A Dip in foF2 Before Sunrise

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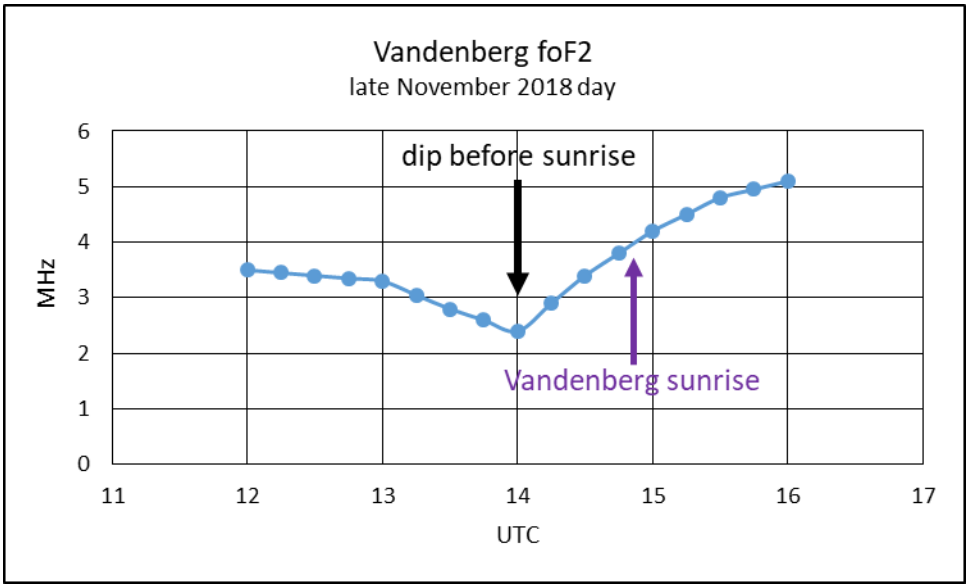
I'm active in QIN, which is the Indiana CW traffic net operating every night throughout the year at 8 PM local time on 3535 KHz. During the winter months, we can have problems with communications with other QIN participants. The reason? The MUF drops pretty low during the winter nights, and the ionosphere can't support the high angles necessary for close-in contacts (essentially NVIS – Near Vertical Incidence Skywave propagation) on 80m.

Propagation for QIN participants is probably a bit worse at solar minimum – where we are now. Our plan of action for nights when we can't hold the net on 80m is to switch to a predetermined frequency on 160m. We can even get a good idea of how 80m will be by monitoring the ionosonde at Alpena, Michigan right before the net is held. Although Alpena is farther north than Indiana, we can correct for our more southerly latitude, and then correct for typical path lengths on QIN.

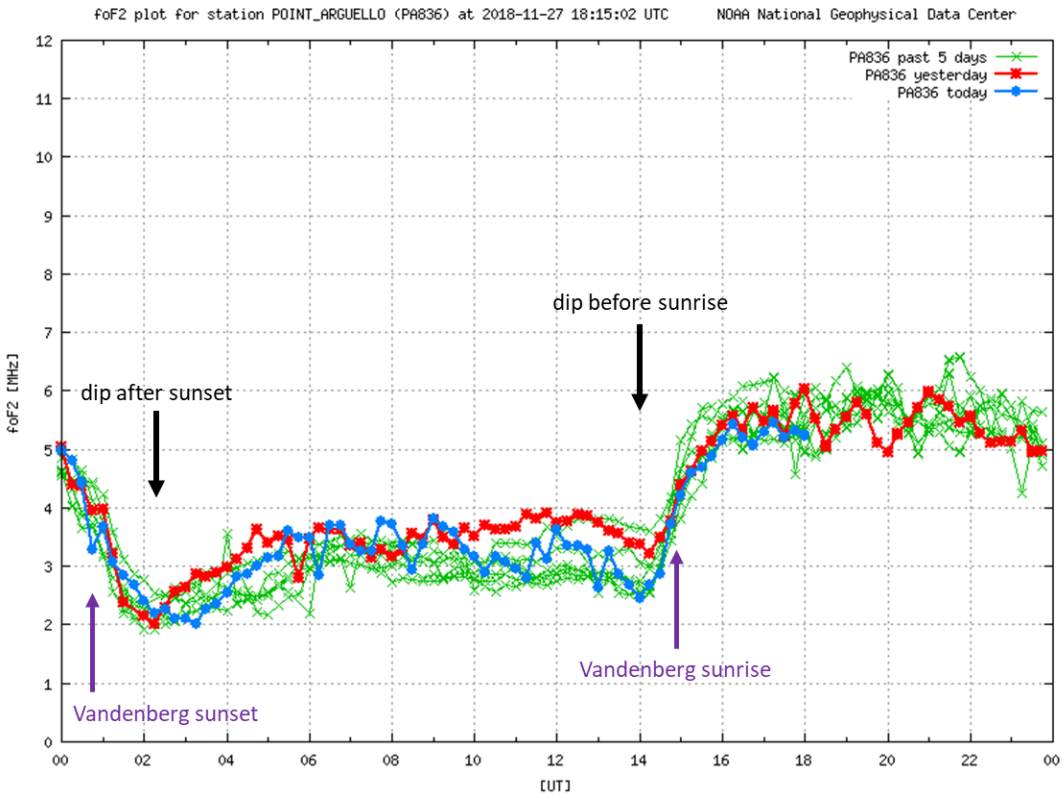
Tied to my experiences on 80m is an e-mail I received from a West Coast ham last November about his experiences with regional contacts on 80m before sunrise (my experiences with QIN are well after sunset). He looked at data from the Vandenberg ionosonde (a.k.a. Point Arguello), right before sunrise on one day. This is what foF2 (the F2 region ordinary-wave critical frequency) looked like.



Two observations are obvious. One, the high-angle MUF [note 1] for several hours before sunrise is at or below 3.5 MHz – communication could be tough with close-in stations on 80m. Two, there is a pronounced dip in foF2 before sunrise. What's causing this dip?

Several wild ideas came to mind (!), but I decided to take a "bigger picture" look at this. Was it just one day in November? Or did it show up every day?

So I looked at the Vandenberg ionosonde data for November 27 (blue data points). Included in the plot was data for the previous day (red data points) and the past five days (many green data points).



This is interesting. There are two consistent dips – one shortly after sunset and one shortly before sunrise. It was time to consult someone more knowledgeable in this area. So I contacted Phil W1PJE. He is an assistant director and head of the Atmospheric and Geospace Sciences group at Haystack Observatory in Massachusetts, operated by MIT (Massachusetts Institute of Technology).

He immediately pointed me to a couple papers to read. One was titled "*Midlatitude nighttime enhancement in F region electron density from global COSMIC measurements under solar minimum winter condition*" [note 2]. The title kind of says it all. There is an enhancement in the F2 region electron density during nighttime in winter at solar minimum. "During nighttime in winter at solar minimum" sure fits the bill here for the measurements in the plot above.

What's really happening is after the sunset the F2 region starts decreasing to a very low value. But it doesn't get to its normal low value because there is an enhancement that starts somewhat after sunset. This enhancement gradually increases during the night, then starts to decrease somewhat before sunrise. The enhancement decreases enough to see the rise before sunrise from the normal very low value. The result is two dips in foF2.

There are many more papers on this interesting phenomenon. The referenced paper suggests the enhancement is a balance between downward plasma flux and recombination. It's interesting to think how this enhancement could affect propagation during winter nights at solar minimum. For one, it could keep 40m open during the night for close-in QSOs.

As a final note, the word COSMIC in the title of the referenced paper refers to the Constellation Observing System for Meteorology, Ionosphere, and Climate satellites.

Notes

1. For propagation at very high angles, the MUF (maximum useable frequency) is for all intents and purposes equal to foF2.

2. Xiaoli Luan, Wenbin Wang, Alan Burns, Stanley C. Solomon and Jiuhou Lei, **Journal of Geophysical Research**, Vol. 113, A09319, doi:10.1029/2008JA013063, 2008