Hydroclimate and Water Management: Process Scales, Data Needs and Modeling Challenges/Opportunities

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Interplay between Meteorology, Hydrology and Water Management

- Hydrometeorology
  - Impact of weather (0-15 days) on hydrology
  - Spatial Impacts: Local, Basin, Regional
  - Water management: Flash flood warnings, Flood forecasts, Peak-power generation
  - Interest is real-time control and operation
- Hydroclimatology
  - Impact of climate (weather over longer time scales) on hydrology
  - Time scales: Monthly, Seasonal, Interannual, Decadal and longer-time scales
  - Spatial scales: Basin, Regional, Continental
  - Water management: Water allocation, Firm power generation, Non-point pollution
  - Interest is mostly planning and management

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Hydroclimatology and Water Management

- **Climate Variability**
  - Structured interannual and longer timescale variations
  - Due to internal feedback processes
  - Adaptive seasonal/interannual water management
- **Climate Change**
  - Increased global CO_2 concentration and its impacts
  - Non-stationary hydroclimatology
  - Relevant to System Design, Planning and Capacity Expansion Projects
- **Focus Attributes: Streamflow, Groundwater and Nutrients**

Climate Variability and Streamflow

- Monthly to Seasonal Streamflow Forecasts
  - Apart from climate forecasts, land-surface conditions provide information
  - Higher skill for snow-melt dominated basins
- Water and Energy Management
  - More beneficial for within-year storage systems as opposed to over-year systems
  - Potential for developing power demand forecasts using temperature forecasts
  - Initial storage should constrain allocation; Use end-of-the-season storage constraint
- Data Needs and Modeling Challenges/Opportunities
  - Streamflow - good; Soil moisture and SWE: Limited satellite (AMSR-E,SMAP, SMOP) & model (NLDAS2) data
  - Modeling challenges: Assimilation of land-surface conditions, Integrated surface water and groundwater models

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Climate variability and groundwater

- Low Frequency Variability and Groundwater
  - Groundwater alone can generate low-frequency variability due to increased residence time without any signal from precipitation
  - Unconfined aquifers – Recharge/discharge patterns with three-month lags/leads over Southeast
- Groundwater Management
  - Potential for conjunctive management
  - Coastal aquifers - Saltwater intrusion during droughts
- Data Needs and Modeling Challenges/Opportunities
  - Groundwater - reasonable; bed rock depth, soil data, hydraulic conductivity – not great; Satellite data – GRACE (Too big)
  - Fully coupled models – PIHM, PARFLOW at basin scale
  - Modeling opportunities: Data assimilation using streamflow and soil moisture

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Climate variability and Nutrients

- Seasonal Nutrient Forecasts
  - Climate drives streamflow, which drives nutrients
  - Partial variability on seasonal nutrient variability should be explainable
- Nutrient Management
  - Potential for changing BMPs conditioned on loadings forecasts
  - Potential trading between point and non-point sources
- Data Needs and Modeling Challenges/Opportunities
  - Nutrients – Sporadic (low spatial and temporal resolution); Other sources: Remote sensing data : MODIS
  - Modeling opportunities: Reconstructed nutrient loadings using paleo information (e.g., tree ring) and observed climate data to quantify interannual variability.

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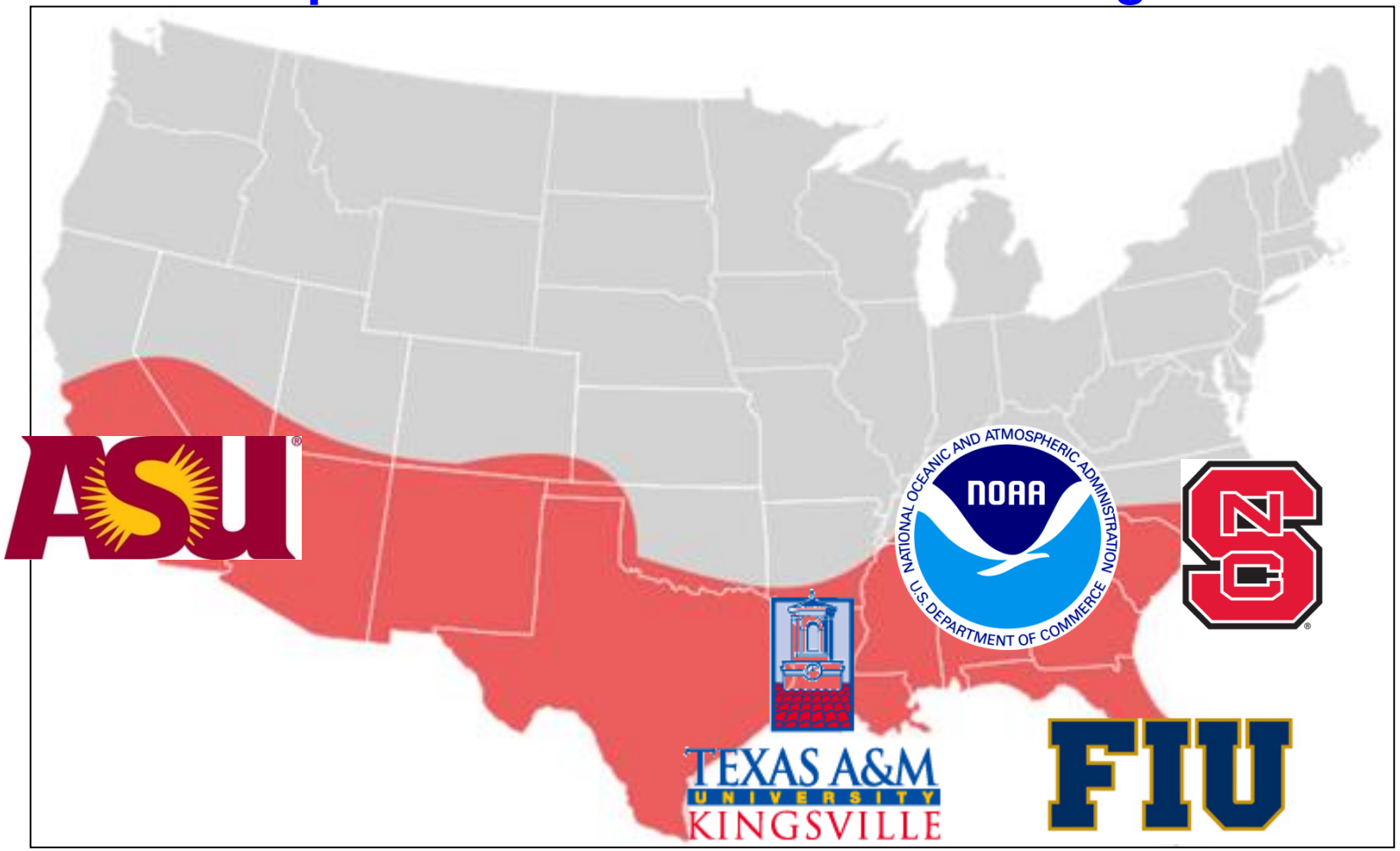
Water Sustainability under Near-term Climate Change: A Cross-Regional Analysis Incorporating Socio-Ecological Feedbacks and Adaptations

http://www.waterforthesunbelt.org/



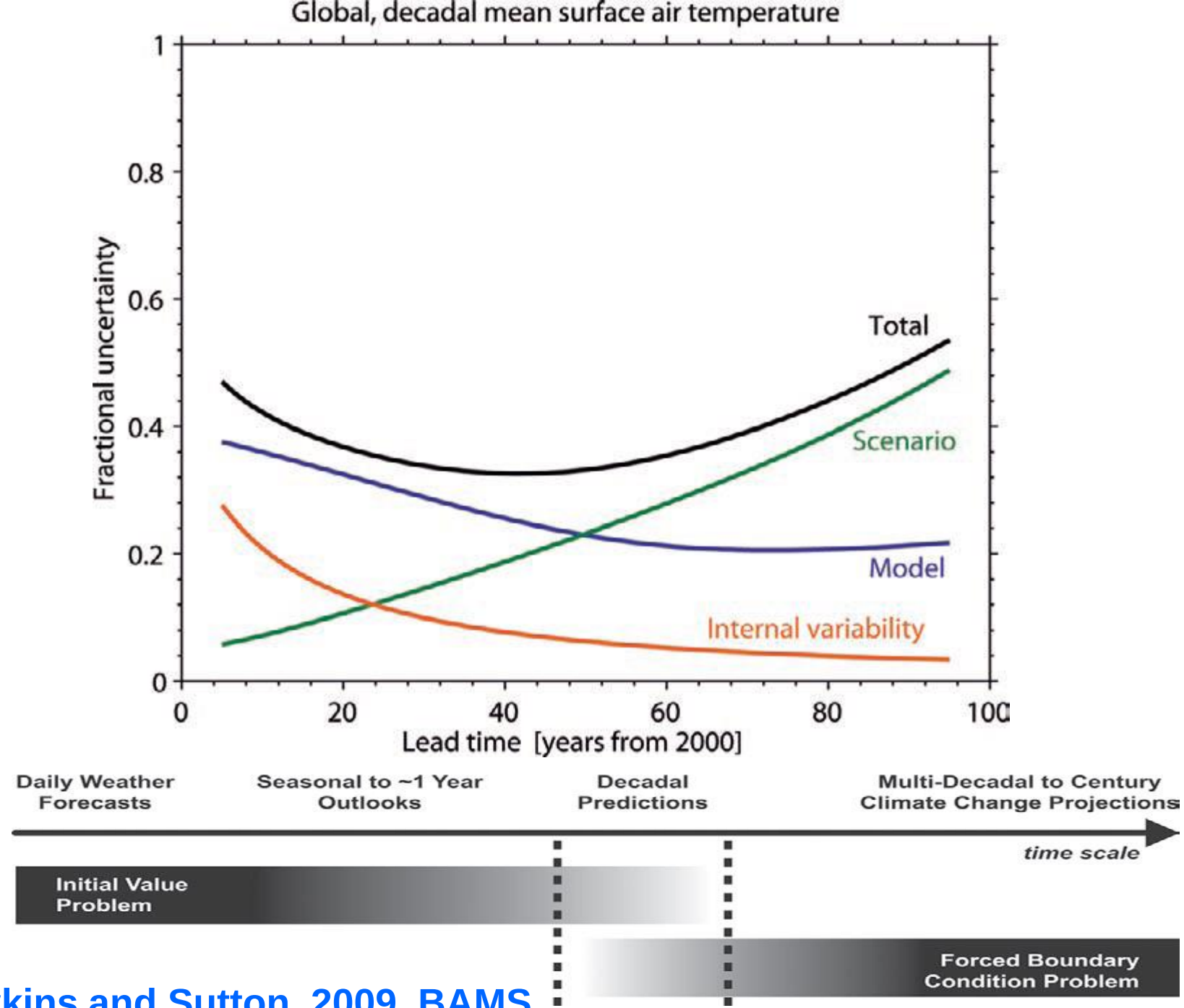
NCSU : Sankar Arumugam, Kumar Mahinthakumar, Emily Berglund

NOAA: Ken Kunkel

FIU : John Kominoski, Megan Hagler **TAMUK:** Tushar Sinha

ASU : John Sabo, Albert Ruthi, Kelli Larson

Near-term Climate Change



Hawkins and Sutton, 2009, BAMS

Near-term Climate Change

Near-term Climate Change, Streamflow and Groundwater

- Changes in 10-30 year Hydroclimatic Projections
  - CMIP5 provides an opportunity for evaluating the utility of models retrospectively
  - Model uncertainty reduction is key due to limited role of scenario uncertainty
- Water Management (Surface Water and Groundwater)
  - Capacity Expansion, Long-term water contracts, System design, Reservoir rule curves, Regulating ecological flows, inter-basin transfers
- Data Needs and Modeling Challenges/Opportunities
  - Streamflow - good; Groundwater – reasonable; Potential for including tree-rings based reconstructed flows to reduce uncertainty
  - Modeling challenges: Reducing model uncertainty in precipitation projections; Representing the human feedback on water use in system planning

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