Hemispheric Snow Cover Extent Variability

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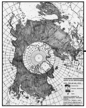
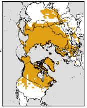
Snow Map Reanalysis

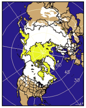
A snow cover extent (SCE) climate data record (CDR) has been derived from a thorough reanalysis of NOAA visible satellite-derived maps of Northern Hemisphere (NH) continental SCE, maps that date back to late 1966. Shown below is an original hand-drawn weekly map [below left] and a digitized version of this map [below center]. In 1999, the weekly NOAA maps transitioned to Interactive Multisensor Snow and Ice Mapping System (IMS) maps [below right].



Visible satellite-derived map for week ending Feb. 28, 1999



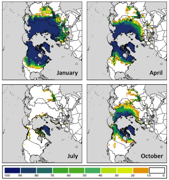
128x128 digitization for week ending Feb. 28,1999



1024x1024 independently produced daily IMS map for Feb. 28, 1999

Comparisons between climatologies of the first 33 years of coarse-scale weekly NOAA maps and finer daily IMS maps from June 1999 to May 2008, plus a two-year overlap of independently-produced weekly products and trial IMS maps were used to generate a consistent, seamless SCE CDR. This included upscaling the finer spatial resolution IMS maps to the older weekly map resolution.

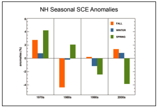
This fine tuning to convert the former Environmental Data Record (EDR) to the new CDR led to no more than 4% reduction in previously reported annual SCE. The largest annual reductions are due to prior overly generous digitization of areas of patchy snow cover.



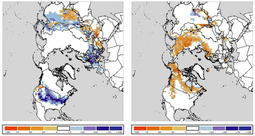
New CDR-derived monthly Northern Hemisphere SCE climatologies 1971-2000

Northern Hemisphere Snow Cover Extent and Variability

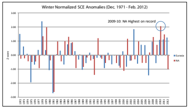
Northern Hemisphere (NH) continental snow cover extent (SCE) during the 2009/10 winter was the second most extensive during the satellite era (1972-2012) and most extensive over North America (NA) [see graph top right]. This was followed by the 4th least extensive spring 2010 NH SCE and least extensive spring 2010 NA cover [graph on bottom right]. Declining spring NH SCE has been observed over the four-decade satellite record [below].

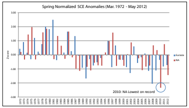


Decadal Departures of Seasonal Northern Hemisphere SCE



SCE anomalies for February [left] and May [right] 2010. Shown as percent differences from 1971-2000 average SCE.





Winter and spring normalized continental SCE anomalies (anomaly minus mean anomaly divided by standard deviation).

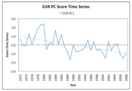
Eurasian Snow Extent Variability and Associated Atmospheric Tendencies

Principal component analysis (PCA) was performed on the annual cycle of Eurasian SCE. Results for the first three components explained 35, 27 and 13% of the variance respectively. Seasonal "breaks" were identified from the loadings of each component.

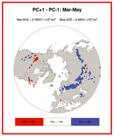
Component Matrix[a]

	Component 1	Component 2	Component 3
Eur1	-.019	.566	-.719
Eur2	.528	.588	-.295
Eur3	.911	.132	.041
Eur4	.864	-.087	.192
Eur5	.852	.148	.131
Eur10	-.006	.718	.268
Eur11	-.286	.640	.588
Eur12	-.390	.724	.006

Red boxes indicate seasonal "breaks" occuring in each component. A late (component 1) and early to mid (component 2) winter period were identified for futher analysis.



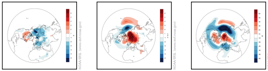
A distinctive downward trend is apparent from PC 1 score time series. Considering the monthly loading distribution of PC 1 [in left table], this component is indicative of recently documented spring decrease in SCE from March to May.



Snow composite analysis based on years falling either +1 or -1 PC were created for those seasons identified from the annual cycle loading pattern. Positive SCE anomalies during PC +1 years from Mar-May [left], indicated by blue areas, represent approximately 15% of the climatological SCE for these months.

PC +1 Years	PC -1 Years
1981	1990
1980	2008
1979	2002
1985	2007
1976	
1987	

Extreme positive and negative years identified from the Eurasian PC 1 score time series.



Surface air temperature PC +1 minus PC -1 years

Sea level pressure PC +1 minus PC -1 years

500 hPa height PC +1 minus PC -1 years

Significant positive correlation between Eurasian PC 1 score time series and both the Western Pacific (WP, 0.4) and the Scandinavian Patterns (SC, 0.33) are evident. Below average temperature in eastern Siberia is associated with the WP, while similar temperature tendencies in central Russia and Western Europe are associated with the SC pattern.

Northern Hemisphere Visible Satellite Snow Mapping Timeline

Date	Event
Nov 1966	Snow mapping begins ESSA Series
Oct 1972	NOAA Series AVHRR
May 1975	GOES Series
1980-81	190 km weekly digitization
Feb 1988	METEOSAT added
Jan 1989	GMS added
1990s	Reanalysis of 1966-71
May 1999	Weekly mapping ends
Feb 1997	IMS 24 km daily begins
Feb 2004 – Present	IMS 4 km daily added

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