Characterizing Regional-Scale Temporal Evolution of Air Dose Rates

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Abstract: This study characterizes the environmental decay of radiation air dose rates in the regional scale around the Fukushima Daiichi Nuclear Power Plant (NPP). We integrate ground-based walk and car surveys, and airborne surveys every year from 2014 to 2016. In addition, we predict the future air dose rate map based on the 2016 integrated map and data-driven environmental decay model.

Keywords: Mapping of air dose rates, Bayesian hierarchical model, Fukushima Daiichi NPP Accident

1. Introduction

Six years has passed since the radionuclide release occurred at the Fukushima Daiichi NPP. An extensive monitoring program has enabled to develop a data-driven environmental decay model for describing and predicting the decay of radiation air dose rates in the environment [1]. However, it has been difficult to quantify the heterogeneity of environmental decay in the regional scale, since spatially extensive airborne survey datasets often have discrepancy with the ground-based measurements and have a larger uncertainty. Recently, Wainwright et al. [2] developed a Bayesian hierarchical modeling approach to integrate multiscale datasets (i.e., car, walk and airborne surveys), and also to estimate the spatial distribution of air dose rates in high resolution over space. In this study, we aim to quantify the temporal changes of air dose rates in the regional scale, and predict them in the future.

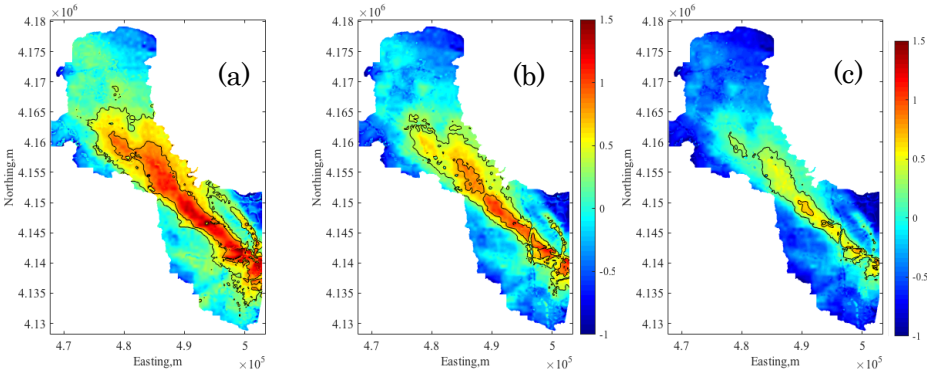

Figure 1. Integrated air dose rate maps (log10 uSv/hr): (a) 2014, (b) 2016 and (c) 2021 (predicted). The black lines are the threshold of 20mSv/yr and 50mSv/yr.

2. Methods

We applied the developed Bayesian estimation method [2] to integrate airborne, car and walk survey data every year from 2014 to 2016. We then quantified the temporal changes over the three years. In addition, we predicted the future air dose rate maps from the 2016 integrated map based on the data-driven decay model developed by Kinase et al. [1].

3. Results and Conclusion

The air dose rate is decreasing consistently, while the region above 20mSv/yr is shrinking (Figure 1). The decrease is particularly significant in the town, while the decrease is slower in the forested region. In 2021, the air dose rates continue to decrease, and the region above 20mSv/yr shrinks significantly. Although there is still a remaining area above 20mSv/yr, this area is almost fully contained within the non-residential forested zone.

References

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