Visual Analysis of Reservoir Simulation Ensembles

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Motivation

- Forecast Oil & Gas production

- Optimal well placement planning

  - What is the net production difference?

  - What is the operational effort?

  - What is the time frame?

  - What is the uncertainty?

Variance Water Saturation

low   high

Mean Water Saturation

low   high

I04
Lat: 0.585, Lon: 0.169
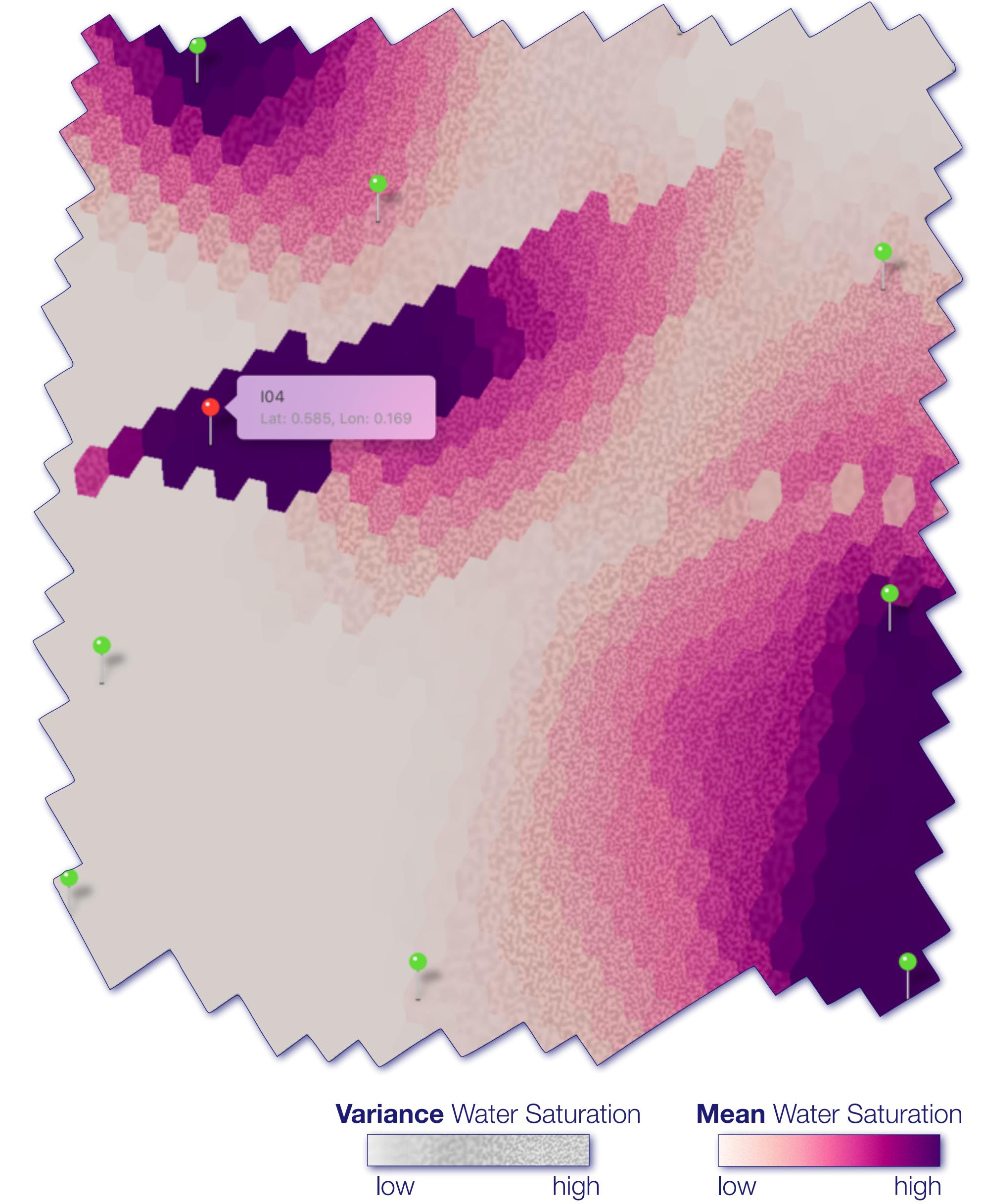
Data

- Large scale forecasts (tens of years)

  - 18 years monthly samples: 216 samples

- Ensemble simulation

  - 55 realizations per sample

- Multivariate / Multidimensional

  - 4 3D variables + 8 1D variables

Variance Water Saturation

low　　　　　high

Mean Water Saturation

low　　　　　high
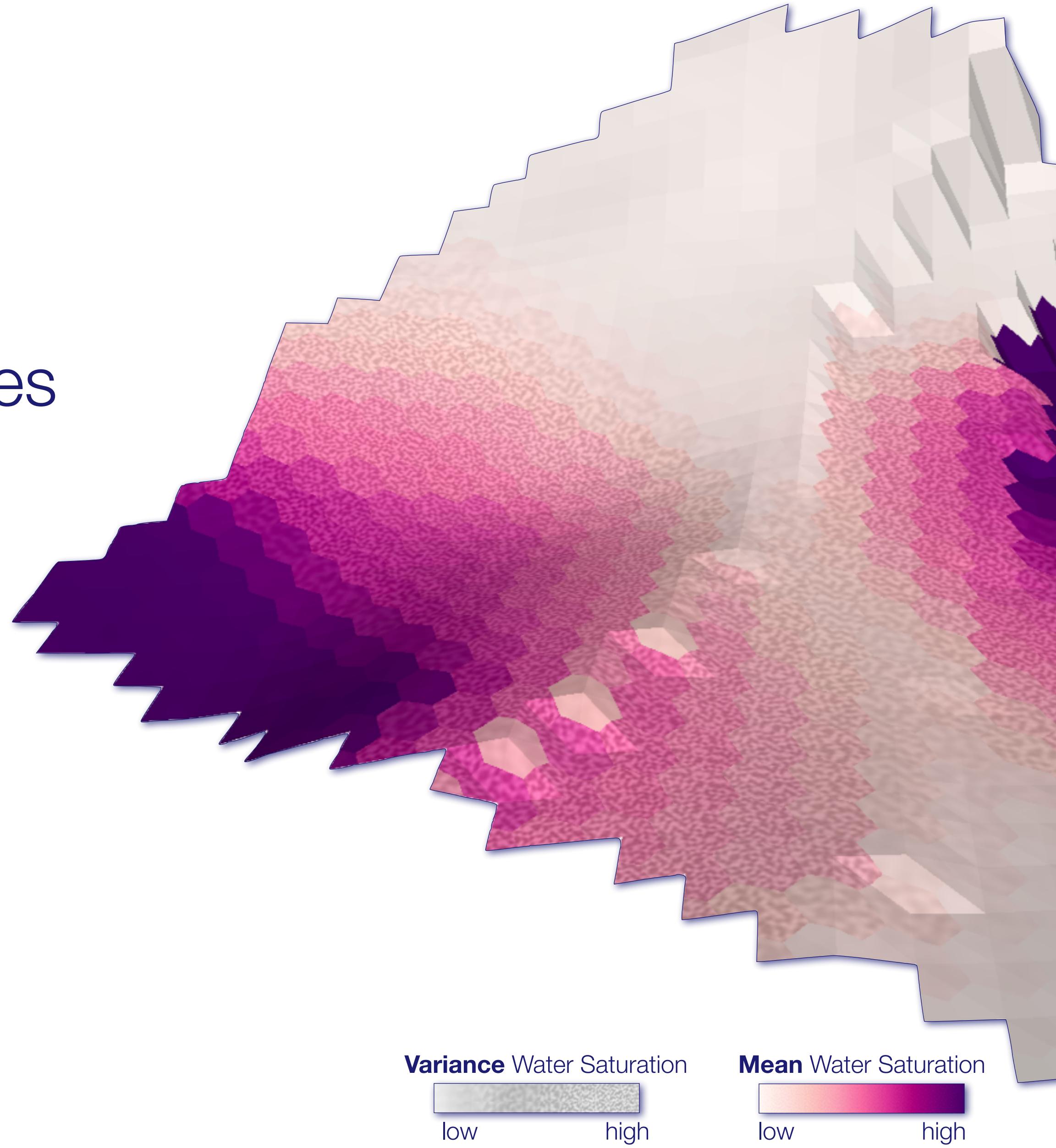
Visual Analysis System

Visual Analysis System

- Tasks

  - Spatial overview generation

    - Find problems in well placement

  - Detail comparison

    - Compare general production rates

   - Compare economical impact (e.g. water cut)
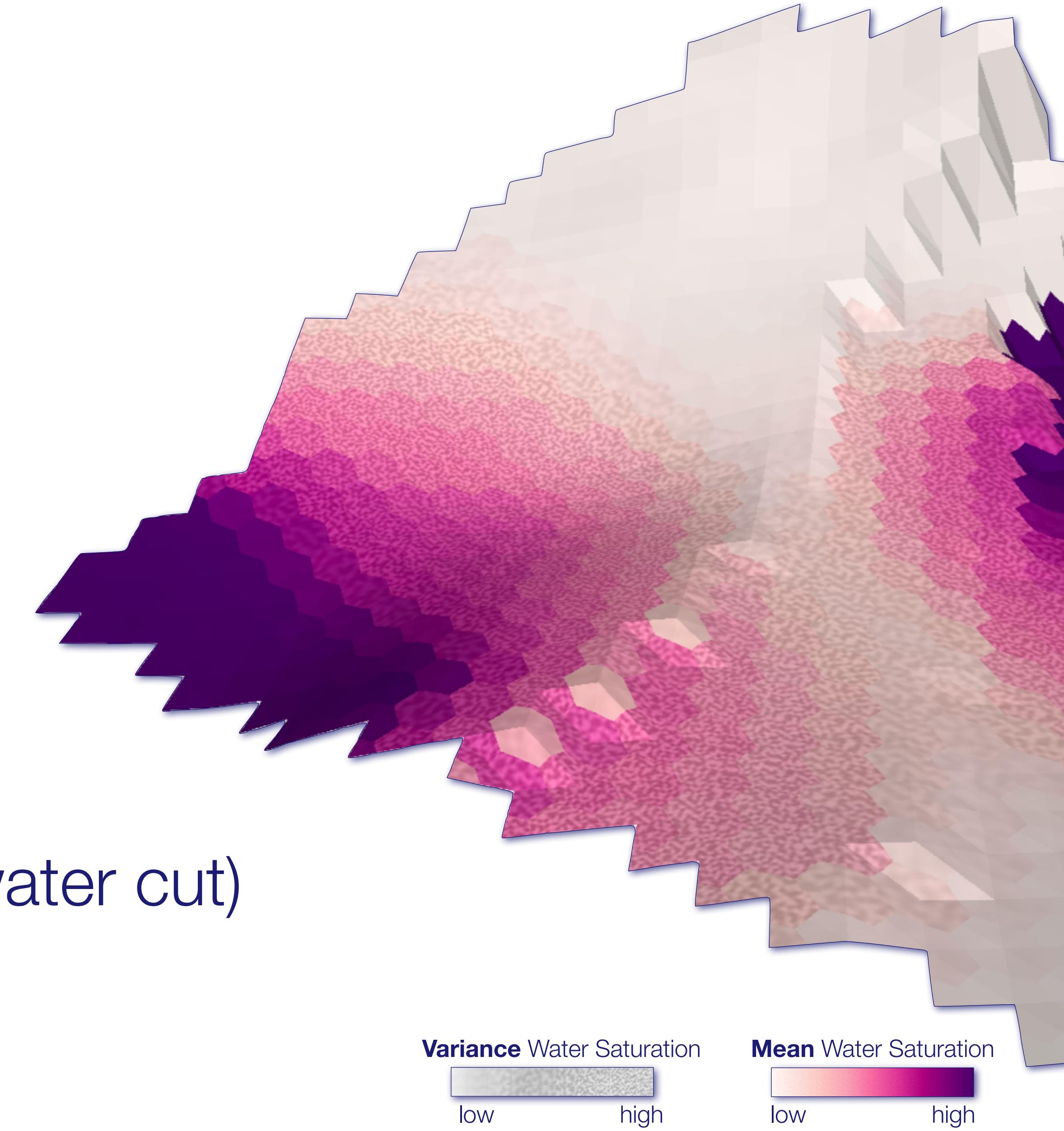
Variance Water Saturation

low   high

Mean Water Saturation

low   high

Spatial View

Variance Water Saturation

low   high

Mean Water Saturation

low   high

Spatial View

Variance Water Saturation

low — high

Mean Water Saturation

low — high

Spatial Overview I

Variance Water Saturation

low   high

Mean Water Saturation

low   high

Spatial Overview I

Injector Wells

Variance Water Saturation

low   high

Mean Water Saturation

low   high

Spatial Overview I

Variance Water Saturation

low   high

Mean Water Saturation

low   high
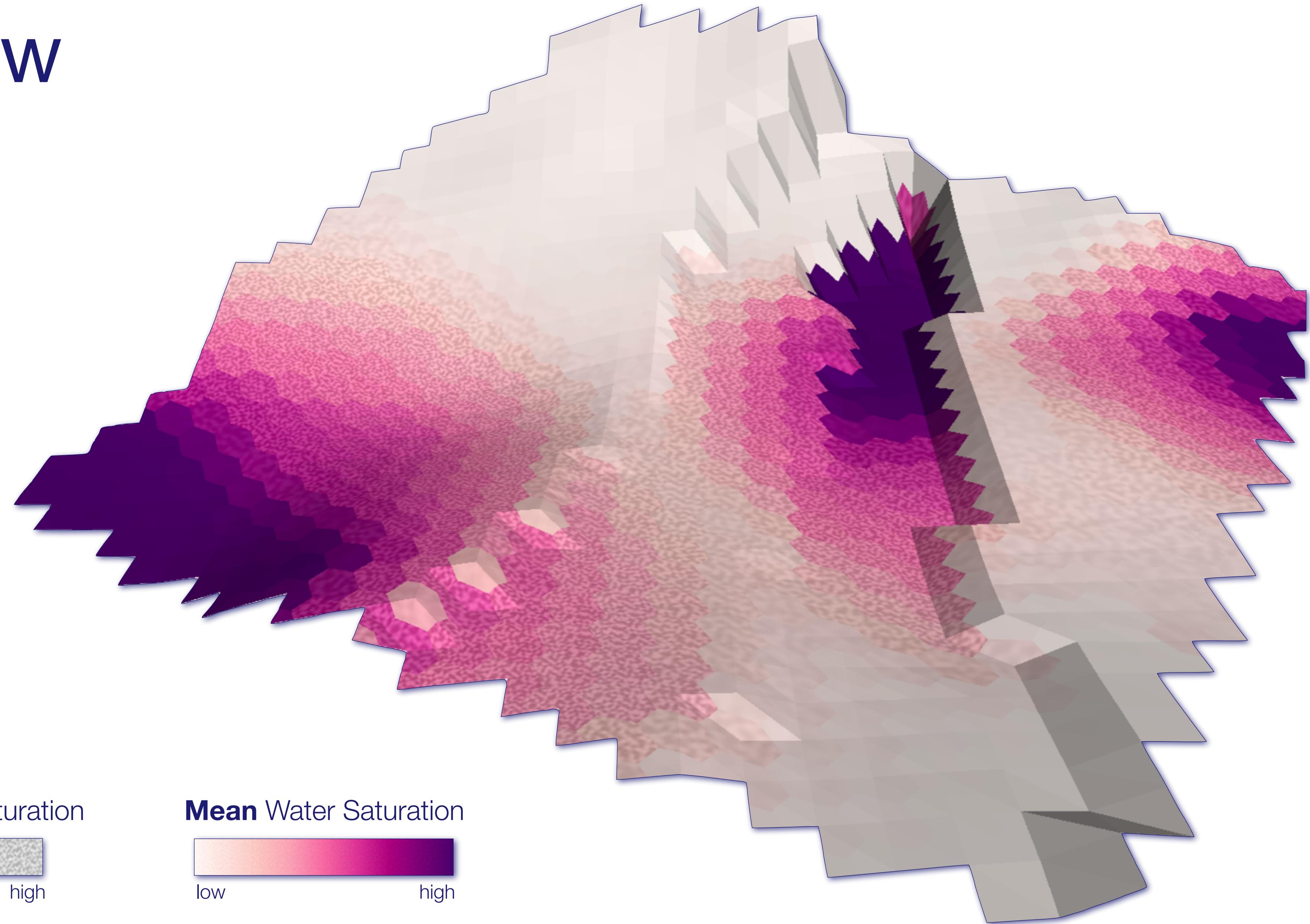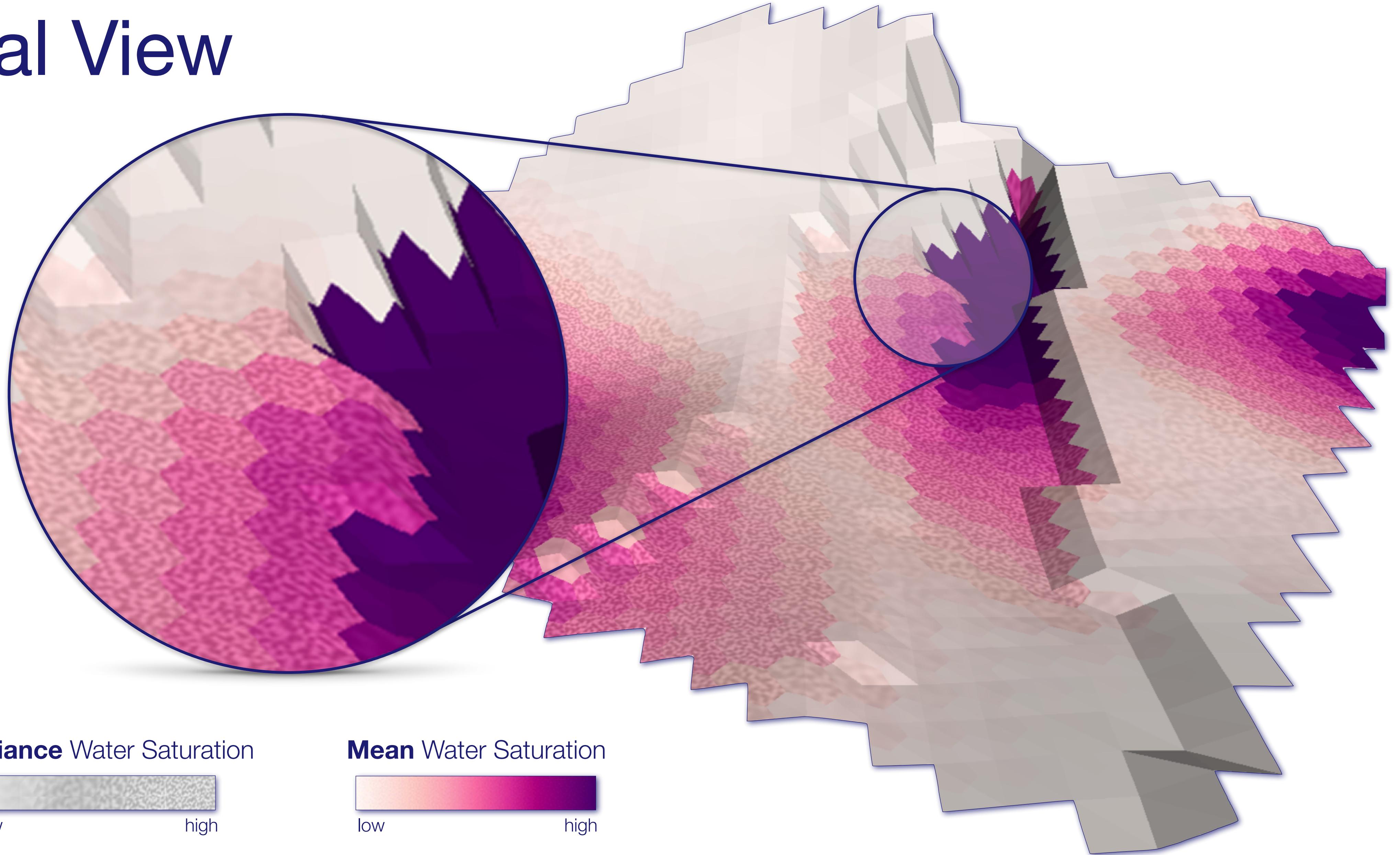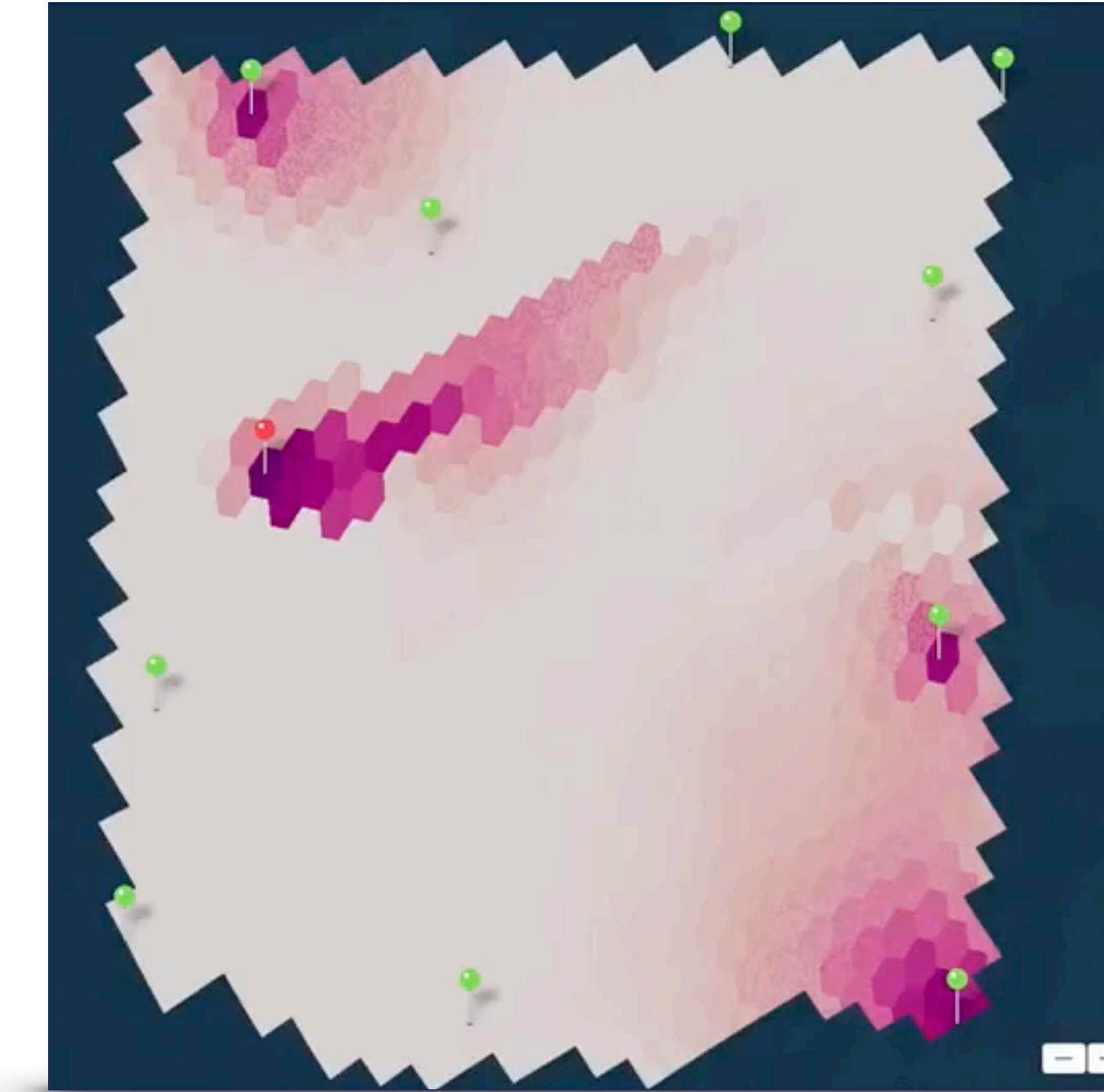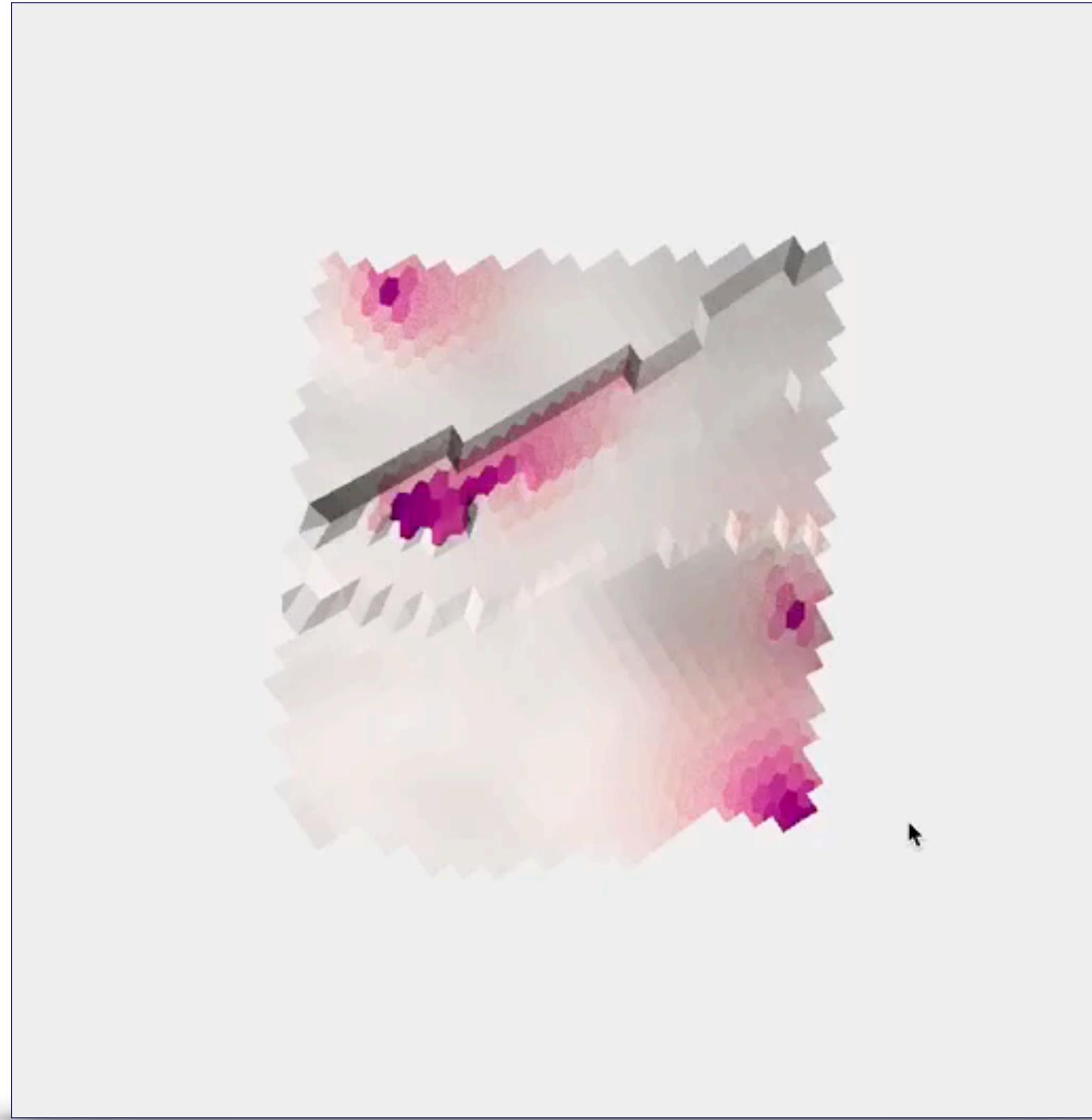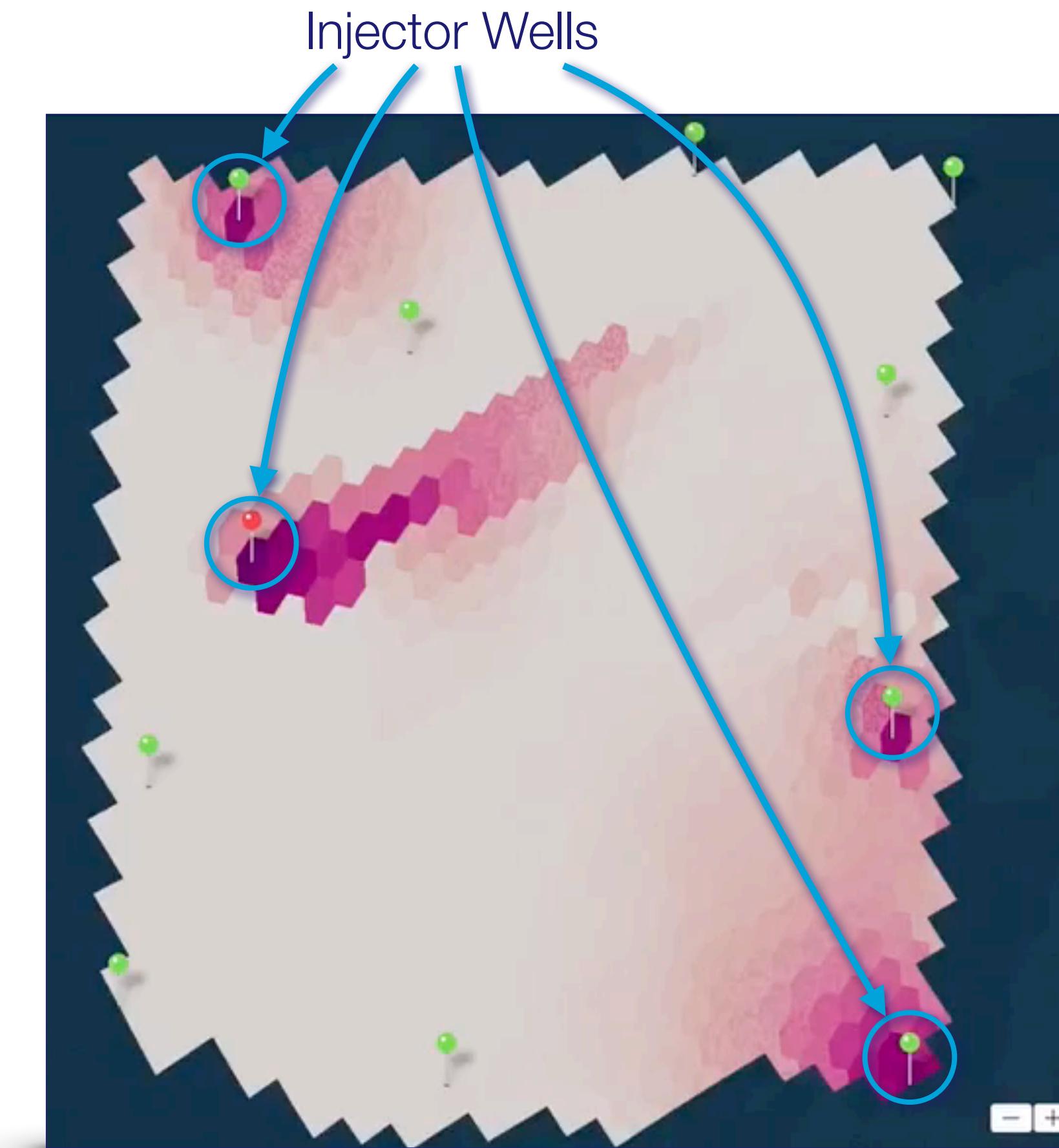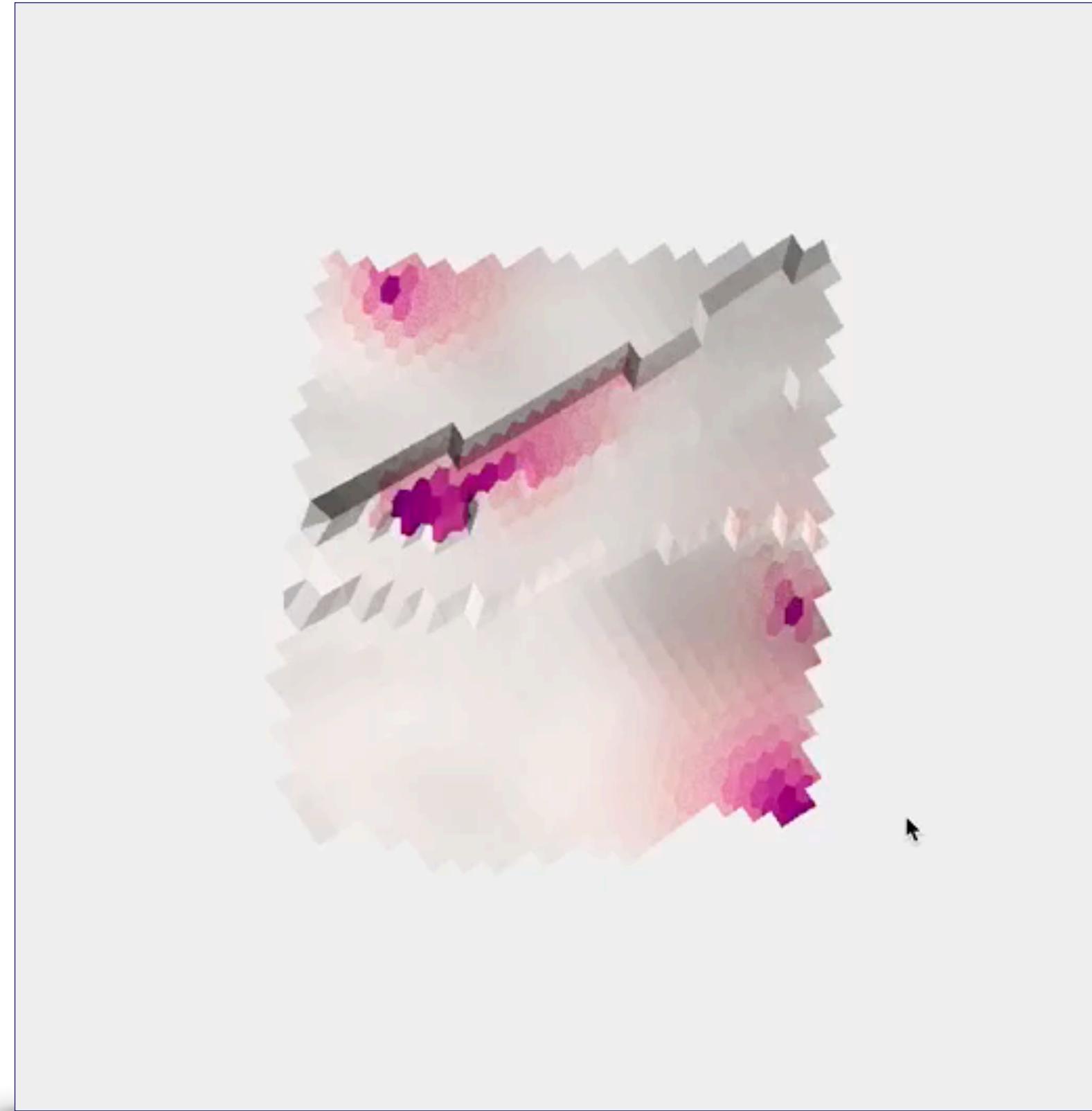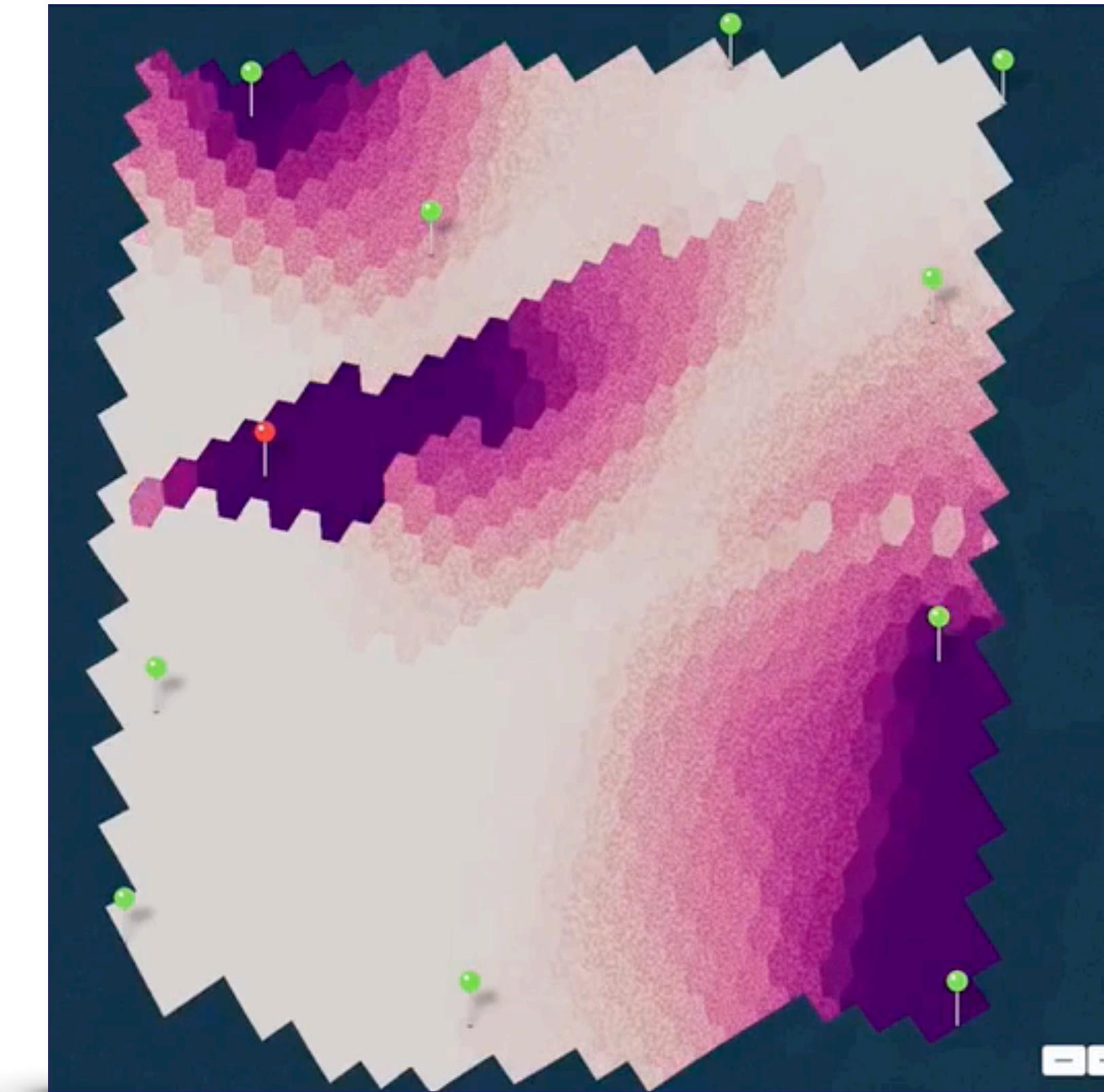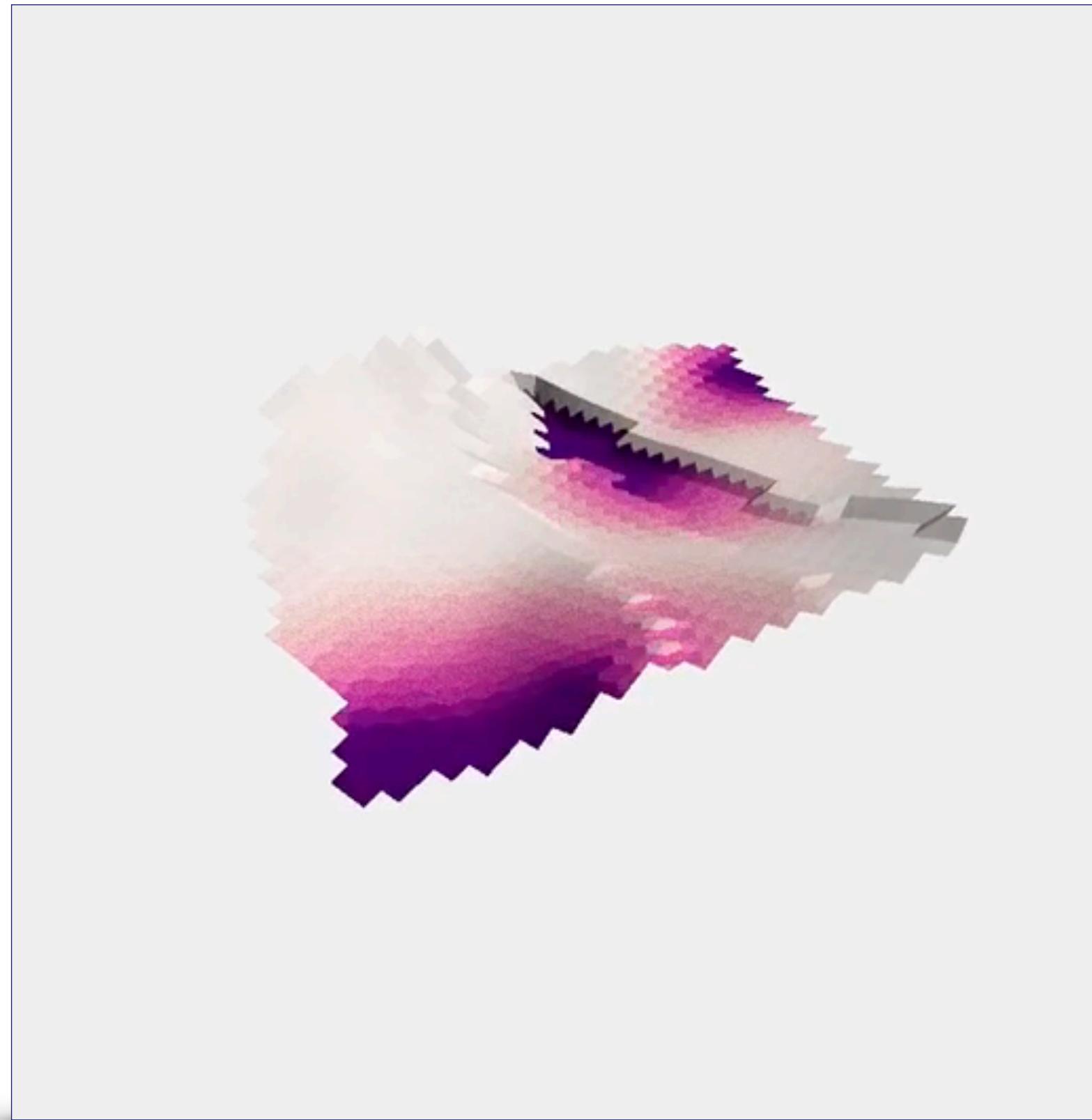
Spatial Overview I

Low Saturation/High Variance
for complete time-series

Variance Water Saturation

low   high

Mean Water Saturation

low   high
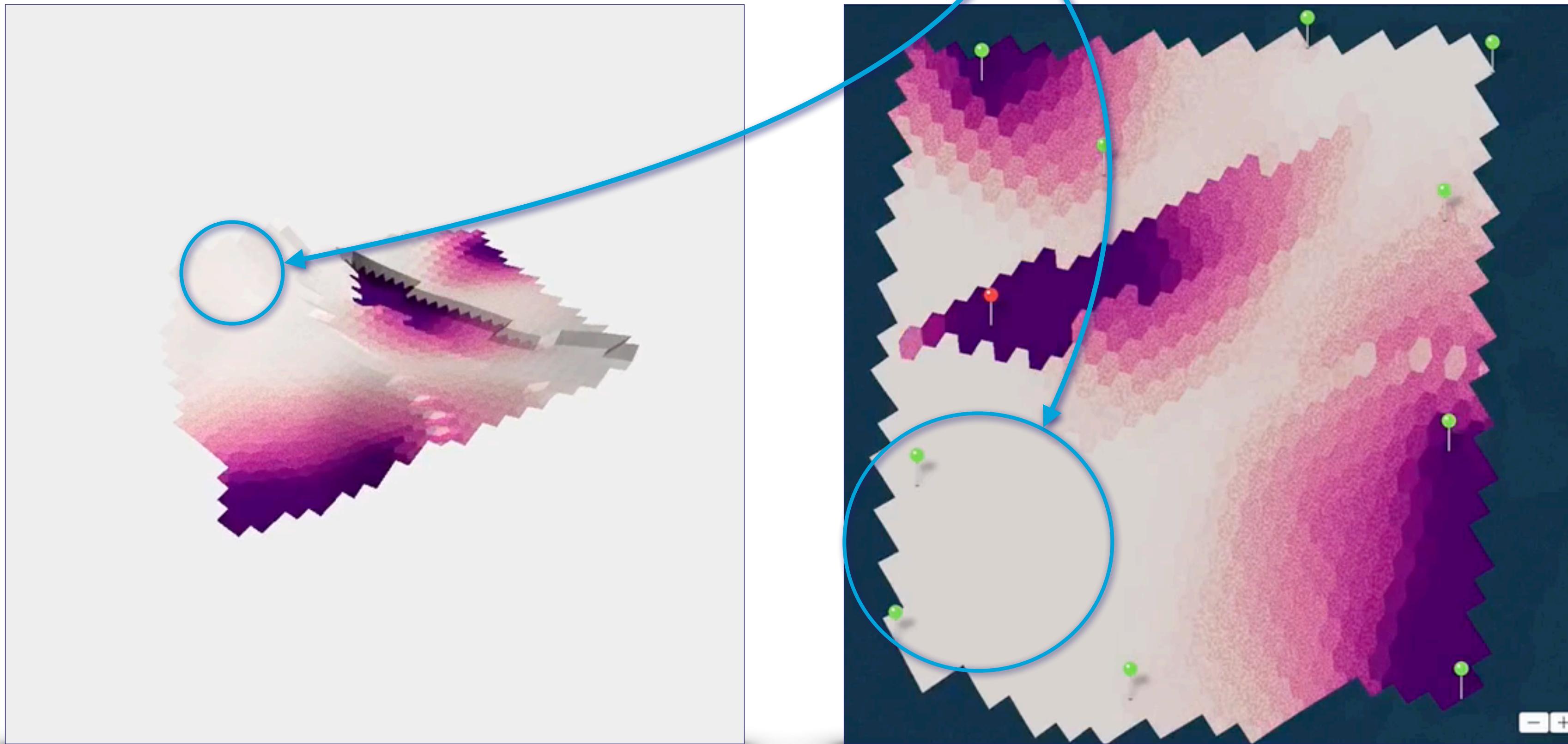
Spatial Overview II
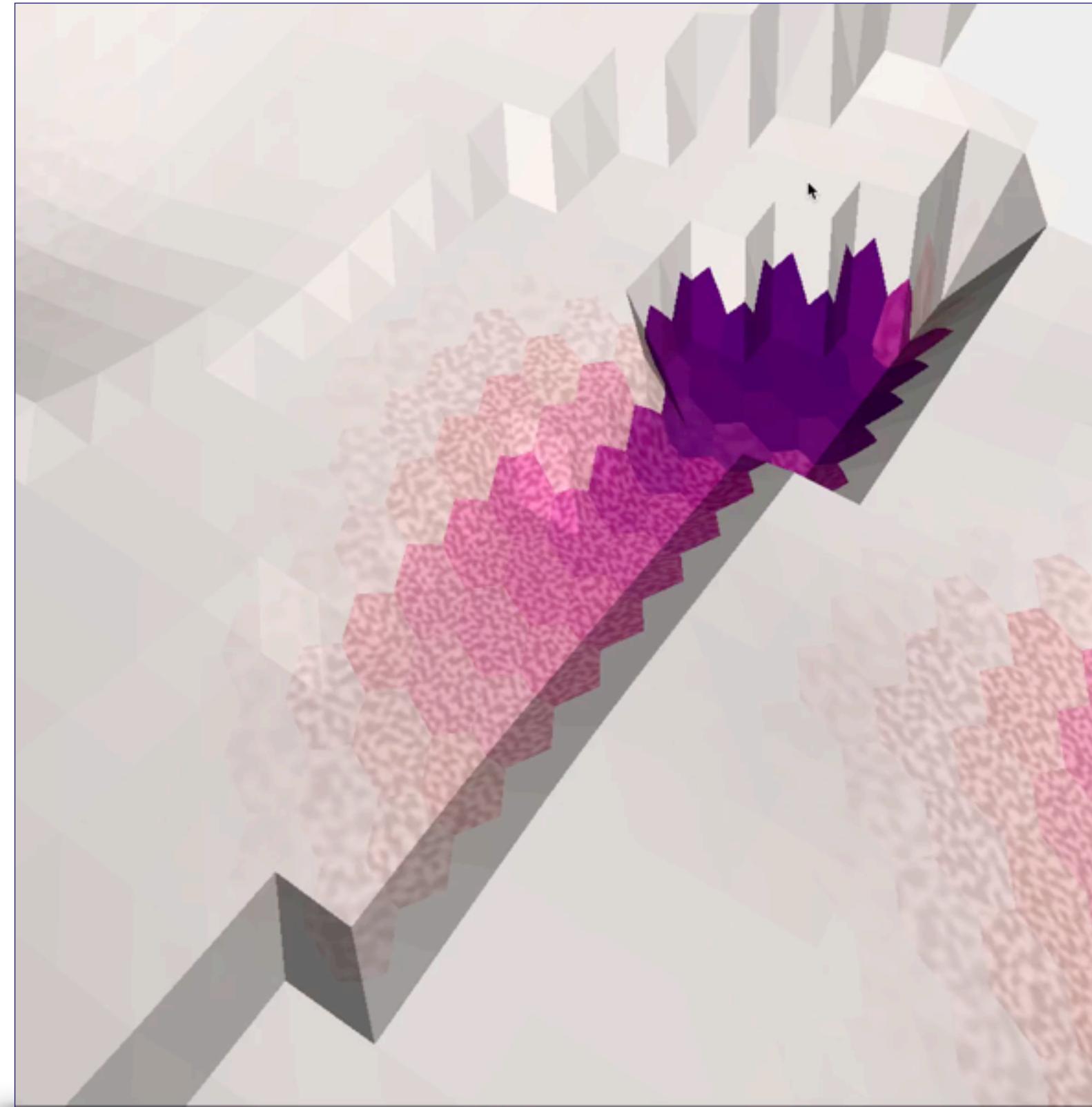
Pressure   Water Saturation
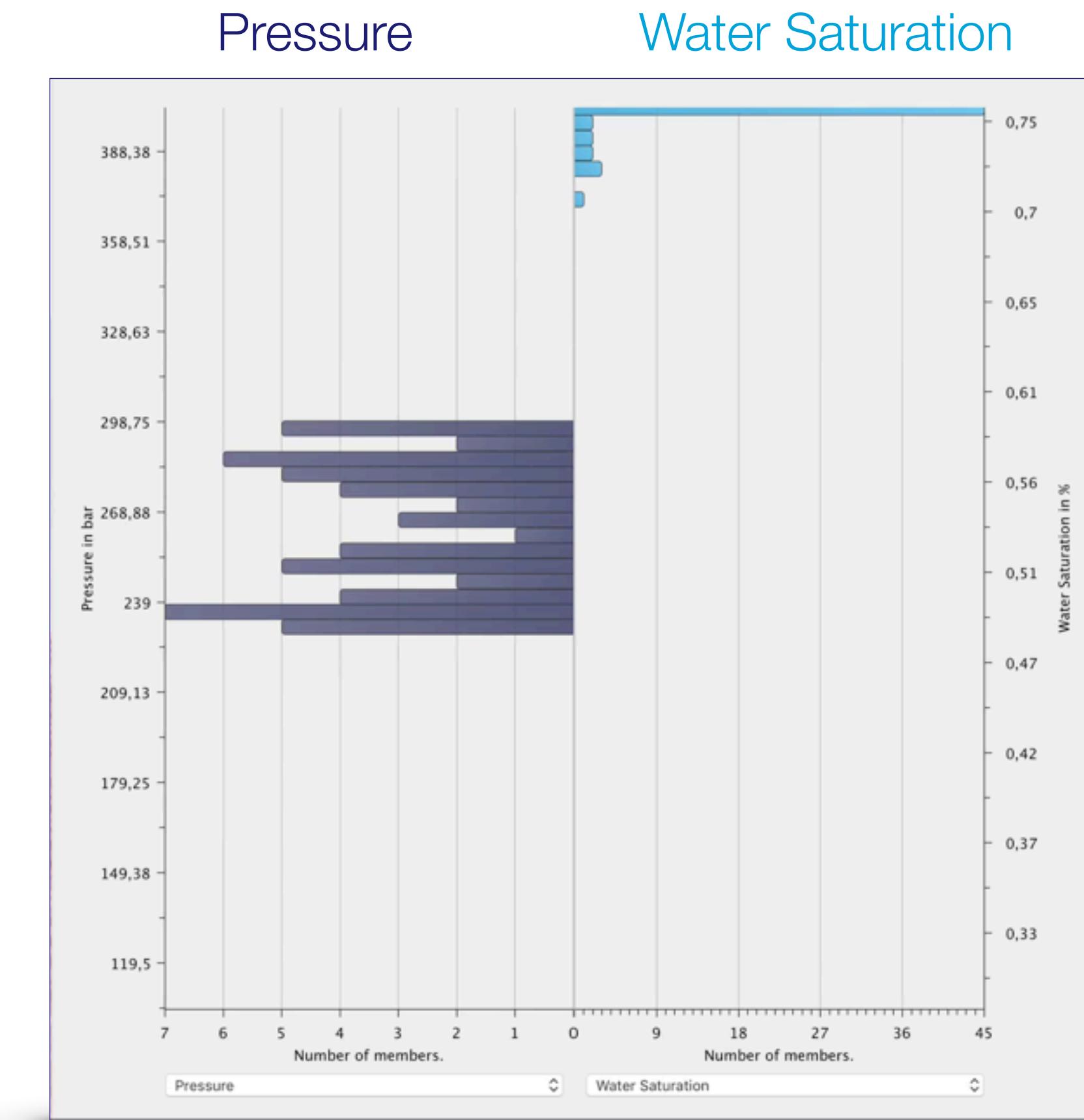
Variance Water Saturation
low   high

Mean Water Saturation
low   high

Spatial Overview II

Detail Comparison

- Compare general production rates

- Compare economical impact

- **Complete temporal evolution**
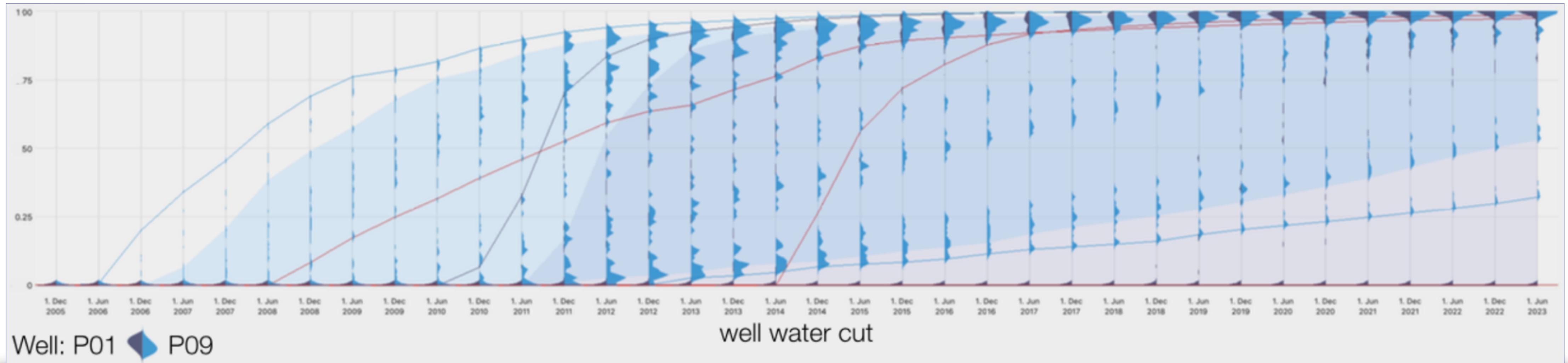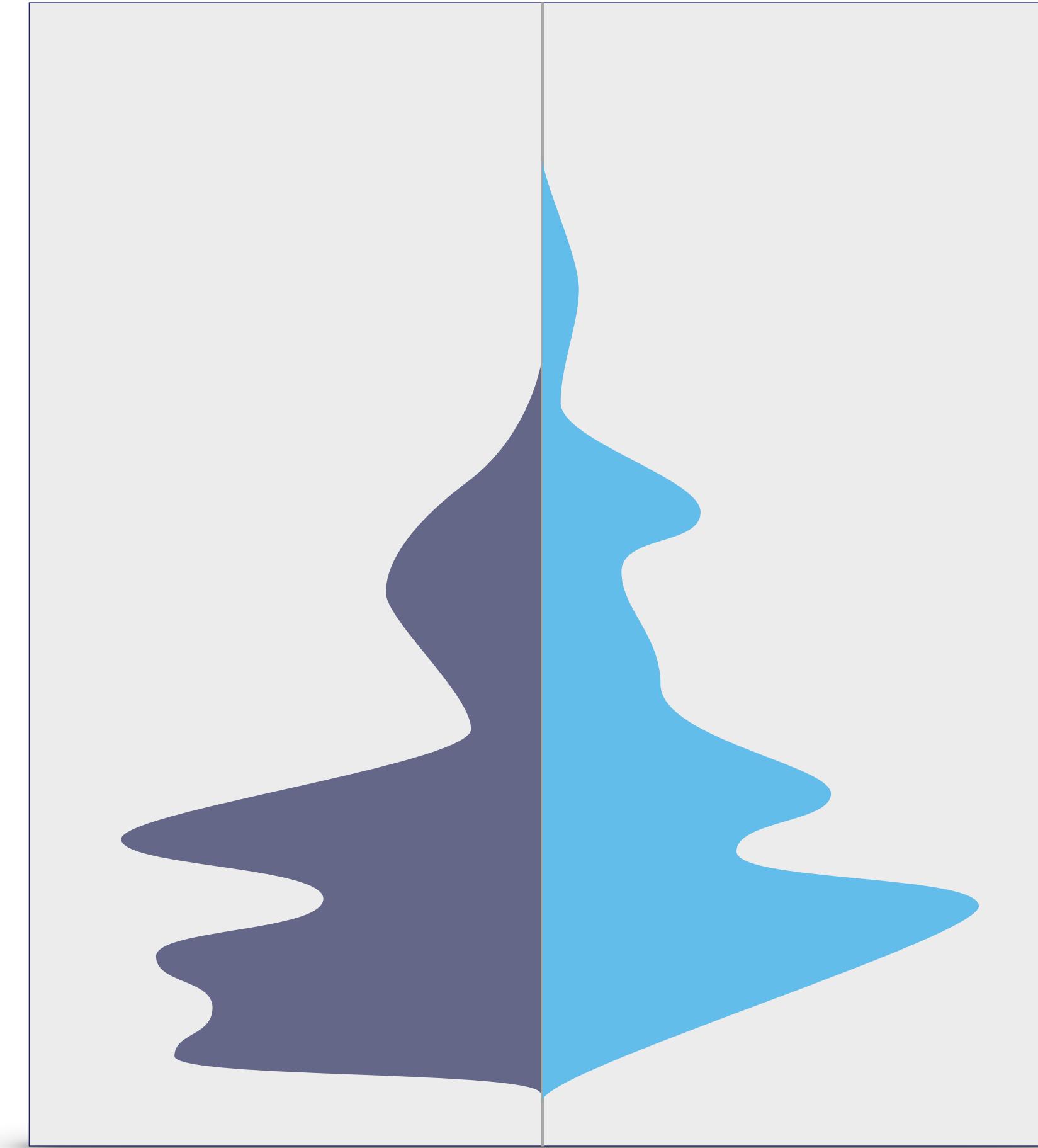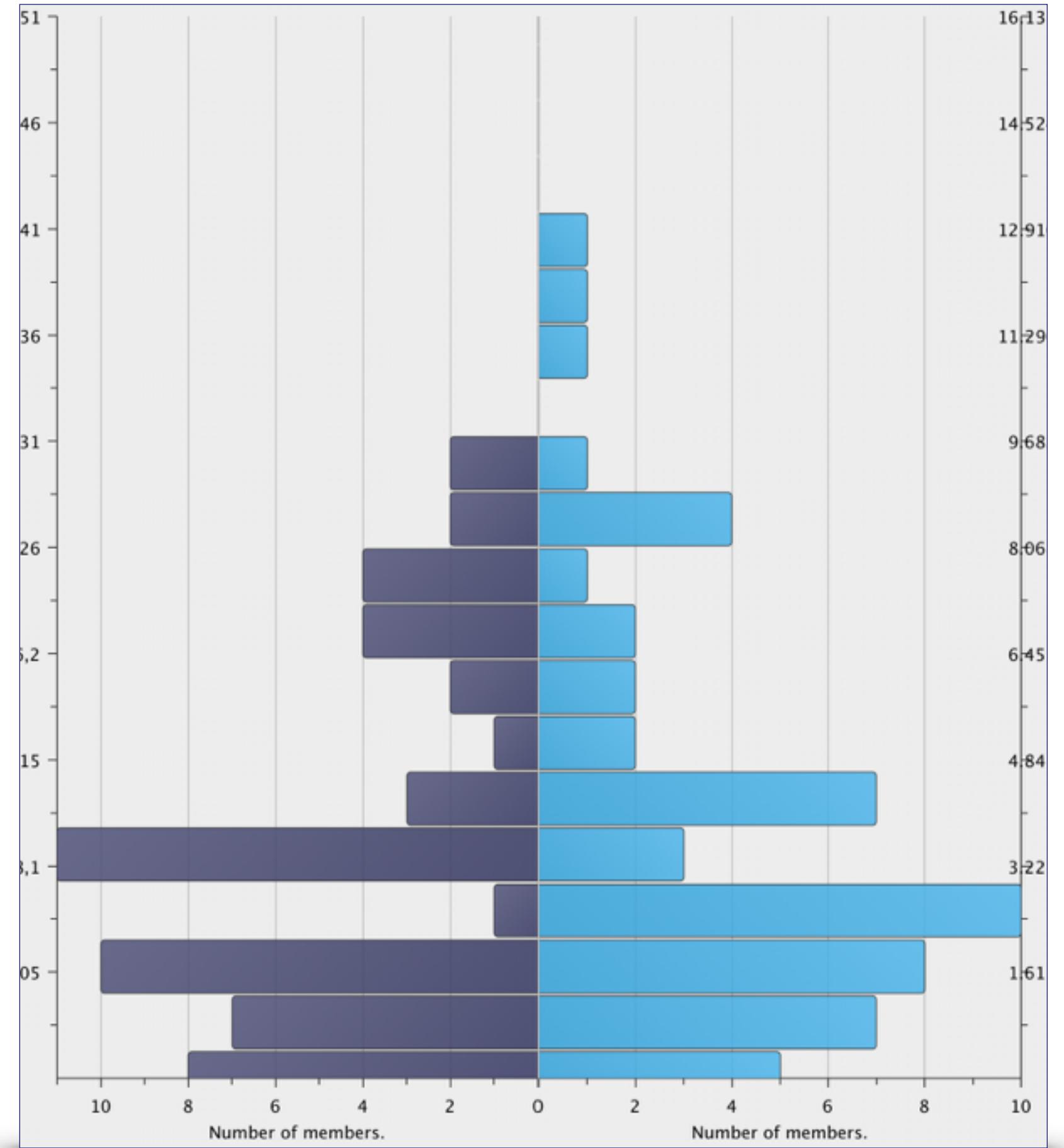
Distribution Glyph & Boxplot

Distribution Glyph & Boxplot
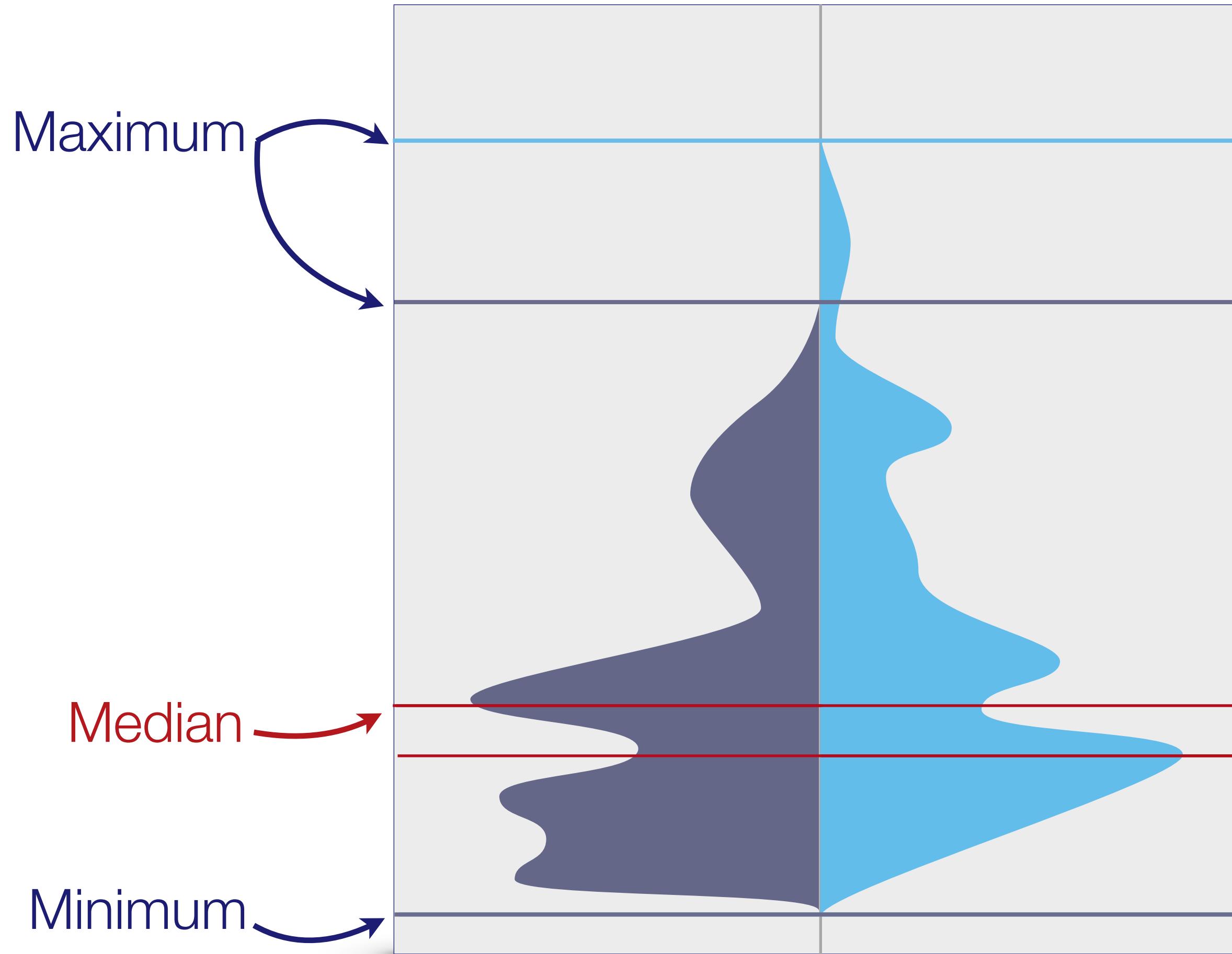
Median

Distribution Glyph & Boxplot

Maximum

Median

Minimum

Distribution Glyph & Boxplot

Maximum

10th to 90th Percentile

Median

Minimum
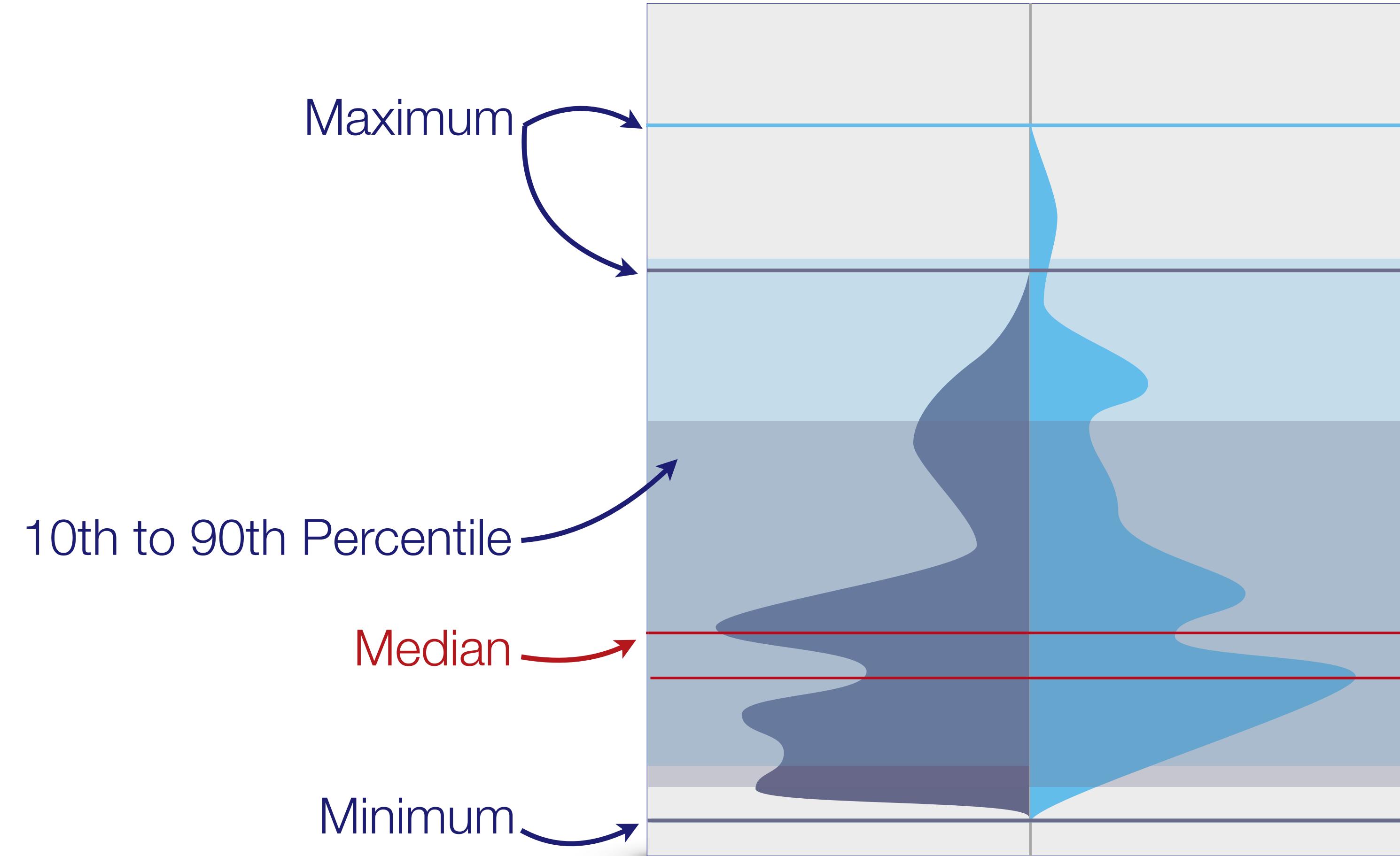
Glyph-Based Time Series
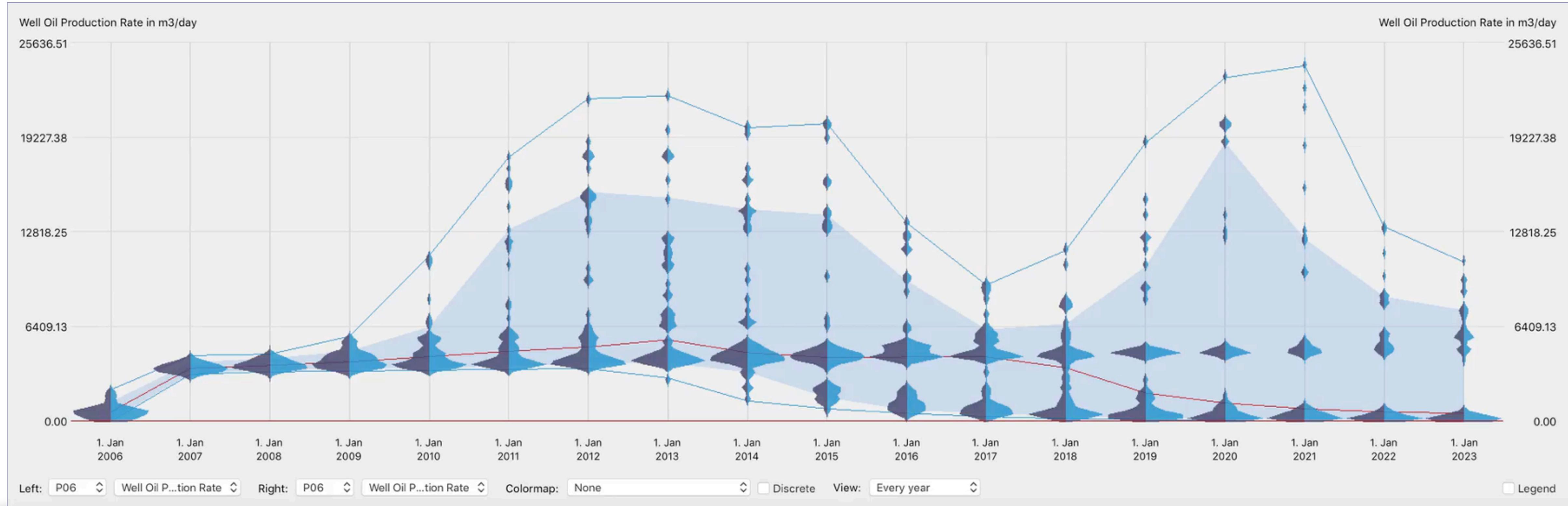
Glyph-Based Time Series
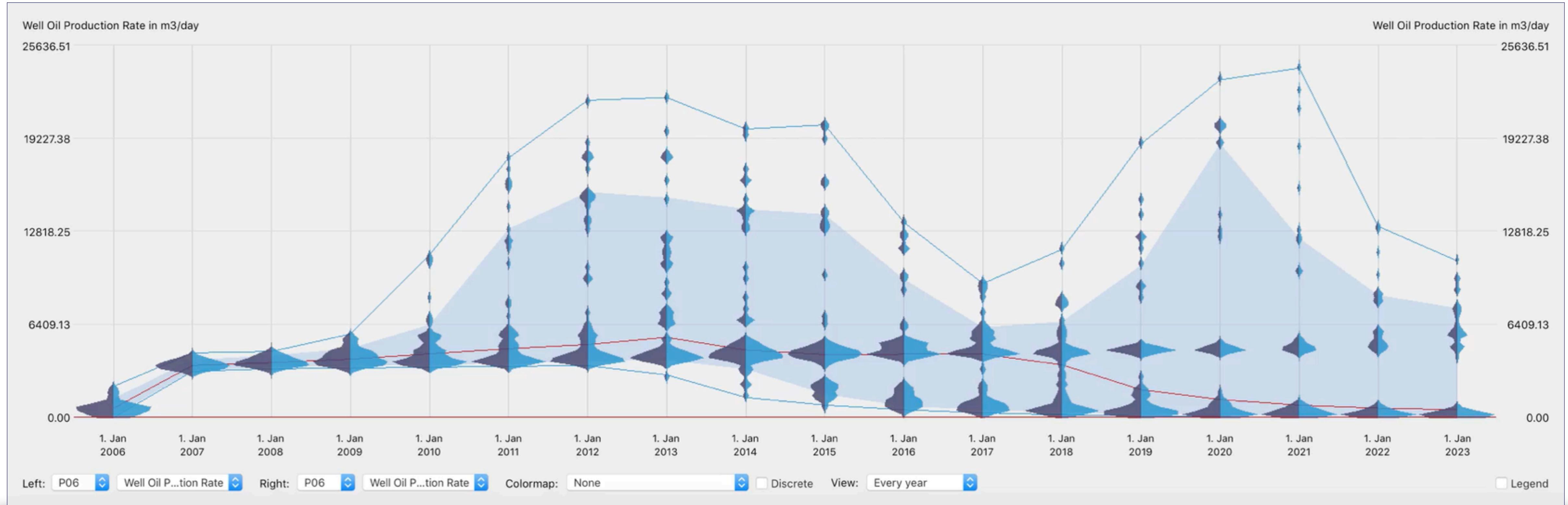
Glyph-Based Time Series
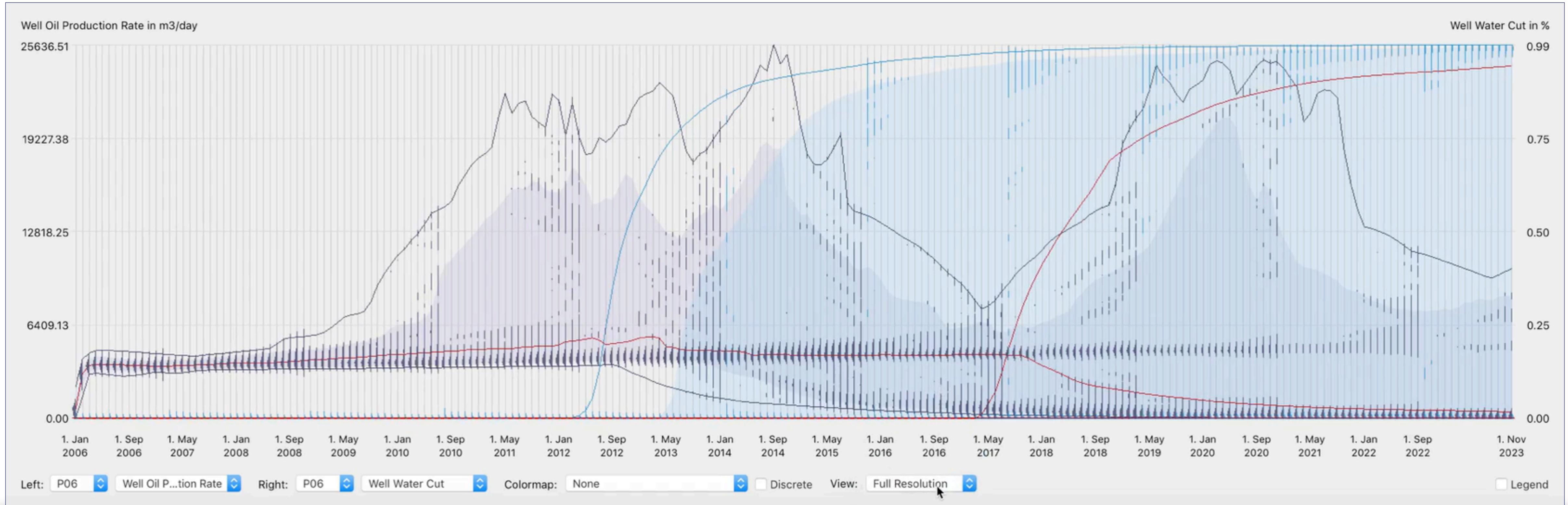
well production rate
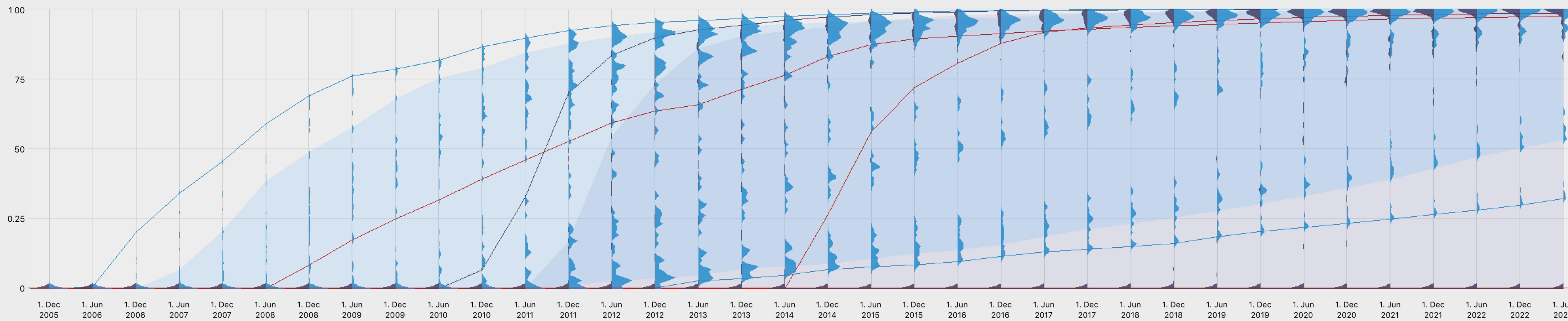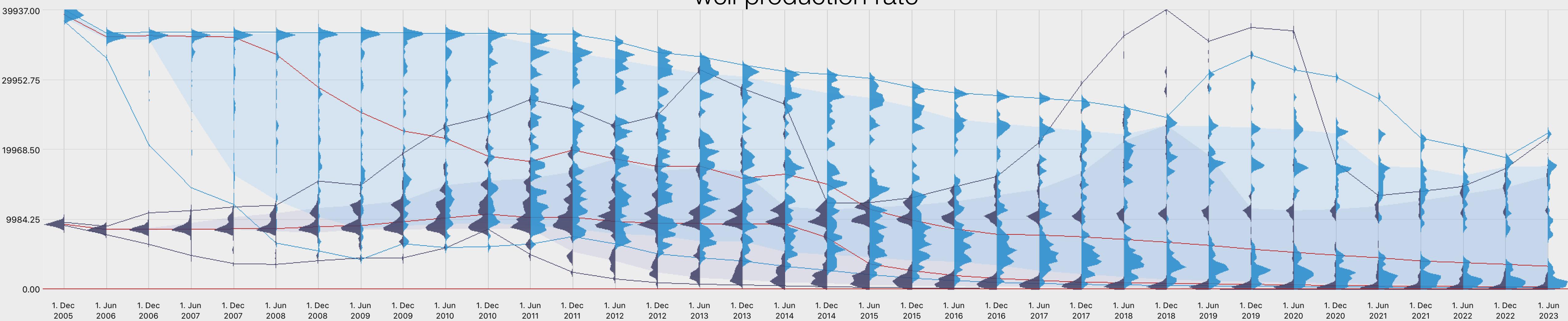
well water cut

Well: P01 ◆ P09

Conclusion

Conclusion & Future Work

- We present an integrated system for reservoir forecast analysis

  - Provides global overview

  - Allows informed decision making

- Future Work

  - Integrate into forecasting workflow

  - Steer forecasting
    request alternative well positions

Visualizing field production in Time Series View
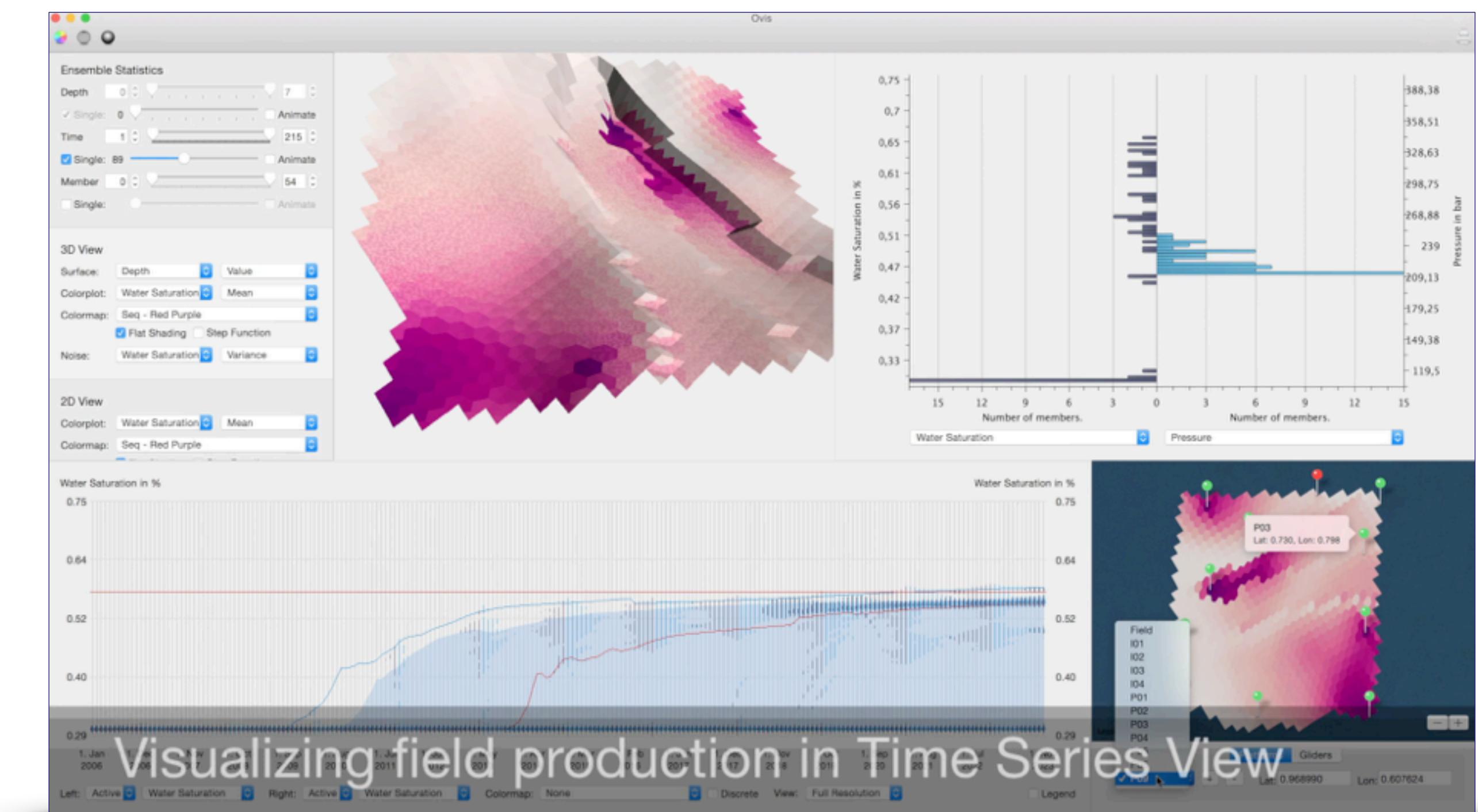
Time for Questions!
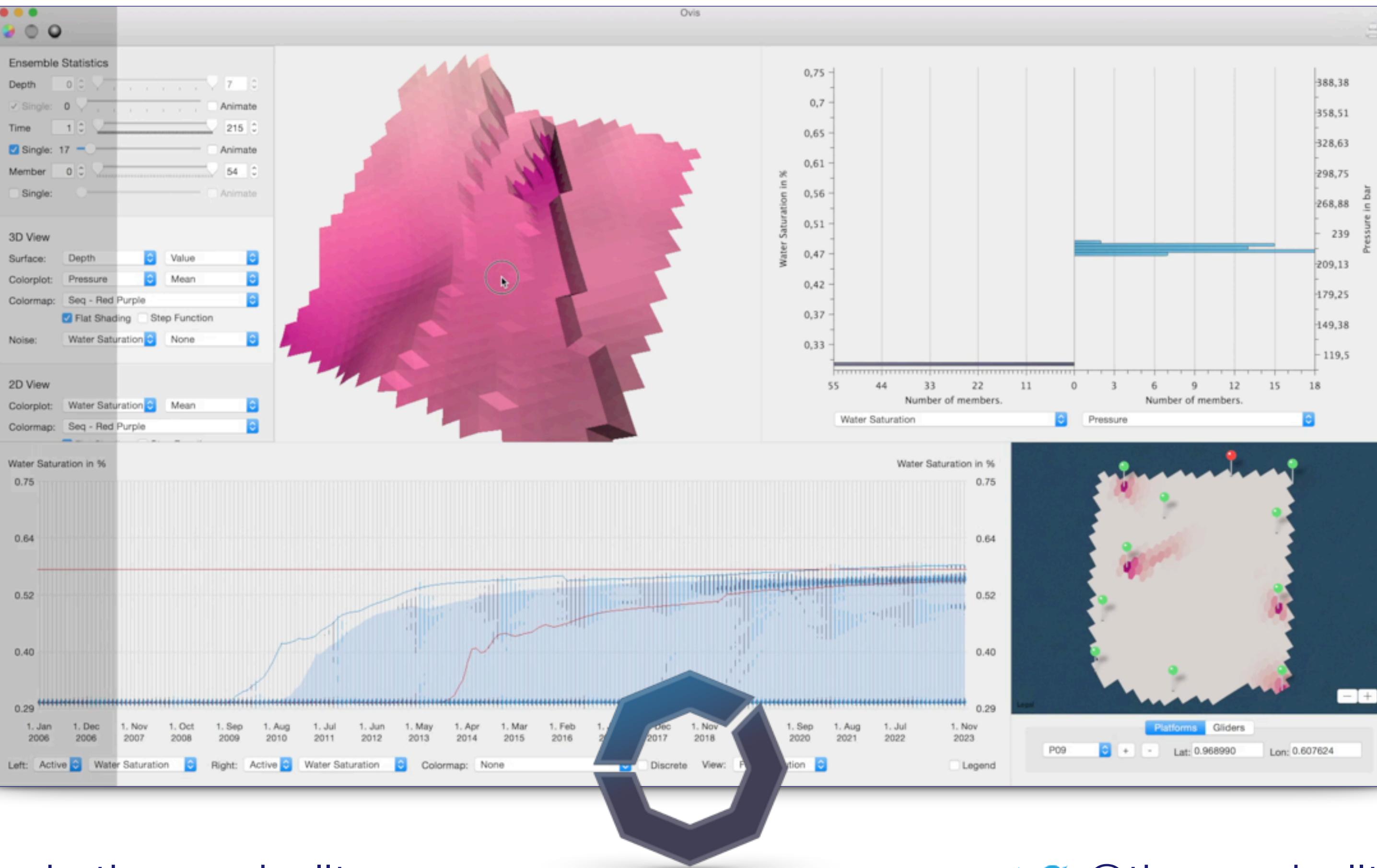
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