The Antarctic Sea Ice spatial variability for the period 1979-2006 and its relationship with atmospheric circulation

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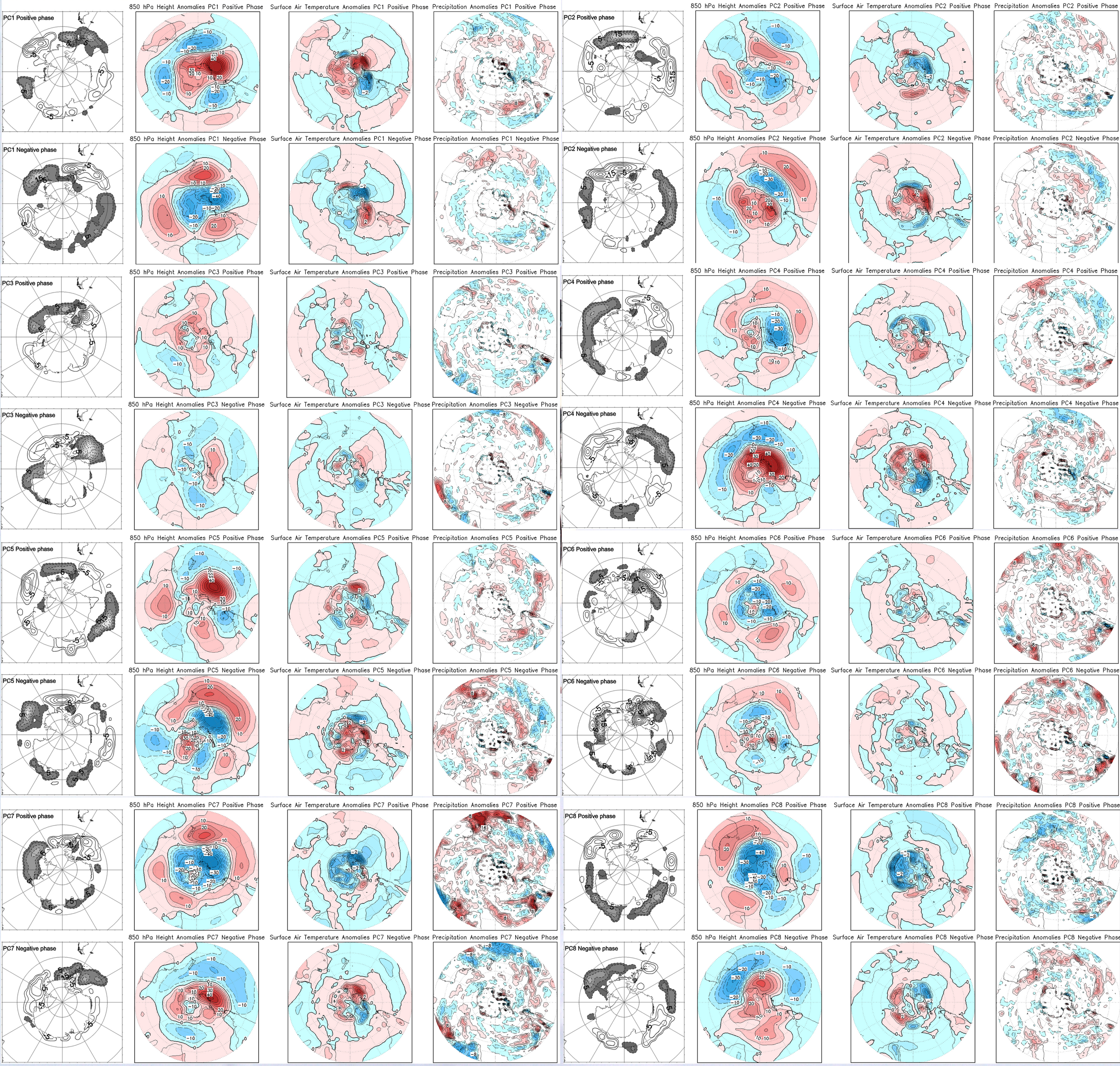
Principal Components Analysis (PCA) in T-Mode (correlation between spatial fields) Varimax rotated was performed on Antarctic monthly sea ice concentration anomalies (SICA), in order to investigate which are the main spatial patterns, when do they appear and how are they related to several atmospheric variables. This analysis provides 8 principal components (5 for winter-spring and 3 for summer-autumn periods) in positive and negative phase (16 spatial patterns), that represent the most important spatial features that dominated sea ice concentration anomalies (SICA) spatial variability in Antarctic Seas for the period 1979-2006. Monthly Polar Gridded Sea Ice Concentrations database derived from satellite information generated by NASA Team algorithm and acquired from the National Snow and Ice Data Center (NSIDC) were used. The connection between sea ice condition and atmospheric circulation is analyzed by mean of 850 hPa height, surface air temperature and precipitation composites anomalies coupled with each SICA pattern. These data were provided by the National Center for Environmental Prediction reanalysis project.

Table: Monthly classification of the sea ice concentration anomalies for the 1979-2006 periods. The numbers indicate the order of the PC that classifies a month. The "+" sign is associated with the positive phase of a PC. The "-" sign indicates the negative phase of the PC. NC is used to denote the unclassified months.

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
January	7-	7-	3+	3+	7-	(7-)	3+	3+	3+	3+	6-	NC	3-6+	3-	(6+)	3-6+	3-	(6-)	6+	6-	7+	6+3+	6-	6+	3-6-	6-3-	7-	(7-8+)
February	7-	7-	3+	NC	(7-)	(3+7-)	3+	3+	3+	3+	6-	NC (3-)	3-6+	3-	(6+)	6+3-	3-	NC	6+(3-)	6-	7+	6+	6-	6+	3-	6-3-	7-	NC
March	7-	7-	3+	3+	7-3+	(7-)	3+	3+	3+	3+	6-	NC	3-(6+)	3-7-	6+(3-)	3-	3-	7+	3-6+	6-7+	7+	6+(7+)	6-	6+	3-	3-6-	(6-7-)	(3+)
April	(6-8-)	7-	3+(7-)	(2+3+)	7-(3-)	7-	7+3+	3+	3+	3+	(8+)	(7+)	3-	3-7-	6+(3-)	3-	3-	7+(6-)	(3-)	7+	7+3+	6+7+	3-	6+	3-	3-6-	(4+6-)	3+
May	8-	7-4-	(7-)	2+(1-)	(3-)	NC	7+(5-)	(2+)	3+(8-2+)	4+	(8+)	4+	(7-1+)	7-3-(4-)	(1-)	3-(2-1+)	(3-)	7+	NC	4-	4+7+	4+(7+1-)	(2-)	6+	2-	(6-)	4+(1+)	(1-6+)
June	(8-)	4-7-	4-	1-(2+)	(1+)	1+(5-)	5-1-	2+5+	2+	4+2-5-	(1-8+)	4+	1+	4-(1+)	8+	1+(8-2-)	5+(8+)	(4+)	8-	2-5-	4+	4+1-	2-5-	1+5+	2-	(2-4-8-)	1+4+	1-
July	8-1-	4-1+	4-1-8-	(8+2+)	4+	5-2-	1-(2+)	2+(5+)	1+2+4-	2-	1-	2+4+1-	1+	4-1+2-	8+(1-)	1+8-	1+5+	8-	1+	5-1-	4+	1-(4+)	1+5-	2+8-	2-	5+	1+	8+5+
August	5+1-	1+4-	8-4-	8+	4+8+	(5-)	1-2+	2+8+1+	4-	2-	1-(5+)	2+4+	1+	2-4-	1-(8+)	(2-8-)	1+	8-	5+	4+5-2-	4+	4+(8-1-)	5-	8-	1-5+	5+	1+5+	2-5+
September	5+2+	1+4-	4-	8+	(4+5-)	1-8-	1-4+	2+(8+)	4-	2-	1-	2+8+4+	NC	5+(2-)	1-(8+)	4+5+	1+	8-5-(4+)	1+	5-4+	5-	8-	2+(5-)	2-	5+1-	5+	2-	2-
October	5+2+	2-1+4-	4-	8+(1+)	(2+)	2+1-	1-4+	2+(4-)	4-	2-8-	1-	2+4+	4-1+	5+2-	8+	1+(5+)	2-	8-4+	2-5-1+	5-1-4+	5-	8-	1-6+	2-	5+	5+	2-	2-
November	5+2+(7-)	2-4-	4-2-	1+8+	1-(4+)	1-8+	1-	2+1+	8-(4-5-)	2-	1-5+	2+1+4+	(4-2-)	5+	8+	1+(3-)	(2-4+)	8-(6+)	4-1+2-	4+(5-)	5-	6-5-	6+4+	5+	5+	5+	2-	8+2-
December	7-	(1+4-)	3+(6+)	1+	1-(6+)	(1-8+)	1-(3+)	2+(1+)	1-(8-7+)	6-(2-)	NC	2+1+(3-6+)	3-	(6+)	(3-)	3-(1+)	(6-)	6+(4+)	6-4-	4+7+	6+1-	6-	6+	3-6-	5+	(5+)	(2-8+)	(6+)

Figures: The 8 obtained Spatial patterns in positive and negative phase and the associated composite of 850 hPa height anomalies, surface temperature anomalies and precipitation anomalies



The first spatial winter-spring pattern in positive (negative) phase shows a positive (negative) sea ice concentration anomaly centre over the Drake Passage and north region of Bellingshausen and Northeast Weddell Seas together with another positive centre over the East Indian Ocean basin. Opposite sign centre over the rest of the Atlantic and Indian Oceans basins and the Amundsen Sea are also presented. A strong positive (negative) 850-hPa height anomaly covers most of the Antarctic Continent centred over the Bellingshausen Sea accompanied by three negative (positive) height anomalies in middle-latitudes (Atlantic, Pacific and Indian Oceans), characterize the atmospheric circulation for this first pattern. Temperature anomalies fields show strong negative (positive) anomalies cores over the areas with positive (negative) SICA centres. These temperature anomalies extend their influences over middle-latitudes (up to 30ºS). Therefore, the meridional temperature gradient is enhanced (reduced) over the South Atlantic Ocean and Southwest Pacific Ocean over the areas with the negative (positive) anomalies of height, giving positive (negative) precipitation anomalies over the Southern Oceans. Each sea ice pattern is characterized by a unique spatial behaviour and is accompanied by a different atmospheric structure.