NASA TECH BRIEF

Marshall Space Flight Center

Atmospheric Density Variations Related to Internal Gravity Waves

Atmospheric density variations may be associated with a number of physical phenomena which include turbulence, auroral activity, atmospheric chemistry, atmospheric heating, and "gravity waves". Evidence of gravity waves, or waves resulting from the effects of compressibility and bouyancy, has been shown from data obtained on wind-speed profiles between the altitudes of 60 and 100 km. These data are determined by a number of methods such as radar tracking of chaff, optical tracking of the chemiluminescent trails from rocket releases, acoustical techniques, and the radar tracking of the ionization trails of meteors. A report has been available that describes a method for estimating gravity-wave density variation from wind speed profile between 60 and 100 km.

The relation of the meteor-trail wind data to internal gravity waves is characterized by roughly horizontal winds which exhibit a strong variation over vertical distances of a few kilometers. A typical variation might depict a vertical scale of about 12 km, a horizontal scale exceeding the vertical scale by a factor of 20 or more, and a period of about 200 minutes. The wind variations are generally seen to increase with height, and a background wind shear is frequently evident.

From the analysis of the effects of background wind shear and mean temperature, under certain approximations, the background wind shear has no effect upon the magnitude of the gravity-wave density variations, although the mean temperature and its vertical gradient may be more significant in this respect. The report considers the background or mean values that are determined from typical vertical profiles of either wind speed or temperature. In addition, wind shear and temperature gradients are introduced into the gravity wave problem, while the simple formulation of an analytical expression that relates density variations to wind speed variations for gravity waves is retained. It is concluded that a single profile is inadequate for a valid determination of the mean or background values and that ensemble averaging over several related profiles is recommended.

The report on the method for estimating gravity-wave density variation from wind speed profiles presents the basic gravity-wave theory. Special attention is given to the justification of the assumptions that are used in establishing and specializing the basic equations. The expression for estimating the variations in density associated with velocity variations in the presence of wind shear and temperature gradients is developed and justified. Critical levels, temperature and wind profiles, and stability are also presented. The method also relates the physical significance of parameters and parametric regimes and includes a discussion on the problem of estimating the background wind speed and the mean temperature from available data.

Note:

Requests for further information concerning the report on atmospheric density variations related to internal gravity waves may be directed to:

Technology Utilization Officer
Code A & TS-TU
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B72-10143

Patent Status:

No patent action is contemplated by NASA.

Source: E. B. Miller of
Northrop Corp.
under contract to
Marshall Space Flight Center
(MFS-21637)

Category 03