Equatorial Neutral Atmosphere Models for high Speed Processing

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Abstract

This work presents a brief discussion on alternative diagnostic type models to process large amount of mesospheric and lower atmospheric data, collected in the equatorial region. For this situation one trades quality in favor of processing speed. The alternative options considered are the geostrophic model, the EGW (equivalent gravity wave) approach, the Geisler approximation and empirical models. A brief analysis of the expected amount of computation work necessary to get the theoretical results is performed, to provide the reader with the necessary elements to chose a competitive model for his data processing.

Introduction

This work presents a brief discussion on alternative diagnostic type models to process large amount of mesospheric and lower atmospheric data, collected in the equatorial region. For this situation one trades quality in favor of processing speed.

This matter was undertaken by many authors as review by Richmond (1975) and Forbes and Hagan (1979). Here the promising models are considered.

Method

Density and temperature models were reviewed by Zamlutti (1998). The vertical structure follows from an hydrostatic equilibrium combined with a Bates type temperature profile. The longitude-time dependence follows the $\exp \cdot i(\omega t - k\phi)$ where t stands for time, ω is the angular frequency of the tidal oscillation, ϕ is the longitude and k the longitudinal wave number. The meridional behavior obeys the first Legendre polynomial (diurnal) and the second one (semi-diurnal).

The different methods use alternative forms to study the equation of motion for the horizontal variables:

$$d\underline{u}/dt + 2\underline{\Omega} \times u + \rho^{-1}\nabla p = \upsilon(\underline{u}_i - \underline{u})$$

where $\underline{u}$ denotes velocity, *p* the pressure, ρ the density, $\underline{\Omega}$ the earth's angular velocity, ν the collision frequency and $\underline{u}_i$ the ion velocity.

The first option is the geostrophic model which employees temperature and density data from empirical models and solve only the equation of motion in order to derive the horizontal wind speeds. The solution for diagnostic type models discards the stress tensor contribution and considers only inertial, pressure gradients and drag to determine the wind speed. The Geisler approach is the version which employees the Coriolis pressure and ion drive terms. It is a quick version to compute winds although its quality ranges around 30-50% accuracy.

The EGW formalism with its Richmond version constitutes a more complete model where density temperature and winds are evaluated by a consistent model which however depends on an adjustment constant. This dependence allows a better fitting with experimental data. A series of expressions are presented for the model, which is option among the simple synoptic models.

The empirical models have the best accuracy, which ranges around 10%, and are currently employed for comparison with data. The Hedin version is presently the best one. However as compared to the previous options it is time consuming and so not very convenient when a few characteristics, like regular temperature or density gradients, favor speed increasing of data processing of the former approaches.

Conclusion

In a balance the Richmond option constitutes the best alternative for massive data processing from equatorial experiments.

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