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The effects of the 2004 Sumatra earthquake on Earth rotation: a comparison between theory and observations

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On 26 December 2004 a large earthquake (M_w=9) shook northern Sumatra, Indonesia, and then shook the whole of humanity by causing probably the deadliest tsunami in recorded history. Conservation of angular momentum, a fundamental principle of physics, indicates that the earthquake also had an effect on Earth rotation. Current theory estimates that this event shifted the mean pole approximately 2.5 cm in the direction of 145˚E and decreased the length of day by 2.68 microseconds [Chao and Gross, *EOS*, 86(1), 2005]. This study compares these theoretical results to observation-based estimates of the Earth orientation parameters (EOP). Among these observational results are the estimates produced daily at the Rapid Service/Prediction Center (RS/PC) of the International Earth Rotation and Reference Systems Service (IERS), located at the U.S. Naval Observatory, by combining observations made with various techniques. In addition to the daily estimates, estimates of EOP from an improved analysis of residuals between numerically-integrated inertial Global Positioning System (GPS) satellite orbits and observed Earth-referenced GPS satellite positions can serve as a source of information on EOP as they actually were after the earthquake. The daily estimates are each day propagated into the future partially on the basis of the observations and partially on the basis of changes in the angular momentum of geophysical fluids. This propagation method can take observations of EOP made before the earthquake and extend them through December 26, giving EOP as they would have been if the earthquake had not occurred plus an amount of prediction uncertainty. The uncertainties in the IERS RS/PC combination process and prediction method are briefly discussed. On the basis of the differences between observed EOP after the earthquake and EOP predicted prior to the earthquake, conclusions are drawn concerning both the

validity of the theoretical results and the observability of large earthquakes in temporal variations of Earth orientation.