CBRFC Evapotranspiration study

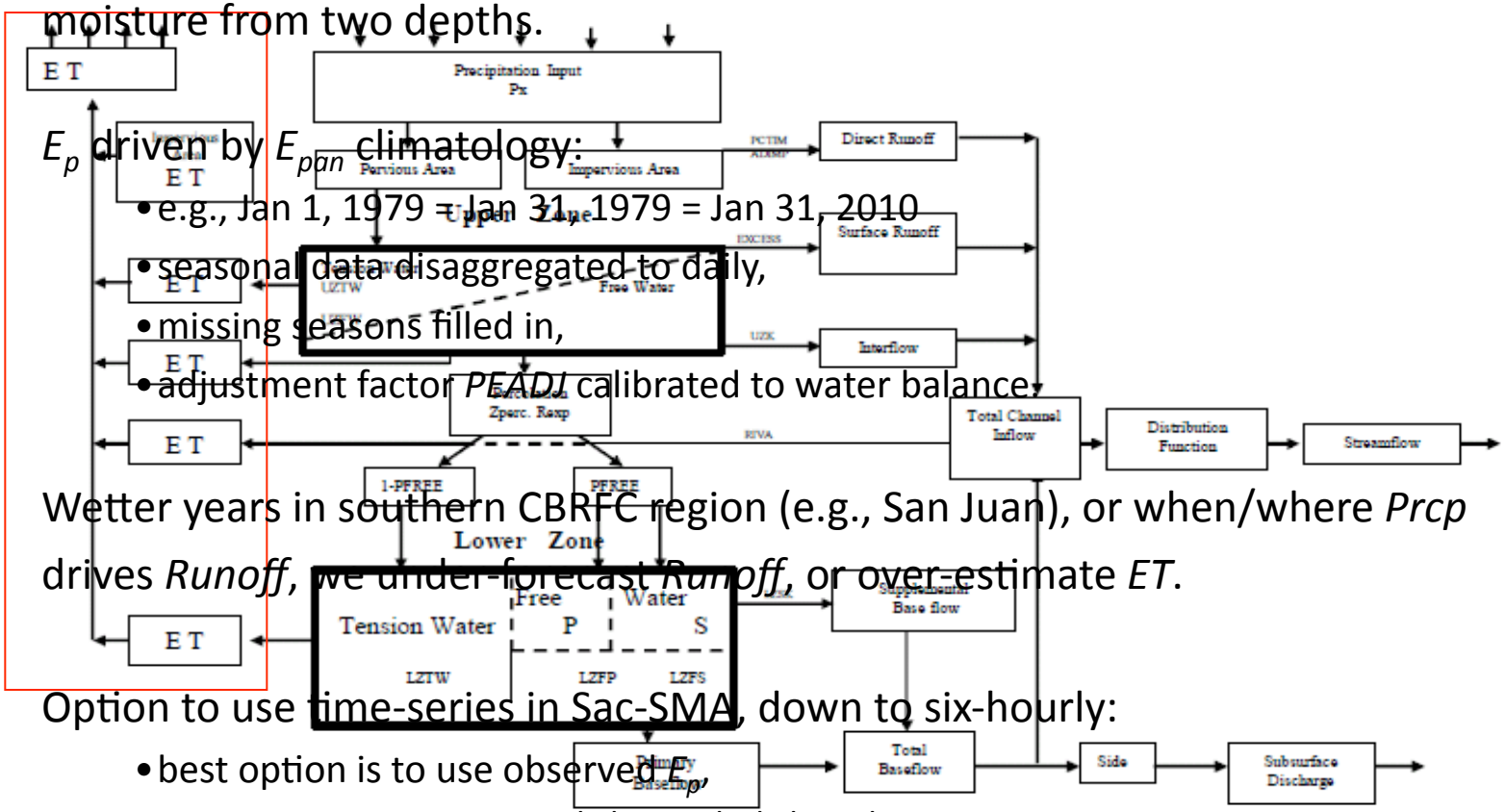
Improve the physics of the treatment of *ET* (and hence evaporative demand) in CBRFC operations, and thereby improve water supply forecast skill.

Cooperate with NWS Western Region Scientific Services Division in provision of scientifically sound, distributed *ET*-related forecasts to end-users.

ET = actual evapotranspiration

How *ET* is currently estimated by the NWS River Forecast System

Sacramento-Soil Moisture Accounting (Sac-SMA) model evaporates soil moisture from two depths.



E_p driven by E_{pan} climatology:

- e.g., Jan 1, 1979 – Jan 31, 1979 = Jan 31, 2010
- seasonal data disaggregated to daily,
- missing seasons filled in,
- adjustment factor *PEADJ* calibrated to water balance.

Wetter years in southern CBRFC region (e.g., San Juan), or when/where *Prcp* drives *Runoff*, we under-forecast *Runoff*, or over-estimate *ET*.

Option to use time-series in Sac-SMA, down to six-hourly:

- best option is to use observed E_p,
  - cannot use E_{pan} at a daily or sub-daily scale,
- best modeling option is a Penman-based estimate,
  - heavy on data inputs/parameters.

E_p = evaporative demand
E_{pan} = pan evaporation
Prcp = precipitation

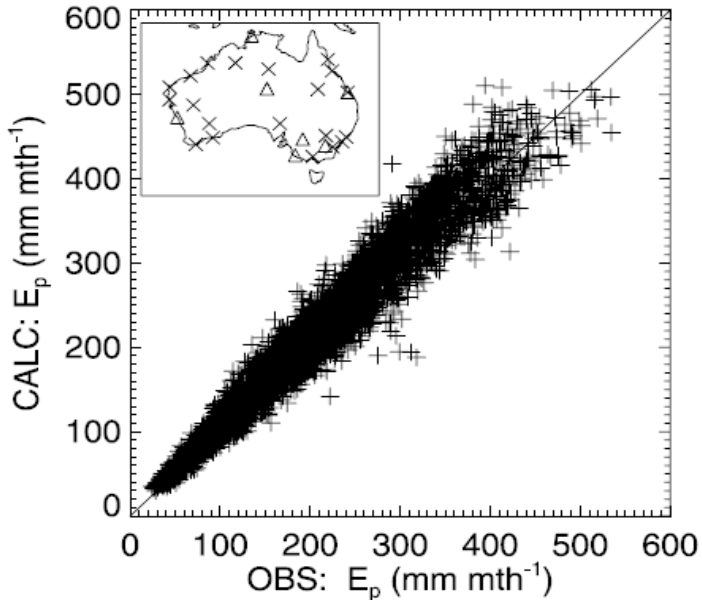
Physically based models:

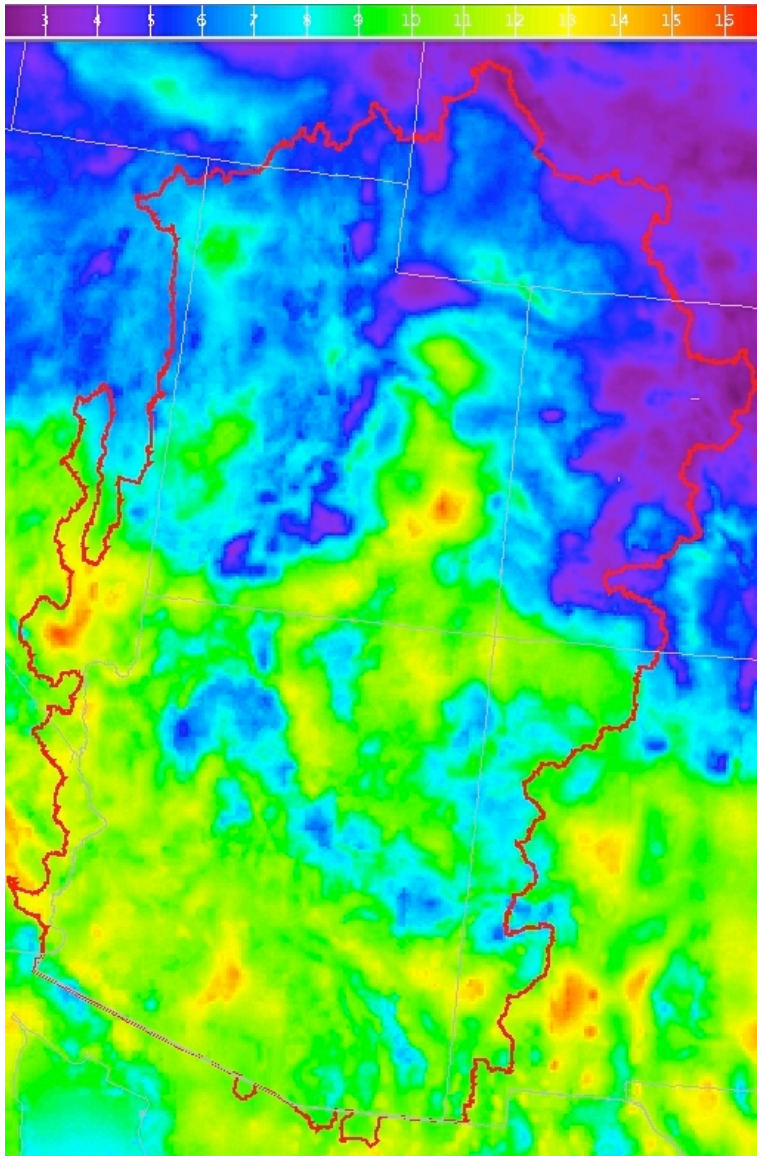
PenPan E_{pan} (synthetic pan evaporation)

Q_n = energy available for *ET*
U_2 = wind speed
e_{sat}-e_a = vapor pressure deficit (~ humidity)
IR = infra-red, or long-wave radiation

$$E_{pan} = \frac{\Delta}{\Delta + a_P\gamma} Q_n + \frac{a_P\gamma}{\Delta + a_P\gamma} f_q(U_2)(e_{sat} - e_a)$$

- synthetic measure of evaporative demand to synthesize E_{pan} observations.
- mixture of radiation (sunshine and *IR*) and drying power of the air (humidity and wind).
- accounts for instrumentation effects:
  - extra sunshine interception by pan walls,
  - increased turbulence across water surface.

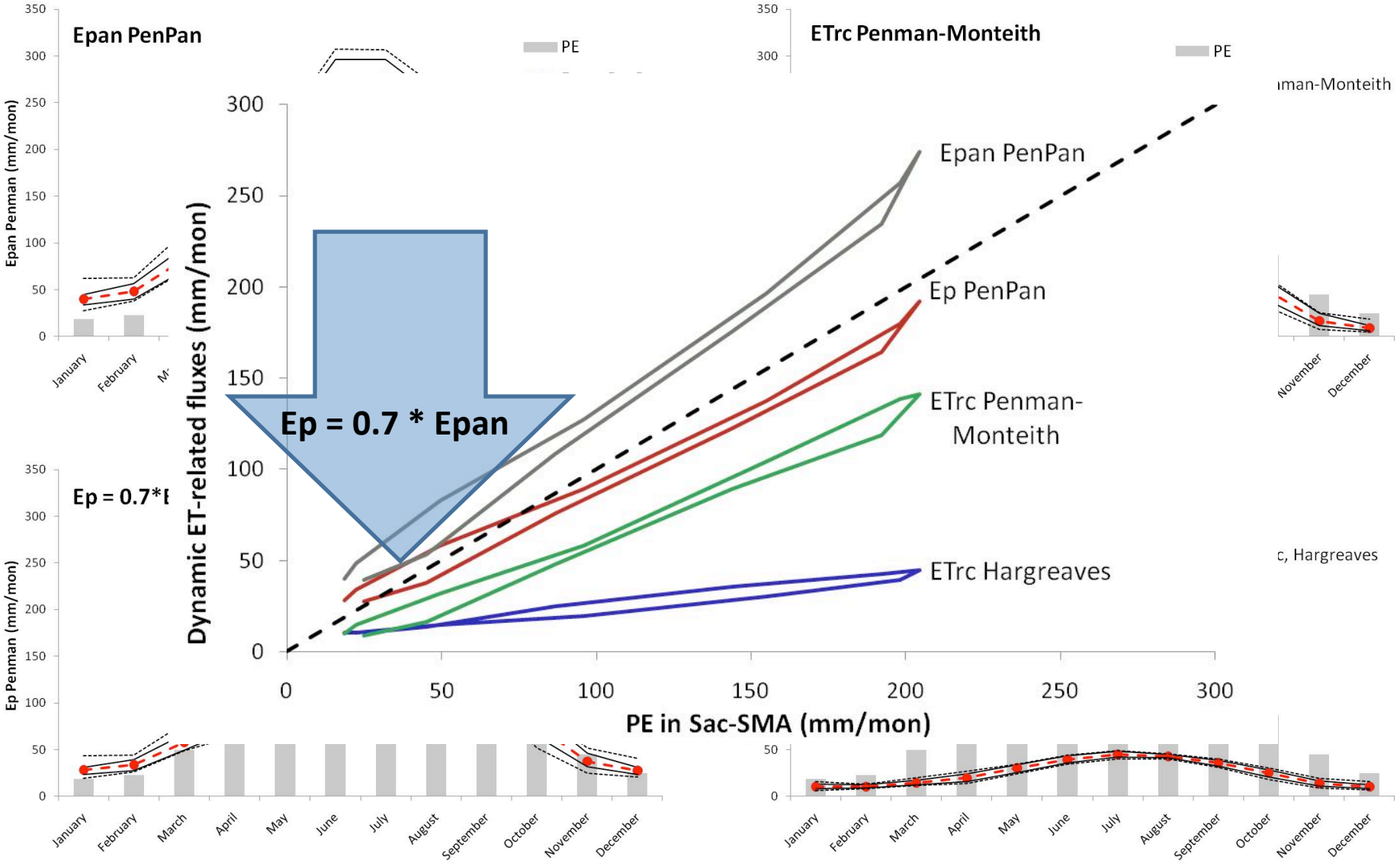




E_{pan} for April 25, 2010 (mm)

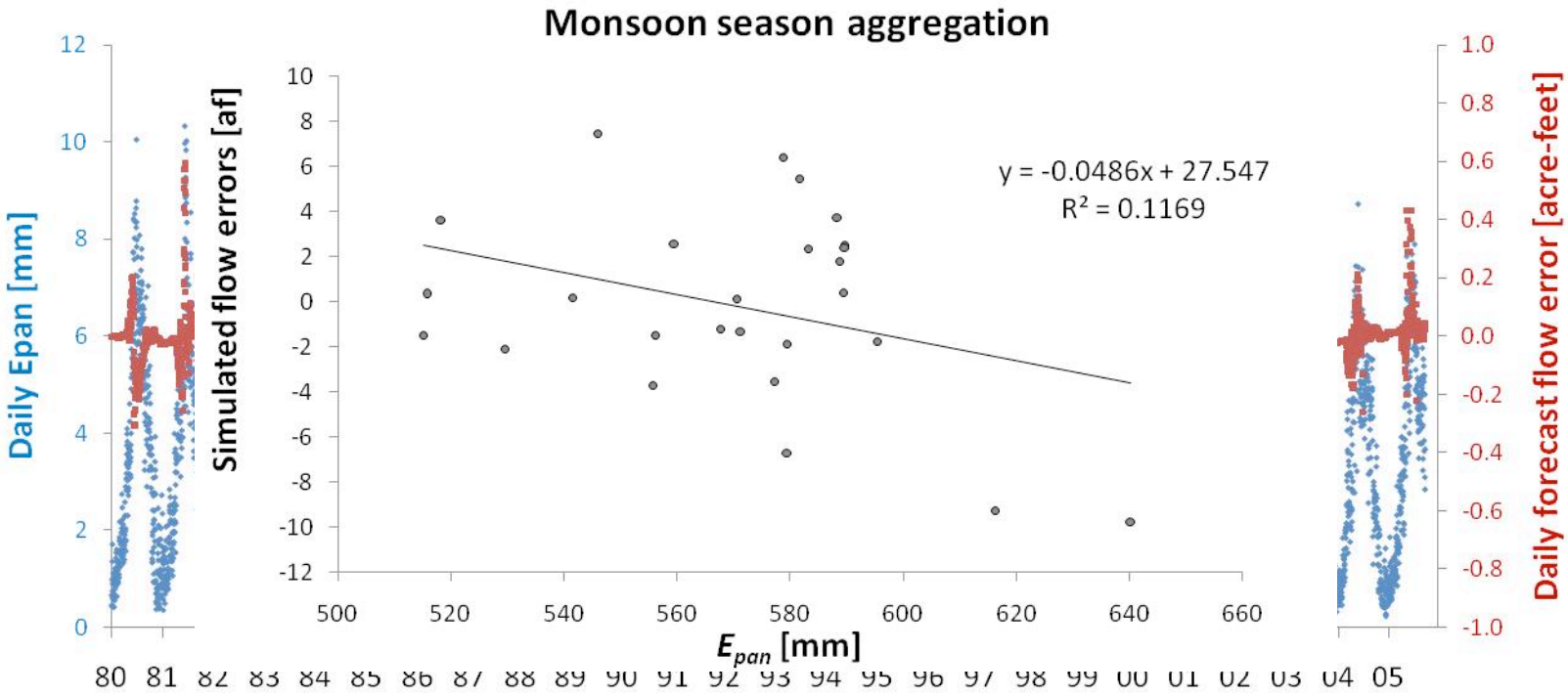
Preliminary results:

climatology of dynamic daily Epan, Ep, and ETrc – Tenmile Creek, CO



Preliminary results:

dynamic Epan vs. historic simulated streamflow errors



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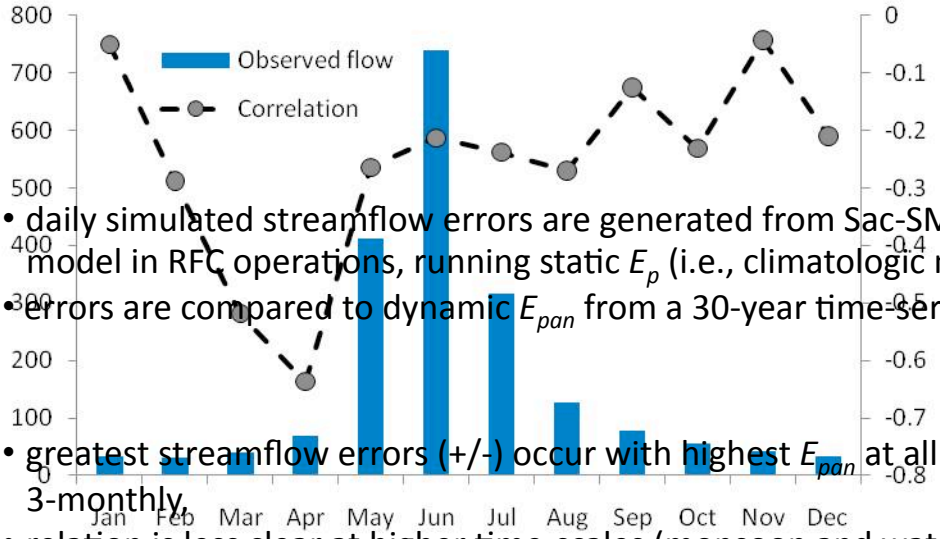
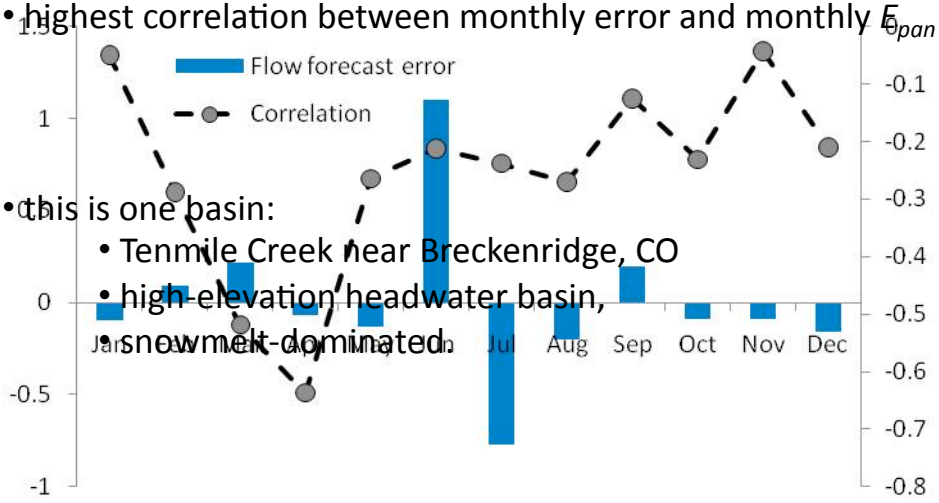


Concept:

- daily simulated streamflow errors are generated from Sac-SMA/SNOW-17 model in RFC operations, running static E_p (i.e., climatologic monthly),
- errors are compared to dynamic E_{pan} from a 30-year time-series.

Results:

- greatest streamflow errors (+/-) occur with highest E_{pan} at all time-scales to 3-monthly,
- relation is less clear at higher time-scales (monsoon and water supply seasons, annual),
- highest correlation between monthly error and monthly E_{pan} is March/April.



Caveat:

- this is one basin:
  - Tenmile Creek near Breckenridge, CO
  - high-elevation headwater basin,
  - snowmelt-dominated.

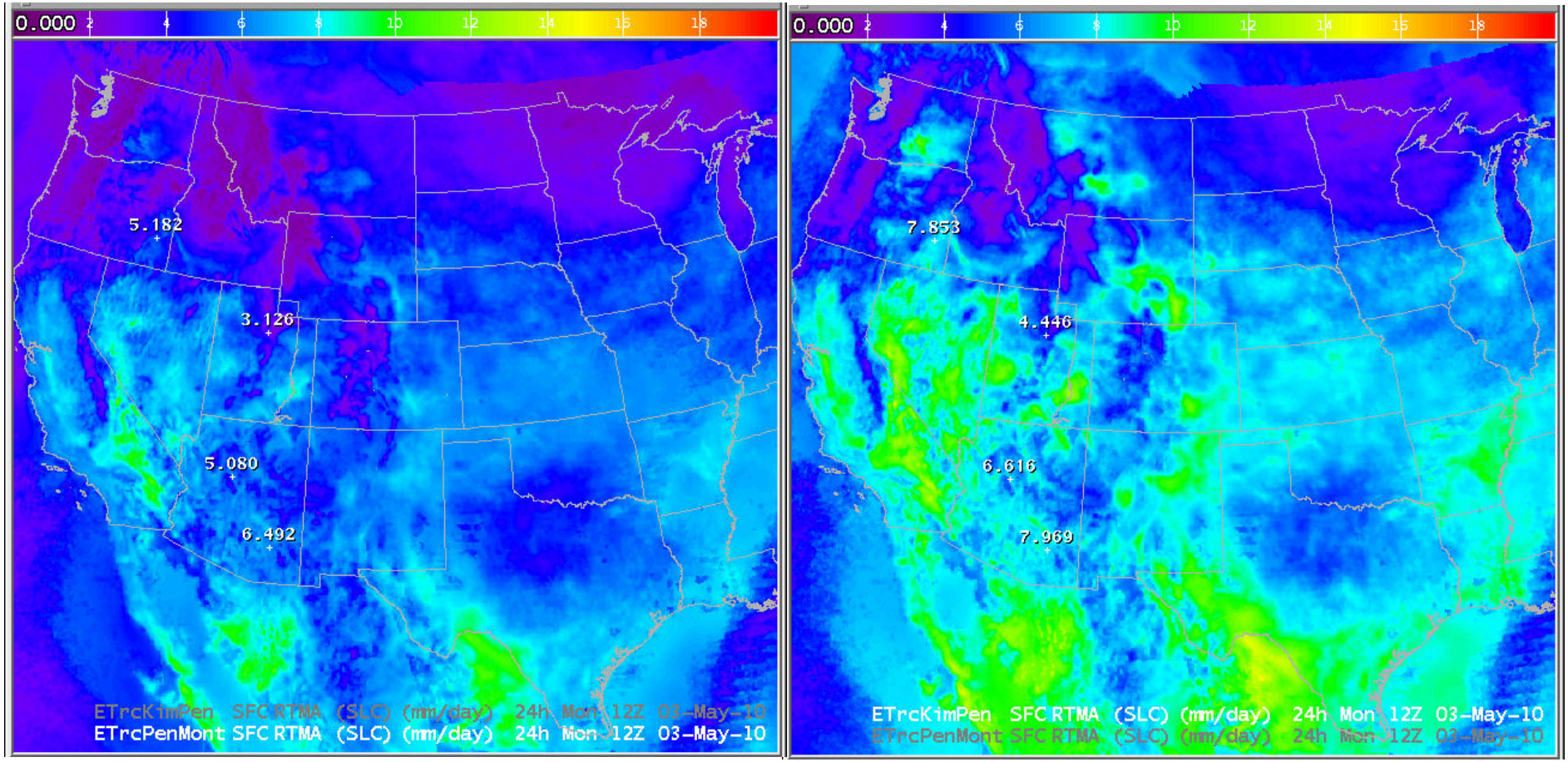
Forecasting ET_{rc} across NWS Western Region:

Penman-Monteith ET_{rc}

$$ET_{rc} = \frac{\Delta}{\Delta + \gamma\left(1 + 0.34U_2\right)} Q_n + \frac{\gamma}{\Delta + \gamma\left(1 + 0.34U_2\right)} \frac{0.9}{T} U_2 \left(e_{sat} - e_a\right)$$

Kimberly Penman ET_{rc}

$$ET_{rc} = \frac{\Delta}{\Delta + \gamma} Q_n + \frac{\gamma}{\Delta + \gamma} \frac{6.43}{86.4} \left(a_{\mathrm{KP}} + b_{\mathrm{KP}} U_2\right)\left(e_{sat} - e_a\right)$$



ET_{rc} forecast for May 3, 2010 (mm)

Forecasting ET_{rc} across NWS Western Region: delivery concept