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Equatorial spread-F

Equatorial spread-F (ESF) phenomenon produces large turbulent like variations of electron density at the base of the F-region and it occurs in association with plasma depleted flux tubes, widely known as plasma bubbles which develop at dusk hours into vertically elongated formations extending to over 1500 km over the

magnetic equator and thousands of kilometers (25°) into the low latitude ionosphere on either side. They consist of irregularity structures of scale sizes varying from 10's of centimeters to 100's of kilometers that are sensitive to a wide variety of diagnostic techniques. The ESF irregularities affect HF communications, as well as the satellite signals used for the many practical applications of our daily life, point to point communication, satellite to ground communications, navigation systems based on GPS satellites, geodesy and over the horizon radars.

A CCD-based all-sky imaging system with 180° field of view has been operating at Kolhapur in India to study the dynamics of these large scale irregularities through the imaging of the OI 630 nm atomic oxygen emission line on clear moon-less nights. The ionospheric plasma bubbles manifest in all-sky imaging observations as north-south aligned intensity depleted regions. The all-sky images also permitted the determination of eastward drift velocity, depth and width of the plasma bubbles for several nights. A comparison has been made between the observed zonal component of plasma drift velocities with the thermospheric zonal neutral wind velocities obtained from the HWM-93 model showing good agreement on some nights. This also provides evidence that the F-region neutral winds were the source of the electric fields driving ion drifts in the tropical latitudes. The rate of change of zonal wind velocities has been modeled and is found to be matching in terms of pressure variation computed from the MSIS-E 90 model. See **page 488**.

Solar variability and Indian monsoon

The forcing factors of Indian monsoon are hotly debated topics of which solar variability is a strong contender. In fact, recently there has been renewed interest in studying the effect of Sun on processes taking place on the earth for which an international program, CAWSES, has been planned. CAWSES (Climate and Weather of the Sun–Earth System) is sponsored by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics), which is established to enhance the understanding of the space environment and its impacts on terrestrial systems. The Indian chapter of the CAWSES is sponsored by ISRO (CAWSES-India). Solar influence on climate is a major theme of CAWSES-India, under which Tiwari and Ramesh present a comprehensive review (**page 477**) of the past solar variability and its effect on the Indian monsoon. They discuss the basics of the solar variability and list various plausible mechanisms through which it can affect the terrestrial climate. More importantly, the authors compare the reconstructed solar variability to SW monsoon *precipitation* record. Most of the earlier palaeomonsoon records are based on SW monsoon *wind* strength and not on the *precipitation*, which is of more relevance to the society. They conclude that solar variability appears to govern the SW monsoon *precipitation* on decadal to centennial time scales and asks for more studies to explore longer time scale correlations. Several important questions addressing which can lead future sun–climate research are also highlighted.

Pollination biology of large cardamom

Amomum subulatum (large cardamom) is the most important perennial cash crop of the Sikkim Himalayan region. Pollination biology of this species has been studied by Sinu and Shivanna (**page 548**). The flowers receive only two flower visitors, a bumblebee (*Bombus haemorrhoidalis*) and a honey bee (*Apis cerena*). Bumblebee is the effective and only pollinator

but *Apis cerana* is the pollen robber. Structural features of the flower differentiate pollinator and pollen robber. The nectar located in the long nectar tube is accessible only to long-tongued bumblebee but not to short-tongued honey bee. The narrow passage between the anther stigma column and the labellum forces the bumblebee to push the anther-stigma column to enter the flower, which brings the body of the bumblebee in contact with the anther and the stigma, and effects pollination. *A. cerena* does not come in contact with the stigma during pollen foraging and hence, unable to bring about pollination. Pollination efficiency in the plantation studied was low due to low population density of the bumblebee. The study highlights the need to conserve the habitat to maintain bumblebee population to sustain pollination efficiency and thus the yield of this important crop.