AN ANALYSIS OF THE ROTATIONAL ACCELERATION OF THE EARTH

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ABSTRACT

The nature of the irregular fluctuations in the speed of the Earth's rotation was investigated using ninety-day means of UT2 - A.1 determined at the U. S. Naval Observatory. Data from June 1955 to April 1978 were included in this study. Statistical analysis of the excess length of day shows no evidence for the persistence of discrete values for periods on the order of five years. No statistical basis for the existence of discrete "turning points" in the rotational speed could be found.

Spectral analysis of the acceleration data shows that the rotational acceleration of the Earth during this period of time may be represented by a constant term plus random changes in acceleration occurring with a frequency greater than once per year. The magnitude of these changes appear to be consistent with estimates of meteorologically induced changes in the rotational acceleration.

An autoregressive integrated moving average (ARIMA) model was fit to the excess length of day data. This model permits simulated series of excess length of day data to be constructed. These simulated series show a statistical similarity to observations made since 1820. However the apparently large changes in the acceleration which occurred around 1870 and 1900 are twice that which can be reasonably accounted for by this model. The details of this analysis will be published later.

DISCUSSION

C. R. Wilson: Why did you smoothe the data at all? How did you decide upon the order of the ARIMA model? How did you treat the early data which were given at a different sample interval?

D. D. McCarthy: The daily values were smoothed to eliminate what was thought to be short-period observational noise. In view of these results perhaps less smoothing would be desirable.

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The order of the ARIMA model used for the estimation of the spectrum and for the simulation was determined from a general information theory criterion due to Akaike and explicity formulated by Ozaki. For prediction purposes, a much simpler model was found to be sufficient. This model was selected using the techniques described by Box and Jenkins.

For the purpose of this paper, the early data were not modeled explicitly. Instead, we took the ARIMA model determined from the last 23 years of observed data, created simulated sequences extending for 150 years, and looked at the peak-to-peak dispersions in the simulated series as compared to the historical data. From this work, we concluded that the ARIMA model could reasonably explain only about half of the peak-to-peak dispersion actually seen in the early historical data.

S. Debarbat: Chollet and myself have begun a similar analysis with the Paris astrolabe observations. I only mentioned this fact in my paper, but it will be very interesting to compare our results with yours.

S. K. Runcorn: Would you like to comment on the possible geophysical interpretation of your data on the length-of-day variations as an accumulation of random impulses?

D. D. McCarthy: Our analysis shows that the length-of-day variations can be simulated with random accelerations occurring more frequently than once per year. We have not attempted to relate these to a geophysical cause. However, the accelerations required appear to be consistent with those which can be produced meteorologically.