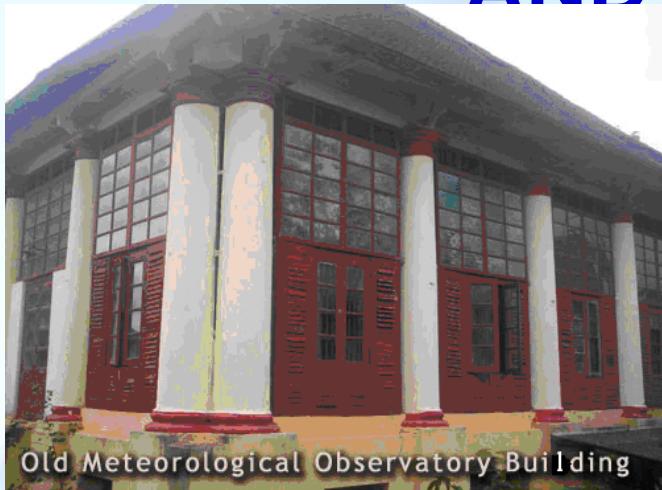


# तापमान की विशेषता और इसकी प्रवृत्ति पर अध्ययन

## STUDY ON TEMPERATURE FEATURES AND ITS TRENDS



1836 - 1992



1992 – Till Date

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# अध्ययन के आधार

## Premise of the study

यह जांच करने के लिए कि तापमान के उच्च मूल्य अधिक घंटों के लिए बने रहेंगे? तीन शहरों में

To examine whether, higher values of temperature are persisting for more hours? Over the three cities

यदि हाँ, तो आने वाले दशकों में वर्तमान स्थिति और इसके संभावित अनुमान क्या हैं?

If so, what is the current status and its likely projections in coming decades?



# विश्लेषण का दृष्टिकोण

## Approach of analysis

- ❖ अधिकतम तापमान तक एक डिग्री अंतराल के साथ प्रत्येक तापमान के निवासी समय की आवृत्ति गणना की गई थी The frequency of resident time of each temperature with one degree interval up to the maximum temperature was calculated.
- ❖ चूंकि तापमान और वर्षा आंकड़ों की उपलब्धता 1969 से है, पहला दशक 1969 -78 से शुरू हुआ, फिर 1979-88 और इसलिए 1971-1980 दशक के कैलेंडर दशक नहीं दर्शाए। Since the availability of Temperature and rainfall data is from 1969, the first decadal started with 1969-78, then 1979-88 and so on instead of calendar decade staring from of 1971-1980.
- ❖ शेष उपलब्ध अवधि को हाल की अवधि की स्थिति पाने के लिए एक साथ लिया गया। The remaining available period also considered together to get the status of recent period.



# Resident time

- ❖ कुल घंटो की संख्या, एक चयनित तापमान मूल्य (एक डिग्री अंतराल के साथ) बनी रहती है (अवलोकन के स्थान पर), क्या उस दिन के लिए उस विशेष तापमान का निवासी समय है। Total number of hours, a selected temperature value (with one degree interval) *persists (over the place of observation)*, Is the resident time of that particular temperature for the day.
- ❖ इस प्रकार का विश्लेषण तापमान का एक उपाय दे सकता है, जिसमें हम सबसे ज्यादा अनावृत होते हैं This *sort of analysis may give an idea of the temperatures range to which we are exposed the most.*

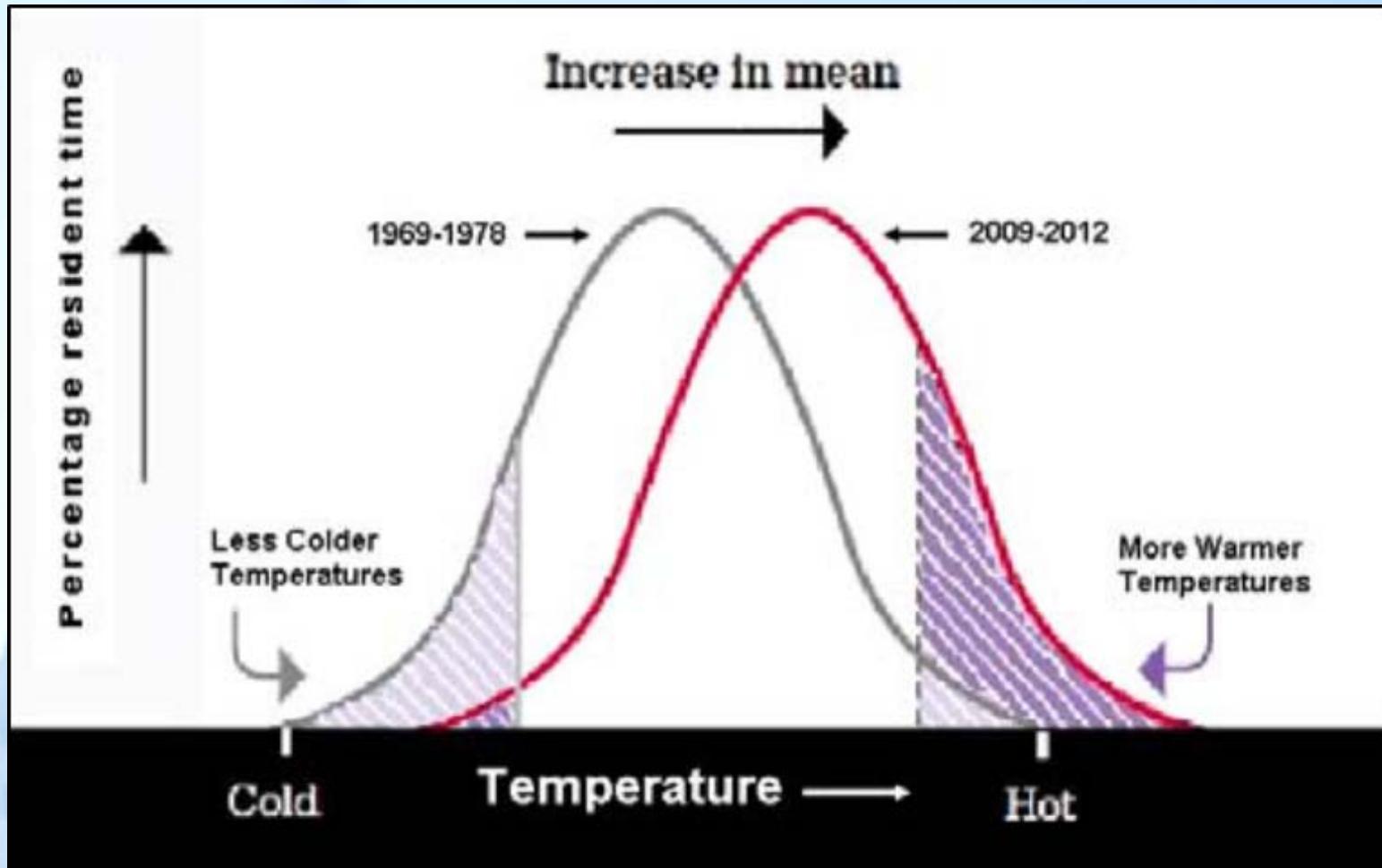


## Percentage frequency -- a standardizing tool

- ❖ आवृत्तियों को निवासी समय के लिए सभी महीनों के लिए प्रत्येक डिग्री के तापमान, जैसे जनवरी, दिसंबर, मौसमी और वार्षिक के संबंध में गणना की जाती है। The frequencies are calculated for resident time with respect to each degree of temperature for all months, viz., January to December, seasonal and annual.
- ❖ वार्षिक आवृत्तियों को अन्य दशकों के साथ तुलना करने के लिए एक मानकीकरण उपकरण के रूप में प्रतिशत आवृत्तियों में परिवर्तित कर दिया जाता है। यह विधि डेटा अंतराल के कारण होने वाली त्रुटियों को सुधार देगा, यदि कोई हो। डेटा टेबल पर निवासी समय का कंट्रूर विश्लेषण भी किया गया है The annual frequencies are converted to percentage frequencies as a standardizing tool for comparing with other decades. This method will rectify the cropping in of errors due to data gaps, if any. Contour analysis of resident time has also been performed on the data tables.
- ❖ निम्नतम न्यूनतम 19.0-19.9 की सीमा में है और अधिकतम अधिकतम 37.0-37.9 की सीमा में है। इसके बाद डेटा को दशक के अनुसार छांटा गया और निवासी समय की आवृत्तियों की गणना 19.0-19.9, 20.0-20.9, 21.0-21.9, ..., 37.0-37.9 के तापमान के संबंध में सभी महीनों के लिए क्रमशः, जनवरी से दिसंबर तक की जाती है और वार्षिक रूप से प्रतिशत आवृत्तियों में परिवर्तित हो जाती है। The lowest minimum is in the range of 19.0-19.9 and highest maximum is in the range of 37.0-37.9. Then sorted the data into decade-wise and frequencies of resident time are calculated with respect to the temperature ranges of 19.0-19.9, 20.0-20.9, 21.0-21.9, ..., 37.0-37.9 respectively for all the months, viz., January to December and also are converted to percentage frequencies.



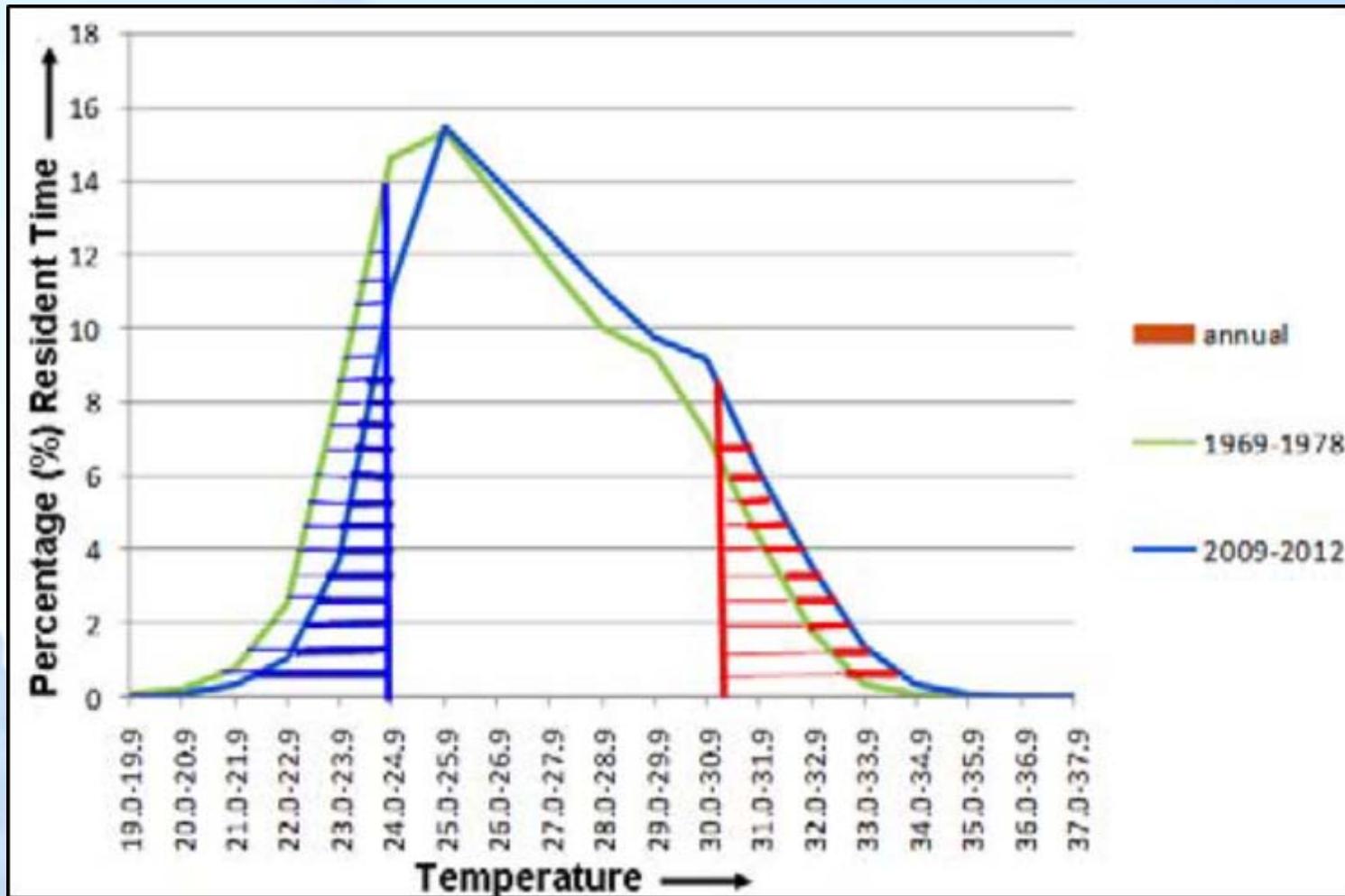
## Expected scenario for a station in view of warming of the climate system



The resident time of the lower and higher temperature regime which together constitute at least 20% of the resident time of the initial decade



## Percentage resident time of the temperature for Thiruvananthapuram



The shift in the frequency of resident time of lower and higher end of temperatures (i.e., up to 24 °C and above 31 °C), The resident time of lower temperatures are decreasing and higher temperatures are increasing and the trend



# Percentage frequency of resident time of temperature for Thiruvananthapuram during 1969-78

1969-1978	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
19.0-19.9	0.14	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.03
20.0-20.9	1.21	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.43	0.18
21.0-21.9	4.30	1.83	0.11	0.05	0.00	0.29	0.06	0.05	0.00	0.25	0.31	1.73	0.77
22.0-22.9	6.68	4.57	0.89	0.51	0.25	2.43	3.13	2.43	0.86	1.29	2.75	4.01	2.51
23.0-23.9	9.55	7.77	3.68	1.75	3.60	9.41	13.15	12.51	7.59	8.79	10.50	10.83	8.29
24.0-24.9	11.89	11.82	7.93	6.03	8.97	14.98	18.30	22.28	19.42	20.89	16.94	15.52	14.62
25.0-25.9	11.56	12.43	12.64	10.39	13.64	14.72	17.58	19.55	20.54	20.28	16.79	13.80	15.34
26.0-26.9	10.27	11.68	13.78	14.70	15.46	14.83	14.17	13.76	15.19	14.08	13.62	11.67	13.57
27.0-27.9	9.41	10.52	11.58	13.72	14.52	13.70	12.36	10.74	11.92	11.47	11.39	10.26	11.76
28.0-28.9	8.82	9.20	10.94	11.51	12.26	11.23	9.62	8.93	9.83	9.63	9.68	8.78	10.01
29.0-29.9	11.30	9.32	10.02	11.57	11.13	9.13	7.26	6.65	8.56	7.97	8.96	9.32	9.26
30.0-30.9	10.18	11.27	10.63	10.14	9.53	5.50	3.41	2.49	5.00	3.88	5.63	8.25	7.17
31.0-31.9	3.86	7.11	10.55	10.45	6.62	3.31	0.77	0.62	1.07	1.39	2.33	4.59	4.38
32.0-32.9	0.73	1.71	6.03	7.47	2.90	0.42	0.15	0.00	0.03	0.08	1.00	0.62	1.74
33.0-33.9	0.08	0.22	1.07	1.52	0.85	0.06	0.06	0.00	0.00	0.00	0.07	0.04	0.33
34.0-34.9	0.01	0.01	0.10	0.19	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
35.0-35.9	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36.0-36.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.0-37.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



# Percentage frequency of resident time of temperature for Thiruvananthapuram during 1979-88

1979-1988	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
19.0-19.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0-20.9	0.28	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.04
21.0-21.9	1.51	0.43	0.04	0.00	0.00	0.00	0.10	0.08	0.00	0.11	0.18	0.78	0.27
22.0-22.9	4.83	2.16	0.07	0.01	0.08	1.06	1.71	1.66	0.48	0.75	1.42	2.40	1.39
23.0-23.9	9.45	6.55	1.50	1.10	1.68	8.67	9.92	8.52	6.12	4.71	9.40	7.09	6.22
24.0-24.9	12.26	12.12	5.57	4.57	4.87	17.36	18.60	20.31	18.52	17.02	17.88	14.36	13.61
25.0-25.9	12.50	13.66	11.24	7.53	7.52	20.51	20.46	21.77	22.49	19.57	18.63	16.19	15.99
26.0-26.9	11.41	11.56	13.30	14.10	13.27	15.20	14.79	14.61	15.11	15.53	12.70	11.65	13.61
27.0-27.9	10.57	11.87	12.52	14.43	16.53	11.44	11.70	9.63	10.48	12.06	11.32	11.14	11.98
28.0-28.9	7.49	8.64	13.40	11.89	13.14	9.94	9.92	10.35	8.98	9.85	9.51	8.63	10.16
29.0-29.9	8.17	8.02	9.97	12.48	11.31	8.29	7.47	9.07	8.84	9.30	9.00	8.66	9.22
30.0-30.9	11.41	11.54	8.13	9.56	10.31	5.34	4.07	3.59	6.51	8.30	7.63	11.64	8.16
31.0-31.9	7.78	10.13	11.46	9.15	11.19	1.87	1.19	0.37	2.25	2.42	2.04	5.84	5.47
32.0-32.9	1.83	2.82	9.71	11.09	8.20	0.28	0.08	0.04	0.19	0.37	0.27	1.13	3.01
33.0-33.9	0.44	0.43	2.65	3.70	1.77	0.03	0.00	0.00	0.03	0.01	0.03	0.23	0.78
34.0-34.9	0.06	0.04	0.32	0.34	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08
35.0-35.9	0.01	0.01	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
36.0-36.9	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.0-37.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



## Percentage frequency of resident time of temperature for Thiruvananthapuram during 1989-98

1989-1998	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
19.0-19.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0-20.9	0.07	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.03
21.0-21.9	1.00	0.50	0.15	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.41	0.17
22.0-22.9	4.60	1.87	0.46	0.00	0.00	0.22	1.64	0.37	0.29	0.25	0.53	2.27	1.04
23.0-23.9	8.30	5.18	1.94	0.60	0.88	5.25	10.76	5.70	3.32	7.36	6.66	6.48	5.21
24.0-24.9	12.92	10.44	4.29	2.35	5.50	14.44	20.52	17.39	13.55	18.30	18.62	14.23	12.72
25.0-25.9	13.04	12.79	9.98	6.70	9.77	20.43	20.52	25.52	22.56	22.98	20.24	15.74	16.69
26.0-26.9	11.58	12.43	13.34	9.68	13.31	17.68	15.42	16.35	17.95	14.85	13.83	12.70	14.09
27.0-27.9	10.56	11.68	13.34	16.33	15.22	14.16	11.57	12.21	13.58	10.86	11.60	11.63	12.73
28.0-28.9	8.07	10.94	12.57	14.27	14.16	11.49	10.82	11.68	9.68	9.17	9.63	9.25	10.97
29.0-29.9	9.07	8.60	10.86	12.92	11.87	9.98	6.81	8.12	9.17	9.29	9.73	8.69	9.59
30.0-30.9	11.80	10.92	9.18	10.17	10.81	4.05	1.76	2.48	7.84	5.87	7.29	9.76	7.65
31.0-31.9	6.36	8.31	11.57	10.42	9.19	1.56	0.18	0.14	1.91	1.03	1.58	6.54	4.89
32.0-32.9	2.18	4.80	8.38	11.53	7.02	0.63	0.00	0.02	0.15	0.03	0.25	1.81	3.06
33.0-33.9	0.37	1.13	3.23	4.51	2.18	0.09	0.00	0.00	0.00	0.00	0.05	0.33	0.99
34.0-34.9	0.07	0.30	0.60	0.43	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.08	0.13
35.0-35.9	0.00	0.00	0.12	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
36.0-36.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.0-37.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



## Percentage frequency of resident time of temperature for Thiruvananthapuram during 1999-2008

1999-2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
19.0-19.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0-20.9	0.24	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.04
21.0-21.9	1.16	0.07	0.01	0.00	0.00	0.07	0.01	0.03	0.13	0.00	0.18	1.47	0.27
22.0-22.9	3.57	1.14	0.03	0.00	0.13	0.64	0.96	1.06	0.64	0.47	1.07	3.97	1.15
23.0-23.9	7.38	4.85	1.26	1.35	1.90	7.04	7.78	5.02	4.51	6.25	6.58	7.62	5.13
24.0-24.9	12.53	9.87	5.13	5.60	5.69	12.95	18.53	16.63	14.59	18.69	18.17	14.15	12.69
25.0-25.9	13.62	14.75	9.54	10.36	10.32	17.13	21.46	22.38	21.09	21.52	19.70	14.85	16.35
26.0-26.9	11.35	12.81	14.52	15.00	13.91	17.30	15.23	15.51	15.46	13.84	12.40	10.77	13.99
27.0-27.9	10.35	11.23	13.80	14.61	17.57	13.30	11.11	11.24	10.97	10.52	9.90	9.63	12.03
28.0-28.9	8.28	9.63	12.11	10.77	12.78	10.27	10.14	9.26	8.82	9.00	9.50	8.01	9.89
29.0-29.9	7.76	7.89	10.24	10.70	10.48	9.58	8.73	9.09	8.74	8.12	7.81	7.26	8.87
30.0-30.9	9.80	8.66	8.19	9.41	9.68	7.26	4.78	7.03	7.86	7.47	8.63	10.37	8.27
31.0-31.9	8.80	10.05	9.57	9.68	8.94	2.90	1.18	2.27	4.82	3.24	5.28	7.97	6.24
32.0-32.9	4.35	6.87	10.91	8.48	6.81	0.91	0.08	0.45	1.94	0.74	0.78	3.12	3.80
33.0-33.9	0.66	1.71	3.96	3.41	1.72	0.56	0.00	0.01	0.42	0.11	0.00	0.59	1.10
34.0-34.9	0.16	0.37	0.64	0.51	0.07	0.08	0.00	0.01	0.00	0.03	0.00	0.04	0.16
35.0-35.9	0.00	0.07	0.07	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
36.0-36.9	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.0-37.9	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



## Percentage frequency of resident time of temperature for Thiruvananthapuram during 2009-2012

2009-2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
19.0-19.9	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.02
20.0-20.9	0.86	0.11	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.09
21.0-21.9	2.48	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.34	0.32
22.0-22.9	4.82	2.63	0.37	0.03	0.00	0.24	0.67	0.34	0.21	0.54	1.32	1.41	1.04
23.0-23.9	8.40	6.05	1.58	0.10	0.30	2.68	6.05	2.59	2.61	2.39	6.49	5.54	3.72
24.0-24.9	13.40	8.60	4.44	2.96	1.88	12.58	15.36	16.83	10.65	13.05	18.89	14.38	11.09
25.0-25.9	11.71	11.69	8.54	8.07	7.39	17.41	20.90	22.92	22.58	19.86	16.49	18.31	15.51
26.0-26.9	10.09	12.09	13.96	12.00	12.60	15.77	16.57	14.92	18.62	16.18	13.51	12.67	14.09
27.0-27.9	9.37	9.90	12.34	15.76	18.35	15.32	13.24	13.00	11.80	11.63	10.63	10.32	12.65
28.0-28.9	8.61	10.18	11.34	13.47	15.52	11.54	9.95	10.48	11.03	10.05	10.03	10.38	11.05
29.0-29.9	7.44	8.71	10.73	11.86	13.07	10.88	9.27	10.11	9.81	8.63	8.33	8.67	9.80
30.0-30.9	11.29	8.20	8.95	12.00	12.77	9.66	6.38	7.73	8.66	7.96	6.74	9.81	9.18
31.0-31.9	8.20	10.80	9.22	8.73	9.98	2.88	1.51	1.04	3.65	6.07	6.22	6.18	6.19
32.0-32.9	2.69	7.81	10.90	8.98	4.70	0.80	0.10	0.03	0.31	3.30	0.90	1.78	3.51
33.0-33.9	0.48	2.16	5.45	4.73	2.55	0.24	0.00	0.00	0.07	0.34	0.03	0.10	1.34
34.0-34.9	0.03	0.36	1.78	1.08	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33
35.0-35.9	0.00	0.04	0.37	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
36.0-36.9	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
37.0-37.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00



## Percentage frequency of resident time of temperature of the head and tail regime

Decade	Mumbai		Thiruvananthapuram		Minicoy	
	< 23 °C	> 31 °C	< 24 °C	> 31 °C	< 25 °C	> 31 °C
1969-78	10.77	8.88	11.78	6.49	8.62	4.09
1979-88	9.05	10.57	7.92	9.35	4.06	6.65
1989-98	8.04	12.30	6.46	9.09	4.72	9.08
1999-08	7.76	12.08	6.58	11.32	3.78	10.65
2009-12	4.96	17.79	5.18	11.44	5.41	11.55

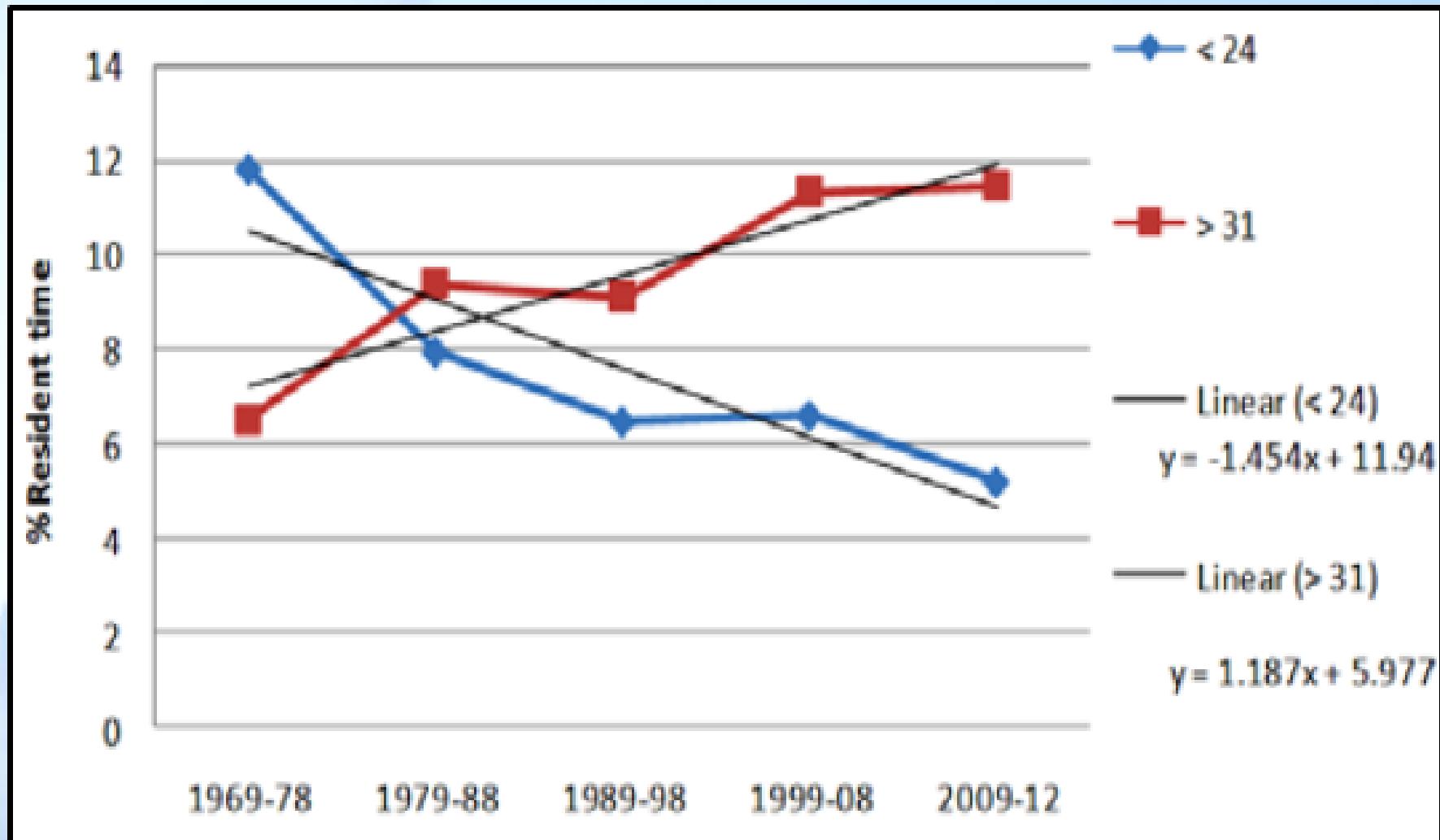


## Percentage frequency of resident time of temperature of head and tail regime during monsoon period

Decade	Mumbai		Thiruvananthapuram		Minicoy	
	< 26 °C	> 30 °C	< 24 °C	> 30 °C	< 26 °C	> 30 °C
1969-78	13.75	10.93	12.96	5.70	12.39	7.98
1979-88	12.40	16.04	9.63	6.41	9.56	11.60
1989-98	10.61	18.97	6.94	5.17	11.49	15.86
1999-08	11.62	14.63	7.00	10.63	9.78	18.73
2009-12	9.38	24.24	3.86	10.73	9.94	14.89



## Decadal linear trend (%) in percentage resident time of the temperature < 24 °C and ≥ 31 °C for Thiruvananthapuram



## दशकीय रैखिक प्रवृत्ति (%) प्रतिशत निवासी समय में तापमान का $<24$ डिग्री सेल्सियस और $\geq 31$ डिग्री सेल्सियस तिरुवनंतपुरम के लिए. Decadal linear trend (%) in percentage resident time of the temperature $< 24^{\circ}\text{C}$ and $\geq 31^{\circ}\text{C}$ for Thiruvananthapuram

- निचले तापमान का निवासी समय प्रति दशक में 1.454% की दर से घट रहा है और अगर समान रैखिक प्रवृत्ति अगले चार दशकों तक जारी है, तो 24 डिग्री सेल्सियस से नीचे के तापमान का उल्लेखनीय निवासी समय नहीं होगा The resident time of lower temperatures are decreasing at the rate of 1.454% per decade and if the same linear trend continues up to the next four decades, then there will not be significant resident time of temperatures below  $24^{\circ}\text{C}$ .
- हालांकि कम तापमान चरम सीमाओं को तोड़ सकता है या निवासी के कुछ प्रतिशत का तापमान 24 डिग्री सेल्सियस से नीचे के तापमान पर होगा, अगर उचित उपयुक्त परिस्थितियां पैदा हो जाए या अगर हम प्रवृत्ति में गैर-रैखिकता पर विचार करें। However lower temperature can break the extremes or some percentage of resident time would still be there for temperatures below  $24^{\circ}\text{C}$ , if suitable synoptic situations arise or if we consider non-linearity in the trend.



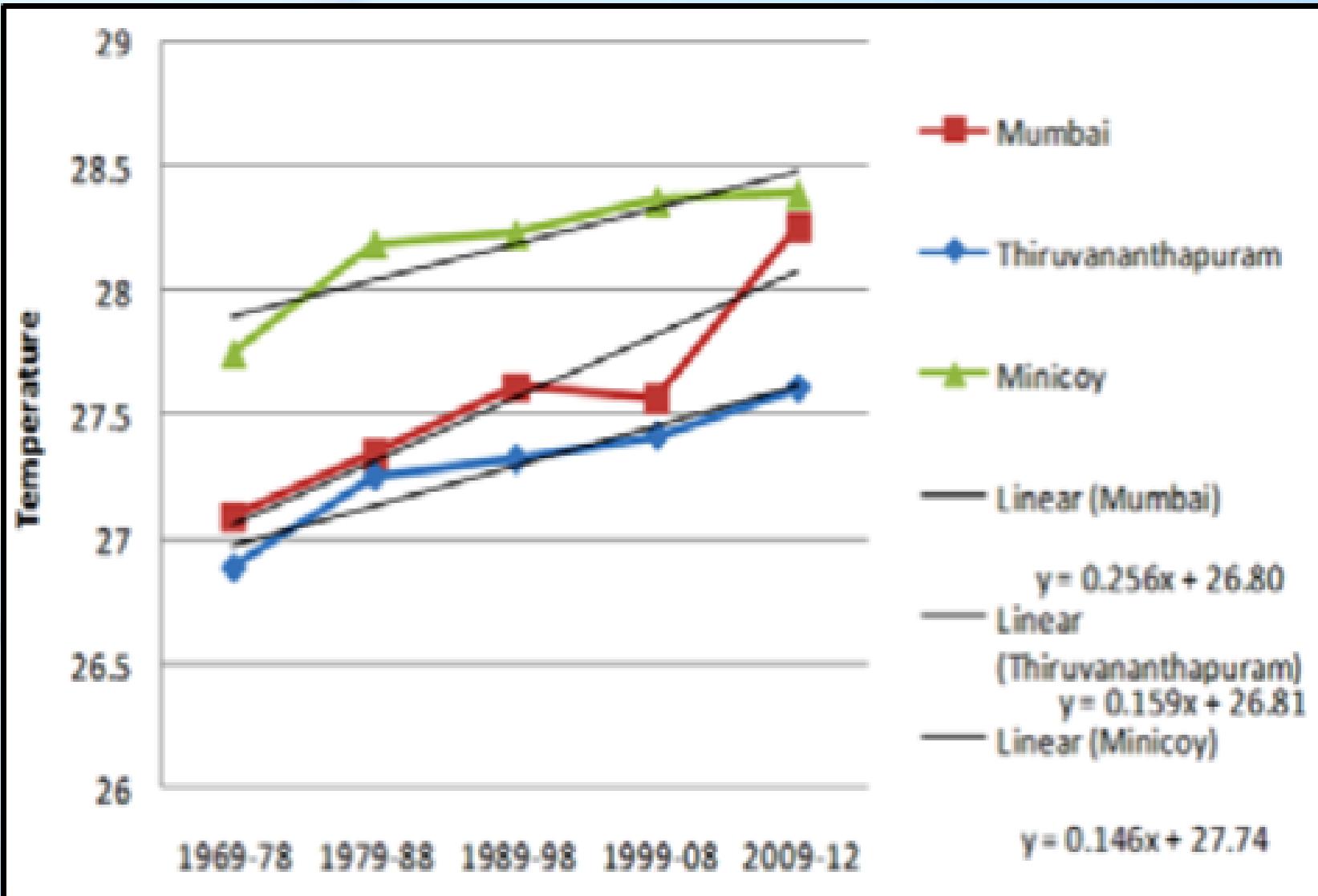
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INDIA METEOROLOGICAL DEPARTMENT



The resident time of higher temperatures are increasing at the rate of 1.187%

## Linear trend ( $^{\circ}\text{C}$ per decade) of decadal mean temperature for Thiruvananthapuram



## Characteristic equation for Thiruvananthapuram

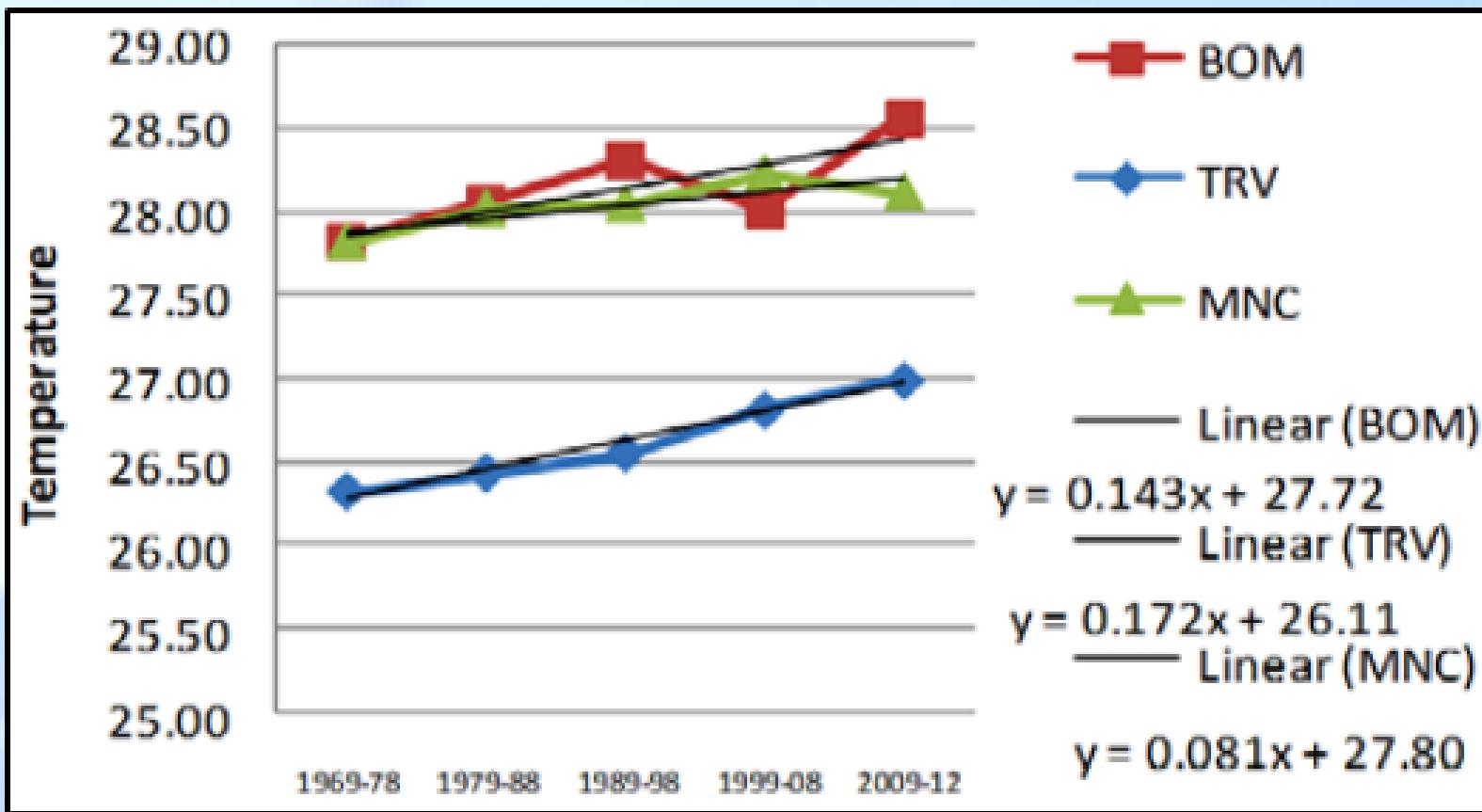
- ✓ The equation for Linear trend ( $^{\circ}\text{C}$  per decade) of decadal mean temperature (characteristic equation) for Thiruvananthapuram is

$$y = 0.159x + 26.81$$

- ✓ Projecting the next decadal mean temperature as  $27.76^{\circ}\text{C}$



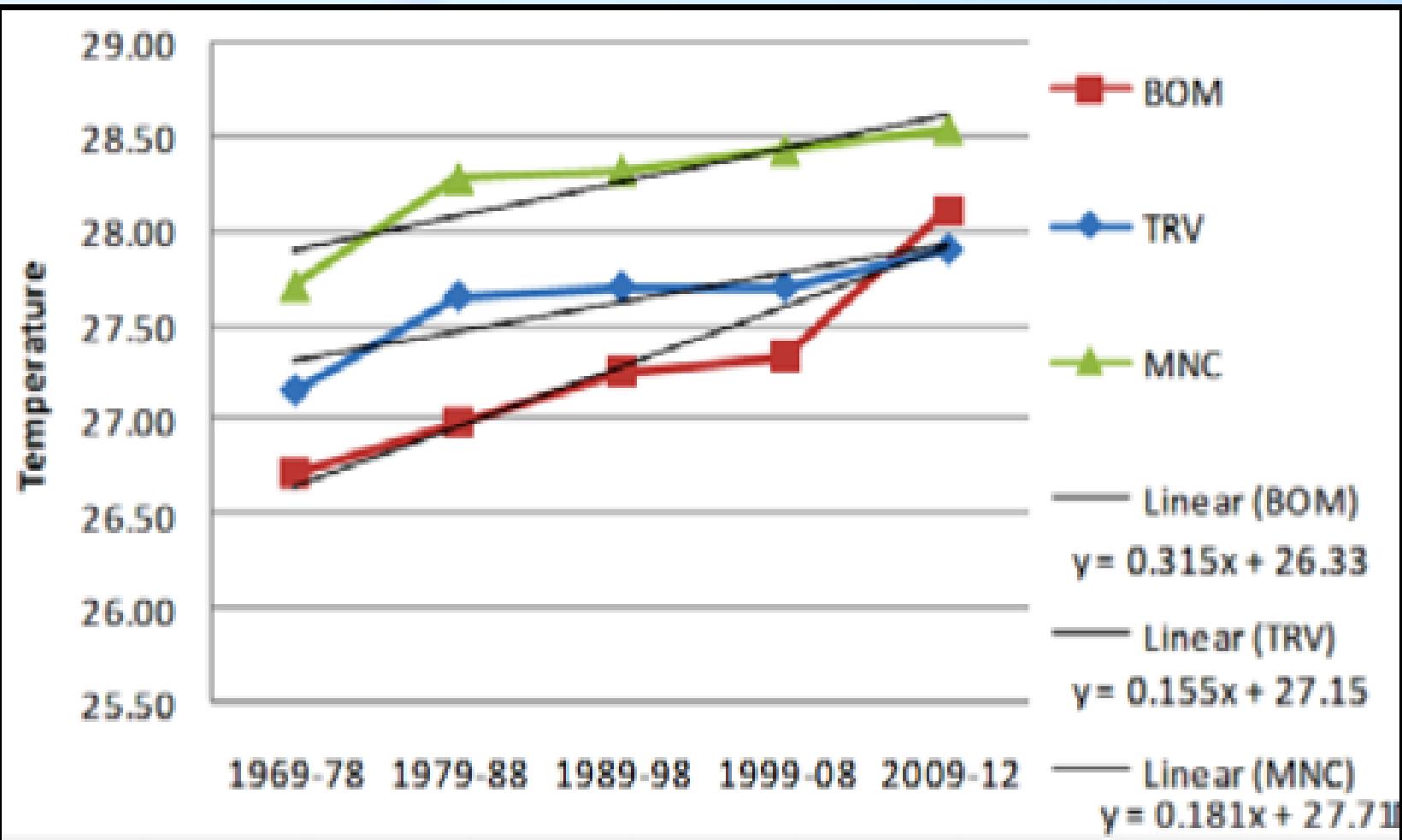
## Decadal linear trends ( $^{\circ}\text{C}$ per decade) in seasonal (monsoon) mean temperature for Thiruvananthapuram



Trend in mean temperature during monsoon period are increasing at  $0.172\text{ }^{\circ}\text{C}$  per decade



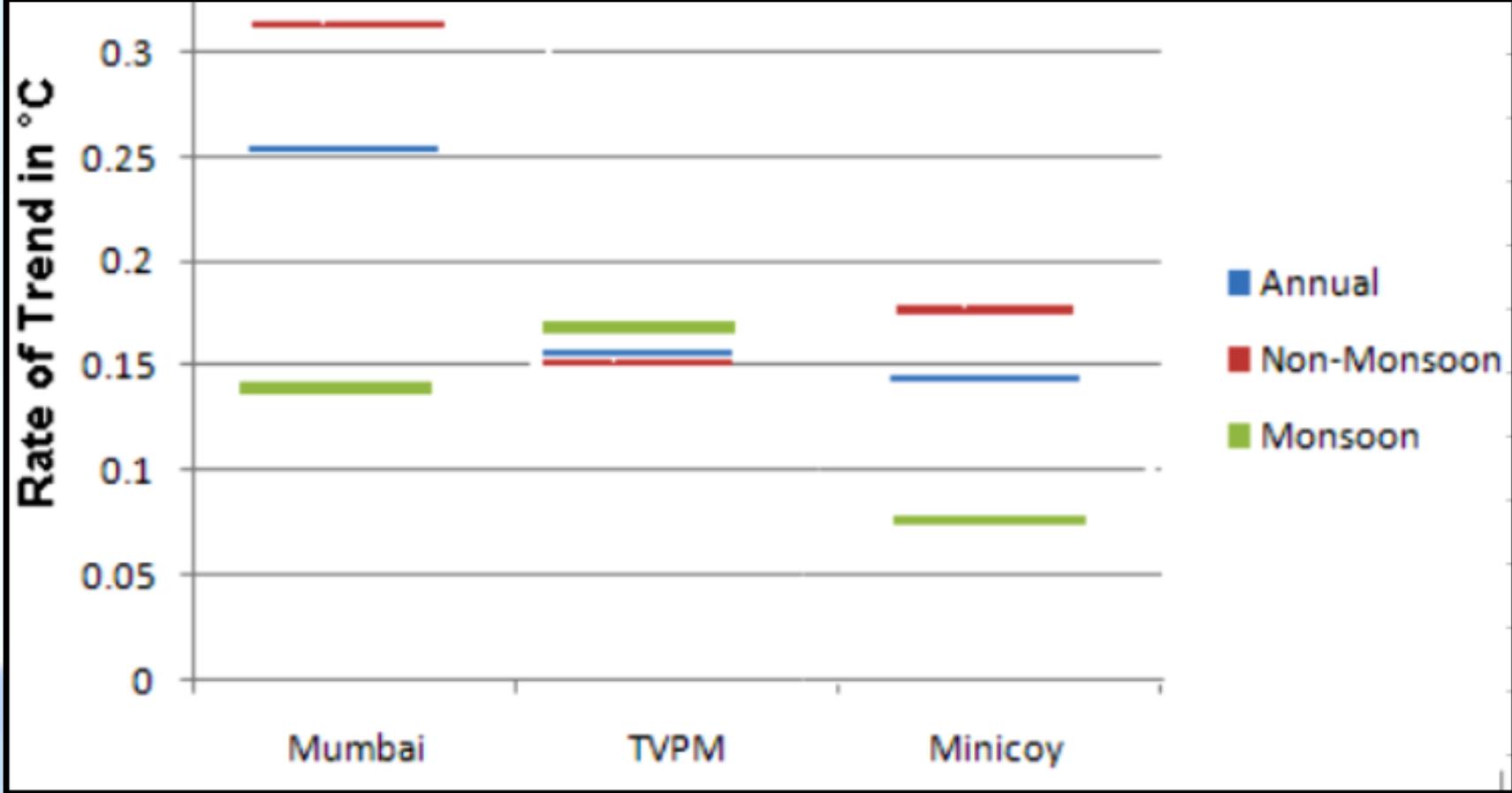
## Decadal linear trends (°C per decade) in non-monsoon season mean temperature for Thiruvananthapuram



Trend in mean temperature during non-monsoon period is increasing at 0.155 °C per decade



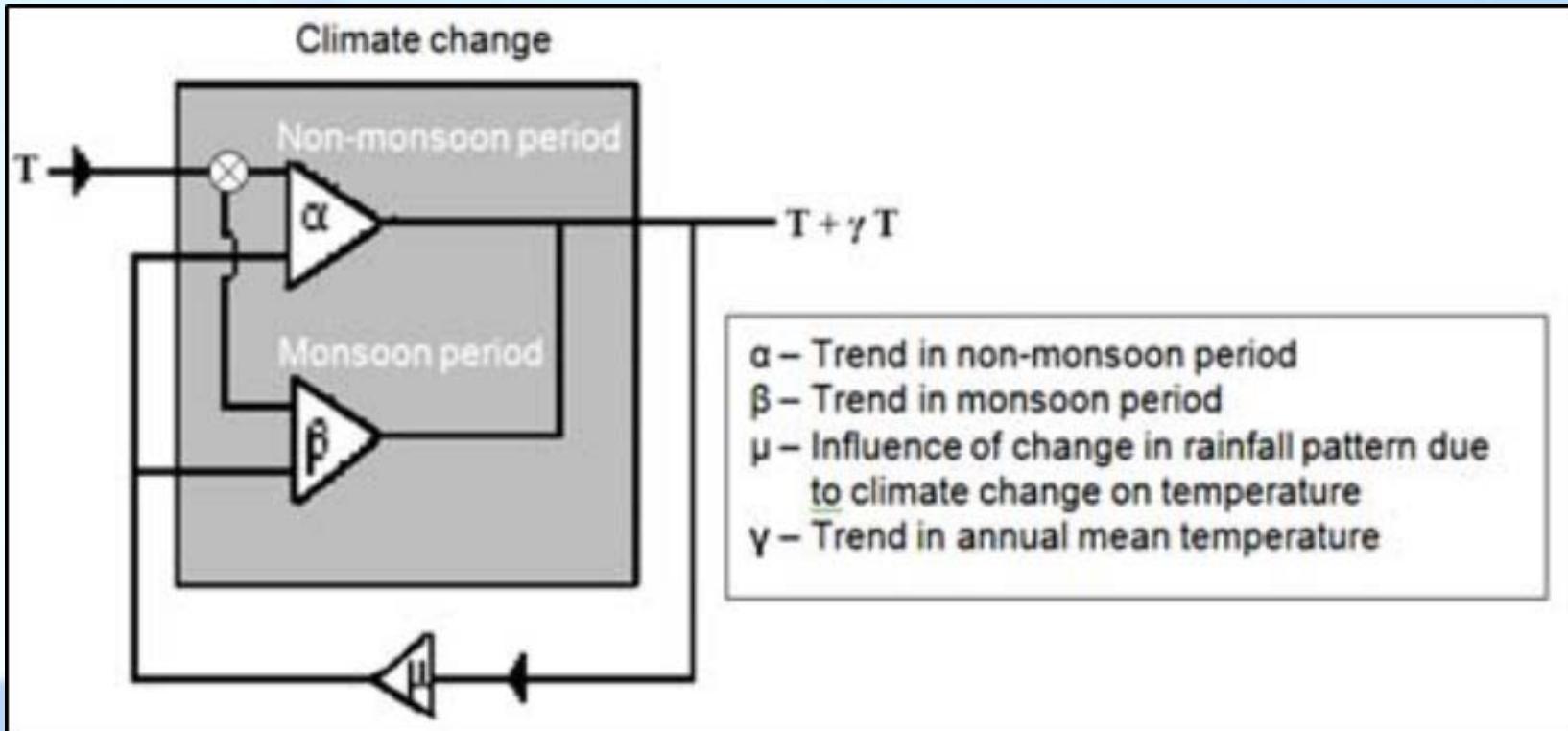
## Decadal rate of trend in temperature ( $^{\circ}\text{C}$ ) for Thiruvananthapuram for annual, non-monsoon and monsoon period



- The rate of increase of mean temperature for Thiruvananthapuram during monsoon seasonal for the study period is  $0.172\text{ }^{\circ}\text{C}$  per decade, is slightly higher than the decadal trend in annual mean  $0.159\text{ }^{\circ}\text{C}$  per decade.
- This small trend may be due to decreasing trend in the rainy days over Thiruvananthapuram.



# Embedded system of climate



- The trend in rainfall pattern due to climate change is in itself work like a feedback mechanism which controls the future trend in temperature and in effect the climate system as a whole.
- Any significant change in rainy days and its intensity due to climate change will certainly influence the future temperature pattern



# ROUTE MAP OF HEAT ISLAND STUDY



# Isotherm analysis of a heat island intensity in Thiruvananthapuram

25<sup>th</sup> July 2015

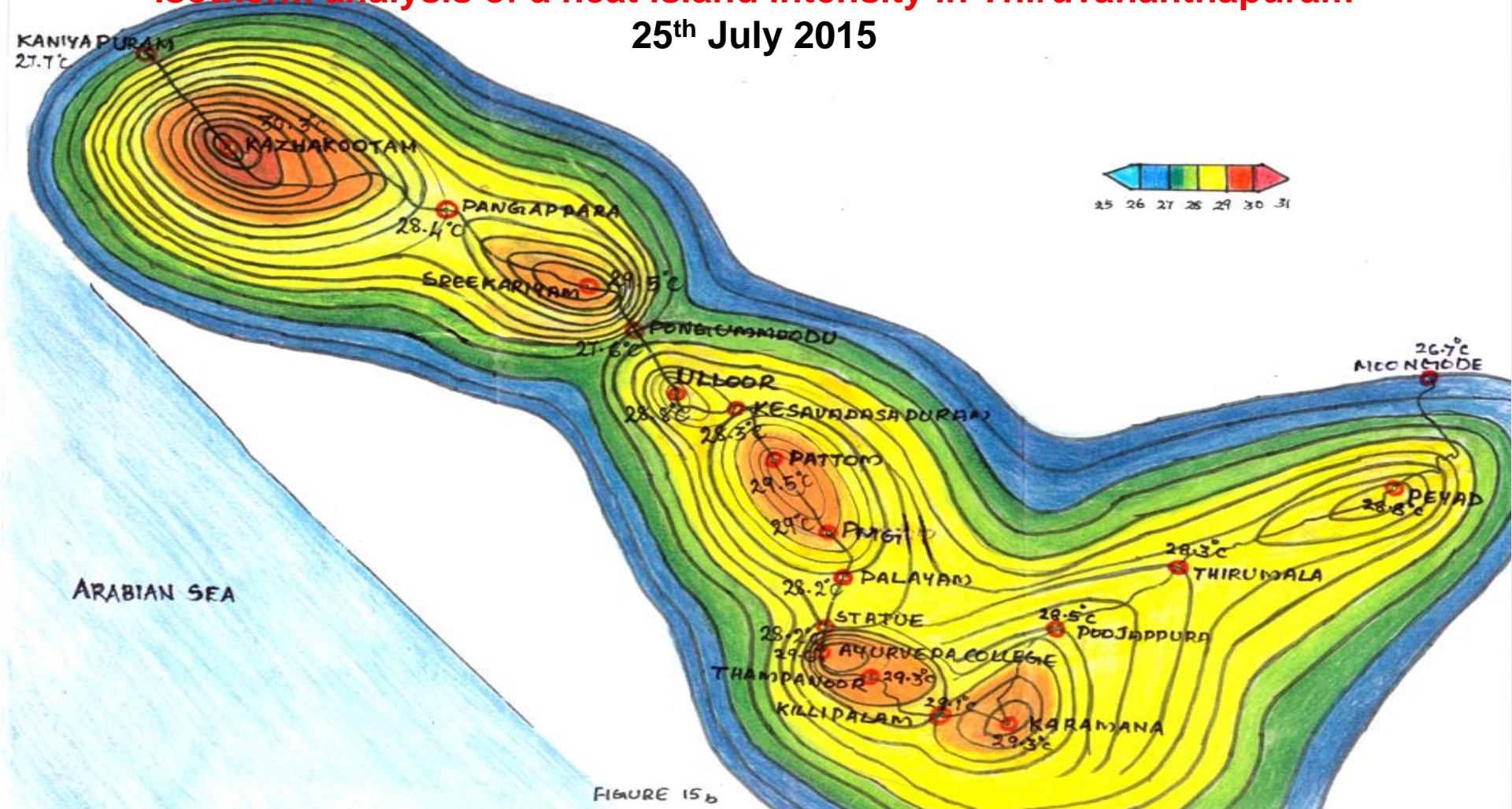


FIGURE 15b

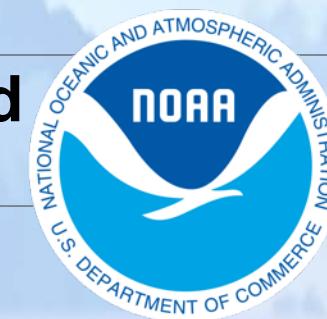
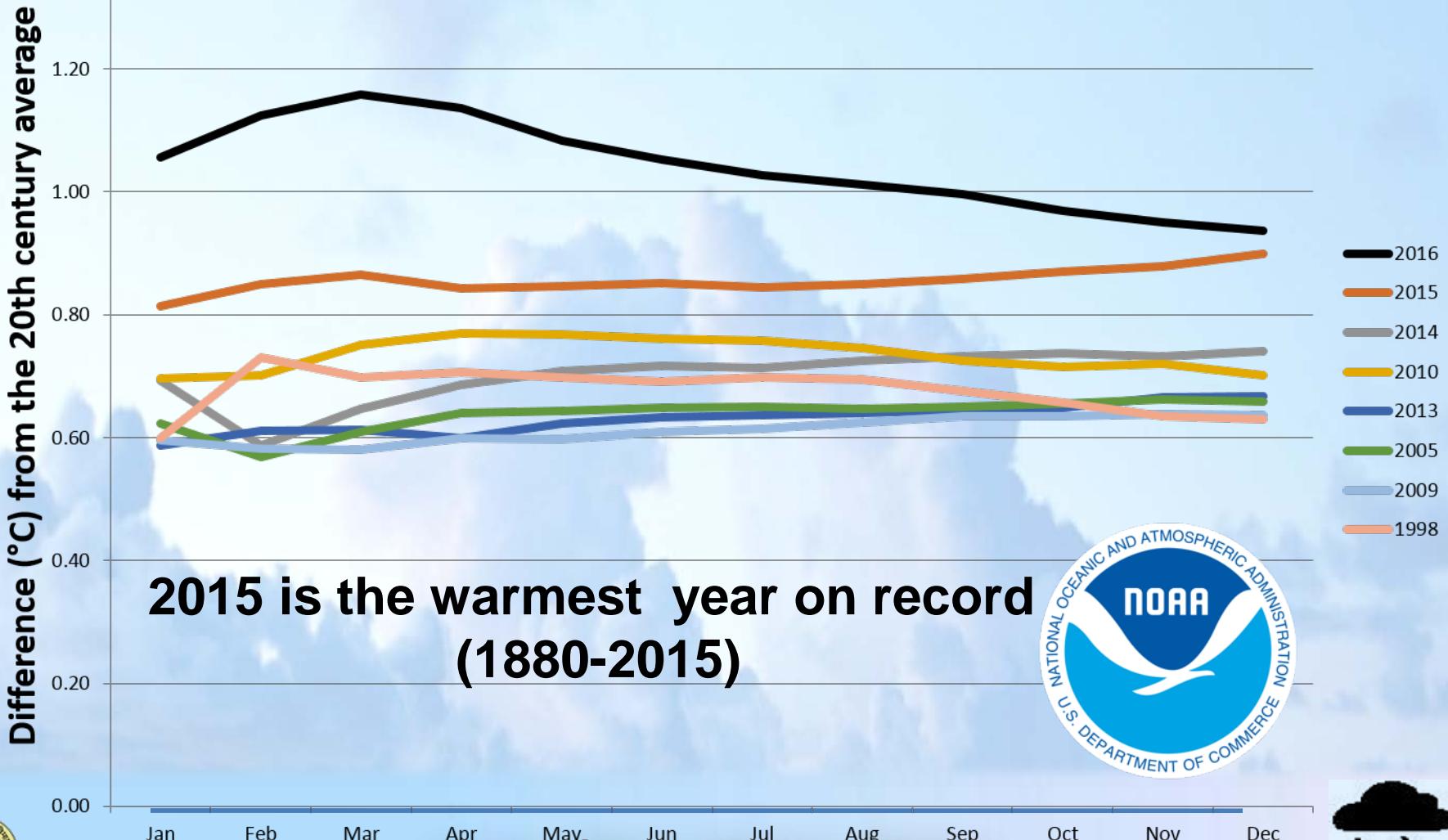
The urban heat islands are also a contributing factor for temperature change. Local governments can play crucial role in mitigating these effect by suitable urban planning (Eg. Switching over to underground cables for electricity distribution to make way for planting more trees in the foot path).



# Year-to-Date Global Temperatures

for 2016 and the other seven warmest years on record

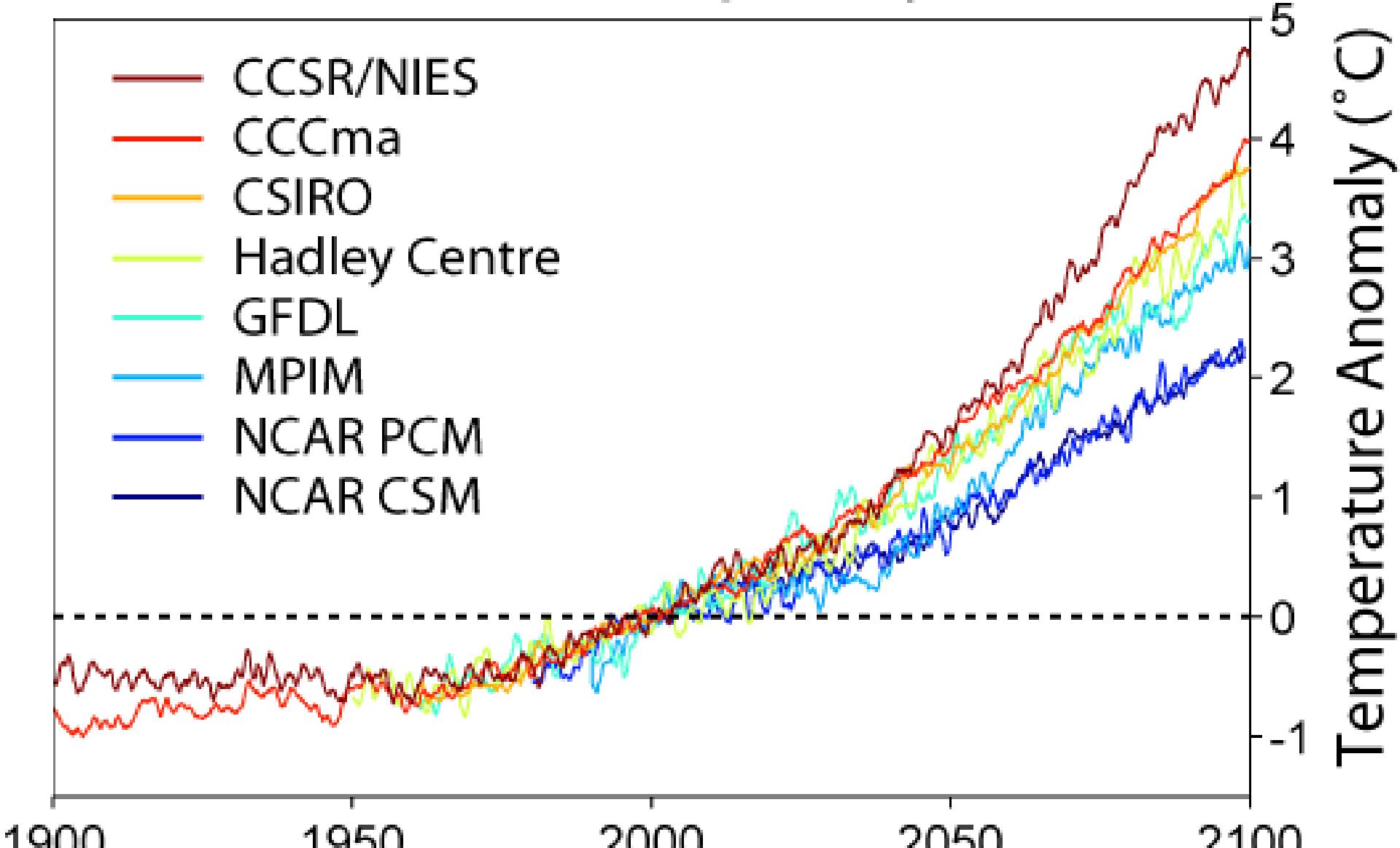
<https://www.ncdc.noaa.gov/sotc/global/2016/10/supplemental/page-2>



2015 is the warmest year on record  
(1880-2015)



# Global Warming Projections



# निष्कर्ष CONCLUSIONS

- 27.76 डिग्री सेल्सियस तापमान को अगले दशक के औसत वार्षिक तापमान के रूप में पेश करना  
Projecting the next decadal mean annual temperatures as 27.76 °C
- तिरुवनंतपुरम में निचला तापमान का निवासी समय प्रति दशक में 1.454% की दर से घट रहा है और अगर समान रैखिक प्रवृत्ति अगले चार दशकों तक जारी है, तो 24 डिग्री सेल्सियस से नीचे तापमान का महत्वपूर्ण निवासी समय नहीं होगा The resident time of lower temperatures in Thiruvananthapuram are decreasing at the rate of 1.454% per decade and if the same linear trend continues up to the next four decades, then there will not be significant resident time of temperatures below 24 °C.
- उच्च तापमान का निवासी समय प्रति दशक में 1.187% की दर से बढ़ रहा है और यदि समान परिवर्ष अगले अस्सी दशकों तक जारी है, तो तापमान 31 डिग्री सेल्सियस से ऊपर होगा The resident time of higher temperatures are increasing at the rate of 1.187% per decade and if the same scenario continues up to the next eighty decades, then the temperatures will be above 31 °C only.



- मानसून की अवधि में वर्षा गतिविधिया वार्षिक औसत तापमान में वृद्धि की प्रवृत्ति के लिए सुधार कारक हो रहा है The rainfall activity in monsoon period seems to be the correction factor for the increasing trend in the annual mean temperature.
- अध्ययन अवधि के लिए माँसून मौसमी समय के दौरान औसत तापमान में वृद्धि दर  $0.172$  डिग्री प्रति डिग्री है, जो दशकों के औसत  $0.159$  डिग्री सेल्सियस प्रति दशक की तुलना में थोड़ा अधिक है The rate of increase of mean temperature for Thiruvananthapuram during monsoon seasonal for the study period is  $0.172^{\circ}\text{C}$  per decade, is slightly higher than the decadal trend in annual mean  $0.159^{\circ}\text{C}$  per decade.
- यह छोटा-सा रुझान तिरुवनंतपुरम से बरसात के दिनों में गिरावट के कारण हो सकता है। This small trend may be due to decreasing trend in the rainy days over Thiruvananthapuram.



- हालांकि, निचले तापमान उनके चरम सीमाओं को तोड़ सकते हैं या निवासी के कुछ प्रतिशत अभी भी कम तापमान के लिए वहां होंगे, अगर उचित उपयुक्त परिस्थितियों उत्पन्न होती हैं या यदि हम प्रवृत्ति में गैर-रैखिकता पर विचार करते हैं। However, lower temperatures can break their extremes or some percentage of resident time would still be there for lower temperatures, if suitable synoptic situations arise or if we consider non-linearity in the trend.
- जलवायु परिवर्तन के कारण वर्षा पैटर्न में प्रवृत्ति ही भविष्य की जलवायु प्रणाली के लिए एक प्रतिक्रिया तंत्र है। The trend in rainfall pattern due to climate change itself is a feedback mechanism for the future climate system.
- शहरी गर्मी भी तापमान परिवर्तन के लिए एक महत्वपूर्ण कारक हैं, जो प्रभाव में वैश्विक जलवायु प्रणाली में योगदान करते हैं। The urban heat islands are also a contributing factor for temperature change, which in effect contribute to the global climate system.



- उपयुक्त शहरी नियोजन से इन प्रभावों को कम करने में स्थानीय सरकार महत्वपूर्ण भूमिका निभा सकते हैं (उदाहरण के लिए, फुट के रास्ते में अधिक वृक्ष लगाए जाने के लिए बिजली वितरण के लिए भूमिगत केबलों पर स्विच करना) | Local governments can play crucial role in mitigating these effect by suitable urban planning (Eg. Switching over to underground cables for electricity distribution to make way for planting more trees in the foot path).
- भारत मौसम विज्ञान विभाग, भारतीय शहरों पर सूक्ष्म स्तर पर एक परियोजना ले सकता है और जलवायु परिवर्तनशीलता पर विस्तृत अध्ययन कर सकता है | IMD can take a project on micro level and detailed study on climate variability over the Indian cities.



धन्यवाद

Thank  
You!



# THANKS

# THANKS

# Website of Meteorological Centre, Thiruvananthapuram [www.imdtvm.gov.in](http://www.imdtvm.gov.in)

FOR WEATHER INFORMATION OVER PHONE

TOLL FREE NUMBER 1800 180 1717  
Phone : 0471 2322894  
EPABX : 0471 2330025 / 0471 2322330  
TeleFax: 0471 2322894  
Email : [mc.trv@imd.gov.in](mailto:mc.trv@imd.gov.in)

[Forecast of the Onset Date of Southwest Monsoon - 2016 over Kerala](#) NEW  
[Today's Weather](#) NEW  
[Register for SMS based Cyclone Alert](#) NEW

**Weather Warning**

KERALA	HEAVY RAINFALL(EXCEEDING 7 CM) IS MOST LIKELY TO OCCUR AT ONE OR TWO PLACES IN KERALA TILL THE MORNING OF 21ST MAY 2016
LAKSHADWEEP	NIL

**FISHERMEN WARNING :** STRONG WINDS FROM NORTHWESTERLY DIRECTION SPEED OCCASIONALLY REACHING 45 TO 55 KMPH LIKELY ALONG AND OFF KERALA COAST AND OVER LAKSHADWEEP AREA DURING NEXT 24 HRS COMMENCING FROM 1400 HRS IST OF 20.05.2016.

**Meteorological Centre, Thiruvananthapuram**

METEOROLOGICAL CENTRE, Thiruvananthapuram caters to the meteorological requirements of Kerala state and Lakshadweep Islands by supervising and

[mc.trv@imd.gov.in](mailto:mc.trv@imd.gov.in) 0471-2322894

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