

北日本における4月と8月気温の 強い相関関係とその時間変動 (3: 1998年は climate-shiftか?)

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目的

- 北日本の農業にとって、作付時期の春と生長・稔実時期の夏の気温は非常に重要である。しかしながら、近年、夏季の気温変動が大きく、冷夏や暑夏が頻発している。冷害や高温による米の品質低下が発生し、気温の変動要因の把握が重要である。
- 特に2010年は春の気温が低く、高温の夏とあわせて極端な季節変化となった。そのような気温変動について、季節変動の規則性の観点から統計的に検討する。

データと方法

- 北日本の平均気温偏差は、東北と北海道の気象官署月平均気温偏差を平均して求めた。
- 平年値は全期間に1981年～2010年平年値を用いている。
- 客観解析データはJRA25を、統計解析にはRおよび気象庁のITACSver.4を用いた。
- 各季節、月の平均値でそれぞれの相関関係を検討し、特に関係の明瞭な4月と8月の事例を中心に客観解析データを用いて解析した。

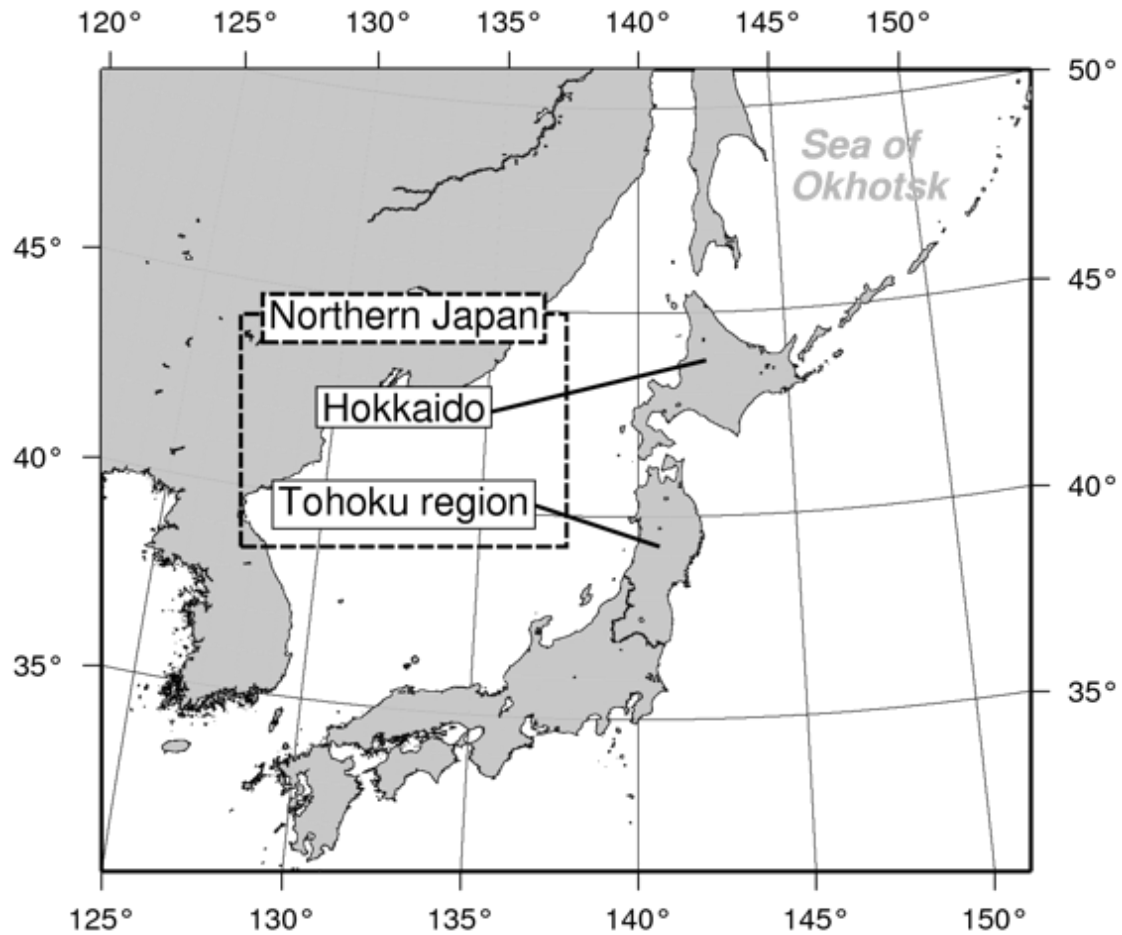


Fig. 1. Map of northern Japan, which consists of Hokkaido and the Tohoku region.

Table 1. Correlation coefficients between each possible pair of monthly mean temperatures in the last 13 years (from 1999 to 2011) in northern Japan. Shaded boxes indicate statistical significance at the 5% level or better.

	Jan											
Feb	0.51	Feb										
Mar	0.14	0.44	Mar									
Apr	-0.11	0.01	0.53	Apr								
May	0.28	0.20	0.27	0.22	May							
Jun	0.41	0.08	-0.59	-0.51	-0.27	Jun						
Jul	-0.06	-0.06	-0.12	-0.19	-0.07	0.17	Jul					
Aug	0.21	-0.01	-0.51	-0.83	-0.41	0.56	0.42	Aug				
Sep	0.21	0.14	-0.34	-0.57	-0.45	0.62	0.46	0.84	Sep			
Oct	0.02	-0.10	0.13	-0.12	-0.69	0.25	0.29	0.33	0.39	Oct		
Nov	-0.25	-0.02	-0.43	-0.44	-0.05	0.45	-0.03	0.19	0.13	0.01	Nov	
Dec	0.16	0.17	0.17	-0.33	0.15	0.20	-0.16	0.11	0.19	0.00	0.45	

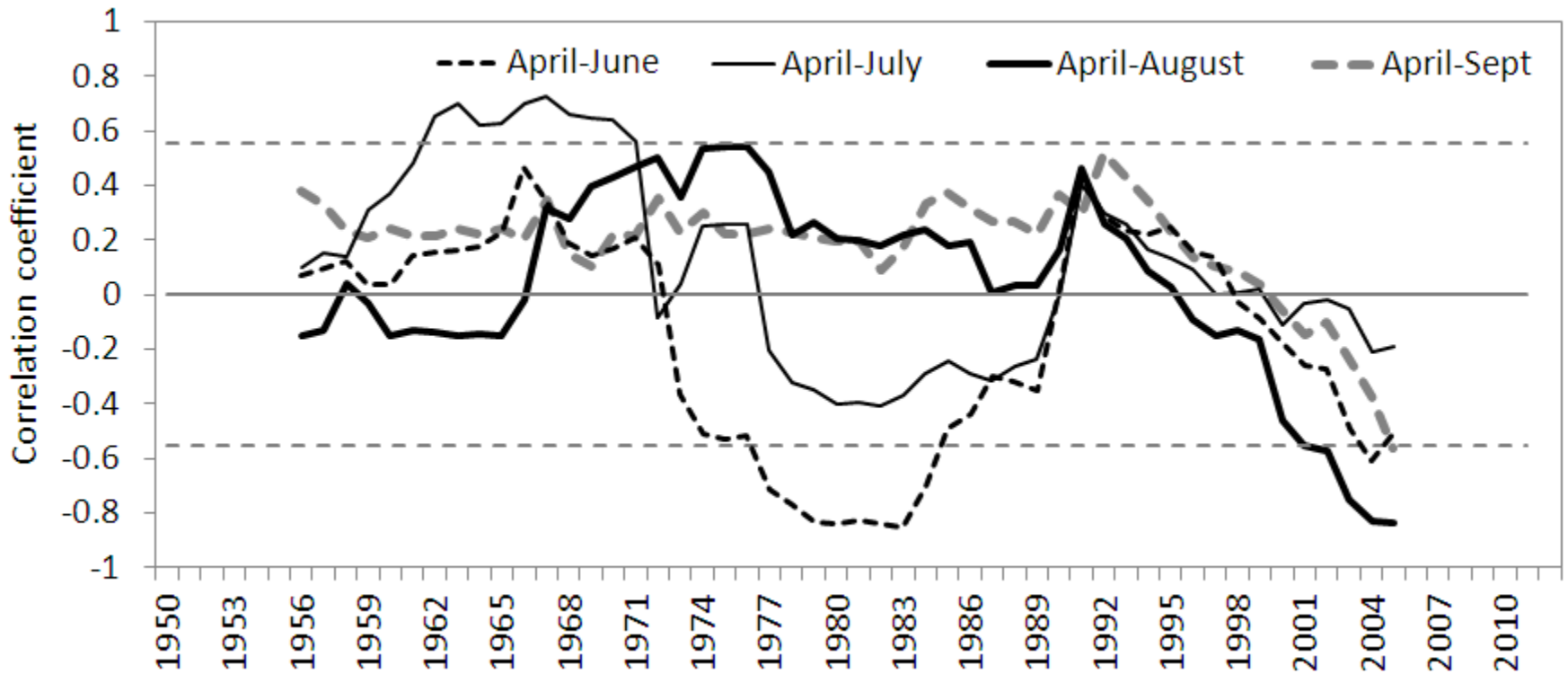


Fig. 2. Thirteen-year running correlation coefficients between April and June, July, August, and September monthly mean temperatures in northern Japan from 1950 to 2011. Values are reported for the year that is the midpoint of the 13-year period. Broken horizontal lines indicate a significance level of 5% where the correlations exceeded an absolute value of approximately ± 0.6 .

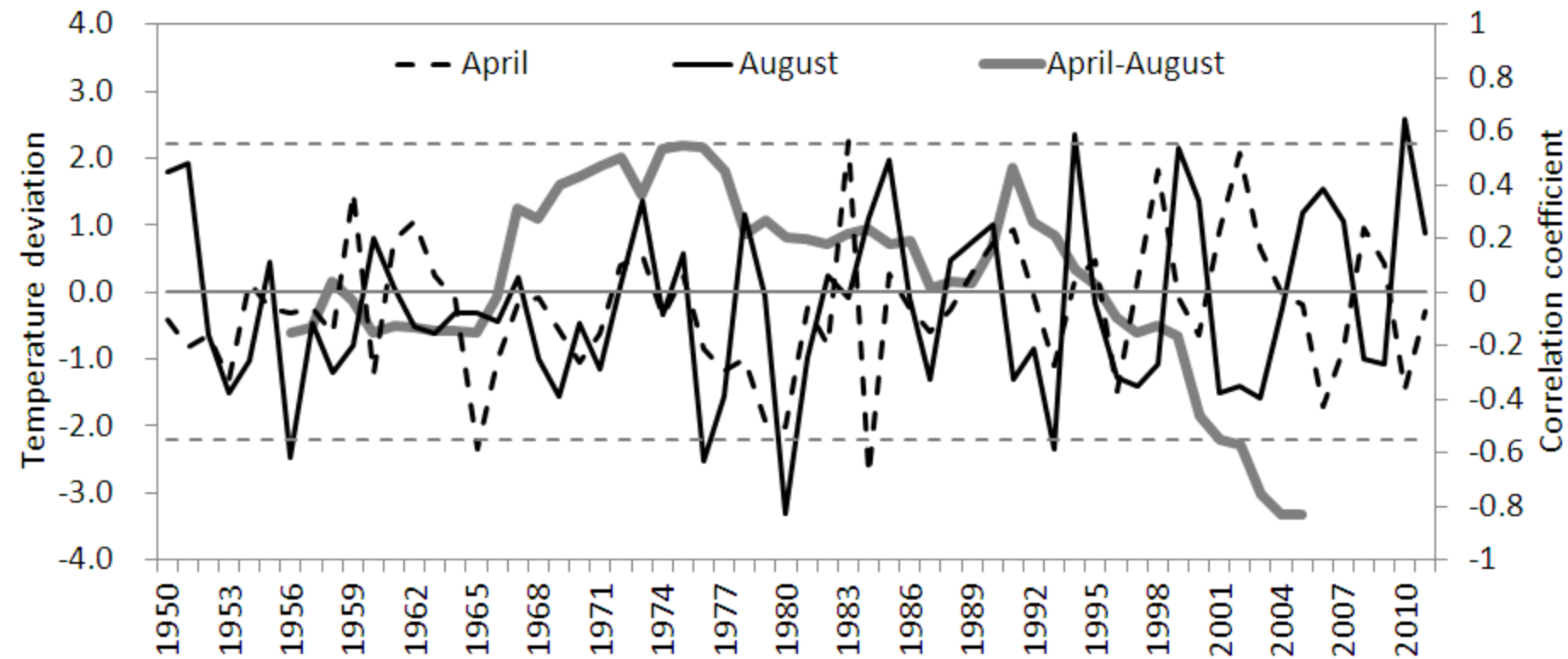


Fig. 3. Time series of the separate monthly mean temperature deviations in April and August in northern Japan, and the 13-year running correlation coefficients between these two months during 1950–2011. Only those few correlation coefficients greater than 0.6 or less than -0.6 (horizontal dashed lines) were significant at the 5% level.

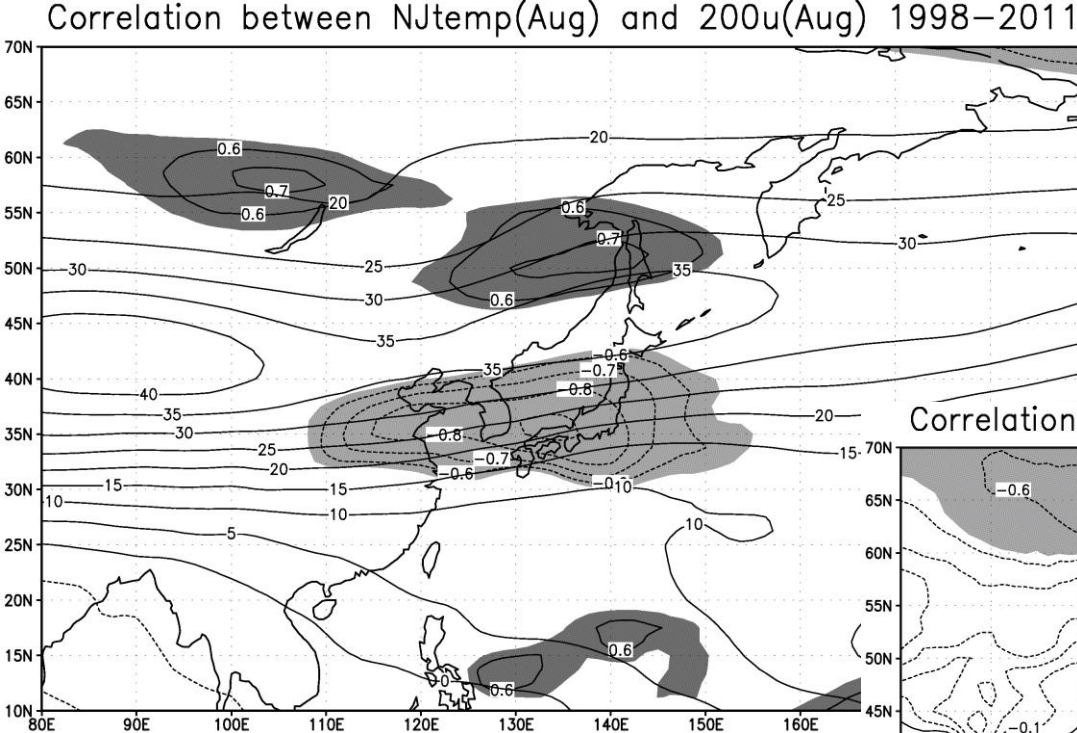


Fig. 4. Correlation between northern Japan's temperature deviation in August and the 200-hPa u -component of wind in the same August from 1998 to 2011, and the normal u -component wind in August.

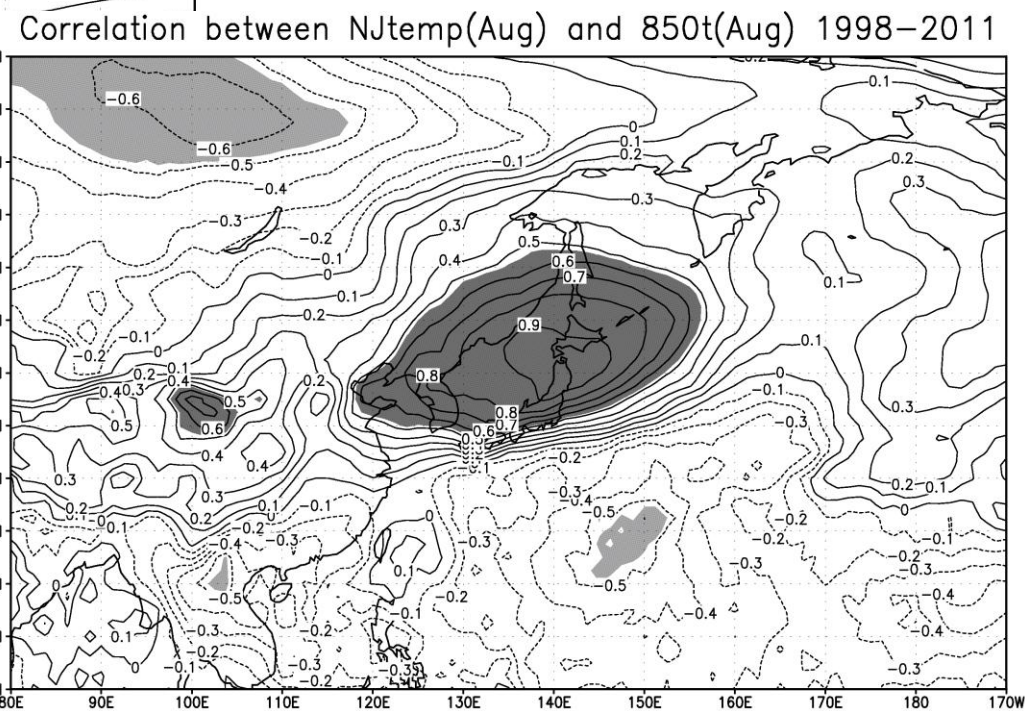


Fig. 5. Correlation between northern Japan's temperature deviation in August and the 850-hPa air temperature in the same August from 1998 to 2011.

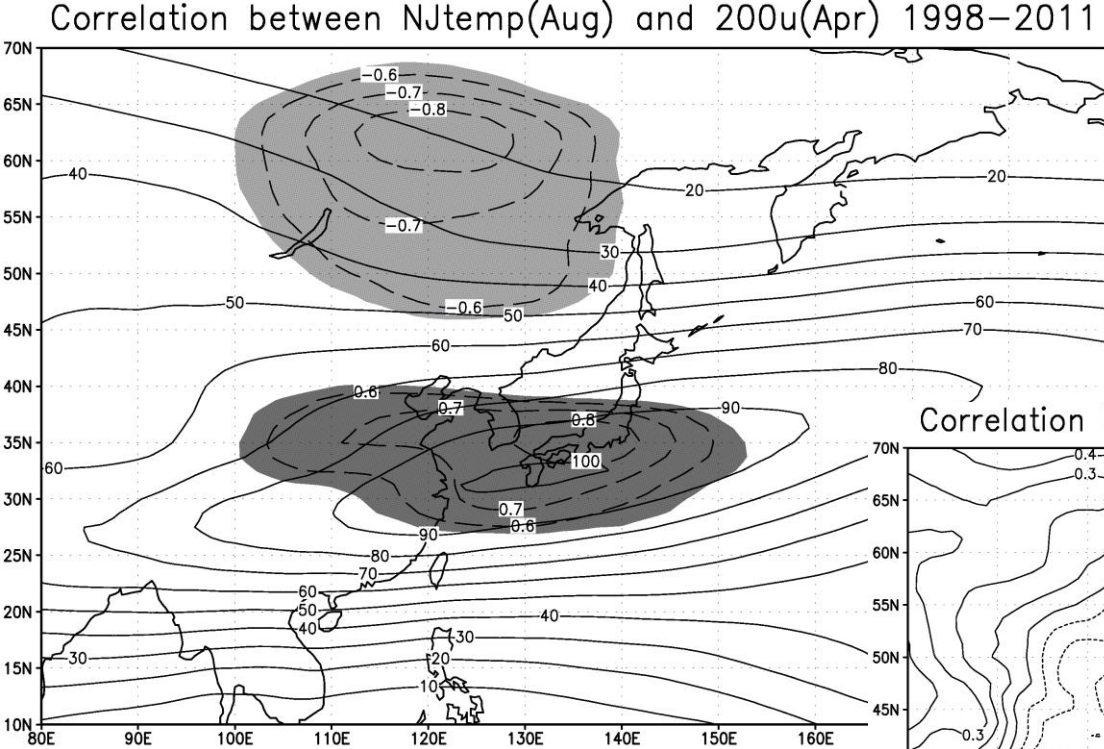


Fig. 6. Correlation between northern Japan's temperature deviation in August and the 200-hPa u -component of wind in April, from 1998 to 2011 (dashed contours and shaded areas), overlaid on the normal u -component distribution of wind in April (thin solid contours).

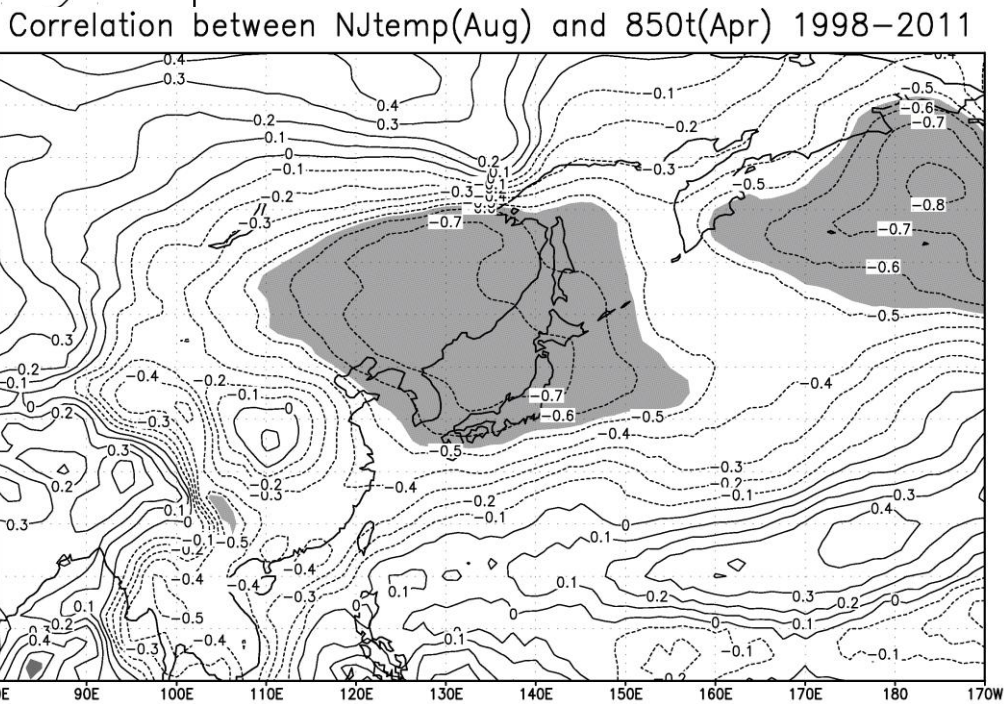


Fig. 7. Correlation between northern Japan's temperature deviation in August and the 850-hPa air temperature in the preceding April from 1998 to 2011.

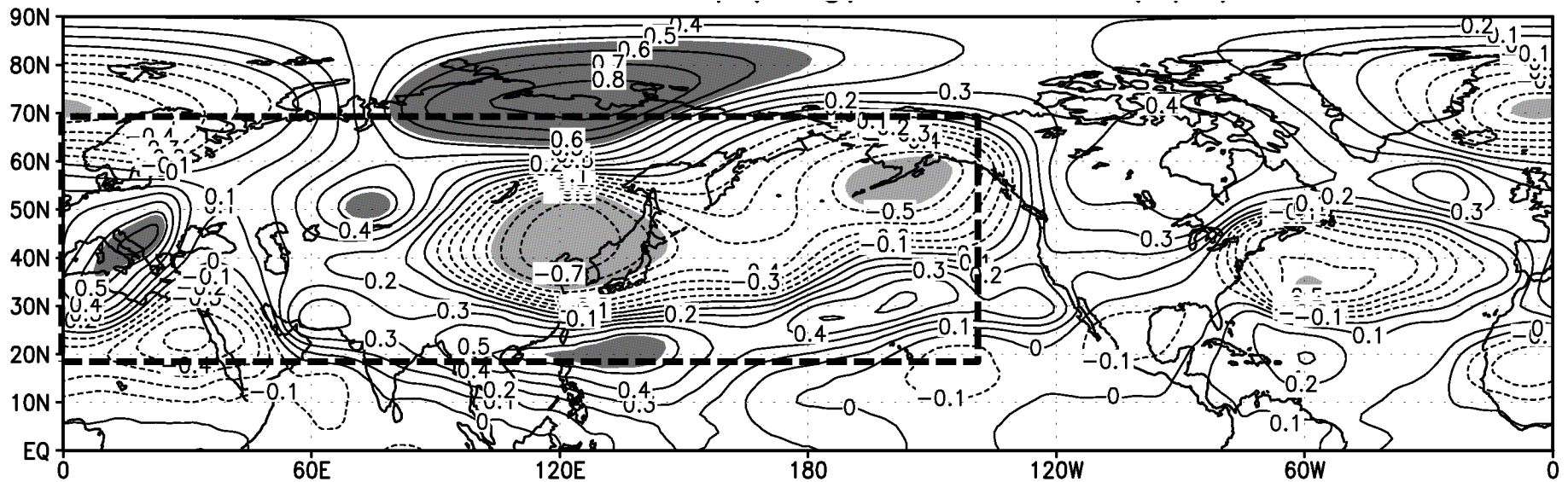


Fig. 8. Correlation coefficients between the surface air temperature deviation in August in northern Japan and the 200-hPa geopotential height in the preceding April, from 1998 to 2011. Shading indicates correlations significant at the 5% level. Dotted lines indicate the EOF analyzed area from 20° N to 70° N latitude and from 0° to 140° W longitude.

Table 2. Correlation coefficients between each PCs in April and August in last 13 years (from 1999 to 2011). Numerals in parenthesis indicate proportion of variance (%). Shaded boxes indicate statistical significance at the 5% level or better.

		August				
		PC1(15.3)	PC2(14.6)	PC3(13.5)	PC4(9.7)	PC5(8.5)
April	PC1(25.2)	0.13	-0.03	0.49	-0.24	-0.11
	PC2(13.9)	0.21	-0.33	-0.78	-0.08	0.48
	PC3(11.2)	-0.11	0.53	-0.22	0.42	-0.09
	PC4(10.8)	0.15	0.43	-0.47	0.23	-0.17
	PC5(7.0)	-0.12	0.42	0.12	0.60	-0.20

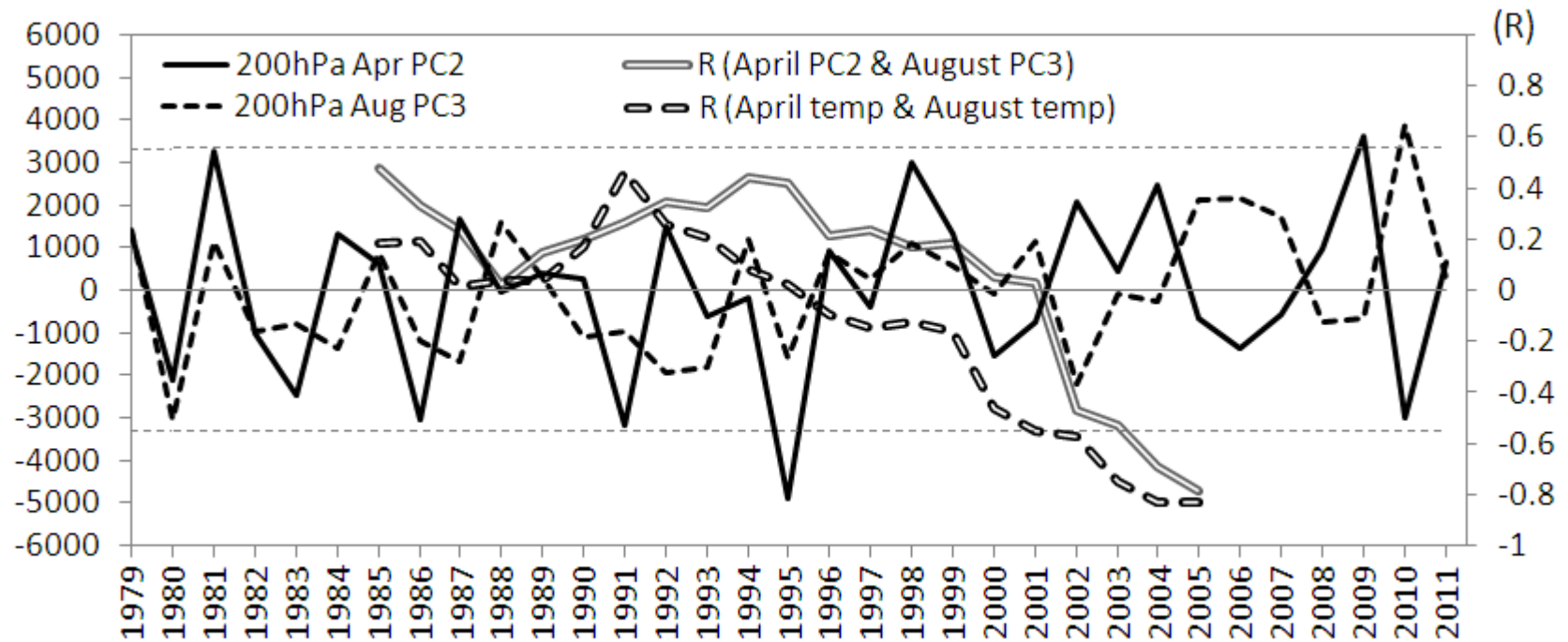
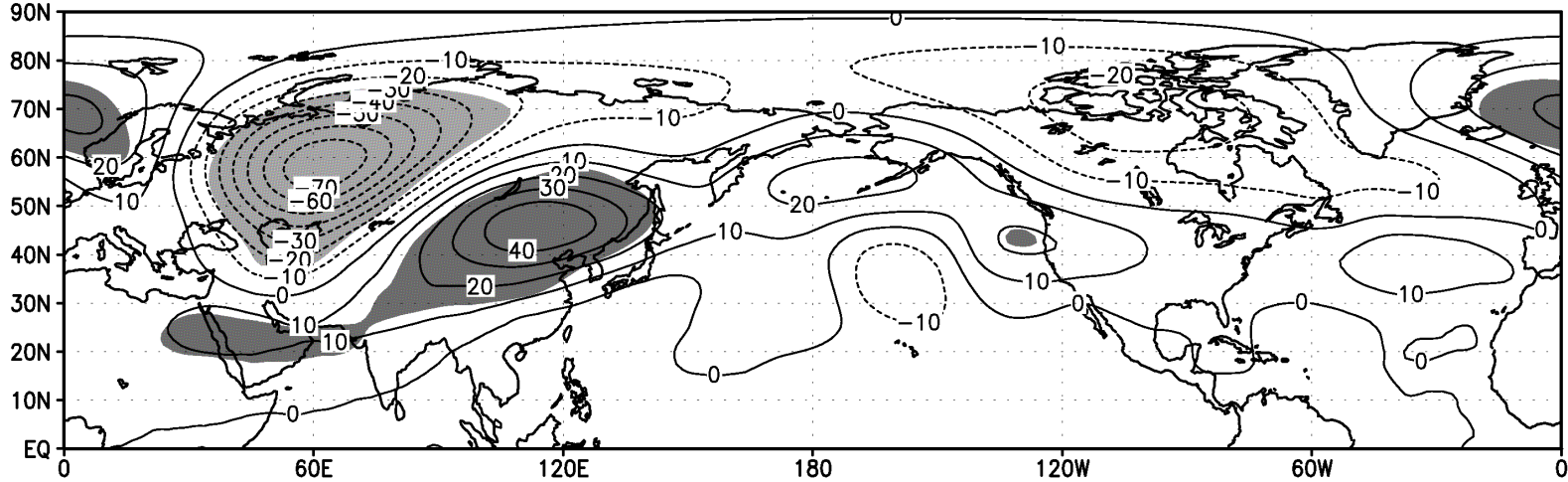


Fig. 9. Time series of PC2 in April and PC3 in August at the 200-hPa level. The solid white line indicates the 13-year running correlation coefficients between PC2 in April and PC3 in August, and the dashed white line indicates the 13-year running correlation coefficients between temperatures in April and August in northern Japan.

(a) April 200hPa height EOF2 1979–2011



(b) August 200hPa height EOF3 1979–2011

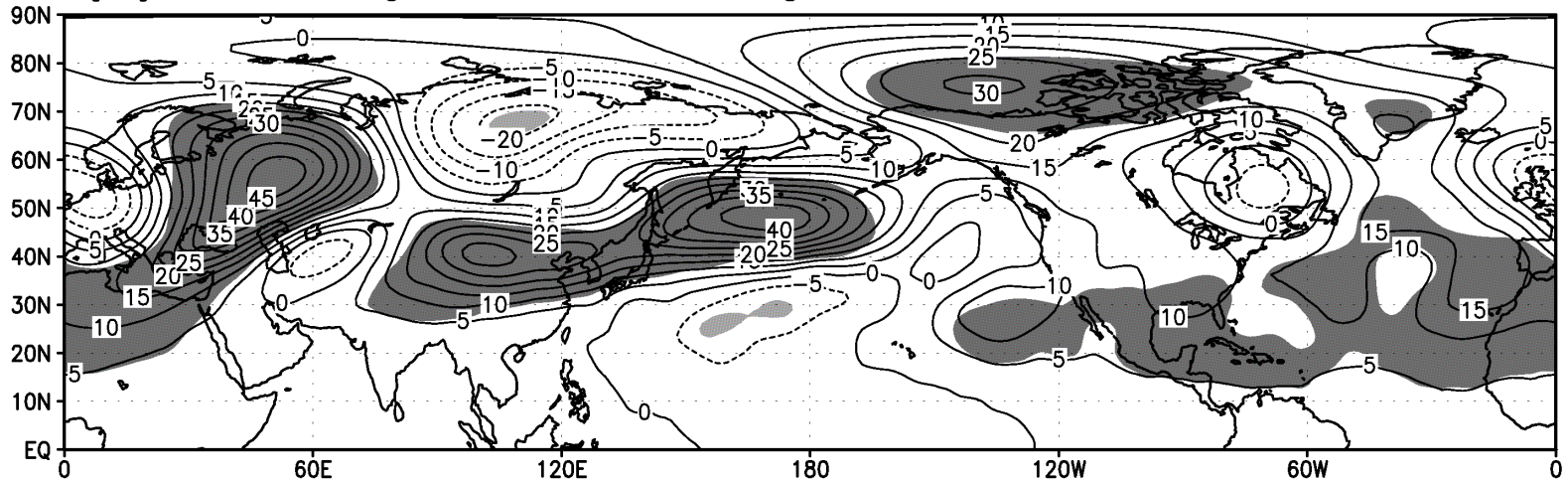
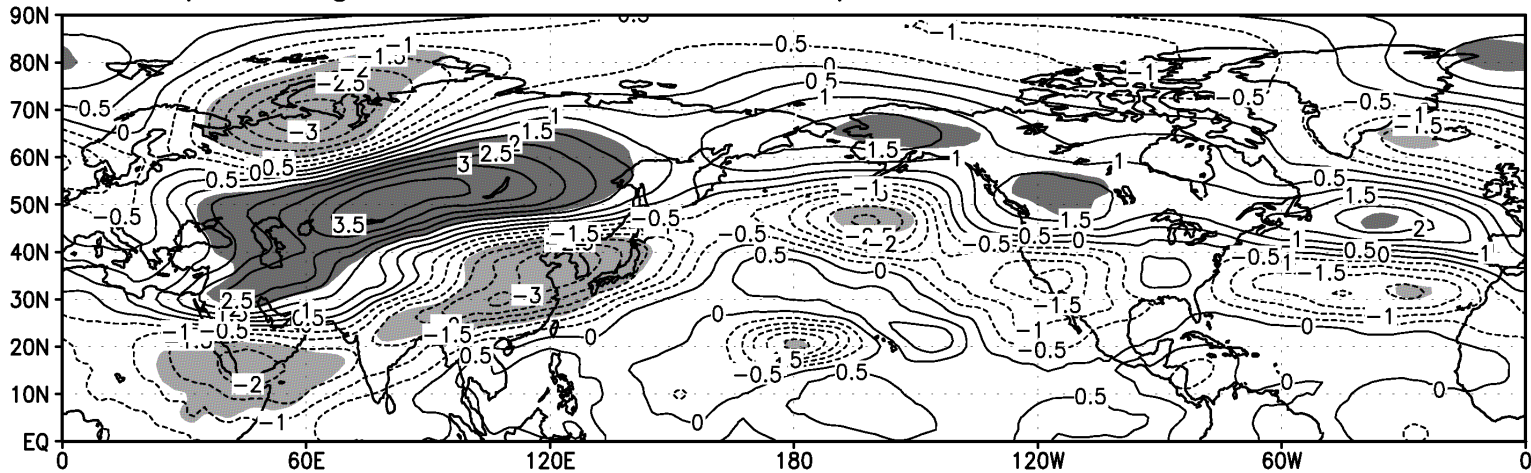


Fig. 10. (a) EOF2 in April, and (b) EOF3 in August on the 200-hPa height field from 1979 to 2011. Unit is m.

(a) April regressed 200h u-component PC2 1979–2011



(b) August regressed 200h u-component PC3 1979–2011

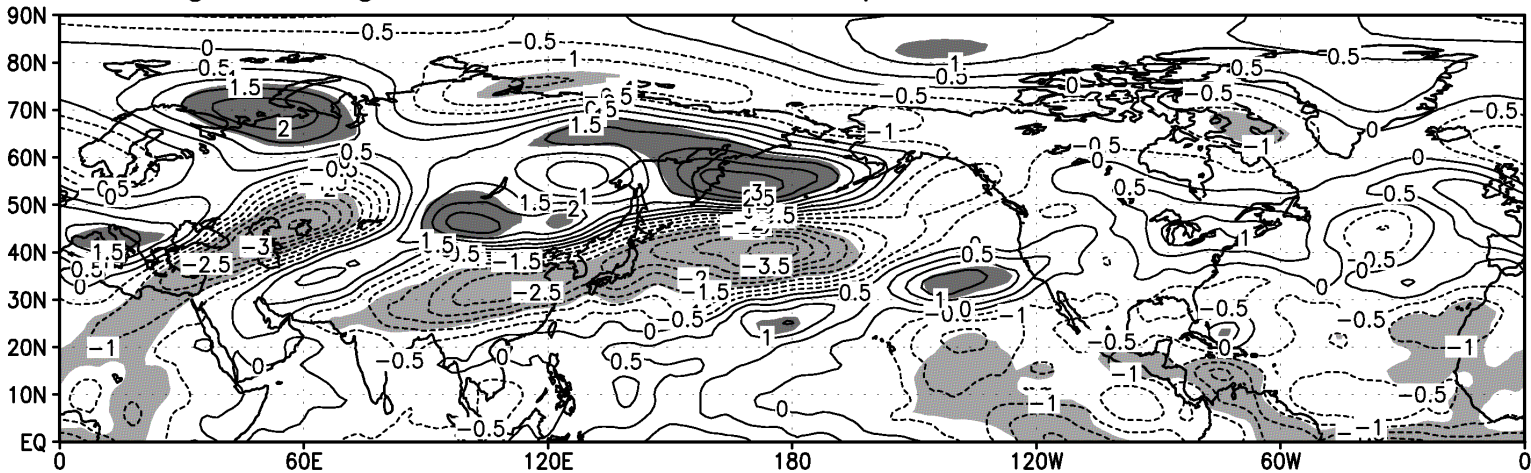


Fig. 11. Regression of (a) the PC2 time series of the 200-hPa height field in April and (b) the PC3 time series of the 200-hPa height field in August against the 200-hPa u -component field.

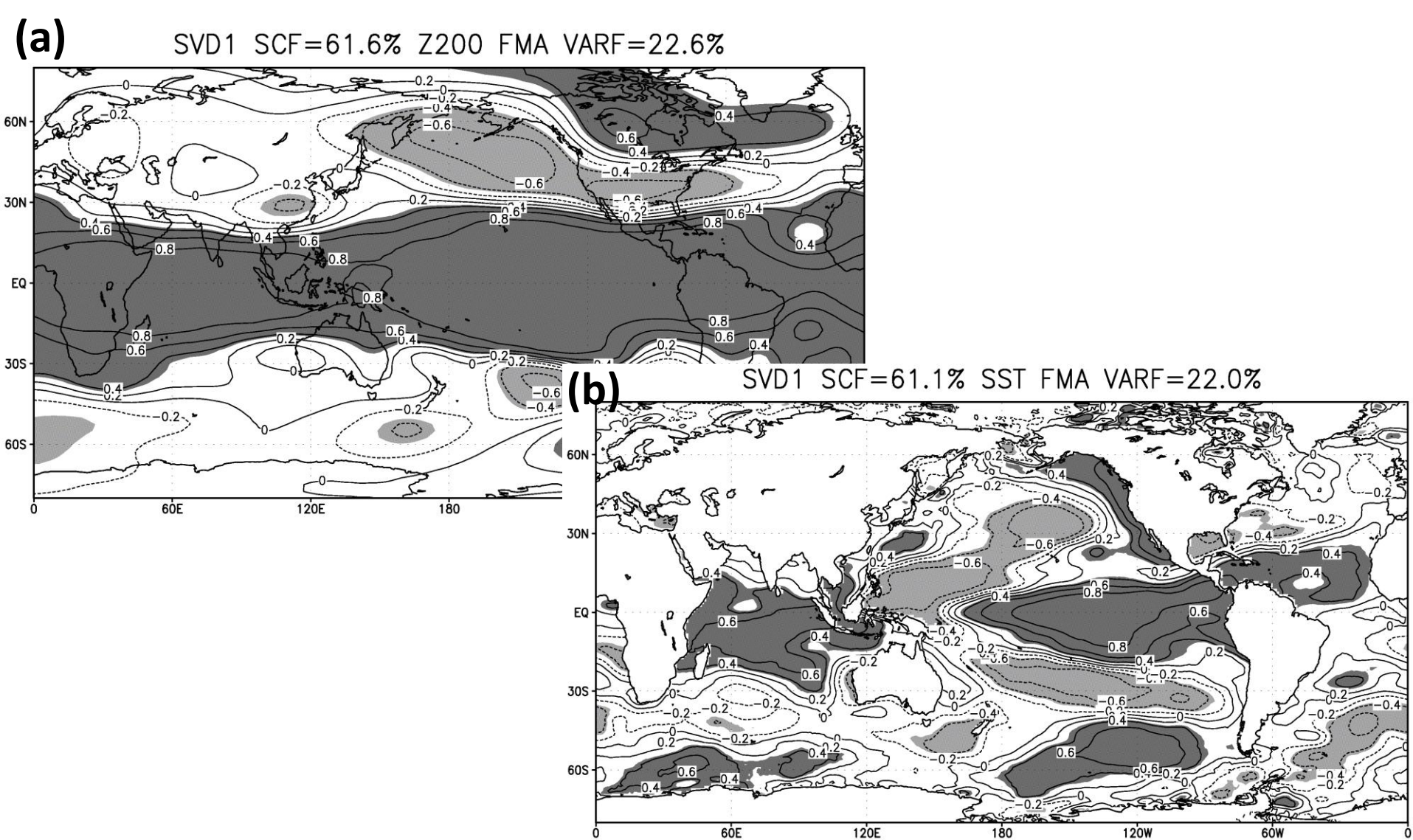
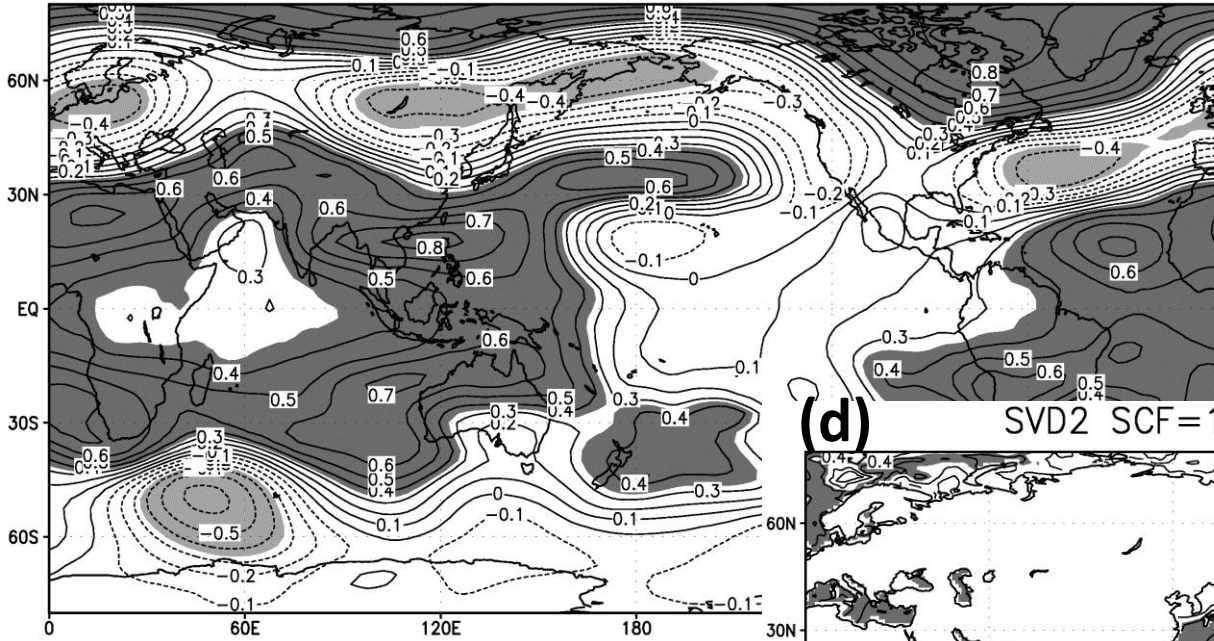


Fig.12. First SVD mode of FMA (February- April) 200 hPa height and SST for 1979-2011.

- a) Heterogeneous correlation map for 200hPa height of mode 1,
- b) Heterogeneous correlation map for SST of mode 1.

(c)

SVD2 SCF=16.1% Z200 FMA VARF=13.4%

**(d)**

SVD2 SCF=16.1% SST FMA VARF=11.9%

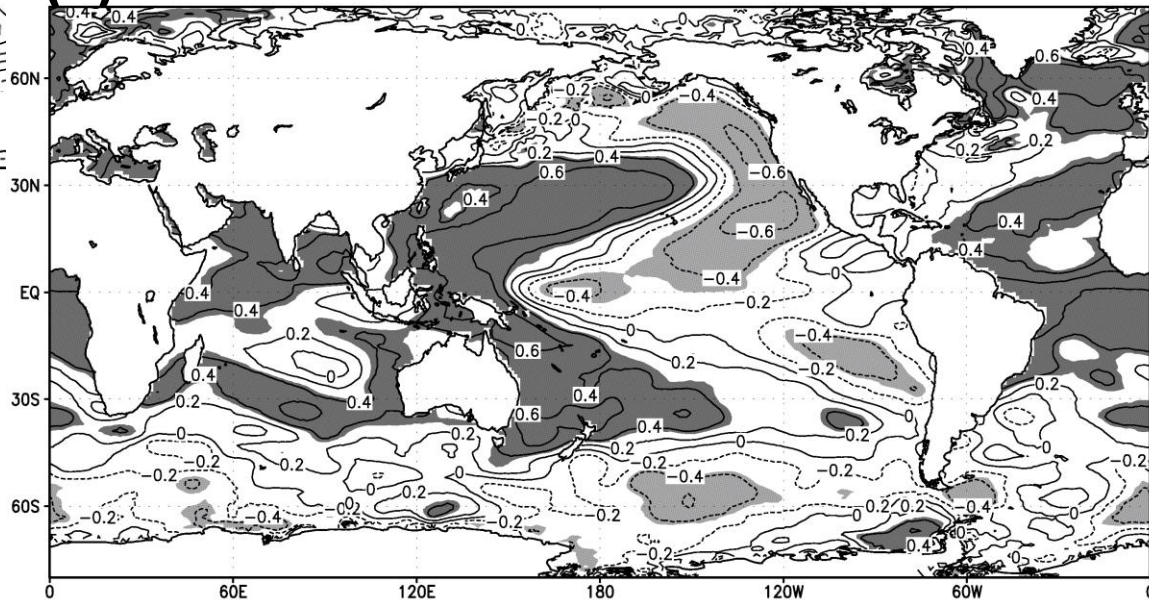


Fig.12. Second SVD mode of FMA (February- April) 200 hPa height and SST for 1979-2011.
 c) Heterogeneous correlation map for 200hPa height of mode 2,
 d) Heterogeneous correlation map for SST of mode 2.

(e) Time series, SVD1: $r=0.95$ SVD2: $r=0.86$ FMA

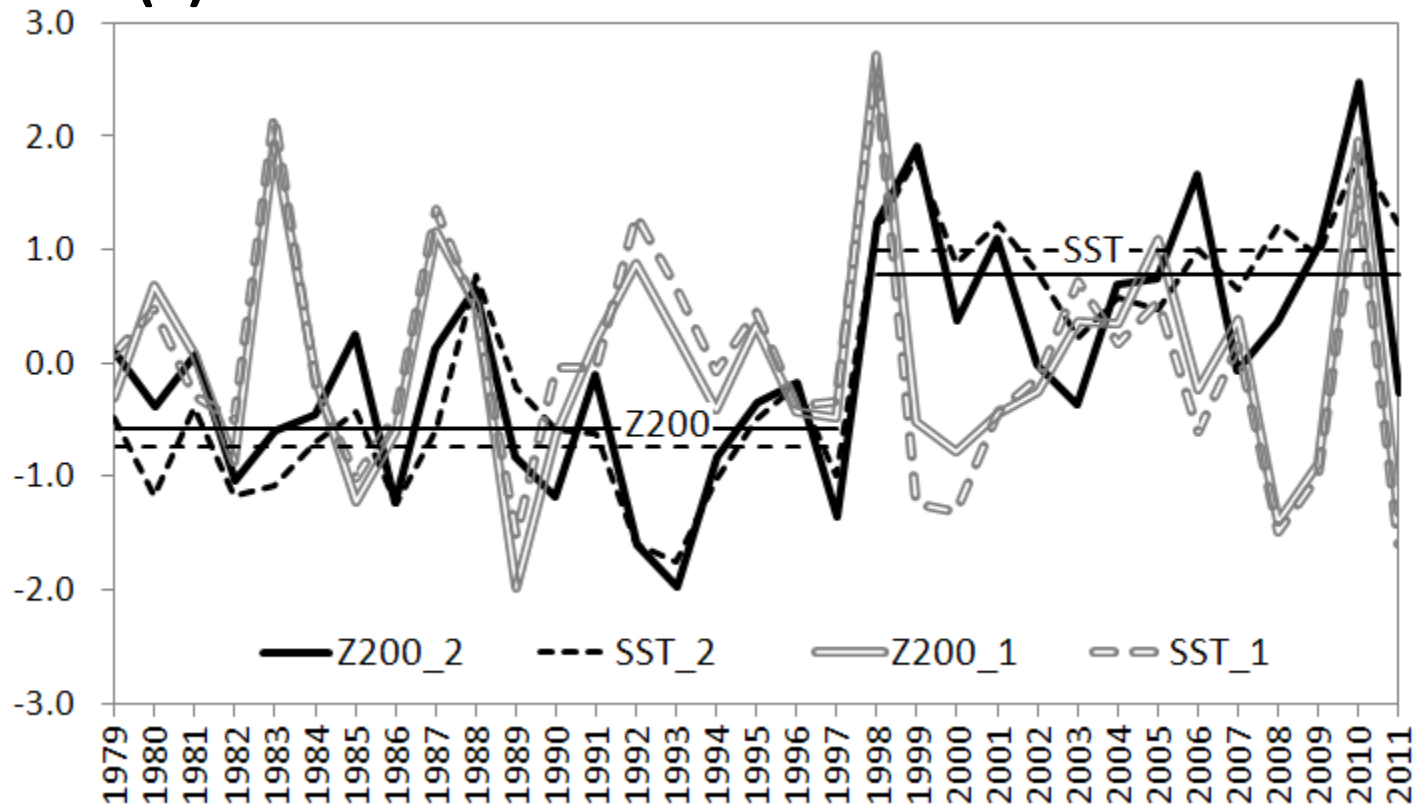
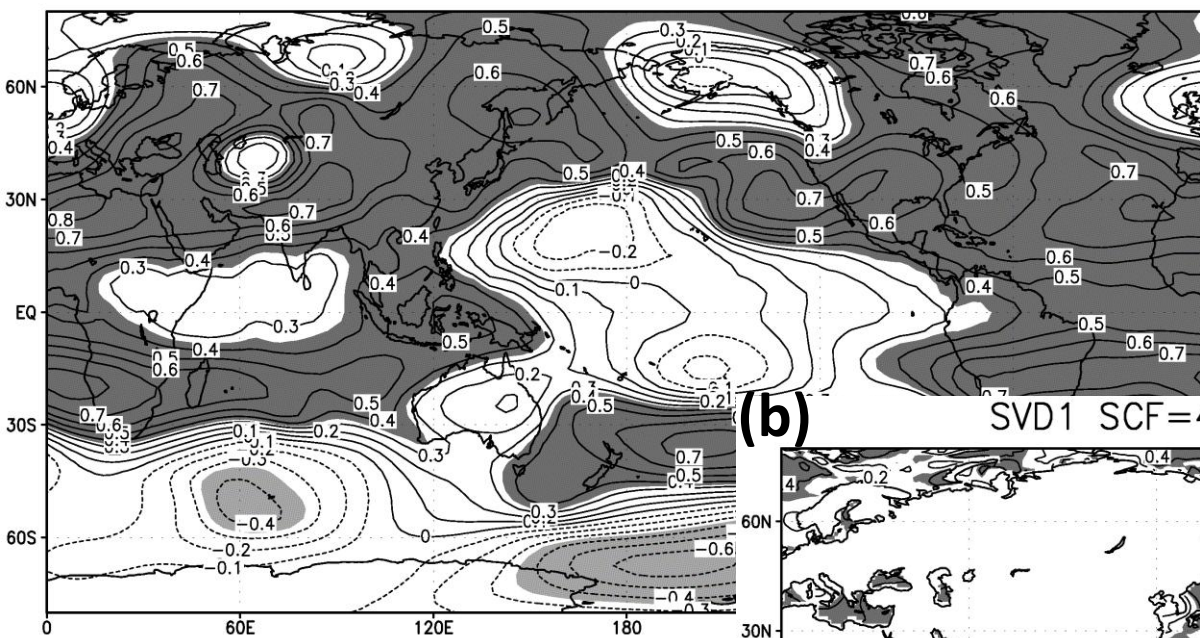


Fig.12. First and second SVD modes of FMA (February- April) 200 hPa height and SST for 1979-2011.

e) Time series of the normalized expansion coefficients for 200hPa height (white solid curve; mode 1, black solid curve; mode 2) and SST (white dashed curve; mode 1, black dashed curve; mode 2). Thin solid and broken lines indicate the average from 1979 to 1997 and from 1998 to 2011 of mode2.

(a) SVD1 SCF=42.4% Z200 JJA VARF=14.9%



(b) SVD1 SCF=42.4% SST JJA VARF=17.5%

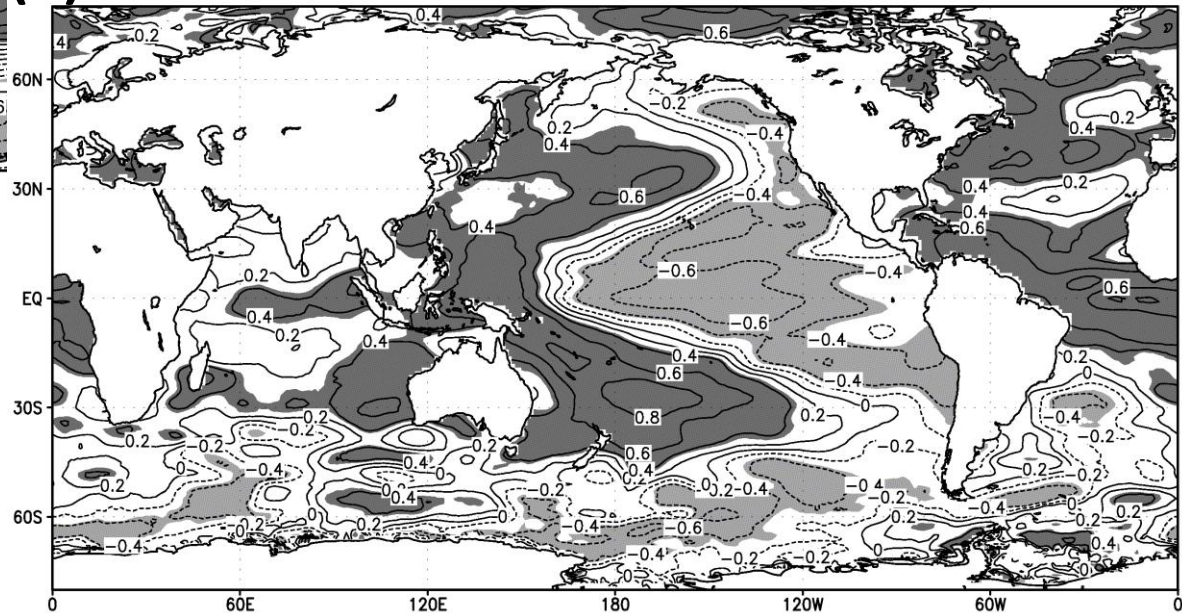
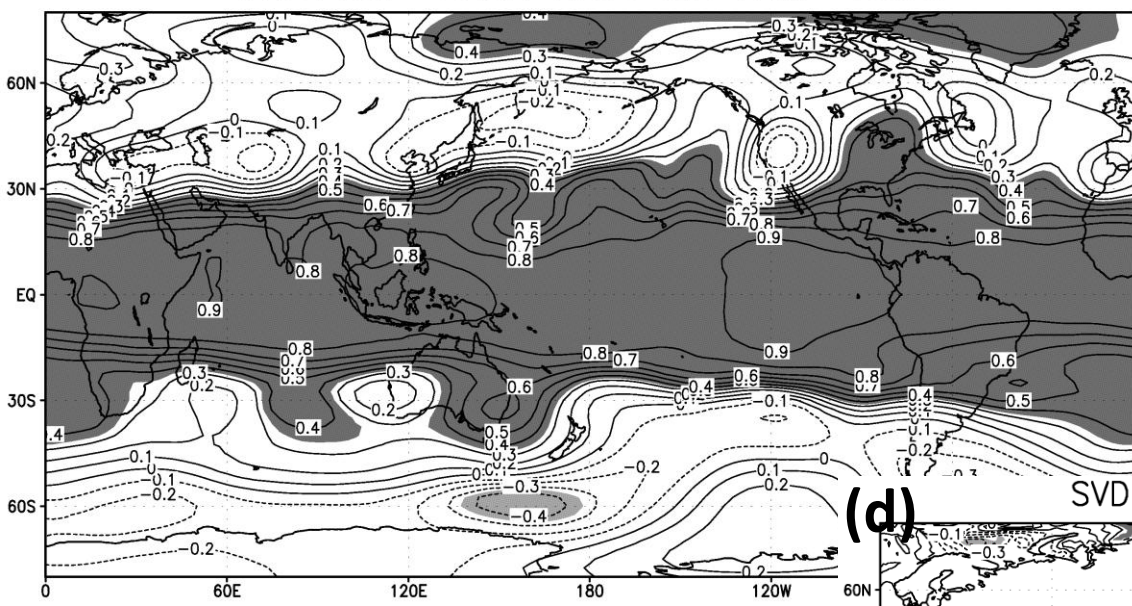


Fig.13. First SVD mode of JJA (June-August) 200 hPa height and SST for 1979-2011.

- a) Heterogeneous correlation map for 200hPa height of mode 1,
- b) Heterogeneous correlation map for SST of mode 1.

(c) SVD2 SCF=17.9% Z200 JJA VARF=10.5%



(d) SVD2 SCF=17.9% SST JJA VARF=11.1%

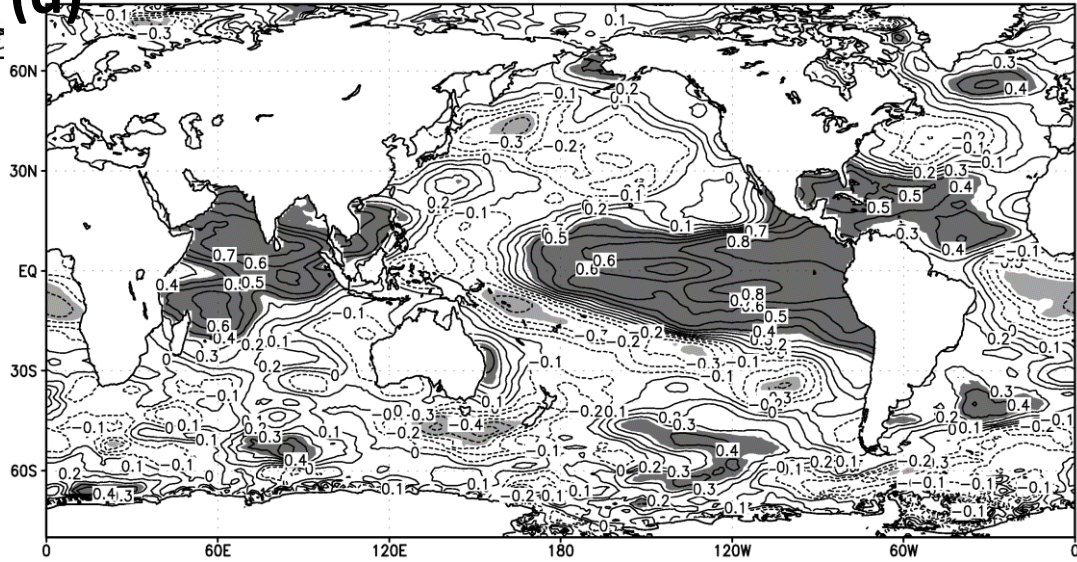


Fig.13. Second SVD modes of JJA (June-August) 200 hPa height and SST for 1979-2011.
c) Heterogeneous correlation map for 200hPa height of mode 2,
d) Heterogeneous correlation map for SST of mode 2.

(e) Time series, SVD1: $r=0.89$ SVD2: $r=0.86$ JJA

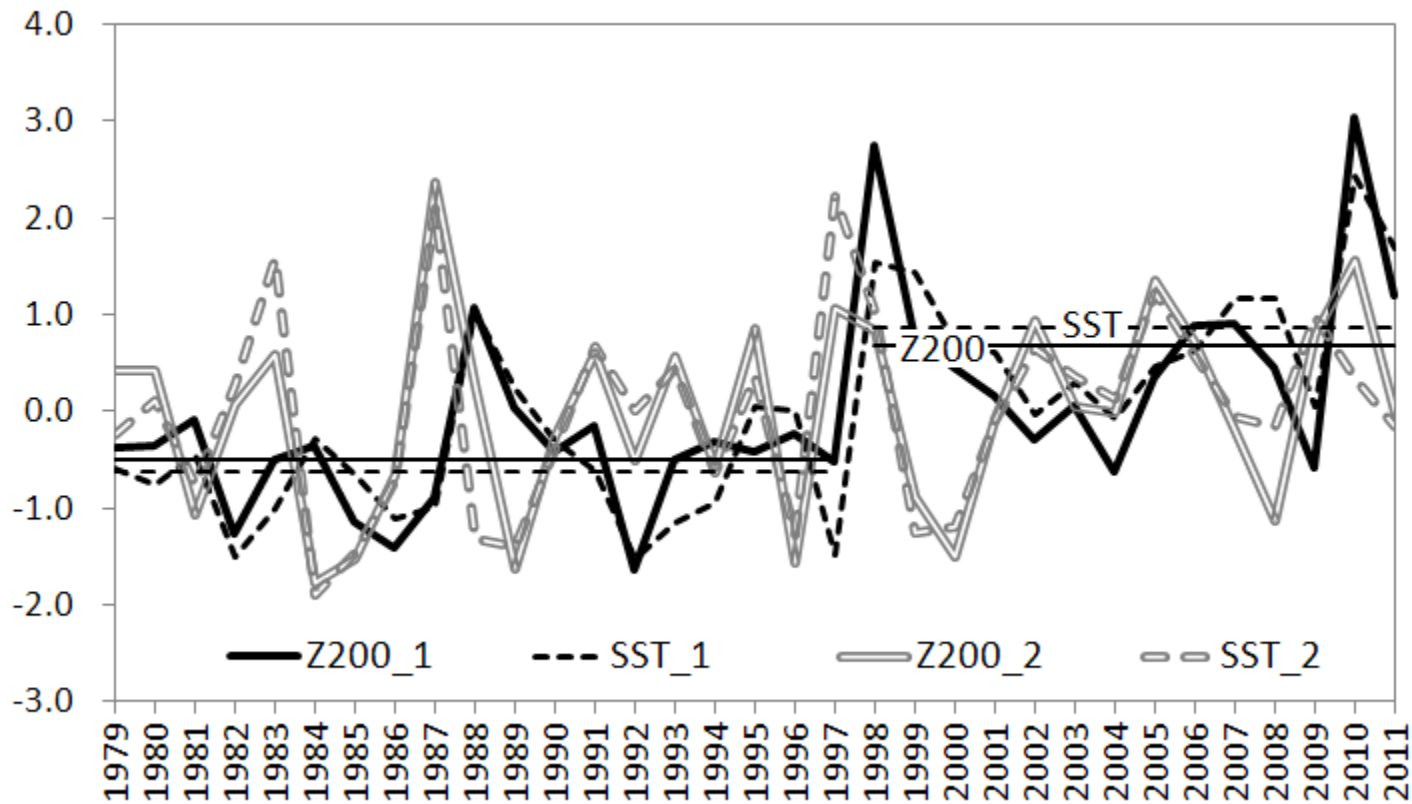
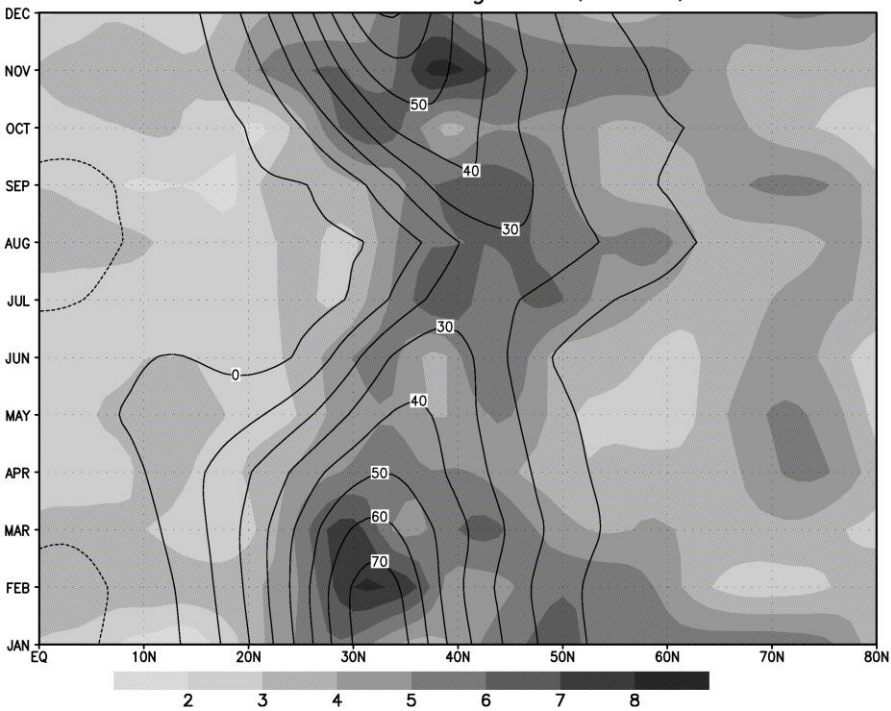


Fig.13. First and second SVD modes of JJA (June-August) 200 hPa height and SST for 1979-2011.

e) Time series of the normalized expansion coefficients for 200hPa height (black solid curve; mode 1, white solid curve; mode 2) and SST (black dashed curve; mode 1, white dashed curve; mode 2). Thin solid and broken lines indicate the average from 1979 to 1997 and from 1998 to 2011 of mode1.

(a)

Time-Lat cross section along 140E, 200u, 1984–1997

**(b)**

Time-Lat cross section along 140E, 200u, 1998–2011

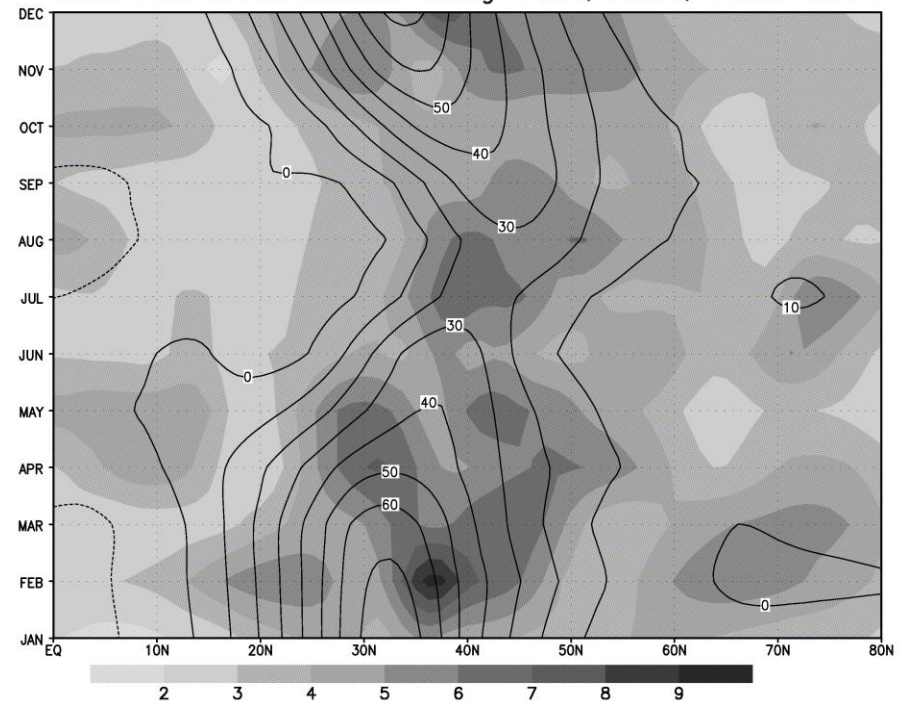
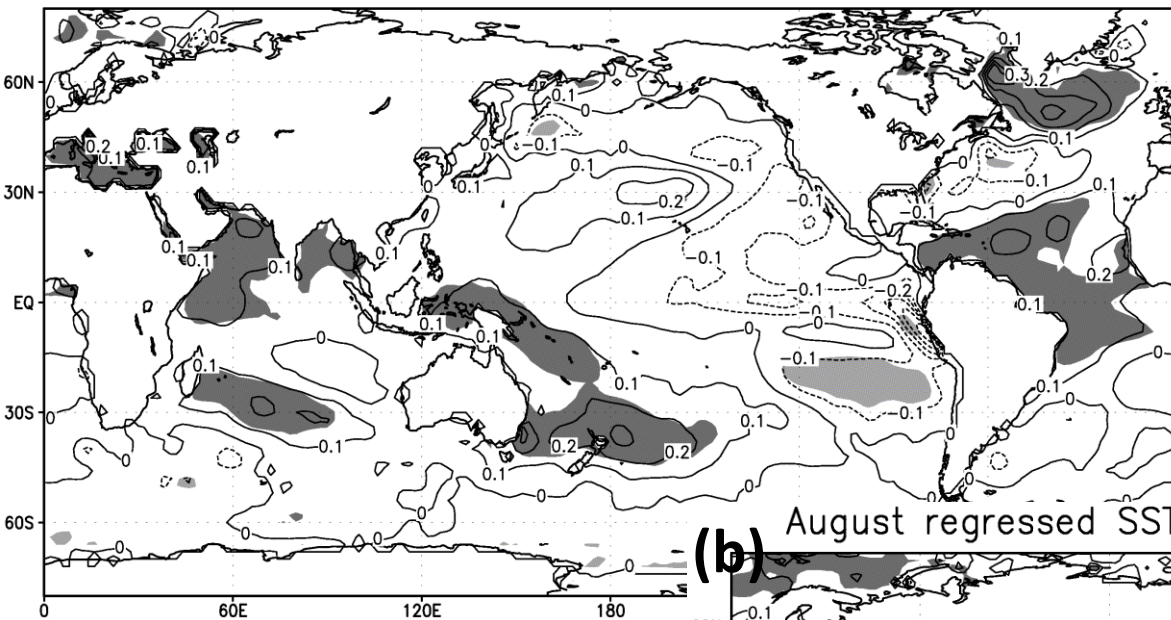


Fig. 15. Time-latitude cross section along 140° E for monthly mean 200 hPa u-component from 1998 to 2011. Contours indicate wind speed (m/s) and shadings indicate standard deviation (m/s). a) 1979–1997, b) 1998–2011.

結論

北日本4月8月気温負の相関関係は、200hPa高度の4月第2主成分、8月第3主成分の出現およびSST変動で説明できた。さらに200hPa高度とSSTのSVD解析結果より、1998年は、北日本における気温変動のみならず、大規模な高度場・SST変動のレジームシフト期間として把握できると思われる。

(a) April regressed SST by 200h PC3 August 1979–2011



(b) August regressed SST by 200h PC3 August 1979–2011

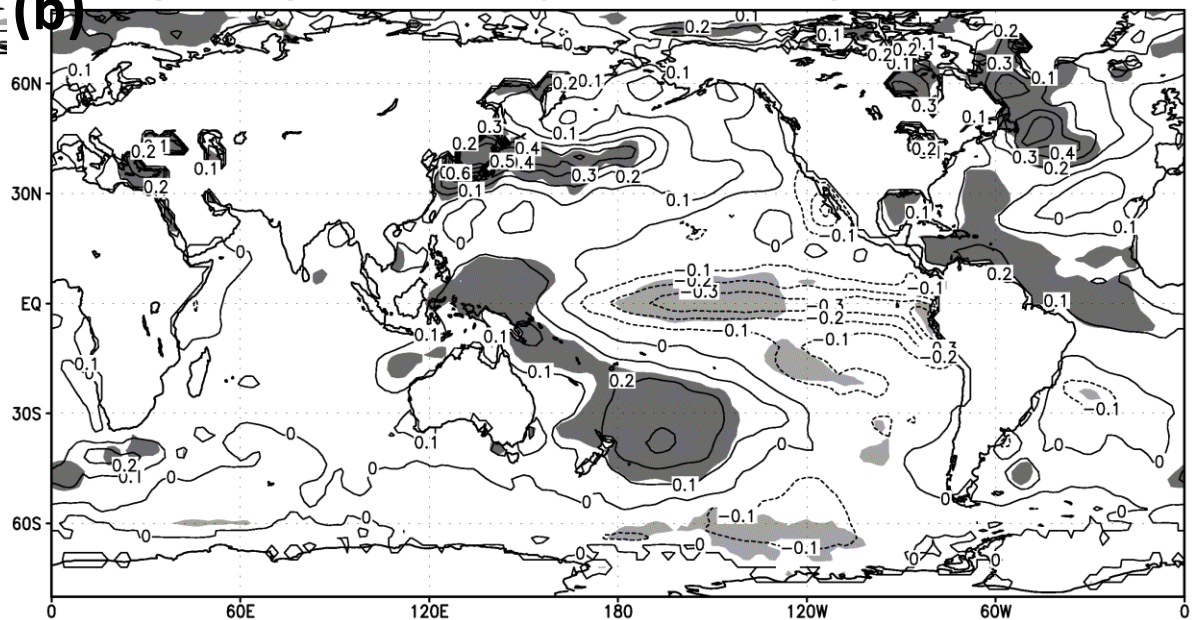


Fig. 14. Regression of the 200-hPa PC3 in August against the SST anomaly in (a) April and (b) August.