Forecasts of future streamflow in a Coastal Plain river using OpenNSPECT

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Agenda

- Background
- Study area
- Model description
- Model parameterization
- Results
- Discussion
- Conclusions

Background

- Childress (2014) work on Blue Crab population dynamics in the Ashepoo-Combahee-Edisto (ACE) estuary, coastal South Carolina
- The discharge characteristics of the Edisto River appear to have a significant effect
  - Based on empirical and model data
  - Due to streamflow impact on salinity gradient and its upriver extent
- Question – what may be the impact of climate change on Blue Crab landings?
  - Investigate with streamflow model

Edisto River watershed

- Entirely in the Coastal Plain physiographic province
  - Upper part in the Sandhills
  - No major impoundments
- Blackwater river
- Soils
  - High permeability and infiltration in interfluves
  - Range from well drained in uplands to poorly drained in riparian areas
    - Often wide floodplains
- No large cities
  - Agriculture, silviculture
- Focus of conservation efforts

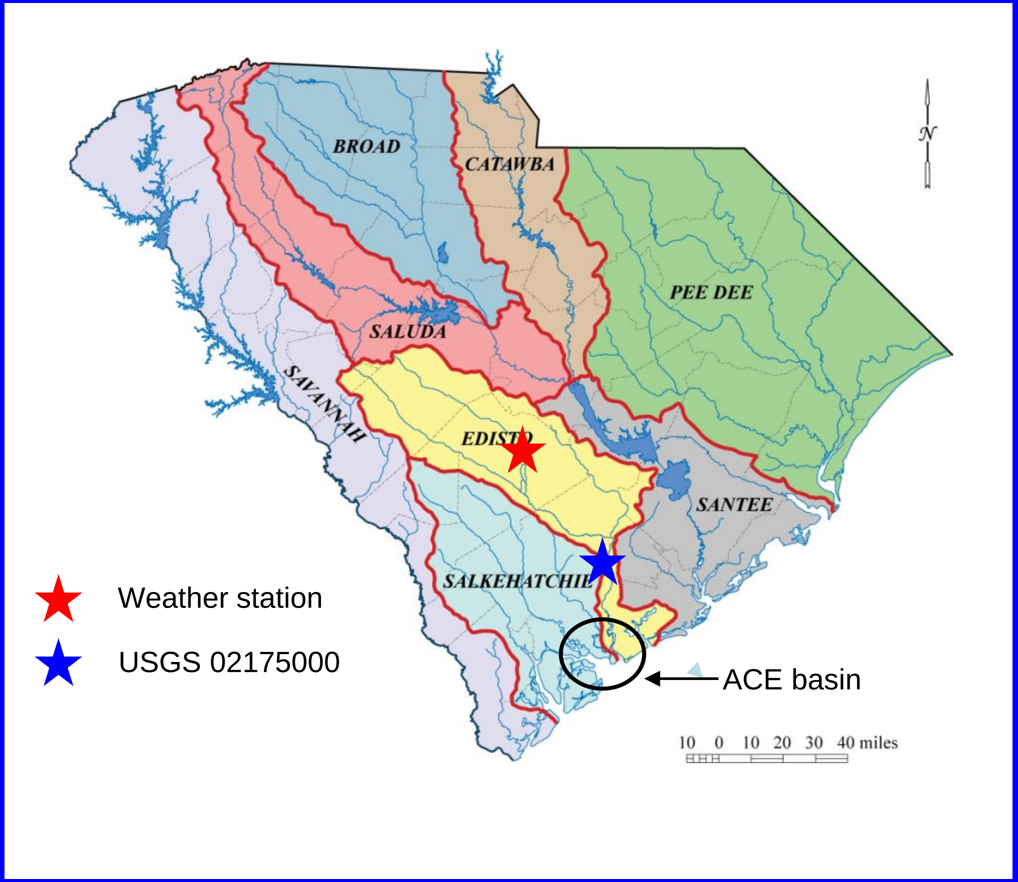
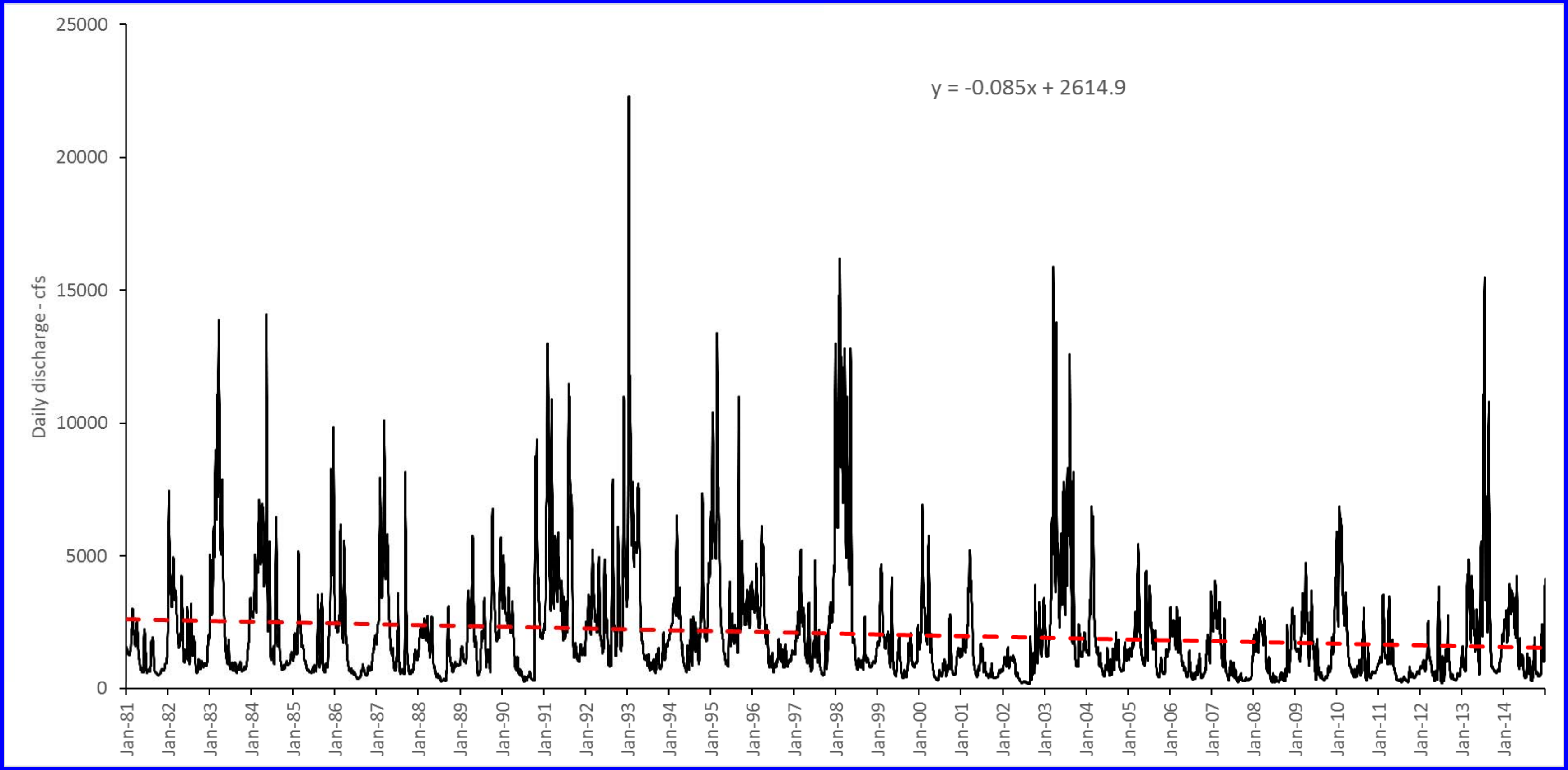


Image from www.dnr.sc.gov

Edisto River streamflow



All discharge data: USGS 0217500 Edisto River near Givhans, SC
retrieved from waterdata.usgs.gov/nwis


CAUTION

OpenNSPECT

- Nonpoint Source Pollution and Erosion Comparison Tool
  - NOAA Office of Coastal Management
  - Estimates, among other things, surface runoff volume
  - Storm event or interval
- GIS-based using MapWindow
  - Uses data layers for elevation, land use/land cover, soils, precipitation
    - Other data when modeling pollutants
- Estimates surface runoff
  - For total streamflow also need subsurface flow

Model parameterization

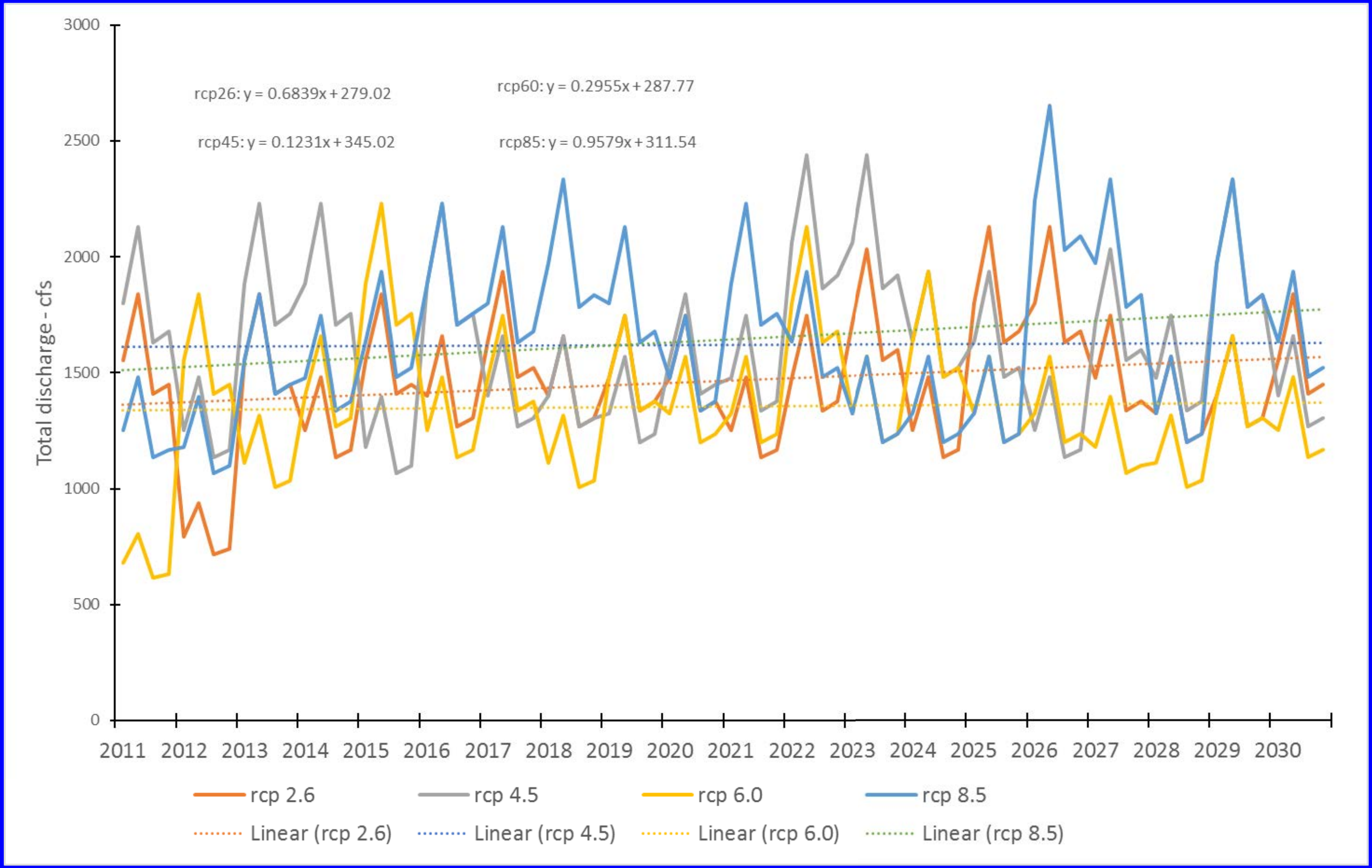
- Digital elevation data
  - Used by OpenNSPECT for watershed/subwatershed delineation
- Land use/land cover
  - Downloaded from C-CAP
- Soils
  - Downloaded from NRCS Soils Data Access
  - Used for runoff curve number
- Precipitation
  - Used GCM data from KMNI (Netherlands) for forecast modeling
  - CMIP 5
  - Monthly precipitation, evapotranspiration

Model execution

- Climate scenarios
  - Use four representative concentration pathways (RCP)
    - IPCC AR5 modeling work
  - Represent trajectories of radiative forcing
    - RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5
  - Downloaded monthly precipitation data from 2011-2030
    - Ensemble means

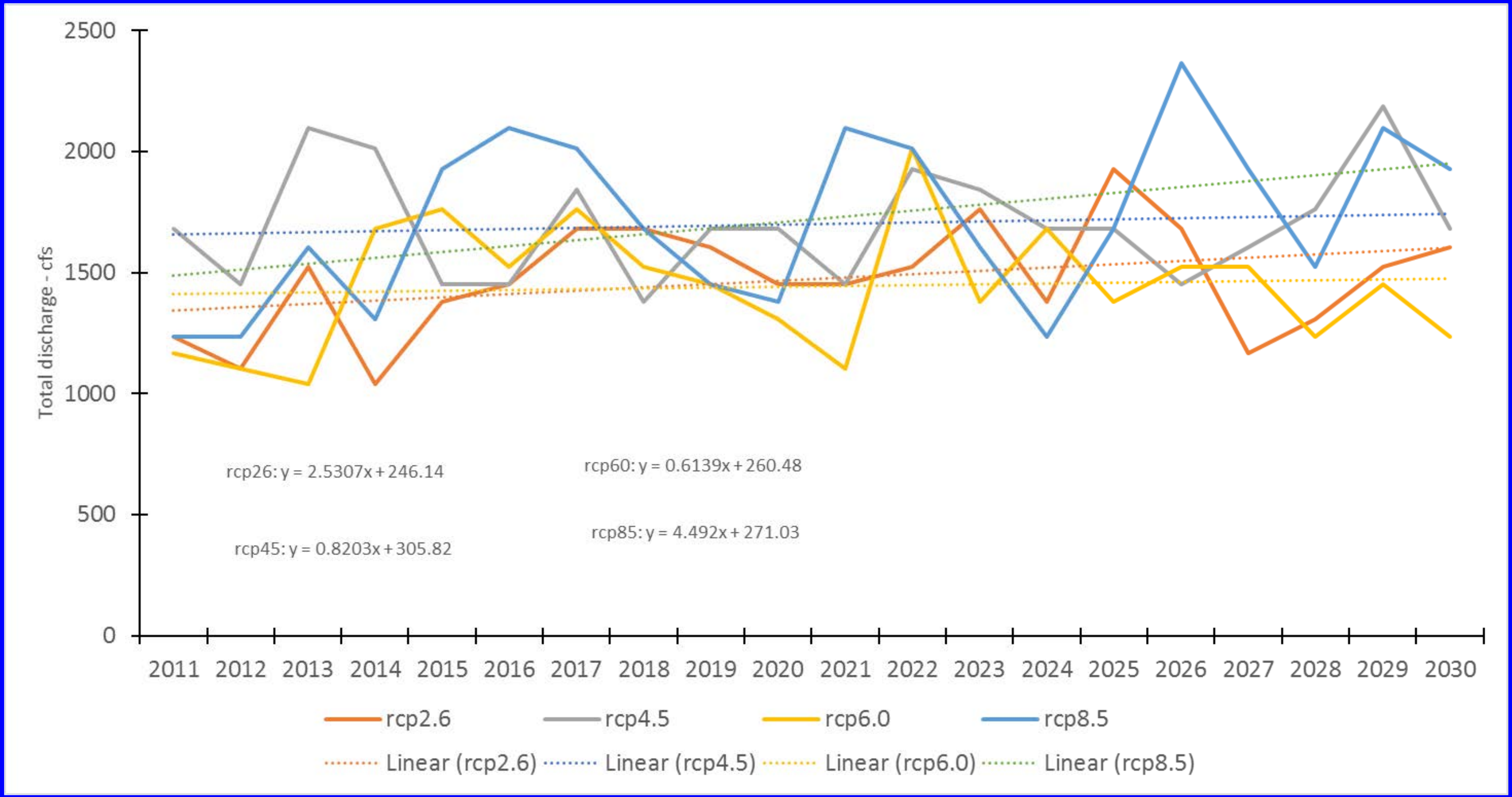
- Summed monthly precip to quarterly (seasonal)
  - Ran the model 320 times
    - Four seasons per year from 2011 – 2030 for four RCPs
  - Model result is total surface runoff volume during the season
  - Estimate total streamflow using empirical relationship between runoff and baseflow
    - Developed from 1981-2010 USGS streamflow record

Results



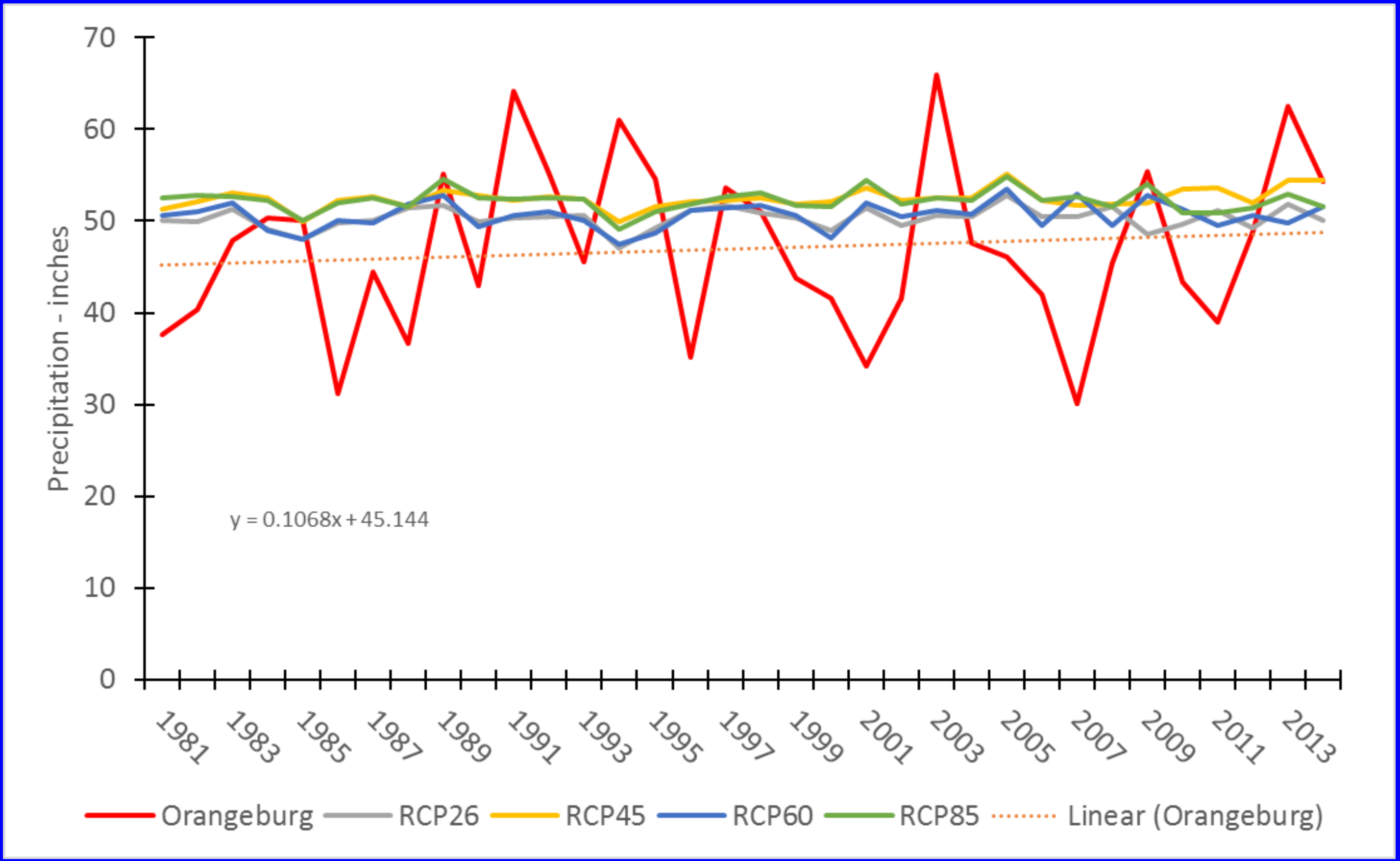
- Total streamflow for each RCP with linear trend line
- Increase ranging from approx. 0.1 – 0.9 cfs per season

Results



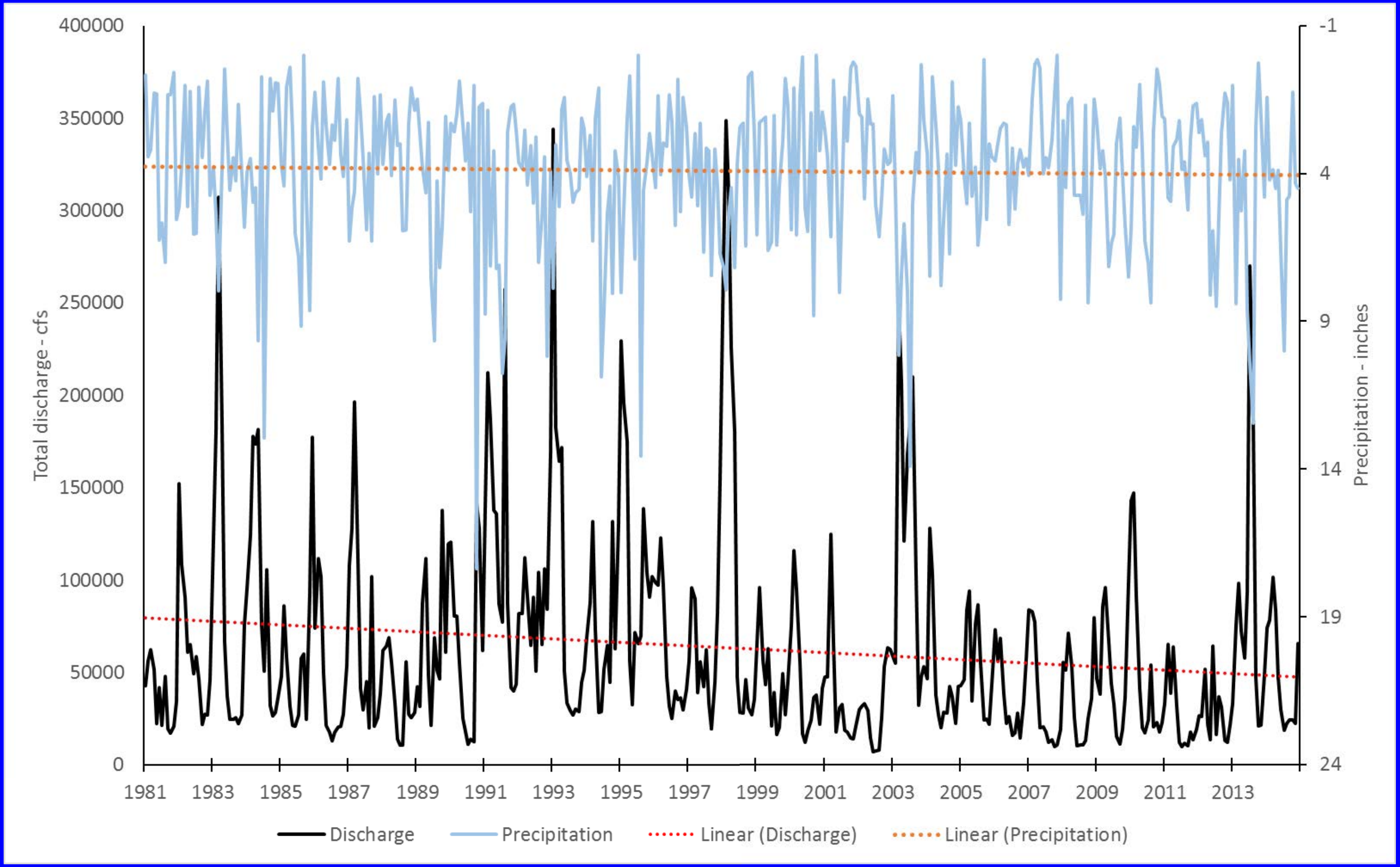
- Total streamflow for each RCP during spring
- Increase ranging from approx. 0.6 – 4.5 cfs per year

Analysis



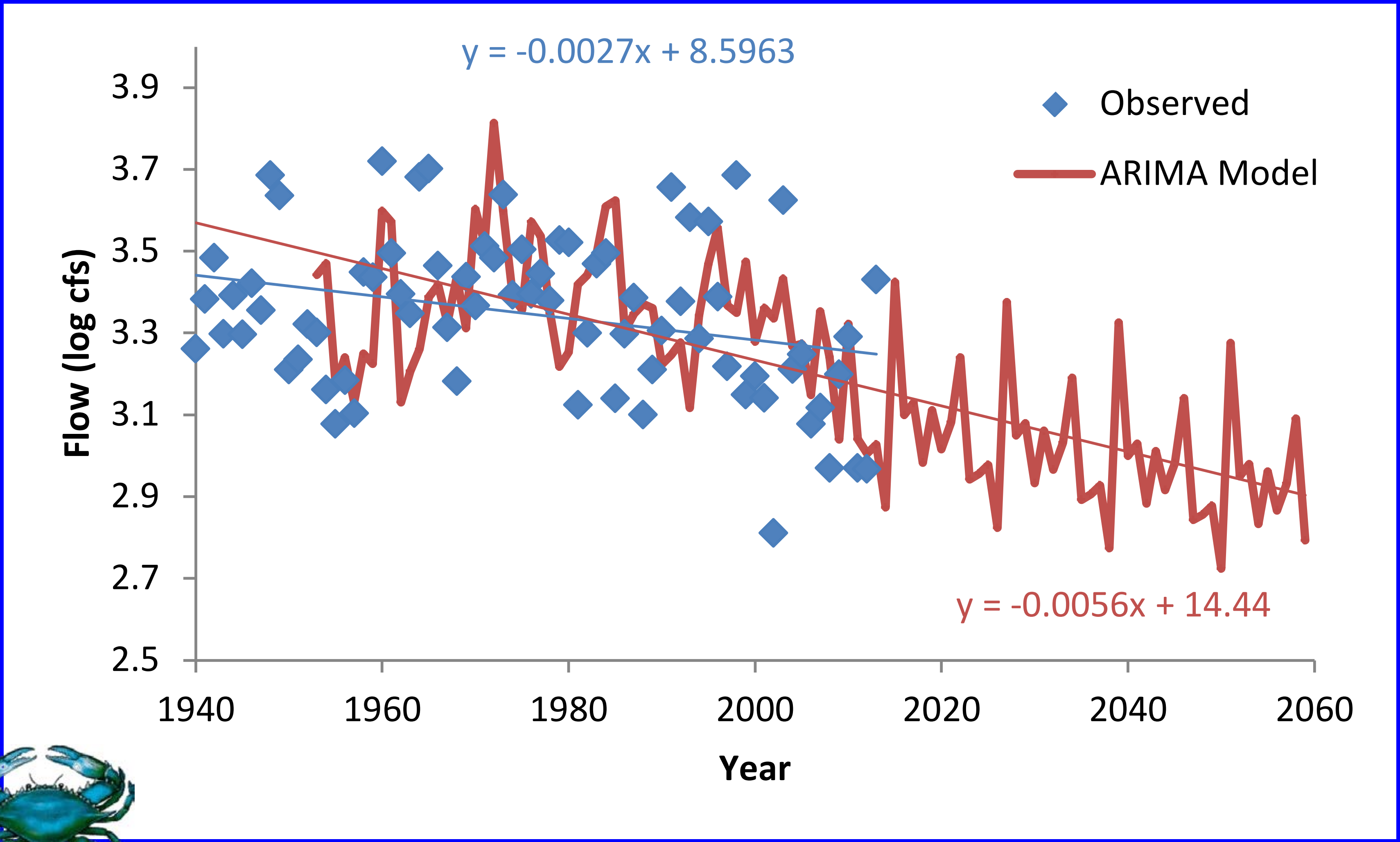
- Compare GCM precipitation to observed at Orangeburg
  - Linear trendline for observed precipitation has small positive slope
  - Weather station data retrieved from ncdc.noaa.gov
  - Station GHCND:USC00386527 - ORANGEBURG 2, SC US

Analysis



- Compare monthly total precipitation to discharge
  - Relatively flat precip linear trend, decreasing discharge trend.

Edisto river discharge will decrease



USGS 02175000 – Edisto River near Givhans Ferry, SC

Observations

- The cause of the decline in Edisto River discharge
  - Does not appear to be precipitation-based
  - Likely a combination of factors
  - Perhaps less precipitation during periods of aquifer recharge
  - Perhaps increase in surface withdrawals
  - Perhaps reduction in base flow
    - But what is driving that?
    - Discharge from confined aquifers
    - Perhaps increase use of wells for irrigation
    - Perhaps increase in vegetation, all types

Observations

- Will the decline continue and, if so, at what rate
  - Simulations that use ensembles of GCM models for precipitation do no provide a clear-cut answer
    - Ensembles used here suggest either flat or small increasing trend
    - These results allow us to bracket potential streamflow responses
  - Continued analysis would require
    - Estimates of anthropogenic influence on water quantity
    - Surface and groundwater withdrawals
    - Past and, especially, the future

Conclusions

- OpenNSPECT
  – Relatively easy to implement
  – Provides rough forecasts of streamflow
  – A good tool to help frame uncertain future
- Additional work
  – Estimates of withdrawals
    - Surface and groundwater
  – Use downscaled estimates of precip, ET

Questions