Performance test and verification of an avian radar in the adverse environment of a wind-power plant

Steinheim, Y., May, R., Kvaløy, P., Vang, R., Hanssen, F., Bevanger, K.

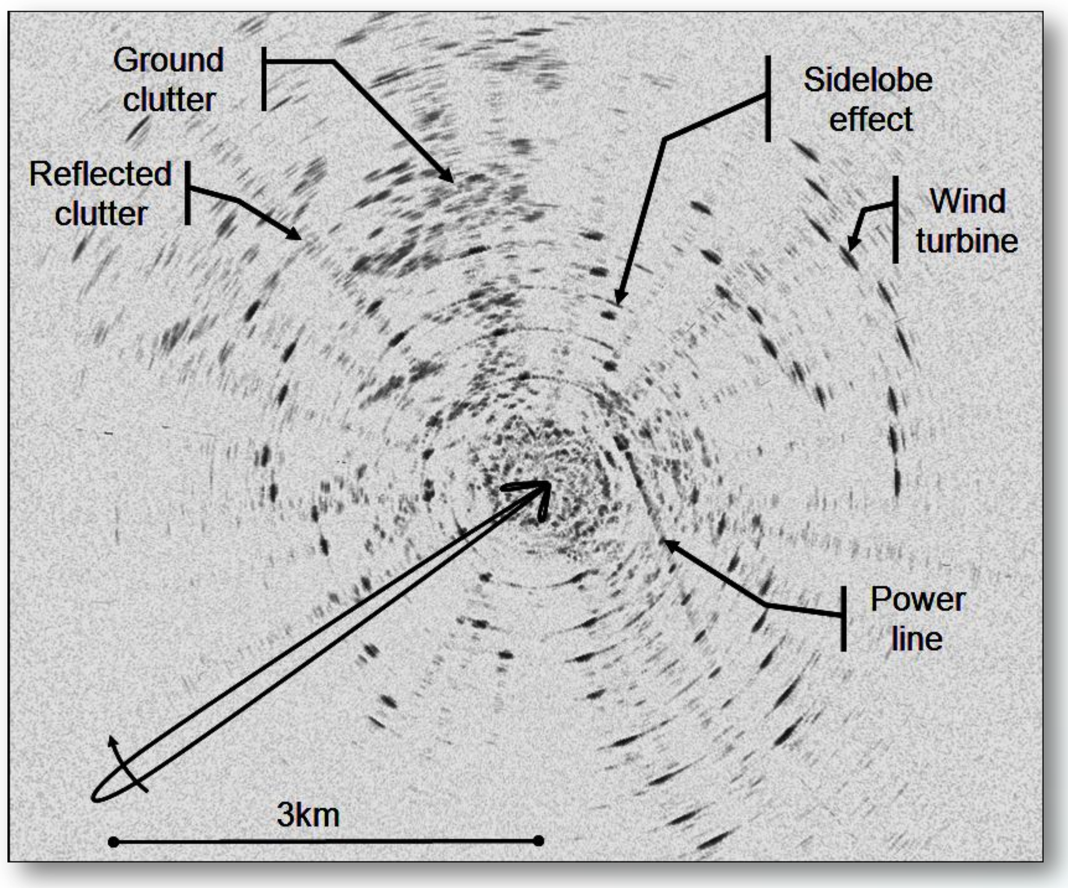
Introduction

The purpose of the work presented has been to investigate into the performance of the avian radar used in the Statkraft wind-power plant at Smøla in the BirdWind project. Recorded radar data will tell us what the radar has been able to see, but for the biological research, it may be of vital importance to have some knowledge of what the radar might have missed, or if there are any biases in the data. The actual performance of a specific radar at a specific site is defined by the properties of the target, the environment at the site, and the technical solution and the configuration of the radar system itself.

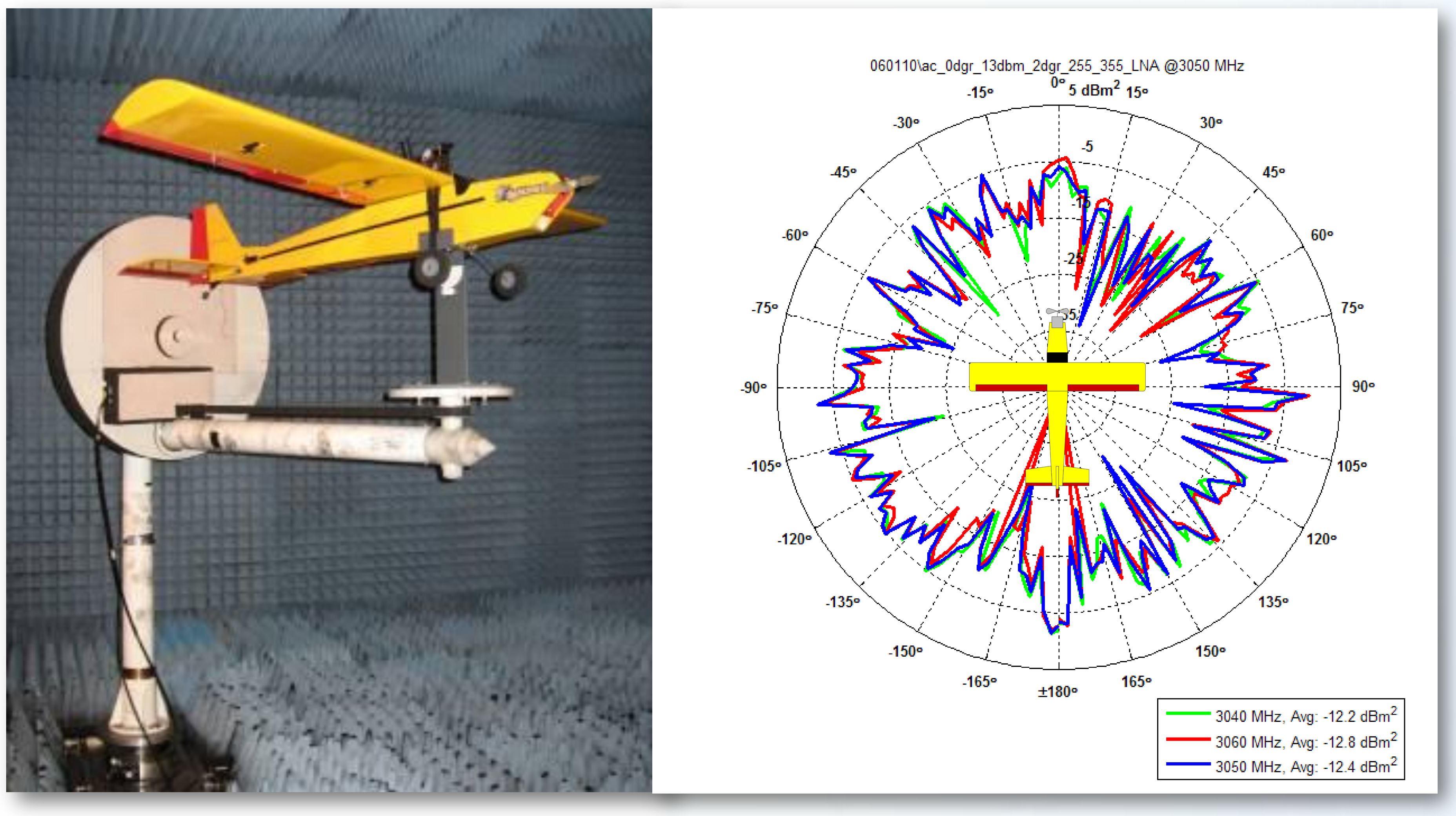
Problem description and selection of method

The avian radar used in the BirdWind project was the commercially available Merlin system from DeTect, USA. This system is based on standard ship radars, but is equipped with a digital processor that extracts and outputs digital target reports. While it is possible ~~also~~ to record ~~also~~ the raw radar picture, ~~it is~~ the digital target reports form ~~that is~~ the final output of the system and this data is therefore used as the basis of the performance analysis presented. In addition to the ever present system noise, several strong sources of clutter can be seen in the radar image from the wind-power plant on Smøla.

The complexity of the environment and its interaction with the automatic radar processor, made any theoretical assessment of radar performance of limited practical use, therefore the main approach taken to radar performance verification has been the use of a controlled test target in the actual operating environment and with the actual radar operative settings. The test target used was a model aircraft equipped with a GPS receiver and a video link, which provided a controlling range of the aircraft of more than 2 km. This enabled the design of virtually any test flight pattern within the wind park area.

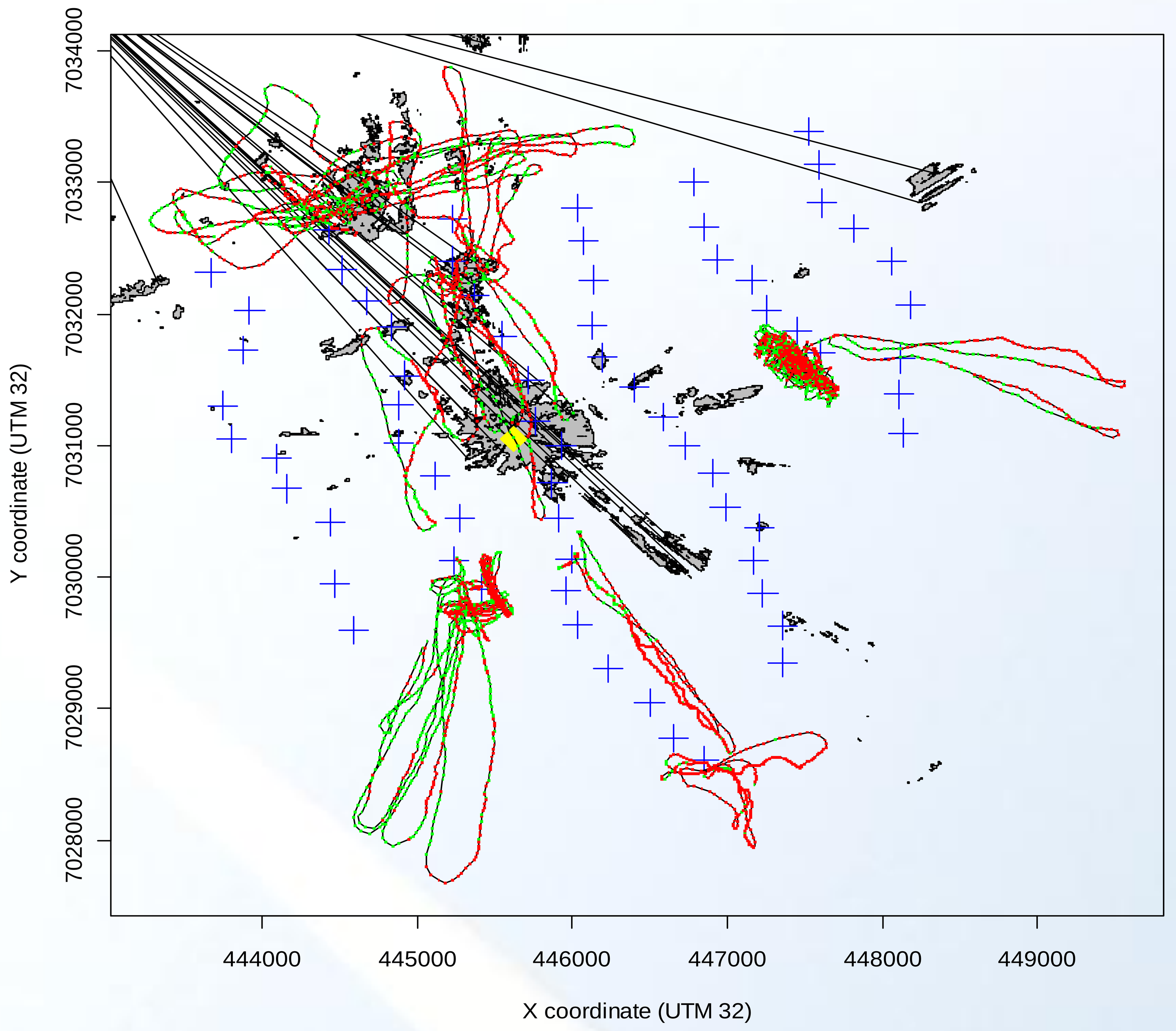


The test target should have a radar cross section (RCS) that correspond to the bird targets RCS as closely as possible. To verify the model aircraft RCS, and to be able to extrapolate the detection performance obtained with the test target to bird targets, a special RCS measurement program for the model aircraft was performed in the radio laboratory at NTNU/SINTEF.

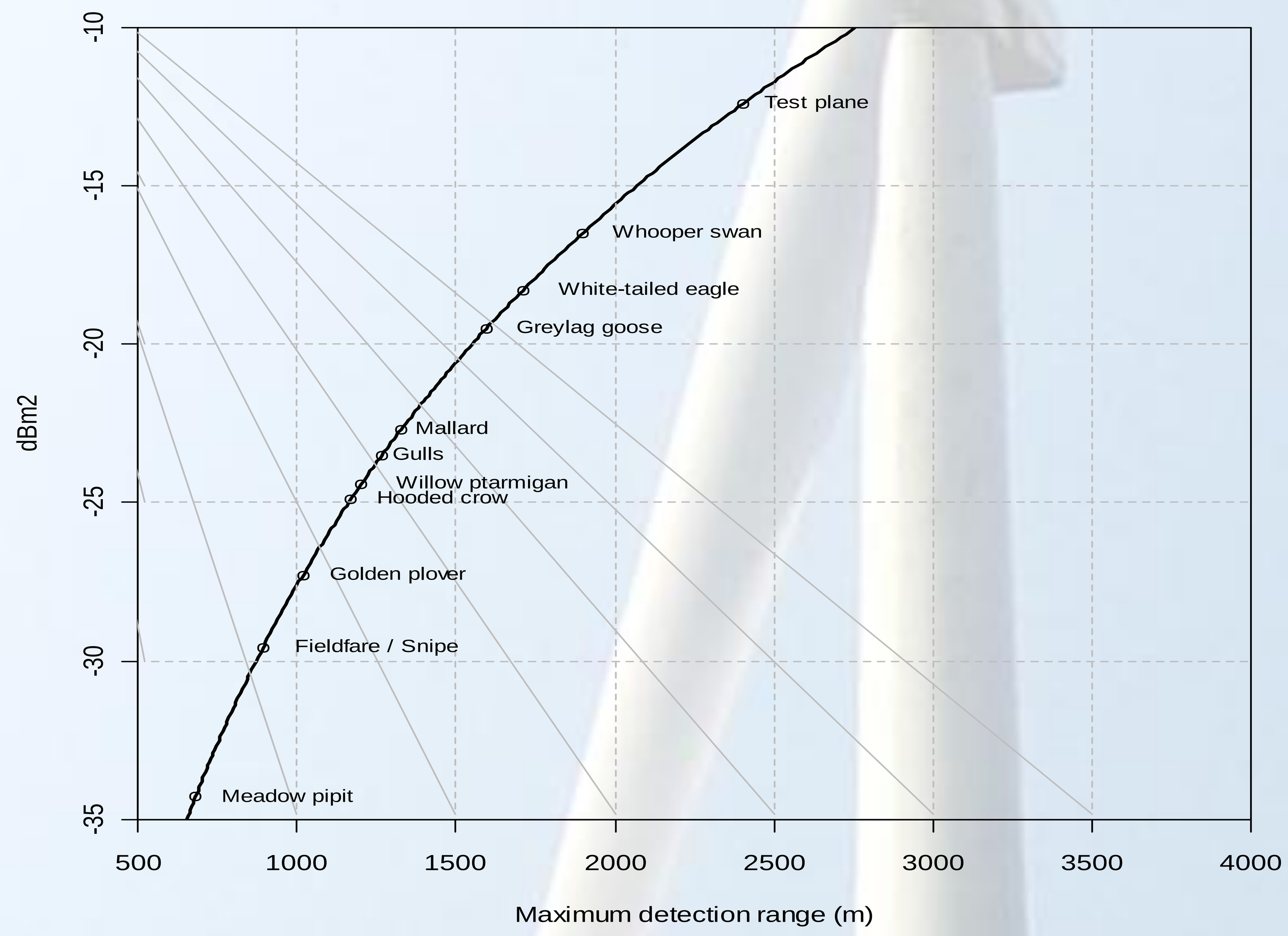


Data analysis and results

The GPS data form the aircraft was used as a reference to remove any systematic position bias in the radar data. To be able to assess the detection performance, a~~n~~ hit/miss analysis (binomial mixed-effects regression) was performed in which a missed detection in a given antenna scan was replaced by the corresponding GPS position for the aircraft. An example of some test tracks is shown below. In this plot the detections are shown as green dots while missed detections are red. The wind turbines are marked with blue crosses, and the dark areas indicate patches of ground clutter.



The recorded radar data was then used to estimate a probability of detection (P_d)s a function of range for the test target. I our case the maximum detection range has been defined as the point in range when the P_d has dropped to 0.5. I.e. when the target is lost on every other antenna scan. When the radar cross section and the detection range of the test target is known, the radar equation can be used to extrapolate the detection range to various sized bird targets. The RCS of the birds has been estimated using the simple model of a water sphere with weight equal to the weight of the bird.



While the specific performance results obtained in these tests at Smøla are highly site and system/setting dependent, the method used should be universal and therefore possible to employ for other similar sites and types of radar equipment.

SINTEF
NINA Norwegian Institute for Nature Research
CEDREN Centre for Environmental Design of Renewable Energy

www.sintef.no

www.nina.no www.cedren.no