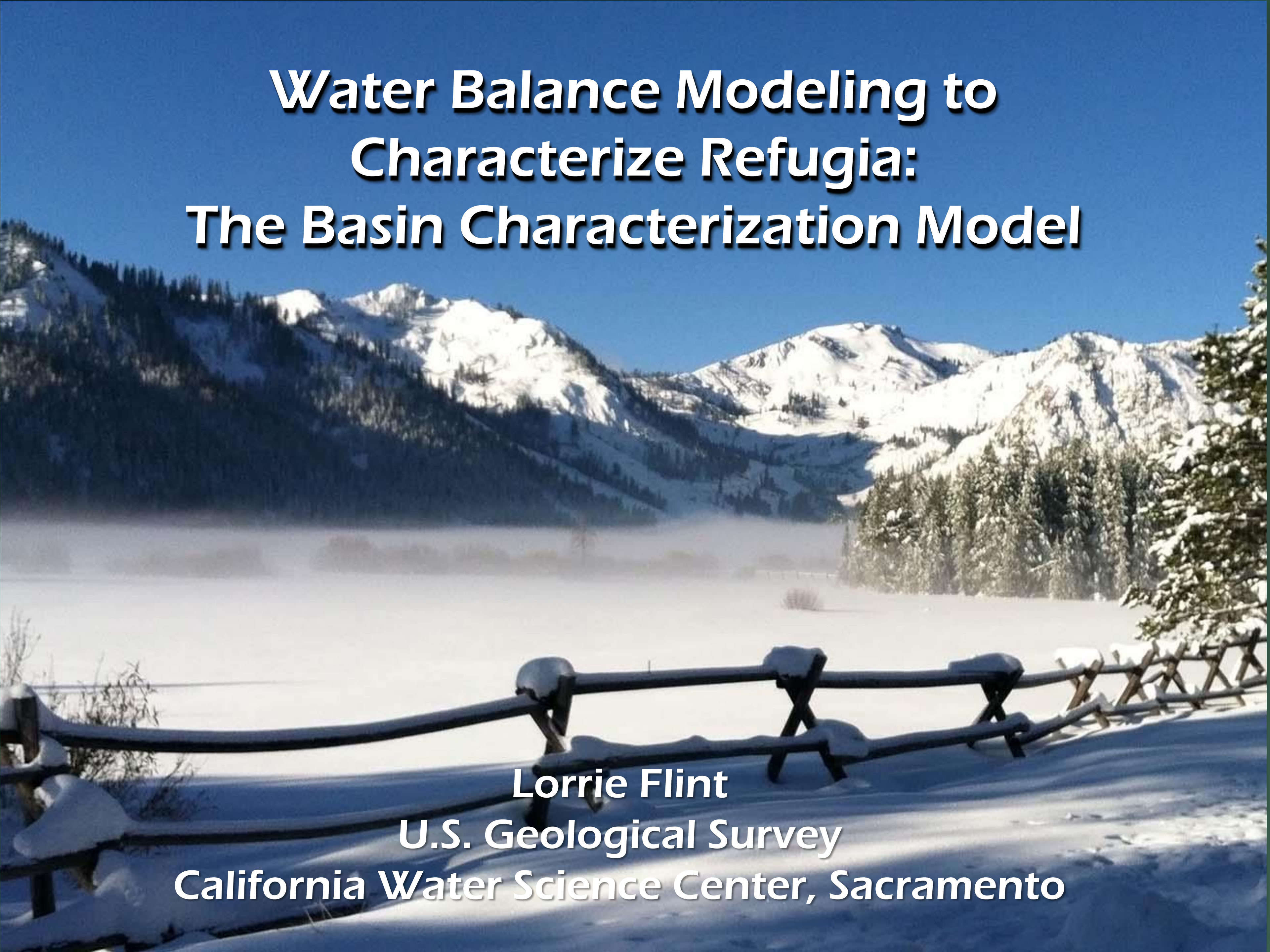
Water Balance Modeling to Characterize Refugia: The Basin Characterization Model



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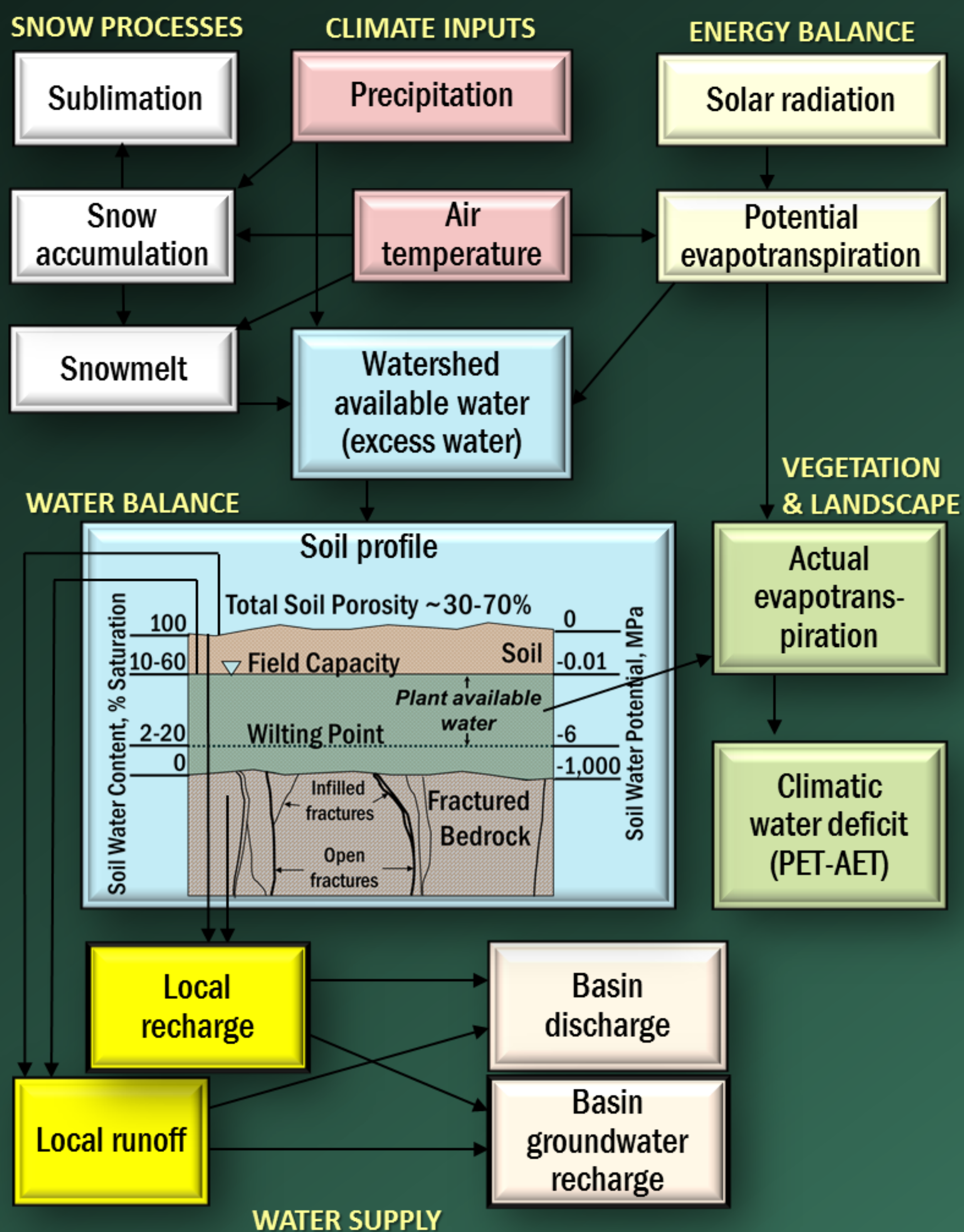
Climate Refugia

- Temperature
- Energy balance: solar radiation, potential evapotranspiration
- Seasonal water availability
- Snow
- Climatic water deficit: PET – AET, landscape stress indicator

Basin Characterization Model



A grid-based water balance model

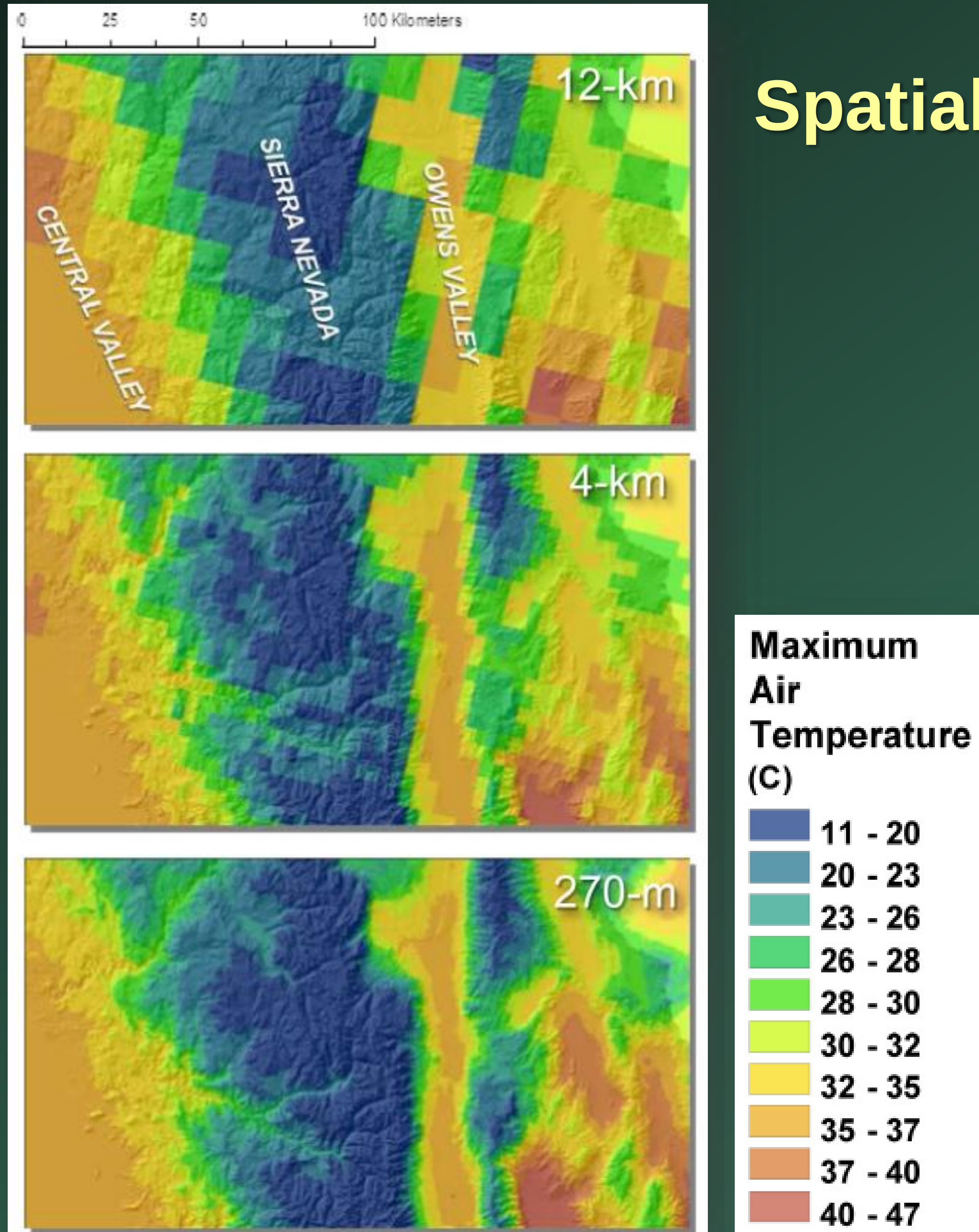
- Uses gridded climate data downscaled to fine spatial scales 270-m (historical and future)
- Incorporates detailed soil properties and estimates of bedrock permeability
- Calculates spatially distributed water supply as recharge and runoff
- Calculates climatic water deficit as an estimate of demand and stress

Spatial Downscaling

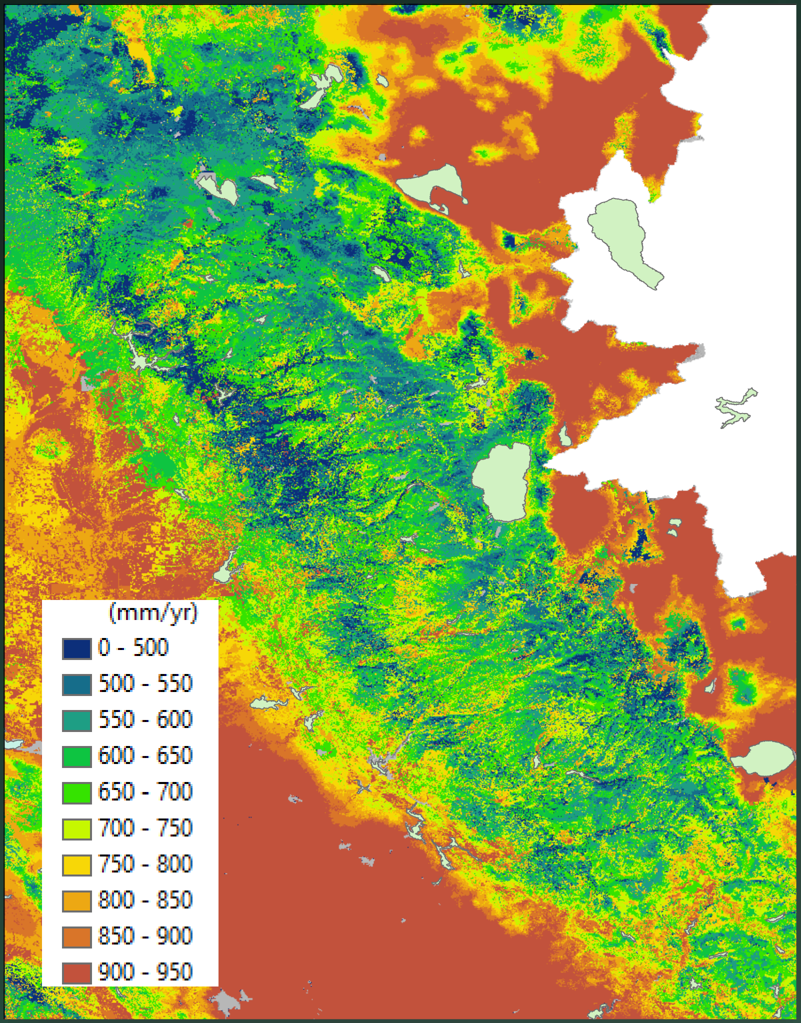
12-km

4-km

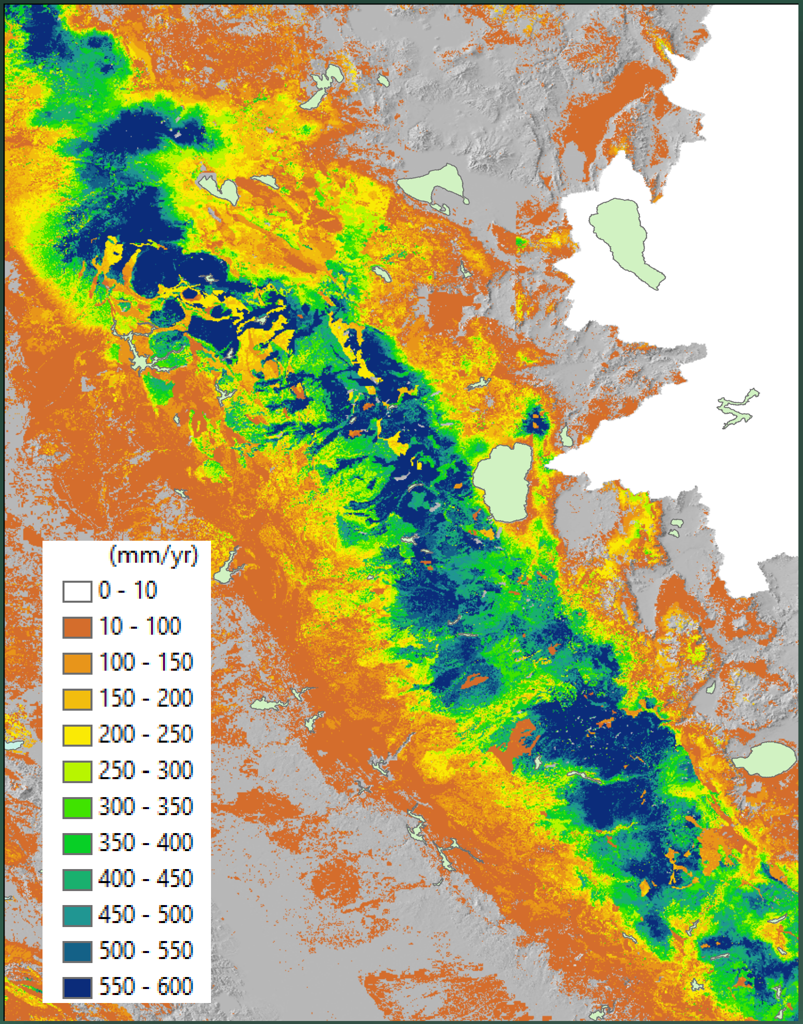
270-m



Climatic Water Deficit (1981-2010)



Recharge

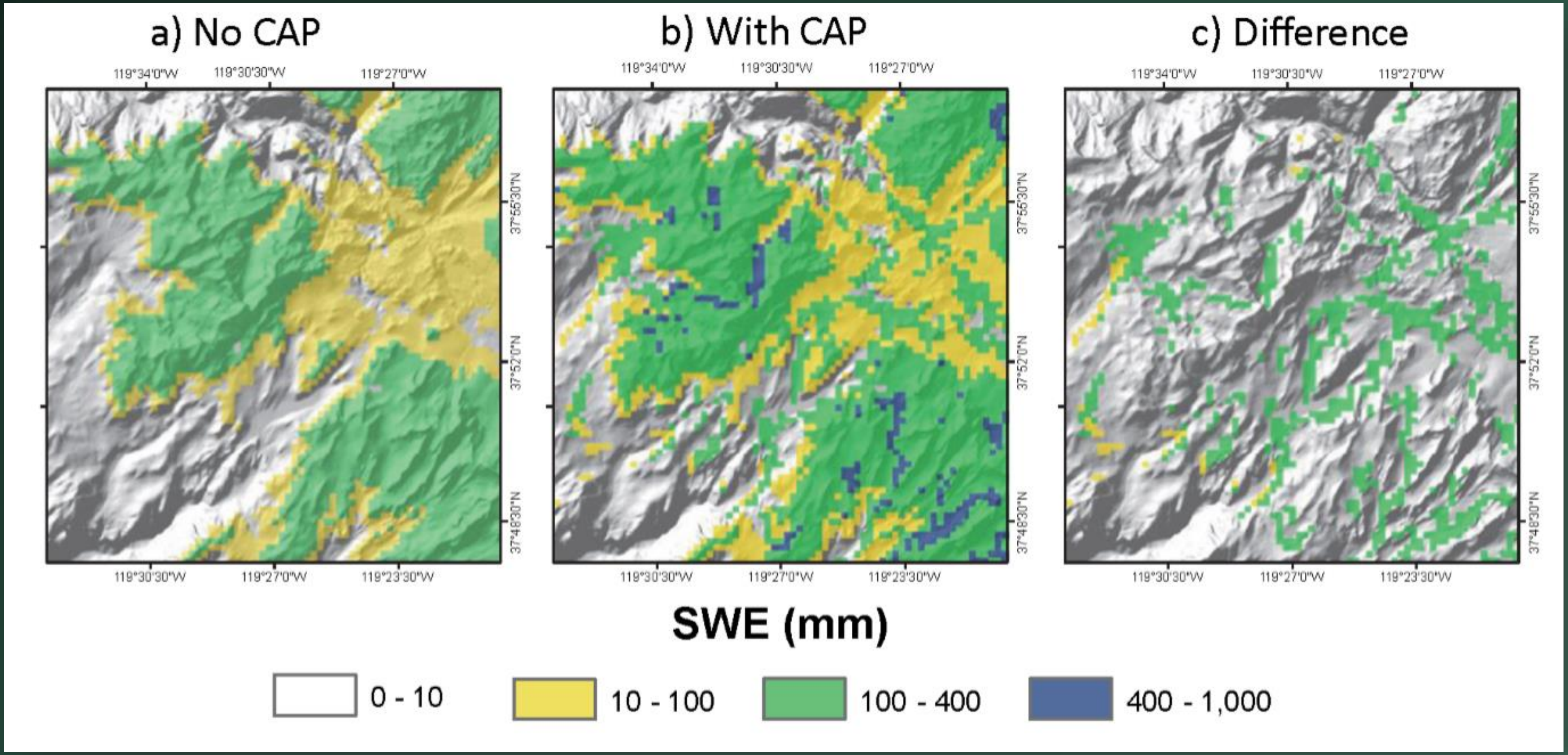


Sierra Nevada Mountains

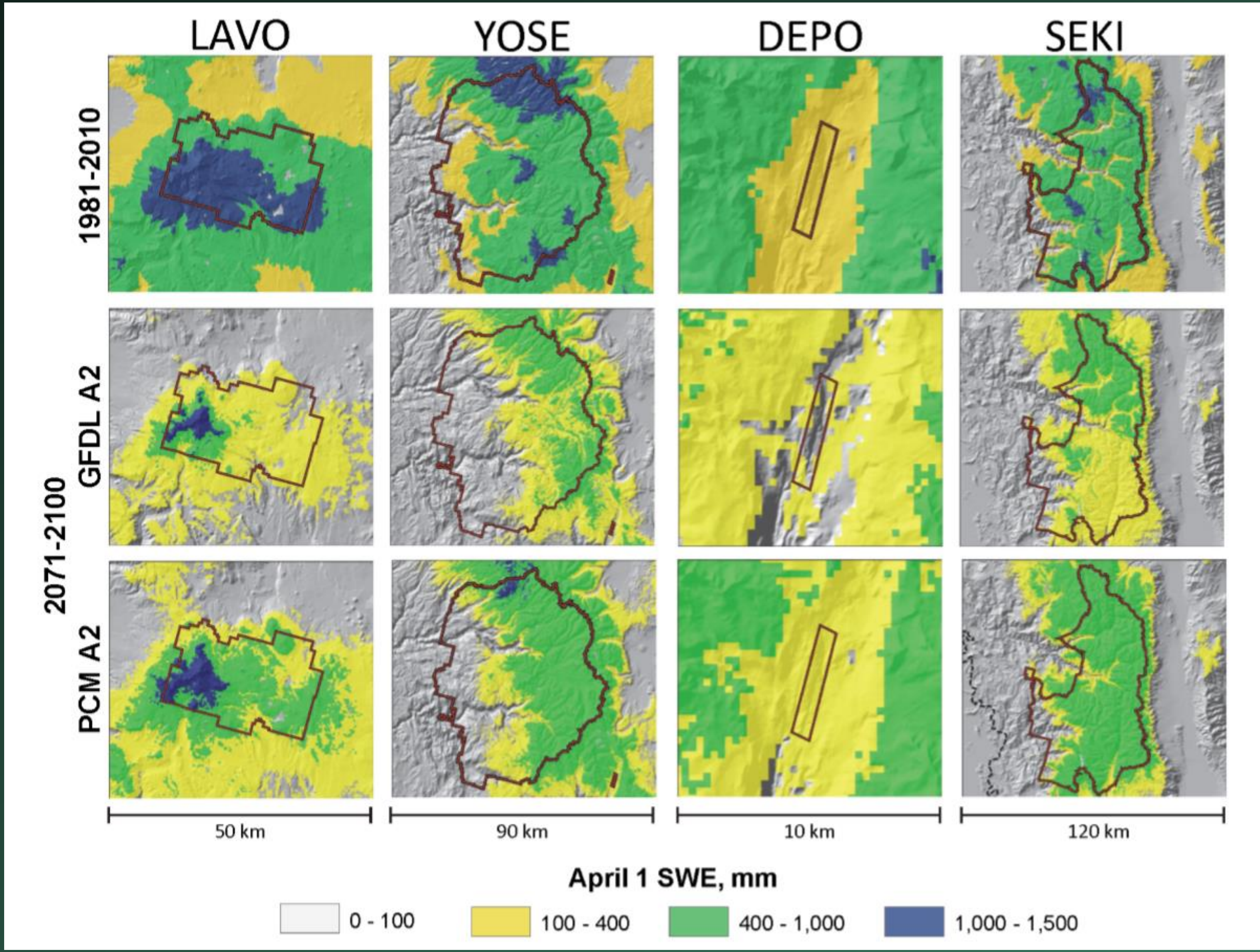
Examples

- Future snowpack for wolverine dens
- Climate and CWD used to identify refugia and connectivity for Sierra Nevada ground squirrels
- CWD changes indicate stability and refugia for biodiversity
- Solar radiation at a very fine scale to identify refugia for rare plants

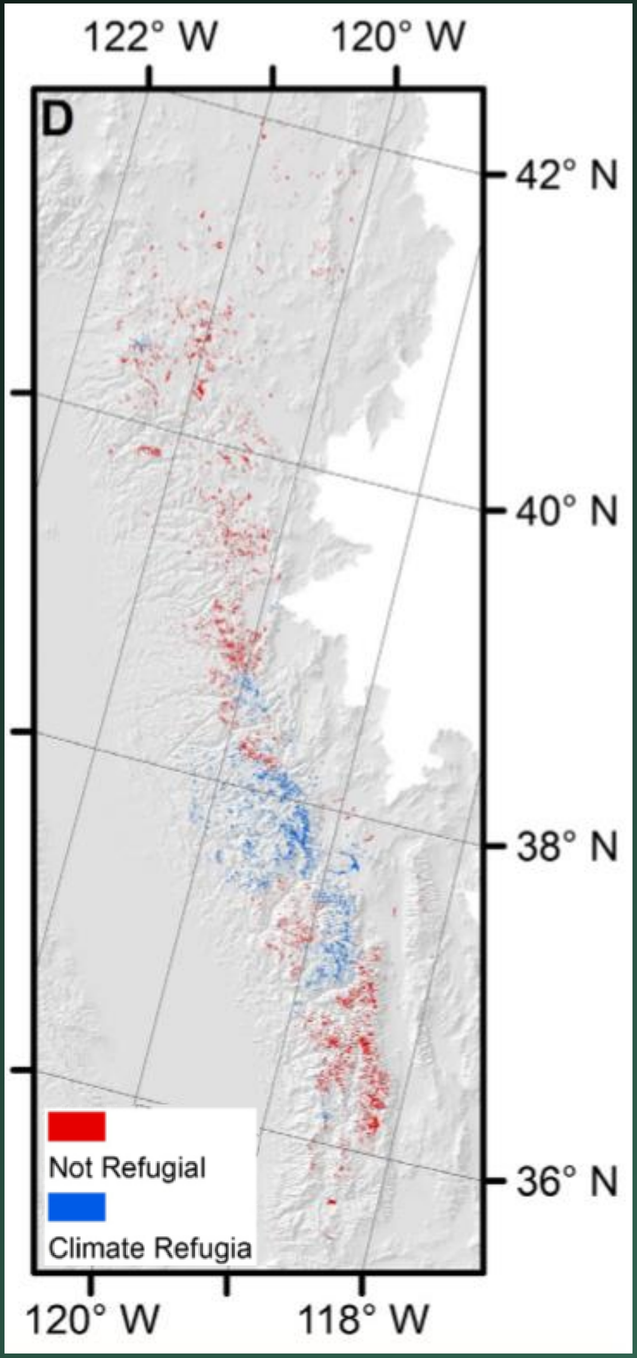
Will there be habitat in the future to introduce wolverines to the Sierra Nevada?



We used maps of cold air pooling to realistically maintain springtime snowpack. Wolverines need at least 400 mm of pack for their dens in the spring.



Then we could model current and future springtime snowpack for 4 national parks.
Green and blue are suitable habitat.

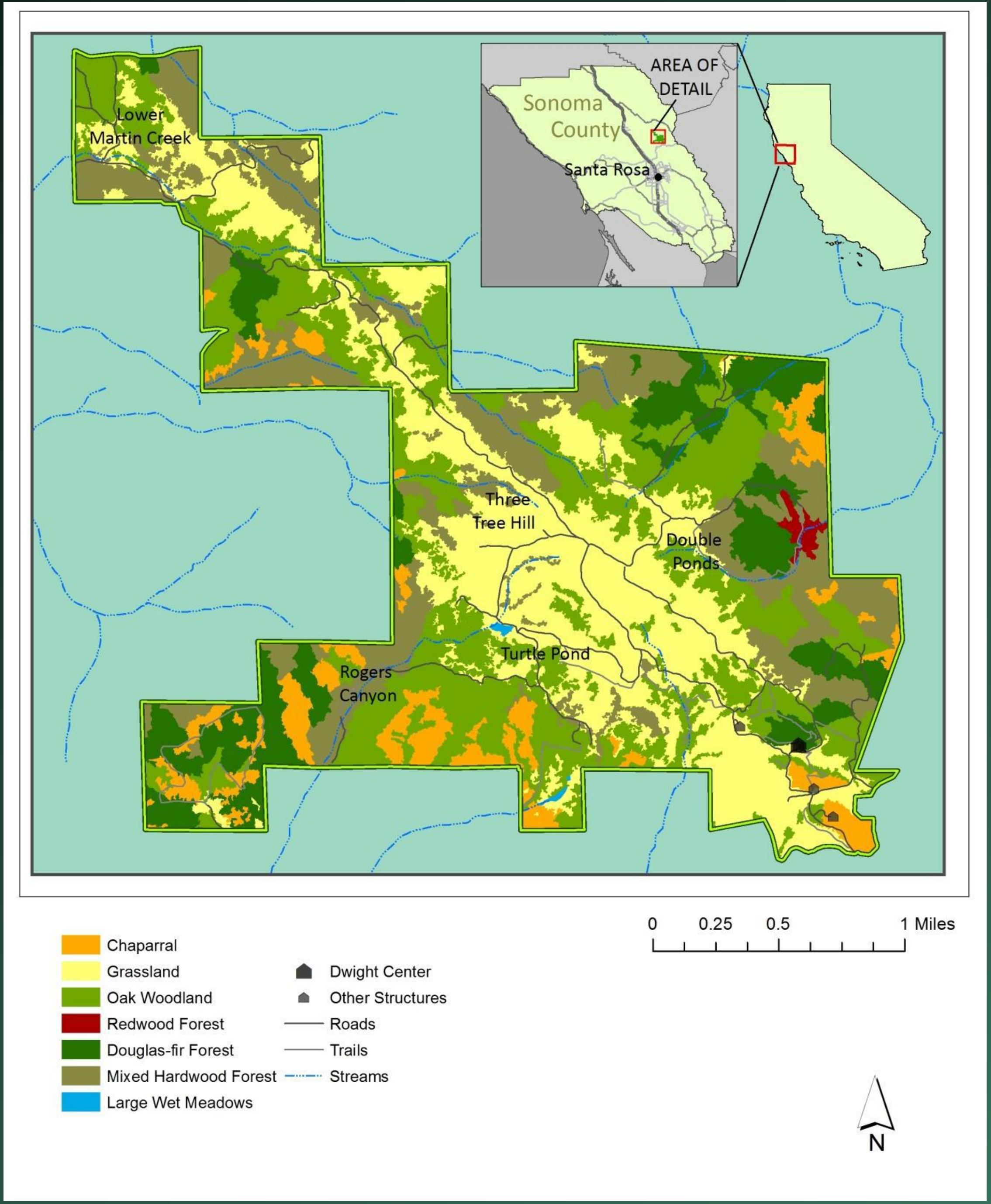


Using fine scale climate data and CWD, the distribution of meadows that are climate refugia for Belding's ground squirrel could assessed

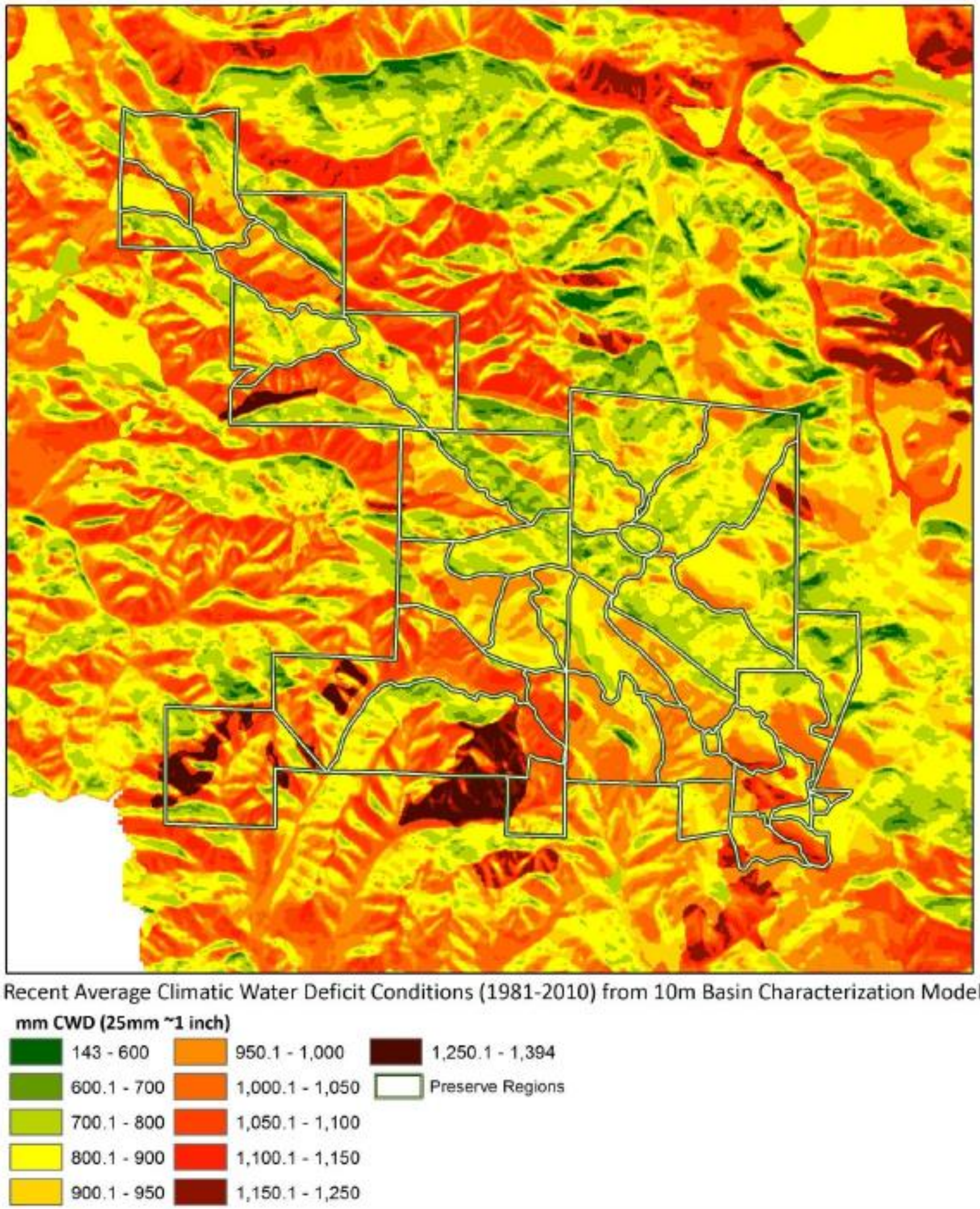
These maps were used to evaluate the potential for connectivity that can support the adaptive capacity of squirrels to future climate

Maher, S.P., Morelli, T.L., Hershey, M., Flint, A.L., Flint, L.E., Moritz, C., and Beissinger, S.T., 2017, Erosion of refugia in the Sierra Nevada meadows network with climate change. Ecosphere 8(4)

Vegetation Communities at Pepperwood Preserve, Sonoma County

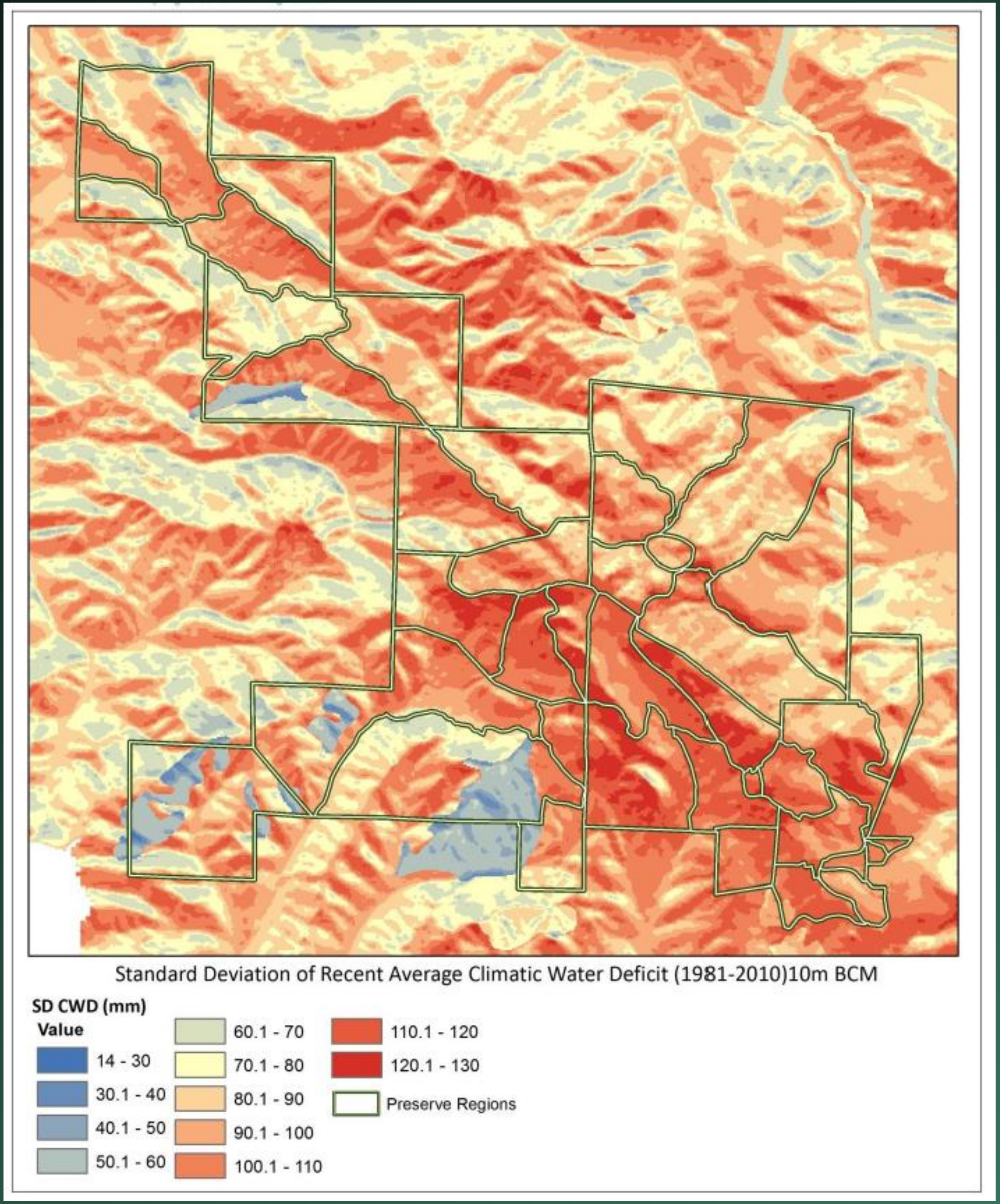


CWD 1981-2010 BCM 10-m model



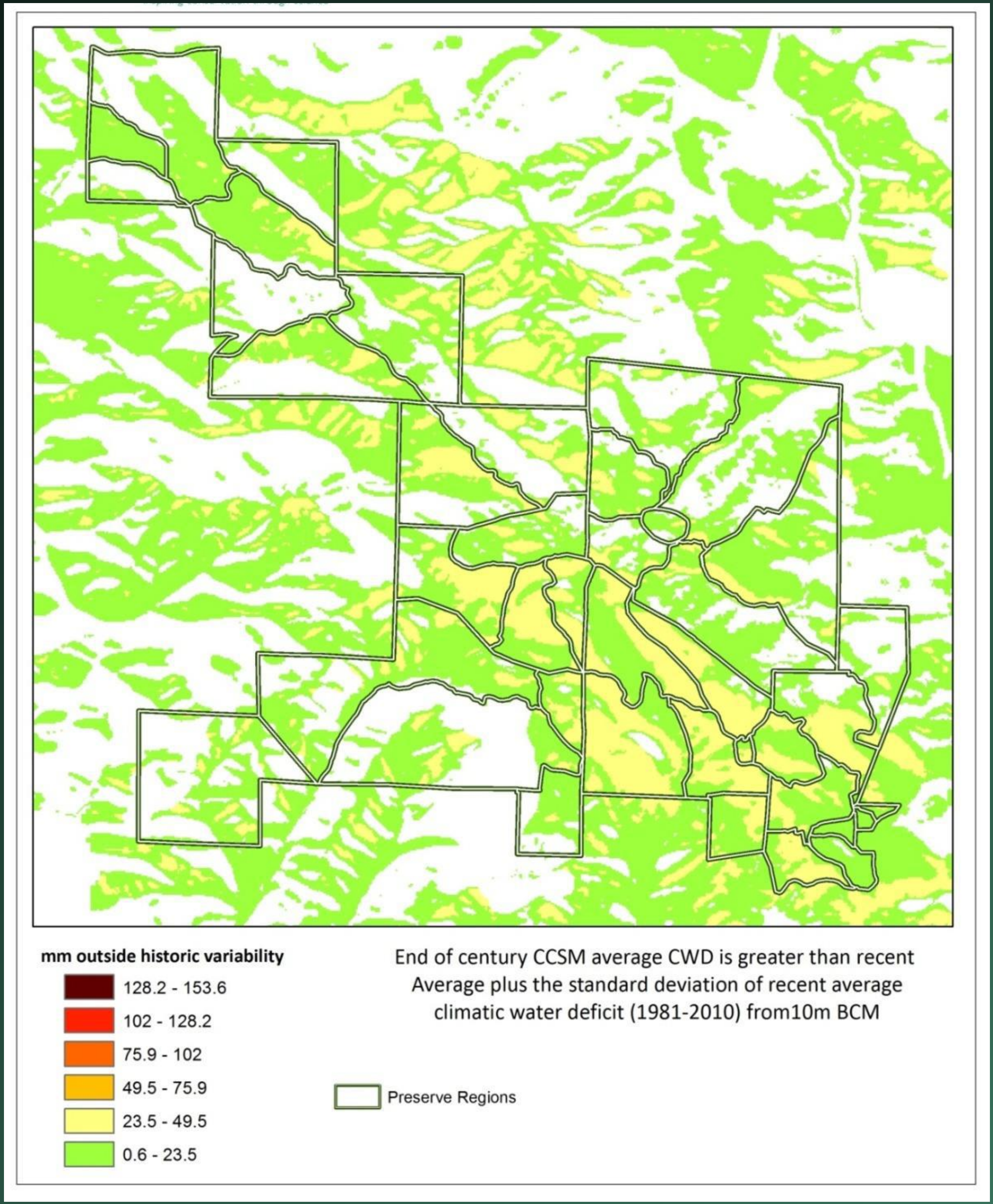
Recent Average Climatic Water Deficit Conditions (1981-2010) from 10m Basin Characterization Model

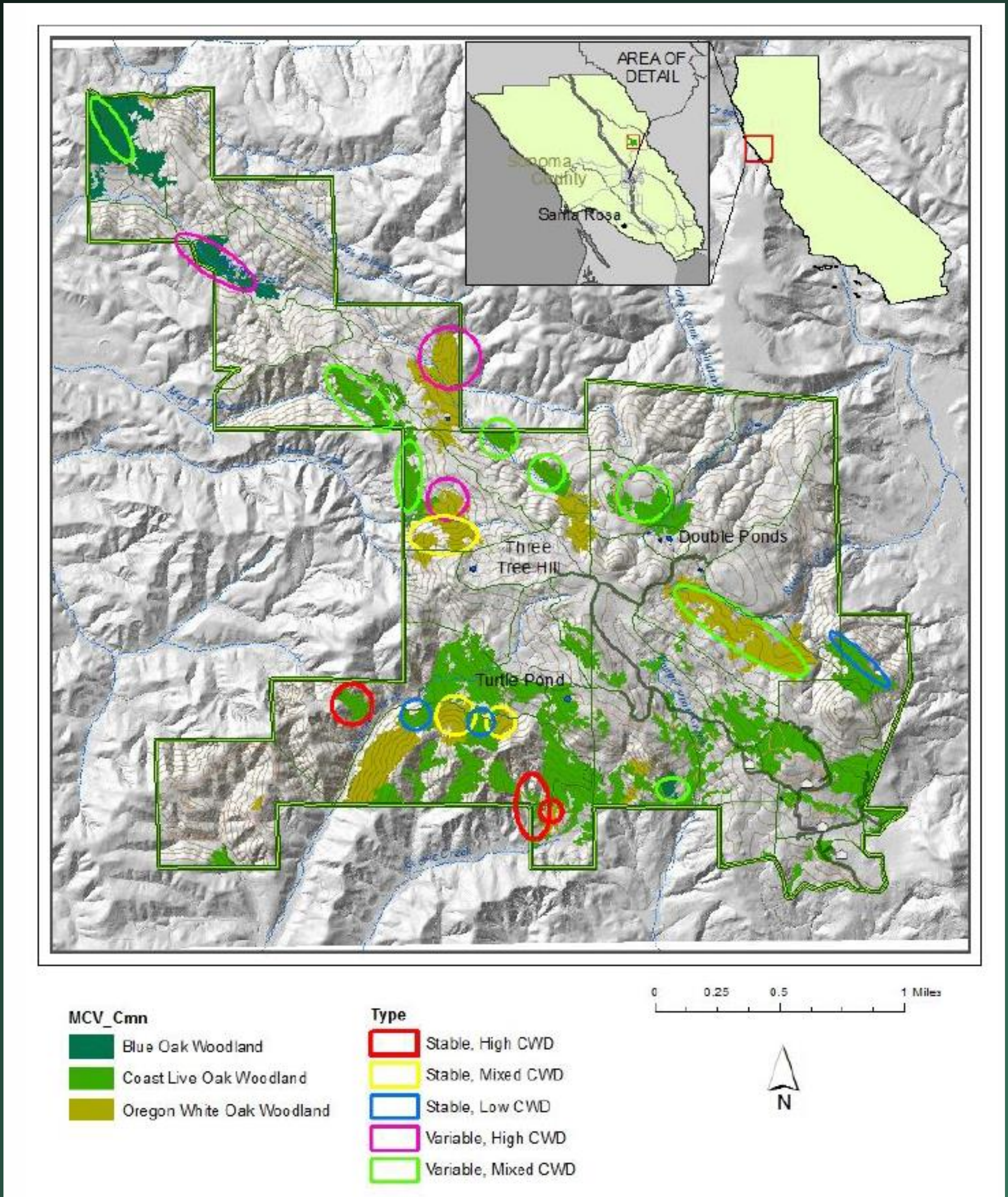
Standard deviation of CWD 1981-2010



End century CCSM4 rcp 8.5

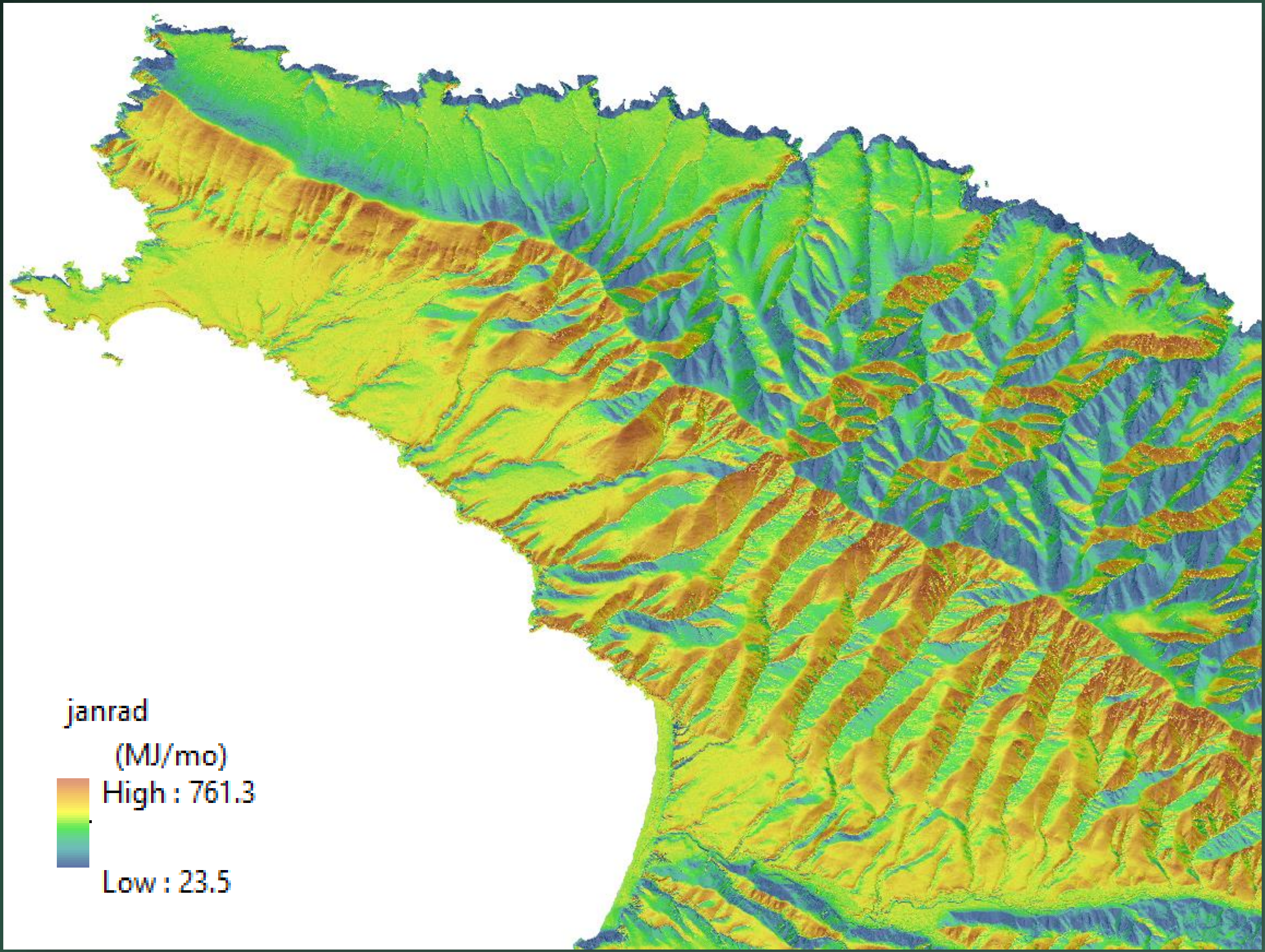
Where average CWD is greater than recent average plus the SD





Monitoring decisions to capture a range of potential conditions from stable to highly variable

Santa Cruz Island, Channel Islands National Park
Monthly solar radiation at 1-m to help locate and identify rare plant species



Basin Characterization Model Status

- BCMv65 (2014)
  - Vegetation transpires at potential evapotranspiration rate until reaching wilting point
  - Historical and 18 futures for California
- BCMv8 (2019)
  - Vegetation transpires less than PET, calibrated to 65 vegtypes on the basis of measured data
  - Improvements to support drought data
  - Options for scenario testing: urbanization, fire, forest management, soil management, managed aquifer recharge
  - Historical and 20 LOCA futures from 4CCCA for California
  - User’s manual in publication phase