Investigating cloud absorption effects I and II: Global and Arctic absorption properties of black carbon and tar balls in clouds and aerosols

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This is a study to understand better Cloud Absorption Effects I and II, which are the effects on cloud heating of absorbing inclusions in hydrometeor particles and of absorbing aerosol particles interstitially between hydrometeor particles at their actual relative humidity (RH), respectively [1]. The GATOR-GCMOM model was used to study these effects as well as optical properties and the mixing states of black carbon (BC) and tar balls (TB) in clouds and aerosols. The globally- and annually-averaged modeled 550-nm aerosol mass absorption coefficient (AMAC) of externally-mixed BC was found to be 6.72 (6.3-7.3) m^2/g, within the laboratory range (6.3-8.7 m^2/g). The global AMAC of externally- plus internally-mixed (IM) BC was 16.2 (13.9-18.2) m^2/g, less than the measured maximum at 100% RH (23 m^2/g). The resulting AMAC amplification factor due to internal mixing was 2.41 (2-2.9), with highest values in high RH regions. The global 650-nm hydrometeor mass absorption coefficient (HMAC) due to BC inclusions within hydrometeor particles was 17.7 (10.6-19) m^2/g, ~9.3% higher than that of the IM-AMAC. The 650-nm HMACs of TBs and SD were half and 1/190th, respectively, that of BC. Modeled aerosol absorption optical depths were consistent with AERONET and OMI data. In column tests, BC inclusions in low and mid clouds (CAE I) gave column-integrated BC heating rates ~200% and 235%, respectively, those of interstitial BC at the actual cloud RH (CAE II), which itself gave heating rates ~120% and ~130%, respectively, those of interstitial BC at the clear-sky RH. Globally, cloud optical depth increased then decreased with increasing aerosol optical depth, consistent with boomerang curves from satellite studies. Thus, CAEs, which are largely ignored, heat clouds significantly.

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Electron Donor Utilization During the Bioreduction of Uranium

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Stimulating microbial reduction of soluble U(VI) to less soluble U(IV) is a promising strategy for remediating uranium contaminated groundwater. Little is known about optimizing the electron donor for promoting this process, nor what fraction of the electron donor is utilized by the target microbial population. Results presented here focus first on the effect of several electron donors on the microbial community and the overall uranium removal efficiency, and then on the specific utilization of acetate by target microorganisms.
Acetate and lactate, as well as more complex and commercially used donors such as a hydrogen-releasing compound (HRC) and vegetable oil were examined in terms of their effect on uranium removal and the microbial community, using flow-through column experiments. The composition of the microbial communities was evaluated with quantitative PCR probing specific 16S rRNA genes and functional genes, phospholipid fatty acid analysis, and clone libraries. For equivalent amounts of donor in terms of total organic carbon, acetate was least effective in U(VI) removal, while vegetable oil and HRC were most effective.
Utilization of acetate was examined closer by utilizing C-13 labeled acetate to determine which microorganisms take up acetate during biostimulation, and how the uptake of acetate by specific organisms, especially *Geobacter sp.*, changes over time during a long-term (~ several months) biostimulation experiment. A biostimulation experiment was performed, operating eight columns in parallel under continuous flow conditions, amended with 3 mM C-12 acetate. At regular time intervals, C-12 acetate flow into a column was switched to C-13 acetate for 36 hours before that column was sacrificed for detailed geochemical and microbiological analyses. Phospholipid fatty acid analysis (PLFA) and stable isotope probing (SIP) were used for the microbial characterization and to differentiate between the biomass that incorporated C-12 vs. C-13. Results showed that the *Geobacter* population remained fairly constant throughout the duration of the experiment (pre and post sulfate reduction), and that of the total amount of acetate incorporated into the overall biomass, about 40% was incorporated into the *Geobacter* biomass throughout the duration of the experiment.
The final experiment to be discussed shows that a very large fraction of acetate supplied for the biostimulation is utilized by methanogens, and that for very long biostimulation times and sufficiently high acetate levels to reduce all available sulfate, methane bubbles will form in the porous medium, which has implications for the system's permeability.