36 hours commencing from 03 GMT. The *mean synoptic hour* of this pressure change chart is *15 GMT of the previous day*. In view of this, the choice of the upper air charts of 12 GMT (mean hour) of the previous day, by the author, for prognosticating broad zones of the thunderstorms and duststorms during a *24 hour*-period commencing from 03 GMT appears to be justified. The author would also take this opportunity to suggest that, as a further step in this investigation, it would be interesting to attempt a prognostic high-level contour chart for the next 24 hours on the basis of the 09/15 GMT (mean hour 12 GMT) chart and determine the zones of convective activity on the basis of this chart.

(d) In explaining the schematic diagrams in figures 29(a), (b) and (c), the author has discussed the role of the dynamical processes and the local factors separately, only for the sake of simplicity in discussion. These local factors and their contribution to the actual development of large-scale convection have been more fully discussed in the later para in the same section of the paper (p. 53) and again in Section 12 (p. 56) where the effects of these local factors in helping the upper divergence field to overcome the resistance to lifting of the moist air have been specifically mentioned.

(e) The author has not stated that the downward motion induced by the dynamical processes is localised. The downward motion must obviously be extensive as it has been attributed to the effect of large-scale patterns. The word 'strong' was used by the author to qualify the downward motion only in a relative sense. The speed of the downward motion will obviously depend upon the amount of upper convergence, which, in its turn, will depend (to a first approximation) upon the amount of negative vorticity advection i.e. upon the negative value of the term

$$- V^2 \left(\frac{\partial k_s}{\partial x} + k_s k_n \right)$$

(p. 51 of the original paper). No quantitative assessment of the downward or upward motion has been made by the author.

In view of the above, the author is still of opinion that the high level vorticity patterns provide a useful tool for the prognostication of the *broad areas* of development of thunderstorms and duststorms in northern India and Pakistan in the premonsoon period, more than 12 hours ahead, whenever adequate Radio-wind and Radio-sonde data are available.

Madras 31, November 9, 1956.

C. RAMASWAMY.

Regional Meteorological Centre.

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Oxygen in Antarctic Air

Dear Sir,

In reviewing the many determinations of atmospheric composition CARPENTER (1937) and PANETH (1937) concluded that the amount of oxygen in air is always the same at open places all over the world. The values generally range from 20.93 to 20.96 volume per cent. HOCK ET AL. (1952) have since published a series of 320 determinations made during an 18 months stay at Pt. Barrow, Alaska, at 71 N. All of these fell between 20.91 and 20.96 per cent and the variation was not considered significant. In sharp contrast to this essentially constant composition of arctic air are the determinations of LOCKHART and COURT (1942) on the oxygen in ground level air in the Antarctic. Their values ranged from 20.76 to 20.48 volume per cent, a surprising amount lower than those from any other place on the earth. In addition they noted a seasonal variation, the summer values being generally lower than the winter ones. GLUCKAUF and PANETH (1946) objected to these measurements because no check analyses on normal air were carried out.

The icebreaker Atka collected a series of air samples off the Antarctic continent in 1955. When these became available[1] it seemed worthwhile to determine the oxygen in them. Empty helium cylinders were filled to 2,000 pounds pressure by a compressor on board ship. Smaller cylinders were later filled from these.

[1] Mr. Paul Humphrey of the U.S. Weather Bureau was responsible for the collection of the gas samples. They were made available to the author through the kindness of Dr. F. T. Haremann of the Argonne National Laboratory.

Triplicate oxygen determinations were made with the $^1/_2$ cc analyser of SCHOLANDER (1947). The instrument is considered accurate to .02 per cent. Measurements were only made after values for local air showed that the instrument was working well. Woods Hole air has never been found to vary significantly from 20.94 per cent over a period of several years. The data are presented in Table 1.

Table 1. Per Cent Volume of Oxygen in Antarctic Air

Sample	Latitude	Longitude	Date	Analysis 1	Analysis 2	Analysis 3	Average
SP-1	10 S	100W	12/16/54	20.90	20.91	20.88	20.90
9	73 S	163W	1/27/55	20.82	20.84	20.83	20.83
10	72 S	131W	1/30/55	20.82	20.82	20.85	20.83
11	69 S	100W	2/3/55	20.88	20.87	20.85	20.87
12	65 S	65W	2/6/55	20.86	20.89	20.85	20.87
15	72 S	15W	2/15/55	20.88	20.87	20.85	20.87
21	12 N	38W	4/2/55	20.86	20.86	20.86	20.86
Woods Hole...	42 N	70W	5/7/56	20.93	20.94	20.96	20.94

All of the samples are significantly below local air by amounts varying from .04 to .11 per cent. Two of the samples are from the tropics where normal values have always been reported. In view of this it is believed that the slightly lower oxygen percentage arose during the sampling and storage of the gas. Because of the greater solubility and reactivity of oxygen nearly all of the conceivable errors would tend to lower it in relation to nitrogen. DOLE ET AL. (1954) found that they had to allow for chemisorption of oxygen in the steel cylinders used to take atmospheric samples from rockets. One is not able to calculate how large such an effect might be. The measurements given here probably do not represent a significant departure from normal atmospheric composition. Since they are as much as .4 per cent above the summer values of Lockhart and Court, their earlier work is not substantiated. It is hoped that the large amount of Antarctic work during the International Geophysical year will include more atmospheric composition measurements.

Woods Hole, Massachusetts, December 25, 1956.

JOHN KANWISHER

Woods Hole Oceanographic Institution.

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On Short-Period Magneto-Hydrodynamic Waves in the Ionosphere

Gentlemen,

An interesting paper by Dr. B. Lehnert was published in *Tellus*, 1956, **8**, No. 2, p. 241. This paper explains the giant pulsation in terms of magneto-hydrodynamic waves travelling between the different ionospheric layers in the auroral zone. It is assumed that the velocity of Alfvén's waves is $H(4\pi\varrho)^{-1/2}$, where ϱ is the density of the atmosphere including neutral atoms. I see some difficulties in this suggestion. The periods of waves T lay in the range between 60 and 300 sec. For the ionosphere the time t_n of mean collisions is according to Dr. B. Lehnert (private communication)

Layer	D	E	F_1	F_2
t_n (sec)	$5 \cdot 10^{-6}$	$5 \cdot 10^{-4}$	1	300

for neutral atoms.

In the D, E and F_1 layers the value of $t_n < T$. However this condition is insufficient to make the neutral part of the atmosphere to oscillate with the ions.

Let the velocity of ions in the wave be v_i. Let the ions reach this velocity due to the action of the magnetic force during the time $t < t_n$. As a result of collisions the ions can transmit their momentum to the neutral atoms. But the abundance of neutral atoms is much greater than that of ions. The total momentum of the atmosphere will be about $\frac{\varrho_i}{\varrho}\,\varrho v_i$ after one collision. N collisions are needed in order that the whole atmosphere should acquire the wave matter velocity. If the wave energy is expressed in terms of the strength of the disturbing magnetic field h, the velocity of ions in the magneto-ionic waves will be about $v = h\,(4\pi\varrho)^{-1/2}$. If the whole atmosphere takes part in magneto-hydrodynamic oscillations, the velocity of matter will