Strengths and Weaknesses of Universal Response Function Approaches for Support of Deployment Decisions

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Pine Integrated Network: Education, Mitigation, and Adaptation project (PINEMAP) is a Coordinated Agricultural Project funded by the USDA National Institute of Food and Agriculture, Award #2011-68002-30185

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Objective

- Use historic progeny tests and weather data to predict response to future climates

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Background
Universal Response Function (URF)

Y_{ij} = f(climate variables for test site *i* and provenance *j*)

- Accounts for both:
  - Environmental effects of *weather* at the site
    - future climate models can be used as input
  - Genetic effects due to selection under a common provenance *climate*

First developed in 2010 Wang *et al. Ecological Applications*, 20(1), 2010, pp. 153-163

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Y_{ij} = f(climate variables for test site *i* and provenance *j*)

- What you measure matters!
- **Productivity** or **adaptation**?
  - Age (early/late)
  - Live tree variables (height, tree volume)
  - Planted tree variables (survival, BA, per area volume)
  - Disease (historic)

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Slash Pine in Pearl River Co., MS

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- Clinal
- Minimize colinearity
- Explanatory and **predictive** power

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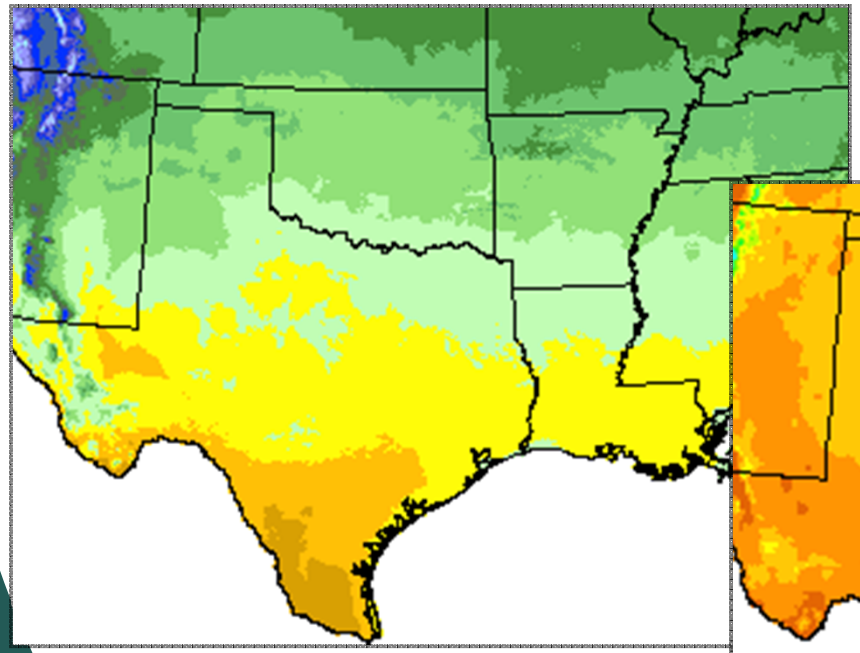
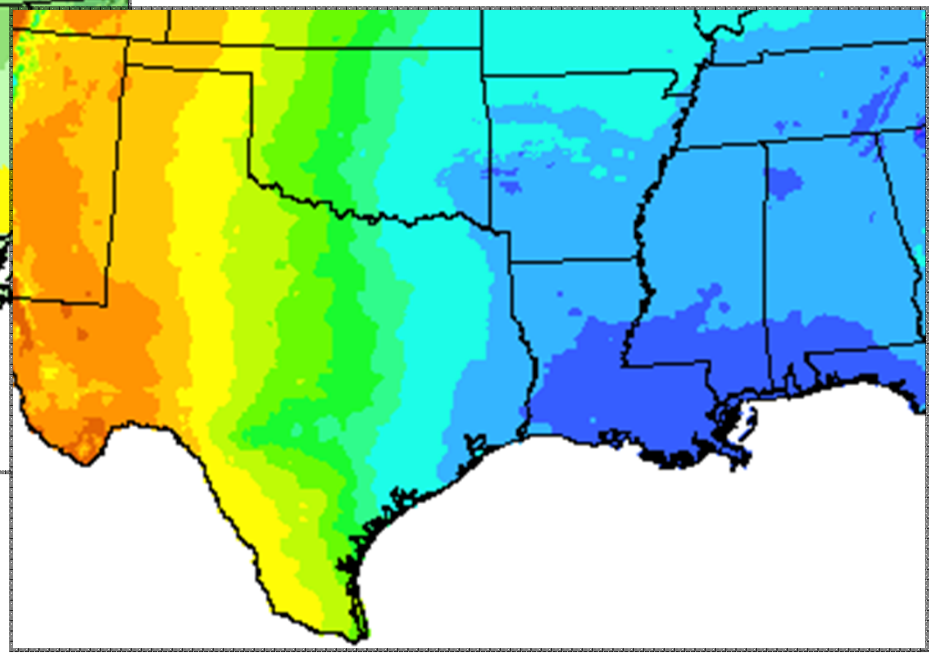
Y_{ij} = f(**climate variables** for test site ***i*** and provenance *j*)



Winter Temperature



Precipitation

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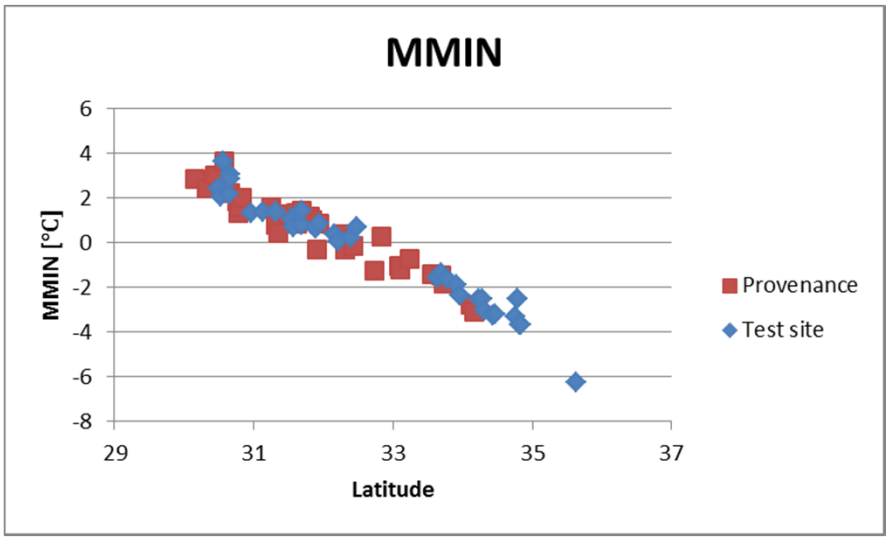
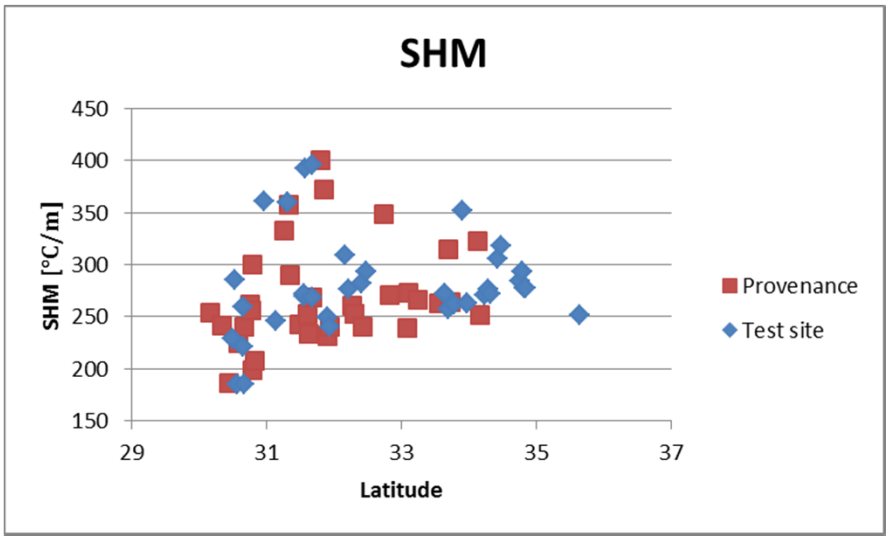
N-S transect





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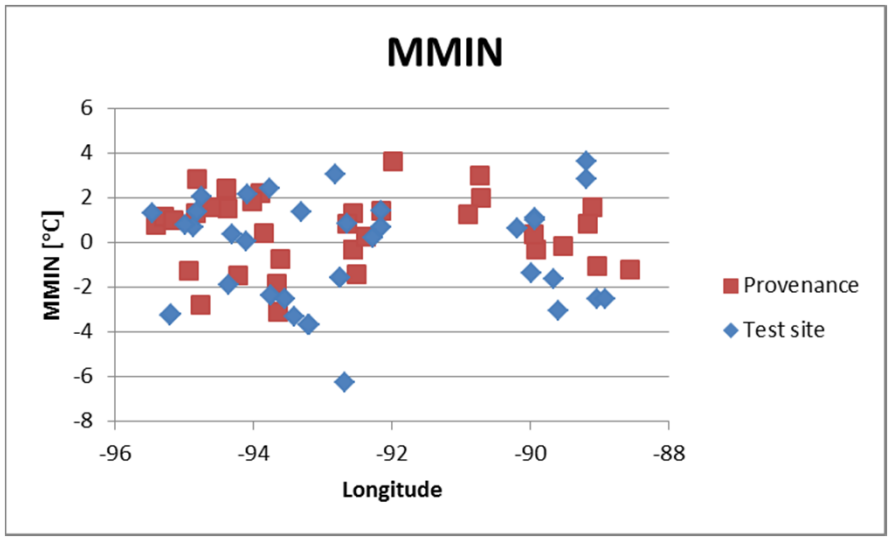
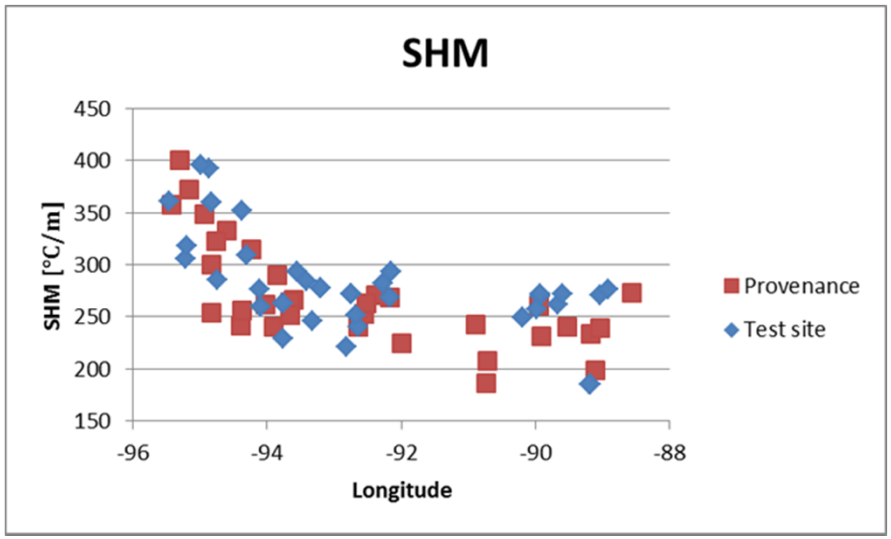
W-E transect





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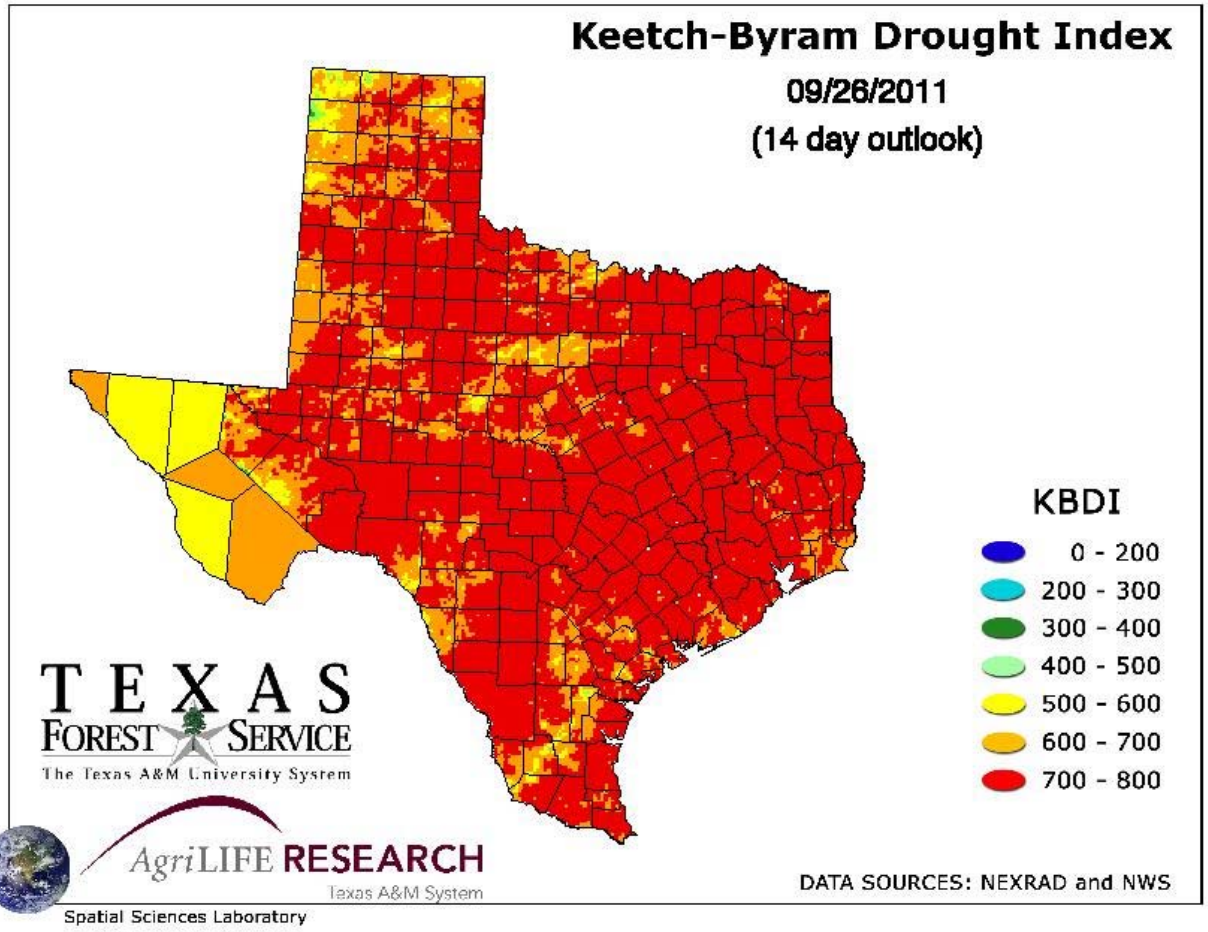
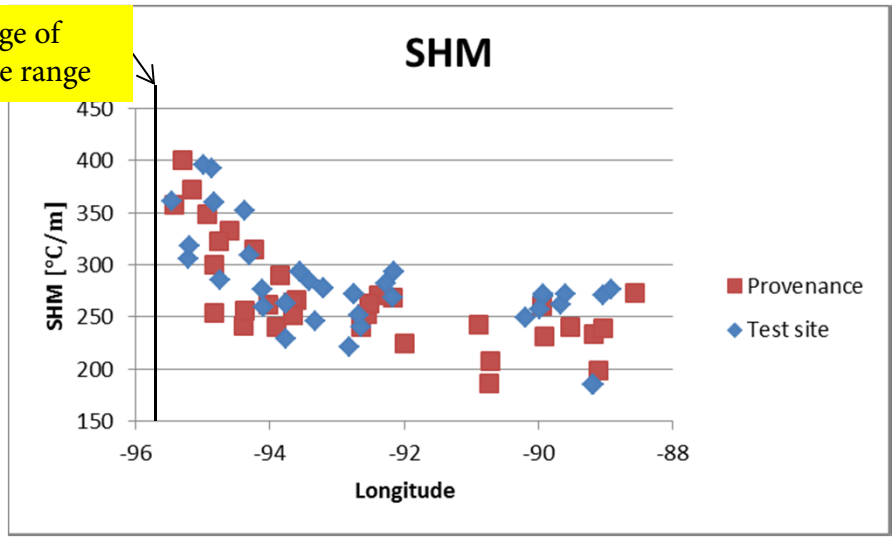
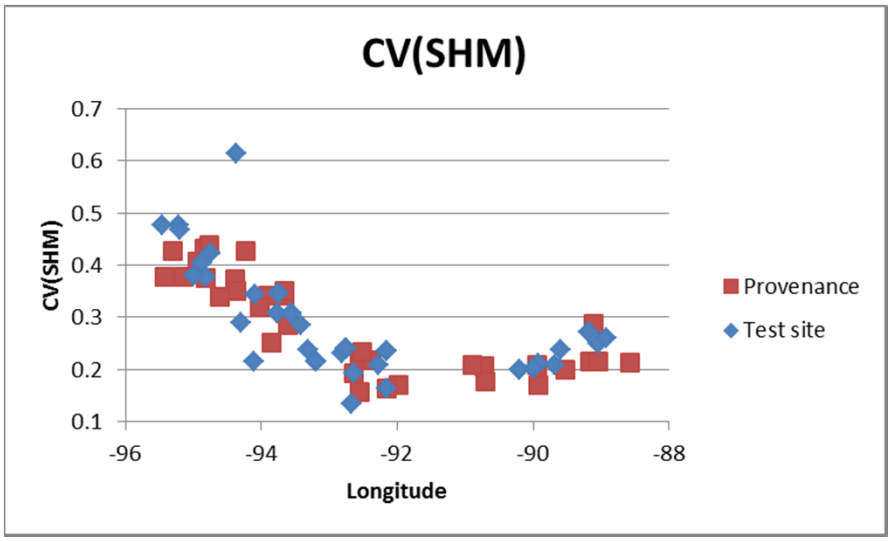
Extreme events and tipping points!



Results
W-E transect

Western edge of loblolly pine range





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Background
Universal Response Function (URF)

Y_{ij} = f(climate variables for **test sites** *i* and provenance *j*)

- Tests established for other purposes
  - Range of conditions sampled limited to commercial forest sites
  - Low quality sites under represented
  - ***Ignores site specific information on soils and silviculture***

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Y_{ij} = f(climate variables for test sites *i* and **provenance** *j*)

- Local adaptation in response to similar selection pressure - *Geographic proximity is a surrogate for genetic similarity*
- Tree to tree variation: random drift, gene flow, and colonization contribute to among and between-population variation

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Common Themes

	TAMU/WGFTIP (15 yr Height and Volume)		NC State (8 yr Height)	U of F (15 yr Height)
	Series I	Series II	Plantation Selection Seed Source Study	Provenance progeny trials
Height (R^2)	0.46	0.42	0.68	0.52
Volume (R^2)	0.29	0.18		
Common predictors: Winter temperatures and aridity Explanatory power is moderate. Predictability is weaker.				

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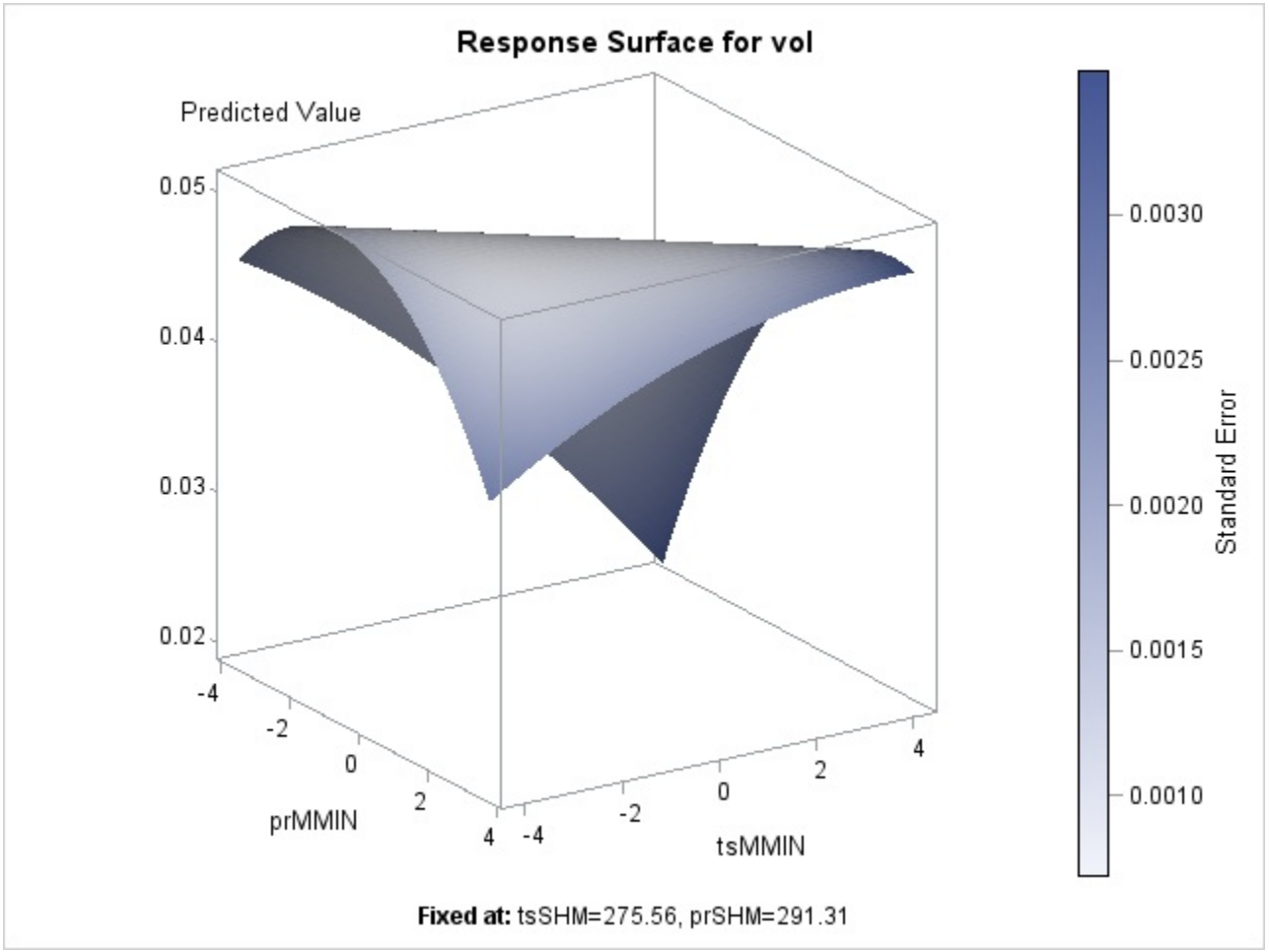
Results (*Series I age 10*)
Optimal transfer distances

$R^2 = 0.25$



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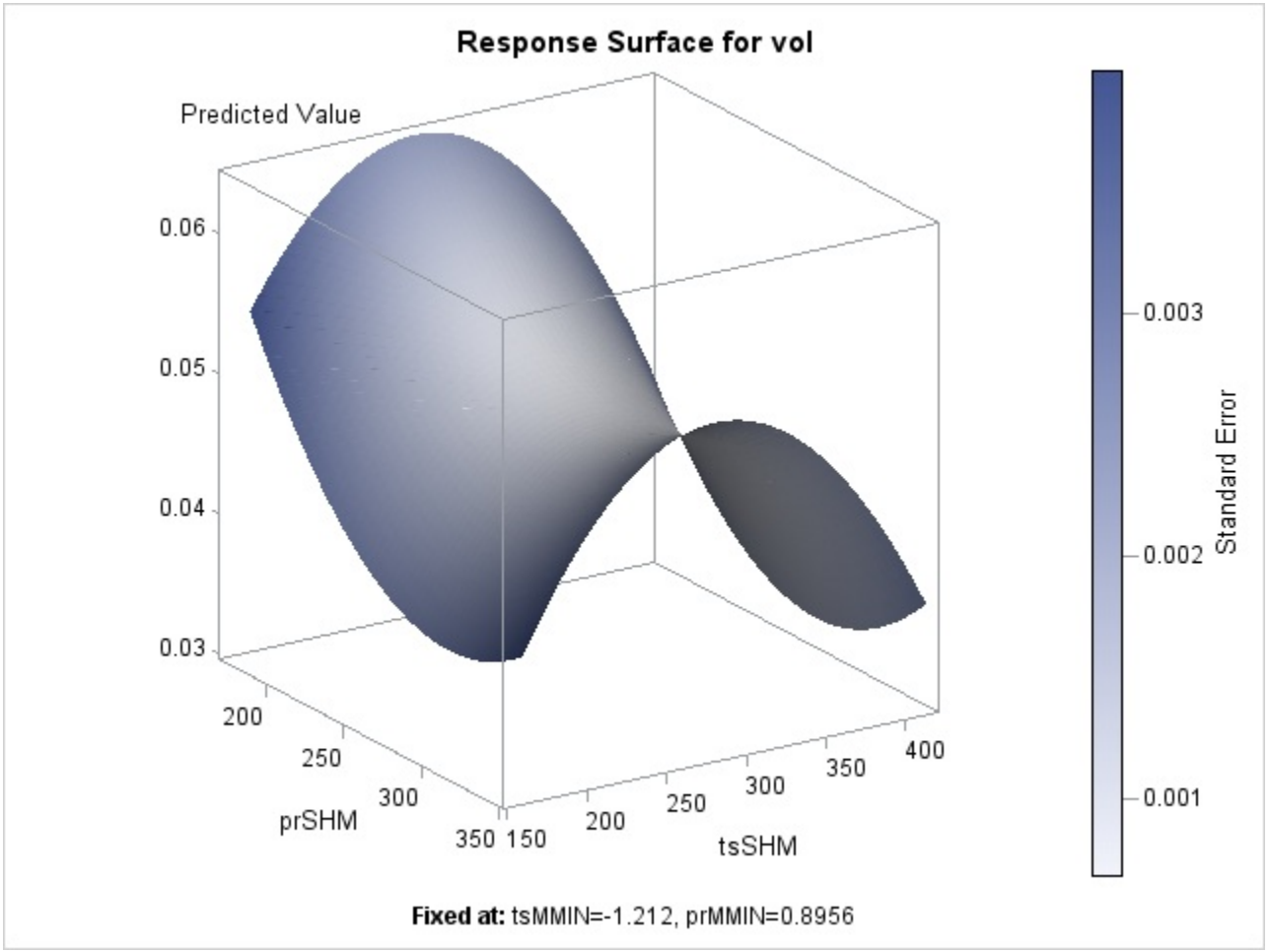
Results
Series I

$R^2 = 0.25$



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Conclusions

- Within optimal transfer distances, additional gains in productivity and resilience can be obtained from:
  - Progeny Testing
  - Silviculture – Especially methods that focus on altering the aridity index through optimal site preparation, competition control, thinning, fertility and drainage
  - Interactions between targeted seedling deployment and site specific management practices were relatively unimportant when compared to main effects

    Plant your best families on your best sites (within the transfer distance)!

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Thank you for your attention!

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