International Council for the Exploration of the Sea

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Hydrography Committee

On the need for a systematic comparison of techniques for determining residual drift

by

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SUMMARY

The commonly-used methods of computing residual drift are discussed and some early results reported from a comparison of three techniques: arithmetic averaging, Doodson's X_0 filter, and 'stream prediction'. It is suggested that, although the large-scale exchange of recorded current meter data and data products from North Sea stations is still at an early stage, a Study Group should provide guide-lines for the computation of Eulerian residual drift on the one hand and Lagrangian drift on the other. This would lead to a general acceptance of the reliability of the estimates of such factors arrived at in slightly different ways, and could save a great deal of duplication of effort as far as data-processing is concerned.

INTRODUCTION

In the last three years the recording current meter has become a most important feature of many oceanographic exercises. In fact lengthy time-series of current velocity and direction observations are now often available and before long they may be expected to become commonplace. Although fisheries oceanographers are undoubtedly interested from time to time in high-frequency phenomena and micro-scale structures, most of their interest in these records centres on the computation of residual drift. Hill and Ramster (in press) discussed this point in general terms and then compared Eulerian residuals computed from several sets of data in the eastern Irish Sea by means of arithmetic averaging over 24 hours 50 minutes, the Doodson X_0 filter (Doodson 1928), and the Godin Low-Pass filter (Godin 1967). Excellent agreement was found between the products of the three filtering techniques, and one of the conclusions of Hill and Ramster was that the practical advantages of the arithmetic averaging method, viz. no wastage of any data, ease of interpretation of products and the possibility of use of 12 hour 25 minute residuals in areas where the diurnal constituents of the tide are unimportant, justified its continued use as the basic approach to the problem of the computation of residual drift.

On the other hand, oceanographers approaching such computations from the viewpoint of tidal theory have tended over the years to use the 'stream-prediction' technique, in which the periodic part of any current meter data is first identified and then subtracted from the observed data to leave an estimate of the net drift over a given time period. A major advantage of this technique is that it can provide an absolute measure of the Eulerian drift at hourly intervals, so that it could be very useful in the study of short-period variability of drift associated, perhaps, with abrupt changes of wind regime. Its main disadvantage is that a long series of accurately timed data is needed so that the various constituents can be reliably defined. Few recording current meters in general use at present provide an indication of the exact time at which any particular measurement was taken and until this is done various assumptions have to be made about the interval between measurements when, as happens quite frequently in practice, the number of observations actually recorded does not exactly match the number expected.

In order to see if there was any agreement between this technique and the less sophisticated filtering methods, we have taken data recorded at 54°32' 4°20', a station lying between the Isle of Man and Scotland (Figure 1), for short periods at various times in the period 10 January 1968-10 December 1969, and computed residual drift in three ways. We have also begun to process in a similar fashion an almost continuous record from a station maintained in Liverpool Bay throughout the period May-September 1970.

METHOD

The residuals were first calculated by averaging, over 24 hours 50 minutes, north and east components respectively of current velocity derived from values recorded at 10 minute intervals. Hourly mean components derived from the same 10 minute values were then used to provide a second estimate of the components of daily mean drift via Doodson's X_o filter. Finally the north and east components of the hourly means were each treated as a time-series and subjected to harmonic analysis by the Tidal Institute Flexible Analysis program (Institute of Coastal Oceanography and Tides, Liverpool). By a least squares technique the facility is given to treat discontinuous data provided by several meters deployed successively on the site, and also it is possible to cope with disparate time systems which arise from the circumstances of laying and recovering the meters. The method also allows the user firstly to select for treatment the particular harmonic constituents which are deemed to be separable within the period of observations, and secondly to impose relationships between the major and minor constituents, in order to assist the separation of tidal constituents which are close in speed. Such relationships were determined from a tidal knowledge of the Irish Sea. In this way the analysis was able to identify 23 tidal constituents, supplemented by 7 others identified by relationship to a major constituent. The tidal constituents so identified were input into the program ELSIE so that they could be synthesized for the period of observation, thereby defining the periodic part of those observations. The same program determined the residuals on an hourly basis, the latter being the difference between the synthesized tide and the observed quantity at the time. When this procedure had been completed for both directional components, the hourly residuals so obtained for each component were then meaned over 24 hours to give a third estimate of the components of the daily residual drift from the data.

RESULTS AND DISCUSSION

Figure 2 compares the results from the three different techniques for a 15-day period taken at random from the 700 days under review. It is readily apparent that there is excellent agreement between the three techniques and this set of early results encourages the belief that a similar situation will be found at other times of the year and in other parts of the shelf seas around Britain. Indeed we have been surprised by the degree of similarity that has been achieved with this set of data, since the recording instruments themselves were at a prototype stage when much of the data was taken and the clock mechanisms were not as good as they are now. The practical problems of laying meters repeatedly in the same place so as to provide a long time-series appear to have been overcome or else are relatively unimportant, and there is little support here for the general feeling among oceanographers that the variability of tidal stream observations in nature in both time and space would be too great for the successful application of stream-prediction techniques.

It will be appreciated that as yet we do not have enough results to come to any firm conclusions. However, cooperative moored current meter projects are becoming commonplace and residuals derived from the basic data in various ways are being freely exchanged between participants; it therefore seems important to raise the point that similar comparisons of techniques to that which we have begun are needed if there is to be a general acceptance of the reliability of the various estimates of residual drift and a consequent avoidance of duplication of processing effort. As far as the North Sea is concerned, recorded current meter data have already been exchanged among ICES members over the better part of a year, and already there are grounds for thinking that the topic should be approached on a systematic basis via the setting up of an informal Study Group that would examine this question and the associated one of the quantification of the Stokes' velocity from region to region in the area. Once these two points of technique have been examined thoroughly and common guide-lines established for data-processors, the large-scale collection and exchange of recording-current-meter data and data products will be on a much firmer basis than at present.

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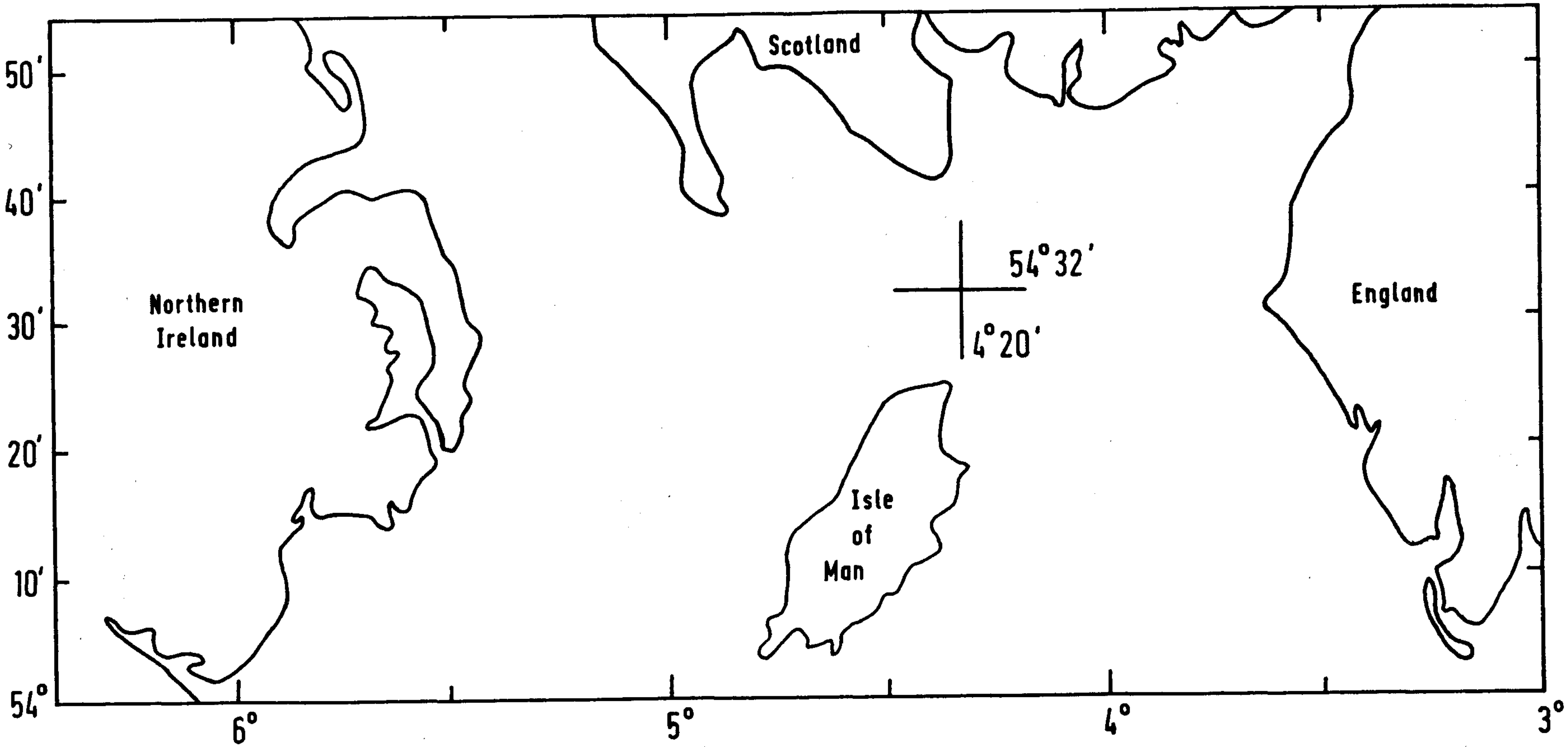

Fig. 1 The position in the Northern Irish Sea at which tidal stream data were recorded at various times in the period 10 January 1968 – 10 December 1969.

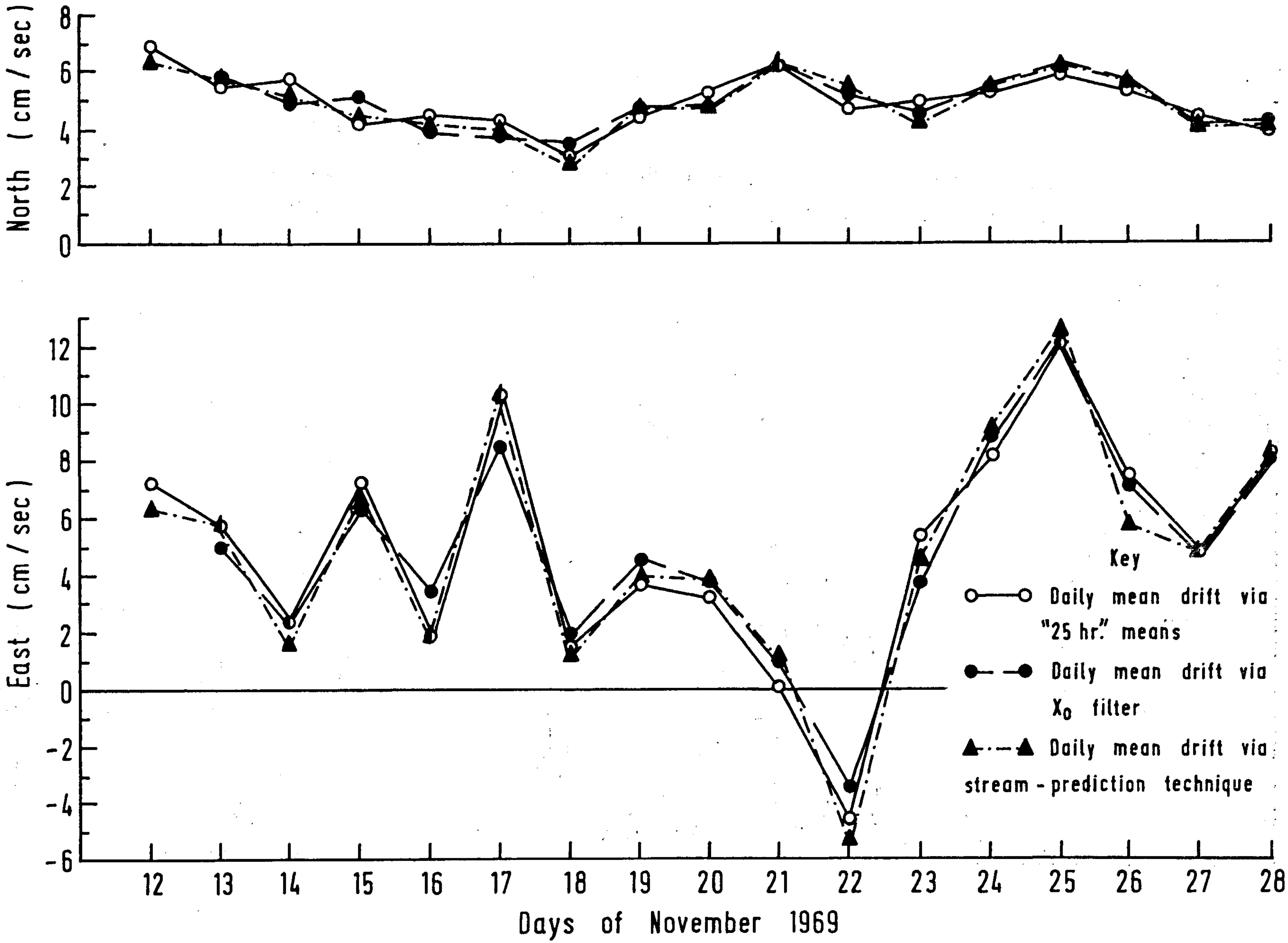

Fig. 2 Comparison of residual drift components via "25"hr. means, X_0 filter and stream - prediction techniques

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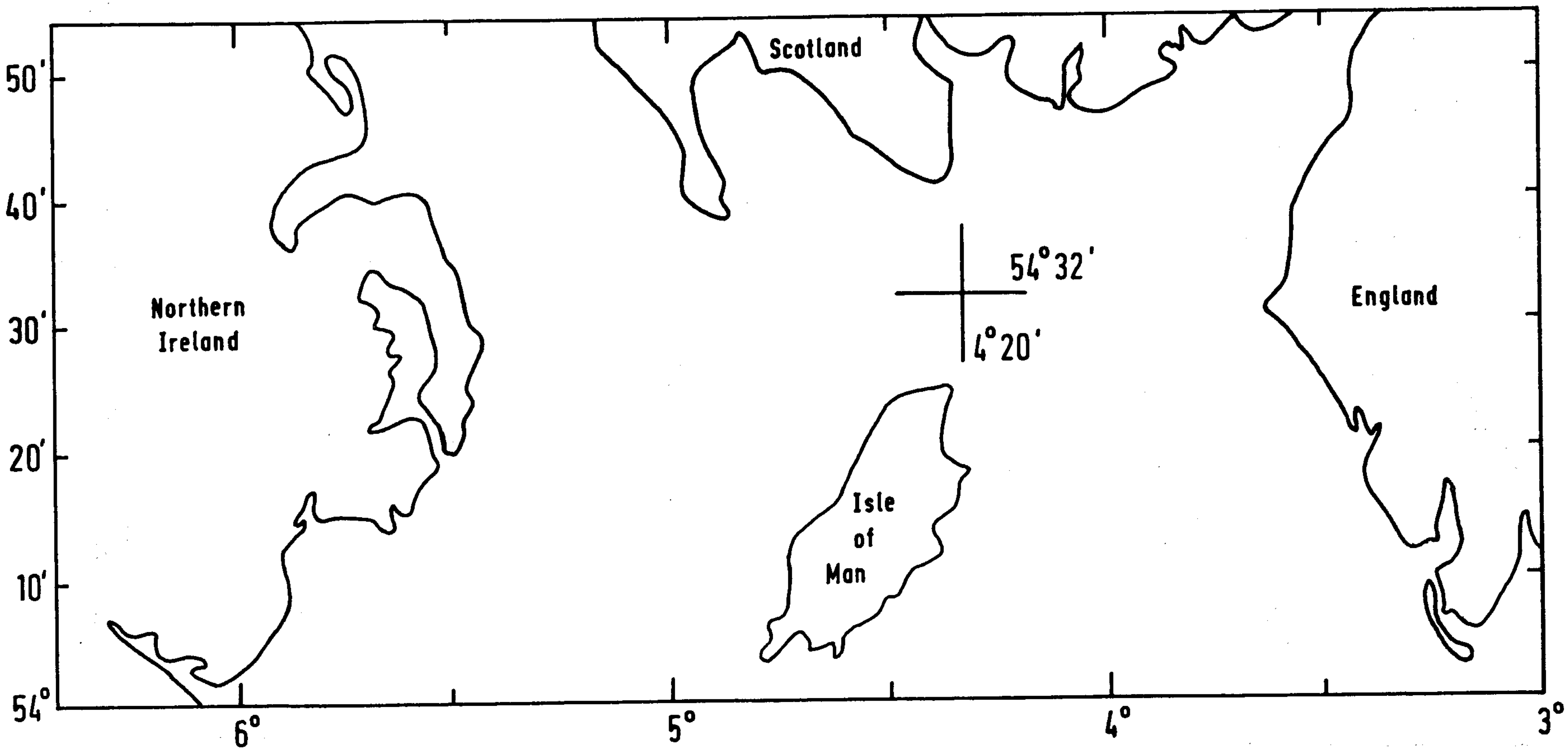

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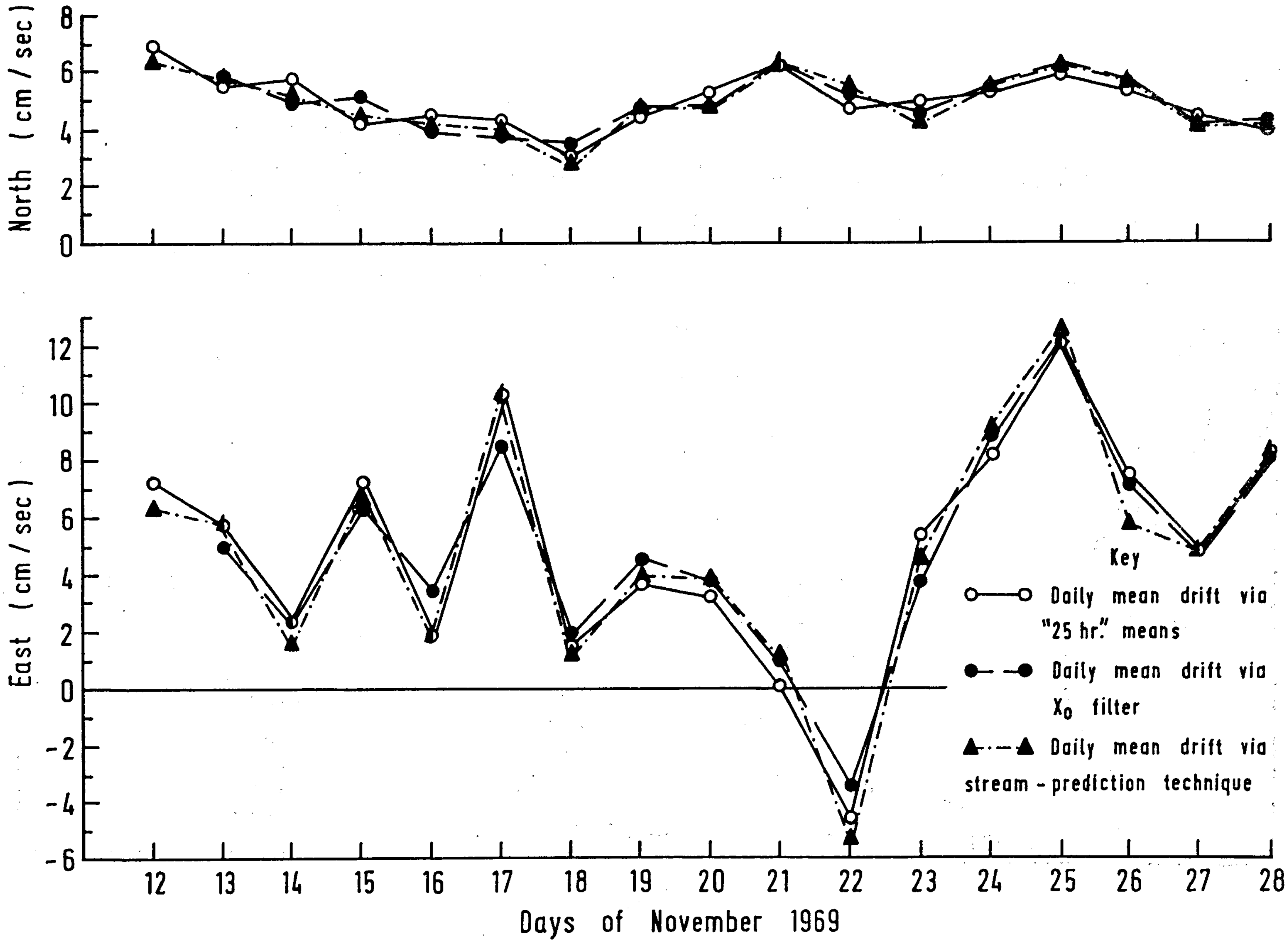

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