

# Needs for Scenarios: Science, Assessments, and Decisionmaking

RICHARD MOSS, JOHN WEYANT

Energy Modeling Forum, Climate Change Impacts/Integrated Assessment  
Snowmass, CO  
30 July – 2 August 2014

The author gratefully acknowledges the U.S. Department of  
Energy's Integrated Assessment Research Program.

# Welcome!

- ▶ Organizing Committee: Richard Moss, John Weyant, Jae Edmonds, Klaus Keller, Jerry Meehl, Brian O'Neill, Keywan Riahi
  - Kate Calvin, link to Impacts Session

# Topics in this Introduction

- ▶ Overview of session questions and structure
  - Continuing to work on “parallel process” –
    - IAM realizations of SSPs
    - “Integration phase”
    - CMIP6 planning
  - Consider additional uses of scenarios beyond traditional international research and assessment processes
    - Distributed assessment
    - Decision support
- ▶ We will cover three specific topics in this introduction:
  - Background: terminology/definitions – are we on the same page?
  - Example to motivate interest in additional uses of scenarios: Evolving US activities in assessment and Agency resource/risk management
  - International scenario process



**Pacific Northwest**  
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

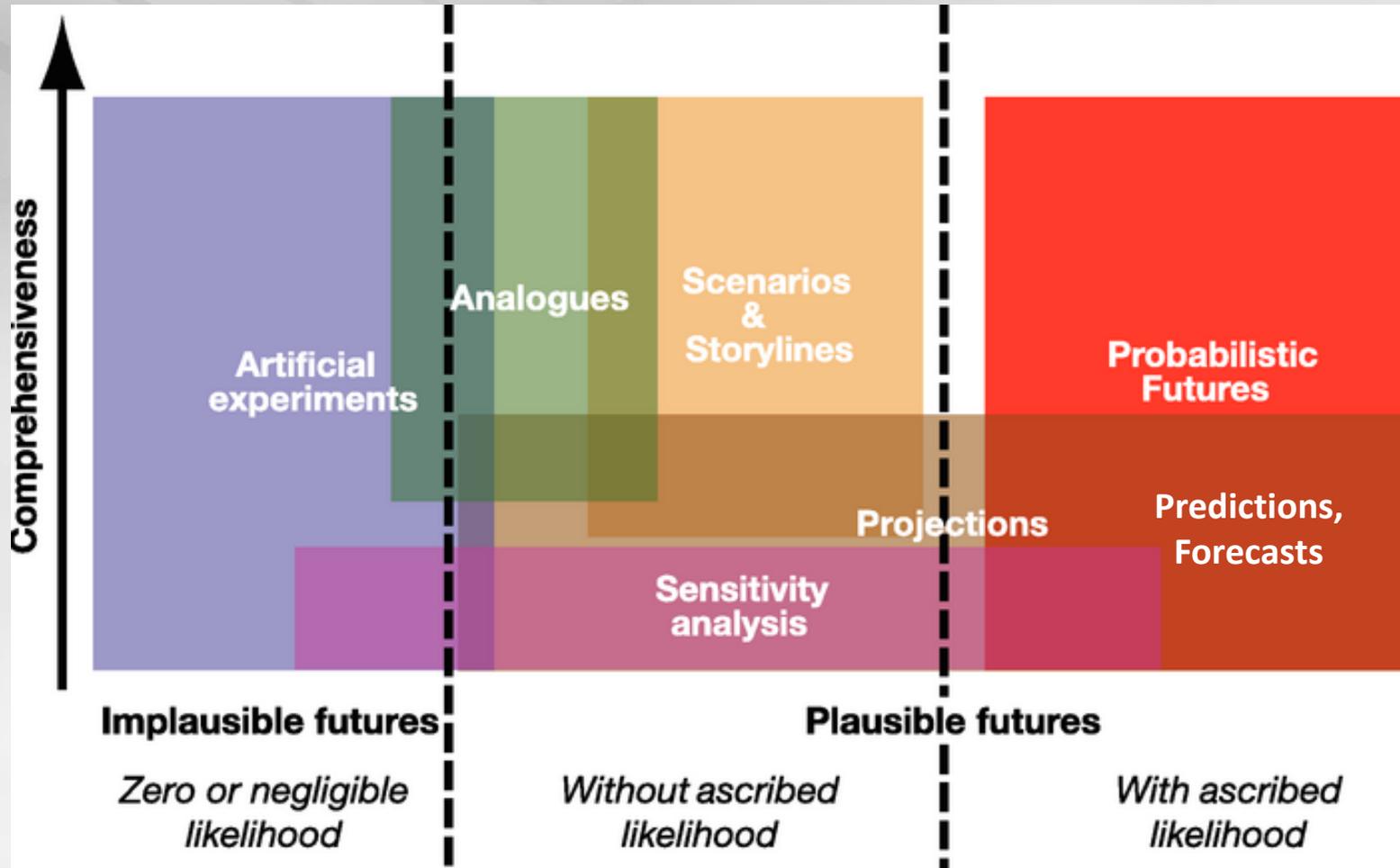
# Points of Departure

# Scenarios...

- ▶ ... are NOT predictions
- ▶ ... are *plausible* descriptions of how aspects of the future might unfold (grounded in science even if not predictive)
- ▶ ... provide another approach to help decision makers frame decisions under uncertainty if framed appropriately (and creatively)
- ▶ ... can be qualitative, quantitative, or both
- ▶ ... are used in climate/global change research in
  - Research
  - Assessments
  - Decision support

This session is designed to explore developments in all three areas

# Terminology: Different Ways to Characterize the Future



Carter et al., 2007. Ch 2, IPCC Fourth Assessment Report, WG2.



# **Evolving Interest in Scenarios (Examples from the US)**

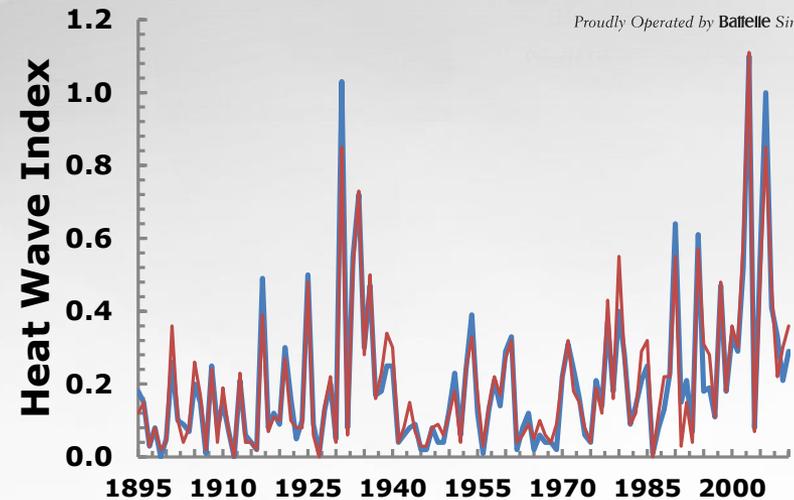


# US Agency Interest in National and Subnational Scale Scenarios

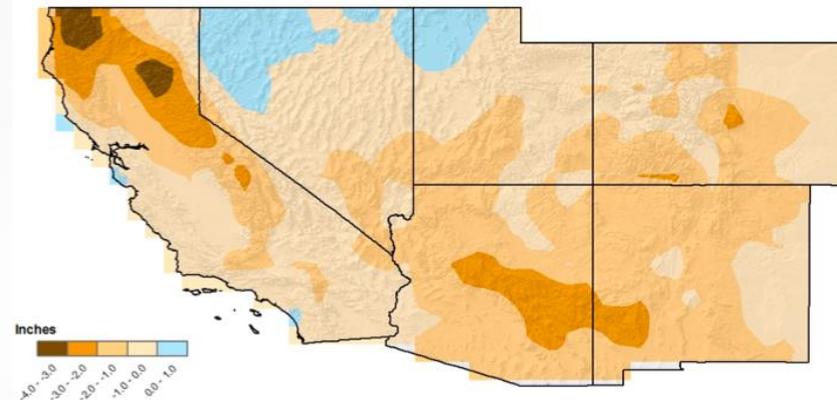
- ▶ Numerous federal agencies are interested in using global change scenarios to support their research and management missions
- ▶ Interest is driven by US National Climate Assessment (NCA) and mandates/needs of Federal agencies
  - Support distributed “Sustained National Assessment”
  - Facilitate comparison and integration across agencies and analyses
  - Enable agencies to meet their specific needs and support their external stakeholders
- ▶ There is interest in integrated, higher resolution information
  - Scale matters to IAV and mitigation implementation
  - There may be more interest in downscaling and very high resolution climate information than is productive
  - Interest in information on extreme events (Wilbanks presentation)
- ▶ We will briefly review NCA and Federal agency interests

# Scenarios for NCA3

- ▶ NCA3 process more user-oriented than previous assessments
- ▶ Purpose of scenarios: provide context and calibrate existing studies
- ▶ What was new in NCA scenarios:
  - Climate “outlooks”
  - Global mean sea level change scenarios *for risk framing*
  - Participatory scenario planning
- ▶ Based on existing literature
  - SRES A2 and B1 CMIP 3, NARCCAP
  - Maurer et al. daily and Hayhoe hourly
  - Bierwagen et al. (ICLUS) population and land scenarios
- ▶ Dissemination through <http://scenarios.globalchange.gov>
- ▶ Need for evaluation
  - What affected use and non-use?



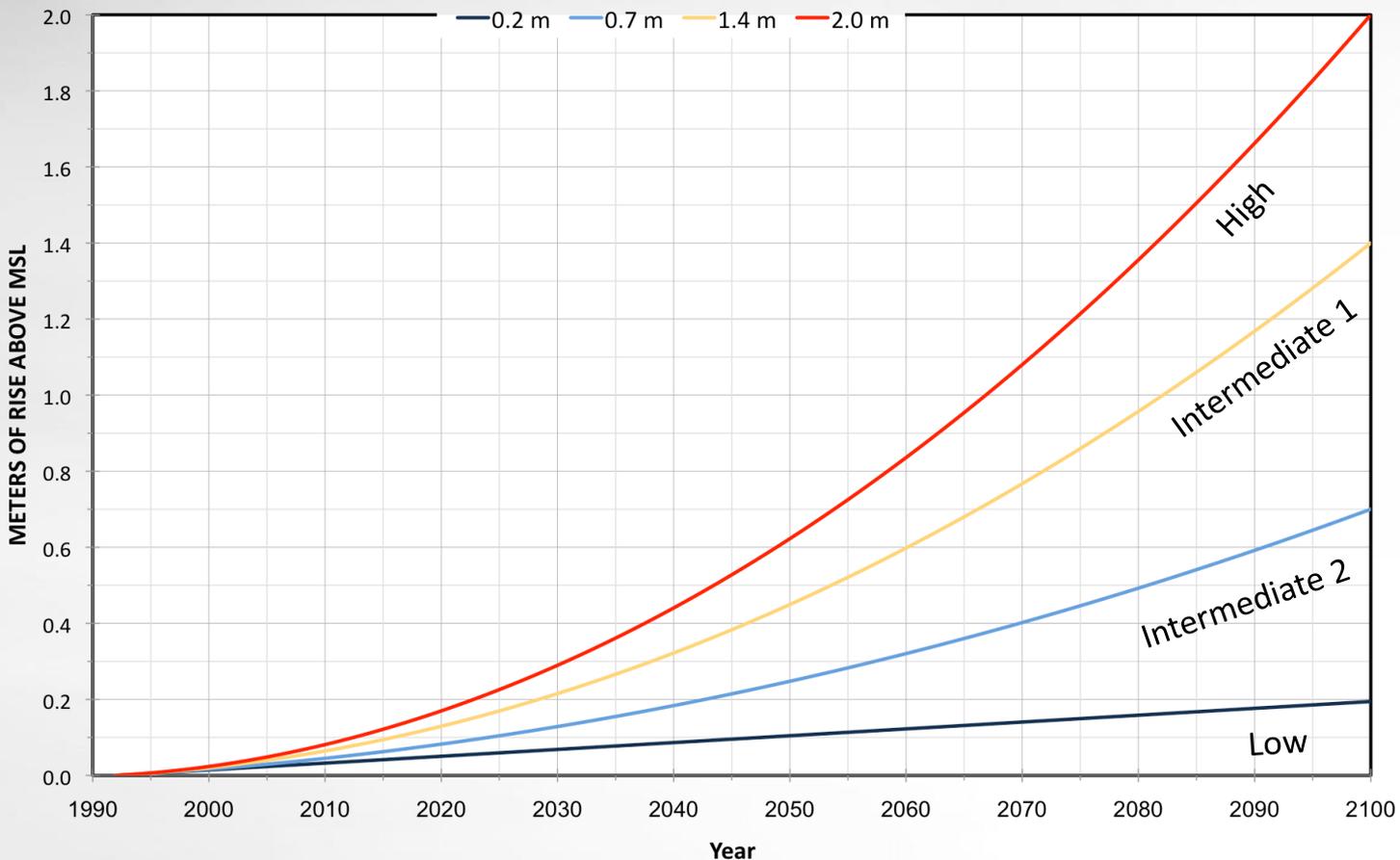
**NARCCAP, Change in Annual Precipitation  
2041-2070 minus 1971-2000**



- **Regional Climate Outlooks: major climatic factors, e.g., drought, heat waves, winter storms, flash floods**

# Sea Level Change Scenarios

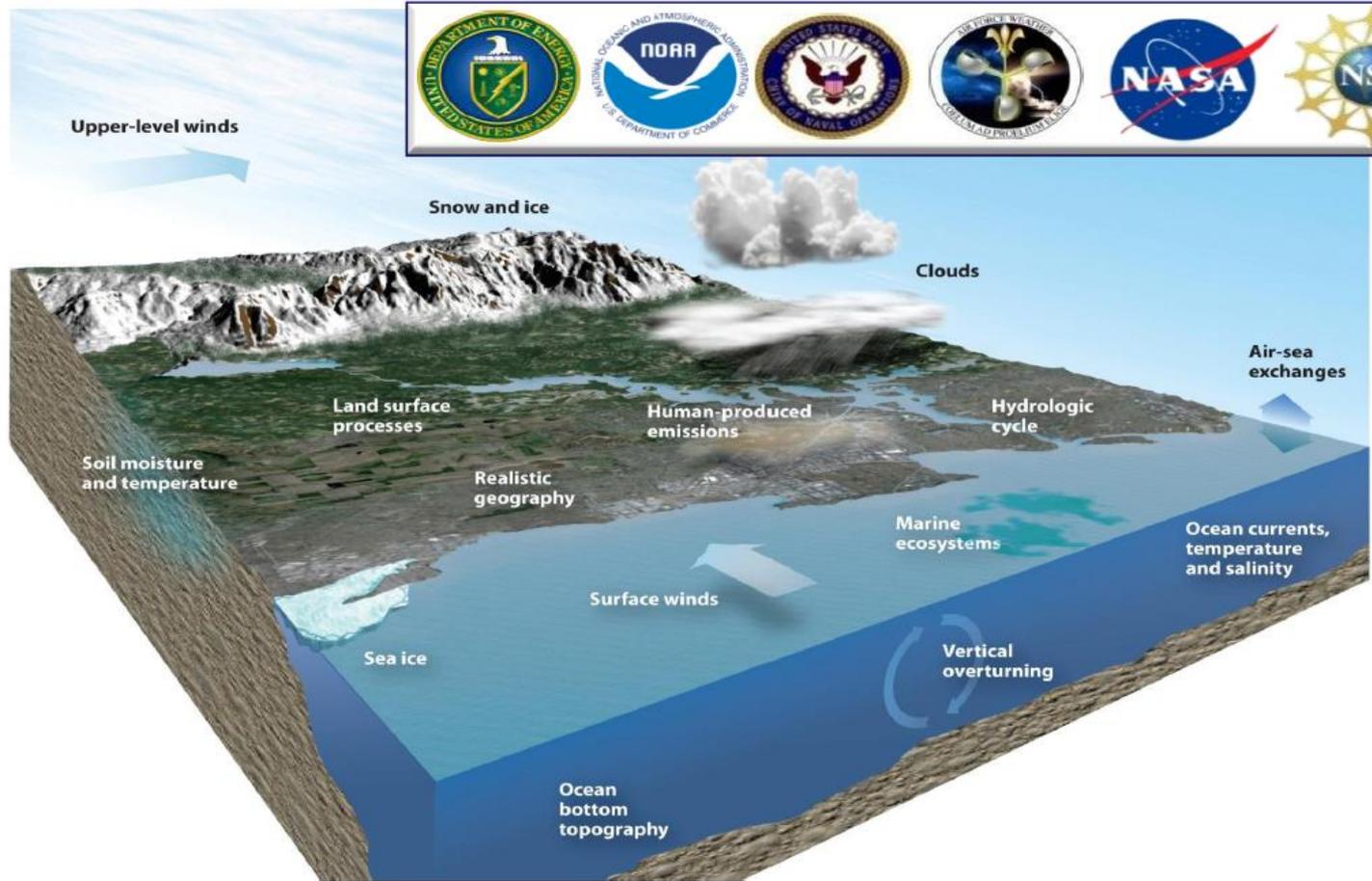
- ▶ Wide range provided for risk framing: guidance to select range based on risk tolerance and characteristics
- ▶ Global mean SLC plus guidance on factors to consider in assessing regional and local SLC



# An Alternative View of What's Needed...



## Long Term Climate Prediction



**ESPC: A unifying NATIONAL effort → one "BEST" prediction for all**

# Scenarios for “Sustained Assessment”

- ▶ Concept of “Sustained Assessment”: complement quadrennial ‘*tomes*’ with ongoing, distributed decision support
  - Emphasis on process of ‘co-production’
- ▶ Scenarios seen as useful input to this new process
- ▶ Some basic characteristics:
  - Problem driven -- engagement with stakeholders
  - Integrate significant trends, e.g., pop, land cover, regional economics, ...
  - Provide technical support
  - Improve visualization, use in decisions





## Box. 6.1. User/Societal Needs

People, communities, states, resource management agencies, and private-sector companies across the country face varied but important planning decisions that will affect the livability and competitiveness of the nation.

### National and regional-scale assessments

- Impacts on power plant cooling, hydropower, bioenergy, and other regional energy systems
- Implications for electricity and other national and regional energy distribution systems
- Cascading, multi-sector dependencies and vulnerabilities
- Energy for future water management
- Aggregate damages and economic implications
- Water transfer and boundary issues

### Sustainable development planning

- Integrated resource planning
- Sustainability options analysis

### Investment and siting decisions

- Facility siting and environmental and economic analysis
- Technology selection and deployment
- Retrofit and/or capital turnover
- Integrated systems designs/perspectives
- Operational reliability

### Adaptation strategies

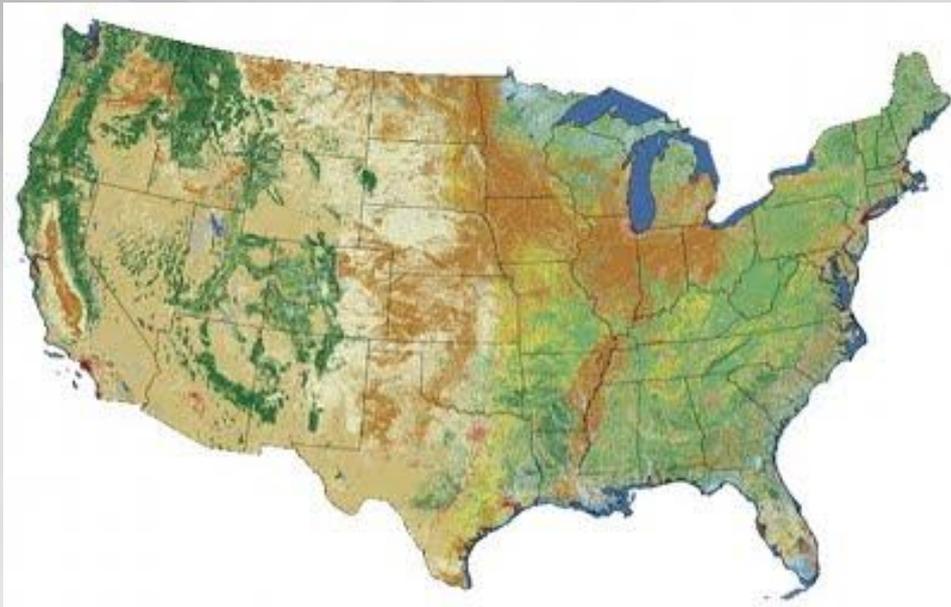
- Implications of adaptation strategies and options
- Global change and other stressors
- Means, extremes, and the implications for vulnerable systems
- Mitigation versus adaptation and search for co-benefits
- Indicators of change

### Technology analysis and R&D insights

- Technology performance (including economic), water efficiency, and demands
- Technology penetration constraints

- ▶ Example agency uses of scenarios
- ▶ DOE Water-energy related  
←
- ▶ Needs also include:
  - Vulnerability assmt
  - Forest resources
  - Carbon stocks
  - Fire management
  - Public health
  - Coastal development
  - Economic planning
  - ...

# Interagency Workshops on Subnational Population and Land Use/Cover Scenarios



NLCD Land Cover Classification Legend

11	Open Water
12	Perennial Ice/Snow
21	Developed, Open Space
22	Developed, Low Intensity
23	Developed, Medium Intensity
24	Developed, High Intensity
31	Barren Land
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Dwarf Scrub*
52	Shrub/ Scrub
71	Grassland/ Herbaceous
72	Sedge/ Herbaceous *
74	Moss *
81	Pasture Hay
82	Cultivated Crops
90	Woody Wetlands
95	Emergent Herbaceous Wetlands

\* Alaska Only

- ▶ Objectives: Evaluate needs and methods for preparation of national land use and population scenarios
- ▶ Topics:
  - Desired characteristics and potential uses?
    - Attributes of land use/cover and population of interest?
    - Spatial scales?
    - Time scales?
    - What uncertainties are most important?
  - Existing data and scenarios?
    - Connections to SSPs?
  - Methods?
  - Programmatic needs/issues?
- ▶ For land workshop, conduct initial discussion of narratives or logical structure
- ▶ See Fred Lipschultz presentation



# International scenario efforts – RCPs and SSPs\*

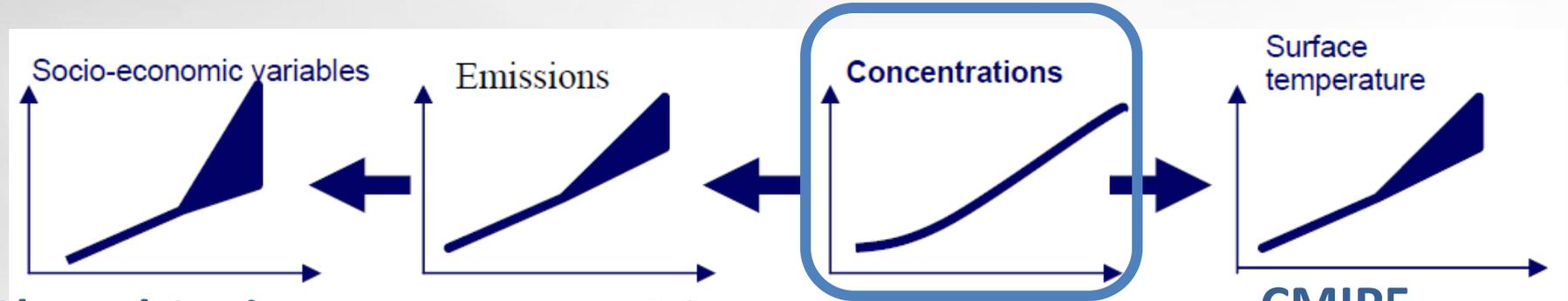
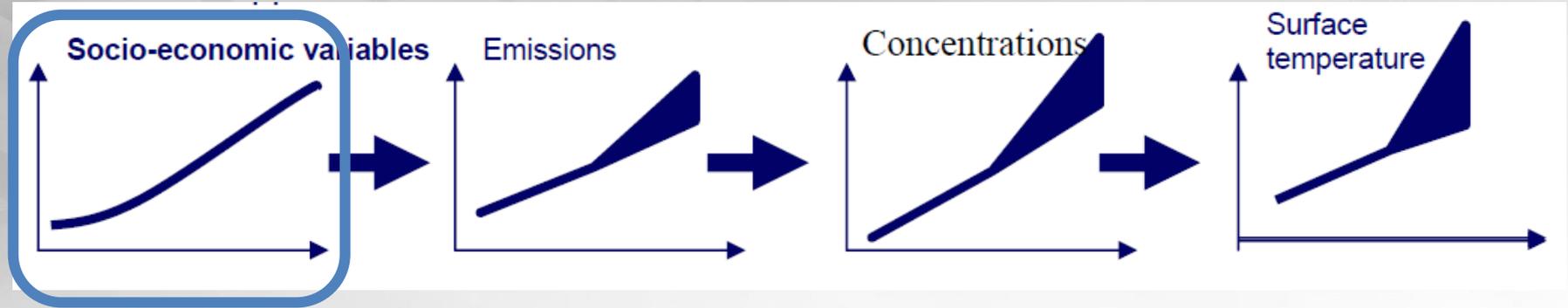
\* A prologue to Brian's remarks

# New Parallel Scenario Process



Pacific Northwest  
NATIONAL LABORATORY

Proudly Operated by **Battelle** Since 1965

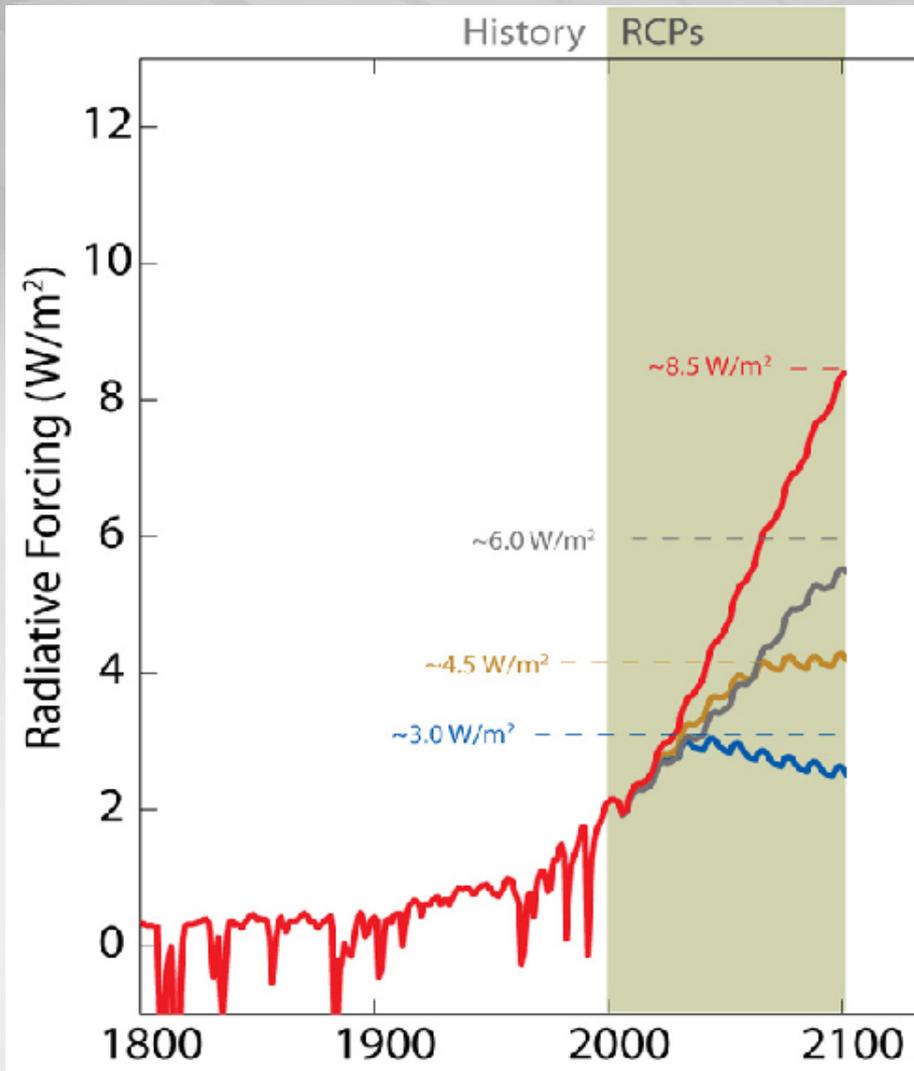


Shared Socio-economic Pathways (SSPs), Shared Policy Assumptions (SPAs) (in process)

RCPs (Complete)

CMIP5 (Complete)

# Representative Concentration Pathways (RCPs)

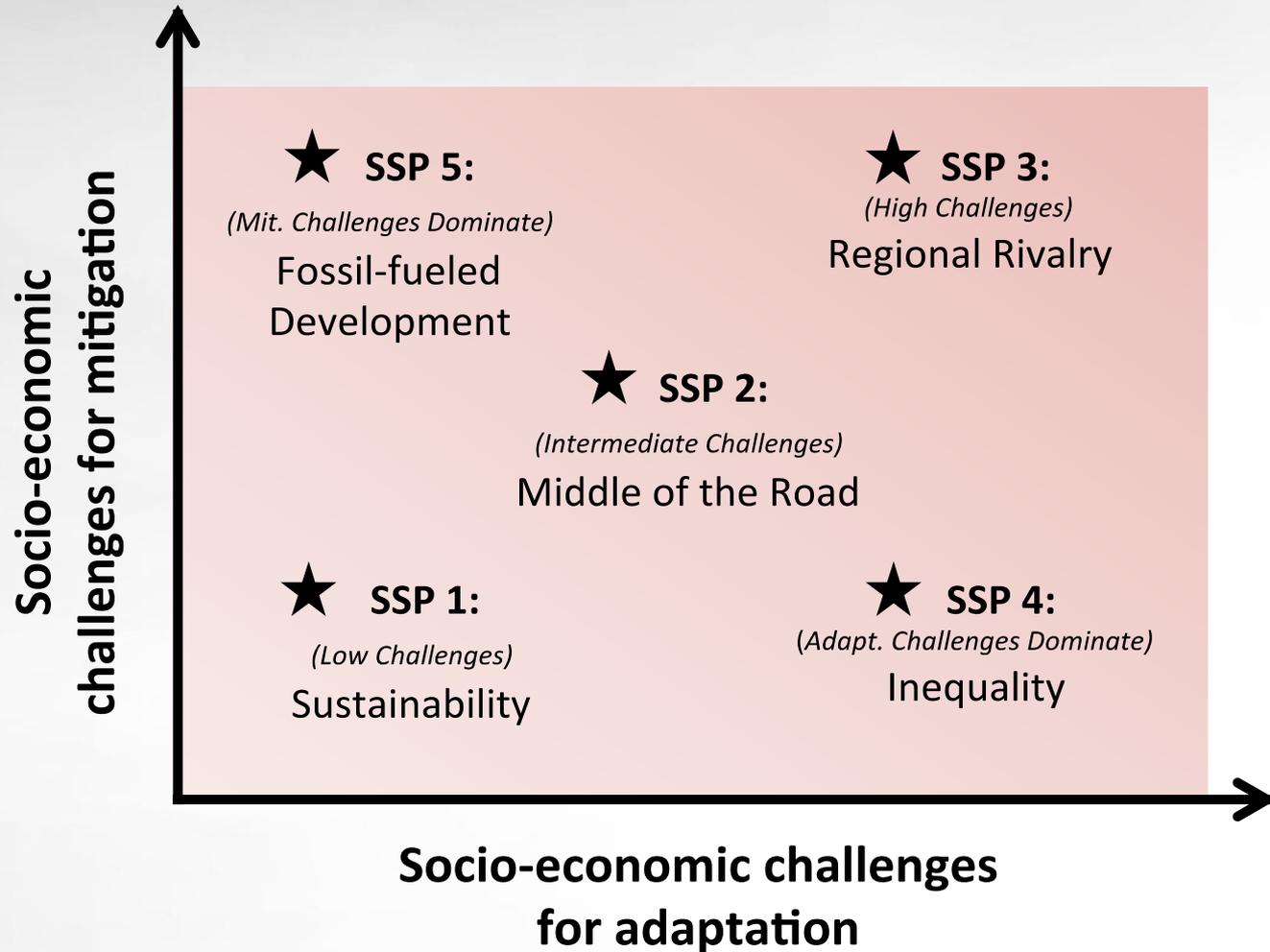


- ▶ The climate modeling community wanted 4 levels of radiative forcing that would span the emissions literature.
  - 8.5  $\text{Wm}^{-2}$  (RCP 8.5, 1350ppm  $\text{CO}_2\text{-e}$ )
  - 6.0  $\text{Wm}^{-2}$  (RCP 6.0, 850ppm  $\text{CO}_2\text{-e}$ )
  - 4.5  $\text{Wm}^{-2}$  (RCP 4.5, 650ppm  $\text{CO}_2\text{-e}$ )
  - 2.6  $\text{Wm}^{-2}$  (RCP 2.6, 450ppm  $\text{CO}_2\text{-e}$ ) ('overshoot')
- ▶ How should this range be interpreted by users?
  - "Compatib[le] with the full range of stabilization, mitigation, and reference emissions scenarios available in the current scientific literature" (Moss et al., 2010)
  - Keller et al. session today



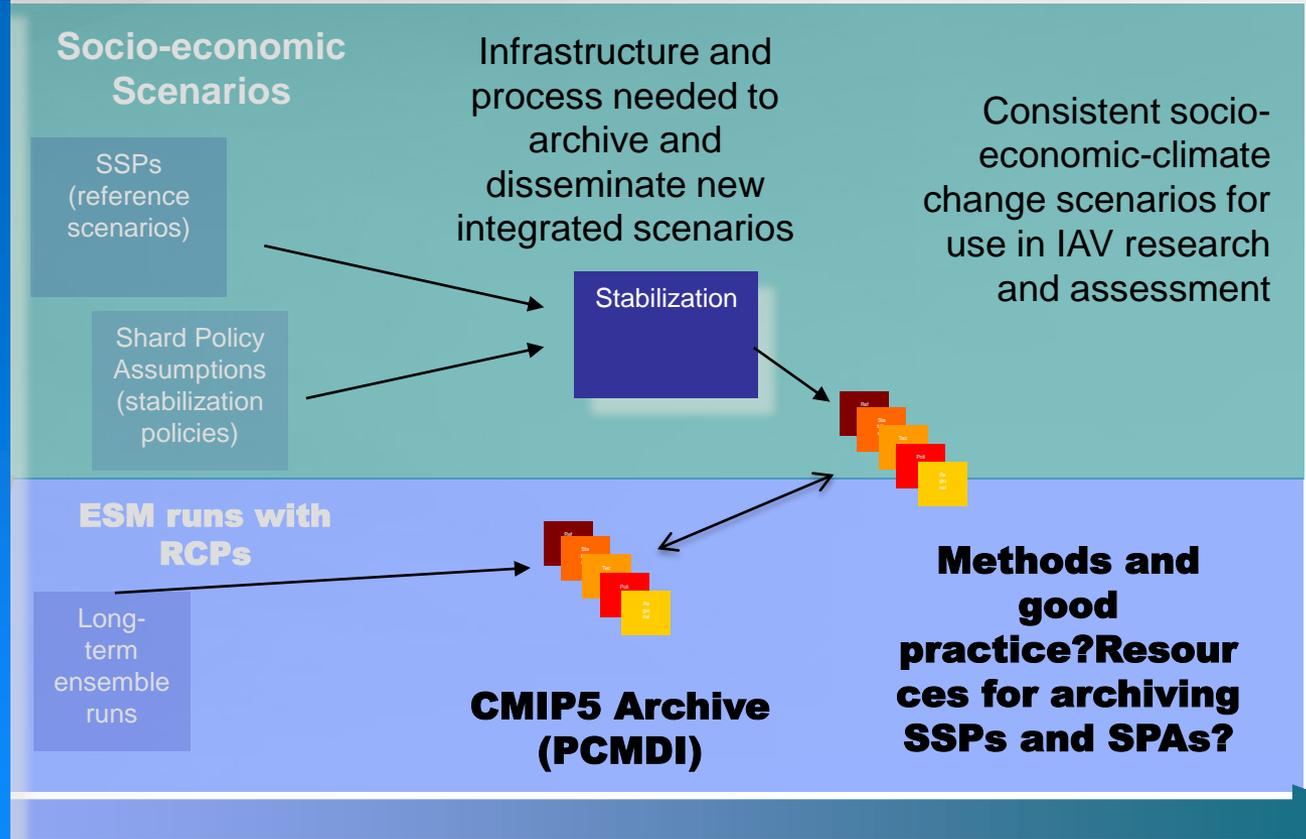
# SSP Logic: Challenges to Adaptation and Mitigation

- ▶ SSPs are new reference pathways (no new climate policies)
- ▶ Design questions:
  - Adapting to impacts from different combinations of climate change and socio-economic pathways?
  - Mitigating to a particular climate target given an SSP?
- ▶ Some SSPs will reproduce RCPs, others require policy assumptions to do so
- ▶ O'Neill, Riahi presentations, possible evening session?



# Integrating socio-economic, climate, and environmental scenarios

Objective: Provide integrated socioeconomic, climate, and environmental scenarios in an accessible format for research, assessments, and decision support



- ▶ Edmonds et al. session on Thursday
- ▶ Status of IAM scenarios, new climate information
- ▶ What are experiences of users?
- ▶ What's needed to foster consistent integration?

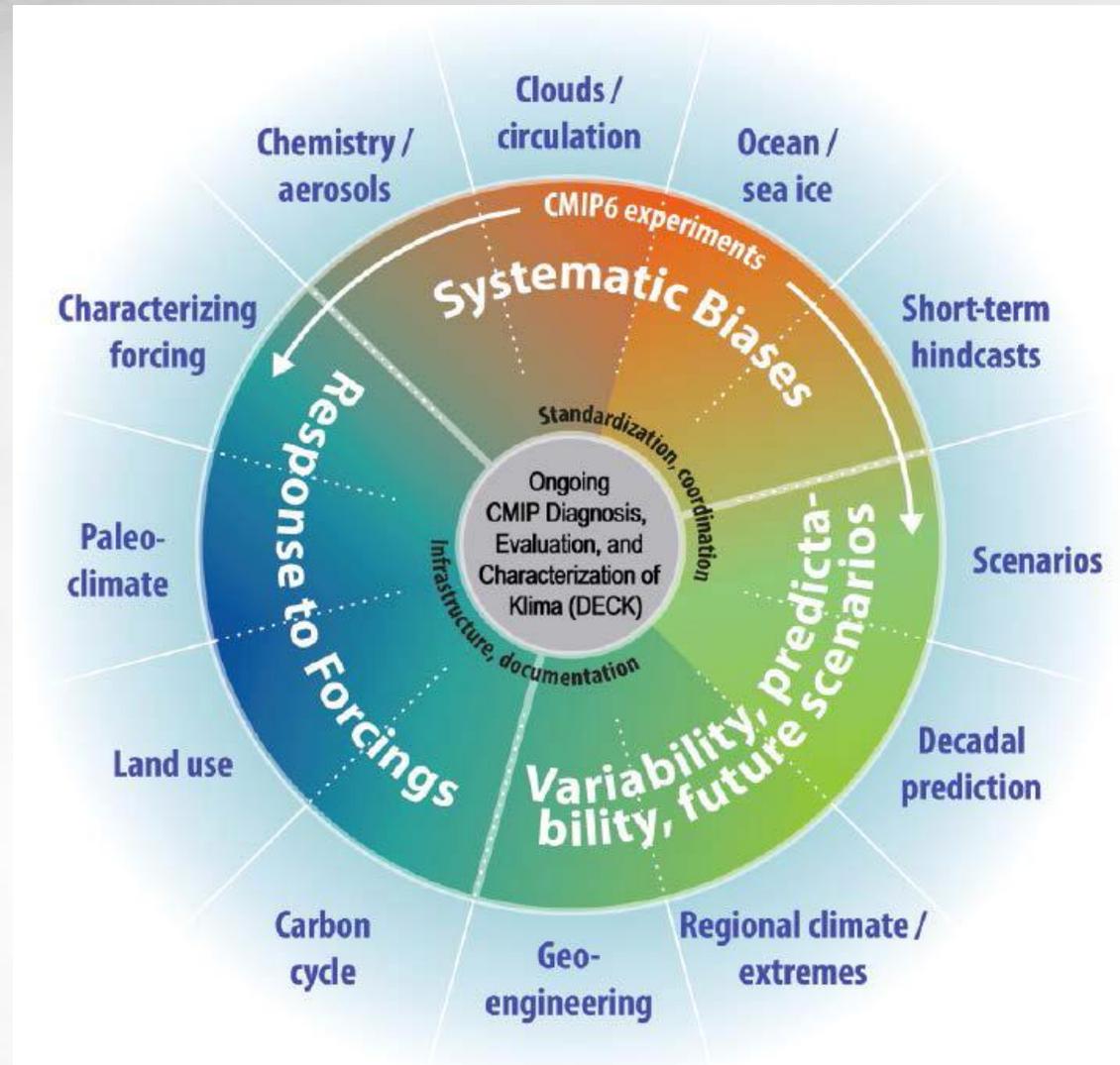
# Organizing Interdisciplinary Model Intercomparisons

## Objective

- Coordinate the next phase of climate science using stylized experiments and scenarios

## Approach

- Three themes were identified: Earth system response to forcing; systematic model biases; and variability, predictability, and future scenarios.
- A small set of standard experiments are planned for model diagnosis and evaluation.
- Additional topics are addressed through specialized MIPs which model teams can join given interest and resource constraints.
- ScenarioMIP: O'Neill, Tebaldi, VanVuuren Co-Chairs
- IAM/IAV input to CMIP6 process discussed in O'Neill et al., session on Friday



# Scenario Session Purposes Revisited

- ▶ Continue to work on “parallel process” –
  - IAM realizations of SSPs
  - “Integration phase”
  - CMIP6 planning
- ▶ Consider additional uses of scenarios beyond traditional international research and assessment processes
  - Distributed assessment
  - Decision support
- ▶ Coordination and follow-up possibilities
  - Identify possible coordinated experiments and activities of interest to sub-groups of modelers and users
  - Plan (or at least identify need for) additional steps to promote consistent integration of scenarios
  - Identify other follow-up activities (workshops, white paper, ...?)

# Session Structure/Organization (1)

- ▶ Wednesday: Probabilistic information on potential climate futures
  - Discuss probabilistic climate information including needs, ongoing efforts, and potential foundations
- ▶ Thursday: Integrating SSPs, SPAs, RCP-based Climate Scenarios: What's Next?
  - Discuss preliminary SSP-based IAM scenario results.
  - Learn about new climate information becoming available based on CMIP5 results and other sources.
  - Learn about experience of users in combining SSPs, SPAs, and RCP-based climate and environmental scenarios (or using integrated combinations of SRES-based scenarios).
  - Identify products or activities (e.g., guidance, outreach, etc.) needed to support proper use of SSPs and newly available climate information by IAV researchers.
  - Identify possible fine tuning of SSP-based IAM scenario results as they are completed to increase their utility.

# Session Overview (2)

- ▶ Friday: IAM/IAV Input to Research Community Scenario Design -- CMIP6
  - Input for scenario experiments for CMIP6 process (AGCI next week) to continue developing CMIP6.
  - ScenarioMIP (LUMIP, ACMIP)
- ▶ Overall conclusions and next steps

# Where To From Here?

