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LOW LEVEL JET-STREAMS, NOCTURNAL THUNDERSTORMS AND COASTAL DESERTS

By H.H. Lettau

Professor Lettau of the Meteorology Department, the University of Wisconsin, described studies of the behaviour of low level jet streams, including a detailed study conducted on the Great Plains of Nebraska where a large tract of land has a gentle upward slope from east to west of about 1 in 500.

For the latter study, techniques were devised to measure wind profiles at heights above those which could be reached by instrumented towers. Here, winds obtained from photographs of the tracks of pilot balloons taken every alternate 20 seconds showed a wind maximum at about 400 metres.

Two-hourly wind observations at a chain of U.S. Weather Bureau stations along latitude 35°N showed the existence, towards the western side of the slope, of a night-time maximum with jet characteristics in the southerly component. The pressure field indicated a warm low in the west and a cold high in the east. Professor Leattau also showed that the summer maximum in thunderstorm activity over U.S.A. occurred in about the same location and at the same time of the day as the low level jet.

He then outlined earlier theories on the formation of the low level jet and advanced his new concept of thermo-tidal winds. Here, insolation cycles associated with meso to large scale effects of sloping terrain set up diurnally see-sawing thermal winds as the forcing function, while the response of actual air motion is modified by internal friction and the coriolis force.

Professor Lettau demonstrated that this concept provides the common basis for the explanation of certain observational features including the nocturnal low level jet of the Great Plains west of the Mississippi River, the nocturnal thunderstorms of this region, and also the regional tendency towards daytime subsidence which may lead to coastal deserts in certain strips along the Pacific slopes of the Andes and Rocky Mountains, analogous to coastal deserts in other tropical and subtropical regions.

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OZONE SOUNDINGS AS IN AID IN TRACING ATMOSPHERIC MOTION

By A.B. Pittock

Dr. Pittock of C.S.I.R.O. Division of Meteorological Physics, Aspendale, Victoria, remarked that the production, transport and destruction of ozone involves the whole of the atmosphere of interest to meteorology. Ozone is produced by photochemical processes in the upper stratosphere, where it is in photochemical equilibrium. It is carried down through the lower stratosphere and troposphere by air motion, and is destroyed by oxidation processes at the earth's surface.

The ozone group at C.S.I.R.O., Aspendale, have been flying electrochemical ozonesondes of the Brewer bubbler type (Brewer and Milford (1960)), produced by Mast Development Corporation, since June 1965. This is in addition to surface ozone measurements and a network of Dobson spectrophotometers.

Ozone destruction at the surface was illustrated by a sounding which showed a rapid decrease in ozone concentration below a low-level inversion. On the other hand a sounding for 20 December 1965, a clear calm day with high surface temperatures, showed an increase in ozone below a low-level inversion, which Dr. Pittock tentatively attributed to local production of ozone in the polluted surface air, similar to the famous Los Angeles type smog (Renzetti (1959)).

The time for the ozone concentration to return half-way to the photo-chemical equilibrium value after a disturbance is a measure of the stability of ozone in the atmosphere. This half-restoration time increases rapidly from less than an hour above about 50 km, to about a day or more at the 10 mb level and a year at the 50 mb level. Hence in the lower stratosphere the ozone mixing ratio is a very conservative property of the particular air mass. Ozone is therefore a useful tracer of atmospheric motion.

By reference to numerous ozone soundings and the corresponding temperatures and contour maps, the usefulness of ozone as a sensitive parameter for day to day motion in the lower stratosphere was illustrated. Its usefulness as a tracer of motion on a larger space and time scale was illustrated by reference to Dr. Pittock's recent work on a thin stable layer of anomalous ozone and dust content (Pittock (1966)). A case thought to illustrate the transfer of air from the stratosphere to the troposphere was shown, as well as two series illustrating the passage of upper level troughs, with associated large increases in the ozone content in the lower stratosphere. It was pointed out that these soundings confirmed and amplified the pioneering work of Dobson and his colleagues, based on the European total ozone network of the late 1920's and 1930's (Dobson, Harrison and Lawrence (1929)).

Dr. Pittock pointed out the value of soundings closely spaced in time and horizontal distance in order to fully utilise the high vertical resolution of the chemical ozonesondes. He illustrated this resolution, and the overall reliability of the sondes, by reference to some intercomparisons of ascent and descent traces and of different types of chemical ozonesondes (Hering and Dutsch (1965)). In October 1966, for the first time in Australia ozone soundings were made from a network of stations, with the help of the Bureau of Meteorology and the Weapons Research Establishment. Preliminary results were shown.

Meanwhile, the regular sounding programme at Aspendale of one sounding per week, plus some additional ones during quarterly world intervals, enabled two-monthly mean distributions to be drawn. This illustrated the seasonal variation in the mean ozone distribution. Most notable features were a major reduction in the ozone concentration in the middle and lower stratosphere between October-November 1965 and December-January 1965-66, and a dramatic rise in the concentrations in the lower stratosphere during June and July 1966.

A comparison of the mean distribution for June-July 1965 and June-July 1966, showed significantly more ozone in 1965 above 18 km, the difference being about 20%. This corresponded to a significantly lower mean total ozone amount in the spring of 1966 compared with that of the previous four years. The question was raised as to whether this was related to the quasi-biennial oscillation in the total ozone reported by Funk and Garnham (1962) for the years 1955-62, but which was not evident in 1963-65 (Kulkarni (1966)).

In conclusion, Dr. Pittock pointed out that much more analysis on a statistical and synoptic basis has yet to be done on the preliminary results presented so far, and that there was obvious value in continuing the regular sounding programme at Aspendale. It was hoped that a synoptic network might operate again from time to time, and that eventually ways would be found to operate a regular sounding programme at other Australian stations. Increasing interest in surface ozone measurements was also foreshadowed, both in relation to problems of micro- and meso-meteorology and also in relation to urban and plant environments.

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