

6 Ship's Meteorological Station

6.1 Leg M42/1a and 1b

(H. D. Behr)

Cruise, course and weather

RV METEOR sailed from Las Palmas Tuesday, June 16, 98 at noon, steering on northerly courses. There were light northeasterly winds at the first station ca. 80 nm northwest of Gran Canaria, originating from a high south of the Azores and a low over the western parts of the Saharan desert. The wind turned to North force 4 during the cruise until we reached the position LP north of La Palma. After station work at LP RV METEOR sailed to station EBC east of Lanzarote. The African low had moved to the west in the meantime causing northeasterly winds of force 6, increasing to 8 for a while. After having finished station work east of Lanzarote R/V Meteor sailed westward again to station ESTOC north of Gran Canaria and after station work there RV METEOR called in to Las Palmas again 25 June to exchange part of the scientific crew.

After having left Las Palmas on 26 June, the vessel steamed again to the array EBC east of Lanzarote to start the hydrographic work on the box north of the Canary Islands. The high near the Azores and the low over the Saharan desert were nearly stationary during the whole time. However, slight movements in their positions and changes in their intensities usually caused northeasterly wind increasing to force 7 in the afternoon decreasing winds to force 3 to 4 during the nights. While approaching the easternmost station on the northern section 357, the Saharan low deepened significantly and moved westward towards the high near the Azores. This caused the northeasterly winds to increase to up to force 8 during the last part of this leg. At station 357 the wind was light and variable, but there was a lot of dust caused by Saharan sand in the air reducing the visibility. After station work at 357 was finished at July 12 R/V METEOR started her transit to the port of Lisbon. On the way, four moorings were to be recovered which was disturbed by rough seas due to the strong winds.

In the morning of July 16, 98 RV METEOR reached Lisbon.

Activities of the Ship's Weather Watch

On a daily basis, *weather reports* were compiled and published. Comments heron were presented on a regular basis to the ship's command and the chief scientist. The other participants of the cruise were informed through a bulletin or on special request. Special advice was given in some cases. The necessary data and weather maps were received from wireless stations (Pinneberg and Nairobi), as satellite pictures (METEOSAT 7 and NOAA 12, 14, and 15), and by fax (forecast charts from ECMWF or DWD) or by e-mail from the 'Deutscher Wetterdienst', Hamburg and Offenbach/Main. The forecasts of weather conditions and height of sea and swell were based essentially on surface analyses charts of the Northern Atlantic Ocean between 60° N and 20° N. Surface observations of West-European and Northwest-African weather-stations and voluntary merchant ships were compiled by hand drawing in these charts and analyzed by hand.

Continuously measured meteorological parameter were recorded, transferred to the ship's data collecting system, and on request were distributed to users through computer links or on disks. The sensors and meteorological equipment were maintained on a regular basis, some repairs were made.

Standard weather WMO observations were made every hour by the watch officer. Eight of them were transmitted into the WMO Global Telecommunication System (GTS); these also included additional eye observations done by meteorological staff.

Every day at 12 UTC one *radiosonde* was launched using the ASAP system by which the vertical profile of pressure, temperature, moisture, and horizontal wind up to an altitude of 20 to 25 km was determined. The processed data of the records (TEMPS) were transmitted to the GTS of the WMO.

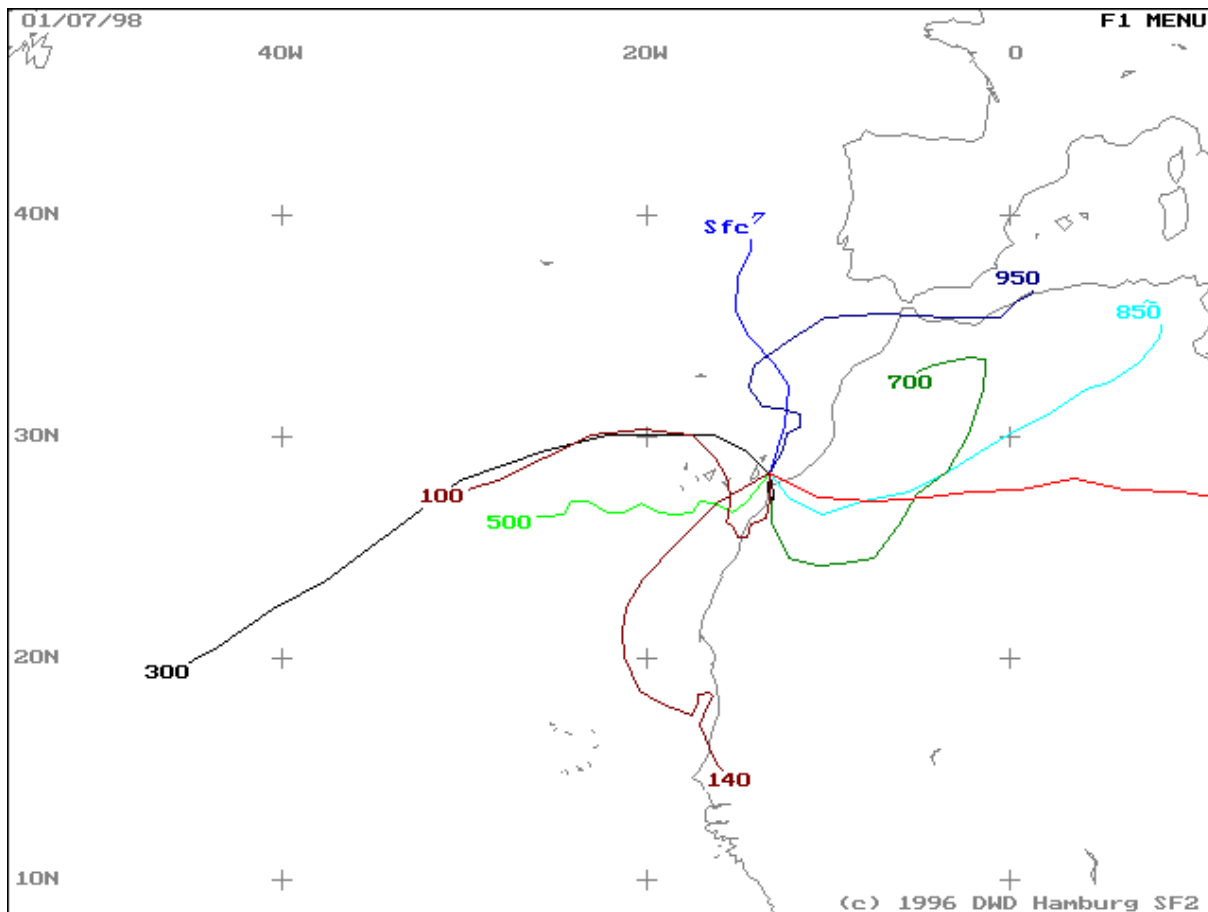


Fig. 94: Backward trajectories in different levels starting 108 hours ago and reaching the position of FS “Meteor” on June 21, 98 00:00 UTC. The pressure levels used are indicated: surface, 950 hPa [0.5 km], 850 hPa [1.5 km], 700 hPa [3.0 km], 500 hPa [5.5 km], and 300 hPa [\approx 9 km], 140 hPa [\approx 14 km], 100 hPa [\approx 16 km], and 50 hPa [\approx 21 km].

Determination of the net total radiation and atmospheric turbidity at sea

Information about the spatial and temporal distribution of the net total radiation and its components at the sea surface as well as atmospheric turbidity are important basic variables in meteorology and oceanography as well. Off Northwest Africa atmospheric dust that originates from the Saharian desert is an important component of atmospheric turbidity, and it also plays an important role in sedimentation in the ocean.

In a special research programme, the following radiation components were recorded during M42/1: direct solar radiation, sunshine duration, global solar radiation and UV-B global solar radiation as well as longwave thermal radiation of the atmosphere. Additional components that are necessary to establish a radiation balance as reflected solar radiation and ocean surface radiation were computed using numerical models that have been successfully tested earlier on research cruises in the Atlantic (BEHR, 1990).

Atmospheric turbidity is expressed by a set of coefficients as follows:

T_L : Linke-turbidity-coefficient, describing all radiative processes in the solar spectrum

T_s : turbidity-coefficient, describing all radiative processes in the short-range part of the solar spectrum which provides information about the dust in the atmosphere

T_r : turbidity-coefficient, describing all radiative processes in the red part of the solar spectrum which provides information about the water-vapor-content in the atmosphere.

Using an exponential decaying law that describes the turbidity effects as the effect of several

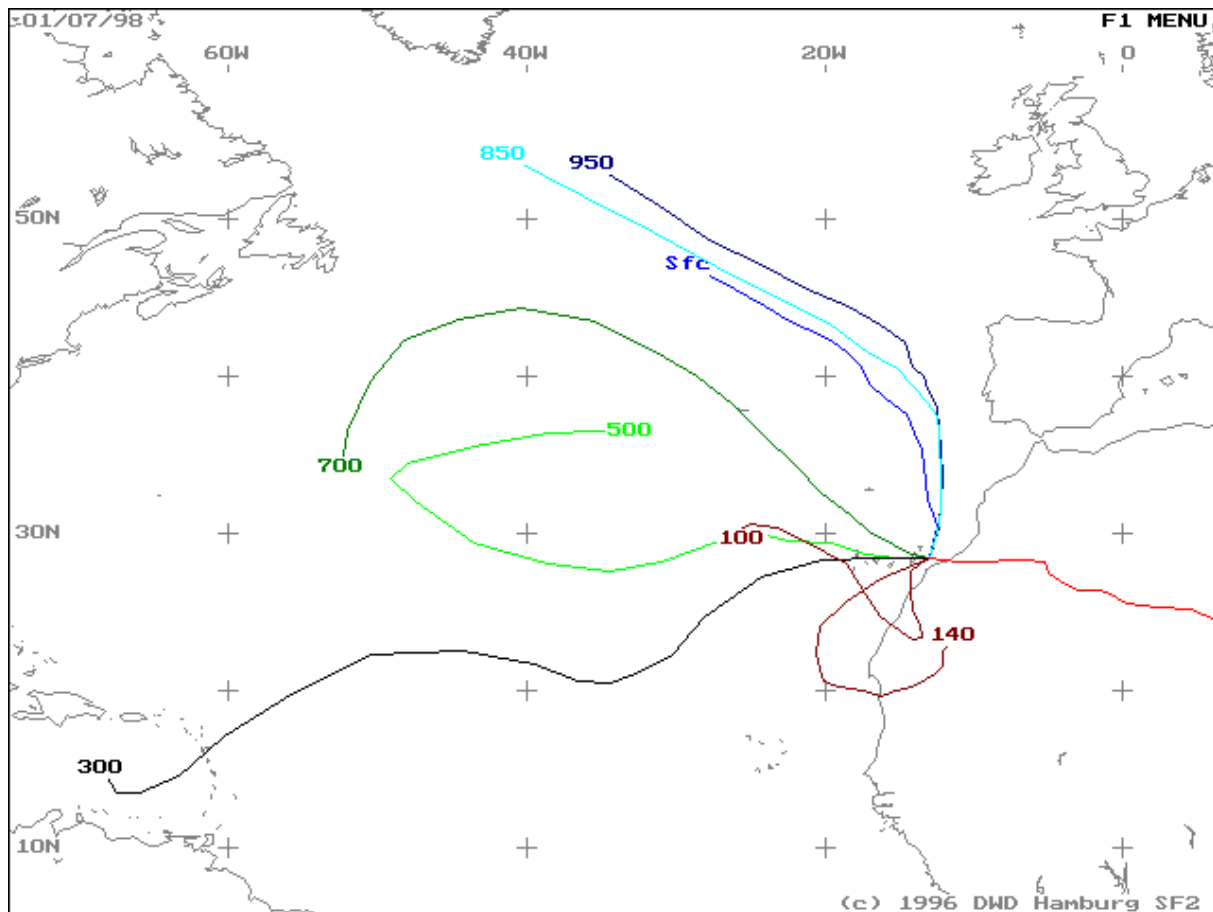


Fig. 95: Same as Fig. 94, but for June 28, 98

(clear) Raleigh atmospheres, the coefficients T_L , T_s , and T_r can be computed by from:

- the known extraterrestrial solar radiation received from a surface normal to the beam of the sun which depends on the distance sun - earth only
- the direct solar radiation received from a surface normal to the beam of the sun, e.g. measured with a Linke-Feussner-Actinometer
- the optical pathlength that depends on the solar elevation angle
- the optical thickness of the atmosphere

The data set of numerous measurements of direct solar radiation done with a Linke-Feussner-Actinometer revealed the spatial and temporal variation of the atmospheric turbidity during M42/1. As a first result, of the section along ca 29°N from EBC to LP (June, 16 to 30) will be shown here. There was clear air during nearly all the time, but a dusty event occurred from June 21 to 25 transporting sand from the Saharan desert. The pathways of the airmasses in 9 different pressure levels is revealed by figures 94 and 95 by backward trajectories. The trajectories started 108 hours before the day chosen in order to reveal the area the air originated from. From June 21 to 25, dusty air originated from the Saharan desert reached RV METEOR in all layers. The Linke-turbidity-factor is correspondingly high: 12 to 18 (see Fig. 96). The increasing content of dust can be seen by increasing values of T_s from 2 to 4. During all other days clear air originating from a maritime area was present in all layers of the atmosphere. The turbidity factors were correspondingly low. These findings correspond to former results found by BEHR (1990, 1992).

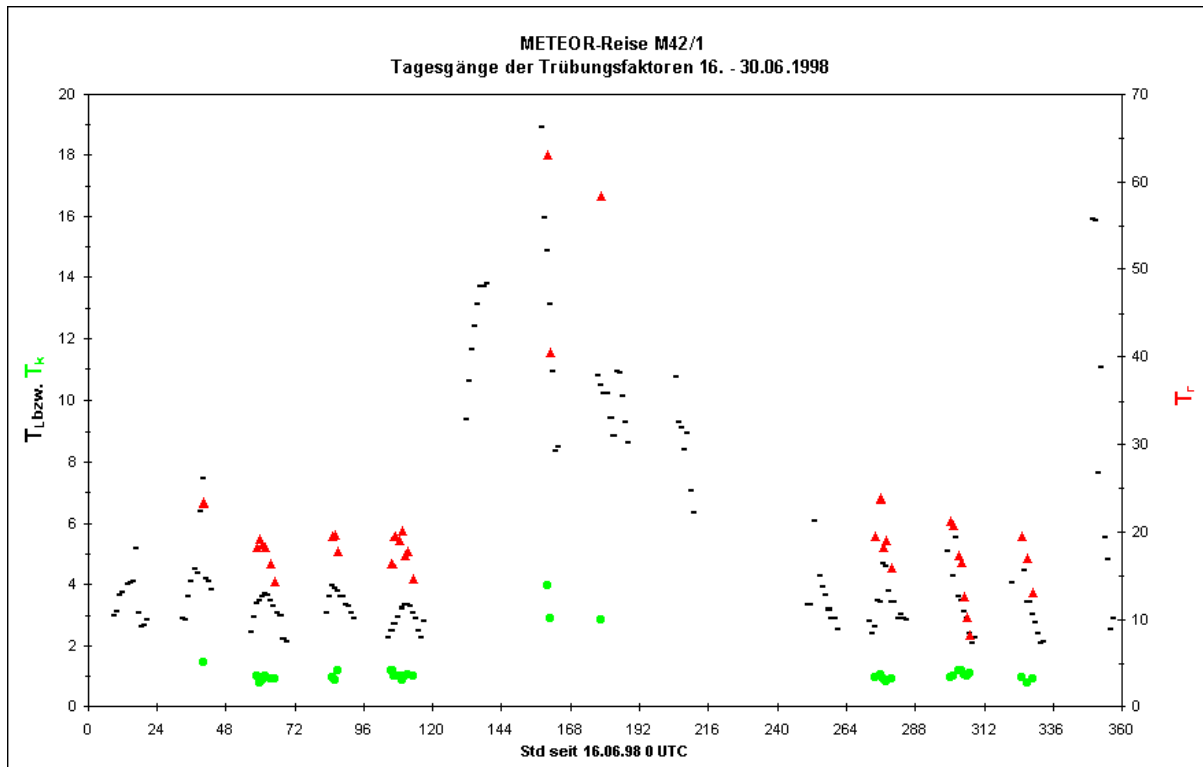


Fig. 96: Daily changes of the atmospheric turbidity coefficients T_L , T_k , and T_r along ca. 29°N (EBC to LP), June 16 to 30, 98.

6.2 Leg M42/2

The weather during METEOR Cruise 42/2, Lisbon-Lisbon, 23.07.98-22.08.98

When METEOR sailed from Lisbon on July 23, the general atmospheric circulation was at its minimum summer intensity. An Icelandic low of 1000hPa was extending into the North Sea, moving into the Norwegian Sea. On the western rim of the Atlantic, a low of 990hPa had reached the Labrador coast, the central North Atlantic being governed by the subtropical anticyclone of only 1026hPa with its centre east of the Azores with a wedge of 1020 hPa at 55North 25West. This wedge was swinging east to the western entrance of the English Channel, deteriorating there during July 25. The vessel experienced northerly winds of up to 5Bft while moving north to her working areas BENGAL and BIOTRANS, then light easterly winds came up which gave way to southerly winds about 5 Bft during the 25th. Meanwhile, the low from Labrador had been moving eastwards steadily, passing south of Greenland and reaching a position south of Iceland, its central pressure filling to 1000hPa.

The meridional circulation being experienced during the onset of the voyage had given way to a weak zonal one. The next low followed on about the same course, southwesterly winds of 6 Bft being observed during July 27, veering and decreasing. A wave developed at its cold front, however, and after having passed the Grand Banks it moved rather rapidly to the north east, reaching the low of 998hPa in Scotland July 29, giving it a new lease of life over the North Sea. Consequently our research vessel experienced northwesterly winds of 5 Bft for a few days, not weakening further until 1 August. In fact, light winds prevailed during that day.

In the meantime another low had developed into a gale center of 990hPa south west of Iceland. Strong advection of warm air masses took place south of the gale centre as its cold front was impeded from advancing southeast by the development of waves along its length. The advection of warm air made the wedge 1030hPa north west of Cape Finisterre hold its own against the warm front of the gale centre swinging east. As a result Southwest 7 Bft was observed for a few hours as

the warm front took its time swinging over the ship's position. Fortunately this proved to be the only near gale of the cruise.

Once its wedge had weakened over the Bay of Biscaya and the frontal trough had moved away westward the subtropical high visited our ship, winds being light and variable during August 4. Similar conditions were observed again during August 12 and 15.

On the whole, it can be said that the General Circulation has taken up quite some intensity during the cruise. There is one more example: During August 12, an already developed low 1006hPa was crossing Nova Scotia in a northeasterly direction. Circulation over the Northeastern Atlantic was dominated then by a gale centre of 980hPa southwest of Reykjanes, Iceland. This moved into the Norwegian Sea. The Canadian low passed the Bell-Isle-Strait on August 14, a separate development taking place at its occlusion point. During August 15, there were two gale centres of 995 hPa, one south of Cape Farvel, the southern tip of Greenland, the other at 52 North 28 West. Both lows moved northeastwards, so RV METEOR experienced southwesterly winds of 6 Bft before the cold front passed the ship on August 16. We then experienced westerly winds of about the same force because of the passage of a trough south of the second low. When scientific work was finished, the ship made her way to Lisbon accompanied by moderate winds from northerly directions. The voyage ended there on August 22.

6.3 Leg M42/3

The weather during METEOR-Cruise 42/3 Lisboa - Las Palmas Aug. 25 to Sept. 24:

When RV METEOR sailed from Lisboa on schedule on Aug. 25 strong northerly winds were blowing along the coast of Portugal. A synoptic situation had developed which was characterized by a low of 1014 west of Porto and an opposing high of 1027 east of the Azores, extending into the Bay of Biscay. This had happened even before the ship had called at Lisboa, and there had been little change so far. As the research vessel proceeded southwest to her first working area, CANIGO, south of the Azores, northerly winds abated and made way to moderate southwesterly winds during Aug. 28. These winds were caused by a low of 1014 at the Azores which had developed during a cut-off-process from the general circulation and filled during the next few days. During the last days of August RV METEOR experienced moderate westerly winds while the subtropical high of 1030 extending from Bermuda to about 32 N, 35 W was opposed by a gale center of 980 covering a large area south of Iceland. Further, the hurrican season had started, and the remnants of hurrican "Bonnie" which had converted to a mid-latitude storm center of 995 were on their way east from Newfoundland, passing just north of the Azores during Sept. 1. Meanwhile, hurrican "Danielle" had reached the area southeast of Cape Hatteras where it became almost stationary.

Data sampling began at the Great Meteor Seamount while winds were weak. The subtropical high had extended to a position east of the Azores. On Sept. 2 the ship's weather station received reports that hurrican "Danielle" had accelerated northeast, passing Cape Race on Sept. 3, thus causing the high's extention. "Danielle" retained hurricane force after it had converted to an extratropical storm center of 965 at 47°N, 30° W on Sept. 5. Sampling work went on unhampered, however, because a wedge of high pressure stayed in the research area. Hurrican "Earl" and its remnants, a gale center of 975, followed on a similar course a few days later, but leaving the ship unmolested too.

The subtropical high which had centered just north of the Azores strengthened to over 1030 on Sept. 9 for the next days. Further south the activity of cloud clusters moving west over the Atlantic, leaving Africa south of Cape Blanc, was strengthened remarkably. R.V. "METEOR" observed easterly winds of 6 Bft from Sept. 10 to 12. But these winds abated to 3 Bft thereafter because the Azores high had weakened. Cloud cluster activity remained about the same until Sept. 14, when one of these clusters suddenly became stronger and started to turn northwards from 21°, N 30° W at

Table 51: Sunrises and sunsets at the Great Meteor Seamount

alle Zeiten Bordzeit (UTC)		
Datum	SA	SU
29.08.98	07:35:00	20:26:00
30.08.98	07:35:36	20:25:00
31.08.98	07:36:12	20:24:00
01.09.98	07:36:48	20:23:00
02.09.98	07:37:24	20:22:00
03.09.98	07:38:00	20:21:00
04.09.98	07:38:24	20:19:36
05.09.98	07:38:48	20:18:12
06.09.98	07:39:12	20:16:48
07.09.98	07:39:36	20:15:24
08.09.98	07:40:00	20:14:00
09.09.98	07:40:36	20:12:48
10.09.98	07:41:12	20:11:36
11.09.98	07:41:48	20:10:24
12.09.98	07:42:24	20:09:12
13.09.98	07:43:00	20:08:00
14.09.98	07:43:36	20:06:48
15.09.98	07:44:12	20:05:36
16.09.98	07:44:48	20:04:24
17.09.98	07:45:24	20:03:12
18.09.98	07:46:00	20:02:00
19.09.98	07:46:36	20:00:48
20.09.98	07:47:12	19:59:36
21.09.98	07:47:48	19:58:24
22.09.98	07:48:24	19:57:12
23.09.98	07:49:00	19:56:00
24.09.98	07:49:24	19:54:48
25.09.98	07:49:48	19:53:36
26.09.98	07:50:12	19:52:24
27.09.98	07:50:36	19:51:12
28.09.98	07:51:00	19:50:00

0600 UTC. It reached 26.5° N, 29.0° W at 2330 UTC on the same day. The tropical low changed direction at the second half of the night, however, moving slowly northeast on Sept. 15. It later accelerated towards the area north of Madeira. After passing the archipelago the system turned towards Gibraltar reaching the area on Sept. 17. Though the tropical low “Albeit” had been quite near the research vessel, winds had remained only in the order of Bft 3 to 4. Winds abated further during the last days of station work which was terminated on Sept., 21. Meanwhile, hurricane “Georges” had developed from a cloud cluster and caused havoc in the Lesser Antilles. The next cloud cluster developed into the tropical storm “Ivan”, moving north at 35° W first and then swinging northeast. By that time, RV METEOR was already on her way to Las Palmas, accompanied by moderate northeasterly winds. A table with times of sunrise and sunset for the days of biological measurements follows below (Table 51).

6.4 Leg M42/4 a and b

(K. Buhlmann, D. Bassek)

Weather and wind conditions during the cruise M42/4 of RV METEOR from Las Palmas to Viana do Castelo (26 September to 25 October 98)

Normally the Atlantic subtropical high situated near the Azores and the Canary Islands lying in the zone of the trade winds, but in the third decade of September and in the beginning of October, however, the high was shifted southwards and reached from the Great Meteor bank to the Canary

Islands and sometimes to Morocco. The reason for this deviation was the track of several tropical cyclones which took the short way from the tropics to the Azores and from there a course eastnortheast to the bay of Biscay and western Europe. As a result of this atmospheric circulation the trade winds were mostly weak or did not exist anywhere.

On 26 September when the first leg of the cruise M42/4 began RV METEOR sailed to the ESTOC-station, where a light trade wind with bft 3, occasionally 4 from eastnortheast was blowing for three days. On 30 September the wind increased to bft 5 from the northnortheast due to some pressurefall over northwestern Africa. Then in the next four days on the La Palma-station the wind was light and variable and sometimes calm. The first leg ended in Las Palmas on 6 October by northeasterly winds bft 4. During this cruise the sky was mostly fair and sometimes cloudy. The visibility was good and sand and dust from the Sahara was not observed.

When RV METEOR left Las Palmas on 8 October to the second part of the cruise the general circulation has changend. A large high with nearly 1040 hPa in its centre had developed in the sea-area northeast of Azores which caused strong trade winds with bft 6 and 7 from northeast. On 10th of october when RV METEOR sailed from the working area north of La Palma on the western side of the isle La Palma southwards an interesting phenomom could be observed. By approaching the northern edge of the island in the afternoon the wind increased from bft 6 to gale force bft 8. Then one hour later the wind decreased rather quickly to bft 2 and turned to southwesterly directions accompanied by pressurefall nearly 4 hPa and dissipating clouds. The reason: In the leeside of the island a small low had developed which was caused by the 2400 m high mountains of the island. When RV METEOR had crossed this lee depression and reached the southern edge of La Palma winds increased again within a quarter of an hour to bft 8 with gusts up to bft 11 and continued in this gale force until the next morning, but got weaker during the day. In the next days when RV METEOR was working in the southern and eastern parts of the Canary Islands the subtropical high was still dominating, but got weaker. So the wind amounted most of the time to bft 4 from northeast. On 17 of October a new high developed north of Madeira and the wind increased bft 5 to 6 for a time, but decreased bft 4 again, when we worked near the coast of Morocco. On 23 October in the evening RV METEOR took course northwards to Viana do Castelo by northeasterly winds bft 4 which turned southwesterly when we arrived the port of destination on 25 of October.