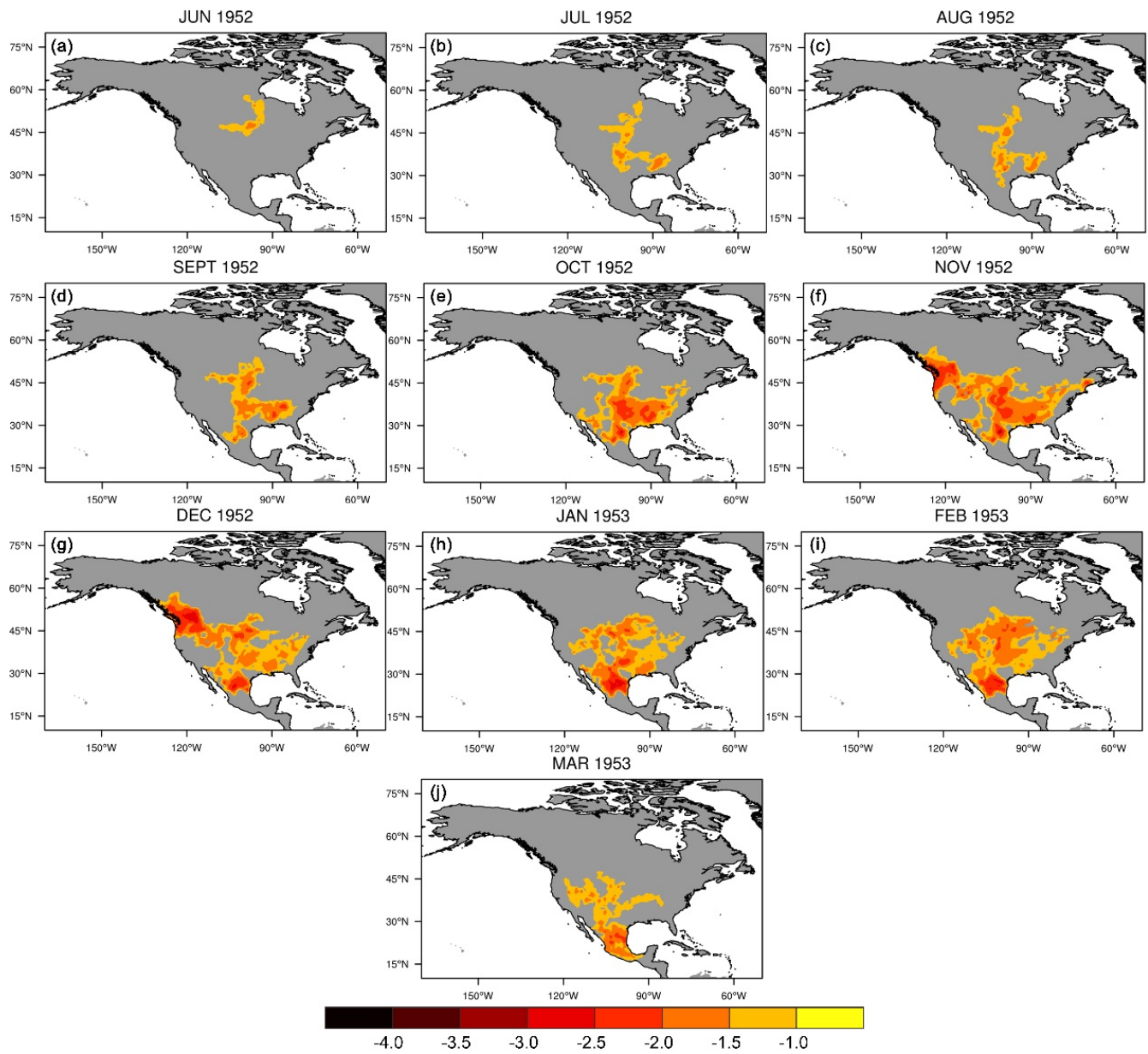**Figure S1.** Locations of the 32 large basins used to evaluate the SZI_{snow}.

Figure S2. Development of a large-scale contiguous drought event in North America identified by the severity–area–duration (SAD) drought diagnosis method. This event started in June 1952 and ceased in March 1953.
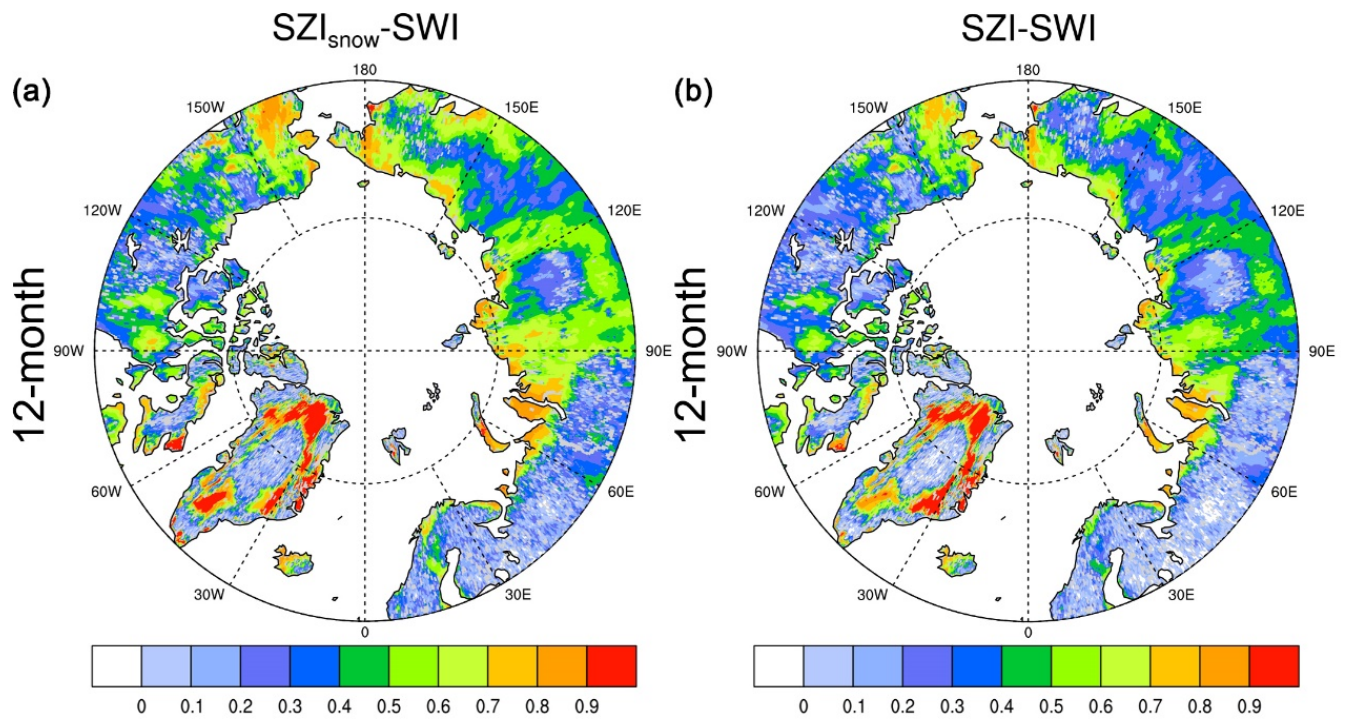
Figure S3. Comparison between the SZI and SZI$_{snow}$ in the context of their performance over the Arctic region. (a) Spatial distribution of the correlation coefficients of the SZI$_{snow}$–SWI over a 12-month timescale. (b) Spatial distribution of the correlation coefficients of the SZI–SWI over a 12-month timescale.

Table S1. Full names of the drought indices listed in Figure 1.

Abbreviations	Full names
SAI	Standardized Anomaly Index
PHDI	Palmer Hydrological Drought Severity Index
SWI	Standardized Water-level Index
SWS	Soil Water Storage
SMA	Soil Moisture Anomaly

Table S2. Full names of the abbreviations used in the SZI$_{snow}$ derivation equations.

Abbreviations	Full names	Abbreviations	Full names
ET	Evapotranspiration	PL_t	Potential L_t
PET	Potential ET	L_s	L from bottom soil layer
E_b	Bare soil evaporation	PL_s	Potential L_s
E_t	Transpiration	SWE	Snow water equivalent
E_i	Canopy water evaporation	ΔSWE	Change of SWE
RO	Runoff	SA	SWE accumulation
PRO	Potential RO	PSA	Potential SA
RO_s	Surface runoff	SM	Snowmelt
RO_b	Baseflow	PSM	Potential SM
RO_{sm}	Snowmelt runoff	P	Precipitation
R	Soil infiltration	$\hat{P}_{snow}$	CAFEC precipitation
PR	Potential R	$P_{rainfall}$	Rainfall
AWC	Available soil water holding capacity	$P_{snowfall}$	Snowfall
S_t	Available soil moisture in top soil layer	α_j	Climatic coefficient of ET
S_u	Available soil moisture in bottom soil layer	β_j	Climatic coefficient of R
ΔS_t	Change of S_t	γ_j	Climatic coefficient of RO
ΔS_u	Change of S_u	δ_j	Climatic coefficient of SA
L	Soil moisture loss	ε_j	Climatic coefficient of L
PL	Potential L	φ_j	Climatic coefficient of SM
L_t	L from top soil layer	Z_{snow}	Moisture anomaly