Forests, water & research in the Sierra Nevada

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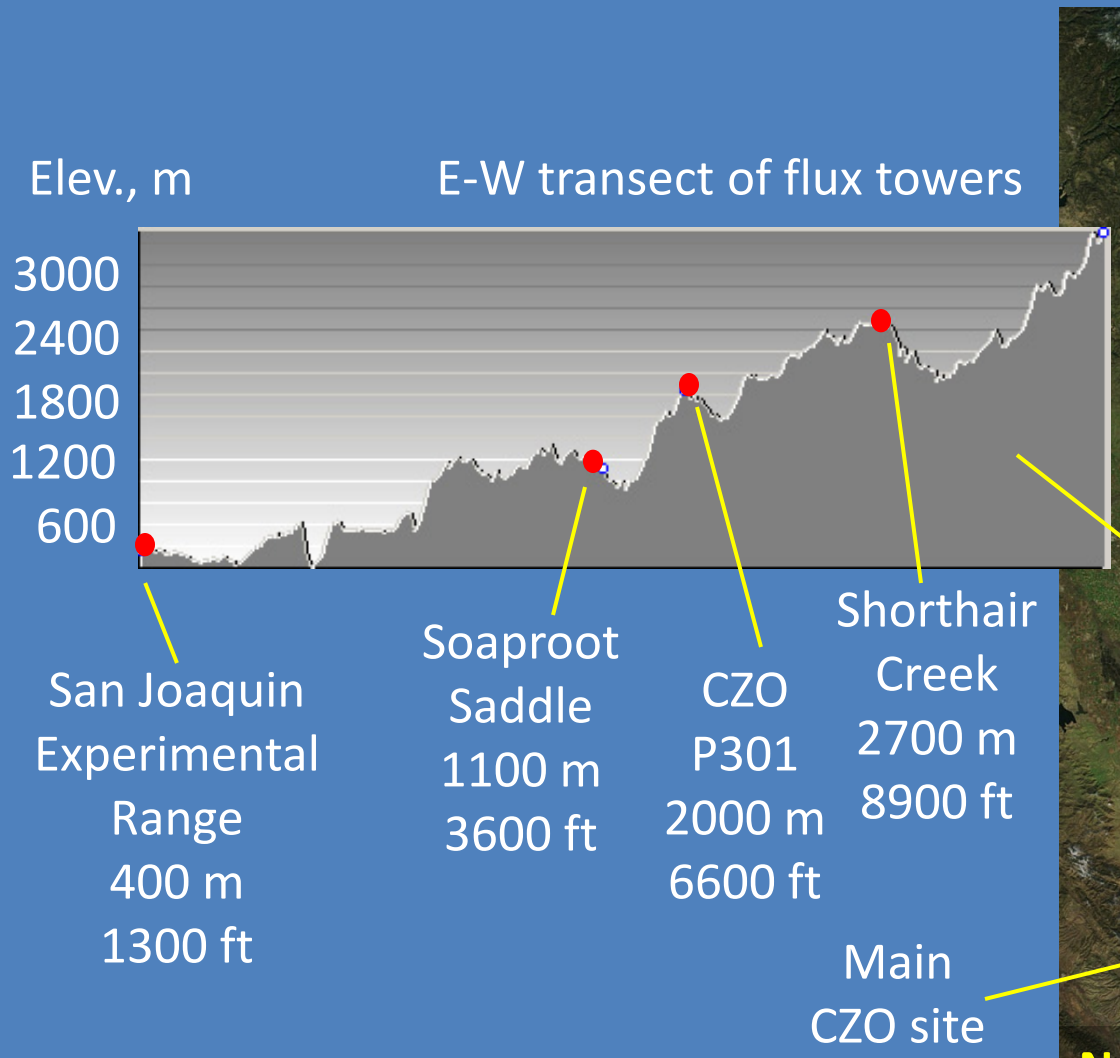
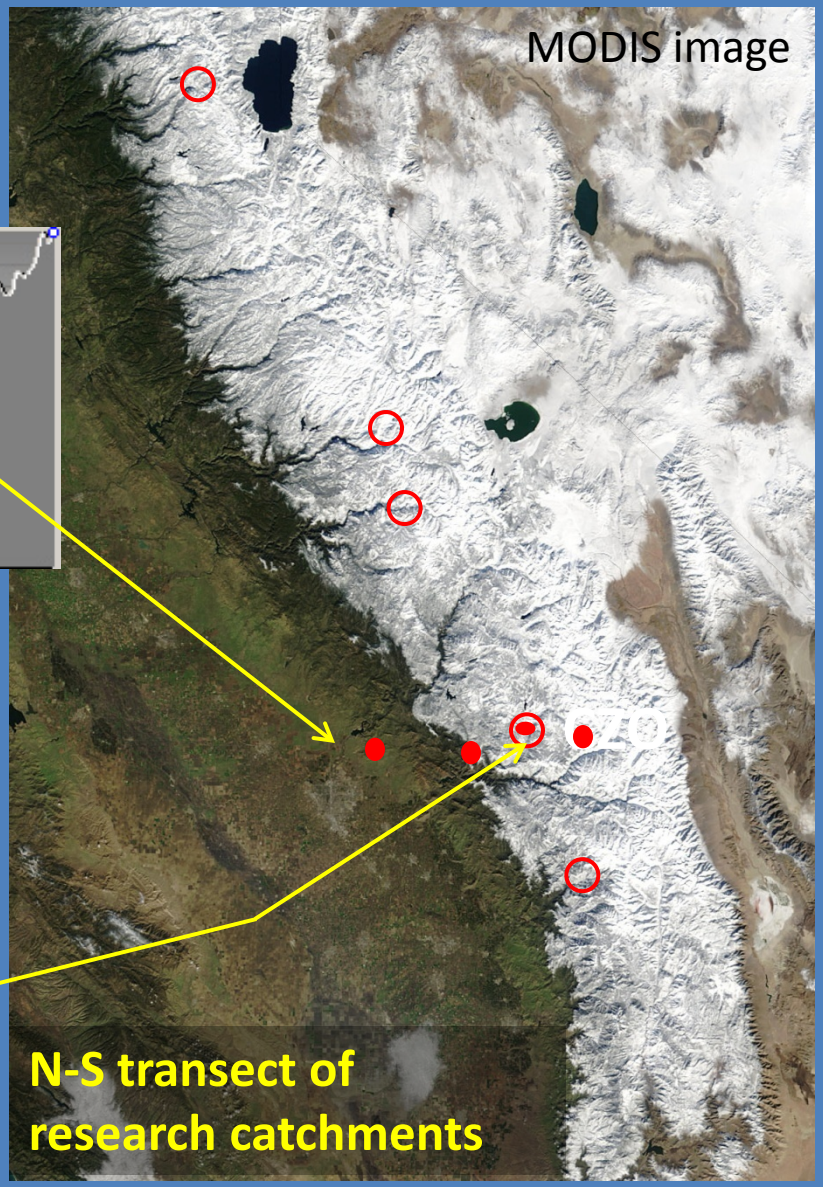
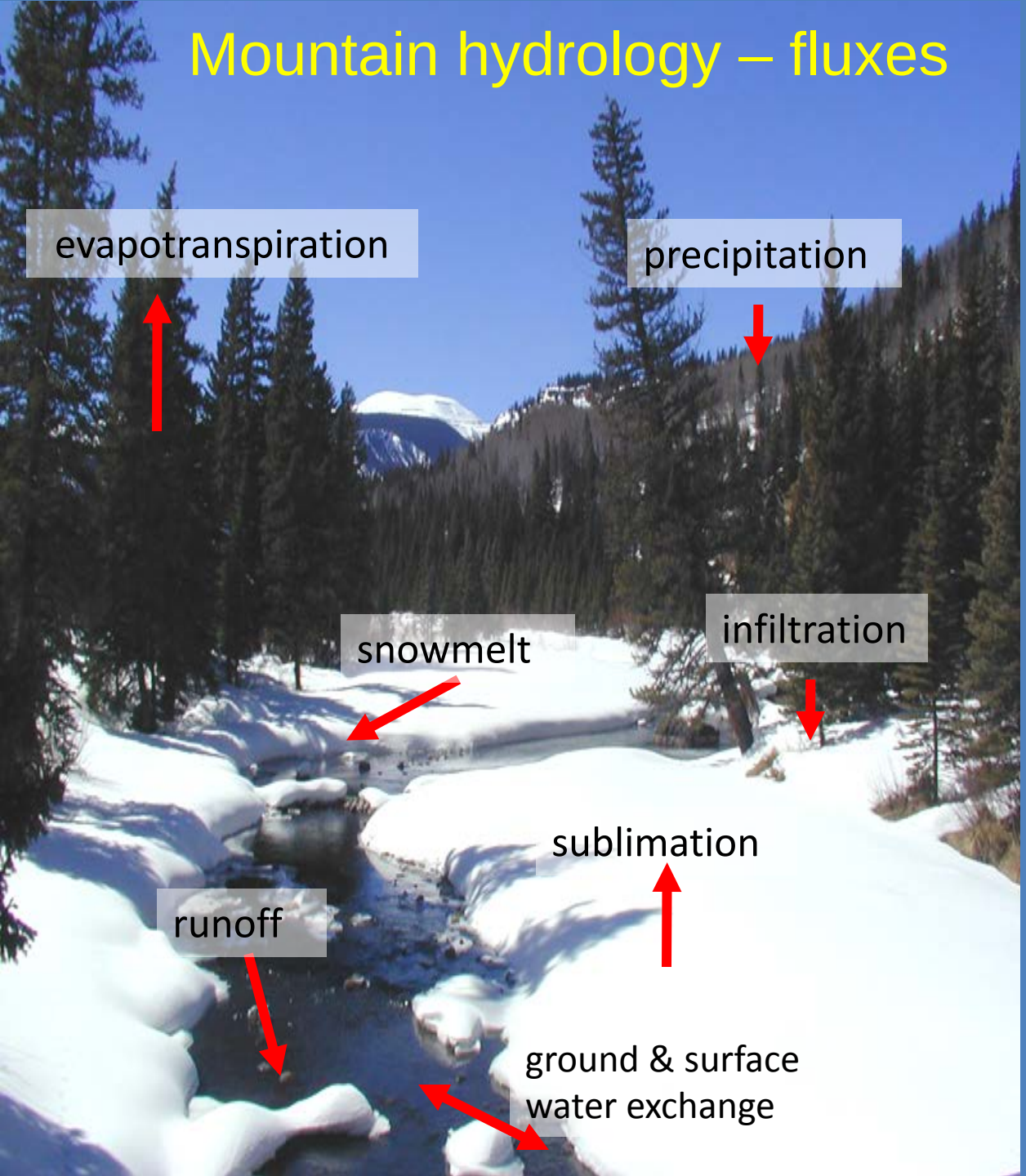
Sierra Nevada watershed research infrastructure





Southern Sierra Critical Zone Observatory

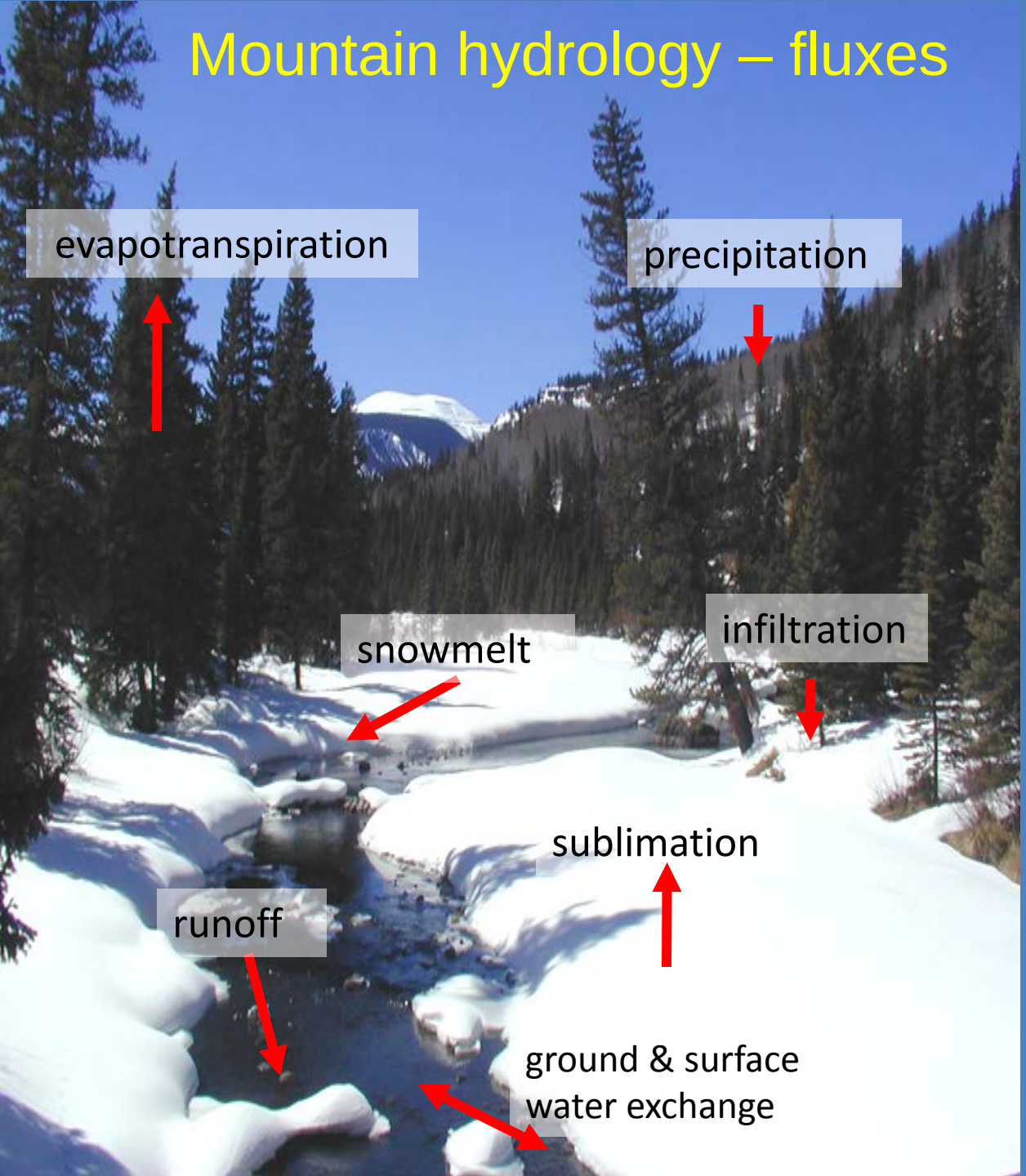


Motivating questions

How will this landscape & the hydrologic processes connecting it alter w/ climate warming & land-use/landcover change?

Reservoirs:
Snowpack storage
Soil-water storage

Mountain hydrology – fluxes



Myth:

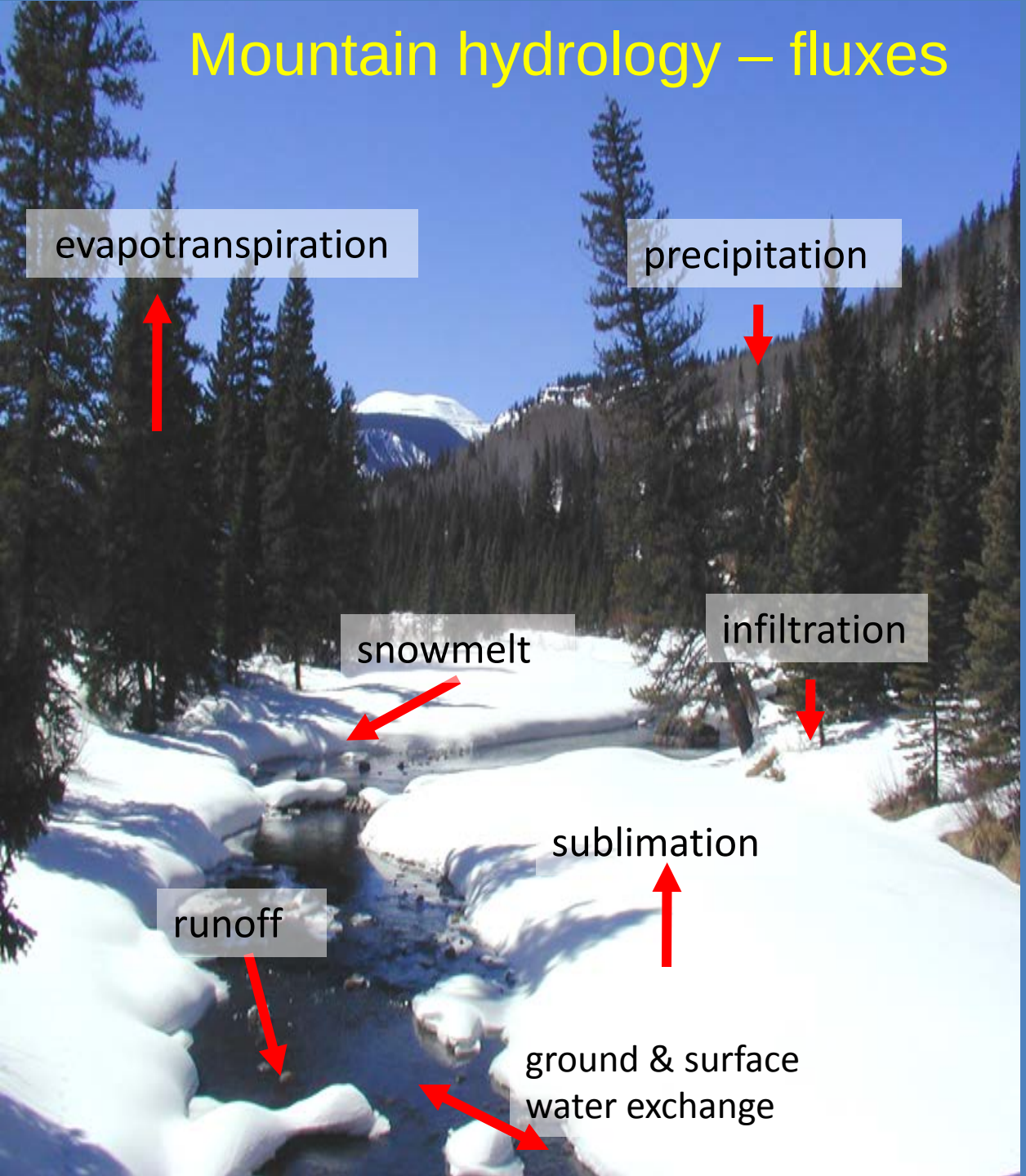
We can, with a high degree of skill, estimate or predict the magnitude of these quantities

Reservoirs:

Snowpack storage

Soil-water storage

Mountain hydrology – fluxes



My biases:

Improved predictions require better process understanding

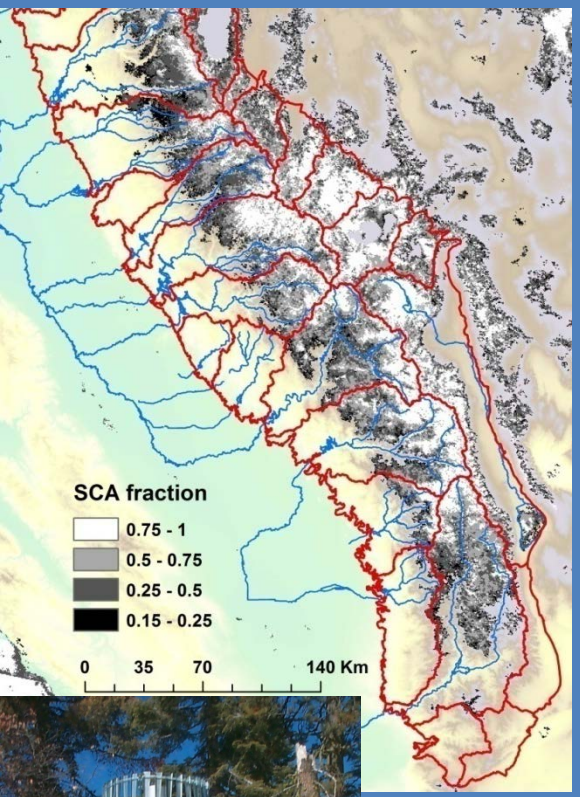
The basis for process understanding is new measurements

Processes are coupled & best studied together

Reservoirs:
Snowpack storage
Soil-water storage

Basic water balance

Precipitation = Evapotranspiration + Runoff



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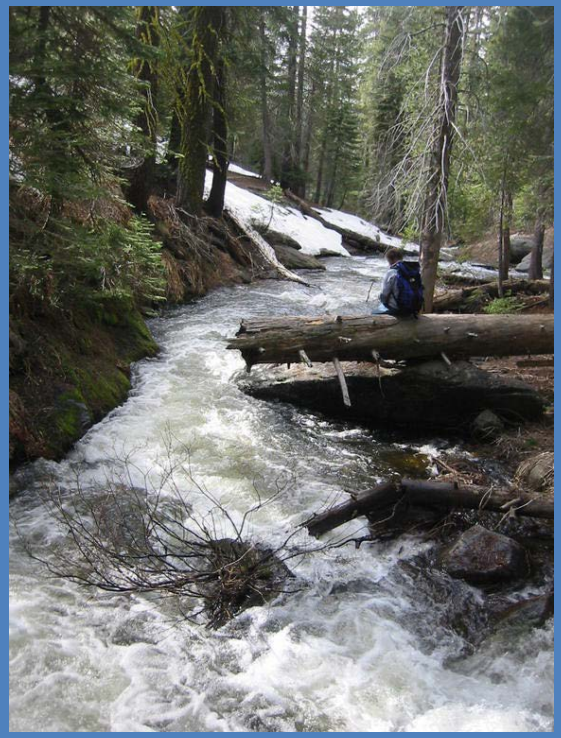
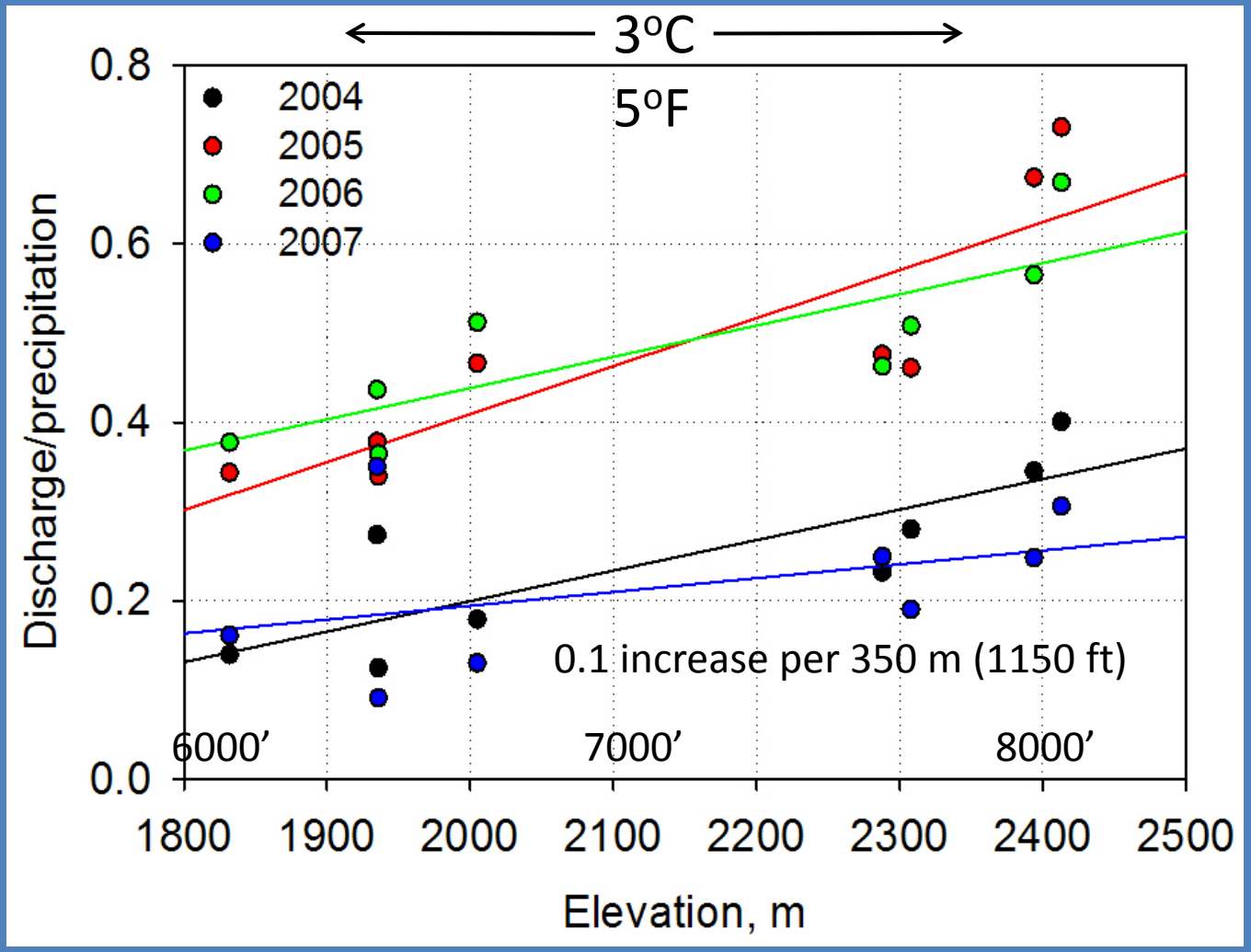


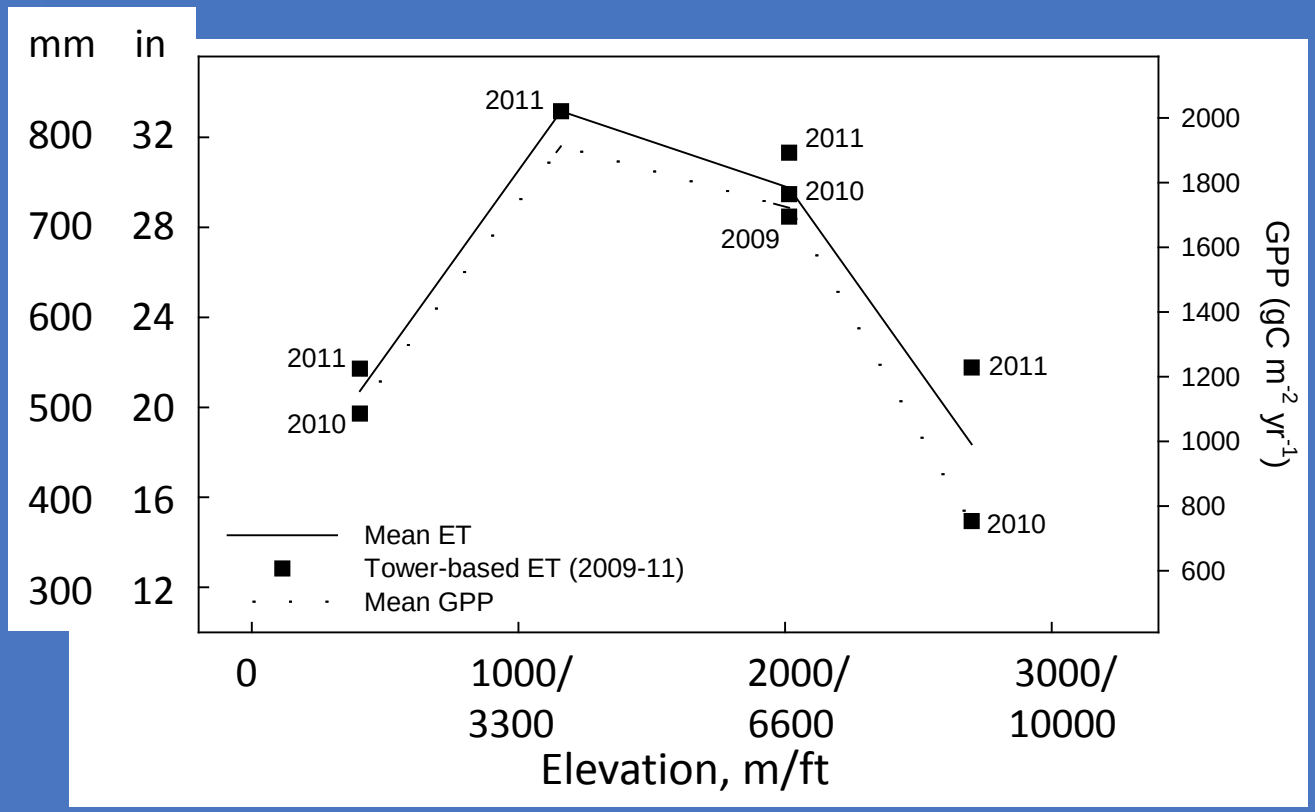


50% more runoff in snow dominated vs. mixed rain-snow catchments

Implication for 2°C warmer climate: Reduce runoff by 10-40% in mixed conifer forest (assuming ecosystems adapt)

Decreasing temperature →
Increasing snow fraction →
Decreasing vegetation →
Coarser soils →

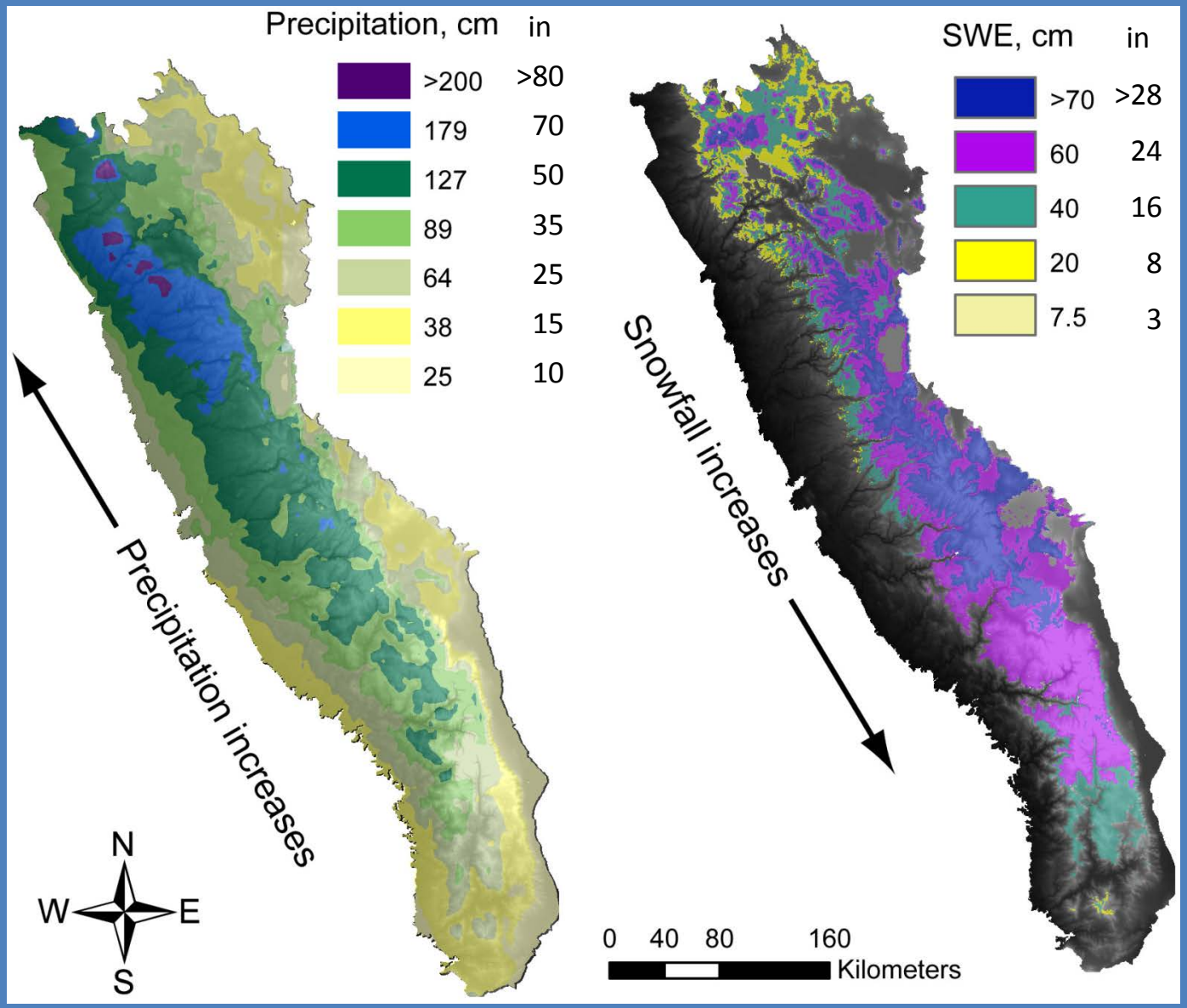
Annual evapotranspiration

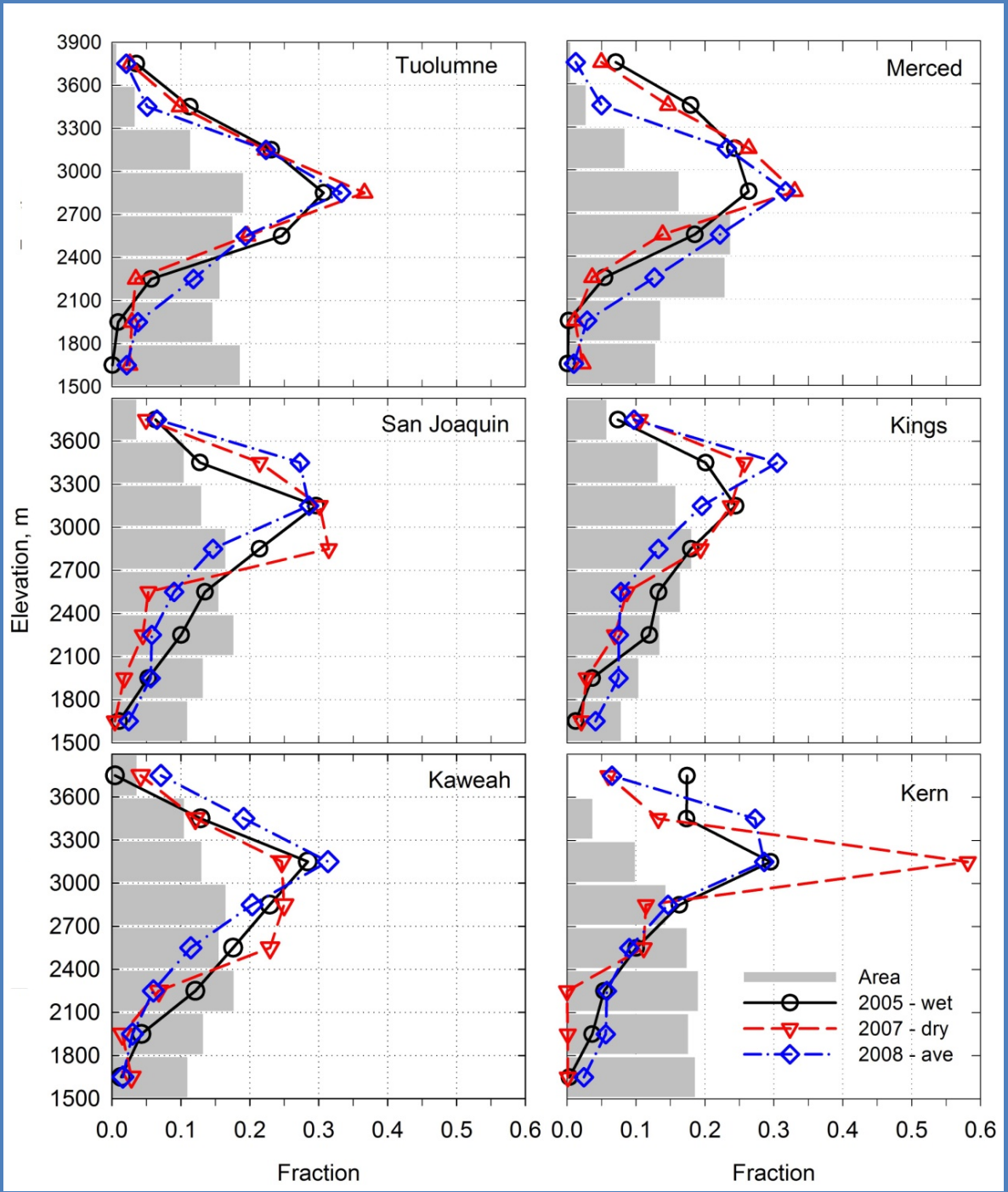


- Highest current evapotranspiration in rain to rain-snow transition region of mixed conifer forest – year-round growth
- Lower elevation is water limited
- Higher elevation is cold limited

Goulden et al., submitted

Sierra Nevada precipitation & snow water equivalent (SWE) – climatological estimate?





Most snowmelt comes from elevations above most measurement of precipitation or snowpack

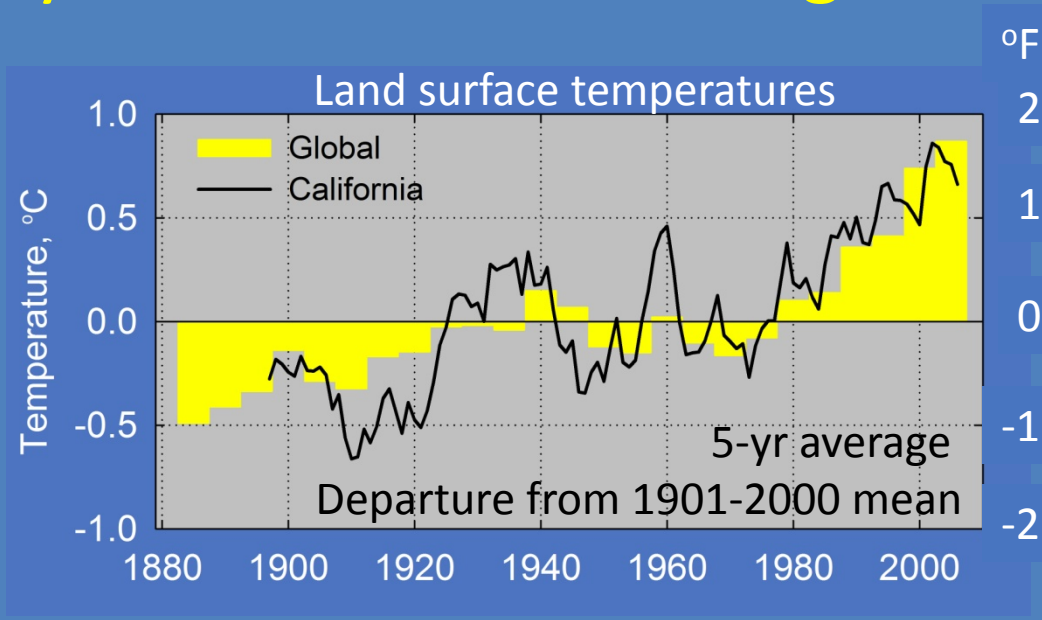
Mountain water cycle & climate warming

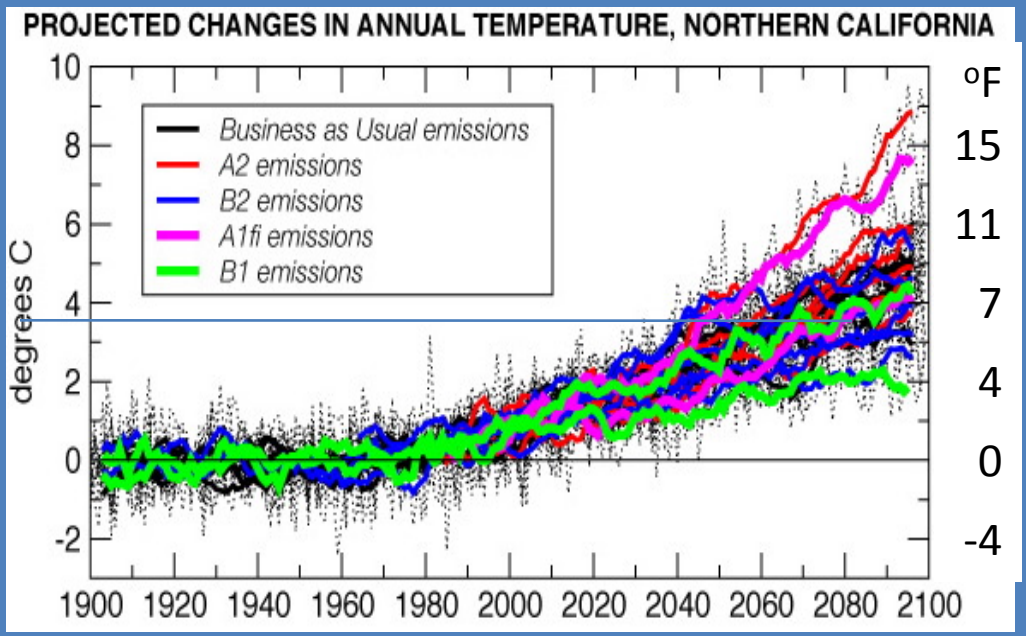
Warming by 2–6°C (4–11°F) drives significant changes:

– rain-vs-snow storms *
– snowpack amounts *
– snowmelt timing *
– flood risk
– streamflow timing *
– low baseflows
– growing seasons *
– recharge?
– drier soil in summer

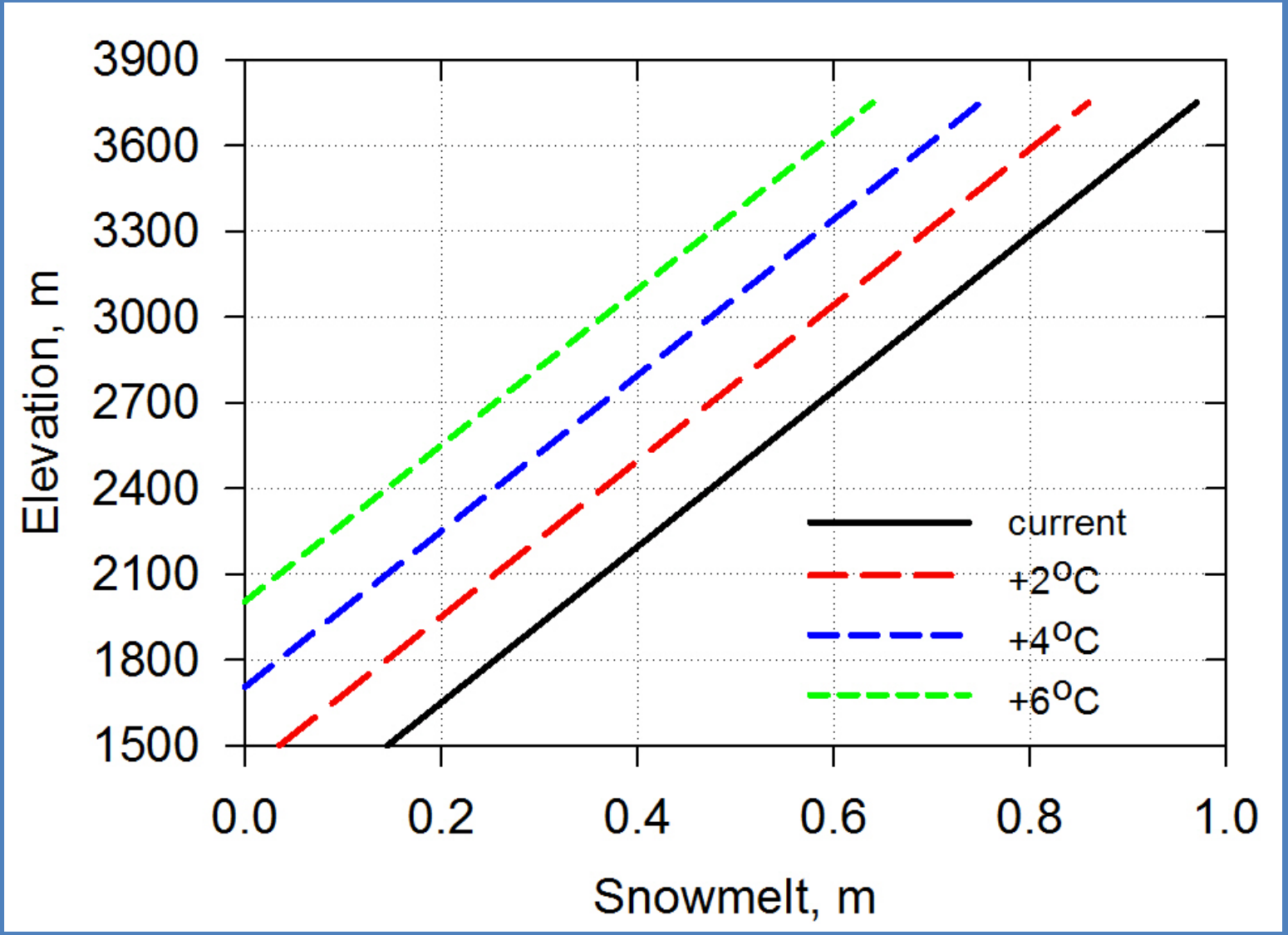
Precipitation changes uncertain

Already observed (*)

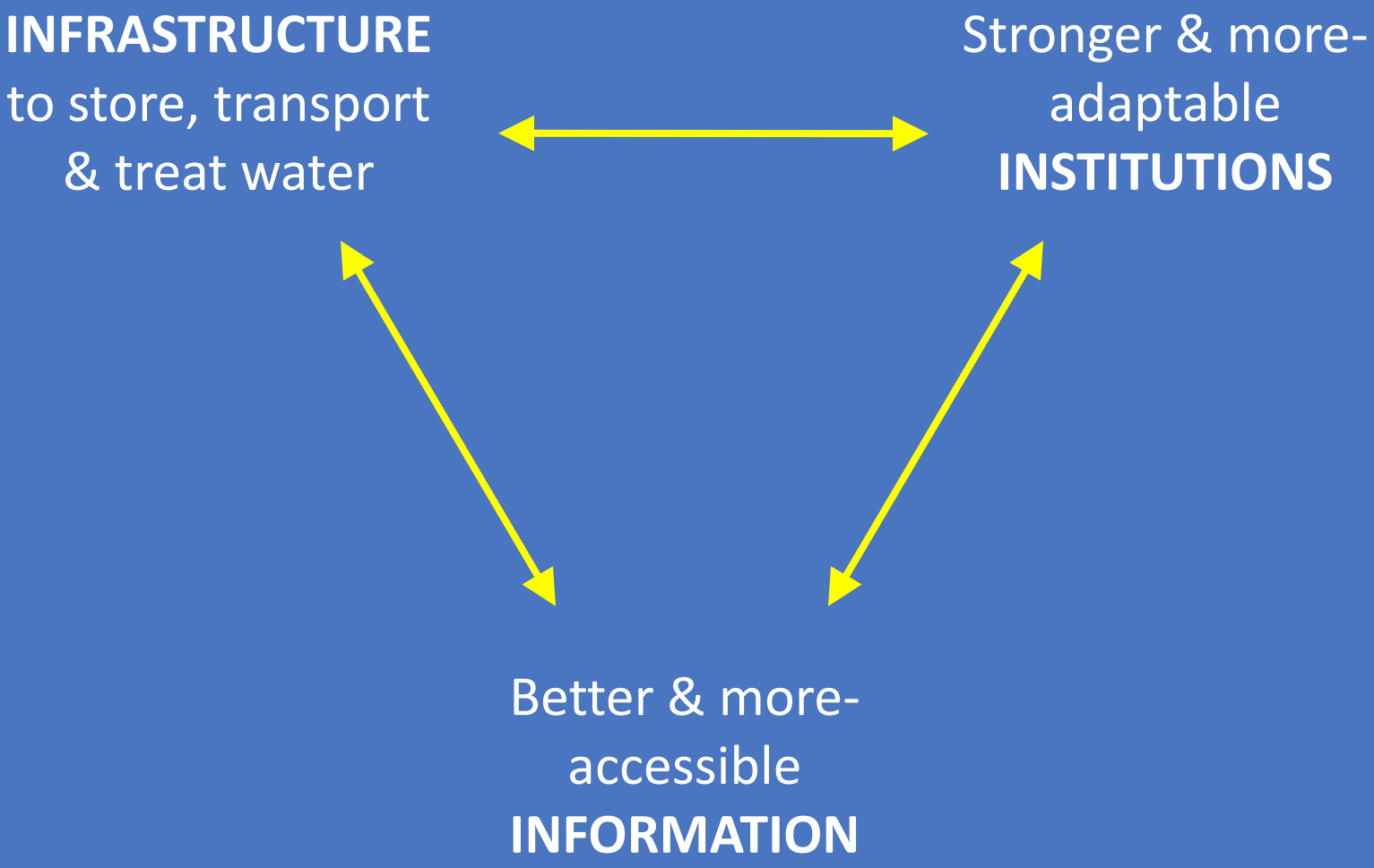




Kings basin snowmelt w/ climate warming



Making a water-secure world – the three I's

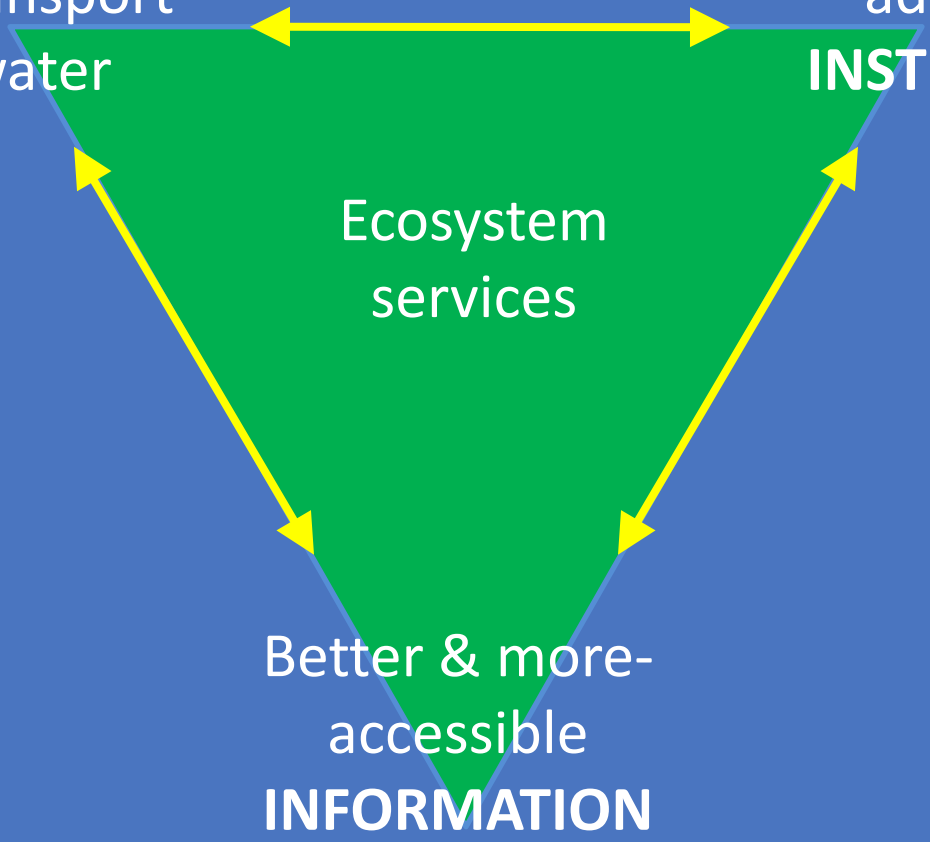


Water security: the reliable availability of an acceptable quantity & quality of water for health, livelihoods & production, coupled w/ an acceptable level of water-related risks

Making a water-secure world – the three I's

INFRASTRUCTURE
to store, transport
& treat water

Stronger & more-
adaptable
INSTITUTIONS

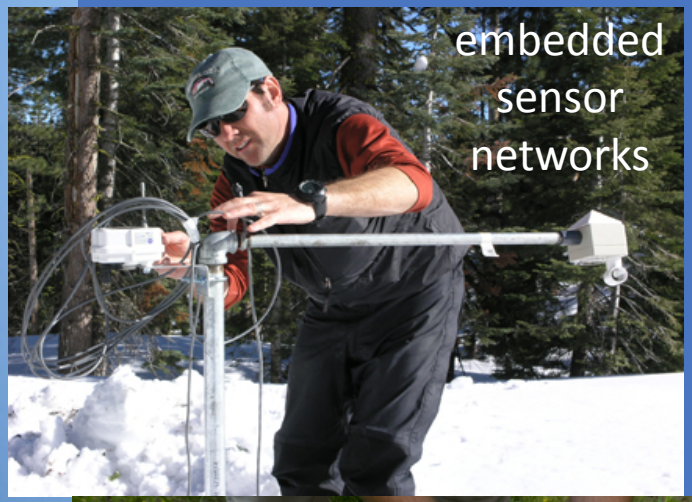


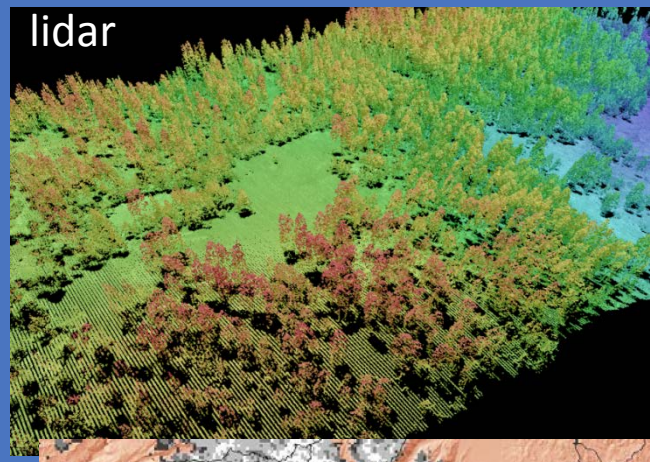
Better & more-
accessible
INFORMATION

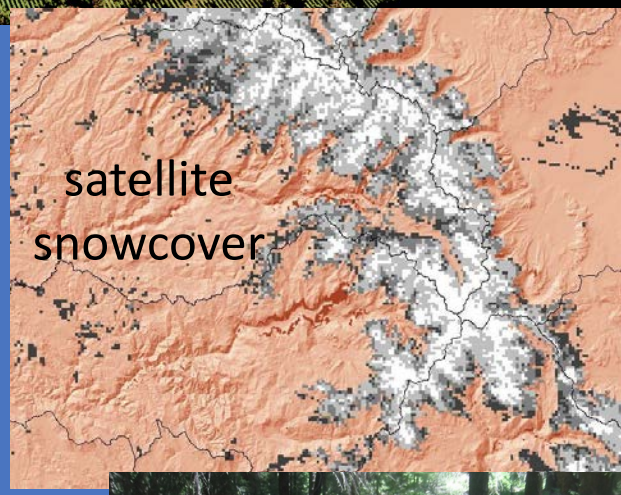
Water is fundamental to sustainable ecosystem services. Water management therefore translates into managing ecosystem services, and must be a fundamental goal of virtually all such efforts.

A new generation of integrated measurements

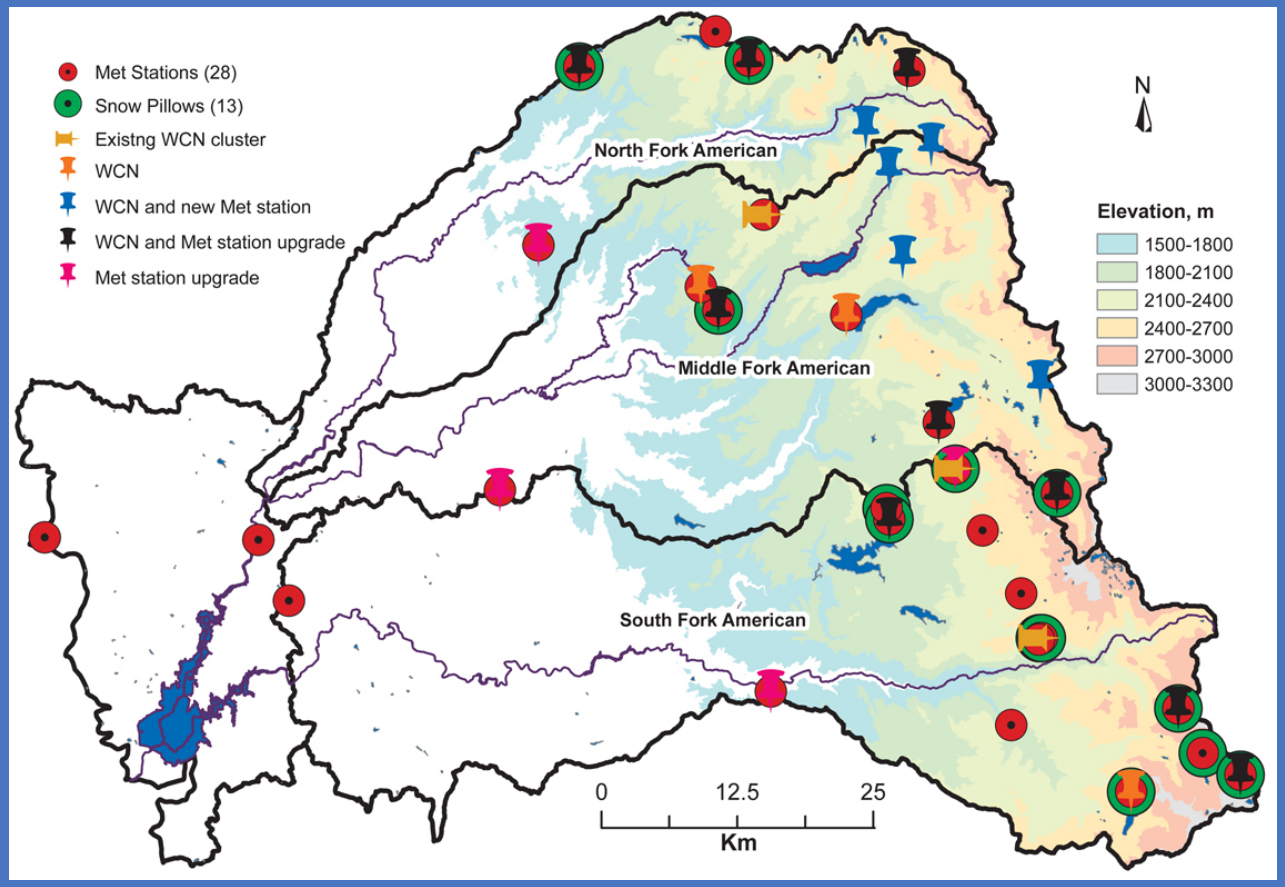
eddy correlation







Basin-wide deployment of hydrologic instrument clusters – American R. basin



Strategically place low-cost sensors to get spatial estimates of snowcover, soil moisture & other water-balance components

Network & integrate these sensors into a single spatial instrument for water-balance measurements.

Building the knowledge base to enhance forest & water management