

Supplement1: RPM and Century model inputs

Data sources from which model inputs were obtained are listed in Table 1. Because RPM was adapted from the Century model, the two models share many required inputs. RPM is a gridded or raster-based model and many of the required inputs are also raster-based. For Century simulations, which are point-based, input values were taken from the same data sources by taking the value from the pixel containing the simulation location.

Table 1. Input data sources and values for RPM and Century model runs.

Input	Source
Soil variables	ISRIC SoilGrids 250m, version 2.0, available from soilgrids.org
Monthly average minimum/maximum daily temperature	Historical average annual monthly minimum and maximum temperature for the period 1970-2000, version 2.0, available from worldclim.org
Monthly precipitation	Historical average annual monthly precipitation for the period 1970-2000, version 2.0, available from worldclim.org
Site parameters	See Table 2.
Plant functional type parameters	See Table 2.
Animal parameters	See Table 2.
Management threshold	100 kg/ha
Crude protein concentration of forage	14.70%
Grazing animal density (fifteen sites across precipitation gradient)	Empirical dung counts (see main text for methodology)
Grazing animal density (Gobi-Steppe ecoregion simulation)	Total number of livestock in each soum in 2018, available from 1212.mn . Converted to Sheep Forage Units following [1]

Table 2. Animal, site, and plant functional type parameters. Birth weight, standard reference weight, and standard fleece weight from [2]. Impacts of grazing on vegetation growth from the “grazing-tolerant” population described by [3]. Parameters for temperate C3 grassland in Tuva, Russia, described by [4] were calibrated via comparison to biomass data collected in Mongolia. See “Calibration of RPM and Century” for calibration methods. See RPM documentation, Appendix 1, for parameter definitions.

Type	Parameter	Value
animal	sex	nonlac_female
animal	age	116
animal	weight	18.6
animal	SRW	32.4
animal	SFW	2.28
animal	birth_weight	2.4
animal	gfcret	0.3
animal	gret_2	0.95
animal	fecf_1	0.5
animal	fecf_2	0.9
animal	feclig	0.25
plant functional type	grzeff	2
plant functional type	biok5	60
plant functional type	biomax	400
plant functional type	cfrtcn_1	0.4
plant functional type	cfrtcn_2	0.25
plant functional type	cfrtcw_1	0.5
plant functional type	cfrtcw_2	0.1
plant functional type	claypg	4
plant functional type	crprt_1	0
plant functional type	crprt_2	0
plant functional type	fallrt	0.2
plant functional type	fligni_1_1	0.2
plant functional type	fligni_1_2	0.26

plant functional type	fligni_2_1	0.00012
plant functional type	fligni_2_2	-0.0015
plant functional type	frtcindx	1
plant functional type	fsdeth_1	0.2
plant functional type	fsdeth_2	0.95
plant functional type	fsdeth_3	0.2
plant functional type	fsdeth_4	150
plant functional type	nlaypg	4
plant functional type	ppdf_1	15
plant functional type	ppdf_2	35
plant functional type	ppdf_3	1
plant functional type	ppdf_4	2.5
plant functional type	pramn_1_1	20
plant functional type	pramn_1_2	90
plant functional type	pramn_2_1	390
plant functional type	pramn_2_2	390
plant functional type	pramx_1_1	35
plant functional type	pramx_1_2	95
plant functional type	pramx_2_1	440
plant functional type	pramx_2_2	440
plant functional type	prbm_n_1_1	50
plant functional type	prbm_n_1_2	0
plant functional type	prbm_n_2_1	390
plant functional type	prbm_n_2_2	0
plant functional type	prbm_x_1_1	55
plant functional type	prbm_x_1_2	0
plant functional type	prbm_x_2_1	420
plant functional type	prbm_x_2_2	0
plant functional type	prdx_1	0.2
plant functional type	rdr	0.05

plant functional type	rtdtmp	2
plant functional type	snfxmx_1	0
plant functional type	vlossp	0.15
plant functional type	gremb	0
plant functional type	growth_months	1,2,3,4,5,6,7,8
plant functional type	senescence_month	9
plant functional type	species_factor	0
plant functional type	digestibility_slope	1.5349
plant functional type	digestibility_intercept	0.4147
site	cmix	0.5
site	adep_1	15
site	adep_10	0
site	adep_2	15
site	adep_3	15
site	adep_4	15
site	adep_5	30
site	adep_6	30
site	adep_7	30
site	adep_8	30
site	adep_9	0
site	agppa	-40
site	agppb	7.7
site	aneref_1	1.5
site	aneref_2	3
site	aneref_3	0.3
site	animpt	5
site	awtl_1	0.8
site	awtl_10	0
site	awtl_2	0.6
site	awtl_3	0.4

site	awtl_4	0.3
site	awtl_5	0.2
site	awtl_6	0.2
site	awtl_7	0.2
site	awtl_8	0.2
site	awtl_9	0
site	bgppa	100
site	bgppb	7
site	damr_1_1	0
site	damr_1_2	0
site	damr_2_1	0.02
site	damr_2_2	0.02
site	damrmn_1	15
site	damrmn_2	150
site	dec1_1	3.9
site	dec1_2	4.9
site	dec2_1	14.8
site	dec2_2	18.5
site	dec3_1	6
site	dec3_2	7.3
site	4-Dec	0.0045
site	dec5_1	0.2
site	dec5_2	0.2
site	deck5	5
site	drain	1
site	edepth	0.2
site	elitst	0.4
site	epnfa_1	0.0001
site	epnfa_2	0.008
site	epnfs_1	30

site	epnfs_2	0.01
site	favail_1	0.9
site	favail_4	0.2
site	favail_5	0.4
site	favail_6	2
site	fleach_1	0.2
site	fleach_2	0.7
site	fleach_3	1
site	fleach_4	0
site	fracro	0.15
site	fwloss_1	0.8
site	fwloss_2	0.8
site	fwloss_3	0.65
site	fwloss_4	0.8
site	minlch	18
site	nlayer	6
site	omlech_1	0.03
site	omlech_2	0.12
site	omlech_3	60
site	p1co2a_1	0.6
site	p1co2a_2	0.17
site	p1co2b_1	0
site	p1co2b_2	0.68
site	p2co2_1	0.55
site	p2co2_2	0.55
site	p3co2	0.55
site	pabres	100
site	pcemic1_1_1	16
site	pcemic1_1_2	200
site	pcemic1_2_1	10

site	pcemic1_2_2	99
site	pcemic1_3_1	0.02
site	pcemic1_3_2	0.0015
site	pcemic2_1_1	20
site	pcemic2_1_2	250
site	pcemic2_2_1	10
site	pcemic2_2_2	99
site	pcemic2_3_1	0.02
site	pcemic2_3_2	0.0015
site	peftxa	0.25
site	peftxb	0.75
site	pligst_1	3
site	pligst_2	3
site	pmco2_1	0.55
site	pmco2_2	0.55
site	pmnsec_1	0
site	pmnsec_2	0
site	pmntmp	0.004
site	pmxbio	600
site	pmxtmp	-0.0035
site	pparmn_1	0
site	pparmn_2	0.0001
site	pprpts_1	0
site	pprpts_2	1
site	pprpts_3	0.8
site	precro	8
site	ps1co2_1	0.45
site	ps1co2_2	0.55
site	ps1s3_1	0.003
site	ps1s3_2	0.032

site	ps2s3_1	0.003
site	ps2s3_2	0.009
site	psecmn_1	0
site	psecmn_2	0.0022
site	psecoc1	0
site	psecoc2	0
site	pslsrb	1
site	rad1p_1_1	12
site	rad1p_1_2	220
site	rad1p_2_1	3
site	rad1p_2_2	5
site	rad1p_3_1	5
site	rad1p_3_2	100
site	rcestr_1	200
site	rcestr_2	500
site	rictrl	0.015
site	riint	0.8
site	rsplig	0.3
site	sorpmx	2
site	spl_1	0.85
site	spl_2	0.013
site	strmax_1	5000
site	strmax_2	5000
site	teff_1	15.4
site	teff_2	11.75
site	teff_3	29.7
site	teff_4	0.031
site	tmelt_1	0
site	tmelt_2	0.002
site	varat1_1_1	14

site	varat1_1_2	150
site	varat1_2_1	3
site	varat1_2_2	30
site	varat1_3_1	2
site	varat1_3_2	2
site	varat21_1_1	22
site	varat21_1_2	400
site	varat21_2_1	15
site	varat21_2_2	100
site	varat21_3_1	2
site	varat21_3_2	2
site	varat22_1_1	20
site	varat22_1_2	400
site	varat22_2_1	12
site	varat22_2_2	100
site	varat22_3_1	2
site	varat22_3_2	2
site	varat3_1_1	8
site	varat3_1_2	200
site	varat3_2_1	6
site	varat3_2_2	50
site	varat3_3_1	2
site	varat3_3_2	2
site	vlossg	1

References

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