The National Integrated Drought Information System

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NOAA

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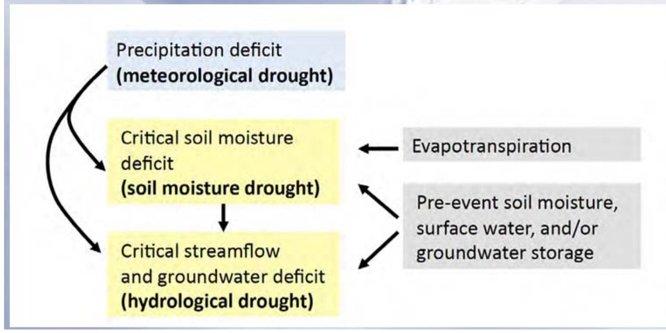
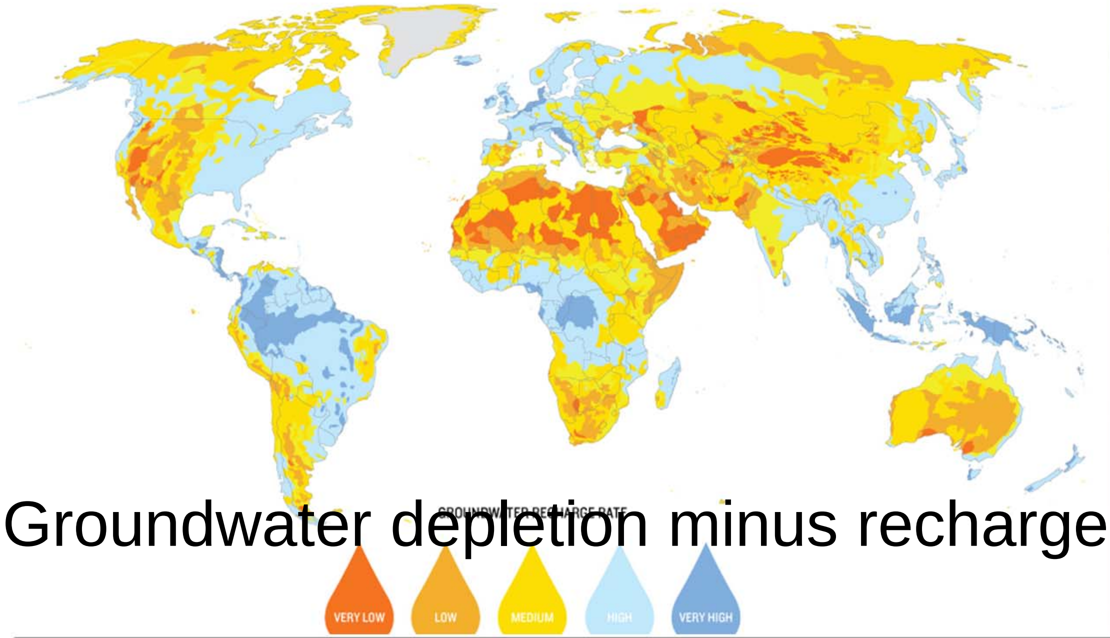
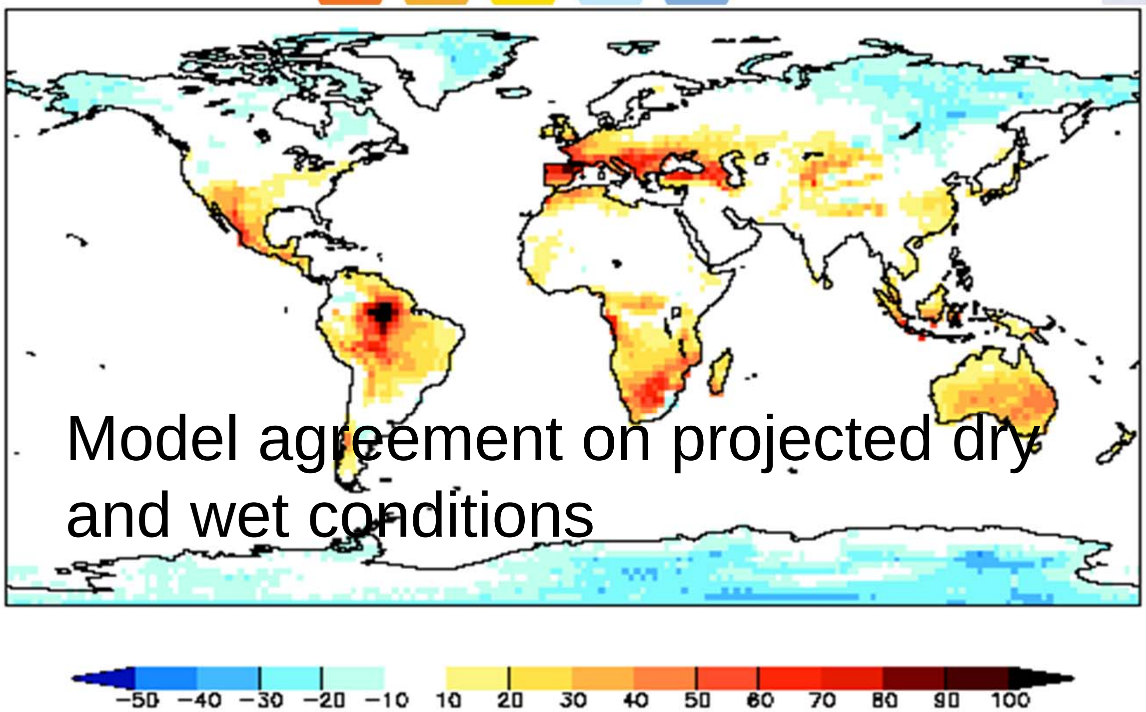




Groundwater depletion minus recharge



Model agreement on projected dry and wet conditions

Climatological Drought indices

- Rainfall
- Rainfall plus potential evaporation
- Rainfall plus evaporation
- Land surface models: Soil moisture
- Land surface plus hydrology: Streamflow

Many potential futures

How will demand vs supply change over time?

Drought- a continuum and an adaptation deficit

Heat Waves

Floods

Storm Track Variations

Madden-Julian Oscillation

El Niño-Southern Oscillation++++++

Decadal Variability

Solar Variability

Deep Ocean Circulation

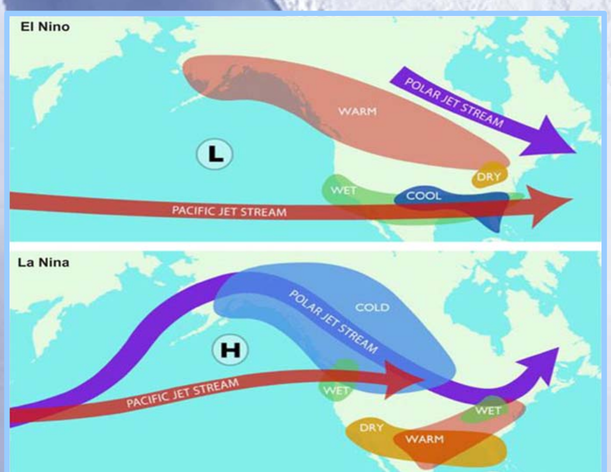
Greenhouse Gases

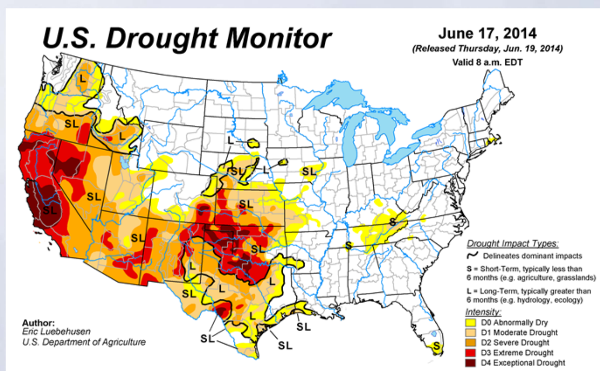
30 DAYS	1 SEASON	3 YEARS	10 YEARS	30 YEARS	100 YEARS

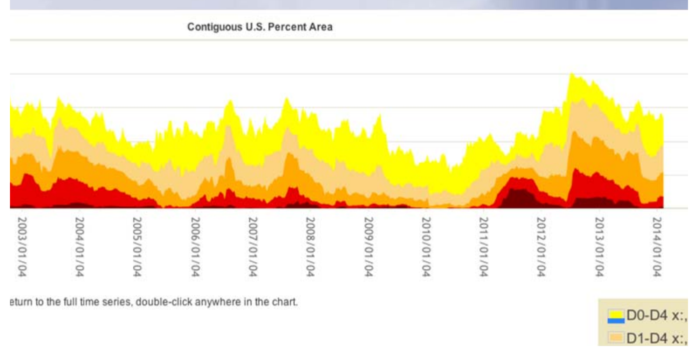
SHORT-TERM

INTERANNUAL

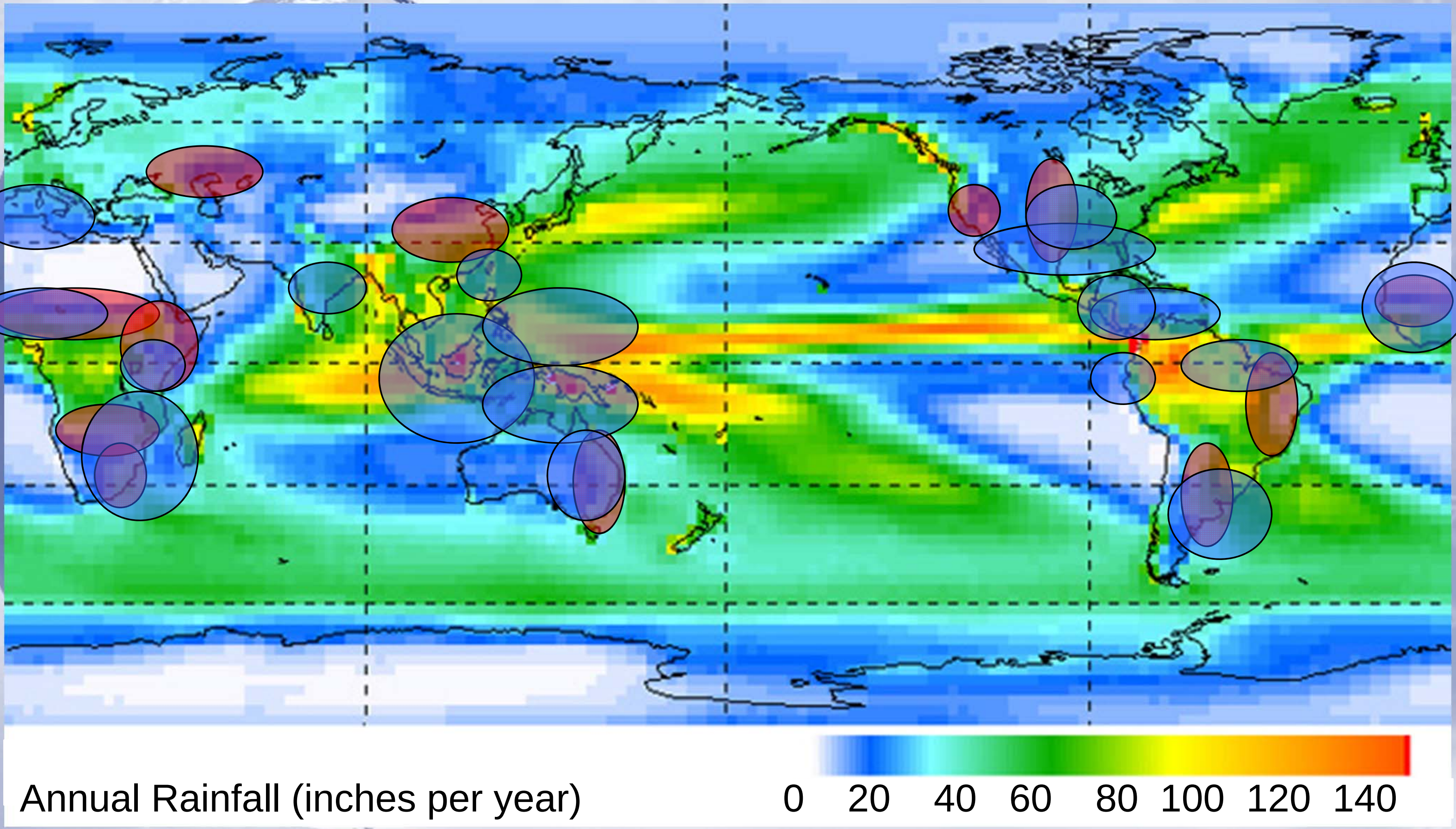
DECADE-TO-CENTURY







Why do some places experience more drought than others?

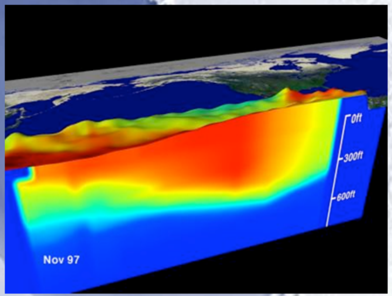


Rainfall tied to sea surface temperatures: ENSO and AMO

Pathways to Monitoring and Predictability

Key Phenomena, variables

SST anomalies	Global-Scale Atmospheric Changes	Regional Forcing and land feedbacks	Local Impacts, Info needs
ENSO, PDO, AMO, warm pool variability, Global Warming, etc	planetary waves, hydrological cycle, monsoons, Hadley Cell, Walker Circulation	precipitation, soil moisture, snow, low level jets, dust, vegetation, land/atmosphere contrasts, changes in weather	soil moisture, stream flow, precipitation, ground water, lakes, reservoirs

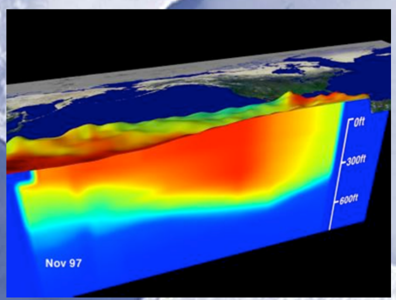


Pathways to Monitoring and Predictability

SST anomalies → **Global-Scale Atmospheric Changes** → **Regional Forcing and land feedbacks** → **Local Impacts, user needs**

Key Phenomena, variables

SST anomalies: ENSO, PDO, AMO, warm pool variability, Global Warming, etc



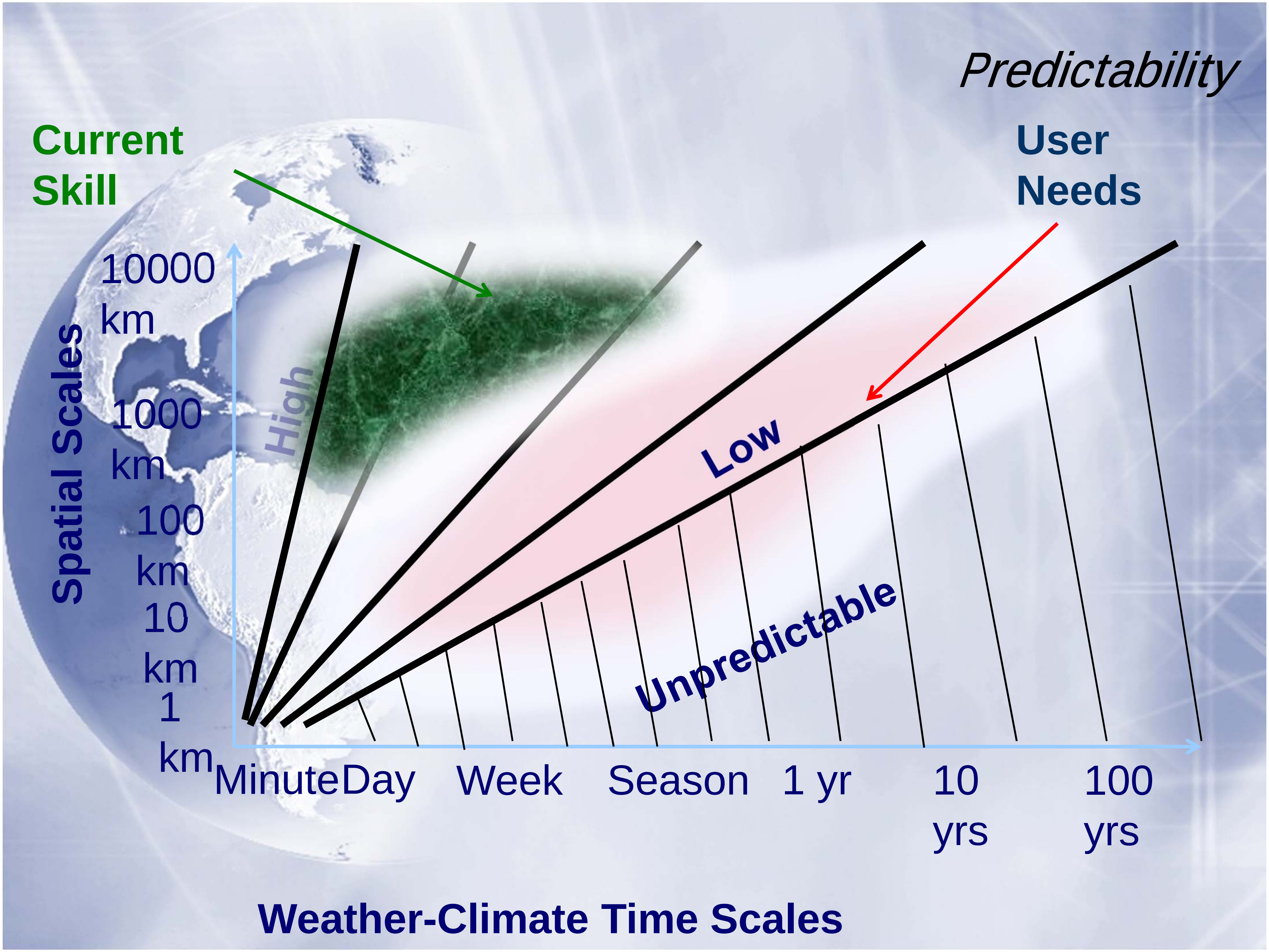
Global-Scale Atmospheric Changes: planetary waves, hydrological cycle, monsoons, Hadley Cell, Walker Circulation

Regional Forcing and land feedbacks: precipitation, soil moisture, snow, low level jets, dust, vegetation, land/atmosphere contrasts, changes in weather

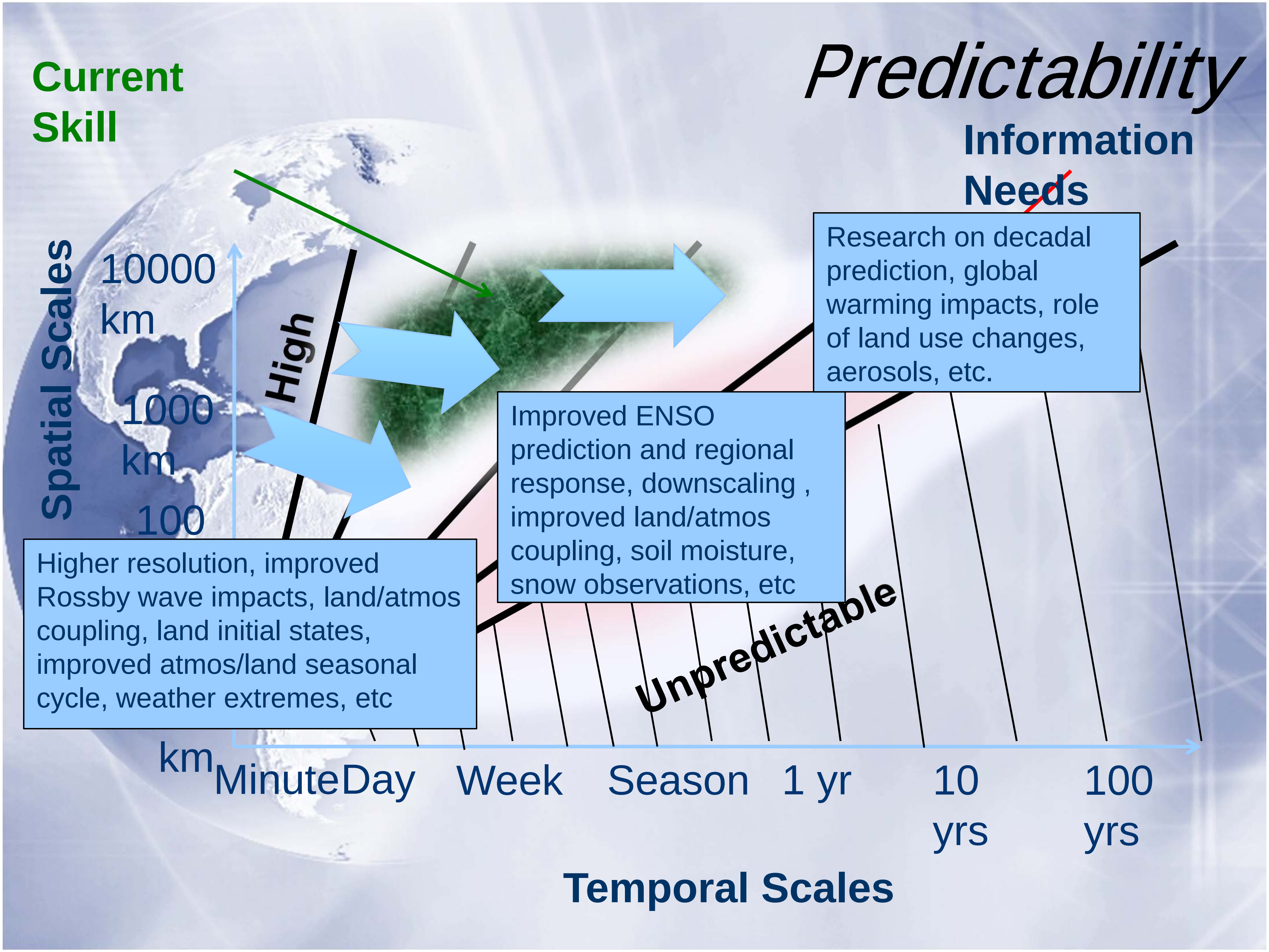
Local Impacts, user needs: soil moisture, stream flow, precipitation, ground water, lakes, reservoirs

Modeling Issues

- Improvements in global coupled models, estimates of ocean variability and predictability, GHGs
- Reduce uncertainties in atmos. response to SST, water cycle, atmos. variability and predictability
- Reduce uncertainties in modeling land/atmosphere interactions, predictability of weather “regimes”, regional climate phenomena
- Improved modeling of “downstream” impacts on land hydrology, higher resolution



Predictability
Current Skill
User Needs
10000 km
1000 km
100 km
10 km
1 km
Spatial Scales
High
Low
Unpredictable
Minute
Day
Week
Season
1 yr
10 yrs
100 yrs
Weather-Climate Time Scales

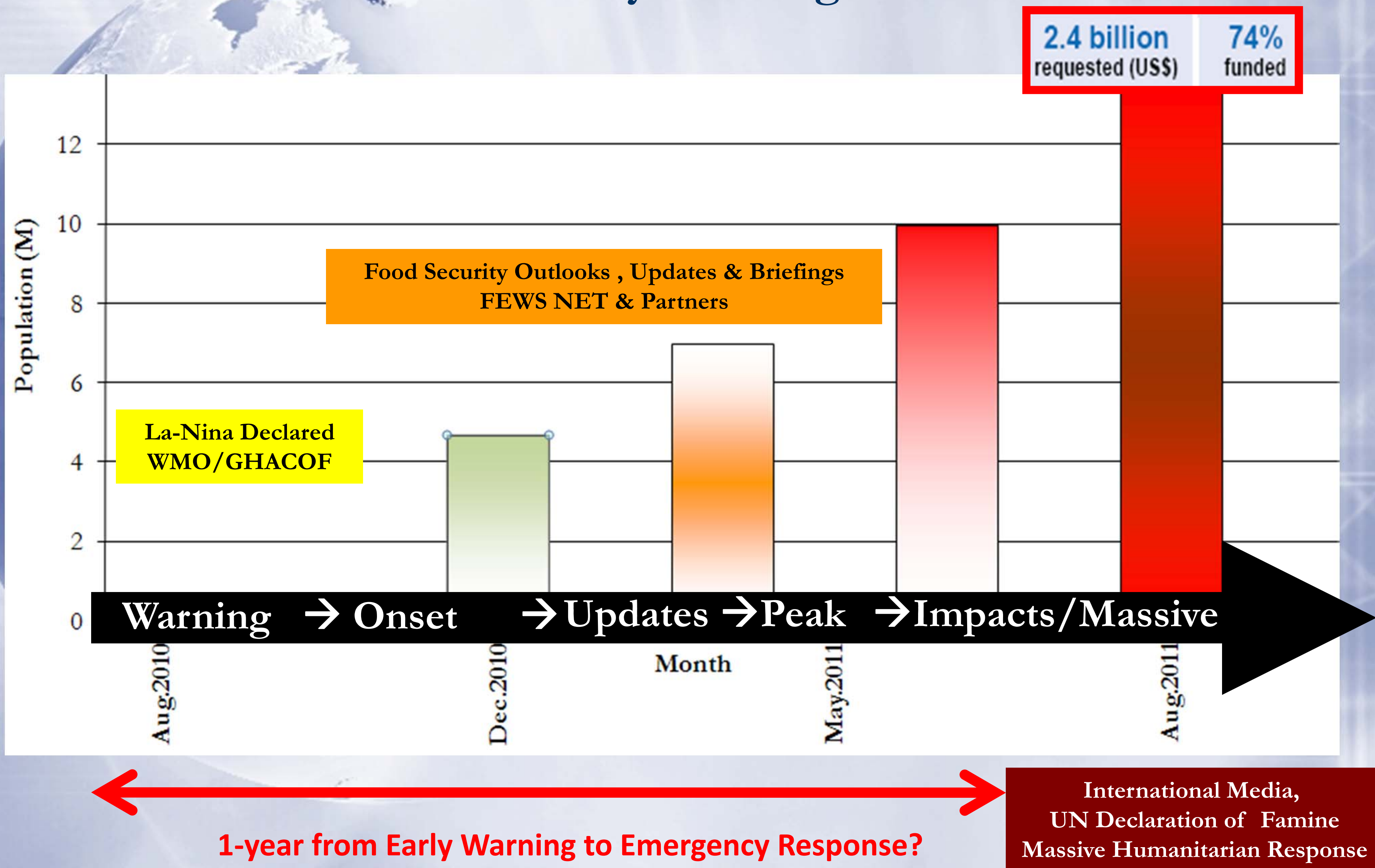

Predictability
Current Skill
Information Needs
Spatial Scales
10000 km
1000 km
100 km
High
Unpredictable
Research on decadal prediction, global warming impacts, role of land use changes, aerosols, etc.
Improved ENSO prediction and regional response, downscaling , improved land/atmos coupling, soil moisture, snow observations, etc
Higher resolution, improved Rossby wave impacts, land/atmos coupling, land initial states, improved atmos/land seasonal cycle, weather extremes, etc
Minute
Day
Week
Season
1 yr
10 yrs
100 yrs
Temporal Scales

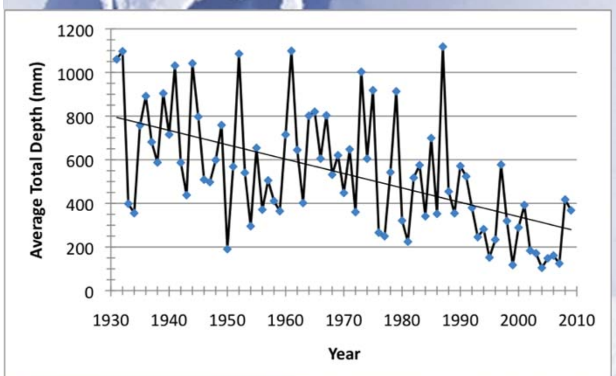
Drought Information Systems: Cases Wilhite, Sivakumar Pulwarty 2014; Pulwarty and Sivakumar, 2014)

Data: current availability and quality of climate observations and impacts data are inadequate for large parts of the globe.

2010/11: Genesis of A Drought Crisis

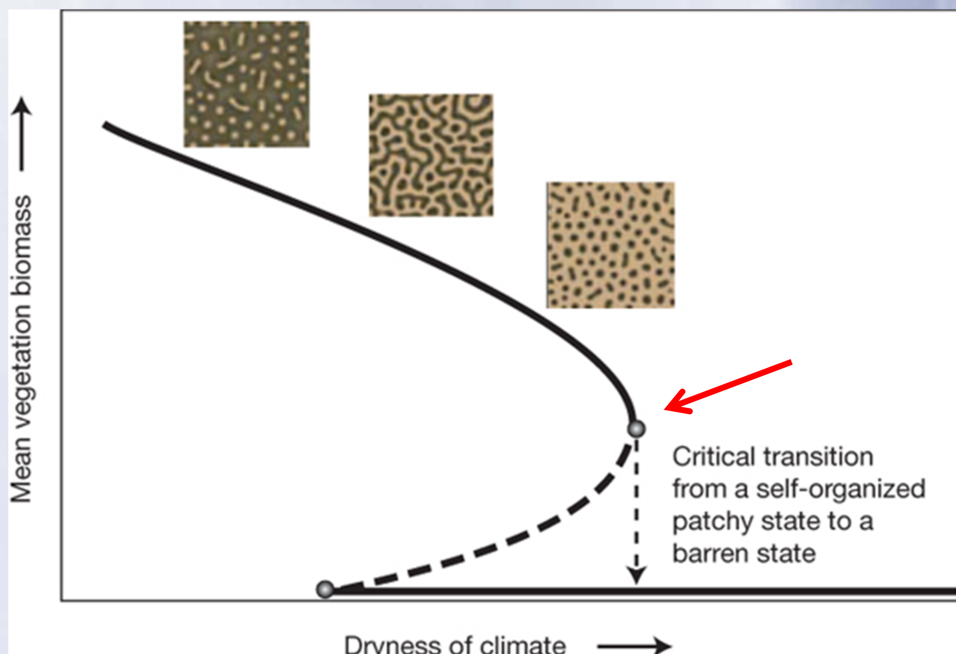
Time-line between Early Warning & Famine Declaration





2000-2009

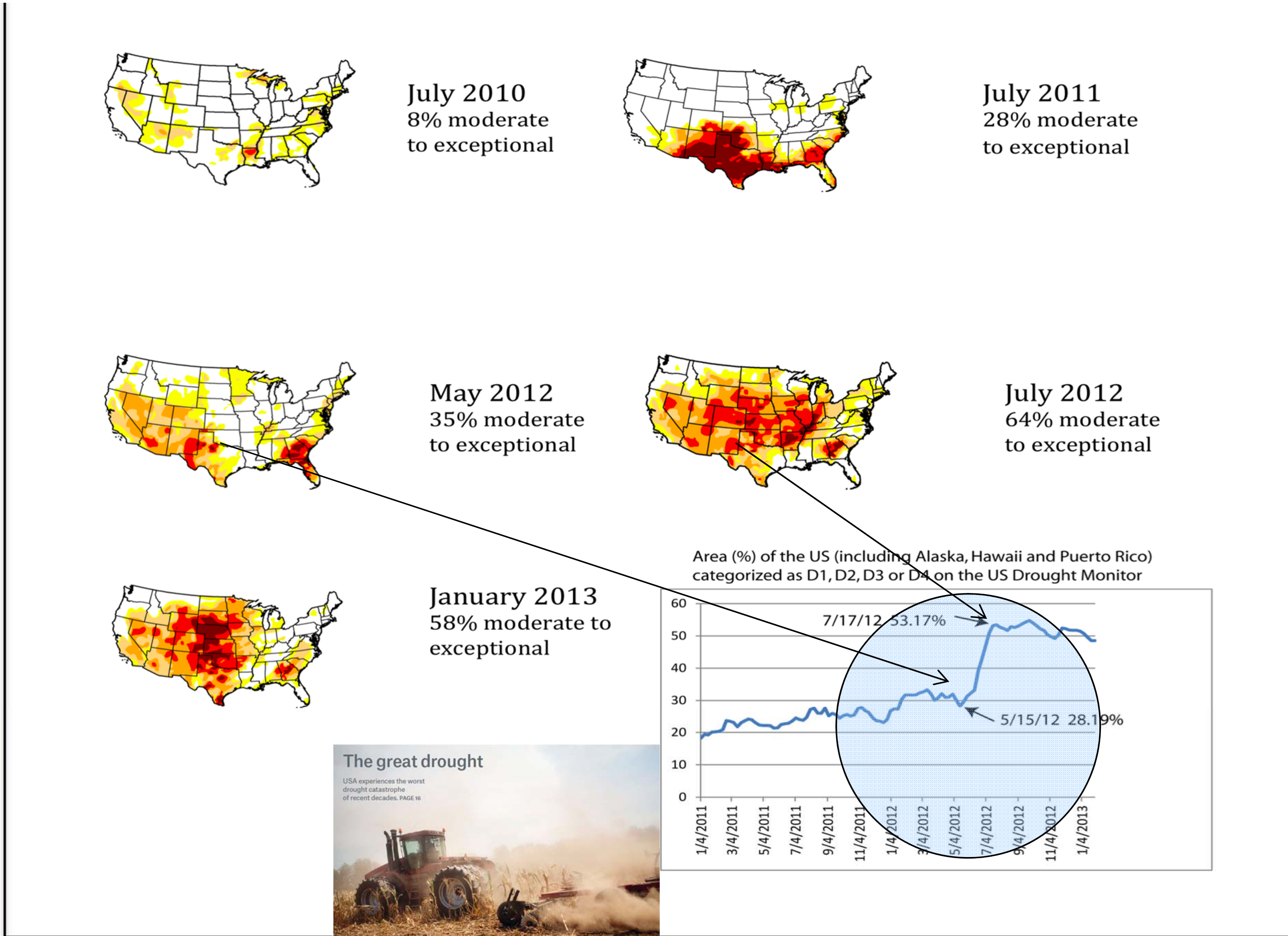
Mean vegetation biomass



Dryness of climate

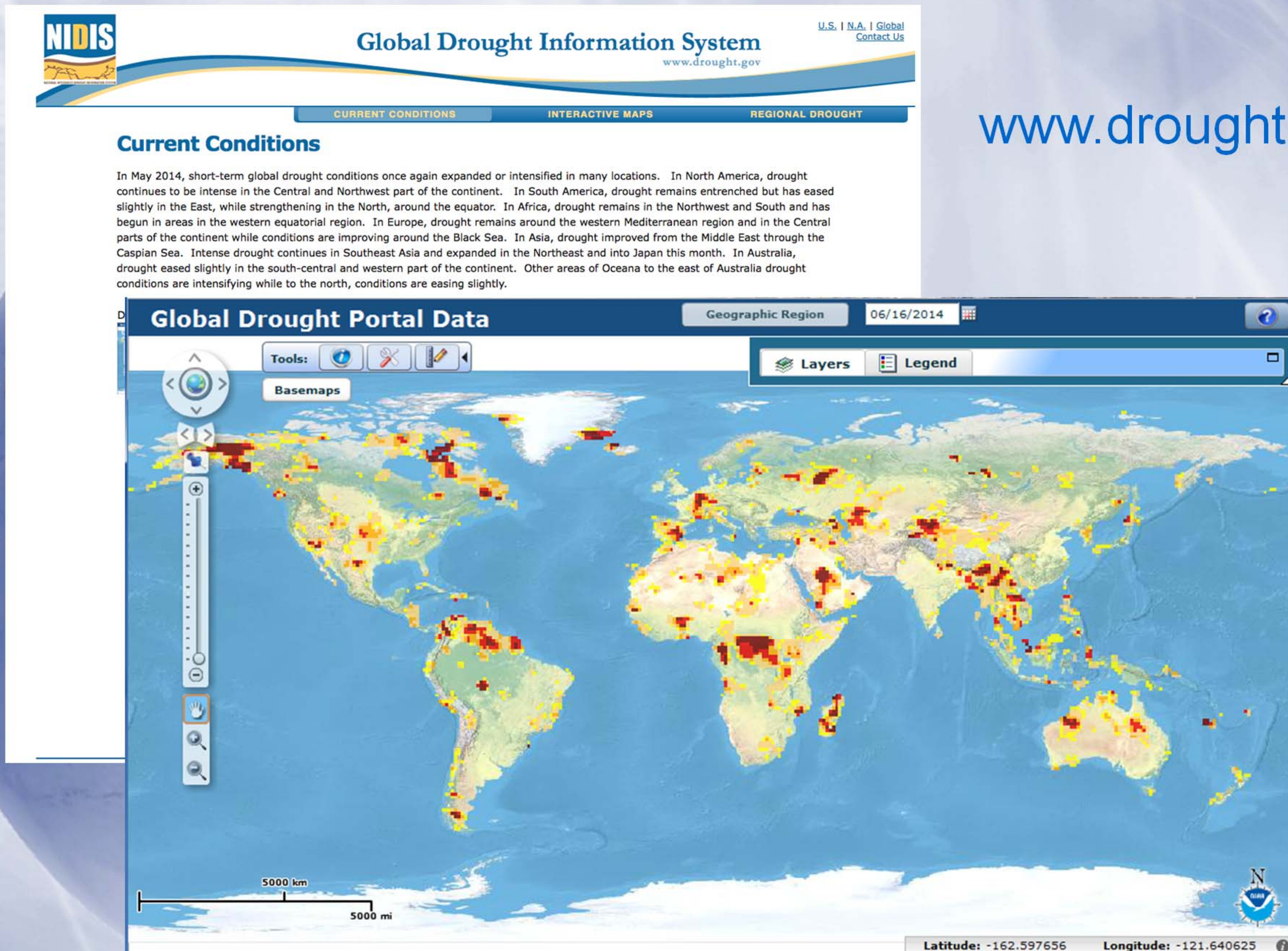
(Nature, 2009)

M. Hiza Redsteer, USGS, NIDIS)

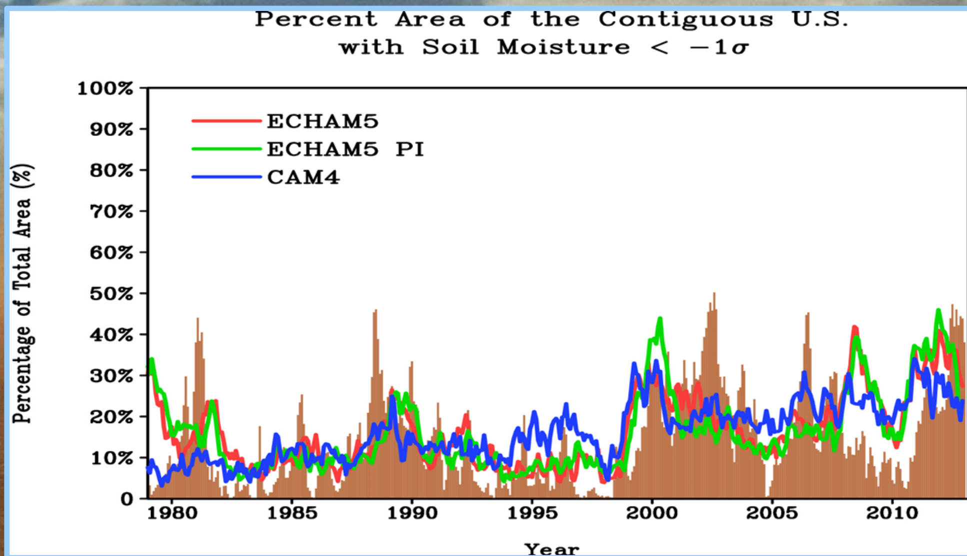


•A complete explanation of these droughts must invoke not just the ocean forcing but also the particular sequence of internal atmospheric variability - weather - during the event.

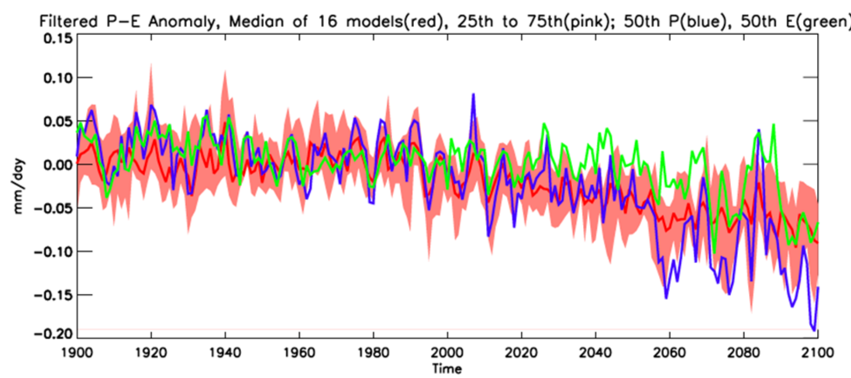
www.drought.gov/gdm



Are Transitions to Semi-Permanent Drought Imminent?



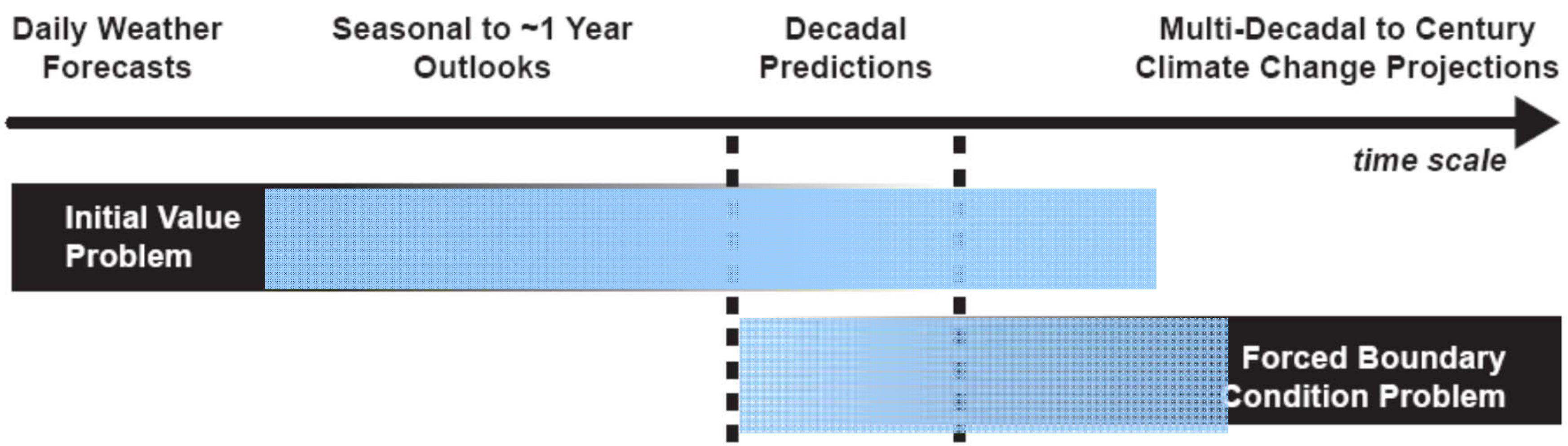
P, *E* and *P-E* averaged across all of SW North America in the IPCC AR5 global climate model simulations and projections for 1900 to 2100



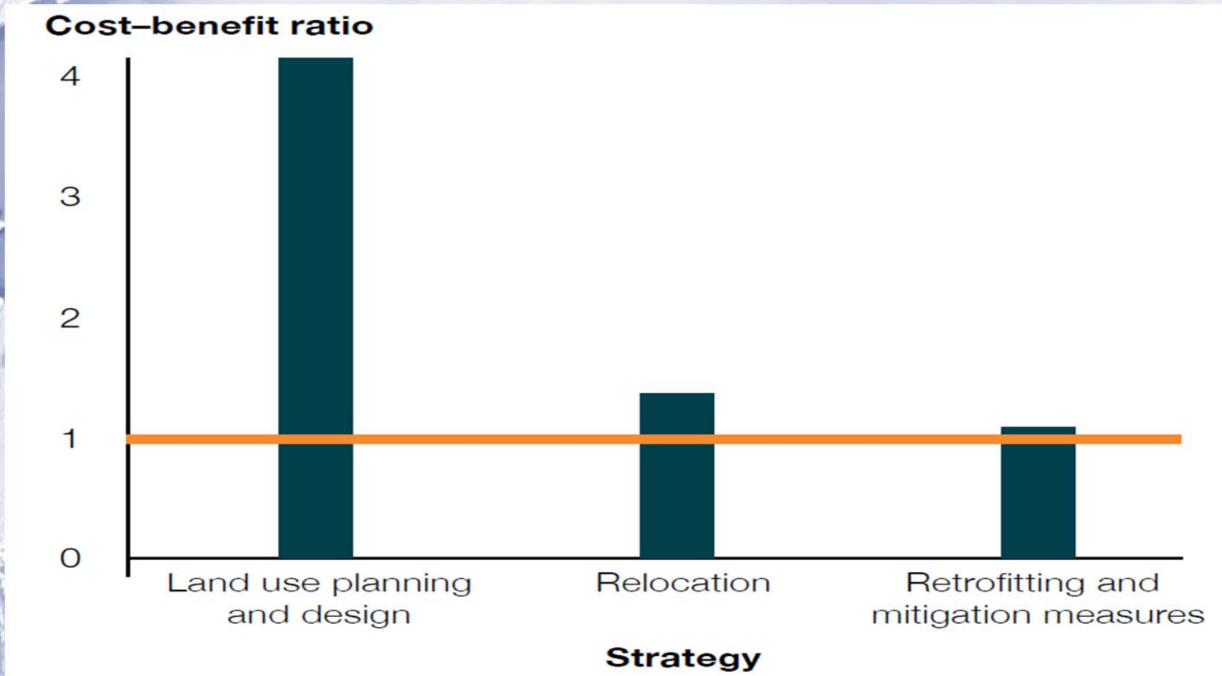
Ongoing transition to a drier climate driven by decreasing precipitation

1. Acknowledge the cross-scale nature of climate, of early warning information-and corresponding monitoring, research and response needs

Decadal prediction lies between initialized weather or seasonal forecasts, and future climate change projections-not just "extremes" or "trends"



2. Understand and communicate the economic and social value of early warning information systems and the relative contributions of system components to informing adaptation



Globally

The total benefits of improved early warning systems would reach between 4 and 36 billion USD per year. Benefit-cost ratios between 4 and 35 with co-benefits (World Bank, 2011)

3. Focus on <u>capacity, accessibility, and Improving decisions:</u> How often should criteria for "robustness" be reconsidered?

Impact assessment and scenario development must approach climate model output far more critically than at present (downscaling is not a substitute for local monitoring)

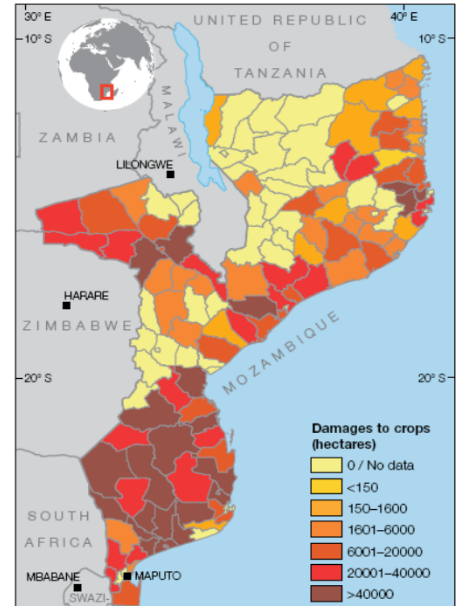
Many countries lack the capacity to anticipate and manage climate related risks and opportunities-use is not an end in itself

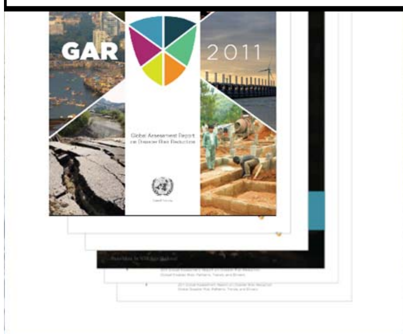
Generate risk profiles and a portfolio of measures-identifying the broader economic, social and environmental benefits of each measure along with its cost

Drought remains a hidden risk

Most estimates of disaster losses exclude indirect losses – livelihoods, informal economies, intangible losses including ecosystem services, quality of life and cultural impacts

In some areas drying due to climate change will be overlain on the periodic droughts those areas have always experienced!





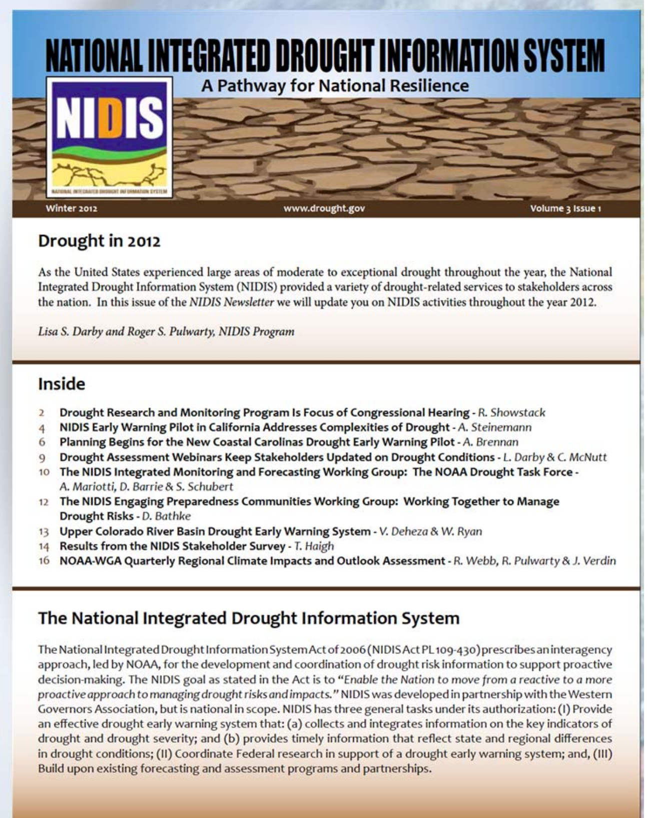
Short-term actions do not always provide long term risk reduction- can reduce or increase longer-term risks

For exposed and vulnerable communities, even non-extreme weather and climate events can have extreme impacts

ISDR

ipcc INTERGOVERNMENTAL PANEL ON climate change

Thank you.



NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

A Pathway for National Resilience

Winter 2012 www.drought.gov Volume 3 Issue 1

Drought in 2012

As the United States experienced large areas of moderate to exceptional drought throughout the year, the National Integrated Drought Information System (NIDIS) provided a variety of drought-related services to stakeholders across the nation. In this issue of the *NIDIS Newsletter* we will update you on NIDIS activities throughout the year 2012.

Lisa S. Darby and Roger S. Pulwarty, NIDIS Program

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The National Integrated Drought Information System

The National Integrated Drought Information System Act of 2006 (NIDIS Act PL 109-430) prescribes an interagency approach, led by NOAA, for the development and coordination of drought risk information to support proactive decision-making. The NIDIS goal as stated in the Act is to *"Enable the Nation to move from a reactive to a more proactive approach to managing drought risks and impacts."* NIDIS was developed in partnership with the Western Governors Association, but is national in scope. NIDIS has three general tasks under its authorization: (I) Provide an effective drought early warning system that: (a) collects and integrates information on the key indicators of drought and drought severity; and (b) provides timely information that reflect state and regional differences in drought conditions; (II) Coordinate Federal research in support of a drought early warning system; and, (III) Build upon existing forecasting and assessment programs and partnerships.

Monitoring, Prediction, Use

Improved satellite estimates and in situ measurements of soil moisture (SMAP) and soil moisture netowrk

Estimates of Ground water/surface water interactions during drought

Near real time attribution of drought

Role of the sea surface temperatures in the various ocean basins

Improved understanding of how decadal variability (PDO, AMO) are impact year to year droughts-improving forecast reliability

Comprehensive assessment of the underlying predictability of surface temperature, precipitation, soil moisture, and stream flow on monthly to decadal time scales

Lessons from NIDIS (Federal, State, Tribal, Local Communities)

Monitoring & Prediction

Drought and Flood Impacts Assessments and Scenarios

Drought Early Warning Information Systems

Communication and Outreach

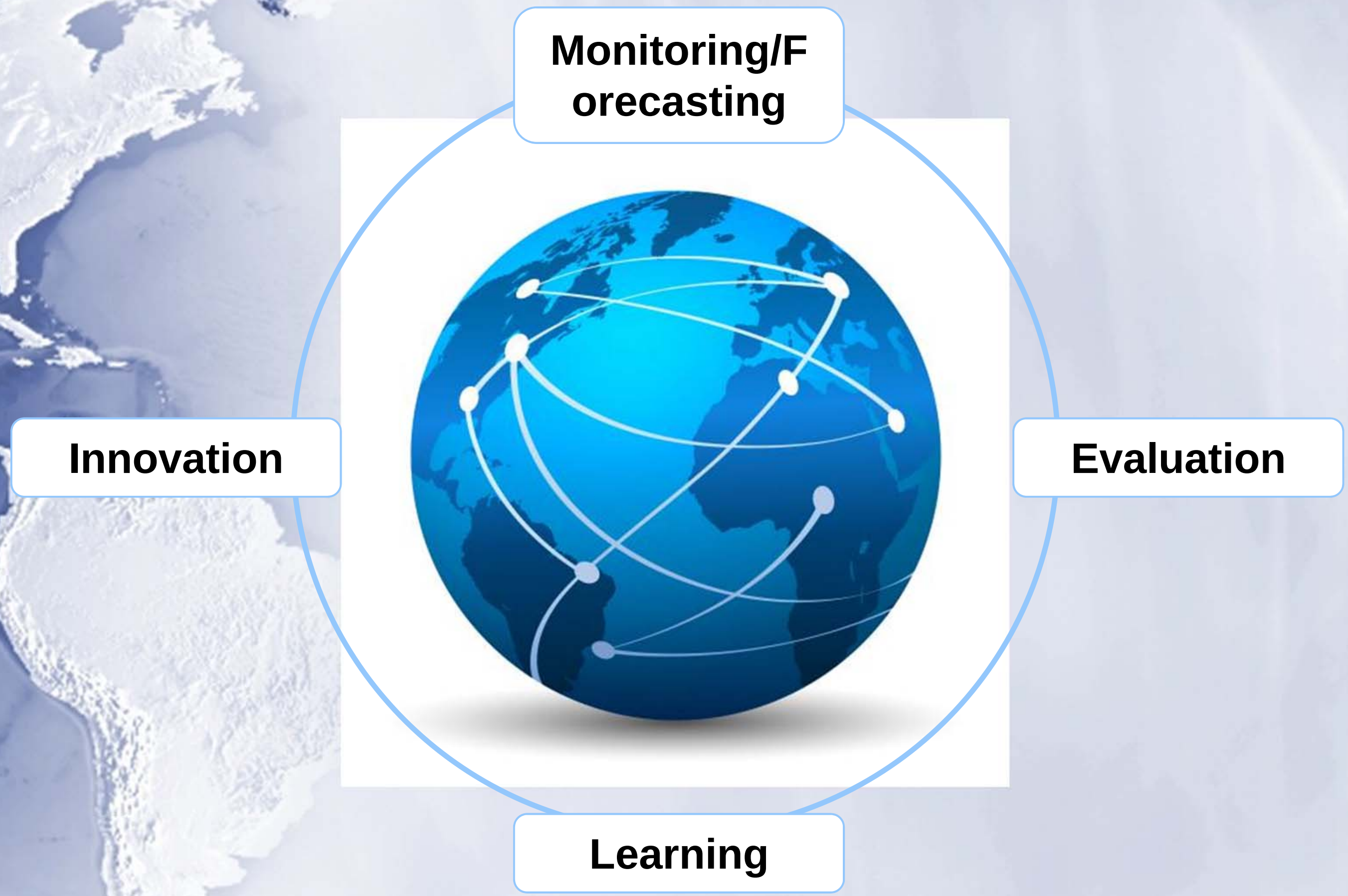
Engaging Preparedness Communities

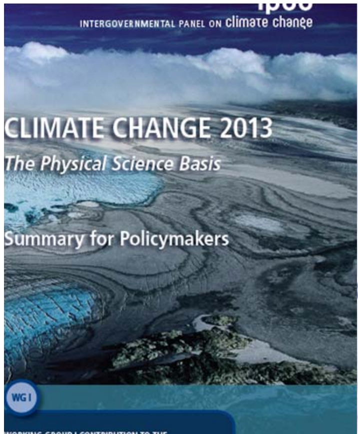
Uses of Drought Information-Municipal water and Food Security

Drought Stage	Water Budget Reductions	Penalties for Violating Water Use Limitations
Moderate *(Storage Index 0.85 to 0.70)*	**More emphasis on basic water use reduction measures and wise water use practices. Use of water monitors to track usage. Target high volume water users. Required budget reductions sufficient to achieve overall 8% reduction in water use.**	**Fines for vi conservatio per the Bou Examples: f driveway w spraying st**
Stage II Serious *(Storage Index 0.70 to 0.55)*	Keep the following vegetation alive: Trees, shrubs, vegetable and flower gardens and lawns. Required budget reductions sufficient to achieve overall **14%** reduction in water use.	Penalize blo several mon restrictors
Stage III Severe *(Storage Index 0.55 to 0.40)*	Keep the following vegetation alive: major trees, major shrubs, and limited vegetable gardens. Greatly reduce outdoor water use and non-essential uses. Required budget reductions sufficient to achieve overall **22%** reduction in water use.	Implement S "more limite lawn waterin pm subject t fines for rep offenders; fi use.
Extreme *(Storage Index less than 0.40)*	Sustain some mature trees, but recognize there may be a major die-off of lawns, trees, and shrubs. Implement aggressive public education and outreach program. Required budget reductions sufficient to achieve overall **40%** reduction in water use.	Stage II and flow restrict moratorium consider ter service for e offenders.

Phase Classification		Key Reference Outcomes *Current or imminent outcomes on lives and livelihoods. Based on convergence of direct and indirect evidence rather than absolute thresholds. Not all indicators must be present for classification..*
1A	Generally Food Secure	***Livelihood Assets*** generally sustainable utilization (of 6 capitals)
1B	Generally Food Secure	
2	Borderline Food Insecure	***Livelihood Assets*** stressed and unsustainable utilization (of 6 capitals)
3	Acute Food and Livelihood Crisis	***Livelihood Assets*** accelerated and critical depletion or loss of access
4	Humanitarian Emergency	***Livelihood Assets*** near complete & irreversible depletion or loss of access
5	Famine / Humanitarian Catastrophe	***Livelihood Assets*** effectively complete loss; collapse

Managing disaster risk in a changing climate





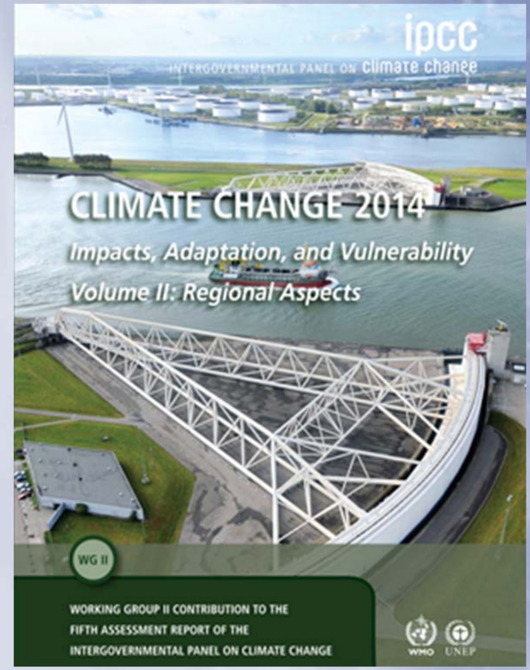
What can we say about future drought intensity?

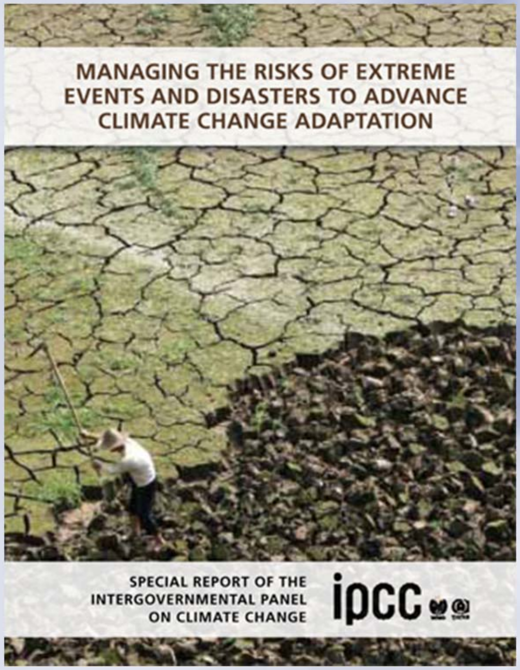
Some regions of the world have experienced more intense and longer droughts- southern Europe and West Africa- some regions droughts have become less frequent, less intense, or shorter, e.g., in central North America and northwestern Australia.

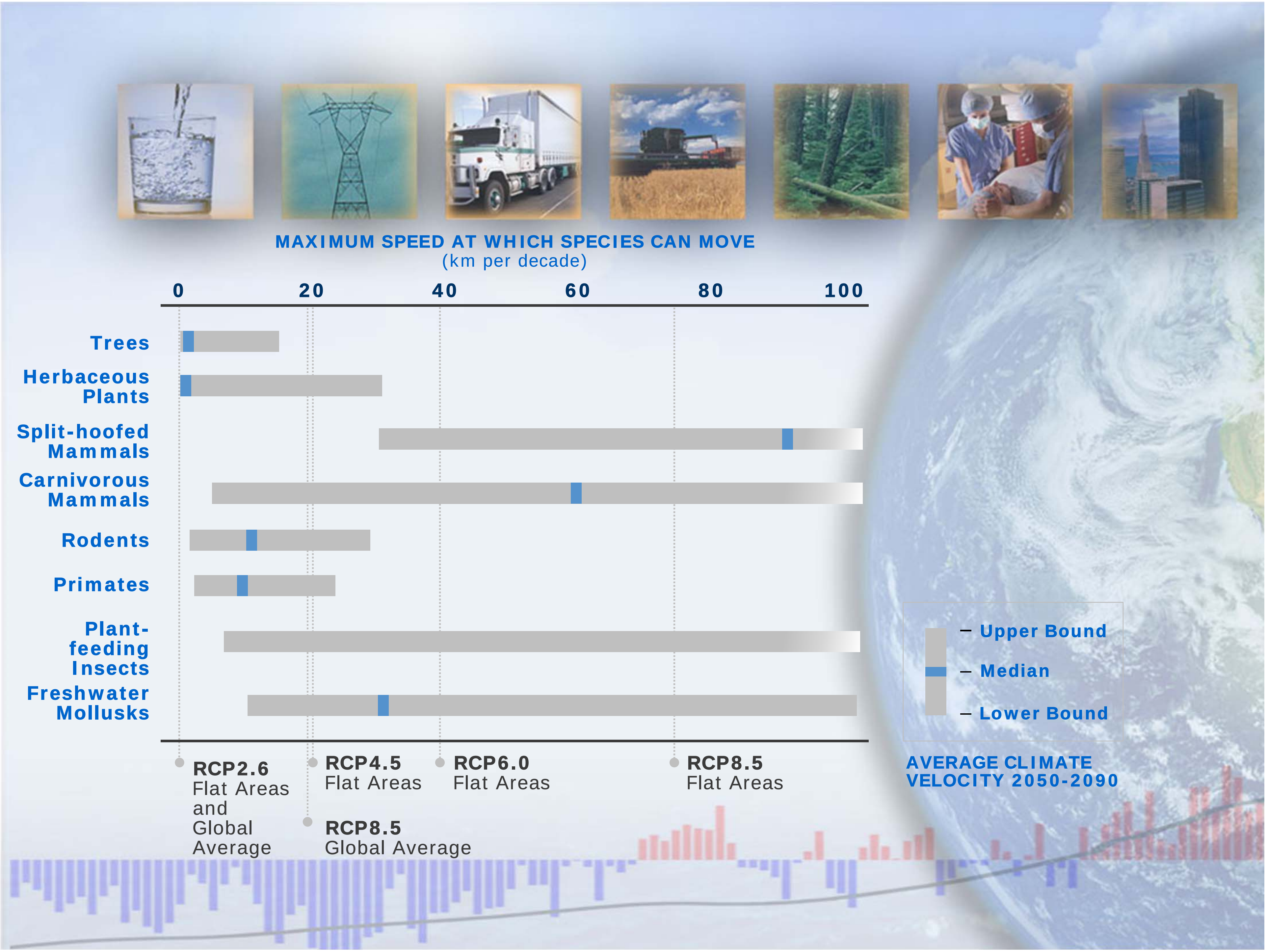
Droughts will intensify in the 21st century in some seasons and areas, due to reduced precipitation and/or increased evapotranspiration- including southern Europe and the Mediterranean region, central Europe, central North America, Central America and Mexico, northeast Brazil, and southern Africa.

Elsewhere there is overall low confidence because of inconsistent projections of drought changes (dependent both on model and dryness index) due to…….

Definitional issues, lack of observational data, and the inability of models to include all the factors that influence droughts preclude stronger confidence than medium in drought projections.






MAXIMUM SPEED AT WHICH SPECIES CAN MOVE
(km per decade)
0
20
40
60
80
100
Trees
Herbaceous Plants
Split-hoofed Mammals
Carnivorous Mammals
Rodents
Primates
Plant-feeding Insects
Freshwater Mollusks
RCP2.6 Flat Areas and Global Average
RCP4.5 Flat Areas
RCP6.0 Flat Areas
RCP8.5 Flat Areas
RCP8.5 Global Average
Upper Bound
Median
Lower Bound
AVERAGE CLIMATE VELOCITY 2050-2090

Key challenges have been identified through widespread assessments with experts of key communities (GCOS, GEO, GFCS)

- **Accessibility:** many countries do not have climate services at all, and all countries have scope to improve access to such services.
- **Capacity:** many countries lack the capacity to anticipate and manage climate related risks and opportunities.
- **Data:** the current availability and quality of climate observations and impacts data are inadequate for large parts of the globe.
- **Partnerships:** interactions between climate service users and providers are not always well developed, and user requirements are not always adequately understood and addressed.
- **Quality**: climate information services are lagging advances in climate and applications sciences, and the spatial and temporal resolution of information is often insufficient to match user requirements.

Recent Studies of Mid-century Climate Change Impacts on Colorado River flows (Lee's Ferry)

Recent Studies	Projected Annual Flow Reductions
Christensen et al., 2004	~18%
Christensen and Lettenmaier, 2007	~6%
Milly et al., 2005	10 to 25%
Hoerling and Eischeid, 2007	~45%
Seager et al., 2007	"an imminent transition to a more arid climate"
McCabe and Wolock, 2008	~17%
Barnett and Pierce, 2008	assumed 10-30%

Response One: These are so different, we can't trust any of them…

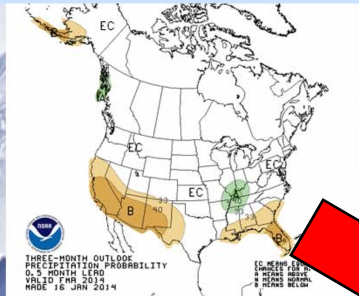
Response Two: We need to resolve these differences! Are the differences due to climate uncertainty or different models and methods?

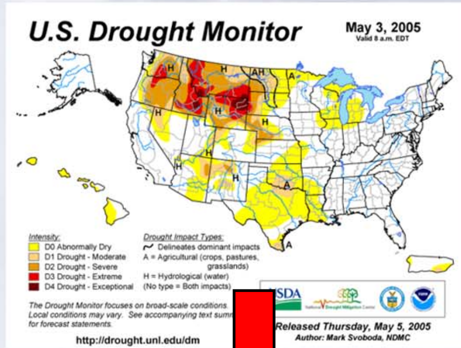
Response Three: None of these studies show increasing flows. Any decrease is a source of concern.

Principal Seasonal Drought Outlook Inputs

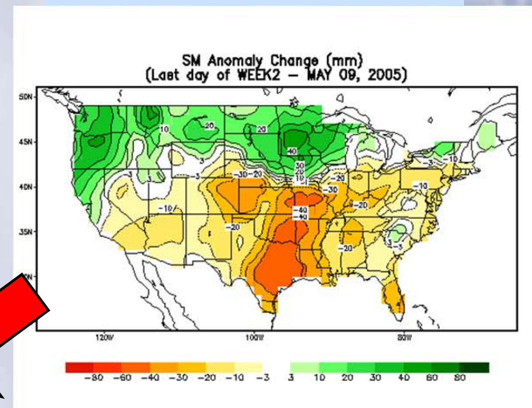
(NOAA/CPC)

CPC Seasonal Outlook

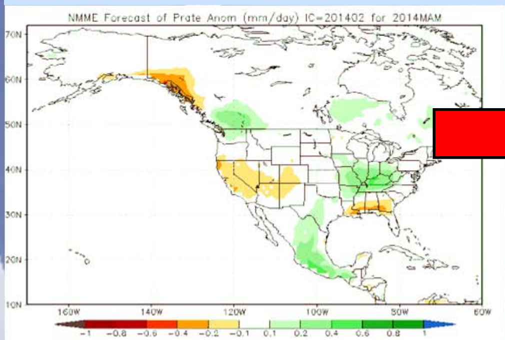




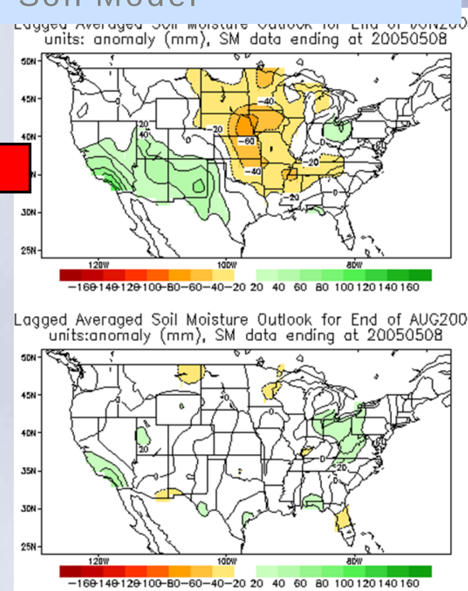
2-Wk Soil Moisture



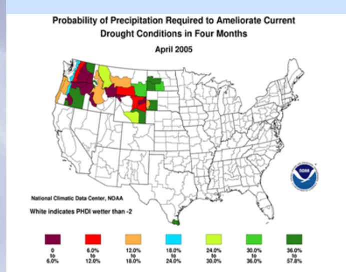
NMME



Constructed Analogue Soil Model



Palmer 4-mo Probabilities



Medium-Range Fcst