# Application of a Physically-Based Distributed Snowmelt Model in Support of Reservoir Operations and Water Management

*and*

# Enhancing Predictions of Climate Change Impacts on Snow Distribution and Melt Patterns in the Mountain West

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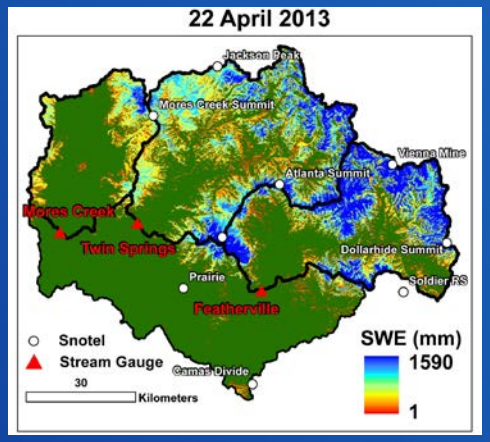
# Application of a Physically-Based Distributed Snowmelt Model in Support of Reservoir Operations and Water Management

## Gap(s) Addressed

- Operational snowmelt-driven streamflow forecasts are largely statistics-based
- Readily available remote sensing data can determine where the snow is but cannot resolve SWE or snow state (susceptibility to melt)
- PBDSMs provide high resolution SWE and melt distributions, robust to non-normal conditions and non-stationary climate

## Graphic




Near real-time, distributed SWE at 100m resolution from a physically-based energy- and mass-balance snow model

## Research Question(s)

1. Can a high-resolution, physically-based snow accumulation and melt model deliver timely and accurate products in a large, operational setting?
2. Can these near real-time products (e.g. distributed SWE, snowcover state, and short-term predicted streamflow) improve reservoir management outcomes?

## Collaborators/Schedule/Source of Support

- Bureau of Reclamation, USDA-ARS, NCAR, NRCS, University of Idaho, Boise State University
- FY2013: Snow Model Proof of Concept
- FY2014: Coupling of snow and hydrologic models
- FY2015: Ingestion of short-term weather forecasts for streamflow forecasts

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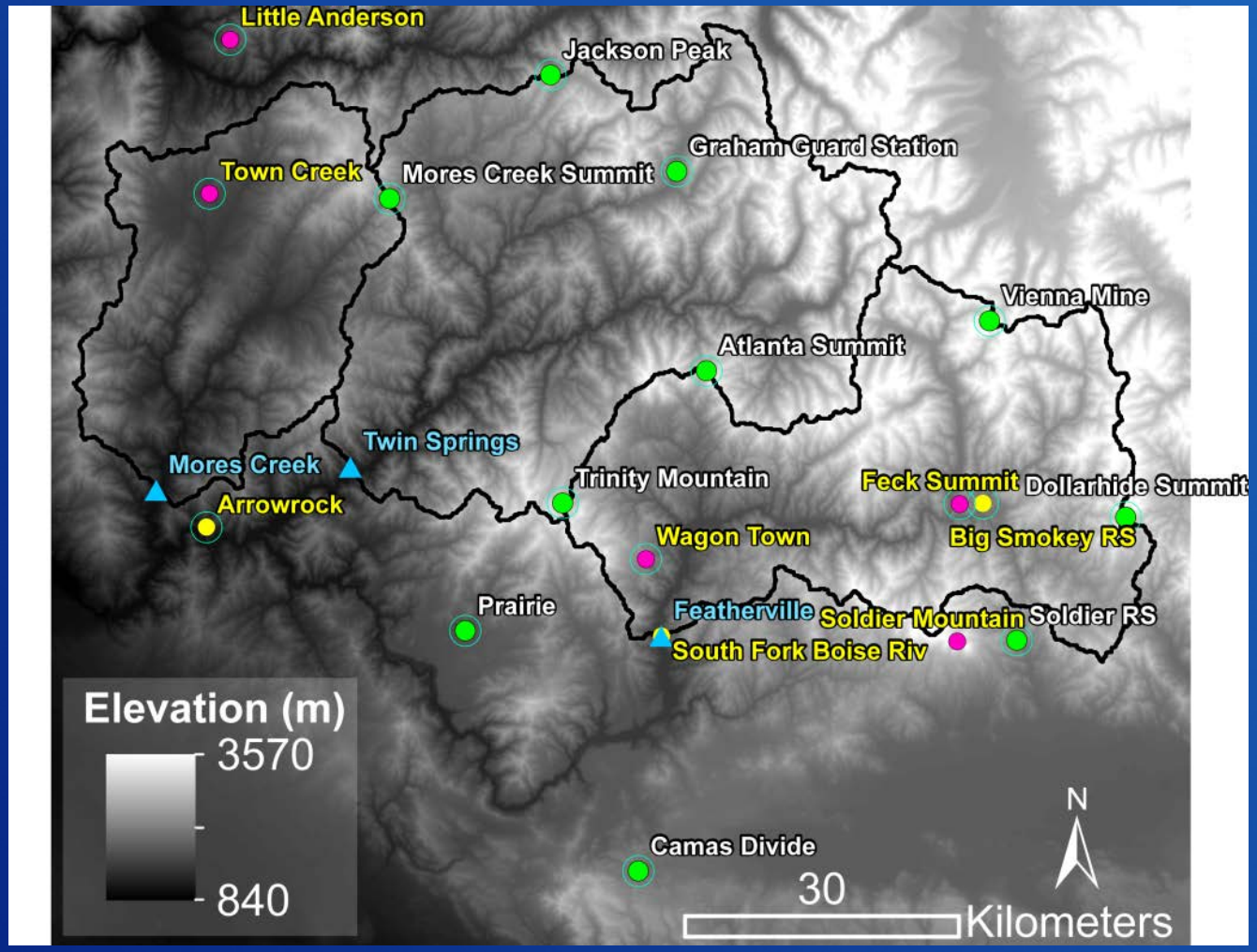
# Boise River Basin

## Three Major Reservoirs

## Total Storage Capacity: 950,000 acre-feet (1.2 km$^3$)

## ~13,000 km$^2$

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# Modeling Description

- Mass and Energy-Balance Snow Model
  - *Isnobal* (Marks et al., 1999)
- All forcings derived from ground-based observations
- ~13,000 $km^2$ modeling domain
- > 1.2 x $10^6$ grid elements
- Hourly mass and energy calculations, 100 meter pixels

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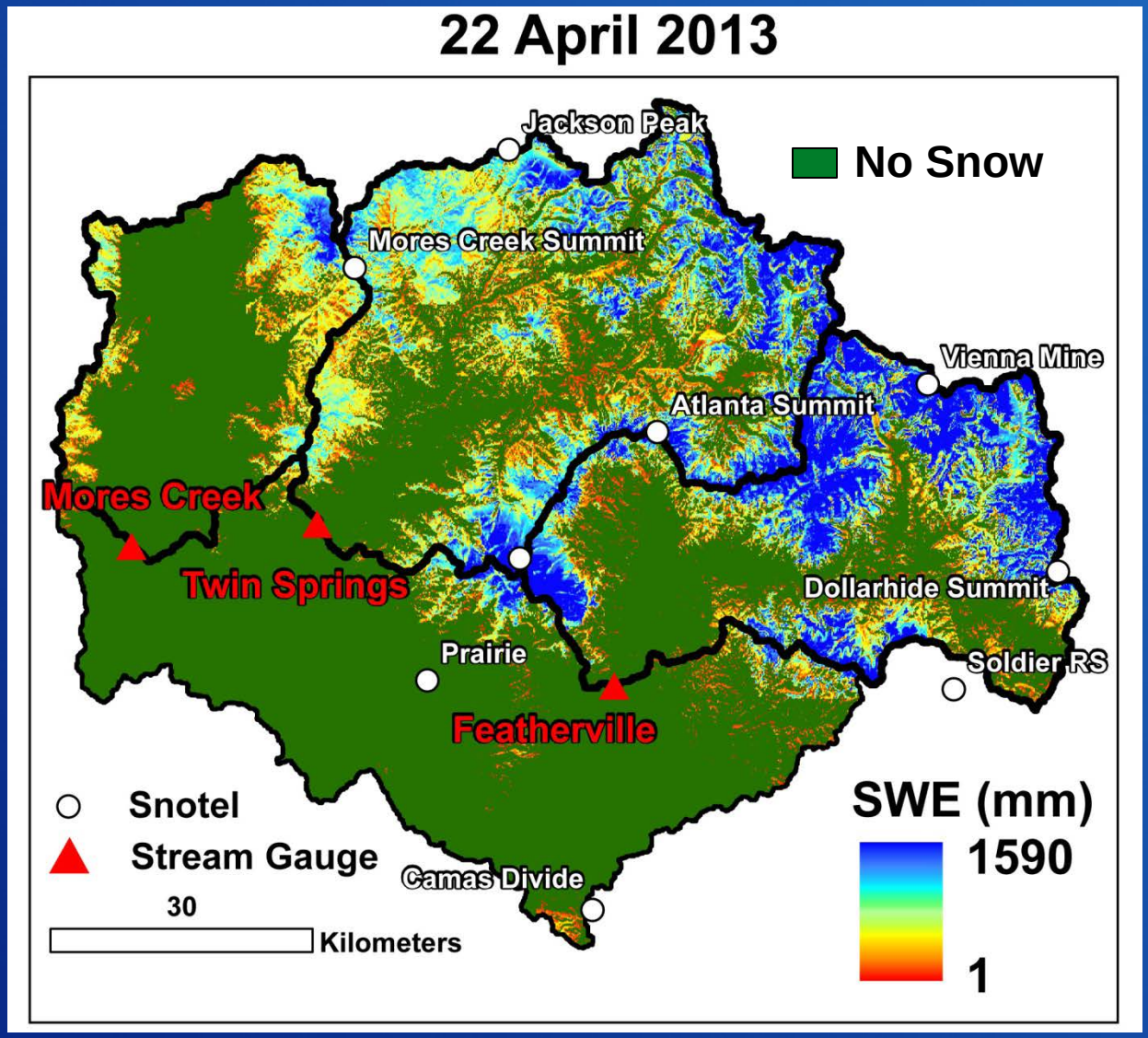
# Products: Distributed SWE

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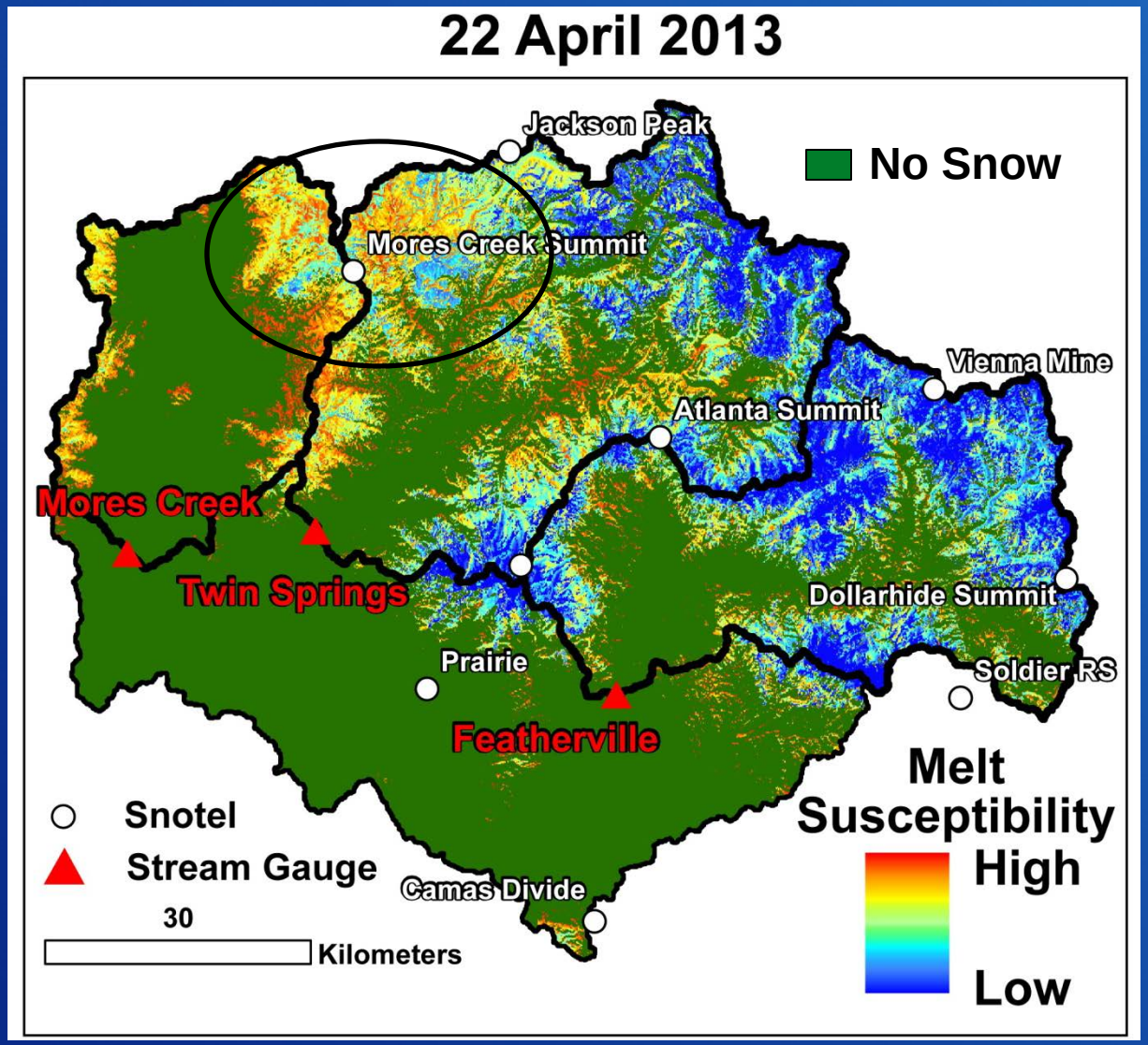
# Products: Melt Susceptibility

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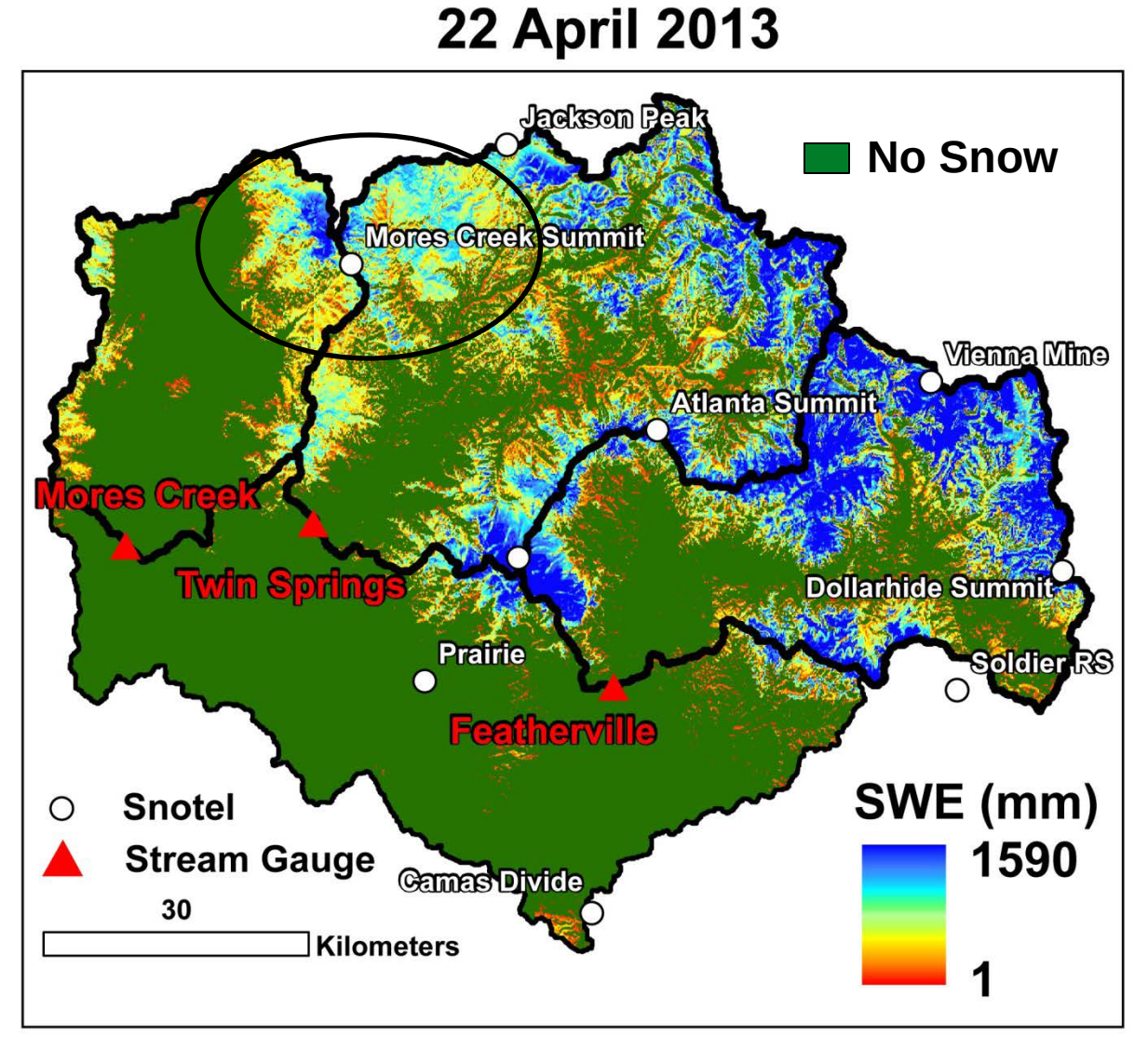
# Products: Distributed SWE

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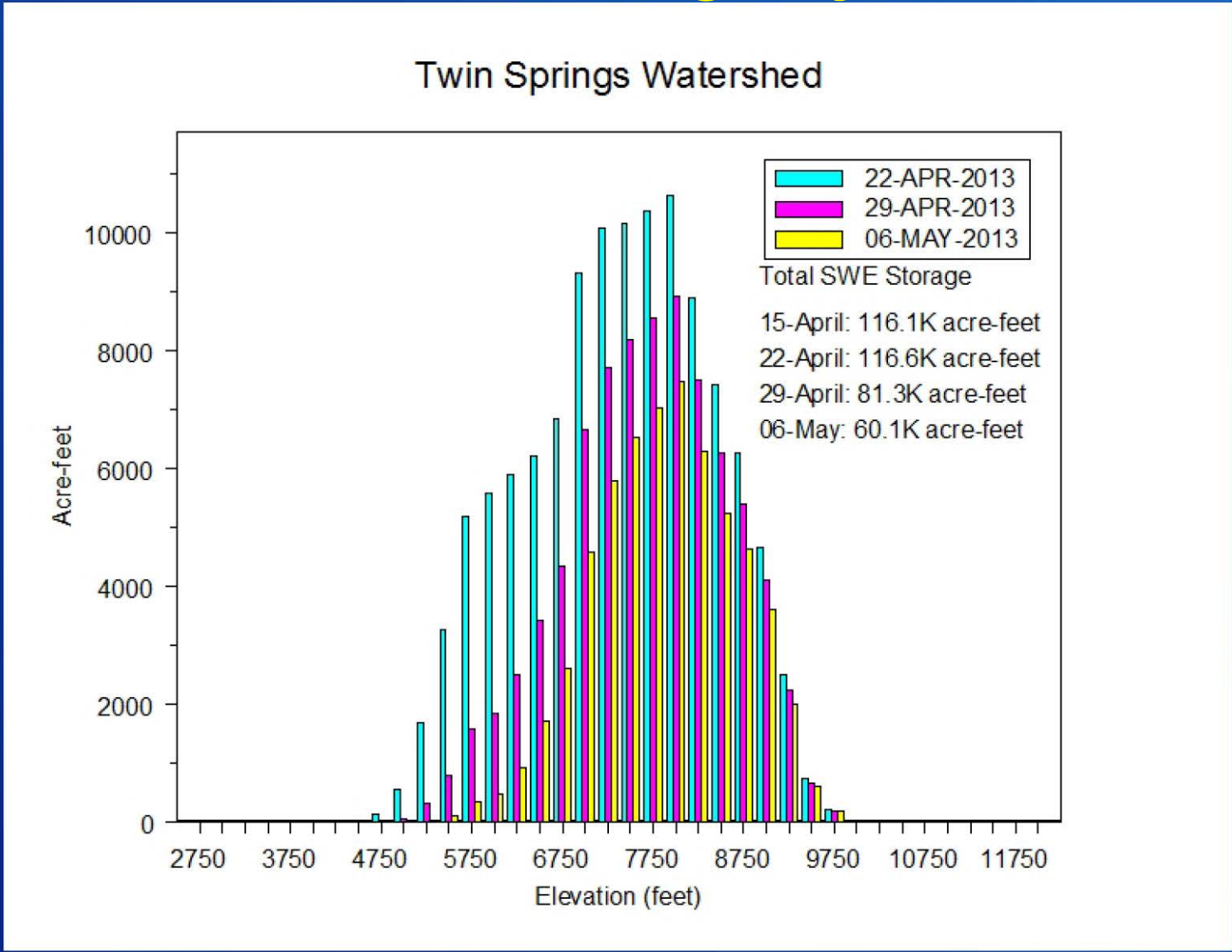
# Products: SWE Storage by Elevation

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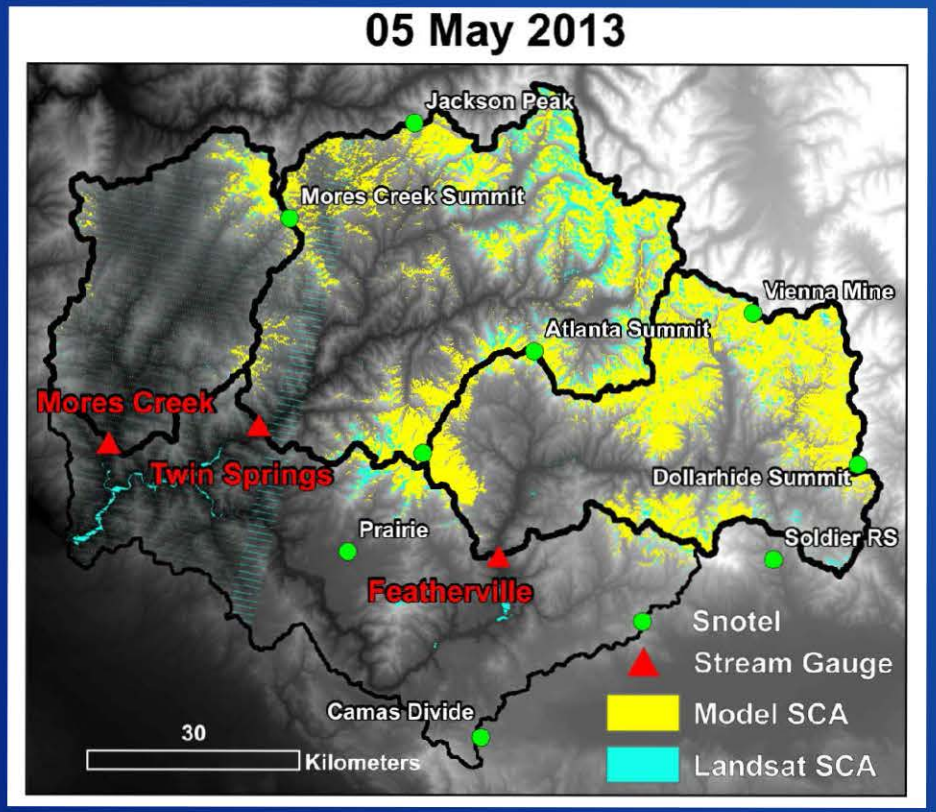
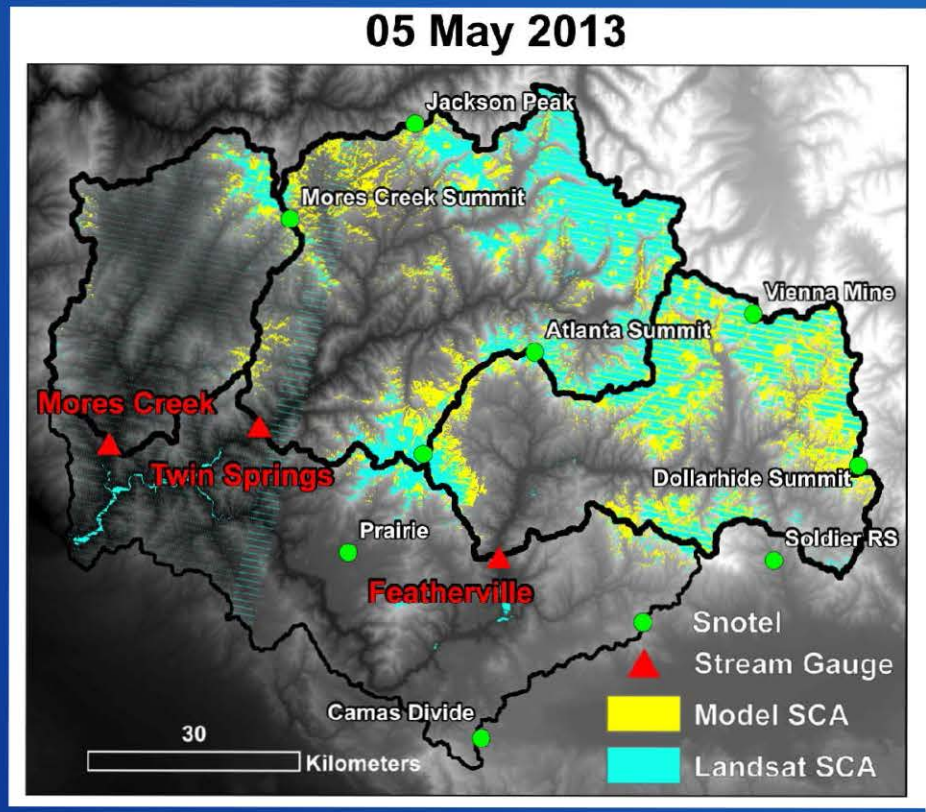
# BRB: Observed and Modeled SCA

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# Application of a Physically-Based Distributed Snowmelt Model in Support of Reservoir Operations and Water Management

## Summary

**A detailed mass- and energy-balance snow model was successfully applied in an operational setting**

## Key Lessons Learned

- **Observational Data Concerns**
  - Quality
  - Representativeness
- **Can weather models aptly fill observational data gaps?**

## Next Steps/Future Work

**FY2014: Coupling of *Isnobal* to hydrologic/routing model to evaluate streamflow simulations**

**FY2015: Automated ingestion of short-term weather forecasts from WRF for short-term runoff forecasting**

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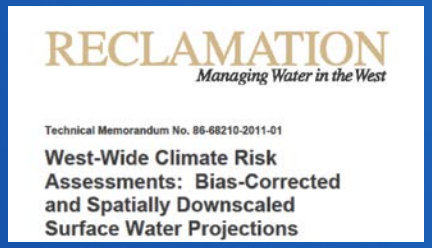
# Enhancing Predictions of Climate Change Impacts on Snow Distribution and Melt Patterns in the Mountain West

## Gap(s) Addressed

- West-Wide Climate Risk Assessments by necessity have applied large-scale models with simplified model representations (e.g. VIC)
- Calibration and scale issues introduce potential biases and errors particularly when evaluating non-stationary conditions such as climate change

## Graphic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Managing Water in the West

Technical Memorandum No. 86-68210-2011-01

West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections

*"Lack of calibration of the hydrologic models is a real issue that needs to be addressed and should be addressed before these models are used in future assessments. Reclamation will (a) refine the VIC application and/or (b) introduce more appropriate hydrologic models."*

## Research Question(s)

1. How are VIC model outcomes related to process parameterizations and calibrations, scale and model structure?
2. What improvements can be gained by more rigorous calibration?
3. What improvements can be obtained with fine-scaled depictions with greater physical representation?
4. How can future projections of the effects of climate change on streamflow patterns in the Western U.S. be improved?

## Collaborators/Schedule/Source of Support

- Bureau of Reclamation, USDA-ARS, NCAR, USDA-NRCS, University of Idaho, Boise State University
- Three year project commencing FY2014

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