U.S. Observations and Monitoring in Support of Adaptive Water Management

Amanda McCarty

18 July 2012

Key Water Findings from the 2009 National Climate Assessment

- Climate change has already altered, and will continue to alter, the water cycle.
- Floods and droughts are likely to become more common and more intense.
- Precipitation and runoff are likely to increase in the Northeast and Midwest in winter and spring, and decrease in the West, especially the Southwest, in spring and summer.
- In areas where snowpack dominates, the timing of runoff will continue to shift to earlier in the spring and flows will be lower in late summer.
- Surface water quality and groundwater quantity will be affected by a changing climate.
- Climate change will place additional burdens on already stressed water systems.
- The past century is no longer a reasonable guide to the future for water management.

Global Change Impacts in the United States 2009

Observed Water-Related Changes in the U.S. During the Last Century

Observed Change	Direction of Change	Region Affected
One to four week earlier peak streamflow due to earlier warming-driven snowmelt	Earlier	West and Northeast
Proportion of precipitation falling as snow	Decreasing	West and Northeast
Duration and extent of snow cover	Decreasing	Most of the United States
Mountain snow water equivalent	Decreasing	West
Annual precipitation	Increasing	Most of the United States
Annual precipitation	Decreasing	Southwest
Frequency of heavy precipitation events	Increasing	Most of the United States
Runoff and streamflow	Decreasing	Colorado and Columbia River Basins
Streamflow	Increasing	Most of East
Amount of ice in mountain glaciers	Decreasing	U.S. western mountains, Alaska
Water temperature of lakes and streams	Increasing	Most of the United States
Ice cover on lakes and rivers	Decreasing	Great Lakes and Northeast
Periods of drought	Increasing	Parts of West and East
Salinization of surface waters	Increasing	Florida, Louisiana
Widespread thawing of permafrost	Increasing	Alaska

Who Cares About Water?

- Water Utilities
- Transportation Authorities
- Farmers
- Energy Companies
- Insurance Industry
- Conservationists
- Tourism/Recreation Sector
- Federal, State, Tribal, and Local Governments
- Public Health Officials
- Researchers
- Citizens

Climate Observations Uses

- Forecasts of water supply
  - When?
  - Where?
  - How Much?
- Input to climate, weather, and water models
- Calibration of models
- Verification and ground truthing of satellite data
- Advance understanding of natural processes

Water Decision Making Needs

Types of Decisions	Scientific Information Needs
Investments in Water Infrastructure	Streamflow and Groundwater Recharge, Water Demand
Discharge Permits	Low-flow Characteristics of Rivers, Properties of Underground Sources of Drinking Water
Design of Facilities Near Sea Level	Estimates of Relative Sea Level Rise and Storm Surge Hazard
Inland Flood Hazard Mitigation	Flood Frequency Estimates
Design and Rehabilitation of Drainage Systems	Estimates of Magnitude, Frequency, and Duration of Extreme Rainfall and Small-stream Flooding
Operation of Water Infrastructure	Estimates of the Probability and Magnitude of Extreme Low Flows and Extreme Flood Flows and Volumes, Estimates of Water Demand, Forecasts at Multiple Time Scales of the Amount of Inflow, Estimates of the Consequences of Various Flow Scenarios on Aquatic Habitat
Protecting Public Health from Water-borne Diseases	Reliable Data on Waterborne Disease Incidence in Populations, Estimates of Likely Timing and Location of Water-borne Pathogens and Contaminants, Monitoring Systems and Interventions for Reducing Health Impacts
Protecting or Restoring Aquatic and Riparian Habitats	Estimates of Likely Streamflow at Multiple Times and Scales, Water Temperature, Quality and Variability, Information on How Conditions Will Affect Habitat and Biological Populations

Adapted from the U.S. National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate

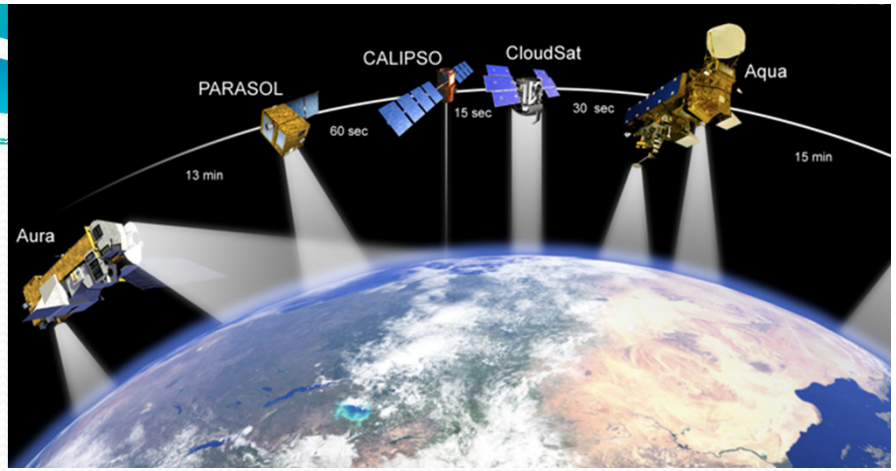
Water Relevant Observations

- Precipitation (type, rate, amount)
- Snow and ice cover and thickness
- River and lake ice
- Soil moisture and temperature
- Water temperatures
- Runoff
- Streamflow
- Evapotranspiration
- Atmospheric water vapor
- Water demand and use information
- Water quantity and availability information
- Analysis of changes in water quality
- Identification of alternative water resources
- Incidence of drought
- Water quality
- Surface temperature
- Surface wind speed and direction

Climate Observations

- Climate observations can include:
  - Routine weather observations collected over extended periods of time
  - Observations collected as part of research initiatives
  - Highly precise, continuous observations collected to document long-term change
  - Observations of climate proxies for historical records
- In situ, non-satellite remote sensing, and satellite observations provide complementary data
- Long-term, high-quality observations are essential

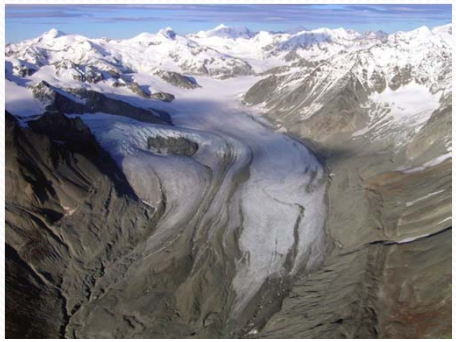
Satellite-based Observations



- Polar-orbiting Operational Environmental Satellites
- Geostationary Operational Environmental Satellites
- Jason Altimeter Series
- Quick Scatterometer (QuikSCAT)
- A-Train Constellation
- Ice, Cloud and Land Elevation Satellite (ICESat)
- Gravity Recovery and Climate Experiment (GRACE)
- LandSat
- Global Precipitation Measurement Mission (2014)

In Situ Observations

- Atmospheric Observations
  - e.g., U.S. Climate Reference Network, Cooperative Observer Program
- Terrestrial Observations
  - e.g., Soil Climate Analysis Network, SNOpack Telemetry Network
- Ocean Observations
  - e.g., Integrated Ocean Observing System, Global Sea Level Observing System



Data Stewardship

Climate.gov
science and services for society

- Integration
  - e.g., Hydrometeorological Automated Data System (HADS), National Climatic Data Center
- Storage and Access
  - e.g., Comprehensive Large Array-data Stewardship System (CLASS), Global Observing System Information Center (GOSIC)
- Analysis
  - e.g., Annual State of the Climate Report
- Reanalysis
  - e.g., Modern Era Retrospective Analysis for Research and Applications (MERRA)
- Tailored Services
  - e.g., U.S. and North American Drought Monitor, National Integrated Drought Information System

International Contributions

- U.S. observational and monitoring activities contribute to:
  - Global Climate Observing System (GCOS)
  - Global Ocean Observing System (GOOS)
  - Global Terrestrial Observing System (GTOS)
  - Committee on Earth Observation Satellites (CEOS)
  - Group on Earth Observations (GEO)
  - Global Earth Observation System of Systems (GOESS)

Support for a National Action Plan

Managing Freshwater Resources in a Changing Climate

GOAL:

Government agencies and citizens collaboratively manage freshwater resources in response to a changing climate in order to ensure adequate water supplies, to safeguard human life, health and property, and to protect water quality and aquatic ecosystems