

Supplementary Material:  
 Spatial analysis of health effects of large industrial incinerators in  
 England, 1998-2008: a study using matched case-control areas  
 Model 2 Residuals

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This document presents an investigation of the residuals from Model 2, for all health outcomes with reported parameter estimates. Parameter estimates are not reported for Non-Hodgkins lymphoma incidence and liver cancer mortality as they had very large standard errors, or for liver cancer incidence as the likelihood function was flat and parameter estimates were unstable.

We apply the diagnostic test for residual spatial correlation used by Fanshawe et al. (2008), comparing the sample correlation of the distances between LSOA centroids and the squared differences between their residuals to that obtained by repeated random assignment of residuals. Correlations and corresponding P-values are given in Table 1.

Health Outcome	Correlation	P Value
Childhood Cancer Incidence	0.02	0.02
Childhood Leukaemia Incidence	0.01	0.61
Leukaemia Incidence	-0.01	0.14
Lung Cancer Incidence	0.05	0.00
All Cause Mortality	0.00	0.97
Infant Mortality	-0.02	0.01

Table 1: Correlation between spatial proximity and value of residual. P value calculated by repeated random re-assignment of residuals.

Maps of the case circles showing the LSOAs they contain, coloured by the value of the corresponding residuals allow a visual impression of any spatial pattern. Maps are given for each case circle and for each health outcome (Figures 1 to 6).

We examine whether there is any trend in the residuals with respect to distance from the incinerator. The residual values for all case circles against distance are given in Figure 7, separately for each health outcome. Also shown is the Lowess smooth (Cleveland, 1979) of these values. Separate Lowess smooths of the residuals for each case circle and health outcome are shown in Figure 8.

We also examine whether there is any trend in the residuals with respect to direction from the incinerator (Figure 9). The residual value for each LSOA in all case circles is plotted at the angle corresponding to the angle from the incinerator. The distance of each point from the centre point in this figure represents the magnitude of the residual (**not** distance to the incinerator). Also shown is the Friedman's smooth (Friedman, 1984) of these values. Separate Friedman's smooths of the residuals for each case circle and health outcome are shown in Figure 10.

## References

- Cleveland, W. (1979). Robust locally weighted regression and smoothing scatterplots. *Journal of the American statistical association*, 74(368):829–836.
- Fanshawe, T., Diggle, P., Rushton, S., Sanderson, R., Lurz, P., Glinianaia, S., Pearce, M., Parker, L., Charlton, M., and Pless-Mulloli, T. (2008). Modelling spatio-temporal variation in exposure to particulate matter: a two-stage approach. *Environmetrics*, 19(6):549–566.
- Friedman, J. (1984). A variable span smoother. Technical Report 5, Laboratory for Computational Statistics, Stanford University.

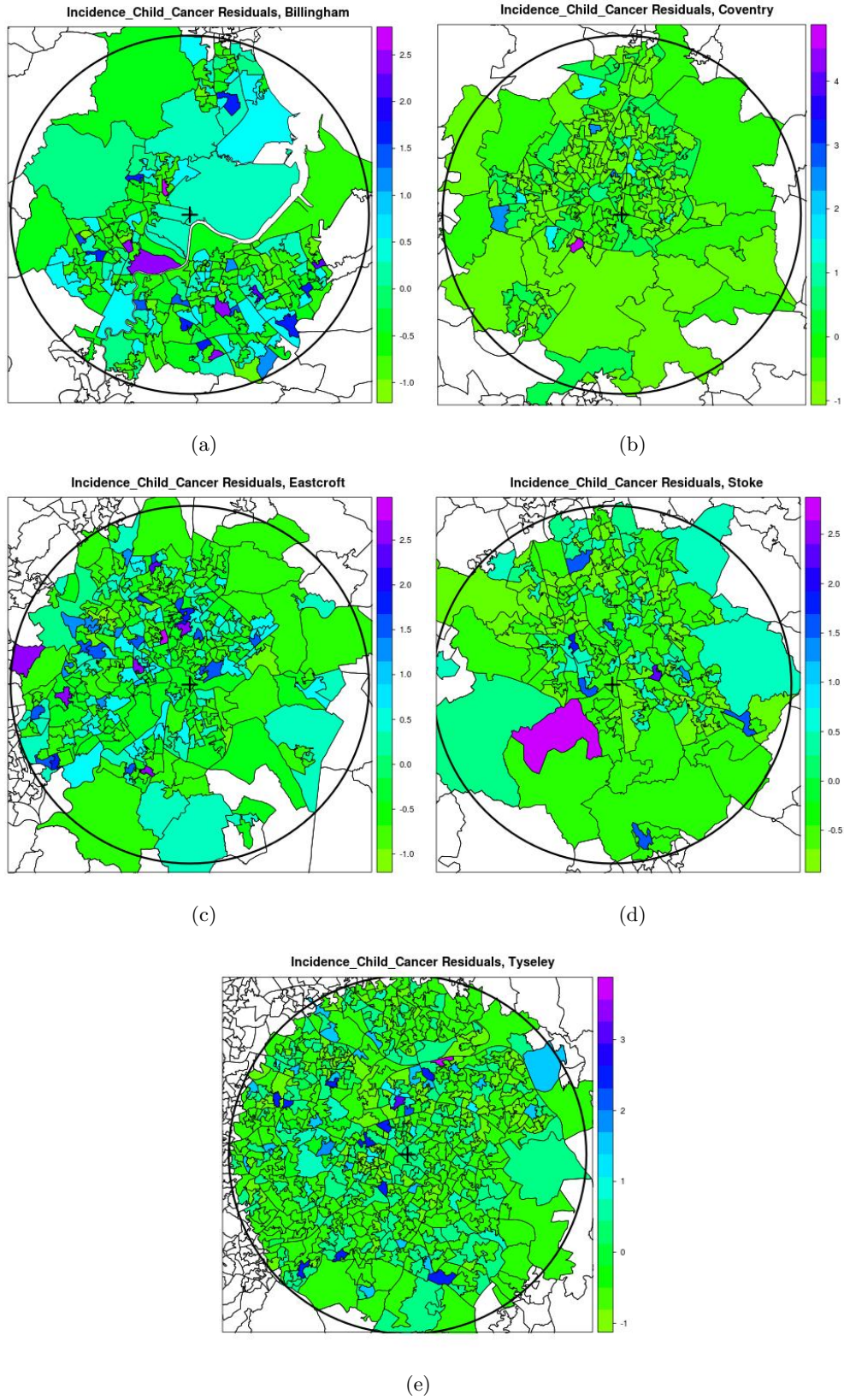


Figure 1: Map of each case circle, with LSOAs coloured by residual value for childhood cancer incidence

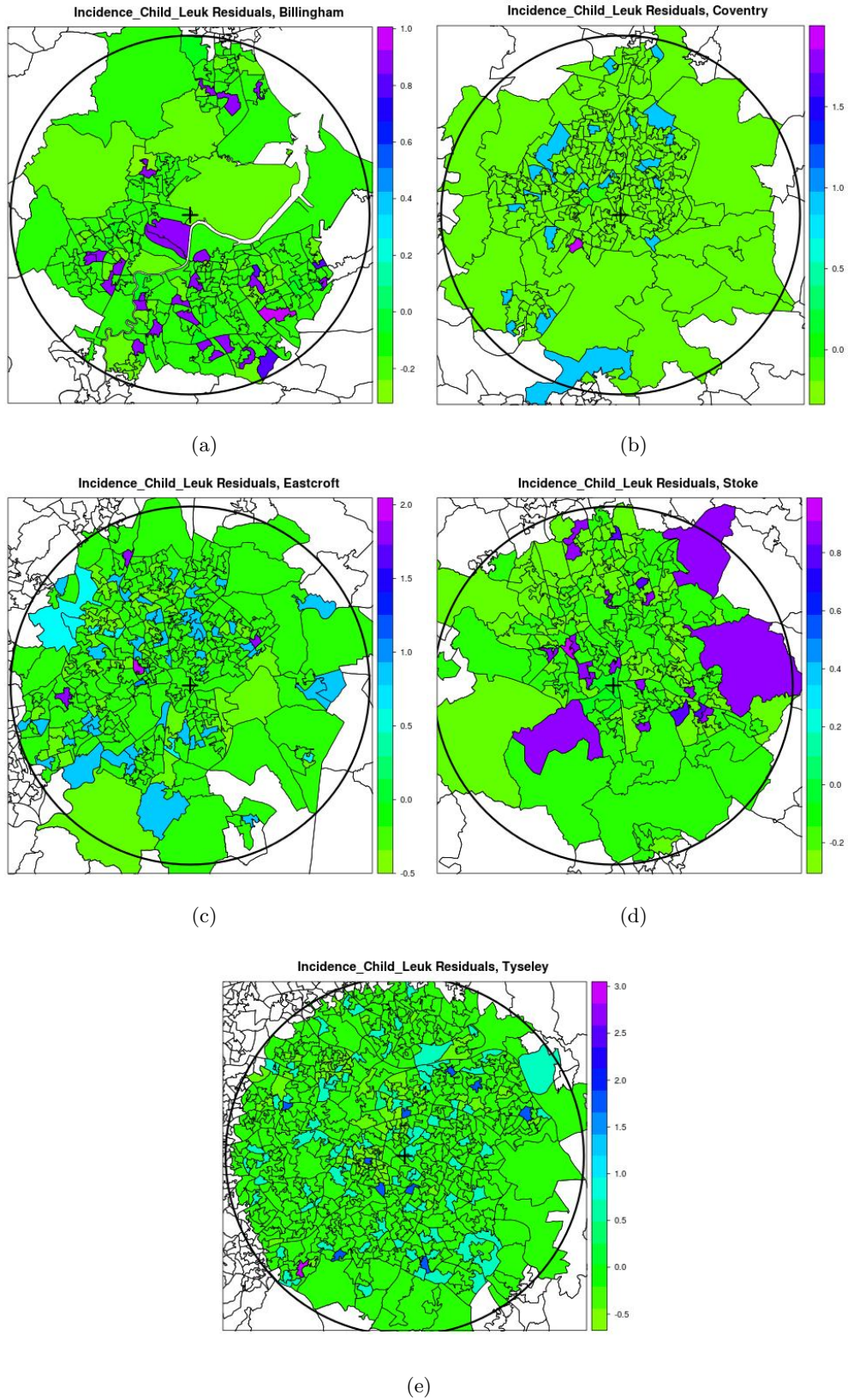


Figure 2: Map of each case circle, with LSOAs coloured by residual value for childhood leukaemia incidence

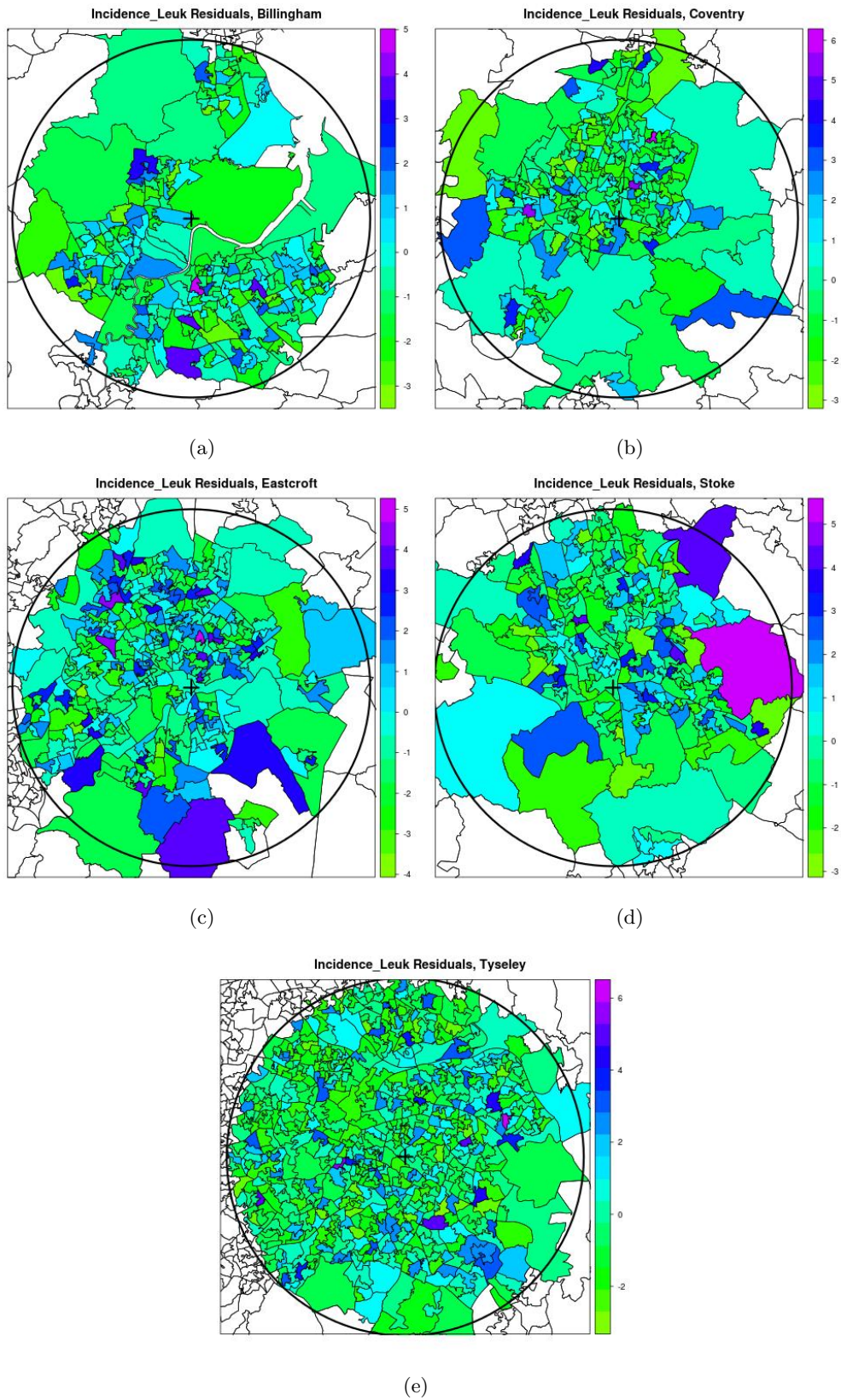


Figure 3: Map of each case circle, with LSOAs coloured by residual value for leukaemia incidence

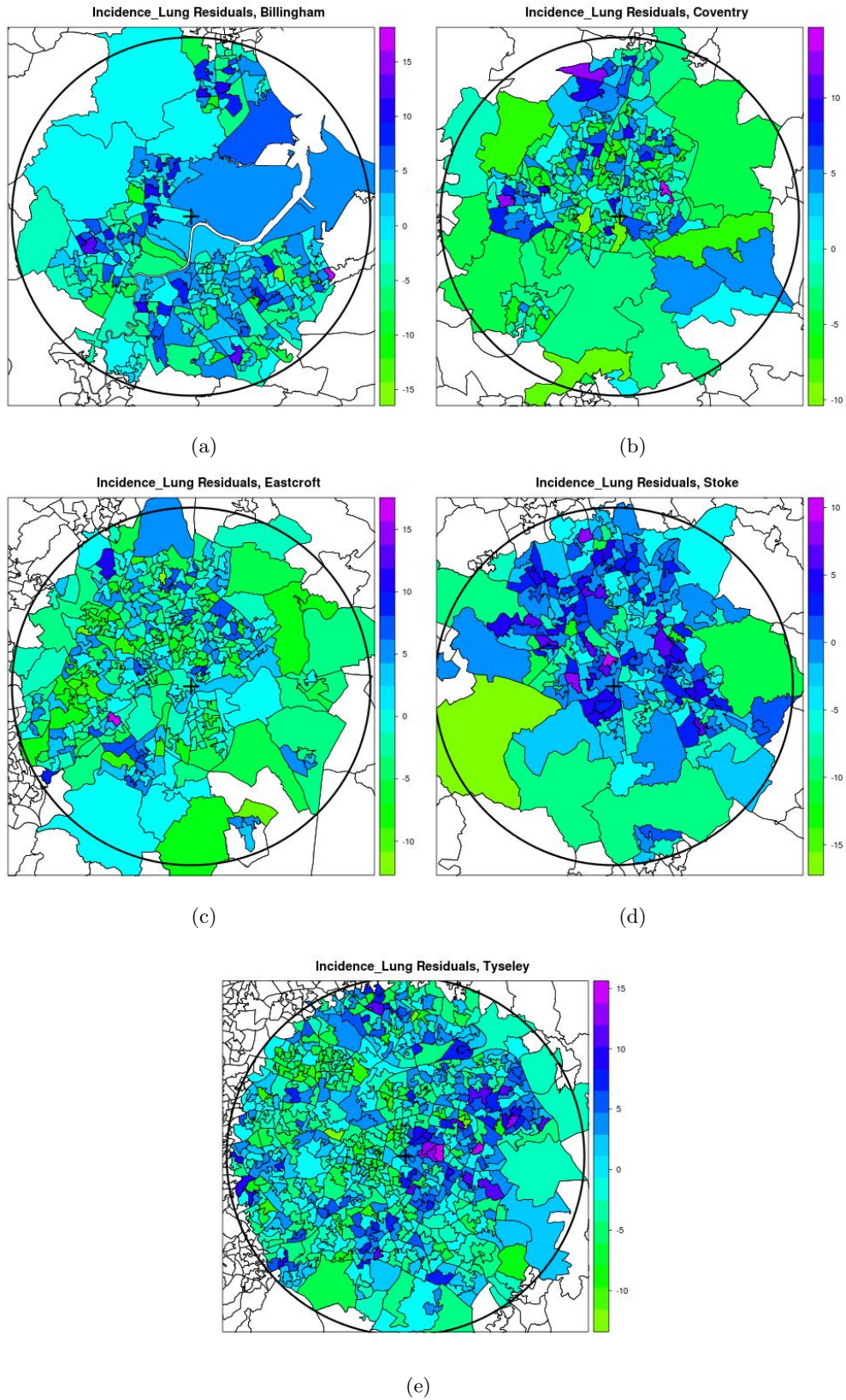


Figure 4: Map of each case circle, with LSOAs coloured by residual value for lung cancer incidence

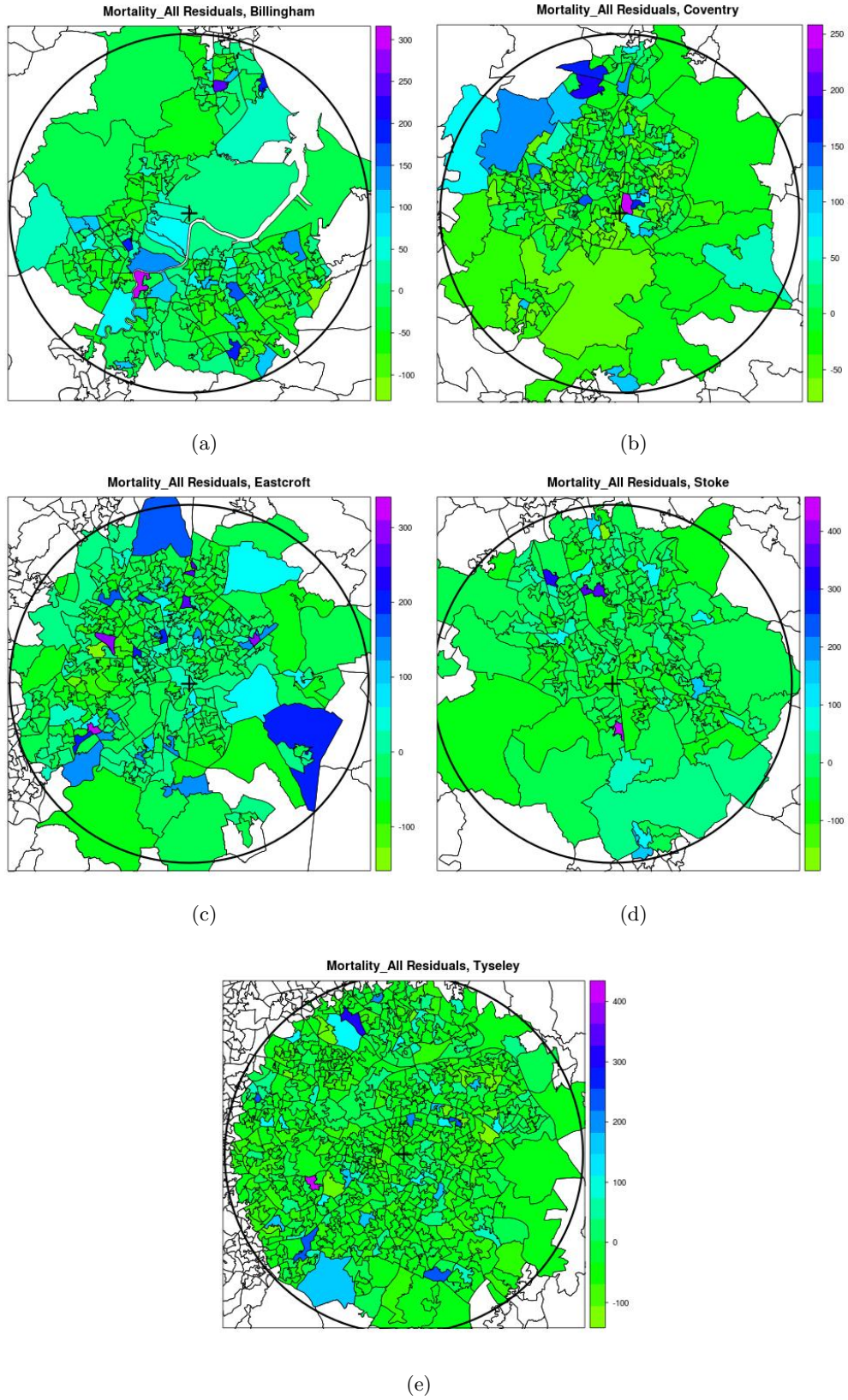


Figure 5: Map of each case circle, with LSOAs coloured by residual value for all cause mortality

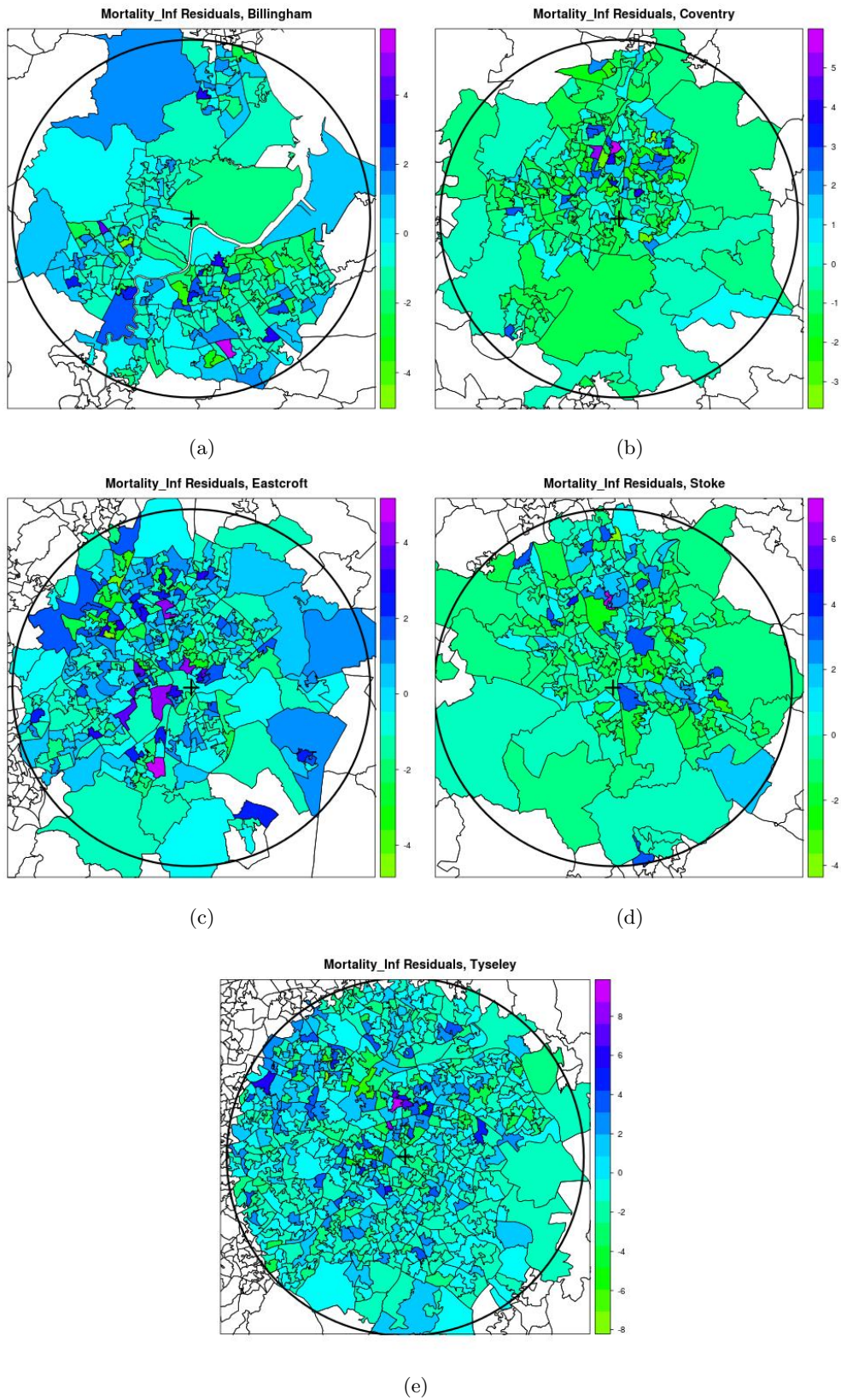
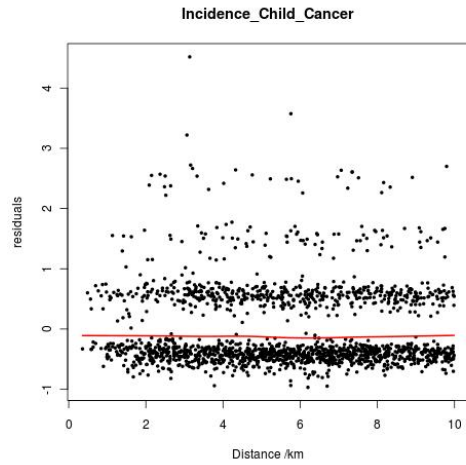
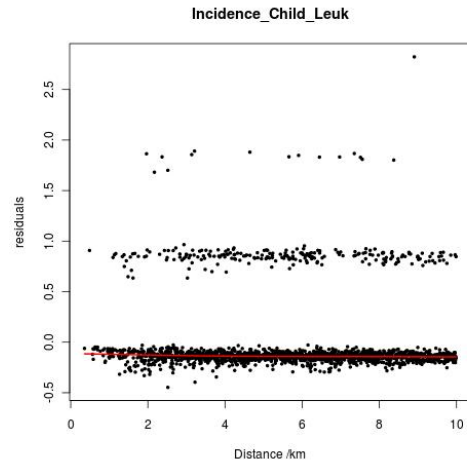


Figure 6: Map of each case circle, with LSOAs coloured by residual value for infant mortality

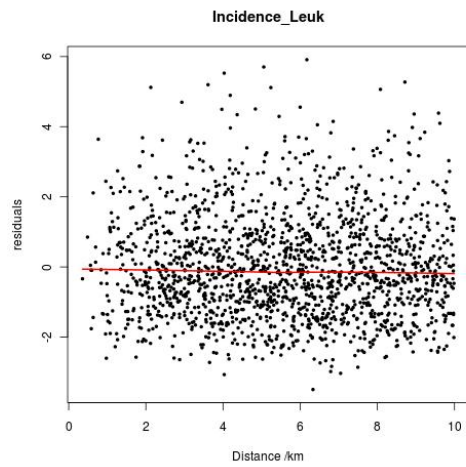




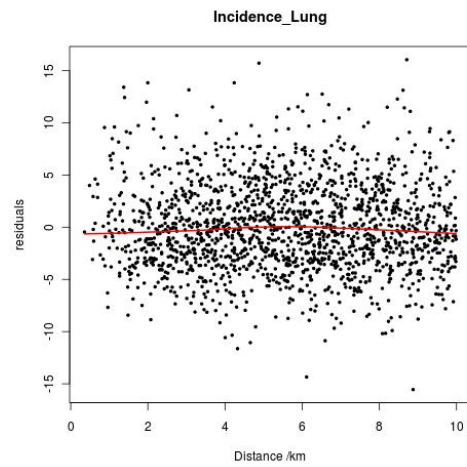
(a) Childhood cancer incidence



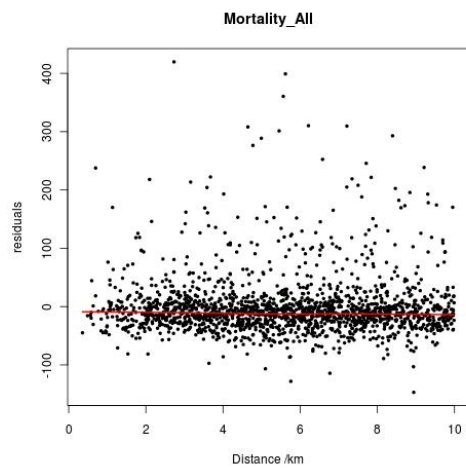
(b) Childhood leukaemia incidence



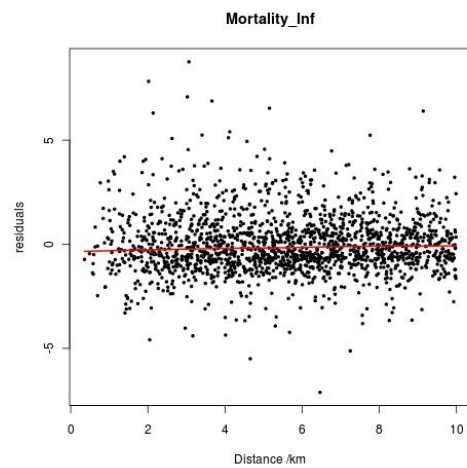
(c) Leukaemia incidence



(d) Lung cancer incidence

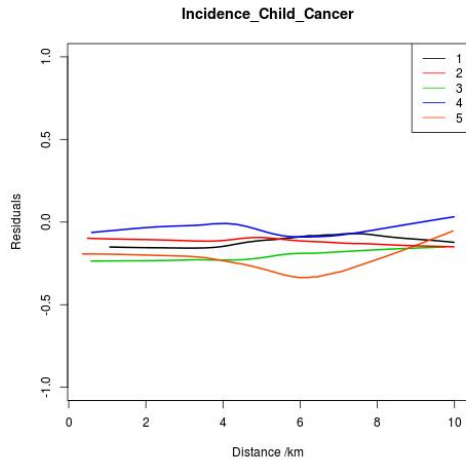


(e) All cause mortality

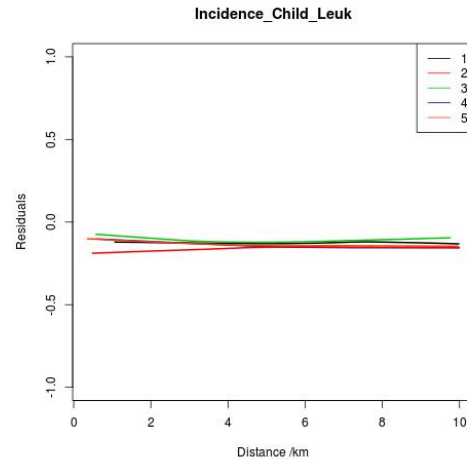


(f) Infant mortality

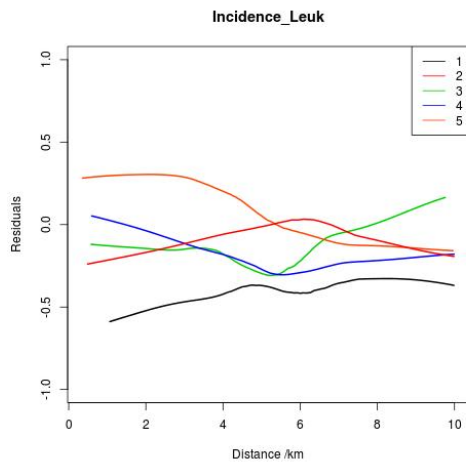
Figure 7: Residuals for all LSOAs in case circles plotted against distance from incinerator, with Lowess smooth (red line)



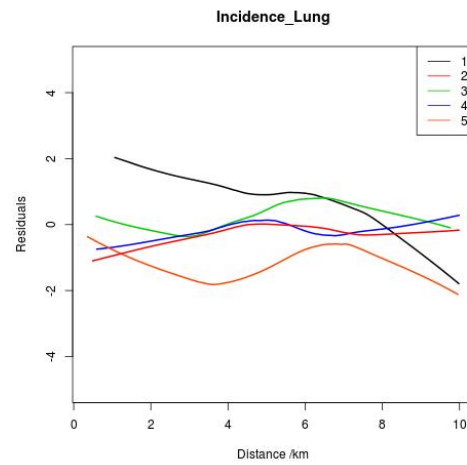
(a) Childhood cancer incidence



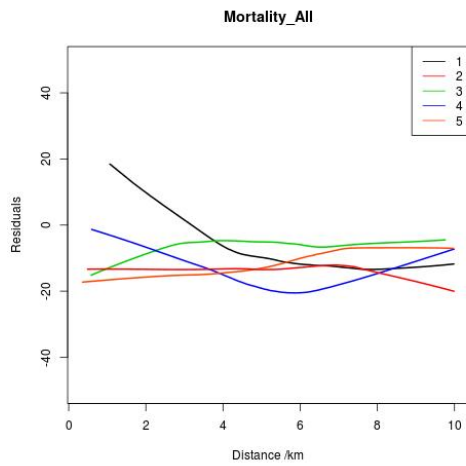
(b) Childhood leukaemia incidence



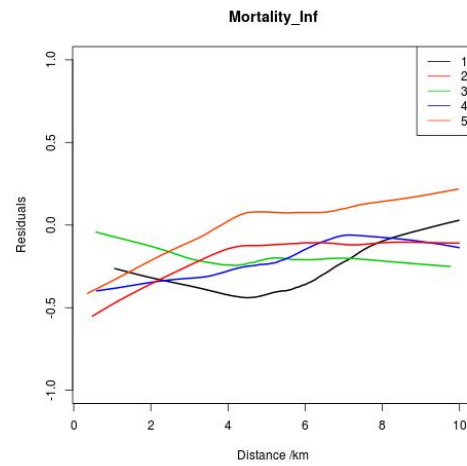
(c) Leukaemia incidence



(d) Lung cancer incidence

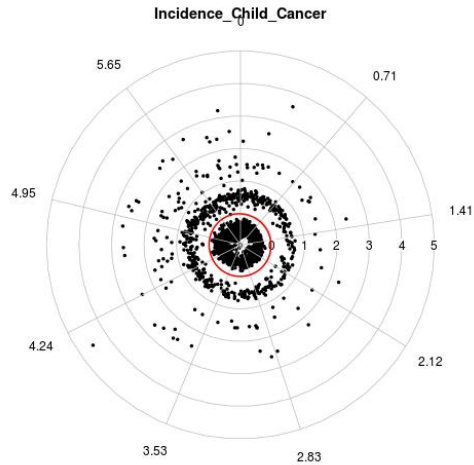


(e) All cause mortality

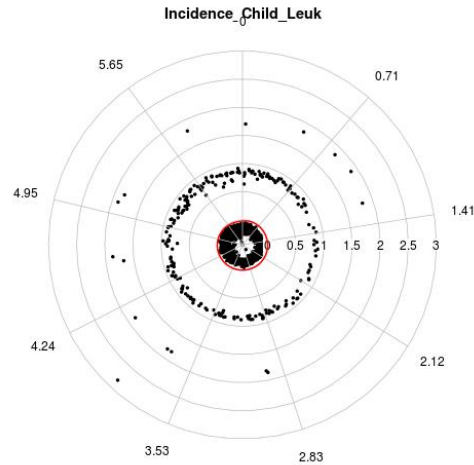


(f) Infant mortality

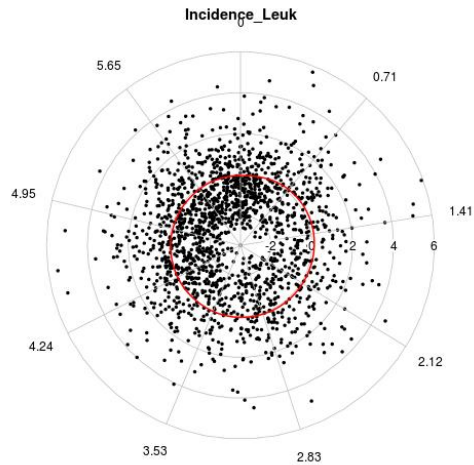
Figure 8: Lowess smooth of residuals plotted against distance from incinerator, for each case circle (1=Billingham, 2=Tyseley, 3=Coventry, 4=Eastcroft, 5=Stoke)



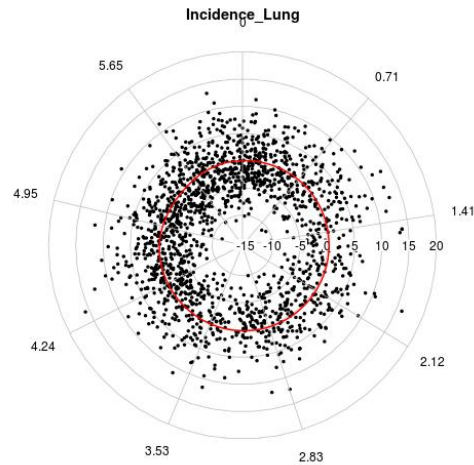
(a) Childhood cancer incidence



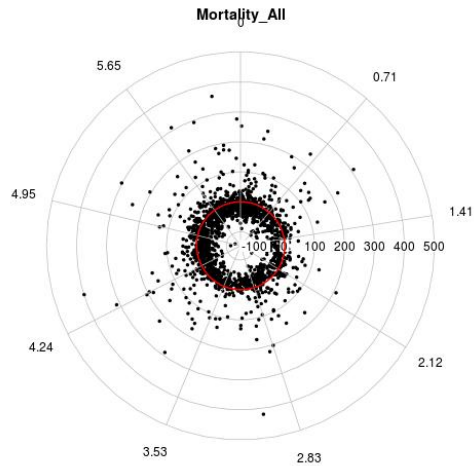
(b) Childhood leukaemia incidence



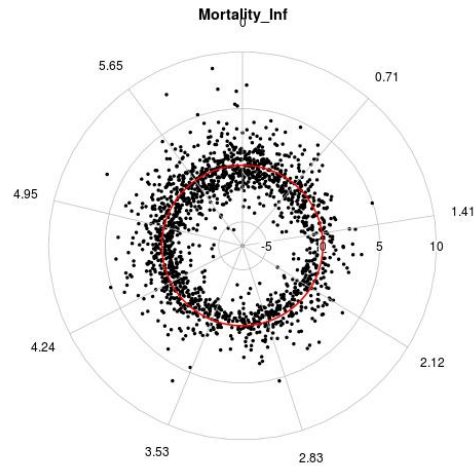
(c) Leukaemia incidence



(d) Lung cancer incidence

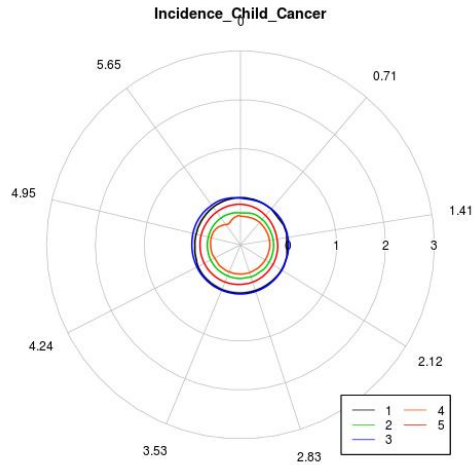


(e) All cause mortality

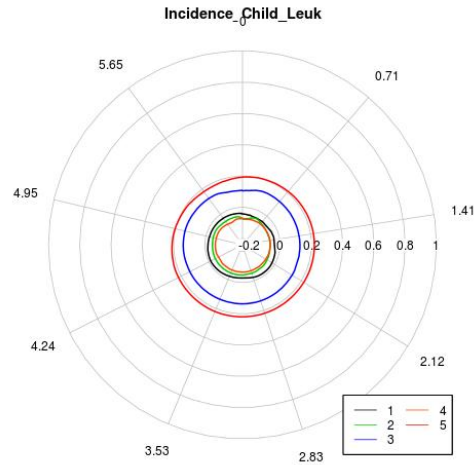


(f) Infant mortality

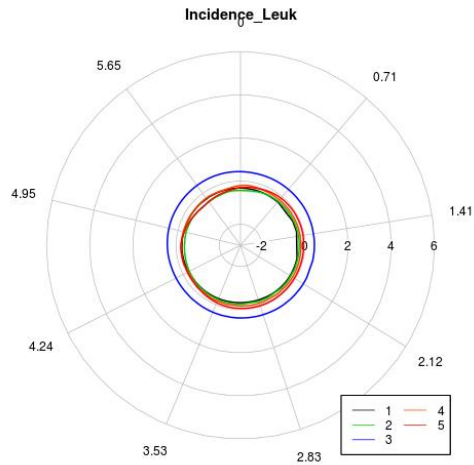
Figure 9: Residuals for all LSOAs in case circles plotted against direction from incinerator, with Friedman's smooth (red line)



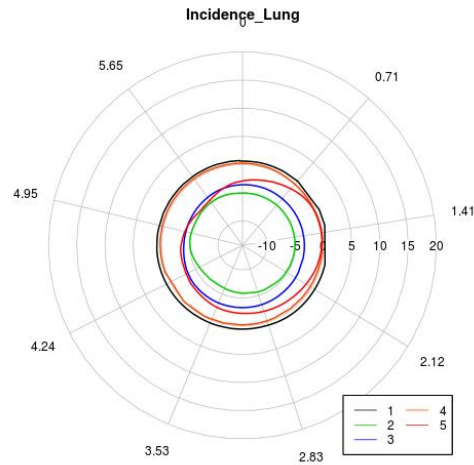
(a) Childhood cancer incidence



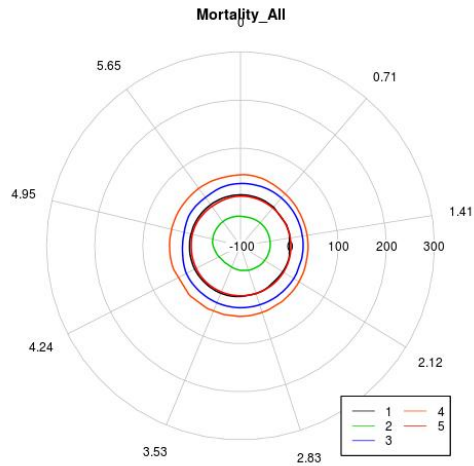
(b) Childhood leukaemia incidence



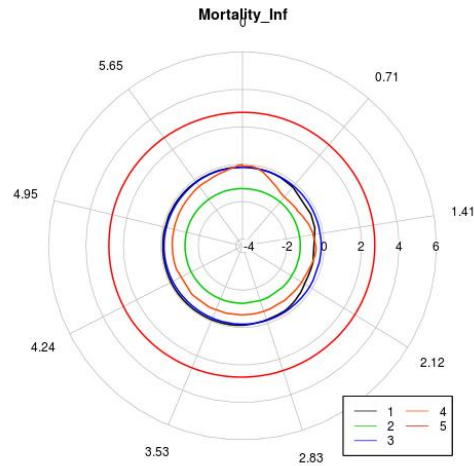
(c) Leukaemia incidence



(d) Lung cancer incidence



(e) All cause mortality



(f) Infant mortality

Figure 10: Friedman's smooth of residuals plotted against direction from incinerator, for each case circle (1=Billingham, 2=Tyseley, 3=Coventry, 4=Eastcroft, 5=Stoke)