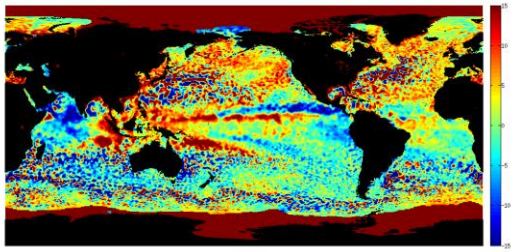
NSF Expeditions in Computing:

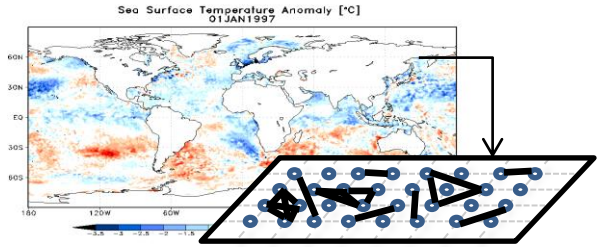
Understanding Climate Change: A Data-driven Approach

Sample of Research Activities



Pattern Mining: Monitoring Ocean Eddies

- Spatio-temporal pattern mining using novel multiple object tracking algorithms
- Created an open source data base of 20+ years of eddies and eddy tracks



Network Analysis: Climate Teleconnections

- Scalable method for discovering related graph regions
- Discovery of novel climate teleconnections
- Also applicable in analyzing brain fMRI data

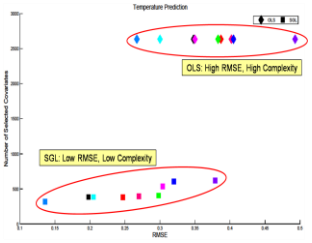
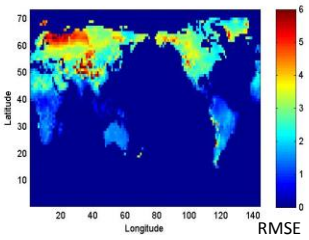


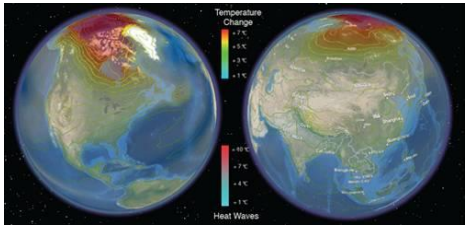
Fig. RMSE vs. Model Complexity of OLS and Sparse Regression Methods



Prediction RMSE from spatially smoothened Multi-model ensemble

Sparse Predictive Modeling: Precipitation Downscaling

- Hierarchical sparse regression and multi-task learning with spatial smoothing
- Regional climate predictions from global observations

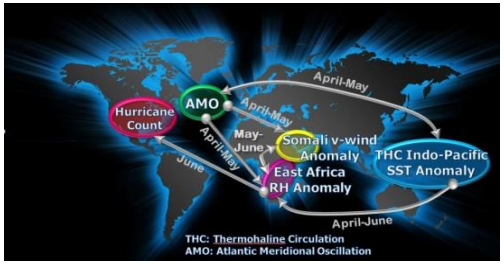


Extremes and Uncertainty: Heat waves, heavy rainfall

- Extreme value theory in space-time and dependence of extremes on covariates
- Spatiotemporal trends in extremes and physics-guided uncertainty quantification

Highlights:

- Highly inter-displicinary
  - Computer science, hydrology, Earth sciences, statistics, civil engineering
- ~ 100 publications (journals, conferences, and workshops) with authors from multiple disciplines
- Public release of software & data products
- Advances in computer science driven by Earth science applications
- Advances in Earth sciences using computer science methods
- Development of physics-guided data mining paradigm



Relationship mining: Seasonal hurricane activity

- Statistical method for automatic inference of modulating networks
- Discovery of key factors and mechanisms modulating hurricane variability

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Sample of Education and Outreach Activities

Engagement with UNEP, IPCC and World Economic Forum and wider climate science and impact community

Application to Climate: Meningitis Problem over West Africa

Breaking Story

Researchers Devise More Accurate Method For Predicting Hurricane Activity

Education

Professional Science Master's degree program in Climate Change & Society

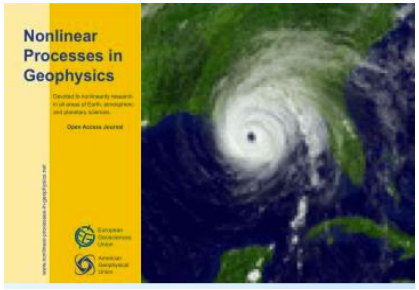
Annual Workshop

Attended by ~ 100 researchers from multiple disciplines

Nurturing a *"Climate Informatics"* Community

"Climate change research is now 'big science,' comparable in its magnitude, complexity, and societal importance to human genomics and bioinformatics." **(Nature Climate Change, Oct 2012)**

Workshops and sessions in climate & computer science venues



Special Issue:
Physics Driven Data Mining

Heavy involvement of Expedition team as authors and guest co-editors in collaboration with leads of the IPCC AR5 and US National Climate Assessment