SHORTER CONTRIBUTION

On four-dimensional data-assimilation

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With the introduction of new observing systems which in our conventional frame of references give non-synchronous data, considerable interest has been given the problem of assimilating these data in numerical models. Various methods have been suggested and some of these have been reviewed in the recent GARP publication No. 11; "The First Garp Global Experiment, Objectives and Plans"; March 1973. Basically all methods have one common feature in that it is tacitly presumed that we should preserve our present time–space reference system and the forecast equations proper to this system. One may however, as will be shown below, remove some of the difficulties by rather simple coordinate transformations.

In order to demonstrate this point we shall look at a simple two-dimensional case, represented by the (x, t)-system in Fig. 1. The x-coordinate here represents longitude and we have therefore along this axis a circular continuation. In the (x, t)-system our present synoptic observations are taken on the thin full line $t = t_1$, t_2 etc. at certain time-intervals while observations from polar orbiting satellites fall along a sloping line, in the case indicated, cutting the x-axis at $x = 2\pi$ and the t-axis at $t = t_1$.

If satellite observations become more abundant than synoptic observations it would seem more profitable to introduce in the equations a new coordinate system (ξ, τ), in which satellite data become synchronous. The difficulty that synoptic observations in this system would become non-synchronous is not a very serious one since it would "only" take an international agreement to arrange for these observations to be made at times $\tau =$ constant, i.e. coordinated with satellite passages. With regard to almost all observations the problem of four-dimensional analysis would then be reduced to a three-dimensional analysis problem.

Naturally all difficulties cannot be removed by this simple transformation. For instance, we would no longer have circular symmetri in analyzed fields and may therefore have to extend the area of analysis. In forecasts, conditions at the eastern boundary of the area could be prescribed if suitable "non-synoptic" observations are made but at the western and much more sensitive boundary this possibility does not exist as can be seen from the figure. Furthermore, a forecast for 12 or 24 hours (depending on satellite velocity) will at the eastern boundary only take us up to actual time and is thus of very little interest. It may therefore be that the best application would consist of a forecast in the (ξ, τ)-system somewhat beyond 12 or 24 hours giving basic data for analysis in the (x, t)-system which in turn could be followed by a conventional forecast in this same system.

The author has no intention to make any detailed analysis of the equations that will be obtained by the coordinate transformation described above. It is reported here merely as a suggestion for further investigation.

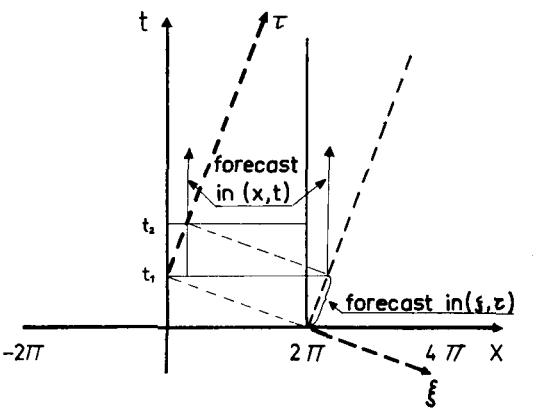

Fig. 1