

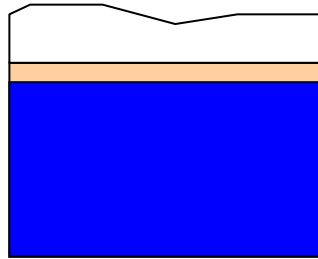
Connections Between Fall SMAP L2 Retrievals and Subsequent Spring Streamflow

Randal Koster*, Qing Liu, Wade Crow, Rolf Reichle

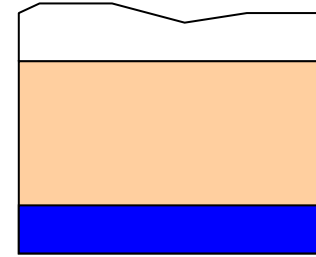
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Soil Moisture and Streamflow Generation

Snow (or rainfall) over wet soil: most of the meltwater runs off into streams, reservoirs.



Snow (or rainfall) over dry soil: much of the meltwater infiltrates the soil and is lost to evapotranspiration $\Rightarrow$ less to streams, reservoirs.

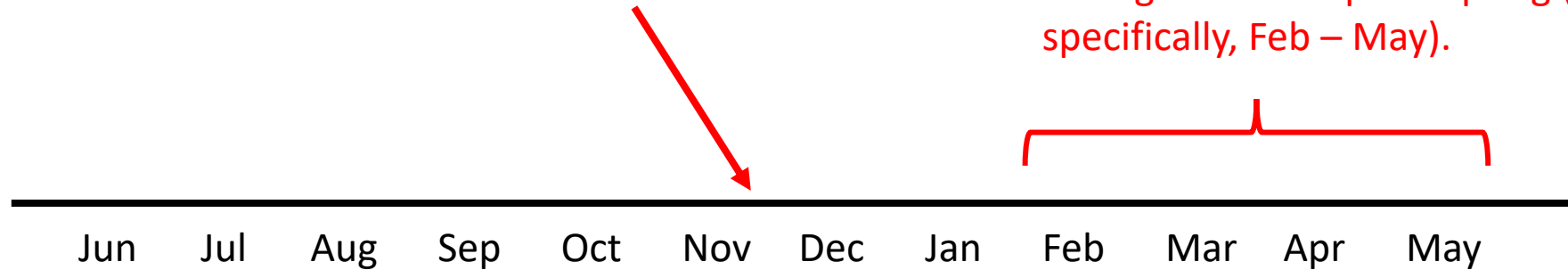


$\Rightarrow$ Knowledge of soil moisture could contribute to streamflow forecasts.

Potential for SMAP-based seasonal forecasts of streamflow

Use SMAP L2 retrievals to estimate “full profile” soil moisture here (Nov. 30)...

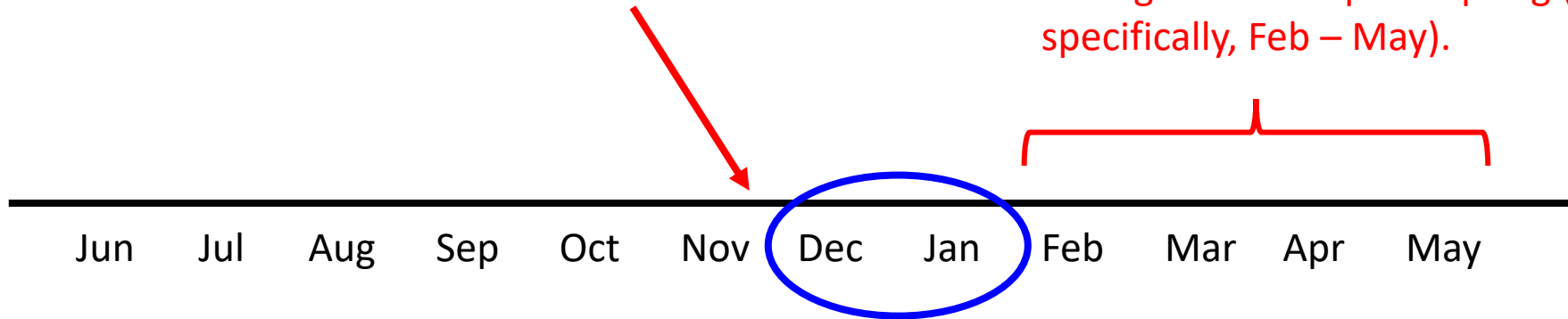
...and relate it to average streamflow during the subsequent spring (more specifically, Feb – May).



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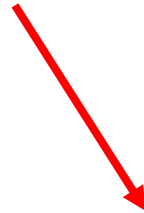
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Take advantage of “quiescent” soil hydrology during winter – low ET helps increase soil moisture memory.

Potential for SMAP-based seasonal forecasts of streamflow

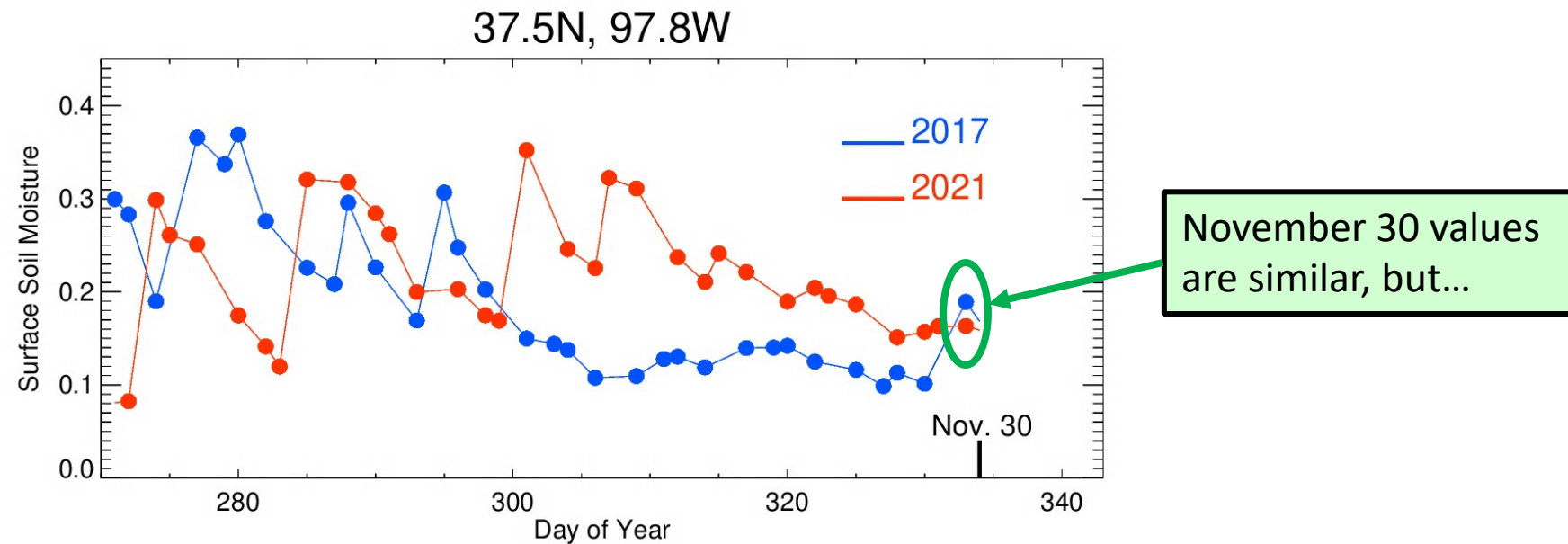
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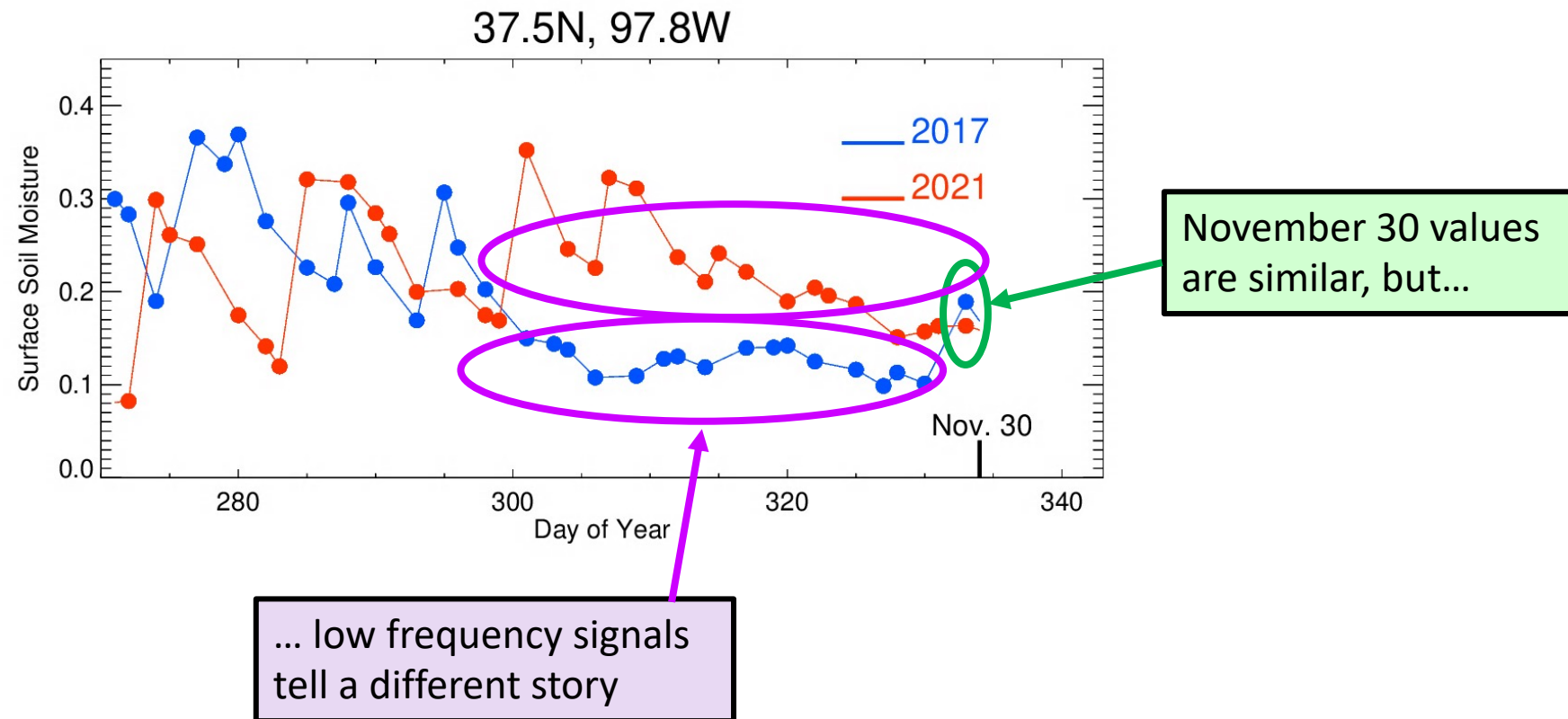
Obvious question:
how do we do this?

Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May

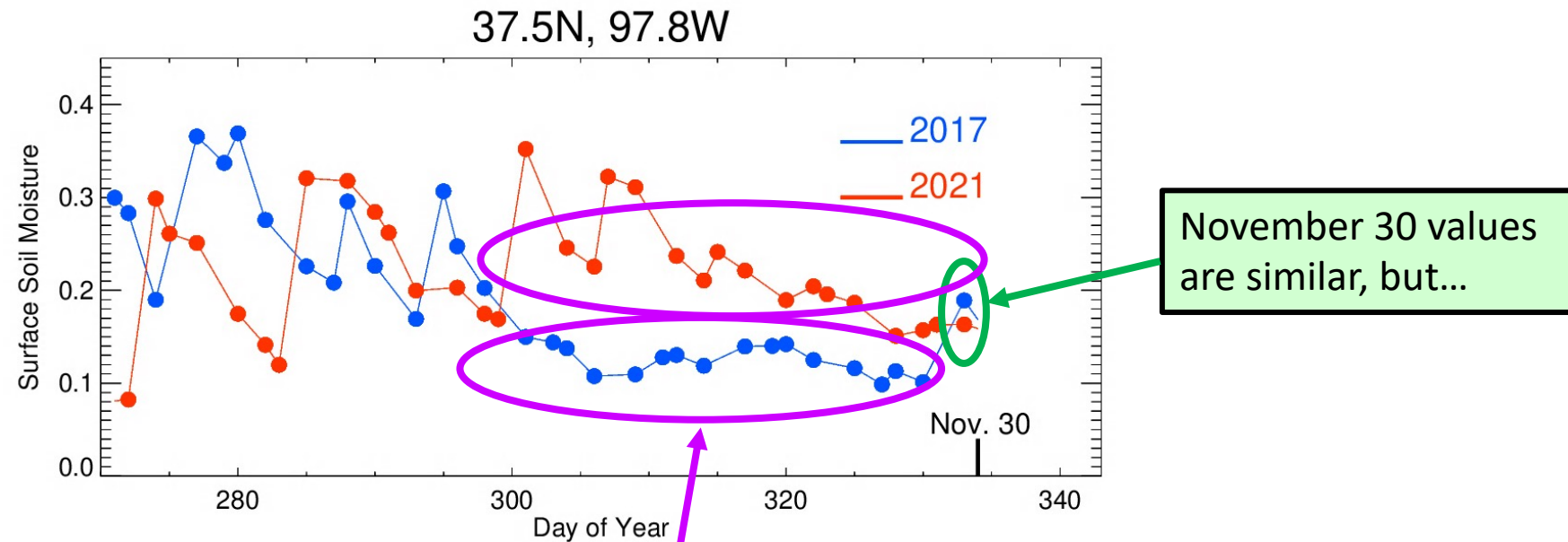
Two L2 time series at a representative site:



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... low frequency signals tell a different story

⇒ Assume the low frequency signal reflects deeper soil moisture!

Exponential filtering (Wagner et al 1999): a way of averaging the retrievals over time to get at the low frequency signal:

$$W_{Nov30} = \sum_{n=0}^N w_n \exp\left(\frac{t_n - t_{Nov30}}{\tau}\right) / \sum_{n=0}^N \exp\left(\frac{t_n - t_{Nov30}}{\tau}\right)$$

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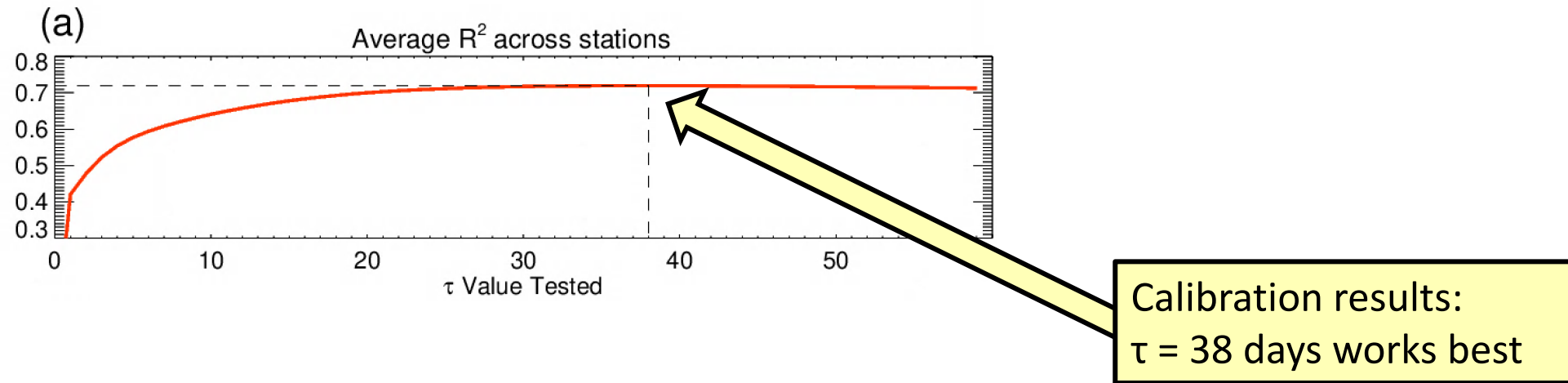
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To get the November 30 full profile soil moisture estimates from the SMAP L2 retrievals, we must calibrate this time scale.

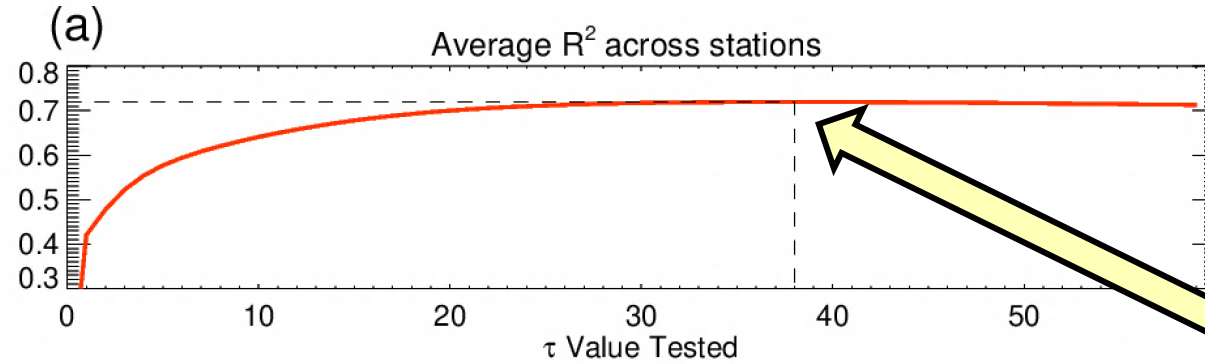
Calibration of τ :

- Within every basin, use an assigned τ value in the filtering equation to derive a Nov. 30 soil moisture estimate.
- Compare these estimates to November 30 profile soil moisture in the basins from MERRA-2 for each of seven years: 2015-2021. *(Note: information on subsequent streamflow is not used in the calibration!)*
- Find the single value of τ that, on average across the basins, provides the highest R^2 between the estimates and the MERRA-2 profile soil moistures.

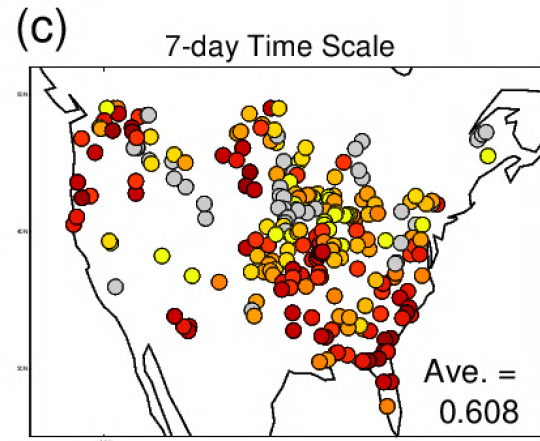
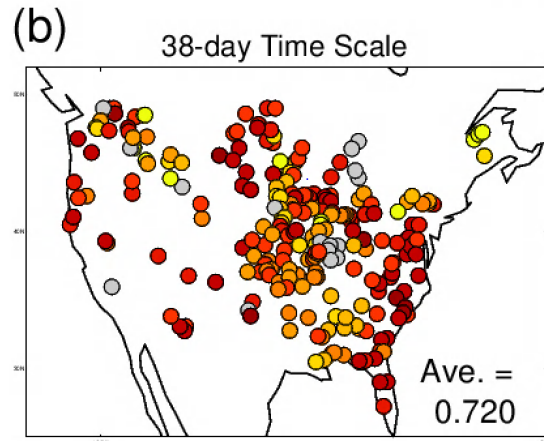
Estimating Nov. 30 Profile Moisture with L2 Retrievals



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Calibration results:
 $\tau = 38$ days works best

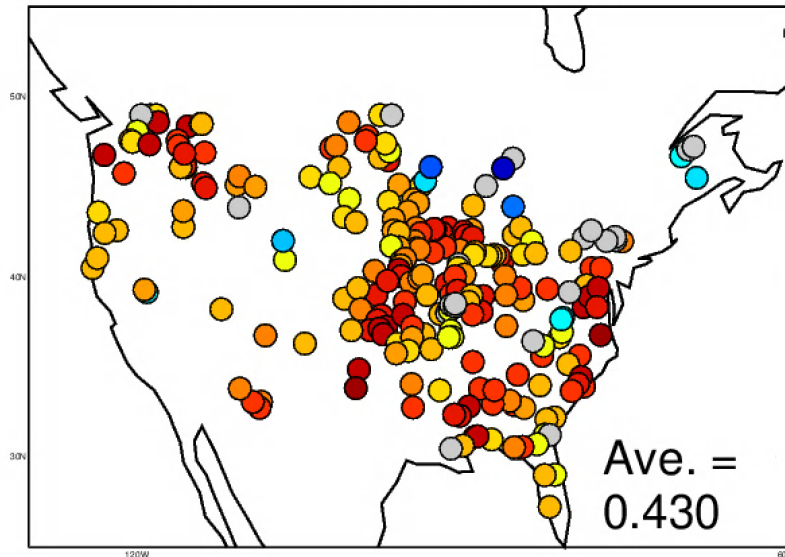


With an ability in hand to estimate November 30 profile soil moisture from L2 retrievals, we are ready to see how the profile estimates relate to subsequent February-May streamflow.

⇒ Compute correlation between L2-based November 30 profile soil moisture estimates and measured streamflow from 7 data pairs (one from each year) within each basin.

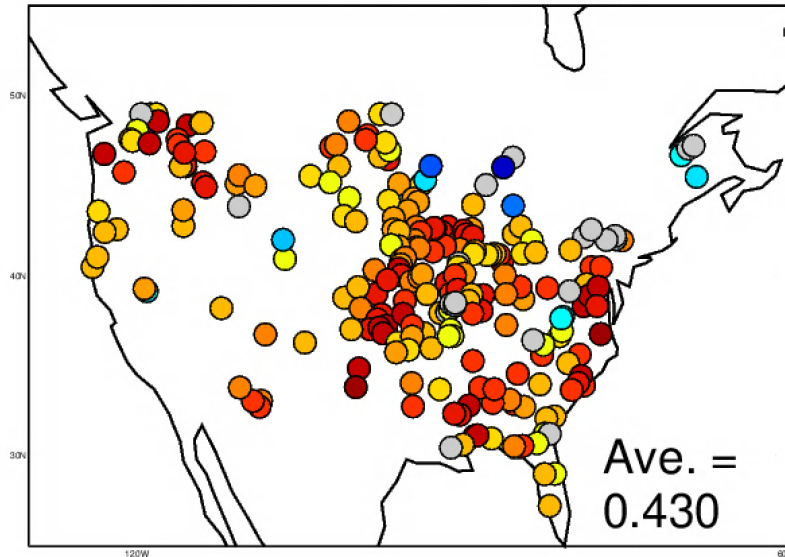
Correlating Nov. 30 Soil Moisture with Subsequent Feb.-May Streamflow

(a) Using 'recommended' and
'uncertain' L2 retrievals

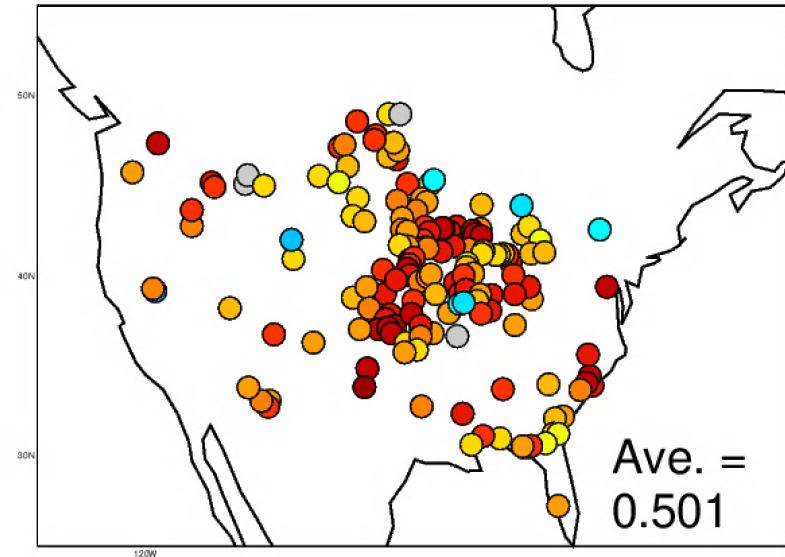


Correlating Nov. 30 Soil Moisture with Subsequent Feb.-May Streamflow

(a) Using 'recommended' and
'uncertain' L2 retrievals



(b) Using only 'recommended'
L2 retrievals



Summary findings:

- 1) SMAP L2 surface soil moisture retrievals can be temporally averaged (with an exponential filter) into estimates of deeper (“profile”) soil moisture.
- 2) Profile soil moisture estimates are significantly correlated with subsequent spring streamflow.

⇒ SMAP L2 soil moisture retrievals can potentially be used to predict seasonal streamflow with some skill.