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Seismic probing of hydration and dehydration reactions in subduction zones

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Over the past decade, high-resolution images based on teleseismic scattered waves have given us new insight into the distribution and movement of water in subduction zones. In particular, these images have shown us where the subducted crust loses the bulk of its water through eclogitization and where the mantle wedge becomes hydrated via serpentinization. The first images provided adequate constraints to infer where these processes occur for uniformly hydrated/dehydrated components of the system. However, we know that this assumption of uniformity does not really apply owing to petrological evidence that prograde and retrograde metamorphic reactions do not proceed uniformly across the subducted crust or mantle wedge. Here, we expand on previous work by (i) comparing high-resolution images from a catalogue that now samples a wide range of subduction zones, and (ii) jointly interpreting these high-resolution images with results from complementary seismic/geodynamic/petrological modelling. Our goal is to generate a set of new models that can help us better constrain the variable levels of hydration within the subducted slab and mantle wedge, and to use these models to better understand how fluid transfer between the various components of the system relates to seismicity. We illustrate these concepts with examples from the Cascadia subduction zone, where we find strong evidence for a layer of metastable gabbro in the lower portion of the subducted crust, and the Western Hellenic subduction zone, where the distribution of intraslab seismicity seems indicative of variable hydration/dehydration regimes along strike.