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Ocean Load Induced Crustal Stress on Milankovic to Sub-annual Time Scales

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One of the great achievements of the GRACE mission is that the non-tidal dynamic mass changes occurring in the ocean are now being monitored globally on monthly time scales. One of the 'spin-offs' of these new solutions is that contemporary, state-of-the-art, ocean models are now validated with respect to their mass-bearing dynamics. This implies that, with both quantifiable accuracy and error budgets now in hand, we can predict a full spectrum of elastic-gravitational interactions with the solid Earth, from its surface to the core-mantle boundary. Such a spectrum includes all elastic-gravitational stresses, stress-rates, displacements, perturbed gravitational fields, etc. We compute these fields and their associated Coulomb failure patterns. A main product of this work is to generate new mapping information about ocean load-induced strain, stress and stress-rate in the crust and lithosphere everywhere across the globe. While we have not yet discovered strong correlations with seismicity and this loading, this mapping does provide, for the first time, a basic information set that serves both the geodetic and seismological communities. At sub-annual time scales the long-wavelength Coulomb stresses are on the order of several kilo Pascals (kPa). At centennial time scales what we currently understand about mass transport between oceans and land implies about a factor of 30 larger. Furthermore, at time scales of the order of the last glacial-to-interglacial transition (21-11 ka) and additional factor of 30 is predicted, to levels of 1-2 MPa. We examine the time-rate of change and spatial properties of Coulomb stress in each of these individual time scale regimes.