The sensitivity of the Met Office evaporation duct model to input parameters

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Evaporation ducts are a manifestation of moisture and temperature gradients that exist immediately above the water surface where evaporation occurs. The accurate prediction of duct properties is fundamental to the understanding of radar propagation patterns, and is therefore of significant value to the Royal Navy (RN). The UK Met Office has developed a web-based evaporation duct tool that is currently in operation with the RN for the prediction of evaporation duct profiles using ship-based observations. The primary aim of the work presented here is to quantify how the precision of the driving input parameters relates to uncertainty in the output duct heights. We drive our model not with ship observations, but using Met Office Numerical Weather Prediction (NWP) data to give improved spatial and temporal coverage. Focus is given to the Arabian Gulf region using a year's worth of data in order to capture seasonal dependencies.

We find that model precision in predicting duct height is strongly related to the accuracy and precision of the input parameters. Random uncertainties as small as 0.1K make it very difficult to make sufficiently precise predictions where the true duct height is above 40m. Furthermore, if the uncertainty is increased to a more realistic magnitude of 0.5K, the model shows considerable variability for true duct heights above 25m. This is especially relevant during the summer months where duct heights sometimes exceed 40m. However, in the winter months where the atmosphere is less stable, ducting events generally occur below 20m and the model is less sensitive to errors in the inputs.

Output duct heights are also found to be particularly sensitive to systematic biases in the air-sea temperature difference and dew-point depression, and can be simulated by adding constant values to the raw NWP data. We find that 0.5K biases can result in up to tens of metres difference in predicted duct heights compared to an unbiased control scenario. Since the self consistency of NWP data naturally suppresses biases in the differences between parameters, it may offer an improved method of driving the model over ship-based observations. However, further investigations are required in order to provide confidence that NWP driven systems can provide as good or better advice compared to systems driven from observations.