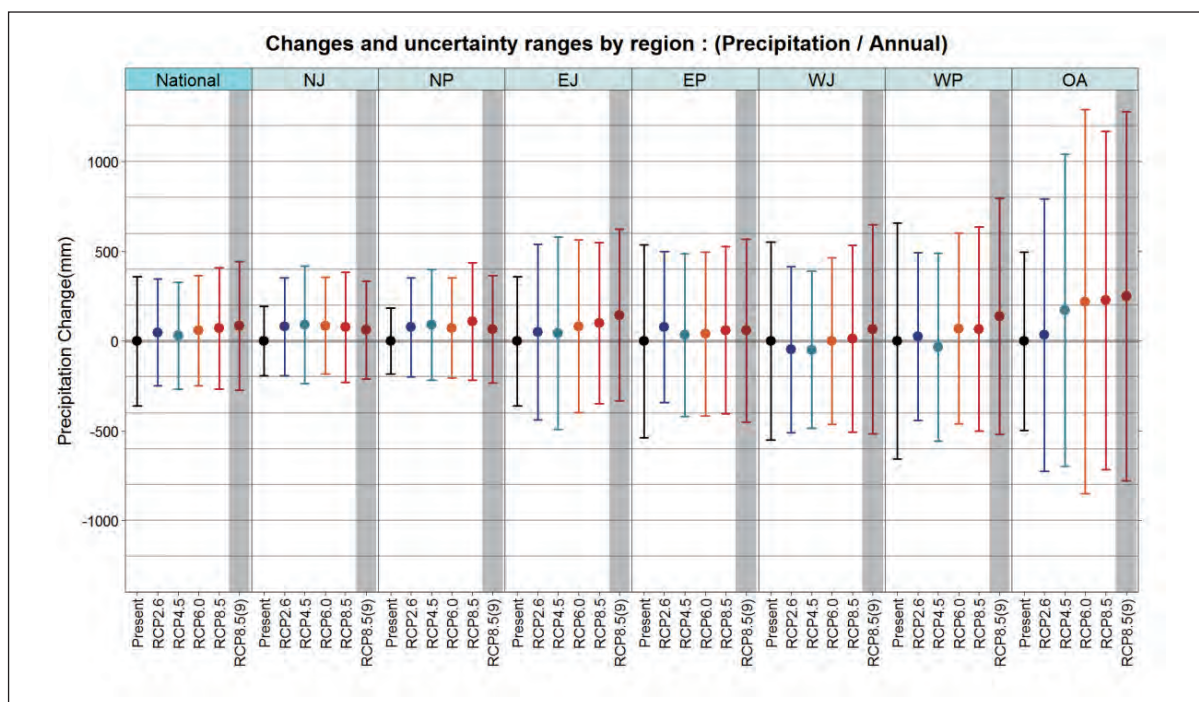# Projections of annual precipitation

■ Regarding annual precipitation, there are both cases of increasing and decreasing tendencies; therefore, any meaningful trend cannot be seen here.

Changes and uncertainty ranges by region : (Precipitation / Annual)

In this graph, the circular marks (points) in the middle of the vertical lines indicate the average values of plural cases and solid lines indicate the range of uncertainties, including interannual fluctuations. "Present" on the horizontal axis indicates the present climate, and RCP2.6 - RCP8.5 indicate the results of each scenario of RCP at the end of the 21st century, and show the range of uncertainties based on the results of the three cases. Although the ranges of uncertainty based on the results of nine cases under the RCP8.5 scenario are also shown here for reference, it should be noted that these values cannot be compared with the values of other scenarios.

(mm)	National	NJ	NP	EJ	EP	WJ	WP	OA
RCP2.6	48.7 (-249.1～346.5)	80.2 (-192.9～353.2)	78.0 (-198.1～354.1)	50.1 (-440.2～540.5)	78.5 (-343.0～500.1)	-47.6 (-511.4～416.2)	26.2 (-440.5～493.0)	34.3 (-724.9～793.4)
RCP4.5	30.3 (-266.7～327.3)	90.8 (-237.2～418.7)	91.3 (-217.0～399.6)	45.2 (-491.2～581.6)	33.8 (-420.1～487.7)	-48.5 (-485.6～388.6)	-33.4 (-557.4～490.5)	172.8 (-696.0～1041.6)
RCP6.0	58.3 (-248.5～365.1)	86.3 (-182.7～355.3)	73.2 (-205.4～351.8)	81.9 (-399.4～563.1)	39.6 (-418.1～497.3)	-0.2 (-465.0～464.6)	69.3 (-462.0～600.6)	219.6 (-850.5～1289.7)
RCP8.5	71.3 (-266.4～409.0)	77.1 (-230.5～384.6)	109.6 (-219.0～438.2)	100.2 (-347.6～548.1)	61.3 (-403.8～526.4)	13.0 (-506.2～532.3)	67.0 (-502.0～636.1)	227.2 (-716.1～1170.6)
RCP8.5(9)	85.2 (-274.1～444.5)	62.1 (-210.6～334.7)	65.7 (-234.0～365.4)	145.0 (-333.1～623.1)	58.9 (-449.7～567.4)	66.3 (-517.2～649.7)	138.2 (-519.4～795.7)	249.5 (-778.3～1277.3)
(Major city)	-	Sapporo	Kushiro	Niigata	Tokyo	Fukuoka	Osaka	Naha
Climatic Normal	-	1106.5	1042.9	1821.0	1528.8	1612.3	1279.0	2040.8

Figures in this table indicate the average values of three cases (YS) under each scenario with the range of uncertainties in parentheses (For the case of RCP8.5 alone, however, both the average value and the range of uncertainties of all nine cases are described). The climatic normal (annual average for the period 1981-2010) for the major city in each region is also shown for reference.

(Note) It is not possible for us to simply compare the regional average value derived from the present climate based on model calculations, with the annual average value obtained from actual observations at a specific location. Furthermore, although we give here a representative major city in each region, the value indicated for that city is by no means a representative value of the climate of the entire region to which the city belongs.

■ Comparison between future changes and interannual fluctuations

Even today, climatic indicators fluctuate year by year, as there are warmer years and colder years, or years with more precipitation and years with less precipitation than average years. Therefore, even if it is warmer this year than last year, or even if it rains this year more than last year, we cannot say for certain that climate change is occurring. In such a situation, what should we do if we say with some certainty that temperature will rise, or precipitation will increase/decrease in the future?

In this publication, whether the future change is meaningful or not is judged by comparing the amount of future change with the standard deviation (indication showing the magnitude of the dispersion of data) of interannual fluctuations over 20 years. Based on the above criteria, we are able to say that the temperature in the future will be higher than that today because we see larger fluctuations of temperature than the interannual fluctuations in every case of the calculation.
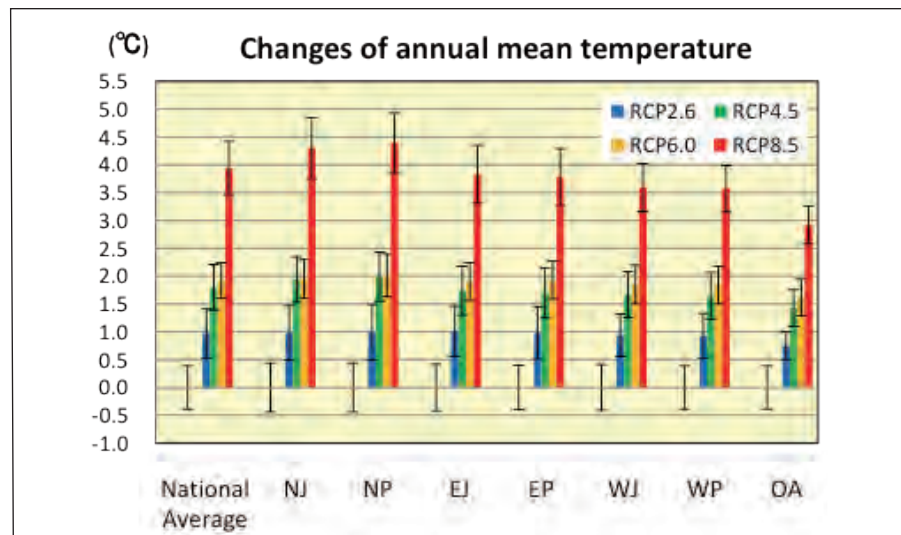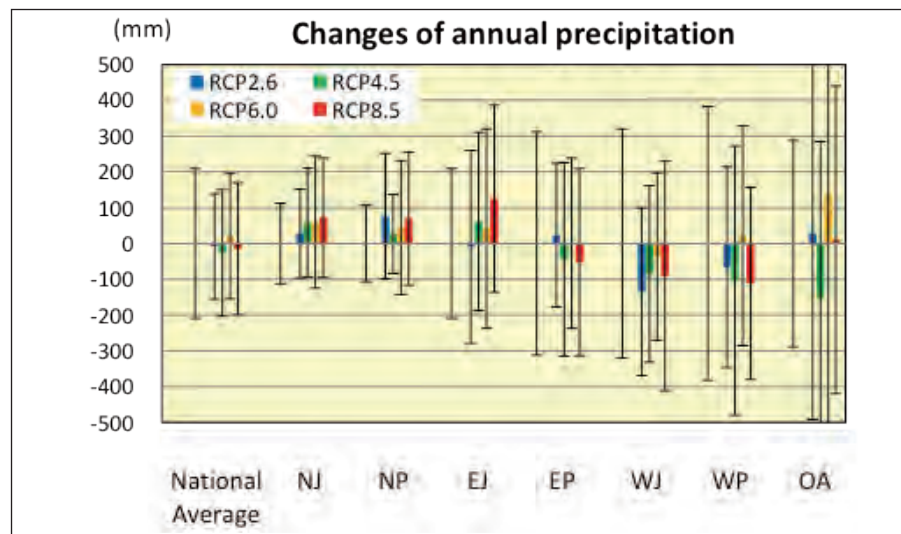

Chart: Change in annual mean temperature (example of SST1/YS case)
Bar graph: Variation from the present climate conditions (blue: RCP2.6; green: RCP4.5; orange: RCP6.0; red: RCP8.5)
Error bar: Standard deviation of interannual fluctuations (Indication without a bar graph is for the case of the present climate.)

The magnitude of change in annual precipitation is smaller than the interannual fluctuations in all cases; therefore, we cannot say that the amount of precipitation in the future will be more than that in the present.
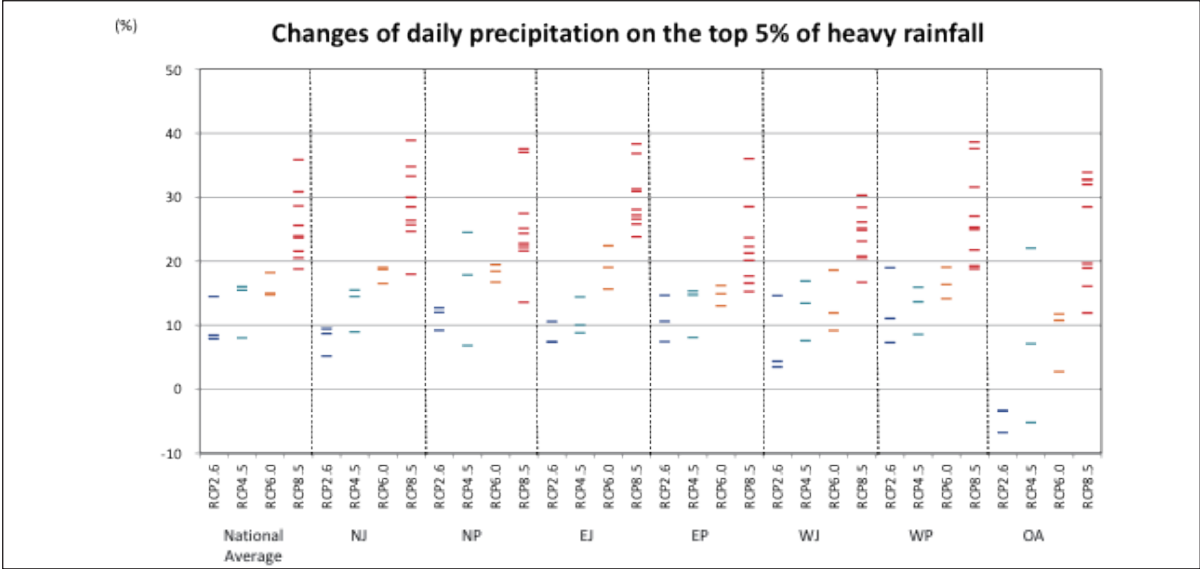
Chart: Change in annual precipitation (example of SST1/YS case)
Bar graph: Variation from the present climate (blue: RCP2.6; green: RCP4.5; orange: RCP6.0; red: RCP8.5)
Error bar: Standard deviation of interannual fluctuations.   (Indication without a bar graph is for the case of the present climate.)
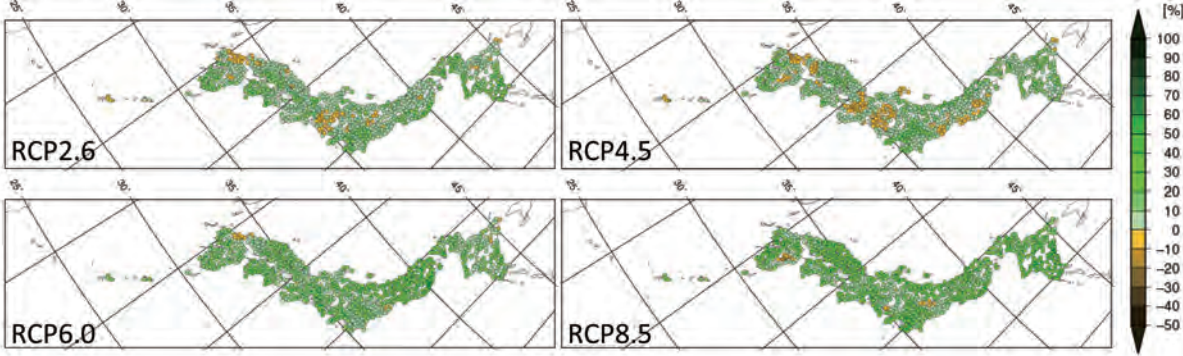
Projections of intence precipitation[9]

■ Intence precipitation is projected to increase nationwide.
(It will increase of about 10% under the RCP2.6 scenario and about 25% under the RCP 8.5 scenario) (national average, annual average)

■ There are cases where intence precipitation is projected to decrease in the Okinawa/Amami under the RCP2.6 and RCP4.5 scenarios.

Changes of daily precipitation on the top 5% of heavy rainfall

(%)	National	NJ	NP	EJ	EP	WJ	WP	OA
RCP2.6	10.3 (7.9 ~ 14.5)	7.8 (5.2 ~ 9.4)	11.3 (9.2 ~ 12.8)	8.5 (7.4 ~ 10.6)	10.9 (7.4 ~ 14.6)	7.5 (3.5 ~ 14.6)	12.4 (7.3 ~ 18.9)	-4.5 (-6.7 ~ -3.3)
RCP4.5	13.2 (8.0 ~ 16.0)	13.0 (9.0 ~ 15.5)	16.4 (6.8 ~ 24.5)	11.1 (8.8 ~ 14.4)	12.7 (8.1 ~ 15.3)	12.6 (7.6 ~ 16.9)	12.7 (8.6 ~ 15.9)	8.0 (-5.2 ~ 22.0)
RCP6.0	16.0 (14.8 ~ 18.2)	18.1 (16.5 ~ 19.0)	18.2 (16.7 ~ 19.5)	19.0 (15.7 ~ 22.4)	14.7 (13.0 ~ 16.2)	13.2 (9.2 ~ 18.6)	16.5 (14.1 ~ 19.0)	8.4 (2.8 ~ 11.7)
RCP8.5	25.5 (18.8 ~ 35.8)	28.9 (18.0 ~ 38.9)	25.7 (13.6 ~ 37.5)	29.9 (23.8 ~ 38.3)	22.4 (15.3 ~ 36.0)	24.0 (16.7 ~ 30.3)	27.2 (18.8 ~ 38.6)	25.2 (11.9 ~ 33.9)
(average in the region wide)	The precipitations above were Calculated by frequent distribution of daily precipitation.							
top 5% rainfall	40 ~ 60(mm)	20 ~ 40(mm)	20 ~ 40(mm)	40 ~ 60(mm)	40 ~ 60(mm)	40 ~ 60(mm)	60 ~ 80(mm)	80 ~ 100 (mm)

This graph indicates the rate of change of the future climate projection (annual average for the period 2080 - 2100) from the present climate (annual average for the period 1984-2004) for each case. Average values of all cases under each scenario are shown in the table above. Average values of the present climate (annual average for the period 1984-2003), calculated based on AMeDAS observation points in each region, are also illustrated for reference.


Distribution of changes of daily precipitation by the top 5% heavy rains
(SST1/YS case only is shown for each scenario)

9---- "Intence precipitation" here is defined as "daily precipitation by the top 5% heavy rains." Out of the total number of daily precipitation events at each location, the average daily precipitation of the top 5% of heavy rains is calculated and used as an indicator to show the magnitude of heavy rains.
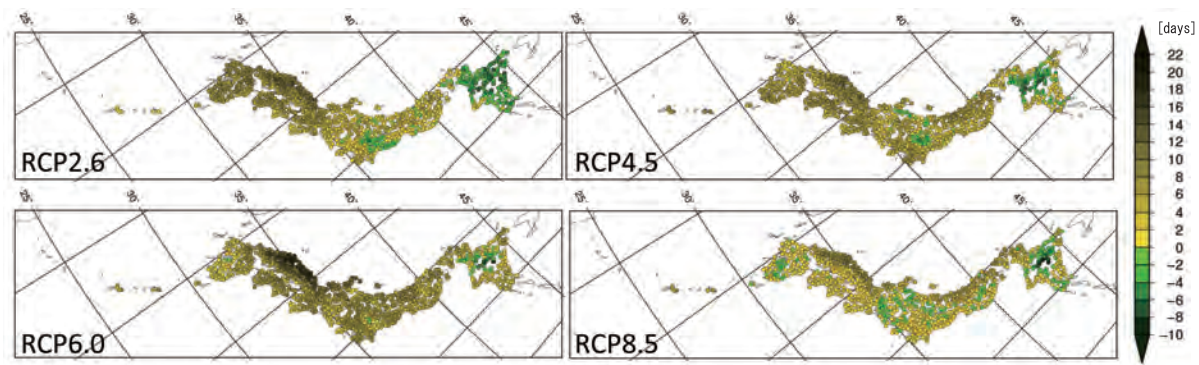
Projections of dry days[10]

■ The number of annual dry days is projected to increase nationwide under the RCP8.5 scenario.
(It will increase by about 10 days under the RCP2.6 scenario and by about 50 days under the RCP8.5 scenario.) (national average,)

■ There are cases where the number of dry days is projected to decrease in some regions under RCP2.6 and RCP4.5 scenarios.

Changes of the numbers of annual dry days
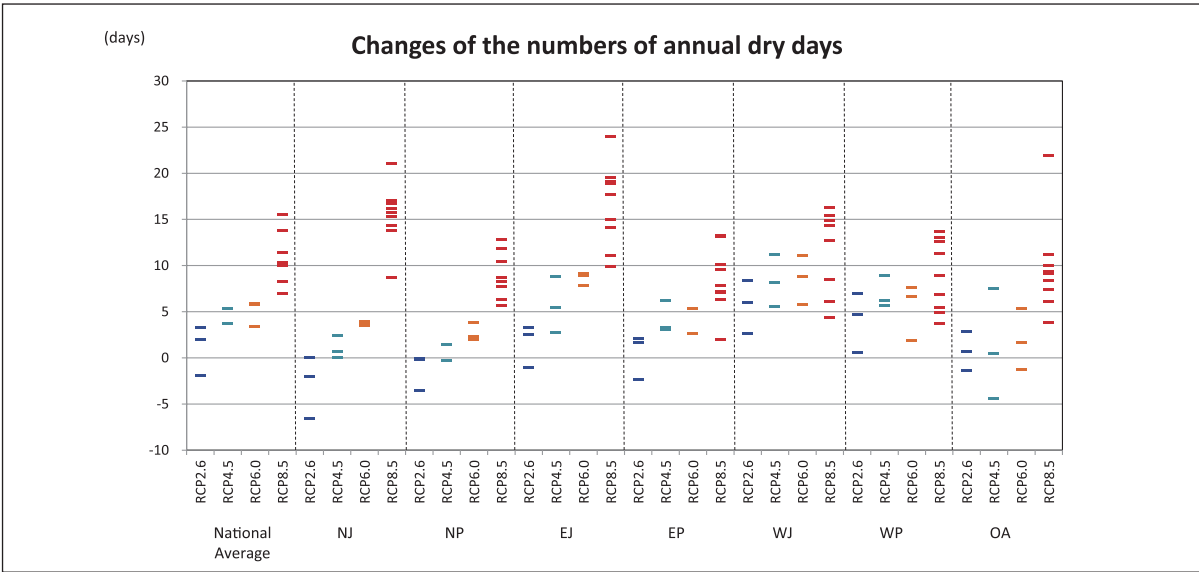
(days)	National	NJ	NP	EJ	EP	WJ	WP	OA
RCP2.6	1.1 (-1.9 ~ 3.2)	-2.9 (-6.6 ~ 0.0)	-1.3 (-3.6 ~ -0.1)	1.6 (-1.1 ~ 3.3)	0.5 (-2.3 ~ 2.1)	5.7 (2.7 ~ 8.4)	4.0 (0.5 ~ 6.9)	0.7 (-1.4 ~ 2.9)
RCP4.5	4.2 (3.7 ~ 5.3)	1.0 (0.1 ~ 2.4)	0.9 (-0.3 ~ 1.5)	5.6 (2.7 ~ 8.8)	4.2 (3.1 ~ 6.2)	8.3 (5.6 ~ 11.2)	6.9 (5.7 ~ 8.9)	1.2 (-4.4 ~ 7.5)
RCP6.0	5.0 (3.4 ~ 5.8)	3.7 (3.5 ~ 3.9)	2.7 (2.0 ~ 3.8)	8.6 (7.8 ~ 9.1)	4.5 (2.6 ~ 5.4)	8.5 (5.8 ~ 11.0)	5.4 (1.9 ~ 7.6)	1.9 (-1.3 ~ 5.3)
RCP8.5	10.7 (6.9 ~ 15.5)	15.4 (8.6 ~ 21.1)	8.9 (5.7 ~ 12.8)	16.6 (9.9 ~ 24.0)	8.5 (2.0 ~ 13.2)	11.7 (4.4 ~ 16.3)	8.9 (3.7 ~ 13.7)	9.7 (3.9 ~ 21.9)
(Major city)	-	Sapporo	Kushiro	Niigata	Tokyo	Fukuoka	Osaka	Naha
Climatic normal	-	225.5	276.7	192.8	263.6	253.7	266.8	243.1

This graph indicates the difference between the future climate projection (annual average for the period 2080-2100) and the present climate (annual average for the period 1984-2004) in each case. Average values of all cases under each scenario are shown in the table above. The climatic normal (annual average for the period 1981-2010) of a major city in each region are also illustrated for reference.
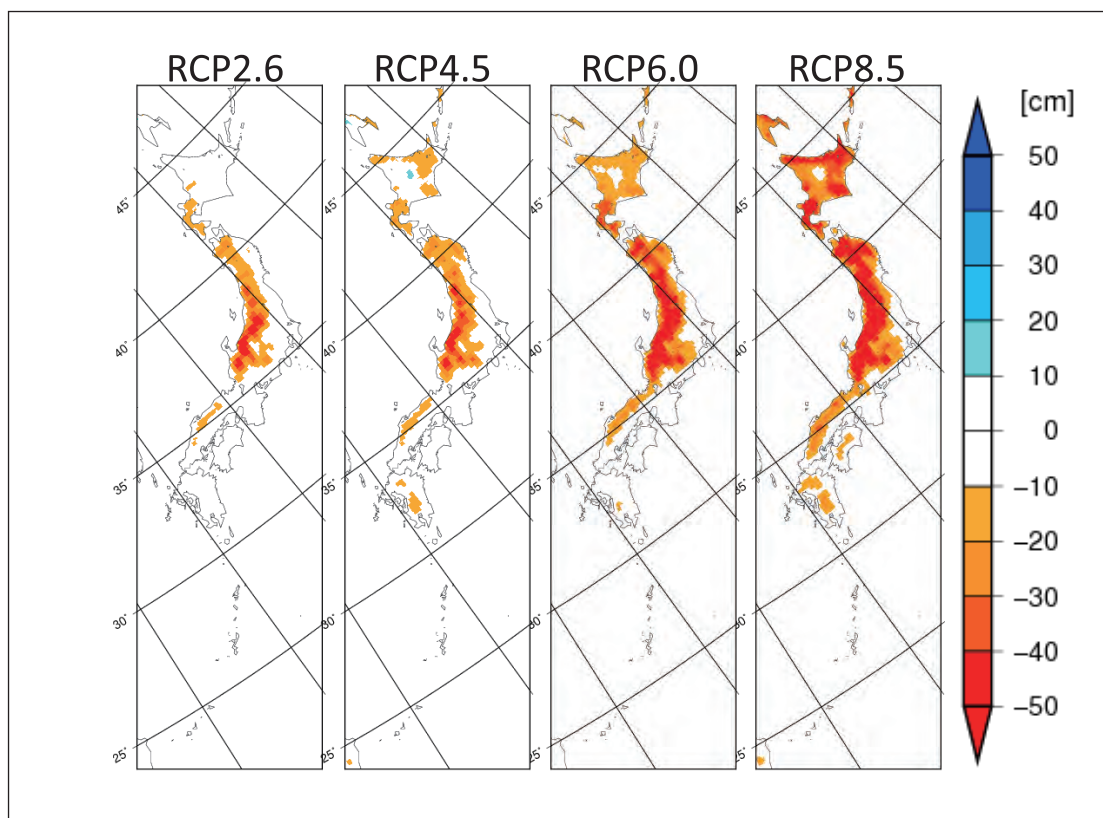

Distribution of changes in the number of annual dry days
(SST1/YS case only is shown for each scenario)

10----- "Dry day" means a day on which the amount of daily precipitation is less than 1.0 mm.

Projections of maximum snow depth[11]

■ The annual maximum snow depth is projected to decrease nationwide.

■ The magnitude of reduction will be large in the Sea of Japan side of eastern Japan, in particular.


Distribution of changes of annual maximum snow depth
(SST1/YS case only is shown for each scenario)

■ Explanation of representative major cities

In this study, we divide Japan into seven regions for convenience, and select one major city in each of the regions. It should be noted here that values for each major city are not representative of the entire region to which the city belongs. For instance, if we simply apply the change of the number of frost days of the Pacific side of eastern Japan to present-day Tokyo, the value becomes negative; this is not the intended use of the data.

Source: Website of Japan Meteorological Agency (http://www.data.jma.go.jp/obd/stats/etrn/)
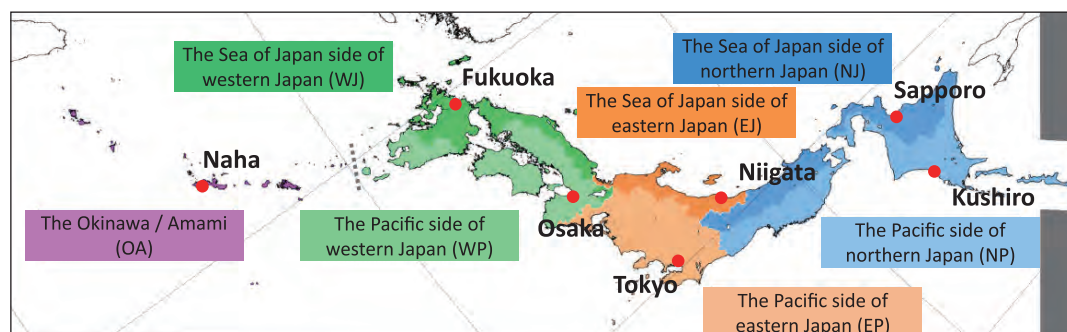

Source: Japan Meteorological Agency (2013) , "Global Warming Projection information Volume 8"(Modified)

11----- Regarding snow depth, there is a high degree of uncertainty associated with the bias error vis-à-vis the present climate. Therefore, we need to be cautious when using it.

Projections of snowfall[12]

■ The amount of annual snowfall will decrease nationwide.

■ It will decrease more in the Sea of Japan side of eastern Japan, in particular.

■ There may be a characteristic with snowfall projected to increase in certain parts of the inland of Hokkaido.
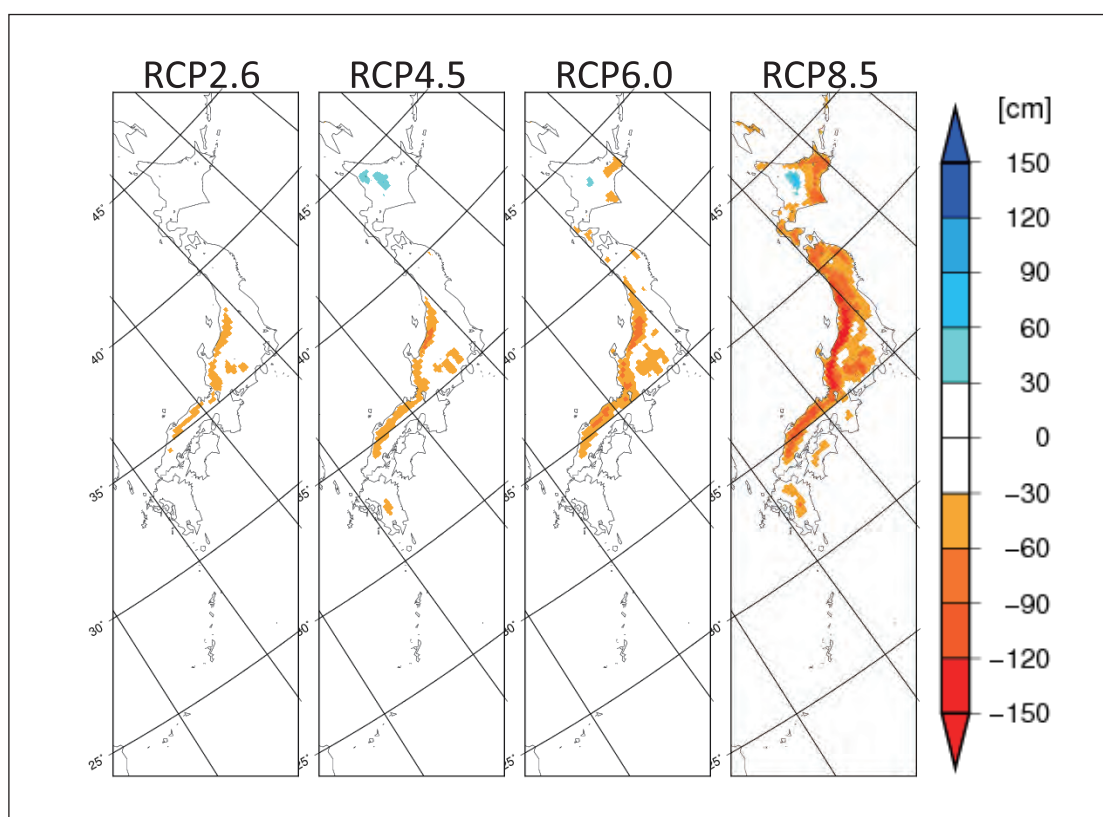
Distribution of changes in annual snowfall amount
(SST1/YS case only is shown for each scenario)

■ Explanation of representative major cities

Annual average values* of various indicators for a major city in each region

*Annual average values are calculated from observed values in the past 30 years (1981-2010)

Region	Major city	Annual mean temperature (℃)	Daily maximum temperature (℃)	Daily minimum temperature (℃)	Annual hot days (days)	Annual frost days (days)	Annual precipitation (mm)	Annual dry days (days)
NJ	Sapporo	8.9	12.9	5.3	8.0	45.0	1106.5	225.5
NP	Kushiro	6.2	10.2	2.3	0.1	44.7	1042.9	276.7
EJ	Niigata	13.9	17.6	10.6	33.5	1.1	1821.0	192.8
EP	Tokyo	15.4	19.8	13.2	46.4	0.0	1528.8	263.6
WJ	Fukuoka	17.0	20.9	13.6	57.1	0.0	1612.3	253.7
WP	Osaka	16.9	21.1	13.3	73.2	0.0	1279.0	266.8
OA	Naha	23.1	25.7	20.8	96.0	0.0	2040.8	243.1

12-----As regards the amount of snowfall, there is a high degree of uncertainty associated with the bias error vis-à-vis the present climate. Therefore, we need to be cautious when using it.