Methodical Example of the Estimation of Regional Carbon Dioxide Production Responsibility on the Basis of in Situ CO2 Atmosphere Concentration Data

Mavrodiev S. Cht. , Pekevski L. , Vachev B.

BEOBAL Project Conference,
Gyuletchitza, Rila Mountain, Bulgaria,
21-25 March 2007

Introduction

One of the recent documents about climate change it is the official **SPM (Summary for Policymakers, Climate Change 2007: The Physical Science Basis) (SPM, IPCC – UN Intergovernmental Panel for Climate Change , 2007)** of FAR (Fourth Assessment Report) of the IPCC (Intergovernmental Panel on Climate Change).
The main conclusion is that with more than "90% confidence" **humans have been the main drivers of warming since the 1950s, and that higher temperatures and rising sea levels would result.**

Starting from the initial IPCC reports – FAR, 1990 and following, SAR (1996) and TAR (2001) there are discussions about some basic postulates, statements, evidences, time scales, ect. (C.R. de Freitas, 2002).
The need of global astrophysical modeling and more global approach is urgent (Rusov at al., 2005).
Additional acceleration of discussions resulted from some resent publications about the role of cosmic rays in clouds formation (Svensmark, 2007a, Svensmark ,Calder 2007b, 2007c)

Summarizing we could state:

The global worming has anthropogenic origin

OR

The visible change of today climate can be due to not well researched cosmic ray driven cloud aerosol generation, not well researched ocean streams, behavior and possible influence of plankton species distribution in ocean and atmosphere.

Experimental data: in situ, airplane and satellite

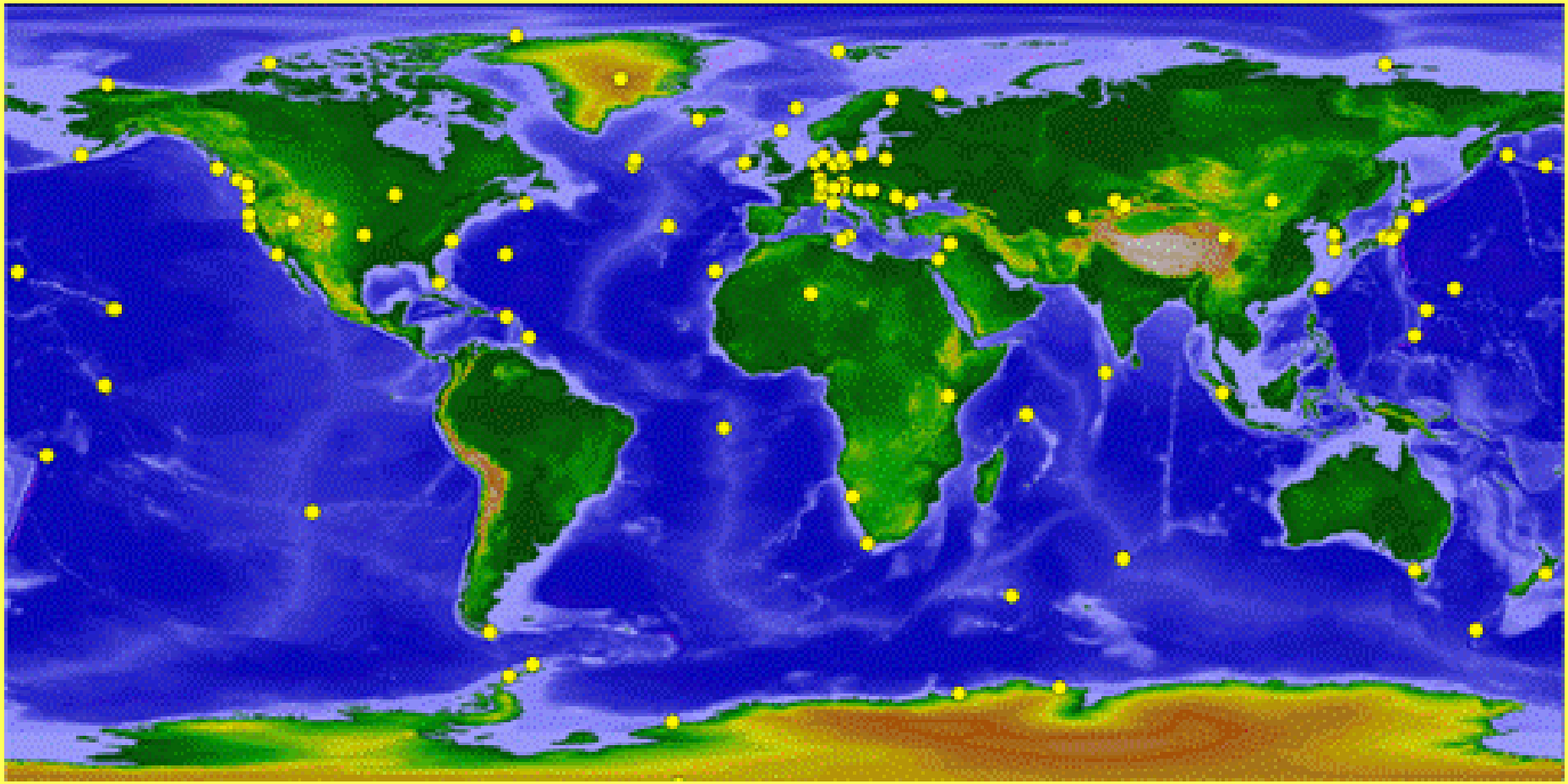


Figure 1: World map of the GAW in situ stations for measuring the CO2 atmosphere concentration. The circles are the coordinates of **139** CO2 stations.
Data source: World Data Centre for Greenhouses Gases http://gaw.kishow.go.jp/wdcgg.html; Carbon Dioxide Research Group, SIO, Scripps Inst. of Oceanography, http://cdiac.esd.ornl.gov/trends/CO2/sio-keel.htm

Estimation of regional CO2 production responsibility

The estimation is based on comparison of the annual mean CO2 atmosphere concentration and regional in situ measured CO2 concentration.
The description of CO2 annual mean CO2 atmosphere concentration is present in the next figure. The mathematical model was discovered under the assumption that the CO2 atmosphere concentration depends on Sun spots number, Sun irradiation and CO2 nature and anthropogenic production (Mavrodiev, Ries, 2006). .

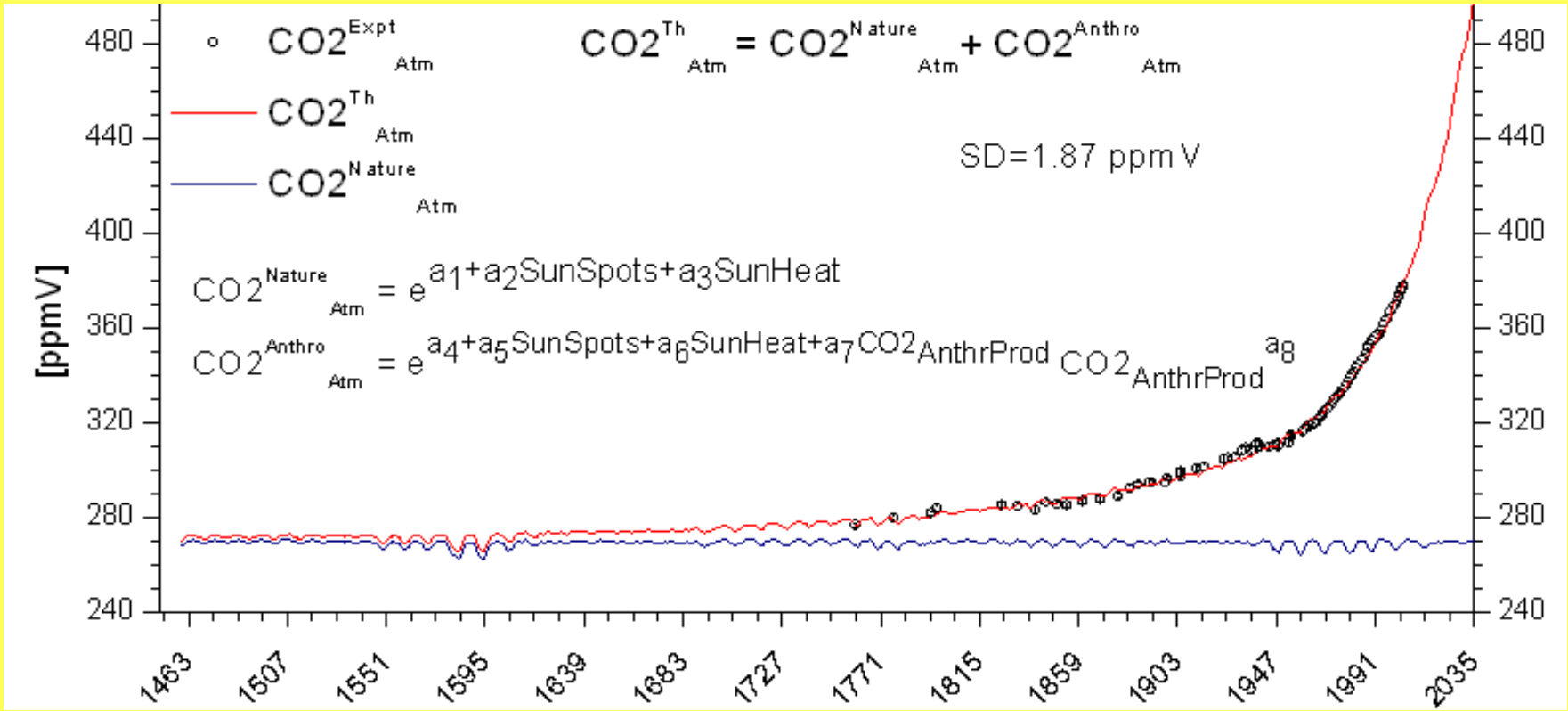
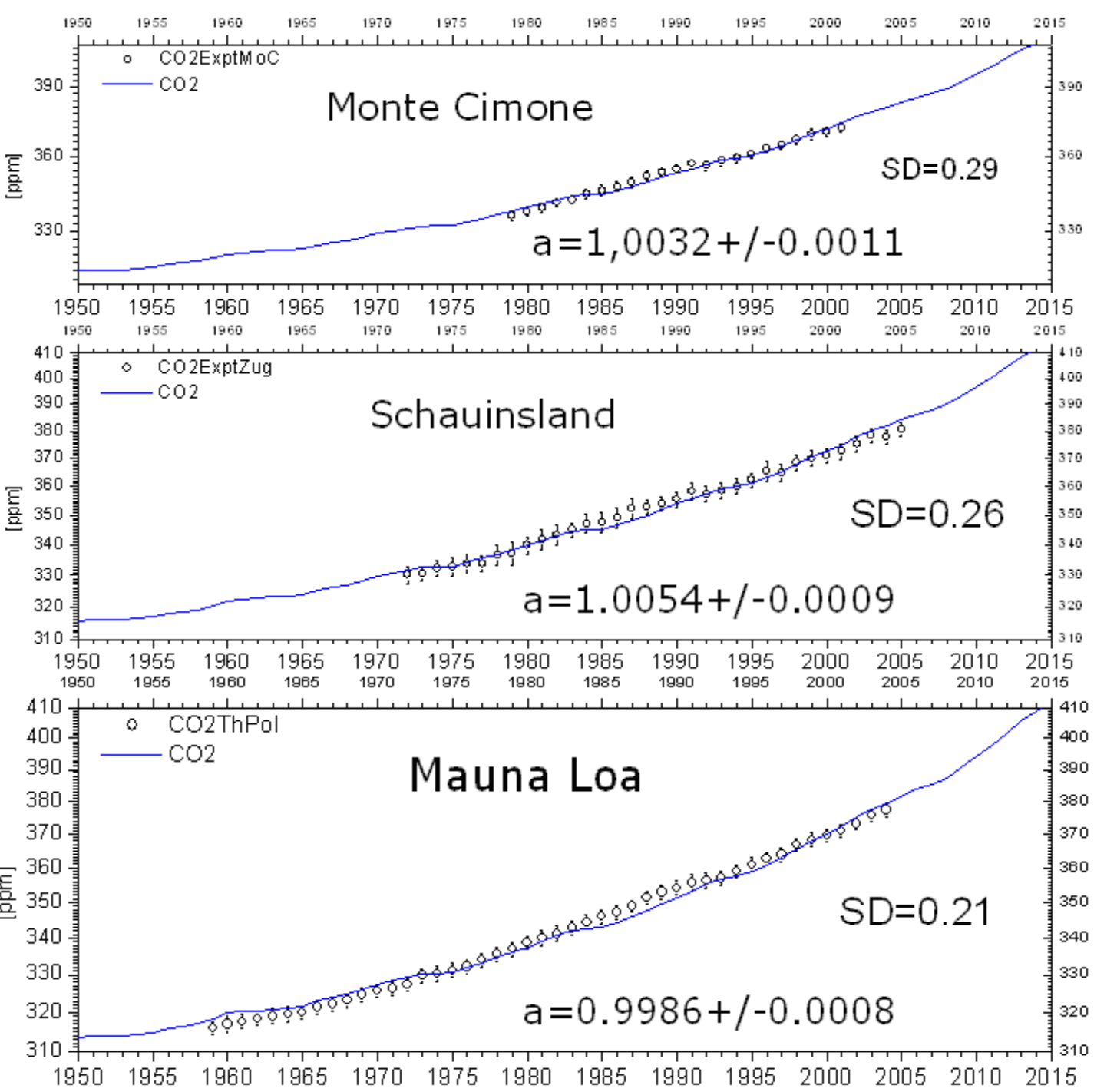


Figure 2. The CO2 **Th Atm** (yr) behavior as function of CO2Anthro**Production**, Sun**Spots** and Sun**Heat** **Data sourse**- Mauna Loa and Global CO2 data:Atmospheric CO2 concentrations (ppmv) derived from in situ air samples collected in Mauna Loa Observatory, Hawaii, (Keeling at all, 2005), (Marland at all, 2006)



Possible application is estimation of the regional CO2 production responsibility by the value of linear fit parameter, different for stations.

Figure 3.

The possible estimation of regional CO2 production responsibility for **Monte Cimone, Schauinsland** and **Mauna Loa Stations**

The blue curve is the mathematical model (fit) of CO2 atmosphere concentration CO2Atm(yr), In: On Some Consequrnces of Global of Global Warming (Mavrodiev, Ries, 2006)

Data source: World Data Centre for Greenhouses Gases http://gaw.kishow.go.jp/wdcgg.html

The explicit form of possible parameterization was analyzed and finaly was used the next parameterization

CO2Local(yr) = a(ilocal) * exp(b * altitude) * CO2Atm(yr),

where a(ilocal), ilocal=1,…,Number of Station and **b [km-1**] are the fit parameters.
The value of parameter **b= 6 * e-3 [km^{-1}],** which is confirmed by both in situ and satellite data.

The Sofia - Dubna inverse problem method- researching of hidden dependence

To research for hidden dependences is performed by solving the problem
Yexpti = Ythi (X),
where i is a number of arguments on which Yexpti depends, Ythi (X) is an analytical function known from the theory or with unknown mathematical size and X is a set of unknown parameters.
Some times experiments produce data, which can not be explained by theory successfully. In this case, the Sofia- Dubna nonlinear approach permits, solving the nonlinear system to discover the unknown mathematical dependences.

One has to stress that the pleasant feature of this mathematical construction is that all theorems are constructive. So, the step from mathematical theory to FORTRAN codes: for example REGN (1972, Dubna), FXY (1997, Dubna), is hard, long, but, clear work (Alexandrov, 1970, 1983, 1997].

Alexandrov L.,Regularized Computational Process of Newton- Kantorovich Type, J. Comp. Math. and Math. Phys., 11, Vol. 1, 36-43, 1971

Alexandrov L.,Autoregularized Iteration Processes of Newton- Kantorovich Type, Comm. JINR, P5-5515, Dubna, 1970

Alexandrov L.,Program REGN, RSIK-ORNL, PSR 165, Oak Ridge, Tennessee, USA,1983

Alexandrov L.,Analyze of Fx = y, (personal communication), 1997

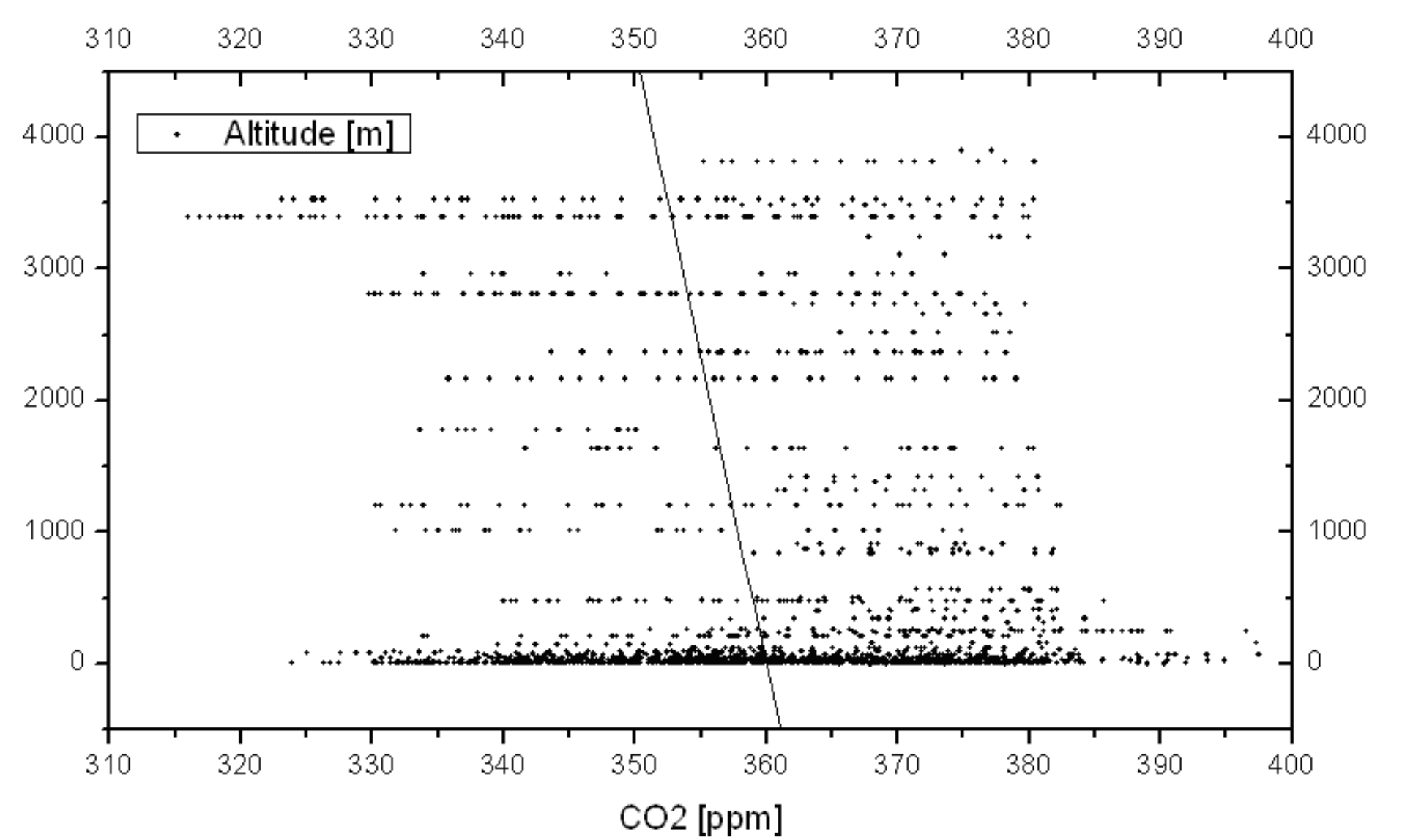
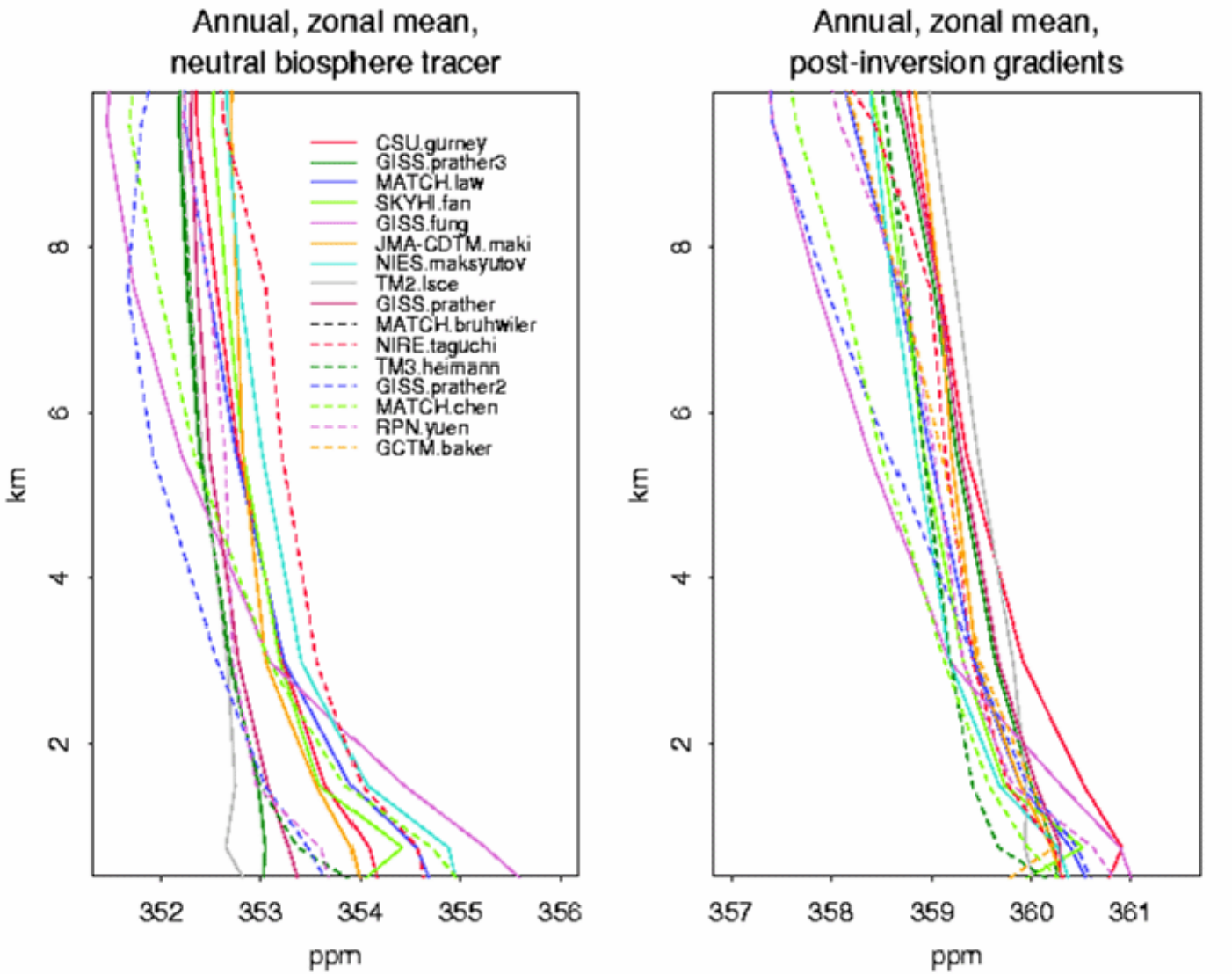


Figure 4. The altitude dependences exp(-b * Alt) of CO2 [ppm] atmosphere concentration, where **b=6.e-6[m-1],** altitude [m]

Data source: World Data Centre for Greenhouses Gases http://gaw.kishow.go.jp/wdcgg.html; Carbon Dioxide Research Group, SIO, http://cdiac.esd.ornl.gov/trends/CO2/sio-keel.htm

The next figure illustrates the exp(- b * Altitude) CO2 concentration behavior on the basis of satellite measurement.



Data Source:
Britton Stephens, **The Vertical Distribution of Atmospheric CO2**, NCAR/ATD, CMDL/ CCGG 8/19/03

Table 2. CO2 production responsibility (illustration for first 17 stations of 139)

Stat num	Hi2	CO2 production responsibility	Relative errror estimation	Latitude	Longitude	Altitude [m]	Number of Years
1	9.19E+00	2.46E+01	3.80E+01	-3.78E+01	7.75E+01	65	25
2	3.24E+00	3.07E+01	1.37E+01	-3.80E+01	7.75E+01	150	9
3	3.94E+00	2.79E+01	3.89E+01	-7.92E+00	-1.44E+01	54	26
4	2.74E-01	2.90E+01	5.70E+01	2.32E+01	5.42E+00	2728	10
5	6.19E+00	2.08E+01	2.24E+01	-3.44E+01	1.85E+01	230	12
6	5.30E+00	2.21E+01	2.51E+01	-4.65E+01	5.19E+01	120	15
7	3.53E-01	3.33E+01	9.08E+01	2.83E+01	-1.65E+01	2367	19
8	6.35E-01	2.98E+01	7.05E+01	2.83E+01	-1.65E+01	2360	14
9	2.26E-03	1.94E+01	1.56E+01	-5.00E-01	3.73E+01	3897	2
10	1.72E+00	2.32E+01	4.42E+00	-2.36E+01	1.52E+01	461	2
11	4.49E+00	2.79E+01	3.72E+01	-4.67E+00	5.52E+01	7	26
12	1.40E-01	5.20E+01	9.91E+00	3.65E+01	1.26E+02	47	6
13	3.74E-02	4.26E+01	9.76E+00	5.52E+01	1.66E+02	13	7
14	5.38E-02	3.46E+01	1.10E+01	4.32E+01	1.46E+02	45	7
15	2.66E-01	4.14E+01	3.59E+01	3.60E+01	1.39E+02	840	13
16	2.66E-01	3.44E+01	1.35E+01	2.45E+01	1.24E+02	10	9
17	8.45E-02	7.43E+01	4.75E+00	3.47E+01	3.77E+01	35	3

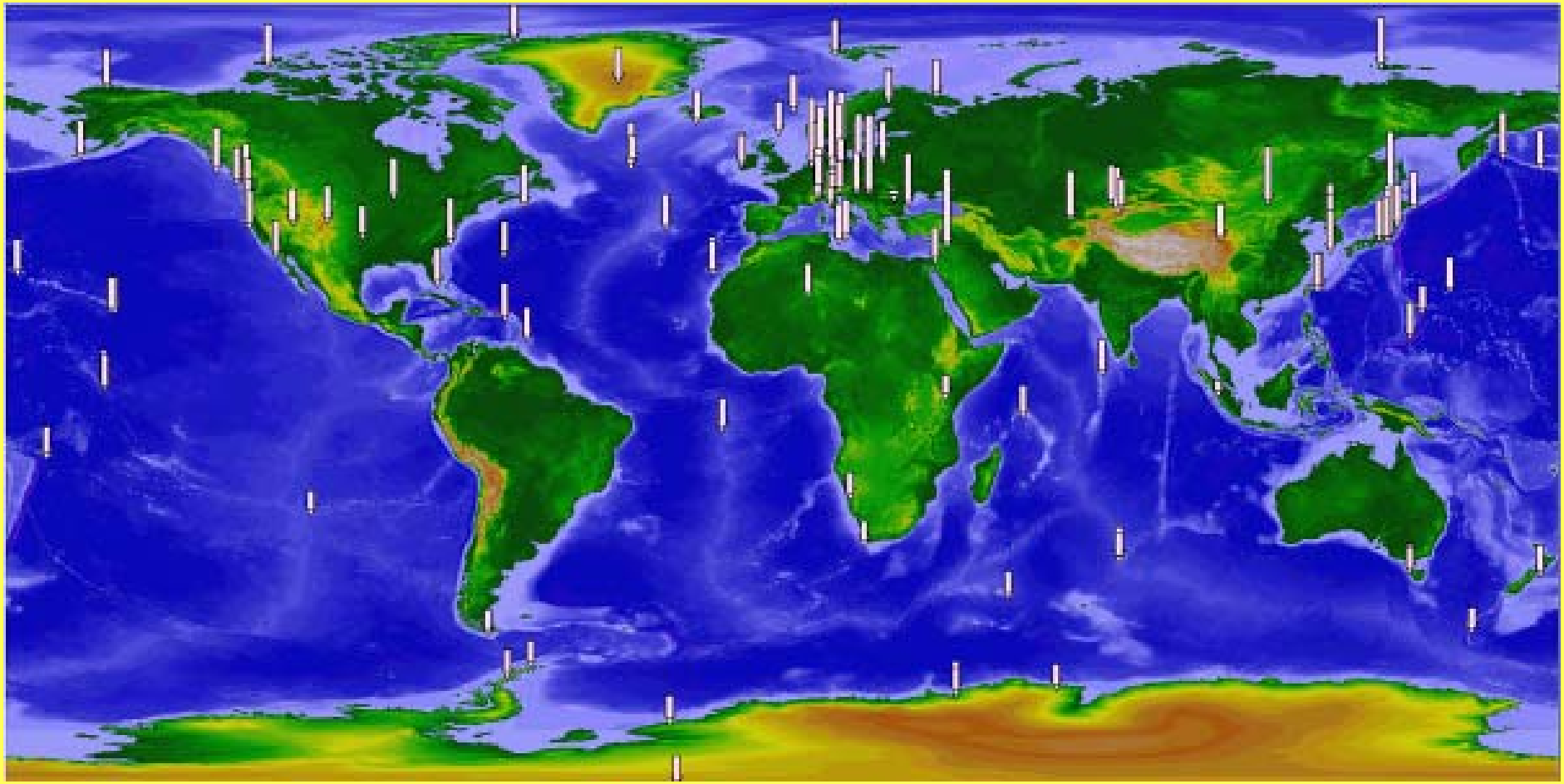


Figure 6. Estimation of regional CO2 production responsibility on the basis of in situ data CO2 atmosphere concentration.
The circles are 139 CO2 stations. The description of the annual CO2 data station is performing with function: CO2Station (yr) = a(iplaces)+exp(b*Altitude)*CO2Earth(yr), where a(iplaces) and b[1/km] are fit parameters and CO2Earth(yr) is the function describing the CO2 atmosphere concentration. The bars are differences (a(iplaces) – 0.9700)*1000, which is relative estimation of the CO2 regional production with mean CO2 atmosphere concentration.
Data source: World Data Centre for Greenhouses Gases http://gaw.kishow.go.jp/wdcgg.html; Carbon Dioxide Research Group, SIO, http://cdiac.esd.ornl.gov/trends/CO2/sio-keel.htm

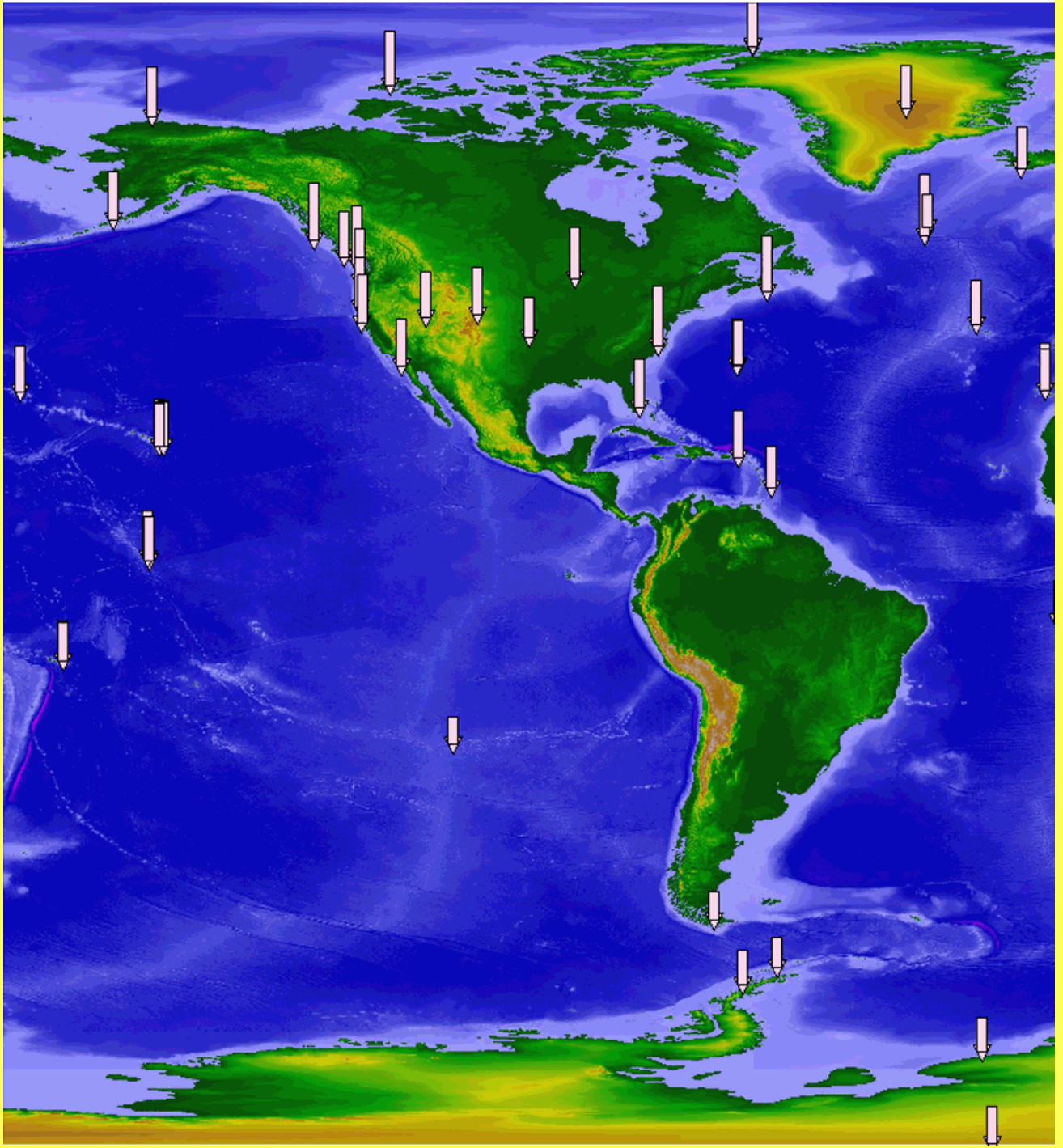


Figure 7. Estimation of regional CO2 production responsibility on the basis of in situ data CO2 atmosphere concentration for **America CO2 stations.** The circles are **26** CO2 stations.

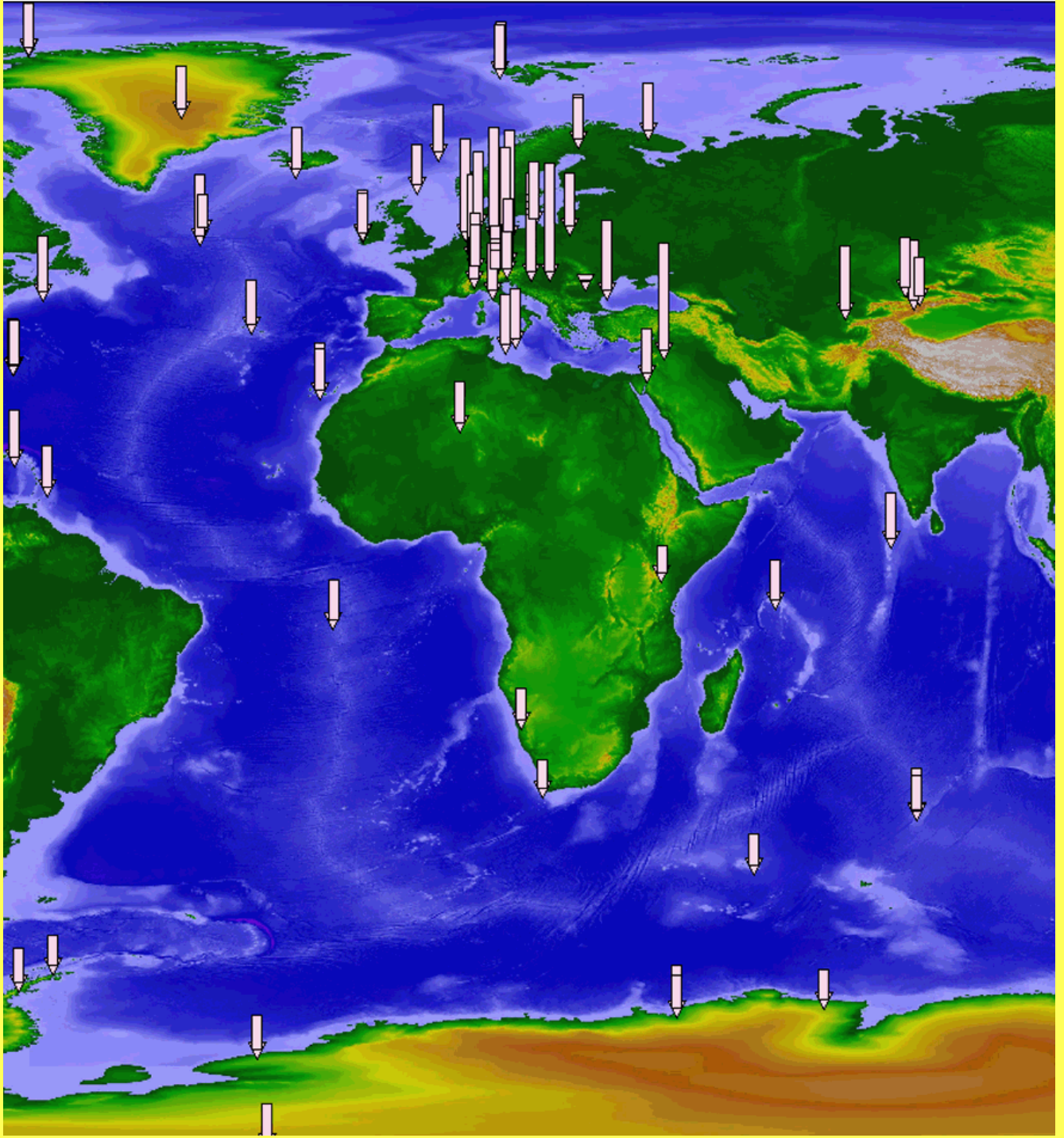


Figure 8. Estimation of regional CO2 production responsibility on the basis of in situ data CO2 atmosphere concentration for Europe, Africa and India CO2 stations.
The circles are **59** CO2 stations.

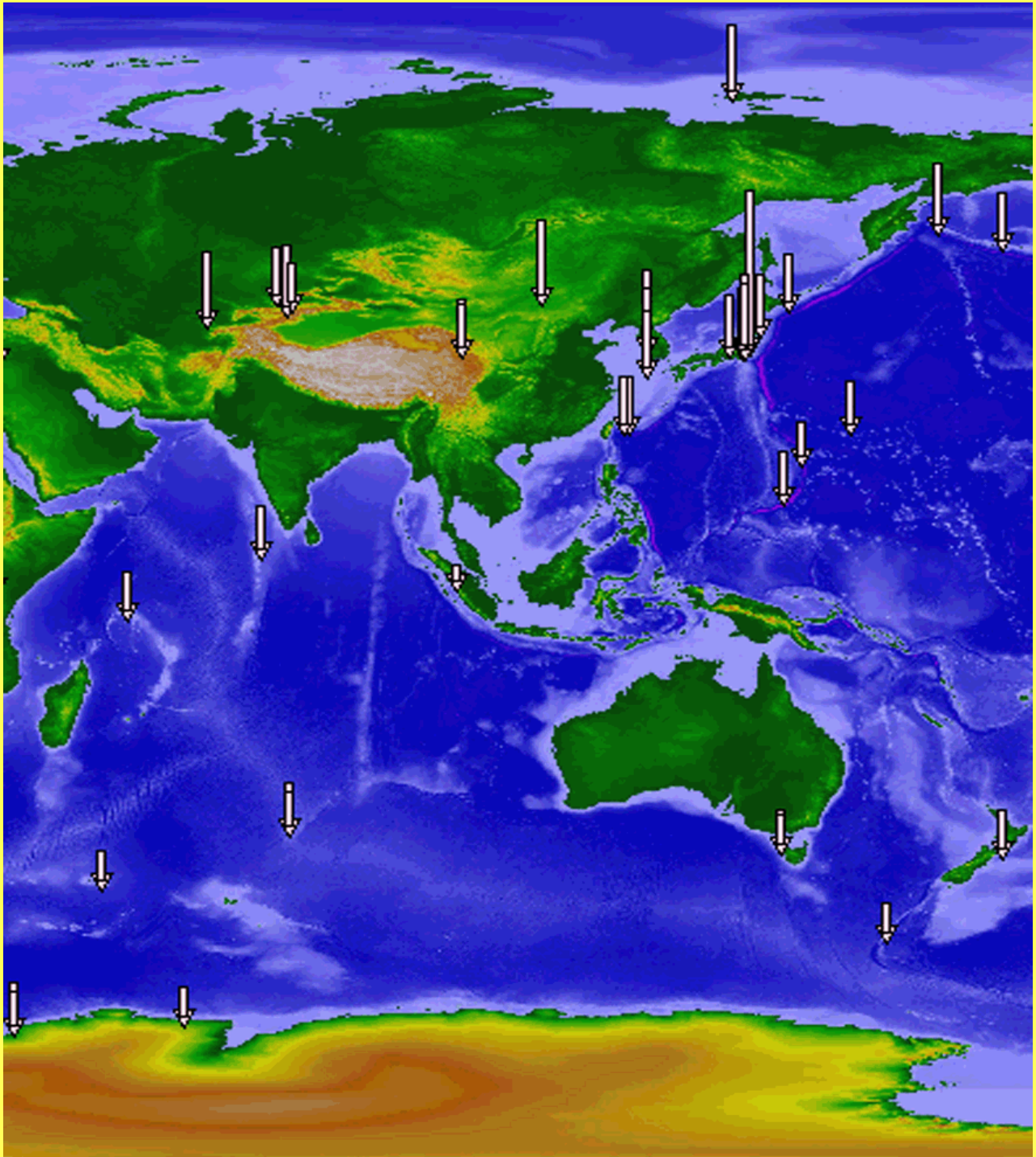


Figure 9. Estimation of regional CO2 production responsibility on the basis of in situ data CO2 atmosphere concentration for Asia CO2 stations. The circles are **24** CO2 stations.

Acknowledgments

The authors are grateful to Cht. S Mavrodiev and I. Kalapov, BEO INRNE, BAS for the team work,

to Dr. Wolfgang Fricke, Hohenpeissenberg Meteorological Observatory, Germany Meteorological Service and Dr. Ludwig Ries, Germany Environmental Agency for critical discussions of the use of results of inverse problems method and for the Hohenpeissenberg century temperature data,

to Dr. Paolo Bonasoni and Dr. P. Cristofanelli, ISAC, CNR, Bologna, Italy for information support.

The partly support of this work by UFS Zugspitze and UBA, Germany and the BEOBAL FP6 project (INCO-CT-2005-016663) is highly appreciated.

Conclusion

The application of this technique for every year estimation of regional greenhouse gases and aerosols production can improve substantially the estimation of anthropogenic environmental regional responsibilities (continents, countries, towns, highways, oil refineries, ect.,)

Thank you for attention!

References

Alexandrov L.,Regularized Computational Process of Newton- Kantorovich Type, J. Comp. Math. and Math. Phys., 11, Vol. 1, 36-43, 1971

Alexandrov L.,Autoregularized Iteration Processes of Newton- Kantorovich Type, Comm. JINR, P5-5515, Dubna, 1970

Alexandrov L.,Program REGN, RSIK-ORNL, PSR 165, Oak Ridge, Tennessee, USA,1983

Alexandrov L.,Analyze of Fx = y, (personal communication), 1997

Freitas C.R. 2002, Are observed changes in the concentration of carbon dioxide in the atmosphere really dangerous?, Bul. of Canadian petroleum geology, vol. 50, 2 (June 2002), p. 297-327.
http://www.friendsofscience.org/documents/deFreitas.pdf

Mavrodiev Strachimir Chr., Ludwig Ries, 2006 On Some Consequrnces of Global of Global Warming, GEIA 2006 Open Conf., Nov.,29 – Dec. 01, Paris, 2006

Prinn Ronald, 2007, Measuring the Uncertainty of Climate Change, Interview for MIT Technology Review, Feb 14, 2007
http://www.technologyreview.com/Energy/18184/

Rusov V.D., A.B.Glushkov, V.N.Vashchenko, 2005 Astrophysical Model of Global Climate of the Earth, Naukova Dumka, Kyiev, 2005, pp..213

Summary for Policymakers, 2007, Climate Change 2007: The Physical Science Basis of FAR (Fourth Assessment Report), (SPM), IPCC , Paris, 5th Feb, 2007
http://www.ipcc.ch/SPM2feb07.pdf

Svensmark H *et al.* 2007a Experimental Evidence for the role of Ions in Particle Nucleation under Atmospheric Conditions *Proc. Roy. Soc. A* (doi:10.1098/rspa.2006.1773 online Nov. 2006)
Svensmark Henrik, Nigel Calder. 2007b The Chilling Stars: A New Theory of Climate Change, UK Publication February 2007, ISBN 1-84046-815-7
Svensmark Henrik, 2007c, Cosmoclimatology: a new theory emerges, Astronomy & Geophysics 48 (1), 1.18–1.24. doi:10.1111/j.1468-4004.2007.48118.x
http://www.blackwell-synergy.com/doi/full/10.1111/j.1468-4004.2007.48118.x

Data Sources

Keeling C.D., T.P. Whort, 2005, Carbon Dioxide Research Group, SIO; Global CO2 Emissions from fossil-Fuel Burning, cement Manufacture and Gas Flaming: 1751 – 2002, March, 10, 2005

Marland Gregg, Tom Boden, Robert J. Andres, 2006, Carbon Dioxide Information Analysis Center, Oak Readge Nat. Lab., May, 2006