ATMO 489
Radar Meteorology

Laboratory #3 (55 points)
09/18/06
Part I: Radar System Characteristics
Part II: Interrogating ADRAD Radar Data

Due: By beginning of next lab session

Part I: Radar Characteristics (30 points)

1. (5 points) *Dynamic Range of a Receiver*: Radar receivers are designed to function over a range of powers. The minimum detectable signal (MDS) is the smallest power that can be detectable above the noise produced by the radar system itself. As the power going into a receiver increases, the output power increases, up to a point. If the input power is increased above some level, the receiver cannot put out any more power and it is said to be saturated (i.e., reaches the saturation power).

a. (3 points) The MDS of a radar receiver is -112 dBm. What is the minimum received power (p_{min}) in mW?

b. (2 points) If the saturation power (P_{sat}) of the same radar is -23 dBm, then what is the dynamic range of the receiver?

2. (25 points) *Radar Antenna Design*:

a. (3 points) Calculate the gain (g) and logarithmic gain (G) of a circular parabolic reflector with a 1.6° beamwidth. How much does G increase or decrease if you change the beamwidth to 0.6°?

b. (6 points) Create a plot of the relative gain of the main lobe of a circular parabolic reflector that is approximated by a Gaussian shape as a function of angular distance (°) from the main lobe axis for a beamwidth of 0.8° and 1.6°. For each beamwidth, what is the relative gain at 0.4° from the main lobe axis? What about at 1.6° from the axis?

c. (10 points) Create a plot of the beamwidth (θ, °) of a circular parabolic reflector as a function of reflector diameter (D) for K_a-band (1.0 cm), K_u-band (1.8 cm), X-band (3 cm), and C-band (5.5 cm) wavelengths for $0.3 \text{ m} \leq D \leq 9 \text{ m}$. You are designing a truck-based mobile radar that can support a maximum reflector diameter of 5-ft. If you wish to use the largest possible wavelength and still achieve a beamwidth < 1° for cumulus cloud studies, what radar band would you utilize? What if your scientific application only required about a 2° beamwidth?

d. (6 points) You wish to study tornadic circulations with radar. What is the beamwidth (°) and minimum diameter (m) of a circular parabolic reflector required to attain an azimuthal (and elevational) beam size of 10 m at 1.5 km in range from a W-band (3 mm) radar? What about a K_a-band (1.0 cm) radar?

Part II: Interrogating ADRAD Radar Reflectivity Data Using SIRIS (25 points)

1. (25 points) *MCS structure and evolution*: Bring up the ADRAD 1 “siris” window.

a. (8 points) Using the CAPPI (Constant Altitude Plan Position Indicator) animation tool, describe the low-level (0.5 km) structure and evolution of the mesoscale convective system (MCS) that moved through College Station last night between 0600-1130 UTC. What are the cell and system motion directions? What is the meteorological significance of this combination?

b. (5 points) Use the OPT (multi-layer) function to change the altitude of the CAPPI. Describe the horizontal structure of the MCS at mid (4.0 km) and upper (8.0 km) levels.

c. (6 points) Load a low-level CAPPI at about 0830 UTC. Using the “CUT” tool, make a line-perpendicular cross-section through the MCS. For the best view, take a line that is about 50 km in range from ADRAD to avoid the “cone of silence” near the radar. Describe the line-perpendicular structure, noting differences in the convective and stratiform regions.

d. (6 points) Load a low-level CAPPI at about 0000 UTC. Using the OPT/multi-layer function, inspect different altitudes through the convection. Using the cut tool, take a vertical cross-section through some convective cells. Compare and contrast the structure at 0000 UTC with 0830 UTC.