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THE TRADE WIND INVERSION ACCORDING TO OBSERVATIONS OF THE FINNISH ATLANTIC EXPEDITIONS 1957—1958

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Abstract

On the basis of the observations of the Finnish Atlantic expeditions during the IGY 1957—1958 the trade wind inversion is studied statistically. The first voyage was made in northern hemispheric autumn (14. 8 — 1. 11), the second in midwinter (11. 12 — 15. 2), the third in spring (20. 3 — 7. 6) and the fourth in late summer (10. 7 — 12. 9). For this reason the observations of different voyages are supposed to be characteristic of these seasons and variations of computed parameters are supposed to be seasonal. The route of the voyages ran north of the Equator near the western coast of Europe and Africa and south of the Equator close to the coast of South America. The observations north and south of the Equator hence should characterize these particular regions of the Atlantic Ocean.

1. *Inversions*

Real inversions in the trade wind zone and partly in the west wind zone are interpreted as trade wind inversions. Small stable layers are not taken into consideration.

On the outbound part of the first voyage the northernmost continuous inversion occurred between 45—14°N, the second between 10—2.5°N and the third between 2—26°S. On the homebound part of this voyage inversions appeared between 28—16°N, 4.5—21°S and 27—35°S. During

the outbound part of the second voyage the first inversion was observed 20—8°N, the second 5—17°S the third partly above the second between 10—21°S and the fourth between 28—33°S. This fourth inversion reached the sea level between 28—30°S. On the homebound part of this voyage the soundings indicated continuous inversions between 30—10°N and 23—35°S. In addition to these several short inversions were detectable south of the Equator. On the outbound part of the third voyage four inversions were observed. Two of these were in the northern hemisphere between 45—36°N and 30—11°N and two in the southern hemisphere between 15—19°S and 24—31°S. On the homebound part of this voyage one continuous inversion occurred north of the Equator between 33—09°N. South of the Equator the observations revealed one double inversion between 4—17°S and another double inversion between 24—31°S. On the outbound part of the fourth and last voyage inversion appeared between 38—18°N, 3—12°S and 28—34°S. On the homebound part of this voyage there was one continuous inversion between 33—15°N which descended to the sea level between 24—20°N. South of the Equator the trade-inversion was split into several shorter portions.

2. *Computations and results*

From the material collected the following parameters for these four voyages were computed; mean height of the inversion base, mean thickness and mean intensity of the inversion, mean relative humidity under and in the inversion, scatterings in intensity and height of the inversion base and the linear correlation between intensity and height of the base of the inversion (Table I). The table presents arithmetic means of observed values obtained from individual soundings. Voyages were made in four different seasons (*c.f.* the abstract). For this reason observations are supposed to be characteristic of the northern hemispheric autumn, middle winter, early spring and summer. According to this assumption variations of calculated parameters in Table I are considered mainly seasonal. The trade wind inversion seems on the average to be lower, thicker and more intensive during the northern hemispheric spring (voyage III) than during the other northern seasons.

Scatterings (δ_x and δ_y in Table I) regarding the height and intensity of the inversion are, however, large indicating that this seasonal variation is not too pronounced. The air beneath the inversion is a little more humid and in the inversion somewhat less humid in that time than during the

TABLE I

Voy-age	Time	$\overline{A}(m)$	$\overline{P}(m)$	$\overline{\Delta T}$(°C)	$\overline{Q_u}$(%)	$\overline{Q_i}$(%)	δ_x	δ_y	r_{xy}
I	14.8 —1.11	1235	357	3.7	78.7	64.2	2.72	660.6	—0.44
II	11.12—15.2	1488	385	3.2	80.0	63.5	2.17	662.8	—0.01
III	20.3 — 7.6	907	498	4.8	81.6	58.6	2.17	657.4	—0.41
IV	10.7 —12.9	1266	396	4.5	80.7	61.6	2.47	547.5	—0.56

$\overline{A}$ = mean height of the inversion base (arithmetic mean)
$\overline{P}$ = mean thickness of the inversion (aritmetic mean)
$\overline{\Delta T}$ = mean intensity of the inversion (mean increase of temperature)
$\overline{Q_u}$ = mean relative humidity under the inversion
$\overline{Q_i}$ = mean relative humidity in the inversion
δ_x = standard deviation of ΔT
δ_y = standard deviation of A
r_{xy} = linear correlation coefficient between A and ΔT

other seasons. Variations in humidities are small as a whole, but the mean relative humidity under the inversion is increasing systematically from northern hemispheric autumn to northern hemispheric spring and then decreasing again, while in the same time the relative humidity inside the inversion is changing in opposite sense. The linear correlation between the height of base and intensity of the inversion is negative on every voyage, which means that intense inversions have a tendency to occur at a low altitude. This correlation is, however, quite poor, in agreement with the observations of VUORELA [2]. In particular the voyage II did not show any correlation at all between the intensity and the height of the inversion base.

The route of the voyages ran in the eastern part of the Atlantic Ocean north of the Equator and in the western part of the Atlantic Ocean south of the Equator. For this reason observations north of the Equator are supposed to characterize the eastern part and observations south of the Equator the western part of the Atlantic Ocean (Table II). In this table the properties of the trade inversion have been treated separately for both hemispheres. The table contains same parametres as the Table I except standard deviations and correlation coefficients. Parametres were computed for the eastern and western parts of the Atlantic Ocean using observations north and south of the Equator separately. According to these parametres the trade wind inversion seems to be lower, thicker

TABLE II

Voyage	Time	$\overline{A}_N(m)$	$\overline{A}_S(m)$	$\overline{P}_N(m)$	$\overline{P}_S(m)$	$\overline{\Delta T}_N(°C)$	$\overline{\Delta T}_S(°C)$	$\overline{Q}_{uN}(\%)$	$\overline{Q}_{uS}(\%)$	$\overline{Q}_{iN}(\%)$	$\overline{Q}_{iS}(\%)$
I	14. 8— 1.11	1275	1202	414	307	4.0	3.5	84.6	73.4	65.9	62.6
II	11.12—15. 2	1372	1718	393	368	4.0	1.5	82.2	75.7	64.1	62.2
III	20. 3— 7. 6	658	1485	577	314	5.4	3.3	85.0	73.8	59.8	55.6
IV	10. 7—12. 9	951	1726	441	253	5.2	2.2	82.1	76.0	62.7	54.3

$\overline{A}_N$ = mean height of the inversion base north of the Equator
$\overline{A}_S$ = mean height of the inversion base south of the Equator
$\overline{P}_N$ = mean thickness of the inversion north of the Equator
$\overline{P}_S$ = mean thickness of the inversion south of the Equator
$\overline{\Delta T}_N$ = mean intensity of the inversion north of the Equator
$\overline{\Delta T}_S$ = mean intensity of the inversion south of the Equator
$\overline{Q}_{uN}$ = mean relative humidity under the inversion north of the Equator
$\overline{Q}_{uS}$ = mean relative humidity under the inversion south of the Equator
$\overline{Q}_{iN}$ = mean relative humidity in the inversion north of the Equator
$\overline{Q}_{iS}$ = mean relative humidity in the inversion south of the Equator

and more intense in the eastern part than in the western part of the Atlantic in accordance with the information given in the reference [1]. The mean relative humidity is higher both inside the inversion and beneath it in the eastern than in the western part of the Atlantic. In the eastern part of the ocean the seasonal variation of the height of the inversion base is quite pronounced. In the northern hemispheric spring the height of the base is lowest (voyage III) and in the winter of the hemisphere it is highest (voyage II). In the western part of the ocean the seasonal variation of the height of the base is less pronounced. In the spring of the southern hemisphere the height of the base was anyhow distinctly lower than during other seasons, which is in agreement with earlier observations of the Finnish Atlantic Expedition in 1939 [3]. Due to the NE—SE direction of the ship route the observations of the eastern part of the Atlantic are made entirely at the side of the northern hemisphere and those of the western part of the ocean respectively at the side of the southern hemisphere. Hence the latitudinal difference between these oceanic regions is quite considerable.

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