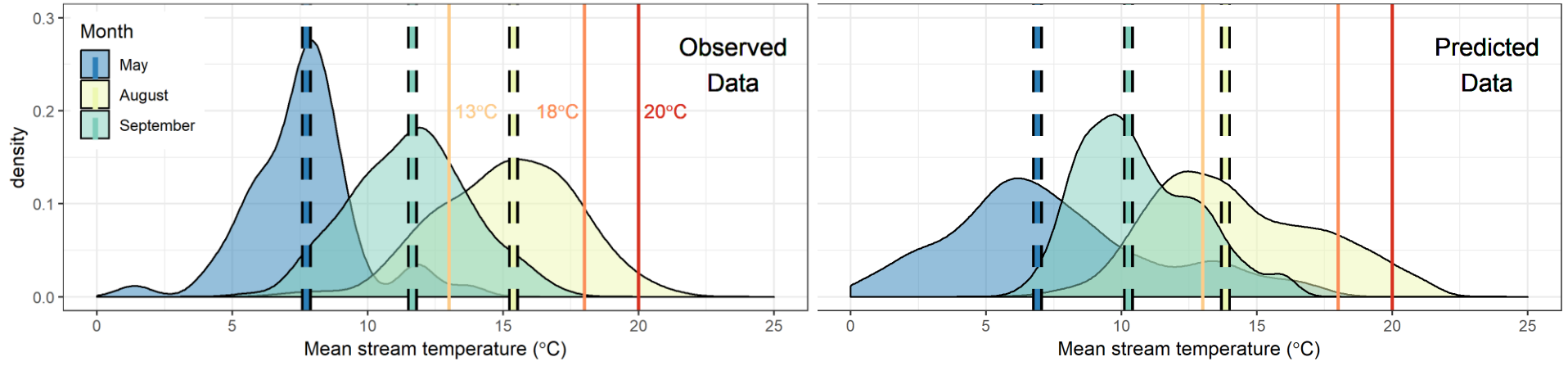
Application of SSN and NorWeST to WQ Standards

SSN Workshop 2019

Session 5



Overview

1. Temperature statistics
2. MFJD Max and 7DADM statistics
3. SSN models and spatial scale
4. SSN models and temporal scale

1. Temperature statistics

Three water quality temp statistics we've worked w/

1. Mean
2. Maximum
3. 7DADM

NorWeST: Mean and growing season MWMT

SSN: predict any statistic

Max and 7DADM not as well predicted as mean

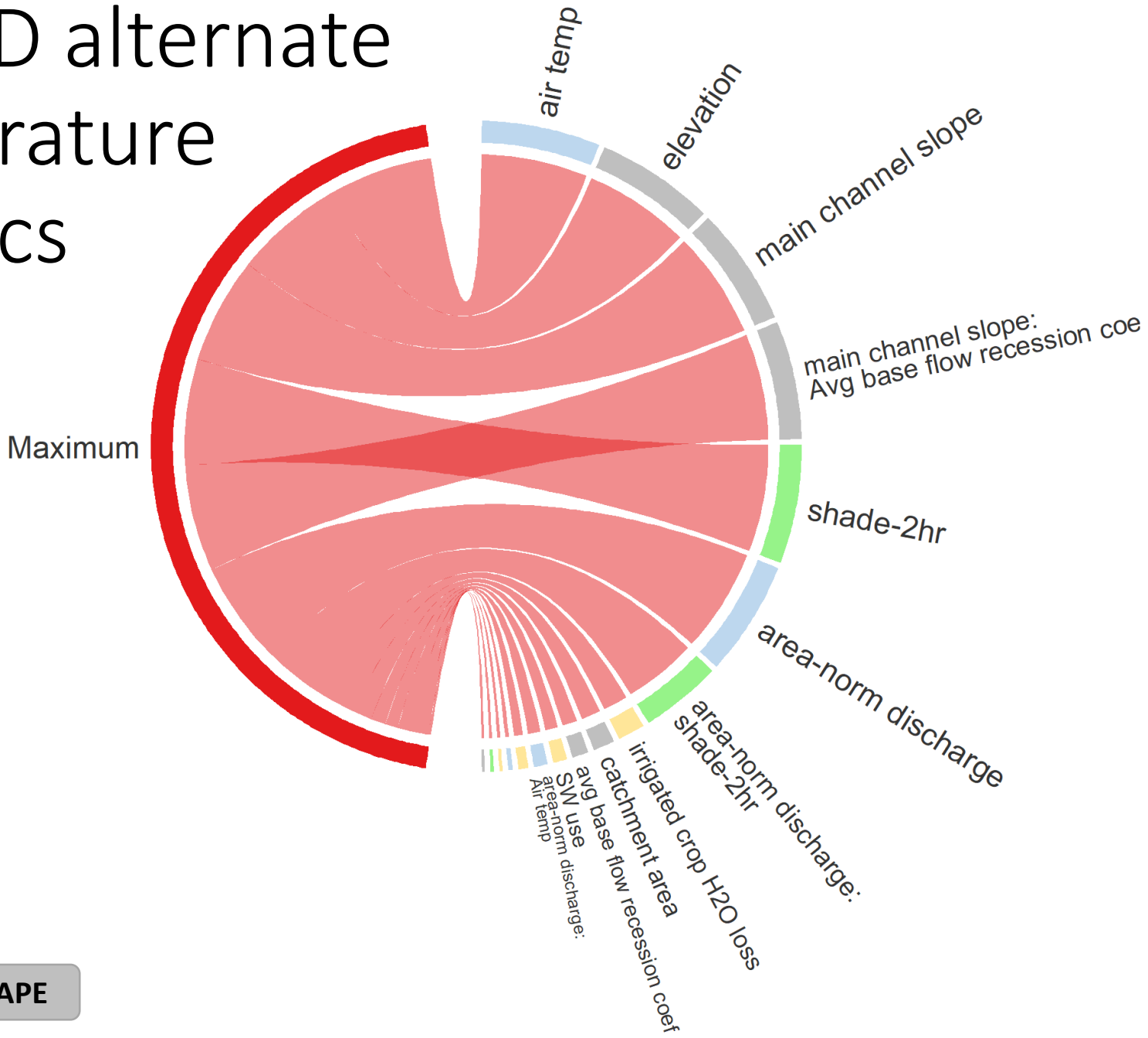
2. MFJD alternate temperature statistics

Built SSN models for maximum and 7DADM

Used same process and covariates as for mean

Derived different suites of models/covariates

2. MFJD alternate temperature statistics



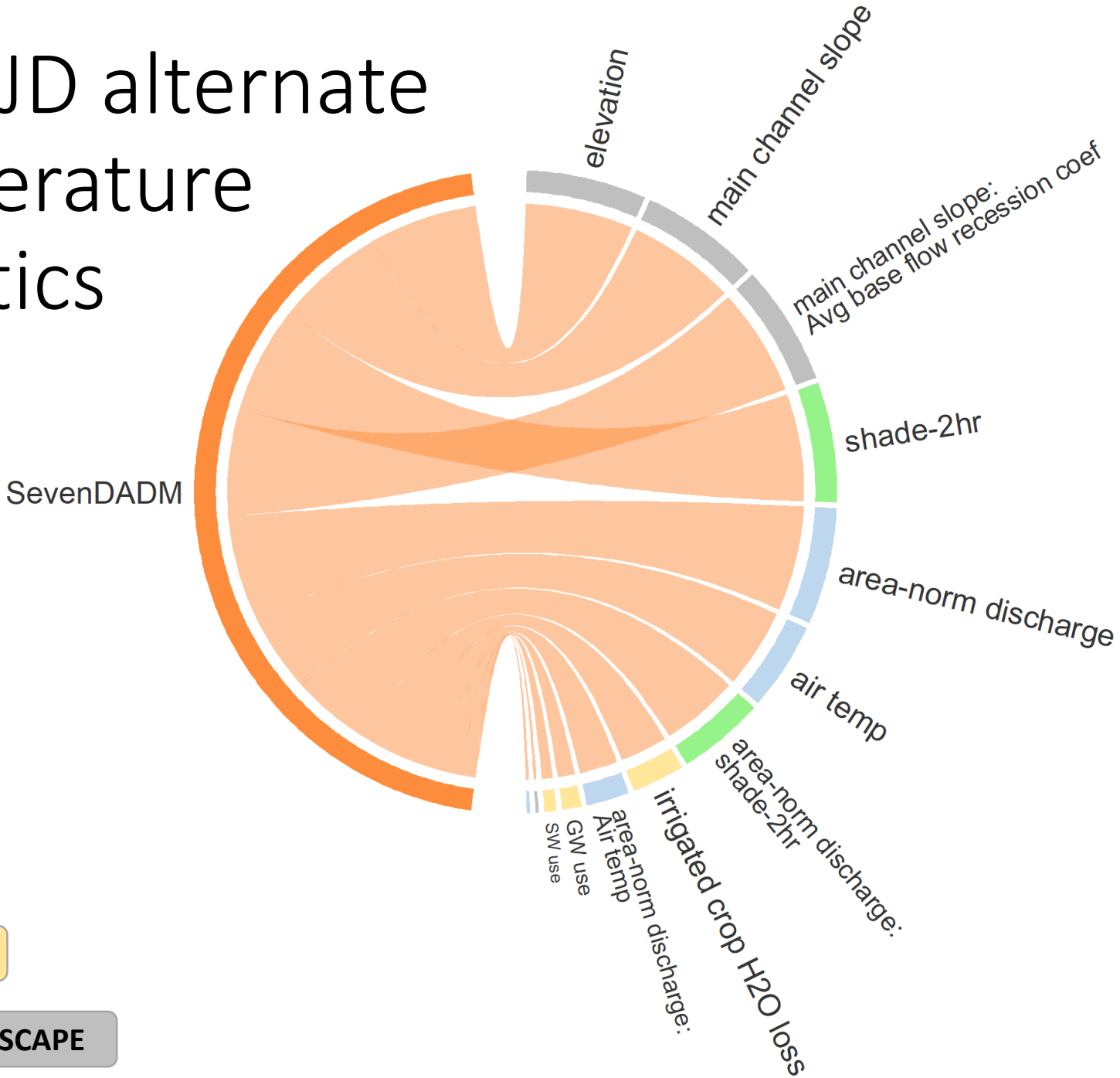
SHADE

CLIMATE

MANAGEMENT

PHYSICAL LANDSCAPE

2. MFJD alternate temperature statistics



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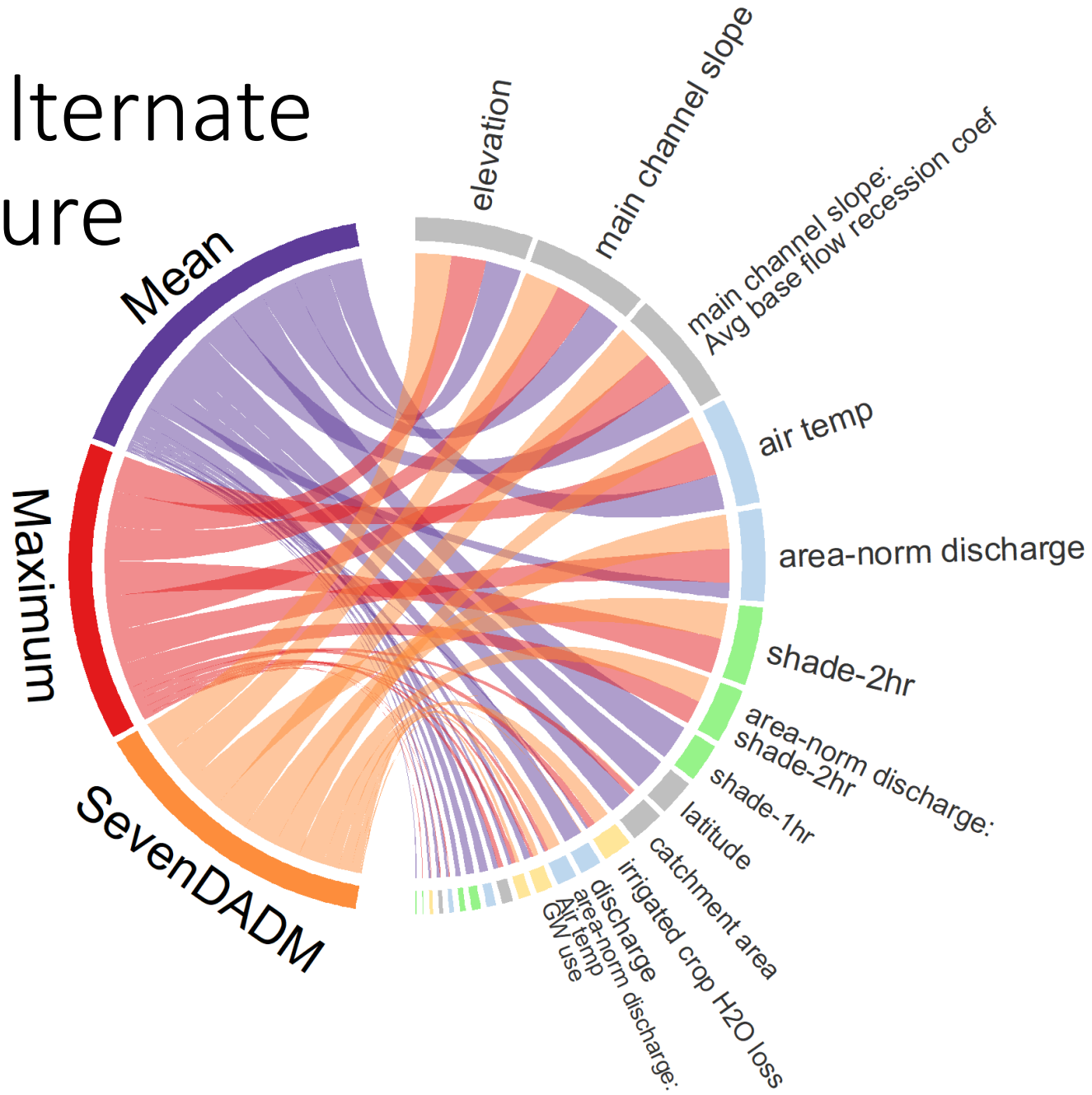
2. MFJD alternate temperature statistics



SHADE

CLIMATE

MANAGEMENT

PHYSICAL LANDSCAPE

2. MFJD alternate temperature statistics: Covariate Relative Importance

For ALL three temperature statistics:

Elevation | Air temp → NorWeST

Main channel slope | Main channel slope : Avg base flow rec. coef.

Shade of some kind

Flow of some kind

Differences Between Temperature statistics:

Mean	Maximum	7DADM
Shade – 1hr	Shade – 2hr	Shade – 2hr
Discharge or Area normalized discharge	Area Normalized Discharge	Area Normalized Discharge
Latitude	Irrigated crop water loss	Irrigated crop water loss
Drainage Area		

2. MFJD alternate temperature statistics

Covariate contributions to predictions

MEAN

Fixed_Effects	Raw_Est	Raw_SE	Std_Est	Std_SE	t.value	p.value
(Intercept)	14.72	0.1644	14.72	0.1644	89.55	0
mnAT.s	0.0028	0.0596	1.066	0.1346	7.918	0
elev_m.s	-0.0103	0.2154	-2.104	0.2261	-9.306	0
y_coord.s	Inf	0.2553	0.5162	0.2527	2.043	0.0424
cmsQkm2.s	-50458	125.5	-0.5235	0.22	-2.38	0.0182
mcslope.s	-0.0017	0	-1.118	0.2049	-5.458	0
shd_cur_01hr.s	-1e-04	0	-1.666	0.217	-7.678	0
mcslope.s:bfrcavg.s	-Inf	7.074	-2.016	0.4152	-4.856	0

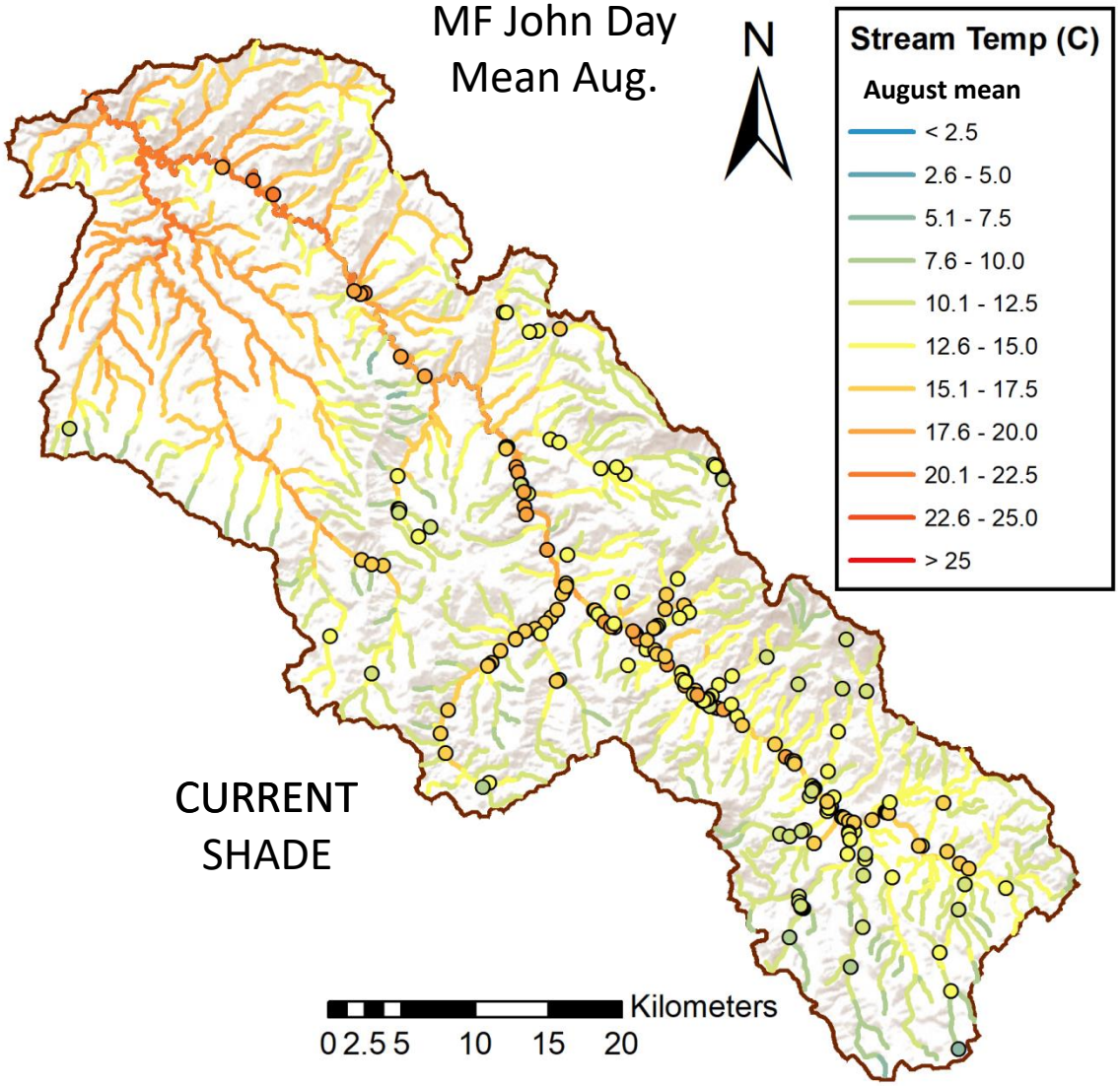
7DADM

Fixed_Effects	Raw_Est	Raw_SE	Std_Est	Std_SE	t.value	p.value
(Intercept)	21.06	0.2573	21.06	0.2573	81.84	0
mnAT.s	0.001	0.2307	0.3834	0.2422	1.583	0.115
elev_m.s	-0.0148	0.4964	-3.018	0.4913	-6.144	0
mcslope.s	-Inf	207.8	-2.202	0.364	-6.048	0
cmsQkm2.s	-185042	0	-1.92	0.401	-4.787	0
shd_cur_02hr.s	-0.004	0	-2.663	0.4658	-5.718	0
crop.s	0	8.42	-0.6296	0.4942	-1.274	0.2041
mcslope.s:bfrcavg.s	-Inf	9.71	-3.713	0.8864	-4.189	0
cmsQkm2.s:shd_cur_02hr.s	0.6383	0.1755	1.441	0.727	1.983	0.0488

3. SSN models and spatial scale

Spatial coverage is where SSN models excel

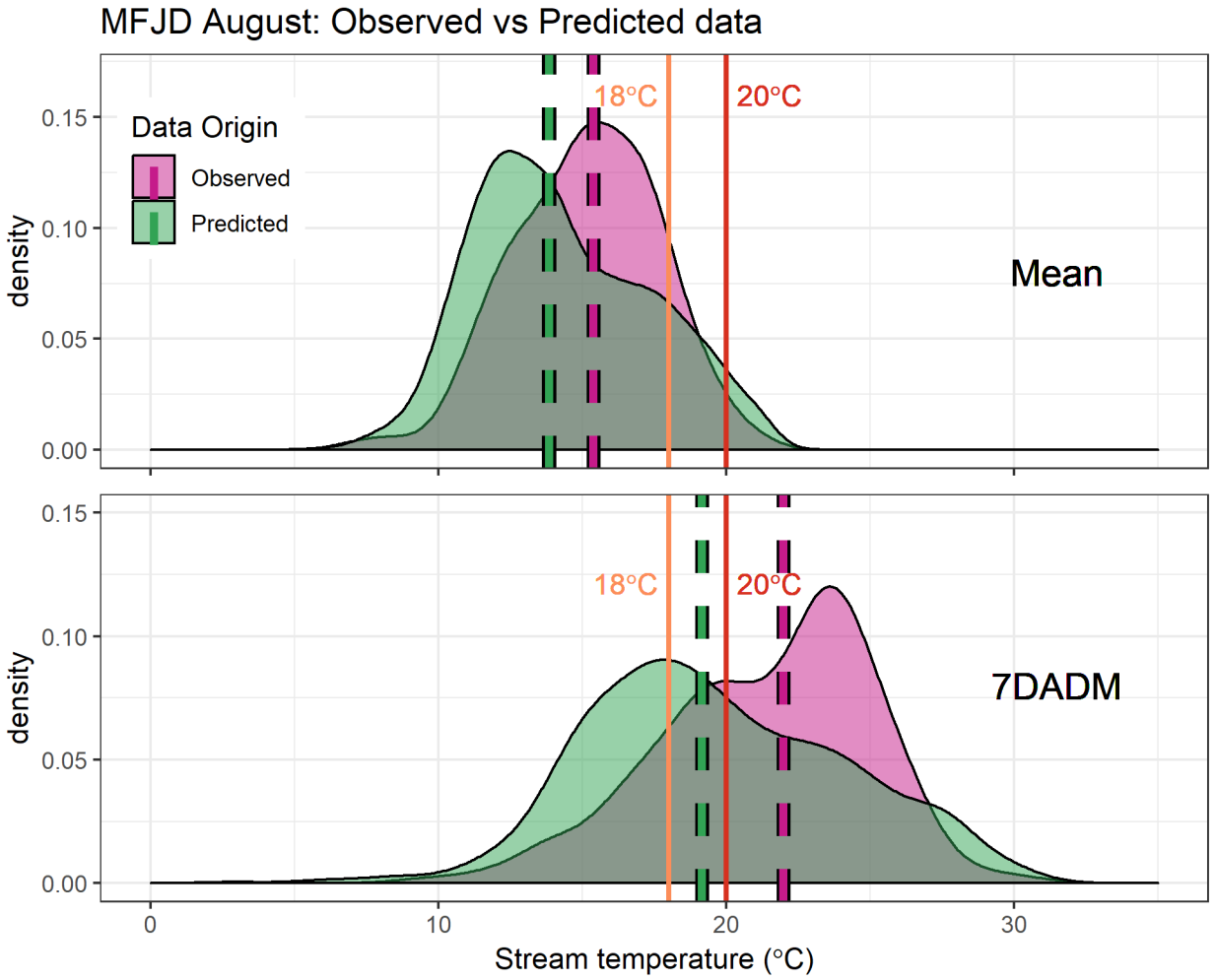
predictions where data do not exist



3. SSN models and spatial scale

Distribution and statistic comparison between *in situ* observed and predicted temperatures

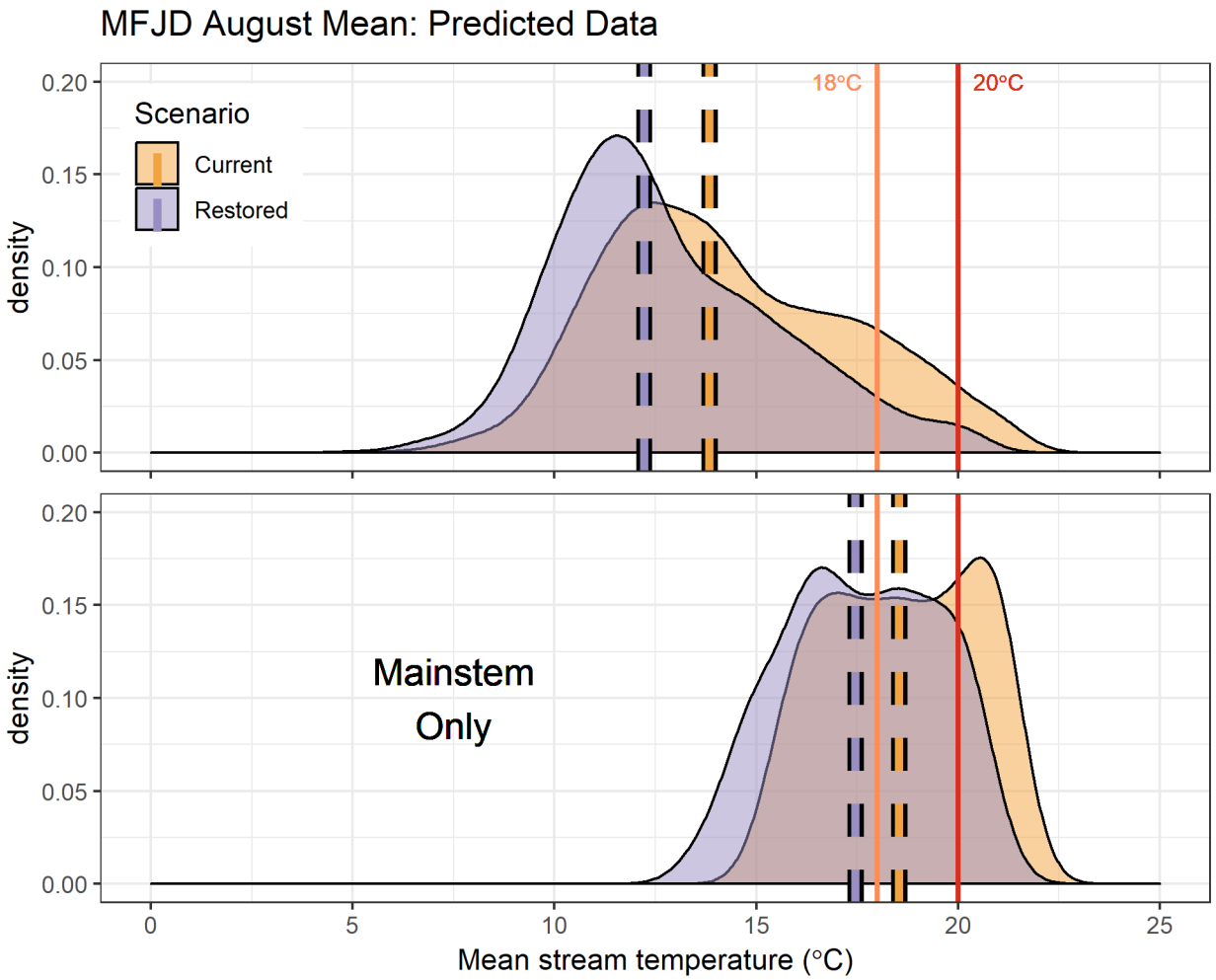
Different shapes and statistics



3. SSN models and spatial scale

Distribution comparison between management predictions

- Current vs restored shade
- Network vs mainstem



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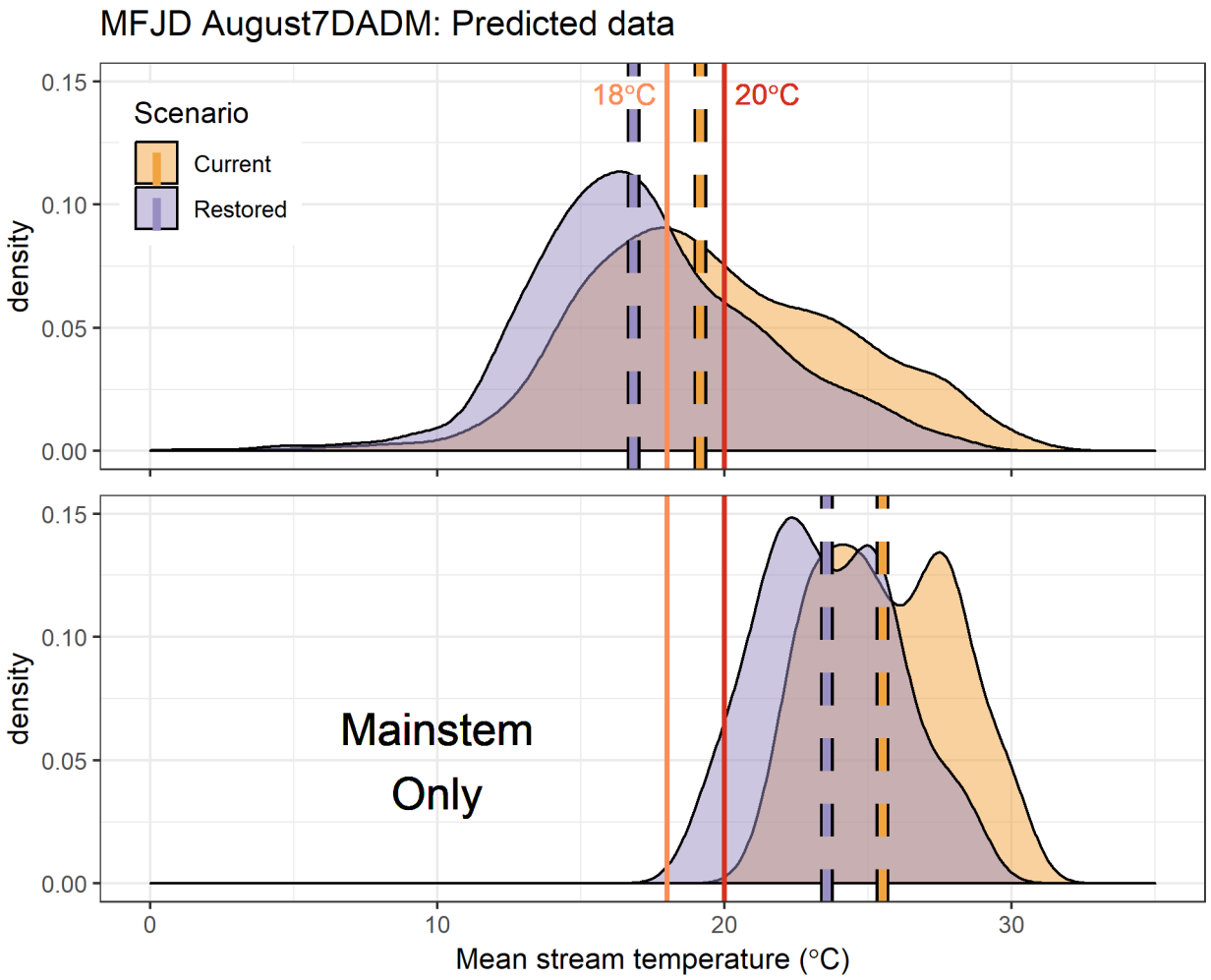


3. SSN models and spatial scale

SSN models can predict locations where downstream warming trends are violated (cool patches)

SSN models provide information about areas new in situ loggers are needed

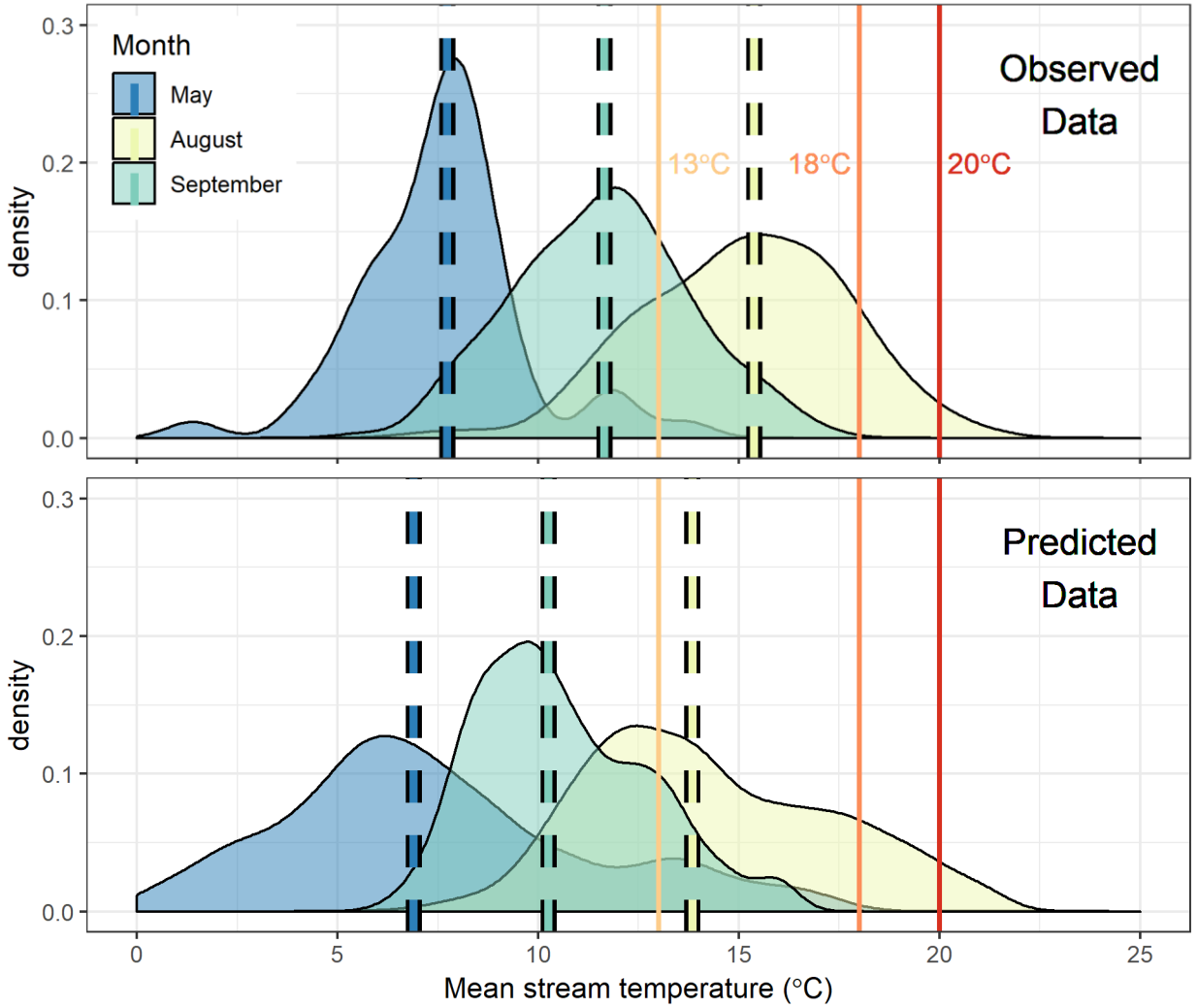
Dendritic connectivity index can characterize the connectivity of a network for different temperature thresholds

4. SSN models and temporal scale

Distributions across time

Different distribution shapes

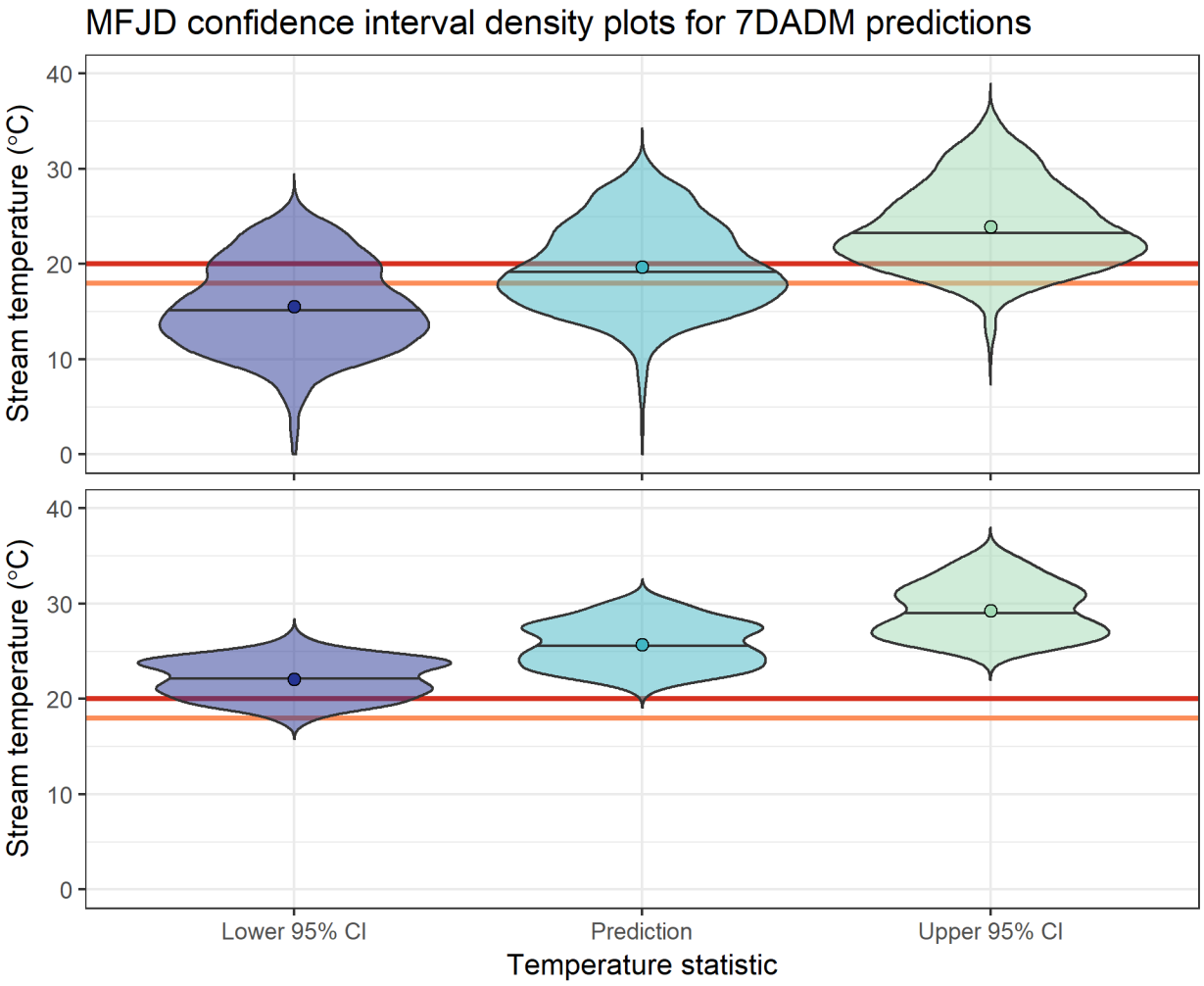
Observed vs predicted



SSN models and exceedance

7DADM criteria exceedance

Network vs Mainstem



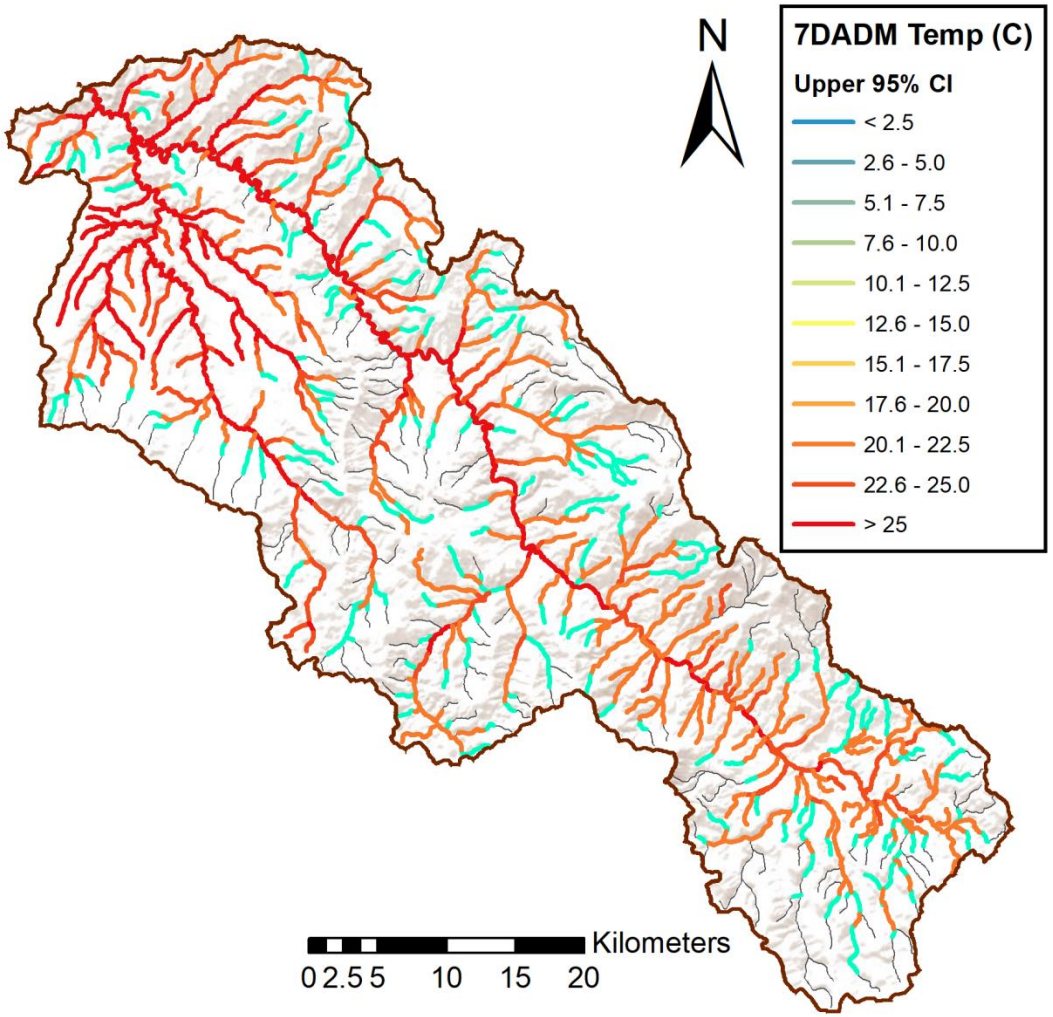
SSN models and exceedance

7DADM criteria exceedance

Current

Vs

Restored



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4. SSN models and temporal scale

Other temporal thermal regime analyses to explore

wavelet analysis

(Steel et al. 2016 JAWRA)

TABLE 1. Stream Temperature Metrics Used in Our Analysis. The wavelet variance metrics decompose the variability of a time series into increasing temporal scales.

Metric Name	Description	Facet
AWAT	Average of all average weekly temperatures	Mean
MWAT	Maximum of all average weekly temperatures	Maximum
MWMT	Maximum of all weekly maximum temperatures	Maximum
mWAT	Minimum of all average weekly temperatures	Minimum
VAR	Empirical variance of the time series	Across-day variance
AvgDelT	Average daily temperature range	Within-day variance
Wv1.5 h	1.5 h wavelet variance	Within-day variance
Wv3 h	3 h wavelet variance	Within-day variance
Wv6 h	6 h wavelet variance	Within-day variance
Wv12 h	12 h wavelet variance	Within-day variance
Wv1 day	1 day wavelet variance	Across-day variance
Wv2 day	2 day wavelet variance	Across-day variance
Wv4 day	4 day wavelet variance	Across-day variance

Traditional statistics

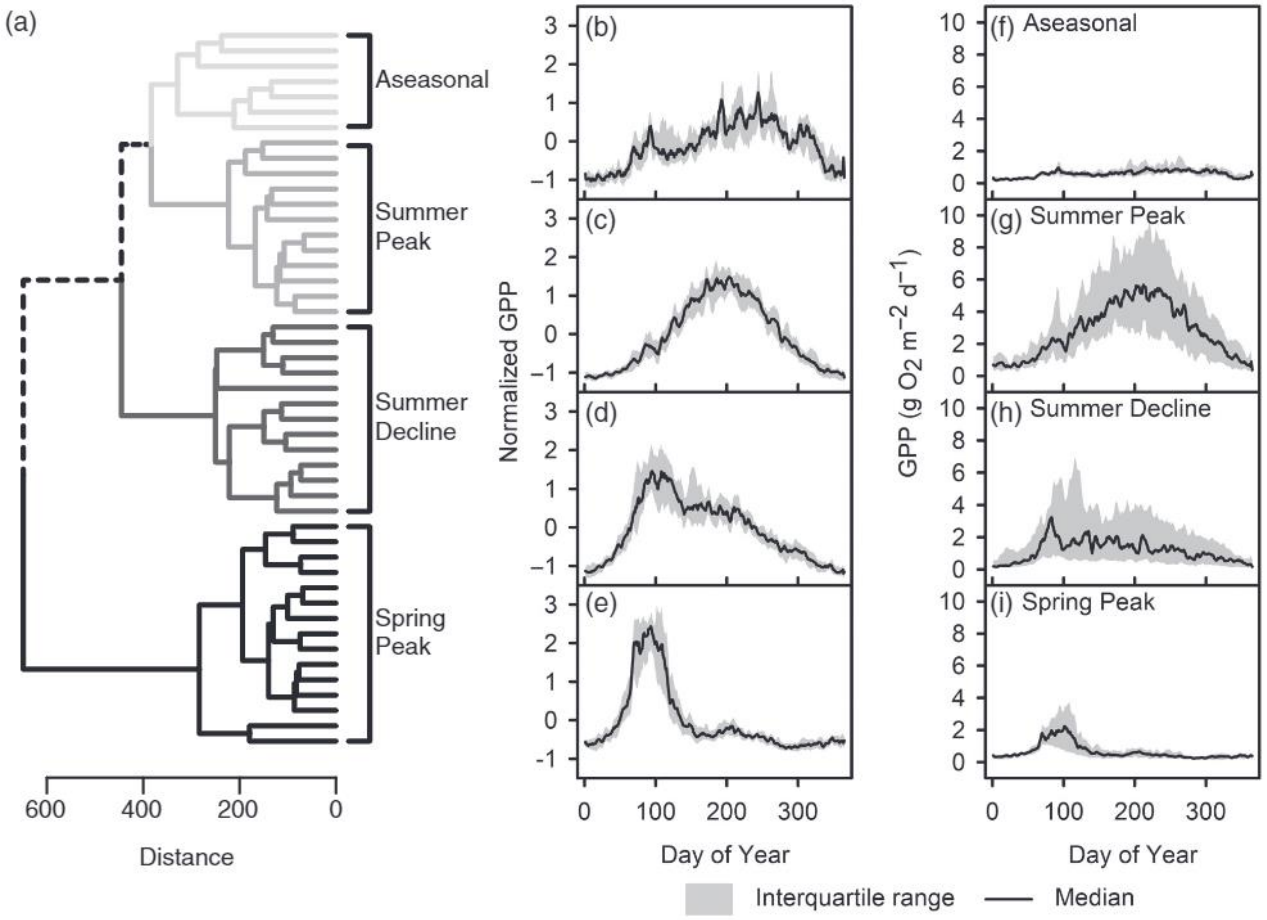
New wavelet statistics

4. SSN models and temporal scale

Other temporal thermal regime analyses to explore

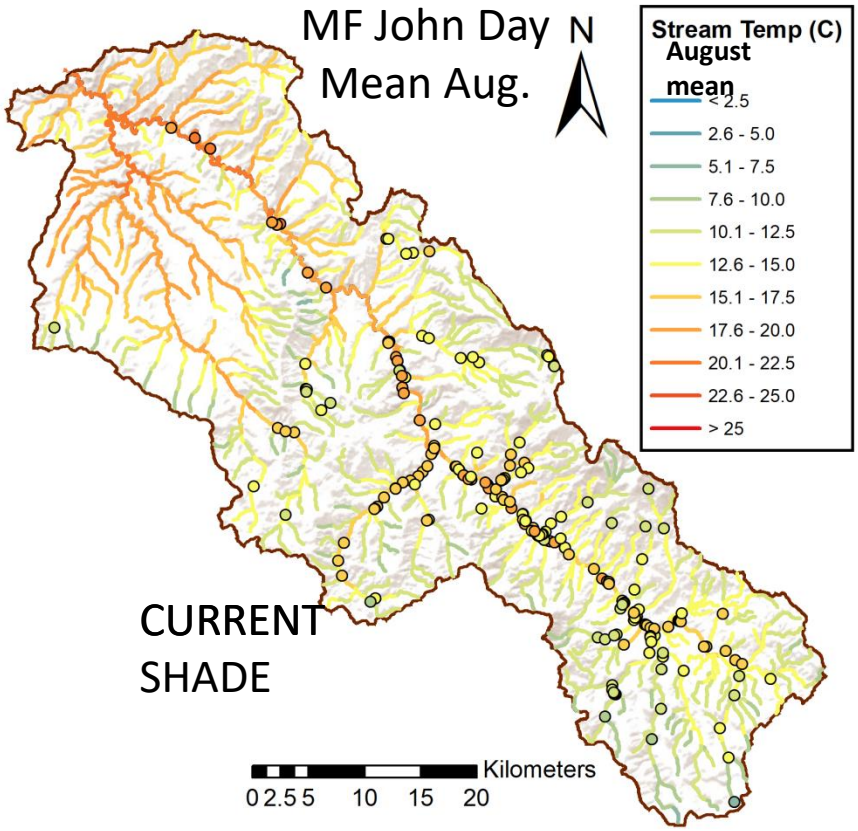
dynamic time warping and clustering

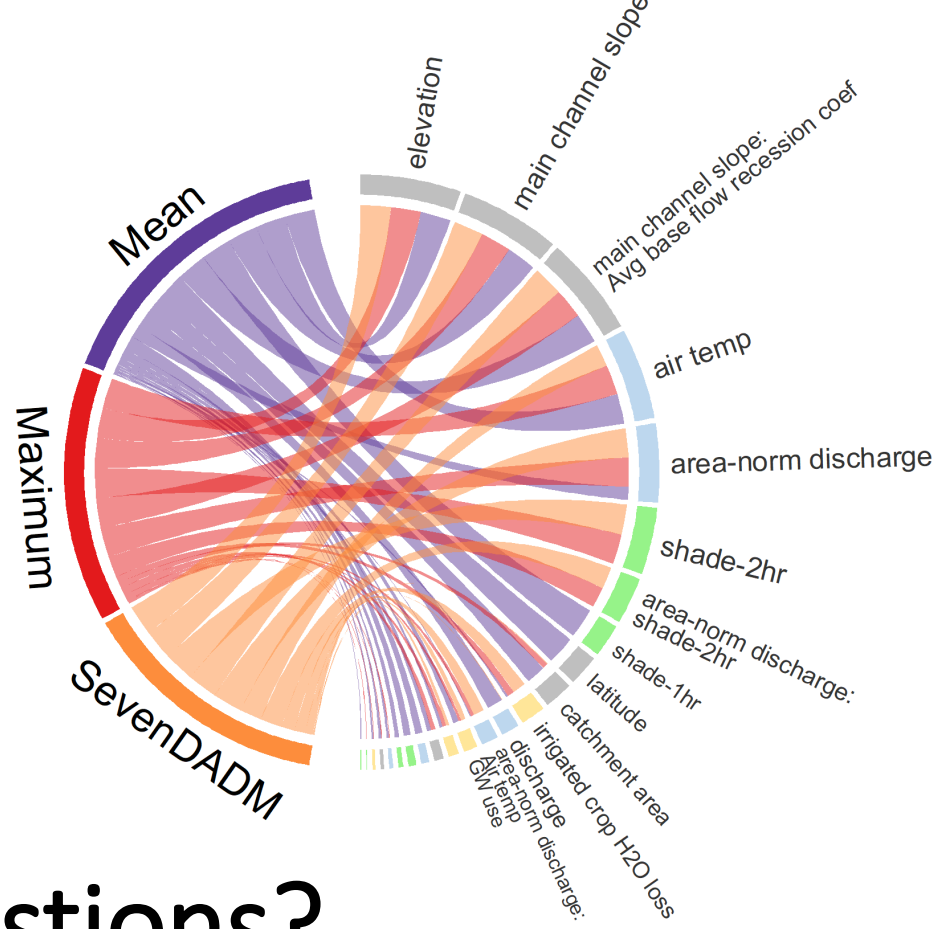
Savoy et al. 2019 L&O (metabolism paper, but methods could be used for thermal regimes too)



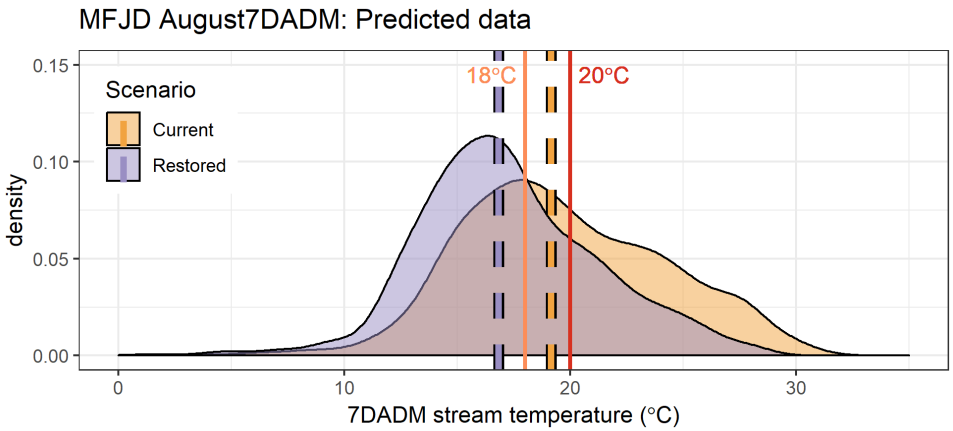
Recap

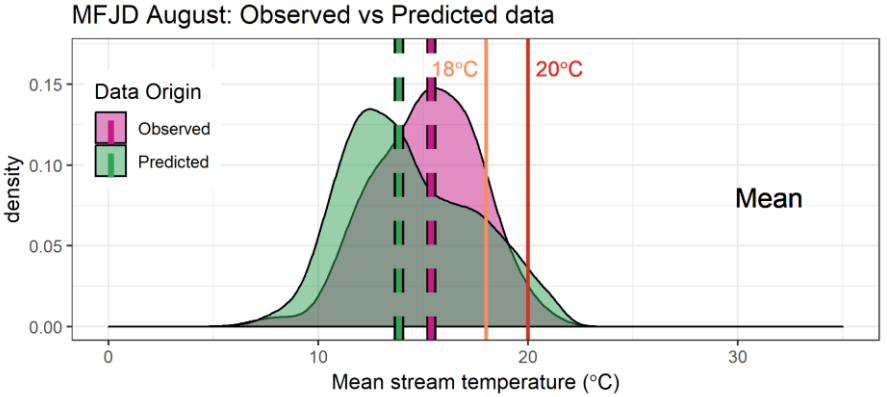
- SSN can be used with a variety of temp stats
- SSN advantages are in their spatial coverage and what can be done with prediction status maps
- SSN disadvantages are in their temporal coverage, but possible to overcome with the right data and methods


MF John Day
Mean Aug.
N
Stream Temp (C)
August
mean
< 2.5
2.6 - 5.0
5.1 - 7.5
7.6 - 10.0
10.1 - 12.5
12.6 - 15.0
15.1 - 17.5
17.6 - 20.0
20.1 - 22.5
22.6 - 25.0
> 25
CURRENT
SHADE
Kilometers
0 2.5 5 10 15 20


Mean
Maximum
SevenDADM
elevation
main channel slope
main channel slope:
Avg base flow recession coef
air temp
area-norm discharge
shade-2hr
area-norm discharge:
shade-2hr
shade-1hr
latitude
catchment area
irrigated crop H2O loss
discharge
area-norm discharge:
Air temp
GW use

Questions?


MFJD August7DADM: Predicted data
Scenario
Current
Restored
18°C
20°C
density
7DADM stream temperature (°C)


MFJD August: Observed vs Predicted data
Data Origin
Observed
Predicted
18°C
20°C
Mean
density
Mean stream temperature (°C)