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Evolution of the 2010 pre- and co-eruptive stress field at Eyjafjallajökull volcano, Iceland

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In the months prior to the the 2010 Eyjafjallajökull eruption in southern Iceland, the Icelandic seismic network (SIL) recorded thousands of earthquakes within the volcano. During the initial flank eruption and the main summit eruption that followed, the rate of recorded earthquakes decreased significantly but remained high enough that the main eruption could be predicted and warnings issued. We use a subset of approximately 3,900 high-quality focal mechanisms from the seismicity catalogue, spanning the interval between June 2009 and the end of the eruption in May 2010, to investigate the temporal and spatial evolution of stresses within the volcano. The large data set allows us to spatially subdivide the volcano using a three-dimesional gridding method ("octree") and to examine temporal changes in stress by determining stress parameters at common points at different epochs. We find that approximately one month before the initial flank eruption, the axis of maximum horizontal compressive stress (SHmax) rotated anti-clockwise by approximately 60 degrees. The new direction of SHmax was maintained for approximately two weeks before rotating back to its original direction. The stress change coincides with a partial migration of seismicity to the south-southeast, at a depth range between 4 and 8 km. By analysing earthquake hypocentres, focal mechanisms, and derived stress parameters in light of previously published geodetic measurements, we investigate how the state of stress varied spatially and temporally within the volcano prior to and during the 2010 eruption, and the implications of changes in stress for models of magma movement through the volcanic edifice.