Much of the following has been extracted from a prototype Polarimetric Tutorial developed by MacDonald Dettwiler and Associates and RADARSAT International under contract to the Canadian Space Agency (No. 9F028-0-4902/06) as part of the Earth Observation Applications Development Program

Polarization Response Plots

When both the amplitude and the phase information are available, it is possible to synthesize the polarization response for all the polarization states. To synthesize the response, phase information and two orthogonal (transmit and receive) polarization states are required. For example, most spaceborne SAR's (e.g. RADARSAT-2) use the HH and VV polarization configuration to satisfy the orthoganality condition. Three dimensional polarization response plots are typically used to illustrate the polarimetry response for a given target. The following conventions are commonly used **(Figure 6)**:

- The radar response is normalized between 0 and 1
- The horizontal axes are the ellipticity angle (χ) and the orientation angle (ø)
- The ellipticity angle ranges between -45° (right circularly polarized) and +45° (left circularly polarized). When (χ) = 0°, we have linear polarization
- The orientation angle (ø) is usually defined between -90° and +90°, but is sometimes defined between 0° and +180°

The polarization response from a number of simple scatterers (such as a sphere, dihedral corner reflector, trihedral corner reflector, and a short, thin cylinder) are well known (Ulaby and Elachi, 1990). The co-polarization and cross-polarization response for a sphere are shown in **Figure 6**. The maximum for the co-polarized response occurs for a 0° ellipticity angle, and is independent of the orientation angle. In contrast, the cross-polarized response is opposite to the co-polarized response, with the maximum response occurring for a ± 45° ellipticity angle, and once again independent of orientation angle. Note the following for (χ) = 0° : (1) ø = -90 or +90 corresponds to horizontal polarization, and (2) ø = 0 corresponds to vertical polarization.

The co-polarized and the cross-polarized response for a dihedral corner reflector is shown in **Figure 7**. The dihedral co-polarized and cross-polarized response is characterized by two maximums/minimums occurring for 0° ellipticity angle, and ± 45° orientation angle. The striking difference in the two responses is due to the extra reflection in the dihedral response that introduces an additional +180° phase shift (compared to the sphere).

The pedistal height (**Figure 8**) can be observed in the co-polarization response plots as the extent that the limits of response plots (± 45º ellipticity angle) rise above or below a normalized σ-value of 0 or 1. It can be noted that as the surface roughness increases, the pedestal height is higher on the graph. The pedestal height indicates the extent of depolarization.

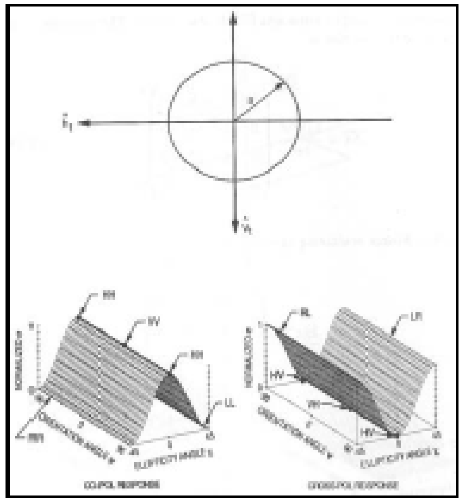

Fig. 6. The co-polarization and cross-polarization response for a sphere *(after Ulaby and Elachi, 1990).*

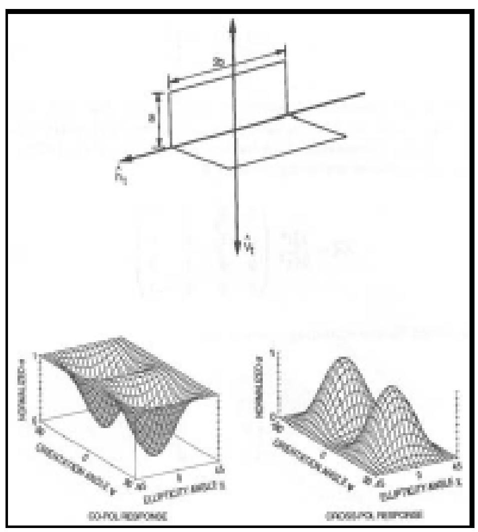

Fig. 7. The co-polarization and cross-polarization response for a dihedral *(after Ulaby and Elachi, 1990).*

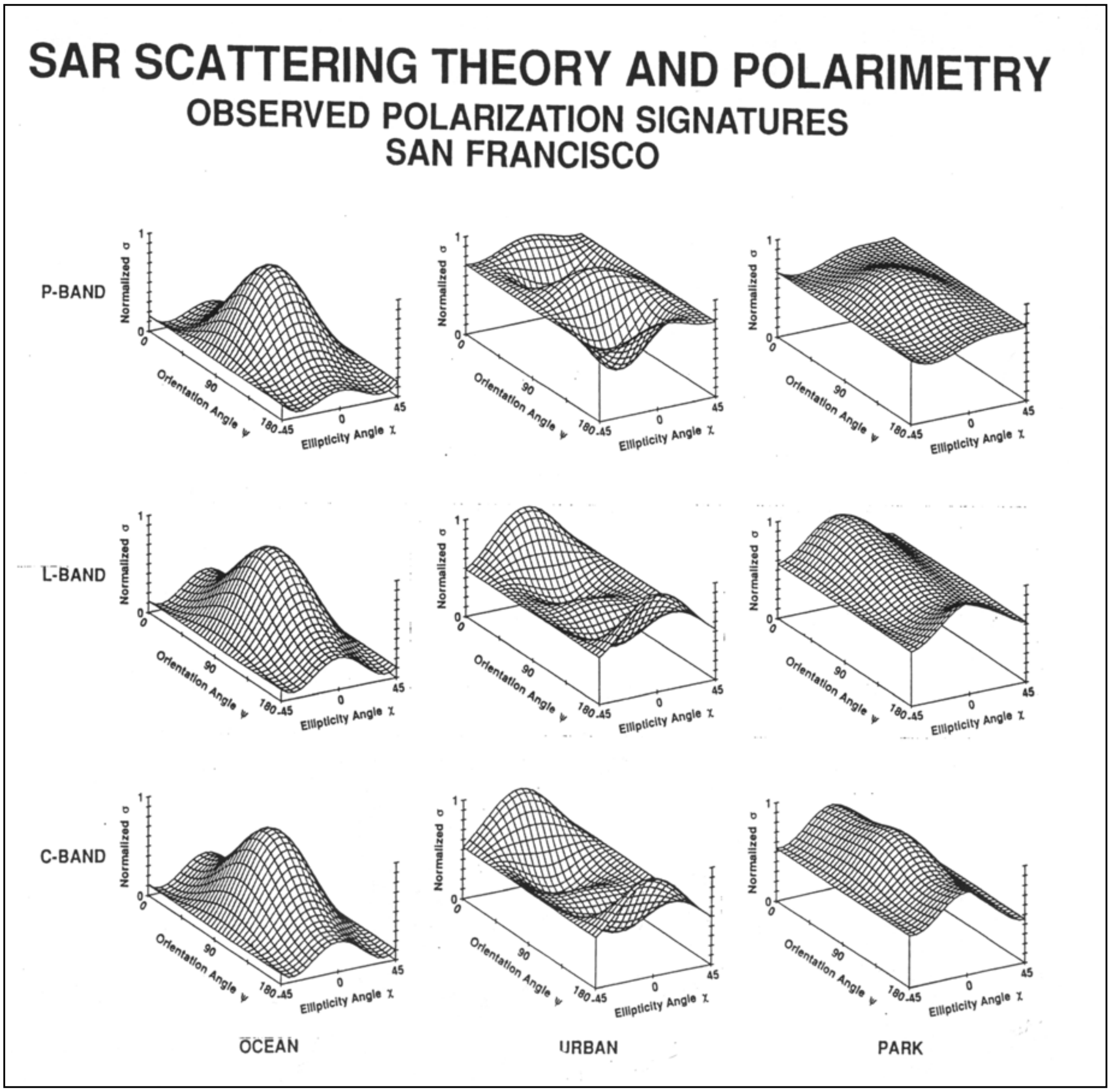

Figure 8: Polarimetric Response Plots (courtesy JPL)