Developing and Transitioning Research Tools for Operational Applications

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USDA-Agricultural Research Service

Boise, Idaho

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Idaho Water Supply Outlook Meeting

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Outline

- iSnobal
  - Overview
  - Operational use
- From research to operations
  - Long term model runs
  - Build new forecast relationships
- A plan going forward

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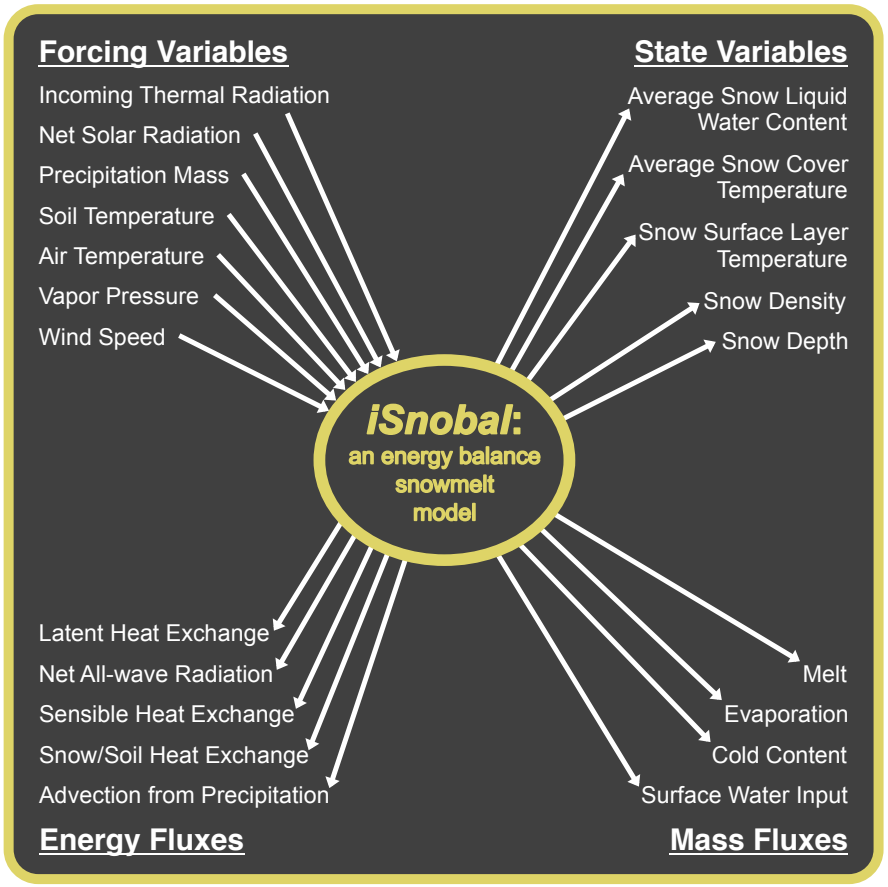
iSnobal Overview

- Physically based snow model (Marks et al. 1999)
- Varying spatial and temporal resolution
- Easily handles rain and rain on snow events
  - Important for flood forecasting
  - Risk management and mitigation
- Input data
  - Air temp, RH, precipitation, wind, radiation
  - New framework for developing forcing data (SMRF)



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Why hasn't iSnobal been implemented yet?

- Limits to development of forcing data
- Computational limits on running iSnobal

This effort is possible because we have addressed and solved these problems

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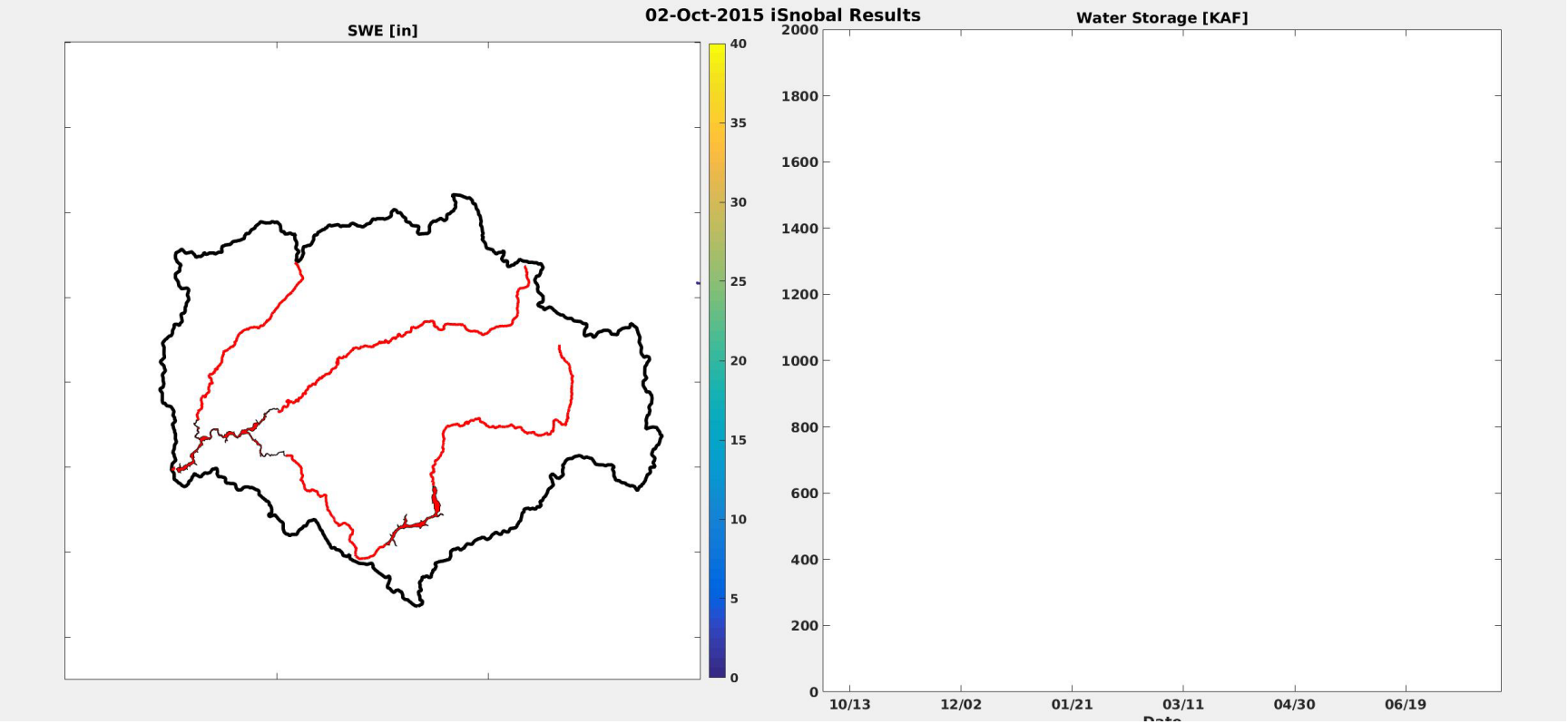
This effort is possible because we have addressed and solved these problems

- Solved the forcing data problem – a 200X improvement!
- I/O and parallel improvements in model software – a 10-20X improvement!
  - All the improvements were made possible by the work in Idaho with USBR and NRCS

Operational Application
WY 2016 Boise River Basin



SMRF and iSnobal now make it operationally feasible to run a physically based model at large scales

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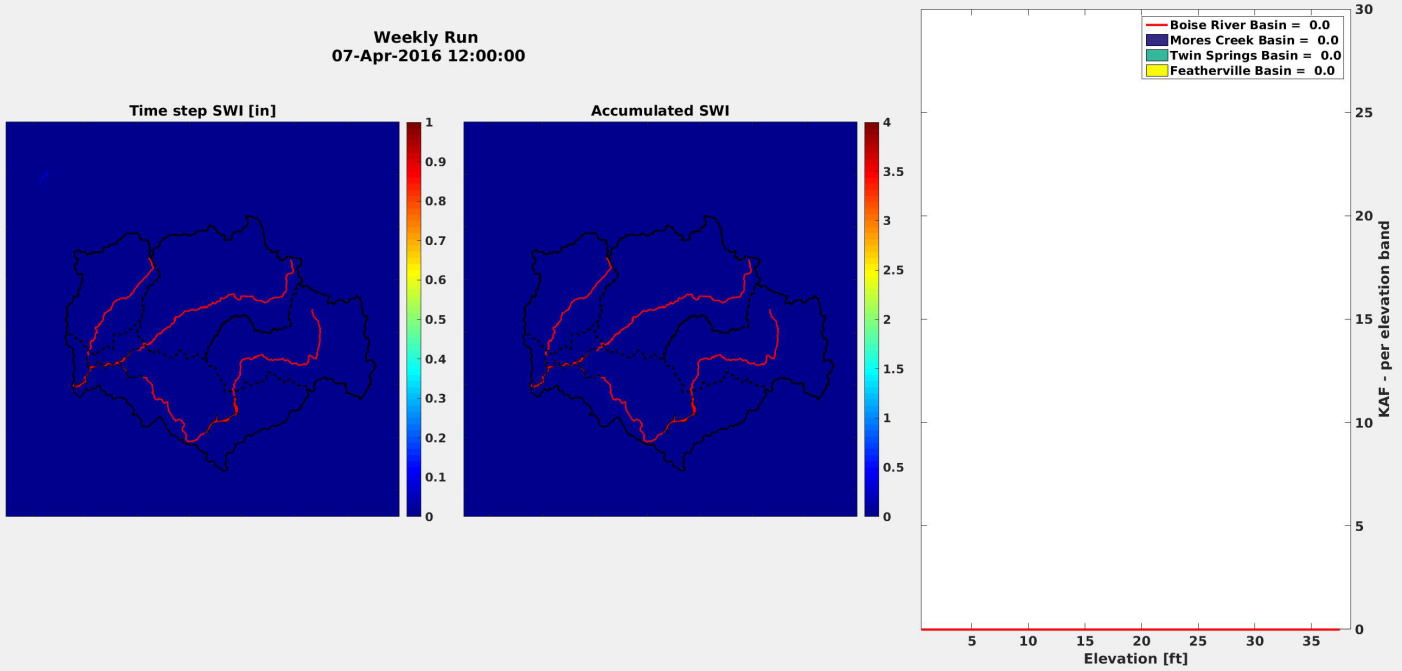

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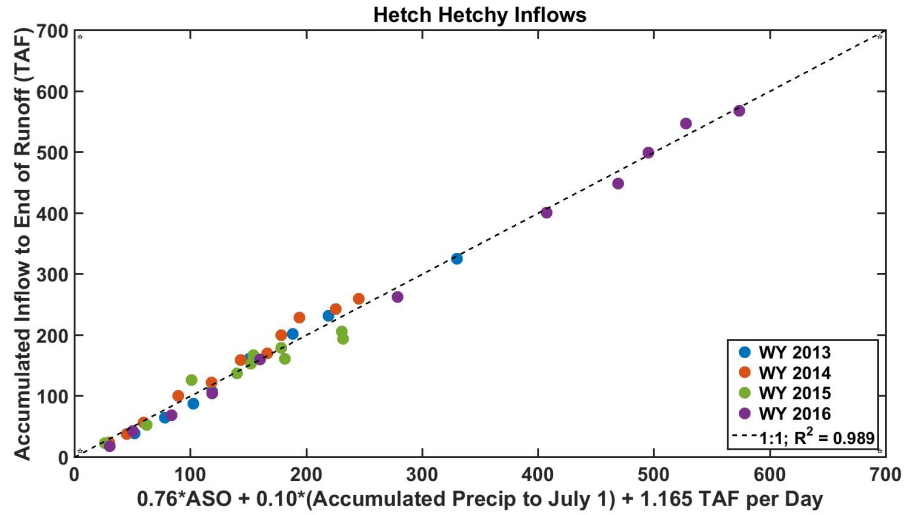
Long Term Runs

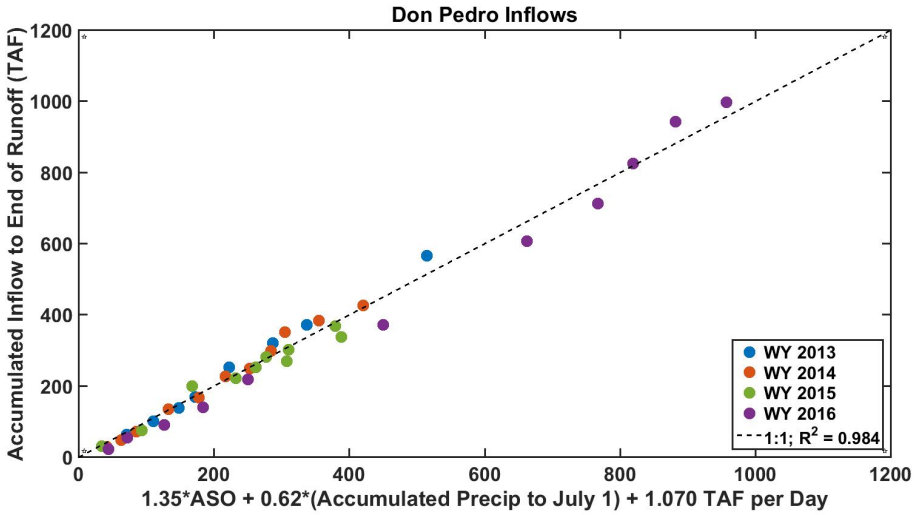
First Goal:

Extend current statistical methods of relating limited point measurements to streamflow

Reason:

Easy transition





From Chris Graham

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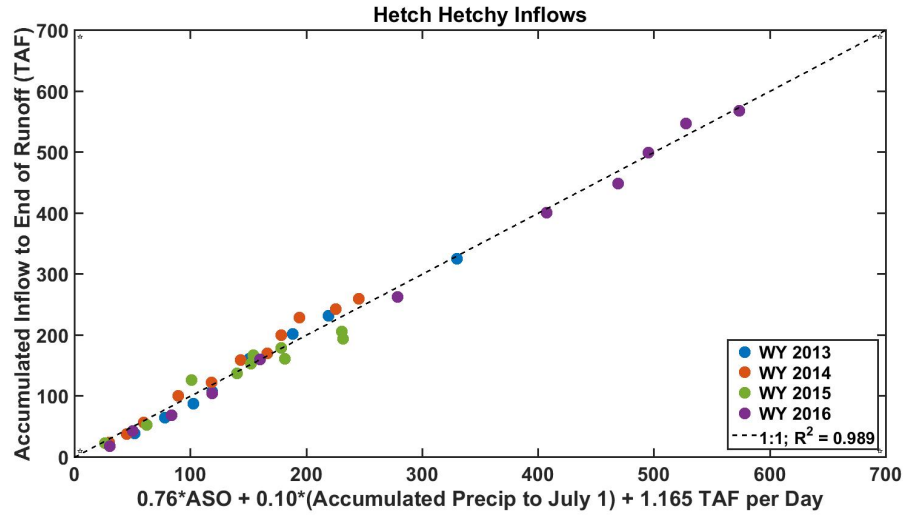
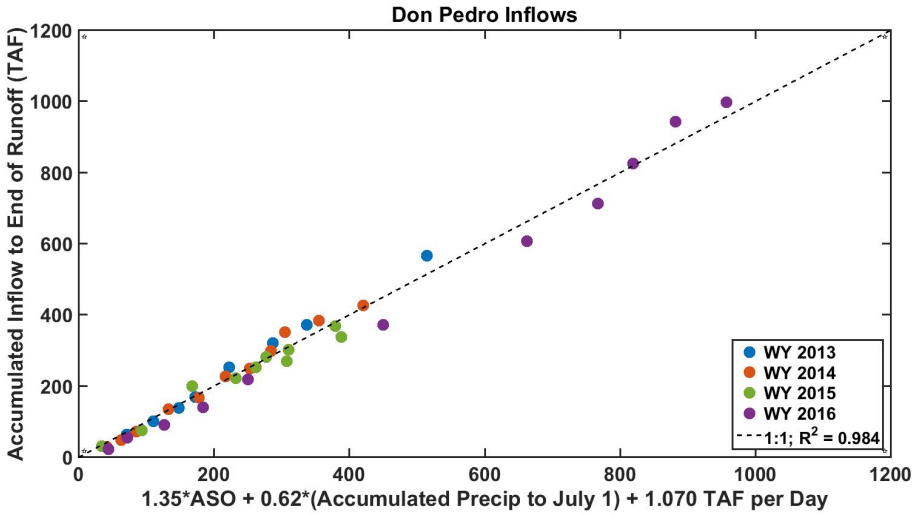
Long Term Runs

- Develop new statistical relationships
  - Distributed model results to measured streamflow
  - 2.25 million model points to 12 SNOTEL locations
- Spatial information improves the accuracy of the water supply forecast
  - Will do better than current statistical methods





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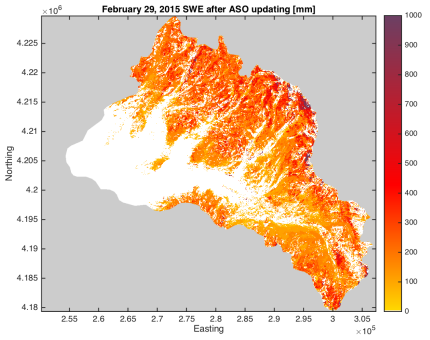
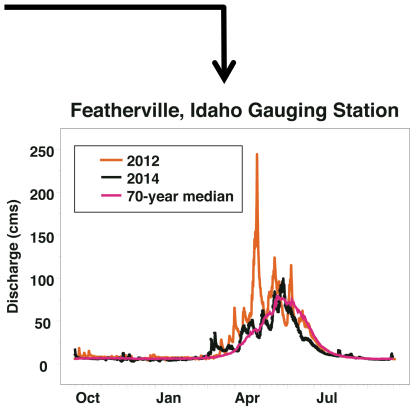
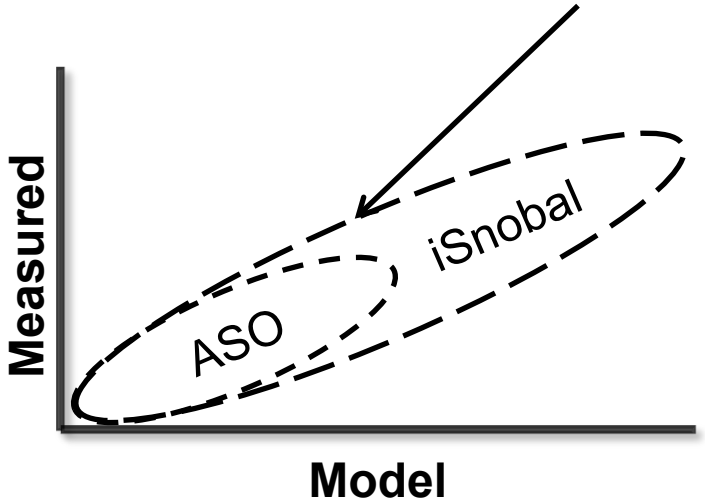
Long Term Runs: Run SMRF/iSnobal

- For the past 15 years
  - Run iSnobal
- Analyze the forcing data and model outputs
  - Build new relationships
  - Based on 15 years instead of 4
- **Massive** support from water managers to build these new relationships
  - Bridges the gap from current methods to the new methods
  - Make decisions with less risk

Model results







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Technology Transfer

- Product improvement
- Testing with end users for implementation
- Begin transitioning products to operational users

- Run new products parallel with old methods
- ARS will provide support on implementation
- Tuning products to the application

- Parallel testing complete
- Full implementation of new water supply forecasting

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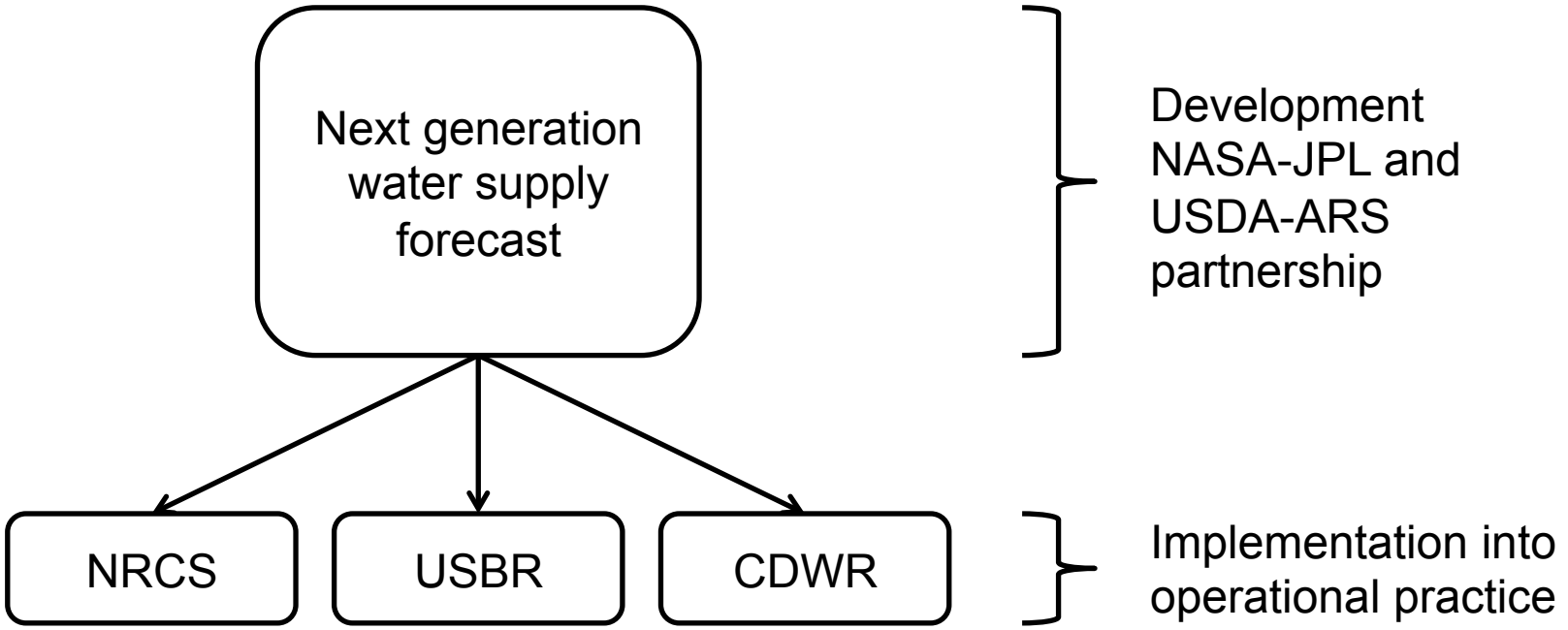
The Partnerships



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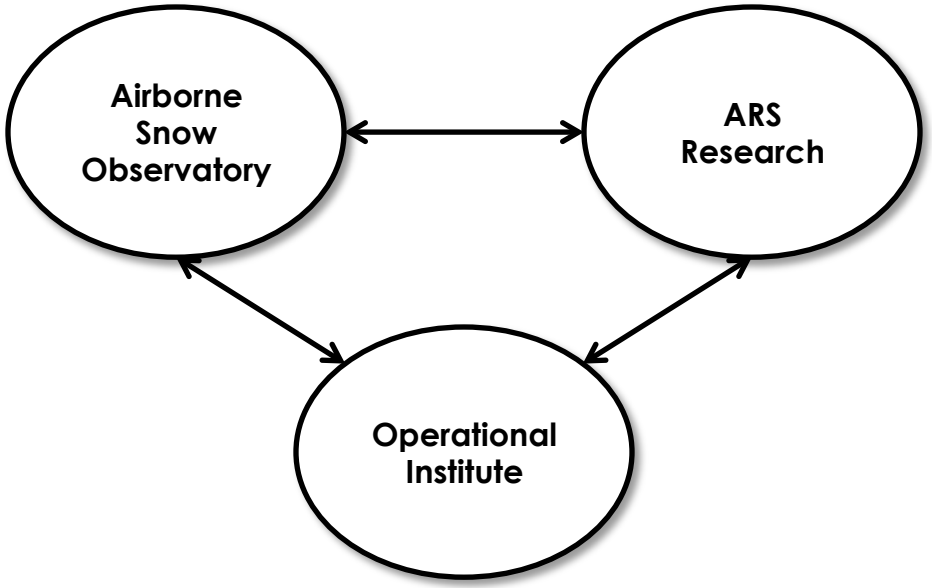
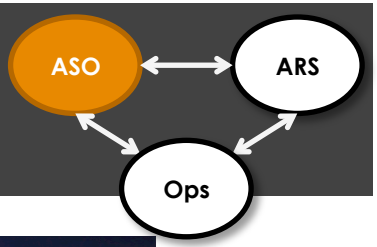
Overall Project Stucture

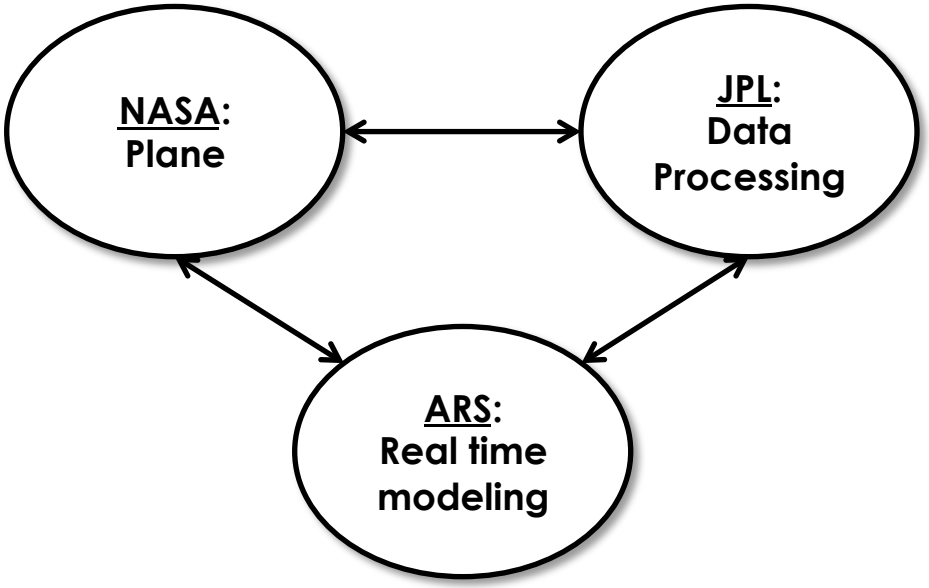


- Airborne Snow Observatory (ASO)
  - Lidar over flights measure snow height multiple times per winter
  - Combine with ARS modeled snow density
  - Produce snapshot of basin SWE
- ARS Research
  - Model research and development
  - Develop new forecasting methods
  - Develop improved physically based models
- Operational Institute
  - Provides operational products to stakeholders
  - Delivers snapshots of basin SWE
  - Operational application of ARS research developments

Airborne Snow Observatory



- Partnership between NASA-JPL and USDA-ARS
- Close to becoming fully operational
- Large support for biweekly flights in numerous CA basins
- Aimed at improving information for CA Department of Water Resources



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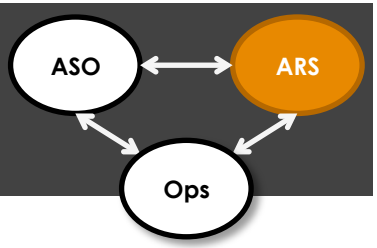
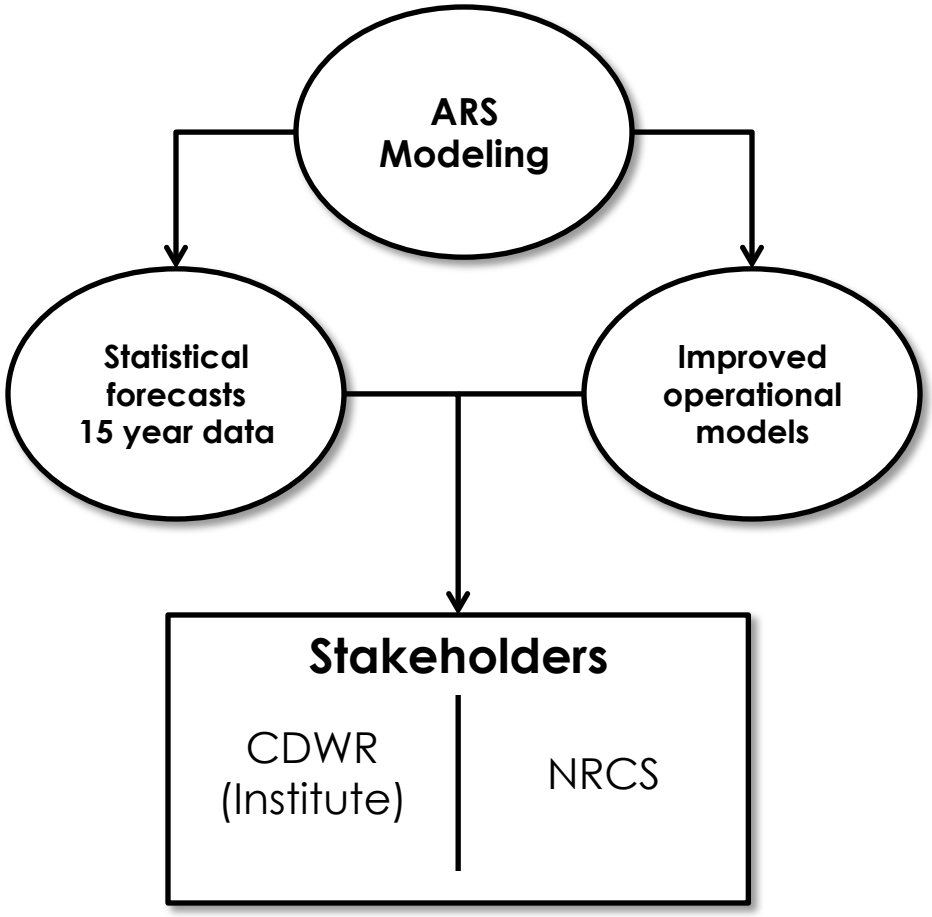
ARS Research



- Developing new forecast methods
  - Based on physically based models
- Develop 15 year datasets
  - Run iSnobal and hydrology model
- Produce new statistical forecasts from distributed model results
  - Aims to redo current methods
  - Ensures easier transition for operational users
- Provide improved physically based models
  - Pass to operational users for application



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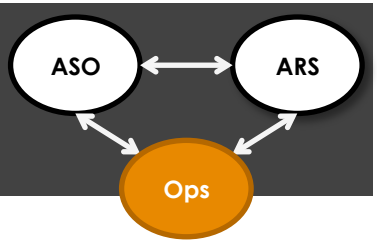
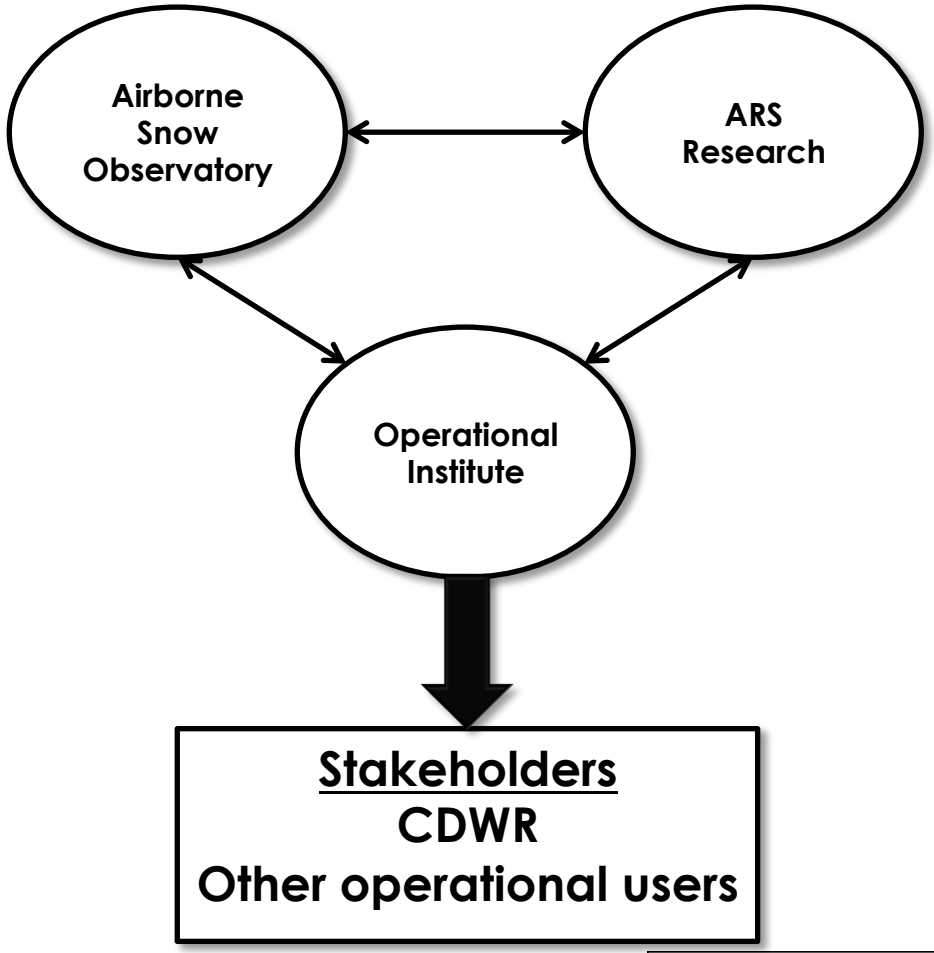
Operational Institute



- Critical infrastructure necessary for long term technology transfer:
  - Modeling
  - Over flights
- Implements the ARS research in operational mode
  - Transition all research within 10 years
- Uses ASO measurements and ARS models to provide operational modeling



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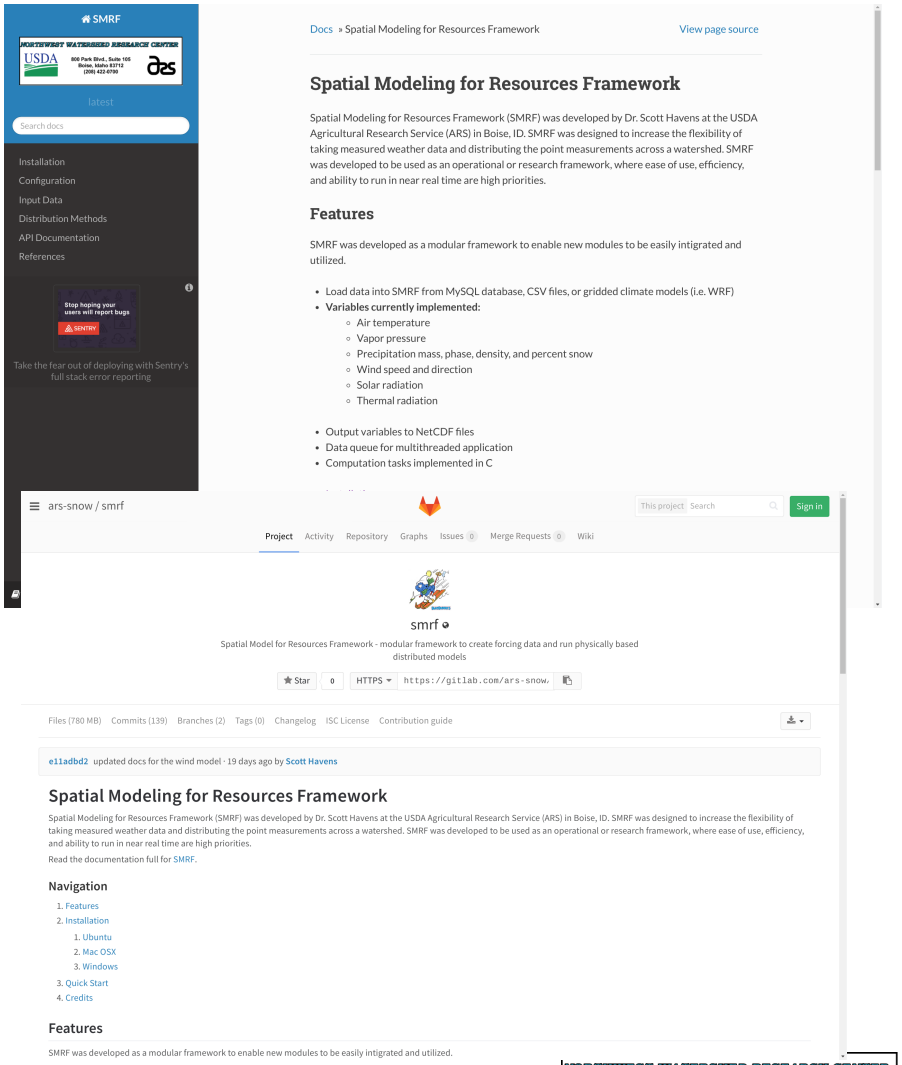
For those interested

Goal is to make everything available so it's easy to run physically based snow models

- Looking for users interested in testing
  - SMRF
  - iSnobal
- Real time model simulations
- Estimating climate variables
  - Precip, temp, dew point, etc..
- Potential forecasts
- Hope to have a running snow model in under 4 hours
  - (Minus data correction…)



Questions?

Sign up for WY2017 BRB reports!

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NRCS Natural Resources Conservation Service

U.S. Department of the Interior Bureau of Reclamation

BOISE STATE UNIVERSITY

State of California

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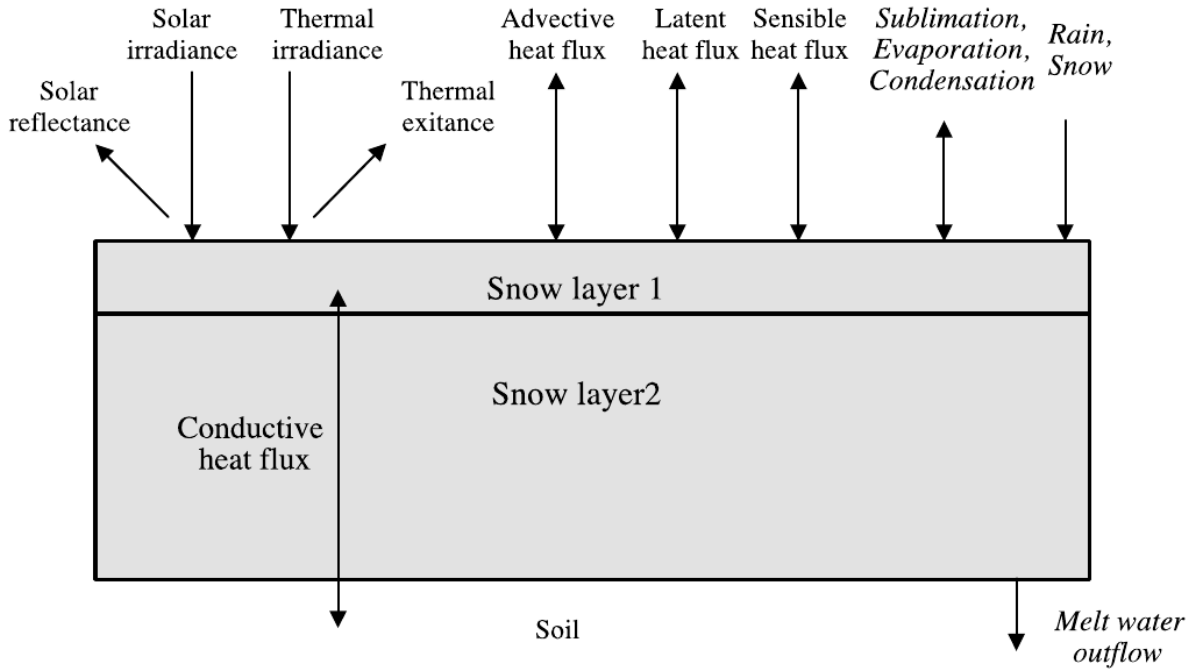
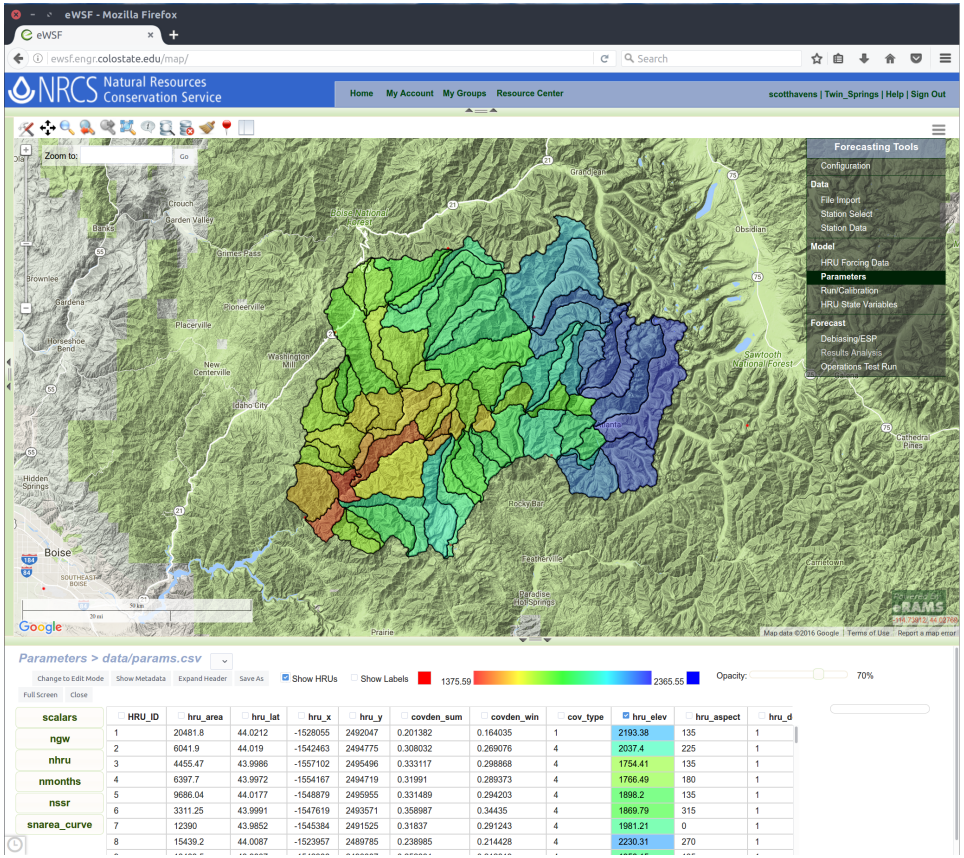
iSnobal Overview



- 2 layer snowpack, energy transfer with atmosphere from surface layer
- Melt is calculated from thermal state of snowpack (cold content)
- Snow Water Input (SWI)
  - Melt water drainage or rain on bare soil

Future Work: PRMS

- Currently establishing methods for a “base line” PRMS run
  - Allows comparison for improvements
- Distribute forcing data with SMRF (climate_hru)
- Replace the snow module
  - iSnobal snow water input and route to streamflow
  - Removes a significant number of calibrated parameters



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Long Term Runs: Ensembles

- Need uncertainty
  - Regulatory agencies face litigation over water supply
  - Make decisions with less risk
- Big data problem
  - Have to place bounds on the results
- With SMRF/iSnobal link
  - First ever ensemble run of physically based model at these scales
- Only model output:
  - ~500 TB for 100 runs/yr
  - Current ARS HPC has only 1.2 PB

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