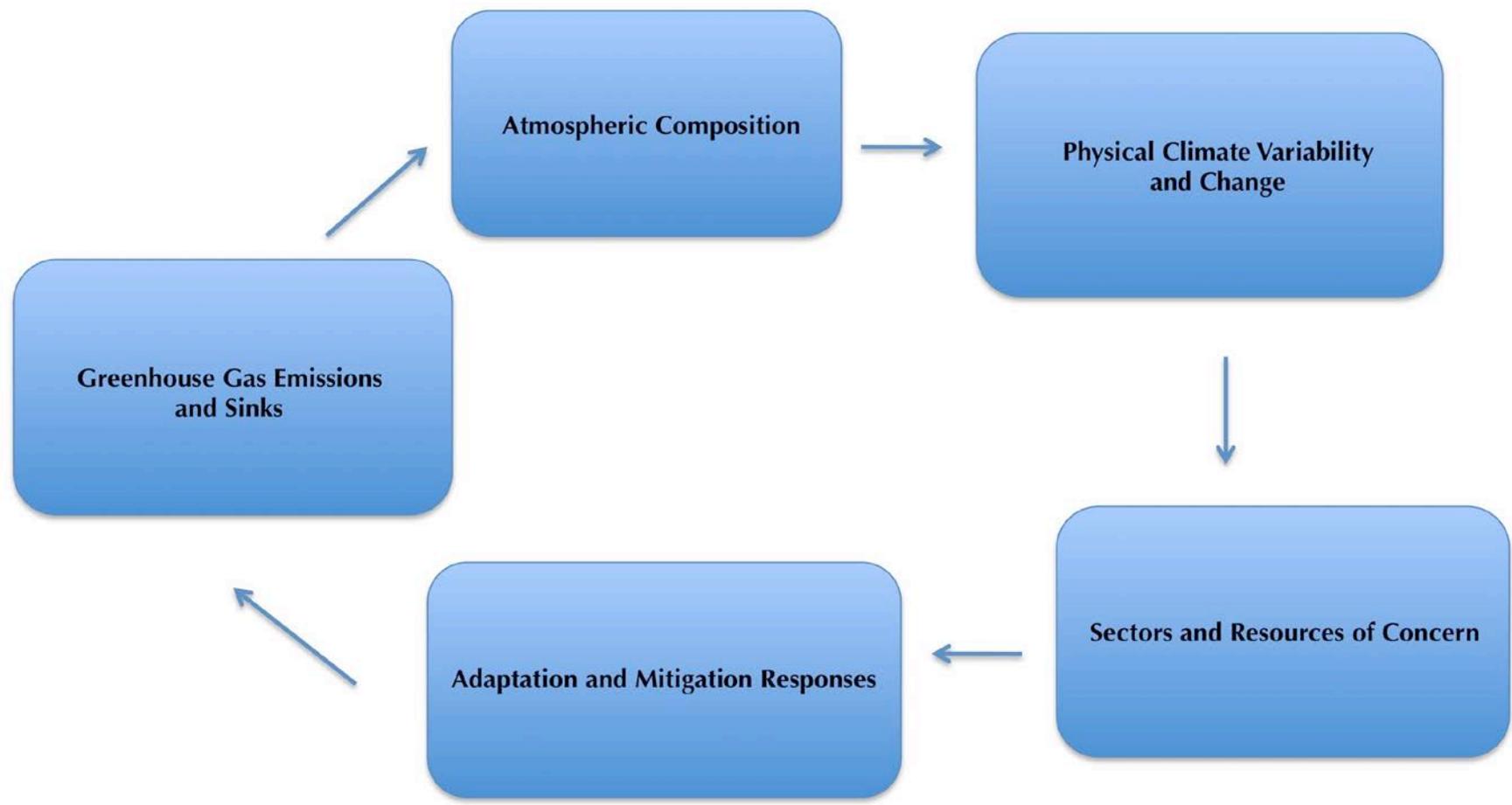


Developing a System of National Indicators to Track Climate Changes, Impacts, Vulnerabilities, and Preparedness

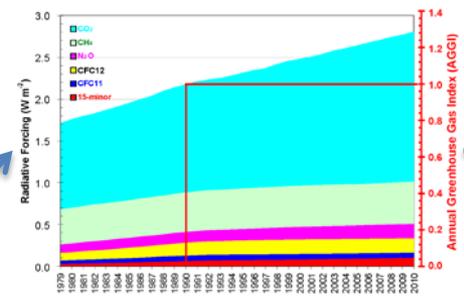
Melissa A. Kenney, University of Maryland, College Park and
USGCRP National Climate Indicator System

Anthony Janetos, Boston University and NCADAC Indicator Work Group Chair

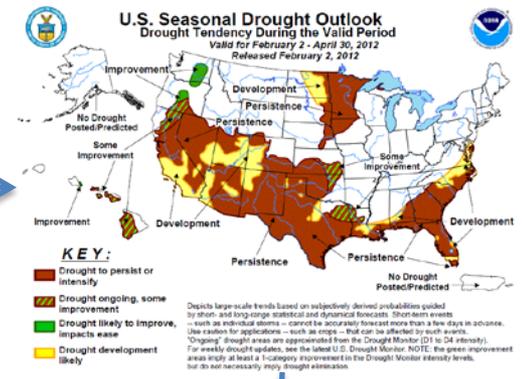




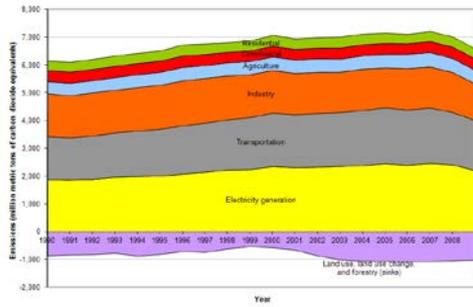
Aggregated GHG Index



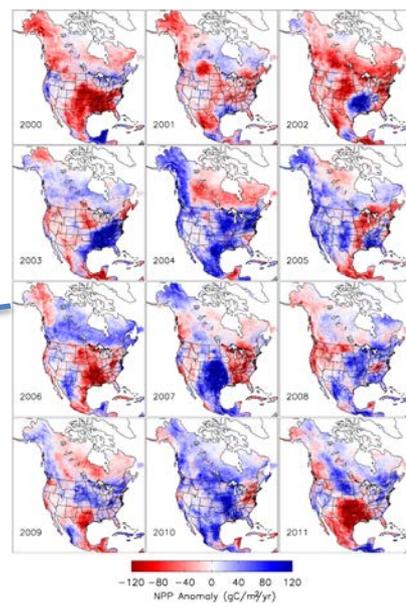
US Drought Monitor



U.S. GHG Emissions by Gas



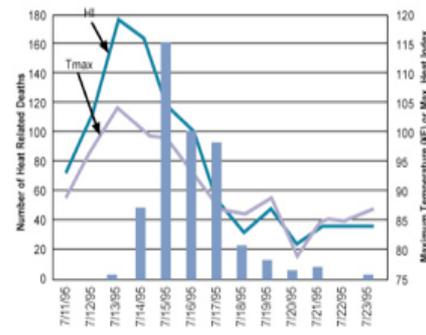
Net Primary Productivity Anomaly



Heat Related Deaths

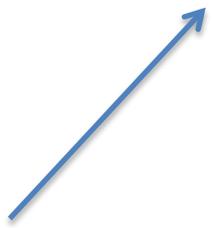
Heat Related Deaths - Chicago, July 1995

Maximum Temperature and Heat Index



This graph tracks maximum temperature (Tmax), heat index (HI), and heat-related deaths in Chicago each day from July 11 to 23, 1995. The gray line shows maximum daily temperature, the blue line shows the heat index, and the bars indicate number of deaths for the day.

Adaptation and Mitigation Responses



A system of physical, ecological, and societal indicators that communicate key aspects of the physical climate, climate impacts, vulnerabilities, and preparedness.

Global Context Indicators Purpose:

- Provide global context for the national or regional indicators

System and Sector Indicators Criteria:

- Scientifically defensible
- Link to conceptual framework
- Defined relationship to climate, but NOT necessarily cause and effect (includes multi-stressor indicators)
- Nationally important
- Scalable, where possible
- Build on or augment existing agency efforts, when possible
- ***Indicators that are already developed and scientifically vetted***

- Implementing in three phases
- Phase 1 is a Pilot System
 - Release roughly 2 months after NCA Report rollout
 - Testing the presentation of the indicators
 - Allow both individual and combinations of indicators to be analyzed
 - Evaluate the actual use of the indicators
 - Series of evaluation studies
- Phase 2 is the Full Launch
 - Roughly a year from launching the pilot
 - More complete indicators per sector
 - Select indicators dynamically updated or customizable
 - Accompanied by special issues publication
- Phase 3 is Ongoing
 - Constant re-evaluation of indicators and system
 - Evaluation of new research for adding indicators

- Global Context
 - Limited number
 - Some indicators simply must be global because of the underlying science
- Sectoral Indicators
 - Changes in key variables
 - Related to climate, but NOT necessarily cause and effect

- Indicators for the pilot must be implementable essentially immediately
- Very difficult criterion to meet
- Lots of papers in the literature doesn't mean something is ready to be implemented
- Routinely produced now
- Documentation available now

Global Context Indicators

Sea Surface Temperature

Sea Ice Extent

Global Average Surface Atmospheric Temperature

Global Emissions by Gas

Global Atmospheric Concentrations of CO₂

Global Sea Level

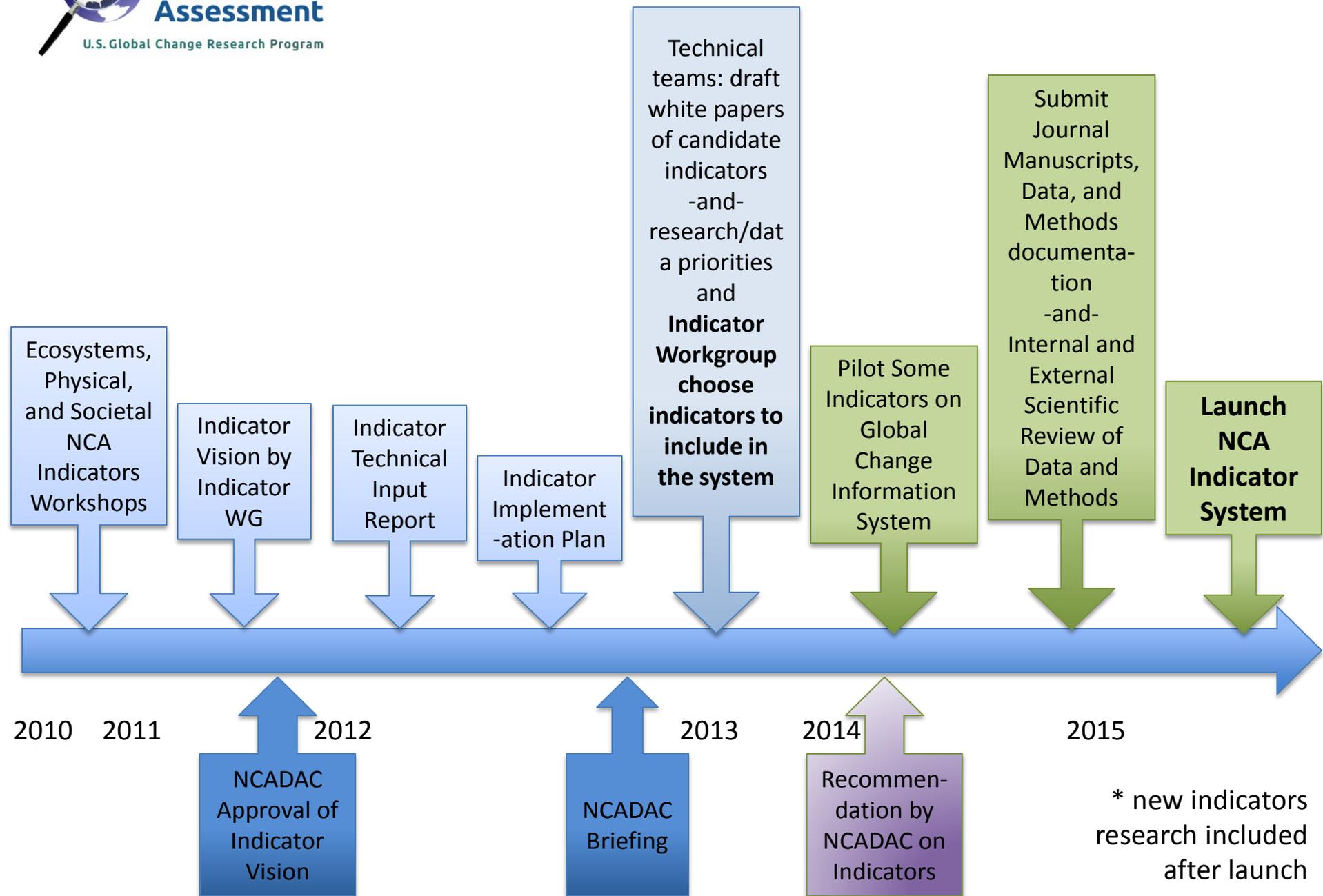
• System/Sector Specific Indicators	
Climate	<ul style="list-style-type: none"> • Surface Temperature for the U.S. • Heat Index • Palmer Drought Severity Index
Water Cycle	<ul style="list-style-type: none"> • Annual and Monthly Precipitation • Heavy Precipitation • Streamflow Indicators
Oceans and Coasts	<ul style="list-style-type: none"> • Regional and Local Sea Level Rise • Ocean Chemistry and Acidification • Chlorophyll Concentration in Surface Ocean Waters • Coral Thermal Stress
Freshwater Ecosystems	<ul style="list-style-type: none"> • Freshwater Temperature • Lake Ice • Dissolved Oxygen

• System/Sector Specific Indicators	
Phenology	<ul style="list-style-type: none"> • Seasonal Climate Indicators • Potential Growing Season • Extended Spring Indices • Snowmelt Runoff
Forests	<ul style="list-style-type: none"> • Forest Area Extent • Wildfire Effects – Burned Area • Forest Growth / Productivity
Grasslands	<ul style="list-style-type: none"> • Grazing Livestock Numbers • Grassland, Rangeland, Pastureland Extent
Agriculture	<ul style="list-style-type: none"> • Crop Condition, Progress, and Production • Rainfall Erosivity • Livestock Death Due to Thermal Stress

• System/Sector Specific Indicators	
Energy	<ul style="list-style-type: none"> • Heating and Cooling Days • Stress Index of Electricity Generation
Infrastructure	<ul style="list-style-type: none"> • Disaster and Emergency Declarations by FEMA • Status of the Nation's Infrastructure
Health	<ul style="list-style-type: none"> • Rates of Heat Related Mortality • <i>Vibrio</i> Outbreaks • Lyme Disease
Mitigation and GHG Sources and Sinks	<ul style="list-style-type: none"> • Total GHG Emissions by Source and Gas • Fossil and Industrial CO₂ Emissions • Annual Terrestrial Net CO₂ Emissions
Adaptation and Hazards	<ul style="list-style-type: none"> • NA – developing workshop to identify datasets

- Very simple needs for the pilot
 - Display static figure(s)
 - Links to web-sites for data/methods
 - Links to methods documents and other publications
 - Cross-linked to regions/sectors, topics identified in the NCA report
- Analogous to creating more figures for a paper or report
- Funding via a contract to NEMAC (funded by NOAA) provided to develop the graphics for the prototype

- Evaluating the selection and mix of indicators to determine whether there should be modification
- Information system use and design
- Understanding and value of information of indicators
- Identifying potential biases or gaps in the underlying indicator data
- Use of indicators in particular decision contexts



Consideration of Indicators from NASA PIs

- The Indicator System is not designed to be static and instead will evolve as new research should be piloted and included and indicators within the system should rotate out because they are not useful to decision-makers.
- The details of the process for including new indicators has not been finalized with the Indicator Work Group, but the criteria for inclusion in the system still hold.
- Because research is often not immediately operationalized, the process will likely include a trial period where it is scientifically vetted, tested for decision-maker utility, and an agency or organization is given time to operationalize the data, analysis and indicator. NASA research will be the first test case for this process.

- Deke Arndt, Physical Indicators Lead (NOAA NCDC)
- Christa Peters-Litard, Water Cycle and Management Lead (NASA)
- Britta Bierwagen, Freshwater Ecosystems Team Lead (EPA ORD)
- Roger Griffis, Oceans and Coastal Team Co-lead (NOAA)
- Laurie Mcgilvary, Oceans and Coastal Team Co-lead (NOAA)
- Dennis Ojima, Grassland Team Lead (Colorado State Univ.)
- Nancy Cavallaro, Grassland Team Co-lead (USDA NIFA)
- Jake Weltzin, Phenology Team Lead (USGS NPN)
- Mike McGeehin, Health Team Lead (RTI International)
- Tom Wilbanks, Energy and Infrastructure Team Lead (ORNL)
- Leon Clarke, Mitigation and GHG Team Lead (DOE PNNL JGCRI)
- Jerry Hatfield, Agriculture Team Lead (USDA)
- Linda Heath, Forest Team Lead (USDA - USFS)
- Patricia Gober – Adaptation and Hazards Team Co-lead (AZ State Univ.)
- Kathleen Tierney – Adaptation and Hazards Team Co-lead (Univ. CO Boulder)
- Biodiversity – forthcoming

- Presenting the indicators through the system will allow the users to consider a wider range of indicators than is presented by any one agency
- Decision-makers can include combinations of the indicators that are most useful for their decision-making purposes
- The process allows us to identify critical research gaps that are needed to address an end-to-end framework and decision-maker needs



**National
Climate
Assessment**

U.S. Global Change Research Program

Questions or Comments?

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