Adapting to Climate Change: Managing with Uncertainty

Susan Riha
Professor, Dept. of Earth and Atmospheric Science
Director, New York State Water Resources Institute
May 16, 2011

Climate Change: Mitigation vs. Adaptation

- **Mitigation** = reducing GHGs in atmosphere
  - alternative energy technologies
  - reducing energy consumption
  - geoengineering technologies
- **Adaptation** = "adjustment in natural or human systems in response to actual or expected climatic stimuli" (IPCC, 2007)
  - climate commitment (at least 2^{o} C due to thermal inertia of oceans)
  - how will human systems adapt?

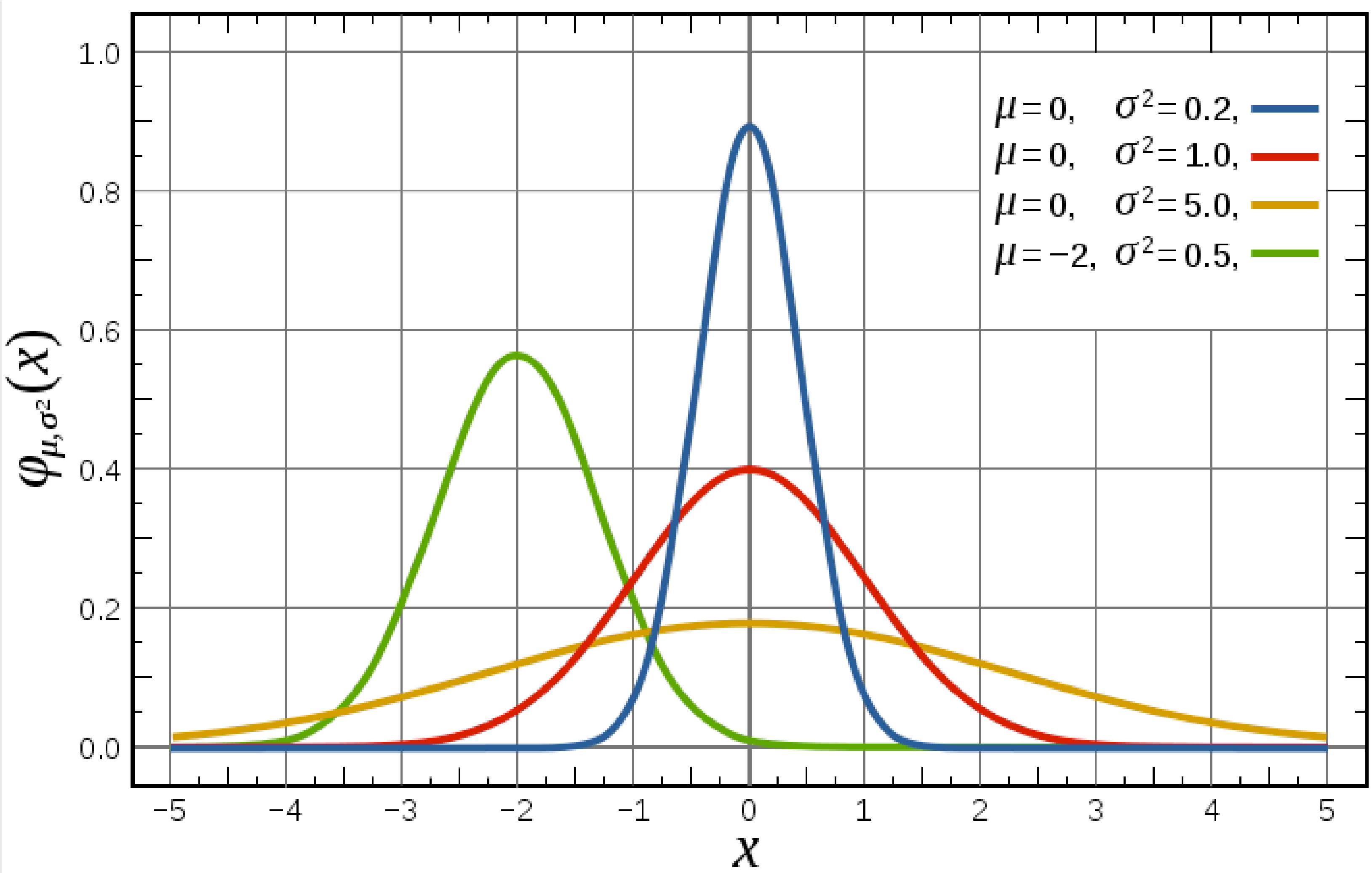
Adapting to Climate Change =
Managing Climate Risks

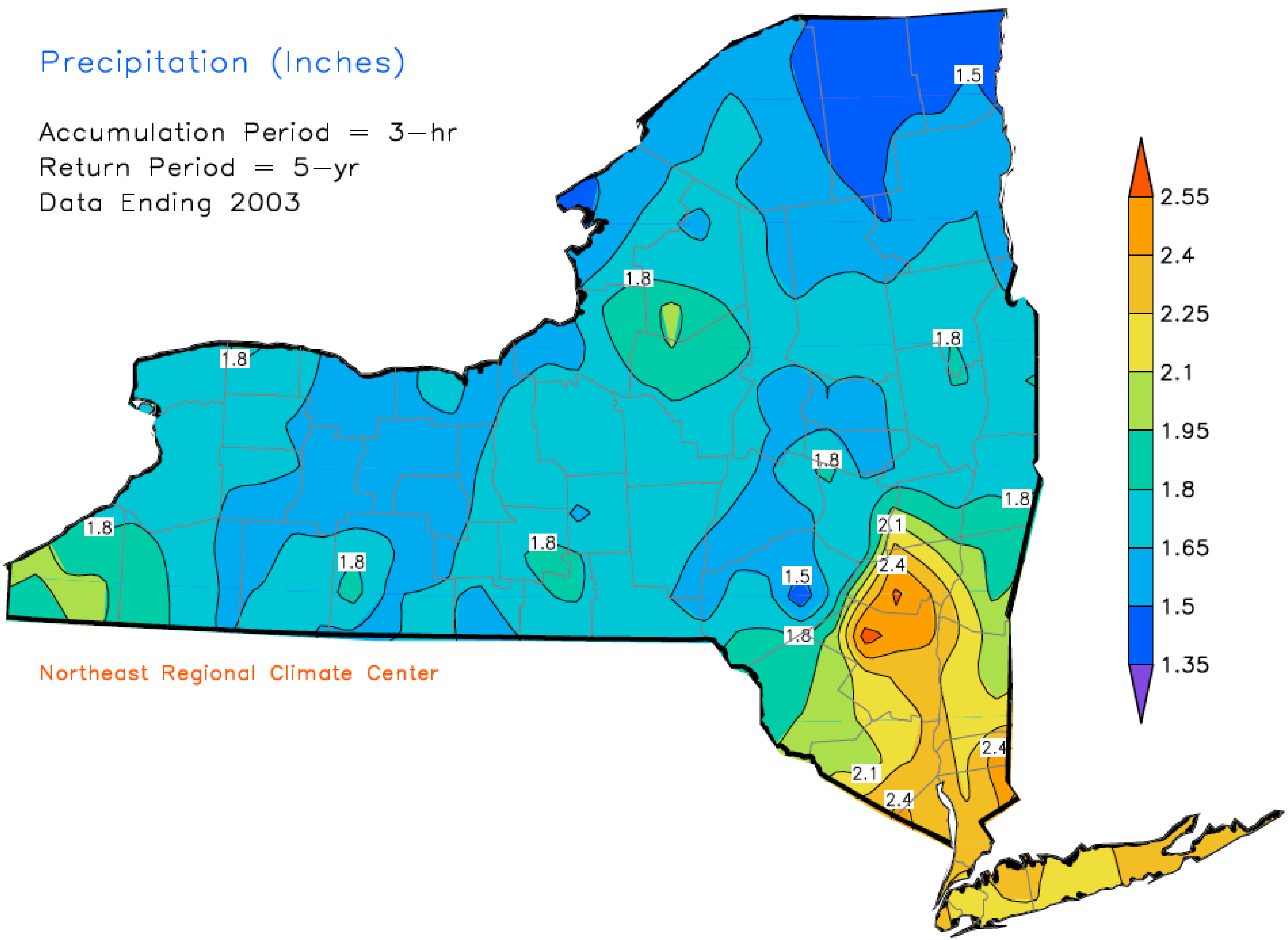
- **Climate Risk**: the effect of climate uncertainty on an activity/objective
- **Uncertainty**: inability to exactly describe future outcomes; more than one possible outcome

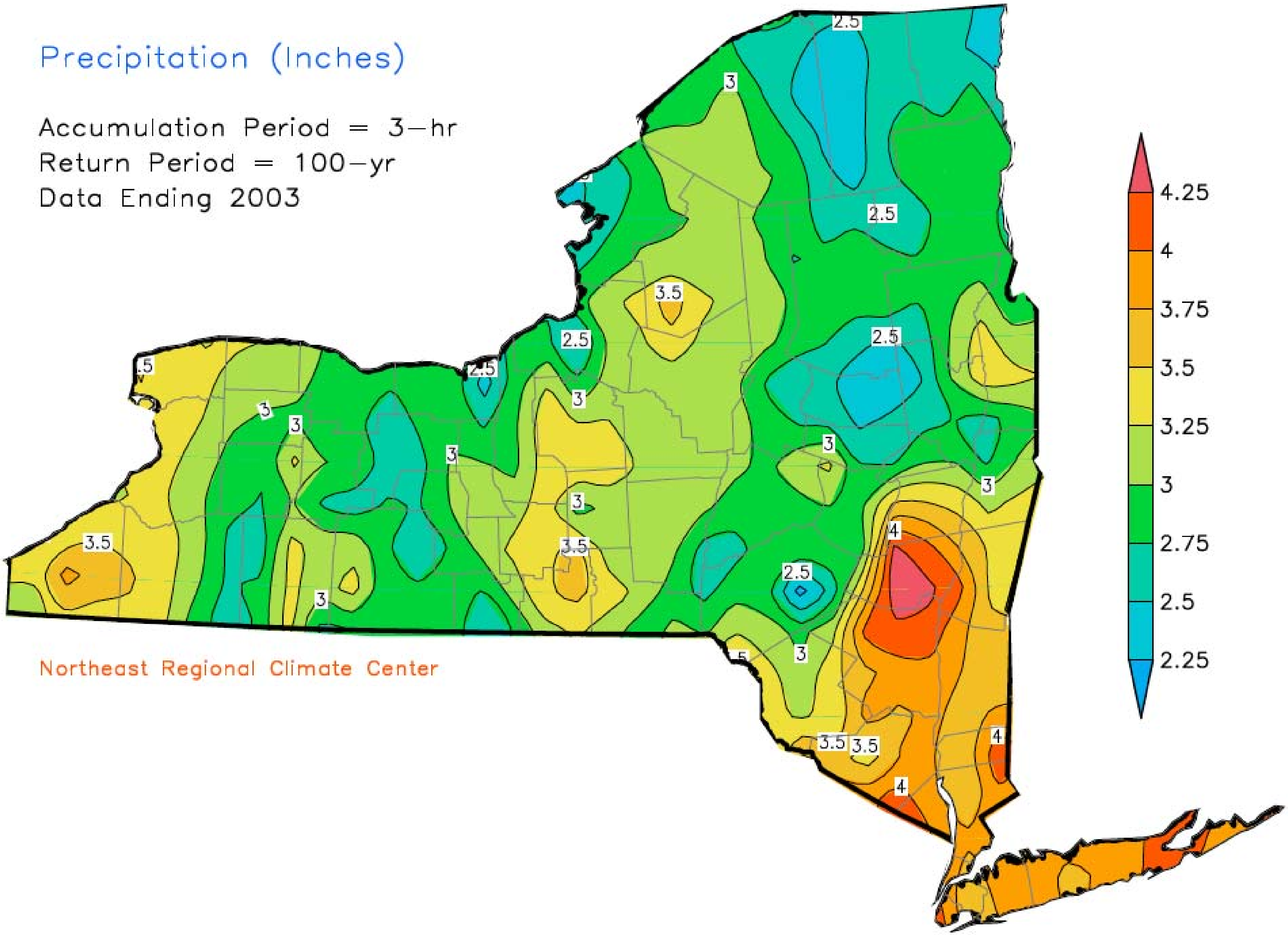
  Generally the case with climate variables, e.g. precipitation, temperature, wind, snow, storm intensity, etc.

Quantifying Climate Uncertainty

“Classic approach” - assume a **stationary climate** and **use probability distributions of historic outcomes** as a proxy for relative frequency of future outcomes




Precipitation (Inches)
Accumulation Period = 3-hr
Return Period = 5-yr
Data Ending 2003
Northeast Regional Climate Center
2.55
2.4
2.25
2.1
1.95
1.8
1.65
1.5
1.35


Precipitation (Inches)
Accumulation Period = 3-hr
Return Period = 100-yr
Data Ending 2003
Northeast Regional Climate Center
4.25
4
3.75
3.5
3.25
3
2.75
2.5
2.25

Climate Information Needed for Managing Climate Risk

- There is now widespread agreement in the scientific community that the **climate is not stationary**, so historic data may have limited value in describing future outcomes.

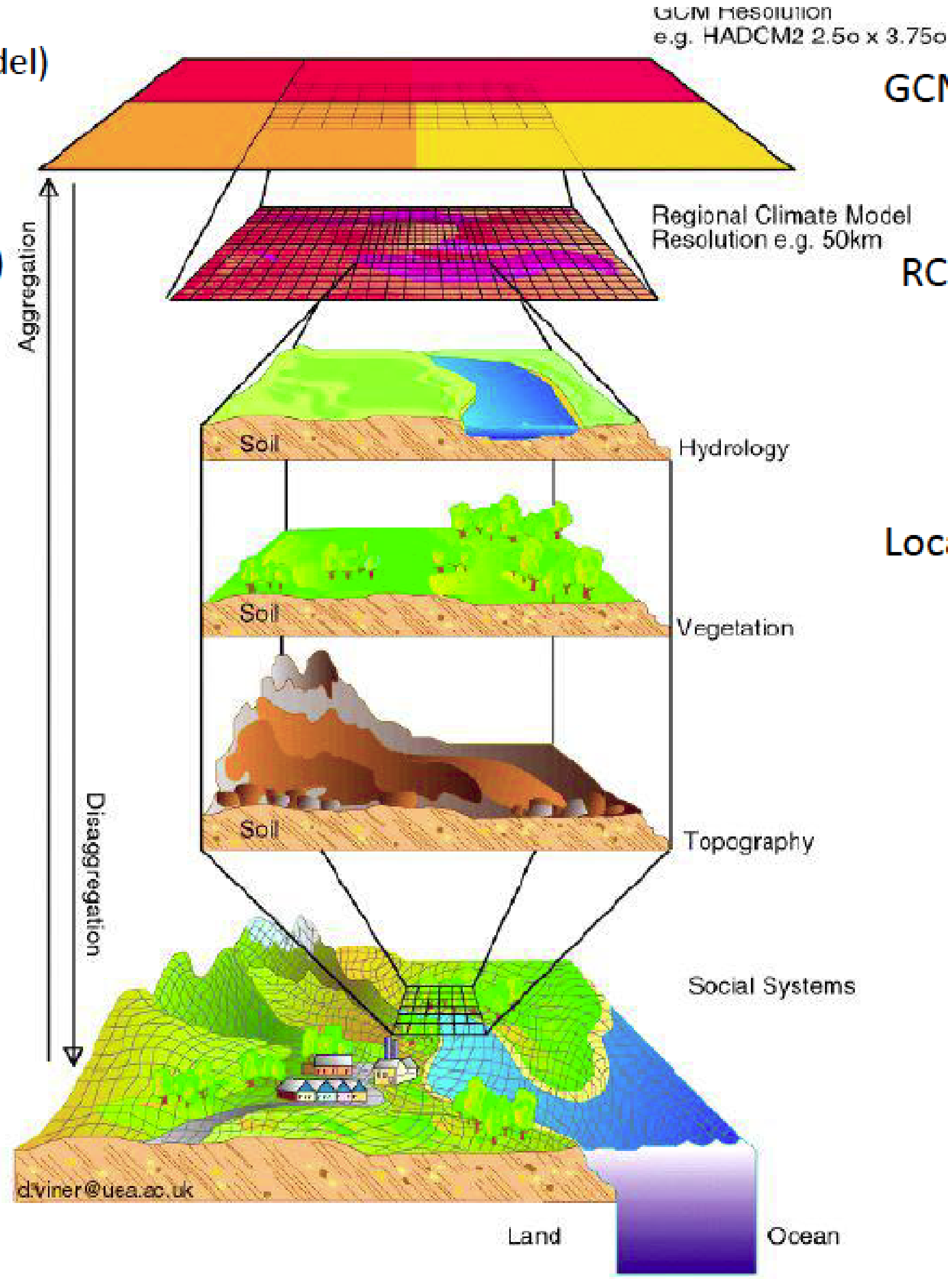
  (Milly et al. 2008 Stationarity is dead: whither water management? Science 319: 573-574)

- To quantify uncertainty, **can we rely on GCMs**?

GCM (general circulation model)

RCM (regional climate model)

Local process model

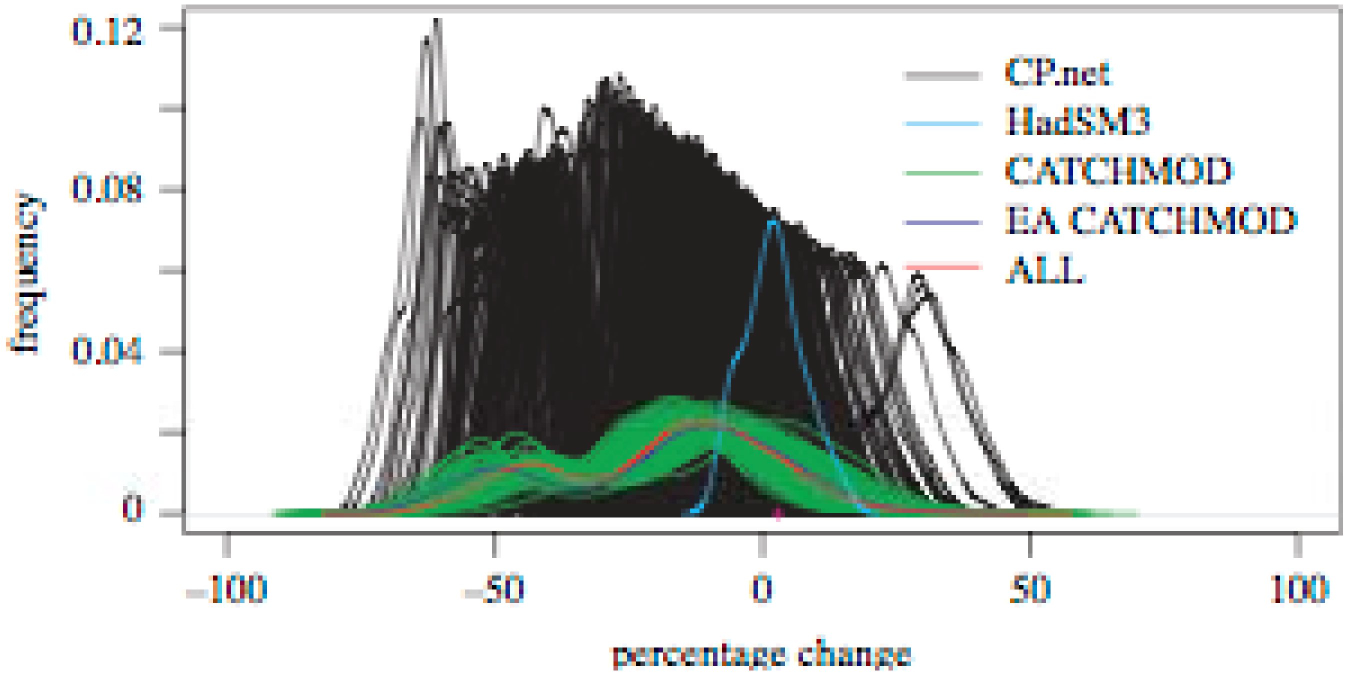


GCM resolution: ~500 km

RCM resolution: ~50 km

Local process model: ~1 km

Source: David Viner, Univ. of East Anglia

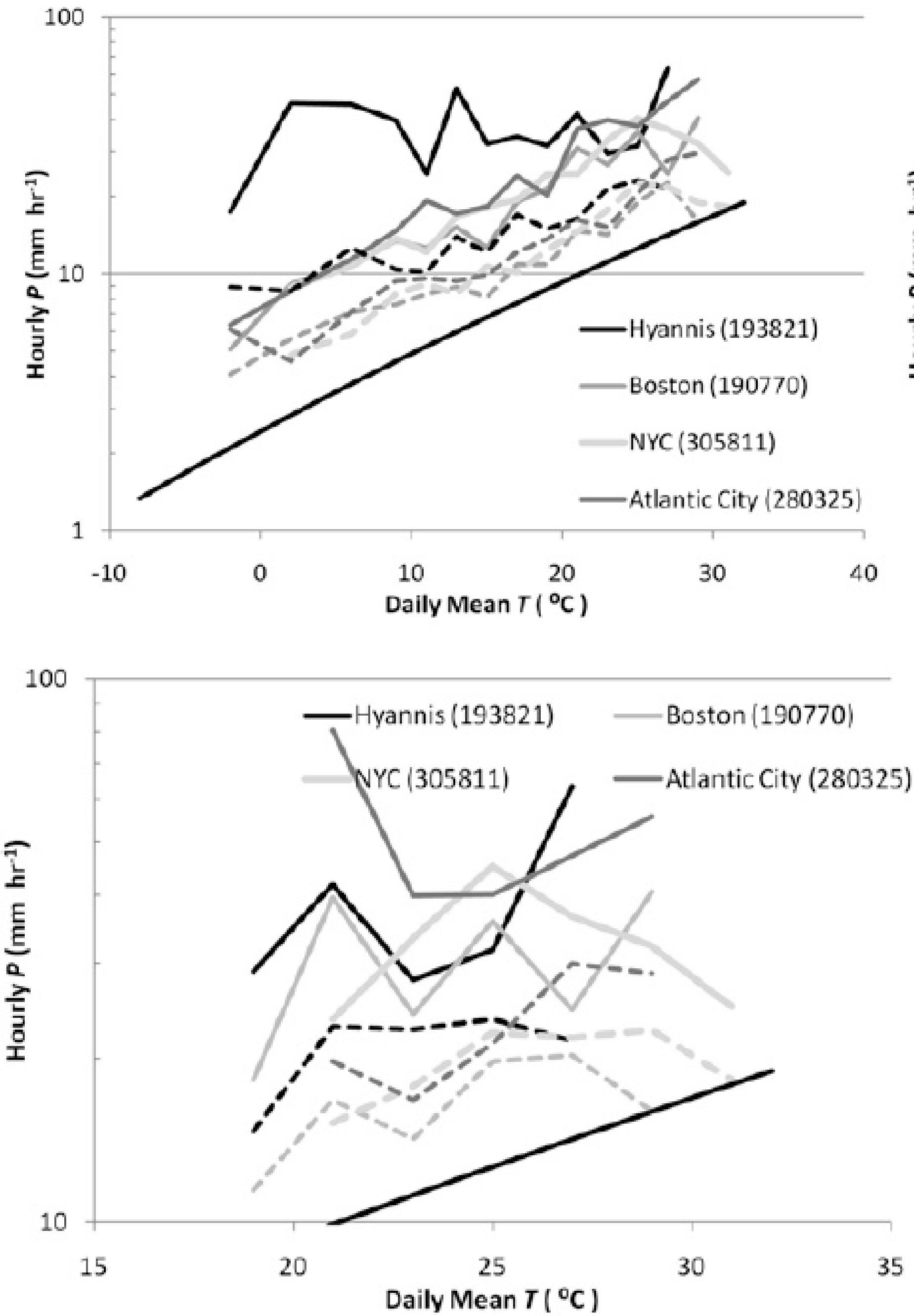


Frequency distribution of predicted changes (using a catchment model) in average flows in
the Thames where different parameterizations of a GCM were combined with different parameterizations of a catchment model (Black lines).

(New et al. 2011. Challenges in using probabilistic climate change information for impact assessments: an example from the water sector. Phil. Trans. R. Soc. 365: 2117-2131.)

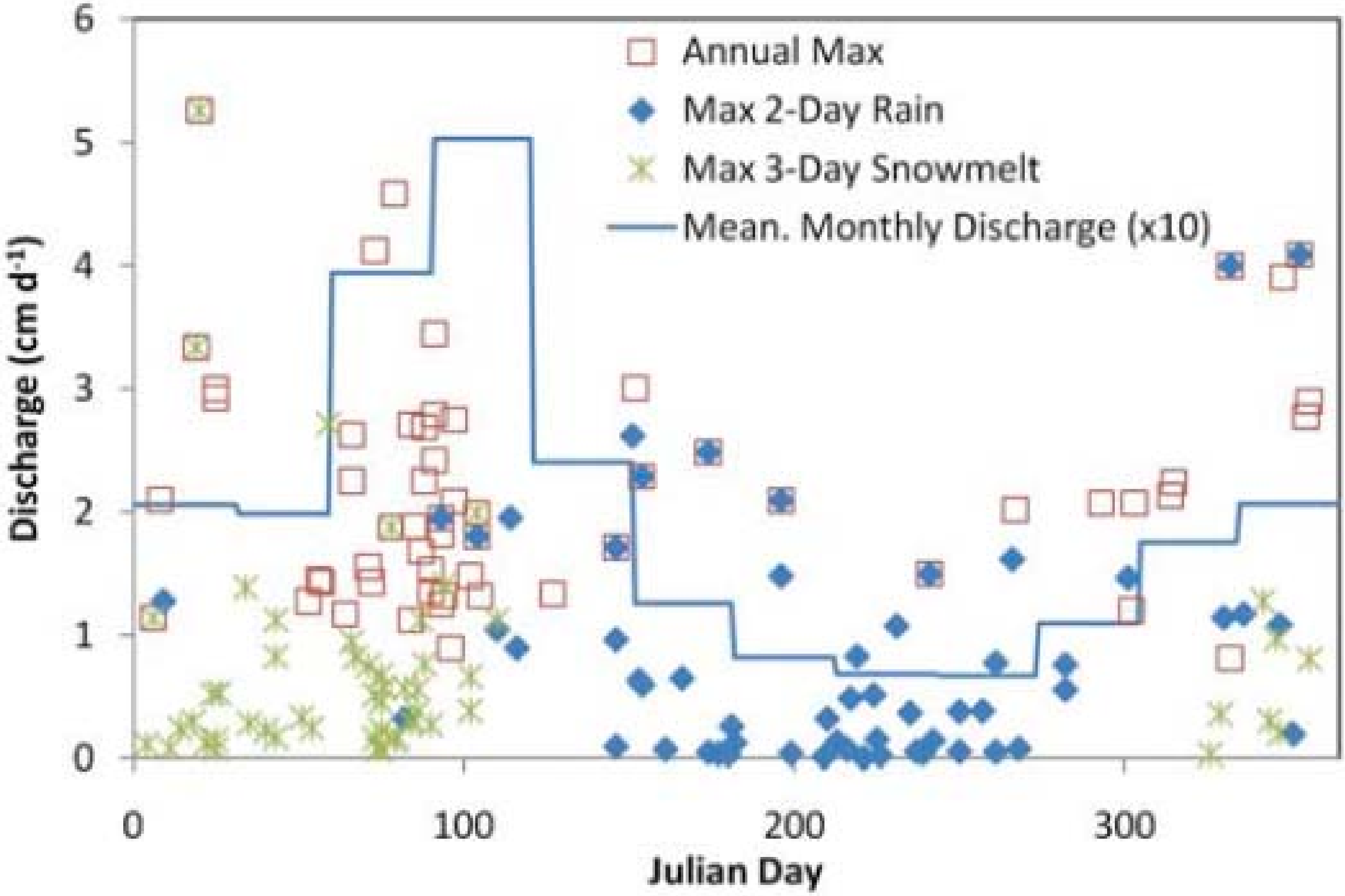
Use of GCMs and Process Models for Non-Quantitative Assessment of Climate Risks

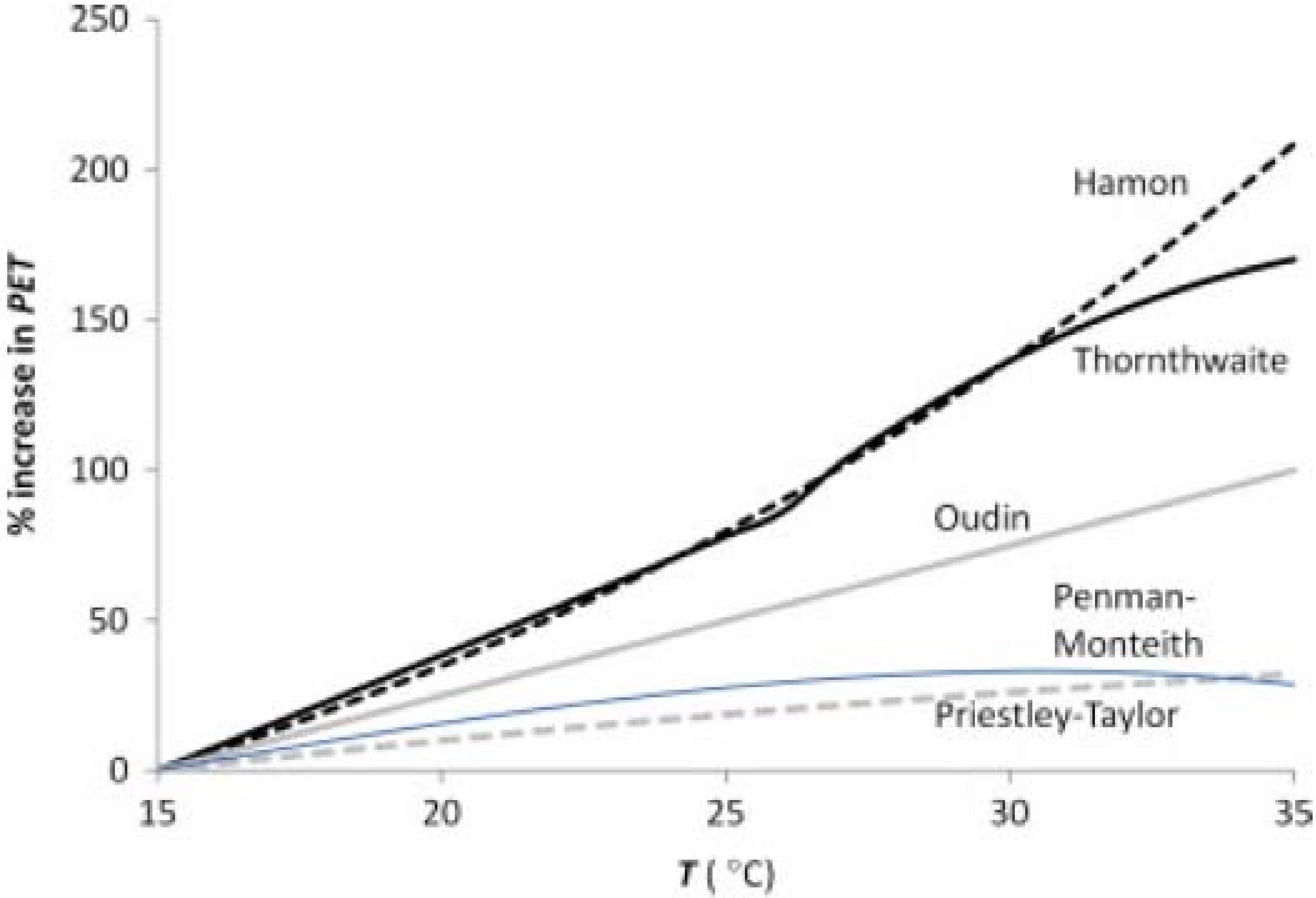
- More extreme rainfall events?
- More flooding?
- More drought?



Hyannis (193821)
Boston (190770)
NYC (305811)
Atlantic City (280325)
Albany (300042)
Syracuse (308383)
Buffalo (301012)
Hourly P (mm hr-1)
Daily Mean T (°C)

Fall Creek, Ithaca, NY





250
200
150
100
50
0
15
20
25
30
35
% increase in PET
T (°C)
Hamon
Thornthwaite
Oudin
Penman-
Monteith
Priestley-Taylor

Different Strategies for Managing Risk

1. **Share**/transfer
   - Share or balance climate risks with others through tools such as insurance and hedge products (derivatives, bonds)
2. **Reduce**/mitigate
   - Reduce likelihood or severity of climate risk (via infrastructure, operations, stockpiling, disaster response)
3. **Avoid** (eliminate, not initiate)
   - Some climate risks can be avoided
4. **Retain**
   - Can be used in the case of very small or very large risks

Non "optimal" Approaches for Managing Risk

- Adaptive management: Originally conceived as a way to make decisions in the face of uncertainty through an iterative process which allows learning over time.
- Precautionary principle: Scientific uncertainty should not preclude cost-effective measures to prevent or mitigate harm.
- No-regrets options: There are other benefits of taking actions that address climate risks.
- Scenario planning/Robust decision making: Developing management strategies that best adapt to a wide range of plausible future conditions.

Role of Local Governments

- Much of our water resource infrastructure already designed to reduce climate risks.
- Asset management important.
  - Grey water resource infrastructure (dams, POTWs, water treatment systems, private wells, septic systems) is expensive and ages.
  - Opportunities for consolidation, downsizing, elimination, replacement with green infrastructure?
- Opportunities?