Comparison of WRTDS and GAMs for evaluating long-term trends in chlorophyll

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October 16, 2015

Since the last call...

- Application of GAMs and WRTDS to 30 year time series of monthly chlorophyll at LE1.2 and TF1.6
- Development of comparable methods for model fitting
- Development of simulated datasets to evaluate flow-normalization
- Comparison of results and conclusions

Model applications

Both models used Vertically-integrated chlorophyll, monthly timestep

LE1.2: lnchla time + ***salinity***

TF1.6: lnchla time + ***flow***

Fits evaluated for whole time series and annual/seasonal/flow aggregations:

- predicted to observed, GAM predicted to WRTDS predicted
- Trends in flow-normalized results

Model fitting and flow-normalization

Objective: compare model fits

Problem: Need methods to prevent over-fitting and to compare apples-to-apples

GAMs - identify optimal degrees of freedom for smoothing parameters

WRTDS - identify optimal window widths for time, discharge (salinity or flow), and season

Existing method for GAMs, k-fold cross-validation and search algorithm ('limited memory BFGS quasi-Newton method') to identify window-widths for WRTDS

Basically, a statistical infrastructure to 'automatically' fit the best model given the dataset

Development of simulated datasets

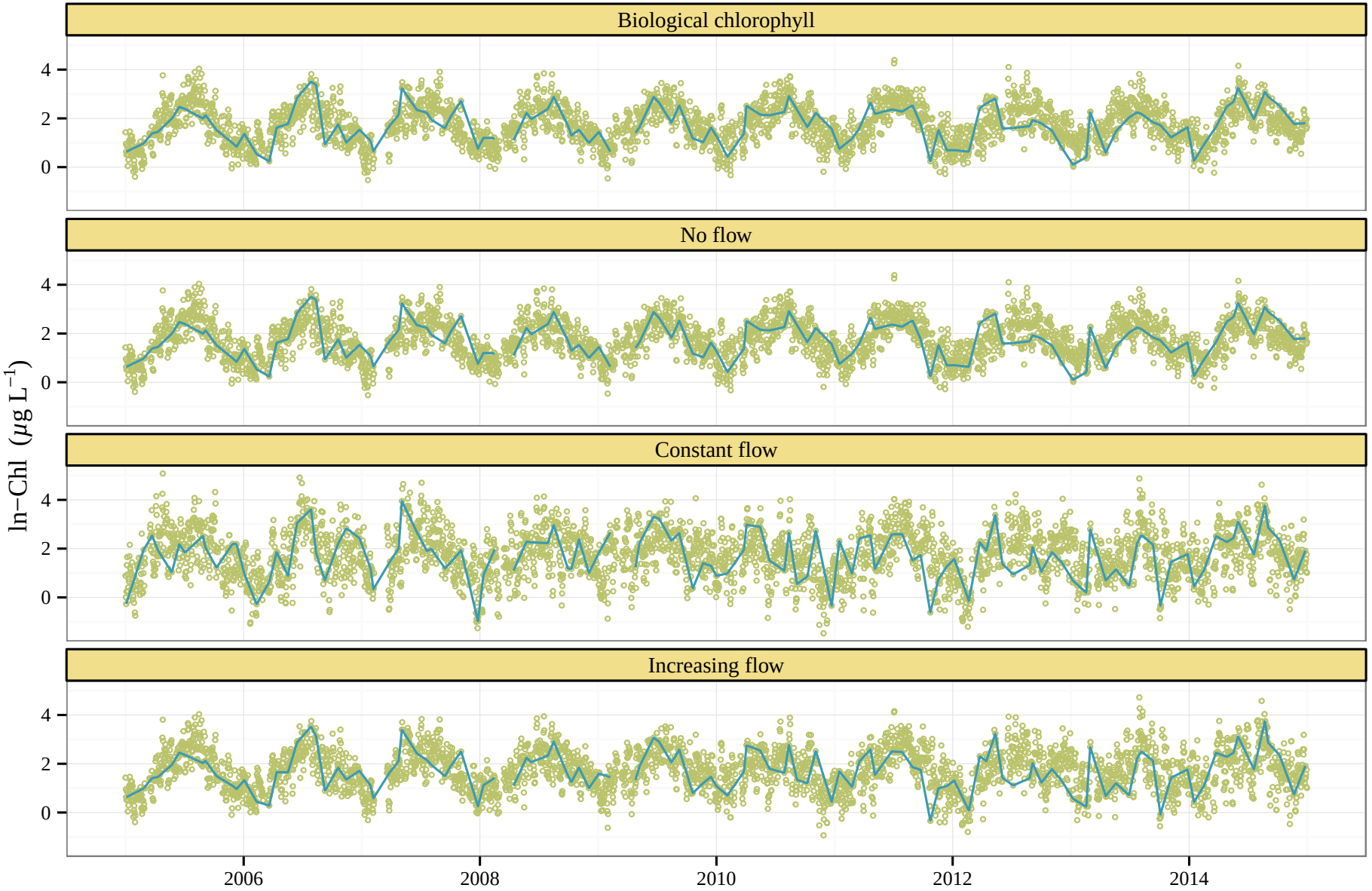
Objective: evaluate ability of each model to reproduce flow-normalized trends

Problem: The true flow-normalized trends are not known and can only be empirically estimated

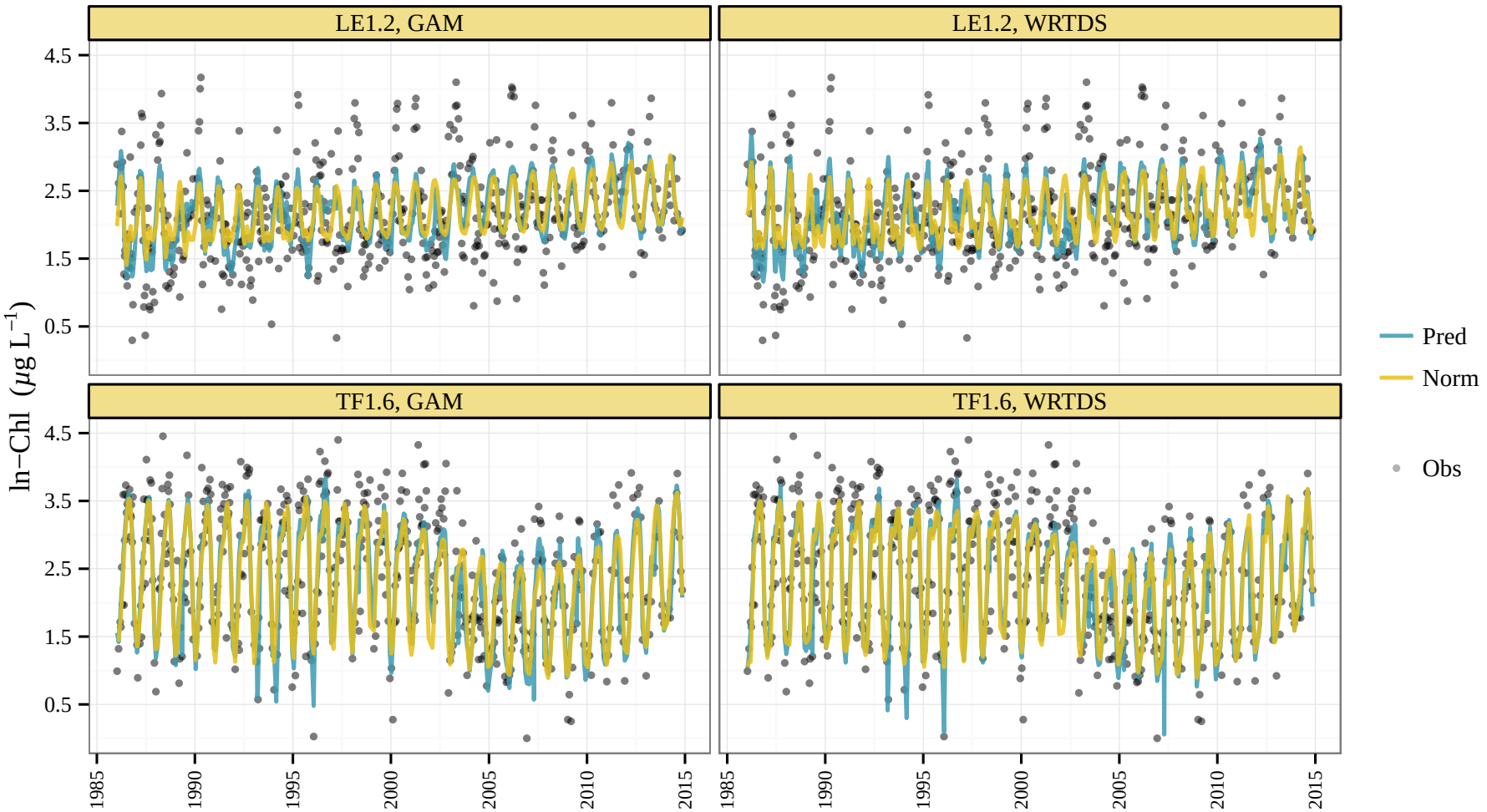
We created monthly simulated datasets following the general technique in Hirsch et al. 2015 (sec. 4, MC simulations)

- Actual daily time series: discharge from Bowie gage, Jug Bay fluorescence
- Overall: $Chl_{obs} = Chl_{flo} + Chl_{bio}$
- From discharge: $Chl_{flo} = I\left(\widehat{Q}_{seas} + \sigma \cdot \varepsilon_{Q,\,sim}\right)$
- From fluorescence: $Chl_{bio} = \widehat{Chl}_{seas} + \sigma \cdot \varepsilon_{Chl,\,sim}$
- indicator I changes to simulate changing flow component

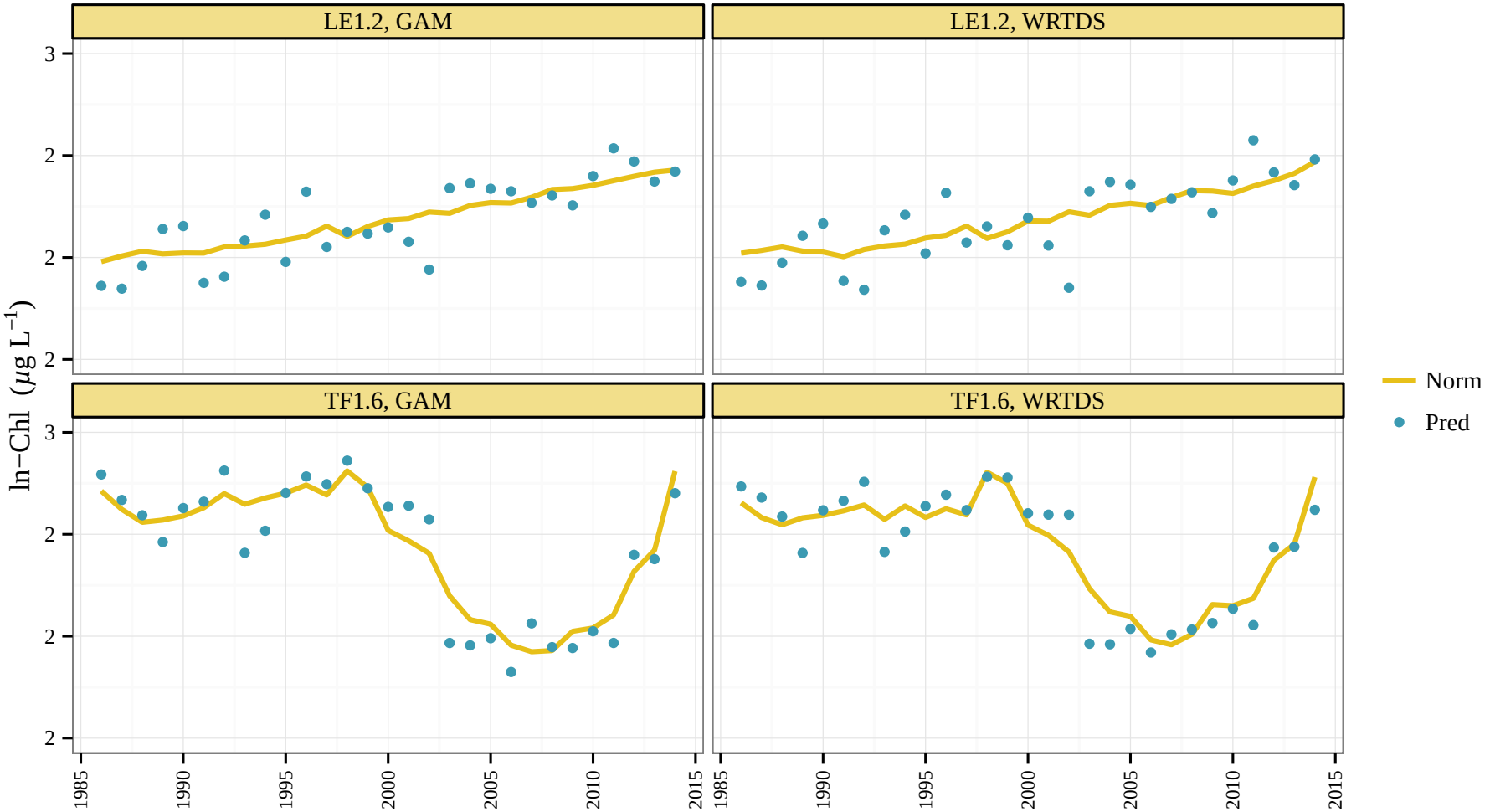
Development of simulated datasets



Results


LE1.2, GAM
LE1.2, WRTDS
TF1.6, GAM
TF1.6, WRTDS
ln−Chl (μg L−1)
4.5
3.5
2.5
1.5
0.5
1985
1990
1995
2000
2005
2010
2015
Pred
Norm
Obs

Results


LE1.2, GAM
LE1.2, WRTDS
TF1.6, GAM
TF1.6, WRTDS
ln−Chl (μg L−1)
3
2
2
2
2
2
1985
1990
1995
2000
2005
2010
2015
Norm
Pred

Results

Table : RMSE of observed to predicted ln-chlorophyll.

Period	LE1.2		TF1.6	
	GAM	WRTDS	GAM	WRTDS
All				
	0.54	0.51	0.54	0.52
Annual				
1986-1993	0.54	0.50	0.53	0.49
1994-2000	0.52	0.50	0.58	0.58
2001-2007	0.63	0.60	0.54	0.53
2008-2014	0.39	0.36	0.49	0.44
Seasonal				
JFM	0.61	0.58	0.53	0.49
AMJ	0.69	0.64	0.60	0.58
JAS	0.38	0.35	0.48	0.46
OND	0.41	0.38	0.55	0.54
Flow				
1 (Low)	0.40	0.36	0.48	0.46
2	0.47	0.42	0.56	0.54
3	0.61	0.57	0.56	0.52
4 (High)	0.64	0.63	0.56	0.54