Modification of the Natural Equatorial Ionosphere: The Metal Oxide Space Cloud (MOSC) Experiment

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With support from the NASA sounding rocket team, AFRL performed two separate 5 kg releases of samarium metal vapor in the lower F-region near Kwajalein Atoll in May 2013. A fraction of the samarium subsequently ionized forming a plasma cloud that persisted for tens of minutes to hours in the post-sunset period. Numerous sensors were used to characterize the clouds including the ALTAIR incoherent scatter radar, multiple GPS and optical instruments, satellite radio beacons, and a dedicated network of high frequency (HF) radio links. The primary objectives of the experiments were to understand the dynamics, evolution and chemistry of Sm atoms in the earth's upper atmosphere. Sm is predicted to both photo-ionize and chemi-ionize through charge exchange with neutral oxygen (O). Ionization rates and loss reactions are not well known. A secondary objective was to understand the interaction of an artificial plasma cloud with the low latitude ionosphere during the pre-reversal enhancement period leading up to the post-sunset development of large-scale Rayleigh-Taylor instability. It was initially hoped that the introduction of the artificial plasma might be sufficient to quench the development of the instability by maintaining high conductivity within the affected flux tubes. Modeling results showed that this result was unlikely due to the relatively small amount of material being released. However, it appeared possible that the presence of SmO+ near the bottomside of the F-region might be capable of reducing the formation of short-scale irregularities within the larger Rayleigh-Taylor 'bubbles'. Indeed, preliminary results indicate that the artificial layers, positioned at 170 and 180 km respectively, did interact with the overlying F region and in at least one case, cause a decrease in the short-scale component of the natural irregularity spectrum. The results suggest that it may be possible to mitigate the formation of low-latitude irregularities responsible for radio wave scintillation with a MOSC-based approach.