Calculation of the ray paths and propagation times of HF radio waves in the simulator of HF-START project.

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HF simulator Targeting for All user's Regional Telecommunications (HF-STRAT) is a collaborative project with NICT, ENRI and Chiba University to provide the information of nowcast of radio propagation. In this project, propagation of HF radio waves is calculated by ray-tracing. Using the results of ray-tracing, we have determined whether HF radio wave travels between any two points. To verify the results of ray-tracing, we have compared the differences of the propagation time determined by the ray-tracing with the observation of the HF radio waves transmitted from Nagara transmitter, RadioNIKKEI (35.46°N, 140.20°E). HF receivers are located at Chiba University (Chiba, 35.62°N, 140.10°E), Sarobetu (Hokkaido, 45.16°N, 141.74°E), Yamagawa (Kagoshima, 31.20°N, 130.61°E), Ogimi (Okinawa, 26.68°N, 128.15°E). In comparing the propagation time between Chiba and the other receivers, it is found that there was a difference of the propagation time between the ray-tracing results and the observations. This is because it is assumed that ground waves are propagated from Nagara to Chiba. By calculating the loss of electric field strength between Nagara and Chiba, we found that the loss of sky wave that is reflected by ionosphere was almost comparable to that of ground wave. Thus, it is possible that the radio wave propagation between Nagara and Chiba is not ground wave but sky wave that is reflected by ionosphere or both ground wave and sky wave signals are received simultaneously by receiver at Chiba. In addition, the comparison between observation of propagation time differences using distant receivers except Chiba and propagation times derived from ray-tracing calculation is in progress to validate results of simulator. In the simulator, we also plan to provide users with options to choose three types of electron density models (IRI, GNSS tomography, GAIA). For these options, we will use the electron density distributions determined by each model in the ray-tracing calculation and analyze the differences between the ray-tracing results statistically.