

Scenarios for Climate Research and Assessment: Past, Present, Future

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- ▶ Rationale, key concepts, and examples
- ▶ International scenario efforts – the ‘parallel process’ (RCPs and SSPs)
- ▶ National and Subnational Scale Scenarios for the United States
 - National Climate Assessment scenarios
 - New subnational scale scenarios



Rationale, key concepts, and examples

Decision Makers Confront Many Uncertainties



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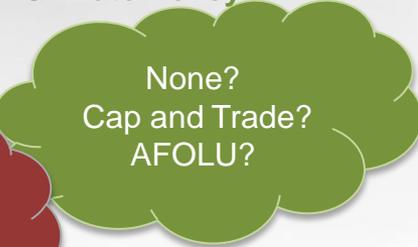
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National or Regional
Climate Policy

Regional Socioeconomics

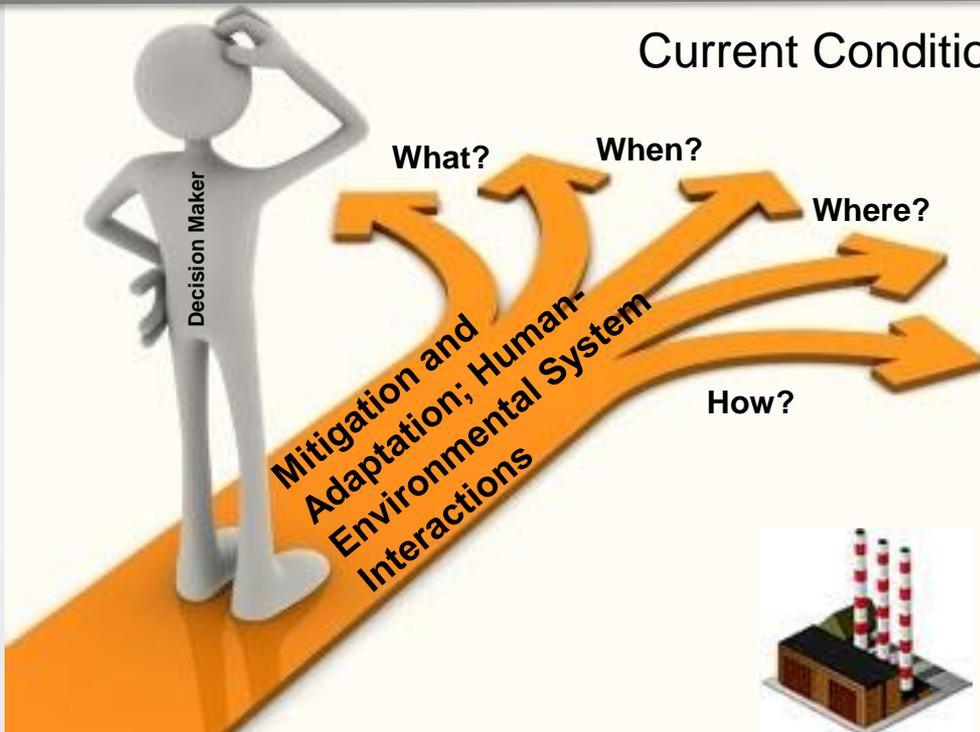
Regional Climate

Regional Impacts and Interactions



Future

Current Conditions



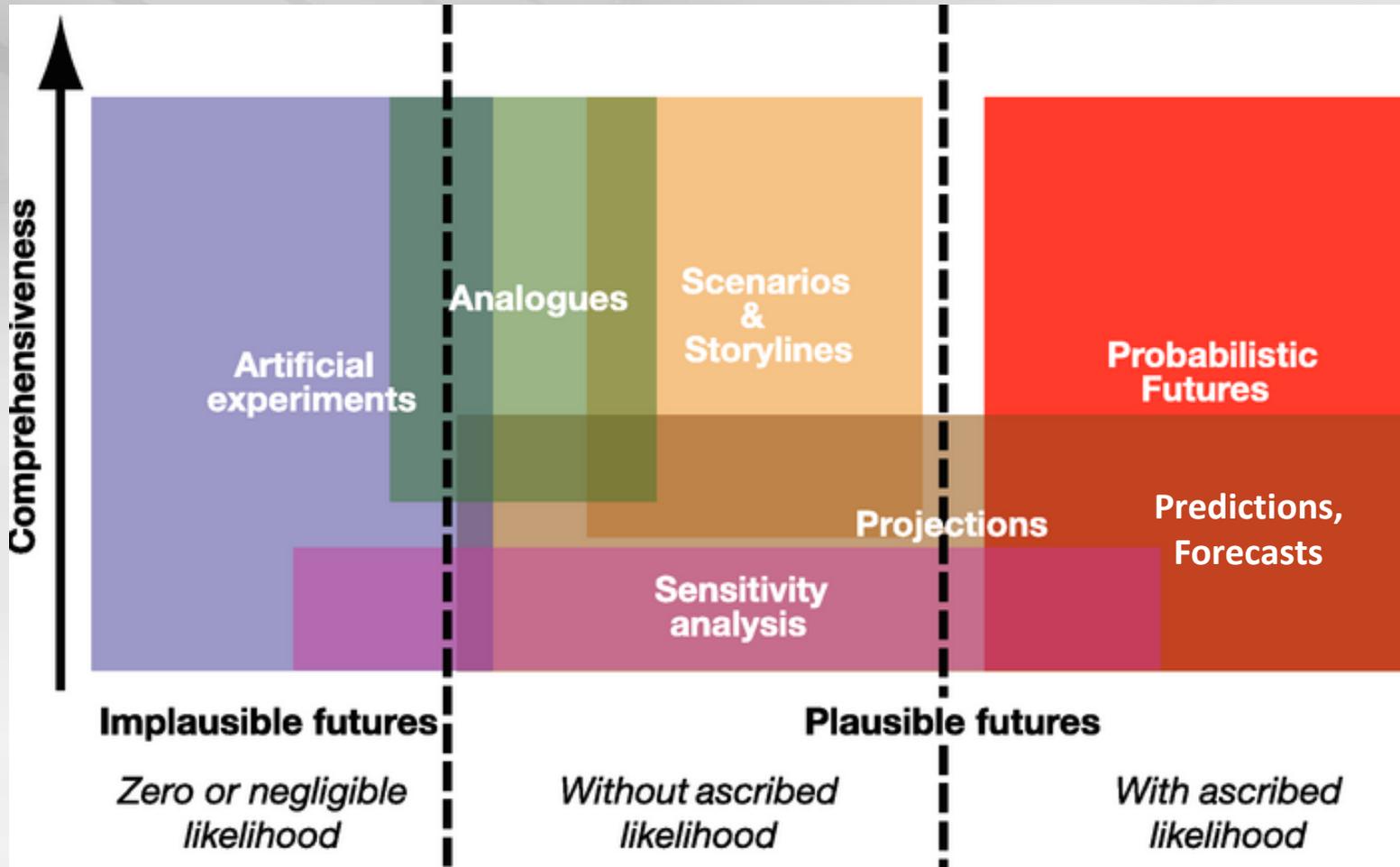
Scenarios...

- ▶ ... are NOT predictions
- ▶ ... are *plausible* descriptions of how aspects of the future might unfold (grounded in science even if not predictive)
- ▶ ... are used to
 - Integrate research
 - Inform decision support and planning
- ▶ ... can be qualitative, quantitative, or both
- ▶ ... often use an overarching logic to relate components





Different Ways to Characterize the Future

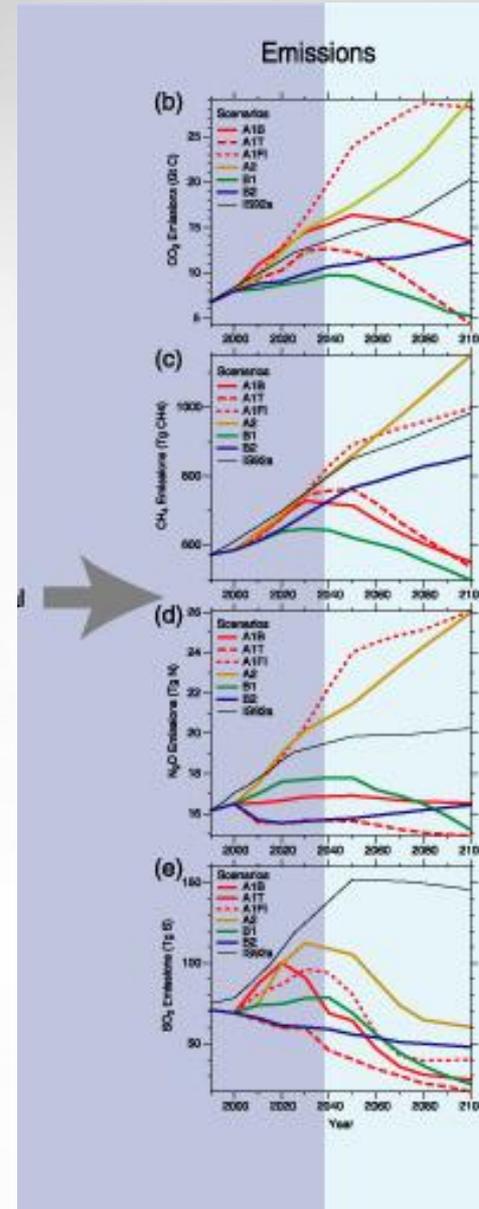
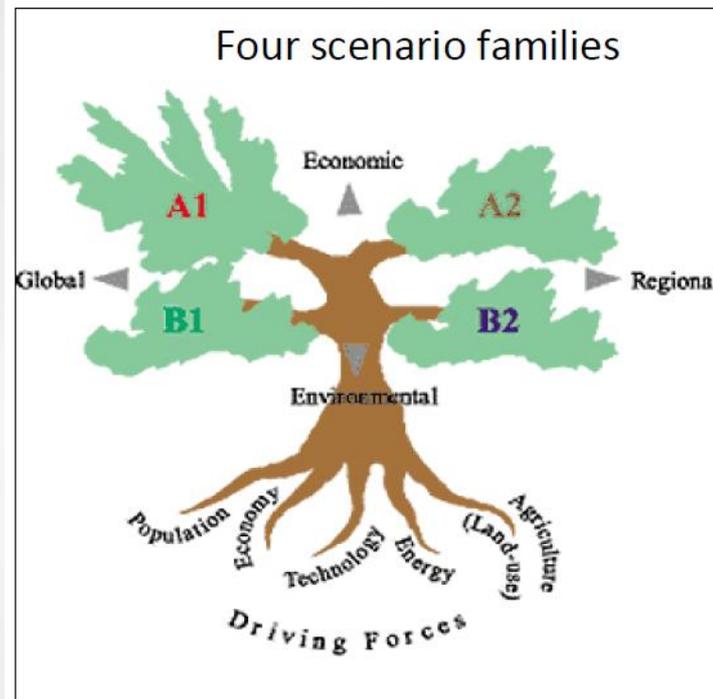
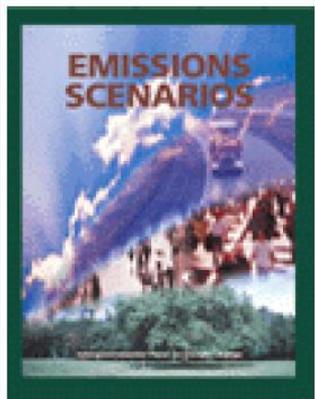


Carter et al., 2007. Ch 2, IPCC Fourth Assessment Report, WG2.



Example: IPCC Special Report On Emissions Scenarios (SRES)

- ▶ Driving question: how could different 'reference' ('business as usual') futures affect emissions?
- ▶ Purpose: provide a set of inputs for climate model experiments



Other International Scenario Families

	IPCC-SRES	GEO-3	Millennium Ecosystem Assessment	FAO
Economic optimism, market liberalisation	A1	Markets First	<i>Global Orchestration</i>	
Reformed market scenario		Policies First	<i>Global Orchestration</i>	
Global sustainable development	<i>B1 (B1-450)</i>	Sustainability First	TechnoGarden	
Regional competition, low growth	A2	Security First	Order from Strength	
Regional sustainable development	<i>B2</i>		Adapting Mosaic	
–Business as usual” (medium	<i>B2</i>			AT2015/2030
Main interest	Greenhouse gas emissions	Global environmental change	Changes in ecosystem services;	Changes in agricultural production

Main Scenario Features

	Economic optimism	Reformed markets	Global sustainable development	Regional competition	Regional sustainable development
Economic development	Very rapid	Rapid	Slow-rapid	Slow	Slow/medium
Population growth	Low	Low	Low	High	Medium
Technology development	Rapid	Rapid	Medium-Rapid	Slow	Slow-medium
Main objectives	Economic growth	Various goals	Economy, Environment, Equality	Security	Local sustainability
Attitude towards env. Protection	Reactive	Pro-active – reactive	Pro-active	Reactive	Pro-active
Trade	Globalisation	Globalisation	Globalisation	Trade barriers	Trade barriers
Policies/institutional development	Policies create level playing fields for markets	Policies help reducing market failures	Strong global governance	Strong national governments	Local steering; local actors



International scenario efforts – RCPs and SSPs*

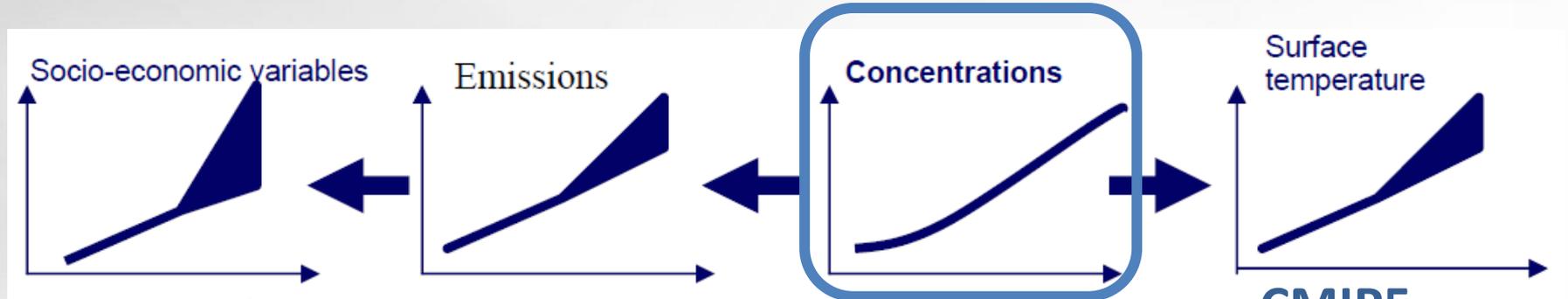
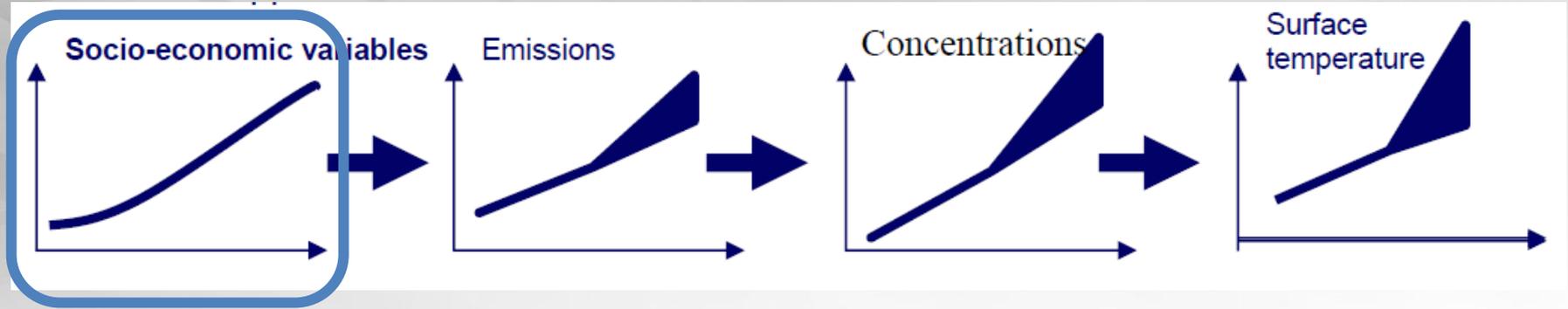
* Everything you wanted to know but were afraid to ask

New Parallel Scenario Process



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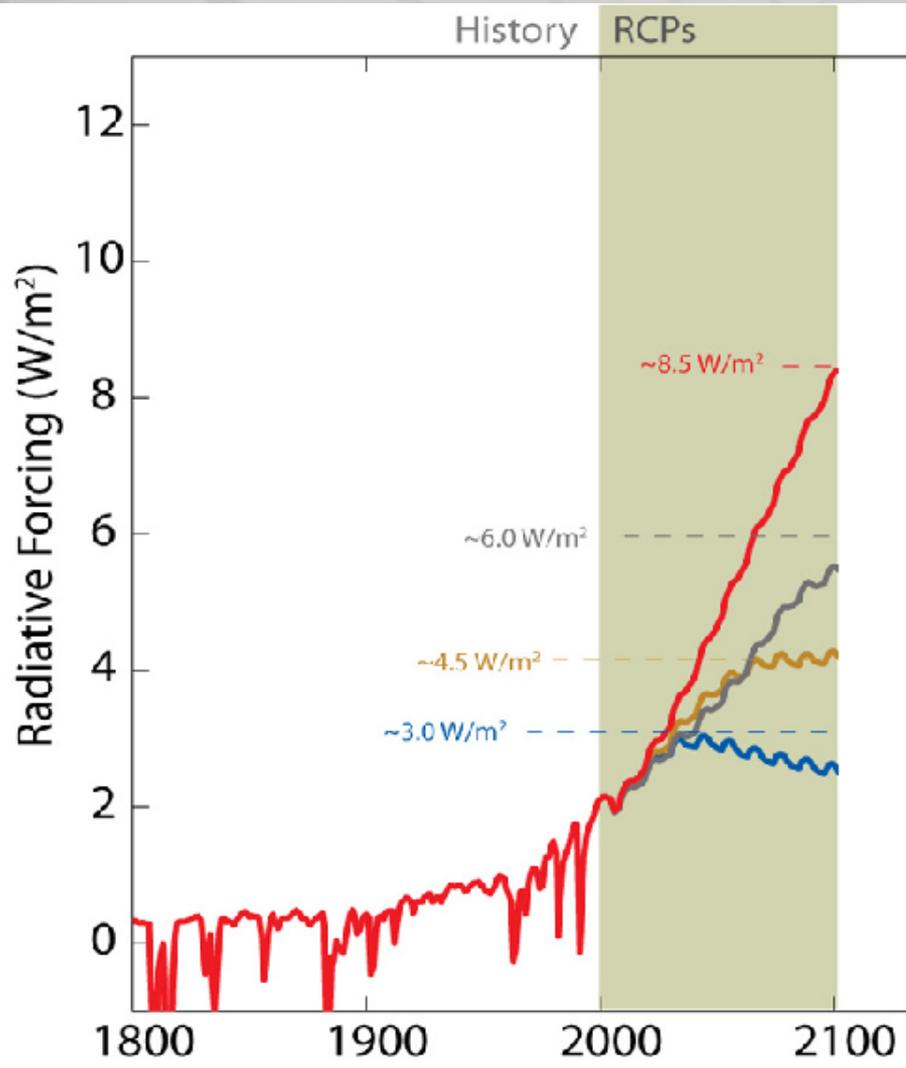


Shared Socio-economic Pathways (SSPs), Shared Policy Assumptions (SPAs) (in process)

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 Wm^{-2} (RCP 8.5, *1350ppm* $\text{CO}_2\text{-e}$)

■ 6.0 Wm^{-2} (RCP 6.0, *850ppm* $\text{CO}_2\text{-e}$)

■ 4.5 Wm^{-2} (RCP 4.5, *650ppm* $\text{CO}_2\text{-e}$)

■ 2.6 Wm^{-2} (RCP 2.6, *450ppm* $\text{CO}_2\text{-e}$) ('overshoot')

► RCPs are just a representative set of scenarios selected from the published literature available at the time



SSP Logic: Challenges to Adaptation and Mitigation

- ▶ SSPs are new reference pathways (no new climate policies)
- ▶ Design questions:
 - Impacts from different combinations of climate change and socio-economic pathways?
 - How easy/difficult to mitigate to a particular climate target given an SSP?
- ▶ Some SSPs will reproduce RCPs, others require policy assumptions to do so

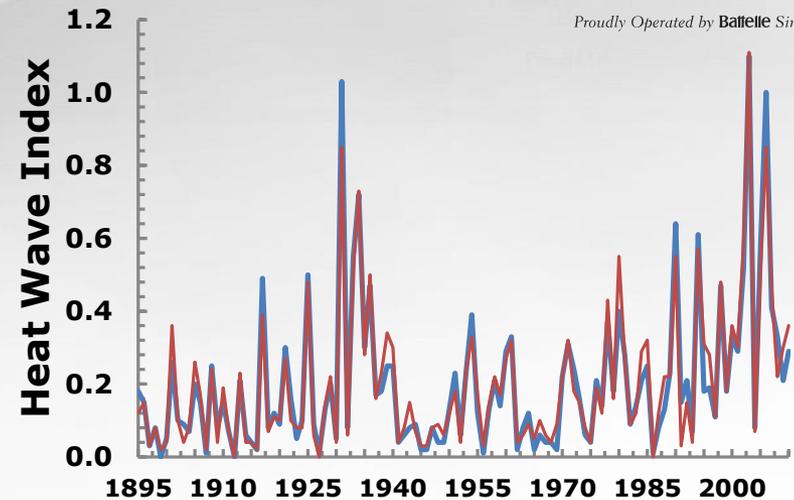




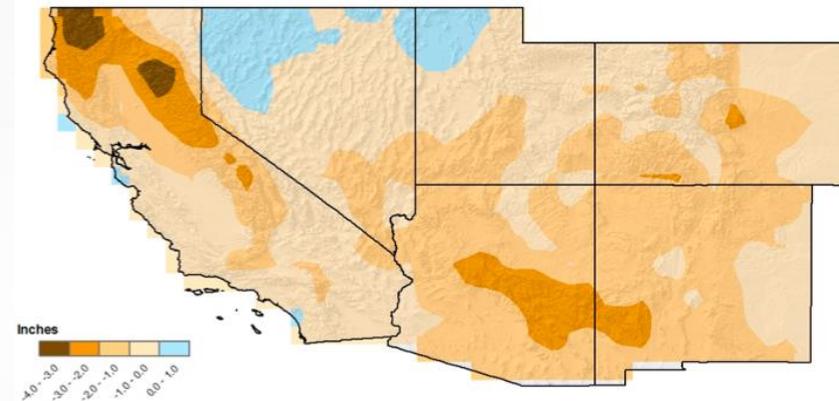
National and Subnational Scale Scenarios for the United States

Scenarios for NCA3

- ▶ Used existing literature
 - SRES A2 and B1 CMIP 3, NARCCAP
 - Maurer et al. daily and hourly (Hayhoe)
 - Bierwagen et al. (ICLUS) population and land
- ▶ What was new:
 - Climate outlooks
 - Global mean sea level change scenarios *for risk framing*
 - Participatory scenario planning
- ▶ Dissemination through <http://scenarios.globalchange.gov>
- ▶ Need for evaluation
 - Purpose: provide context and calibrate existing studies
 - What affected use and non-use?
- ▶ Planning for sustained assessment and NCA4 should start now!



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



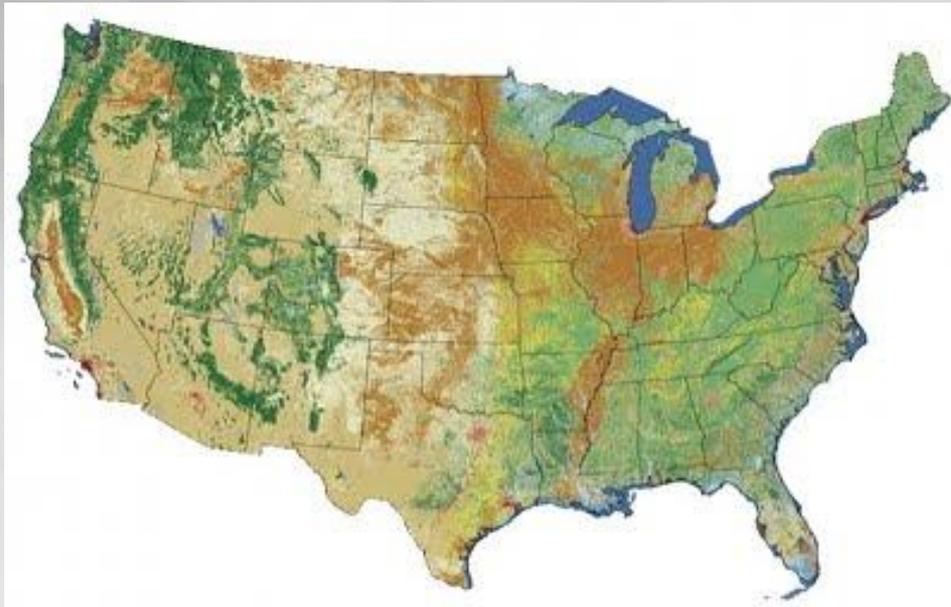
- **Regional Climate Outlooks: major climatic factors, e.g., drought, heat waves, winter storms, flash floods**



Increasing Interest in National and Subnational Scale Scenarios in US Agencies

- ▶ Numerous federal agencies are interested in using global change scenarios to support their research and management missions
- ▶ Interest is driven by fundamental science opportunities and ‘considerations of use’ (federal to local)
- ▶ There are needs for integrated, higher resolution information
 - Scale matters to IAV and mitigation implementation
- ▶ Subnational scenarios can provide common assumptions but shouldn’t be rigid
 - Facilitate comparison across agencies and analyses
 - Agencies want to customize scenarios to meet their specific needs and support their external stakeholders

Interagency Workshops on Subnational Population and Land Use/Cover Scenarios



NLCD Land Cover Classification Legend

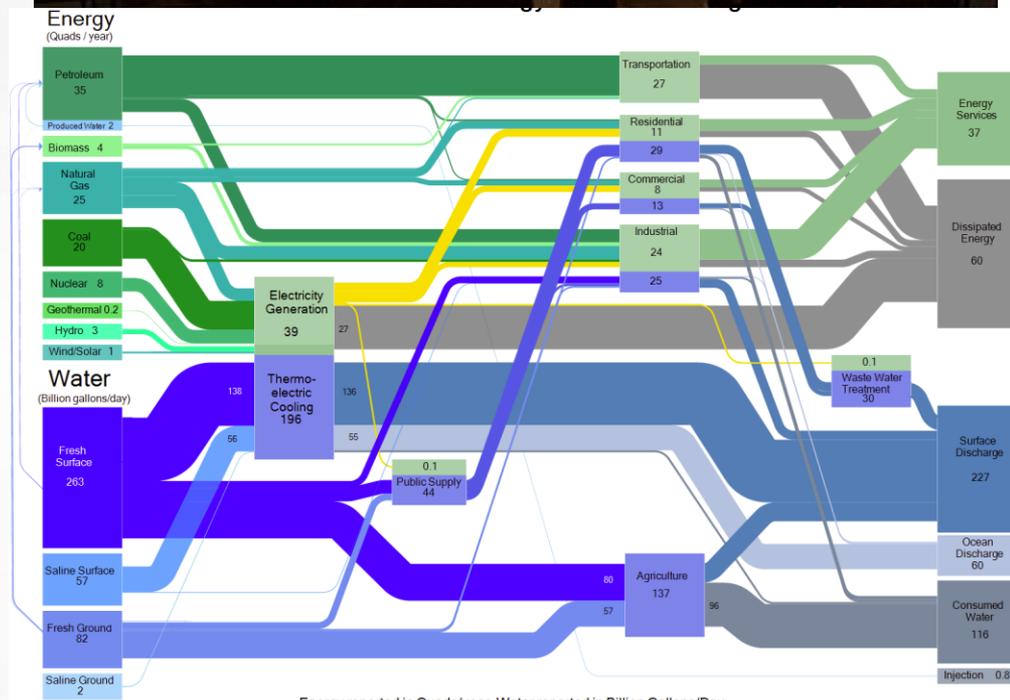
11	Open Water
12	Perennial Ice/Snow
21	Developed, Open Space
22	Developed, Low Intensity
23	Developed, Medium Intensity
24	Developed, High Intensity
31	Barren Land
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Dwarf Scrub*
52	Shrub/ Scrub
71	Grassland/ Herbaceous
72	Sedge/ Herbaceous *
74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

* Alaska Only

- ▶ Objectives: Evaluate needs and methods for preparation of subnational 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?
 - Methods?
 - Programmatic needs/issues?
- ▶ For land workshop, conduct initial discussion of narratives or logical structure

Scenarios for Sustained Assessment

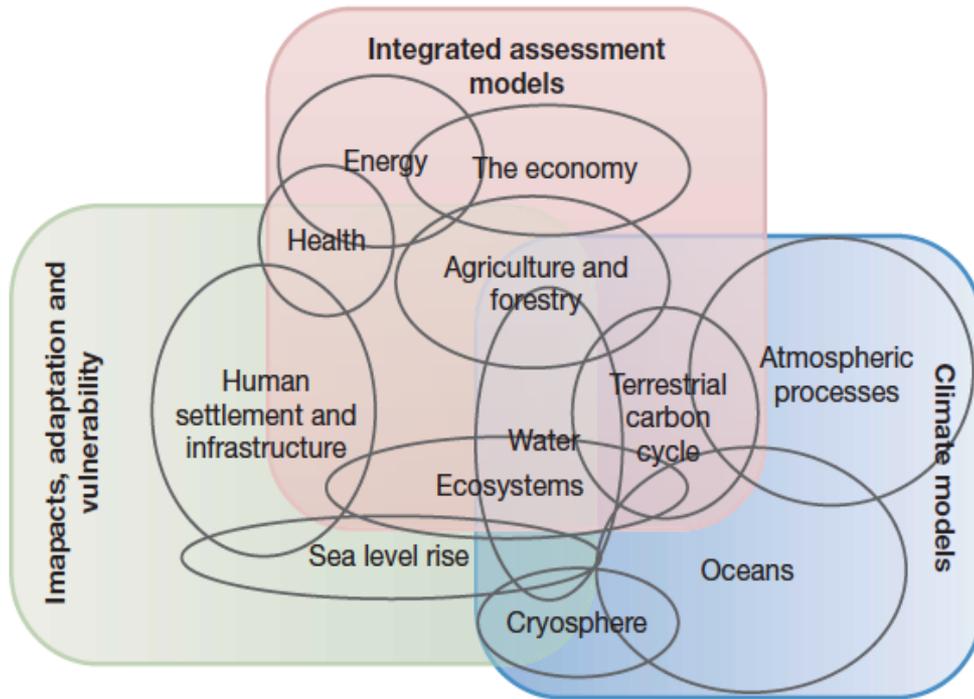
- ▶ Objective: provide scenario resources for distributed use
- ▶ Some basic characteristics of a new scenario enterprise:
 - Problem driven -- engagement with stakeholders
 - Integrate significant trends, e.g., pop, land cover, regional economics, ...
 - Provide technical support
 - Improve visualization, use in decisions
 - Ground truthing – link to observations
- ▶ Integration and accessibility are key challenges



Take Aways

- ▶ Global change research requires integrated, multi-faceted scenarios
- ▶ International scenario activities have evolved to facilitate closer collaboration across research communities and research on a range of specific topics
- ▶ US Agencies and users want to explore development of subnational scenarios of key drivers of environmental change and capacities for response
 - Integrated science
 - Support for resource assessments and other mandated activities
 - Adaptation and mitigation planning
- ▶ There is an opportunity to improve application of social, environmental, and climate science to develop these scenarios in methodologically sound ways
- ▶ The population and land scenario workshops will explore user needs, data/methods, and programmatic requirements, focusing on social and environmental science components

Discussion





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

▶ Water-energy related
←

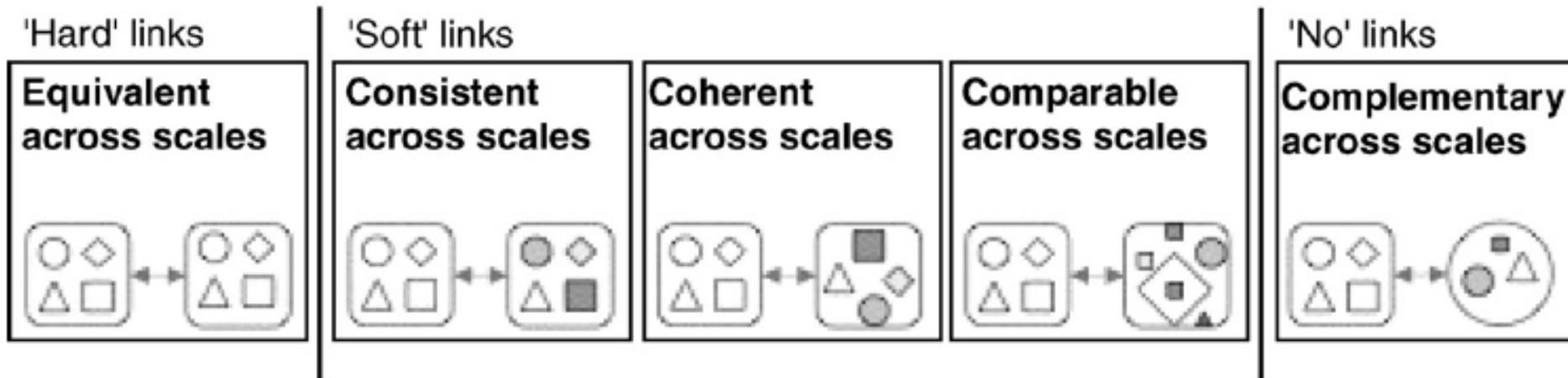
- ▶ Needs also include:
- Vulnerability assmt
 - Forest resources
 - Carbon stocks
 - Fire management
 - Public health
 - Coastal development
 - Economic planning
 - ...

Developing Scenarios and Using is Challenging

- ▶ Choose the problem first.
- ▶ Tailor the scenario to the problem.
- ▶ Identify the important outcomes and metrics.
- ▶ Identify the key drivers/scenario logic and metrics.
- ▶ Focus on the key variables: What range might they assume across plausible future states of the world? Identify divergent conditions.
- ▶ Keep it simple: Build lists of reasons why drivers/variables might assume divergent values.
- ▶ Examine how sensitive outcome variables are to key input variables
- ▶ Use uncertainty analysis: Construct conditional subjective probability distributions for key variables for use in probabilistic analysis.
- ▶ Avoid taboos: Include undesirable but plausible futures.

Scientific and Methodological Questions

- ▶ Understanding coupled Earth-human systems?
 - E.g., carbon cycle, hydrology, reg. climate, ...?
 - Regional and sectoral integration/feedbacks?
- ▶ Observational and modeling challenges?
 - Which data sets, predictability, which methods, UQ, extremes, ...?
- ▶ Scenario issues?
 - Level of consistency across scenario types and scales?
 - Degree of difference or 'separation' between scenarios that is 'significant'?



Report Topics

- ▶ Goals, uses, and needs
- ▶ Current data, models, and tools
- ▶ Drivers
- ▶ Links to other areas, multiple stresses
- ▶ Logic/storylines
- ▶ Quantification needs and opportunities (including new methods)
- ▶ Options for paths forward
 - Near-term: developing subnational scale land scenarios
 - Long-term: research opportunities

Information desired from “Drivers” breakout groups

- ▶ Lists of drivers
- ▶ Impacts (H-M-L)
- ▶ Level of certainty/uncertainty (H-M-L)
- ▶ Feasibility (availability of data/models)