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International Ozone Sonde Intercomparsion at the Observatory Hohenpeißenberg 19. January – 5. February 1970

von
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Abstract

Six different wet chemical ozone sondes were compared based on the results of 41 tandem flights under field conditions. The analyses of these sounding data show that the four ozone sondes, which are presently used in routine sounding program, produce only minor systematic differences against each other, if a single factor adjustment to the total amount is used. The other instruments, being still in the experimental stage, are somewhat less stable.

Zusammenfassung

Sechs verschiedene Ozonsonden des naß-chemischen Typs wurden in 41 Tandem-Ballonaufstiegen unter normalen Aufstiegsbedingungen verglichen. Die Analyse der Aufstiegsdaten zeigt, daß die vier zur Zeit im regelmäßigen Aufstiegsbetrieb eingesetzten Ozonsonden nur sehr geringe Abweichungen untereinaner aufweisen, wenn mit einem für den Einzelaufstieg konstanten Korrekturfaktor an den Gesamtozongehalt angeglichen wird. Die anderen zwei, noch im Entwicklungsstadium befindlichen Geräte sind etwas weniger stabil.

1. Introduction

During the last years the knowledge of the vertical distribution of atmospheric ozone has become of increasing importance for meteorological studies of the behaviour of the free atmosphere. Large scale studies and the tests of satellite ozone instrumentation need ozone data from all over the world. These data are obtained with different types of ozone sondes, thus an intercomparison of the different instruments under field conditions was urgently needed.

A relatively large number of intercomparisons between different methods and instruments for measuring vertical ozone distribution has already been carried out during the past 12 years. Publications giving results of such earlier experiments are compiled in (1) — (3), this list may not be complete. While in most of those cases chemical and optical instruments were involved several times together with indirect methods, the present experiment intercompared only wet chemical sondes which are now mostly used in sounding routines.

The intercomparison was performed from January 19 to February 5, 1970 at the Meteorological Observatory Hohenpeissenberg (47,8° N, 11,0° E) of the Meteorological Service of the Federal Republic of Germany. It was supported financally by the World Meteorological Organization and by the International Association of Meteorology and Atmospheric Physics through the International Ozone Commission.

In spite of the possibility of adverse weather conditions this period had been chosen in order to obtain developed structures of the vertical ozone profile.

2. The Instruments

2.1. Brewer-Mast Ozone Sonde (Photo 1)

1960 BREWER and MILFORD (4) described an electrochemical ozone detector using the well-known oxidation of KI by O_3 as basic reaction. 1961 GRIGGS (5) investigated the physical and chemical aspects in detail; these sondes are manufactured by the Mast Development Company, Davenport, Iowa, USA.

Photo 1 illustrates the Brewer-Mast ozone sonde, model 730—5, used during the intercomparison. The sonde is built into a cylindrical polystyrene case being 40 cm long and 23 cm in diameter, weighing 1000 gr including batteries. It is flown in connection with the normal American radiosonde (weight 1100 gr).

In operation a miniature pump forces ambient air continuously into the ozone detector, the so-called bubbler, comprising a platinum screen cathode and a silver wire anode immersed in a buffered potassium

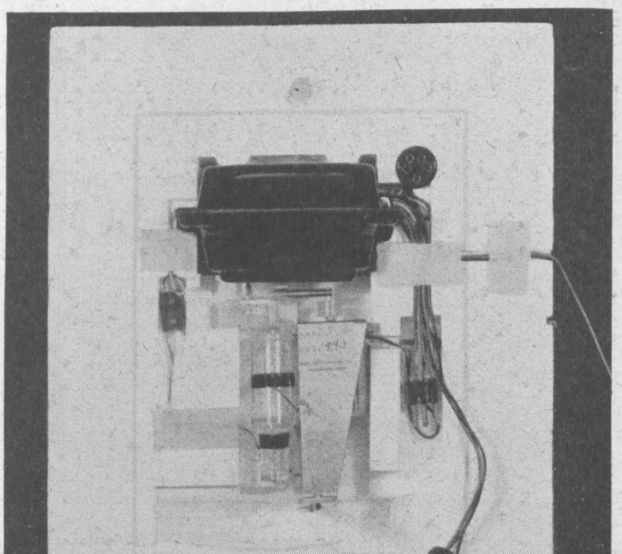

Photo 1:
Brewer-Mast Ozone Sonde Model 730-5

iodide solution. A polarizing potential of 0.42 V is applied to the electrodes. As the air, containing ozone, bubbles through the electrolyte, oxydation forms free iodine by:

$$O_3 + 2\,J^- + H_2O \rightarrow O_2 + 2\,OH^- + J_2 \qquad [1].$$

The iodine contacts the platinum cathode through diffusion and the sensor's bubbling action and receives there 2 electrons per molecule by:

$$J_2 + 2\,e \rightarrow 2\,J^- \qquad [2].$$

The corresponding process at the anode

$$2\,Ag \rightarrow 2\,Ag^+ + 2\,e \qquad [3]$$

forms iodine but it is prevented from entering the solution through the formation of practically insoluble silver iodide. In principle, each ozone molecule entering the sensor causes a flux of 2 electrons through the external circuit. The resulting current modulates the frequency of a blocking oscillator. For data telemetry, an electronic switch (flip flop) periodically shuts the blocking oscillator of the radiosonde and connects the blocking oscillator of the Brewer-Mast sonde to the transmitter of the radiosonde. In our case the operating period of the flip flop was 8 sec. : 4 sec. for ozone data, and 4 sec. for meteorological information.

After the official intercomparison period the Mast sonde model 730−5 was also compared with an other Brewer-Mast ozone sonde model 730−7T, see photo 2. The latter model has a different data telemetry system.

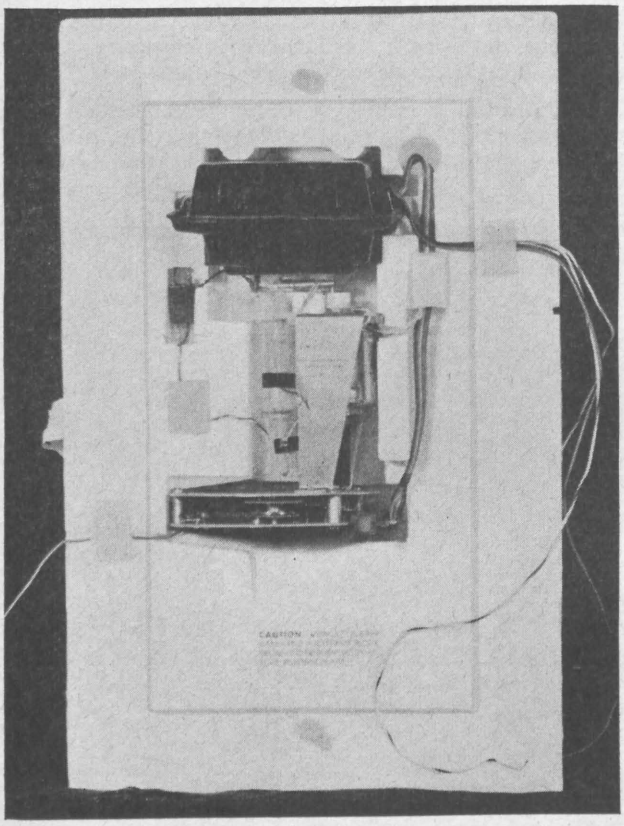

Photo 2:
Brewer-Mast Ozone Sonde Model 730-7T

Its signal processor is connected to the normal radiosonde by means of a mechanical commutator. The telemetered data include ozone zero frequency and pump temperature signals transmitted at 5 minutes intervals. Operating period of this switch was 10 sec. : 3 sec. ozone data, 7 sec. normal radiosonde data.

2.2. Komhyr Electrochemical Concentration Cell (ECC) Ozone Sonde (Photo 3)

This sonde is a further development of KOMHYR's carbon-iodine ozone sonde (6). The ECC sonde is manufactured by Science Pump Corporation of Candem, New Jersey, USA. It is built into a polystyrene case of the size 16 x 16 x 22 cm, weighing 600 gr with batteries. It is flown in connection with the normal American radiosonde (weight 1100 gr).

The sensor used in this sonde is an electrochemical concentration cell (7) employing iodine/iodide redox electrodes made of two bright platinum electrodes immersed in buffered potassium iodide solution contained in

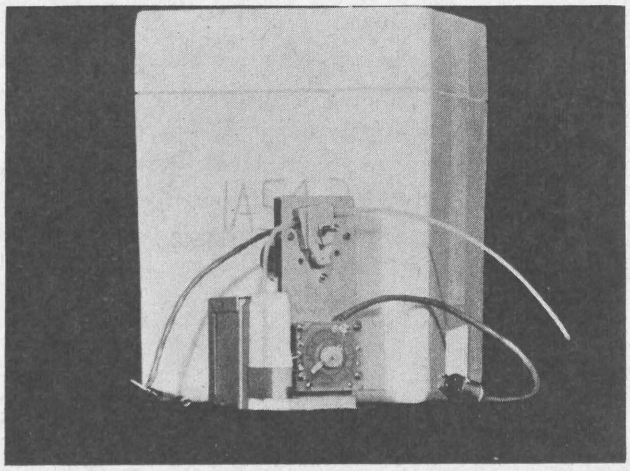

Photo 3:
Komhyr Electrochemical Concentration Cell Ozone Sonde

separate cathode and anode chambers, fabricated from Teflon. The chambers are electrically linked by an ion brigde, consisting of lighty packed cotton fibres which prevents mixing of the anode and cathode electrolytes, thereby preserving their concentration. Activated charcoal added to the electrolyte in the anode chamber absorbs iodine from the solution, causing an internal cell emf to be generated due to the presence of different concentrations of iodine in the cathode and anode chamber electrolytes, thus this sensor functions without an externally applied polarizing voltage.

In operation ambient air is forced by means of a nonreactive teflon gas sampling pump (8) through the potassium iodide solution contained in the cathode chamber. The ozone molecules in the air react as shown in formula [1] with the solution, producing iodine. The iodine reaches the platinum cathode by diffusion and mixing and is reconverted to iodide by excepting electrons from it. Simultaneously electrons are released at the anode by the desolved iodide. The iodine formed is absorbed by the activated charcoal. An electric current proportional to the rate of conversion of iodine to iodide, and therefore to the rate at which ozone enters the sensor, flows through the cell's external circuit.

This current is impressed upon an electronic coupler whose resistance of which varies proportional to the current. Ozone data are telemetered for 4 sec. out of every 20 sec. when a mechanical commutator substitutes the coupler for meteorological information of the radiosonde. The telemetering system is calibrated in flight by transmitting at 2 minutes intervals the ozone zero and ozone calibrate signals, each of 4 sec. duration. In addition, an ozone sonde box temperature measurement is given for 2 sec. once every 2 minutes.

2.3. KC-68 Carbon-Iodine Ozone Sonde (Photo 4)

This ozone sonde, being developed 1966 by KOBAYASHI and TOYAMA (9) is a modified version of KOMHYR's initial sensor (6). It is manufactured by the Meisei Denki Co. Ltd., Chuo-Ku, Tokyo, Japan. The sonde is built into a polystyrene box, 22 cm long, 16 cm wide, 38 cm high, weighing 2000 gr with batteries, air pressure and temperature sensors and a transmitter.

The ambient air is pumped through the buffered potassium iodide solution in the reaction cell which consists of a main cell with a platinum gauze electrode and a side cell with an active carbon electrode. The ozone

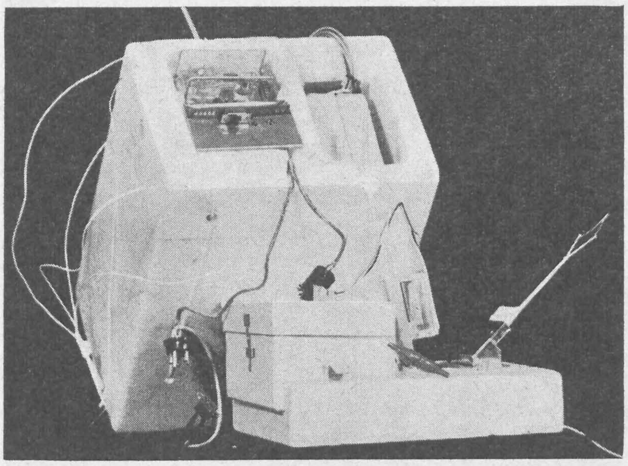

Photo 4:
KC-68 Carbon-Iodine Ozone Sonde

reacts with the solution as shown in formula [1] and liberates free iodine which contacts the platinum screen in the main cell, and is reconverted to iodide by receiving 2 electrons from it according to formula [2].

Simultaneously the following reaction takes place at the active carbon electrode of the side cell:

$$C + 2\,OH^- \longrightarrow CO + H_2O + 2\,e \qquad [4]$$

CO is likely to be absorbed by the carbon.

Accordingly, one ozone molecule "pumps" two electrons through a load resistor of 1 kΩ between the two electrodes. The reaction current controls through an electronic system the blocking oscillator of the transmitter. In addition this ozone sonde has thermistors for atmospheric and for reaction cell temperatures and a baroswitch for measuring air pressure. Through a switching circuit ozone data (for 20 sec.) and air temperature data (for 10 sec.) are telemetered alternately. The standard input signal and the zero signal are transmitted for 10 sec. once every 5 minutes in order to obtain information about the drift of the telemetering system.

At each of the 17 contacts of the baroswitch a reference resistor and the reaction thermistor are successively inserted into the base circuit of the blocking oscillator for 10 sec. each.

2.4. Brewer Ozone Sonde, Type India (Photo 5)

This sonde consists of a Brewer type bubbler sensor, it is built in the laboratories of the Indian Meteorological Office. The instrument having its own transmitter and sensors for air pressure, temperature and humidity is contained in a polystyrene box 33 cm long, 24 cm wide, 25 cm high. Its weight is 2400 gr including batteries, meteorological sensors and transmitter.

The newly developed sampling pump uses a hypodermic glass syringe for piston and cylinder and teflon for the value assemblies and the inlet and outlet tubes. The basic operating principle is the same as in the miniature

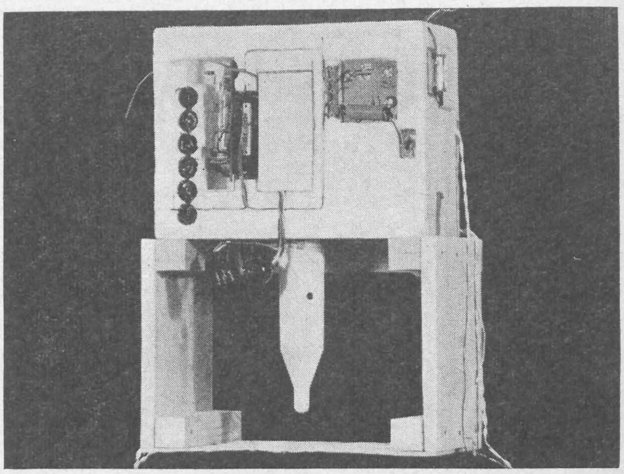

Photo 5:
Brewer Ozone Sonde Type India

pump mostly used at present in ozone sonde; however, since the volume of air pumped per stroke is about 2 cc, the pump executes only about 100 strokes per minute compared to 2500 to 5000 strokes of the miniature pumps. Therefore a big capacitor is needed for smoothing the electric signal.

The sensor current is amplified by a differential amplifier and converted into signals for modulating the carrier frequency of the transmitter. A mechanical commutator switches the data in the following order: Ozone — air temperature — ozone — atmospheric humidity — ozone — air temperature — ozone — inside temperature. One cycle takes about 30 to 35 sec. for transmitting signals of each element for about 4 sec.

A second commutator geared down by 4:1 with respect to the first one monitors the modulator reference frequency bypassing during 6 sec. all other elements for each rotation of the commutator. The 12 contacts of the baroswitch shunt the hygristor through a 15 kΩ resistor, thus if a pressure contact occurs during a humidity transmission a high references frequency (80 to 85 Hz) will result.

2.5. Brewer Ozone Sonde, Type Italy (Photo 6)

This ozone sonde, used by the Italian Weather Service, has a Brewer type electrochemical cell as ozone sensor. It is built in the laboratory of the Experimental Scientific Observatory of Aeronautical Meteorology, Cagliari, Italy. The instrument is housed in a cylindrical container, 41 cm high and about 25 cm in diameter. The weight, including batteries, is 1500 gr. It is flown in combination with an American type radiosonde.

Ambient air is aspirated through a bent-down glass tube, protruding about 7 cm outside the box, by a plexiglass oscillating cylindrical alternating micropump, with a stainless steel piston driven by a motor stabilized at 2.000 r.p.m. Rotating speed remains constant for about 3 hours of continuous operation since power variations of the batteries are compensated by the self-regulating speed system. The micropump is lubricated by a very thin coat of silicon oil.

The air bubbles into the electrolyte through another glass tube. Glass and plexiglass were prefered to other plastic materials because they appeared in laboratory tests better suited to keep O_3 decomposition and iodine

3.2. Composition of the Working Teams

Brewer-Mast Ozone Sonde:

Chief:	Dipl.-Met. R. HARTMANNSGRUBER	Met. Observatorium Hohenpeissenberg, FRG
Operators:	H. HEYER U. SCHALL	

Electrochemical Concentration Cell Ozone Sonde:

Chief:	R. D. GRASS	ESSA Research Lab., Boulder, USA

KC-68 Ozone Sonde:

Chief:	Y. SEKIGUCHI	Aerol. Section, Jap. Met. Agency, Tokyo, Japan
Assistant:	T. SHIBATA	Meisei Denki K. K., Moriya Kojo, Japan

Brewer Ozone Sonde, Type India:

Chief:	C. R. SREEDHARAN	Met. Office, Poona, India
Partly assisted by:	J. RAEBER	ETH Zürich, Switzerland

Brewer Ozone Sonde, Type Italy:

Chief:	DR. N. MATTANA	Exper. Scient. Observatory Aeronaut. Met. Cagliari, Italy
Assistants:	P. PORRA A. ORZATI	

Brewer Ozone Sonde, Type GDR:

Chief:	DR. K. GRASSNICK	Met. Hauptobs. Potsdam, GDR
Assistant:	M. GÖRSDORF	Aerol. Obs. Lindenberg, GDR

Receiving Equipments:

Tower 1:	S. STEINER	Met. Obs. Hohenpeissenberg
Assistant:	A. STÖGBAUER	
Bergheim:	F. DAMM	Met. Obs. Hohenpeissenberg
Assistant:	H. SCHILCHER	

Repair Shop:

Chief:	Dipl.-Ing. J. RIEDL	Met. Obs. Hohenpeissenberg
Assistants:	R. SCHMIDT A. STÖGBAUER	

Launch:

Chief:	L. ERBERTSEDER	Met. Obs. Hohenpeissenberg
Assistants:	Staff members	

Management of the Intercomparison Flights:

Chief:	DR. W. ATTMANNSPACHER	Met. Obs. Hohenpeissenberg
Assistant:	Dipl.-Met. R. ANIOL	

3.3. Receiving Facilities and Launch Area

The transmitters of all ozone sondes being tested, were working between 1660 and 1700 Mc. One electronic theodolit of the American type GMD-Ib was located at the main tower of the observatory, 30 meters above ground (975 + 30 meters msl). The second electronic theodolit was installed at the "Bergheim" area (935 msl), 900 meters eastwards of the main tower.

The balloons of the type Totex 3000 were filled in a tent 200 meters east of the main tower. The balloons functioned remarkably well, they were launched on a snowy slope east and north of the tent.

The communication between the receiving facilities, the ozone laboratory and the tent was done by an interphone system and a telephone system.

Each balloon train was approximately 30–50 meters long, two parachutes, separated from each other 5–10 meters where suspended 5 meters below the balloon, followed 10–30 meters lower by the first and 10 meters further down by the second ozone sonde. The radiosonde carrier frequencies were offset by 20 Mc to avoid interference.

The ozone sondes were prepared by the teams named above in accordance to their instruction manuals. The final work was done in the ozone laboratory of the observatory. It was possible to check the sensors with an ozone generator of the Regener type.

Dobson spectrophotometer total ozone measurements were made, if possible, several times per day; spectrophotometer No 104 was used for this purpose. This instrument had been checked against the spectrophotometers No 15 and 101 of the Lichtklimatisches Observatorium Arosa in April 1968.

3.4. Test Program

It was planned to launch every six participating sondes daily in three tandem flights, however, due to adverse weather conditions and to technical problems it was not possible to stick to this schedule. Only on four days all six sondes could be launched, on the other 11 flight days one or several instruments were not included.

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The flight program demanded launches in poor weather conditions in order to remain within the prefixed period. During the first week abnormally good weather provided good smooth launches, but especially during the last week the operation was made difficult by strong gusty winds and snow showers. Launches were performed with windspeeds up to 14 m/sec. causing a nearly horizontal start of the sondes for one flight.

On January 22 after the first tandem flight the scanner of the GMD-Ib stopped turning. The failure could be repaired during the night and the launches were continued on morning of the 23d.

Very strong winds (maximum gusts of 43 m/sec.) interrupted the intercomparison flights on February 3.

The actual combination of flights on the different days is shown by table 1.

4. Analyses of Data

4.1. General

As already stated we had initially hoped to launch all six participating sondes daily in three tandem flights, but it was impossible in practice. Of course this makes the comparative evaluation of the data considerably more difficult.

Clearly there have been real changes in ozone distribution from one flight to the next on single days (see e. g. January 21 and 30), thus only tandem flights can give strict comparability of instruments. The uneven distribution of such tandems, however (see table 1), makes a statistical evaluation on this limited basis seem not very practical, so we decided to do the main comparison of sondes by taking differences against daily mean values. As there are 14 comparison days we may hope that the influences of short term ozone fluctuations and also of the uneven distribution of launches of the different types are largely eliminated when mean values over the whole period are taken.

Four of the participating sonde types have already been used in routine sounding programs; three of them (Brewer-Mast, Komhyr Concentration Cell and KC-68 carbon-iodide) are commercially produced while the fourth, the Italian version of the Brewer sonde, has so far been built in a laboratory of the Italian Meteorological Service. The Indian version of the Brewer sonde has already been used in a relatively large number of flights, but was altered just before the intercomparison (new pumping device and corresponding change in the electronics). The instrument built in the GDR was only flown once or twice before the intercomparison. The latter two instruments were thus still in the experimental stage, so it is not surprising that the data obtained with these types were somewhat less stable than the others (relatively high variability of most properties).

4.2. The Single Factor Adjustment

It is well known that the Brewer type electrochemical sondes (and also the Regener chemiluminescent instrument) normally do not yield the full total amount simultaneously measured with the Dobson spectrophotometer when the flight data are vertically integrated (taking into account the ozone amount above burst level). It has so far been the standard procedure to adjust the partial pressure measured by these instruments by multiplying all readings with the same single factor (10). A main object of this experiment has been to check the usefulness of such methods.

For this purpose it seemed adequate to compare mean values of partial pressure over layers of considerable thickness. The layers used in the Umkehr evaluation (pressure ratio 2:1 between bottom and top of the layer, i. e. layers of a geometrical thickness of about 4,5 km) were chosen. Instead of layer 7 (7.8 — 15.6 mb) the mean value between 9 and 11 mb was used in order to get a better data coverage. Table 2 a shows the daily mean values for these layers and table 2 b the deviations of the single instruments from these means.

From table 2 a and b and from figures 1 and 2 it is seen that the single factor adjustment brings the data into reasonably good agreement, i. e. there is not much systematic deviation between the results obtained with different types of instruments after applying this adjustment. In the stratosphere the deviation from the mean is less than 5% for each instrument, but in the troposphere the relative errors can be larger (up to 25%).

The Brewer-Mast sonde apparently tended to give too low readings in the troposphere, this effect being strongest on days with pronounced inversions above the station i. e. when the mountain top of Hohenpeissenberg was still in the dirty ground layer. Thus there is a certain indication that some poisoning of the instrument may have occured and might be responsible for the partial ozone distruction in the troposphere (some dirt may be retained by the pump lubricant and only be gradually neutralized by the high ozone flow through the instrument in the lower stratosphere). Great care in the final preparation is thus indicated: considerable ozonization just before launch and no unnecessary aspiration of polluted air. — The balancing positive deviations above 125 mb are only 3% or less.

The Indian instrument produced on the other hand relatively strong positive deviations from the mean in the troposphere (15—25%) and corresponding low readings in the stratosphere (up to 5%), the reasons for which are not really understood.

The deviations shown by the other instrument were not larger than 7%. While most instruments show a more or less regular pattern with height (fig. 2 a) the sonde type GDR was somewhat erratic in this respect.

4.3. Consistency of Each Type of Sonde

The single deviations of the sondes of each type from the respective daily mean (table 3) show a considerable scatter which partly reflects the influence of the ozone changes during the day (i. e. the meteorologically induced noise in the experiment), but which is also a result of variations in performance of a certain sonde type. With one exception (Brewer-Mast sonde in the upper troposphere) this scatter (represented by the standard deviation from the systematic difference) is considerably larger than the deviation itself, i. e. the observed discrepancies, between the different types of sondes (after the single factor adjustment) are not very significant. The sum of these standard deviations (last column in table 3) is of the same order for the Brewer-Mast, the KC-68, the Brewer type Italy and the ECC sonde, but considerably higher for the instruments from India and from the GDR (suggesting a somewhat reduced stability for the latter two, which happen to be the two types which are still in the development stage).

If the flights with these two instruments are not taken into account in this comparison, the negative deviations of the Brewer-Mast sonde below 125 mb are considerably reduced (more than 15% and they are almost completely due to 2 out of 10 flights) while the ECC sonde shows almost as big positive deviations in the three lowest layers as seen in figure 2 b and table 3.

4.4. Correction Factor

It has already been mentioned that the agreement between the different instruments is quite good after application of the single factor correction although the raw data may differ considerably (fig. 3); the mean correction factors are thus rather different for the various types of instruments (table 4). They are of the order of 1.2 for the Brewer type instruments operated with lubricated pumps (Brewer-Mast sonde, Brewer sonde type Italy, Brewer sonde type GDR); the Brewer sonde type India with the same kind of sensor but a non-lubricated glass pump gives a mean factor much closer to unity. For the two carbon-iodine type instruments (ECC and KC-68), however, the mean correction factor is almost 1.0.

If ozone soundings must be made without concurrent total ozone measurements (e. g. in high latitude winter) a relatively steady value of the correction factor is important; the most probable value need not necessarily be 1.0 although this is certainly useful. For the Brewer-Mast, the Brewer type Italy and the KC-68 sondes the standard deviation of the correction factor was between 0.05 and 0.06, for the Brewer type India instrument 0.07, for the ECC sonde 0.09, and for the Brewer type GDR instrument 0.22.

4.5. Sensitivity

No wet chemical ozone sonde (all participating instruments were of this type) can follow a change in ambient ozone concentration, thus some smearing of detail structure is produced. There is some difference in the relaxation time of the different types of instrument as is easily seen by comparing the single ascents. Clearly the Indian sonde shows less details than the others. This is due to its experimental type pump which was superior to those of the other Brewer type instruments with respect to avoiding ozone destruction in the intake (smaller correction factor) but which leads to a larger relaxation time because of the large capacity needed in parallel with the sensor for smoothing out the pulsations in air flow. The sensitivity differences between the other instrument types are somewhat less obvious.

For obtaining a quantitative measure of the instrumental sensitivity all decreases of partial pressure between 800 and 30 mb were summed up. Obviously this sum is a function of the ability of an instrument to show the actual details. This test must be applied with caution because fluctuations of the readings due to instrumental (mostly electronic) trouble will also tend to encrease the sum. There is no indication of such problems in this material. The sum to be used here as sensitivity index is however quite strongly dependent on the actual ozone distribution. For comparison purposes the differences of the single instruments against daily means have thus been taken (see table 5). The test indicates the Brewer-Mast and the ECC sonde to be the most sensitive of the participating instruments (positive deviation of 39 and 36 nb respectively from the mean sum of 217 nb). As already mentioned the Brewer sonde type India was least sensitive (negative deviation of 66 nb) while the other 3 instruments do not differ much from each other in this respect (−6, −9 and −16 nb respectively for the sonde types Brewer GDR, KC-68 and Brewer Italy). The scatter of these sensitivity numbers around the mean is least for the Brewer sonde type Italy (± 26 nb), the Brewer-Mast and the KC-68 instruments (both ±36 nb), while the Brewer sonde type India and the ECC sonde (both ± 56 nb) show a high standard deviation and the Brewer sonde type GDR (±44 nb) is intermediate.

4.6. Detailed Vertical Distribution

Comparison between figures 1 a respectively 1 b and figure 3 demonstrates the improvement in agreement between soundings obtained with different types of instruments which is reached by the single factor adjustment. To give optimum comparability the distributions shown in this section are not the simple means of all flights made with the particular instrument but were obtained by adding the mean deviation of that type at each standard level (see column 1 of table 6) to the average of the 14 daily mean vertical distributions. The deviations for the narrow layers between these standard levels are shown on an enlarged scale in figures 4 a and 4 b. Superimposed on the large scale features shown by figure 2 a and discussed in section 4.2. we find considerable variations from one layer to the next. These are produced by ozone changes from one tandem flight to the next on single days, by differences in sensitivity between the instruments and presumably also by the inaccuracies of the pressure sensors. With the pronounced sandwich structure encountered on some days, relatively small errors in pressure detection may yield considerable ozone differences at fixed levels. The deviations of single flights from the daily means at each standard level are shown by tables 6 a − f.

Comparison between these tables and tables 2 a and 2 b and between figures 4 a and 4 b and figures 1 a and 1 b show that the systematic differences between various types of sondes (considering data corrected by the single factor adjustment) are quite minor compared with the noise in the data.

4.7. Tandem Flights with Two Instruments of the Same Type

One tandem flight has been made with each of the four sonde types which may be called routine instruments (Brewer-Mast, ECC, KC-68 and Brewer type Italy). The agreement after single factor adjustment was quite good for the two Brewer type instruments: the sum of the differences in Umkehr layer means was 9.8 and 13.1 nb for the Brewer-Mast and the Brewer type Italy sonde respectiveley (although the correction factors differed considerably within the tandems); the differences in sensitivity measure was also relatively small (22 and 13 nb). For the ECC sonde and especially for the KC-68 instrument the corresponding sums were larger (21.5 and 37.1 nb) and the sensitivity measures of the two sondes in these tandems deviated by 114 and 50 nb from each other.

The stability of the different types of instruments cannot, however, be reliably compared with a sample of this size. Two tandem flights made in March after the intercomparison period with Brewer-Mast instruments (comparing, however, two types with different electronics, namely the model 730-5, currently used in the European network, and the model 730-7 T which measures also pump speed and also has a different sequence in data transmission) gave larger discrepancies in the layer mean differences and in the sensitivity measure (see table 7).

4.8. Possible Distortion of Vertical Distribution by Single Factor Adjustment and the Importance of Descent Readings

The intercomparison material comprises two cases which demonstrate clearly that an uncritical application of the single factor adjustment can produce strongly distorted vertical distributions.

On January 21, the Brewer-Mast sonde happened to aspirate car exhaust fumes when carried to the launching place. Zero or even negative readings resulted until a considerable amount of ozone had passed through the instrument in the lower stratosphere (fig. 5a); after this it recovered but the readings remained somewhat low throughout the sounding. As the single factor adjustment cannot restore the missed low level ozone it yields by compensation considerably too high concentrations around the level of the maximum (fig. 5 b).

On January 31, the GDR instrument increasingly lost sensitivity after entering the stratosphere, presumably due to partial pump failure. A single factor adjustment of the observed data (fig. 6a) thus yields a completely distorted vertical distribution (fig. 6b).

These two intercomparison cases deviate so obviously from the normal behaviour that the malfunctioning could be recognized without the data of the intercompared instrument and the ascent would be rejected. In less obvious cases erroneous distribution would result. It is therefore important in a normal sounding routine to obtain data on descent, as well as ascent. This would almost certainly indicate also smaller partial pump failures of the type shown in figure 6 or might permit use of the single factor adjustment in the other example either using descent data alone or correcting the more detailed ascent by comparison with the descent (see (11)). Unfortunately almost no descent data have been obtained during this intercomparison because rapid descents at great horizontal distances prevented reliable readings on the downward leg.

4.9. Some Remarks About Single Flight Days

Jan. 20, 1970: Obvious changes in ozone distribution from one flight to the next. Disappearence of tropospheric peak at 300 mb from morning to afternoon (the maximum given by the ECC sonde at 245 mb is shown by none of the other instrument). The secondary minimum at 140 mb becomes more pronounced during the day.

Jan. 21, 1970: Pronounced variations of ozone distribution during the day. Increasing strength of the secondary maximum from morning to afternoon; change in tropospheric ozone distribution (perhaps simulated by contamination of instruments near ground). Simultaneous variation of tropopause level. Very pronounced smearing of details by the Brewer sonde type India.

Jan. 23, 1970: Probably slight contamination of Brewer-Mast instrument near ground level, which could be corrected if descent data were available.

Jan. 27, 1970: Some indication of partial pump failure of Brewer sonde type GDR above 20 mb: less distortion of vertical distribution might result if this part of the flight were disregarded in the single factor adjustment.

Jan. 29, 1970: The question arises whether the abnormally high readings of the Brewer type India — Brewer type Italy tandem at the top of the flight might be produced by erroneous pressure readings above about 20 mb, simulating bigger altitudes than were actually reached (no hypsometer was used).

Jan. 30, 1970: Increasing strength of the first maximum just above the tropopause during the day. The pressure readings of the Brewer type India — KC-68 tandem between 130 and 50 mb seem to be high compared with the other two flights.

Feb. 2, 1970: There was a strong indication that the pressure readings of the KC-68 tandem were too low between 500 and 30 mb. A corresponding correction was applied in the final evaluation.

5. Conclusions

The intercomparison showed that the ozone sondes which are presently used in routine sounding programs (Brewer-Mast, ECC, KC-68 and Brewer type Italy) produce only minor systematic differences against each other, if a single factor adjustment to the total amount is used. The difference between maximum and minimum values in any layer are hardly more than 5 nb. In the stratosphere the discrepancies produced by using different types of instrument are about the same as the errors introduced by the inaccuracies determining the total amount. When world wide tropospheric ozone distributions are to be deduced from soundings with different types of instrument however, the results of this intercomparison should possibly be used to adjust the data.

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8. Appendix

8.1. Tables

Table 1: Intercomparison flight schedule

Date	O_3-gram No	Sondes A	Sondes B	Results A	Results B	Date	O_3-gram No	Sondes A	Sondes B	Results A	Results B
19.1.	1	Br.Mast	-Br.Mast	+	+	28.1.	19	KC-68	-Br.Mast	+	+
20.1.	2	ECC	-Br.Mast	+	+	28.1.	20	Br.GDR	-Br.It.	+	+
20.1.	-	Br.Ind.	-KC-68	-)[1]	-)[2]	28.1.	21	Br.Ind.	-ECC	+	+
20.1.	3	KC-68	-Br.It.	+	+	29.1.	22	Br.GDR	-Br.Mast	+	+
21.1.	4	Br.Ind.	-ECC	+	+	29.1.	23	KC-68	-ECC	+	+
21.1.	5	KC-68	-Br.Mast	+	-)[3]	29.1.	24	Br.Ind.	-Br.It.	+	+
21.1.	6	ECC	-Br.It.	+	+	30.1.	25	Br.It.	-Br.Mast	+	+
22.1.	7	Br.Ind.	-Br.Mast	+	+	30.1.	26	Br.GDR	-ECC	+	+
23.1.	8	KC-68	-ECC	+	+	30.1.	27	KC-68	-Br.Ind.	+	+
23.1.	9	Br.GDR	-Br.Mast	+	+	31.1.	-	Br.GDR	-Br.Ind.	-)[9]	-)[10]
23.1.	10	Br.Ind.	-Br.It.	+	+	31.1.	28	Br.It.	-ECC	+	+
23.1.	-	ECC	-ECC	-)[4]	-)[4]	31.1.	29	KC-68	-Br.GDR	+	-)[11]
24.1.	11	Br.It.	-Br.Mast	-)[5]	+	2.2.	30	Br.It.	-Br.Mast	+	+
24.1.	12	Br.Ind.	-KC-68	-)[6]	+	2.2.	31	ECC	-ECC	+	+
24.1.	13	Br.GDR	-ECC	+	+	2.2.	32	KC-68	-KC-68	+	+
26.1.	14	Br.Ind.	-Br.Mast	-)[7]	+	4.2.	33	KC-68	-Br.Mast	+	+
26.1.	15	KC-68	-Br.GDR	+	+	4.2.	34	KC-68	-Br.It.	+	-)[12]
26.1.	16	ECC	-Br.It.	-)[8]	+	5.2.	35	KC-68	-Br.Ind.	+	+
27.1.	17	ECC	-Br.Mast	+	+	5.2.	36	Br.It.	-Br.It.	+	+
27.1.	18	Br.Ind.	-Br.GDR	+	+	11.3.	37	Br.M/5	-Br.M/7T	+	+
						25.3.	38	Br.M/5	-Br.M/7T	+	+

Explanation of poor results (-):

)[1] registration unriable

)[2] batteries exhausted

)[3] aspiration of car exhaust just before launch

)[4] reading up to 190 mb low maximum altitude only

)[5] mal function of ozone sonde

)[6] damaged at launch (sudden change of wind)

)[7] failure above 73 mb

)[8] partly unreliable readings

)[9] without tandem sonde no pressure data

)[10] abortive launch (high winds)

)[11] mal function in upper part of sounding

)[12] ozone sonde failure above 250 mb

Table 2a: Daily mean values of ozone concentration (nb partial pressure) for "Umkehr" layers

"Umkehr" lay. / Date / Tot.Oz.		1 ground to 500 mb	2 500 to 250 mb	3 250 to 125 mb	4 125 to 62.5 mb	5 62.5 to 31.2 mb	6 31.2 to 15.6 mb	7 11 to 9 mb	number of flights
19.1.	338	26.9	15.4	49.2	111.0	163.9	128.8	-	2
20.1.	302	25.1	19.9	39.2	67.1	160.1	121.1	62.7	4
21.1.	360**	15.0	20.6	63.9	132.8	174.0	119.2	58.9	5
22.1.	320	19.8	22.1	71.2	75.9	59.6	113.0	62.3	2
23.1.	303	17.9	17.2	40.1	72.5	157.9	114.0	60.8	6
24.1.	310*	26.2	27.3	74.9	73.0	136.2	100.9	57.1	4
26.1.	290	20.2	11.6	26.6	86.5	145.9	111.2	57.9	4
27.1.	342	30.3	22.3	59.5	135.9	167.7	112.1	50.5	4
28.1.	324	24.9	18.0	36.2	122.9	167.7	104.6	53.7	6
29.1.	313	23.9	16.2	40.0	91.6	153.8	99.7	67.0	6
30.1.	346	26.3	16.3	61.2	151.5	163.9	96.3	52.0	6
31.1.	370*	17.4	23.0	100.2	127.2	174.9	107.7	57.7	3
2.2.	400	23.8	16.4	77.8	154.2	201.6	132.4	57.9	6
4.2.	345	24.2	15.7	71.8	82.3	186.4	133.5	53.5	3
5.2.	355*	23.5	21.2	89.9	110.4	182.3	117.2	-	4
Mean		23.0	18.8	60.1	106.3	166.4	114.1	57.8	65

* No total ozone observations

** Total ozone from zenith blue sky observation

Table 2b: Deviation of single flights from daily means in "Umkehr" layers

Sonde resp. "Umkehr" layer No.	Date of flight (Jan. resp. Feb.)													
Br. Mast	20.	22.	23.	24.	26.	27.	28.	29.	30.	2.	4.			
1	- 0.5	- 6.2	-16.8	2.7	- 1.4	-2.0	-1.9	- 1.1	- 2.0	0.8	- 4.5			
2	0.0	- 5.5	- 7.6	- 5.9	- 4.1	-3.8	-2.3	- 3.0	- 4.1	- 4.3	- 6.6			
3	0.0	- 1.5	- 0.5	- 5.6	0.5	-4.6	-1.1	- 6.2	-11.2	- 0.6	1.2			
4	- 8.5	- 0.8	1.8	4.4	- 2.8	-1.8	6.9	9.4	- 9.7	10.4	- 5.4			
5	- 4.1	3.4	8.1	0.9	- 1.0	-3.5	2.3	11.0	6.0	1.0	12.9			
6	6.6	2.6	5.8	- 5.8	5.3	-3.2	4.4	9.8	7.5	1.0	0.4			
7	-	-	0.0	5.6	1.1	3.9	-0.6	- 8.4	-	-	-			
ECC	20.	21.	21.	23.	24.	27.	28.	29.	30.	31.	22.			
1	6.6	- 8.8	3.9	6.9	- 1.0	7.2	-1.9	1.7	- 0.2	2.8	0.0	2.9		
2	12.0	0.9	- 1.8	5.6	1.4	-0.5	-4.6	- 1.0	0.1	0.9	1.1	2.7		
3	12.0	- 4.3	8.6	8.8	7.9	-1.1	2.2	- 1.7	0.6	3.9	- 1.2	-6.6		
4	-10.7	4.7	6.1	- 6.0	- 2.2	1.3	0.5	0.4	2.2	2.3	0.2	-7.9		
5	-20.9	10.1	1.5	- 2.2	7.7	0.4	-2.6	1.1	0.0	- 1.4	0.7	1.4		
6	0.4	- 0.5	- 2.7	1.2	4.5	-4.0	2.9	4.8	3.7	- 2.9	- 0.5	2.3		
7	-	- 0.1	- 6.5	- 1.5	-11.0	-4.0	0.3	-	1.2	-	-	-		
KC-68	20.	21.	23.	24.	26.	28.	29.	30.	31.	2.	2.	4.	4.	5.
1	0.3	- 6.5	5.7	- 3.5	1.6	-2.2	-1.4	- 5.6	- 3.5	- 6.1	0.3	1.5	3.0	5.0
2	- 4.2	- 7.7	1.9	- 5.7	0.8	-3.1	-0.6	- 1.7	- 0.8	0.1	2.1	2.5	4.2	- 0.4
3	- 3.9	- 2.6	10.1	- 6.5	2.5	0.6	0.5	13.5	- 0.1	2.4	7.5	3.7	- 5.6	13.8
4	11.2	2.0	- 1.6	0.8	3.3	9.7	6.9	9.1	0.0	- 2.8	2.0	-1.1	6.6	0.9
5	11.6	9.5	- 1.2	- 2.1	- 2.9	0.5	7.3	5.3	0.5	7.2	- 1.3	-1.1	-11.7	- 4.6
6	- 6.7	7.9	0.4	4.6	- 3.6	-3.9	5.0	2.7	- 1.2	2.7	- 7.5	-3.3	2.8	- 4.5
7	-	- 2.3	- 1.0	10.4	- 1.3	0.4	-	-	-	-	-	-	-	-

Table 2b continued

Sonde resp. "Umkehr" layer No.	Date of flight (Jan. resp. Feb.)									
Br. type Ind.	21.	22.	23.	27.	28.	29.	30.	5.		
1	1.5	6.1	4.9	5.0	2.0	8.2	- 3.9	0.7		
2	9.2	5.5	5.0	9.0	4.0	11.7	- 5.6	- 5.4		
3	- 3.7	1.5	2.7	0.3	- 9.5	13.3	4.0	- 8.2		
4	- 8.5	0.7	- 1.3	-11.6	-16.4	-10.0	2.7	- 0.7		
5	-11.8	- 3.4	- 8.5	-14.2	7.2	-23.8	- 8.7	10.5		
6	- 1.7	- 2.6	- 1.5	3.4	3.1	- 8.4	- 5.6	3.2		
7	4.1	-	-	-	-	1.2	- 1.0	-		
Br. type It.	20.	21.	23.	26.	28.	29.	30.	31.	2.	5.
1	- 6.4	9.7	5.6	5.1	- 3.3	- 7.0	- 1.8	0.8	2.5	-3.2
2	- 7.8	0.4	- 0.3	0.6	- 1.8	- 3.8	- 1.0	- 0.1	-1.7	2.3
3	- 8.3	1.8	2.8	- 4.3	2.3	3.0	- 6.0	- 3.7	-1.4	-5.9
4	7.6	- 4.3	1.9	5.2	7.4	-14.2	- 4.6	- 2.4	-1.8	-1.4
5	13.5	- 9.4	-10.4	0.0	3.0	- 2.7	3.3	0.8	-9.0	-3.7
6	- 0.2	- 2.9	- 8.6	- 2.2	- 5.3	- 4.3	2.5	4.0	2.2	1.2
7	-	4.6	-	-	-	7.1	-	-	-	-
Br. type GDR	23.	24.	26.	27.	28.	29.	30.			
1	- 6.5	1.8	- 5.3	-10.1	7.2	0.4	2.0			
2	- 4.5	10.3	2.6	- 4.7	7.9	- 3.5	1.2			
3	-24.0	4.1	1.1	5.4	5.7	- 9.0	- 0.7			
4	7.1	- 3.2	- 5.8	12.1	- 8.1	7.5	0.2			
5	12.9	- 6.7	3.7	17.1	-10.2	7.1	- 5.7			
6	2.9	- 2.3	0.3	3.4	- 1.2	- 4.9	-10.7			
7	-	- 5.1	0.3	-	-	-	- 0.2			

<u>Table 3:</u> Mean and standard deviation (Δ resp. σ, nb partial pressure) from daily average in "Umkehr" layers

Sonde	flights	"Umkehr" layers 1: ground to 500 mb Δ	σ	2: 500 mb to 250 mb Δ	σ	3: 250 mb to 125 mb Δ	σ	4: 125 mb to 62.5 mb Δ	σ	5: 62.5 to 31.2 mb Δ	σ	6: 31.2 to 15.6 mb Δ	σ	7: 11 mb to 9 mb Δ	$\sum_{1}^{7} \lvert\sigma\rvert$
Br.Mast	11	-3.0 (-2.6)	± 5.1	-4.2 (-2.8)	± 2.1	-2.7 (-2.8)	± 3.8	0.3 (-0.7)	± 6.9	3.5 (3.0)	± 5.5	3.1 (2.8)	± 4.7	0.3 (0.3)	28.1
ECC	12	1.7 (2.0)	± 4.5	1.4 (2.7)	± 4.2	2.4 (2.3)	± 5.8	-0.7 (-2.0)	± 5.0	-0.4 (-1.2)	± 7.5	0.8 (0.4)	± 3.1	-3.1 (-3.6)	30.1
KC-68	14	-0.8 (-0.4)	± 4.0	-0.9 (0.0)	± 3.3	2.6 (2.4)	± 6.3	3.5 (3.3)	± 4.3	1.2 (0.7)	± 6.1	-0.3 (-1.0)	± 4.8	-1.2 (1.3)	28.8
Br.Ind.	8	3.1	± 4.2	4.7	± 5.8	1.2	± 8.7	-4.8	± 8.2	-4.8	±11.9	-0.2	± 4.1	+2.7	42.8
Br.It.	11	0.3 (0.8)	± 5.3	-0.9 (-0.1)	± 3.0	-1.8 (-2.7)	± 4.1	-0.5 (-1.6)	± 6.3	-1.5 (-1.5)	± 6.9	-1.2 (-1.6)	± 3.8	+5.8 (6.7)	29.4
Br.GDR	7	-1.5	± 6.2	1.3	± 6.1	-2.5	± 7.6	1.4	± 7.6	2.6	±10.8	-1.8	± 4.9	-2.4	47.3

Result for layer 7 are unreliable because of small number of data

In brackets corresponding values of the mean deviation if only Brewer-Mast, ECC, KC-68 and Br.It. sonde are taken into account.

Table 4: Correction factor of each flight

Type: / Date	Br.Mast	ECC	KC-68	Br.Ind.	Br.It.	Br.GDR	Mean
19.1.	1.25						
	1.17						1.21
20.1.	1.22	0.96	1.06		1.19		1.085**
21.1.		1.13	1.01	0.99	1.20		1.112
		1.23					
22.1.	1.20			1.13			1.165
23.1.	1.23	1.08	0.93	1.03	1.16	1.55	1.163*
24.1.	1.11	1.08	0.93			0.96	1.02
26.1.	1.20		0.95		1.18	1.52	1.213
27.1.	1.15	1.05		1.06		1.34	1.15
28.1.	1.16	0.95	0.98	1.13	1.26	1.21	1.115
29.1.	1.27	0.93	1.03	1.04	1.10	1.13	1.083
30.1.	1.10	0.95	1.02	0.92	1.17	1.11	1.045*
31.1.		0.97	0.91		1.11		0.983
2.2.	1.19	0.97	1.06		1.19		1.06
		0.92	1.03				
4.2.	1.27		1.05				1.107
			1.00				
5.2.			0.95	1.03	1.27		1.175*
Mean:	1.195	1.017	0.993	1.041	1.186	1.261	1.115
Standard deviation:	±0.056	±0.094	±0.051	±0.072	±0.052	±0.218	

* No total ozone observations
** Total ozone from zenith blue sky reading

Table 5: Sensitivity of the sondes
Characterized by deviations from daily mean "vertical variability measure" (VVM) in nb

Date	Daily mean	Br.Mast	ECC	KC-68	Br.Ind.	Br.It.	Br.GDR
20.1.	123.5	- 25.0	60.5	-12.0		-23.5	
21.1.	265.1		173.9	-32.1	-184.2	-31.2	
			73.3				
22.1.	213.0	55.7			- 55.7		
23.1.	154.6	41.3	20.4	21.3	- 72.2	3.2	-13.0
24.1.	225.1	51.4	27.3	-29.8			-48.9
26.1.	177.7	36.6		-24.6		7.9	-20.0
27.1.	178.0	7.6	0.8		- 90.3		71.9
28.1.	171.0	41.8	21.5	26.7	- 32.1	-17.4	-40.4
29.1.	152.3	47.2	- 16.5	-15.8	- 61.1	11.5	34.6
30.1.	283.2	2.0	- 3.2	82.5	- 41.3	-11.3	-27.7
31.1.	332.1		52.7	-43.0		- 8.7	
2.2.	394.4	112.4	71.1	-53.9		-83.1	
			- 42.7	- 3.7			
4.2.	169.8	62.6		-14.1			
				-48.4			
5.2.	191.6			-16.4	9.0	- 6.5	
						-19.1	
Mean:	216.6	+ 39.4	+ 36.6	- 9.3	- 66.0	-16.2	- 6.2
Standard deviation:		± 35.8	± 56.2	±36.4	± 56.0	±26.3	±43.8

$$VVM \equiv \sum_{i=1}^{n} a_i \qquad a_i = p_3(i) - p_3(i+1) \quad \text{if } p_3(i) - p_3(i+1) > 0$$

$$a_i = 0 \quad \text{if } p_3(i) - p_3(i+1) \leq 0$$

p_1 = 800 mb $\qquad p_{n+1}$ = 30 mb

Tables 6:

Deviations (Δ_{TOT}, Δ_{DAY}) of the ozone partial pressure data of each sonde from the total and daily mean values at standard pressure levels.

6a:	Data	for	Brewer-Mast	sonde
6b:	"	"	ECC	"
6c:	"	"	KC-68	"
6d:	"	"	Br.Ind.	"
6e:	"	"	Br.It.	"
6f:	"	"	Br.GDR	"

TABLE 6 a DATA FOR BREWER-MAST SONDE

LEVEL MB	TOTAL MEAN	Δ_{TOT}	Δ_{DAY} 20.1.	22.1.	23.1.	24.1.	26.1.	27.1.
800	20.5	-2.8	-1.0	-9.5	-18.7	4.5	.5	-2.5
700	21.9	-3.1	0.0	-5.5	-19.3	2.0	-1.5	-4.3
600	19.0	-3.9	-2.0	-5.5	-18.0	1.5	-2.0	-.5
500	17.0	-3.2	-1.8	-6.5	-9.5	.3	-3.3	-2.3
400	14.6	-3.7	-5.5	-6.5	-5.8	-1.5	-3.5	-1.3
300	13.2	-4.5	8.3	-5.5	-10.3	-8.3	-5.0	-5.5
250	21.4	-6.0	-4.3	1.0	-3.0	-17.7	-4.3	-9.8
200	49.1	-3.4	2.3	2.0	-13.7	3.0	-.5	-10.5
175	62.7	-2.5	-1.8	-7.0	-.8	-5.3	-3.0	-4.8
150	81.4	.7	0.0	13.0	7.0	-19.7	12.0	-.5
137.5	81.9	-.6	2.3	7.0	9.8	-2.3	4.3	3.0
125	81.2	1.3	1.5	-15.5	-5.8	-1.5	-10.7	2.3
112.5	77.3	-7.4	-4.8	-11.0	-.8	-3.0	1.0	-26.7
100	83.9	-2.9	-7.0	-3.5	-4.2	-1.0	1.3	3.8
90	103.7	2.7	-10.2	.5	-.5	3.0	-3.5	12.7
80	113.1	2.4	-5.8	6.0	-1.3	2.8	3.8	3.0
70	139.0	2.8	-13.0	6.5	10.5	-2.3	-12.2	-1.5
65	148.8	5.2	-6.5	7.0	11.3	14.0	9.8	-2.8
60	149.9	2.2	-10.7	5.0	13.0	-1.5	-10.7	-3.0
55	164.0	4.6	-13.2	1.5	15.0	-2.3	-6.0	-9.3
50	183.1	7.9	-1.5	1.5	15.5	9.0	11.3	-5.8
45	187.0	7.2	-6.3	11.0	7.2	3.8	0.0	-1.8
40	176.4	-.2	-3.5	3.5	12.3	-6.3	-6.3	-9.8
37.5	170.8	-.0	.8	2.0	-3.3	-3.0	-1.8	-2.3
35	165.7	2.0	3.5	4.0	2.0	1.3	-4.0	-1.8
32.5	157.3	4.4	4.8	-3.5	8.0	6.0	5.8	-4.3
30	145.5	4.4	5.8	0.0	5.5	-5.5	5.5	-2.0
28	136.7	3.6	4.0	2.0	4.2	-5.0	6.8	-18.2
26	130.2	3.7	3.8	2.5	5.7	-2.0	17.7	-13.0
24	119.9	1.2	3.5	3.0	3.5	-18.0	9.5	-1.3
22	113.3	2.0	6.5	-.5	10.0	-10.2	5.3	-1.3
20	108.4	4.3	17.0	2.5	7.2	-7.0	1.0	2.8
19	102.9	3.0	10.0	3.5	.3	-5.3	4.5	4.5
18	99.4	3.0	5.8	7.0	6.3	-2.3	.8	1.3
17	94.3	2.4	4.5	3.0	5.2	-1.5	.5	1.0
16	90.3	2.3	3.3	4.0	.5	-.8	-.5	7.0
15	86.1	2.5	4.0	6.0	-3.5	-2.0	.8	9.5
14	80.4	1.7	11.3	2.0	-3.7	-2.0	-.5	3.0
13	75.1	1.5	7.7	3.5	-1.0	.3	-1.8	3.0
12	70.4	1.0	4.0	3.0	-.4	2.3	-3.0	3.0
11	63.4	-.6	0.0	0.0	-1.8	4.8	-1.3	3.0
10	58.5	.3	0.0	0.0	.3	5.5	1.0	4.0
9	51.8	.7	0.0	0.0	.5	7.3	2.3	6.0
8	45.8	-2.3	0.0	0.0	1.3		0.0	
7	44.9	0.0		0.0				

TABLE 6 a cont. DATA FOR BREWER-MAST SONDE

LEVEL MB	ΔDAY 28.1.	29.1.	30.1.	2.2.	4.2.
800	-1.0	-2.3	-.7	3.8	-3.7
700	-1.8	-2.0	-1.3	3.8	-3.7
600	-4.8	-1.0	-3.0	-1.0	-6.7
500	-1.0	-.8	-1.8	-2.0	-6.0
400	-1.3	-2.2	-3.5	-4.7	-5.3
300	-2.7	-4.2	-3.2	-5.5	-7.7
250	-3.3	-5.8	-10.2	-4.5	-4.3
200	-2.5	-8.3	-18.0	2.3	6.3
175	-.2	-8.2	-6.7	14.3	-4.0
150	-1.7	4.3	-5.5	-7.7	6.3
137.5	-.2	-8.8	-3.0	-18.8	.3
125	36.3	-11.5	4.7	23.8	-9.0
112.5	18.5	-.3	-8.8	-24.7	-20.7
100	7.5	3.7	-47.7	24.2	-8.7
90	22.7	-.7	-5.0	16.5	-5.7
80	-3.2	27.0	-7.8	-3.5	5.3
70	-3.8	20.0	15.7	10.2	.7
65	-6.0	7.3	6.5	15.0	2.0
60	-6.3	20.3	7.7	4.8	5.3
55	10.5	7.5	5.8	10.2	31.3
50	.8	20.0	3.2	12.0	21.3
45	2.3	19.5	13.5	6.3	23.3
40	-2.3	8.8	3.2	-8.8	6.7
37.5	5.8	2.3	-.8	-7.8	8.0
35	3.3	5.8	3.5	-1.5	5.3
32.5	6.8	11.7	5.5	4.3	3.3
30	4.8	14.2	9.0	8.8	2.3
28	11.5	14.7	9.7	8.3	1.7
26	.7	13.8	7.2	3.8	.3
24	3.3	9.0	.7	.8	-1.0
22	4.0	8.3	3.7	-3.2	-.3
20	11.0	9.7	5.8	-1.8	-1.0
19	5.2	5.4	4.8	-.8	.3
18	2.7	5.4	4.2	-.3	2.3
17	2.5	4.8	4.5	.3	1.7
16	2.8	3.6	4.8	1.7	-1.0
15	-.4	3.2	6.8	2.5	.7
14	-2.0	-1.8	8.7	3.2	1.0
13	-1.6	-5.0	9.7	.3	2.0
12	2.6	-6.8	8.3	-3.0	1.3
11	.8	-6.6		-6.3	1.0
10	-.7	-8.0			
9	-1.5	-9.0			
8		-12.7			
7					

TABLE 6 b DATA FOR ECC SONDE

LEVEL MB	TOTAL MEAN	Δ TOT	Δ DAY 20.1.	21.1.	21.1.	23.1.	24.1.	27.1.
800	26.3	3.1	8.0	-12.8	13.2	9.3	-.5	8.5
700	25.7	.8	2.0	-9.6	5.4	7.7	-2.0	5.8
600	23.9	1.0	6.0	-7.8	-.8	5.0	-.5	6.5
500	19.7	-.5	6.3	-4.8	-3.8	1.5	-2.8	2.8
400	18.8	.5	11.5	-3.0	-4.0	2.2	-2.5	.8
300	19.4	1.7	11.3	3.0	0.0	11.7	3.8	-1.5
250	32.0	4.6	27.7	-3.4	6.6	5.0	15.2	-6.8
200	55.5	3.0	15.2	-6.6	20.4	10.3	-4.0	-2.5
175	68.9	3.7	5.3	7.2	2.2	13.2	14.7	-3.8
150	83.8	3.1	11.0	-6.6	-4.6	6.0	22.2	-4.5
137.5	83.2	.7	11.3	-3.0	-1.0	6.8	-7.3	7.0
125	76.1	-3.8	4.5	-22.8	39.2	7.2	-7.5	7.3
112.5	84.4	-.3	1.3	14.8	14.8	1.2	-5.0	-26.7
100	88.6	1.8	0.0	-1.0	7.0	-6.2	-2.0	19.7
90	100.4	-.6	-8.3	3.0	17.0	.5	0.0	14.7
80	111.6	.9	-5.8	12.4	-7.6	.7	2.8	3.0
70	131.4	-4.7	-28.0	-4.4	5.6	-26.5	-1.3	-1.5
65	139.7	-3.8	-34.5	-.6	5.4	-29.7	14.0	3.3
60	141.4	-6.3	-45.7	4.6	-3.4	-12.0	7.5	2.0
55	150.9	-8.5	-46.3	-4.6	10.4	-23.0	-1.3	-6.3
50	173.3	-1.9	-32.5	.6	10.6	3.5	3.0	6.3
45	182.1	2.3	-8.3	-.4	6.6	3.2	10.7	3.3
40	178.7	2.1	-.5	15.6	-4.4	7.3	12.7	-8.8
37.5	175.3	4.4	-11.3	15.2	3.2	8.7	18.0	.8
35	166.9	3.2	-1.5	12.8	2.8	0.0	11.3	-2.8
32.5	154.0	1.1	-6.3	12.2	.2	-2.0	-10.0	-1.3
30	140.4	-.8	-3.3	-26.2	-4.2	2.5	3.5	-4.0
28	132.8	-.4	1.0	-11.0	-3.0	-.8	9.0	-13.2
26	127.9	1.3	7.8	.8	1.8	-1.3	12.0	-14.0
24	120.4	1.8	-3.5	6.6	4.6	-1.5	10.0	-3.3
22	111.8	.5	-3.5	-3.6	-.6	-2.0	-.3	-4.3
20	103.8	-.3	-4.0	-7.8	.2	1.2	2.0	3.8
19	99.8	-.1	-1.0	-2.4	-.4	6.3	1.8	-6.5
18	96.7	.3	.8	8.2	-5.8	6.3	-2.3	-.8
17	92.1	.1	1.5	9.8	-9.2	1.2	.5	2.0
16	87.8	-.2	-1.7	9.4	-11.6	3.5	.3	2.0
15	83.1	-.5	-1.0	6.6	-13.4	3.5	-1.0	4.5
14	77.4	-1.2	5.3	3.8	-15.2	3.3	-2.0	-3.0
13	71.8	-1.7	2.7	1.2	-16.8	2.0	-3.8	-3.0
12	67.5	-1.9	0.0	-.4	-16.4	2.6	-6.8	-3.0
11	62.4	-1.7		-2.0	-13.0	2.3	-9.3	-3.0
10	55.0	-3.2		-3.4	-8.4	-1.8	-12.5	-4.0
9	48.7	-2.3		5.5		-2.5	-7.8	-6.0
8	45.0	-3.1		-1.5		-1.8	-6.7	
7	42.4	-2.6				.5	-5.7	

TABLE 6 b cont. DATA FOR ECC SONDE

LEVEL MB	Δ DAY 28.1.	29.1.	30.1.	31.1.	2.2.	2.2.
800	1.0	2.7	.3	4.3	-.2	2.8
700	-2.8	-1.0	-2.3	4.3	-2.2	3.8
600	-1.8	1.0	-1.0	2.0	0.0	3.0
500	-6.0	-2.8	-.8	2.0	1.0	1.0
400	-4.3	-1.2	-.5	4.3	.3	2.3
300	-5.7	-1.2	-1.2	-4.7	1.5	3.5
250	-4.3	.2	2.8	6.3	3.5	2.5
200	.5	-1.3	6.0	9.3	-4.7	-6.7
175	4.8	-7.2	1.3	-.3	7.3	-.7
150	8.3	-5.7	-.5	5.7	11.3	-5.7
137.5	9.8	-3.8	-3.0	18.3	-10.8	-15.8
125	-14.7	-3.5	-4.3	-10.3	-25.2	-15.2
112.5	-17.5	-.3	-10.8	18.7	6.3	.3
100	5.5	11.7	16.3	-5.3	-10.8	-12.8
90	-9.3	-2.7	1.0	-3.0	1.5	-21.5
80	13.8	4.0	18.2	1.3	-11.5	-20.5
70	13.2	-4.0	-16.3	-3.0	8.2	1.2
65	13.0	2.3	-7.5	7.3	-8.0	-11.0
60	-6.3	-1.7	-4.3	-1.3	-2.2	-13.2
55	-10.5	2.5	-1.2	-10.3	-5.8	-5.8
50	-.2	-1.0	-1.8	-5.7	3.0	-8.0
45	-4.7	-.5	-1.5	7.3	3.3	3.3
40	-2.3	1.8	-5.8	-6.7	7.2	9.2
37.5	-1.2	.3	-.8	6.0	5.2	9.2
35	-.7	1.8	4.5	1.3	4.5	4.5
32.5	.8	1.7	7.5	-3.0	6.3	7.3
30	1.8	1.2	8.0	-2.3	5.8	7.8
28	.5	2.7	3.7	-1.0	2.3	5.3
26	4.7	4.8	-4.8	-2.3	.8	5.8
24	6.3	6.0	-1.3	-2.3	-3.2	2.8
22	4.0	6.3	4.7	-3.7	3.8	4.8
20	-1.0	4.7	-.2	-5.3	2.2	1.2
19	1.2	4.4	.8	-5.0	-.8	.2
18	1.7	3.4	.2	-3.7	-3.3	-1.3
17	.5	2.8	.5	-2.7	-4.7	-.7
16	-.2	2.6	1.8	-2.3	-5.3	-.3
15	-1.4	2.2	1.8	-1.3	-6.5	.5
14	-2.0	.2	1.7		-6.8	1.2
13	-2.6	1.0	2.7		-4.8	2.3
12	1.6	1.2	.3		-3.0	3.0
11	.8	2.4	3.8		-1.3	2.8
10	.3		.7		-1.0	1.0
9			-1.0			
8			-2.5			
7						

TABLE 6 c DATA FOR KC-68 SONDE

LEVEL MB	TOTAL MEAN	Δ_{TOT}	Δ_{DAY} 20.1.	21.1.	23.1.	24.1.	26.1.	28.1.
800	22.2	-1.1	0.0	-11.8	7.3	-5.5	.5	0.0
700	23.9	-1.1	1.0	-3.6	5.7	-2.0	.5	-3.8
600	22.4	-.5	-1.0	-4.8	5.0	-2.5	2.0	-2.8
500	19.6	-.6	-.8	-6.8	2.5	-2.8	2.8	-2.0
400	17.1	-1.2	-1.5	-6.0	-1.8	-6.5	2.5	-2.3
300	17.1	-.6	-8.8	-8.0	7.7	-7.3	-1.0	-3.7
250	27.4	.0	-10.2	-6.4	4.0	-11.7	1.8	-4.3
200	56.9	4.4	-6.8	2.4	18.3	1.0	1.5	-5.5
175	64.3	-.9	2.3	-15.8	29.2	-14.2	8.0	2.8
150	82.0	1.3	-5.0	2.4	5.0	-4.8	-1.0	2.3
137.5	86.6	4.2	-3.8	-3.0	5.8	-5.3	5.3	-4.2
125	85.1	5.2	.5	7.2	5.2	-.5	10.2	36.3
112.5	91.5	6.8	3.3	5.8	1.2	1.0	1.0	3.5
100	90.7	3.9	4.0	-5.0	-1.2	0.0	6.3	13.5
90	106.8	5.8	9.8	3.0	3.5	2.0	3.5	27.7
80	115.7	5.0	9.3	-2.6	4.7	-2.3	1.8	4.8
70	139.4	3.2	23.0	7.6	-20.5	17.7	11.7	-.8
65	142.7	-.8	20.5	6.4	-10.7	-12.0	-14.2	-3.0
60	153.4	5.7	31.3	16.6	0.0	-4.5	-1.8	5.7
55	165.2	5.8	28.8	14.4	-15.0	12.7	1.0	3.5
50	175.4	.2	17.5	17.6	-.5	-9.0	-.8	-.2
45	175.7	-4.2	4.8	18.6	.2	-8.3	-7.0	1.3
40	178.0	1.4	-.5	6.6	4.3	-3.3	-6.3	-.3
37.5	170.6	-.2	3.8	2.2	6.7	-10.0	-4.8	-8.2
35	162.1	-1.6	-2.5	1.8	-1.0	-.8	-4.0	1.3
32.5	151.8	-1.1	-1.3	-.8	-1.0	18.0	-5.3	1.8
30	140.1	-1.0	-3.3	12.8	.5	15.5	-2.5	1.8
28	132.1	-1.1	-2.0	13.0	-1.8	3.0	-2.3	1.5
26	125.5	-1.0	-6.3	8.8	-2.3	-10.0	-3.3	-2.3
24	118.6	-.0	-2.5	-3.4	-.5	8.0	-4.5	-3.7
22	110.2	-1.1	-5.5	1.4	-3.0	9.8	-3.8	-8.0
20	103.9	-.2	-13.0	18.2	1.2	5.0	-4.0	-4.0
19	99.8	-.1	-10.0	14.6	6.3	2.8	-5.5	-2.8
18	95.8	-.6	-8.3	10.2	1.3	2.8	-4.3	-5.3
17	91.1	-.8	-7.5	8.8	2.2	1.5	-3.5	-9.5
16	88.2	.2		6.4	5.5	.3	-1.5	-4.2
15	83.8	.2		3.6	5.5	4.0	-1.3	-.4
14	78.2	-.4		3.8	4.3	4.0	-2.5	-1.0
13	72.5	-1.0		3.2	1.0	4.3	-3.8	-.6
12	68.3	-1.1		2.6	.6	6.3	-6.0	2.6
11	62.8	-1.2		0.0	-.8	6.8	-4.3	.8
10	59.3	1.1		-4.4	-.8	13.5	-1.0	.3
9	51.7	.6			-3.5	5.3	.3	1.5
8	49.3	1.1			-3.8	8.3		
7	46.9	1.9			-.5	6.3		

TABLE 6c cont. DATA FOR KC-68 SONDE

LEVEL MB	Δ_{DAY} 29.1.	30.1.	31.1.	2.2.	2.2.	4.2.	4.2.	5.2.
800	-.3	-6.7	-3.7	-9.2	-1.2	1.3	2.3	12.0
700	-2.0	-6.3	-2.7	-7.2	-1.2	1.3	2.3	2.5
600	-2.0	-4.0	-3.0	-5.0	1.0	2.3	4.3	3.3
500	-1.8	-3.8	-4.0	-2.0	2.0	2.0	4.0	2.8
400	-1.2	-2.5	-6.7	.3	1.3	1.7	3.7	2.8
300	-1.2	-1.2	3.3	1.5	2.5	3.3	4.3	.3
250	5.2	8.8	5.3	-1.5	4.5	.7	3.7	.5
200	5.7	24.0	-6.7	3.3	14.3	6.3	-12.7	16.5
175	-7.2	2.3	-4.3	-19.7	-11.7	3.0	1.0	11.5
150	-6.7	10.5	-7.3	6.3	2.3	9.3	-15.7	19.7
137.5	-3.8	1.0	-22.7	25.2	22.2	8.3	-8.7	41.7
125	-2.5	-6.3	3.7	9.8	10.8	1.0	8.0	-11.0
112.5	.7	18.2	-7.3	12.3	20.3	-6.7	27.3	15.2
100	-2.3	42.3	7.7	-3.8	-1.8	-4.7	13.3	-13.0
90	4.3	5.0	8.0	-.5	9.5	2.3	3.3	-.3
80	19.0	-12.8	6.3	20.5	25.5	1.3	-6.7	.8
70	12.0	-.3	4.0	-9.8	-6.8	2.7	-3.3	8.3
65	10.3	-3.5	-12.7	-1.0	3.0	-1.0	-1.0	12.2
60	5.3	3.7	.7	6.8	12.8	2.3	-7.7	8.3
55	10.5	19.8	19.7	2.2	.2	-4.7	-26.7	15.2
50	7.0	8.2	-2.7	3.0	-1.0	.3	-21.7	-14.5
45	4.5	-13.5	-13.7	2.3	-10.7	.3	-23.7	-13.5
40	9.8	8.2	11.3	9.2	-2.8	-.3	-6.3	-9.8
37.5	11.3	8.2	-4.0	12.2	-1.8	-3.0	-5.0	-11.0
35	1.8	8.5	-7.7	7.5	-10.5	-3.7	-1.7	-11.5
32.5	6.7	5.5	-8.0	-.7	-14.7	-4.7	1.3	-12.2
30	4.2	-3.0	-4.3	-8.2	-18.2	-5.7	3.3	-7.8
28	3.7	.7	-3.0	-4.7	-15.7	-6.3	4.7	-5.5
26	6.8	9.2	-.3	1.8	-11.2	-6.7	6.3	-5.3
24	8.0	6.7	-1.3	6.8	-9.2	-6.0	7.0	-5.8
22	6.3	-2.3	-.7	4.8	-11.2	-3.3	3.7	-3.3
20	1.7	-.2	1.7	1.2	-6.8	-1.0	2.0	-5.3
19	1.4	-1.2	1.0	1.2	-4.8	-.7	.3	-4.3
18	2.4	-2.8	.3	2.7	-2.3	-.7	-1.7	-2.3
17	2.8	-3.5	-.7	2.3	-1.7	.7	-2.3	-1.5
16	2.6	-4.2	-1.3	1.7	-1.3	1.0	0.0	-2.0
15	3.2	-7.2	-1.3	1.5	-1.5	-1.3	.7	-3.3
14	4.2	-10.3	0.0	1.2	-1.8	-1.0	0.0	-6.0
13	2.0	-12.3	0.0	0.0	0.0	-2.0	0.0	-2.5
12	-1.8	-13.7	0.0	0.0	0.0	-1.7	.3	
11	-5.6	-8.3	0.0	0.0	0.0	-1.0	0.0	
10			0.0				0.0	
9			0.0				0.0	
8			0.0				0.0	
7			0.0					

TABLE 6d DATA FOR BREWER SONDE TYPE INDIA

LEVEL MB	TOTAL MEAN	Δ_{TOT}	Δ_{DAY} 21.1.	22.1.	23.1.	27.1.	28.1.	29.1.
800	28.6	5.3	-3.8	9.5	1.3	6.5	11.0	7.7
700	28.9	4.0	-3.6	5.5	5.7	7.8	2.2	10.0
600	26.0	3.1	5.2	5.5	8.0	1.5	-4.8	9.0
500	24.4	4.3	8.2	6.5	8.5	5.8	-3.0	8.2
400	24.6	6.3	12.0	6.5	8.2	6.8	3.7	9.8
300	23.8	6.1	7.0	5.5	.7	12.5	6.3	13.8
250	30.7	3.3	.6	-1.0	2.0	16.3	8.7	15.2
200	53.1	.6	-19.6	-2.0	2.3	8.5	.5	13.7
175	63.5	-1.7	-4.8	7.0	-3.8	-3.8	-15.2	16.8
150	76.6	-4.1	13.4	-13.0	6.0	-6.5	-16.7	10.3
137.5	79.9	-2.6	4.0	-7.0	6.8	-15.0	-29.2	19.2
125	76.4	-3.5	-23.8	15.5	10.2	-9.8	-26.7	20.5
112.5	80.5	-4.1	-28.2	11.0	10.2	2.3	-39.5	10.7
100	87.0	.2	-2.0	3.5	6.8	-22.2	-19.5	-2.3
90	92.4	-8.6	-26.0	-.5	-7.5	-20.2	-24.3	5.3
80	102.3	-8.4	15.4	-6.0	-9.3	-15.0	-4.2	-36.0
70	126.8	-9.4	-3.4	-6.5	-10.5	-11.5	-.8	-29.0
65	137.9	-5.6	-11.6	-7.0	-6.7	-13.8	9.0	-23.7
60	140.5	-7.3	-6.4	-5.0	-8.0	-15.0	1.7	-32.7
55	155.6	-3.8	-7.6	-1.5	-3.0	-8.3	-4.5	-32.5
50	164.8	-10.3	-16.4	-1.5	-27.5	-10.7	4.8	-30.0
45	168.4	-11.4	-22.4	-11.0	-13.8	-21.7	7.3	-28.5
40	170.2	-6.4	-9.4	-3.5	-5.7	-21.7	5.7	-21.2
37.5	168.2	-2.6	-9.8	-2.0	.7	-11.3	12.8	-14.7
35	159.0	-4.7	-7.2	-4.0	0.0	-14.7	14.3	-12.2
32.5	149.8	-3.1	-2.8	3.5	-2.0	-8.3	14.8	-13.3
30	139.7	-1.4	13.8	0.0	-.5	-5.0	5.8	-15.8
28	132.5	-.6	9.0	-2.0	.2	9.8	2.5	-15.3
26	126.6	.0	-1.2	-2.5	-.3	14.0	6.7	-14.2
24	117.1	-1.6	-5.4	-3.0	-1.5	5.8	1.3	-11.0
22	109.2	-2.1	-1.6	.5	-2.0	4.8	-1.0	-9.7
20	100.7	-3.4	-8.8	-2.5	-1.8	-2.3	1.0	-8.3
19	97.2	-2.7	-8.4	-3.5	.3	.5	3.2	-8.6
18	93.5	-2.9	-7.8	-7.0	-3.7	5.3	3.7	-8.6
17	90.6	-1.3	-5.2	-3.0	.2	1.0	7.5	-9.2
16	85.6	-2.4	-1.6	-4.0	-.5	-2.0		-7.4
15	81.4	-2.2	2.6	-6.0	-.5	-2.5		-7.8
14	77.8	-.8	3.8	-2.0	-.7			-3.8
13	71.7	-1.9	4.2	-3.5	-2.0			-3.0
12	68.1	-1.3	5.6	-3.0	-3.4			2.2
11	66.1	2.1	6.0					2.4
10	60.3	2.1	6.6					1.0
9	52.6	1.5						2.0
8	51.5	3.4						4.3
7	43.2	-1.8						-3.5

TABLE 6 d cont. DATA FOR BREWER SONDE TYPE INDIA

LEVEL MB	Δ DAY 30.1.	5.2.
800	2.3	8.0
700	4.7	-.5
600	5.0	-4.8
500	5.2	-5.3
400	5.5	-2.3
300	5.8	-2.8
250	3.8	-19.5
200	3.0	-1.5
175	.3	-10.5
150	-.5	-26.3
137.5	-3.0	3.8
125	-.3	-14.0
112.5	6.2	-5.8
100	37.3	0.0
90	12.0	-7.3
80	-13.8	1.8
70	-17.3	4.3
65	-7.5	16.3
60	-9.3	16.3
55	-2.2	29.2
50	-5.8	4.5
45	-7.5	6.5
40	-5.8	10.2
37.5	-3.8	7.0
35	-18.5	4.5
32.5	-20.5	3.8
30	-15.0	5.3
28	-14.3	6.5
26	-6.8	4.8
24	-1.3	2.3
22	-6.3	-1.3
20	-7.2	2.8
19	-7.2	1.8
18	-7.8	2.8
17	-5.5	3.5
16	-4.2	3.0
15	-6.2	4.8
14	-8.3	6.0
13	-9.3	2.5
12	-7.7	
11	-2.3	
10	-1.3	
9	1.0	
8	2.5	
7	0.0	

TABLE 6 e DATA FOR BREWER SONDE TYPE ITALY

LEVEL MB	TOTAL MEAN	Δ_{TOT}	Δ_{DAY} 20.1.	21.1.	23.1.	26.1.	28.1.	29.1.
800	22.4	-.9	-7.0	15.2	8.3	5.5	-12.0	-6.3
700	26.8	1.9	-3.0	11.4	8.7	5.5	.2	-5.0
600	24.1	1.2	-3.0	8.2	6.0	5.0	2.2	-9.0
500	20.8	.6	-3.8	7.2	2.5	2.8	-1.0	-5.8
400	18.0	-.3	-4.5	1.0	2.2	.5	-.3	-4.2
300	15.7	-2.0	-10.7	-2.0	-4.3	0.0	-2.7	-2.2
250	25.0	-2.4	-13.2	2.6	-5.0	-.3	-3.3	-.8
200	47.9	-4.6	-10.7	3.4	7.3	-3.5	-3.5	-.3
175	67.2	2.0	-5.8	11.2	-5.8	-4.0	1.8	8.8
150	80.9	.1	-6.0	-4.6	10.0	-7.0	7.3	2.3
137.5	81.4	-1.1	-9.8	3.0	7.8	-10.7	19.8	12.2
125	82.2	2.3	-6.5	.2	2.2	-6.8	-10.7	13.5
112.5	83.1	-1.5	.3	-7.2	-2.8	2.0	28.5	-4.3
100	83.0	-3.8	3.0	1.0	.8	-1.8	3.5	-7.3
90	100.7	-.3	8.8	3.0	-2.5	-1.5	2.7	-4.7
80	104.5	-6.2	2.3	-17.6	-2.3	4.8	.8	-35.0
70	139.8	3.6	18.0	-5.4	14.5	11.7	5.2	-15.0
65	145.9	2.3	20.5	.4	8.3	18.7	1.0	-11.7
60	147.3	-.5	25.2	-11.4	-6.0	16.3	10.7	-10.7
55	157.2	-2.2	30.7	-12.6	12.0	6.0	8.5	-.5
50	175.4	.3	16.5	-12.4	-14.5	5.3	2.8	-6.0
45	182.5	2.7	9.8	-2.4	-11.8	2.0	2.3	-3.5
40	174.0	-2.6	4.5	-8.4	-24.7	-5.3	15.7	-.2
37.5	167.9	-3.0	6.8	-10.8	-16.3	-8.8	2.8	4.3
35	161.5	-2.2	.5	-10.2	-12.0	-7.0	-9.7	2.8
32.5	149.8	-3.1	2.8	-8.8	-14.0	-9.3	-12.2	-8.3
30	138.9	-2.2	.8	3.8	-13.5	-8.5	-8.2	-7.8
28	129.3	-3.8	-3.0	-8.0	-9.8	-8.3	-12.5	-9.3
26	122.8	-3.8	-5.3	-10.2	-7.3	-5.3	-8.3	-8.2
24	117.1	-1.5	2.5	-2.4	-5.5	-5.5	-6.7	-6.0
22	111.0	-.3	2.5	4.4	-5.0	-4.8	-5.0	-4.7
20	103.7	-.3	0.0	-1.8	-5.8	-1.0	-4.0	-3.3
19	99.9	-.0	1.0	-3.4	-6.7	.5	-4.8	-2.6
18	96.3	-.1	1.8	-4.8	-12.7	4.8	-1.3	-2.6
17	91.8	-.1	1.5	-4.2	-12.8	7.5	1.5	-1.2
16	87.6	-.3	-1.7	-2.6	-10.5	8.5	3.8	-1.4
15	83.9	.3	-3.0	.6	-5.5	5.8	3.6	-.8
14	78.8	.1	-16.7	3.8	-1.7	3.5	5.0	1.2
13	76.0	2.4	-10.3	8.2	1.0	.3	8.4	5.0
12	71.3	2.0	-4.0	8.6			-4.4	5.2
11	71.1	7.1		9.0				7.4
10	66.5	8.3		9.6				7.0
9	51.8	.8		-5.5				7.0
8	53.0	4.9		1.5				8.3
7	48.4	3.5						3.5

TABLE 6 e cont. DATA FOR BREWER SONDE TYPE ITALY

LEVEL MB	Δ DAY 30.1.	31.1.	2.2.	5.2.	5.2.
800	3.3	-.7	3.8	-10.0	-10.0
700	3.7	-1.7	2.8	-.5	-1.5
600	-1.0	1.0	2.0	1.3	.3
500	.2	2.0	0.0	1.8	.8
400	-.5	2.3	.3	.8	-1.3
300	-.2	1.3	-3.5	1.3	1.3
250	-9.2	-11.7	-4.5	10.5	8.5
200	-17.0	-2.7	-8.7	-4.5	-10.5
175	1.3	4.7	10.3	3.5	-4.5
150	-2.5	1.7	-6.7	6.8	-.3
137.5	9.0	4.3	-1.8	-20.2	-25.2
125	5.7	6.7	-4.2	17.0	8.0
112.5	2.2	-11.3	-14.7	-1.8	-7.8
100	-56.7	-2.3	5.2	8.0	5.0
90	-6.0	-5.0	-5.5	4.8	2.8
80	-.8	-7.7	-10.5	-1.3	-1.3
70	26.7	-1.0	-2.8	-5.8	-6.8
65	9.5	5.3	2.0	-13.8	-14.7
60	3.7	.7	-9.2	-11.7	-12.7
55	-14.2	-9.3	-.8	-19.7	-24.7
50	2.2	8.3	-9.0	10.5	-.5
45	24.5	6.3	-4.7	-7.5	14.5
40	9.2	-4.7	-13.8	2.3	-2.8
37.5	4.2	-2.0	-16.8	3.0	1.0
35	2.5	6.3	-4.5	3.5	3.5
32.5	-1.5	11.0	-2.7	3.8	4.8
30	-4.0	6.7	3.8	1.3	1.3
28	1.7	4.0	4.3	-.5	-.5
26	1.2	2.7	-1.2	.8	-.3
24	-2.3	3.7	1.8	2.3	1.3
22	-.3	4.3	.8	2.8	1.8
20	1.8	3.7	4.2	.8	1.8
19	3.8	4.0	5.2	-.3	2.8
18	6.2	3.3	4.7	-2.3	1.8
17	.5	3.3	4.3	-3.5	1.5
16	-6.2	3.7	3.7	-3.0	2.0
15	-2.2	2.7	3.5	-4.3	2.8
14	2.7		3.2		
13	4.7		2.3		
12	3.3		3.0		
11			4.8		
10					
9					
8					
7					

TABLE 6 f DATA FOR BREWER SONDE TYPE GDR

LEVEL MB	TOTAL MEAN	Δ_{TOT}	Δ_{DAY} 23.1.	24.1.	26.1.	27.1.	28.1.	29.1.	30.1.
800	19.8	-3.5	-7.7	1.5	-6.5	-12.5	1.0	-1.3	1.3
700	23.2	-1.7	-8.3	2.0	-4.5	-9.3	6.2	0.0	1.7
600	23.1	.2	-6.0	1.5	-5.0	-7.5	12.2	2.0	4.0
500	21.4	1.2	-5.5	5.3	-2.3	-6.3	13.0	3.2	1.2
400	19.0	.7	-4.8	10.5	.5	-6.3	4.7	-1.2	1.5
300	19.1	1.4	-5.3	11.7	6.0	-5.5	8.3	-5.2	-.2
250	29.0	1.6	-3.0	14.2	2.8	.3	6.7	-13.8	3.8
200	50.5	-2.1	-24.7	0.0	2.5	4.5	10.5	-9.3	2.0
175	63.5	-1.7	-31.8	4.8	-1.0	12.2	5.8	-3.2	1.3
150	76.5	-4.3	-34.0	2.3	-4.0	11.5	.3	-4.7	-1.5
137.5	78.4	-4.0	-37.2	14.7	1.3	5.0	3.8	-14.8	-1.0
125	74.4	-5.5	-18.8	9.5	7.3	.3	-20.7	-16.5	.7
112.5	90.2	5.5	-8.8	7.0	-4.0	51.3	6.5	-6.3	-6.8
100	86.0	-.8	3.8	3.0	-5.8	-1.3	-10.5	-3.3	8.3
90	96.4	-4.6	6.5	-5.0	1.5	-7.3	-19.3	-1.7	-7.0
80	114.9	4.2	7.7	-3.3	-10.2	9.0	-12.2	21.0	17.2
70	138.5	2.3	32.5	-14.2	-11.3	14.5	-12.8	16.0	-8.3
65	146.3	2.7	27.3	-16.0	-14.2	13.2	-9.0	15.3	2.5
60	153.0	5.2	13.0	-1.5	-3.8	16.0	-5.3	13.3	-1.3
55	162.9	3.5	14.0	-9.3	-1.0	23.8	-7.5	12.5	-8.2
50	176.7	1.6	23.5	-3.0	-15.7	10.2	-8.2	10.0	-5.8
45	181.8	1.9	15.2	-6.3	5.0	15.2	-8.7	8.5	-15.5
40	181.8	5.3	6.3	-3.3	17.7	40.2	-16.3	.8	-8.8
37.5	171.4	.6	3.7	-5.0	15.2	12.7	-12.2	-3.7	-6.8
35	167.2	3.5	11.0	-11.7	15.0	19.2	-8.7	-.2	-.5
32.5	154.7	1.8	11.0	-14.0	8.8	13.8	-12.2	1.7	3.5
30	142.8	1.6	5.5	-13.5	5.5	11.0	-6.2	4.2	5.0
28	136.9	3.8	8.2	-7.0	3.8	21.7	-3.5	4.7	-1.3
26	126.4	-.1	5.7	0.0	-9.3	13.0	-1.3	-3.2	-5.8
24	118.1	-.6	5.5	0.0	.5	-1.3	-.7	-6.0	-2.3
22	112.3	1.0	2.0	.8	3.3	.8	6.0	-6.7	.7
20	102.7	-1.4	-1.8	0.0	4.0	-4.3	-3.0	-4.3	-.2
19	98.8	-1.2	-6.7	.8	.5	1.5	-1.8		-1.2
18	95.7	-.7	2.3	1.8	-1.3	-5.8	-1.3		.2
17	91.3	-.6	4.2	-.5	-4.5	-4.0	-2.5		3.5
16	86.9	-1.0	1.5	.3	-6.5	-7.0	-2.2		7.8
15	81.6	-2.0	.5	-1.0	-5.3	-11.5	-1.4		6.8
14	79.3	.7	-1.7	0.0	-.5		0.0		5.7
13	74.4	.9	-1.0	-.8	5.3		-3.6		4.7
12	72.3	3.0	.6	-1.8	9.0		-2.4		9.3
11	65.7	1.6	.3	-2.3	5.7		-2.3		6.8
10	57.3	-.9	2.3	-6.5	0.0				.7
9	50.4	-.6	5.5	-4.8	-2.7				
8	49.4	1.3	4.3	-1.7					
7	44.3	-.7		-.7					

Table 7: Mean values (nb partial pressure) for "Umkehr" layers 1 - 6 and their differences for tandem flights with the same type of sondes

Layer	Br.Mast (19.1.) A	B	|Δ|	ECC (2.2.) A	B	|Δ|	KC-68 (2.2.) A	B	|Δ|
1	27.5	26.3	1.2	23.9	26.8	2.9	17.5	23.8	6.3
2	15.2	15.5	0.3	17.4	19.0	1.6	16.5	18.8	2.3
3	48.0	50.4	2.4	76.3	70.9	5.4	81.1	85.7	4.6
4	110.7	111.2	0.5	152.2	144.1	8.1	155.5	160.6	5.1
5	165.8	161.9	3.9	203.4	204.1	0.7	206.7	197.9	8.8
6	128.0	129.5	1.5	132.6	135.4	2.8	133.6	123.6	10.0
CF	1.25	1.17		0.97	0.92		1.06	1.03	
$\sum \|\Delta\|$			9.8			21.5			37.1
VVM	172	153		466	352		341	391	

Layer	Br.It. (5.2.) A	B	|Δ|	Br.Mast (11.3.) 730-5	730-7T	|Δ|	Br.Mast (25.3.) 730-5	730-7T	|Δ|
1	21.0	20.3	0.7	20.8	27.4	6.6	27.5	27.4	0.1
2	24.8	23.5	1.3	11.8	19.4	7.6	27.8	26.3	1.5
3	90.0	84.0	6.0	117.8	123.2	4.4	113.2	118.1	4.9
4	111.5	109.0	2.5	191.1	188.0	3.1	102.7	106.6	3.9
5	180.1	178.6	1.5	196.7	194.3	2.4	153.1	157.8	4.7
6	117.3	118.4	1.1	117.7	114.2	3.5	136.6	134.1	2.5
CF	1.27	1.22		1.17	1.25		0.99	1.03	
$\sum \|\Delta\|$			13.1			27.6			17.6
VVM	185	173		406	296		362	371	

CF = correction factor

VVM = vertical variability measure

8.2. Figures

Page:

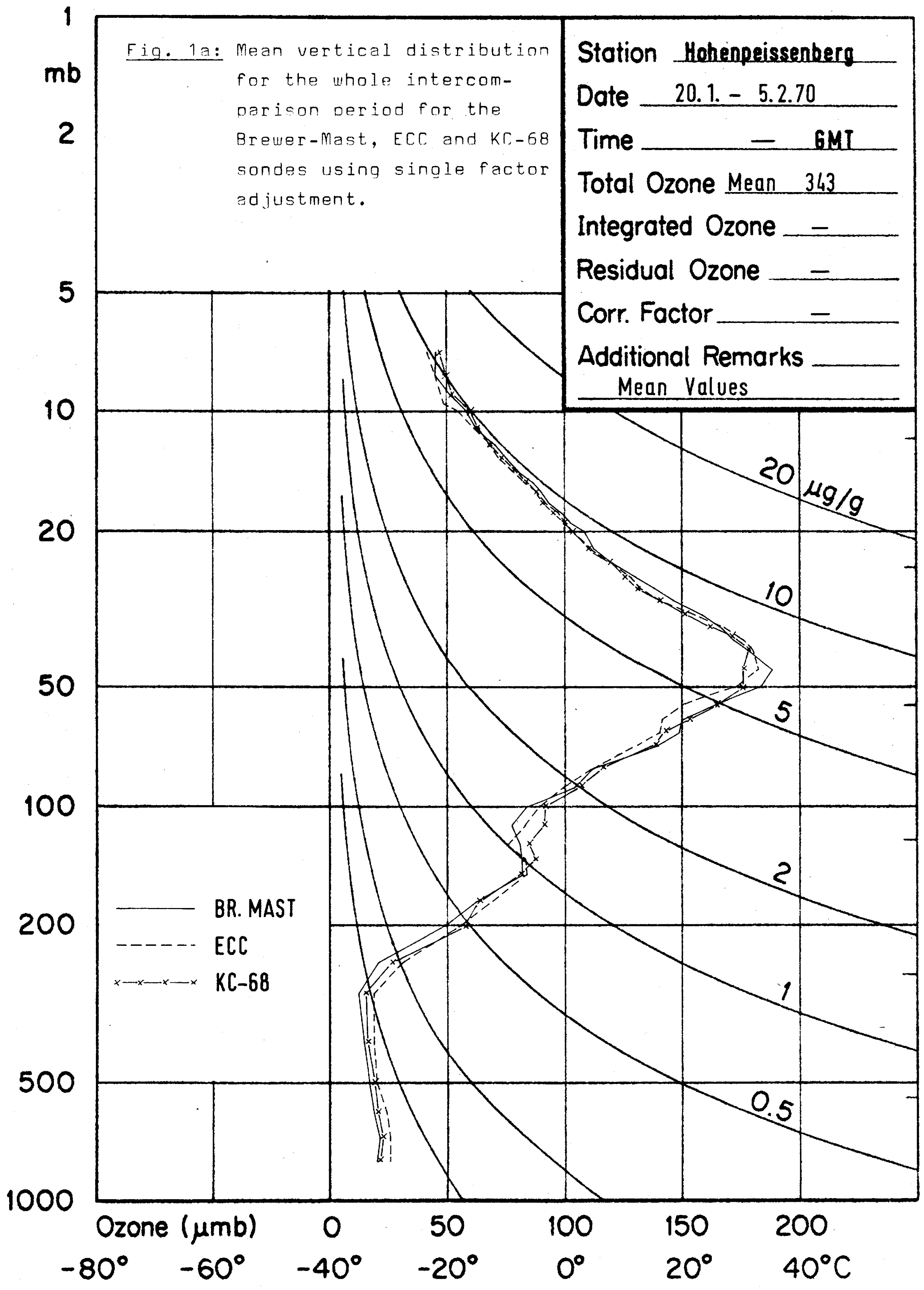


Fig. 1a: Mean vertical distribution for the whole intercomparison period for the Brewer-Mast, ECC and KC-68 sondes using single factor adjustment.

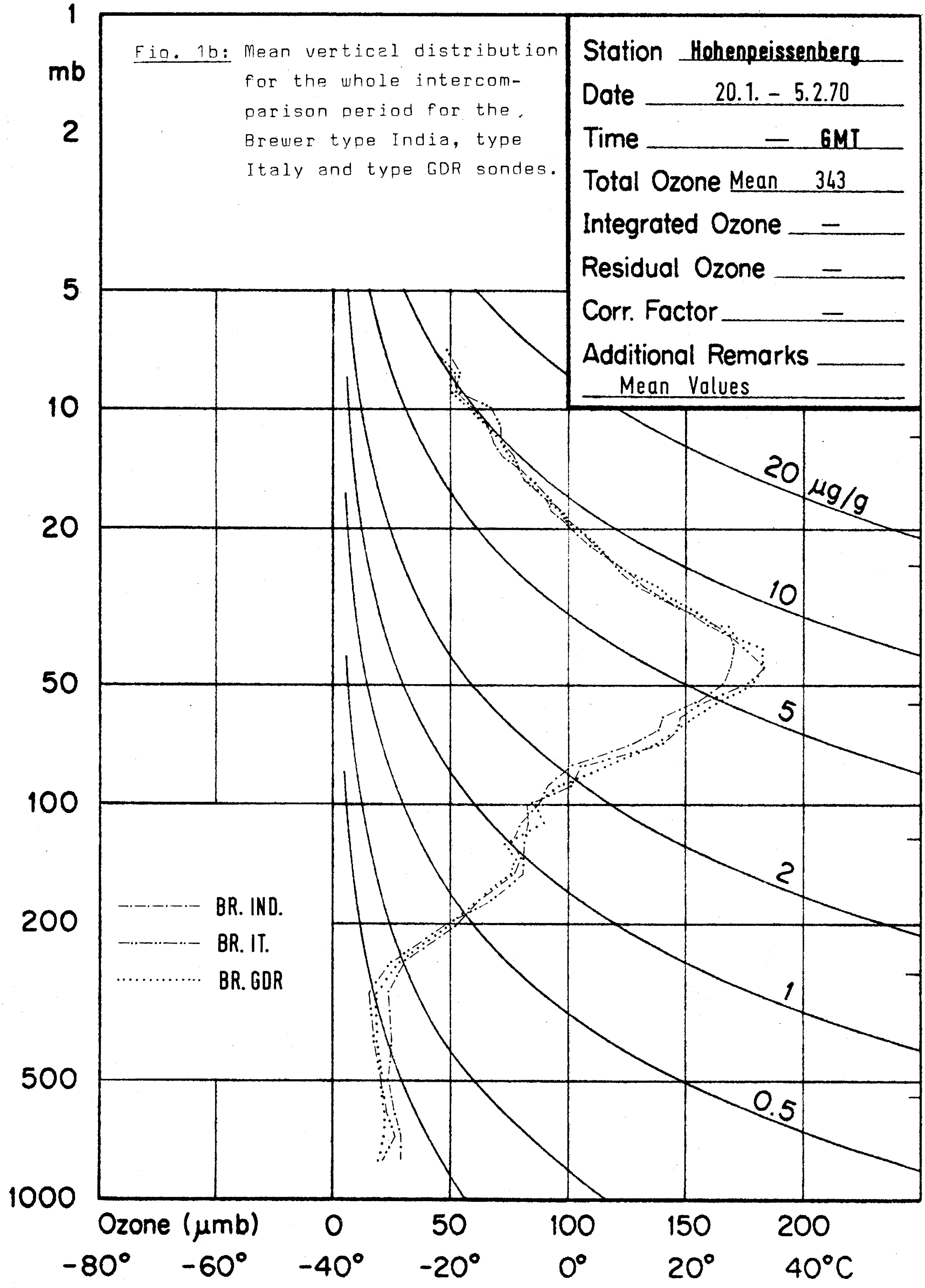


Fig. 1b: Mean vertical distribution for the whole intercomparison period for the Brewer type India, type Italy and type GDR sondes.

Fig. 2a: Average deviation of each sonde from overall mean computed for "Umkehr" layers.

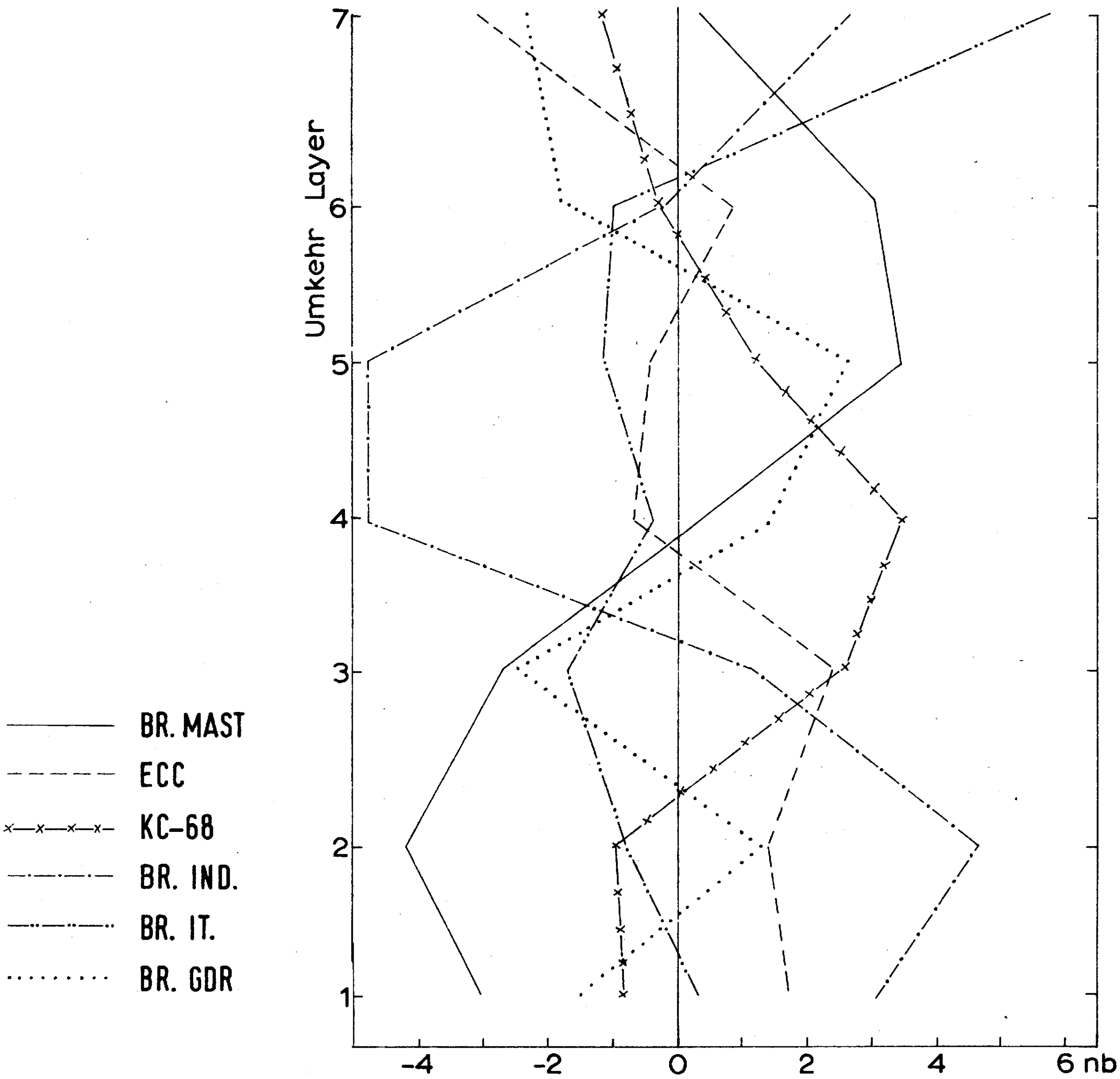
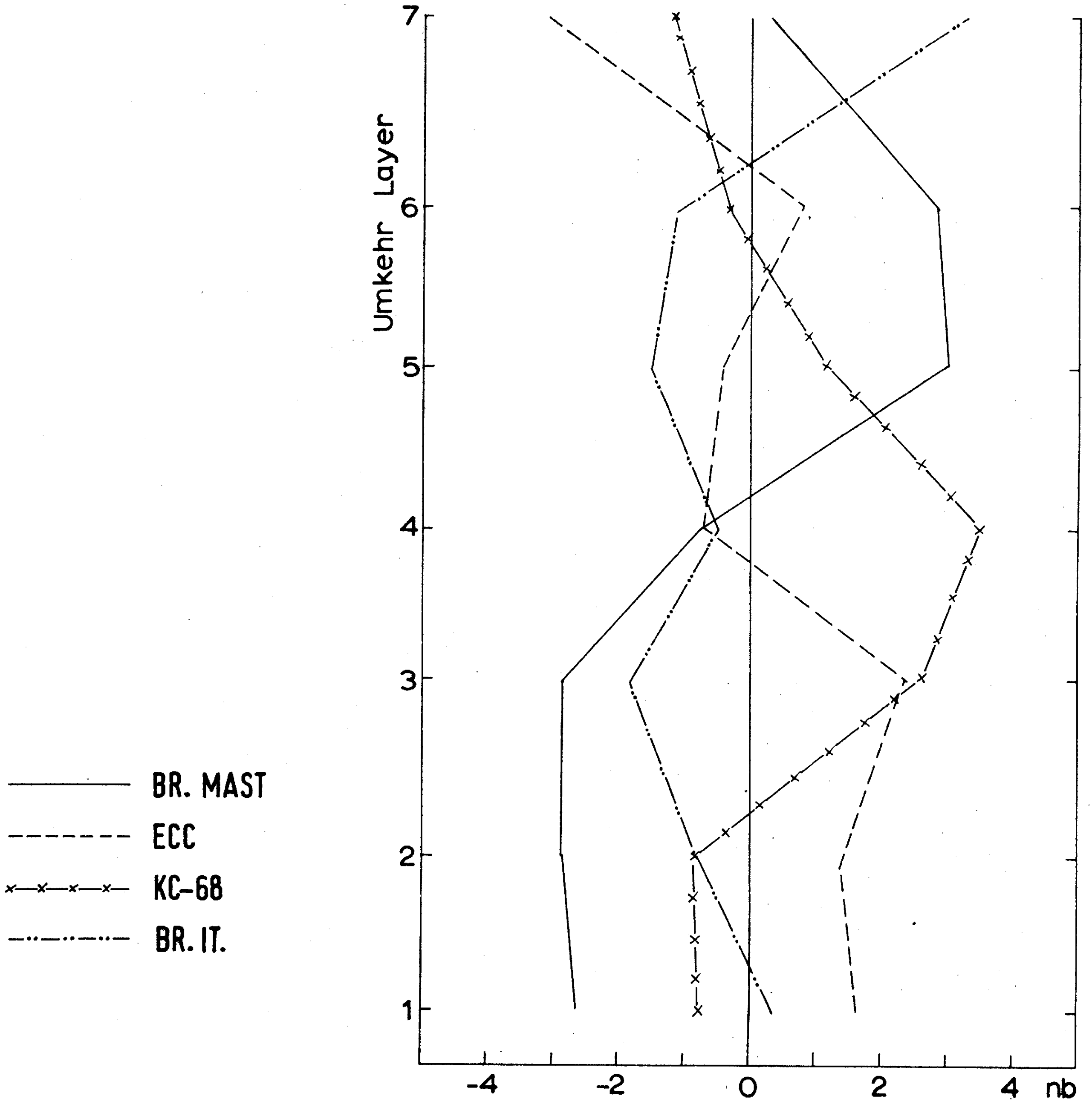


Fig. 2b: Average deviation of Brewer-Mast, ECC, KC-68 and Brewer type Italy sondes from overall mean computed for "Umkehr" layers.



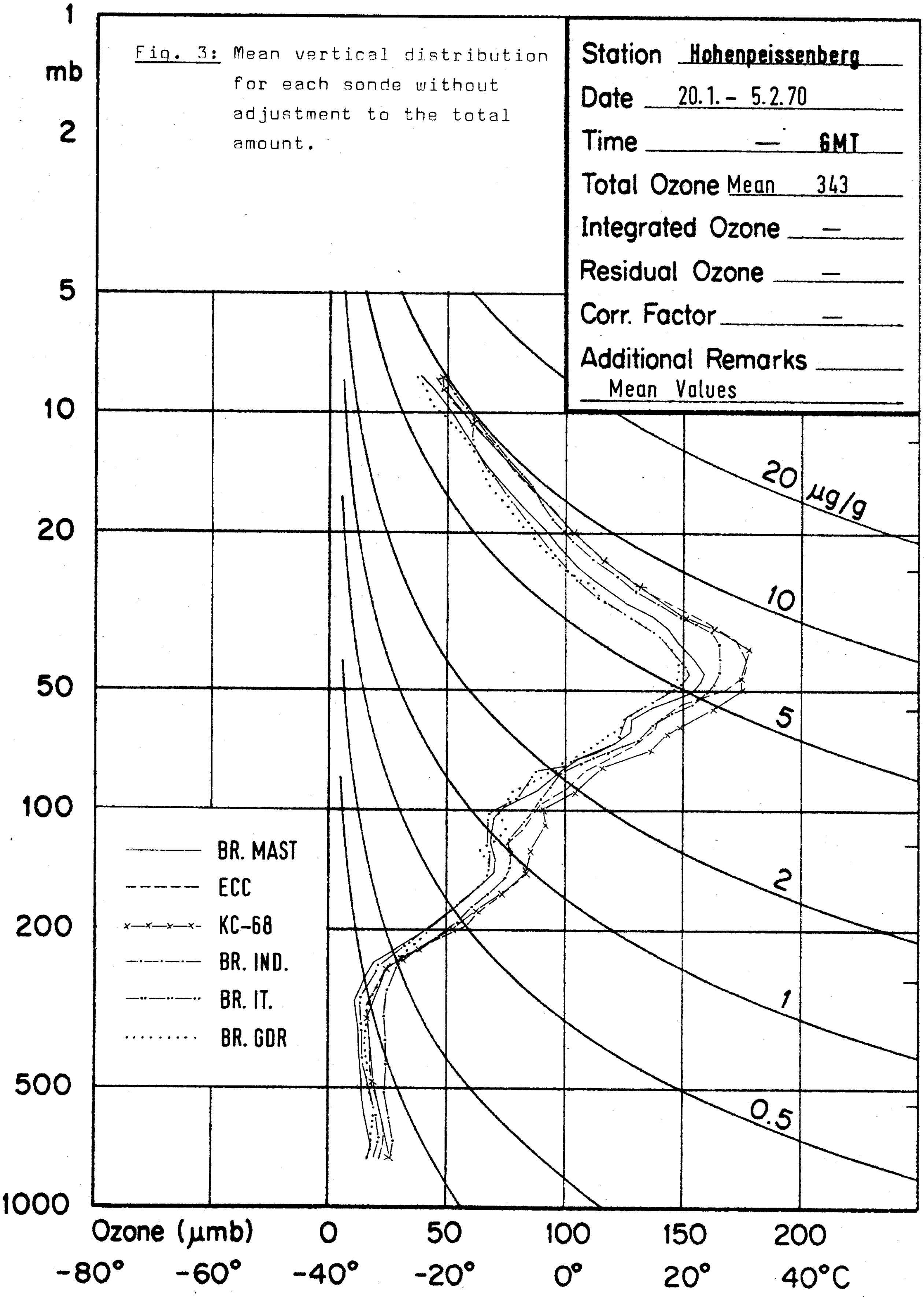


Fig. 3: Mean vertical distribution for each sonde without adjustment to the total amount.
Station Hohenpeissenberg
Date 20.1.- 5.2.70
Time — GMT
Total Ozone Mean 343
Integrated Ozone —
Residual Ozone —
Corr. Factor —
Additional Remarks
Mean Values
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
BR. MAST
ECC
KC-68
BR. IND.
BR. IT.
BR. GDR
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

Fig. 4a: Average deviation of the Brewer-Mast, ECC and KC-68 sondes from the overall mean computed for the narrow layers between standard pressure levels.

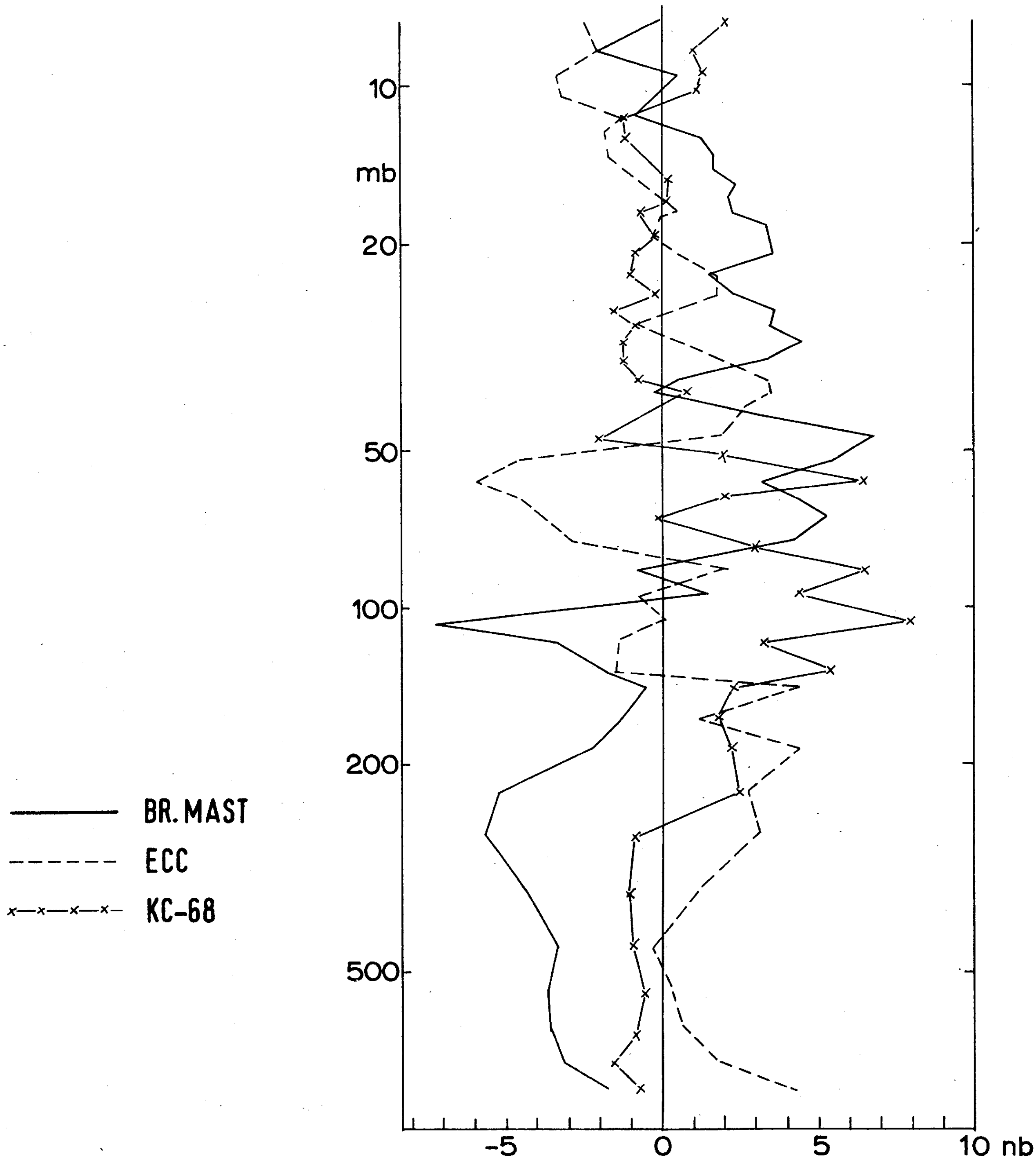


Fig. 4b: Average deviation of the Brewer type India, Italy and GDR sondes from the overall mean computed for the narrow layers between standard pressure levels.

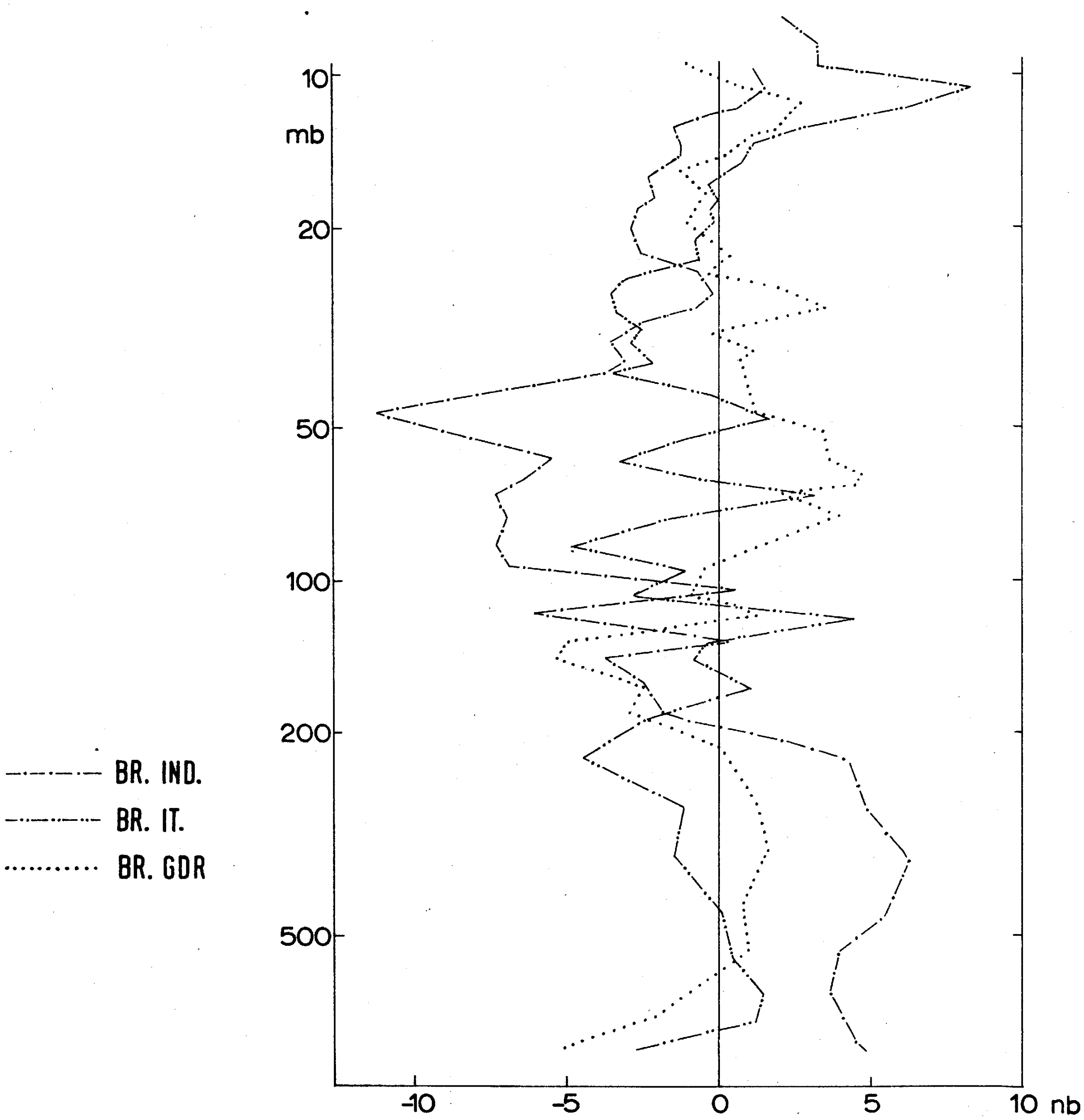


Fig. 5a: Depression of ozone readings at low levels due to contamination of the instrument (Brewer-Mast) before launch.

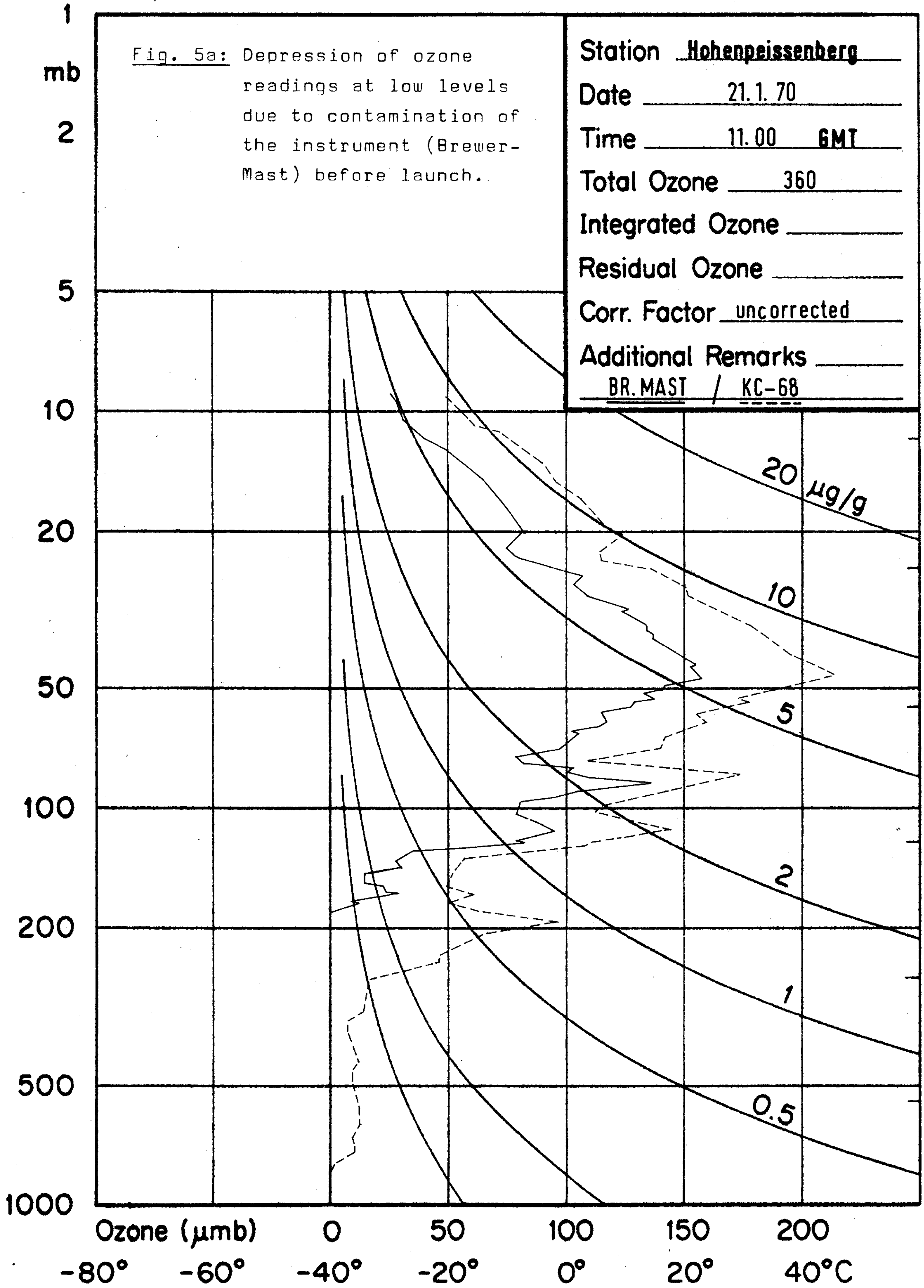
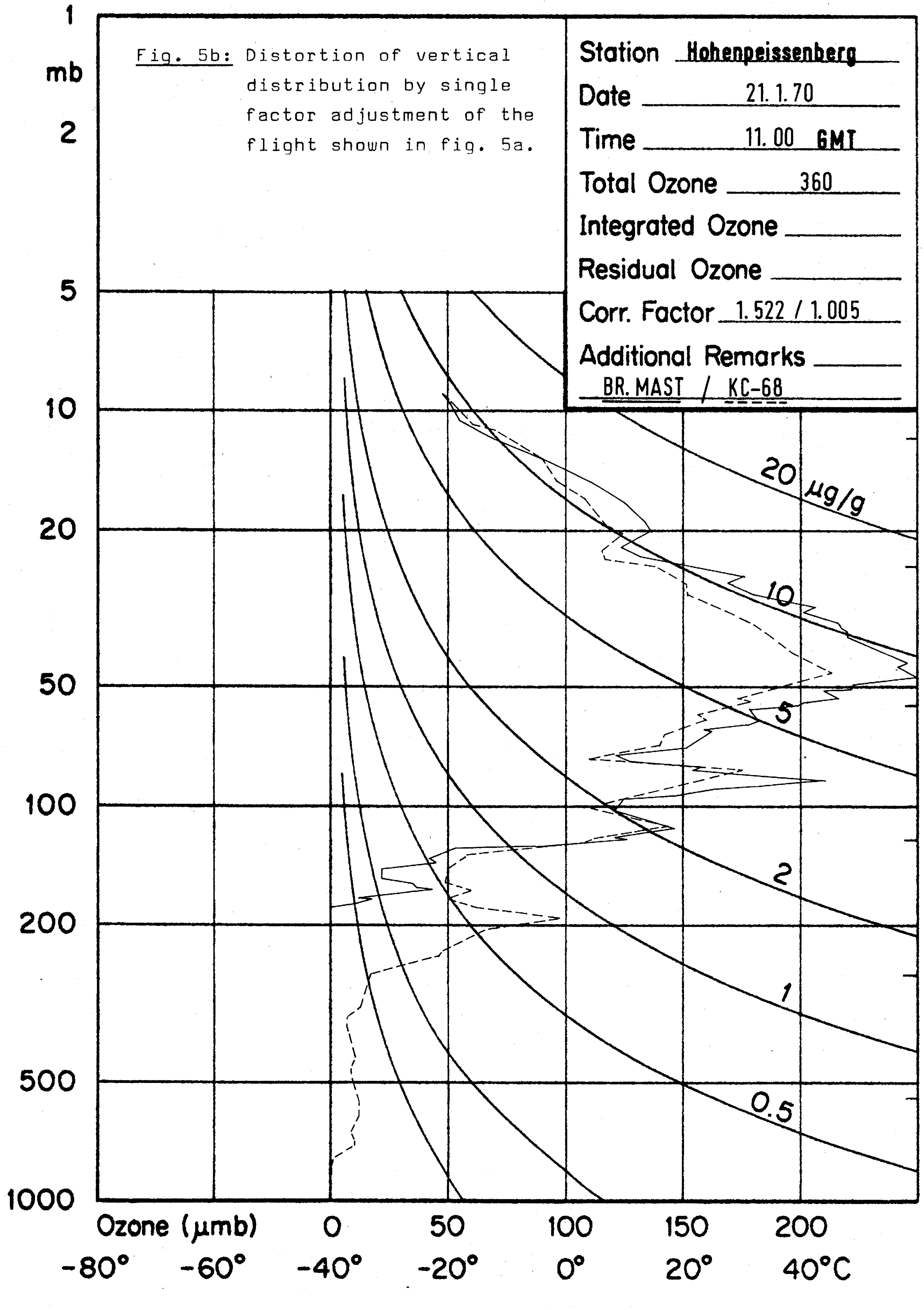


Fig. 5b: Distortion of vertical distribution by single factor adjustment of the flight shown in fig. 5a.



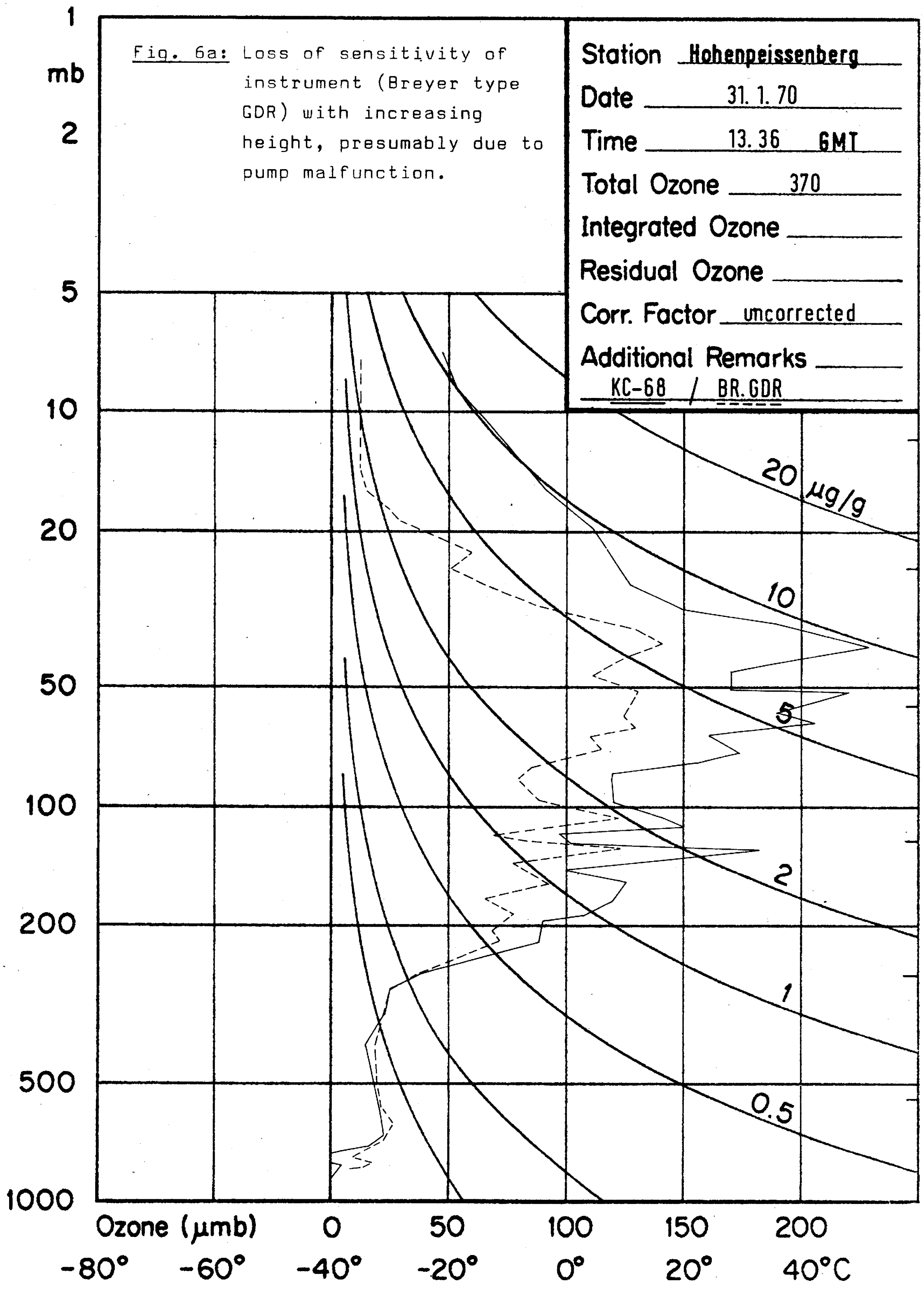


Fig. 6a: Loss of sensitivity of instrument (Breyer type GDR) with increasing height, presumably due to pump malfunction.
Station Hohenpeissenberg
Date 31. 1. 70
Time 13.36 GMT
Total Ozone 370
Integrated Ozone
Residual Ozone
Corr. Factor uncorrected
Additional Remarks
KC-68 / BR.GDR
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

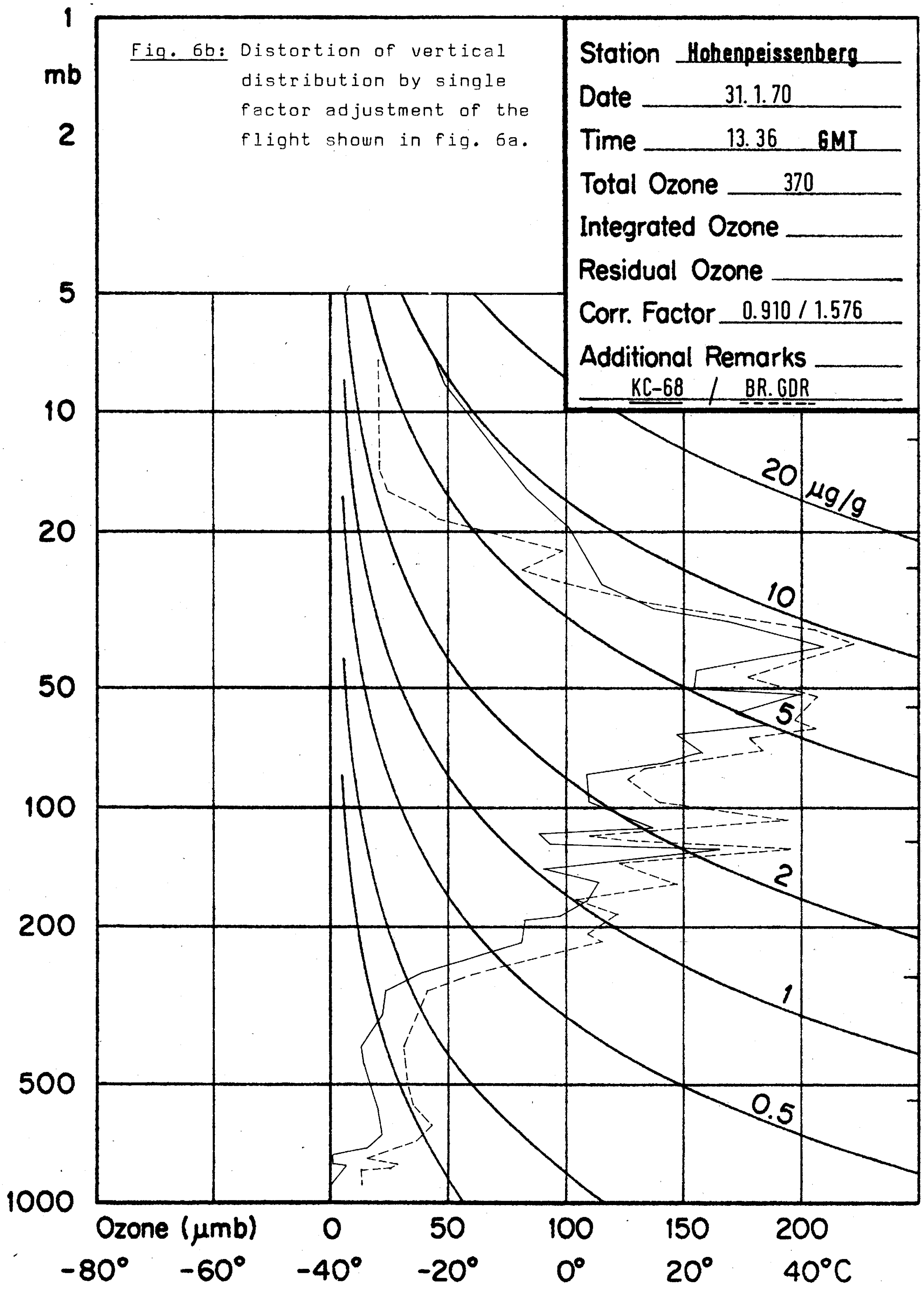
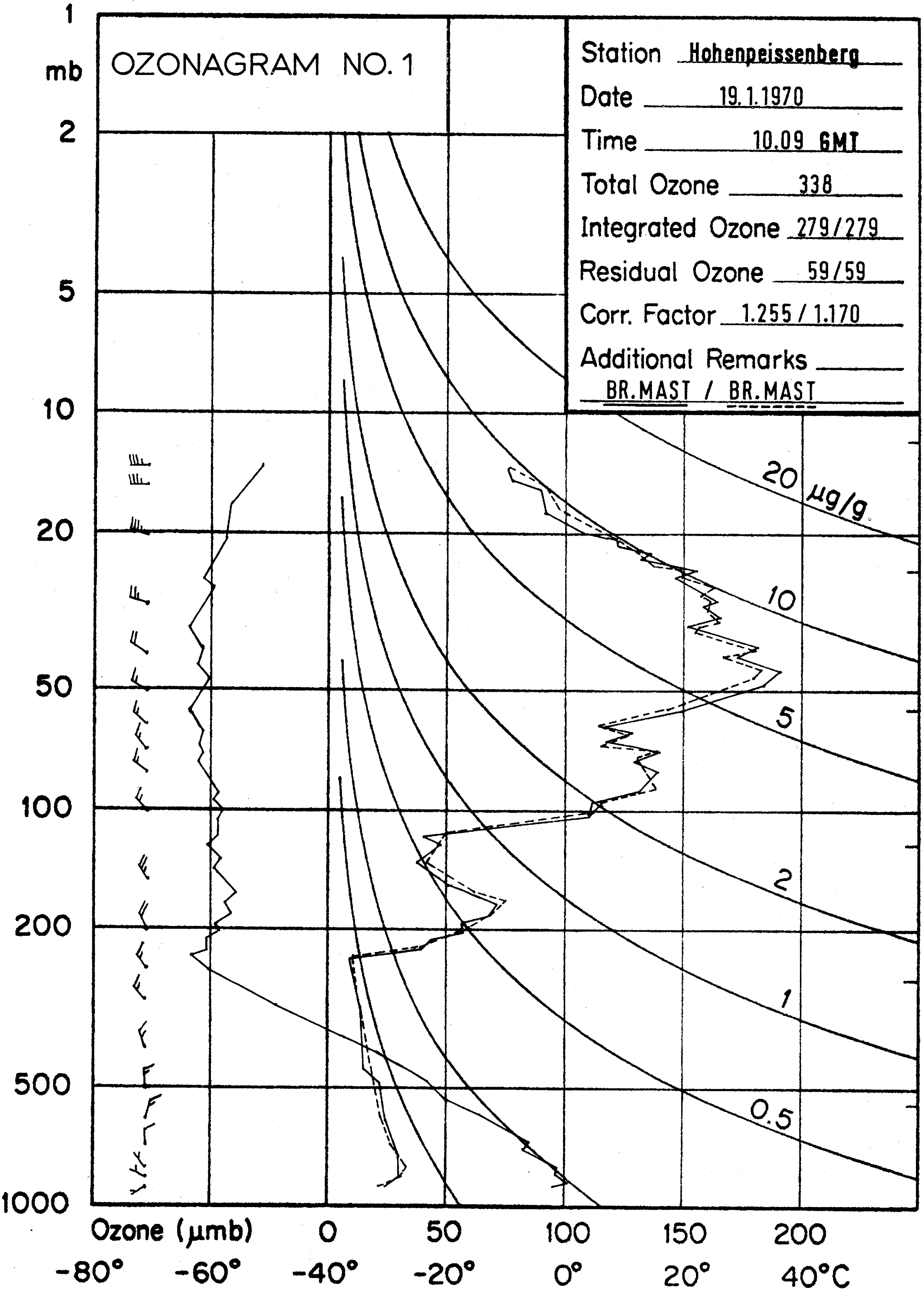
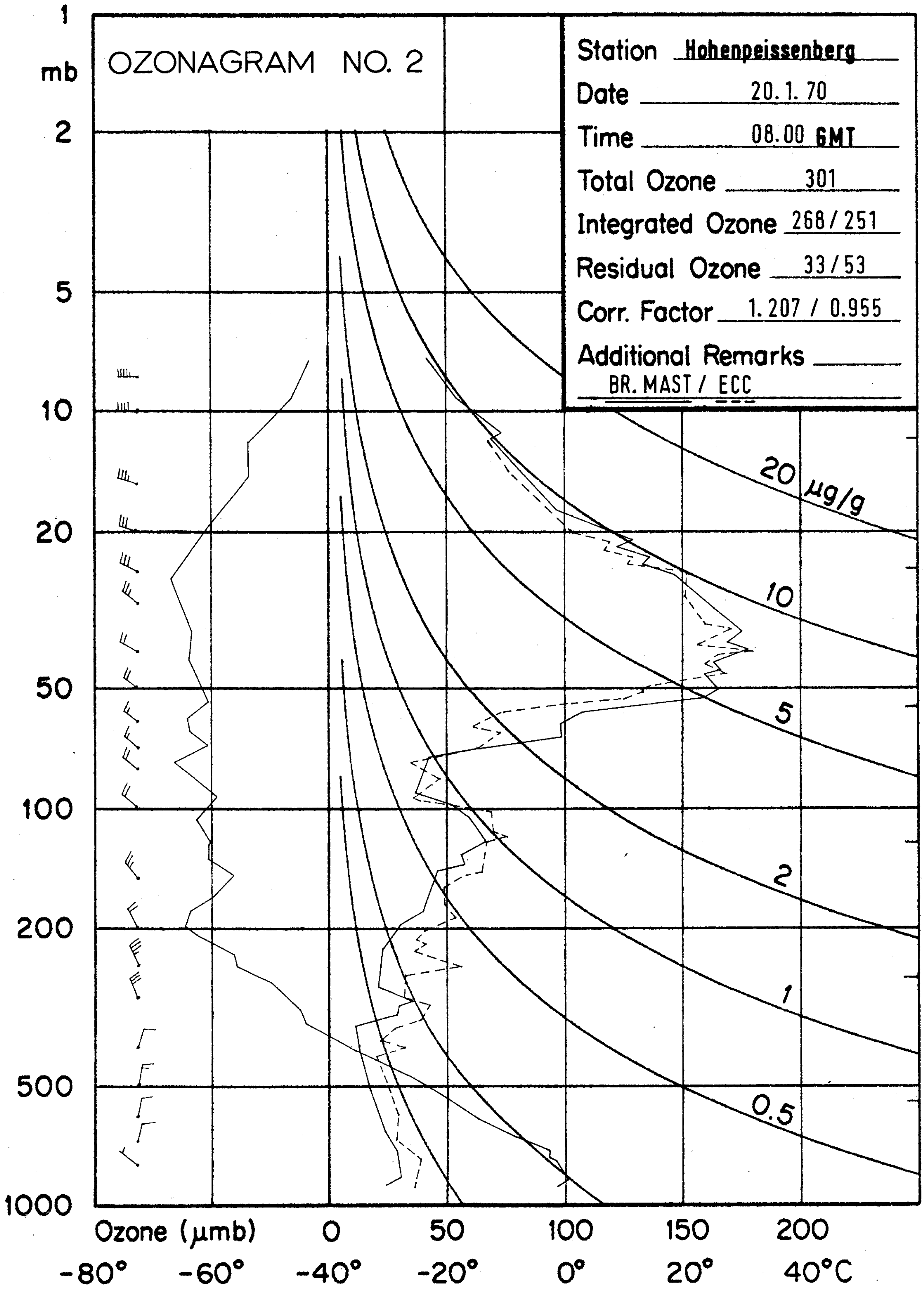


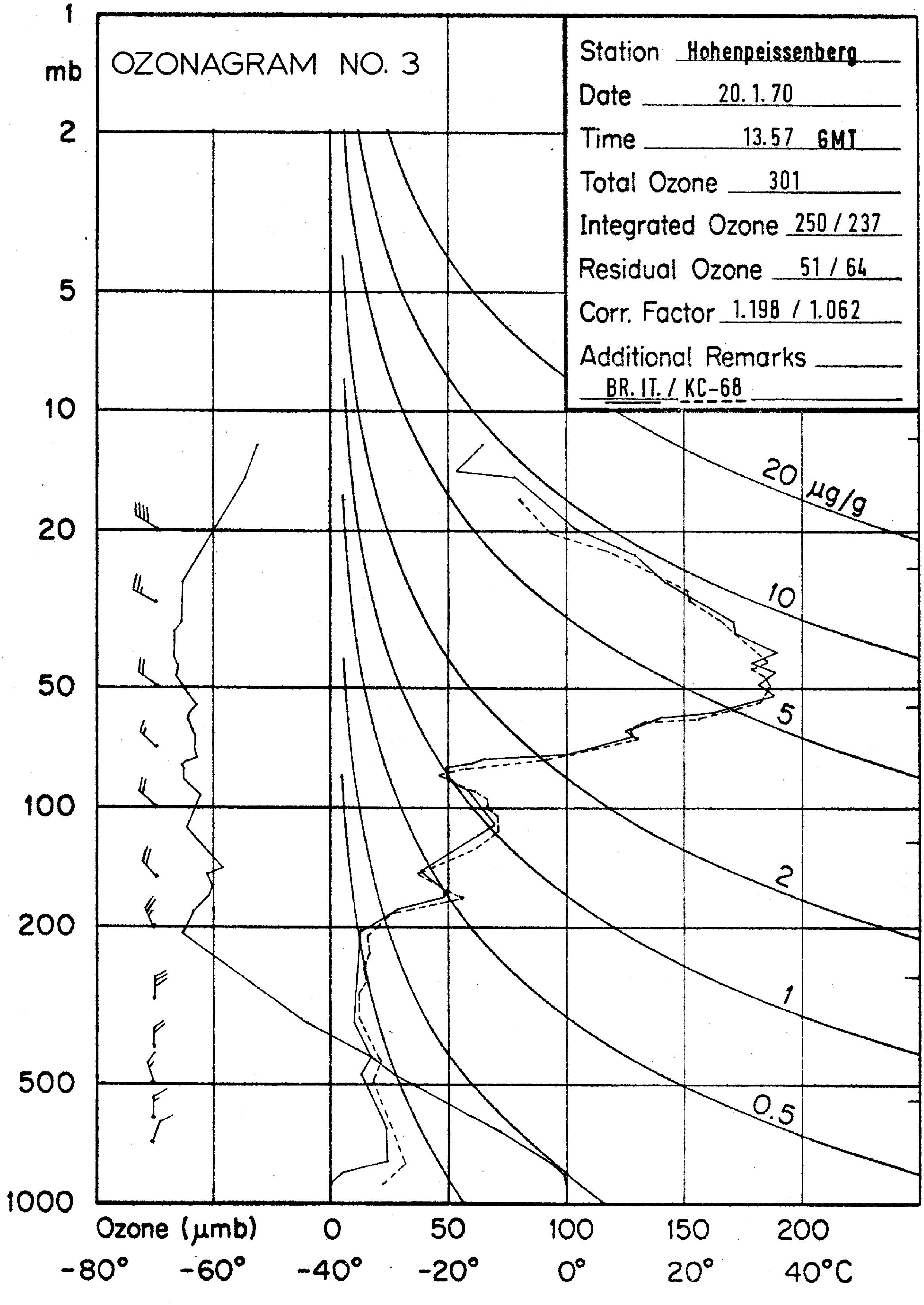
Fig. 6b: Distortion of vertical distribution by single factor adjustment of the flight shown in fig. 6a.

8.3. Ozonagrams

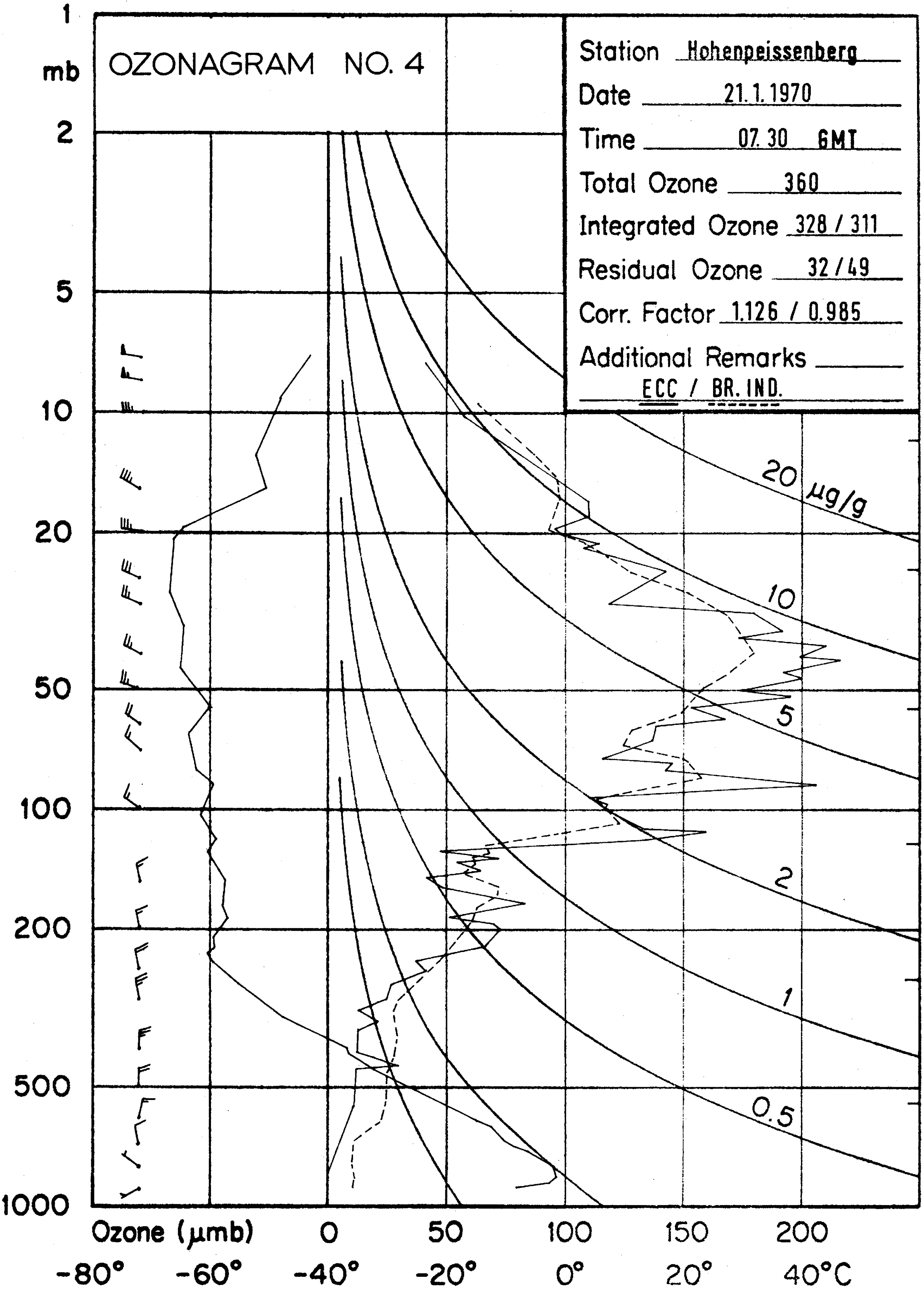
For each successful flight the ozone profiles of both ozone sondes, the temperature profile of the sonde being used for the air pressure measurement and the vector winds aloft are represented on the following pages.

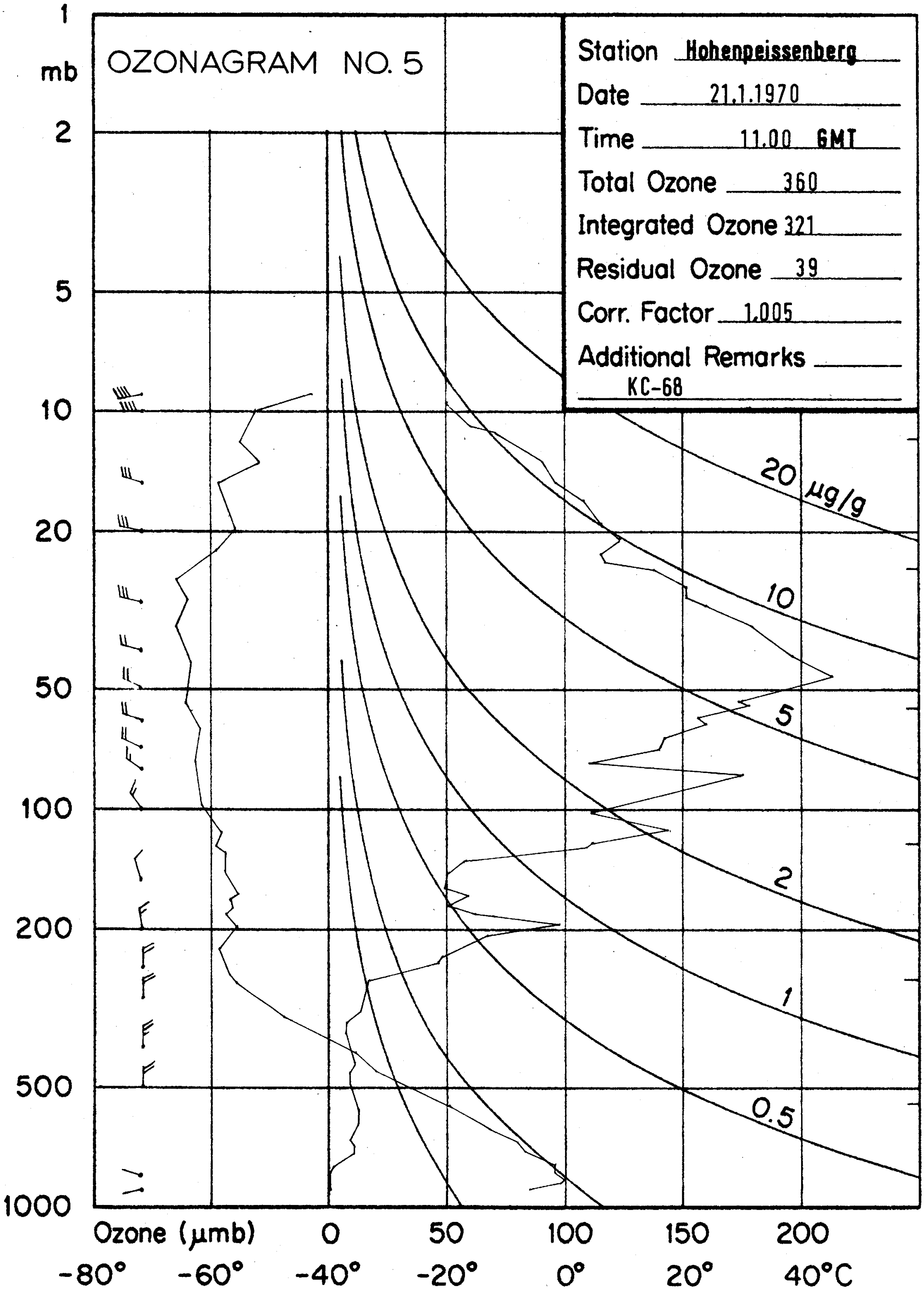

OZONAGRAM NO. 1
Station Hohenpeissenberg
Date 19.1.1970
Time 10.09 GMT
Total Ozone 338
Integrated Ozone 279/279
Residual Ozone 59/59
Corr. Factor 1.255 / 1.170
Additional Remarks
BR.MAST / BR.MAST
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

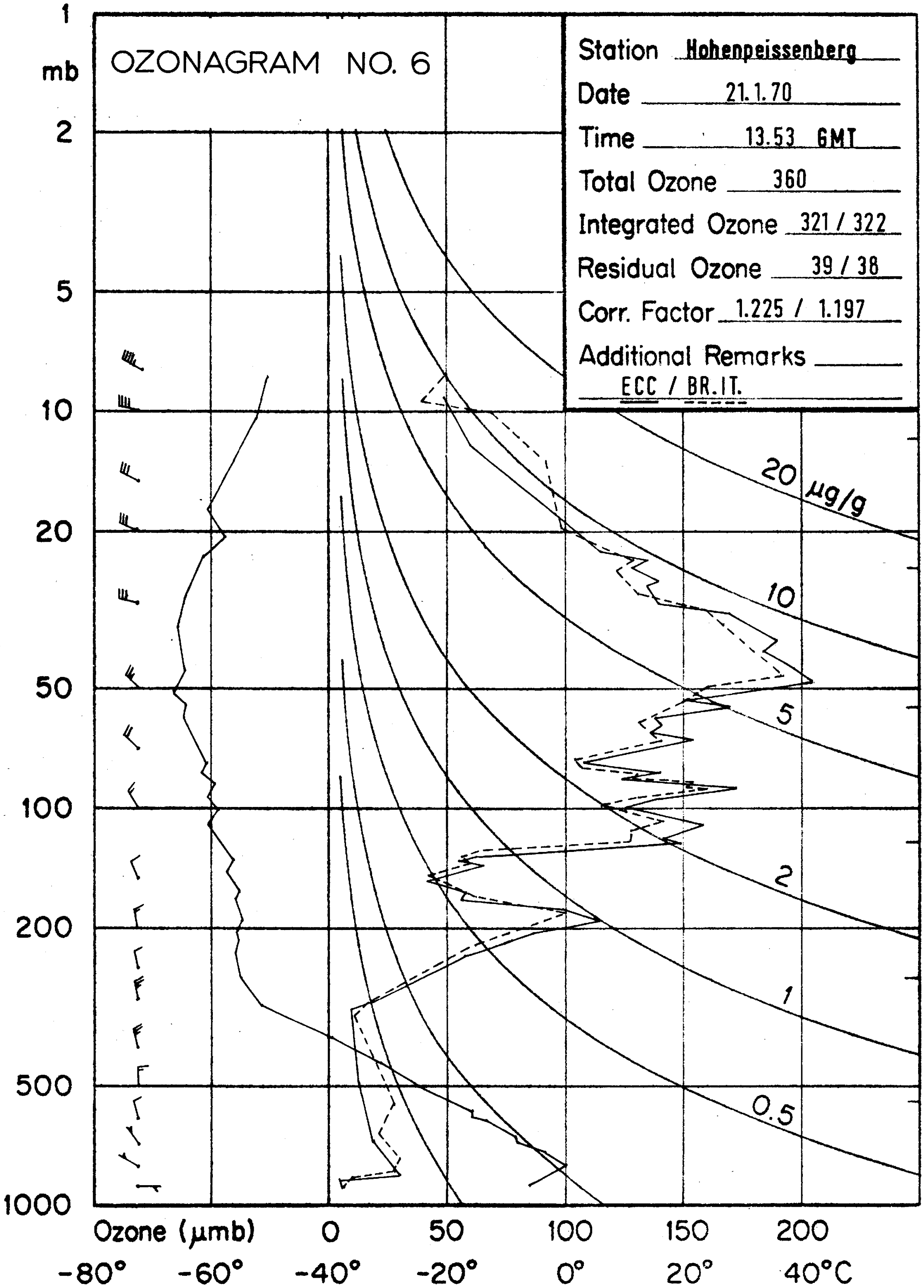

OZONAGRAM NO. 2
Station Hohenpeissenberg
Date 20.1.70
Time 08.00 GMT
Total Ozone 301
Integrated Ozone 268/251
Residual Ozone 33/53
Corr. Factor 1.207 / 0.955
Additional Remarks
BR. MAST / ECC
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C

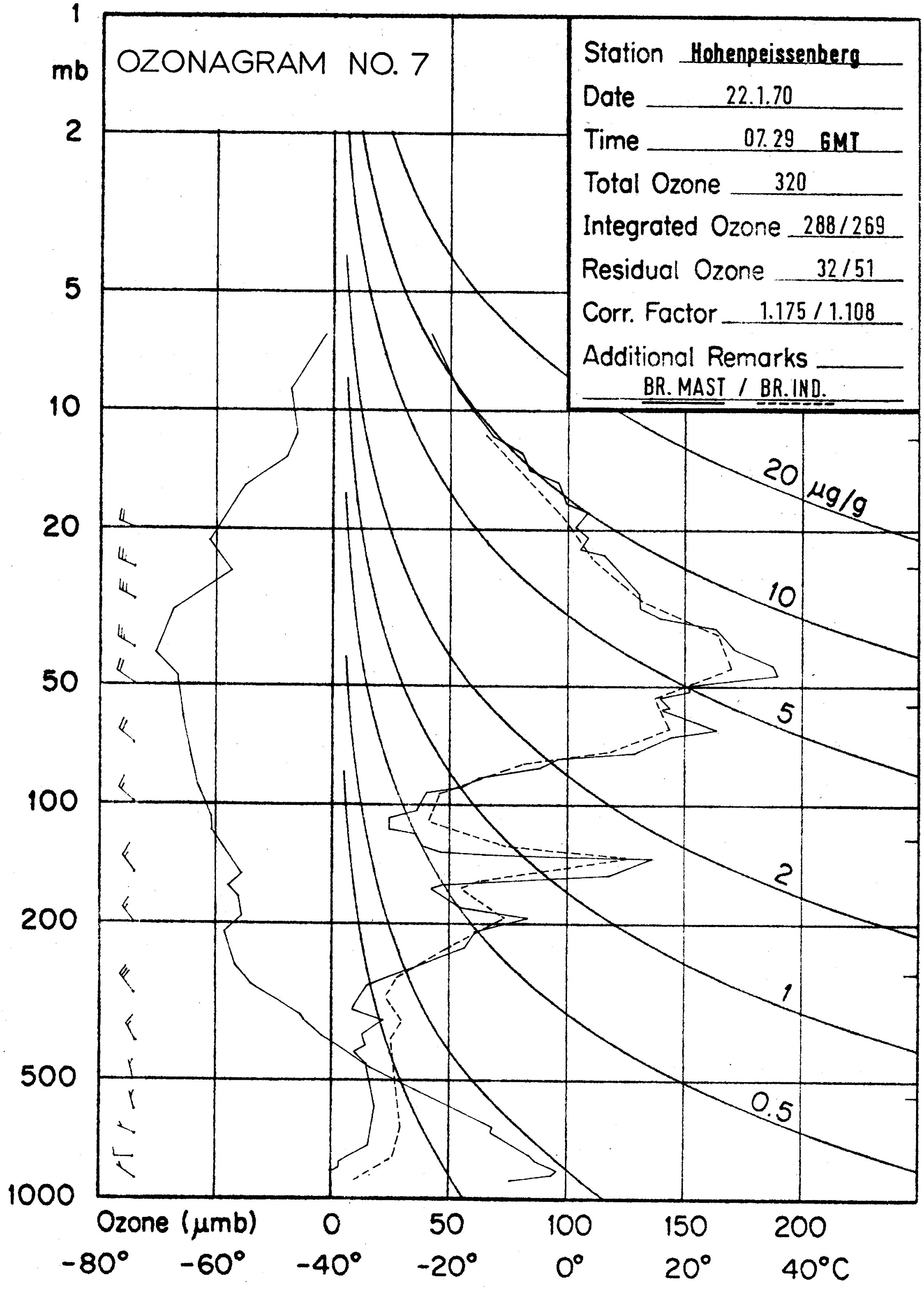


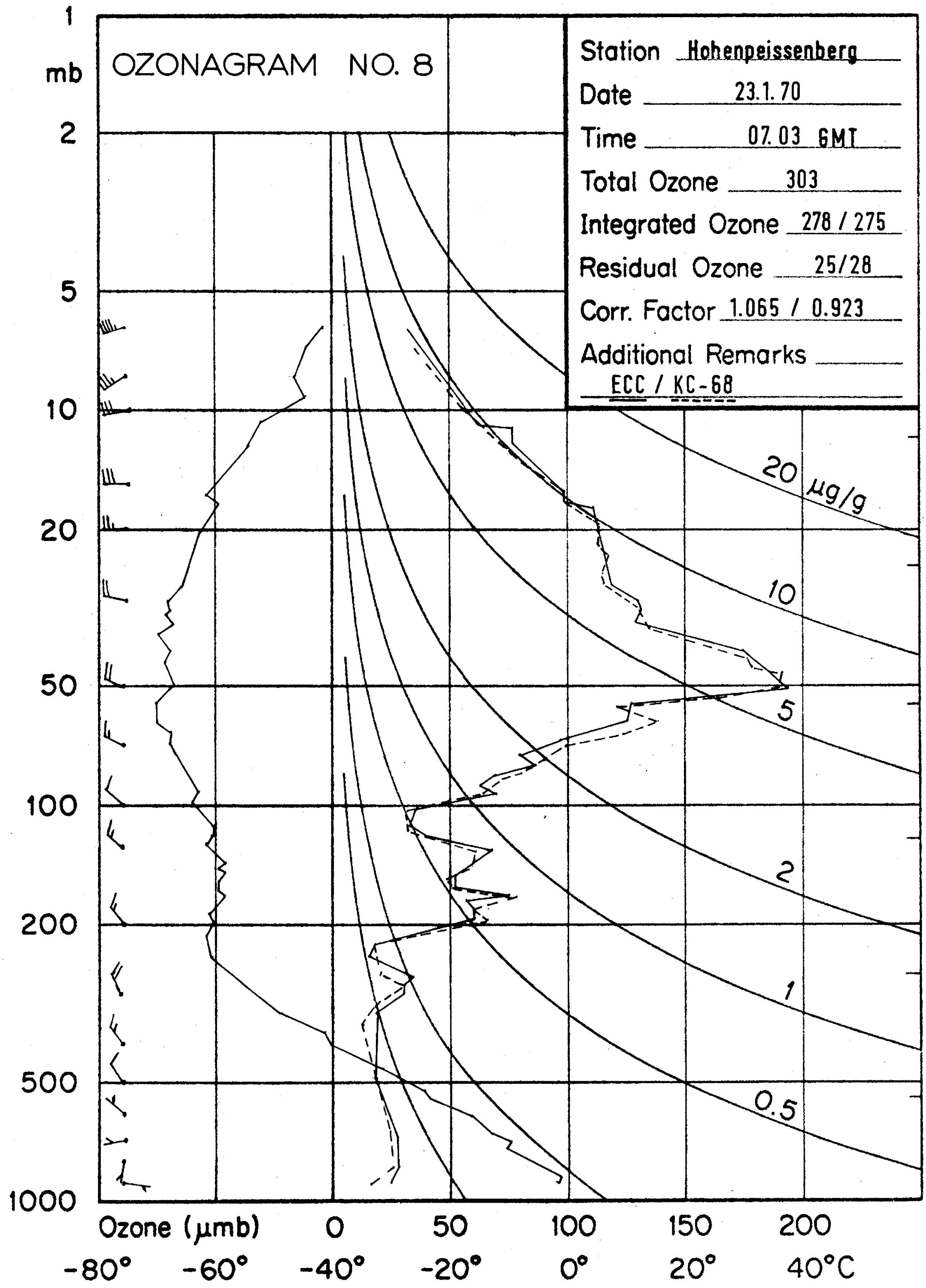
OZONAGRAM NO. 3
Station Hohenpeissenberg
Date 20.1.70
Time 13.57 GMT
Total Ozone 301
Integrated Ozone 250 / 237
Residual Ozone 51 / 64
Corr. Factor 1.198 / 1.062
Additional Remarks
BR. IT. / KC-68
1
mb
2
5
10
20
50
100
200
500
1000
20 μg/g
10
5
2
1
0.5
Ozone (μmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

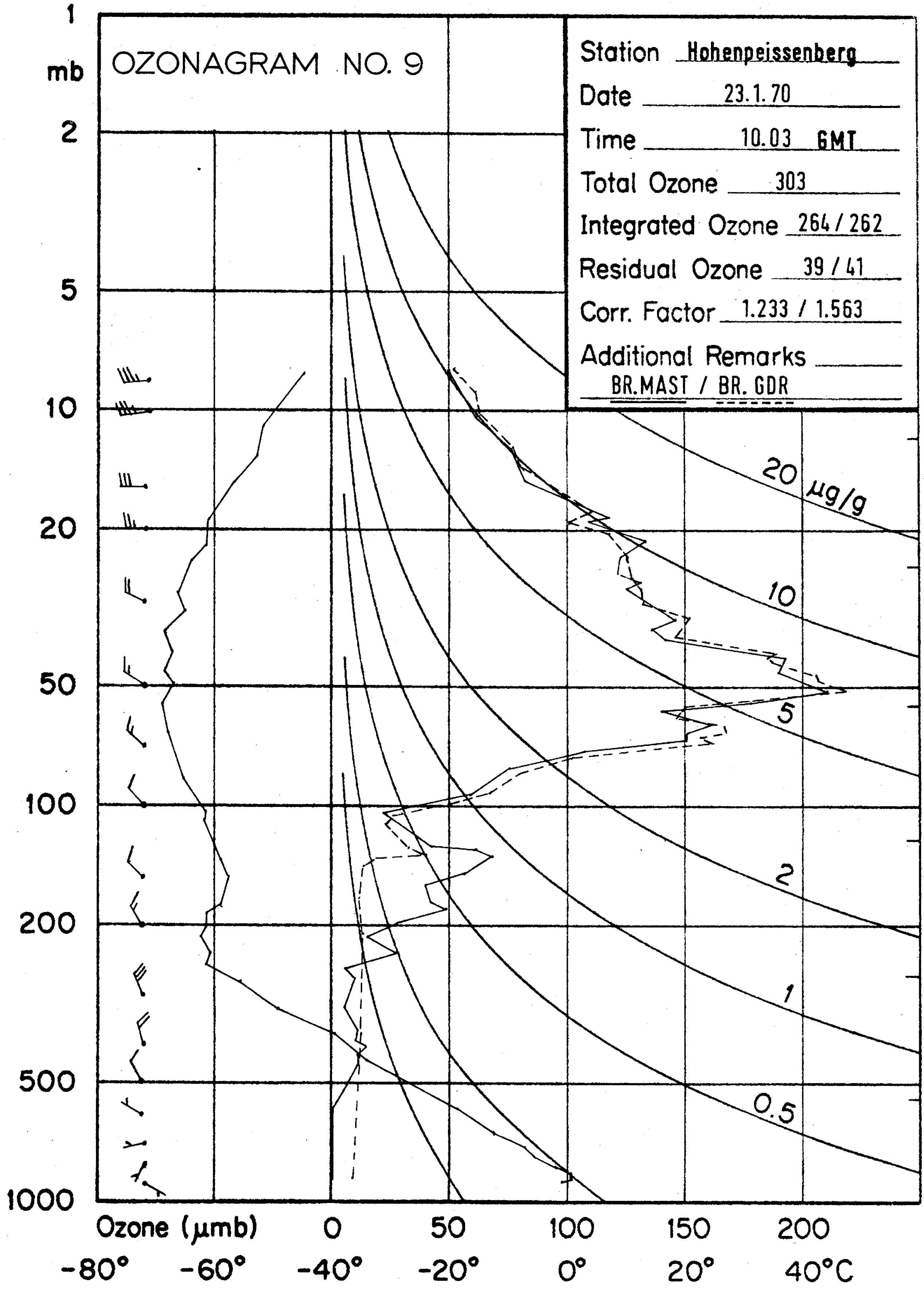

OZONAGRAM NO. 4
Station Hohenpeissenberg
Date 21.1.1970
Time 07.30 GMT
Total Ozone 360
Integrated Ozone 328 / 311
Residual Ozone 32 / 49
Corr. Factor 1.126 / 0.985
Additional Remarks
ECC / BR. IND.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C

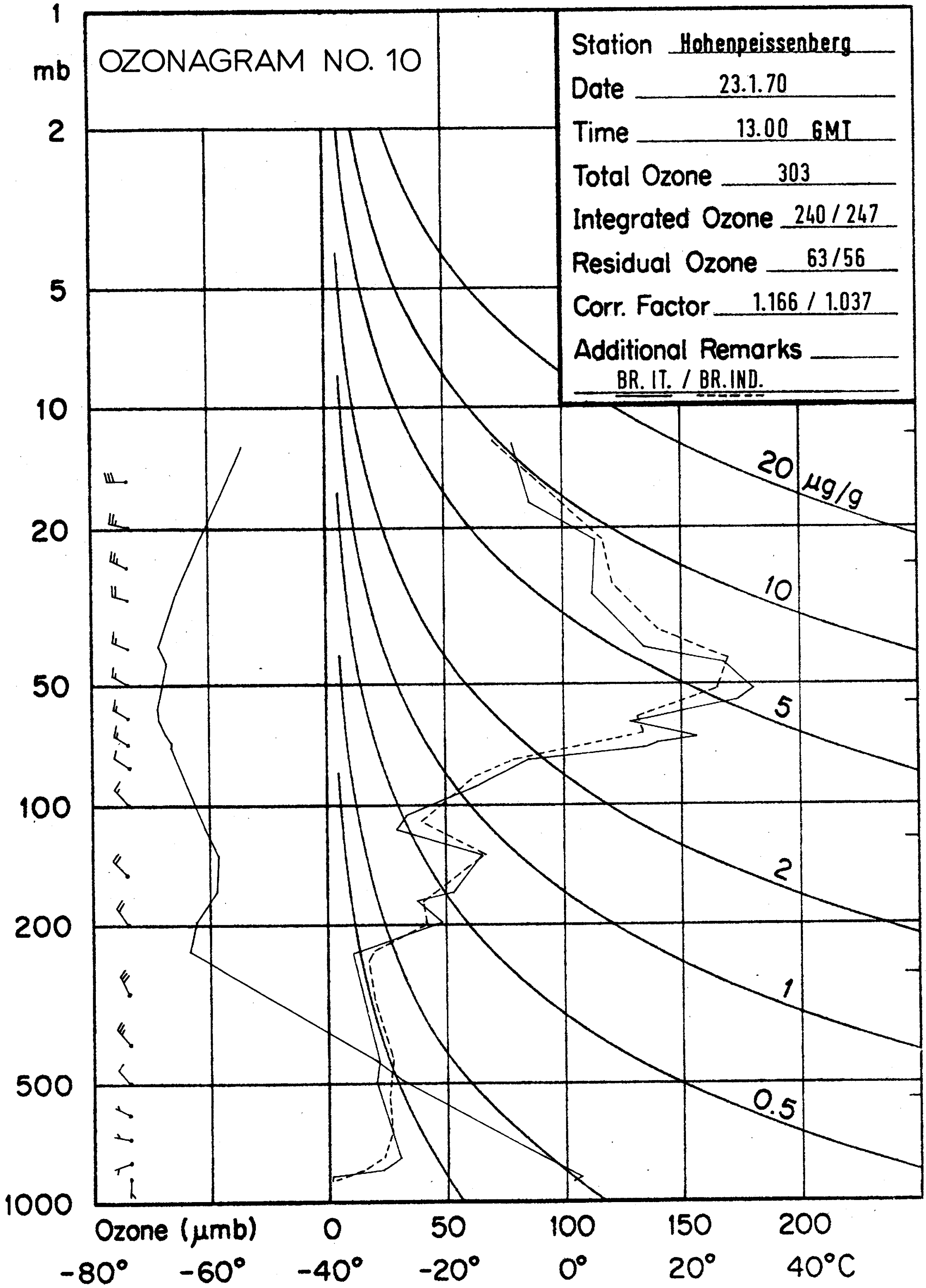

OZONAGRAM NO. 5
Station Hohenpeissenberg
Date 21.1.1970
Time 11.00 GMT
Total Ozone 360
Integrated Ozone 321
Residual Ozone 39
Corr. Factor 1.005
Additional Remarks
KC-68
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C

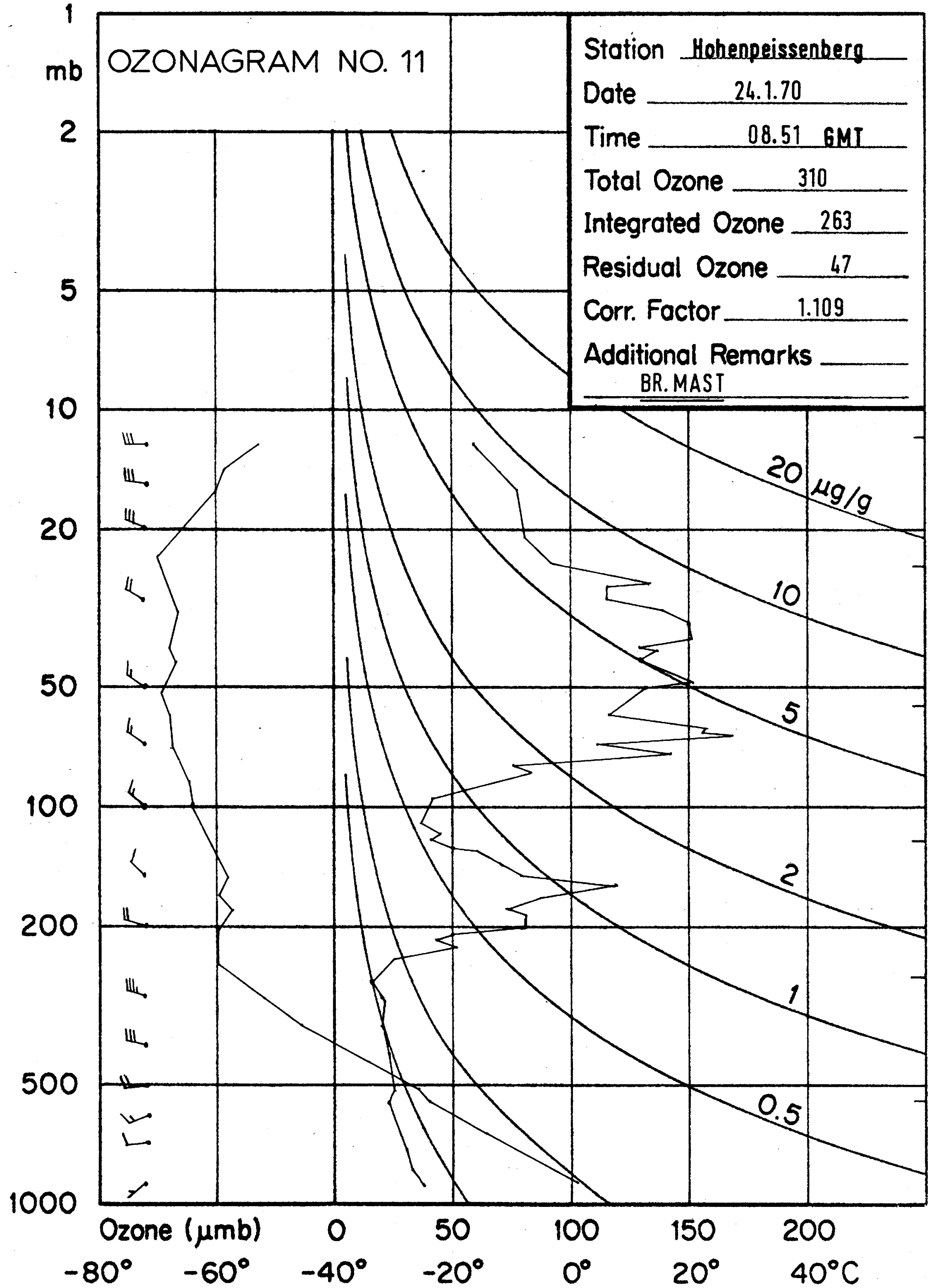

OZONAGRAM NO. 6
Station Hohenpeissenberg
Date 21.1.70
Time 13.53 GMT
Total Ozone 360
Integrated Ozone 321 / 322
Residual Ozone 39 / 38
Corr. Factor 1.225 / 1.197
Additional Remarks
ECC / BR.IT.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 7
Station Hohenpeissenberg
Date 22.1.70
Time 07.29 GMT
Total Ozone 320
Integrated Ozone 288/269
Residual Ozone 32/51
Corr. Factor 1.175 / 1.108
Additional Remarks
BR. MAST / BR. IND.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

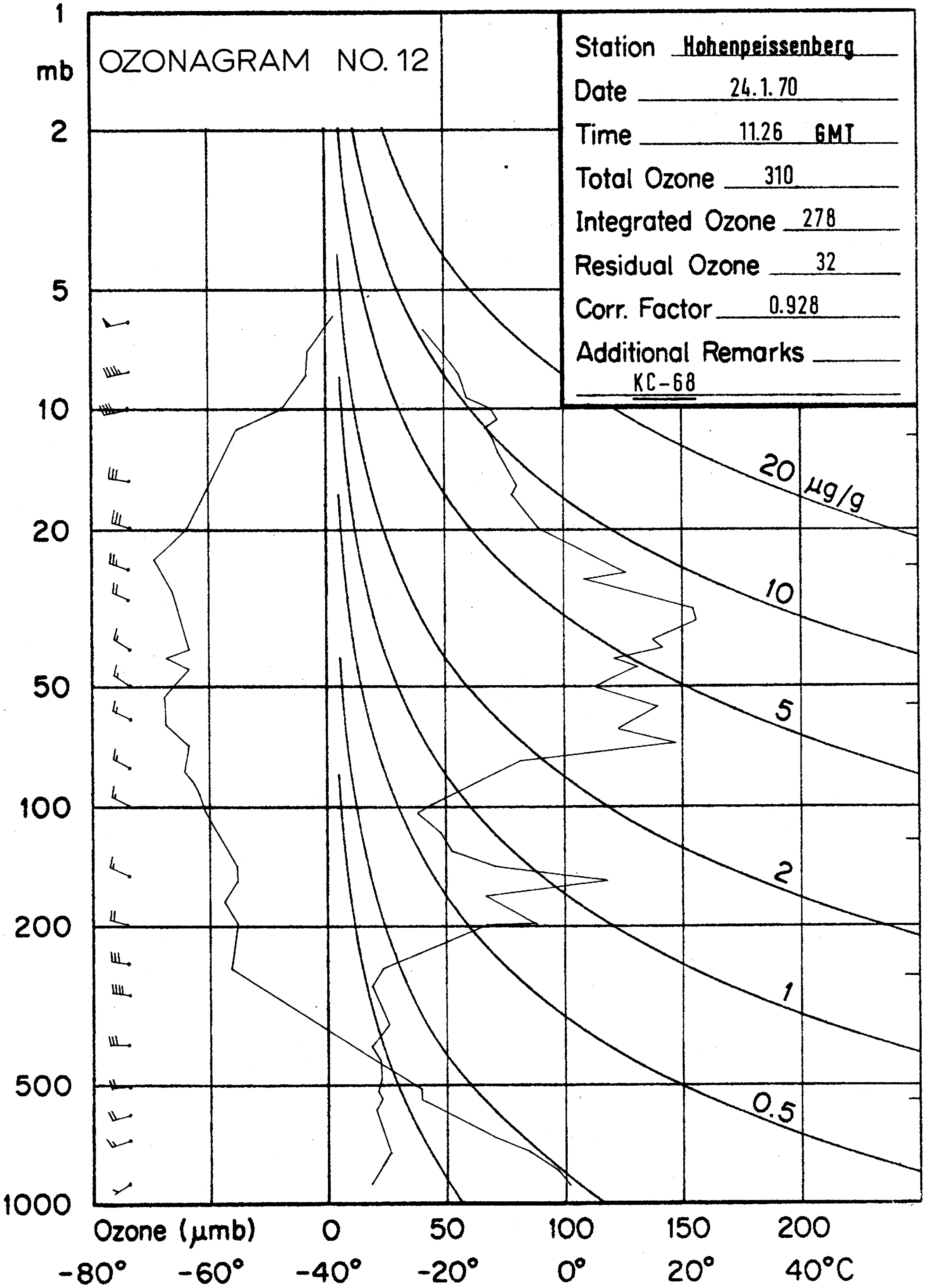

OZONAGRAM NO. 8
Station Hohenpeissenberg
Date 23.1.70
Time 07.03 GMT
Total Ozone 303
Integrated Ozone 278 / 275
Residual Ozone 25/28
Corr. Factor 1.065 / 0.923
Additional Remarks
ECC / KC-68
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 9
Station Hohenpeissenberg
Date 23.1.70
Time 10.03 GMT
Total Ozone 303
Integrated Ozone 264 / 262
Residual Ozone 39 / 41
Corr. Factor 1.233 / 1.563
Additional Remarks
BR.MAST / BR. GDR
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 10
Station Hohenpeissenberg
Date 23.1.70
Time 13.00 GMT
Total Ozone 303
Integrated Ozone 240 / 247
Residual Ozone 63/56
Corr. Factor 1.166 / 1.037
Additional Remarks
BR. IT. / BR.IND.
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C



OZONAGRAM NO. 11
Station Hohenpeissenberg
Date 24.1.70
Time 08.51 GMT
Total Ozone 310
Integrated Ozone 263
Residual Ozone 47
Corr. Factor 1.109
Additional Remarks
BR. MAST
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C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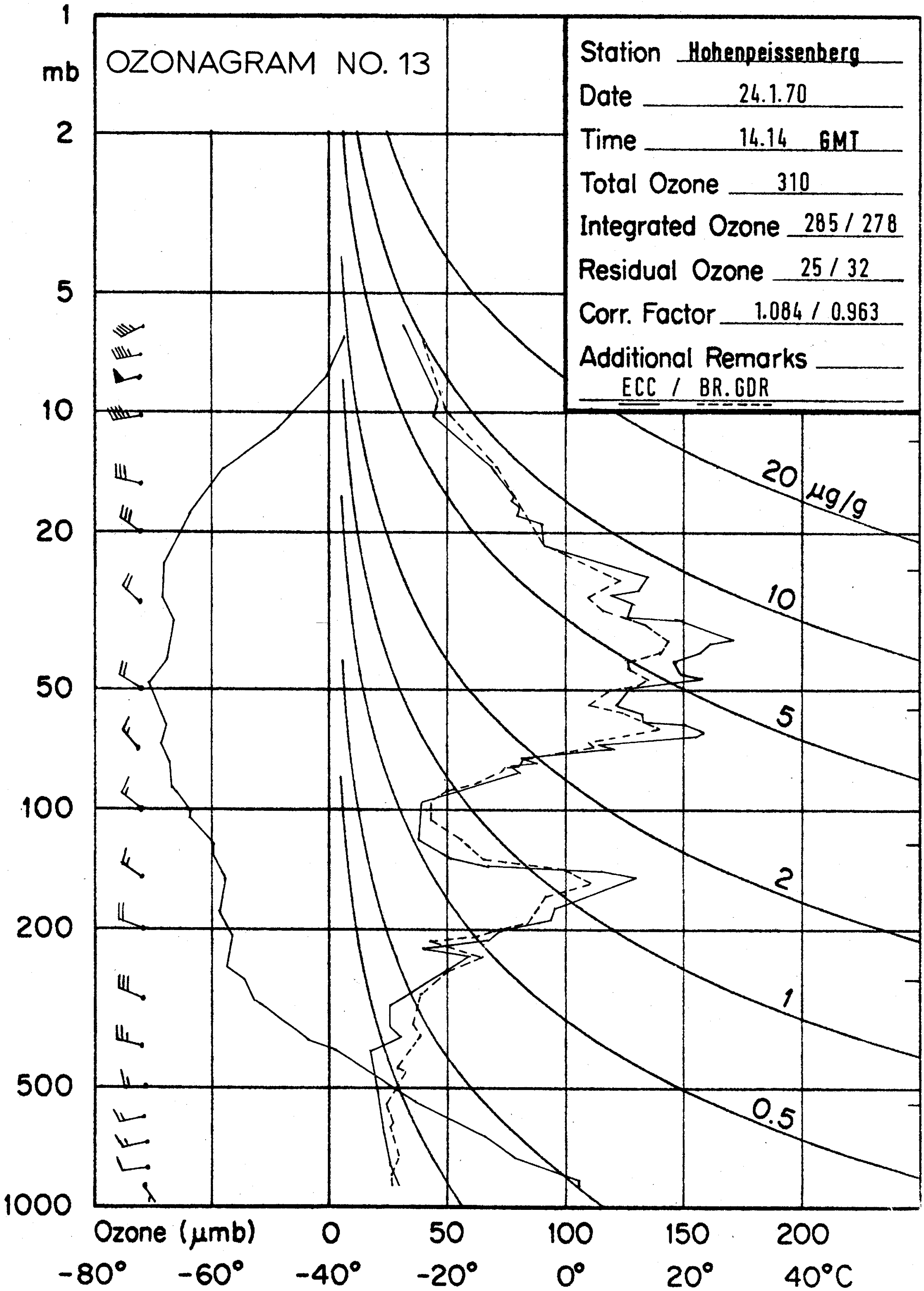
Station Hohenpeissenberg
Date 24.1.70
Time 11.26 GMT
Total Ozone 310
Integrated Ozone 278
Residual Ozone 32
Corr. Factor 0.928
Additional Remarks
KC-68
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C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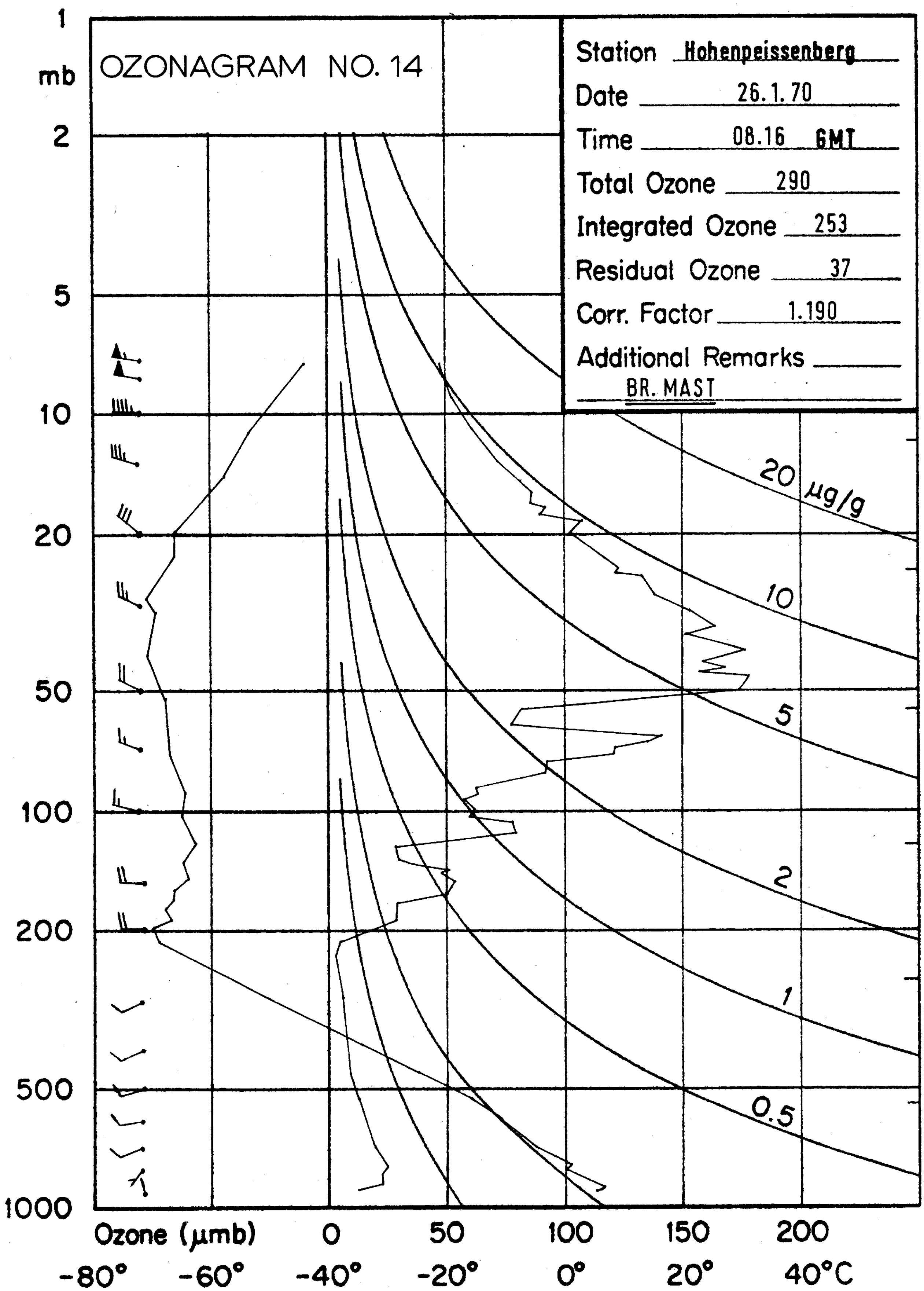
Station Hohenpeissenberg
Date 24.1.70
Time 14.14 GMT
Total Ozone 310
Integrated Ozone 285 / 278
Residual Ozone 25 / 32
Corr. Factor 1.084 / 0.963
Additional Remarks
ECC / BR.GDR
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C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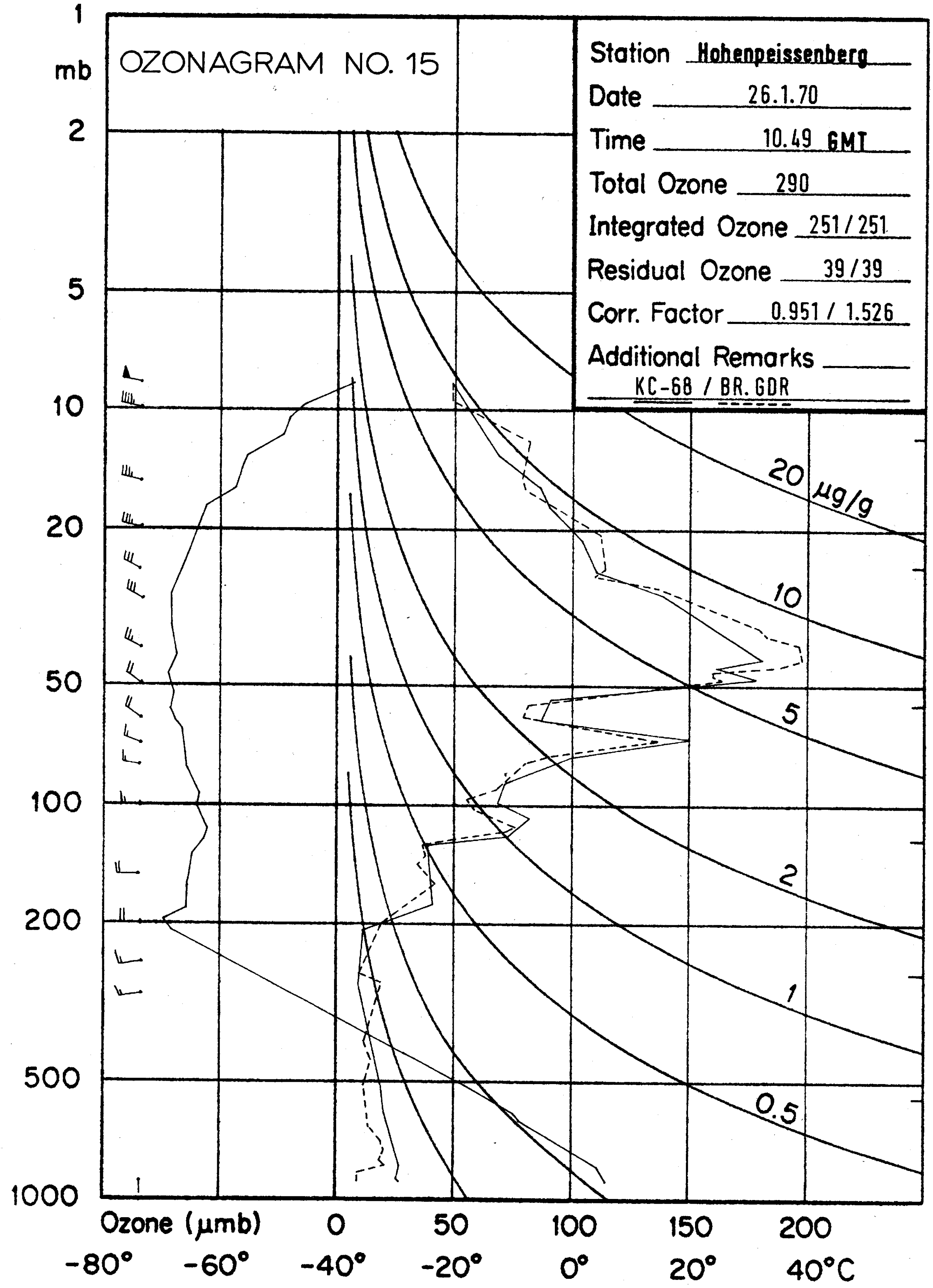
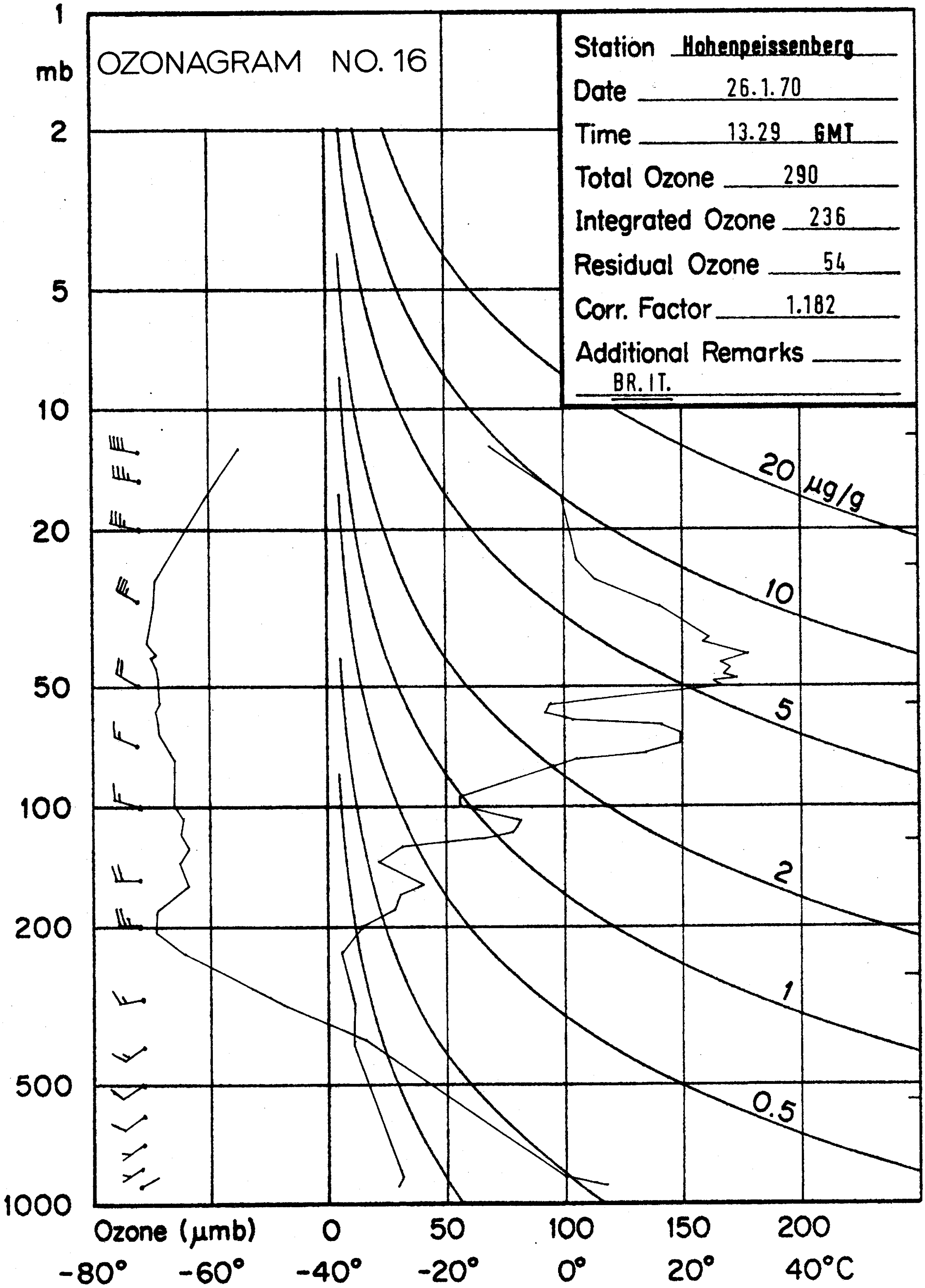
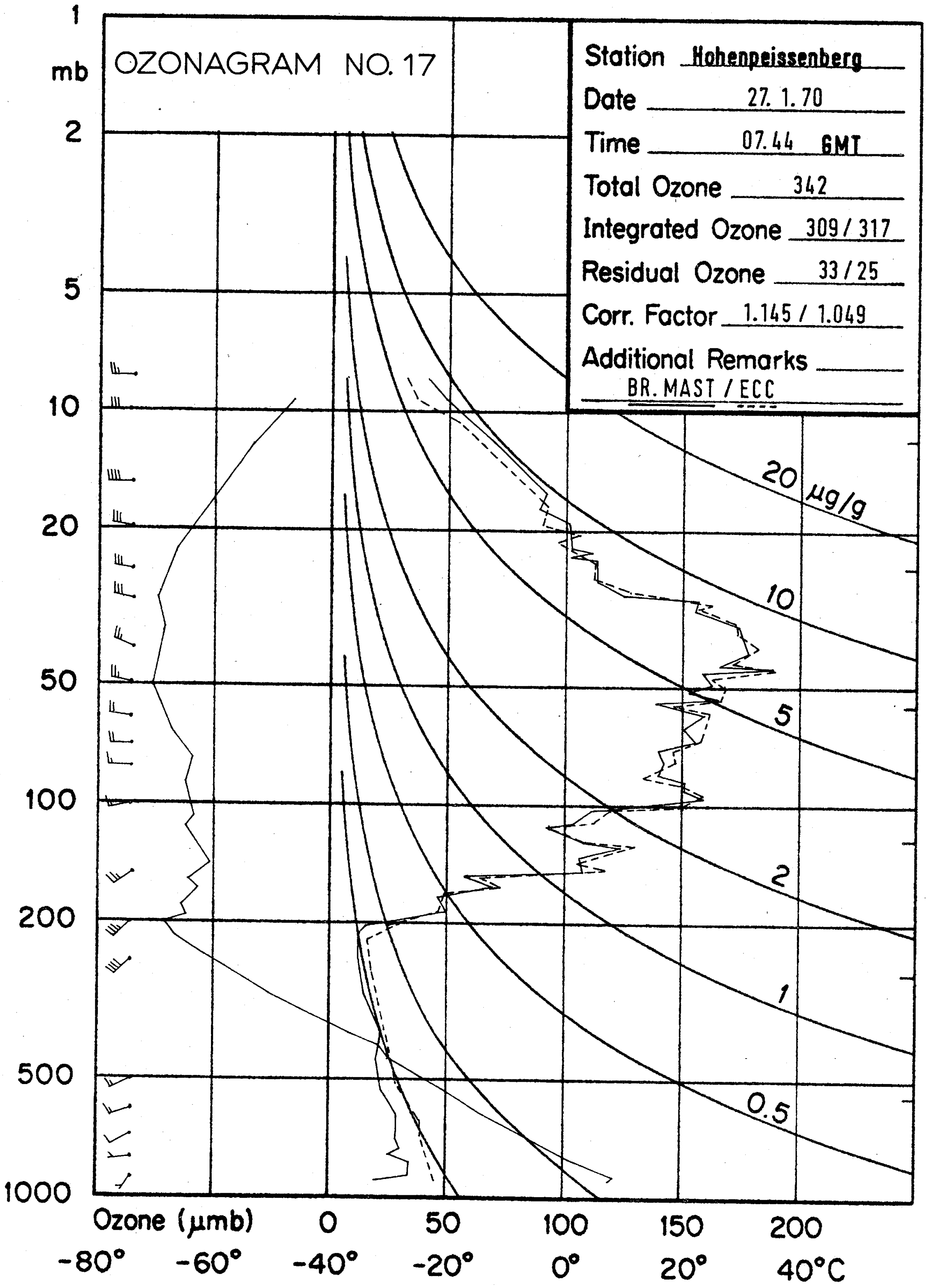
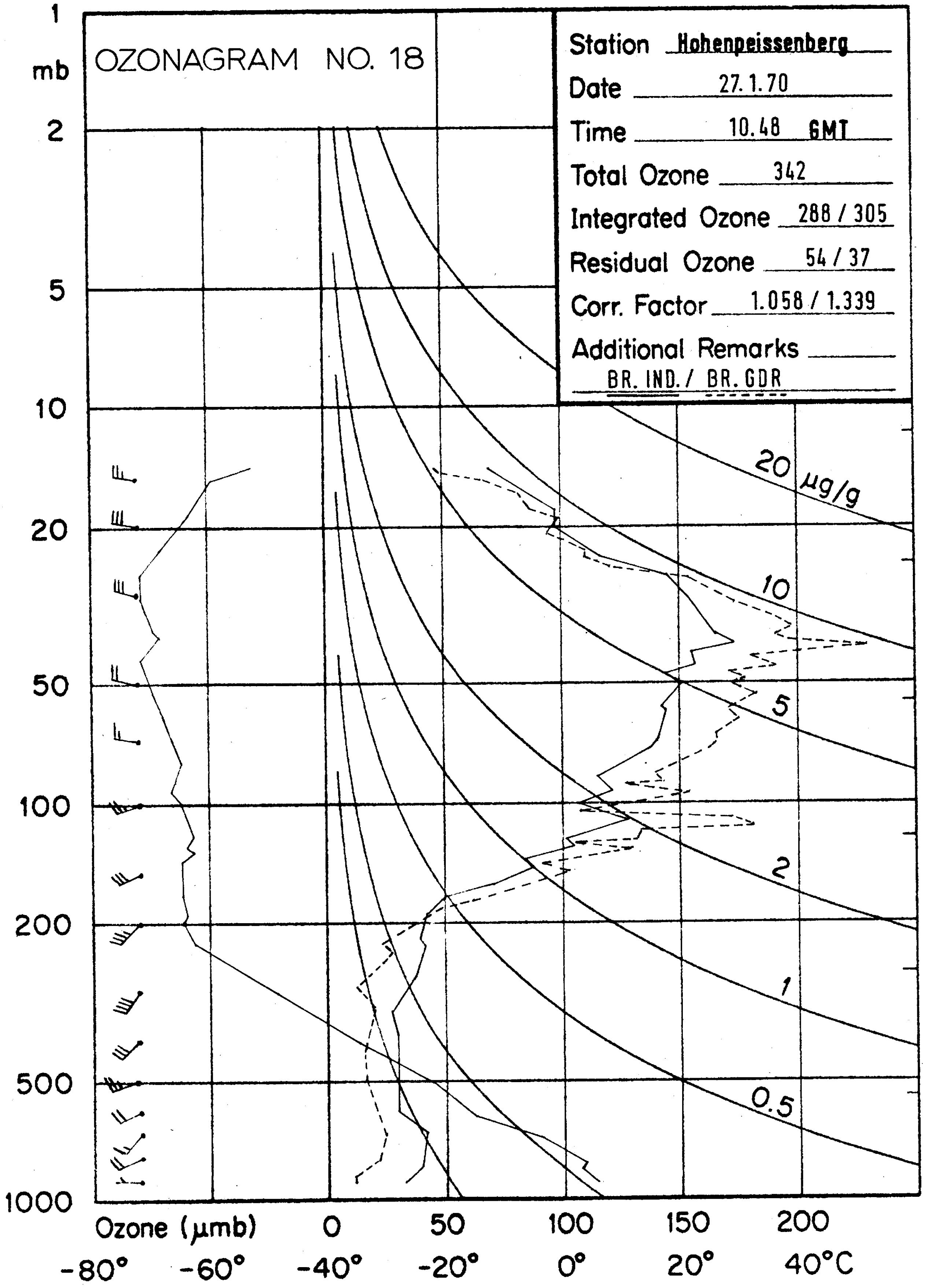
Station Hohenpeissenberg
Date 26.1.70
Time 08.16 GMT
Total Ozone 290
Integrated Ozone 253
Residual Ozone 37
Corr. Factor 1.190
Additional Remarks
BR. MAST
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 15
Station Hohenpeissenberg
Date 26.1.70
Time 10.49 GMT
Total Ozone 290
Integrated Ozone 251 / 251
Residual Ozone 39 / 39
Corr. Factor 0.951 / 1.526
Additional Remarks
KC-68 / BR. GDR
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

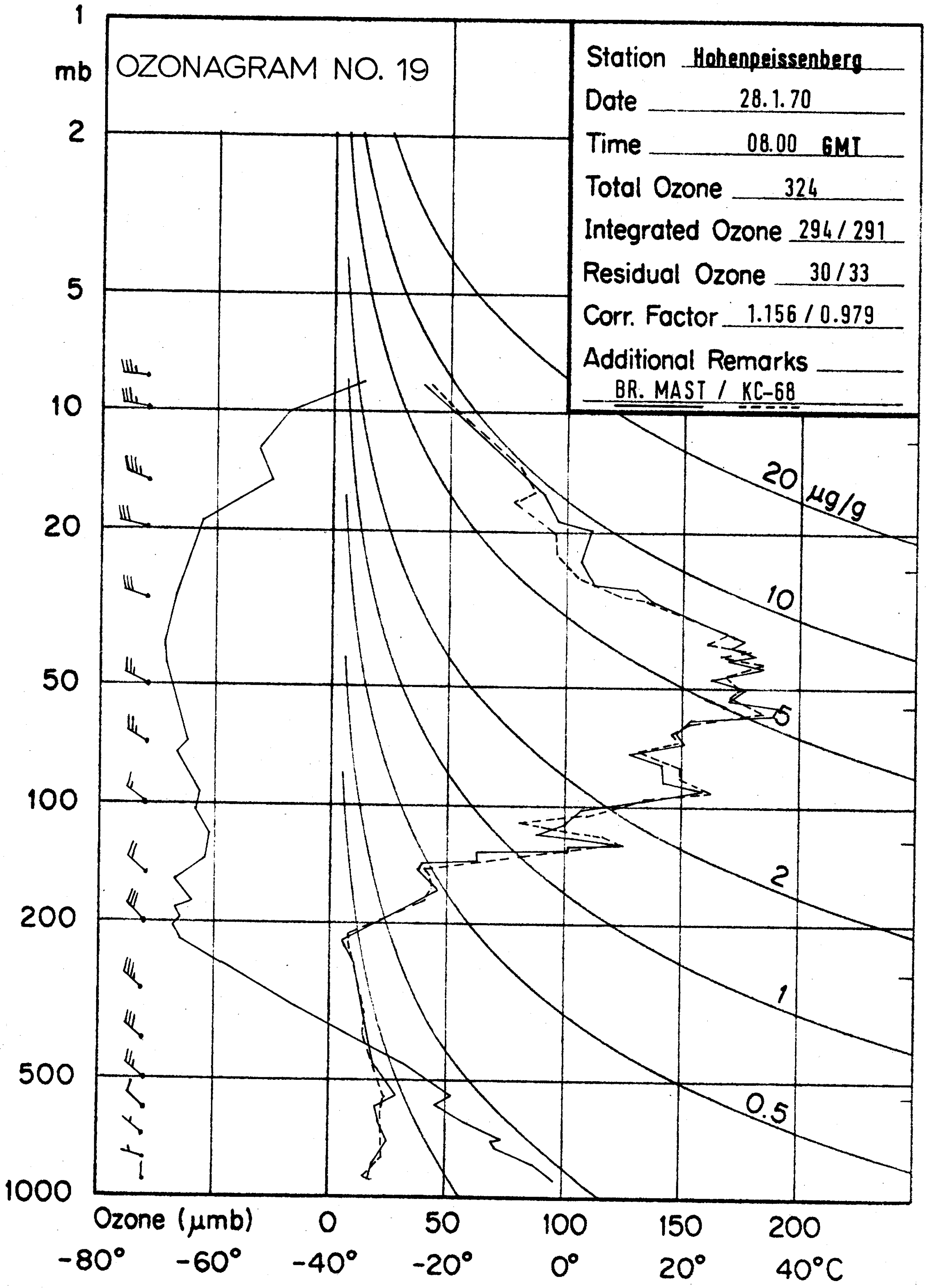


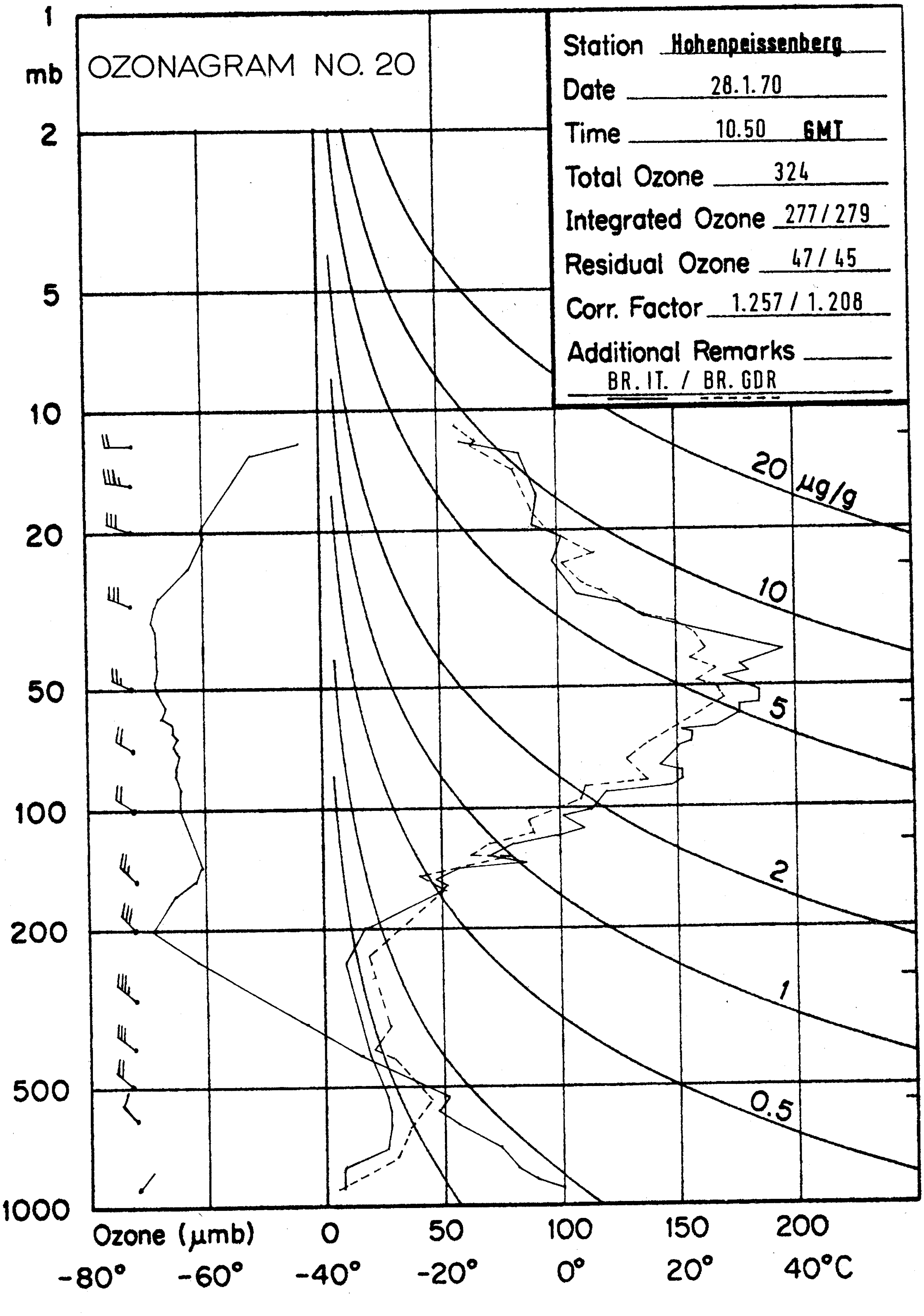
OZONAGRAM NO. 16
Station Hohenpeissenberg
Date 26.1.70
Time 13.29 GMT
Total Ozone 290
Integrated Ozone 236
Residual Ozone 54
Corr. Factor 1.182
Additional Remarks
BR. IT.
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 17
Station Hohenpeissenberg
Date 27. 1. 70
Time 07.44 GMT
Total Ozone 342
Integrated Ozone 309 / 317
Residual Ozone 33 / 25
Corr. Factor 1.145 / 1.049
Additional Remarks
BR. MAST / ECC
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C



OZONAGRAM NO. 18
Station Hohenpeissenberg
Date 27.1.70
Time 10.48 GMT
Total Ozone 342
Integrated Ozone 288 / 305
Residual Ozone 54 / 37
Corr. Factor 1.058 / 1.339
Additional Remarks
BR. IND. / BR. GDR
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 19
Station Hohenpeissenberg
Date 28.1.70
Time 08.00 GMT
Total Ozone 324
Integrated Ozone 294 / 291
Residual Ozone 30 / 33
Corr. Factor 1.156 / 0.979
Additional Remarks
BR. MAST / KC-68
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 20
Station Hohenpeissenberg
Date 28.1.70
Time 10.50 GMT
Total Ozone 324
Integrated Ozone 277/279
Residual Ozone 47/45
Corr. Factor 1.257/1.208
Additional Remarks
BR.IT. / BR.GDR
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
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0.5
Ozone (µmb)
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50
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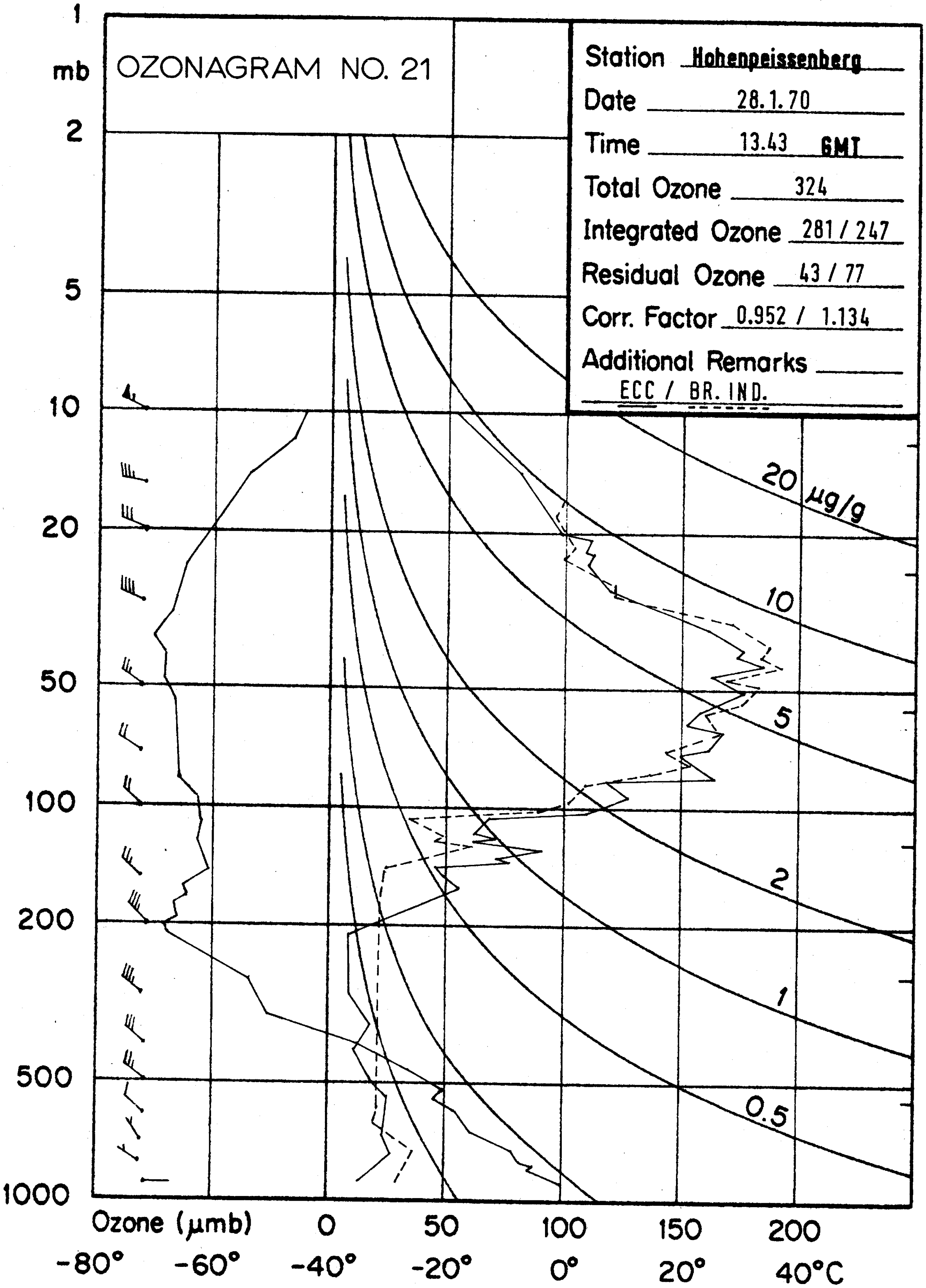
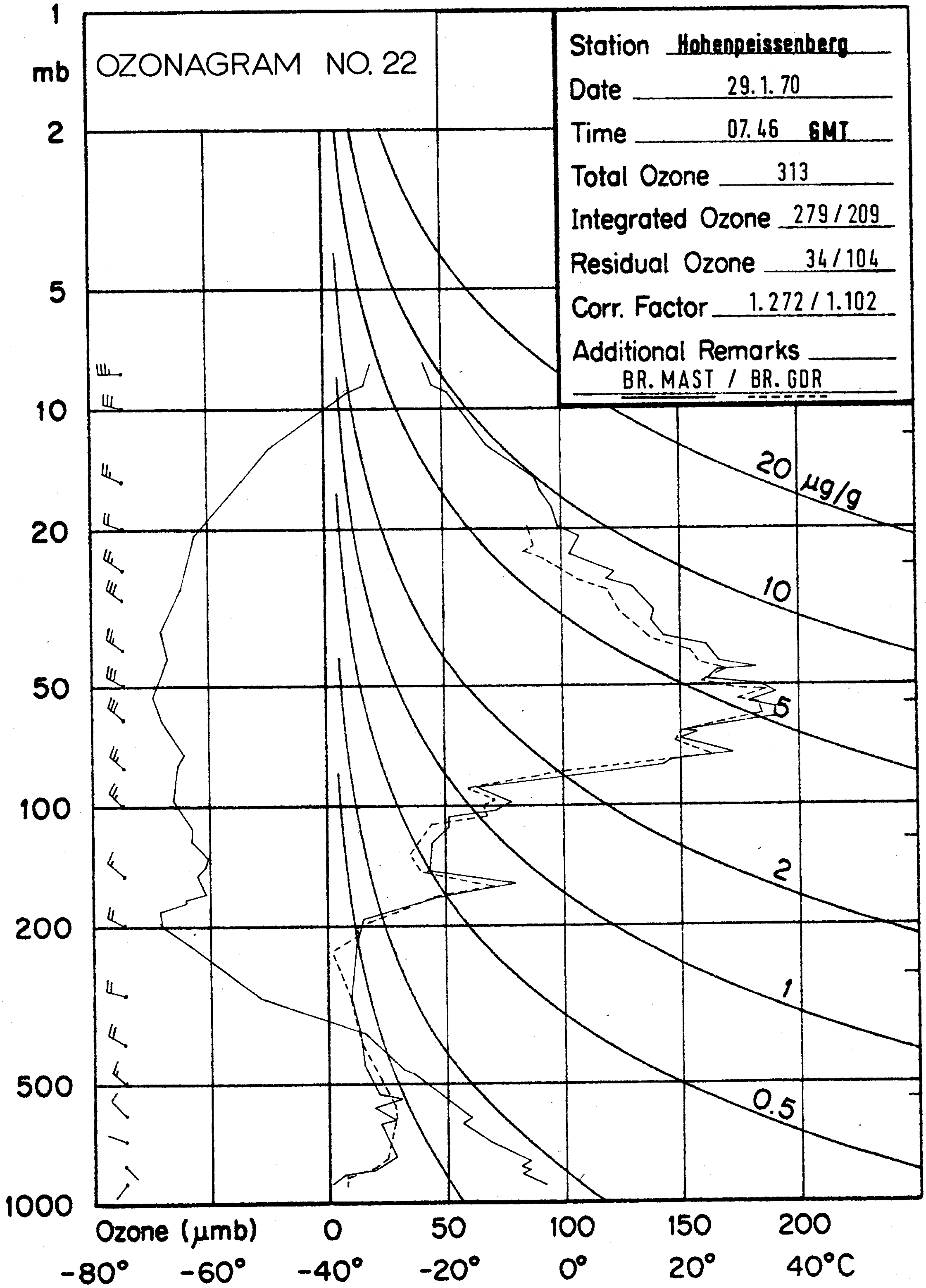
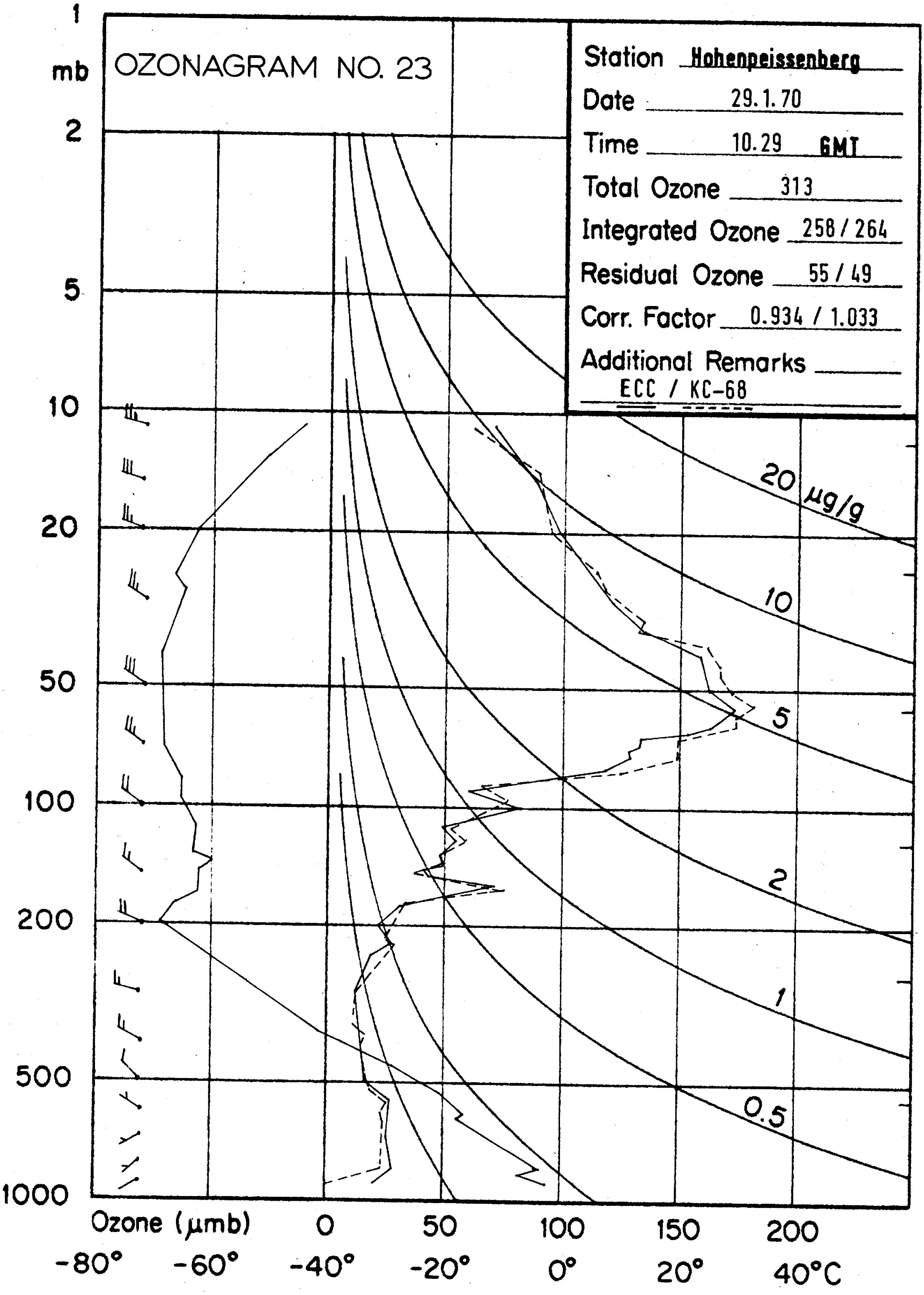
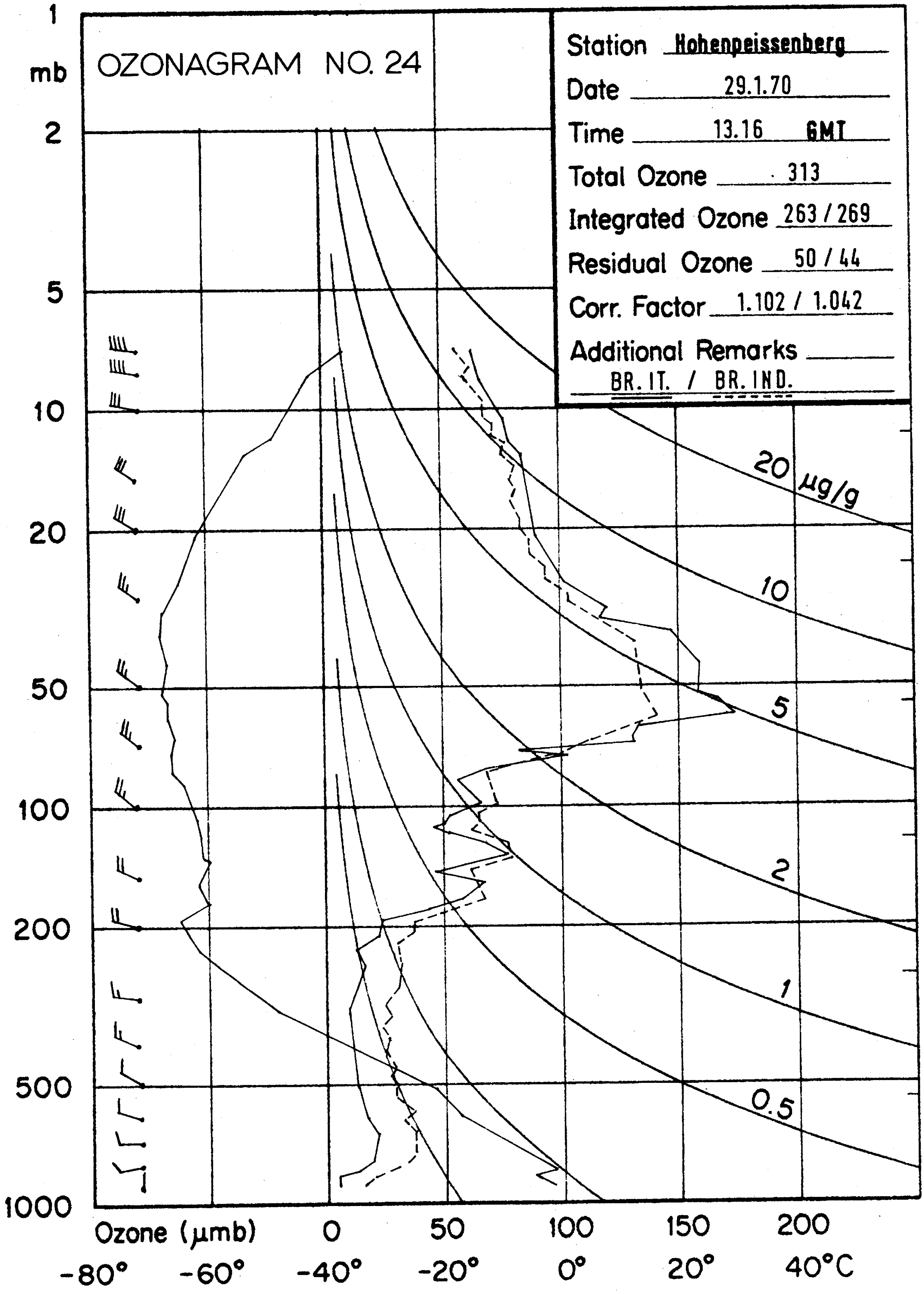
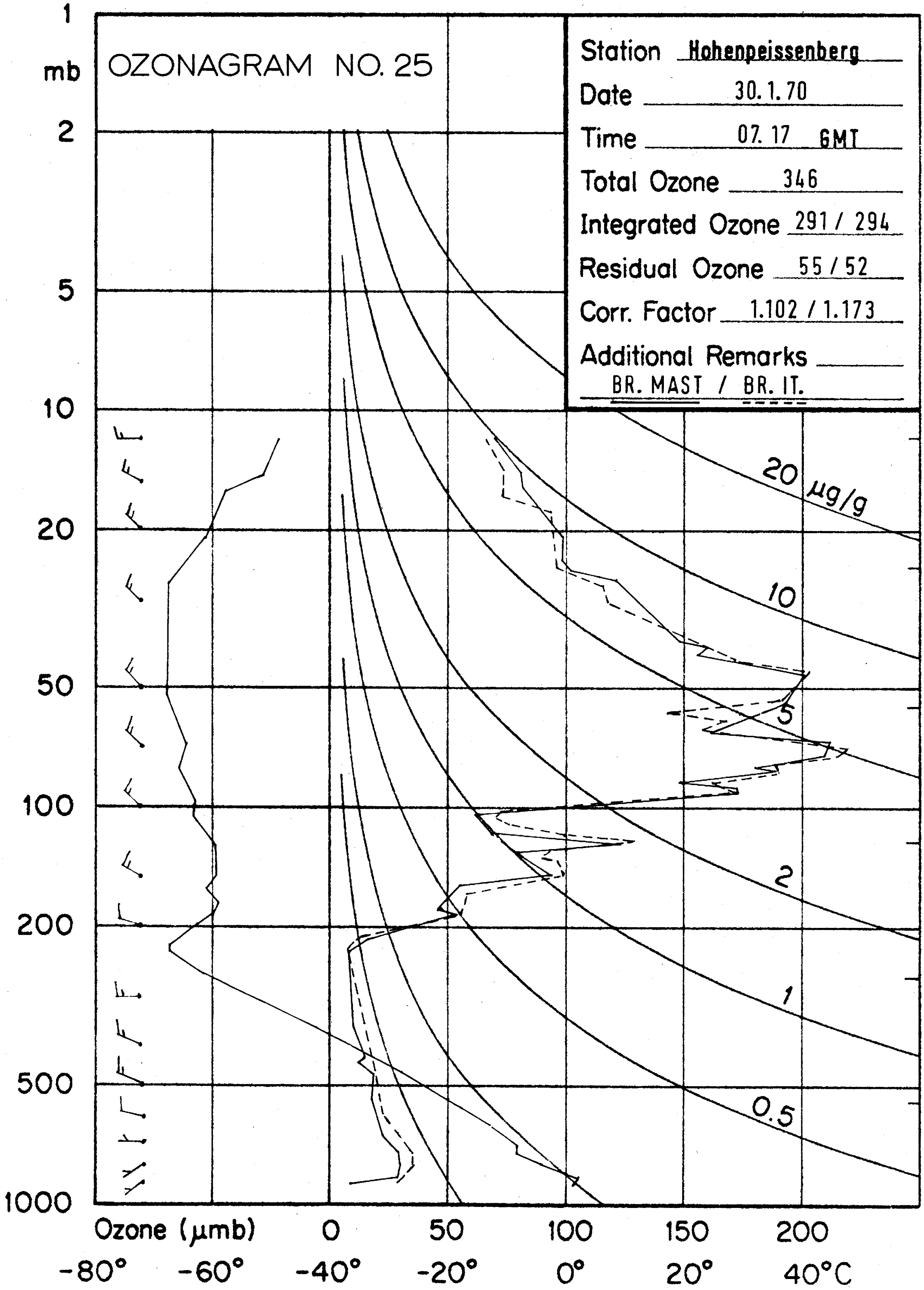
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C

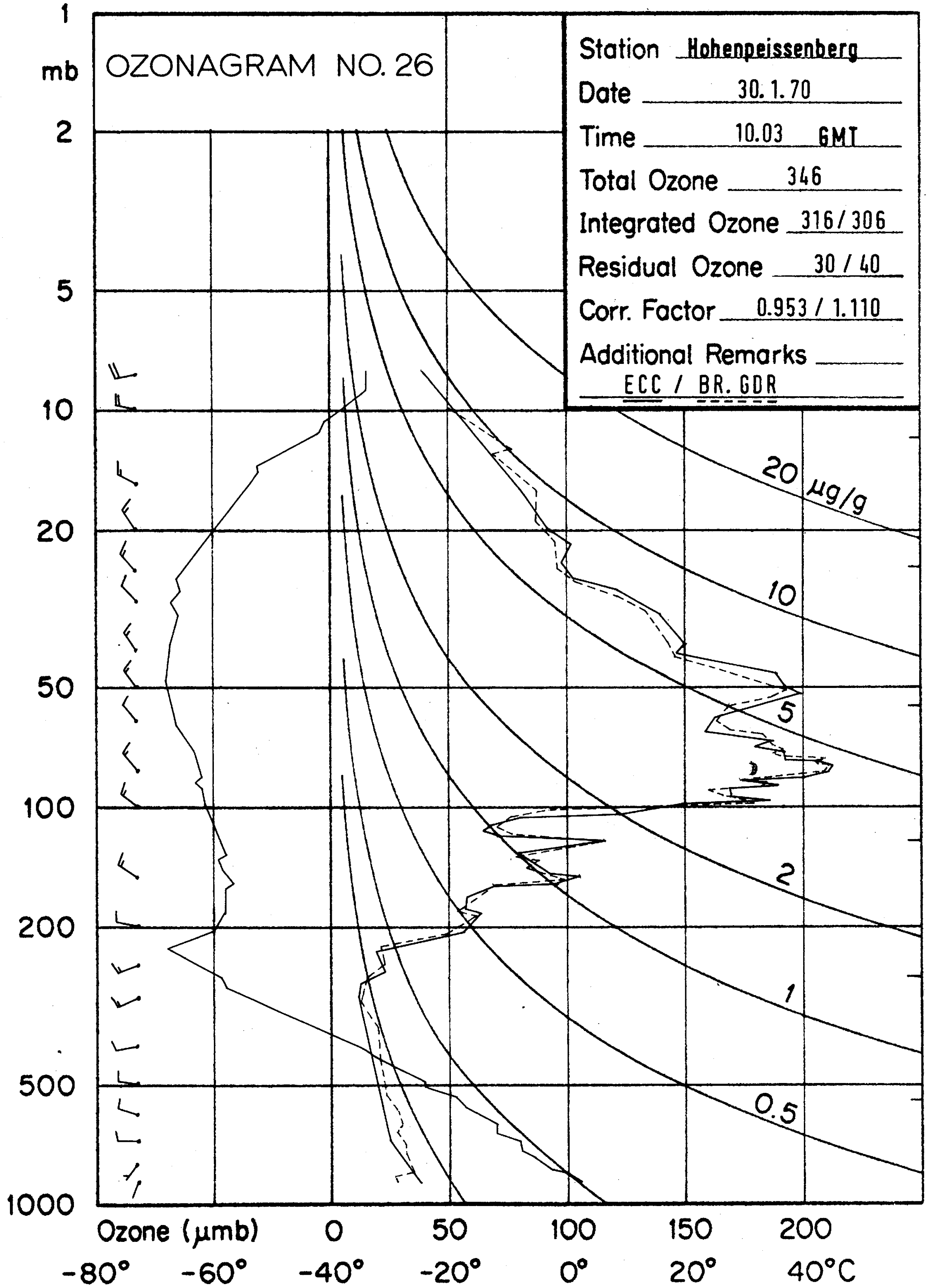

OZONAGRAM NO. 21
Station Hohenpeissenberg
Date 28.1.70
Time 13.43 GMT
Total Ozone 324
Integrated Ozone 281 / 247
Residual Ozone 43 / 77
Corr. Factor 0.952 / 1.134
Additional Remarks
ECC / BR. IND.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C

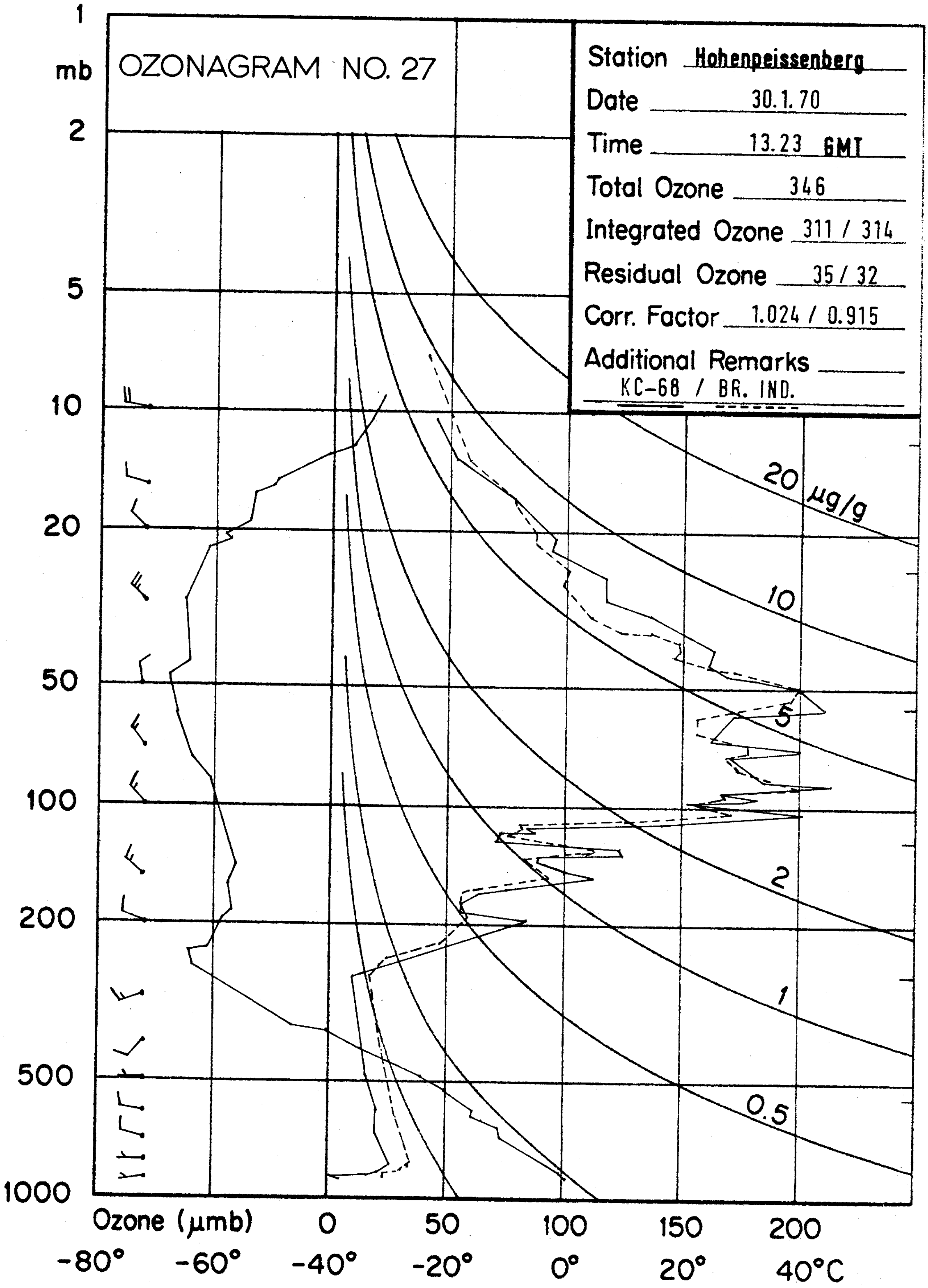

OZONAGRAM NO. 22
Station Hohenpeissenberg
Date 29.1.70
Time 07.46 GMT
Total Ozone 313
Integrated Ozone 279 / 209
Residual Ozone 34 / 104
Corr. Factor 1.272 / 1.102
Additional Remarks
BR. MAST / BR. GDR
1
mb
2
5
10
20
50
100
200
500
1000
20 μg/g
10
5
2
1
0.5
Ozone (μmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C

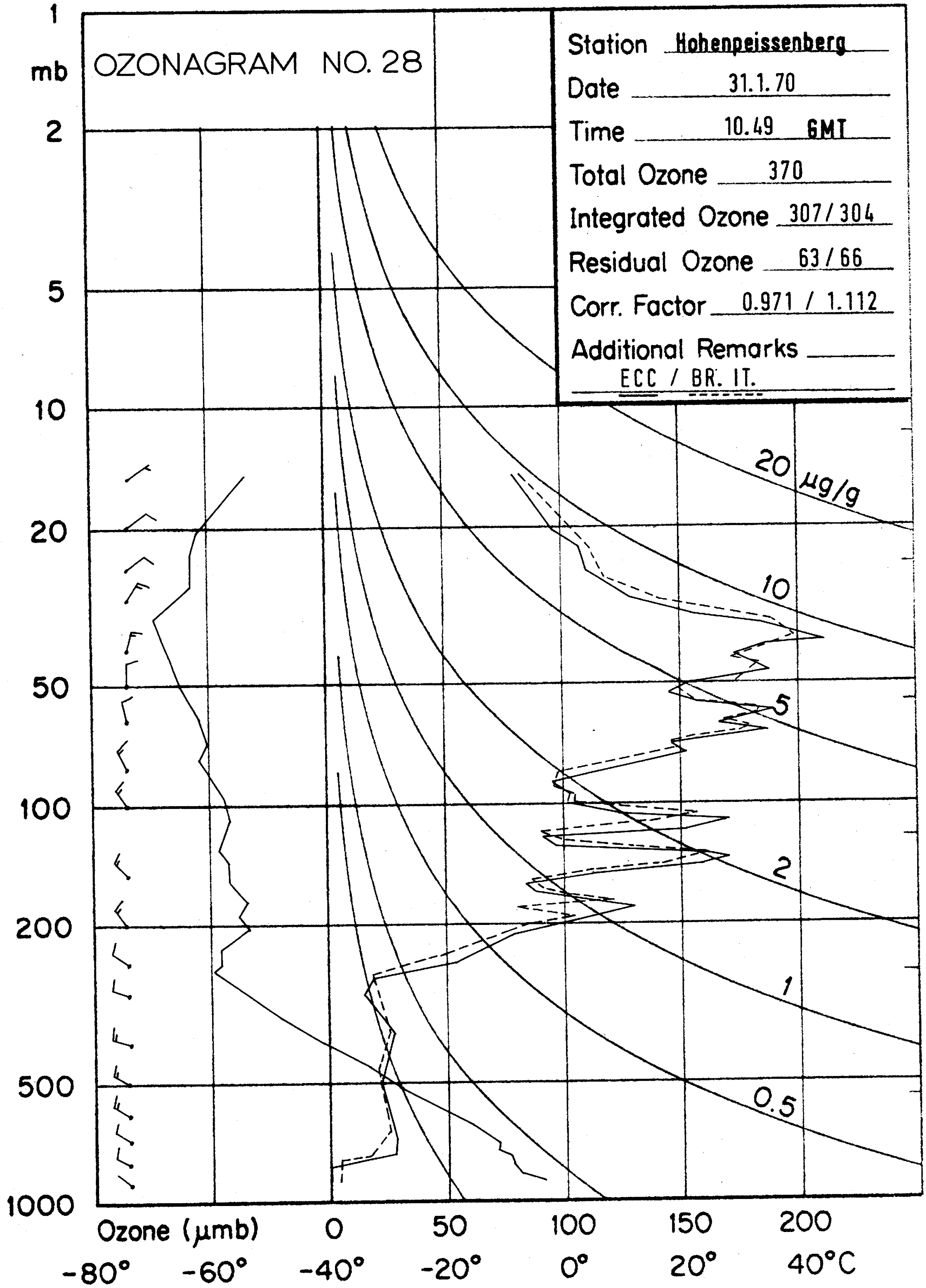

OZONAGRAM NO. 23
Station Hohenpeissenberg
Date 29.1.70
Time 10.29 GMT
Total Ozone 313
Integrated Ozone 258 / 264
Residual Ozone 55 / 49
Corr. Factor 0.934 / 1.033
Additional Remarks
ECC / KC-68
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 24
Station Hohenpeissenberg
Date 29.1.70
Time 13.16 GMT
Total Ozone 313
Integrated Ozone 263 / 269
Residual Ozone 50 / 44
Corr. Factor 1.102 / 1.042
Additional Remarks
BR. IT. / BR. IND.
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 25
Station Hohenpeissenberg
Date 30.1.70
Time 07.17 GMT
Total Ozone 346
Integrated Ozone 291 / 294
Residual Ozone 55 / 52
Corr. Factor 1.102 / 1.173
Additional Remarks
BR. MAST / BR. IT.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 26
Station Hohenpeissenberg
Date 30.1.70
Time 10.03 GMT
Total Ozone 346
Integrated Ozone 316/306
Residual Ozone 30/40
Corr. Factor 0.953/1.110
Additional Remarks
ECC / BR. GDR
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 27
Station Hohenpeissenberg
Date 30.1.70
Time 13.23 GMT
Total Ozone 346
Integrated Ozone 311 / 314
Residual Ozone 35 / 32
Corr. Factor 1.024 / 0.915
Additional Remarks
KC-68 / BR. IND.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C



OZONAGRAM NO. 28
Station Hohenpeissenberg
Date 31.1.70
Time 10.49 GMT
Total Ozone 370
Integrated Ozone 307/304
Residual Ozone 63/66
Corr. Factor 0.971 / 1.112
Additional Remarks
ECC / BR. IT.
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
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-80°
-60°
-40°
-20°
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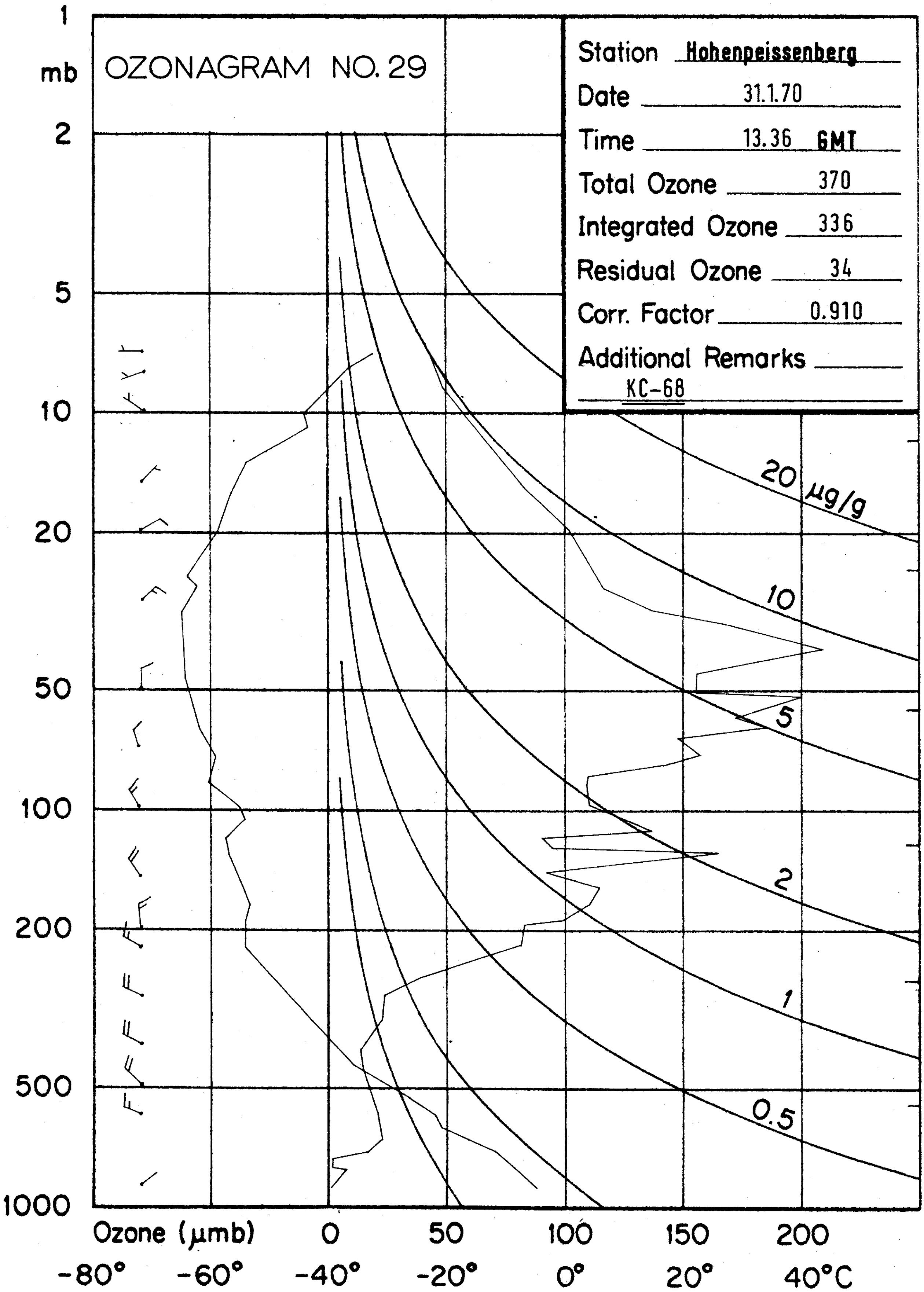
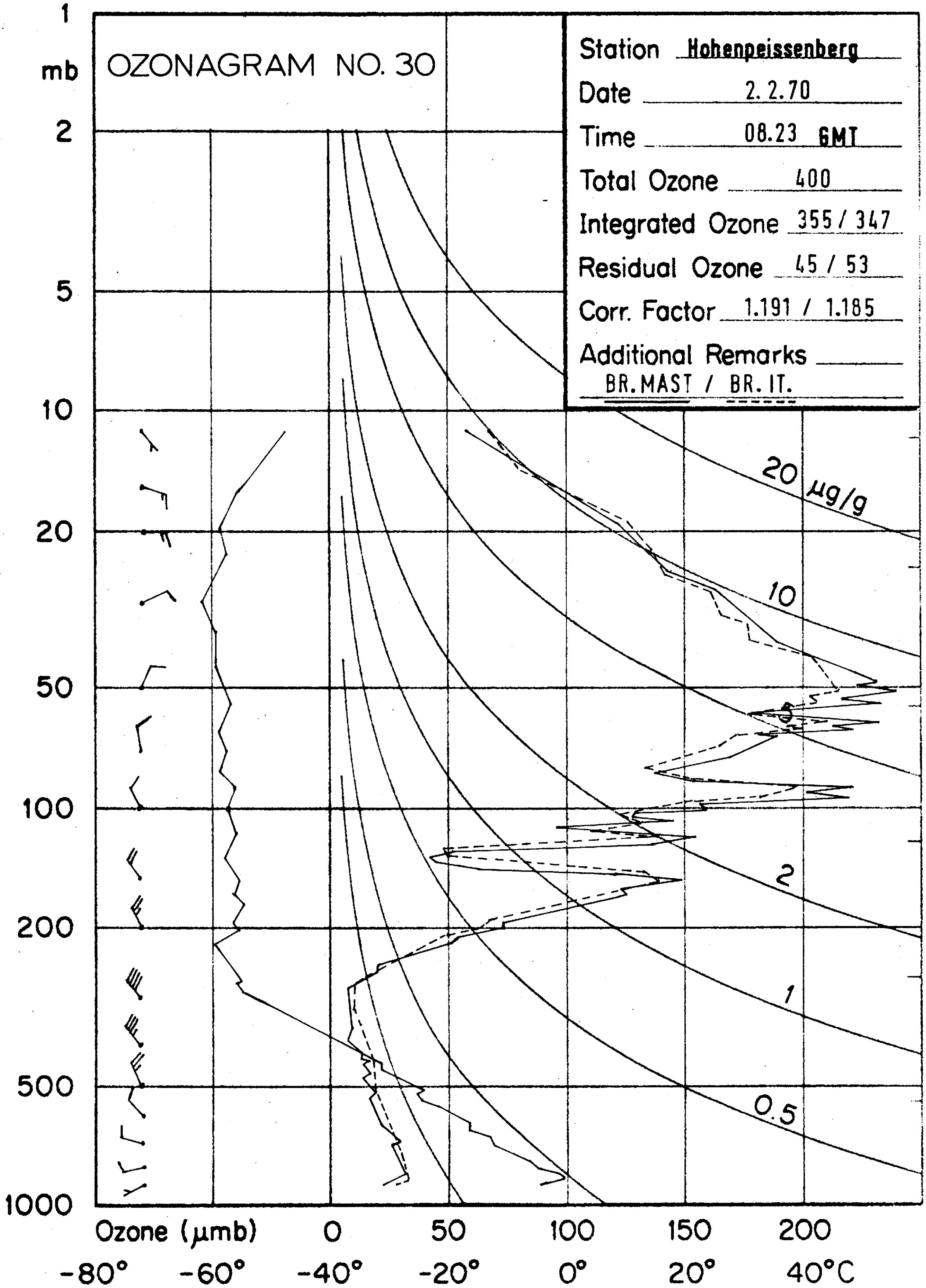
20°
40°C


OZONAGRAM NO. 29
Station Hohenpeissenberg
Date 31.1.70
Time 13.36 GMT
Total Ozone 370
Integrated Ozone 336
Residual Ozone 34
Corr. Factor 0.910
Additional Remarks
KC-68
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 30
Station Hohenpeissenberg
Date 2. 2. 70
Time 08.23 GMT
Total Ozone 400
Integrated Ozone 355 / 347
Residual Ozone 45 / 53
Corr. Factor 1.191 / 1.185
Additional Remarks
BR. MAST / BR. IT.
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
2
1
0.5
Ozone (µmb)
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50
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-80°
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-40°
-20°
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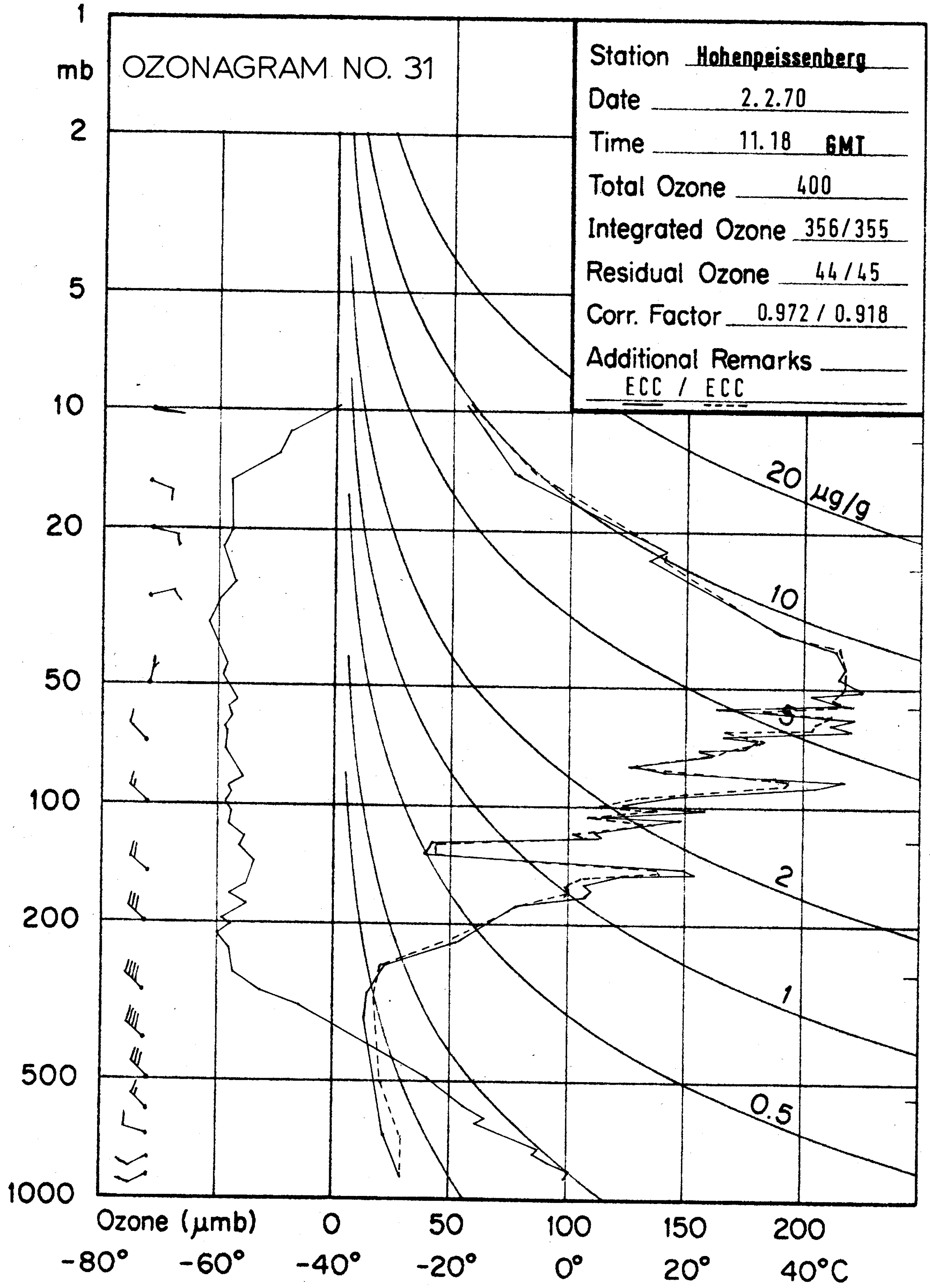
20°
40°C



OZONAGRAM NO. 31
Station Hohenpeissenberg
Date 2.2.70
Time 11.18 GMT
Total Ozone 400
Integrated Ozone 356/355
Residual Ozone 44/45
Corr. Factor 0.972 / 0.918
Additional Remarks
ECC / ECC
mb
1
2
5
10
20
50
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1000
20 µg/g
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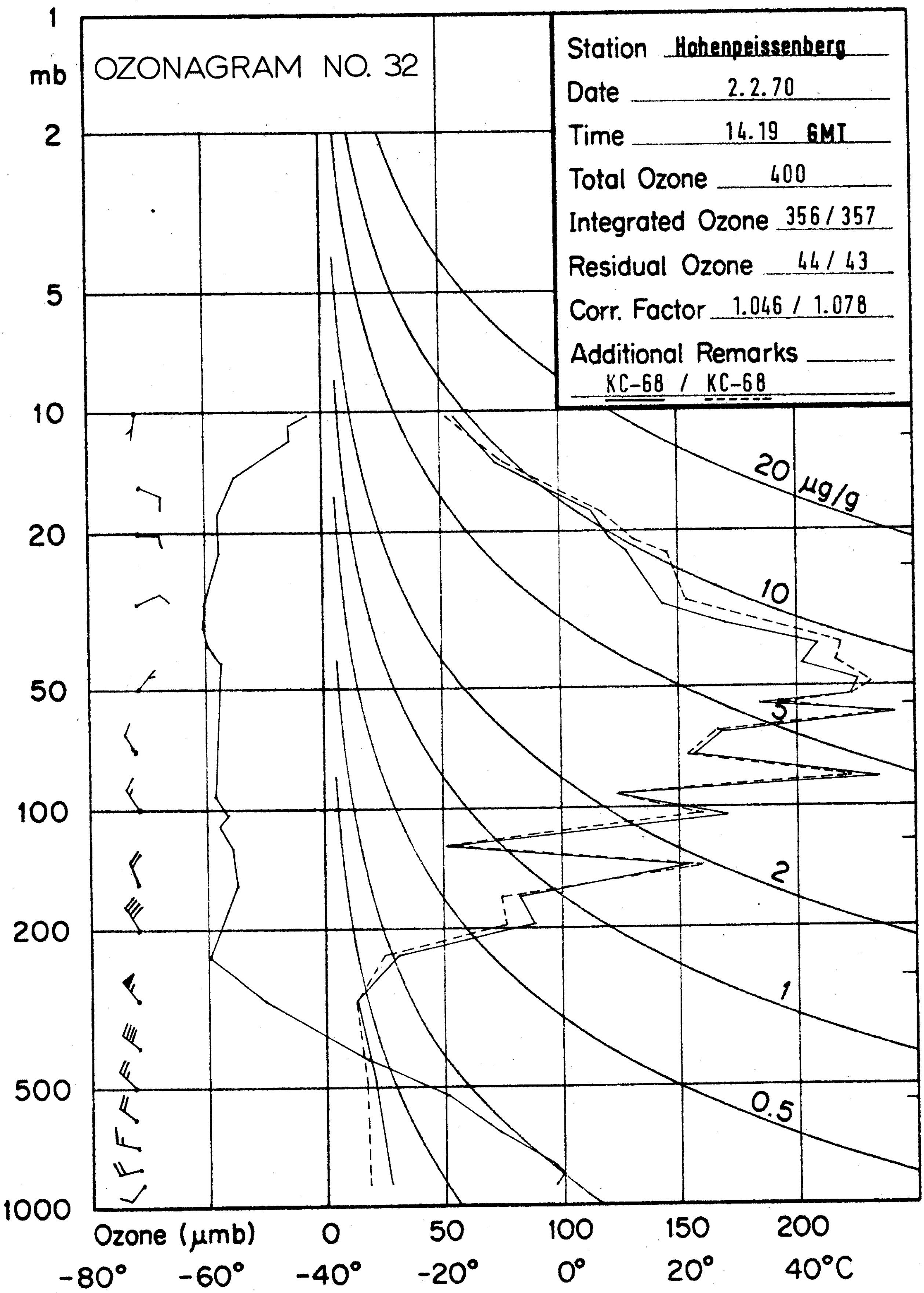
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 32
Station Hohenpeissenberg
Date 2.2.70
Time 14.19 GMT
Total Ozone 400
Integrated Ozone 356 / 357
Residual Ozone 44 / 43
Corr. Factor 1.046 / 1.078
Additional Remarks
KC-68 / KC-68
1
mb
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
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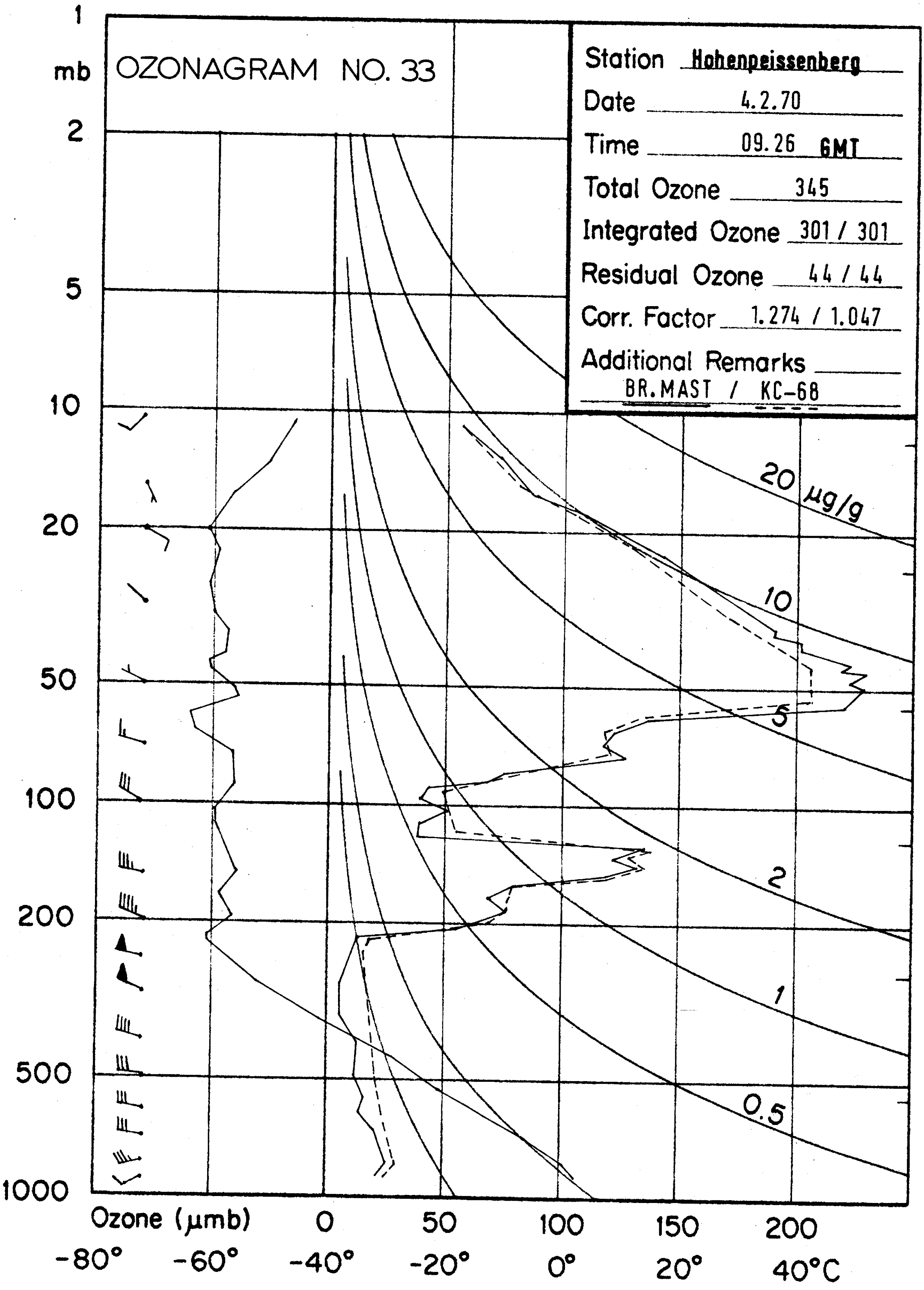
200
-80°
-60°
-40°
-20°
0°
20°
40°C



OZONAGRAM NO. 33
Station Hohenpeissenberg
Date 4.2.70
Time 09.26 GMT
Total Ozone 345
Integrated Ozone 301 / 301
Residual Ozone 44 / 44
Corr. Factor 1.274 / 1.047
Additional Remarks
BR.MAST / KC-68
mb
1
2
5
10
20
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20 µg/g
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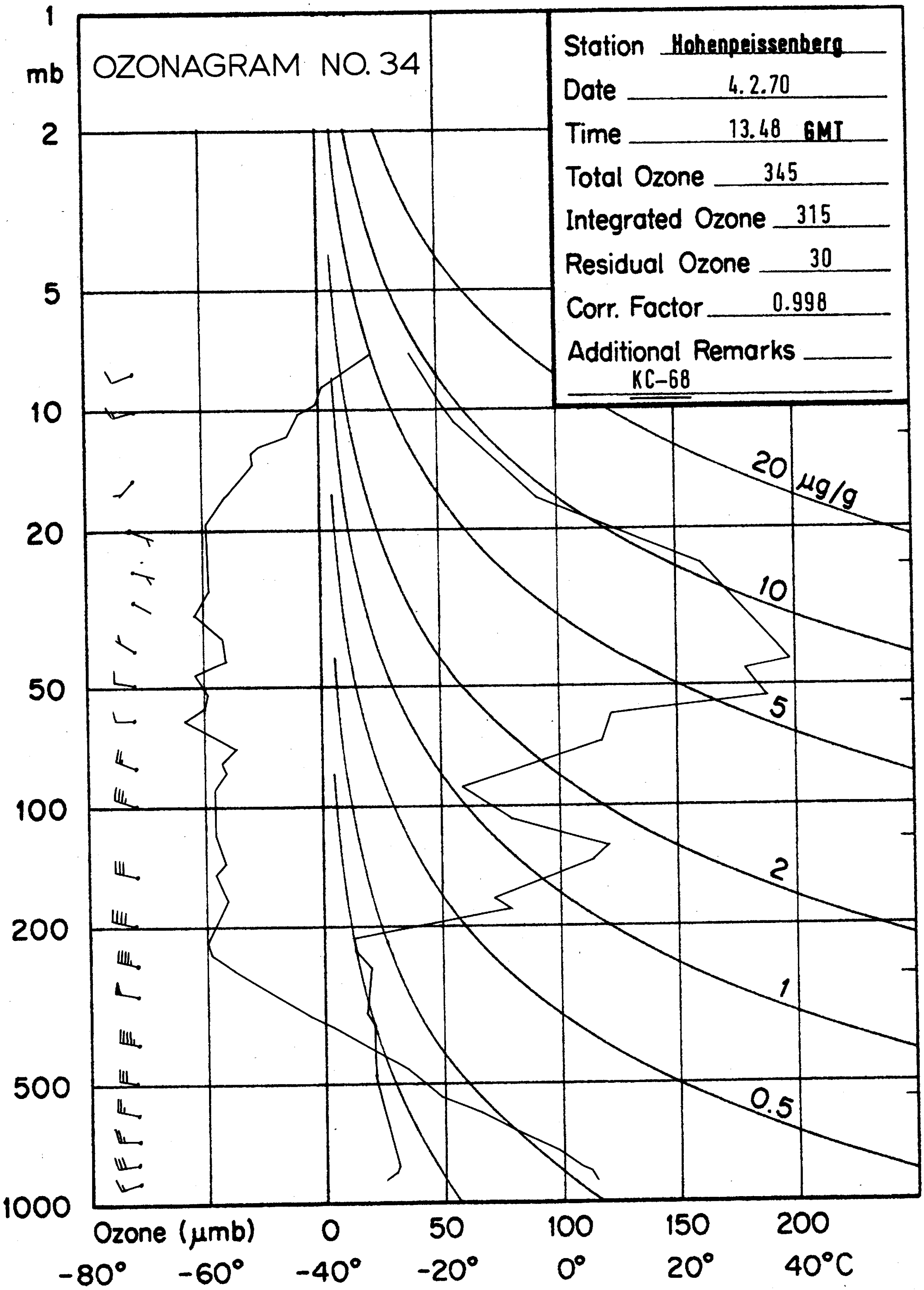
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 34
Station Hohenpeissenberg
Date 4.2.70
Time 13.48 GMT
Total Ozone 345
Integrated Ozone 315
Residual Ozone 30
Corr. Factor 0.998
Additional Remarks
KC-68
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
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0.5
Ozone (µmb)
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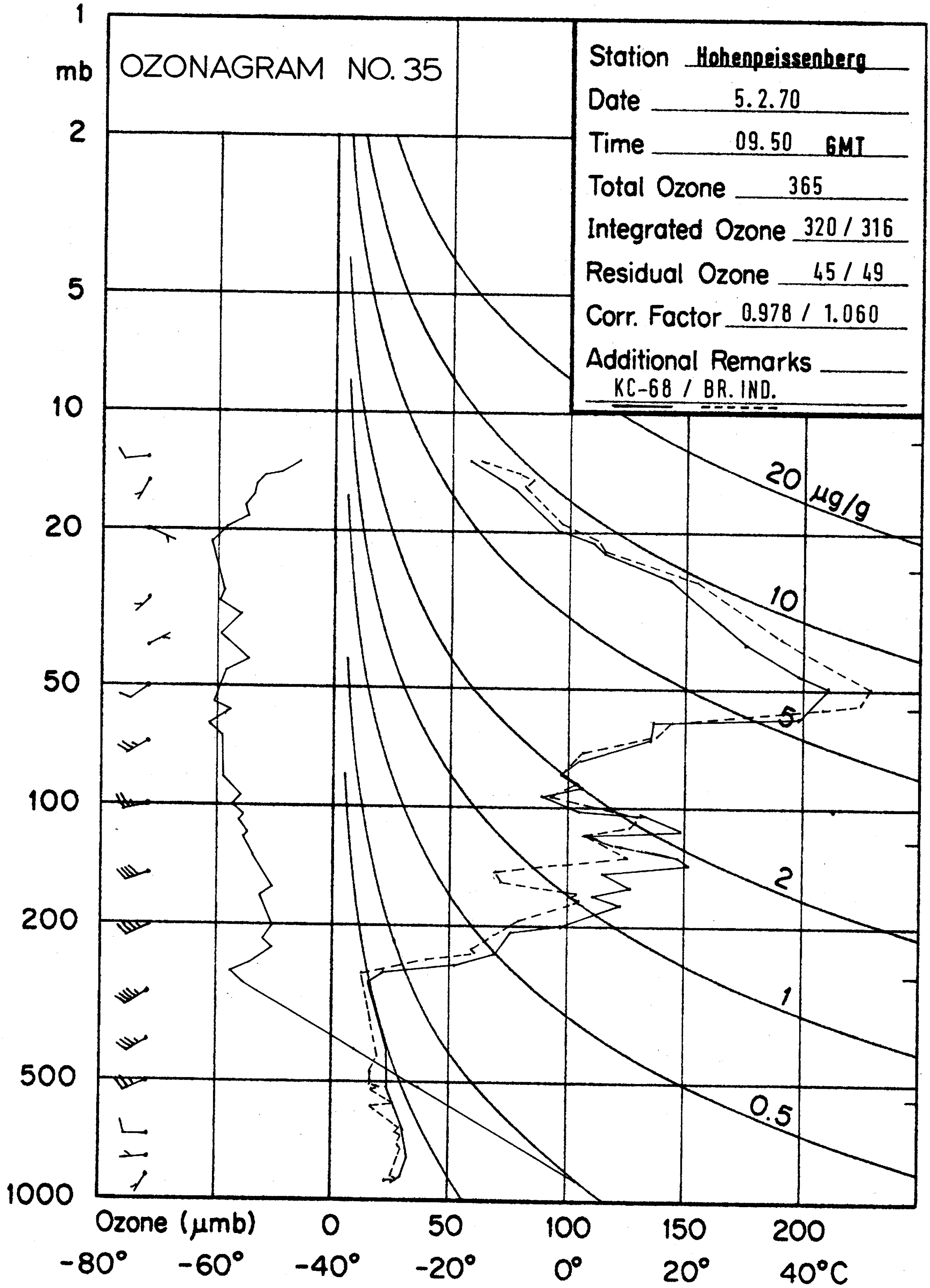
-80°
-60°
-40°
-20°
0°
20°
40°C



OZONAGRAM NO. 35
Station Hohenpeissenberg
Date 5.2.70
Time 09.50 GMT
Total Ozone 365
Integrated Ozone 320 / 316
Residual Ozone 45 / 49
Corr. Factor 0.978 / 1.060
Additional Remarks
KC-68 / BR. IND.
mb
1
2
5
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20 µg/g
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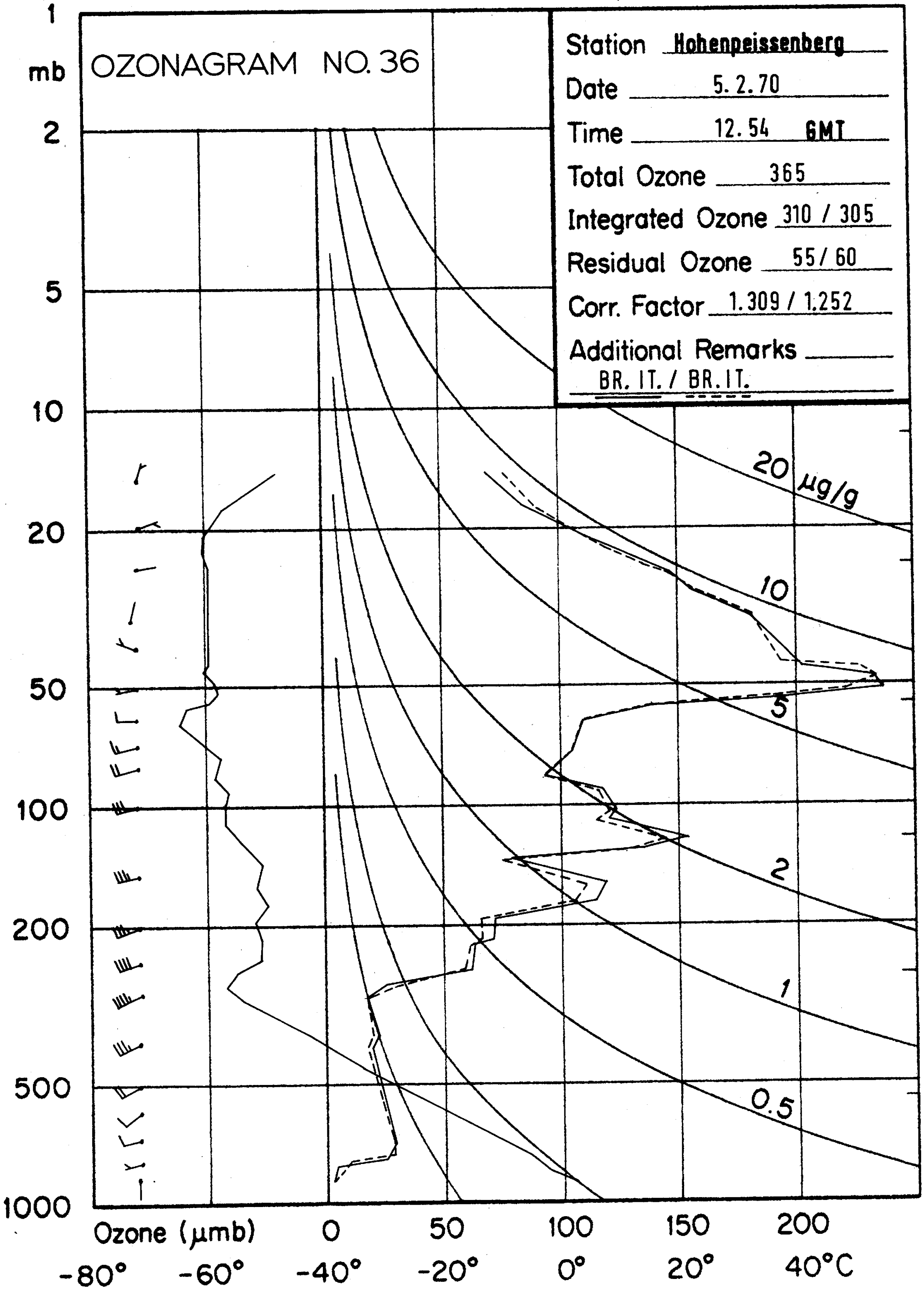
0.5
Ozone (µmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 36
Station Hohenpeissenberg
Date 5. 2. 70
Time 12. 54 GMT
Total Ozone 365
Integrated Ozone 310 / 305
Residual Ozone 55 / 60
Corr. Factor 1.309 / 1.252
Additional Remarks
BR. IT. / BR. IT.
mb
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1000
20 µg/g
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1
0.5
Ozone (µmb)
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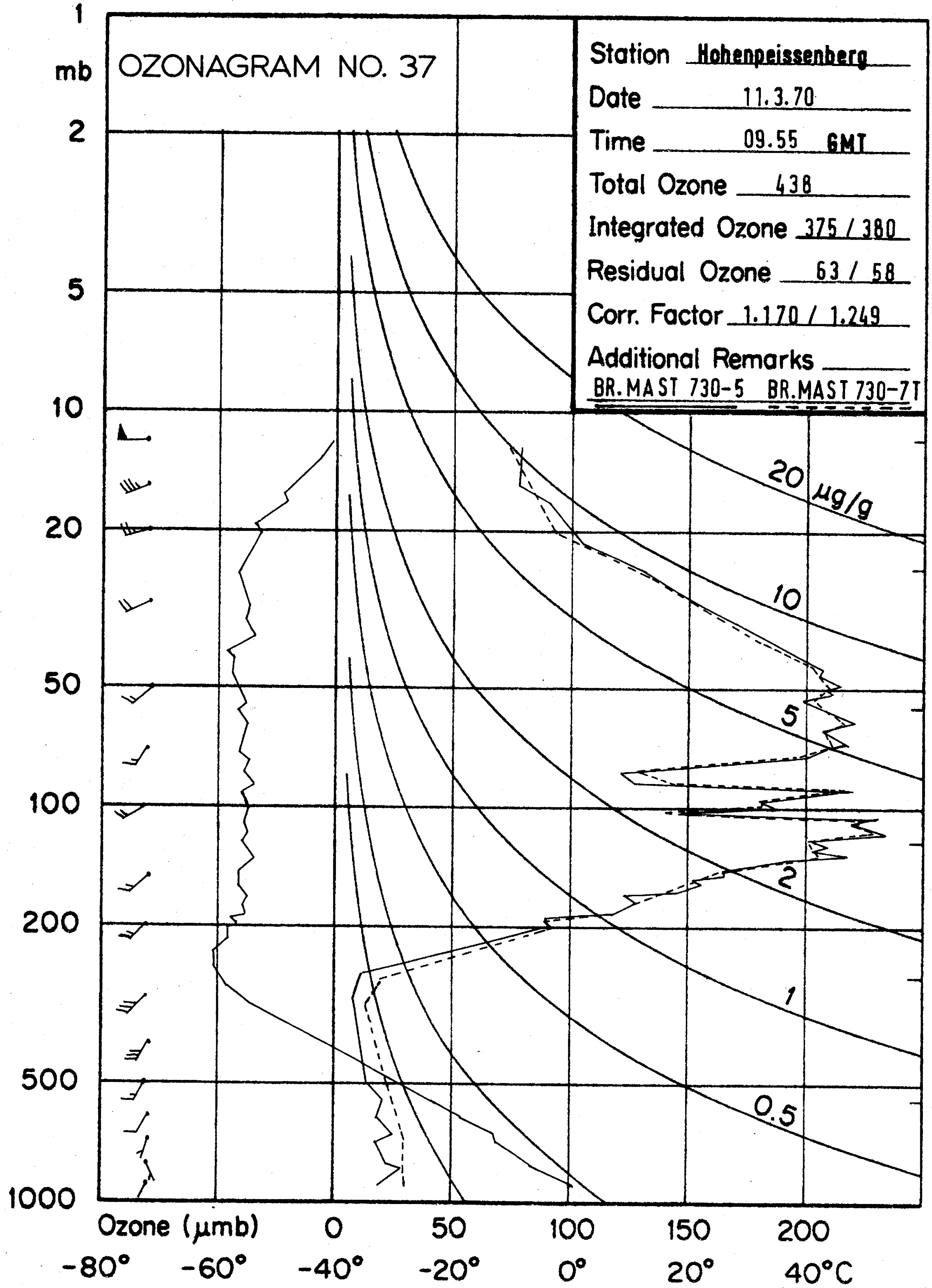
-80°
-60°
-40°
-20°
0°
20°
40°C


OZONAGRAM NO. 37
Station Hohenpeissenberg
Date 11.3.70
Time 09.55 GMT
Total Ozone 438
Integrated Ozone 375 / 380
Residual Ozone 63 / 58
Corr. Factor 1.170 / 1.249
Additional Remarks
BR.MAST 730-5 BR.MAST 730-7T
mb
1
2
5
10
20
50
100
200
500
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20 μg/g
10
5
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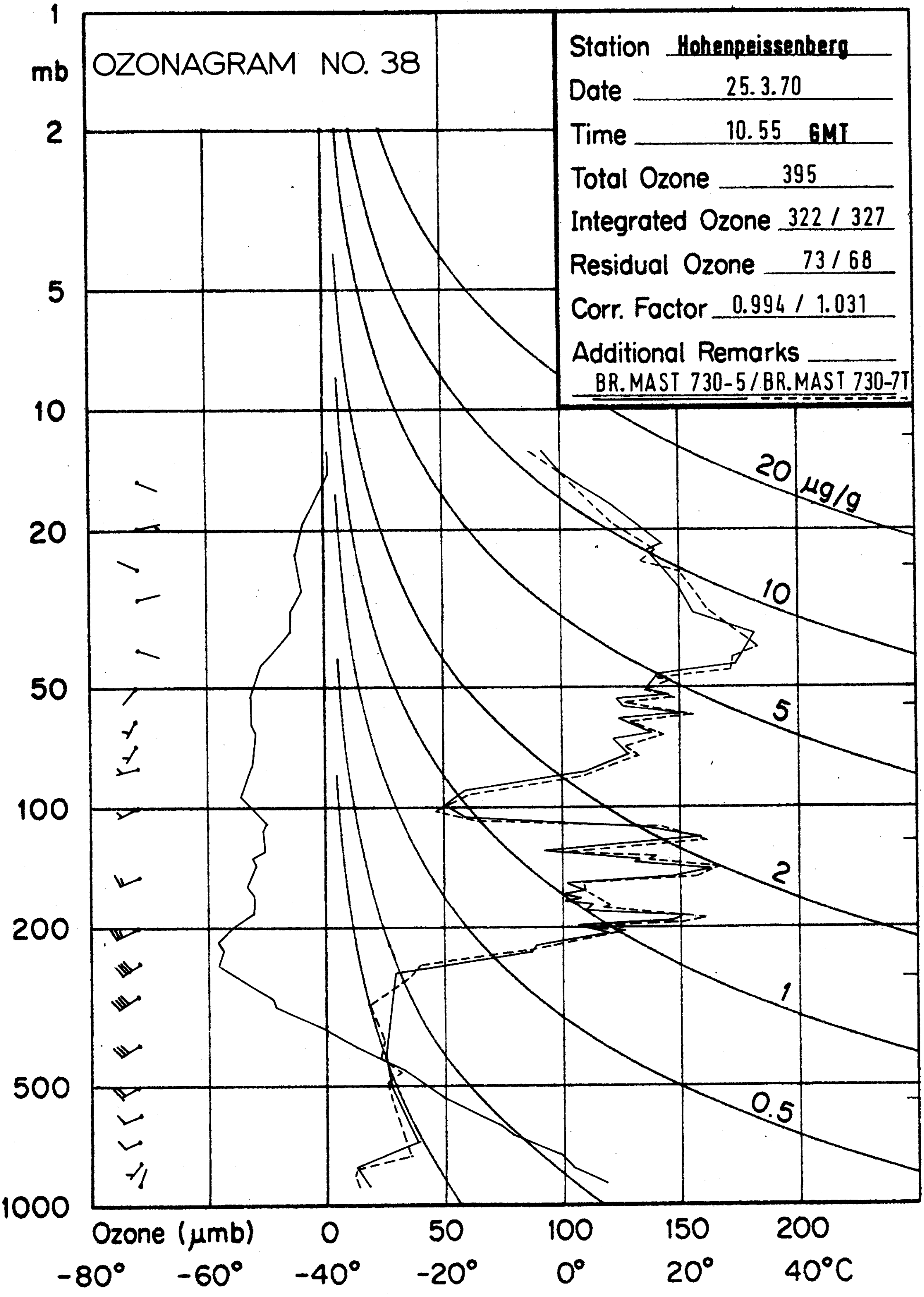
1
0.5
Ozone (μmb) 0 50 100 150 200
-80° -60° -40° -20° 0° 20° 40°C


OZONAGRAM NO. 38
Station Hohenpeissenberg
Date 25.3.70
Time 10.55 GMT
Total Ozone 395
Integrated Ozone 322 / 327
Residual Ozone 73 / 68
Corr. Factor 0.994 / 1.031
Additional Remarks
BR.MAST 730-5 / BR.MAST 730-7T
mb
1
2
5
10
20
50
100
200
500
1000
20 µg/g
10
5
2
1
0.5
Ozone (µmb)
0
50
100
150
200
-80°
-60°
-40°
-20°
0°
20°
40°C