Spatial Modeling of Drought Using Artificial Neural Networks

Scott Goodrick Yongqiang Liu John Stanturf

United States Forest Service Athens, Georgia, USA

Introduction

- Drought is a natural disaster that can have severe economic consequences across a large area
- Spatial extent of drought is vital component in assessing consequences
- Remote sensing good tool but lacks ability to examine past events

Alternative Methods of Spatial Modeling

- Use routine weather observations
- Methodology should account for a wide range of environmental features that affect variability in the observations

Artificial Neural Networks

- Means of mapping a set of input data to a desired output
- Universal function approximator
- Excellent tool for discovering patterns within the data

Network Diagram



Data

Weather observations

- Temperature (Output)
- Location
- Topography
 - Elevation
 - Slope/Aspect
- Land Cover
 - Vegetation Cover

Network Diagram



Application of ANN

Data preparation

- Adjusting the Distribution
- Training Set
- Testing Set
- Training Methodology
 - Error minimization problem
 - Two stage training
 - Focus on cases with poor performance

Analysis Region



Results

• Network Training Performance

50 40 Max Mean + σ 30 Mean 20 🛰 Mean - σ Min 10 0 -10 -20 -30 $20^{30401}20^{30415}20^{30429}20^{30513}20^{30521}20^{30521}20^{30524}20^{30524}$

50 40 30 20 10 0 -10 -20 -30 $20^{30401}20^{30415}20^{30429}20^{30513}20^{30513}20^{3051}20^{30510}20^{30524}$

50 40 30 20 10 0 -10 -20 -30 $20^{30401}20^{30415}20^{30429}20^{30513}20^{30513}20^{3051}20^{30510}20^{30524}$

50 40 30 20 10 0 -10 -20 -30 20030401 51 20³⁰⁴¹⁵ 20³⁰⁴²⁹ 20³⁰⁵¹³ 20³⁰⁵²¹ 20³⁰⁶¹⁰ 20³⁰⁶²⁴

Correlation

Maximum	0.936
Mean + σ	0.988
Mean	0.988
Mean – σ	0.965
Minimum	0.972

Results

- Neural Network has learned the input data very well
- How well does it represent data not present in the training data set.



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- RMSE for Testing Data: 3.11 C

Measuring Drought

- Drought can be viewed as two components
 - Rainfall Deficit Term
 - Drying Term
- Use ANN temperature analysis to calculate drying term
- Contrast 2001 and 2003

Comparison of Mean High Temperatures







Difference 2003-2001

Summary

- Artificial Neural Networks are capable of producing realistic spatial fields of temperature
- Artificial Neural Networks allow us to look at a spatial representation of historical conditions from routine weather observations

Future Work

- Extend analysis to other weather parameters
- Test at higher spatial resolutions
- Test as a means of downscaling climate model data