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From cold to warm gas giants: A three-dimensional atmospheric general circulation modeling

We present a three-dimensional general circulation model suitable for simulating the atmospheric dynamics of giant gas planets. It was applied to studying the changes induced by an increased heating due to stellar radiation absorption compared to a Saturn-like planet. Such gravitationally unlocked ''warm'' extrasolar planets exist in large quantities at distances intermediate between those for cold and hot transiting giants, for instance, HD 155358b and HD 96063b. Our simulations indicate that inclusion of a moderate meridional temperature gradient in the troposphere significantly alter the circulation in the stratosphere, especially the zonal wind, which becomes superrotating on the entire planet. Thermal tides, which are almost certain on strong-lit and fast-rotating planets, changes mostly the meridional circulation, and, given its weakness, may reverse it. The analysis show that many of these changes are due to the momentum deposited by vertically propagating tides, and smaller scale eddies trapped in the troposphere.