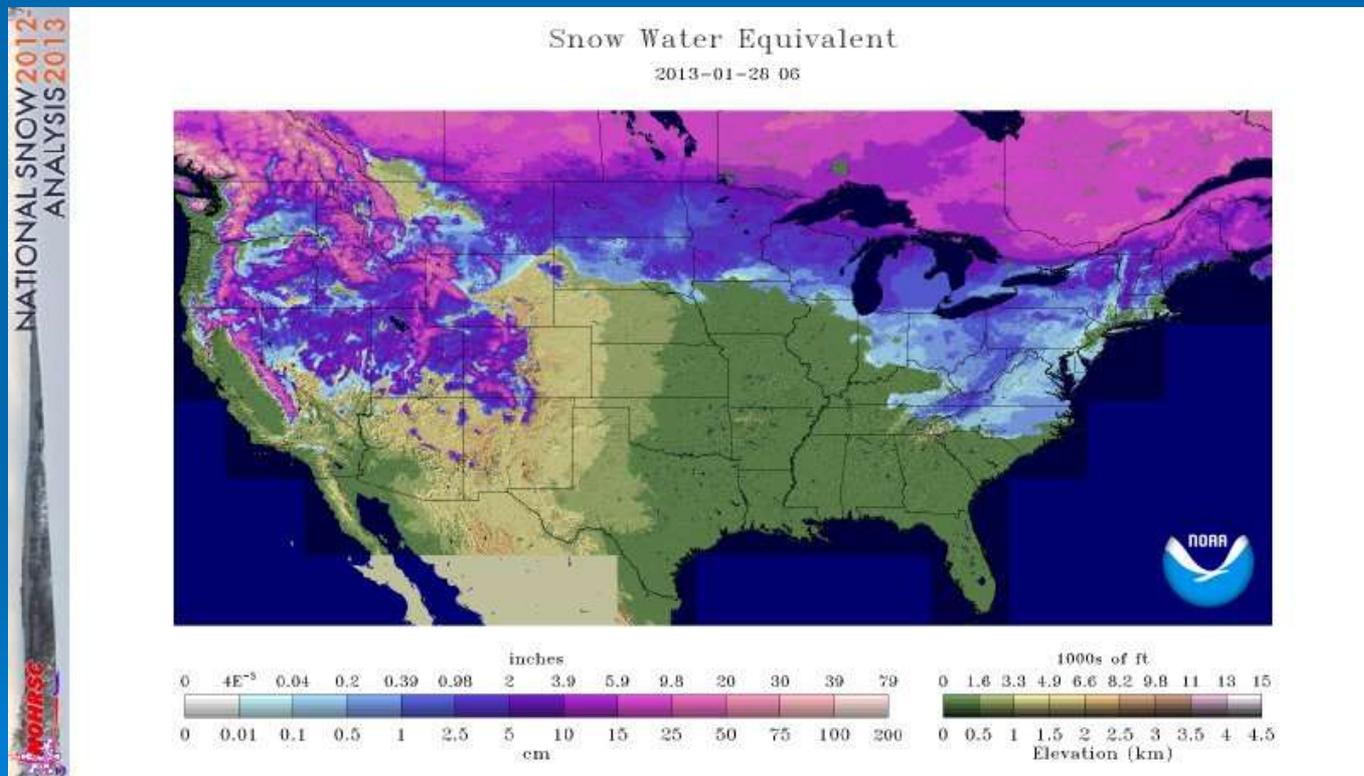


Evaluation of SNODAS Snow Depth and SWE

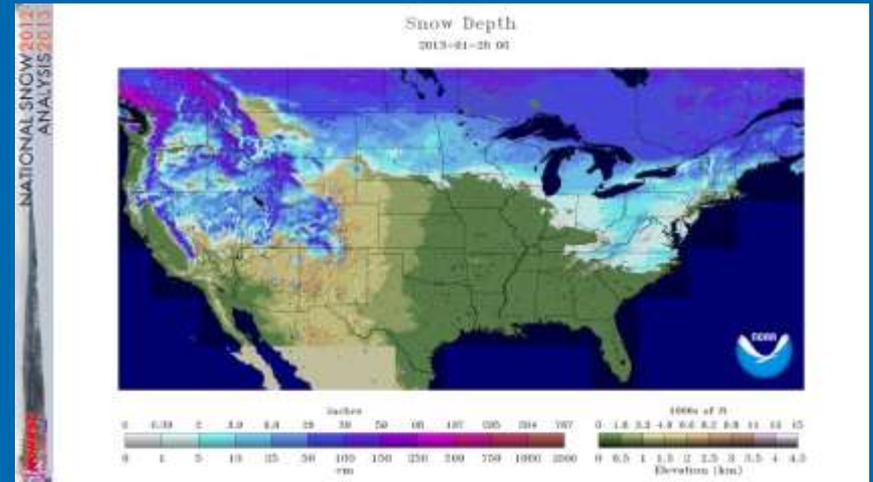
D.W. Clow, L. Nanus, K. Verdin, J. Schmidt



Funding provided by CWCB

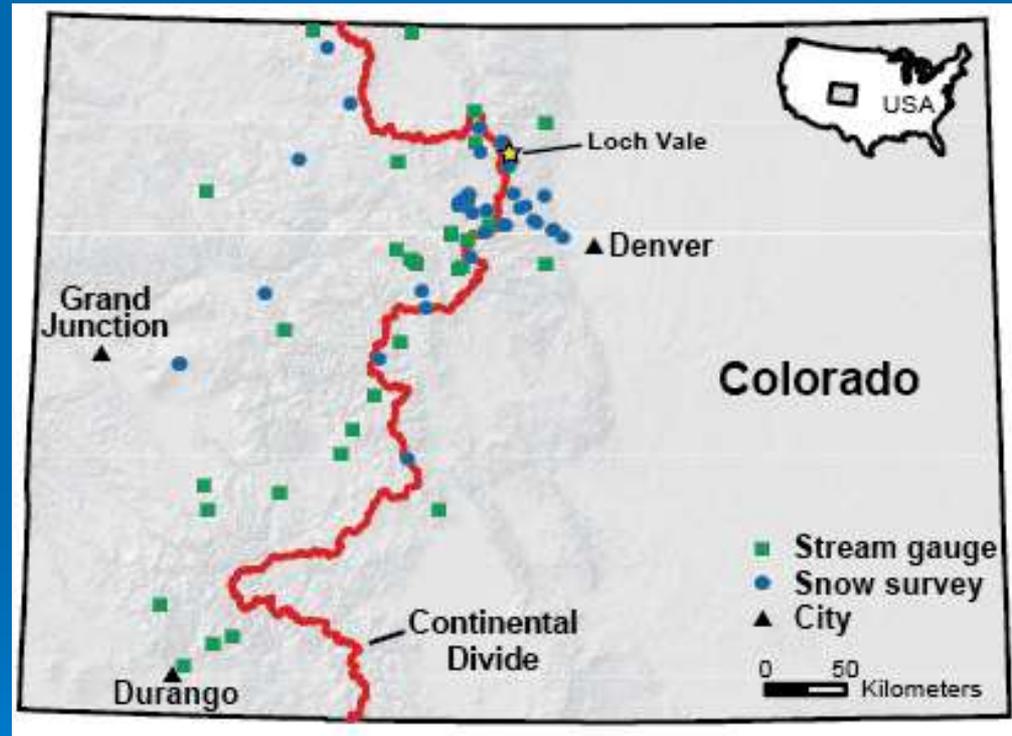
What is SNODAS?

- SNOW Data Assimilation model
- NOAA - NWS
 - www.nohrsc.nws.gov/nsa/
- Daily estimates of snow depth, SWE, ...
- 1 km resolution for conterminous U.S.



Problem and Approach

- Problem:
 - Little data left for validation
- Approach:
 - Snow Surveys
 - Water-Balance Calculations
- Solutions?

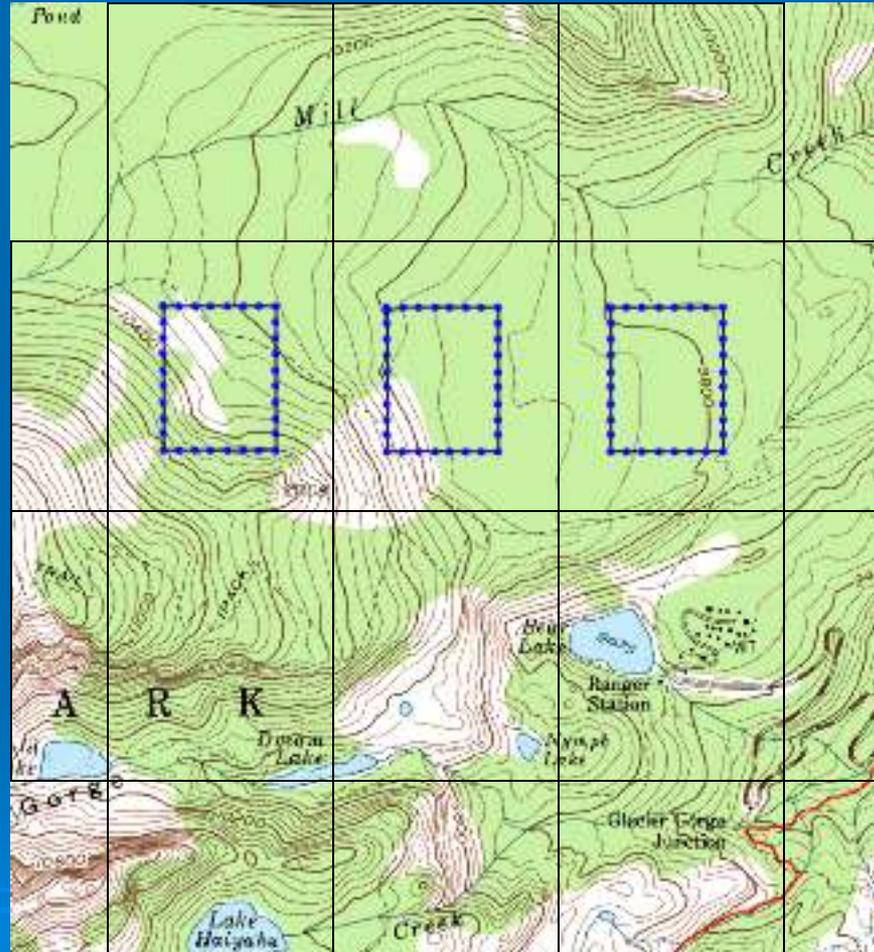


Snow Surveys

➤ Snow Depths

- Snow depth at ~40 points/grid

- ~50 sites



Snow Surveys

➤ Snow Depths

- Snow depth at ~40 points/grid
- Snow density in pits



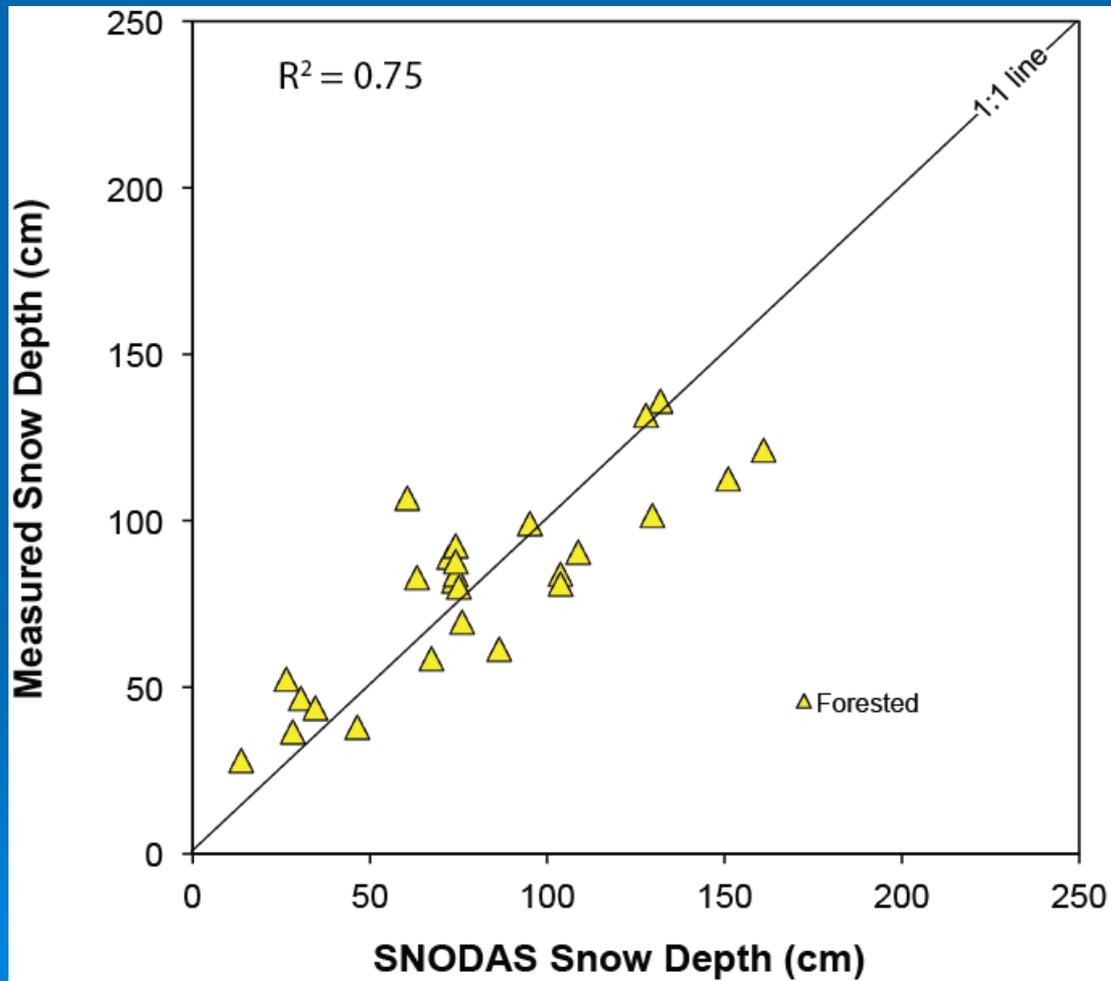
Snow Surveys

➤ Snow Depths

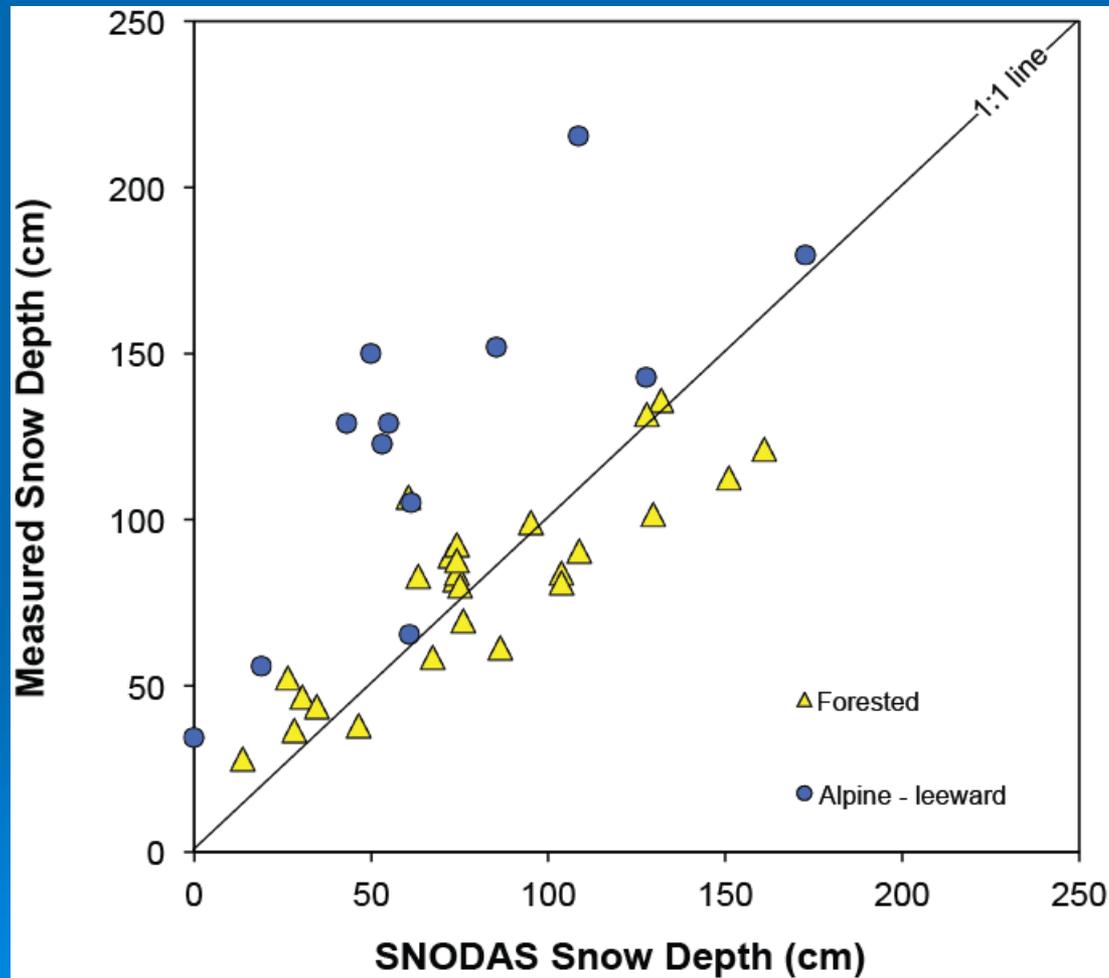
- Snow depth at ~40 points/grid
- Snow density in pits
- $SWE = \text{Depth} \times \text{Density}$



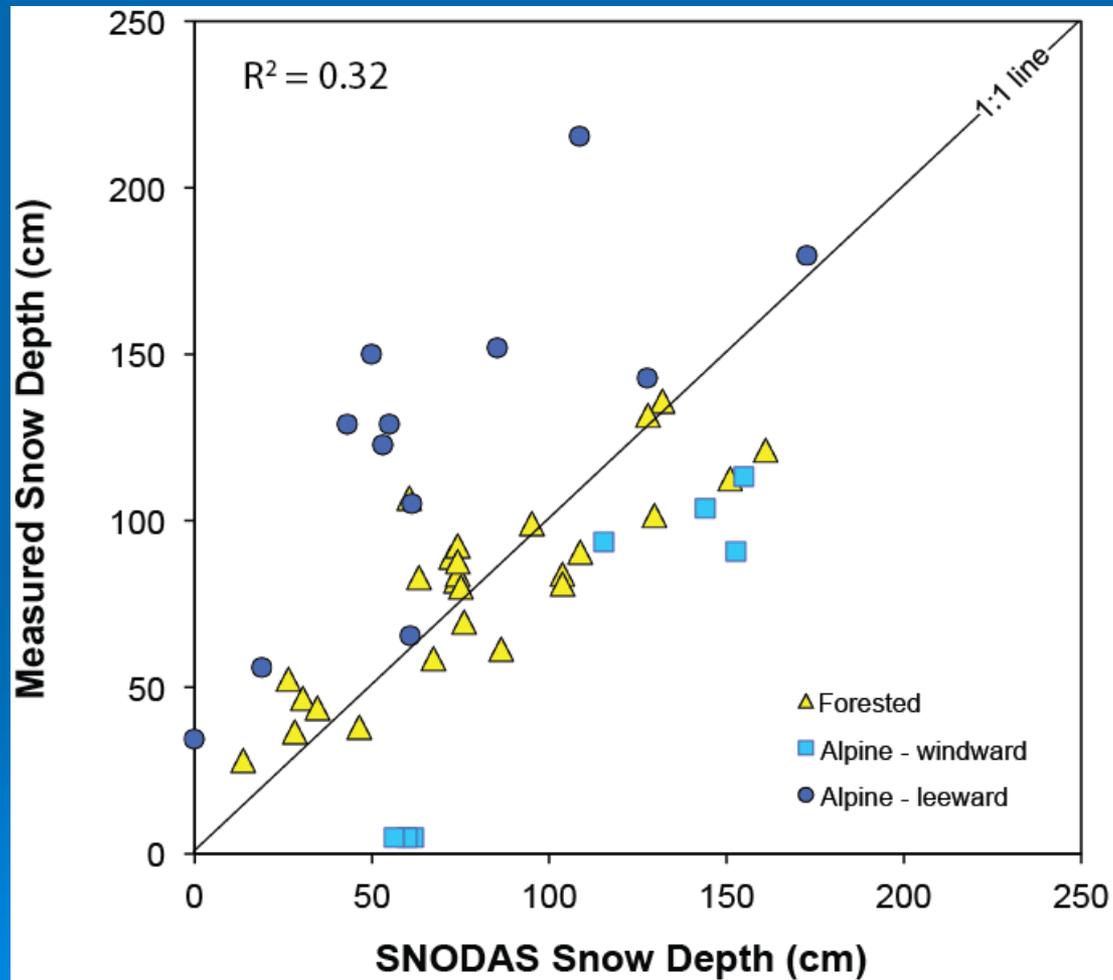
Snow depths agreed well in forest



Estimates were biased in alpine zone



Estimates were biased in alpine zone



- Remember this slide

Watershed Scale

- How does SNODAS perform at watershed scale?
 - Do errors cancel?
 - Water balance approach



Water Balance Calculations

➤ Runoff =

$$\text{SWE}_{\text{April 1}} + \text{precipitation} - \text{sublimation} - \text{ET} \pm \text{storage}$$

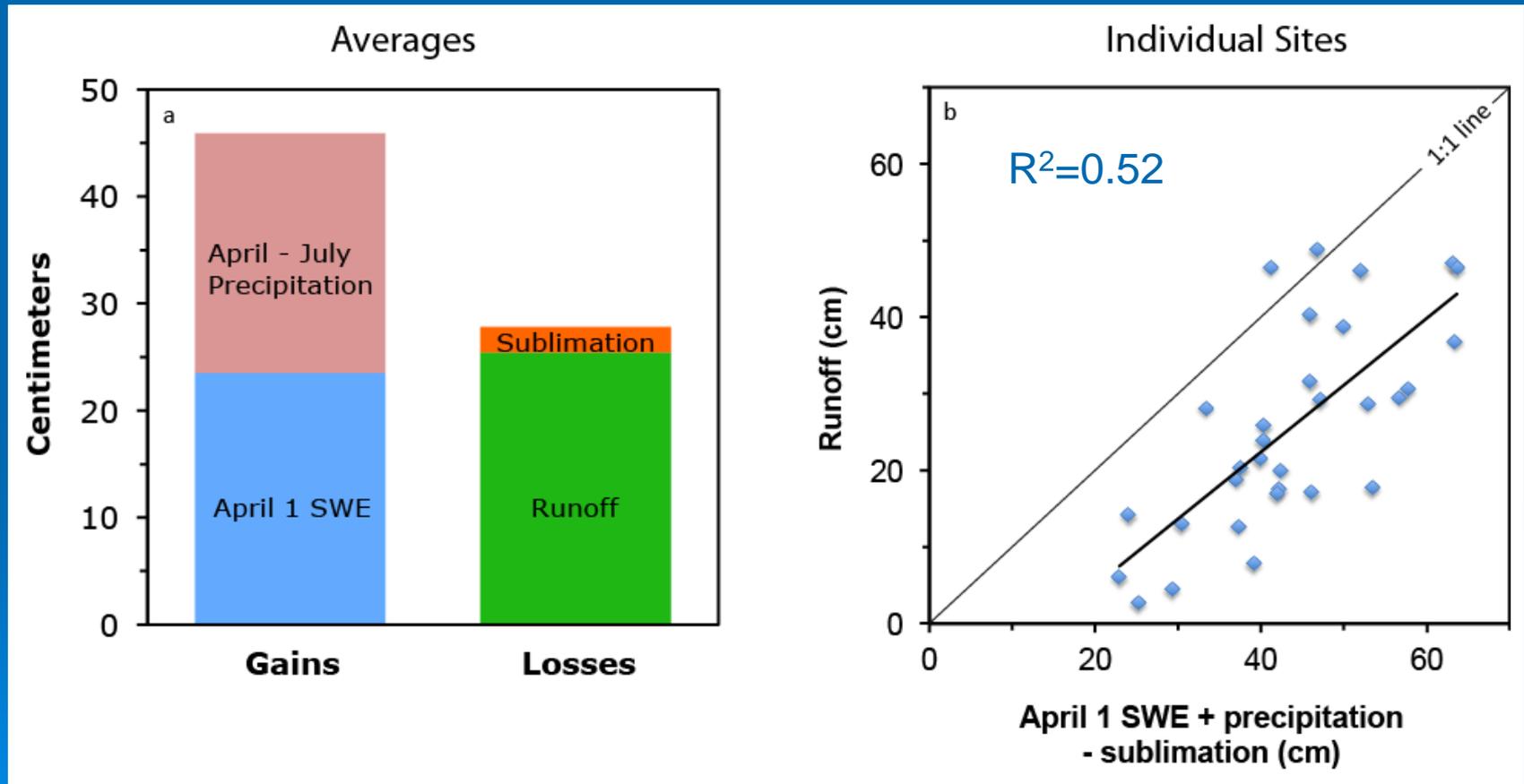
Snowmelt Period:

April – June

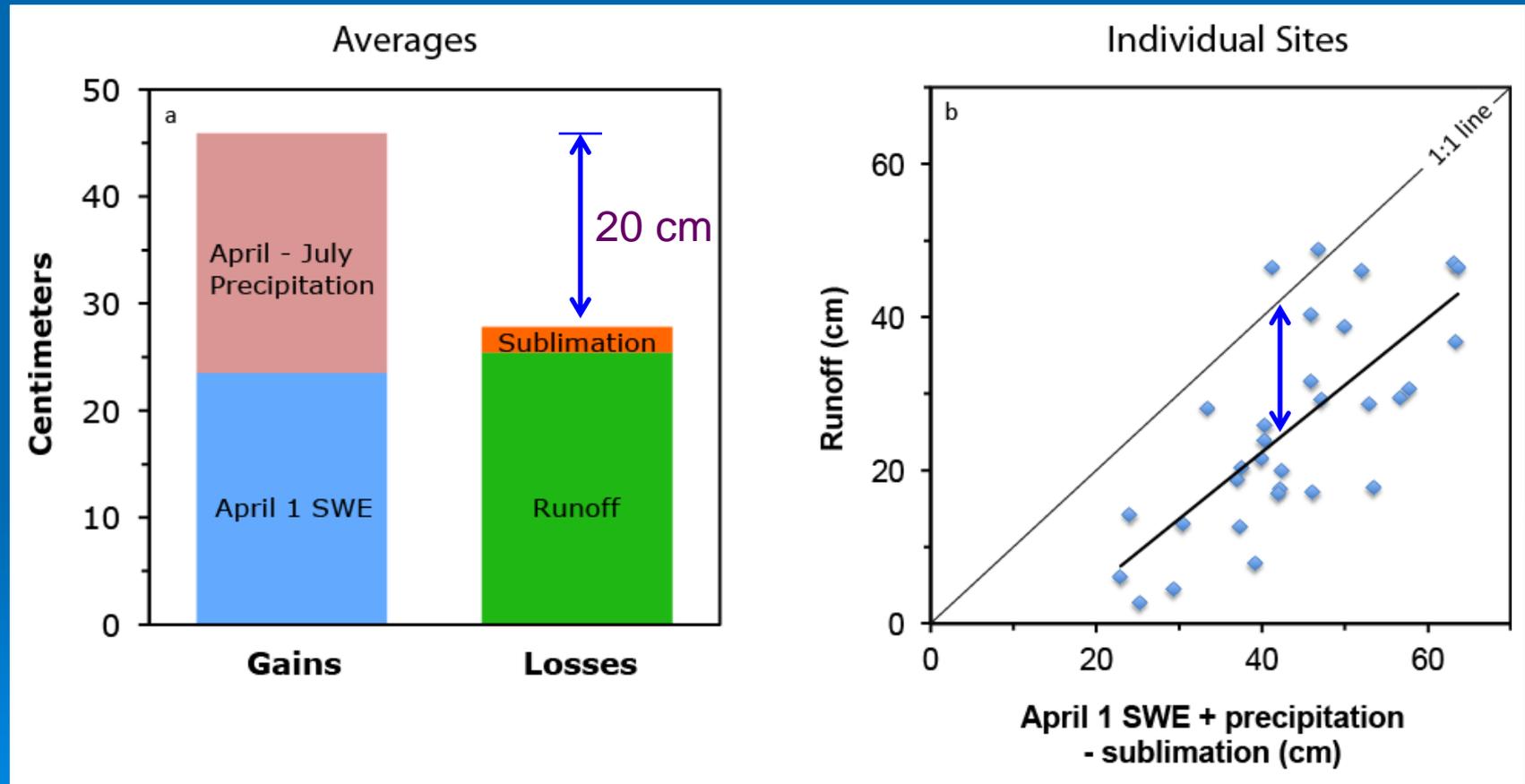
- Runoff is from USGS gages
- All other terms from SNODAS
 - ~25 sites



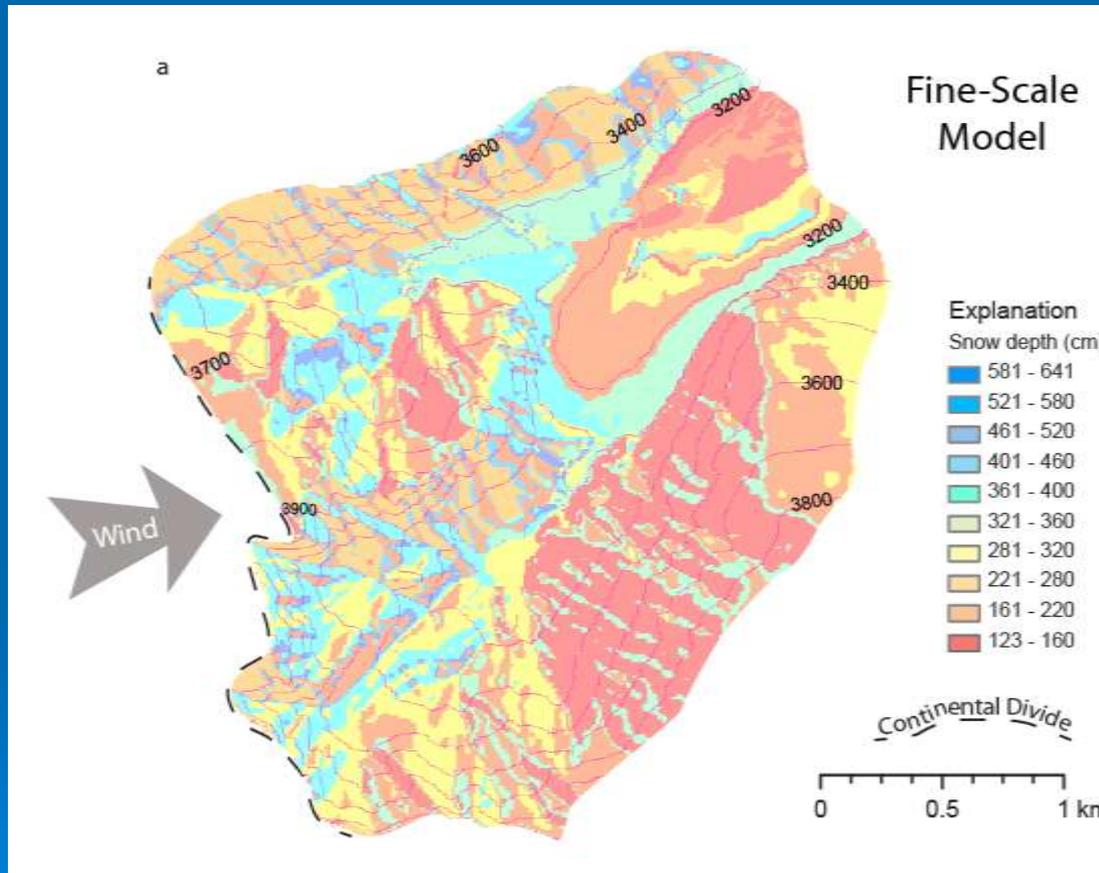
Water balance results indicate moderate agreement



ET and recharge account for ~ 20 cm



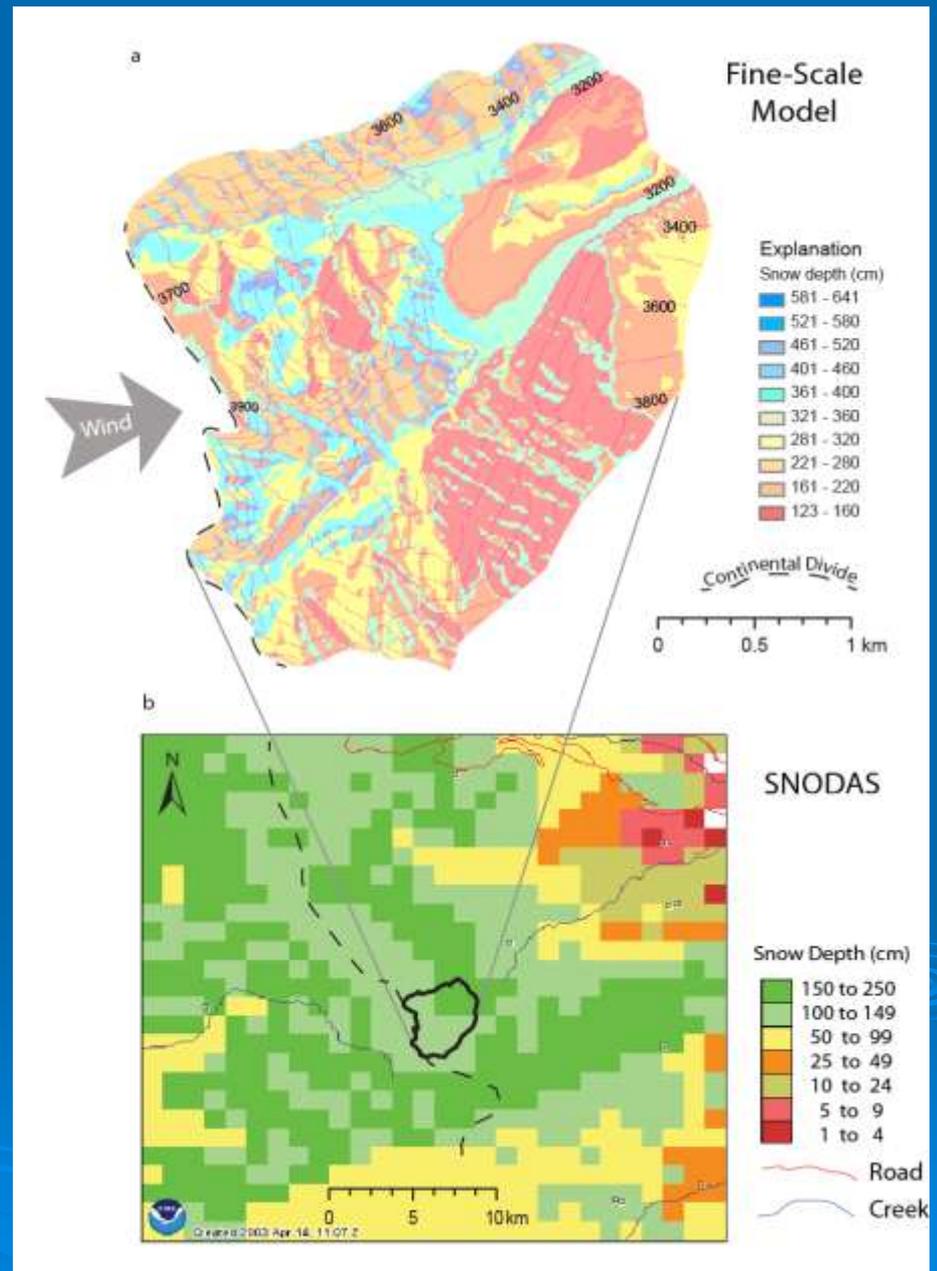
Wind and terrain influence snow distribution



- Snow Survey Conducted in 2003 (318 points)
- Regression model developed using:
 - Wind Direction
 - Slope
 - Aspect
 - Vegetation

Loch Vale, Rocky Mountain National Park

SNODAS does not account for wind redistribution of snow



Examples of Wind Drifts



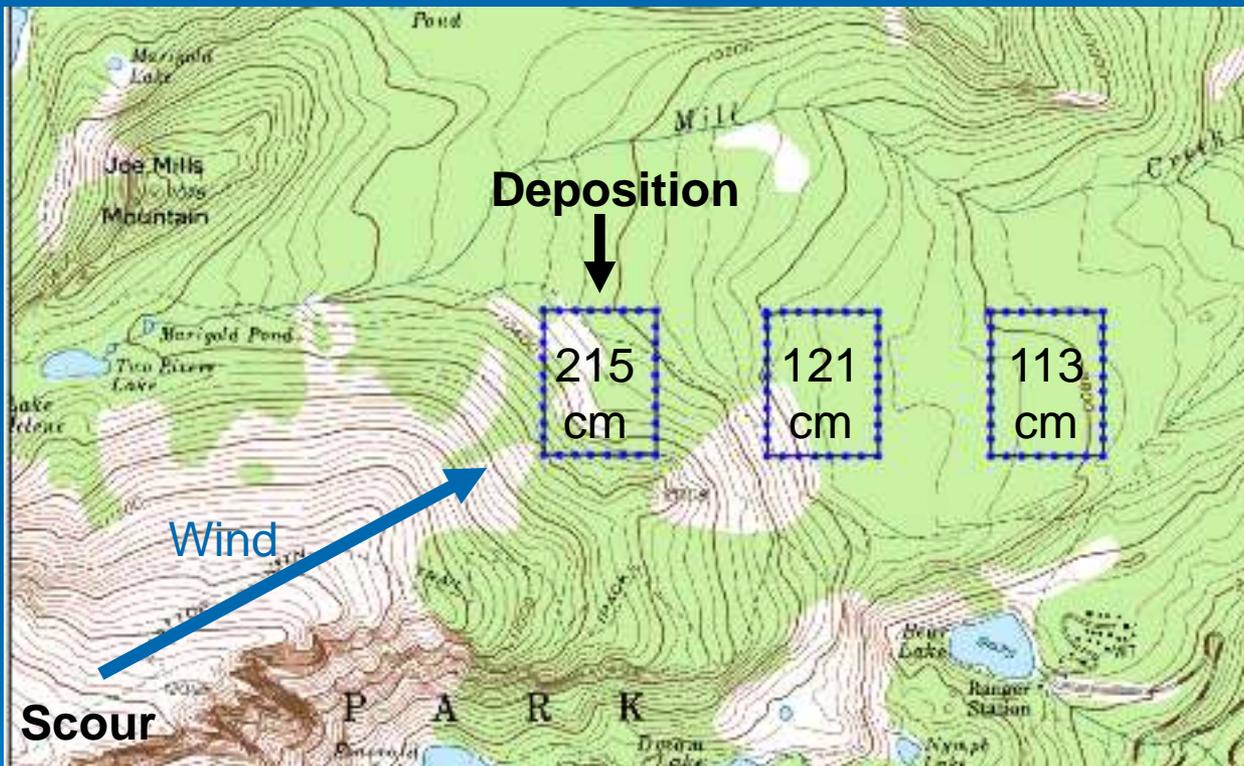
- Wind drifts can be caused by
 - topographic features (above)
 - or vegetation (right)
- Persistent year to year

Wind Drift near Continental Divide



- Persistent patterns

Snow accumulates in Lee zone



Solution?

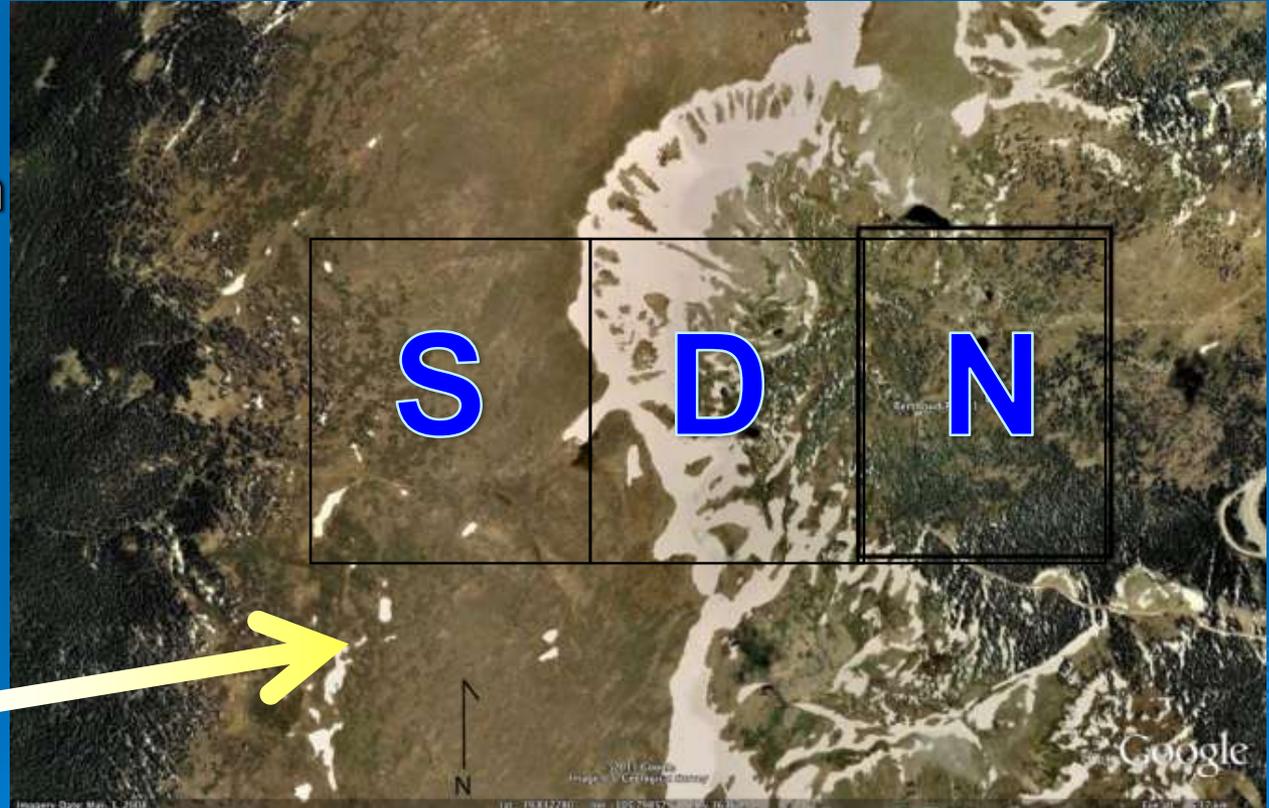
➤ Effect varies with distance

Alpine sites were categorized

➤ GIS analysis of terrain in upwind direction

- Scour
- Deposition
- No effect

Wind



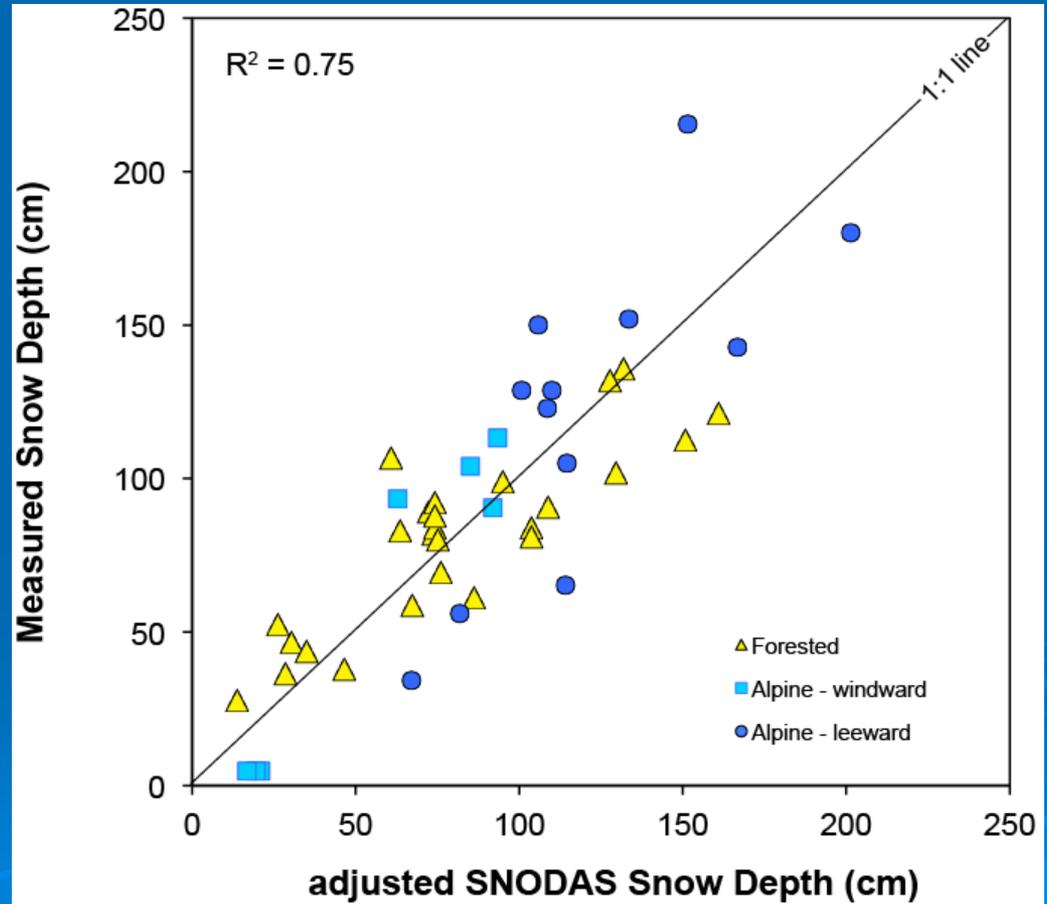
Adjusted SNODAS snow depths agree well with measurements

➤ Objective:

- Improve SNODAS estimates

➤ Model Includes:

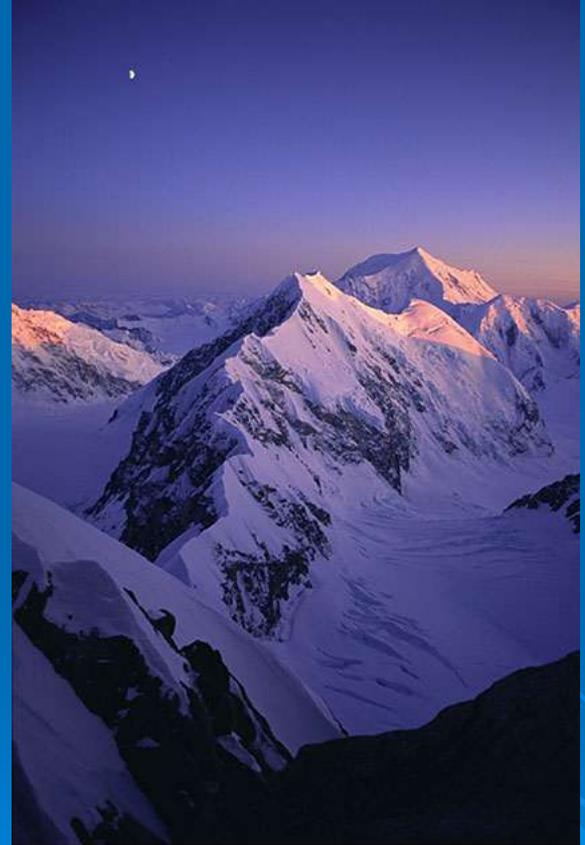
- SNODAS snow depth
- Wind effect variable



Conclusions

- SNODAS performed well in forested areas, but not in alpine zone
- Water balance results indicated moderate agreement
- SNODAS could be improved using topographic, vegetation, meteorological information to account for wind redistribution

Clow, et. al., 2012, Hydrol. Processes,
doi: [10.1002/hyp.9385](https://doi.org/10.1002/hyp.9385).



Study performed by USGS in cooperation
with Colorado Water Conservation Board