

## Geo-engineering side effects: Heating the tropical tropopause by sedimenting sulphur aerosol?

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### **Geo-engineering side effects: heating the tropical tropopause by sedimenting sulphur aerosol?**

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Anthropogenic greenhouse gas emissions tend to warm the global climate. Countermeasures must be taken in order to minimize the harm for humans and environment. Various geo-engineering ideas are currently discussed that might help in this respect, besides politically and socially difficult to achieve reductions of greenhouse gases. Crutzen [2006] initiated a lively scientific discussion by proposing to consider enhancing stratospheric sulphate aerosols. Sulphate aerosols may cool the Earth surface by reflecting solar short wave radiation back to space. A part of the anthropogenic climate warming might be compensated by increasing the amount of sulphate aerosols in the stratosphere, for example by sulphur injections. The scientific community is challenged to answer the question, whether we understand the involved processes enough to predict all important consequences of such a geo-engineering project. In nature tremendous enhancement of stratospheric aerosol could be observed after strong volcanic eruptions in the tropics. Mt. Pinatubo eruption in 1991 is the best observed eruption in the past. Up to 20 Mt of SO<sub>2</sub> was blown to the stratosphere [Bluth et al., 1992]. A cooling of about 1.5 °K on surface was attributed to Mt. Pinatubo eruption [Robock, 2000 and references herein]. We investigate to which extent the effects on climate after Mt. Pinatubo eruption serve as an analogue for the consequences of geo-engineering. We present modelling results of Mt. Pinatubo and anthropogenic sulphur injections in the lower stratosphere with AER 2D aerosol model [Weissenstein et al. 1997, 1998, 2005] and chemistry climate model SOCOL [Egorova et. al 2005, Schraner et al. 2008]. Even if the main goal, the cooling of the global mean temperatures can be achieved by enhanced stratospheric aerosols, the possible side effects are considerable [e.g. Trenberth and Dai 2007, Robock et al. 2008, Solomon 1999]. One possible side effect of such a geo-engineering fix might be the warming of the tropical tropopause and consequently the increase of the amount of stratospheric water vapour. A scenario with continuous SO<sub>2</sub> injections into the lower stratosphere may provide conditions for efficient condensation of H<sub>2</sub>SO<sub>4</sub> onto pre-existing stratospheric aerosols, which subsequently grow to large sizes and sediment into the tropical tropopause region. The absorption of long wave radiation by the aerosol increase tropopause temperatures rise and as a consequence the entry mixing ratio of water vapour increases. However uncertainties in the modelling are remarkable. Uncertainties in total sulphur mass, particle size distribution and resulting effect on optical properties after Mt. Pinatubo eruption plus the uncertainties of aerosol and climate models add up to uncertainties which should be taken as a warning. Do we really want to jeopardize Earth future on such high uncertainties?

#### References

- Bluth, G. J. S., S. D. Doiron, C. C. Schnetzler, A. J. Krueger, and L. S. Walter (1992), Global tracking of the so<sub>2</sub> clouds from the June, 1991 mount-pinatubo eruptions, *Geophysical Research Letters*, 19 (2), 151–154. Crutzen, P. J. (2006), Albedo enhancement by stratospheric sulfur injections: A contribution to resolve a policy dilemma?, *Climatic Change*, 77 (3-4), 211–219. Egorova, T. A., E. V. Rozanov, V. A. Zubov, E. Manzini, W. Schmutz, and T. Peter (2005), Chemistry-Climate Model SOCOL: a validation present-day climatology, *Atmos. Chem. Phys.*, 5, 1557–1576. Hansen, J., A. Lacis, R. Ruedy, and M. Sato (1992), Potential climate impact of mount-pinatubo eruption, *Geophysical Research Letters*, 19 (2), 215–218. Rasch, P. J., P. J. Crutzen, and D. B. Coleman (2008), Exploring the geoengineering of climate using stratospheric sulfate aerosols: The role of particle size, *Geophysical Research Letters*, 35 (2), L02809. Schraner, M., A. Fischer, P. Kenzelmann, E. Rozanov, and T. Peter (2008), Validation of chemistry climate model socol, *Atmos. Chem. Phys.* Solomon, S. (1999), Stratospheric ozone depletion: A review of concepts and history, *Reviews Of Geophysics*, 37(3), 275-316. Trenberth K. E. and A. Dai (2007). Effects of Mount Pinatubo volcanic eruption on the hydrological cycle as an analog of geoengineering. *Geophysical research letters*, Vol. 34, L15702, doi:10.1029/2007GL030524. Weissenstein, D. K., G. K. Yue, M. K. W. Ko, N. D. Sze, J. M. Rodriguez, and C. J. Scott (1997), A two-dimensional model of sulfur species and aerosols, *Journal Of Geophysical Research-Atmospheres*, 102 (11D), 13,019–13,035. Weissenstein, D. K., M. K. W. Ko, I. G. Dyominov, G. Pitari, L. Ricciardulli, G. Visconti, and S. Bekki (1998), The effects of sulfur emissions from hscat aircraft: A 2-d model intercomparison, *Journal Of Geophysical Research-Atmospheres*, 103 (D1), 1527–1547.