Institute of Meteorology ,
Hydrology and Environment, Mongolia

Relationship between AO, NAO and EAWM indexes and climate of Mongolia

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Aim

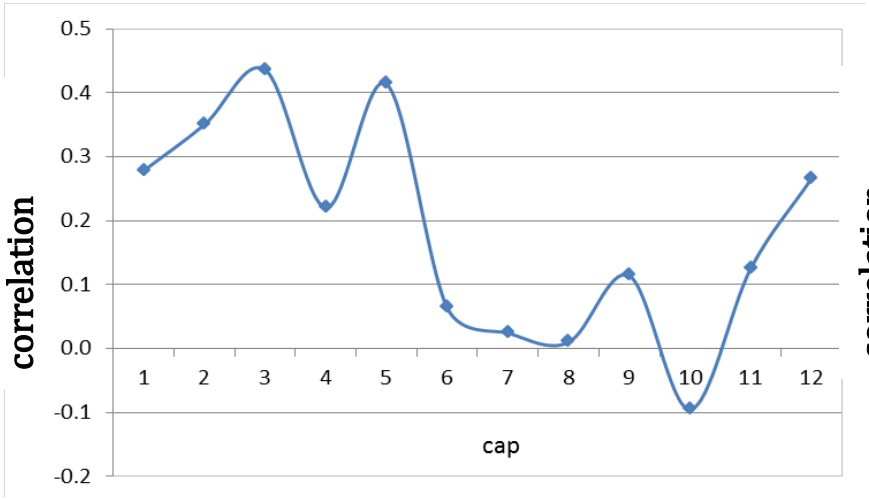
1. To investigate large scale circulation, and regional scale circulation impact on climate of Mongolia
2. To use the study result in further statistical prediction method development

Data

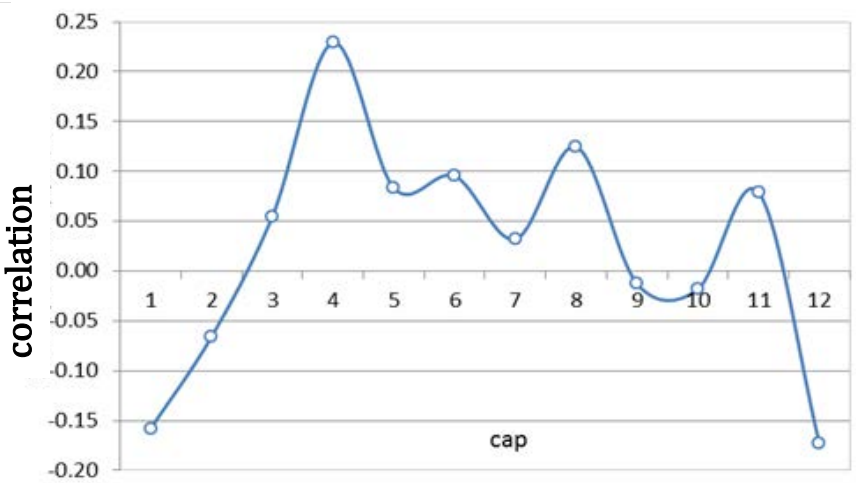
- (1) monthly-mean reanalysis data from the NCEP-DOE reanalysis version II, from January 1979 to December 2013 with a horizontal resolution of 2.5° ×2.5°
- (2) monthly amount precipitation data from the Global Precipitation Climatology Centre (GPCC) Version 6 reanalysis data from January 1979 to December 2010 with a horizontal resolution of 0.5°×0.5°,
- (3) Air temperature data from the Europian Center for Medium-Range Weather Forecast (ECMWF) interim reanalysis data from January 1979 to December 2013 with a horizontal resolution of 0.5°×0.5°,
- (4) Observation data from Mongolia 69 stations monthly mean data from January 1979 to December 2013, such as air temperature and precipitation.
- (5) AO & NAO of NCEP, 1961-2013

AO impact

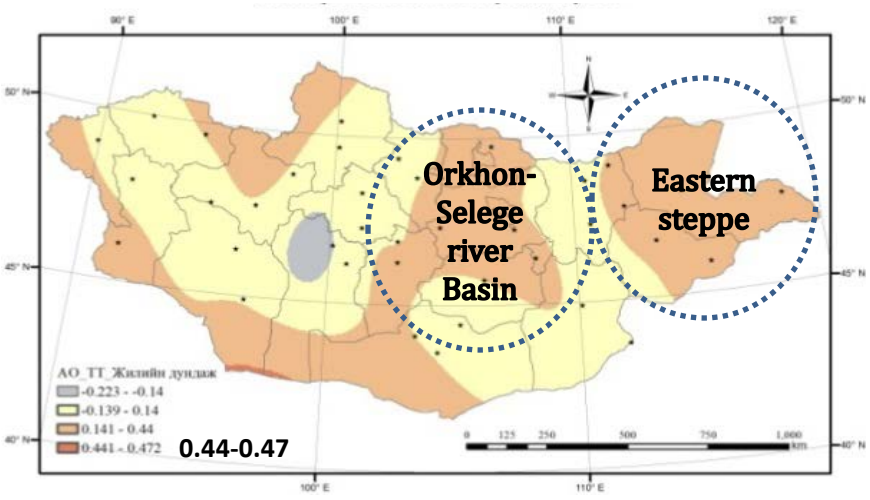
Temperature



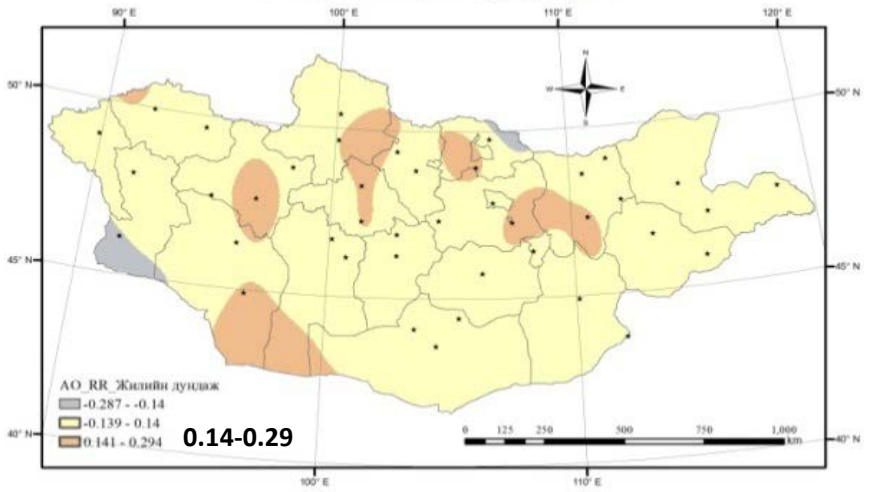
Precipitation



Annual mean distribution of T&AO correlation

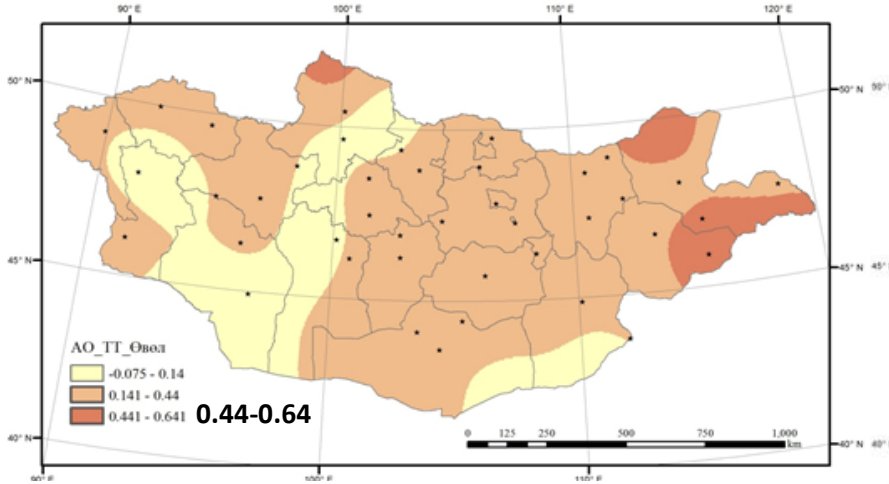


Annual mean distribution of R&AO correlation

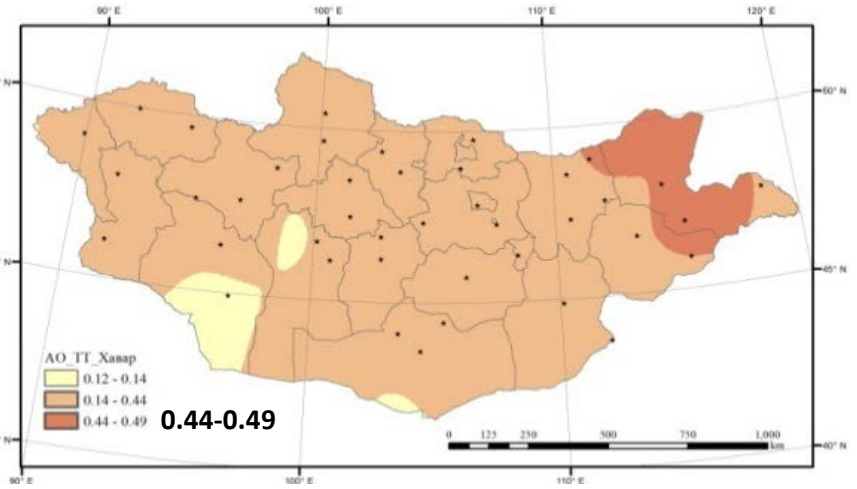


Seasonal correlation –T&AO.

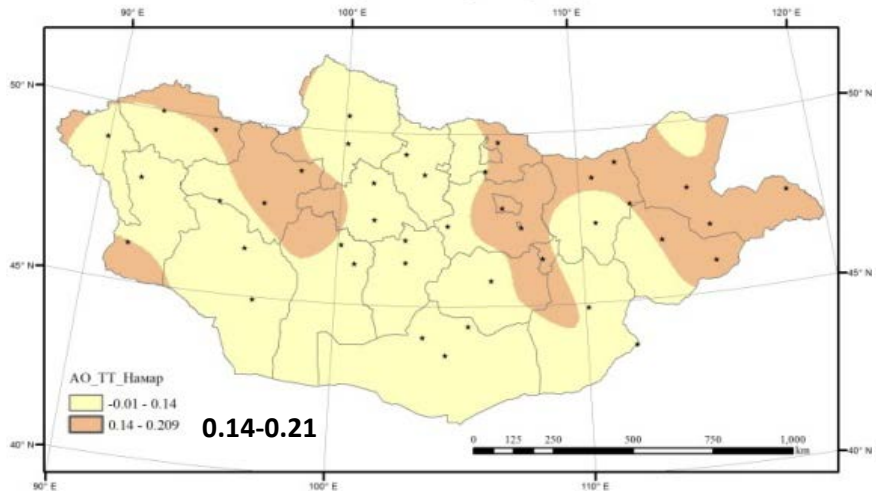
winter



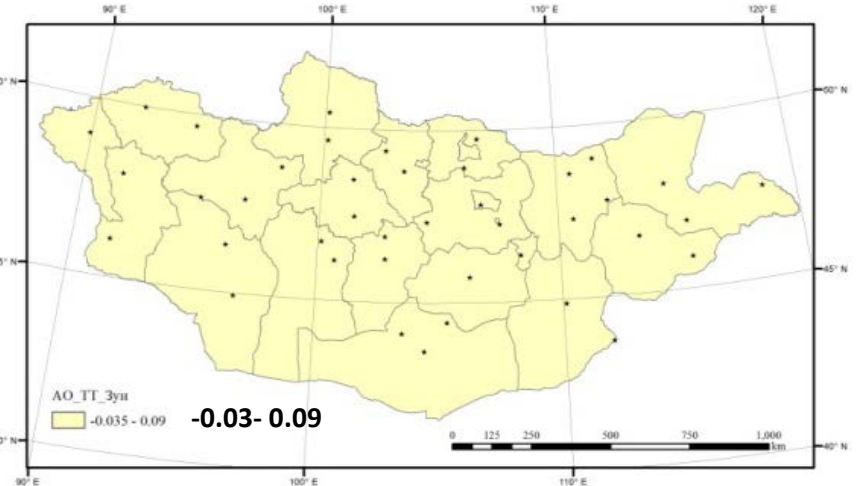
spring



autumn

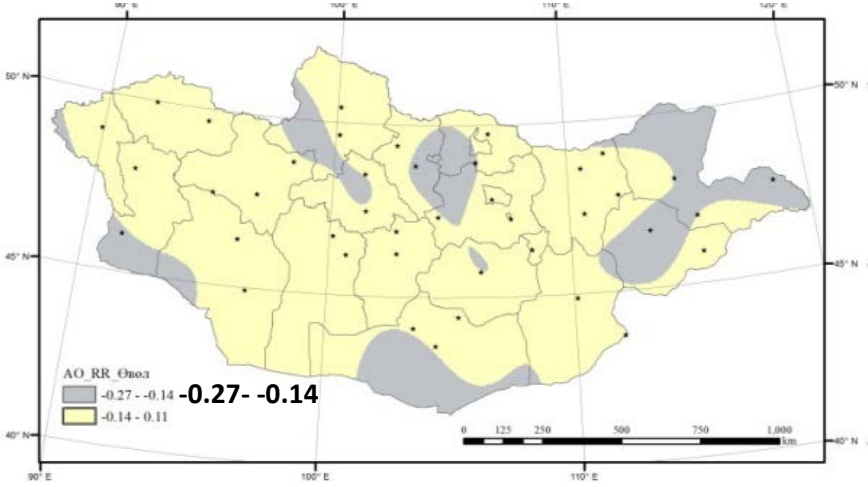


summer

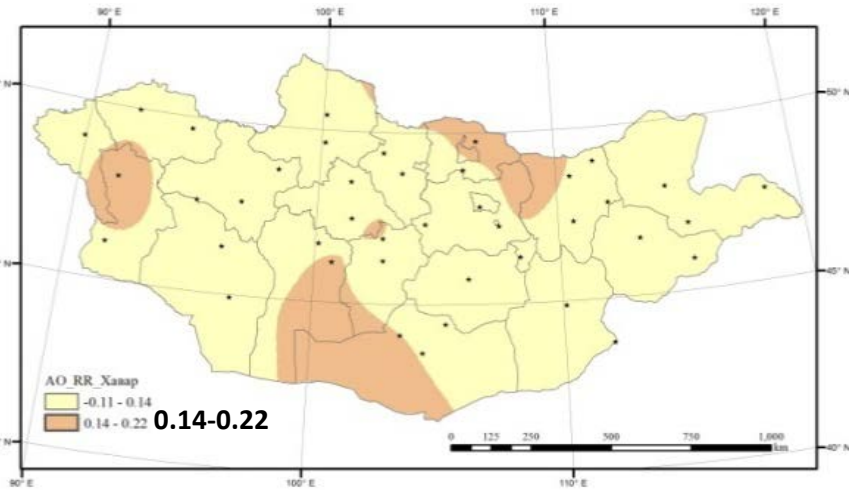


Seasonal correlation –R&AO.

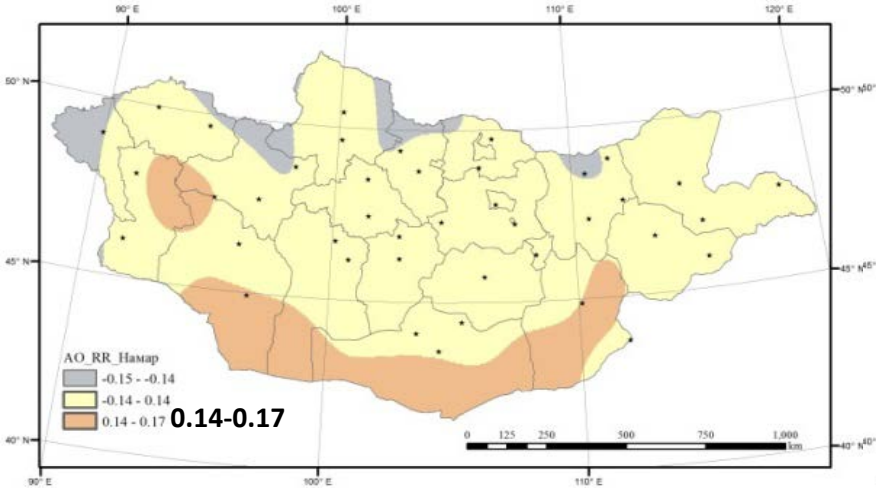
winter



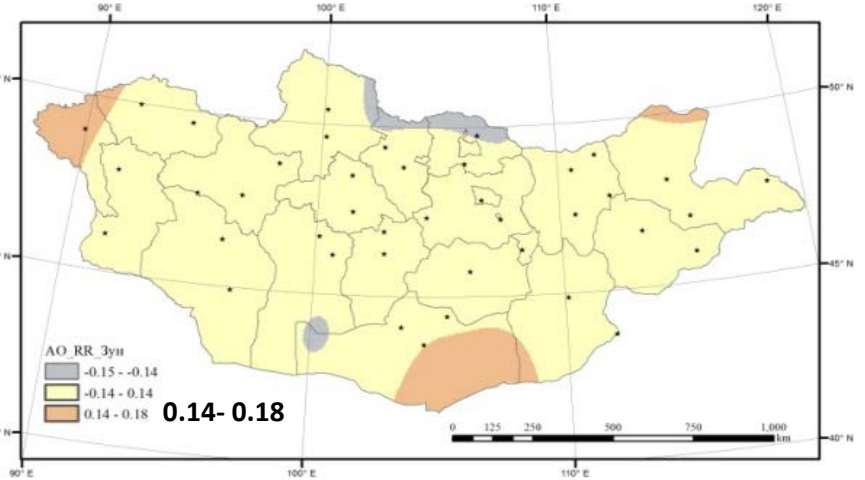
spring



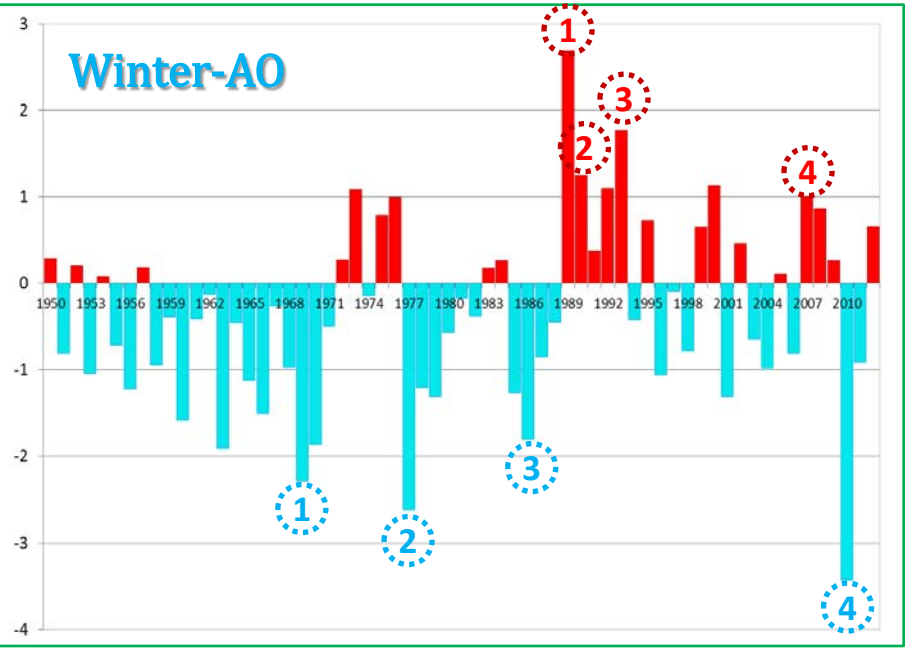
autumn



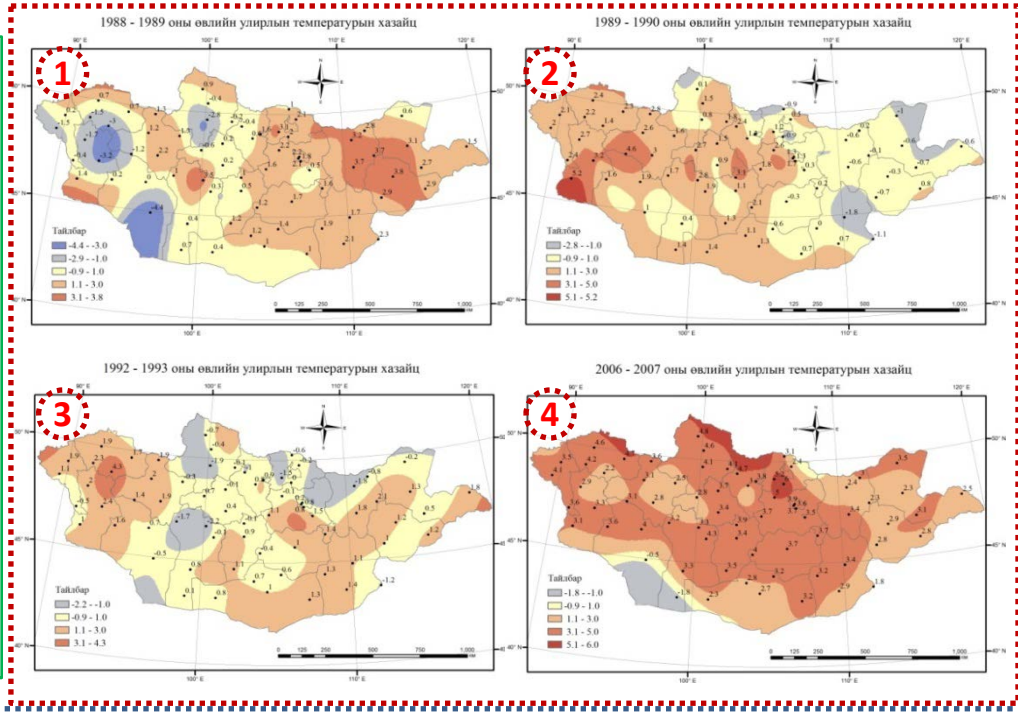
summer

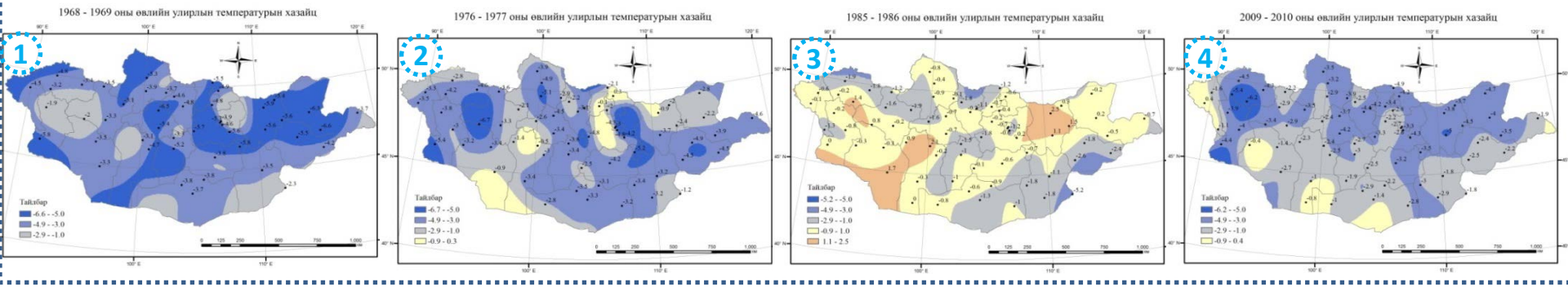


Extreme cases -AO



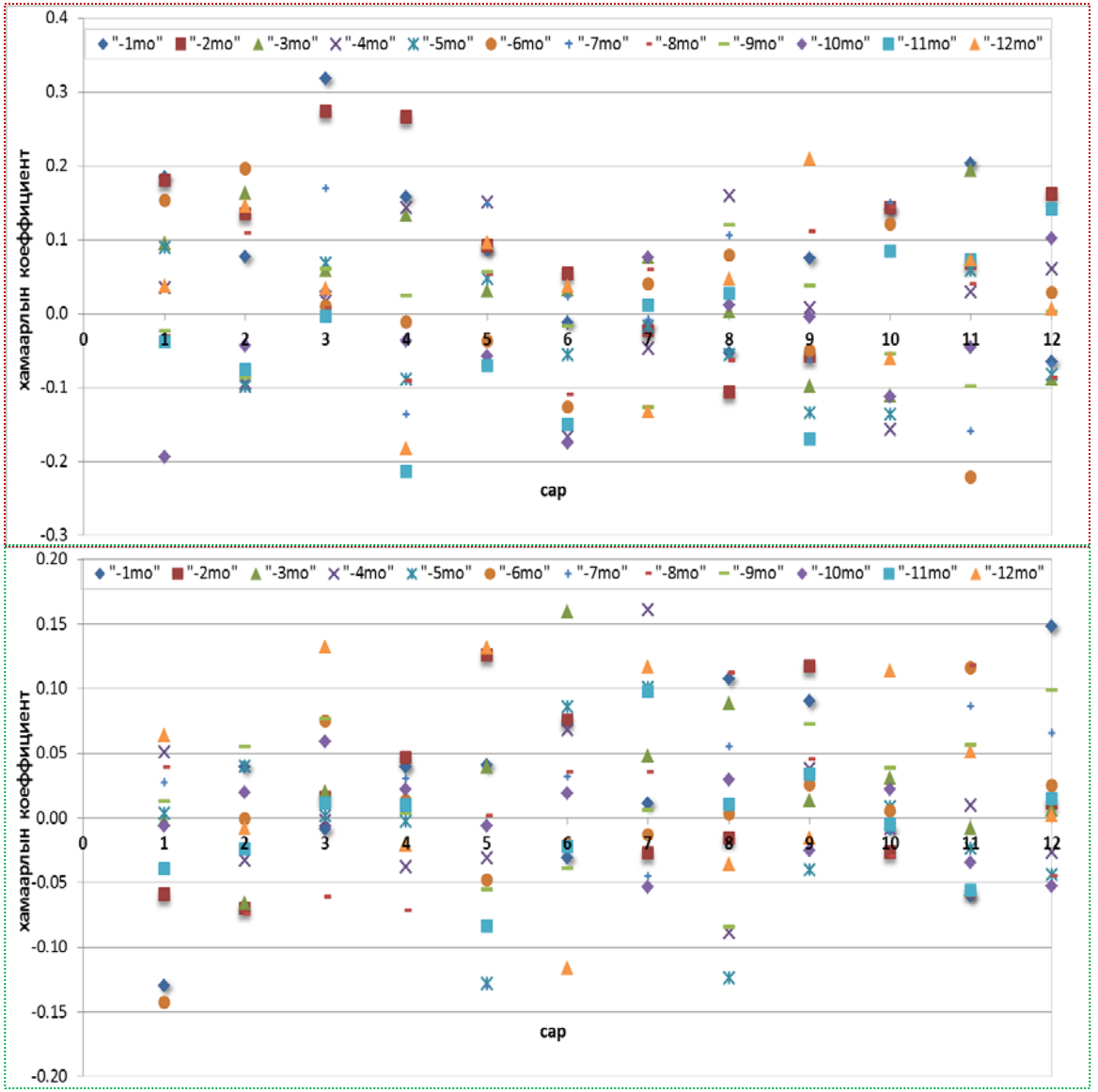
Winter temperature anomaly





Predictive skill-lag correlation

- **Temperature**
- **Precipitation**



Conclusion

- AO has more impact on temperature than precipitation of Mongolia.
- Not only the winter AO has the highest influence on winter temperature of Mongolia, but also the spring AO, even though its amount is small, has similar degree of influence on spring temperature.
- Spatial distribution of impact is the highest (~0.67) over Orkhon-Selenge River Basin and Eastern steppe of Mongolia.
- The AO could have certain predictive skill for temperature and precipitation.

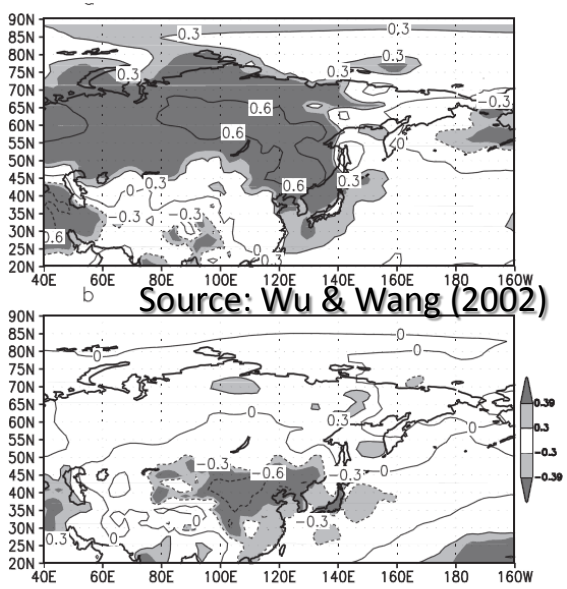
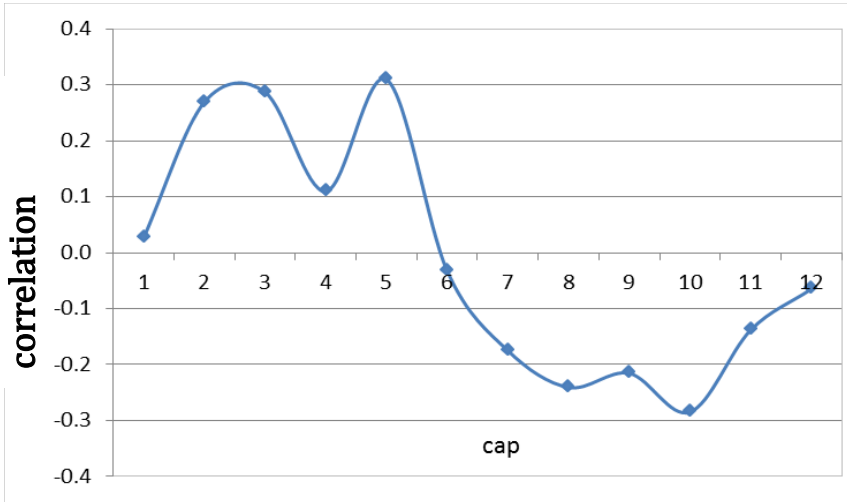


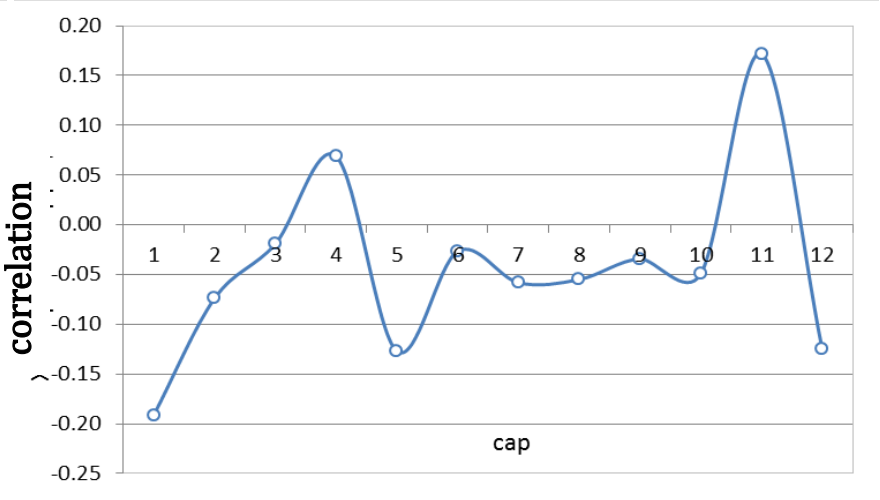
Figure 5. Correlations of surface air temperature with (a) the winter AO and (b) the SH index. The meaning of the shading is the same as in Figure 4.

NAO impact

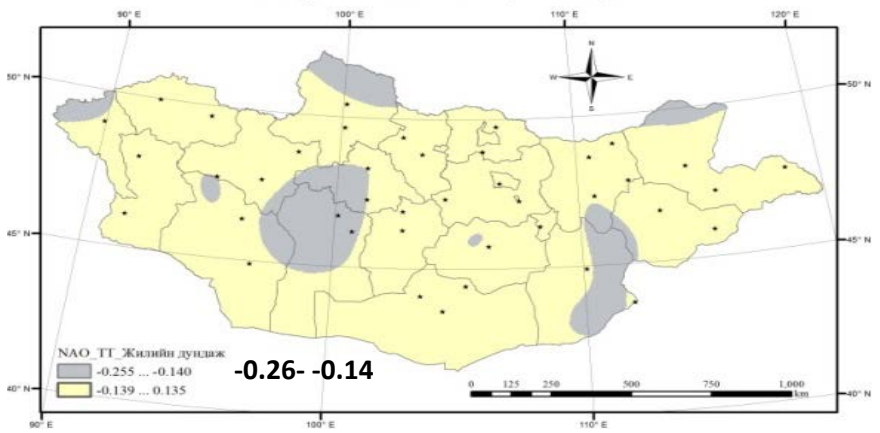
Temperature



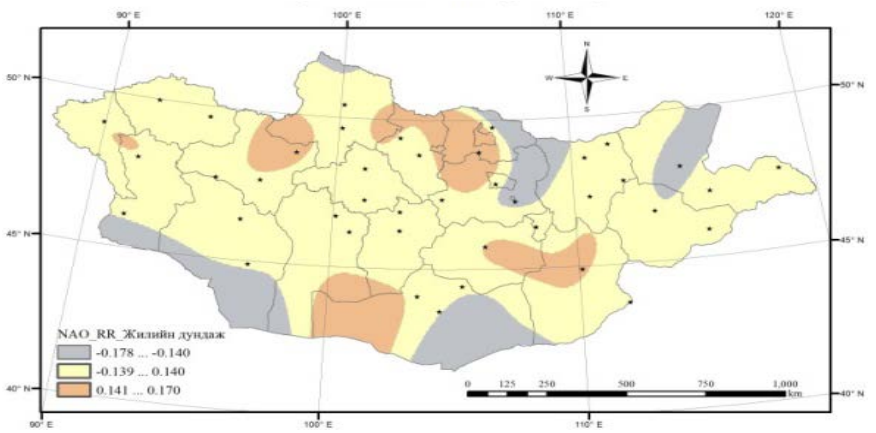
Precipitation



Annual mean distribution of T&NAO correlation

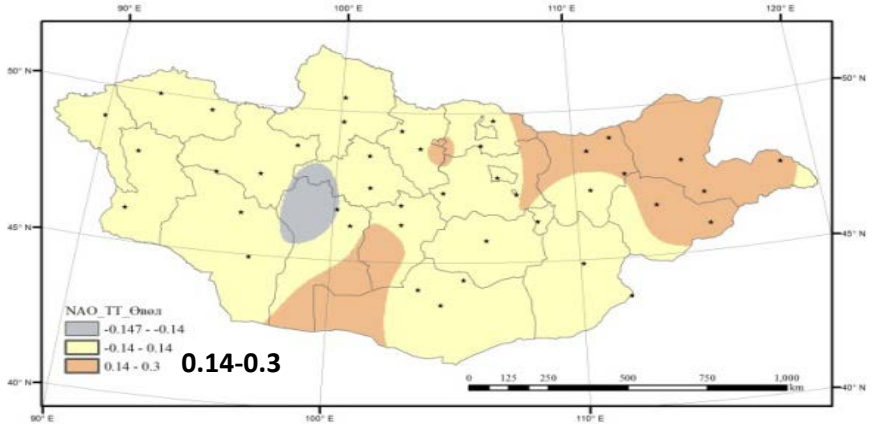


Annual mean distribution of R&NAO correlation

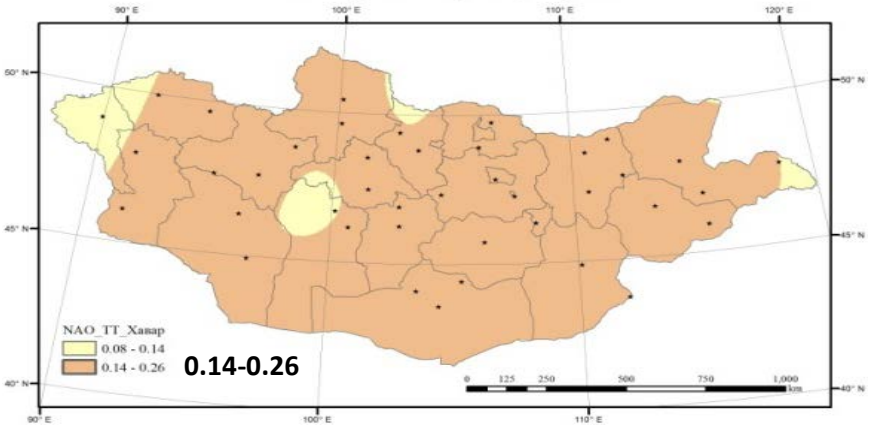


Seasonal correlation –T&NAO.

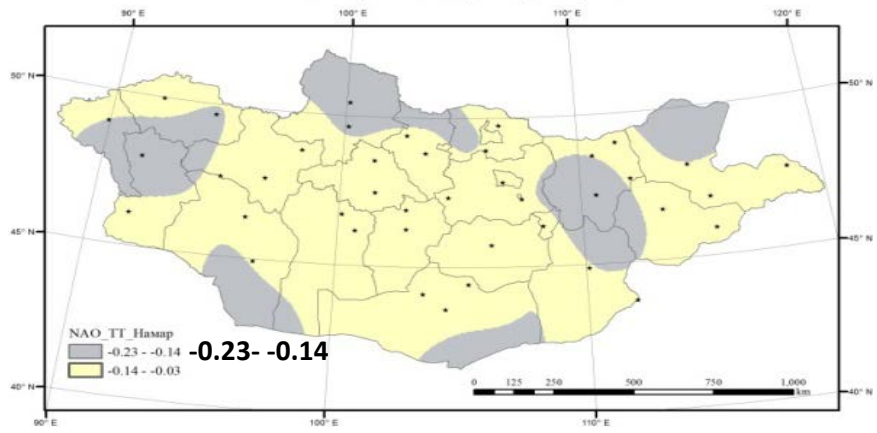
winter



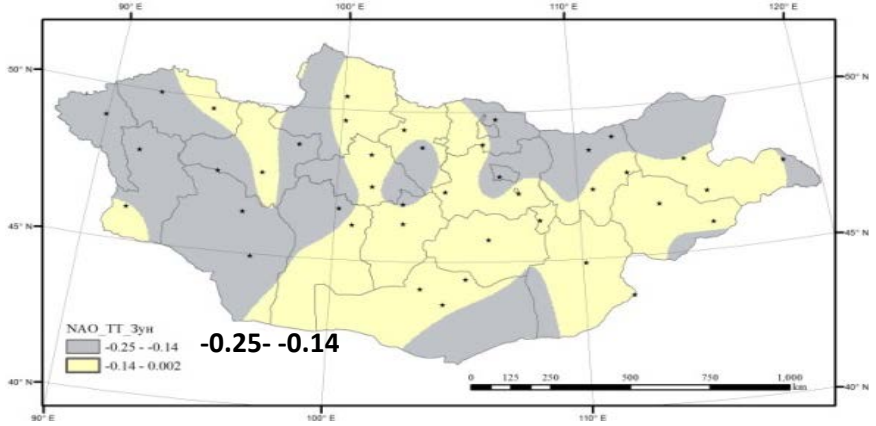
spring



autumn

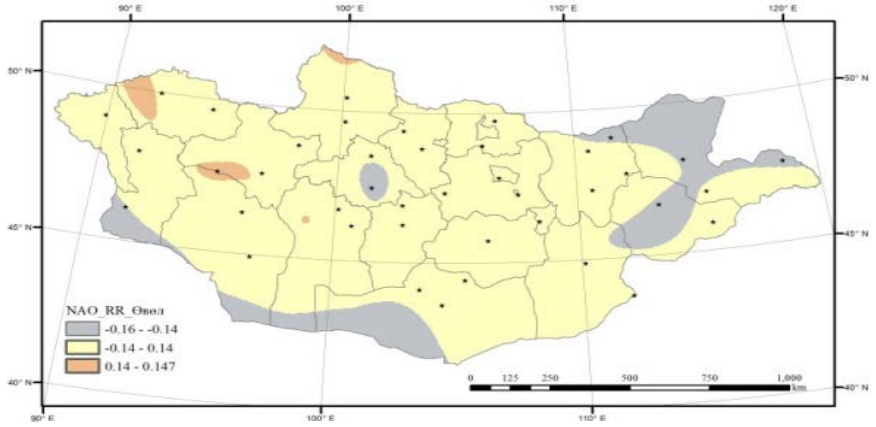


summer

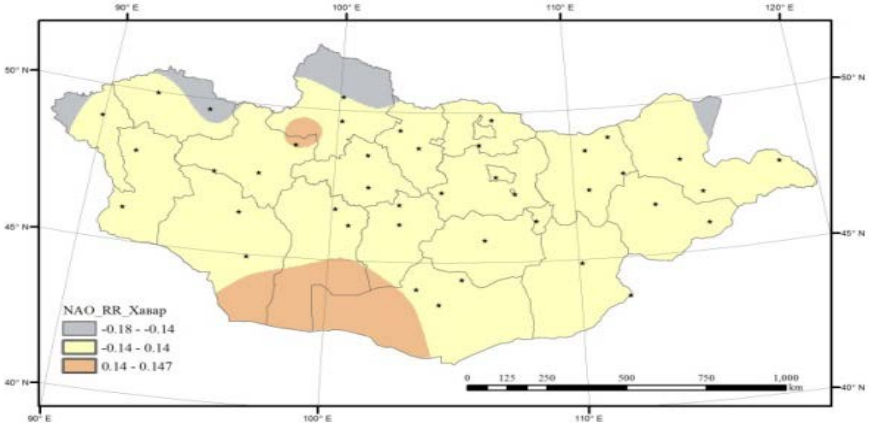


Seasonal correlation –R&NAO.

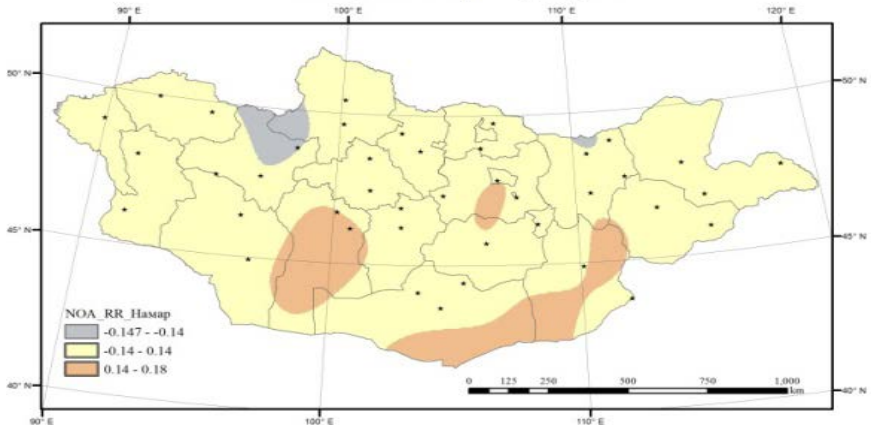
winter



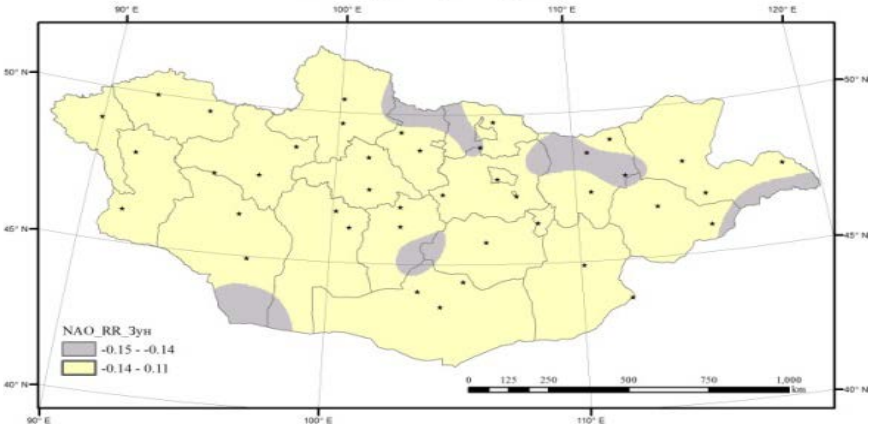
spring



autumn

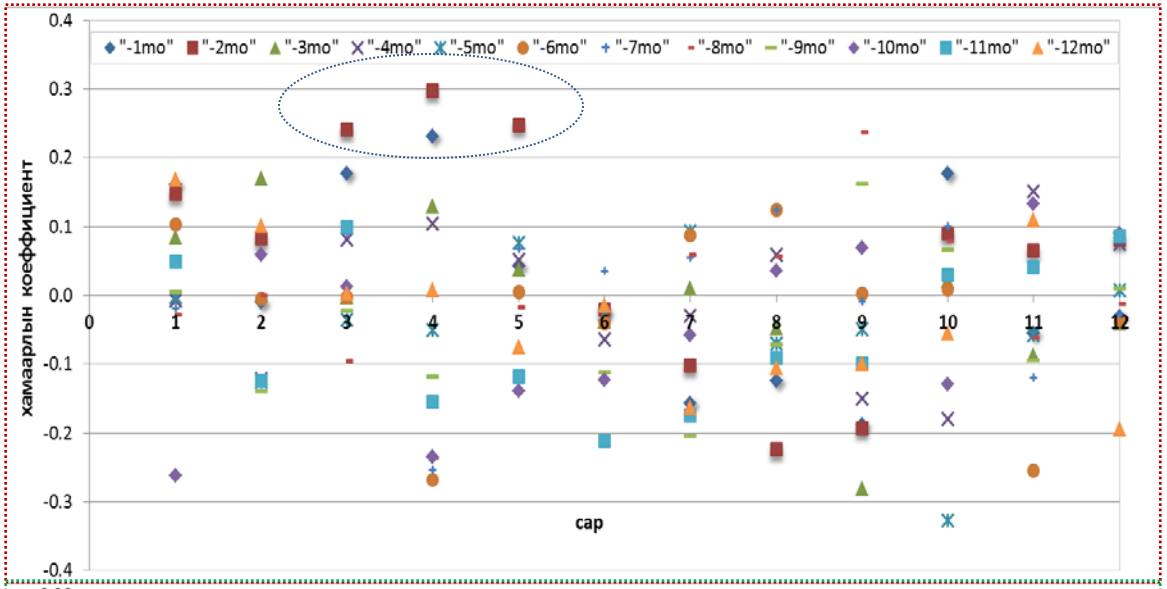


summer

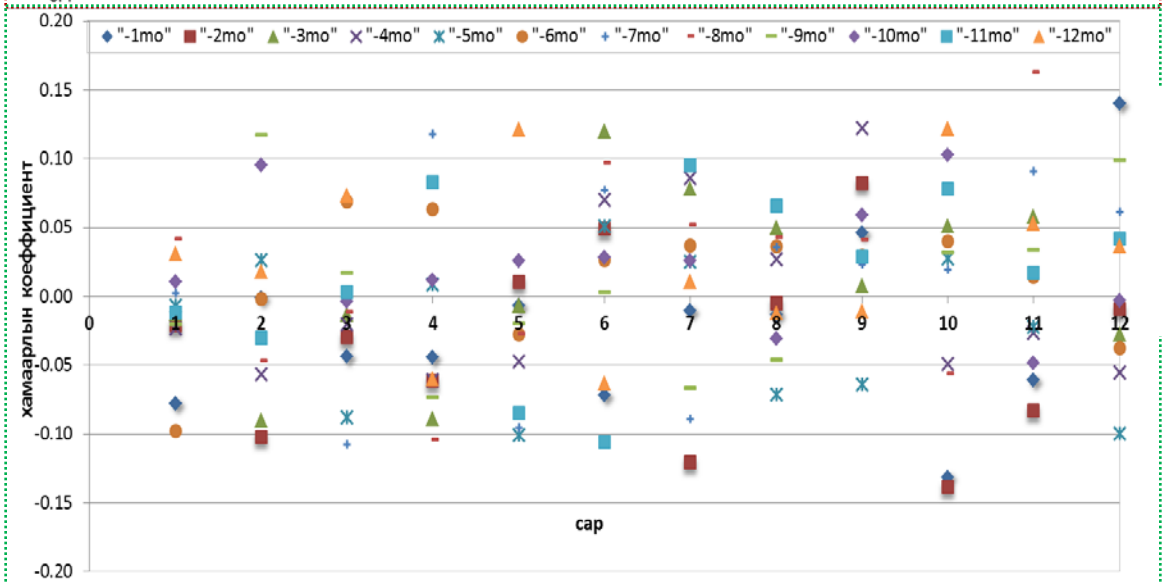


Predictive skill-lag correlation

- **Temperature**



- **Precipitation**



Conclusion

- NAO has more impact on temperature than precipitation of Mongolia.
- NAO has mostly positive impact on winter and spring temperature and negative impact on autumn and summer temperature of Mongolia.
- But, the impact does not have any spatial pattern.
- In monthly basis, NAO could be one of the predictors for climate of Mongolia.

Impact of EA Monsoon

- EASM indexes-15

	Reference	Defining variable(s), Level (hPa), and regions	Correlation	
			Temperature	Precipitation
1	Y. F. Wang et al. (2001)	v, 850 hPa, (20^0 -40^0 N, 110^0 -140^0 E)	0.08	0.11
2	Wu and Ni (1997)	v, 850 hPa, (20^0 -40^0 N, 110^0 -130^0 E)	0.13	0.16
3	Li and Zeng (2002)	u, v, 850 hPa, (10^0 -40^0 N, 110^0 -140^0 E)	-0.27	0.02
4	Wang (2002)	u, v, 850 hPa, (20^0 -40^0 N, 110^0 -125^0 E)	-0.06	0.21
5	Qiao et al. (2002)	u, v, 850 hPa, (20^0 -40^0 N, 110^0 -140^0 E)	-0.09	0.14
6	Wang et al. (1998)	v, 850-200 hPa, (5^0 -15^0 N, 90^0 -130^0 E)	-0.08	0.04
7	He et al. (2001)	u, 850-200 hPa, (0^0 -10^0 N, 100^0 -130^0 E)	-0.04	-0.02
8	Webster and Yang (2004)	u, 850-200 hPa, (10^0 -40^0 N, 110^0 -140^0 E)	0.21	0.13
9	Zhao and Zhou (2005)	SLP gradient, (30^0 -50^0 N, 110^0 -160^0 E)	0.06	-0.23
10	Guo (1983)	SLP gradient, (10^0 -50^0 N, 110^0 -160^0 E)	0.06	-0.23
11	Shi and Zhu (1996)	SLP gradient, (20^0 -50^0 N, 110^0 -160^0 E)	0.10	-0.26
12	Peng et al. (2000)	Φ gradient, 500 hPa, (10^0 -50^0 N, 110^0 -150^0 E)	0.23	-0.31
13	Wang and Fan (1999)	u, 850 hPa, (10^0 -20^0 N, 100^0 -150^0 E) - (25^0 -35^0 N, 100^0 -150^0 E)	0.05	-0.03
14	Zhang et al (2003)	u, 850 hPa, (10^0 -20^0 N, 100^0 -150^0 E) - (25^0 -35^0 N, 100^0 -150^0 E)	0.10	-0.02
15	Lau and Yang (2000)	u, 200 hPa, (40^0 -50^0 N, 110^0 -150^0 E) - (25^0 -35^0 N, 110^0 -150^0 E)	-0.18	0.18

EAWM indexes

	Reference	Defining variable(s), Level (hPa), and regions	Correlation	
			Temperature	Precipitation
1	Ji et al. (1997)	v, 1000 hPa, (10° -30°N, 115° -130°E)	0.18	0.33
2	Lu and Chan (1999)	v, 1000 hPa, (7.5° -20°N, 107.5° -120°E)	0.03	0.32
3	Chen and Sun (1999)	v, 1000 hPa, (15° - 30°N, 115° - 130°E)	0.18	***0.35***
4	Chen et al. (2000)	v, 10 m, (10° -25°N, 110° -130°E and 25° -40°N, 120° -140°E)	0.33	***0.38***
5	Hu et al.(2000)	v, 10 m, (15° -40°N, 115° -130°E)	***0.36***	***0.38***
6	Yang et al.(2002)	v, 850 hPa, (20° -40°N, 100° -140°E)	0.03	0.31
7	Wang and Jiang (2004)	u, v, 850 hPa, (25° -50°N, 115° -145°E)	0.16	***0.35***
8	Jhun and Lee (2004)	u, 300 hPa, (27.5° -37.5°N, 110° -170°E) - (50° -60°N, 80° -140°E)	**-0.65**	-0.27
9	Xu and Ji (1965)	SLP gradient, (30° -40°N, 100° -120°E) - (30° -40°N, 130° -140°E)	-0.21	*-0.21*
10	Guo (1994)	SLP gradient, (10° -60°N, 110° -160°E)	**-0.44**	*-0.20*
11	Shi (1996)	SLP* gradient, (20° -50°N, 110° -160°E)	-0.32	***-0.35***
12	Wu and Wang (2002a)	SLP* gradient, (20° -70°N, 110° -160°E)	**-0.44**	*-0.28*
13	Chan and Li (2004)	SLP gradient, (30° -55°N, 100° -120°E) - (30° -55°N, 150° -170°E)	**-0.44**	*-0.23*
14	Wang et al. (2009b)	SLP* gradient, (40° -70°N, 110° -160°E)	**-0.58**	*-0.09*
15	Gong et al.(2001)	SLP, (40° -60°N, 70° -120°E)	**-0.73**	*-0.15*
16	Sun and Li (1997)	Φ, 500 hPa, (30° -45°N, 125° -145°E)	**0.55**	0.22
17	Cui and Sun (1999)	Φ^*,500 hPa, (35° -40°N, 110° -130°E)	**0.63**	0.24
18	Wang et al.(2009a)	PC1 of Φ^*, 500 hPa, (25° -50°N, 100° -180°E)	-0.04	-0.12
19	Lin and Wen (2013)	SLP* (2*(40° -60°N,70° -120°E) - (30° -50°N, 140° -170°E)- (20°S–10°N, 110°–160°E))/2	**-0.62**	*-0.12*
20	Liu S	SLP gradient, (10° -50°N, 110° -150°E)	***-0.38***	*-0.25*
21	He and Wang (2012)	SLP (40° -60°N, 80° -125°E)+ Φ500(25° -45°N, 110° -145°E)+ u300(25° -40°N,80° -180°E) - (45° -60°N, 60° -160°E)	**-0.58**	-0.17
22	Zhu (2008)	u, 500 hPa, (25° -35°N, 80° -120°E) - (50°-60°N, 80° -120°E)	**-0.80**	-0.16

Modification

Zhu (2008)

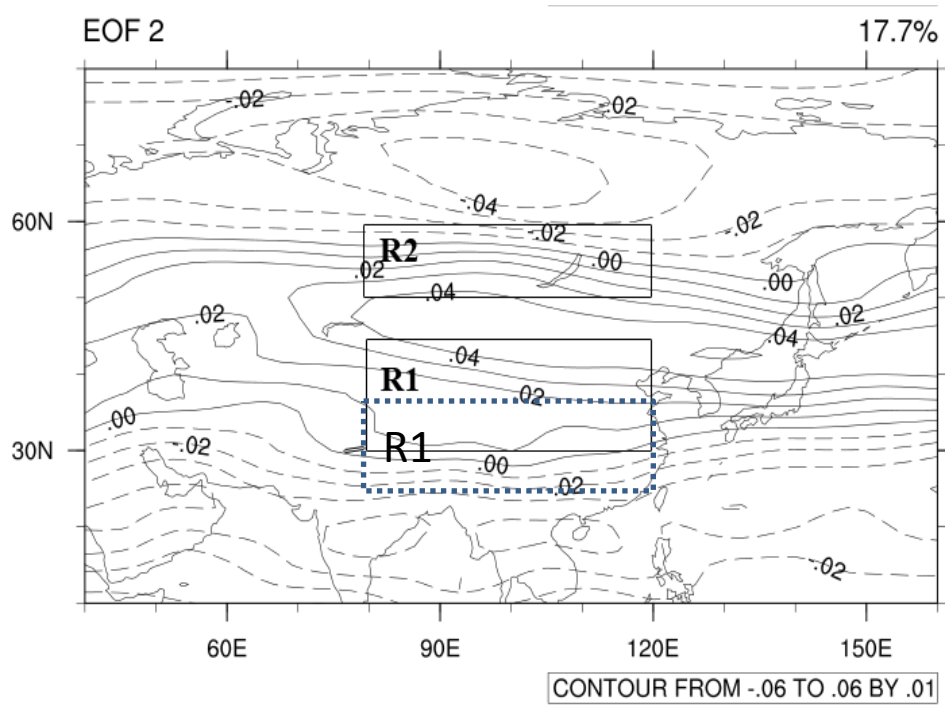
u,500hPa (25°-35°N, 80°-120°E)-
(50°-60°N, 80°-120°E)

u,500hPa (30°-45°N, 80°-120°E)-
(50°-60°N, 80°-120°E)

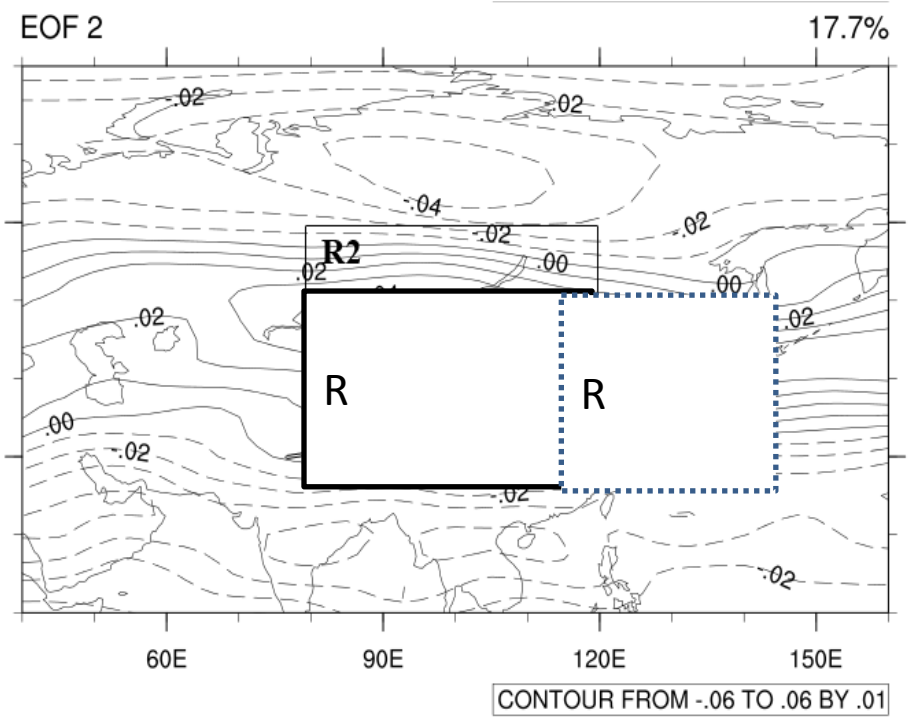
Wang & Jiang (2004)

u,v 850hPa (25°-50°N, 115°-145°E)

u,v 850hPa (25°-50°N, 80°-120°E)



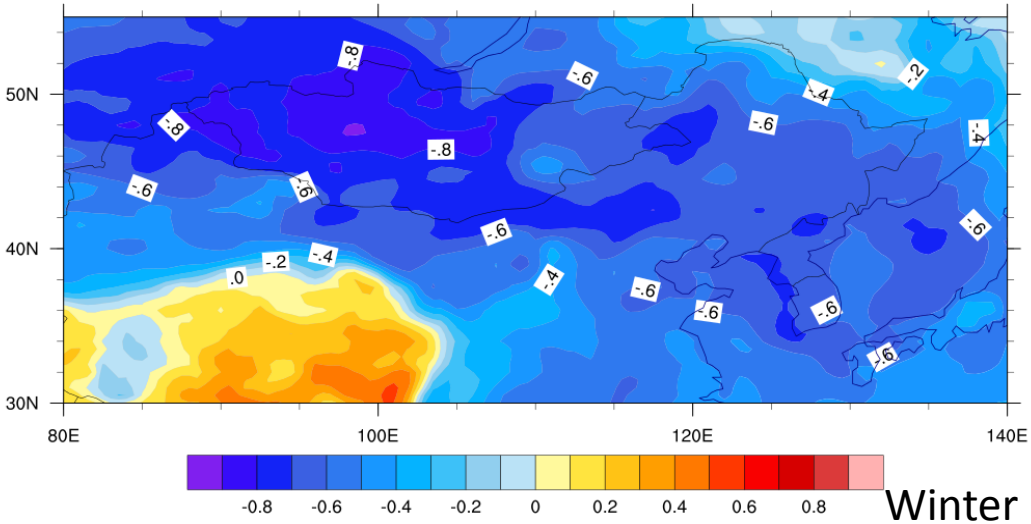
R=-0.8 -> -0.83



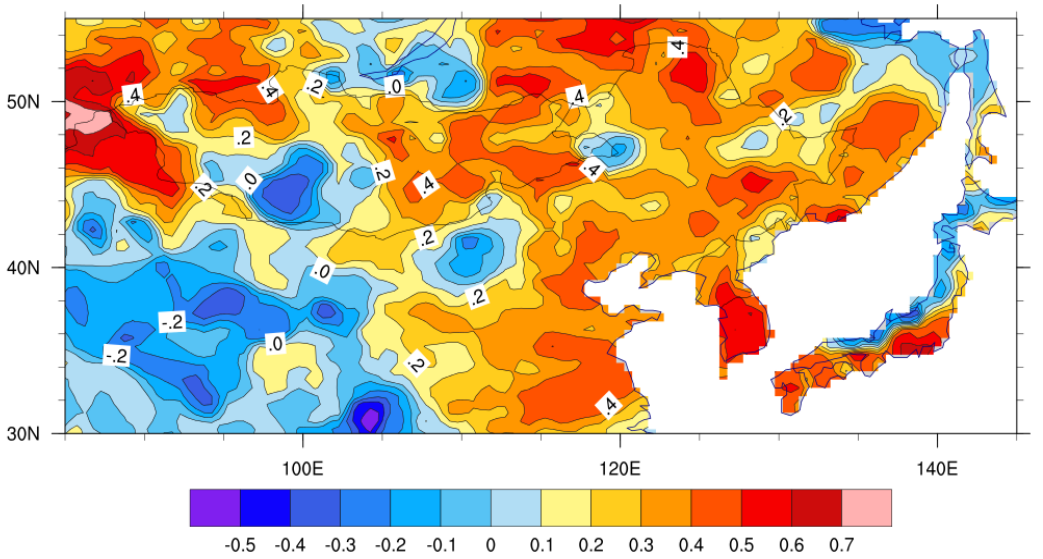
R=0.35 -> 0.40

Spatial distribution of EAWM impact

Winter Temperature & modified Zhu index



Winter precipitation & modified Wang&Jiang index



Conclusion

- The EAWM has stronger correlation with winter climate than that is EASM has with summer climate of Mongolia.
- The EAWM has higher impact on temperature compared to precipitation.
- Zhu's index has the highest correlation with temperature of Mongolia
- Modified Wang & Jiang index has the highest correlation with precipitation of Mongolia.

Summary conclusion

- The EAWM has the highest correlation with winter climate of Mongolia compared to AO and NAO.
- Winter climate of Mongolia is more predictable, especially, winter temperature is more predictable.
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THANK YOU FOR YOUR ATTENTION