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Ocean tides and rotation rates: A Venusian application

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Potential solar tides in an ancient Venusian ocean are simulated using a dedicated numerical tidal model. A series of simulations with ocean depths varying between 330-4500m and rotational periods ranging from -243 to 64 Earth days were used to calculate tidal dissipation rates and the resulting tidal torque and associated spin down of Venus' rotation rate. The results show that tidal dissipation rates on Venus could have varied over 3 orders of magnitude depending on rotational period and ocean depth, with the most energetic simulations dissipating nearly as much tidal energy as the solar tide does in Earth's oceans today. This occurs at all depth configurations when the rotation period is close to one Earth day. The associated tidal torque is large and of the same order of magnitude as today's total tidal torque on Earth and an order of magnitude below the atmospheric torque reported for present-day Venus. Consequently, an ocean tide on ancient Venus, albeit probably short-lived in geological terms, could have had significant effects on the rotational history of the planet if its rotation rate was faster than today. In fact it could have changed the rotational period by several days per million years. These calculations have important implications for the rotational periods of exoplanetary worlds and the location of the inner edge of the liquid water habitable zone.