Effects of noise-mitigated offshore pile driving on harbour porpoise abundance in the German Bight 2014-2016 (Gescha 2)

Assessment of Noise Effects

Appendix

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Assessment of Noise Effects

Appendix

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A APPENDIX

Hourly CPOD data

Raw data: Additional plots

In the report, only Gescha 2 raw-data distributions of four selected variables of special interest were shown. Here, we also present the respective distributions for Gescha 1 raw data.

Gescha 1 raw data available for analyses in the report

Distance to piling (A_dist):

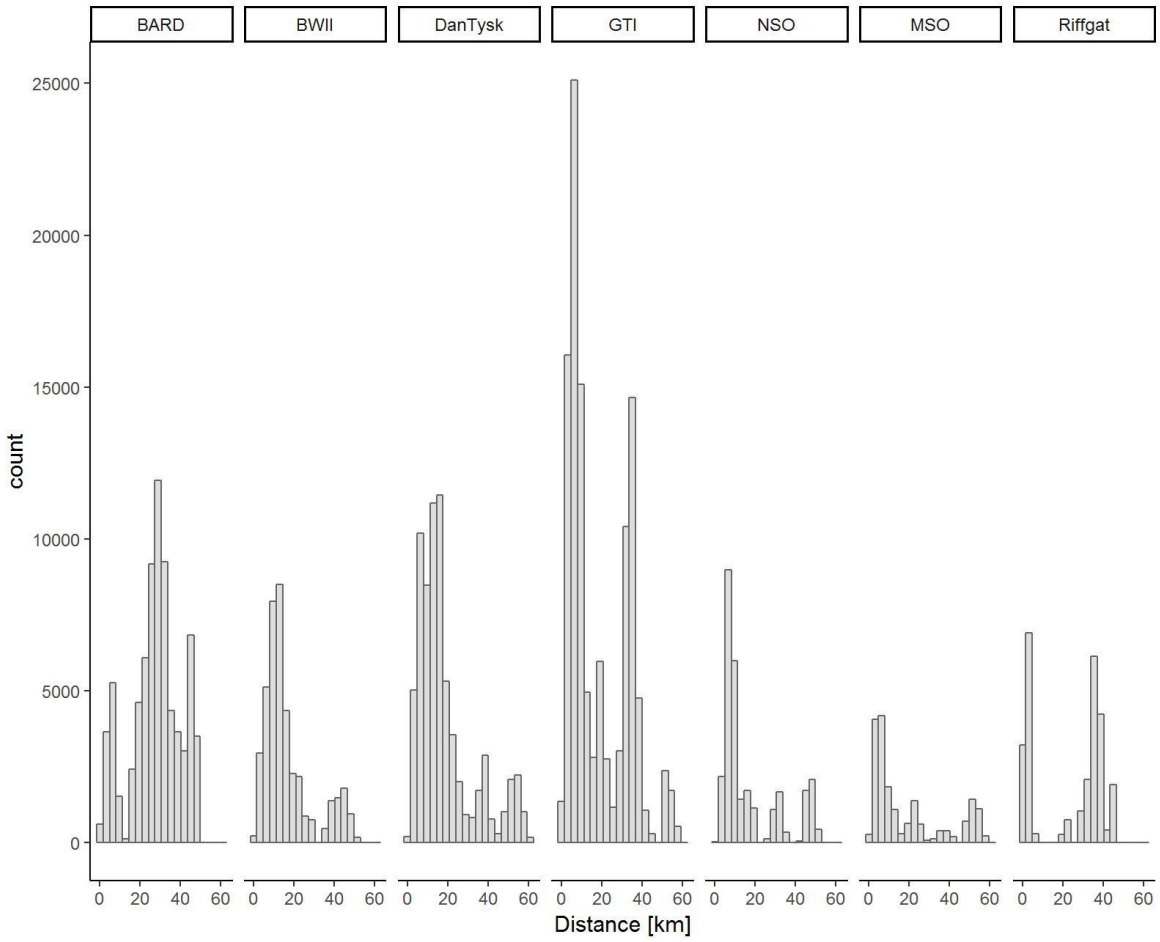


Figure A.1 Gescha 1: Availability of hourly CPOD data for certain distance classes of variable A_dist (CPOD distance to piling locations of the investigated OWFs).

Time relative to piling (A_HRW):

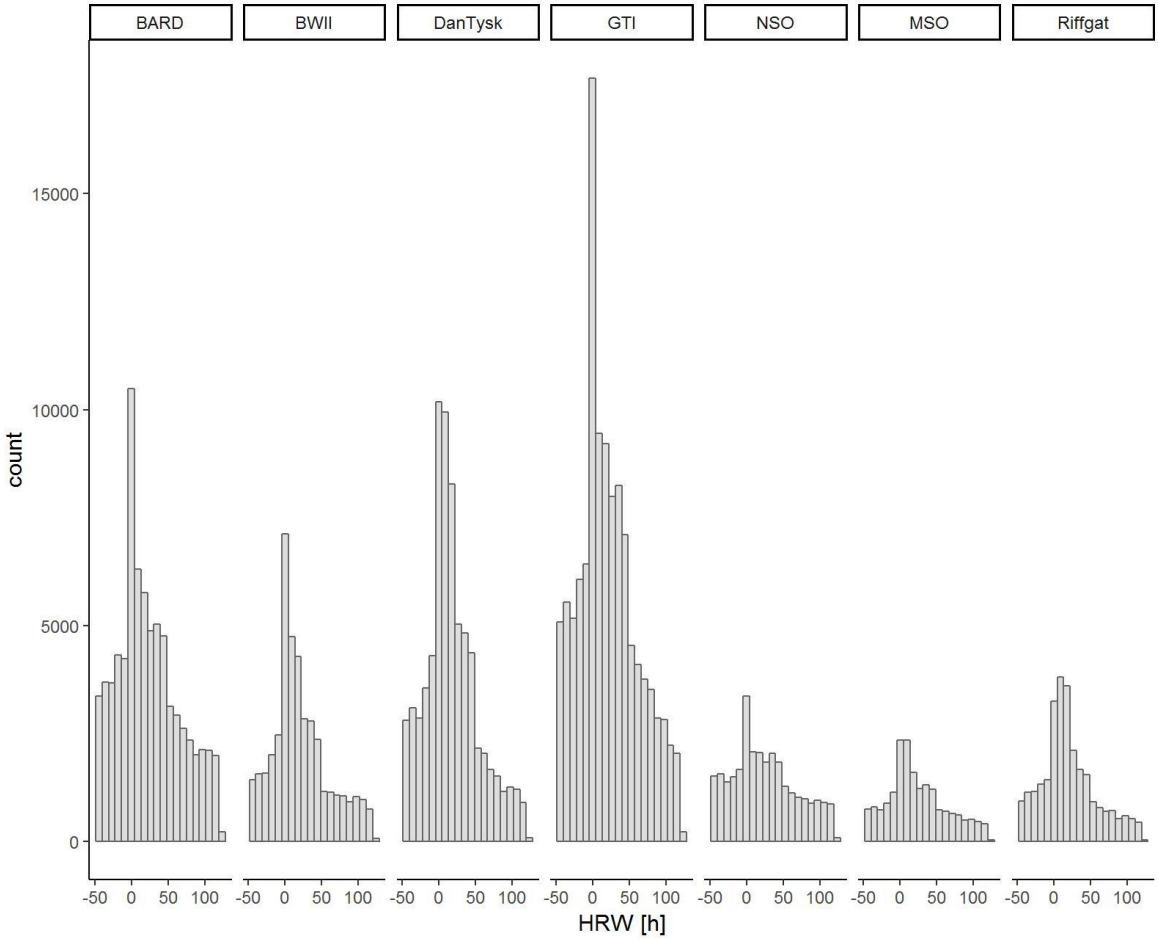


Figure A.2 Gescha 1: Availability of hourly CPOD data for the variable A_HRW (time relative to piling hour) at the investigated OWFs.

Sound level of SEL_{05} in 750 m distance (SEL05_750):

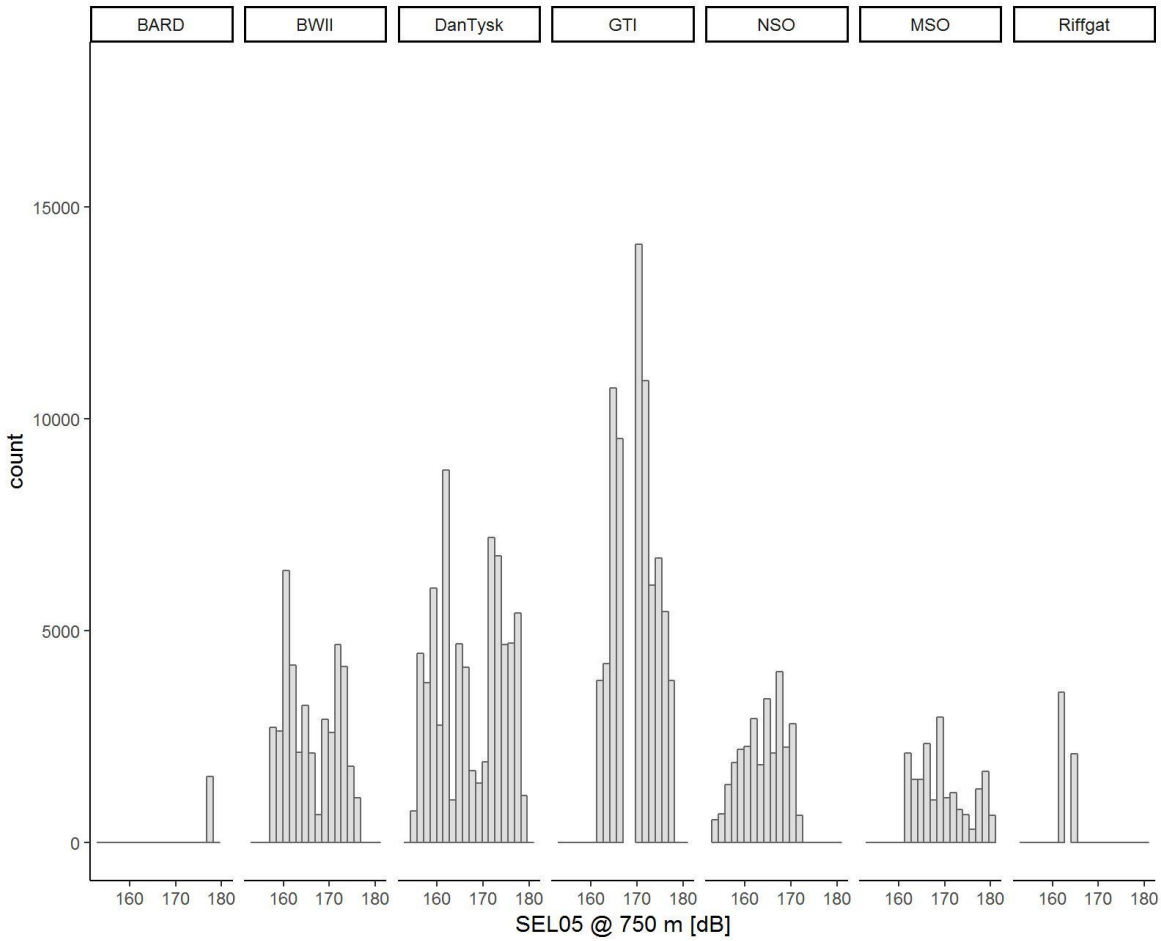


Figure A.3 Gescha 1: Availability of hourly CPOD data for the variable SEL05_750 (sound level of SEL_{05} in 750 m distance in dB) at the investigated OWFs.

Time relative to piling (A_HRW):

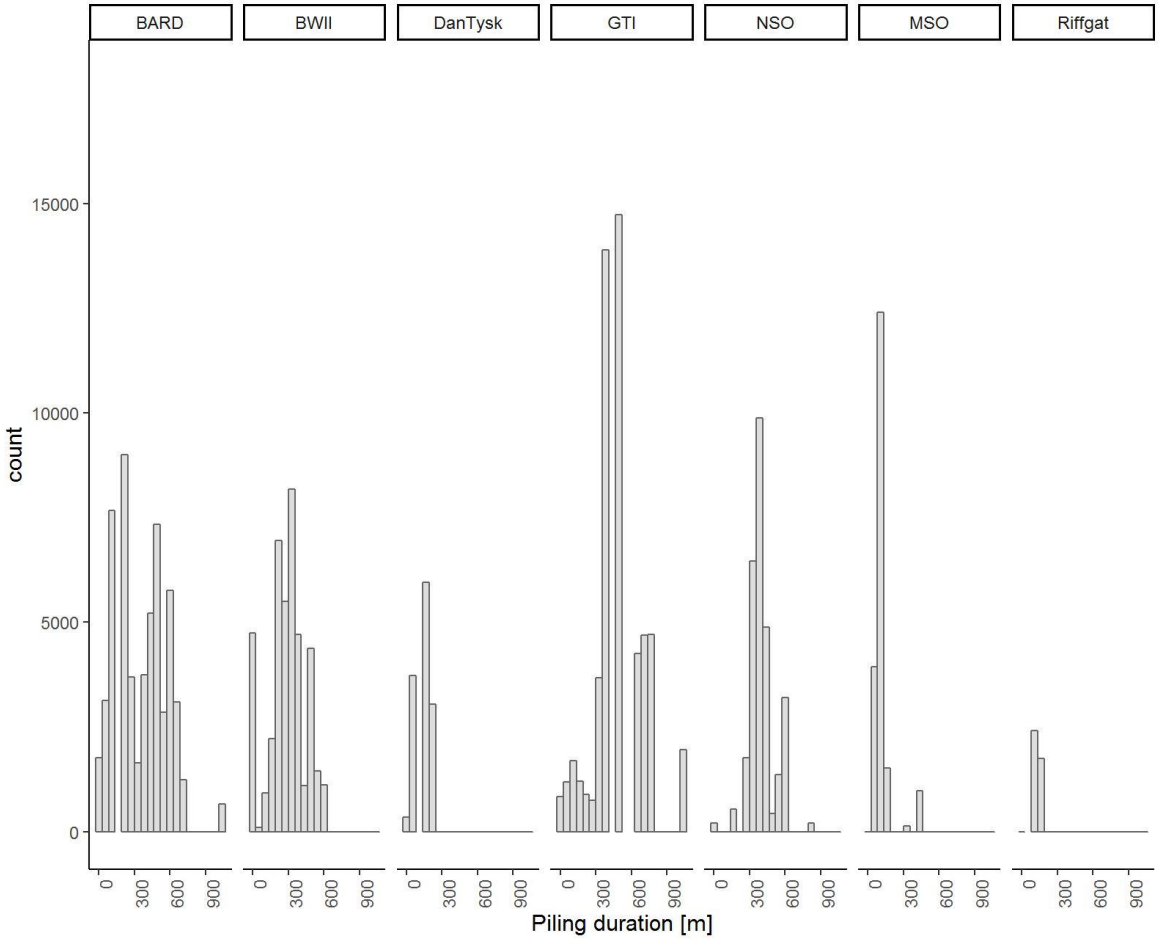


Figure A.4 Gescha 1: Availability of hourly CPOD data for the variable A_pilingduration (duration of piling events in minutes) at the investigated OWFs.

WP 3.1 – Global models: Additional plots

Default GAM plots for global models in the report

Due to technical reasons, standard error contour lines of the 20 % reduction line in the Reference-type models and the zero line of the Cl-type models could not be shown in the coloured plots of the report. Here, we show the default plots of the *gam.plot()* function which also give standard error contour lines. Regarding the Reference-type models, however, the following default plots cannot show effects on the response scale (e.g., the 20 % reduction line with standard errors), but only on the scale of the linear predictor where zero equals the average of fitted values. Therefore, the default GAM plots for the Reference-type models presented below only allow for the assessment of the approximate range of the standard error for this model type, by looking at error lines of a contour line being closest to the 20 % reduction line. These approximate ranges are used in the tables of the report.

Gescha 2: Global Cl-type GAM

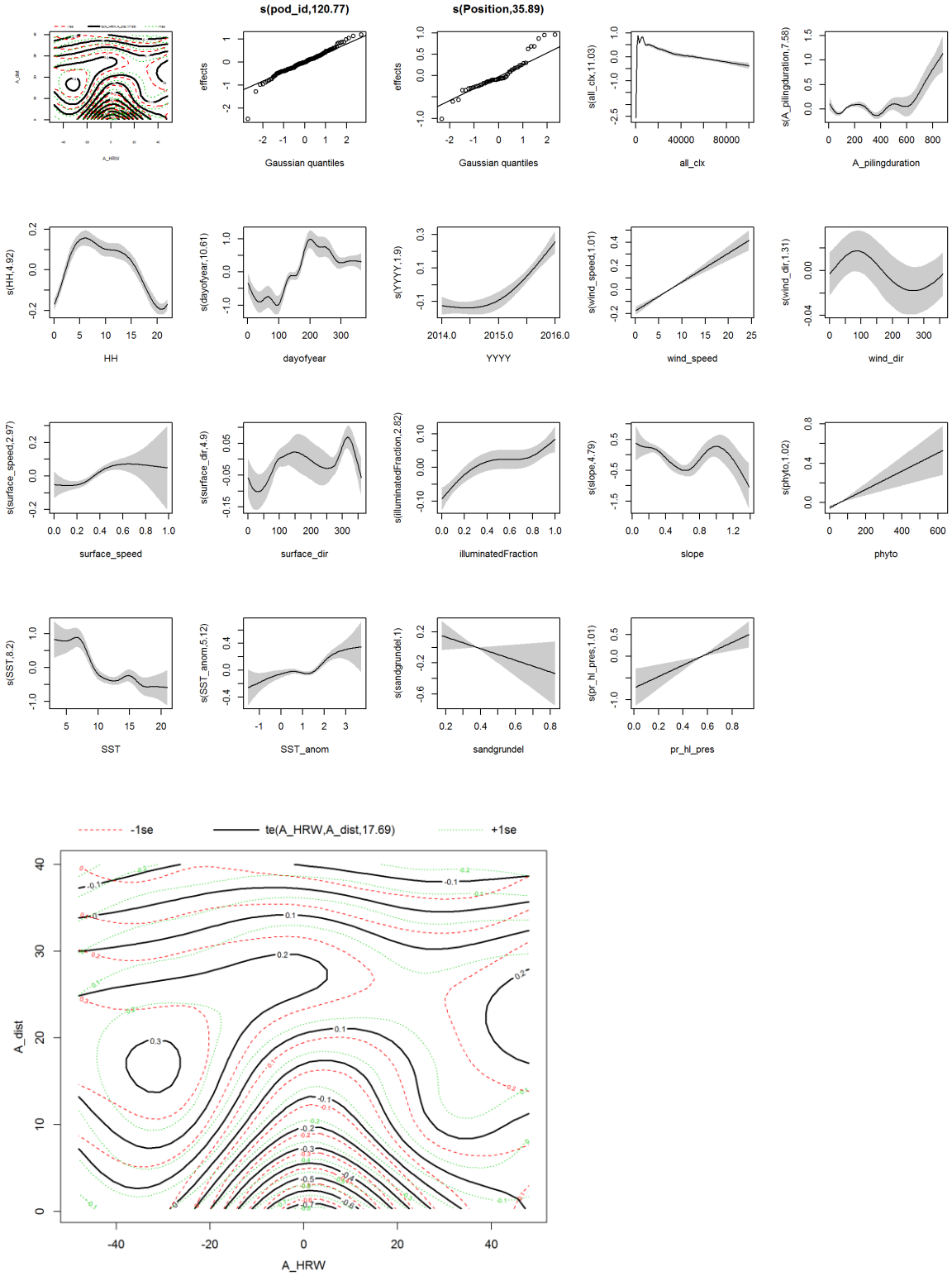


Figure A.5 *Global Cl-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.*

Gescha 1: Global Cl-type GAM

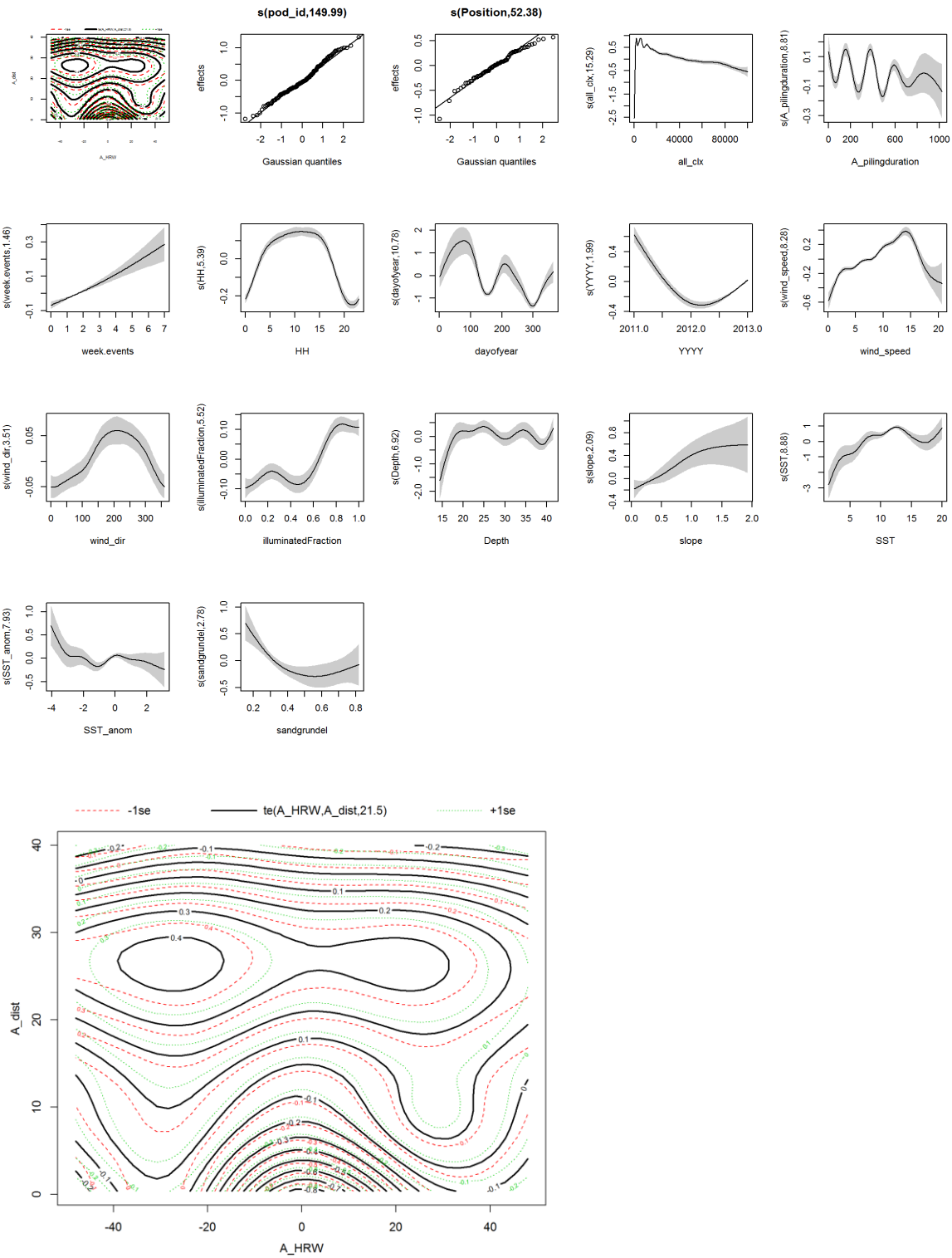


Figure A.6 *Global Cl-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.*

Gescha 1 & 2: Global Cl-type GAM

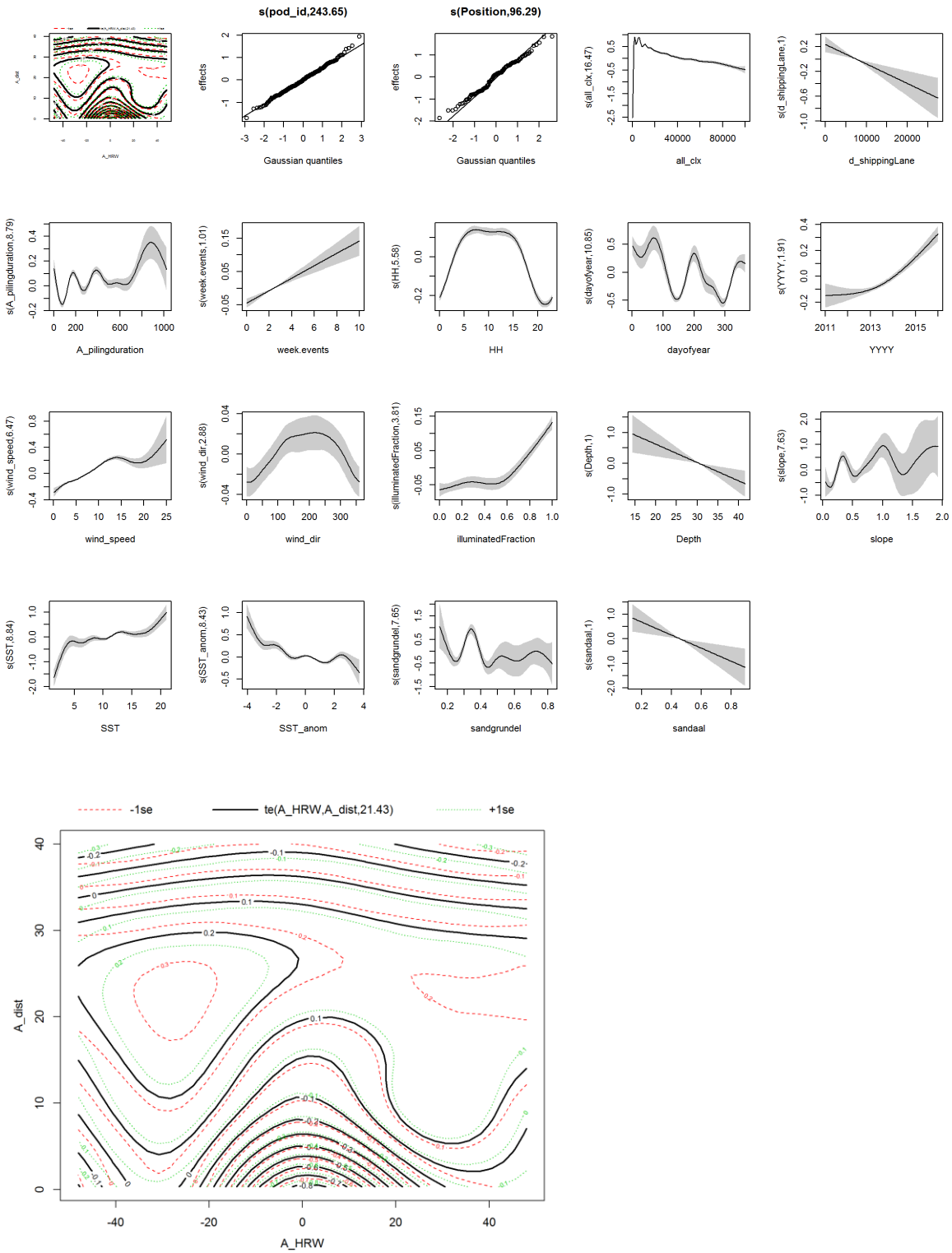
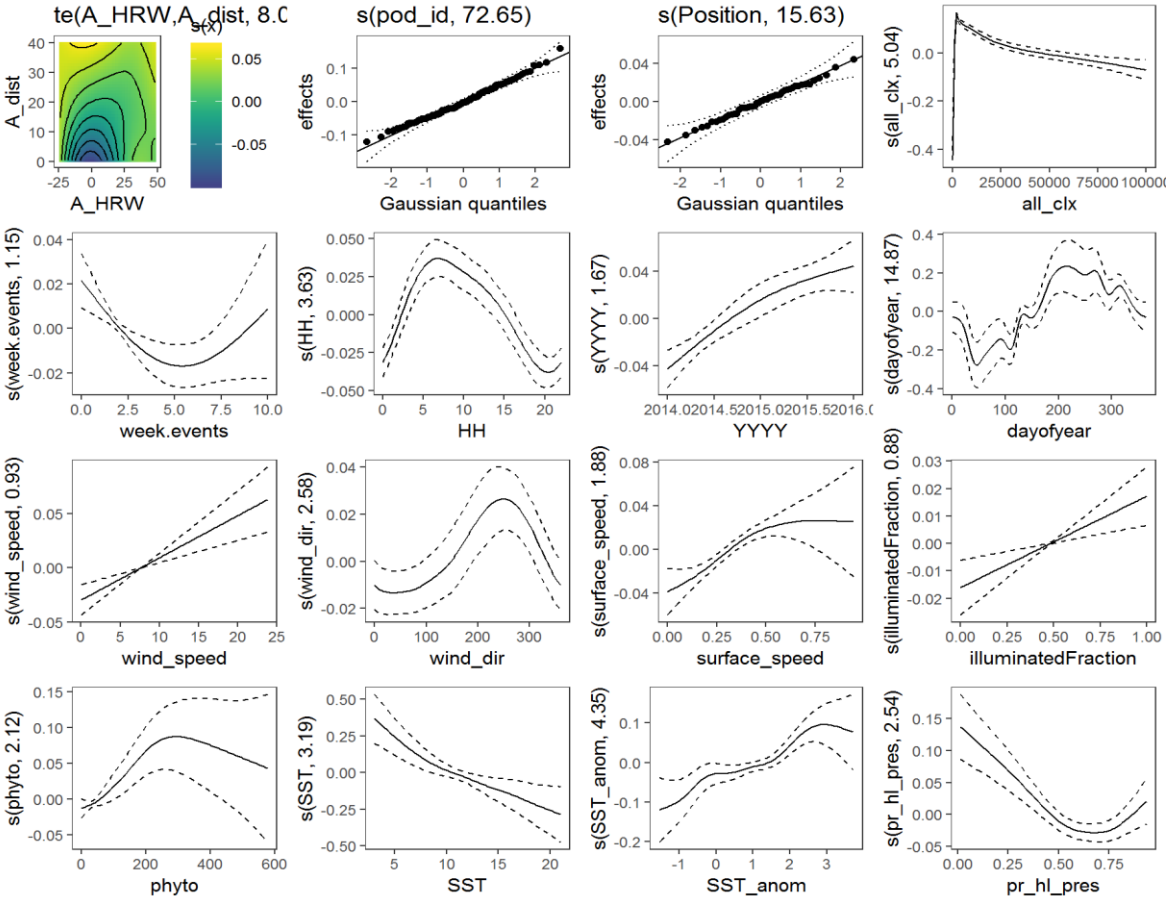


Figure A.7 *Global Cl-type GAM M3.1aG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.*

Gescha 2: Global Reference-type GAM



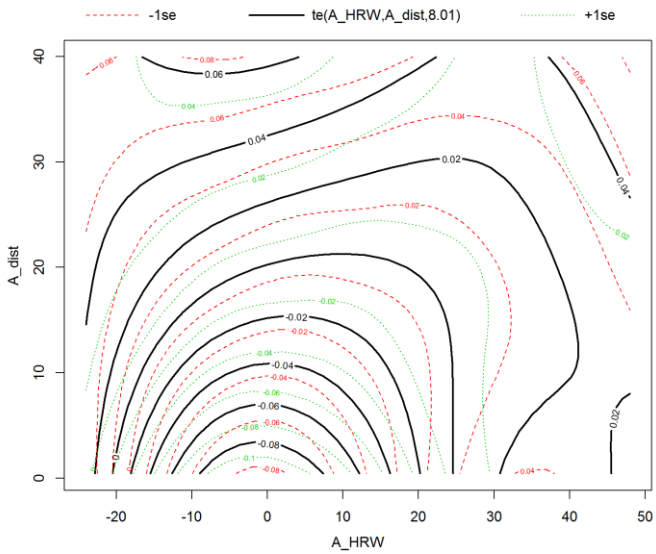
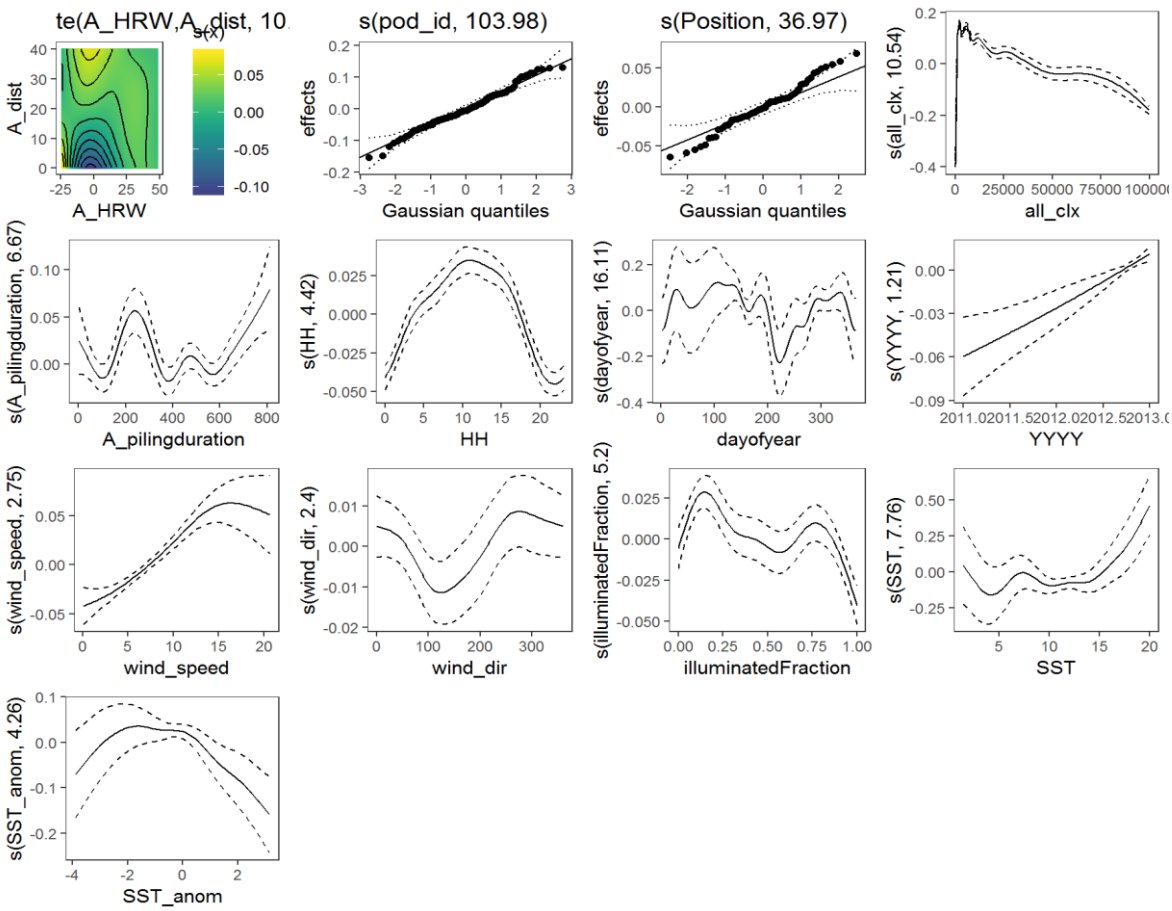


Figure A.8 *Global Reference-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.*

Gescha 1: Global Reference-type GAM



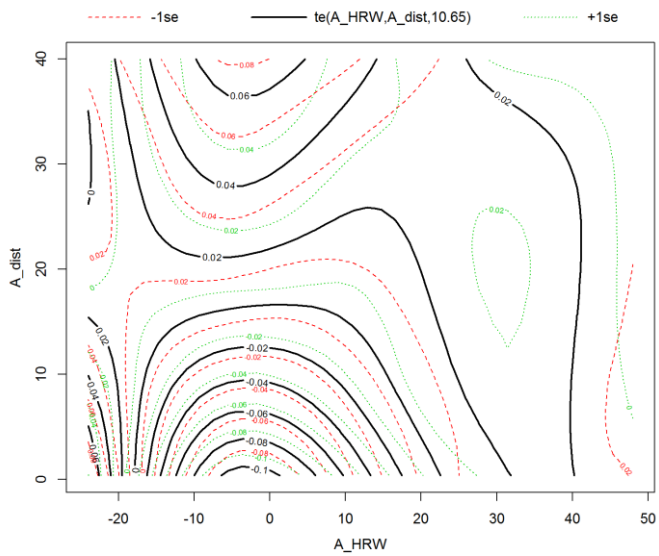


Figure A.9 *Global Reference-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.*

Gescha 1 & 2: Global Reference-type GAM

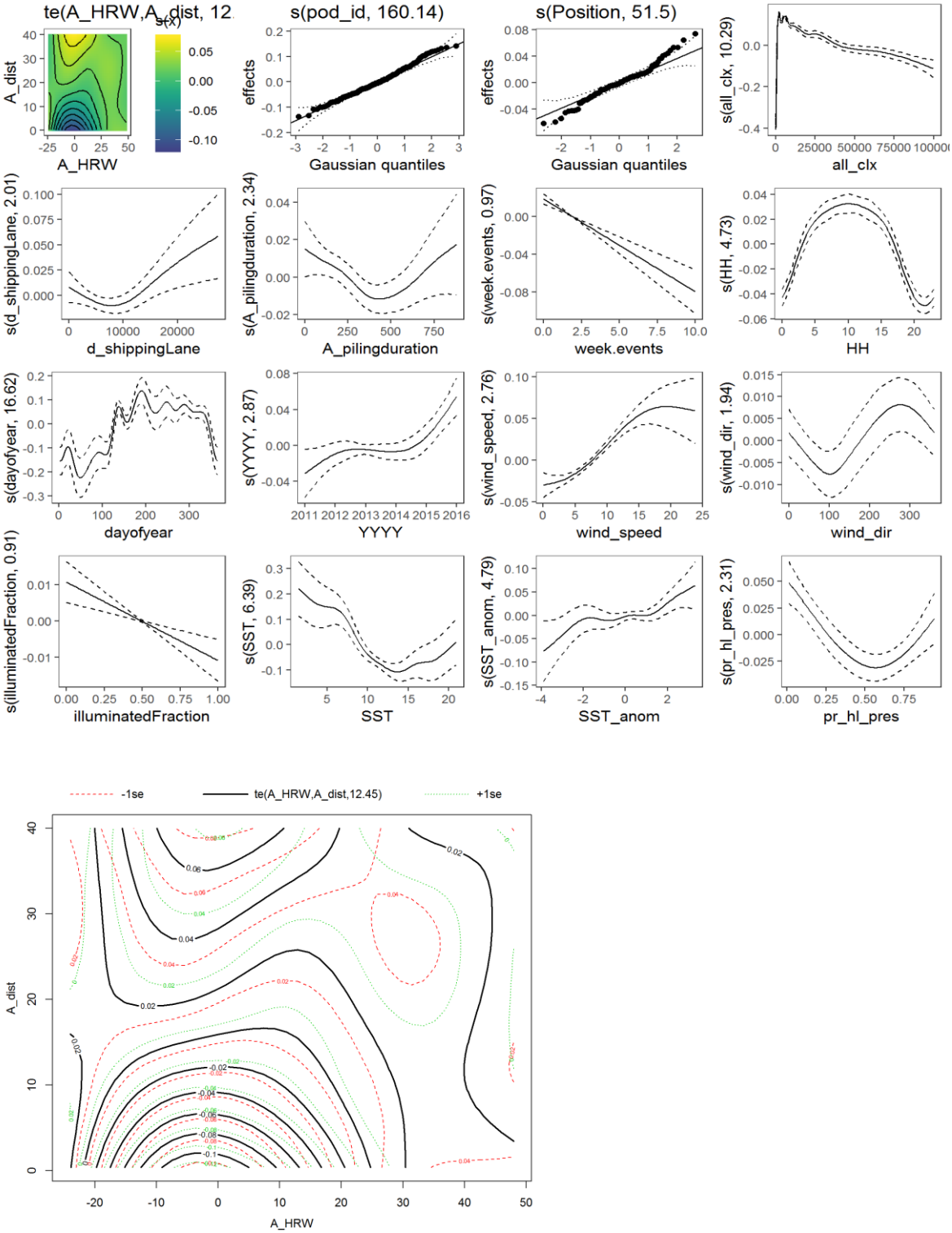


Figure A.10 Global Reference-type GAM M3.1aG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

Directly comparable statistical models

Not only the best-fitted models, but also directly comparable global models were computed for each of the G1 and G2 datasets of mitigated pilings, based on the significant covariates of the best-fitted Reference-type or Cl-type model for the combined G1 & G2 dataset (GAM: M3.1aG12).

Gescha 2: Comparable global Cl-type GAM

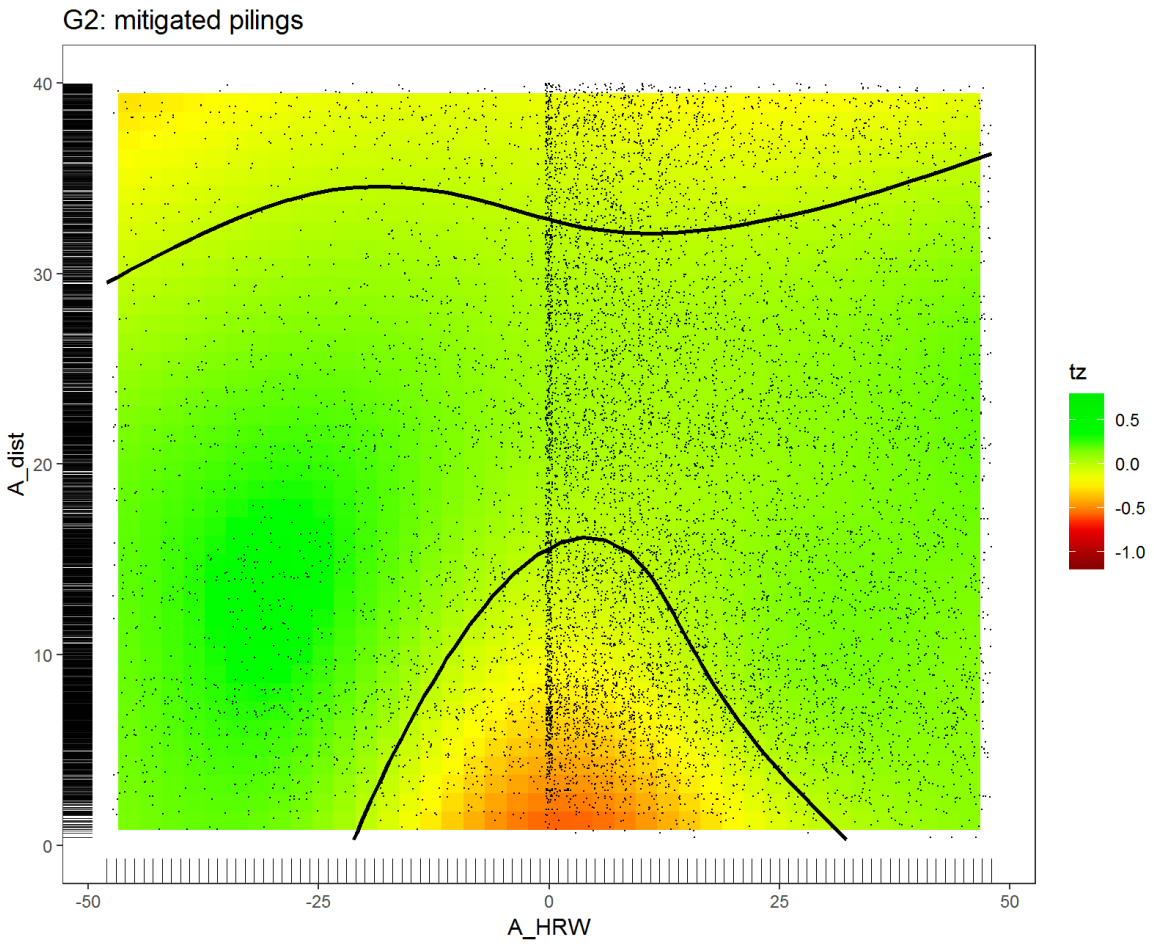


Figure A.11 Comparable global Cl-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); DPH values on scale of the linear predictor where zero equals the average of fitted values (dotted lines: std. error), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

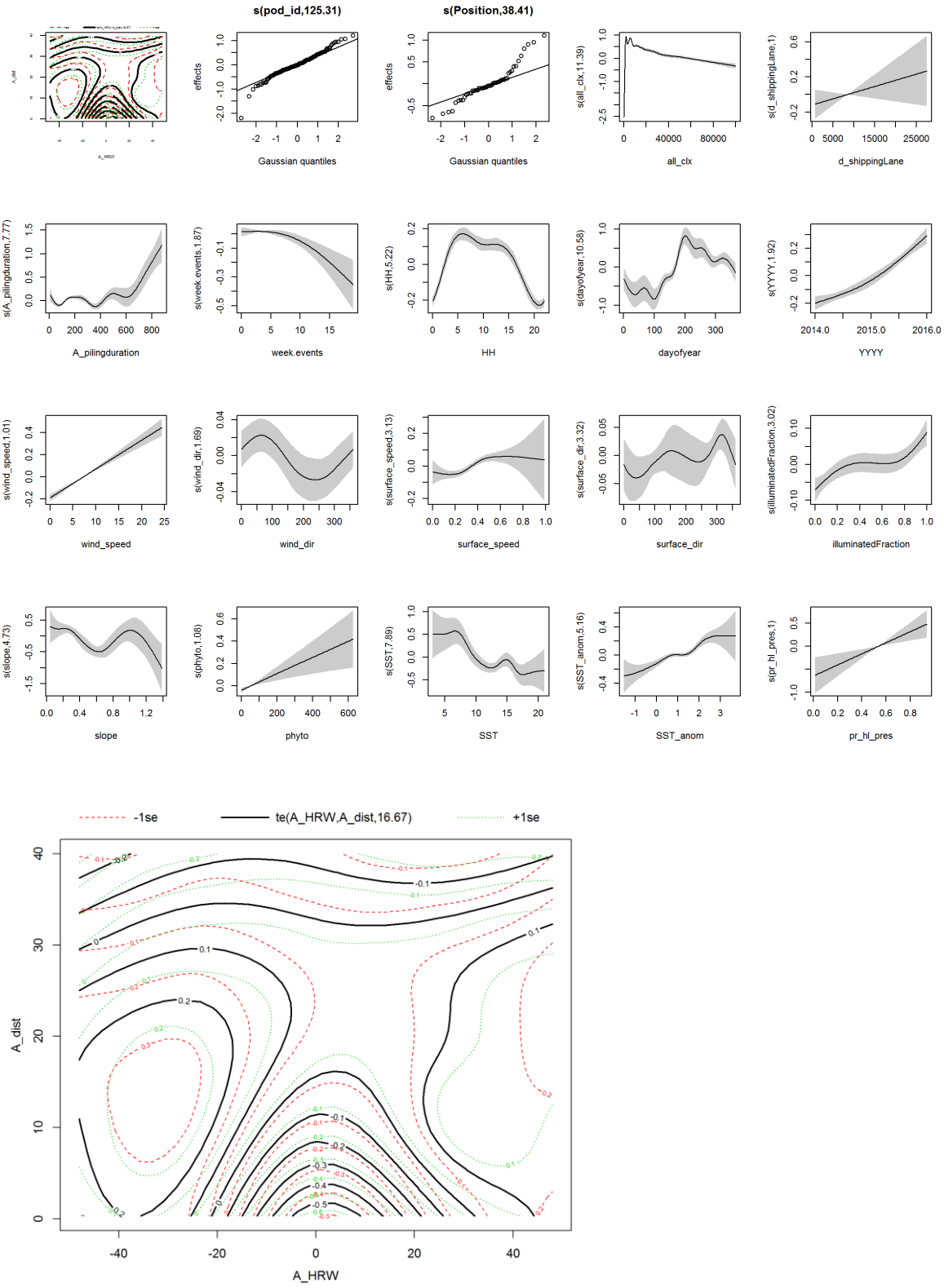


Figure A.12 Comparable global Cl-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

Gescha 1: Comparable global Cl-type GAM

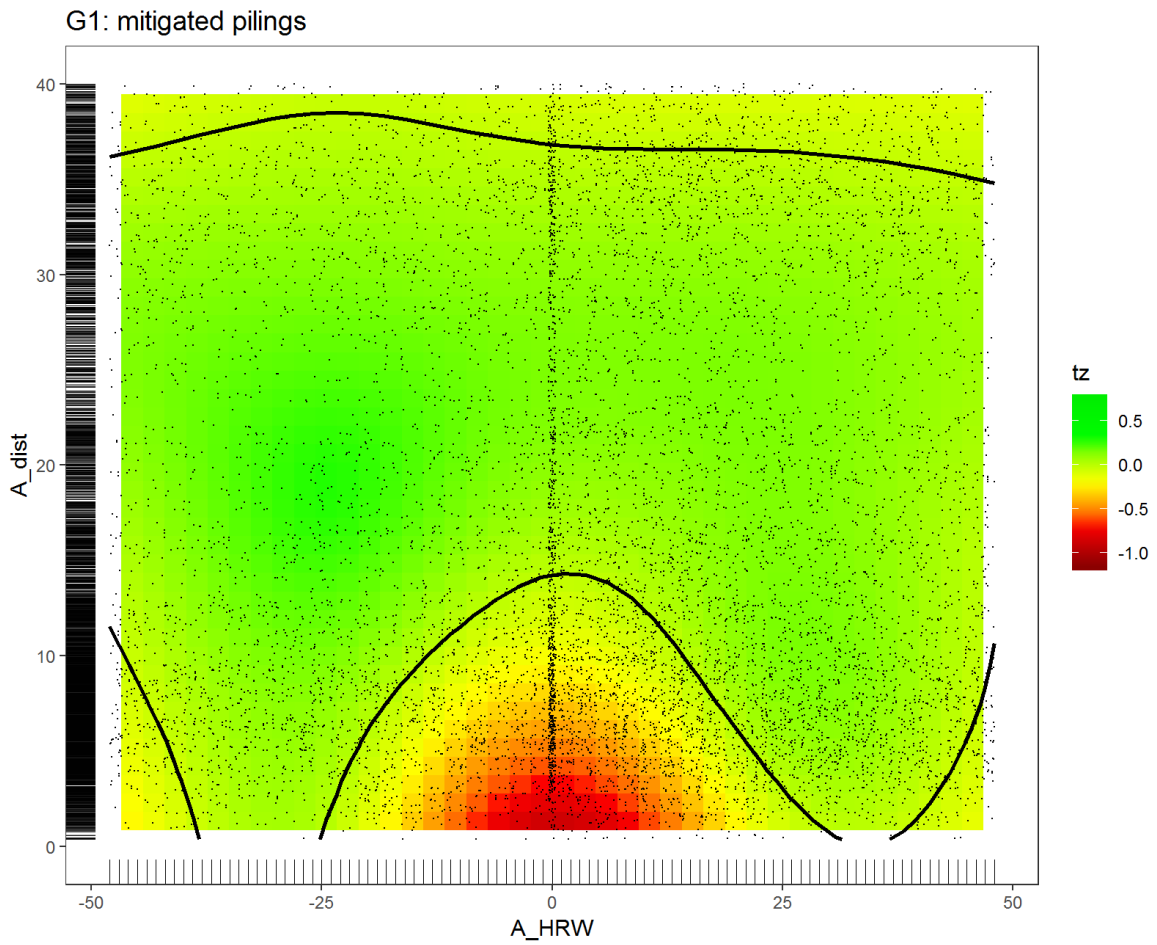


Figure A.13 Comparable global Cl-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); DPH values on scale of the linear predictor where zero equals the average of fitted values (dotted lines: std. error), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

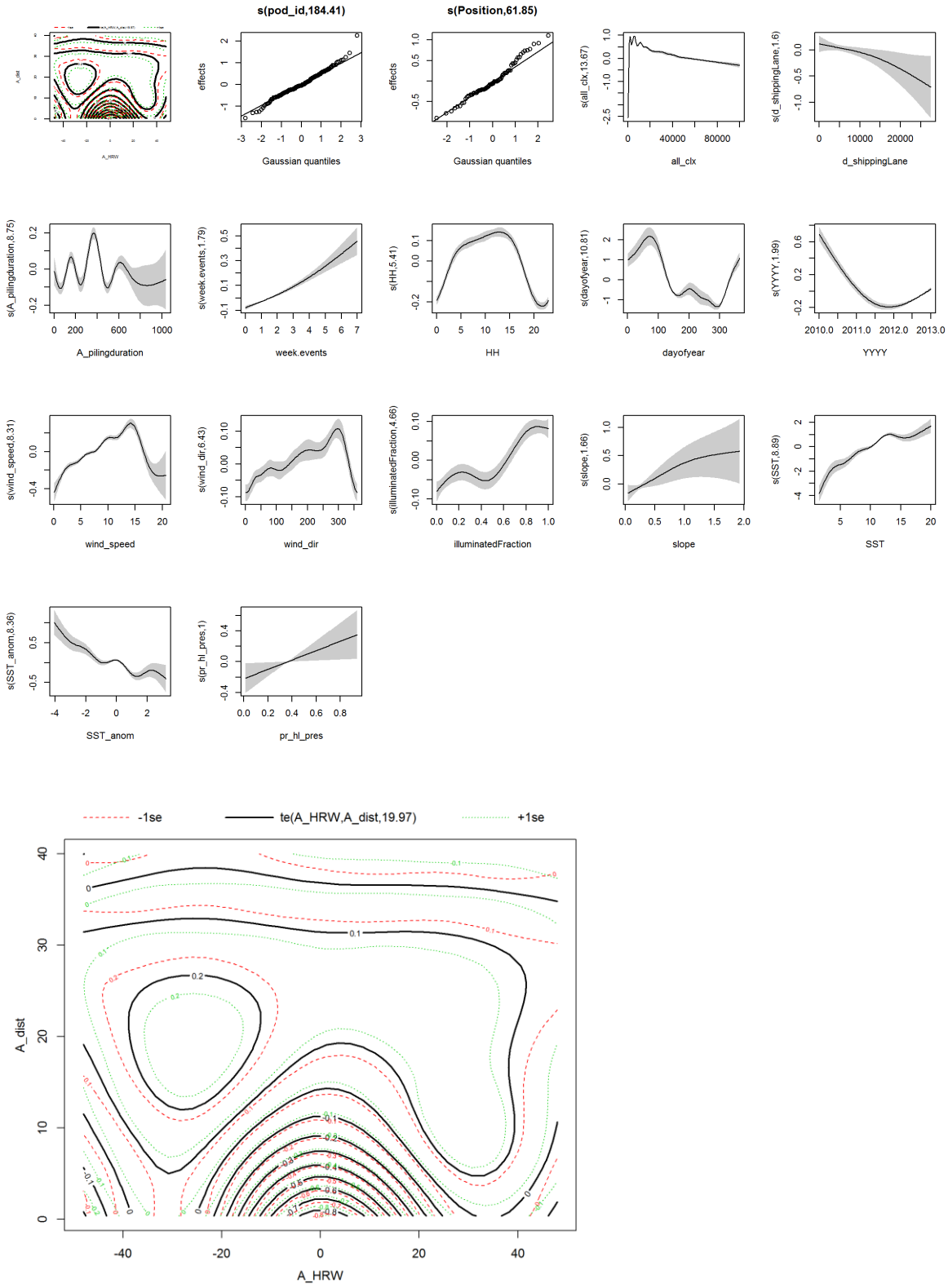


Figure A.14 Comparable global Cl-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

Gescha 2: Comparable global Reference-type GAM

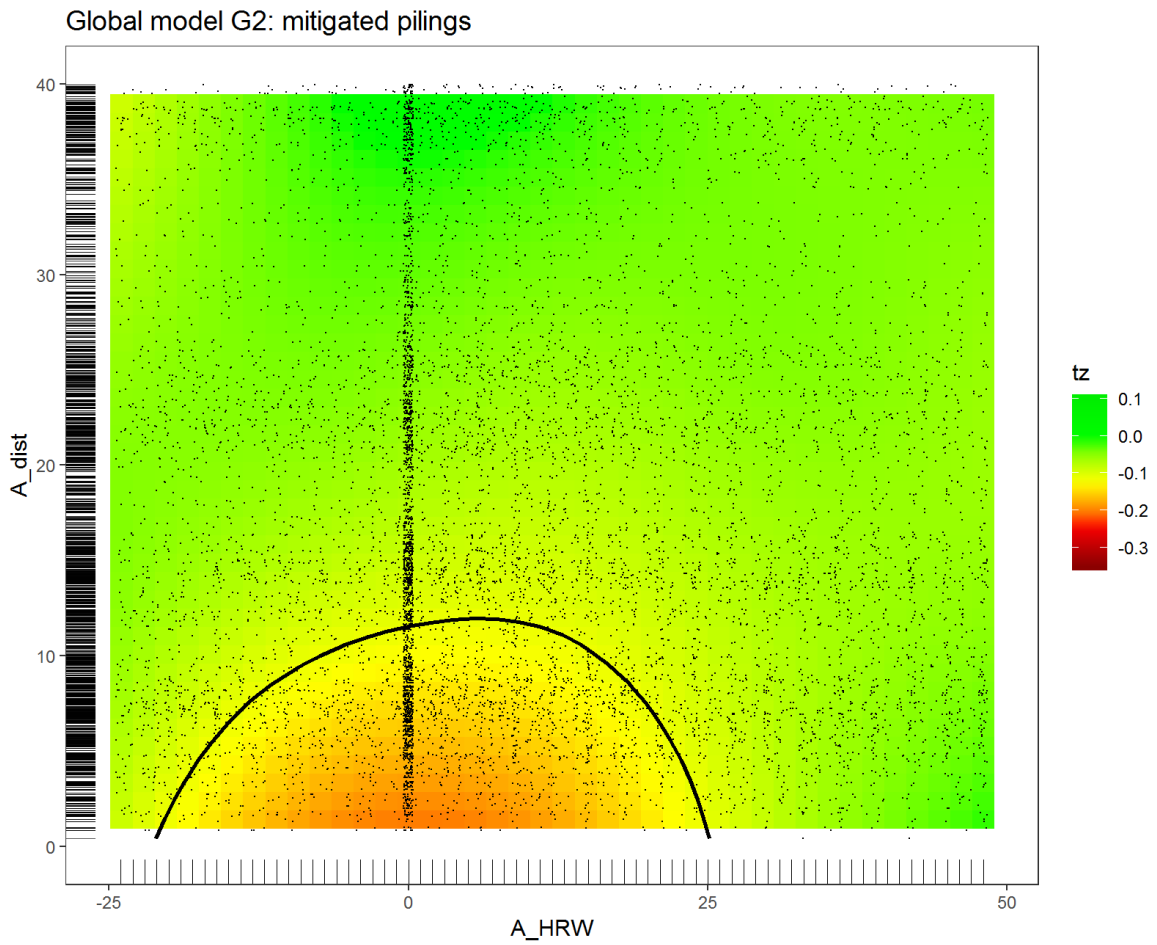


Figure A.15 Comparable global Reference-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

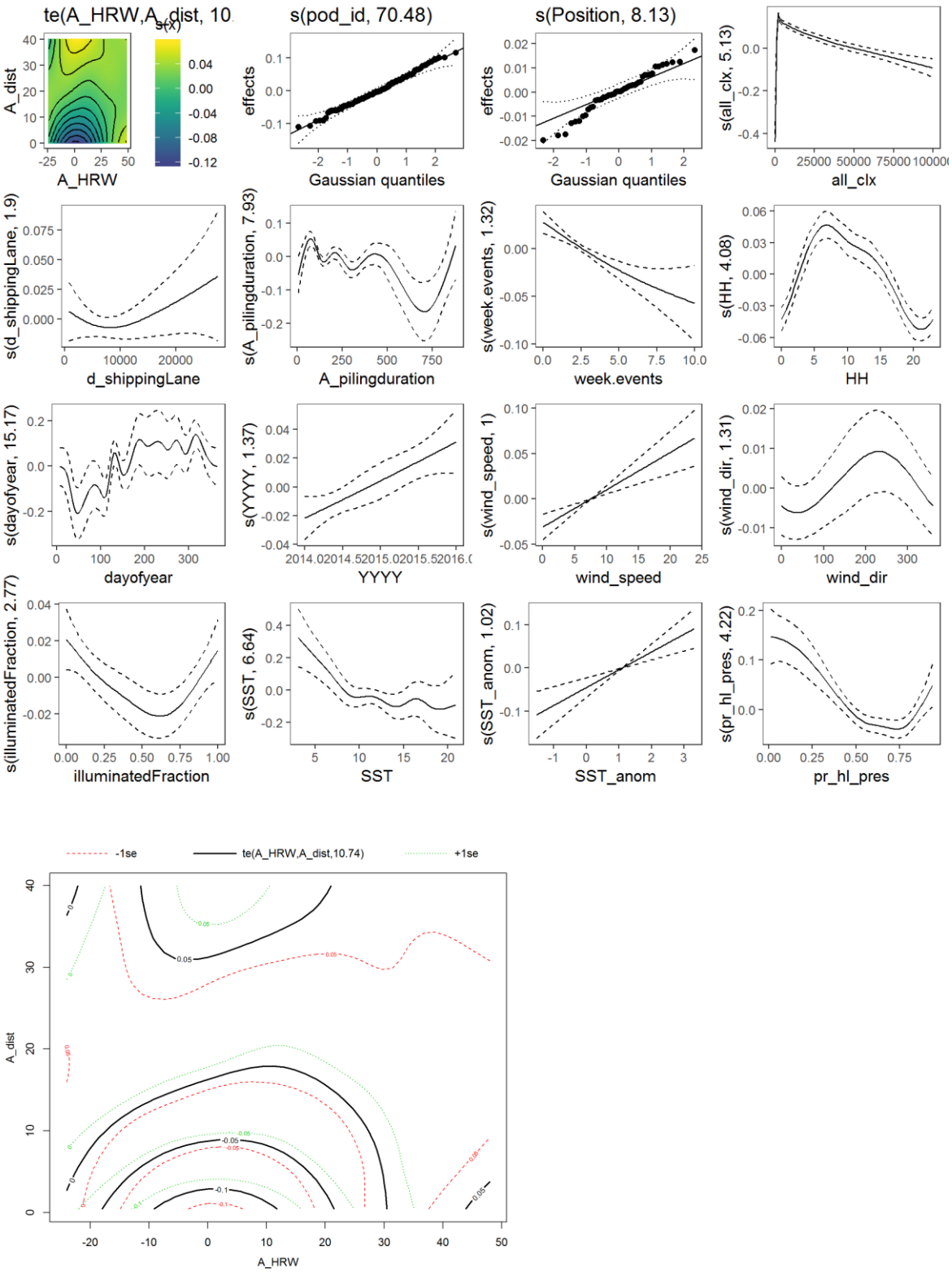


Figure A.16 Comparable global Reference-type GAM M3.1aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Gescha 1: Comparable global Reference-type GAM

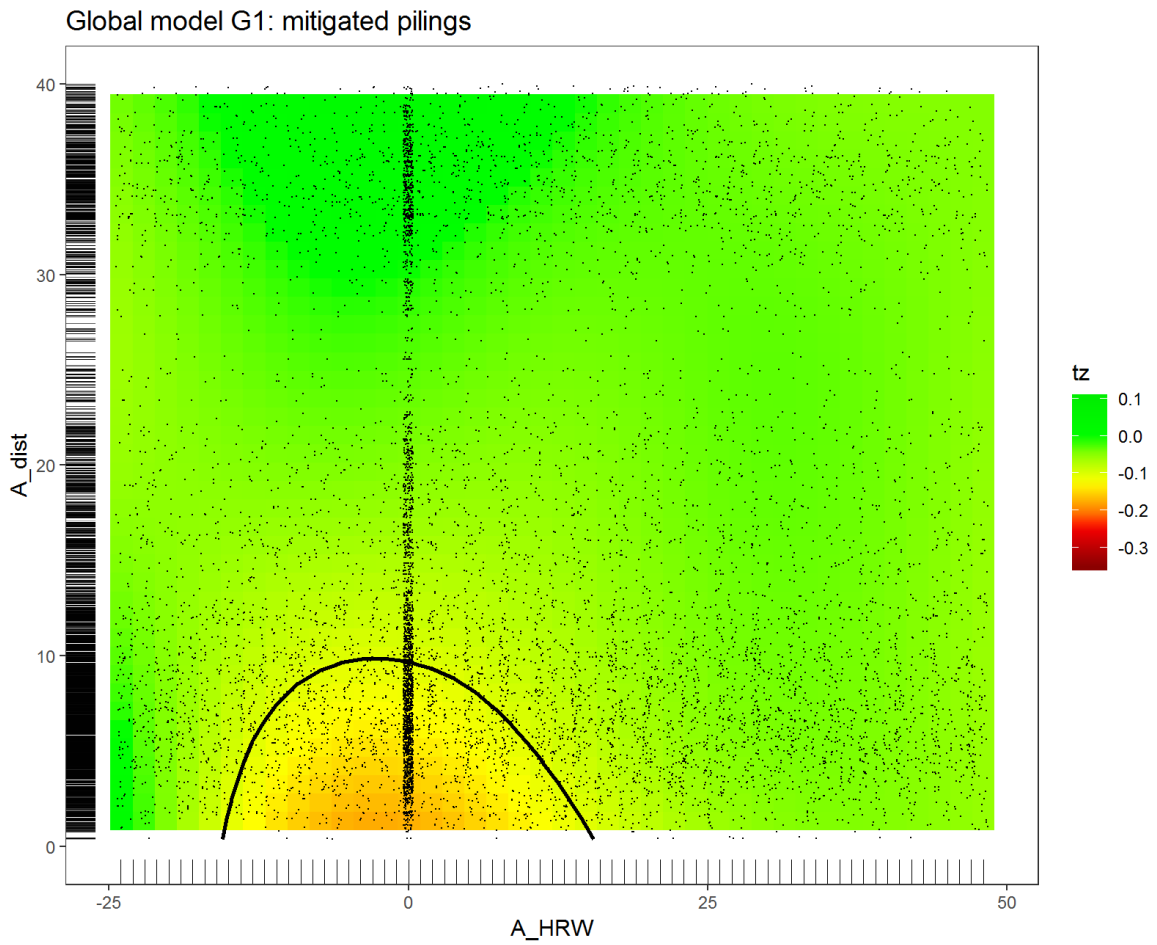
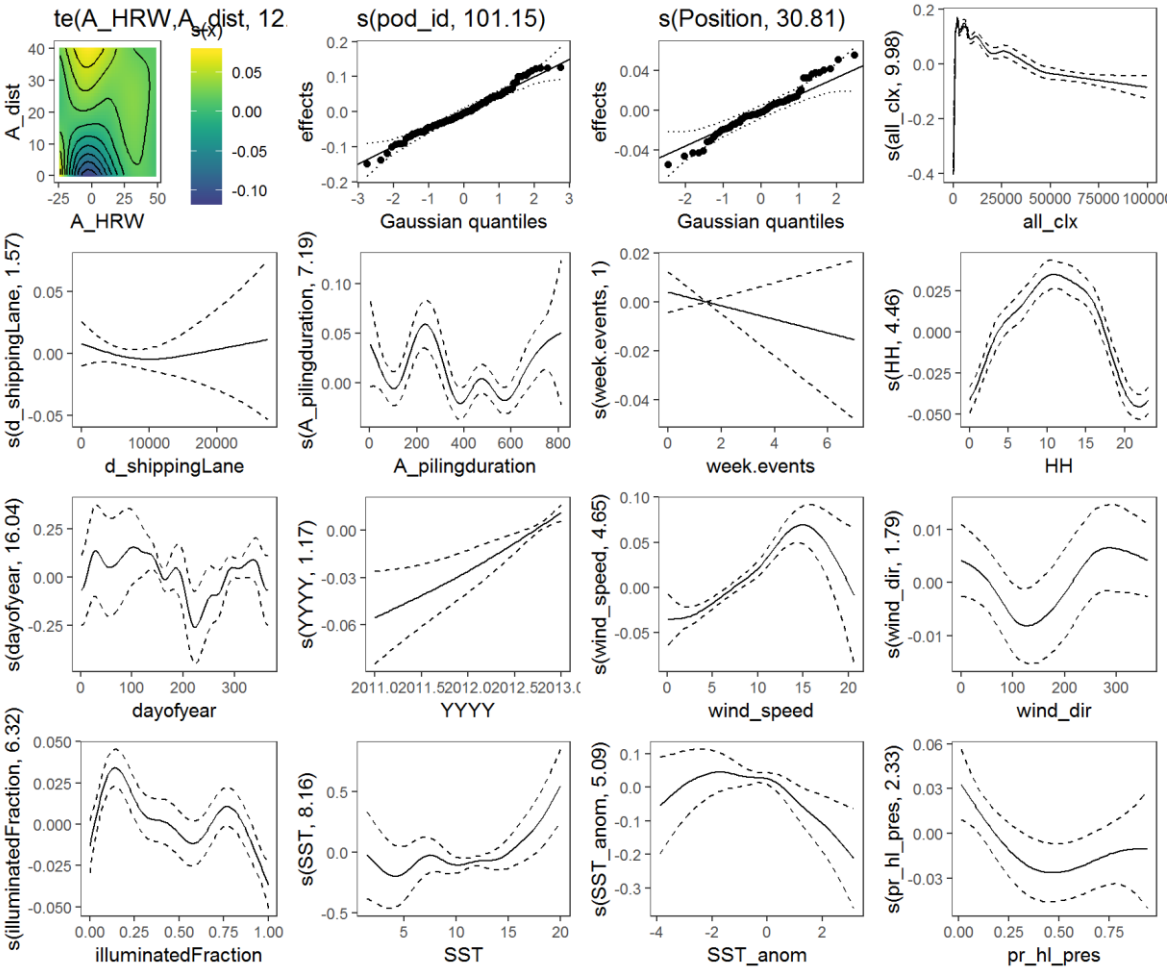


Figure A.17 Comparable global Reference-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); dDPH_ref values on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.



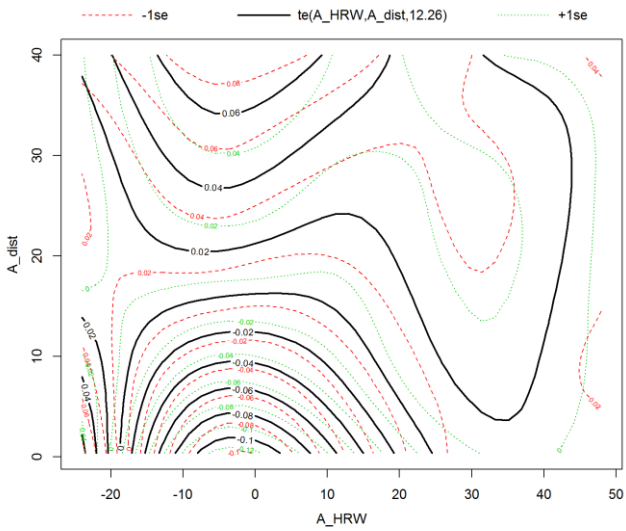


Figure A.18 Comparable global Reference-type GAM M3.1aG1: Mitigated pile driving 2011-2013 (Gescha 1); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Gescha 1 & 2: GAM plots for global models on unmitigated pilings

Effects of unmitigated pilings were only investigated for the combined Gescha 1 & 2 dataset, since not enough such piling events were available for each of the projects alone, especially regarding the Reference-type model. The Cl-type model was computed for a subset of 20,000 data rows as computation was not conductable in time otherwise. Model specifications are given in Table A.2.

Gescha 1 & 2: Global Cl-type GAM on unmitigated pilings

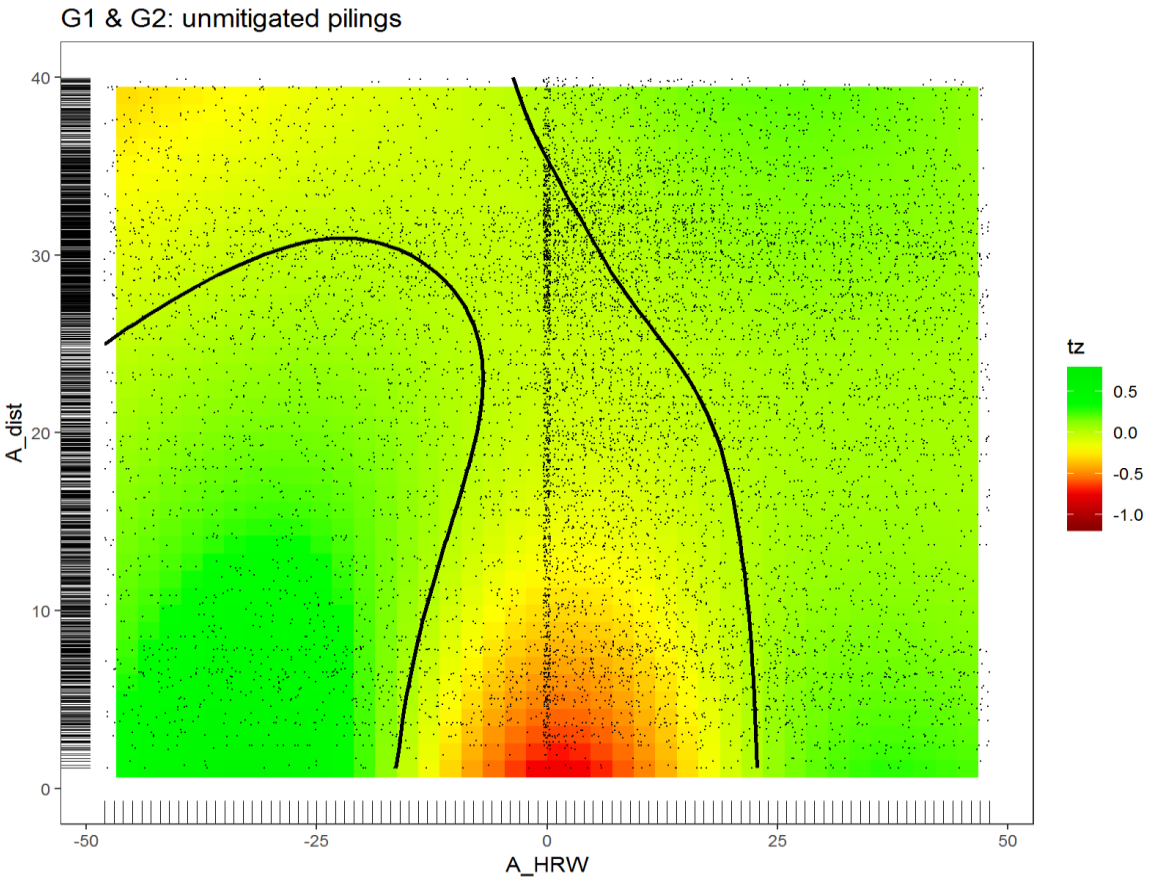
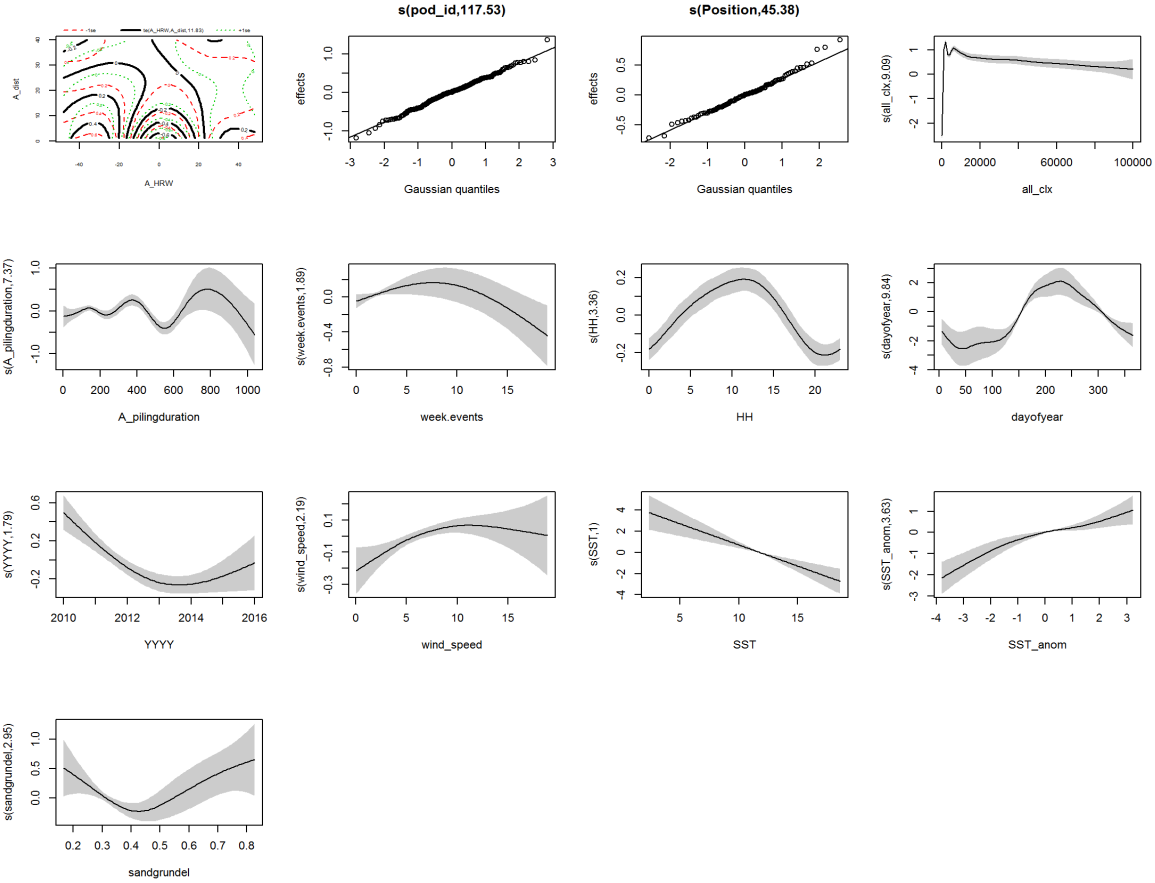


Figure A.19 Global Cl-type GAM M3.1a3G12: Unmitigated pile driving 2011-2016 (Gescha 1 & 2); DPH values on scale of the linear predictor where zero equals the average of fitted values (dotted lines: std. error), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

The global Cl-type model shows a zero line (average of fitted values) which is open-ended with respect to distance (only the lower s.e. was assessible: 22 km). This might have been caused by spatial heterogeneity, as we find lower detection rates also in large distances many hours before piling (Figure A.19). It caused the zero line to be lifted outwards as it represented the mean of the fitted values. The piling effect reached further than for mitigated pilings, but interestingly the onset of effects started later (unmitigated: from hrw-16 [s.e.: hrw-14 to hrw-19]; mitigated: from hrw-28 [s.e.: hrw-∞ to hrw-24]) and ended later (unmitigated: until hrw+23 [s.e.: hrw+20 to hrw+26]; mitigated: until hrw+28 [s.e.: hrw+25 to hrw+33]). The difference before pile driving might have been due to the additional effects of vessels carrying noise-mitigation equipment; however, it was not found with the following Reference-type model. The difference after pile driv-

ing cannot be sufficiently explained, as we found the opposite trend with the following Reference-type model. See Table A.1 for effect error ranges.



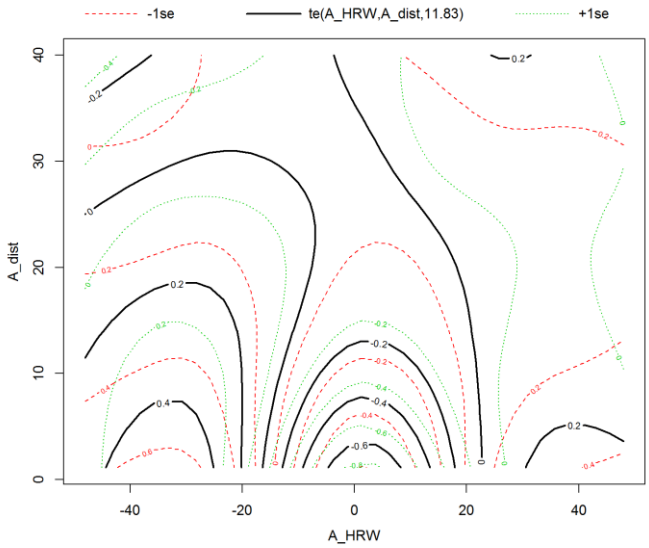


Figure A.20 Global Cl-type GAM M3.1a3G12: Unmitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.

Gescha 1 & 2: Global Reference-type GAM on unmitigated pilings

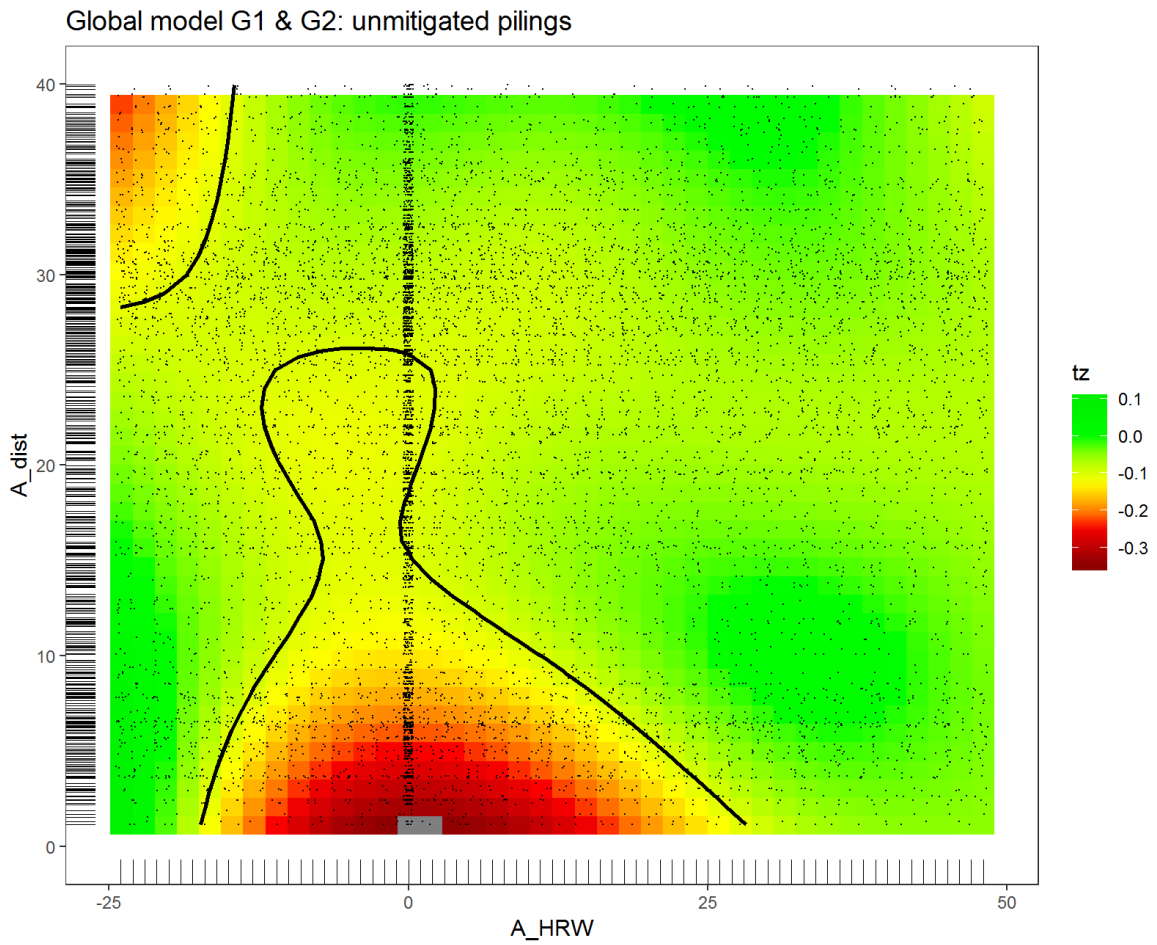


Figure A.21 Global Reference-type GAM M3.1a3G12: Unmitigated pile driving 2011-2016 (Gescha 1 & 2); dDPH_ref values on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

Also the global Reference-type model shows that effects of unmitigated pilings are farther-reaching than those of mitigated pile driving (unmitigated: 26 km [s.e.: 22-30 km]; mitigated: 11 km [s.e.: 10-12 km]). With the Reference-type model a 20 % reduction of *dDPH_ref* relative to reference level occurred at a similar time before piling (around hrw-18; Figure A.21), but an effect of at least 20 % reduced *dDPH_ref* lasted much longer after piling (unmitigated: hrw+28 [s.e.: hrw+24 to hrw+34]; mitigated: hrw+19 [s.e.: hrw+17 to hrw+21]). The difference after pile driving might be due to the longer timespan it took porpoises to return from farther distances; however, the opposite trend was found with the Cl-type model. At the hours of pile driving, the effect at close range was much stronger for unmitigated pilings (dark-red colour in Figure A.21) than for mitigated pilings (bright-orange colour; see Figure 4.11 in report). See Table A.1 for effect error ranges.

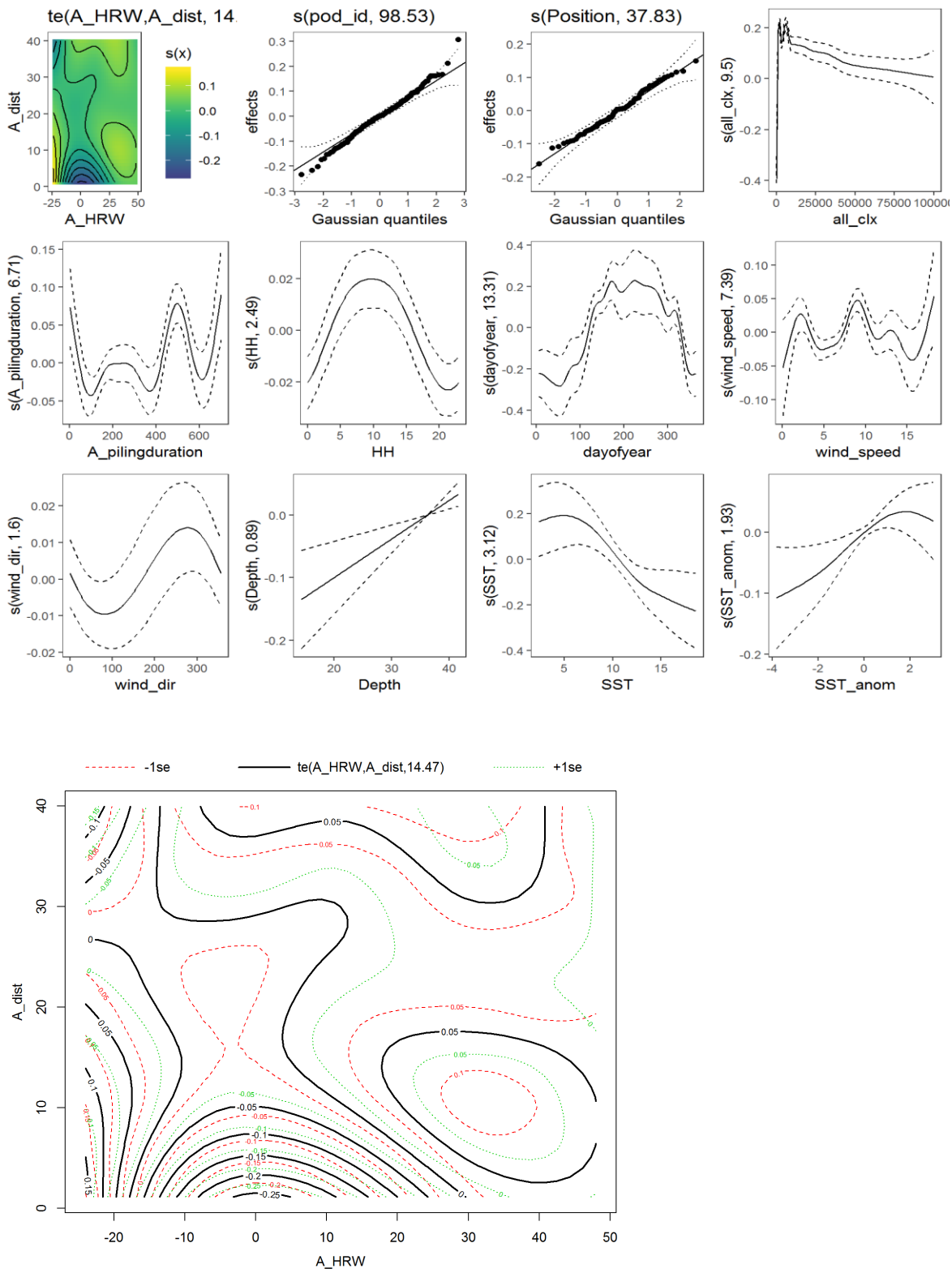


Figure A.22 Global Reference-type GAM M3.1a3G12: Unmitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

WP 3.1 – Global models: Additional tables

Gescha 1 & 2: Effect range and duration for unmitigated pile driving

Table A.1 Summary of effect ranges and durations for the Gescha 2, Gescha 1, and the Gescha 1 & 2 dataset of unmitigated pilings under both model types (with approximate range after standard errors obtained by default GAM plots shown above; ∞: no finite lower or upper standard error or mean).

Study	Cl-type: Min. effect range at hrw0	Cl-type: Min. effect duration before piling (0 km)	Cl-type: Min. effect duration after piling (0 km)	Cl-type: Min. effect duration before piling (3 km)	Cl-type: Min. effect duration after piling (3 km)	Ref-type: 20 % reduction at hrw0	Ref-type: 20 % reduction before piling (0 km)	Ref-type: 20 % reduction after piling (0 km)
G1G2	∞ (22-∞) km	17 (15-19) h	23 (20-26) h	16 (14-18) h	23 (20-25) h	26 (22-30) km	18 (16-19) h	28 (24-34) h

Gescha 1 & 2: Parameters of models on unmitigated pile driving

Table A.2 *Summary of specifications and results of the final global and noise-level models on unmitigated pile driving: Inclusion and significance levels of each variable are indicated as follows: '-': variable not significant and therefore not included into the final model, except if it is a variable of primary interest, in which case 'ns' (not significant); other levels of significance: '***': p<0.001; '**': p<0.01; '*': p<0.05; empty cell: variable not in the starting set of variables; variable of primary interest within each model highlighted by grey cell.*

Work package	**3.1**		**3.3**	
Model number	**M3.1a3G12**		**M3.3a3G12**	
Model **Years** **Mitigation status** **Subset**	**global** **2011-16** **unmitigated** **c**		**noise level** **2011-16** **unmitigated** **0-40 km, hrw 0**	
Model type	**Cl-type**	**Ref-type**	**Cl-type**	**Ref-type**
Position (random factor)	***	***	***	**
pod_id (random factor)	***	***	*	***
DPHt (factor)	***		***	
YYYY (smooth)	***	-		**
dayofyear (cyclic smooth)	***	***	***	-
HH (cyclic smooth)	***	***	*	-
wind_speed (smooth)	**	***	**	***
wind_dir (cyclic smooth)	-	**	***	-
surface_speed (smooth)				
surface_dir (cyclic smooth)				
SST (smooth)	***	**	-	-
SST_anom (smooth)	***	***		-
all_clx (smooth)	***	***	***	***
depth (smooth)	-	***	***	-
slope (smooth)	-	-	-	-
phyto (smooth)				
illimunatedFraction*(smooth)*	-	-	-	-
sandaal (smooth)	-	-	-	-
sandgrundel (smooth)	***	-	-	-
A_pilingduration (smooth)	***	***	-	-
week.events (smooth)	**	-	-	-
d_shippingLane (smooth)	-	-	-	-
Interaction of ***A_HRW*** and ***A_dist*** (tensor)	***	***		
Interaction of ***A_dist*** and ***SEL05_750*** (tensor)			***	***
Deviance explained %	24.8	21.1	31.2	33.0
N hourly data	20,000	15,989	1,871	1,081
N piling events	385	131	35	20

WP 3.3 – Noise-level models: Additional plots

In the report, only noise models for the combined Gescha 1 & 2 dataset were shown since those models were based on the broadest dataset. In addition, we present the noise-level models for the Gescha 2 dataset alone, as well as additonal plots of the *gam.plot()* function showing standard errors.

As with the global models, standard error contour lines of the 20 % reduction line in the Reference-type models and the zero line of the CI-type models could not be shown in the coloured plots of the report, due to technical reasons. Regarding the Reference-type models, the following default plots cannot show effects on the response scale (e.g., the 20 % reduction line with standard errors), but only on the scale of the linear predictor where zero equals the average of fitted values. Therefore, the default GAM plots for the Reference-type models presented below only allow for the assessment of the approximate range of the standard error for this model type, by looking at error lines of a contour line being closest to the 20 % reduction line.

Gescha 2 models

Effect of piling-noise level at hrw 0 relative to distance from construction site

Mitigated pilings:

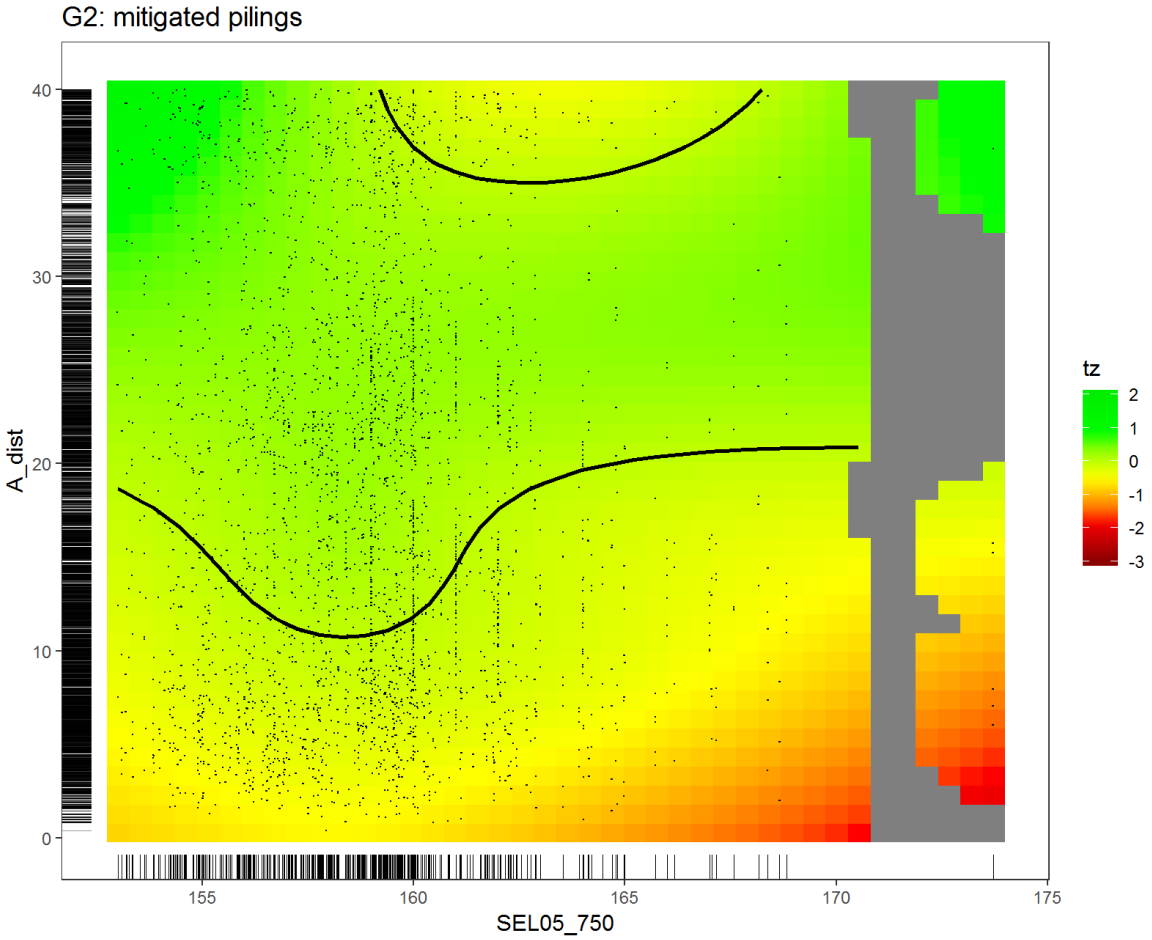


Figure A.23 Cl-type noise-level GAM M3.3a1G2: Mitigated pile driving 2014-2016 (Gescha 2); DPH values at piling hour (hrw 0) on scale of the linear predictor where zero (black lines) equals the average of fitted values, modelled on the interaction of the variables SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data.

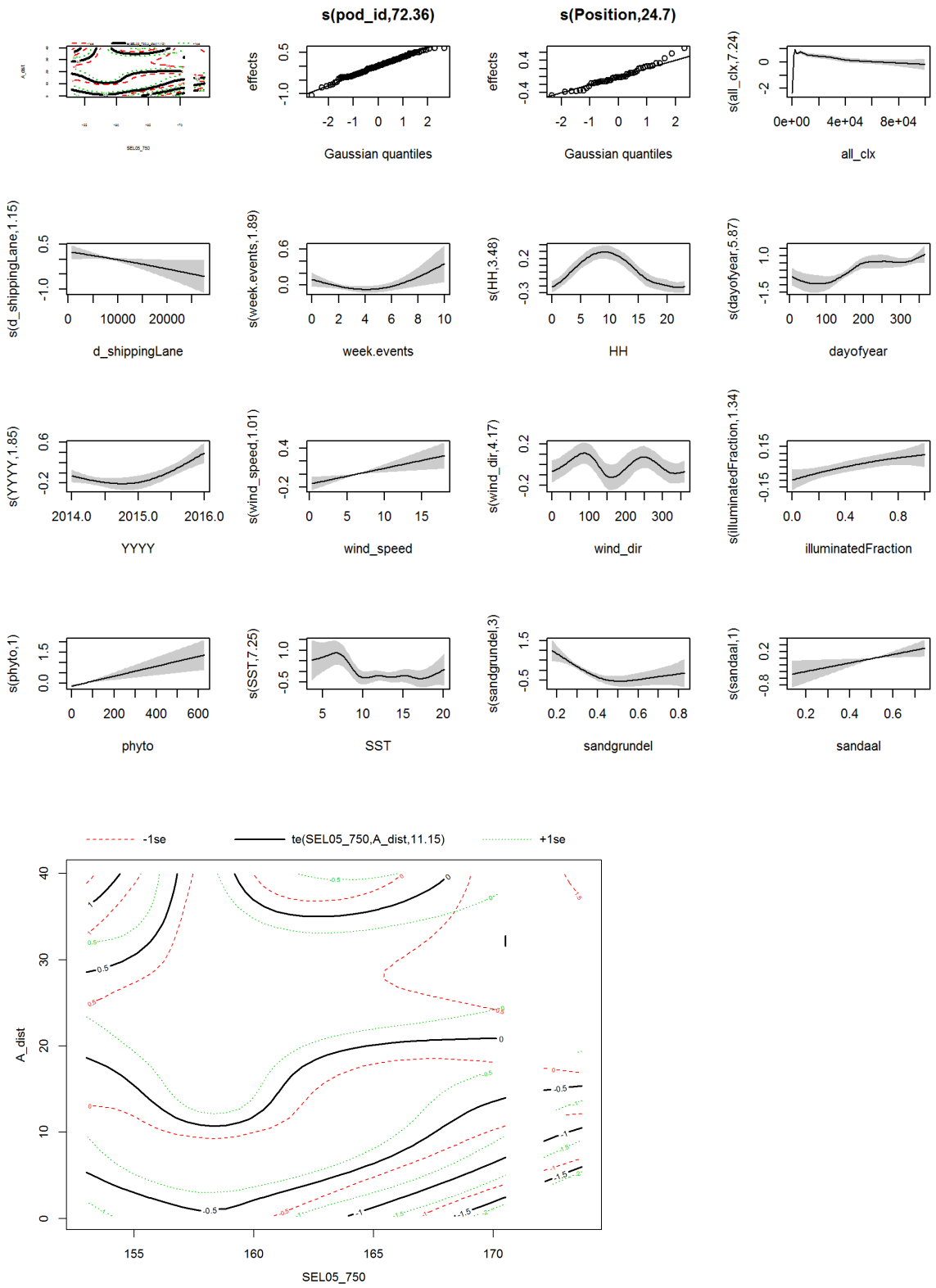


Figure A.24 Cl-type noise-level GAM M3.3a1G2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

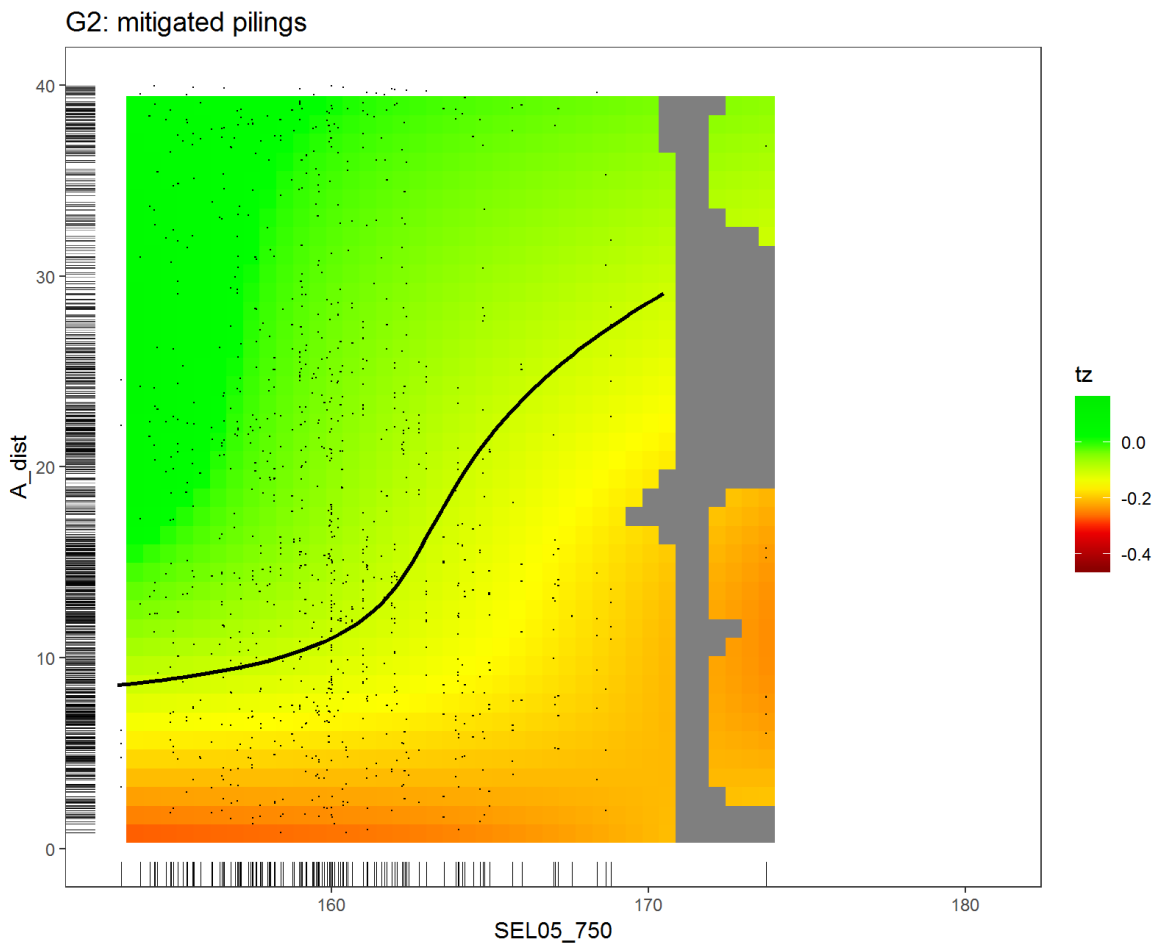


Figure A.25 Reference-type noise-level GAM M3.3a1G2: Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values at piling hour (hrw 0) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data.

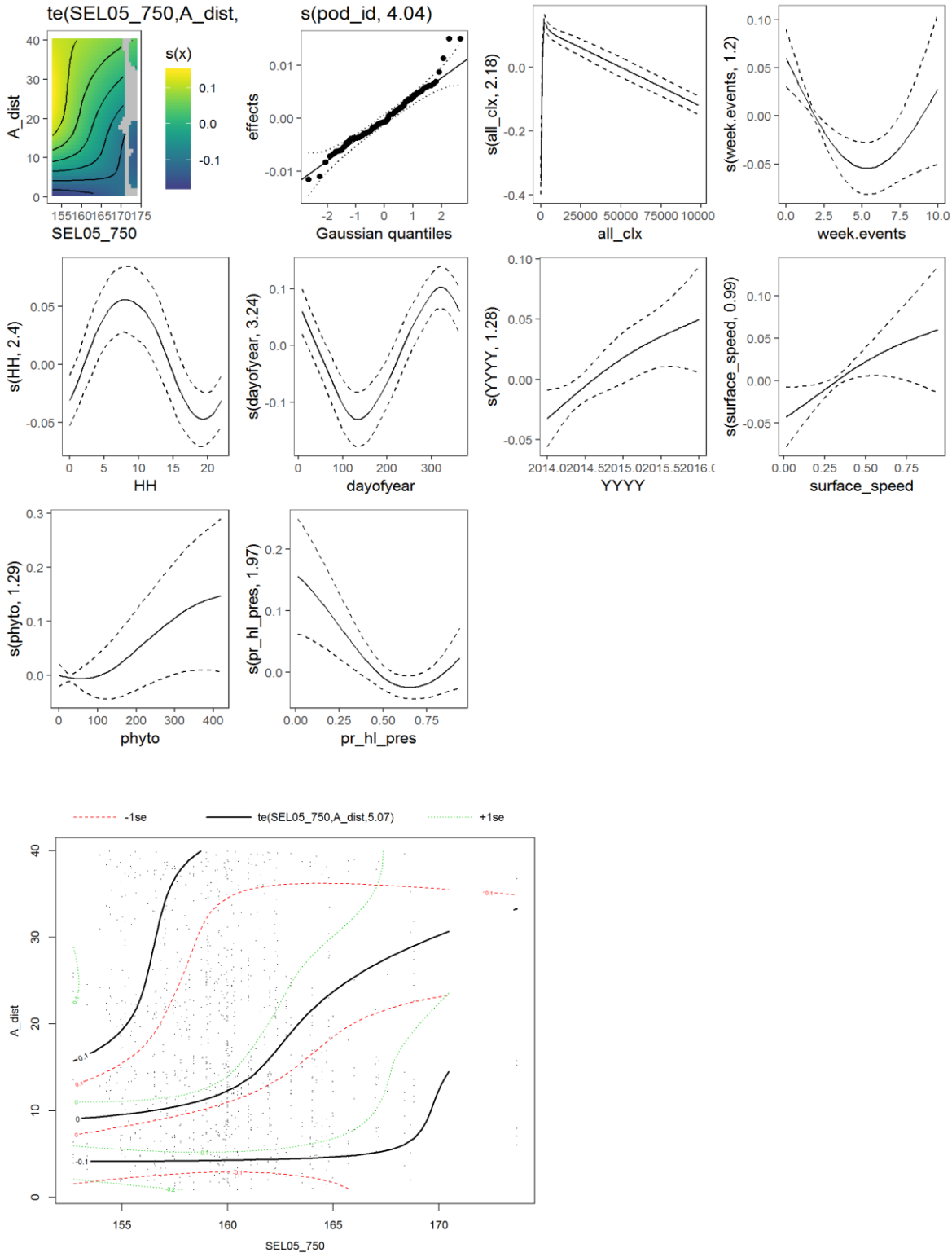


Figure A.26 Reference-type noise-level GAM M3.3a1G2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Mitigated and unmitigated pilings:

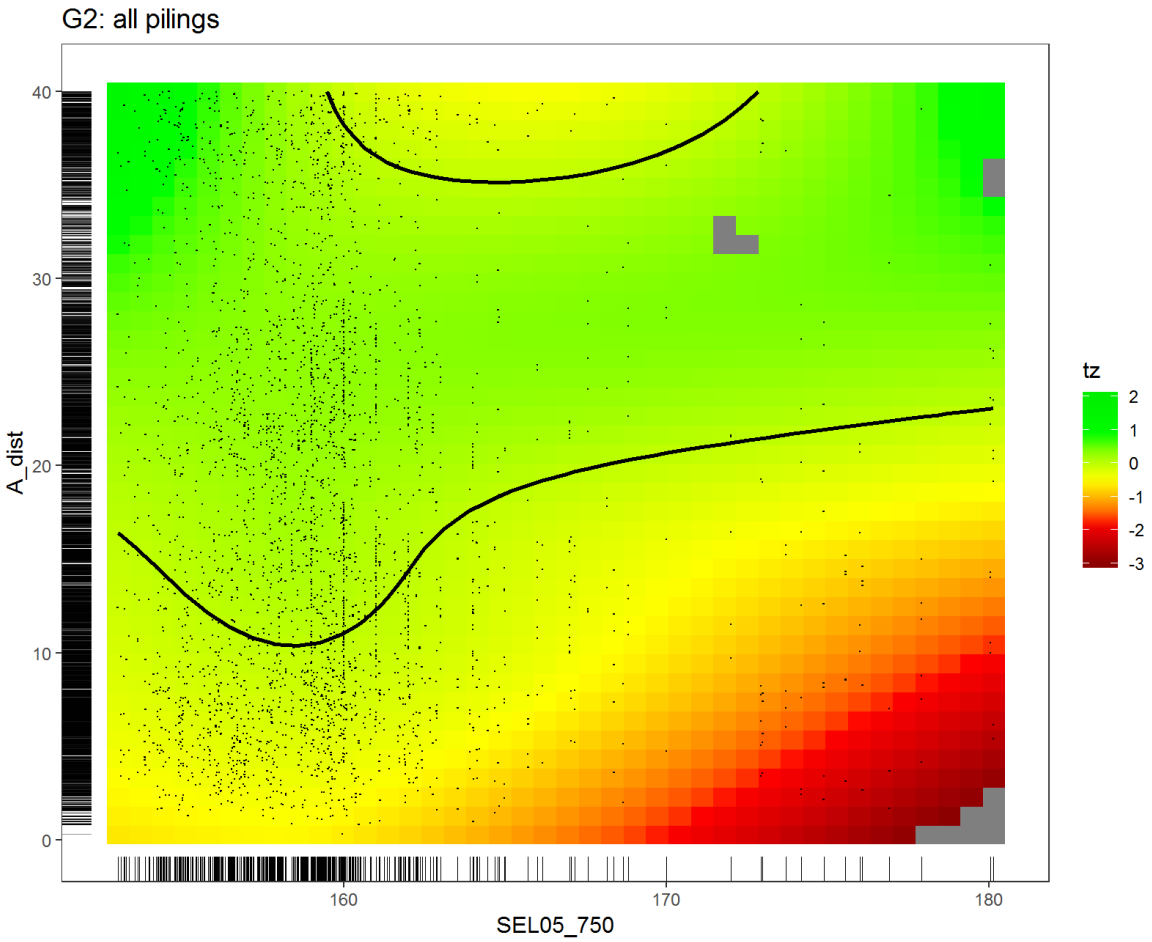


Figure A.27 Cl-type noise-level GAM M3.3a2G2: All pilings 2014-2016 (Gescha 2); DPH values at piling hour (hrw 0) on scale of the linear predictor where zero (black lines) equals the average of fitted values, modelled on the interaction of the variables SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data.

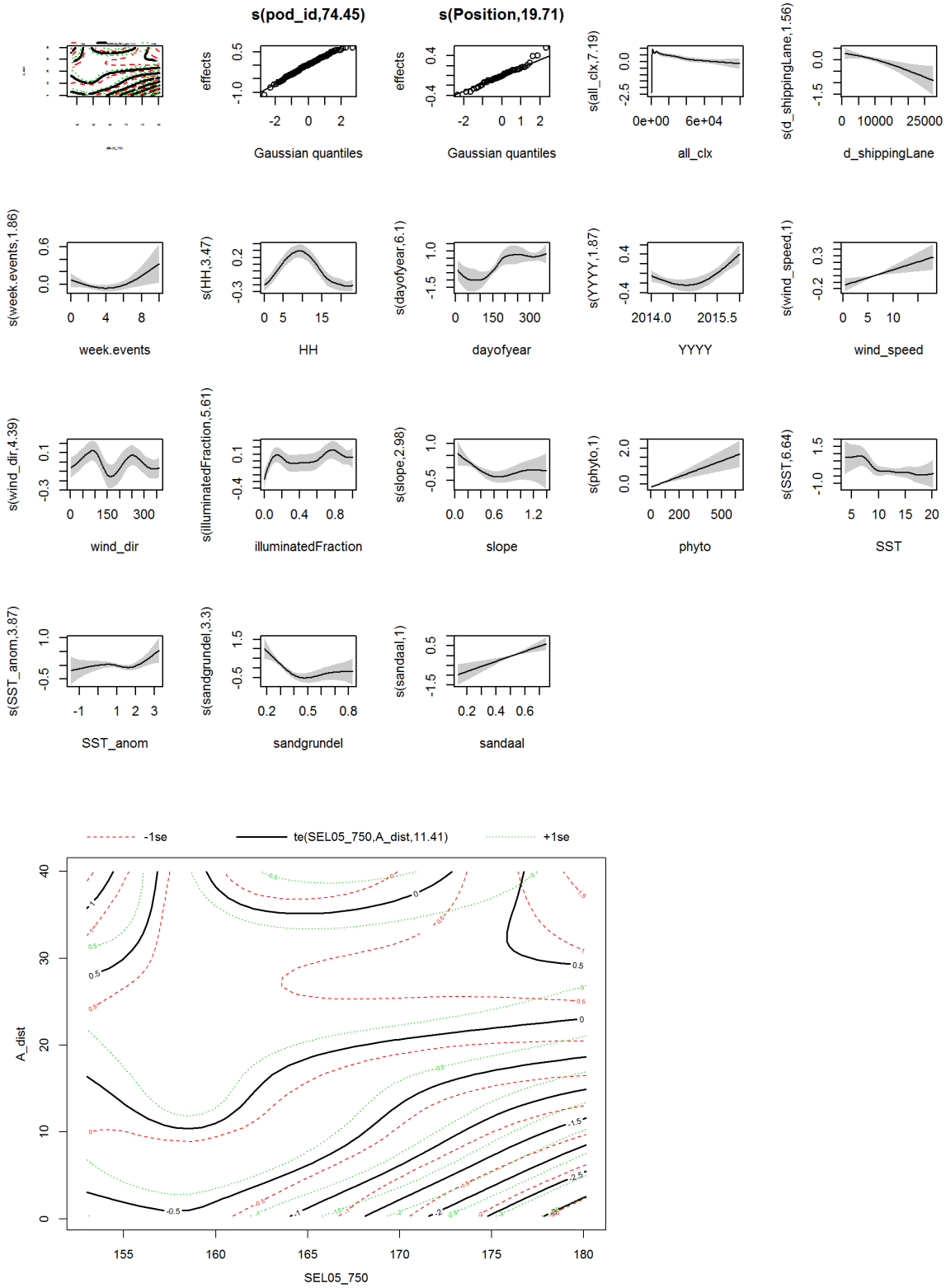


Figure A.28 *Cl-type noise-level GAM M3.3a2G2: All pilings 2014-2016 (Gescha 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.*

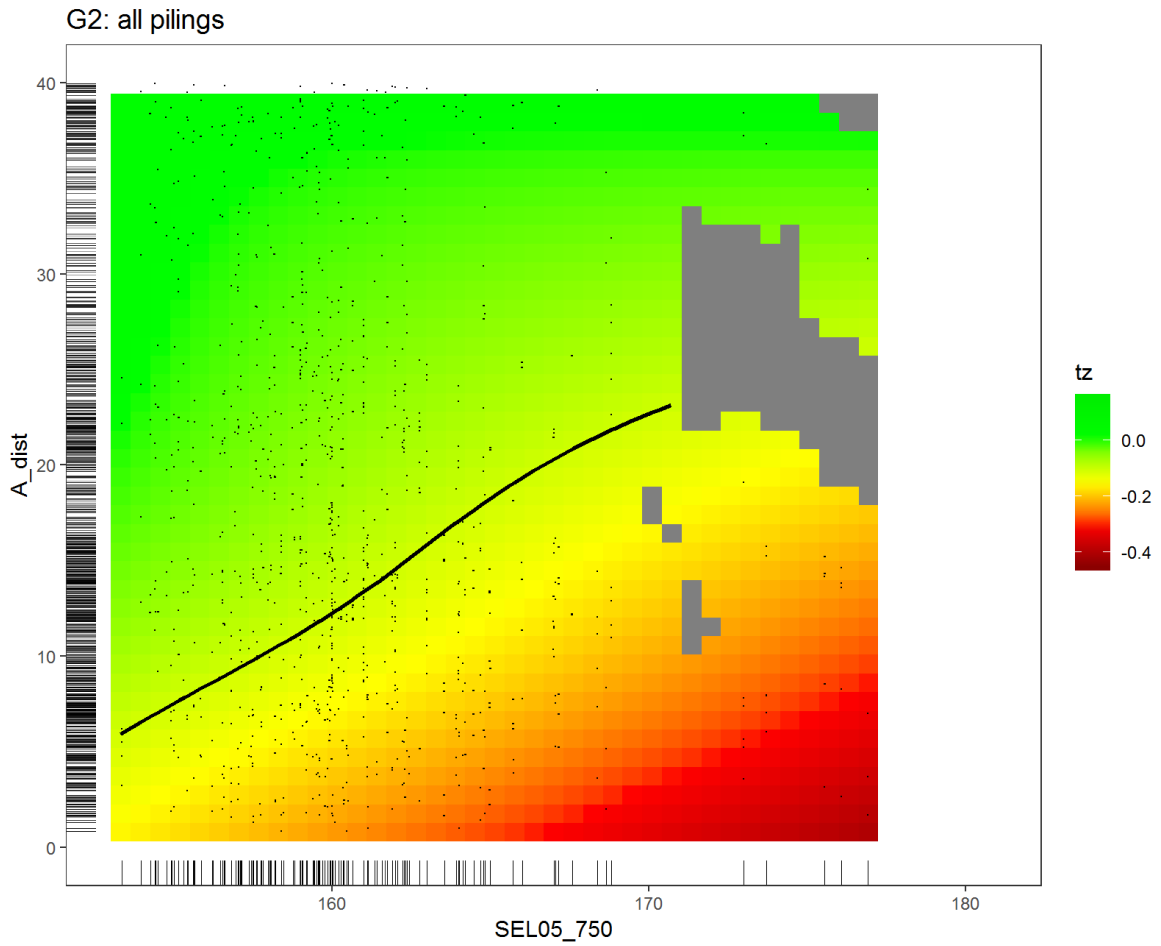


Figure A.29 *Reference-type noise-level GAM M3.3a2G2: All pilings 2014-2016 (Gescha 2); dDPH_ref values at piling hour (hrw 0) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data; the pattern of an increase from about 165 dB is not to be found here, but it has to be kept in mind that the dataset is much smaller here than for the combined Gescha 1 & 2 dataset and only has very few unmitigated pilings (= loud noise levels) included.*

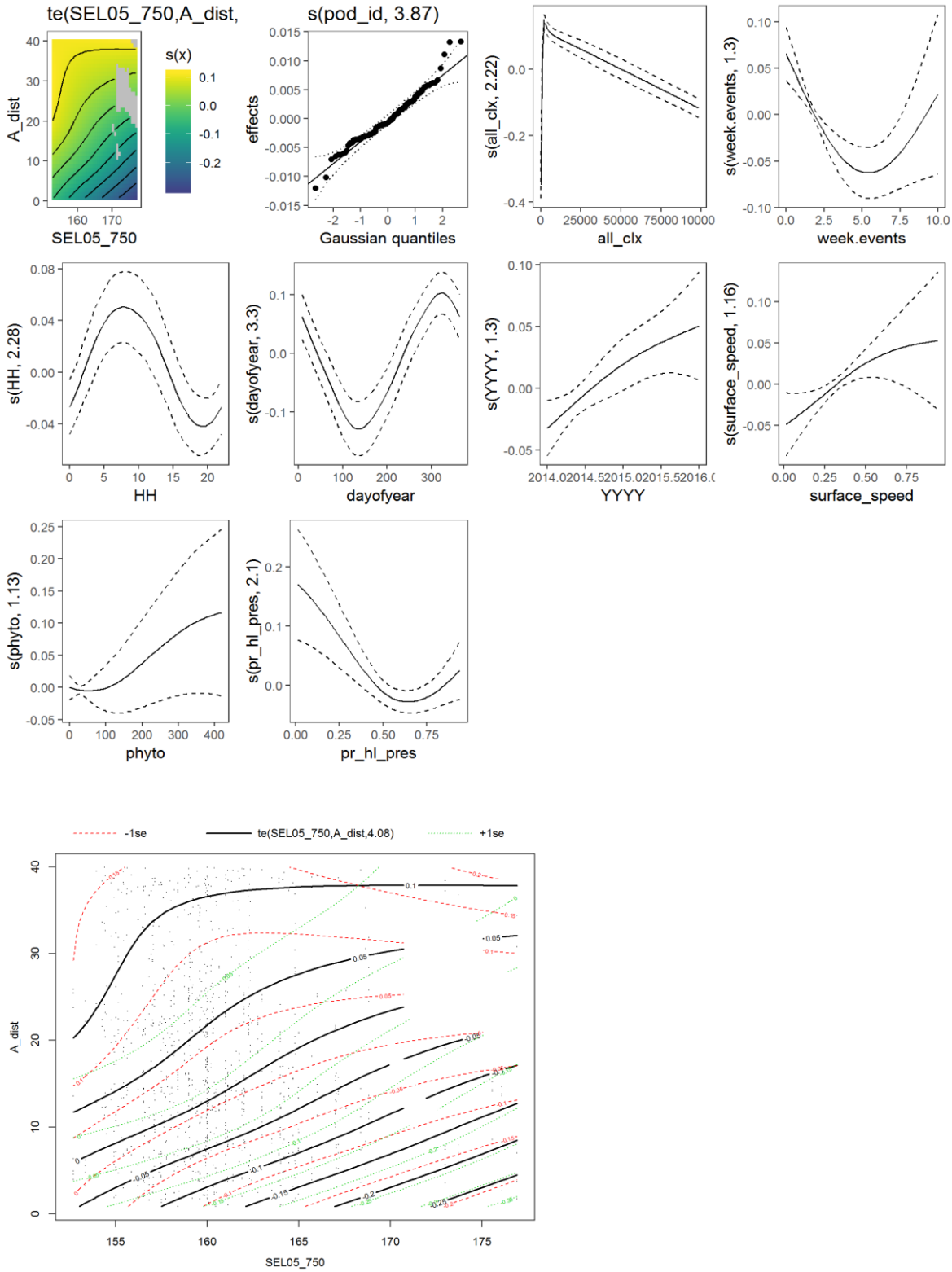


Figure A.30 Reference-type noise-level GAM M3.3a2G2: All pilings 2014-2016 (Gescha 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Unmitigated pilings:

Effects of unmitigated pilings were only investigated for the combined Gescha 1 & 2 dataset, since not enough such piling events were available for each of the projects alone, especially with respect to noise-level data. Model specifications are given in Table A.2.

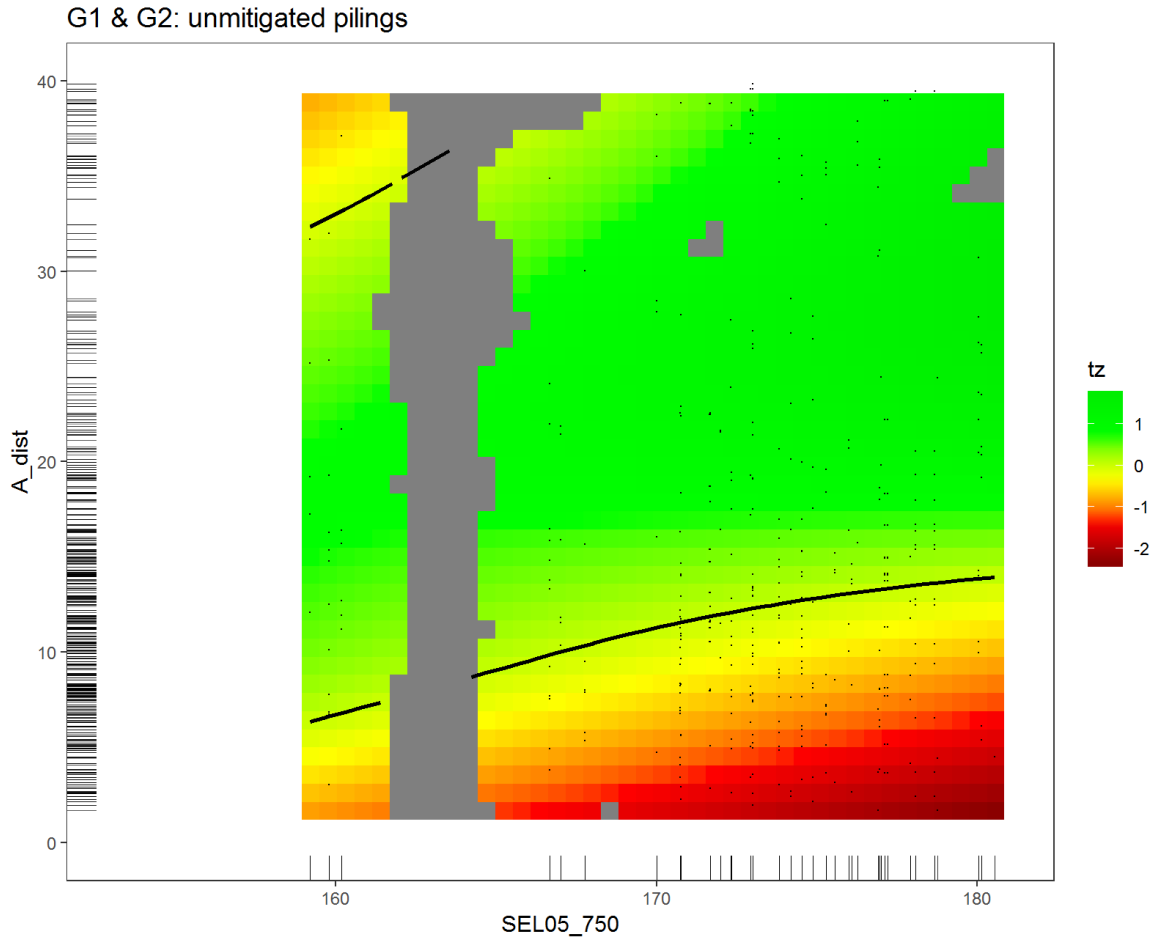


Figure A.31 Cl-type noise-level GAM M3.3a3G12: Unmitigated pilings 2011-2016 (Gescha 1 & 2); DPH values at piling hour (hrw 0) on scale of the linear predictor where zero (black lines) equals the average of fitted values, modelled on the interaction of the variables SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data.

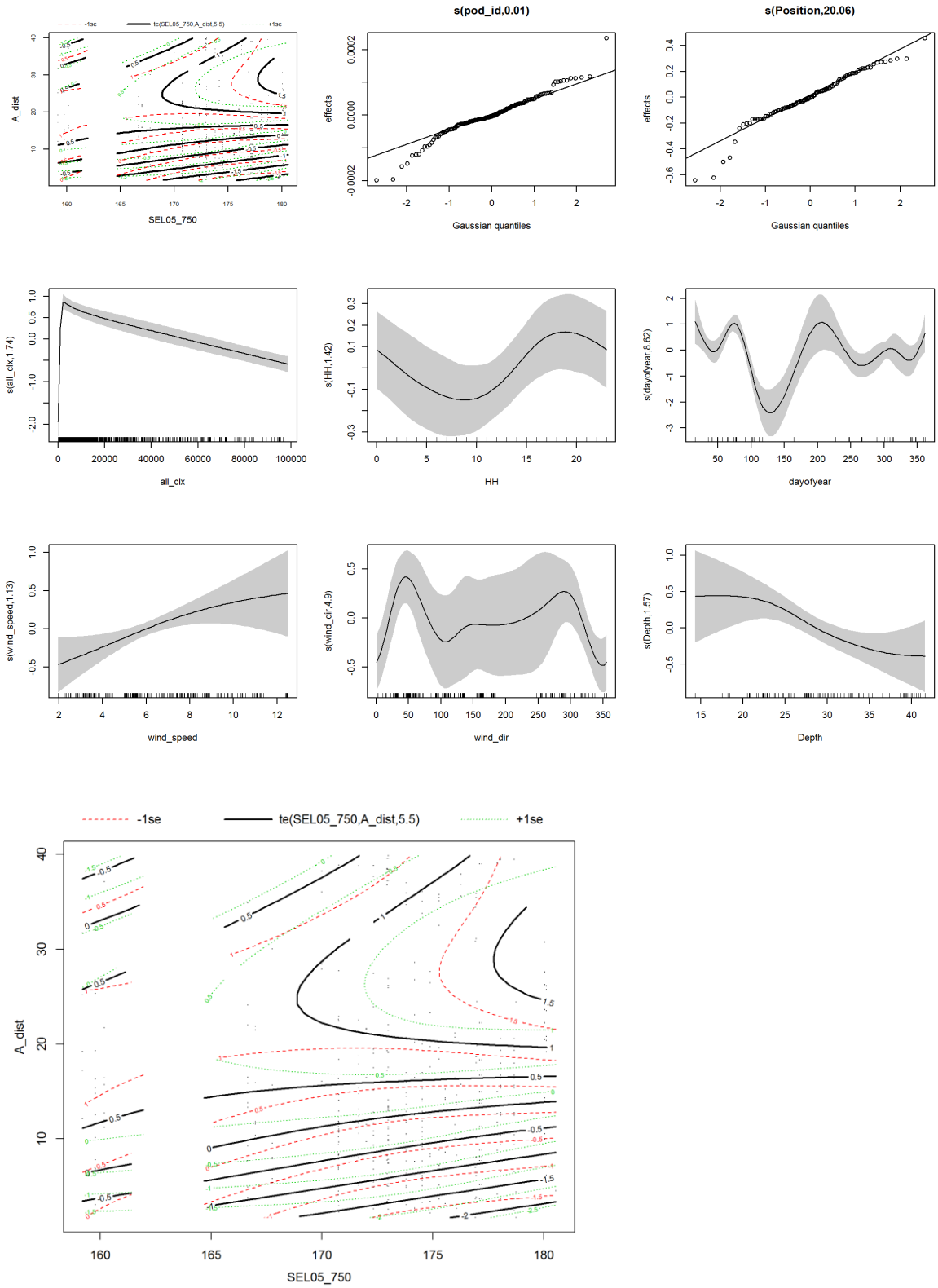


Figure A.32 Cl-type noise-level GAM M3.3a3G12: Mitigated pilings 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

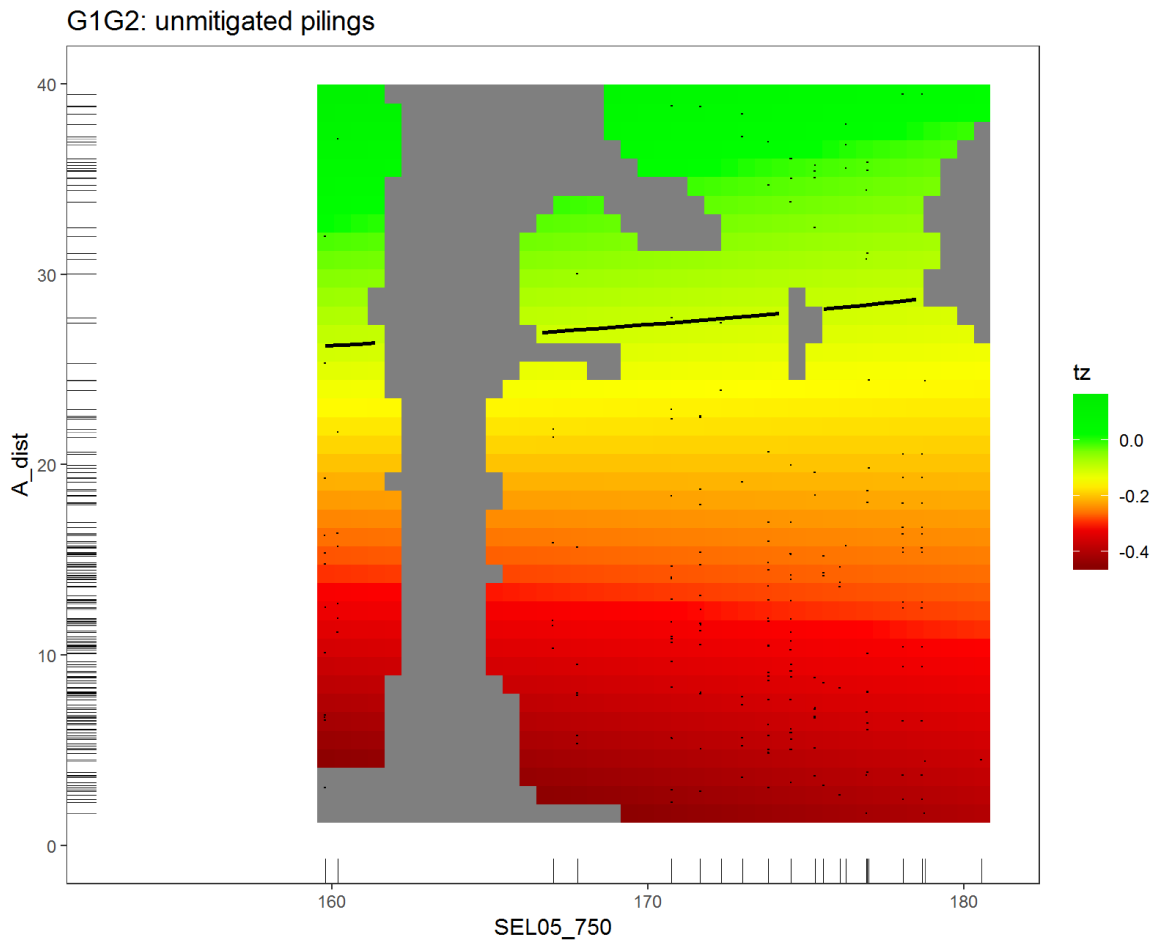


Figure A.33 Reference-type noise-level GAM M3.3a3G12: Unmitigated pile driving 2011-2016 (Gescha 1 & 2); dDPH_ref values at piling hour (hrw 0) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_dist (distance to piling); black dots: data.

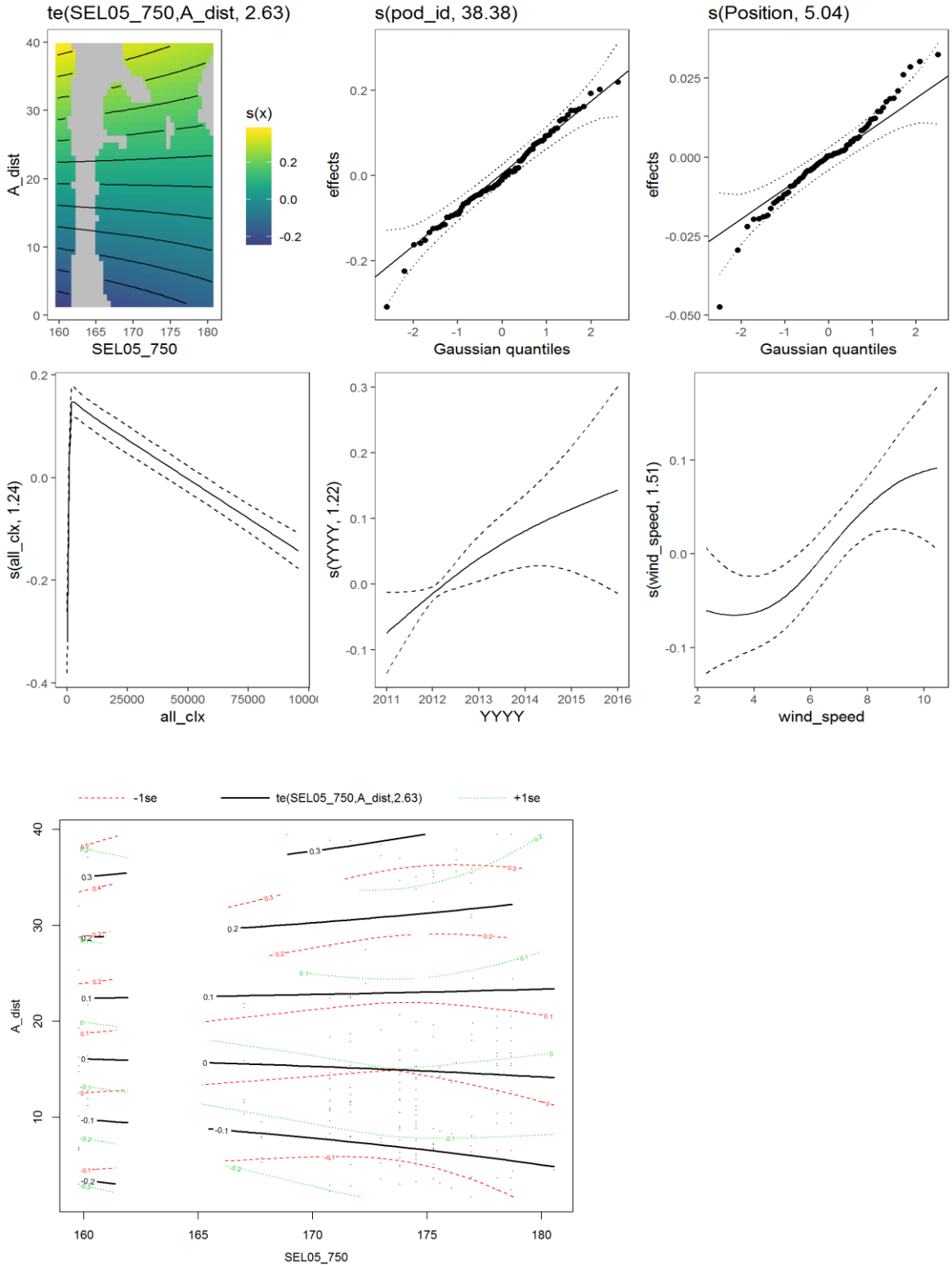


Figure A.34 Reference-type noise-level GAM M3.3a3G12: Unmitigated pilings 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Effect of piling-noise level in relation to time after pile driving (in up to 10 km distance)

Mitigated pilings:

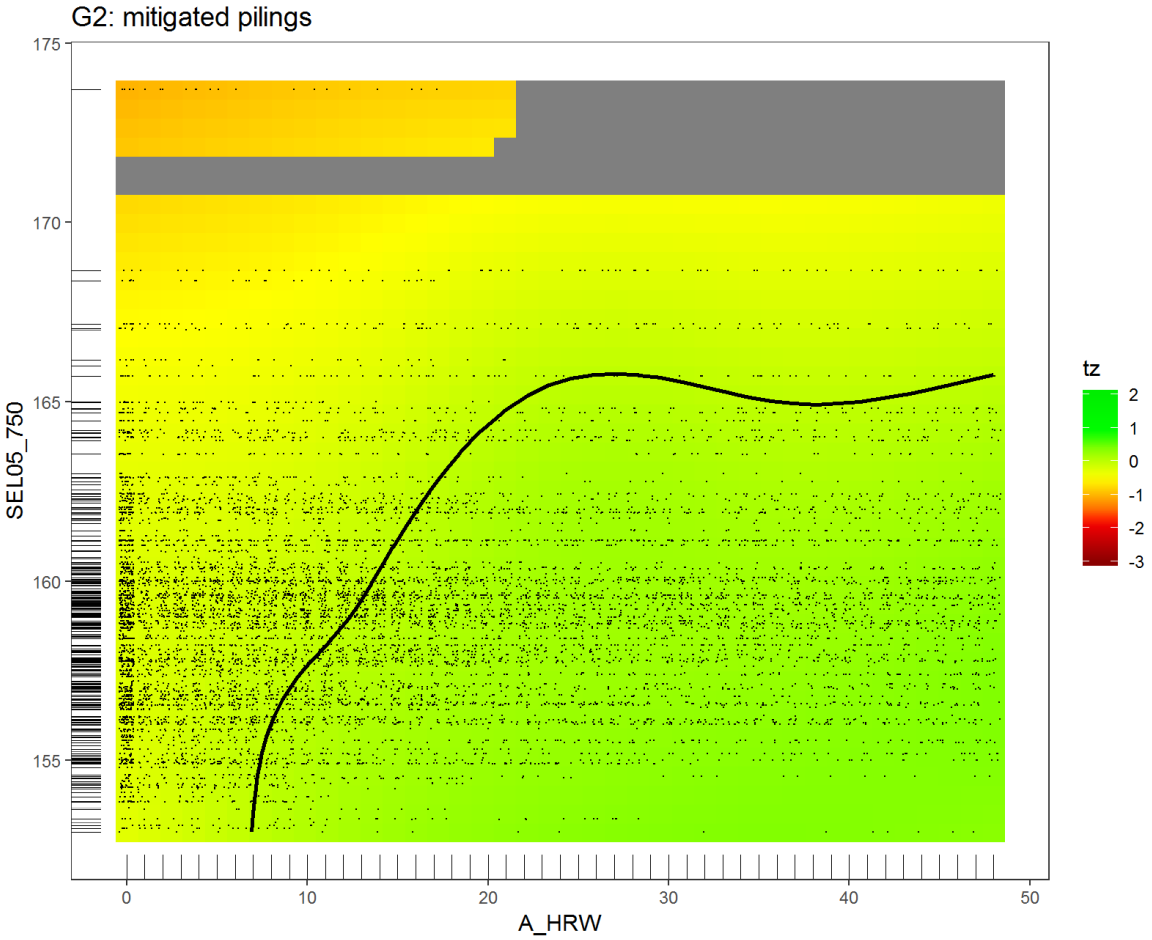


Figure A.35 Cl-type noise-level GAM M3.3b1G2: Mitigated pile driving 2014-2016 (Gescha 2); DPH values in close range (0-10 km) on scale of the linear predictor where zero equals the average of fitted values, modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); black dots: data.

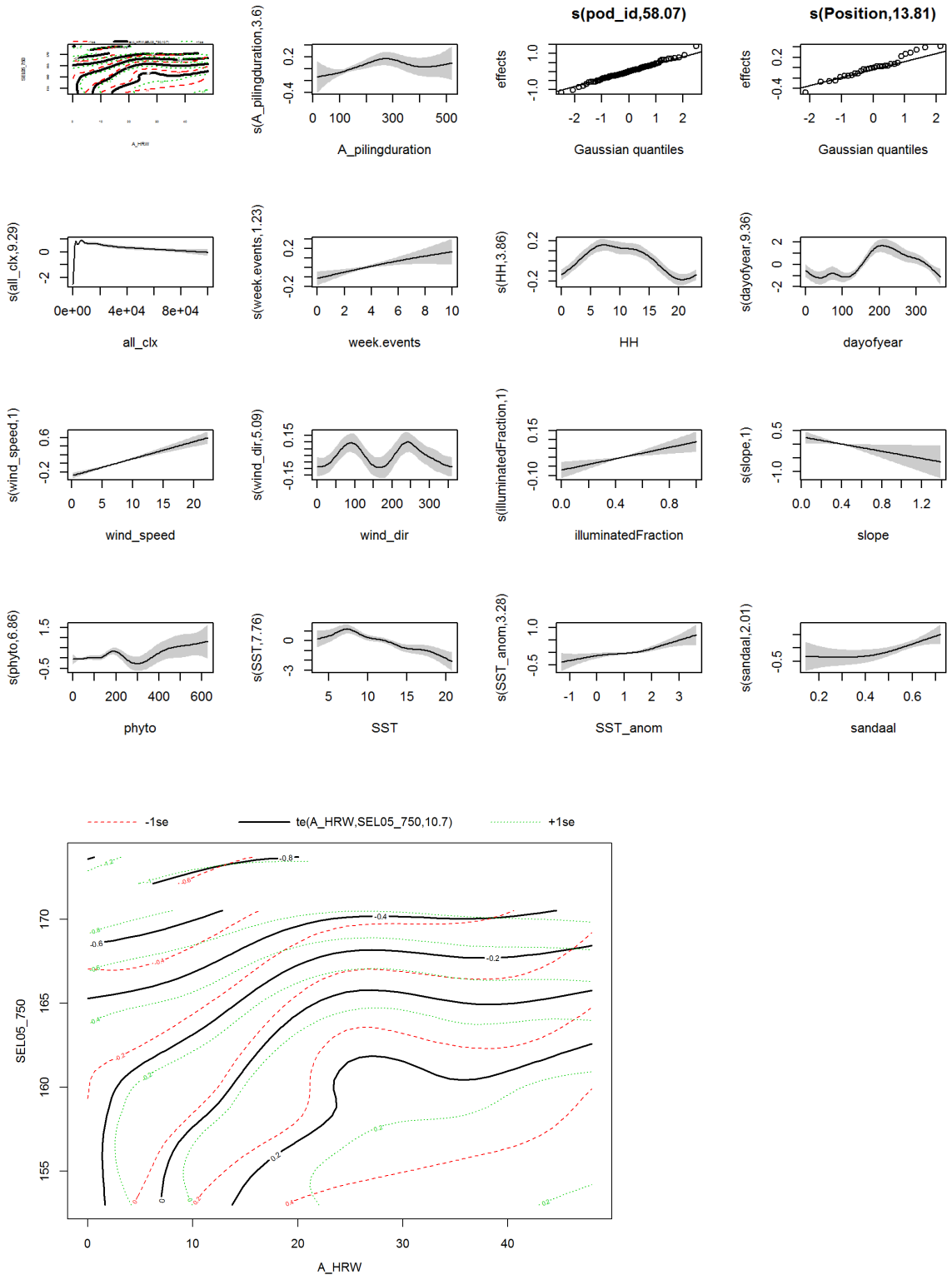


Figure A.36 *Cl-type noise-level GAM M3.3b1G2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.*

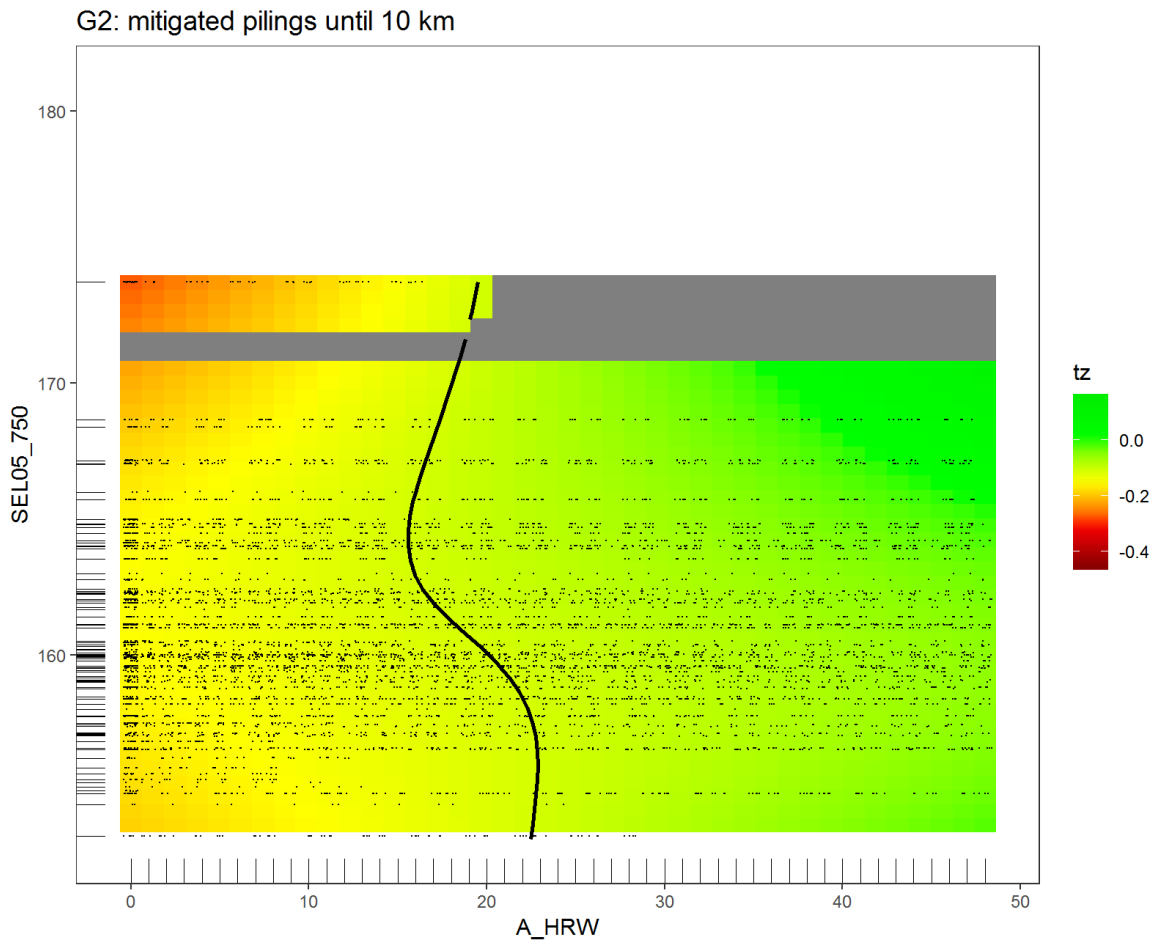
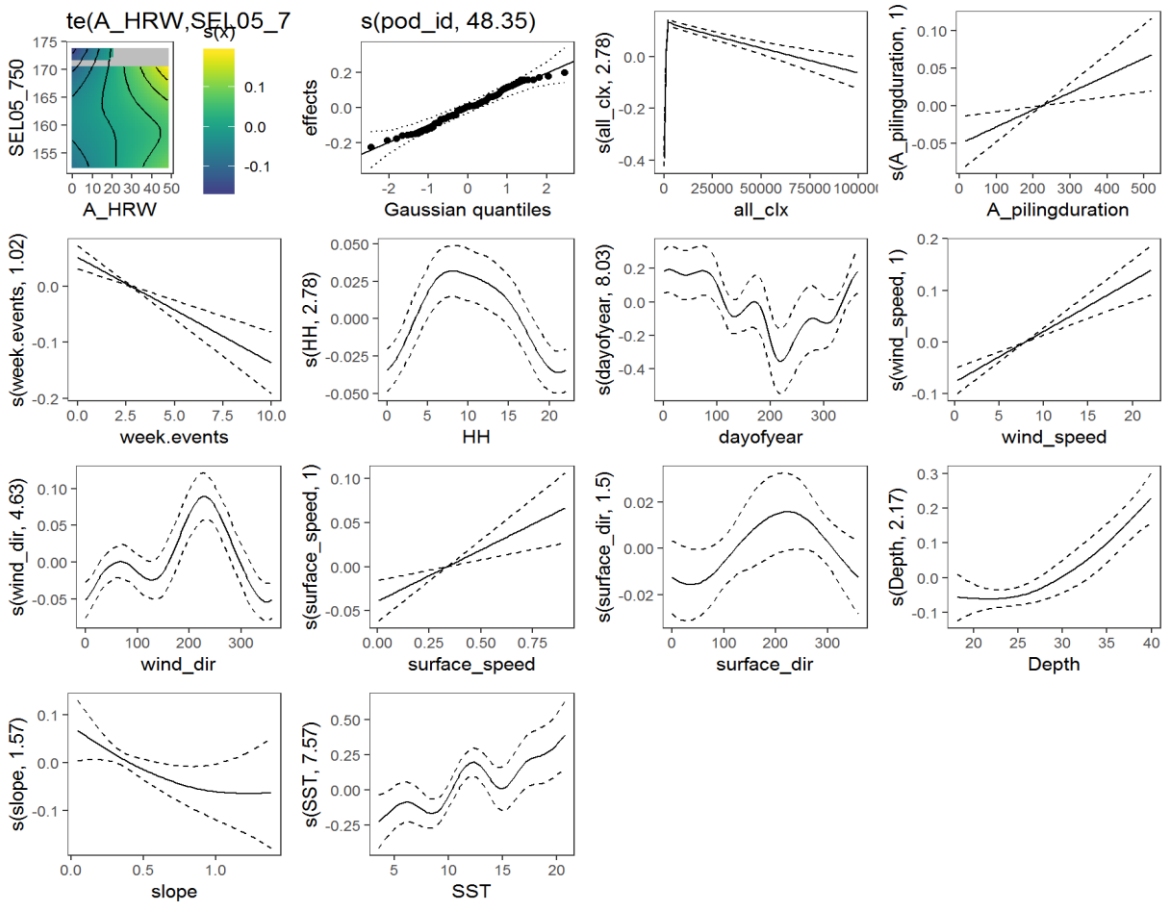


Figure A.37 Reference-type noise-level GAMs M3.3b1G2: Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values in close range (0-10 km) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); black dots: data.



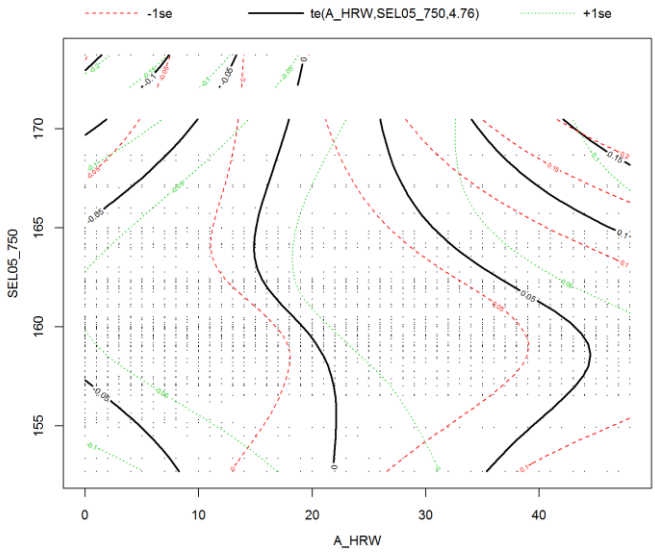


Figure A.38 Reference-type noise-level GAM M3.3b1G2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Mitigated and unmitigated pilings:

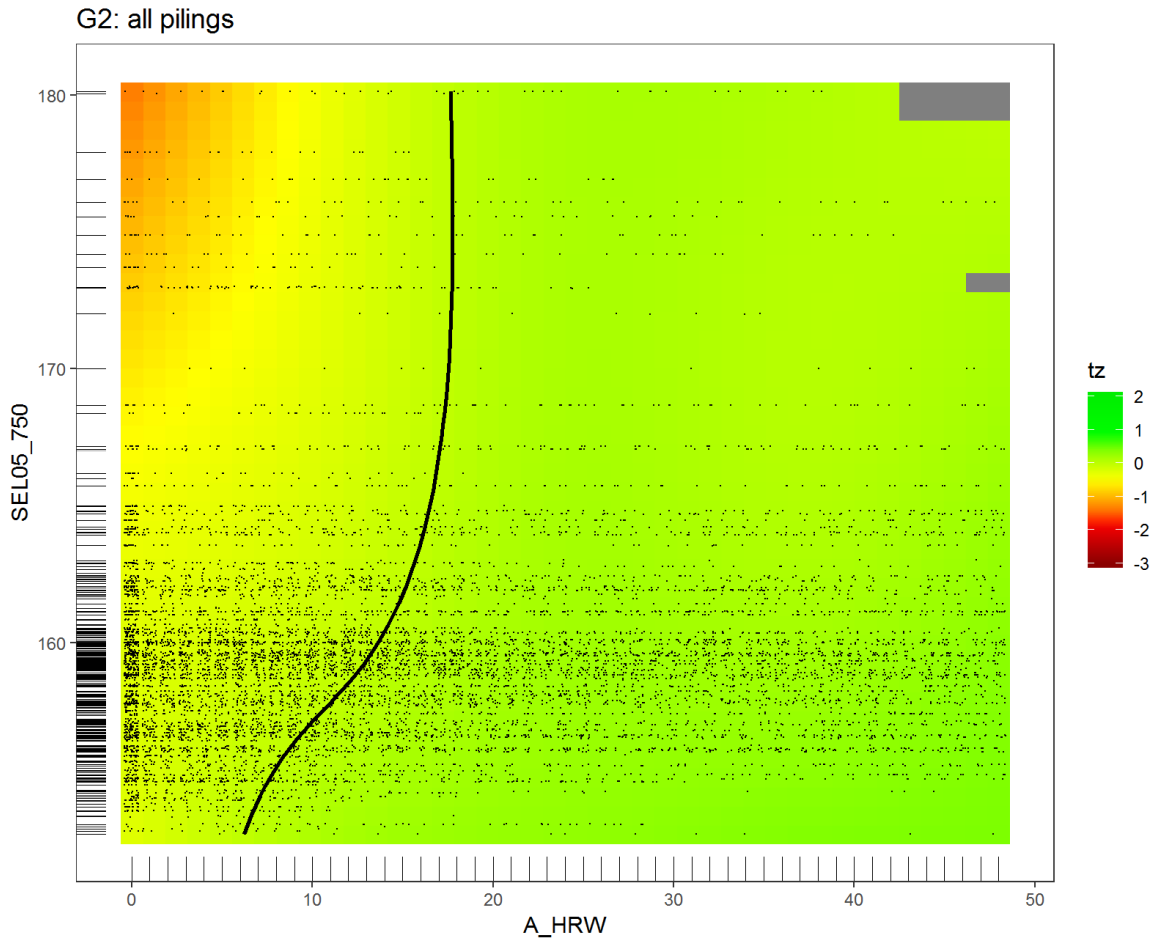


Figure A.39 Cl-type noise-level GAM M3.3b2G2: All pilings 2014-2016 (Gescha 2); DPH values in close range (0-10 km) on scale of the linear predictor where zero equals the average of fitted values, modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); black dots: data.

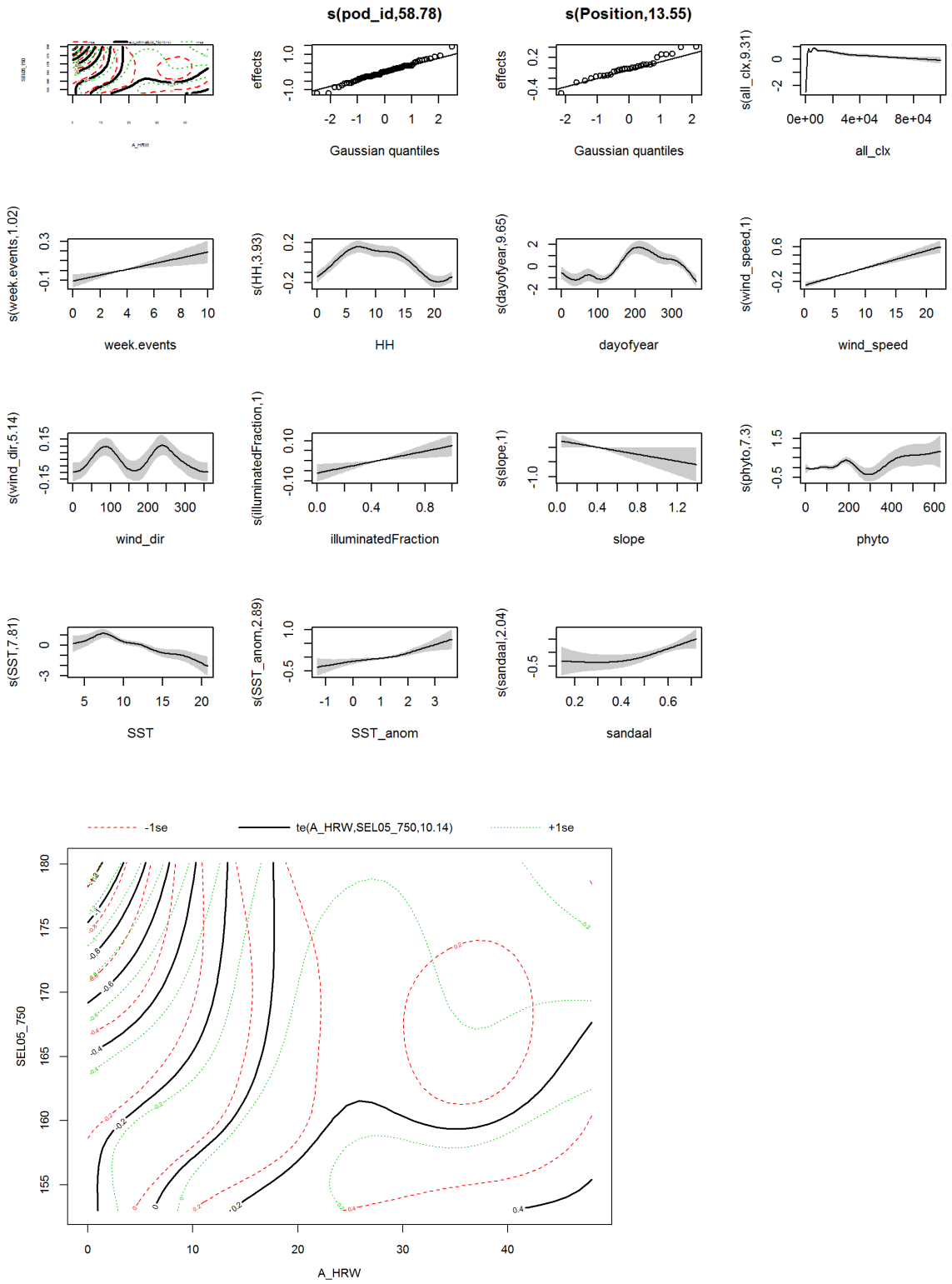


Figure A.40 *Cl-type noise-level GAM M3.3b2G2: All pilings 2014-2016 (Gescha 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.*

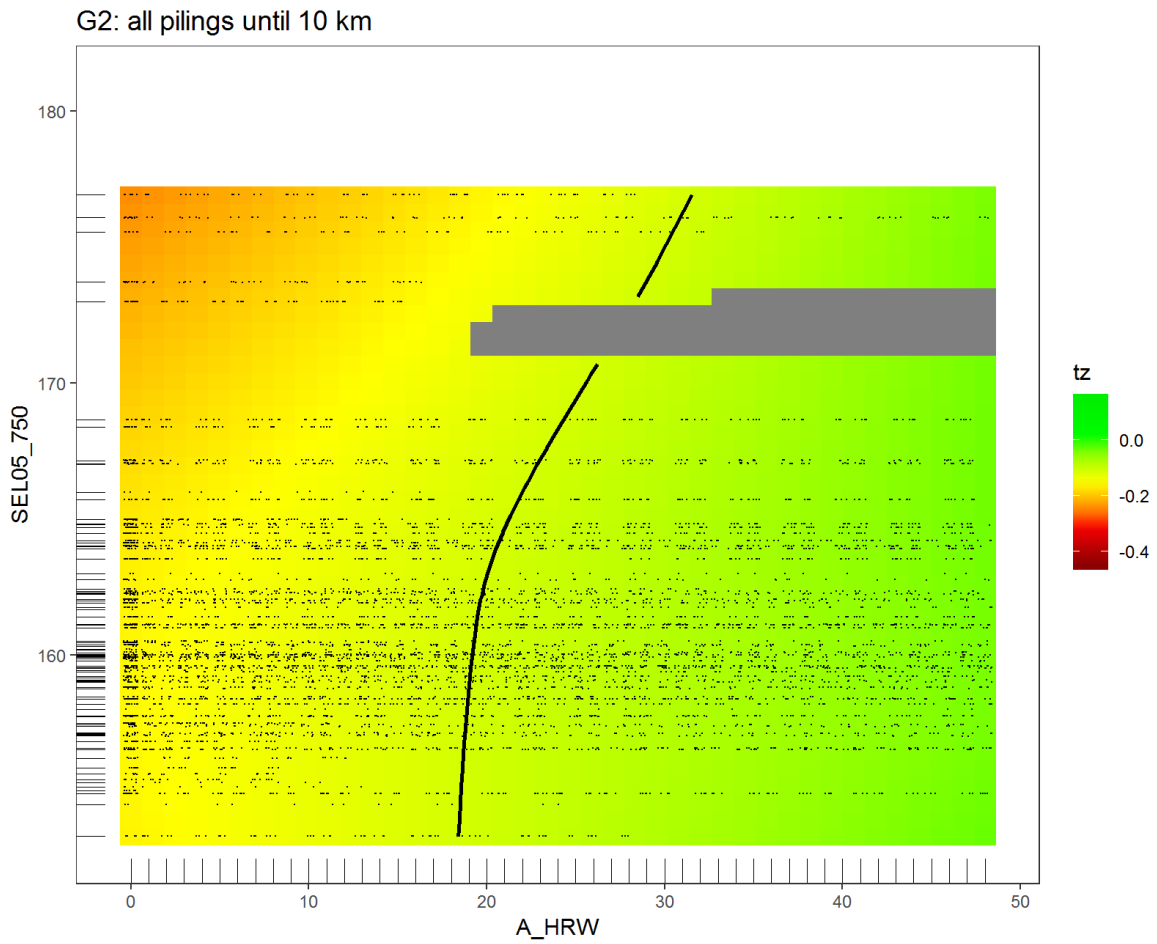


Figure A.41 Reference-type noise-level GAM M3.3b2G2: All pilings 2014-2016 (Gescha 2); dDPH_ref values in close range (0-10 km) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); black dots: data.

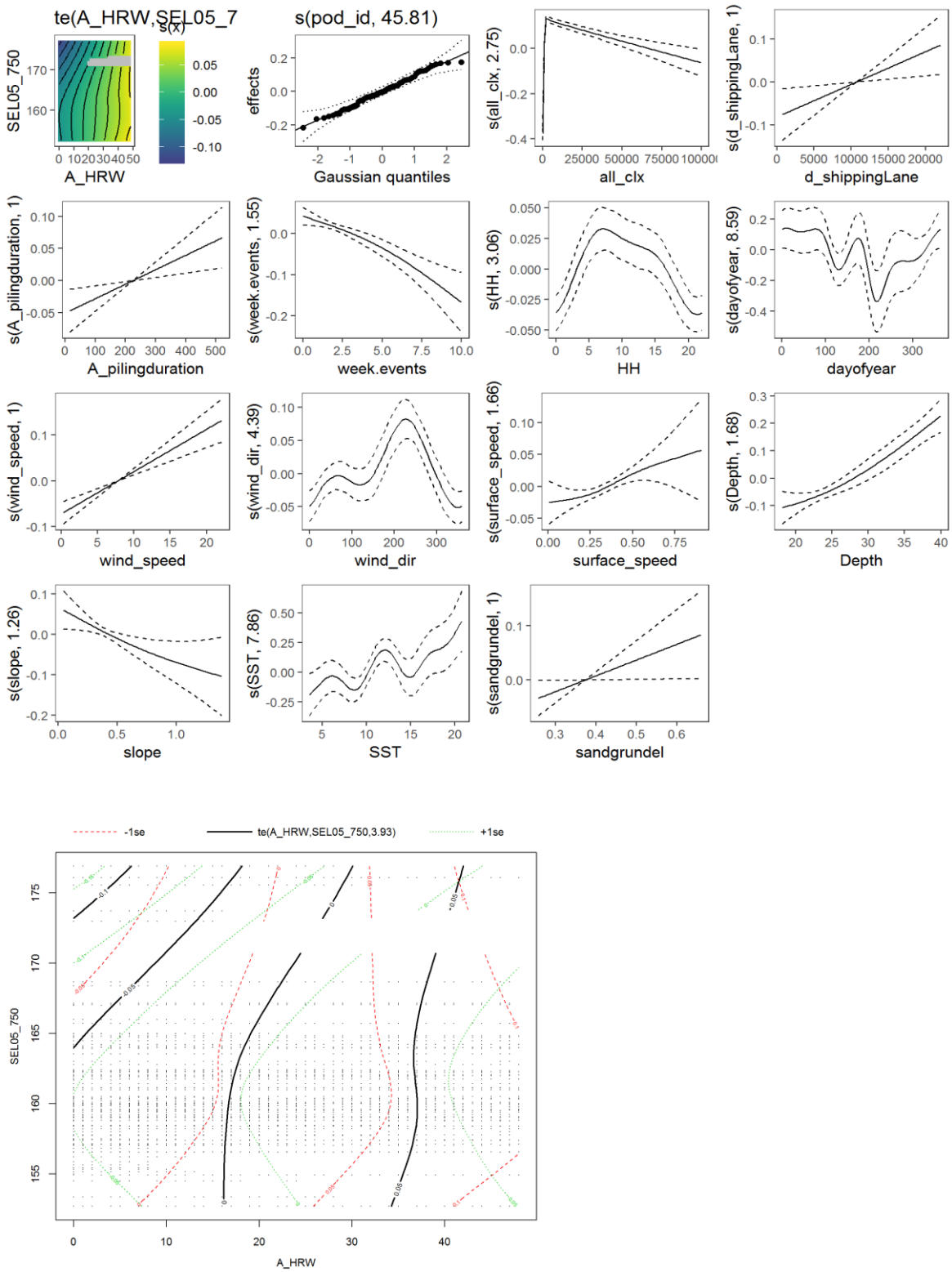


Figure A.42 Reference-type noise-level GAM M3.3b2G2: All pilings 2014-2016 (Gescha 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Gescha 1 & 2 models

In addition to the plots for noise-level models on mitigated and all pilings of the combined Gescha 1 & 2 dataset already presented in the report, standard plots of the *gam.plot()* function are shown here which also include standard-error contour lines.

Effect of piling-noise level at hrw 0 in relation to distance from construction site

Mitigated pilings:

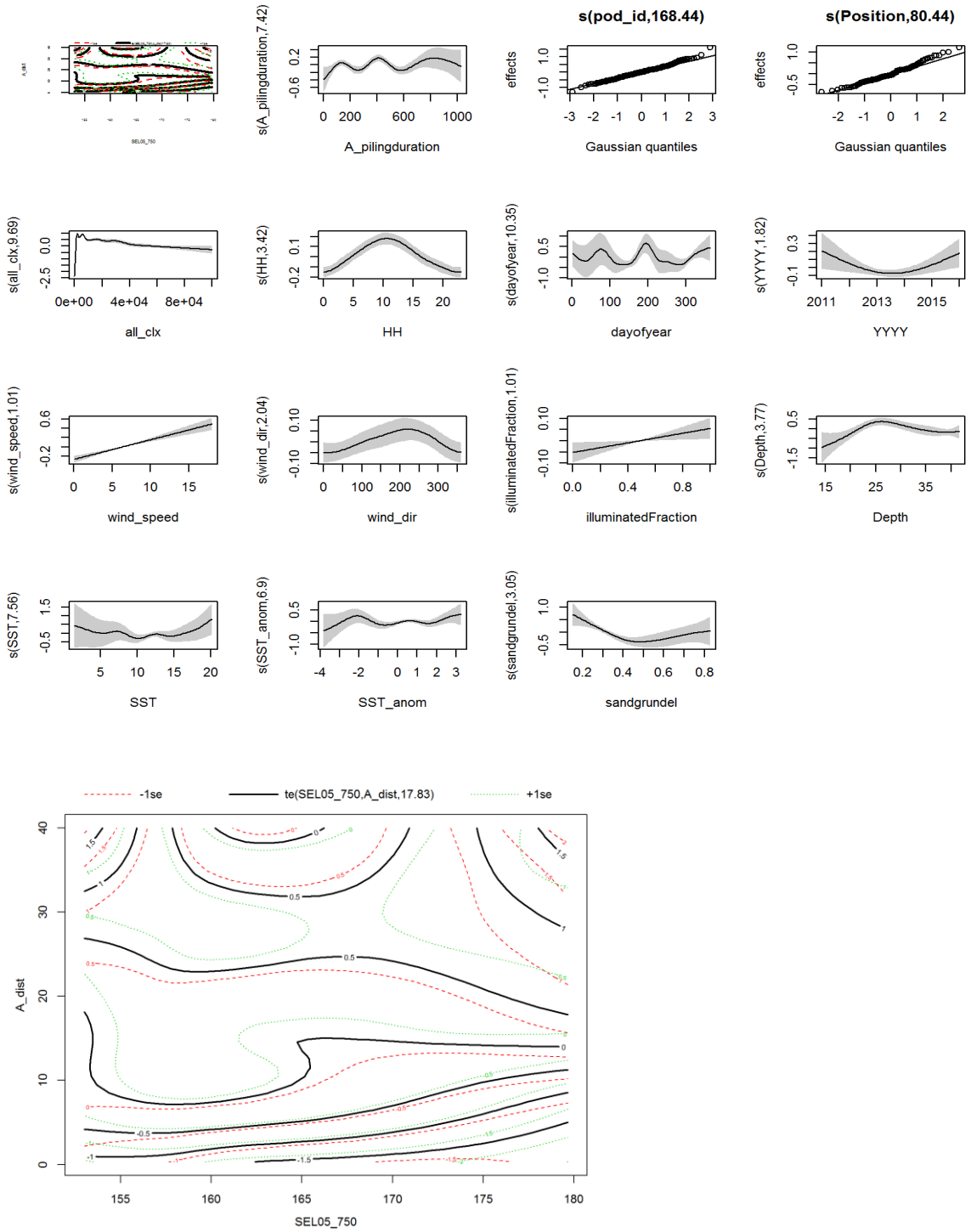


Figure A.43 Cl-type noise-level GAM M3.3a1G12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons was not shown for the zero lines in the report figure.

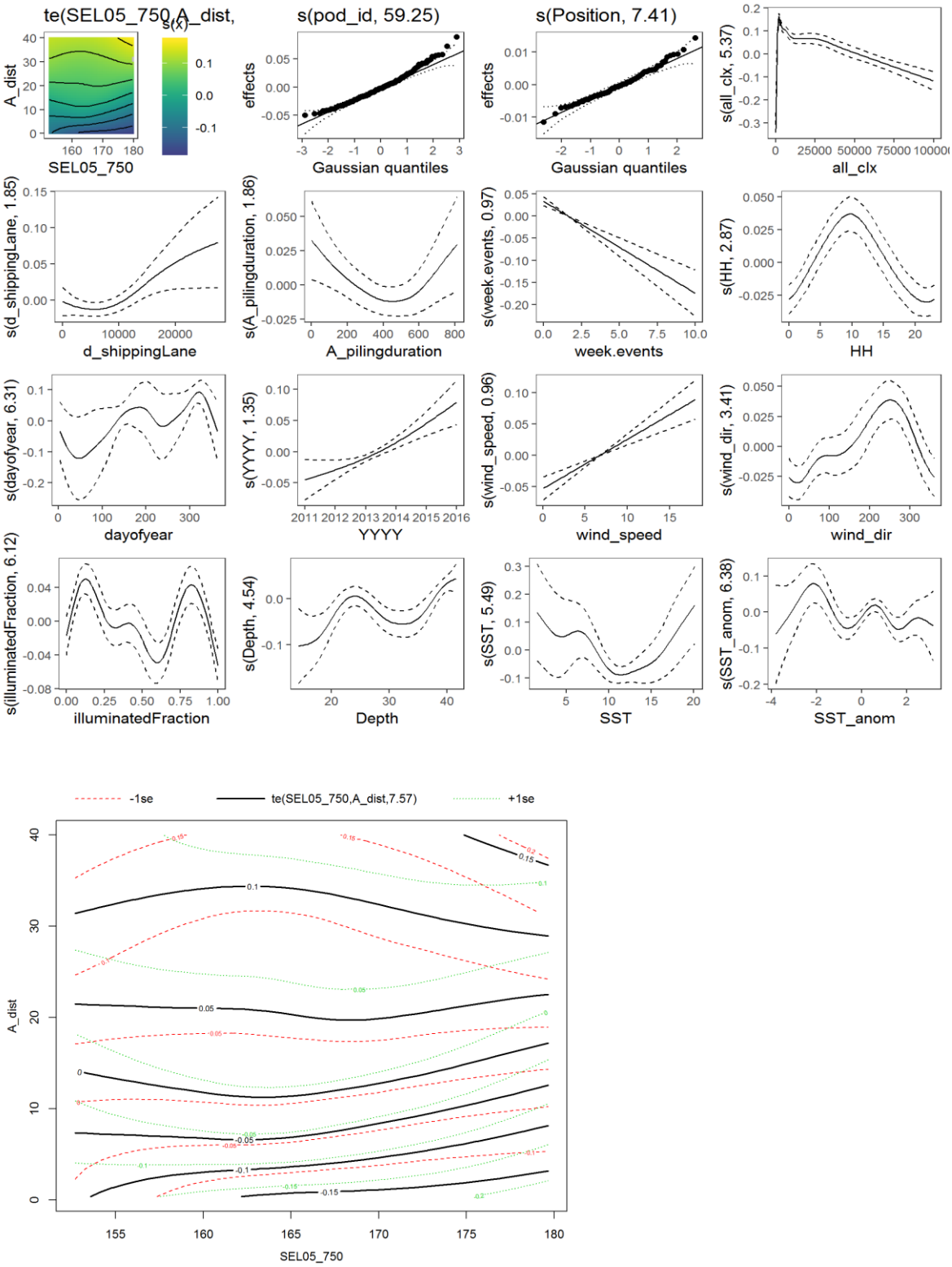


Figure A.44 Reference-type noise-level GAM M3.3a1G12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

Mitigated and unmitigated pilings:

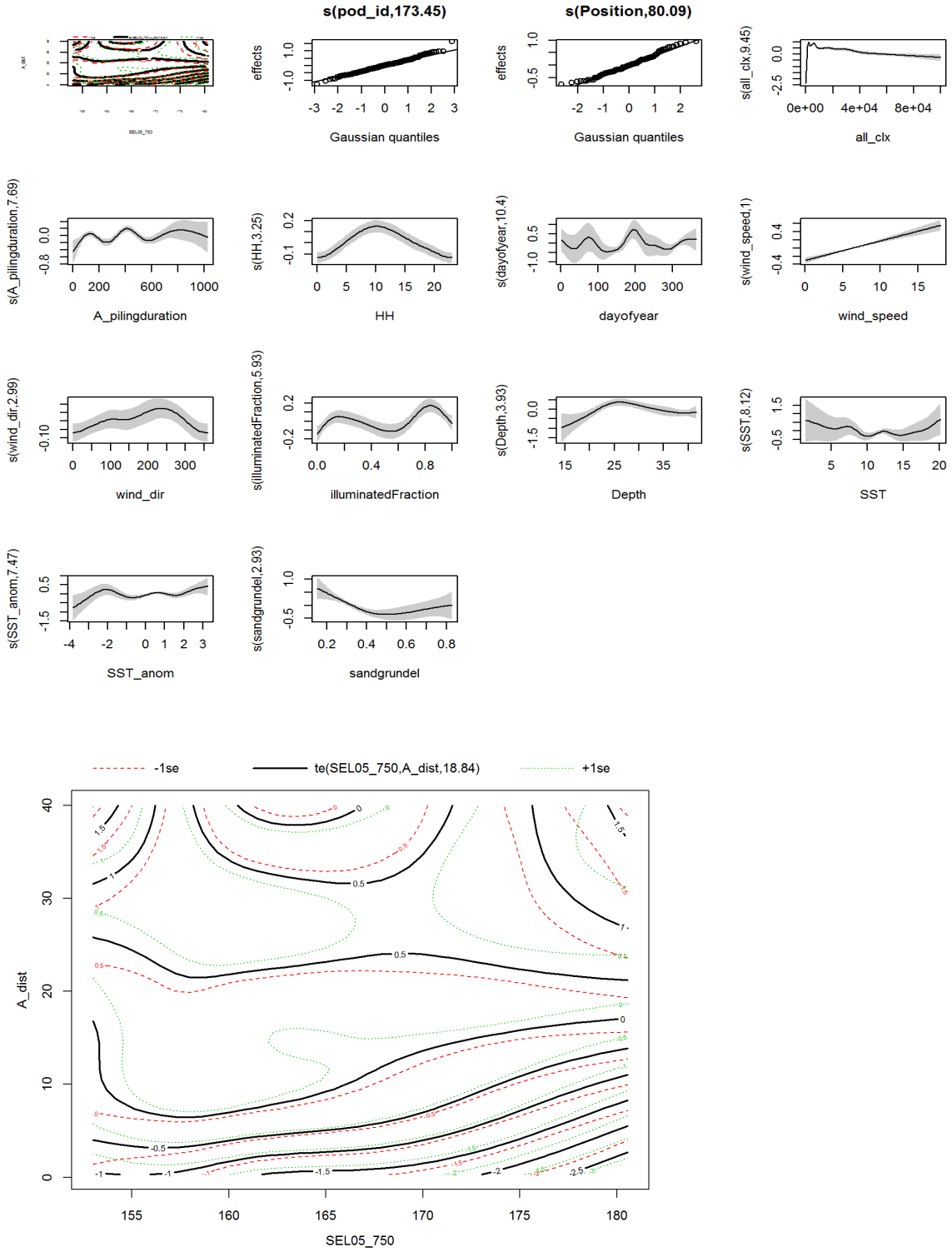


Figure A.45 Cl-type noise-level GAM M3.3a2G12: All pilings 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.

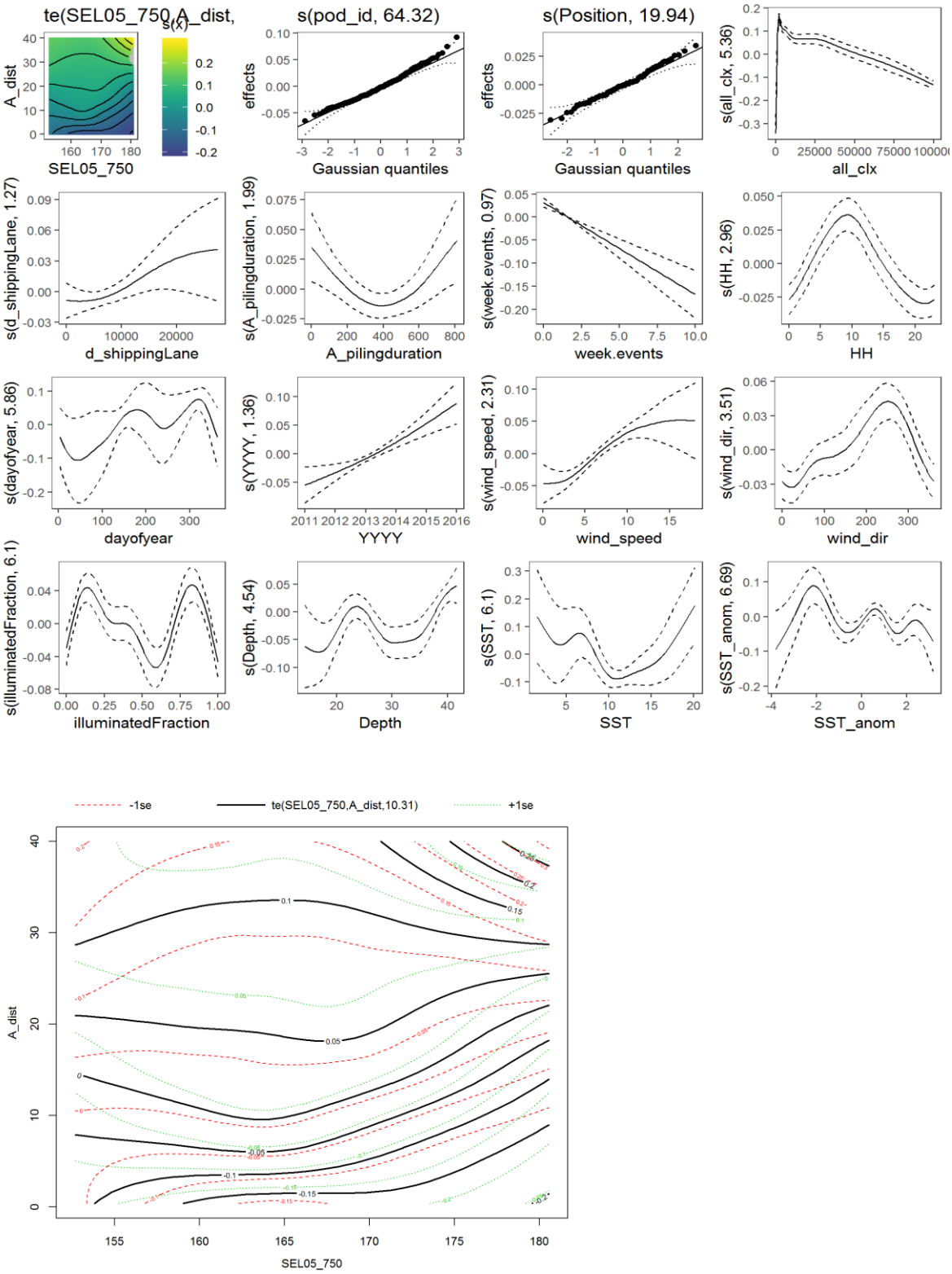


Figure A.46 Reference-type noise-level GAM M3.3a2G12: All pilings 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of SEL05_750 (noise level of SEL_{05} in 750 m distance) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

Effect of piling-noise level in relation to time after pile driving (in up to 10 km distance)

Mitigated pilings:

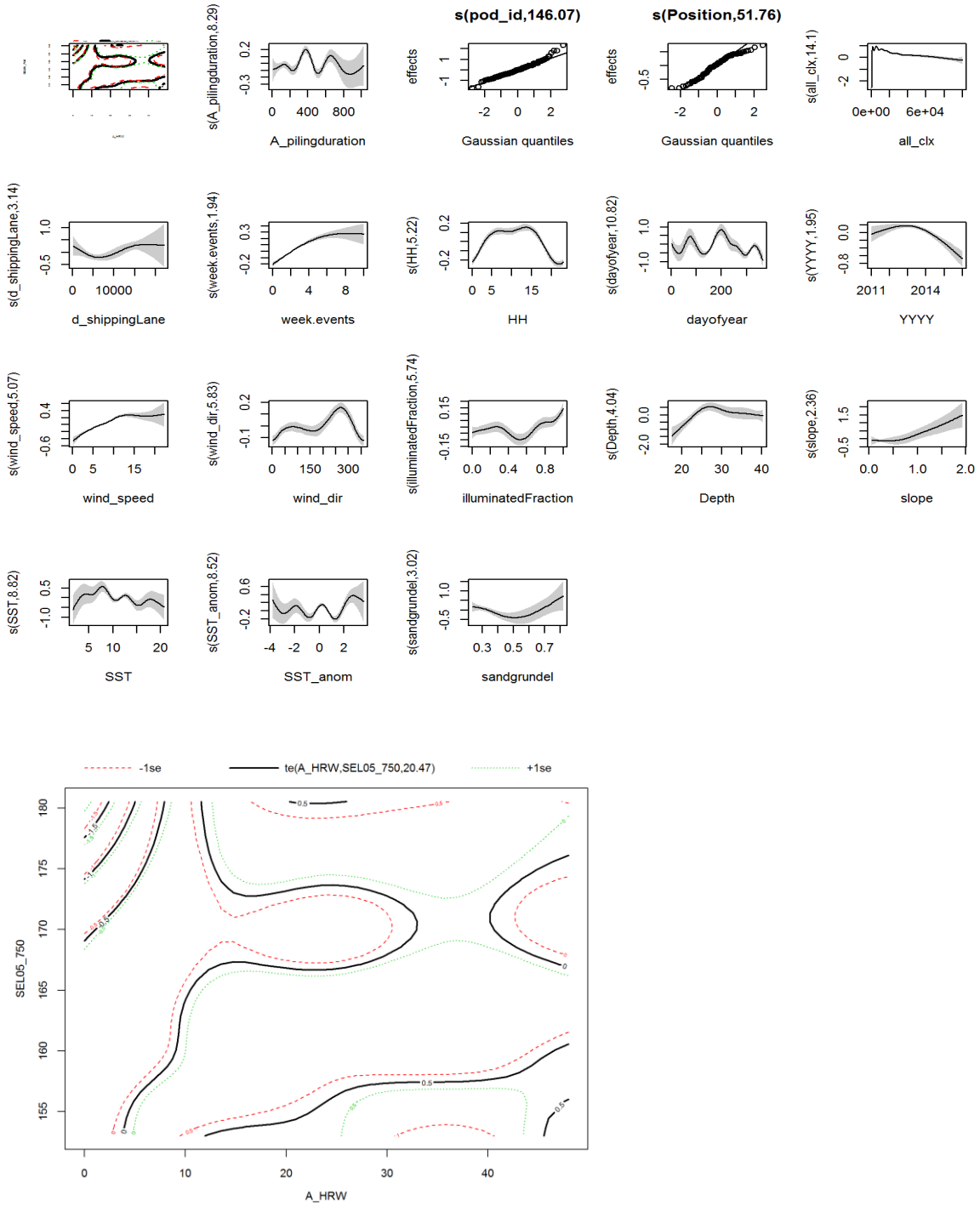
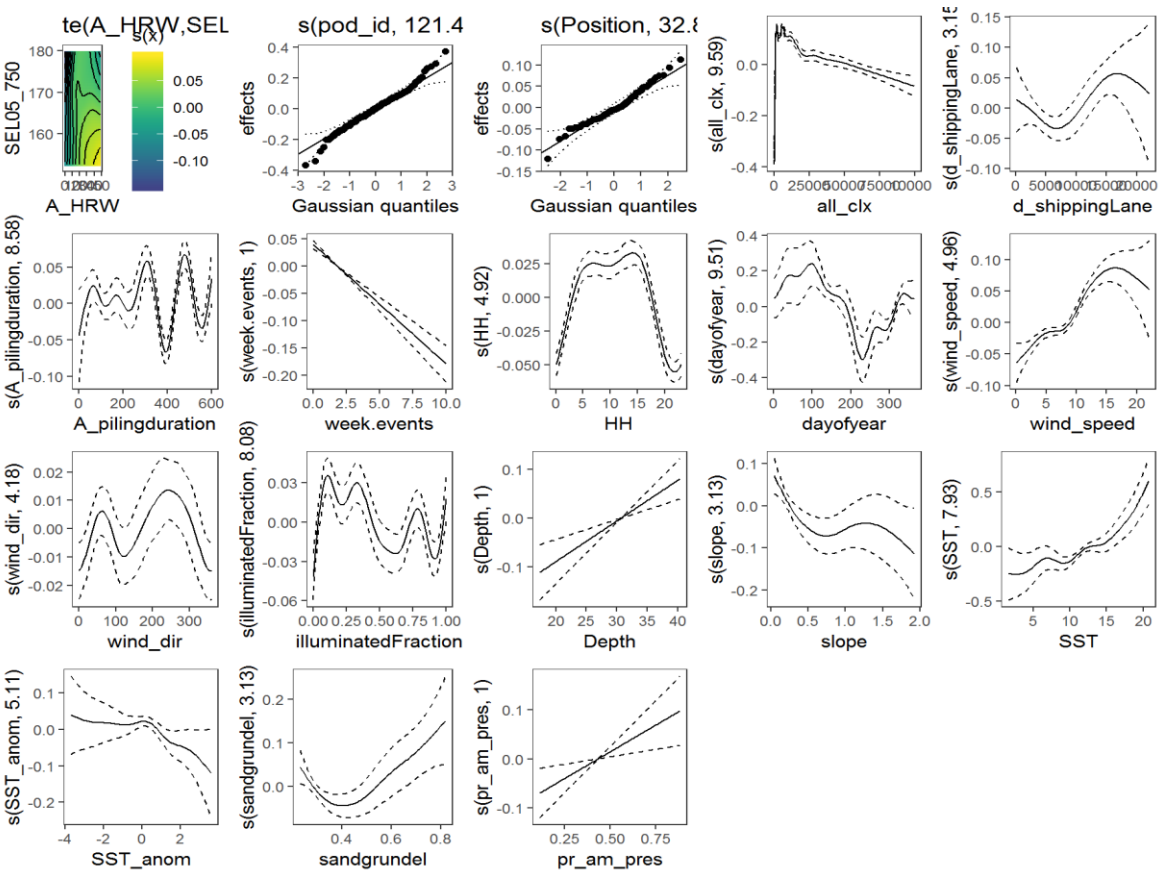


Figure A.47 Cl-type noise-level GAM M3.3b1G12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.



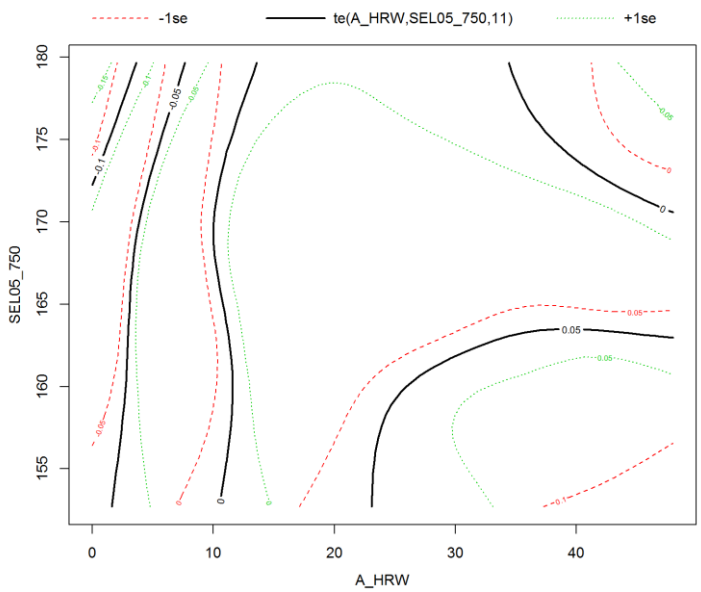


Figure A.48 Reference-type noise-level GAM M3.3b1G12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

Mitigated and unmitigated pilings:

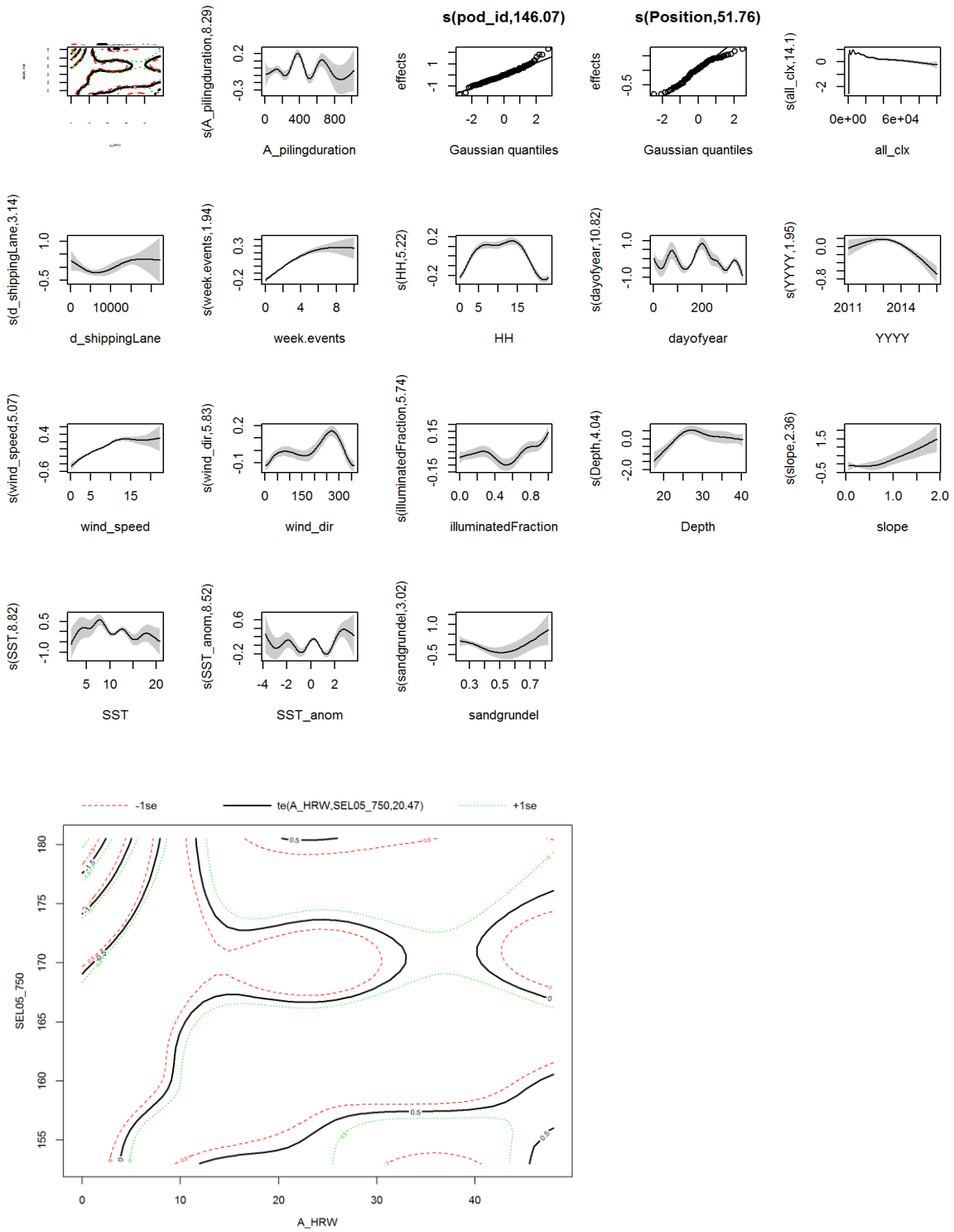


Figure A.49 *Cl-type noise-level GAM M3.3b2G12: All pilings 2011-2016 (Gescha 1 & 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.*

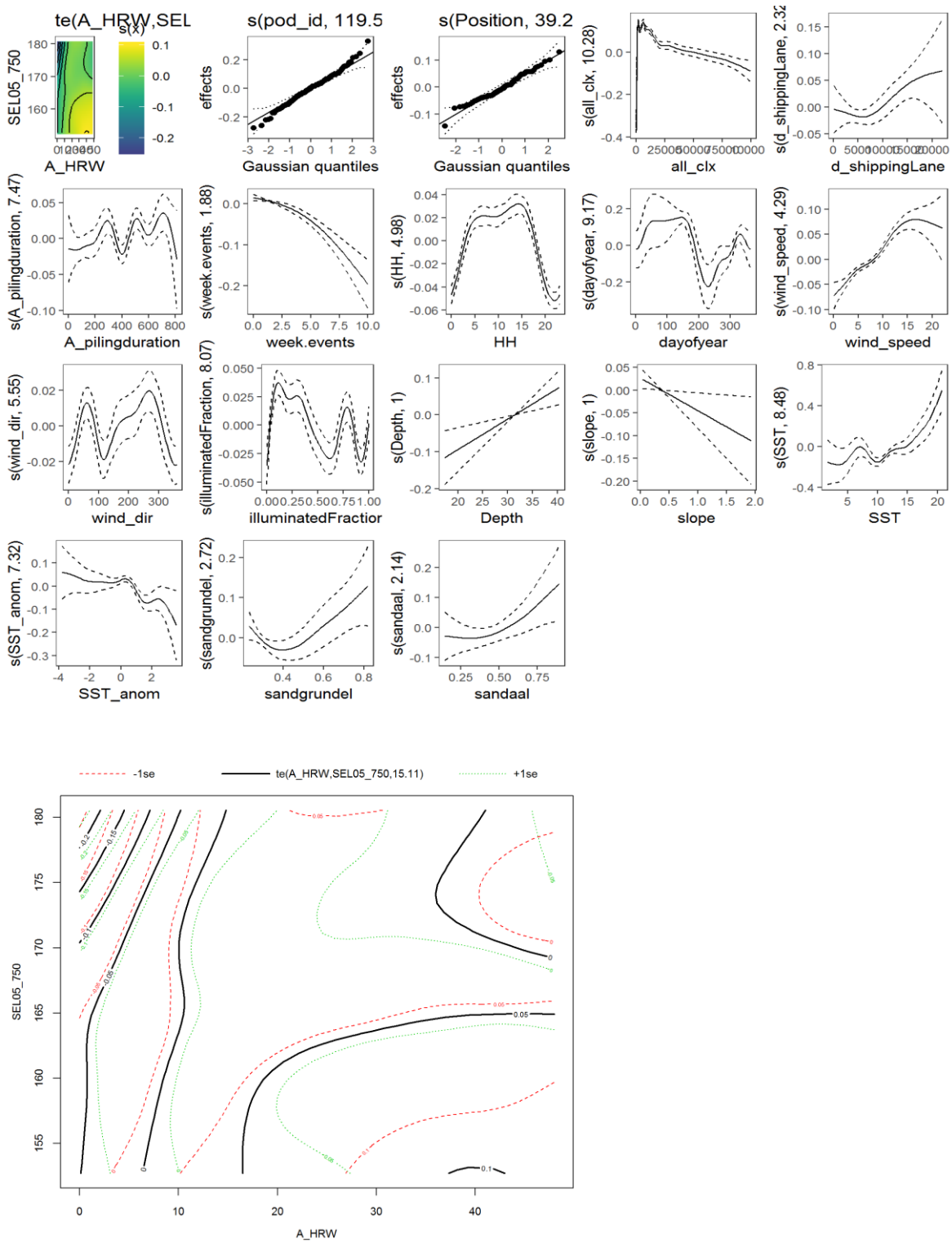


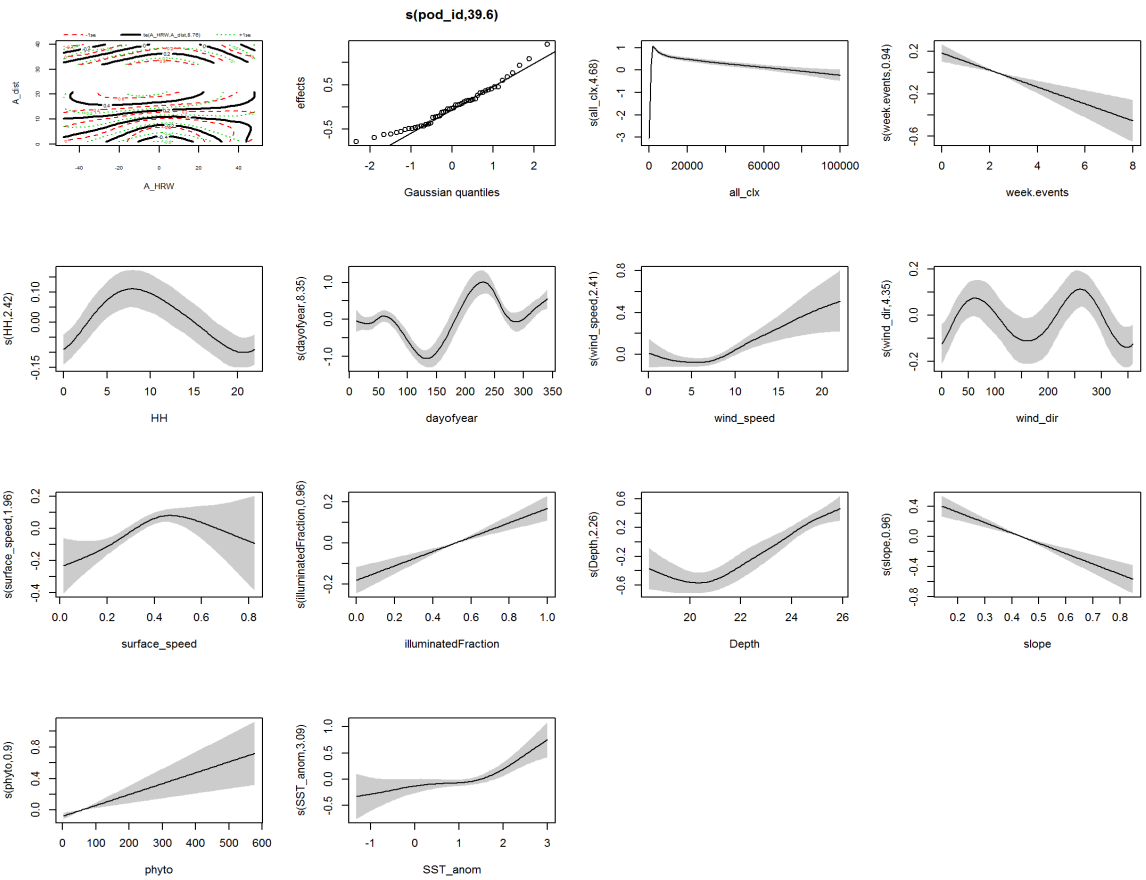
Figure A.50 Reference-type noise-level GAM M3.3b2G12: All pilings 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables SEL05_750 (sound level of SEL_{05} in 750 m distance) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

WP 3.4 – OWF-specific models: Additional plots

Regarding the coloured plots for selected OWFs in the report, standard error contour lines of the 20 % reduction line in the Reference-type models and the zero line of the CI-type models could not be shown due to technical reasons. For those OWFs, we present the default plots of the *gam.plot()* function which also give standard error contour lines. Regarding the Reference-type models, however, the following default plots cannot show effects on the response scale (e.g., the 20 % reduction line with standard errors), but only on the scale of the linear predictor where zero equals the average of fitted values. Therefore, the default GAM plots for the Reference-type models presented below only allow for the assessment of the approximate range of the standard error for this model type, by looking at error lines of a contour line being closest to the 20 % reduction line. These approximate ranges are used in the tables of the report.

With four wind farms (BU, N1, VM, GEM), less than 30 piling events were left for Reference-type models. Three OWFs (BR, GW, GEM) had no close-range data and hence offered no possibilities for meaningful analyses. Reference-type models for BU and VM have a slightly restricted range of pre-piling reference data. The respective model plots are shown here only for completeness, but without additional plots with standard errors.

Additional plots for Cl-type OWF models shown in the report



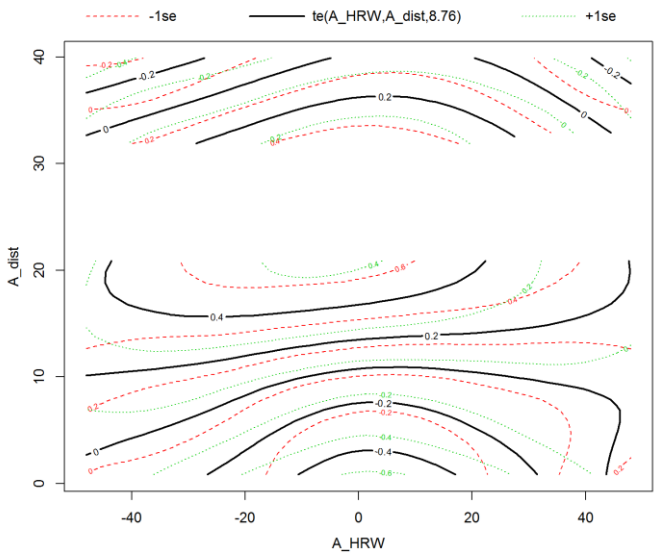


Figure A.51 Cl-type GAM M3.4a for OWF ABW: Mitigated pile driving 2014-2016; upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel shows the standard error (dotted lines) which due to technical reasons could not be shown with the zero line in the report figure.

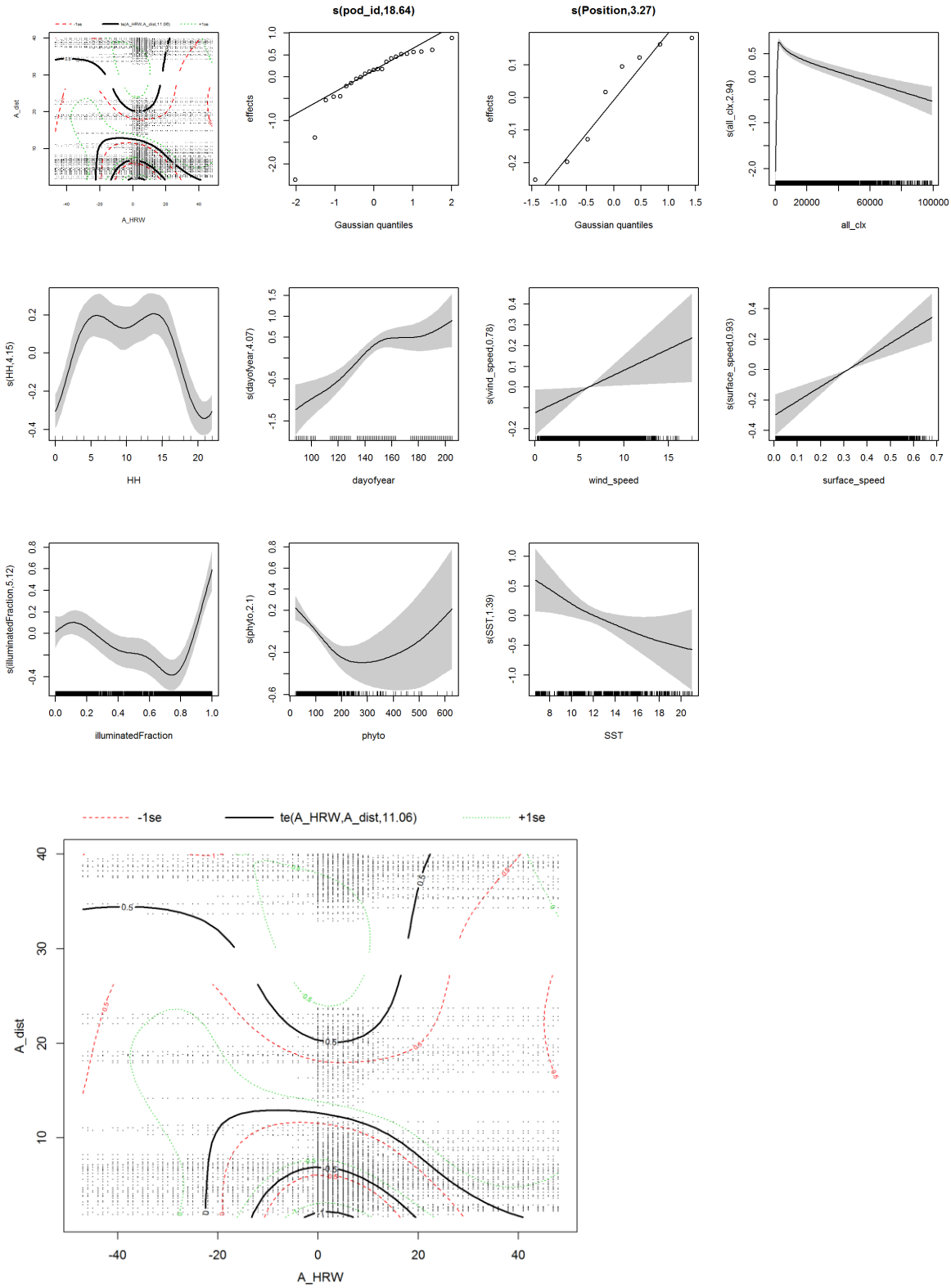
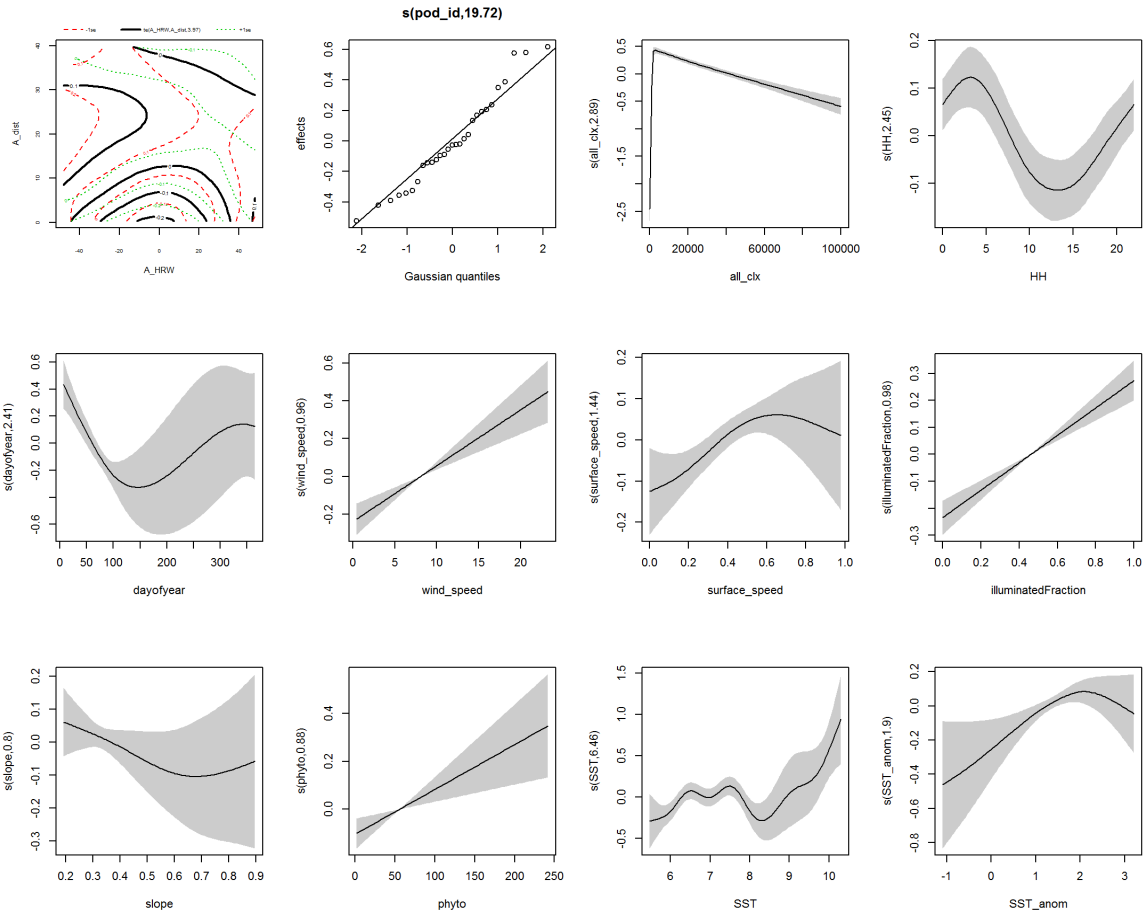


Figure A.52 Cl-type GAM M3.4c for OWF BU: Mitigated pile driving 2014-2016; upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel shows the standard error (dotted lines) which due to technical reasons could not be shown with the zero line in the report figure.



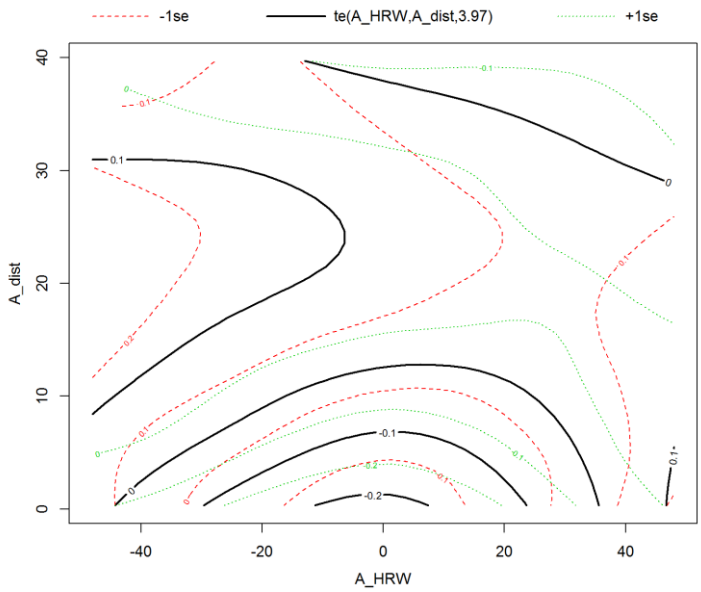
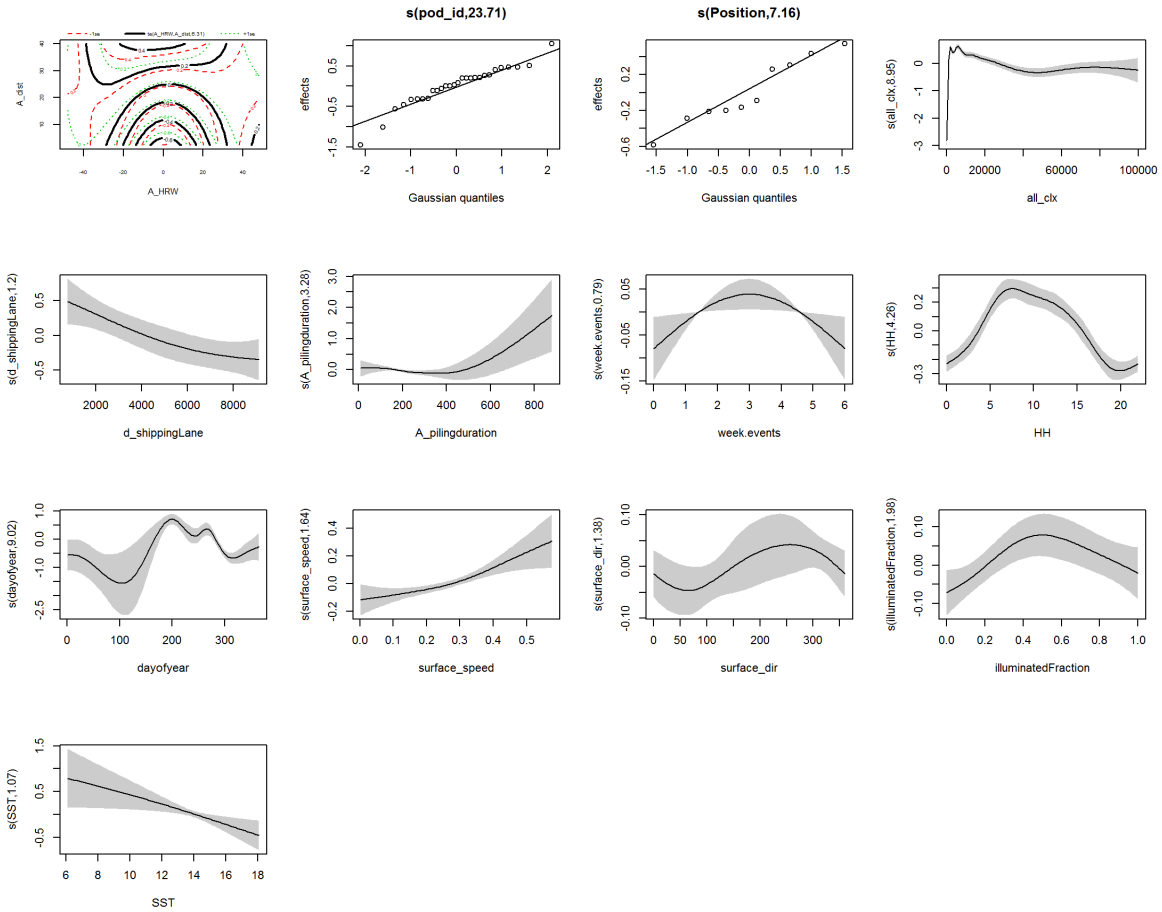


Figure A.53 Cl-type GAM M3.4e for OWF N1: Mitigated pile driving 2014-2016; upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel shows the standard error (dotted lines) which due to technical reasons could not be shown with the zero line in the report figure.



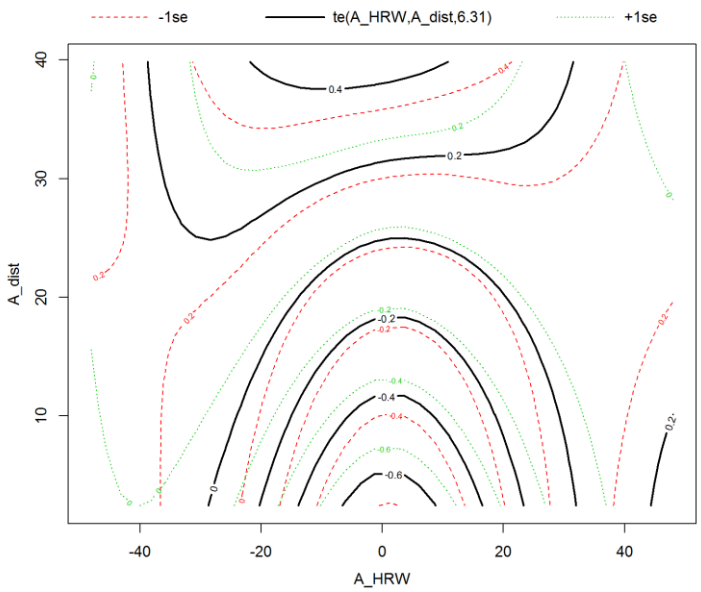


Figure A.54 Cl-type GAM M3.4f for OWF SB: Mitigated pile driving 2014-2016; upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel shows the standard error (dotted lines) which due to technical reasons could not be shown with the zero line in the report figure.

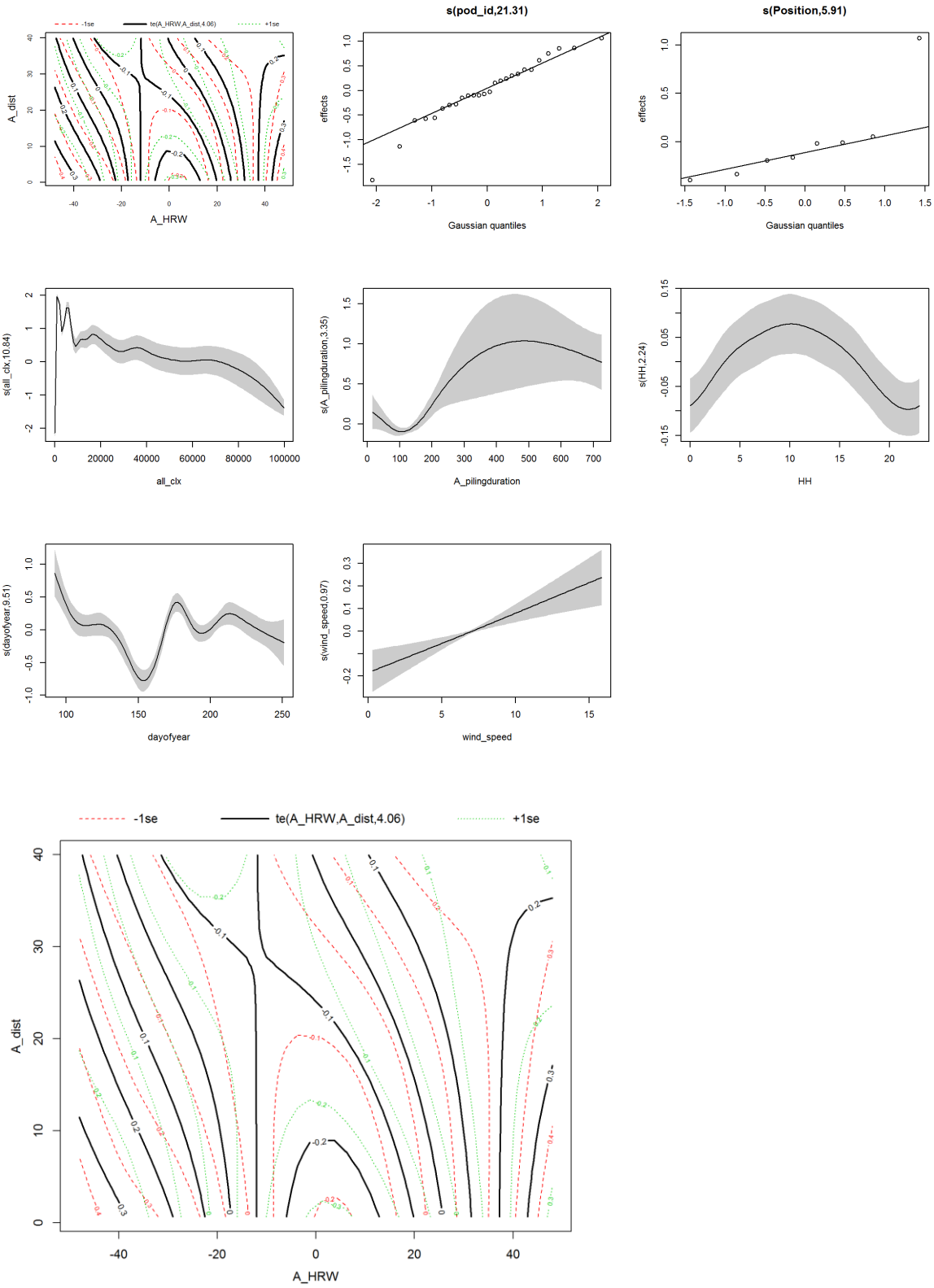


Figure A.55 Cl-type GAM M3.4g for OWF VM: Mitigated pile driving 2014-2016; upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel shows the standard error (dotted lines) which due to technical reasons could not be shown with the zero line in the report figure.

Additional plots for Reference-type OWF models shown in the report

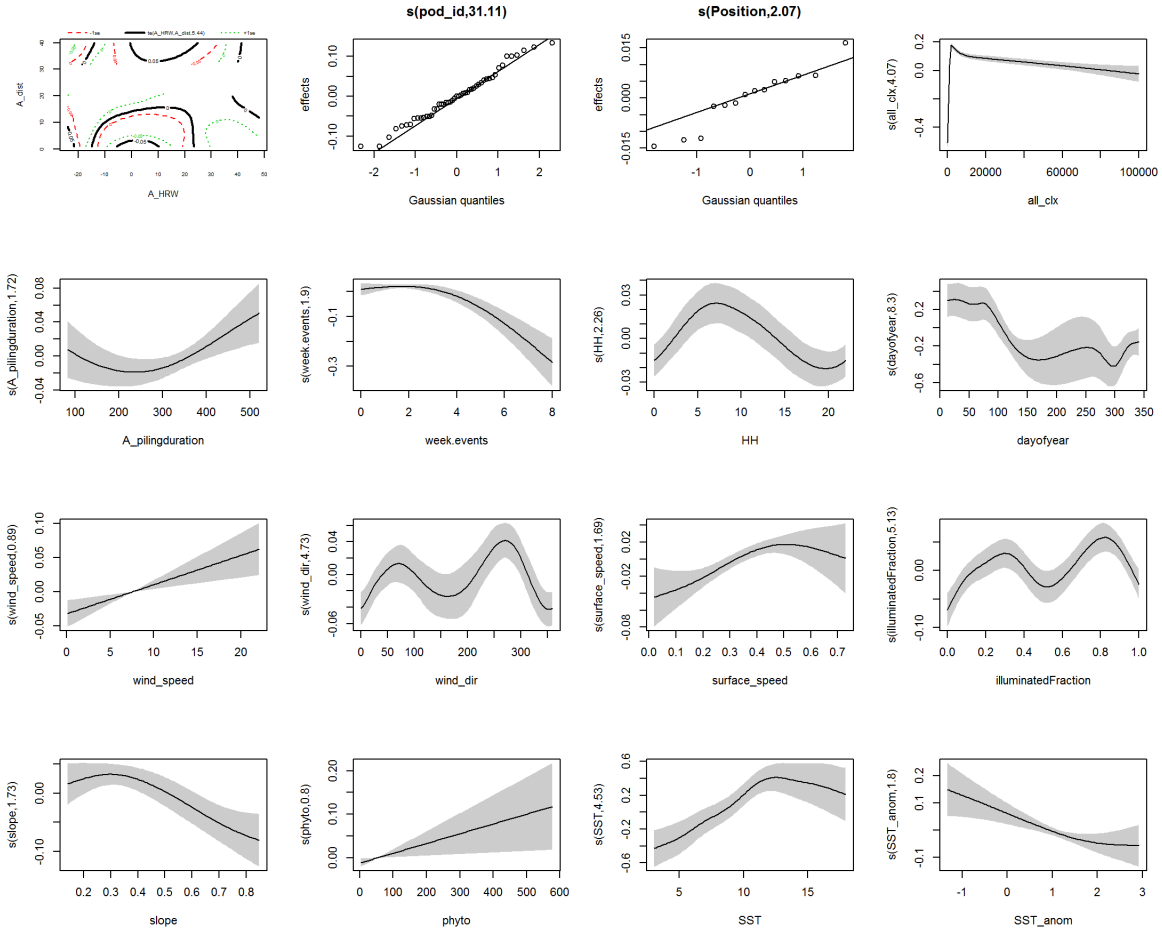


Figure A.56 Reference-type GAM M3.4a for OWF ABW: Mitigated pile driving 2014-2016; dDPH_ref values modelled on each variable; upper left panel: dDPH_ref values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

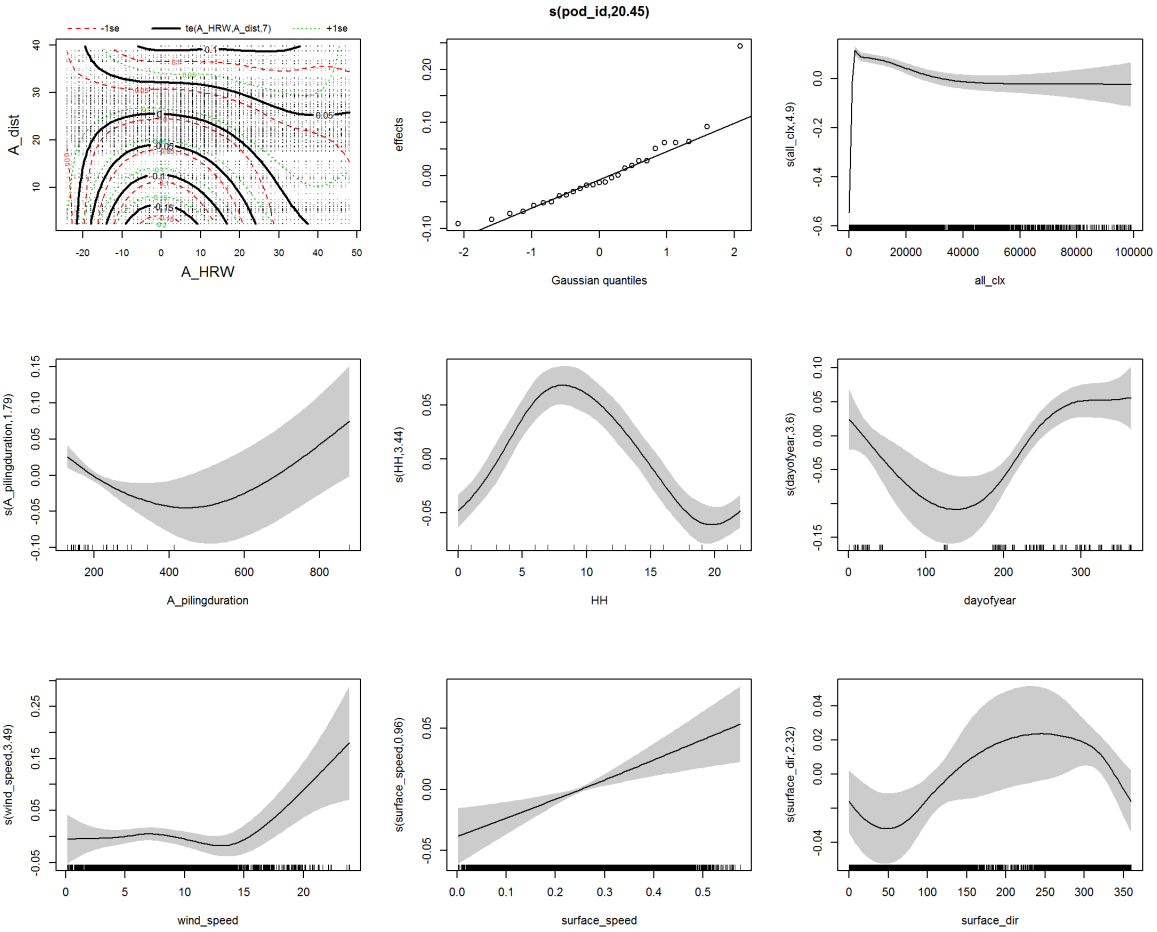
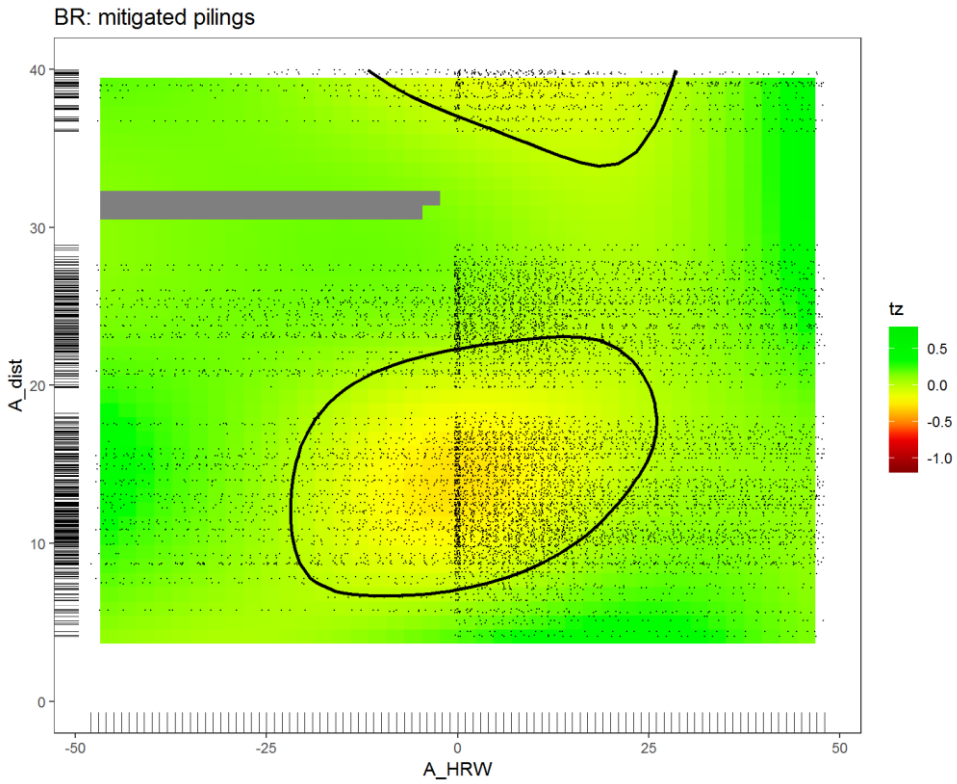


Figure A.57 Reference-type GAM M3.4f for OWF SB: Mitigated pile driving 2014-2016; dDPH_ref values modelled on each variable; upper left panel: dDPH_ref values modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); in contrast to the report figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

CI-type model plots for OWFs with insufficient close-range data (BR, GW, GEM)



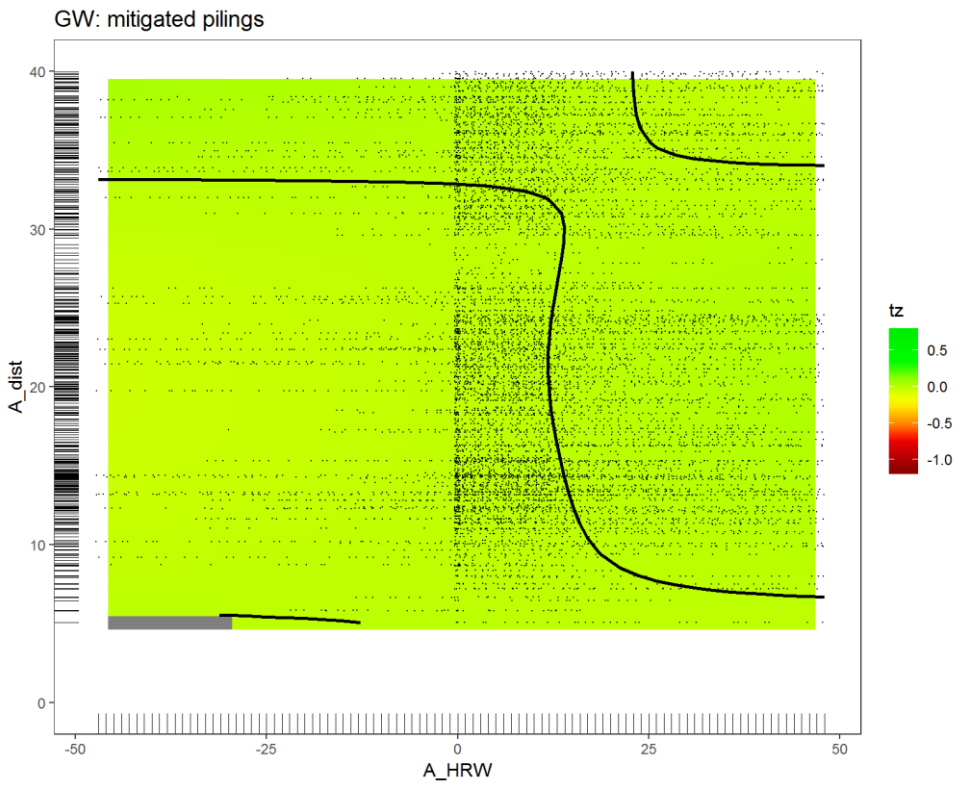


Figure A.58 CI-type GAMs M3.4b & M3.4d for OWFs BR & GW: Mitigated pile driving 2014-2016; DPH values on scale of the linear predictor where zero equals the average of fitted values (dotted lines: std. error), modelled on interaction of variables dist (distance) and A_HRW (hour relative to piling); black dots: data.

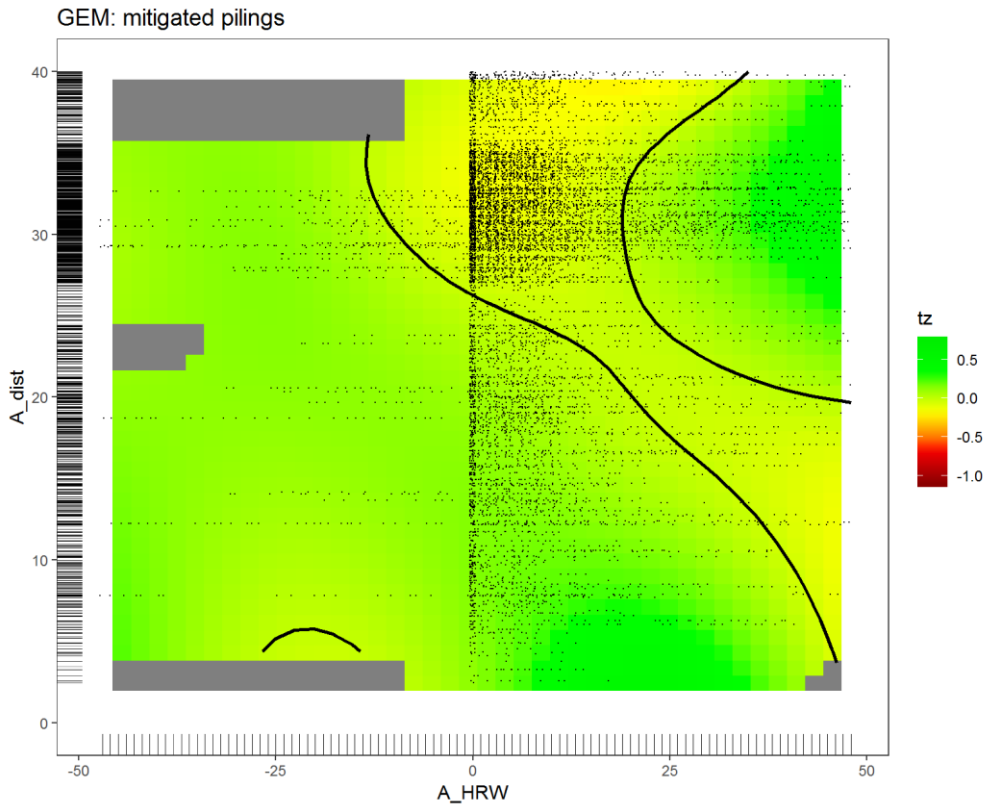


Figure A.59 Cl-type GAM M3.4g for OWF GEM (unmitigated pile driving 2014-2016): DPH values on scale of the linear predictor where zero equals the average of fitted values (dotted lines: std. error), modelled on interaction of variables dist (distance) and A_HRW (hour relative to piling); black dots: data.

Reference-type model plots for OWFs with insufficient number of pilings (BU, N1, VM, GEM) or insufficient close-range data (BR, GW, GEM)

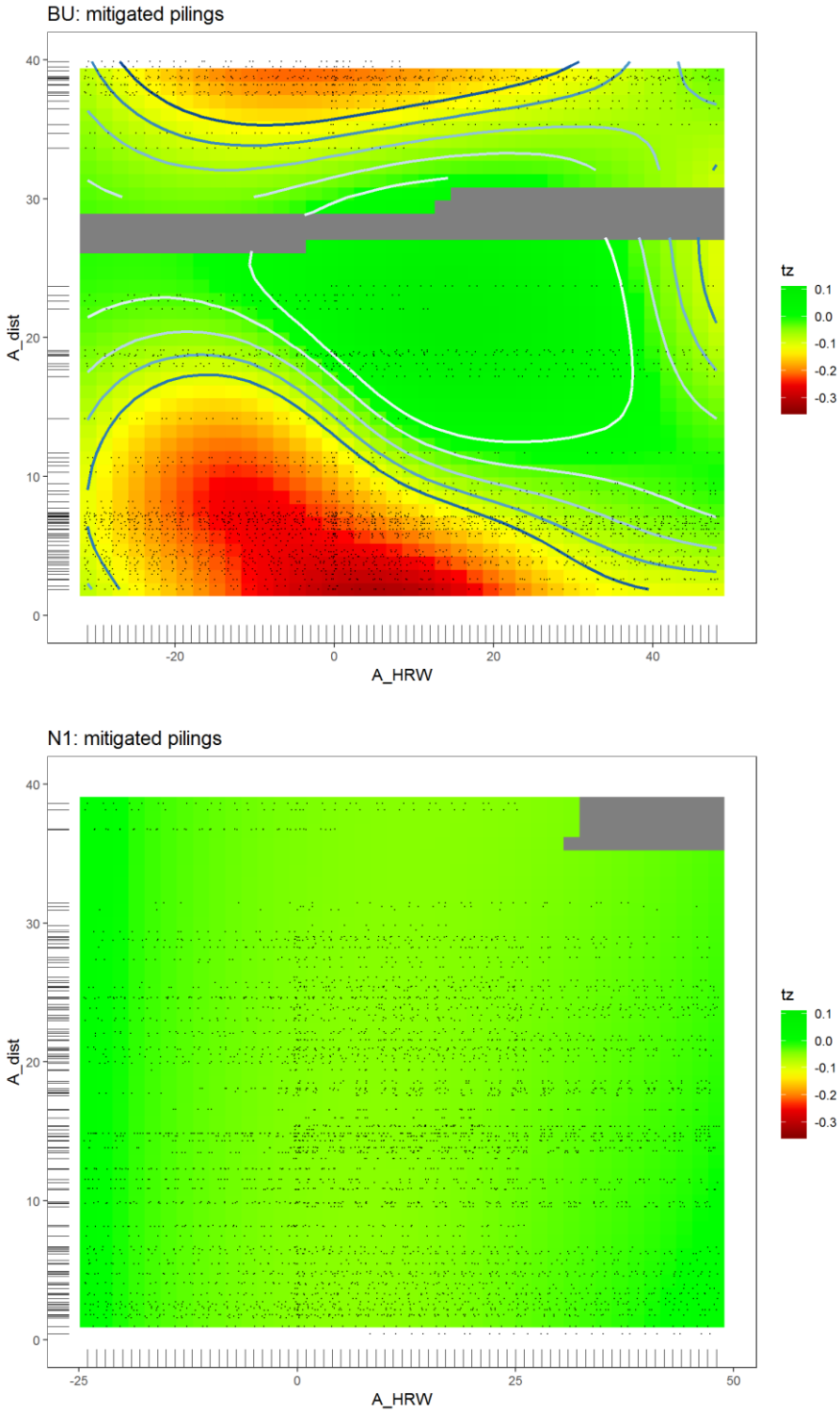


Figure A.60 Reference-type GAMs M3.4c & M3.4e for OWFs BU & N1 (BU: alterred reference periods: pre-piling from hrw-48 to hrw-32; post-piling from hrw+61 to hrw+84): Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values on scale of the response where zero equals no effect (BU: contour lines from bright to dark: 0, 5, 10, 15, and 20 % reduction of dDPH_ref relative to reference level; N1: reduction less than 20 %), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

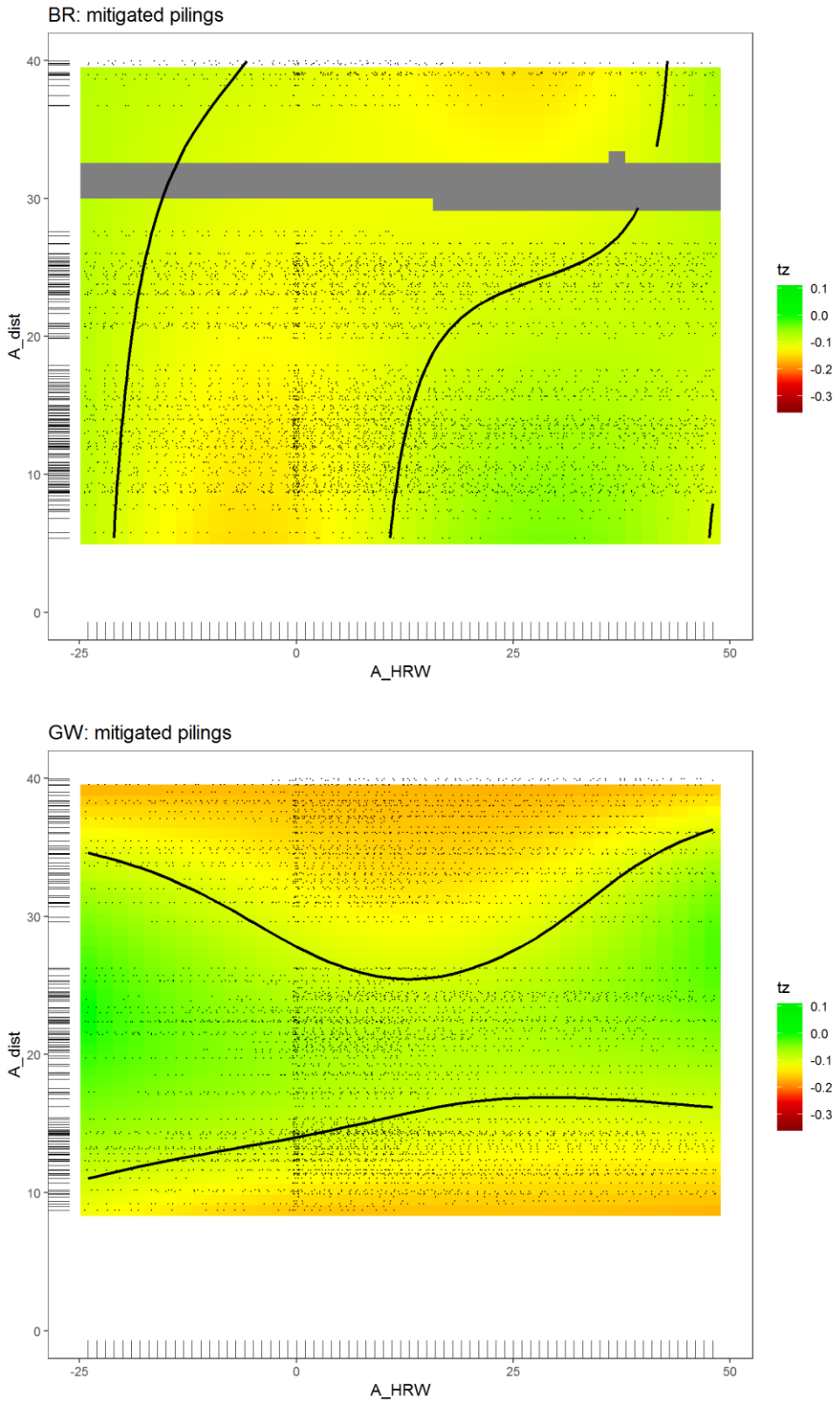
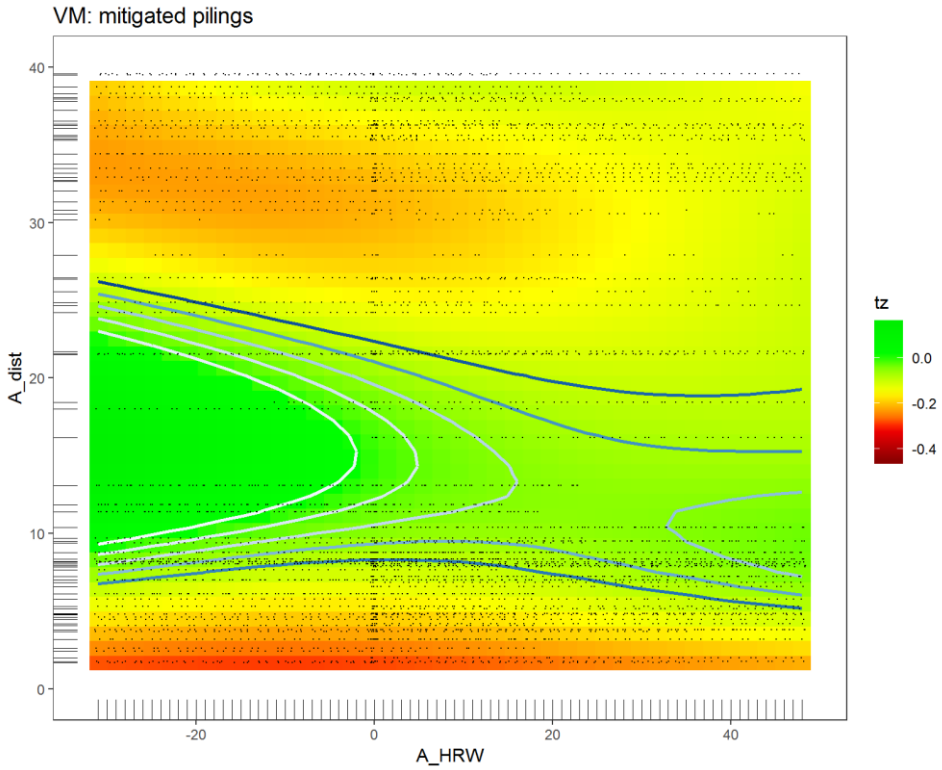


Figure A.61 Reference-type GAMs M3.4b & M3.4d for OWFs BR & GW: Mitigated pile driving 2014-2016; dDPH_ref values on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.



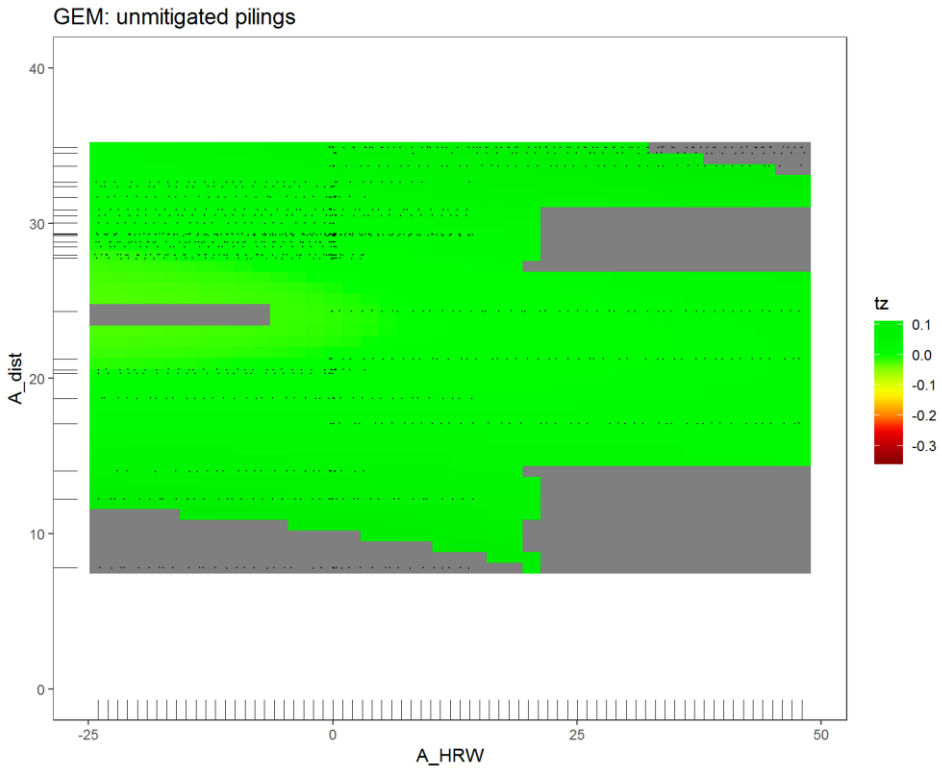


Figure A.62 Reference-type GAMs M3.4g & M3.4h for OWFs VM & GEM (VM: mitigated pile driving 2014-2016; alterred reference periods: pre-piling from hrw-48 to hrw-32; post-piling from hrw+61 to hrw+84; GEM: unmitigated pile driving 2014-2016); dDPH_ref values on scale of the response where zero equals no effect (VM: contour lines from bright to dark: 0, 5, 10, 15, and 20 % reduction of dDPH_ref relative to reference level; GEM: reduction less than 20 %, but only four available piling events), modelled on the interaction of the variables A_dist (distance) and A_HRW (hour relative to piling); black dots: data.

WP 3.5 – Piling-duration models: Additional plots

In the report, only piling-duration models for mitigated pilings of the combined Gescha 1 & 2 dataset were shown since those models were based on the broadest dataset. Here, we also present the piling-duration models for the Gescha 2 dataset alone, as well as additonal plots of the *gam.plot()* function showing standard errors.

As with the global models, standard error contour lines of the 20 % reduction line in the Reference-type models and the zero line of the CI-type models could not be shown in the coloured plots of the report, due to technical reasons. Regarding the Reference-type models, the following default plots cannot show effects on the response scale (e.g., the 20 % reduction line with standard errors), but only on the scale of the linear predictor where zero equals the average of fitted values. Therefore, the default GAM plots for the Reference-type models presented below only allow for the assessment of the approximate range of the standard error for this model type.

Gescha 2 models

Effect of piling duration at hrw 1-3 in relation to distance from mitigated pilings

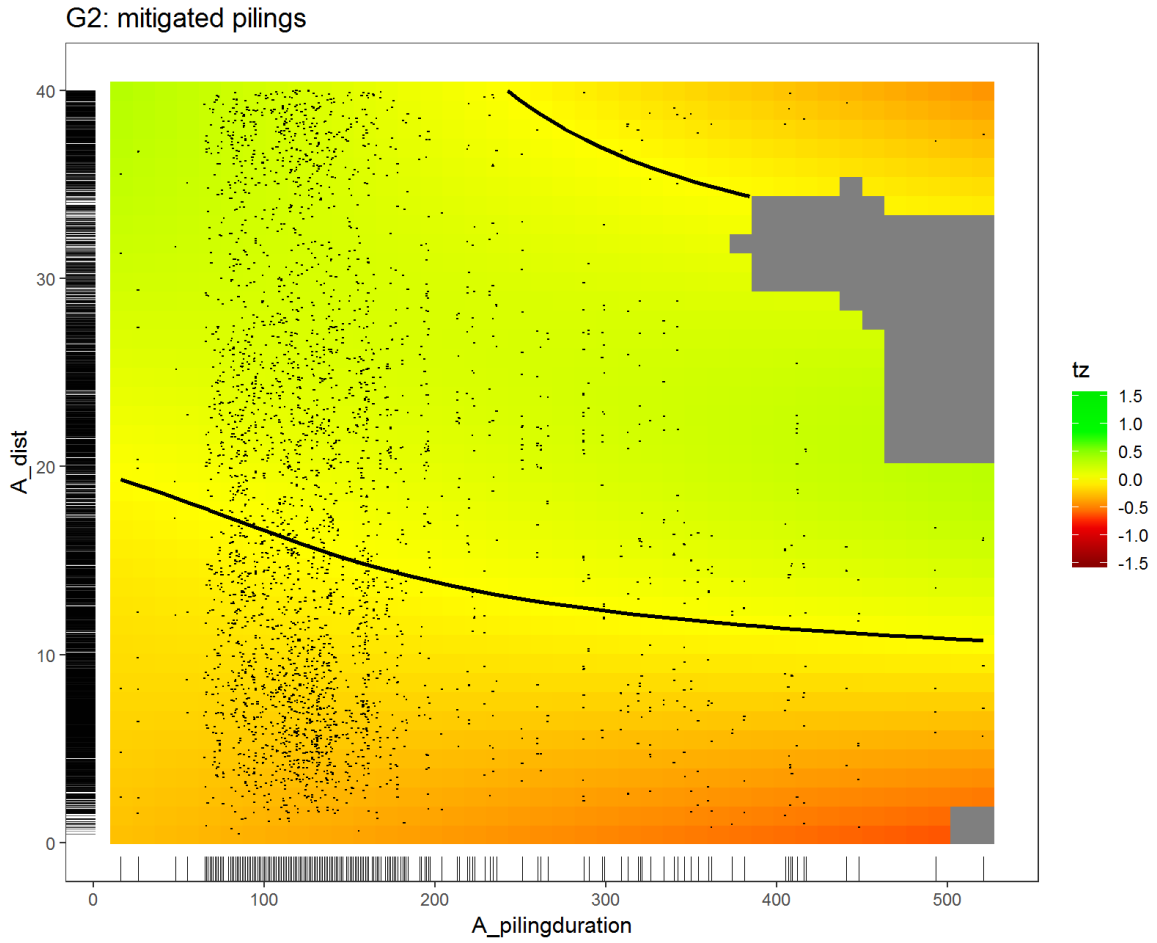


Figure A.63 Cl-type piling-duration GAM M3.5aG2: Mitigated pile driving 2014-2016 (Gescha 2); DPH values shortly after piling hours (hrw 1-3) on scale of the linear predictor where zero (black lines) equals the average of fitted values, modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_dist (distance to piling); black dots: data.

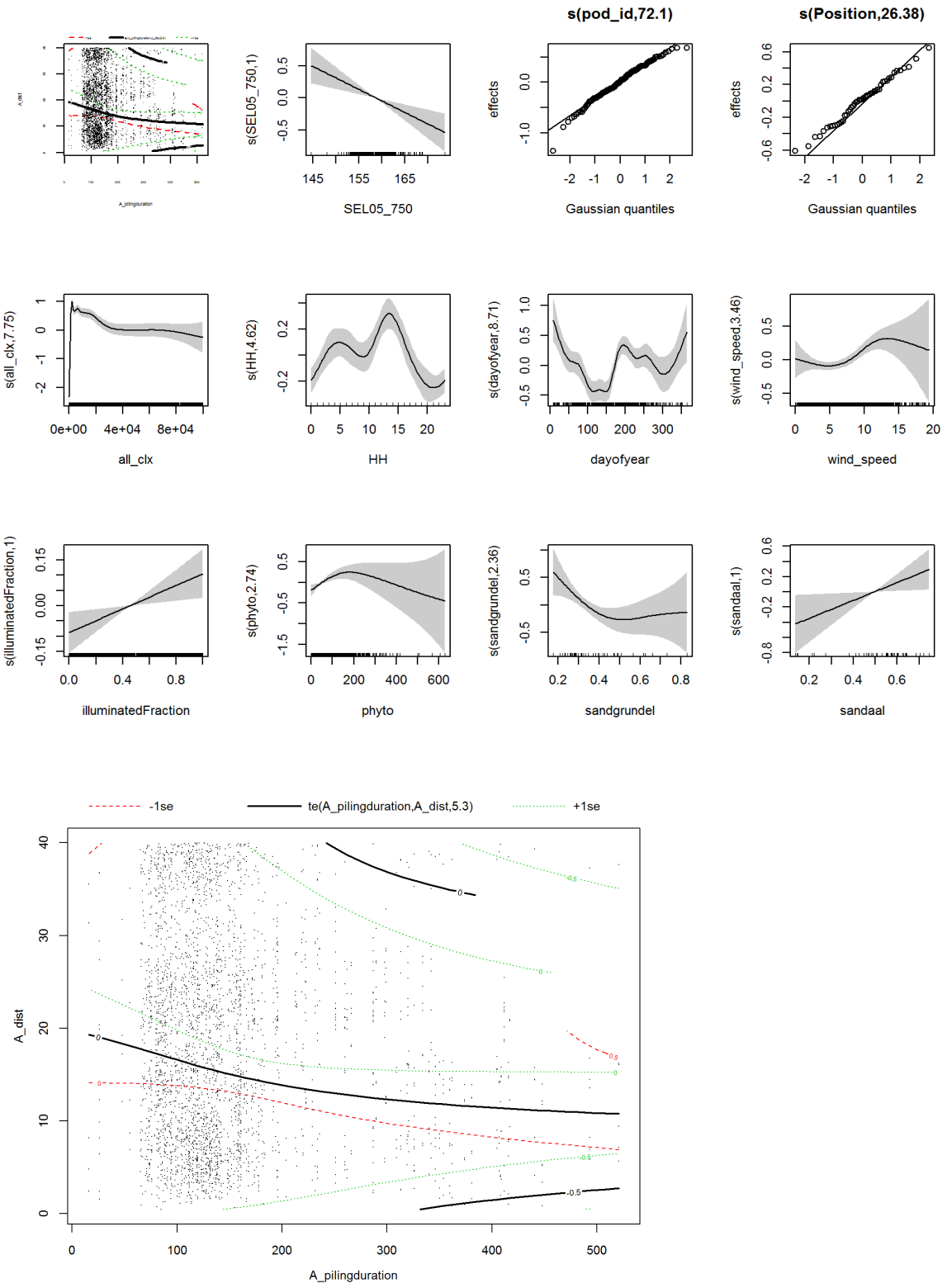


Figure A.64 Cl-type piling-duration GAM M3.5aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_pilingduration (piling duration in min) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

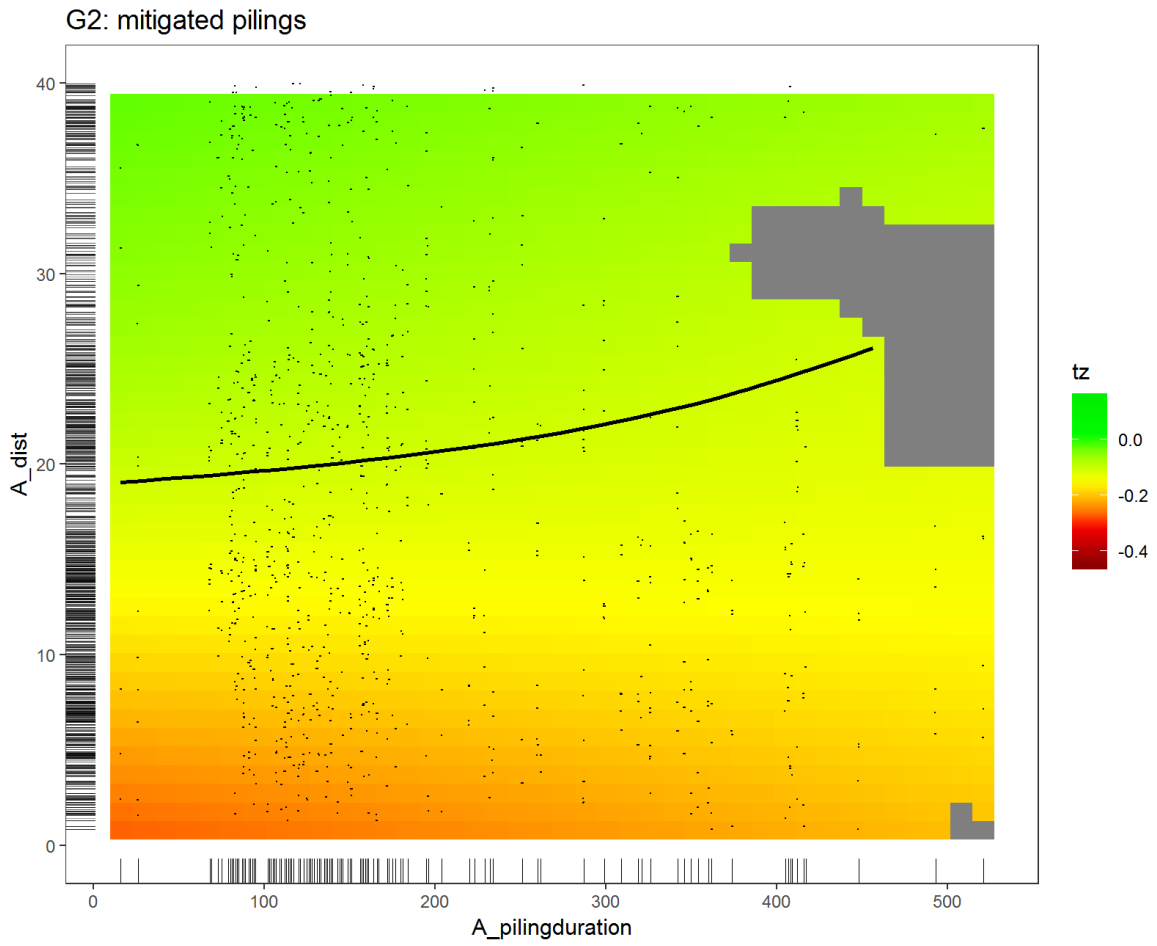


Figure A.65 Reference-type piling-duration GAM M3.5aG2: Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values shortly after piling hours (hrw 1-3) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_dist (distance to piling); black dots: data.

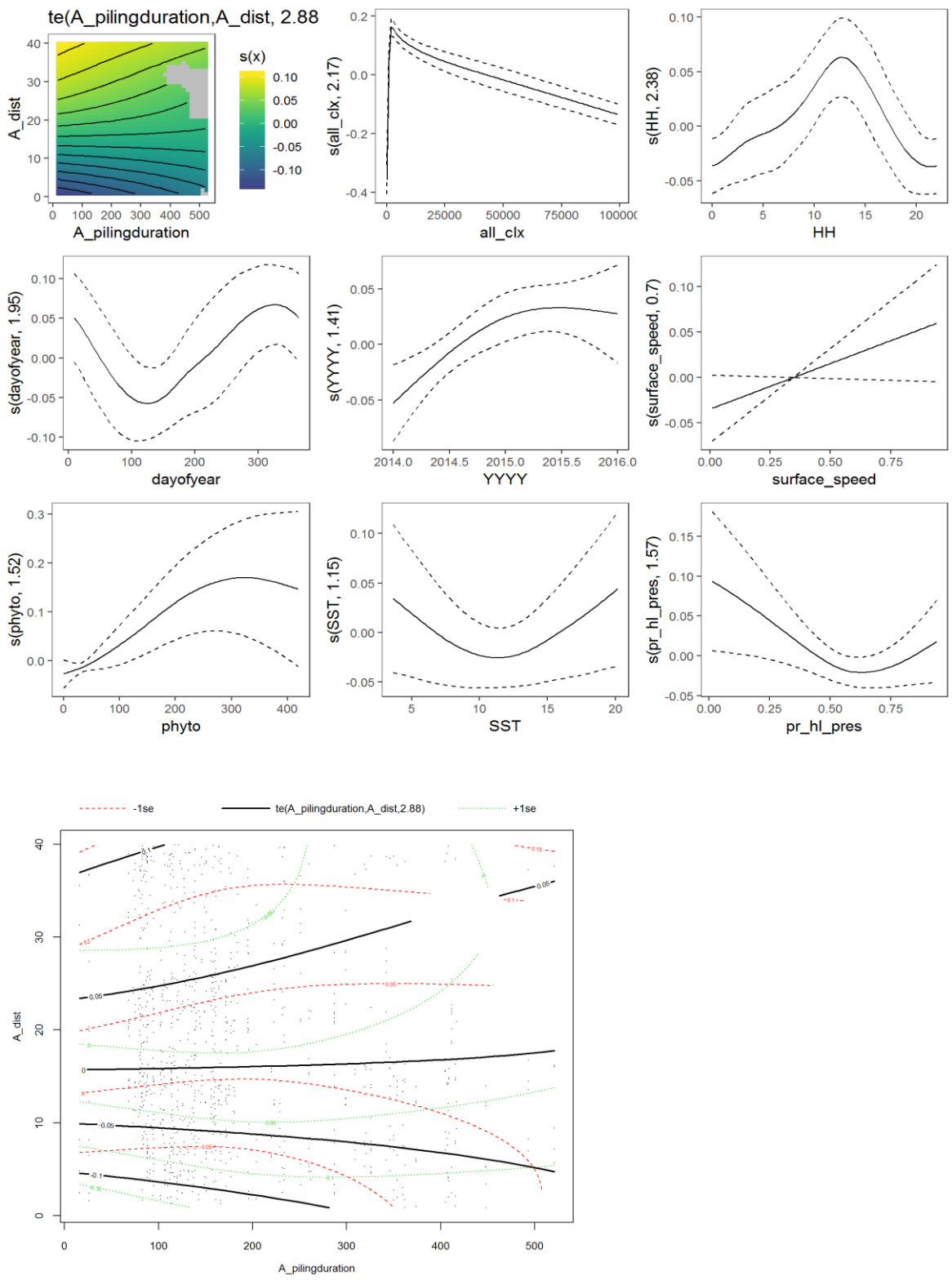


Figure A.66 Reference-type piling-duration GAM M3.5aG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_pilingduration (piling duration in min) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Effect of piling duration in relation to time after noise-mitigated pile driving (data in up to 10 km distance)

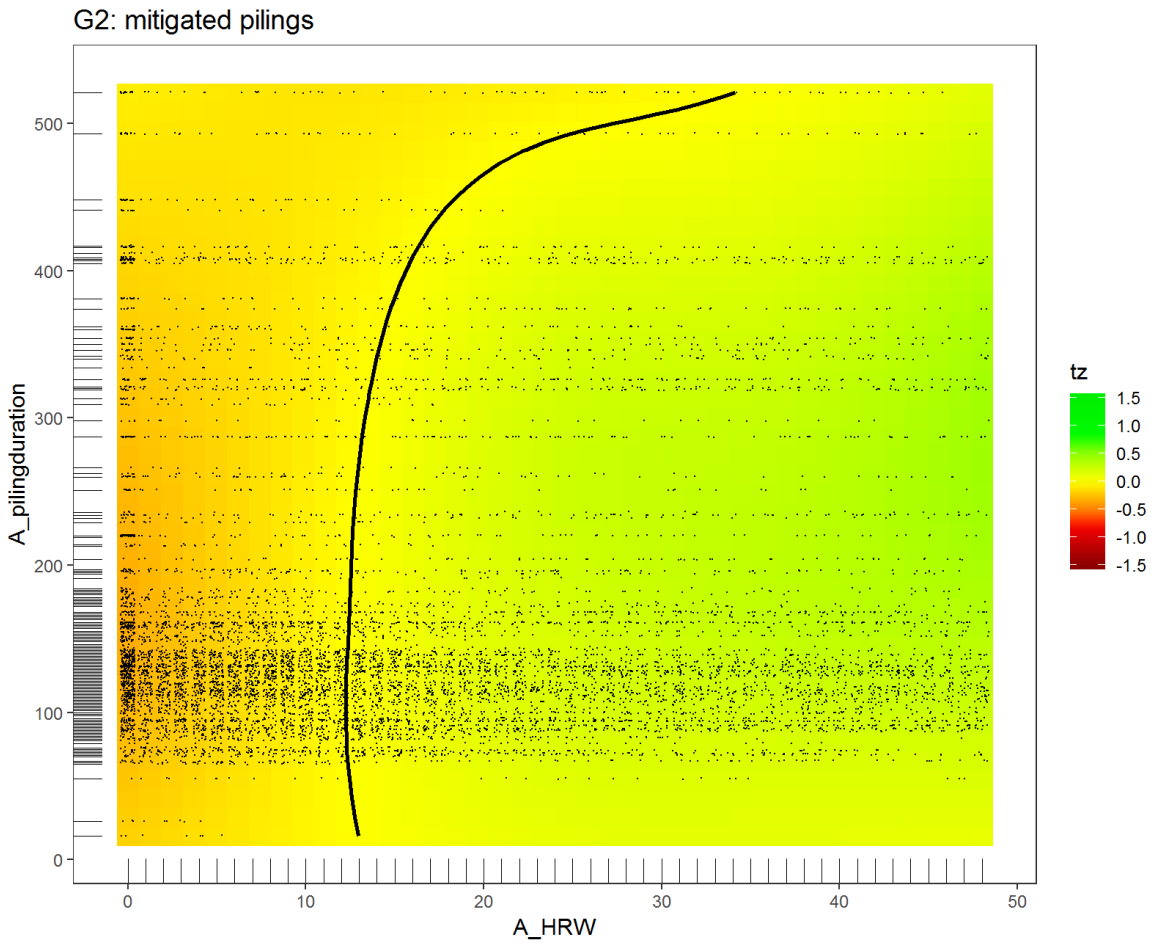


Figure A.67 Cl-type piling-duration GAM M3.5bG2: Mitigated pile driving 2014-2016 (Gescha 2); DPH values in close range (0-10 km) on scale of the linear predictor where zero equals the average of fitted values, modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); black dots: data.

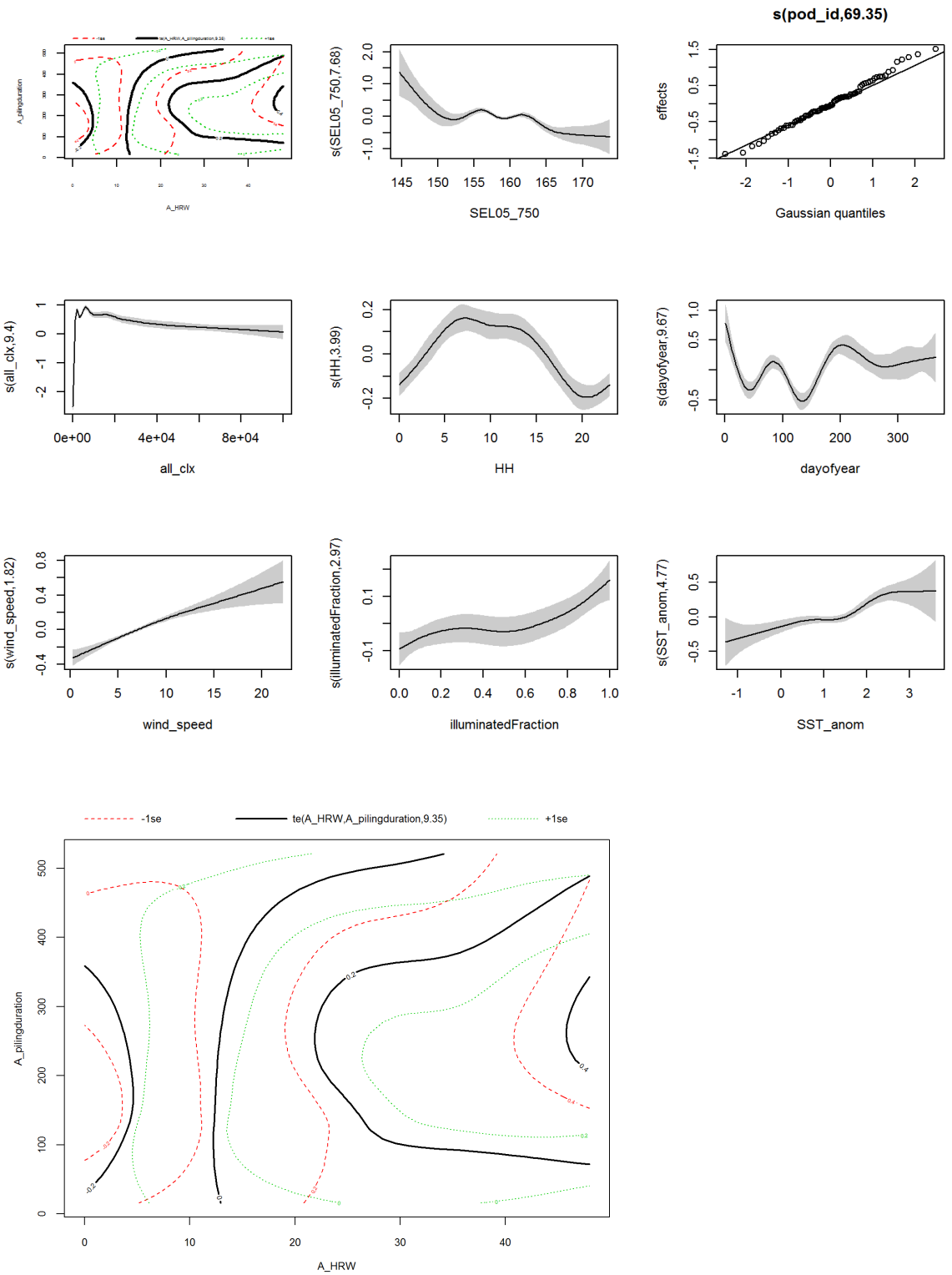


Figure A.68 Cl-type piling-duration GAM M3.5bG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the previous figure.

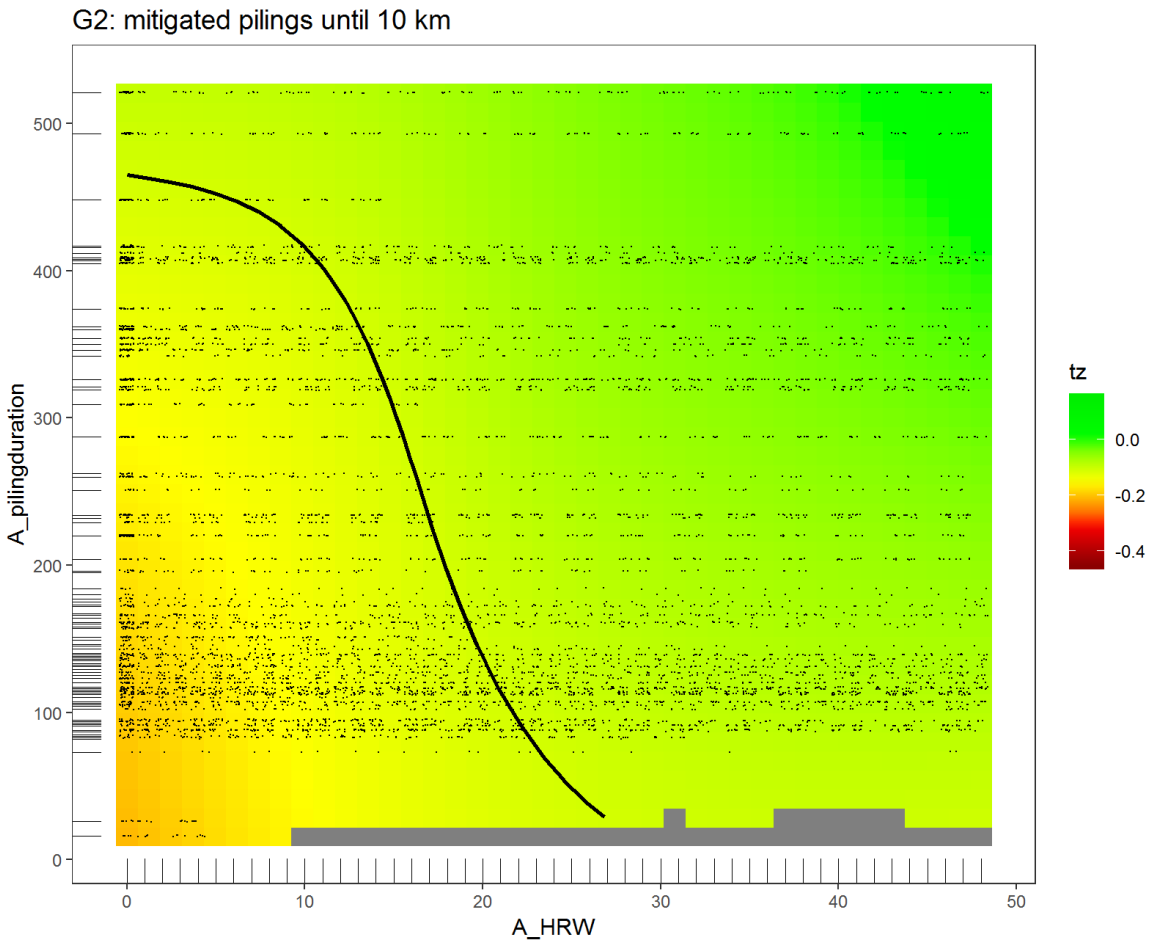
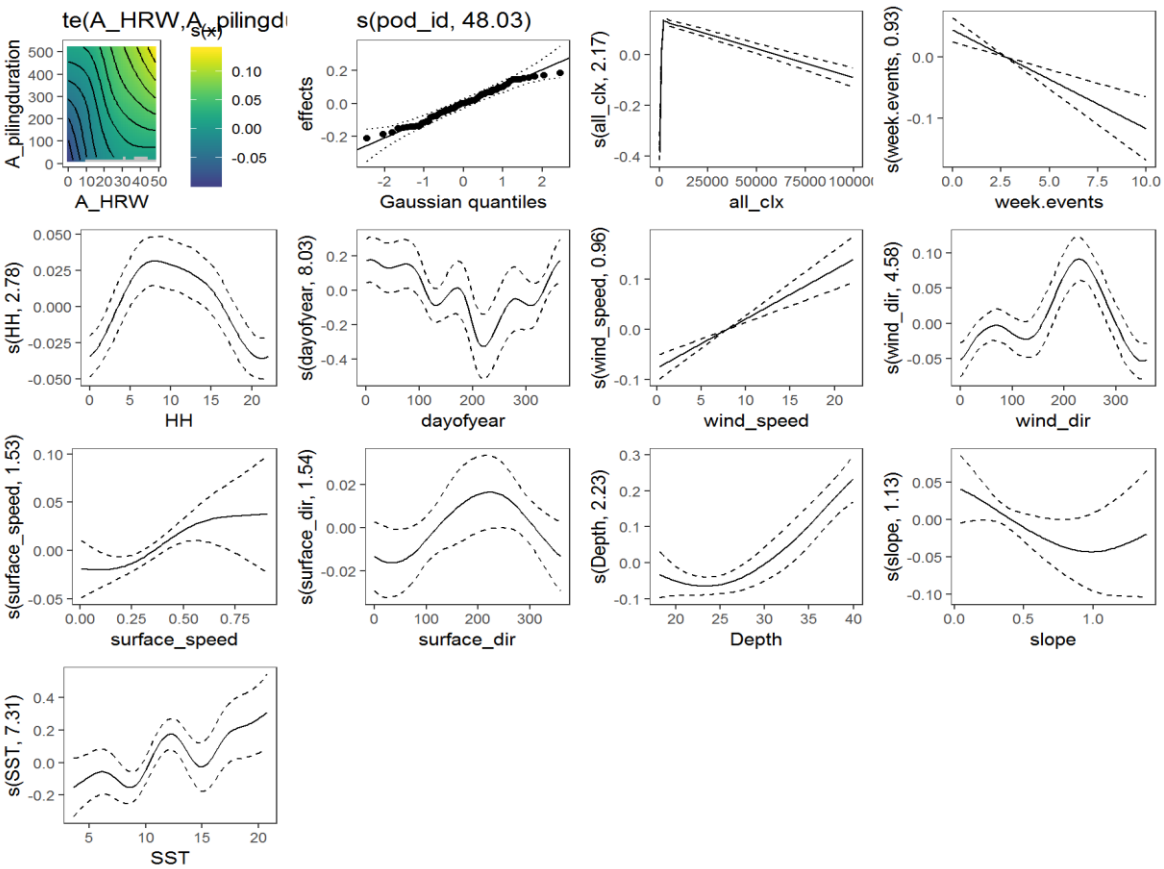


Figure A.69 Reference-type piling-duration GAM M3.5bG2: Mitigated pile driving 2014-2016 (Gescha 2); dDPH_ref values in close range (0-10 km) on scale of the response where zero equals no effect (black contour line: 20 % reduction of dDPH_ref relative to reference level), modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); black dots: data.



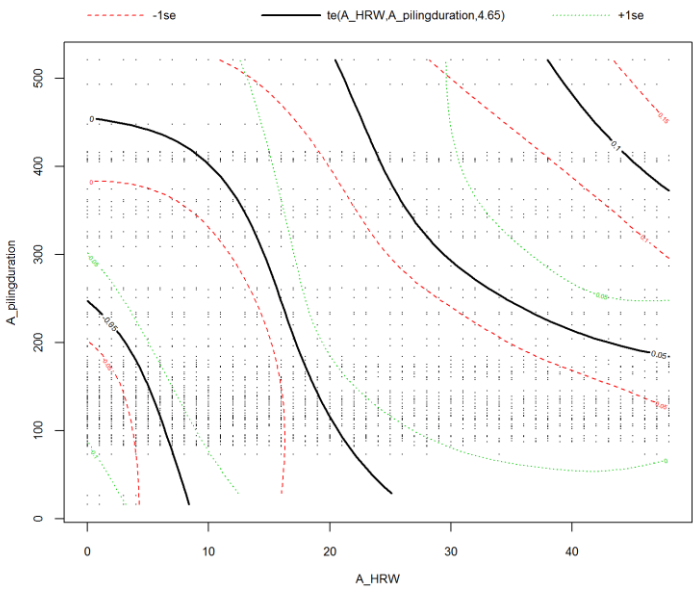


Figure A.70 Reference-type piling-duration GAM M3.5bG2: Mitigated pile driving 2014-2016 (Gescha 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the previous figure.

Gescha 1 & 2 models

In addition to the plots for piling-duration models on the combined Gescha 1 & 2 dataset already presented in the report, standard plots of the *gam.plot()* function are shown here which also include standard error contour lines.

Effect of piling duration at hrw 1-3 in relation to distance from mitigated pilings

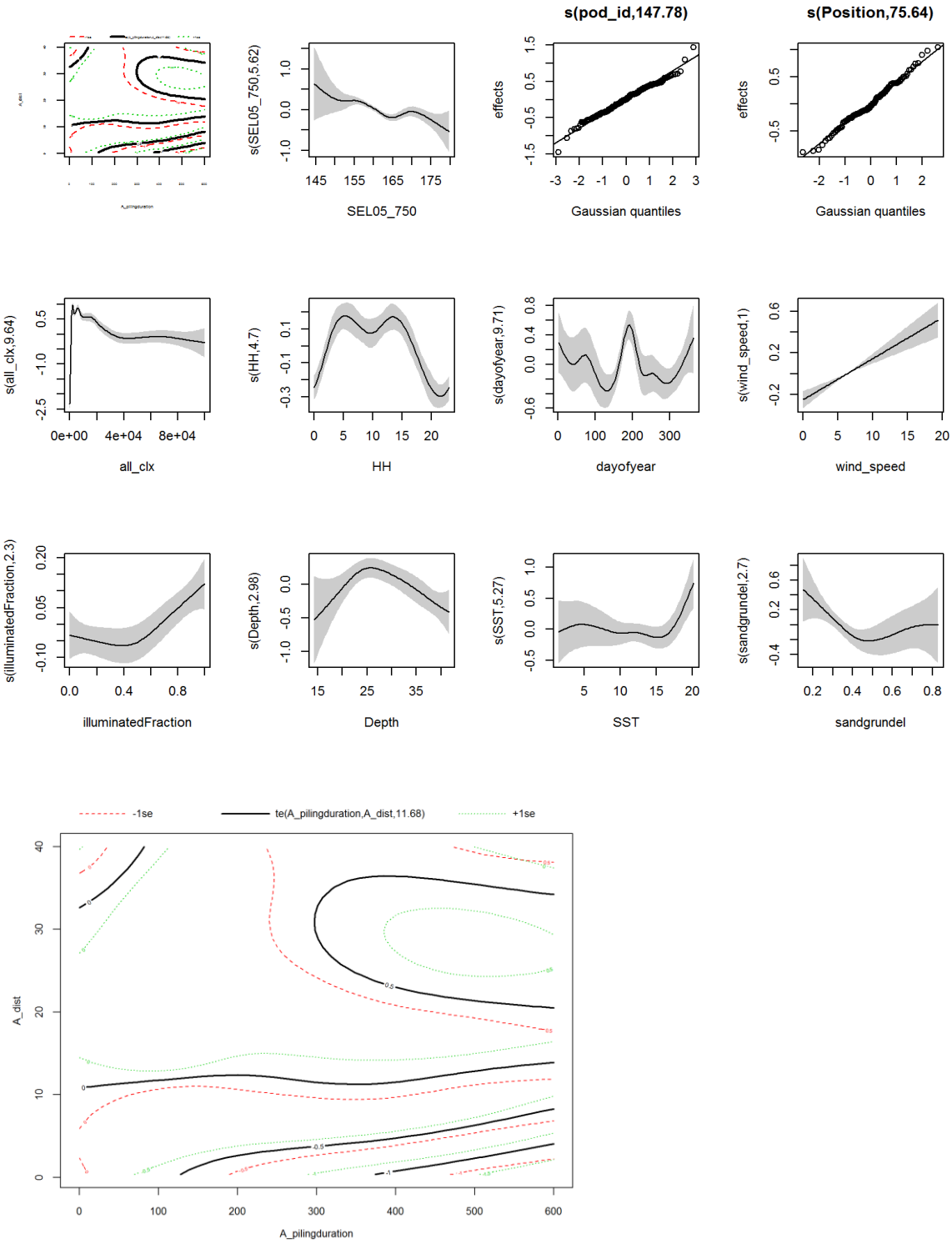


Figure A.71 *Cl-type piling-duration GAM M3.5aG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values modelled on each variable; lower panel: DPH values modelled on the interaction of A_pilingduration (piling duration in min) and A_dist (distance to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons was not shown for the zero lines in the report figure.*

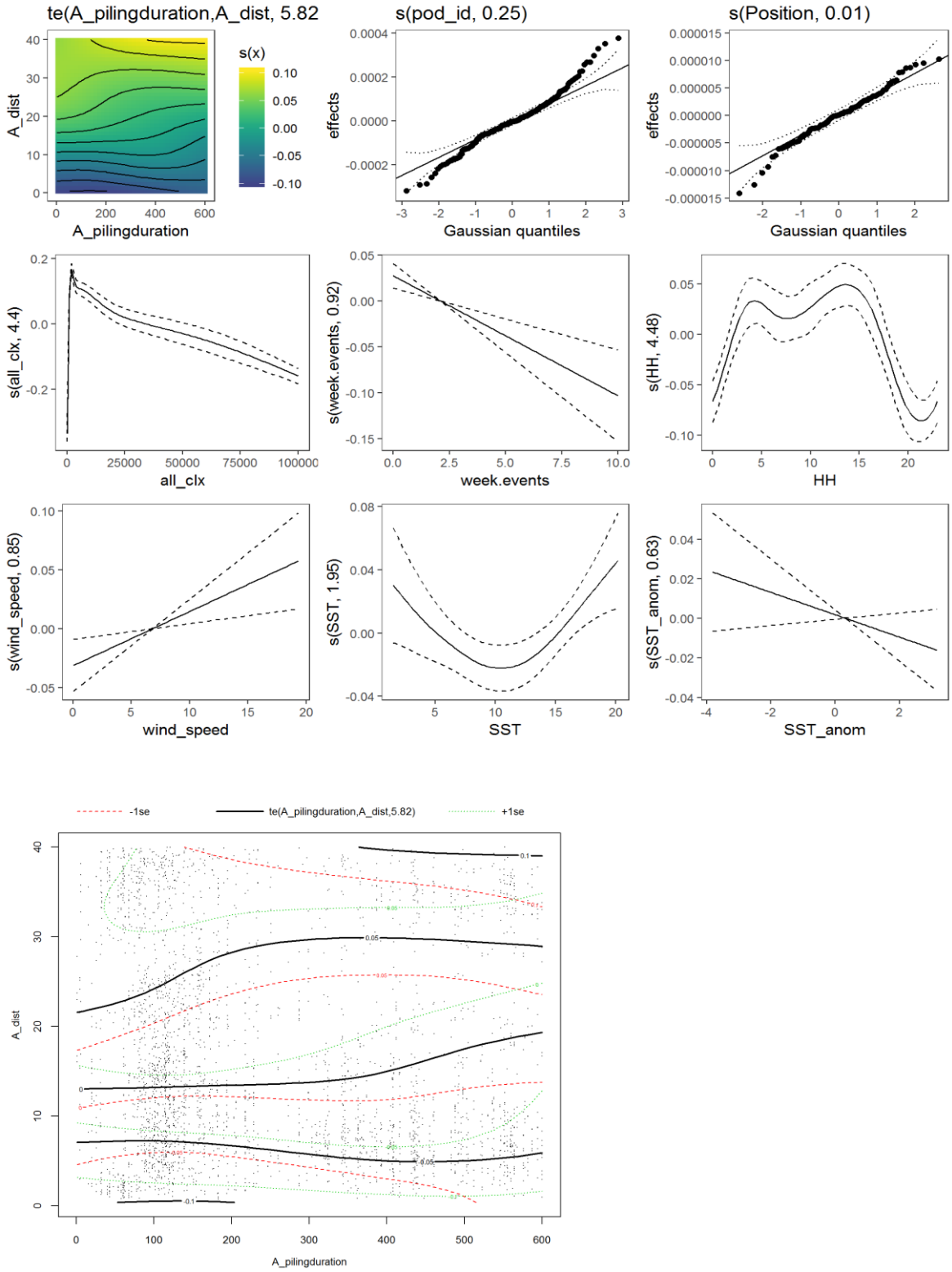
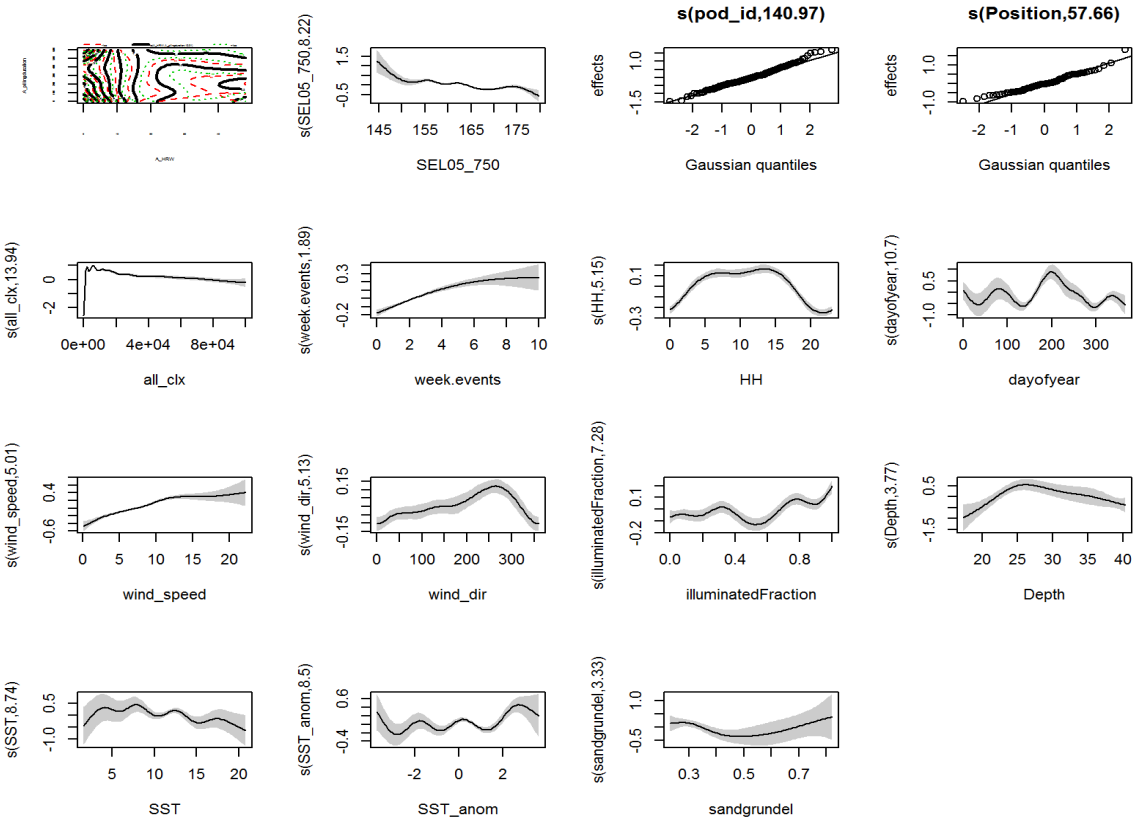


Figure A.72 Reference-type piling-duration GAM M3.5aG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values modelled on each variable; lower panel: dDPH_ref values modelled on the interaction of A_pilingduration (piling duration in min) and A_dist (distance to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

Effect of piling duration in relation to time after noise-mitigated pile driving (data in up to 10 km distance)



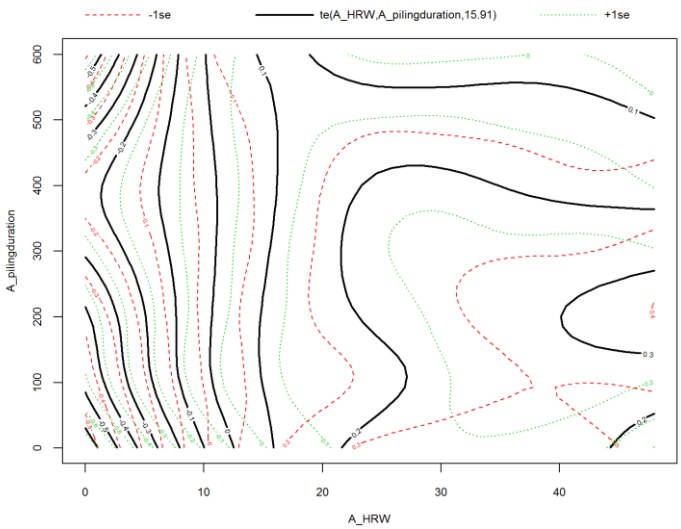


Figure A.73 Cl-type piling-duration GAM M3.5bG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: DPH values in close range (0-10 km), modelled on each variable; lower panel: DPH values in close range (0-10 km), modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); DPH values on scale of the linear predictor where zero equals the average of fitted values; this panel presents the standard error (dotted lines) which due to technical reasons could not be shown with the zero lines in the report figure.

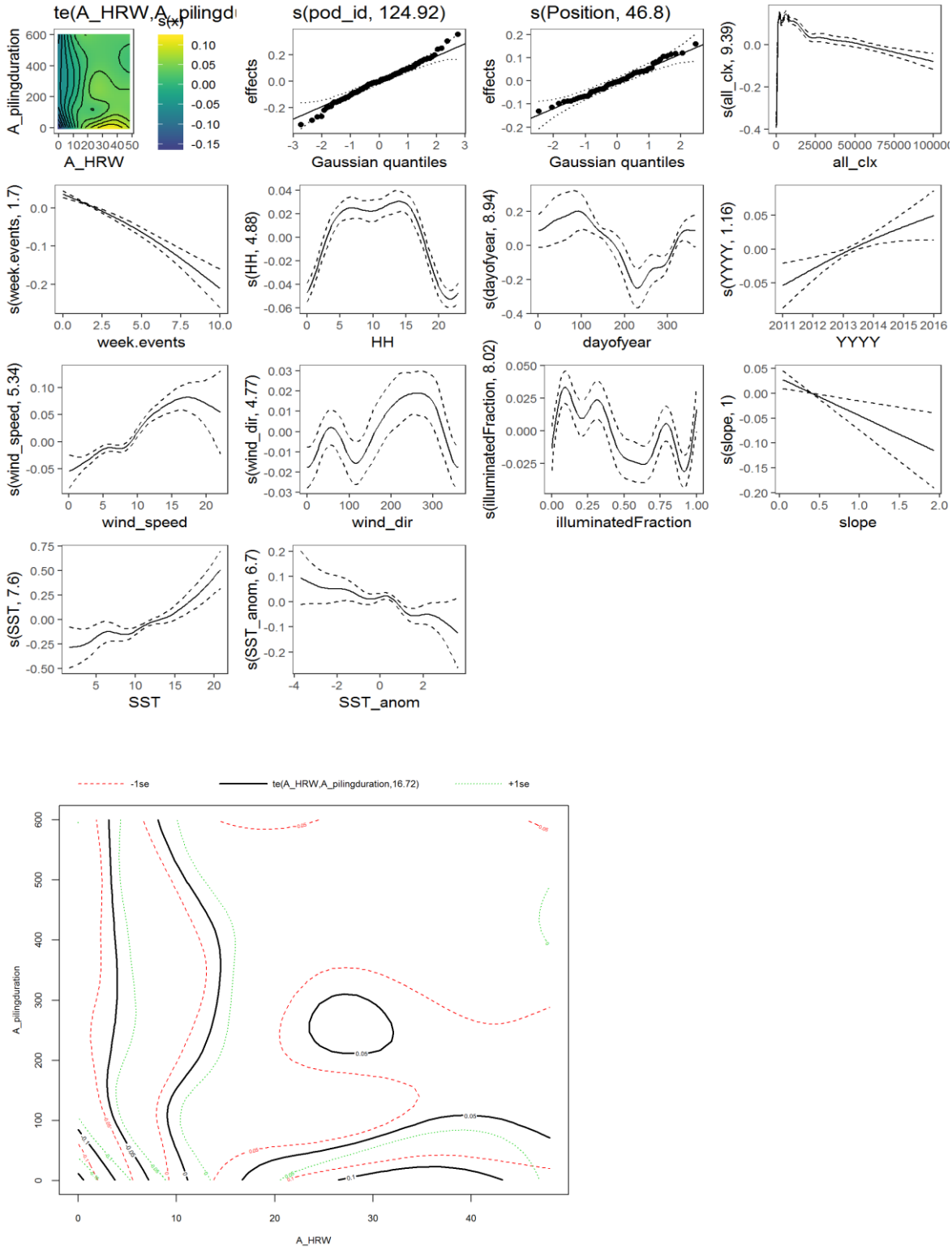


Figure A.74 Reference-type piling-duration GAM M3.5bG12: Mitigated pile driving 2011-2016 (Gescha 1 & 2); upper panel: dDPH_ref values in close range (0-10 km), modelled on each variable; lower panel: dDPH_ref values in close range (0-10 km) modelled on the interaction of the variables A_pilingduration (piling duration in min) and A_HRW (hour relative to piling); in contrast to the previous figure, no percentage of reduction on the response scale is shown here, but zero equals the average of fitted values; this panel gives an idea of the standard error (dotted lines) which due to technical reasons could not be shown with the 20 % line in the report figure.

WP 3.6 – Effects before pile driving: Additional plots

Gescha 1: OWF raw data plots

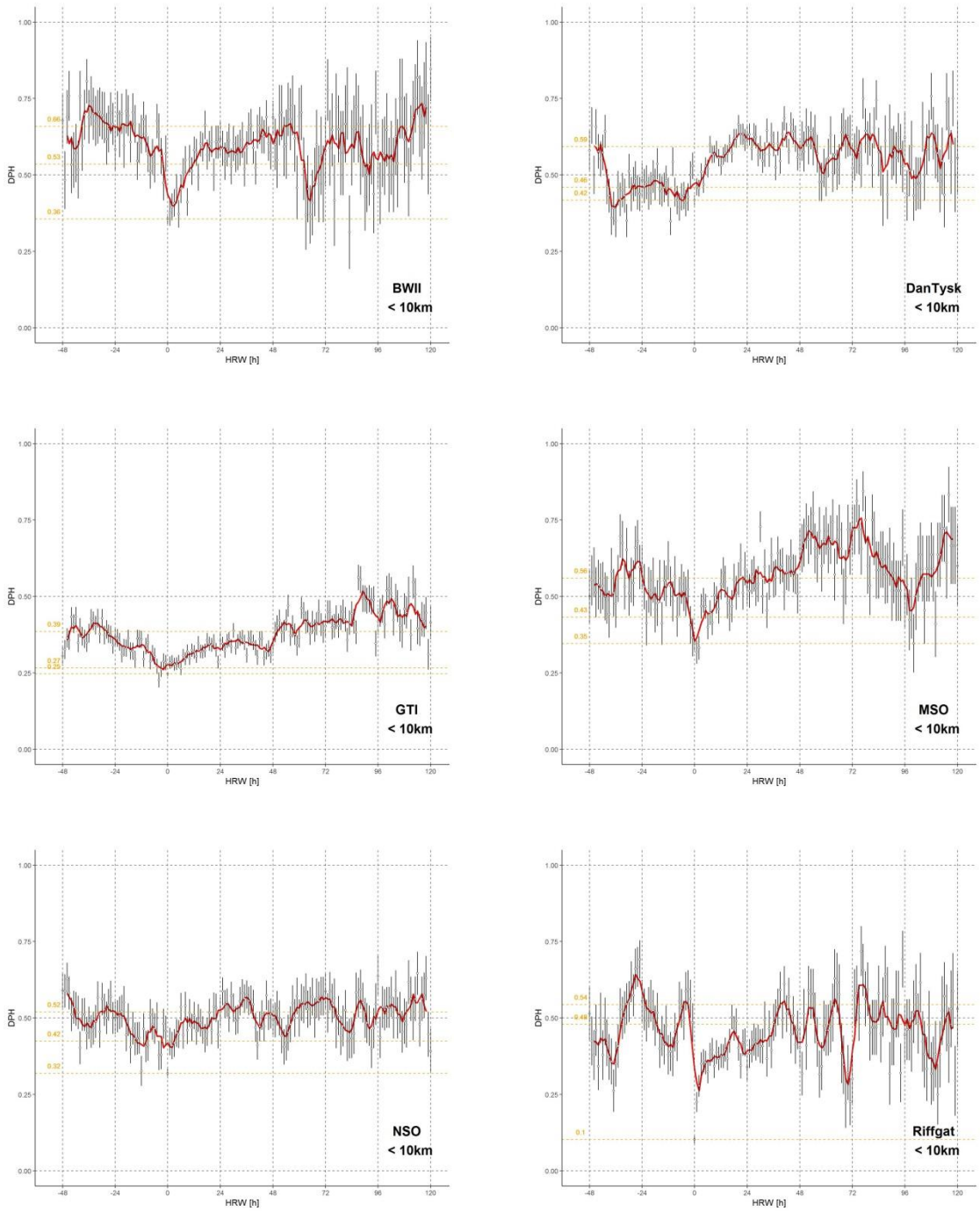


Figure A.75 Gescha 1: DPH raw data (with std. errors) along time axis for six OWFs; hour zero (hrw0) denotes piling hour(s); yellow dotted lines show the following average DPH values: upper: Baseline (hrw-48 to hrw-24); middle: Traffic (hrw-3 to hrw-1); lower: Piling (hrw0).

WP 3.6 – Effects before pile driving: Additional tables

Gescha 1: Effects before pile driving for single OWFs

Table A.3 *Gescha 1: OWFs (mitigated pilings): Mean DPH rates in up to 10 km distance from construction sites for three time classes: Baseline (Reference time: hrw-48 to variable end); Traffic (times of boat-traffic and other noise sources before piling: variable start, until hrw-1); Piling (deterrence and piling time: hrw0). The last hour of the Baseline ("Baseline end") and the first hour assigned to Traffic ("Traffic start") were chosen for each wind farm individually according curves in the raw data plots (Figure A.75).*

Phase	BWII	DanTysk	GTI	MSO	NSO	Riffgat
Baseline	0.66	0.59	0.39	0.56	0.52	0.54
Traffic	0.53	0.46	0.27	0.39	0.42	0.48
Piling	0.36	0.42	0.25	0.35	0.32	0.1
Baseline end	hrw-21	hrw-41	hrw-28	hrw-24	hrw-20	hrw-25
Traffic start	hrw-3	hrw-5	hrw-5	hrw-3	hrw-4	hrw-5

Aerial survey data

Detailed method description for the three digital aerial survey methods used to survey the German Bight.

APEM

APEM Ltd. uses own planes of the type "P68 Observer 2". From 2014 to 2016 three different planes (G-TETRA, G-GIGA and G-RIPA) were used. Flights are aborted if sea state is higher than five and midday hours are avoided, so that glare and sea state does not impact picture quality. A technician on board controls the picture quality during the entire flight. A Leica RCD 30-Medium Format System and a Track'Air Multi Camera System (foto camera) is used. An object detection software developed by APEM Ltd. automatically detects animals and other objects on the pictures. Within quality assurance 10 % of the pictures are manually checked by experienced personnel. When the manual and automatic detection does not differ by more than 10 %, pictures with targets are passed to species identification. Experienced APEM picture evaluators manually identify targets to the lowest possible taxonomic rank. They can refer to an assisting identification software and species catalogue, if needed. A designated quality assurance manager reanalyses 10 % of the pictures. The species identification process is finalised, when the two sets of results do not differ by more than 10 %. APEM Ltd. submits the effort and object information in the required "BSH format" for digital aerial surveys with respective information on flight conditions and object characterisation.

DAISI

IfAÖ GmbH uses planes of the type "Partenavia P 68" and all surveys within the study period were done with the same plane (DGKRE). Two foto cameras of the type PhaseOne IXA180 are mounted on a platform below the plane. At flight height of about 1400 ft and focal length of 110 mm, a strip width of 407 m is reached. For the analysis a grid is applied to the pictures and objects in each grid cell are systematically marked by experienced personnel. For quality assurance 10 % of the pictures are reanalysed and 90 % of consistency are required to pass to the species identification. At least two experts independently identify the marked objects to the lowest possible taxonomic rank. An expert, who wasn't involved in the previous identification process, reanalyses 10 % of the identified objects. An accordance of 90 % is needed to finalize the species identification. IfAÖ GmbH submits the effort and object information in the required "BSH format" for digital aerial surveys with respective information on flight conditions and object characterisation.

HiDef

HiDef uses own planes of the type "Partenavia P 68" and six different planes (OY-SUR, OY-ILS, OY-INS, OY-GIS, OY-GNS and OY-GPS) were used from 2014 to 2016 in the different areas. The angle of the four video cameras can be adjusted independently to avoid glare on the recordings. The inner cameras cover a strip width of 129 m, while the outer cameras cover 143 m. Together the effective strip width equals 544 m and including camera spacing, the total width is 604 m. HiDef videos are watched by reviewers, who first mark any kind of object on the films. In a second step, experienced personnel identify the marked targets to the lowest possible taxonomic rank. Each

step is followed by a quality control, where a second reviewer and identifier reassess 20 % of the material. If results between reviewers differ by more than 10 % the step has to be repeated. The remaining discrepancy material is analysed by a third person. Bioconsult SH GmbH submits the effort and object information in the required "BSH format" for digital aerial surveys with respective information on flight conditions and object characterisation.

WP 3.2 – Aerial survey data: Additional plots

General harbour porpoise distribution and density

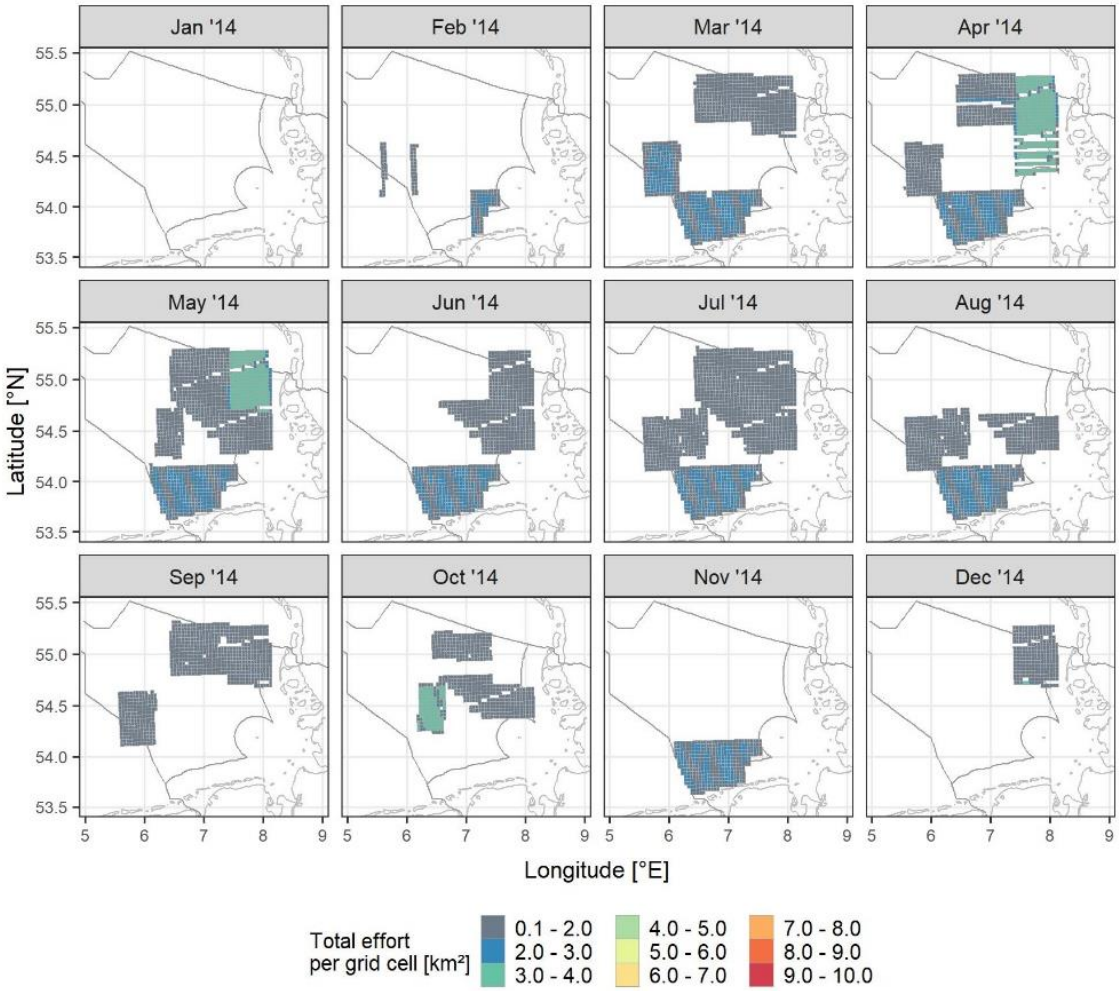


Figure A.76 Digital aerial survey effort distribution as image area analysed [km²] per grid cell for 2014.

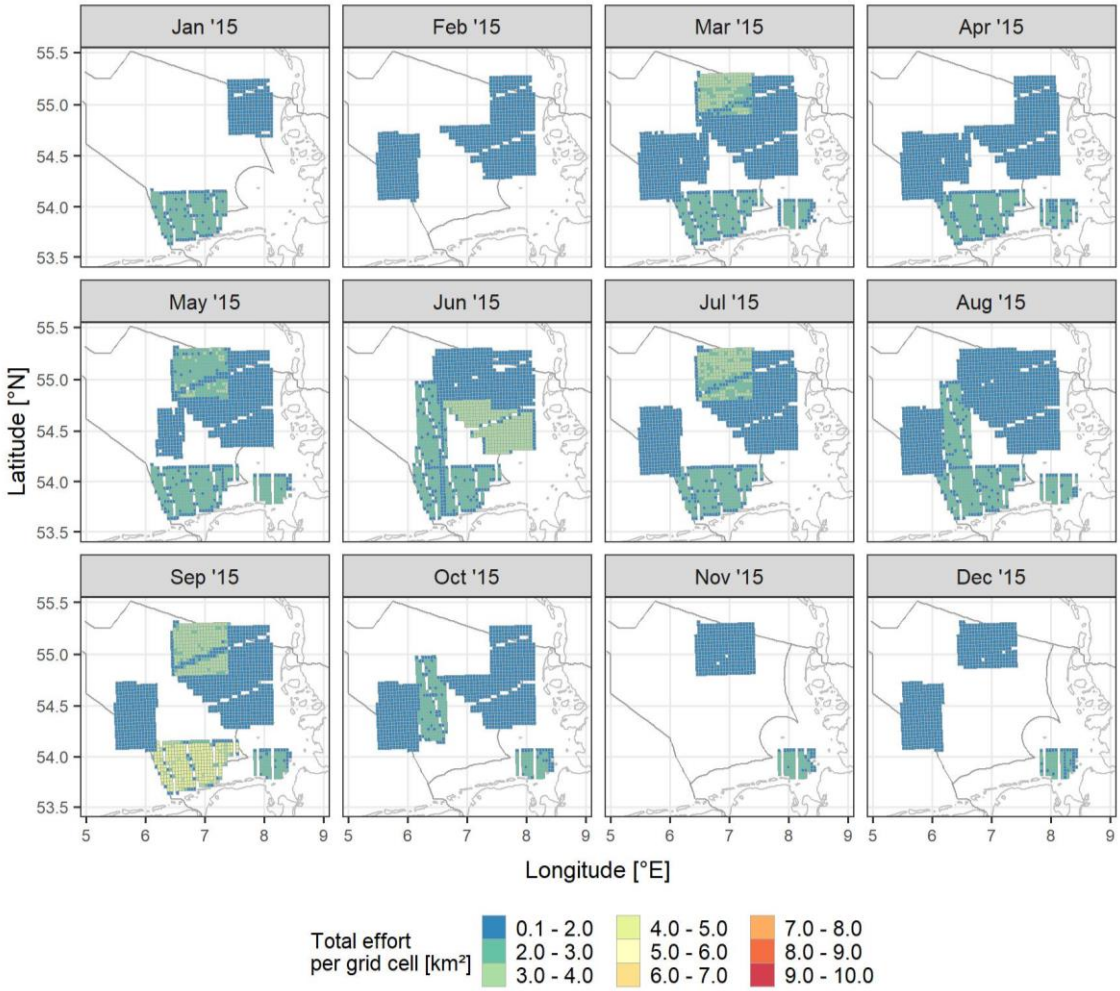


Figure A.77 Digital aerial survey effort distribution as image area analysed [km²] per grid cell for 2015.

Figure A.78 Digital aerial survey effort distribution as image area analysed [km²] per grid cell for 2016.

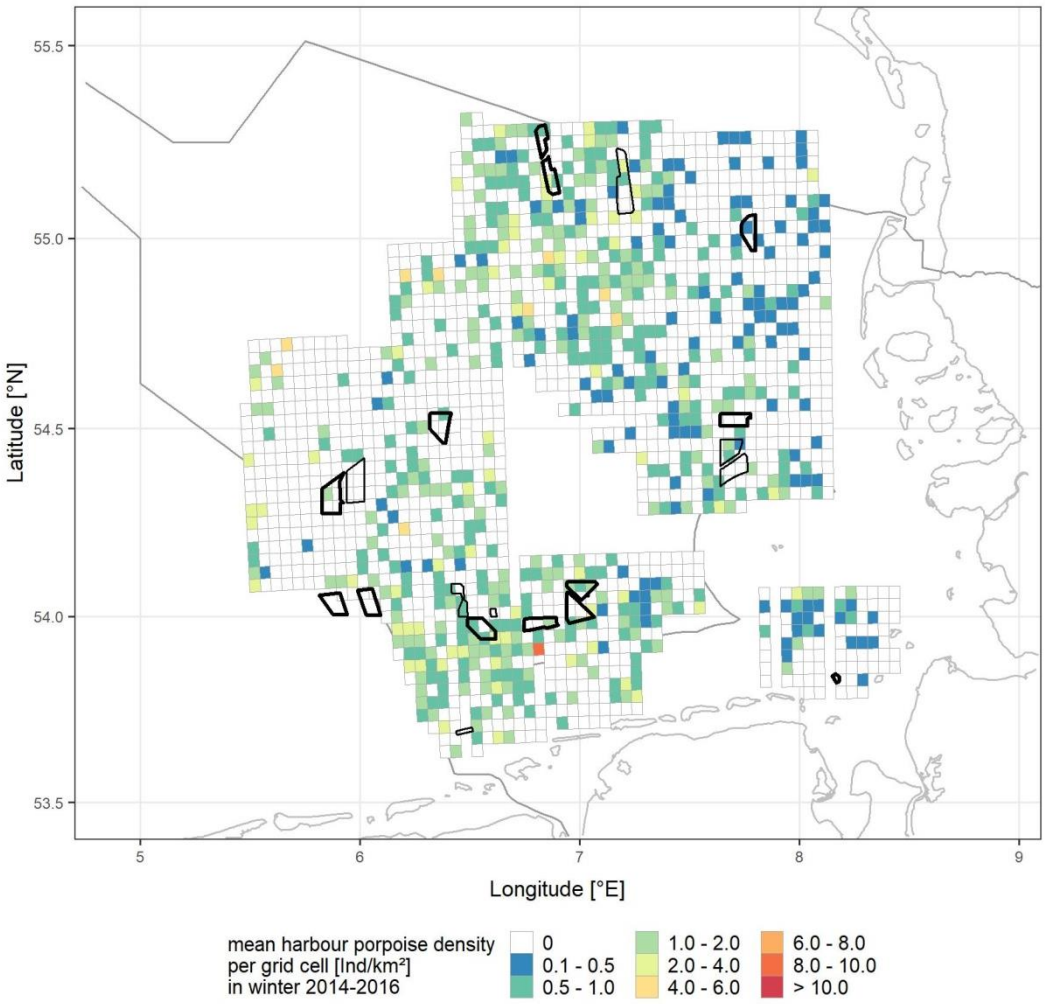


Figure A.79 Harbour porpoise densities [Ind./km²] per grid cell in winter in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

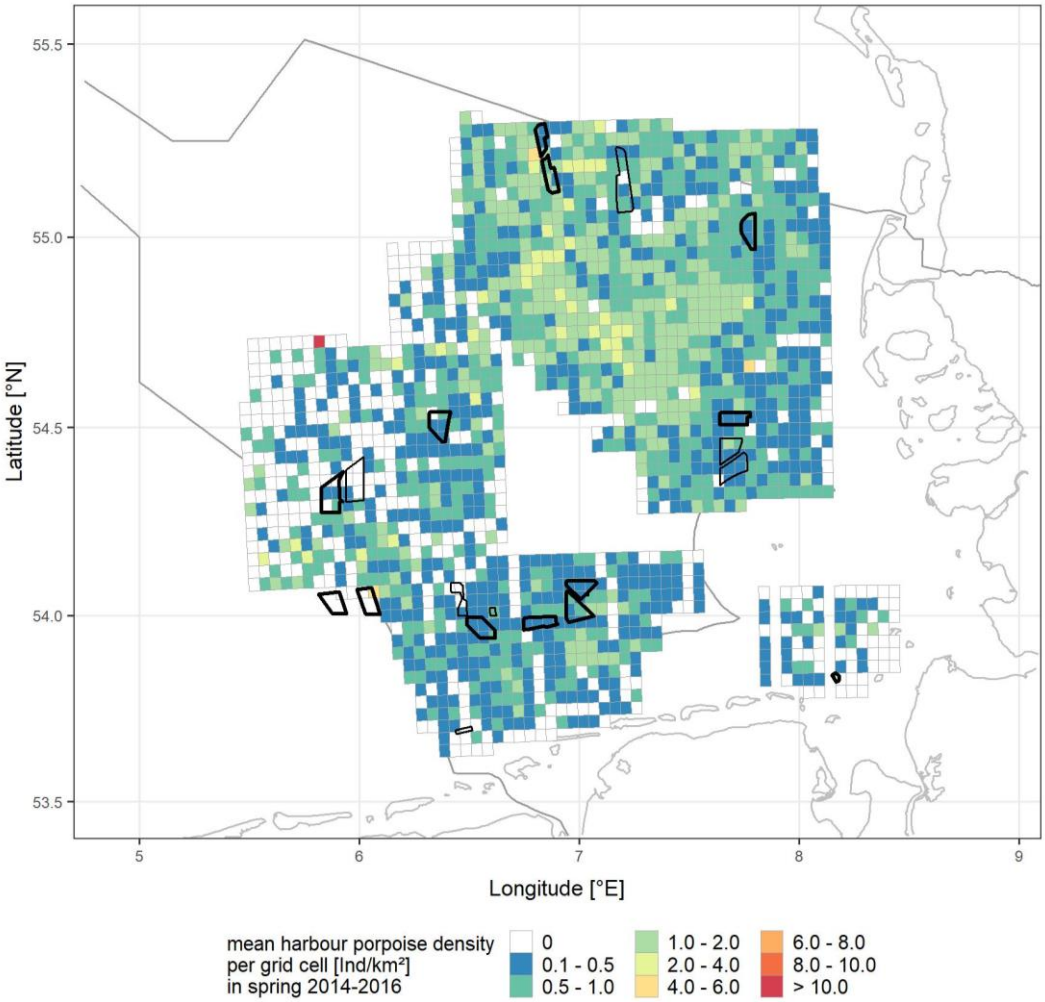


Figure A.80 Harbour porpoise densities [Ind./km²] per grid cell in spring in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

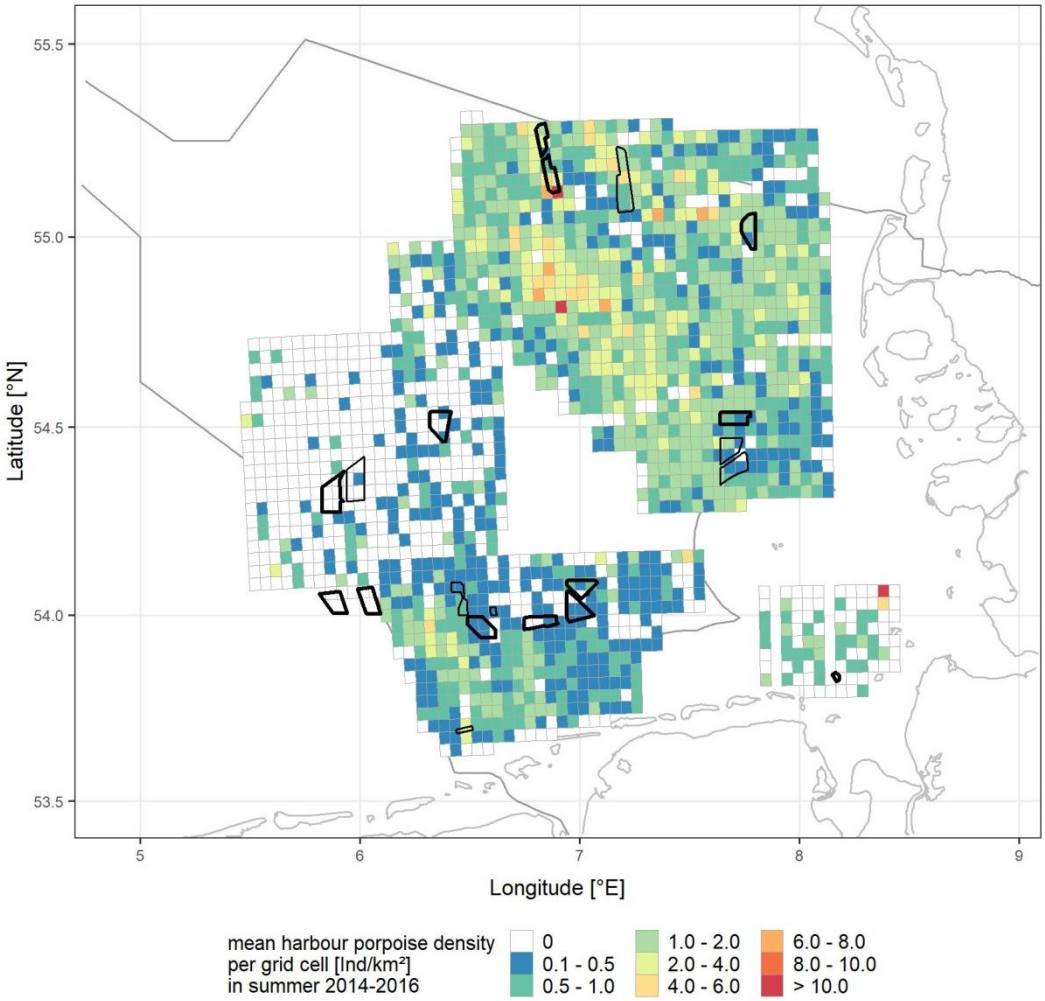


Figure A.81 Harbour porpoise densities [Ind./km²] per grid cell in summer in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

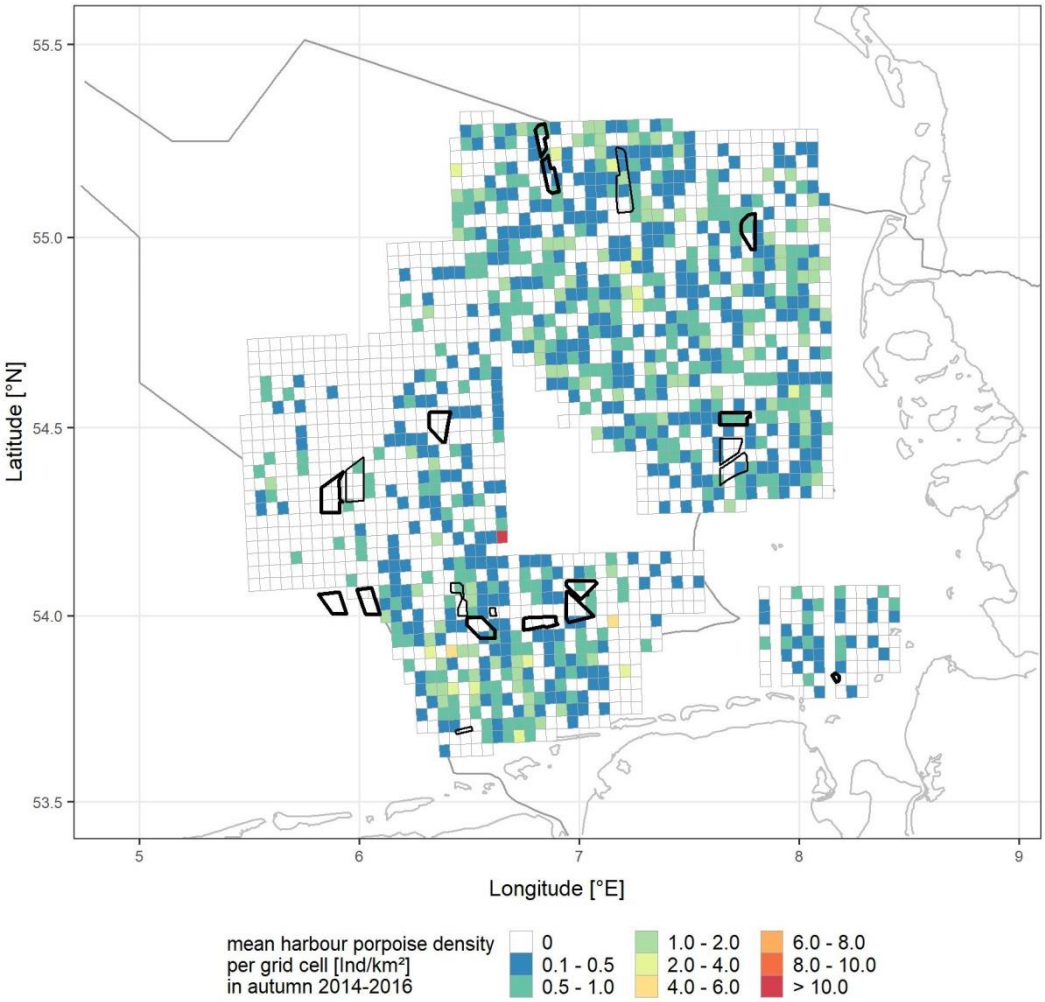


Figure A.82 Harbour porpoise densities [Ind./km²] per grid cell in autumn in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

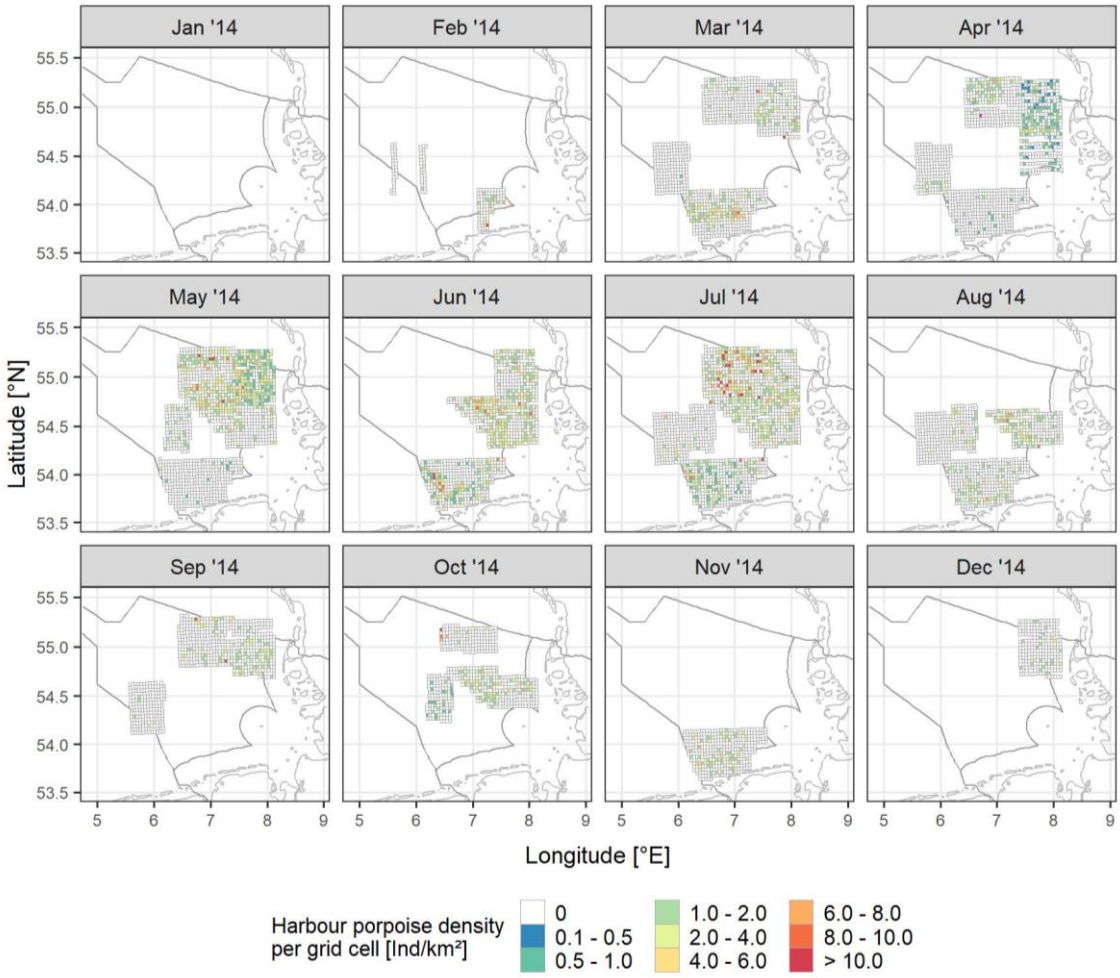


Figure A.83 Monthly porpoise densities [Ind./km²] per grid cell in the German Bight for 2014.

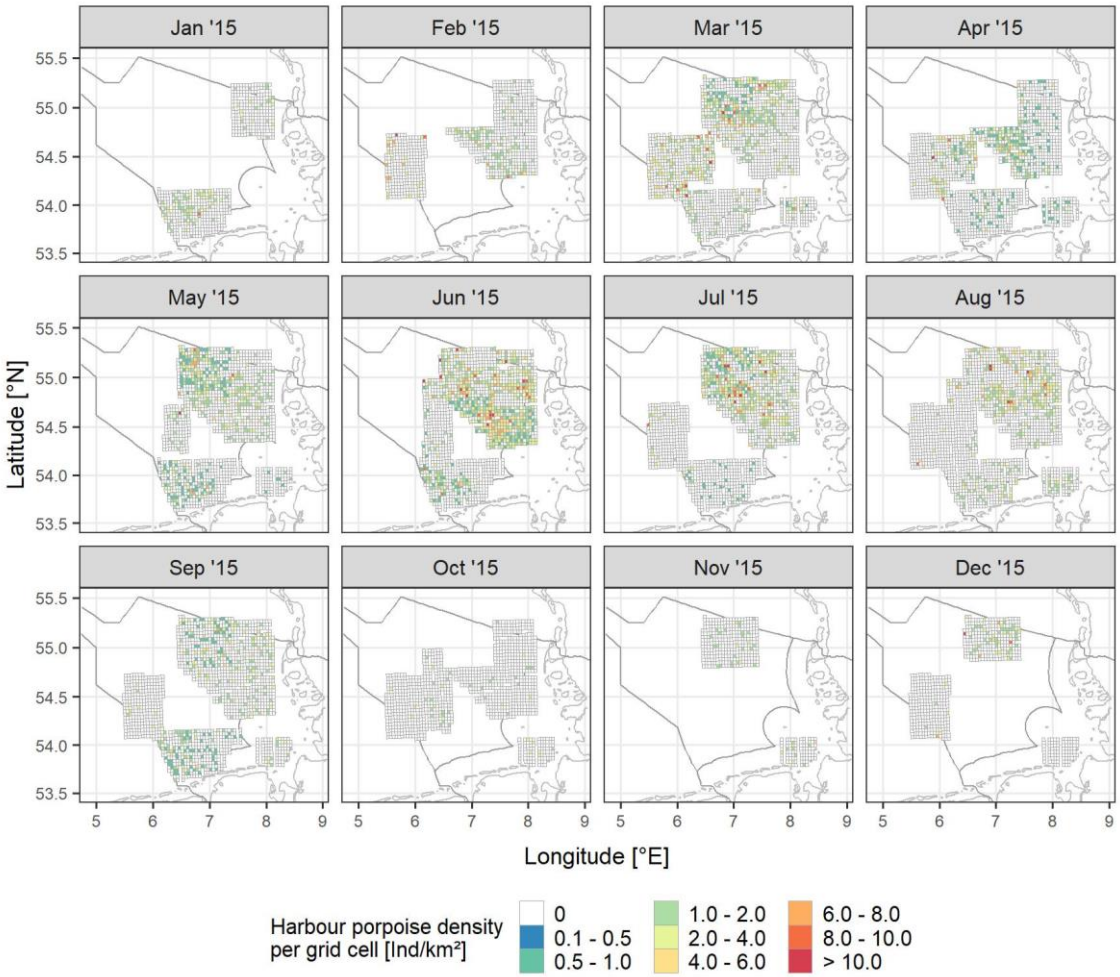


Figure A.84 Monthly porpoise densities [Ind./km²] per grid cell in the German Bight for 2015.

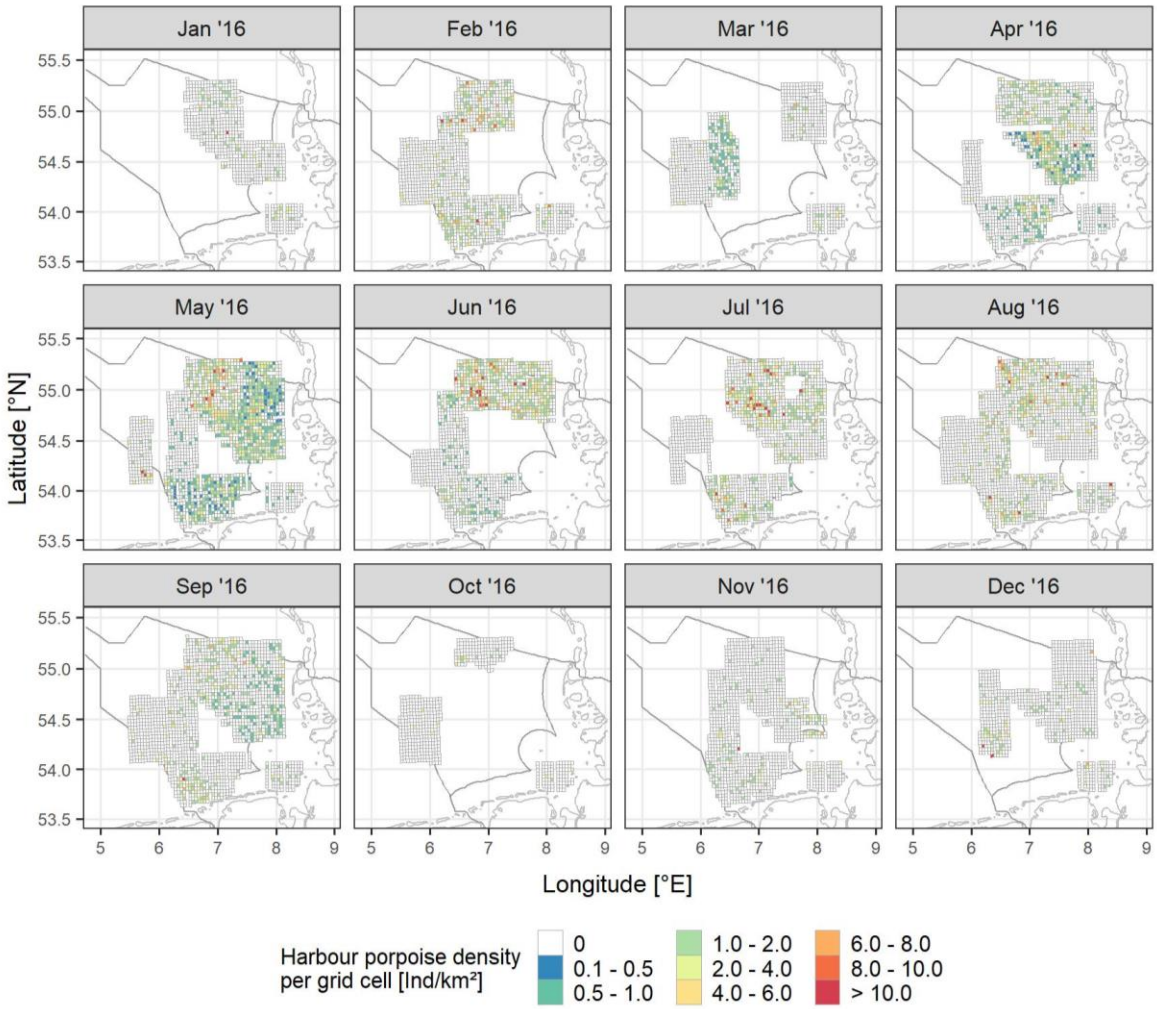


Figure A.85 Monthly porpoise densities [Ind./km²] per grid cell in the German Bight for 2016.

Gradient analysis

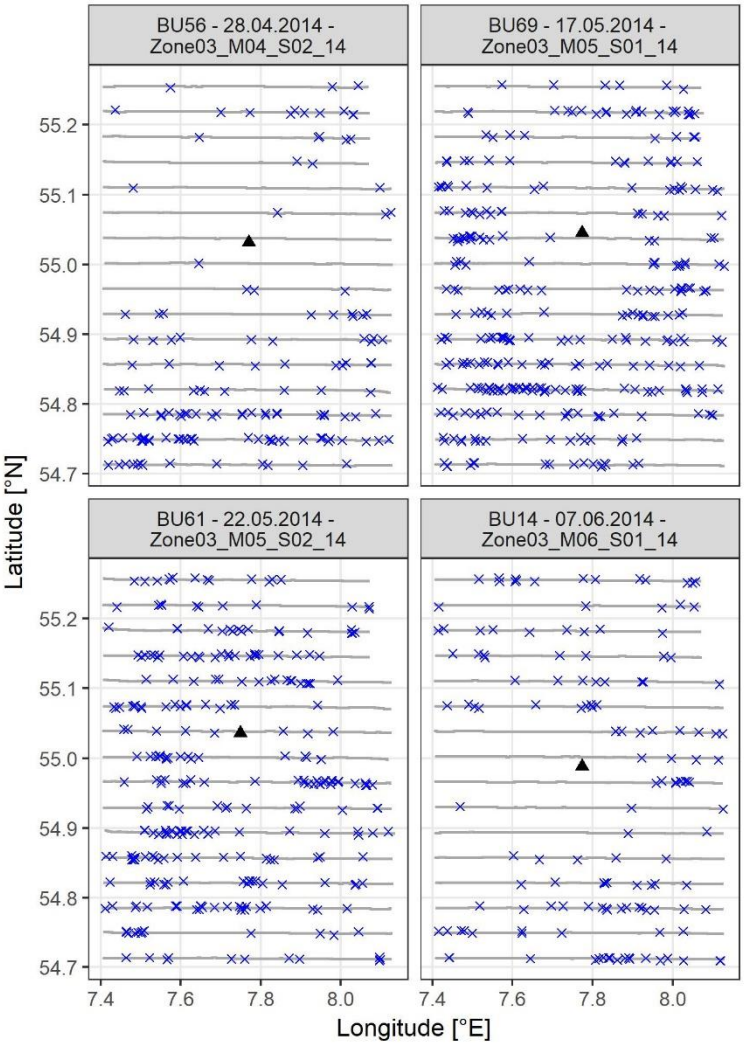


Figure A.86 All harbour porpoise sightings during surveys in Butendiek Cluster. Only surveys used within the gradient analysis are shown. Sightings are indicated with a blue cross. The label gives piling event, date of flight and survey ID. Position of piling event is indicated with black triangle.

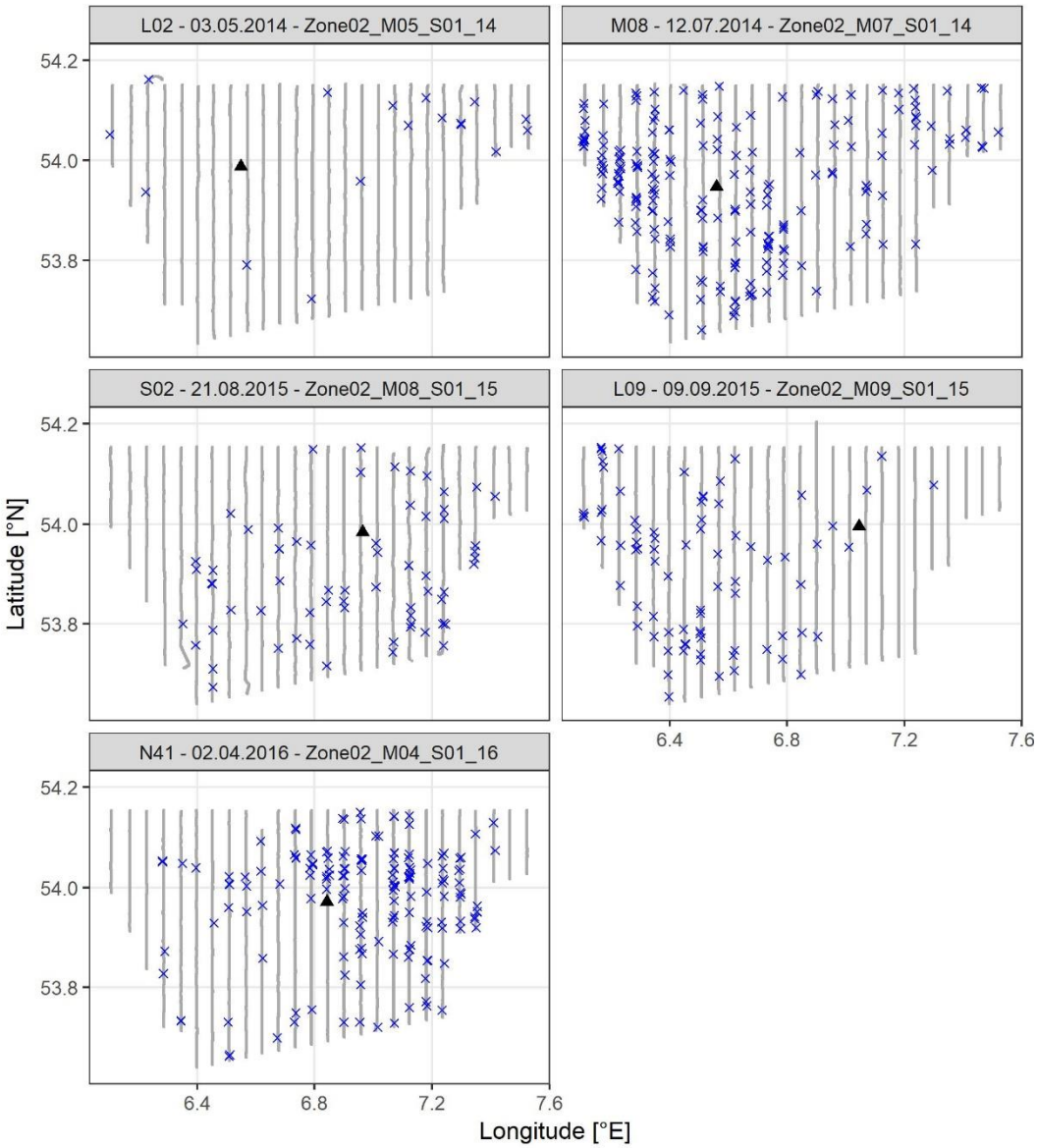


Figure A.87 All harbour porpoise sightings during surveys in Cl. Nördlich Borkum. Only surveys used within the gradient analysis are shown. Sightings are indicated with a blue cross. The label gives piling event, date of flight and survey ID. Position of piling event is indicated with black triangle.

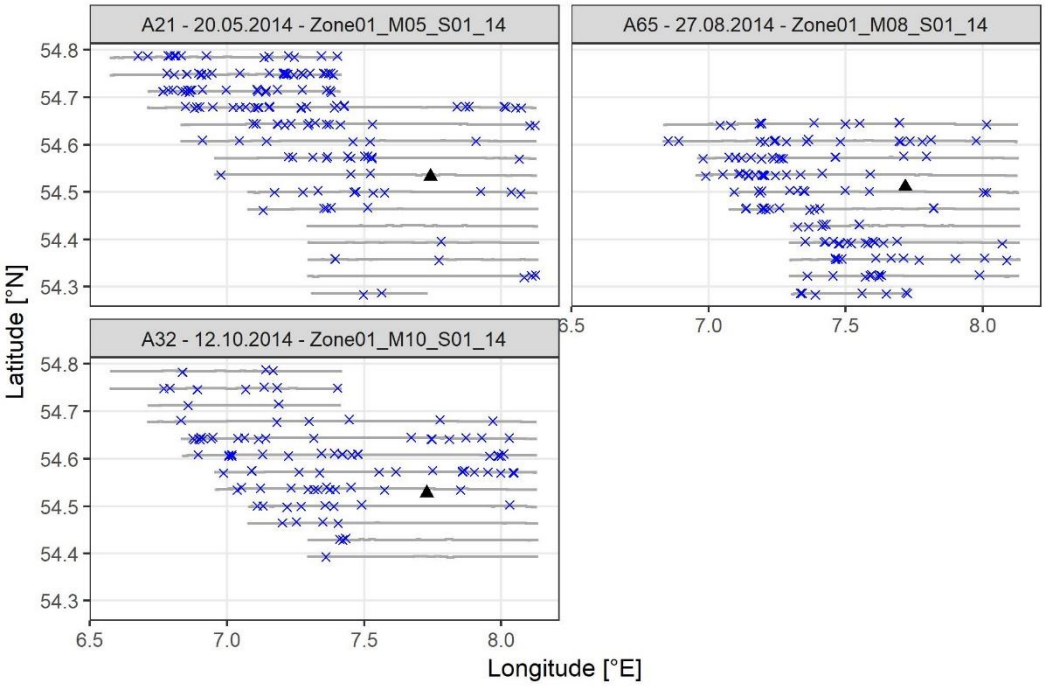


Figure A.88 All harbour porpoise sightings during surveys in Cl. Helgoland. Only surveys used within the gradient analysis are shown. Sightings are indicated with a blue cross. The label gives piling event, date of flight and survey ID. Position of piling event is indicated with black triangle.

Environmental parameters within the Large-scale model

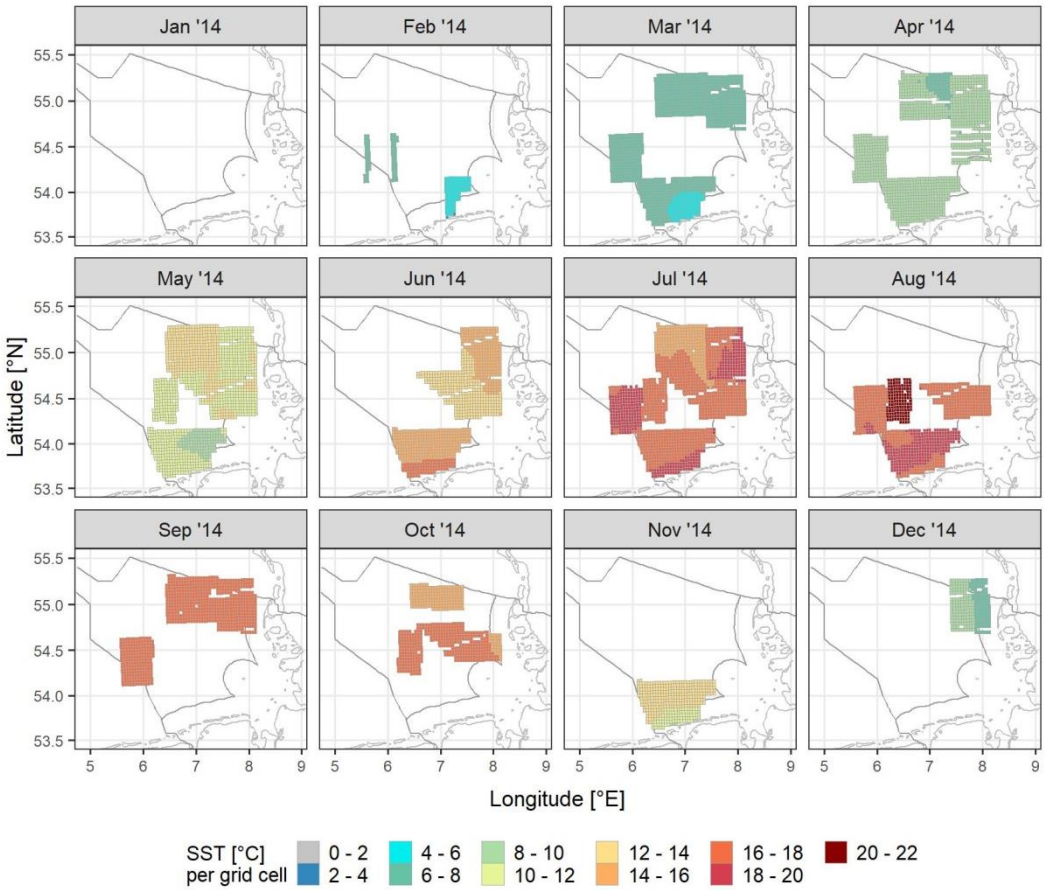


Figure A.89 Monthly sea surface temperature (SST) per grid cell in the German Bight for 2014.

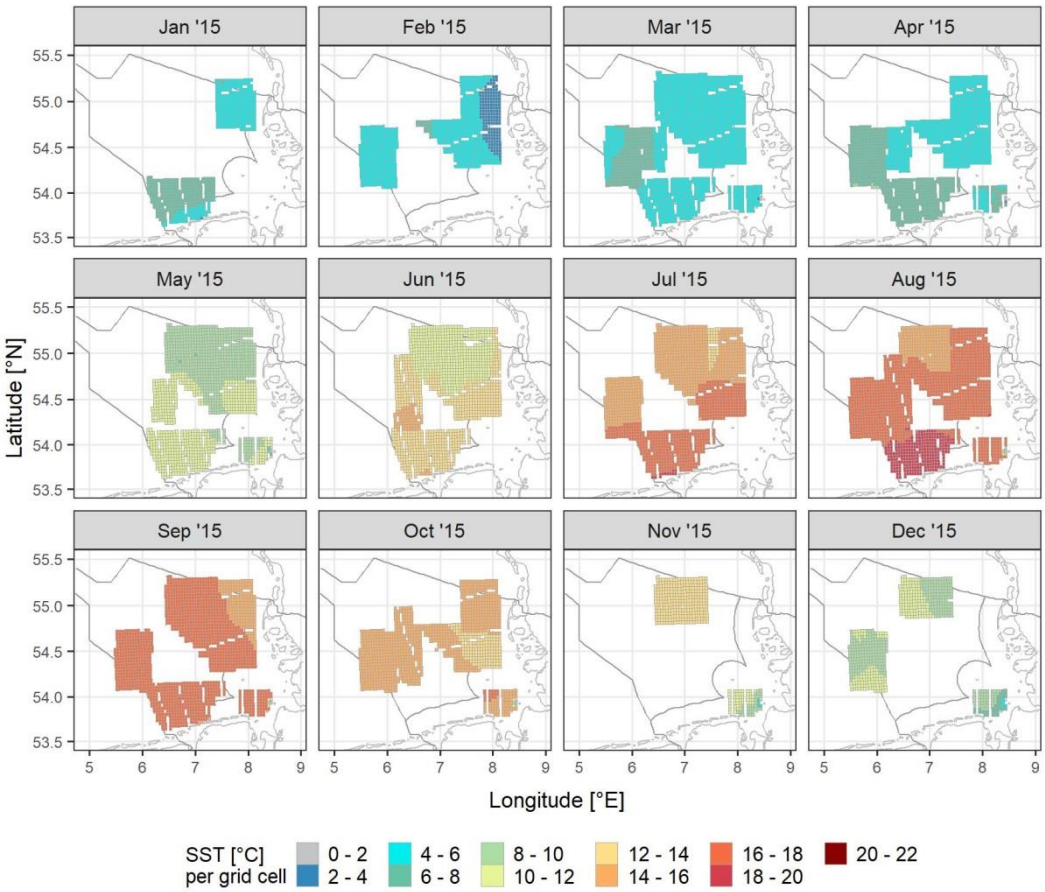


Figure A.90 Monthly sea surface temperature (SST) per grid cell in the German Bight for 2015.

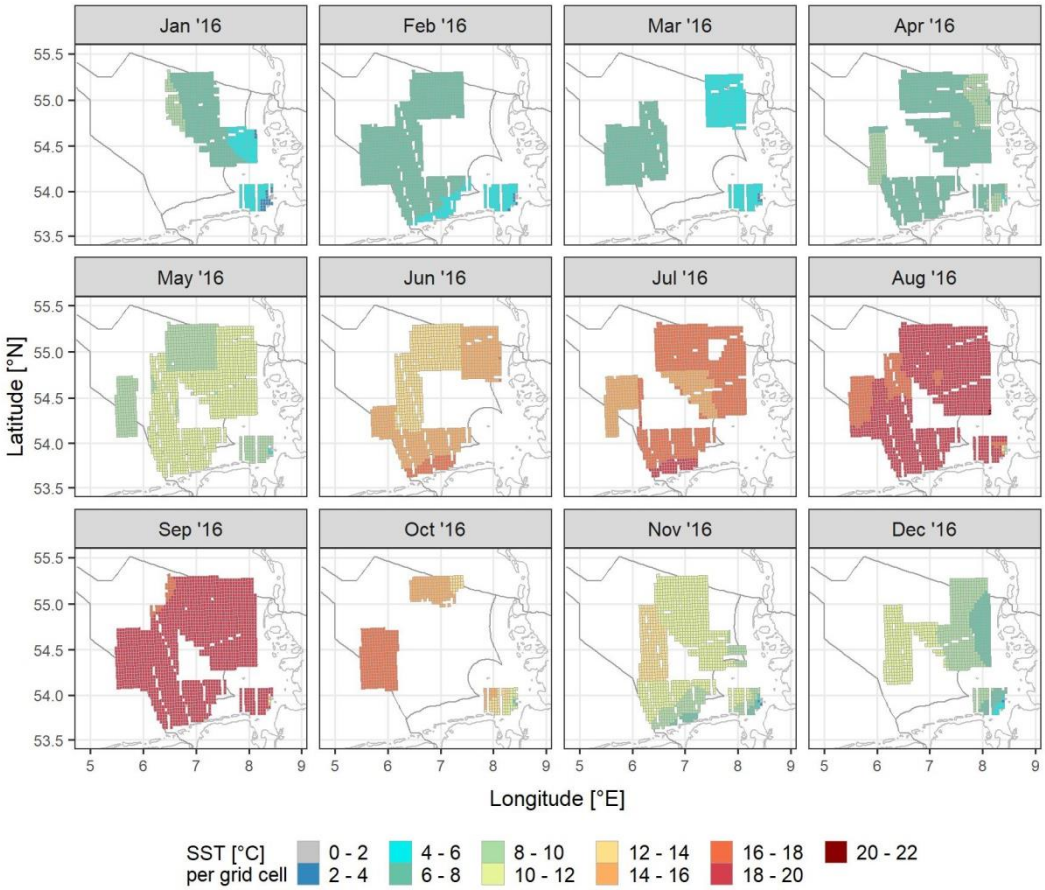


Figure A.91 Monthly sea surface temperature (SST) per grid cell in the German Bight for 2016.

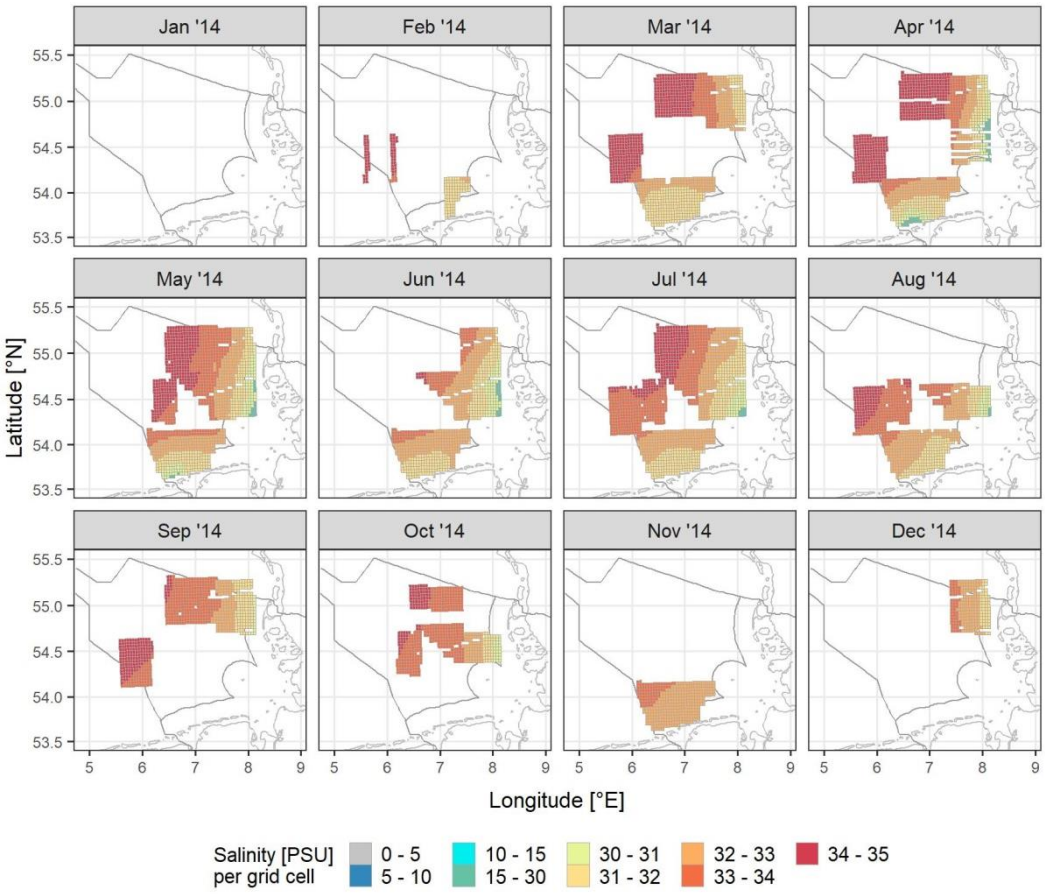


Figure A.92 Monthly salinity values per grid cell in the German Bight for 2014.

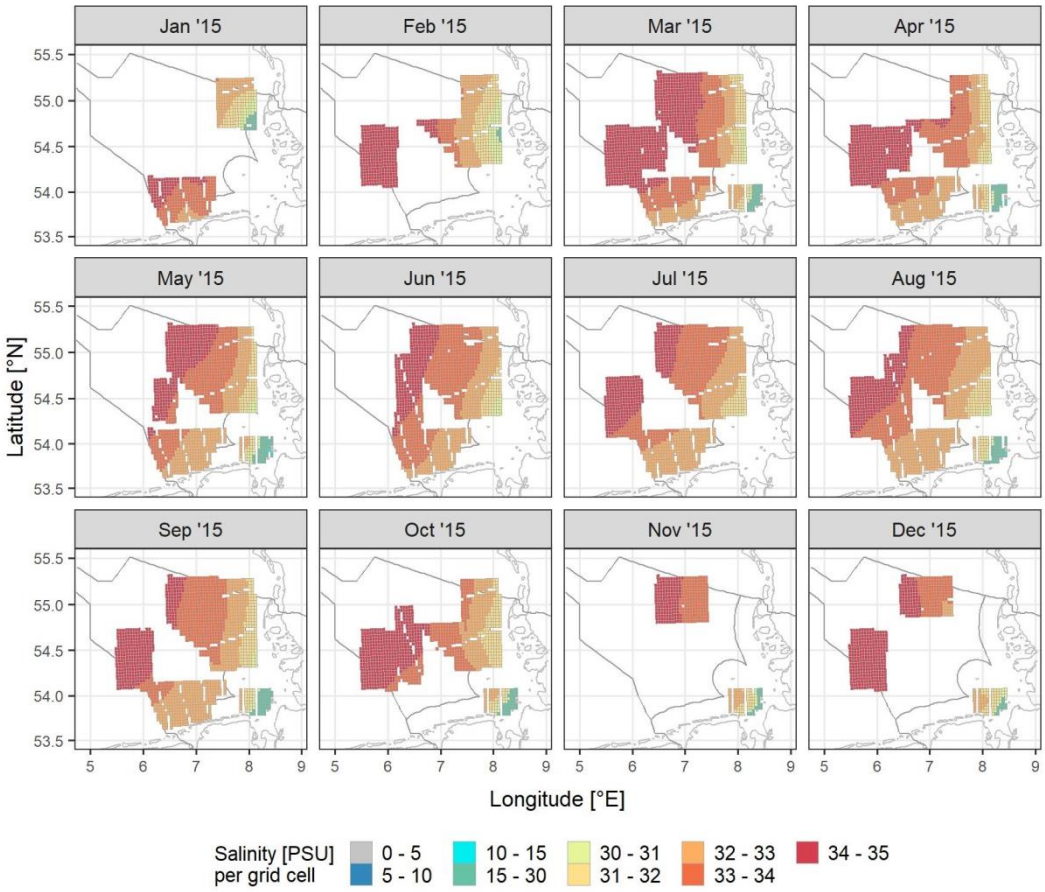


Figure A.93 Monthly salinity values per grid cell in the German Bight for 2015.

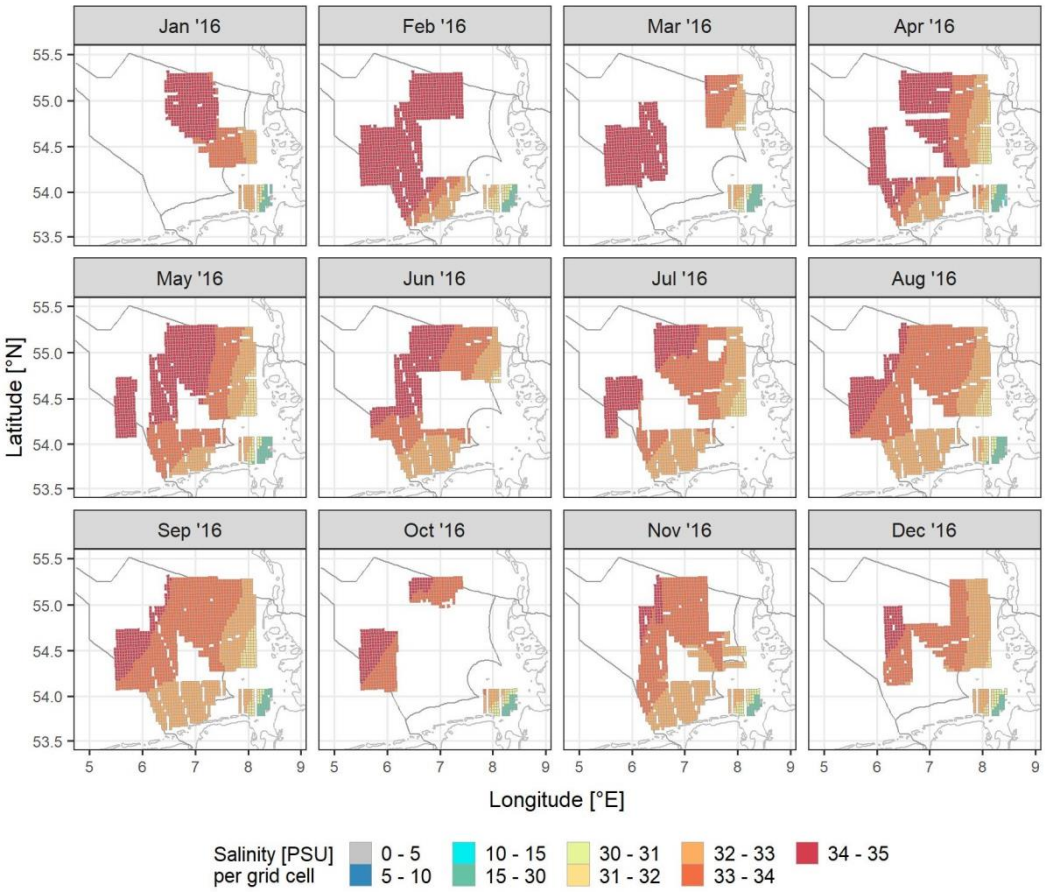


Figure A.94 Monthly salinity values per grid cell in the German Bight for 2016.

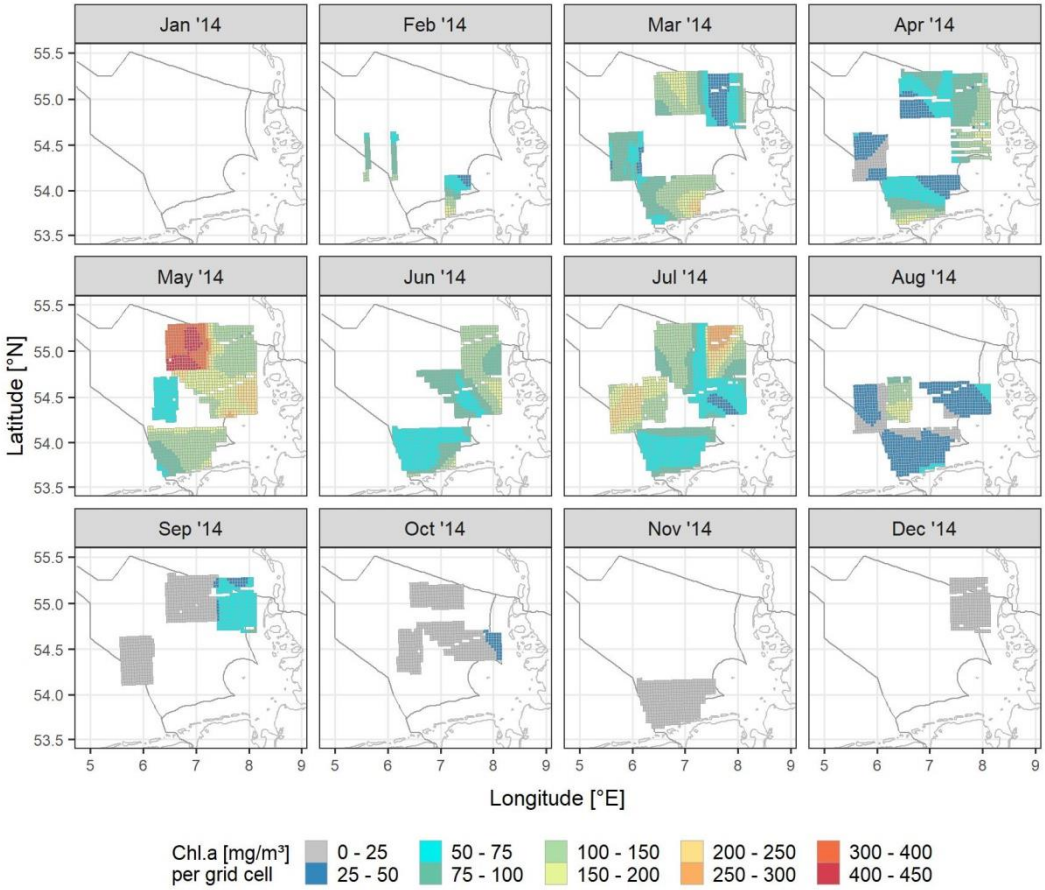


Figure A.95 Monthly Chl.a values per grid cell in the German Bight for 2014.

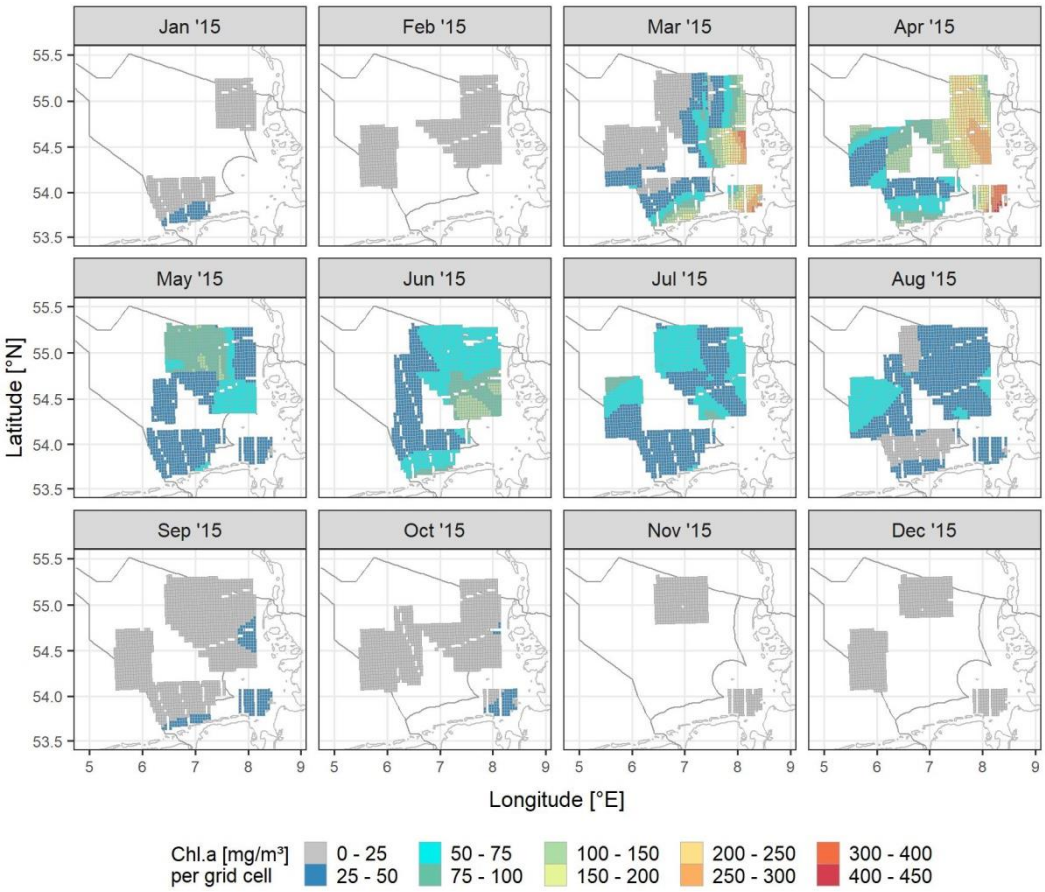


Figure A.96 Monthly Chl.a values per grid cell in the German Bight for 2015.

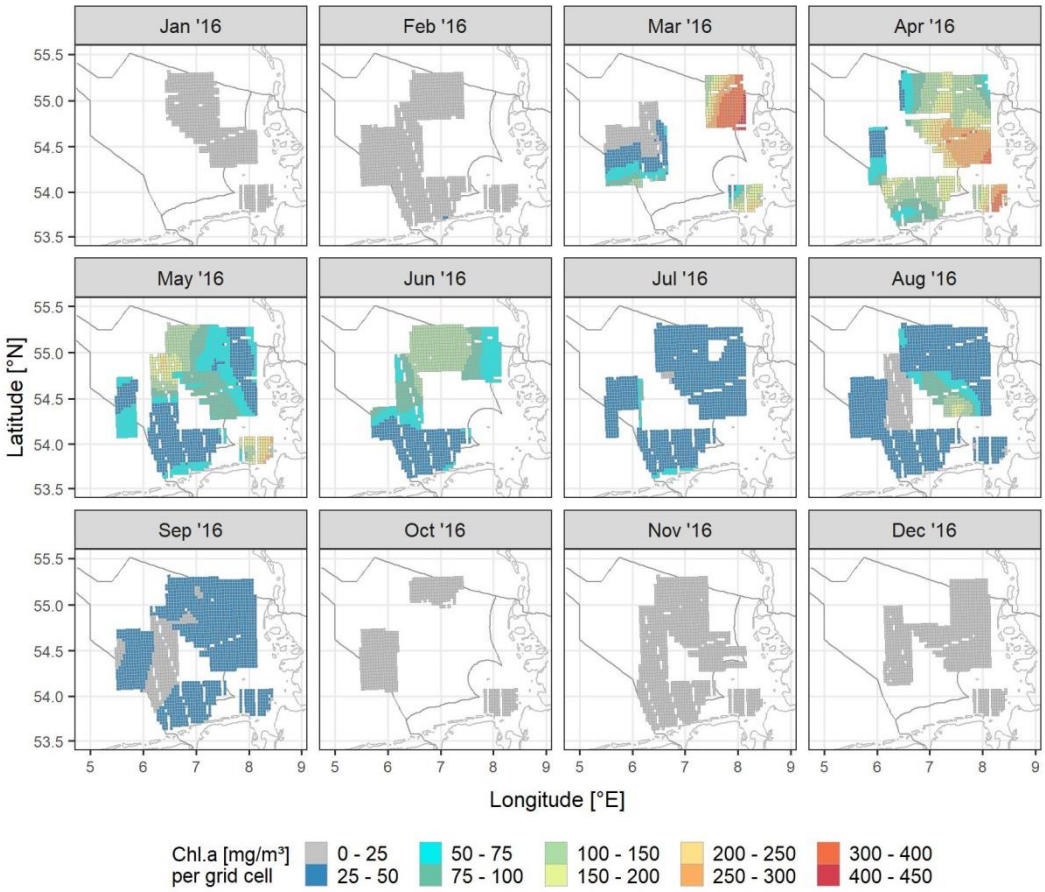


Figure A.97 Monthly Chl.a values per grid cell in the German Bight for 2016.

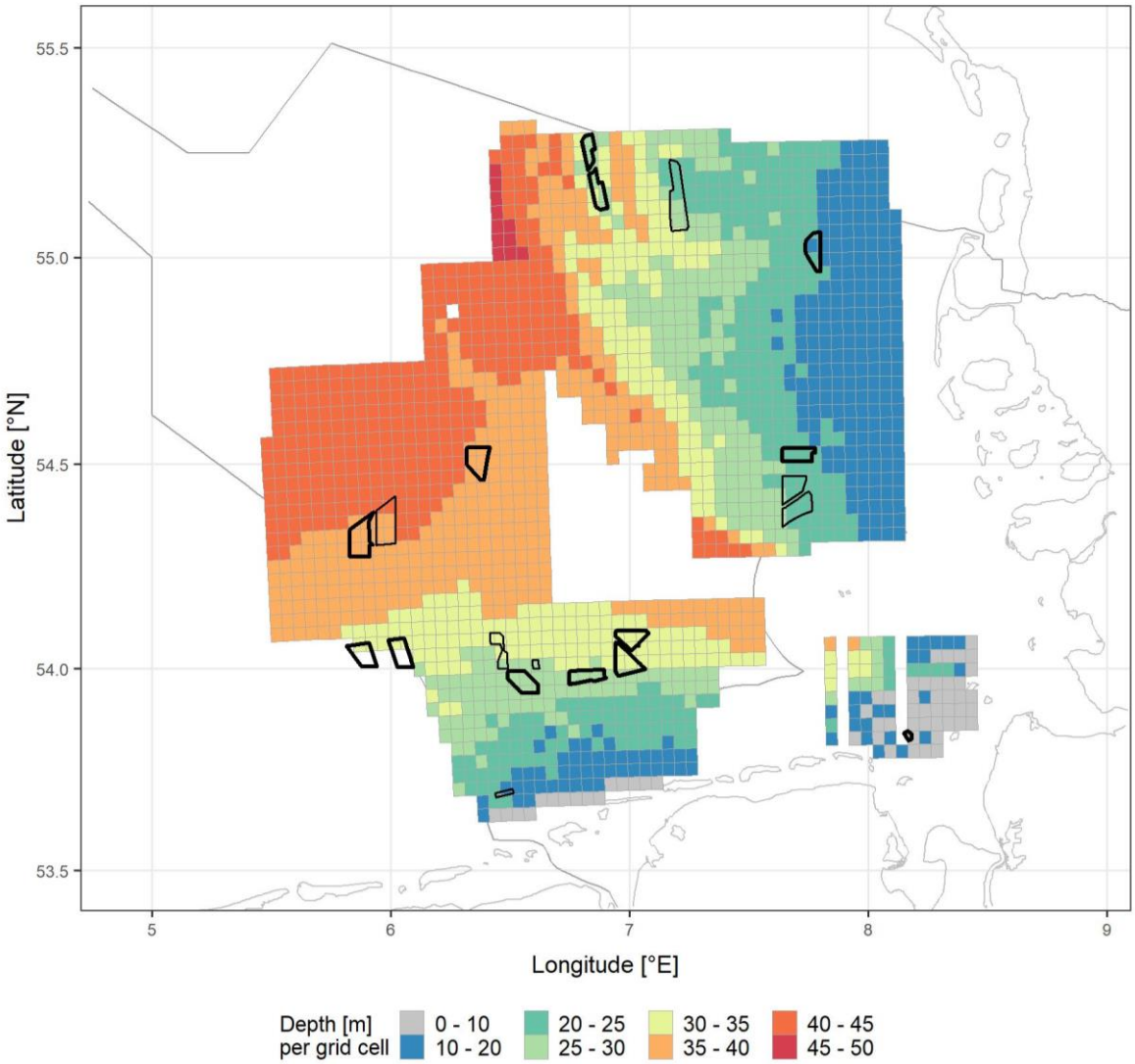


Figure A.98 Water depth per grid cell in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

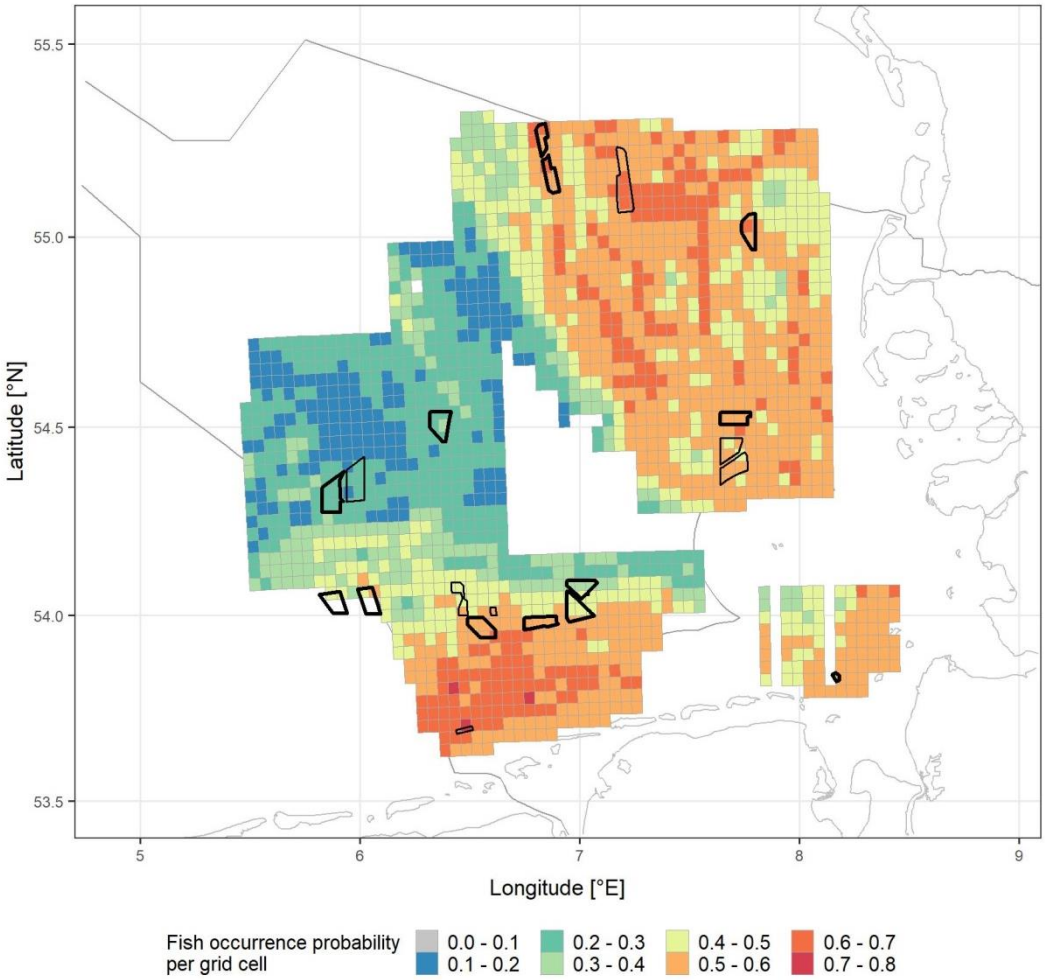


Figure A.99 Probability of fish occurrence (sandeel and sand goby species together) per grid cell in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

Figure A.100 Shipping lane positive (orange) or negative (blank) grid cells in the German Bight. Existing wind farms prior to 2014 are indicated by a thin black outline, while wind farms constructed within the study period are indicated in bold.

Large-scale model

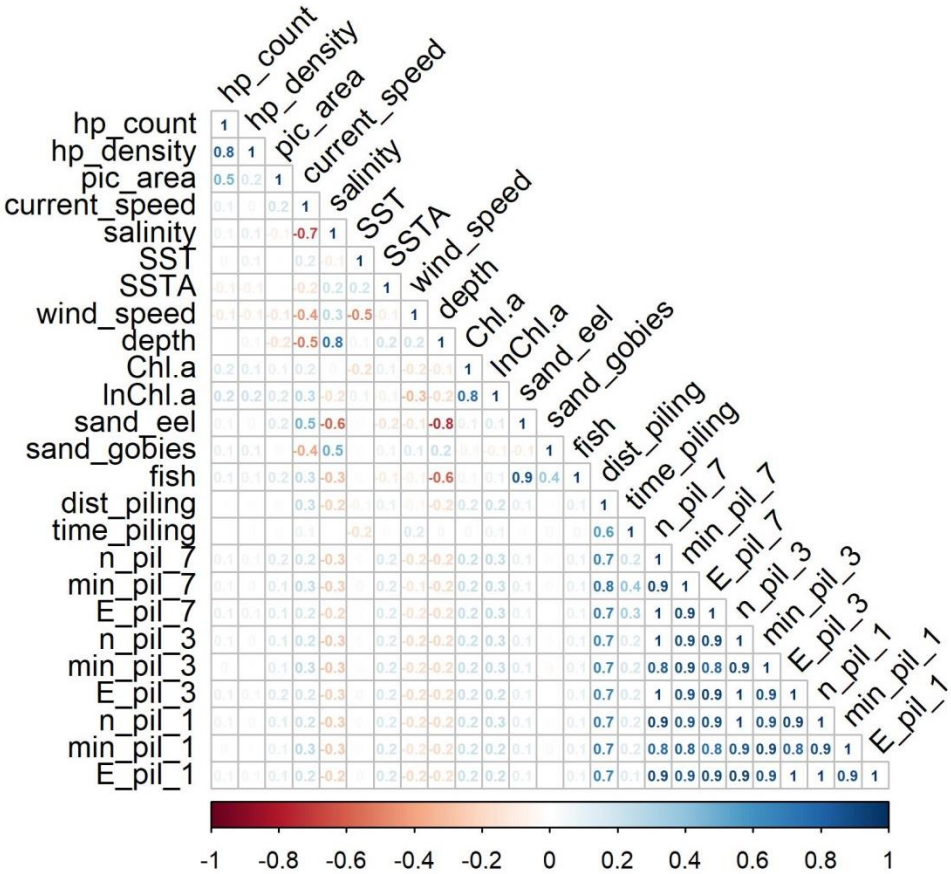


Figure A.101 Correlation between explanatory variables for the "Northeast" dataset. Variables are explained in the main report.

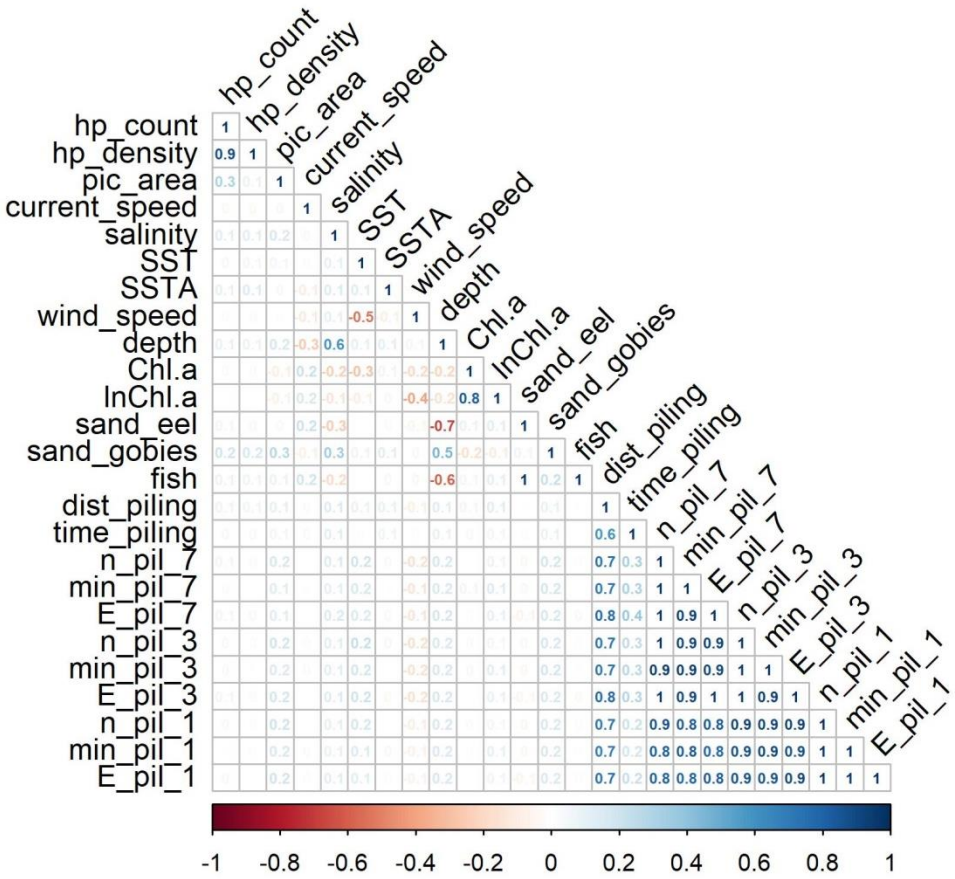


Figure A.102 Correlation between explanatory variables for the "South" dataset. Variables are explained in the main report.

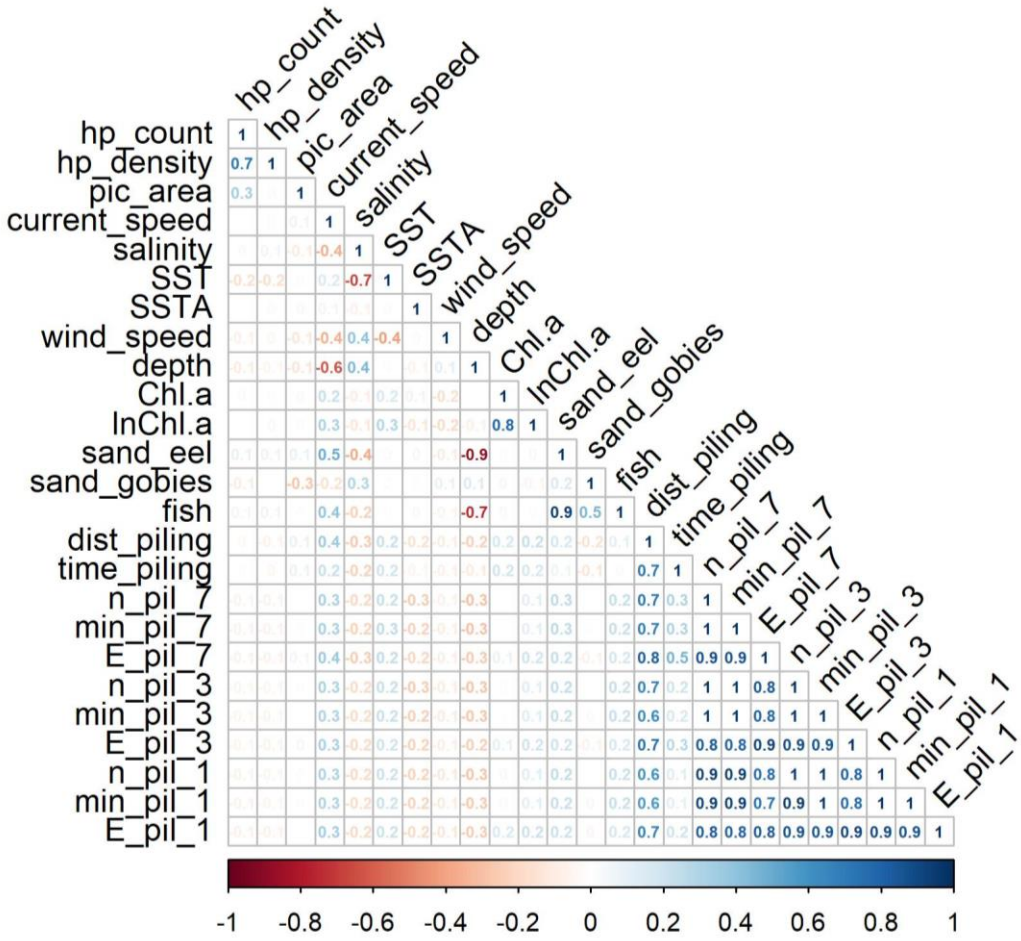


Figure A.103 Correlation between explanatory variables for the "West" dataset. Variables are explained in the main report.

WP 3.2 – Aerial survey data: Additional tables

General data treatment

Table A.4 Common database structure and variable collection of digital aerial survey data.

Sheet	Variable	Explanation
Tripdaten	TRIP_ID	Sequential number for each day of the survey and for each change in the other columns; the information in this column is the link to "Basisdaten" and "Tripdaten"
	CRUISENO	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year.
	OWPAS	Client / Applicant
	PROJECT	Name of the project
	CLUSTER	If the project belongs to a cluster, please note down the name of the cluster, otherwise record 0
	LAB	Name of the company engaged for the EIA
	SCIENTIST	Name of the responsible scientist.
	DATATYPE	Object of investigation e.g. seabirds, seabirds and marine mammals, marine mammals
	TECHNIQUE	Technique of investigation e.g. ship counts, digital aerial counts, visual aerial counts
	OBSERVER	originator of the images/videos= Name of the performing institution
	PLANE	Call sign of the plane used for the survey; if two planes used, add one row for each plane with Trip-ID
	NUMBER_OF_PLANES	number of planes used for one survey
	DOUBLE_PLATFORM	Flight with two platforms following each other to evaluate the method; if not applicable record 0
	DATE	Date of survey. One survey can last for several days until the whole area is covered. For each day create a new row with a Trip_ID
	STARTTIME	start time of the count (UTC)
	ENDTIME	end time of the count (UTC)
	CAMERA_SYSTEM	specification of the used camerasystem (for detailed information about the camera please use a separate template)
	RESOLUTION	resolution at the sea surface (target resolution)
	PLANE_FLIGHT_HEIGHT_PLANED	Flight altitude (target altitude)
	STRIP_WIDTH	Transect counts: overall strip width from all parallel cameras (before processing) Grid counts: area of each image (before processing)
	PLANE_SPEED	Target flight speed
	POSITION_ACCURACY	Mean deviation from the real position of the image in relation to the position from the GPS-device (delay in the triggering of the camera,...)

Sheet	Variable	Explanation
	METHOD_ID	Transect (1) Grid (2)
	AREA_OBERSERVED	'area observed' (on effort) before processing the images/videos
	AREA_ANALYSED	'area observed' after processing the images/videos
	POSITIONSYSTEM	Name of the used position system; e. g. GPS-Navstar, GPS-diff.
	POSIT_PRECISION_CODE	Accuracy of the used position system (according to the information of the system) 1 = decimal degree with 1 decimal place, 2 = decimal degree with 2 decimal places, 3= decimal degree with 3 decimal places etc.
	REFSYSTEM	Geodetic reference system
	NOTES	Notes
Basisdaten	POSITION_ID	For each flight a sequential numbering (1-x) for all pictures "on-effort". Please don't number the pictures between the transects. Use one numbering for all cameras together. For Videos take one position per second. The information in this column is the link between "Basisdaten" and "Oberservations"
	TRIP_ID	Sequential number for each day of the survey and for each change in the other columns; the information in this column is the link to "Basisdaten" and "Tripdaten"
	CRUISENO	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year.
	CAMERA_NUMBER	For parallel-wired cameras, fill in the camera number
	TRANSECT_NUMBER	For transectsurveys,please fill in the transectnumber; for gridsurvey record 0
	DATE	date of survey
	TIME	Time of the recording (accurate to a centisecond)
	LAT_PIC_CENTER	Position (latitude) of the centre of the image. Decimal degree with 6 decimal places in WGS 84
	LON_PIC_CENTER	Position (longitude) of the centre of the image. Decimal degree with 6 decimal places in WGS 84
	PLANE_FLIGHT_HEIGHT	effective flight hight of the plane during the recording (10m accuracy)
	PIC_AREA_ANALYSED	Footprint of the image, respectively the area per second after processing the image (effective analysed area)
	GLARE	Intensity of the reflection of the sun in regular intervals (for details see additional chart) and after a change of direction or transect, ascertained for the analysed part of the image. 1=no or hardly any glare. No impact on the identification 2=medium impact 3=strong impact

Sheet	Variable	Explanation
	SEASTATE	Determined from the images in regular intervals (for details see additional chart) and after a change of direction or transect. Coding in numbers by Petersen.
	TURBIDITY	Determined from the images in regular intervals (for details see additional chart) and after a change of direction or transect. 1= no turbidity, 2= medium turbidity (the view into the water is restricted), 3=strong turbidity (impossible to look into the water). Foam and algae on the water surface have to be considered in this category.
	ICE	Determined from the pictures: ice coverage in tenth: 0= 0/10, 1= 1/10, 2= 2/10,3= 3/10 … 10= 10/10
	CLARITY	Clarity of the air; Determined from the images in regular intervals (for details see additional chart) 0 = not recorded 1 = little 2 = medium 3 = strong
	PIC_QUALITY	1= the image has been analysed 2= image quality too bad for analysis
	PIC_FILENAME	filename/memory location of the image
	NOTES	Notes
Observations	Observation_ID	Sequential numbering for each observation (bird, marine mammal, abiotic things). One row for each individual
	POSITION_ID	There must be a corresponding record in "Basisdaten". The information in this column is the link between "Basisdaten" and "Oberservations"
	CRUISENO	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year
	ABIOTIC_STRUCTURES	Specification of abiotic structures (e.g. ship, OWP-turbine, buoy). Coding in numbers; if no abiotic structure exists, record 0
	ABIOTIC_OBSERVATION	Specification of abiotic observations (e. g. waste, oil, front, …), coding in numbers
	OBSERVATION	Euring code for every observation of birds or marine mammals. If the identification of the species is not possible please fill in the next taxonomic rank. If no sighting exists record 0
	CONFIDENCE	Confidence in the identification of the species. Coding in numbers or prose (detailed information can be found in an extra chart). If no sighting exists in "Observations" record 0
	SCIENTIFIC_NAME	scientific name of the observed bird or mammal. If no sighting exists in "Observations" record 0
	BEHAVIOUR	Specification of the behaviour of the marine mammal/ seabird, Coding in numbers. If no behaviour is visible or no sighting exists in "Observations" record 0
	ACTIVITY	1= swimming 2= flying; If no sighting exists in "Observations" record 0
	FAMILY_GROUP	For adult + juvenile pairs (e.g. harbour porpoise with calf, guillemot with chick) use a sequential numbering (1-x) with the same number for both individuals from one pair.

Sheet	Variable	Explanation
	ASSOCIATIONS	Specification of the association of the marine mammal/ Seabird, Coding in numbers; If no behaviour is visible or no sighting exists in "Observations" record 0
	HEADING	bird-flight /mammal-swimming direction of individual; 360°, 45°, 90°, 135°, 180°, 225°, 270°, 315°; If no direction is visible or no sighting exists in "Observations" record 0
	SUBMERGED	bird/mammal on the water surface. For birds only relevant if they show diving behaviour o=surface has been breached, u= below the surface, x=not clearly visible; if not applicable record 0
	AGE_CLASS	Specification of the age of the bird; A (adult), IM (immature)
	AGE_YEARS	Specification of the calender-year of the bird
	PLUMAGE	Specification of the plumage of the bird
	SEX	M =male, F=female
	LENGTH	Measurement from the beak to the end of the tail
	WING_SPAN	Measurement of the wing span
	FLIGHT_HEIGHT	flight height (only for flighing birds); if not applicable record 0
	FLIGHT_HEIGHT_CONFIDENCE	confidence interval of the flight height measurement; if not applicable record 0
	FLIGHT_HEIGHT_METHOD_ID	method of the flight height measurement 1= parallax method, 2=calculation with body size; if not applicable record 0
	LAT_OBJECT	exact position of the sighting (bird, mammal, abiotic structure) on the image. Decimal degree with 6 decimal places in WGS 84
	LON_OBJECT	exact position of the sighting (bird, mammal, abiotic structure) on the image. Decimal degree with 6 decimal places in WGS 84
	NOTES	

Table A.5 Example of "Tripdaten" data used within the statistical analysis of digital aerial survey data.

	A	B	C	D	E	F	G	H	I	J	K
1	CRUISENO	PROJECT	CLUSTER	OBSERVER	DATE	STARTTIME	ENDTIME	AREA_OBERSERV	AREA_ANALYSED	REFSYSTEM	NOTES
2	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year.	Name of the project	If the project belongs to a cluster, please note down the name of the cluster, otherwise record 0	originator of the images/videos= Name of the performing institution	Date of survey. One survey can last for several days until the whole area is covered. For each day create a new row with a Trip_ID	start time of the count (UTC)	end time of the count (UTC)	'area observed' (on effort) before processing the images/videos	'area observed' after processing the images/videos	Geodetic reference system	Notes
3	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Optional
4	char40	char40	char40	char40	Date (YYYYMMDD	Time (hh:mm:	Time (hh:mm:	num4c2	num6c2	char20	char250
5						hh:mm:ss	hh:mm:ss	km²	km²		
6			Name des Clusters, 0		YYYYMMDD	00:00:00- 23:5	00:00:00- 23:59:59				
7	darf nicht leer sein	darf nicht leer	darf nicht leer	darf nicht leer sein	darf nicht leer sein	darf nicht leer	darf nicht leer	darf nicht leer sein	darf nicht leer sein	darf nicht leer se	
8	Zone02_M01_S01_	Cluster Nördli	Cluster Nördli	HiDef	20150127	09:14:52	15:42:47	573,39	571,56	WGS84	
9	Zone02_M03_S01_	Cluster Nördli	Cluster Nördli	HiDef	20150305	11:39:53	14:54:43	599,06	598,94	WGS84	
10	Zone02_M04_S01_	Cluster Nördli	Cluster Nördli	HiDef	20150410	10:31:18	17:06:19	599,08	599,03	WGS84	
11	Zone02_M05_S01_	Cluster Nördli	Cluster Nördli	HiDef	20150521	09:03:08	16:39:39	599,99	596,38	WGS84	

Table A.6 Example of "Basisdaten" data used within the statistical analysis of digital aerial survey data.

	A	B	C	D	E	F	G	H	I	J
1	POSITION_ID	CRUISENO	DATE	TIME	LAT_PIC_CENTER	LON_PIC_CENTER	PIC_AREA_ANALYSED	SEASTATE	PIC_QUALITY	NOTES
2	For each flight a sequential numbering (1-x) for all pictures "on-effort". Please don't number the pictures between the transects. Use one numbering for all cameras together. For Videos take one position per second.The information in this column is the link between "Basisdaten" and "Obersservations"	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year.	date of survey	Time of the recording (accurate to a centisecond)	Position (latitude) of the centre of the image. Decimal degree with 6 decimal places in WGS 84	Position (longitude) of the centre of the image. Decimal degree with 6 decimal places in WGS 84	Footprint of the image, respectively the area per second after processing the image (effective analysed area)	Determined from the images in regular intervals (for details see additional chart) and after a change of direction or transect.Coding in numbers by Petersen.	1= the image has been analysed 2= image quality to bad for analysis	Notes
3	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Optional
4	num	char40	Datum (YYYY	hh:mm:ss.f	num2c6	num2c6	num1c4	num1	num1	char250
5							km²			
6	1-x		YYYYMMDD					0-9	1 or 2	
7	darf nicht leer sein	darf nicht leer sein	darf nicht leer	darf nicht leer	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein	
8	C1D0120150127091452	Zone02_M01_S01_1	20150127	09:14:52	53,992716	6,107899	0,0062	4	1	
9	C2D0120150127091452	Zone02_M01_S01_1	20150127	09:14:52	53,992716	6,107899	0,0056	4	1	
10	C3D0120150127091452	Zone02_M01_S01_1	20150127	09:14:52	53,992716	6,107899	0,0056	4	1	
11	C4D0120150127091452	Zone02_M01_S01_1	20150127	09:14:52	53,992716	6,107899	0,0062	4	1	
12	C1D0120150127091453	Zone02_M01_S01_1	20150127	09:14:53	53,9931	6,108002	0,0076	4	1	
13	C2D0120150127091453	Zone02_M01_S01_1	20150127	09:14:53	53,9931	6,108002	0,0068	4	1	
14	C3D0120150127091453	Zone02_M01_S01_1	20150127	09:14:53	53,9931	6,108002	0,0068	4	1	

Table A.7 Example of "Observations" data used within the statistical analysis of digital aerial survey data.

	A	B	C	D	E	F	G	H	I
1	POSITION_ID	CRUISENO	OBSERVATION	SCIENTIFIC_NAME	SUBMERGED	AGE_CLASS	LAT_OBJECT	LON_OBJECT	NOTES
2	There must be a corresponding record in "Basisdaten". The information in this column is the link between "Basisdaten" and "Oberservations"	Unique code to identify the survey within a construction project or a cluster e. g. projectID + year	Euring code for every observation of birds or marine mammals. If the identification of the species is not possible please fill in the next taxonomic rank. If no sighting exists record 0	scientific name of the observed bird or mammal. If no sighting exists in "Observations" record 0	bird/mammal on the water surface. For birds only relevant if they show diving behaviour o=surface has been breached u= below the surface x=not clearly visible; if not applicable record 0	Specification of the age of the bird; A (adult), IM (immature)	exact position of the sighting (bird, mammal, abiotic structure) on the image. Decimal degree with 6 decimal places in WGS 84	exact position of the sighting (bird, mammal, abiotic structure) on the image. Decimal degree with 6 decimal places in WGS 84	
3	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Pflichtfeld	Optional	Pflichtfeld	Pflichtfeld	Optional
4	num	char40	num5	char40	char1	char2	num2c6	num2c6	
5									
6	1-x		Codeliste	Codeliste	o, u, x, 0	A, IM			
7	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein	darf nicht leer sein, darf bei Säugersichtu		darf nicht leer se	darf nicht leer sein	
8	C1D012015012709	Zone02_M01_S01	63510	Phocoena phocoena	o		53,993596	6,174862	
9	C1D012015012709	Zone02_M01_S01	63510	Phocoena phocoena	o		53,863285	6,231594	
10	C1D012015012711	Zone02_M01_S01	63510	Phocoena phocoena	o		54,084059	6,625356	
11	C1D012015012712	Zone02_M01_S01	63510	Phocoena phocoena	o		53,92734	6,679686	
12	C1D012015012712	Zone02_M01_S01	63510	Phocoena phocoena	o		53,946774	6,680396	
13	C1D012015012712	Zone02_M01_S01	63510	Phocoena phocoena	o		53,948586	6,680647	
14	C1D012015012712	Zone02_M01_S01	63510	Phocoena phocoena	o		54,106114	6,680062	

Table A.8 Flight information on all digital aerial surveys included in the study.

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
Butendiek	Zone03_M03_S01_14	HiDef	25.03.2014 07:51 - 25.03.2014 14:21	453.29	452.94
	Zone03_M04_S01_14	HiDef	19.04.2014 13:24 - 19.04.2014 17:07	390.24	390.24
	Zone03_M04_S02_14	HiDef	28.04.2014 13:10 - 28.04.2014 17:01	390.54	390.52
	Zone03_M05_S01_14	HiDef	17.05.2014 11:52 - 17.05.2014 15:32	391.71	391.64
	Zone03_M05_S02_14	HiDef	22.05.2014 12:26 - 22.05.2014 16:27	390.87	390.83
	Zone03_M06_S01_14	HiDef	07.06.2014 12:57 - 07.06.2014 16:39	390.74	390.71
	Zone03_M07_S01_14	HiDef	16.07.2014 13:36 - 16.07.2014 17:30	390.99	390.65
	Zone03_M09_S01_14	HiDef	05.09.2014 12:38 - 05.09.2014 16:16	444.98	439.08
	Zone03_M12_S01_14	HiDef	09.12.2014 09:00 - 09.12.2014 12:59	389.93	384.07
	Zone03_M01_S01_15	HiDef	27.01.2015 09:42 - 27.01.2015 14:57	367.59	355.76
	Zone03_M02_S01_15	HiDef	18.02.2015 13:02 - 18.02.2015 15:03	390.07	390.00
	Zone03_M03_S01_15	HiDef	11.03.2015 08:46 - 11.03.2015 14:35	390.71	390.60
	Zone03_M04_S01_15	HiDef	04.04.2015 06:32 - 04.04.2015 10:11	390.68	390.65
	Zone03_M05_S01_15	HiDef	02.05.2015 12:33 - 02.05.2015 16:13	390.33	378.56

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone03_M06_S01_15	HiDef	04.06.2015 13:12 - 04.06.2015 18:09	372.79	372.49
	Zone03_M07_S01_15	HiDef	01.07.2015 13:16 - 01.07.2015 17:01	396.20	394.49
	Zone03_M08_S01_15	HiDef	09.08.2015 12:22 - 09.08.2015 16:07	390.98	382.99
	Zone03_M09_S01_15	HiDef	26.09.2015 07:59 - 26.09.2015 13:59	390.60	354.50
	Zone03_M10_S01_15	HiDef	12.10.2015 08:14 - 12.10.2015 14:19	391.53	391.50
	Zone03_M03_S01_16	HiDef	23.03.2016 09:39 - 23.03.2016 15:47	391.26	391.16
	Zone03_M04_S01_16	HiDef	28.04.2016 13:26 - 28.04.2016 17:23	392.12	392.07
	Zone03_M05_S01_16	HiDef	06.05.2016 07:22 - 06.05.2016 13:44	390.68	383.37
	Zone03_M05_S02_16	HiDef	13.05.2016 12:33 - 13.05.2016 16:34	391.33	362.20
	Zone03_M05_S03_16	HiDef	27.05.2016 12:29 - 27.05.2016 16:22	391.28	391.23
	Zone03_M06_S01_16	HiDef	22.06.2016 13:49 - 22.06.2016 17:38	392.63	392.57
	Zone03_M07_S01_16	HiDef	20.07.2016 06:49 - 20.07.2016 14:52	322.96	322.95
	Zone03_M08_S01_16	HiDef	25.08.2016 13:21 - 25.08.2016 18:32	391.47	390.15
	Zone03_M09_S01_16	HiDef	12.09.2016 09:02 - 12.09.2016 16:02	390.63	390.56

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone03_M09_S02_16	HiDef	21.09.2016 06:57 - 21.09.2016 12:49	387.85	387.76
	Zone03_M12_S01_16	HiDef	05.12.2016 09:00 - 05.12.2016 13:46	392.06	390.30
Cl. Helgoland	Zone01_M04_S01_14	HiDef	11.04.2014 13:11 - 11.04.2014 16:47	381.00	367.01
	Zone01_M04_S02_14	HiDef	25.04.2014 12:10 - 25.04.2014 16:02	381.06	381.04
	Zone01_M05_S01_14	HiDef	20.05.2014 12:23 - 20.05.2014 17:10	570.67	561.89
	Zone01_M06_S01_14	HiDef	03.06.2014 05:33 - 03.06.2014 10:09	579.78	579.74
	Zone01_M07_S01_14	HiDef	07.07.2014 14:21 - 07.07.2014 18:40	510.16	493.46
	Zone01_M08_S01_14	HiDef	27.08.2014 13:54 - 27.08.2014 17:08	378.02	377.98
	Zone01_M10_S01_14	HiDef	12.10.2014 08:49 - 12.10.2014 15:28	436.81	433.48
	Zone01_M02_S01_15	HiDef	04.02.2015 08:40 - 04.02.2015 13:23	509.40	504.10
	Zone01_M03_S01_15	HiDef	17.03.2015 07:41 - 17.03.2015 15:58	510.18	510.18
	Zone01_M04_S01_15	HiDef	03.04.2015 07:03 - 03.04.2015 14:36	510.73	510.70
	Zone01_M05_S01_15	HiDef	22.05.2015 09:19 - 22.05.2015 16:38	512.99	446.48
	Zone01_M06_S01_15	HiDef	04.06.2015 05:37 - 04.06.2015 10:15	510.31	510.28

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone01_M06_S02_15	HiDef	12.06.2015 04:52 - 12.06.2015 09:34	510.70	510.62
	Zone01_M07_S01_15	HiDef	16.07.2015 12:58 - 16.07.2015 17:47	511.08	509.66
	Zone01_M08_S01_15	HiDef	10.08.2015 07:58 - 10.08.2015 15:29	510.35	499.63
	Zone01_M09_S01_15	HiDef	26.09.2015 07:25 - 26.09.2015 14:58	511.91	511.87
	Zone01_M10_S01_15	HiDef	23.10.2015 08:02 - 23.10.2015 15:16	510.25	500.41
	Zone01_M01_S01_16	HiDef	20.01.2016 09:47 - 20.01.2016 14:20	510.79	510.72
	Zone01_M04_S01_16	HiDef	01.04.2016 07:36 - 01.04.2016 14:57	511.33	511.27
	Zone01_M04_S02_16	HiDef	09.04.2016 09:44 - 09.04.2016 16:57	610.70	597.70
	Zone01_M05_S01_16	HiDef	05.05.2016 07:36 - 05.05.2016 14:36	511.63	500.51
	Zone01_M05_S02_16	HiDef	28.05.2016 07:51 - 28.05.2016 14:54	511.53	508.72
	Zone01_M07_S01_16	HiDef	13.07.2016 07:30 - 13.07.2016 14:35	511.30	485.11
	Zone01_M08_S01_16	HiDef	02.08.2016 14:15 - 02.08.2016 18:45	497.09	318.40
	Zone01_M09_S01_16	HiDef	08.09.2016 09:36 - 08.09.2016 16:35	510.98	510.94
	Zone01_M09_S02_16	HiDef	20.09.2016 08:59 - 20.09.2016 16:01	511.26	510.21

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone01_M11_S01_16	HiDef	23.11.2016 09:04 - 23.11.2016 14:13	434.39	423.75
	Zone01_M12_S01_16	HiDef	04.12.2016 09:00 - 04.12.2016 13:48	509.93	509.88
Cl. Nördlich Borkum	Zone02_M02_S01_14	HiDef	18.02.2014 09:21 - 18.02.2014 13:34	602.09	602.02
	Zone02_M03_S01_14	HiDef	12.03.2014 07:47 - 12.03.2014 14:00	597.43	593.02
	Zone02_M04_S01_14	HiDef	22.04.2014 09:00 - 22.04.2014 16:34	600.44	600.35
	Zone02_M05_S01_14	HiDef	03.05.2014 07:10 - 03.05.2014 14:24	602.80	590.84
	Zone02_M06_S01_14	HiDef	26.06.2014 08:37 - 26.06.2014 16:41	599.73	586.11
	Zone02_M07_S01_14	HiDef	12.07.2014 08:41 - 12.07.2014 15:53	601.01	593.86
	Zone02_M08_S01_14	HiDef	27.08.2014 08:05 - 27.08.2014 16:51	592.59	561.76
	Zone02_M11_S01_14	HiDef	25.11.2014 08:30 - 25.11.2014 14:14	598.70	572.36
	Zone02_M01_S01_15	HiDef	27.01.2015 09:14 - 27.01.2015 15:42	573.39	571.56
	Zone02_M03_S01_15	HiDef	05.03.2015 11:39 - 05.03.2015 14:54	599.06	598.94
	Zone02_M04_S01_15	HiDef	10.04.2015 10:31 - 10.04.2015 17:06	599.08	599.03
	Zone02_M05_S01_15	HiDef	21.05.2015 09:03 - 21.05.2015 16:39	599.99	596.38

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone02_M06_S01_15	HiDef	11.06.2015 08:03 - 11.06.2015 16:31	599.38	578.26
	Zone02_M07_S01_15	HiDef	24.07.2015 05:16 - 24.07.2015 12:41	599.60	599.55
	Zone02_M08_S01_15	HiDef	21.08.2015 07:35 - 21.08.2015 14:01	601.81	601.76
	Zone02_M09_S01_15	HiDef	09.09.2015 08:56 - 09.09.2015 16:35	602.38	598.92
	Zone02_M09_S02_15	HiDef	27.09.2015 07:55 - 27.09.2015 15:16	600.80	600.73
	Zone02_M02_S01_16	HiDef	16.02.2016 10:33 - 16.02.2016 14:56	599.88	562.73
	Zone02_M04_S01_16	HiDef	02.04.2016 07:22 - 02.04.2016 14:44	603.56	597.75
	Zone02_M05_S01_16	HiDef	04.05.2016 08:36 - 04.05.2016 15:52	599.63	517.33
	Zone02_M05_S02_16	HiDef	30.05.2016 08:53 - 30.05.2016 16:40	600.17	561.89
	Zone02_M06_S01_16	HiDef	28.06.2016 10:31 - 28.06.2016 17:55	600.04	599.98
	Zone02_M07_S01_16	HiDef	21.07.2016 07:17 - 21.07.2016 14:50	599.97	476.81
	Zone02_M08_S01_16	HiDef	31.08.2016 09:00 - 31.08.2016 16:33	601.27	601.21
	Zone02_M09_S01_16	HiDef	13.09.2016 08:34 - 13.09.2016 16:30	600.49	600.39
	Zone02_M11_S01_16	HiDef	24.11.2016 10:05 - 24.11.2016 13:28	597.25	597.23

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
Cl. Östlicher Austerngrund	2014-05-16-GT1	DAISI	16.05.2014 09:18 - 16.05.2014 14:01	247.10	245.94
	2014-07-12-GT1	DAISI	12.07.2014 08:24 - 12.07.2014 12:05	288.30	284.66
	2014-08-05-GT1	DAISI	05.08.2014 08:35 - 05.08.2014 12:52	291.18	289.32
	2014-10-02-GT1	DAISI	02.10.2014 09:51 - 02.10.2014 13:41	280.05	280.05
	2014-10-12-GT1	DAISI	12.10.2014 08:31 - 12.10.2014 12:14	292.89	292.89
	2015-03-11-GT1	DAISI	11.03.2015 09:36 - 11.03.2015 13:21	282.37	282.37
	2015-04-03-GT1	DAISI	03.04.2015 08:10 - 03.04.2015 11:56	280.13	280.13
	2015-05-24-GT1	DAISI	24.05.2015 08:16 - 24.05.2015 12:28	269.22	269.22
	Zone08_M06_S01_15	HiDef	29.06.2015 13:40 - 29.06.2015 17:13	407.88	390.71
	Zone08_M08_S01_15	HiDef	22.08.2015 10:09 - 22.08.2015 15:36	406.21	406.18
	Zone08_M10_S01_15	HiDef	23.10.2015 08:08 - 23.10.2015 13:39	405.99	405.95
	Zone08_M02_S01_16	HiDef	28.02.2016 11:32 - 28.02.2016 15:13	408.14	401.91
	Zone08_M03_S01_16	HiDef	12.03.2016 12:25 - 12.03.2016 16:02	403.31	358.24
	Zone08_M03_S02_16	HiDef	26.03.2016 07:23 - 26.03.2016 11:18	406.38	394.32

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone08_M05_S01_16	HiDef	12.05.2016 10:50 - 12.05.2016 16:03	406.65	393.85
	Zone08_M06_S01_16	HiDef	03.06.2016 10:49 - 03.06.2016 15:58	407.02	407.02
	Zone08_M08_S01_16	HiDef	15.08.2016 10:05 - 15.08.2016 15:37	405.4	405.4
	Zone08_M09_S01_16	HiDef	09.09.2016 10:52 - 09.09.2016 14:33	406.35	406.31
	2016-11-11-HS-GT1	DAISI	11.11.2016 08:45 - 11.11.2016 12:32	343.88	343.88
	2016-12-04-HS-GT1	DAISI	04.12.2016 09:09 - 04.12.2016 12:51	347.16	347.16
Cluster 6	B_2014_01	APEM	25.02.2014 08:10 - 26.02.2014 11:20	114.50	114.48
	B_2014_01	APEM	02.03.2014 09:45 - 03.03.2014 11:31	156.60	156.56
	B_2014_02	APEM	21.03.2014 10:42 - 23.03.2014 14:21	223.14	223.14
	B_2014_03	APEM	15.04.2014 07:31 - 16.04.2014 09:48	226.00	225.98
	B_2014_04	APEM	15.07.2014 14:55 - 17.07.2014 10:06	216.17	216.17
	B_2014_05	APEM	25.08.2014 10:13 - 26.08.2014 14:26	229.91	229.91
	B_2014_06	APEM	28.09.2014 07:34 - 29.09.2014 11:40	219.42	219.42
	C6_2015_01	APEM	17.02.2015 09:33 - 19.02.2015 12:07	237.21	237.06

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	C6_2015_02	APEM	10.03.2015 14:32 - 12.03.2015 15:15	241.99	240.87
	C6_2015_03	APEM	17.04.2015 17:17 - 19.04.2015 17:00	244.45	243.92
	C6_2015_04	APEM	20.07.2015 17:33 - 22.07.2015 10:33	274.40	273.90
	C6_2015_05	APEM	20.08.2015 07:33 - 21.08.2015 12:47	245.33	244.81
	C6_2015_06	APEM	18.09.2015 11:11 - 20.09.2015 10:33	271.22	270.97
	C6_2015_07	APEM	12.10.2015 11:52 - 14.10.2015 10:03	252.04	251.57
	C6_2015_08	APEM	17.12.2015 11:05 - 20.12.2015 12:43	258.66	258.26
	C6_2016_09	APEM	26.02.2016 11:23 - 28.02.2016 12:10	270.15	265.94
	C6_2016_10	APEM	25.03.2016 17:09 - 27.03.2016 15:11	271.27	271.14
	C6_2016_01	APEM	30.04.2016 10:24 - 01.05.2016 16:51	252.07	250.49
	C6_2016_12	APEM	28.06.2016 12:30 - 29.06.2016 14:30	87.47	87.30
	C6_2016_12	APEM	06.07.2016 12:32 - 07.07.2016 12:49	159.01	158.96
	C6_2016_13	APEM	28.07.2016 07:48 - 30.07.2016 15:58	242.19	242.19
	C6_2016_14	APEM	23.08.2016 11:47 - 25.08.2016 15:13	297.26	297.26

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	C6_2016_15	APEM	19.09.2016 15:51 - 22.09.2016 09:26	243.99	243.85
	C6_2016_16	APEM	05.10.2016 10:52 - 07.10.2016 13:27	240.52	240.52
Dan Tysk / Sandbank	DT_2014_01	APEM	24.03.2014 10:18 - 25.03.2014 09:47	323.33	323.33
	DT_2014_02	APEM	16.04.2014 10:11 - 16.04.2014 16:50	391.69	391.69
	2014-05-26-DT-SB	DAISI	26.05.2014 04:56 - 26.05.2014 15:15	409.86	318.39
	2014-07-07-DT-SB	DAISI	07.07.2014 07:46 - 07.07.2014 14:50	390.02	390.02
	2014-09-29-DT-SB	DAISI	29.09.2014 07:25 - 29.09.2014 15:20	389.48	389.48
	2014-10-30-DT-SB	DAISI	30.10.2014 08:23 - 30.10.2014 11:06	209.04	209.04
	2015-03-09-DT-SB	DAISI	09.03.2015 09:18 - 09.03.2015 15:34	286.10	284.78
	2015-03-18-DT-SB	DAISI	18.03.2015 09:03 - 18.03.2015 14:32	417.25	417.07
	2015-05-01-DT-SB	DAISI	01.05.2015 08:25 - 01.05.2015 14:52	334.76	262.76
	2015-05-08-DT-SB	DAISI	08.05.2015 08:41 - 08.05.2015 14:03	390.68	390.68
	2015-06-04-DT-SB	DAISI	04.06.2015 07:45 - 04.06.2015 13:19	391.38	391.38
	2015-07-03-DT-SB	DAISI	03.07.2015 09:28 - 03.07.2015 14:40	388.07	388.07

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	2015-07-14-DT-SB	DAISI	14.07.2015 09:42 - 14.07.2015 14:51	396.90	396.90
	2015-08-02-DT-SB	DAISI	02.08.2015 09:16 - 02.08.2015 14:26	386.47	386.47
	2015-09-19-DT-SB	DAISI	19.09.2015 08:44 - 19.09.2015 14:05	407.66	407.66
	2015-09-28-DT-SB	DAISI	28.09.2015 08:33 - 28.09.2015 13:54	405.16	405.16
	2015-11-01-DT-SB	DAISI	01.11.2015 07:47 - 01.11.2015 13:01	373.96	373.96
	2015-12-07-DT-SB	DAISI	07.12.2015 08:31 - 07.12.2015 12:44	339.17	339.17
	2016-01-21-DT-SB	DAISI	21.01.2016 08:51 - 21.01.2016 13:53	344.42	344.42
	2016-02-16-DT-SB	DAISI	16.02.2016 09:24 - 16.02.2016 14:36	382.36	382.36
	2016-04-01-DT-SB	DAISI	01.04.2016 09:54 - 01.04.2016 14:56	334.18	334.18
	2016-05-10-DT-SB	DAISI	10.05.2016 11:19 - 10.05.2016 16:46	392.15	392.15
	2016-06-03-DT-SB	DAISI	03.06.2016 07:16 - 03.06.2016 12:11	364.63	364.63
	2016-07-21-DT-SB	DAISI	21.07.2016 10:28 - 21.07.2016 15:32	406.59	406.59
	2016-08-27-DT-SB	DAISI	27.08.2016 09:43 - 27.08.2016 14:40	394.21	394.21
	2016-09-09-DT-SB	DAISI	09.09.2016 09:30 - 09.09.2016 14:44	414.22	414.22

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	2016-10-25-DT-SB	DAISI	25.10.2016 07:14 - 25.10.2016 10:01	189.87	189.87
	2016-11-23-DT-SB	DAISI	23.11.2016 08:18 - 23.11.2016 13:24	383.37	383.34
Nordergründe	Zone06_M03_S01_D01_15	HiDef	12.03.2015 09:34 - 12.03.2015 11:50	254.04	254.04
	Zone06_M04_S01_D01_15	HiDef	05.04.2015 07:05 - 05.04.2015 09:19	241.12	241.12
	Zone06_M05_S01_D01_15	HiDef	11.05.2015 15:15 - 11.05.2015 17:37	250.92	250.92
	Zone06_M08_S01_15	HiDef	01.08.2015 09:59 - 01.08.2015 12:43	242.07	241.9
	Zone06_M09_S01_15	HiDef	10.09.2015 07:46 - 10.09.2015 10:06	242.42	242.28
	Zone06_M10_S01_15	HiDef	10.10.2015 09:21 - 10.10.2015 11:41	243.33	243.23
	Zone06_M11_S01_15	HiDef	23.11.2015 10:08 - 23.11.2015 12:34	245.31	245.09
	Zone06_M12_S01_15	HiDef	13.12.2015 10:40 - 13.12.2015 13:01	242.05	241.76
	Zone06_M01_S01_16	HiDef	28.01.2016 11:26 - 28.01.2016 13:44	242.75	242.37
	Zone06_M02_S01_16	HiDef	17.02.2016 10:51 - 17.02.2016 13:18	246.28	246.06
	Zone06_M03_S01_16	HiDef	12.03.2016 11:54 - 12.03.2016 14:13	241.75	239.40
	Zone06_M04_S01_16	HiDef	11.04.2016 12:46 - 11.04.2016 15:04	242.22	238.42

Survey area	Cruise number	Method	Flight dates	Observed area [km²]	Analysed area [km²]
	Zone06_M05_S01_16	HiDef	02.05.2016 10:37 - 02.05.2016 12:59	241.81	239.77
	Zone06_M08_S01_16	HiDef	17.08.2016 08:52 - 17.08.2016 11:19	242.53	240.43
	Zone06_M09_S01_16	HiDef	06.09.2016 12:50 - 06.09.2016 15:17	247.49	245.72
	Zone06_M10_S01_16	HiDef	27.10.2016 11:00 - 27.10.2016 13:19	242.19	231.48
	Zone06_M11_S01_16	HiDef	14.11.2016 09:35 - 14.11.2016 11:59	243.14	241.34
	Zone06_M12_S01_16	HiDef	06.12.2016 11:24 - 06.12.2016 13:49	242.07	239.66

Table A.9 Proportion of time at the surface for porpoises based on Teilmann *et al. (2013; see literature list of the report).*

time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
21.00 – 03.00	0.48	0.42	0.51	0.61	0.57	0.55	0.55	0.49	0.49	0.49	0.49	0.52
03.00 – 09.00	0.46	0.39	0.48	0.59	0.55	0.53	0.53	0.47	0.47	0.46	0.46	0.50
09.00 – 15.00	0.44	0.37	0.46	0.57	0.53	0.51	0.51	0.45	0.45	0.44	0.44	0.48
15.00 – 21.00	0.42	0.36	0.44	0.55	0.51	0.49	0.49	0.43	0.43	0.42	0.42	0.48

Large-scale model

Table A.10 Model parameter and GAM results for the "Northeast" model on porpoise presence/absence for data subset excluding APEM observations.

Variable	Regression technique	Df / Edf	Chi²]	p-value
OWF presence	factor	2	4.833	0.0891
year	factor	2	3.831	0.1473
observer method	factor	2	0.016	0.9921
te(x,y, unique month)	3-D tensor spline	245.298	689.64	< 0.000
salinity	thin plate smooth	2.962	16.98	0.0013
fish probability	thin plate smooth	1	24.66	< 0.000
month	cyclic smooth	4.296	97.48	< 0.000
total picture area analysed	thin plate smooth	4.106	238.74	< 0.000

Data of mobile CPODs

WP 4.1 – Efficiency of deterrence measures: Additional plots

Figure A.104 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF Amrumbank West. Detection-positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

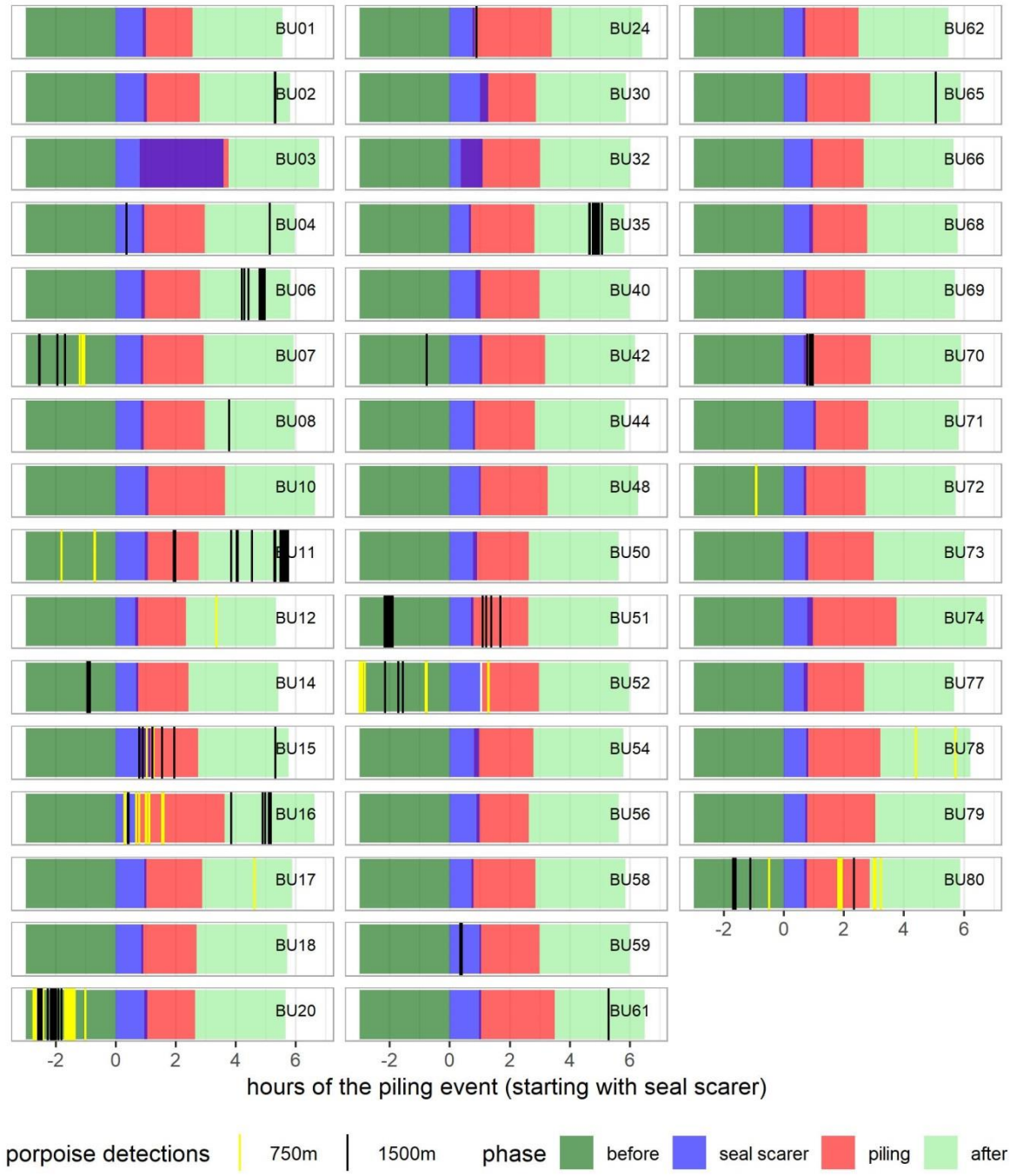


Figure A.105 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF Butendiek. Detection-positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

Figure A.106 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF Nordsee One. Detection-positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

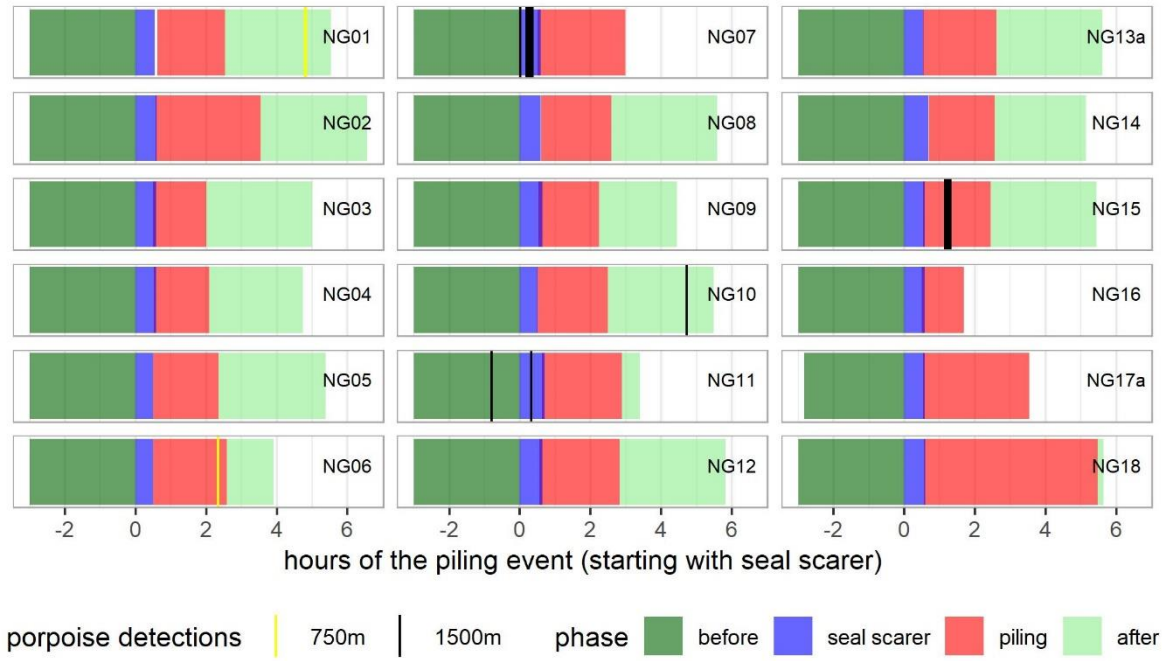


Figure A.107 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF Nordergründe. Detection-positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

Figure A.108 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF Sandbank. Detection -positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

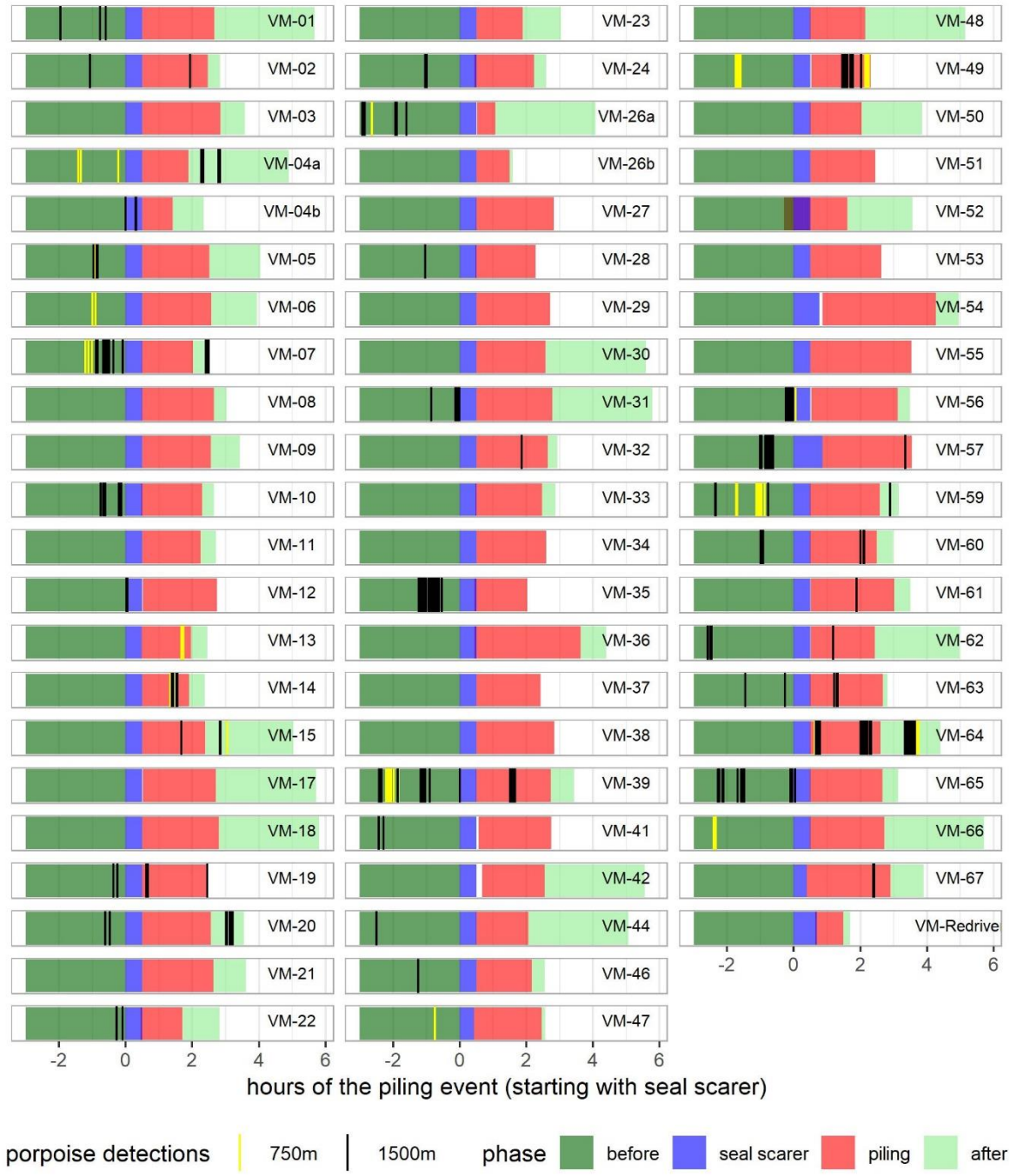


Figure A.109 Overview of phase duration cut to 3 h before seal scarer activity and 3 h after piling for piling events of OWF VejaMate. Detection -positive minutes are indicated as porpoise detections at 750 m and 1500 m distance. A differently coloured block compared to phase colours indicates a phase overlap. Labels give the name of the foundation.

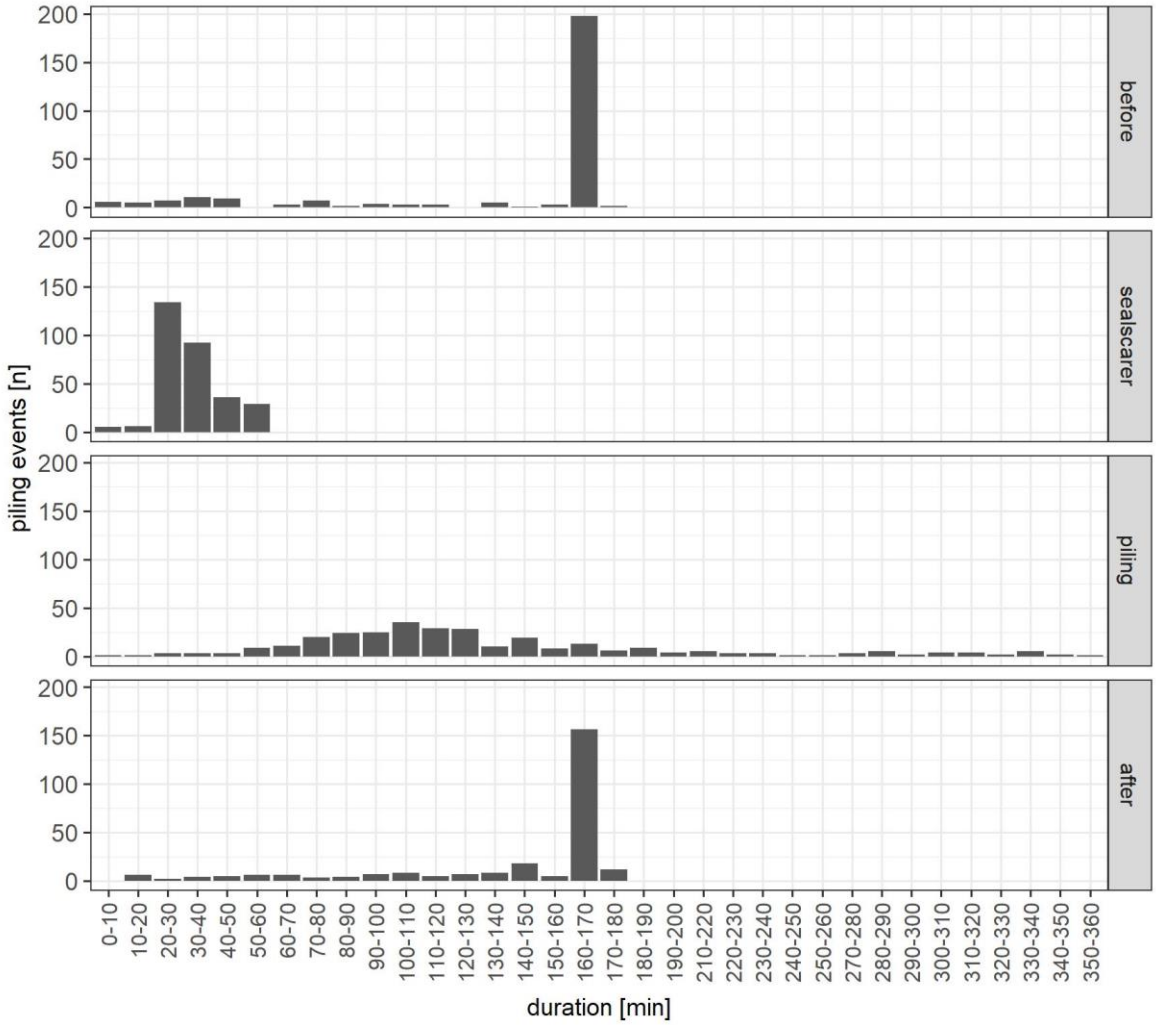


Figure A.110 Number of piling events by phase duration [min]. Dataset from 1500 m distance to the construction site was used. Piling events of the projects ABW, BU, N1, NG, SB, and VM were pooled.

WP 4.1 – Efficiency of deterrence measures: Additional tables

Table A.11 Simultaneous test-statistics for Tukey's all-pairwise comparison of phases. Significantly different phases are indicated in bold (p < 0.05).

	Estimate	Std. error	P-value
seal scarer – before	**-0.44312**	**0.14895**	**0.0153**
piling – before	**-0.52813**	**0.12033**	**<0.001**
after – before	-0.20969	0.11836	0.2830
piling – seal scarer	-0.08502	0.14738	0.9381
after – seal scarer	0.23343	0.15234	0.4136
after – piling	**0.31844**	**0.10991**	**0.0194**

Table A.12 Statistics of the comparison of odds ratio between phases. Odds ratios significantly different from 1 are indicated in bold (p < 0.05).

	Estimate	Lower confidence interval	Upper confidence interval	P-value
seal scarer – before	**0.6420329**	**0.4385046**	**0.9400272**	**0.0153**
piling – before	**0.5897062**	**0.4333814**	**0.8024187**	**<0.001**
after – before	0.8108384	0.5989100	1.0977591	0.2830
piling – seal scarer	0.9184983	0.6298580	1.3394118	0.9381
after – seal scarer	1.2629234	0.8551267	1.8651921	0.4136
after – piling	**1.3749872**	**1.0378152**	**1.8217017**	**0.0194**

Daily CPOD data

WP 5.1 – Population-level effects: Additional plots

Raw data plots

Raw data plots – single station models

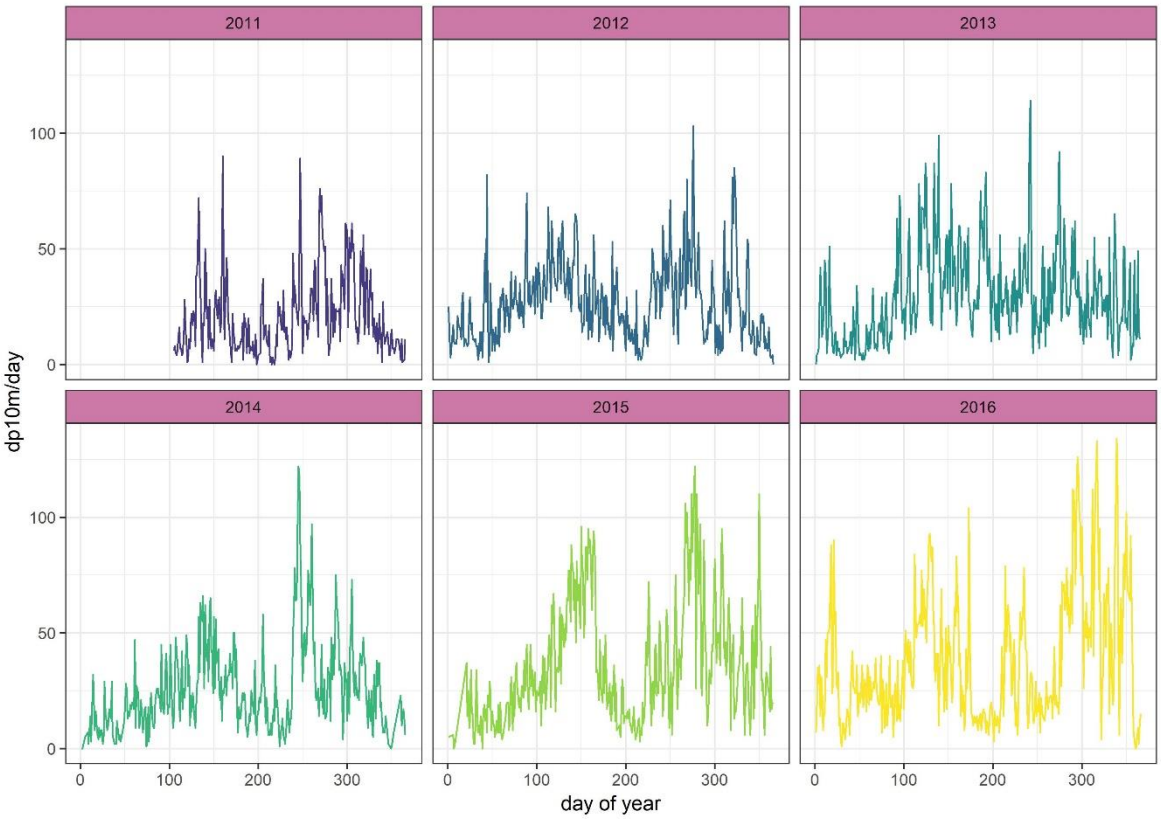


Figure A.111 Raw data of monitoring position BU2.

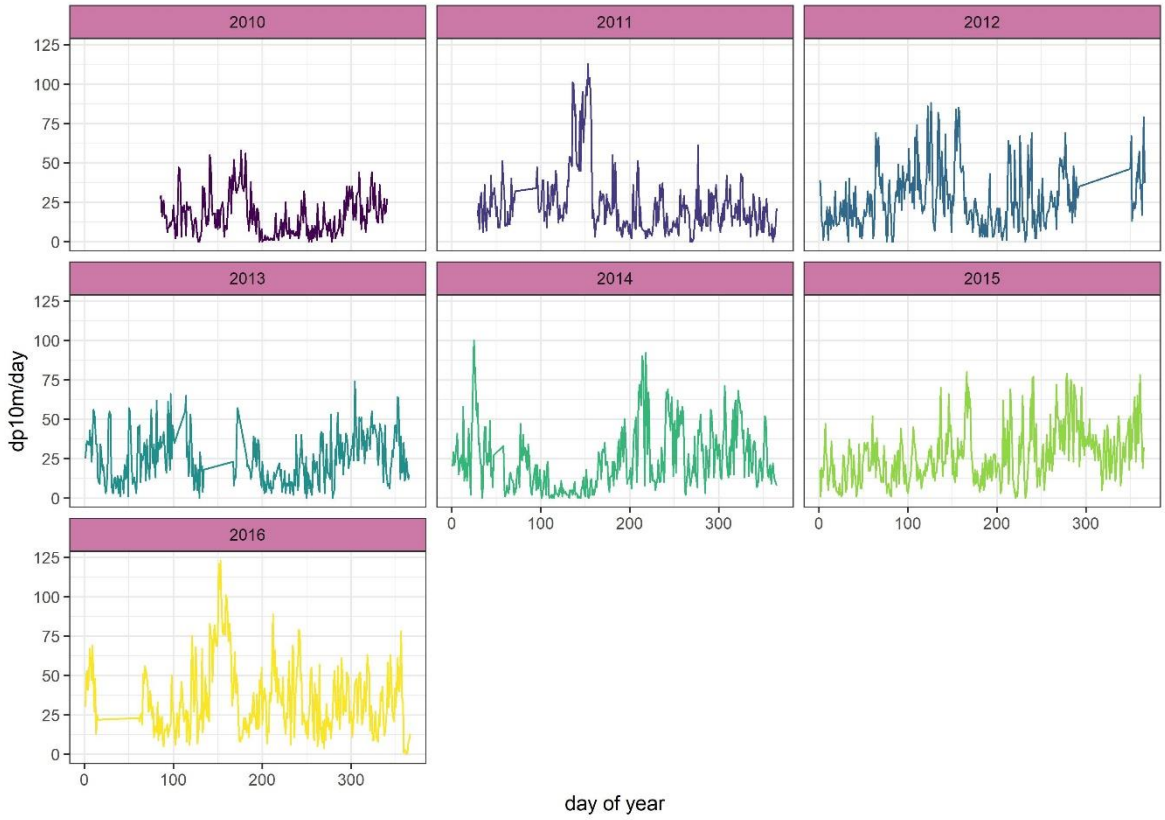


Figure A.112 Raw data of monitoring position S10.

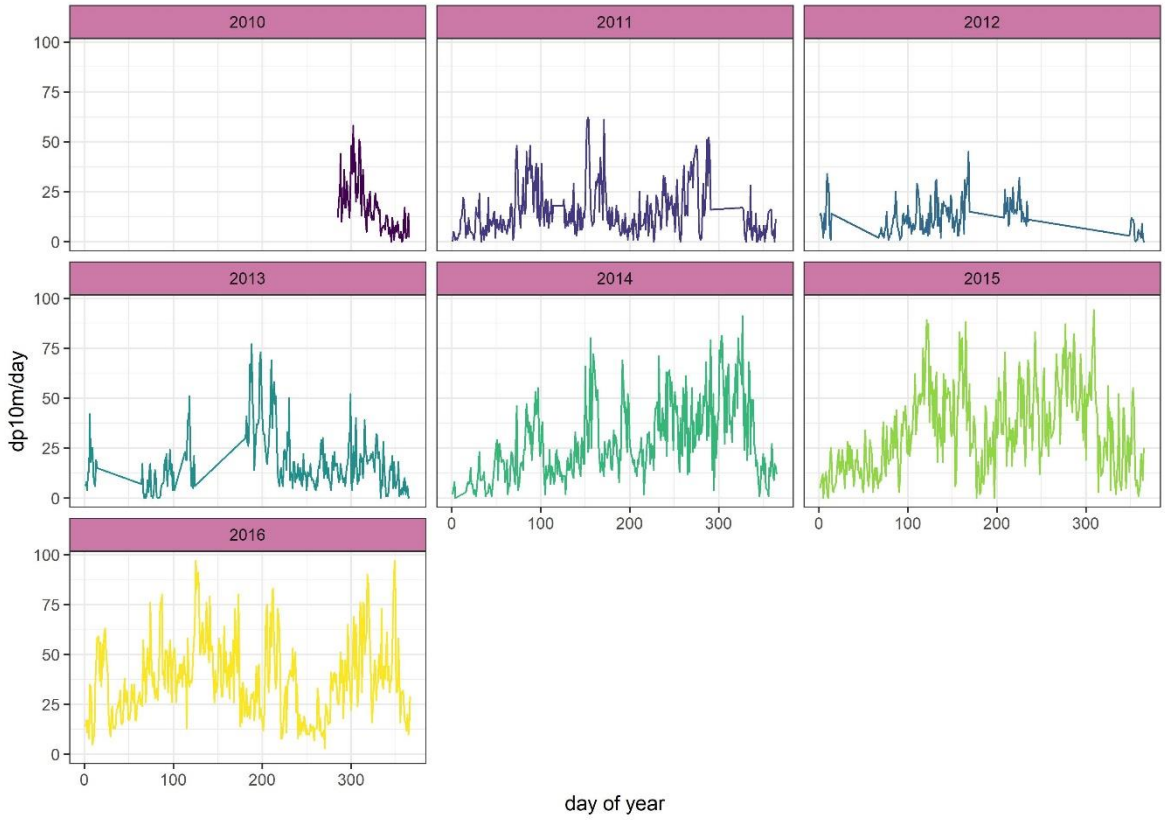


Figure A.113 Raw data of monitoring position S13.

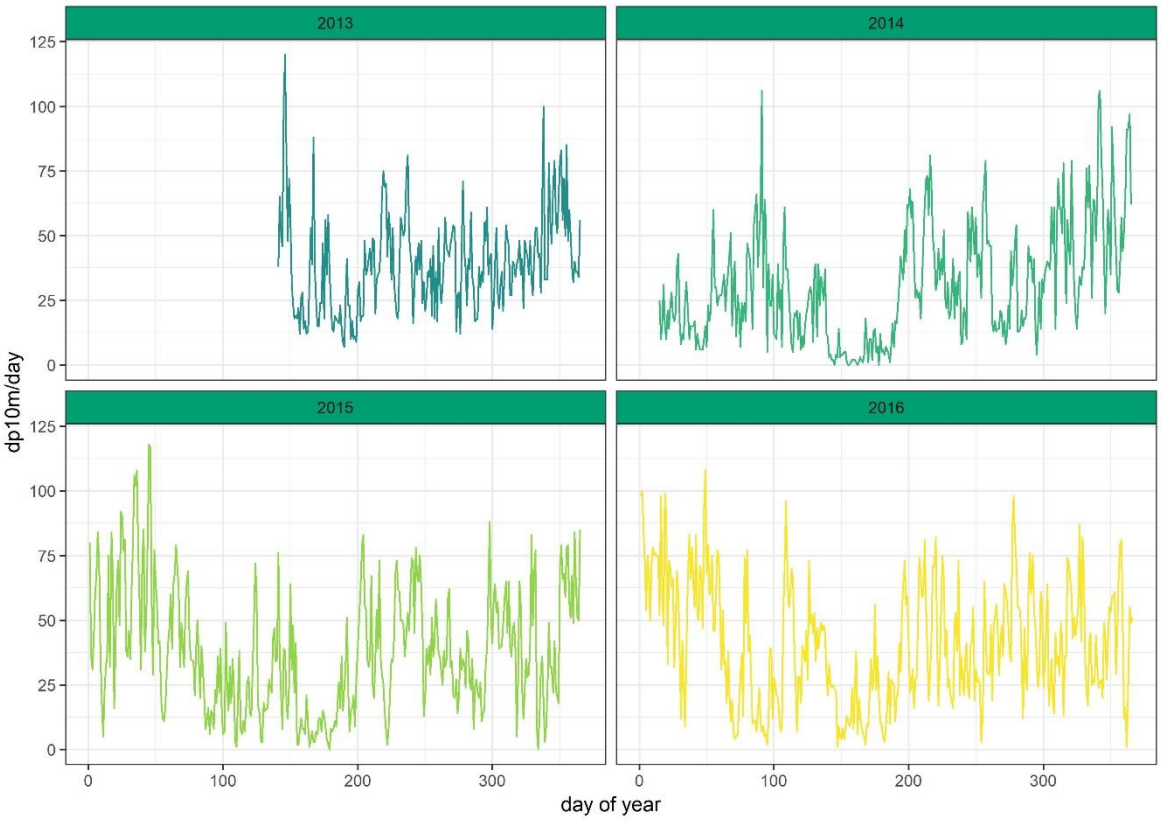


Figure A.114 Raw data of monitoring position BR1.

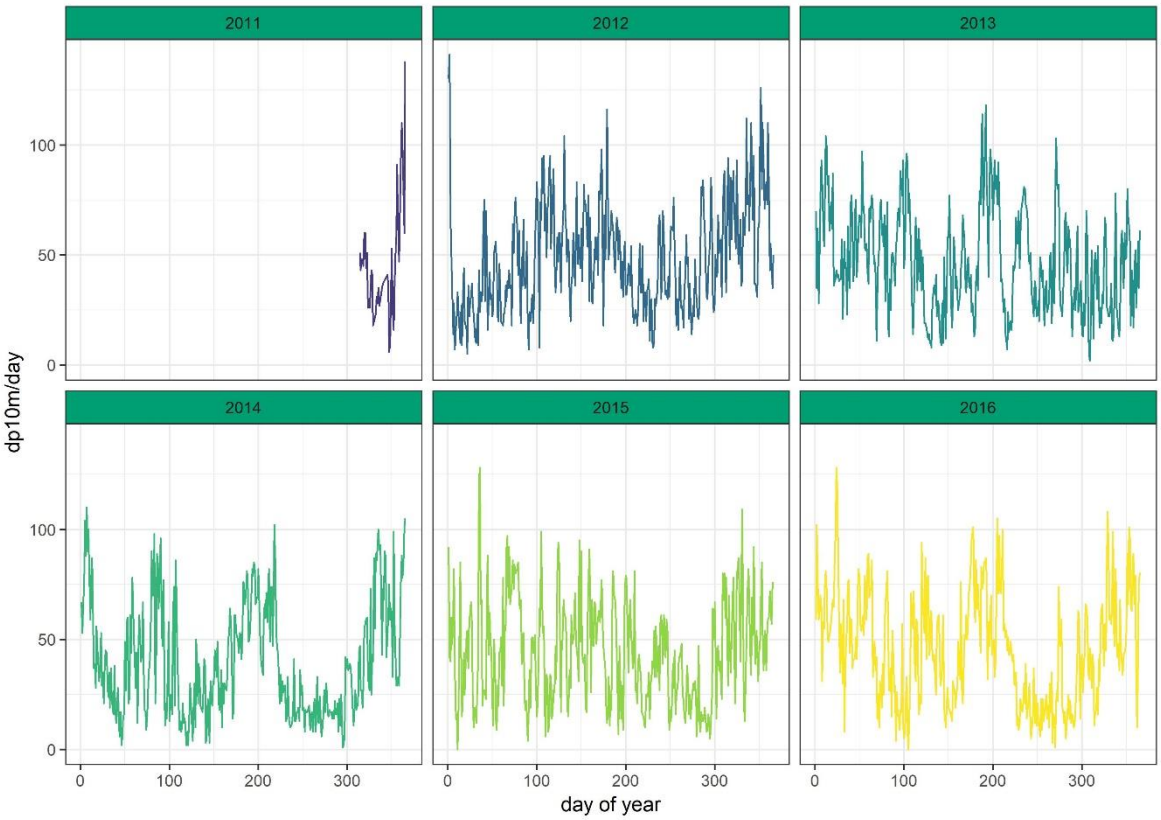


Figure A.115 Raw data of monitoring position MEG1.

Figure A.116 Raw data of monitoring position BR2.

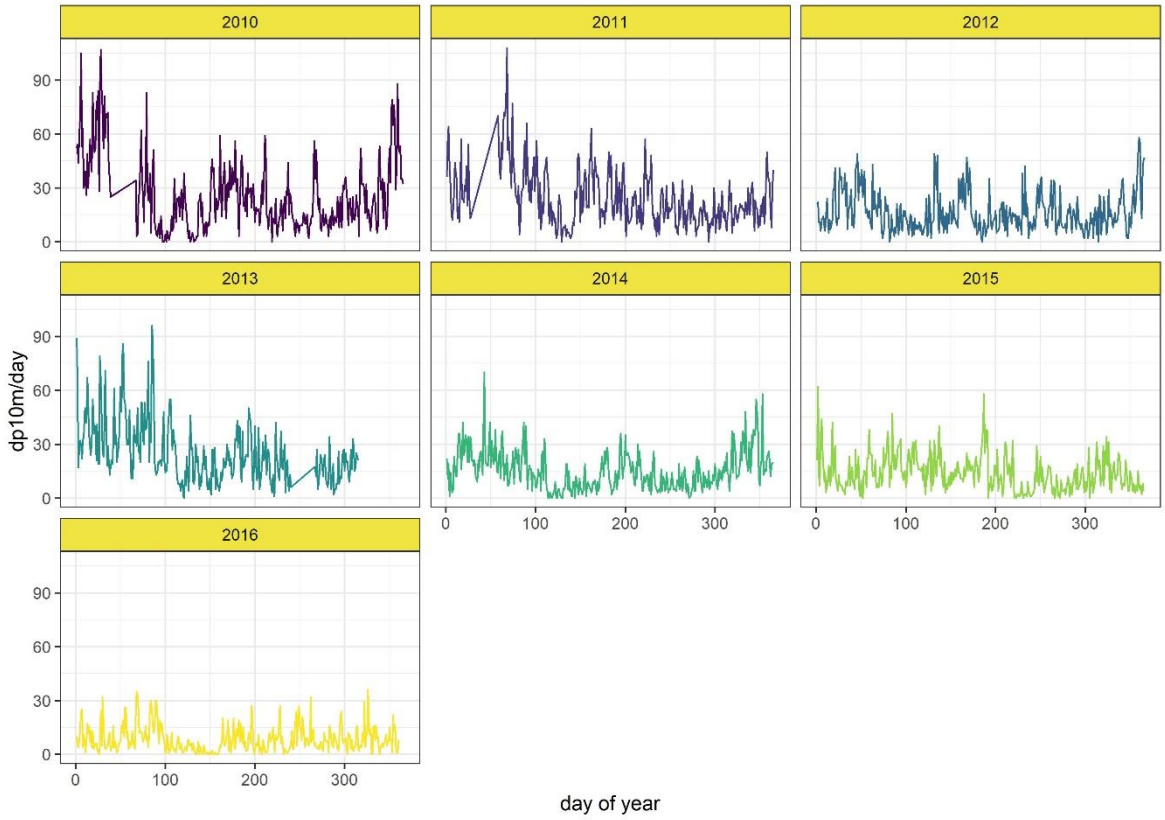


Figure A.117 Raw data of monitoring position S4.

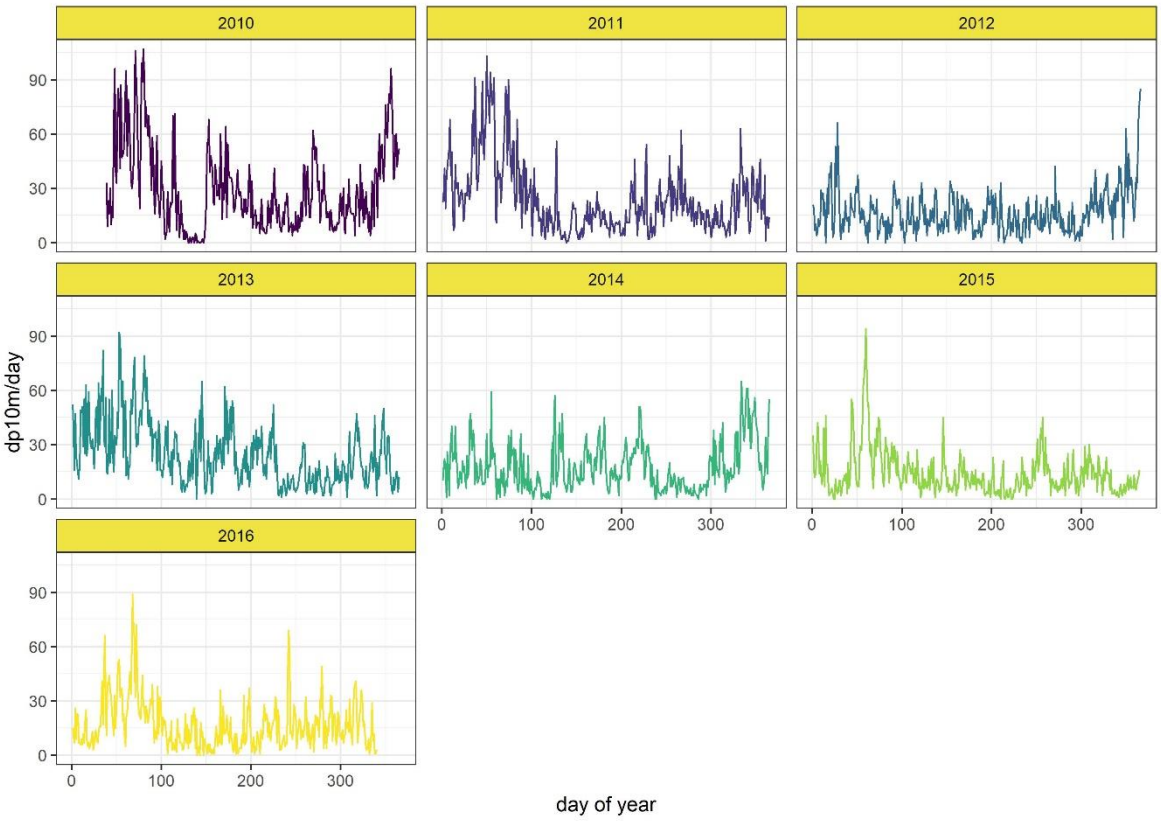


Figure A.118 Raw data of monitoring position S8.

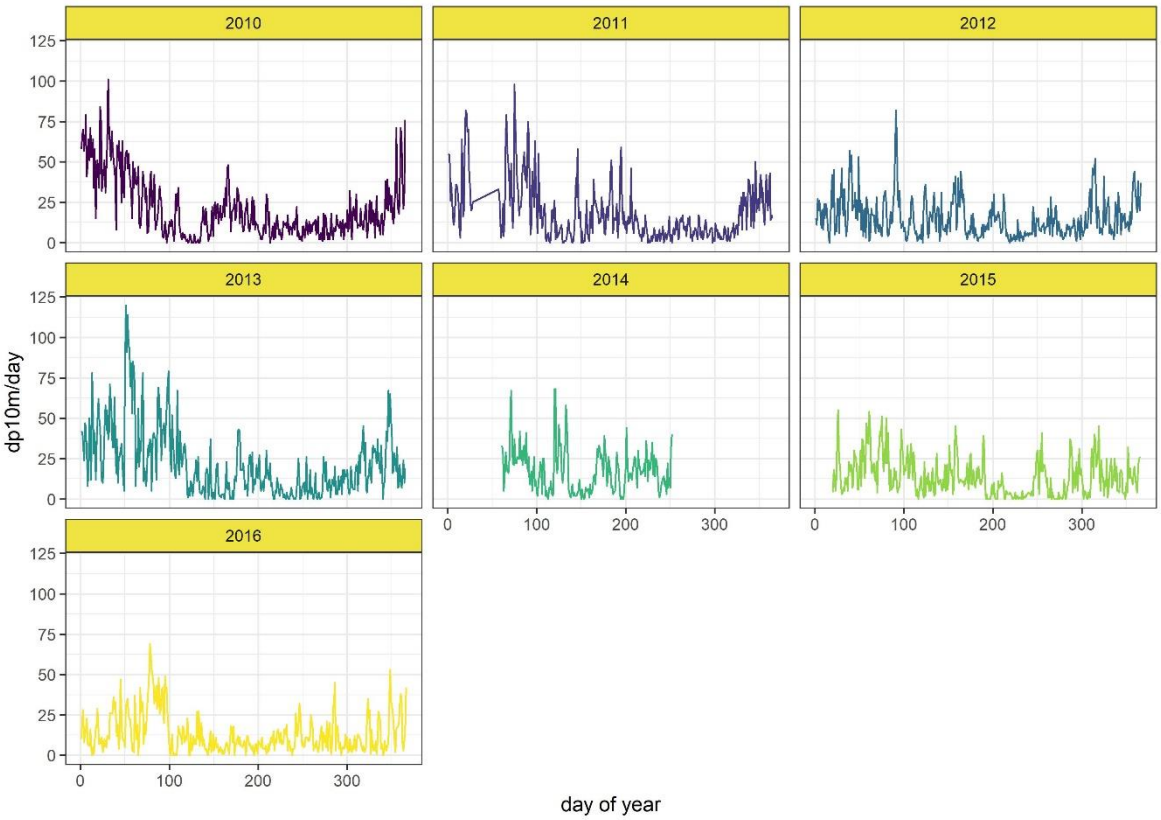


Figure A.119 Raw data of monitoring position S3.

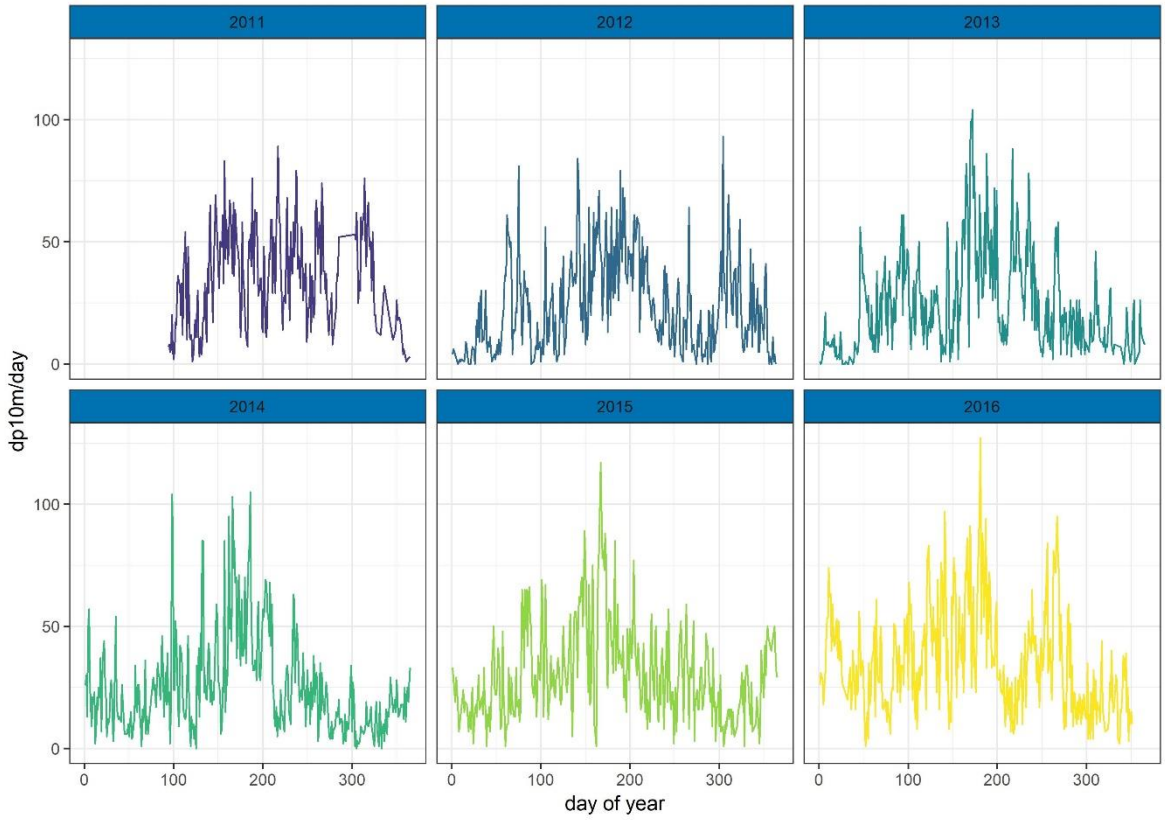


Figure A.120 Raw data of monitoring position DT1.

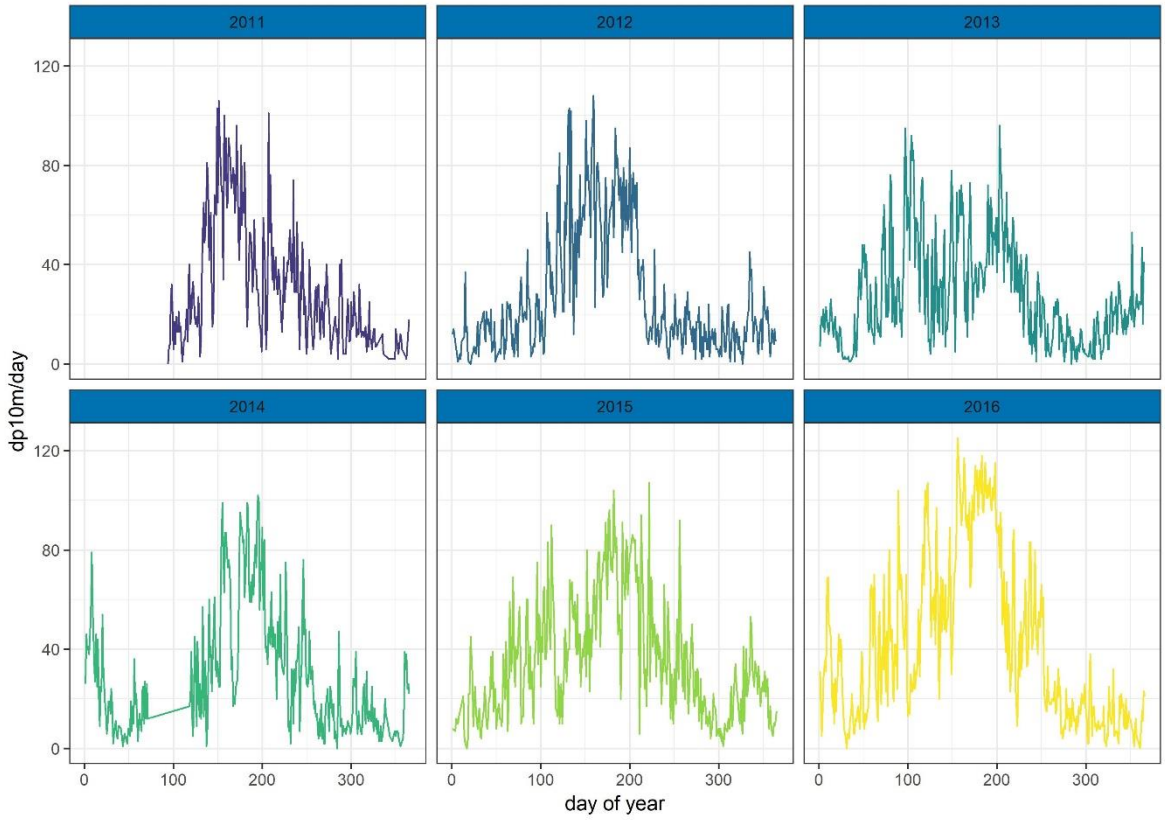


Figure A.121 Raw data of monitoring position DT2.

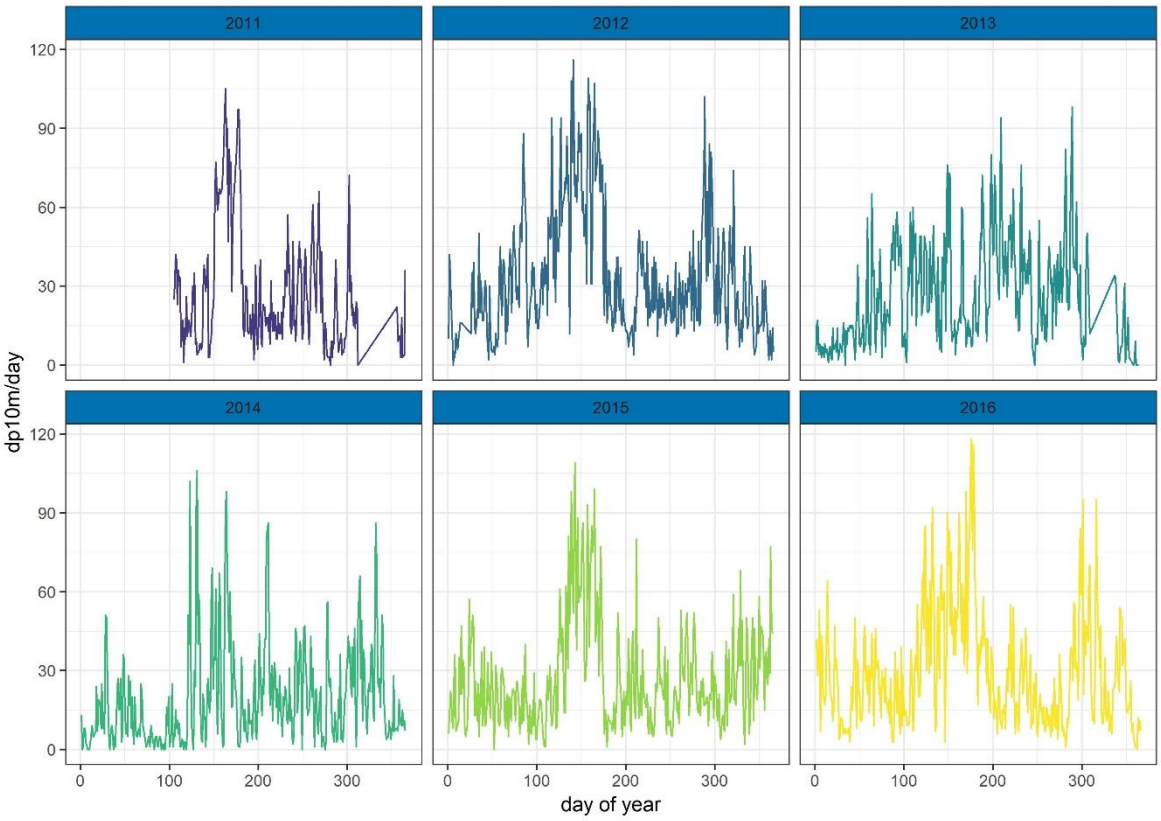


Figure A.122 Raw data of monitoring position BU1.

Raw data plots – subarea models

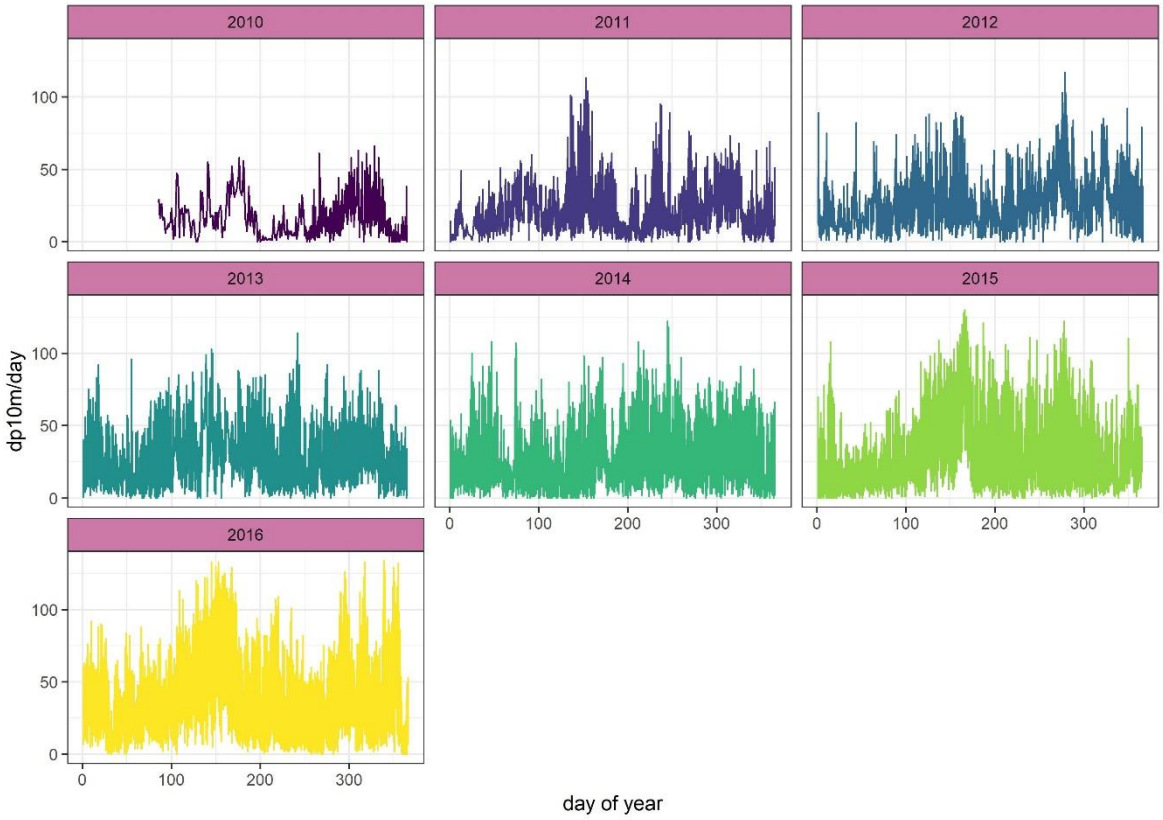


Figure A.123 Raw data of subarea 1; phenology by year.

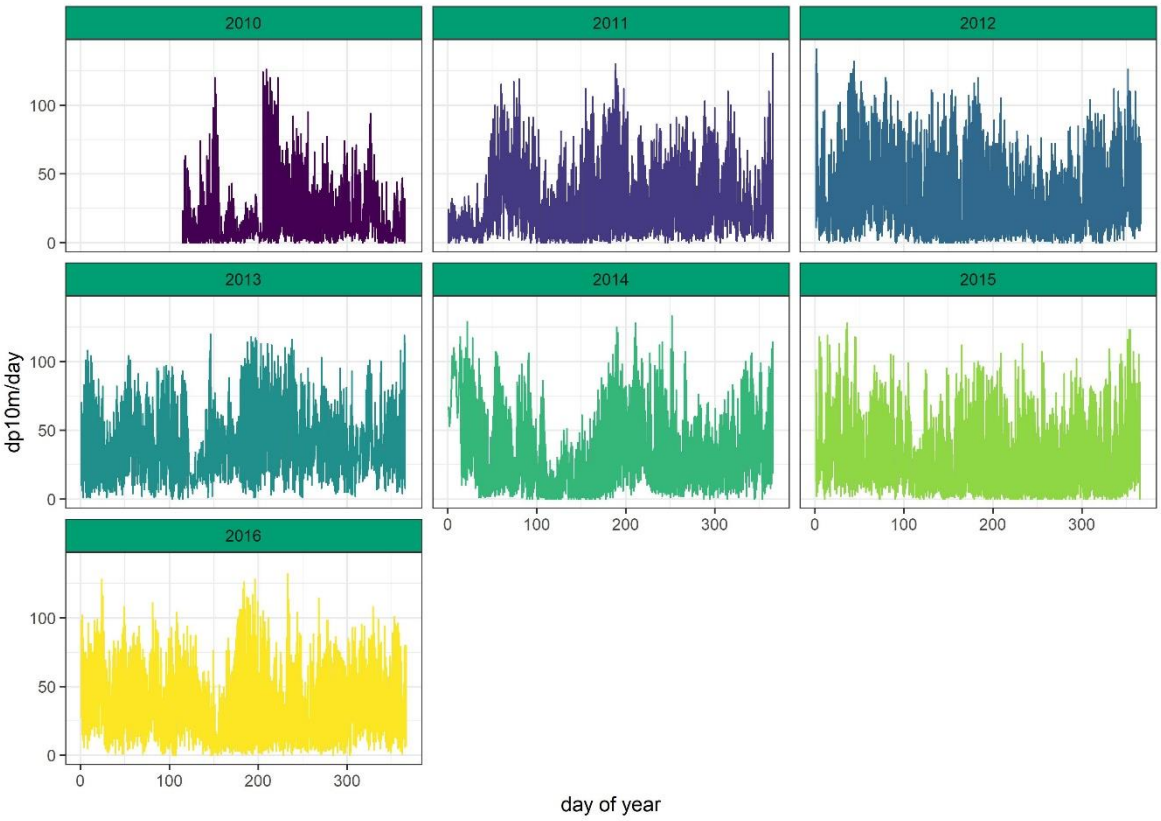


Figure A.124 Raw data of subarea 2; phenology by year.

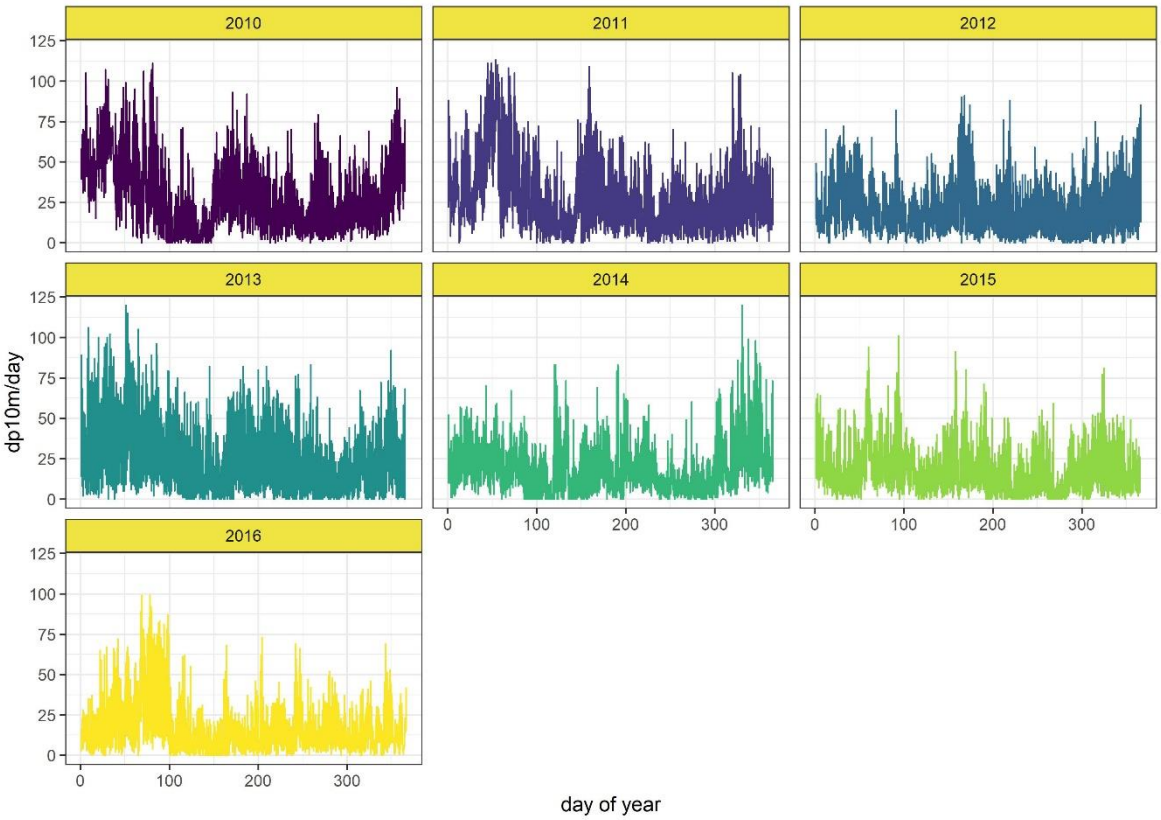


Figure A.125 Raw data of subarea 3; phenology by year.

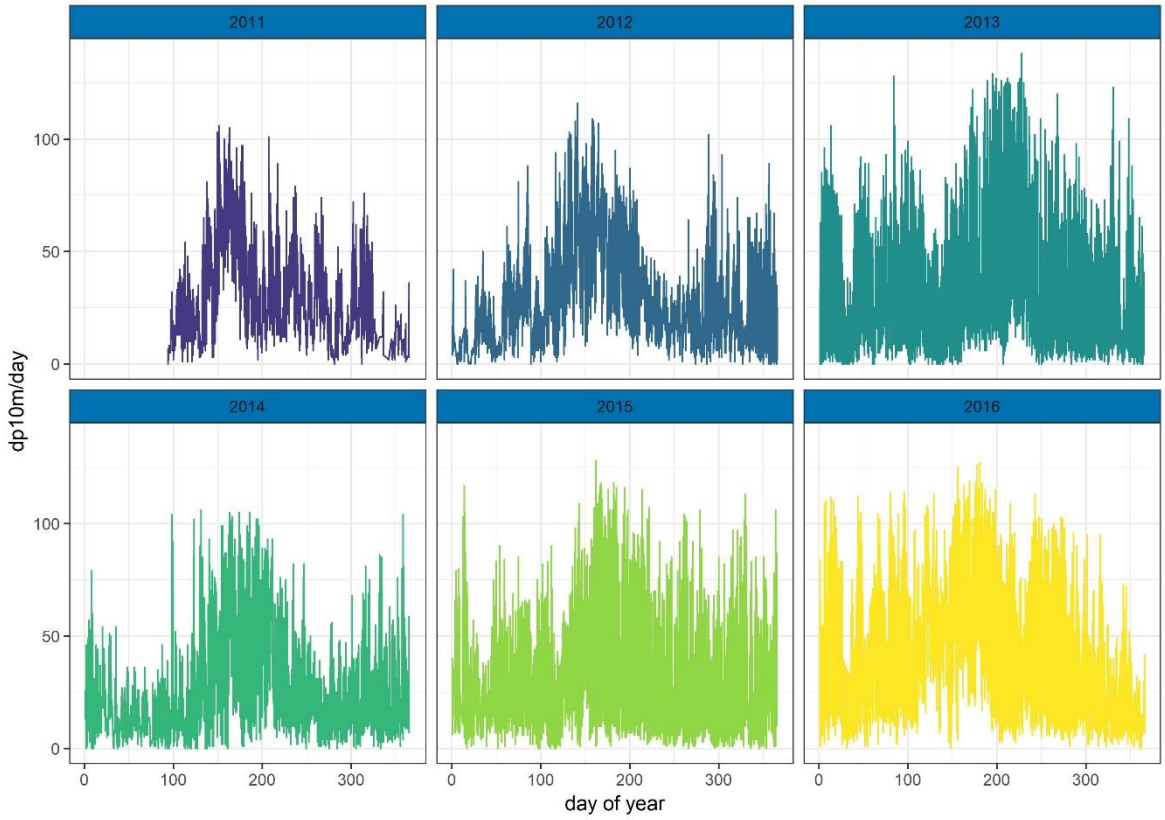


Figure A.126 Raw data of subarea 4; phenology by year.

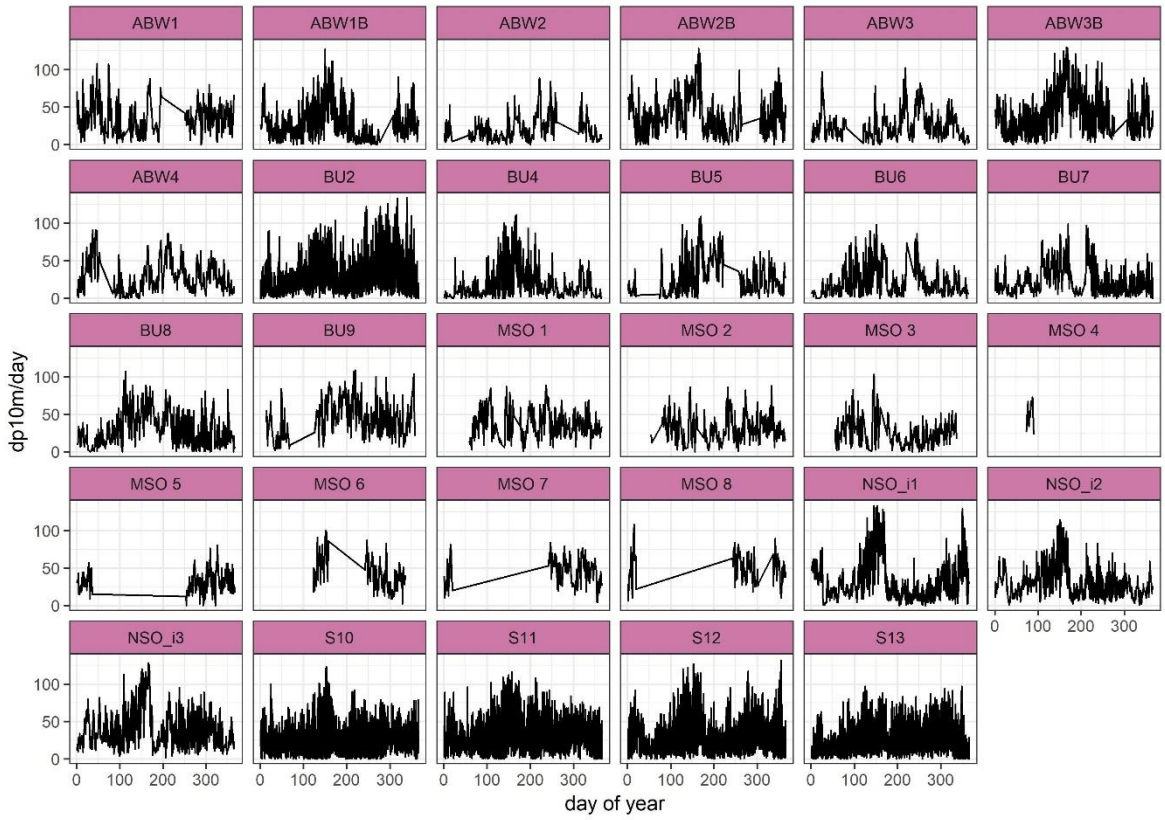


Figure A.127 Raw data of subarea 1; phenology by monitoring position.

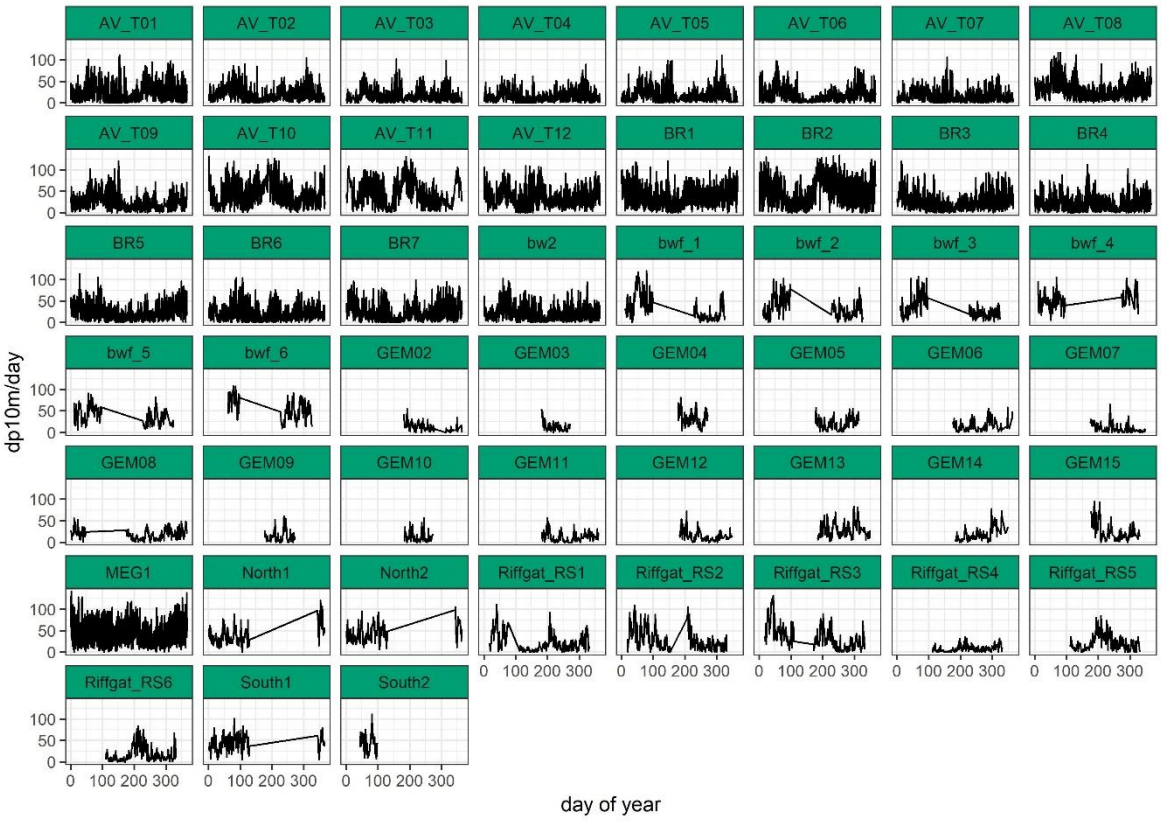


Figure A.128 Raw data of subarea 2; phenology by monitoring position.

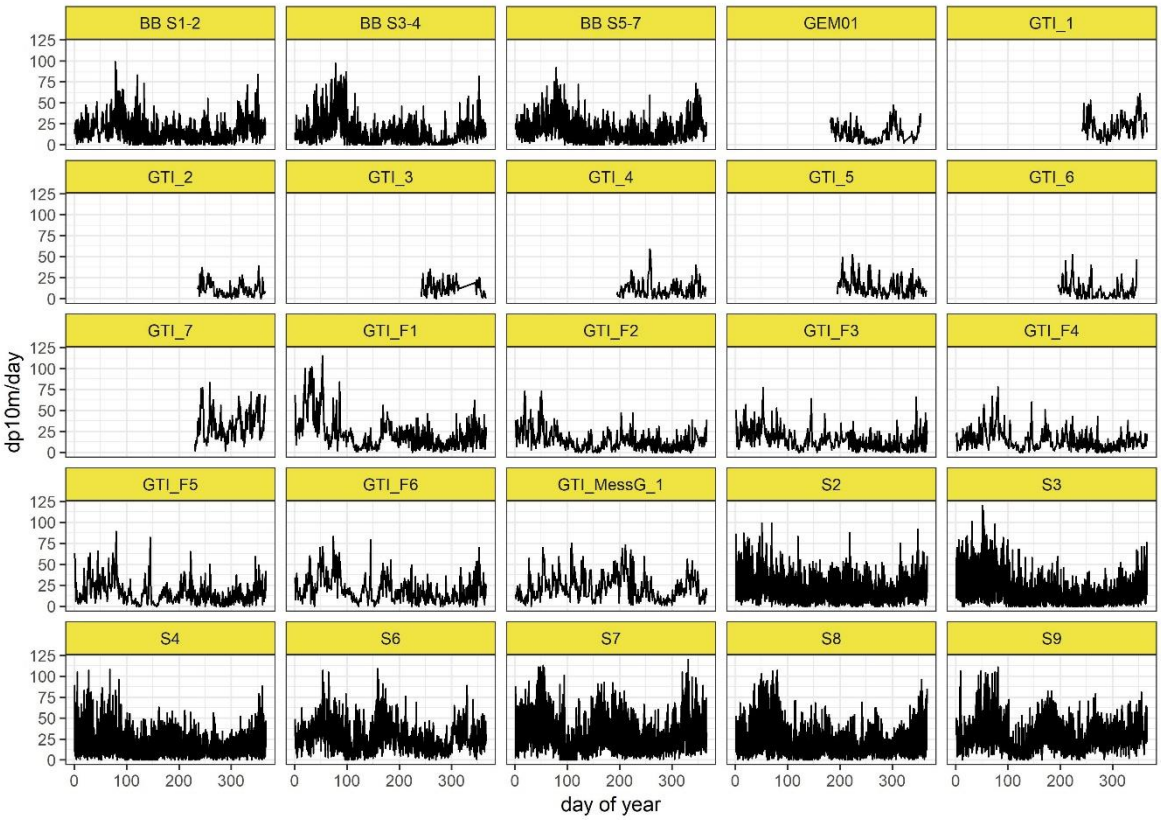


Figure A.129 Raw data of subarea 3; phenology by monitoring position.

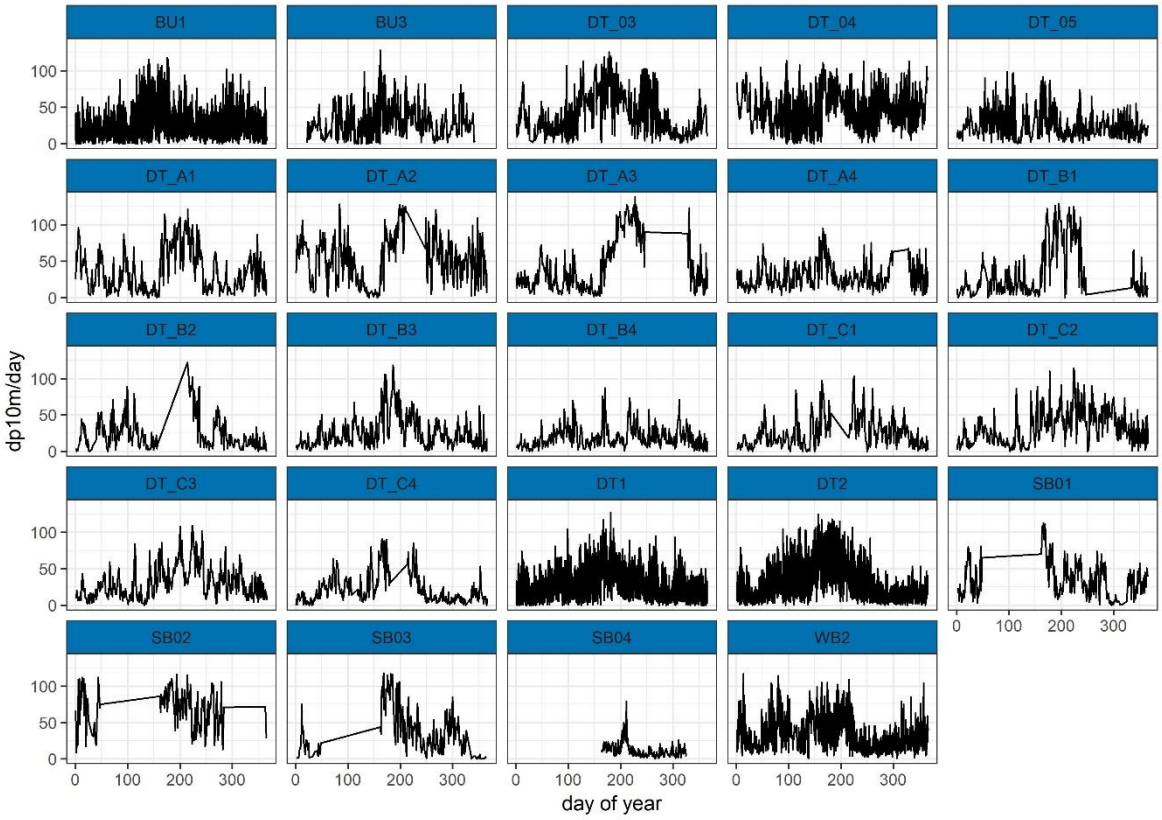


Figure A.130 Raw data of subarea 4; phenology by monitoring position.

Raw data plots – piling

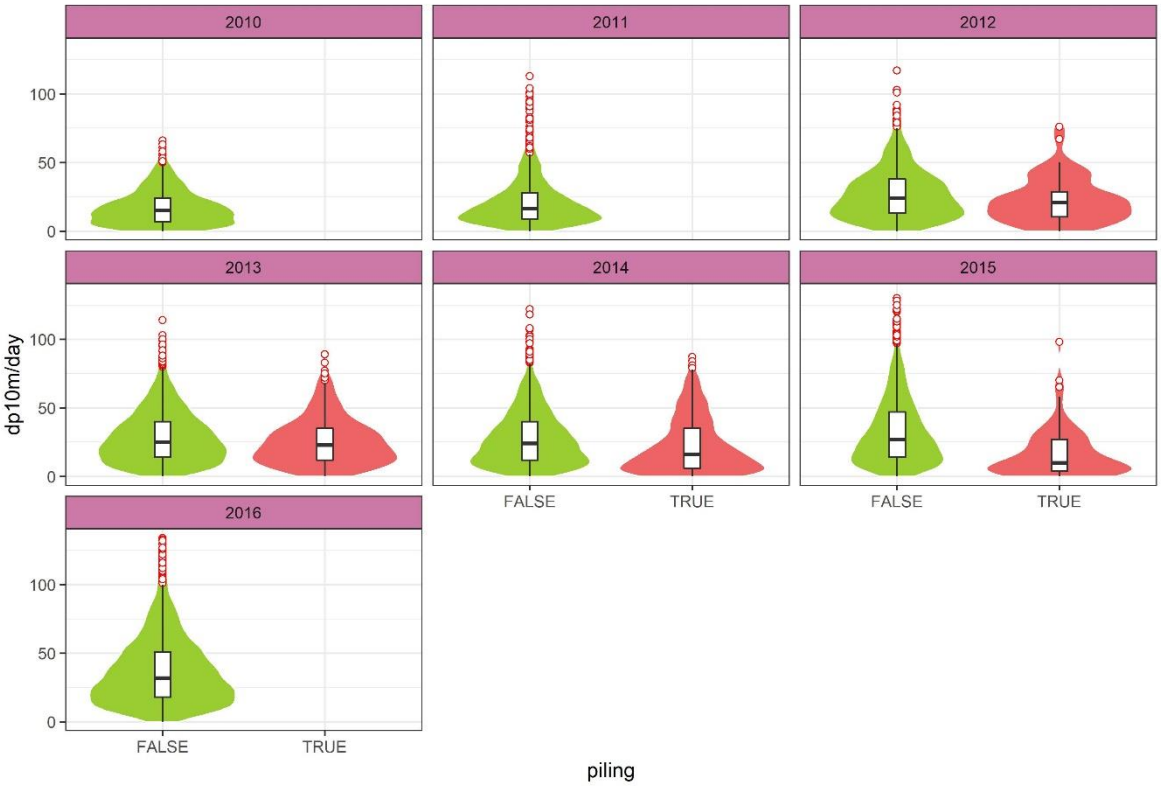


Figure A.131 Raw data of subarea 1; piling in 20 km around monitoring position and non-piling days.

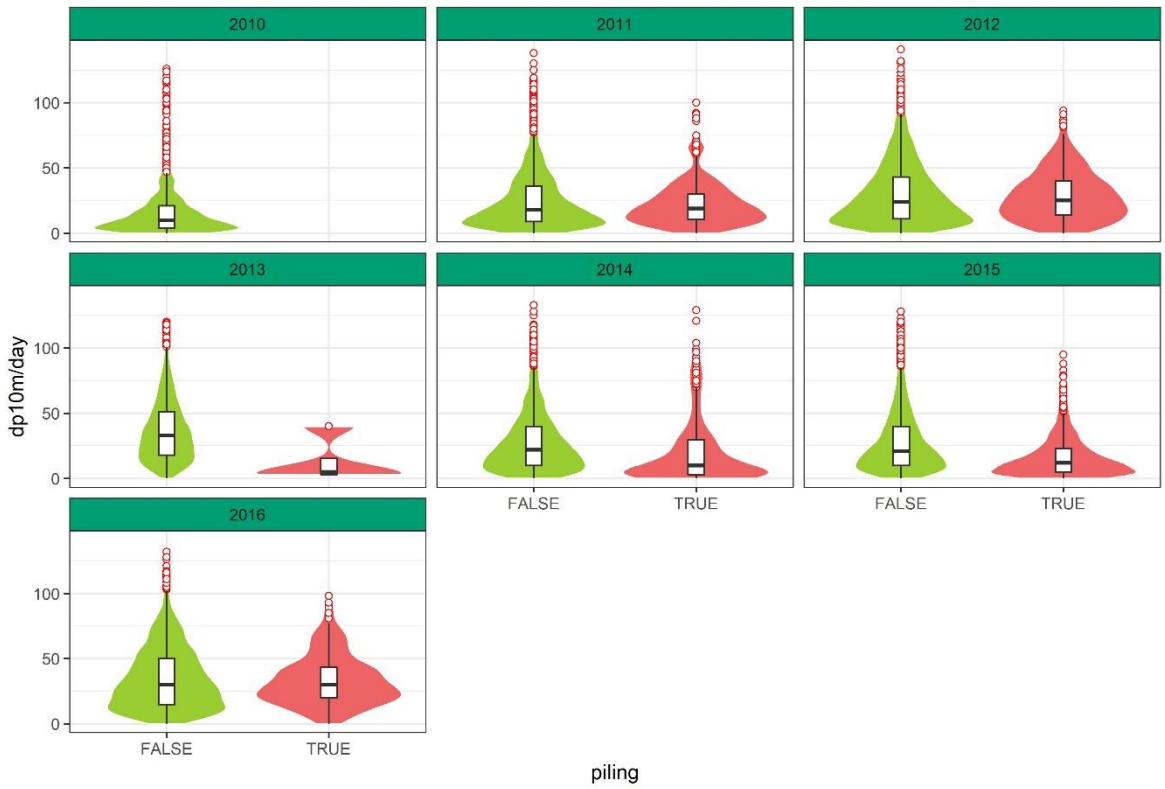


Figure A.132 Raw data of subarea 2; piling in 20 km around monitoring position and non-piling days.

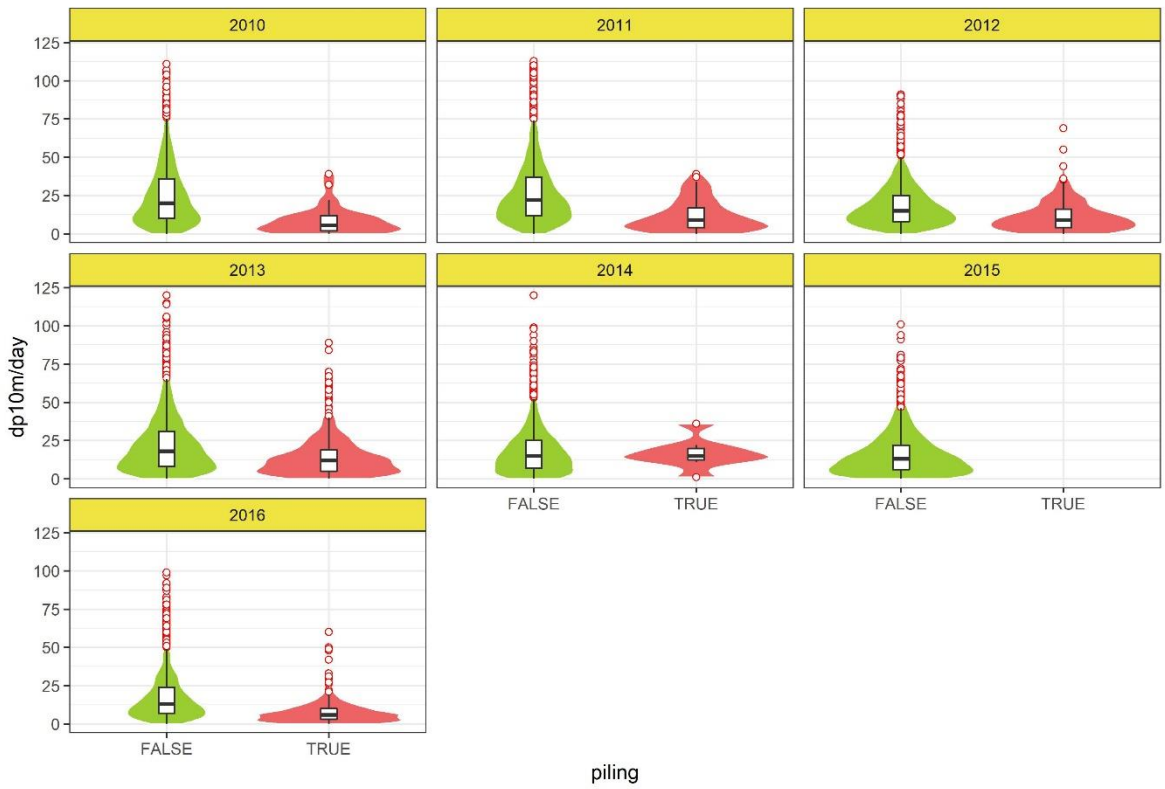


Figure A.133 Raw data of subarea 3; piling in 20 km around monitoring position and non-piling days.

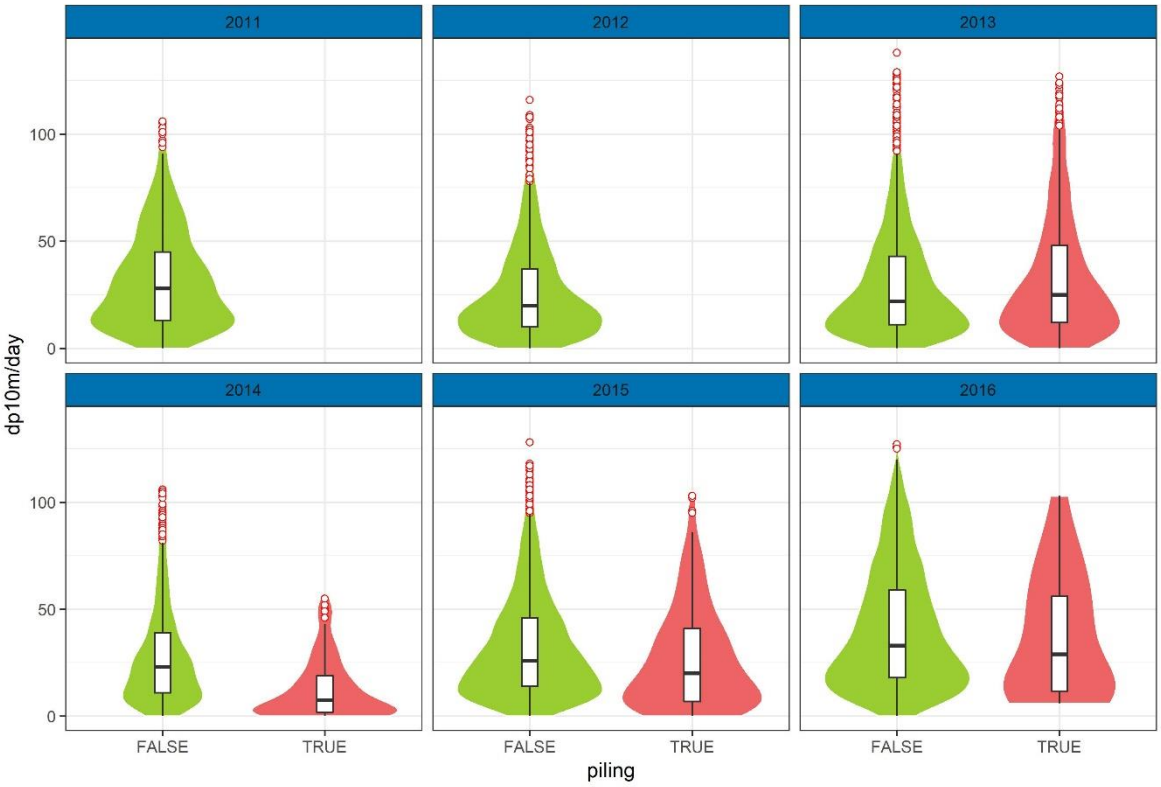


Figure A.134 Raw data of subarea 4; piling in 20 km around monitoring position and non-piling days.

Habituation models – finer scaled distance classes

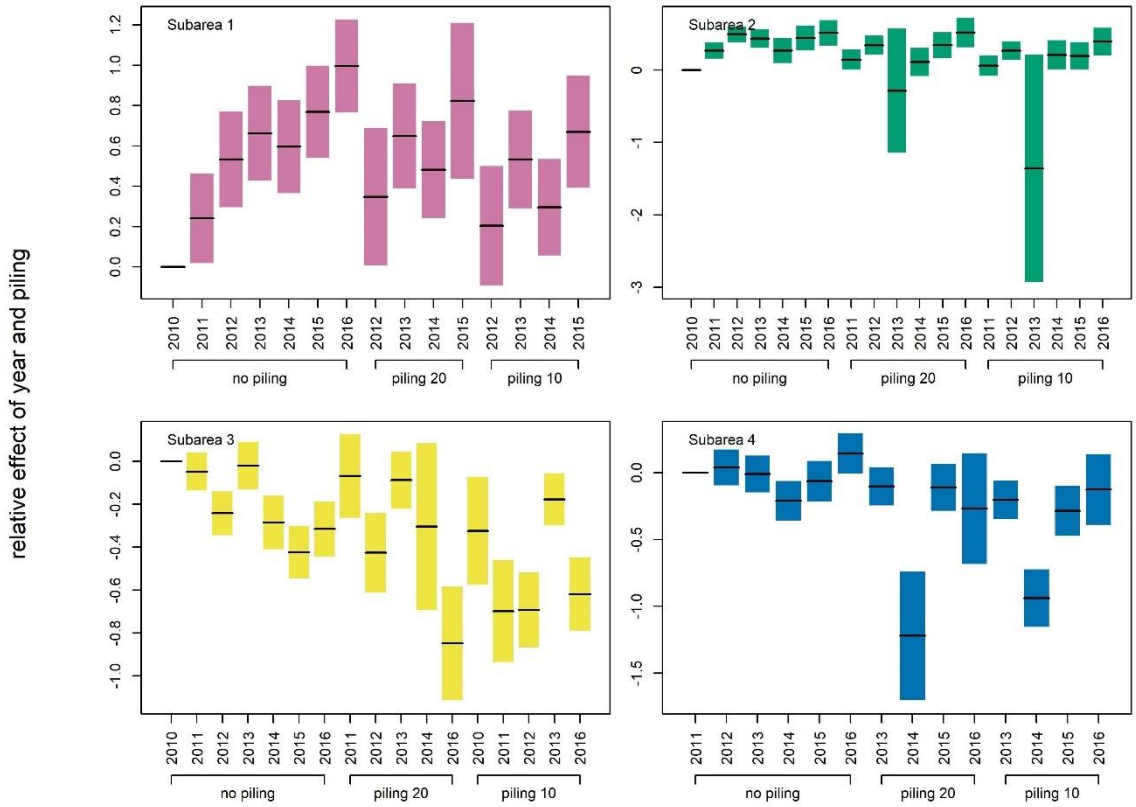


Figure A.135 Assessing possible habituation or sensitisation processes by comparing "long term trends" for days without and with piling in a 10 and 10-20 km radius around POD stations.

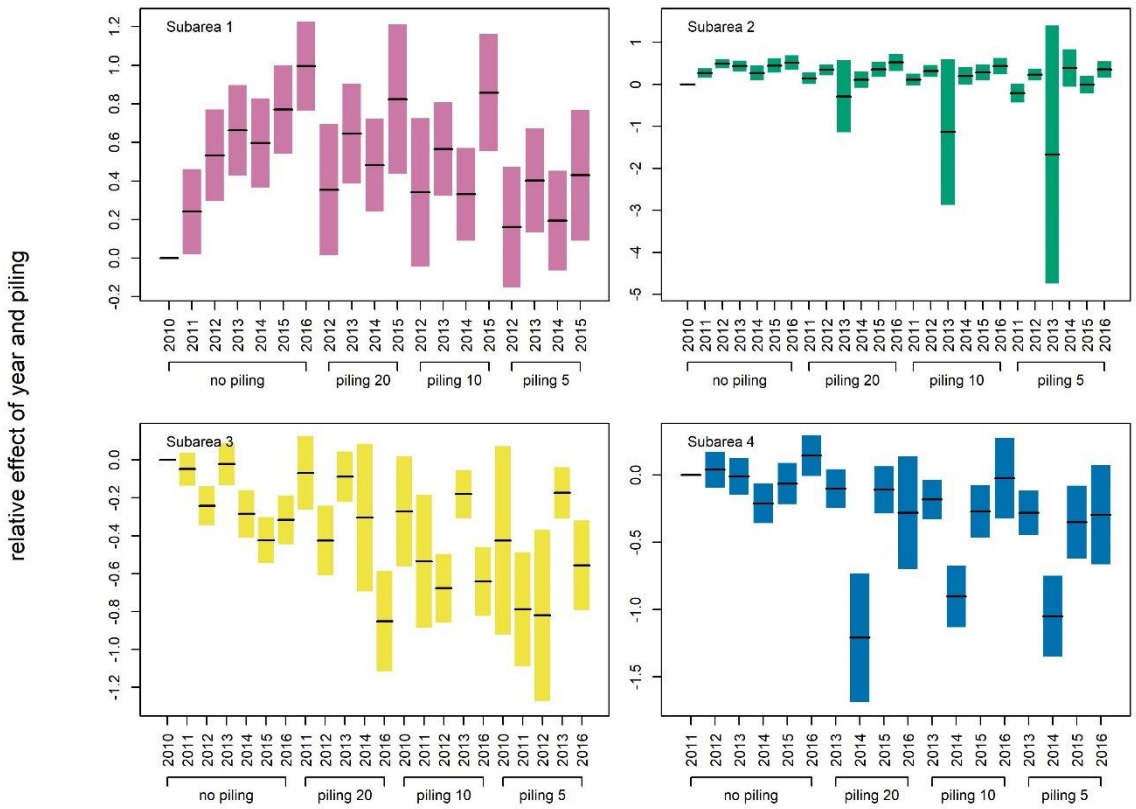


Figure A.136 Assessing possible habituation or sensitisation processes by comparing "long term trends" for days without and with piling in a 5, 5-10 and 10-20 km radius around POD stations.

Model-validation plots

Single station models

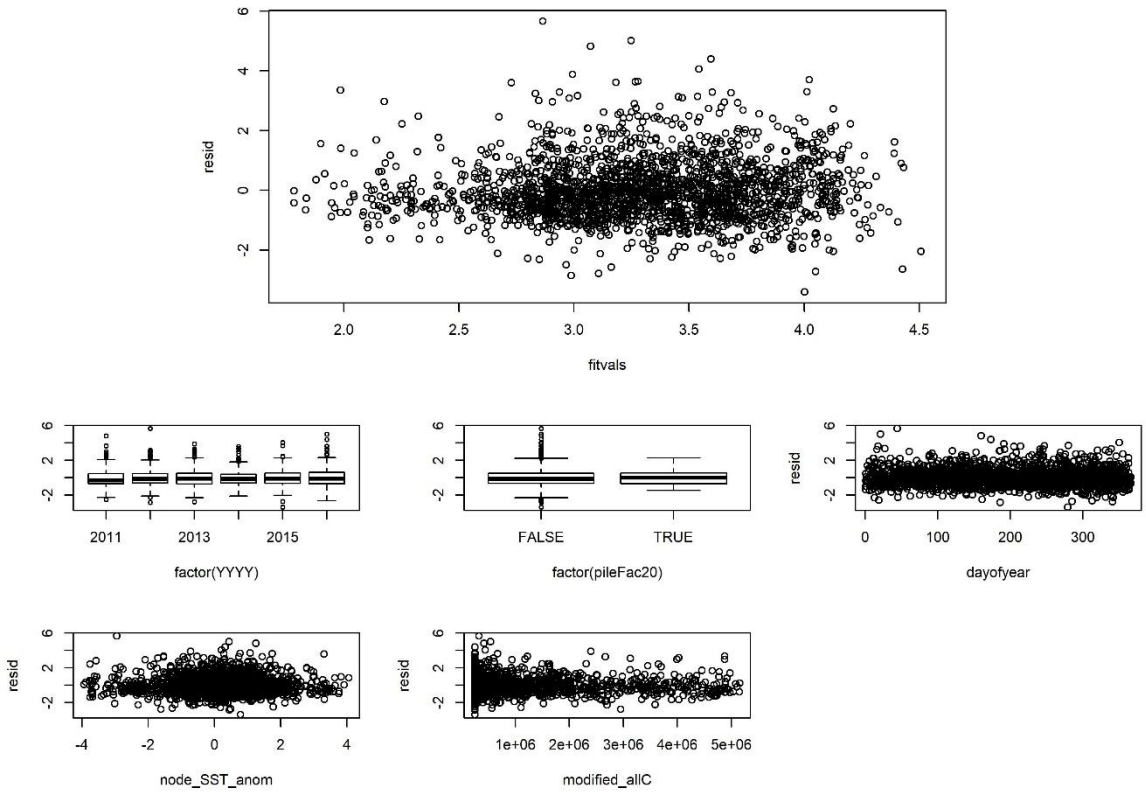


Figure A.137 Model validation of single station model for BU2.

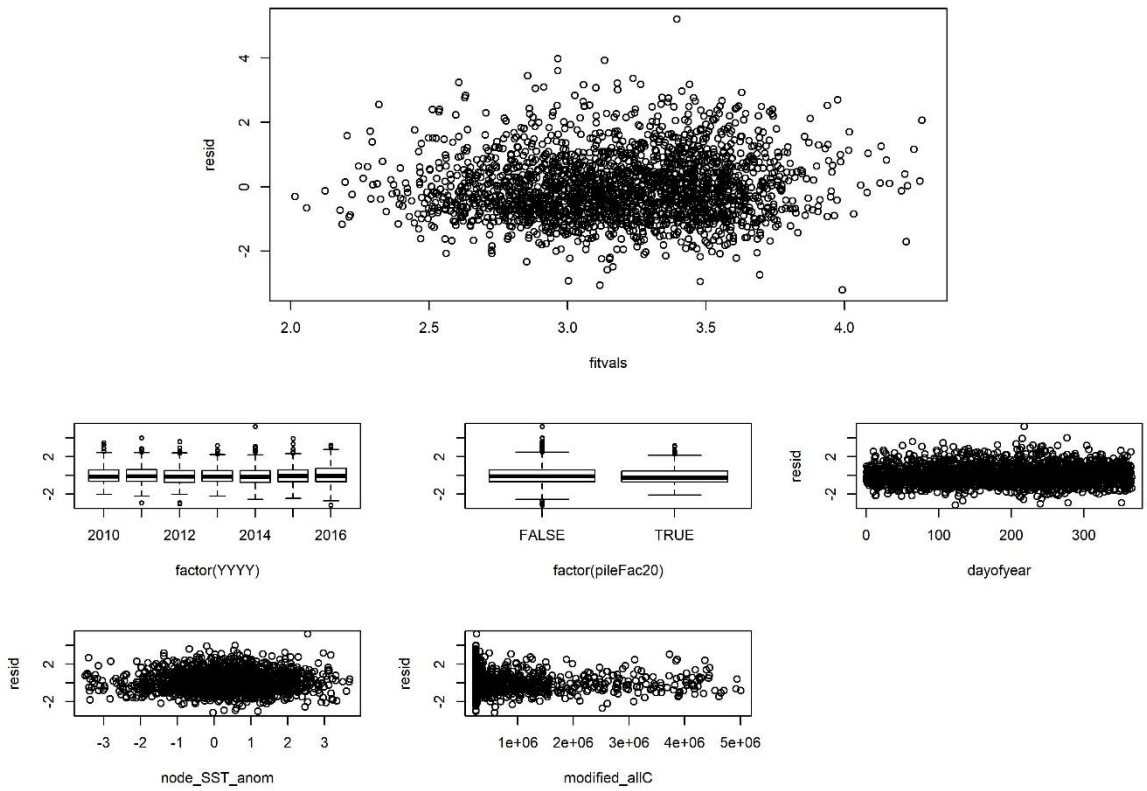


Figure A.138 Model validation of single station model for S10.

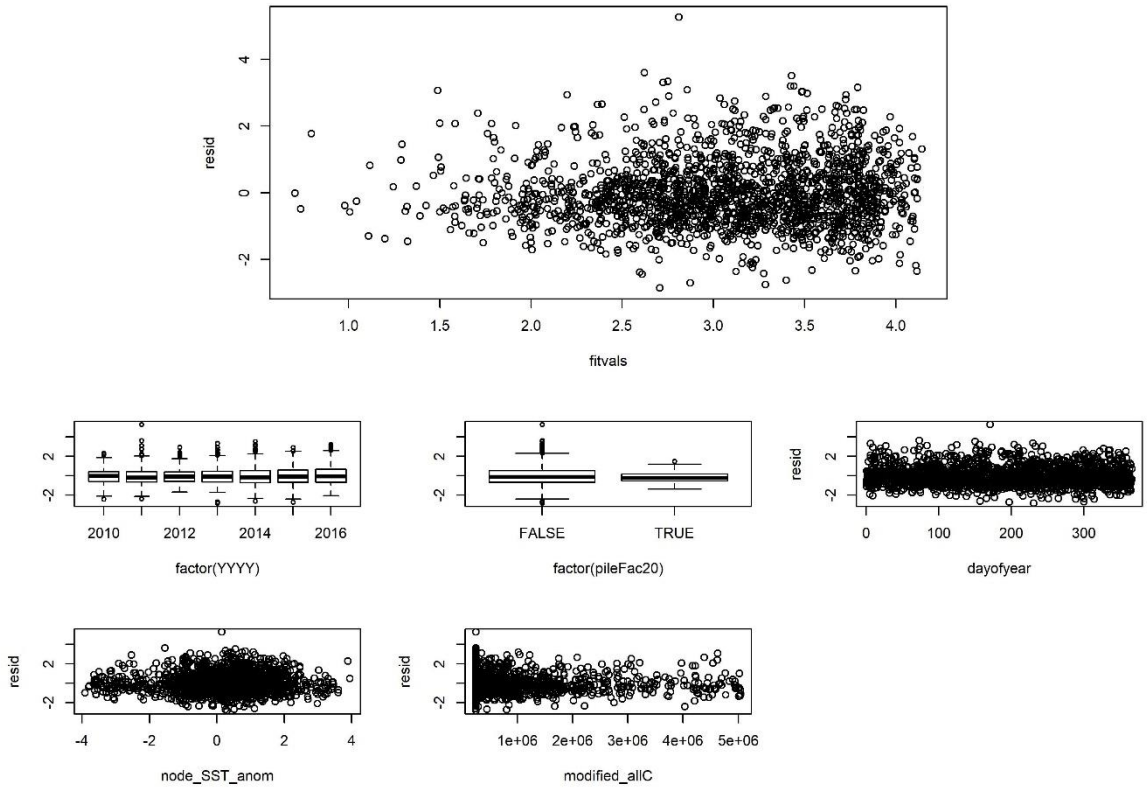


Figure A.139 Model validation of single station model for S13.

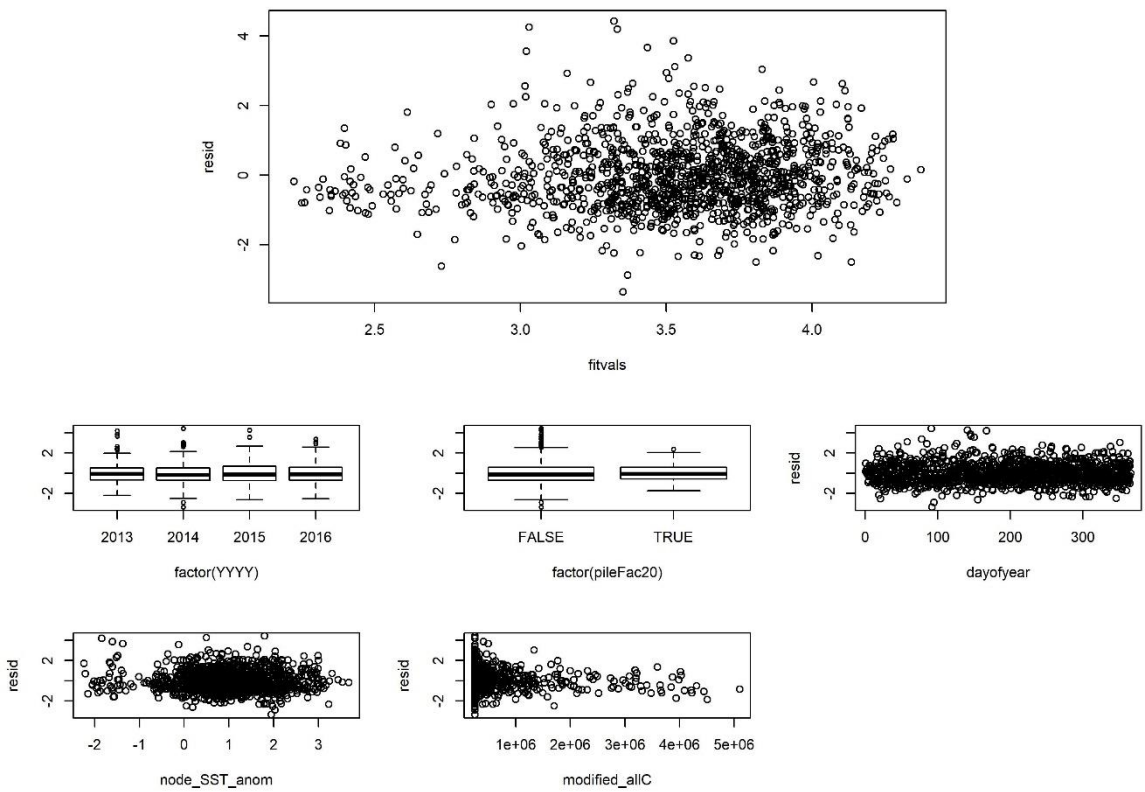


Figure A.140 Model validation of single station model for BR1.

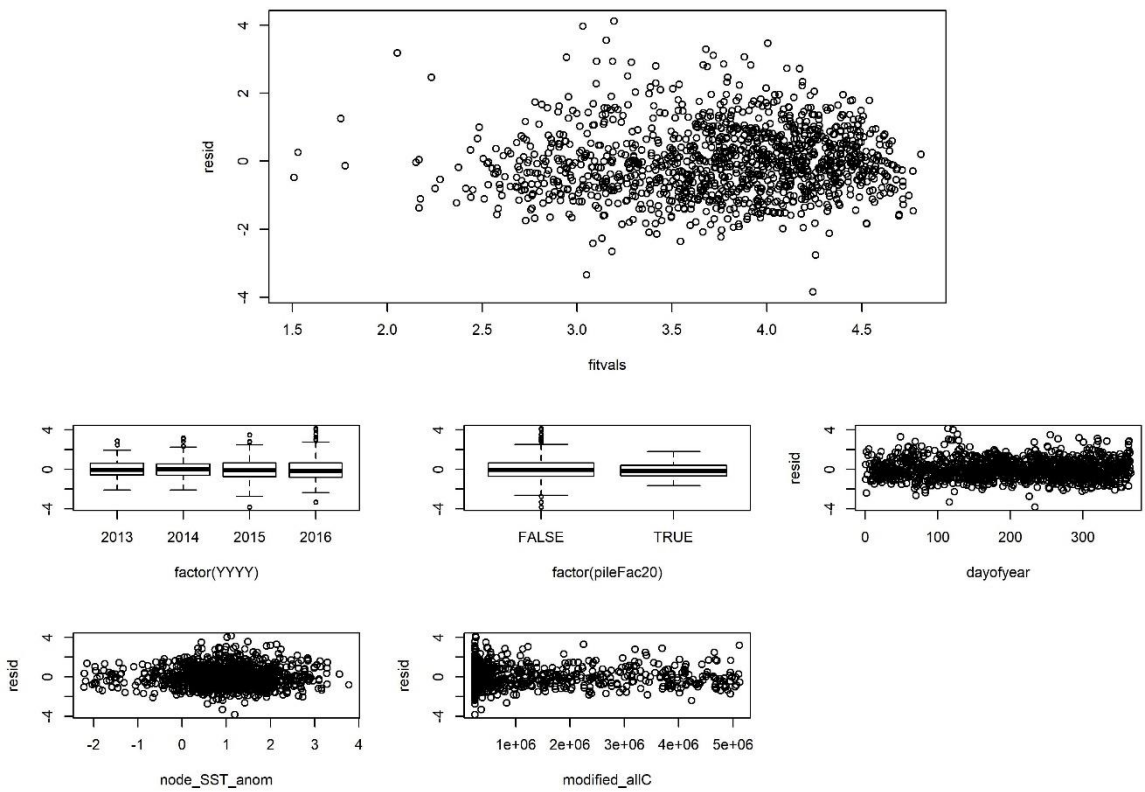


Figure A.141 Model validation of single station model for BR2.

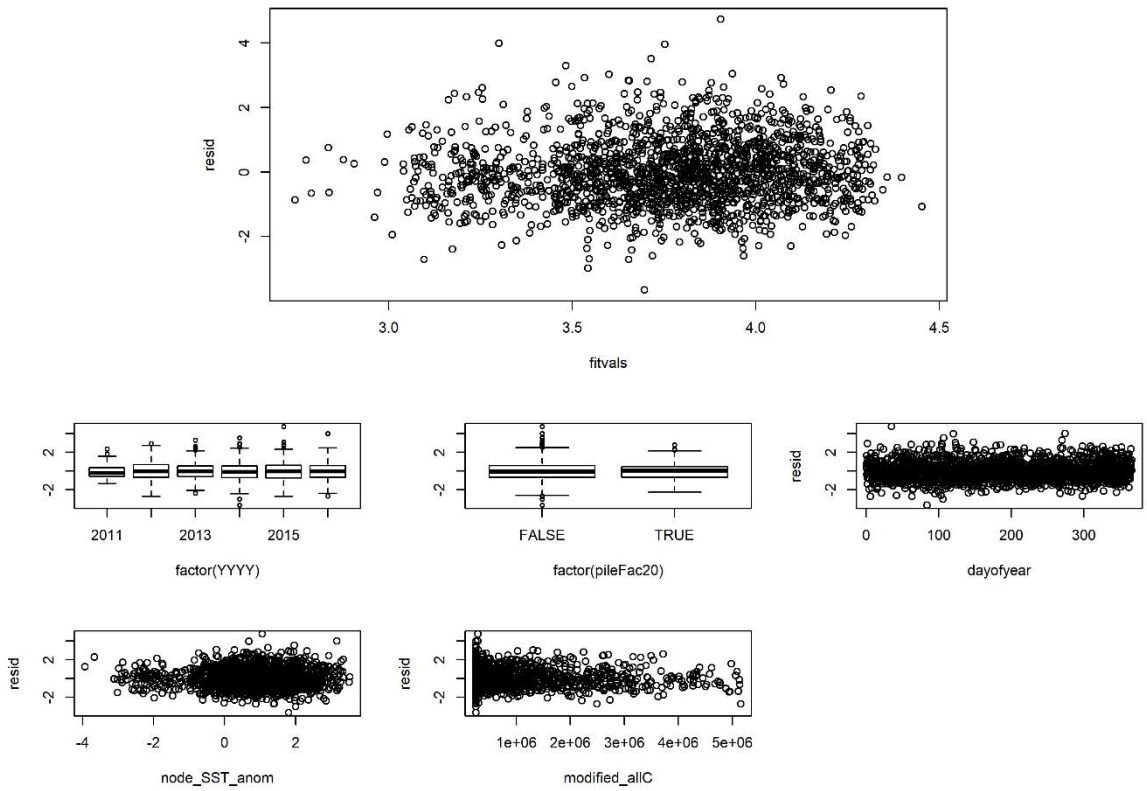


Figure A.142 Model validation of single station model for MEG1.

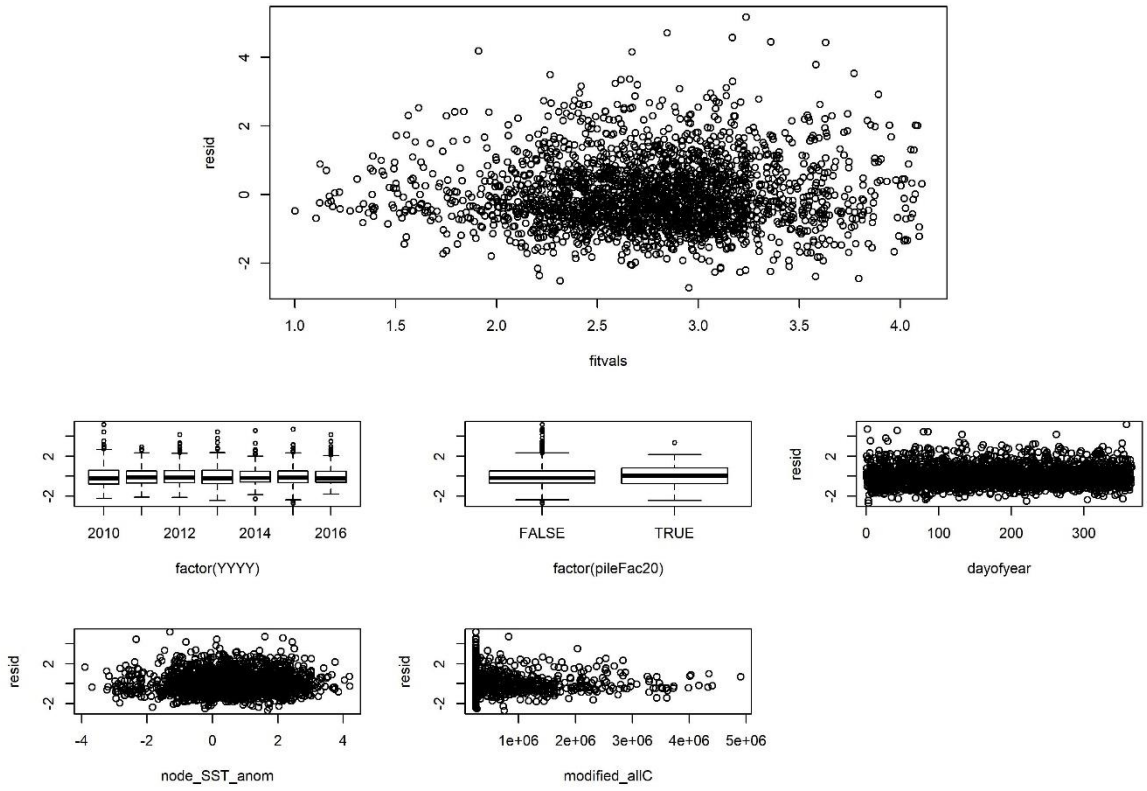


Figure A.143 Model validation of single station model for S4.

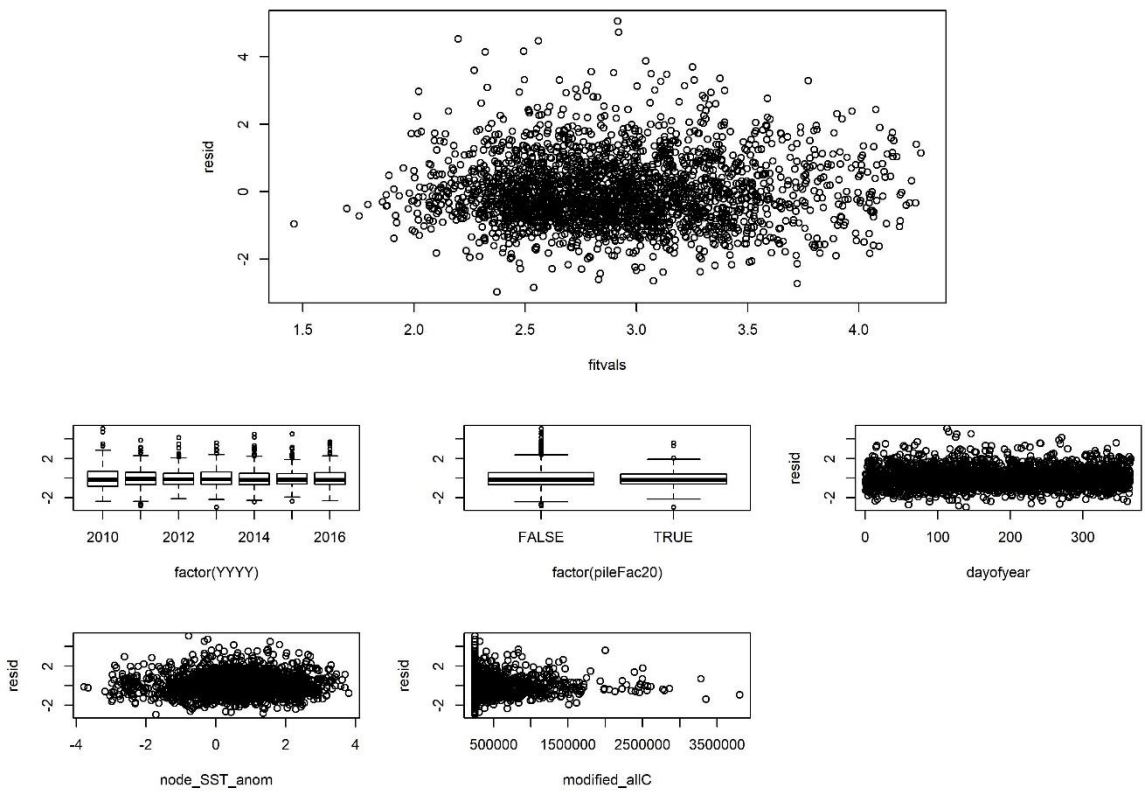


Figure A.144 Model validation of single station model for S8.

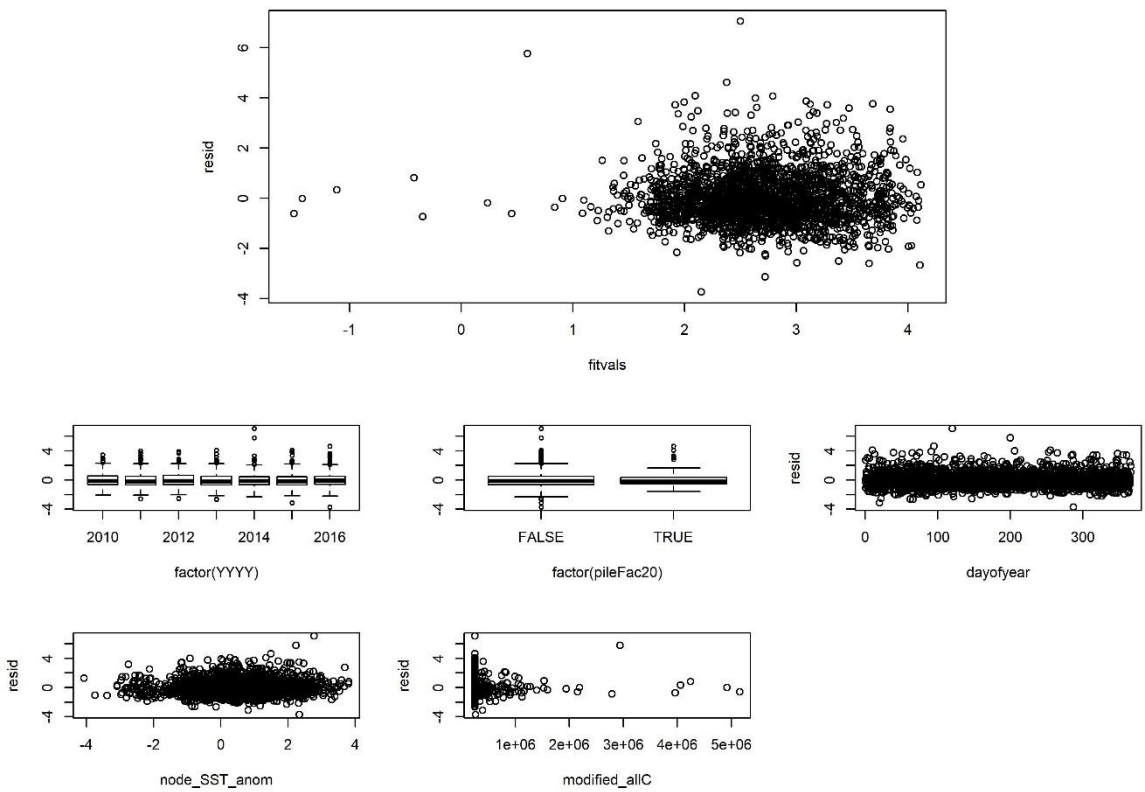


Figure A.145 Model validation of single station model for S3.

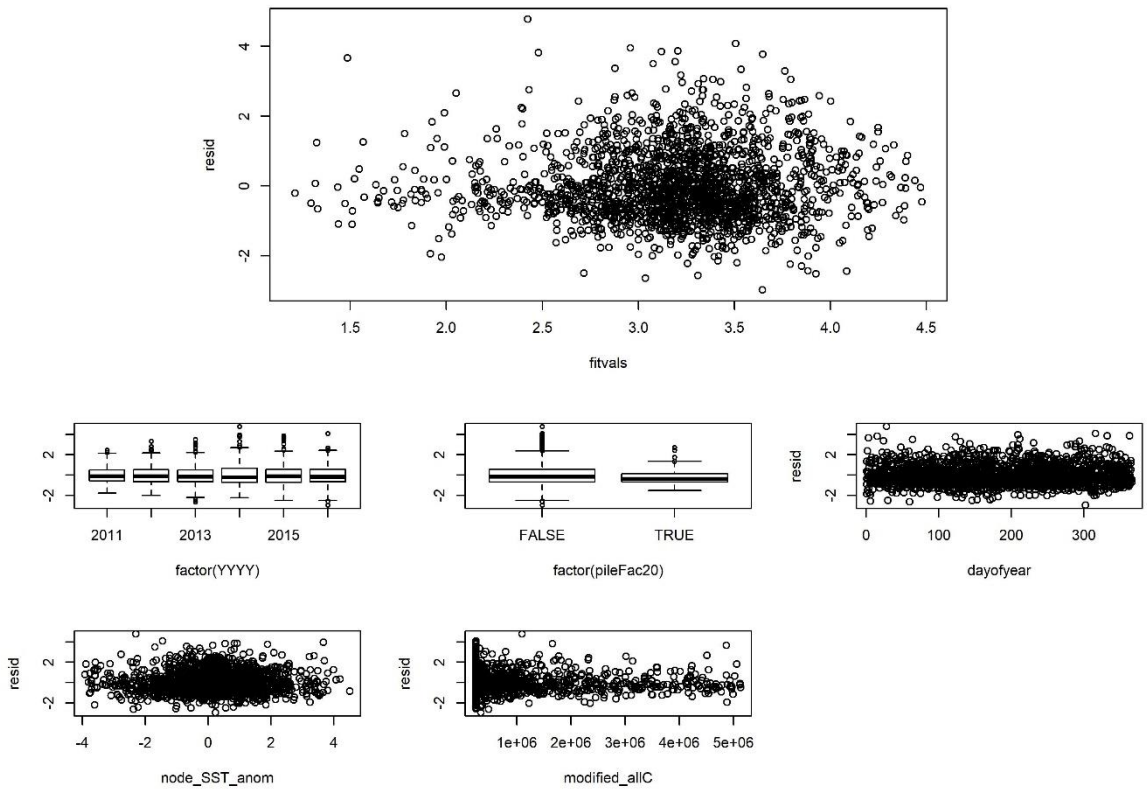


Figure A.146 Model validation of single station model for BU1.

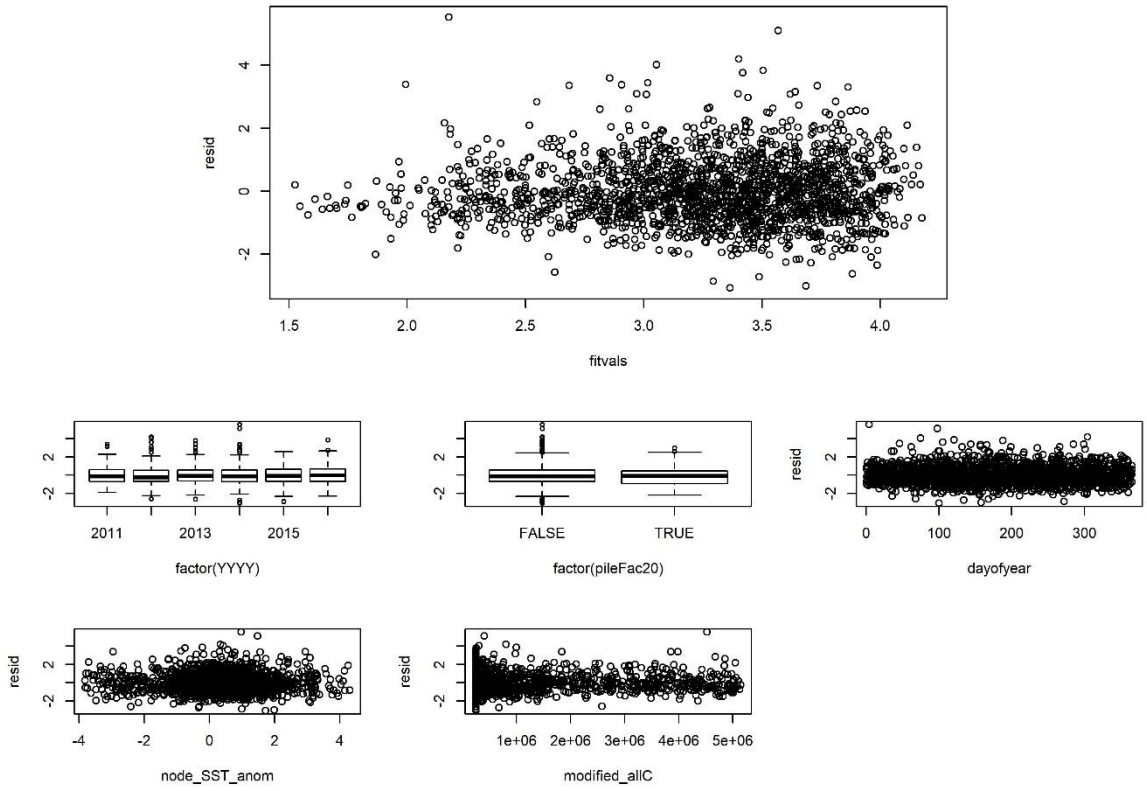


Figure A.147 Model validation of single station model for DT1.

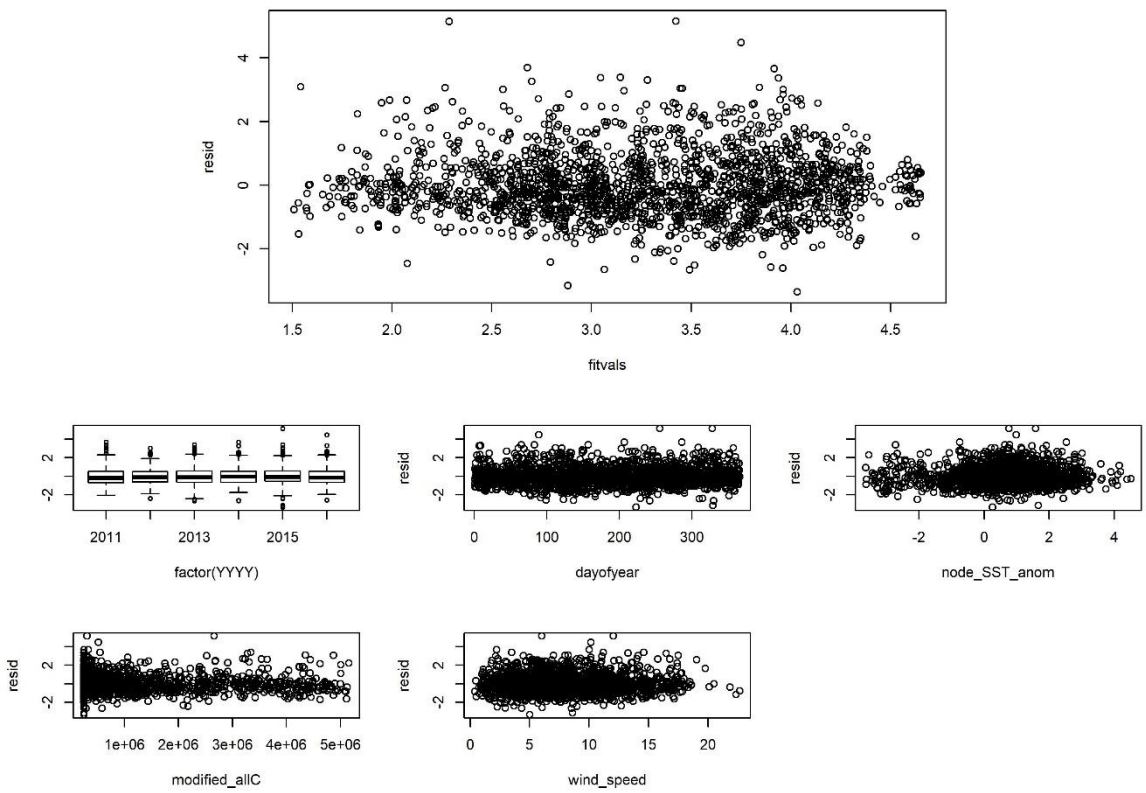


Figure A.148 Model validation of single station model for DT2.

Subarea models

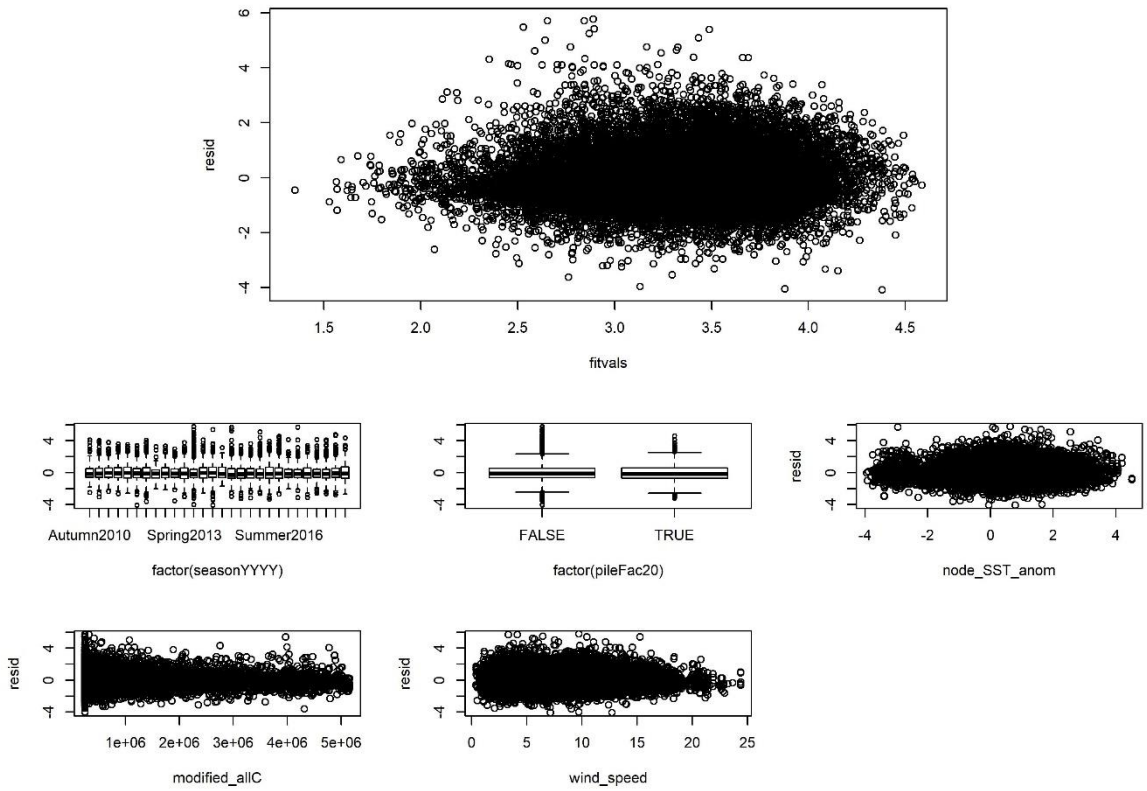


Figure A.149 Model validation of phenology model for subarea 1.

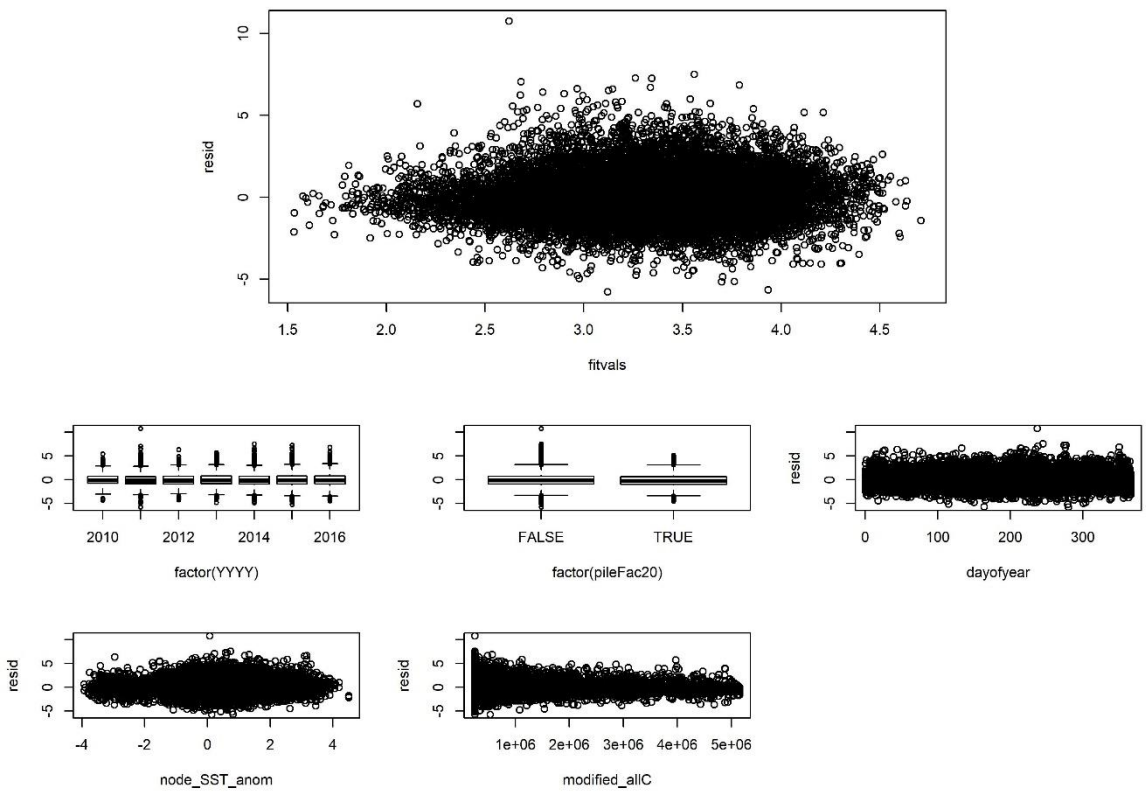


Figure A.150 Model validation of magnitude model for subarea 1.

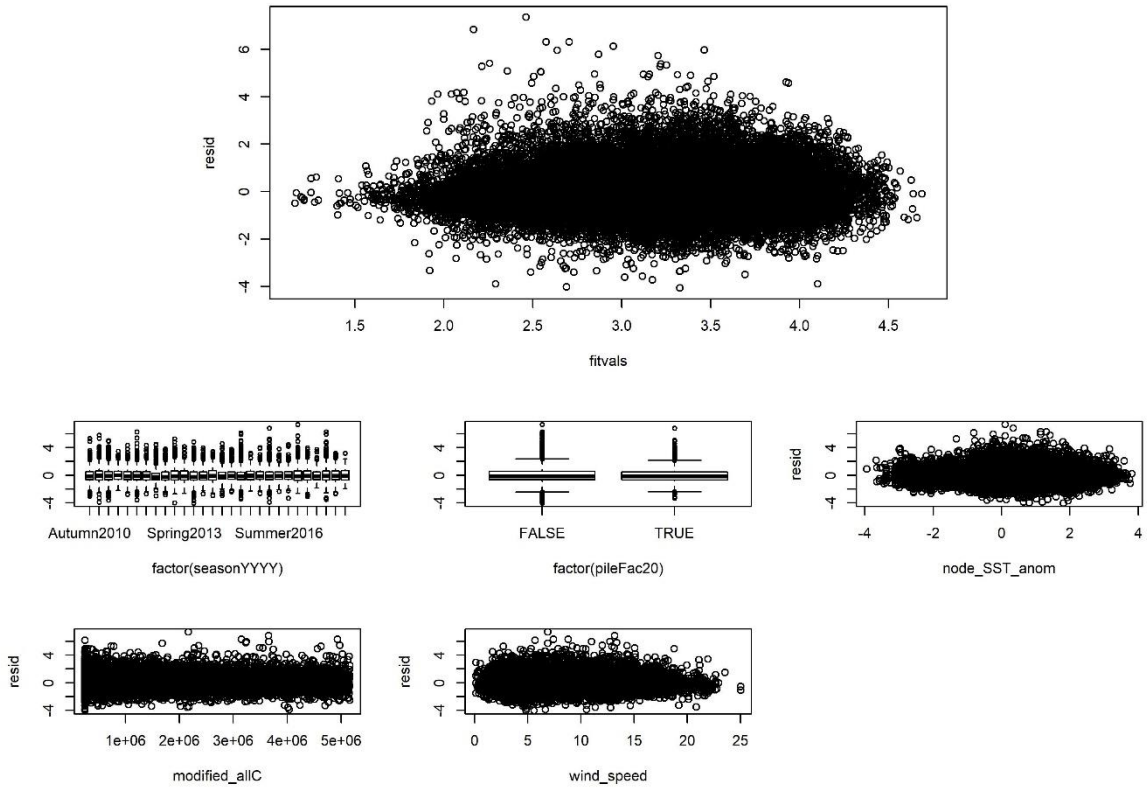


Figure A.151 Model validation of phenology model for subarea 2.

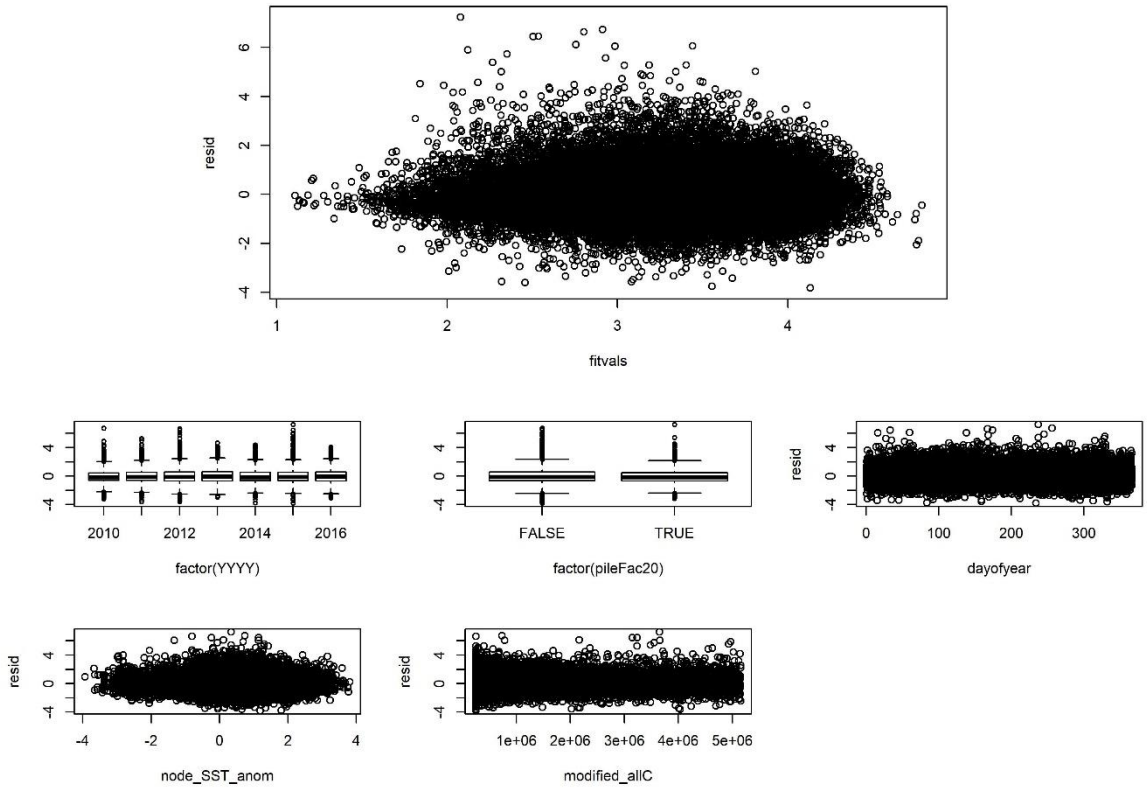


Figure A.152 Model validation of magnitude model for subarea 2.

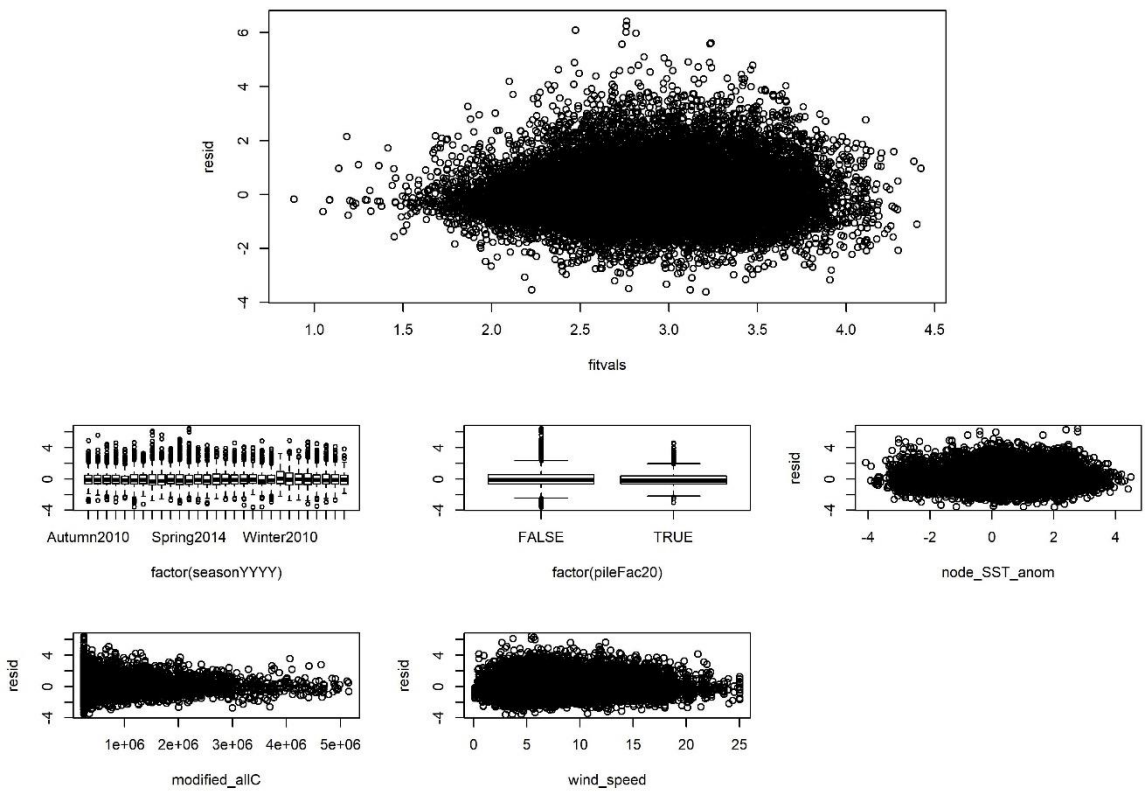


Figure A.153 Model validation of phenology model for subarea 3.

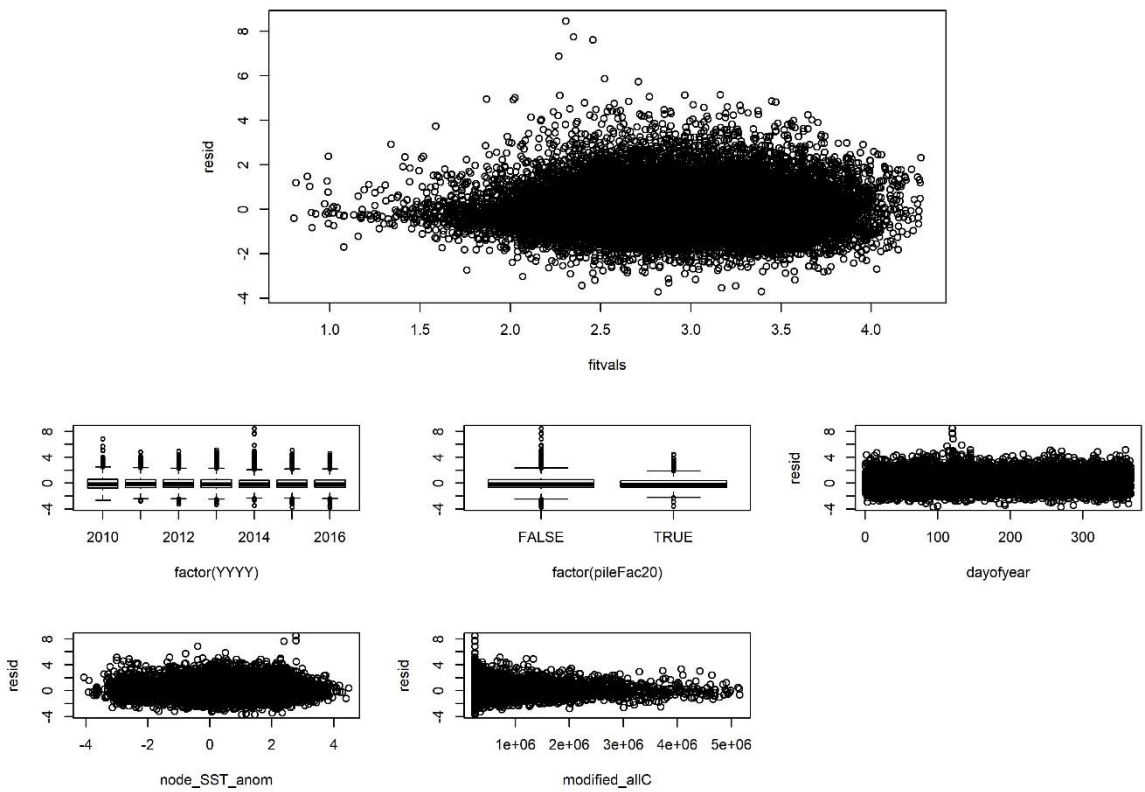


Figure A.154 Model validation of magnitude model for subarea 3.

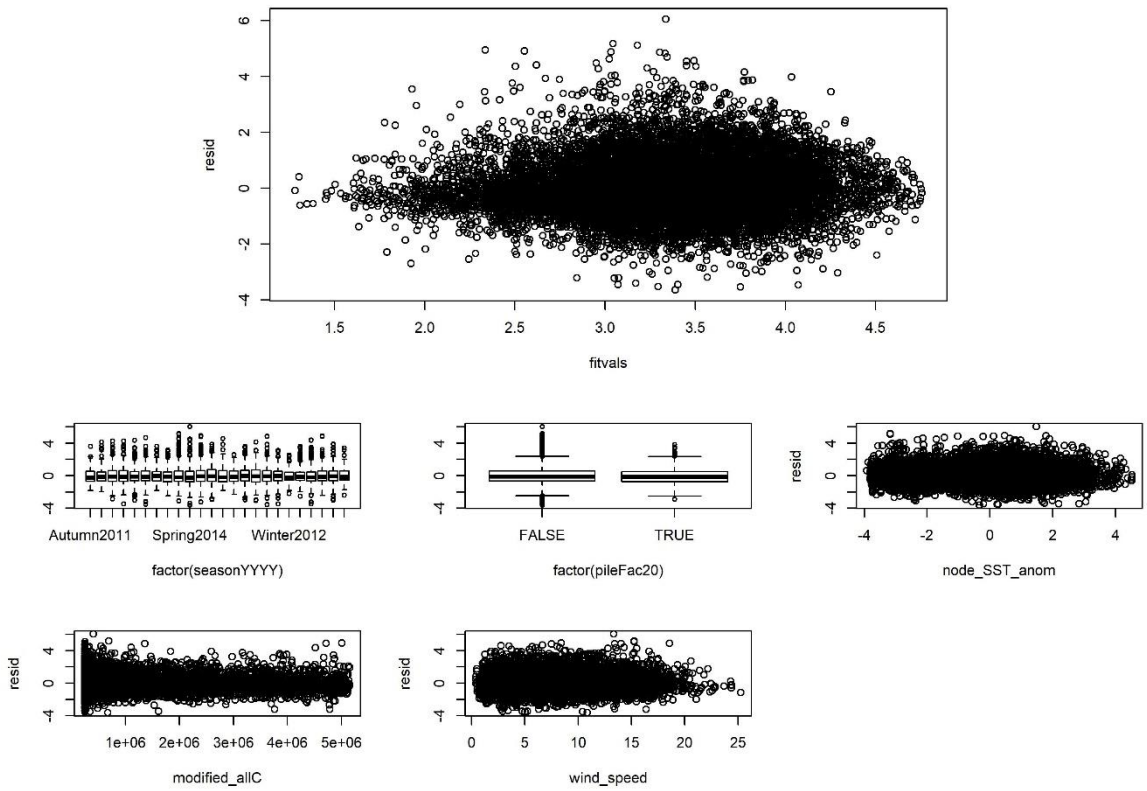


Figure A.155 Model validation of phenology model for subarea 4.

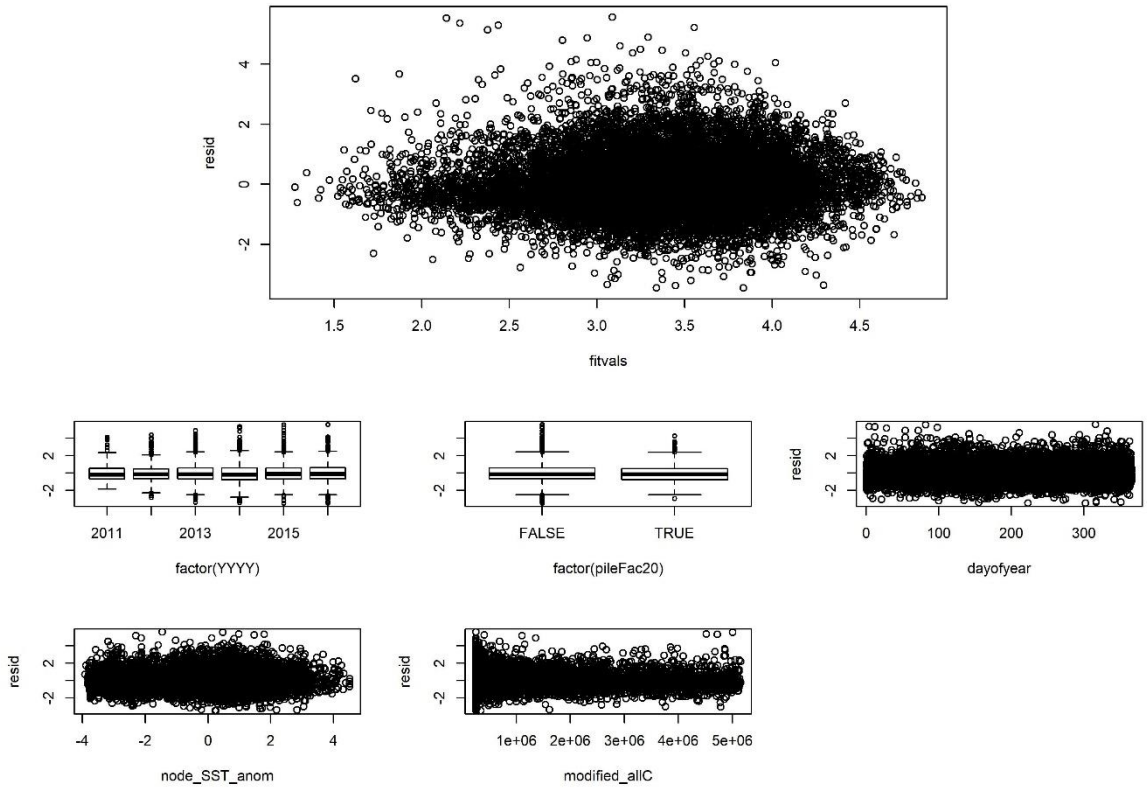


Figure A.156 Model validation of magnitude model for subarea 4.

German Bight model

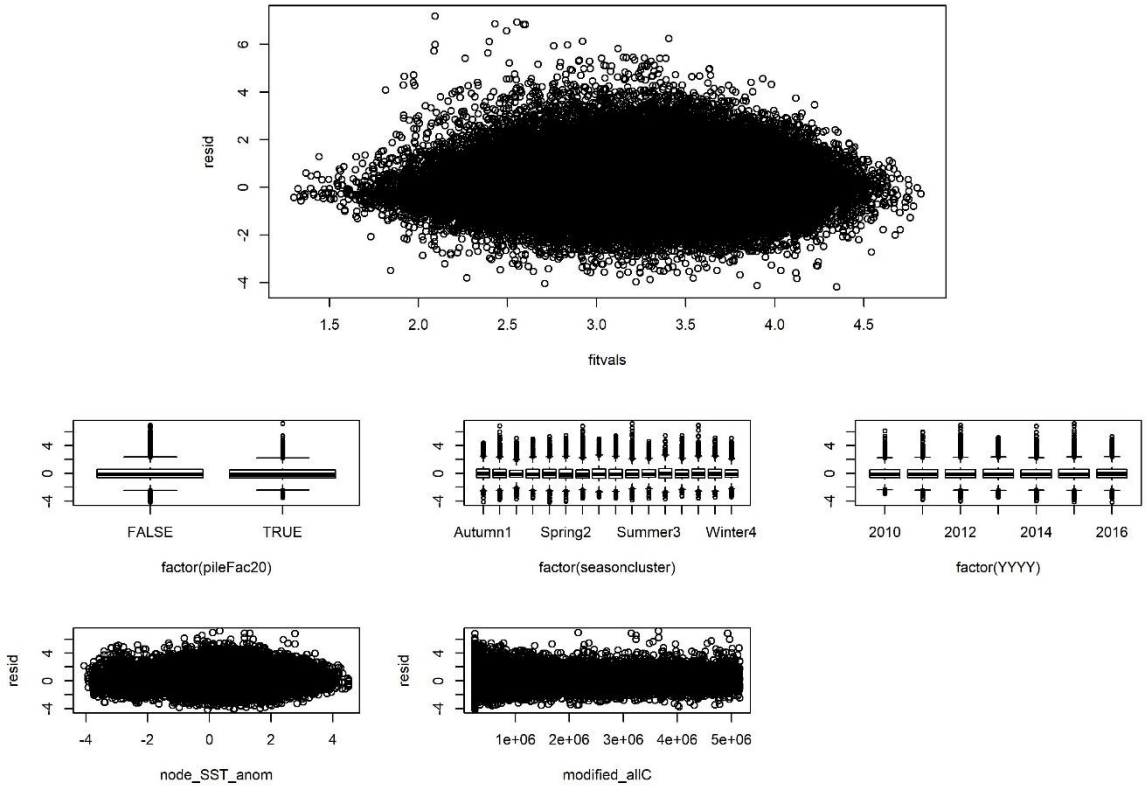


Figure A.157 Model validation of German Bight model.

Habituation models

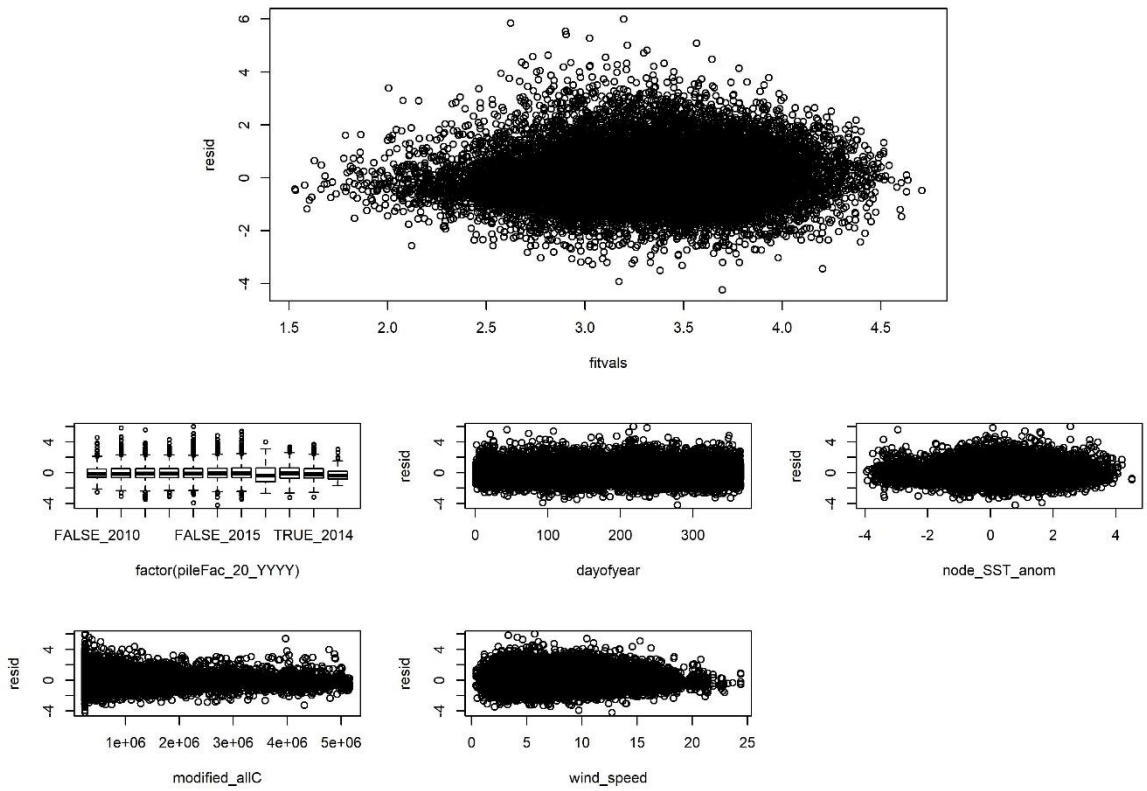


Figure A.158 Model validation of habituation model for subarea 1.

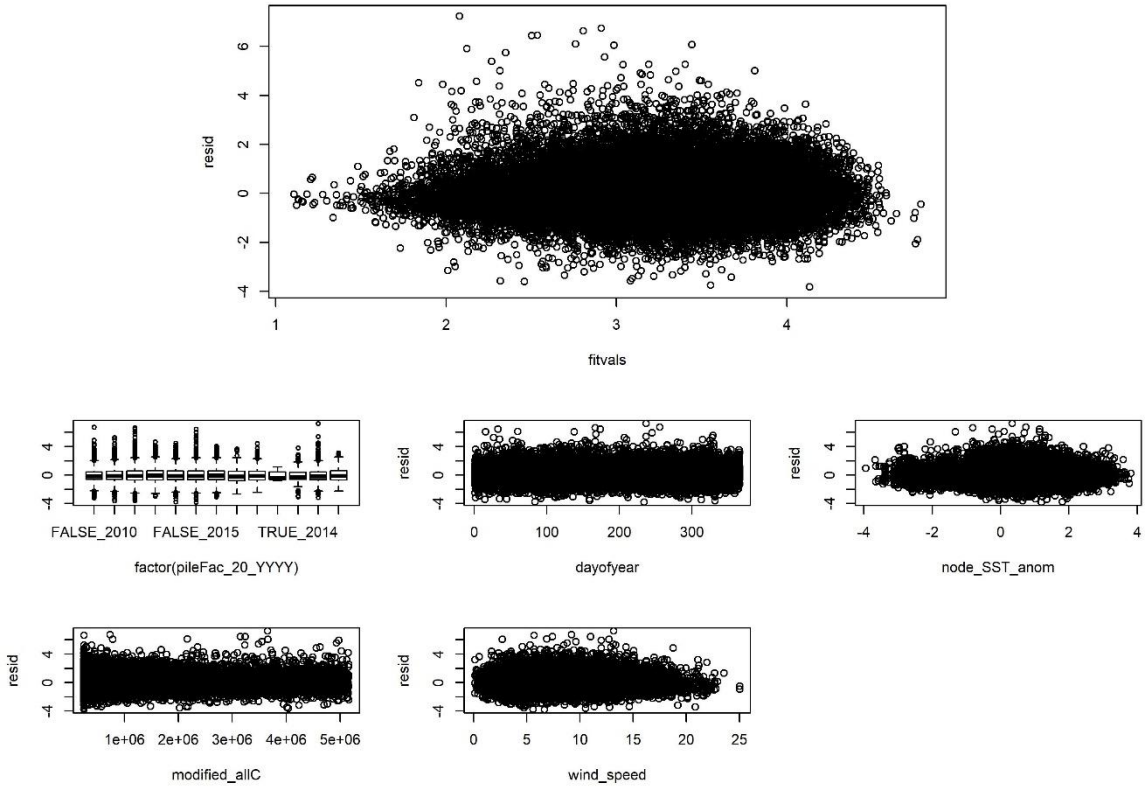


Figure A.159 Model validation of habituation model for subarea 2.

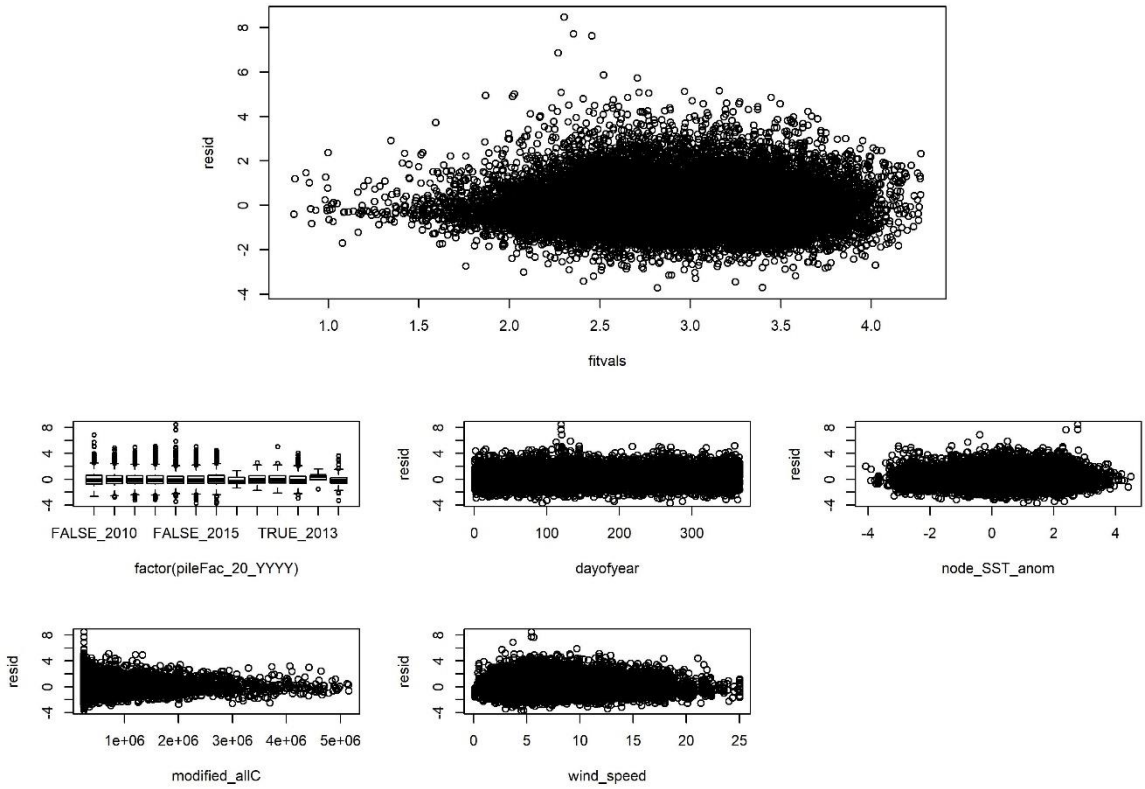


Figure A.160 Model validation of habituation model for subarea 3.

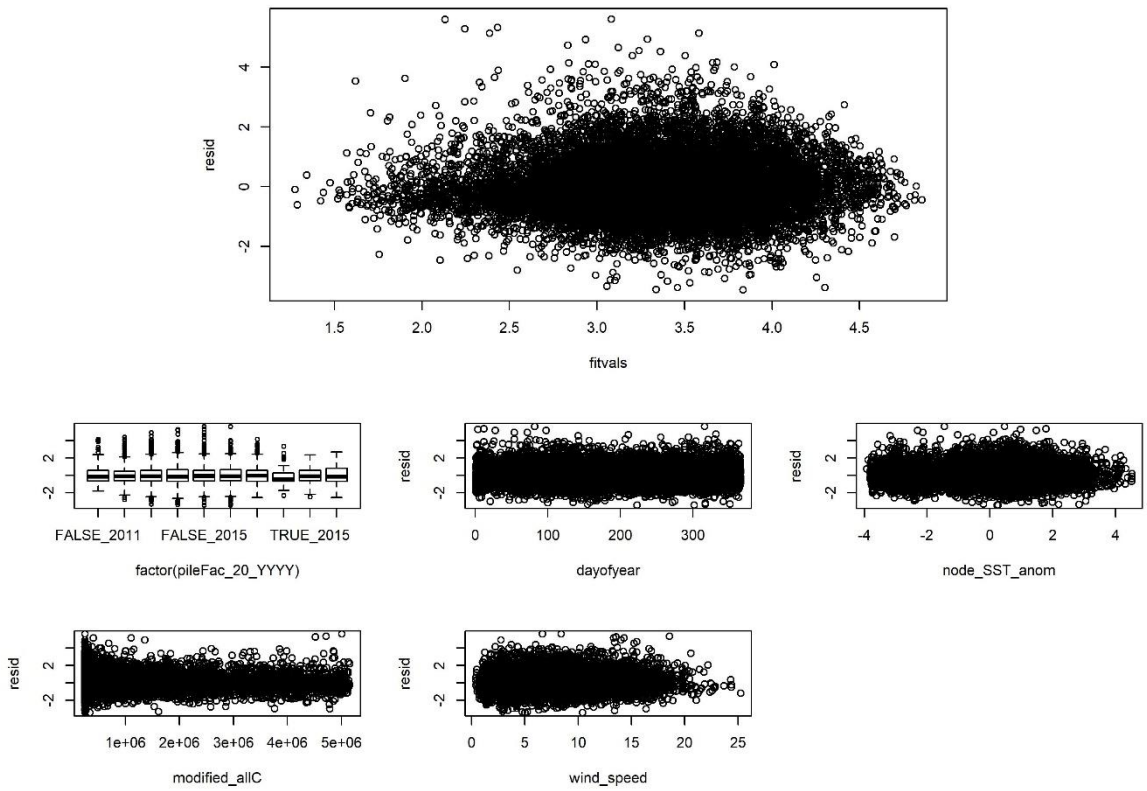


Figure A.161 Model validation of habituation model for subarea 4.

WP 5.1 – Population-level effects: Additional tables

Habituation models – finer scaled distance classes

*Table A.13 Parameters used in habituation models of Figure A.135. Significance codes: '***' p<0.001, '**' p<0.01, '*' p<0.05, '.' p<0.1, 'n.s.' p≥0.1. Terms for whom no significance estimates are available are marked n.a. and terms not included in the model are marked with '-'.*

variable name	variable type in model	purpose	subarea			
			1	2	3	4
data set			per subarea			
dp10m	response		n.a.	n.a.	n.a.	n.a.
day of year	cyclic smooth	yearly phenology	***	***	***	***

variable name	variable type in model	purpose	subarea			
			1	2	3	4
pile_10_20 year	factor	changes over time; comparing patterns with (0-10 and 10-20 km radius from monitoring station) and without piling	***	***	***	***
SSTA	smooth	effect of temperature anomalies	**	n.s.	*	***
all clicks	smooth	correct for technical biases	***	***	***	***
wind speed	smooth	effect of wind speed	***	***	***	***
station	random factor	effect of POD-location	n.a.	n.a.	n.a.	n.a.
POD ID	random factor nested in station	sensitivity differences between PODs	n.a.	n.a.	n.a.	n.a.
error distribution	quasi-Poisson		n.a.	n.a.	n.a.	n.a.
temporal autocorrelation	ARMA on day (p=1, q=0)	correct for temporal dependence between consecutive days	n.a.	n.a.	n.a.	n.a.
AIC		goodness of model fit	26270.47	40950.73	36972.48	19501.73
r-squared adjusted		coefficient of determination	0.223	0.179	0.24	0.241

variable name	variable type in model	purpose	subarea			
			1	2	3	4
number of data records		sample size	18093	26312	21332	13657

*Table A.14 Parameters used in habituation models of Figure A.136. Significance codes: '***' p<0.001, '**' p<0.01, '*' p<0.05, '.' p<0.1, 'n.s.' p≥0.1. Terms for whom no significance estimates are available are marked n.a. and terms not included in the model are marked with '-'.*

variable name	variable type in model	purpose	subarea			
			1	2	3	4
data set			per subarea			
dp10m	response		n.a.	n.a.	n.a.	n.a.
day of year	cyclic smooth	yearly phenology	***	***	***	***
Pile_5_10_20 year	factor	changes over time; comparing patterns with (0-5, 5-10 and 10-20 km radius from monitoring station) and without piling	***	***	***	***
SSTA	smooth	effect of temperature anomalies	**	n.s.	*	***
all clicks	smooth	correct for technical biases	***	***	***	***
wind speed	smooth	effect of wind speed	***	***	***	***

variable name	variable type in model	purpose	subarea			
			1	2	3	4
station	random factor	effect of POD-location	n.a.	n.a.	n.a.	n.a.
POD ID	random factor nested in station	sensitivity differences between PODs	n.a.	n.a.	n.a.	n.a.
error distribution	quasi-Poisson		n.a.	n.a.	n.a.	n.a.
temporal autocorrelation	ARMA on day (p=1, q=0)	correct for temporal dependence between consecutive days	n.a.	n.a.	n.a.	n.a.
AIC		goodness of model fit	26258.04	40923.89	36978.9	19505.84
r-squared adjusted		coefficient of determination	0.223	0.18	0.24	0.241
number of data records		sample size	18093	26312	21332	13657