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The puzzle of massive negative ions above the ionospheric D-region – Revisit, new insights, and suggestion of a puzzle solution

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Inspired by new experimental possibilities, previous pioneering rocket borne ion-mass spectrometer measurements, made by our MPIK-Heidelberg research group in the lower ionosphere, are revisited and reanalyzed. The most puzzling observation made in two of our previous rocket missions is the detection of a layer of massive negative ions (about 100-400 atomic mass units), dominating the negative ion population present at heights between the top of the ionospheric D-region and about 90 km. The presence of these massive negative ions suggests that they are relatively stable against electron detachment by UV-photons and by free oxygen atoms. Loss of these ions should, at least, occur by recombination with positive ions. Since charge neutralization via negative ion-positive ion recombination is much slower than positive ion-electron recombination, negative ions should live much longer than positive ions and therefore may grow more efficiently. Previously, we have hypothesized that the formation of, at least, some of the massive negative ions may involve meteoric material. Interestingly, the massive negative ions may have potentially important direct and indirect roles. They may influence noctilucent cloud formation and their formation may significantly influence free electron loss. Furthermore the massive negative ions have an important indirect role as an analytical tool for highly sensitive detection of ultra-trace gases, particularly certain meteoric molecular gases, present in the lower ionosphere. However, the sparse previous rocket borne measurements of the massive negative ions suffered from limited sensitivity and relatively poor mass resolution. Therefore, unambiguous identification of their mass numbers and chemical nature was not possible. In the present contribution is suggested a powerful novel rocket borne ion mass spectrometer technique with greatly improved sensitivity and mass resolution, which should have the potential of contributing markedly to resolving the puzzle of lower ionospheric massive negative ions.