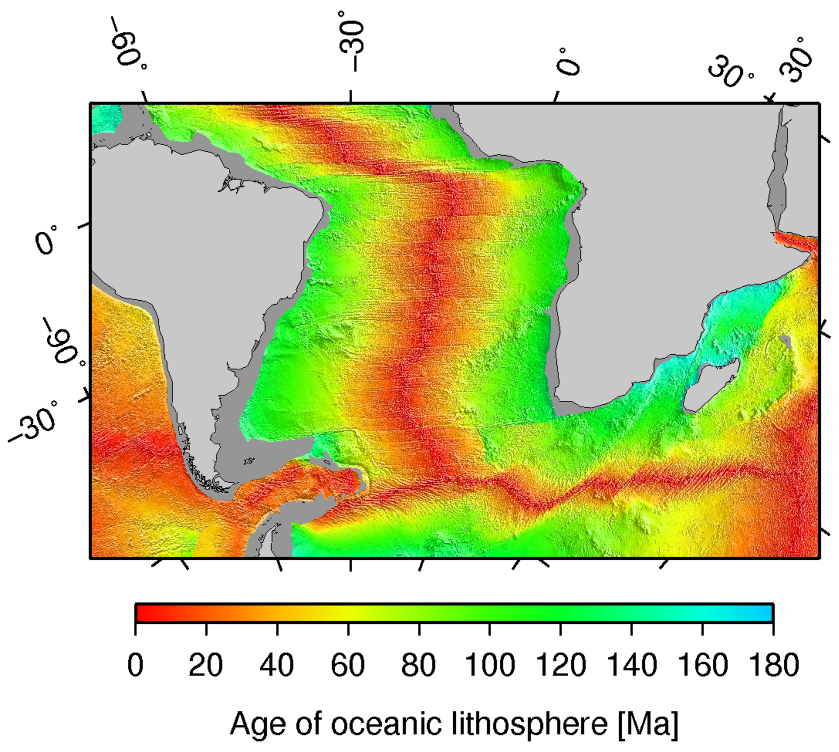
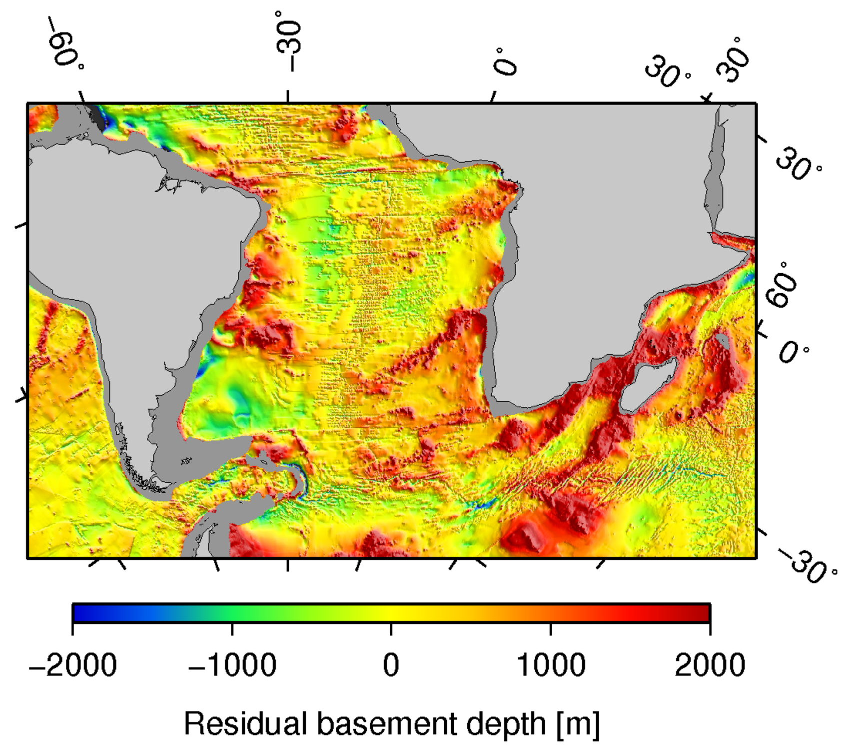
The South Atlantic region



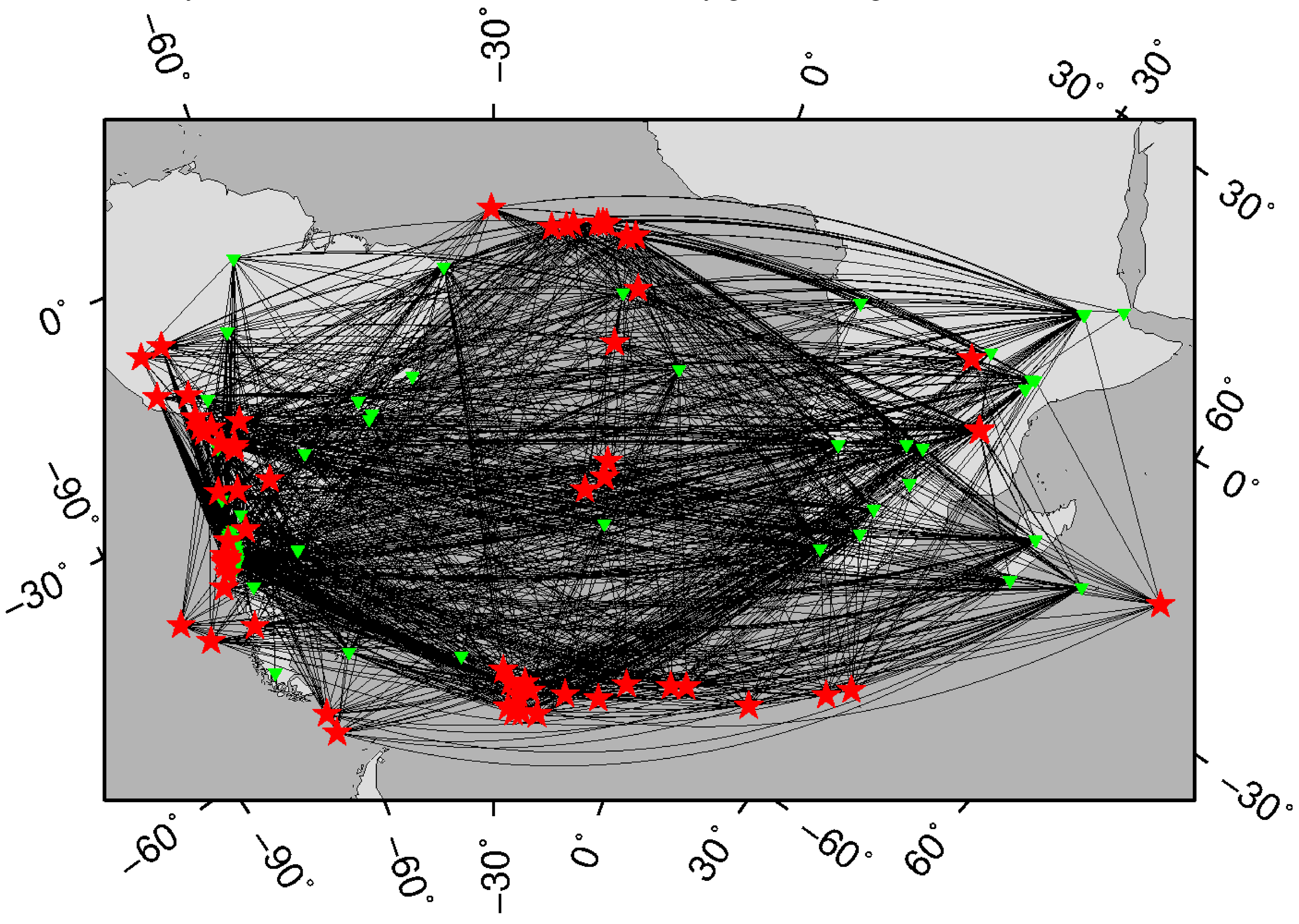
The South Atlantic region has evolved in a passive margin setting since the breakup of Africa and South America around 140 Ma. It thus presents relatively simpler tectonic, geologic and geodynamic histories, with a potentially large amount of geophysical data, like well preserved sedimentary basins and magnetic isochrons. This should simplify the interpretation of the recovered seismic anomalies, and make them easier to compare with their surface effects and expressions.





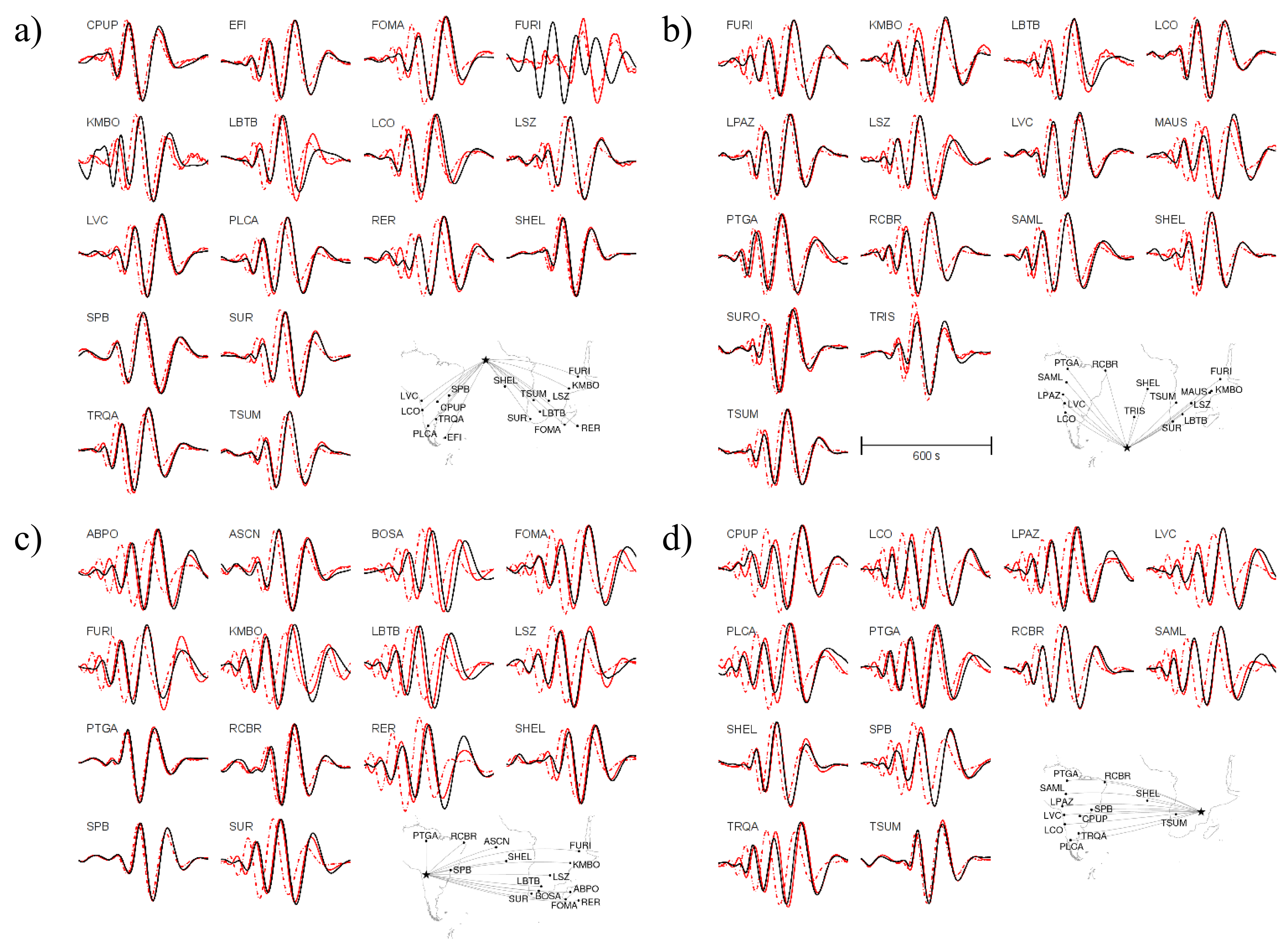
Seismic data

The region is characterized by a quite favorable distribution of earthquakes, but the station coverage is quite poor. In order to extract the maximum amount of information from each seismogram we resorted to an efficient adjoint method developed by Andreas Fichtner (2006). We used phase misfits obtained via time-frequency analysis of the cross-correlation between synthetics and observed seismograms to compute adjoint sources and Fréchet derivatives. Our dataset comprises ~4000 high quality waveforms, mainly vertical-component recordings, filtered between 120 and 250 s. The resulting ray coverage is showed in the figure below: epicentres are marked by red stars while stations are denoted by green triangles.

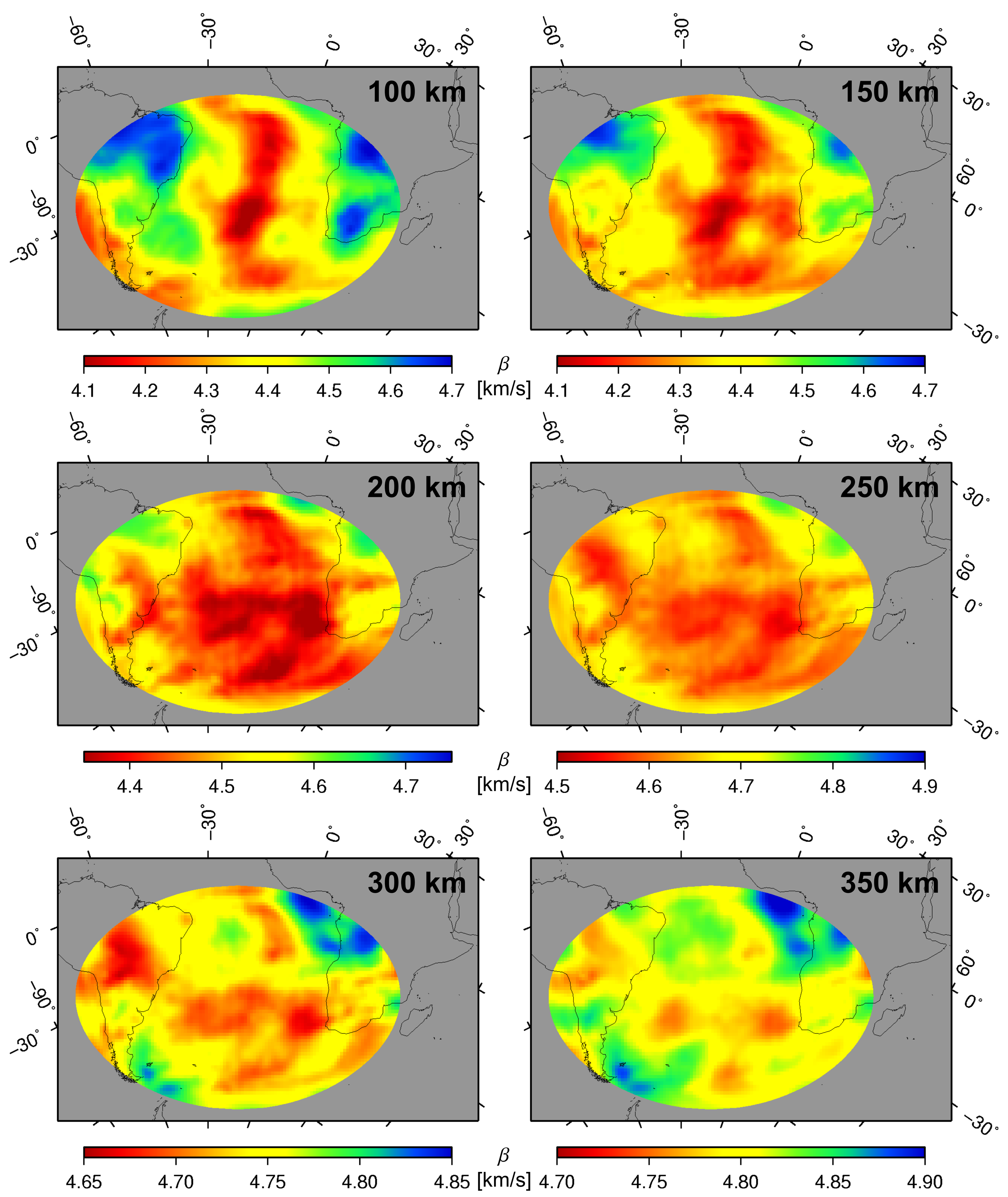


Waveform fit and current model

A clear measure of the improvement achieved by the inversion is given by the comparison of the initial and final synthetic waveforms with the observed seismograms. The total time window length of the fitted portions has increased by a factor of 2, with a 50% mist reduction over the original time windows.



Data are plotted as thick black lines, synthetics calculated with the final model as thick red lines, synthetics calculated with the initial model as dash-dotted red lines. Panel a: seismograms for an Ms 6.4 event occurred on December 9th, 2009 at the Central Mid-Atlantic Ridge (1°S, 21°W). Notice the complete dissimilarity between the observed and the modeled waveform for station FURI, that prevented the computation of a meaningful misfit and the improvement of the fit. Panel b: seismograms for an Ms 6.8 event occurred on January 5th, 2010 east of the South Sandwich islands (58°S, 15°W). Panel c: seismograms for an Ms 6.2 event occurred on November 14th, 2009 in Jujuy, Argentina (23°S, 67°W). Panel d: seismograms for an Ms 5.9 event occurred on December 8th, 2009 in Tanzania (10°S, 34°E).



Horizontal slices of the S velocity model at six different depths. At 150 km depth the velocity anomalies are still strongly influenced by the chemical composition and thermodynamic evolution of the lithosphere. Between 200 and 300 km depth the mantle is dominated by slow, elongated anomalies, while deeper than 300 km the slow anomalies become more rounded, possibly related to columnar upwelling material coming from deeper in the mantle.