“Global warming and livestock sector in Mongolia”

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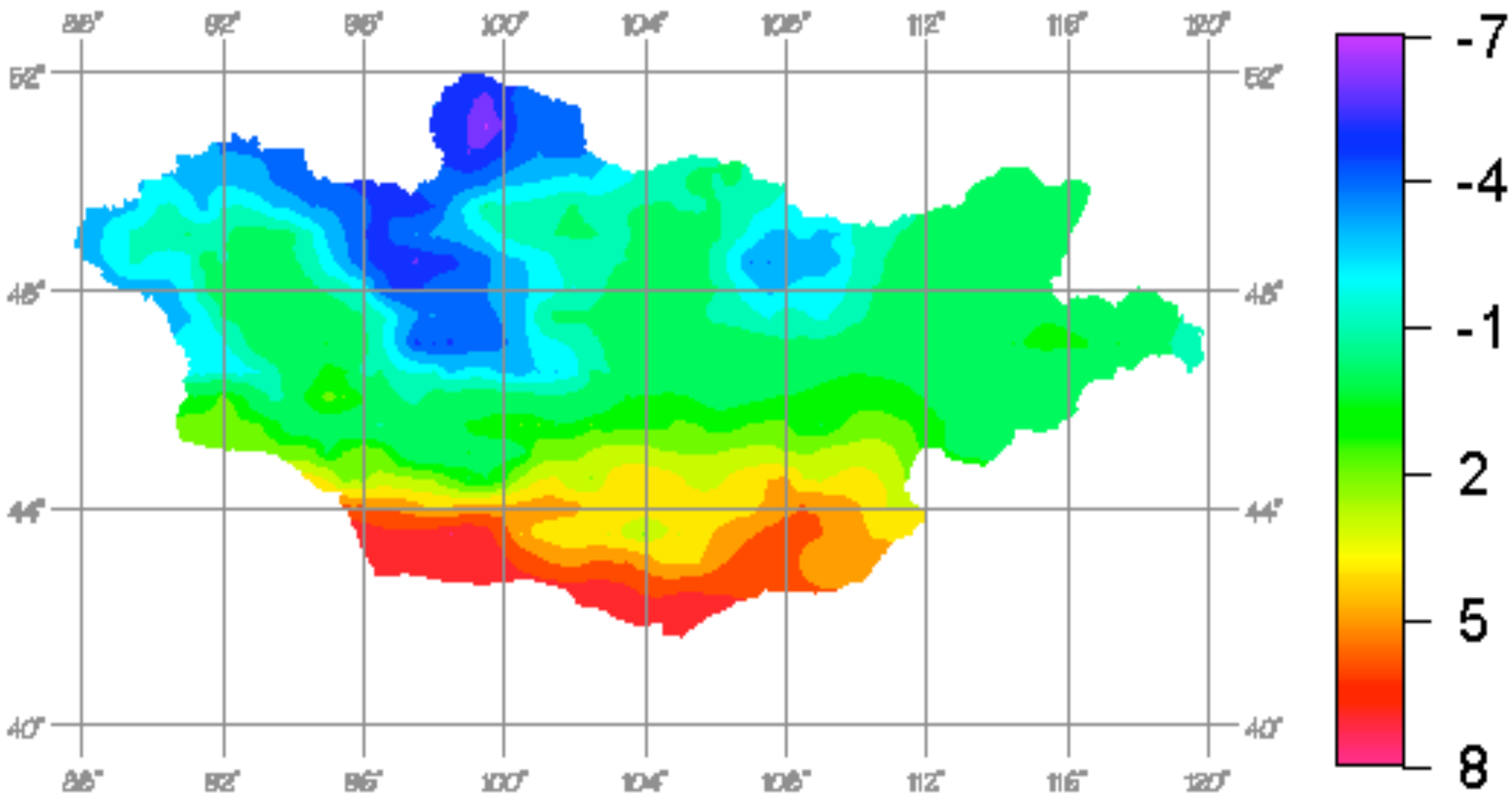
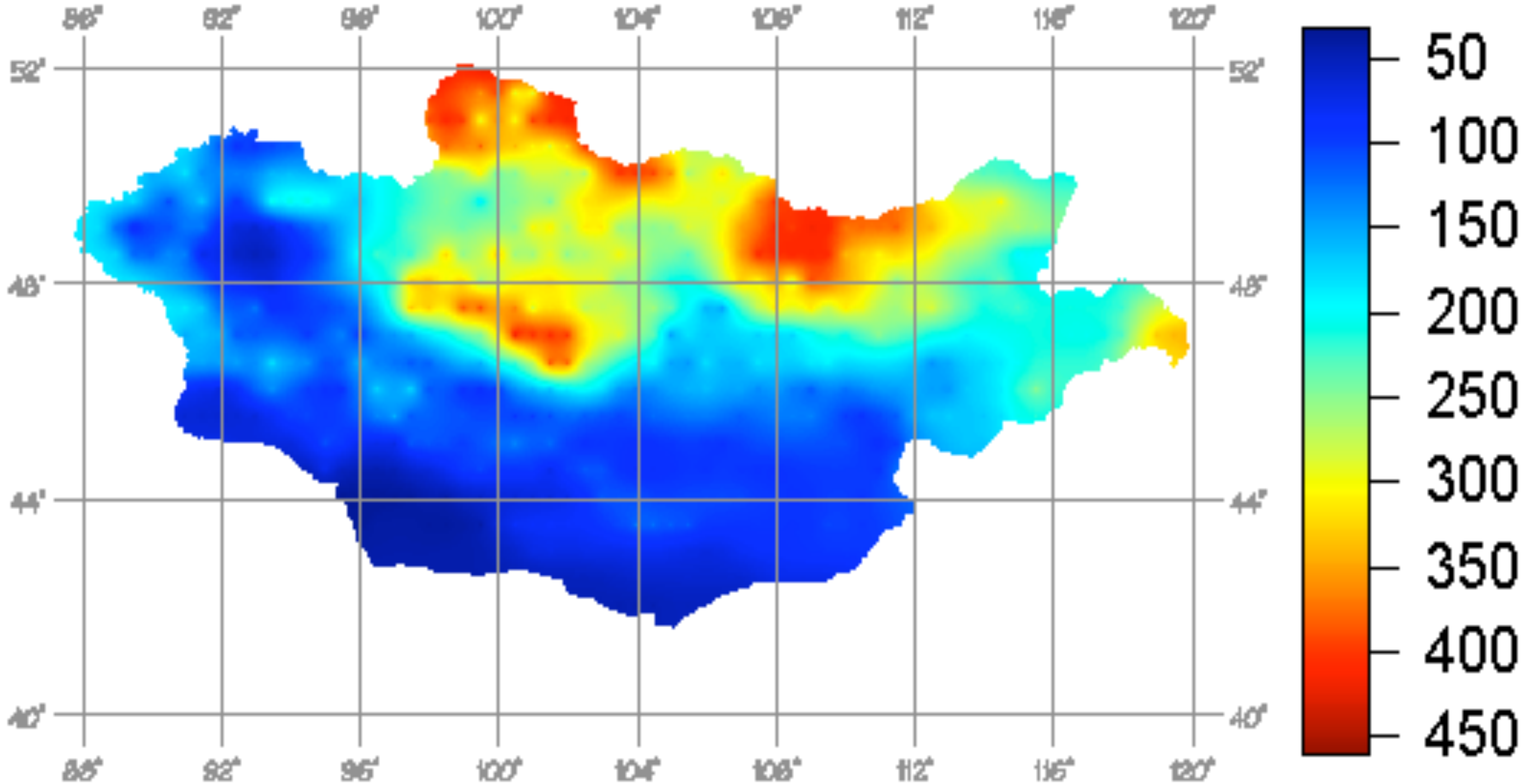
Geographical location of Mongolia

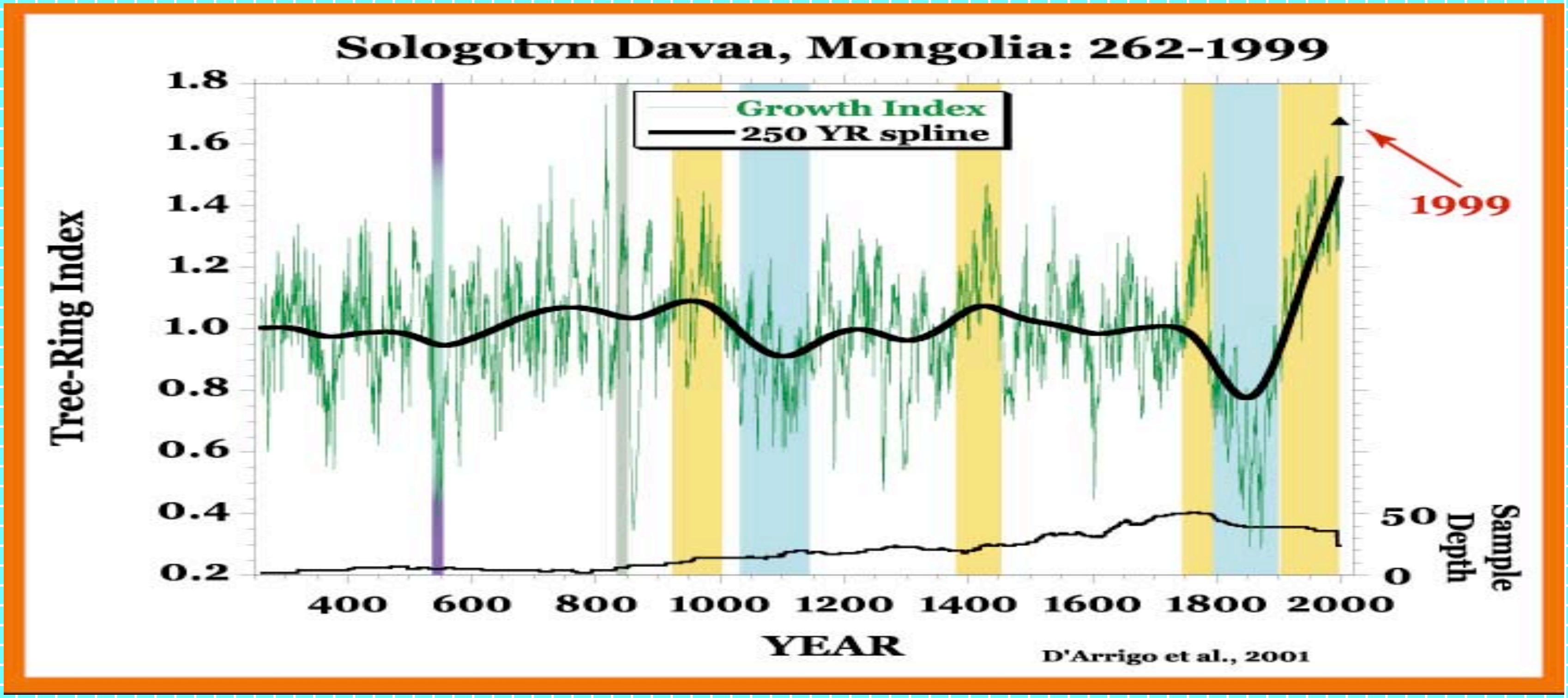
Annual mean temperature, ^{0}Ñ



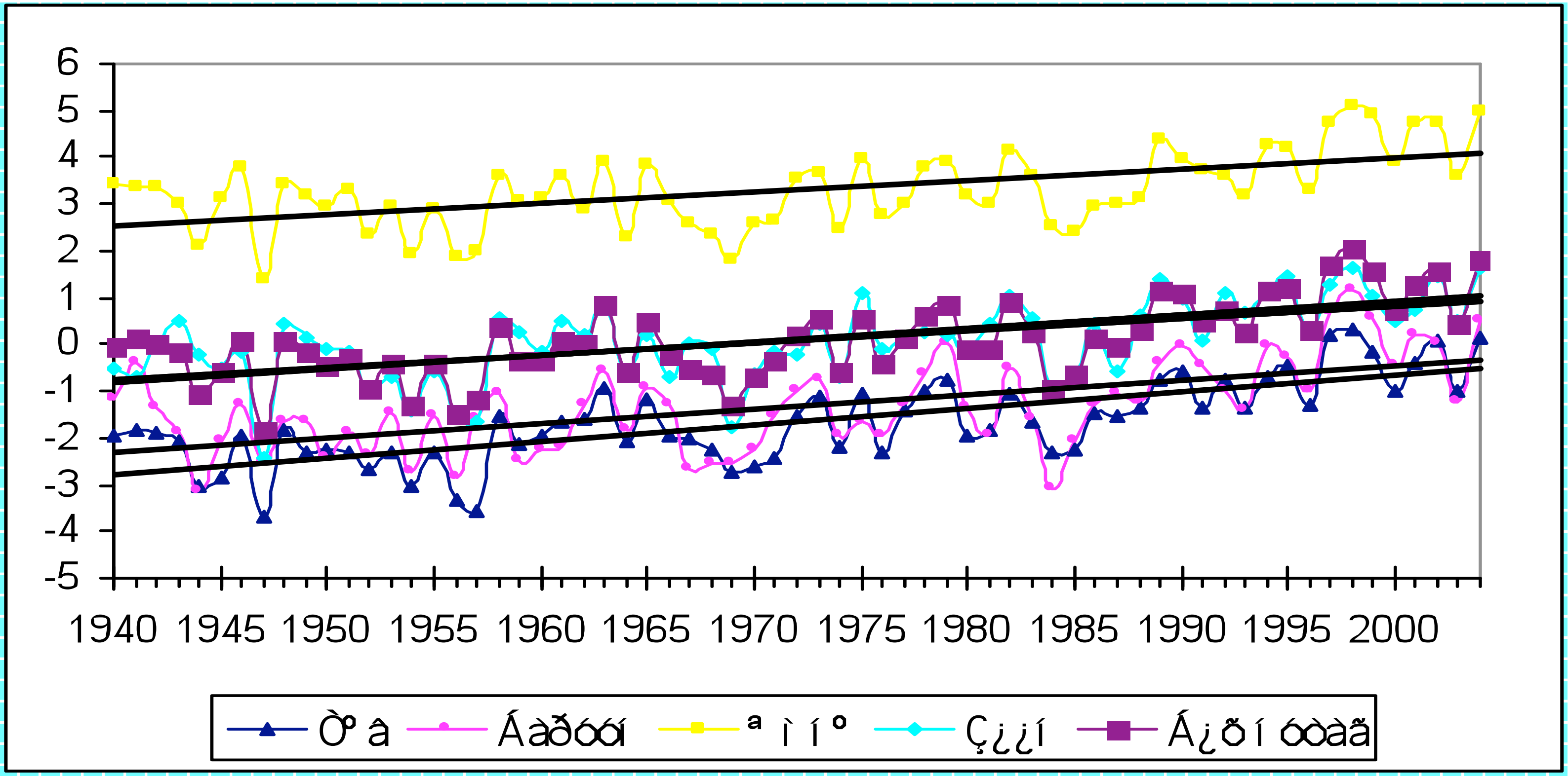
Annual precipitation, mm



Global warming was observed in period such as 650-850, 920-1020, 1370-1480, from end of 1700 to beginning of 1800, and second half of 20th century. Among those, 8 occurrences of 10 years with warming climate is observed since 1950. But coldest period is observed during the 536-545, 1020-1125 period and 19th century. Among those, 9 of 10 years with cold climate was observed within 1838-1877 as well.

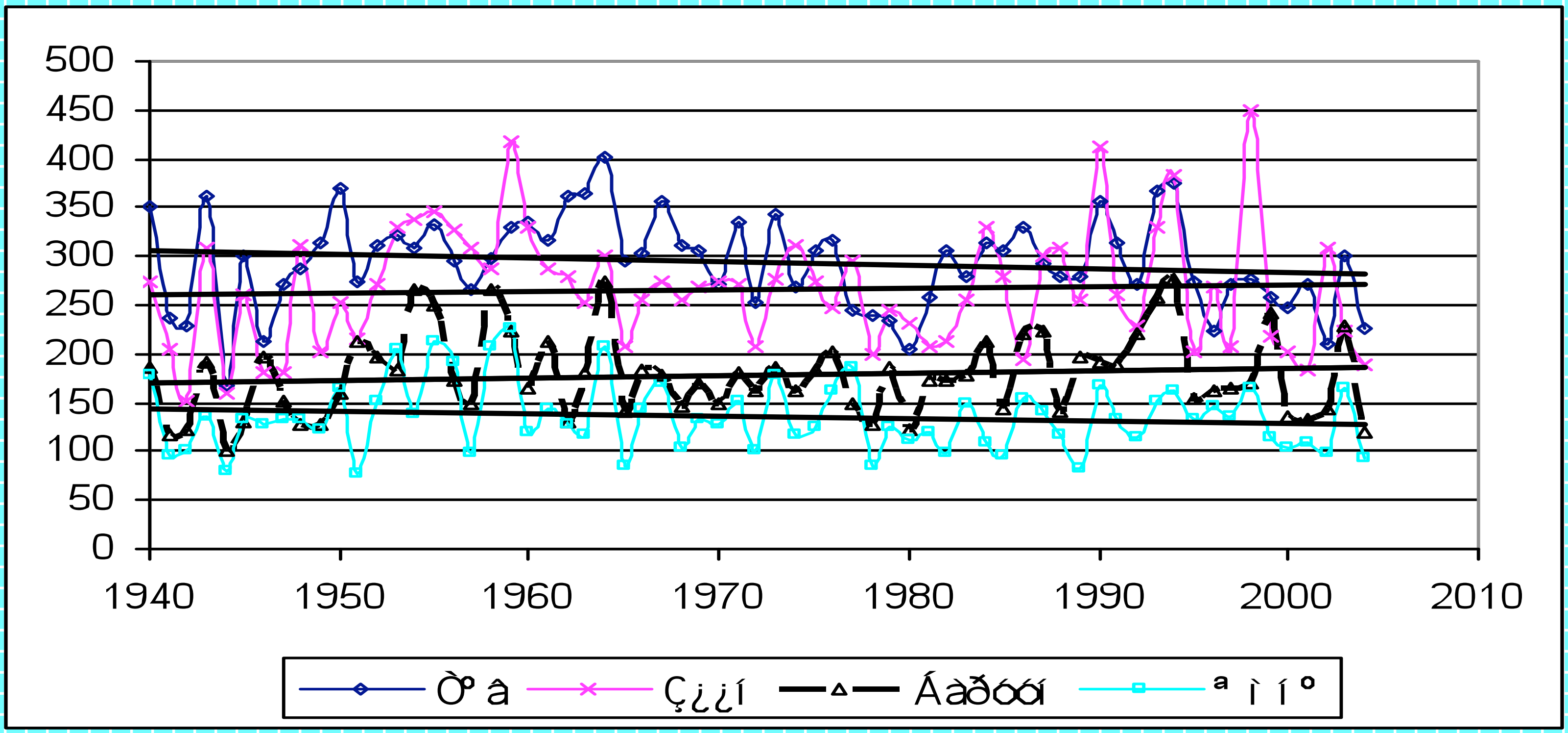


Time series of annual mean temperature

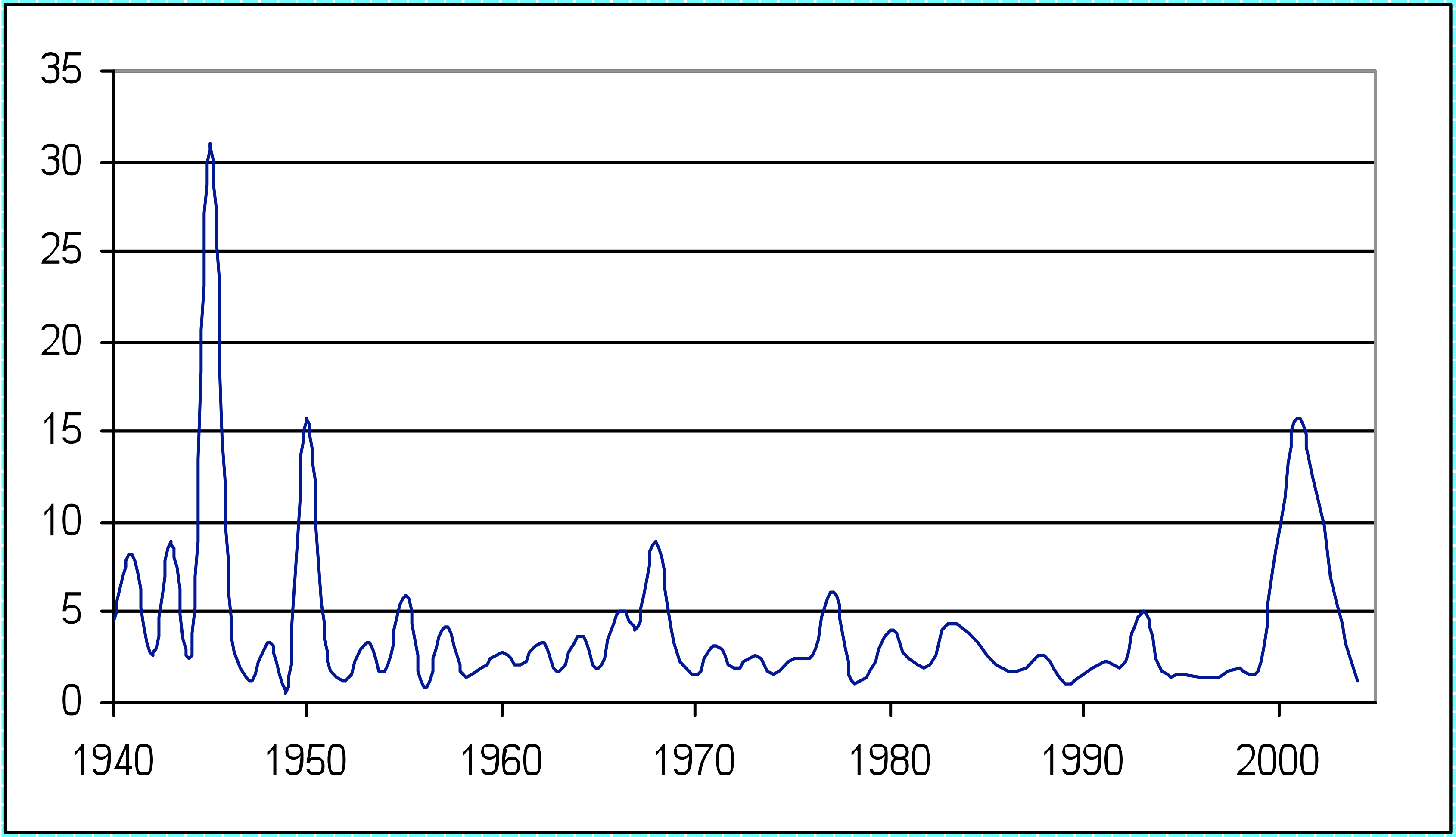


Annual mean temperature is increased by1.9⁰Ñ,
3.6⁰Ñ in winter, 1.4-1.9⁰Ñ in spring and 0.6⁰Ñ in summer within 1940-2004

Regional linear trends show that precipitation is decreased by 8.7-12.5% in Central and Southern (Gobian) region and increased by 3.5-9.3% in Western and Eastern region of Mongolia, respectively, compare to their mean value within 65 years. Autumn, winter precipitation is increased by 5.2-10.7% and summer is decreased by 9.1-3.0.



Percetage of livestock losses in total numer of livesctock



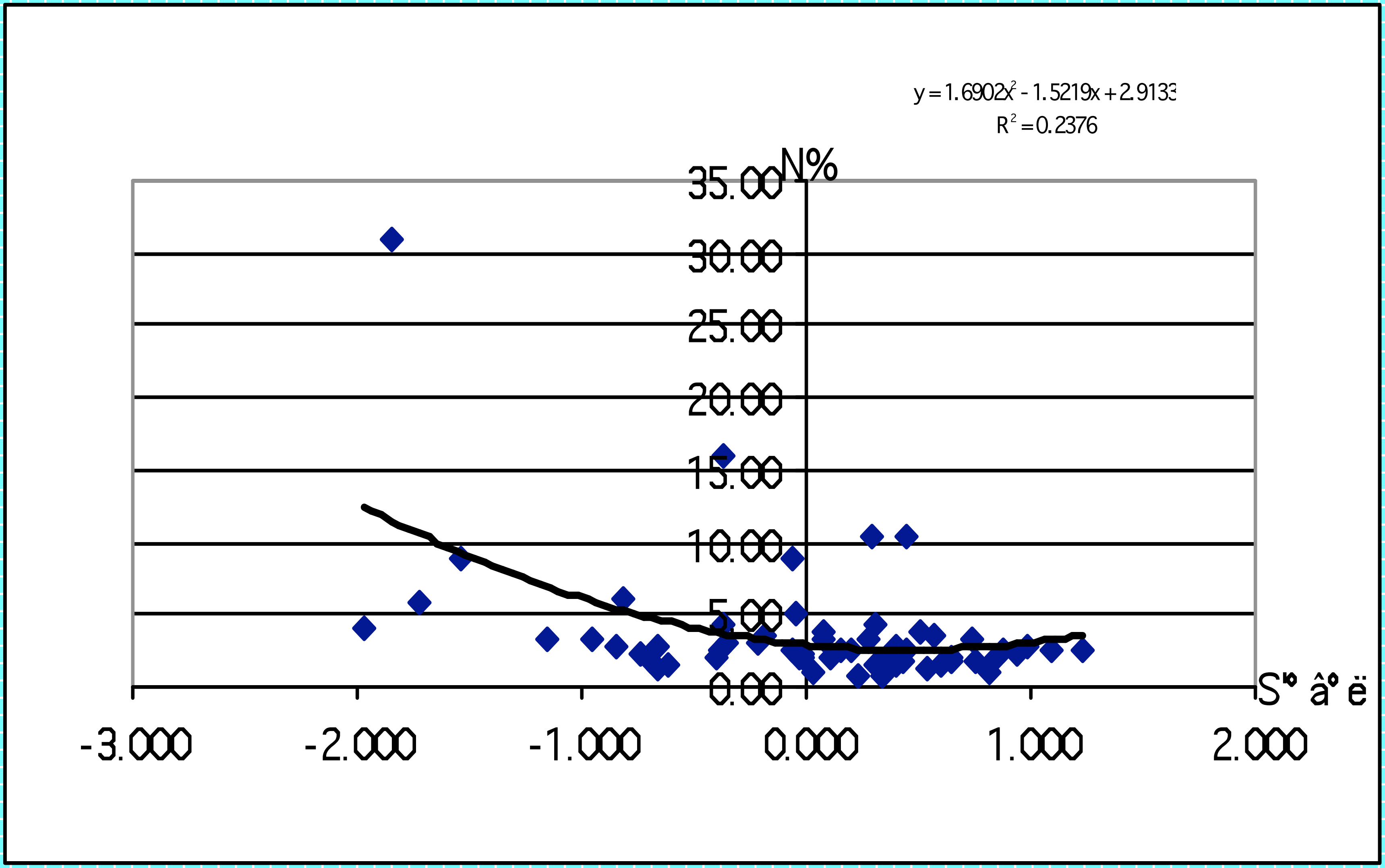
Drought and Dzud (harsh winter) assessment

$$s_{sammer} = \sum_{t=1}^{n}\left(\frac{T-\overline{T}}{\sigma_T}\right) - \sum_{t=1}^{n}\left(\frac{P-\overline{P}}{\sigma_p}\right)$$

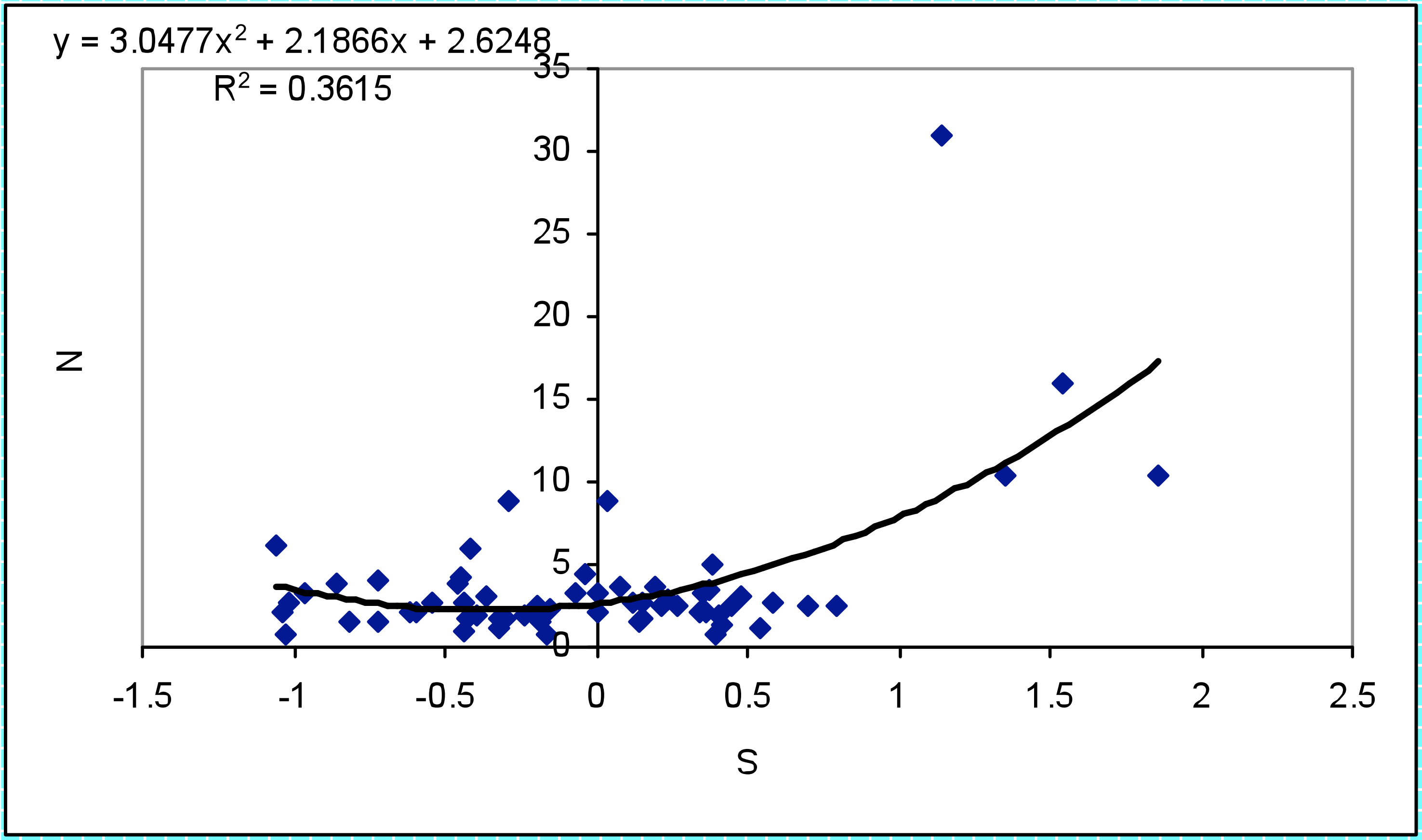
$$S_{winter} = \sum_{i=1}^{n}\left(\frac{T-\overline{T}}{\sigma_{\mathrm{T}}}\right)_i - \sum_{i=1}^{n}\left(\frac{P-\overline{P}}{\sigma p}\right)_i$$

$$\Delta S = S_{summer} - S_{winter}$$

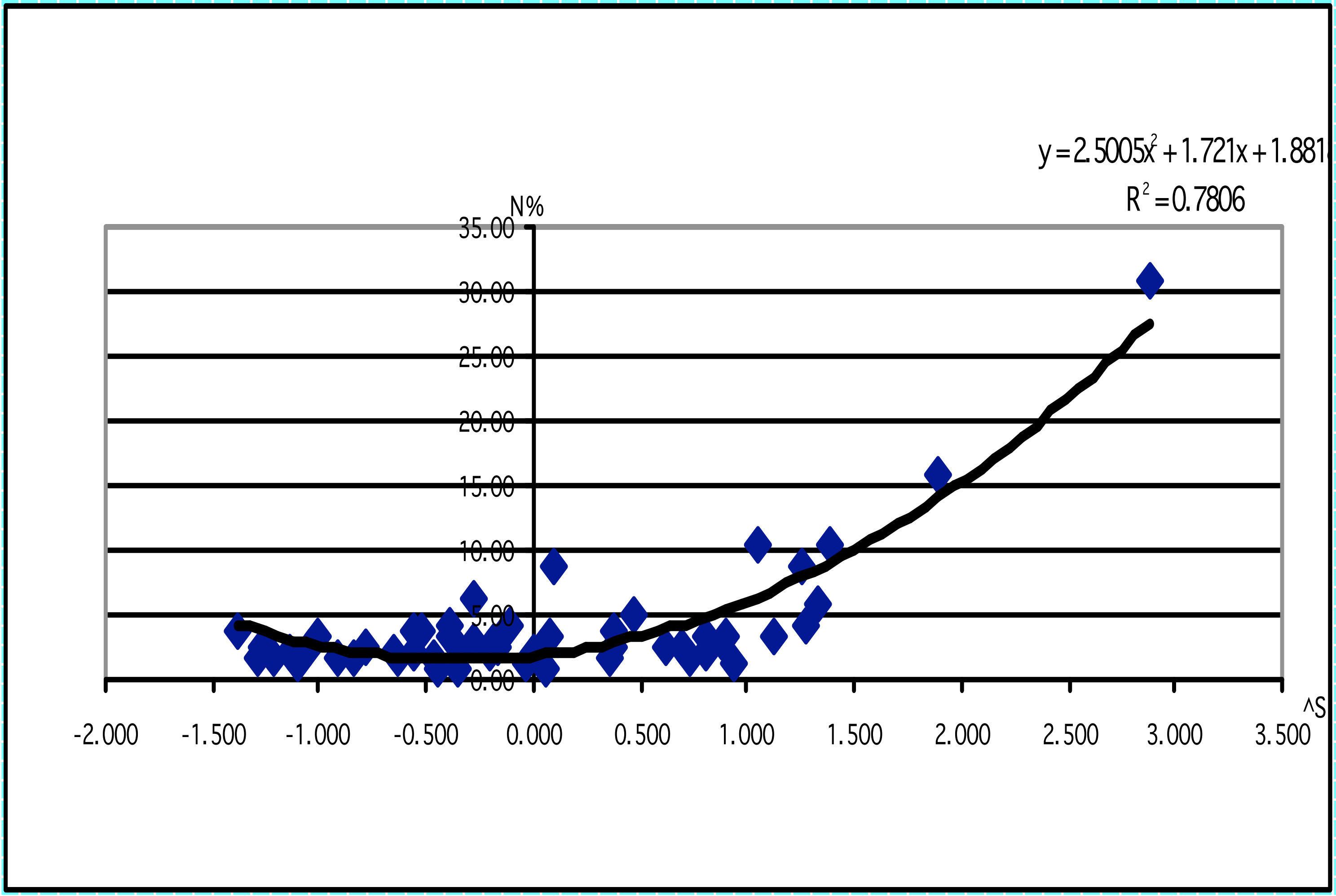
Relationship between winter index and livestock losses



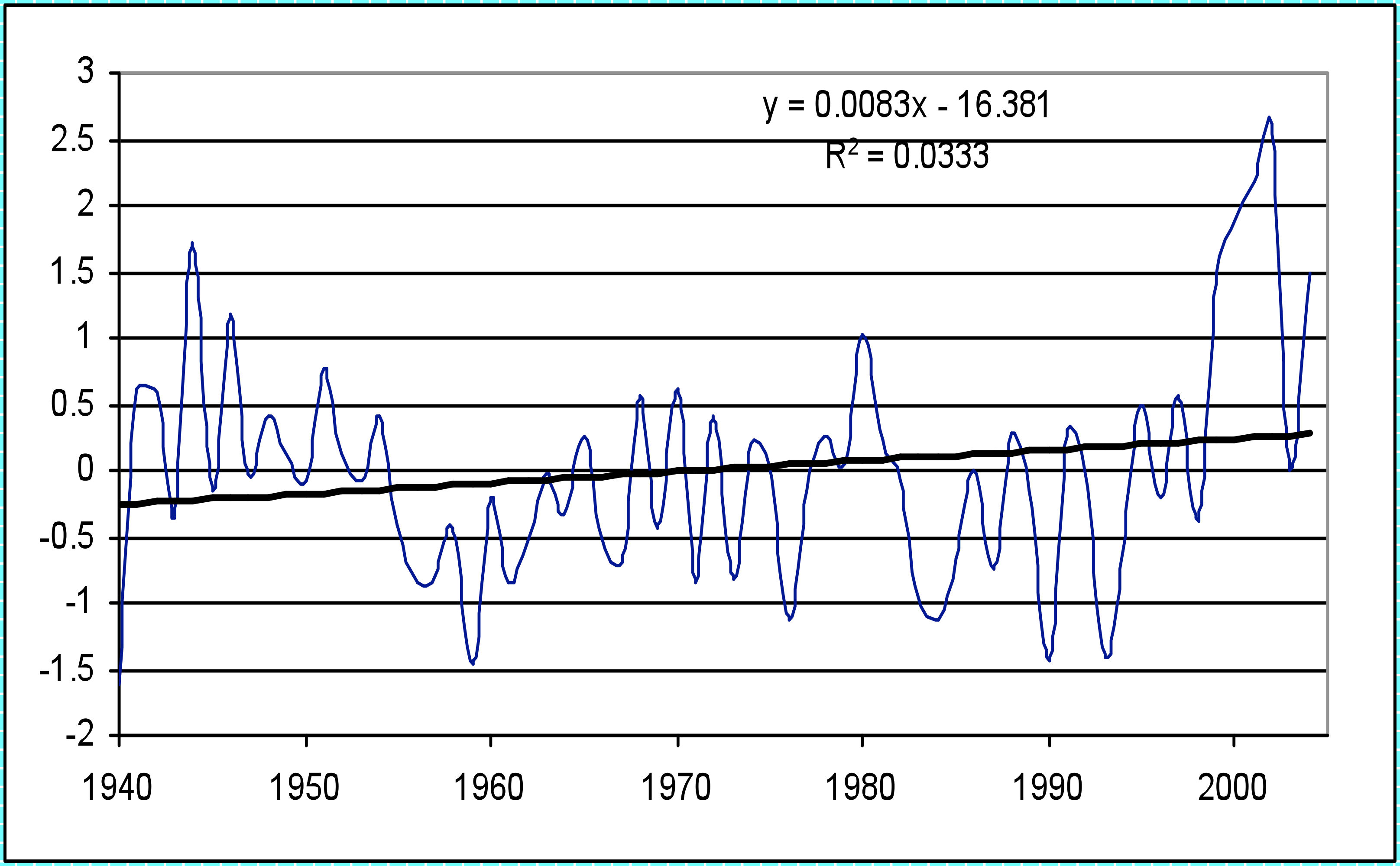
Relationship between summer index and livestock losses



Relationship Dzud index and livestock losses



Drought index time series



Seasonal climate change for temperature and precipitation estimated by HadCM3 model

Óóð àì üñãàëûí çàãâàðûí íýð	Óëèðàë	SRES A2						SRES B2					
		2020		2050		2080		2020		2050		2080	
		T^0C	R%	T^0C	R%	T^0C	R%	T^0C	R%	T^0C	R,%	T^0C	R,%
HadCM3	Æèë	1.37	2.4	2.81	11.5	4.88	14.3	1.52	5.2	2.43	11.1	3.49	11.6
	ª âº ë	0.85	23.6	2.38	38.7	3.89	67.0	0.96	16.5	1.73	34.4	2.48	54.7
	Õàâàð	1.28	7.0	2.61	16.8	4.37	18.7	1.38	6.0	1.97	11.9	3.11	17.6
	Çóí	1.99	-2.5	3.53	7.1	6.35	6.4	2.23	3.1	3.31	8.7	4.66	4.5
	Í àì àð	1.37	4.4	2.71	8.9	4.91	16.5	1.52	7.5	2.7	10.2	3.71	12.0

Summer and autumn sheep weight changes estimeted by SRES A2, HADCM3 scenarois

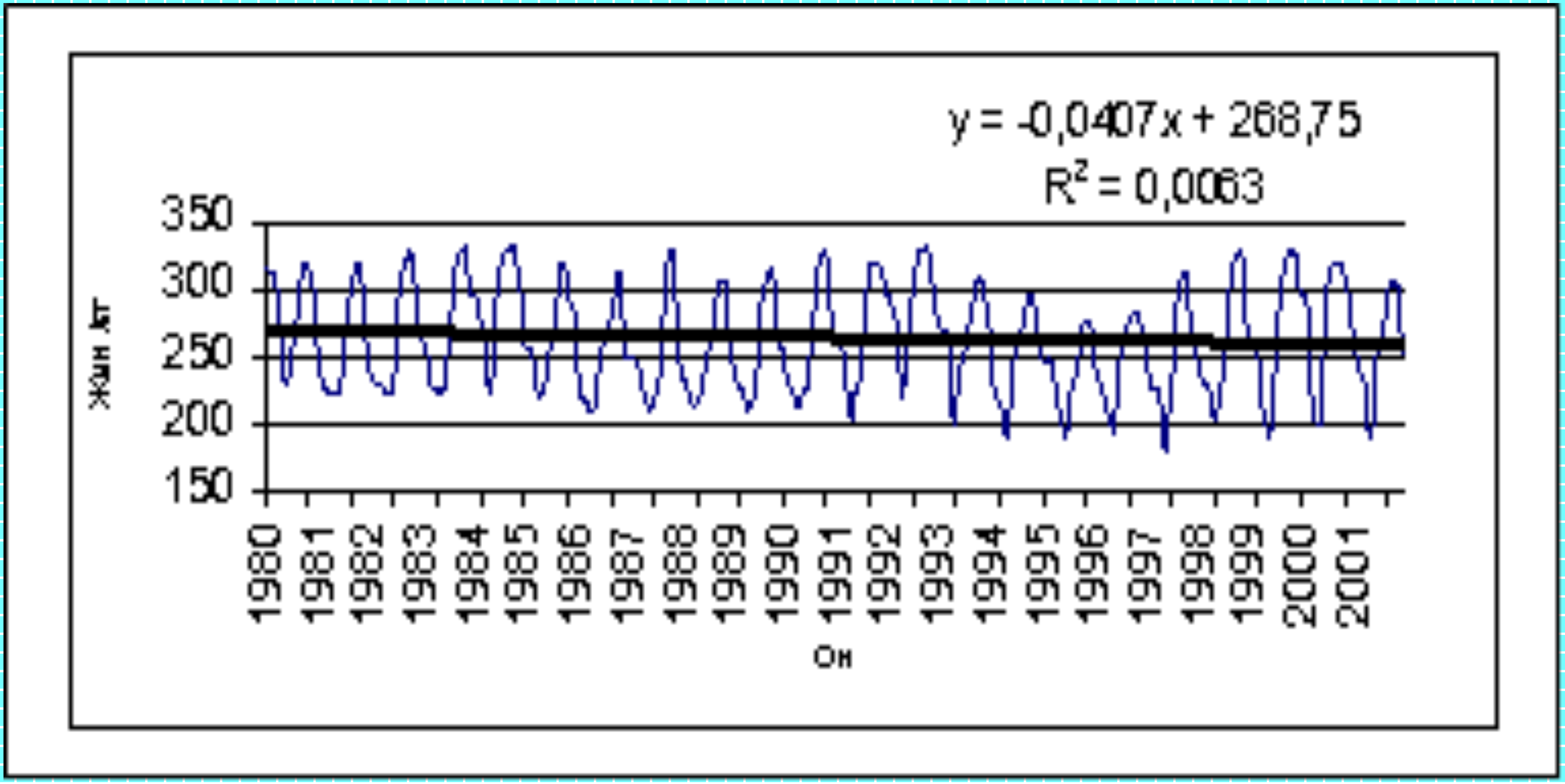
Á¿ñ	2020	2050	2080
Î éò õýýð	-10.68	-34.40	-57.75
Òàë õýýð	-12.85	-31.67	-39.50
ª í äº ð óóë	-2.92	-3.05	-9.03
Ãî âü öº ë	2.02	3.87	-0.18

Dzud index and livestock losses under SRES A2, B2 of HadCM3 scenarois

	À2			Â2		
	2020	2050	2080	2020	2050	2080
Ssum	1.83	2.44	4.84	1.72	2.15	3.62
Swin	-0.2	0.16	0.09	-0.05	-0.15	-0.325
ΔS	2.03	2.28	4.75	1.77	2.3	3.94
ΔN	12	17.8	66.5	12.1	19.1	47.5

Thank you for attention

¯õðèéí àìüäûí ººð÷ëºëò



HADCM3 çàãâàðûí ¿ð ä¿íã àøèãëàí òîîöñîí õîíèíû áýë÷ýýðèéõ íºõöëèéí èðýýä¿éí áàéäàë /%/

	Î äî î ãèéí	HADCM3 SRESA2			HADCM3 SRESB2		
		2020	2050	2080	2020	2050	2080
Õýâèéí	25.139	15.13	5.67	1.56	12.24	6.90	1.56
Õ¿í äðýõ	36.596	26.81	25.25	21.80	27.47	25.47	21.80
Ñààòàõ	38.265	58.06	69.08	76.64	60.29	67.63	76.64

Ìàëûí çóí-íàìðûí æèíãèéí ººð÷ëºëò áýë÷ýýðëýõ õóãàöààíààñ õàìààðàõ áàéäàë /HADCM3 çàãâàð,2050 îí

HADCM3						
Áàéãàëèéí á¿ñ	Áýë÷ýýðëýõ õóãàöààí û ººð÷ëºëò					
	0	2	4	6	8	10
2050						
Îéò õýýð	-5.50	-3.68	-2.25	-1.16	-0.33	
Òàë õýýð	-5.27	-3.53	-2.48	-1.21	-0.26	
ªíäºð óóë	-1.17	-0.63	-0.19	0.20	0.58	
Ãîâèéí á¿ñ	0.25	0.55	0.69	0.80	0.92	

2020 îíû ¿åä çóíû áýë÷ýýðëýëòèéã 4 öàãààð ñóíãàõàä æèíãèéí äóòóóã 1.4-1.9 êã-ààð íºõºõ áîëîìæòîé.

Ìàëûí æèíãèéí àëäààãäëûã áàãàñãàõûí òóëä 2020 îíû ¿åä íýã õîíèíûã ºäºðò 1.2 êã õ¿÷èò òýæýýë, ýñâýë 3.0 êã ø¿¿ñëýã òýæýýëýýð íýìæ òýæýýõ õýðýãòýé

Áàéãàëèéí á¿ñ	2020	2050	2080
Õ¿÷èò òýæýýë			
Îéò õýýð	1.2	1.6	2.1
Òàë õýýð	1.8	1.8	2.4
ª í äº ð óóë	0.8	1.2	1.5
Ãî âü öº ë	-	-	0.4
Ø ¿¿ñëýã òýæýýë			
Îéò õýýð	3.0	3.4	3.6
Òàë õýýð	3.3	4.2	4.6
ª í äº ð óóë	1.9	2.3	2.8
Ãî âü öº ë	-	-	2.1

Ãýâ÷ èéì áîëîìæ áèé áèë ¿¿

Äàñàí çîõèöîõóéí çàðèì õóâèëáàðóóäààñ

- Áýë÷ýýðèéí çºâ îíîâ÷òîé ìåíåæìåíò áóé áîëãîõ:

--áýë÷ýýðèéí ãàçðûí õàðèëöààã ýðõ ç¿éí áàòàëãààòàé áîëãîõ,

- Áýë×ýýðèéí õàìòàðñàí ìåíåæìåíò ÿâóóëàõ,

-áàéãàëèéí áîëîí õ¿íèé ¿éë àæèëëàãààíû ñºðºã íºëººëëººñ áýë÷ýýðèéã õàìãààëàõ, óðüä÷èëàí ñýðãèéëýõ,

-áýë÷ýýðèéí òºëºâ áàéäàë, ÷àíàðûí ¿íýëãýý, çýðýãëýë òîãòîîõ õÿíàëò øèíæèëãýýíèé ñ¿ëæýý á¿ðä¿¿ëýõ,

-Áýë÷ýýòèéã ¿íý òºëáºðòýé àøèãëàõ,

-äîðîéòîëä îðñîí áýë÷ýýð íóòãèéã ñýðãýýõ,

-Áýë÷ýýðèéí ìàë àæ àõóéã õºãæ¿¿ëýõýä Ìîíãîë ìàëûí ýêîëîãèéí çîõèñòîé íóòãèéí ¿çýë áàðèìòëàëä íèéö¿¿ëýí îäîîãèéí çàñàã çàõèðãàà, íóòàã äýâñãýðèéí íýãæèéí ººð÷ëºëòèéã ÿàðàâ÷ëàí õèéõ

Ãàí-çóäààñ óðüä÷èëàí ñýðãèéëýõ òîãòîëöîîã áîëîâñðîíãóé áîëãîõ

¯ðãýëæëýë

- Ñóóðèí ìàë àæ àõóéã õºãæ¿¿ëýõ íü

Ýðèí ¿åèéí íºõöºë áàéäàë õºãæëèéí øààðäëàãààð Ìîíãîë îðîíä ñóóðèí, õàãààñ ñóóðèí ìàë àæ àõóé ýðõëýõ ñî¸ë èðãýíøëèéí õýâ øèíæ á¿ðýëäýæ ýõëýýä áàéíà. Ìîíãîë óëñ çàõ çýýëèéí íèéãýì-ýäèéí çàñãèéí öîî øèíý òîãòîëöîîíä øèëæèæ áàéãàà ýíý ¿åä ìàë àæ àõóéí õýòèéí òºëºâèéã òîäîðõîéëîõ, çàãâàð áîëîâñðóóëàõ çýðýã çîðèëòóóä òóëãàð÷ áàéãàà áºãººä ¿¿íä óëàìæëàëò ìàë àæ àõóéã áýë÷ýýðèéí íººöºíä òóëãóóðëàí í¿¿äëèéí àðãààð ýðõëýõ, õ¿í àì øèã¿¿ ñóóðüøñàí õîò ñóóðèíãèéí á¿ñýíä ýð÷èìæñýí ìàë àæ àõóéã õºãæ¿¿ëýõýýð òóñãàõ íü ç¿éòýé ãýæ ýðäýìòýä, ìýðãýæèëòýí¿¿ä ¿çäýã áàéíà

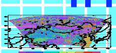
Ìàë àæ àõóéã ýð÷èìæ¿¿ëýõýä á¿ñ íóòãèéí òóëãóóð òºâ¿¿äèéí õ¿÷èí ç¿éëèéã èë¿¿òýé õàðãàëçàõ õýðýãòýé áàéíà.

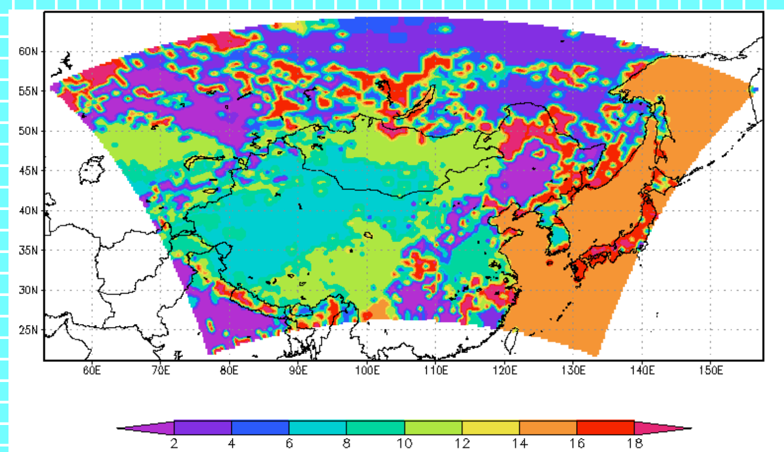
Sensitivity study

In the sensitivity study, we assign control experiment as CTL and desertification experiment as DSR

In the DSR experiments, semi-desert is replaced by desert (type 11 to 8), short grass is replaced by semi desert (type 2 to 11) including whole model domain

All other physics and numeric options are same in the experiments



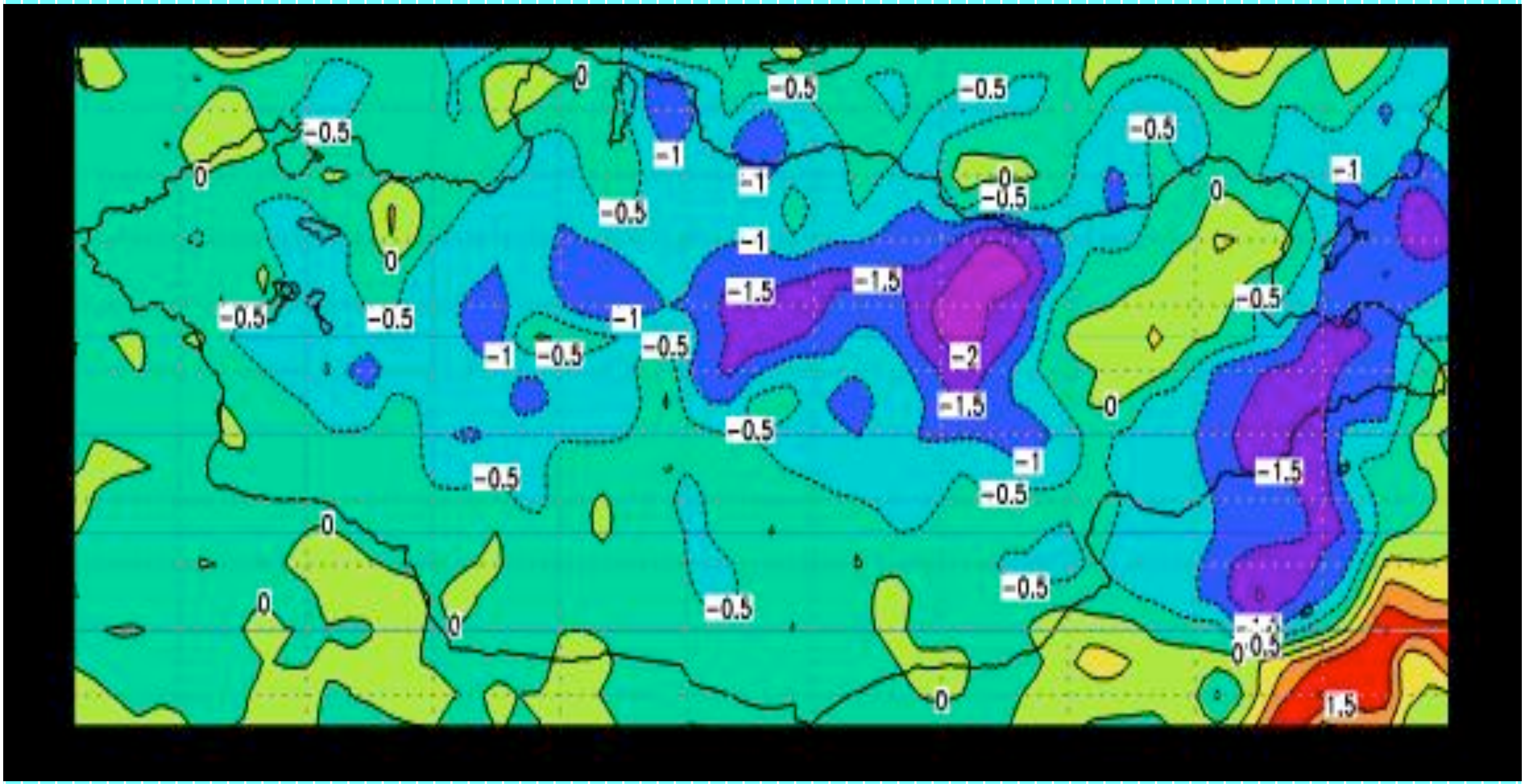


Summary of the CTL and DSR experiments: mean of three years simulated

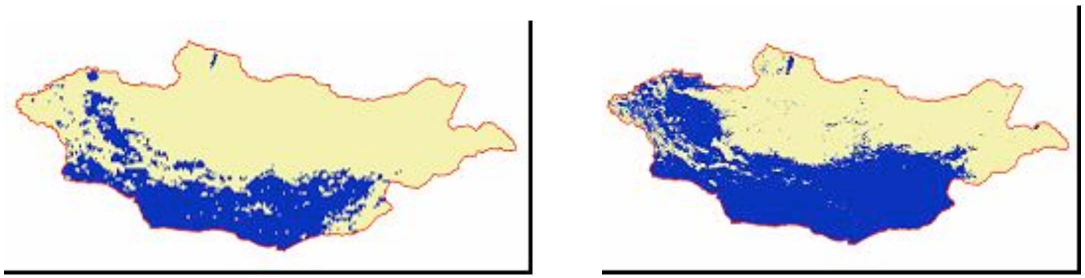
for June, July and August.

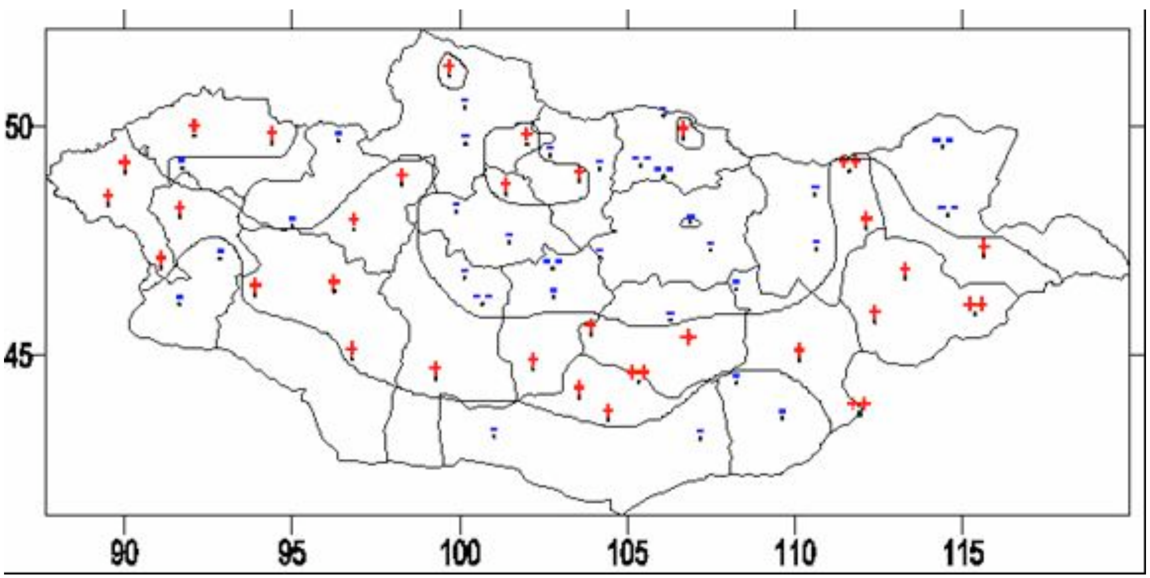
	June			July			August		
	CTL	DSR	Δ	CTL	DSR	Δ	CTL	DSR	Δ
Hydrological cycle									
Precipitation, mm/day	2.86	2.31	-0.55	2.97	2.53	-0.43	2.67	2.36	-0.31
Evapotranspiration, mm/day	2.09	1.44	-0.65	2.26	1.66	-0.60	1.93	1.55	-0.38
Runoff, mm/day	0.38	0.25	-0.13	0.44	0.32	-0.12	0.40	0.29	-0.10
Soil moisture upper layer, mm	22.7	25.2	2.5	23.6	25.3	1.7	24.2	24.6	0.4
Soil moisture root zone, mm	228.0	143.4	-84.6	233.0	161.5	-71.6	238.4	179.4	-59.0
Surface climate									
Surface air tempeature	16.8	18.5	1.7	20.2	22.0	1.8	17.7	19.0	1.3
Anemometer relative humidity	60.4	48.8	-11.6	59.4	49.6	-9.8	62.6	55.1	-7.5

Average summer precipitation difference between DSR and CTL experiments



Changes of area with NDVI≤0.0.07 /blue/ and NDVI >0.07 /yellow/
Comment: a) 3rd decade of Aug, 1982 b) 3rd decade of Aug, 2005





Multi year trend of different intenceties rain with 0.1-15 mm/day and more than 15.1 mm/day weight in the seasonal precipitation (May-Aug) (sign of a – coefficient of linear trend line, (If light rain weight is reduced and heavy rain weight has increased, sign is plus (+), in reverse, sign is marked as minus (-). If signicance level is higher than 90 %, double signs are marked)