TRADE STUDIES FOR OFFSET REFLECTORS WITH APPLICATIONS FOR CONICAL SCANNING RADIOMETERS

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ABSTRACT

The future National Polar-orbiting Environmental Satellite System (NPOESS) Microwave Imager/Sounder (MIS), a space-borne conical scanning radiometer, uses an offset main reflector with multiple antenna feedhorns to receive upwelling microwave radiation from the Earth's surface and atmosphere. The offset reflector approach is a convenient and economic way to achieve the desired antenna footprints on the Earth. The main reflector is offset in order to keep the individual feeds out of the reflector aperture, and therefore avoid blocking incoming radiation that would distort the antenna pattern. Using multiple feeds allows the sensor to operate over a wide range of frequencies without the use of overly complex multi-band feedhorns. However, this approach requires a more complicated layout of the antenna feedhorns at the focal point of the main reflector. All of the feeds cannot be located at the focus, and the resulting antenna patterns of any off-focus feeds will be impacted.

The relationship between the resulting antenna pattern and the illumination of the reflector from each feedhorn, as well as the pattern's dependency on frequency, is examined. Some general relationships include the adverse impacts of increasing the feedhorn's electrical distance from the focus in the plane of the feed's aperture, such as irregular beam shape and lower main beam efficiency. In addition, use of multiple single frequency feedhorns require that the higher frequency feeds be located closer to the focus than lower frequency feeds. Improvements in beam shape and efficiency can be obtained by moving the feeds closer to the reflector (in a direction perpendicular to the feed aperture) but this improvement is limited. Sub-illumination of the reflector leads to larger antenna beam footprints, decrease in spillover effects, greater beam efficiency, and improved beam shape for the higher frequency feeds. However, this requires larger feeds and impacts the other frequency bands' antenna performance because they must be located further from the reflector focus. Improved spatial resolution can be achieved by increasing the electrical size of the reflector, however, sampling requirements require antenna footprints that are large enough to eliminate gaps in coverage between subsequent scans. A flatter reflector profile can decrease cross-polarization and improve beam shape but requires a longer focal length. As a result, the individual feeds require larger apertures to ensure proper illumination of the reflector.

This paper will describe the design trade space for the MIS reflector and feed geometry using metrics derived from simulation of the antenna patterns. The metrics include the footprint size, footprint shape, polarization purity, main beam efficiency, and spillover. The effects of varying the reflector diameter, aperture offset, and focal length will be examined along with variations (translation, tilt, and rotation) in

feed placement with respect to the focal point of the main reflector. And finally, the impact of the antenna feed layout on the sensor common swath width is described. Feeds located off-focus will have an antenna beam that is no longer aligned with the mechanical boresight of the antenna, impacting the common swath width for multi-frequency measurements. MIS must supply measurements for several environmental products that depend on multiple frequency bands. Accordingly, the relative placement of each antenna feed pattern must be considered over the entire scan of the sensor to determine the swath width for each MIS Environmental Data Record (EDR), which is a critical factor in the MIS sensor design.