リモートセンシングによる広域観測データの空間誤差推定に関する研究

Estimation of spatial errors in remotely sensed observation data

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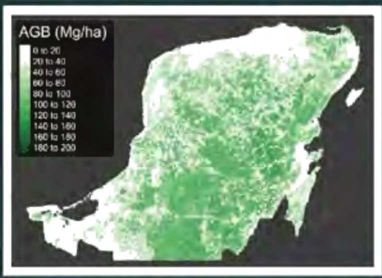
リモートセンシングによる広域観測データに対し、誤差の空間不均一性を評価する手法を開発した。平均誤差、平均絶対誤差、平方根平均二乗誤差、ピアソンの積率相関係数の算出に地理的加重モデルを適用し、誤差の空間分布を地図化した。

The objective of this study is to investigate spatial structures of error in the assessment of continuous raster data. The use of conventional diagnostics of error often overlooks the possible spatial variation in error because such diagnostics report only average error or deviation between predicted and reference values. In this respect, we develop Geographically Weighted (GW) versions of the mean signed deviation, the mean absolute error and the root mean squared error and to quantify their spatial variations.

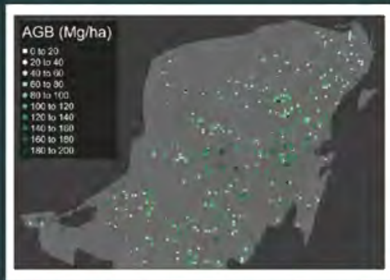
Materials

Rodriguez-Veiga et al. (2016)が作成した2004-2007年のメキシコ・ユカタン半島の地上部バイオマス量の推定図を使用した。参照データとして、286地点で測定されたin-situデータ（INFyS）を利用した。

The reference data for this case study was provided by the INFyS *in-situ* observation data which record measures of AGB (Mg ha^{-1}) at four nested 0.04 ha subplots within 1 ha field plots (Rodriguez-Veiga, 2016). Data from a total of 286 (1 ha) field plots were used as reference measures of AGB for the period 2004-2007 (Figure 4).

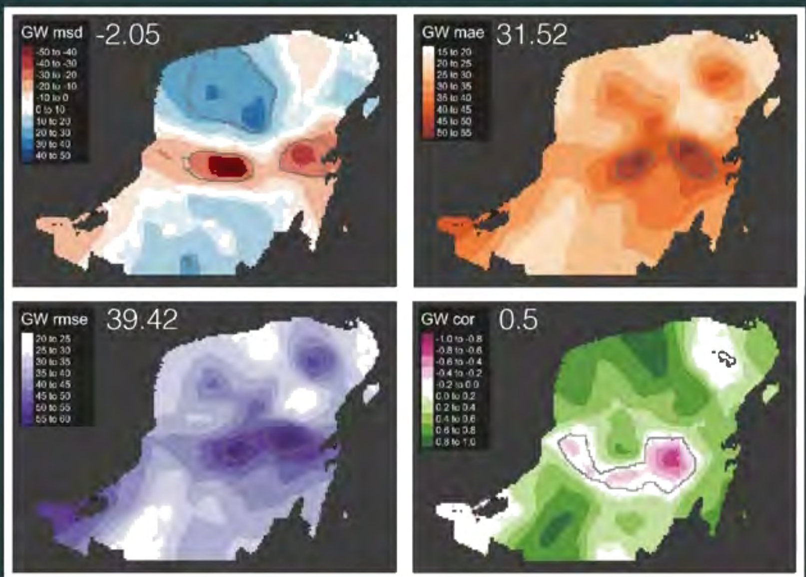


地上部バイオマス量推定図
Estimated above ground biomass
（Rodriguez-Veiga et al., 2016)



地上部バイオマス量参照データ分布図
Referenced *in-situ* data of above ground biomass.
(Inventario Nacional Forestal y de Suelos (INFyS))

Results



DISCUSSION & CONCLUSION

本研究では誤差の空間不均一性、どの地域で過大／過小推定がなされているかを評価する手法を開発した。適用には通常の精度評価同様に、ランダムサンプリングされた参照データのみでよく、従来の精度評価手法を容易に拡張することができる。今後は、このように推定された空間誤差を用いて、より高精度の環境観測マップの作成に寄与する手法の開発に取り組んでいきたい。

We developed and applied an error evaluation tool to identify in which areas errors are over / under estimated by considering spatial heterogeneity of error. Similar to the conventional way, only randomly sampled reference data are used in this approach, suggesting easy application to any other case studies. Future works would focus on the development of highly accurate environmental monitoring map by utilizing such spatial errors.

METHODOLOGY

平均誤差、平均絶対誤差、平方根平均二乗誤差、ピアソンの積率相関係数を地理的加重モデルに適用した。

Mean Signed Deviation (msd), Mean Absolute Error (mae), Root Mean Squared Error (rmse), and Pearson's correlation coefficient (cor) were considered and incorporated into geographically weighted models.

$$gw.msd(x_i, y_i) = \frac{\Sigma_{j=1}^{n} \omega_{ij}(y_j - x_j)}{\Sigma_{j=1}^{n} \omega_{ij}}$$

$$gw.mae(x_i, y_i) = \frac{\Sigma_{j=1}^{n} \omega_{ij}|y_j - x_j|}{\Sigma_{j=1}^{n} \omega_{ij}}$$

$$gw.rmse(x_i, y_i) = \sqrt{\frac{\Sigma_{j=1}^{n} \omega_{ij}(y_j - x_j)^2}{\Sigma_{j=1}^{n} \omega_{ij}}}$$

$$gw.cor(x_i, y_i) = \frac{c(x_i, y_i)}{s(x_i)s(y_i)}$$

$$s(x_i) = \sqrt{\frac{\Sigma_{j=1}^{n} \omega_{ij}(x_j - m(x_i))^2}{\Sigma_{j=1}^{n} \omega_{ij}}}$$

$$m(x_i) = \frac{\Sigma_{j=1}^{n} \omega_{ij} x_j}{\Sigma_{j=1}^{n} \omega_{ij}}$$

$$c(x_i, y_i) = \frac{\Sigma_{j=1}^{n} \omega_{ij}\left[(x_j - m(x_i))(y_j - m(y_i))\right]}{\Sigma_{j=1}^{n} \omega_{ij}}$$

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References: **Tsutsumida N., Rodriguez-Veiga P., Harris P., Balzter H., Comber A. (2019) Investigating Spatial Error Structures in Continuous Raster Data, International Journal of Applied Earth Observation and Geoinformation, 74, 259-268**

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