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Modelling of Io's Atmosphere for the IVO Mission

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The Io Volcano Observer (IVO) is a proposed NASA Discovery-class mission (currently in Phase A), that would launch in early 2029, arrive at Jupiter in the early 2033, and perform ten flybys of Io while in Jupiter's orbit. IVO's mission motto is to 'follow the heat', shedding light onto tidal heating as a fundamental planetary process. Specifically, IVO will determine (i) how and where heat is generated in Io's interior, (ii) how heat is transported to the surface, and (iii) how Io has evolved with time. The answers to these questions will fill fundamental gaps in the current understanding of the evolution and habitability of many worlds across our Solar System and beyond where tidal heating plays a key role, and will give us insight into how early Earth, Moon, and Mars may have worked.

One of the five key science questions IVO will be addressing is determining Io's mass loss via atmospheric escape. Understanding Io's mass loss today will offer information on how the chemistry of Io has been altered from its initial state and would provide useful clues on how atmospheres on other bodies have evolved over time. IVO plans on measuring Io's mass loss in situ with the Ion and Neutral Mass Spectrometer (INMS), a successor to the instrument currently being built for the JUpiter Icy moons Explorer (JUICE). INMS will measure neutrals and ions in the mass range 1 – 300 u, with a mass resolution (M/ΔM) of 500, a dynamic range of > 10^5, a detection threshold of 100 cm^{-3} for an integration time of 5 s, and a cadence of 0.5 – 300 s per spectrum.

In preparation for IVO, we model atmospheric density profiles of species known and expected to be present on Io's surface from both measurements and previous modelling efforts. Based on the IVO mission design, we present three different measurement scenarios for INMS we expect to encounter at Io based on the planned flybys: (i) a purely sublimated atmosphere, (ii) the 'hot' atmosphere generated by lava fields, and (iii) the plume gases resulting from volcanic activity. We calculate the expected mass spectra to be recorded by INMS during these flybys for these atmospheric scenarios.