EE/GP140 - Homework Set No 7

Handout 34

Due: Friday, Feb. 29
In class or to TA or in box outside my office

1. In class we began to evaluate a radar scattering model of vegetation. We identified 3 scattering mechanisms and their relative intensities to various radar wavelengths and polarizations, as follows:

	L-HH	L-HV	C-HH	C-HV
Mechanism (1) grass	1	0	5	3
Mechanism (2) corner reflection	10	0	10	0
Mechanism (3) volume scatter	3	3	5	5

We also defined for one field the following percentage of each mehcanism:

(1) grass	90 %
(2) corner reflection	1 %
(3) volume scatter	9 %

(a) Calculate the expected cross-section at all four radar wavelengths and polarization combinations, as we did in class for L-HH.

(b) For a second field, with the following contributions from each of the mechanisms, calculate the four cross-sections

(1) grass	60 %
(2) corner reflection	5 %
(3) volume scatter	35 %

(c) What is the ratio $\frac{\text{cross-section of field 2}}{\text{cross-section of field 1}}$ for each polarization/wavelength combination? Which would you choose to best discriminate these two fields?

2. Let's suppose that biomass density is related to the observable parts of the vegetation as follows.

Plant part	Relative biomass density
grass	1
trunks	100
canopy	5

Then the relative biomass for field 1 is

grass:	$90\% \times 1 =$	0.90
trunks:	$1\% \times 100 =$	1.00
canopy:	$9\% \times 5 =$	0.45
Total		2.35

(a) What is the relative biomass for field 2?

(b) What is the ratio of biomass for field 2 to that of field 1?

(c) Which of the previous wavelength/polarization combinations have a ratio closest to the biomass ratio?

(d) Could the ratio found by this wavelength/polarization (prob (c)) be an approximate measure of relative biomass? How accurate would it be?

3. Assume the same scattering model calculations we have been using, but say we have only 3 channels, L-HH, C-HH, and C-HV:

	L-HH	C-HH	C-HV
Mechanism (1) grass	1	5	3
Mechanism (2) corner reflection	10	10	0
Mechanism (3) volume scatter	3	5	5

For the following 3 fields, invert the measurements to find the relative proportions of each mechanism

	L-HH	C-HH	C-HV
Field 1	1.65	5.25	3.05
Field 2	2.70	5.50	3.50
Field 3	1.68	5.20	3.20

Hint: Set up a system of simultaneous eqautions relating the field mechanism proportions to the measurements, and solve these either by matrix inversion or by direct elimination of variables. See me about any difficulties with the mathematical steps. Use the following matrix form:

$$Ax = y$$

where A is a 3 by 3 matrix giving mechanism powers, and x and y are relative proportion and measurement vectors respectively.

$$\begin{pmatrix} 1 & 10 & 3 \\ 5 & 10 & 5 \\ 3 & 0 & 5 \end{pmatrix} \begin{pmatrix} amt.of(1) \\ amt.of(2) \\ amt.of(3) \end{pmatrix} = \begin{pmatrix} LHH \\ CHH \\ CHV \end{pmatrix}$$

↑	↑	↑
known from model mechanism	find this vector	known from measurements

4. Using Matlab, read in the three files entitled harvardforest1200.lhh, harvardforest1200.lhv, and harvardforest1200.chh. These are images of an East-coast deciduous forest that has been studied by a team at Harvard University. Each image has lines 1200 pixels in length, with wavelengths and polarizations as indicated by the file suffixes.

   (a) Create a three-color image of the region and make sure you can see several terrain types: a lake, an agricultural area, some buildings, and the forested area. Submit this image.

   (b) Using a method similar to that you used in problem 3 above, create a set of output images depicting each of the three scattering mechanisms- single bounce, corner reflector, and volume scattering. Use the grayscale colormap to display these as black and white images. Submit each of these three images.

   (c) Which areas of the image are dominated by single bounce scattering? Where does volume scattering dominate?