Satellite-based estimates of fine particulate matter during the Moscow wildfires of 2010

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Acute exposure to high levels of fine particulate matter ($PM_{2.5}$), such as emitted by the Moscow wildfires in summer 2010, are associated with serious adverse health effects, yet the location and scale of such events often make *in situ* monitoring difficult. Recent satellite retrieval developments have the potential to monitor surface pollution during these events. We estimate daily $PM_{2.5}$ concentrations using satellite observations during the Moscow fires. We increase the coverage of aerosol optical depth (AOD) retrieved from the Moderate Resolution Imaging Spectroradiometer (MODIS) by relaxing the operational cloud screening criteria which can mistake extreme aerosol events for cloud. This relaxed product shows excellent agreement with coincident operational retrievals (r^2=0.994; slope = 1.010) and increases coverage during the fires by 21.3%. We relate MODIS AOD to $PM_{2.5}$ using a chemical transport model (GEOS-Chem) and find good agreement with $PM_{2.5}$ values estimated from *in situ* PM_{10}. We find that the relationship between AOD and $PM_{2.5}$ is insensitive to uncertainties in biomass burning emissions. Satellite-derived and *in situ* values both indicate peak daily mean $PM_{2.5}$ of ~600 μg/m^3 on August 7, 2010 around Moscow, with a potential ~400 excess deaths during the fires.

Growth rate of giant gypsum crystals

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Mineralogical processes taking place close to equilibrium, or with very slow kinetics, are difficult to quantify precisely. The determination of ultra slow precipitation rates should reveal characteristic timing associated to processes that are important at geological scale. We designed a high-resolution phase-shift interferometer to measure growth rates of crystals at very low supersaturation values. To test this technique, we selected the giant crystals of gypsum of Naica ore mines

(Mexico), a challenging subject in mineral formation. They are formed by a self-feeding mechanism driven by solution-mediated anhydrite-gypsum phase transition, and are the result of an extremely slow crystallization process close to equilibrium [1]. To calculate the formation time of these crystals we measured the growth rates of the {010} face of gypsum growing from current waters from Naica at different temperatures. The slowest measurable growth rate was found at 55 °C, being $1.4\pm0.2\times10^{-5}$ nm/s, the slowest value measured for a crystal growth process. At higher temperatures growth rates increase exponentially due to decreasing gypsum solubility and higher kinetic coefficient [2]. At 50 °C neither growth nor dissolution was observed indicating that growth of giant crystals of gypsum occurred at Naica between 58 °C and current temperature of Naica waters, confirming formation temperatures determined from fluid inclusion studies. Our results demonstrate the usefulness of applying advanced optical techniques in laboratory experiments to gain a better understanding of crystal growth processes occurring at a geological time scale.

[1] García-Ruiz *et al*. (2007) *Geology* **35**, 327–330. [2] Van Driessche *et al*. (2010) *Cryst. Growth Des*. **10**, 3909–3916.