# Appendix A-1

This appendix summarizes selected (derived) thermo-physical parameters for surface (lower boundary) characterization and input to the atmospheric model. For each of the 2-km resolution domain (D04) and the six 500-m resolution domains (D05 through D10), the following gridded parameters are presented in this appendix: (1) urban fraction, (2) albedo, (3) soil moisture content, (4) roughness length (m), and (5) shade factor.

These parameters may be scaled down when used in the model, depending on the approach. In the 500-m domains, some of these properties are weighted by the non-urban fraction in each grid cell and the urban-fraction properties assigned at the 500-m level based on area-specific information from the 500-m land-use analysis.

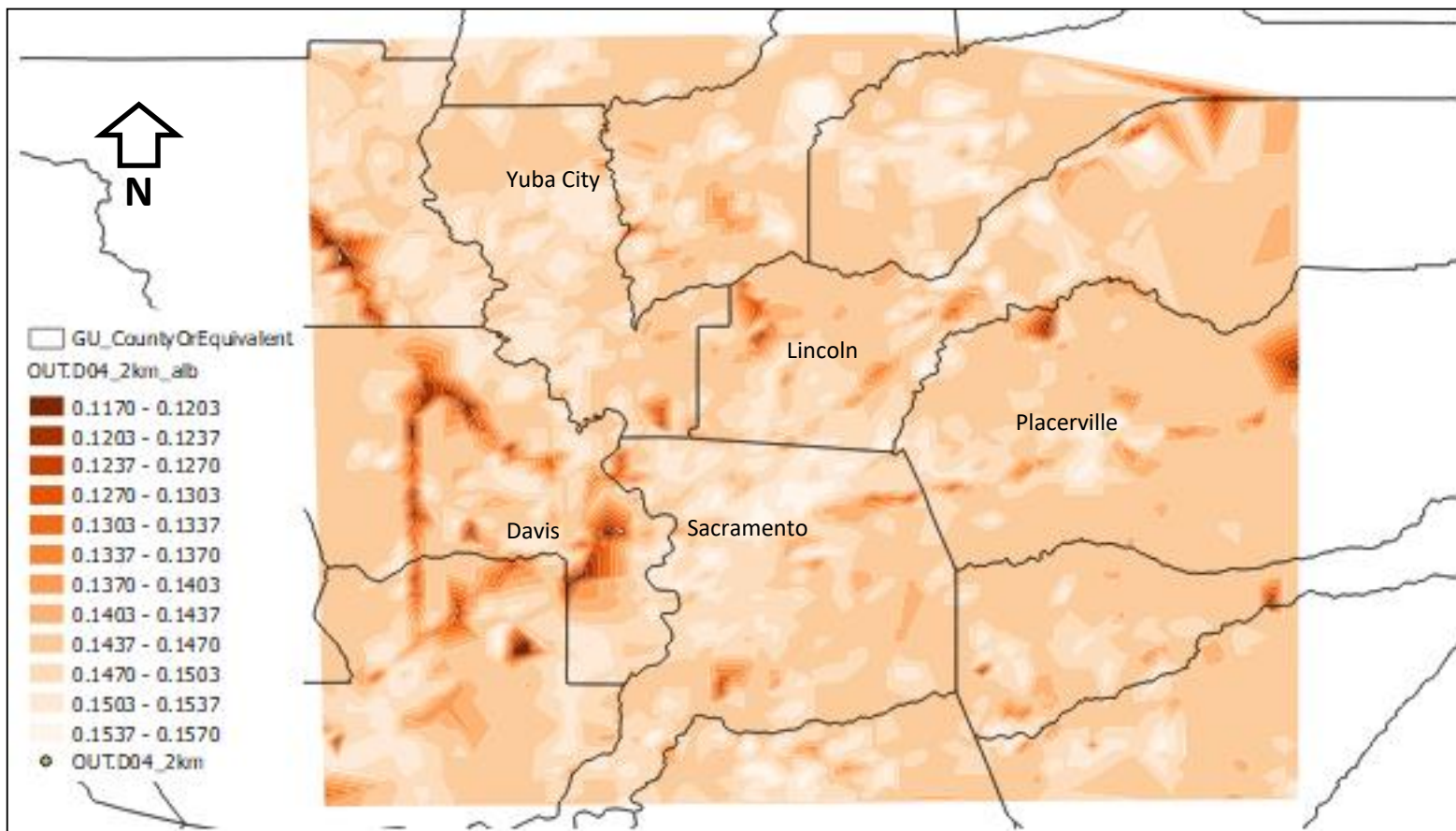# Physical characterization of the surface: 2-km domain
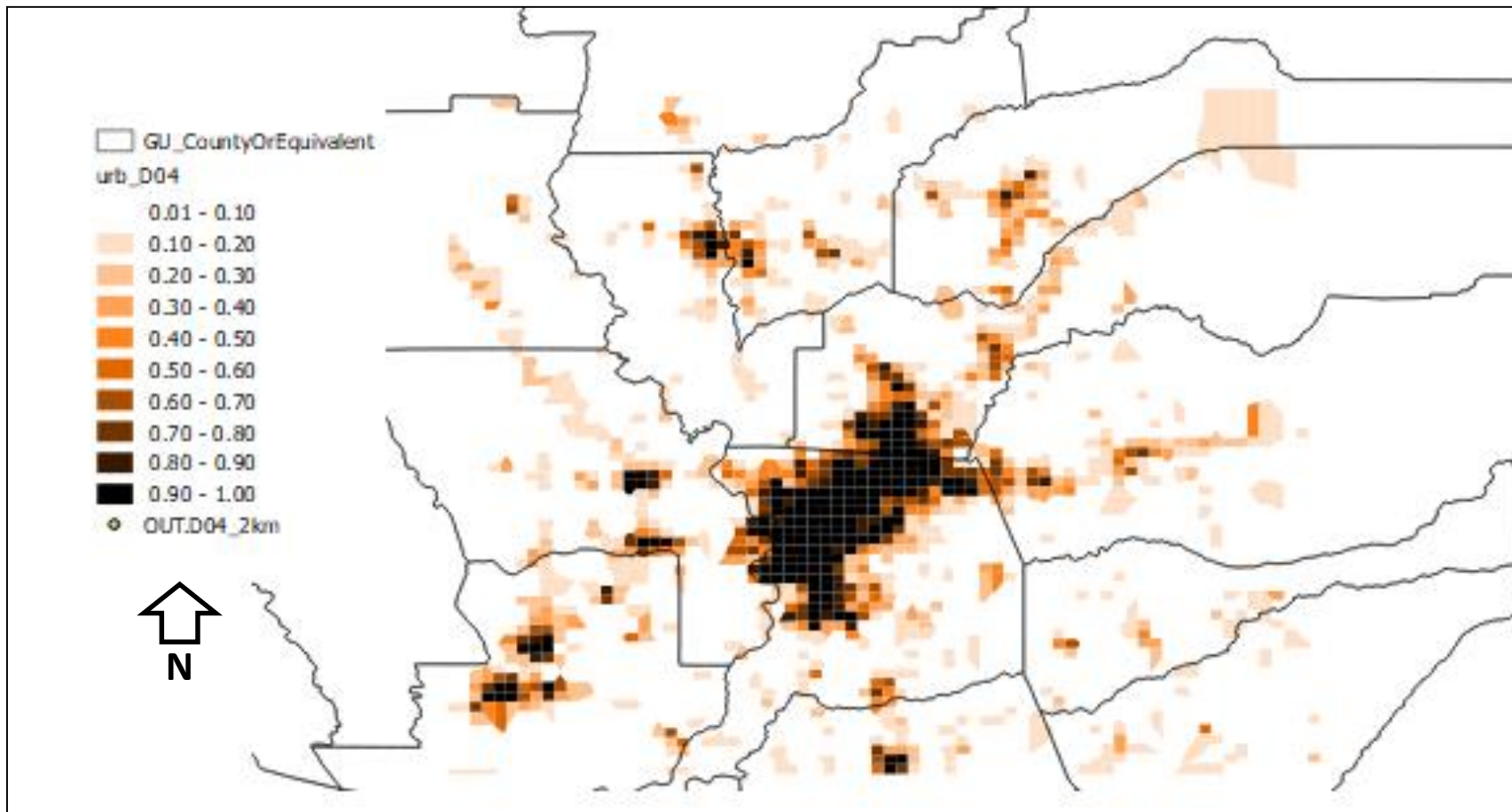
NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D04 (2 km domain)

NLCD: National Land Cover Data
GIRAS: USGS Geographic Information Retrieval and Analysis System

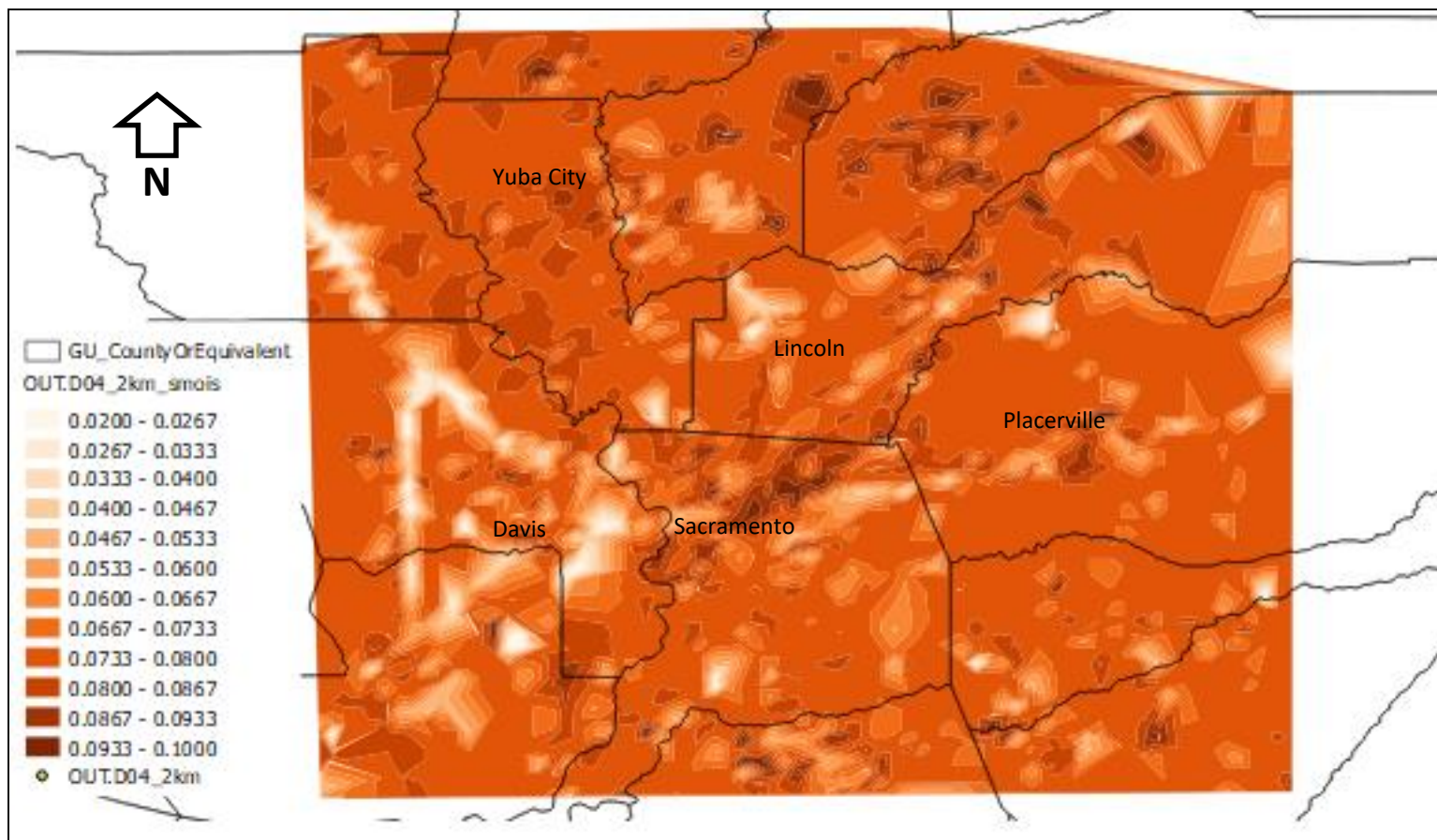# Physical characterization of the surface: 2-km domain

NLCD2011_GIRAS-based calculation of albedo in D04 (2 km domain)
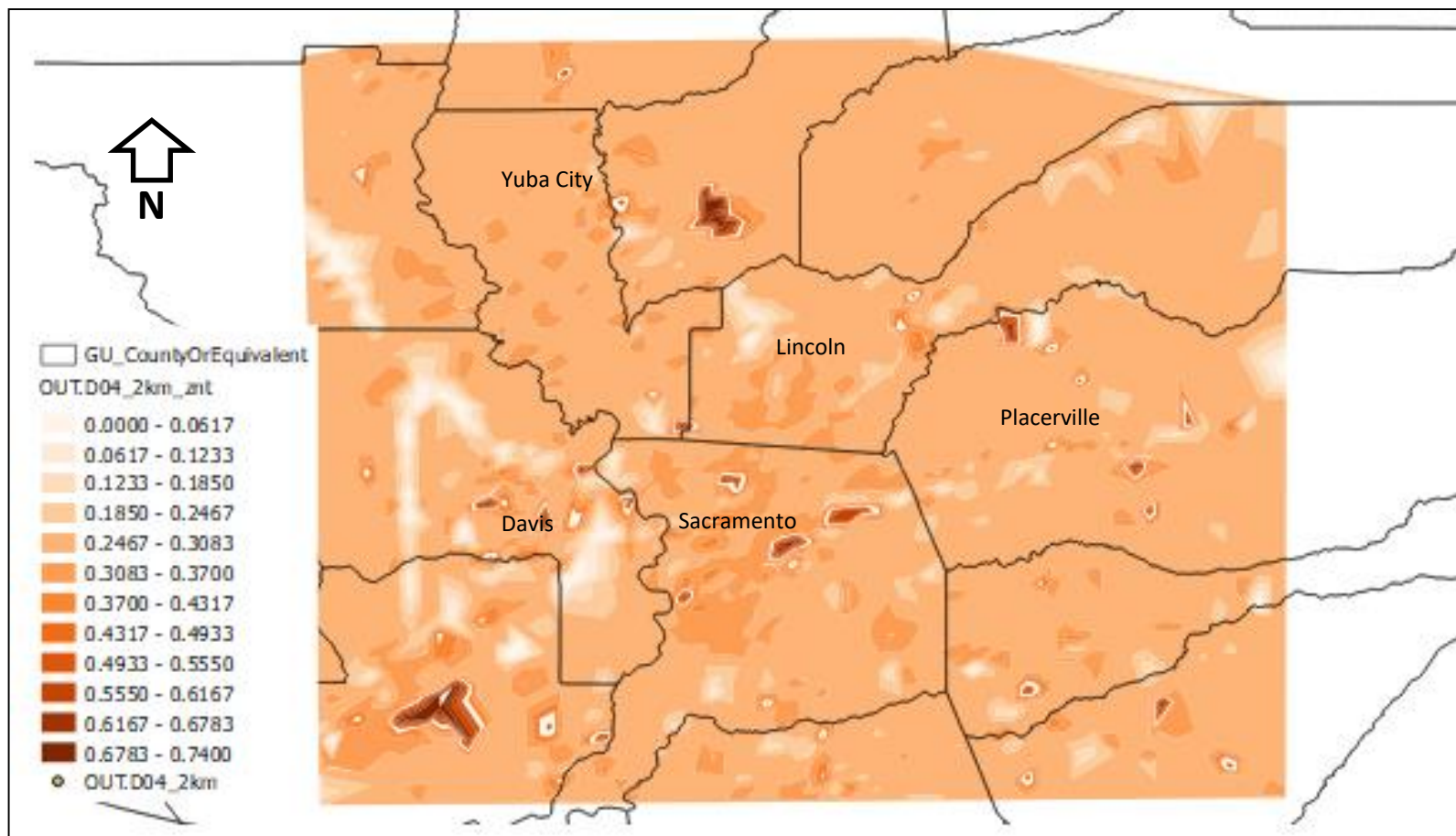
NLCD: National Land Cover Data

GIRAS: USGS Geographic Information Retrieval and Analysis System

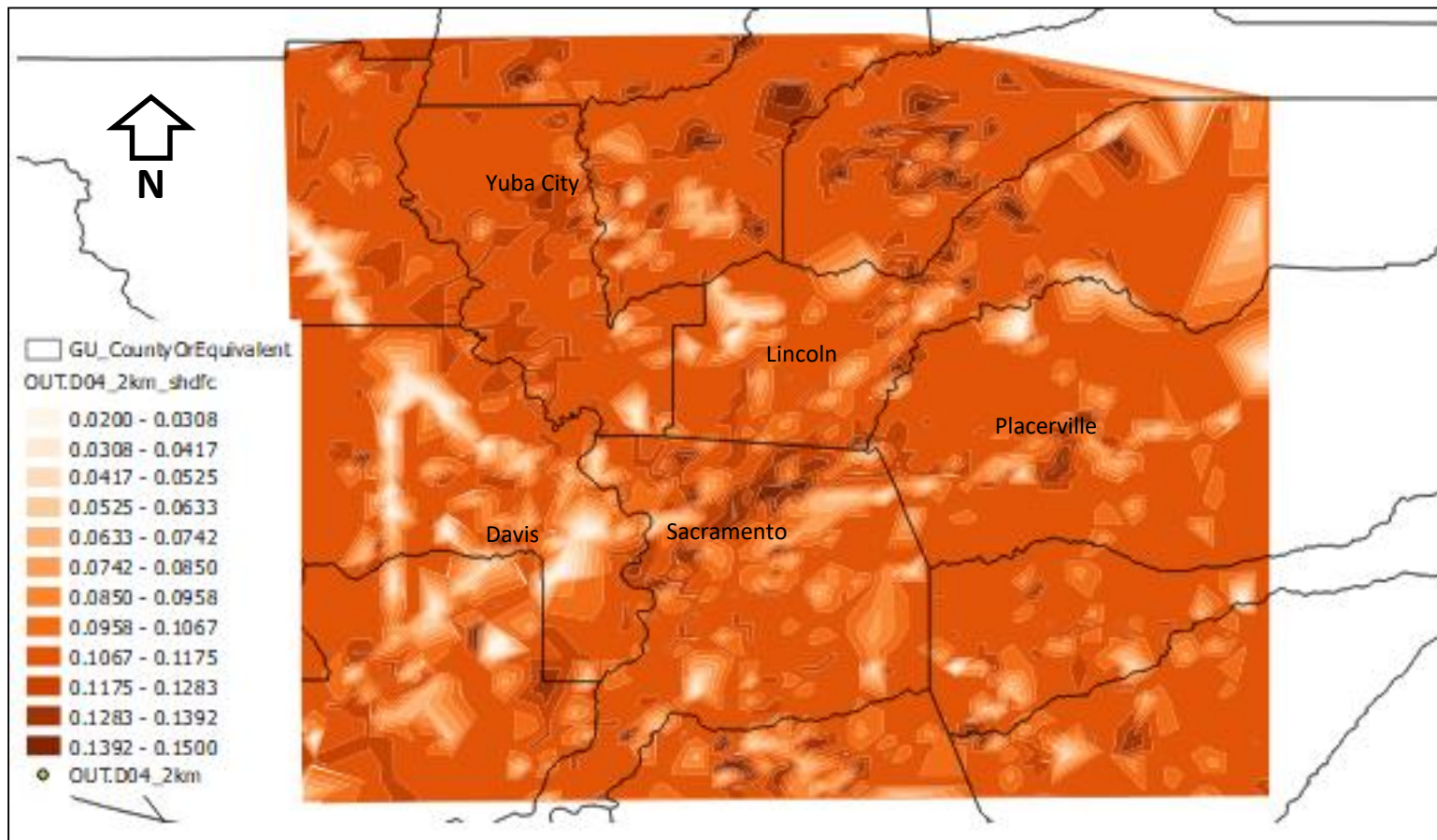# Physical characterization of the surface: 2-km domain

NLCD2011_GIRAS-based calculation of soil moisture content in D04 (2 km domain)
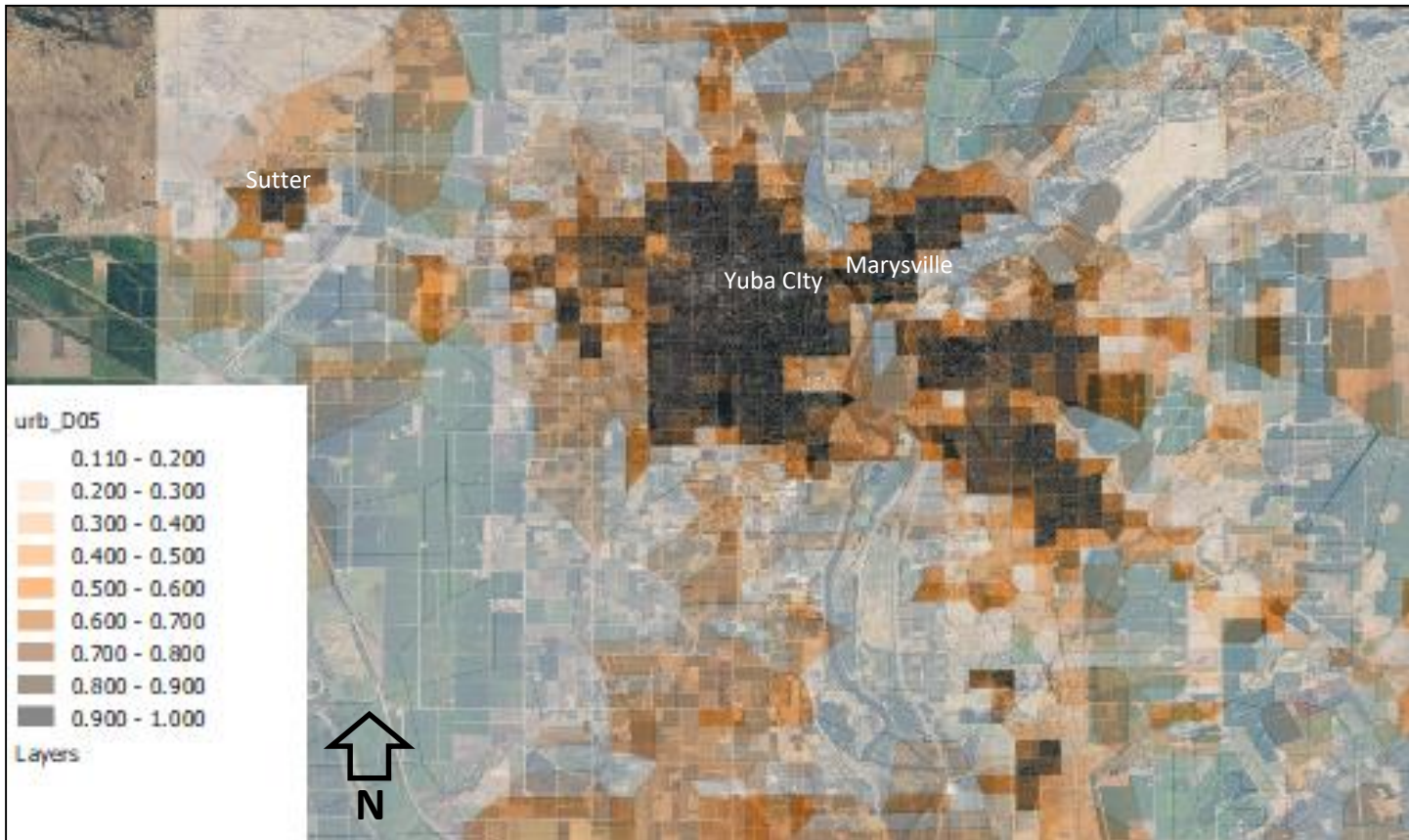
Physical characterization of the surface: 2-km domain

NLCD2011_GIRAS-based calculation of roughness length (m) in D04 (2 km domain)
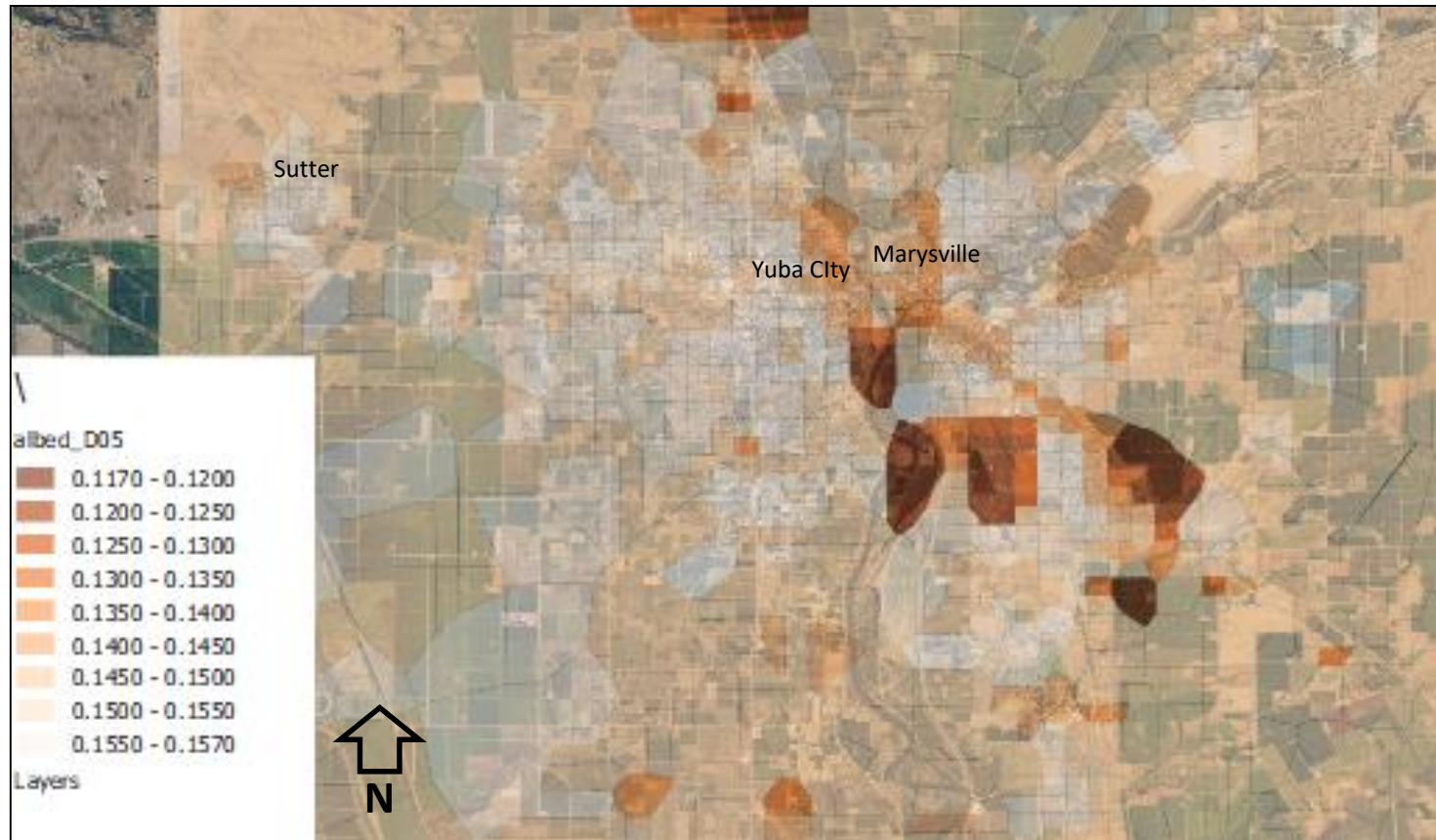
Physical characterization of the surface: 2-km domain

NLCD2011_GIRAS-based calculation of shade factor in D04 (2 km domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D05 (500 m domain)

Physical characterization of the surface: 500-m domains

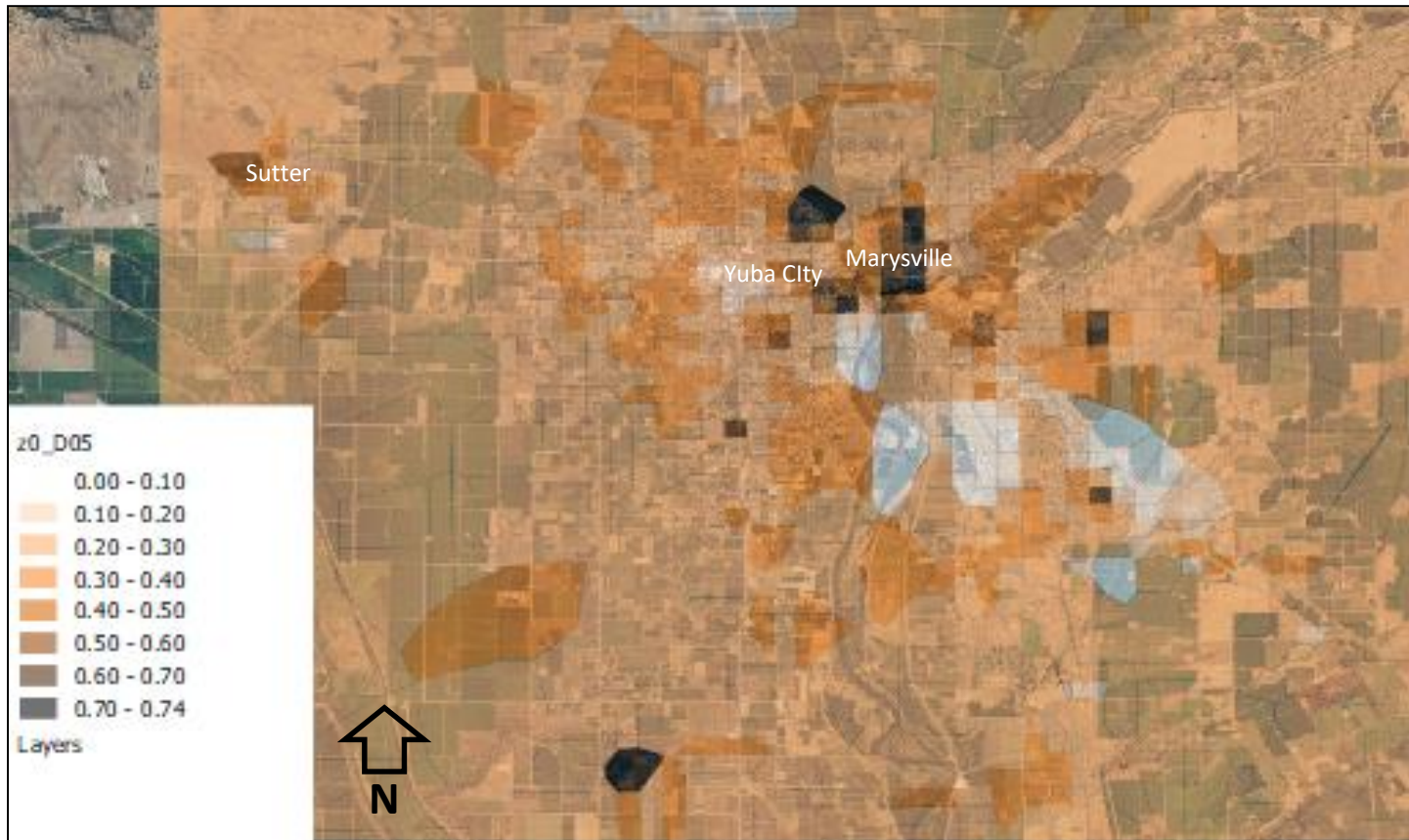NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D05 (500 m domain)
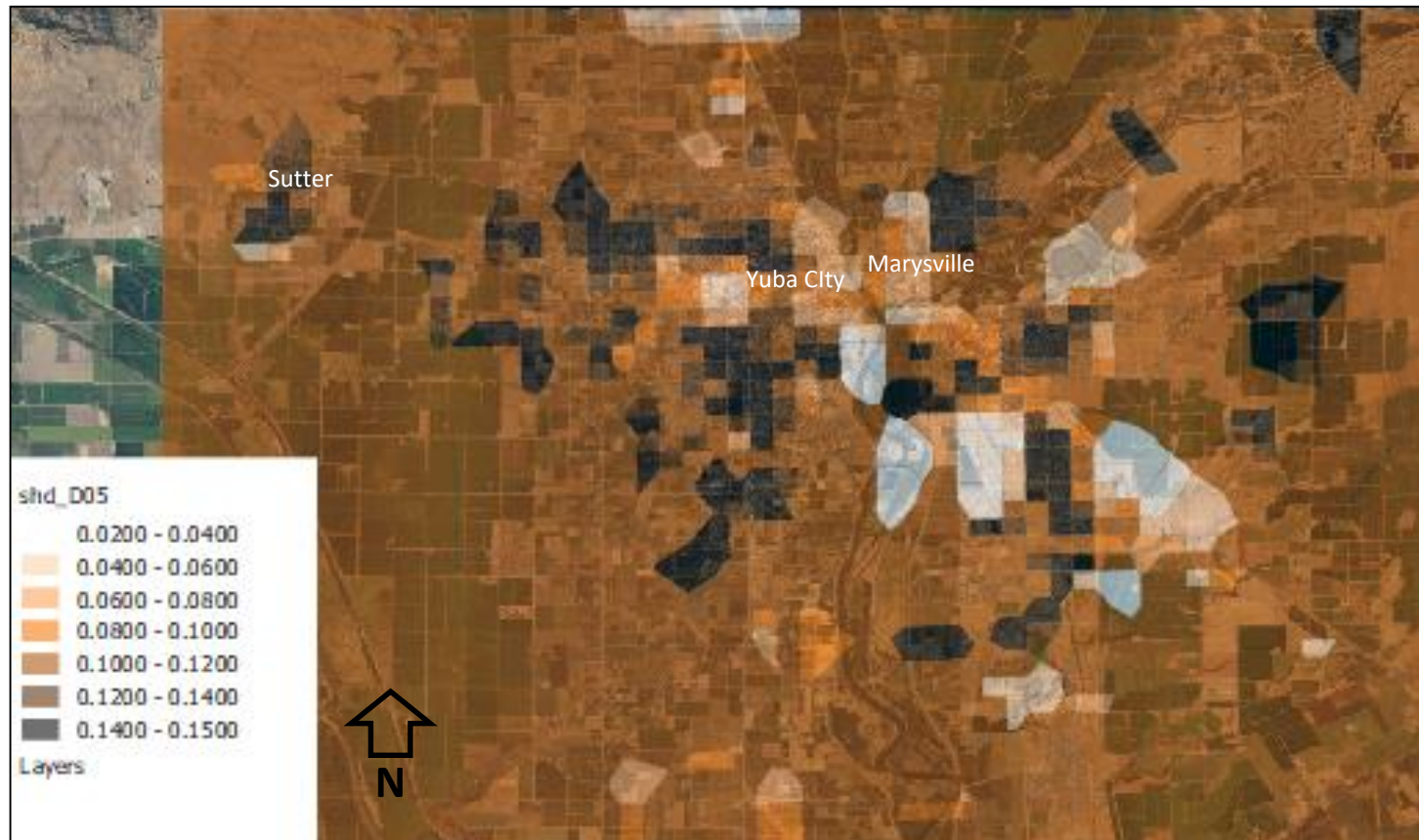
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of soil moisture content in D05 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of roughness length (m) in D05 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of shade factor in D05 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D06 (500 m domain)
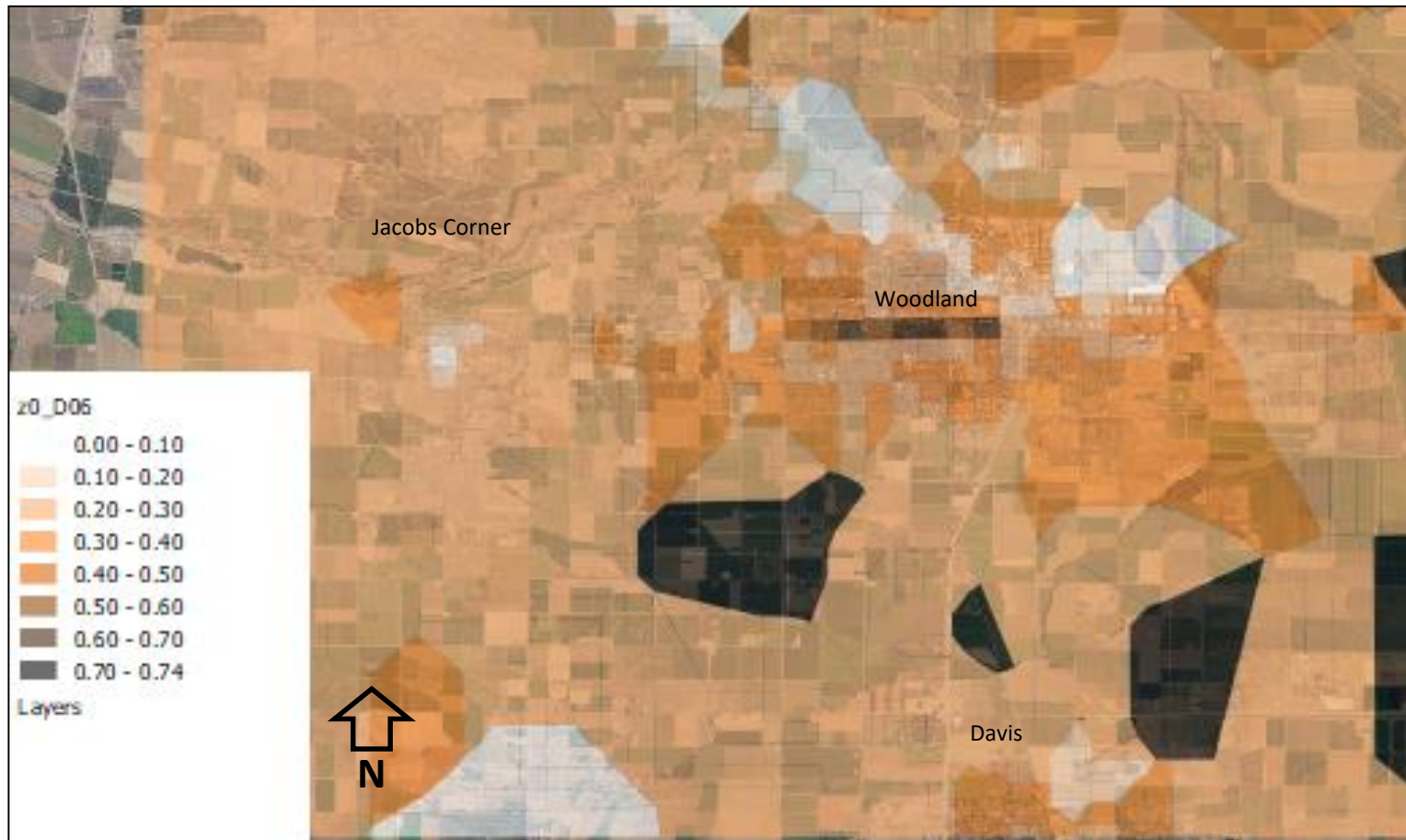
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D06 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of soil moisture content in D06 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of roughness length (m) in D06 (500 m domain)

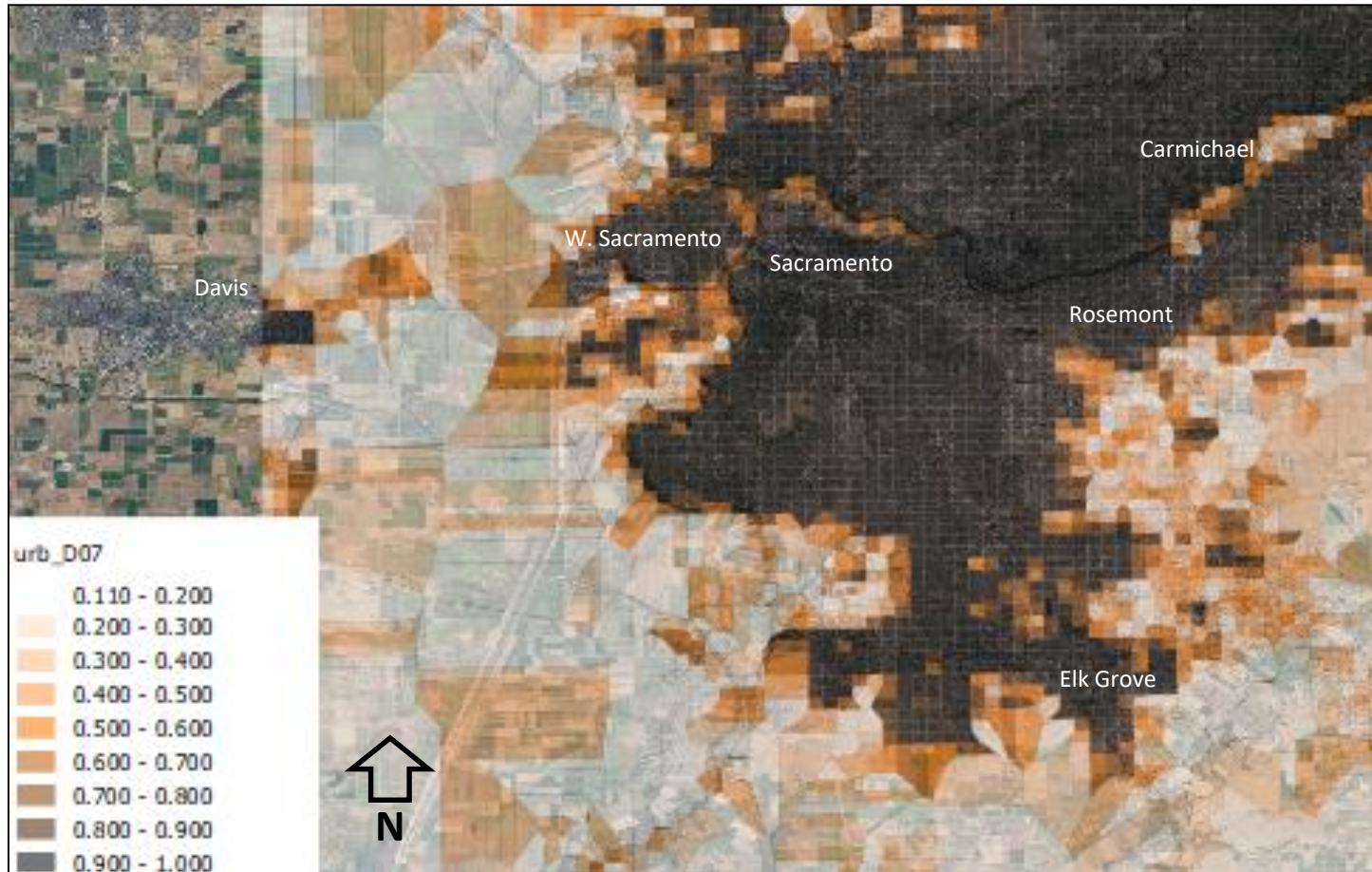# Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of shade factor in D06 (500 m domain)
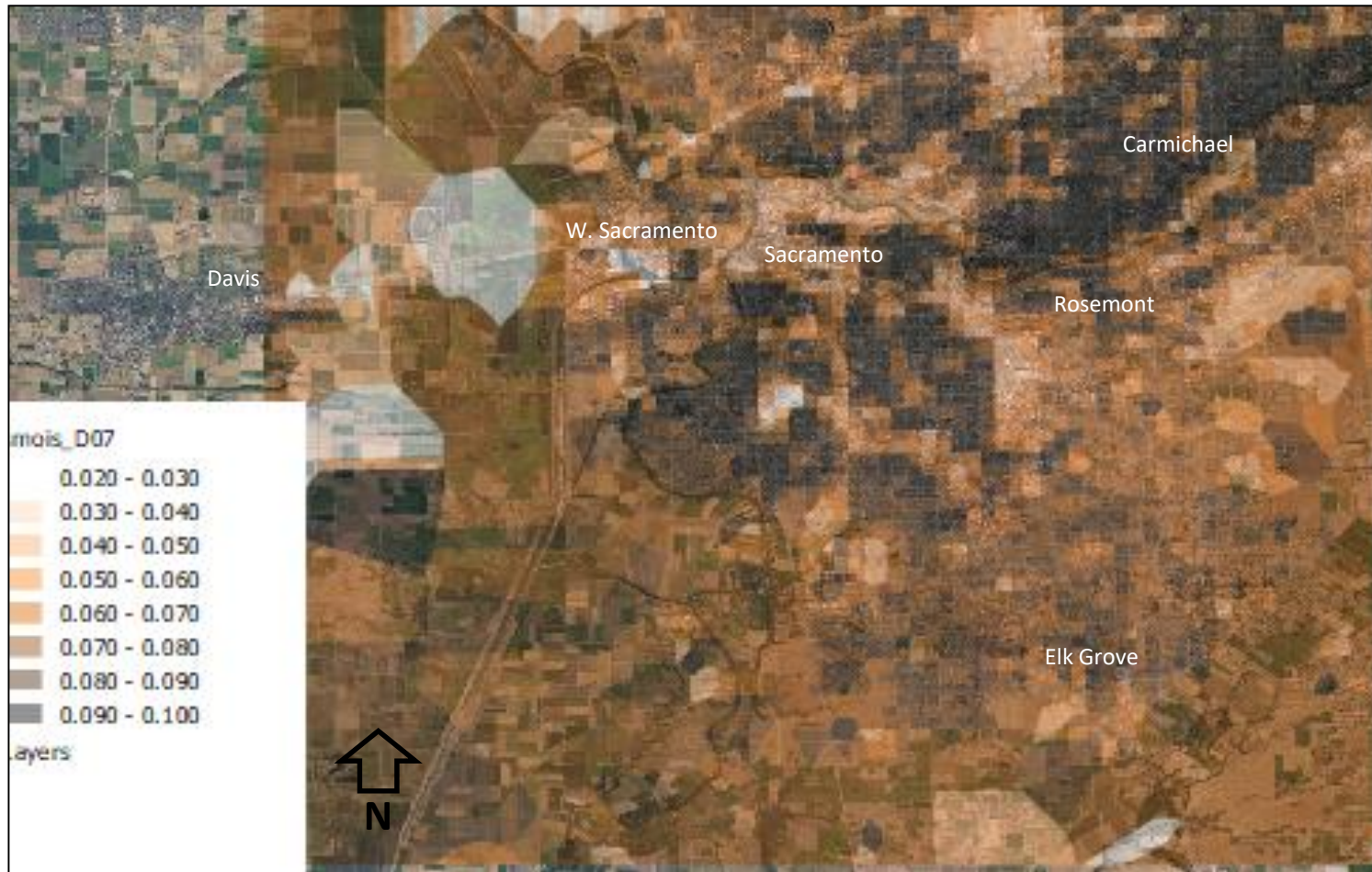
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D07 (500 m domain)

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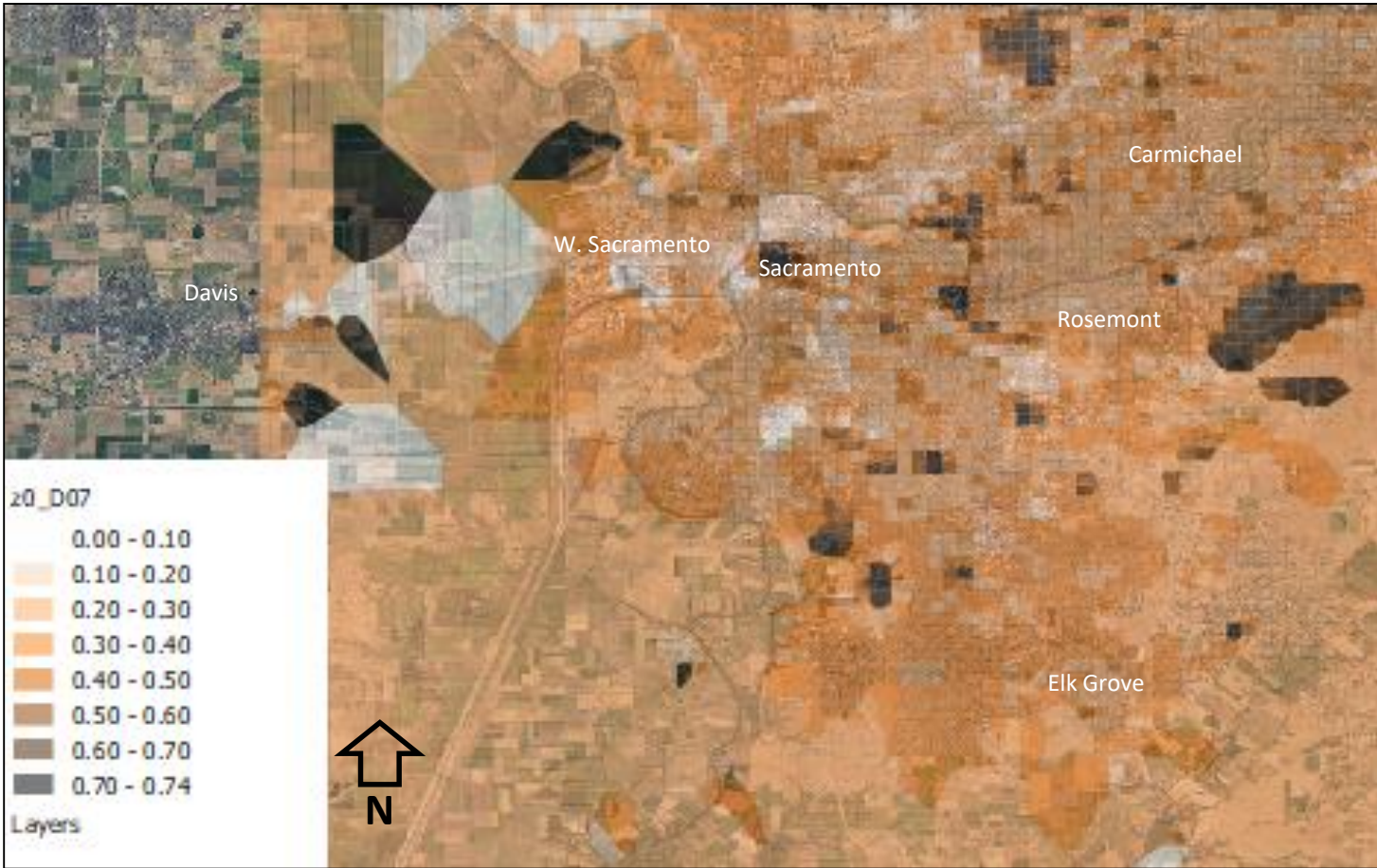# Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D07 (500 m domain)
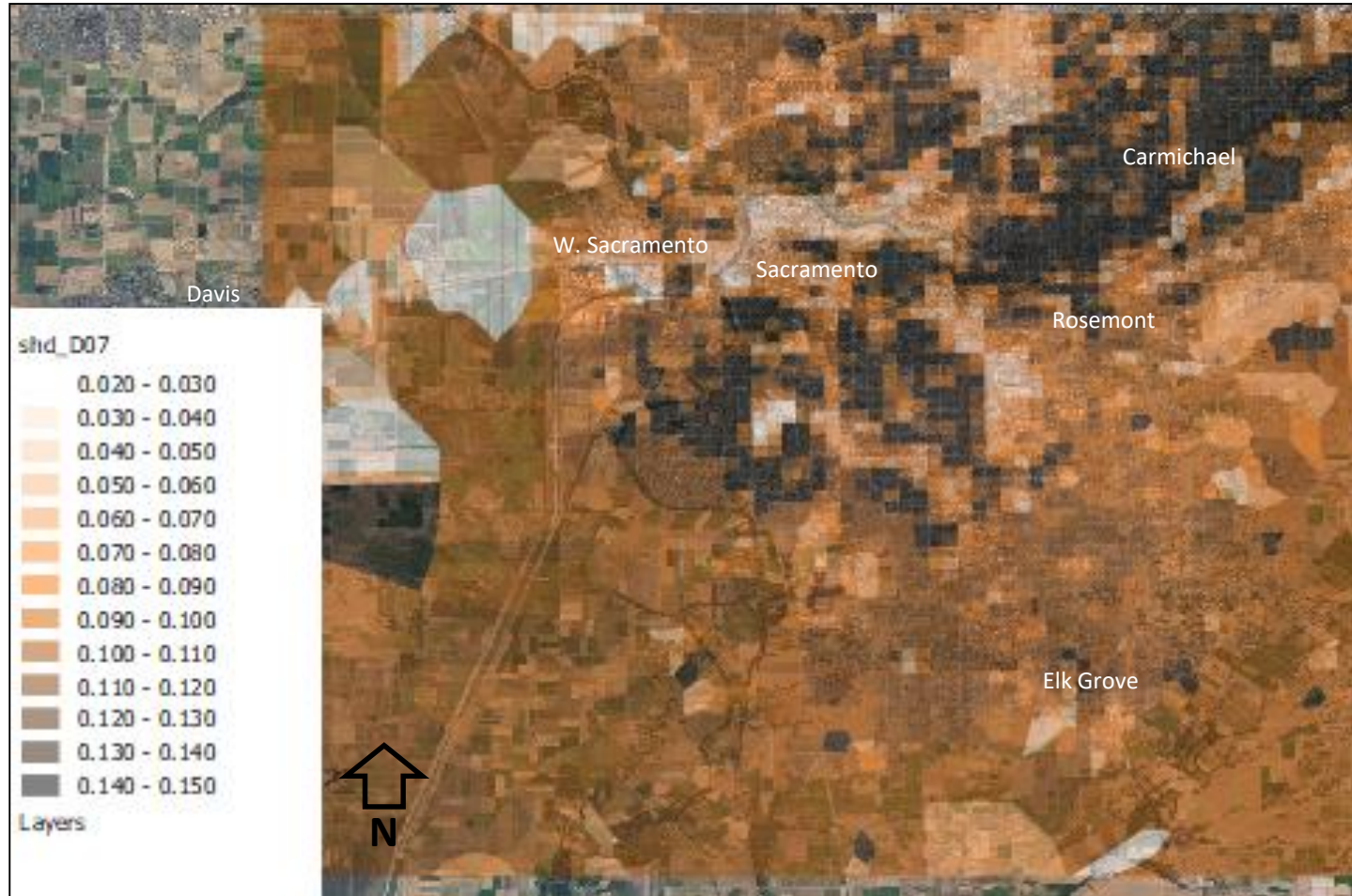
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of soil moisture content in D07 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of roughness length (m) in D07 (500 m domain)
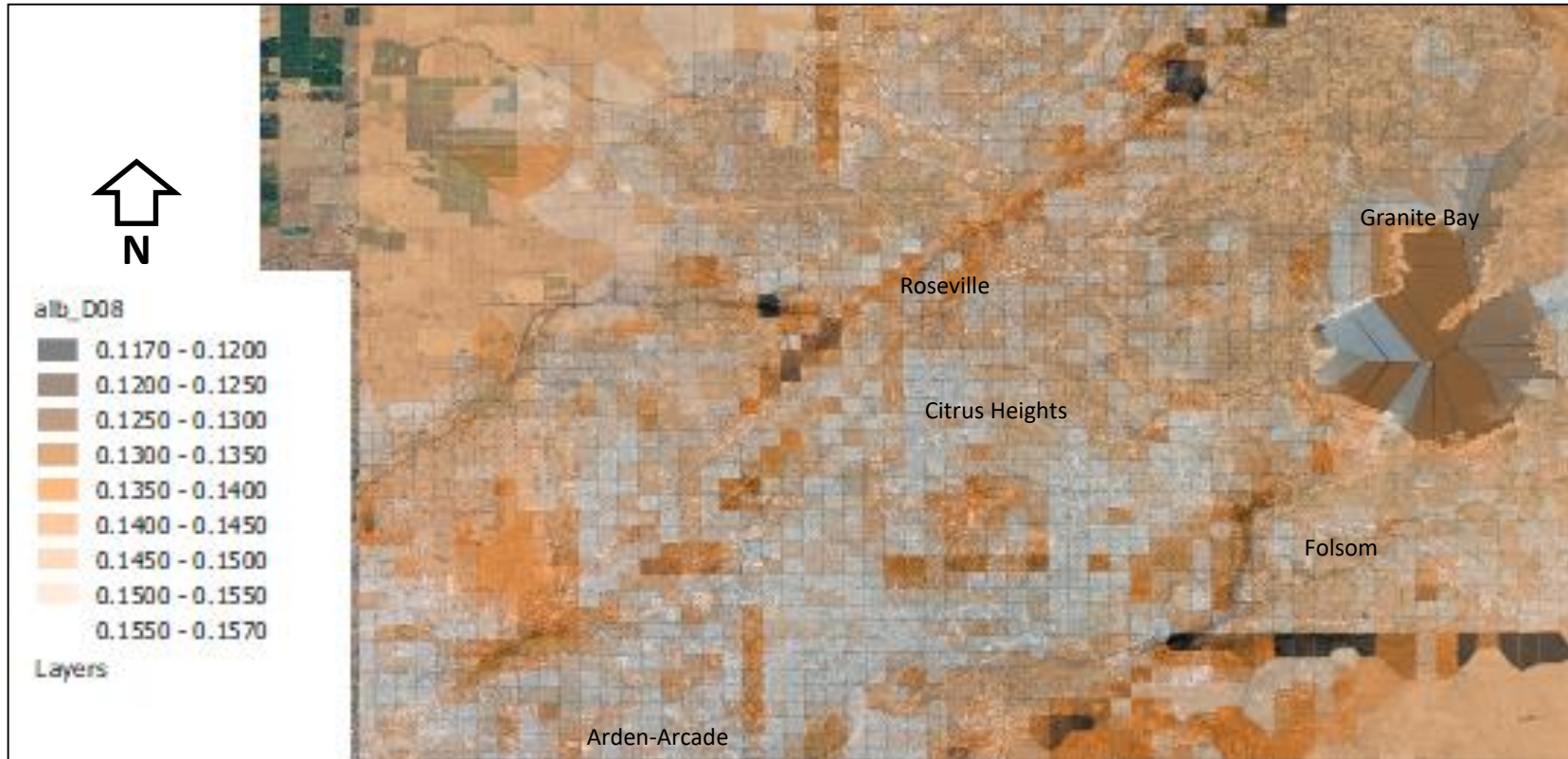
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of shade factor in D07 (500 m domain)
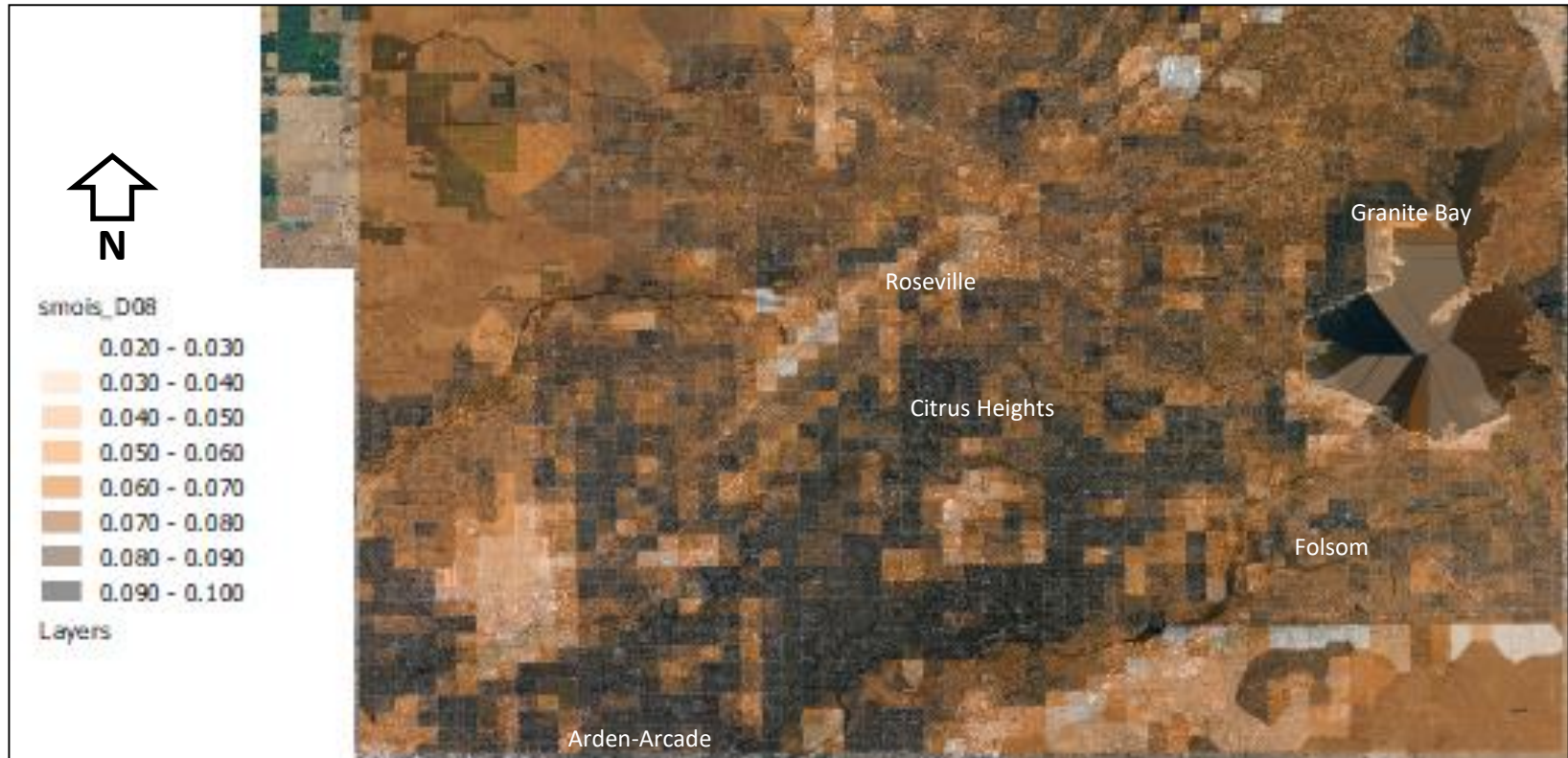
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D08 (500 m domain)

Physical characterization of the surface: 500-m domains

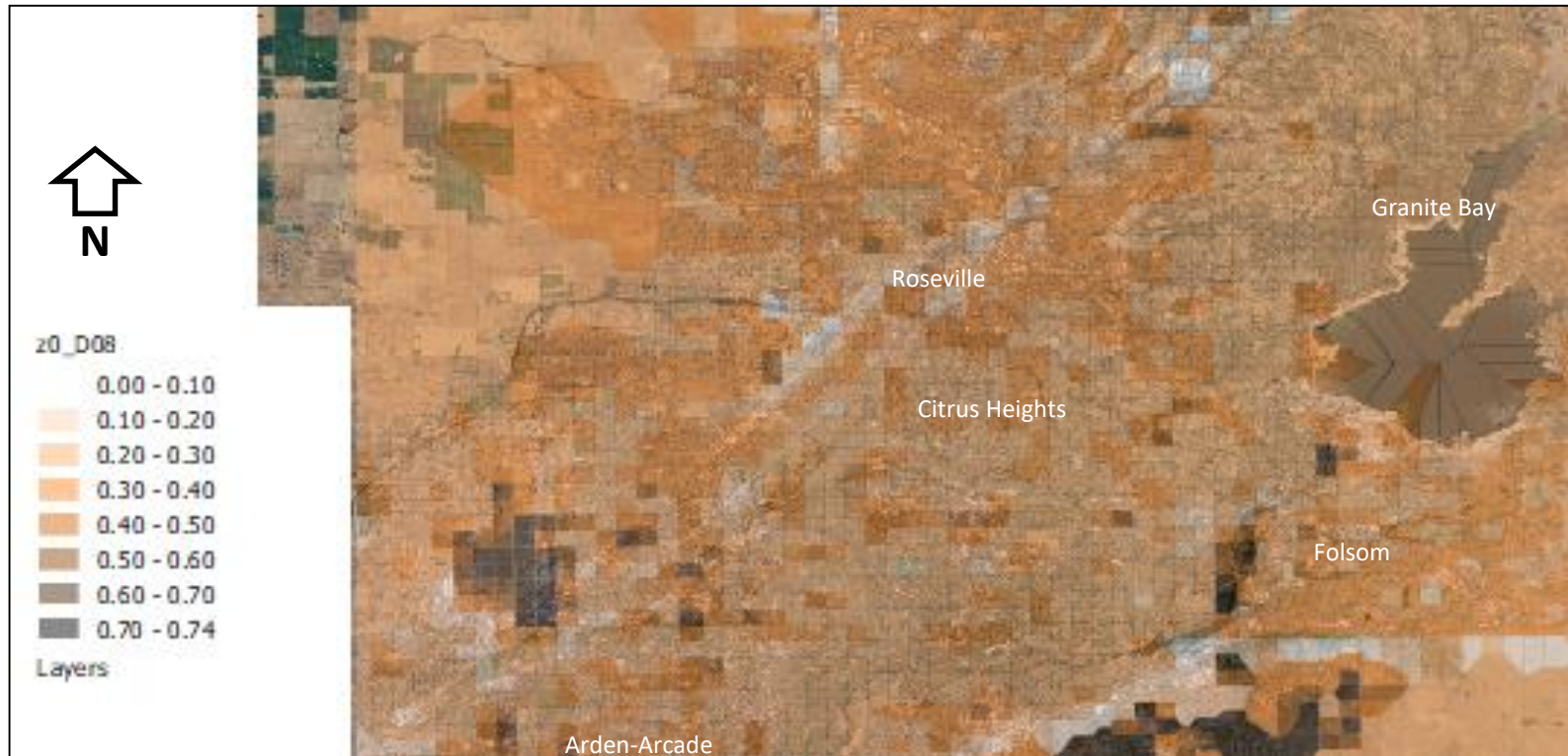NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D08 (500 m domain)

Physical characterization of the surface: 500-m domains

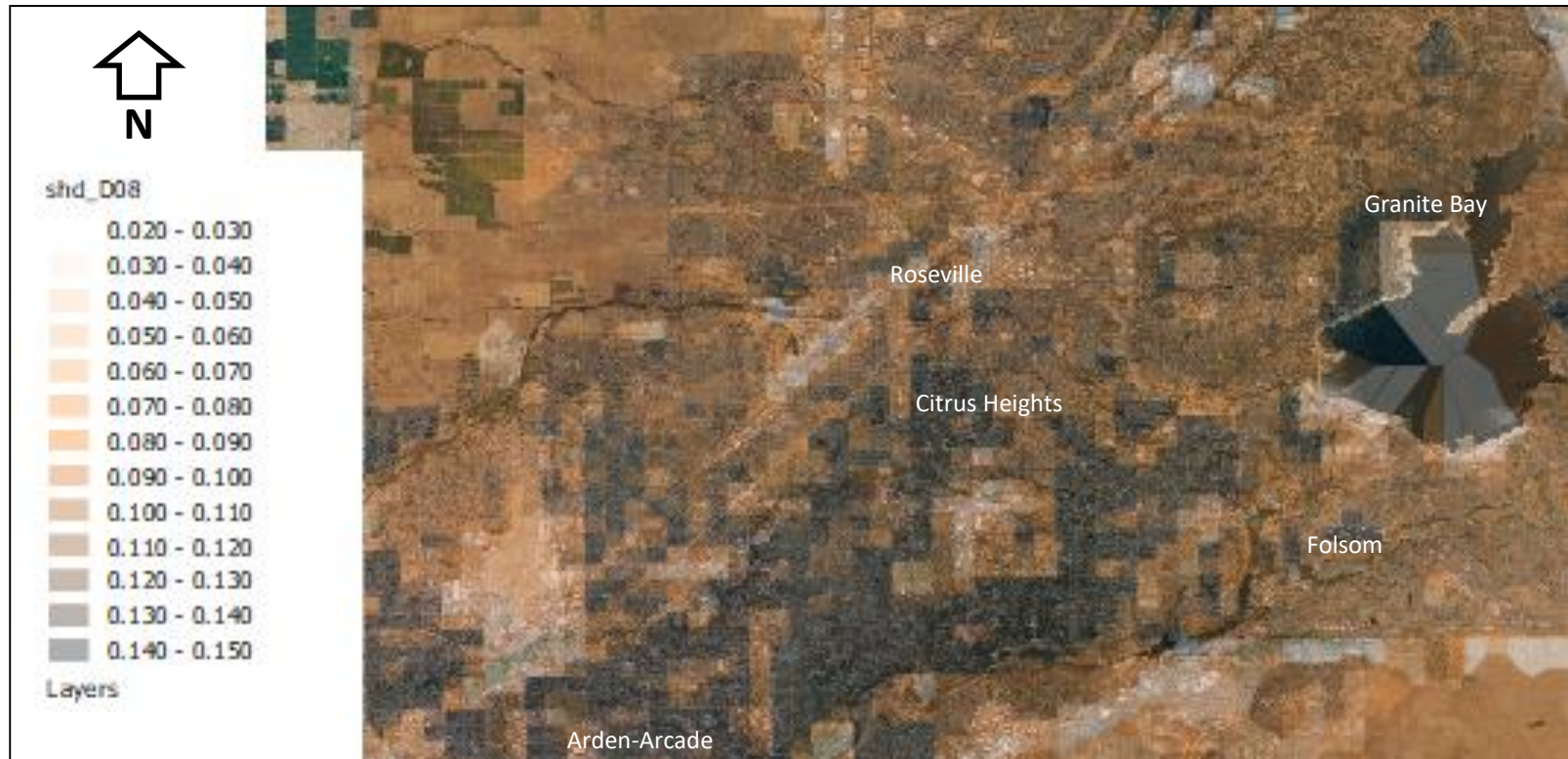NLCD2011_GIRAS-based calculation of soil moisture content in D08 (500 m domain)

Physical characterization of the surface: 500-m domains
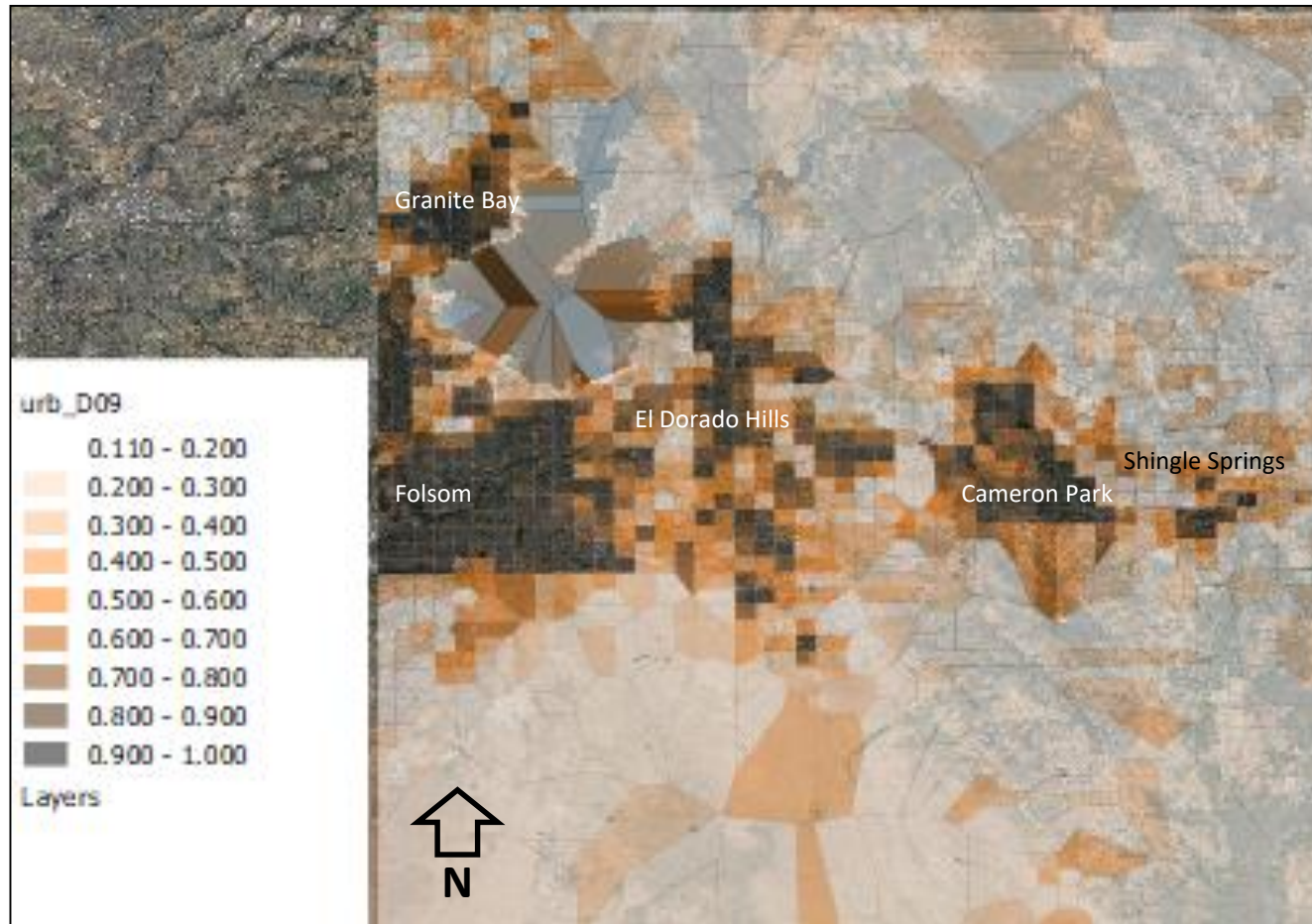

NLCD2011_GIRAS-based calculation of roughness length (m) in D08 (500 m domain)

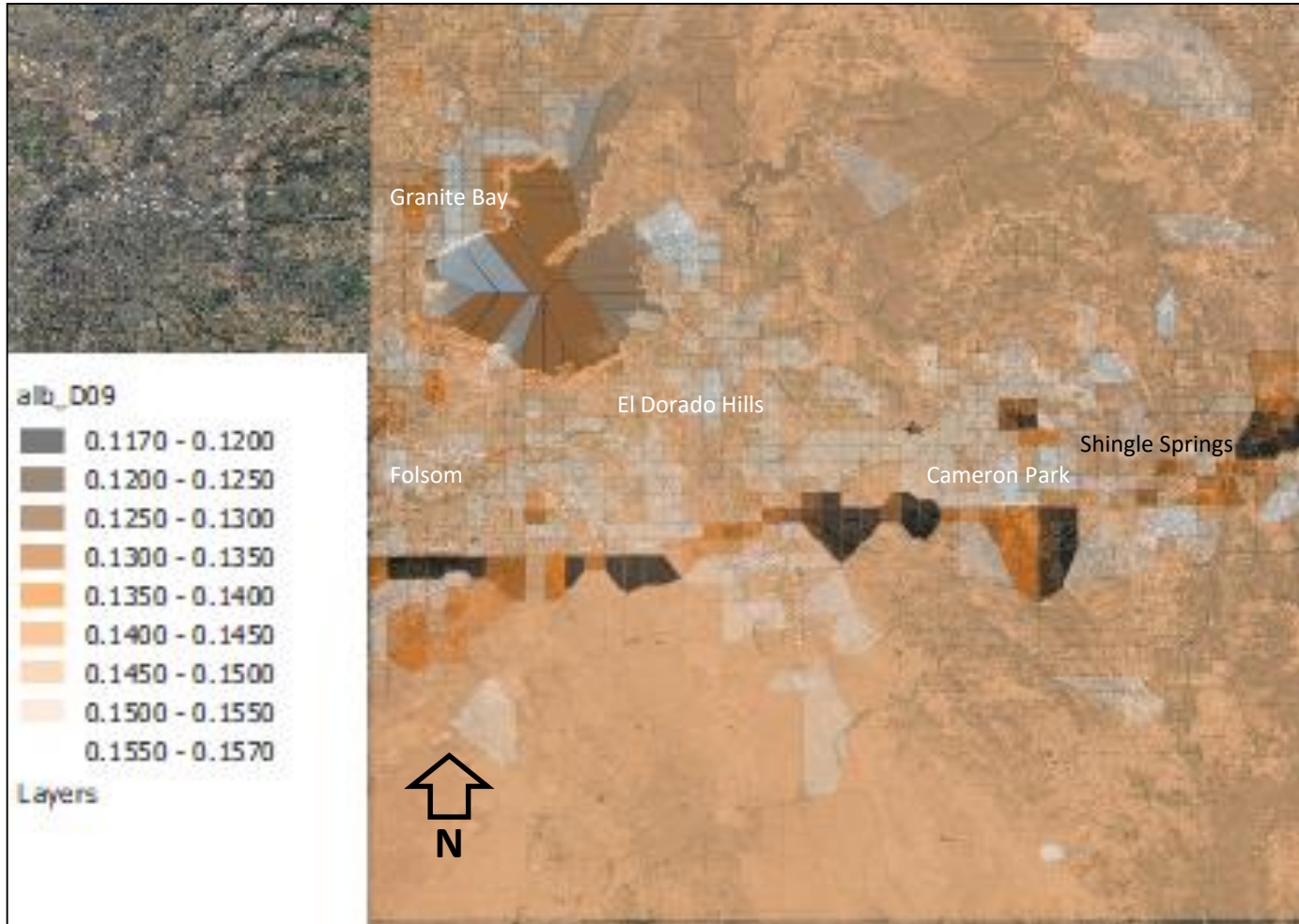# Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of shade factor in D08 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D09 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D09 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of soil moisture content (0 - 1) in D09 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of roughness length (m) in D09 (500 m domain)

Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of shade factor in D09 (500 m domain)
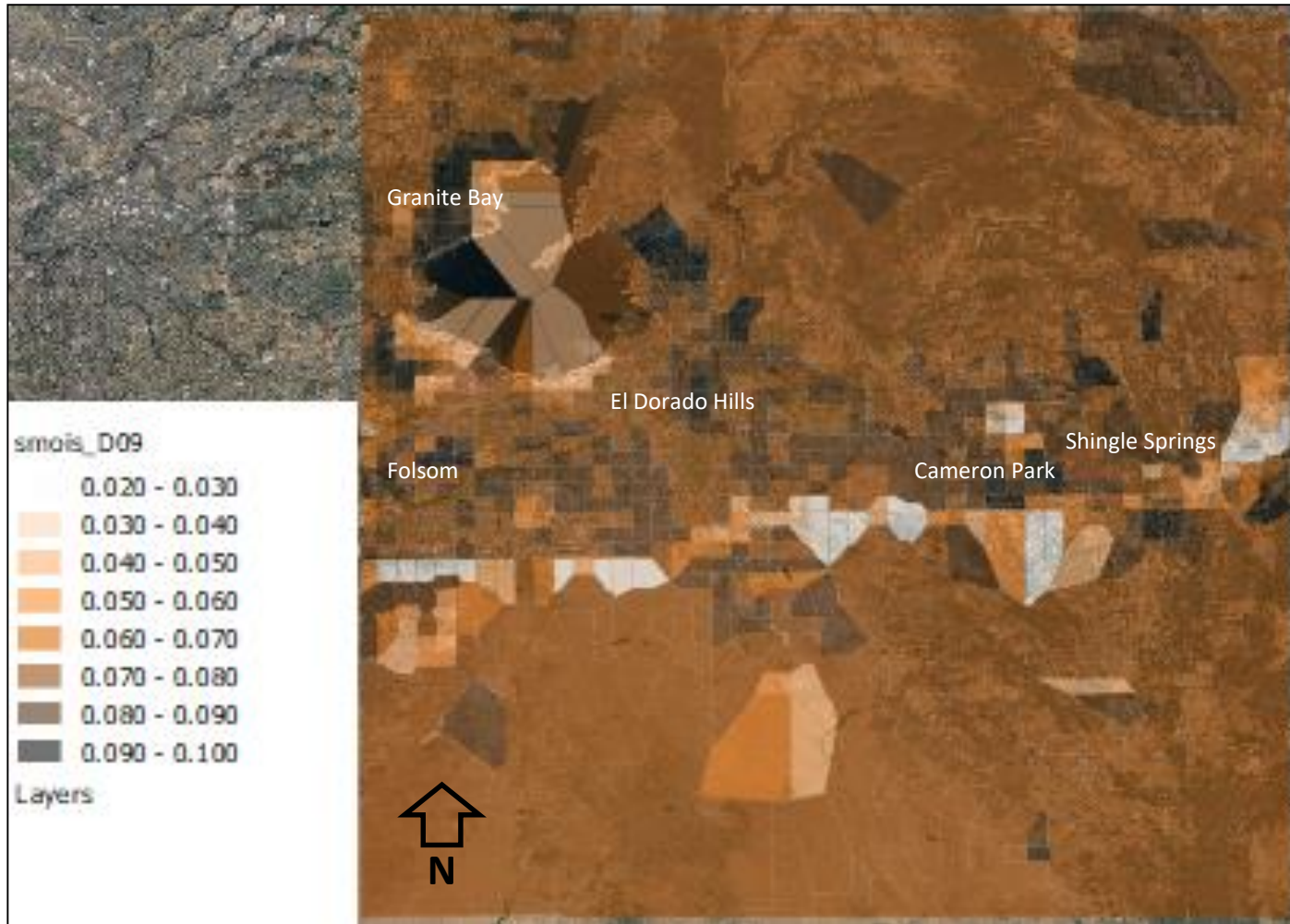
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of urban fraction (0 - 1) in D10 (500 m domain)
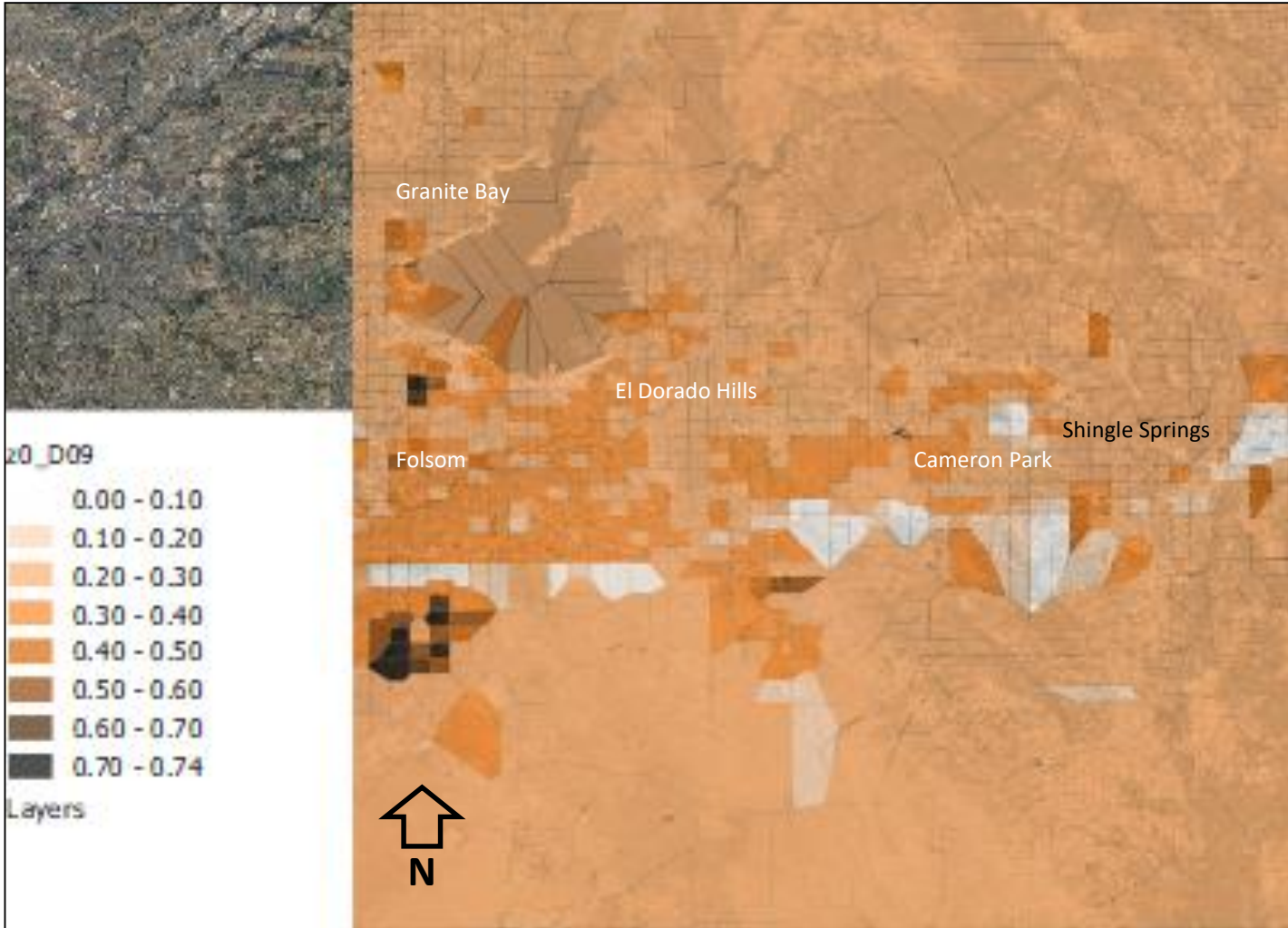
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of albedo (0 - 1) in D10 (500 m domain)

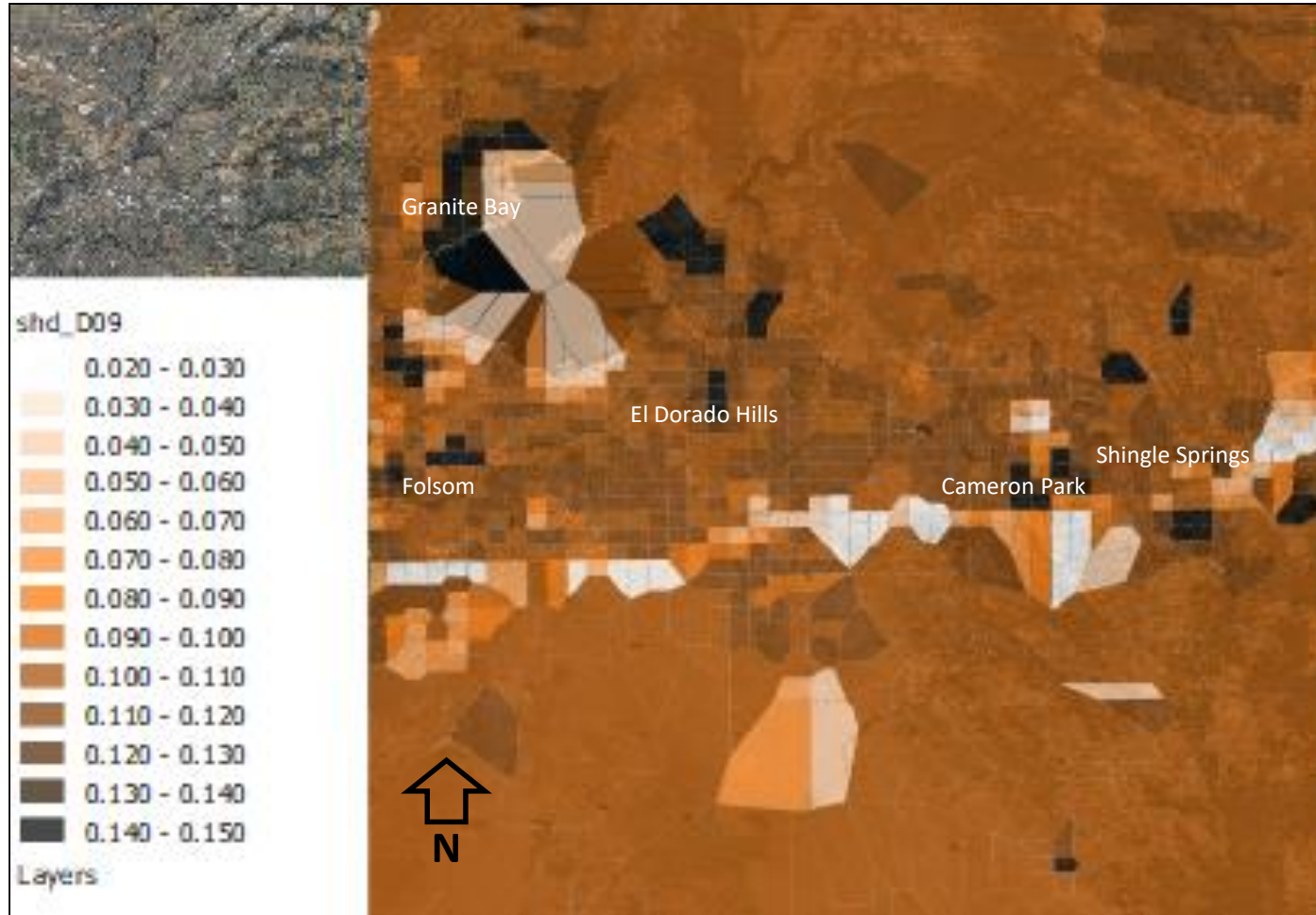# Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of soil moisture content (0 - 1) in D10 (500 m domain)
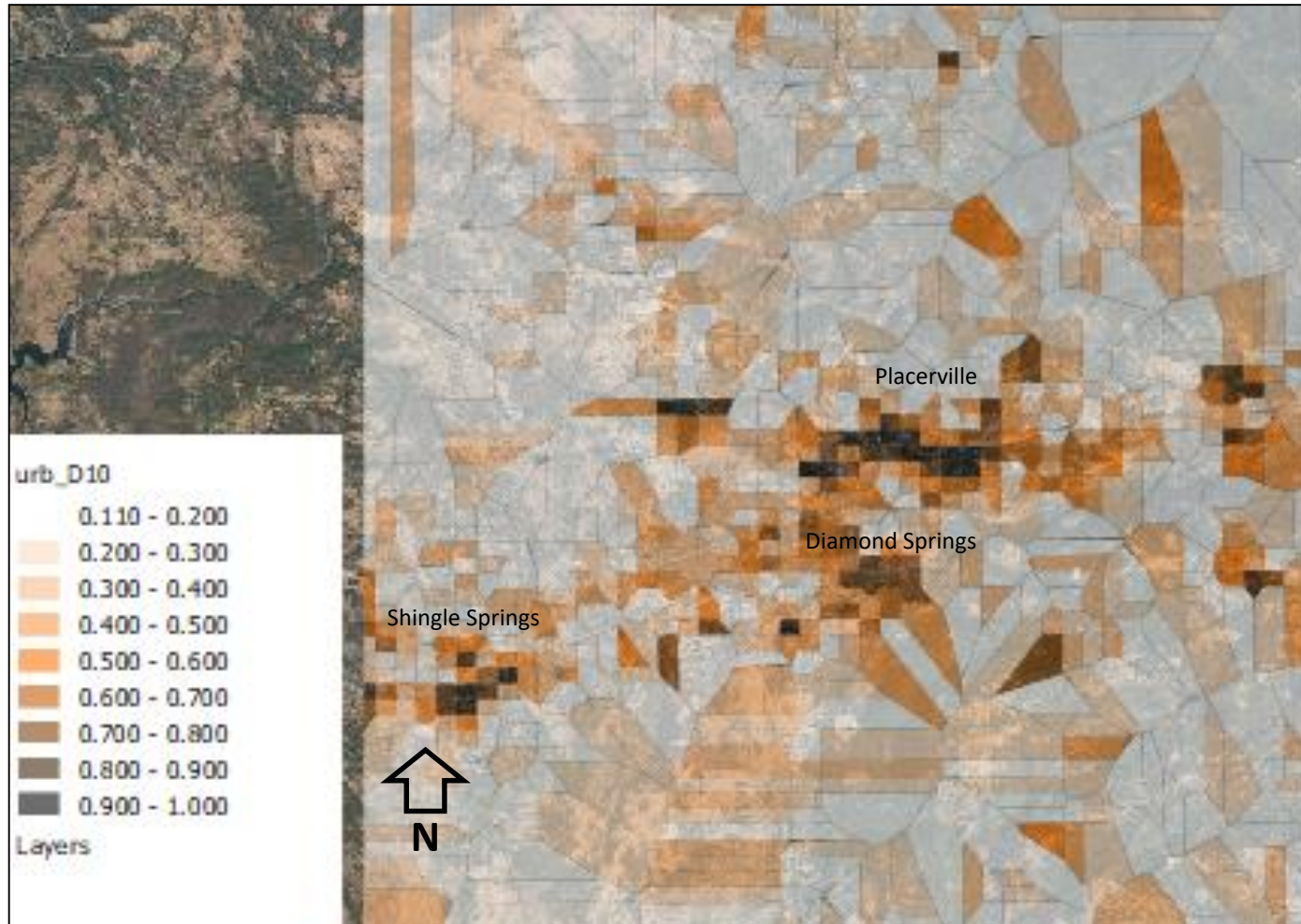
Physical characterization of the surface: 500-m domains

NLCD2011_GIRAS-based calculation of roughness length (m) in D10 (500 m domain)

Physical characterization of the surface: 500-m domains

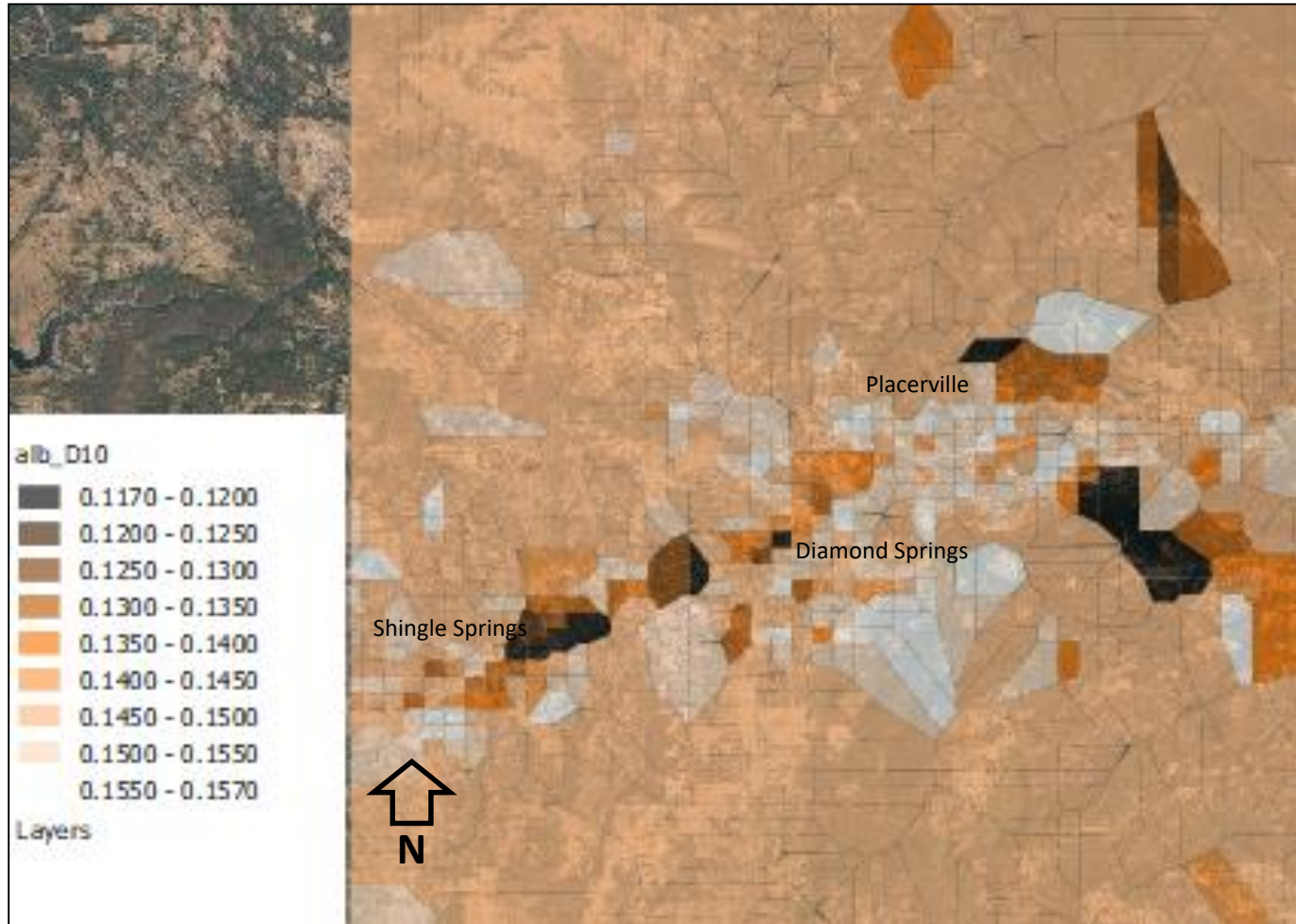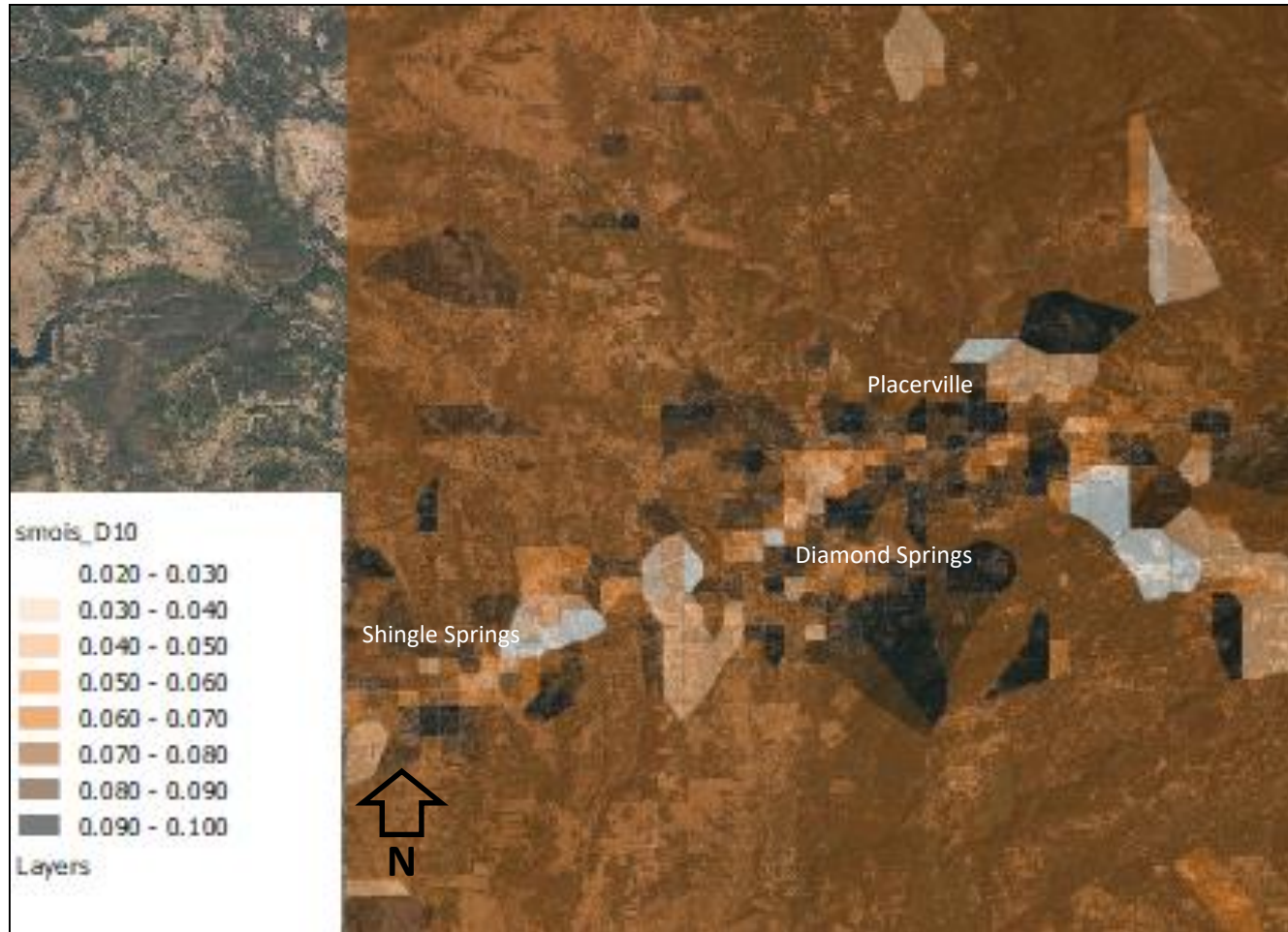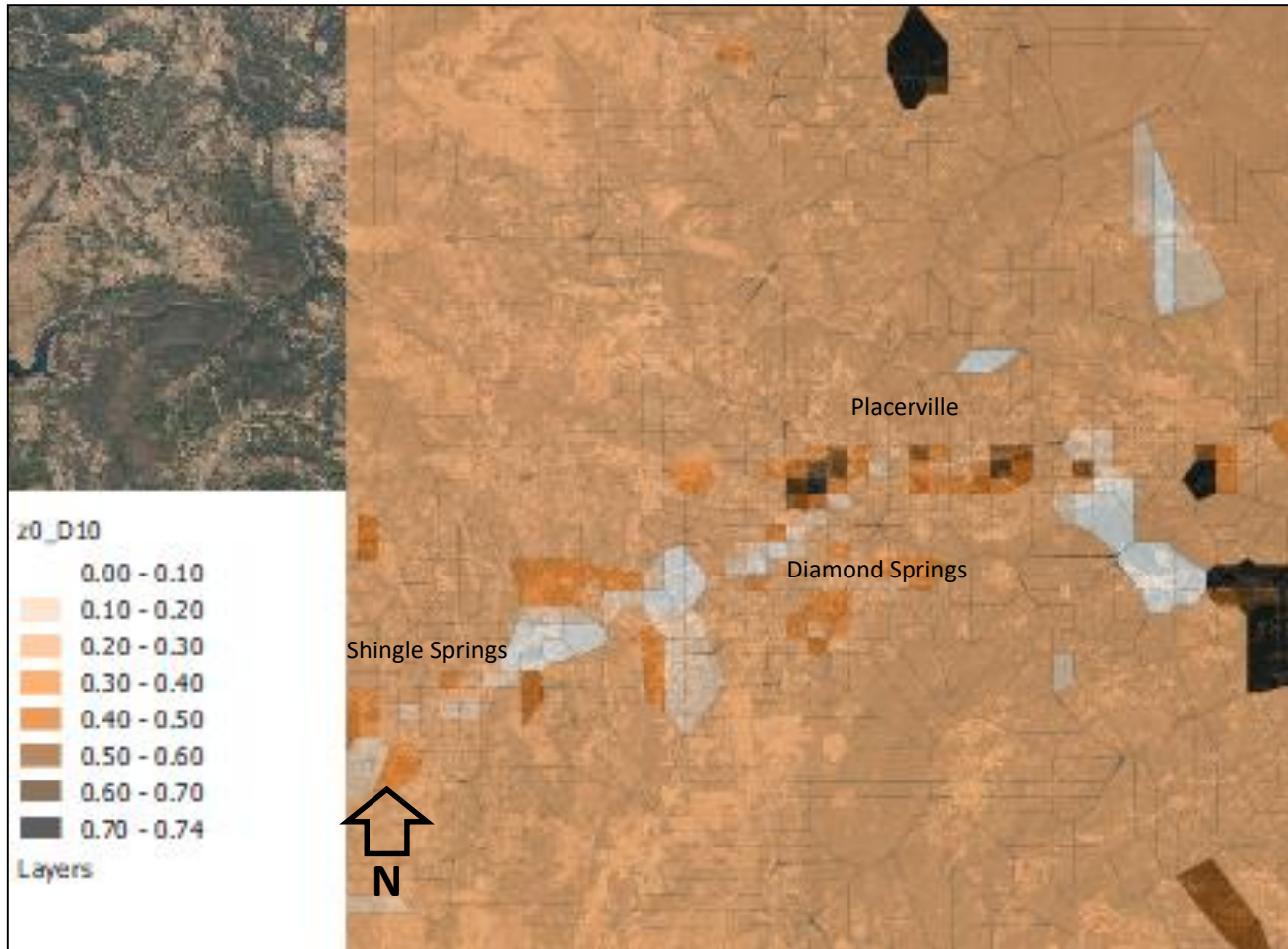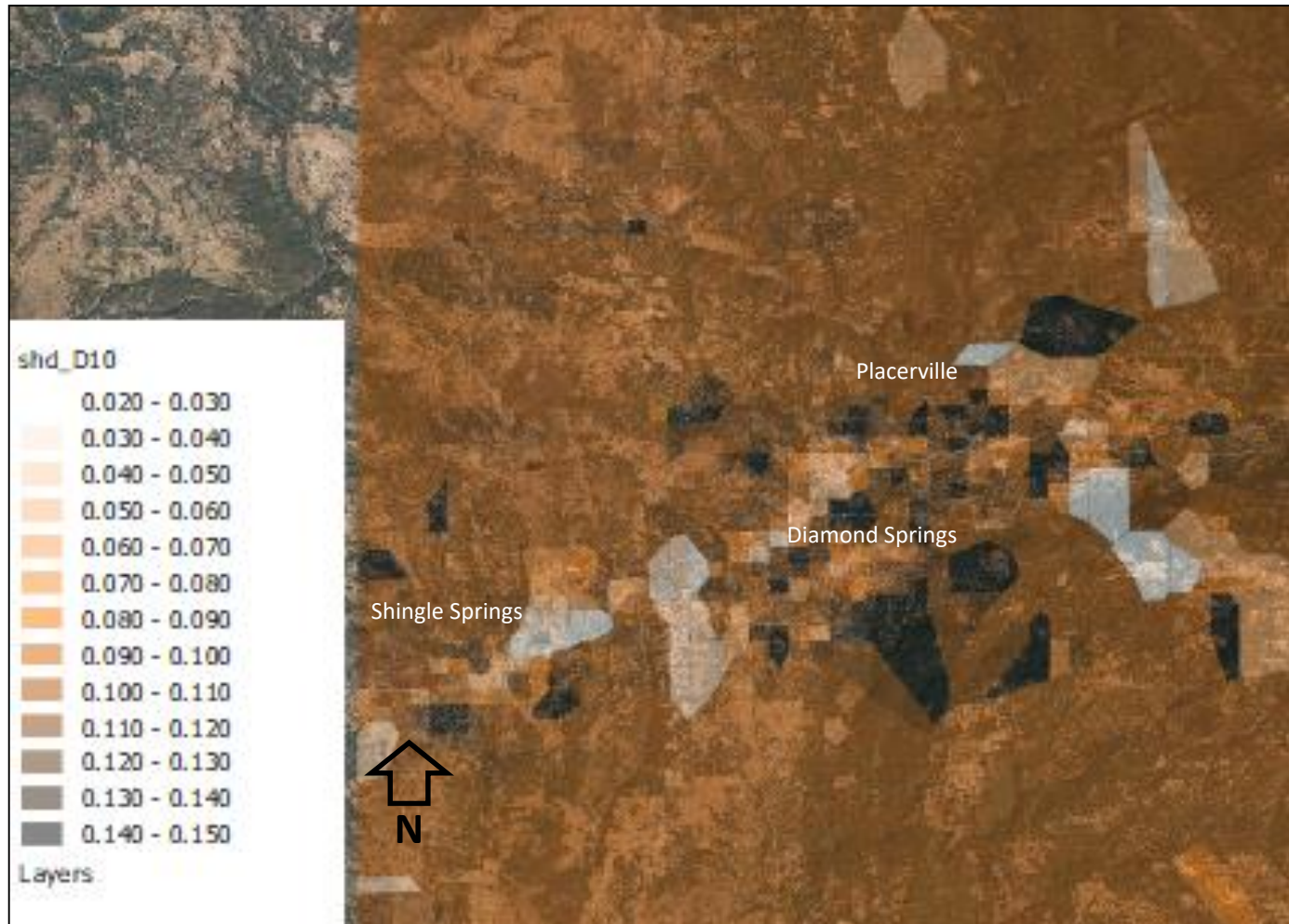NLCD2011_GIRAS-based calculation of shade factor in D10 (500 m domain)

Appendix A-2

The maps in this appendix provide the locations of urban cells (indicated by small circles) in each 500-m domain. These are the locations where the urban model (urban parameterizations) is triggered, or called.

The circles are color-coded to represent urban fraction at each location, as indicated in each figure's legend.

Note: The maps are not to the same scale.

D05 urban cells

Legend:
- ○ 0.110 - 0.199
- ○ 0.199 - 0.288
- ○ 0.288 - 0.377
- ○ 0.377 - 0.466
- ○ 0.466 - 0.555
- ● 0.555 - 0.644
- ● 0.644 - 0.733
- ● 0.733 - 0.822
- ● 0.822 - 0.911
- ● 0.911 - 1.000
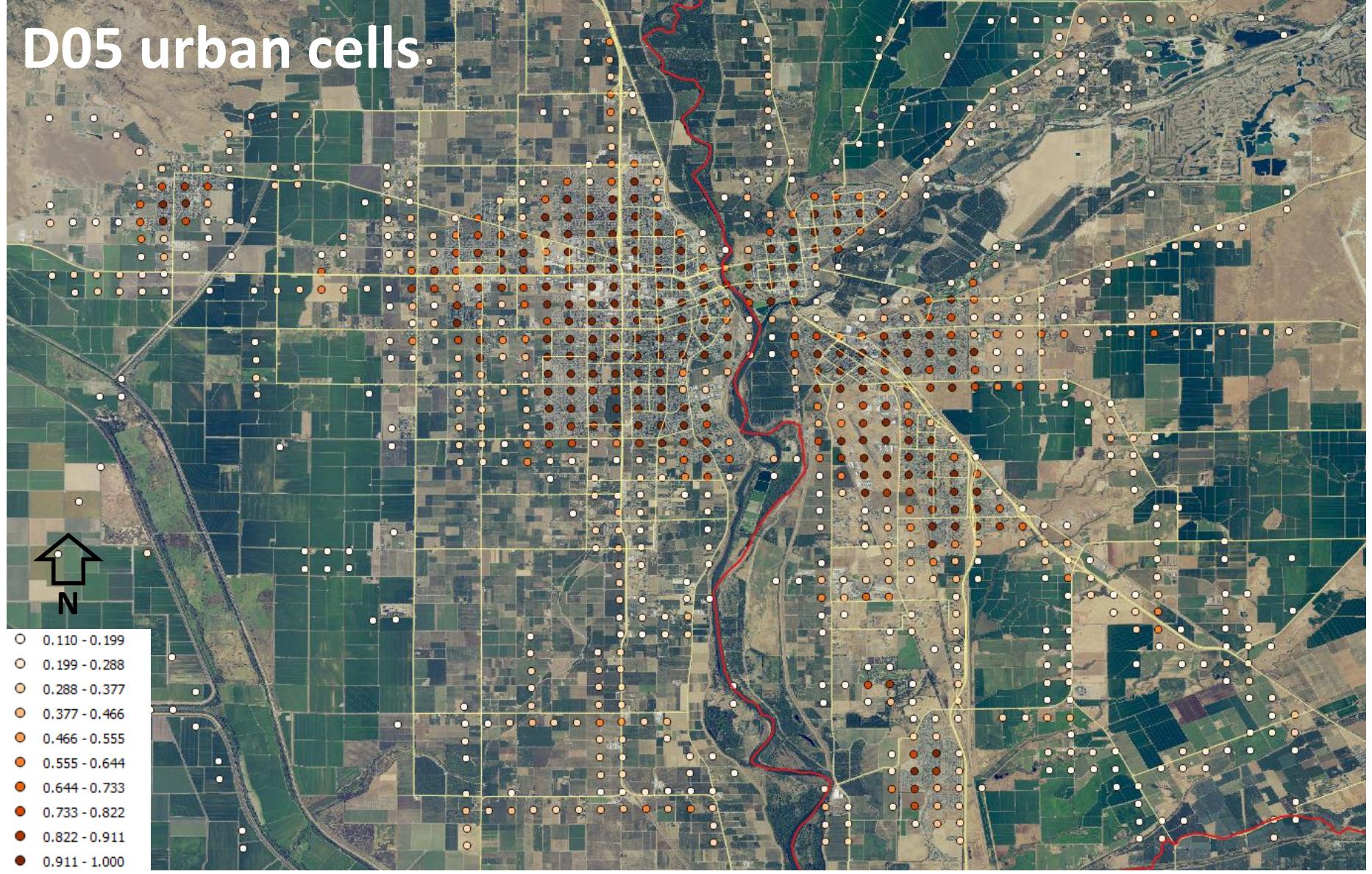
Yuba City / Marysville Urban Fraction (933 trigger cells in this domain)

D06 urban cells
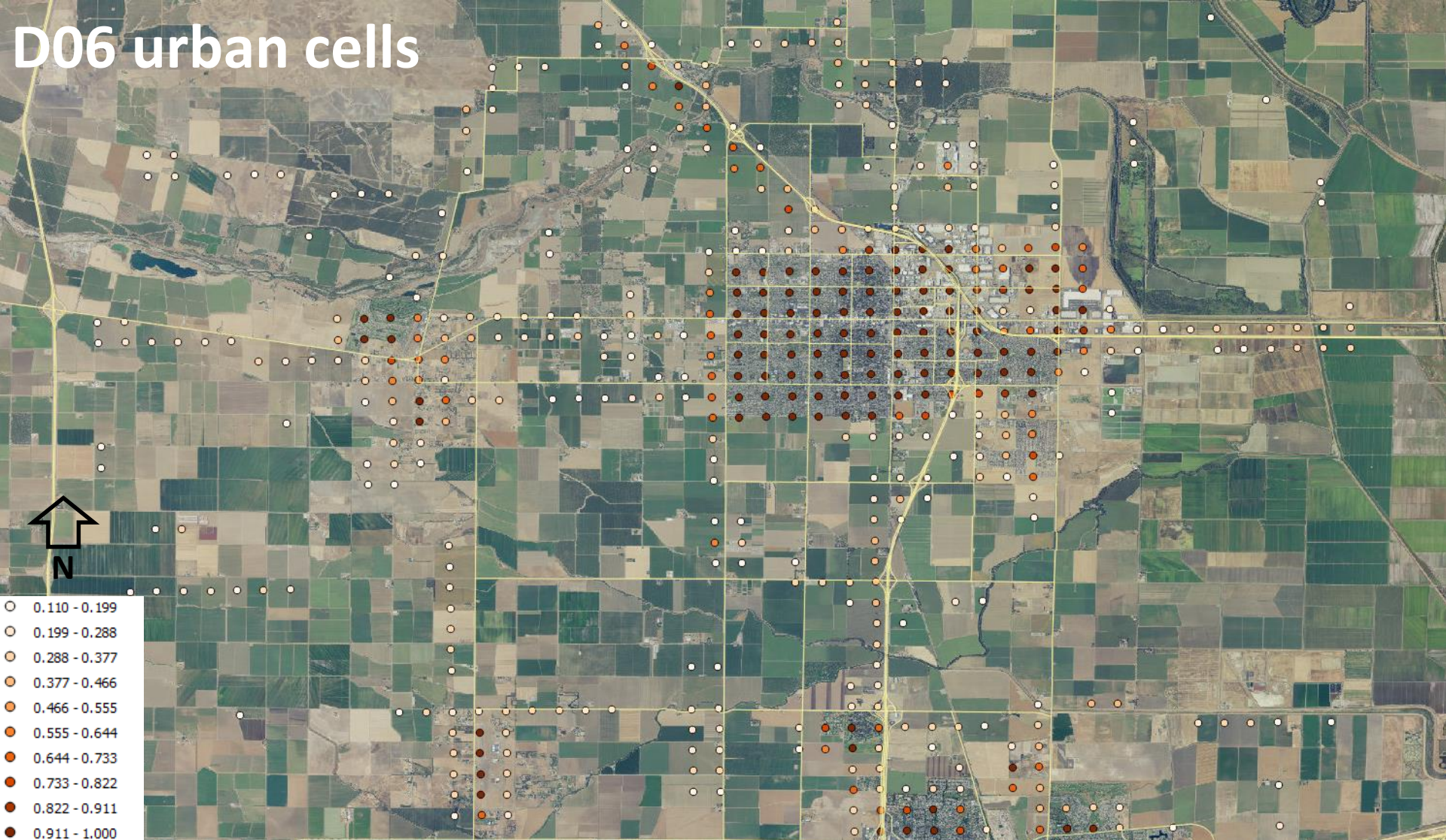
Woodland Urban Fraction (501 trigger cells in this domain)

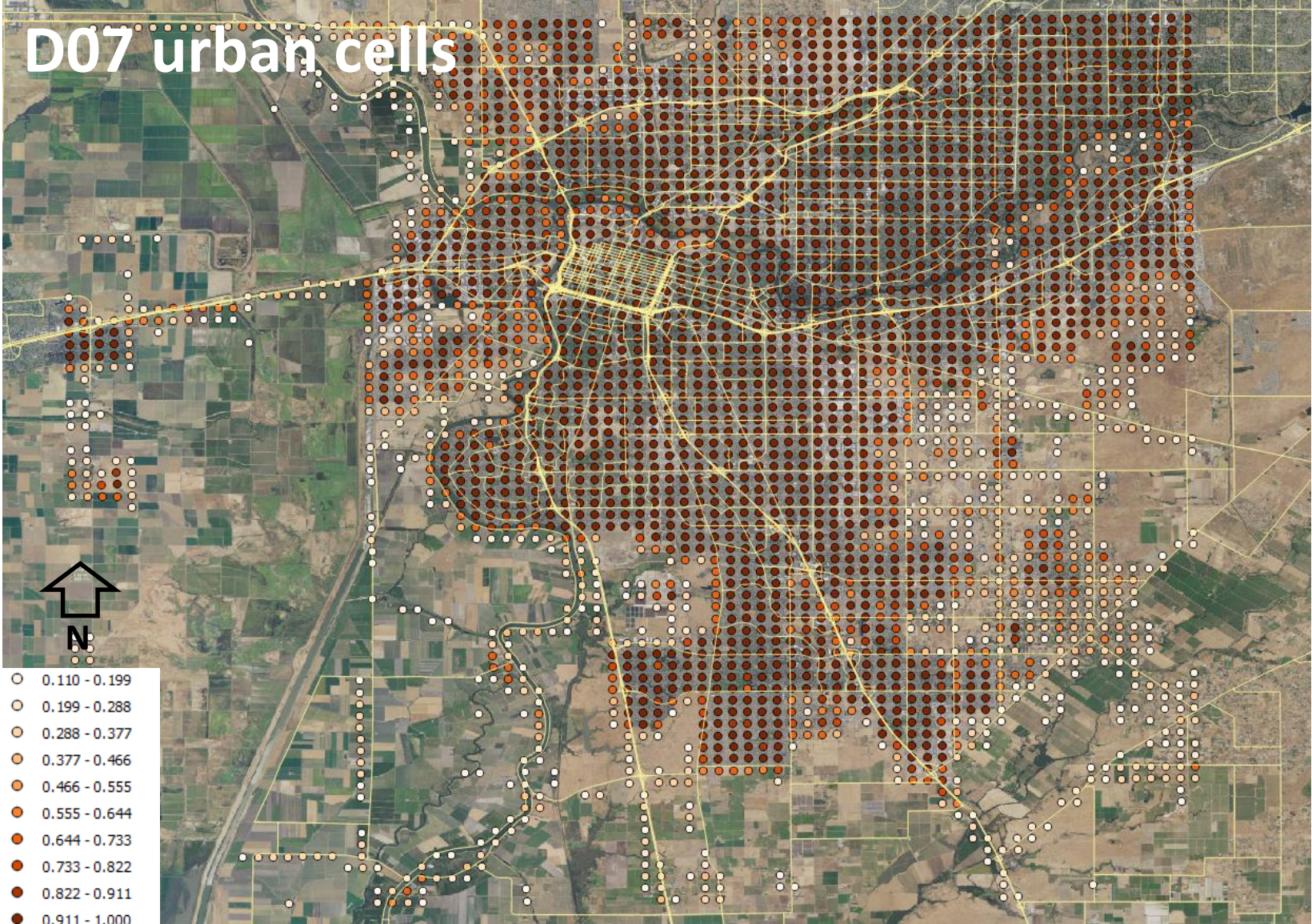Legend:
- 0.110 - 0.199
- 0.199 - 0.288
- 0.288 - 0.377
- 0.377 - 0.466
- 0.466 - 0.555
- 0.555 - 0.644
- 0.644 - 0.733
- 0.733 - 0.822
- 0.822 - 0.911
- 0.911 - 1.000

Sacramento Urban Fraction (3153 trigger cells in this domain)

D08 urban cells

Legend:
- ○ 0.110 - 0.199
- ○ 0.199 - 0.288
- ○ 0.288 - 0.377
- ○ 0.377 - 0.466
- ○ 0.466 - 0.555
- ○ 0.555 - 0.644
- ● 0.644 - 0.733
- ● 0.733 - 0.822
- ● 0.822 - 0.911
- ● 0.911 - 1.000
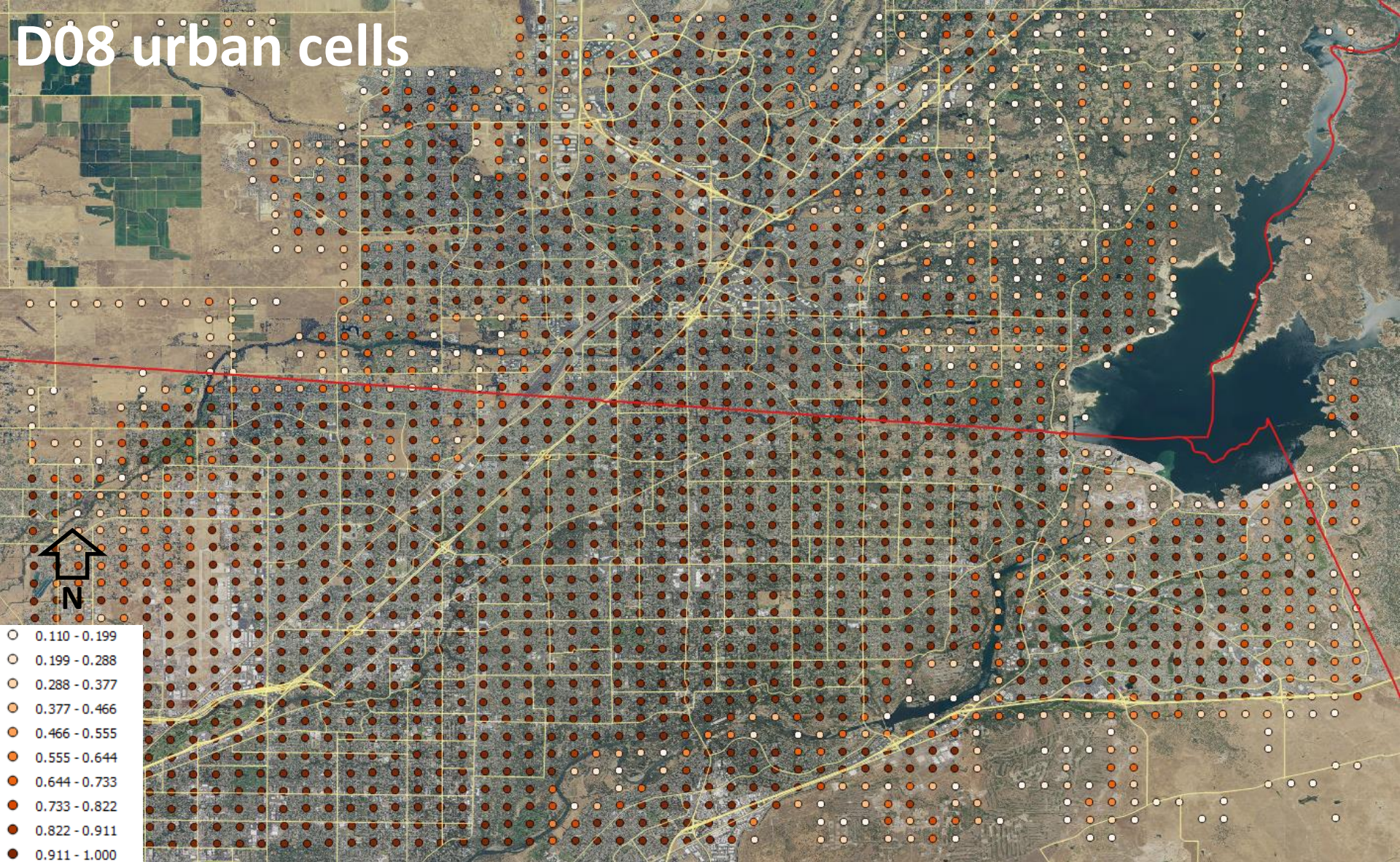
Sacramento – Rocklin – Roseville Urban Fraction (2251 trigger cells in this domain)

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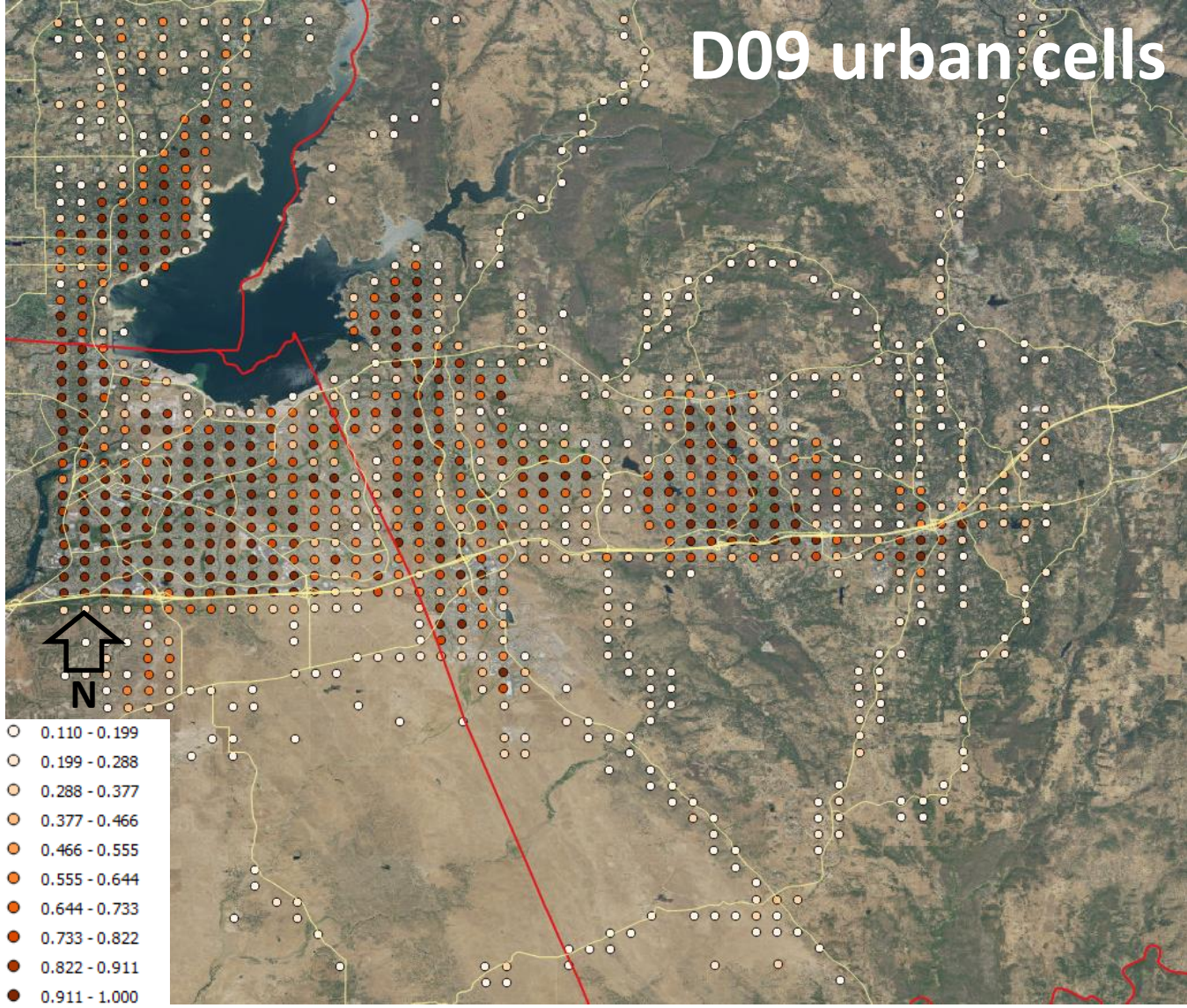
Folsom / El Dorado Hills Urban Fraction (1022 trigger cells in this domain)

D10 urban cells

Legend:
- 0.110 - 0.199
- 0.199 - 0.288
- 0.288 - 0.377
- 0.377 - 0.466
- 0.466 - 0.555
- 0.555 - 0.644
- 0.644 - 0.733
- 0.733 - 0.822
- 0.822 - 0.911
- 0.911 - 1.000
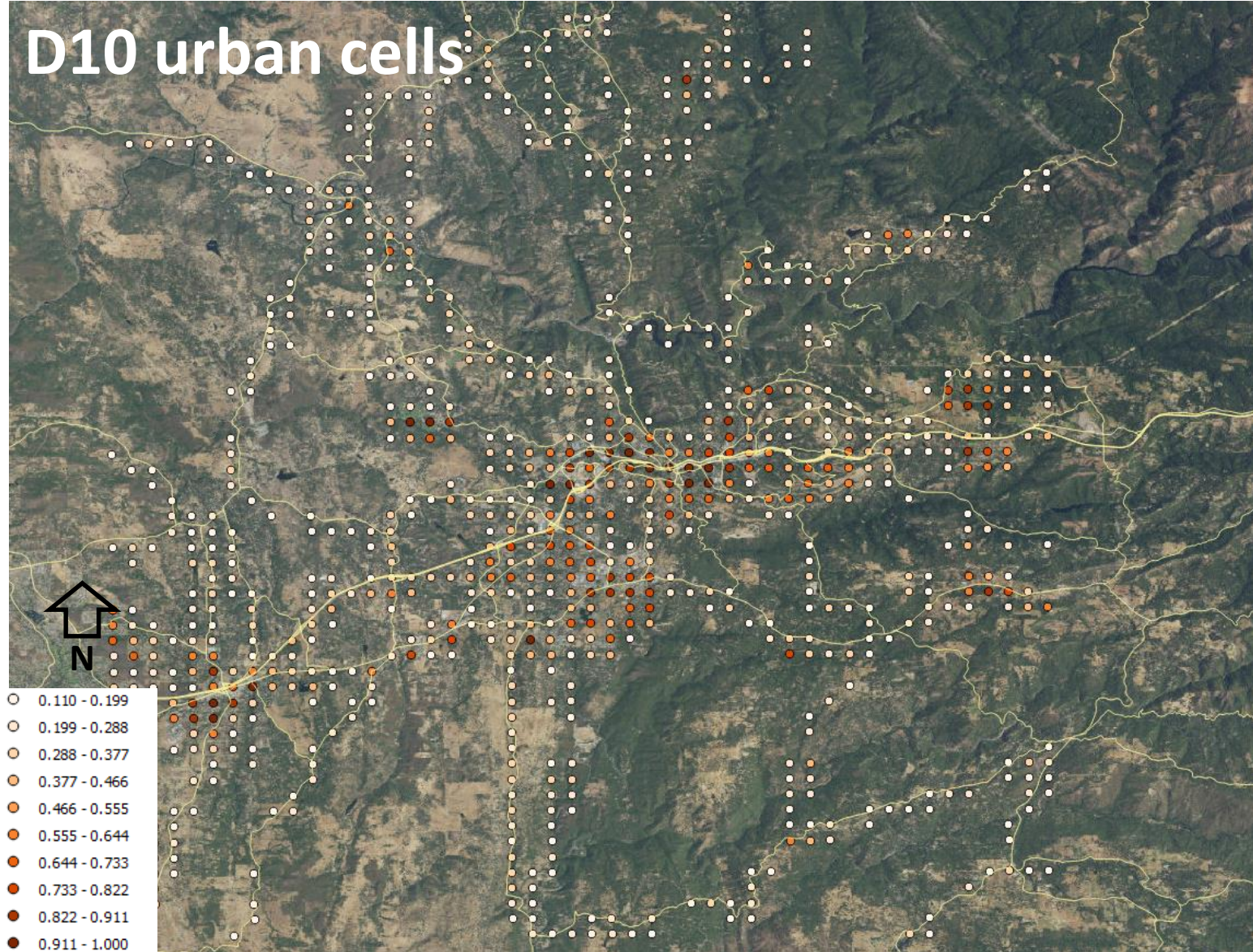
Placerville / Diamond Springs Urban Fraction (845 trigger cells in this domain)

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Appendix B-1

The maps in this appendix provide model (gridded) and observational (contoured) temperature fields in the Capital region for selected time intervals. The model temperature is a UHII-equivalent average over the 2-week intervals specified in each figure, whereas the observational temperature is presented as degree-hour per day averages (DHPD) over the specified months.

Because of the different time-interval lengths between the model (degree-hour per hour averaged over 15 days) and observations (degree-hours per day averaged over one month) and because the model has a much higher spatial resolution (gridded) than the sparse observational weather network (contoured), the correlation between the two sets of maps may not always be apparent.

The observational DHPD maps are labeled with "YYYYMM", whereas the model maps are labeled with year and interval "int#", where, in the following examples, int2: June 16-30, int4: July 16-31, and int6: August 16-31.
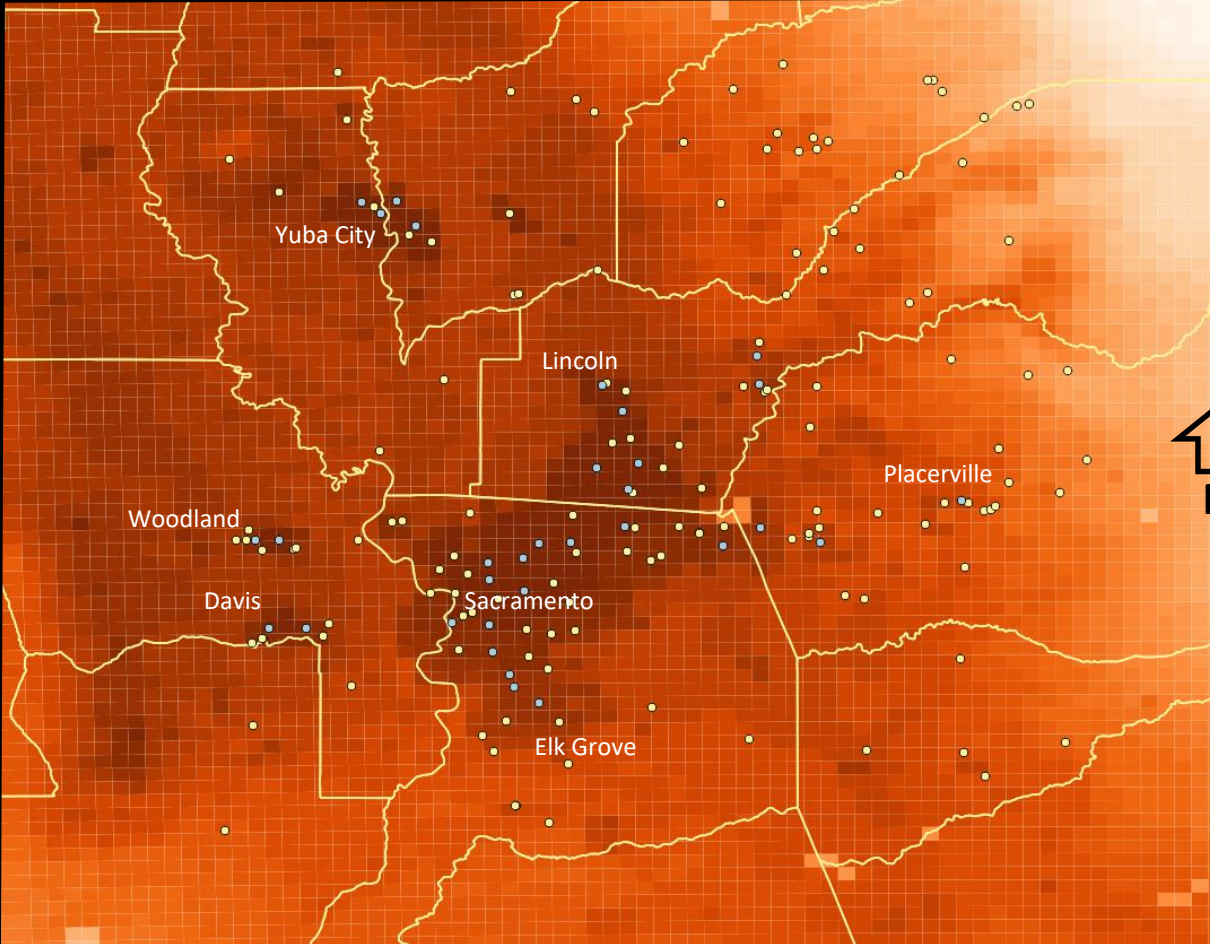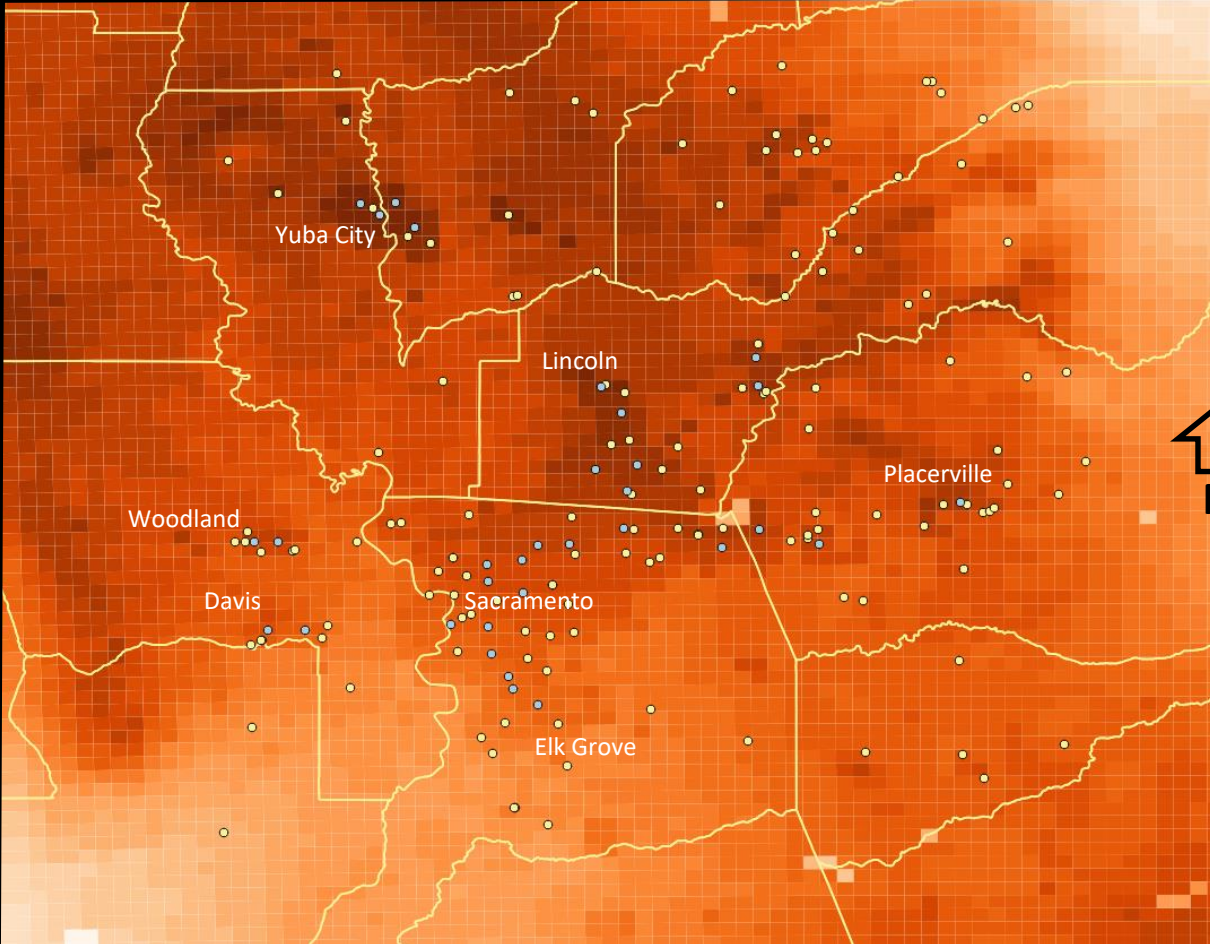
201306 DHPD observational

- ☰ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2013, interval 2
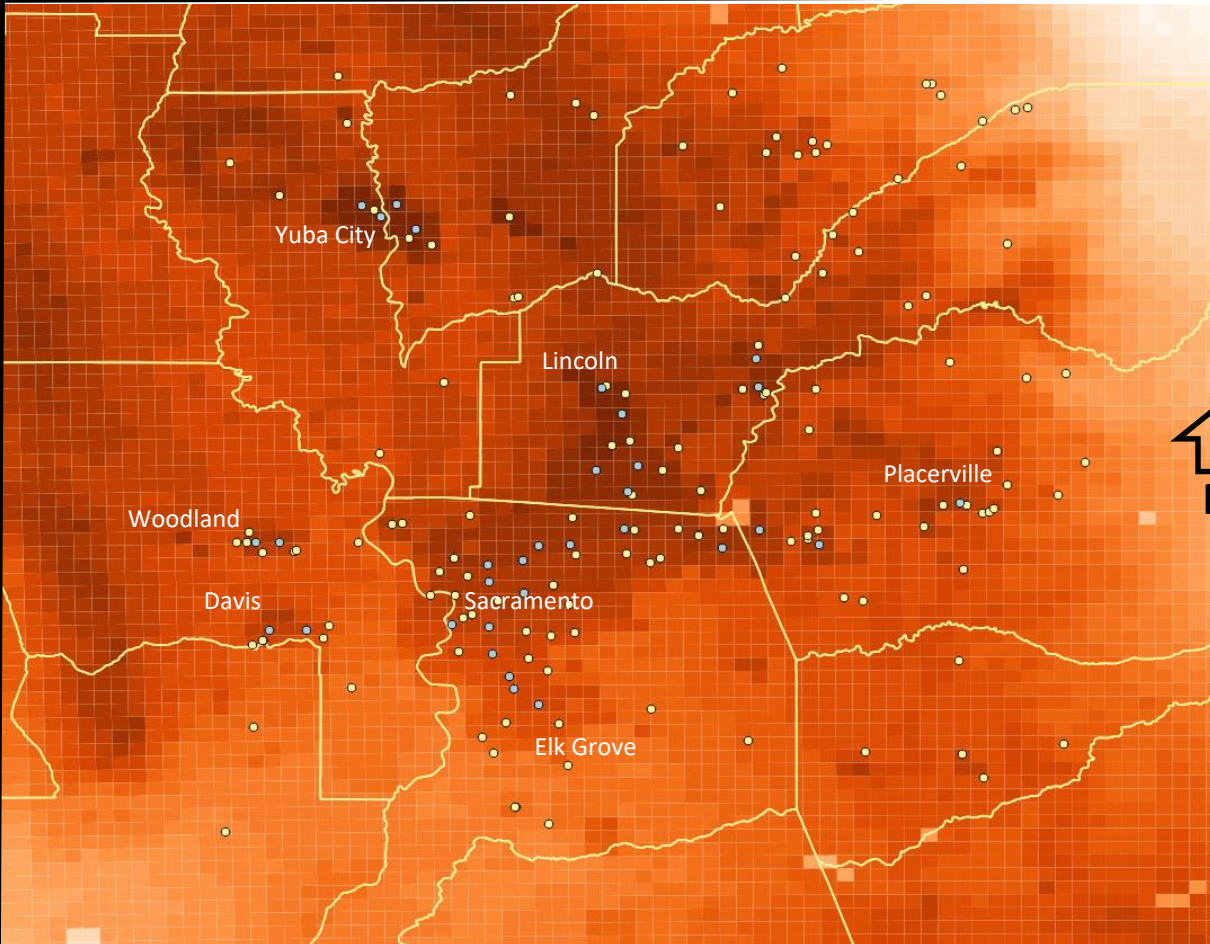- ☰ 30 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 11.52 – 26.18 °C

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

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201307 DHPD observational

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

- All hours, non-threshold, average 2-m AGL air temperature (°C)
- 2-km domain; Year 2013, interval 4
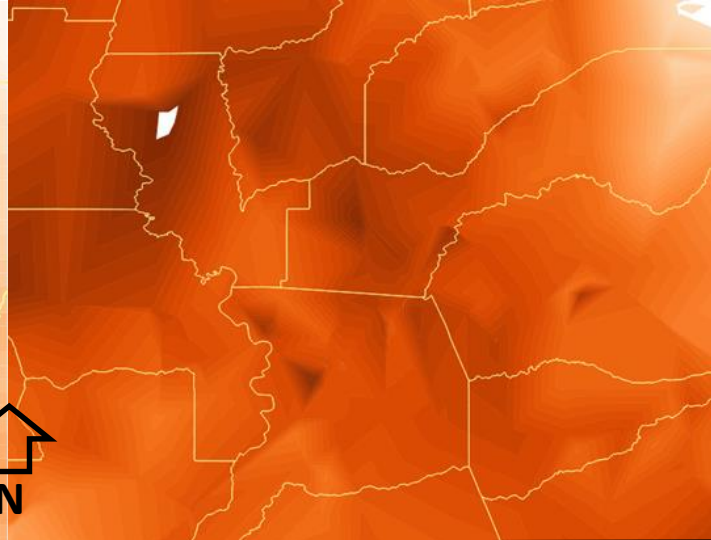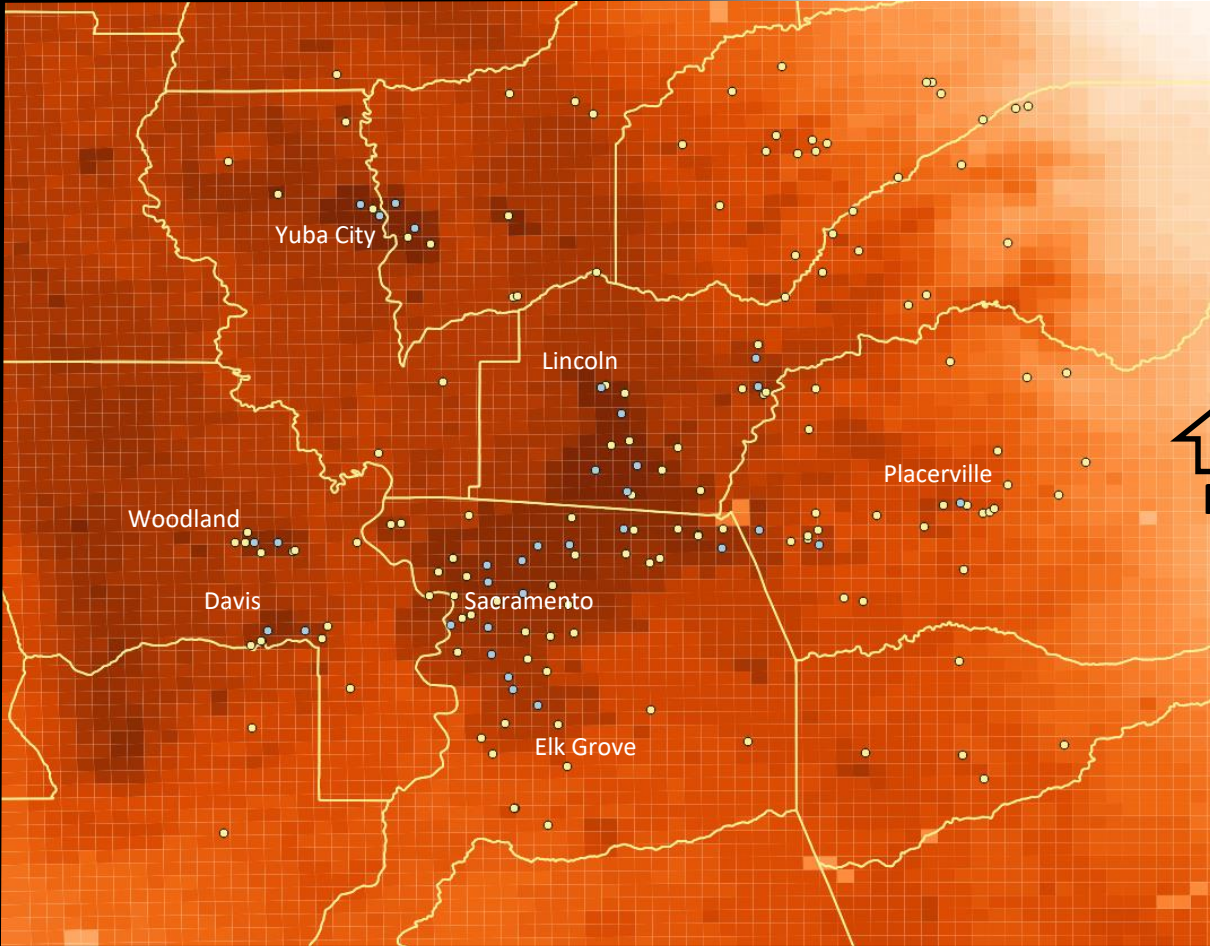- 25 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 16.98 – 29.12 °C

201308 DHPD observational

N

≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
≡ 2-km domain; Year 2013, interval 6
≡ 25 temperature levels, Δ ≈ 0.5 °C; Actual range: 15.28 – 28.50 °C

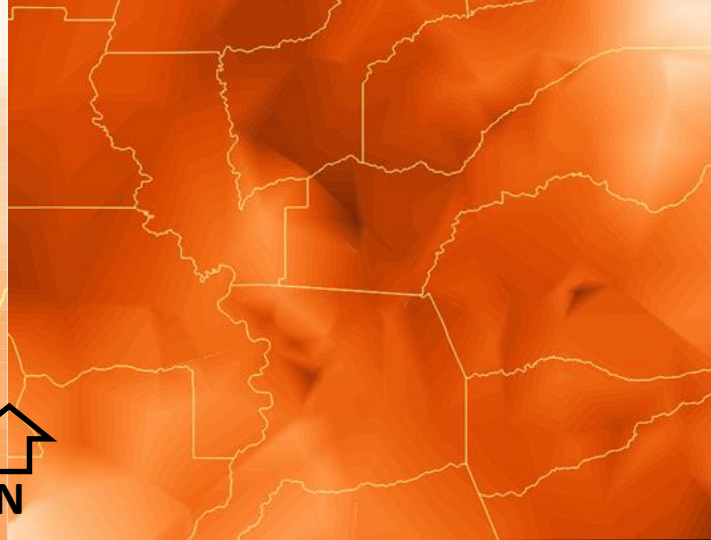Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day[-1] averaged over all hours in given month YYYYMM).

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201406 DHPD observational

N

- ≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2014, interval 2
- ≡ 30 temperature levels, Δ ≈ 0.5 °C; Actual range: 11.91 – 26.70 °C

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

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201407 DHPD observational

N

- ≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2014, interval 4
- ≡ 22 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 17.78 – 28.51 °C
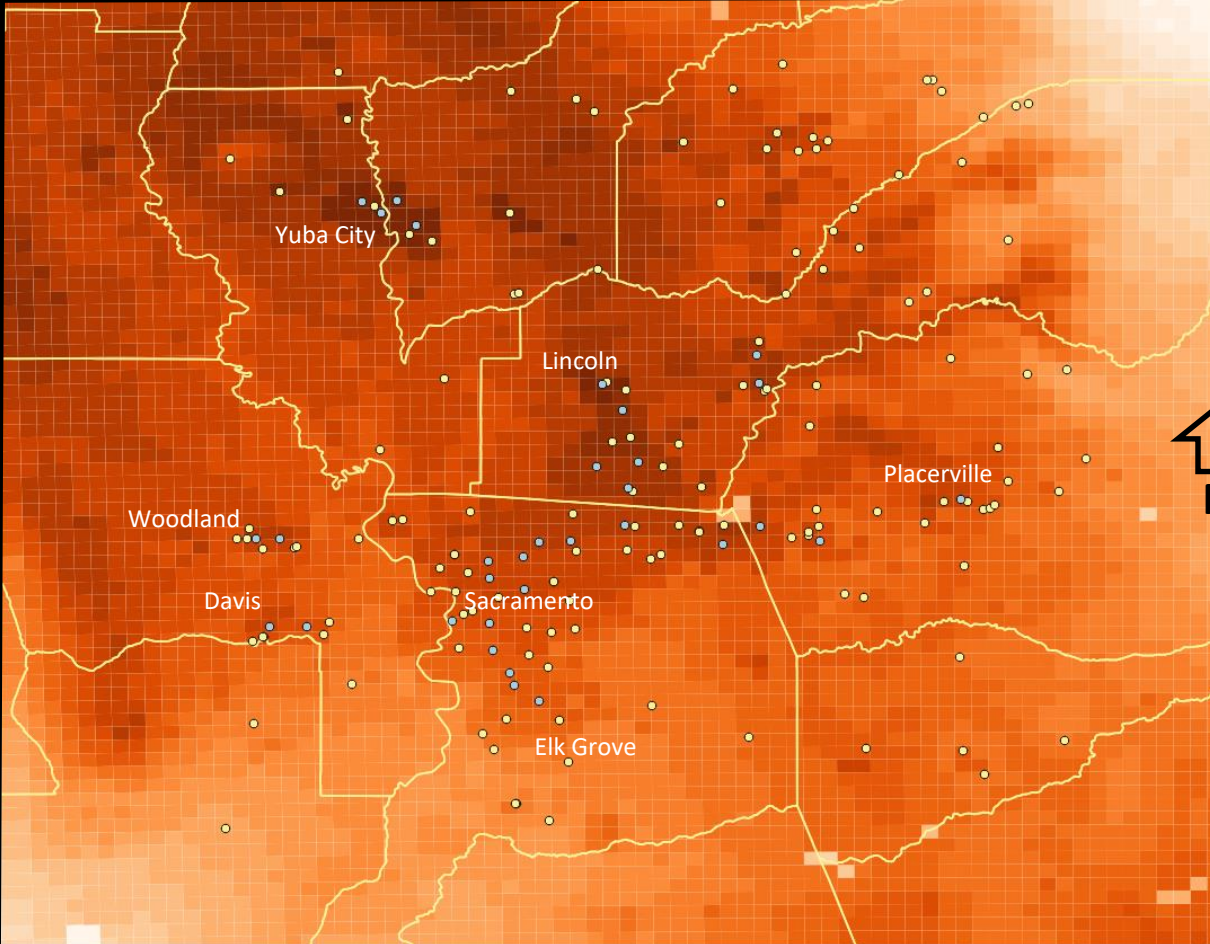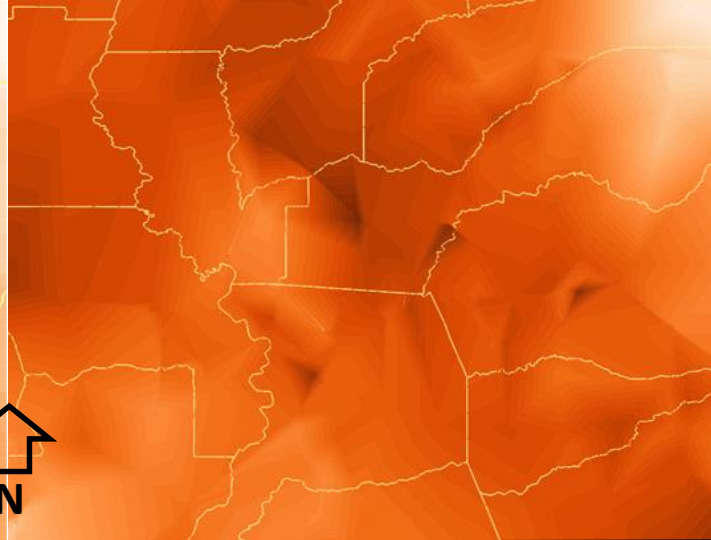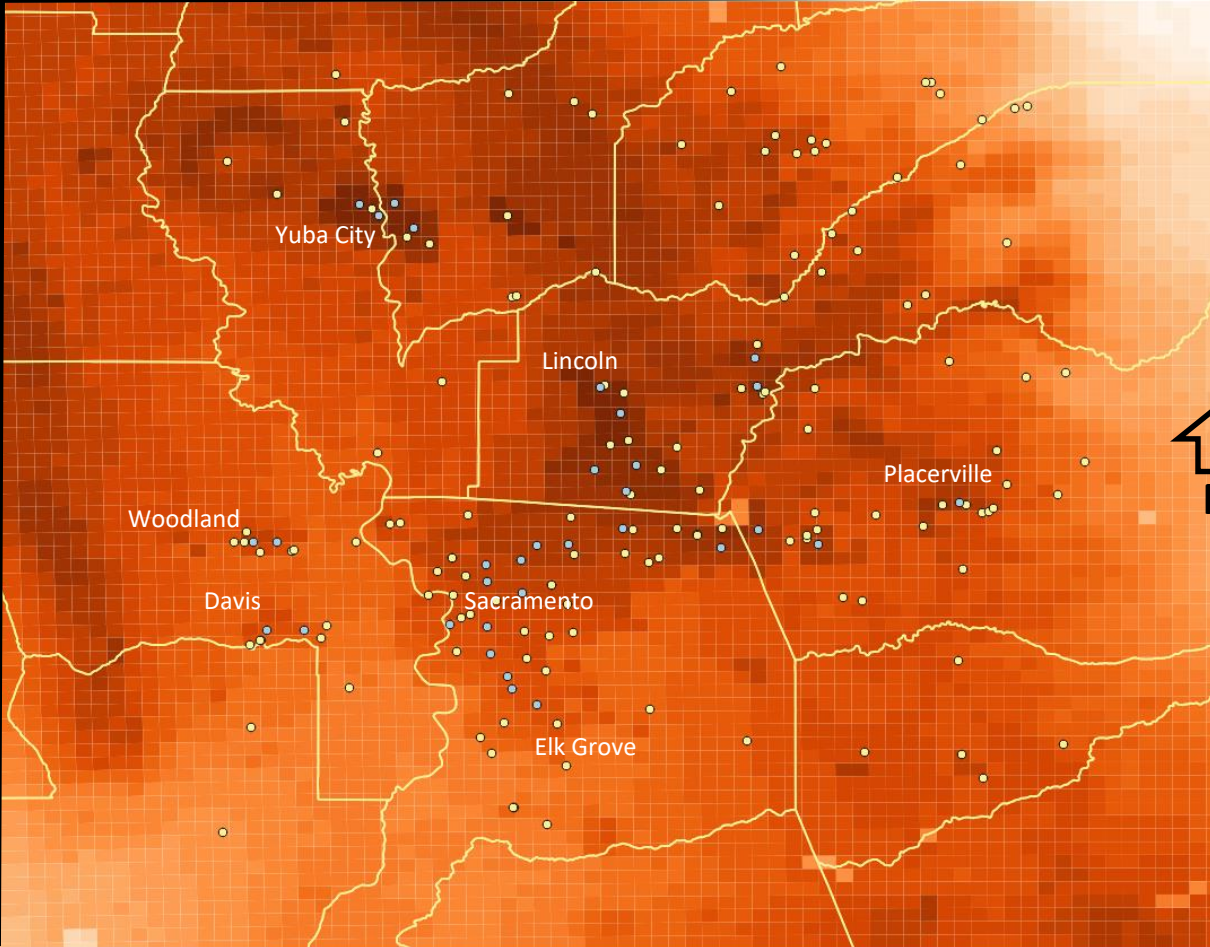
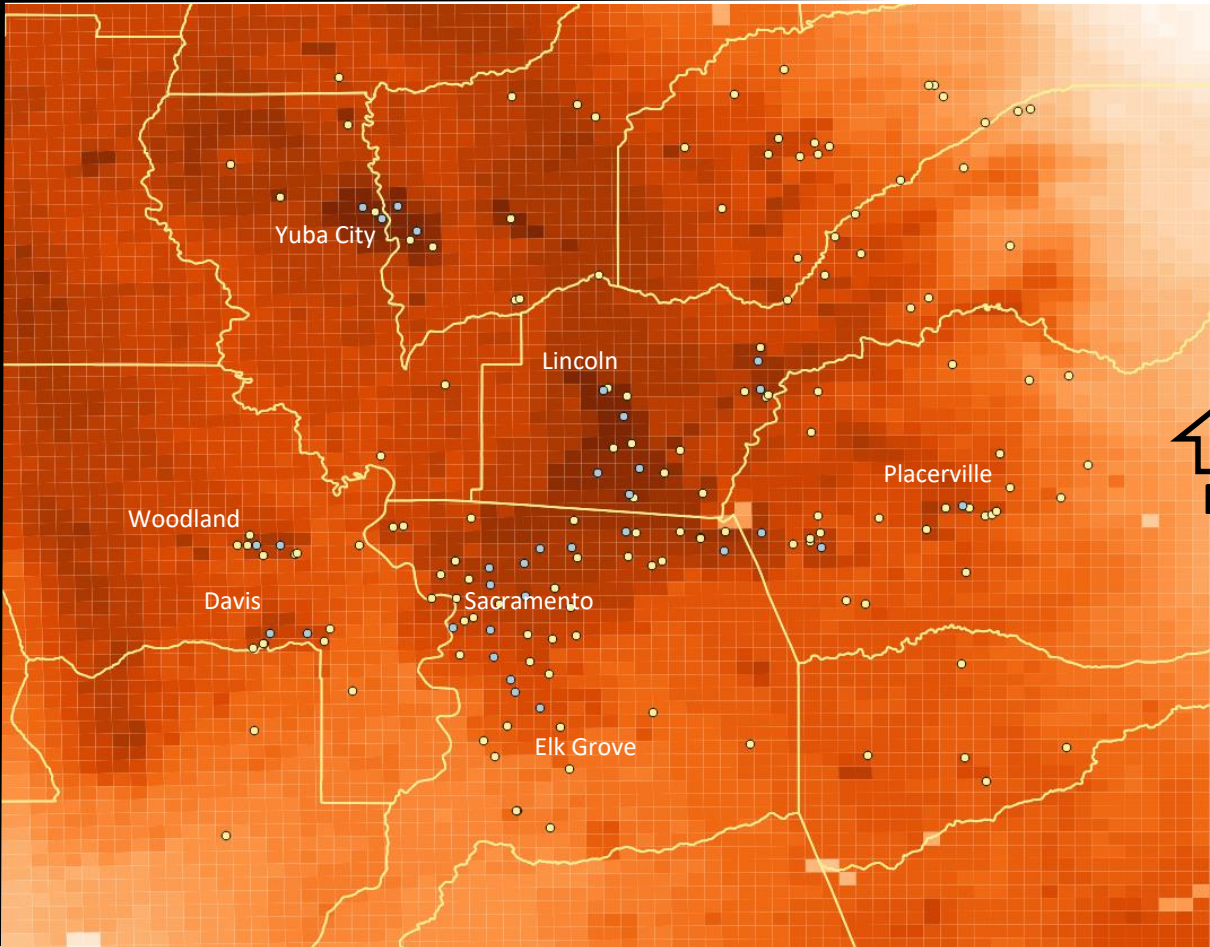**Left:** Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

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201408 DHPD observational

N

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
≡ 2-km domain; Year 2014, interval 6
≡ 25 temperature levels, Δ ≈ 0.5 °C; Actual range: 14.75 – 27.70 °C
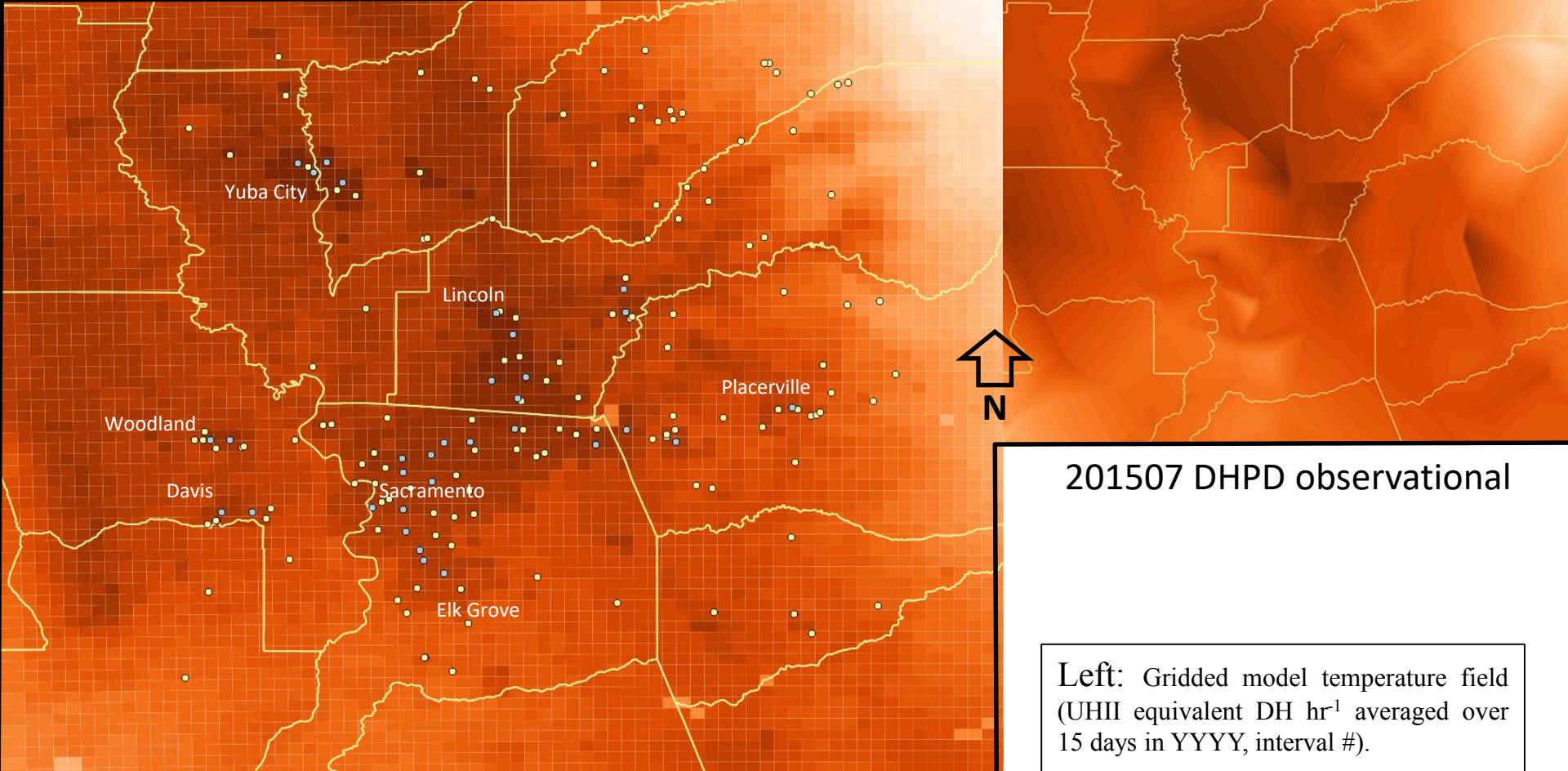
201506 DHPD observational

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

- ☰ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2015, interval 2
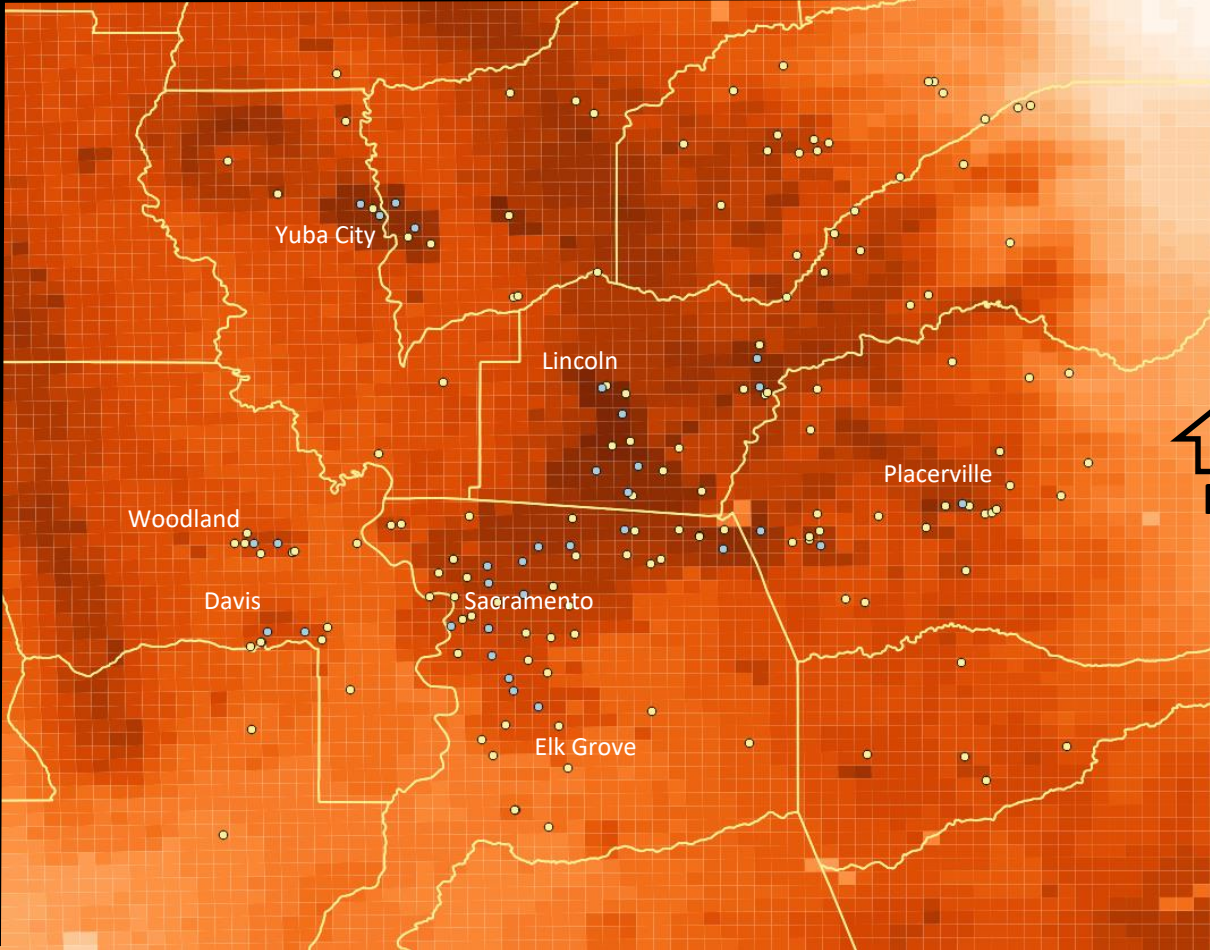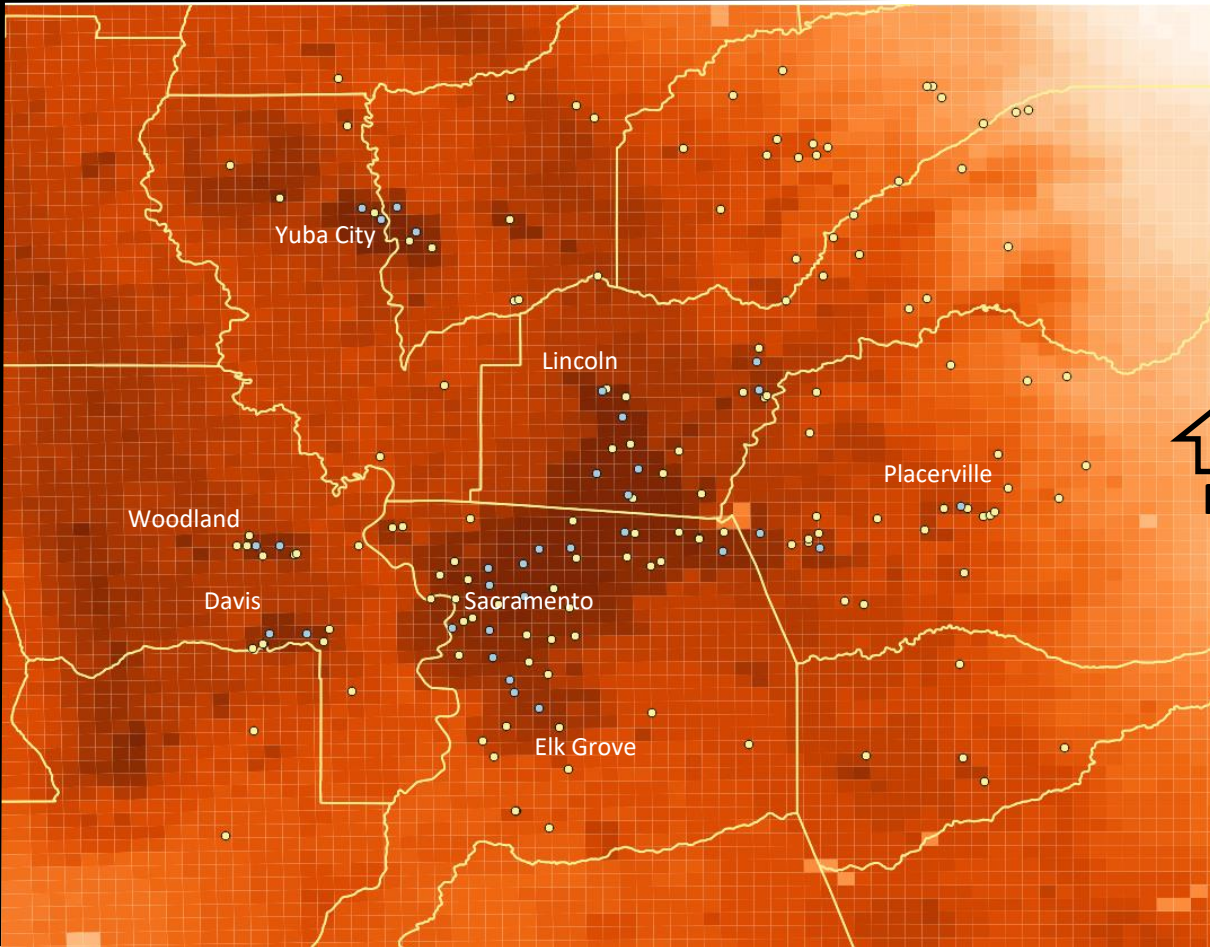- ☰ 27 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 16.91 – 30.20 °C

201507 DHPD observational

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
≡ 2-km domain; Year 2015, interval 4
≡ 30 temperature levels, Δ ≈ 0.5 °C; Actual range: 14.89 – 30.03 °C

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201508 DHPD observational

- ☰ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2015, interval 6
- ☰ 25 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 16.77 – 28.86 °C

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).
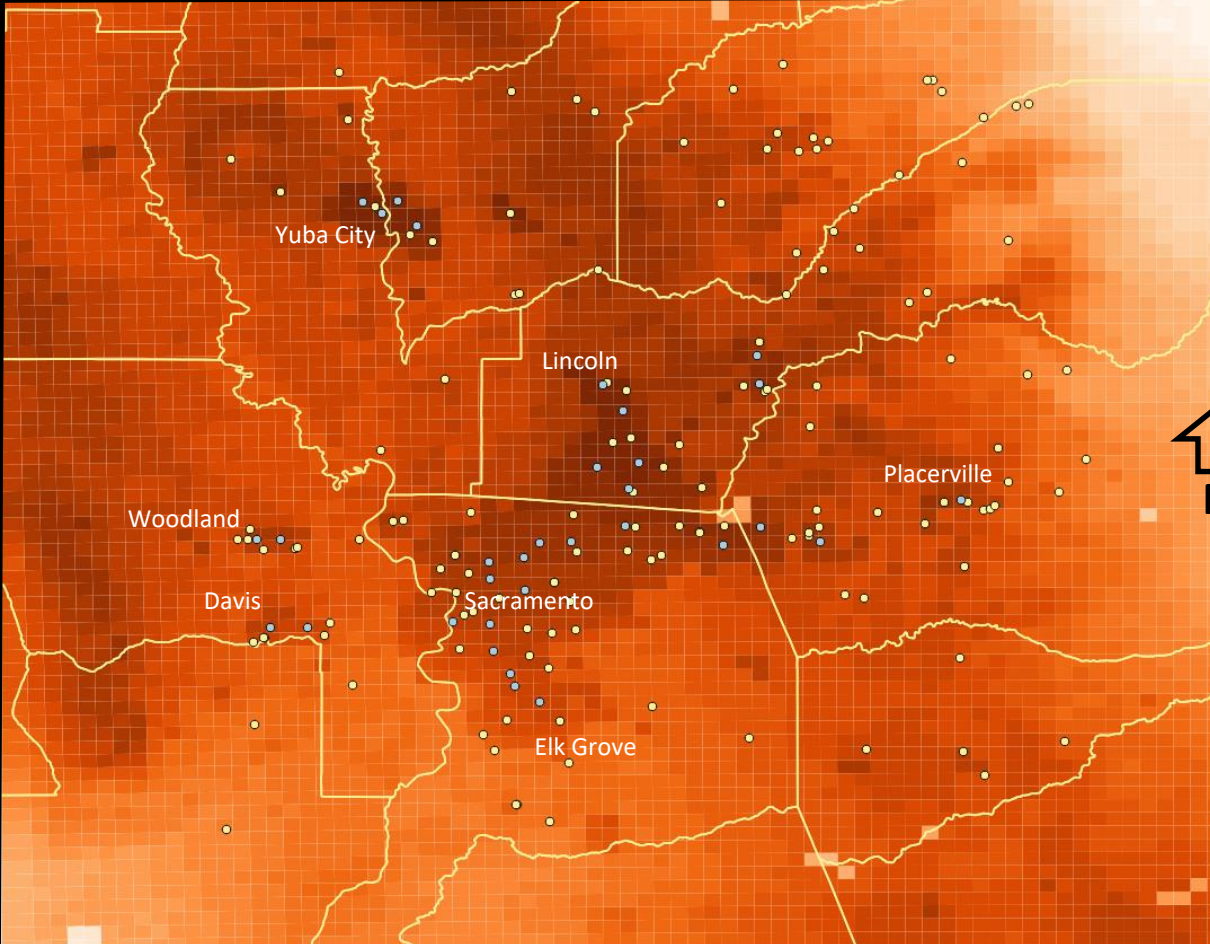
Altostratus Inc.

N

201606 DHPD observational

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
≡ 2-km domain; Year 2016 , interval 2
≡ 30 temperature levels, Δ ≈ 0.5 °C; Actual range: 13.71 – 28.55 °C
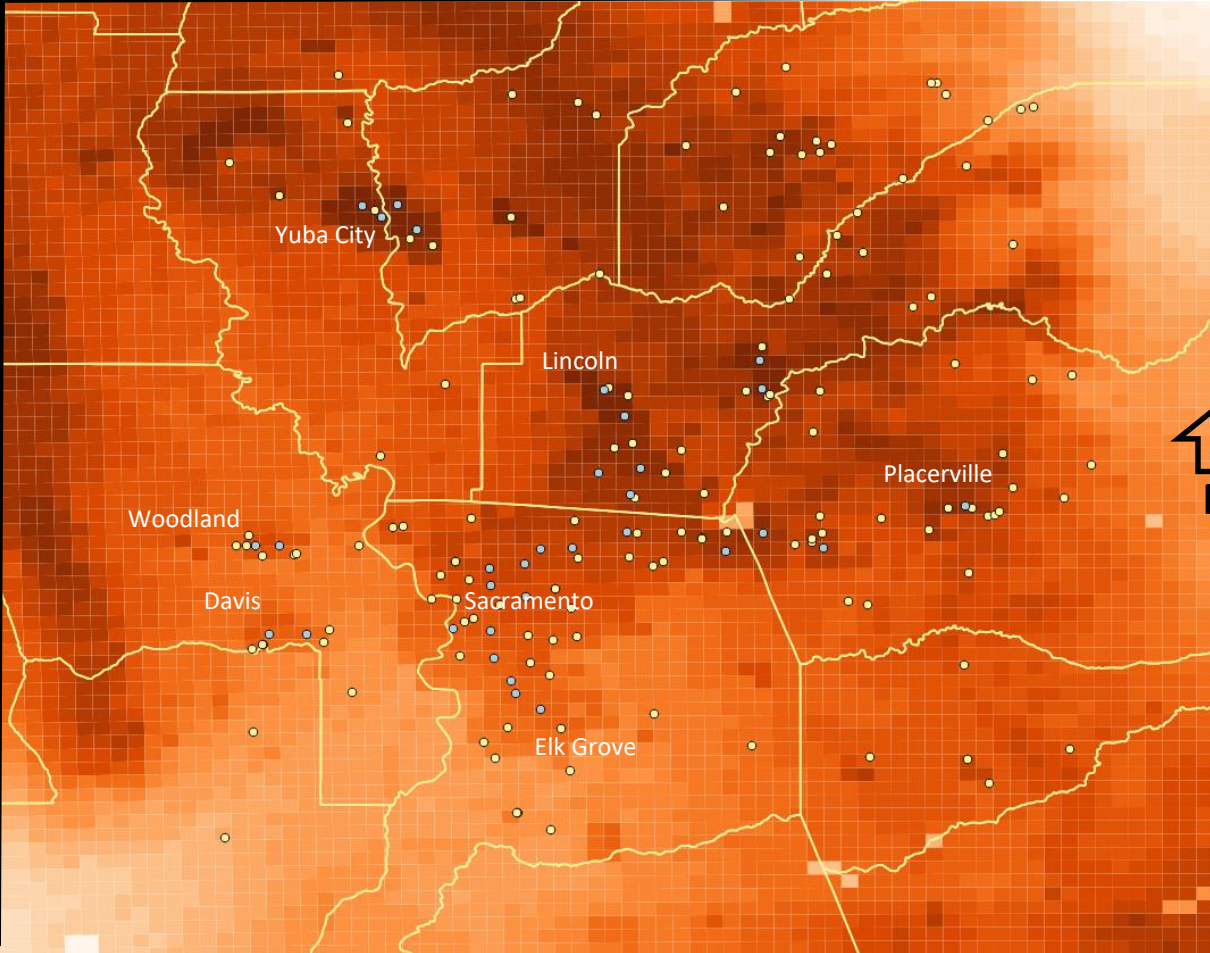
Altostratus Inc.

201607 DHPD observational

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

- ≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2016 , interval 4
- ≡ 27 temperature levels, Δ ≈ 0.5 °C; Actual range: 17.30 – 31.02 °C

201608 DHPD observational

- ≡ All hours, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2016 , interval 6
- ≡ 23 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 17.52 – 28.79 °C

Left: Gridded model temperature field (UHII equivalent DH hr^{-1} averaged over 15 days in YYYY, interval #).

Top-right: Contoured observational temperature field (DH day^{-1} averaged over all hours in given month YYYYMM).

Appendix B-2

The maps in this appendix provide the model (gridded) temperature fields in the Capital region for selected time intervals at 1500 PDT. The model temperature is an average over the 2-week intervals specified in each figure.

The model maps are labeled with year and interval "int#", where, in the following examples, int2: June 16-30, int4: July 16-31, and int6: August 16-31.

The white circles are locations of weather stations and the blue circles are probing points for further analysis of model output at those locations.
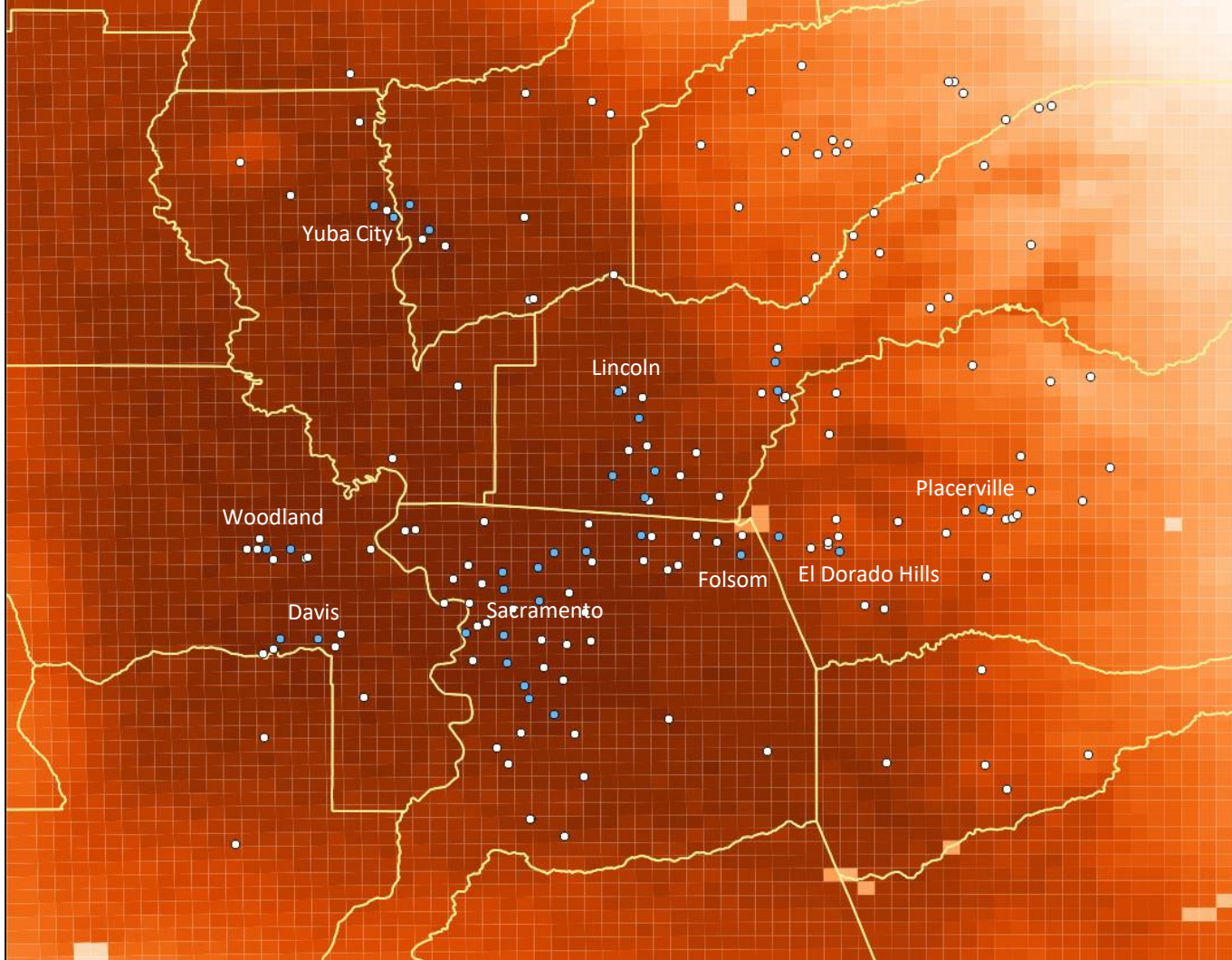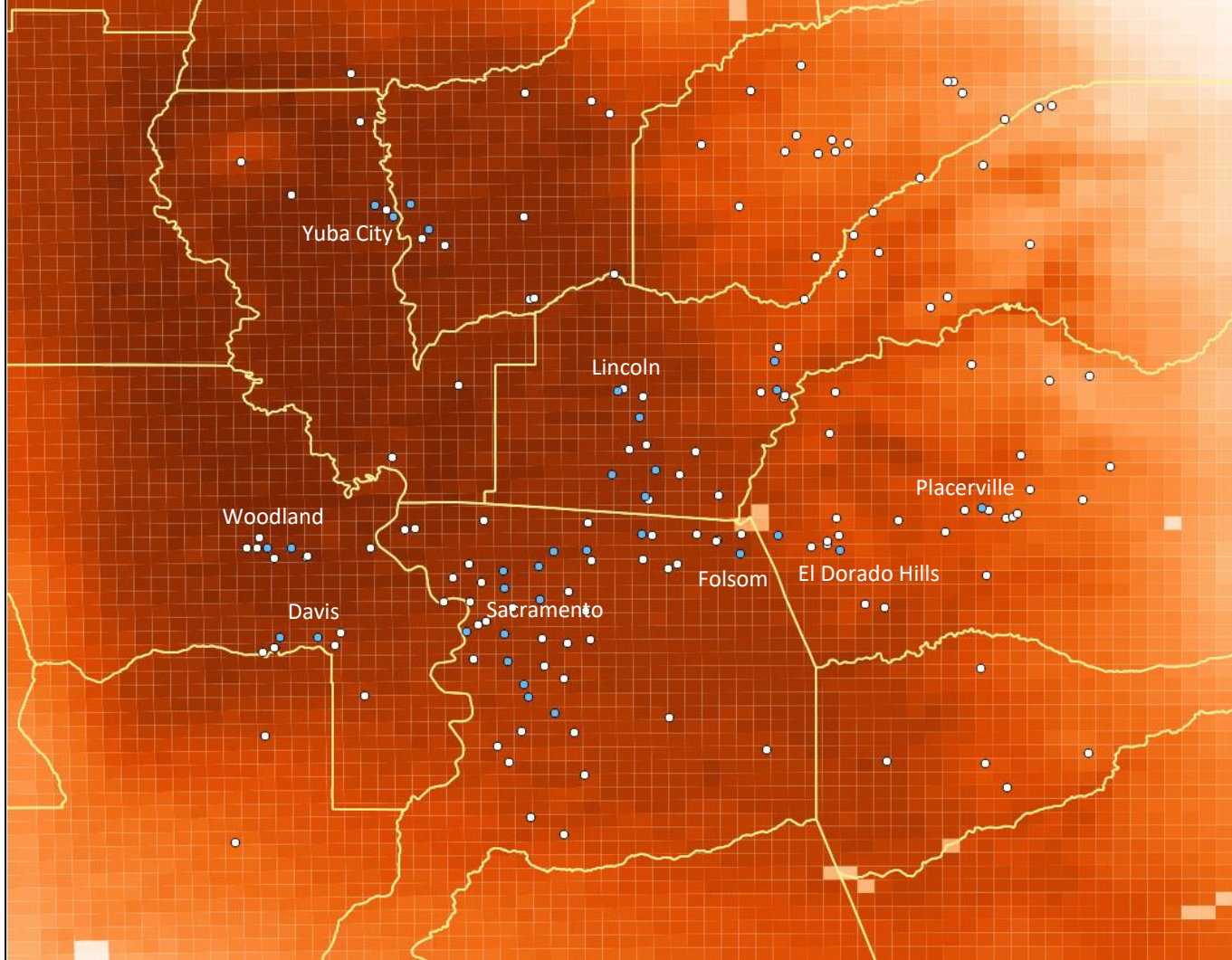
- ≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2013, interval 2
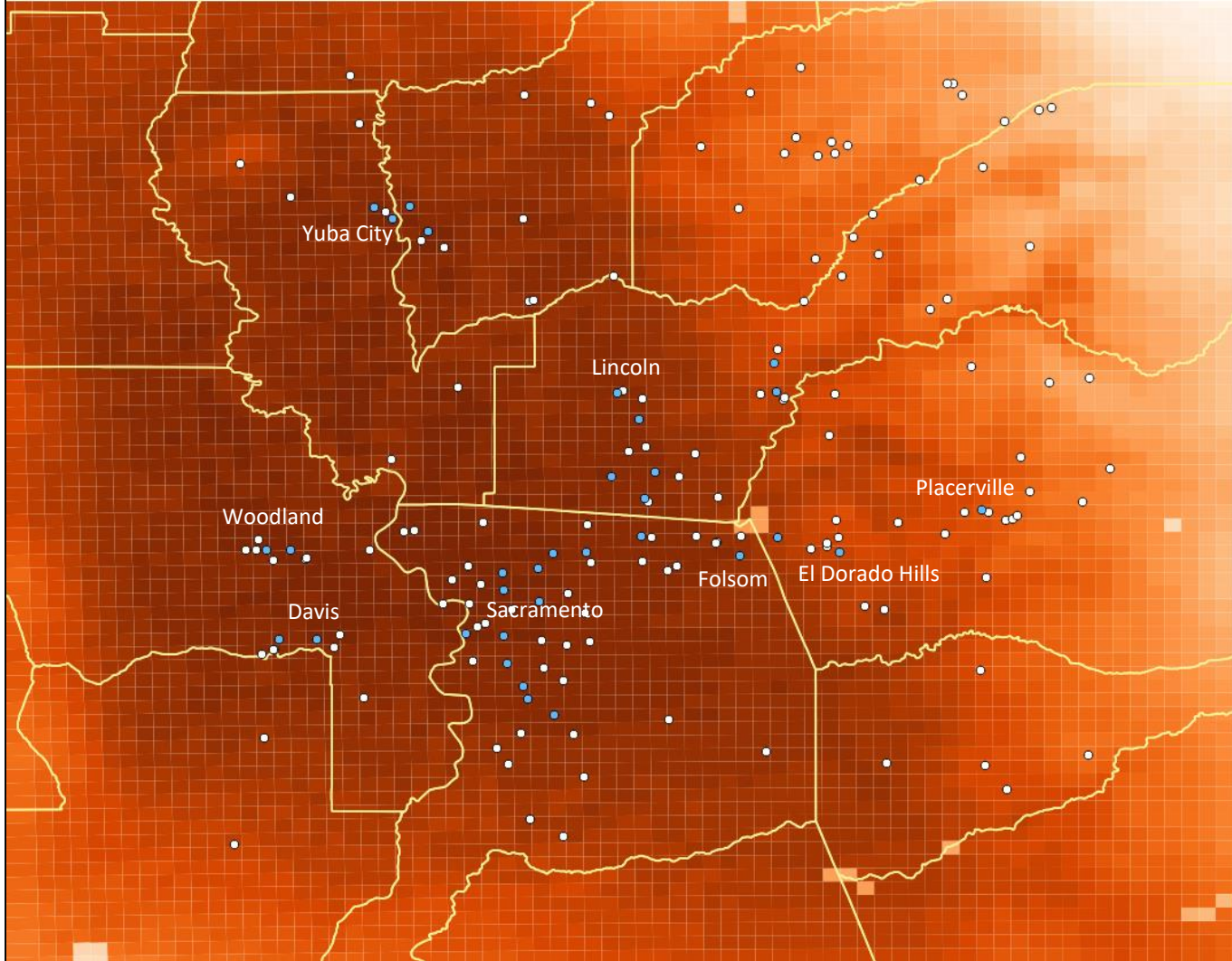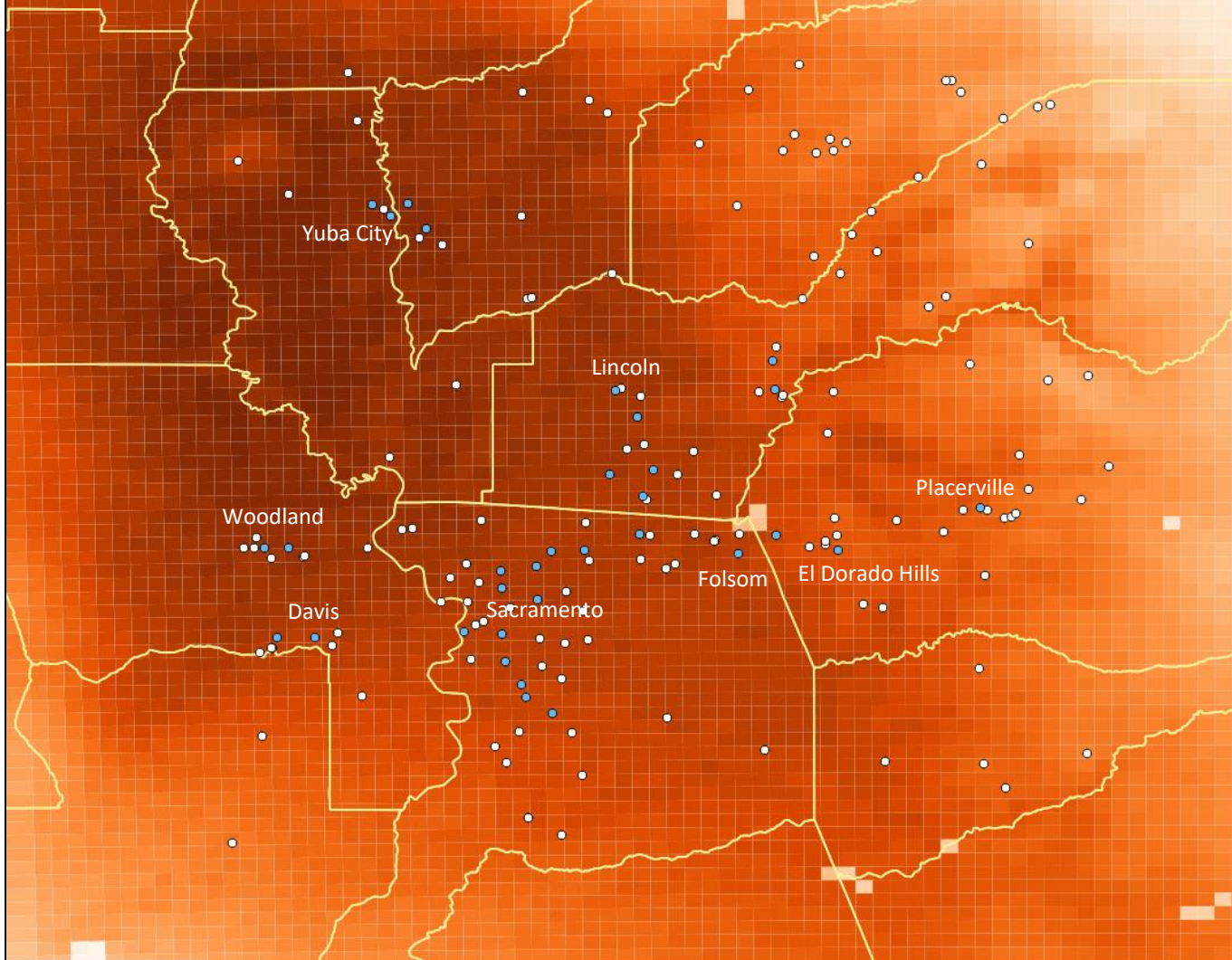- ≡ 30 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 14.59 – 32.23 °C
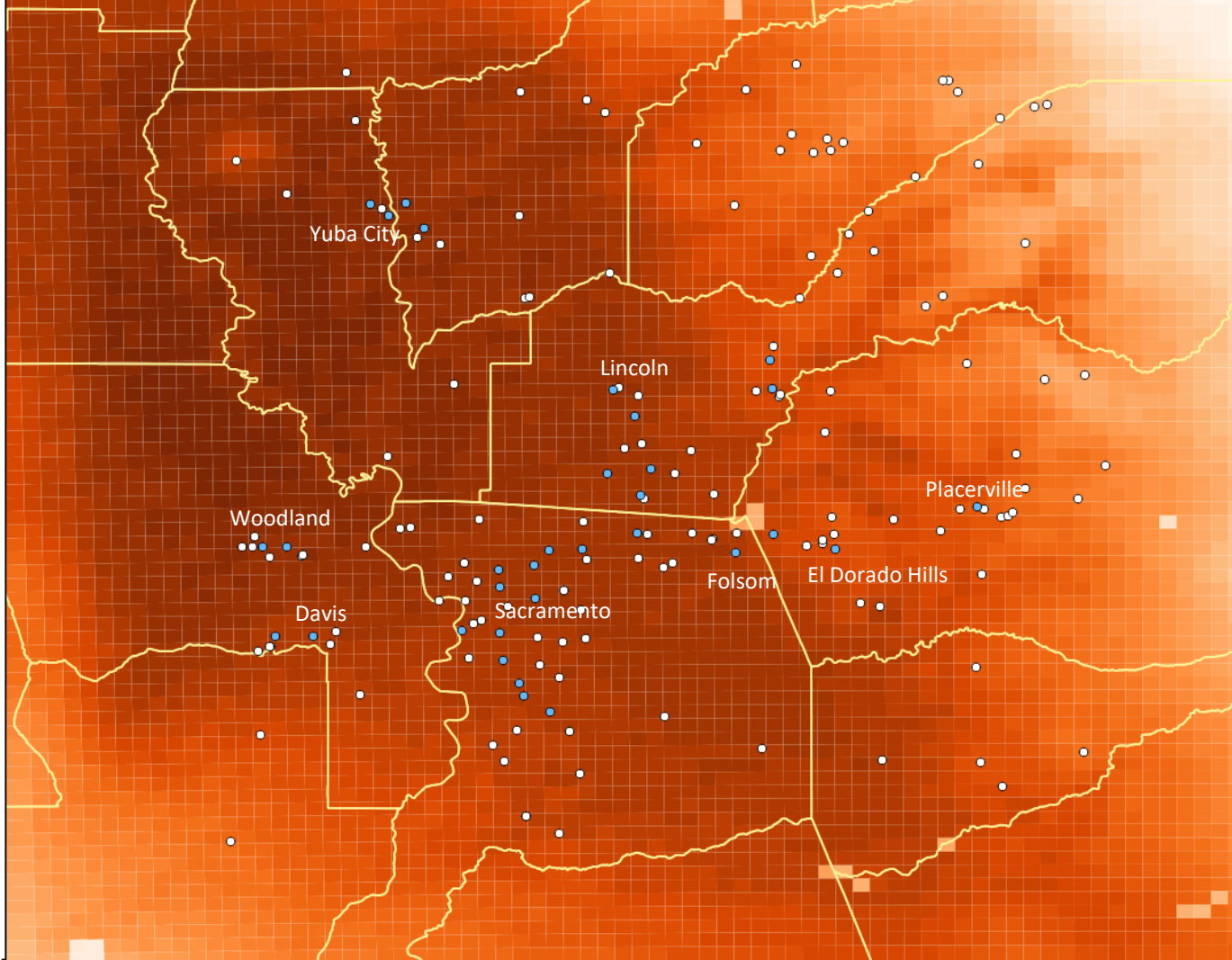
N

Altostratus Inc.
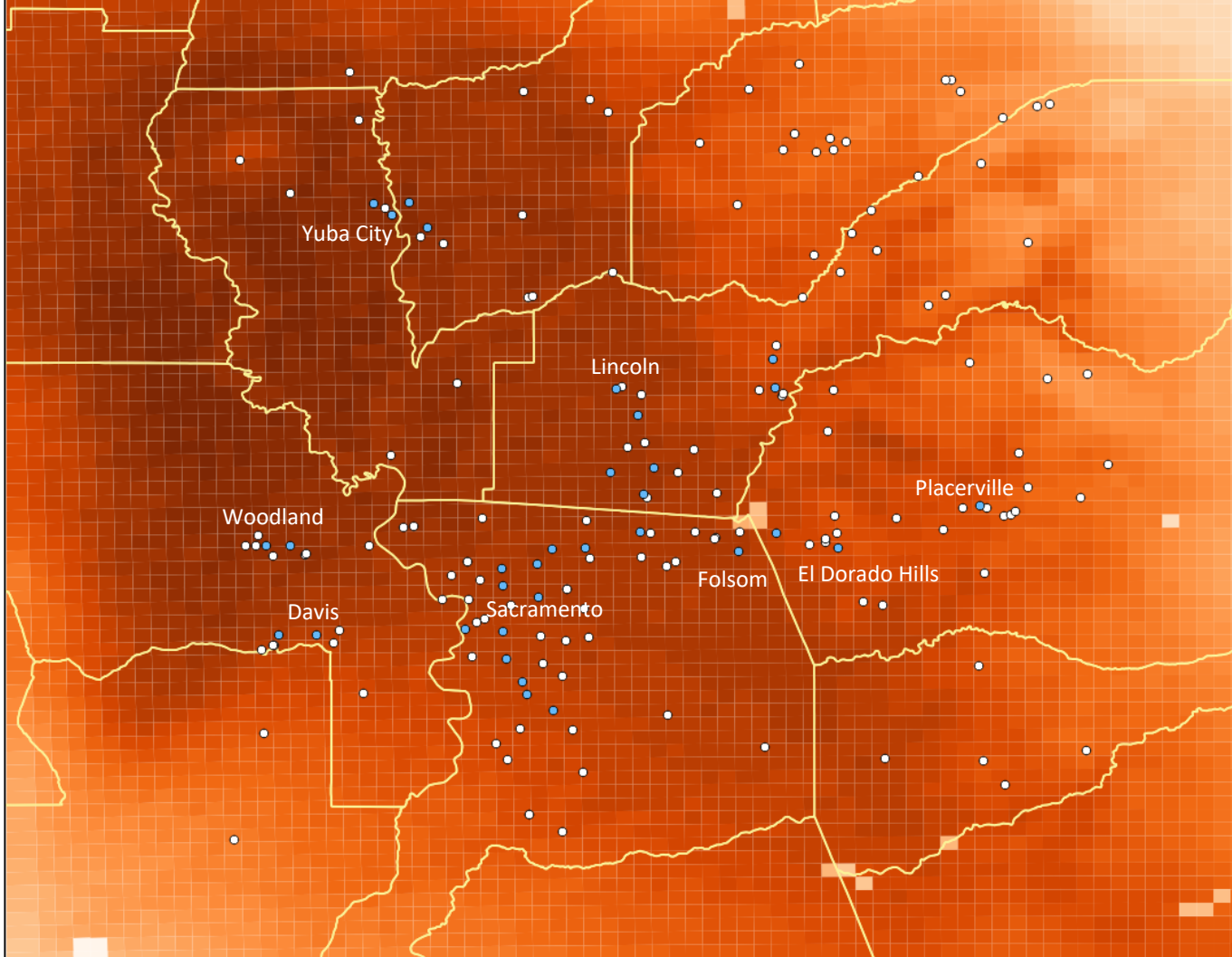
- ☰ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2013, interval 4
- ☰ 35 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 18.59 – 36.99 °C

N

Altostratus Inc.

- ≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2013, interval 6
- ≡ 32 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 18.43 − 36.29 °C

N

Altostratus Inc.

- ≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2014, interval 2
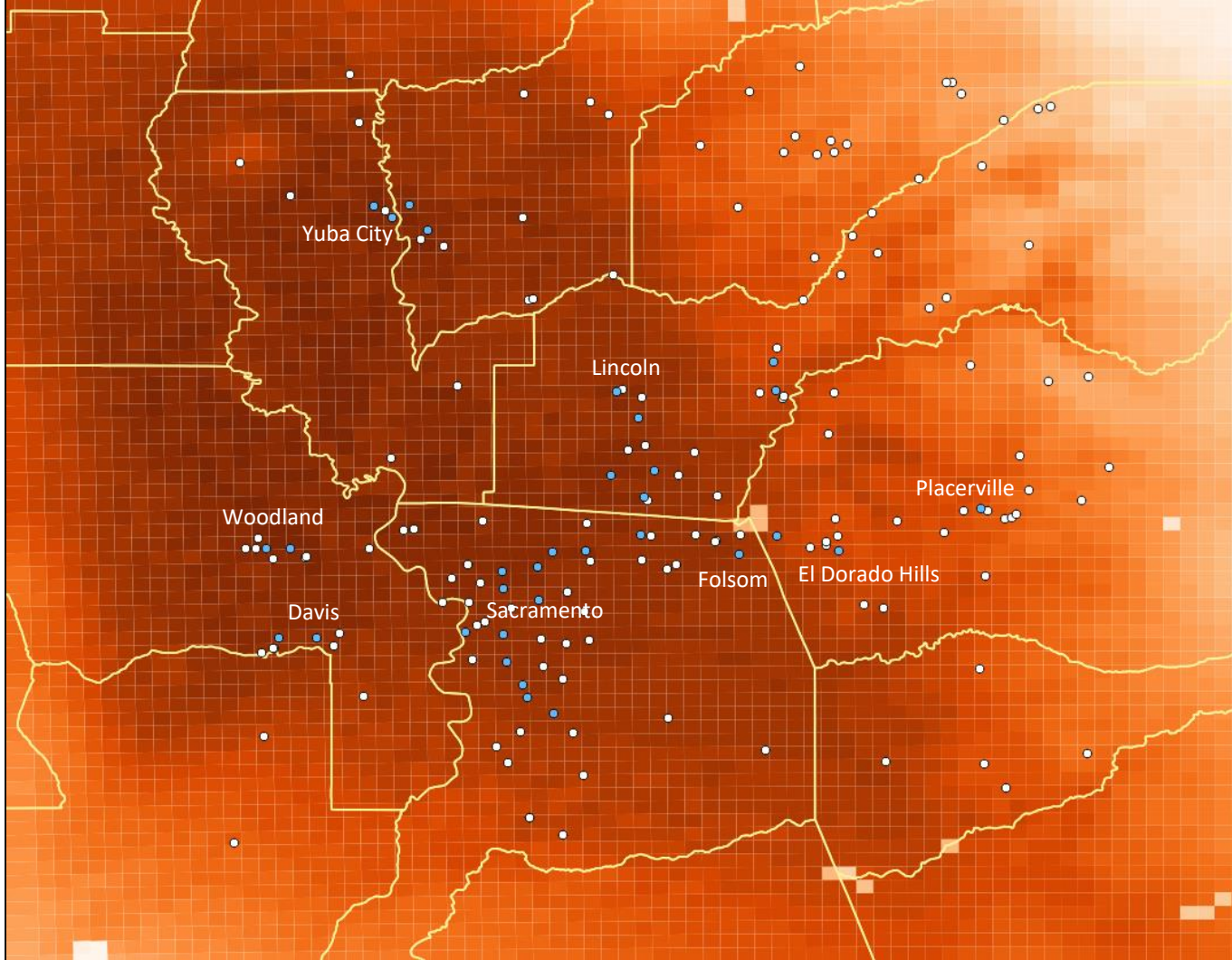- ≡ 33 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 15.68 – 33.66 °C
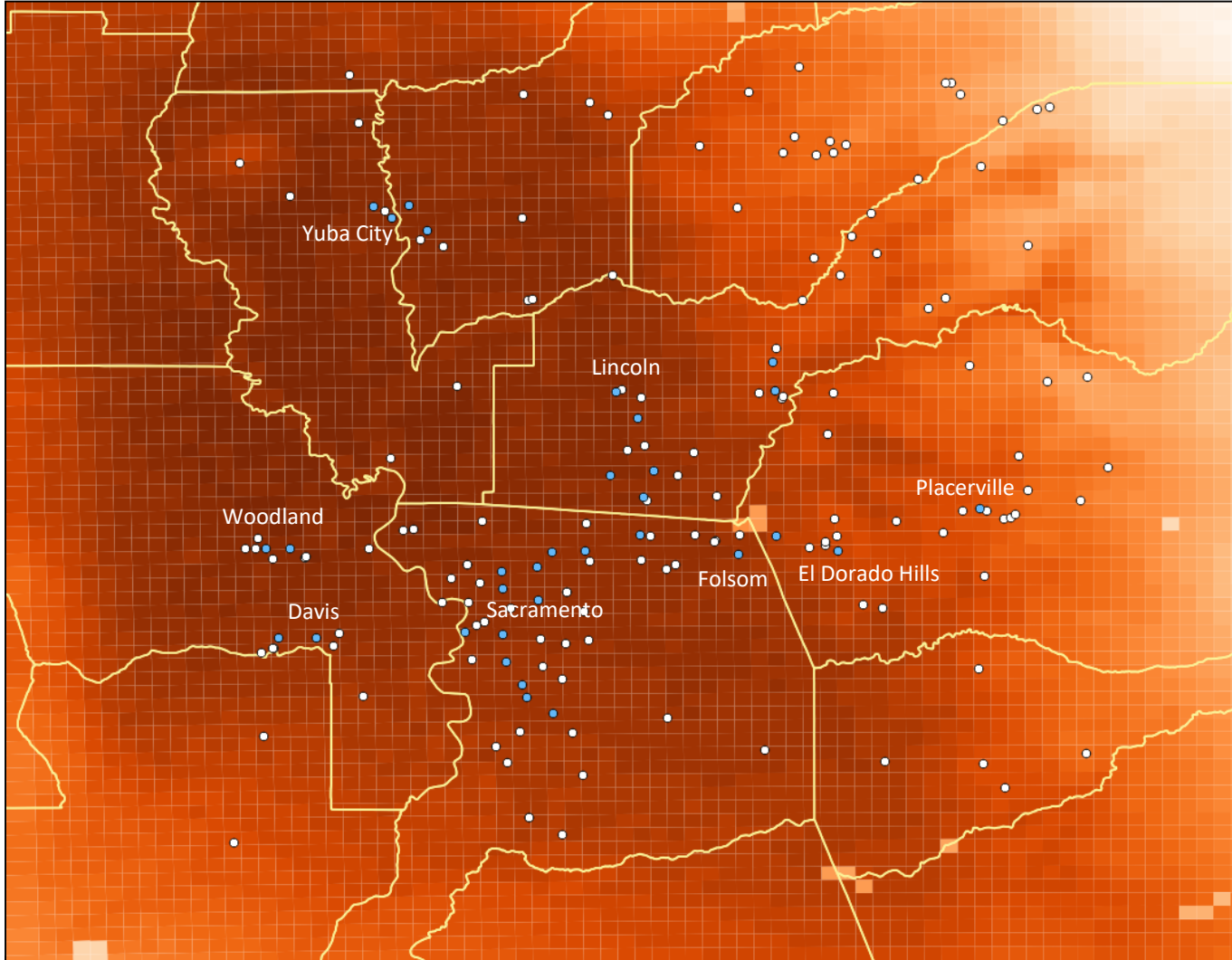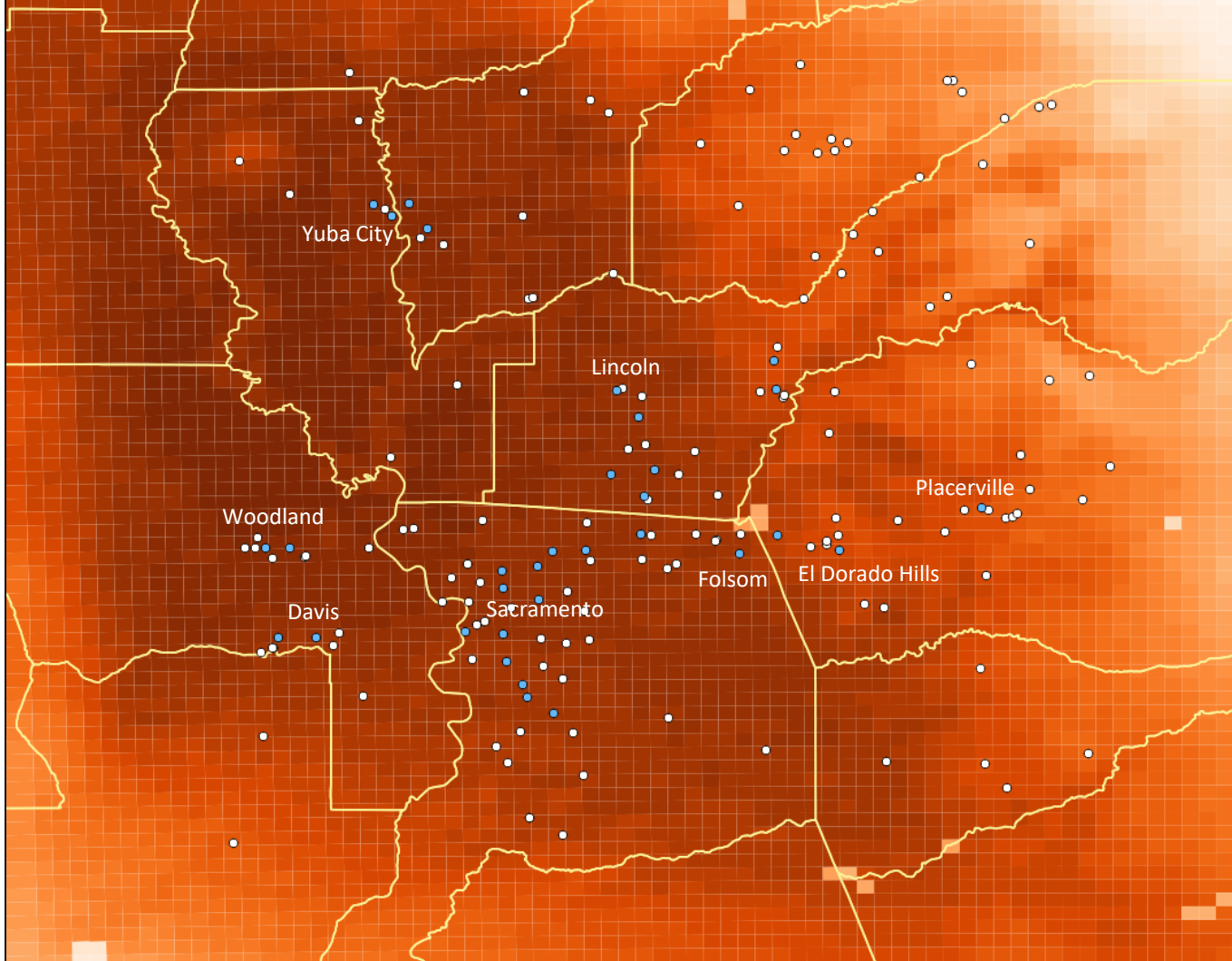
N

- ≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2014, interval 4
- ≡ 33 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 19.41 – 36.91 °C

N

Altostratus Inc.

- ≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ≡ 2-km domain; Year 2014, interval 6
- ≡ 33 temperature levels, Δ ≈ 0.5 °C; Actual range: 18.07 − 35.64 °C

N

Altostratus Inc.

Capital Region Heat Pollution Reduction   Appendix B-2   7

- ☰ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2015, interval 2
- ☰ 33 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 21.01 – 37.41 °C
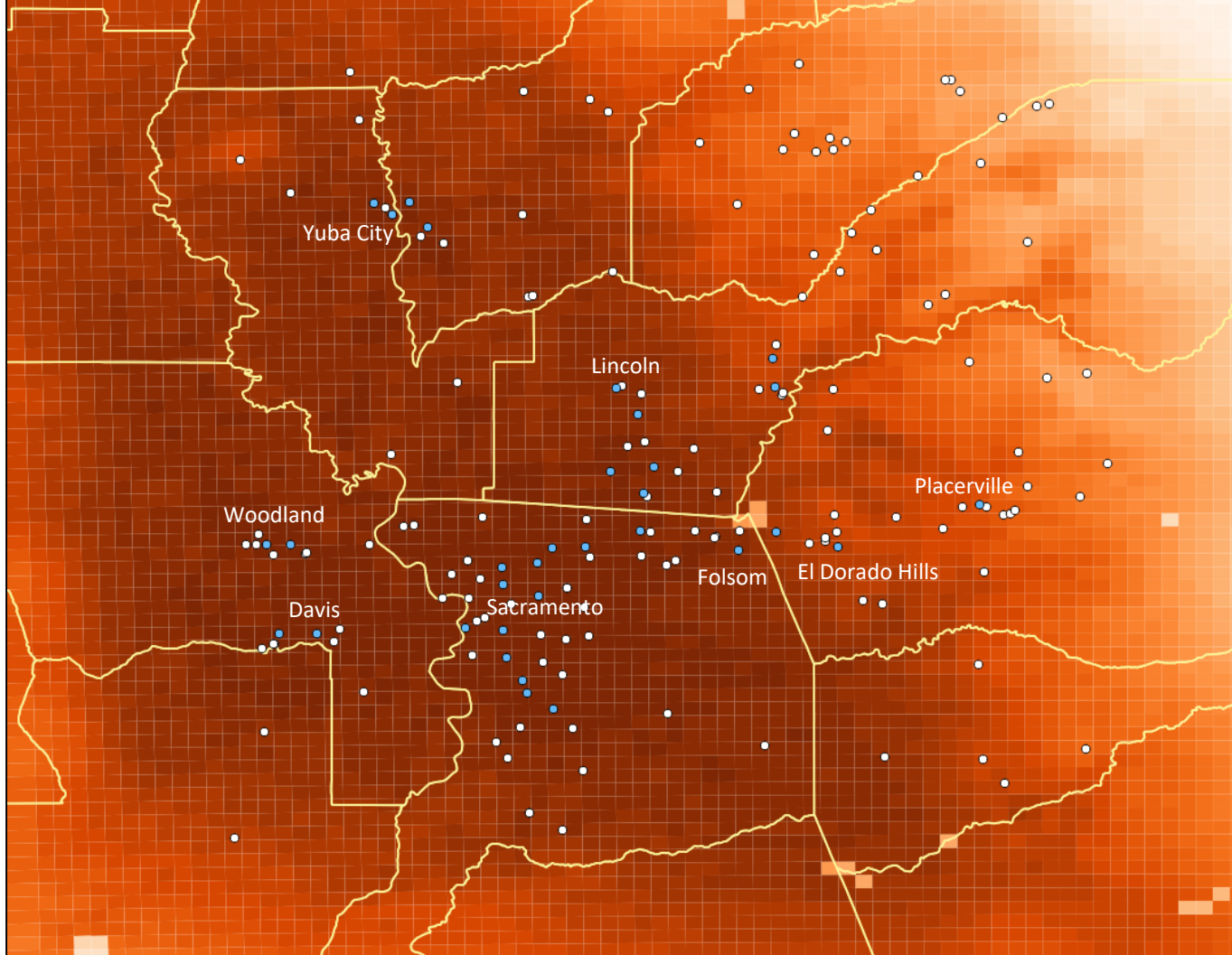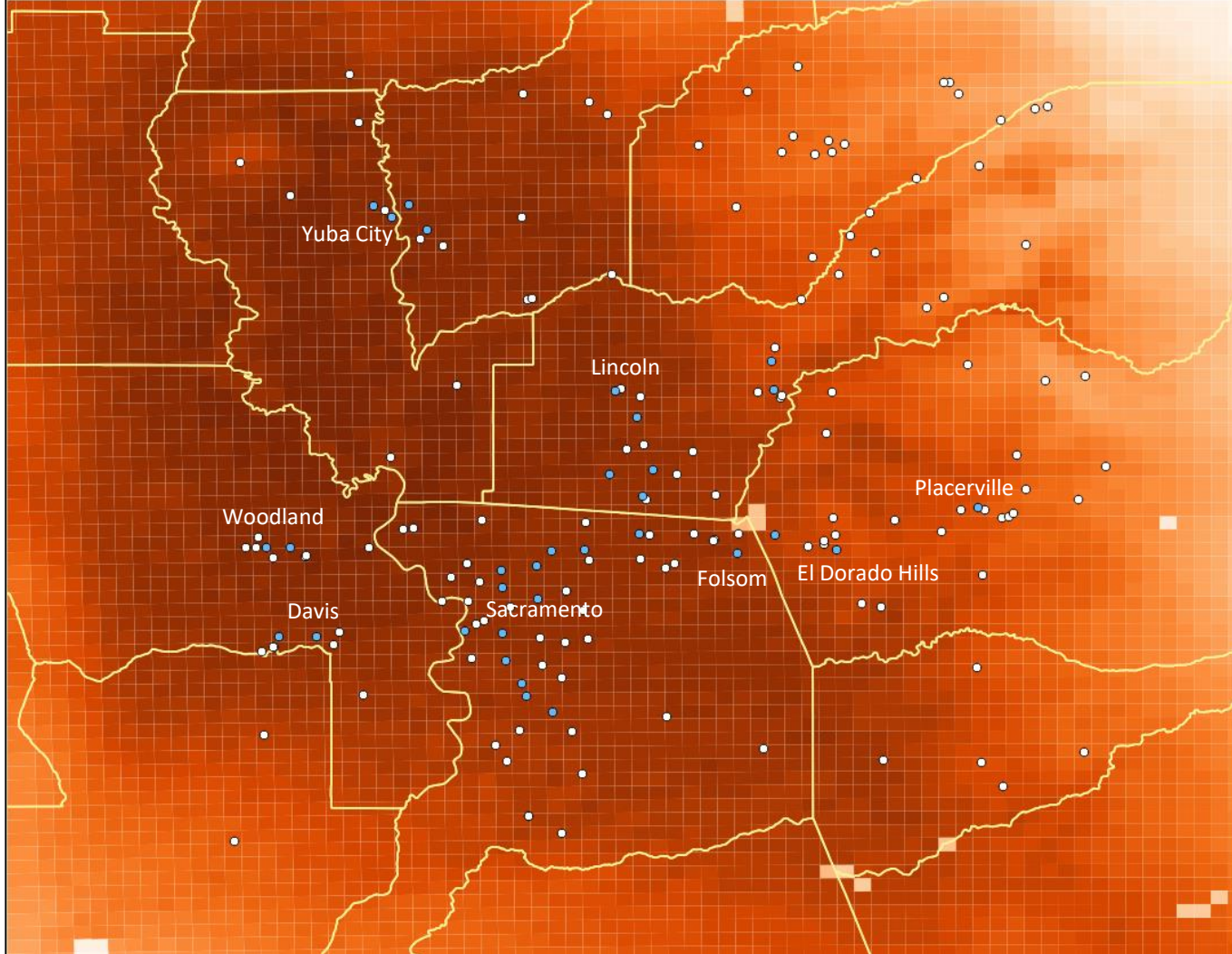
N

Altostratus Inc.

- 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- 2-km domain; Year 2015, interval 4
- 36 temperature levels, Δ ≈ 0.5 °C; Actual range: 17.71 – 37.41 °C

N

Altostratus Inc.

≡ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
≡ 2-km domain; Year 2015, interval 6
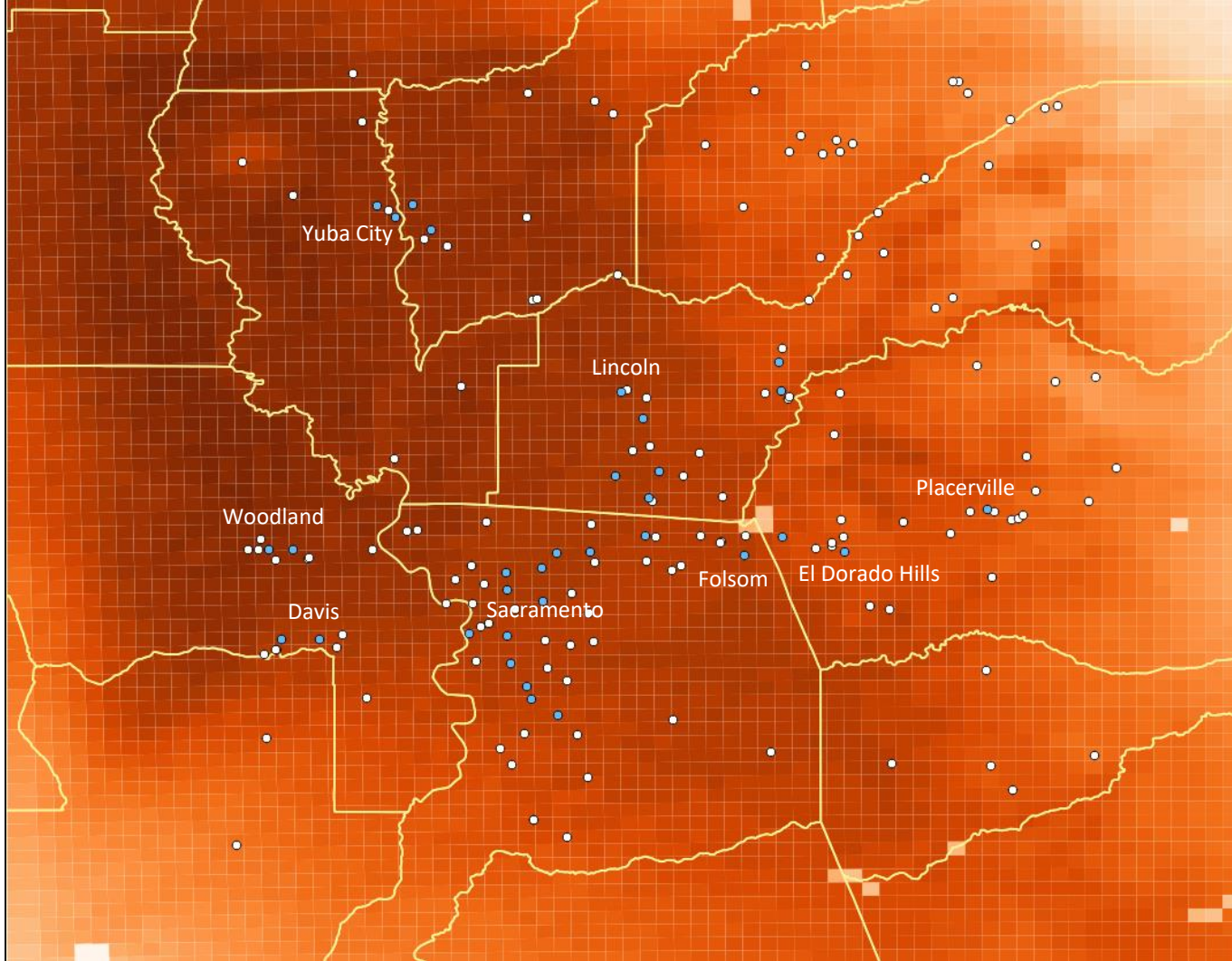≡ 33 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 19.77 − 36.46 °C

N

- ☰ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2016, interval 2
- ☰ 33 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 17.71 – 35.60 °C

N

AltostratusInc.

- ☰ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2016, interval 4
- ☰ 34 temperature levels, Δ ≈ 0.5 °C; Actual range: 20.84 – 39.17 °C

N

- ☰ 1500 PDT, non-threshold, average 2-m AGL air temperature (°C)
- ☰ 2-km domain; Year 2016, interval 6
- ☰ 26 temperature levels, $\Delta \approx 0.5$ °C; Actual range: 19.06 – 37.57 °C

N

Altostratus Inc.

Appendix C-1

The maps in this appendix provide the change in roadway and pavement surface temperature that result from implementing the SMAQMD ZEV readiness plan in the Sacramento domain D07. Figures are for 1700 PDT (rush hour) and all-hour averages for the intervals specified on each figure.
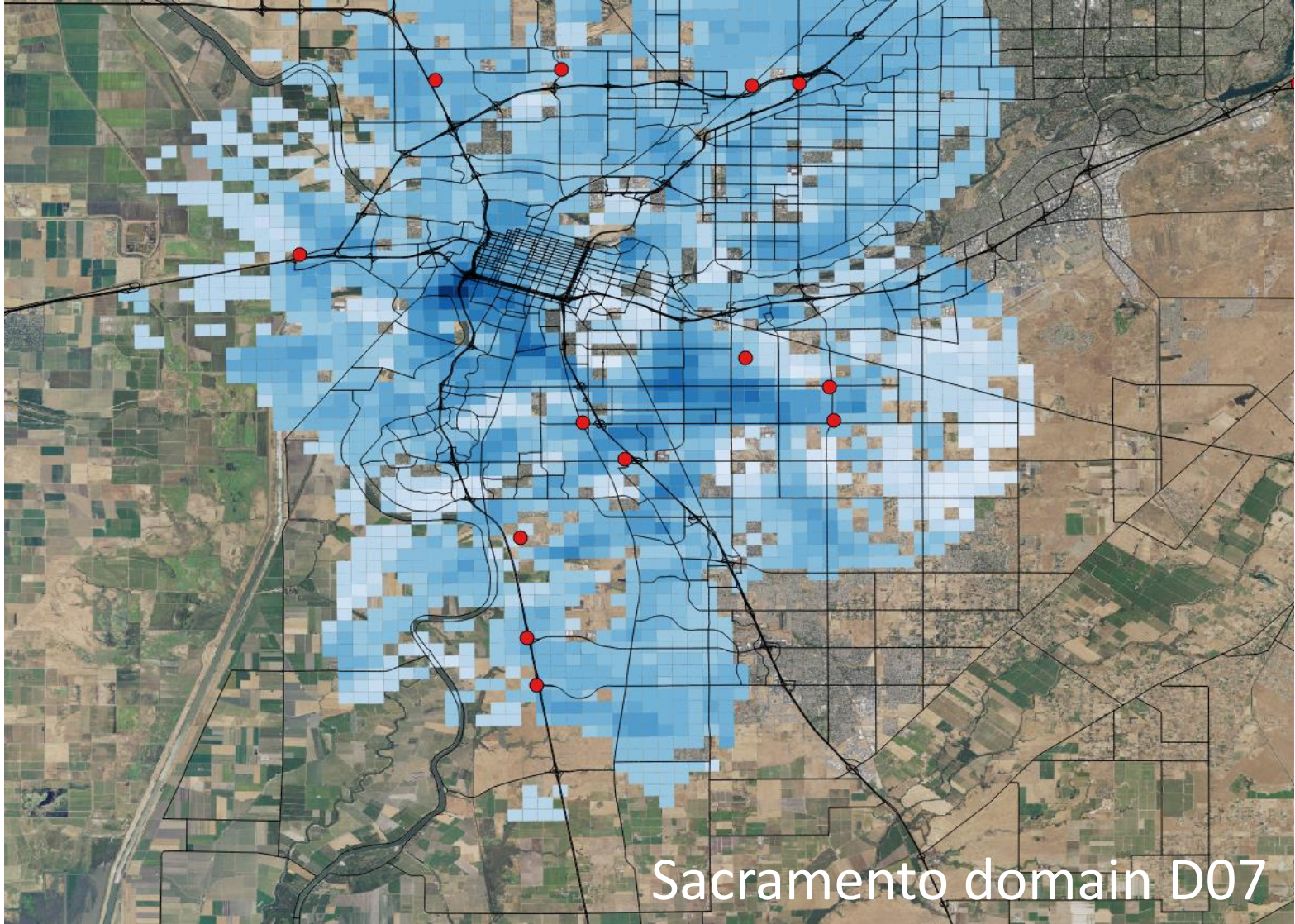
Sacramento domain D07
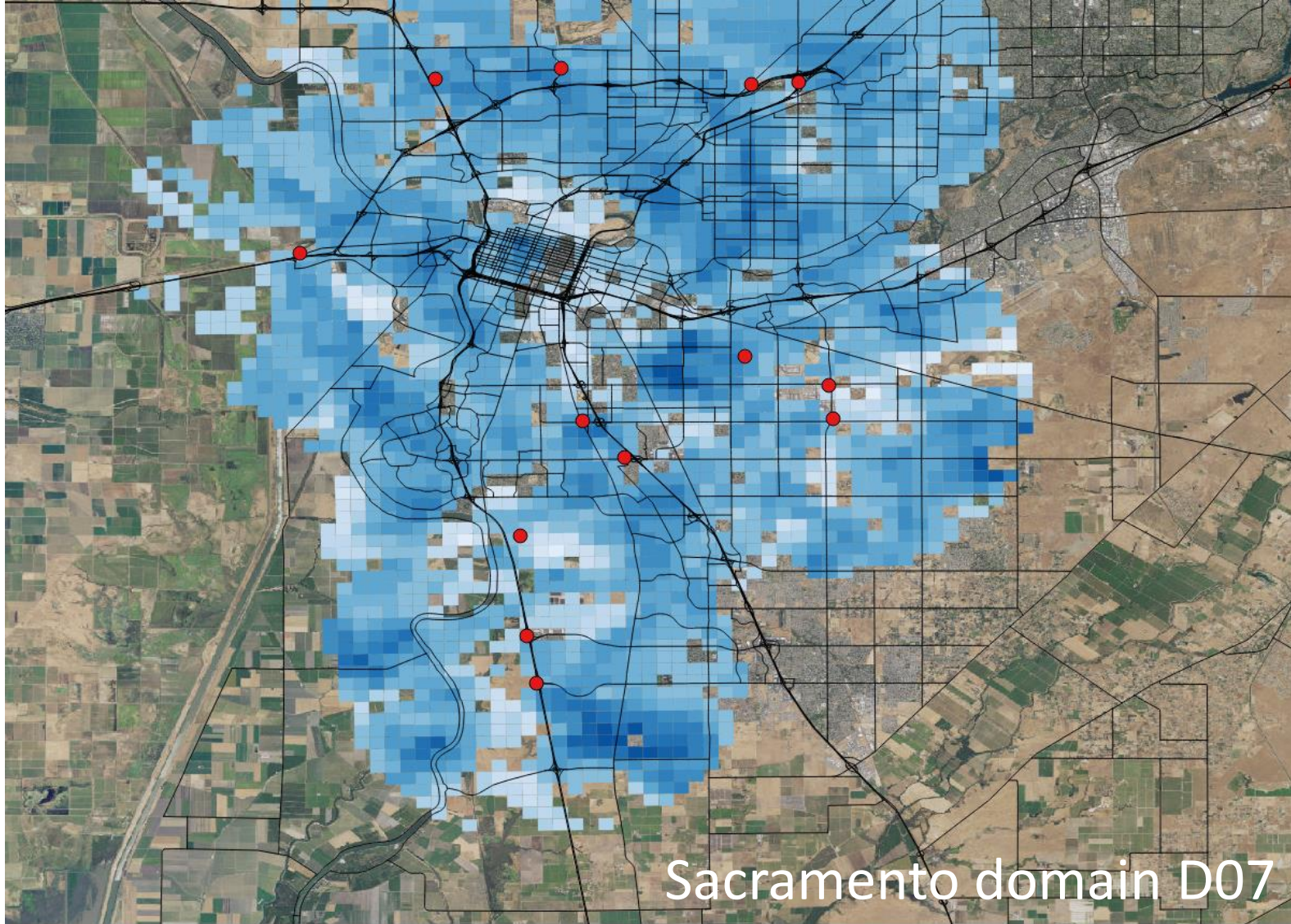
Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2013_int3
Maximum change: -2.97 °C, color step is ~0.25 °C
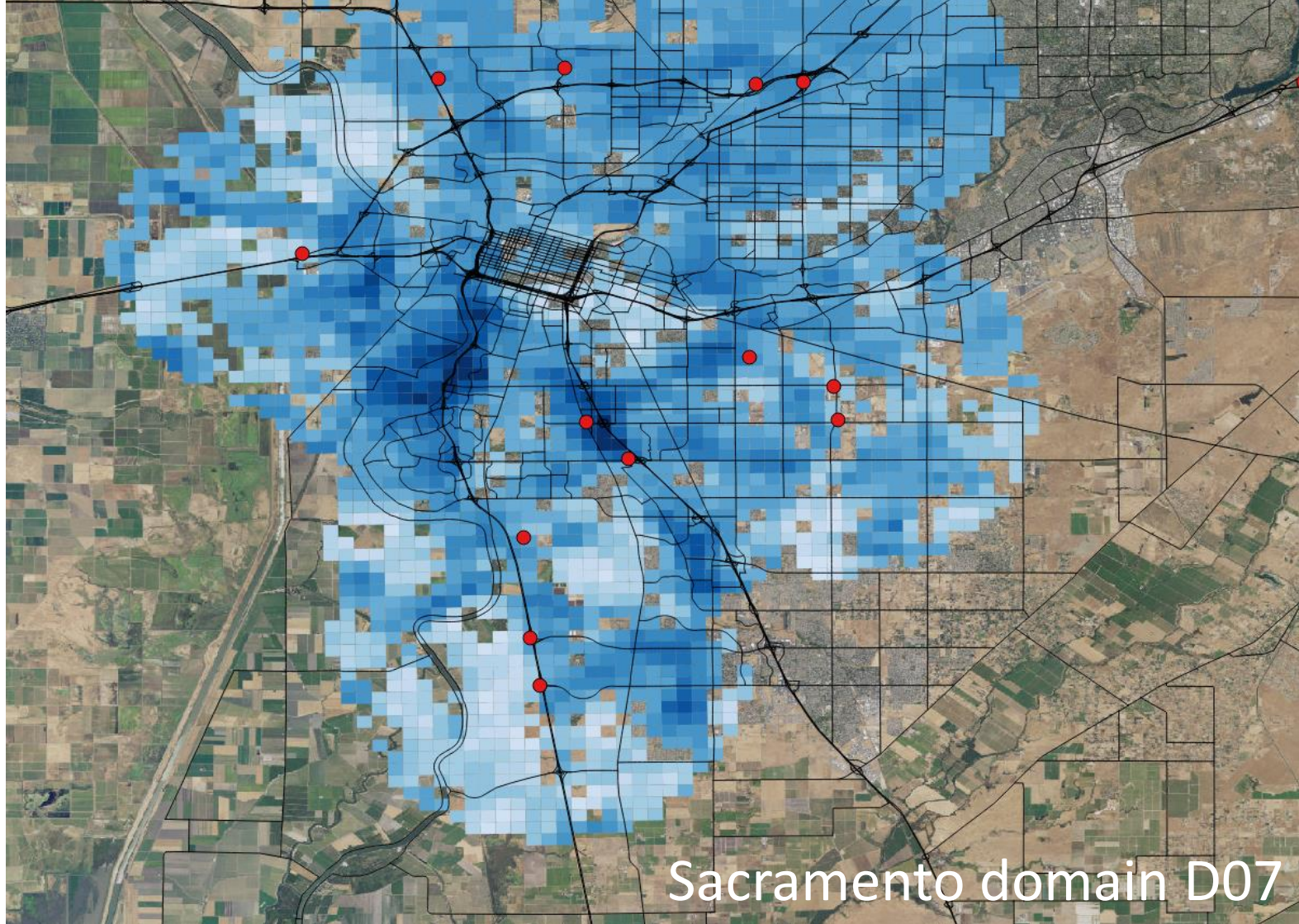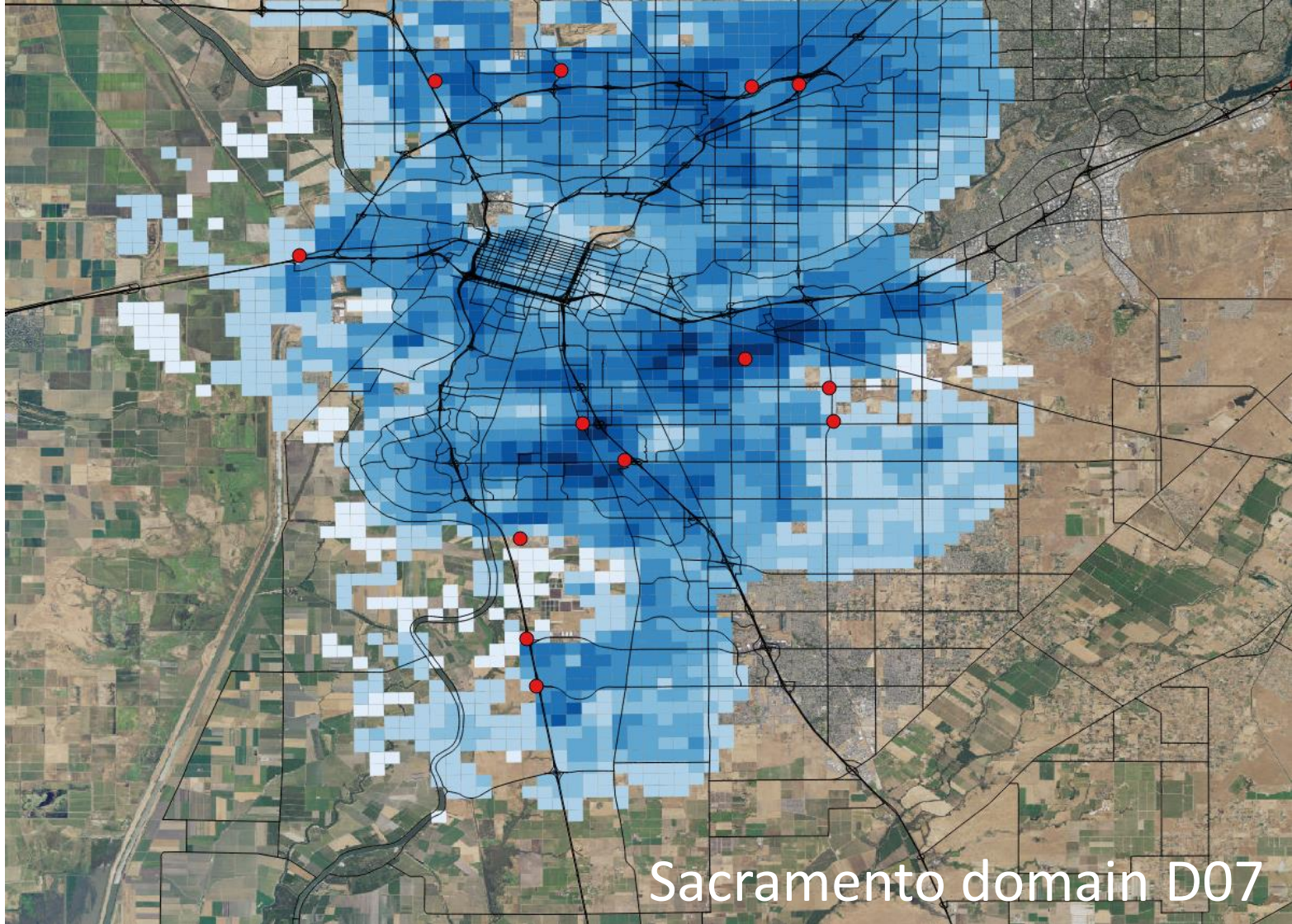
Altostratus Inc.

Sacramento domain D07

Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2015_int1
Maximum change: -2.81 °C, color step is ~0.25 °C

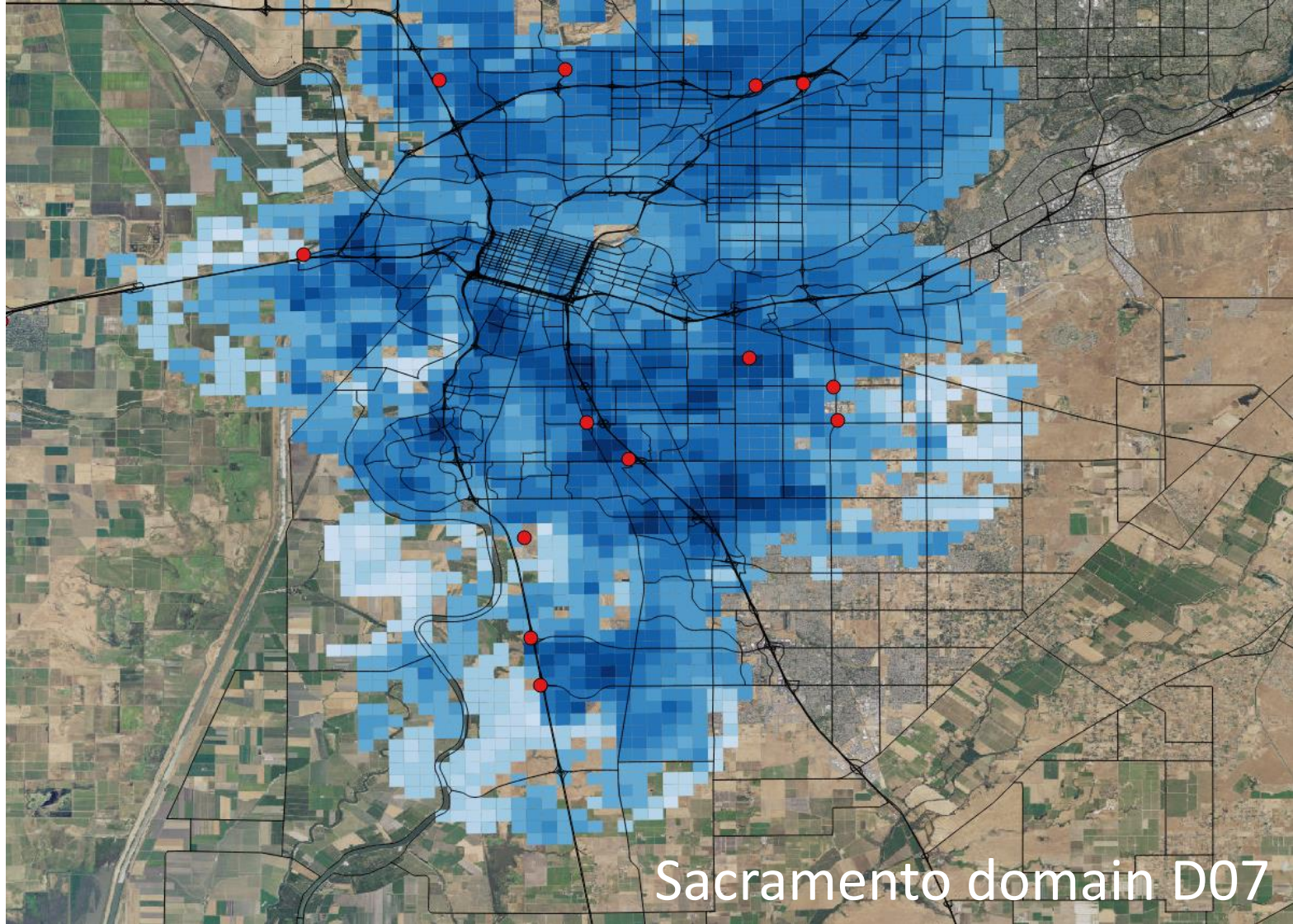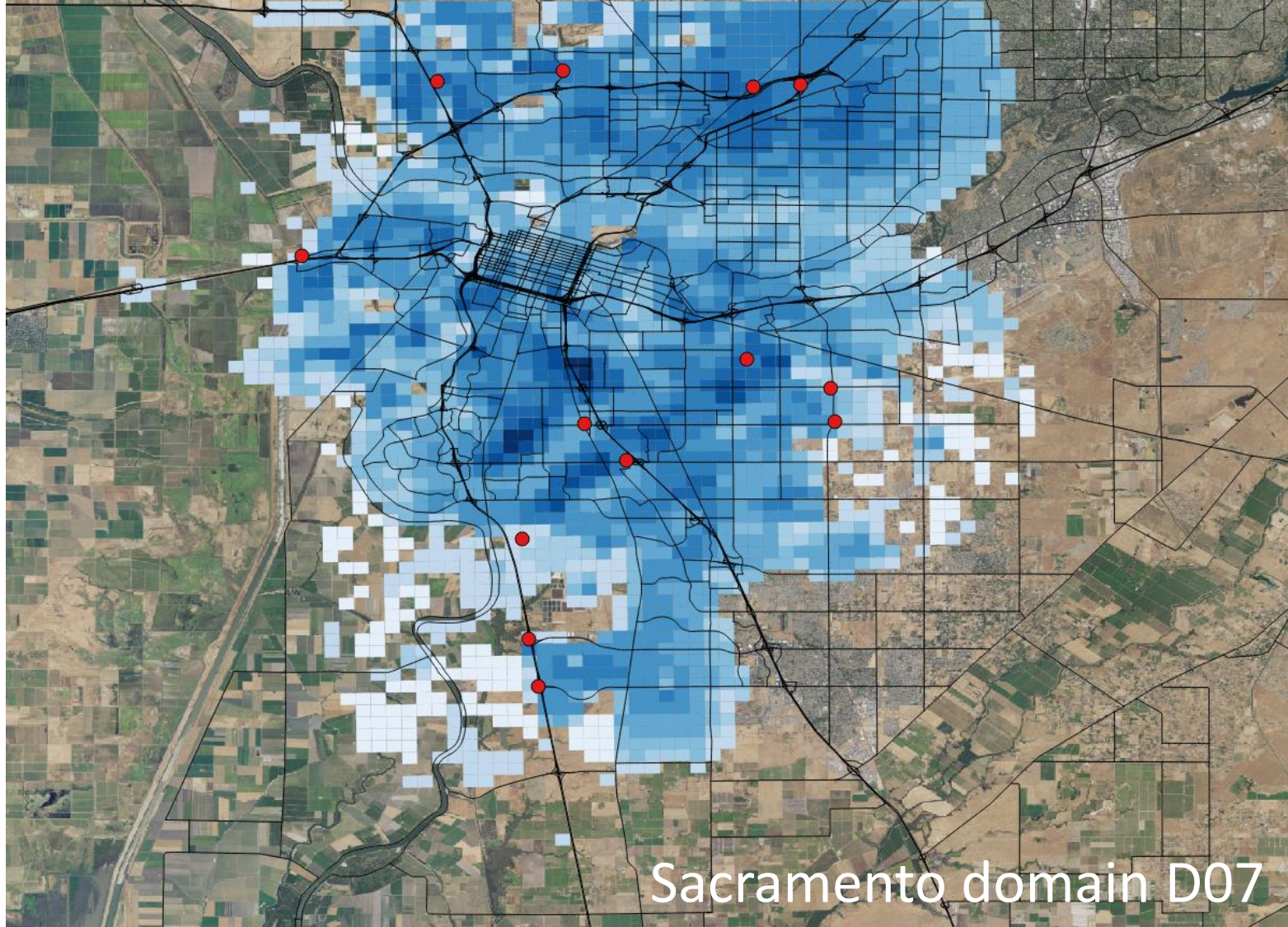**Altostratus** Inc.

Sacramento domain D07

Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2016_int5
Maximum change: -3.34 °C, color step is ~0.25 °C

Altostratus Inc.

Sacramento domain D07

Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2013_int3
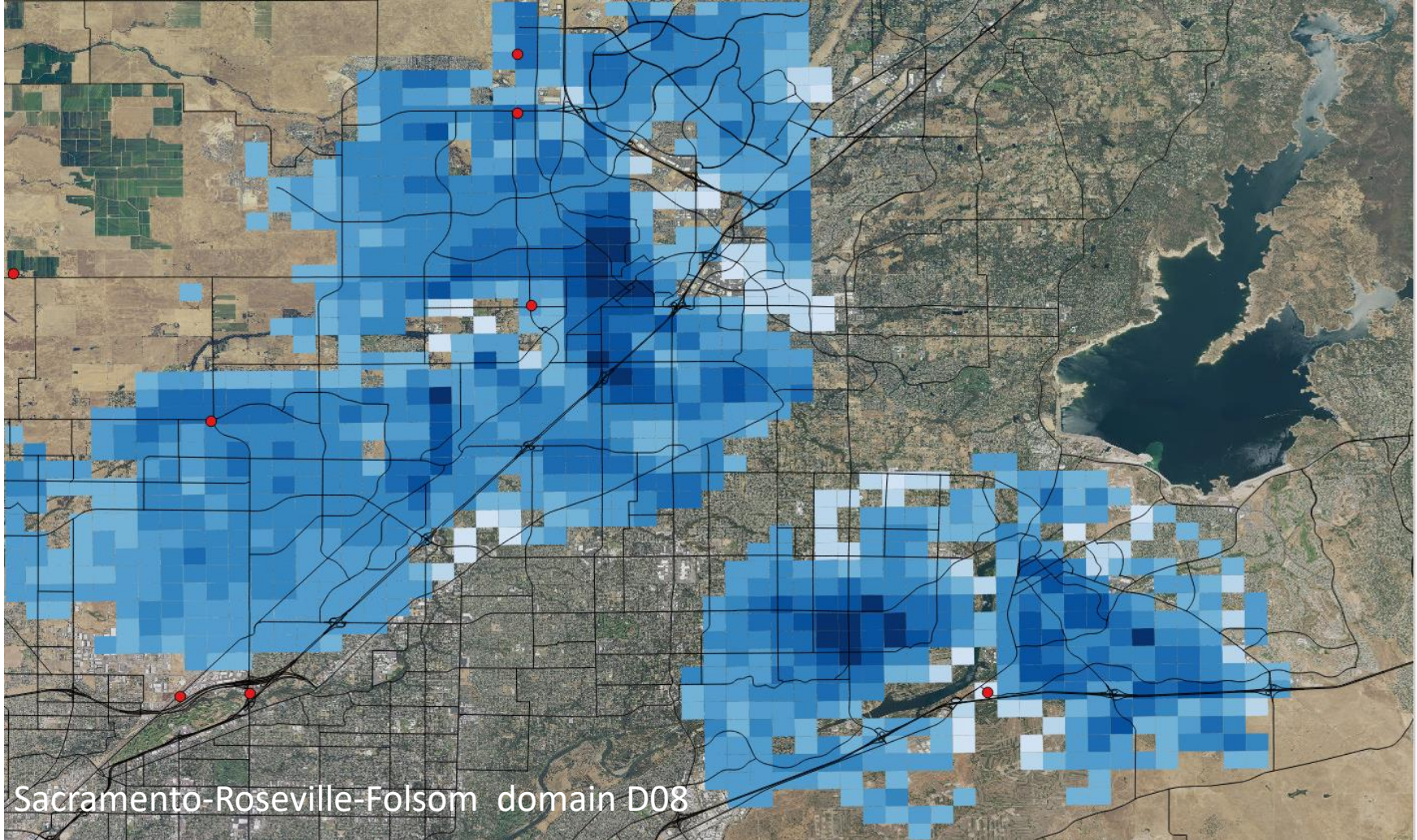Maximum change: -0.87 °C, color step is ~0.10 °C

Altostratus Inc.

Sacramento domain D07

Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2015_int1
Maximum change: -0.84 °C, color step is ~0.10 °C

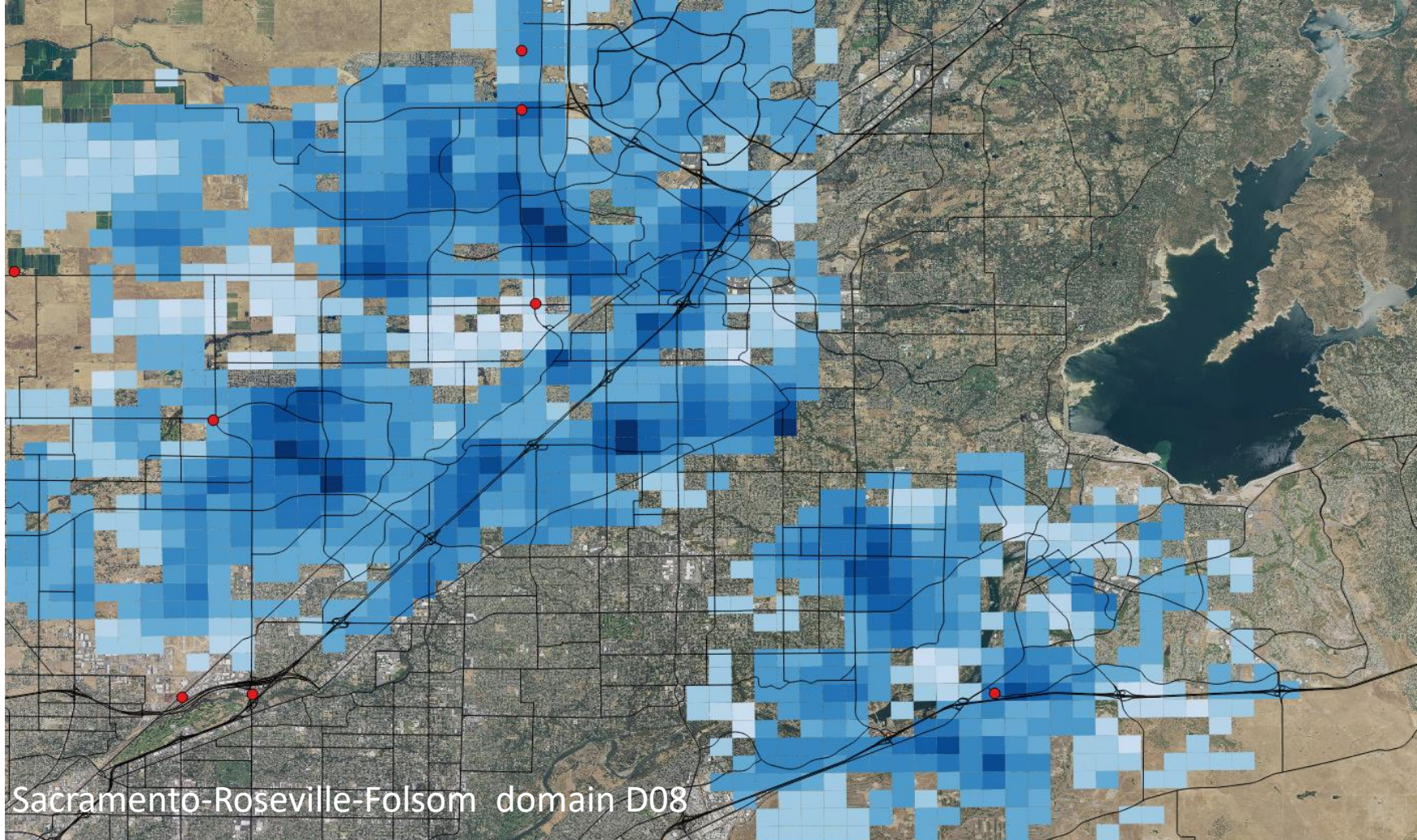**Altostratus** Inc.

Sacramento domain D07

Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2016_int5
Maximum change: -0.86 °C, color step is ~0.10 °C

**Altostratus** Inc.

Appendix C-2

The maps in this appendix provide the change in roadway and pavement surface temperature that result from implementing the SMAQMD ZEV readiness plan in the Sacramento-Roseville-Folsom domain D08. Figures are for 1700 PDT (rush hour) and all-hour averages for the intervals specified on each figure.

Altostratus Inc.

Sacramento-Roseville-Folsom domain D08

Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2013_int3
Maximum change: -1.58 °C, color step is ~0.25 °C

Altostratus Inc.

Sacramento-Roseville-Folsom domain D08

Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2015_int1
Maximum change: -2.17 °C, color step is ~0.25 °C
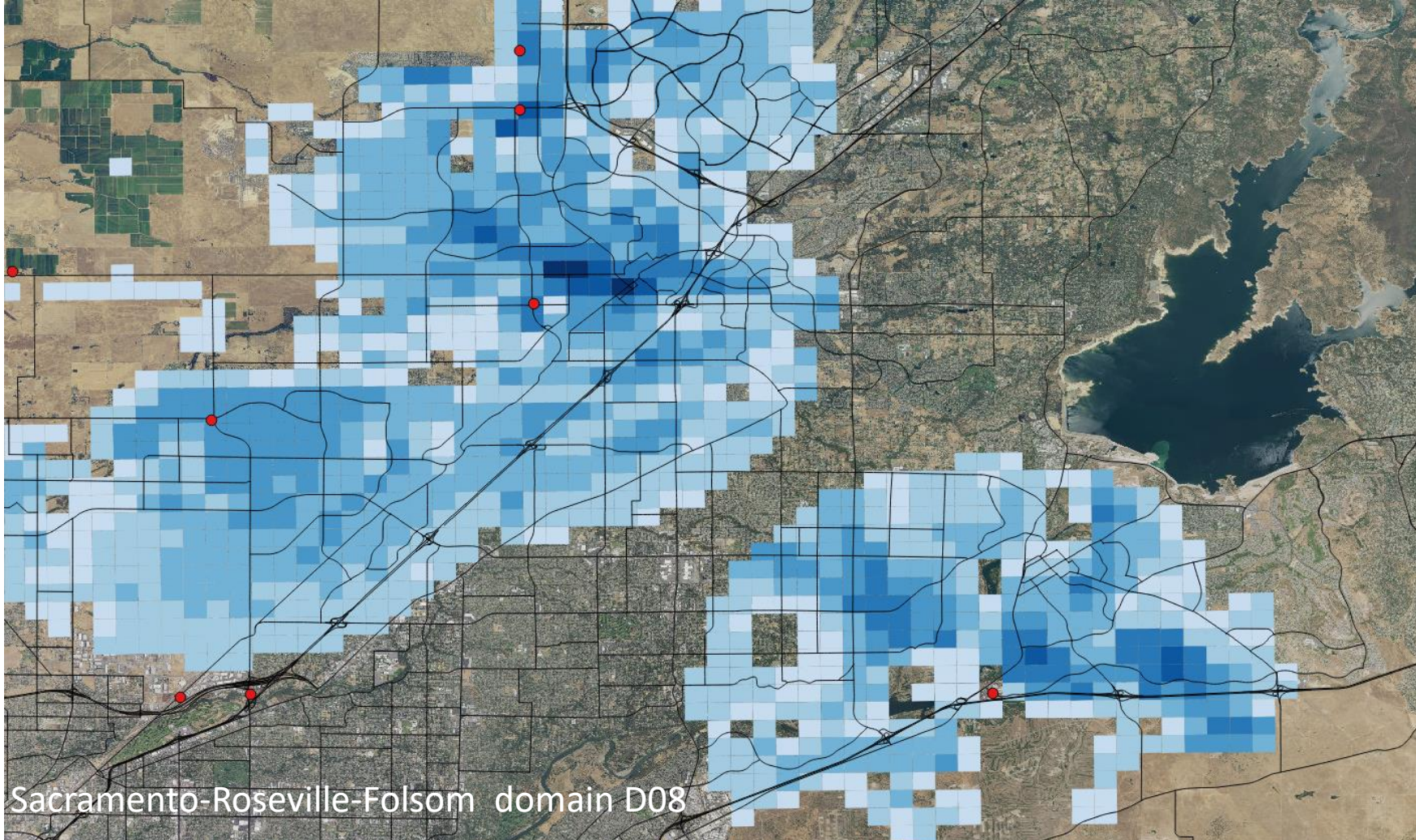
Altostratus Inc.

Sacramento-Roseville-Folsom domain D08

Change in surface temperature (°C) for case SMAQMD ZEV, average at 1700 PDT for 2016_int5
Maximum change: -1.79 °C, color step is ~0.25 °C
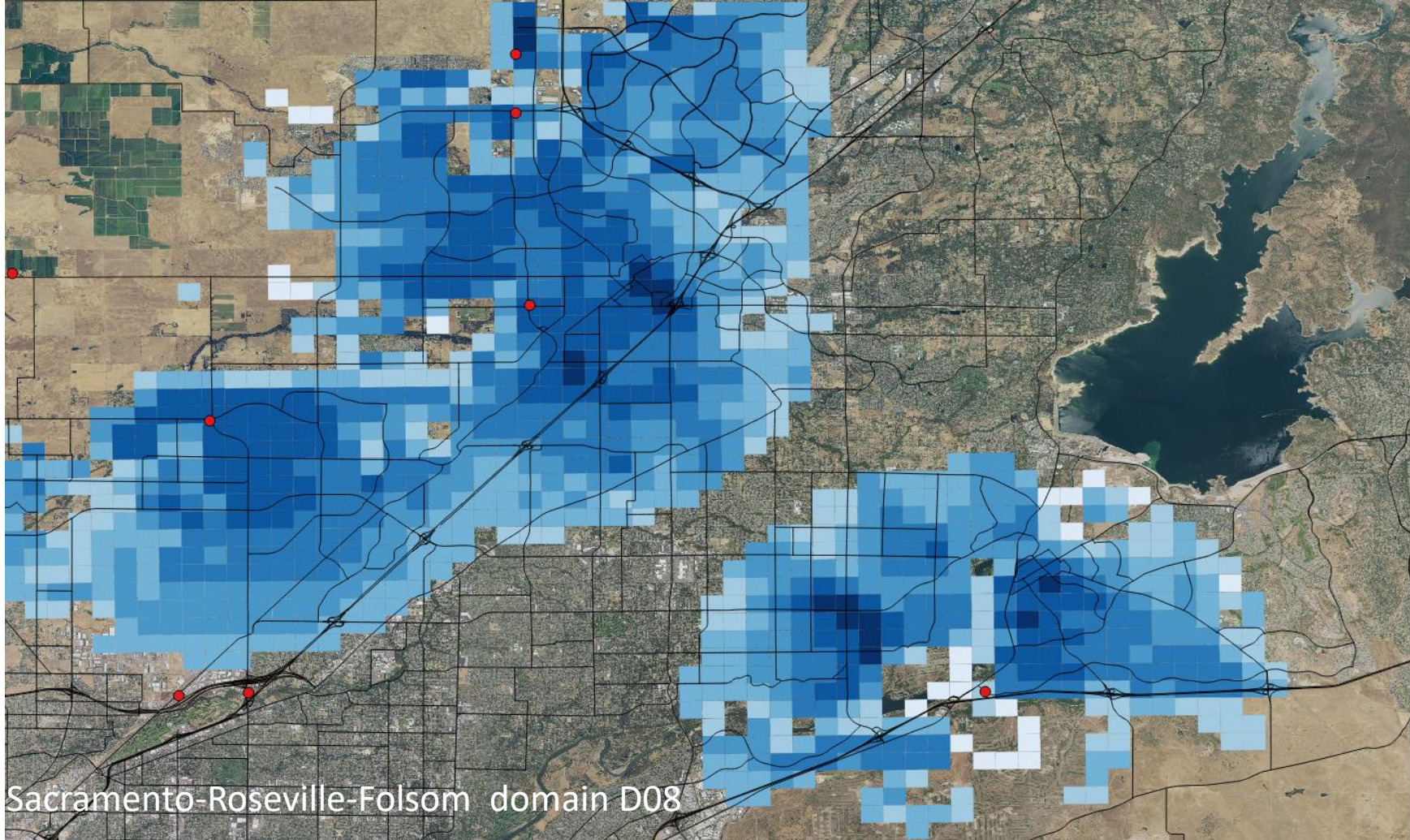
Altostratus Inc.

Sacramento-Roseville-Folsom domain D08

Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2013_int3
Maximum change: -0.73 °C, color step is ~0.10 °C
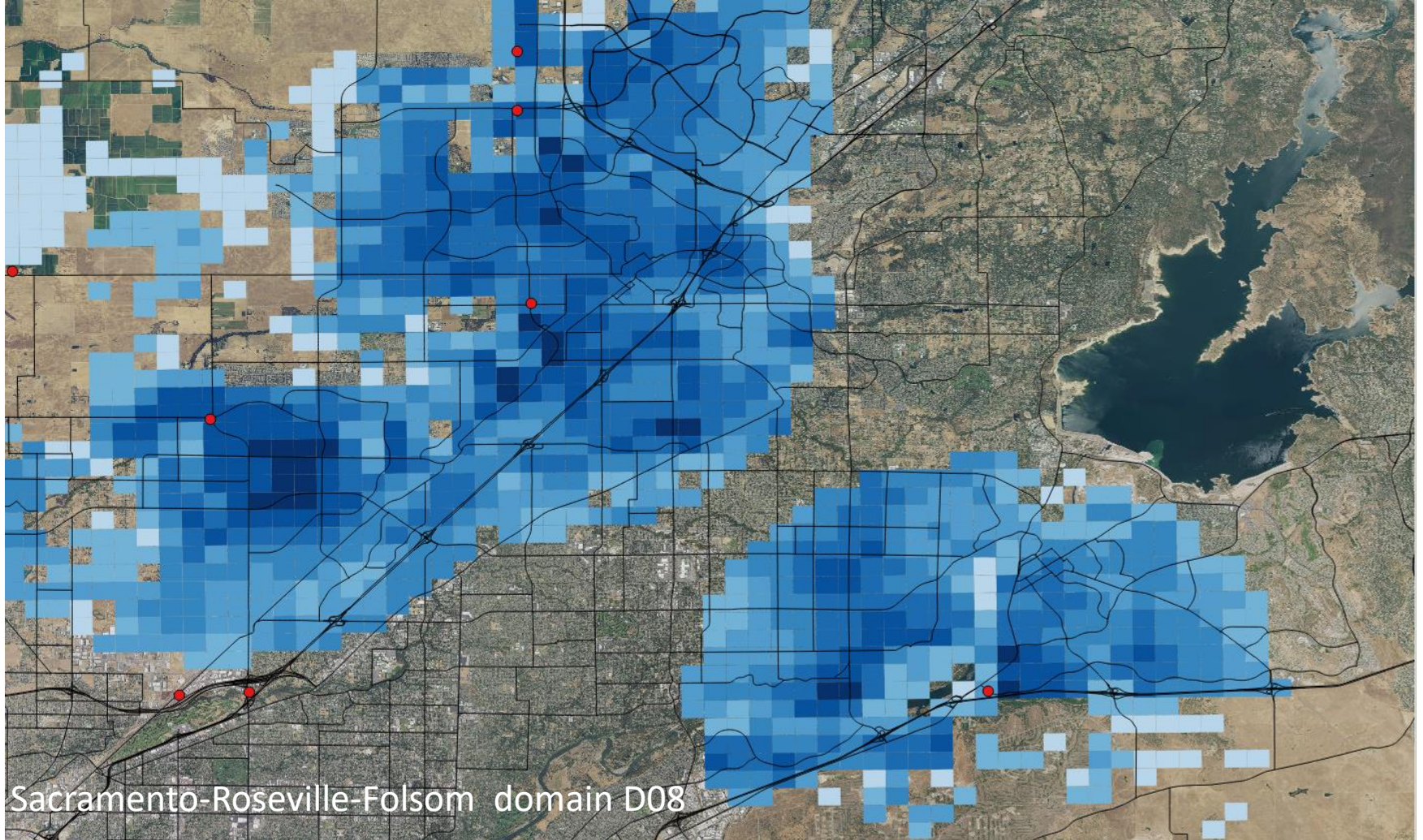
Altostratus Inc.

Sacramento-Roseville-Folsom domain D08

Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2015_int1
Maximum change: -0.74 °C, color step is ~0.10 °C

Altostratus Inc.

Sacramento-Roseville-Folsom domain D08
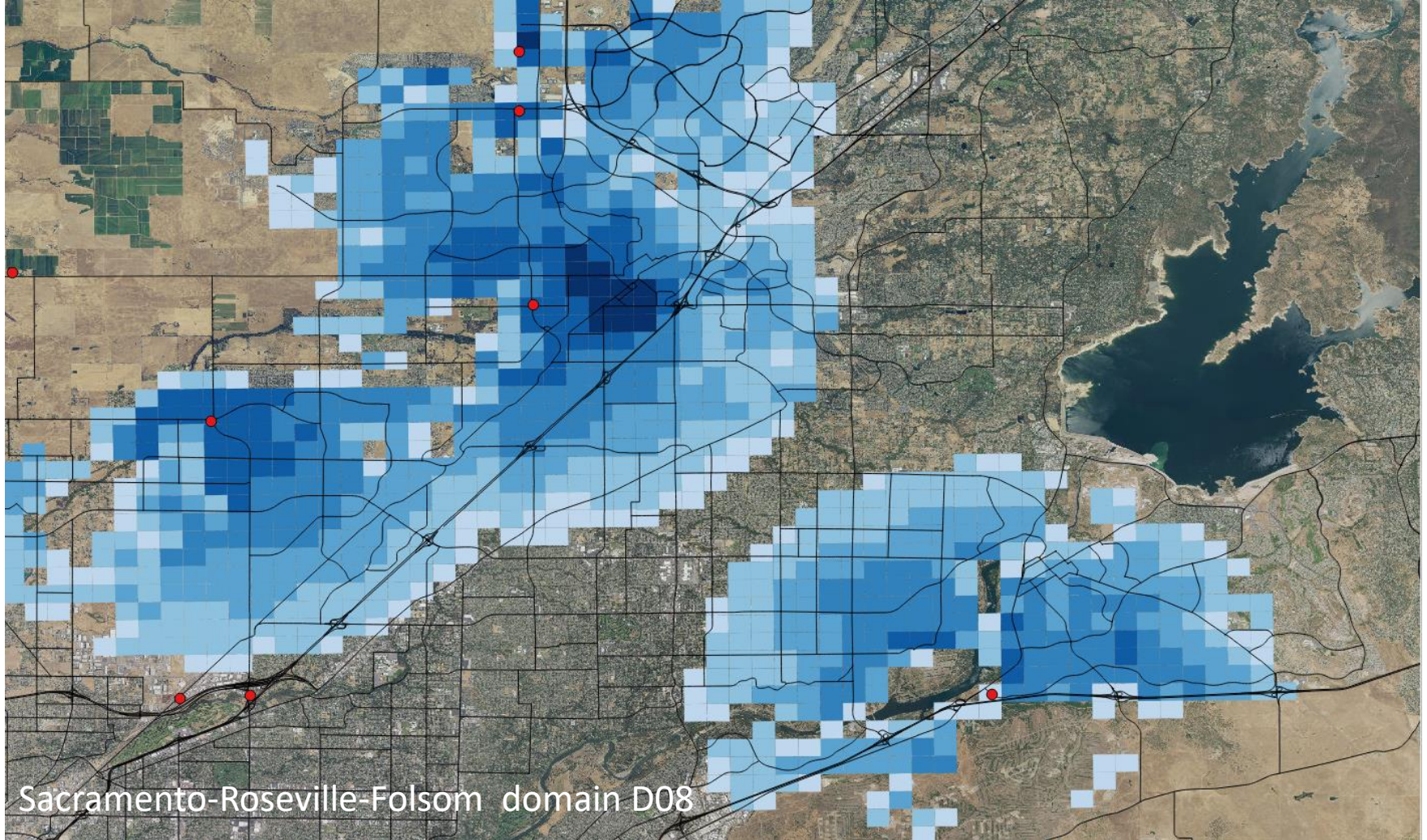
Change in surface temperature (°C) for case SMAQMD ZEV, all-hours average for 2016_int5
Maximum change: -0.74 °C, color step is ~0.10 °C

Altostratus Inc.

Appendix D-1

The maps in this appendix provide tiers of the UHII (in the top, green colored figures) at 1 ºC intervals. In the bottom part of each figure, the UHII tier (shown in dotted pattern) is superimposed over the CalEnviroScreen 3.0 score (where the darker areas have a higher CES 3.0 score).
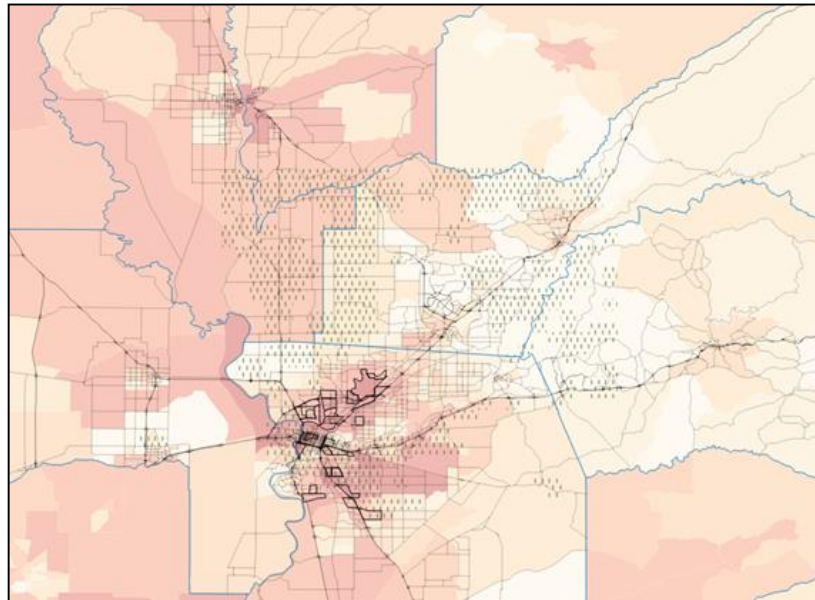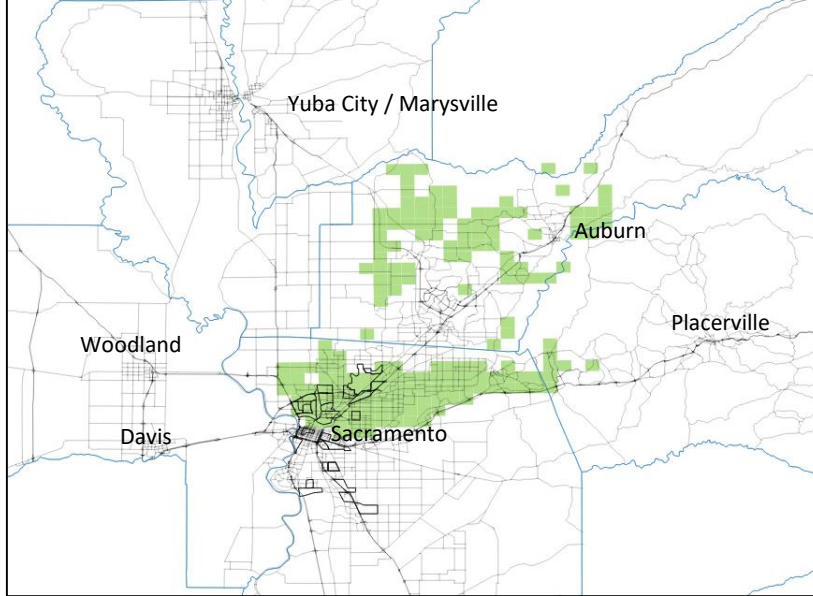
.
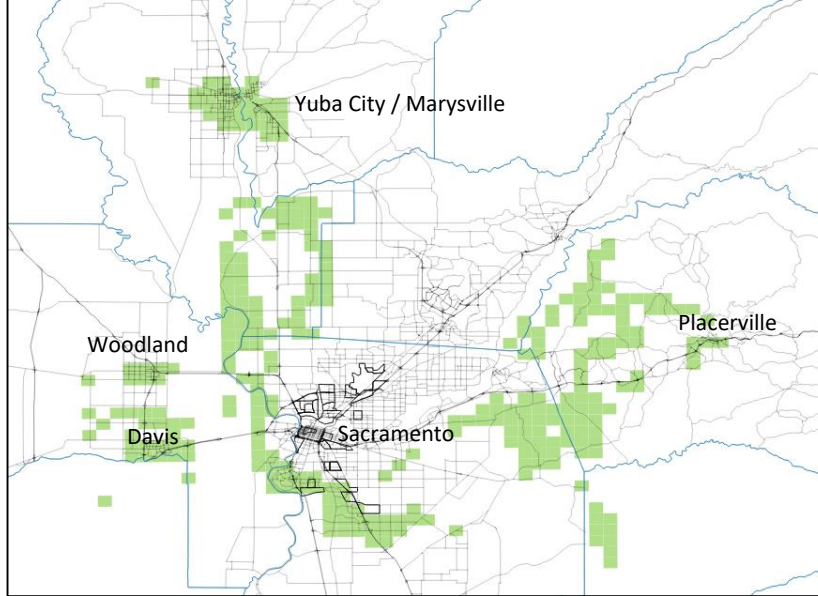
Tier 1 all-hours UHII (1 – 2 °C)
2015 int4
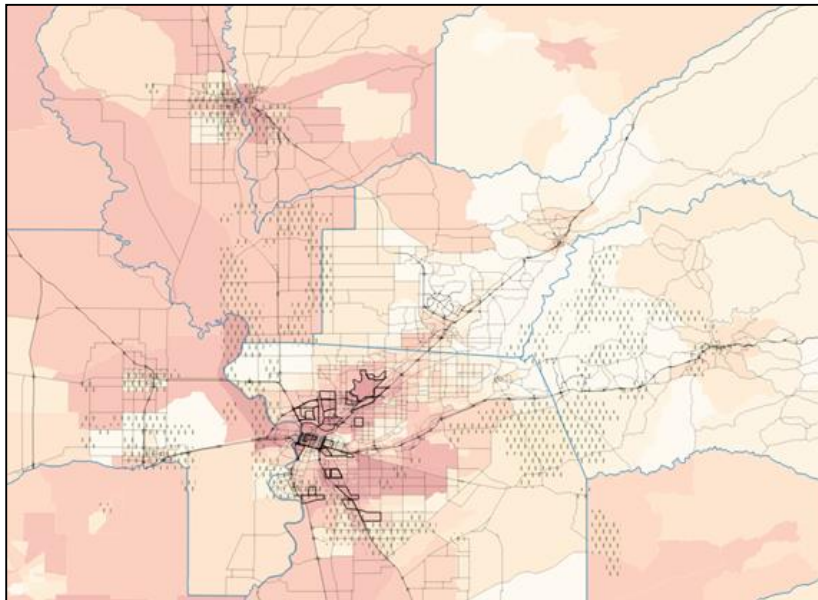
Tier 1 all-hours UHII (1 – 2 °C)
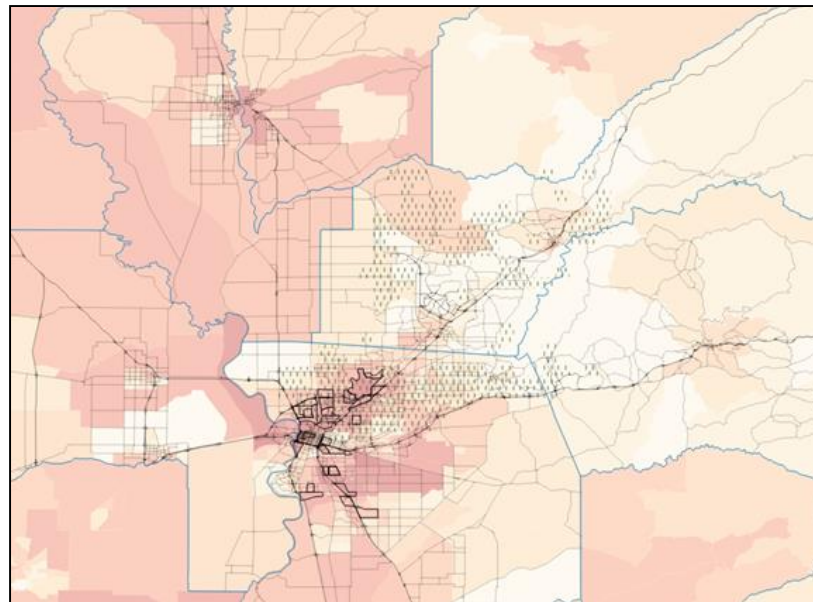2015 int4 (dotted) vs. CEC 3.0

Altostratus Inc.
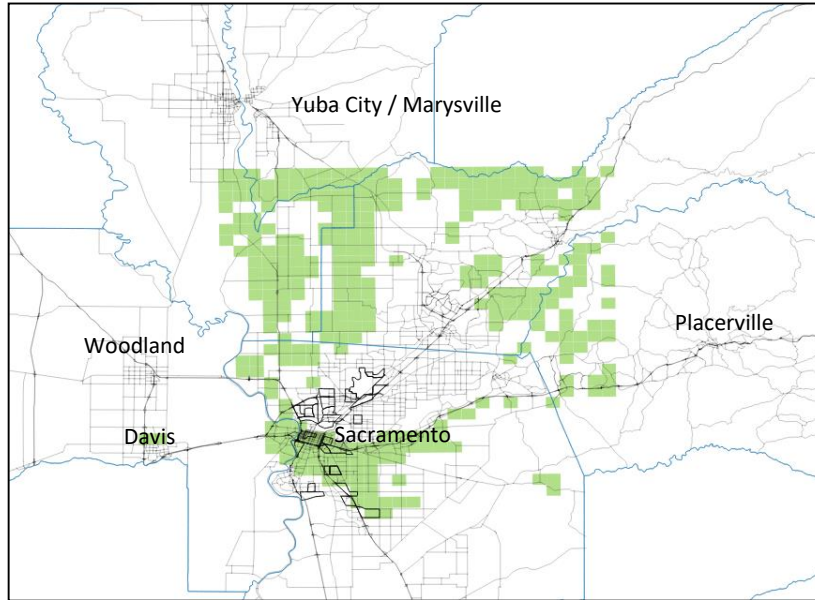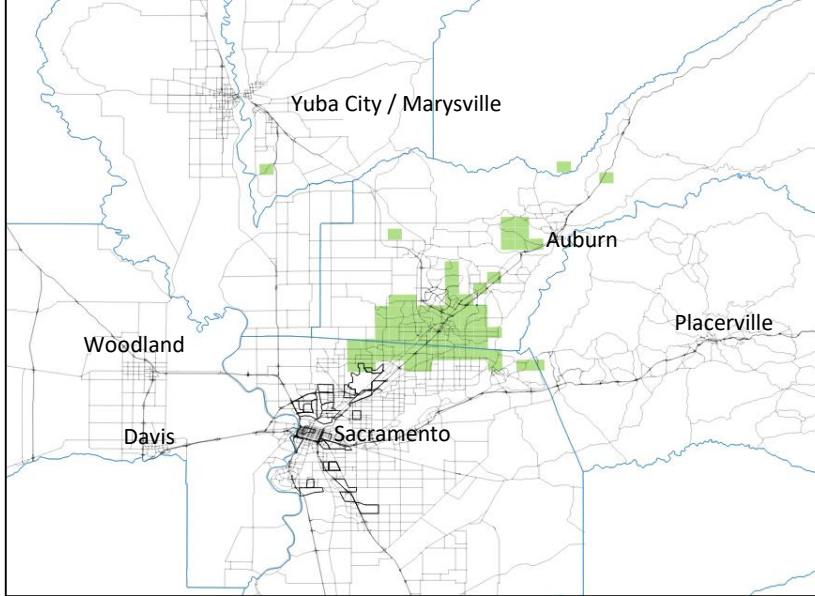
Tier 2 all-hours UHII (2 – 3 °C)
2015 int4

Tier 2 all-hours UHII (2 – 3 °C)
2015 int4 (dotted) vs. CES 3.0

Tier 3 all-hours UHII (3 – 4 °C)
2015 int4

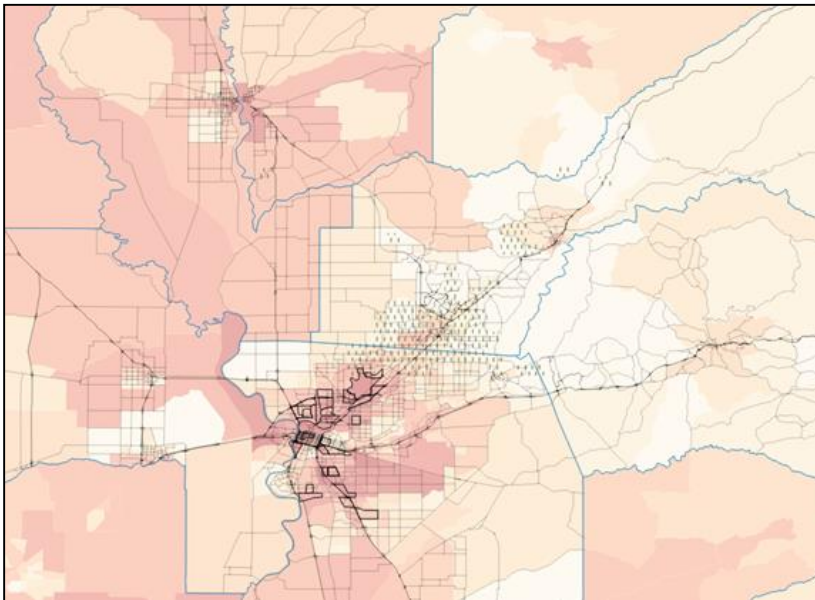Tier 3 all-hours UHII (3 – 4 °C)
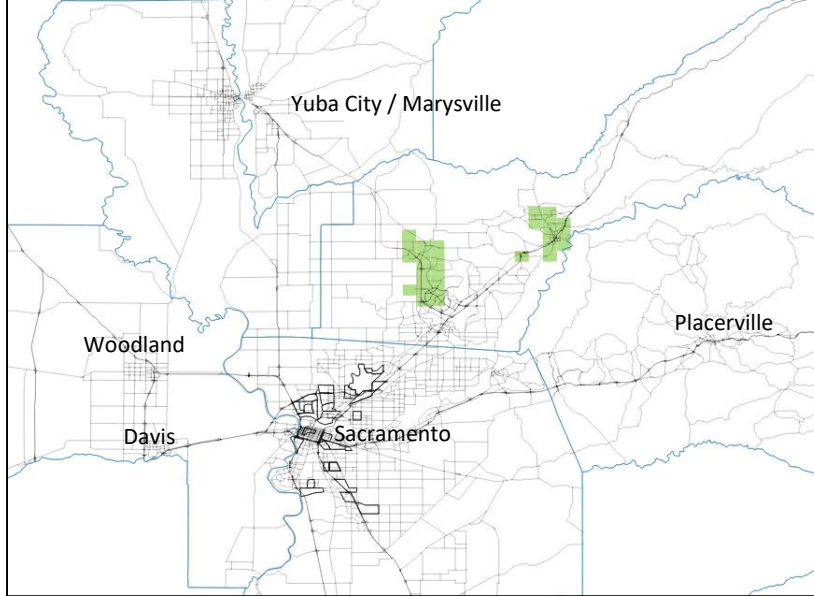2015 int4 (dotted) vs CES 3.0

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Tier 4 all-hours UHII (4 – 5 °C)
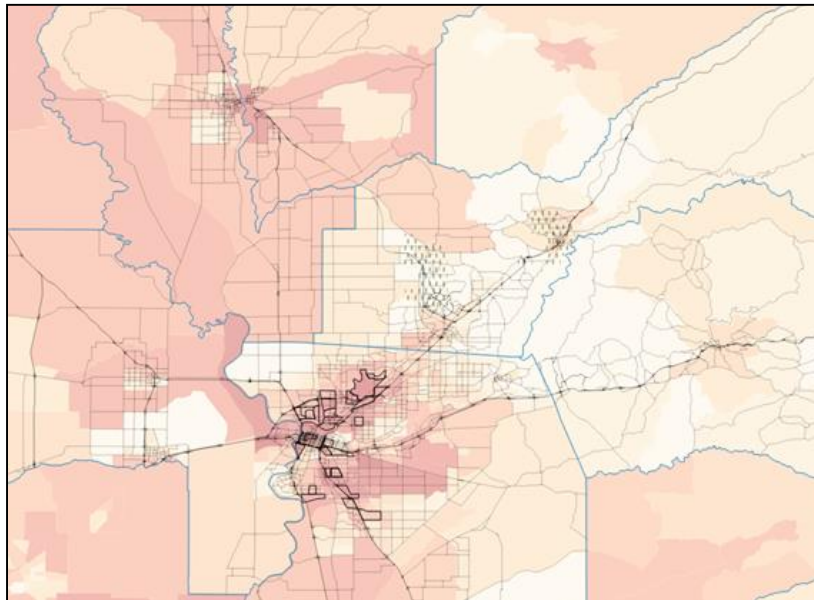2015 int4

Tier 4 all-hours UHII (4 – 5 °C)
2015 int4 (dotted) vs. CES 3.0

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Tier 5 all-hours UHII (5 – 6 °C)
2015 int4

Tier 5 all-hours UHII (5 – 6 °C)
2015 int4 (dotted) vs. CES 3.0

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Appendix D-2

This appendix shows a larger version of wuSCORE maps defined and discussed in the report. The temperature-weighted UHII score (wuSCORE) and how it is computed are both discussed in the report.

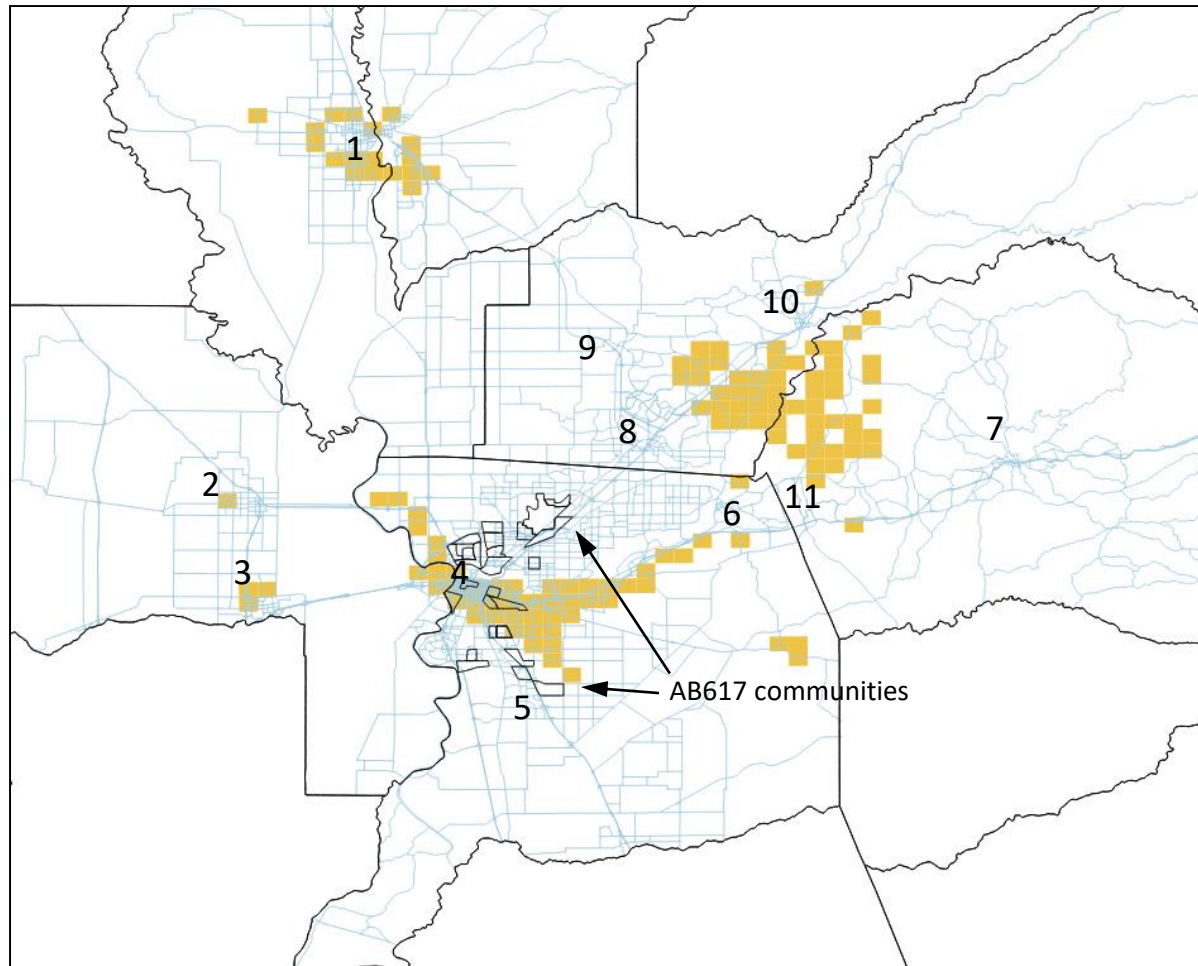The higher the wuSCORE, the highest the UHII and temperature are.

Air-temperature weighted UHII score
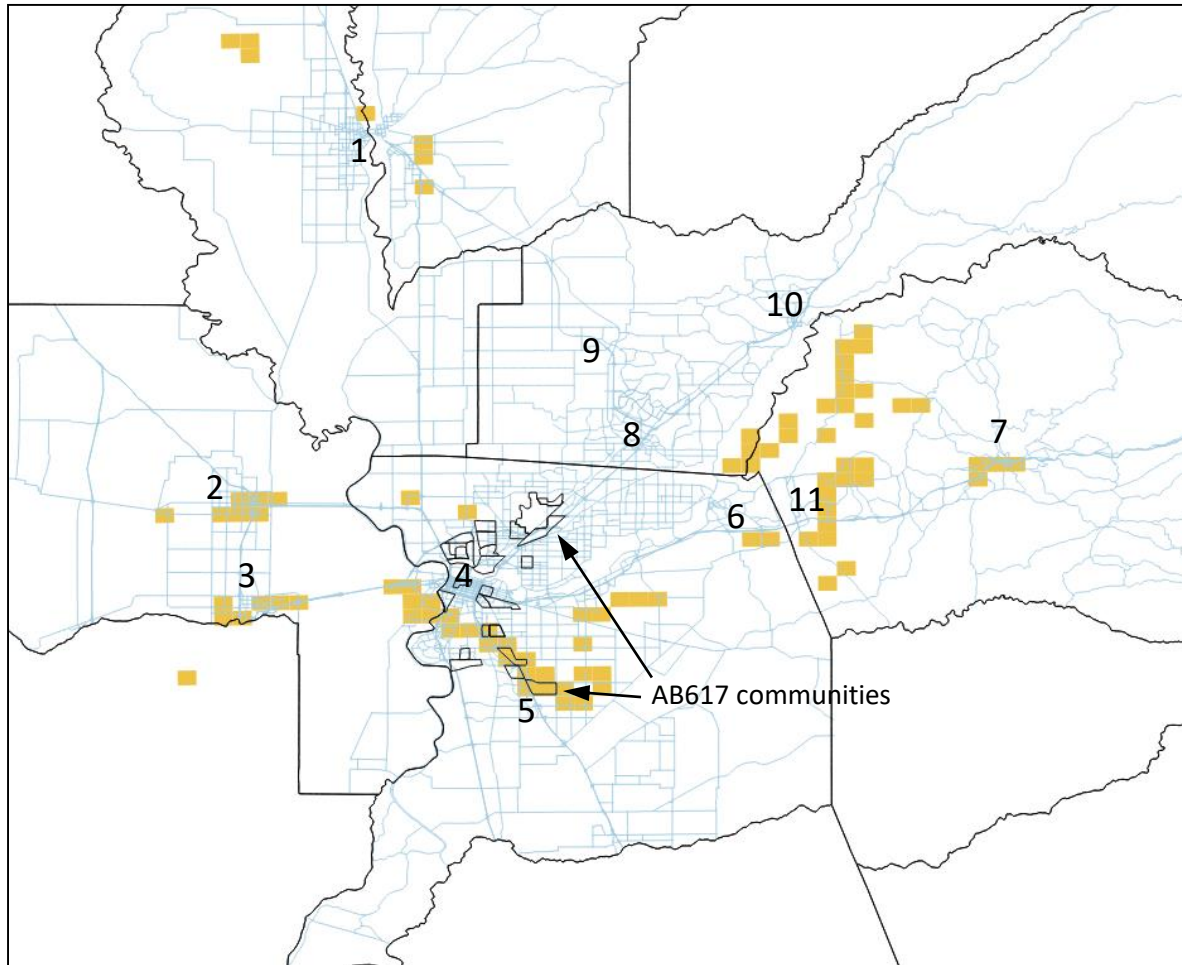
UHII-Tair weighted Tier 1: wuSCORE : 0.53 – 1.06

1: Yuba City / Marysville
2: Woodland
3: Davis
4: Sacramento
5: Elk Grove
6: Folsom
7: Placerville
8: Roseville
9: Lincoln
10: Auburn
11: El Dorado Hills

AB617 communities

Altostratus Inc.

Air-temperature weighted UHII score

1: Yuba City / Marysville
2: Woodland
3: Davis
4: Sacramento
5: Elk Grove
6: Folsom
7: Placerville
8: Roseville
9: Lincoln
10: Auburn
11: El Dorado Hills

AB617 communities

UHII-Tair weighted Tier 2: wuSCORE : 1.06 – 1.60

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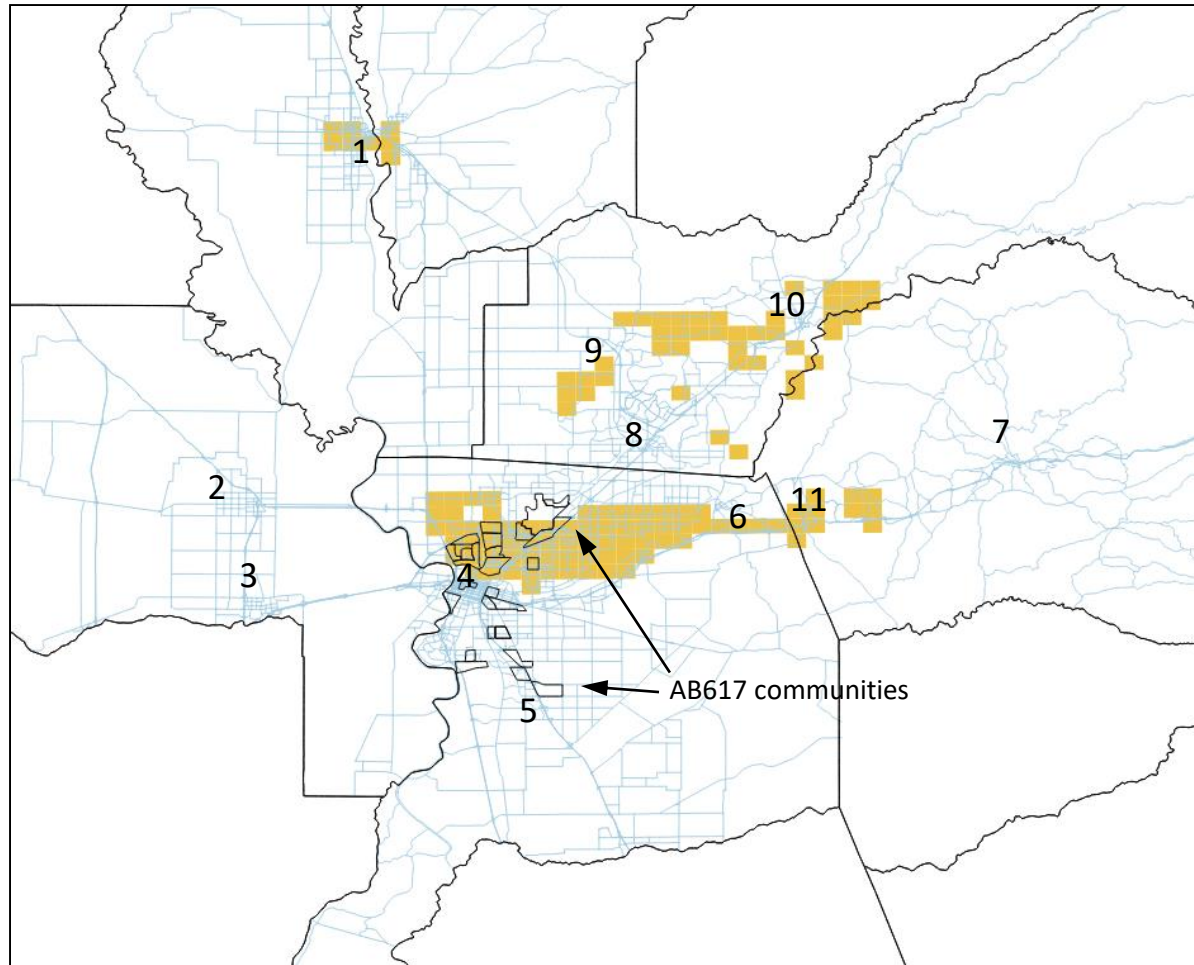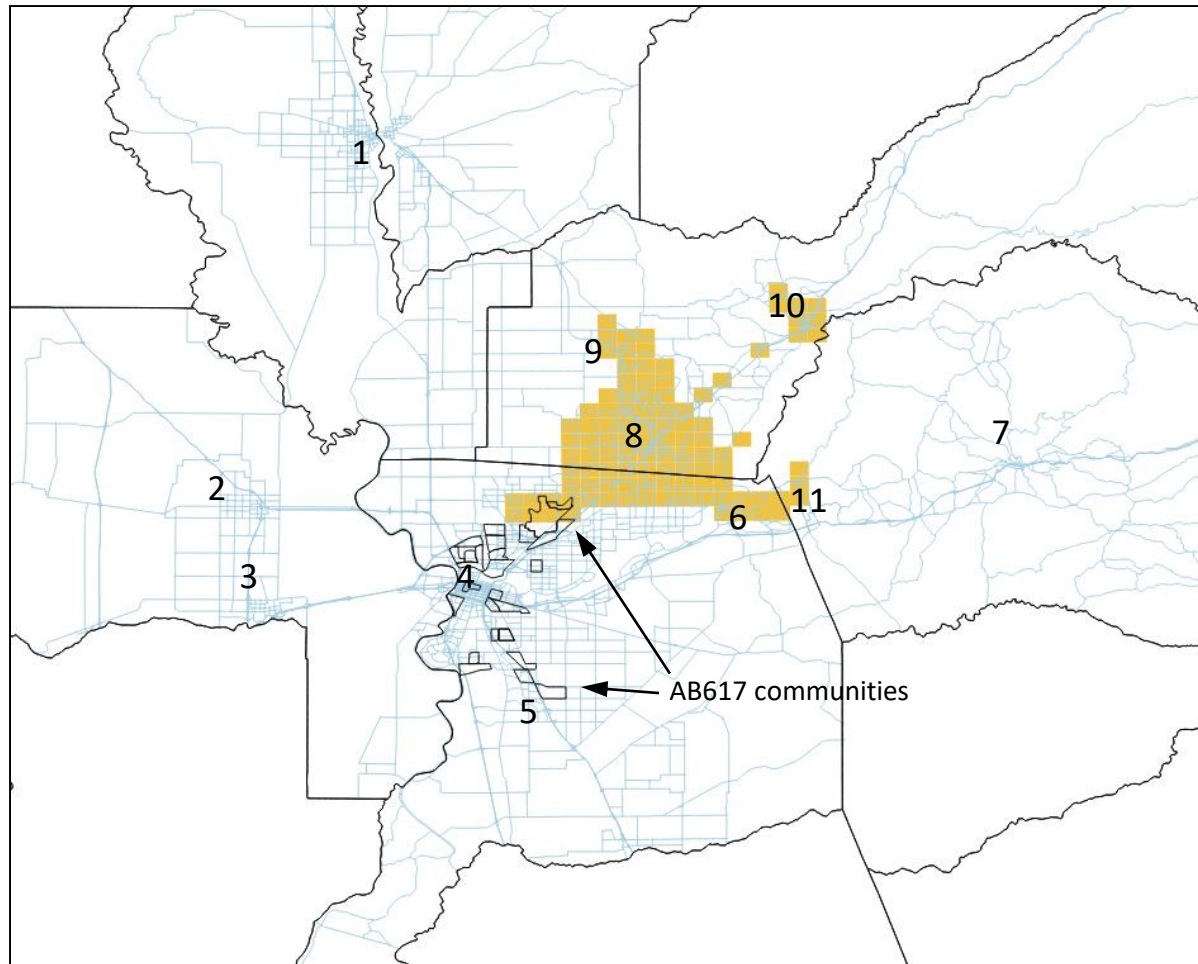
Air-temperature weighted UHII score

1: Yuba City / Marysville
2: Woodland
3: Davis
4: Sacramento
5: Elk Grove
6: Folsom
7: Placerville
8: Roseville
9: Lincoln
10: Auburn
11: El Dorado Hills

UHII-Tair weighted Tier 3: wuSCORE : 1.60 – 2.13

Air-temperature weighted UHII score

UHII-Tair weighted Tier 4: wuSCORE : 2.13 – 2.66

1: Yuba City / Marysville
2: Woodland
3: Davis
4: Sacramento
5: Elk Grove
6: Folsom
7: Placerville
8: Roseville
9: Lincoln
10: Auburn
11: El Dorado Hills

AB617 communities

Altostratus Inc.