would be applicable at intermediate latitudes. On the other hand, a circulation regime such as that proposed by Goody and Robinson (1966) would require symmetry about the Venus-Sun line. Here no permanently hot or permanently cold regions exist, and we might expect buffering to be effective over much of the planet. The reports by Sinclair *et al.* (1970) of marginal detection of possible 15–20K temperature variations along the equator cannot be reconciled with the Goody-Robinson circulation model, whether or not the proposed buffering effect is important, unless they refer to large regions whose elevations differ about 2–2.5 km. Radar topography studies near the Venus equator (Ash *et al.*, 1968; Smith *et al.*, 1970) are mildly in disagreement with this alternative, and probably the safest conclusion is that longitudinal (phase) temperature variations do not exist at present levels of measurement accuracy.

It must be stressed that this buffering effect serves to damp out periodic excursions in temperature, but is ineffectual against secular changes. It is therefore not possible to apply the model to thermostat a permanently cool region, such as the polar regions in axisymmetric circulation models. Numerical models of the Venus circulation incorporating this effect may help shed light on the nature of the planetary circulation, heat balance, and wind velocities.

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Jovian Ultraviolet Reflectivity Compared to Absorption by Solid Ammonia

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ABSTRACT

A simplified model of Jovian clouds was used to fit the shape of the geometric albedo curve between 1800 and 1950 Å. Absorption by uniform layers of gaseous and solid cubic ammonia over a gray surface resulted in a curve that was in good agreement with reported experimental measurements.

It has been suggested by many authors that the clouds of Jupiter are composed of solid ammonia but no direct experimental evidence has been available to support this hypothesis. The purpose of this note is to point out that a sharp decrease in the Jovian geometric albedo between 1800 and 1950 Å (Anderson *et al.*, 1969) can perhaps be explained as absorption by a mixture of gaseous and solid ammonia in the cubic crystal form. A more positive identification cannot be made for several reasons: 1) the only experimental data on solid cubic ammonia in this spectral region consists of four data points (Dressler and Schnepp, 1960), only two of which are useful for the present calculations; 2) it is impossible to construct an appropriate scattering model because of a lack of laboratory data on solid ammonia; and 3) the spectrum does not have unique features that can be associated with solid ammonia.

We have attempted to fit the shape of the geometric albedo curve from 1800 to 2150 Å by considering a gray surface, with an albedo of 0.2, overlaid with uniform layers of ammonia ice and/or gas. This value of the geometric albedo was chosen to approximate the experimental data outside the spectral region of strong absorption. It is the result of scattering by a mixture of

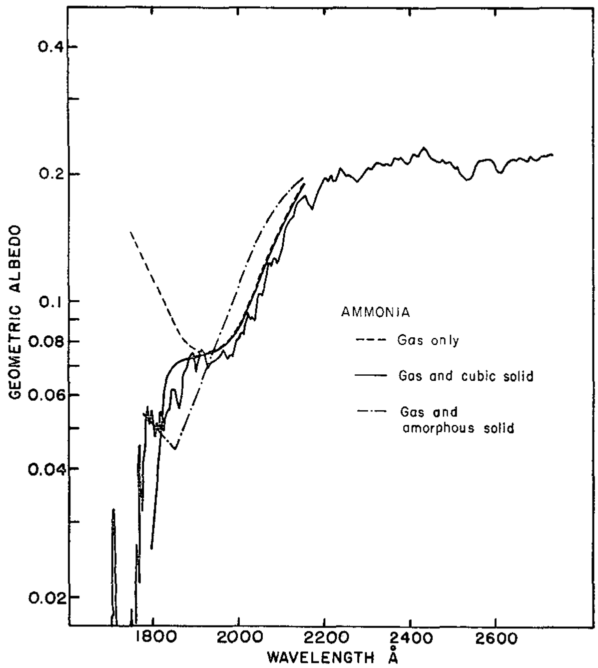

FIG. 1. Experimental (jagged line) and calculated (smooth lines) Jovian geometric albedos.

cloud particles and atmospheric gases. Both amorphous and cubic crystal ices were considered. Which form occurs depends upon whether the ice forms above or below 125K. The cubic crystal forms above 125K. If one assumes only gaseous ammonia, the albedo curve can be fitted nicely down to 1950 Å, but at shorter wavelengths there is a considerable discrepancy between theory and experiment. Such a curve is shown as a dashed line in Fig. 1 for an amount[1] of 1.6×10^{-3} cm-atm of NH_3. If a 8.5 μ layer of cubic crystal ammonia is added to the gas, strong absorption occurs below 1900 Å, and a reasonably good fit to the data is obtained. This curve is shown in Fig. 1 as a solid line. If amorphous ice is used with the gas, the agreement is poor. A sample calculation for the amorphous ice, also plotted in Fig. 1, shows that the trend of the curve is not correct below 1900 Å.

A mixture of ammonia gas and cloud particles of almost pure solid NH_3 with a cubic structure is quite consistent with current Jovian atmospheric models. For example, since Lewis (1969) and others predict pure solid NH_3 cloud tops at a temperature level near 150K, the cubic ice form would be expected. It is thought that this is a much more likely candidate for the absorption below 2100 Å than the hydrocarbons suggested by Greenspan and Owen (1967).

[1] No attempt should be made to attach a physical significance to the amounts of substances used in our over-simplified model.

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Geostrophic Turbulence

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ABSTRACT

A theory is presented for the spectra of horizontal velocity and temperature at high wavenumbers in three-dimensional quasi-geostrophic flow. The theory predicts a minus third power dependence on both the horizontal and vertical wavenumbers for the spectra of both the kinetic energy and the temperature variance, with amplitudes determined by the pseudo-potential vorticity transfer function. It also predicts equipartition among the components of kinetic energy and available potential energy. Comparisons of the predicted with the observed spectra of kinetic energy and temperature are cited. There is approximate agreement, notably in the prediction of equipartition.

1. Introduction

Theoretical studies of atmospheric predictability (Lorenz, 1969; Leith, 1971) have emphasized the importance of the equilibrium energy spectrum of the atmosphere as determining the rate at which uncertainties at small scales propagate to larger scales and