Tributary volumetric flux estimates III: Summary of process

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These slides were presented at the Wood River Valley Modeling Technical Advisory Committee meeting Tuesday, 12Aug2014, 10am-3pm at the Community Campus, Minnie Moore Rm, in Hailey. Taken outside the context of the original presentation, these slides may not provide a complete or accurate representation of the speaker's intent.

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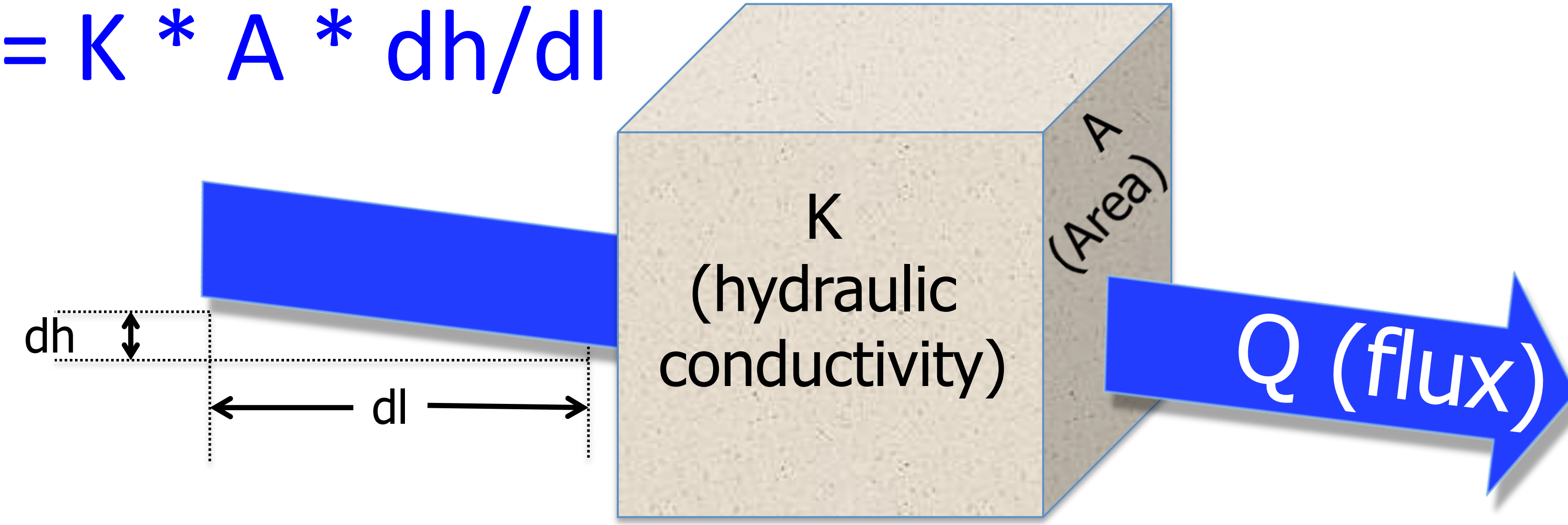
Problem: Representation of subsurface tributary inflow

$$Q = K * A * dh/dl$$



- Subsurface flow from tributary canyons into the aquifer system is difficult to quantify with any certainty

- Decided to use Darcian flux approach—presented at Dec 2013 MTAC meeting
- Yielded a "mean" flux rate

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Seasonality of tributary underflow

- Tributary underflow, especially in the smaller canyons, is not a constant flux—some temporal variation is needed.
- Allocate underflow using a scaling index based on an observable and defensible signal

Mean underflow x Scaling index =

Seasonal underflow

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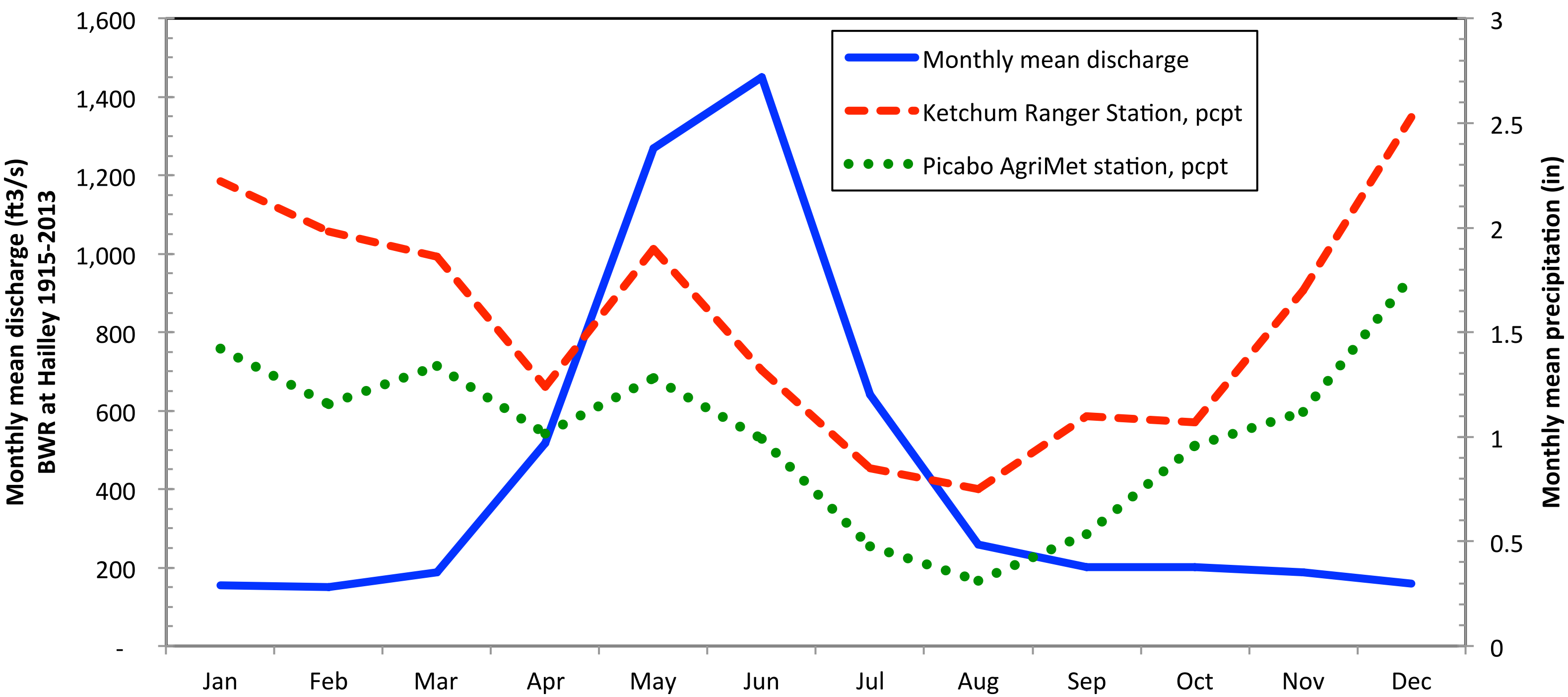
What should we use to represent seasonality?

- Precipitation?
  - Doesn't capture snowmelt
- Stream discharge?
  - Discharge aggregates precipitation and snowmelt



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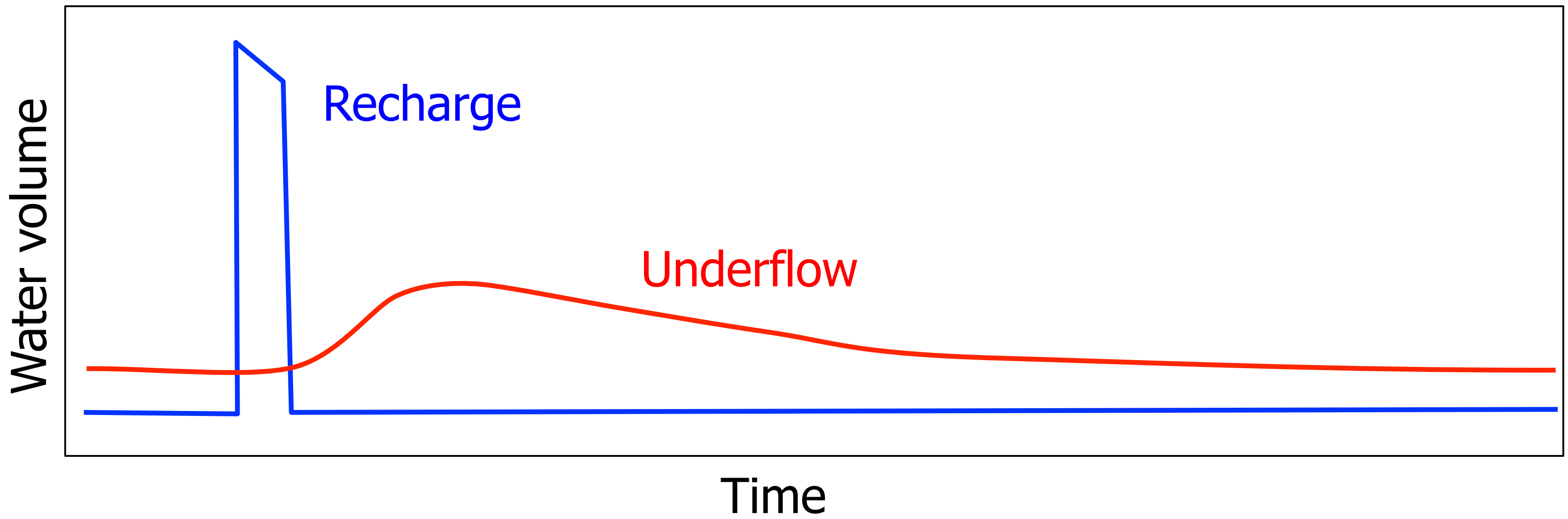
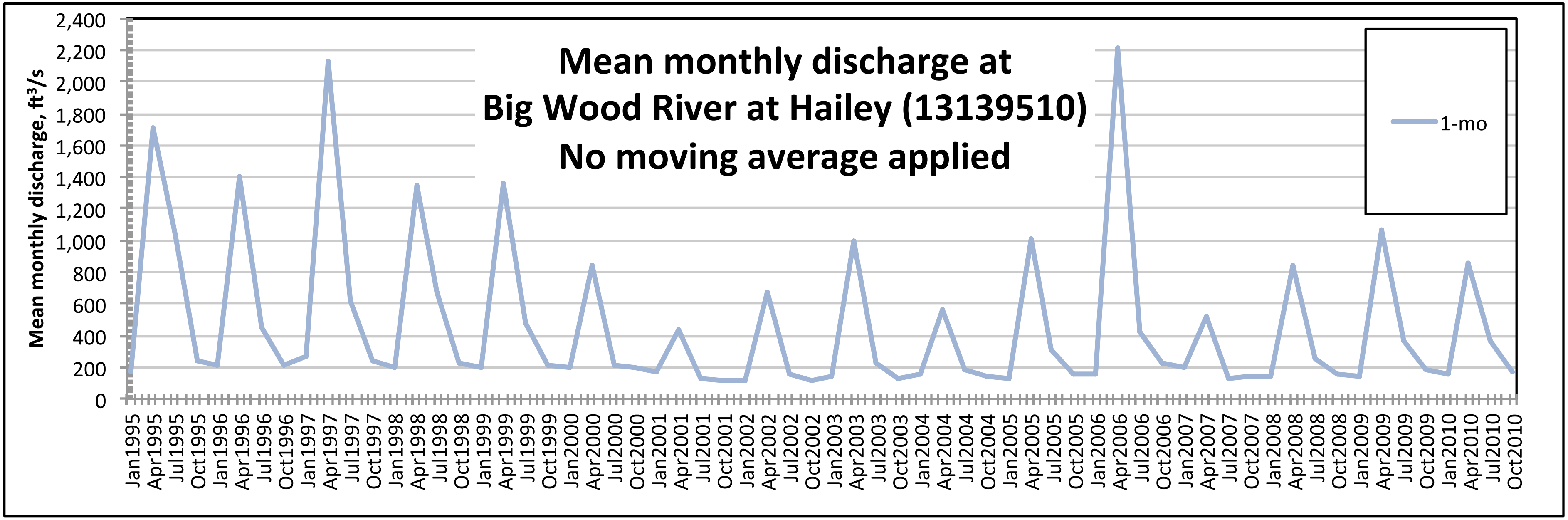
How does recharge become tributary underflow?



- Begins with infiltration of water which eventually becomes recharge
- Recharged water moves downgradient
- Eventually passes out of tributary as underflow

Integrating/lagging recharge



- Applied a moving average to monthly mean discharge
  - Incorporated the months prior to and including the given month
- Tried 1, 3, 4, 6, 9, and 12 month windows

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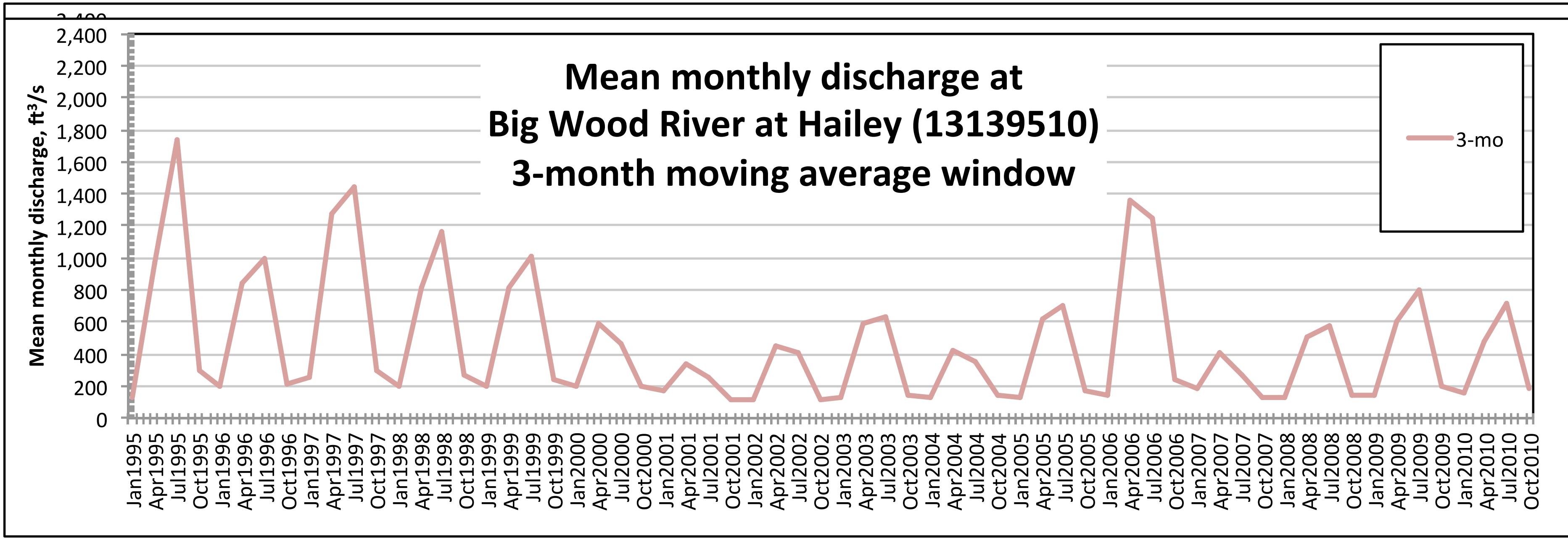
Integrating/lagging recharge



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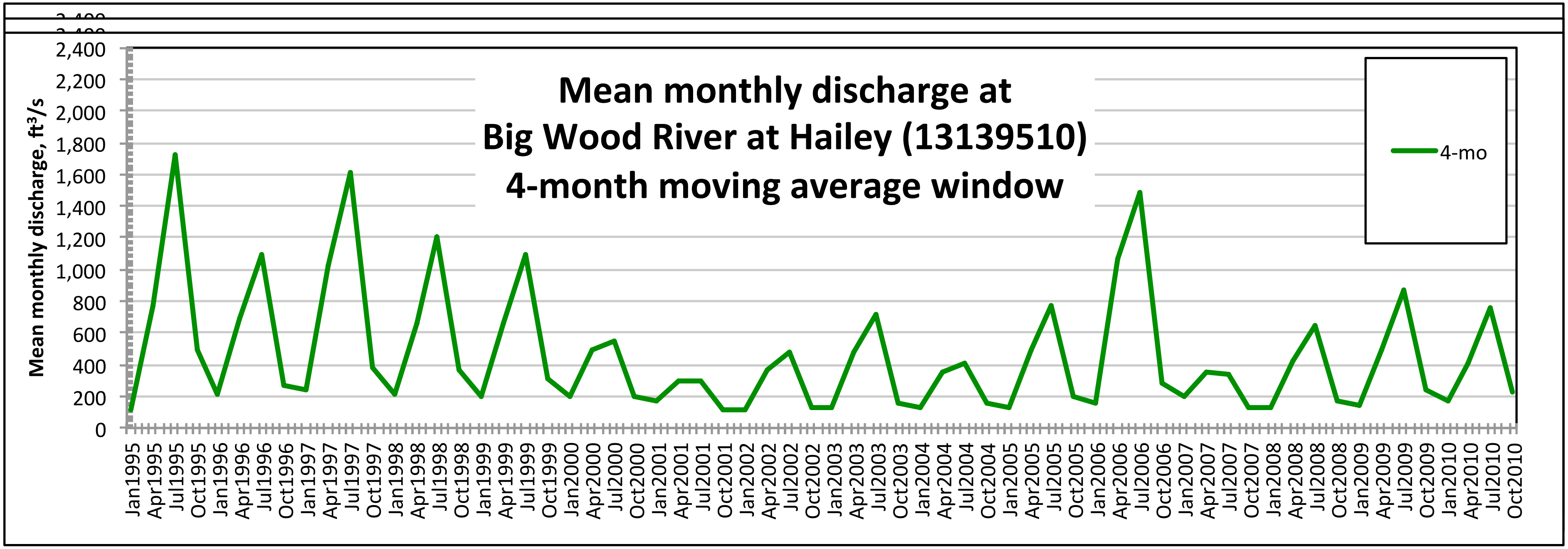

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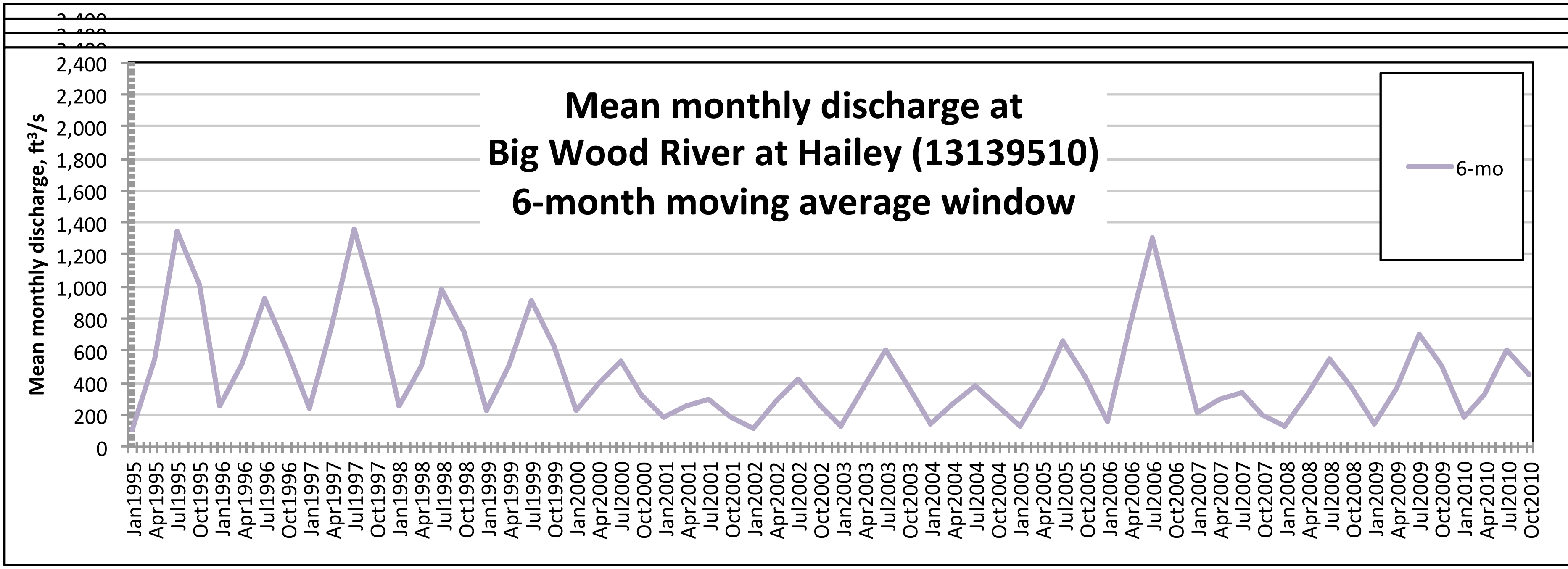

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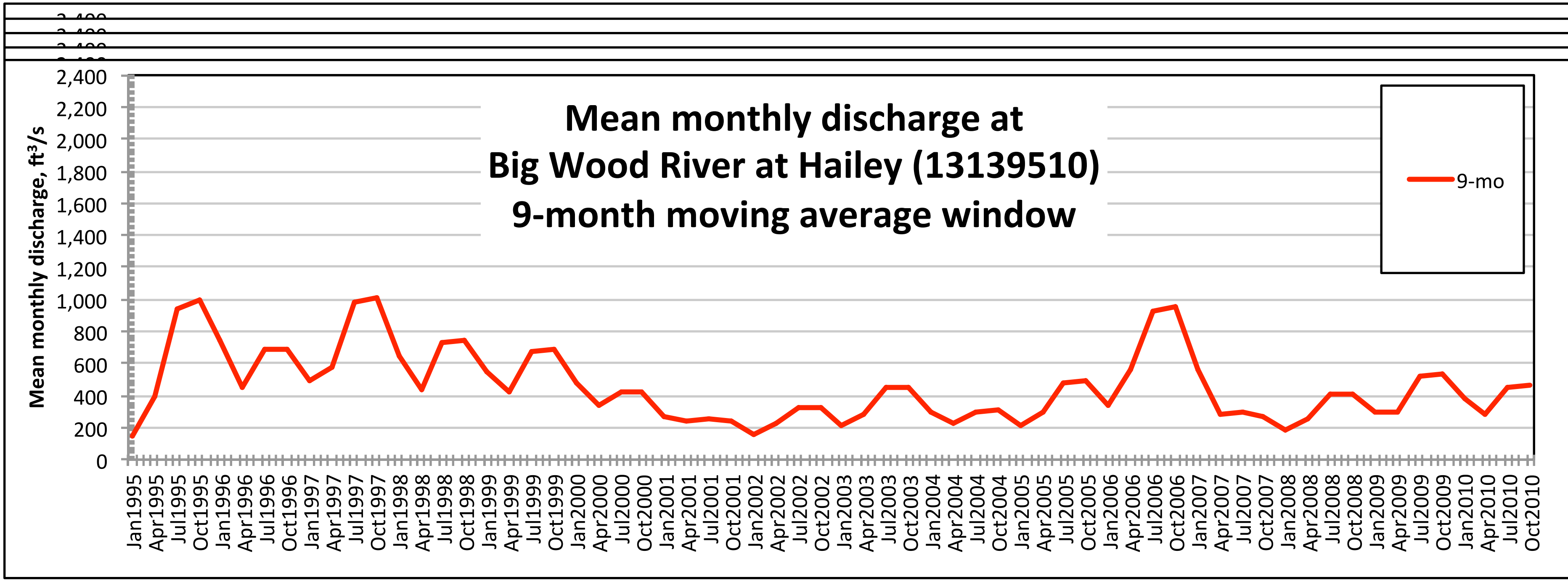

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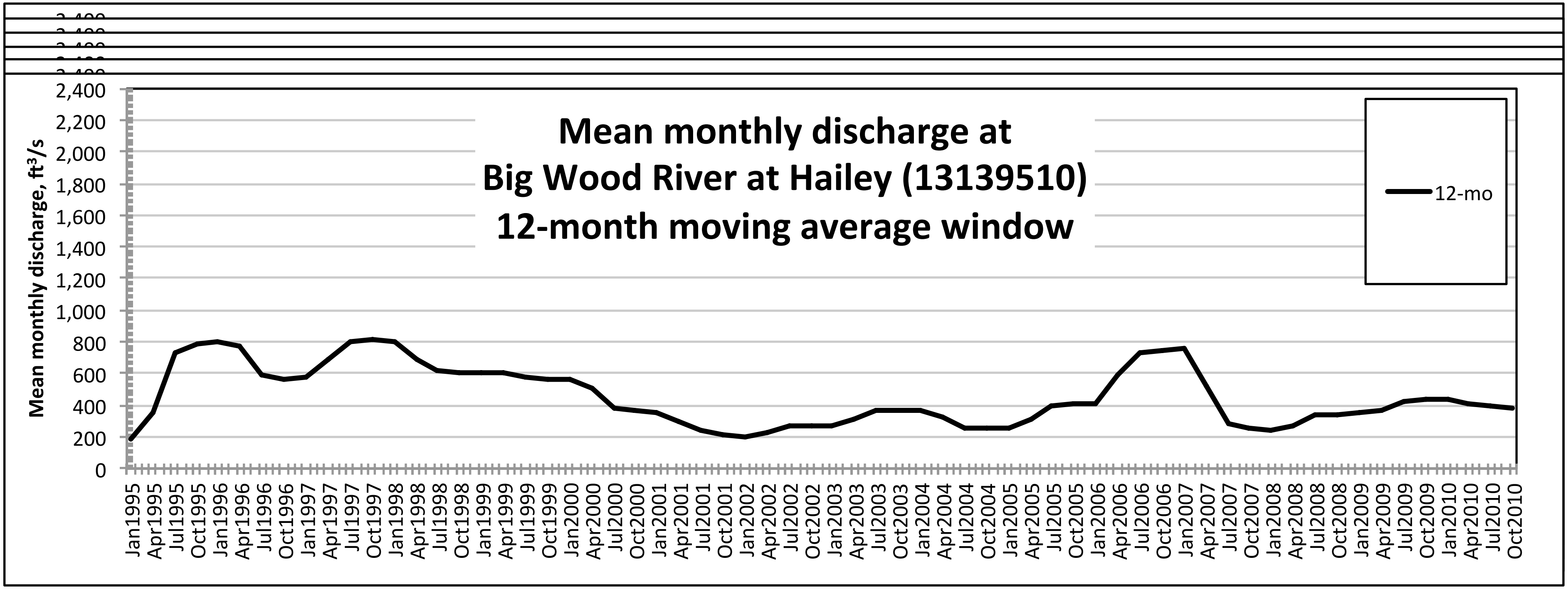

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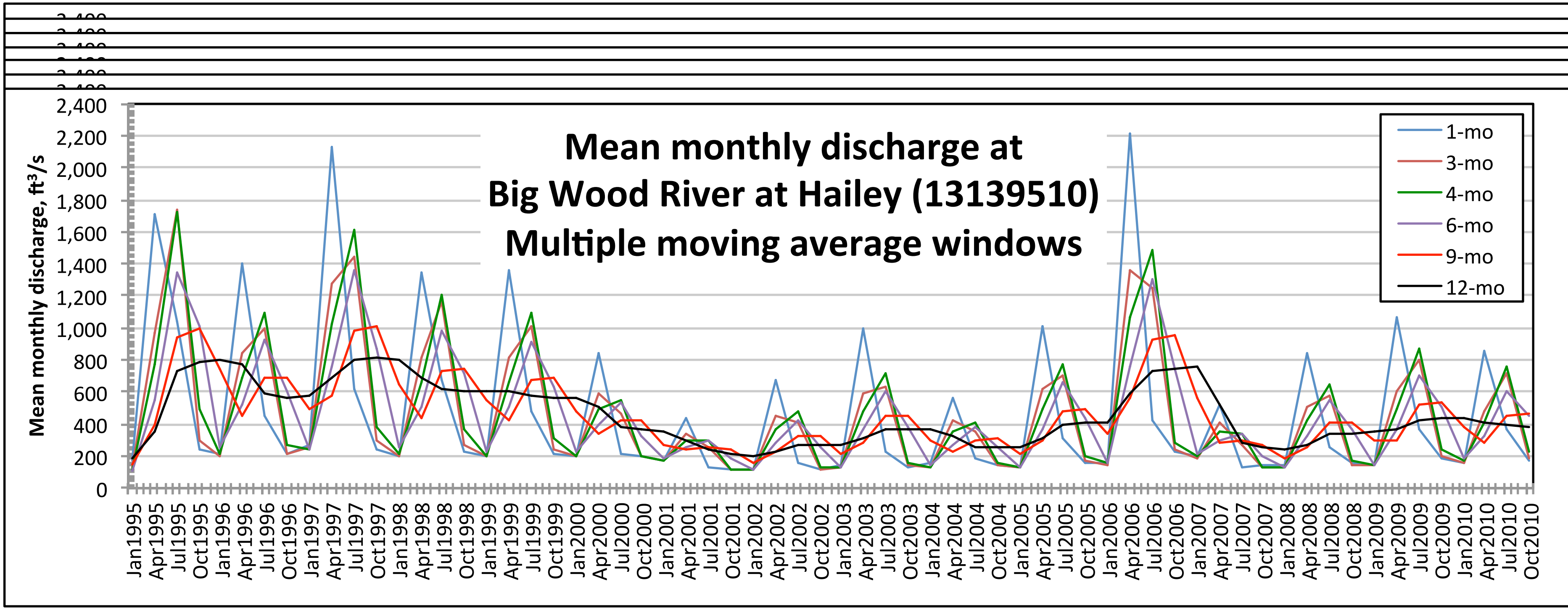

- Applied a moving average to monthly mean discharge
  - Incorporated the months prior to and including the given month
- Tried 1, 3, 4, 6, 9, and 12 month windows
- 9-month average was chosen as best compromise between timing and signal magnitude

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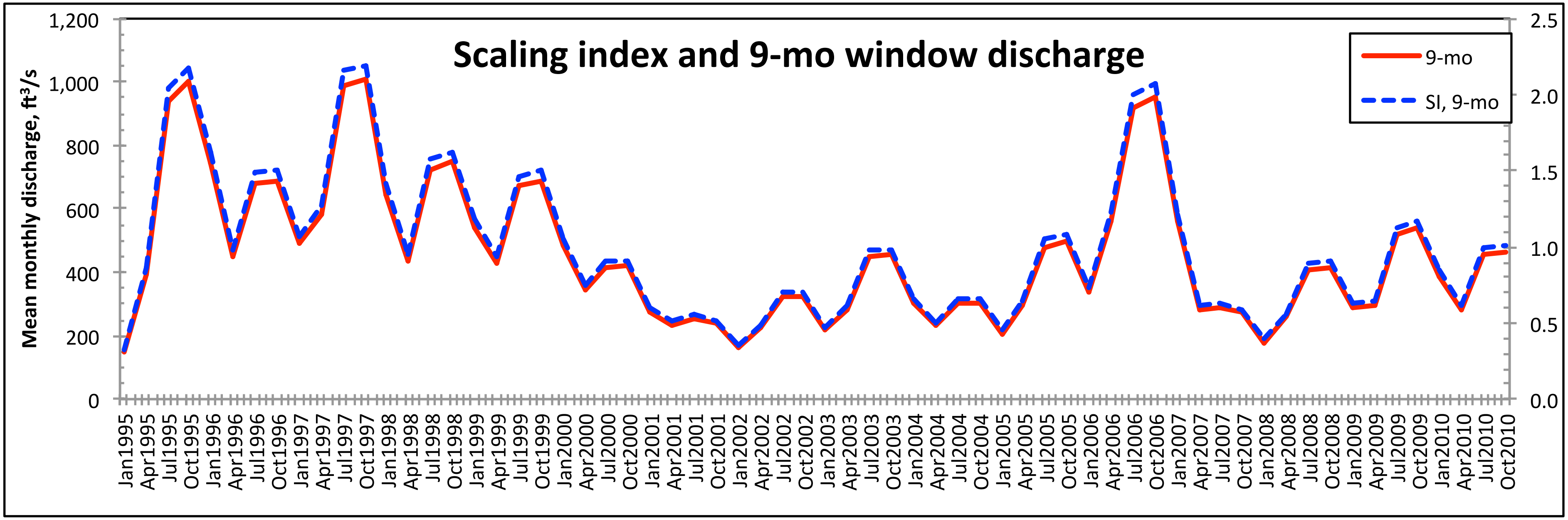
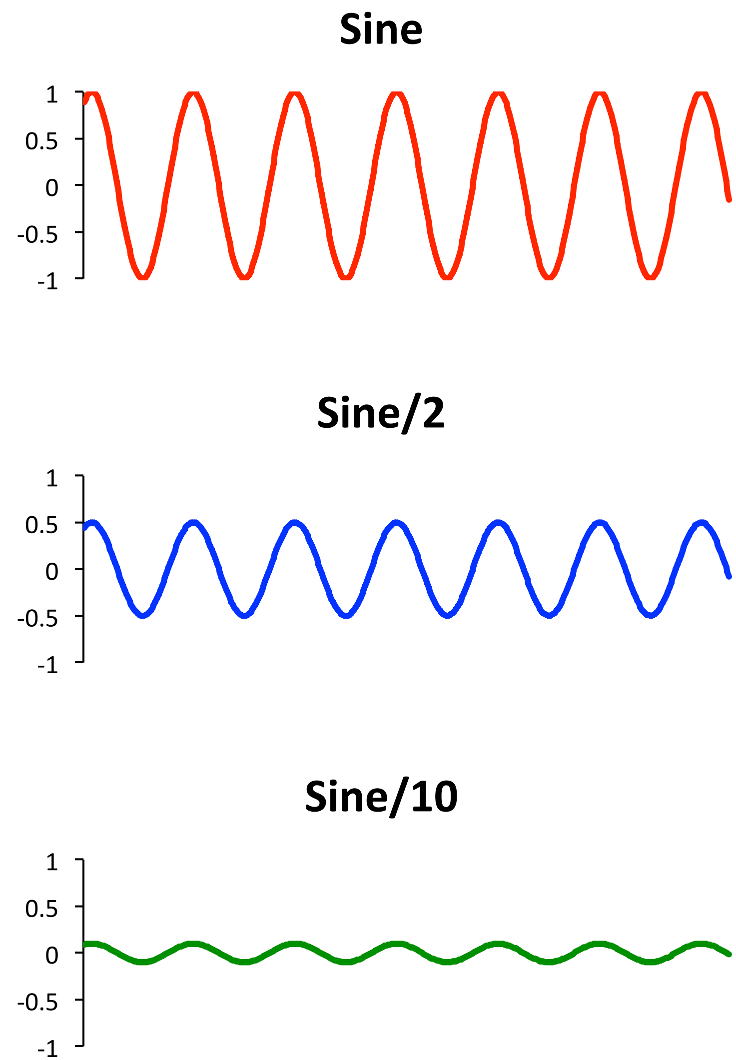
Scaling index vs Discharge



- Scaling index has same shape as smoothed discharge

Damping

- **Damping** is an influence within or upon an oscillatory system that has the effect of reducing, restricting or preventing its oscillations. --Wikipedia
- Amplitude reduces the magnitude of a signal: the mean remains the same but the total range is reduced. (Low-pass filter)
- Can be represented with one parameter



Damping process

- Calculate smoothed quarterly discharge (*Dsqm*)

Quarter	*D*	*Dsqm (9-mo)*
Jan1995	170	147
Apr1995	1,718	394
Jul1995	1,042	942
Oct1995	238	1,000
…	…	…
Jan2010	154	388
Apr2010	859	283
Jul2010	363	455
Oct2010	176	465
Mean:	463	**460**

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Damping process

- Calculate smoothed quarterly discharge (*Dsqm*)
- Choose Reduction Factor (*RF*) ≥ 1 ***RF = 2***
- Temporary Signal (TS) = *Dsqm* ÷ *RF*

Quarter	*Dsqm (9-mo)*	*TS*
Jan1995	147	74
Apr1995	394	197
Jul1995	942	471
Oct1995	1,000	500
…	…	…
Jan2010	388	194
Apr2010	283	141
Jul2010	455	227
Oct2010	465	232
Mean:	**460**	**230**

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Damping process

- Calculate smoothed quarterly discharge (*Dsqm*)
- Choose Reduction Factor (*RF*) ≥ 1 ***RF = 2***
- Temporary Signal (TS) = *Dsqm* ÷ *RF*
- Single Amplitude Reduction (*SAR*) = *Dspm* + *TSm* – *TS* = Damped quarterly mean (*Ddqm*)

Quarter	*Dsqm (9-mo)*	*TS*	*SAR/Ddqm*
Jan1995	147	74	303
Apr1995	394	197	427
Jul1995	942	471	701
Oct1995	1,000	500	730
…	…	…	…
Jan2010	388	194	424
Apr2010	283	141	371
Jul2010	455	227	457
Oct2010	465	232	462
Mean:	**460**	**230**	**460**

Damping process

- Calculate smoothed quarterly discharge (*Dsqm*)
- Choose Reduction Factor (*RF*) ≥ 1 ***RF = 2***
- Temporary Signal (TS) = *Dsqm* ÷ *RF*
- Single Amplitude Reduction (*SAR*) = *Dspm* + *TSm* – *TS* = Damped quarterly mean (*Ddqm*)
- Calculate SI = *Ddqm* ÷ *Ddpm*

Quarter	*SAR/Ddqm*	*SI*
Jan1995	303	0.66
Apr1995	427	0.93
Jul1995	701	1.52
Oct1995	730	1.59
…	…	…
Jan2010	424	0.92
Apr2010	371	0.81
Jul2010	457	0.99
Oct2010	462	1.01
Mean:	**460**	…

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Damping process

- Calculate smoothed quarterly discharge (*Dsqm*)
- Choose Reduction Factor (*RF*) ≥ 1 ***RF = 2***
- Temporary Signal (TS) = *Dsqm* ÷ *RF*
- Single Amplitude Reduction (*SAR*) = *Dspm* + *TSm* – *TS* = Damped quarterly mean (*Ddqm*)
- Calculate SI = *Ddqm* ÷ *Ddpm*
- *SI* ×

  = *Seasonal underflow*

Quarter	*SI*	*Quarterly mean underflow*	*Seasonal underflow*
Jan1995	0.66	1.2	0.79
Apr1995	0.93	1.2	1.1
Jul1995	1.52	1.2	1.8
Oct1995	1.59	1.2	1.9
…	…	…	…
Jan2010	0.92	1.2	1.1
Apr2010	0.81	1.2	0.97
Jul2010	0.99	1.2	1.18
Oct2010	1.01	1.2	1.2
Mean:	…	…	…

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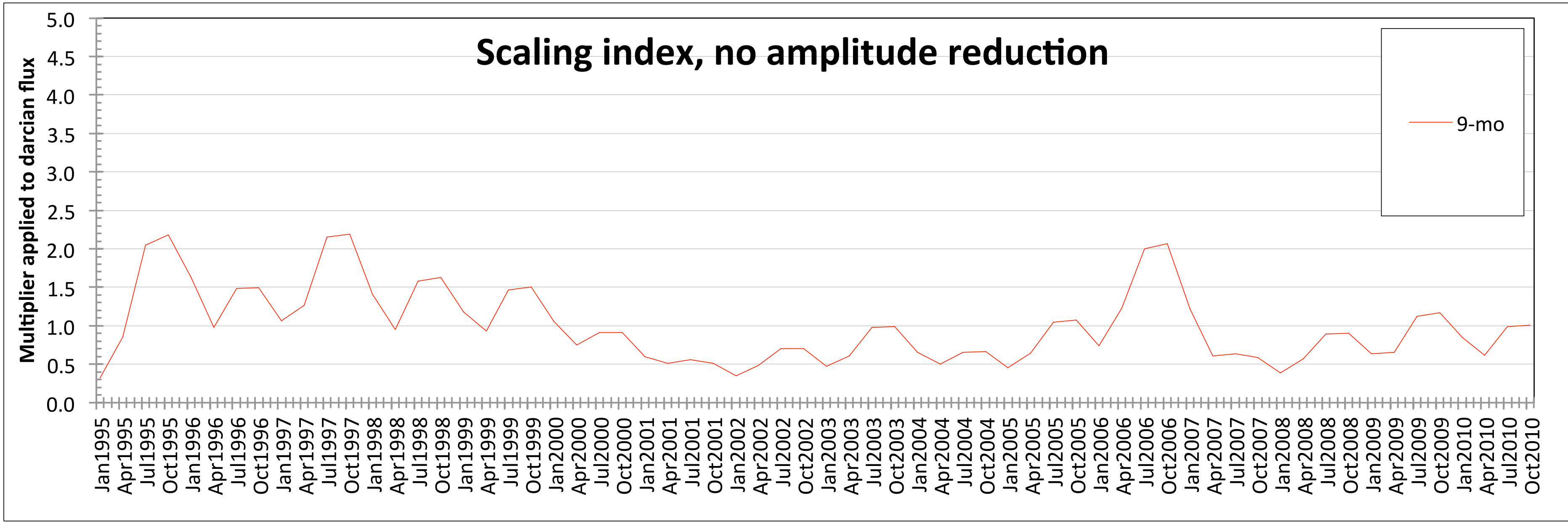
Single amplitude reduction



- How does the Reduction Factor (RF) affect the scaling index (SI)?

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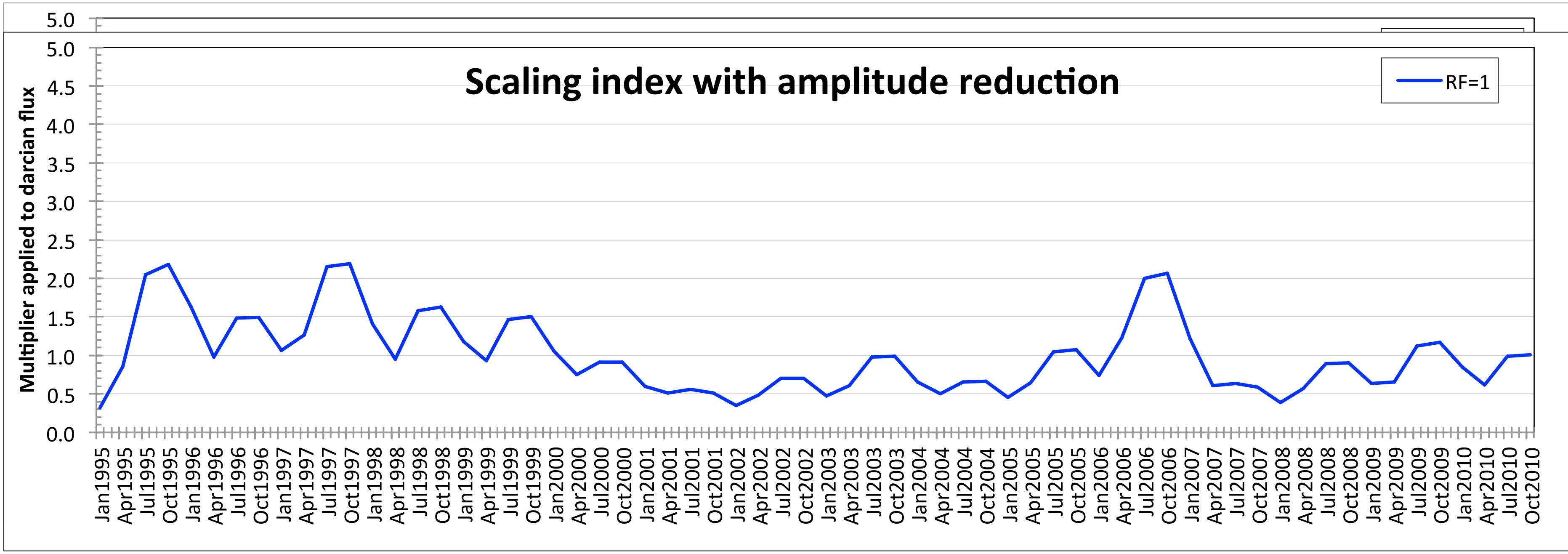
Single amplitude reduction



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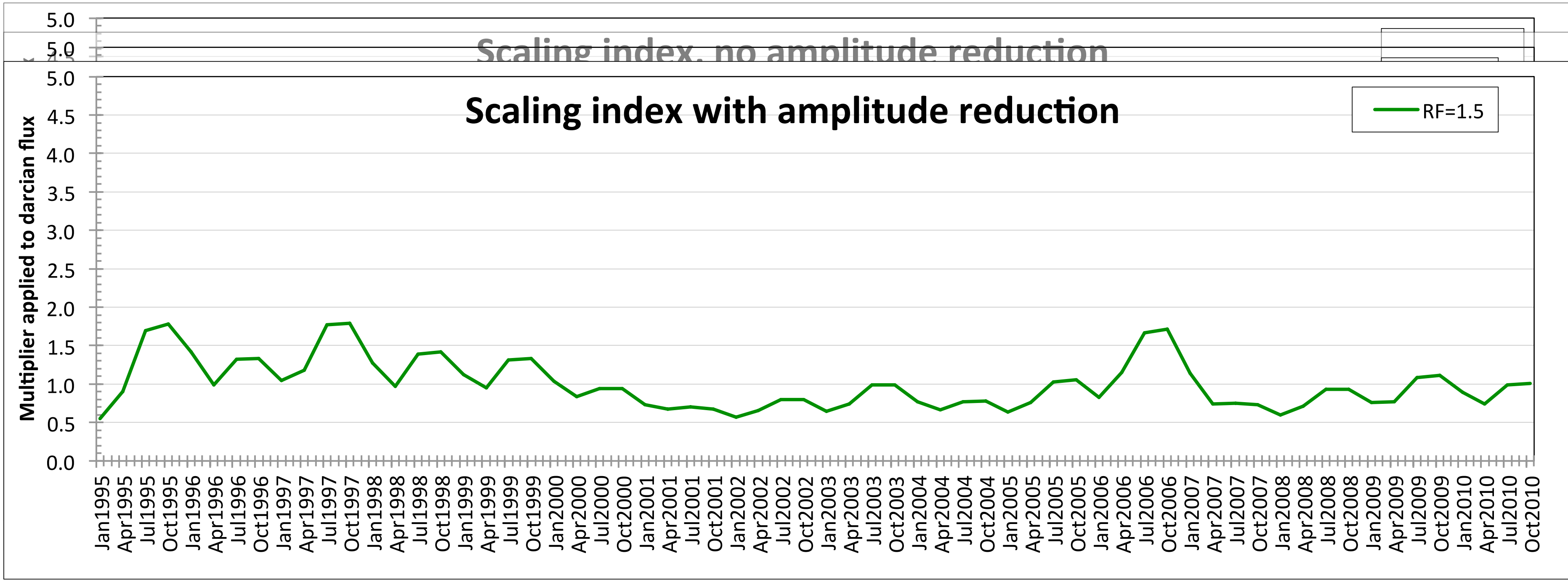
Single amplitude reduction



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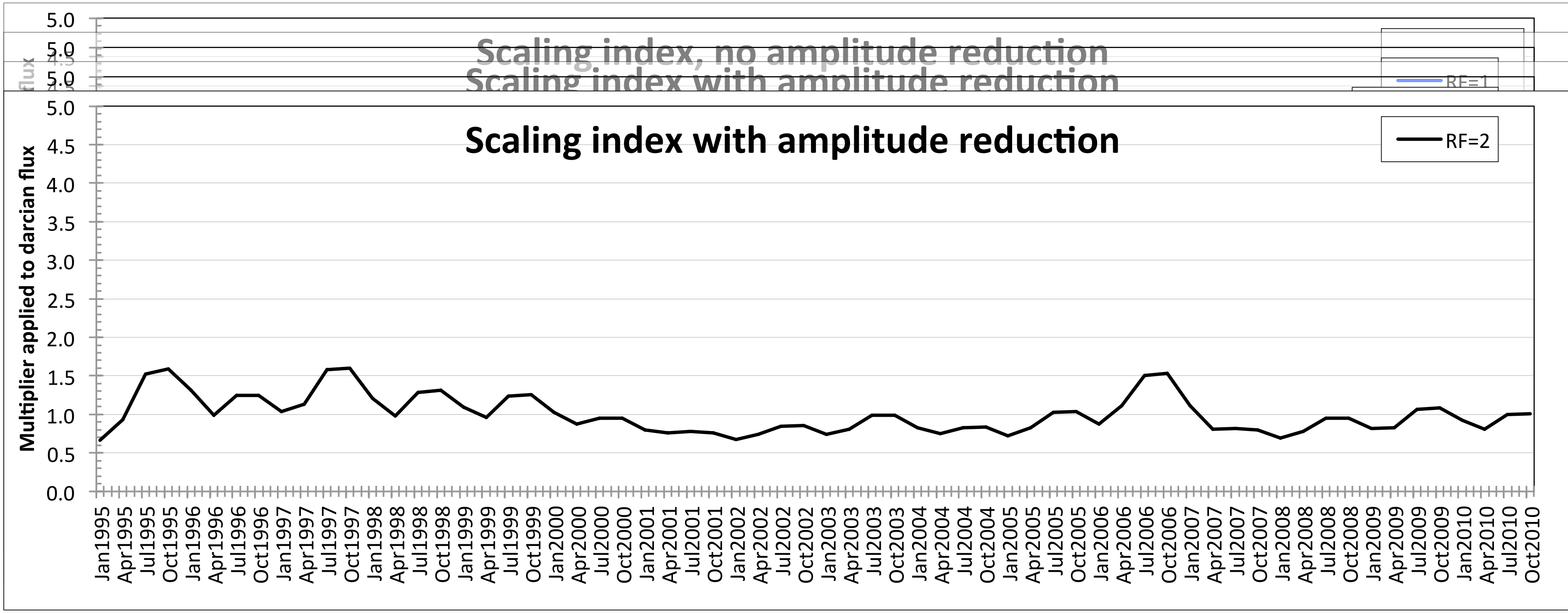
Single amplitude reduction



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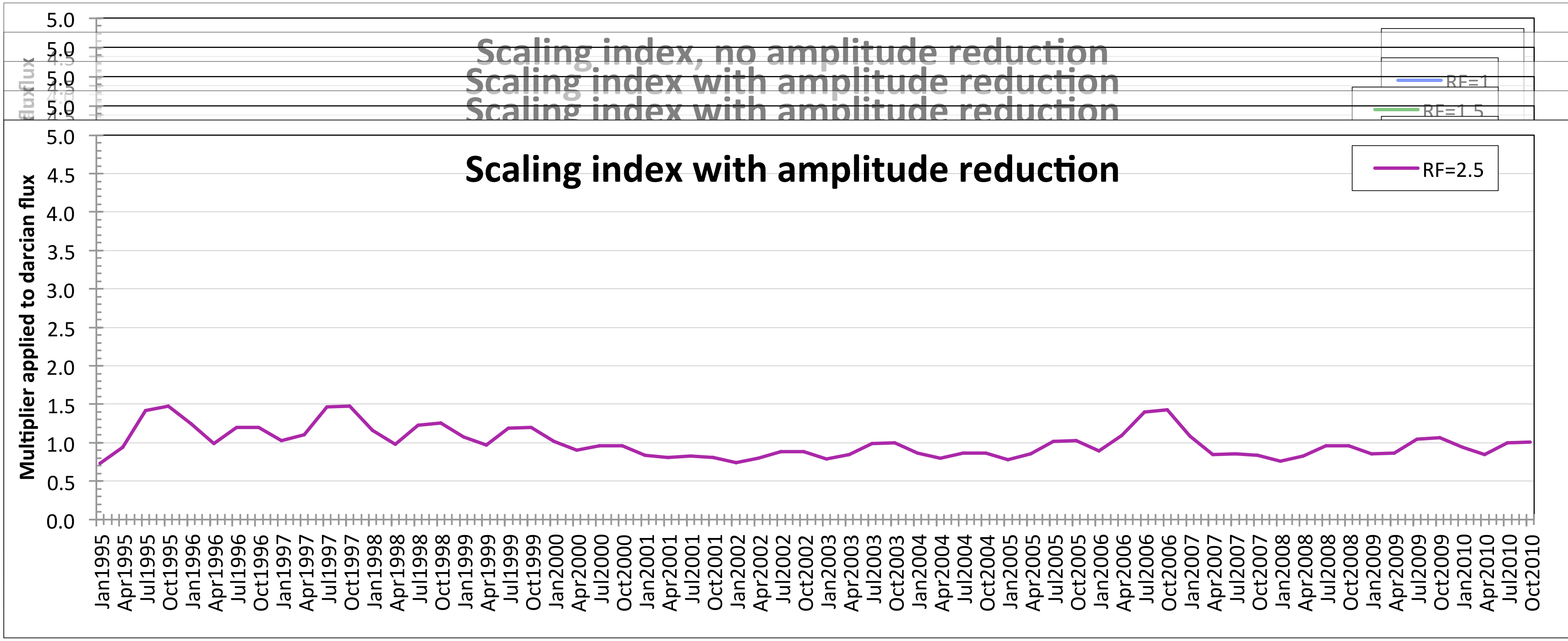
Single amplitude reduction



- How does the Reduction Factor (RF) affect the scaling index (SI)?

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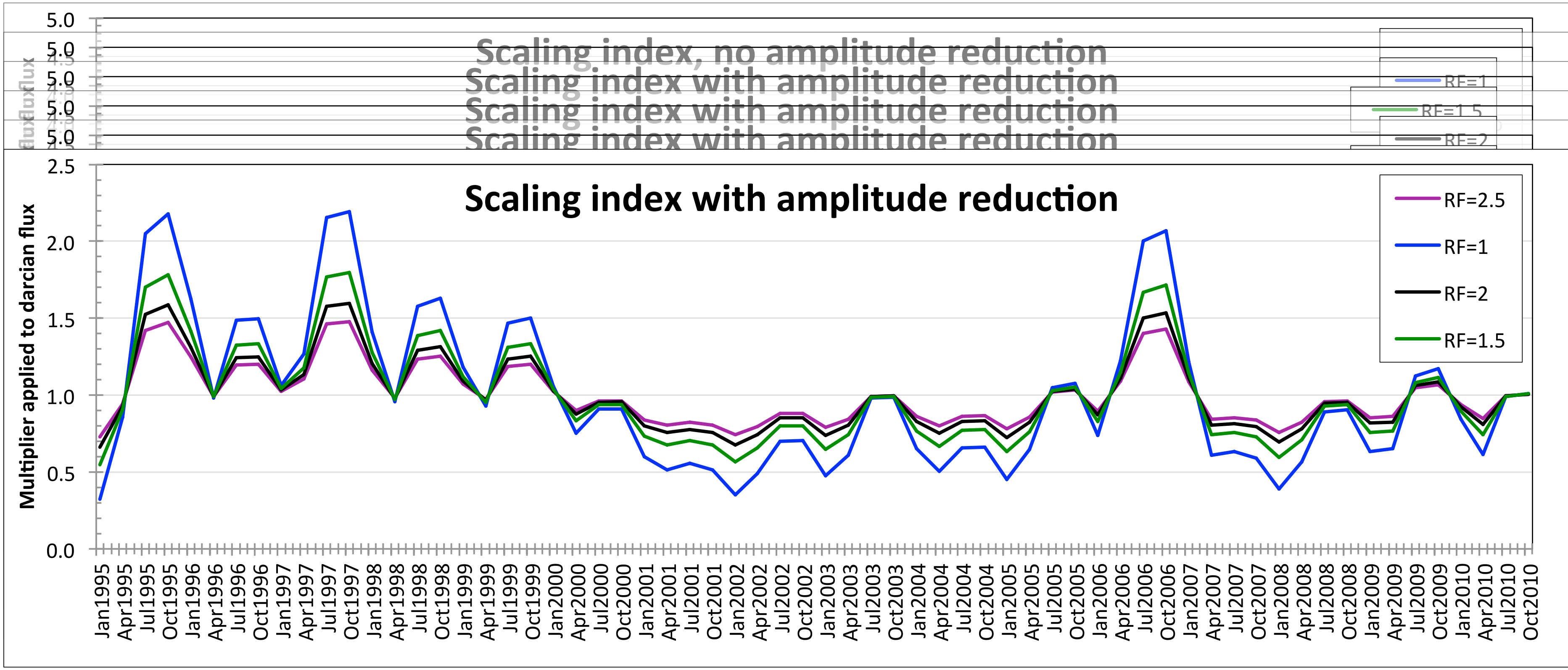
Single amplitude reduction



- How does the Reduction Factor (RF) affect the scaling index (SI)?
- Starting value for RF = 2
- PEST will be allowed to vary RF during calibration

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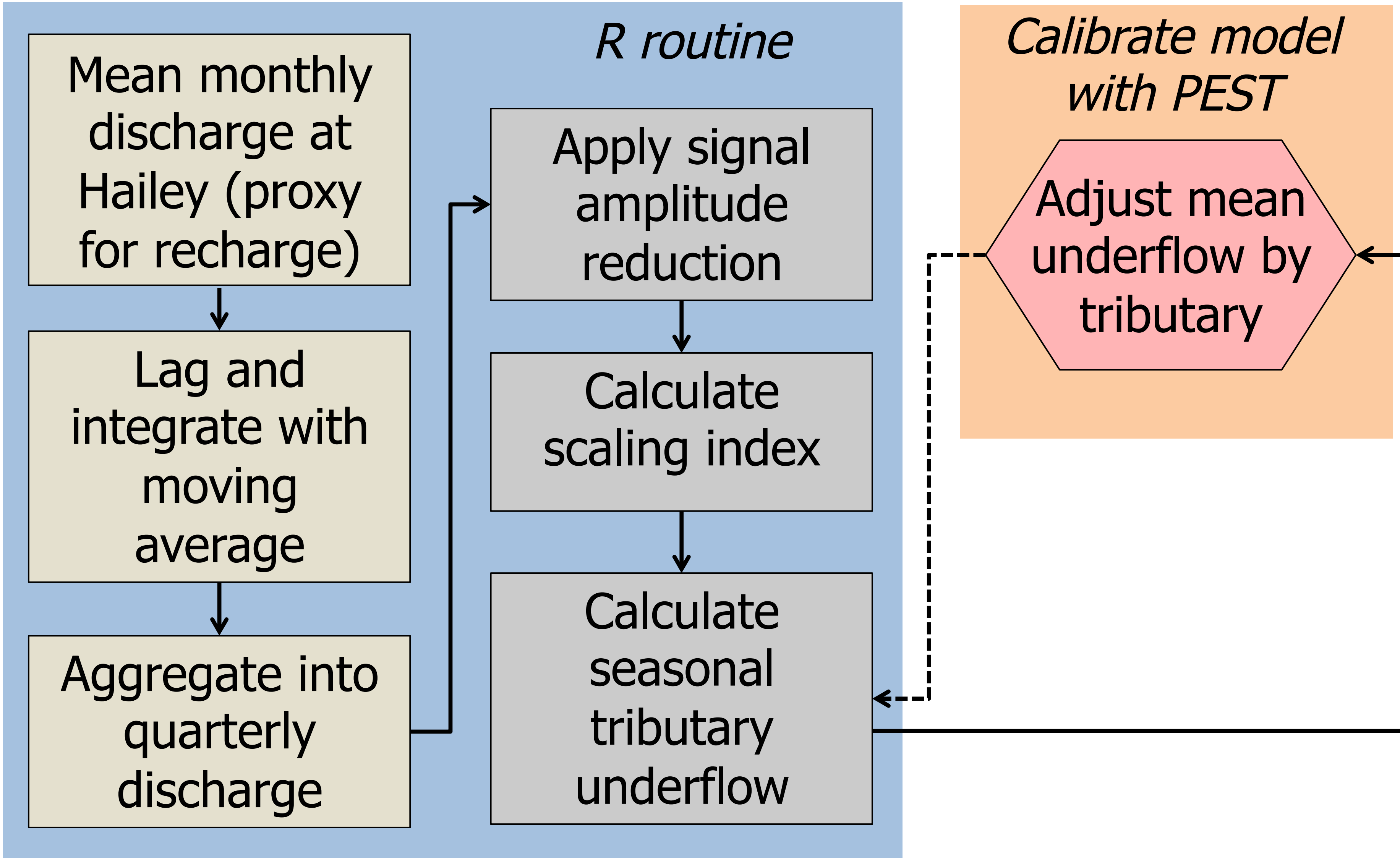
Tributary underflow process (steady state)



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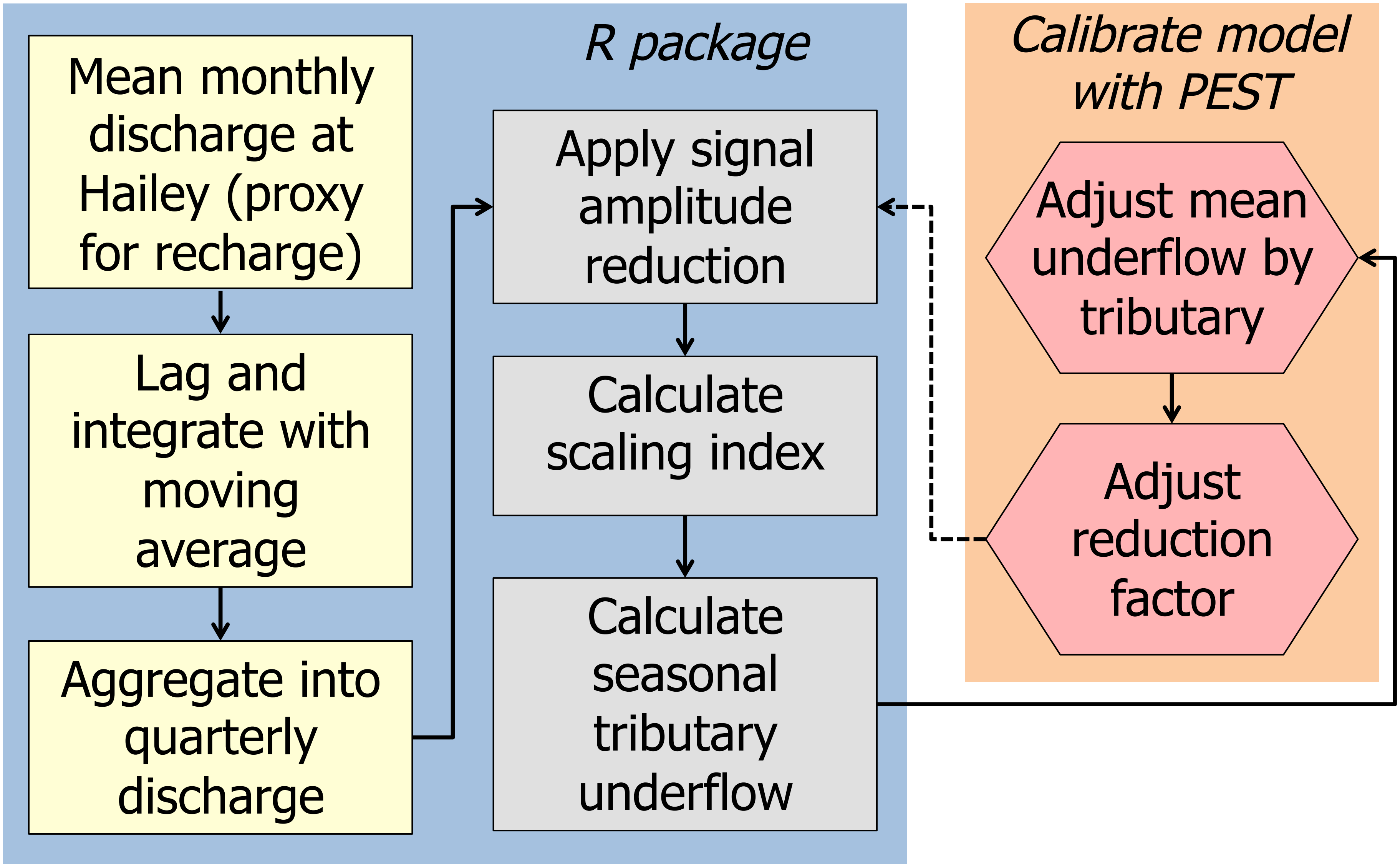
Tributary underflow process (transient)



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