U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service

NOAA Technical Memorandum NWS SR-70

WIND AND DUST STUDY FOR LUBBOCK, TEXAS

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FORT WORTH, TEXAS
July 1973

INTRODUCTION

This paper reports on a study of 87,660 observations of wind velocity and related occurrence of dust at Lubbock, Texas during the period 1951-1960.[1] During the period studied, a total of 2,073 cases had dust occurring at the time of observation; this represents 2.37% of the total number of observations. The occurrence of dust is reported on National Weather Service surface observations when the visibility decreases to less than 7 miles because of dust.

In order to give some idea of the magnitude of the dust problem in the Lubbock area, the following information is given. For the 1950 dust season Warn and Cox (1951)[2] made calculations of the amounts of dust associated with ten dust storms. Their calculations were based on samples of dust amounts over a 5-mile-wide strip across the City of Lubbock. It was calculated that a total of 17566.2 tons of sediment crossed the strip during these ten dust storms. The average was 121.8 tons per hour per storm. Surface sediment was carried to a maximum height of 25 thousand feet in one of the more intense dust storms. During this same storm a calculated total of 792.6 tons per hour was transported across the city. It is not uncommon in the Lubbock area for dust to reach heights of 10 to 12 thousand feet.

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[1] 87,660 cases of Weather Service Observations of Wind Direction and Velocities and Dust Occurrences. Period 1951-1960.

[2] American Journal of Science, Vol. 249, Aug. 1951. Pp 553-568.

Quantity and particle size of material carried by the wind are determined by several factors: (1) wind velocity, (2) air turbulence, (3) moisture content of the air, (4) conditions of the soil over which the air moves, i.e., moist or dry soil, and (5) amount of vegetation growing in the areas. Consideration should also be given to up- or downslope motion of the air as it moves from lower to higher terrain, or vice versa. However, this factor is believed to have only a minor effect on the amount of sediment picked up during dust occurrences.

Dust occurrences in the Lubbock area are of two basic types. The first is the local dust occurrence. Local dust develops due to weather conditions in the immediate area. In these cases, dust is usually of short duration and not very intense. An example of this is the case in which dust is raised in the vicinity of thunderstorms. Local dust may also be associated with the passage of a cold front, usually from the north or northnortheast.

The second type of dust occurrence is the large scale dust storm. These storms are associated with synoptic scale low pressure systems or troughs occurring along the eastern slopes of the Rocky Mountains. Such occurrences are usually of longer duration and more intense than locally raised dust. Winds around a low pressure system often develop sustained velocities of 25 knots or more while the low moves from west to east across the Lubbock area. As these systems approach, the wind direction will generally be from the south with a gradual shift to the northwest as the systems progress eastward. Under such conditions it is not uncommon to find the source area of the dust to be over 100 miles from Lubbock.

DISCUSSION

Wind rose data combined with topographical features, soil classification and meteorological conditions are treated according to arbitrarily selected directional sectors.

Northeast through Southeast This sector accounted for 34% (See Fig. 1) of the total number of wind observations in the Lubbock area during the period. However, it accounted for only 8.6% (See Fig. 2) of the winds during dust conditions. Winds from these directions are deflected upward at the escarpment marking the boundary of the High Plains of Texas. This topographical barrier has a tendency to decrease the wind velocities due to frictional effects. The escarpment extends from the northeast to the southsoutheast of Lubbock. The area east of the escarpment is largely covered by vegetation and thus limits available dust. The area is generally composed of hard lands from the northnortheast to the southeast and mixed lands from the southeast to the southsoutheast (See Fig. 3), which would tend to inhibit dust occurrences. It should be noted that intense dust occurrences rarely find their source in this area. Furthermore, surface winds from eastsoutheast through southsoutheast often carry moisture from the Gulf of Mexico which can also inhibit the occurrence of dust.

South through Westnorthwest This sector accounted for 49% (Fig. 1) of the total number of wind observations in the Lubbock area during the period. However, 68% (Fig. 2) of the time during dust occurrences winds were from this sector. Sustained velocities of 21 to 30 knots occurred a large percentage of the time from this sector. Velocities were in this range with south winds 65% of the time (See Fig. 4) decreasing to

38% of the time for winds from the westnorthwest. Highest velocities were associated with directions of westsouthwest and west. Frequency of west and westsouthwest winds from this sector was 37% (See Fig. 5) however this subsector accounted for only 13% of the overall distribution (Fig. 1). The source area (Fig. 3) of dust with winds from this sector comprises sandy lands which are fairly barren. The sector apparently gives up sediment much more readily than the hard and mixed lands in other sectors. Winds from these directions are often associated with the large scale pressure systems or troughs that move across the Lubbock area, and sometimes with dry Pacific fronts that pass through the area. Immediately following the front winds may be in the higher velocity categories, 21 to 30 knots or greater.

Northwest and Northnorthwest This sector accounted for 6% (Fig. 2) of the wind observations with concurrent occurrence of dust. However, the overall frequency of wind observations from this sector was only 4% (Fig. 1). The dust vector wind rose (Fig. 5) reveals the largest number of dust occurrences with wind velocities of 21 to 30 knots or greater. Terrain features may play a role in the relatively low percentages of dust occurrences in the lower velocity categories -- there is a marked downslope in this sector. The terrain map (Fig. 5) will show altitudes of 4,000 feet in Parmer County to the northwest sloping to 3240 feet in the Lubbock area. Also, the hard lands in this sector are less likely to give up sediment with the lower wind velocities. Another factor may be that winds from these directions usually occur with the passage of low pressure centers and troughs. The western portions of these systems have a tendency to be more stable with a commensurate decrease in low

level turbulence. In summary: downslope motion, hard soils and a general decrease in low level turbulence may all contribute to the lesser number of dust occurrences with the lower wind velocities, 20 knots or less.

Warn and Cox found that during severe duststorms the sediment received from these directions did not match the available soil type in the local area. Samples were taken as much as 100 miles to the northwest and it was found that some of the samples did not match the sediment samplings taken in this range. They concluded that with strong winds (25 knots, sustained) the source area for the dust was outside the 100 mile range.

North and Northnortheast Winds from this sector accounted for 10% (Fig. 1) of the total number of observations. The sector accounted for 17% (Fig. 2) of the overall total during dust occurrences with the largest number of occurrences with wind velocities of 21 to 30 knots. Less than 0.5% (Fig. 5) of the dust observations occurred with winds in the 0 to 10 knot category. This is one of the smallest percentages from any direction. In the 11 to 20 knot category, only 2% of the total number of dust occurrences were noted; however, the overall frequency of winds from this sector was 5% (Fig. 4).

It should be pointed out that in general winds from the north and northnortheast are associated with the passage of cold fronts. There is usually intense low level turbulence and strong, gusty surface winds associated with the passage of these fronts. At times such fronts give rise to lines of thunderstorms which result in increased winds and turbulence as the thunderstorms approach. In some cases fronts will

have large amounts of moisture and this of course would inhibit dust occurrence. However, the other factors increase the probability for dust occurrence. After these fronts move to the south of the Lubbock area, winds shift to a more northeasterly direction, generally within 2 or 3 hours after the front has passed. As the fronts progress southward, the cold air stabilizes the lower levels resulting in a decrease in low level turbulence which would result in a decrease in dust occurrence.

Lands in this sector are classified as hard (clay). This would indicate higher velocities, 21-30 knots or greater, in order to sustain dust occurrences. The dust vector wind rose (Fig. 5) indicates that the stronger velocities, 21-30 knots or greater, greatly increase the probability of dust occurrence in this sector.

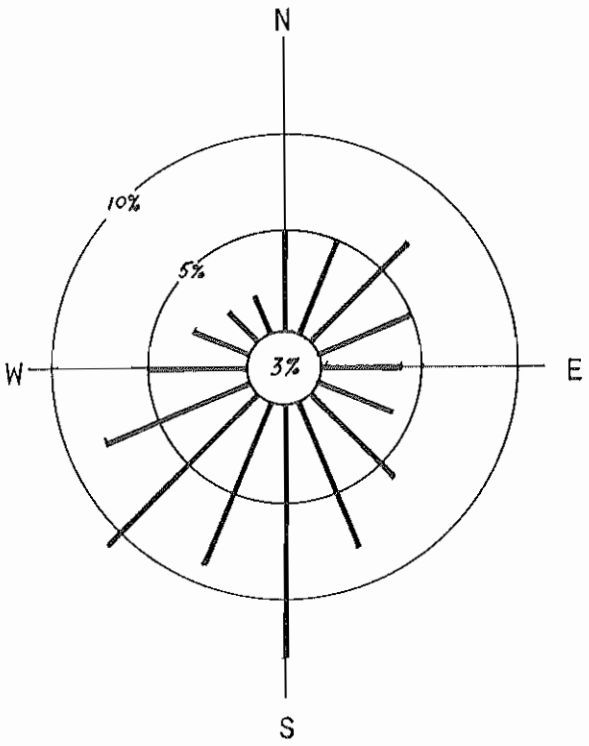

Fig. 1 Total Direction Wind Rose
Lubbock, Texas 1951-1960

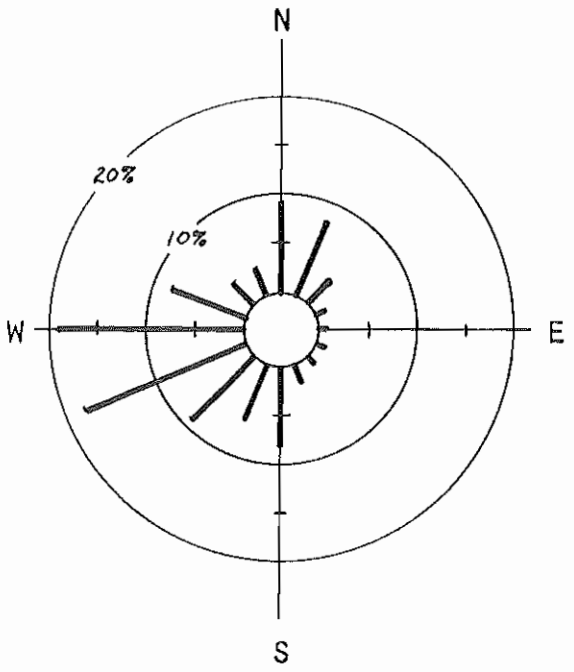

Fig. 2 Dust Direction Wind Rose
Lubbock, Texas 1951-1960

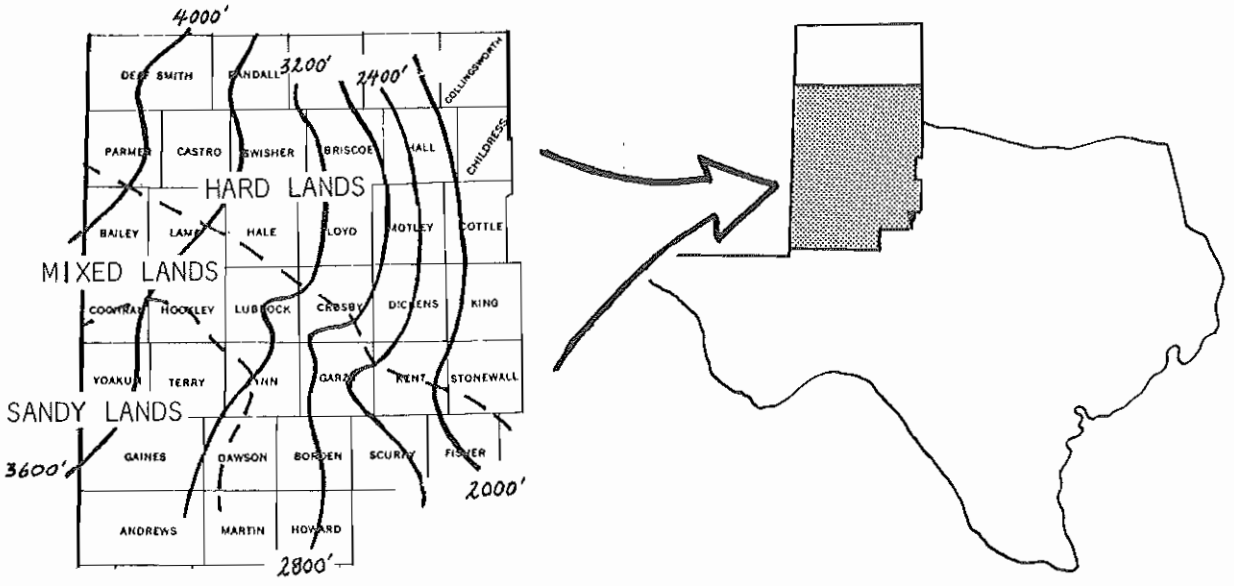

Fig. 3 Topographical Features (High Plains of Texas)

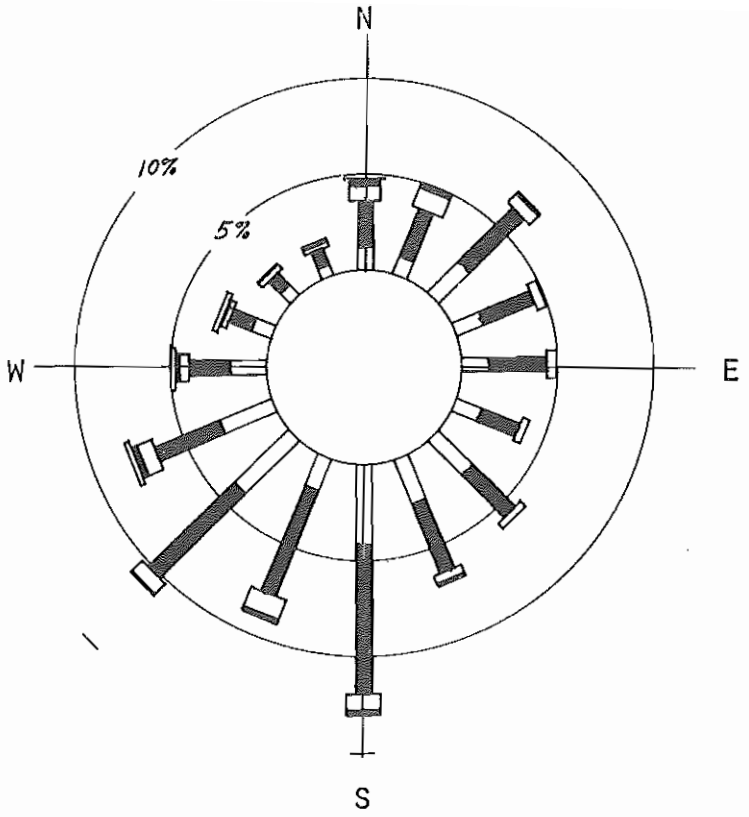

Fig. 4 Total Vector Wind Rose... Lubbock, Texas 1951-1960

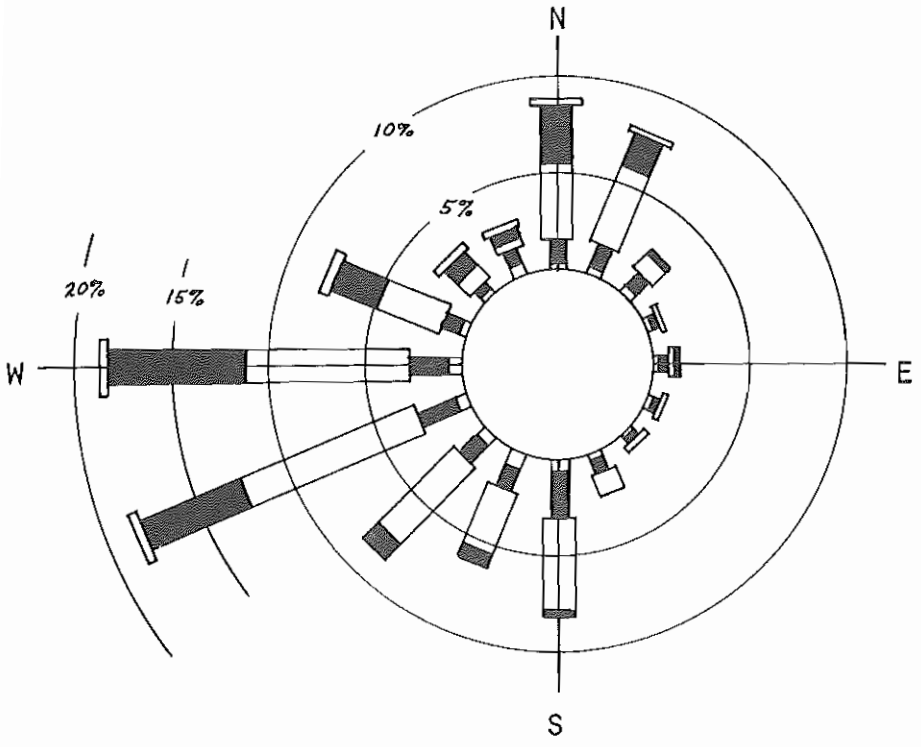

Fig. 5 Dust Vector Wind Rose... Lubbock, Texas 1951-1960