INTERACTIONS BETWEEN MICROWAVE POWER TRANSMISSIONS FROM A SOLAR POWER STATION AND THE IONOSPHERE-ATMOSPHERE SYSTEM

Rietveld Michael
Heating Division,EISCAT, Ramfjordmoen, TromsÃ¸ Norway 9027

ABSTRACT

Because the microwave frequencies (2.45 or 5.8 GHz are commonly suggested) used to transfer energy from the solar power station to the ground are typically several hundred times greater than the ionospheric plasma frequency, one would expect the interaction to be minimal. Ionospheric scintillation could, however, be a disturbing effect on the beam. For large enough electric field strength some non-linear effects can occur, the most important of which are expected to be Ohmic heating of the D and E regions, and non-linear plasma wave excitation in the E and F regions through three-wave interactions and the ponderomotive force. Such interactions with the plasma must extract energy from the high-power beam and lead to electron heating in the ionosphere and the excitation of electron density irregularities which may affect propagation of the beam itself as well as other radio waves over a wider range of frequencies. It has been estimated that the ionospheric heating effects of a microwave beam from a 10 GW power station in geosynchronous orbit are similar to those of a MW-class ground-based HF heating facility. Such heating and irregularity generation using powerful HF pump waves has been studied extensively worldwide for several decades now and may help answer some of the questions raised by the proposed microwave transmissions. The electron temperature may increase by an order of magnitude in the lower ionosphere during such HF wave injections, which has been verified indirectly through a number of ground-based experiments. But how relevant these HF results are to microwave transmissions is not completely clear and requires further theoretical and especially experimental research.

Atmospheric effects on the microwave beam may include attenuation through the atmosphere and rain, depending on frequency. There are theoretical ideas that powerful microwaves in the stratosphere could damage the ozone layer, but other studies suggest that they would produce an artificial ozone layer. The relevance of these ideas to transmissions from a solar power station will be discussed.

The expected effects of powerful microwave beams on the ionosphere and atmosphere are summarised. Many theoretical studies were made in the nineteen seventies and eighties, but few experimental results exist. In one of the few experiments performed, plasma wave excitations in the ionosphere were associated with 2.45 GHz transmissions from the mother rocket in a mother-daughter rocket experiment in 1983. An overview of the expected interactions based on the theoretical and experimental studies, and directions for future research are presented.