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# MAGNETIC CONTROL OF THE HIGH-LATITUDE THERMOSPHERE

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I am going to describe observations of composition and density made with the neutral mass spectrometer on the polar-orbiting OGO-6 satellite. The observations were made during a quiet magnetic period in late August and early September 1969 when the satellite perigee was near the South Pole.

The observations show that there are marked cyclic variations in density and composition which have a 24-hr period, and these are interpreted to indicate a significant heat input into the polar thermosphere, possibly due to particle precipitation.

Figure 1 shows the variations of helium, nitrogen, and oxygen density as a function of time at constant altitude. Note the cyclic variation in both $N_2$ and helium, with $N_2$ and helium being out of phase. Oxygen shows no particular strong effect. (This is atomic oxygen; we could not measure $O_2$.)

To interpret these measurements, we should keep in mind that the plane of the satellite orbit was essentially fixed with respect to the Sun, so that these observations are essentially at uniform local time; but as Greenwich time progresses and the Earth turns underneath the orbit, we see a succession of longitudes. In other words, longitude is perfectly correlated with universal time.

Figure 2 shows the latitude distribution of this phenomenon. We have contours of constant nitrogen and helium densities plotted on a geographical latitude-longitude grid. We note a maximum in nitrogen at approximately 160° W longitude and 70° S latitude and at the same time there is a minimum of helium.

Now, upon examining individual orbits of the satellite, we found that nitrogen densities actually tend to maximize at close approach to the magnetic pole; but the orbits which occurred near 8 hr Greenwich mean time, which corresponds to 160° W longitude, indicated the highest overall densities, and these dominate the picture.

To understand these unique observations of composition, when nitrogen is increasing at a time when helium is decreasing, we can refer to a theory proposed by Hans Mayr of our laboratory. This theory indicates that the effect

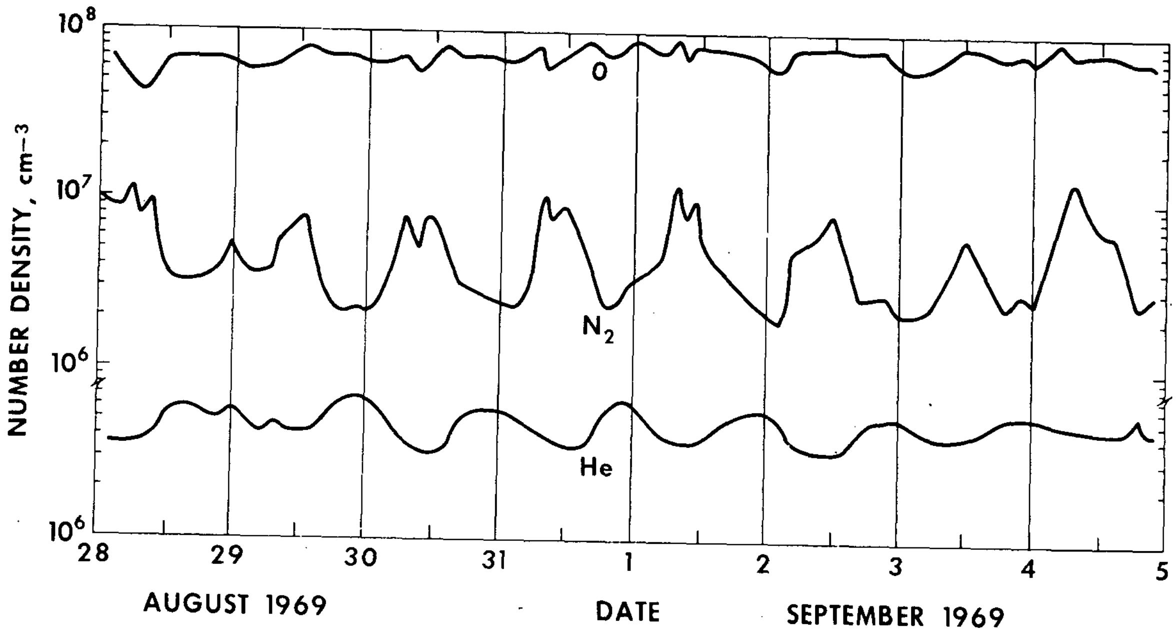


Figure 1–Gas densities at 430-km altitude as observed by the OGO 6 satellite near the South Pole.

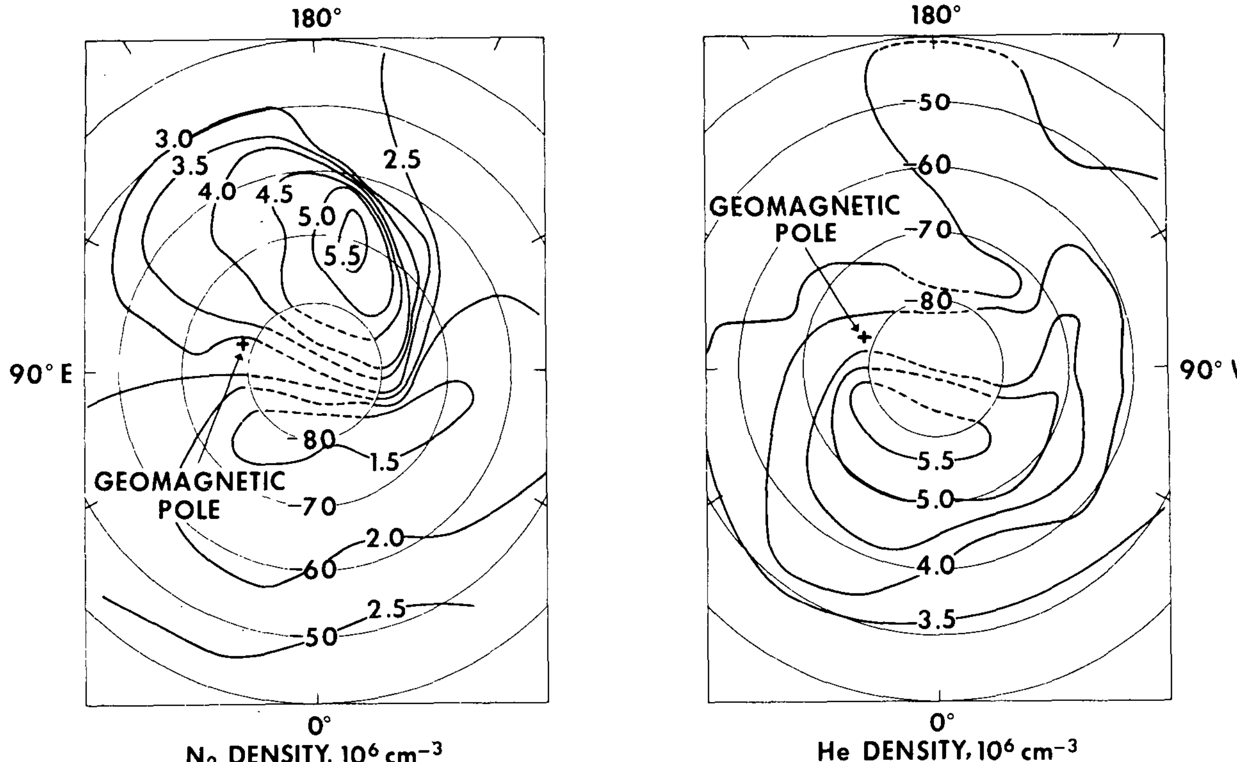


Figure 2–Contours of observed constant $N_2$ and helium densities plotted on a geographical latitude-longitude grid. Densities are extrapolated to 450 km.

of heat input into the thermosphere would, through increased temperature and establishment of a circulation pattern, result in just the types of composition changes observed. The heavier gases, such as nitrogen, would tend to increase at the time of energy input; and light gases, like helium, would tend to decrease at certain altitudes.

If we take into account the fact that observations of electron density made simultaneously on the OGO satellite also have strong variations and correlate very strongly with the nitrogen densities, this suggests that particle precipitation would be a likely explanation for this heat input.

It is known from measurements that the poleward boundary of auroral electron precipitation shows periodic variations that are consistent with these observations. We would expect that particle precipitation would have a periodic variation because the Earth's magnetic dipole is going through a 24-hr period with respect to the Sun.

In summary this suggests that there is a modulation in the magnetosphere causing a modulation of electron precipitation. This precipitation heats the atmosphere directly or through joule heating, and this increased joule heating causes a change in the composition of the atmosphere.

*CHAIRMAN:*

Are there any questions?

*MEMBER OF THE AUDIENCE:*

How much did the temperature increase at this time and have you attempted to correlate the temperature measurement in the atmosphere with the Blamont red line measurement?

*MR. HEDIN:*

We have been trying to get his measurements. We just do not have the exact thing to compare with ours. There are difficulties in that he does not measure at the satellite position or altitude and so it is not easy to correlate his data with ours. He also measures only in sunlight and these particular data were mostly obtained in darkness. The temperature change was on the order of a 200 K increase, I believe.