

### Ensemble spring flood forecasting in Sweden: ECMWF vs. climatology



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#### **Acknowledgements**



# **Energiforsk**

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### The challenge



 To predict the accumulated spring flood volume (SFV; see figure below) in two Swedish rivers (Vindelälven and Ljusnan) on 1/1, 1/3 and 1/5



### The engine

**SMHI** 

The HBV model, well calibrated for each river



#### Tabell 1 Egenskaper för de stationer som använts i studien.

Äl∨	Station	Area	Medel-Q <sub>VF</sub>	H	BV
		(KIII-)	(117/5)	R²	RVE
Vindelälven	Sorsele	6054	289	0.89	3.2
	Vindeln*	11846	400	0.91	1.5
Ljusnan	Svegsjön	8484	209	0.87	-0.6
	Dönje*	14743	291	0.85	0.5

\*Utlopp



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- 3. Accumulate the discharge in the spring flood period ( $\rightarrow$  SFV), calculate percentiles





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- 3. Accumulate the discharge in the spring flood period (→volume), calculate percentiles

#### The competing drivers in step 2 (1981-2010)

- Climatology (IHMS): P and T during the forecast period from all historical years
- ECMWF: P and T from seasonal forecasts (System 4)



### ECMWF T bias (°C) - original (ORG)



• Comparison with local observations in period 1981-2010

			Jan	Feb	Mar	Apr	Мај	Jun	Jul
Vindelälven	1/1	ORG	-0.6	-0.3	-1.1	-1.6	-1.7	-1.2	-1.0
	1/3	ORG			-1.1	-1.5	-1.8	-1.4	-1.0
	1/5	ORG					-0.7	-0.3	-0.6
Ljusnan	1/1	ORG	-1.2	-0.5	-1.3	-1.5	-0.9	-0.1	-1.0
	1/3	ORG			-1.3	-1.4	-1.1	-0.2	-0.9
	1/5	ORG					0.1	0.5	-0.5

### ECMWF P bias (%) - original (ORG)



• Comparison with local observations in period 1981-2010

			Jan	Feb	Mar	Apr	Maj	Jun	Jul
Vindelälven	1/1	ORG	-6.9	10.3	7.7	29.5	15.9	7.3	-3.8
	1/3	ORG			1.5	32.7	20.8	7.2	-1.9
	1/5	ORG					31.8	18.2	0.6
Ljusnan 1/1	1/1	ORG	4.5	10.8	8.4	4.4	13.9	1.8	4.4
	1/3	ORG			8.0	13.5	19.0	-0.8	5.7
	1/5	ORG					34.0	8.7	5.3

### **Distribution-Based Scaling (DBS)**



- Bias correction of daily time series by distribution mapping using a Gamma (double) distribution for precipitation and a Gaussian for temperature
- Trained on hindcasts 1981-2010, applied to the same period
- Each calendar month corrected separately



Yang, W., Andréasson, J., Graham, L.P., Olsson, J., Rosberg, J., and F. Wetterhall (2010) Distribution-based scaling to improve<sub>11</sub> usability of regional climate model projections for hydrological climate change impact studies, Hydrol. Res., 41, 211-229.

### ECMWF T bias (°C) - corrected (DBS/COR) SMH

• Comparison with local observations in period 1981-2010

			Jan	Feb	Mar	Apr	Мај	Jun	Jul
Vindelälven	1/1	ORG	-0.6	-0.3	-1.1	-1.6	-1.7	-1.2	-1.0
		DBS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1/3	ORG			-1.1	-1.5	-1.8	-1.4	-1.0
		DBS			0.0	0.0	0.0	0.0	0.0
	1/5	ORG					-0.7	-0.3	-0.6
		DBS					0.0	0.0	0.0
Ljusnan	1/1	ORG	-1.2	-0.5	-1.3	-1.5	-0.9	-0.1	-1.0
		DBS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1/3	ORG			-1.3	-1.4	-1.1	-0.2	-0.9
		DBS			0.0	0.0	0.0	0.0	0.0
	1/5	ORG					0.1	0.5	-0.5
		DBS					0.0	0.0	0.0

## ECMWF P bias (%) - corrected (DBS/COR) SMHI

			Jan	Feb	Mar	Apr	Maj	Jun	Jul
Vindelälven	1/1	ORG	-6.9	10.3	7.7	29.5	15.9	7.3	-3.8
		DBS	0.7	3.1	2.1	7.2	6.0	1.3	0.7
	1/3	ORG			1.5	32.7	20.8	7.2	-1.9
		DBS			1.6	6.7	5.8	1.2	0.8
	1/5	ORG					31.8	18.2	0.6
		DBS					5.8	0.9	0.7
Ljusnan	1/1	ORG	4.5	10.8	8.4	4.4	13.9	1.8	4.4
		DBS	0.9	4.2	2.7	10.2	4.3	0.8	0.8
	1/3	ORG			8.0	13.5	19.0	-0.8	5.7
		DBS			2.7	10.5	4.3	0.9	0.8
	1/5	ORG					34.0	8.7	5.3
		DBS					4.4	0.7	0.7

### **Results: SFV bias (%)**



		Vindelälven				
		Sorsele	Vindeln			
1/1	IHMS	-6.7	-5.8			
	ECorg	3.6	8.1			
	ECDBS	2.8	0.8			
1/3	IHMS	-3.9	-3.2			
	ECorg	2.3	6.6			
	ECDBS	1.0	-0.3			
1/5	IHMS	-4.1	-4.5			
	ECorg	2.8	3.6			
	ECDBS	0.3	0.1			

### **Results: Mean Absolute Error in SFV**





### **Ensemble evaluation**







### **Q-ensemblespridning**



d Vindeln 1/3



**SMHI** 

### The "peak day"



Besides a fixed 3-month window we used a moving 1-month window to define maximum total volume and the "peak day"



### Peak day forecasts in Vindeln







### So, how about that other river?



SFV bias	SFV bias		snan
		Svegsjön	Dönje
1/1	IHMS	-5.3	-2.2
	EC <sub>org</sub>	30.0	24.0
	EC <sub>dbs</sub>	16.0	9.1
1/3	IHMS	-3.7	-7.8
	EC <sub>org</sub>	22.2	-20.6
	EC <sub>dbs</sub>	12.1	-4.0
1/5	IHMS	-2.9	-4.8
	EC <sub>org</sub>	32.0	-22.8
	EC <sub>dbs</sub>	8.5	-5.1

SFV MA	=	Ljusnan			
		Svegsjön	Dönje		
1/1	IHMS	15.0	20.7		
	EC <sub>org</sub>	33.0	31.2		
	EC <sub>dbs</sub>	22.9	25.3		
1/3	IHMS	15.5	16.1		
	EC <sub>org</sub>	25.9	22.0		
	EC <sub>dbs</sub>	20.4	14.3		
1/5	IHMS	19.8	10.9		
	EC <sub>org</sub>	35.6	22.8		
	EC <sub>dbs</sub>	23.5	10.6		

### Why no improvement in Ljusnan?



- Less accurate P bias-correction?
- Complex regulation?
- Mixture of rain and snow?



### **Conclusion: a draw**



No one gets the belt but the fight must continue...



# Thanks for your attention!

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