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REPLY

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The comment by Taylor et al. [this issue] is the latest in a series of criticisms on the interpretation of the VLF signals seen at low altitudes in the dark Venus ionosphere as due to lightning. These comments have not provided convincing evidence that the lightning interpretation is incorrect. In particular, in the present comment the authors are mistaken in their assertion that there is no altitude falloff of the 100-Hz signals, that there is no planetographic association and that a linear conducting region could not "hang up" interplanetary field lines. Moreover, the authors propose no mechanism which explains the observed properties of the waves nor any evidence for solar wind control of the observed emissions.

The data shown in Figure 1 of the comment by Taylor et al. [this issue] clearly show the altitude dependence reported by Scarf et al. [1987]. Inspection of the inset of Figure 1 shows the "event curves" to be well above the "dwell time curve" from 160 to 250 km, and below the dwell time curve at higher altitudes. The curves would not cross unless there were a significant altitude variation in event occurrence rate. This result was also found by Russell et al. [1988a] in an independent study of rates of occurrence of these signals normalized by the precise observing intervals and not approximately as done here. Furthermore, Figure 1 of Scarf et al. [1987] clearly shows the altitude falloff because once periapsis altitude ceased being controlled and the altitude rose, the event rate decreased sharply.

The omission of data below 150 km by Scarf et al. [1987] was the proper course of action. As shown by Russell et al. [1988a] there are very few data below 150 km. These lowest-altitude data are not distributed uniformly over the surface of Venus. Thus Scarf et al. [1987] wisely and properly omitted these data which could be misleading. Further, Scarf et al. [1987] did not dismiss the need for a rigorous study but referred the reader to a study in progress that has now been published [Russell et al., 1988a].

The fact that the season 8 events which constituted the linear feature in Aphrodite were mainly (but not solely) from two passes is an important point, and we thank the authors for bringing this to our attention. In our mind, as theirs, this calls into question the need to invoke any linear conducting region. However, we cannot rule out such an explanation for these events based on the calculation of expected decay times. Lava has a low electrical conductivity compared to iron. A long iron deposit only 100 m across with a conductivity of 10^7 mhos/m [Hodgman, 1974] would "hang up" an applied magnetic field for over a day. One could choose much weaker conductivities or small dimensions and still obtain diffusion times of the order of minutes, which is long enough to be consistent with the satellite observations. This explanation was not a major conclusion of Scarf et al. [1987], and they referred to it as "speculative."

The authors claim that the 100-Hz signals have no correlation with planetary coordinates. This point has been discussed at length in other publications. In particular, we have shown that VLF signals seen when PVO was below 300 km occur more frequently over specific planetographic regions. These higher occurrence rates show some persistence from observing season to observing season [Russell et al., 1988b]. However, it is possible that the strong local time variation present in the data [Russell et al., 1988c; 1989a] together with the limited number of observing seasons is responsible for causing an apparent planetographic correlation. There are not enough data unambiguously to either prove or rule out a planetographic effect. The presence or absence of a correlation with planetary coordinates has no implications for existence or absence of lightning on Venus. Such a correlation would have implications only for the source mechanism for the lightning.

The authors also claim that they have shown that 100-Hz signals occur exclusively in ducts. This too has been answered before. Scarf [1986] showed specific examples of signals outside of ducts and ducts without VLF signals. Russell et al. [1989b] showed statistically that the ducts (as identified by strong magnetic fields) had a distinctly different distribution than the 100-Hz bursts. Moreover, when VLF signals do occur with low-altitude troughs they occur more or less at random in the duct and not at the edges. Moreover, the waves are electromagnetic, and not electrostatic, as clearly demonstrated by published polarization diagrams [Scarf and Russell, 1988].

In short, the authors present no convincing evidence against the interpretation of the 100-Hz bursts seen in the dark ionosphere of Venus as being caused by lightning in the atmosphere, and they show no evidence for their claim that the 100-Hz noise "will be encountered variably from nightside season to season, dependent upon the prevailing characteristics of the solar wind and IMF at that time." In fact, the evidence is overwhelmingly in favor of this interpretation, from the detection of the expected electromagnetic signals on all four Venera 11, 12, 13 and 14 landers [Ksanfomaliti, 1979, 1983] to the local time distribution of the VLF bursts [Russell et al., 1989a,b]. On the other hand, the evidence for a linear highly conducting feature on the planet is weak. The original paper referred to the model as "very speculative" and said that the result was "basically unexplained." The analysis of Taylor et al. [this issue] only reemphasizes

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the speculative nature of the explanation and lessens the need to explain it.

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