

D31
176

N85-20481

TWILIGHT INTENSITY VARIATION OF THE INFRARED HYDROXYL AIRGLOW

R. P. Lowe, K. L. Gilbert and R. J. Niciejewski

Department of Physics
The University of Western Ontario
London, Canada N6A 3K7

The vibration rotation bands of the hydroxyl radical are the strongest features in the night airglow and are exceeded in intensity in the dayglow only by the infrared atmospheric bands of oxygen. Since their discovery over thirty years ago, the bands have been the basis of many studies of the behaviour of the region near the mesopause such as its temperature, composition and the effect of gravity waves.

One aspect of the hydroxyl airglow behaviour which has not been well studied is the variation of intensity during evening twilight. There are two reasons for this:

- (1) Scattered sunlight has made ground-based measurements only possible when the sun is more than 6° below the horizon. Thus the only measurements available have been from aircraft or balloons.
- (2) The rapid changes which occur at twilight require a time resolution of a few minutes. Few airglow spectrometers have the sensitivity to provide this time resolution while maintaining the good spectral resolution required to discriminate satisfactorily against the scattered sunlight contribution.

Using a ground-based Fourier Transform Spectrometer, we have been able to make hydroxyl intensity measurements as early as 3° solar depression. As will be seen below, models of the twilight behaviour show that this should be sufficient to provide measurement of the main portion of the twilight intensity change. Our instrument is equipped with a liquid nitrogen-cooled germanium detector whose high sensitivity combined with the efficiency of the FTS technique permits spectra of the region 1.1 to 1.6 μm at high signal-to-noise to be obtained in two minutes. The use of a polarizer at the entrance aperture of the instrument reduces the intensity of scattered sunlight by a factor of at least ten for zenith observations.

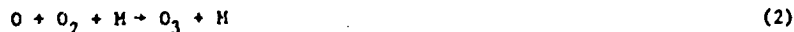
RESULTS

Three spectra of the region of the 4-2 and 3-1 OH bands are shown in Figure 1. Some of the individual lines of the bands can be readily identified in the spectrum taken at 3.02° solar depression and the remainder of the band is clearly visible by 5.49°. The feature at 6320 cm⁻¹ is the 0-1 band of the infrared atmospheric system of oxygen.

We have prepared a computer model of the behaviour of the hydroxyl intensity for comparison with the observations. Although the model is relatively simple, it is not possible to provide more than a brief outline here. Excited hydroxyl radicals are assumed to be produced exclusively by



Ozone is produced by



and destroyed through photodissociation by sunlight

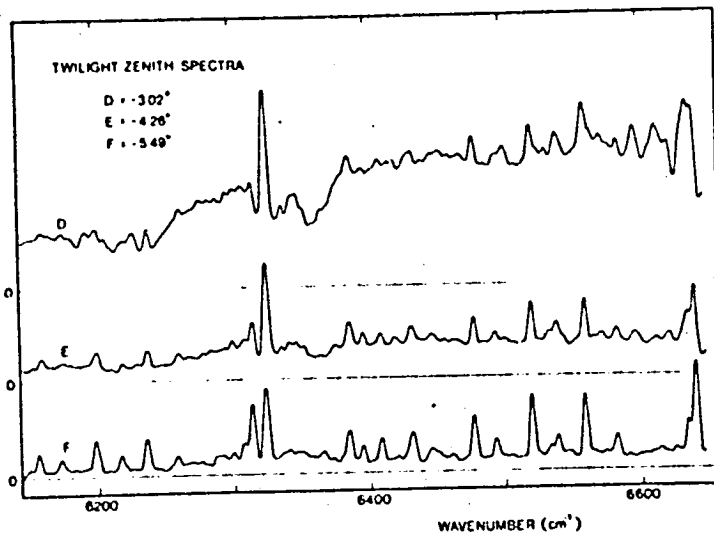
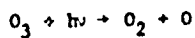


Figure 1.



as well as by process (1). At evening twilight, the cessation of process (3) leads to an increase in the ozone concentration and hence in the hydroxyl production rate. The extent of this increase depends on the atomic hydrogen profile assumed. We have assumed an initial hydrogen profile with a peak of 1.6×10^8 atoms/cm³ at 85 km. The model has also been run with various multiples of this profile. One important feature of the model is that the photodissociation rate as a function of altitude is recalculated at each step to allow for the increase in the ozone concentration.

The model calculation and observations taken on an evening in March are shown in Figure 2. The observations have been normalized to give agreement at large solar depressions. The agreement of the observation with the model is quite good although the fit is better with a model calculation for which the atomic hydrogen concentration is doubled. Data for three other spring nights is available. For two of these, the increase is comparable to the night shown. On the third, only partial data is available due to cloudy conditions at the start of the observing period. The increase observed is more rapid and fits the model calculation for the normal hydrogen profile.

DISCUSSION

We have shown the feasibility of making ground-based observations of the evening twilight increase in hydroxyl excitation. The principal value of such observations is the information they provide on the hydrogen atom concentration near the mesopause, a quantity for which there is only scanty data available.

Preliminary data are consistent with hydrogen atom concentrations at 85 km in the range $1.5 - 3 \times 10^8$ cm⁻³.

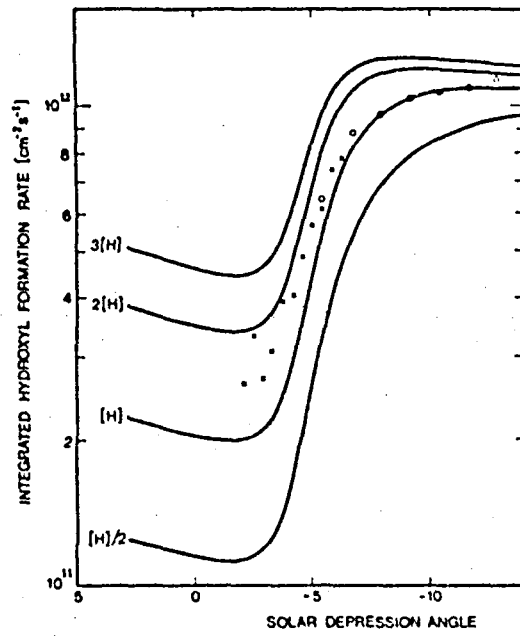


Figure 2.