

Can the IGY Global Ionosphere be Recovered?

A Data Mining Mission

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Ionograms and the Global Ionosphere

- The International Geophysical Year (IGY) from 1957-58 fielded the most comprehensive set of instrumentation in the modern scientific age; and Sputnik started the Space Age.
- A large archive of IGY ionograms on 35mm film still exists in global repositories World Data Centers (WDC).
- Most ionograms were recorded at a 15-minute (or better) cadence, but the official analysis is limited to an hourly summary. Hence data-mining for science is very possible.
- Modern analysis of the films will allow bottomside electron density profiles (EDPs) on the most comprehensive global scale.

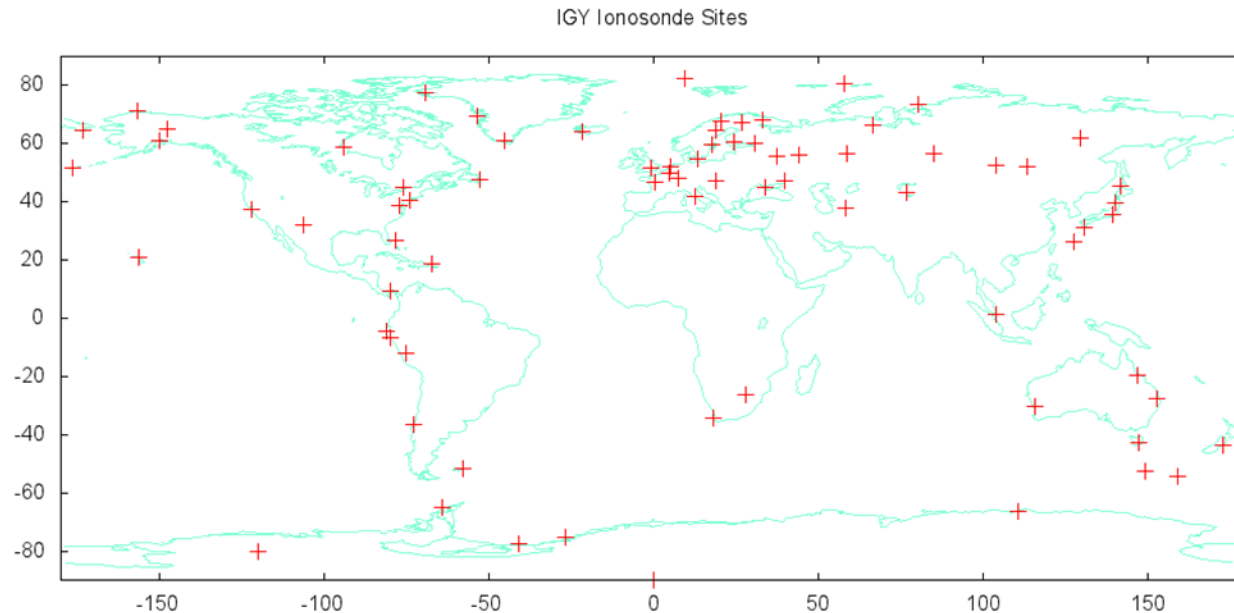


Overview

- Are enough IGY sites available?
- Are the ionograms adequate?
- Can ionogram coordinate registration be validated?
- Was IGY a scientifically interesting period?
- Open E-region Science Questions.
- Open F-region Science Questions.



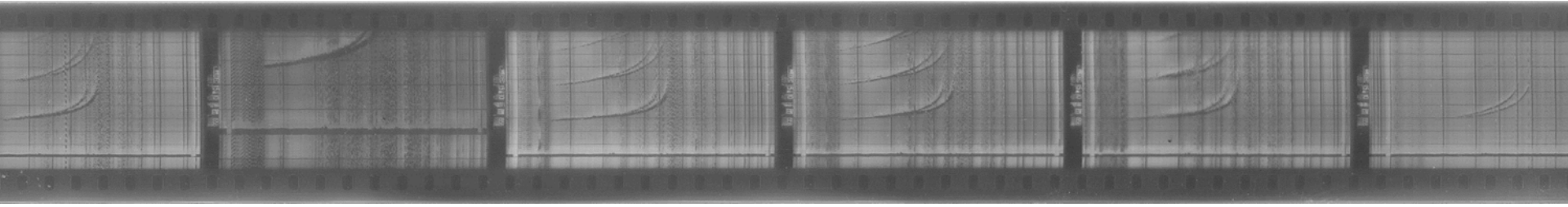
IGY Ionosonde Distribution Based on SPIDR



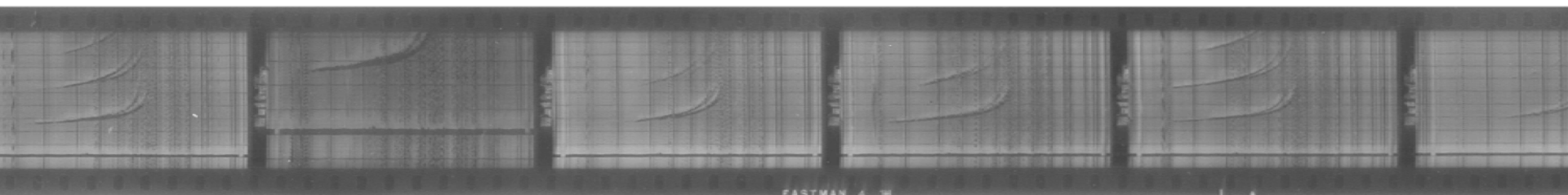
- Over 100 ionosondes operated at some point during the IGY.
- The map above shows a subset of 76 sites that operated routinely during most of the IGY period.
- Hourly hand-scaled values for these sites are available from NGDC SPIDR.
- Depending on source as many as 300 ionosondes operated during IGY!?



The 35 mm Film Ionogram Archive

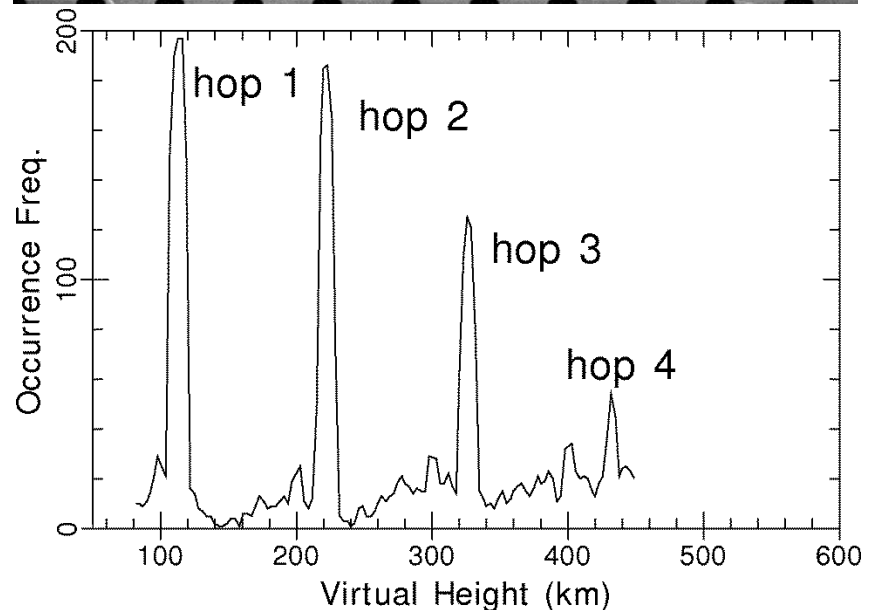
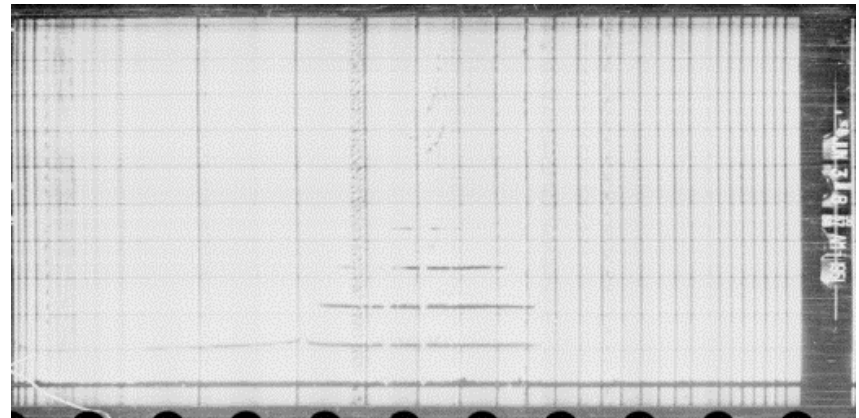


- The 35mm films are generally stored on movie-style reels
- Each reel has 2-3 weeks of ionograms depending on cadence
- Frames have timestamps, frequency markers, and virtual height markers



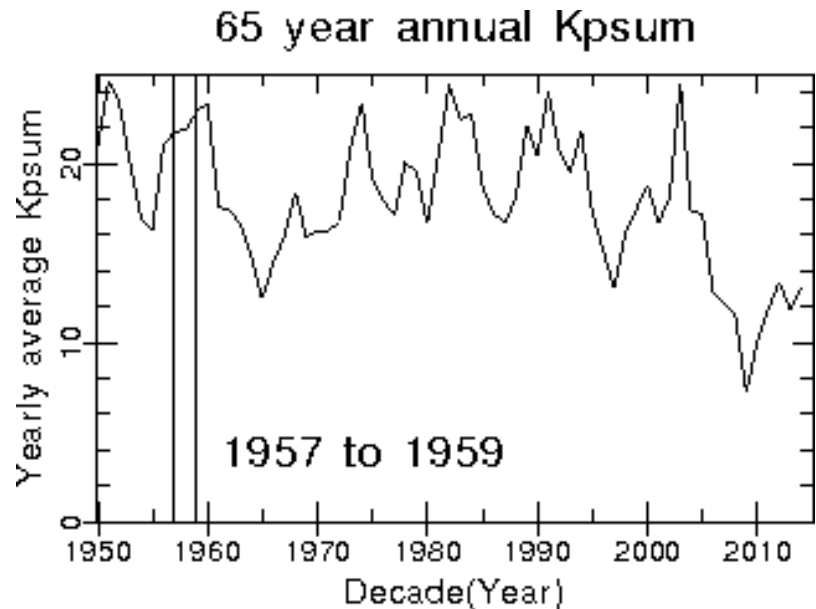
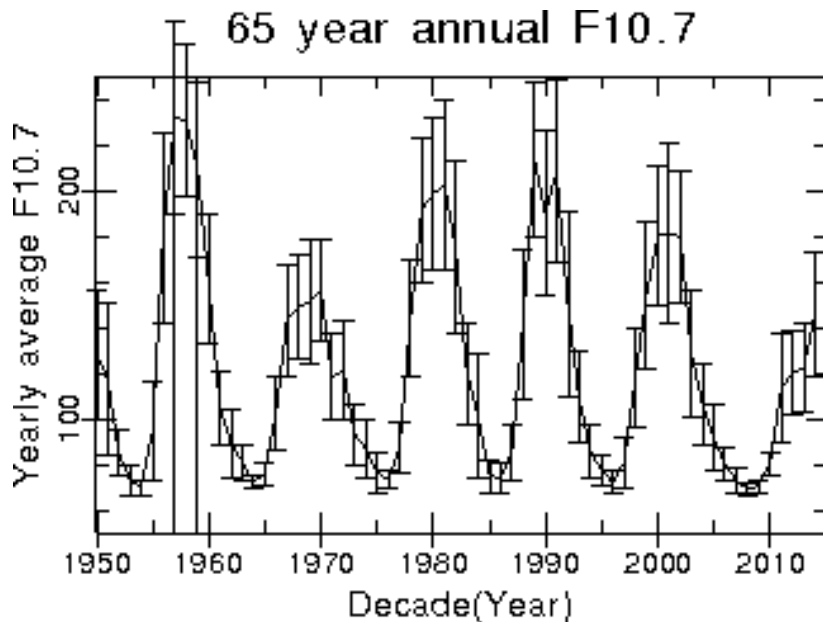
Can “Film” Ionograms be Calibrated?

- **VIRTUAL HEIGHT-true height?**
- Ionograms with multiple-hop sporadic E may be used to check virtual height calibration
- Sporadic E layers provide sharp reflection surfaces between 100-120 km
- Each hop or reflection should be a multiple of the layer virtual height
- **FREQUENCY?**
- Using known transmitters
- Fort Belvoir (down the road) has well defined 2.5 MHz WWV signal.



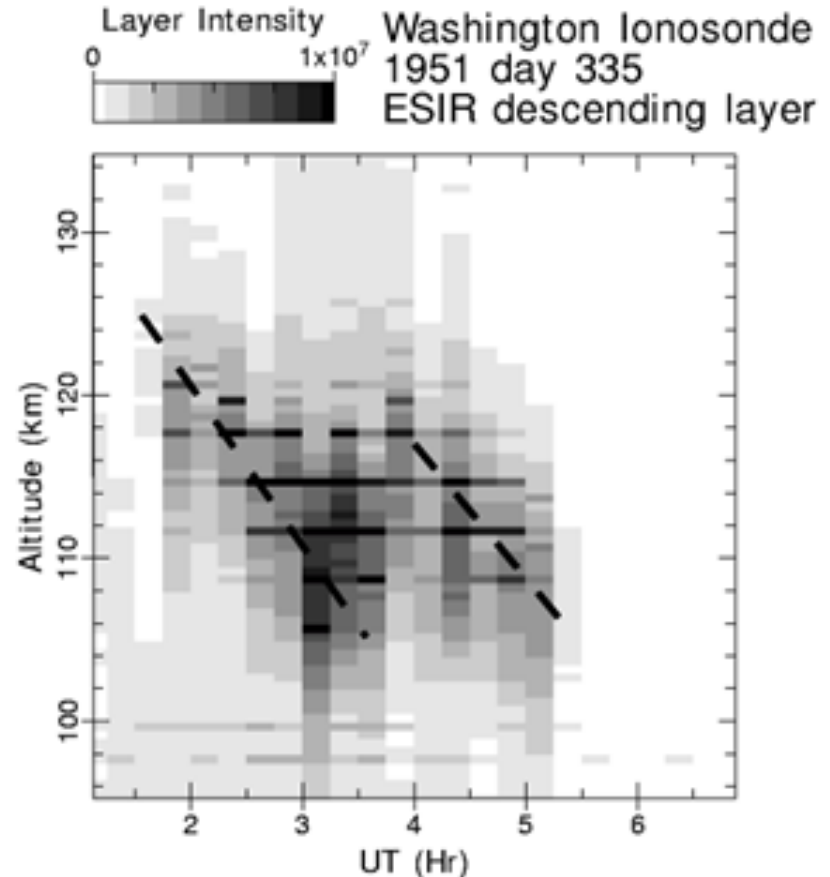
Was IGY a Scientifically Interesting Period?

- Solar activity is summarized by the annual F10.7 index and its standard deviation
- Geomagnetic activity is summarized by the annual KpSum
- 2 Vertical lines indicate the IGY period, 1957-1958



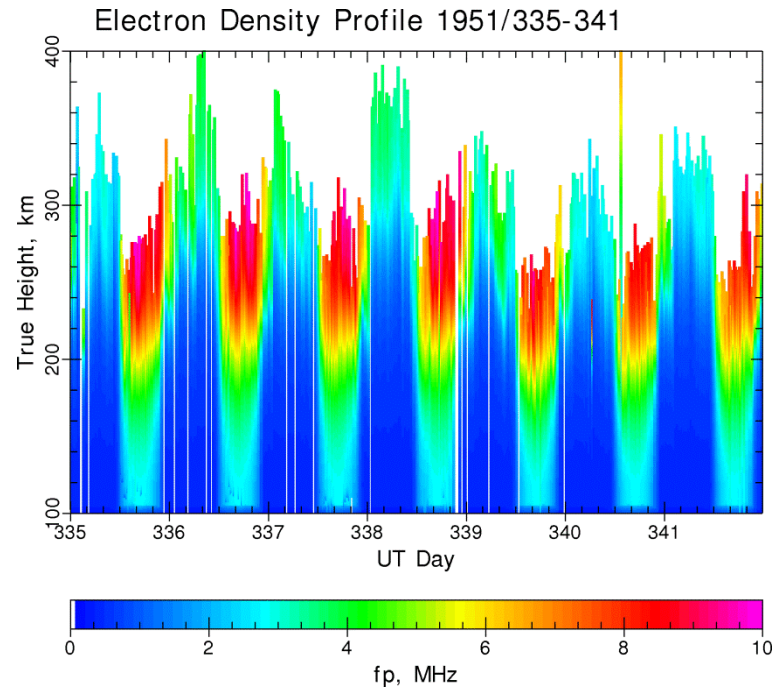
Sequential and Descending Layers: E-Region Dynamics

- E-region dynamics may be seen in the 15-minute cadence ionograms.
- Analysis of film ionograms from Ft. Belvoir have shown the presence of descending layers.
- These layers may be used to study atmospheric waves and tides.
- **Note:** a few miles to the south is the location of Ft. Belvoir where the NBS developed the ionosondes used extensively in IGY.

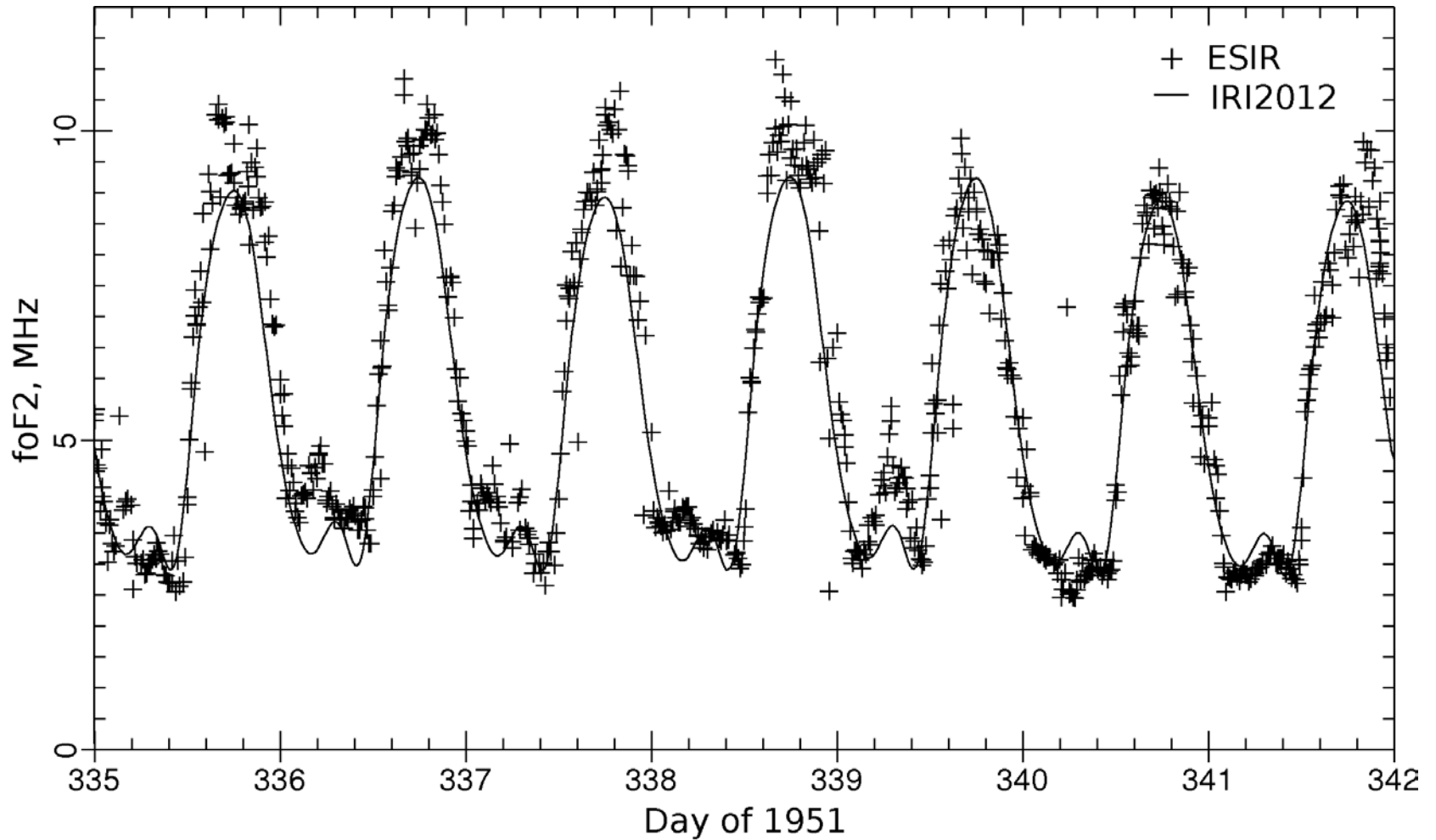


Electron Density Profiles: F-Region Dynamics

- 1951 Ft. Belvoir ionograms extracted from 35mm film with 15 minute cadence.
- The digitized ionograms may be analyzed with autoscaling software such as SEC's ESIR.
- Electron density profiles (EDPs) can be generated for suitable ionograms.
- EDPs reveal waves and trends that are not obvious from the traditional hourly scaled URSI key parameters.



F-Region Dynamics



Discussion

- Archived IGY data sets contain a large amount of scientific information that has not been extracted. (I estimate 95%)
- Analysis with modern models and tools and comparison with more recent data sets may reveal long-term trends and other phenomena.
- International effort to recover the IGY Ionosphere:
- PHASE I: identify WDC holdings globally and international effort to digitize these ionogram films.
- PHASE II: Cal/Val effort to convert films ionograms to digital ionograms. Techniques exist, and better ones can be developed.
- PHASE III: Ionogram Inversion to EDPs and global representations of ionospheric dynamics at 15 minute cadence. Techniques exist and better ones can be developed. NEW SCIENCE

