ATMOSPHERIC ANGULAR MOMENTUM TIME SERIES: CHARACTERIZATION OF THEIR INTERNAL NOISE AND CREATION OF A COMBINED SERIES

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ABSTRACT. The effects of the atmosphere on the Earth rotation are classically computed using the angular momentum approach. In this method, the variations in the rotation of the Earth are estimated from the variations in the atmospheric angular momentum (AAM). Several AAM time series are available, from different meteorological centers. However, the estimation of atmospheric effects on Earth rotation differs when using one atmospheric model or the other. The purpose of our work is to build an objective criterion which justifies the use of one series in particular. We determine the quality of each series by making an estimation of their noise level, using a generalized formulation of the "three-cornered hat method". As the quality of the series varies in time, we construct a combined AAM series, using time dependent weights chosen so that the noise level of the combined series, estimated using the three-cornered hat method, is minimal.

1. INTRODUCTION

The angular momentum approach considers that the total system Earth and atmosphere is isolated so that variations in the Earth angular momentum are associated with opposite variations in the atmospheric angular momentum (AAM). The atmospheric angular momentum data are obtained from meteorological models of global atmospheric circulation. The International Earth Rotation Service (IERS) Special Bureau for the Atmosphere (Salstein *et al.* 1993) provides the data coming from five meteorological centers: the ECMWF (European Center for Medium-Range Weather Forecast), the UKMO (United Kingdom Meteorological Office), the JMA (Japanese Meteorological Agency), the NCEP (National Center for Environmental Prediction) and the NCEP/NCAR (National Center for Environmental Prediction/ National Center for Atmospheric Research) which makes a 'reanalysis' series. When the correlation between the atmospheric excitation and geodesic data is computed, we show that the results differ from one atmospheric model to another: the estimation of atmospheric effects on Earth rotation depends on the atmospheric series chosen.

2. THE THREE-CORNERED HAT METHOD AND NOISE LEVEL ESTIMATION

We determined the quality of the AAM series by making a comparison of the series with each other with a generalized formulation of the "three-cornered hat" method (Premoli and Tavella

1993, Galindo *et al.* 2001). This method relies on the hypothesis that the signal is the part of the series common to all of them and that the noise is the remaining part of it. The method allows then an estimation of the variance of the noise, which reflects its noise level. We show that the noise level of the series is varying in time and that none of them has at each time the lowest noise level (Koot *et al.* 2005).

3. A COMBINED AAM TIME SERIES

This provides the motivation to generate a series by combination of the five time series available, which would present at each time an estimated noise level as low as possible. The combined series allows to take advantage of the information included in each series, its weight in the combination depending on its noise level.

To check the combination, we computed the correlation as a function of time between the combined AAM series and Earth rotation data (COMB2002 of Gross 2003). We show that our combined series is always amongst the best correlated series. For example, the correlation between the Z component of the AAM and the Length-of-Day lies between 95.40 % (NCEP model) and 97.88% (NCEP/NCAR reanalysis) for the 5 existing models while the combined series gives a correlation of 98.02%.

4. CONCLUSION

We showed that the combination of the atmospheric angular momentum time series allow to create less noisy data series which offer at each time a good correlation with Earth rotation. The creation of combined series seems thus to be a promising tool to improve the evaluation of atmospheric effects on Earth rotation.

5. REFERENCES

Barnes, R.T.H., R. Hide, A.A. White, and C.A. Wilson, Atmospheric angular momentum fluctuations, length-of-day changes and polar motion, *Proc. R. Soc. London, Ser. A, 387*, 31-73, 1983.

Galindo, F.J., J.J. Ruiz, E. Giachino, A. Premoli and P. Tavella, Estimation of the covariance matrix of individual standards by means of comparison measurements, *"Advanced Mathematical and Computational Tools in Metrology, vol.5", Series on Advances in Mathematics for Applied Sciences vol. 57, World Scientific, Singapore*, pp. 179-183, 2001.

Gross, R. S., Combinations of Earth orientation measurements: SPACE2002, COMB2002, and POLE2002, *JPL Publ., 03-11*, 28 pp., 2003.

Koot, L., O. de Viron and V. Dehant, Atmospheric angular momentum time series: a characterization of their internal noise and creation of a combined series, in preparation.

Premoli, A. and P. Tavella, A Revisited Three-Cornered Hat Method for Estimating Frequency Standard Instability, *IEEE Transactions on Instrumentation and Measurement, Vol. 42, No. 1*, pp. 7-13, 1993.

Salstein, D.A., Kann, D.M., Miller, A.J., and Rosen, R.D., The sub-bureau for atmospheric angular momentum of the international Earth rotation service: A meteorological data center with geodetic applications, *Bull. Am. Meteorol. Soc. 74*, 67-80, 1993.