スポラディックE層によるVHF航空航法無線異常伝搬の観測と発生統計

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Statistical study of VHF anomalous propagation due to Sporadic E over the air navigation band

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The sporadic E layer (Es) is an isolated region of high-density ionisation in the E-region ionosphere which is usually transient and localised. The electron density of typical Es often exceeds that of day-time F2 layer and its plasma frequency may reach above 10 MHz. A patch of Es reflects very-high frequency (VHF; 30-300 MHz) radio waves with frequencies up to about 100 MHz in oblique propagation. This has been known as anomalous propagation by the Es (here we abbreviate it as EsAP) for long time. However, comprehensive observation of EsAP in the relatively higher part of VHF range, especially above 100 MHz, has not been performed to date. This is partly due to the sporadic nature of the events, and partly due to the fact that the impact of the Es on radio operation in this frequency range has not been clearly identified.

A band of frequencies between 108 MHz and 118 MHz is allocated to aeronautical navigation (NAV) such as VHF Omni-Directional Range (VOR) and Instrument landing system (ILS) localizer (LOC). Within the band, about 200 separate frequencies (channels) are allocated these stations. As the number of stations exceeds the number of channels, several stations share a single frequency in such a way that the distance between any of two such stations is longer than the range of normal VHF propagation. Furthermore, in addition to above conventional NAV systems, a new system called Ground Based Augmentation System (GBAS) VHF ground-air Data Broadcast (VDB), which has started operations in the world, will also share the same frequency range. Under normal conditions, owing to the frequency allocation scheme mentioned above, VHF signals from several stations will not interfere the desired signal. When an Es presents it is possible that one (undesired) signal interfere another (desired) signal through EsAP, and may affect the stable operation of NAV systems. However, the impact of EsAP in this frequency band has not been asessed quantitatively.

We have been recording the intensities of NAV band radio waves in Chofu (35.4N, 139.3E) and Kure (34.2N, 132,8E) since 2012 to study the occurrence of the Es with respect to time and location. Using the archived three-year data we have performed statistical study and found that there have been several occations in which the strength of an undesired signal exceeded the strenght of the desired signal. In some cases the strength of the undesired signal reached the critical level documented in NAV redio receiver standards. These results indicate that EsAP is an active subject in the context of space weather.

In this talk we present the detailed statistics of EsAP in NAV radio band.