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Sensitivity of atmospheric wave drag to wind shear

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The Conservation of Angular Momentum is a very strong constraint on the Earth's rotating motion. It means that if one of the components of the Climatic System changes its angular momentum (e.g. the Atmosphere), another component (e.g. the Lithosphere) will have to compensate this variation with a change of opposite sign. There are different processes of momentum exchange between the Atmosphere and the Lithosphere. This study focuses on the momentum exchange by the production of internal gravity waves in flows over complex topography. This transfer occurs because there is a drag force in these flows that results from the perturbation pressure difference measured on the mountain flanks. Such difference is imposed by the geometry of the waves, leading to a pressure excess upstream and a pressure deficit downstream of the mountains. This drag force is important because it slows the mean flow. This process is not resolved by the majority of the operational numerical models, especially climate models, given their low resolution. As a consequence, processes with this type of horizontal scale (10 to 100 km, approximately) must be parameterized to represent their impact on the large-scale flow. Recent parameterizations are based on theoretical models that compute the exact drag for an elliptical mountain using linear theory. Each grid box of the model is characterized by four parameters that fit the equivalent elliptical mountain. These parameters are obtained from real subscale topography datasets. The model is then applied to that idealized mountain. Recent theoretical results proposed by our group (Teixeira & Miranda 2006) led to an improvement of this kind of models, by taking the vertical wind shear into account, while previous models assumed a constant wind. The goal of this work is to show the importance of this improvement using real meteorological and topographic datasets. USGS topographic data with 1 km resolution was used for terrain data and the ERA-40 reanalysis was used to estimate meteorological variables. The results showed that the global distribution of gravity-wave drag is significantly changed when the wind shear effect is taken into account. The impact of the correction is especially significant in the Antarctic region where

the wind shear is considerable, given its particular meteorological and geographical conditions. The gravity-wave torque that acts on the planet is also quantified because it shows how the gravity-waves may affect the planetary motion. A time series of this variable was calculated and shows a consistent annual cycle. This cycle is explained by the strong seasonal variation in the mid-latitude westerlies in the Northern Hemisphere in conjunction with the variation of opposite sign in the Southern Hemisphere, near the edges of Antarctica. Even in this integrated perspective, the wind shear has a substantial impact because it amplifies the annual cycle of the torque exerted by gravity-waves on the planet, especially in the Northern Hemisphere Summer.