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Atmosphere Angular Momentum Time Series for CONT05

Johannes Boehm, Paulo Jorge Mendes Cerveira, Sigrid Englich, Harald Schuh

Institute of Geodesy and Geophysics, Vienna University of Technology, Austria

Abstract. We compare four atmosphere angular momentum time series for the time span of CONT05, a 15 days period in the second half of September 2005. Two series are based on analysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF) (with different horizontal resolutions), the third series was derived from 3 and 6 hours forecast and boundary condition data of the ECMWF, and the fourth series from data of the National Centers for Environmental Prediction (NCEP) was provided by the Special Bureau of the Atmosphere (SBA). As expected, both series from ECMWF analysis data agree at the level of 10^{23} kg·m^2/s or better, except for the mass terms when inverted-barometer (IB) correction is applied where the selection of the land-sea mask is a critical factor. Six hours forecast values from the ECMWF agree at the level of 10^{24} kg·m^2/s or better with the analysis data. The motion terms from NCEP as provided by the SBA deviate from the other series because wind fields are only applied up to 10 hPa.

1. Introduction

The components of the inertia tensor c_{13}, c_{23}, and c_{33} in kg·m^2 (mass terms) and of the relative angular momentum l_1, l_2, and l_3 in kg·m^2/s (motion terms) due to the atmosphere can be determined with (1), (2) and (3), (4), respectively [1]. The abbreviations in these equations are: r radius, g gravity, p_S surface pressure, φ latitude, λ longitude, u eastward and v northward velocity component of the wind.

$$c_{13} + i \cdot c_{23} = -\int\int \frac{1}{g} \cdot r^4 \cdot p_S \cdot sin\varphi \cdot cos^2\varphi \cdot e^{i\lambda} \cdot d\lambda \cdot d\varphi, \qquad (1)$$

$$c_{33} = \int\int \frac{1}{g} \cdot r^4 \cdot p_S \cdot cos^3\varphi \cdot d\lambda \cdot d\varphi, \qquad (2)$$

$$l_1 + i \cdot l_2 = -\int\int\int \frac{1}{g} \cdot r^3 \cdot (u \cdot sin\varphi + i \cdot v) \cdot cos\varphi \cdot e^{i\lambda} \cdot d\lambda \cdot d\varphi \cdot dp, \qquad (3)$$

$$l_3 = \int\int\int \frac{1}{g} \cdot r^3 \cdot u \cdot cos^2\varphi \cdot d\lambda \cdot d\varphi \cdot dp. \quad (4)$$

The European Centre for Medium-Range Weather Forecasts (ECMWF) is archiving analysis data (AN) every 6 hours, i.e. at 0, 6, 12, and 18 UT. Furthermore, it is providing forecast data (FC, initialized at 0 and 12 UT) and boundary condition data (BC, initialized at 6 and 18 UT). FC and BC data are available with a time resolution of 3 hours. To create a continuous 3-hours time series, which is based on forecast steps as short as possible, we concatenate the 3 and 6 hour steps from FC and BC data, respectively (Tabl. 1).

Table 1. Forecast data (FC) and Boundary Condition data (BC) from the ECMWF are concatenated to create continuous 3-hours series with forecast steps as short as possible (3 and 6 hours)

Time (UT)	Type	Initialized (UT)	Step (hours)
0	BC	18	6
3	FC	0	3
6	FC	0	6
9	BC	6	3
12	BC	6	6
15	FC	12	3
...			

2. Comparison of Mass and Motion Terms During CONT05

We compare four different series of (relative) angular momentum contributions during the time span of the continuous VLBI campaign CONT05 (second half of September 2005):

- 1^o ECMWF analysis data as determined in Vienna (vie-an),
- 1^o ECMWF FC plus BC data as determined in Vienna (vie-fc),
- 1.825^o ECMWF analysis data as determined by the GeoForschungsZentrum Potsdam (gfz),
- 2.5^o NCEP reanalysis data as determined by the Special Bureau of the Atmosphere (sba) [2].

Fig. 1 and 2 and Tabl. 2 and 3 show the differences and standard deviations of the mass terms for the equatorial and axial components, respectively. Fig. 3 and Tabl. 4 illustrate the comparison of the motion terms.

Table 2. Standard deviations for c_{13} (left) and c_{23} (right) with inverted barometer (lower left triangles) and non-inverted barometer (upper right triangles) correction expressed as angular momentum in 10^{23} kg·m^2/s

–	vie-an	vie-fc	gfz	sba	vie-an	vie-fc	gfz	sba
vie-an	–	2.5	0.1	2.2	–	2.2	0.1	2.3
vie-fc	0.9	–	2.5	3.7	1.3	–	2.2	3.3
gfz	1.2	1.3	–	2.3	1.1	1.5	–	2.3
sba	0.8	1.4	1.3	–	1.3	2.1	1.9	–

Table 3. Standard deviations for c_{33} with inverted barometer (lower left triangle) and non-inverted barometer (upper right triangle) correction expressed as angular momentum in 10^{23} kg·m^2/s

–	vie-an	vie-fc	gfz	sba
vie-an	–	6.1	0.2	4.5
vie-fc	3.7	–	6.1	6.1
gfz	18.9	18.9	–	4.5
sba	4.4	5.1	19.0	–

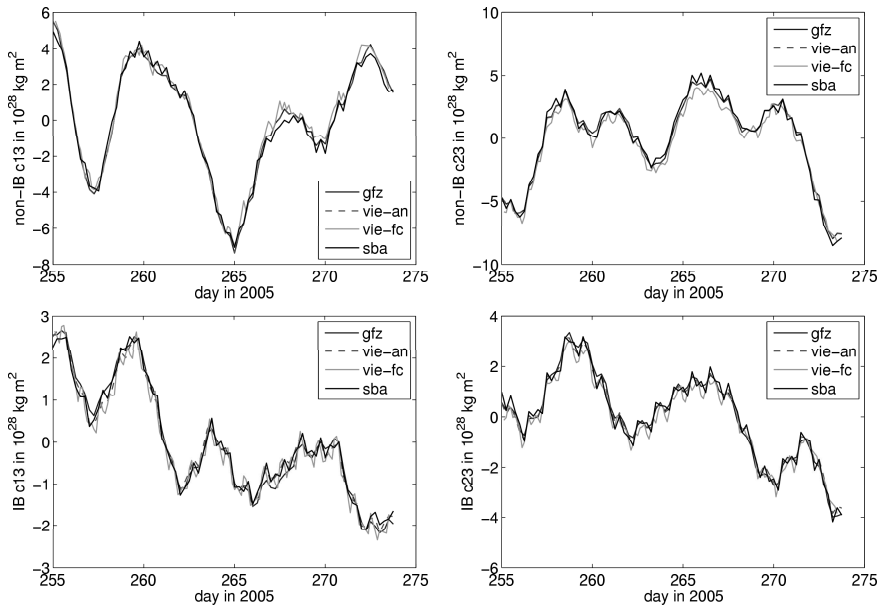

Figure 1. Components of the inertia tensor. Upper left: non-IB c_{13}, upper right: non-IB c_{23}, lower left: IB c_{13}, lower right: IB c_{23}

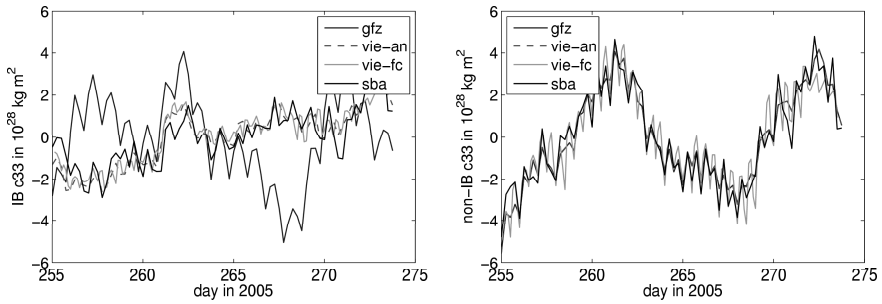

Figure 2. Components of the inertia tensor. Left: IB c_{33}, right: non-IB c_{33}

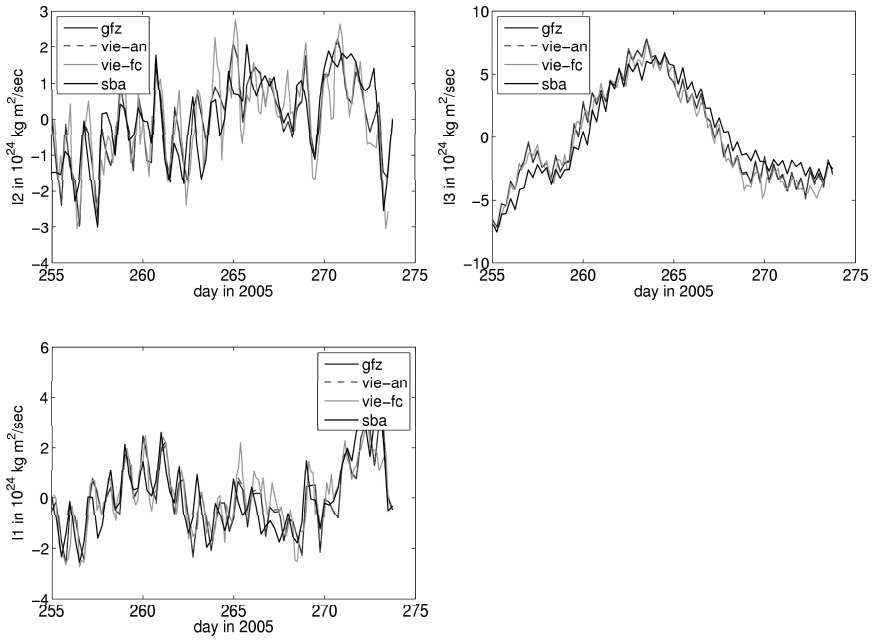

Figure 3. Components of the relative angular momentum. Upper left: l_2, upper right: l_3, lower left: l_1

The following conclusions can be drawn from the comparisons:

- As expected, the non-IB mass and motion terms from ECMWF analysis data determined in Vienna and Potsdam agree on average to better than 0.2 and $1.0{\cdot}10^{23}$ kg·m^2/s, respectively, as the horizontal resolution is not a critical factor for the determination of the angular momentum functions. The differences are larger by a factor of 10 for the IB mass terms because of the differences in the land-sea mask (Tabl. 2).

Table 4. Standard deviations for l_1 (lower left triangle) and l_2 (upper right triangle of left part) and for l_3 (right side) in 10^{23} kg·m^2/s

–	vie-an	vie-fc	gfz	sba	vie-an	vie-fc	gfz	sba
vie-an	–	6.3	0.7	8.5	–	7.5	1.0	12.4
vie-fc	6.2	–	6.4	8.7		–	7.5	12.8
gfz	0.4	6.2	–	8.4			–	11.6
sba	7.2	9.5	7.2	–				–

- The deviation of the c_{33} (IB) inertia tensor component is too large; thus, further investigations need to be carried out (Tabl. 3).
- ECMWF 6-hours forecast data agrees at a level of 10^{24} kg·m^2/s or better with the time series from analysis data, in terms of angular momentum.
- For the motion terms, the deviation is largest for the NCEP time series from the SBA, because wind fields were only used up to 10 hPa (unlike the ECMWF series where wind fields up to 1 hPa are used).

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References

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