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SOME REMARKS CONCERNING THE GERMAN WEEKLY NORTH SEA T_o-CHART

by

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ABSTRACT

Including the data basis and processing, the actual compilation of the weekly t_o-chart is described. In comparison to the t_o-data transmitted direct from different research vessels, the accuracy of the ship observation used can be estimated regionally during the period of the International Young Fish Survey 1986.

Finally, the partly large differences of the chart compiled weekly from ship observations compared with satellite images are discussed.

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INTRODUCTION

The Federal German North Sea t_o chart has been issued weekly since September 1968 by the Deutsches Hydrographisches Institut (DHI) as a paper copy of about 55 cm to 70 cm. It seems to be one of the last remaining survivors of a group of traditional SST charts of or including the North Sea which once were issued periodically by different nations.
Our recipients today and - it is hoped - users are fisheries associations, weather services, marine institutes, and navy offices (SAR services) adjacent to the North Sea, in North America and even in Japan.

The surface temperature anomalies of the week including the 15th of each month - related to the long term means 1905-54 (ICES, 1962) - are inserted into the t_o chart.
Since 1970, comments about the previous winter water temperatures and a forecast of the bottom temperatures for the following summer are supplied in May. Other irregular supplements deal with vertical temperature and bottom temperature distributions, mostly based upon IGOSS-data of research vessels. A graphic reduction of the t_o chart is regularly prepared for facsimile transmission and can also be mailed.

Several attempts have been made to investigate a fixed grid interpolation of the chart series for temperature fluctuations. The charts of the period 1971 to 1980 have been used to compile weekly and monthly means (Becker et al., 1986).
These statistics also include the differences to the ICES long term means (1905-54).
Now, that the chart has nearly reached its 18th birthday, it is time to discuss the past and future method of compilation and - maybe - possible supporting satellite images. Thus, the reader - and especially the user - is now asked to write his/her wishes and comments about the Federal German t_o chart.

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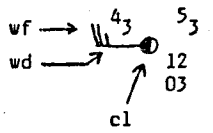
COMPILATION OF THE t_o CHART

The t_o chart was and still is compiled from the surface temperatures contained in the standard WMO weather observations made by vessels in the North Sea. From Wednesday, 00 UTC, to Tuesday, 21 UTC, the incoming data of all observation times were, and are, taken into account. From the beginning of the compilation of the chart until last year, all the ship observation telex paper prints passing through the Seewetteramt Hamburg (SWA) to or from the central of the Deutschen Wetterdienst, Offenbach (DWD), were sorted daily by hand. The observations from the North Sea, the area 50° N to 62° N and 4° W to 12° E, were drawn into a transparent original chart (also by hand), insofar as they showed realistic water temperatures (criteria see below). Air temperature (ta), water temperature (tw), cloudiness (cl), wind direction (dd) and wind speed (ff), waves (wh), and the day of observation (dd) marked the observation in the chart in the following manner:



tw: 5.3 °C wd: 270°
ta: 4.3 °C wf: 23-27 knots
cl: 4/8 wh: 1.5 m (03x0.5 m)
dd: 12th of the Month

Irregular surface temperature measurements from ships of opportunity - especially those of research vessels - completed the data base if they were received in time (time of going to press: Wednesday, 09 UTC).
The number of usable observations is fluctuating with increasing tendency: about 250 values was the weekly mean during the first years; up to 700 values, chosen from more than 2000 automatically transmitted data of one week, provide a good chart today.
From these selected values, from about one third up to the half are from fixed stations (reported daily several times), the others are singles. Up to 170 t_o values can also be added during one week if a research vessel sends hourly SST-measurements to us direct.

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For years, different attempts have been made to establish a computer collection and sorting routine in either the DHI or in the DWD. Gaps of unknown type and depth absorbed more or less large parts of the data set. Other difficulties were the lack of guaranteed transmission times and data lines. By means of the present computers in the DHI and DWD, and some special equipment installed for IGOSS purposes, an automatic data transfer and sorting has been established for months and is effective when "all systems go".
Comparisons of the data lists resulting from the automatic data transfer and the manually sorted telex paper prints of the SWA corresponding, revealed observations in both sets which were not contained in the other. These unilateral data amounted up to 20 % (in the mean, about 5 %) of the total North Sea observation set. Until now, the differences are explainable only in parts: The broad spectrum of small transmitting errors (incomplete 5-figure groups, or one figure more in one group; letters in a group; blanks, breaks, etc; changed group sequences) excludes a lot of observations from the computer file.
Another part of the differences are the delayed incoming observations (reaching the DWD after the standard times). They are given to the SWA, but not transferred into the files transmitted to the DHI because completeness is not a weather service aim in a well covered area. However, we need every water temperature that is available. Besides these, there are still some unknown gaps on both methods which we hope to find and fill up.

At the moment, the list of the automatic transferred and sorted data are used to compile manually the original transparent chart. During that, an individual quality check, especially of the water temperatures, takes place (criteria see below). As during the years before, the analysis of the t_o chart is carried out manually with more emphasis laid upon the values of the last few days and with respect to the recent weather. Some short remarks written onto the original chart give to the user some explanation of the analysis.

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Parallel to the list printing of the daily sorted observations, they are placed in a weekly file after an individual quality check (interactive job which, by the way, nearly needs the same time as the handplotting). From the fixed stations reporting several times a day (light vessels, rigs, buoys), only the 12 UTC messages (or the one next to it) are taken in this weekly file. The water temperatures, at positions which are twice or more times in this weekly file, are averaged with more emphasis laid upon the values of the latter days of the period under review. After the end of the collection period, the temperatures of the weekly file are plotted and the (still) manual analysis is compared to that originating from the daily lists. One actual disadvantage of the plot is the lack of the other weather parameters, which we were not able to insert into the plot without too much overlapping. They are very valuable for interpreting the water temperatures. Problems in analyzing the plot are created by sudden larger temperature changes, e.g. by upwelling at the southern Norwegian coast. However, they are only small stones on the way to a completely automatic t_o chart at which we aim to. Nevertheless, such a chart has to be at least of the same qualities than that handmade, for the continuation of an 18 year time series and keeping it consistent.

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ACCURACY OF THE t_o CHART

Owing to the fact, that no instrument can be always absolutely accurate, one has to deal with the instrumental errors first. The temperatures in the standard ship observations are given in tenths of a Centigrade. Usually, the water temperatures at the cooling water inlet are used for the weather observations. As Walden (1966) calculated, such temperatures differ by about +0.3 K from bucket values. Mittelstaedt (1969) estimated the error to be of the same magnitude. As far as I am able to judge the accuracy of those different pieces of equipment, I use $\pm$0.5 K as instrumental error (if it is more, the observation will be recognized to be wrong, see below). I can only trust that the majority of the incoming values is better, however, the development of more accurate temperature sensors during the years past has led to the belief in unchanging instruments. Temporally-dependent changes are not noticed, as even research vessels and a research platform have revealed.

Greater sources of errors are the reading, coding, and transmitting of the data (including the vessel's positions). We are unable to distinguish between such sources, but we do not accept ship-measured water temperatures of 20 °C in winter months from the Scottish Highlands. Besides deleting incomplete observations, the sorting programme labels with question marks all water temperatures outside the margin of $\pm$1 K compared to the next observations. This corresponds to the former individual noticing of local differences of more than 0.5 K within short period of time. Taking into account the other parts of the observation, and keeping in mind the actual hydrographic and meteorological situation of the area where the observation was made, the compiler has to decide, whether or not these marked values indicate strong seasonal heating for instance, or if they depend upon different measuring depths (unfortunately, such depths are not given in the observations), or if they are just wrong.

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Upwelling effects, wind induced turbulences and transports, and a lot of other events could be the reasons behind large differences. Thus, the decision "error" or "no error" essentially depends upon the knowledge of the actual weather situation combined with the oceanographic knowledge of the compiler. On the other hand, after preparing the chart for years, this provides one with more than an instinct for the quality of the measurements of the more frequently recurring call signs. Thus, it is possible to distinguish between those vessels providing good observations and those which are less good (as mentioned before: 700 out of more than 2000!).

Summarizing, the accuracy of the (manually) plotted observations is better than $\pm$0.5 K.

However, this refers only to an accuracy at one moment at a special position, and not to the accuracy of the t_o chart. To obtain an idea of the chart's accuracy, measurements from the IYFS '86 could be referred to. Luckily, the Leading Scientists of the vessels participating had heard of my plea for surface temperatures. Some of the data did not reach us in time, and they could not be used for chart compilation. However, they were used to check the plotted temperature distribution.
In the Figure, the (positive and negative) differences of the temperatures - posted charts minus delayed t_o measurements corresponding - are given.In calculating those differences, the partly severe cooling of the North Sea from the end of January to the end of February was not taken into account. Thus, the larger differences in the German Bight area, along the Norwegian Deep, and off the southeast English coast, are caused by the severe cooling and spreading of cold coastal waters within the weekly periods. These are the same areas where, during the summer season, the largest heating occurs.

That means, that the weekly mean temperature chart is less accurate than $\pm$1 K in some areas with special weather situations; however, in the majority of the areas the accuracy seems to be better than $\pm$1 K.

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WEEKLY t_o CHARTS AND SATELLITE IMAGES

In most cases, the thermal structures of satellite IR images differ quite a lot from a corresponding traditional t_o chart (e.g. Riepma, 1985). This originates on one hand from the different length scales: the images give structures with scales down to the resolution of the satellite sensor (metres); the t_o chart shows structures down to some ten kilometres. On the other hand: the images show skin temperatures at a moment; the t_o chart gives a mean temperature of a surface layer of up to 6 m thickness. It is not possible to shorten the t_o chart period under analysis down to about one or two days. However, it is possible to average the satellite-given features; as, for instance, Huber (1984). During the period April/May 1984, he found that the temperature changes given in the t_o chart were also in the different images. The average satellite temperatures were mostly beneath the t_o values observed by the vessels (up to 3 K). Maybe this was an effect of the data processing. Owing to the fact that it would be advantageous if parts of the satellite-measured temperature structures could be transferred to the t_o chart - for instance, off the Norwegian, English, and Scottish coasts - a future project will be undertaken from February to May 1987. Ideas and ground truth measurements are welcome.

TO SUM UP:

It seems likely that the Federal German t_o chart will continue to be issued in future years. Some of the users have already sent in information about their use of the chart, this leads one to the conclusion that the reason for receiving it is not only its supply free-of-charge.

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