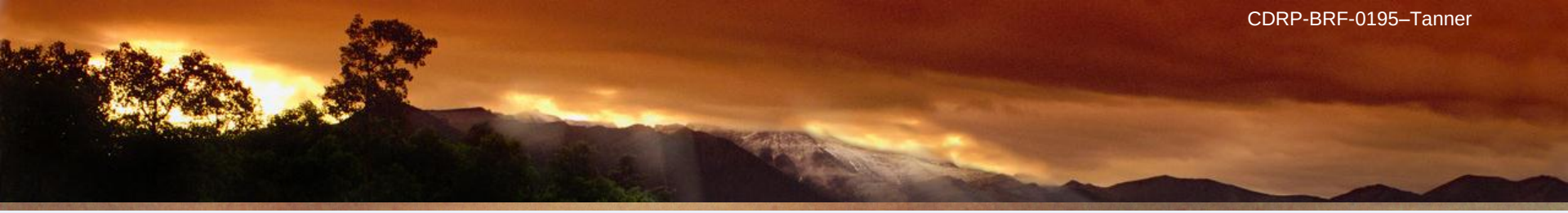


Use-Inspired Climate Observation, Monitoring, and Data Records

Michael D. Tanner
Deputy Director
National Climatic Data Center

July 31, 2012

Introduction

- Monitoring the Earth's Climate
- Climate and Climate Services Definition
- Example NOAA Climate Products and Services
- Climate Risk Management
- Agriculture
- Energy
- Construction
- Emerging Public and Private Roles

National Climatic Data Center

Acquire and ingest data from Agency, non-governmental, and international sources

Archive and scientific stewardship of the Nation's weather and climate data

Provide access to data, metadata (information about the data), and product

Monitor and describe the Climate from the local- to global-scale

Observing the Earth

Global Climate Observing System (GCOS)

- Long-term observations required for:
  - Monitoring the climate system
  - Detecting and attributing climate change
  - Assessing impacts of, and supporting adaptation to, climate variability and change
  - Application to national economic development
  - Research to improve understanding, modeling, and prediction of the climate system
- Addresses the total climate system
  - Physical, chemical and biological properties
  - Atmospheric, oceanic, terrestrial, hydrologic, and cryospheric components

WMO UNESCO IOC ICSU International Council for Science UNEP

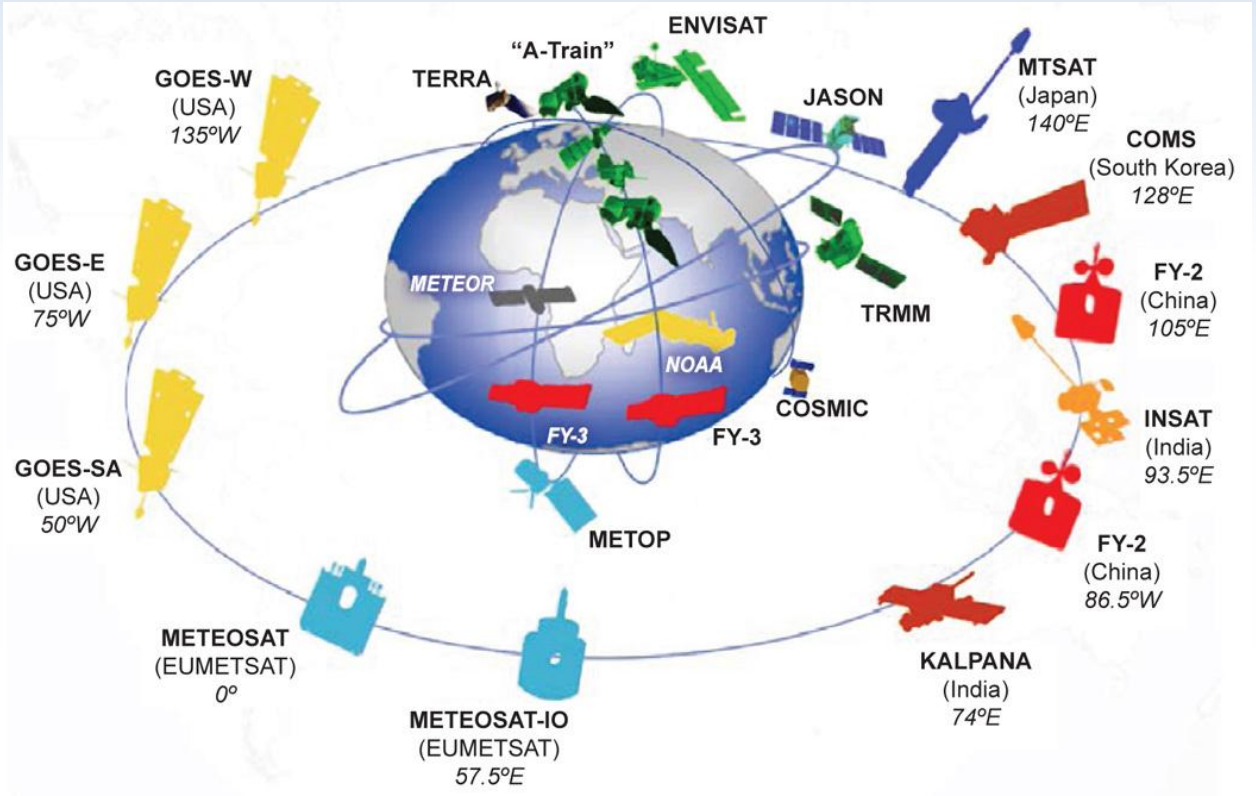
GCOS - Essential Climate Variables
Building Blocks for NOAA's Climate Data Record Program and our tie to Programs across the US Federal Sector

DOMAIN	ESSENTIAL CLIMATE VARIABLES
 **Atmospheric** (over land, sea and ice)	**Surface**[2]**:** Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. **Upper-air:** Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). **Composition:** Carbon dioxide, Methane, and other long-lived greenhouse gases; Ozone and Aerosol, supported by their precursors
 **Oceanic**	**Surface**[3]**:** Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour (for biological activity), Carbon dioxide partial pressure, Ocean acidity. **Sub-surface:** Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers, Phytoplankton; Marine biodiversity and habitat properties[4]
 **Terrestrial**	River discharge, Water use, Ground water, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture

http://www.wmo.int/pages/prog/gcos

Looking at the Earth:
A Constellation of Satellites

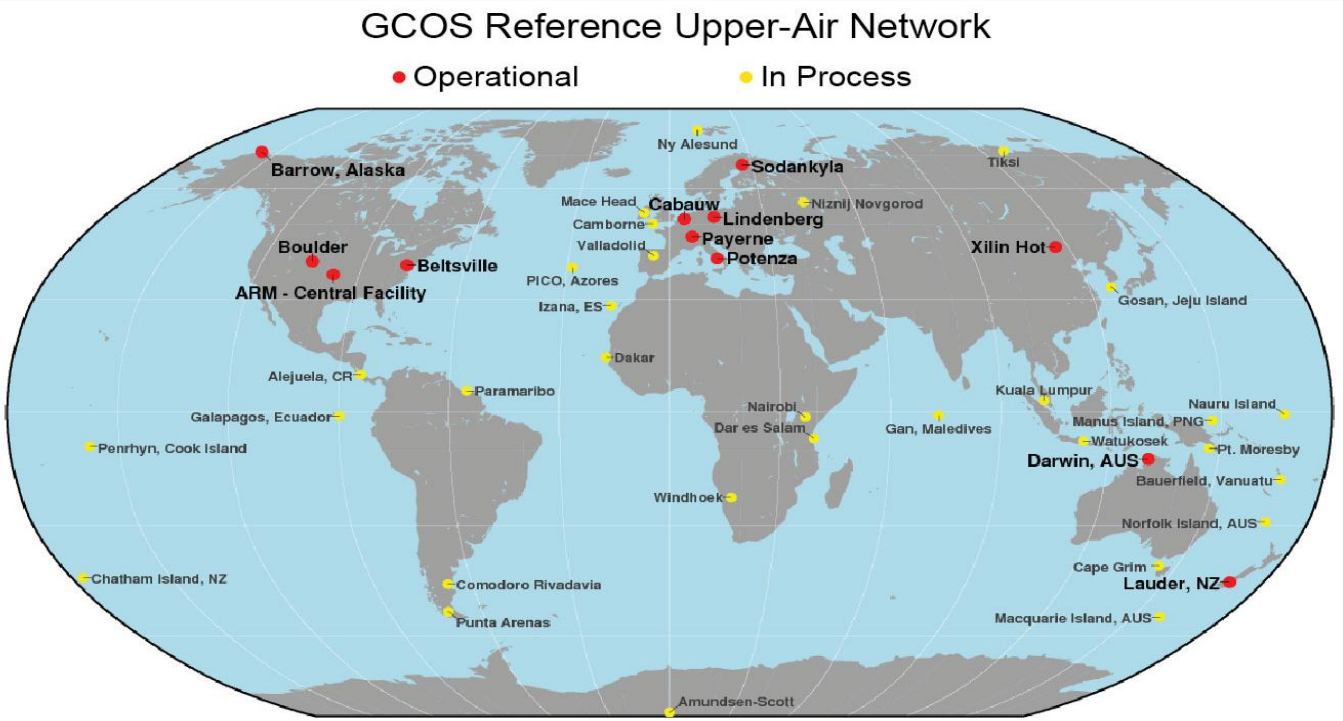
- Space-based Global Observing System as of about 2010
- Geo-synchronous and polar orbits
- International effort to achieve continuous global coverage



http://www.wmo.int/pages/prog/gcos

Atmosphere Domain

- **Observations span the globe, e.g.**
  - **Fundamental Atmospheric CDRs at NCDC**
    - **At-sensor reflectance**
  - **Thematic Atmospheric CDRs at NCDC**
    - **Aerosol Optical Thickness**
  - **Land surface observations**
  - **Energy from the sun**
  - **Atmospheric composition**
    - **Greenhouse gases, water vapor, micron-size particulates**



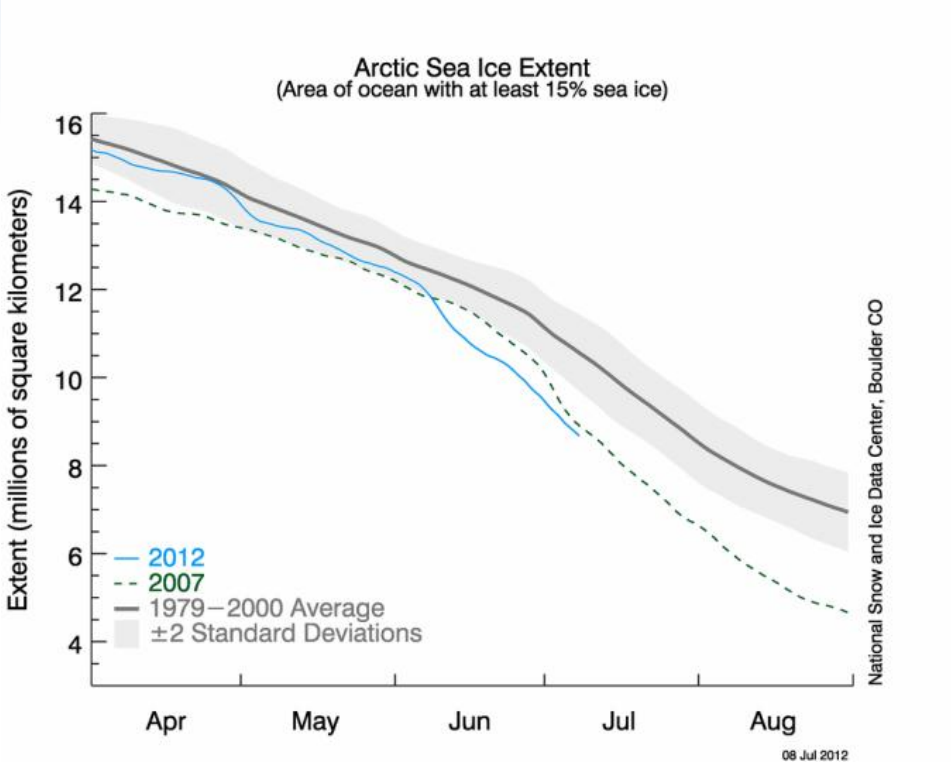
Ocean Domain

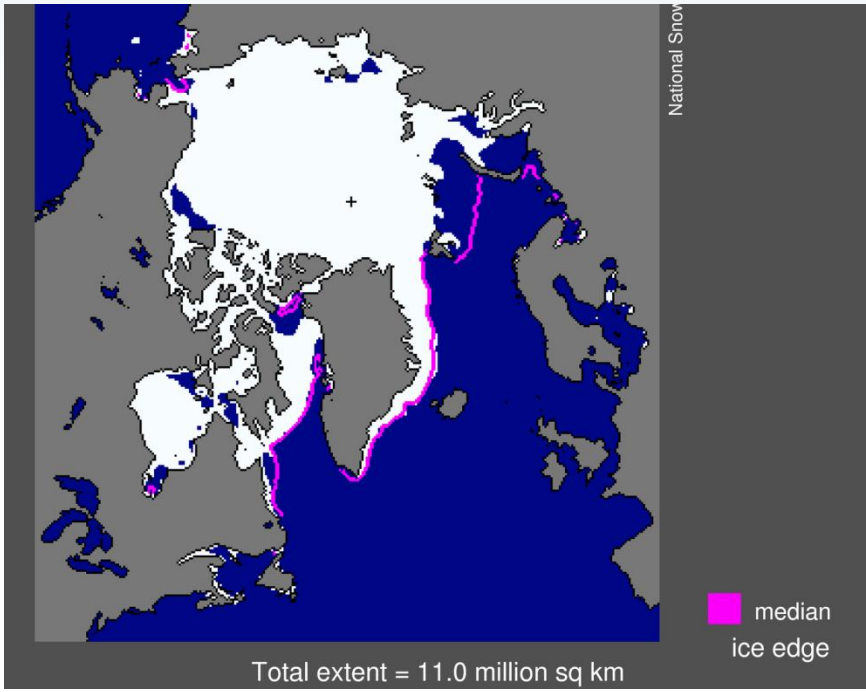
Examples, CDRs and other Observations

- **Pathfinder Sea Surface Temperature CDR at NCDC**
- **Optimally Interpolated SST at NCDC**
- **Sea Ice Extent Thematic CDR at NCDC**
- ~3000 Argo floats
  - Temperature and salinity profiles
- ~ 1250 drifting buoys
  - Surface currents, temperature, pressure
- ~ 350 embarked systems
  - Temperature, pressure, salinity, O_2, CO_2
- ~ 100 research vessels
  - All parameters
- ~ 200 marigraphs and holographs
  - Detecting tsunamis
- ~ 50 commercial ships
  - Temperature and salinity
- ~ 200 moorings
  - All parameters

Arctic Sea Ice
A Thematic Climate Data Record at NCDC

- September 2011 sea ice extent was 2nd smallest since the satellite era began
- Old ice (4–5 years) reached record low in 2011: 81% below average
- Bering Straight
  - Projections imply Ice-free conditions by 2030's, ice free summer by mid-century.





National Snow and Ice Data Center

Global Terrestrial Observations

River discharge	Water use	Groundwater	Lakes	Snow cover	Glaciers & ice caps	Permafrost & seasonally frozen ground	Albedo

Land cover	fAPAR	Leaf area index	Above-ground biomass	Fire disturbance	Soil moisture	Soil carbon	Ice sheets

All of these examples are emerging or established Climate Data Records

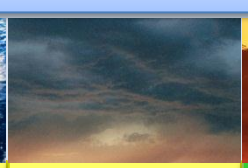
You will hear about user-driven applications of these CDRs during this meeting

Essential Climate Variables for Extremes

- Sustained coverage is essential to monitor temporal trends
- Need sufficient
  - Sustained period of record
  - Data quality
  - Metadata
- Biggest challenges at local scale
  - Hail
  - Extreme weather events
  - Storm surge
  - Sustained observations

CDRS Essential to Regional Scale


hurricanes/ typhoons


extra-tropical storms


heat waves


cold waves


Droughts


Floods


storm surge


ice storms/ freezing rain


snowstorms/ blizzards

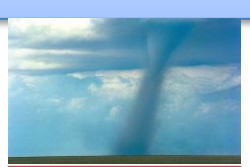

off-season freezes

CDRs blended with in-situ observations essential to Local Scale


hail


lightning


severe thunderstorms/ downbursts


tornadoes

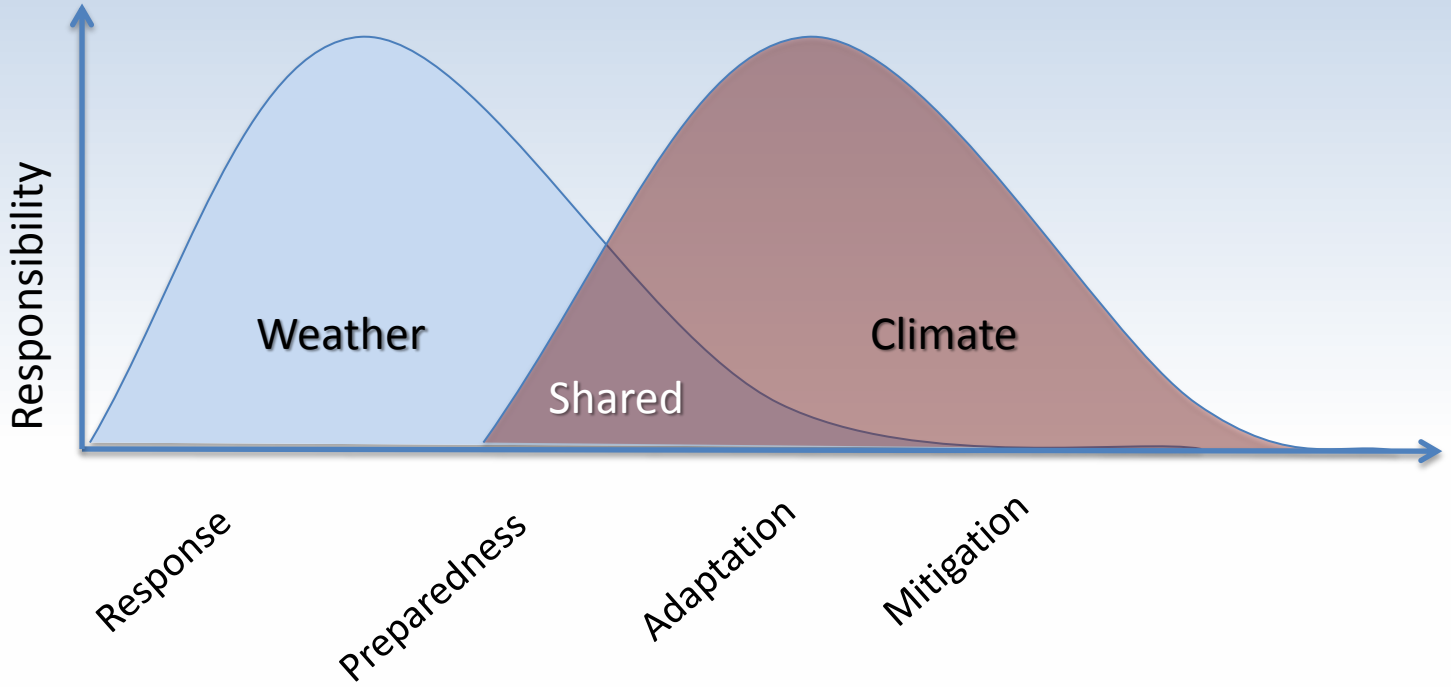
Karl, T.R., Trenberth, K.E., Tanner, M.D., et al., Challenges of a Sustained Climate Observing System, Plenary paper for the WCRP Open Science Conference, Denver, CO, October 2011.

Use-inspired Climate Products

- Climate
  - "Climate is what you expect, weather is what you get" Mark Twain
- Climate Services
  - "A mechanism to identify, produce, and deliver authoritative and timely information about climate variations and trends and their impacts on built, social-human, and natural systems on regional, national, and global scales to support decision making." - NRC 2009

Example NOAA Climate Products and Services

Distinction Between Weather and Climate



Weather	Shared	Climate
Personal Action Dominates	⟷	Societal Action Dominates
High Freq of Information	⟷	Low Freq of Information
Short Lifetime of Product	⟷	Long Lifetime of Product

Climate Risk Management

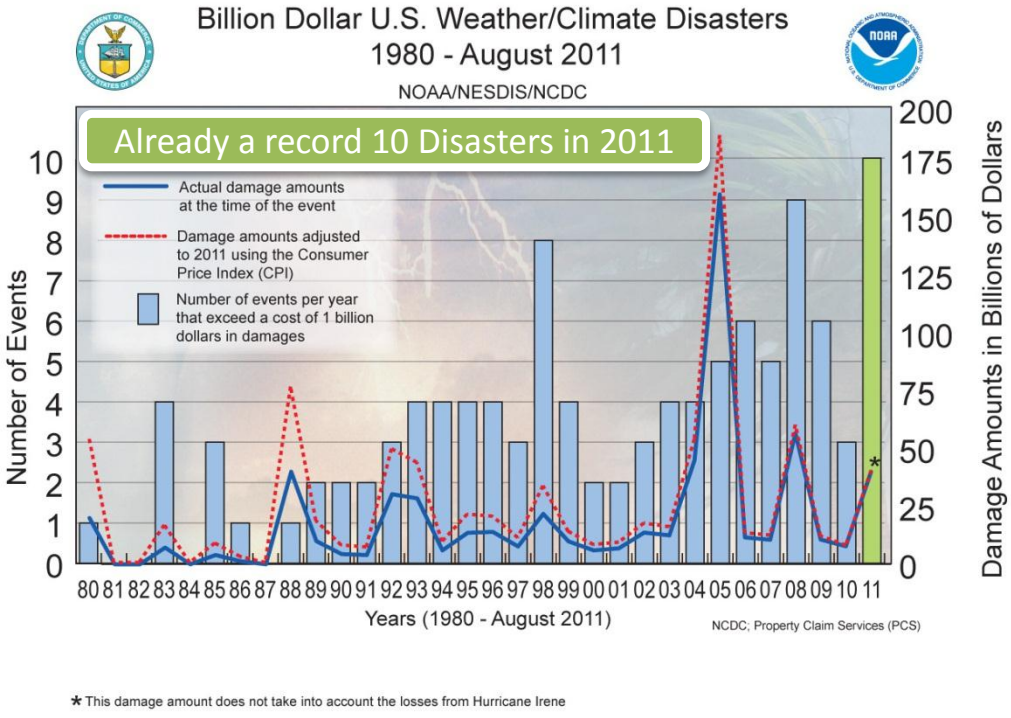
- Billion Dollar Weather and Climate Disasters
- Climate Extremes Index
- Extreme Precipitation
- Hurricane climatology and prediction

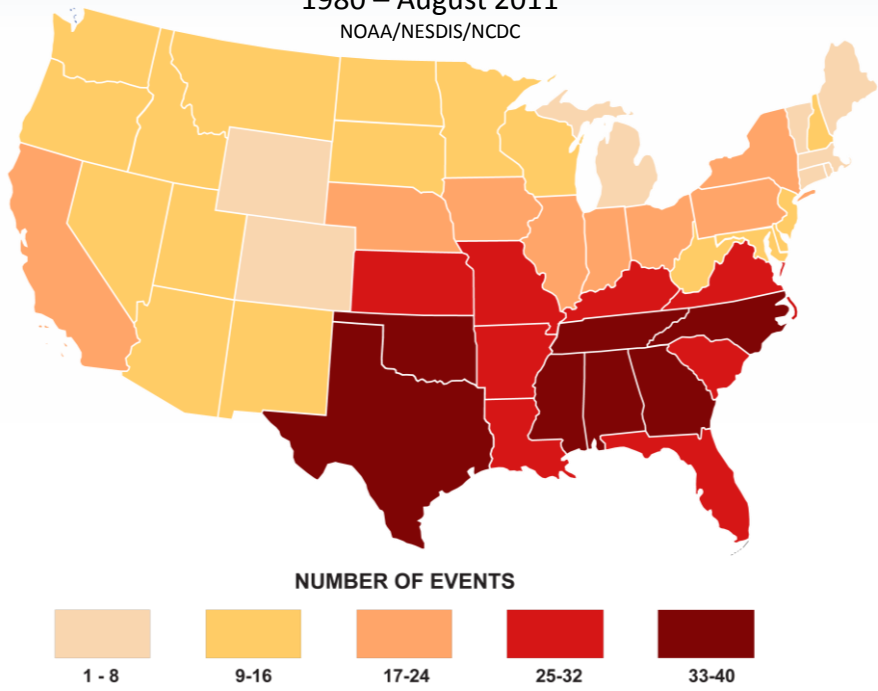
A Disastrous Year: Weather and Climate Disasters 2011

NOAA/NCDC

Billion Dollar Weather and Climate Disasters

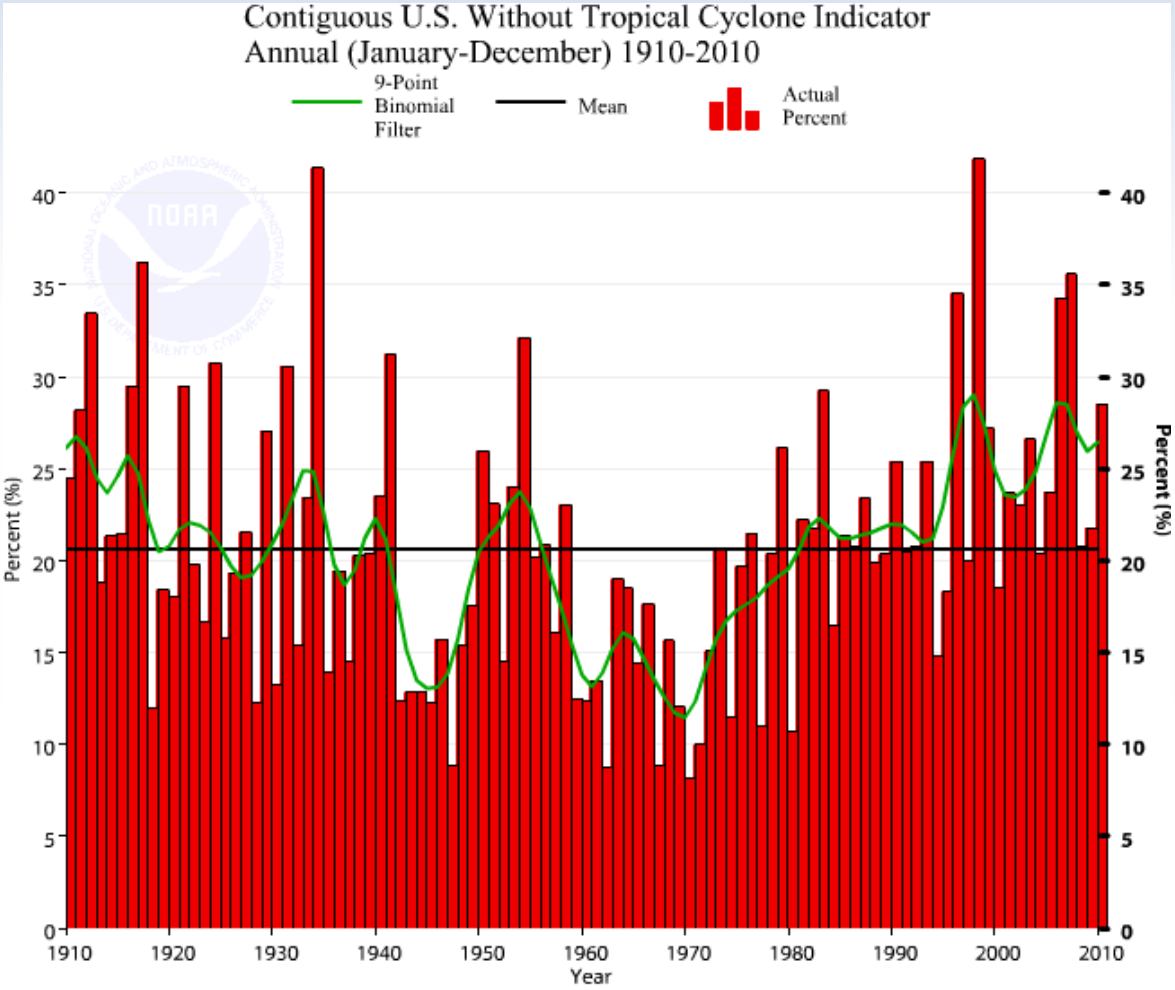
- Since 1980, the U.S. has seen a total of 110 weather-related disasters each totaling over $1 billion dollars in damage.
- Total standardized losses since 1980 of billion-dollar disasters exceeds $750 billion.
- Is the Nation becoming more exposed and/or sensitive to severe events?





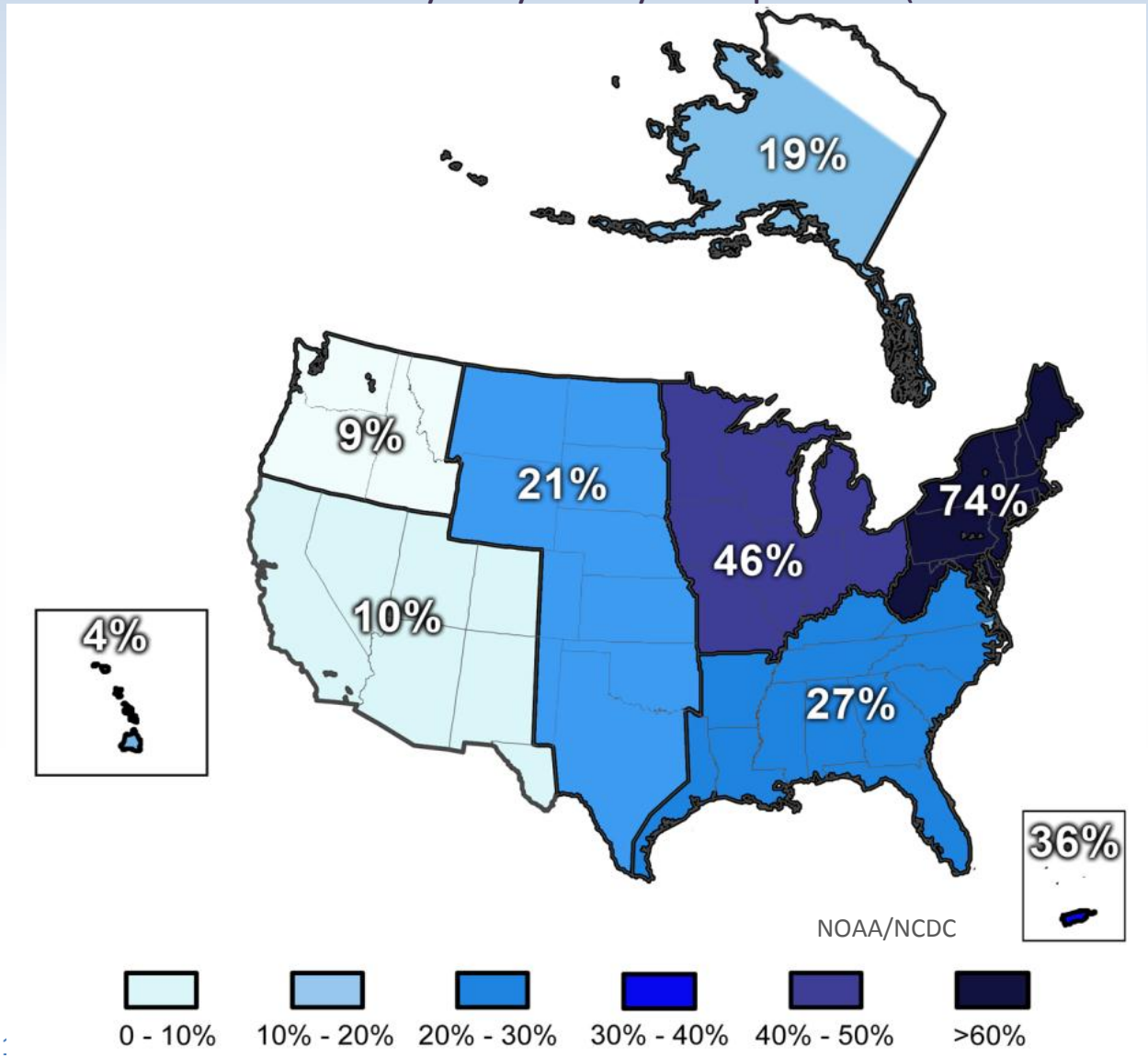
Climate Extremes Index

- Increasing since about 1970

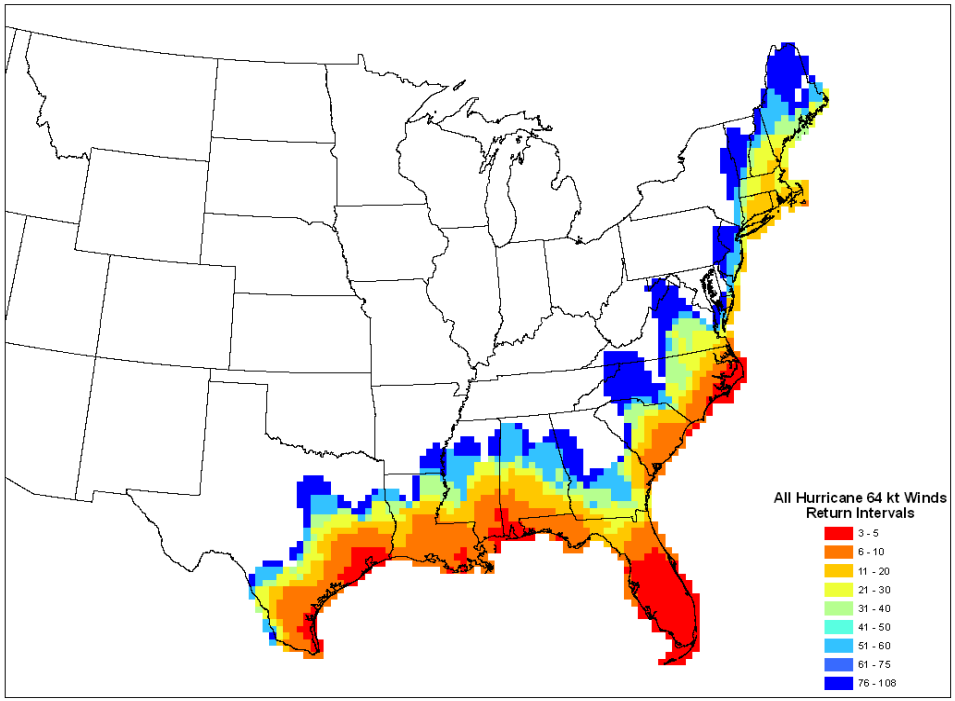


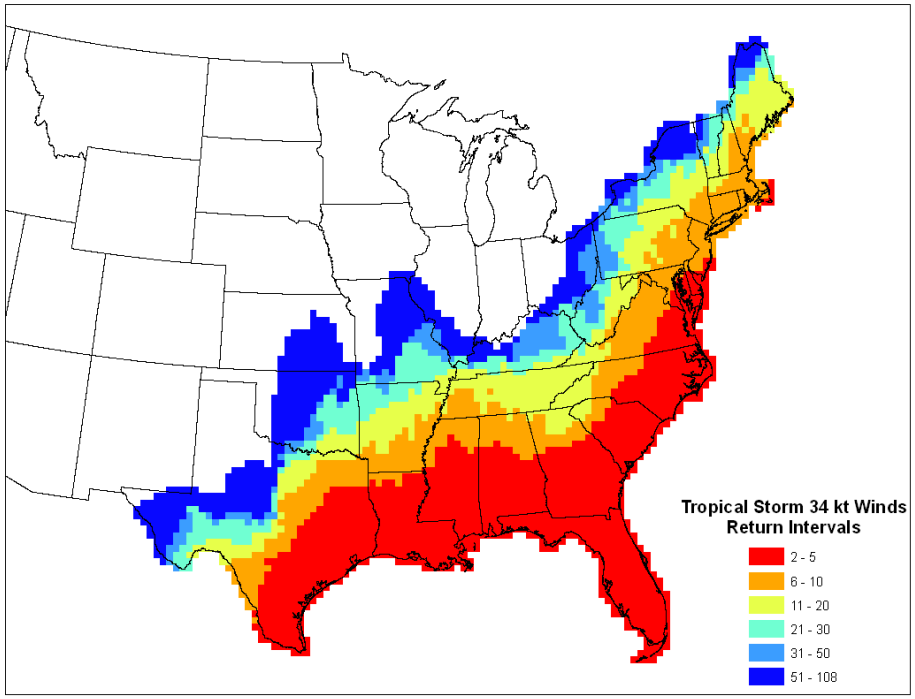
Extreme Precipitation

Observed Trends in 1-day Very Heavy Precipitation (1958 to 2010)



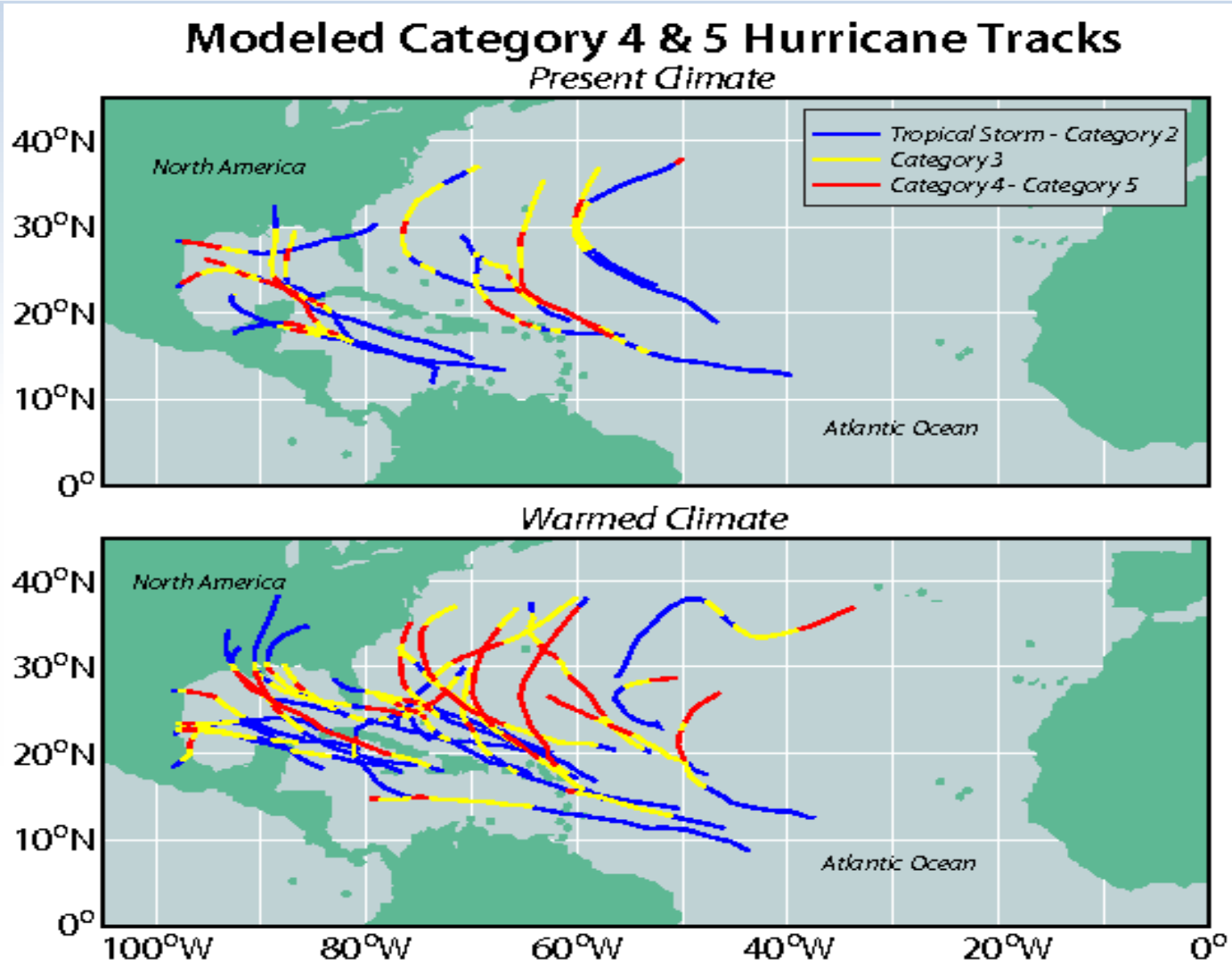
Coasts and Climate Resilience: Hurricane Climatology





- **Climatology of the Inland Frequency of Hurricanes and Tropical Storms: 1900-2008**

Coasts and Climate Resilience: Predicting Category 4 & 5 Hurricane Changes



Conclusion:
Best estimate is for doubling of Category 4-5 storms in Atlantic by end of century.

Agriculture

- 30-Year Climate Normals
- Changes in Normals and Plant Heartiness Zones
- Drought Monitoring and Outlooks

30-Year Climate Normals

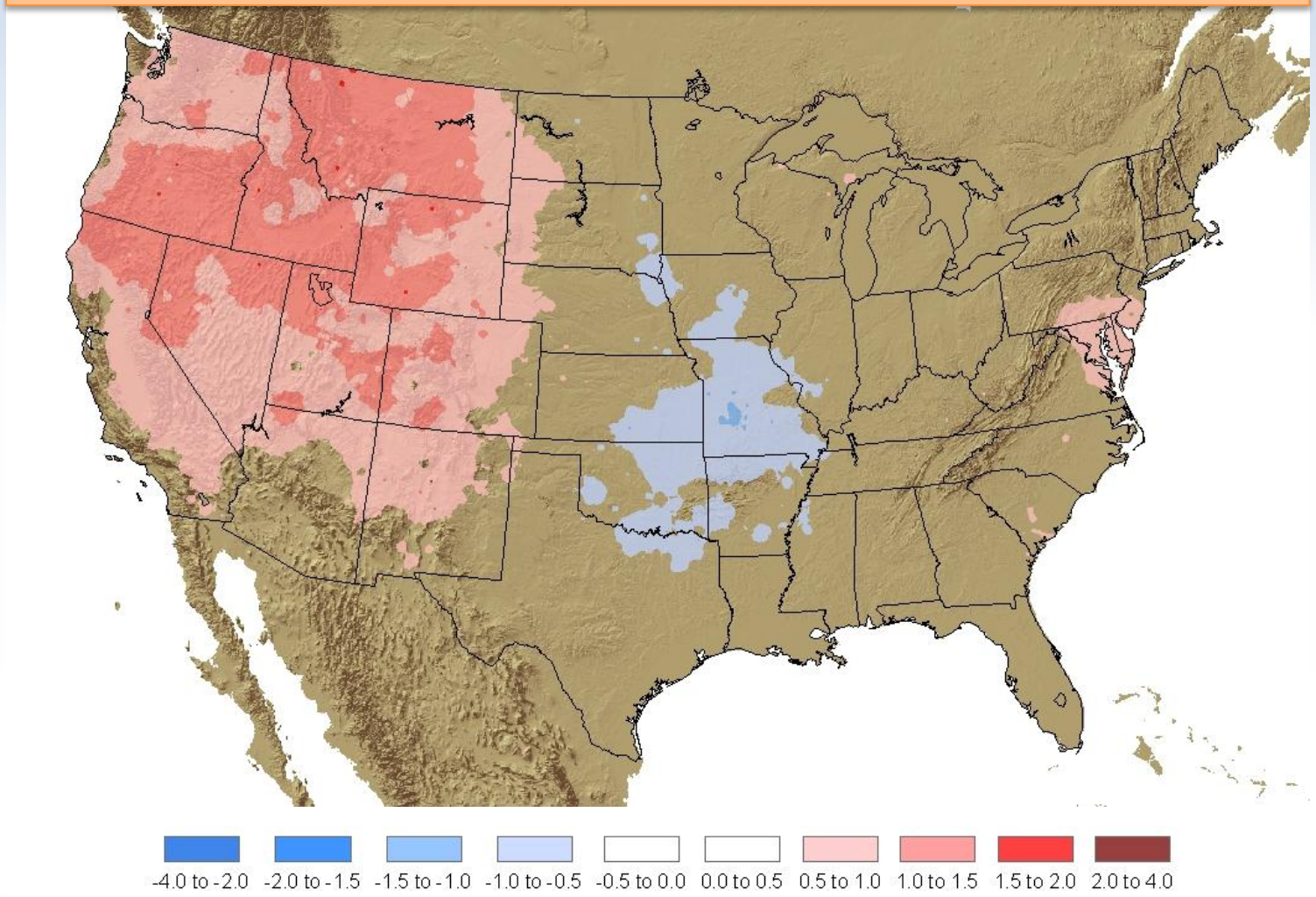
- Used to understand typical climate conditions
- The "normal" of a particular variable, such as temperature, is defined as the 30-year average
- Widely used by broadcast meteorologists, energy industry and agricultural/gardening sector

Normals Include:

- **Maximum and Minimum Temperatures**
- **Precipitation, Snowfall, and Snow Depth**
- **Heating and Cooling Degree Days**

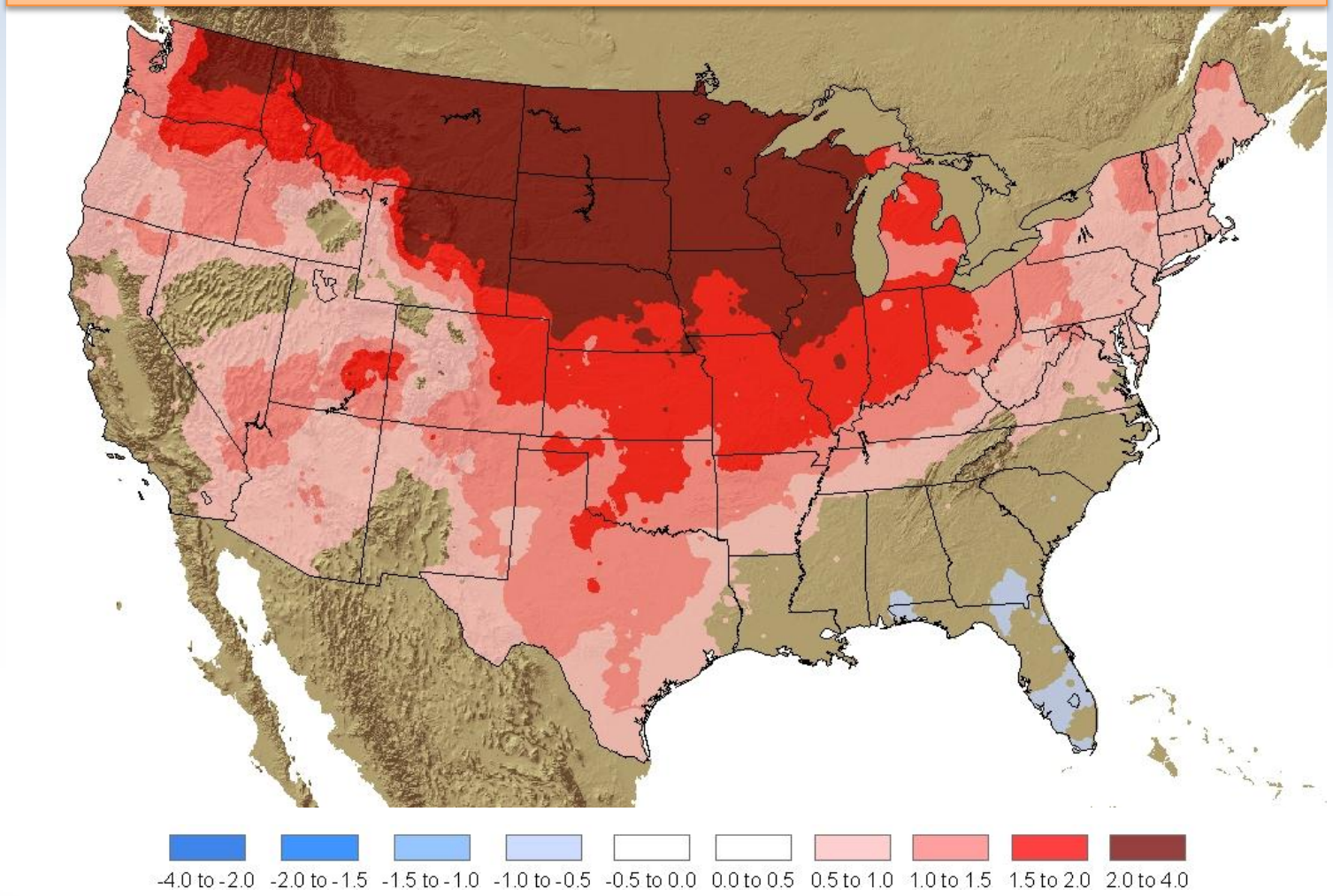
Normals Change in Temperature

July Maximum Temperature (F): 1981-2010 Minus 1971-2000



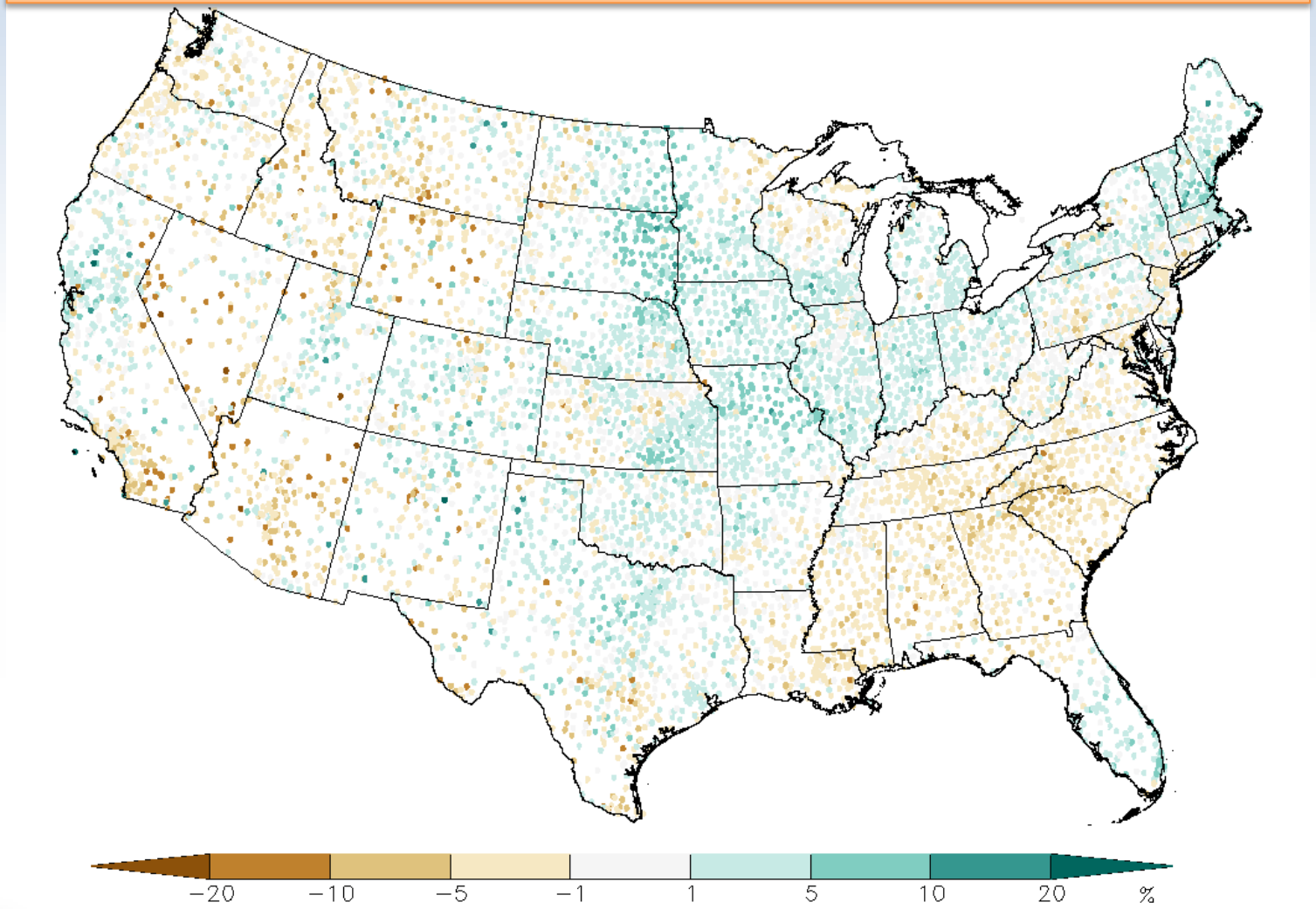
Normals Change in Temperature

January Minimum Temperature (F): 1981-2010 Minus 1971-2000



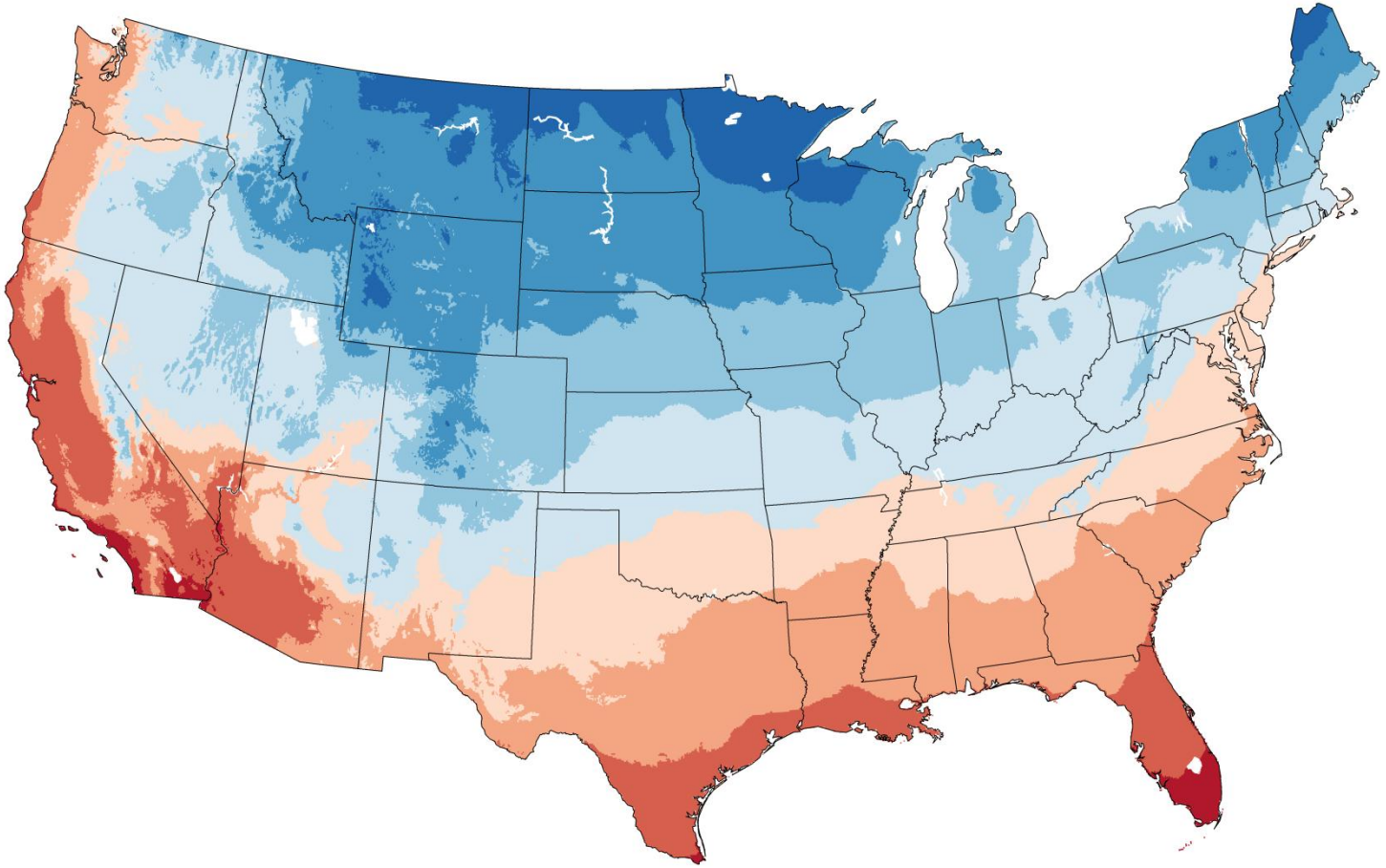
Changes in Precipitation

Percent Changes in Annual Normal Precipitation



Climate-Related Planting Zones: 1971-2000

Based on Current 30-Year Normals



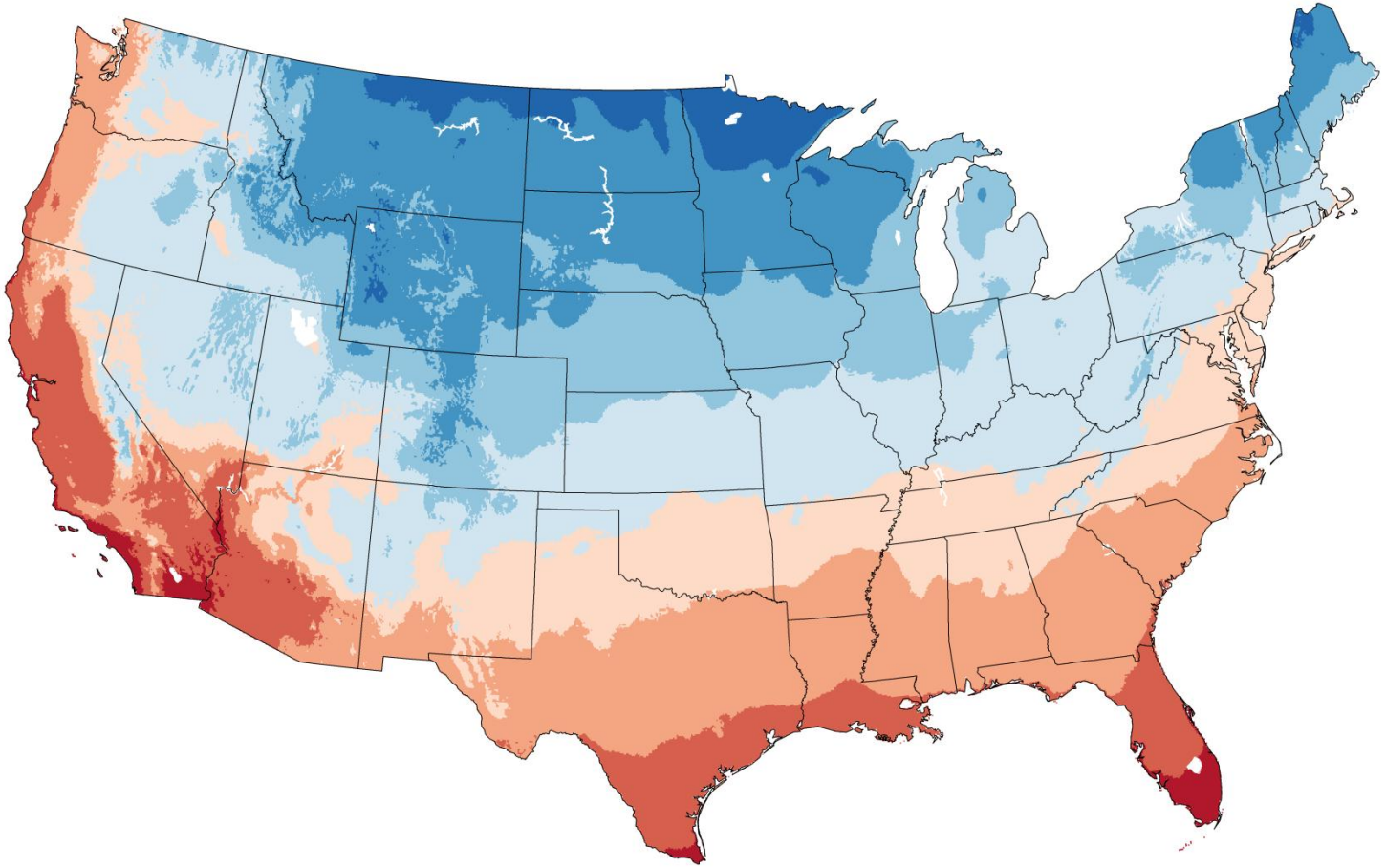
Average Annual Minimum Temperature by Climate-Related Planting Zone

- Zone 3 (-39 to -30 F)
- Zone 4 (-29 to -20 F)
- Zone 5 (-19 to -10 F)
- Zone 6 (-9 to 0 F)
- Zone 7 (1 to 10 F)
- Zone 8 (11 to 20 F)
- Zone 9 (21 to 30 F)
- Zone 10 (31 to 40 F)

Disclaimer: This illustration of nationwide patterns and changes in climate-related planting zones for gardeners was created as a special service to the American Public Gardens Association by the National Oceanic and Atmospheric Administration (NOAA). The official Plant Hardiness Zone map was prepared by the U.S. Department of Agriculture (USDA) in 1990 using data collected and distributed by NOAA. USDA is currently updating its official map, which will soon be available via the Internet.

Climate-Related Planting Zones: 1981-2010

Based on New 30-Year Normals (Available July 1, 2011)



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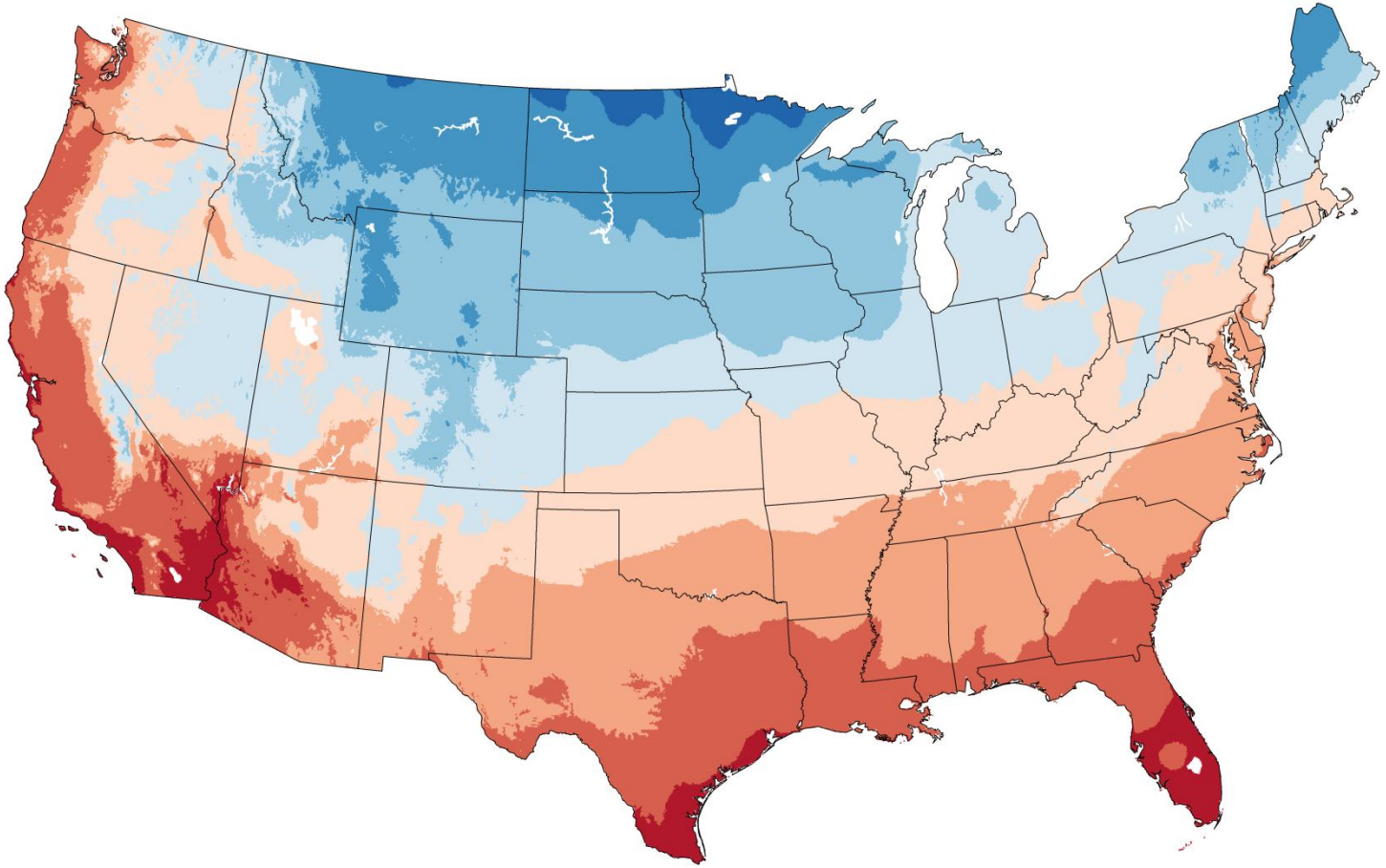
Projected Planting Zones: 2011-2040

Derived from Historical Data for 1971-2010



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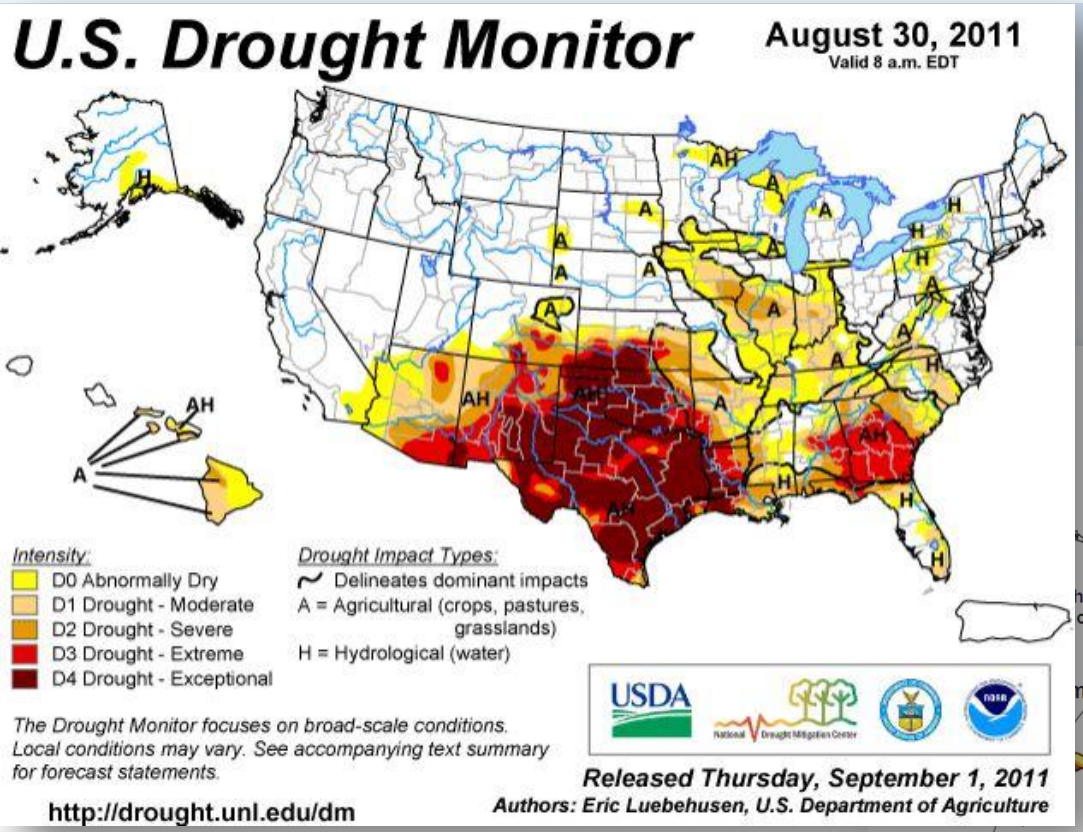
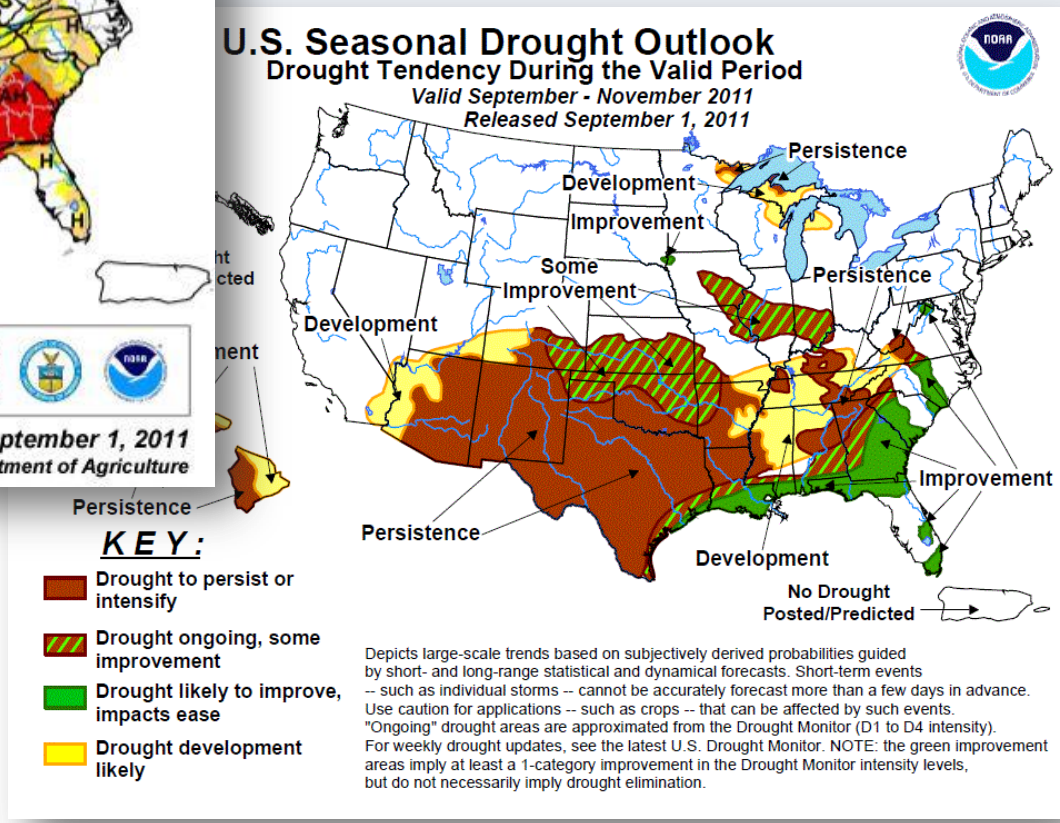
Drought


U.S. Drought Monitor
August 30, 2011
Valid 8 a.m. EDT
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://drought.unl.edu/dm
Released Thursday, September 1, 2011
Authors: Eric Luebehusen, U.S. Department of Agriculture


U.S. Seasonal Drought Outlook
Drought Tendency During the Valid Period
Valid September - November 2011
Released September 1, 2011
Persistence
Development
Improvement
Some Improvement
Persistence
Development
Persistence
Improvement
Persistence
Development
No Drought Posted/Predicted
KEY:
Drought to persist or intensify
Drought ongoing, some improvement
Drought likely to improve, impacts ease
Drought development likely
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

Energy

- Ice Storms

Ice Storms

Applications & Impacts

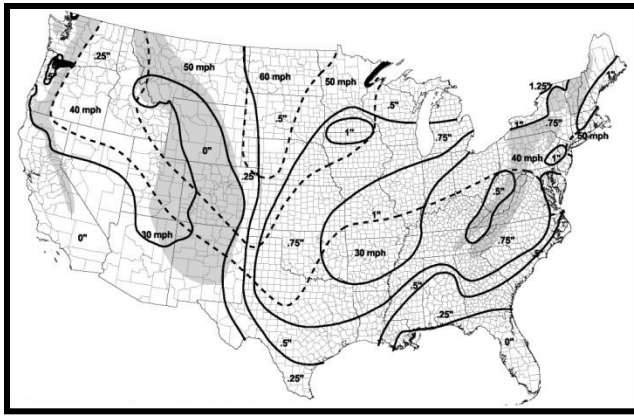
- **Energy Sector Impacts**
  - Power supply interrupted due to downed:
    - Transmission towers
    - Power poles and lines
    - Transformers
  - Transportation to make repairs impeded
  - Loss of revenue from unsold power & cost to make repairs

- **Costliest U.S ice storms**
  - Northeast U.S.
    - Jan 1998; > $1.4 billion damages
  - Southeast U.S.
    - Feb 1994; > $3 billion damages

NOAA Information Used

Freezing Rain/Ice Storm Statistics
-# days/hours with freezing rain
-ice storm losses
-Part of a National Engineering Design Standard

50-year recurrence interval for ice thickness from freezing rain and concurrent wind gusts.



Construction

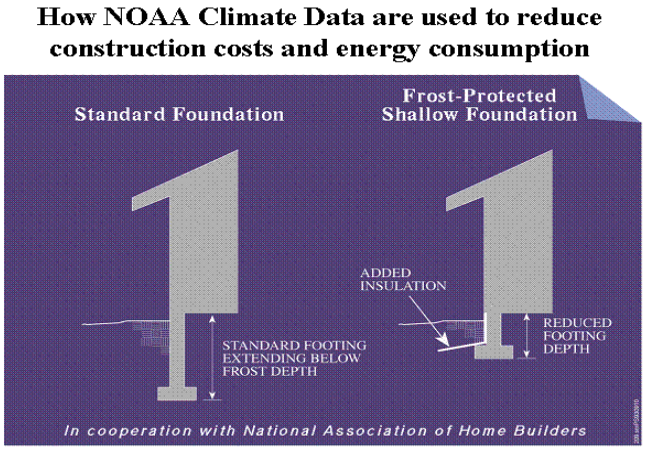
- Frost-Protected Shallow Foundation & Air Freezing Index

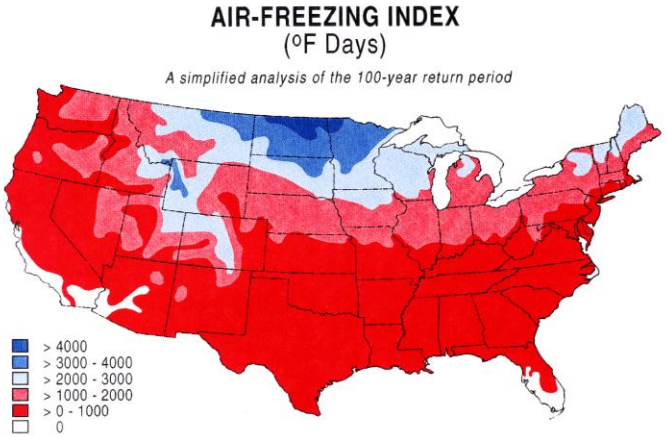
Frost-Protected Shallow Foundation

Applications & Benefits

- **Construction Benefits Cost Savings**
  - Foundation depths now 16 inches vs. several feet
  - Green building: limited site disturbance
  - Building cost saving: 1.1 to 3.8% of total home price
  - **Projected annual savings: $330 million**
- **Energy Cost Savings**
  - Added insulation protects foundation from frost heave
  - Amount of insulation determined by NOAA's Air Freezing Index
  - **Projected annual energy savings: 586,000 megawatt-hours**

NOAA Information Used





The amount of insulation needed to protect a building foundation is determined by the Air-Freezing Index.

Roles of NOAA and Private Sector

- Emerging NOAA role
  - Meet Government to Government responsibilities
  - Provide the public a certain level of authoritative government information for decision making–return on taxpayer investment
  - Provide easy and full access to all data and information and ensure full transparency in practices and methods to foster growth of a private-sector climate industry to meet specialized business and public sector needs
- Emerging Private Sector Role
  - Invest in capacity to support private sector market development and growth
  - Support climate information and decision support customized to meet specific company and/or industry needs
  - Invest in research, observations, and modeling to meet specific company and/or industry needs
  - Commit to sustained dialog with the public sector, and work to develop mechanisms for sharing proprietary information

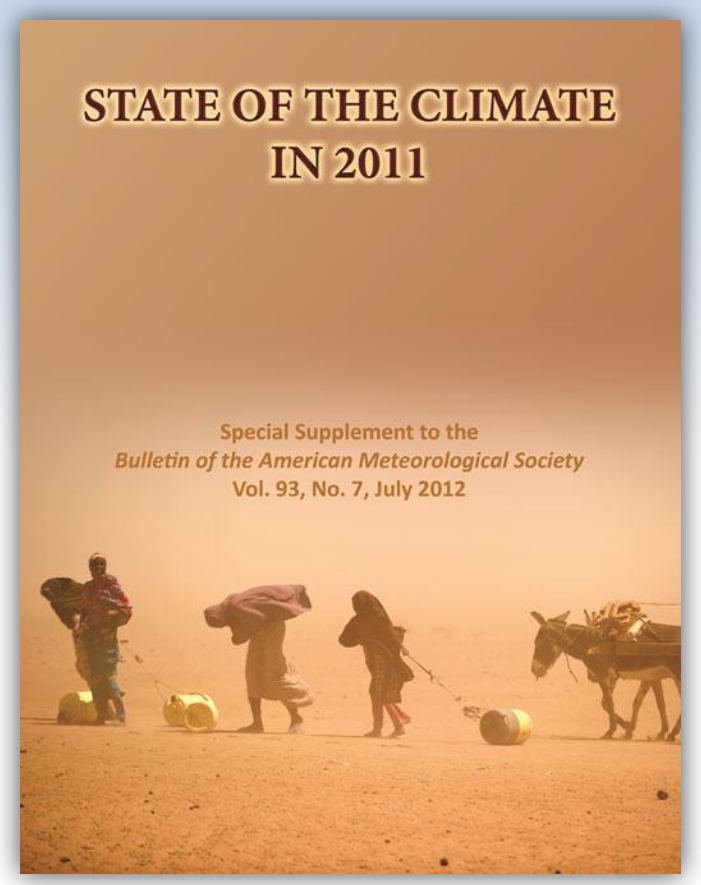
U.S. and NOAA Priorities for understanding climate

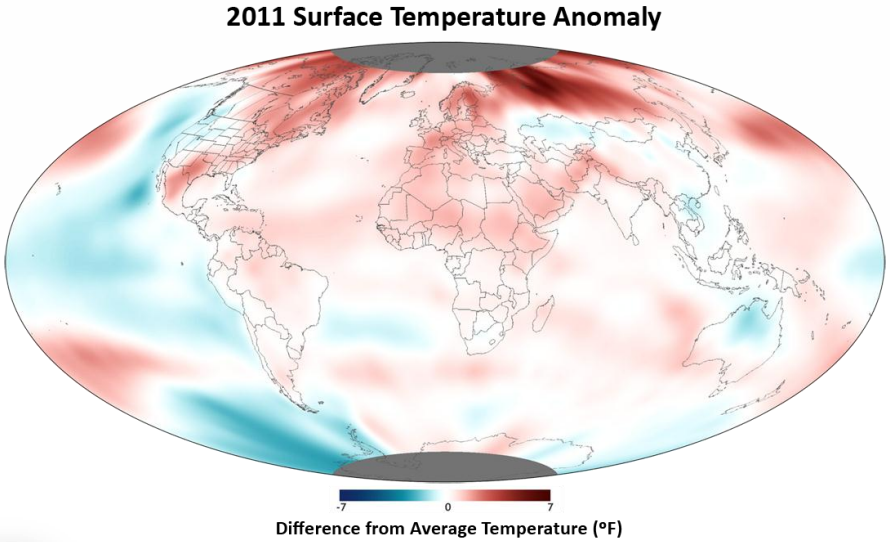
User Engagement Early on is Critical

- Cross-cutting themes within NOAA
  - Water Resources (flooding and drought)
  - Weather Extremes
  - Coastal Inundation
  - Marine Ecosystems

State of the Climate in 2011

- 22nd Annual Report
  - Tracking 43 global-scale climate indicators
  - 378 authors from 48 countries
  - 17 editors on 3 continents
- Focus of *Bulletin of the American Meteorological Society* Supplement
  - Surveys the changing state and the behavior of the physical climate system





Thank You


Weekly
Monthly
Seasonal – Annual
Decadal
Local
Regional
National & Global
Snowfall Impact Index – FEMA, disaster response
Heating & Cooling Degree Days – Energy Sector
Temperature & Precipitation Outlooks – Agriculture
Extreme Detection & Attribution – Insurance
Hurricane Tracks – Emergency Planners
Heat Wave Prediction – Public Health Officials
Drought Outlook – Agriculture
Climate Normals – Construction, Infrastructure, Agriculture
Drought Monitor – Agriculture
Monthly State of the Climate Reports – Decision Makers
Annual State of the Climate Reports – Decision Makers
National Climate Assessment – Decision Makers

Thank You!

Michael D. Tanner
Deputy Director
National Climatic Data Center

July 31, 2012