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Can the IGY Global Ionosphere be Recovered?

Abstract:

The 1957-58 International Geophysical Year (IGY) is regarded by many as the threshold of mankind's entry into space exploration. Now 58 years later, we understand and can describe in detail the five complete solar cycles since then, where each cycle is different. We know that the Earth's magnetic field has changed, causing changes in our planet's space weather shield. The Earth's atmosphere itself has also undergone changes, but has the interface region between space and our planet's atmosphere, the ionosphere and thermosphere, also undergone change? What could such changes tell us about changes in the atmosphere? Researchers have theoretically modeled the sensitivity of the ionosphere to hypothetical long-term changes in the atmosphere and have spent years of intense research to verify the results.

In this presentation, we address the question of whether it is possible to reconstruct the global ionosphere of the IGY era adequately to address these important questions regarding long-term change using our past and present knowledge of the ionosphere.

First, our present-day knowledge of the ionosphere prior to the space age will be assessed, particularly its limitations. Much of the knowledge we have regarding the mid-century ionosphere comes from hand-scaled ionospheric sounding parameters pertaining to the E- and F-layers. Except for IGY, most observations were tailored to operational HF radio wave propagation. Thus, while the F layer height hmF2 would be scientifically useful as a sensitive indicator of atmospheric change, the F-layer height was often represented by the M3000 parameter, which is an empirical estimate of the relationship between layer height, frequency, and oblique radio wave propagation distances. Unfortunately, the relationships between M3000 and hmF2 are, at best, qualitatively related and involve various assumptions and approximations, so hmF2 is not reliably obtained from available M3000 records.

Second, we discuss the largely untapped archive of observations of the IGY-era ionosphere, which could provide a detailed representation of the historical ionosphere. Well over a hundred ionosondes were operating during the IGY and their records are well-preserved at various archive facilities. The archives include photographic records of complete ionograms captured in various forms, particularly on 35 mm film reels. Available hand-scaled records are often hand-written and difficult to transcribe, and many of the records are limited to hourly observations, while the films generally record 15-minute or better cadence. Thus the bulk of these ionogram records await modern scientific processing to recover the full electron density profiles (EDP) contained in their o- and x-traces. In addition, the effects of planetary waves, tides, and other atmospheric disturbances can be analyzed with modern tools.

We will outline how ionospheric EDP can be obtained from archived observations. We will also review recent progress in ionogram conversion techniques, recovering data from early 1950s. This will set the stage for an international effort to recreate an accurate historical ionosphere.