7.0 Atmospheric and weather effects

Radar is not a status symbol. We install it to help us navigate in other than perfect weather conditions. Because of this it is prudent to know how various atmospheric conditions might adversely affect our equipment and what we can do to reduce the effects.

7.1 Anomalous Propagation (AP)

AP is an atmospheric phenomenon which usually occurs in good conditions. It is also referred to as ducting. It is the effect where your line-of-sight radar appears to be able to see over the horizon! When the air is stable and a layer of warmer air settles over a cold surface layer, it can create a condition called an inversion. Most people are familiar with seeing the smoke from a fireplace rising straight up on a cold night, then abruptly spreading out sideways to form a distinct flat layer. That is the ideal visual indication of an inversion boundary.

When the boundary between the cooler, lower layer and the warmer air above is distinct and quite even, and the height of the boundary above the surface is a suitable harmonic of the wavelength of the radar signal, the transmitted pulse of energy can be reflected, ducted or bounced beyond the normal radar horizon. Providing these atmospheric conditions are stable enough, the echo reflected from a distant target can also be ducted back into your antenna, thus displaying paints well beyond your normal pickup range. This is atmospheric or anomalous propagation (AP). It seldom occurs in other than cool and reasonably quiet meteorological conditions. The cold east coast Labrador Current and the cool west coast Japanese Current can often provide the colder surface layer required to set up these conditions. The relatively cool waters of Lake Superior are also conducive to supporting temperature inversions.

7.2 Precipitation

Radar is at its best in foggy conditions. Fog does not reduce the performance of radar to any significant degree, and as a result the radar-equipped vessel is at a great advantage navigating in tight quarters with virtually zero visibility. This is where the operators’ interpretive skill and experience can, and will, be truly tested. Feeling one’s way safely into a strange harbour through a “pea soup” fog, and finding the jetty less than a boat length off the bow, is euphoric and proves the worth of the learning effort.

However, the 3 cm wavelength of the marine radar makes it quite sensitive to rain or snow squalls. The radar may paint these areas similar to the scintillating grass closer to the antenna. Like sea clutter, when these squalls are heavy enough, the echoes can mask a target return within the area of the squall itself. They may also throw a shadow that can hide or greatly reduce the strength of target echoes beyond them.

7.2.1 Line squalls

Radar is very good at picking up more complex weather systems and can clearly display approaching heavy weather. This can be of particular advantage when you are confronted by a line squall. Careful observation of the apparently solid mass of approaching thunderstorms and manipulation of your radar's Gain control can often reveal areas of lesser activity and passages between the worst thunder heads. "Bad weather intelligence" is always welcome!

7.3 Antenna stability

Optimal radar coverage is highly dependent upon the placement and stability of the antenna assembly. While the physical attributes of the vessel and the needs of the owner dictate the mounting location of the antenna, the stability of the antenna is at the mercy of the elements.

7.3.1 Sailing

Radar antennas are designed to provide the narrowest possible beam-width horizontally and an acceptable width vertically (about 25°). When the antenna itself is not horizontal, the power of the beam is projected downward on the low side and upward on the high side. On a sailboat sailing "on the wind" with a 17° heel (not unusual), a fixed antenna's beam would be scanning the sky to windward, while it is beaming most of its energy into the water to leeward.

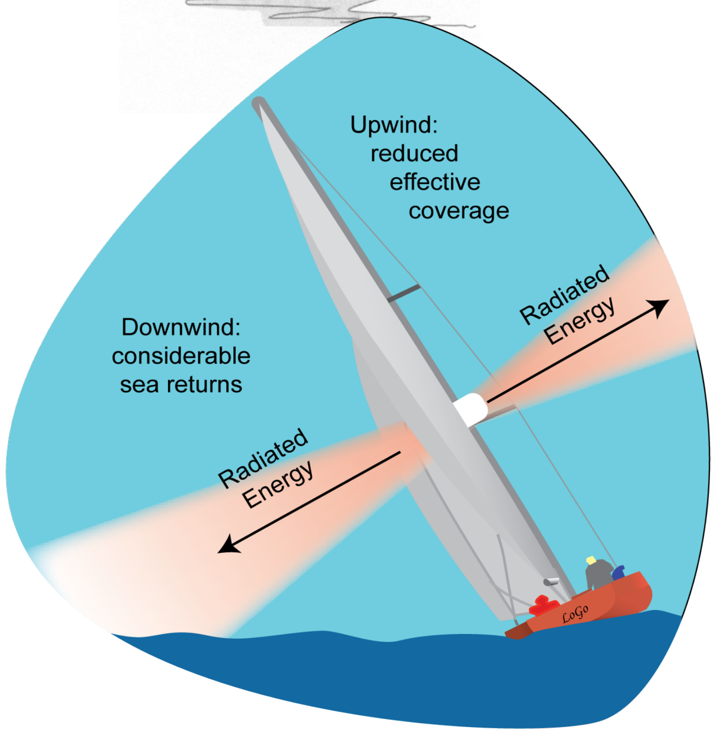

Figure 7.1 Heeling antenna

7.3.2 Powering

With a planing hull, the high cruising speed will usually have the vessel about level with its waterline on-the-plane, but quite bow-high at "off the step" slow manoeuvring speeds. An antenna mounted on a radar arch may be installed to give the optimal coverage at either cruising speed or at the displacement manoeuvring speed. As radar is much more critical in poor visibility, the second choice is recommended. Unless a compensation device of some sort is installed, optimum radar coverage will not be available across the entire operating speed-ranges of these boats.

7.4 Self-levelling mounts

Rough water introduces another variable to be taken into consideration, rolling. Sailboat owners can overcome the problem by installing a self-levelling radar mount. These units can be used to mount the antenna unit hanging from the backstay, on the mast, or on a radar pole designed for the purpose. Using a "damped" pendulum principle, they effectively neutralize the effects of heeling under sail and significantly reduce the rolling effects of a heavy seaway. Similar devices may be found on powerboats, but they are much less common. The cost of these devices alone can be comparable to the cost of some of the smaller radar sets, which is probably why they are not seen in general use. They are, however, becoming much more common as owners realize their advantages.

Warning: Radar is a "microwave" device, and as such, is potentially just as dangerous as the microwave oven in your kitchen. However, kitchen microwaves are carefully shielded to prevent the escape of microwave energy, which can harm a bystander, but radar is not! The radar antenna is designed to project its microwave energy outward in high-powered bursts. When it is operating, there is an area around a radar antenna that is constantly filled with RF microwave energy. It is not advisable to remain, work or sit in the immediate vicinity of a transmitting radar antenna. The radar should by put into "stand by" mode or turned off, if it is necessary for a crew member to be close to, or in line with the antenna, for any extended time.

7.5 Summary

- AP, or ducting, can noticeably increase the range of the pickup and tracking of targets on a radar, apparently over-the-horizon. This usually happens in calm weather conditions with cool surface temperatures and warmer air aloft.

- Rain, sleet or snow paint well on a marine radar. Heavy areas of precipitation can mask a legitimate target echo and cast a radar shadow over the area beyond them.

- Radar can clearly show less dangerous passages through a line squall or around thunderstorms.

- Siting and mounting a radar antenna requires consideration of the desired range of surveillance. The higher the placement, the better the range of coverage.

- Self-levelling mounts will significantly improve the radar efficiency on a sailboat, when heeled, and on all boats, in rolling seas.

- The danger of continuous exposure to microwave radiation from a marine radar cannot be overemphasized. This should be taken into consideration when installing the antenna.

Next **- Practical application**

Now that we know how a radar works, it is time to see how we can use it when we are "navigating using radar".