Spring Flow and Reach Gain Forecasting for Middle Snake River

Update

February 12, 2015

BROCKWAY
ENGINEERING
P.L.L.C.

Recap

- Previous work:
  - Consider annual series (max, min, or average)
  - Develop relationship to hydrologic variables
  - Problem: model stability, verification

Recap

- Current work: paired data approach to forecast spring flows and reach gain
  - Limit model to single groundwater level
  - For each well water level, search ahead in time *n* days for the nearest (in time) spring flow
  - Calculate correlation coefficient
  - Repeat for *n* = 5 to 1830 days (zero to 5 years) with a step of 5 days
  - Find the time lag, *n*, with the maximum correlation
  - Repeat for all wells considered

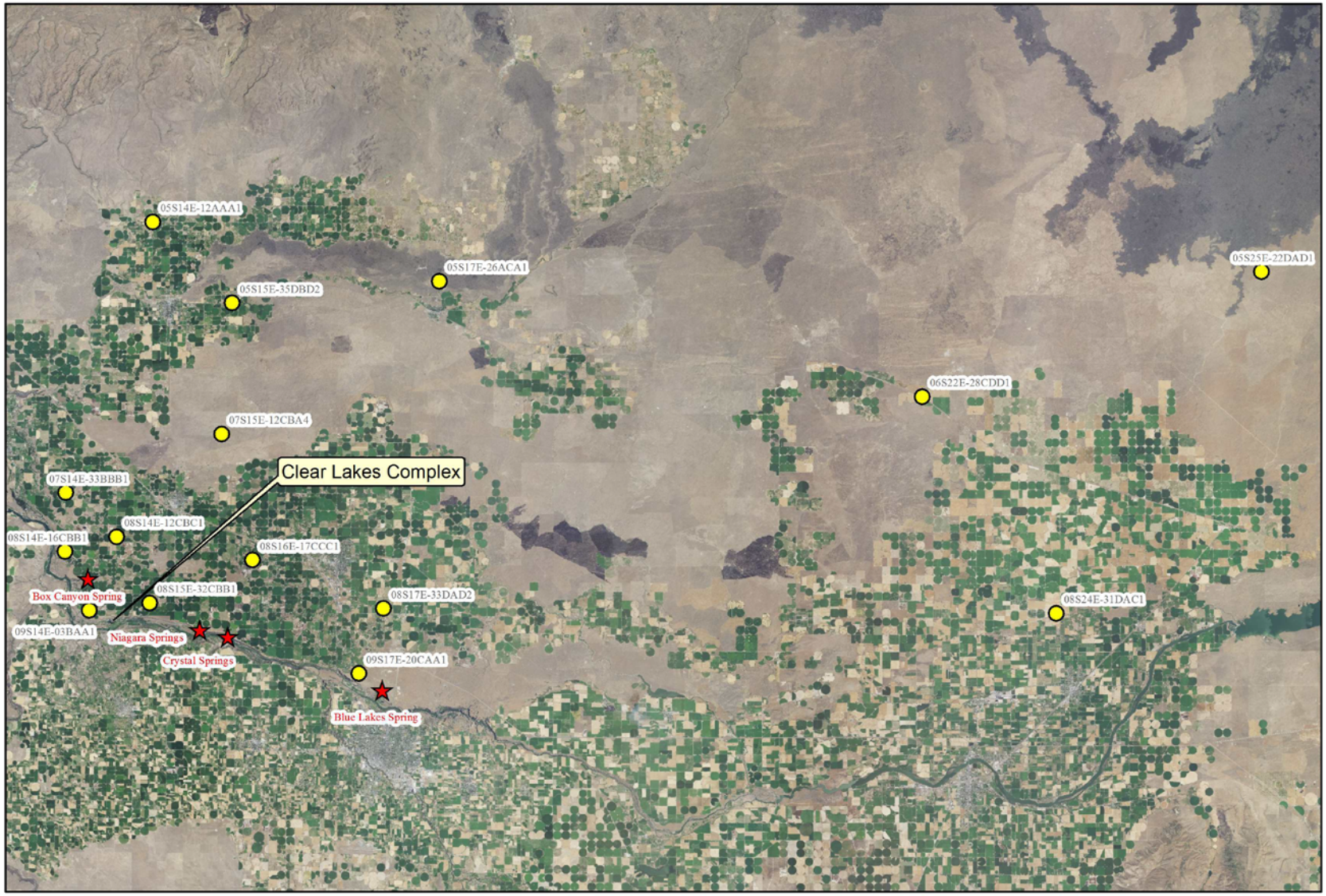
Recap

- Pros and cons
  - Uses all available data (typically early 1980s – 2014)
  - Sample size is large (500 to 2500 data pairs)
  - More robust models
  - Tends to be weighted toward more current data (this is a good thing)
  - Can forecast flows at any time (not limited to annual series)
  - But, generally lower Pearson's correlations
  - Only works for springs or reach gain, not for streamflows

Variables

CSF	Clear Springs Foods weekly flow
Snake River Farm	Snake River Farm spring weekly flow
Crystal	Crystal Springs weekly flow
Box Canyon	Box Canyon Spring daily flow
Blue Lakes	Blue Lakes Spring daily flow
Briggs	Briggs Spring daily flow
RG_KimKH_Min	Kimberly to King Hill reach gain, monthly calc (ESPA targets)
SR_Murphy_Min	Snake River near Murphy, minimum 3-day flow April-October
SR_Murphy_MinWinter	Snake River near Murphy, minimum 3-day flow November-March

Path: F:\Projects\Clear Springs-IPCO Reach Gain\ARCVIEW MAPS\Predictors for optimally - lagged forecast models.mxd



0 3 6 12 Miles

PREDICTORS FOR OPTIMALLY - LAGGED FORECAST MODELS

NAIP 2013 AERIAL

Legend

Observed_Wells

Springs

N

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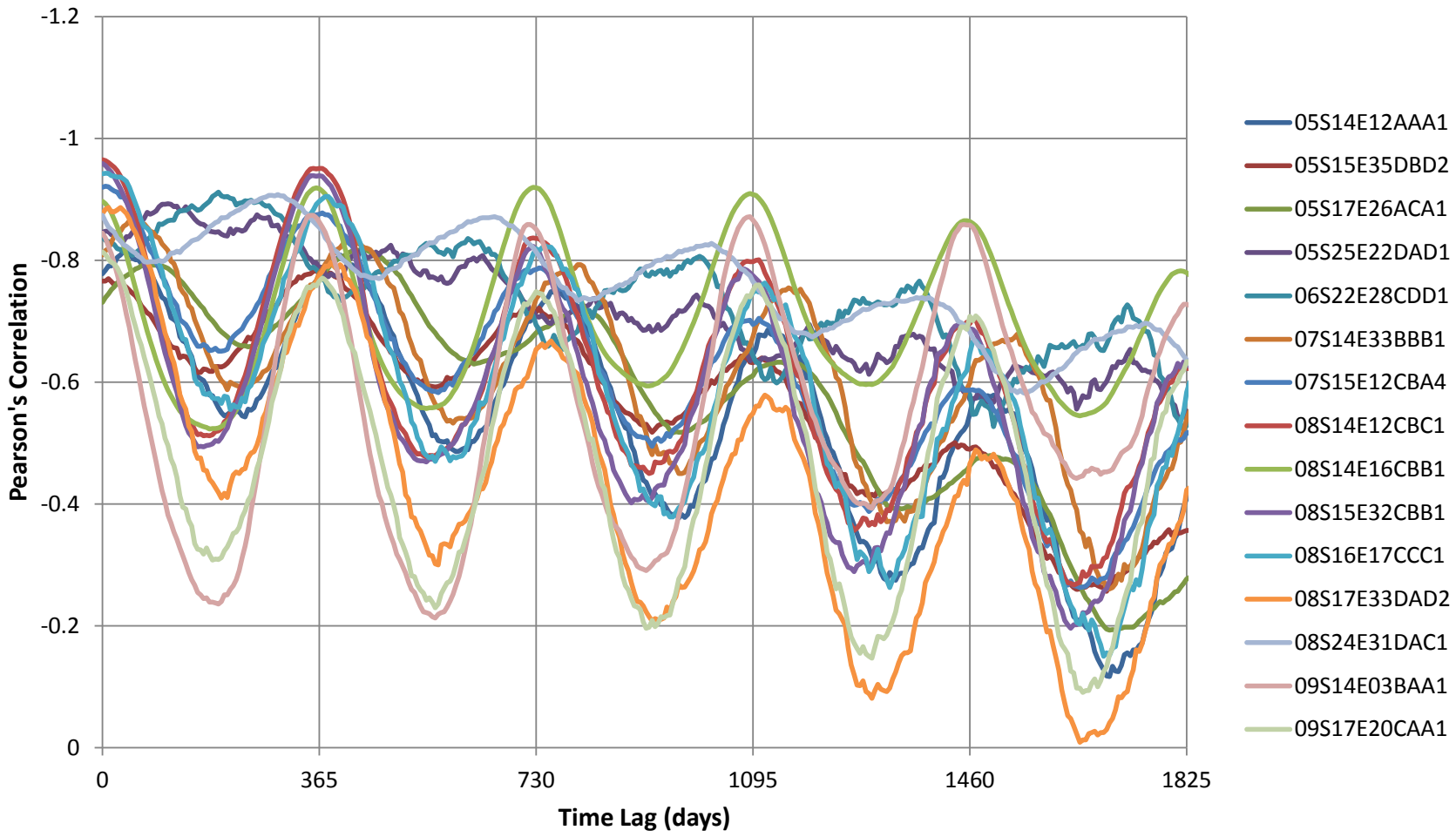
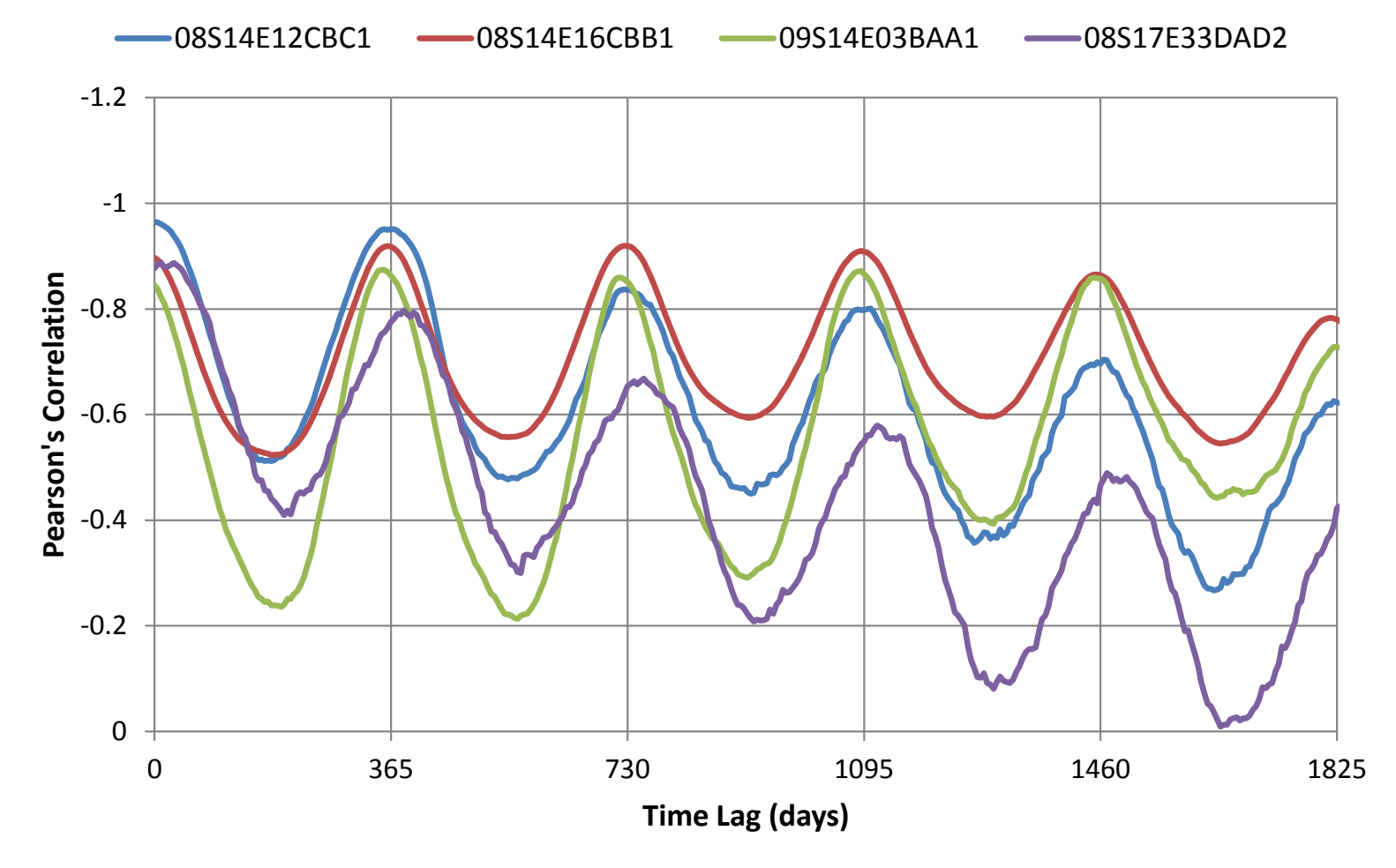
ALR - Date: 2/10/2015

Correlation functions – Clear Springs

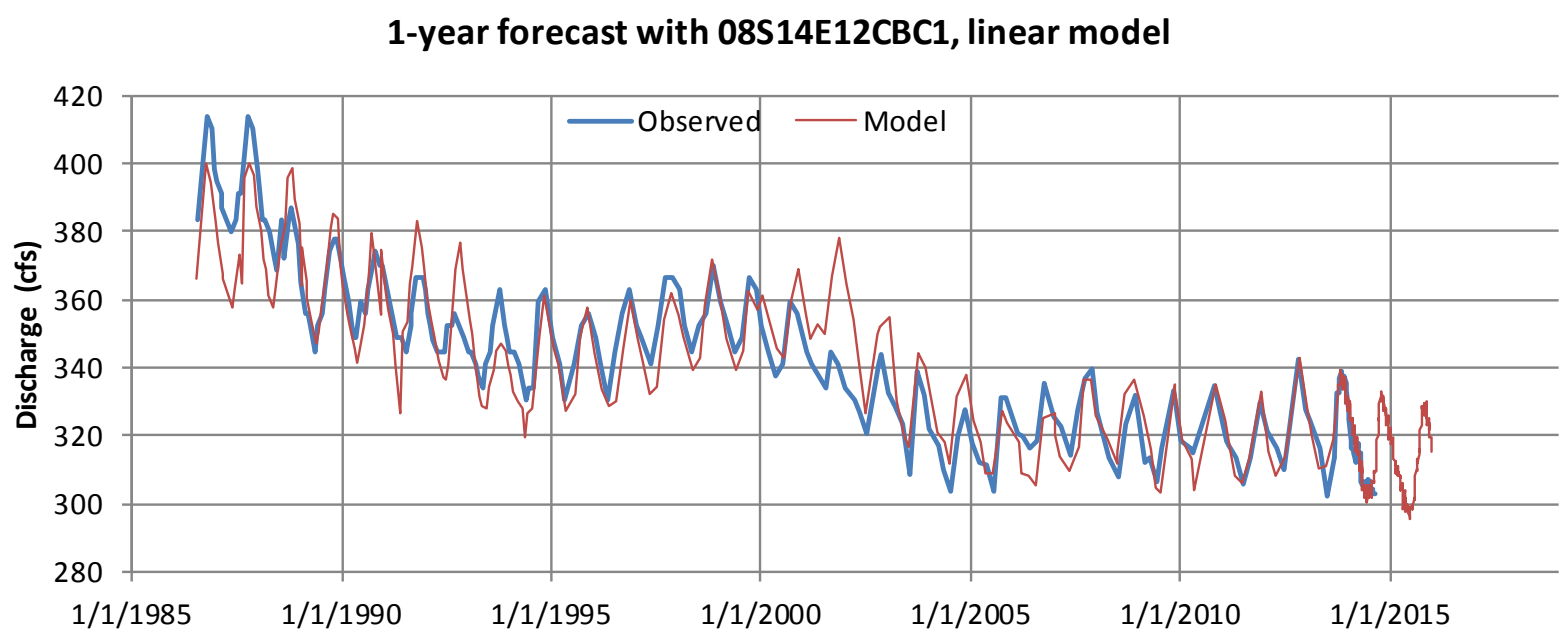


Example correlation functions – Clear Springs



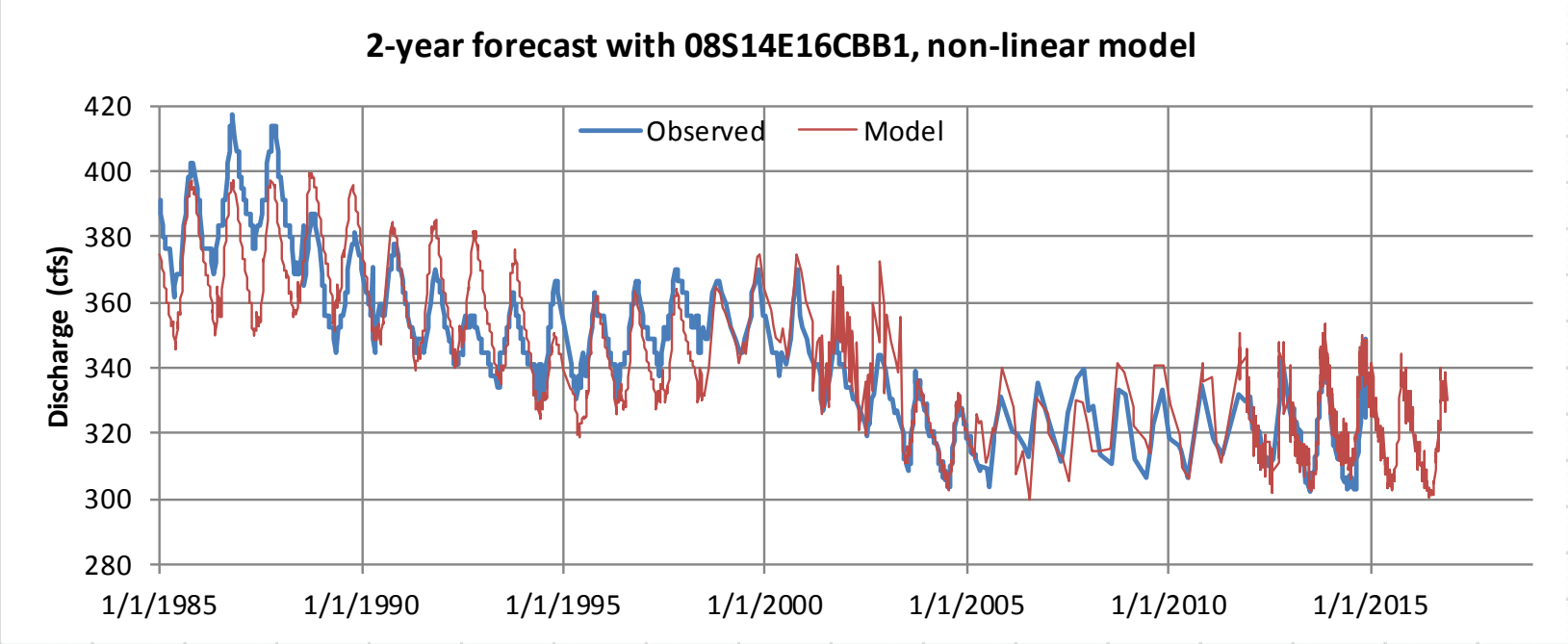
Clear Springs models

Model:	**1-year forecast**
	$Q_t = 816.46 - 6.8081\ z_{t-365}$
Predictand:	Clear Springs daily discharge, 365 days ahead
Predictor:	08S14E12CBC1
Adjusted R-squared:	0.906
SE of estimate:	7.1 cfs



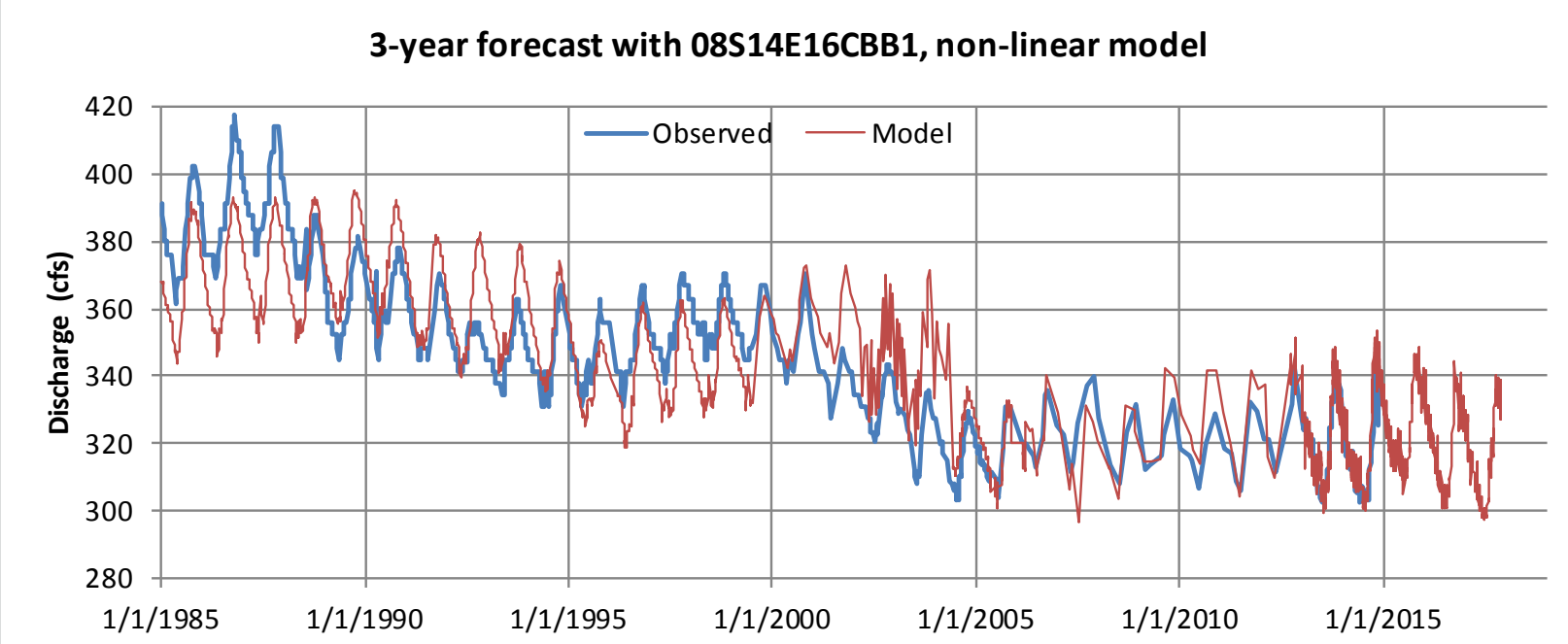
Clear Springs models

Model:	**2-year forecast**
	$Q_t = 4152.28 - 167.567\ z_{t-725} + 1.81789\ z^2_{t-725}$
Predictand:	Clear Springs daily discharge, 725 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.860
SE of estimate:	9.22 cfs



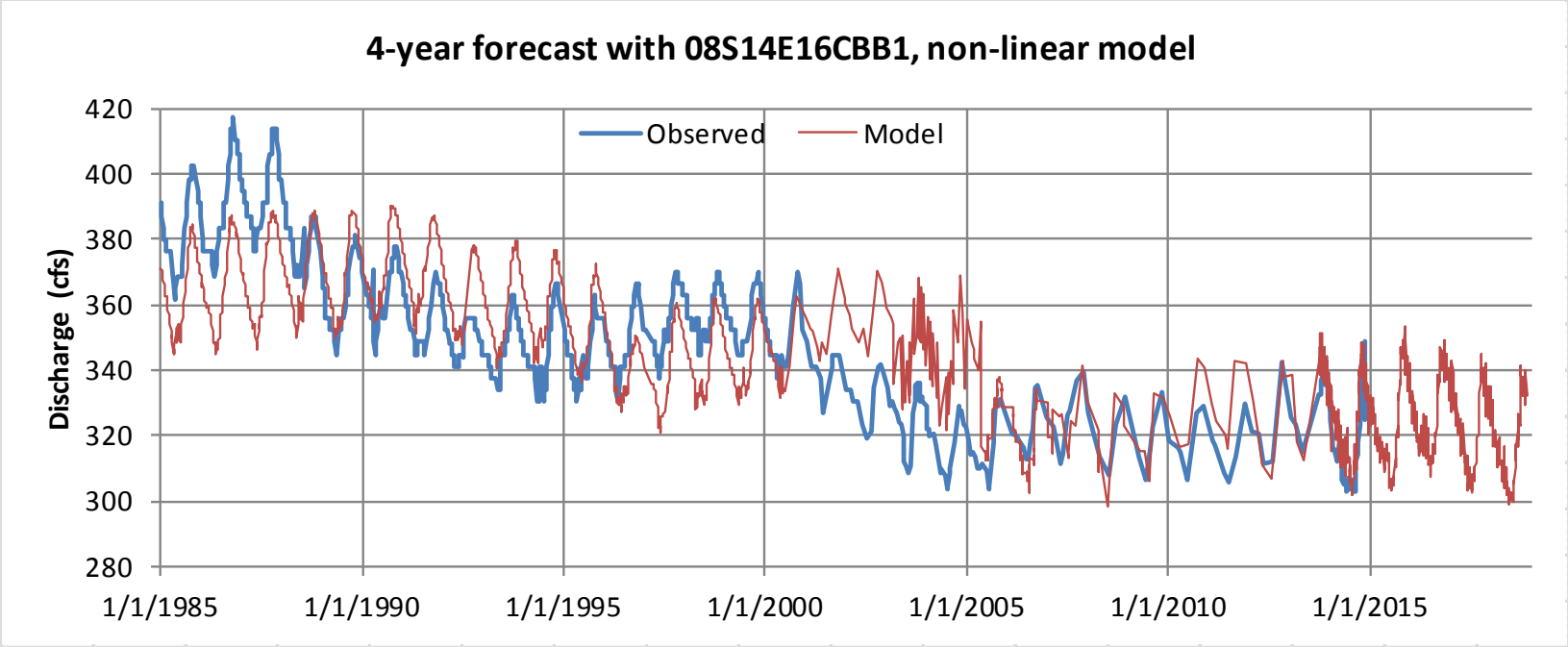
Clear Springs models

Model:	**3-year forecast**
	$Q_t = 3085.79 - 115.858\ z_{t-1090} + 1.19151\ z^2_{t-1090}$
Predictand:	Clear Springs daily discharge, 1090 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.833
SE of estimate:	10.51 cfs



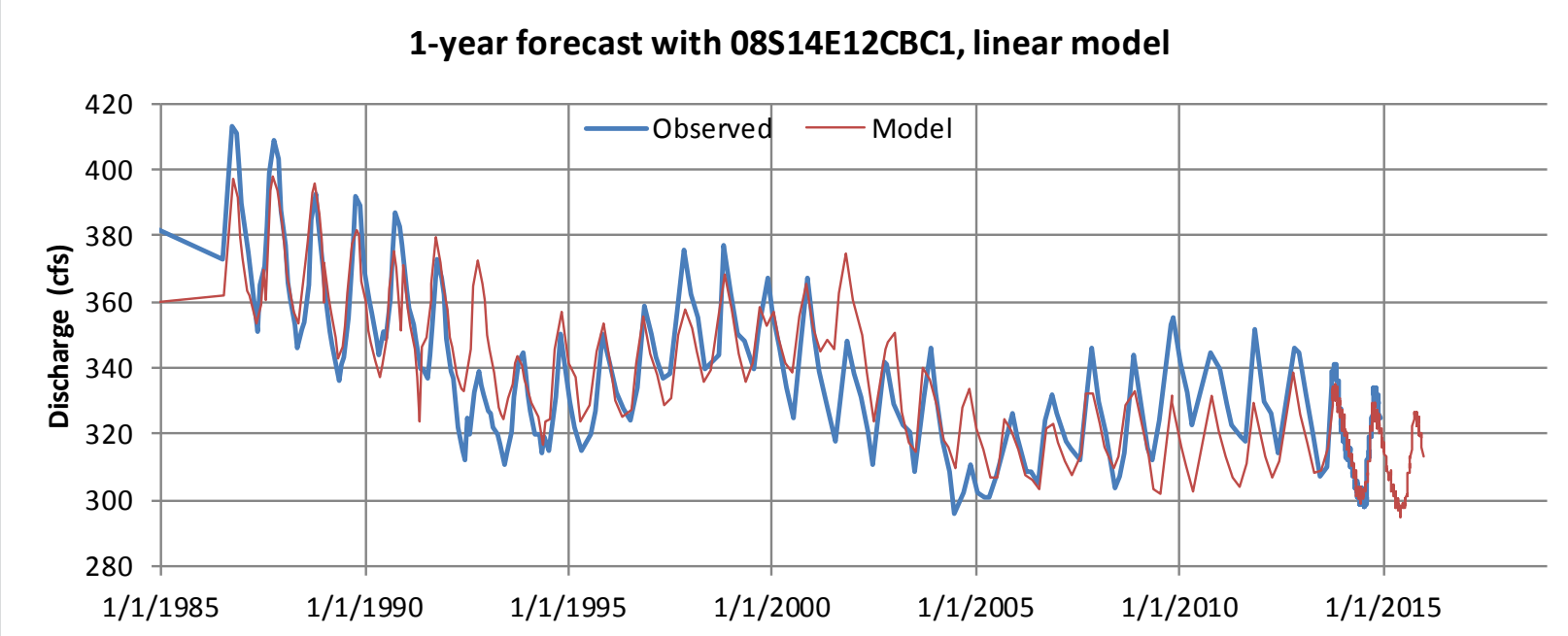
Clear Springs models

Model:	**4-year forecast**
	$Q_t = 2484.22 - 87.7504\ z_{t-1455} + 0.864526\ z^2_{t-1455}$
Predictand:	Clear Springs daily discharge, 1455 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.752
SE of estimate:	12.62



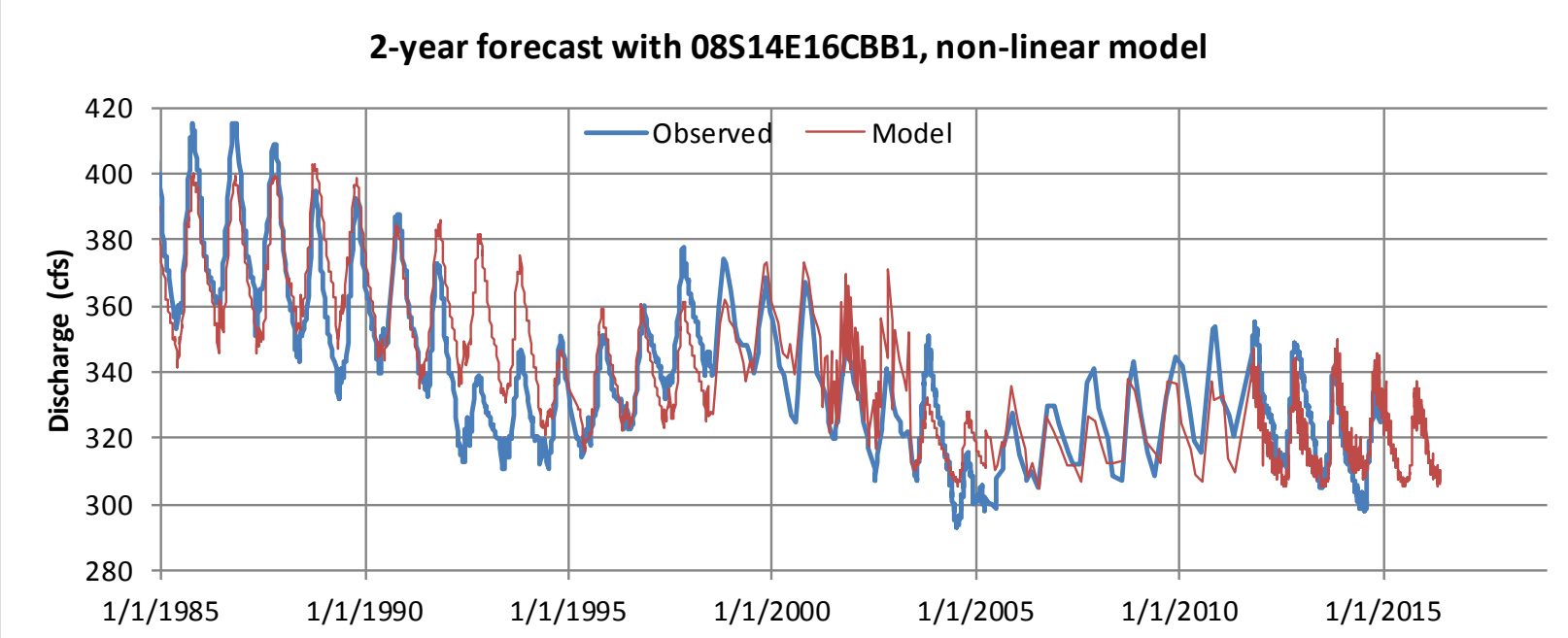
Box Canyon models

Model:	**1-year forecast**
	$Q_t = 1021.69 - 13.017\ z_{t-355} + 0.046028\ z^2_{t-355}$
Predictand:	Box Canyon Spring daily discharge, 355 days ahead
Predictor:	08S14E12CBC1
Adjusted R-squared:	0.860
SE of estimate:	8.1 cfs



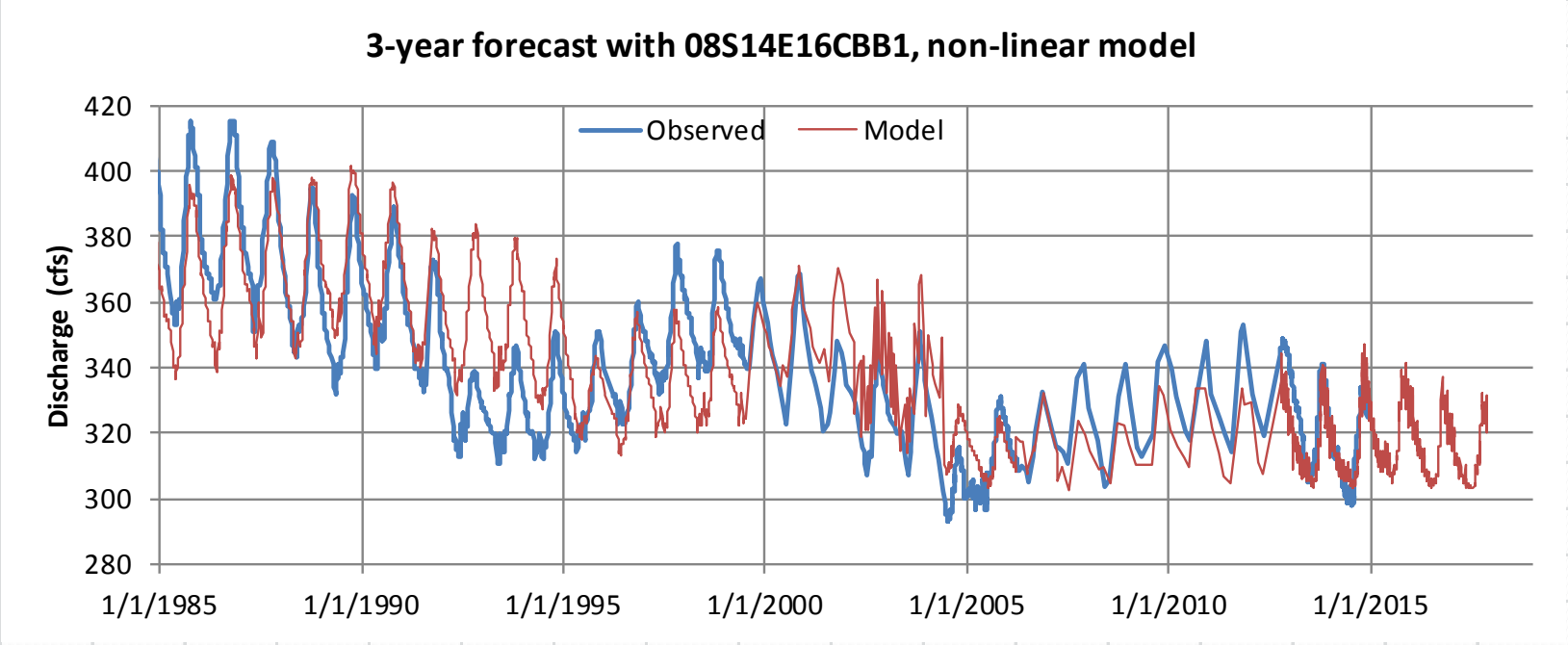
Box Canyon models

Model:	**2-year forecast**
	$Q_t = 5915.0 - 253.81\ z_{t-730} + 2.8703\ z^2_{t-730}$
Predictand:	Box Canyon Spring daily discharge, 730 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.812
SE of estimate:	12.1 cfs



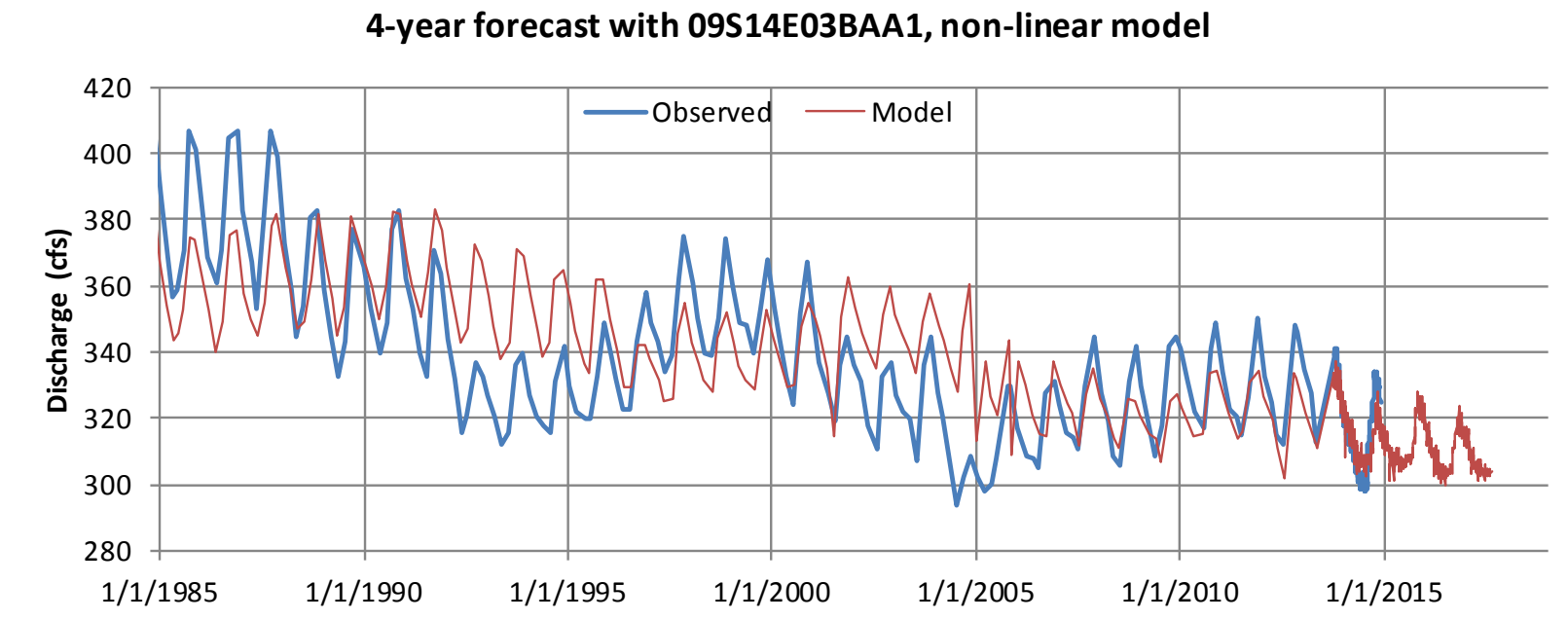
Box Canyon models

Model:	**3-year forecast**
	$Q_t = 6263.3 - 270.93\ z_{t-1095} + 3.0788\ z^2_{t-1095}$
Predictand:	Box Canyon Spring daily discharge, 1090 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.792
SE of estimate:	13.3 cfs



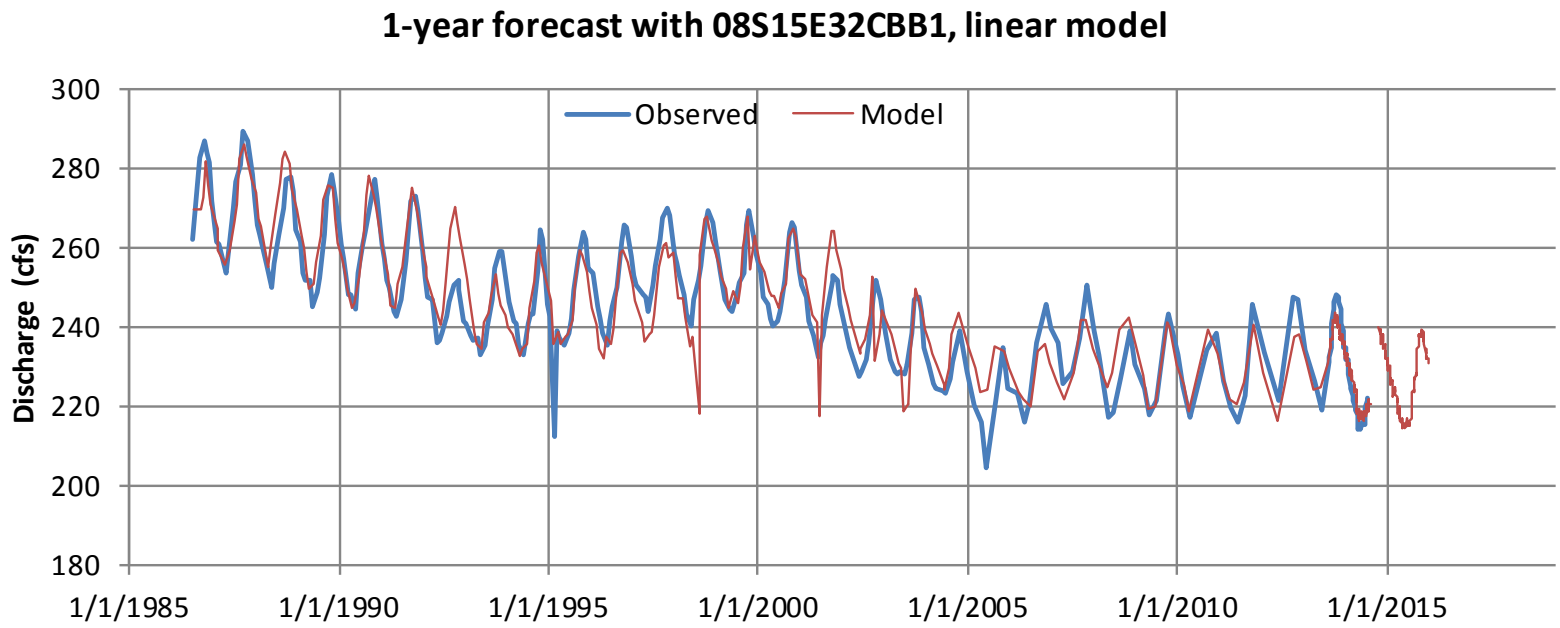
Box Canyon models

Model:	**4-year forecast**
	$Q_t = 3991.87 - 83.1551\ z_{t-1460} + 0.460543\ z^2_{t-1460}$
Predictand:	Box Canyon Spring discharge, 1460 days ahead
Predictor:	Well 09S14E03BAA1
Adjusted R-squared:	0.727
SE of estimate:	11.72



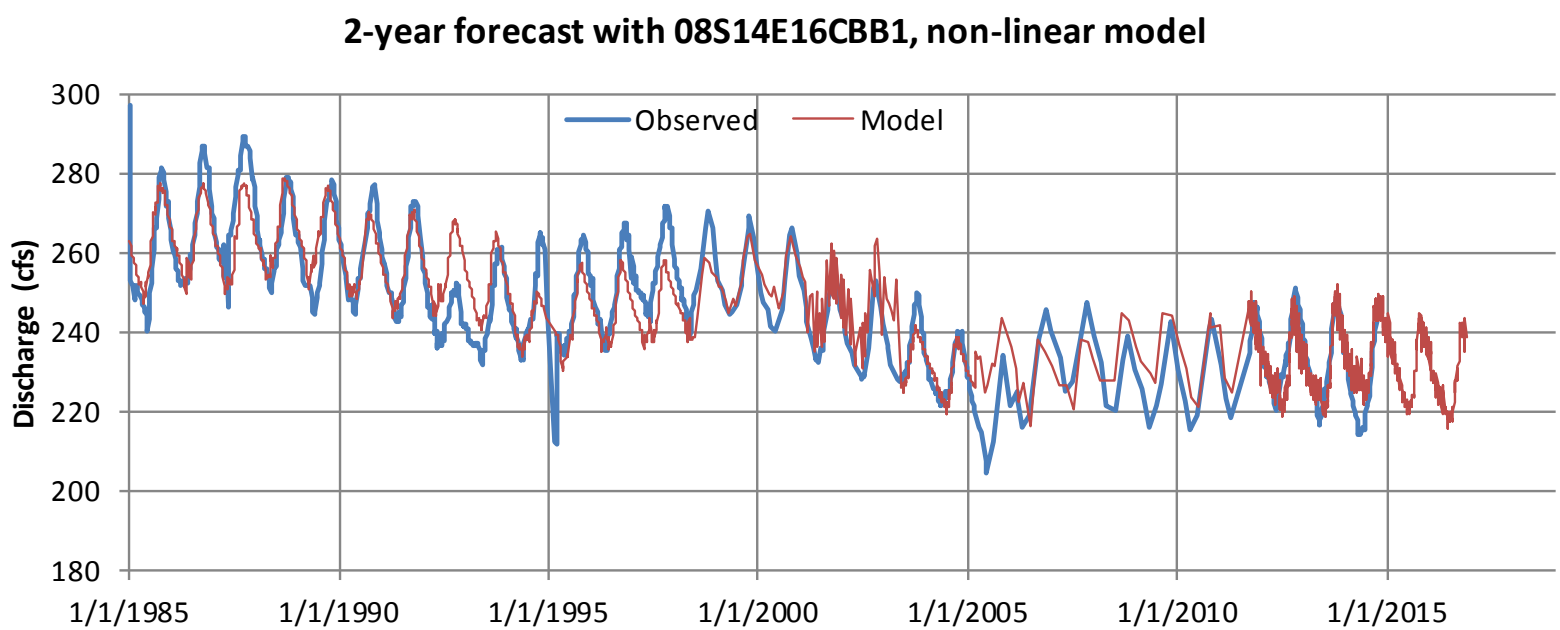
Crystal Springs models

Model:	**1-year forecast**
	$Q_t = 524.701 - 3.75205\ z_{t-340}$
Predictand:	Crystal Springs discharge, 340 days ahead
Predictor:	08S15E32CBB1
Adjusted R-squared:	0.888
SE of estimate:	5.5 cfs



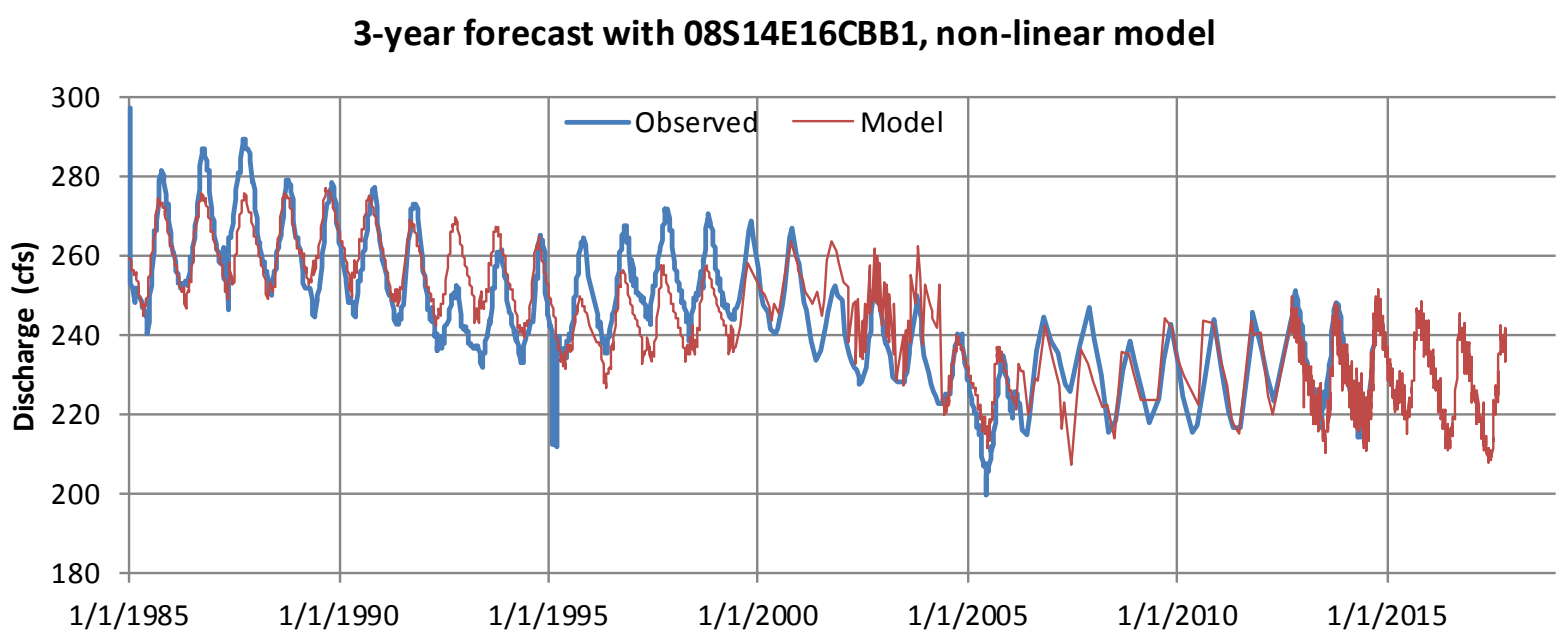
Crystal Springs models

Model:	**2-year forecast**
	$Q_t = 2124.14 - 80.2916\ z_{t-710} + 0.839035\ z^2_{t-710}$
Predictand:	Crystal Springs daily discharge, 710 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.832
SE of estimate:	6.39 cfs



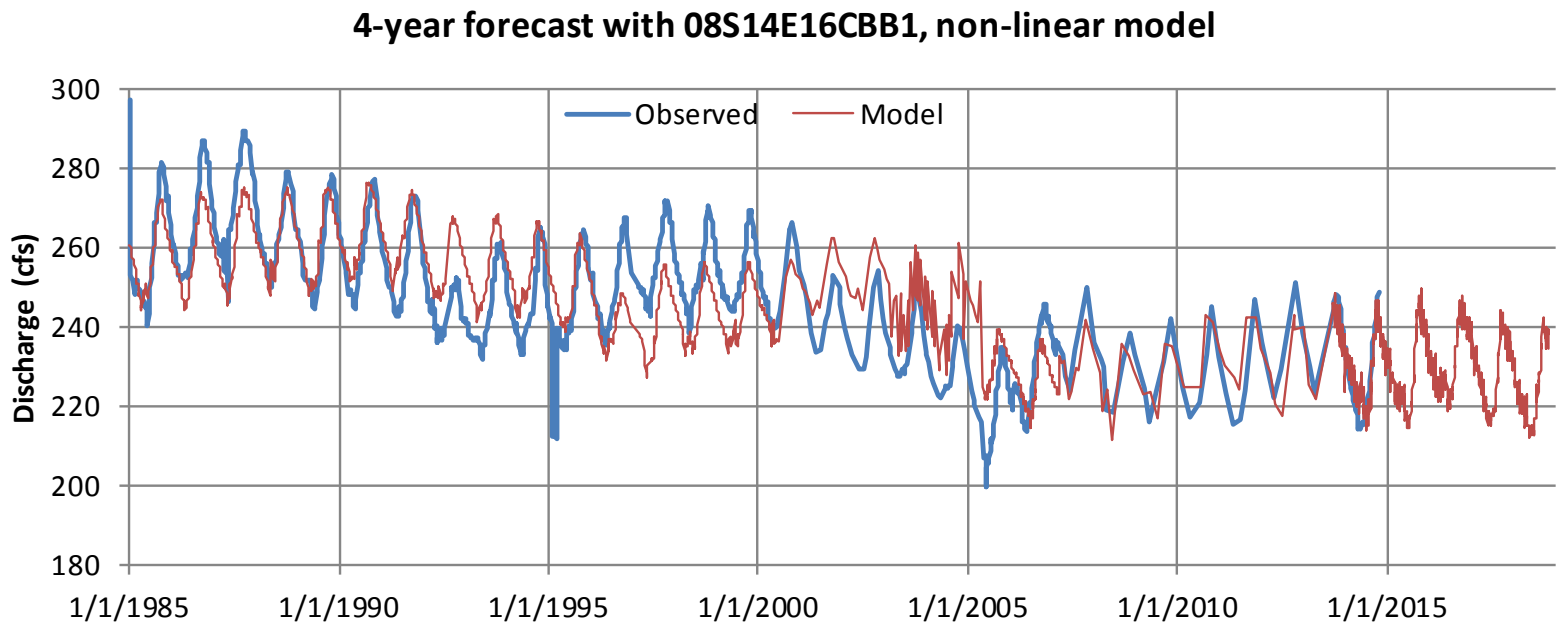
Crystal Springs models

Model:	**3-year forecast**
	$Q_t = 1220.94 - 35.1280\ z_{t-1075} + 0.273991\ z^2_{t-1075}$
Predictand:	Crystal Springs daily discharge, 1075 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.826
SE of estimate:	7.38 cfs



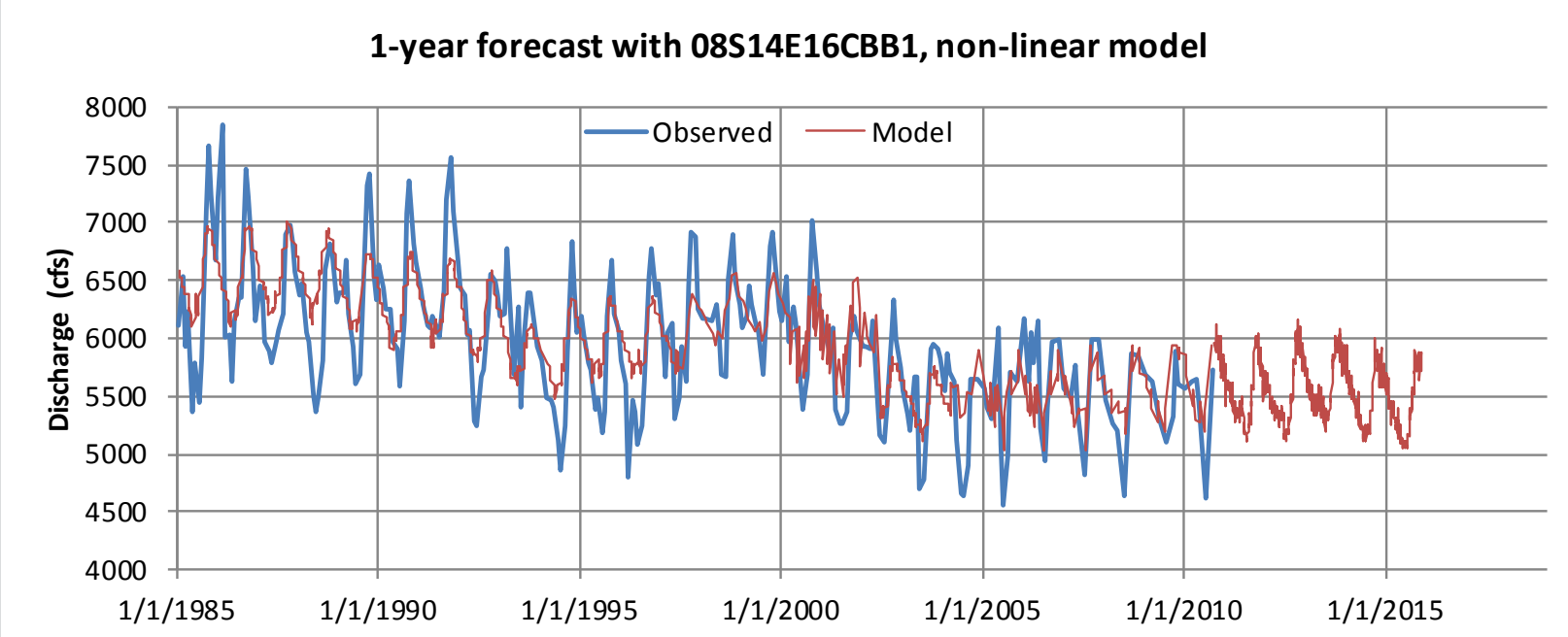
Crystal Springs models

Model:	**4-year forecast**
	$Q_t = 1747.88 - 61.686\ z_{t-1440} + 0.60789\ z^2_{t-1440}$
Predictand:	Crystal Springs discharge, 1440 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.736
SE of estimate:	9.27



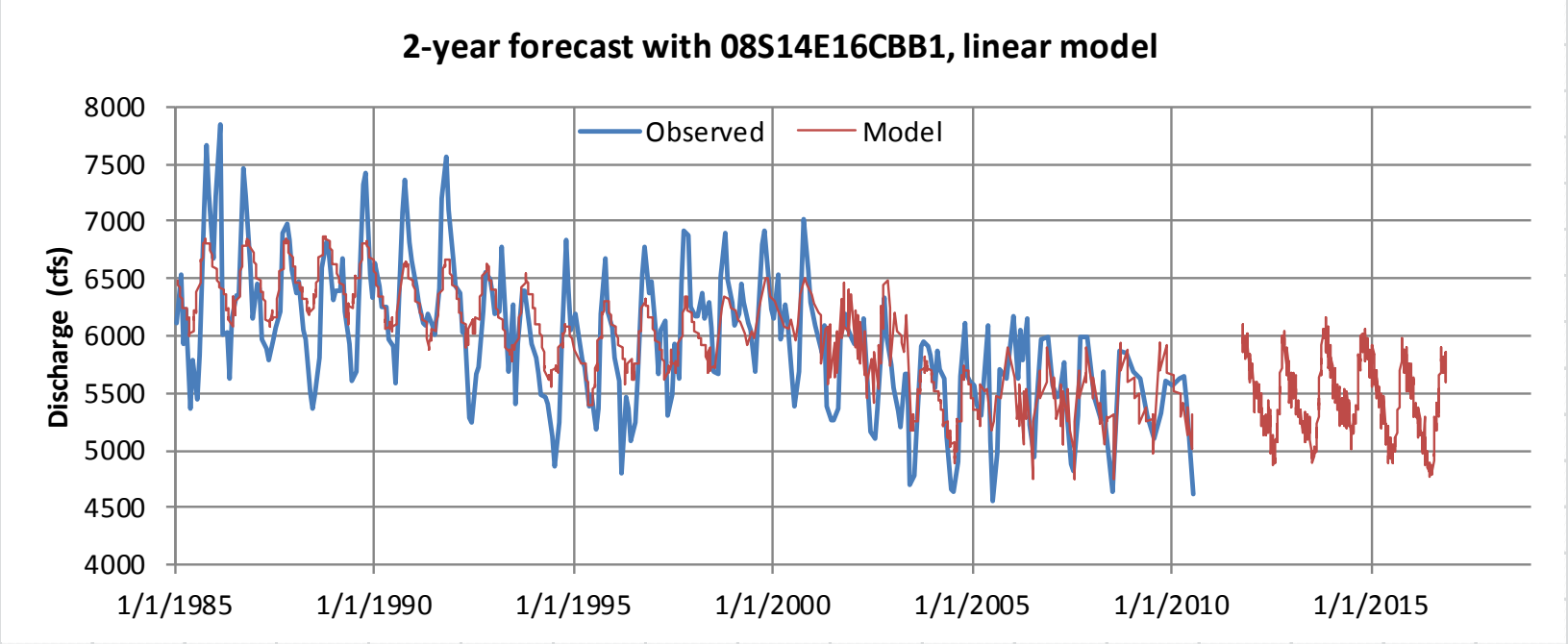
Reach Gain Kim-KH models

Model:	**1-year forecast**
	$Q_t = 62480.4 - 2397.13\ z_{t-360} + 24.7887\ z^2_{t-360}$
Predictand:	Kim-KH monthly reach gain, 360 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.618
SE of estimate:	367 cfs



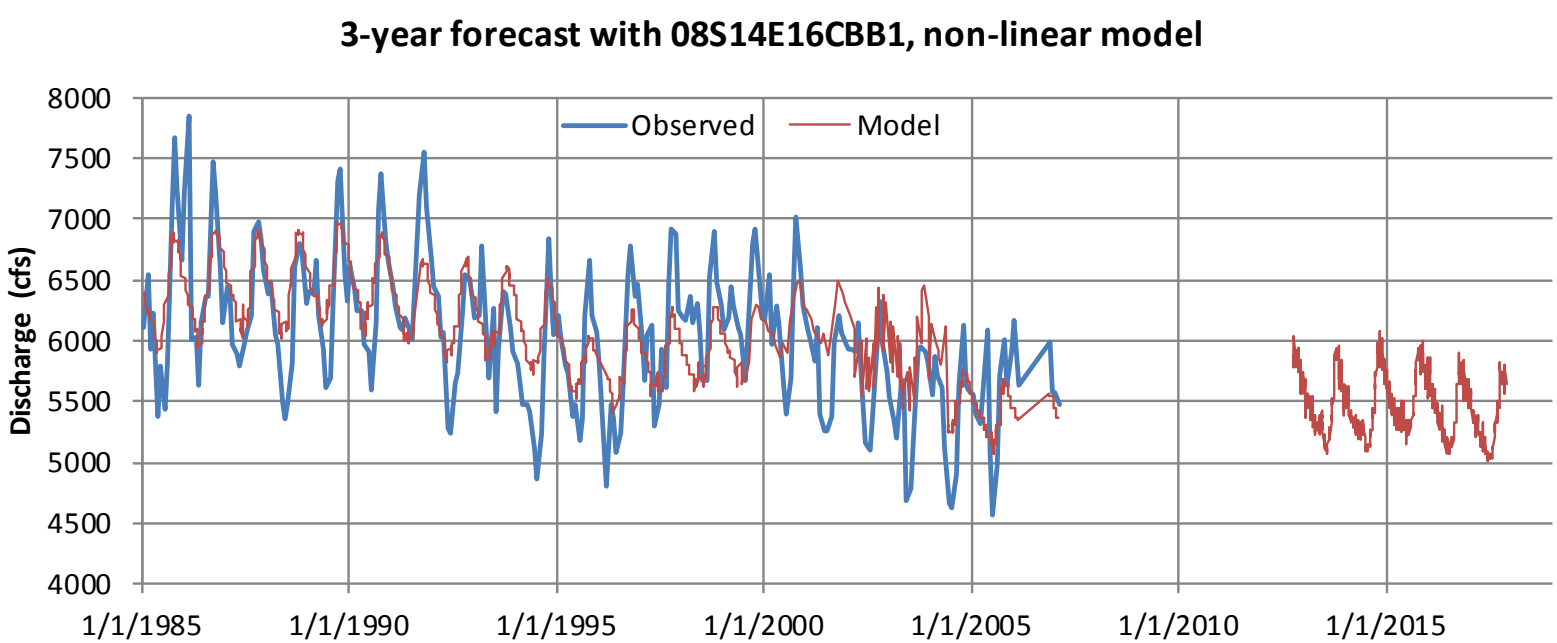
Reach Gain Kim-KH models

Model:	**2-year forecast**	y = -385.733114x + 21,666.709301
	$Q_t = 21666.7 - 383.733\ z_{t-730}$	$R^2 = 0.645787$
Predictand:	Kim-KH monthly reach gain, 730 days ahead	
Predictor:	Well 08S14E16CBB1	
Adjusted R-squared:	0.646	
SE of estimate:	367 cfs	



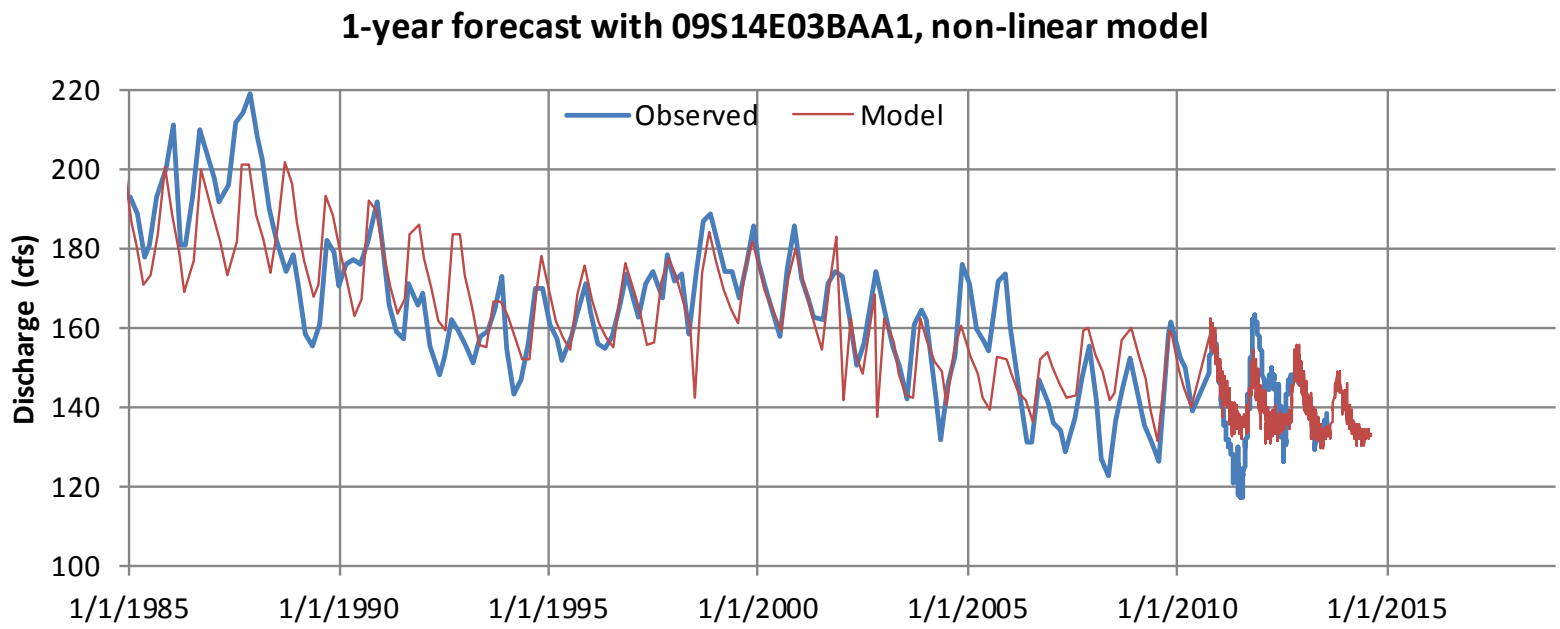
Reach Gain Kim-KH models

Model:	**3-year forecast**
	$Q_t = 72332 - 2885.25\ z_{t-1095} + 30.7851\ z^2_{t-1095}$
Predictand:	Kim-KH monthly reach gain, 1095 days ahead
Predictor:	Well 08S14E16CBB1
Adjusted R-squared:	0.583
SE of estimate:	401 cfs



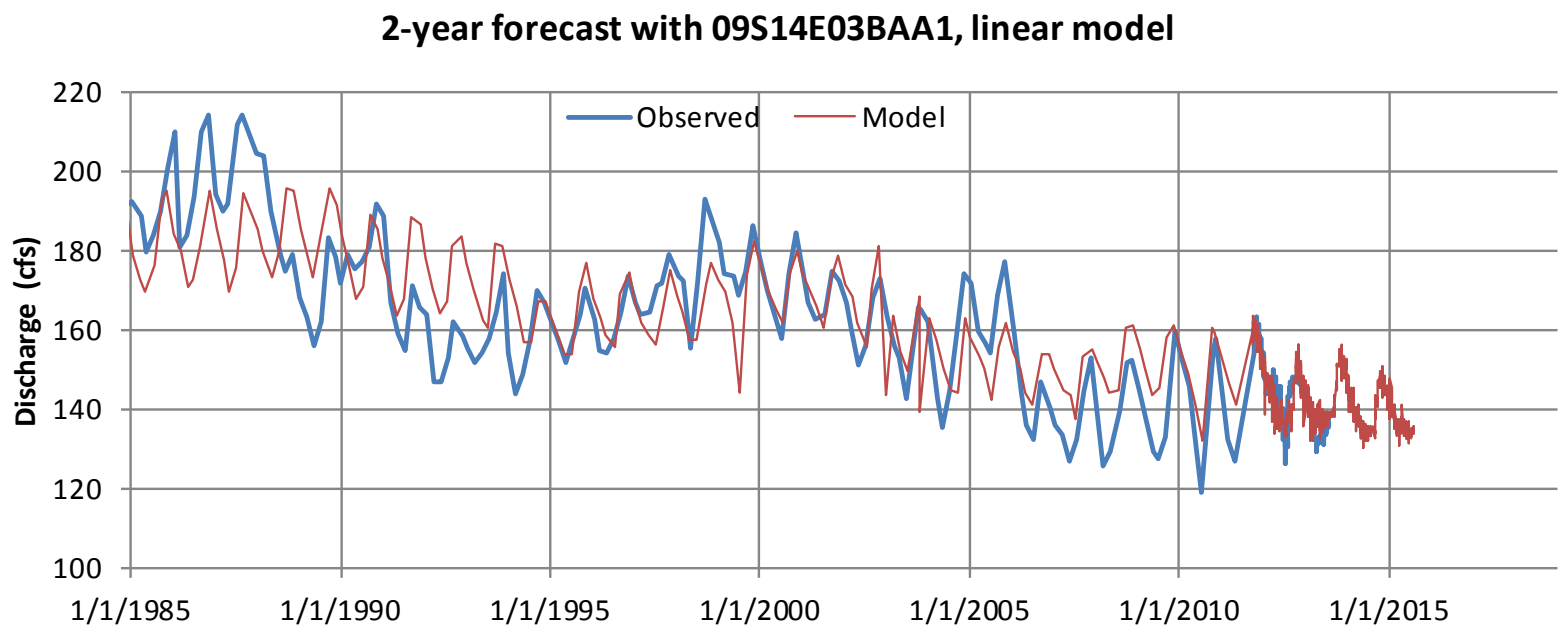
Blue Lakes models

Model:	**1-year forecast**
	$Q_t = 3073.03 - 65.27485\ z_{t-360} + 0.354206\ z^2_{t-360}$
Predictand:	Blue Lakes Spring discharge, 360 days ahead
Predictor:	09S14E03BAA1
Adjusted R-squared:	0.696
SE of estimate:	8.8 cfs



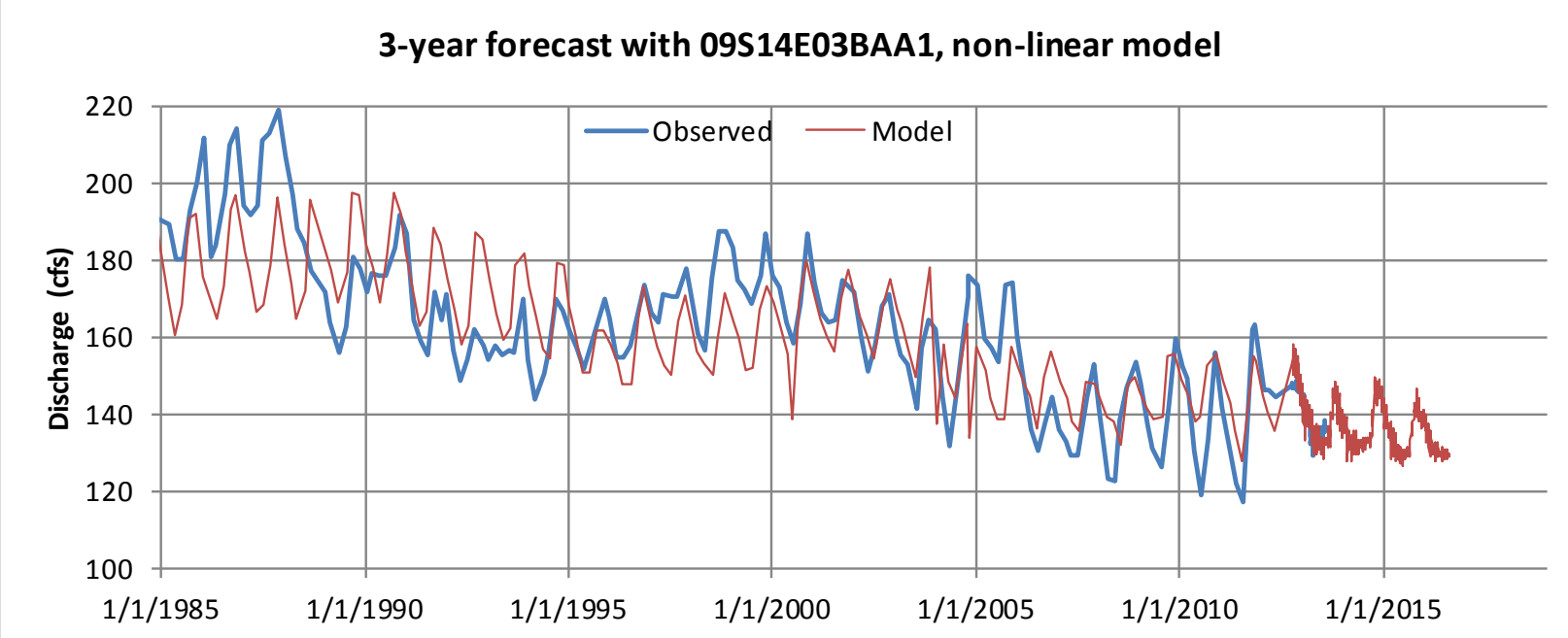
Blue Lakes models

Model:	**2-year forecast**
	$Q_t = 965.79 - 10.6120\ z_{t-725}$
Predictand:	Blue Lakes Spring discharge, 725 days ahead
Predictor:	09S14E03BAA1
Adjusted R-squared:	0.791
SE of estimate:	7.2 cfs

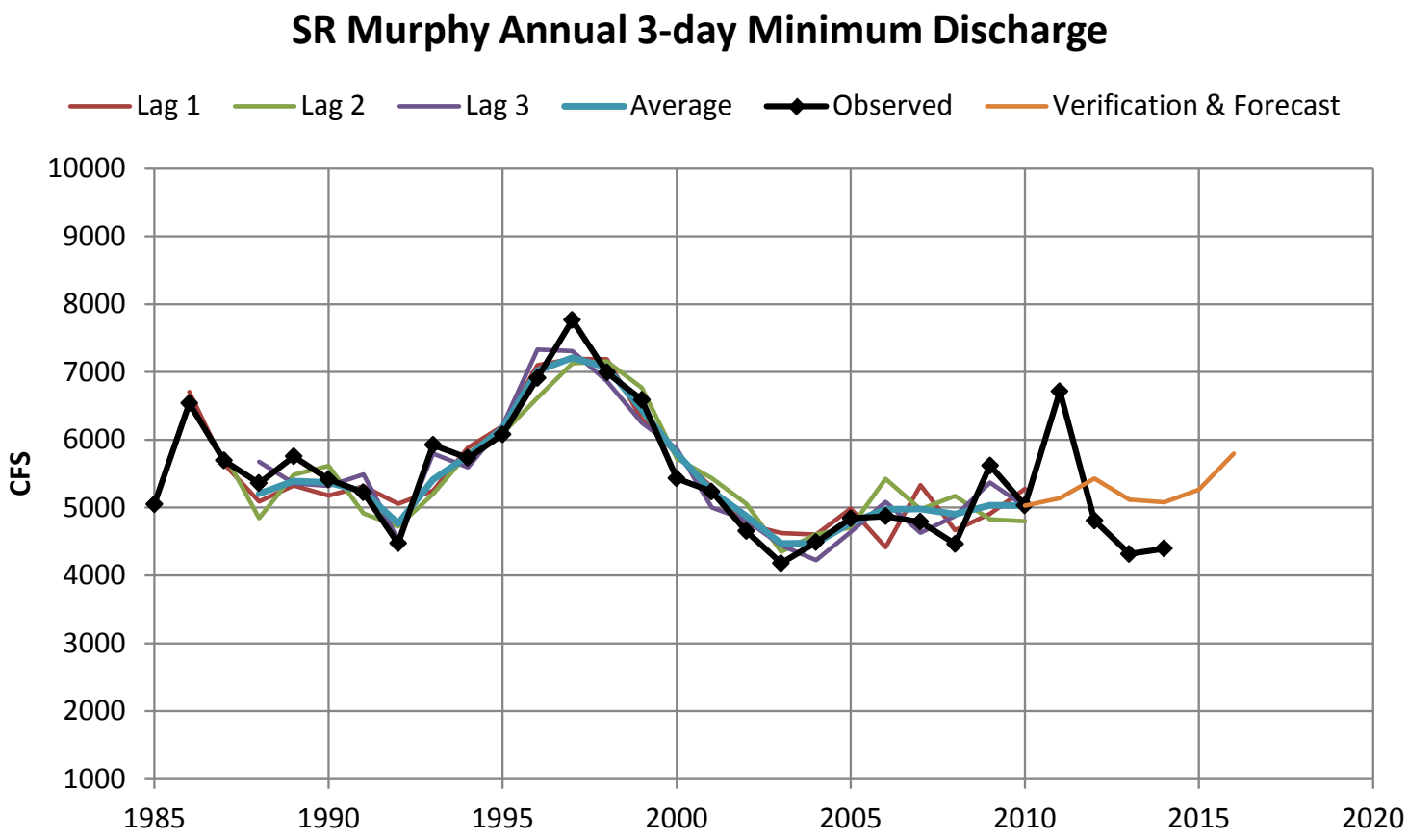


Blue Lakes models

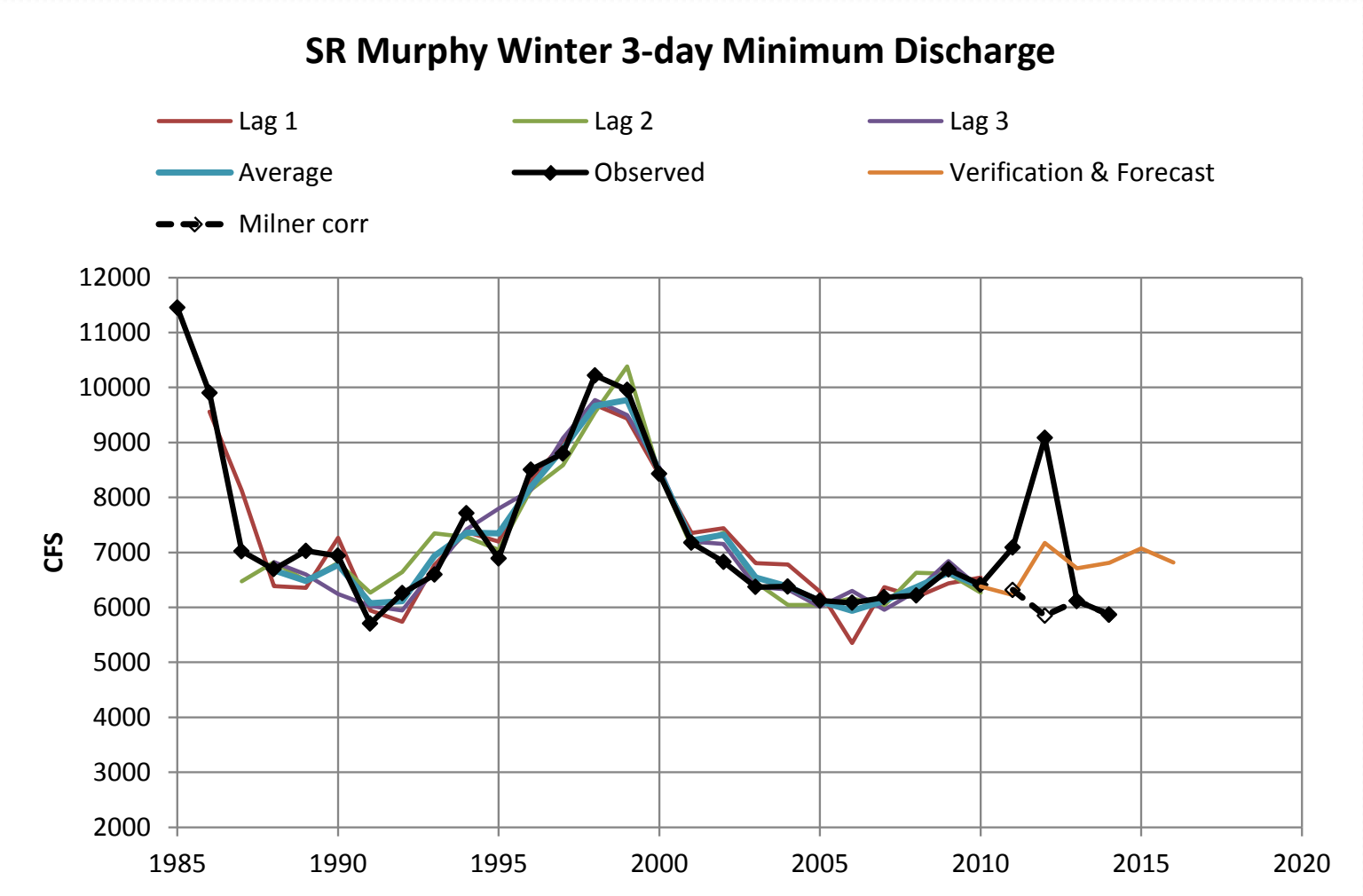
Model:	**3-year forecast**
	$Q_t = 3635.59 - 80.3990\ z_{t-1090} + 0.455031\ z^2_{t-1090}$
Predictand:	Blue Lakes Spring discharge, 1090 days ahead
Predictor:	09S14E03BAA1
Adjusted R-squared:	0.755
SE of estimate:	9.6 cfs



Snake River nr Murphy Minimum – Annual Model



Snake River nr Murphy Minimum – Annual Model



Next Steps

- Jackknife procedure to verify models
- Update with data recently made available by IDWR
- Continue efforts on Snake River minimums
  - Better correction for flow passing Milner

Data issues

- Delay in groundwater data being downloaded and made available
- Field checks of instrumentation
- Basic data QC
- ESPA reach gain data
  - Calculated by IDWR only through 2010. Updating this data through 2014 would provide significant value.
  - The exact procedure for calculating reach gains should be made available so that we can duplicate it and/or extend it.