DEW POINT TEMPERATURES OVER THE WORLD AND THEIR IMPORTANCE TO INDIAN SHIPPING

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ABSTRACT

It is pointed out that dew point temperature measurements are very important for the efficient management of cargo ventilation in Indian ships and for the prevention of sweat-damage to cargo when the ships undertake long voyages around the world.

Maps of Monthly Mean Dew point temperatures at sea-level over the globe between 75° N. and 65° S. in January, April, July and October are presented and discussed with reference to the Indian Shipping routes.

INTRODUCTION

THERE are a number of ways of defining the humid state of the atmosphere and the term "Dew point" is one of the ways of defining it. For the purpose of this article, the dew point may be defined as the temperature at which the moisture present in any sample of air is just sufficient to saturate it. If the sample of air is cooled *below* this critical temperature which is referred to as the dew point temperature or simply as the dew point, the air cannot hold all the water-vapour which was initially in it and consequently, the excess of water-vapour will condense into droplets of water.

To illustrate the significance of the dew point in cargo-ventilation problems, let us give an example. Suppose, in the month of July, a certain type of cargo is stowed into a hold in a ship in Bombay which is to proceed to Fremantle in South Australia and that it is *not* subject to ventilation during the voyage. Also suppose that the dew point temperature of the air inside the cargo at Bombay was 25° C. Now, July is a mid-winter month in the southern hemisphere. Consequently, after the ship crosses the equator and approaches Australia, the temperature of the outside air as well as of the surrounding sea-water progressively decreases and the ship's boards become correspondingly colder by thermal conduction. When the temperature of the board-side falls below 25° C.—the original dew point of the air in the ship's hold—the air in contact with the board-side inside the ship's hold, cannot retain the same amount of water-vapour as it did when the ship was in Bombay. Consequently, the excess of water-vapour condenses on the board-side (and on decks or ceilings) and the cargo may get wet either by direct contact or by the water dropping down. The water, which thus wets the cargo and enters into it, is referred to by seamen as "sweating" of the cargo.

Sweat on cargo can also be caused by moisture arising from the cargo itself as in the case of fruits, vegetables, etc. Also some types of cargo such as jute, wool, cotton and hides are "hygroscopic": they have an affinity for moisture which is so great that they can absorb moisture even from air whose relative humidity is not very high. Such materials also sweat inside the ship's hold.

Sweating of cargo can also be caused by faulty ventilation procedures. For instance, certain types of cargo emit foul smell or exude poisonous vapours. In order to get rid of these odours and gases, seamen have necessarily to employ ventilation (Thomas, 1961). They usually admit fresh clean air from the outside atmosphere and allow the foul air inside the cargo space to escape through the discharge-vents. Now if the *dry bulb temperature* of the air inside the cargo space is initially say 15° C. and the air from the outside atmosphere admitted by ventilation has a *dew point* of 20° C., the admitted air cannot retain all the water-vapour it held initially and at least some of the water-vapour will be precipitated as sweat on the cargo.

Seamen are also aware of another type of danger to cargo, namely, that due to heat internally generated within certain types of cargo, *e.g.*, coal, hay and wool if wet or damp (Thomas, 1961). The heat generated in such cases, if left unchecked, may lead to spontaneous combustion and outbreak of fire, resulting in the loss of the ship, not to mention the loss of the cargo. For removing the heat generated, seamen have to employ ventilation. But this very ventilation can cause sweat-hazards if it is inappropriately employed in a meteorological situation of the type explained in the preceding paragraph.

The above instances are intended mainly to show that open ventilation, *which is primarily employed to reduce moisture in the holds*, has to take into account various aspects. Above all, it requires a correct scientific appreciation of the various factors involved.

Past experience has shown that cargo-damages due to sweat can be very considerable (Thomas, 1961) and can lead to very heavy claims. In the case of countries like India, such heavy claims are bound to have an impact on national economy.

It is relevant to mention in this connection that a survey conducted by the World Meteorological Organisation (1957) of such open ventilation-procedures has shown that, in the vast majority of cases, ships' officers, belonging even to the scientifically-advanced countries of the West, followed only certain thumb-rules and that they had no clear logical instructions in this regard. On the basis of this survey, the WMO (1957, 1968) stressed the desirability of a proper scientific appreciation of the problem and suggested ventilation procedures on the basis of regular but simple measurements of the important meteorological element, the dew point temperature. The purpose of this article is to focus the attention of Indian shipping interests to this problem and to provide new scientific material in the form of mean dew point charts for the world which will lead to a better appreciation of the scientific aspects of the problem.

Scientific Principles and Procedures for Ventilation Management

The fundamental point we have to remember when discussing ventilation management is that the cargo is a big reservoir of heat and moisture and that it tends to maintain in ships' holds, the meteorological conditions at the loading ports and/or the conditions within the cargo itself. We should also bear in mind that the temperature of the cargo will change more slowly than the ship's environment along its course.

From the definition of the dew point given earlier, it may be seen that the dew point is the most suitable meteorological element for the purpose we have in view. Hence, measurements of dew point temperature within the ship's holds would give us the best possible indication of the moisture content of the air above and within the cargo. Unfortunately, however, measurement of the dew point temperature in the interstices in the cargo is a very complex problem and it is doubtful whether representative values of the dew point can be obtained even with a number of very expensive distant-reading devices. On the other hand, it is reasonable to assume that when fresh air from the atmosphere outside the ship is admitted into the air spaces, the dew point of the outflowing air will be a good indicator of the general moisture conditions of the hold from which it comes. Hence, whatever may be the arrangement for reducing the moisture in holds, *its practical management should as far as possible be guided by the measurement of the dew point temperature.* This can be done with the help of a simple hand-driven fan-ventilated psychrometer suggested by WMO (1957, 1968). The procedure to be followed will be on the following lines:

(*i*) Measure the dew point of the outside air that will flow into the ventilators. Keep an eye on the difference between the dry bulb and the dew point temperatures. If the difference between the two, *i.e.*, if the "dew point depression" is small, you run the risk of introducing air which may cause sweat on the cargo even if the dry bulb temperature is low.

(*ii*) Put the ventilation system into operation.

(*iii*) Shortly after ventilation is started, measure the *dew point* of the air flowing *out from* the ventilator.

(*iv*) Continue ventilation as long as the outflowing air has a *higher dew point* than that of the air stream from the outer atmosphere which feeds into the ventilator.

(*v*) If, by chance, the exit stream shows a *lower dew point in comparison with the input air, stop ventilation forthwith*, as otherwise, moisture will be deposited in the hold and further ventilation will only increase sweat-hazards.

(*vi*) At longer intervals, but, at less than 6 hours, recheck the dew point of the atmosphere around the ship that feeds into the ventilation system. Use this latest reading as a fresh starting-point for determining whether ventilation is necessary or not.

(*vii*) On the basis of the readings recorded, maintain graphs showing the dry bulb and dew point temperatures at the inflow and outflow ends and enter on the graphs the times of opening and stopping of the ventilation system.

INDIAN SHIPPING ROUTES AND
MEAN DEWPOINT (°C) OF AIR AT SEA-LEVEL, JANUARY

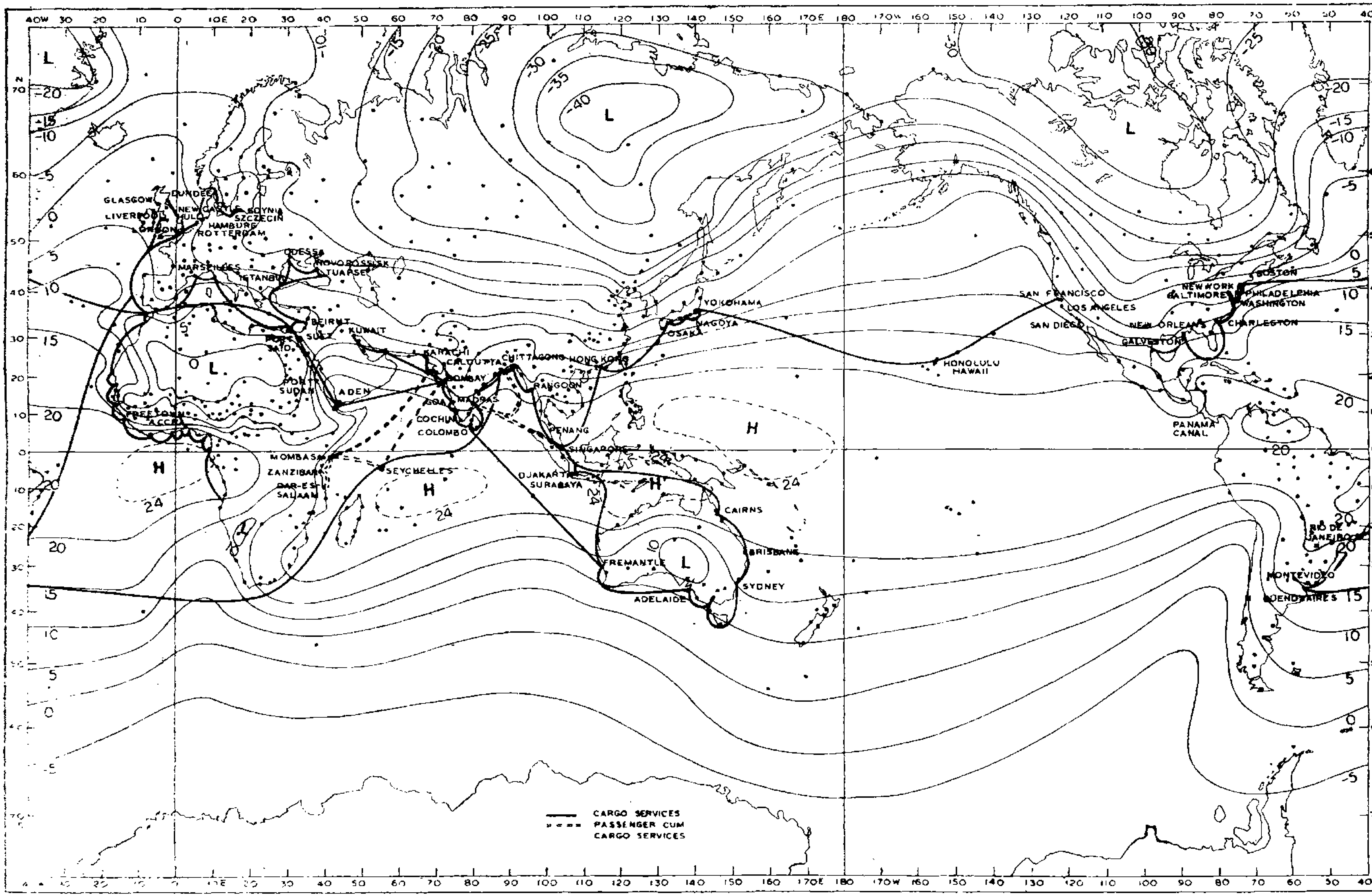

FIG. 1. The thin continuous lines are lines of equal dew point—the "isodews"—at sea-level. They have been drawn at intervals of 5° C. The broken thin lines are odd isopleths of 24° C. The shaded circles show the observatories on the basis of whose long-term mean data, the mean isodews have been drawn. Stations whose altitudes were *more than 800 geopotential metres* above sea-level have been *omitted* so that the maps may be truly representative of near-sea-level conditions. For analysis over North Atlantic and North Pacific Oceans, refer to text. (*Contd. under Fig. 2.*)

Impact on Nation's Economy

Table I* gives an idea of the annual export of certain principal commodities from India which are liable to sweat-damage. Table II* gives similar information in respect of annual imports of principal commodities into India. The values of the commodities in lakhs of rupees may be particularly noted. These will give an idea of the possible losses if the cargo is damaged by sweat due to unscientific management of ventilation.

Table I

Exports† from India during 1968–69

Serial No.	Commodity	Value in lakh Rs.	Percentage to total exports
1	Jute and jute manufactures	21,694	16·0
2	Solvent extracted groundnut oil cake	4,947	3·7
3	Leather, all kinds ..	7,199	5·3
4	Tobacco and tobacco manufactures	3,316	2·5
5	Spices ..	1,541	1·1
6	Cotton (raw) ..	1,574	1·2
7	Hides and skins ..	532	0·4
	Total ..	40,803	30·2

Table II

Imports† into India during 1968–69

Serial No.	Commodity	Value in lakh Rs.	Percentage to total imports
1	Food grains:		
	Wheat ..	25,949	
	Rice ..	5,747	
	Other cereals ..	1,501	
		33,197	17·8
2	Chemicals:		
	Fertilisers ..	15,019	
	Others ..	22 407	
		37,426	20·1
3	Cotton ..	9,018	4·8
4	Fruits and vegetables ..	10,952	5·9
	Total ..	90,593	48·6

* These figures have been extracted from the *Merchant Marine Directory Supplement* 1970 published under the authority of Director-General of Shipping, Government of India, by the Central Committee for National Maritime Day Celebrations, Bombay.

† The lists of commodities vulnerable to sweat-hazard, given above, are by no means exhaustive.

Isodews Over the World

The dew point temperatures along a ship's route do not vary at random. They follow, *in the mean*, a definite pattern, changing gradually with the change in the months of the year.

Figures 1 and 2 show the *mean* dew point temperature maps for the world at sea-level prepared on the basis of recent data for a large number of years (*e.g.*, from WMO, 1962). For the North Atlantic and North Pacific Oceans, isopleths of dew points based on ships' logs, "ocean stations" and selected coastal stations as published by U.S. Weather Bureau and Navy Hydrographic Office (1961, Navair, 1966) were taken into account. As far as the author is aware, previous *global* dew point maps of this kind were published by Sir Napier Shaw more than three decades ago (Shaw, 1936) but they were based on far scantier data than the present maps.

Over the isopleths of dew points which we shall refer to as ISODEWS, we have superposed a map showing the routes along which Indian ships were plying in 1967 (Central Committee for National Maritime Day Celebrations, Bombay, 1967).

Although the isodews are based on monthly mean values, they strikingly bring out the large range of dew points, through which an Indian ship has to pass during some of its voyages. For instance, a ship proceeding from Colombo to Fremantle and Adelaide during the South-west monsoon month of July passes from a region of 25° C. to a region of about 5° C., in the mean, in dew point. Likewise, a ship proceeding from Bombay to Buenos Aires *via* Seychelles and round the Cape of Good Hope especially in the month of January will pass through steep dew point gradients at several stages after passing the Mozambique Channel. It is along such routes that great care will have to be exercised in ventilation management.

Similar mean world maps for the transition months of April and October have also been prepared but they are not reproduced here. However, Table III which gives the monthly mean dew points at selected stations will give an idea of the mean dew point variations in the transition months.

*It is important to remember that the above-*mentioned maps represent the mean conditions

INDIAN SHIPPING ROUTES AND
MEAN DEWPOINT (°C) OF AIR AT SEA-LEVEL, JULY

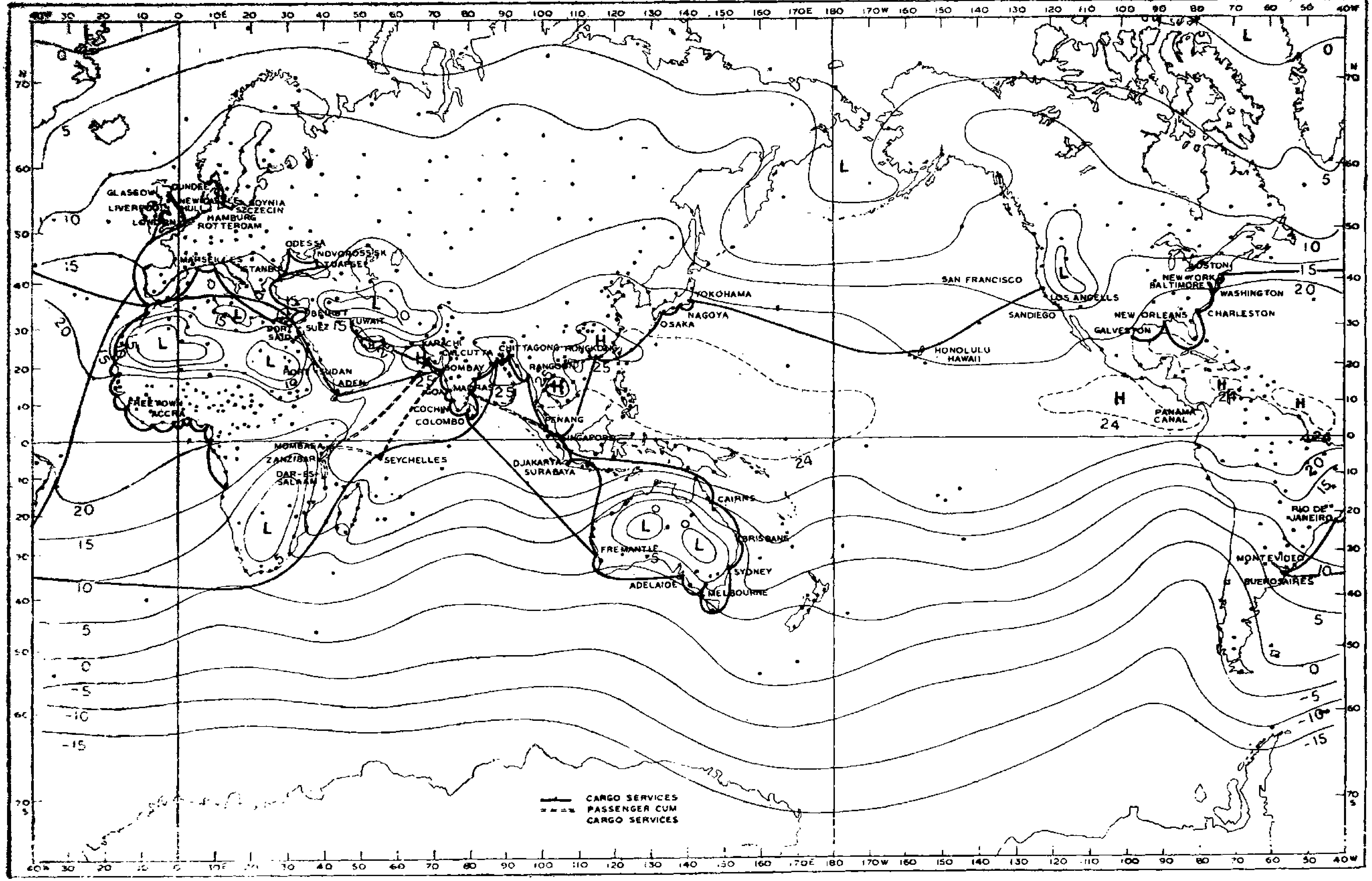

FIG. 2. The thick lines are the Indian shipping routes as in March 1967. There are now additional routes extending to Great Lakes in U.S.A. and to Mauritius. Note that the gradients of the isodews in the southern hemisphere are steeper than those in the northern hemisphere over the vast oceans equatorward of 60° N and 60° S. Areas where the gradients of the isodews are steep are those where special watch should be kept over the dew point temperatures if the cargoes are ventilated by open ventilation techniques.

TABLE III

Monthly mean dew point temperatures

S. No.	Name of station	Country	Monthly mean dew point in °C. January	April	July	October
1	Bombay ..	India	18	22	25	24
2	Colombo ..	Ceylon	21	24	24	23
3	Honkong ..	Honkong	11	19	25	19
4	Tokyo ..	Japan	− 4	7	21	13
5	Hawaii ..	U.S.A.	17	18	19	19
6	San Francisco ..	U.S.A.	6	8	11	10
7	London ..	U.K.	2	5	13	8
8	Accra ..	Ghana	23	24	22	23
9	New York City ..	U.S.A.	− 4	4	17	9
10	Montevideo ..	Uruguay	16	13	7	10
11	Cape Town (D. F. Malan)	Republic of South Africa	14	12	9	10
12	Mahe (Seychelles)	Seychelles	23	24	21	23
13	Perth (Fremantle) ..	Australia	13	11	8	9
14	Adelaide ..	Australia	10	9	6	7

in the respective months. Although they will be useful in long-term planning of ventilation-management for new shipping routes, the actual dew point temperatures, on individual occasions, may differ appreciably from the mean values. For example, on certain occasions, especially in middle latitudes, there could be sudden outbreaks of cold air from polar regions in either of the hemispheres. Cargoes on the 'tween decks (Thomas, 1961, WMO, 1957, 1968) would be affected by such invasions of cold air. Foreknowledge of this event will help the Indian shipping officers to plan for ventilation measures before the actual encounter with the chilling condition.

CONCLUSION

The general principles and procedures explained above and the mean isodew maps for the world will give the Indian shipping interests an idea of the importance of the dew point as a parameter over which the ships officers will have to keep watch during their long voyages around the world. By so doing, they might be making a significant contribution to the betterment of our national economy.

ACKNOWLEDGEMENTS

The mean isodew maps for the world were prepared with the financial support of the Council of Scientific and Industrial Research, New Delhi, as part of a Research Scheme. The author's warm and sincere thanks are due to Mr. S. N. Banerji, Senior Chartering Officer, Ministry of Transport, Government of India, for making available relevant literature about stowage of cargoes and for providing information about the Indian shipping routes. Mr. P. S. Harihara Iyer, Meteorologist, New Delhi, went through the manuscript of this article and offered his comments for which the author is grateful. The author is also indebted to Dr. P. Koteswaram, Director-General of Observatories, for providing facilities for this investigation.

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