Solar-Cycle & Short-Term Variations of Topside Ionospheric Electron-Density Profiles

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Progress as of September 2006

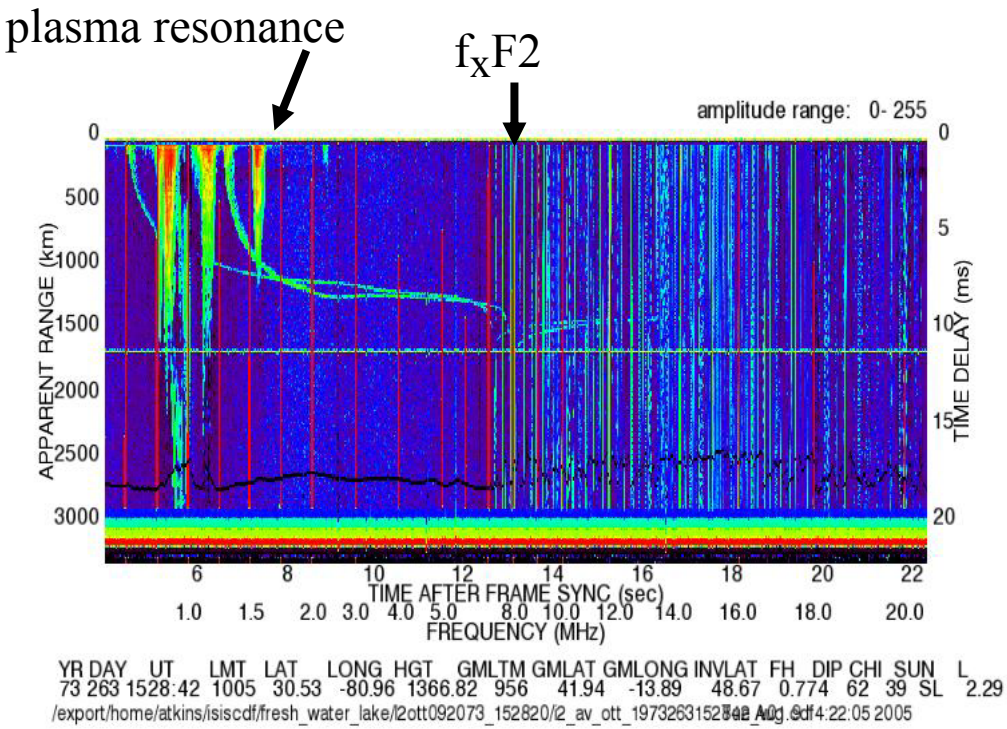
- **Extended ISIS digital ionospheric topside-sounder ionogram database**
  - > 470,000 ionograms now in National Space Science Data Center (NSSDC)
  - Alouette 2, ISIS 1 and ISIS 2 digital ionograms extend over 19 years (1966-1984)

- **Processed Digital ionograms into topside vertical electron-density profiles $N_e(h)$**
  - > 115,000 TOPIST automatically-scaled ISIS-2 $N_e(h)$ profiles now in NSSDC
  - Supplements > 170,000 hand-scaled Alouette 1&2 and ISIS 1 & 2 $N_e(h)$ profiles

- **Extracted O^+/H^+ transition heights from topside $N_e(h)$ profiles**
  - Analysis applied to individual passes
  - Analysis also applied to the above hand-scaled $N_e(h)$ profile database

ISIS-2 digital topside ionogram (apparent range vs. frequency f) illustrating:

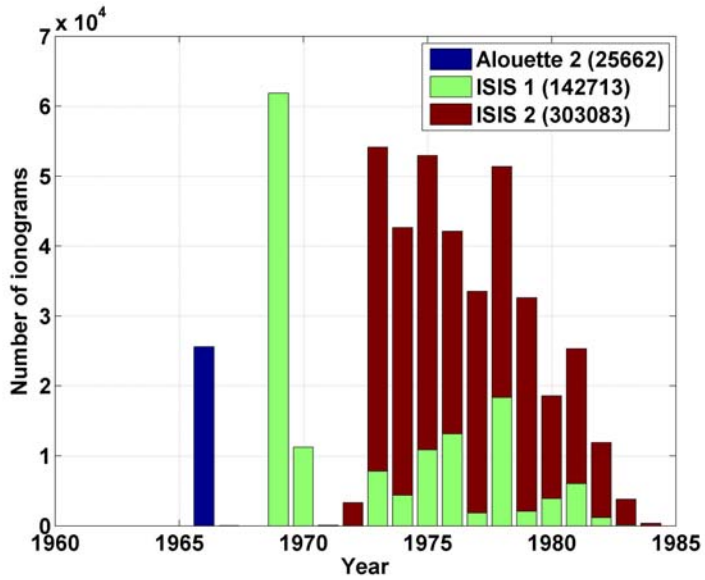
- plasma resonances
- ionospheric penetration freq. f_xF2
- ionospheric reflections when $f < f_xF2$
- surface reflections and ground-noise breakthrough when $f > f_xF2$



Distribution of digital topside ionograms available from NSSDC by satellite:

- Alouette 2 launched in 1965
- ISIS 1 launched in 1969
- ISIS 2 launched in 1971

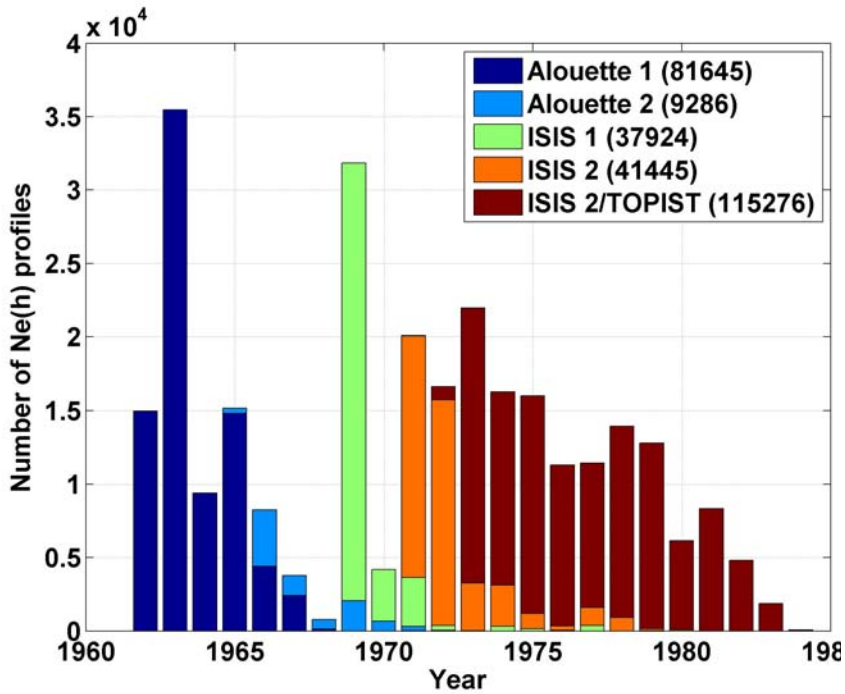
Ionospheric reflections used to derive topside N_e (h)

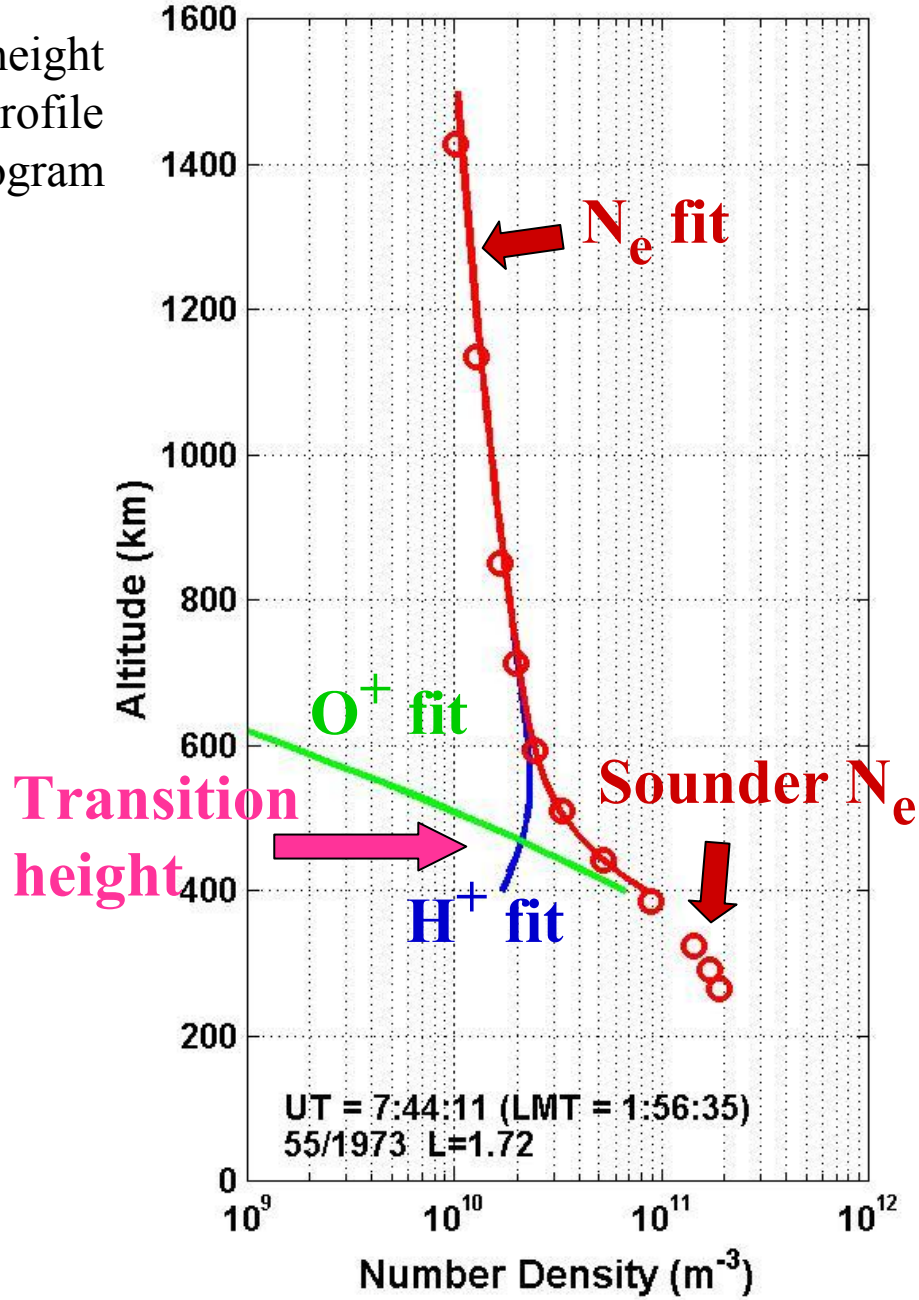


Example of O^+/H^+ transition height determination from topside $N_e(h)$ profile from mid-latitude ISIS-2 ionogram

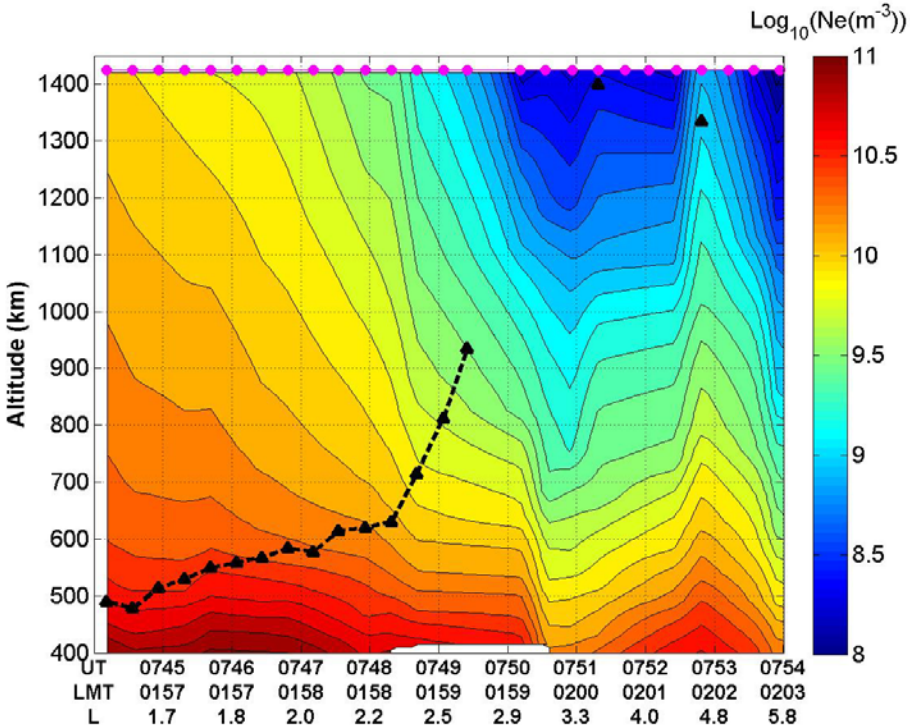
Distribution of topside $N_e(h)$ profiles available from NSSDC based on:

- hand scaling of ionospheric reflections
- auto scaling (TOPIST) of reflections

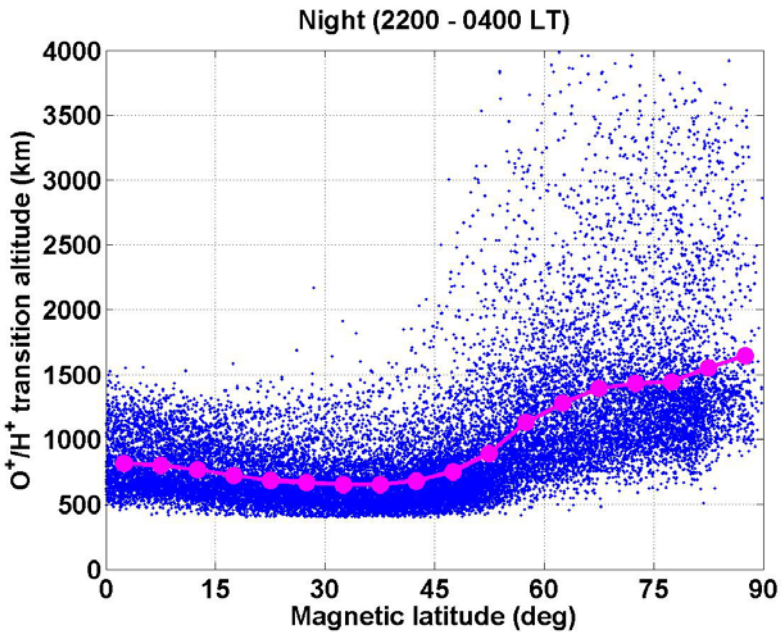




ISIS-2 orbit-plane N_e contour plot with O^+/H^+ transition-height determination 24 Feb 1973



Local nighttime O^+/H^+ transition-heights from ~ 22,000 hand-scaled Alouette 1 & 2 and ISIS 1 & 2 $N_e(h)$ profiles from NSSDC (satellite altitudes ≥ 1000 km)



Webb, P. A., R. F. Benson, and J. Grebowsky, *Radio Sci.*, *41*, RS6S34, doi:10.1029/2005RS003391, 2006

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