Increases in surprising ocean temperatures will challenge the limits of ecosystems and people to adapt

Andrew J. Pershing

Nicholas Record, Bradley Franklin, Brian Kennedy, Katherine Mills, Andrew Thomas, Michael Alexander, James Scott
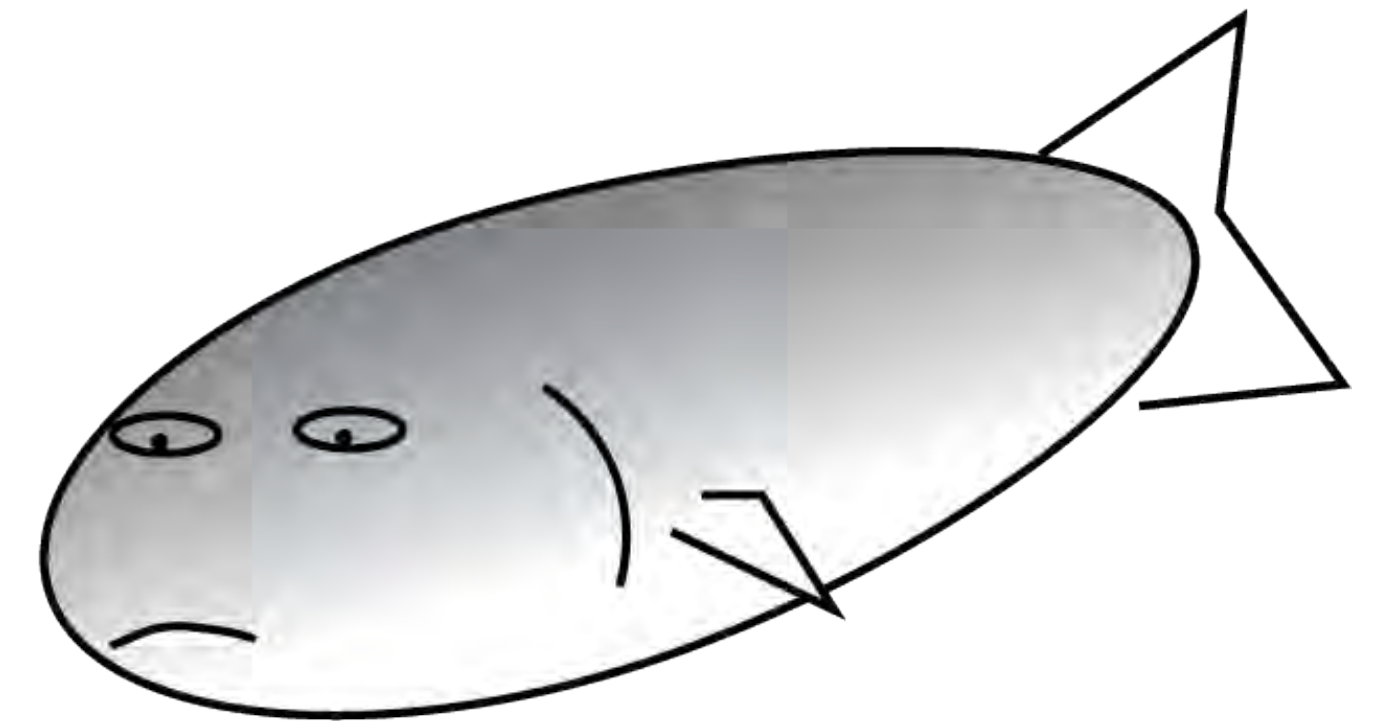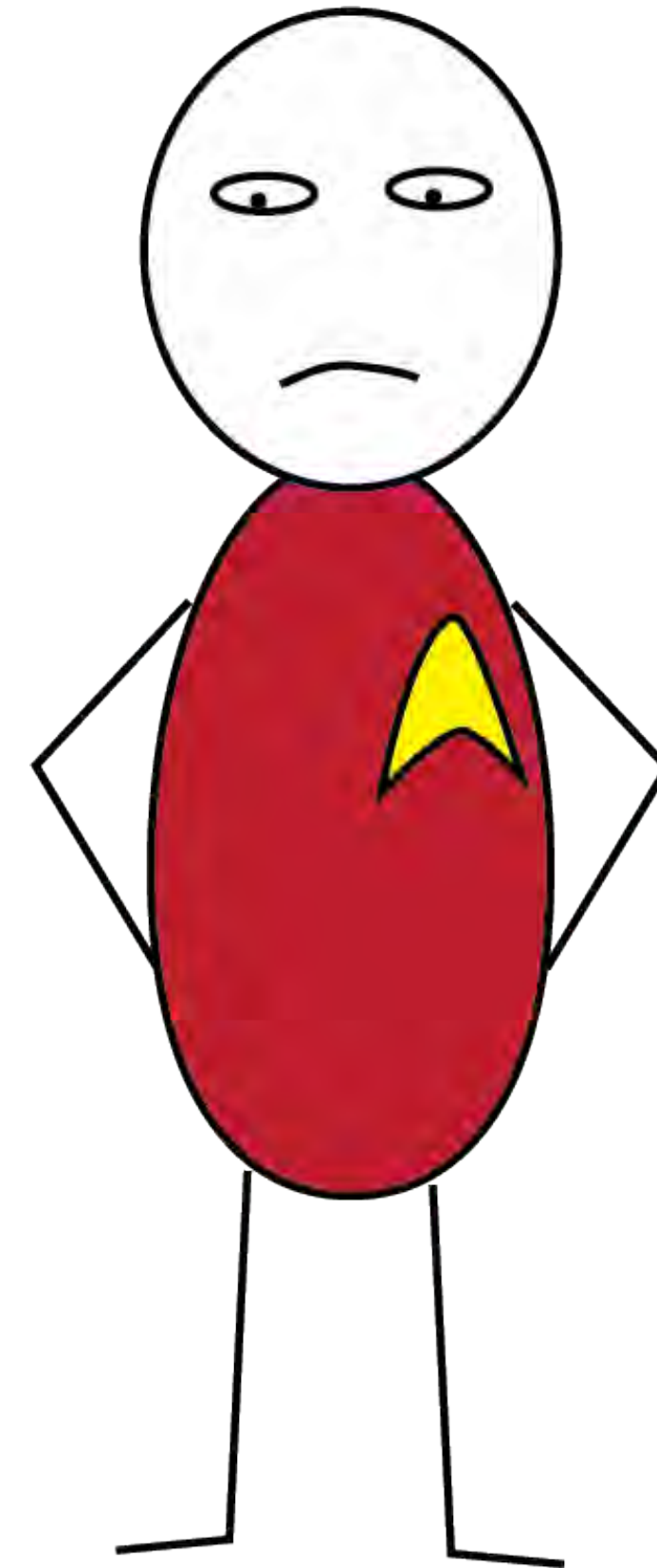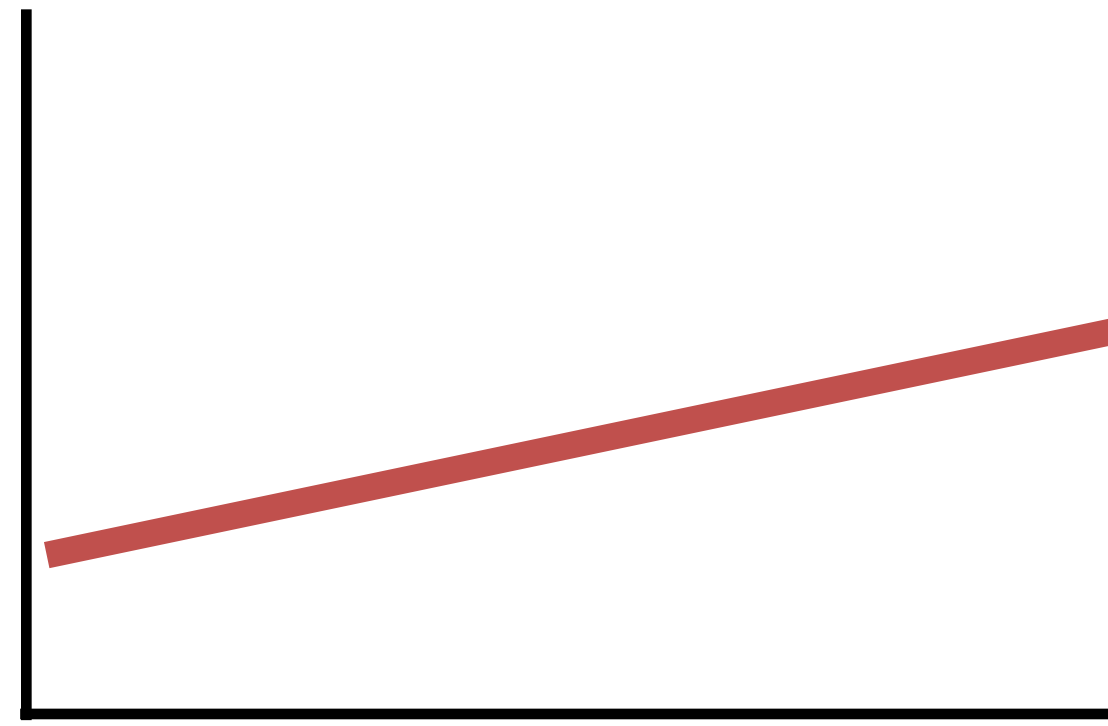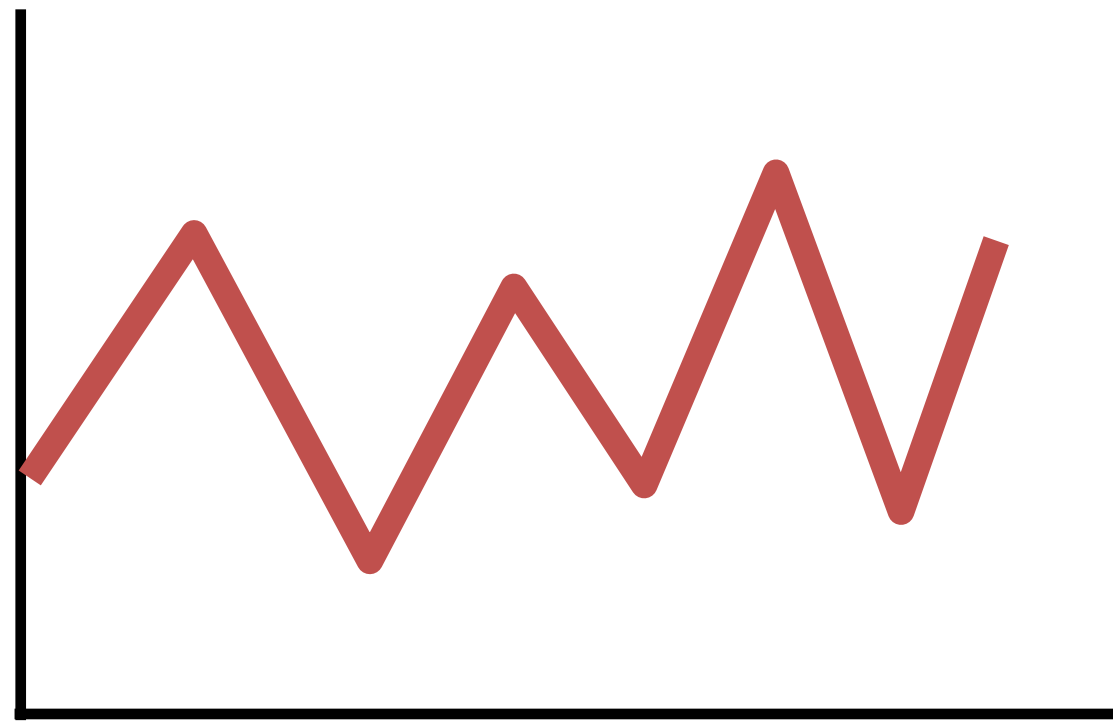
apershing@gmri.org
@sci_officer

Gulf of Maine Research Institute

Science. Education. Community.

A conceptual model

e: apershing@gmri.org   t: @sci_officer
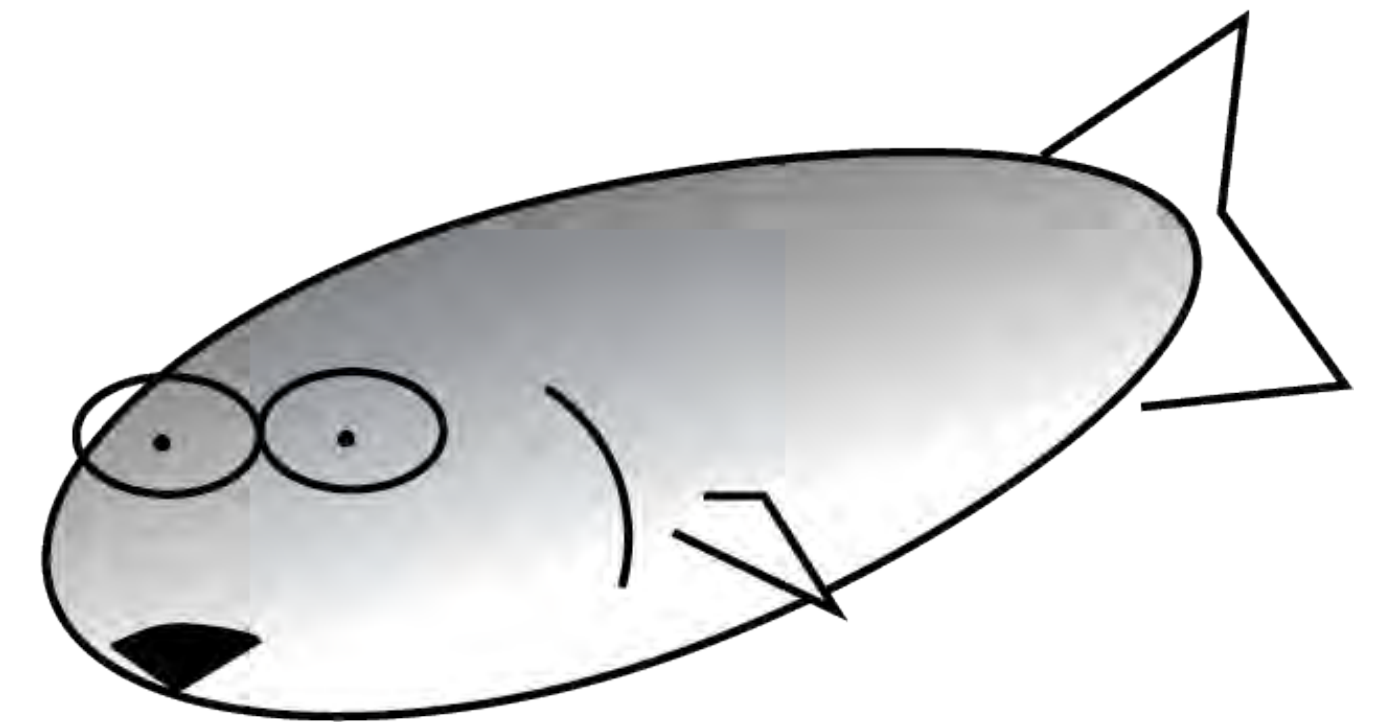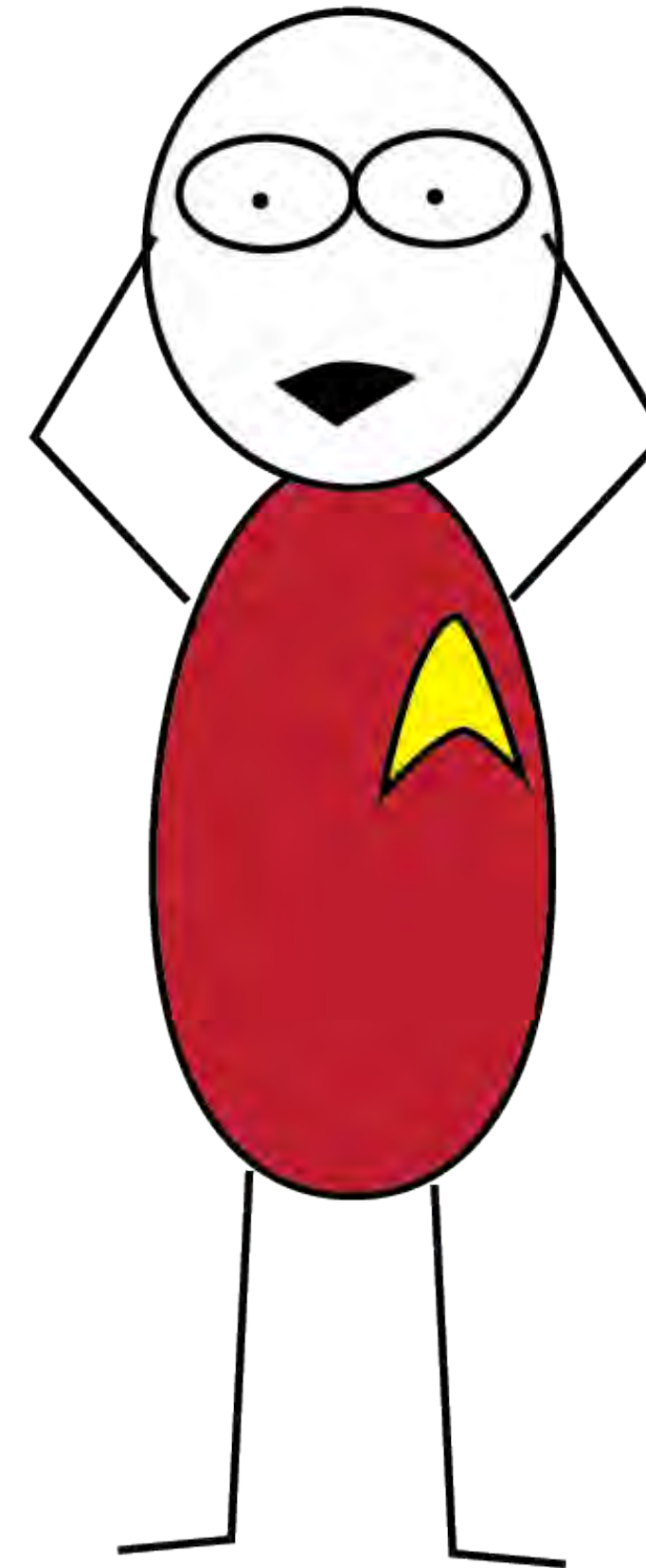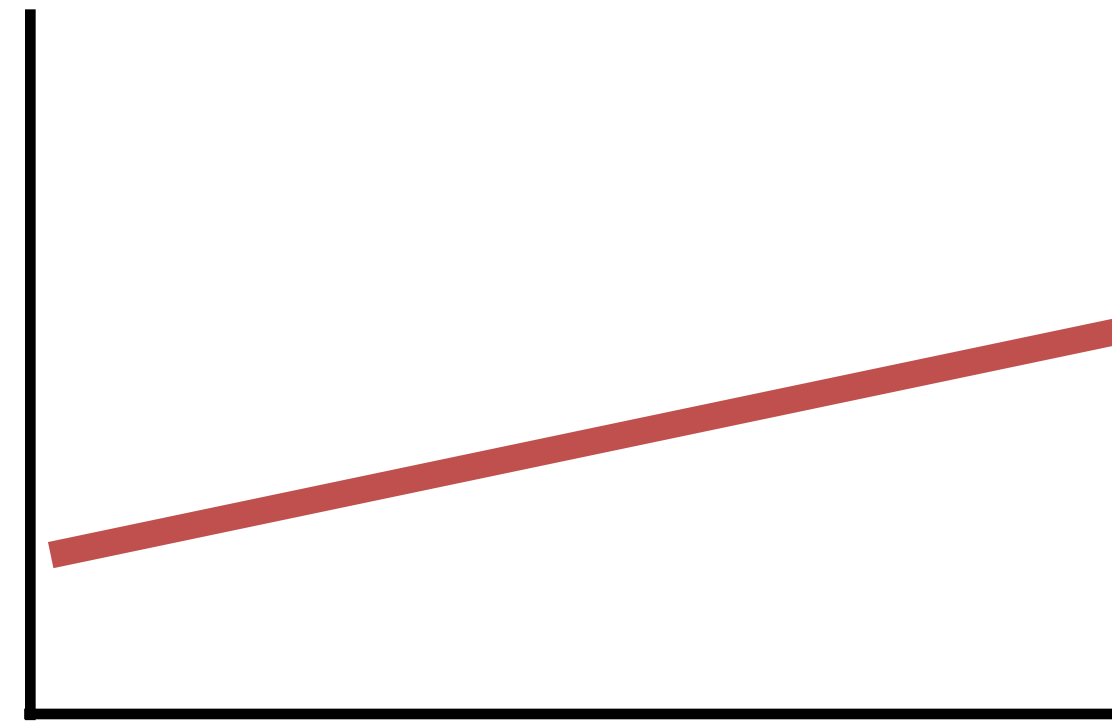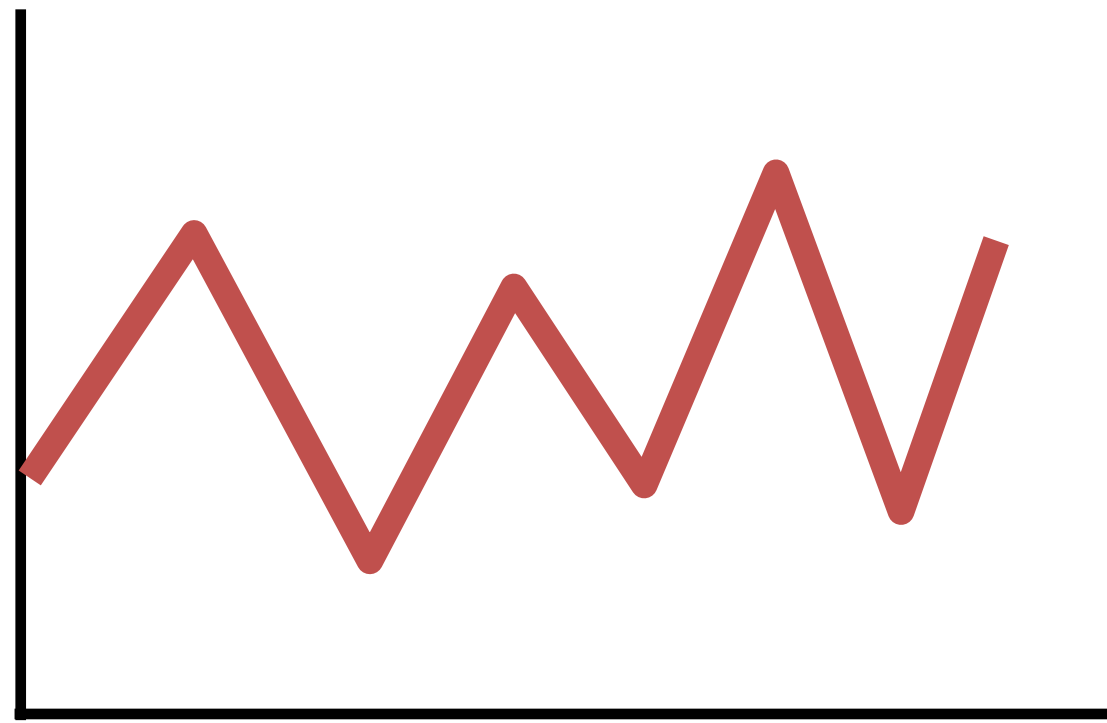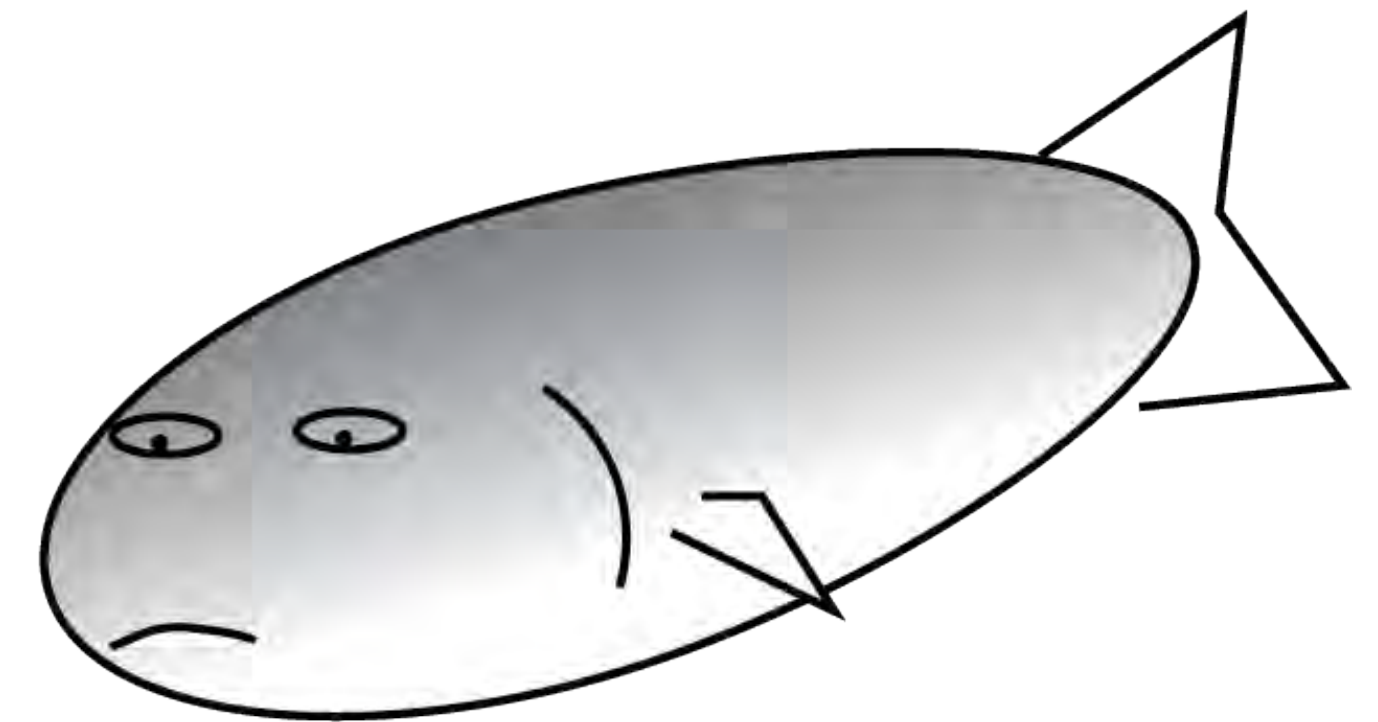
A conceptual model
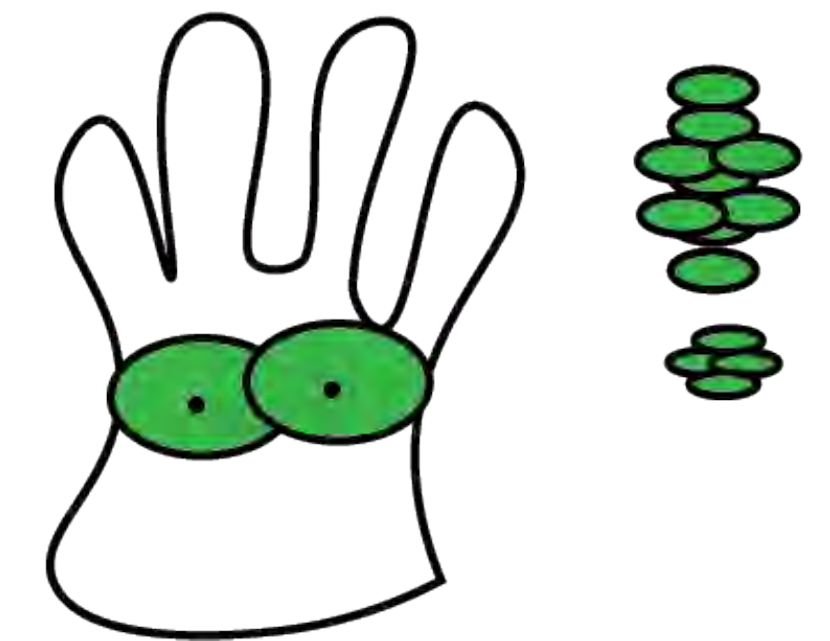
A conceptual model
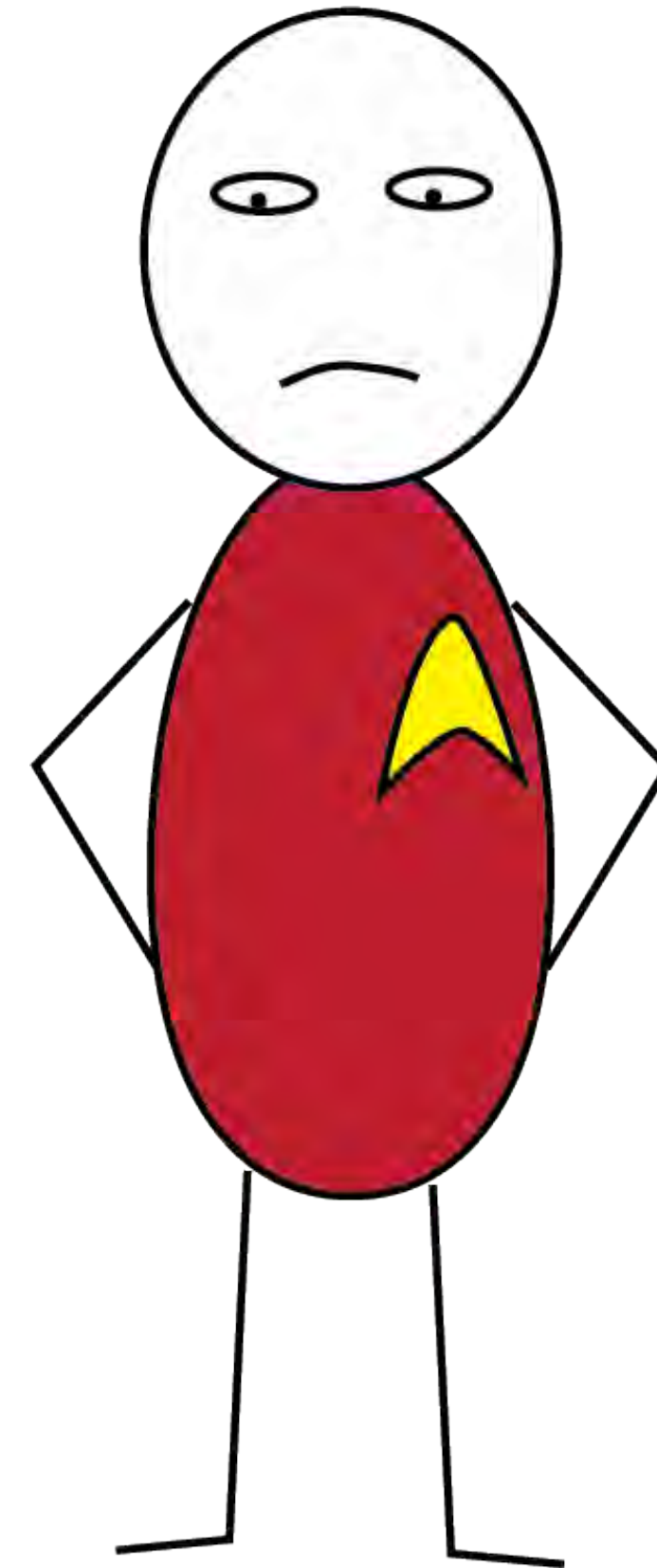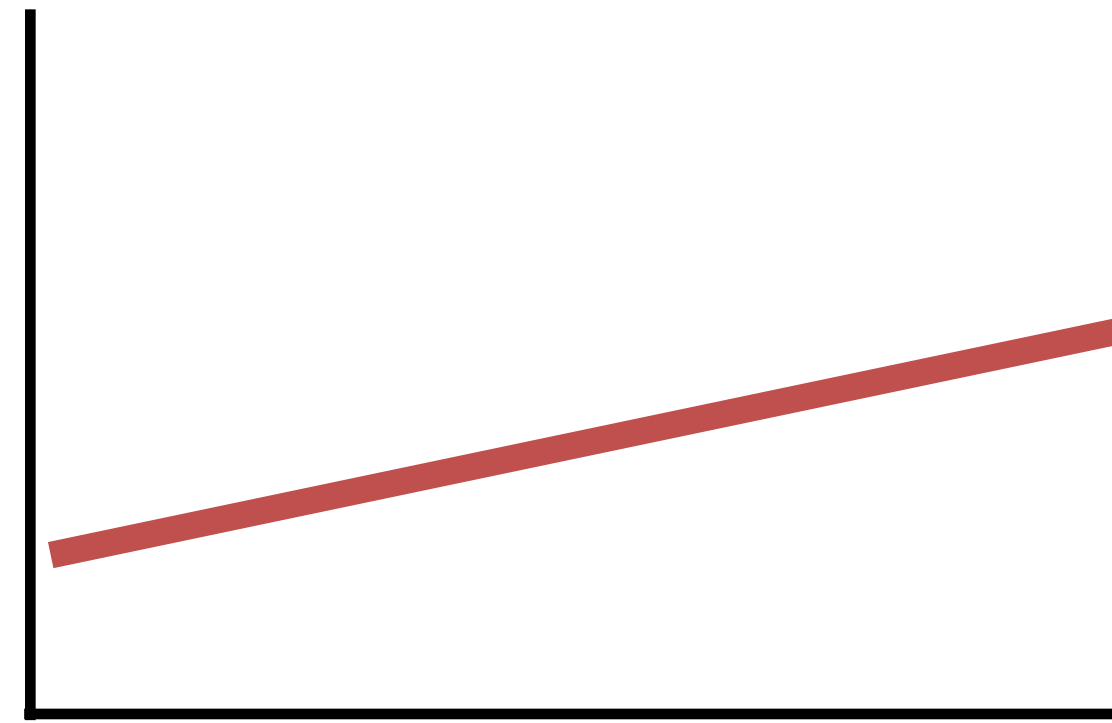
Surprises

- Define a "surprise" as an event that is unlikely based on recent conditions
  - 30 year rolling climatology, p=0.03
  - simple model of adaptation
- Calculated theoretical probability of surprise, accounting for trend
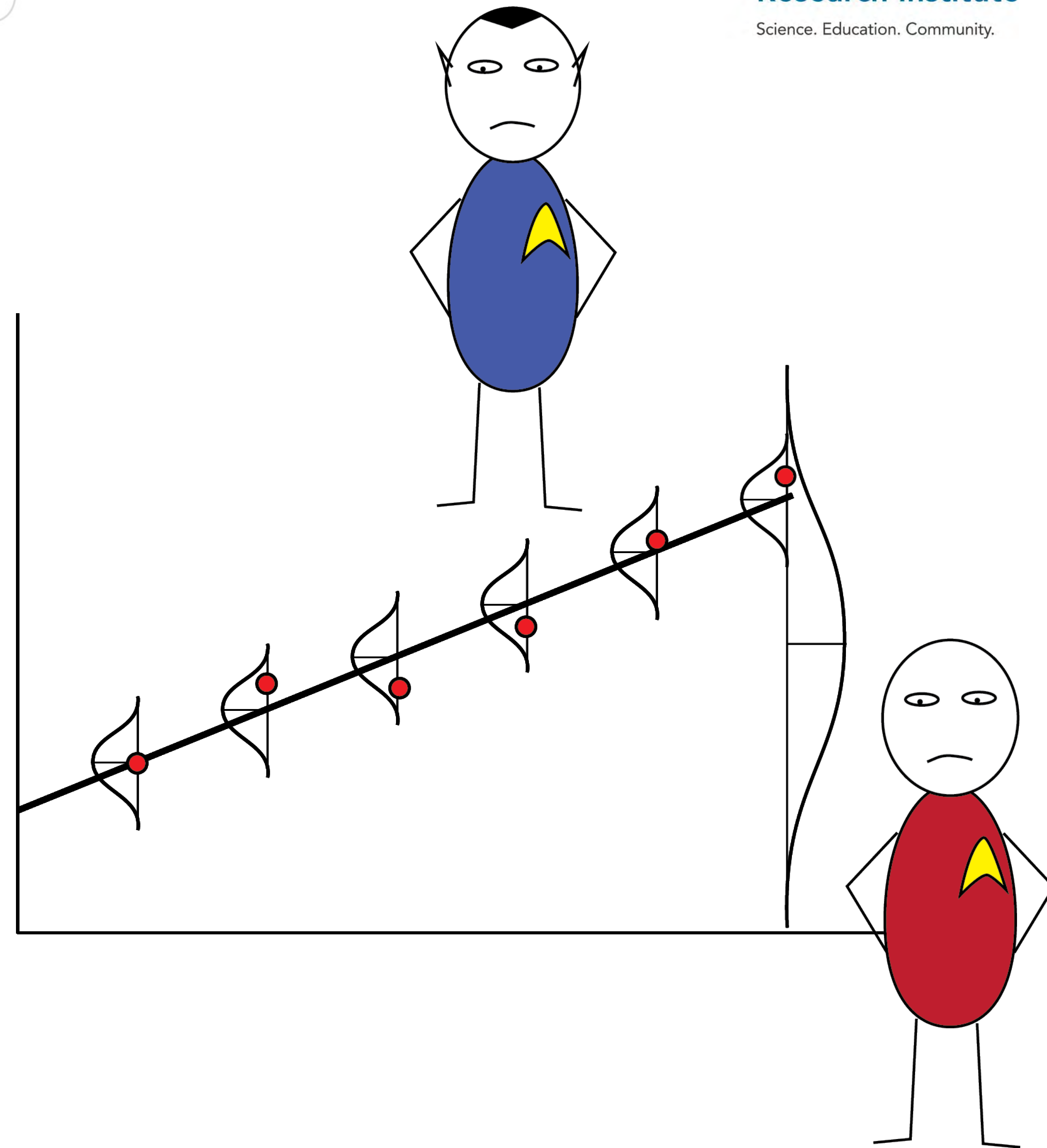
Probability of being surprised
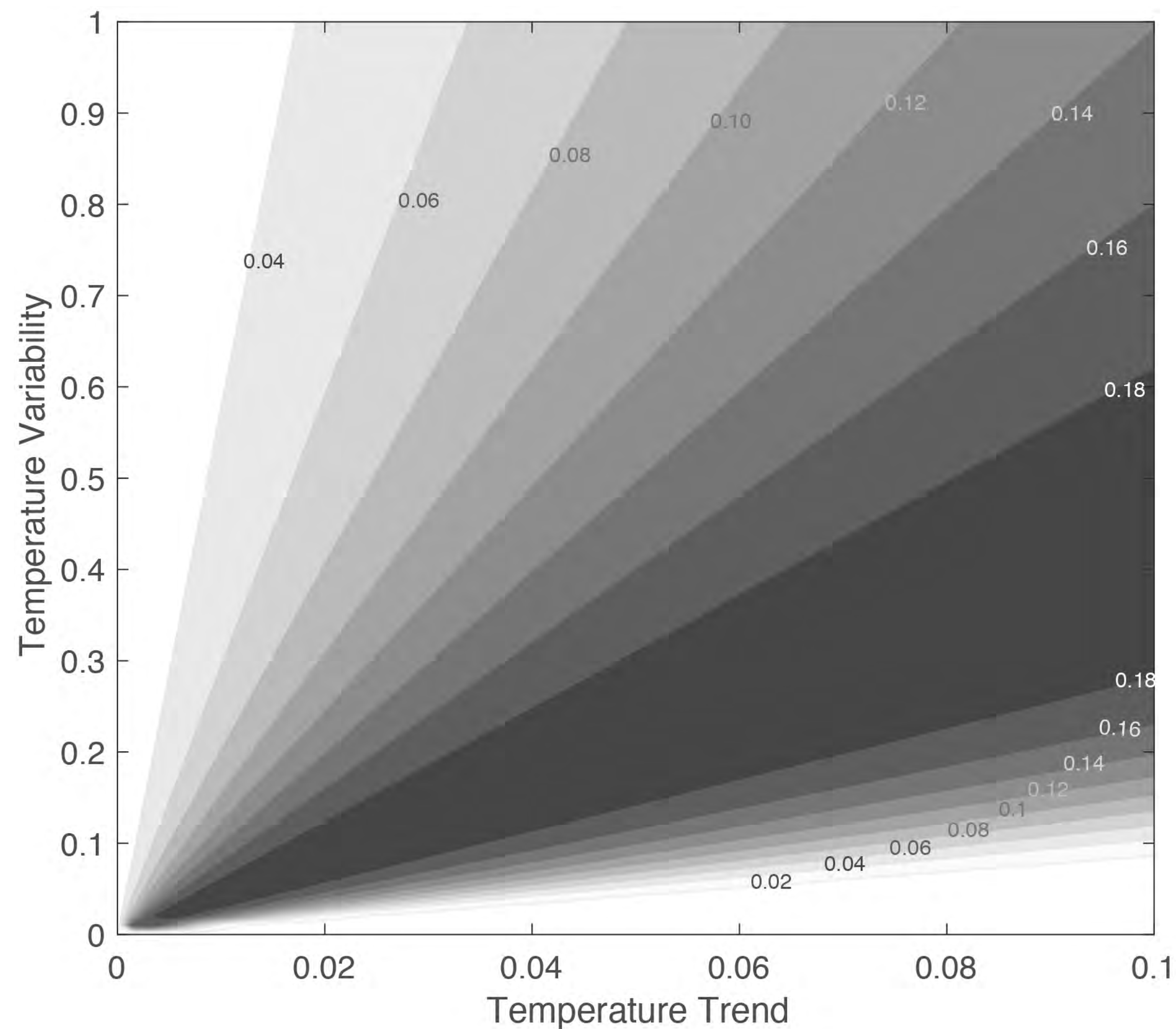
- Depends on inherent *variability* & *trend*

e: apershing@gmri.org   t: @sci_officer

Probability of being surprised
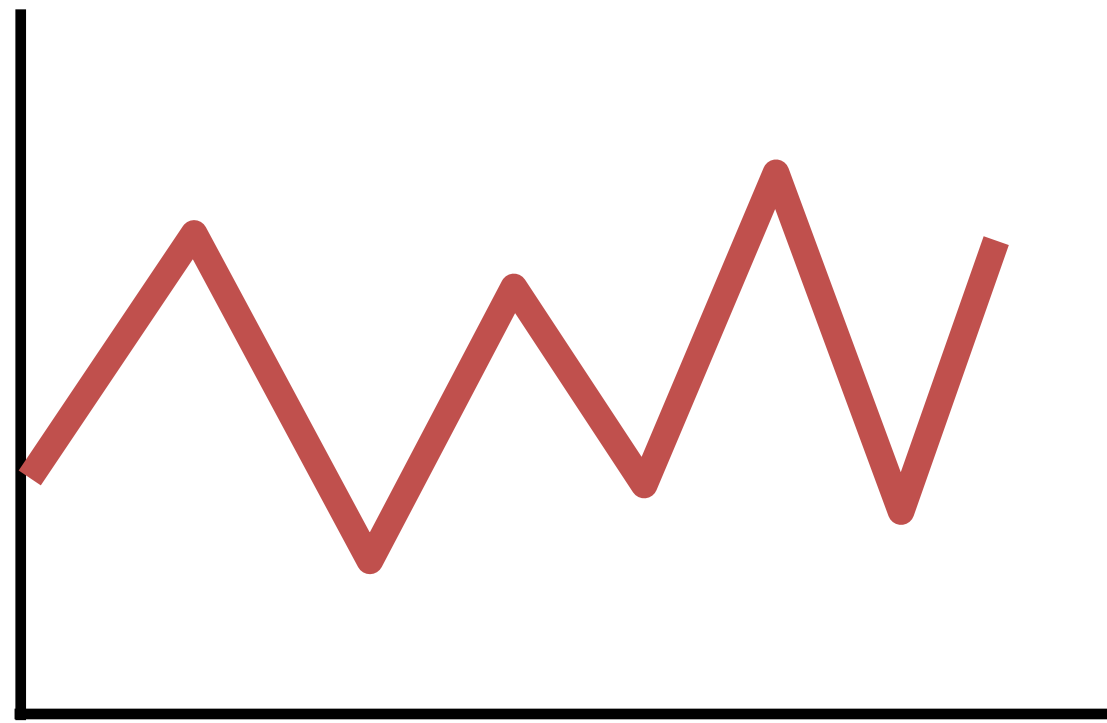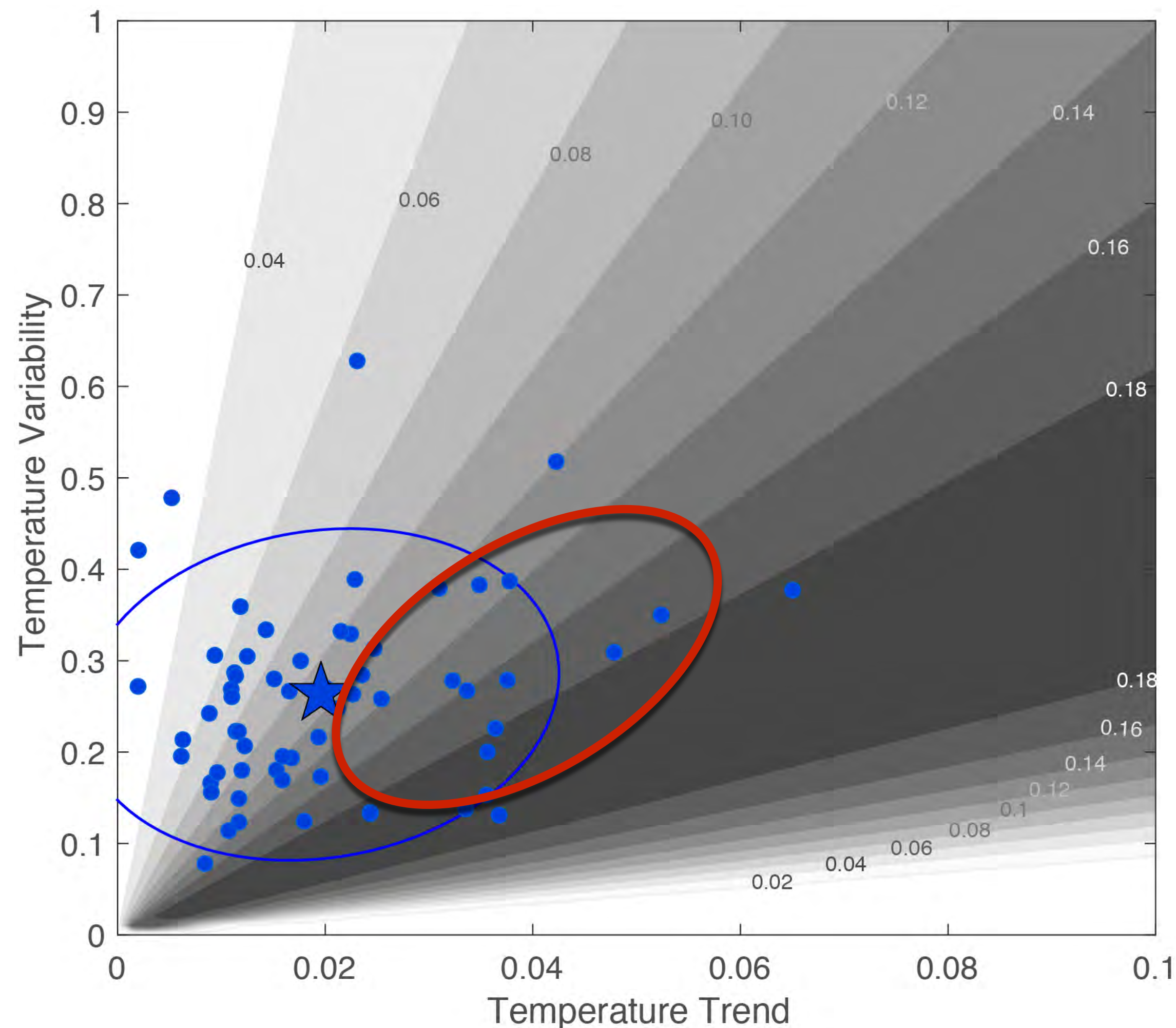

- Depends on inherent **variability** & **trend**
- Large Marine Ecosystems (LMEs) now have elevated chance of surprise
  - 4x assumed level

e: apershing@gmri.org   t: @sci_officer

History of surprises

Observed and expected number of LME surprises
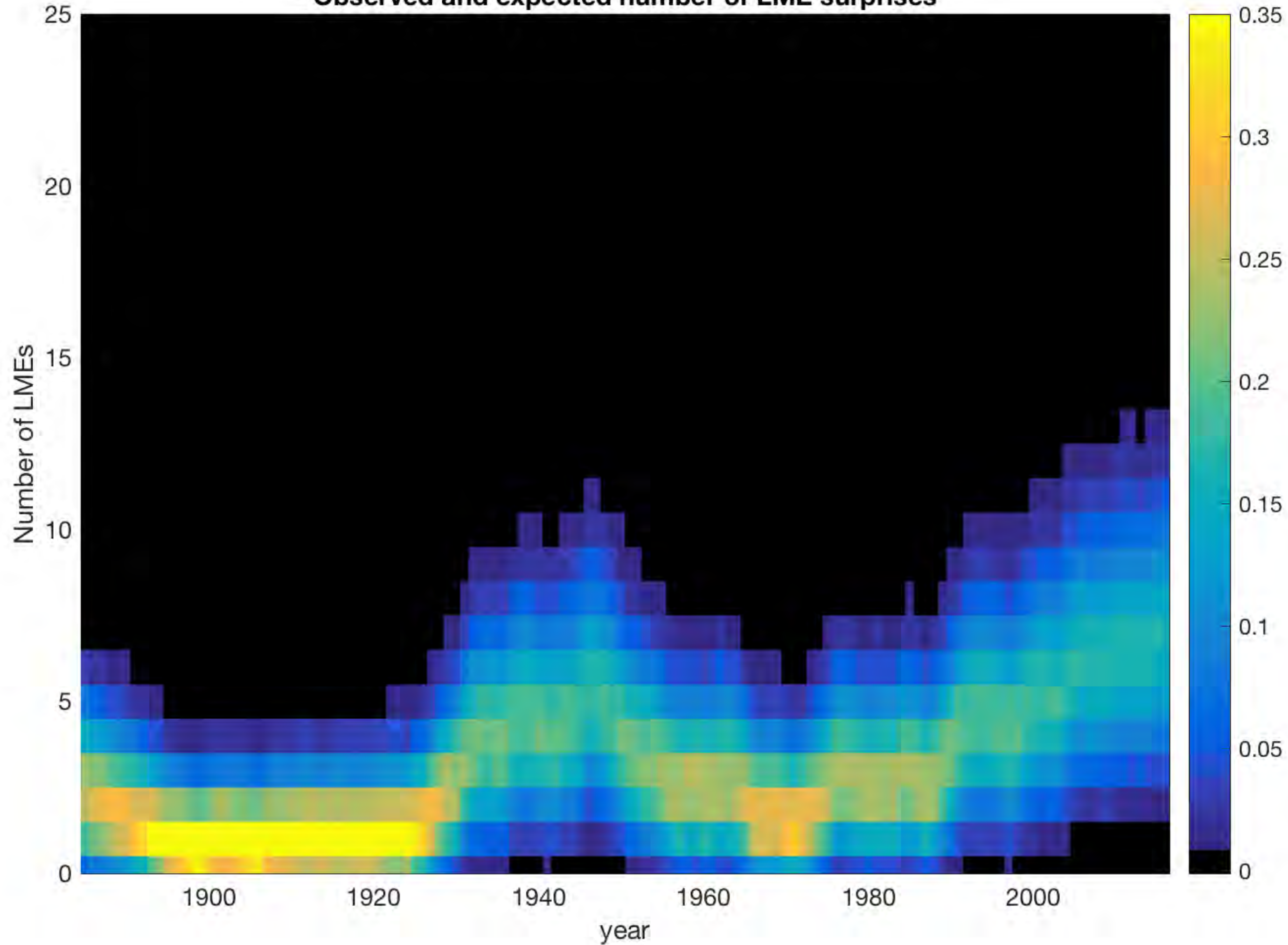
- Expected number of surprised LMEs varies with global trends

History of surprises

Observed and expected number of LME surprises

- Expected number of surprised LMEs varies with global trends
- Recently, more surprises than expected

History of surprises

Observed and expected number of LME surprises
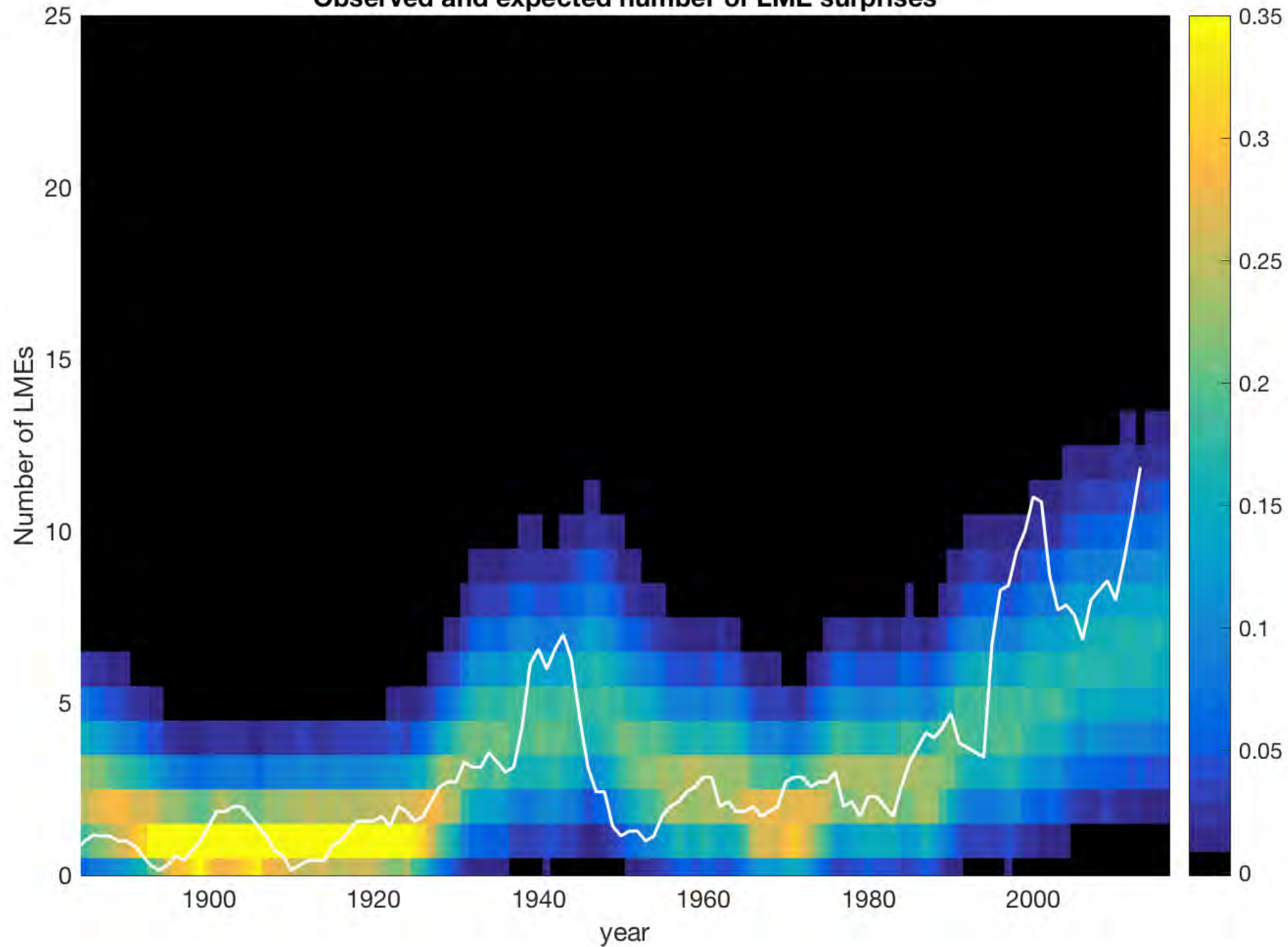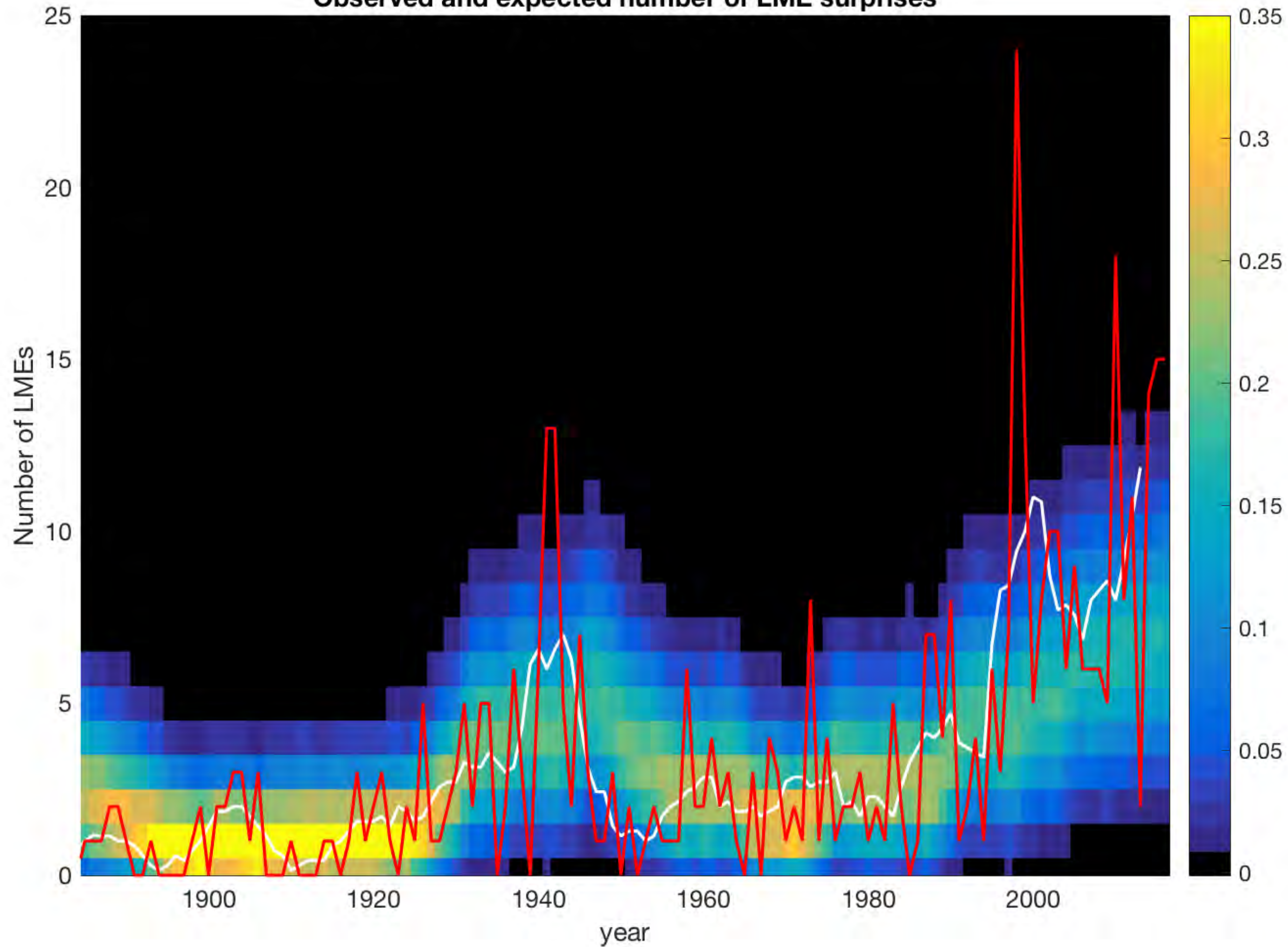
- Expected number of surprised LMEs varies with global trends
- Recently, more surprises than expected
- 1999, 2010, 2015, 2016 stand out
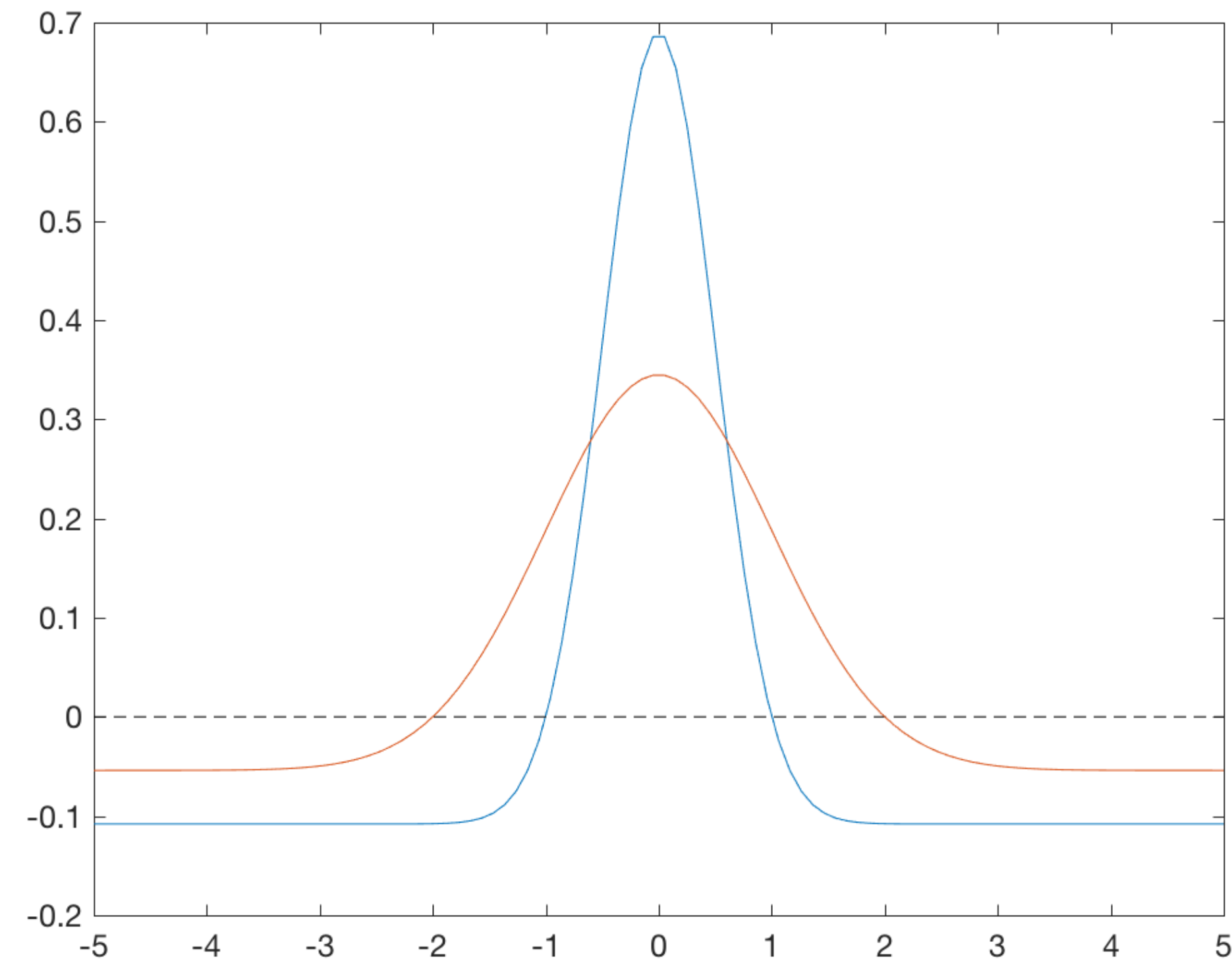
e: apershing@gmri.org   t: @sci_officer

Surprising surprises
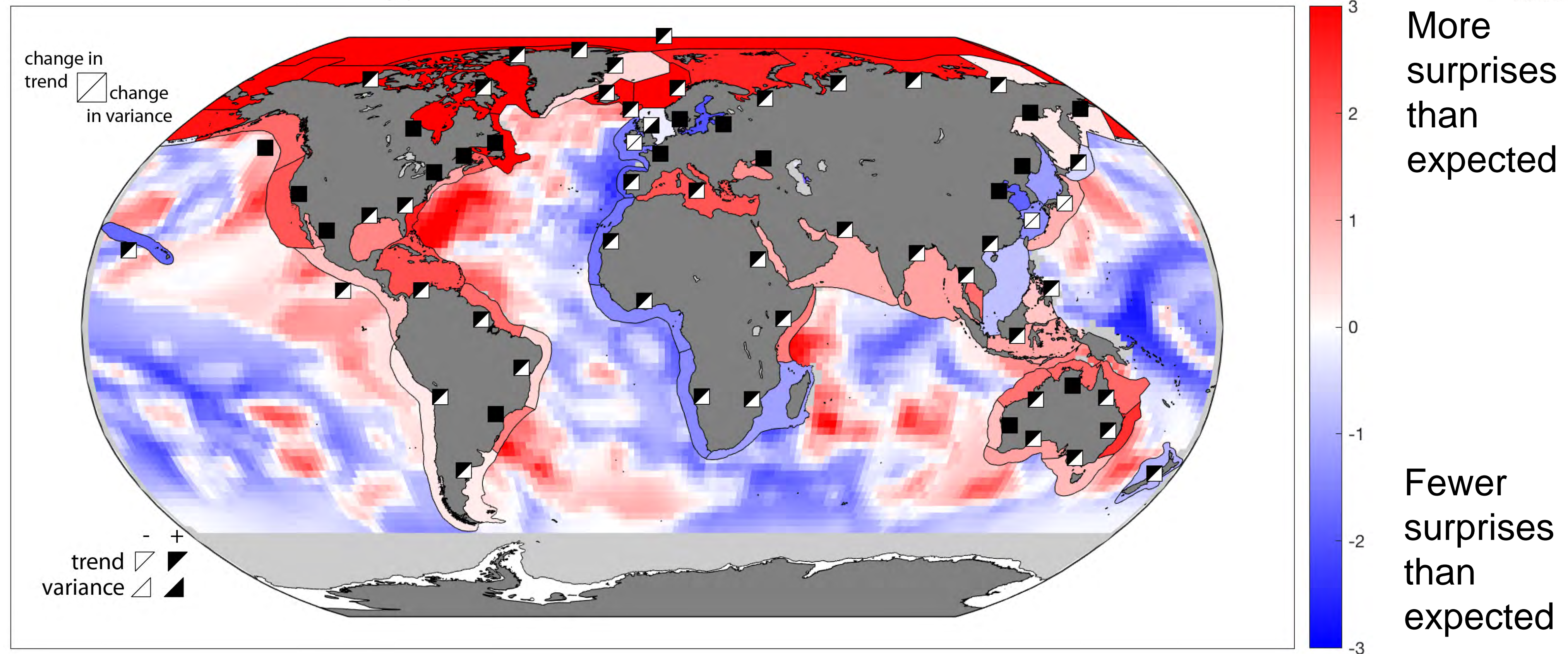
- Arctic, northwest Atlantic, Caribbean, northeast Pacific, Australia, Indian Ocean

- Extra surprises due to accelerating warming

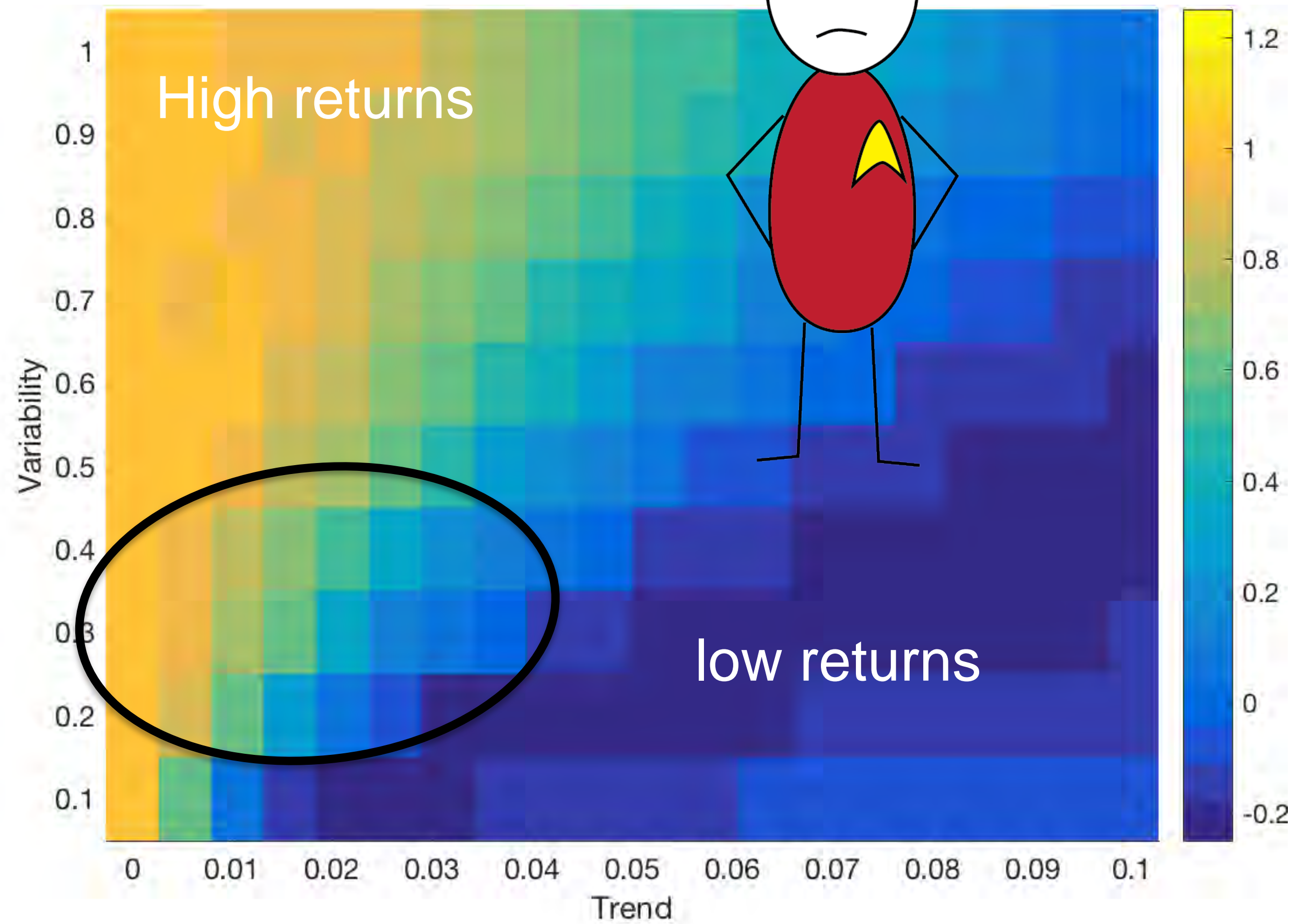*e: apershing@gmri.org   t: @sci_officer*

Simple Adaptation Model

- Humans "invest" based on expected conditions in the ecosystem
  - focus for high-risk/high-reward
  - or spread
- Base investments on
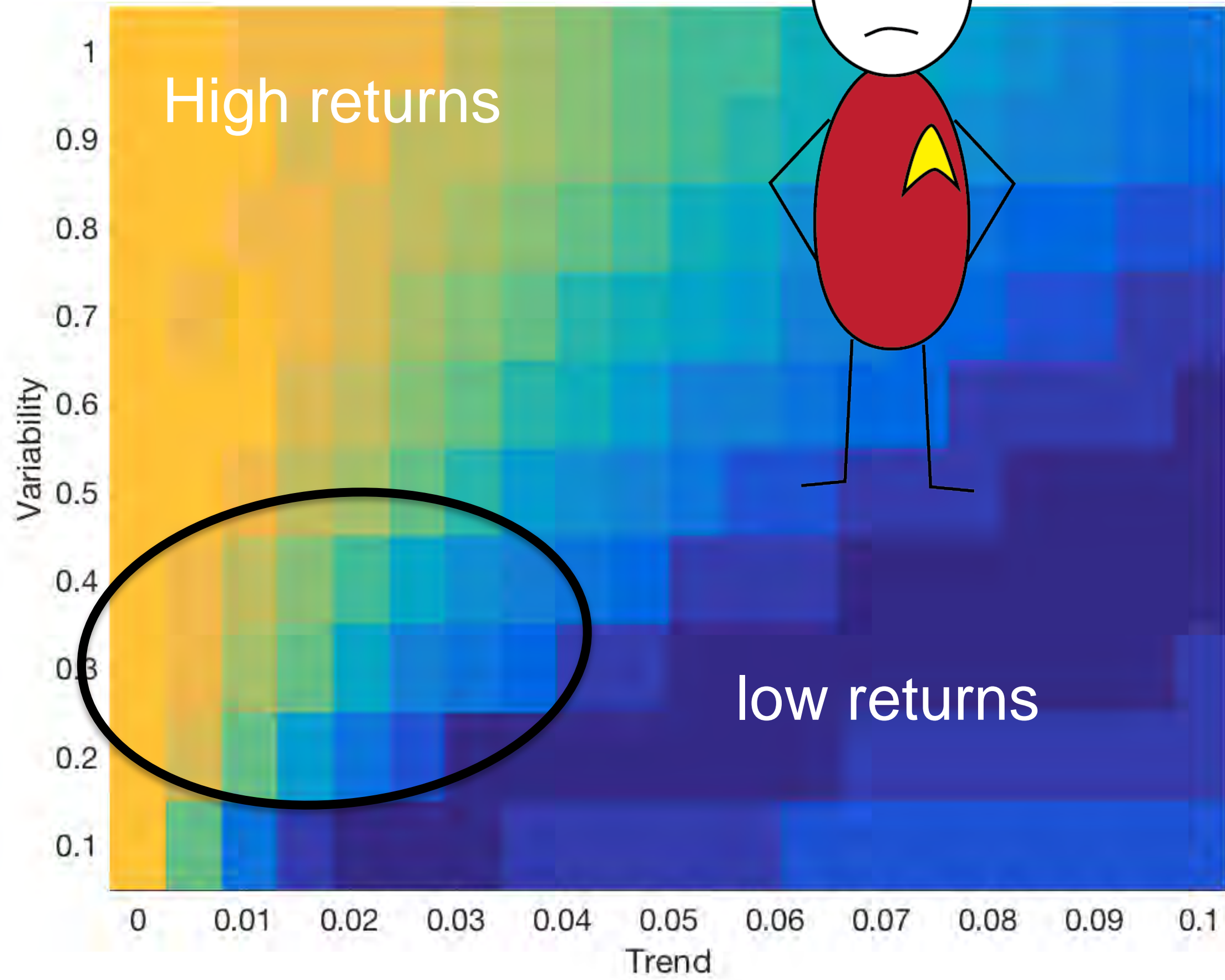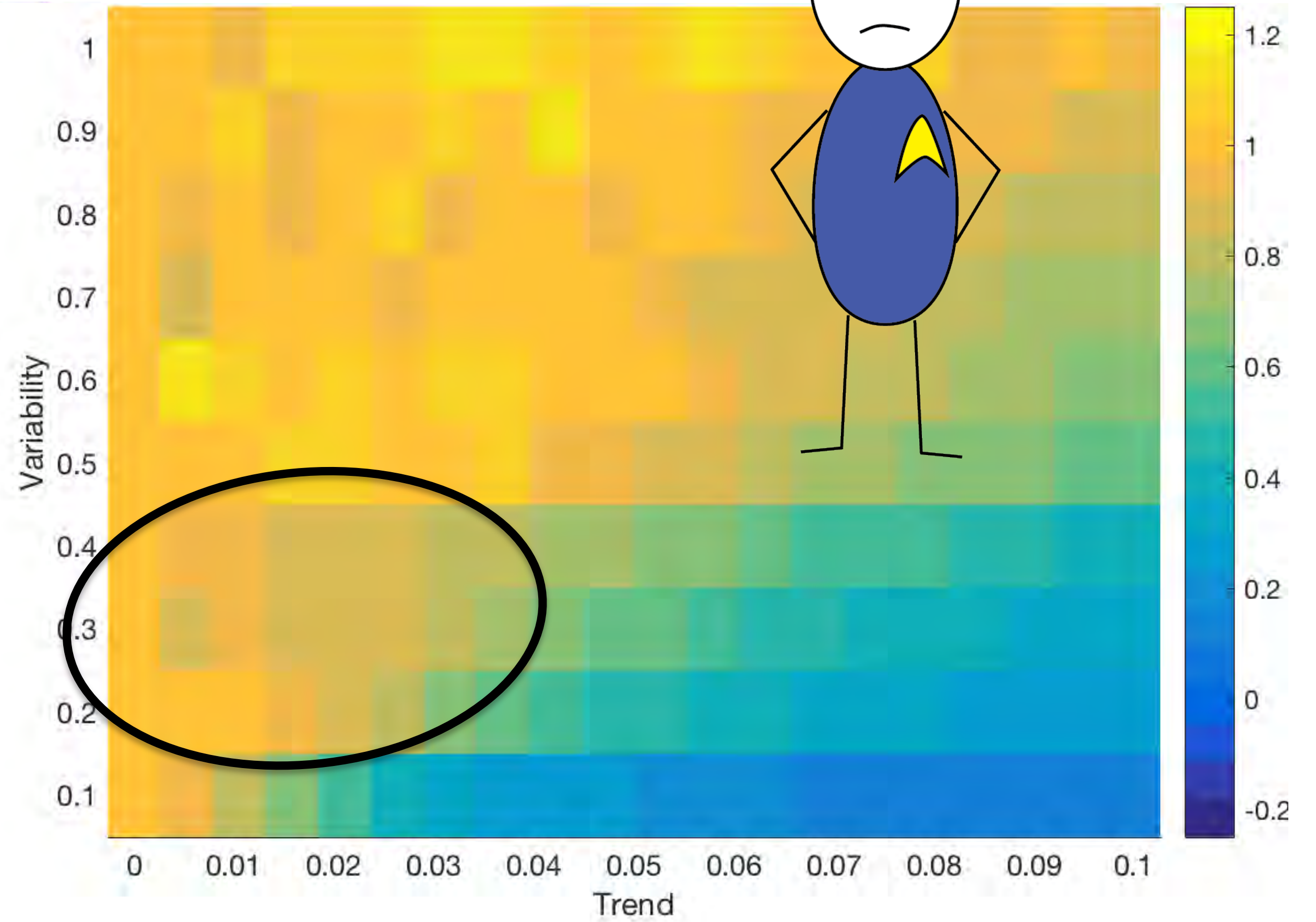 - past mean & variance
  - past trend

e: apershing@gmri.org   t: @sci_officer

Simple Adaptation Model

Backward-looking

High returns

low returns

Simple Adaptation Model

Backward-looking

High returns

low returns

Forward-looking

Simple Adaptation Model
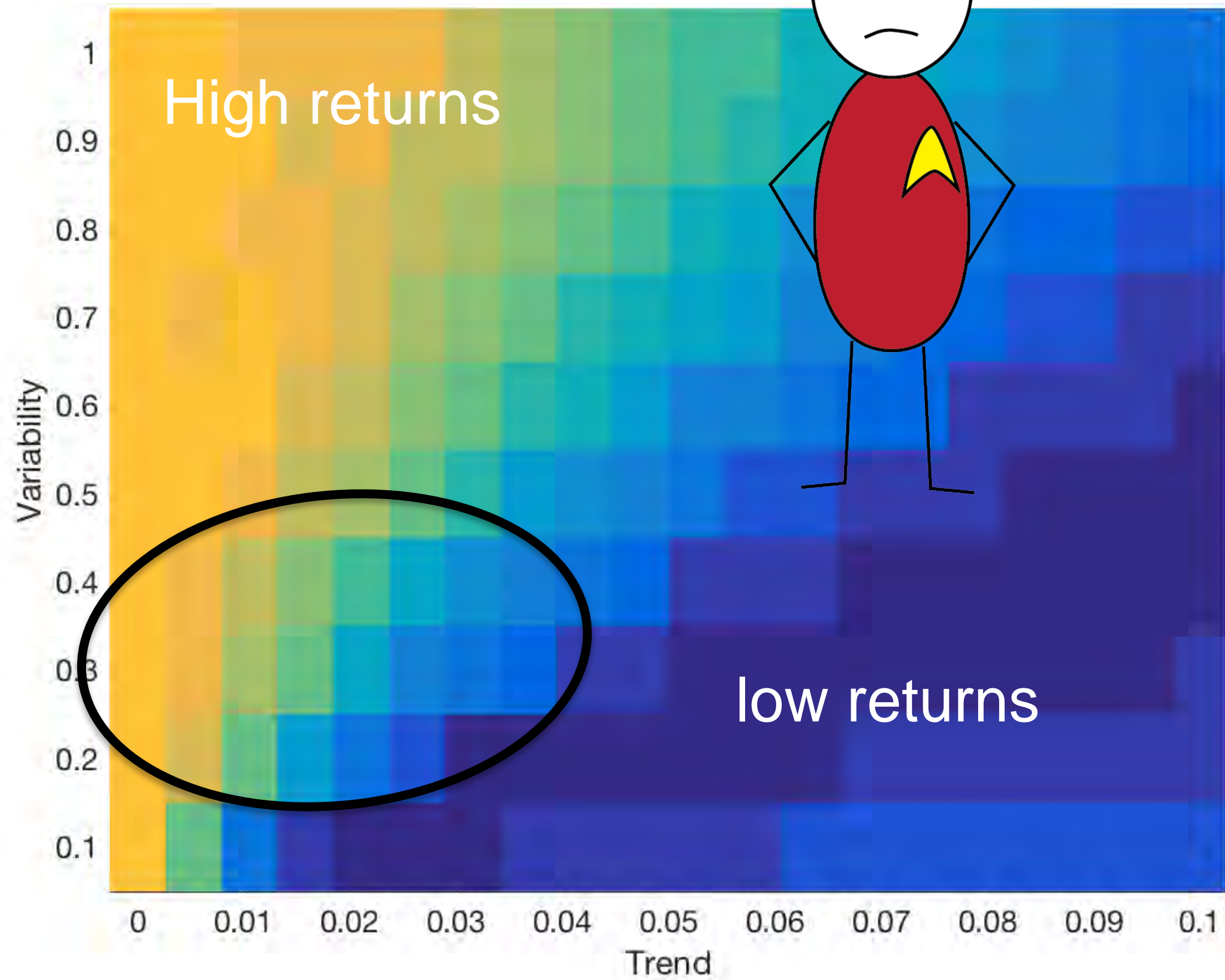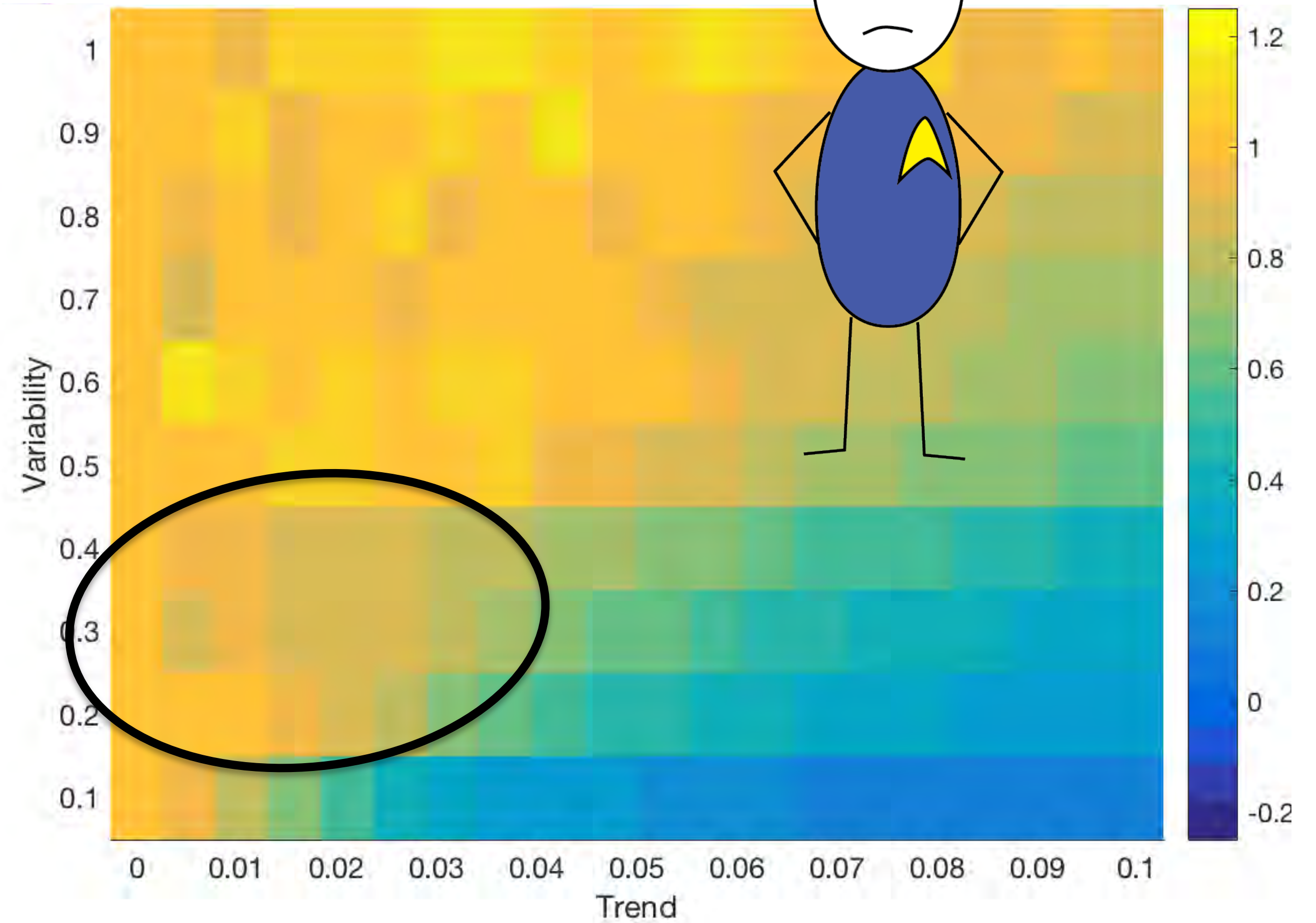
- Strong trends break "natural" adaptation

e: apershing@gmri.org   t: @sci_officer

Simple Adaptation Model
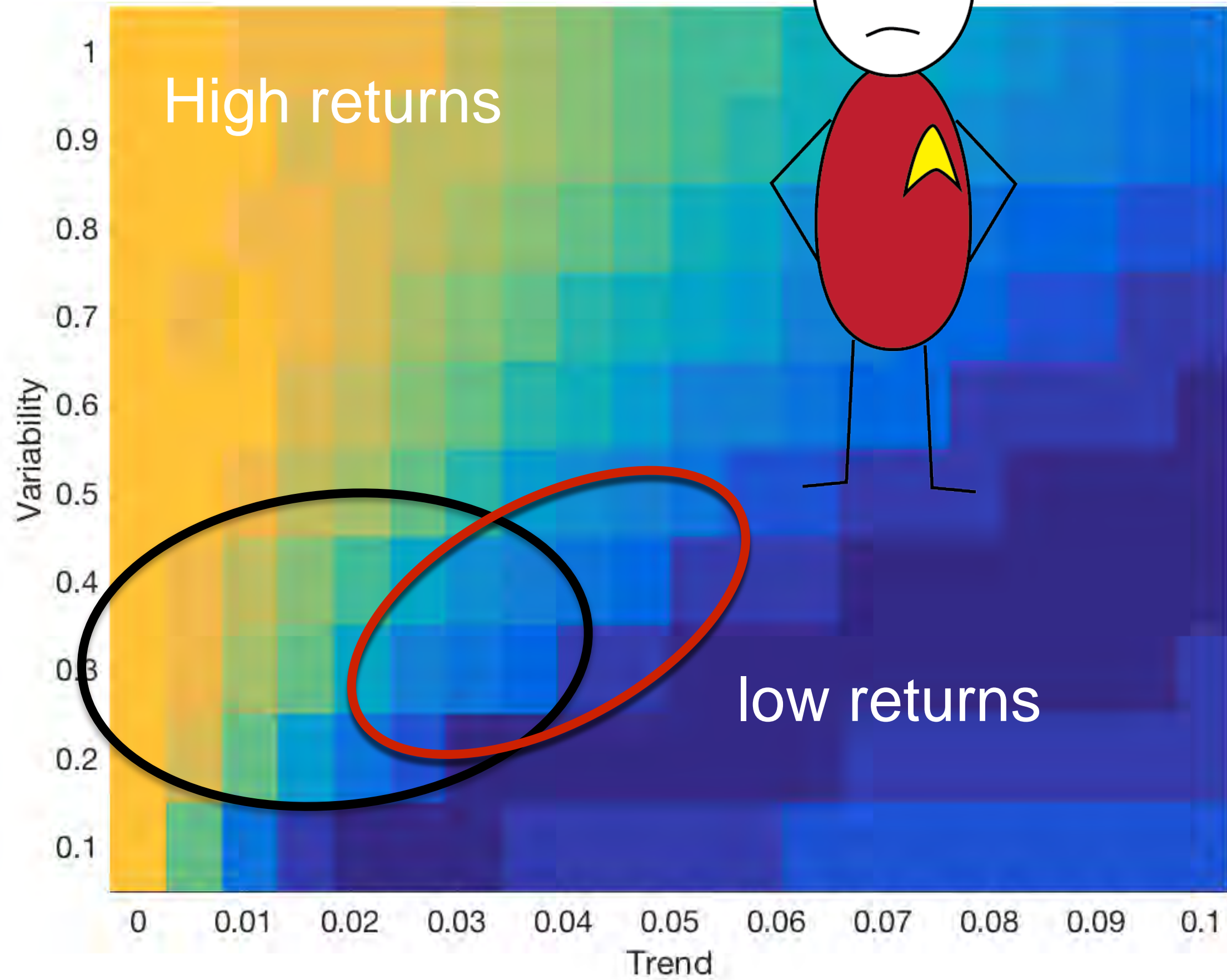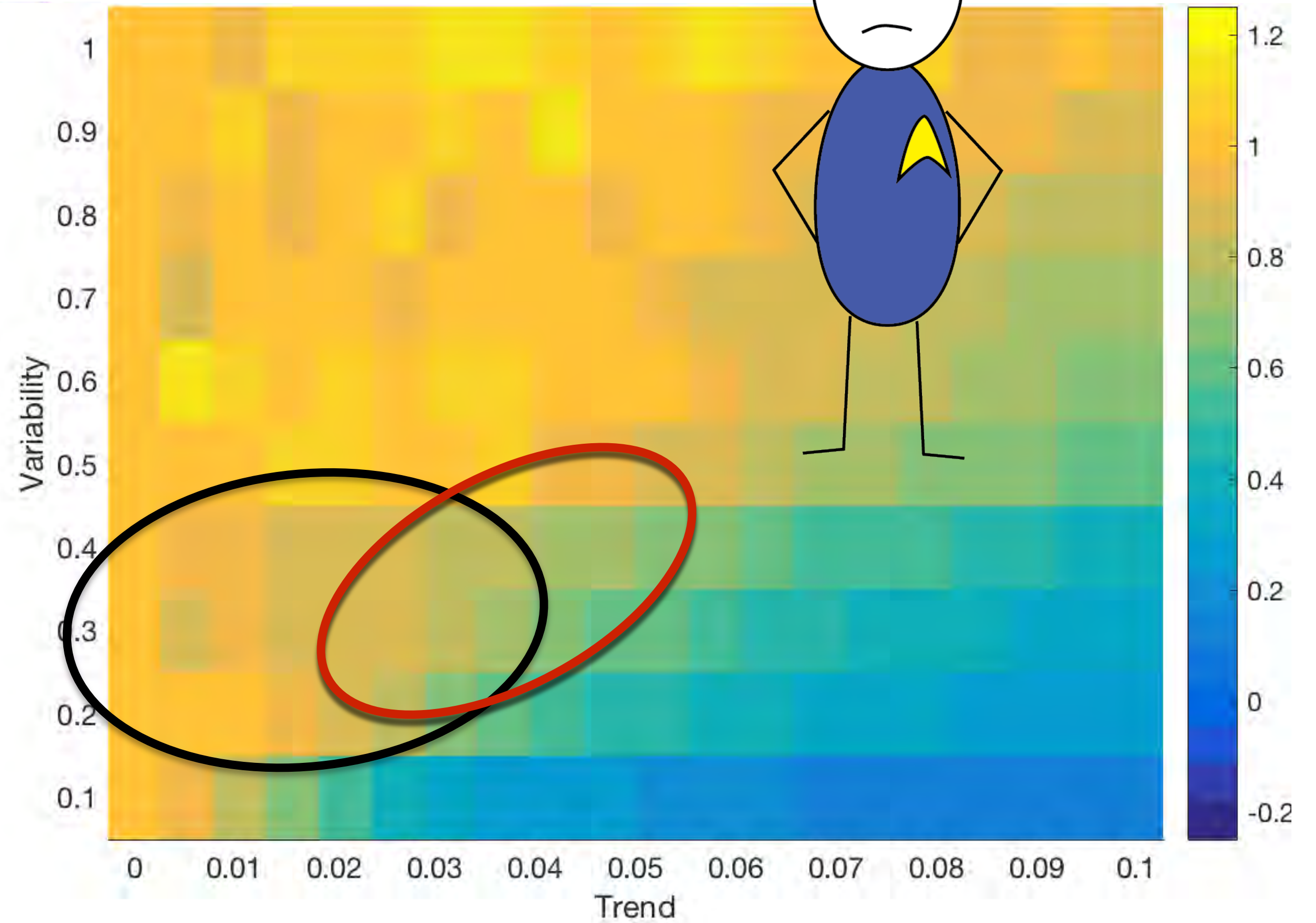
- Strong trends break "natural" adaptation
- LMEs moving into high-surprise zone

e: apershing@gmri.org   t: @sci_officer

Surprise!
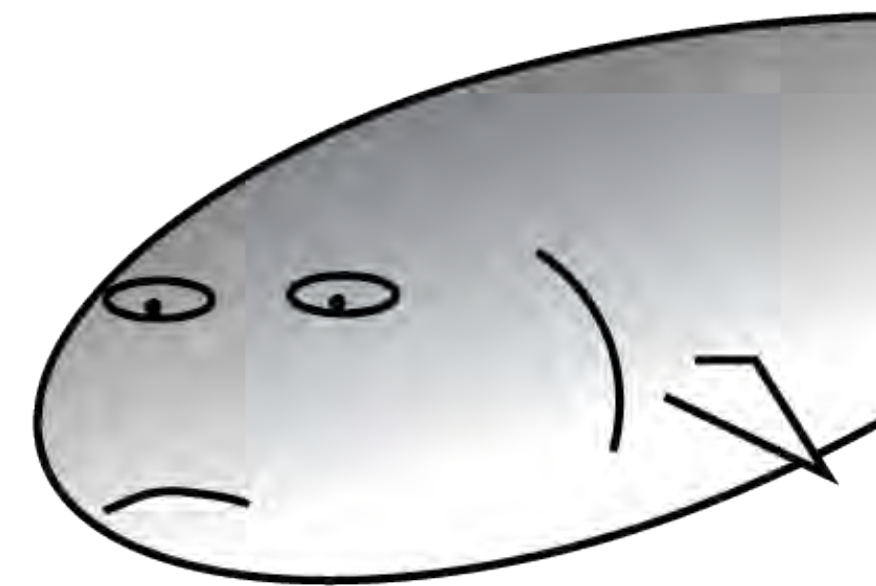
Gulf of Maine
Research Institute
Science. Education. Community.

- Surprising increase in surprising ocean temperatures

- Surprises can motivate adaptation

- Strong trends break backward-looking decisions:
  - many decisions made by individuals and businesses
  - stock assessments
  - fishery allocations

Surprise!

- Surprising increase in surprising ocean temperatures

- Surprises can motivate adaptation

- Strong trends break backward-looking decisions:
  - many decisions made by individuals and businesses
  - stock assessments
  - fishery allocations

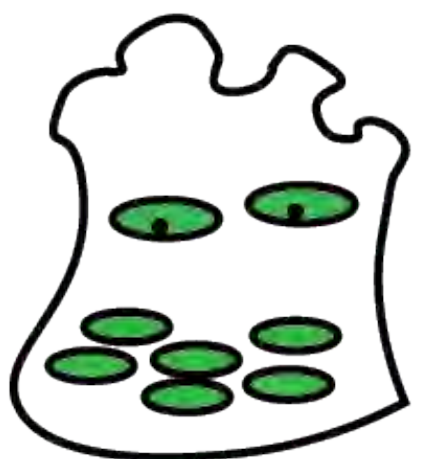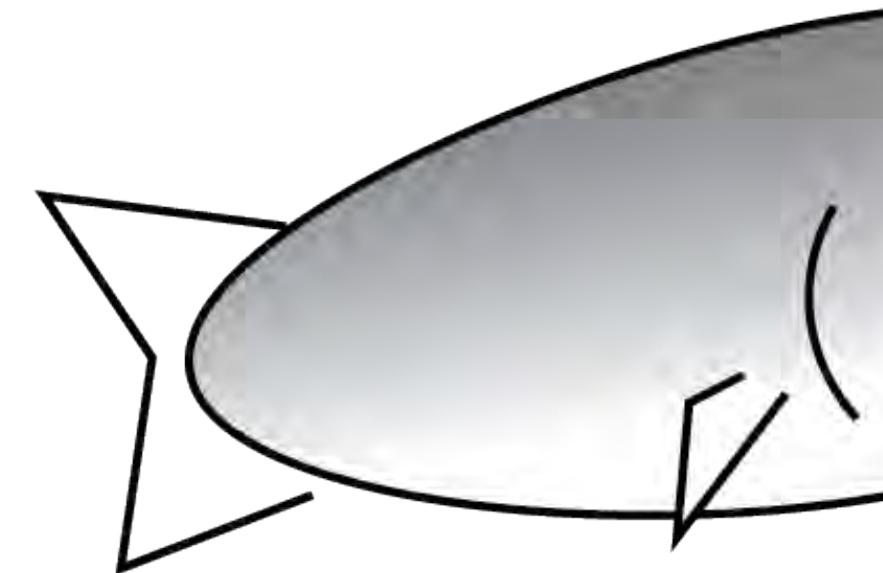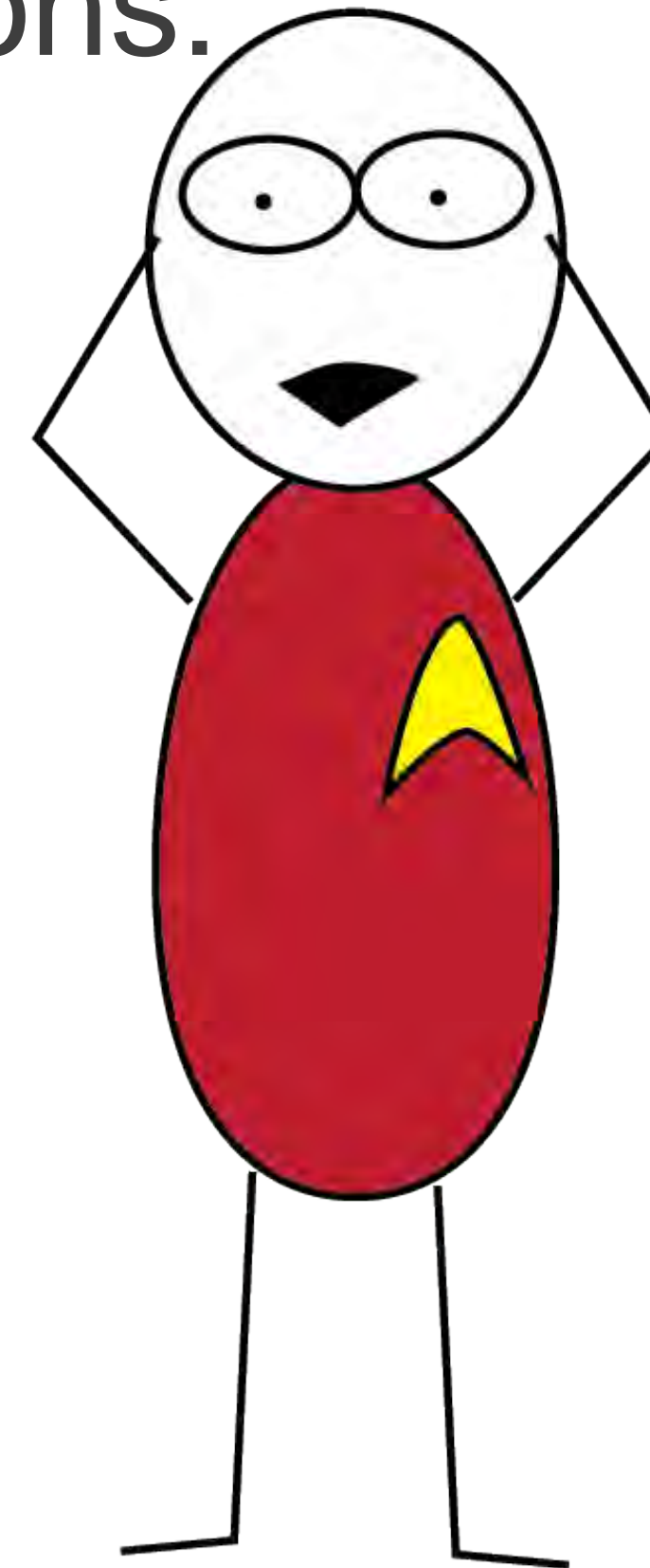*e: apershing@gmri.org   t: @sci_officer*

Surprise!

- Surprising increase in surprising ocean temperatures

- Surprises can motivate adaptation

- Strong trends break backward-looking decisions:
  - many decisions made by individuals and businesses
  - stock assessments
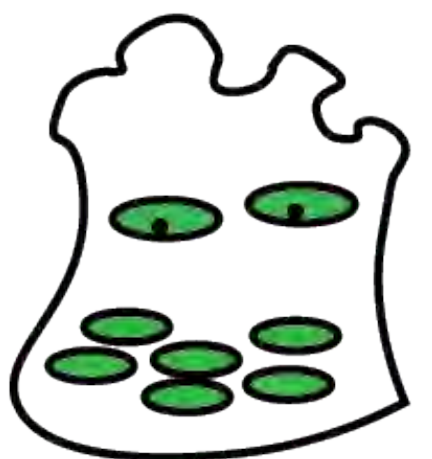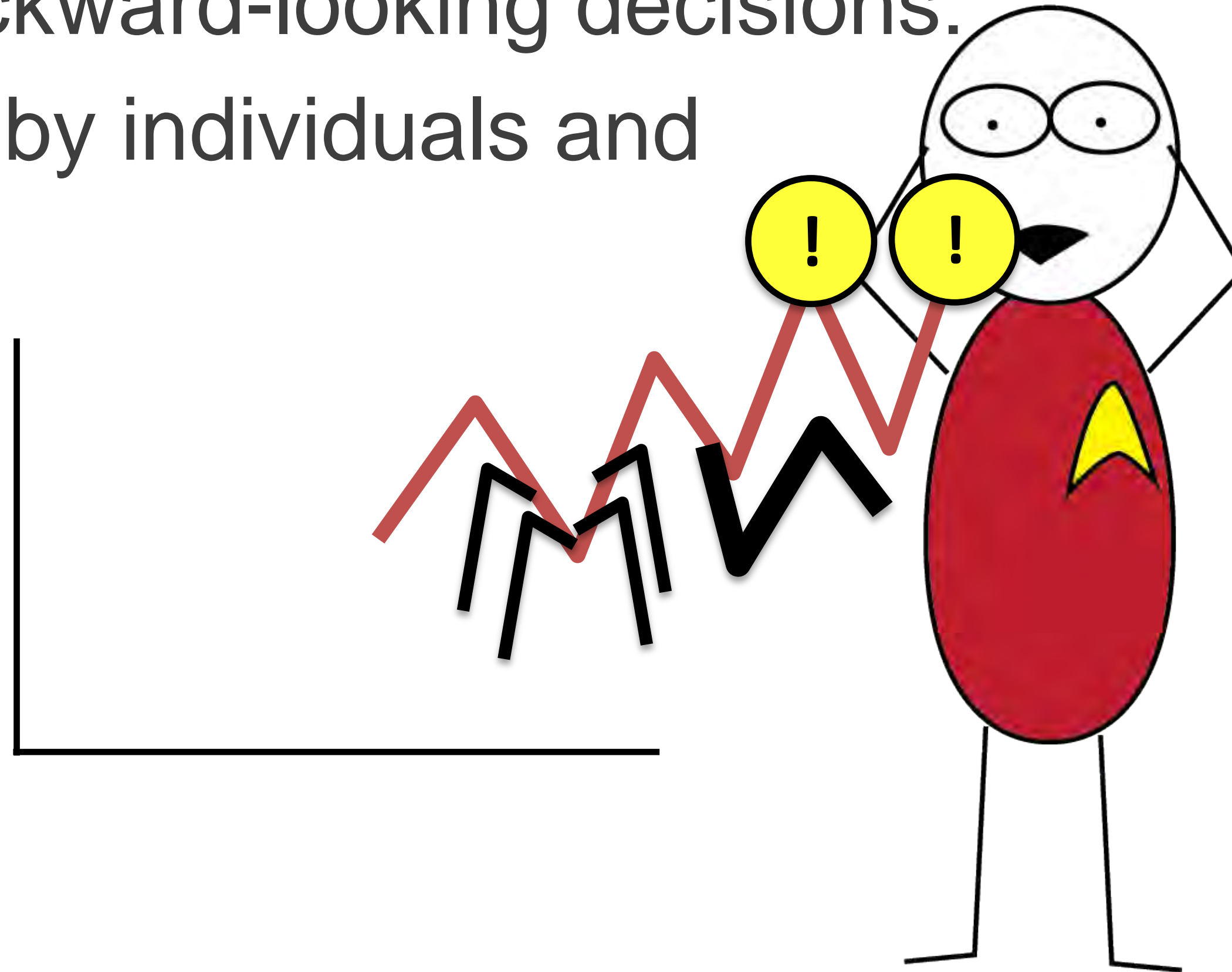 - fishery allocations

Surprise!

- Surprising increase in surprising ocean temperatures

- Surprises can motivate adaptation

- Strong trends break backward-looking decisions:
  - many decisions made by individuals and businesses
  - stock assessments
  - fishery allocations

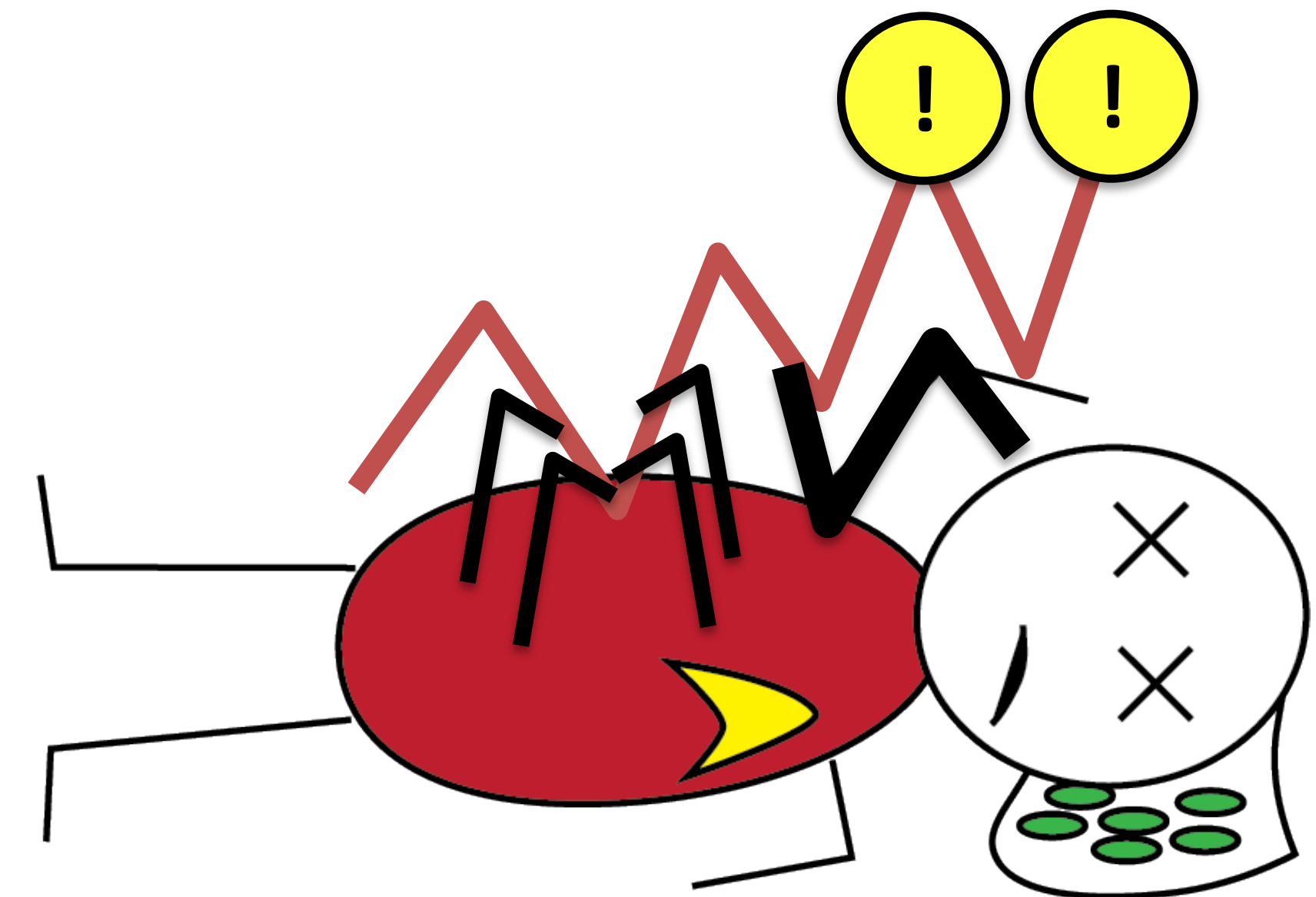e: *apershing@gmri.org*   t: *@sci_officer*

Surprise!

- Surprising increase in surprising ocean temperatures

- Surprises can motivate adaptation

- Strong trends break backward-looking decisions:
  - many decisions made by individuals and businesses
  - stock assessments
  - fishery allocations

Surprise!