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Simulating the response of Mercury's neutral sodium exosphere to a X-class solar flare

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Mercury exhibits a tenuous and nearly collisionless surface-bounded exosphere, which demonstrates large variations over the span of a single orbit around the Sun. The sodium content has been shown to be especially variable, with global asymmetries between dawn/dusk and north/south. These are accompanied by more rapid changes on a time-scale of a few Earth hours. The weak magnetic field, tenuous atmosphere and close distance from the Sun makes Mercury more susceptible to solar transients than other terrestrial planets. For this reason, the short-term variations in the sodium emission have been linked to coronal mass ejections (CMEs) or even solar flares. In this first work, we simulate the response of Mercury's exosphere to a X-class solar flare.

We will employ the Exospheric Global Model (EGM), a 3-D parallelized Monte Carlo model, to simulate Mercury's neutral sodium exosphere. In this model, a representative number of test-particles $(\sim 10^7)$ are followed as they move on ballistic (collisionless) trajectories inside the exosphere. These particles can escape from the exosphere, stick to the surface or be re-ejected through one of three processes: thermal desorption, photo-stimulated desorption and solar wind sputtering. With reference to solar flares, we expect a momentaneous increase in the solar photon flux. The release of neutral sodium from the surface through photo-stimulated desorption (PSD) should follow this trend. By introducing a step increase in the photon flux we can mimic this effect and determine how quickly the system reacts to a typical variation of the solar flux induced by a X-class flare. From the minimum response time we can establish whether solar flares are capable of inducing short-term changes in the exospheric sodium emission that could be observable from Earth, by MESSENGER or BepiColombo instruments.