The impact of climate, CO_2, nitrogen deposition and land use change on simulated contemporary global river flow

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Introductions

- Climate change and human activities are expected to strongly change the global hydrological cycle
- The terrestrial ecosystem regulates hydrology via biophysical and biogeochemical feedbacks
- How different constraints limit the ET, runoff and river flow is still uncertain
- More researches on runoff than river flow

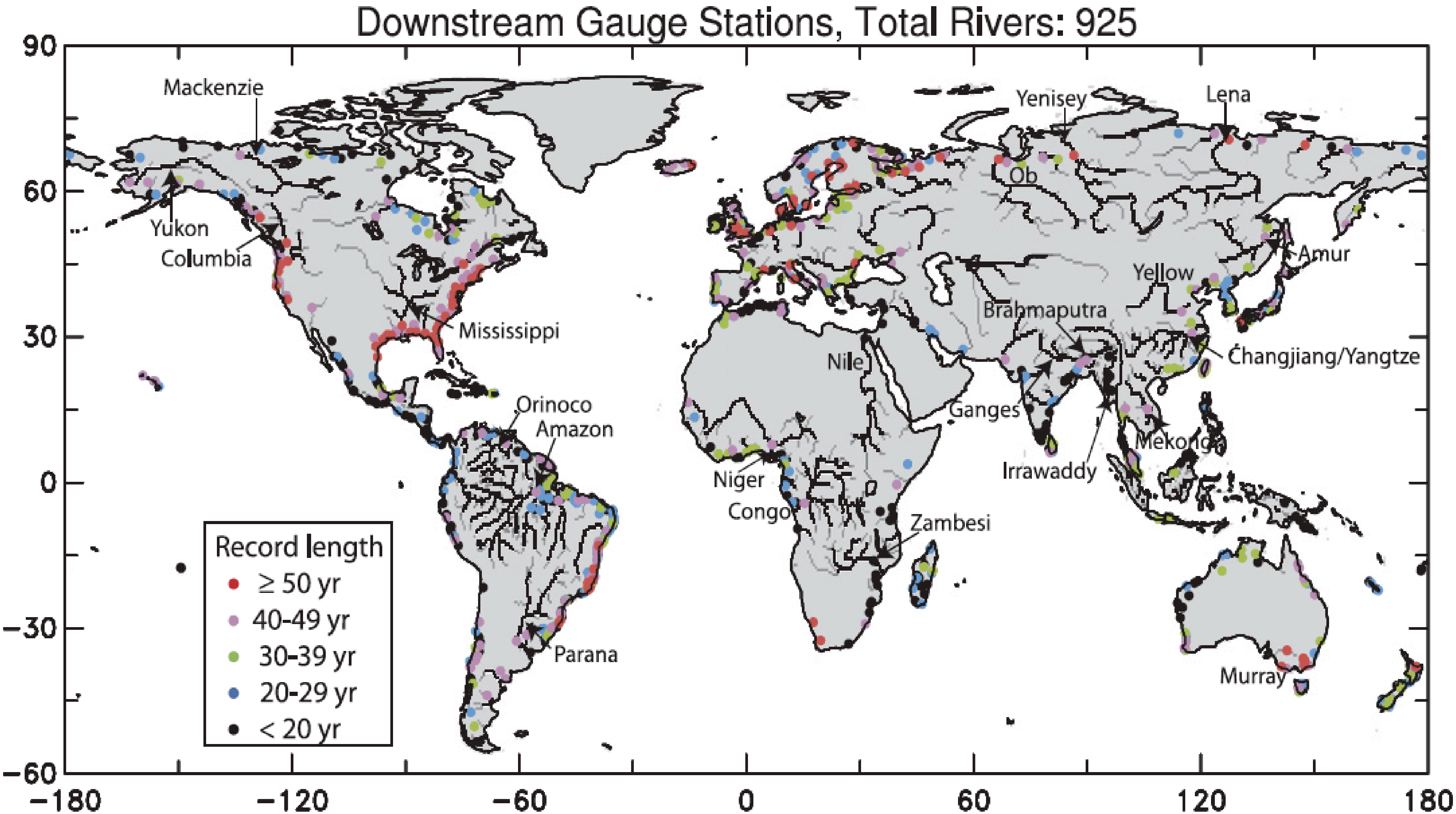


FIG. 1. Distribution of the farthest downstream gauge stations (dots) for the world's 925 largest rivers included in this study. Also shown are the world's major river systems as simulated by the CLM3. The color of the dots indicates the record length at the station during 1948–2004.

Dai et al., 2009, J. Climate

Model and dataset

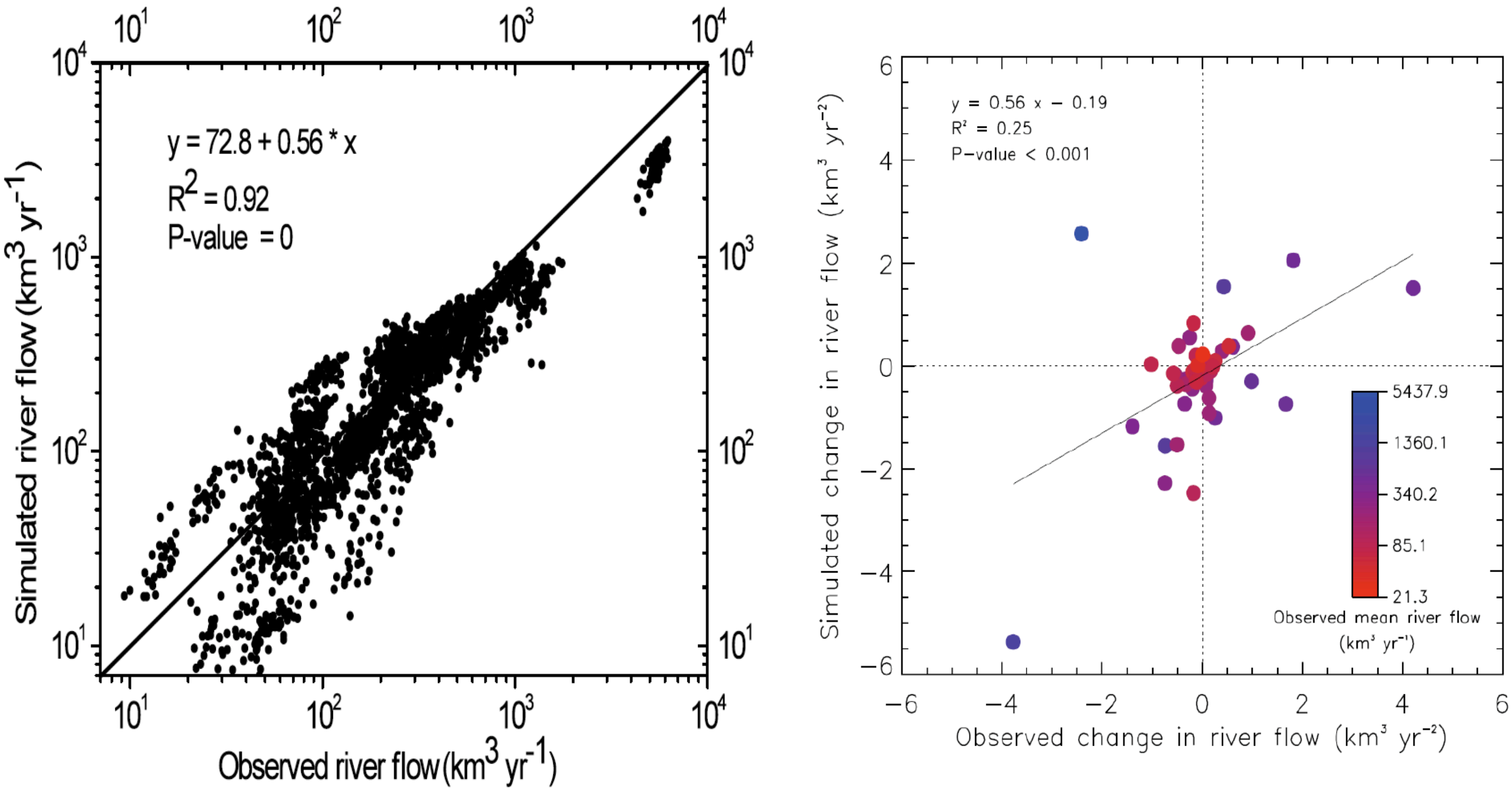
- CLM4: the land surface component of the CCSM4 (Oleson et al., 2010)
- river transfer model (RTM) in CLM4 (Branstetter et al., 1999 and 2001; Oleson et al., 2010)
- Observed river flow from Dai et al., 2009
- Qian et al. (2006) climates (1948-2004), and a repeating 25-yr (1948-1972) for 1850-1947
- CO_2 and N are similar to Bonan and Levis (2010)
- LUHa.v1 (Hurtt et al., 2006)

Experimental Design

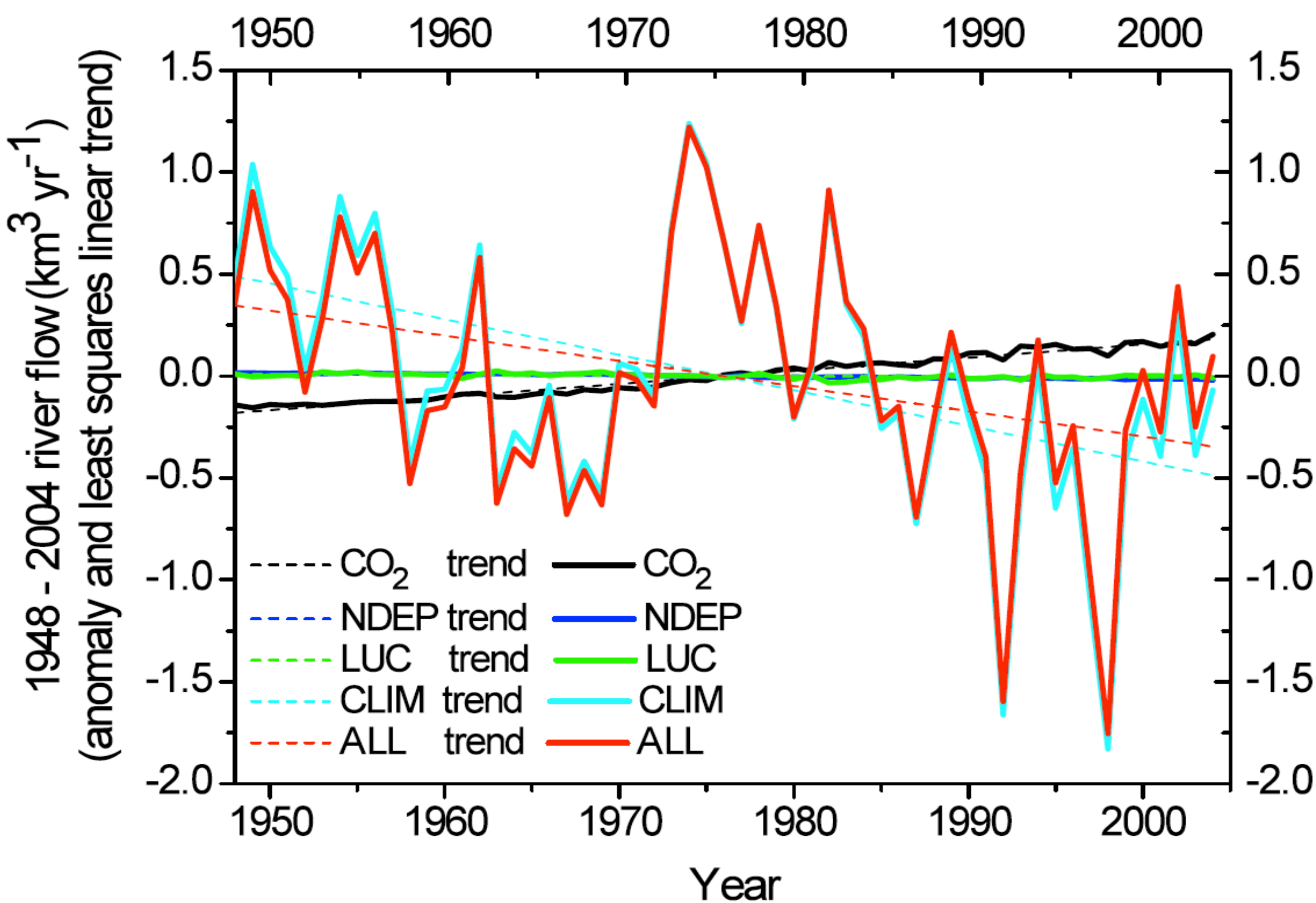
✧Results are based on simulations between 1948-2004 from 1850-2004

Exp.	Driving factors			
	Climate	CO_2	Nitrogen	Land D
E1	yes	yes	yes	yes
E2	yes	no	no	no
E3	yes	yes	no	no
E4	yes	no	yes	no
E5	yes	no	no	yes

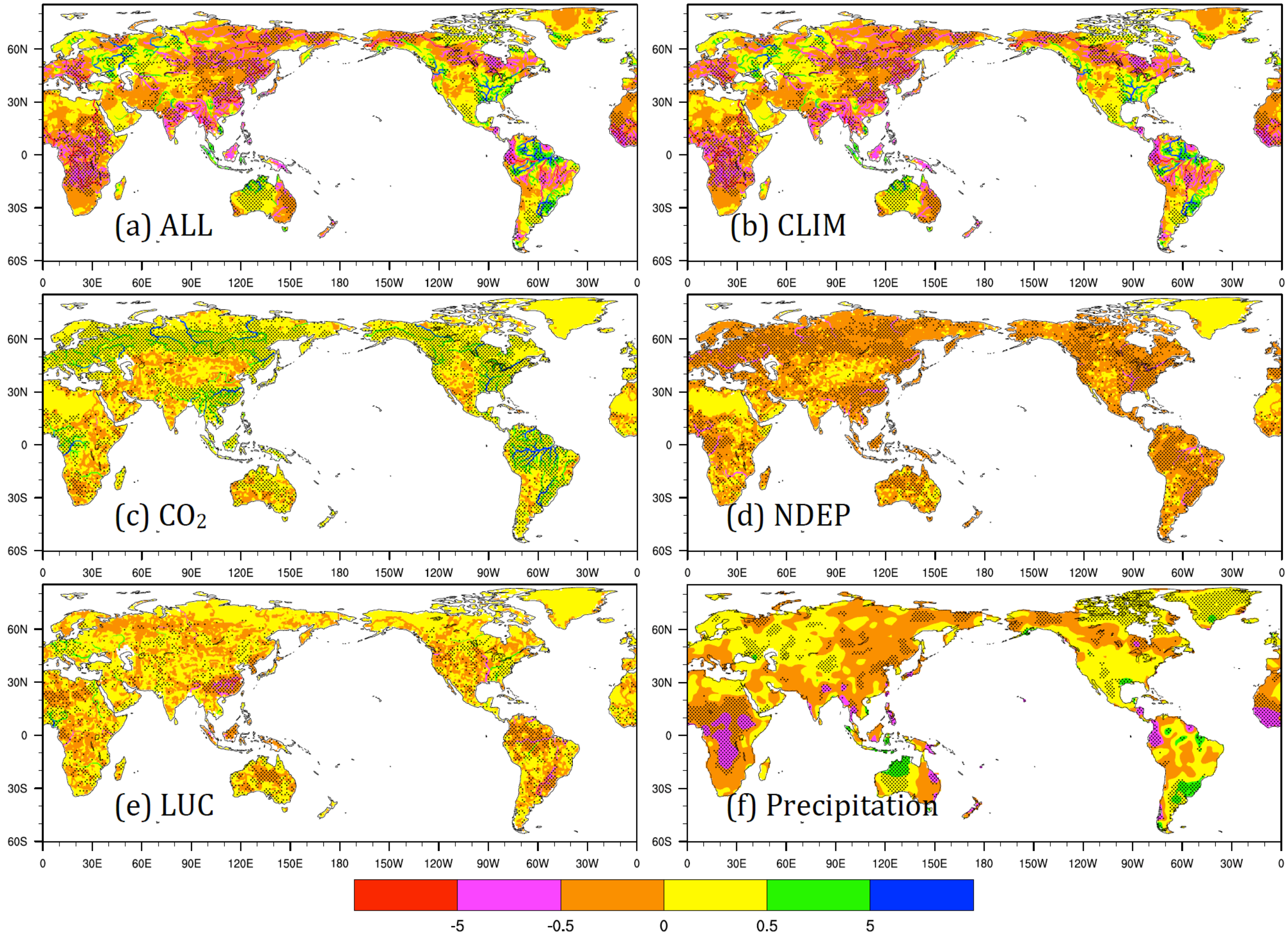
ALL(E1), CLIM(E2), CO2 (E3-E2), NDEP(E4-E2) and LUC(E5-E2)



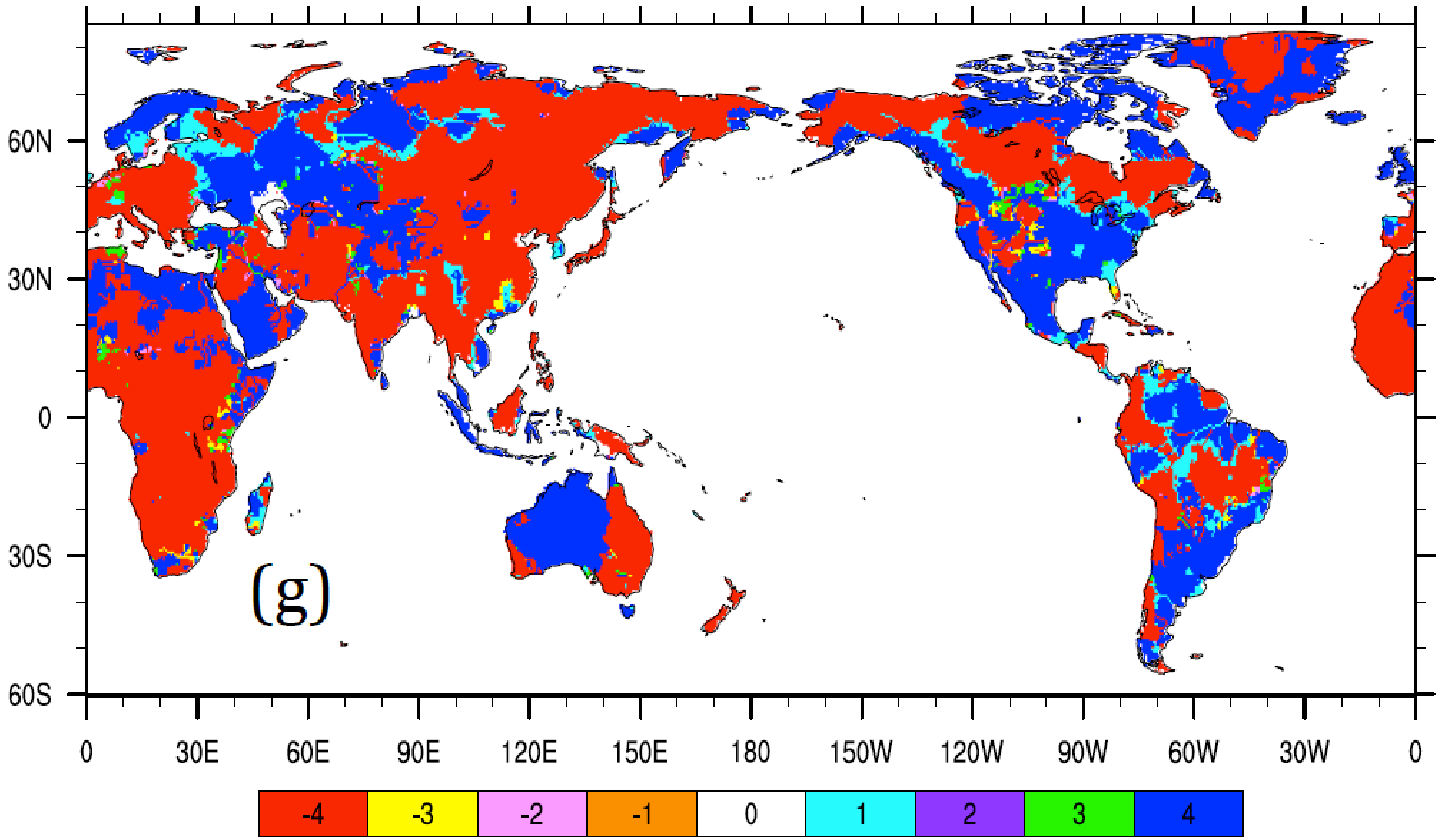
Predicted (ALL) vs. observed (Dai et al., 2009) annual river flow over the period 1948-2004 for the world's 50 largest rivers



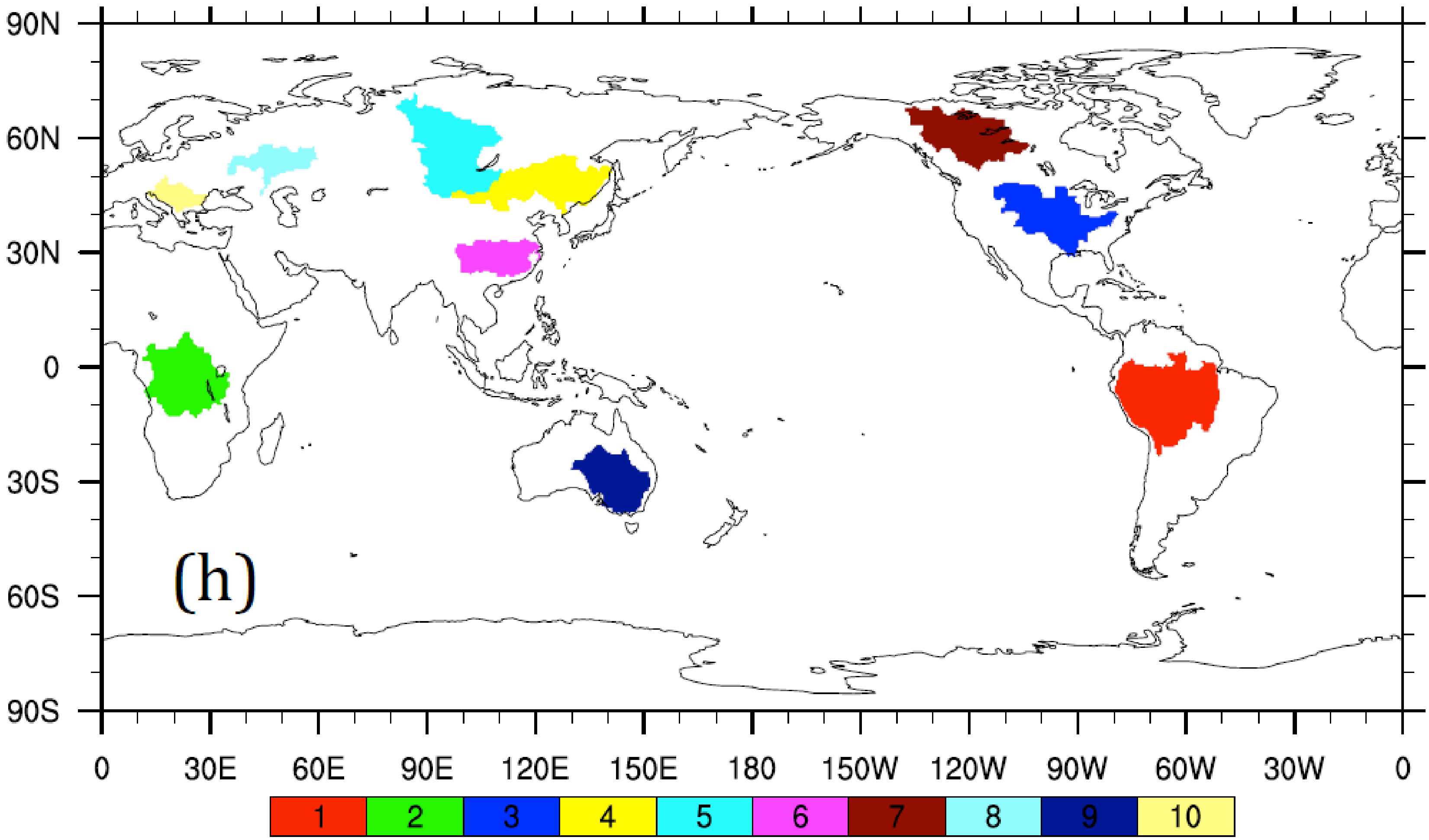
Time series of model simulated annual anomalies of global averaged river flow (km3 yr-1) and associated least squares linear trend



Spatial distributions of river flow linear trend



-4 De. due to climate
-3 De. due to land use
-2 De. due to N Dep.
-1 De. due to CO_2
0 No trend
1 In. due to CO_2
2 In. due to N Dep.
3 In. due to land use
4 In. due to climate



1 Amazon 2 Zaire 3 Mississippi 4 Amur 5 Yenisei
6 Chang Jiang 7 MacKenzie 8 Volga 9 Murray 10 Danube

Region	ALL	CLIM	CO_2	NDEP	LUC
Globe	-0.0123	-0.0174	0.0064	-0.0006	-0.0003
Amazon	0.0084	-0.0404	0.0505	-0.0012	-0.0004
Zaire	-0.1258	-0.1343	0.0105	-0.0011	-0.0008
Mississippi	0.0371	0.0313	0.0104	-0.0026	-0.0012
Amur	-0.0490	-0.0554	0.0072	-0.0006	0.0002
Yenisei	-0.0239	-0.0315	0.0086	-0.0005	-0.0003
Chang Jiang	-0.0742	-0.0764	0.0274	-0.0035	-0.0203
Mackenzie	-0.0145	-0.0224	0.0083	-0.0003	0.0000
Volga	0.0416	0.0319	0.0108	-0.0019	0.0014
Murray	-0.0013	-0.0015	0.0002	0.0000	0.0000
Danube	-0.0675	-0.0765	0.0105	-0.0042	0.0046

Conclusions

- Significant decrease in global averaged river flow during 1948-2004 is mainly a consequence of climate forcing
- Nitrogen deposition and land use change make minor contributions of this decreasing trend
- CO_2 causes increasing trend of global scale river flow
- the relative role of different driving factors is not constant across the globe
- Climates, ecosystem biogeochemical cycles and LULCC should be considered for future hydrologic researches

Thanks