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Effects of doubling CO₂ concentration on Sporadic E around Japan region based on GAIA

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This study utilizes the Ground-to-topside Atmosphere Ionosphere model for Aeronomy (GAIA) to investigate the effects of doubling CO₂ concentration on the occurrence of Sporadic E (Es) layers around Japan region. Using two datasets, representing normal and doubled CO₂ conditions for the year 2001, the vertical ion convergence (VIC) and other related parameters were calculated during the Summer Solstice. The VIC distribution around Japan was examined in terms of daily variations at four ionosonde stations around Japan: Wakkanai, Kokubunji, Yamagawa, and Okinawa. Based on our analysis, a general increase in the magnitude of VIC around Japan under doubled CO₂ conditions are observed, while the altitude of VIC magnitude maxima decreases. Potential physical processes driving vertical ion convergence under these conditions are identified. At altitudes of 90-100 km, the increase in VIC magnitude is primarily driven by zonal wind and a decreasing ratio of ion-neutral collision frequency to ion gyrofrequency. At 100-105 km, the increase is mainly influenced by the aforementioned ratio. These mechanisms are clearly observed at Kokubunji, Yamagawa, and Okinawa, but not as evident at Wakkanai, of which mechanism mainly driven by zonal wind, regardless of altitude difference. The results revealed in this study suggest that the climate change will enhance Es and its occurrence.