

Evaluating groundwater conservation using emerging remotely sensed products

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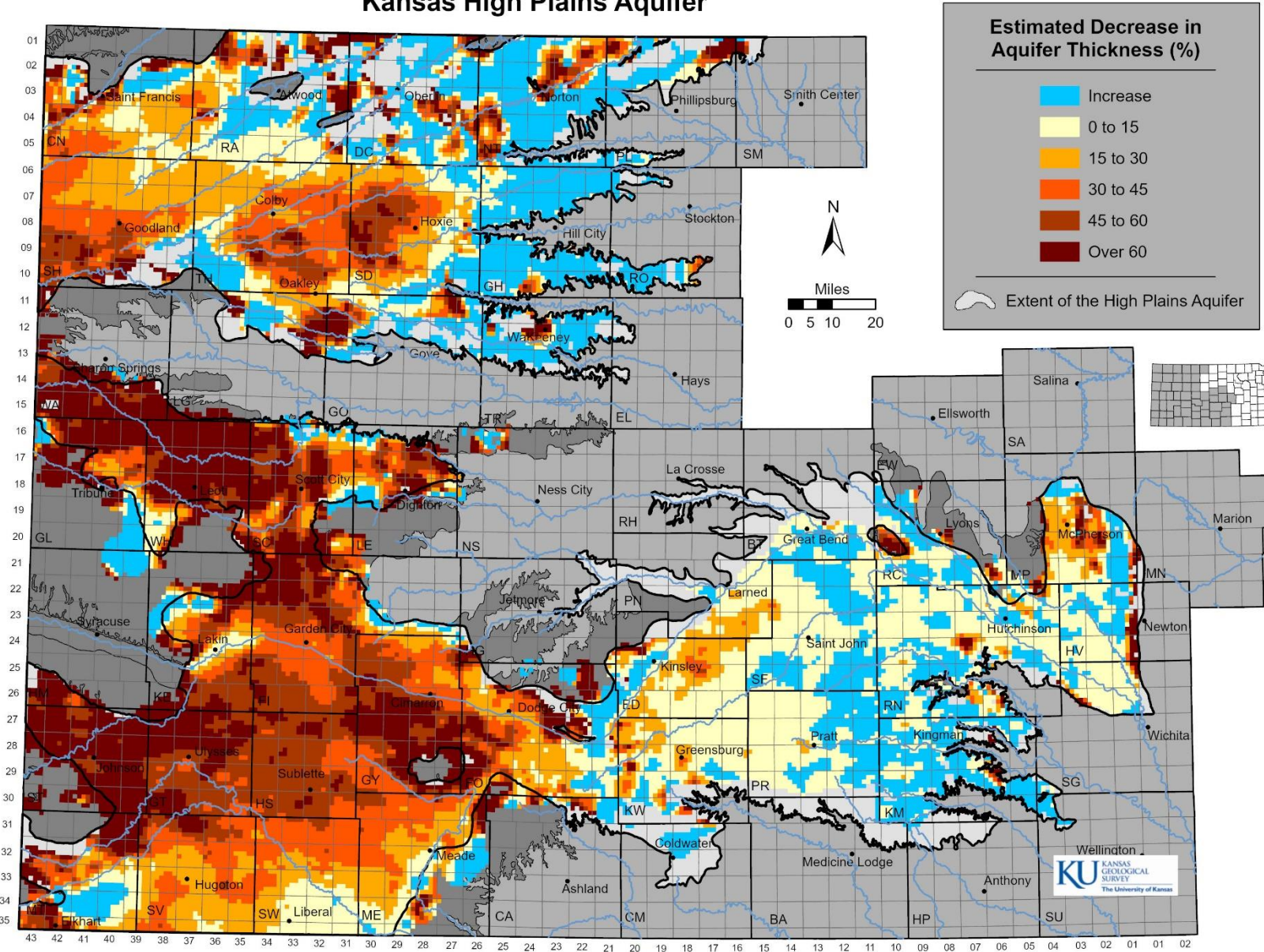
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Groundwater challenges

Percent Change in Aquifer Thickness, Predevelopment to Average 2020-2022,
Kansas High Plains Aquifer



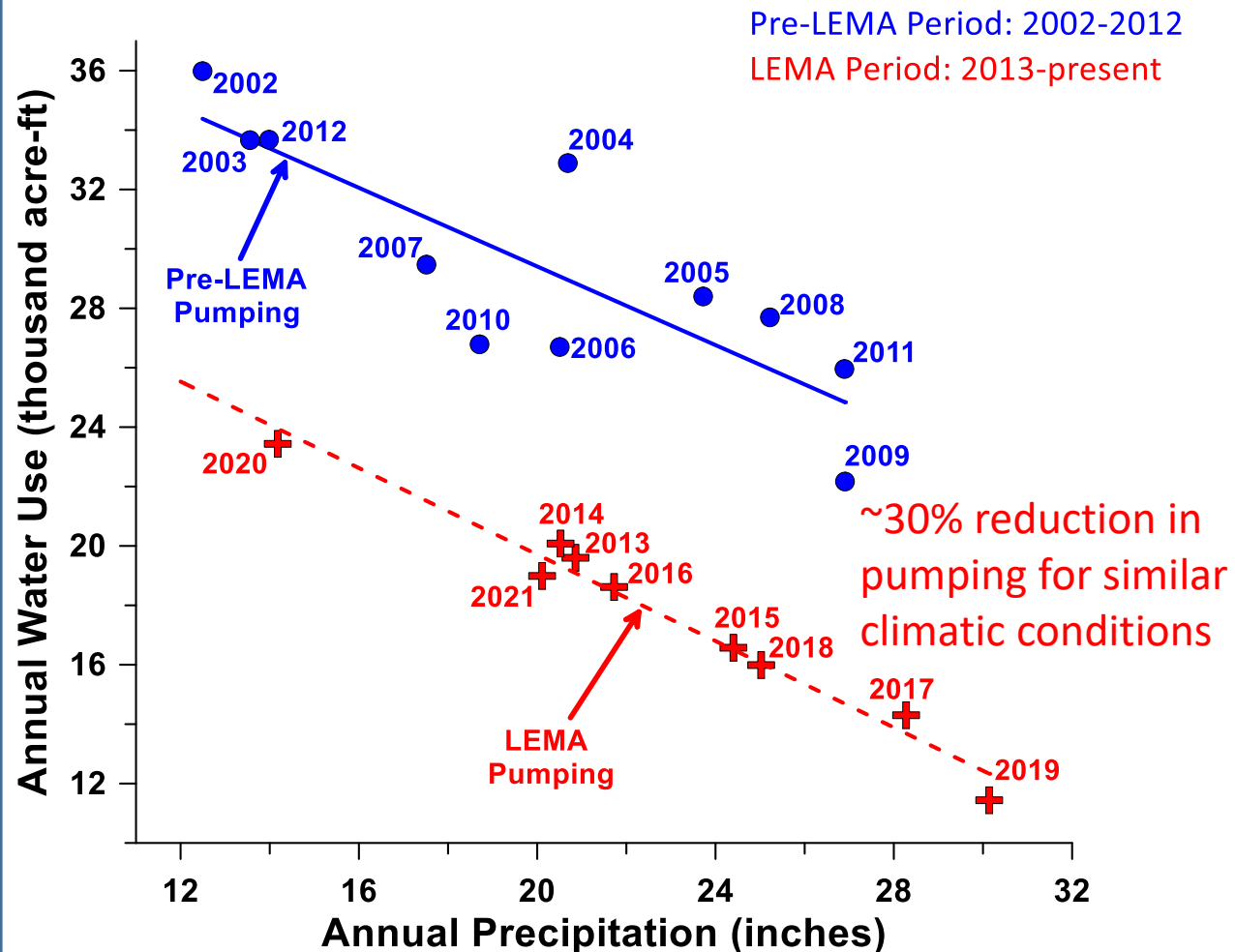
- Declining water levels in High Plains Aquifer
- Conservation options include local enhanced management area (LEMA) and water conservation area (WCA) programs

Groundwater conservation success

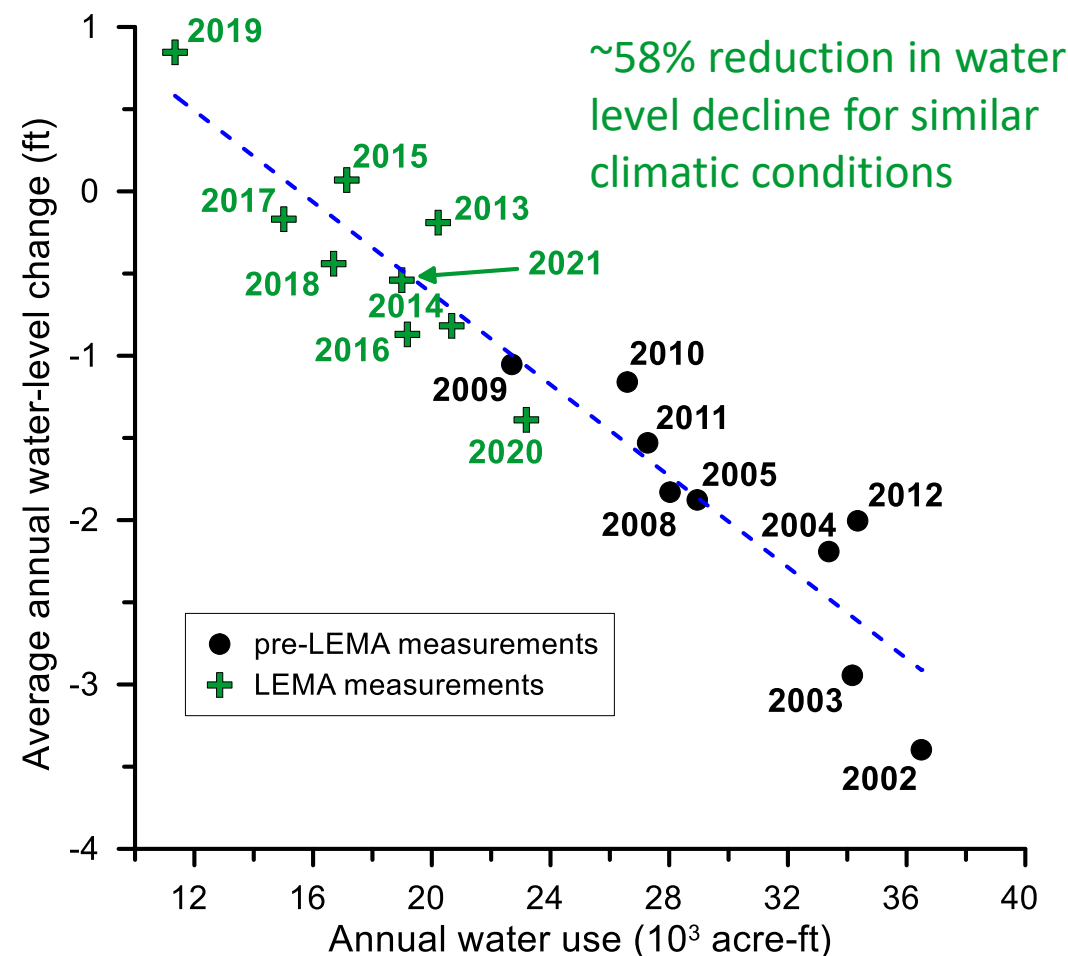
SD-6 LEMA has reduced water use

and slowed water table decline

Sheridan-6 LEMA



GMD4 Sheridan-6 LEMA



Closing the water balance

- Groundwater use and water level data extremely useful for assessing irrigation and groundwater conservation program effectiveness

Potential

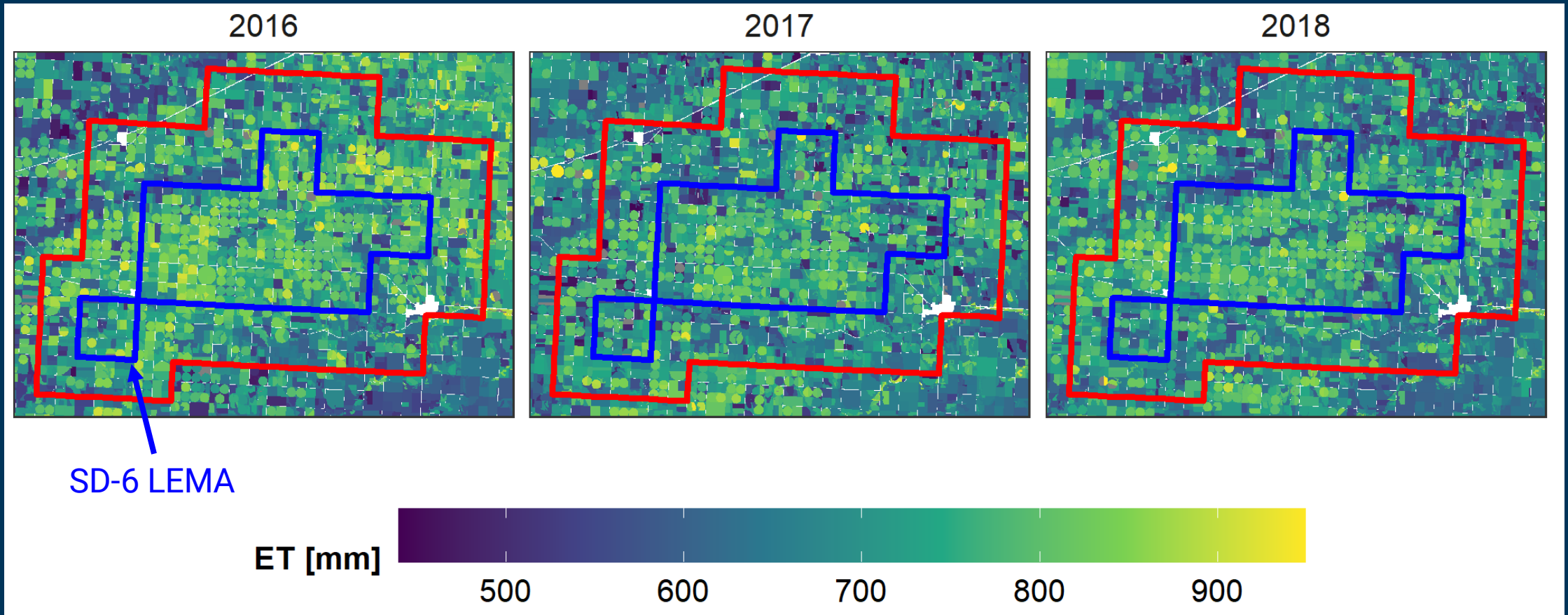
- However, gaps remains:
 - Spatial scale: Points of diversion (wells) → Field or sub-field (30 m)
 - Temporal scale: Annual, with lag → Near-real-time
 - Water balance: Only measure pumping → Other parts of water balance (ET, return flows, ...)
- One potential tool for spatial and temporal disaggregation: remote sensing
 - New product: OpenET (daily, 30 m resolution)

1. Can satellite-based approaches provide reasonable estimates of groundwater pumping?

2. What are major sources of uncertainty in translating ET to pumping volumes?



OpenET: A new tool

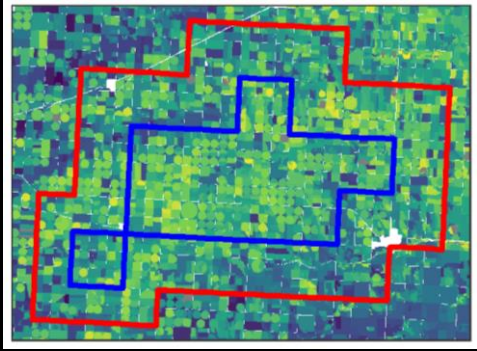


- Application-ready data for 6 algorithms + ensemble mean
- Daily, 30 m resolution → using field averages here
- Throughout presentation, using preliminary data
- Details in Melton et al. (2021) *JAWRA*

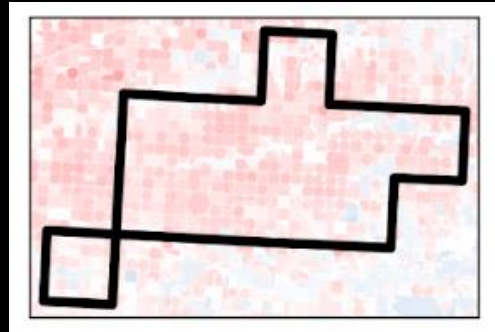
* Preliminary, pre-release data

Can ET data provide reasonable pumping estimates?

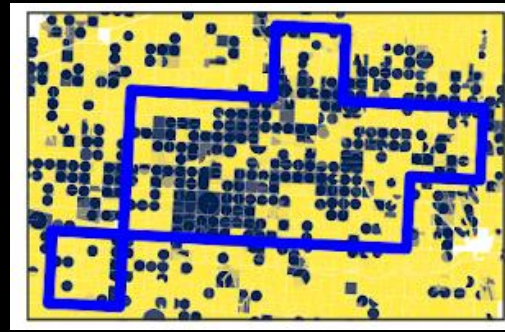
Total Growing Season ET*



Precipitation Deficit (ET - P)



Irrigation Mask (AIM; Deines et al)



QAQC Procedure

- Identify anomalous land covers
- Percentile by crop type/irrigation status/year
- Negative values

* Also tested total annual and water year

Compare to flowmeter data



Water Rights Groups

- Group fields by water right, place of use, and point of diversion.

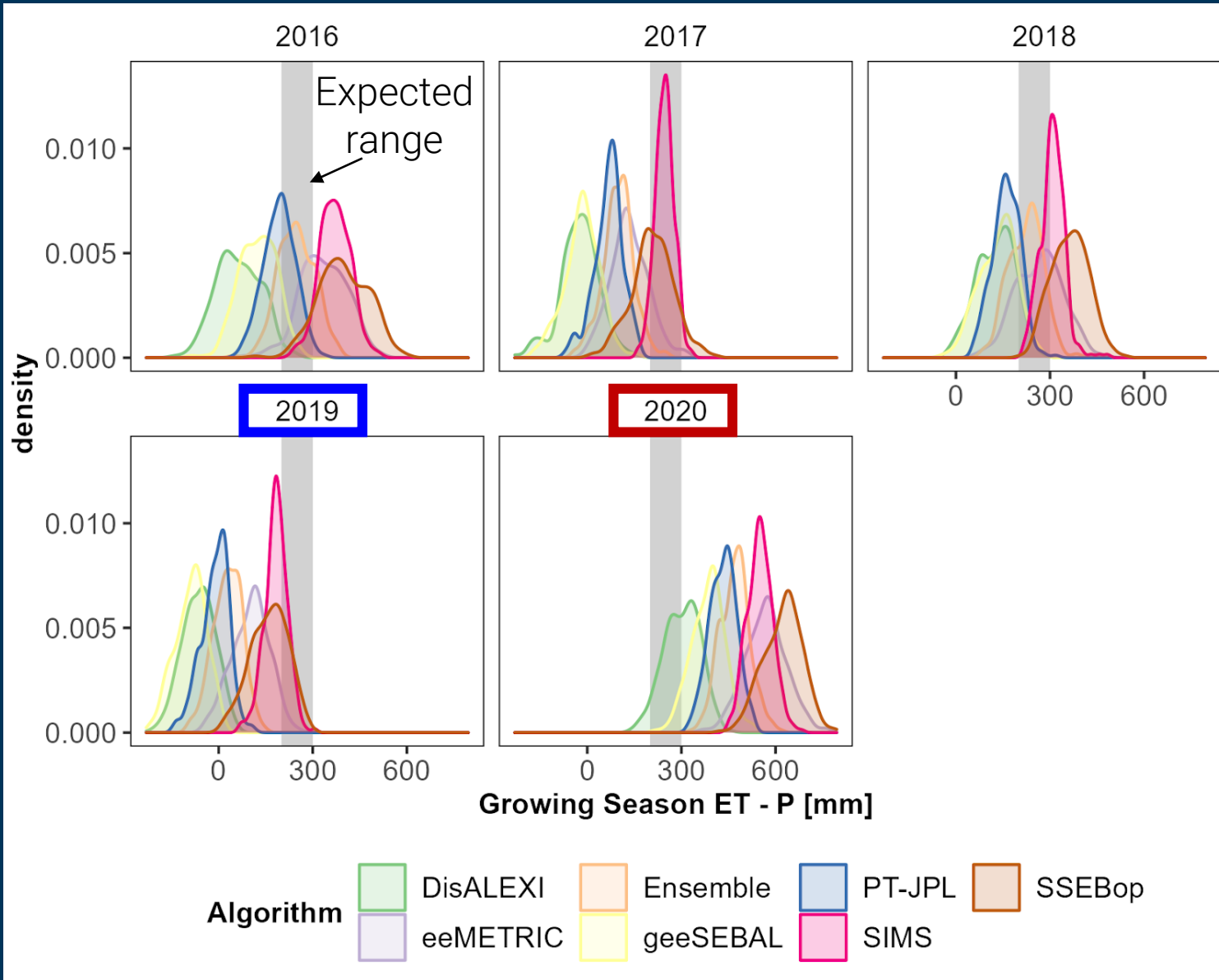
Annual field-resolution irrigation depth [mm]

* Preliminary, pre-release data

OPENET

Comparison: Field-Resolution

Estimated irrigation for all irrigated fields in LEMA by year

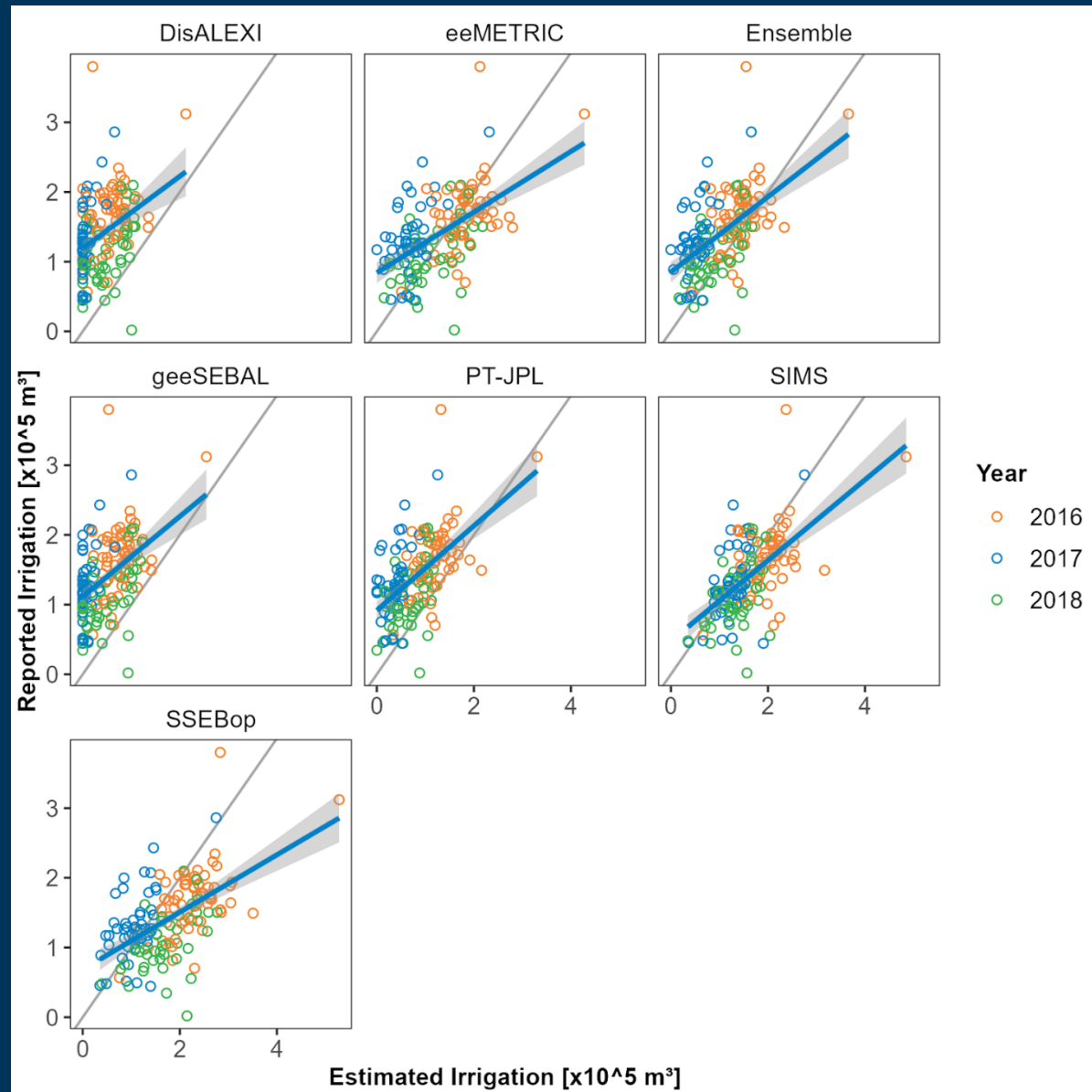


- Variability among algorithms
 - Low end: geeSEBAL, DisALEXI
 - High end: SSEBop, SIMS
 - *Source of uncertainty*
- Variability among years
 - Wet year (2019): underestimate
 - Dry year (2020): overestimate
 - Method does not account for year to year soil moisture carryover
 - *Source of uncertainty*

* Preliminary, pre-release data

Comparison: Water Rights Group

Comparison to flowmeter data for each water rights group

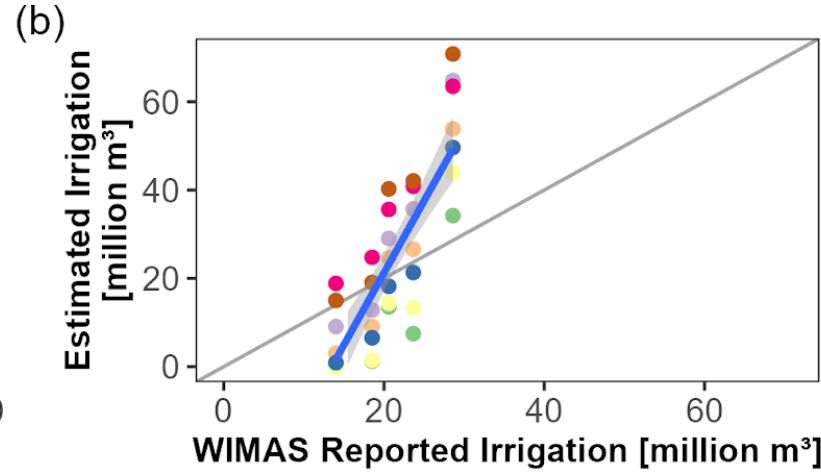
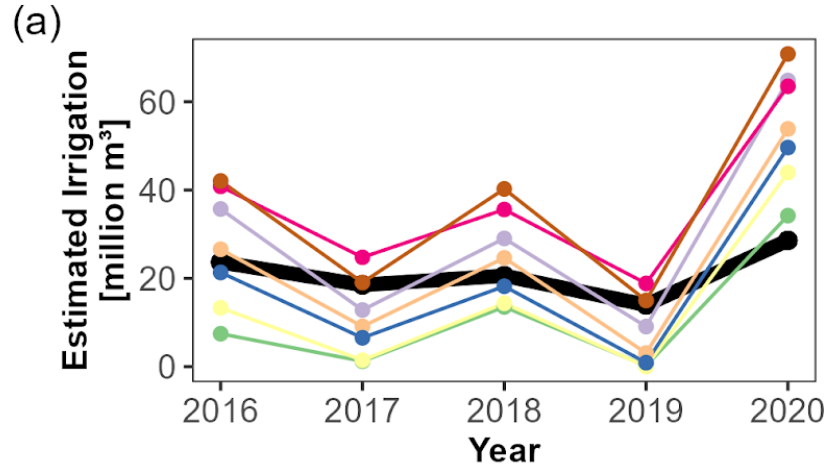


- Only the “easy” water rights groups are shown
 - 1 field, 1 well, 1 water right
 - Decent agreement, especially for ensemble
 - Worse fit for more complex water rights groups → *source of uncertainty*
- Variability among algorithms
 - *source of uncertainty*

* Preliminary, pre-release data

Comparison: LEMA-scale

Comparison to flowmeter data for entire LEMA



- Substantially more variability in OpenET estimates than flowmeter data

Summary

Can satellite-based approaches provide reasonable estimates of groundwater pumping?

- General agreement on trends and order of magnitude, but not resolved to management-relevant accuracy

What are major sources of uncertainty?

- ET estimates → differences among algorithms
- Estimating irrigation from ET → multiple approaches
- Linking fields to wells → changes through the years!
- Timescale of aggregation → soil moisture carryover
- More I didn't mention:
 - Irrigation status → disagreement among datasets
 - Precipitation dataset → variability among options

Thank you for your attention!

In sum:

- Remotely sensed approaches have promise for assessing irrigation water use and water conservation effectiveness.
- However, substantial uncertainties remain – resolving these will be key to operational use and spatial/temporal disaggregation.

How can you see using OpenET data in your work?

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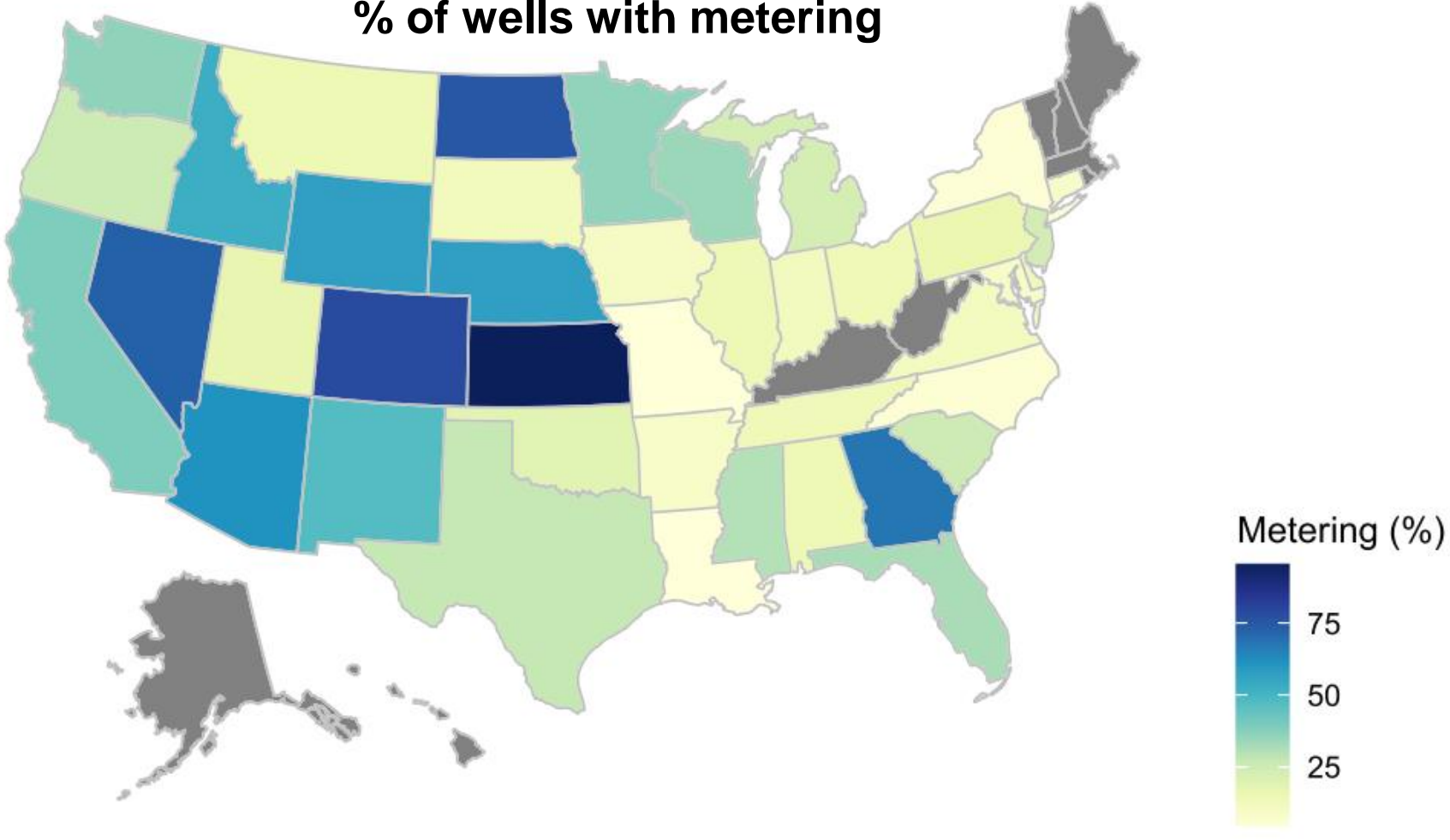


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Atmosphere: ET and management

What if you don't live in Kansas? ...maybe Montana?

% of wells with metering



Can satellite-based approaches provide reasonable estimates of groundwater pumping?

What are major sources of uncertainty?