The composition of the lower mantle constrained by experiments on the elasticity of magnesium silicate perovskite

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Comparison between seismic estimates for S and P wave velocities and similar experimental estimates for appropriate rock compositions is the only rigorous method for determining the composition of the Earth's lower mantle. Magnesium-silicate perovskite is the dominant mineral of the Earth's lower mantle. The composition of silicate perovskite forming within a typical Bulk Silicate Earth composition is dominated by the $MgSiO_3$ component but will also contain sub equal proportions of Al and Fe. The lower mantle may also contain a significant proportion of remnant subducted basaltic crust, from which more Al and Fe-rich silicate perovskite would form. Fe and Al substitution in perovskite will therefore be a significant source of chemical variability in the lower mantle and potentially the main cause of observed seismic heterogeneity in this region.

Using Brillouin spectroscopy we have studied the elasticity of $MgSiO_3$ perovsktie single crystals in the diamond anvil cell to lower mantle pressures. In addition we have examined the elasticity of polycrystalline $MgSiO_3$ perovskite plus samples of the same phase containing Fe and Fe and Al using ultrasonic interferometry in the multianvil. These measurements were performed at the APS synchrotron x-ray source to enable pressure and sample length measurements and were performed up to 25 GPa and 1200 K. The results allow models for seismic wave velocities in the lower mantle to be tested against seismic models and for variations in velocity in the lower mantle to be understood in terms of temperature and composition.

Simulating Arctic Black Carbon with GEOS-Chem/CMAQ Modelling System

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Introduction

Arctic black carbon (BC) is of special interest because it makes a 10-100 times larger climate forcing impact thant a midlatitude source of equal strength[1]. To fully understand the impacts of Arctic BC on both air quality and climate forcing, it is necessary to identify the transport, distribution, and concentrations of Arctic BC within modeling work. However, currently very limited infromation of BC emission inventory over Arctic region is available except for biomass burning which takes about 35% of total BC emission. In this study, GEOS-Chem has been applied to investigate Arctic BC with EDGAR emission inventory for year 2006-2008 with grid resolution of 2x2.5°. With initial and boundary conditions dynamically downscaled from GEOS-Chem[2], Hemispheric-CMAQ is also applied with the same emission inventory but at finer resolutions as 108km and 36km to eiliminate the model discrepancy and uncertainties caused by grid resolutions. Model performances are evaluated against surface network observations from AERONET for 2 sites in US and 2 sites in Russia. GEOS-Chem is found to be able to reproduce BC over US domain generally well with NMB as 4.5% and 7.9% for US sites, and underestimate BC over Russia greatly with NMB of -81.36% and -81.71%. Modelling results from Hemispheric CMAQ will be able to provide more detailed BC information including spatial distributiona and temporal variations, and also the cross-Arctic transport of BC.

Preliminary Summary

Based on our preliminary results, Arctic black carbon emission inventory is underestimated by 285 ~ 2500% over noth Eurasia area in the EDGAR HTAP emission inventory.

[1] Stohl (2011) *The Arctic as a Messenger for Global Processes, conference presentation, May4 th*, Copenhagen
[2] Lam and Fu (2009) *Atmos. Chem. Phys* 9, 9169-9185