

Recovery of Mars ionospheric electron density profiles acquired by the Mariner 9 radio occultation instrument

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Abstract SA51A-2140

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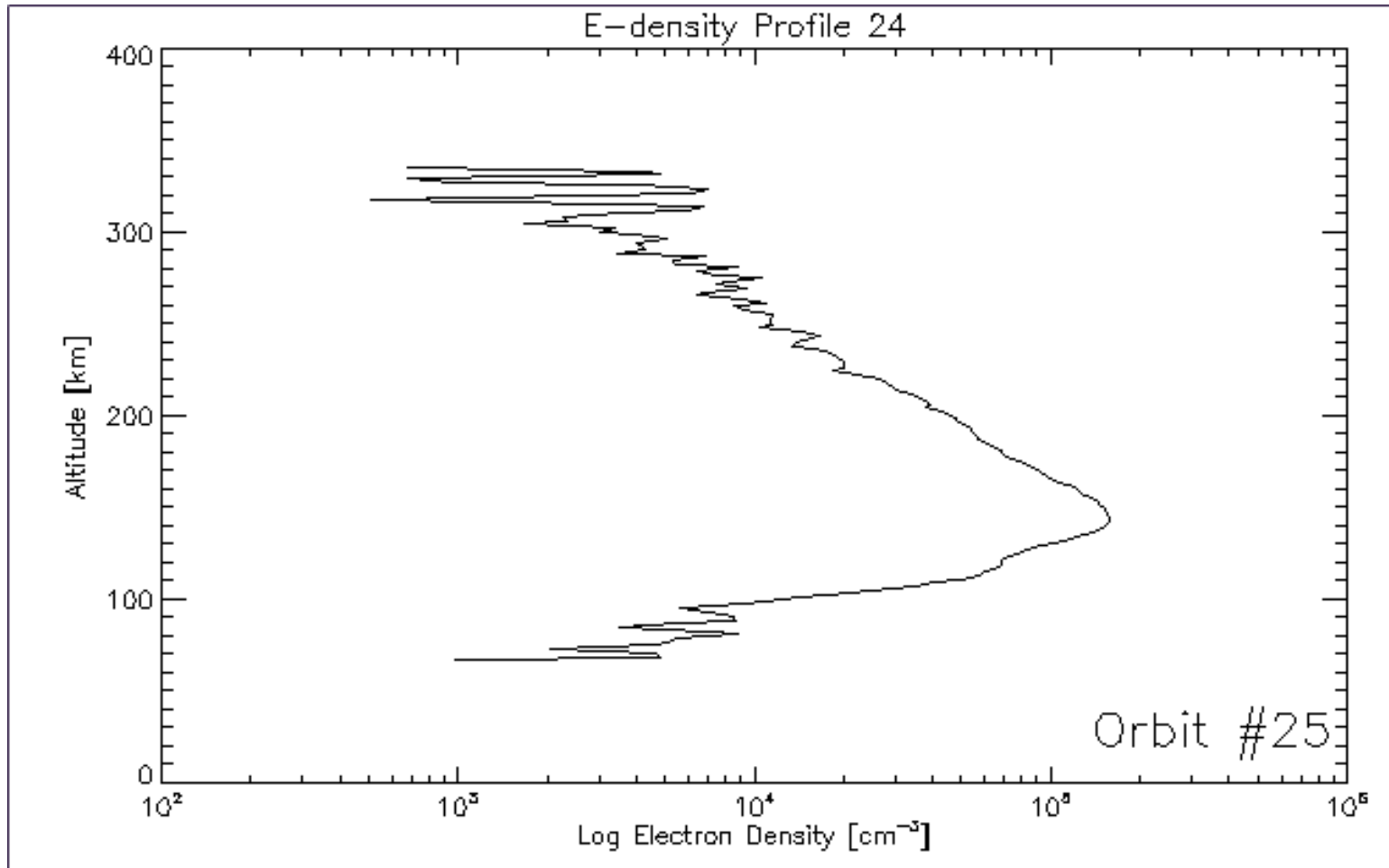
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Abstract

The Mariner 9 radio occultation experiment acquired 118 profiles of dayside ionospheric electron density from 1971-2. Relative to the MGS dataset, which contains the only electron density profiles for Mars that are readily available to the public today, the Mariner 9 dataset has some unique characteristics. Profiles extend to 300-400 km, thereby probing the topside ionosphere better than the MGS profiles that typically terminate around 200 km. Profiles were acquired during the waning phase of a tremendous dust storm, when the ionospheric peak was 20-30 km higher than normal. Profiles are distributed globally, whereas MGS profiles are poleward of 60 degrees north latitude, and sample solar zenith angles as low as 47 degrees, whereas MGS was limited to 71 degrees and higher. We have digitized the Mariner 9 electron density profiles from their microfilm archive. Here we report on archiving plans for these profiles. Since there have been many scientific discoveries at Mars since the last studies of these Mariner 9 data, we also present a preliminary report on scientific analysis of these profiles.

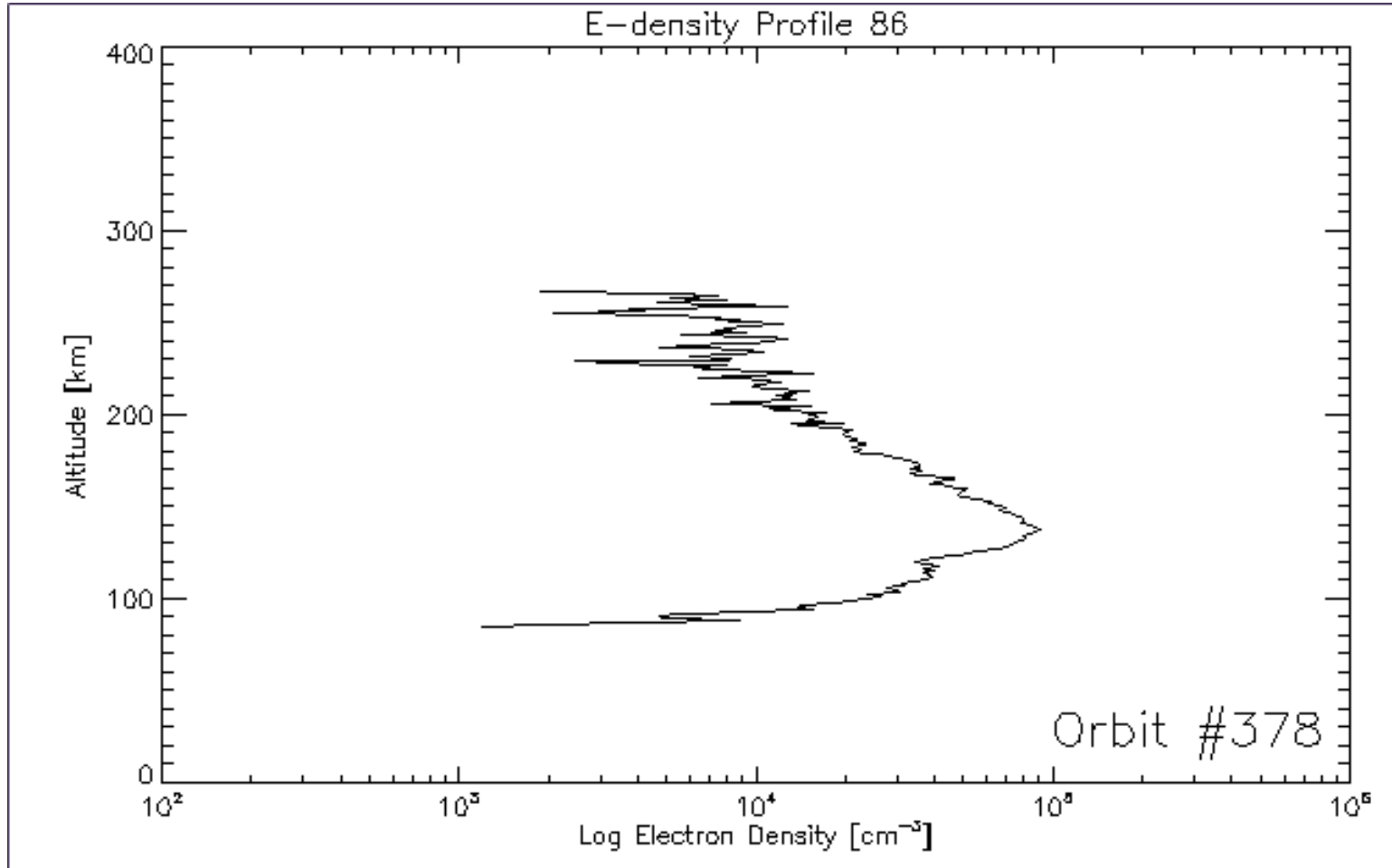
Example profile – 1

Prime mission – SZA = 51.9°, latitude = 28.7°S, longitude = 224.9°W



Example profile – 2

Extended mission – SZA = 79.2°, latitude = 82.1°N, longitude = 335.5°W



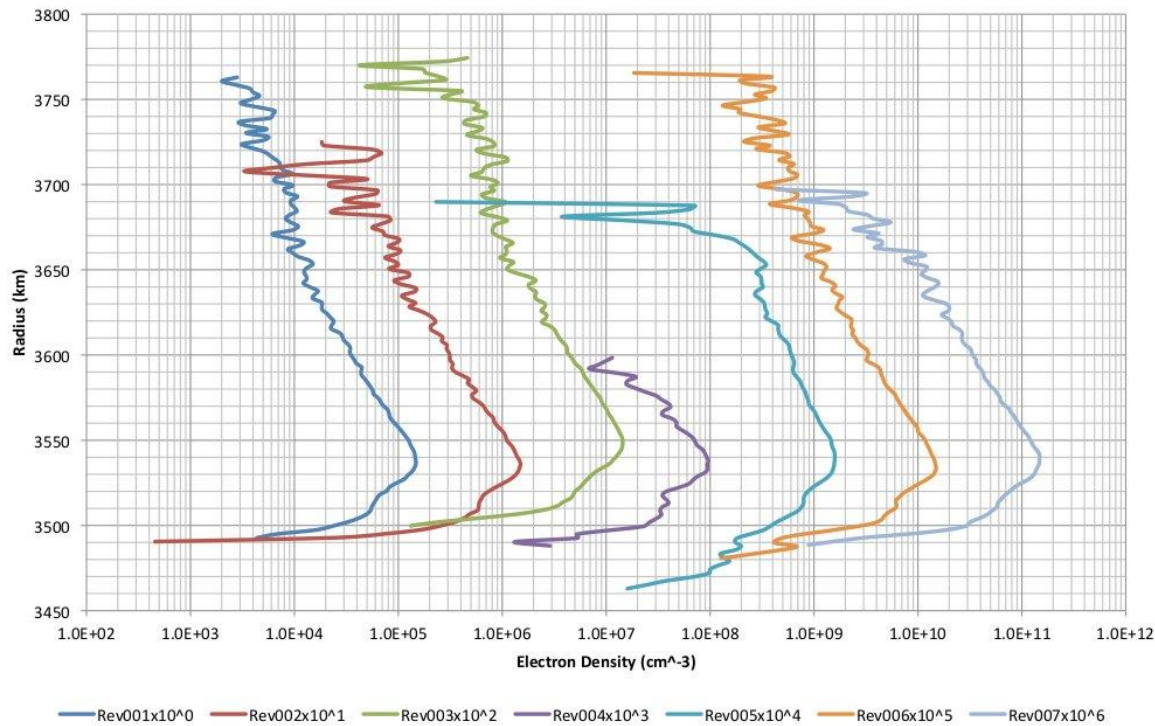
Value of Mariner 9 profiles

- High vertical extent. Profiles terminate at 300-400 km, approaching ionopause, whereas MGS profiles terminate at 200 km.
- Coverage of an immense dust storm.
- Global coverage. Almost all MGS profiles are north of 60°N , far from crustal field regions.
- Solar zenith angle (SZA) coverage. SZA down to 47° , whereas MGS has $\text{SZA} > 71^{\circ}$.

Data availability

- Published figures in several articles
- NSSDC has microfilm of printed tables of electron densities and radial distances
- We have laboriously extracted these data from digital images of the microfilm records
- Recovered profiles will be made publicly available and delivered to the PDS

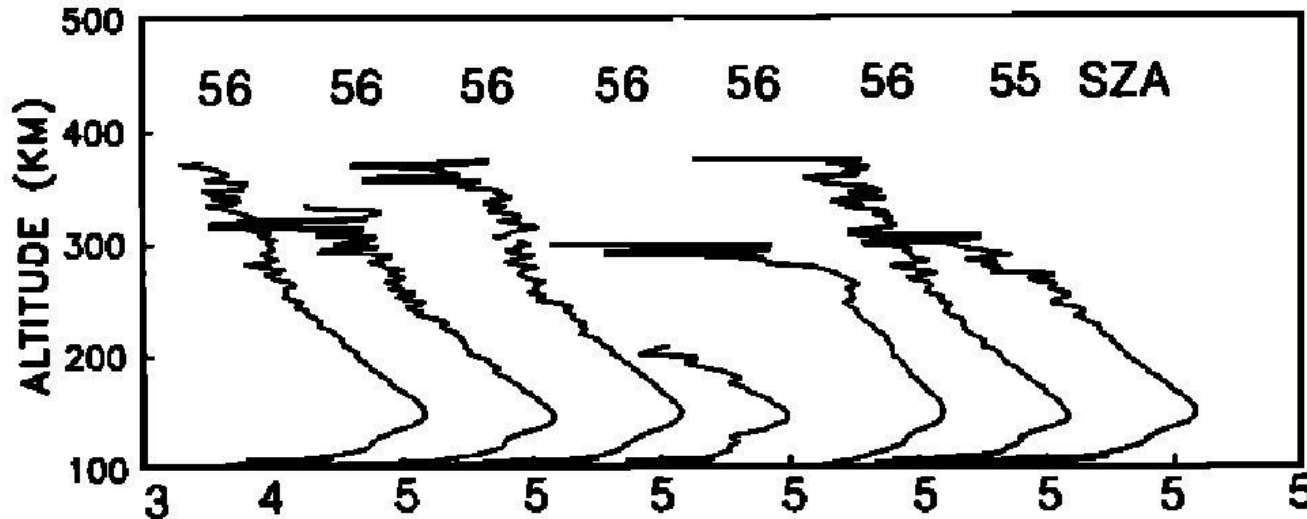
Mariner 9 Revs 1-7 Entry



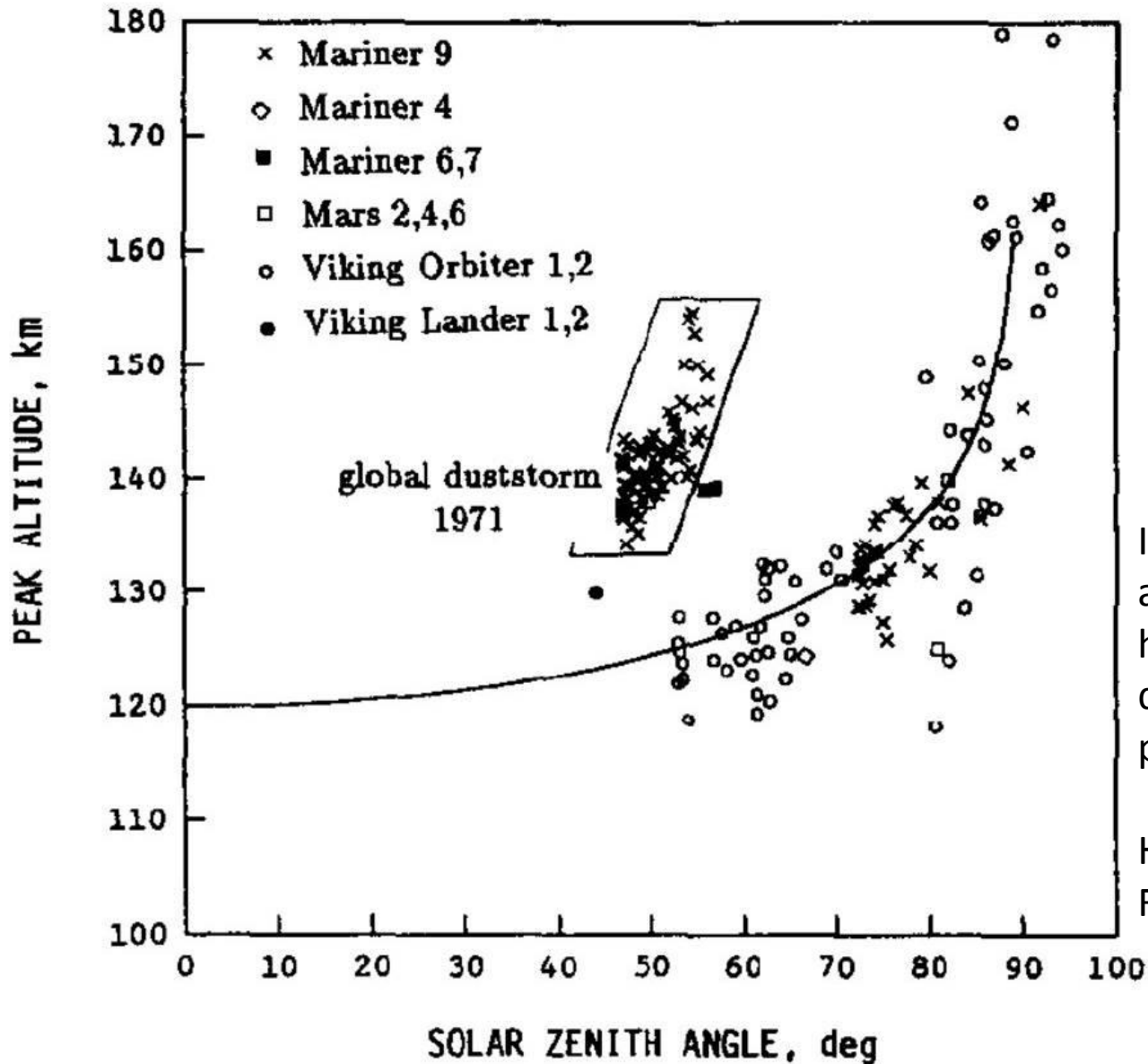
Mariner 9 profiles from
NSSDC microfilm
Orbits 1-7

Agreement with earlier
publications is excellent

MARINER 9 REVS 1-7 ENTRY



Mariner 9 profiles from
Zhang et al. (1990)
Orbits 1-7



Ionospheric peak altitudes abnormally high during immense dust storm of Mariner 9 primary mission

Hantsch and Bauer (1990) Figure 3

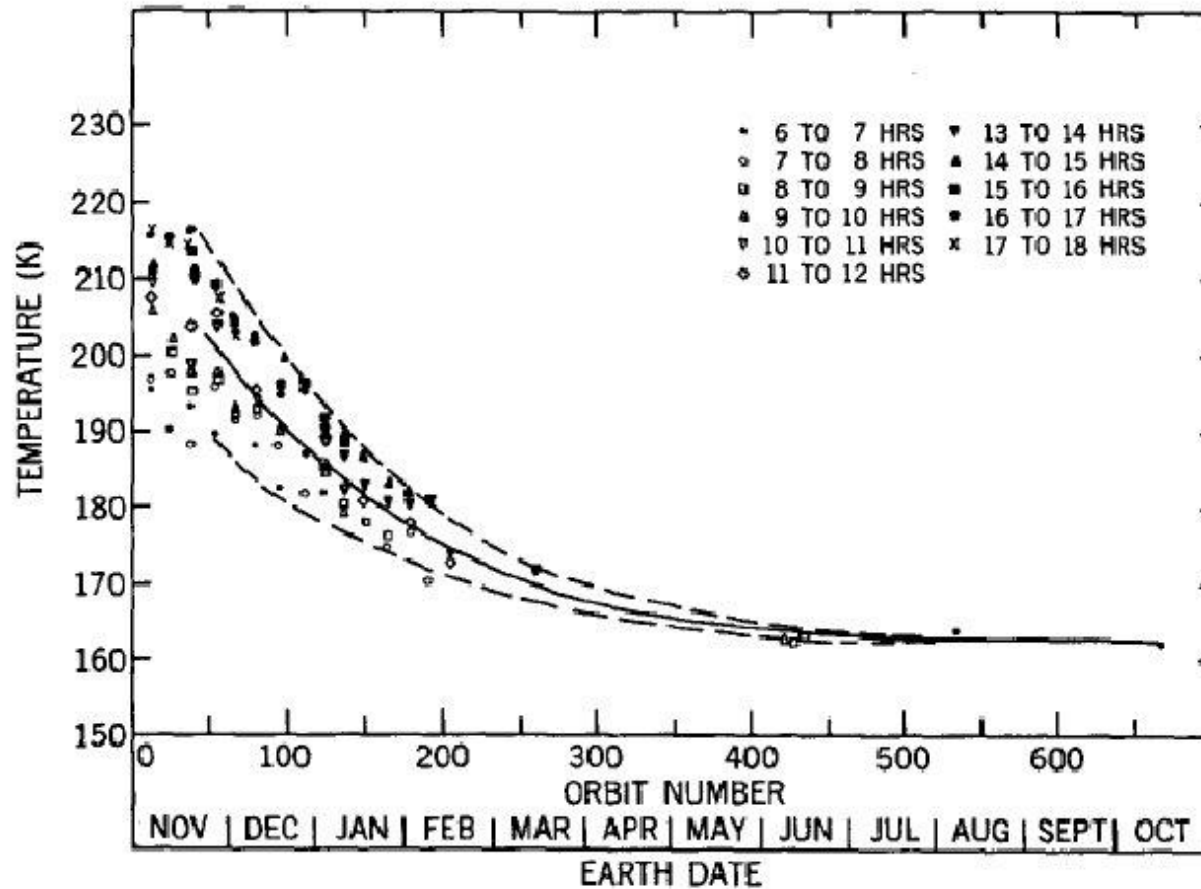
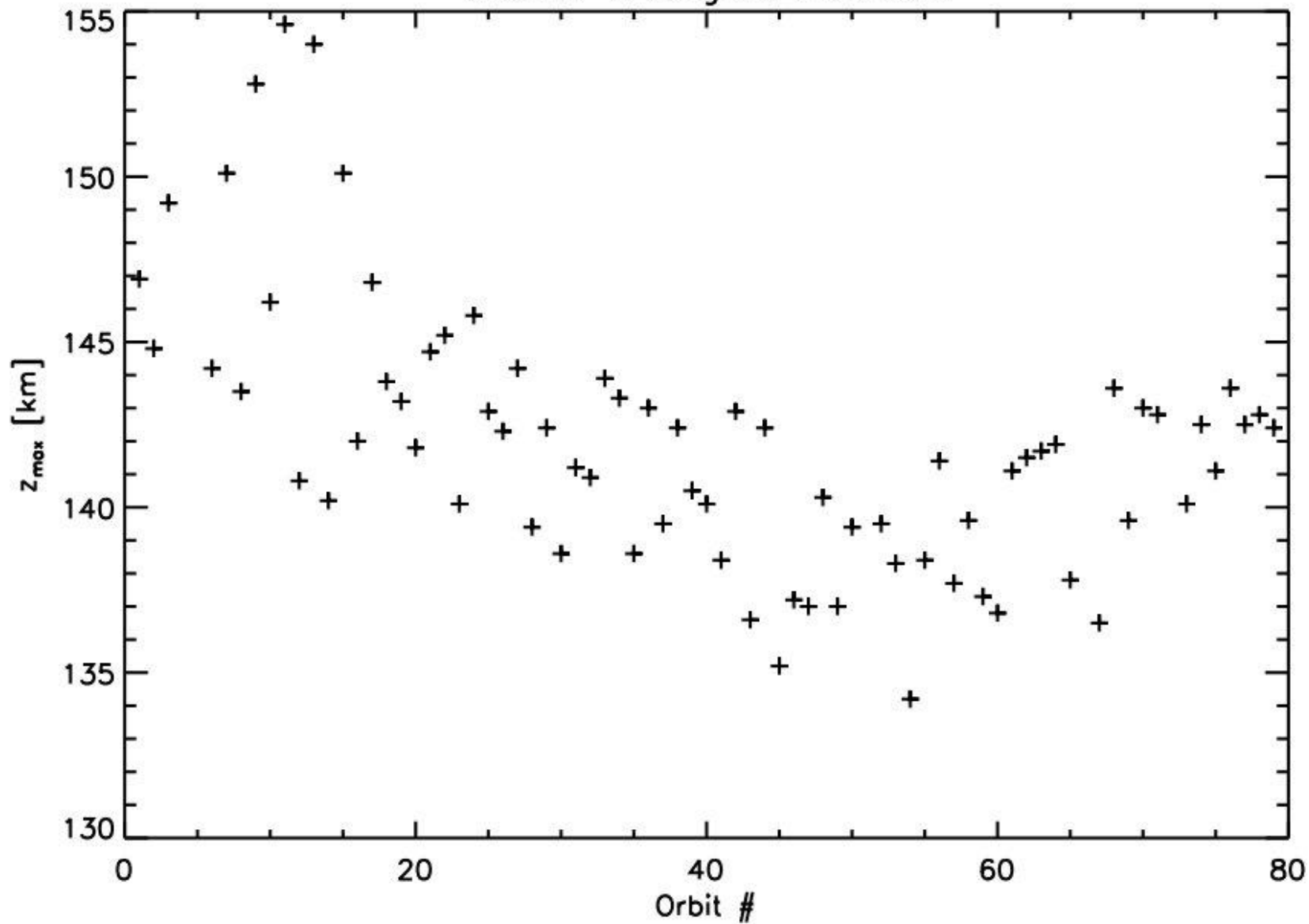


FIG. 1. Secular variation of atmospheric temperatures at the 0.3 mbar level for the latitude interval -20° to -30° . The abscissa is Mariner 9 orbit number with the corresponding Earth date also shown. Data points prior to orbit 210 represent averages over approximately 6 days while data points after orbit 210 represent individual measurements. The data have been organized by Martian local time as indicated in the key to the various symbols. The solid line represents the mean temperature and the broken lines the limits of the diurnal excursion calculated using a heating model described in the text.

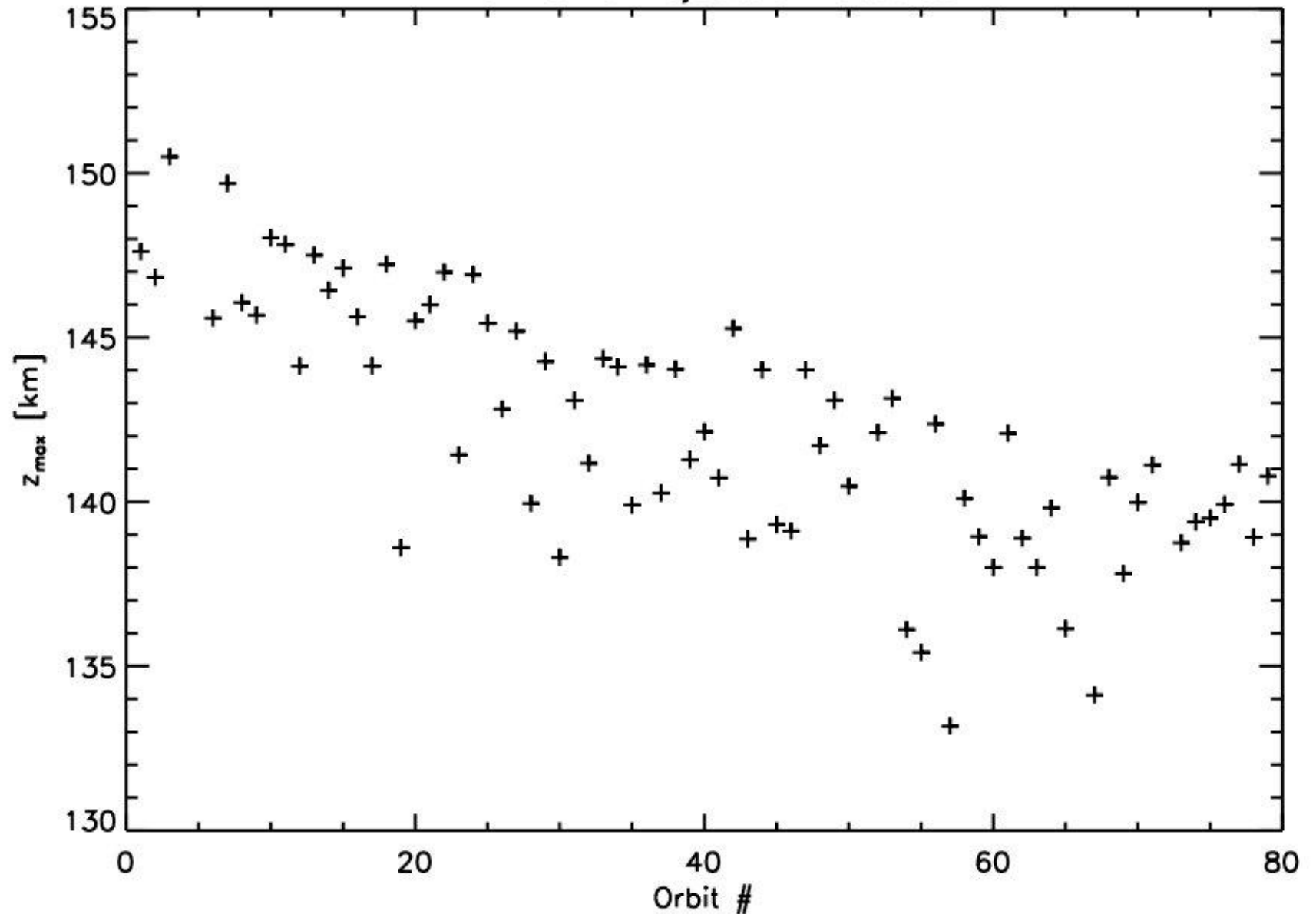
Atmospheric temperatures at 0.3 mbar ($20^{\circ}\text{S} - 30^{\circ}\text{S}$) recorded by Mariner 9 IRIS
 Conrath (1975) Figure 1 show the decline of the dust storm

Mariner 9 Original Altitudes



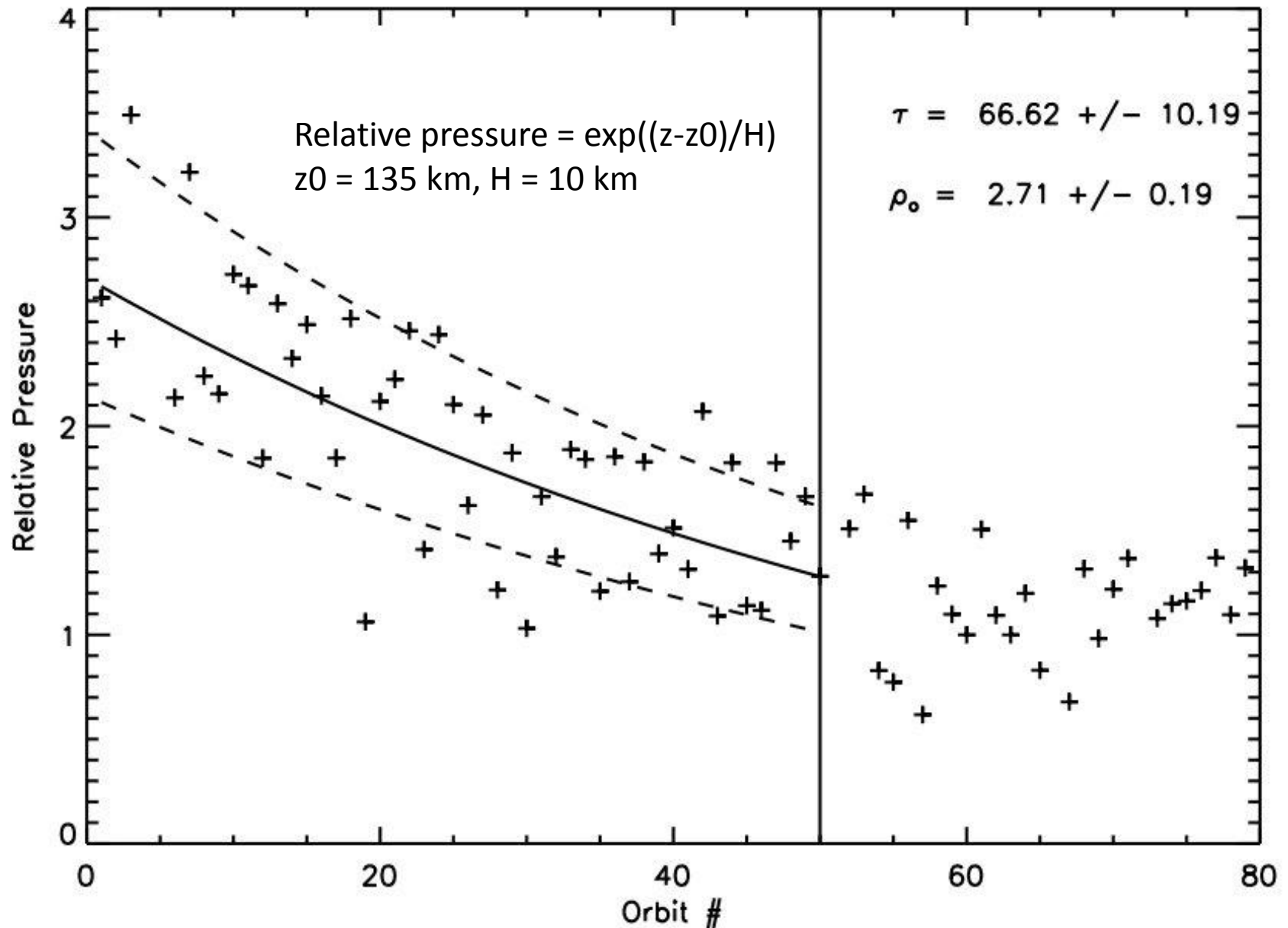
Peak altitudes were listed by Mariner 9 experimenters, but Mars geodesy has improved since Original altitudes are misleading

Mariner 9 Adjusted Altitudes



Adjusting to a better reference surface for altitude more clearly shows the decline in peak altitude with time that occurred during the waning of this dust storm

Mariner 9 Dust Storm

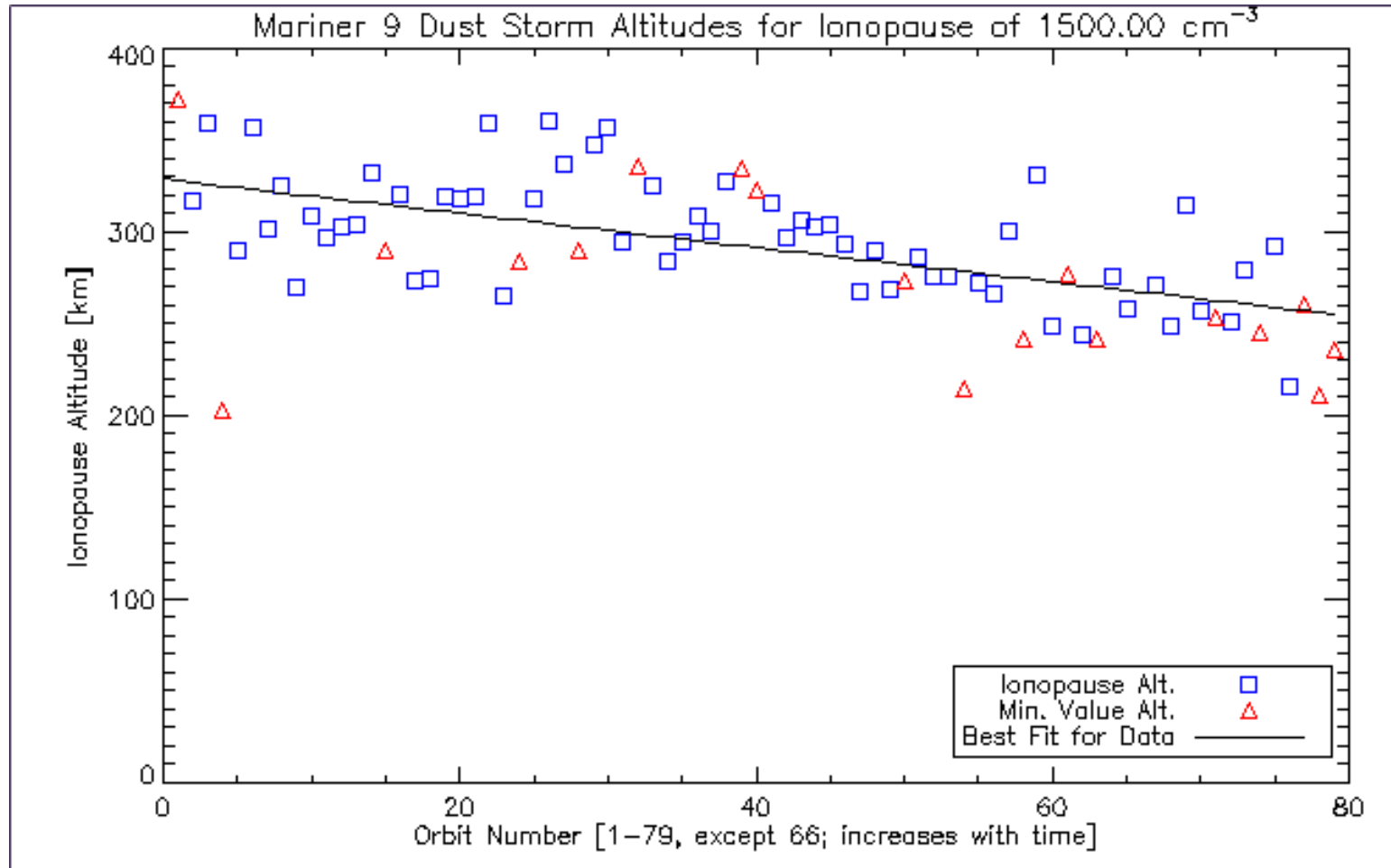


The pressure at a fixed thermospheric altitude decays exponentially

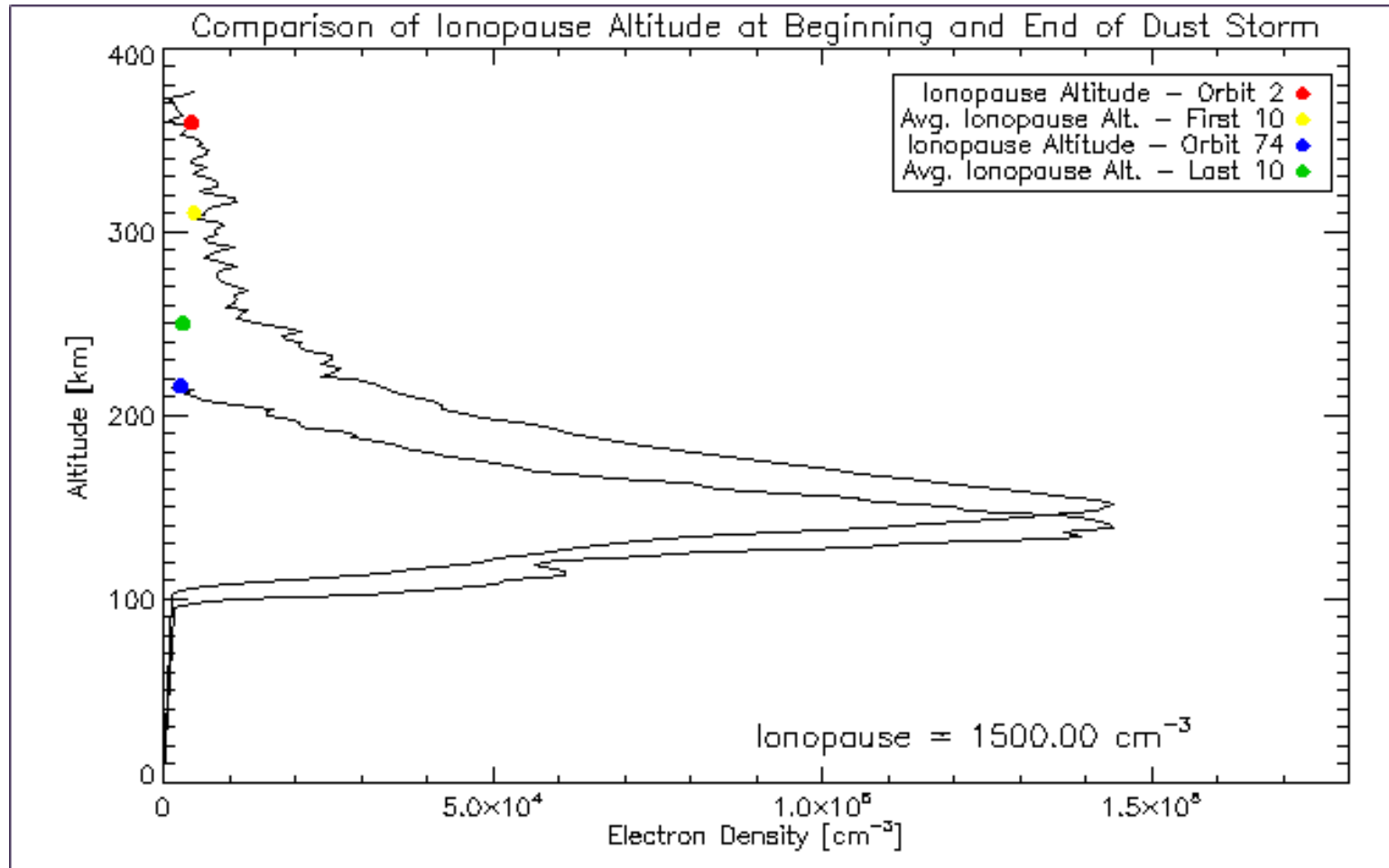
Timescale is 66.62 orbits or 33 days, and pressure is 2.71x larger at orbit 1 than at orbit 80

Ionopause affected by dust storm

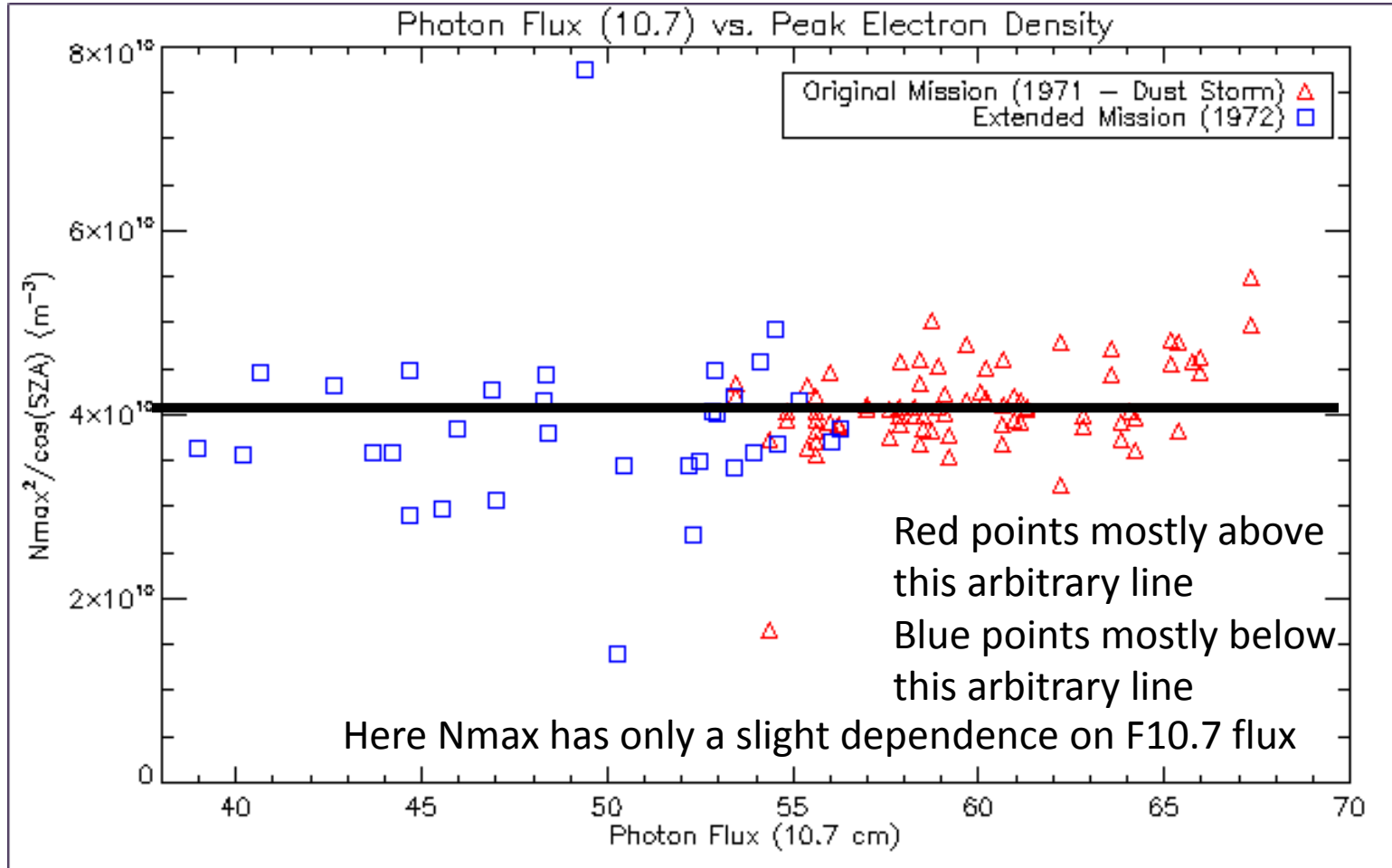
Altitude at which $N=1500 \text{ cm}^{-3}$ decreases by $\sim 80 \text{ km}$ as dust storm wanes

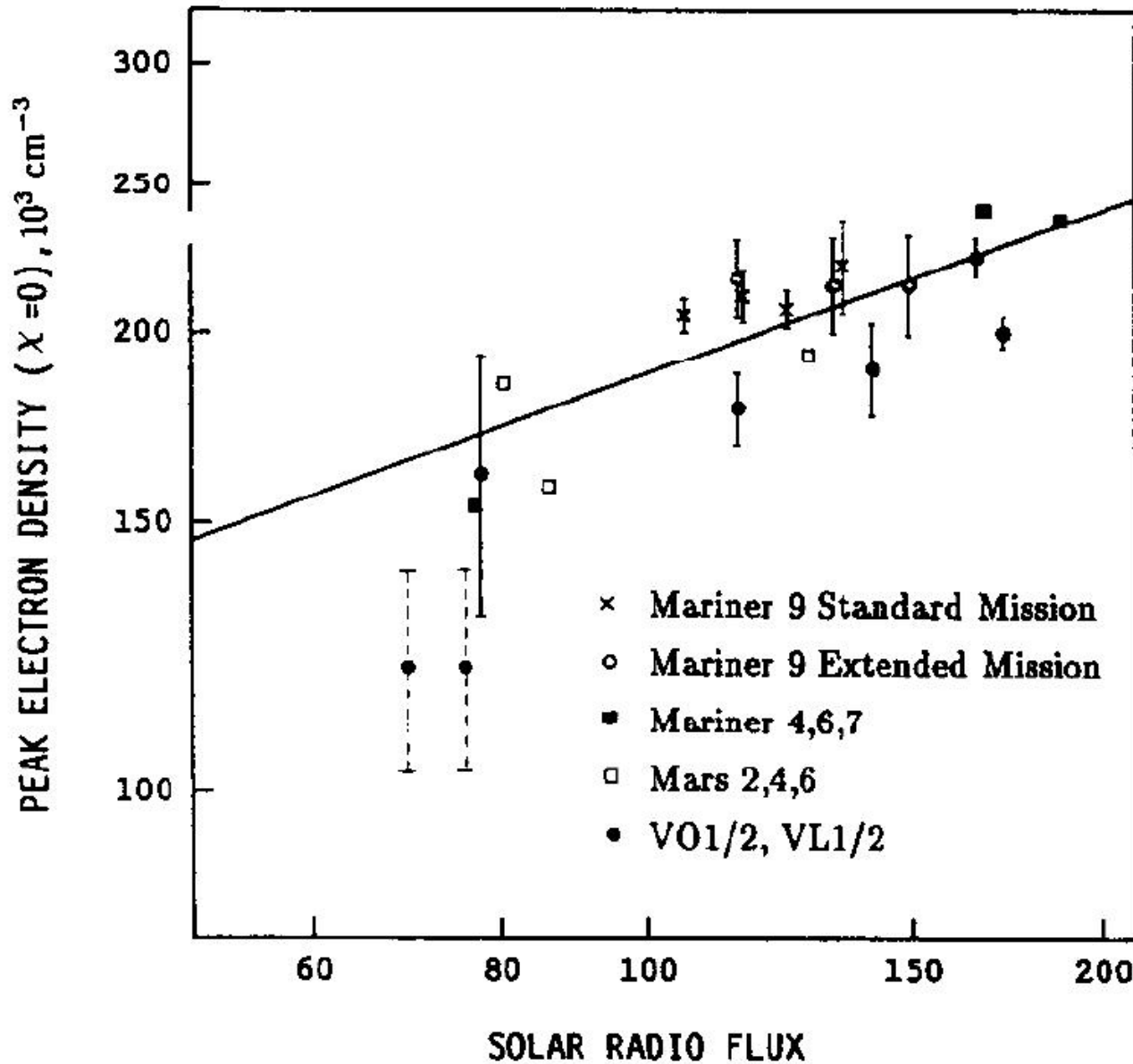


Changes in ionopause altitude



Peak density insensitive to F10.7





Weak dependence of N_{max} on F10.7 for Mariner 9 observations is consistent with previous workers

Hantsch and Bauer (1990)
Figure 4

Conclusions

- 114 Mariner 9 electron density profiles have been recovered
- They will be available soon and archived soon
- Lots of effects of immense dust storm, including peak altitude and ionopause altitude
- Interesting lack of dependence of N_{\max} on solar flux