Fixed Height S-Band Radar Observations of the Stratosphere

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Introduction

It is now known that turbulence and mixing in the lower stratosphere occurs in intermittent layers of thickness between about 30 and 300 meters. Layered structures also exist in the ocean (Woods, 1969) and in the atmospheres of the other planets (Gierasch and Conrath, 1987). It appears that dissipative processes in stratified geophysical fluids frequently take place in thin layers. It is therefore of great importance to observe and document the nature of these dynamical regions. The Arecibo facility is uniquely capable of performing these high resolution measurements.

The S-band radar system has been configured for high resolution studies of the lower stratosphere, and data have been collected and analyzed, demonstrating its potential and capabilities. Previous effort was directed to a description of a wide region of the atmosphere, with only brief attention dedicated to continuous observations of a particular height. We propose a new series of observations focusing on the time evolution of waves and turbulence at a fixed altitude.

The mode of operation that best meets this objective is "Fixed mode pointing," as described by Ierkic *et al.* (1990) (attached as an Appendix), and no new techniques need to be developed.

Objectives

Previous work has revealed the general distribution of turbulent layers in elevation and time, and has given some indication of the frequency of their occurrence (Woodman, 1980; Sato and Woodman, 1982, Ierkic *et al.,* 1990). In a new study we wish to follow the time development of individual patches of turbulence from genesis to decay. For example, under the most popular hypothesis, turbulent layers are produced by breaking of internal gravity waves. If this is true, a detailed observation should show an initial structure that is purely wavelike, followed by a nonlinear regime which may be complicated, finally ending with a residual patch of decaying turbulence. In the experiment we propose, a fixed volume in space will be monitored and the mean wind will advect the turbulent regions through the observation point. Whether the time development can be determined depends on the advection time through the observation point compared to the lifetime of the layer. Layers of large horizontal extent may intercept the observation point through their entire history. Careful examination of the inferred properties of the layers should reveal whether we are detecting time development or, on the other hand, watching the steady state of a patch of limited extent as it drifts through the beam. Either possibility will yield important information, one on spatial intermittency and the other on temporal.

Another objective is to determine the vertical velocity over an extended time interval to determine if there is a steady flow, such as might be caused by a large scale orographic wave (Hines, 1989), as well as periodic components due to propagating waves.

In addition to the observational advances that we can anticipate with high probability based on previous experience, it is possible that new discoveries will be made during this experiment. For example, it has been suggested (e.g. Reiter, 1975; Crane 1980) that intrusions of tropospheric layers into the lower stratosphere are responsible for important stratosphere-troposphere exchanges. Our high resolution data would be ideal to delineate such an event.

Implementation

We will address these general objectives by measuring the forward scattering intensity, the vertical velocity, and its standard deviation. The sampled volume is 600 m deep and 50 m wide, and we observe with a vertical resolution of 20 m.

The specific strategy will be to scan in height until an active layer is observed, then fix the antenna pointing for the duration of its activity. We will use the 430 MHz Arecibo radar to estimate horizontal winds through the troposphere and stratosphere, from about 6 km to 20 km altitude, at times interspersed with the S-band observations. We will coordinate with the San Juan Meteorological Station to receive balloon data as near as possible to the time of our observations. The rawindsonde data includes temperature and wind profiles from the surface to about 30 km altitude.

We are requesting four observing sessions each of eight hours duration from 0600 to 1400 hours on alternate days. The morning hours are best to avoid tropospheric rain and clouds, which strongly contaminate the radar return. Events described by Ierkic *et al.* (1990) showed durations from less than one hour to several hours, generally with shorter durations at greater heights. An eight hour session should allow observation of several events, even at lower ranges. Observing periods on alternate days will give time for preparation for the next session. We will also require three periods of three hours each during working hours for system checks with the last such period using the 2380 MHz transmitter and the Higuillales link. Part of that time will be employed in perfecting the procedure to interleave the operation of the S-band and 430 MHz radars.

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