RADAR PENETRATION IN THE AMAZONIAN RAIN FOREST

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ABSTRACT

Radar return from vegetation covered terrains is due to three components: (1) the scattering resulting from the top surface of the vegetation canopy (surface scattering); (2) the scattering which occurs within the vegetation layer (volume scattering) and (3) the scattering which takes place at the surface below the vegetation canopy (ground scattering). Through the studies of selected areas a case is presented where most of the radar return observed in radar imageries results from the scattering at the surface below the vegetation layer (ground scattering).

1. INTRODUCTION

Orbital imaging radars such as the SEASAT and the Shuttle Imaging Radar (SIR) have provided new perspectives to studies on microwave remote sensing. The availability of orbital radar data from different parts of the world, such as the Brazilian territory, has permitted to study the interaction of microwaves with ground targets at frequencies other than the existing x-band airborne radars.

The Brazilian territory has been covered by orbital imaging radars installed on board the Space Shuttle during two experiments (SIR-A, November 1981; SIR-B, October 1984).

The Shuttle Imaging Radars, SIR-A and B, are both L-band synthetic aperture radars (1.3 GHz). They were deployed at orbital altitudes around 260 km. The SIR-A has an antenna with a fixed look angle of $47^{o} \pm 3^{o}$, while the SIR-B has a variable look angle within 15 and 60 degrees. Both imaging radars present a small difference between the angle of the incidence at the near an far range. This difference is of 6 degrees which makes variations between the near and the far range of an imagery negligible as compared, for example, to airborne radars. Angle of incidence is one of the factors which determines radar return from a vegetation layer. Thus, in the analysis of imageries of the SIR-A, incidence angle within the same scene is not a major concern.

2. RADAR RETURN FROM VEGETATION

A vegetation covered terrain can be considered a layer which include a cloud of multiple scatters (e.g. MacDonald et al., 1980). When incoming radar waves reach the vegetation layer, the scattering will occur at the top surface of the vegetation layer, within the layer and at the surface below the vegetation canopy. Consequently, radar return or backscattering from vegetation covered terrains will consist of

$$\sigma_T^o = \sigma_s^o + \sigma_v^o + \sigma_g^o ,$$

where

σ_T^o = is the total radar return of backscattering observed in the radar imagery,

σ_s^o = is the surface scattering component and results from the interaction of the radar waves with the top surface of the vegetation,

σ_v^o = is the volume scattering componentand results from the radar interaction with the vegetation canopy as a layer,

σ_g^o = is the ground component and corresponds to the scattering which occurs at the surface below the vegetation layer.

3. DISCUSSION

The total radar return os backscattering from vegetation covered terrains includes surface scattering (σ_s), volume scattering (σ_v) and ground scattering component (σ_g). The degree of contribution from each of these components in the total radar return will depend on radar frequency, incidence angle, radar polarization which are radar system parameters therefore controllable. Other factors which dictate surface, volume or ground scattering are the complex dielectric constant of the canopy, the structure (leaves, stalks, trunks, etc) and the height of the canopy, the surface roughness and the moisture. All these factors will determine radar penetration through the vegetation canopy and attenuation and, as a result of this, the degree of participation of the surface, volume and ground scattering in the total radar return. The case presented in this paper suggests that a great part of the total radar return is due to the surface below the canopy (ground scattering).

The SIR-A, as mentioned previously, is a L-band radar, and at these frequencies (1.3 GHz) radar penetration through the vegetation is of the order of several meters (e.g. Ulaby et al., 1982).

During the analysis of SIR-A imageries (Ford and Cunha, 1985) over the Amazon region, it was observed that some areas displayed very high return. These bright areas are part of a drainage network, and include relatively broad flood plains which in turn are covered by a dense vegetation canopy. Field check (January, 1985) of selected areas which display bright response on radar imagery has shown the following characteristics: broad flood plains with dense vegetation; ground surface covered by a water layer as the result of the annual floods (November - January). The standing water in those swampy areas in terms of radaris a perfectly smooth surface, thus a highly reflecting surface. Consequently, radar penetration through the vegetation layer reaches the water where multiple reflections occur and this results in a reinforcement of the total radar return. Compared with other vegetation covered areas but without a water layer, radar return is much smaller than vegetation covered terrains with standing water below the canopy. Therefore, the strong return observed in the radar imageries indicates a higher contribution due to the ground surface below the canopy (ground scattering).

4. REFERENCES

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