



# Recent Advances and Future Directions of GCAM

November 5, 2019

**Mohamad Hejazi**  
on behalf of the GCAM Team

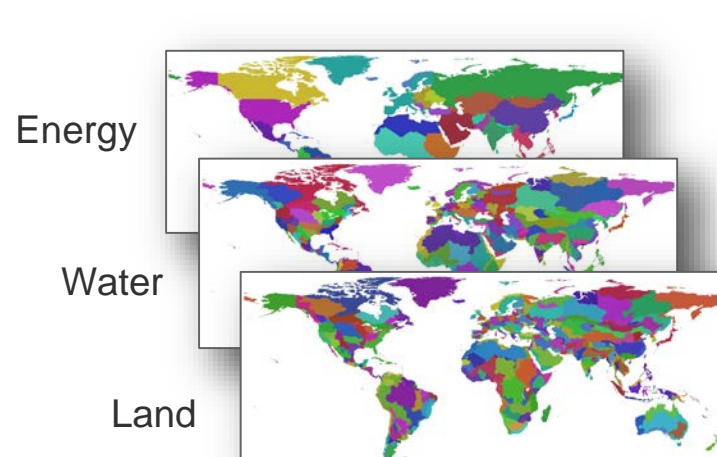


PNNL is operated by Battelle for the U.S. Department of Energy





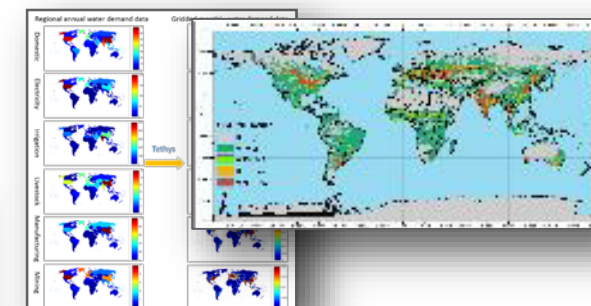
# Working across multiple scales (spatially, temporally, and technological)



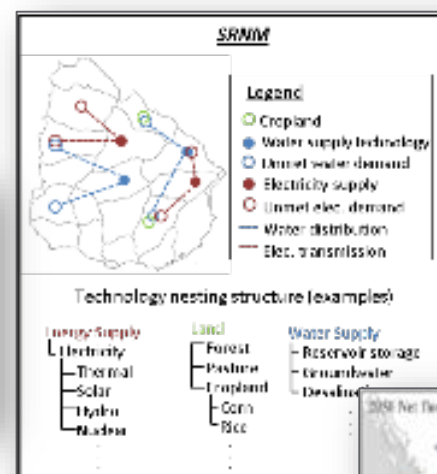
Telescoping in  
GCAM Core



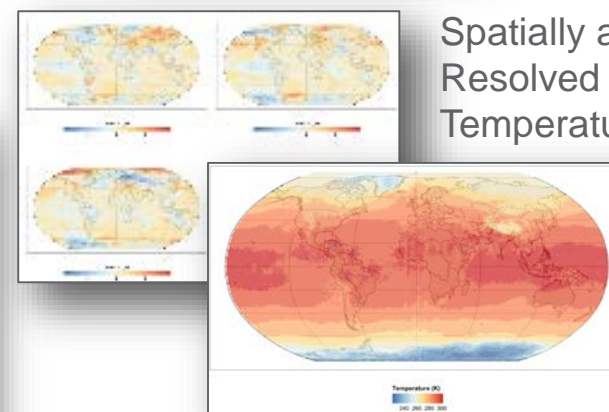
Disaggregation  
Models



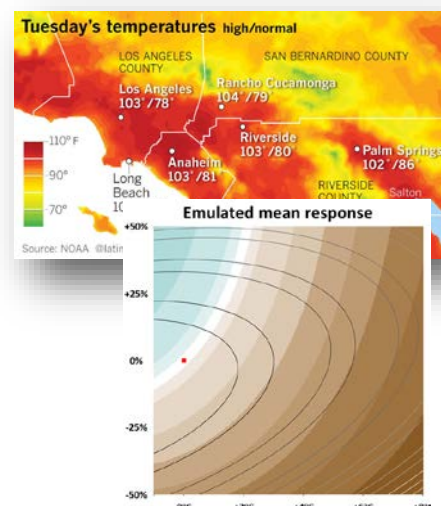
Basin-level multi-sector model



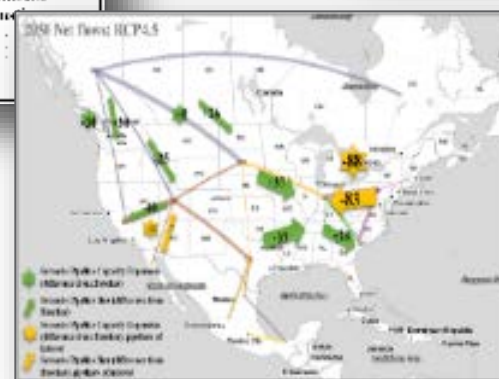
Spatially and Temporally-  
Resolved Precipitation and  
Temperature



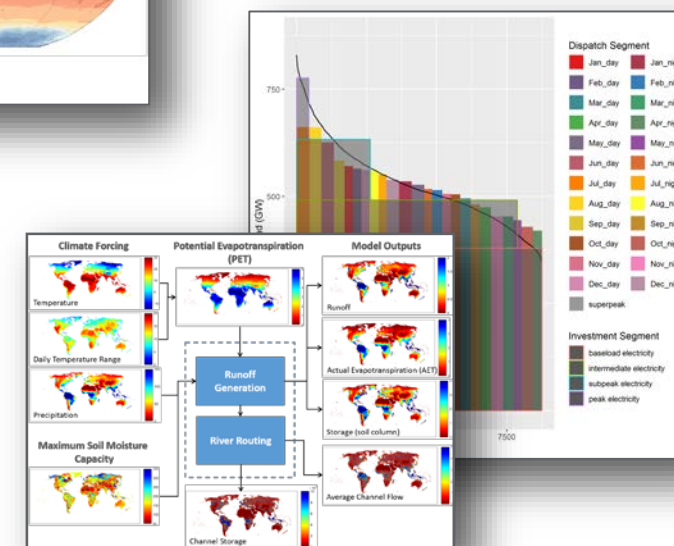
Incorporating extremes



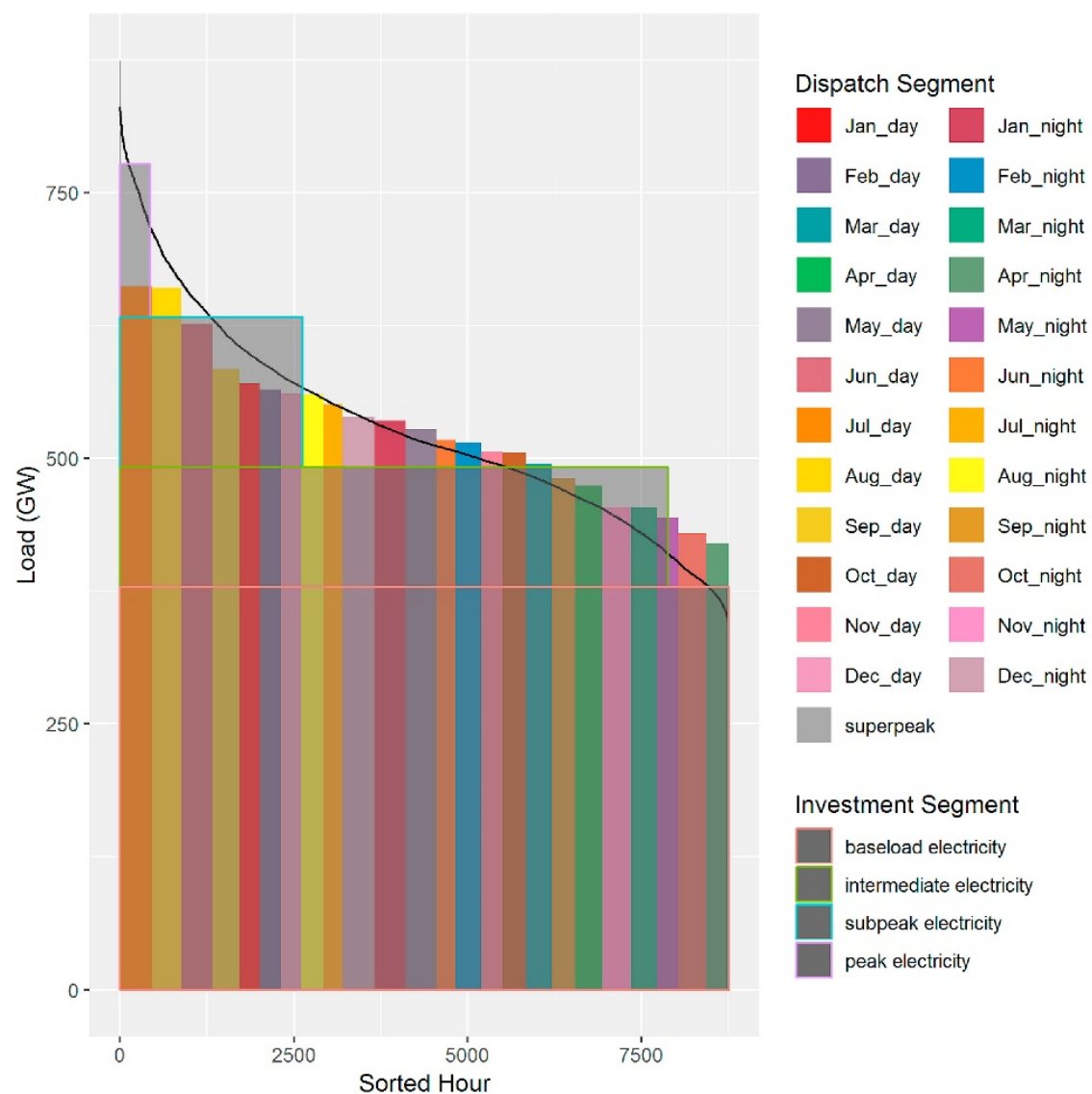
Linking with natural  
gas infrastructure  
model



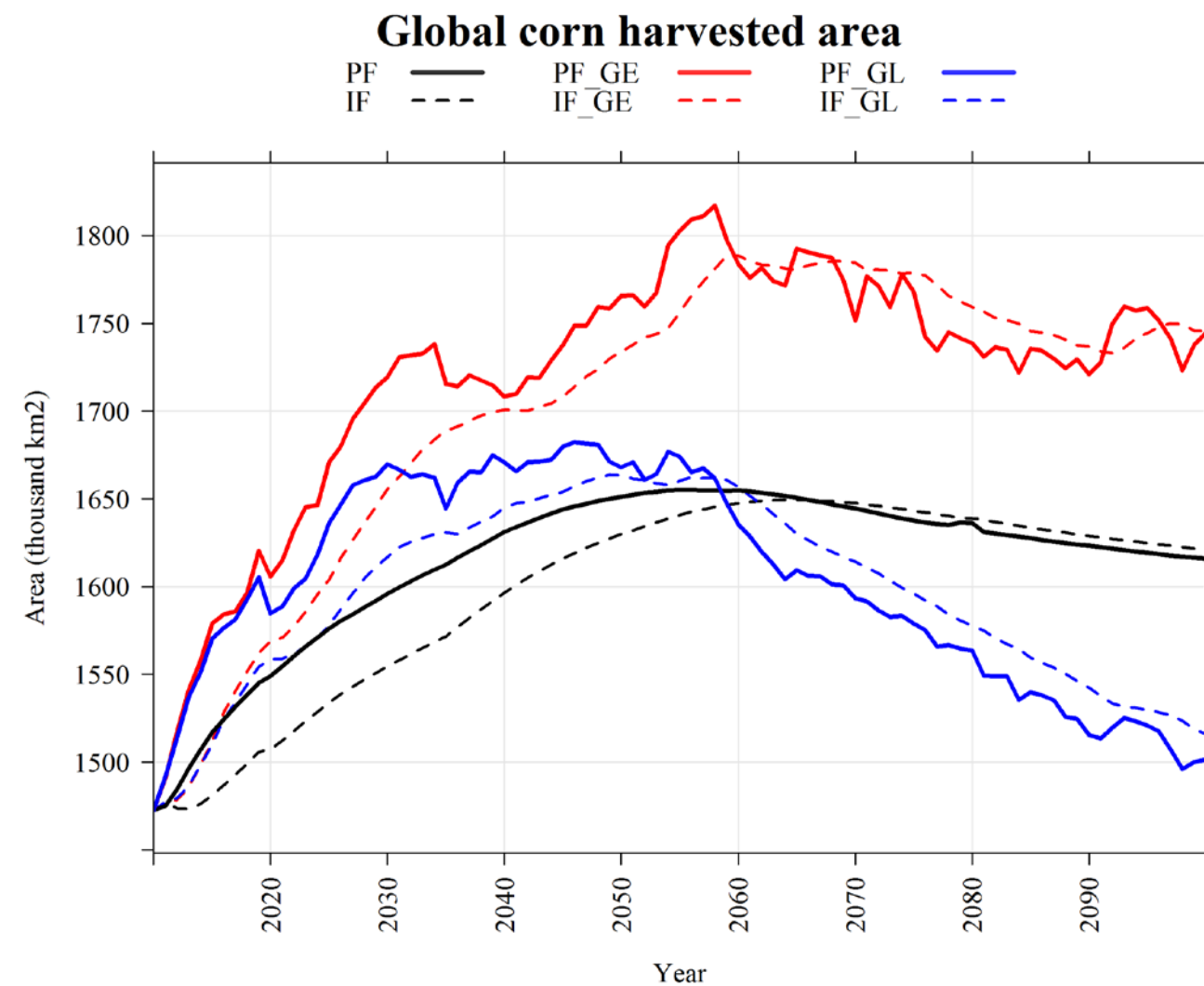
Subannual electricity;  
monthly water balance



# GCAM with annual time step and sub-annual dynamics



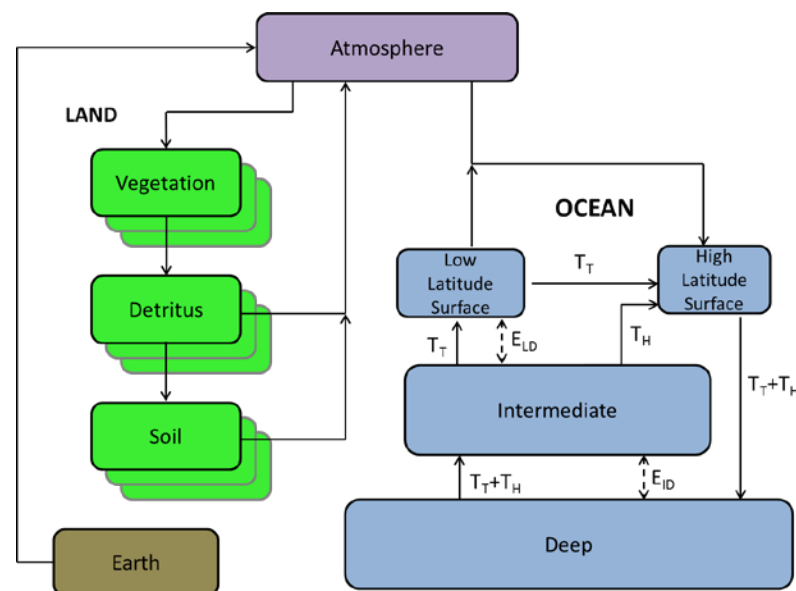
Wise et al. (2019), Khan et al. (in prep)



Zhao et al. (in review), Zhao et al. (in prep)

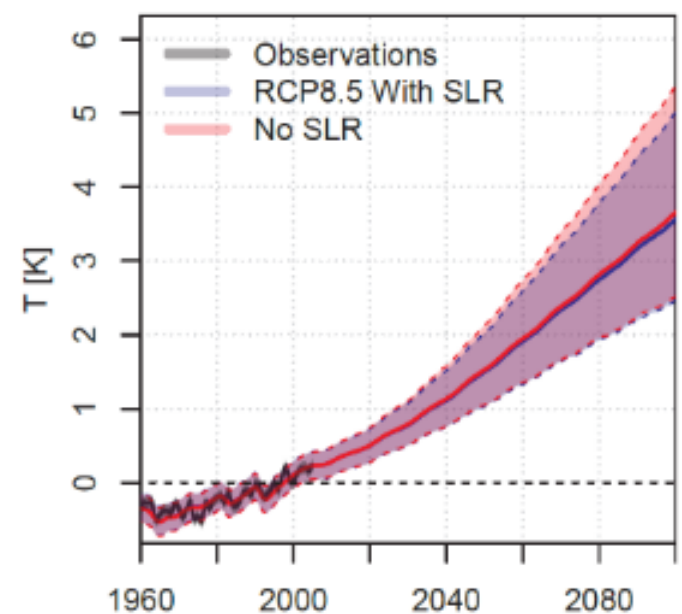


# Emulation and hierarchical modeling

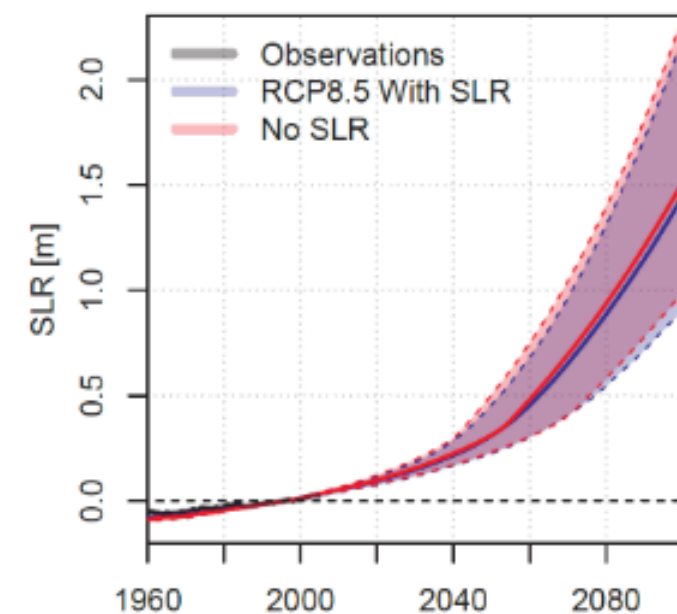


Hartin et al., 2015, 2016, Willner et al., 2017

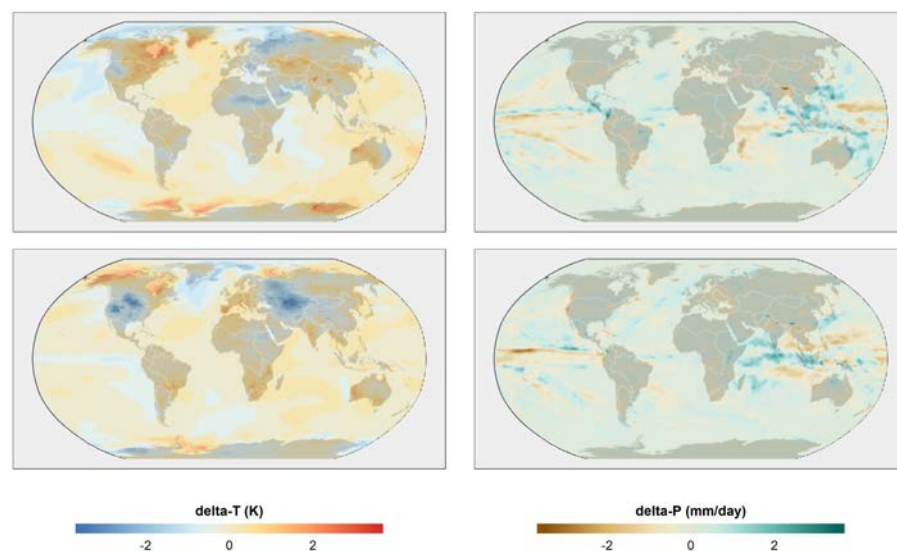
Global Mean Temperature



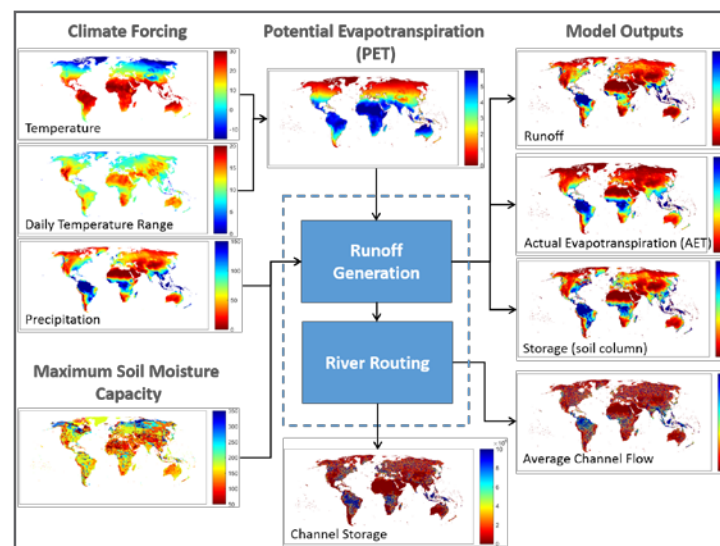
Global Sea-Level Rise



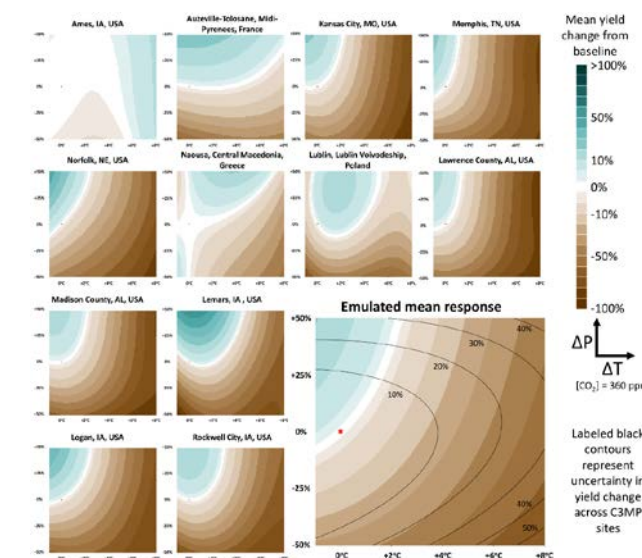
Vega-Westhoff et al 2019, Sriver et al., in prep.



Kravitz et al. 2017, Link et al. 2019, Snyder et al., 2019



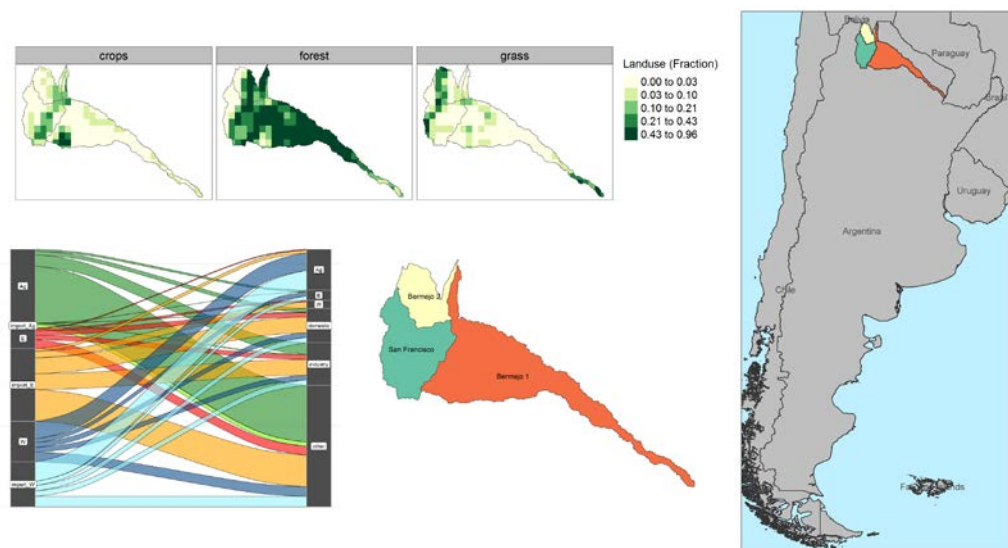
Li et al. 2017, Liu et al. 2018, Vernon et al., 2019



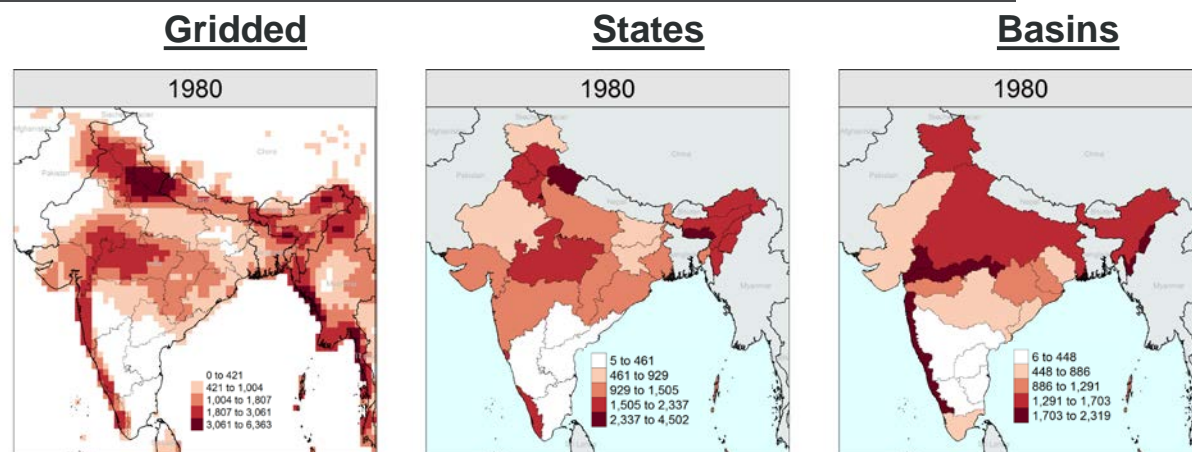
Snyder et al., 2019, Snyder et al., in prep.

# Example regional projects using GCAM

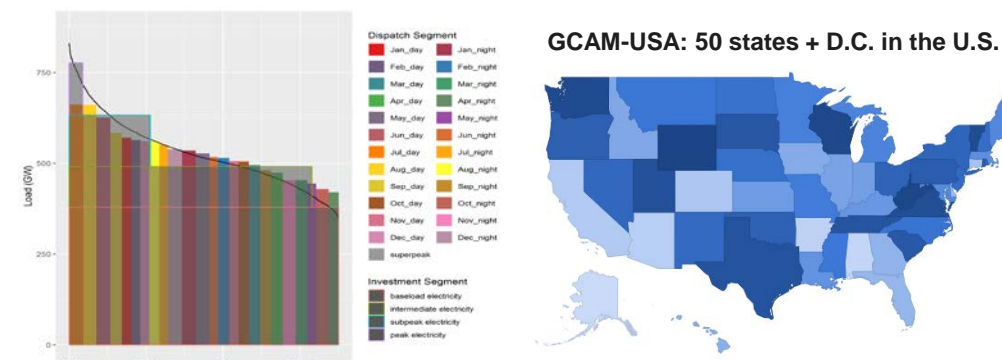
## LAC – Sub basin modeling



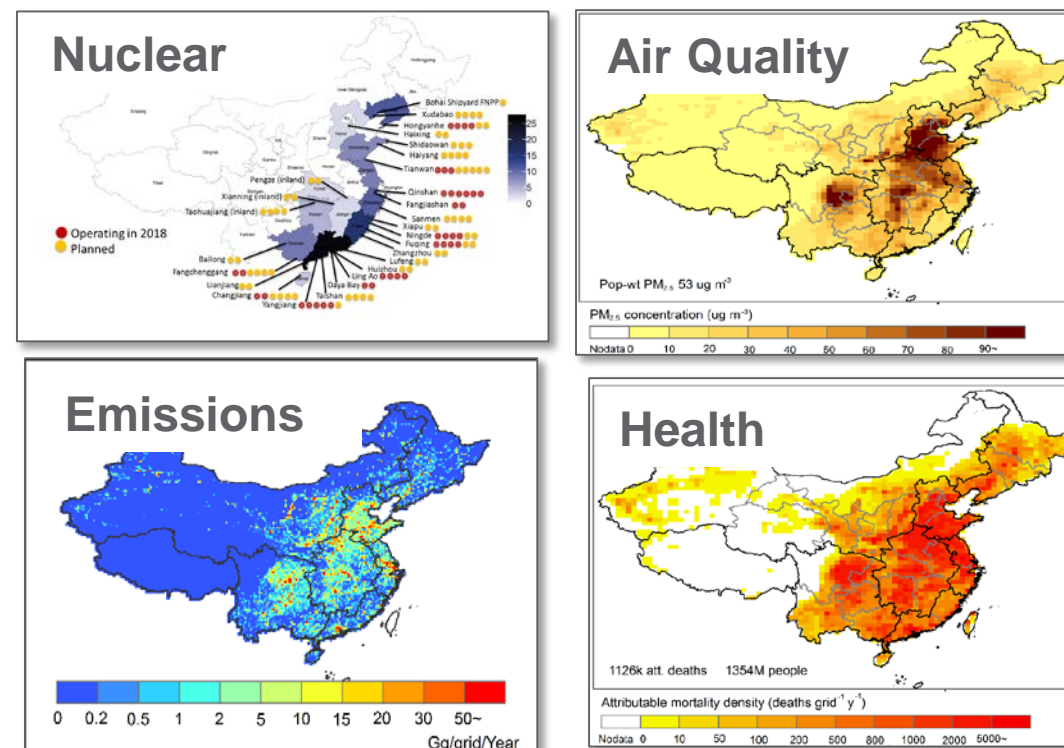
## India – States/Basins – Water Scarcity



## US – States – Sub-annual Electricity Dispatch Profiles



## China – Provincial – Health



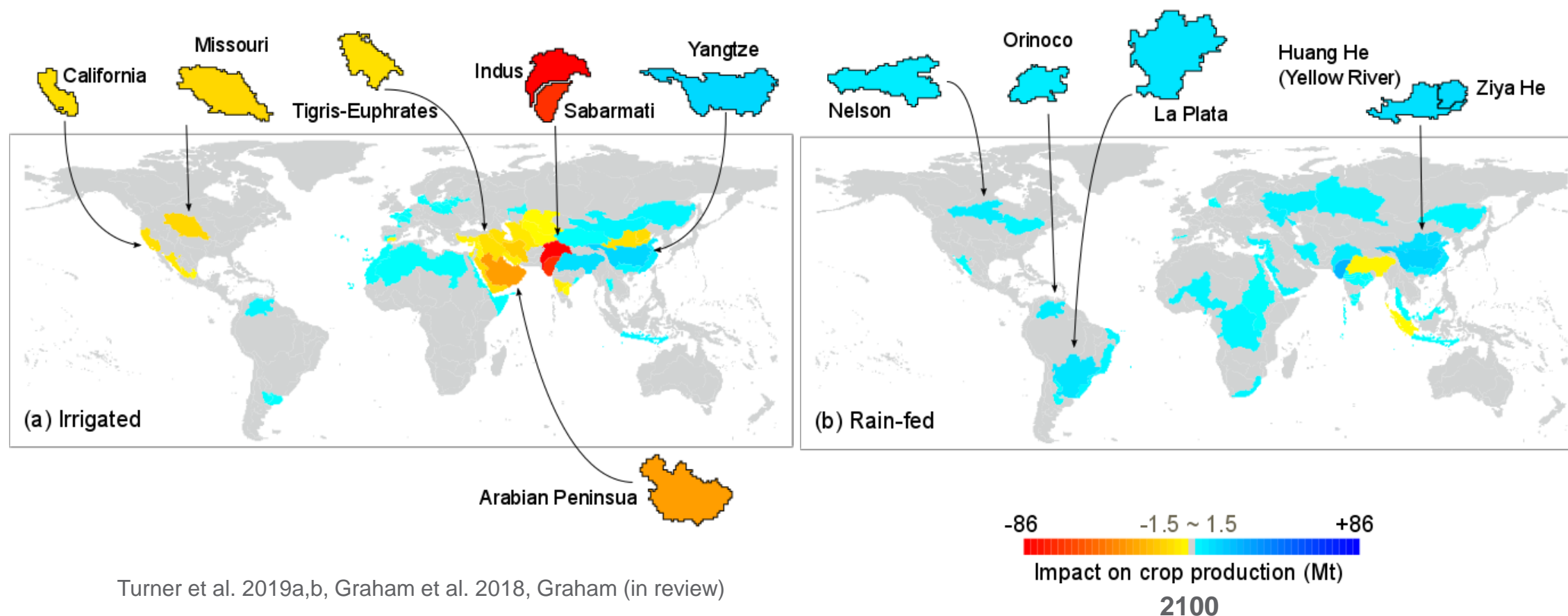


# Exploring the implications of water limits in GCAM – water supply/allocations are part of the GCAM release

**Objective:** explore the response of land use and agriculture to constraints in groundwater availability and cost.

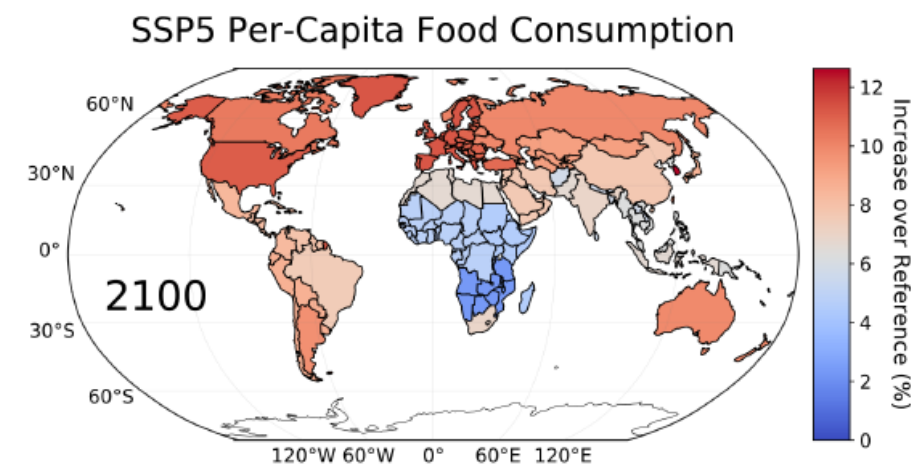
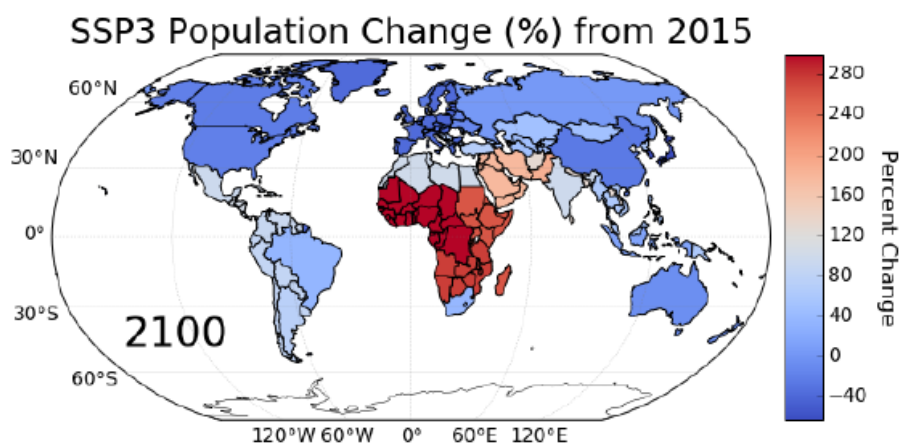
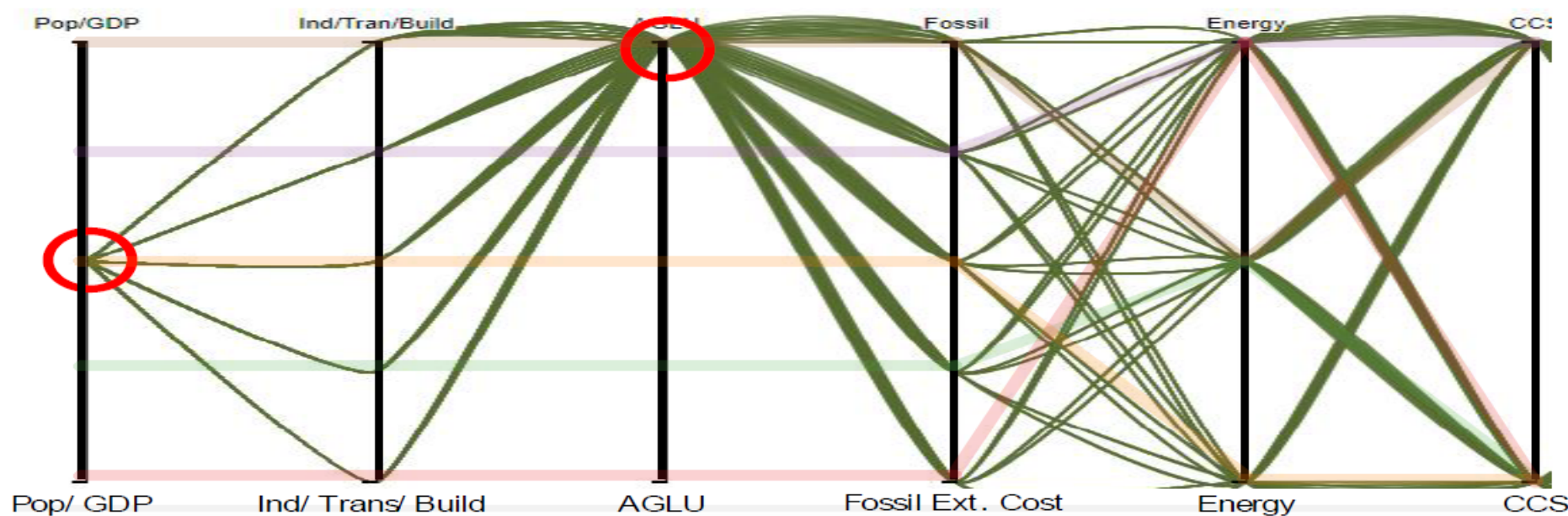
**Approach:** simulate GCAM with and without groundwater constraints; analyze location and mode of crop production.

**Impact:** modest changes in irrigation and location of crop growth can ensure global food supplies are met despite constrained water resources.



# Exploring uncertainty in highly complex, interconnected systems

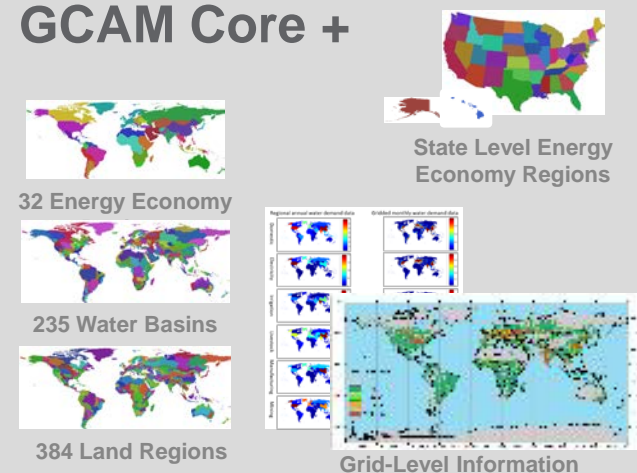
## Exploration and Quantification of Uncertainty in Integrated Energy-Water-Land Systems



# Expanding the Interactions between systems

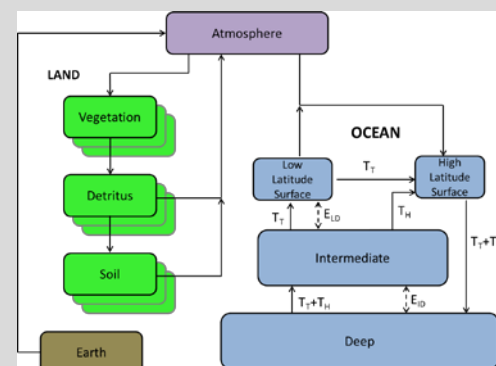
**Human Systems  
Dynamics (Emissions,  
Land Cover)**

**GCAM Core +**



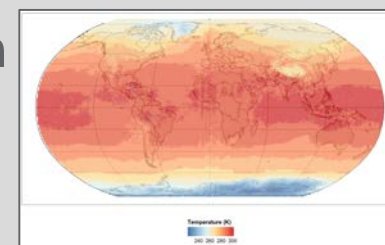
**Global Mean Surface  
Temperature**

**Hector**

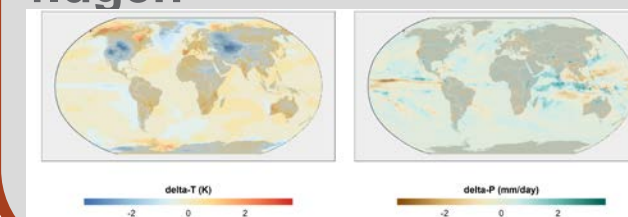


**Spatially and Temporally-  
Resolved Precipitation  
and Temperature**

**dnnclim**



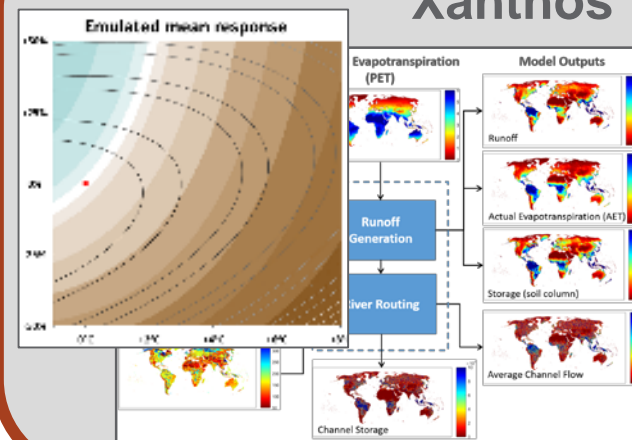
**fldgen**



**Water Availability and  
Agricultural Yields**

**Persephone**

**Xanthos**





- The next GCAM Community Annual Meeting will be in the Spring of 2021. There won't be a meeting in 2020.
- We will continue to support the GCAM user community through our various online interfaces.
- We will also continue to release GCAM updates over the next 18 months.
- New GCAM releases will be announced on the GCAM listserve.
- Questions regarding GCAM should be posted to GitHub issues (<https://github.com/JGCRI/gcam-core/issues>).
- There are instructions on joining the listserve on this page: <http://www.globalchange.umd.edu/gcam/gcam-community/>



**Thank you**





## Other future directions

- Improve the representation of technological options (infinite nesting), storage, and response strategies
- Account for multiple stressors/influences affecting EWL systems simultaneously
- Expand on the emulation capability to account for the climate effect on natural and unmanaged systems including the use of machine learning techniques
- Expand on the scenario discovery capability