G. Scalera, E. Boschi and S. Cwojdziński (eds.), 2012
THE EARTH EXPANSION EVIDENCE – A Challenge for Geology, Geophysics and Astronomy
Selected Contributions to the Interdisciplinary Workshop of the 37th International School of Geophysics
EMFCSC, Erice (4-9 October 2011)

The Earth Expansion Evidence

Geodetic Problems of an Expanding Globe

Simple Critical Arguments

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Abstract. Because unequivocal evidence exist in favor of the expansion of the globe through geologic time, and if the expansion of our planetary body is ongoing today and not confined to the past or episodic in time, some subtle causes must consequently exist of the inability of Geodesy in revealing a plausible expansion rate. Old critical arguments around the possibility of a vicious circle in the geodetic theoretical methods (Blinov, 1987; Scalera, 2003) has revealed their inadequacy in respect of the geometry of space geodesy. On the bases of an old argument (Scalera, 2003), it has been then developed a new more realistic one, in which it is demonstrated that spurious effects can probably bias what is believed to be systematic-error-free data. It is argued that Geodesy still has to full develop a theoretical treatment of an expanding globe

Key words. Expanding Earth – Geodesy on increasing radius globe – Decreasing curvature effects – Systematic errors in Geodesy

1. Introduction

Albeit a large amount of evidence coming from various fields is in favor of an expanding Earth, never a clear result supporting an expanding globe has been found by geodetic methods (Gerasimenko, 2003; Shen et al., 2011). The little eventual rates of expansion (Heki et al., 1989; Kostelecký & Zeman A. 2000; Gerasimenko, 2003, Shen et al., 2011; Wu et al., 2011; Devoti et al., 2012; Sarti, 2012) are too small in comparison to the error-bar and then they cannot be considered as supporting or not the Earth expansion.

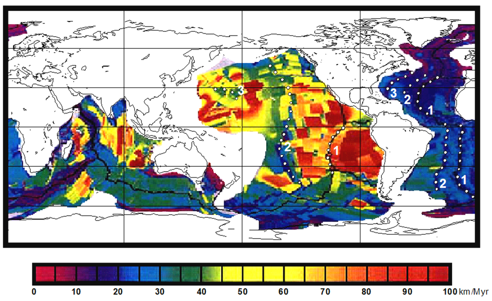


Fig. 1. In the *Half Spreading Map of the Oceans* at least three periods of slowdown are present: the Recent, the Cretaceous-Cenozoic boundary and Jurassic-Cretaceous boundary, indicated by white circles and the numbers 1, 2 and 3 respectively.

A banal solution – not excluded by other solutions – is the possible slowdown of the Earth's expansion in the Recent and in other paricular geologic periods. Albeit no final evidence of this possibility exsists, some real support is provided by the *Half Spreading Map of the Oceans* (Müller et al., 1997; McElhinny & McFadden, 2000) and related arguments (see Scalera, 2012; this volume). In the *Half Spreading Map of the Oceans* at least three periods of slowdown are present: the Recent, the Cretaceous-Cenozoic bound-

SOLUTION UNITS---------->	Tx mm	Ty mm	Tz mm	D ppb	Rx .001"	Ry .001"	Rz .001"	EPOCH
ITRF2005	-2.0	-0.9	-4.7	0.94	0.00	0.00	0.00	2000.0
ITRF2000	-1.9	-1.7	-10.5	1.34	0.00	0.00	0.00	2000.0
ITRF97	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
ITRF96	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
ITRF94	4.8	2.6	-33.2	2.92	0.00	0.00	0.06	2000.0
ITRF93	-24.0	2.4	-38.6	3.41	-1.71	-1.48	-0.30	2000.0
ITRF92	12.8	4.6	-41.2	2.21	0.00	0.00	0.06	2000.0
ITRF91	24.8	18.6	-47.2	3.61	0.00	0.00	0.06	2000.0
ITRF90	22.8	14.6	-63.2	3.91	0.00	0.00	0.06	2000.0
ITRF89	27.8	38.6	-101.2	7.31	0.00	0.00	0.06	2000.0
ITRF88	22.8	2.6	-125.2	10.41	0.10	0.00	0.06	2000.0

Table 1. Transformation parameters from ITRF2008 to past ITRFs (data provided by IERS). The parameters are derived from those published in the IERS Technical Notes and Annual Reports. The ”scale factor” – namely the size of the geodetic network – is the parameter D ($\times 10^{-9}$). From the series of D it is possible to evaluate the averaged radius increase in the time span from the past ITRFs to the 2008. The last two values of the D series (ITRF89 and ITRF88) are too high and different with respect to the others, and this should be considered not significant but a sign of the initial period of adjustment of the geodetic methodology.

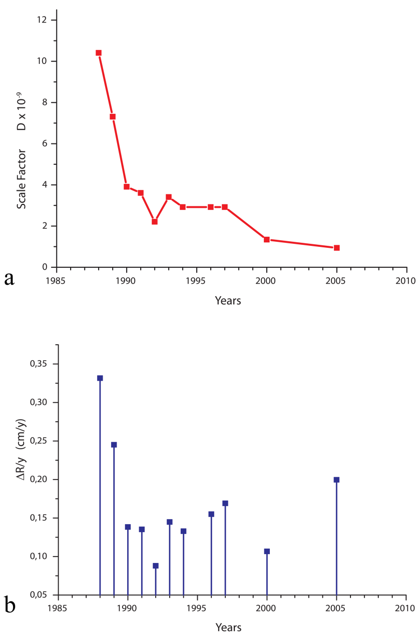


Fig. 2. The scale factor D and its consequences. – a) Values of the scale factor D at different years, with respect to the ITRF-2008. – b) The values of the radius variations annual rate $\Delta R/y$, averaged on the time lapses from the indicated year to 2008. With the exception of the probably spurious values of 1988 and 1989, the series seems to indicate a value around 0.15 cm/y. This means a total expansion of 3.0 cm on about 20 years.

ary and Jurassic-Cretaceous boundary (see Fig. 1).

The ”scale factor” D provided by IERS as the size of the geodetic network in different years of updating of the ITRF (Table 1) seems in favor of an increase of the Earth’s radius of more than 2 cm in the twenty years time lapse 1988-2008 (Fig. 2ab). However, this value is one order of magnitude less than the expected value of about 1.5 cm/y that can be deduced by paleogeographic reconstructions (Scalera, 2001, 2003; Maxlow, 2005; and others) from Triassic to Recent.

Obviously a multeplicity of causes can be superimposed and the second important branch to be investigated is the existence of some idden inadequacy or vicious circle in the geodetic methodology.

2. Spurious effects in VLBI?

If we are convinced – or if definitively it will be demonstred – that the expansion of our planetary body is ongoing today and not confined to the past or episodic in time, a reason for the undetectability of an expansion rate must be found. Severe sus-

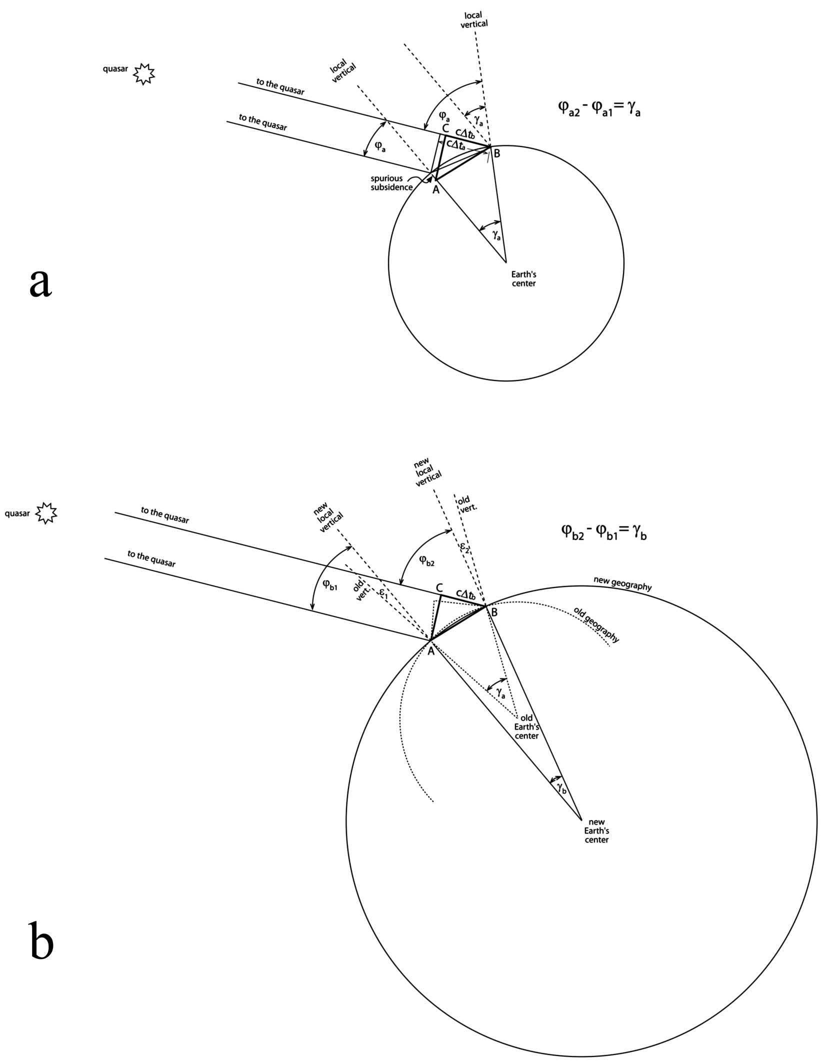


Fig. 3. Spurious subsidence on an expanding globe. See explanations in the text.

picions converge on the geodetic method, when it is applied to a globe of variable size in time.

Bajgarová & Kostelecký (2005) have analyzed the argument of Blinov (1987) and they concluded that the argument is not valid. They wrote:

> [... ...] *Especially the VLBI, its principles and assumptions, has often been misunderstood in many ways. The VLBI is a purely geometrical method that uses as a constant only the speed of light in vacuum – a frequent mistake is based on the assumption that space geodesy applies some constant radius before any measurement starts.* [... ...]

Having then realized that the old Blinov argument – beside others independently found but substantially equivalent ones (Scalera, 2003) – cannot resolve the outstanding problem of a geodesic science unable to reveal the expansion, I have searched for an argument in which the Earth's radius is not first actor, and main role is played by the time *t* and the velocity of light *c*.

The VLBI technique is considered to be a pure geometric method acting in

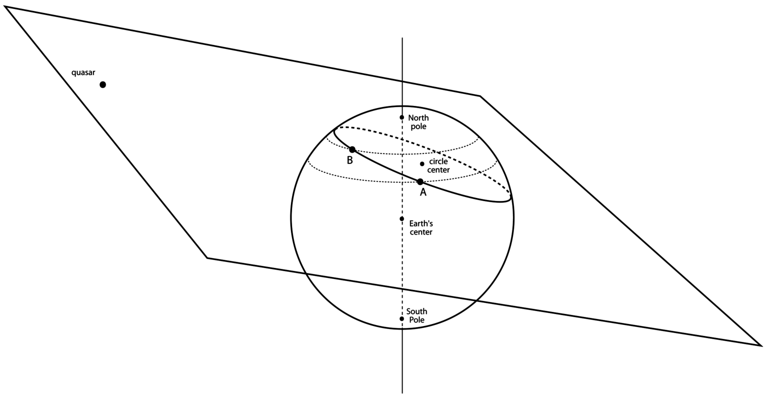


Fig. 4. The general case of the mutual position of two VLBI stations A and B, and a quasar. The plane on which the three objects lie, cuts the globe along a 'small circle' having its center not on the Earth's center.

Cartesian geometry, without possibility of systematic errors coming from the spherical geometry of the changing size planet.

In Fig. 3ab the section of the Earth is represented on a plane passing on three points: the quasar and the two station sites, which are all three located on a meridian circle plane. This is only a particular case of a simplified perfectly spherical example, while actual Earth is near to a triaxial ellipsoid where geodetics (generally open curves) – and not great circles – individuate the shortest surface-distance between two sites.

The general case (but again on the simpler sphere) is shown in Fig. 4, in which the quasar and the two sites A and B are on a plane that cuts the Earth along a 'little circle' that own a center not coincident in general with the Earth's center nor with a point of the North-South polar axis.

In Fig. 3a, the initial situation is represented at the time t_1. The observable Δt_a is combined to the light velocity c to know by simple trigonometric functions on the triangle ABCa the chord between site A and site B. In Fig. 3b, the new shorter time lapse Δt_b is observed. If geodesists are not aware of the expansion of the Earth between the dates of the two surveys, the triangle ABCb (drawn in bold) is used "as if" it was located on the old geography of a), with the old Earth's radius.

I have then traced the triangle ABCb in bold in the Fig. 3a. Then, as it is shown in Fig. 3a the use of the new triangle – resolved on the real expanded Earth in Fig. 3b – on the old-radius sphere would be interpreted as a subsidence of the site A, and not as a whole Earth expansion.

Also in the general case – represented in Fig. 4 – the same effects can occur, but with the spurious displacements not grossly aligned to the local vertical but contained in the plane of the 'little circle' – complanar to the quasar on wich the two VLBI antennas A and B are located.

Obviously, in the VLBI method, the chord between a pair of stations is computed as an average over observations of several quasars on the heaven sphere. But this non-general example of a trivial methodological shortcoming is useful to consider that if the possibility exists that – without awareness – the geodesists assign the results of observations not to Earth's expansion but to a not real subsidence, how we can be sure of the correctness of all the VLBI statistical procedure and results?

3. Concluding remarks

Tilting of the antennas may be are also invoked. Other second order effects are possible due to the variation of the curvature – see Fig. 5 – and also to the still unknown partial dissipation of the old

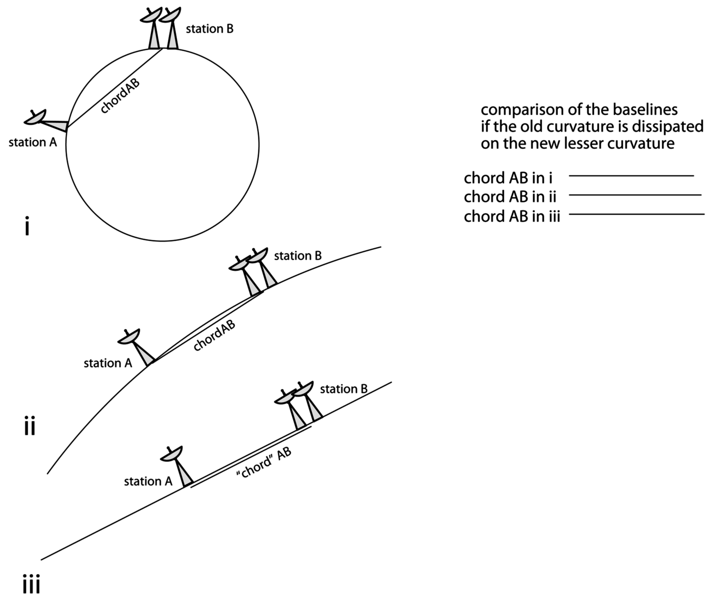


Fig. 5. Other possible effects that Geodesy tends to neglect in the VLBI survey. Tilting of the antennas can be caused by partial dissipation of the old curvature on the lesser one.

higher curvature on the new larger sphere of lesser curvature with mechanisms already diffusely described (Hilgenberg, 1933; Rickard, 1969; Cwojdziński, 2012 this book). The possibility exists that the reduction of the data on the internationally adopted ellipsoid can produce further problems, and other sources of systematic errors have been treated by Sarti et al. (2011) and Sarti (2012). Finally, in geodetic techniques making use of artificial satellites (GPS, DORIS, ...) the possibility that a less than centimetric expansion may be hidden in the satellites orbital decay should not be forgot (Scalera, 2006). A slowdown of the expansion envisaged in the introduction of this paper can be superimposed.

The expanding globe appears as an object of great complexity of behaviour that – in Geodesy – still lacks for a complete and unambiguous theoretical treatment.

I hope that this very short note – surely not completely general – beside the other paper presented in this Proceedings Geodetic section, could constitute a further element of meditation about the future needed progresses that Earth Sciences expect from Geodesy to clarify this fundamental complex topic of the planetary size variation.

Acknowledgements. Discussions and materials provided by Pierguido Sarti and Roberto Devoti have helped in writing this short note. This paper is dedicated to the late physicist, Prof. Carlo Vista, cousin and friend, but like a brother, that disappeared before his time while I am composing this note.

References

Bajgarová T., Kostelecký J. (2005). The hypothesis on the Earth's expansion in the light of space geodesy results. Acta Geodyn. Geomater., 2, No.3 (139), 95-101.

Blinov V.F. (1987). O drejfie kontinentov i razširenii Zemli na osnovanii instrumentalnych izmierenij (About the drift of the continents and the Earth expansion, on the basis of instrumental measurements). Tichookieanskaja Geologia, 5, 94-101.

Carey S.W. (1976). The Expanding Earth. Elsevier Scientific Publishing Company, Amsterdam-Oxford New York, 488 pp.

Carey S.W. (1988). Theories of the Earth and Universe. A History of Dogma in the Earth Sciences. Stanford University Press, Stanford, California, 413 pp.

Cwojdziński S. (2003). The tectonic structure of the continental lithosphere considered in the light of the expanding Earth theory – a proposal of a new interpretation of deep seismic data. Polish Geol. Inst. Special Papers, 9, 80 pp.

Devoti R., Esposito A., Pietrantonio G., Pisani A.R., Riguzzi F. (2012). GPS Positioning and Velocity Field in the Apennines Subduction Zone. This volume.

Gerasimenko M.D. (1993). The problem of the change of the Earth dimension in the light of space geodesy data. In: G. Scalera and K.-H. Jacob (eds.) Why Expanding Earth? – A book in Honour of Ott Christoph Hilgenberg. Proceedings of the 3rd Lautenthaler Montanistisches Colloquium, Mining Industry Museum, Lautenthal (Germany) May 26, 2001 (INGV Publication, Rome), 395-405.

Heki K., Takahashi Y., Kondo T. (1989). The baseline length changes of circumpacific VLBI networks and their bearing on global tectonics. IEEE Transactions on Instrument And Measur., 38 (2), 680-683.

Hilgenberg O.C. (1933). Vom wachsenden Erdball. Giessman & Bartsch GmbH. Berlin. 56 pp.

Kostelecký J., Zeman A. (2000). Hypothesis of the Earth's body expansion and global plate motions from the point of view of contemporary geodetic reference frames. Acta Geol. Geoph. Hung., 35 (4), 415-424.

Maxlow J. (2005). Terra Non Firma Earth. Oneoff Publishing, ISBN 0 952 2603 28

McElhinny M.W., McFadden P.L. (2000). Paleomagnetism, continents and oceans. Academic Press, New York, 380 pp.

Müller R.D., Roest W.R., Royer J.Y., Gahagan L.M., Sclater J.G. (1997). Digital isochrons of the world's ocean floor. Jour. Geophys. Res., 102, 3211-3214.

Müller R.D., Sdrolias M., Gaina C., Roest W.R. (2008). Age, spreading rates, and spreading asymmetry of the world's ocean crust. Geochem. Geophys. Geosyst., v. 9, Q04006, doi:10.1029/2007GC001743.

Rickard M.J. (1969). Relief of curvature on expansion – a possible mechanism of geosynclinal formation and orogenesis. Tectonophysics, 8 (2), 129-144.

Sarti P. (2012). The Consistency Between Local and Space Geodetic Observations – Accuracy of the Global Terrestrial Reference Frame. This volume.

Sarti P., Abbondanza C., Petrov L., Negusini M. (2011). Height bias and scale effect induced by antenna gravity deformations in geodetic VLBI data analysis. J. Geodesy, 85 (1), 1-8, doi: 10.1007/s00190-010-0410-6.

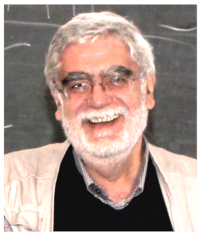
Scalera G. (2001). The global paleogeographical reconstruction of the Triassic in the Earth's dilatation framework and the paleoposition of India. Annali di Geofisica (Annals of Geophysics), 44 (1), 13-32.

Scalera G. (2003). The expanding Earth: a sound idea for the new millennium. In: G. Scalera and K.-H. Jacob (eds.) Why Expanding Earth? – A book in Honour of Ott Christoph Hilgenberg. Proceedings of the 3rd Lautenthaler Montanistisches Colloquium, Mining Industry Museum, Lautenthal (Germany) May 26, 2001 (INGV Publication, Rome), 181-232.

Scalera G. (2006). Are artificial satellites orbits influenced by an expanding Earth? Annals of Geophysics, 49 (2/3), 819-824.

Shen W.-B., Sun R., Chen W., Zhang Z., Li J., Han J., Ding H. (2011). The expanding Earth at present: evidence from temporal gravity field and space-geodetic data. Annals of Geophysics, 54 (4), doi: 10.4401/ag-4951.

Wu X., Collilieux X., Altamimi Z., Vermeersen B.L.A., Gross R.S., Fukumori I. (2011). Accuracy of the International Terrestrial Reference Frame origin and Earth expansion. Geophys. Res. Lett., 38, L13304, doi:10.1029/2011GL047450.



Author's Biographical Notes: *Giancarlo Scalera was born in Barletta, Italy, on 4 April 1949. He get the University degree in Physics at the University of Bari (1975) discussing a Doctoral Thesis on foundation of Physics. Immediately after, he proposed a local model that is able to violate the Bell's inequality. On 1976 Scalera was Assistant lecturer at the Geodesy Institute of the University of Bari and he collaborated to the maintenance of the seismic network of the University of Calabria. On 1979 he was at work in the INGV in Rome. The map of the Maximum Intensity Felt in Italy was drawn by Scalera and co-authors. Research was made in global tectonics, paleogeography and geodynamics, adopting the expanding Earth model. He performed historical researches about shape and movements of the Earth, and on scientists involved in the expanding Earth. Presently is proposer of a new mechanism of muntain building based on isostasy. Giancarlo married on 1980 and has a doughter. He loves painting and sculpturing, and – ever more rarely – use the bicycle for excursions.*