

Interdecadal variability of Asian summer monsoon and tropical cyclone activity

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Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

Outline

- Interdecadal variability of Asian summer monsoon and tropical cyclone activity

based on “Kubota, H., Y. Kosaka, and S.-P. Xie, 2015: A 117-year long index of the Pacific-Japan pattern with application to interdecadal variability, *Int. J. Climatol*, in press.”

- Recent activities of data rescue studies

Recovery of historical station and tropical cyclone track data over the western north Pacific

Collaboration with “Atmospheric Circulation Reconstructions over the Earth (ACRE)”

Japanese 20th century reanalysis project

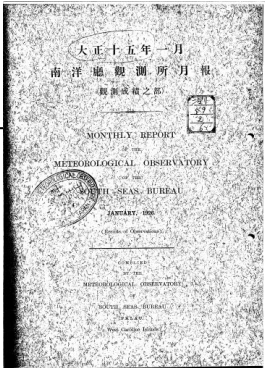
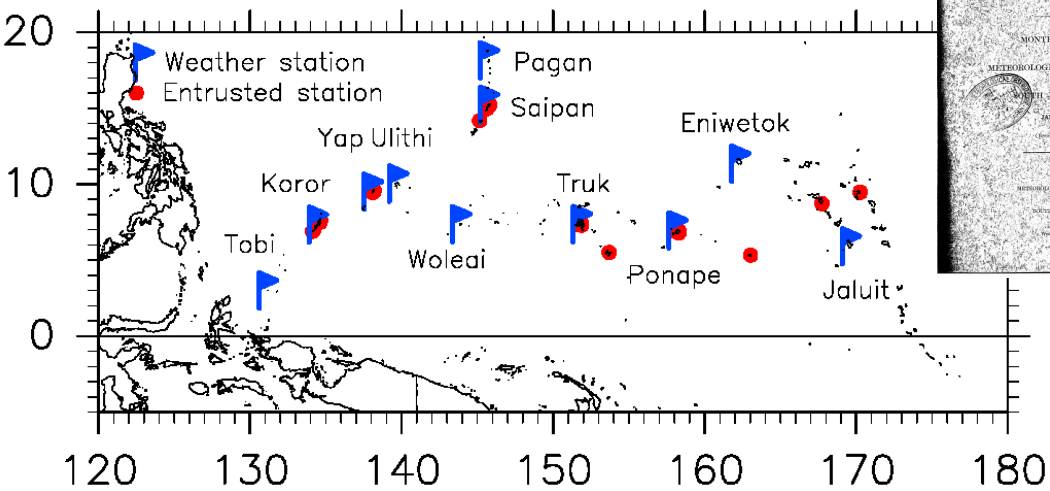
Data rescue of Japanese pilot balloon data

Background of Data rescue research



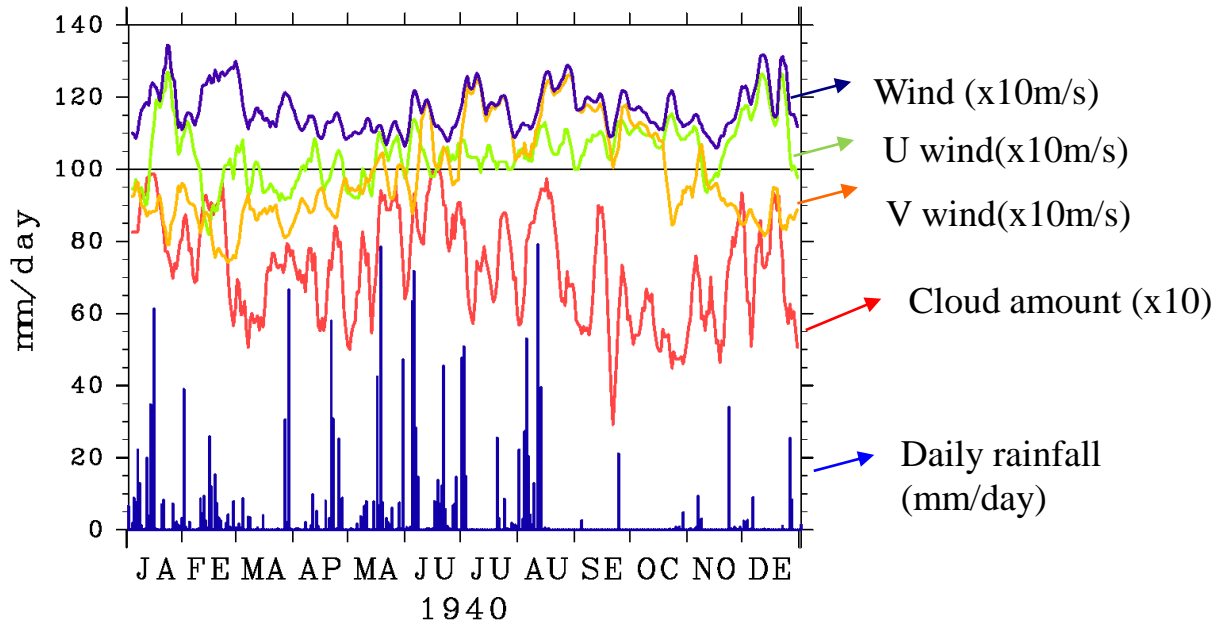
Monthly report of South Seas Bureau (July 1923—Dec. 1941)

South Seas Bureau



South Seas Bureau Tokobe station (Tobi)(1939-1941?)

1940 tobi rainfall



History of atmospheric observation over the western north Pacific											
	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Satellite											
Upper-air, aircraft											
Surface											

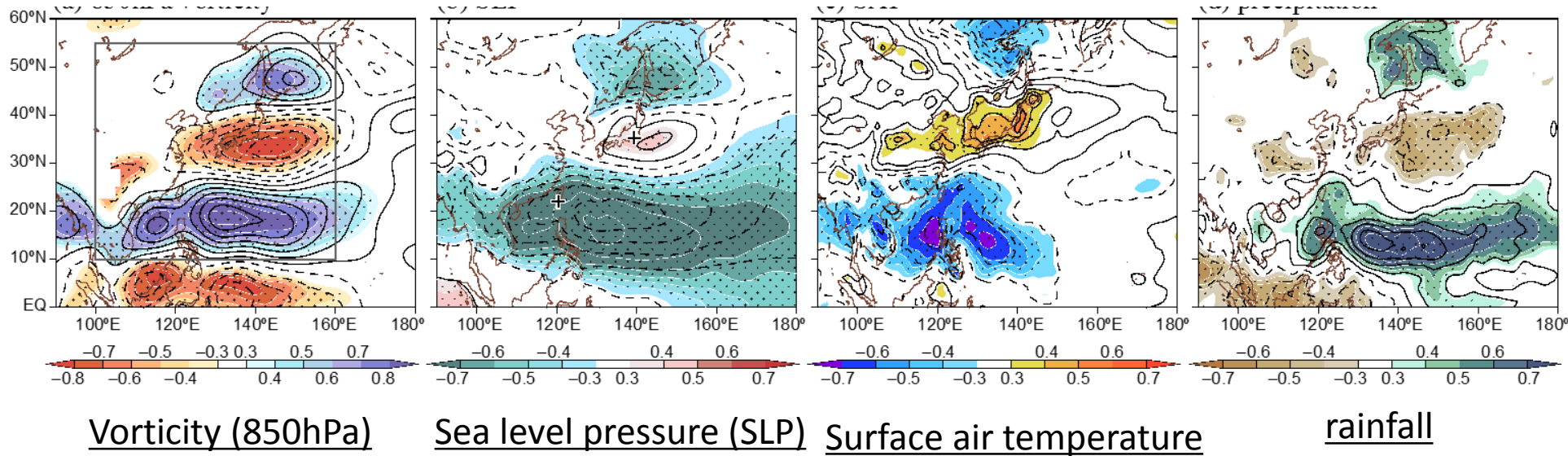
Purpose of this study

Interdecadal variability of Asian summer monsoon over the western North Pacific is investigated.

Pacific-Japan (PJ) pattern index is introduced for the summer monsoon index.

This new index can trace summer monsoon back to 1897 for 117 years by using surface pressure data.

Pacific-Japan (PJ) pattern



The Pacific-Japan (PJ) pattern is known as a major pressure pattern during summer over the western North Pacific (Nitta 1987; Kosaka and Nakamura 2006).

The correlation between SLP, surface temperature, rainfall and EOF PC1 850hPa vorticity (JJA) (10-55N, 100-160E) (1979—2009; JRA55) (33.5%).

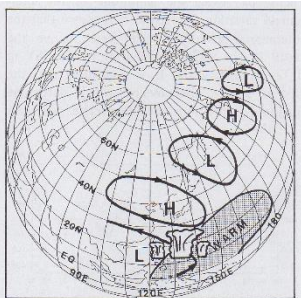
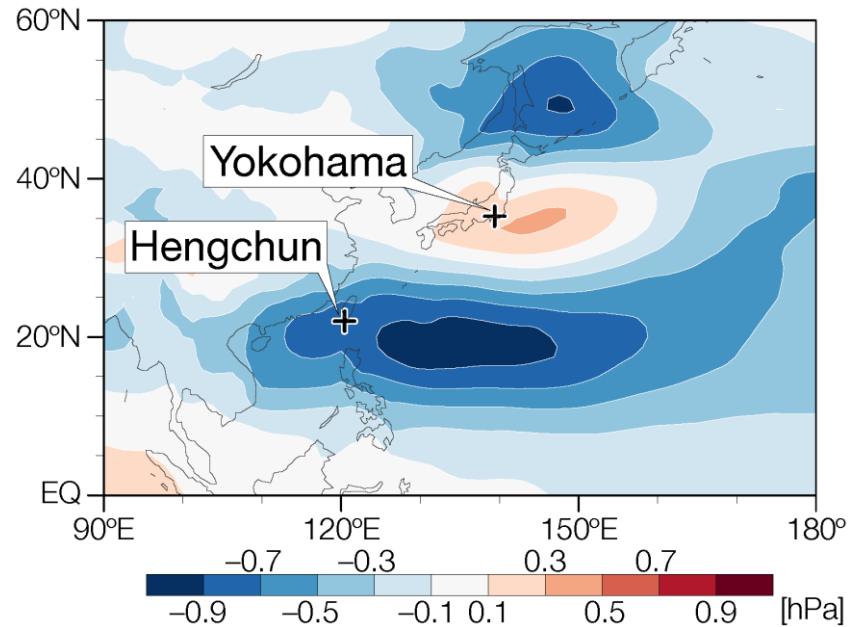


Fig. 18. Schematic pictures showing the relationships between SST anomalies, convective activities and atmospheric Rossby-wave trains.

Nitta(1987)

Definition for PJ pattern index



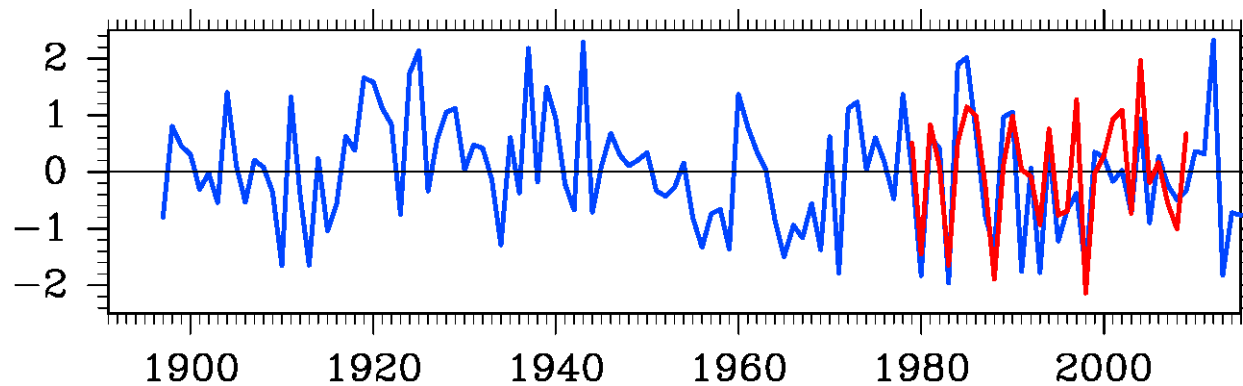
PJ pattern index:

Yokohama (Japan) — Hengchun (Taiwan)

(JJA mean sea level pressure)
(provided by JMA and CWB)

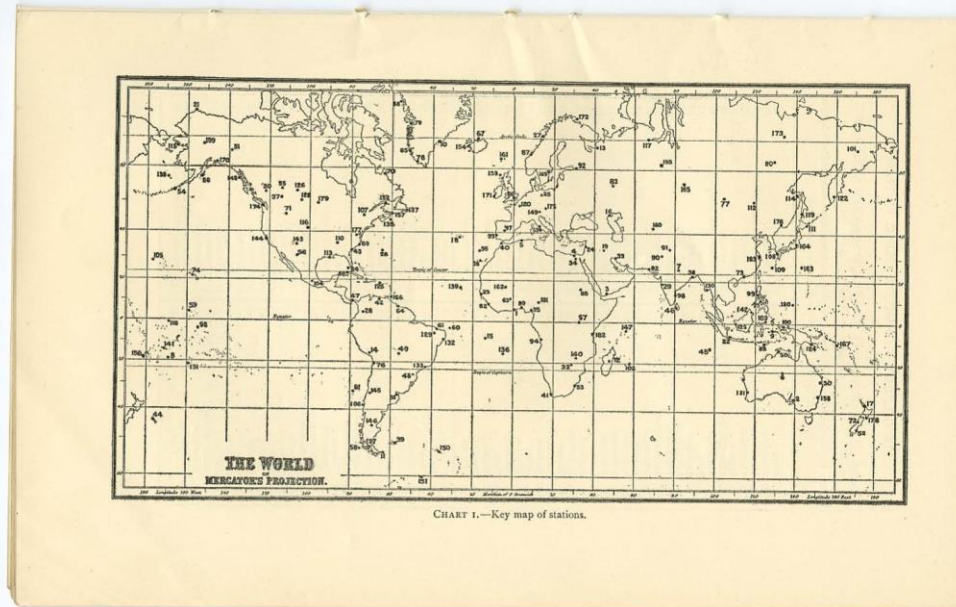
EOF PC1 and PJ pattern
index correlation **0.74**
(1979-2009)

1897–2015 PJ index JJA



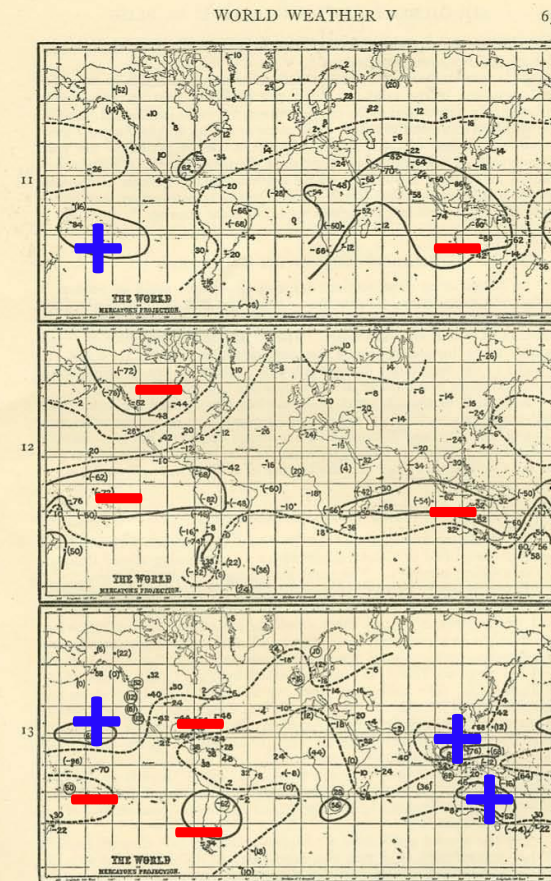
— PJ pattern index
— EOF 1
(850hPa vorticity)

First study of using see-saw of pressure



Stations list

Correlation to Southern Oscillation (DJF)



pressure

temperature

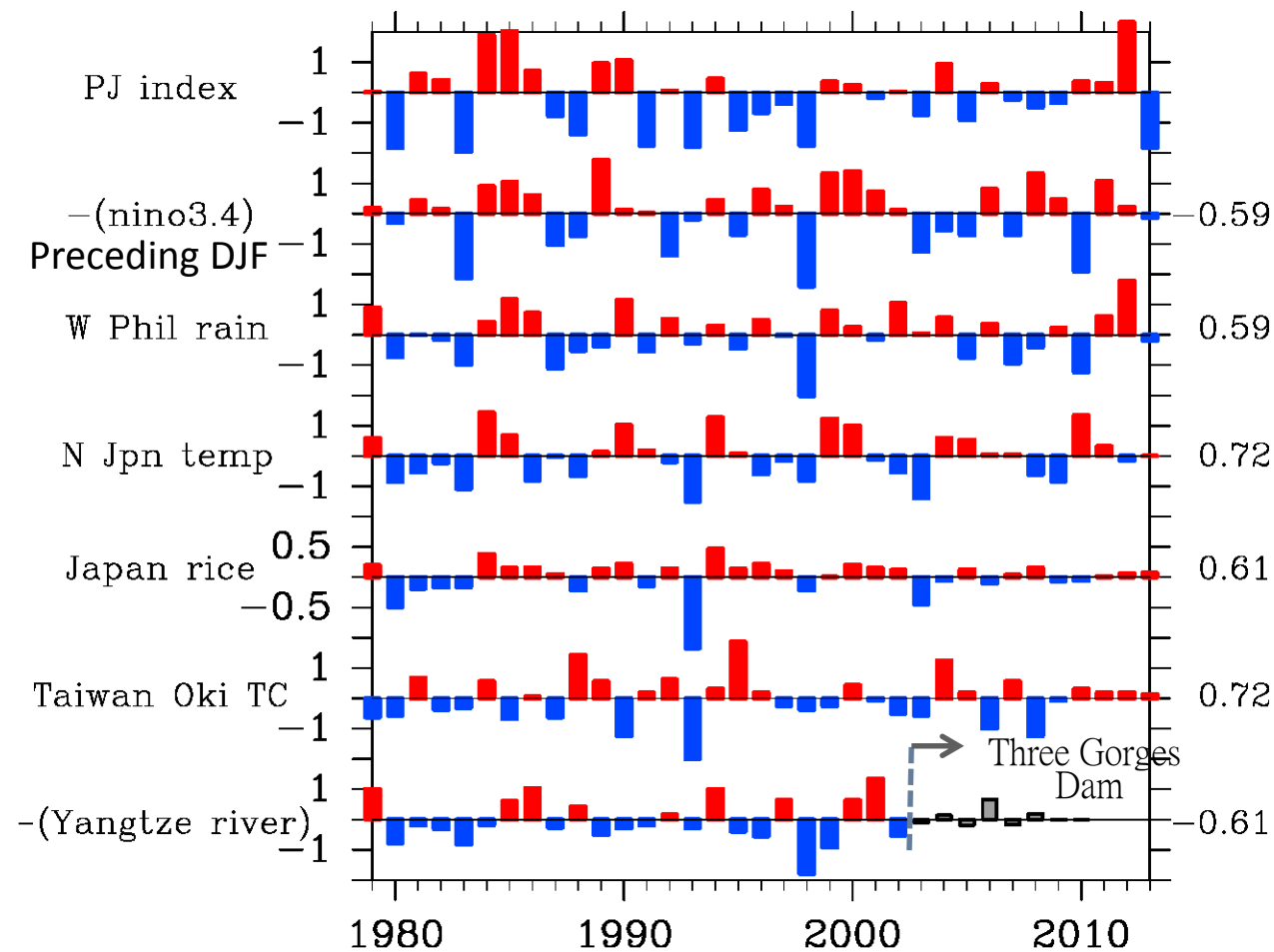
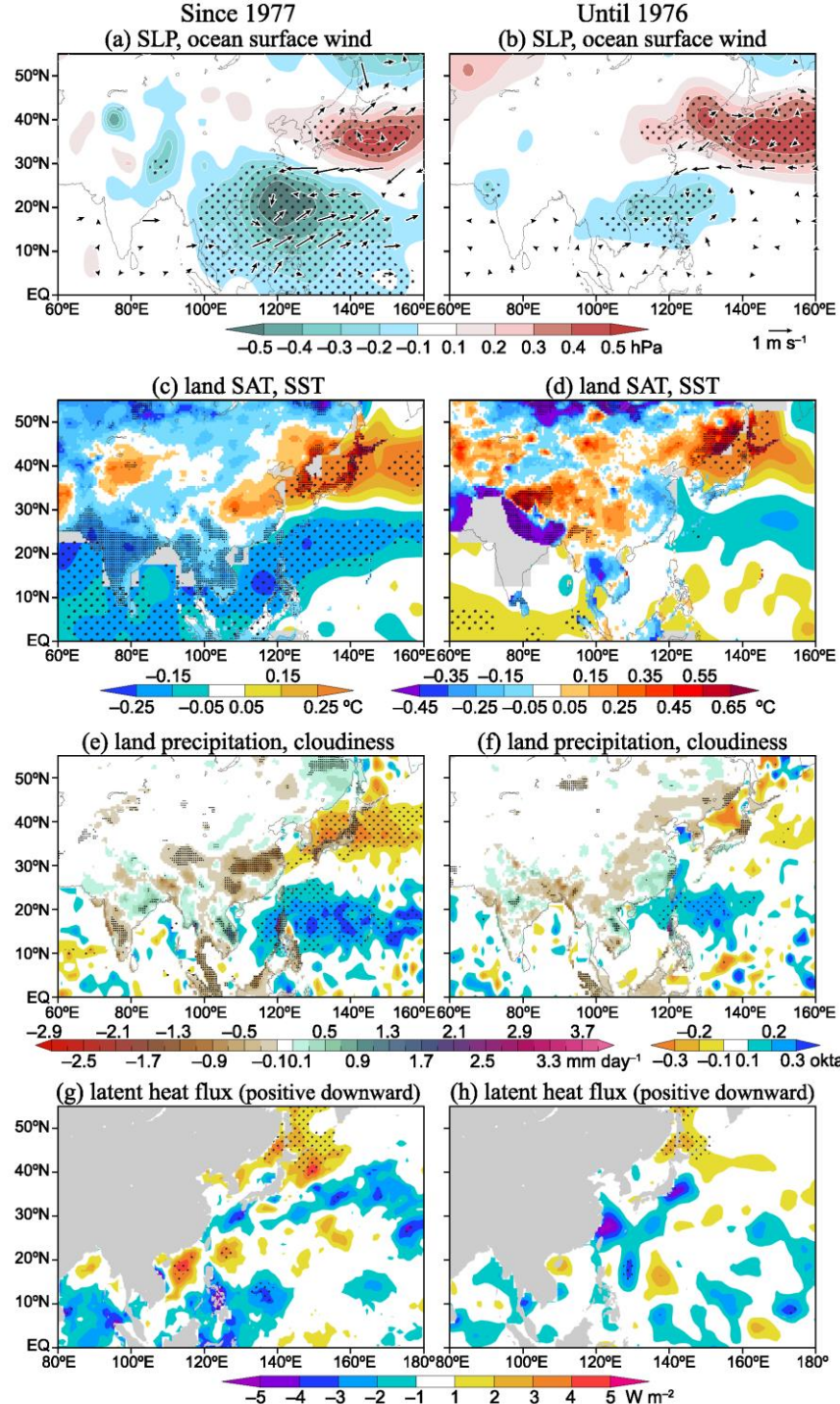
rainfall

CHART 11.—S.O. of D-F with contemporary pressure.
CHART 12.—S.O. of D-F with contemporary temperature.
CHART 13.—S.O. of D-F with contemporary rainfall.

Walker and Bliss (1932)

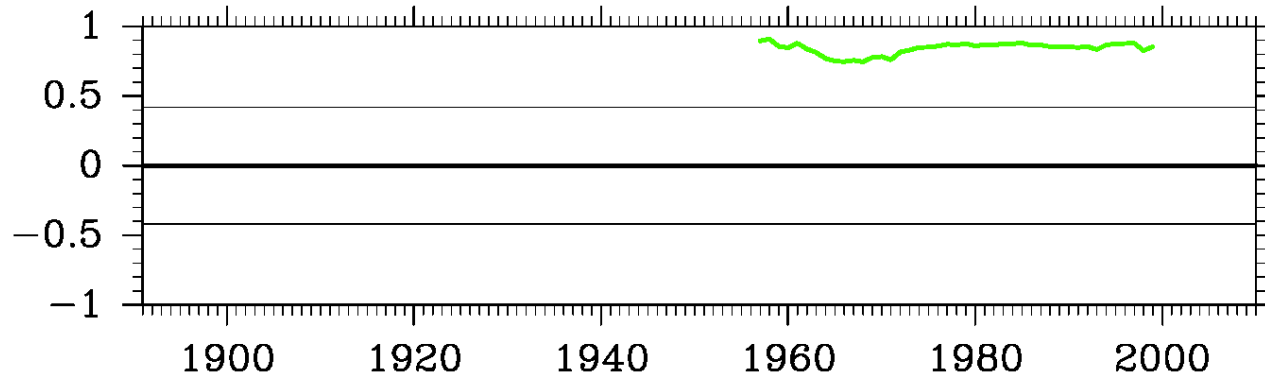
The relation between PJ pattern and Asian summer climate

1979–2013 PJ index and other indices



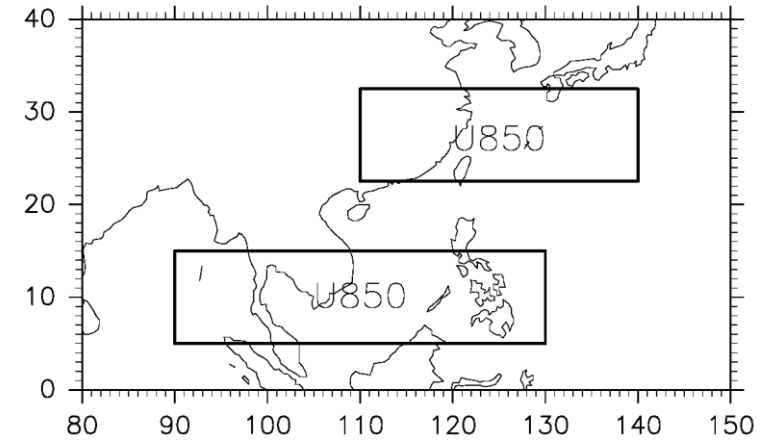
Comparison with other summer monsoon index

1897–2009 PJ index–Monsoon index



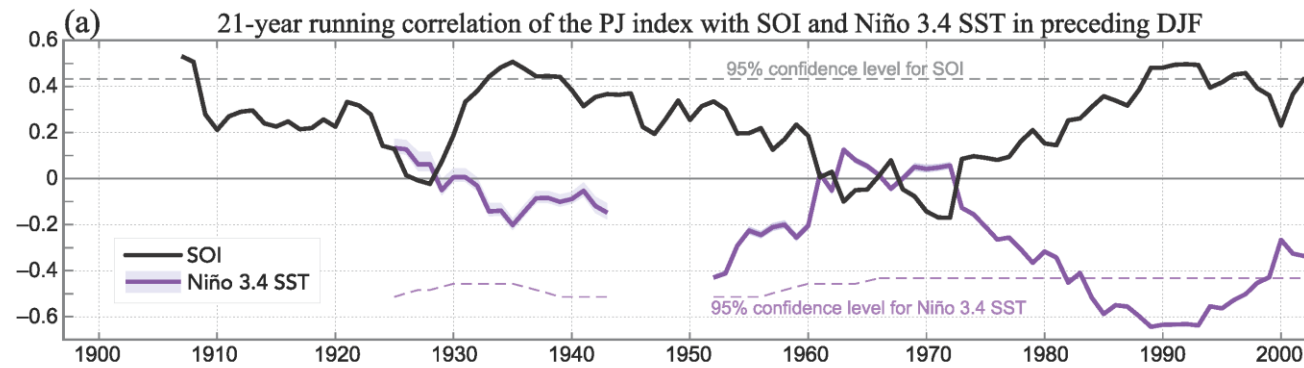
Correlation with ERA40 monsoon index (21 years running)

Monsoon index (Wang and Fan 1999)

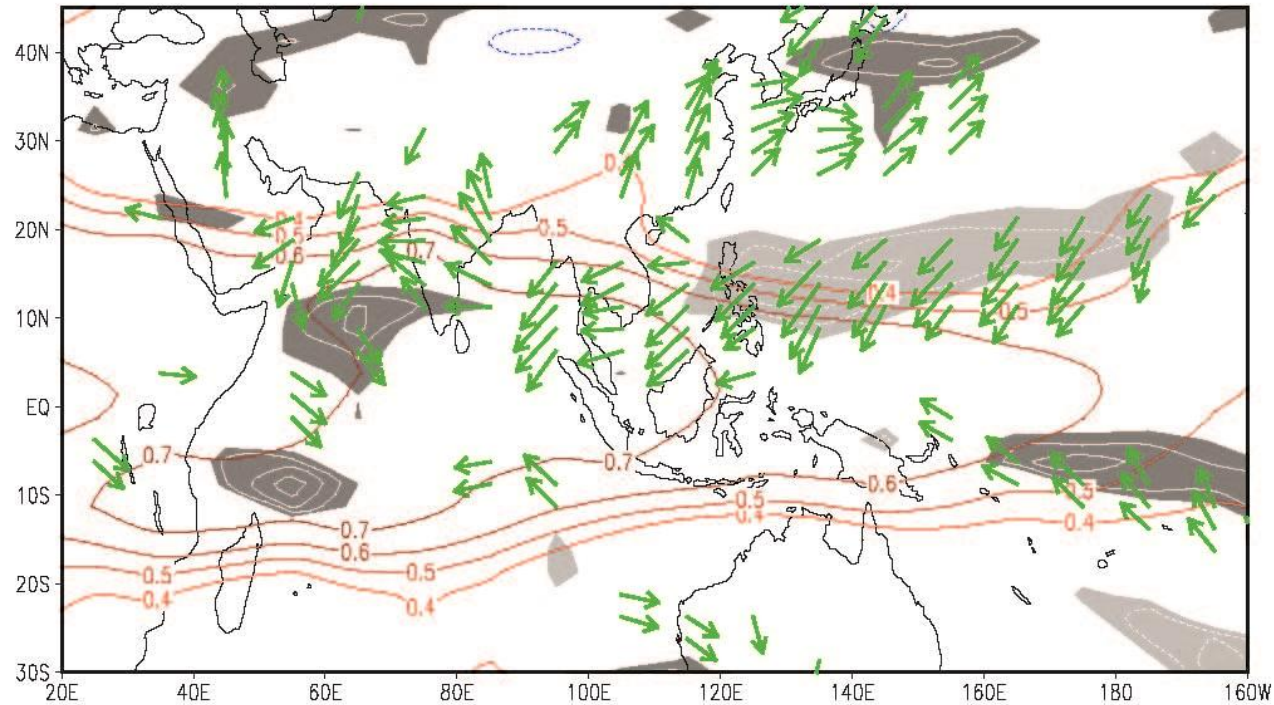


Best index among 25 indices
Wang et al. 2008

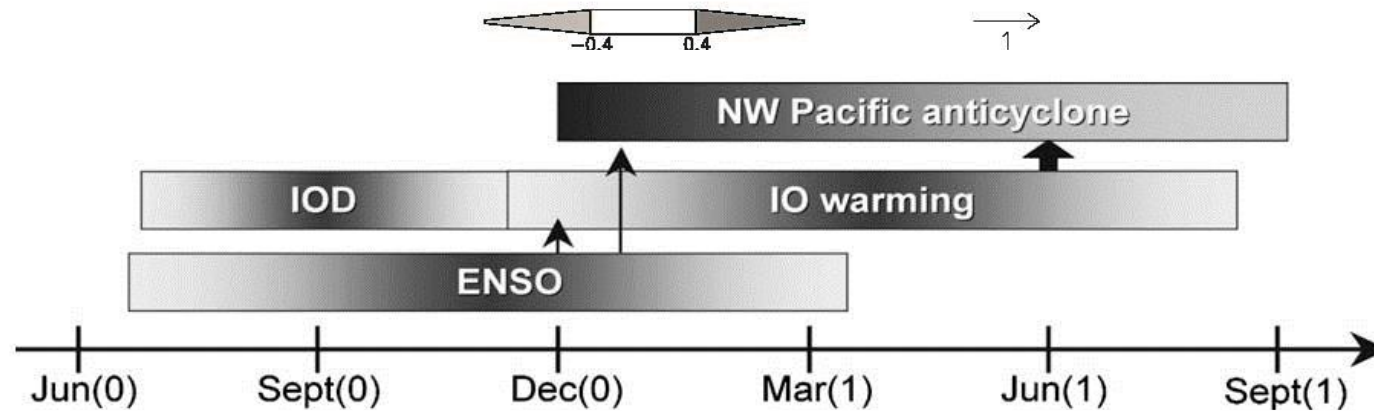
The correlation between PJ pattern index and ENSO



The relation between ENSO and summer western north Pacific convections

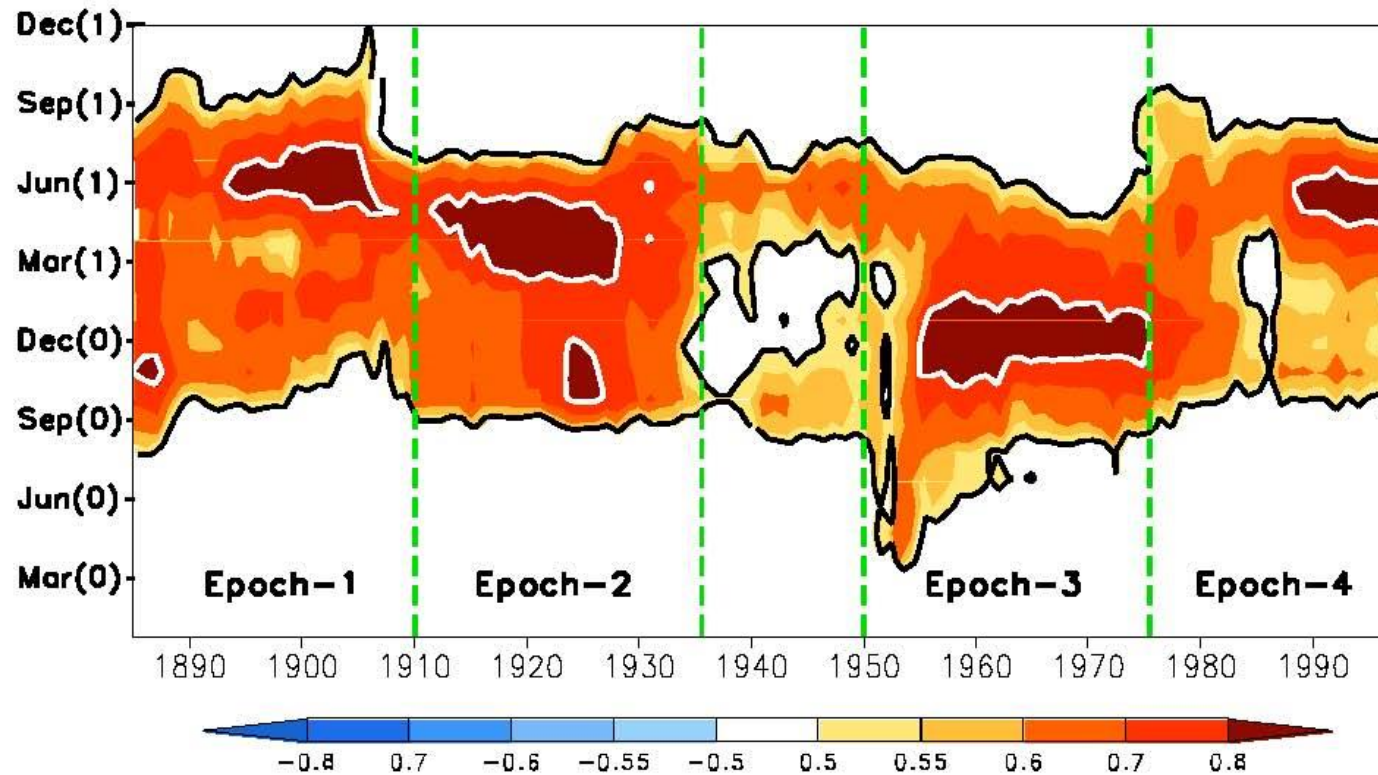


Correlation between
Niño3.4 SST
(preceding NDJ) and
Troposphere temperature
(850-250hPa) (JJA)、
Precipitation (JJA)、and
Surface wind(JJA)



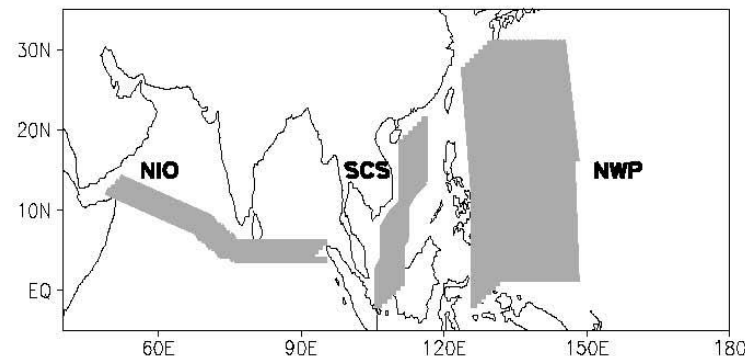
Xie et al. 2009

Interdecadal variability of the ENSO, Indian Ocean teleconnection



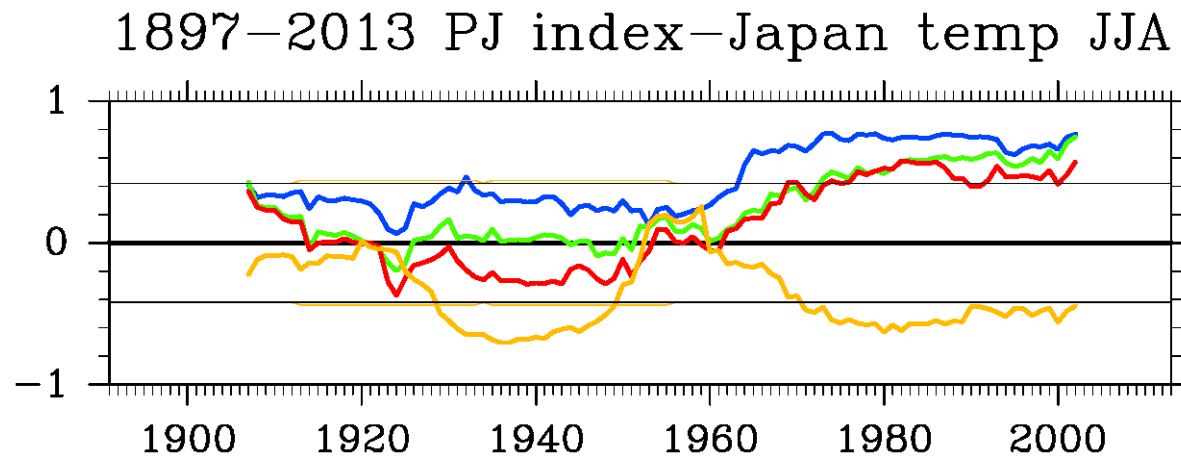
Correlation between
Northern Indian Ocean
SST and
Niño3.4 SST (NDJ)
(21 years sliding correlation)
(black contour:
95% confidence level)
(white contour:
correlation exceeds
0.8)

ICOADS
Ship track data



Chowdary et al. 2012

Correlation between Japan summer temperature and PJ index



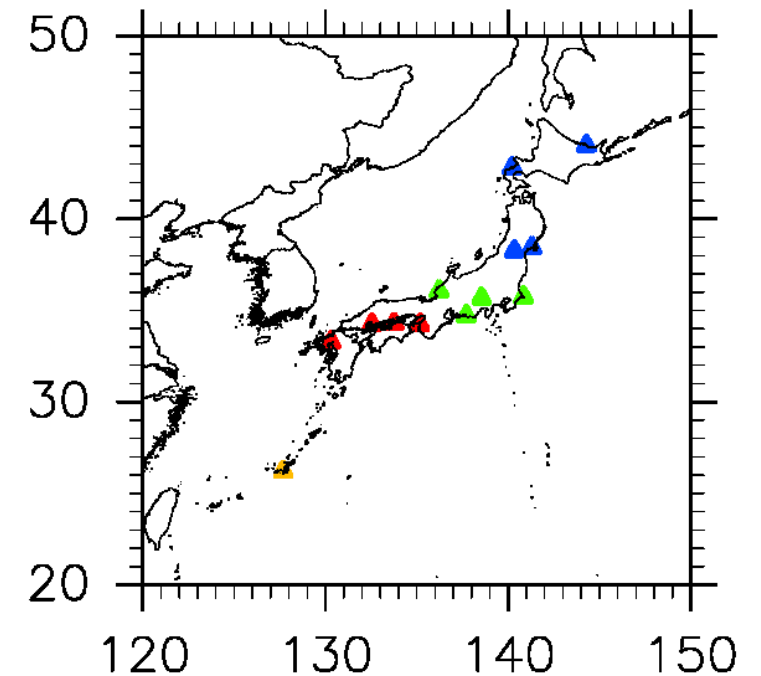
Northern Japan: Abashiri, Suttsu, Yamagata, Ishinomaki

Eastern Japan: Fushiki, Hamamatsu, Kofu, Choshi

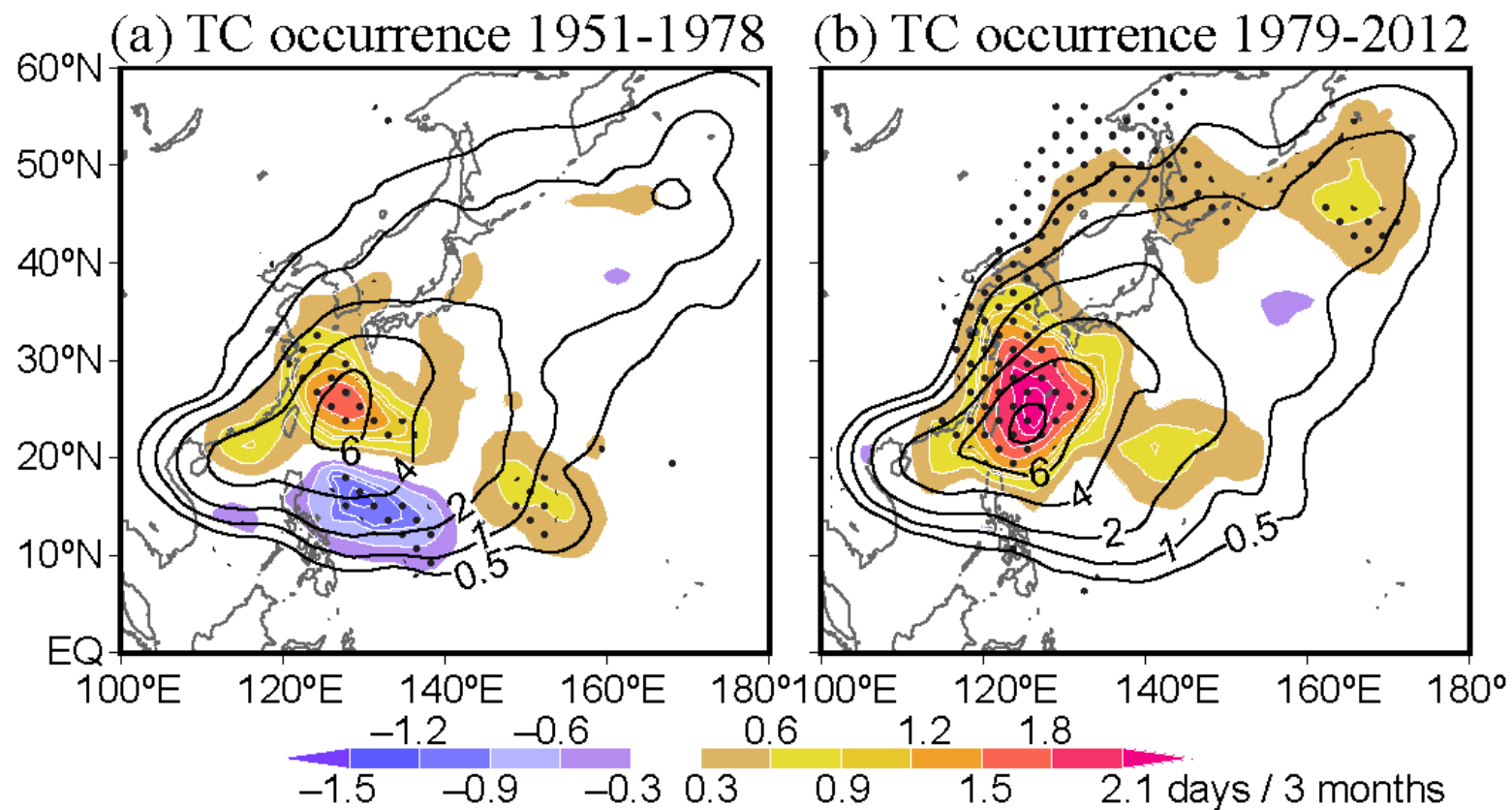
Western Japan: Wakayama, Kure, Tadotsu, Saga

Southwestern Japan: Naha

21 years running correlation



Regression between TC occurrence and PJ pattern index (JJA)



TC days: TC<500km

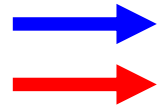
contour: climatology

Historical typhoon track data collected and digitized over the western north Pacific

Kubota (2012)

Best track data over the Western North Pacific

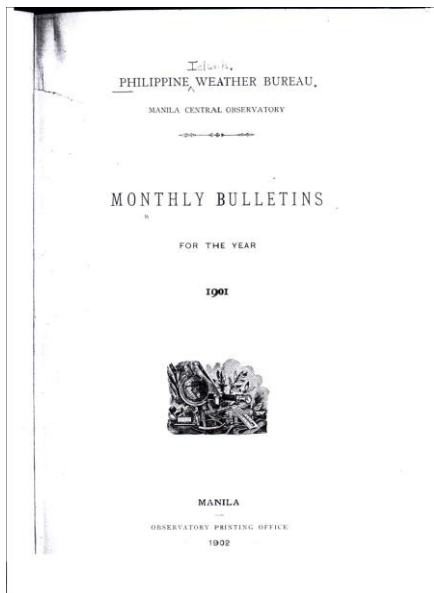
	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
USA, Philippines			→	→	→	→	→	→	→	→	→	→	→
Japan			→	→	→	→	→	→	→	→	→	→	→
Taiwan		→	→	→	→	→	→	→	→	→	→	→	→
Hong Kong	→	→	→	→	→	→	→	→	→	→	→	→	→
Shanghai	→	→	→	→	→	→	→	→	→	→	→	→	→



digitized
collected



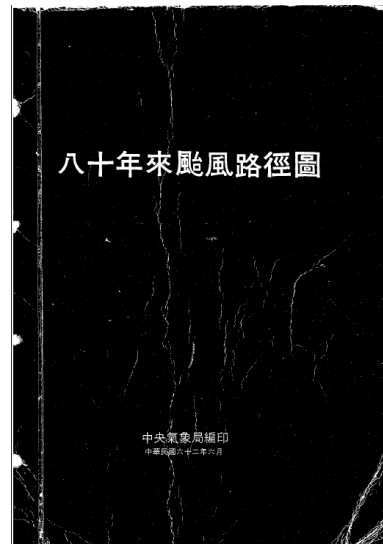
available



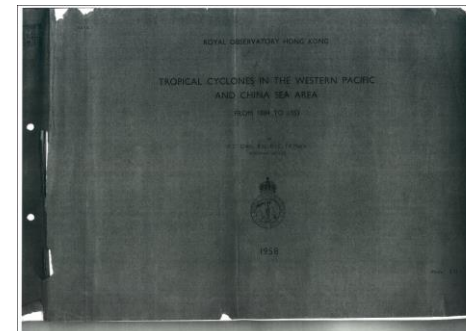
Philippines
(Univ. Hawaii)

氣象要覽
第三十三號
明治三十四年一月號

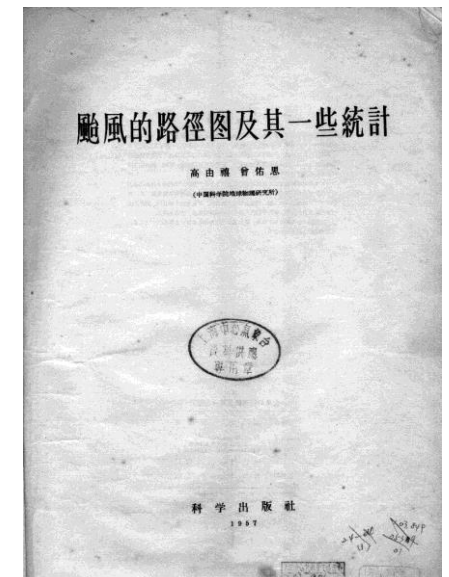
Japan
(JMA library)



Taiwan
(CWB)

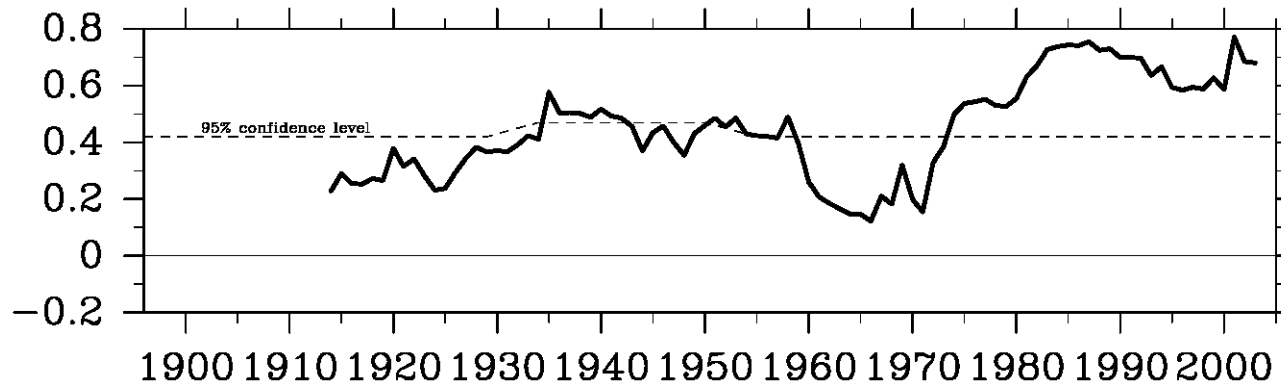


Hong Kong
(Hong Kong Observatory)
(1958 reedited)

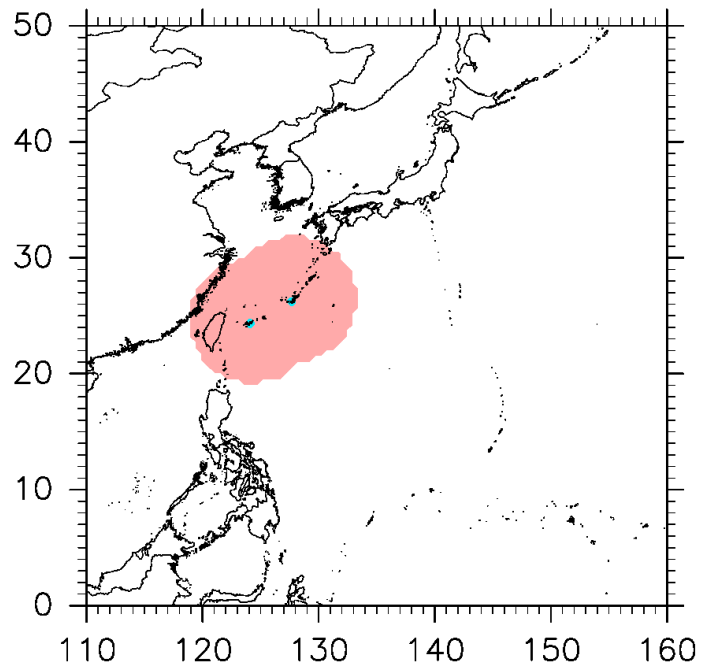


Shanghai(Zi-Ka-Wei)
(Shanghai observatory)
(1957 reedited)

Correlation of TC numbers (JJA) and PJ index



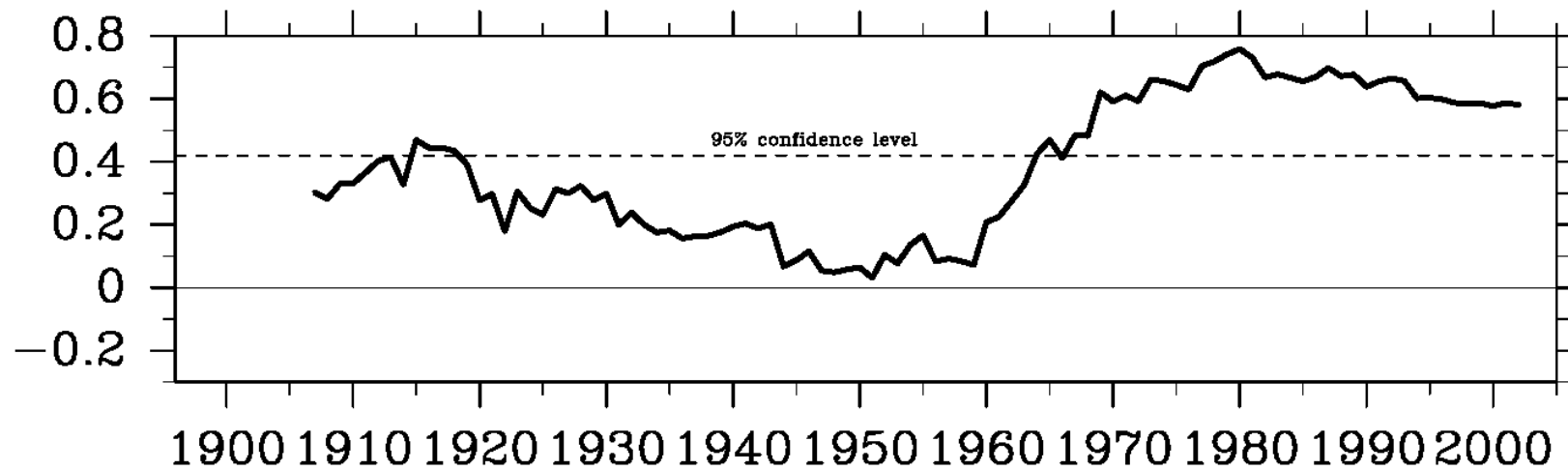
(21 years running)



Typhoon track dataset over the target area 1904-2013

1904-1910	Combination of Philippine and Japan dataset (Central Meteorological Observatory of Tokyo Japan)
1911-1939	Philippine Weather Bureau
1940-1944	data missing
1945-2013	Joint Typhoon Warning Center

Correlation of Japan annual rice product and PJ index



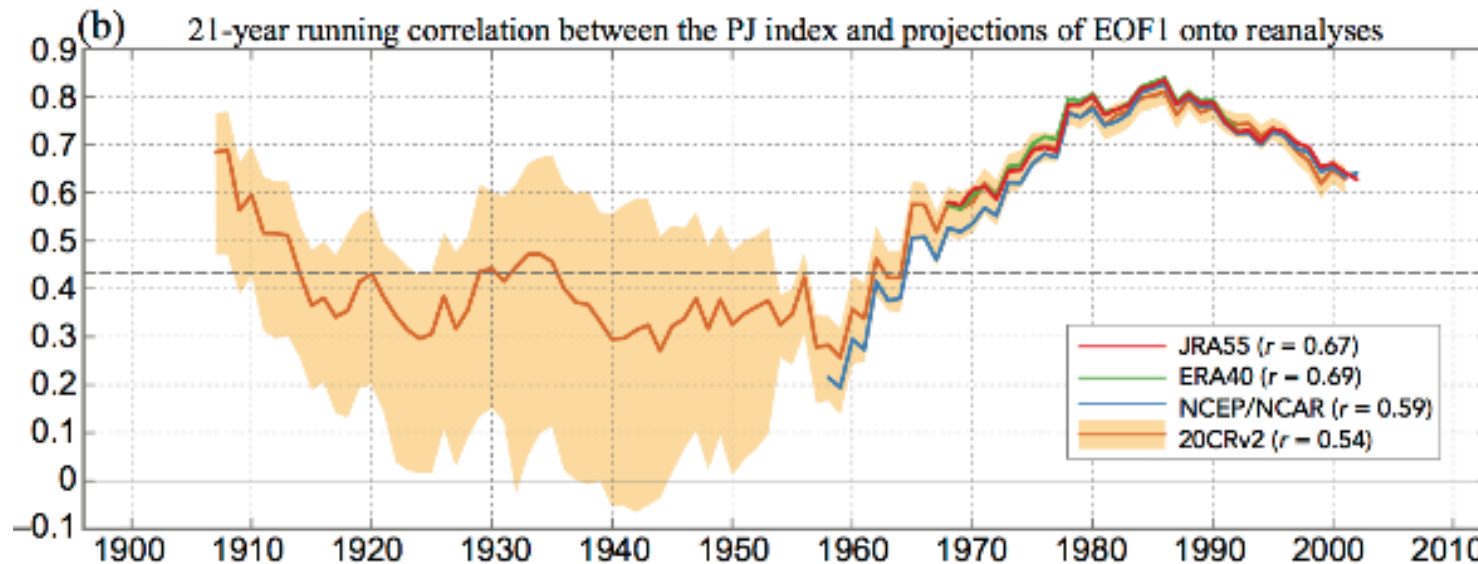
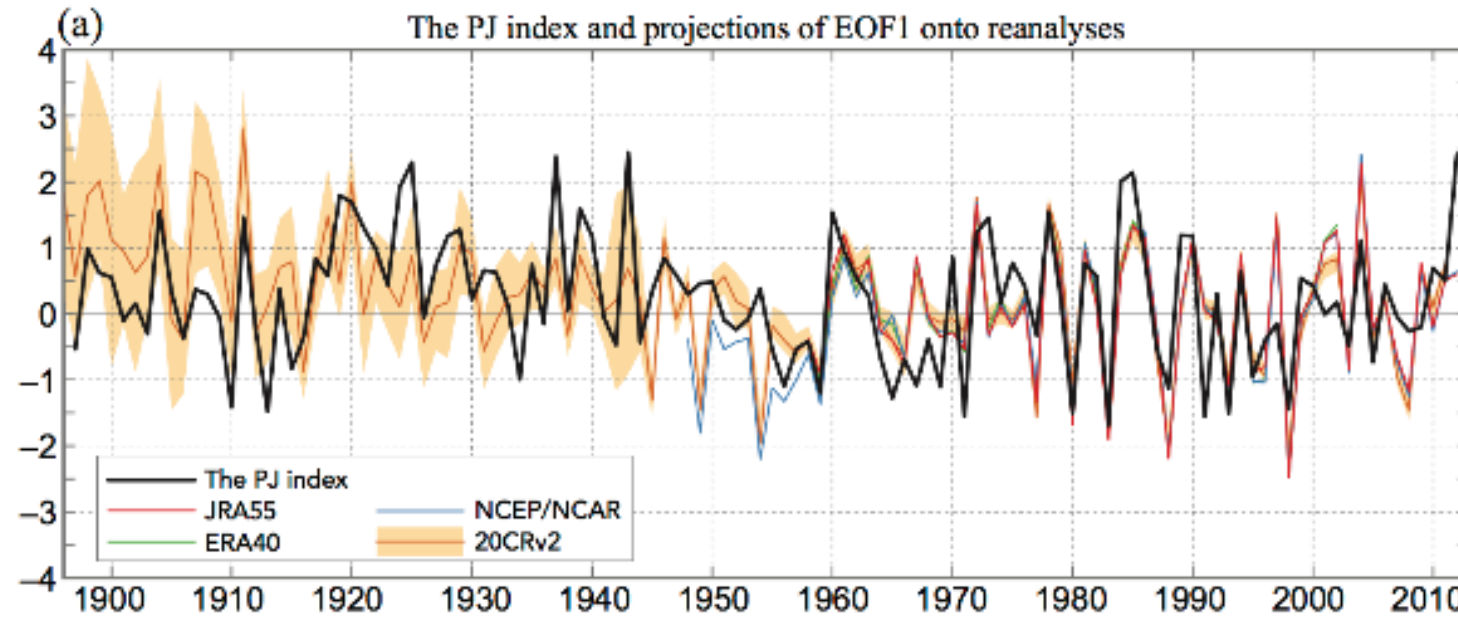
(21 years running)



PJ pattern index and its projection onto EOF1

Station-based PJ index

Projections onto EOF1s of
850hPa vorticity for 1979-2009



21 years running correlations of
the projection time series with
the PJ index

Summary

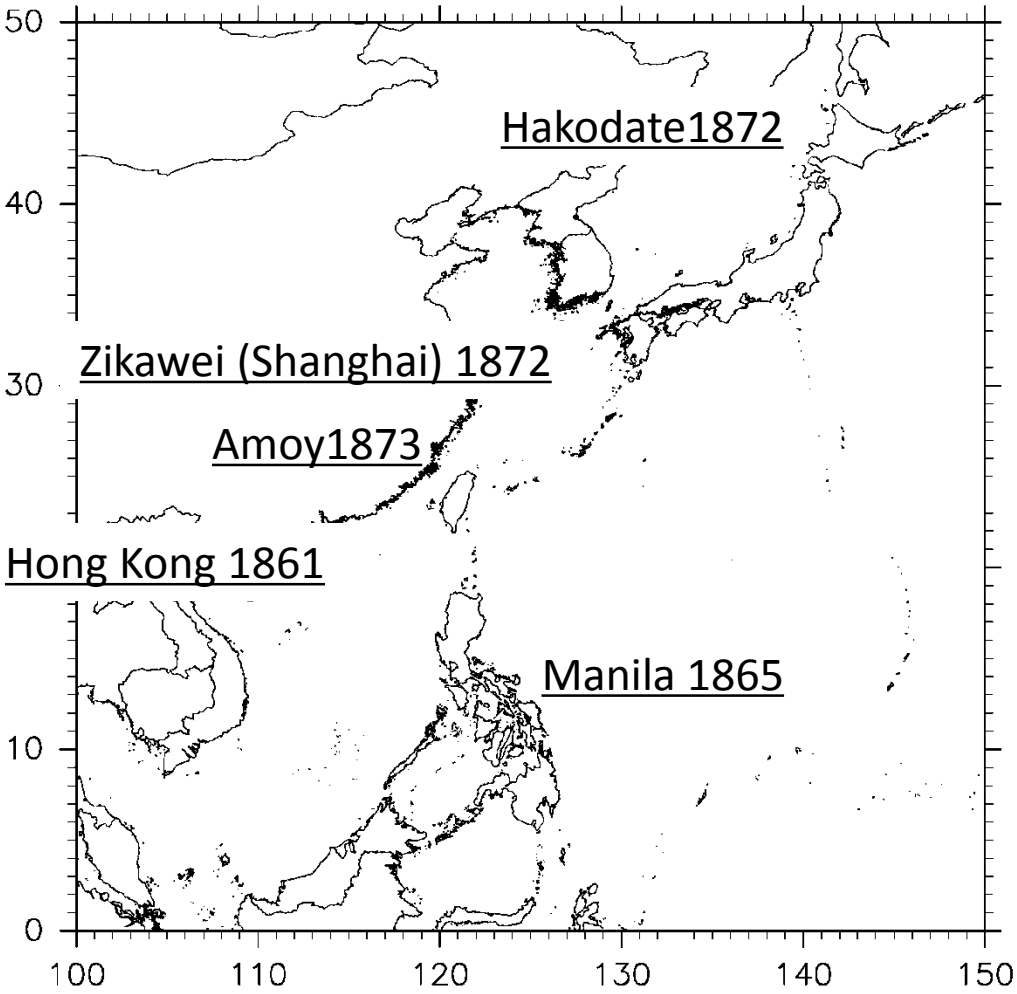
- A new **PJ pattern index** is introduced for representing Asian summer monsoon over the western north Pacific by using surface pressure data.
- This index has an advantage to trace Asian summer monsoon **back to 1897** for 117 years.
- The positive (negative) PJ pattern follows by La Niña (El Niño) .
- During the positive phase of PJ pattern, **Western North Pacific summer monsoon** activity is intensified including **tropical cyclone** activity and produces a lot of **rain** in Asian summer monsoon region and **dry hot** summer in Japan, Korea and Yangtze river basin of China.
- PJ pattern index demonstrates the interdecadal variability of the high correlation period **after 1970s and before 1910s** between ENSO and PJ pattern index, and low correlation period during **1920s to 1970s**.
- It is connected to the strength of the **variance** of ENSO and PJ pattern index .

First meteorological observation in East and Southeast Asia

- pressure
- temperature (inside)
- wind direction
- wind speed
- Temperature
- Dew point temp
- weather
- rain duration
- rainfall

CHINA COAST METEOROLOGICAL REGISTER.											
RECEIVED OCT 9 1873 Telegram of the 5 th August, 1873 at noon.											
STATIONS.	HONGKONG.			AMOI.			SHANGHAI.				
Observations.	Previous day at 4 P.M.	On date at 10 A.M.	Remarks.	Previous day at 4 P.M.	On date at 10 P.M.	Remarks.	Previous day at 4 P.M.	On date at 10 A.M.	Remarks.	Previous day at 4 P.M.	
Barometer,	29.90	29.90		29.90	30.01		29.84	29.86			
Thermometer attached, ...	81	78					84	82			
Direction of Wind,	S.E.	S.E.		S.S.E.	N		S.S.E.	S.E.			
Force "	6	6		2	1		4	4			
Thermometer,				86	85		85	86.5			
"				80	78		81	78.5			
Wet Bulb,	0.C.	0.P.		6.1.	6.1.		6.6	0.C.			
Hours of Rain,		12									
Quantity fallen,		2.00									
Hong Kong Amoy Shanghai											
Barometer attached, ...	82	82									
Direction of Wind,	S.E.	S.S.E.		S.E.	NNW						
Force "	5	6		2	1						
Thermometer,	82	83		92	83						
"	82	80		82	78						
Wet Bulb,	r	c		6.6	6.6						
Hours of Rain,	6										
Quantity fallen,136										

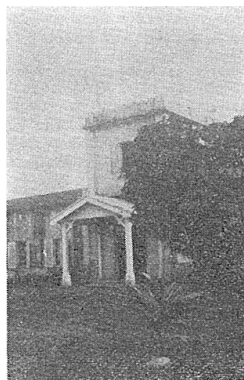
China coast Meteorological Register 1873.8.5



(Early China Coast Meteorology)



South Seas Bureau (Koror) 1923-1945 (visited 2013)



昭和4年ころのパラオ観測所

Kawasaki (1956)



Hong Kong Observatory 1884-
(visited 2009)

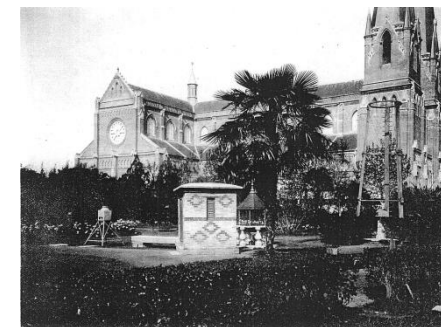


Zi-Ka-Wei
(Shanghai Observatory)
1872- (visited 2010)

Photos in 1910



OBSERVATOIRE DE ZI-KA-WEI - 1910.
Vue de la grande salle de l'observatoire.
À gauche (mont) nouvelle salle météorologique. Le puits est dans la touffe de bambous, devant l'Eglise.



OBSERVATOIRE DE ZI-KA-WEI - 1910.
Du gauche à droite : planimètres, évaporimètres, néphoscopes.
Vue prise de l'abri "Météorologie".



Philippines dataset

Boletin Mensual (Spanish) 1865-1901

1866-1869, 1870-1874, 1876, 1878-1879, 1884-1888 Met Office (courtesy of Prof. Zaiki and Akasaka)

1880-1882, 1890-1901 Japan Meteorological Agency

1883 Environment Canada

Monthly Bulletins (American) 1901-1940

Hamilton Library at University of Hawaii

Monthly 1901-1940

Annual 1903-1938, (1939 Environment Canada)

South China and South Seas weather report (Japanese)

1936-1940 8 NOAA central library (courtesy of Dr. Rob Allan)

South Seas weather report (Japanese) 1940 9-1941 12

National Taiwan University (courtesy of Prof. Hung)

Monthly Bulletins (Japanese) 1942 9-1944 2 (partly)

Japan Meteorological Agency, Ministry of Defense,

Library of Congress

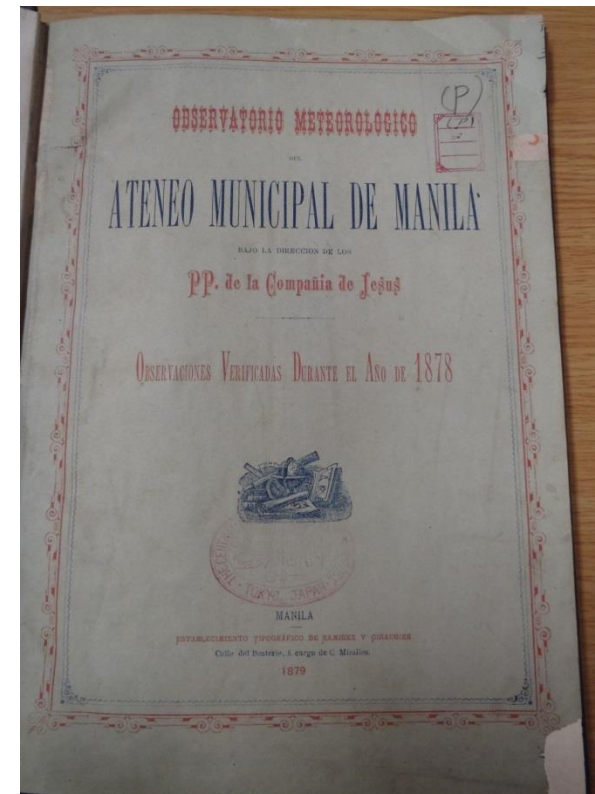
(courtesy of Prof. Akasaka, Tsukahara, and Kobayashi)

NOAA NCDC (American) 1945-

PAGASA (Philippine) 1949-2013

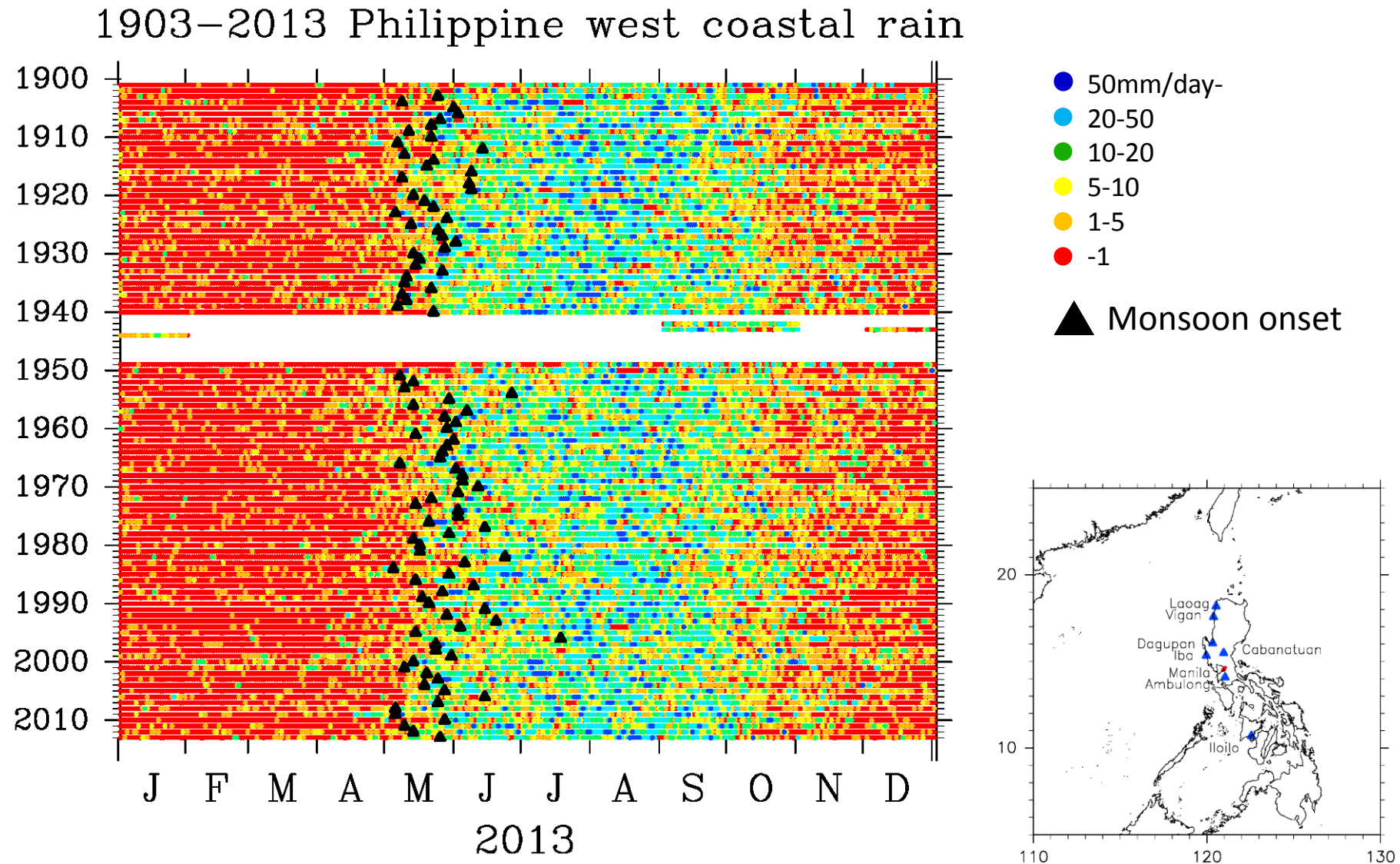
Red: collected

Blue: digitized



Ateneo Municipal de Manila 1878

Seasonal march of rainfall in the northwestern Philippines

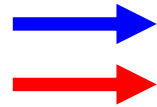


Historical typhoon track data collected and digitized over the western north Pacific

Kubota (2012)

Best track data over the Western North Pacific

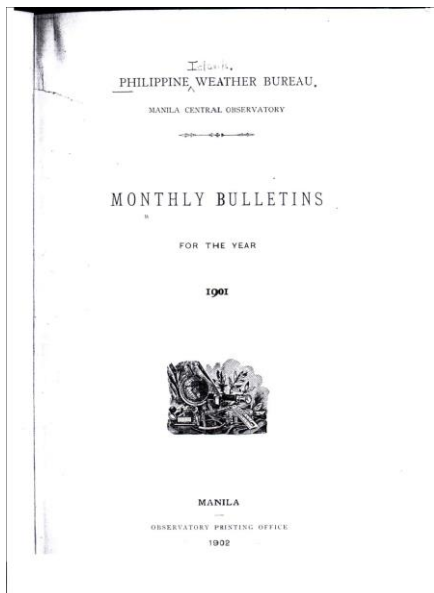
	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
USA, Philippines			→	→	→	→	→	→	→	→	→	→	→
Japan			→	→	→	→	→	→	→	→	→	→	→
Taiwan		→	→	→	→	→	→	→	→	→	→	→	→
Hong Kong	→	→	→	→	→	→	→	→	→	→	→	→	→
Shanghai	→	→	→	→	→	→	→	→	→	→	→	→	→



digitized
collected



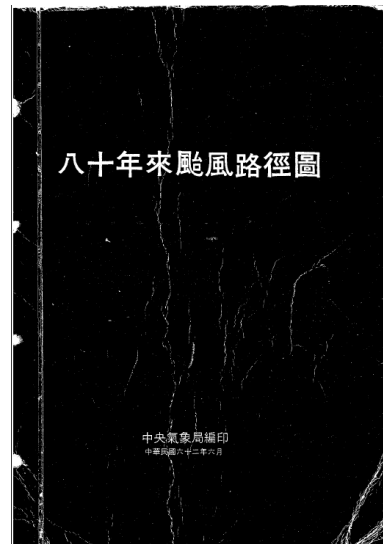
available



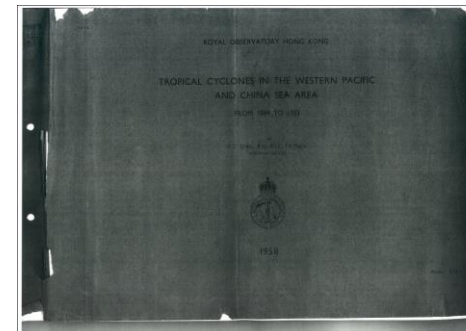
Philippines
(Univ. Hawaii)

氣象要覽
明治三十四年一月號

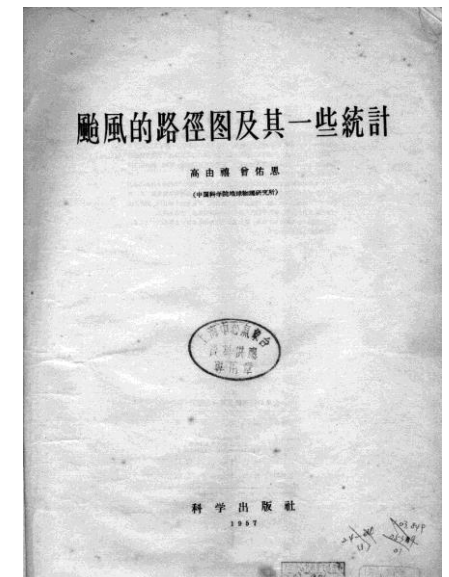
Japan
(JMA library)



Taiwan
(CWB)



Hong Kong
(Hong Kong Observatory)
(1958 reedited)



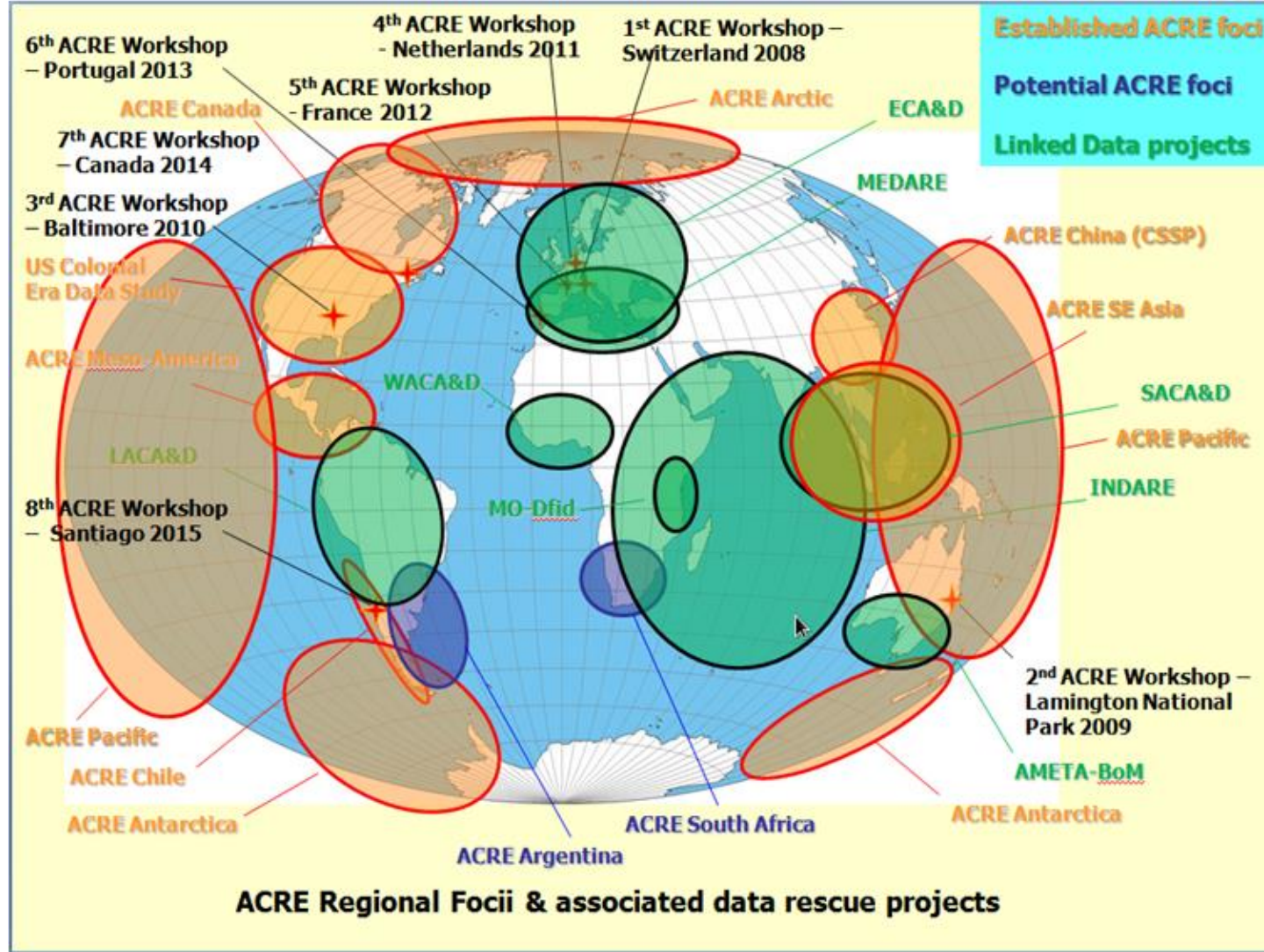
Shanghai(Zi-Ka-Wei)
(Shanghai observatory)
(1957 reedited)

Historical typhoon track data over western north Pacific

	Philippine Weather Bureau	Central Meteorological Observatory Tokyo Japan	Hong Kong Observatory	Zi-Ka-Wei (Shanghai) Observatory	Central Weather Bureau Taiwan
period	1902-1940 Aug.	1900-1950	1884-1953	1884-1957	1892-1996
coverage	WNP	WNP	WNP up to 30N	WNP	WNP
typhoon definition	less than 750mmHg (1000hPa)	N/A	more than 32kt or 64kt	N/A	N/A
data	typhoon date and locations	typhoon date, locations, center pressure (some)	typhoon date and locations	typhoon date and locations	typhoon date, locations, center pressure and wind (some)
interval	daily (some 6 hourly)	daily (some 6 hourly)	daily	daily	daily (some 6 hourly)
references	Monthly Bulletins of Philippine Weather Bureau 1902-1940	Geophysical Review 1900-1950, Wadachi 1952: Typhoon tracks 1940-1950	Chin, P. C., 1958: Tropical cyclones in the Western Pacific and China Sea area from 1884 to 1953	Gao 1957: Typhoon tracks and statistical analysis	Xu, H. et al. 1973: 80 years typhoon track 1892-1977, Shieh, S.-L. et al., 1998: Tropical cyclone tracks over Taiwan and its vicinity 1897-1996

Atmospheric Circulation Reconstructions over the Earth (ACRE)

Initiative both undertakes and facilitates the recovery of historical instrumental surface terrestrial and marine global weather observations to underpin 3D weather reconstructions (reanalyses) spanning the last 200-250 years for climate applications and impacts needs worldwide.



ACRE 8th workshop at University of Chili, Santiago Oct. 2015

(Atmospheric Circulation Reconstructions over the Earth)

Data rescue

ACRE China (Guoyu Ren), ACRE Southeast Asia (Fiona Williamson), SACA&D

ACRE Pacific, Antarctica, ACRE South Africa, ACRE Meso-America, ACRE Argentina, ACRE Chili

20th century reanalysis

NOAA 20CRv3 (Gill Compo)

ERA-20C

SOUSEI 150-year coupled reanalysis (Japanese)

ICOADS version 3.0 (Philip Brohan)

Citizen Science

Oldweather.org (Philip Brohan), Weather Detective (Christa Pudmenzky) (Australia)



20th century reanalyses

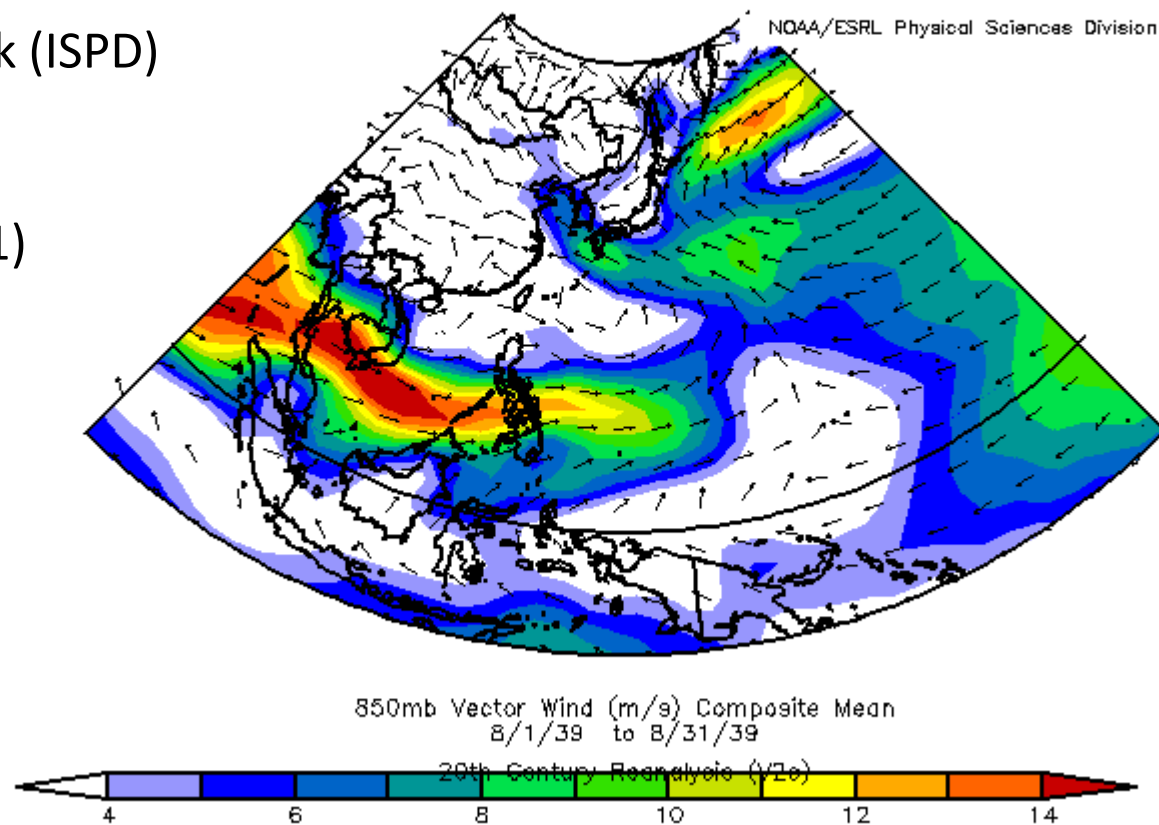
Three dimension dataset assimilated by sea surface pressure (SLP) and sea surface temperature (SST) data.

Benefit: It overcomes the gaps between the era before and after satellite and upper-air observations and is suitable for long-term variability studies.

SLP: International Surface Pressure Databank (ISPD)

SST: ICOADS, COBE-SST2

- NOAA 20CR (Compo et al. 2011) (1851-2011)
- ERA-20C (Poli et al. 2013) (1900-2010)
- Japanese 20CR by SOUSEI (in preparation)



NOAA 20CR Aug 1939 850hPa wind

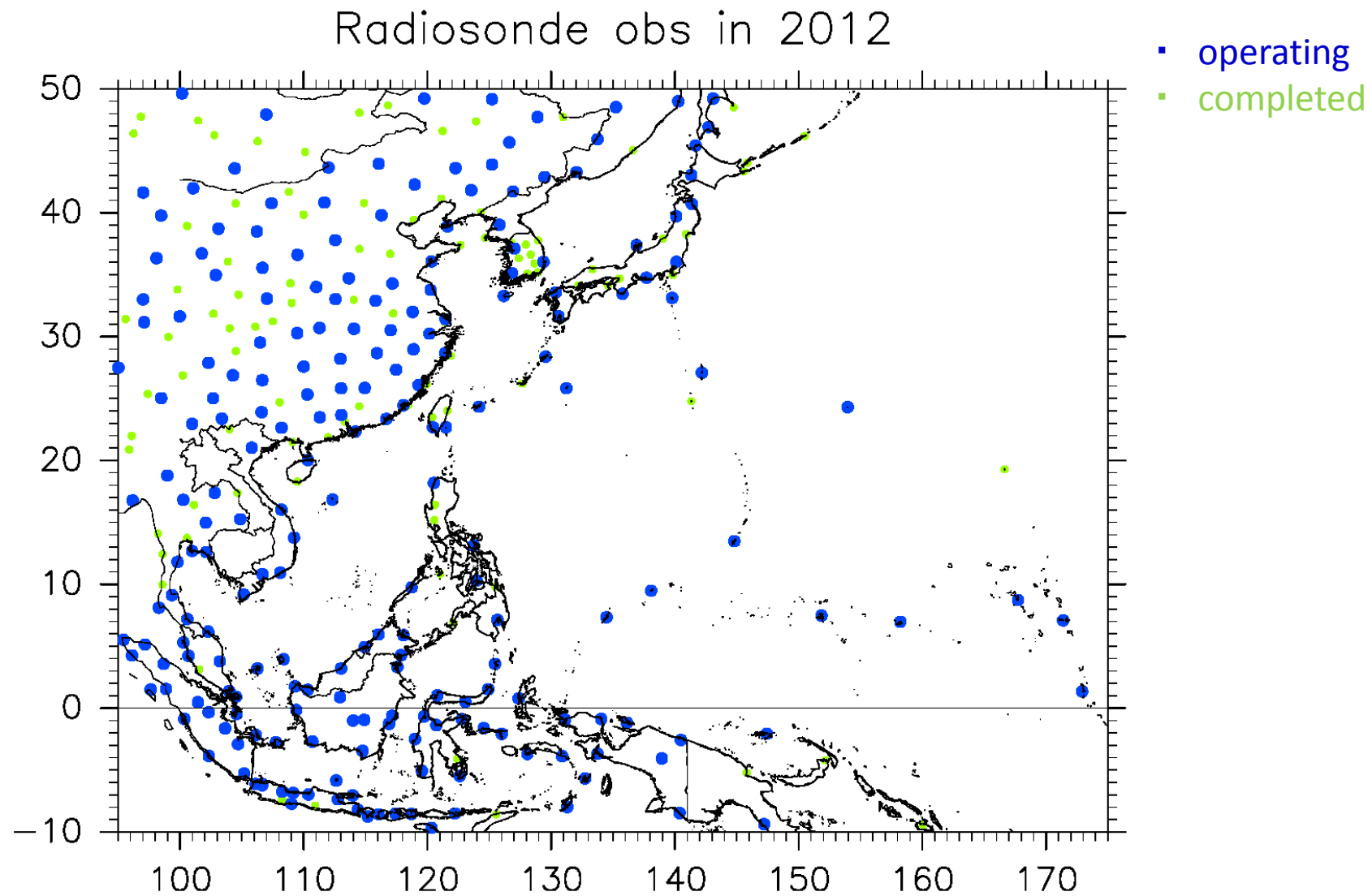
Radiosonde observation
(temp, humidity, pressure, wind speed, wind direction)



Pilot balloon observation
(wind speed, wind direction)

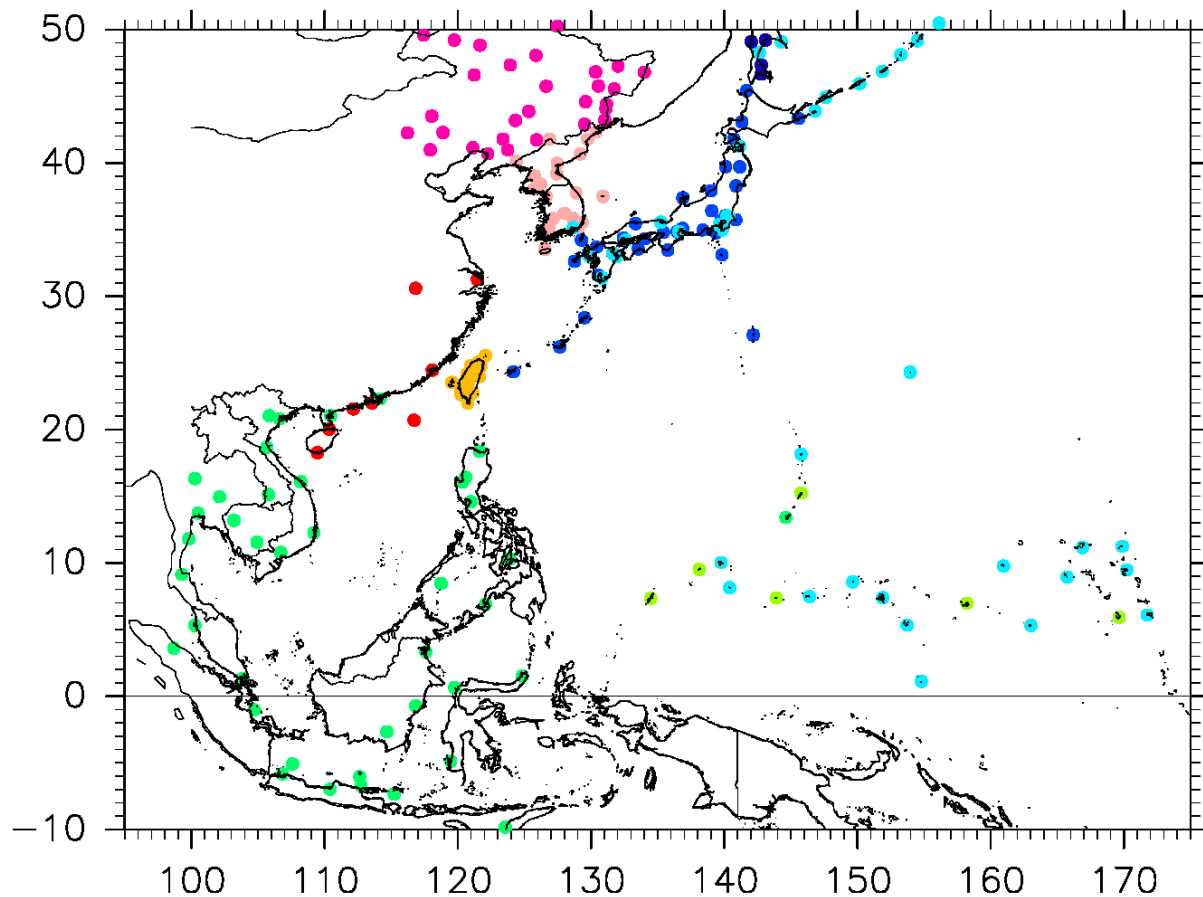


Current radiosonde and pilot balloon observation in Asia



Japanese pilot balloon observation during 1920s-1940s

Pilot balloon obs in 1930s



All the data are stored in JMA library

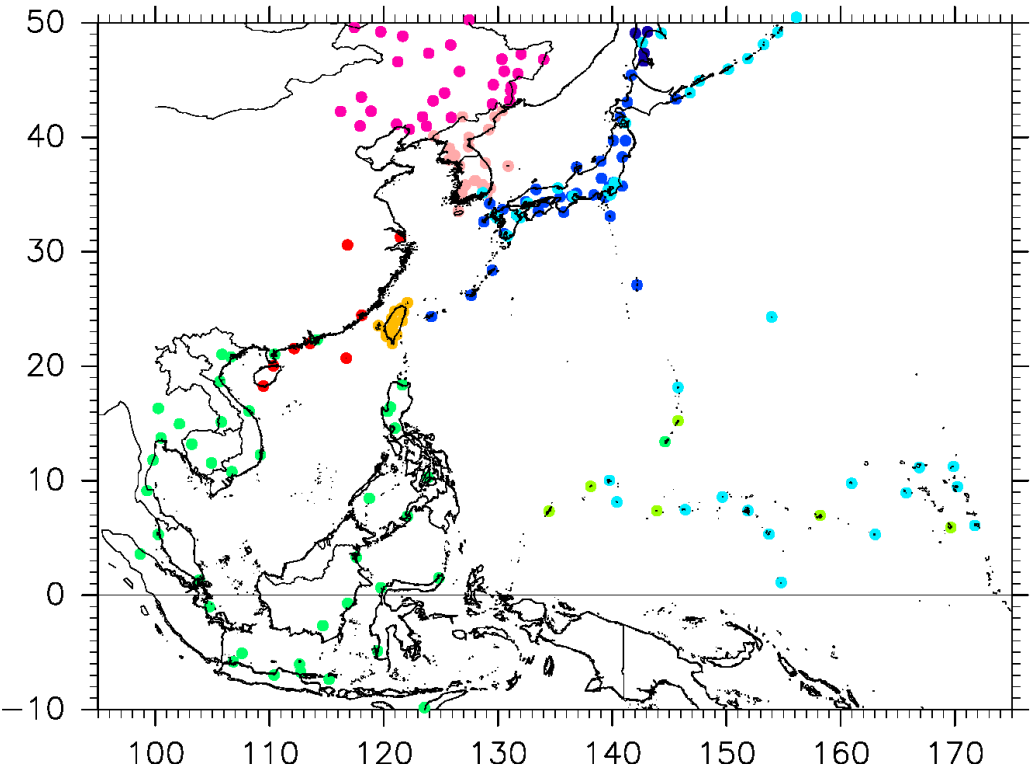
(total 197stations)

高層気象台気象概報 (1)
(1921-1985)
上層気流月報(中央気象台)
(1932-1942) (33)
海軍高層気象台月報 (42)
(1937-1940)
上層気流観測表
(南洋庁気象台) (6)
(1925-1940)
朝鮮上層気流月報 (21)
Aerological data of Korea
(1930-1944)
上層気流観測報告
(台湾総督府気象台) (12)
(1933-1942)
満州高層気流観測月報 (29)
Aerological data of Manchuria
Aerological data of Dairen
(1935-1944)
樺太上層気流観測報告 (4)
(1928-1941)
上層気流月報(上海気象台)
(1940-1944) (8)
呂宋印度支那上層気流報告
南方気象調査月報
(1936-1941) (41)

Japanese pilot balloon observation during 1920s-1940s

	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944
Japan																								
South Seas Bureau																								
Taiwan																								
Korea																								
Manchuria																								
Sakharin																								
South East Asia																								
Japan Navy																								
China																								

Pilot balloon obs in 1930s



QUARTERLY REPORT OF THE PILOT BALLOON OBSERVATIONS IN FORMOSA

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January to March, 1935

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August, 1935



January					Taihoku					1935				
Height in hectometer	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel	Direct Vel
Surface		E 3.1	Continued	Continued		ENE 2.2		E 1.1		E 4.1	Continued			
0 — 1		83 6.0	216 4.0	232 11.5		53 2.3		63 3.7		91 8.9	96 9.7			
1 — 2	2nd	81 8.7	201 4.7	Entered into SK	3rd	54 4.4		65 4.2		91 7.9	124 7.2			
2 — 3		95 7.5	188 5.0			48 7.0	4th	49 4.9	5th	86 11.7	116 9.2			
3 — 4	8h 05m	109 5.6	188 5.4		8h 01m	40 6.4		46 7.2	7h 58m	83 12.4	Entered into SK			
4 — 5		132 4.8	216 5.3			27 7.0		49 7.0		82 12.9				
5 — 6	10 N	132 4.0	196 7.2		10 N.SK	28 9.7		48 8.8	7 N.SK.CK	75 14.2				
6 — 7	18°8C	98 3.9	225 6.6		16°0C	33 8.4		54 10.7	15°2C	74 13.9				
7 — 8		82 4.7	229 9.1			37 11.7		Entered into N		77 15.0				
8 — 9		102 3.2	230 9.8			Entered into N				79 14.4				
9 — 10		134 1.2	233 10.7							96 12.1				
Surface		E 5.6	Continued		ENE 6.3	Continued		— 0.0	Continued	Continued				
0 — 1		82 8.5	135 9.5		75 13.2	209 1.4		111 3.2	257 3.8	229 4.0				
1 — 2		80 13.0	186 4.2		75 12.4	326 0.8		81 5.1	249 4.6	194 4.5			13th	
2 — 3	7th	90 11.8	193 4.5	10th	76 14.4	322 1.5		98 5.0	249 4.7	191 6.1			8h 00m	
3 — 4	7h 49m	88 11.9	185 2.6	7h 51m	79 12.9	269 3.4		119 2.5	258 5.2	184 7.3				
4 — 5		99 12.1	235 3.8		86 13.0	206 6.9	3 KC.SK	121 5.4	273 4.5	184 7.8	4 S.SK			
5 — 6	9 KC.K.SK	104 9.6	Entered into SK	1 KC.SK	102 10.0	239 3.2	Haze	141 4.5	241 7.7	156 6.5	Haze			
6 — 7	16°8C	99 10.0		18°2C	117 9.4	255 3.6		199 2.0	253 6.7	Entered into KC	18°2C			
7 — 8		121 10.1			140 6.7	255 4.7	16°2C	210 1.7	248 7.9					
8 — 9		130 8.5			162 6.9	Burst		242 1.9	240 9.0					
9 — 10		130 11.0			181 2.6			266 3.0	251 5.5					
Surface	— 0.3		ENE 2.7	Continued		SE 1.3	Continued		E 1.3	Continued				
0 — 1	186 0.7		59 3.5	into SK		154 1.7	Entered into S		86 1.8	Entered into SK				
1 — 2	197 2.4	16th	55 3.7		17th	126 2.8		18th	54 3.0				19th	
2 — 3	105 3.4		55 5.2			76 2.0			40 2.7					
3 — 4	107 2.7	8h 04m	58 5.5		7h 50m	48 3.7		7h 50m	33 2.8				7h 42m	
4 — 5	102 3.5		59 5.3		10 SK.S.N	47 5.8		10 SK.N	35 3.1				10 SK.S.N	
5 — 6	Interapt by haze	9°5C	52 5.0		8°4C	47 7.0		8°3C	35 3.4				9°7C	
6 — 7			47 5.8			49 7.4			30 2.8					
7 — 8			51 5.8			45 9.4			23 2.9					
8 — 9			54 5.6			48 6.0			33 4.1					
9 — 10			Entered			51 8.2			38 5.4					
Surface	E 4.1	Continued		— 0.4	Continued		WNW0.5	Continued		E 5.7	Continued			
0 — 1	101 4.5	Entered into S		109 1.2	160 1.4		265 1.3	331 9.4		89 7.0	134 13.7			
1 — 2	90 9.3		20th	132 1.5	242 1.4	21st	266 1.9	318 9.8	22nd	87 12.0				
2 — 3	86 8.7			102 2.5	242 2.1		272 2.9	304 9.4		86 13.2				
3 — 4	76 11.5		7h 45m	88 5.0	232 3.8	7h55m	273 2.1	288 10.9	8h04m	84 14.0				
4 — 5	75 9.0			75 6.0	Entered into SK		275 2.0	Entered into SN	2 SK	84 13.5				
5 — 6	71 7.0		10 SK.N.S	74 5.9		Haze	275 2.6		Haze	89 11.6				
6 — 7	73 8.3		11°4C	78 5.7			278 3.4			101 10.3				
7 — 8	74 9.4			91 5.0		12°7C	320 3.2		14°0C	102 11.9				
8 — 9	74 9.5			104 6.3			322 3.4			119 12.7				
9 — 10	76 9.7			134 4.8			320 7.2			130 14.0				
Surface		E 2.9	Continued		E 3.0	Continued		ESE 0.9	Continued		ESE 2.4			
0 — 1		64 6.8	Entered into N		99 5.5	Entered into SK		82 2.6	64 11.2		96 4.5			
1 — 2		64 7.7		25th	98 7.0			79 6.7	65 9.8	31st	93 6.4			
2 — 3	24th	56 12.6			89 8.9			66 7.3	70 10.1		92 6.4			
3 — 4	7h 51m	56 12.5		7h51m	80 10.2			61 8.3	81 8.2	8h0Cm	85 10.5			
4 — 5		56 10.8			78 10.5			54 9.0	Entered into SK		81 11.4			
5 — 6	10 SK.N	59 10.2		7 KC.SK	90 8.8		10 SK	55 10.8		10 SK.N	79 11.6			
6 — 7		53 7.8		14°3C	91 8.8			59 12.3		12°1C	79 14.3			
7 — 8		52 9.6			99 10.2			58 11.7			84 10.6			
8 — 9		60 7.2			118 8.4			60 11.3			86 9.8			
9 — 10		68 6.2			128 8.4			60 10.4			into SK			

Taipei Taiwan
Jan 1935