Approach to Incorporating Climate Change in the Probabilistic Performance Assessment

Topics

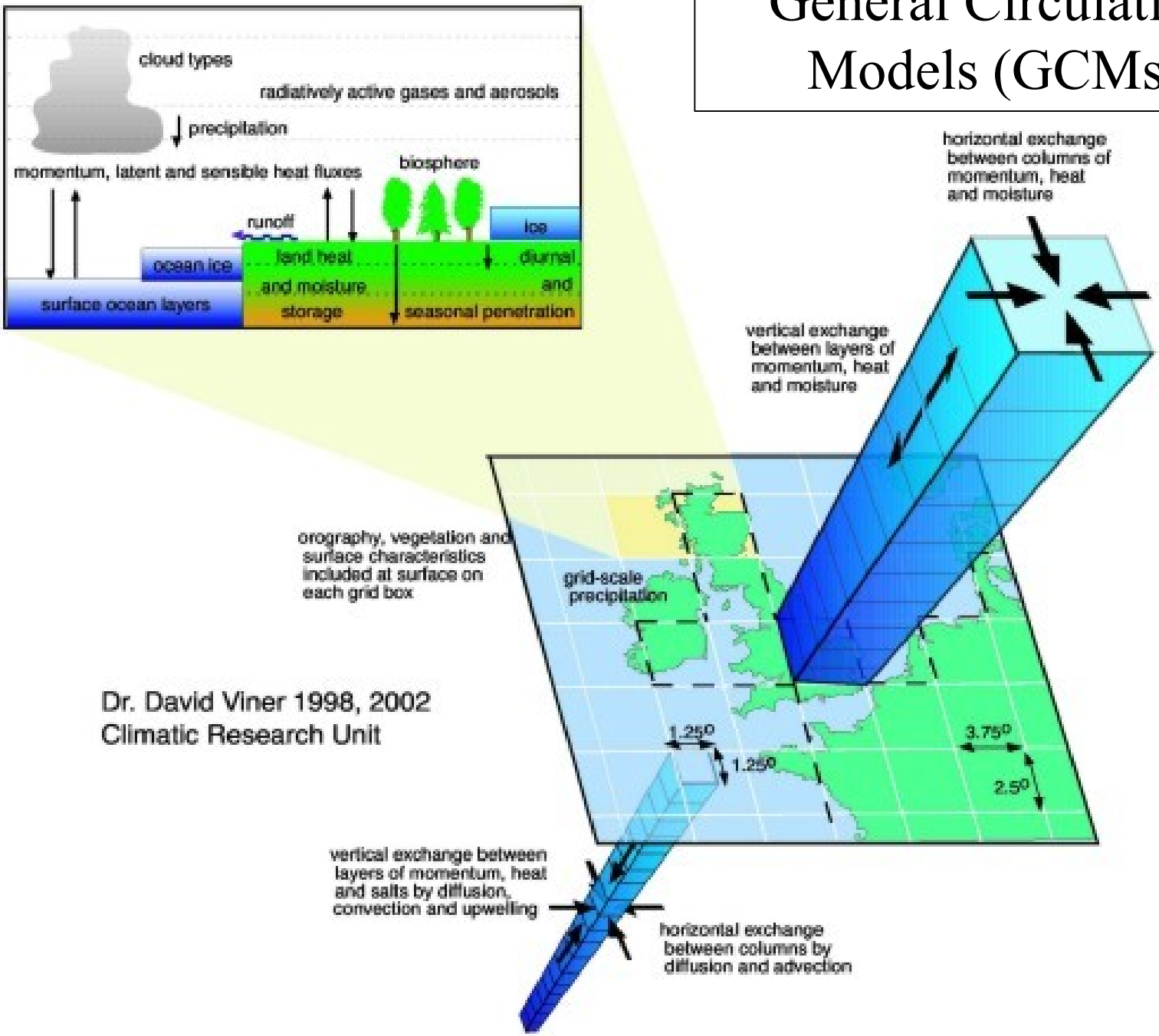
- Climate Change
  - Scenarios of future change
- Erosion
  - Impacts of future change on gully head retreat and hillslope failure

Climate Change

- Future scenarios of climate come from the Intergovernmental Panel on Climate Change (IPCC) analyses

- These scenarios are generated using both complex models and assumptions about the future (i.e. year 2100)

General Circulation Models (GCMs)



Climate Change

- The goal of these climate change scenarios is not to predict the future
- The goal is to assess the impacts of different scenarios of human activity on key aspects of the global climate system

Climate Change

- This necessarily involves lots of assumptions (e.g. concentrations of greenhouse gases in the atmosphere)
- The Neptune approach uses the state of the science for climate models to inform the Performance Assessment

Climate Change

- The Erosion Working Group (EWG) used output from General Circulation Models (GCMs) to simulate impacts of increased precipitation on future erosion rates

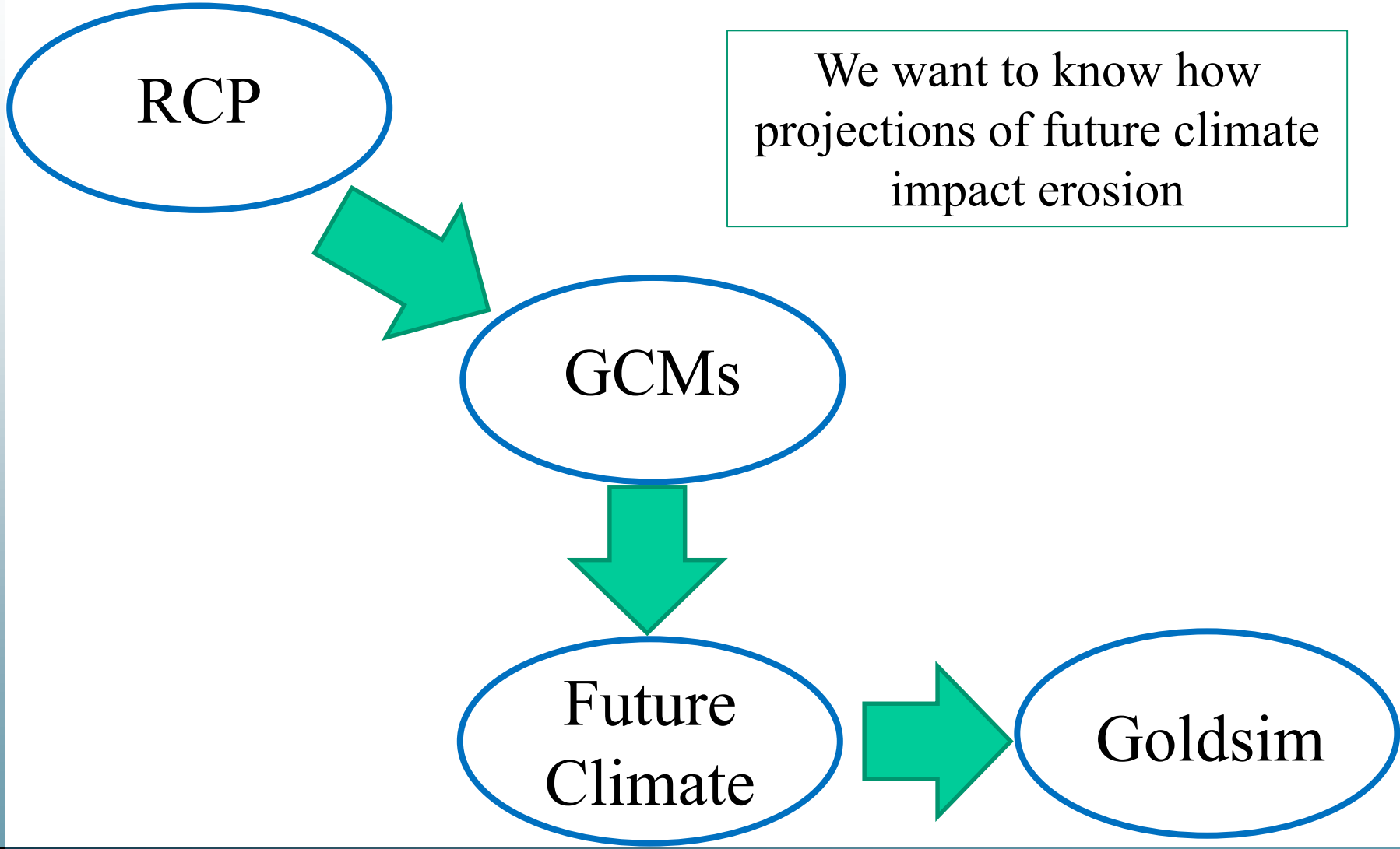
- GCMs use inputs about future population, energy use, and land use

Representative Concentration Pathways (RCPs)

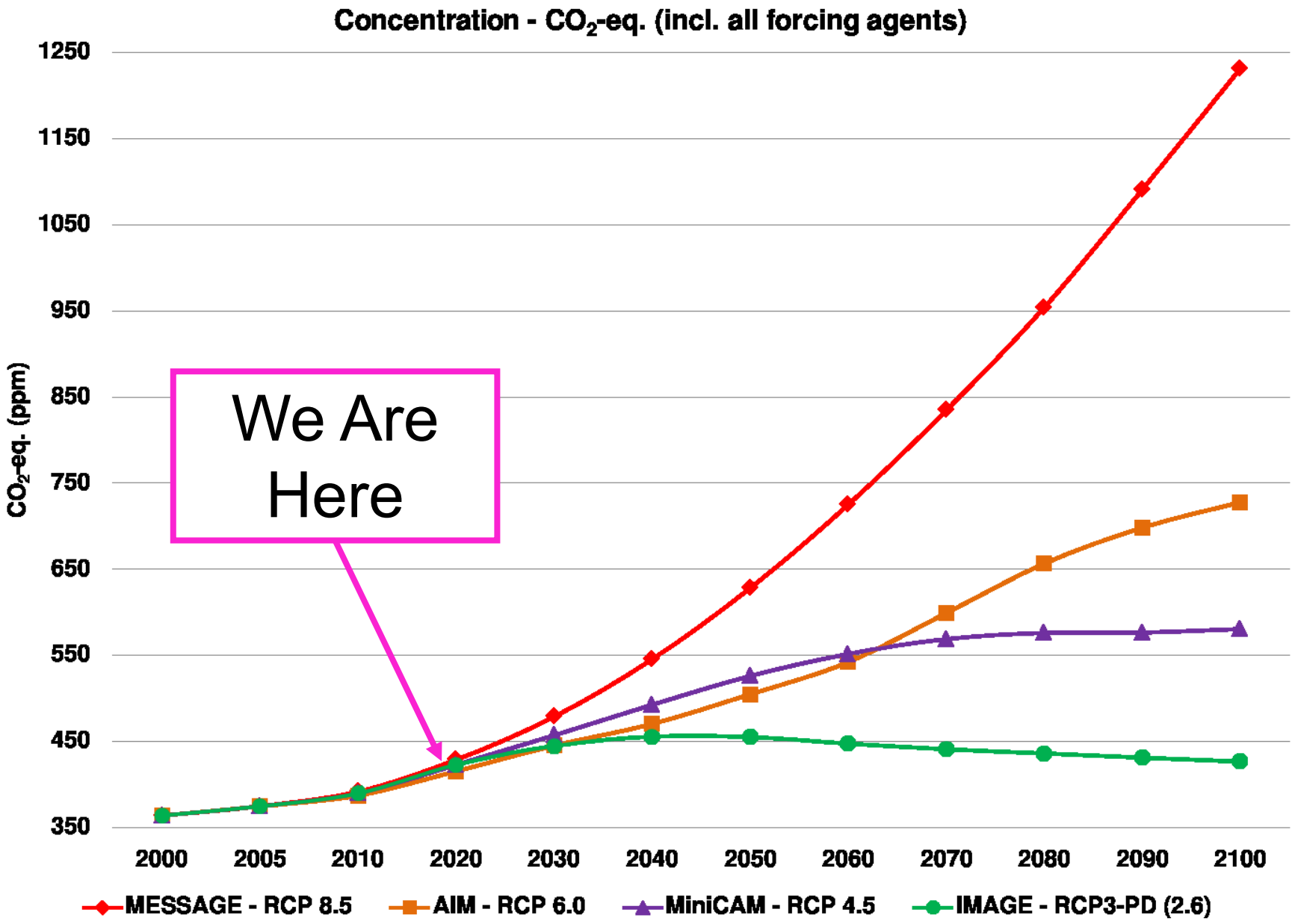
- RCPs are collections of assumptions about population growth, energy use patterns, and land use change and their effect on greenhouse gas concentrations

- Economic development associated with energy usage (e.g. how much and from what sources) is an important driver of future climate

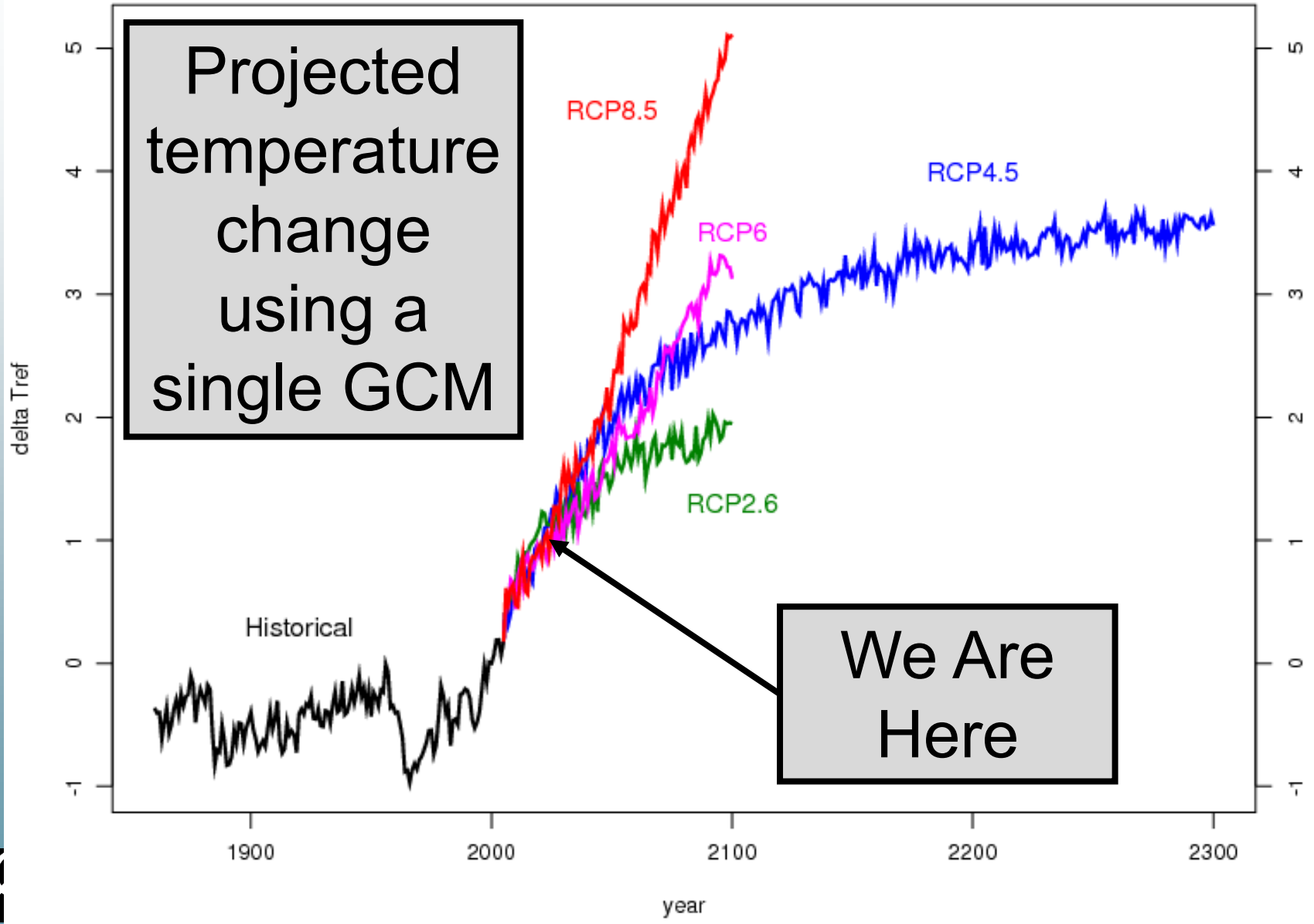
Data Flow



We want to know how projections of future climate impact erosion


Concentration - CO_2-eq. (incl. all forcing agents)
1250
1150
1050
950
850
750
650
550
450
350
CO_2-eq. (ppm)
We Are Here
2000
2005
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
MESSAGE - RCP 8.5
AIM - RCP 6.0
MiniCAM - RCP 4.5
IMAGE - RCP3-PD (2.6)

Global Surface Temperature Change



Climate Change

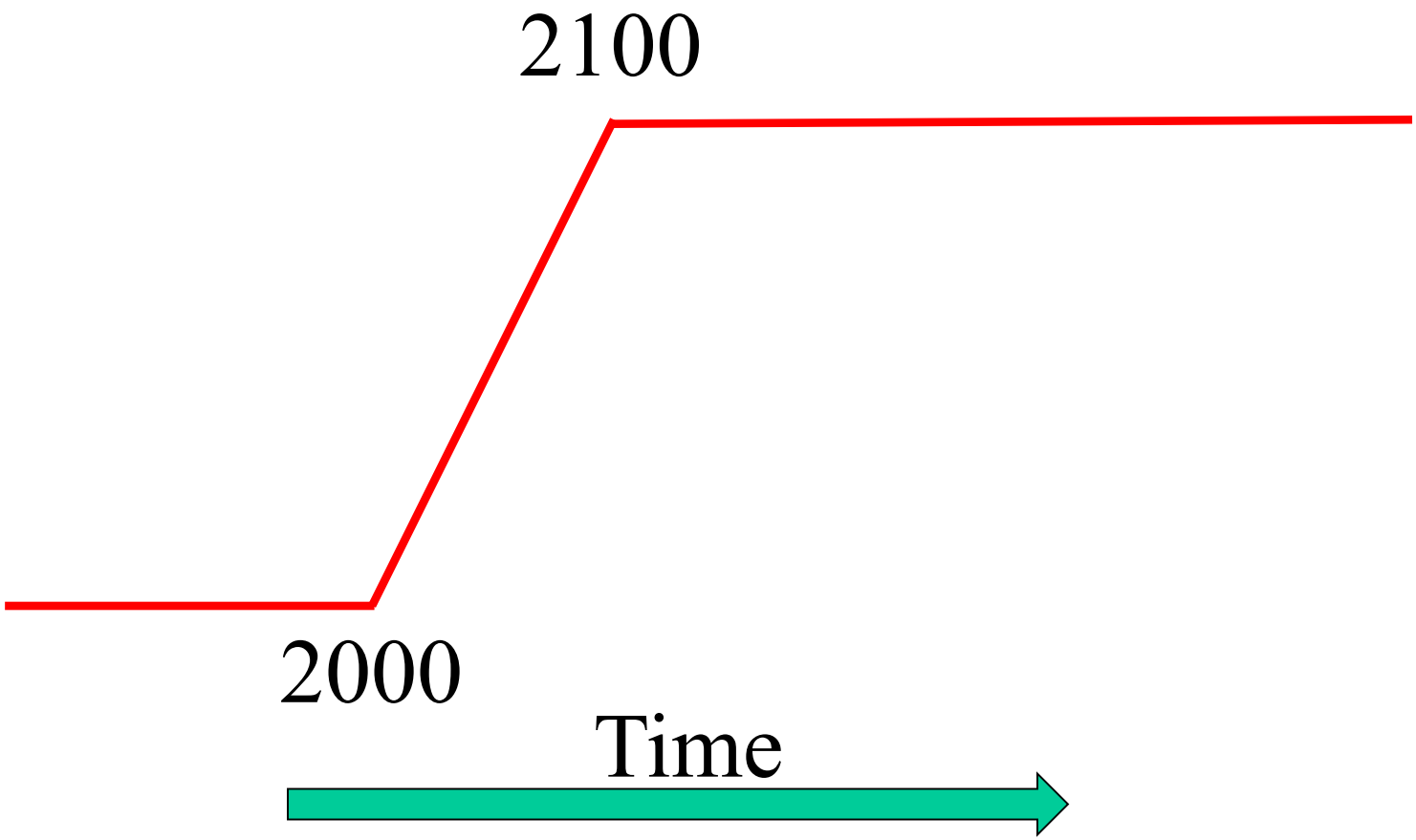
- Multiple scenarios used by the EWG to simulate future erosion

- We selected the scenario with the highest increases in CO_2 (RCP8.5), highest population growth, etc.

Climate Change

- Climate change was depicted out to 2100
- After 2100, it is assumed that the climate forcing stabilizes
- EWG erosion models are run out several thousand years after that

Climate Change: Conceptual Model



Climate Change

- In terms of precipitation RCP 8.5 corresponds to
  - Same number of days of precipitation
  - Increase in intensity of precipitation events
  - Increase in the annual precipitation total

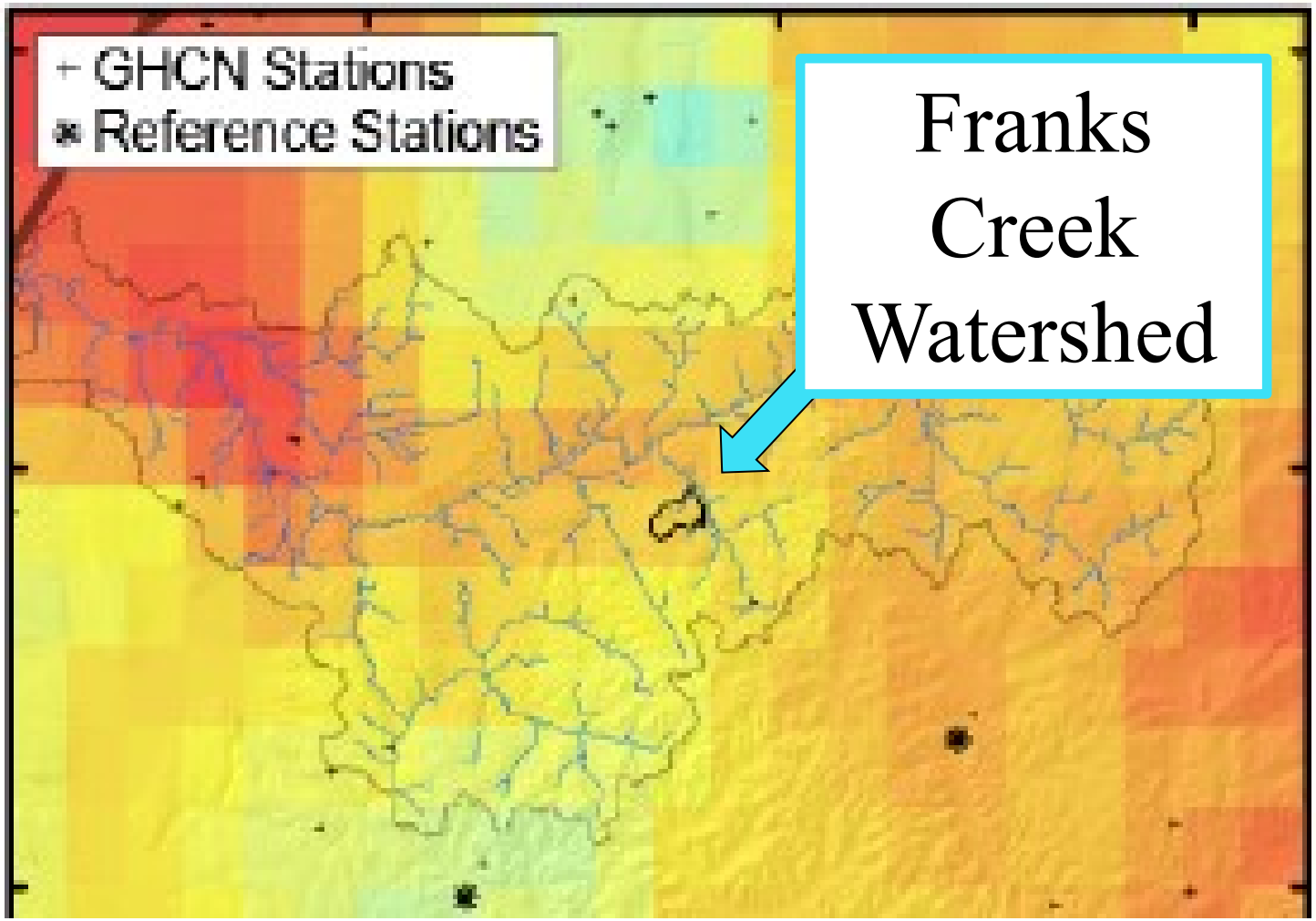
Climate Change

- Output from GCMs driven by RCPs are spatial grids of projected temperature and precipitation

- These grids cells are large and need to be “downscaled” for applications like the EWG modeling

Mean Annual Precipitation

1970-1999



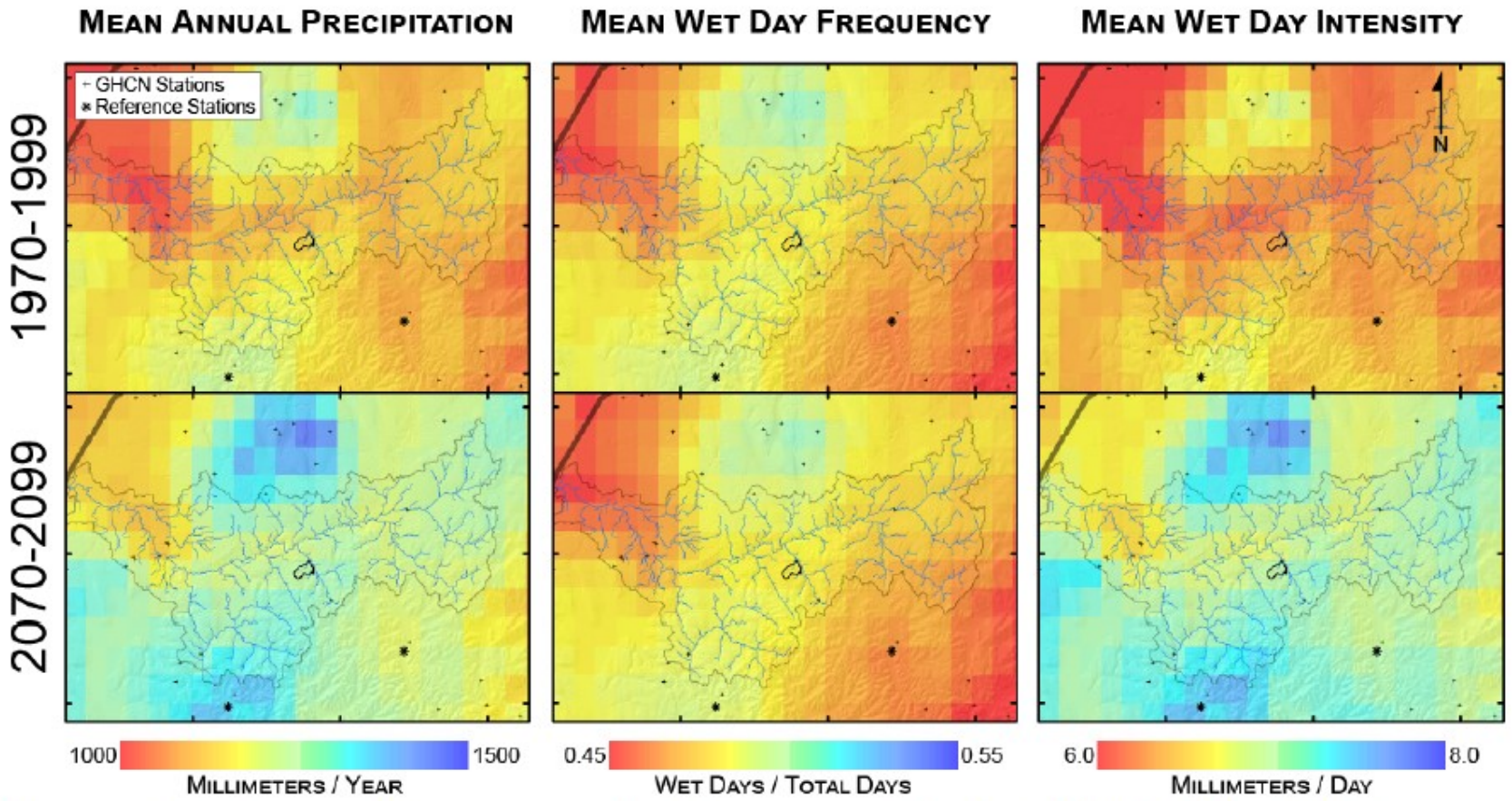
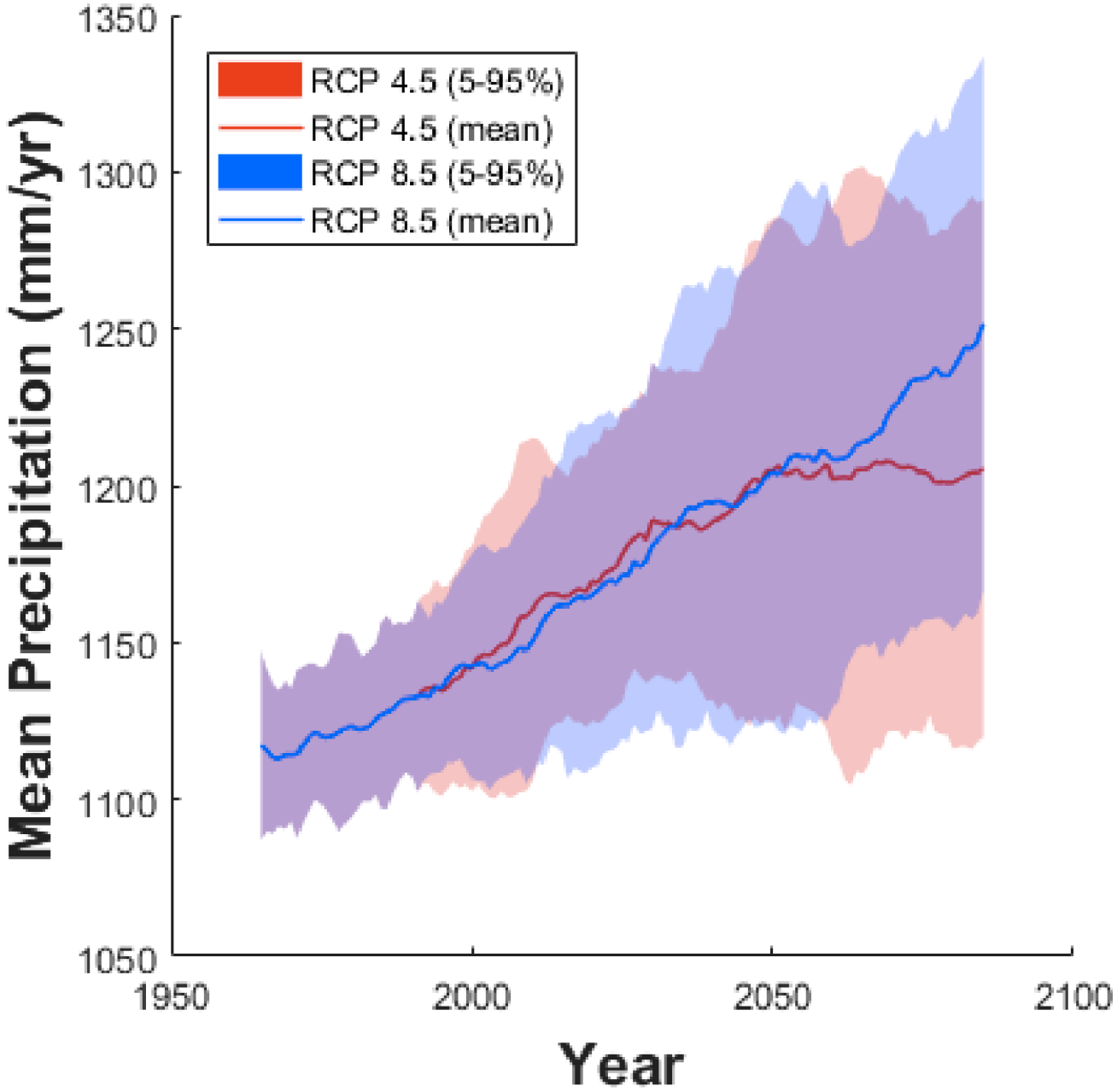
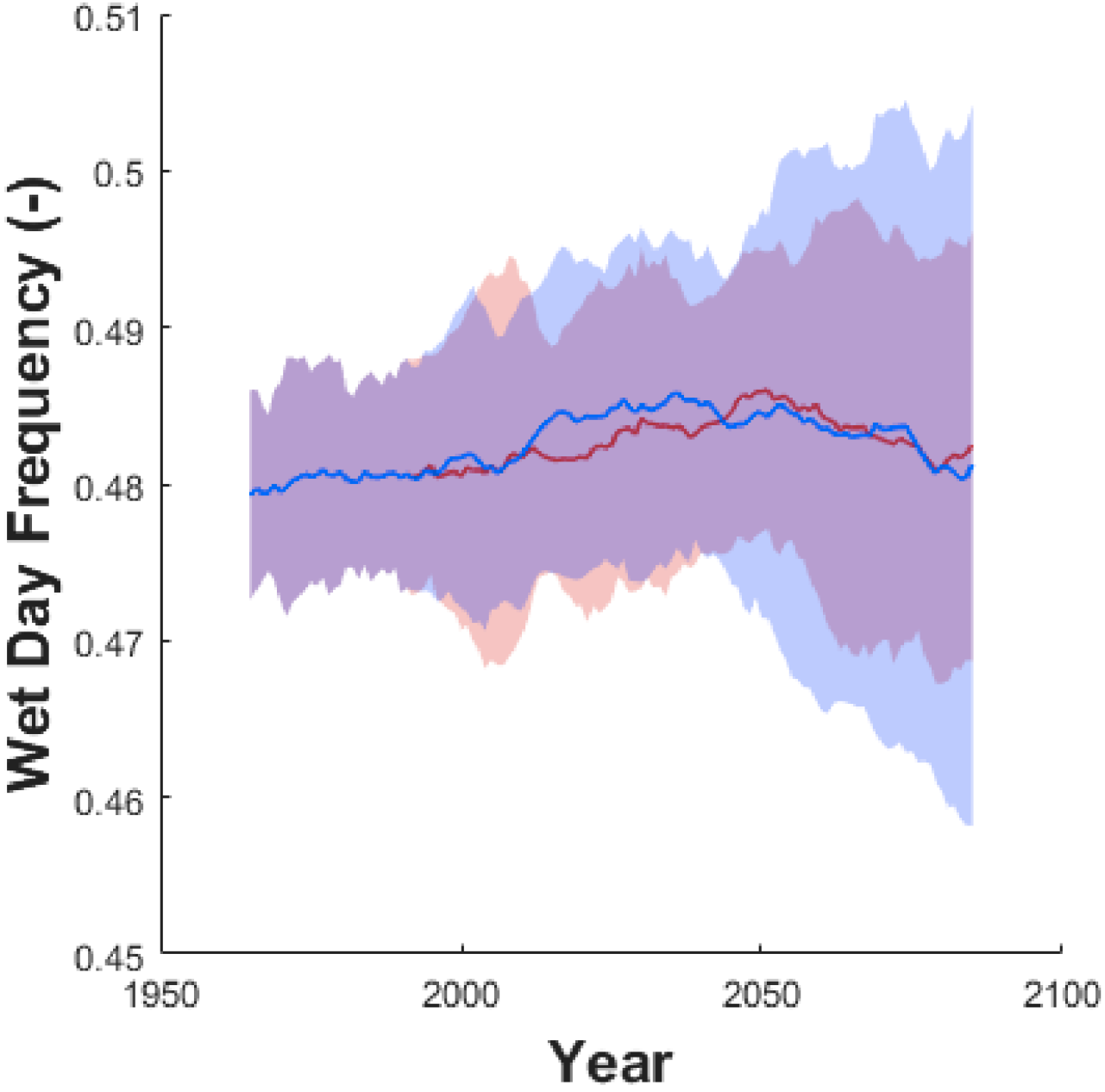
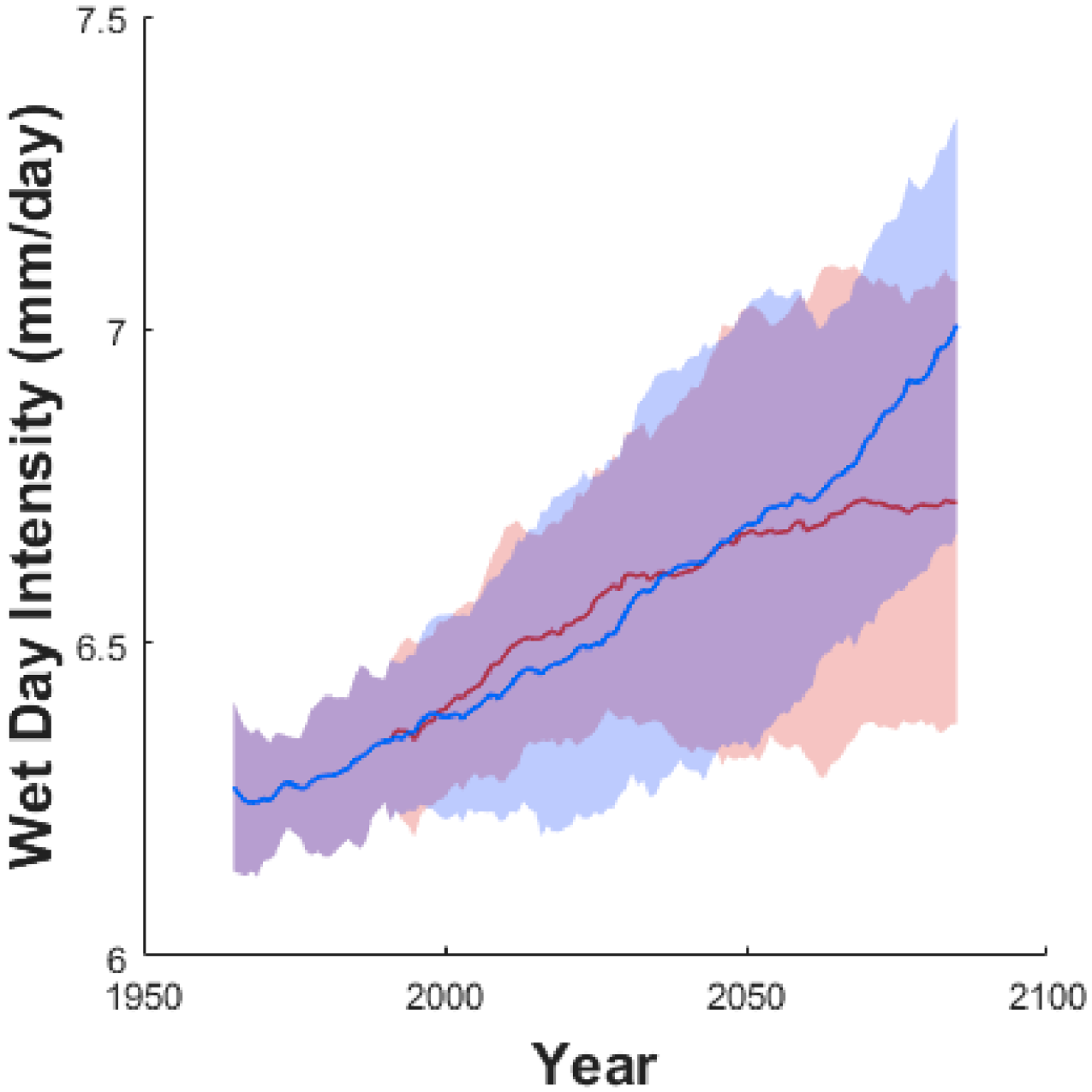


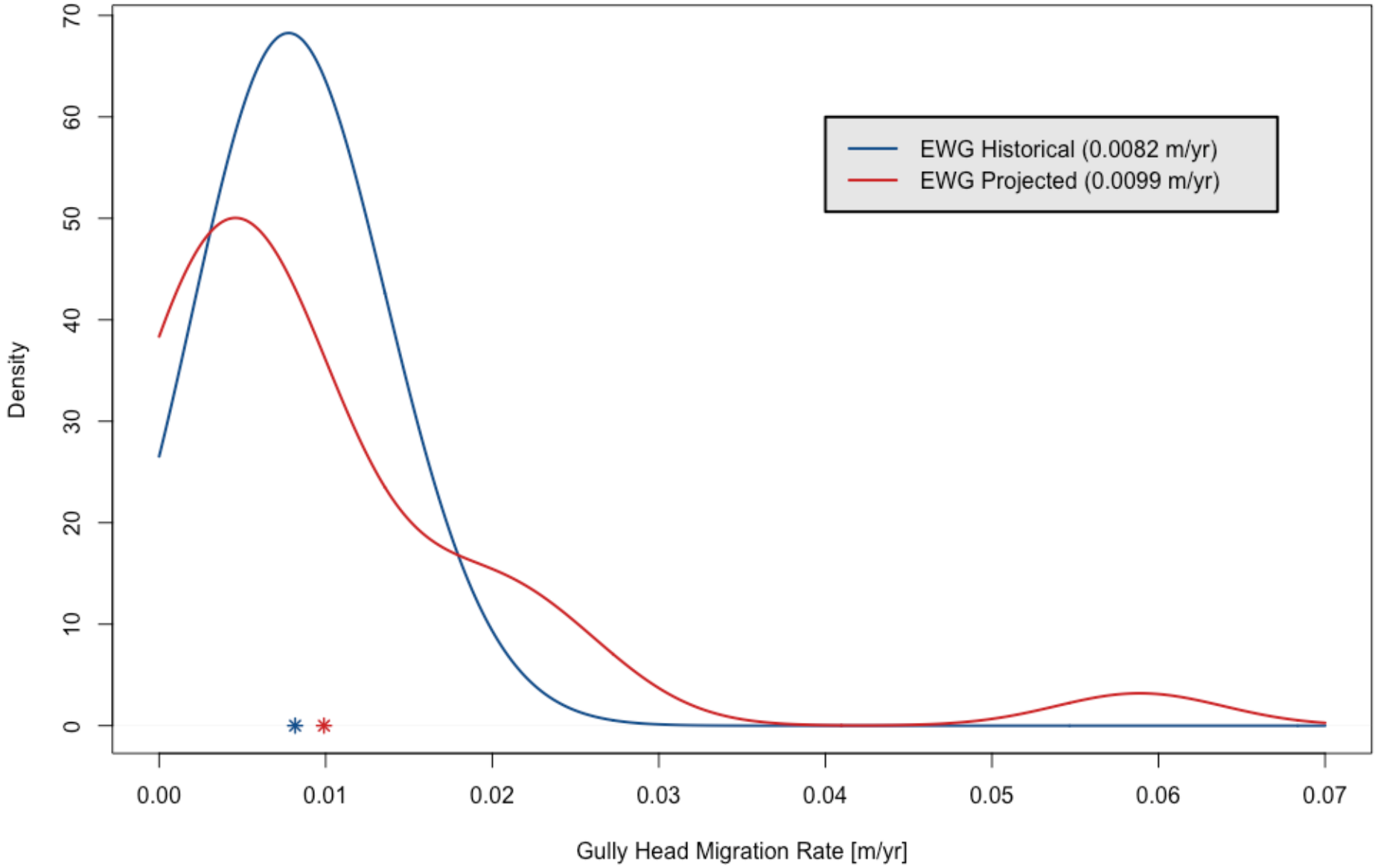
Figure 11.2: 30-year climate normals derived from MACAv2-METDATA daily for mean annual precipitation (left), mean wet day frequency >0.8 mm/day (center), and mean wet day intensity >0.8 mm/day (right). Top panels are based historic training results (1970-1999) and bottom panels are based on RCP 8.5 (2070-2099). Black crosses are locations of all GHCN stations with the two shown in Figure 5.2 highlighted as large stars. Tick marks on maps are in 15 mile increments and the Frank's Creek watershed is shown using a bold black line.


RCP 4.5 (5-95%)
RCP 4.5 (mean)
RCP 8.5 (5-95%)
RCP 8.5 (mean)
Mean Precipitation (mm/yr)
1350
1300
1250
1200
1150
1100
1050
1950
2000
2050
2100
Year


Wet Day Frequency (-)
0.51
0.5
0.49
0.48
0.47
0.46
0.45
1950
2000
2050
2100
Year


Wet Day Intensity (mm/day)
7.5
7
6.5
6
1950
2000
2050
2100
Year

EWG Gully Head Migration Rates



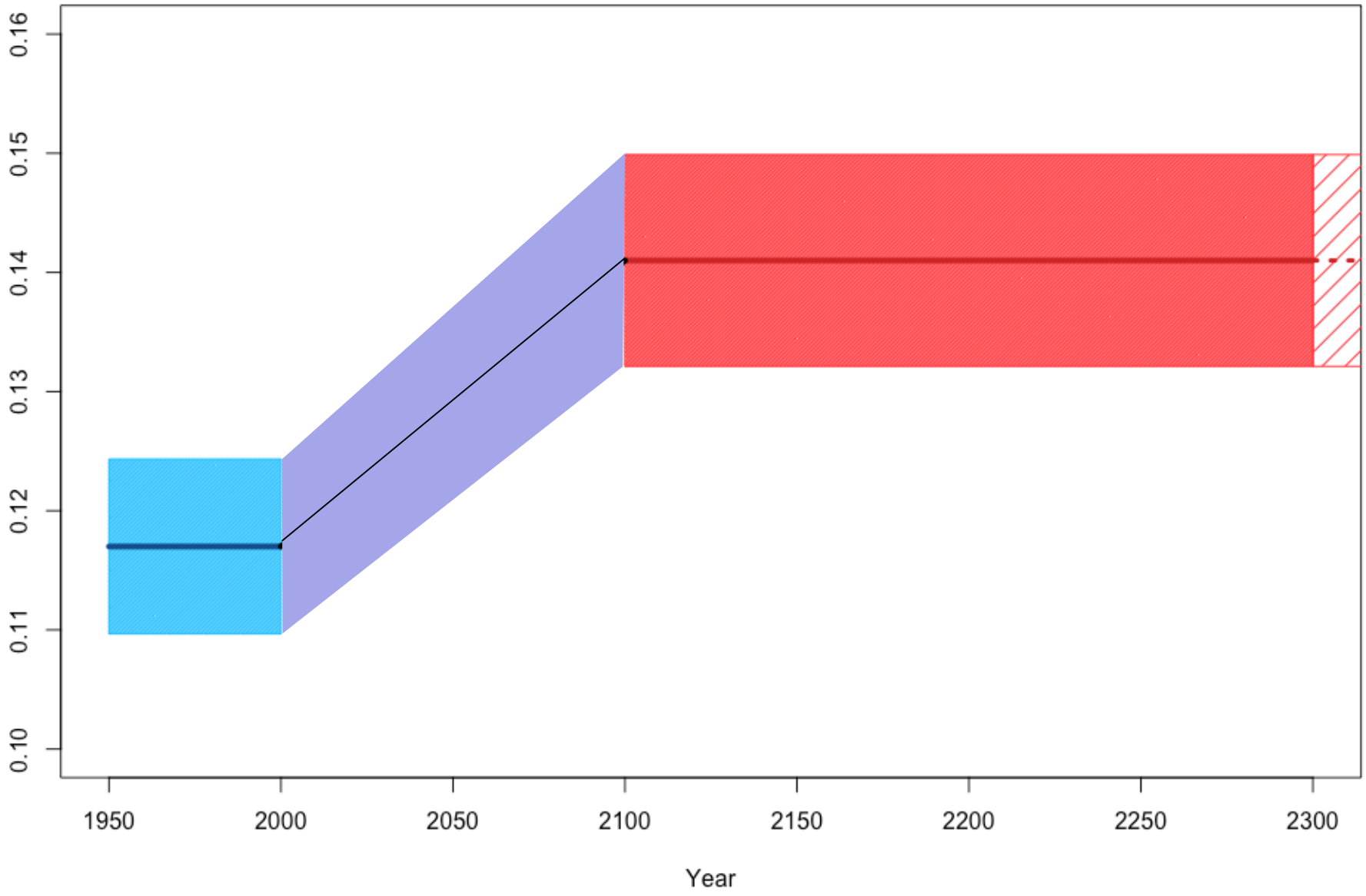
Climate Change: Erosion

- EWG estimates of the impact of climate change on erosion rates were quantified
- These were applied to the rates of erosion estimated from Neptune's analysis of historical aerial imagery

Gully Head Migration Rate

- Historical aerial image estimate is 0.117 m/yr
- Adjusted for impacts of climate change using EWG information yields 0.141 m/yr, a 21% increase

Gully Head Migration Rates



Hillslope Failure Rate

- Historical aerial image estimate is 0.0216 m/yr
- Adjusted for impacts of climate change using EWG information yields 0.0331 m/yr, a 53% increase

Summary

- Erosion
  - Future climate change results in increased rates of erosion for gully head advance and hillslope failure