Impact of Eurasian spring snow decrement on East Asian summer precipitation

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• Many researches have investigated the impact of Eurasian snow on the East Asian Climate.
• Previous studies are mainly based on snow cover variability itself.
• Spring snow decrement (SSD) is closely related with snowmelt and latent heat.
• The SSD’s impacts are investigated in this study.

Climatological annual cycle of monthly snow water equivalent (SWE, light blue bars) and snow decrement (SD, orange bars) over the Eurasian continent (35° – 76° N, 0° – 150° E) during 1980–2013 (Units: mm). Positive and negative SDs represent increase and decrease SWE in succeeding month with respect to the previous one.
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• Monthly mean atmospheric data from NCEP/NCAR Reanalysis I with a horizontal resolution of $2.5^\circ \times 2.5^\circ$;
• Monthly mean sea ice concentration (SIC) and sea surface temperature (SST) from the Met Office Hadley Centre with a horizontal resolution of $1^\circ \times 1^\circ$;
• Monthly mean soil moisture from the ERA-Interim reanalysis with a horizontal resolution of $0.75^\circ \times 0.75^\circ$;
• Monthly mean snow water equivalent (SWE) data of GlobSnow V2 from the Finnish Meteorological Institute.
• The time period is taken from 1979 to 2013.
• The NCAR Community Atmospheric Model version 3.1 (CAM3.1) was employed.
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SSDI index is defined as the difference of SSD between the rectangles with positive values (46°–58°N, 96°–138°E) and negative values (54°–68°N, 48°–84°E) shown in (a).
Partial correlation coefficients of SSDI index with East Asian summer precipitation when the linear parts related to the (a) Nino3.4 and (b) Arctic sea ice concentration (SIC) are removed.
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Regressed (a) late spring (AMJ) and (b) summer (JJA) 289 cm soil moisture (SM) against SSDI (shadings; units: m³/m³)
Regressed summer (JJA) (a) surface solar radiation flux, (b) longwave radiation flux, (c) sensible heat flux, (d) latent heat flux, and (e) net heat flux anomalies (shadings; units: W/m$^2$) against SSDI
Regressed summer (a) surface temperature (shadings; units: °C), (b) atmospheric thickness between 500 hPa and 1000 hPa (Z500-Z1000, units: gpm), and (c) 700 hPa meridional temperature gradient (shadings; units: °C/grid) against SSDI
Regressed summer (a) 200 hPa zonal wind (shadings; units: m/s) and (b) 500 hPa geopotential height (shadings; units: gpm) against SSDI. The zonal winds with speed greater than 20 m/s are enclosed by the black lines in (a).
Regressed (a) late spring (AMJ) and (b) summer (JJA) 500 hPa stream function (shading; units: m²/s) and associated wave activity flux (vector; units: m²/s²) against SSDI index
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The model is spun up for 20 years and then integrates forward for 50 years. The data for December 1 of the last 50 years are used as initial fields, and the 50 initial conditions are used for ensemble simulation.

Reduce and increase the snowfall rate by 50% over western and eastern regions, respectively.

CAM3.1 simulations of (a) spring SWE and (b) SSD (shadings; units: mm) anomalies in response to the anomalous snowfall rate over the Eurasian continent. The thin and thick black lines denote values with statistical significance exceeding the 90% and 95% confidence levels, respectively.
CAM3.1 simulations

(a) JJA Ts

(b) JJA Z500-Z1000

(c) JJA 700hPa -dT/dy

(d) JJA U200

(e) JJA Z500

(f) JJA WAF
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• A west-east dipole pattern in Eurasian SSD anomalies is significantly related to East Asian summer precipitation, with more rainfall over northeastern China and the Yellow River valley and less rainfall over Inner Mongolia and southern China.

• Such dipole SSD pattern in Eurasian causes local soil moisture anomalies lasting from spring to the following summer, which alters summertime surface heat flux and near-surface temperatures.

• The near-surface thermal anomalies causes an acceleration of the subtropical westerly jet stream, increase the local 1000–500 hPa thickness, leading to an enhanced Eurasian Rossby wave train.

• The enhanced wave train spreads from eastern Europe eastward to East Asia and influences the summer precipitation over China.