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Vertical Structure of Currents and Temperature due to variable wind and air pressure

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Temperature and current measurements in 11 levels have been carried out by means of an observation mast during the period 10.8. - 29.8.1961 at the position $\varphi = 55^\circ\ 00,7'N$, $\lambda = 14^\circ\ 10,0E$ (Arcona-Basin). The bottom depth was 46 m.

Fig.1 shows mean conditions of Temperature (T), Salinity (S) and Density (σ_t) at the beginning of the records and the mean values of u (East)- and v (North)- component of currents during a two-day-interval. The current distribution looks very complicated. Due to the wind before this period which was mainly from SE, the v-component seems to indicate a drift current in the upper layer. In the cold Baltic Winter Water (20-30 m) the currents change from SW to NE and the same is true in the more haline bottom layer. The same current structure has been observed at 3 different positions in a triangle with a base of 10 nautical miles. The dotted line (v) in fig.1 indicates the expected v-component in the upper layer neglecting the drift current. Thus we get the generalized stratification of fig.2.

In fig.3 the upper parts show the wind and air pressure during the mentioned 20-day-period at Fehmarn (Western Baltic) and Sandvig (Bornholm). On August 12th, 1961 the wind changes in the Bornholm area from eastern directions to western ones and blows with about 3-5 Bft during the whole time. The air pressure changes slowly, with "periods" of only 3 days and more.

Furthermore fig.3 shows the current velocities (absolute value of the current) V in 7, 21, 27, 31 and 41 m depth and the directions R. The current responds in some depths immediately to the wind variation on August 12th,1961. In addition a system of oscillations is set up which shows strong inertial periods ($14,5^h$). The variations with depth are obvious.

In fig. 4 the temperature fluctuations are shown. If we assume that the horizontal temperature gradients are small it can be seen from this fig. that no pronounced vertical movements occur during the strong current fluctuations. This is in agreement with the theory. Inertial oscillations consist of horizontal movements of the water particles on inertial orbits.

In order to get an insight into the spectrum of the oscillations we carried out, power spectrum analysis of the u- and v-components of the current velocities. Filter techniques have been applied to eliminate periods less than 4^h and beyond 50^h. Thus the static respond to the long periodic forces is cut off.

Fig. 5 gives the results. The left (right) part shows the energy distribution of the u- (v)- components in the five levels for a period of 9 days.

The spectra show energy concentrations at the inertial period T_E ($14,5^h$) and in the range of the seiches. The resolution in the seiches range is only small. The mean value of the energy distribution of the five levels is shown in the upper-most part. The u-component (East-West) has maxima at T_E and in the range of the basic seiches (27^h and 39^h), which are represented by a broad plateau (due to the resolution). In the case of the v-component the 22^h-oscillation occurs also which is the second harmonic of the seiches system Western Baltic - Gulf of Bothnia. This oscillation is only little indicated in the u-energy. As may be seen from the power spectra of the given levels, the energy as a function of the periods varies with depth. Therefore the fluctuations seem to be mainly of an internal type. The energy in the range below T_E may be interpreted as higher harmonic of the seiches of the Baltic. These waves have been observed in nearly all our records.

Measurements of the type shown in fig.3 have been carried out during the same time at 3 positions in the same area. The analysis of the records has not yet been finished.

Fig.1: Mean temperature, salinity, density and current distribution at position
$\varphi = 55^{\circ}$ 00,7'N, $\lambda = 14^{\circ}$ 10'OE (10.-11.8.1961)

Fig.2: Generalized current distribution at the position

Fig.3: Actual currents at the position (velocity V and direction R) in 7, 21, 27, 31 and 41 m depth

Fig.4: Temperature fluctuations at the position

Fig.5: Power spectra of the records shown in fig. 3

(All figures are generalized in this paper)

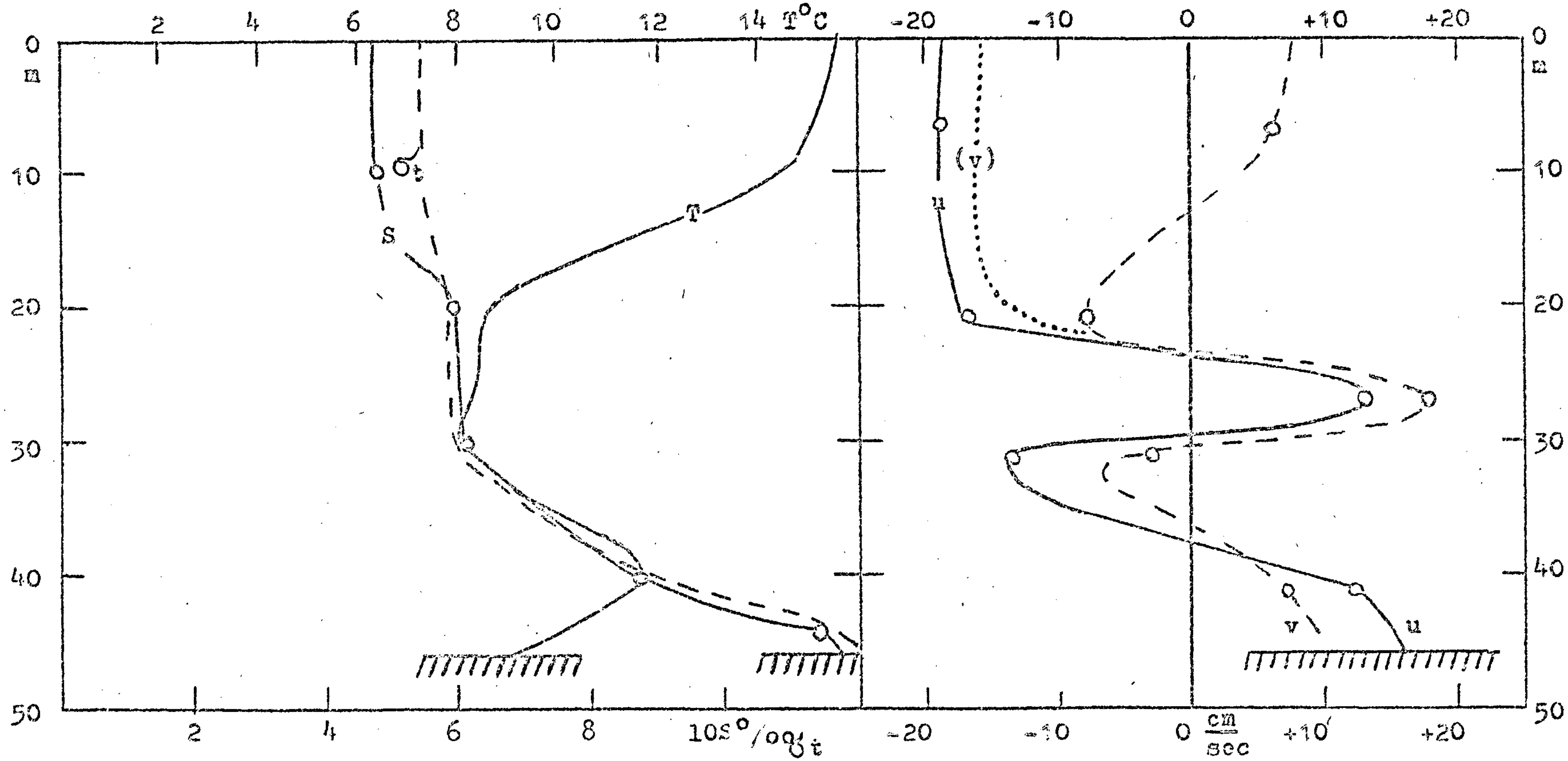
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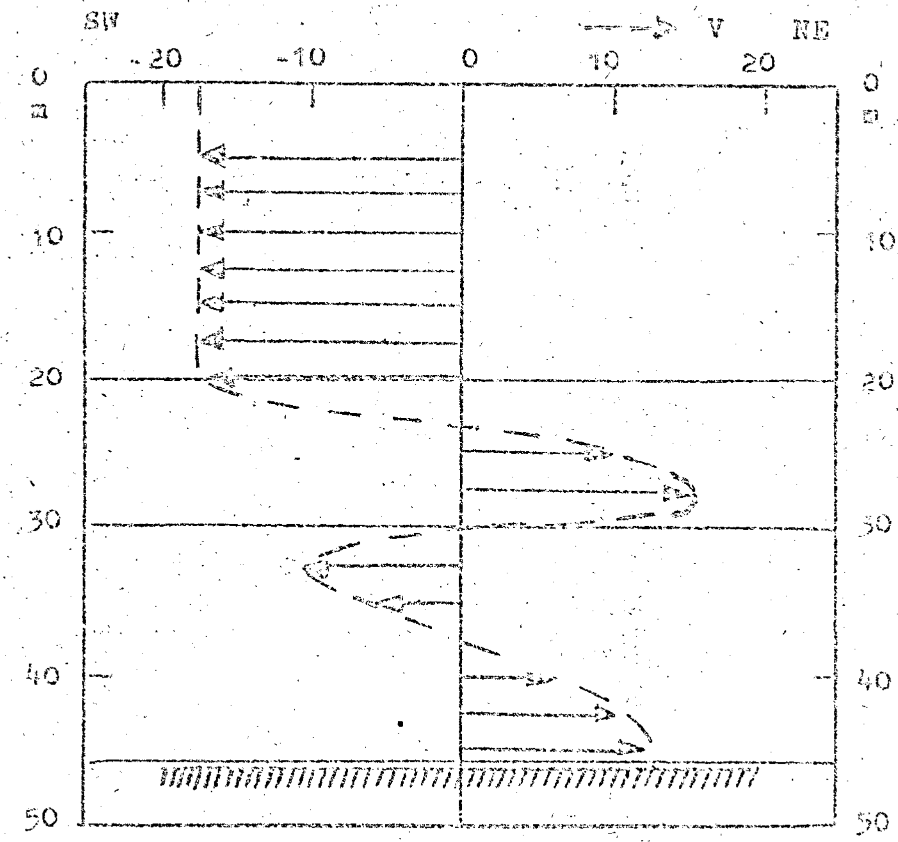
Fig. 1

Fig.2



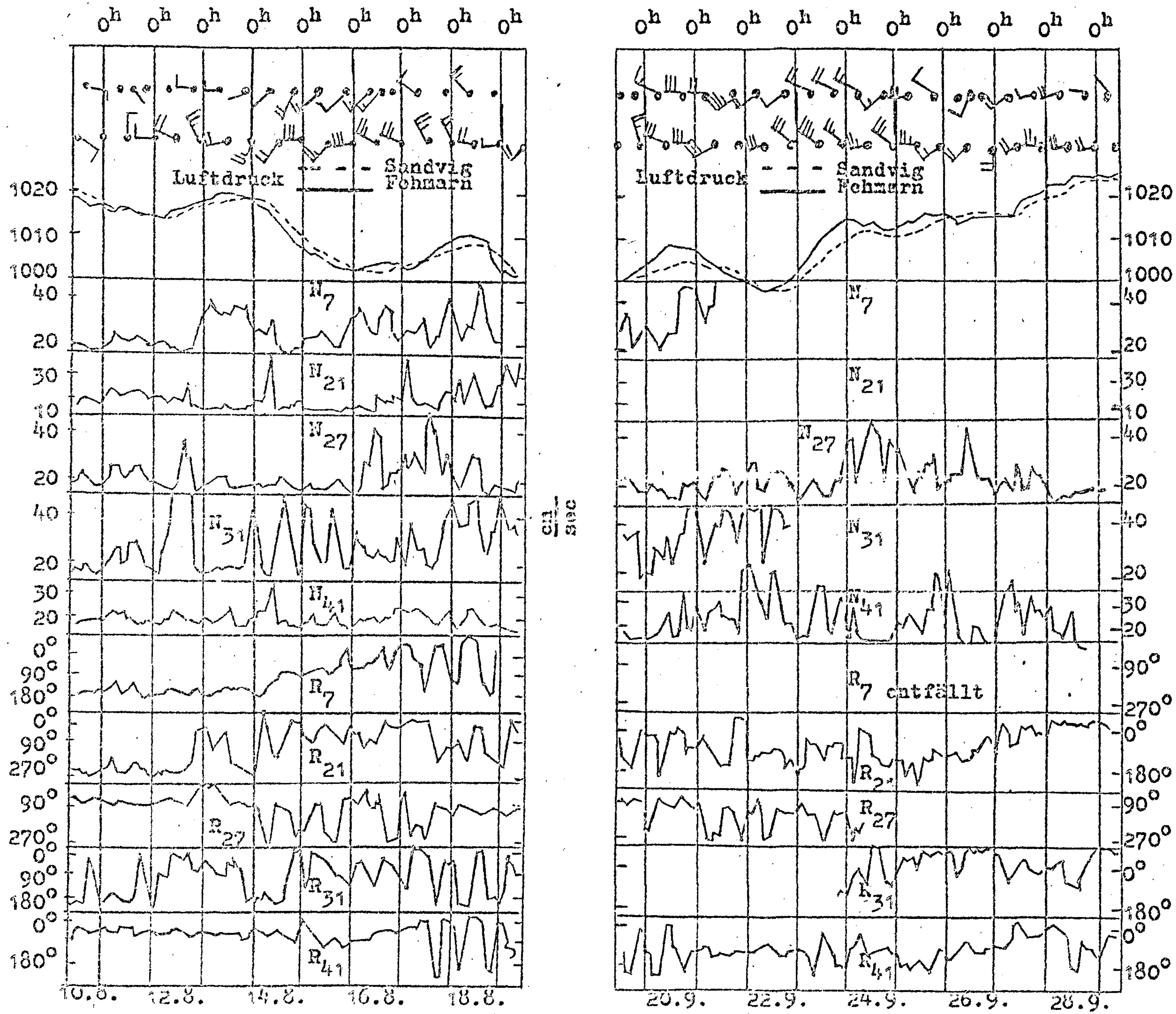

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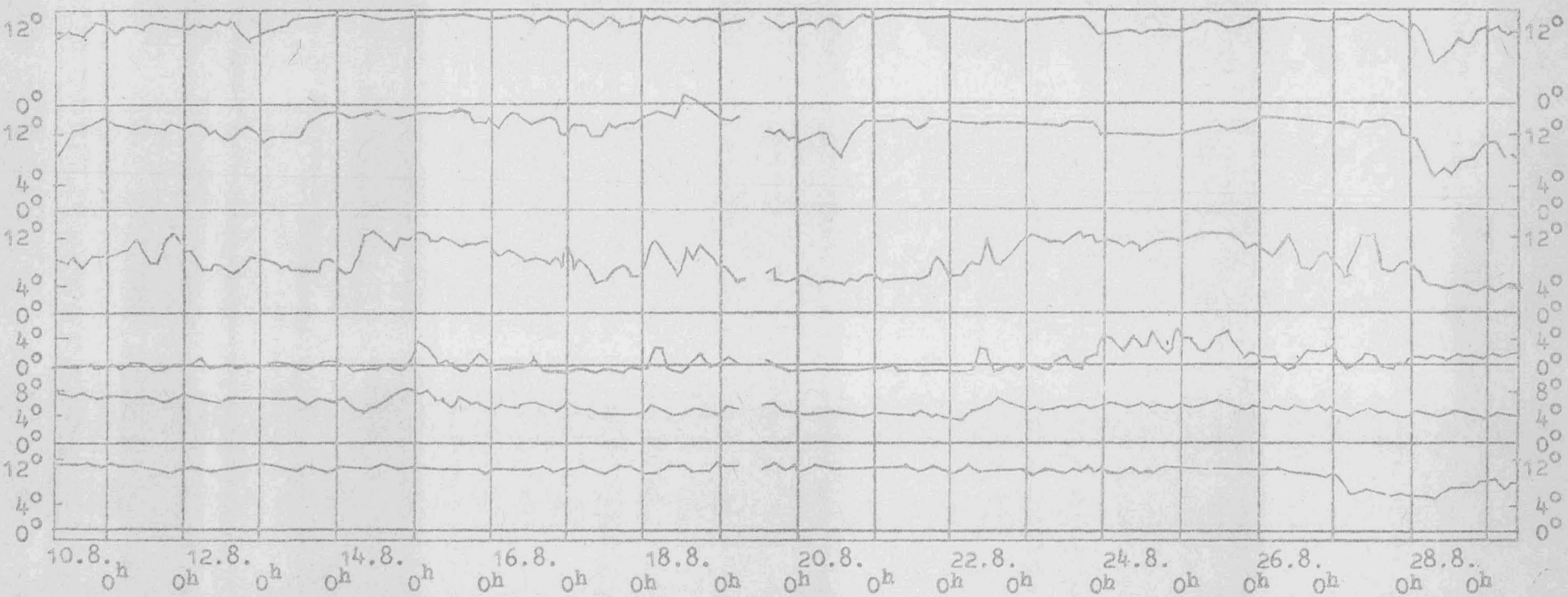
Fig. 5

Fig. 4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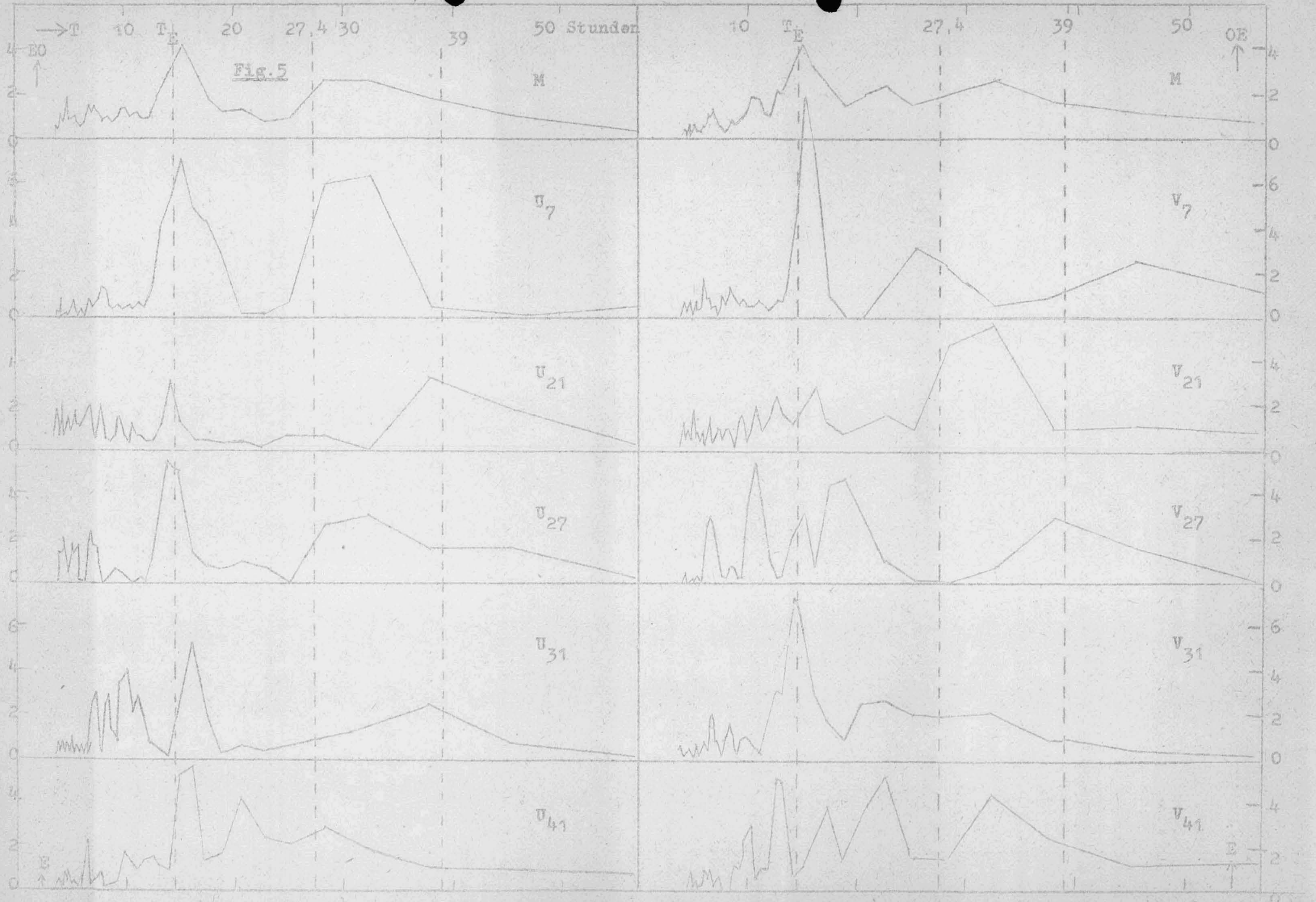

→T 10 T_E 20 27,4 30 39 50 Stunden
10 T_E 27,4 39 50
EO
OE
Fig.5
M
U_7
U_21
U_27
U_31
U_41
V_7
V_21
V_27
V_31
V_41
E