Supplement of

The Standardized Vertical Velocity Anomaly Index (SVVAI) : Using Atmospheric Dynamical Anomalies to Simulate and Predict Meteorological Droughts

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S1: Details about forecast vertical velocity (ω) and precipitation data sub sets retrieved from CFSv2 products

Since NOAA Climate Forecast System released the second-version products on 1 April 2011, prediction of regional drought processes in the present study before and after this date were forced with the CFS reforecast outputs and the CFSv2 products, respectively. All the relevant reforecast and forecast datasets are accessible on the website (https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/climate-forecast-system-version2-cfsv2).

Specifically speaking, regarding prediction of drought processes before 1 April 2011, we retrieved reforecast vertical velocity (ω) and precipitation rate data subsets from the webpage (https://nomads.ncdc.noaa.gov/modeldata/cfs_reforecast_6-hourly_9mon_pgbf/) and the webpage (https://nomads.ncdc.noaa.gov/modeldata/cfs_reforecast_6-hourly_9mon_flxf/), respectively. For prediction of drought processes after 1 April 2011, we retrieved relevant datasets from the webpage (https://nomads.ncdc.noaa.gov/modeldata/cfsv2_forecast_6-hourly_9mon_pgbf/) and the webpage (https://nomads.ncdc.noaa.gov/modeldata/cfsv2_forecast_ts_9mon/), respectively.

To meet requirements of lead time (60 days) in the study, the prospective 60-day forecast (reforecast) data subsets are retrieved from CFSv2 and CFS products. All the relevant reforecast and forecast datasets are 6-hourly, and then they are transformed into daily products with a simple time-weighted mean on the base of forecast files (UTC 00 and 12 for vertical velocity (ω), and UTC 00, 06, 12, and 18 for precipitation rate). Regarding spatial resolution of reforecast or forecast products, they are all interpolated into a resolution of 1°×1° using the nearest neighbour method.

S2: Details about calculation of temporal correlation coefficients (TCC) and pattern correlation coefficients (PCC)

TCC strictly follows the computational formula of correlation coefficients (CC) shown in the manuscript, which is simple and easily understood. To strictly compute PCC, i.e., Anomaly Correlation (see section 8.6.4 in the book(Wilks, 2011)), the originally gridded forecast and observed values ought to be firstly converted to anomalies, when the climatological average values of the observed field at each of M grid-points are subtracted from both forecasts and observations.

In the present study, gridded SPI3 and SVVAI correspond to the original variables mentioned above, and their climatologically mean values are almost zero. Thus, the step of being converted to anomalies can be ignored, which means that PCC also follows the formula of CC shown in the manuscript.

Area weight is another issue to illustrate. Areas covered by one gridded point in the longitude-latitude coordinate system vary with latitude, and therefore area weight is considered while computing PCC in others' drought-related study (Pu et al., 2016). However, because drought study region in the present study cover relatively small range of latitudes, area weight can be ignored.

Table S1. Identification of region-scale severe or extreme drought processes and associated key phase division.

Region	Name of Drought Processes	Duration	Occurrence	Persistence	Peak	Recovery	End
East China	the 2011 spring-summer	152 d	26 Feb 2011	13 Mar 2011	30 Apr 2011	23 Jun 2011	27 Jul 2011
	the 2013 summer-autumn	94 d	28 Jul 2013	13 Aug 2013	09 Sep 2013	05 Oct 2013	29 Oct 2013
InnerMongolia	the 2010 summer-autumn	69 d	26 Jul 2010	24 Aug 2010	06 Sep 2010	18 Sep 2010	02 Oct 2010
North China	the 2010/2011 winter	83 d	06 Dec 2010	20 Dec 2010	08 Feb 2011	25 Feb 2011	26 Feb 2011
	the 2014 summer-autumn	78 d	15 Jul 2014	26 Jul 2014	22 Aug 2014	13 Sep 2014	30 Sep 2014
Northeast China	the 2011/2012 autumn-winter	152 d	10 Aug 2011	08 Sep 2011	14 Nov 2011	06 Dec 2011	08 Jan 2012
Northwest China	the 2013 spring	66 d	02 Mar 2013	20 Mar 2013	14 Apr 2013	21 Apr 2013	06 May 2013
	the 2015 summer-autumn	100 d	29 Jul 2015	25 Aug 2015	31 Aug 2015	20 Oct 2015	05 Nov 2015
South China	the 2009 winter-spring	85 d	30 Jan 2009	05 Feb 2009	27 Feb 2009	04 Mar 2009	24 Apr 2009
	the 2011 spring-summer-autumn	226 d	12 Mar 2011	02 Apr 2011	21 Jun 2011	30 Sep 2011	23 Oct 2011
Southwest China	the 2009 winter-spring	71 d	31 Jan 2009	04 Feb 2009	05 Feb 2009	27 Feb 2009	11 Apr 2009
	the 2009/2010 autumn-winter-spring	283 d	14 Jul 2009	07 Oct 2009	27 Nov 2009	31 Mar 2010	22 Apr 2010
	the 2011 spring-summer-autumn	222 d	10 Apr 2011	30 Apr 2011	05 Sep 2011	06 Nov 2011	17 Nov 2011
	the 2012 spring	63 d	01 Apr 2012	18 Apr 2012	06 May 2012	11 May 2012	02 Jun 2012
	the 2012/2013 winter-spring	154 d	29 Nov 2012	11 Dec 2012	11 Jan 2013	21 Mar 2013	01 May 2013
Tibet	the 2009 winter-spring	127 d	25 Jan 2009	26 Jan 2009	10 Feb 2009	21 May 2009	31 May 2009
Xinjiang	the 2009 summer-autumn	137 d	06 Jun 2009	26 Jul 2009	29 Aug 2009	04 Sep 2009	20 Oct 2009
	the 2013/2014 winter	72 d	23 Nov 2013	16 Dec 2013	16 Jan 2014	23 Jan 2014	02 Feb 2014

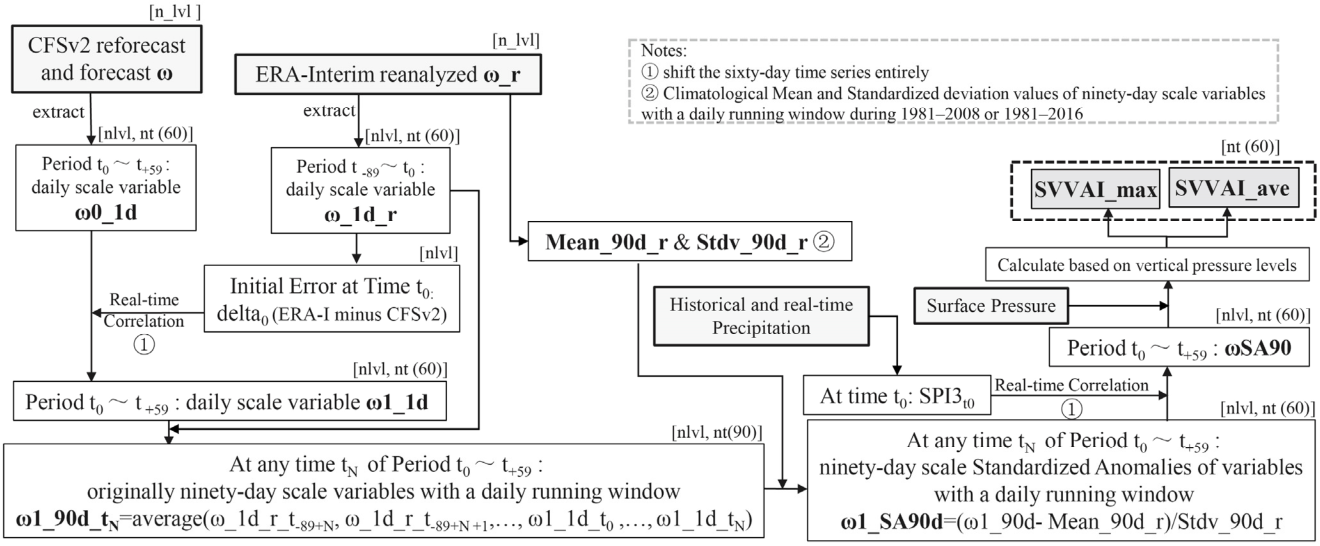

Figure S1. Detailed procedures of computing the indices SVVAI_max and SVVAI_ave on the basis of forecast and reanalysed datasets at the grid and region scales

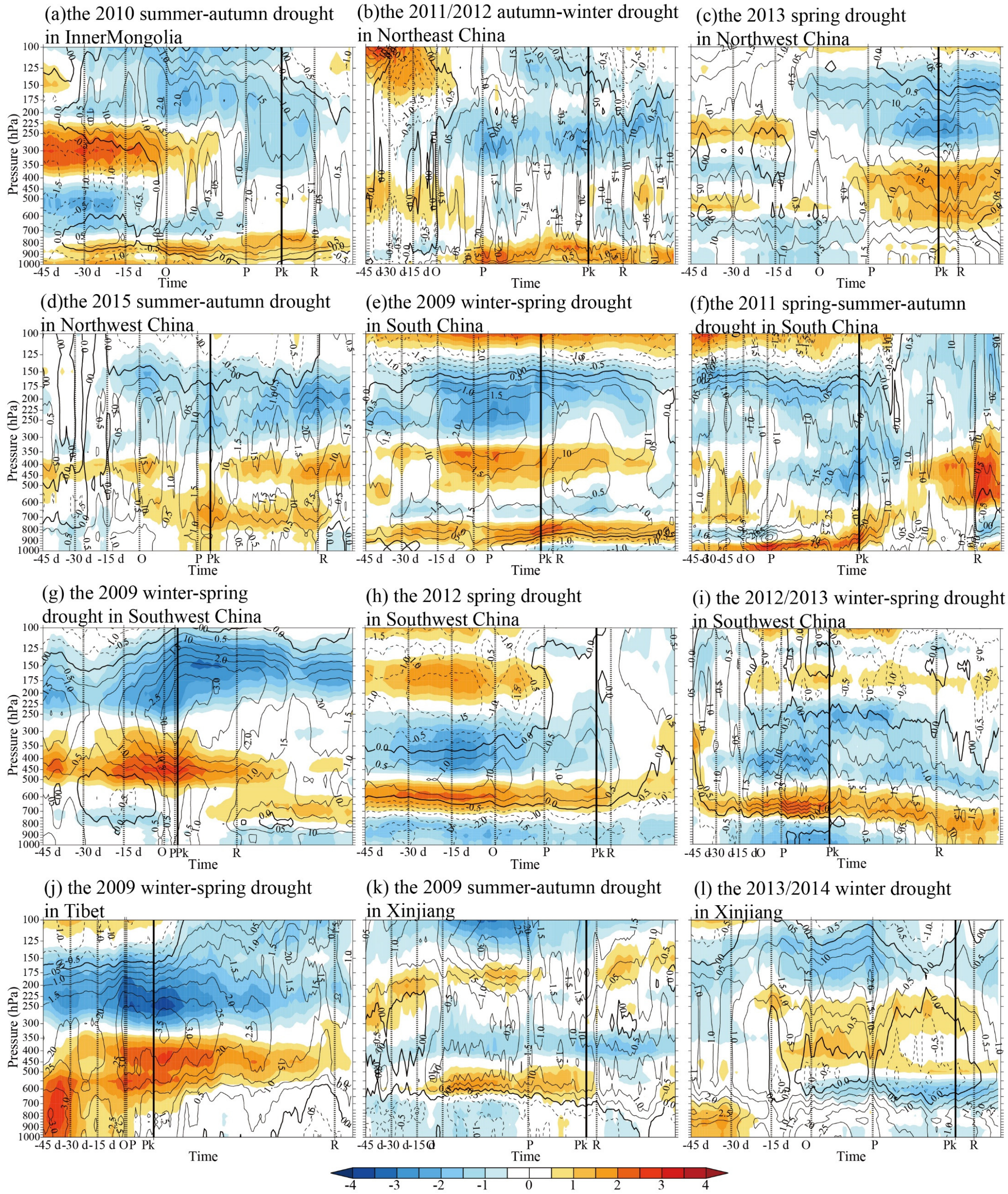

Figure S2. Same as Figure 2, but for the other twelve drought processes during 2009–2016.

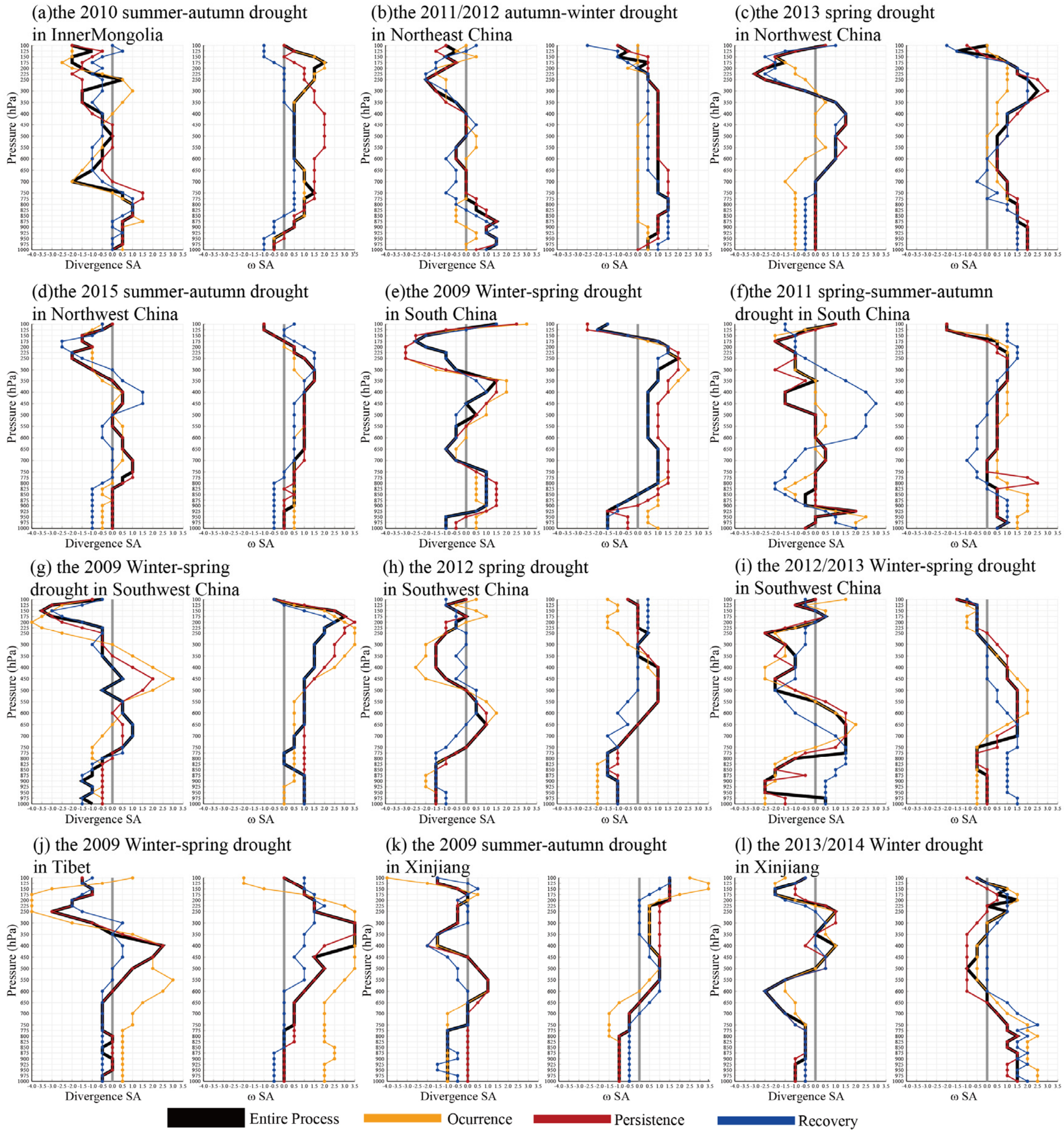

Figure S3. Same as Figure 3, but for the other twelve drought processes during 2009–2016.

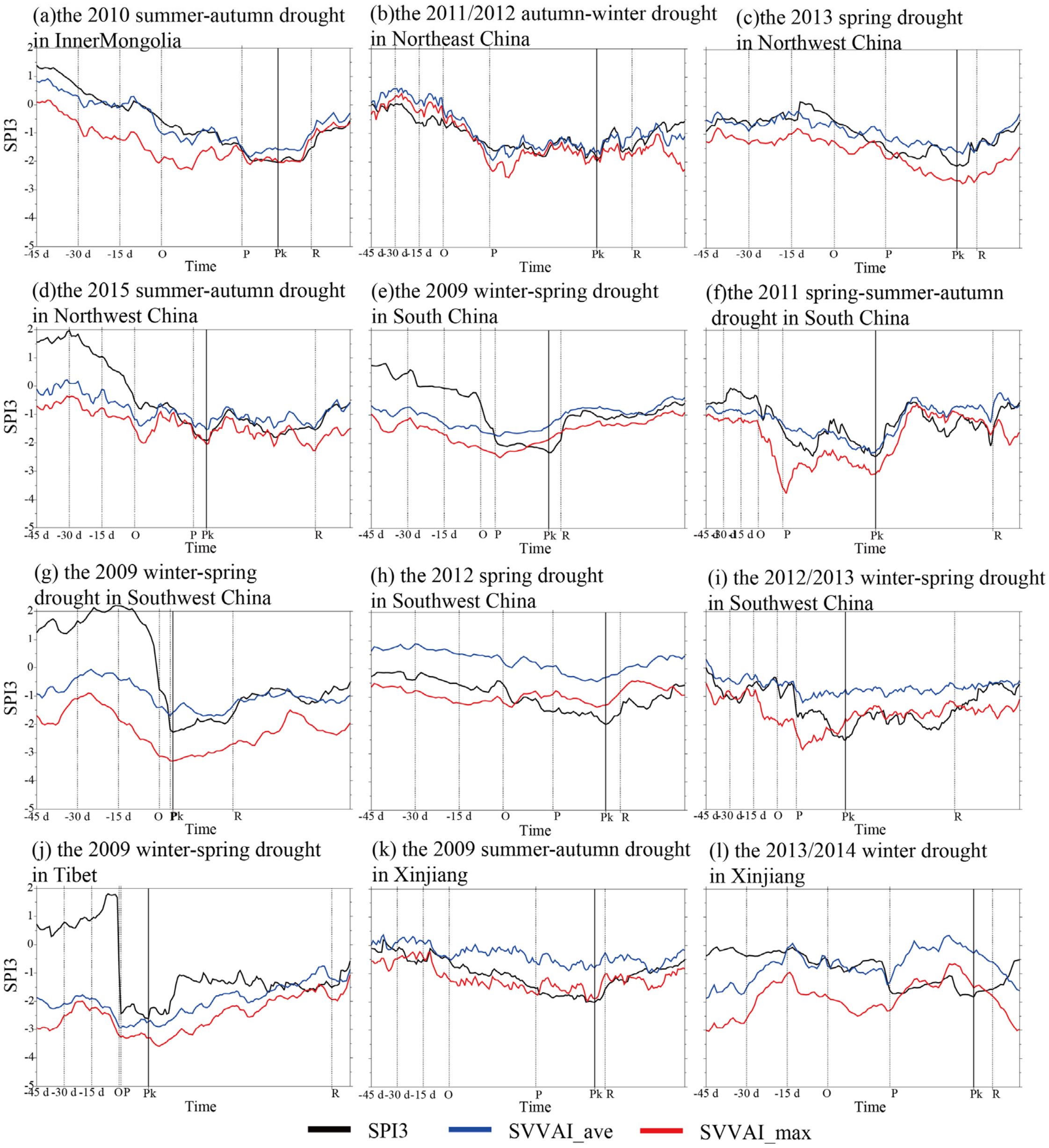

Figure S4. Same as Figure 4, but for the other twelve drought processes during 2009–2016.

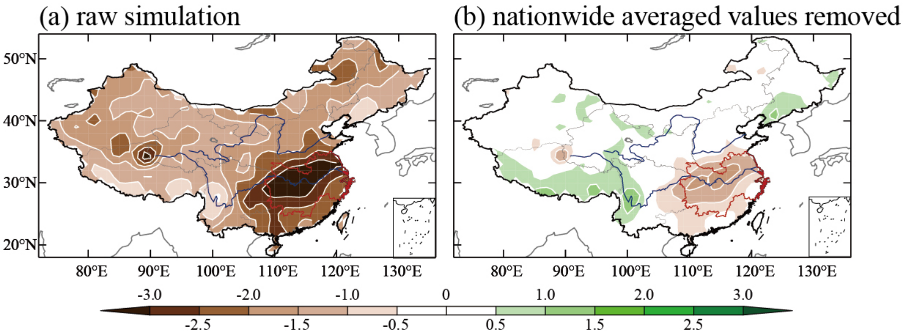

Figure S5. The composited spatial distribution of the 2011 East China drought (Figure 5 (a1)) simulated by raw SVVAI_max (a) and those with nationwide averaged values removed (b)

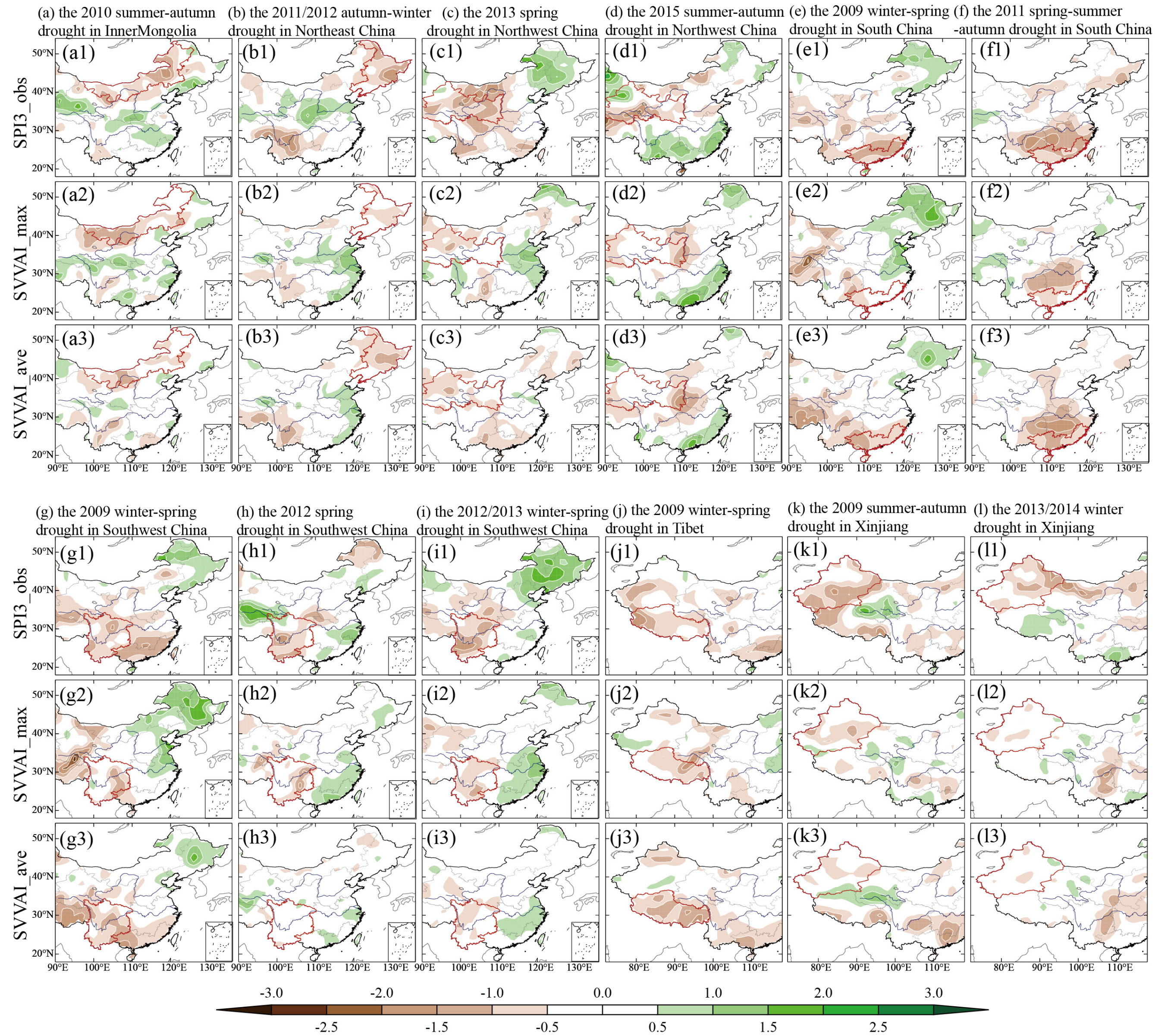

Figure S6. Same as Figure 5, but for the other twelve drought processes during 2009–2016.

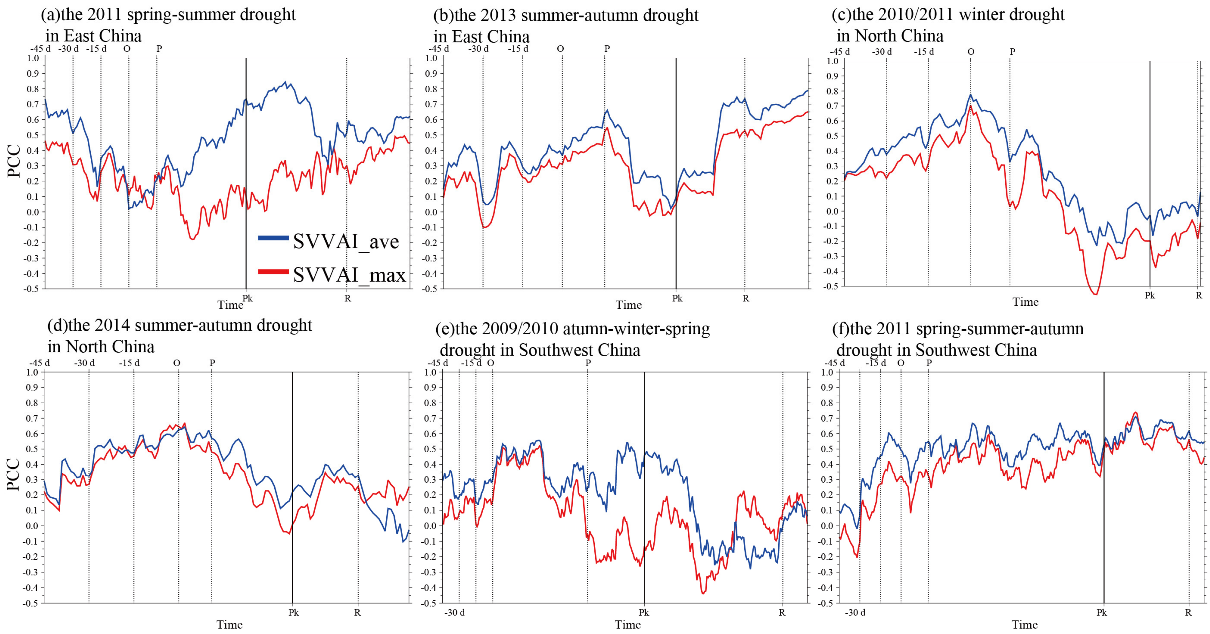

Figure S7. Temporal evolution of Pattern Correlation Coefficients (PCC) of spatial simulation using the SVVAI with respect to gridded SPI3 during six typical regional drought processes over China. PCC is calculated regarding target drought regions.

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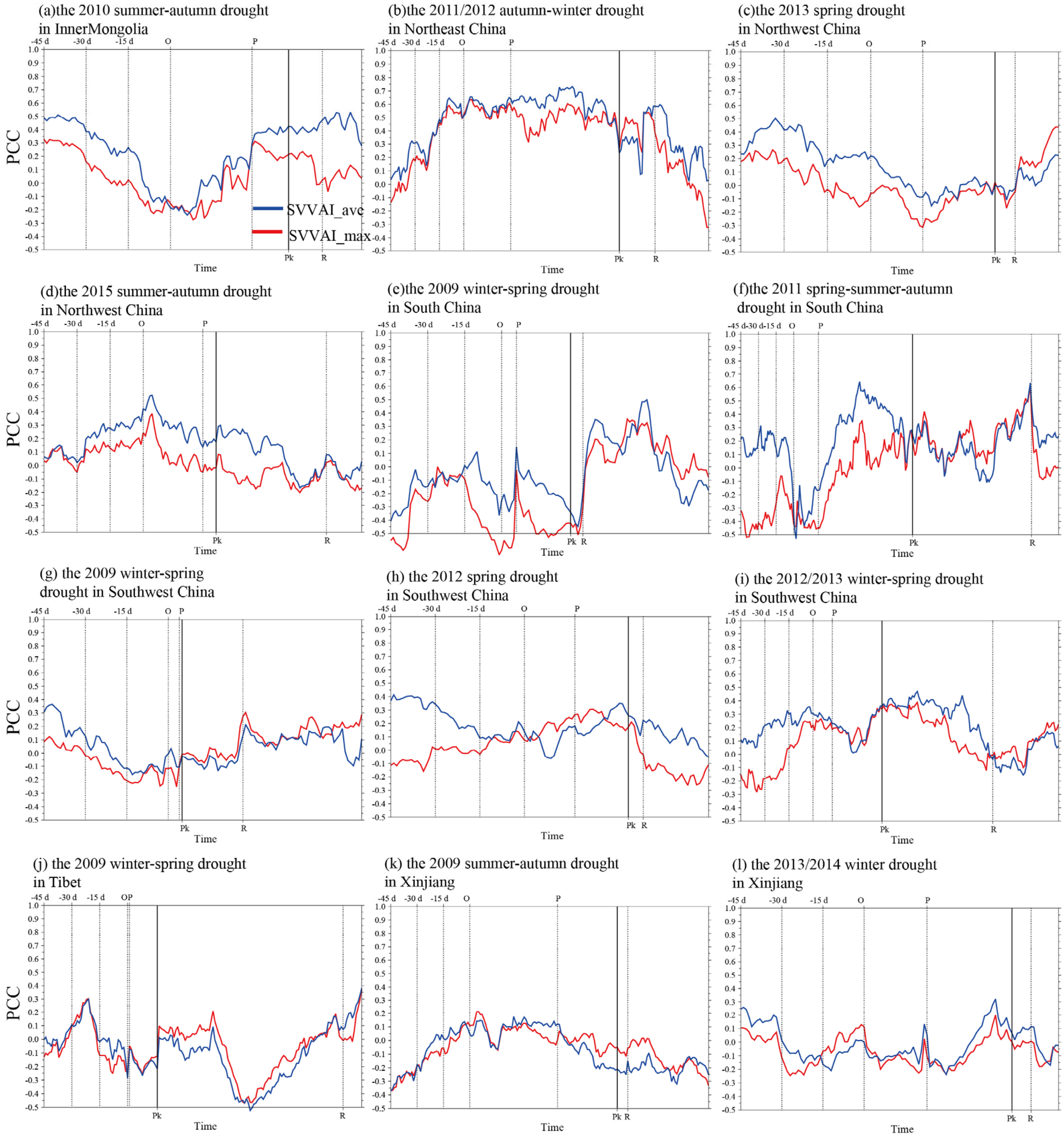

Figure S8. Same as Fig. S7, but for the other twelve drought processes during 2009–2016.

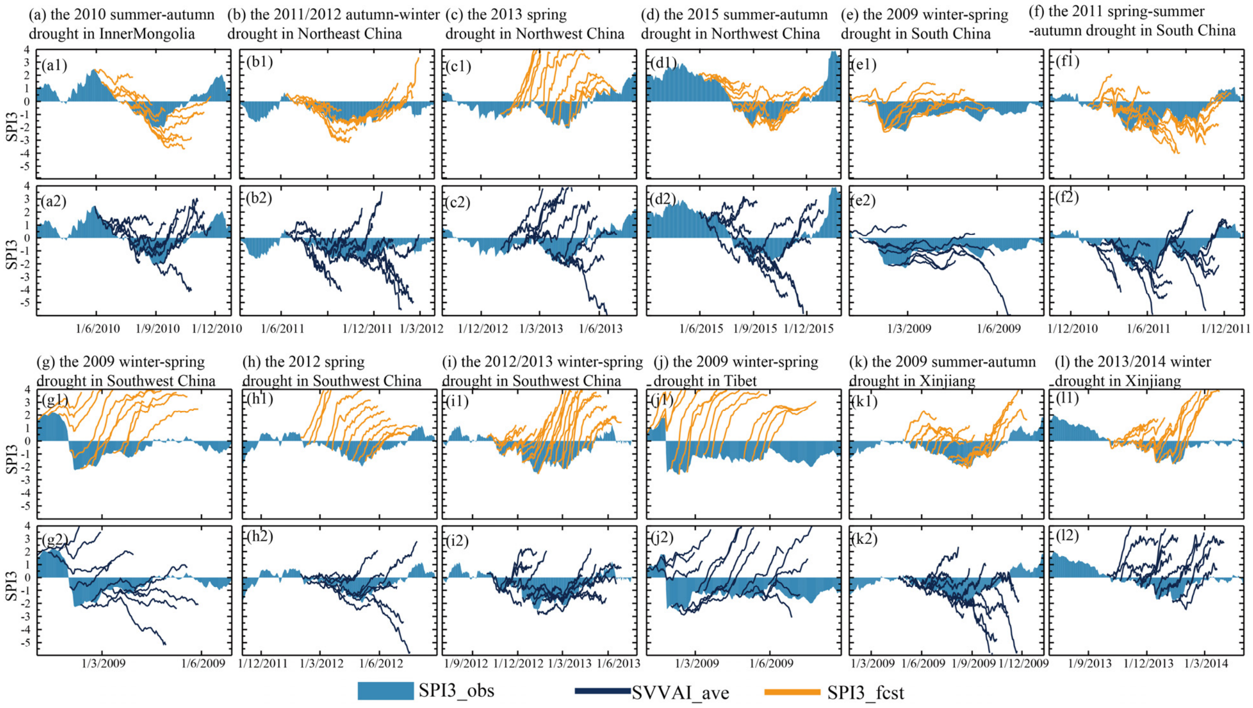

Figure S9. Same as Figure 7, but for the other twelve drought processes during 2009–2016.

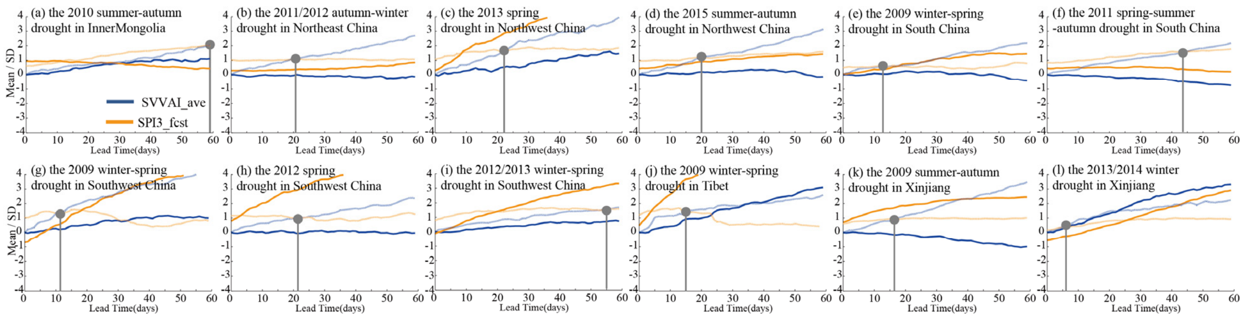

Figure S10. Same as Figure 8, but for the other twelve drought processes during 2009–2016.