VKI Lectures (Quiroz)

INTRODUCTION TO ATMOSPHERIC STRUCTURE

1. Basic structure. Description according to electron concentration, chemical composition, and temperature, with emphasis on the latter. Enigma of the warm winter mesosphere.

2. Fundamental equations. Review of geostrophic and thermal wind equations, equation of state and hydrostatic equation, and their applicability at altitudes up to 150 km. Various forms of the integrated hydrostatic equation will be considered, as well as the concept of scale height. (Equation showing interlevel relation of pressure, temperature and density will be presented in later lecture.) Equations are given in Appendix to this outline.

OBSERVATIONAL NETWORKS

1. Radiosondes. Altitudes reached. Temperature and pressure accuracies. Density of observations at 10, 5 mb (~31, 36 km). Synoptic constant-pressure maps drawn from radiosonde data (to 10 mb).

2. Constant-level balloons. Consideration of expected lifetime in relation to altitude. Results of Southern Hemisphere projects.

3. Rocket techniques. Main classes of measurements (brief survey), with emphasis on altitude domains and quantity of data obtained.

4. Rocket networks. Sites at which grenade, falling sphere, and thermistor soundings are made.

5. Limitations in soundings with small rockets. Limitations related to geographical coverage, non-uniform instrumentation, and altitude capabilities. Accuracy of measurement; "repeatabi of measurements.

6. Synoptic maps drawn from rocket data. Procedure for making weekly analyses at 5, 2, and 0.4-mb levels (~36, 43, 55 km).

7. Satellite observations. Methods for inferring vertical temperature profiles (currently to 30 km) and shortcomings in these methods. Data coverage.

INTERLEVEL RELATION OF TEMPERATURE, DENSITY, AND PRESSURE

Preliminary remarks on ratio of observational error to real atmosp variation; uses of rocket data, including use of density data in re-entry analysis.

1. Why study the density? Possible stratospheric influence on lower ionosphere. Surface heating of re-entry vehicles.

2. Basic density distribution. Basic model of seasonal variation. Uncertainty in lower thermosphere and in very high latitudes.

3. Interlevel relations. Derivation and significance of the relations,

$$\frac{1}{\rho(z)}\frac{\partial \rho(z)}{\partial t} = \frac{1}{\rho_0}\frac{\partial \rho_0}{\partial t} + \frac{1}{H}(\Delta z - H_0)\frac{1}{T_0}\frac{\partial T_0}{\partial t} \qquad H = RT/g \qquad (1)$$

$$\frac{1}{p(z)}\frac{\partial p(z)}{\partial t} = \frac{1}{p_0}\frac{\partial p_0}{\partial t} + \left(\frac{\Delta z}{H}\right)\frac{1}{T_0}\frac{\partial T_0}{\partial t} \qquad (2)$$

Application to concept of isopycnic levels. Maxima in wind flow related to maxima in pressure gradient.

4. Density "prediction." Processing of special rocket data samples, patterns of interlevel correlation found, and develop of specification equations by statistical regression.

DENSITY VARIATIONS (SPECIAL ASPECTS)

1. High-latitude regime. Derivation of preliminary monthly means for very high latitude (80°N), using data for Soviet station (Heiss Island), etc., at 30 to 50 km. Comparison of results with curves for lower latitudes.

2. Synoptic density fields. Derivation of maps for 30 and 40 km. Summer and winter fields; departures from standard. Large longitudinal variation in high latitudes (60°N).