

- (ii) The relation between albedo, and cloud undercast as obtained from an aircraft flight at 25,000 ft. testing instrumentation over northeast U.S.A. Albedo observations were obtained from up and down-facing Eppley radiometers. Such studies were carried out for two seasons in Antarctica where they will assist in estimating the albedo by seasons with varying amounts of ice and water. They will be useful in the interpretation of satellite observations, and in preparing a radiation climatology of the region.
- (iii) Mean winter atmospheric cooling rates at the South Pole based on radiometersonde measurements. This showed cooling rates of 2 to 3°C/day just above the ice plateau, 1°C/day at 500 mb decreasing to about 0.2°C/day at about 200 mb, then increasing to about 1°C/day at 50 mb. A further diagram showed that the cooling above 200 mb tended to increase with decrease in latitude, at least to the latitude of Wilkes (66°S).
- (iv) Calculated mean annual, mean October - March and mean April - September snow surface temperatures over Antarctica. The lowest temperatures for each period occur over Eastern Antarctica, the mean annual being below - 55°C and the others below - 45°C and - 65°C respectively.
- (v) Two South Pole ozonesonde ascents (27.10.62 and 16.11.62), before and after the springtime warming. This showed a marked increase in ozone between 200 mb and 10 mb over this period. Between 100 and 50 mb the partial pressure of ozone increased from about 125 to 225 micro-millibars. Marked increases in ozone occur simultaneously with sudden stratospheric warmings.
- (vi) Time sections of 10-day and 3-day mean 50-mb temperatures illustrated the general warming trend at that height from September to November, and the marked variations that occur in the trend in different years. Mr. Rubin explained these as being due to circulation changes and vertical motions.

In reply to a request for information regarding the atmospheric electricity measurements being made, Mr. Rubin said that observations are being made of the potential gradient a few metres above the ground. Observations were also being made by others at Antarctica. He mentioned that Wexler, Moreland and Weyant had suggested that the maximum surface ozone in winter was associated with winds from the continent to the sea and downward vertical motion carrying ozone from the stratosphere to the ground in winter. It had also been suggested that the ozone present might be due to electric discharges in the atmosphere during periods of blowing snow. These measurements are being made to test this theory.

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STRATOSPHERIC MEASUREMENTS OF ION DENSITY AND ELECTRICAL CONDUCTIVITY

by G. Paltridge

Mr. G. Paltridge of the R.A.A.F. Academy, Point Cook, Victoria, stated that a knowledge of the altitude distribution of the electrical conductivity of the atmosphere is extremely important, as conductivity is the independent variable which determines the other electrical parameters such as the electric field, the air-earth potential, and the atmospheric space charge. The electrical conductivity (λ) in turn depends on the "small ion" density (n)

and the small ion mobility (k) according to the relations

$$\lambda^{\pm} = n^{\pm} e k^{\pm} \quad \dots (1)$$

$$\text{and } \lambda = \lambda^{+} + \lambda^{-} \quad \dots (2)$$

where the superscripts indicate the polarity and e is the charge of an electron.

So that by relation (1), high altitude measurements of both λ^{\pm} and n^{\pm} should lead to values of mobility which satisfy the relation

$$k^{\pm} \propto \frac{1}{\rho} \quad \dots (3)$$

since the small ion mobility is known to be inversely proportional to atmospheric density (ρ).

The method of ion density and conductivity measurement from balloons has remained the same since such measurements were first attempted. It consists of measuring the ionic current in a cylindrical charged capacitor. Aspiration of the capacitor is maintained by the ascent of the balloon. In the "saturated" state, when all ions which enter the capacitor contribute to the current, the current is a function of n^{\pm} and G (the flow rate through the capacitor). If the voltage on the capacitor is lowered (or the flow rate increased) the capacitor becomes "unsaturated". That is, the current is independent of G and is a function of n^{\pm} and k^{\pm} , or in other words λ^{\pm} . By suitably adjusting the physical dimensions of the capacitor and the voltage applied to it, one can therefore measure either n^{\pm} or λ^{\pm} .

Many such measurements have been made from balloons. They have yielded independent values of n^{\pm} and λ^{\pm} which contradict the inverse density rule for small ion mobility. A series of four balloon flights over Melbourne which simultaneously measured λ^{\pm} and n^{\pm} yielded similar results, even though extreme precautions were taken to eliminate such effects as photo-electric emission.

It became evident that these anomalous results were being generated by aerodynamic defects in the apparatus. Subsequent wind tunnel investigation of the behaviour of such equipment has shown:

- (a) that without a flow rate correction which must be calibrated as a function of height for an individual instrument, the recorded ion density will be in error by greater than a factor of 2 at higher altitudes, and
- (b) the conductivity measurement becomes inaccurate at the altitude where the velocity profile at the exit of the condenser becomes different to the profile at the entrance. For the present instrument this altitude is 22 km, but will be as low as 5 to 10 km for apparatus of smaller dimensions.

Application of an experimental correction factor to the ion density profiles gives agreement with relation (3) up to this limiting altitude.

Further experiments have been conducted, (1) to measure the polar ratios $\frac{n^{+}}{n^{-}}$ and $\frac{\lambda^{+}}{\lambda^{-}}$ using small vertically ascending balloons, and (2) to measure n^{\pm} and λ^{\pm} from a large floating plastic balloon, where aspiration of the capacitor at varying flow rates was achieved by means of a pump. Both experiments have yielded results consistent with the previously indicated high stratospheric dust concentration over Melbourne since the Mount Agung volcanic explosion.

The presence of significant amounts of dust in the stratosphere will theoretically have the following effects on the atmospheric electric parameters:-

- (1) A general reduction in both the positive and negative small ion densities owing to the "attachment" of the small ions to the large dust particles.
- (2) A positive to negative small ion density ratio of 1.3 owing to the preferential attachment of the higher mobility ion. The ratio $\frac{k_-}{k_+}$ is approximately 1.3 .
- (3) A positive to negative conductivity ratio of 1.0 owing to effect (2). and
- (4) A stratification of the vertical ion density profile owing to the expected stratification of upper atmosphere dust.

The vertical sounding experiments have confirmed all four of these theoretically predictable effects. The floating balloon experiment, which yielded positive conductivity and positive ion density data consistent with the inverse density rule for small ion mobility, confirmed the effect (1) at the higher altitude of 30 km. This last experiment indicated also a considerable time variation in ion density, and it is being repeated in conjunction with a geiger counter to investigate the reason for this.

In order to confirm the balloon findings, a more sophisticated instrument has been developed for the measurement of positive and negative ion density from a Sabre aircraft. Initial flight trials are proceeding, and when fully developed the instrument will be suitable for such measurements from any subsonic aircraft.

