Comparing Kriging Techniques: Spatiotemporal Versus Pooled-Spatial Interpolations of Temperature Anomalies

James R. Kinney[12], Jared W. Oyler[23]
[1]Pomona College [2]Network for Sustainable Climate Risk Management [3]Penn State University

Introduction

Problem

- Accurate high-resolution gridded temperature datasets are necessary for effective climate downscaling
- Current gridded datasets us simple inverse distance weighting interpolation methods and lack a temporal component

Solution

-Test advanced spatiotemporal interpolation techniques and compare the accuracy to a simpler pure spatial model

Hypothesis

- With annual temperature data, we do not expect strong temporal covariance; therefore the spatiotemporal result will be very similar to the pure spatial result.

Methods

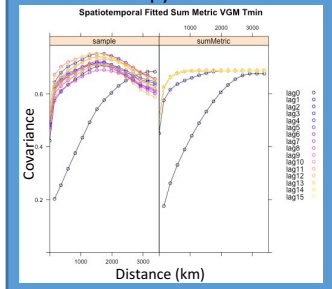
Spatiotemporal Approach

Data Organization

- USHCN annual temperature anomaly

ST Variogram Fitting

- Choose covariance model
- ST anisotropy



Empirical vs. Fitted ST Variogram

ST Kriging

-Choose time grid to krige

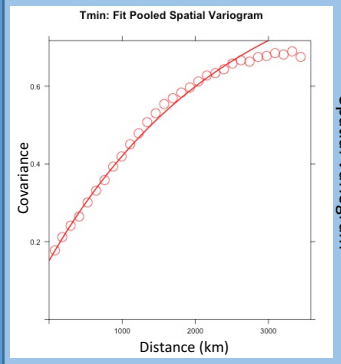
Cross Validation

- Time series by station

Pure Spatial Approach

Data Organization (annual anomalies)

Pooled Variogram Fitting



Empirical vs. Fitted Pooled Spatial Variogram

Kriging

- Choose year to krige

Cross Validation

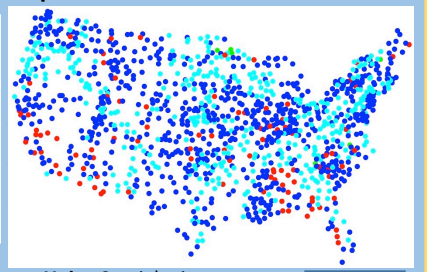
- All stations by year

Results

Statistical Summary

Error Statistic	Spatio-temporal	Spatial
MAE tmin	0.33°C	0.63°C
RMSE tmin	0.42°C	0.78°C
MAE tmax	0.31°C	0.72°C
RMSE tmax	0.40°C	0.91°C

Spatial Patters of RMSE Difference

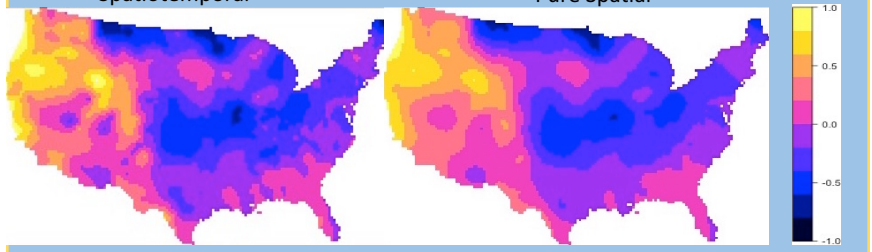


Units: Spatial minus Spatiotemporal RMSE

= [-1,0]
= [0,.5]
= [.5,1]
= [1,2]

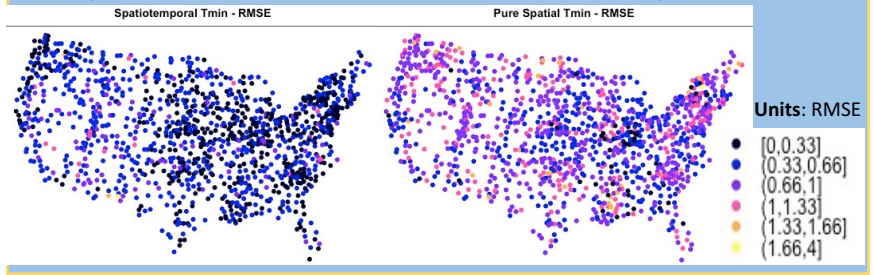
T-Min Predictions for 1995 to .25 Degree Grid

Spatiotemporal | Pure Spatial



Units: Predicted Temp. Anomaly

Spatial Patterns of Stations' Average RMSE



Units: RMSE

[0,0.33]
(0.33,0.66]
(0.66,1]
(1,1.33]
(1.33,1.66]
(1.66,4]

Conclusions

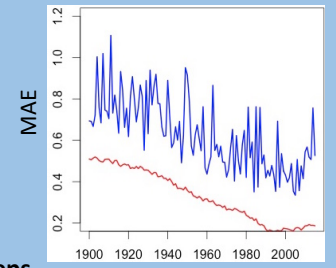
Take Home Points to Remember

- The addition of a temporal covariance component improved interpolation accuracy of min and max temperature anomalies
- Fitting a spatiotemporal versus a pure spatial variogram is more subjective and complex, but worth the extra effort

Further Question

- How do the accuracies of these models vary over time?

MAE per year: Spatiotemporal vs. Pure Spatial



= Pure Spatial

= Spatiotemporal

- Less year to year variation from spatiotemporal model as expected
- Downward trend likely due to increase in station count through time

Next Steps

- Investigate monthly and daily anomaly data where we expect greater temporal covariance and therefore greater benefit from ST methods
- Apply this method to improve precipitation interpolations
- Compare this spatiotemporal method to the method of fitting a separate variogram for each time step

Acknowledgments & References

References

Veronesi, F. (2015, August 27). Spatio-Temporal Kriging in R. Retrieved June 1, 2016, from http://www.r-bloggers.com/spatio-temporal-kriging-in-r/

Pebesma, E. (26, September 09). Spacetime: Spatio-Temporal Data in R. Journal of Statistical Software, 15(7). https://cran.r-project.org/web/packages/spacetime/vignettes/jss816.pdf

This work was supported by the National Science Foundation through the Network for Sustainable Climate Risk Management (SCRiM) under NSF cooperative agreement GEO-1240507. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.