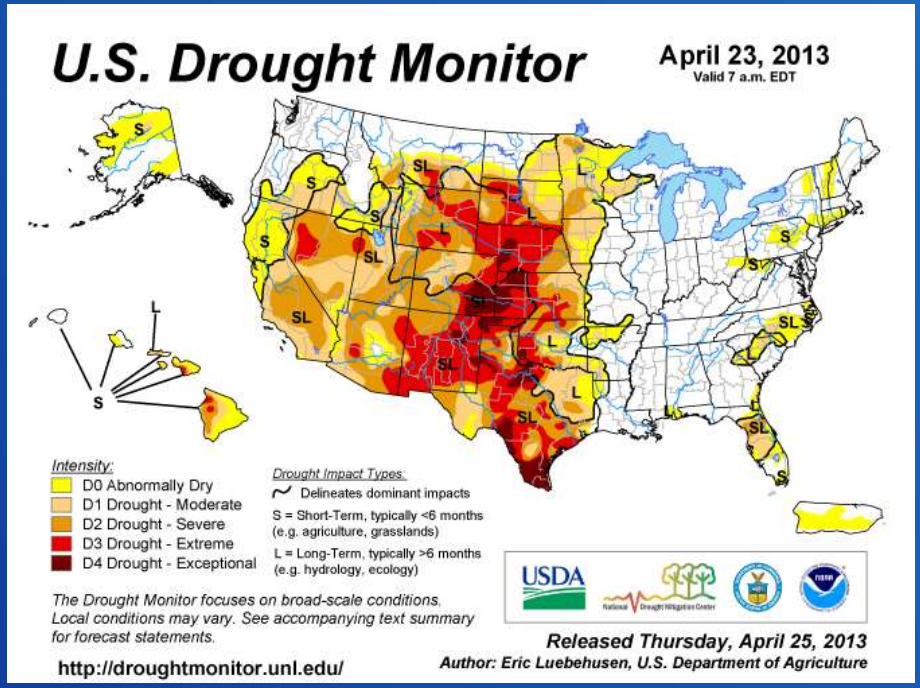
RECLAMATION

Managing Water in the West

Improving how we Anticipate and Prepare for Drought in Reservoir Operations



Levi Brekke, Reclamation

Improving Drought Prediction at Seasonal to Inter-Annual Timescales, WSWC / CA-DWR, Apr 29 – May 1, San Diego, CA

U.S. Department of the Interior
Bureau of Reclamation

Outline

- NOAA-Reclamation Drought Meeting November 6-7, 2012

- CCAWWG “STdoc“ and related Reclamation R&D efforts

NOAA-Reclamation Drought Meeting November 6-7, 2012

- Themes
  - focus on drought-affected basins in 2012, review hydrology and operations;
  - consider 2013 hydrologic outlooks and associated operations;
  - discuss science needs

- Sponsors:
  - NIDIS, NOAA Earth System Research Laboratory, and Reclamation R&D
- Participants:
  - NOAA (NWS RFCs, CPC, ESRL), NIDIS, Reclamation (Ops. staff, R&D)
- Presentations:;
  - http://drought.gov/drought/news/workshop-%E2%80%93-review-2012-drought-and-preparing-water-year-2013-drought-possibilities

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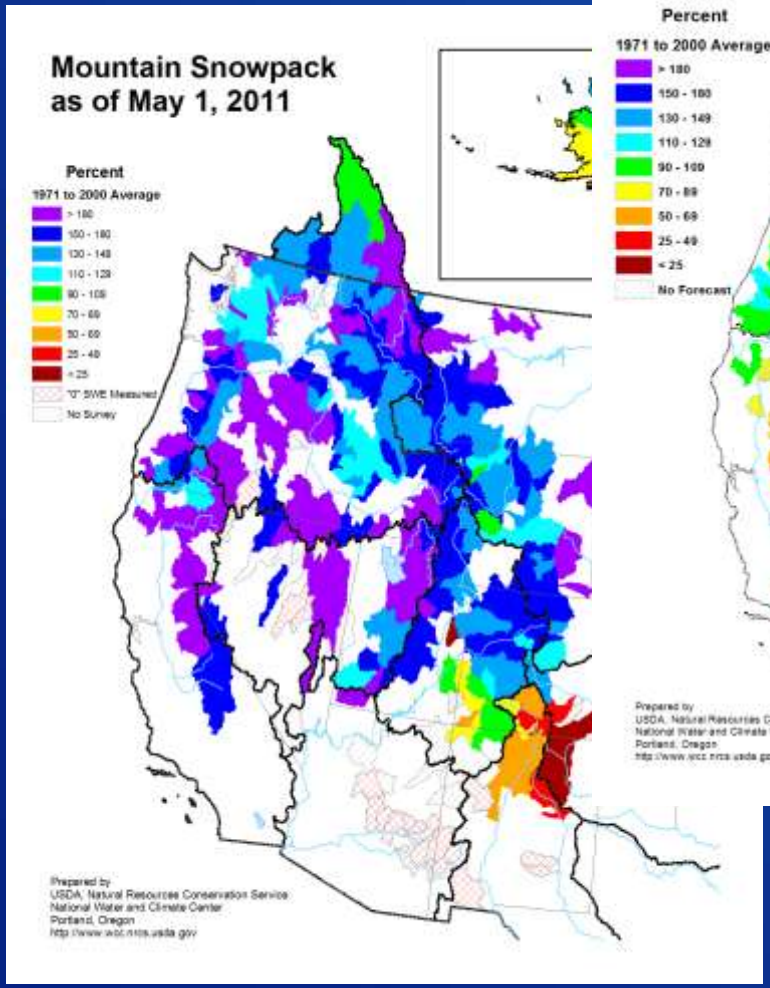
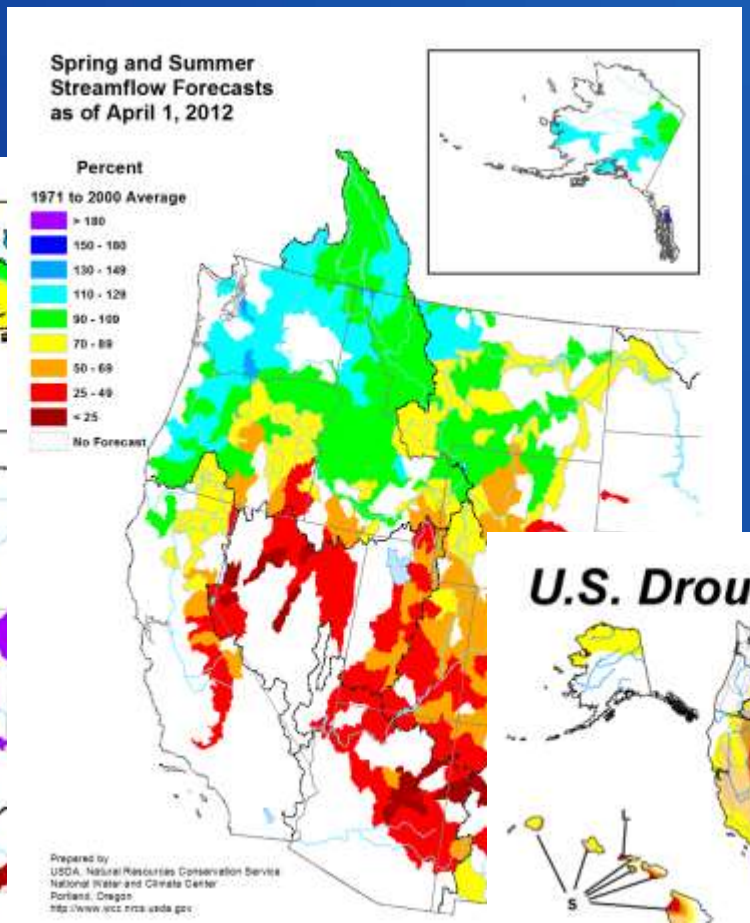
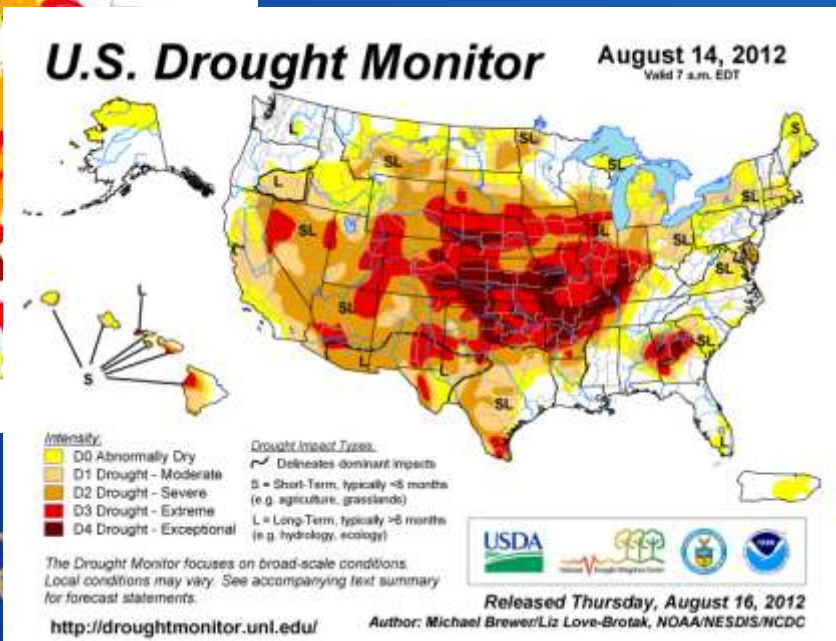
2012 Hydrologic Experience







2012 Operations Experience

- Focused on drought-affected regions (UC, LC, MP and GP)
- Consequences varied due to various factors
  - storage abundance (**)
  - type of precipitation regime
  - water management constraints
  - types of users
  - user sophistication
  - expected water supply reliability
- Looking ahead to tools and solutions, we're going to have to align them to really different types of basins.

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2013 Outlooks

- Premise:
  - Can we develop useful 2013 hydrology and operational outlooks that account for (1) warming trend, (2) basin carryover-effects from prior-year drought, and/or (3) NOAA CPC seasonal climate/drought outlooks?
- Hydrology:
  - Six NWS RFCs (AB, CN, CB, MB, NW, WG) provided ESP WY 13 monthly runoff outlooks (issued late Oct, Nov-Sep period)
  - Reclamation TSC post-processed ESP products using member-weighting schemes aligned with CPC seasonal climate outlooks
  - Member-weighted and -unweighted ESP forecasts very similar; exercise useful for illustration but ended up offering limited value
- Operations
  - Discussed how to translate ESP products into ensemble-operations outlooks (more later)

User Needs, Science Discussion

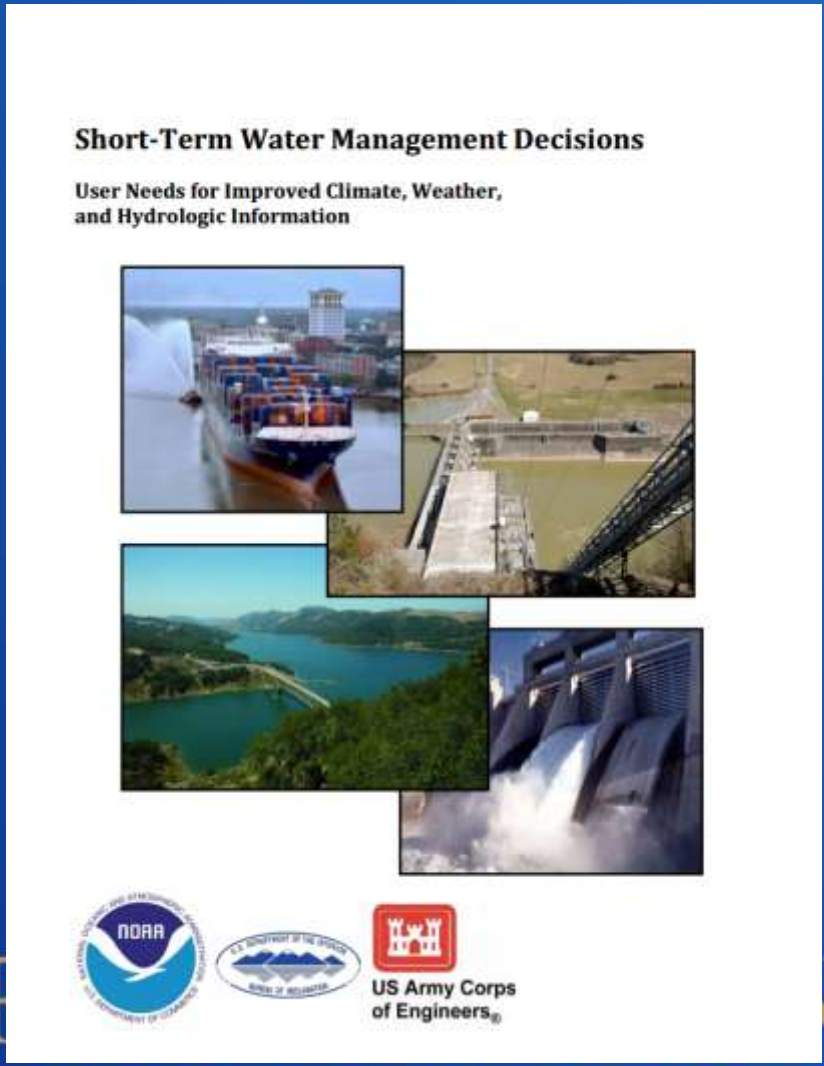
- Seasonal Prediction e.g.,
  - better spring season runoff volume forecasts (UC, MP); more tributaries (UC)
  - better alignment of RFC ESP hydrology forecasts w/ CPC products (MP) or CFSv2 (CNRFC, CBRFC)
  - teleconnections for regions w/ weak ENSO signal (UC)
  - more hindcast diagnostic, focus on years with big errors, identify reasons (GP)
- Science Opportunities
  - Focus: Jan-Jun runoff
  - role of basin antecedence → case for monitoring, data assimilation?
  - role of better climate forecasts → use CFSv2, NMME? focus on influential variables & months?
- Sub-seasonal Prediction during Spring
  - better snowmelt information during the snowmelt season (GP, UC, PN)
  - better ability to predict May-June precipitation (PN, GP); April lead is sufficient
- Science Opportunities
  - One-month outlooks w/ one-month leads (during spring) receives less attention than 3-month outlooks w/ longer leads … Harder problem? Off the radar?
- Hydrologic monitoring needs were also shared…
  - snowpack, soil moisture, groundwater (GP), evapotranspiration

Outline

- NOAA-Reclamation Drought Meeting November 6-7, 2012

- CCAWWG “STdoc“ and related Reclamation R&D efforts

- Report summarizes needs
  - monitoring
  - forecasting
  - information use
- Drivers
  - Most of our decisions involve contemporary water management
  - We can increase our ability to adapt to climate change by improving contemporary use of monitoring & forecasts



http://www.ccawwg.us/docs/Short-Term_Water_Management_Decisions_Final_3_Jan_2013.pdf

Summary of Needs: Monitoring

Sub-Category	Label	Need Statement
General	M1	Sustained support for monitoring networks that provide observations of weather and hydrologic conditions.
Precipitation	M2	Expanded networks of weather stations in water management regions that are currently served by relatively low station density.
Snowpack	M3	More interactive snow analysis products characterizing basin-distributed snow-covered area and snow-water equivalent
	M4	Expanded networks of snow-observing stations in the Central and Eastern United States.
Streamflow	M5	Preserving and expanding networks of streamflow observations with a focus on streams and rivers that are currently ungauged.

Example Reclamation R&D investment: Airborne Snow Observatory – Value of Information Project (NASA JPL, Reclamation UC/TSC)

- FY13-14 Project:
  - Assess value of (1) improved hydrology model and (2) enhanced snow & dust monitoring w.r.t. spring reservoir operations
  - Basins: Gunnison & San Juan (Colorado)
- Approach
  - Synthetic ASO →
  - Alternative hydrologic forecasting methods
  - ops under each alternative
  - valuation of ops differences

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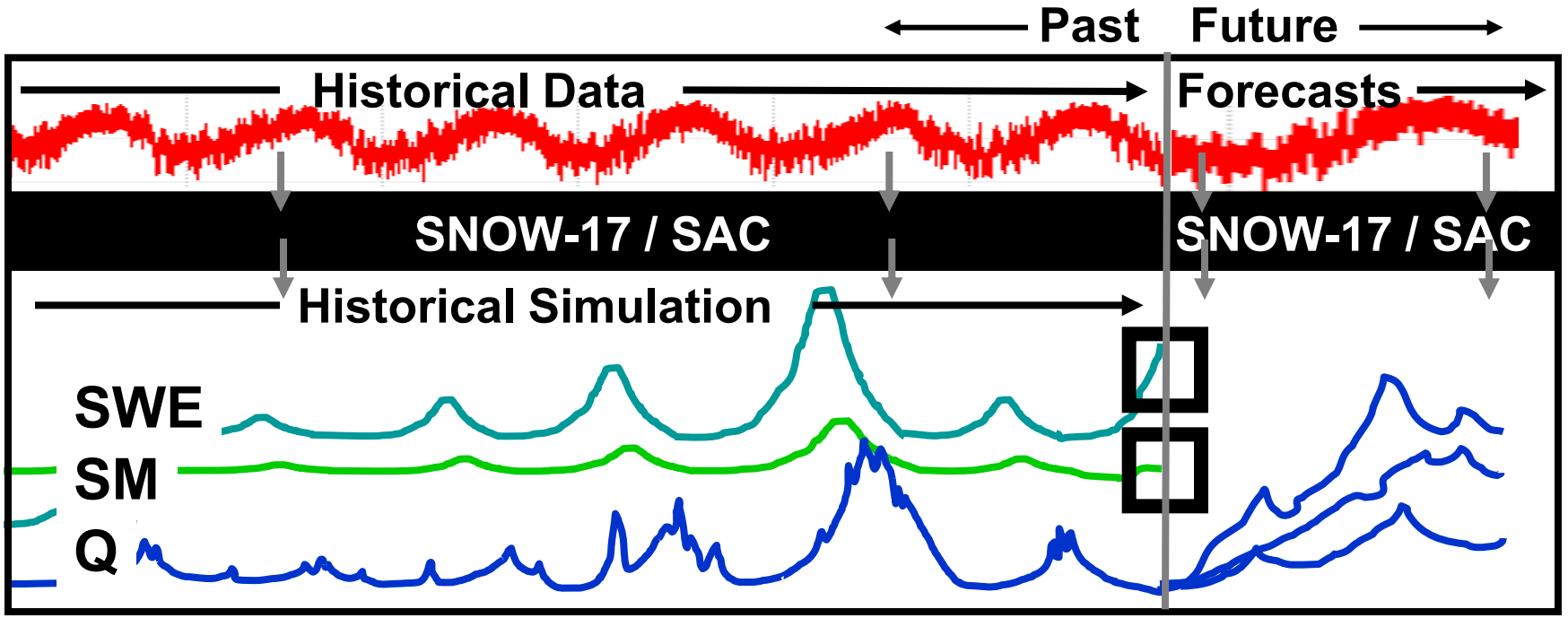
Summary of Needs: Forecasting

Sub-Category	Label	Need Statement
General	F1	Enhanced suite of hydrologic predictions spanning lead -times of days to seasons and consistent with the continuum of weather to climate forecast products.
Precipitation, supporting Fine Resolution Outlooks	F2	More reliable quantitative precipitation forecasts (QPF) on lead times of hours to days.
	F3	Improved precipitation forecasts for landfalling storms in coastal areas.
Streamflow, supporting Fine Resolution Outlooks	F4	Enhanced streamflow predictions on lead times of hours to days, particularly during storm events.
Streamflow, supporting Med. Resolution Outlooks	F5	Enhanced streamflow predictions on lead times of days to weeks, particularly during the snowmelt season
Runoff Volume, supporting Coarse Resolution Outlooks	F6	Improved anticipation of runoff volumes during lead times of months to seasons.
Water Level	F7	Enhanced prediction products characterizing potential water levels during storm events.
Other Hydroclimate	F8	Multi-variate suite of climate to hydrologic predictions that comprehensively characterizes the state and evolution of basin hydrologic conditions on lead times of days to seasons.

Example Reclamation R&D Investment: Streamflow Predictability Project (NCAR RAL, USACE, Reclamation R&D/TSC; FY13-15)



Uncertainties	Method(s)	Impact
Model inputs	Probabilistic quantitative precipitation estimation	Initial Conditions
Hydrological Model	Perturb model states Multiple parameter sets Multiple model structures	Initial conditions Forecasts
Weather/Climate Forecasts	Ensemble forecasts (the seamless suite)	Forecasts

Example Reclamation R&D Investment: Streamflow Predictability Project (NCAR RAL, USACE, Reclamation R&D/TSC, FY 13-15)

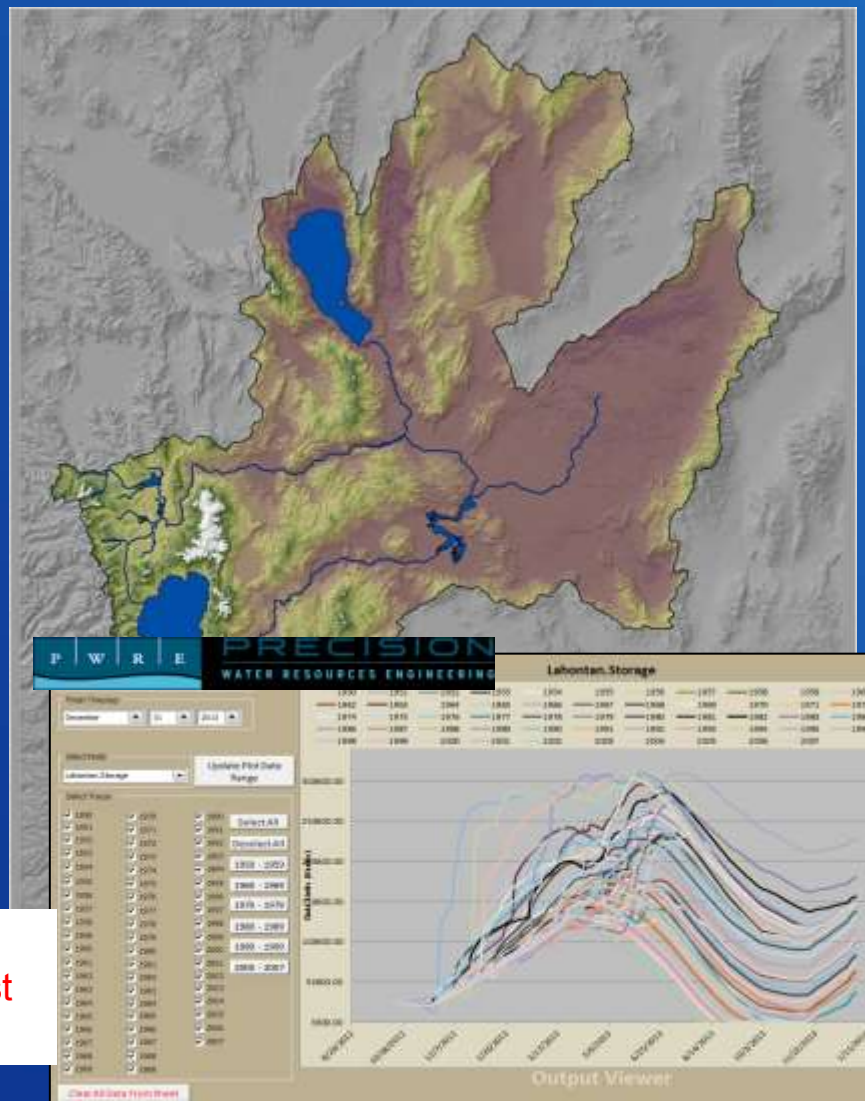
- Assess performance of current hydrologic models used by the NWS, and assess dependence of model performance on
  - Physical characteristics of the basins (climate, vegetation, soils, topography)
  - Reliability of quantitative precipitation estimates (e.g., station density, radar)
- Assess the relative importance of hydrologic and meteorological/ climatological information in determining forecast skill
- Conduct research to improve estimates of uncertainty
  - During model spin-up
  - During the forecast period
- Conduct research to reduce forecast uncertainty
  - Better hydrologic models
  - Better weather forecasts and climate outlooks
  - Adoption of hydrologic data assimilation methods and statistical post-processing methods
- Examine impact of different sources of uncertainty in water management decisions

Summary of Needs: Understanding on Product Relationships and Utilization in Water Management

Sub-Category	Label	Need Statement
Information on Product Development and Qualitative Attributes	U1	More detailed meta-information describing product skill, reliability, and development.
Information Synthesis	U2	Guidance on how to synthesize available hydroclimate information relative to its collective applicability to water management situations.
Education on Water Management and Forecasting Principles	U3	Training resources on water management principles spanning multiple time-scales.
	U4	Training resources on probabilistic forecasting principles and risk-based decision-making.

Example Reclamation Regions Applications: Developing “Ensemble Operations Outlooks” (Riverware community; UC & MP)

- Goal: Expand capacity to explore hydrologic scenarios and communicate operational uncertainties
- Develop model that emulates operator sensibility
  - information synthesis
  - consideration of management requirements and constraints
  - discretionary target setting for storage, release, deliveries, etc
- Model is like “Mapquest”, not a blind optimization tool



(e.g., Truckee/Carson Basins, Oct 2012 outlook for WY 2013: 11 of 58 (19%) forecast traces show shortage on Newlands Project)

Summary

Questions?
lbrekke@usbr.gov

- NOAA-Reclamation Drought Meeting
  November 6-7, 2012
  - Users interested in enhanced hydrologic monitoring + improved prediction (seasonal runoff; sub-seasonal climate and runoff during spring)

- CCAWWG “STdoc“, Reclamation efforts
  - Report describes community needs related to improving hydroclimate information (monitoring + forecasting) and how we make use of it (www.ccawwg.us)
  - Reclamation R&D and Regions are investing in efforts to address various needs, but a community response will be required to fully realize improved prediction skill and/or approaches for making use of available hydroclimate information

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