

Supplement of Biogeosciences Discuss., 12, 11833–11861, 2015  
<http://www.biogeosciences-discuss.net/12/11833/2015/>  
doi:10.5194/bgd-12-11833-2015-supplement  
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*Supplement of*

## **Modelling anomalies in the spring and autumn land surface phenology of the European forest**

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## Supporting information

Table S1. Random Forest models for anomalies in spring phenology. TX, TN and TG: maximum, minimum and average temperature, respectively; PP: precipitation; SIS: surface incoming shortwave radiation; DAL: surface radiation daylight; GDD: growing degree days; CHIL: chilling requirements; FF, LF and PF: first, last and period of freeze, respectively.

Models												Ps-
GDD03	MTG3	MTX3	MTN3	CHIL3	F	CRR3	MRR3	CSIS3	MSIS3	CDAL3	MDAL3	0.58
GDD03	MTG9	MTX9	MTN9	CHIL3	F	CRR3	MRR9	CSIS3	MSIS9	CDAL3	MDAL9	0.61
GDD53	MTG3	MTX3	MTN3	CHIL3	F	CRR3	MRR3	CSIS3	MSIS3	CDAL3	MDAL3	0.57
GDD53	MTG9	MTX9	MTN9	CHIL3	F	CRR3	MRR9	CSIS3	MSIS9	CDAL3	MDAL9	0.61
GDD09	MTG3	MTX3	MTN3	CHIL9	F	CRR9	MRR3	CSIS9	MSIS3	CDAL9	MDAL3	0.58
GDD09	MTG9	MTX9	MTN9	CHIL9	F	CRR9	MRR9	CSIS9	MSIS9	CDAL9	MDAL9	0.60
GDD59	MTG3	MTX3	MTN3	CHIL9	F	CRR9	MRR3	CSIS9	MSIS3	CDAL9	MDAL3	0.59
GDD59	MTG9	MTX9	MTN9	CHIL9	F	CRR9	MRR9	CSIS9	MSIS9	CDAL9	MDAL9	0.61
GDD03	MTG3	MTX3	MTN3	CHIL3	F	CRR3	MRR3	-	-	-	-	0.54
GDD03	MTG9	MTX9	MTN9	CHIL3	F	CRR3	MRR9	-	-	-	-	0.57
GDD53	MTG3	MTX3	MTN3	CHIL3	F	CRR3	MRR3	-	-	-	-	0.54
GDD53	MTG9	MTX9	MTN9	CHIL3	F	CRR3	MRR9	-	-	-	-	0.57
GDD09	MTG3	MTX3	MTN3	CHIL9	F	CRR9	MRR3	-	-	-	-	0.54
GDD09	MTG9	MTX9	MTN9	CHIL9	F	CRR9	MRR9	-	-	-	-	0.53
GDD59	MTG3	MTX3	MTN3	CHIL9	F	CRR9	MRR3	-	-	-	-	0.55
GDD59	MTG9	MTX9	MTN9	CHIL9	F	CRR9	MRR9	-	-	-	-	0.55
GDD03	MTG3	MTX3	MTN3	CHIL3	F	-	-	-	-	-	-	0.54
GDD03	MTG9	MTX9	MTN9	CHIL3	F	-	-	-	-	-	-	0.56
GDD53	MTG3	MTX3	MTN3	CHIL3	F	-	-	-	-	-	-	0.53
GDD53	MTG9	MTX9	MTN9	CHIL3	F	-	-	-	-	-	-	0.56
GDD09	MTG3	MTX3	MTN3	CHIL9	F	-	-	-	-	-	-	0.52
GDD09	MTG9	MTX9	MTN9	CHIL9	F	-	-	-	-	-	-	0.52
GDD59	MTG3	MTX3	MTN3	CHIL9	F	-	-	-	-	-	-	0.52
GDD59	MTG9	MTX9	MTN9	CHIL9	F	-	-	-	-	-	-	0.54
GDD03	MTG3	MTX3	MTN3	CHIL30	-	-	-	-	-	-	-	0.48
GDD03	MTG9	MTX9	MTN9	CHIL30	-	-	-	-	-	-	-	0.49
GDD53	MTG3	MTX3	MTN3	CHIL30	-	-	-	-	-	-	-	0.48
GDD53	MTG9	MTX9	MTN9	CHIL30	-	-	-	-	-	-	-	0.49
GDD09	MTG3	MTX3	MTN3	CHIL90	-	-	-	-	-	-	-	0.49
GDD09	MTG9	MTX9	MTN9	CHIL90	-	-	-	-	-	-	-	0.45
GDD59	MTG3	MTX3	MTN3	CHIL90	-	-	-	-	-	-	-	0.48
GDD59	MTG9	MTX9	MTN9	CHIL90	-	-	-	-	-	-	-	0.47
GDD03	MTG3	MTX3	MTN3	-	-	-	-	-	-	-	-	0.41
GDD03	MTG9	MTX9	MTN9	-	-	-	-	-	-	-	-	0.38
GDD53	MTG3	MTX3	MTN3	-	-	-	-	-	-	-	-	0.41
GDD53	MTG9	MTX9	MTN9	-	-	-	-	-	-	-	-	0.37
GDD09	MTG3	MTX3	MTN3	-	-	-	-	-	-	-	-	0.43
GDD09	MTG9	MTX9	MTN9	-	-	-	-	-	-	-	-	0.37
GDD59	MTG3	MTX3	MTN3	-	-	-	-	-	-	-	-	0.42
GDD59	MTG9	MTX9	MTN9	-	-	-	-	-	-	-	-	0.40

Table S2. Random Forest models for anomalies in autumn phenology. TX, TN and TG: maximum, minimum and average temperature, respectively; PP: precipitation; SIS: surface incoming shortwave radiation; DAL: surface radiation daylight; GDD: growing degree days; CHIL: chilling requirements; FF, LF and PF: first, last and period of freeze, respectively.

Models														Ps-R <sup>2</sup>
GDD030	MTG30	MTX30	MTN30	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30	FF	FF	LF	PF	0.78
GDD030	MTG90	MTX90	MTN90	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90	FF	FF	LF	PF	0.81
GDD530	MTG30	MTX30	MTN30	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30	FF	FF	LF	PF	0.78
GDD530	MTG90	MTX90	MTN90	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90	FF	FF	LF	PF	0.81
GDD090	MTG30	MTX30	MTN30	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30	FF	FF	LF	PF	0.81

GDD090	MTG90	MTX90	MTN90	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90	FF	FF	LF	PF	0.80
GDD590	MTG30	MTX30	MTN30	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30	FF	FF	LF	PF	0.81
GDD590	MTG90	MTX90	MTN90	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90	FF	FF	LF	PF	0.79
GDD030	MTG30	MTX30	MTN30	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30					0.74
GDD030	MTG90	MTX90	MTN90	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90					0.81
GDD530	MTG30	MTX30	MTN30	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30					0.75
GDD530	MTG90	MTX90	MTN90	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90					0.81
GDD090	MTG90	MTX90	MTN90	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90					0.79
GDD090	MTG30	MTX30	MTN30	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30					0.80
GDD590	MTG90	MTX90	MTN90	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90					0.79
GDD590	MTG30	MTX30	MTN30	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30					0.79
GDD030	MTG30	MTX30	MTN30	CRR30	MRR30	FF	FF	LF	PF					0.72
GDD030	MTG90	MTX90	MTN90	CRR30	MRR90	FF	FF	LF	PF					0.77
GDD530	MTG30	MTX30	MTN30	CRR30	MRR30	FF	FF	LF	PF					0.74
GDD530	MTG90	MTX90	MTN90	CRR30	MRR90	FF	FF	LF	PF					0.77
GDD090	MTG30	MTX30	MTN30	CRR90	MRR30	FF	FF	LF	PF					0.76
GDD090	MTG90	MTX90	MTN90	CRR90	MRR90	FF	FF	LF	PF					0.73
GDD590	MTG30	MTX30	MTN30	CRR90	MRR30	FF	FF	LF	PF					0.76
GDD590	MTG90	MTX90	MTN90	CRR90	MRR90	FF	FF	LF	PF					0.73
GDD030	MTG30	MTX30	MTN30	CSIS30	MSIS30	CDAL30	MDAL30							0.72
GDD030	MTG90	MTX90	MTN90	CSIS30	MSIS90	CDAL30	MDAL90							0.78
GDD530	MTG30	MTX30	MTN30	CSIS30	MSIS30	CDAL30	MDAL30							0.73
GDD530	MTG90	MTX90	MTN90	CSIS30	MSIS90	CDAL30	MDAL90							0.77
GDD090	MTG90	MTX90	MTN90	CSIS90	MSIS90	CDAL90	MDAL90							0.77
GDD090	MTG30	MTX30	MTN30	CSIS90	MSIS30	CDAL90	MDAL30							0.77
GDD590	MTG90	MTX90	MTN90	CSIS90	MSIS90	CDAL90	MDAL90							0.77
GDD590	MTG30	MTX30	MTN30	CSIS90	MSIS30	CDAL90	MDAL30							0.76
GDD030	MTG30	MTX30	MTN30	FF	FF	LF	PF							0.71
GDD030	MTG90	MTX90	MTN90	FF	FF	LF	PF							0.73
GDD530	MTG30	MTX30	MTN30	FF	FF	LF	PF							0.72
GDD530	MTG90	MTX90	MTN90	FF	FF	LF	PF							0.72
GDD090	MTG90	MTX90	MTN90	FF	FF	LF	PF							0.70
GDD590	MTG30	MTX30	MTN30	FF	FF	LF	PF							0.71
GDD590	MTG90	MTX90	MTN90	FF	FF	LF	PF							0.70
GDD030	MTG30	MTX30	MTN30	CRR30	MRR30									0.66
GDD030	MTG90	MTX90	MTN90	CRR30	MRR90									0.75
GDD530	MTG30	MTX30	MTN30	CRR30	MRR30									0.68
GDD530	MTG90	MTX90	MTN90	CRR30	MRR90									0.75
GDD090	MTG90	MTX90	MTN90	CRR90	MRR90									0.69
GDD090	MTG30	MTX30	MTN30	CRR90	MRR30									0.73
GDD590	MTG90	MTX90	MTN90	CRR90	MRR90									0.70
GDD590	MTG30	MTX30	MTN30	CRR90	MRR30									0.73

Table S3. Random Forest models for anomalies in autumn phenology considering spring anomalies as a predictor. TX, TN and TG: maximum, minimum and average temperature, respectively; PP: precipitation; SIS: surface incoming shortwave radiation; DAL: surface radiation daylight; GDD: growing degree days; CHIL: chilling requirements; FF, LF and PF: first, last and period of freeze, respectively.

Models													Ps-R <sup>2</sup>
Sp. Anom.	GDD030	MTG30	MTX30	MTN30	CHIL30	FF	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30	0.58
Sp. Anom.	GDD030	MTG90	MTX90	MTN90	CHIL30	FF	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90	0.61
Sp. Anom.	GDD530	MTG30	MTX30	MTN30	CHIL30	FF	CRR30	MRR30	CSIS30	MSIS30	CDAL30	MDAL30	0.58
Sp. Anom.	GDD530	MTG90	MTX90	MTN90	CHIL30	FF	CRR30	MRR90	CSIS30	MSIS90	CDAL30	MDAL90	0.61
Sp. Anom.	GDD090	MTG30	MTX30	MTN30	CHIL90	FF	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30	0.59
Sp. Anom.	GDD090	MTG90	MTX90	MTN90	CHIL90	FF	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90	0.60
Sp. Anom.	GDD590	MTG30	MTX30	MTN30	CHIL90	FF	CRR90	MRR30	CSIS90	MSIS30	CDAL90	MDAL30	0.60
Sp. Anom.	GDD590	MTG90	MTX90	MTN90	CHIL90	FF	CRR90	MRR90	CSIS90	MSIS90	CDAL90	MDAL90	0.61
Sp. Anom.	GDD030	MTG30	MTX30	MTN30	CHIL30	FF	CRR30	MRR30					0.55
Sp. Anom.	GDD030	MTG90	MTX90	MTN90	CHIL30	FF	CRR30	MRR90					0.57
Sp. Anom.	GDD530	MTG30	MTX30	MTN30	CHIL30	FF	CRR30	MRR30					0.54
Sp. Anom.	GDD530	MTG90	MTX90	MTN90	CHIL30	FF	CRR30	MRR90					0.57
Sp. Anom.	GDD090	MTG30	MTX30	MTN30	CHIL90	FF	CRR90	MRR30					0.55
Sp. Anom.	GDD090	MTG90	MTX90	MTN90	CHIL90	FF	CRR90	MRR90					0.53
Sp. Anom.	GDD590	MTG30	MTX30	MTN30	CHIL90	FF	CRR90	MRR30					0.56
Sp. Anom.	GDD590	MTG90	MTX90	MTN90	CHIL90	FF	CRR90	MRR90					0.55
Sp. Anom.	GDD030	MTG30	MTX30	MTN30	CHIL30	FF	CRR90	MRR90					0.55
Sp. Anom.	GDD030	MTG90	MTX90	MTN90	CHIL30	FF							0.56
Sp. Anom.	GDD530	MTG30	MTX30	MTN30	CHIL30	FF							0.54
Sp. Anom.	GDD530	MTG90	MTX90	MTN90	CHIL30	FF							0.56
Sp. Anom.	GDD090	MTG30	MTX30	MTN30	CHIL90	FF							0.54
Sp. Anom.	GDD090	MTG90	MTX90	MTN90	CHIL90	FF							0.52
Sp. Anom.	GDD590	MTG30	MTX30	MTN30	CHIL90	FF							0.53
Sp. Anom.	GDD590	MTG90	MTX90	MTN90	CHIL90	FF							0.55
Sp. Anom.	GDD030	MTG30	MTX30	MTN30	CHIL30								0.50
Sp. Anom.	GDD030	MTG90	MTX90	MTN90	CHIL30								0.51
Sp. Anom.	GDD530	MTG30	MTX30	MTN30	CHIL30								0.50
Sp. Anom.	GDD530	MTG90	MTX90	MTN90	CHIL30								0.51
Sp. Anom.	GDD090	MTG30	MTX30	MTN30	CHIL90								0.51
Sp. Anom.	GDD090	MTG90	MTX90	MTN90	CHIL90								0.48
Sp. Anom.	GDD590	MTG30	MTX30	MTN30	CHIL90								0.51
Sp. Anom.	GDD590	MTG90	MTX90	MTN90	CHIL90								0.51
Sp. Anom.	GDD030	MTG30	MTX30	MTN30									0.42
Sp. Anom.	GDD030	MTG90	MTX90	MTN90									0.41
Sp. Anom.	GDD530	MTG30	MTX30	MTN30									0.42
Sp. Anom.	GDD530	MTG90	MTX90	MTN90									0.40
Sp. Anom.	GDD090	MTG30	MTX30	MTN30									0.44
Sp. Anom.	GDD090	MTG90	MTX90	MTN90									0.39
Sp. Anom.	GDD590	MTG30	MTX30	MTN30									0.43
Sp. Anom.	GDD590	MTG90	MTX90	MTN90									0.42