

Impact of Lockdown Measures during COVID-19 Pandemic on Water Vapors in Subtemperate and Subtropical Zones of Jammu Region, Jammu & Kashmir Union Territory, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MS and VV designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RS and CS managed the analyses of the study. Author SMD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To evaluate the effect of lockdown amid COVID 19 pandemic on water vapors in atmosphere under subtemperate and subtropical zones of Jammu region.

Methodology: To study the variation in atmospheric chemistry, the data was analyzed on fortnightly basis in order to assess the water vapor presence in the atmosphere during complete lockdown, i.e. from 24th March to 17th May 2020. The data of Temperature and Relative Humidity were recorded

from Agrometeorological Observatory situated at respective locations under study. The water vapor attributing parameters were calculated by adopting different formulae.

Results: The analysis of weather data was done by adopting different statistical techniques and it was found that ambient temperature was below normal with a deviation of -5.99% and -3.69% under subtropical and subtemperate zone. With the downshifting pattern observed in temperature, the density of air also decreased with deviation of -0.29% in subtropical zone and -0.46 % in subtemperate zone. The relative humidity, mixing ratio and dew point temperature under subtropical conditions were increased by 8.19, 1.03 and 1.61% respectively, while under subtemperate zone the parameters increased by 3.98, 4.51 and 10.3% respectively. The saturated mixing ratio, enthalpy and absolute humidity were deviated by -4.53%, -5.45 and -1.50% in subtropical zone and 5.94, 6.62 and 8.28 % in subtemperate zone.

Conclusion: Variable significant patterns were observed for each parameter and thus it can be concluded that lockdown had a plausible impact on all humidity or water vapor attributes.

Keywords: Temperature; density of air; dew point; relative humidity; absolute humidity; mixing ratio; saturated mixing ratio; enthalpy.

1. INTRODUCTION

Vulnerable ecosystems around the world have been facing continuous threat of being extinct due to the uncontrolled anthropogenic and anti-nature activities. Despite the rising emissions and above normal temperature and humidity values we have still not taken the nature warnings very seriously. These repeatedly unheard voices of nature led to the COVID 19 pandemic as an outburst towards our attitude and disrespect to mother earth. As an indirect outcome, we noticed mother earth healing on its own during lockdown as a clear answer to our carelessness towards our biological ecosystems. It's still not clear, how many times in future, we will be going to face such pandemics but one point is clear that despite such warning situations, we will never clarify our stand on our future emission policies making times tougher for survival. In Indian context, last 1-2 decades has witnessed an exponential growth in industrial sector, which has no doubt improvised the living standards of people but has also increased the fleet of vehicles on road causing huge emissions [1] and can be considered as a setback to emission control policies.

Water vapor is also considered as the most important greenhouse gas in atmosphere [2]. The heat reflected from earth's atmosphere is absorbed by water vapor molecules in lower atmosphere which in turn contributes toward warming. However increased water vapor content due to presence of more dry air is referred to as feedback process [3]. This water vapor feedback process is considered as the most important process and is responsible for doubling the global warming effect when

compared to the addition of carbon dioxide in its own [4].

COVID -19 first case in India was first reported in Kerala on January 30 and since then we have facing huge surge in cases number till the end of lockdown and was declared as Pandemic by World Health Organization (WHO) in mid-march 2020 [5]. The disease was first reported in Wuhan, China in December 2019 and since then spreading its presence in the entire world without any treatment yet. The control measures were opted to reduce the intensity of its spread with lockdown as most effective option in lowering infection numbers. On March 24, 2020; Honorable PM of India Sh. Narendra Modi declared a complete lockdown of 21 days in entire country during his live address to the nation, which was further extended for 19 days on April 14, 2020 in phase II followed by 14 days till 17th May in phase III. As an indirect positive effect on environment of the lockdown phases, we have observed significant change in water vapors level of atmosphere. The present study is therefore much more designated towards lockdown impact amid COVID 19 pandemic on levels of atmospheric water vapors and chemistry. The objectives of the study were:-

- To quantify the magnitude of variation of water vapor attributes from values observed at same altitude range in 2019.
- To compare the water vapors level change in atmosphere between lockdown in subtemperate and subtropical zones of Jammu region
- To evaluate correlation among water vapors during complete lockdown in year

2020 for subtemperate and subtropical zones of Jammu region

The study is thought to be a plausible addition to the scientific community for framing future policies with the public involvement related to climate change for the area.

2. MATERIALS AND METHODS

The subtemperate zone was represented by Rajouri and Udhampur districts and falls between 33.3716° N, 74.3152° E to 32.9160° N, 75.1416° E, altitude 814 -915 m amsl. The subtropical zone was represented by Jammu, Samba and Kathua districts and falls between 32.7266° N, 74.8570° E to 32.3863° N, 75.5173° E, altitude 327-393 m amsl. To analyze the variation, the data was analyzed on fortnightly basis from beginning to end of complete lockdown, i.e. from 24th March to 17th May 2020. The data of Temperature and Relative Humidity were recorded from Agrometeorological Observatories situated at respective locations under study. *Jammu, Kathua, Samba are the subtropical districts and Udhampur, Rajouri are classified as subtemperate districts of Jammu Province.* In description of results, deviation percentages was calculated by analyzing the frequency of variation from mean values and have been written in symmetrical pattern highlighting Jammu, Kathua, Samba values for subtropical and Rajouri, Udhampur value for subtemperate region. The weather data between 814-915m amsl of year 2019 of Jammu Division was used for comparison with subtemperate districts and weather data of year 2019 between 327-393m amsl of Jammu Division was used for comparison with subtropical districts. The ambient pressure was calculated using pressure calculator by www.mide.com/air-pressure-at-altitude-calculator and values obtained were 0.96 atm for subtropical zone and 0.94 atm for subtemperate zone.

The Mixing ratio (W) was calculated, using formula:

$$W, \text{ g kg}^{-1} = 621.97 \times P_w / (P - P_w)$$

Where P_w is water vapor pressure, P is ambient pressure [6].

The Saturated mixing ratio (W_s) was calculated, using formula:

$$W_s, \text{ g kg}^{-1} = 621.97 \times P_{ws} / (P - P_{ws})$$

Where P is ambient pressure, P_{ws} is saturated water vapor pressure [6].

The Enthalpy (h) was calculated, using formula:

$$h, \text{ kJ kg}^{-1} = T \times (1.01 + 0.00189 \times W) + 2.5 \times W$$

Where T is ambient temperature in °C, W is mixing ratio (mass of water vapor / mass of dry air) in g/kg [7].

The Dew Point (T_d) was calculated, using formula:

$$T_d, \text{ }^\circ\text{C} = (B_1 \times (\ln(\text{RH} / 100) + A_1 \times T / (B_1 + T)) / (a_1 - (\ln(\text{RH} / 100) - A_1 \times T / (B_1 + T)))$$

Where T is the ambient temperature in °Celsius, RH is relative humidity (%), $A_1 = 17.625$, $B_1 = 243.04^\circ\text{C}$ [8].

The Pressure of Dry Air (P_d) was calculated, using formula:

$$P_d = P - P_w$$

Where P is the entered ambient pressure and P_w is the water vapor pressure.

The Density of Air (ρ) was calculated, using formula:

Calculation makes use of the ideal gas law: $PV = nRT$, where P , V and T is the pressure, volume and temperature respectively; n is the amount of substance, and R is the ideal gas constant. *Note*, that n/V is the density (ρ), then the ideal gas law can be re-written as follows: $P = \rho RT$, and the formula for density is simply this: $\rho = P/RT$.

The pressure of wet air is the sum of the pressure of dry air (P_d) and the water vapor pressure (P_w):

$$\rho = P_d / (R_d \times T) + P_w / (R_w \times T)$$

Where the specific gas constant for dry air, $R_d = 287.058$ and the specific gas constant for water vapor, $R_w = 461.495$ [9].

The Absolute Humidity (AH) was calculated, using formula:

$$\text{AH}, \text{ kg m}^{-3} = P_w / (R_w \times T)$$

Where, P_w is the water vapor pressure, T is ambient temperature in Kelvin, R_w is specific

gas constant for water vapor and it is equal to 461.5. This formula is derived from *Ideal gas law*, and adapted for water vapor.

In order to have a representation of entire population and to describe the basic features of data in study, Descriptive statistics method was opted to find the Highest, Lowest, Mean, Standard Error, Standard Deviation, Coefficient of Variation, Kurtosis and Skewness values and was run in MS-Excel 2010 along with Pearson Correlation in SPSS 16.0 to find out the significant values and impact of one parameter over another. Deviation percentage among mean values of lockdown vs. 2019 was calculated for each parameter.

3. RESULTS AND DISCUSSION

3.1 Ambient Temperature (AT) (°C)

Fortnightly analysis related to change in temperature values and descriptive coefficients are depicted in Table 1. The fortnightly analysis showed a significant impact of lockdown on ambient temperature in both subtropical and subtemperate zones (Fig. 1). The deviation percentage compared to mean values of lockdown vs. year 2019 was -10.86 %, -12.03 %, -10.77 % for Jammu, Kathua, Samba subtropical districts and -11.24 %, 0.86 % for Rajouri and Udhampur subtemperate districts. However, Udhampur district in first fortnight remained near last year values but didn't show any decreasing pattern. During 2nd fortnight, deviation percentage observed was -2.11 %, -5.62 %, -3.17 % for subtropical districts and -3.90 %, -10.0 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in temperature values highlighting change of -4.70 %, -6.94 %, -5.27 % in subtropical districts and -0.97 %, -11.27 % for subtemperate districts. In 4th fortnight of lockdown, the change observed was -3.88 %, -3.40 %, -3.24 % for subtropical districts and 5.5%, -12.4 % for subtemperate zones. Rajouri has shown an increasing trend of ambient temperature in last phase of complete lockdown, however can be *attributed* to heavy Defence movement as area lies closer to International Border between India and Pakistan.

Cumulative analysis highlighted significant deviation of -5.99 % in subtropical zone and -3.69 % in subtemperate zone of Jammu province. The significant reduction in both the

agro-ecological zones can be attributed to reduction in anthropogenic activities amid lockdown [10]. In addition to above, changes in the economic output, decreased energy consumption, reduced emissions from land usage, livestock, septic processes and application of synthetic fertilizers due to lockdown might have resulted in lower atmospheric temperature than 2019; thus lowering risk of threat to our environment [11,12]. Also, the concentration of pollutants such as NO₂, SO₂, CO, Particulate Matter is considered as dominant reason of increase in air temperature [13] but lack of anthropogenic activities might have resulted in lesser emissions resulting in lower temperature values. In another study [14], there was also depiction of a positive correlation between air quality parameters and weather parameters. [15, 12] have already reported that the high accumulation of greenhouse gases may lead to surging temperatures and may also affect other climatic components like fog, dew, precipitation etc. [13] have also reported reduction in temperature values by 3-5 °c as compared to pre-lockdown period in middle catchment of Dwarka river basin of Eastern India due to reduction in industry and vehicular movement induced energy footprints.

3.2 Relative Humidity (RH) (%)

Relative Humidity values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 2. The fortnight analysis showed a significant impact of lockdown on relative humidity in both subtropical and subtemperate zones (Fig. 2). The deviation percentage compared to mean values of lockdown vs. year 2019 was 5.7 %, -2.20 %, -0.05 % for Jammu, Kathua, Samba subtropical districts and 28.20 %, 17.53 % for Rajouri and Udhampur subtemperate districts. However, Kathua and Samba districts in first fortnight depicted less water content in air. During 2nd fortnight, deviation percentage observed was -4.50 %, -18.00 %, -20.90 % for subtropical districts and 9.40 %, -6.30 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 49.1 %, 35.4 %, 29.40 % in subtropical districts and 7.24 %, -8.92 % for subtemperate districts. In 4th fortnight of lockdown, the change observed was 18.35 %, 5.52 %, 0.56 % for subtropical districts and -0.74 %, -14.5 % for subtemperate zones.

Table 1. Descriptive coefficients of Ambient Temperature (°C) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	18.20	17.30	17.80	17.30	16.93	17.30	12.80	14.30	14.30	14.30
	Highest	22.10	26.20	22.10	26.20	22.48	26.20	19.20	21.40	21.40	21.50
	Mean	19.93	22.36	19.67	22.36	19.95	22.36	16.65	18.76	18.76	18.60
	S.E	0.26	0.66	0.33	0.66	0.44	0.66	0.46	0.59	0.59	0.55
	S.D	1.01	2.54	1.28	2.54	1.71	2.54	1.79	2.29	2.29	2.14
	C.V	0.05	0.11	0.07	0.11	0.09	0.11	0.11	0.12	0.12	0.11
	Kurtosis	0.24	-0.21	-0.77	-0.21	-0.69	-0.21	-0.04	-0.53	-0.53	0.01
	Skewness	0.43	-0.38	0.17	-0.38	-0.41	-0.38	-0.62	-0.90	-0.90	-0.85
2nd Fortnight Analysis	Lowest	20.90	19.10	17.10	19.10	20.55	19.10	17.60	14.30	14.30	17.90
	Highest	28.75	27.50	28.40	27.50	29.10	27.50	20.70	22.40	22.40	26.95
	Mean	24.27	24.78	23.39	24.78	24.01	24.78	19.19	19.97	19.97	22.19
	S.E	0.50	0.56	0.75	0.56	0.62	0.56	0.28	0.54	0.54	0.69
	S.D	1.94	2.18	2.89	2.18	2.40	2.18	1.09	2.11	2.11	2.68
	C.V	0.08	0.09	0.12	0.09	0.10	0.09	0.06	0.11	0.11	0.12
	Kurtosis	1.42	2.15	0.27	2.15	-0.19	2.15	-1.43	2.91	2.91	-0.81
	Skewness	0.67	-1.36	-0.53	-1.36	0.26	-1.36	0.19	-1.55	-1.55	0.04
3rd Fortnight Analysis	Lowest	24.70	26.55	22.20	26.55	24.23	26.55	18.90	19.30	19.30	21.75
	Highest	28.60	28.50	29.50	28.50	29.93	28.50	24.10	22.70	22.70	27.60
	Mean	26.19	27.51	25.60	27.51	26.06	27.51	21.27	21.48	21.48	24.21
	S.E	0.35	0.14	0.46	0.14	0.39	0.14	0.34	0.28	0.28	0.41
	S.D	1.34	0.54	1.78	0.54	1.52	0.54	1.30	1.07	1.07	1.60
	C.V	0.05	0.02	0.07	0.02	0.06	0.02	0.06	0.05	0.05	0.07
	Kurtosis	-0.45	-0.56	0.81	-0.56	1.60	-0.56	0.72	-0.52	-0.52	0.09
	Skewness	0.89	-0.02	0.39	-0.02	1.12	-0.02	0.66	-0.72	-0.72	0.70
4th Fortnight Analysis	Lowest	24.10	26.10	22.90	26.10	22.28	26.10	19.70	19.90	19.90	19.90
	Highest	29.80	30.90	29.90	30.90	29.45	30.90	24.95	24.10	24.10	26.95
	Mean	27.21	28.31	27.32	28.31	27.39	28.31	23.20	21.98	21.98	25.10
	S.E	0.47	0.53	0.70	0.53	0.67	0.53	0.49	0.50	0.50	0.62
	S.D	1.49	1.68	2.23	1.68	2.12	1.68	1.54	1.57	1.57	1.96
	C.V	0.05	0.06	0.08	0.06	0.08	0.06	0.07	0.07	0.07	0.08
	Kurtosis	1.97	-1.29	0.00	-1.29	3.44	-1.29	2.34	-1.66	-1.66	6.72
	Skewness	-0.56	0.20	-0.80	0.20	-1.71	0.20	-1.25	-0.19	-0.19	-2.42

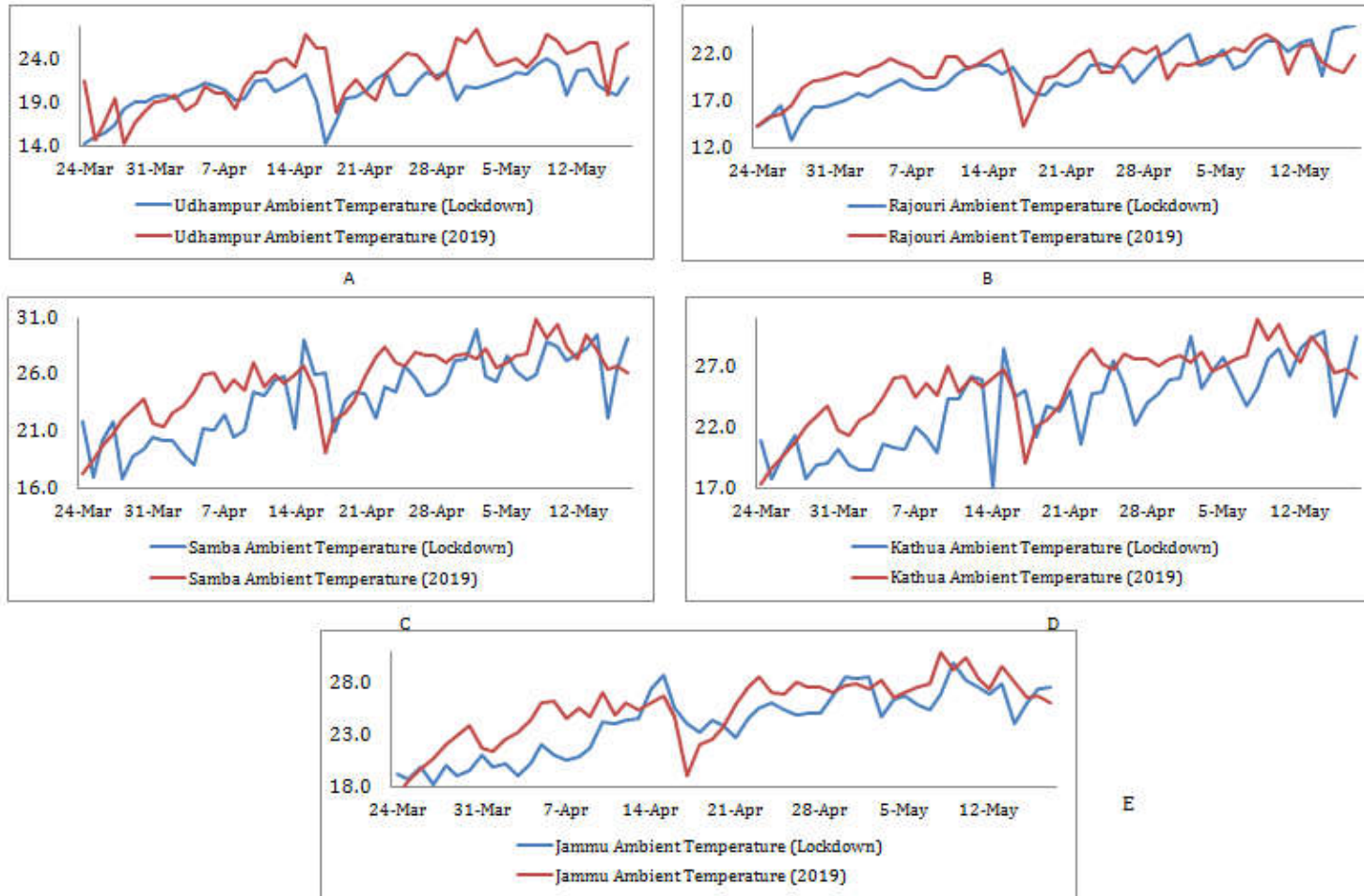


Fig. 1. Effect of complete lockdown on ambient temperature ($^{\circ}\text{C}$) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 2. Descriptive coefficients of Relative Humidity (%) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	52.00	46.50	44.00	46.50	43.13	46.50	64.00	50.00	35.50	50.00
	Highest	94.00	78.00	96.00	78.00	96.50	78.00	78.00	61.00	91.50	61.00
	Mean	68.10	64.43	63.00	64.43	61.05	64.43	70.53	55.00	64.53	55.00
	S.E	3.05	1.80	3.92	1.80	4.09	1.80	1.03	0.74	4.16	0.74
	S.D	11.80	6.97	15.20	6.97	15.85	6.97	4.01	2.88	16.10	2.88
	C.V	0.17	0.11	0.24	0.11	0.26	0.11	0.06	0.05	0.25	0.05
	Kurtosis	0.35	2.92	0.60	2.92	0.80	2.92	-0.48	0.50	-0.21	0.50
	Skewness	0.82	-0.86	1.09	-0.86	1.14	-0.86	0.27	-0.05	-0.08	-0.05
2nd Fortnight Analysis	Lowest	43.00	48.50	39.00	48.50	37.63	48.50	62.50	55.50	45.50	55.50
	Highest	75.00	92.00	68.00	92.00	70.75	92.00	76.50	90.00	83.00	90.00
	Mean	56.93	59.63	48.90	59.63	47.18	59.63	68.73	62.83	58.90	62.83
	S.E	2.17	2.79	2.16	2.79	2.32	2.79	1.20	2.25	2.36	2.25
	S.D	8.41	10.79	8.37	10.79	8.98	10.79	4.66	8.73	9.13	8.73
	C.V	0.15	0.18	0.17	0.18	0.19	0.18	0.07	0.14	0.16	0.14
	Kurtosis	0.33	5.49	0.38	5.49	2.10	5.49	-1.26	6.80	2.64	6.80
	Skewness	0.62	2.10	1.03	2.10	1.39	2.10	0.28	2.45	1.29	2.45
3rd Fortnight Analysis	Lowest	42.00	27.00	33.50	27.00	33.13	27.00	57.50	53.50	41.00	53.50
	Highest	68.00	52.50	66.50	52.50	62.88	52.50	75.00	81.50	71.00	81.50
	Mean	51.93	34.83	47.13	34.83	45.08	34.83	64.53	60.17	54.80	60.17
	S.E	2.11	2.12	2.76	2.12	2.53	2.12	1.47	1.77	2.09	1.77
	S.D	8.17	8.22	10.69	8.22	9.81	8.22	5.68	6.84	8.09	6.84
	C.V	0.16	0.24	0.23	0.24	0.22	0.24	0.09	0.11	0.15	0.11
	Kurtosis	-0.57	0.31	-0.84	0.31	-1.17	0.31	-0.55	6.88	-0.14	6.88
	Skewness	0.79	1.11	0.51	1.11	0.40	1.11	0.66	2.32	0.08	2.32
4th Fortnight Analysis	Lowest	41.00	29.50	32.00	29.50	29.50	29.50	53.00	52.00	38.50	52.00
	Highest	68.00	58.00	61.00	58.00	61.25	58.00	70.50	66.00	67.00	66.00
	Mean	50.30	42.50	44.85	42.50	42.74	42.50	59.65	60.10	51.30	60.10
	S.E	2.54	3.09	2.66	3.09	2.85	3.09	1.46	1.31	3.21	1.31
	S.D	8.02	9.77	8.41	9.77	9.02	9.77	4.62	4.14	10.15	4.14
	C.V	0.16	0.23	0.19	0.23	0.21	0.23	0.08	0.07	0.20	0.07
	Kurtosis	1.73	-1.07	0.30	-1.07	0.88	-1.07	3.38	0.35	-1.34	0.35
	Skewness	1.31	0.22	0.56	0.22	0.76	0.22	1.28	-0.47	0.29	-0.47

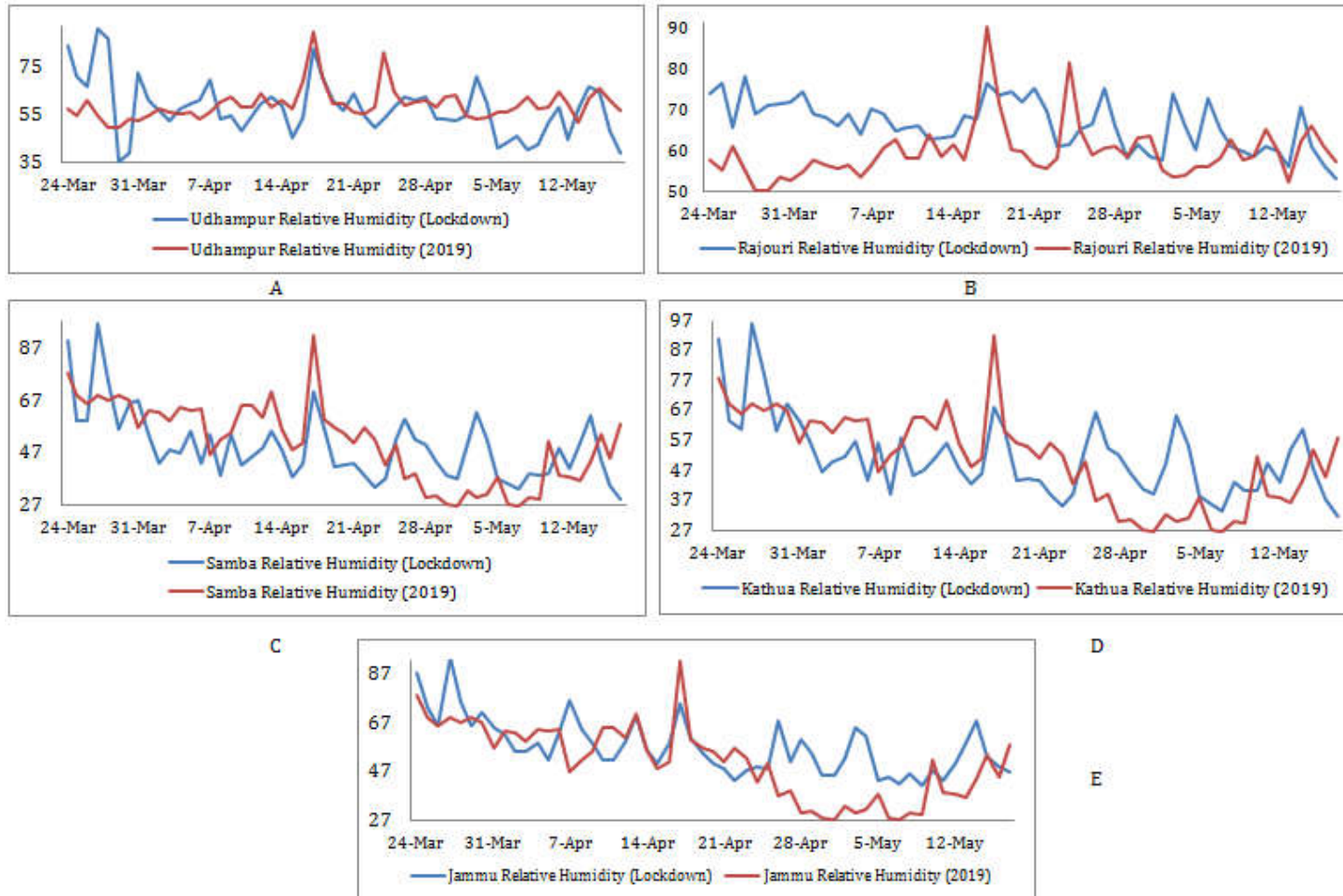


Fig. 2. Effect of complete lockdown on Relative Humidity (%) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 3. Descriptive coefficients of Mixing Ratio (g kg⁻¹) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	8.02	9.39	6.83	9.39	6.73	9.39	7.97	3.34	4.65	3.34
	Highest	12.83	14.25	17.05	14.25	17.70	14.25	10.34	9.98	15.15	9.98
	Mean	10.30	11.47	10.08	11.47	9.95	11.47	9.26	8.07	9.66	8.07
	S.E	0.38	0.42	0.74	0.42	0.83	0.42	0.20	0.43	0.72	0.43
	S.D	1.47	1.64	2.87	1.64	3.21	1.64	0.76	1.67	2.81	1.67
	C.V	0.14	0.14	0.28	0.14	0.32	0.14	0.08	0.21	0.29	0.21
	Kurtosis	-0.68	-1.15	2.09	-1.15	2.17	-1.15	-0.97	3.84	0.51	3.84
Skewness	0.42	0.36	1.51	0.36	1.60	0.36	-0.28	-1.69	0.30	-1.69	
2nd Fortnight Analysis	Lowest	8.58	10.16	6.41	10.16	5.92	10.16	9.34	9.42	7.77	9.42
	Highest	14.75	15.19	15.15	15.19	15.50	15.19	11.61	11.02	18.94	11.02
	Mean	11.33	12.10	9.87	12.10	9.10	12.10	10.56	10.09	11.04	10.09
	S.E	0.49	0.44	0.62	0.44	0.59	0.44	0.15	0.14	0.67	0.14
	S.D	1.90	1.72	2.40	1.72	2.28	1.72	0.58	0.55	2.61	0.55
	C.V	0.17	0.14	0.24	0.14	0.25	0.14	0.06	0.05	0.24	0.05
	Kurtosis	-0.92	-1.02	0.40	-1.02	3.95	-1.02	0.44	-1.36	5.99	-1.36
Skewness	0.35	0.56	0.51	0.56	1.61	0.56	-0.25	0.15	2.05	0.15	
3rd Fortnight Analysis	Lowest	8.84	6.56	6.77	6.56	6.97	6.56	10.33	9.33	8.31	9.33
	Highest	13.96	13.14	15.00	13.14	13.80	13.14	12.58	19.55	15.50	19.55
	Mean	11.60	8.54	10.76	8.54	10.36	8.54	11.31	11.28	11.53	11.28
	S.E	0.44	0.56	0.70	0.56	0.63	0.56	0.16	0.64	0.54	0.64
	S.D	1.71	2.17	2.70	2.17	2.45	2.17	0.62	2.50	2.07	2.50
	C.V	0.15	0.25	0.25	0.25	0.24	0.25	0.06	0.22	0.18	0.22
	Kurtosis	-1.43	0.17	-1.22	0.17	-1.55	0.17	-0.03	9.63	-0.69	9.63
Skewness	0.13	1.14	0.36	1.14	-0.06	1.14	0.20	2.91	0.10	2.91	
4th Fortnight Analysis	Lowest	10.30	7.80	8.67	7.80	7.52	7.80	11.23	10.07	8.56	10.07
	Highest	14.50	14.71	18.00	14.71	16.43	14.71	13.07	12.68	15.76	12.68
	Mean	11.76	10.59	11.44	10.59	10.11	10.59	11.77	11.12	11.31	11.12
	S.E	0.40	0.66	0.95	0.66	0.88	0.66	0.18	0.25	0.70	0.25
	S.D	1.26	2.10	3.02	2.10	2.78	2.10	0.56	0.81	2.22	0.81
	C.V	0.11	0.20	0.26	0.20	0.28	0.20	0.05	0.07	0.20	0.07
	Kurtosis	1.63	0.14	1.49	0.14	2.10	0.14	2.68	-0.05	0.28	-0.05
Skewness	1.30	0.77	1.46	0.77	1.37	0.77	1.57	0.73	0.79	0.73	

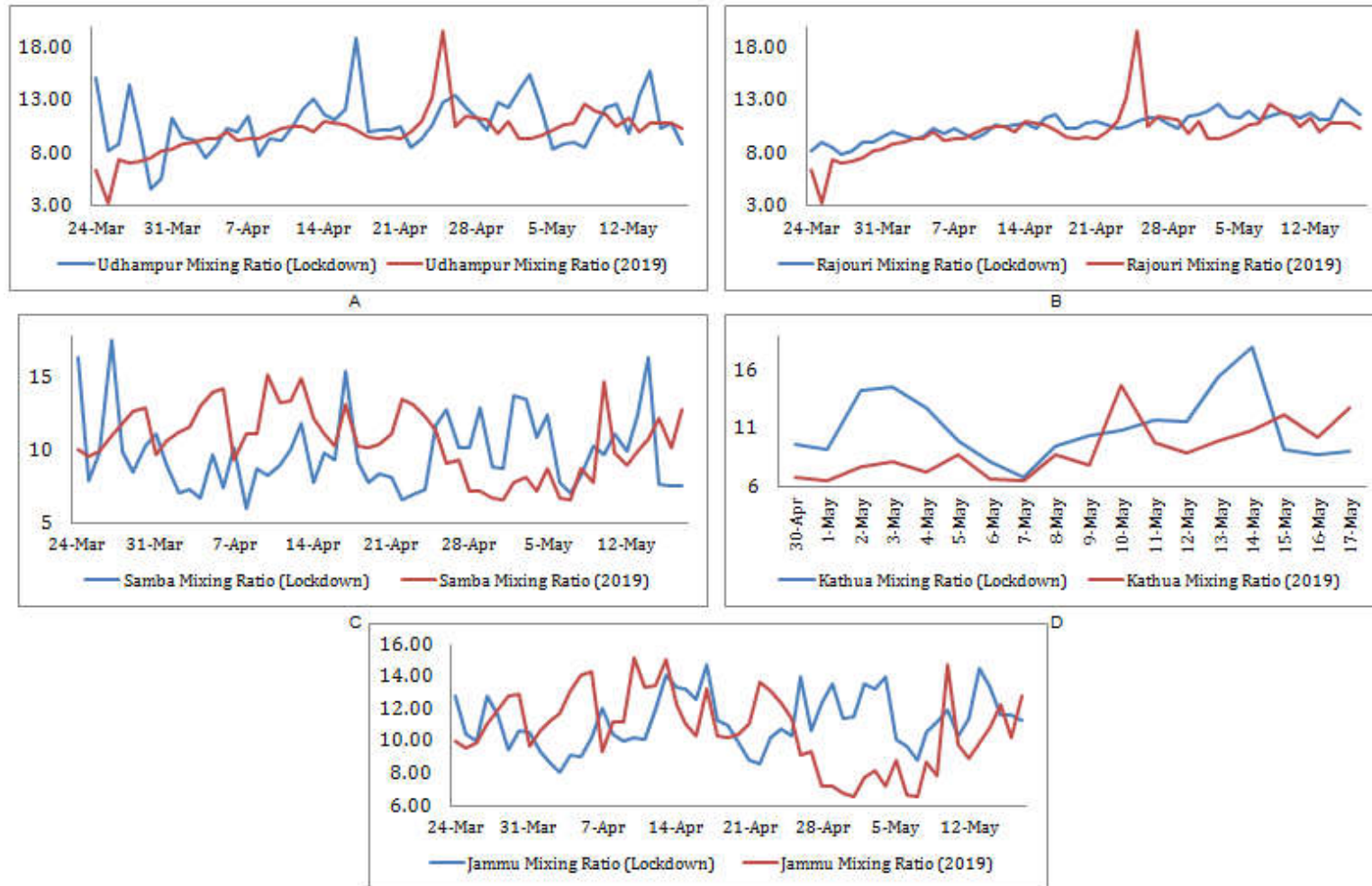


Fig. 3. Effect of complete lockdown on Mixing Ratio (g kg⁻¹) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Cumulative analysis highlighted significant deviation of 8.19 % in subtropical zone and 3.98 % in subtemperate zone of Jammu province. Enhanced values of relative humidity as compared to year 2019 have been observed in both the agro-ecological zones and can be based on the fact that saturation of water in air had led to temperature drop and more water wasn't required which caused high relative humidity [16]. Also, increase in tropospheric water vapor content might have caused increased precipitation, lowering temperature and increased relative humidity [12].

3.3 Mixing Ratio (W) ($g\ kg^{-1}$)

Mixing Ratio values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 3. The fortnight analysis showed a significant impact of lockdown on mixing ratio in both subtropical and subtemperate zones (Fig. 3). The deviation percentage compared to mean values of lockdown vs. year 2019 was -10.2 %, -12.11 %, -13.25 % for Jammu, Kathua, Samba subtropical districts and 12.85 %, 19.70 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was -6.36 %, -18.42 %, -24.79 % for subtropical districts and 4.65 %, 9.41 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 35.83 %, 25.93 %, 21.31 % in subtropical districts and 0.26 %, 2.21 % for subtemperate districts. In fourth fortnight of lockdown, the change observed was 11.04 %, 8.02 %, -4.53 % for subtropical districts and 5.84 %, 1.70 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of 1.03 % in subtropical zone and 4.51 % in subtemperate zone of Jammu province. In agrometeorological measurements, mixing ratio is defined as the gram of water vapor per kg of dry air and was observed more in lockdown as compared to year 2019. However, in relative humidity parameter, we have already observed that the saturation of air led to the temperature drop causing high relative humidity and in the same way, mixing ratio is the direct result or is a function of RH [17], which implies mixing ratio, increased in both zones with increase in RH.

3.4 Saturated Mixing Ratio (W_s) ($g\ kg^{-1}$)

Saturated Mixing Ratio values were analyzed on fortnightly basis and descriptive coefficients are

depicted in Table 4. The fortnight analysis showed a significant impact of lockdown on saturated mixing ratio in both subtropical and subtemperate zones (Fig. 4). The deviation percentage compared to mean values of lockdown vs. year 2019 was -15.21 %, -9.71 %, -9.32 % for Jammu, Kathua, Samba subtropical districts and -10.69 %, 1.14 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was -1.15 %, 0.62 %, -4.66 % for subtropical districts and -5.34 %, 15.30 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of -7.10 %, -4.47 %, -7.75 % in subtropical districts and -1.22 %, 18.60 % for subtemperate districts. In 4th fortnight of lockdown, the change observed was -6.41 %, 1.01 %, -5.67 % for subtropical districts and 8.27 %, 21.48 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of -4.53 % in subtropical zone and 5.94 % in subtemperate zone of Jammu province. Saturated mixing ratio refers to the mass of water vapor that can be held in kg of dry air at saturation. The relation between air temperature and saturated mixing ratio is exponential which states saturated mixing ratio is a function of temperature at constant air pressure [18]. However, in subtropical zone with decrease in temperature values, the saturated mixing ratio is also lowered but in subtemperate zone where temperature is lowered but air pressure has decreased with increase in altitude leading to rise in parcels of unsaturated air forcing cloud formation and rains making air saturated and increase in saturated mixing ratio [19].

3.5 Dew Point (T_d) ($^{\circ}C$)

Dew Point values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 5. The fortnight analysis showed a significant impact of lockdown on dew point in both subtropical and subtemperate zones (Fig. 5). The deviation percentage compared to mean values of lockdown vs. year 2019 was -9.90 %, -19.62 %, -23.27 % for Jammu, Kathua, Samba subtropical districts and 23.53 %, 22.66 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was -7.01 %, -12.98 %, -21.84 % for subtropical districts and 5.09 %, 8.36 % for subtemperate districts.

Table 4. Descriptive coefficients of Saturated Mixing Ratio (g kg^{-1}) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	13.60	12.89	14.20	12.89	13.40	12.89	10.25	6.09	11.32	6.09
	Highest	17.50	22.86	18.70	22.86	19.05	22.86	15.56	17.89	18.01	17.89
	Mean	15.27	18.01	16.06	18.01	16.33	18.01	13.28	14.87	15.04	14.87
	S.E	0.26	0.74	0.34	0.74	0.45	0.74	0.39	0.80	0.51	0.80
	S.D	0.07	0.16	0.08	0.16	0.11	0.16	0.11	0.21	0.13	0.21
	C.V	1.00	2.86	1.33	2.86	1.74	2.86	1.50	3.09	1.96	3.09
	Kurtosis	0.46	-0.36	-0.60	-0.36	-0.81	-0.36	-0.39	3.85	-0.33	3.85
	Skewness	0.56	0.01	0.34	0.01	-0.22	0.01	-0.40	-1.86	-0.60	-1.86
2nd Fortnight Analysis	Lowest	16.22	14.47	16.27	14.47	15.80	14.47	14.04	11.32	14.32	11.32
	Highest	26.42	24.42	27.58	24.42	26.90	24.42	17.12	19.05	25.17	19.05
	Mean	20.56	20.80	20.93	20.80	19.83	20.80	15.58	16.46	18.98	16.46
	S.E	0.77	0.67	0.79	0.67	0.78	0.67	0.28	0.53	0.83	0.53
	S.D	2.98	2.61	3.04	2.61	3.01	2.61	1.09	2.04	3.21	2.04
	C.V	0.14	0.13	0.15	0.13	0.15	0.13	0.07	0.12	0.17	0.12
	Kurtosis	0.40	1.14	0.19	1.14	0.66	1.14	-1.44	1.80	-0.65	1.80
	Skewness	0.91	-0.99	0.35	-0.99	0.62	-0.99	0.24	-1.22	0.30	-1.22
3rd Fortnight Analysis	Lowest	20.57	23.05	18.80	23.05	19.70	23.05	15.27	15.66	18.23	15.66
	Highest	26.10	25.94	29.40	25.94	28.20	25.94	21.18	19.41	26.20	19.41
	Mean	22.63	24.36	23.27	24.36	22.47	24.36	17.79	18.01	21.36	18.01
	S.E	0.50	0.23	0.66	0.23	0.57	0.23	0.39	0.31	0.57	0.31
	S.D	1.92	0.89	2.54	0.89	2.20	0.89	1.49	1.19	2.19	1.19
	C.V	0.08	0.04	0.11	0.04	0.10	0.04	0.08	0.07	0.10	0.07
	Kurtosis	-0.35	-1.03	1.60	-1.03	2.11	-1.03	0.88	-0.67	0.36	-0.67
	Skewness	0.96	0.08	0.86	0.08	1.14	0.08	0.87	-0.64	0.91	-0.64
4th Fortnight Analysis	Lowest	19.82	22.40	19.60	22.40	17.60	22.40	16.07	16.27	16.29	16.27
	Highest	28.06	29.90	30.20	29.90	27.30	29.90	22.72	21.18	25.17	21.18
	Mean	24.07	25.72	25.98	25.72	24.26	25.72	20.16	18.62	22.62	18.62
	S.E	0.68	0.83	1.08	0.83	0.92	0.83	0.61	0.58	0.77	0.58
	S.D	2.15	2.62	3.41	2.62	2.90	2.62	1.93	1.84	2.44	1.84
	C.V	0.09	0.10	0.13	0.10	0.12	0.10	0.10	0.10	0.11	0.10
	Kurtosis	1.79	-1.20	-0.51	-1.20	2.31	-1.20	1.31	-1.65	5.91	-1.65
	Skewness	-0.22	0.31	-0.58	0.31	-1.42	0.31	-0.81	-0.11	-2.21	-0.11

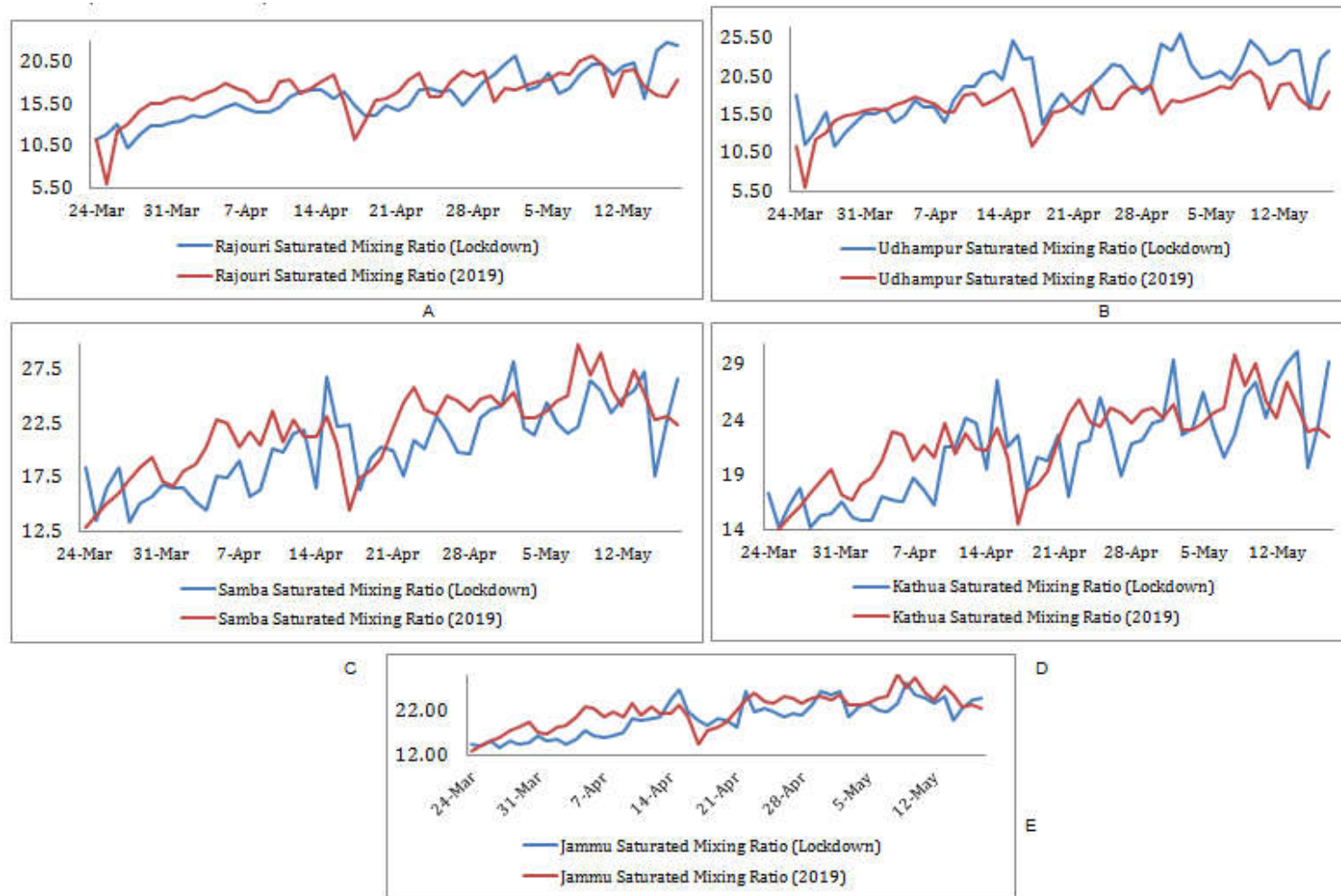


Fig. 4. Effect of complete lockdown on Saturated Mixing Ratio (g kg⁻¹) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 5. Descriptive coefficients of Dew Point (°C) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	10.12	12.40	6.80	12.40	6.61	12.40	9.06	3.11	1.40	3.11
	Highest	17.78	18.80	20.60	18.80	21.20	18.80	12.90	12.40	18.70	12.40
	Mean	13.82	15.34	12.33	15.34	11.77	15.34	11.39	9.22	11.31	9.22
	S.E	0.65	0.56	1.00	0.56	1.10	0.56	0.32	0.65	1.18	0.65
	S.D	2.51	2.16	3.87	2.16	4.27	2.16	1.24	2.52	4.57	2.52
	C.V	0.18	0.14	0.31	0.14	0.36	0.14	0.11	0.27	0.40	0.27
	Kurtosis	-1.34	-1.30	0.64	-1.30	0.98	-1.30	-0.56	0.95	0.83	0.95
	Skewness	0.25	0.20	0.75	0.20	1.11	0.20	-0.67	-1.00	-0.57	-1.00
2nd Fortnight Analysis	Lowest	11.10	13.60	5.91	13.60	5.60	13.60	11.40	11.50	8.69	11.50
	Highest	19.31	19.60	41.70	19.60	24.40	19.60	14.68	13.80	22.30	13.80
	Mean	15.11	16.25	14.14	16.25	12.70	16.25	13.19	12.55	13.60	12.55
	S.E	0.66	0.51	2.15	0.51	1.19	0.51	0.22	0.21	0.82	0.21
	S.D	2.54	1.99	8.34	1.99	4.61	1.99	0.84	0.81	3.19	0.81
	C.V	0.17	0.12	0.59	0.12	0.36	0.12	0.06	0.06	0.23	0.06
	Kurtosis	-1.01	-1.54	9.58	-1.54	2.31	-1.54	0.57	-1.40	3.25	-1.40
	Skewness	0.11	0.02	2.82	0.02	1.34	0.02	-0.33	-0.05	1.27	-0.05
3rd Fortnight Analysis	Lowest	11.50	7.18	6.69	7.18	8.00	7.18	12.90	11.38	9.67	11.38
	Highest	18.53	16.70	18.70	16.70	18.30	16.70	15.90	16.74	19.80	16.74
	Mean	15.47	10.06	13.09	10.06	12.92	10.06	14.21	13.35	14.38	13.35
	S.E	0.57	0.77	0.98	0.77	0.97	0.77	0.22	0.36	0.74	0.36
	S.D	2.21	3.00	3.81	3.00	3.77	3.00	0.84	1.38	2.88	1.38
	C.V	0.14	0.30	0.29	0.30	0.29	0.30	0.06	0.10	0.20	0.10
	Kurtosis	-1.12	0.47	-1.12	0.47	-1.59	0.47	-0.12	1.45	-0.66	1.45
	Skewness	-0.07	1.14	0.10	1.14	0.06	1.14	0.12	0.70	-0.01	0.70
4th Fortnight Analysis	Lowest	13.90	9.85	10.30	9.85	9.17	9.85	14.10	12.20	10.11	12.20
	Highest	19.10	19.40	21.50	19.40	21.10	19.40	16.49	16.00	19.41	16.00
	Mean	15.82	14.03	14.08	14.03	13.10	14.03	14.84	13.82	14.02	13.82
	S.E	0.50	0.93	1.15	0.93	1.21	0.93	0.23	0.38	0.91	0.38
	S.D	1.57	2.93	3.64	2.93	3.82	2.93	0.71	1.21	2.88	1.21
	C.V	0.10	0.21	0.26	0.21	0.29	0.21	0.05	0.09	0.21	0.09
	Kurtosis	1.17	-0.32	0.67	-0.32	0.80	-0.32	2.64	-0.61	-0.23	-0.61
	Skewness	1.12	0.48	1.18	0.48	0.98	0.48	1.52	0.46	0.49	0.46

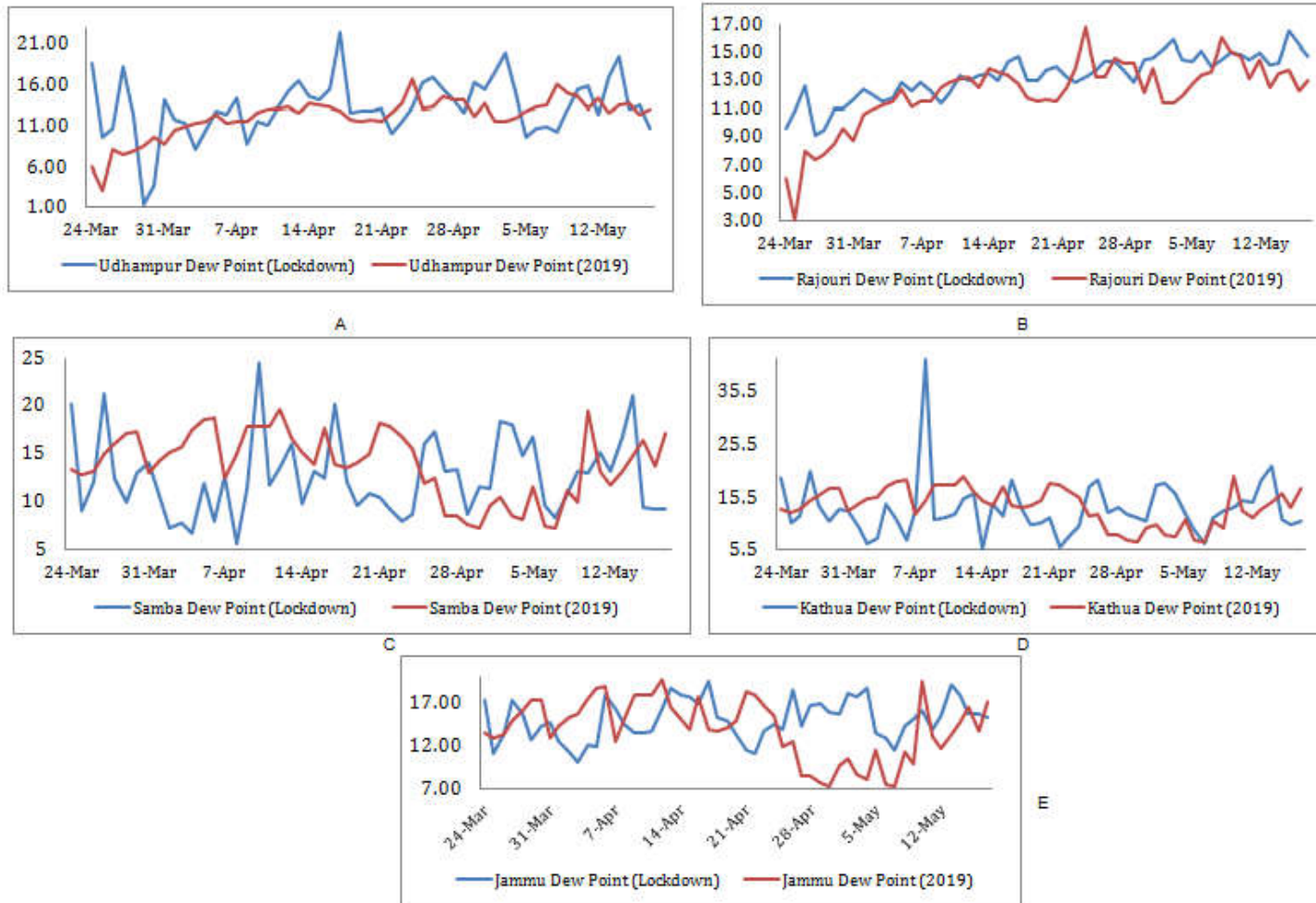


Fig. 5. Effect of complete lockdown on Dew Point (°C) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 6. Descriptive coefficients of Enthalpy (kJ kg^{-1}) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	39.64	42.83	30.00	42.83	35.30	42.83	33.00	13.63	28.70	13.63
	Highest	51.81	62.79	64.80	62.79	67.10	62.79	45.00	46.98	60.20	46.98
	Mean	45.92	52.01	44.43	52.56	45.13	52.01	39.88	38.48	43.07	38.48
	S.E	0.91	1.73	2.42	1.66	2.55	1.73	0.95	2.25	2.32	2.25
	S.D	3.42	6.49	9.06	6.22	9.55	6.49	3.55	8.43	8.69	8.43
	C.V	0.07	0.12	0.20	0.12	0.21	0.12	0.09	0.22	0.20	0.22
	Kurtosis	-0.42	-0.94	1.54	-0.57	1.83	-0.94	-0.57	5.72	0.05	5.72
	Skewness	0.09	0.23	1.10	0.02	1.56	0.23	-0.43	-2.16	0.40	-2.16
2nd Fortnight Analysis	Lowest	45.23	48.60	33.41	48.60	35.70	48.60	42.00	40.10	38.10	40.10
	Highest	62.80	66.00	63.90	66.00	65.90	66.00	49.70	50.12	73.90	50.12
	Mean	53.74	55.55	49.45	55.55	48.07	55.55	46.05	45.57	51.00	45.57
	S.E	1.52	1.49	2.03	1.49	1.84	1.49	0.57	0.77	2.15	0.77
	S.D	5.88	5.79	7.88	5.79	7.14	5.79	2.21	2.97	8.31	2.97
	C.V	0.11	0.10	0.16	0.10	0.15	0.10	0.05	0.07	0.16	0.07
	Kurtosis	-1.34	-1.06	0.30	-1.06	1.91	-1.06	-0.86	-0.67	3.41	-0.67
	Skewness	0.33	0.42	-0.08	0.42	0.93	0.42	-0.23	-0.15	1.37	-0.15
3rd Fortnight Analysis	Lowest	46.58	44.89	37.30	44.89	39.14	44.89	46.06	44.20	41.10	44.20
	Highest	63.53	94.90	66.20	94.90	65.40	94.90	54.90	53.90	64.60	53.90
	Mean	55.82	52.98	52.30	52.98	51.35	52.98	49.95	48.61	53.43	48.61
	S.E	1.24	3.33	2.02	3.33	1.99	3.33	0.64	0.74	1.81	0.74
	S.D	4.82	12.89	7.84	12.89	7.70	12.89	2.49	2.88	7.00	2.88
	C.V	0.09	0.24	0.15	0.24	0.15	0.24	0.05	0.06	0.13	0.06
	Kurtosis	-0.77	8.68	-0.17	8.68	-0.89	8.68	-0.64	-0.82	-0.91	-0.82
	Skewness	-0.15	2.77	0.20	2.77	0.20	2.77	0.38	0.10	-0.03	0.10
4th Fortnight Analysis	Lowest	48.18	44.90	41.10	44.90	41.80	44.90	48.40	45.10	46.40	45.10
	Highest	65.20	68.50	76.40	68.50	71.60	68.50	58.00	56.10	66.40	56.10
	Mean	57.13	54.69	55.35	54.69	52.44	54.69	52.98	50.24	53.44	50.24
	S.E	1.24	1.83	3.03	1.83	2.56	1.83	0.85	1.04	1.96	1.04
	S.D	4.12	6.05	10.05	6.05	8.48	6.05	2.81	3.46	6.50	3.46
	C.V	0.07	0.11	0.18	0.11	0.16	0.11	0.05	0.07	0.12	0.07
	Kurtosis	2.70	2.25	0.89	2.25	1.53	2.25	-0.11	-0.77	-0.18	-0.77
	Skewness	-0.36	0.88	0.92	0.88	1.07	0.88	0.14	0.37	0.69	0.37

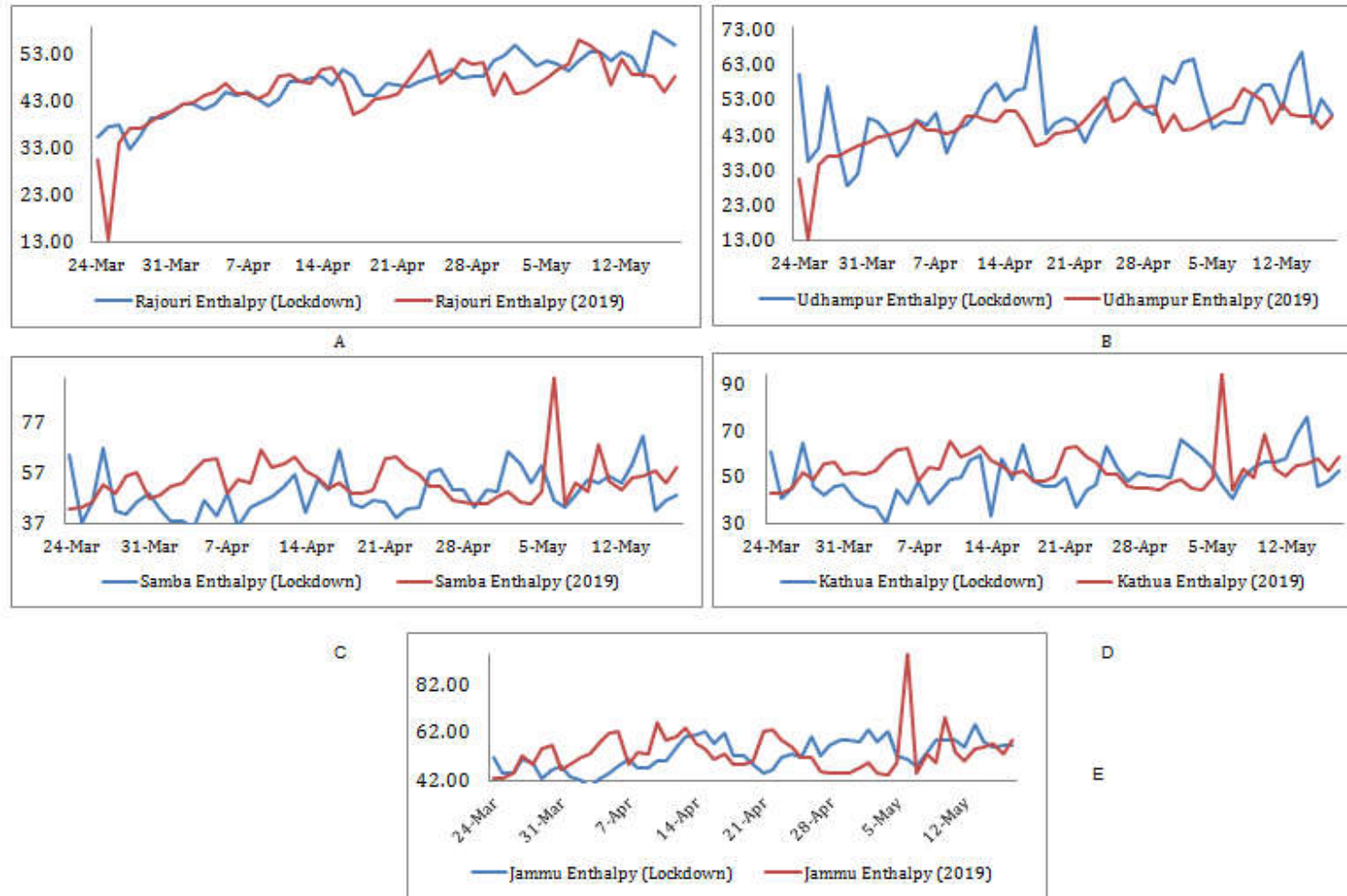


Fig. 6. Effect of complete lockdown on Enthalpy (kJ kg⁻¹) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 7. Descriptive coefficients of Absolute Humidity (g m^{-3}) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	9.18	10.50	7.70	10.50	7.20	10.50	8.74	3.79	5.16	3.79
	Highest	14.62	15.70	17.90	15.70	18.50	15.70	11.08	10.60	15.90	10.60
	Mean	11.71	12.86	10.86	12.86	10.57	12.86	9.99	8.67	10.34	8.67
	S.E	0.43	0.44	0.73	0.44	0.85	0.44	0.20	0.44	0.75	0.44
	S.D	1.66	1.71	2.84	1.71	3.31	1.71	0.76	1.70	2.90	1.70
	C.V	0.14	0.13	0.26	0.13	0.31	0.13	0.08	0.20	0.28	0.20
	Kurtosis	-0.65	-1.23	2.42	-1.23	2.08	-1.23	-0.98	4.07	0.48	4.07
	Skewness	0.44	0.30	1.64	0.30	1.57	0.30	-0.26	-1.73	0.26	-1.73
2nd Fortnight Analysis	Lowest	9.63	11.40	6.95	11.40	6.70	11.40	10.03	10.06	8.37	10.06
	Highest	16.42	16.70	15.75	16.70	17.75	16.70	12.40	11.67	19.50	11.67
	Mean	12.67	13.48	10.38	13.48	10.26	13.48	11.28	10.76	11.64	10.76
	S.E	0.53	0.48	0.63	0.48	0.67	0.48	0.16	0.14	0.67	0.14
	S.D	2.04	1.85	2.42	1.85	2.59	1.85	0.60	0.56	2.59	0.56
	C.V	0.16	0.14	0.23	0.14	0.25	0.14	0.05	0.05	0.22	0.05
	Kurtosis	-0.79	-1.14	0.45	-1.14	4.70	-1.14	0.54	-1.45	5.97	-1.45
	Skewness	0.35	0.54	0.52	0.54	1.76	0.54	-0.21	0.08	2.05	0.08
3rd Fortnight Analysis	Lowest	9.90	7.31	7.17	7.31	7.80	7.31	10.94	9.92	4.93	9.92
	Highest	16.73	14.80	15.60	14.80	15.20	14.80	13.33	14.09	16.10	14.09
	Mean	13.10	9.35	11.23	9.35	11.62	9.35	12.01	11.32	11.65	11.32
	S.E	0.53	0.63	0.71	0.63	0.72	0.63	0.16	0.27	0.72	0.27
	S.D	2.05	2.44	2.75	2.44	2.79	2.44	0.64	1.04	2.80	1.04
	C.V	0.16	0.26	0.25	0.26	0.24	0.26	0.05	0.09	0.24	0.09
	Kurtosis	-1.18	0.68	-1.23	0.68	-1.64	0.68	0.37	2.68	1.03	2.68
	Skewness	0.20	1.37	0.35	1.37	-0.08	1.37	0.06	1.11	-0.81	1.11
4th Fortnight Analysis	Lowest	11.45	8.72	9.09	8.72	8.34	8.72	11.82	10.01	9.01	10.01
	Highest	15.90	16.85	18.42	16.85	17.90	16.85	13.66	13.30	16.32	13.30
	Mean	13.05	12.32	11.85	12.32	11.15	12.32	12.39	11.55	11.84	11.55
	S.E	0.43	0.87	0.95	0.87	0.93	0.87	0.17	0.32	0.71	0.32
	S.D	1.37	2.77	3.02	2.77	2.96	2.77	0.53	1.01	2.25	1.01
	C.V	0.11	0.22	0.25	0.22	0.27	0.22	0.04	0.09	0.19	0.09
	Kurtosis	1.11	-0.98	1.52	-0.98	2.22	-0.98	3.27	-0.59	0.26	-0.59
	Skewness	1.21	0.47	1.47	0.47	1.44	0.47	1.69	0.17	0.76	0.17

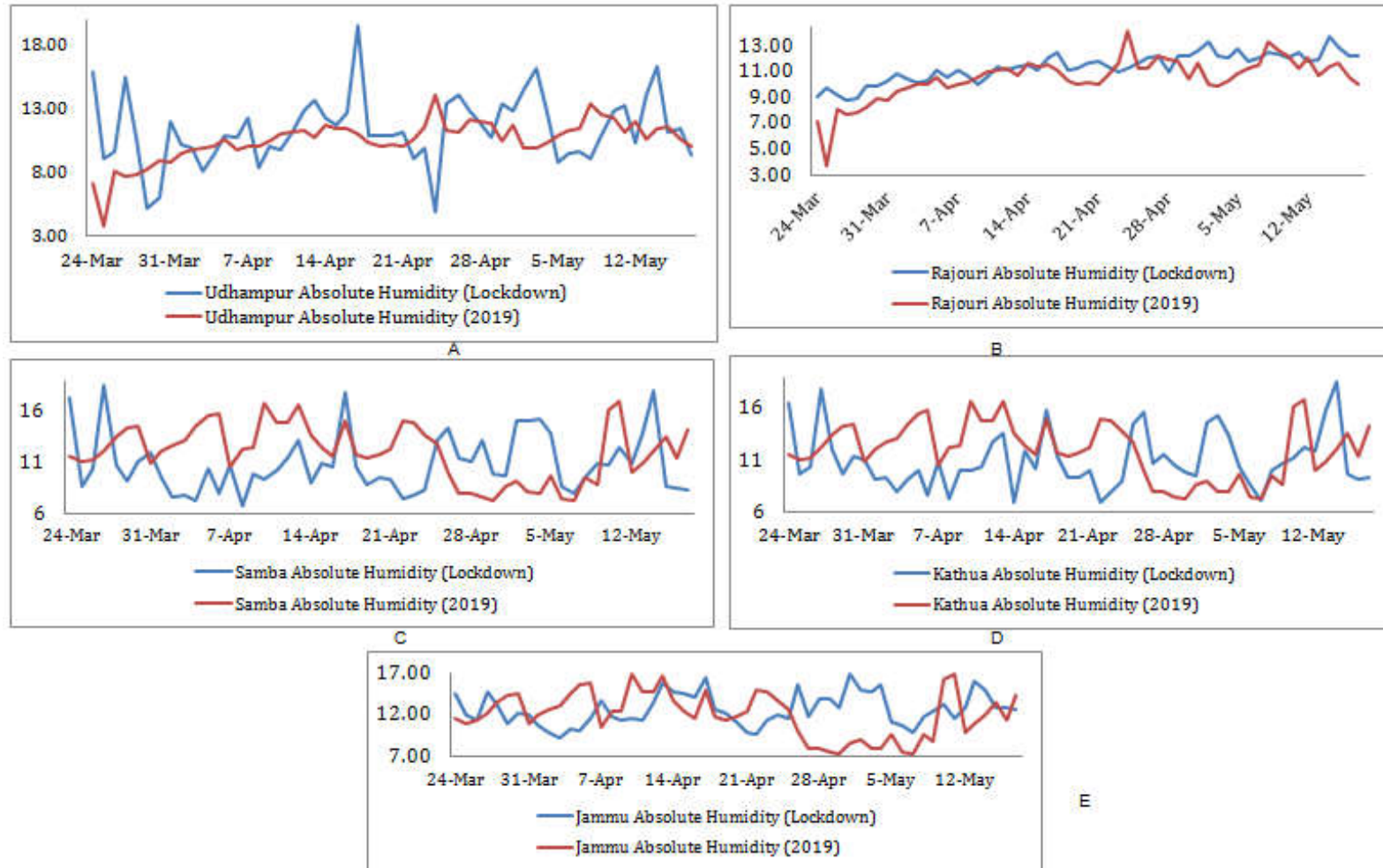


Fig. 7. Effect of complete lockdown on Absolute Humidity (kJ m⁻³) variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 53.67 %, 30.11 %, 28.42 % in subtropical districts and 6.44 %, 7.71 % for subtemperate districts. In fourth fortnight of lockdown, the change observed was 8.03 %, 0.35 %, -6.62 % for subtropical districts and 7.38 %, 1.44 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of 1.61 % in subtropical zone and 10.32 % in subtemperate zone of Jammu province. So, comparatively, dew point has increased between lockdown and can be based on lowering of temperature causing moist air to cool down promptly. [20, 21] also notice increased trend of dew point with decrease in temperature.

3.6 Enthalpy (h) (kJ kg⁻¹)

Enthalpy values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 6. The fortnight analysis showed a significant impact of lockdown on enthalpy in both subtropical and subtemperate zones (Fig. 6). The deviation percentage compared to mean values of lockdown vs. year 2019 was -11.70 %, -15.46 %, -13.22 % for Jammu, Kathua, Samba subtropical districts and 3.63 %, 11.92 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was -3.25 %, -10.98 %, -13.46 % for subtropical districts and 1.05 %, 11.91 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 5.36 %, -1.28 %, -3.07 % in subtropical districts and 2.75 %, 9.91 % for subtemperate districts. In fourth fortnight of lockdown, the change observed was 4.46 %, 1.20 %, -4.11 % for subtropical districts and 5.45 %, 6.36 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of -5.45 % in subtropical zone and 6.62 % in subtemperate zone of Jammu province. However, it's already proven that the enthalpy depends mainly on two parameters: temperature and humidity and with increase or decrease in temperature there is increase or decrease in enthalpy [22] that's why we have observed decrease in enthalpy with decrease in temperature in subtropical zone but the increased enthalpy in subtemperate zone can be correlated with increased air pressure [23].

3.7 Absolute Humidity (AH) (kg m⁻³)

AH values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 7. The fortnight analysis showed a significant impact of lockdown on absolute humidity in both subtropical and subtemperate zones (Fig. 7). The deviation percentage compared to mean values of lockdown vs. year 2019 was -8.94 %, -15.55 %, -17.80 % for Jammu, Kathua, Samba subtropical districts and 15.22 %, 19.26 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was -6.00 %, -22.99 %, -23.88 % for subtropical districts and 4.83 %, 8.17 % for subtemperate districts.

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 40.10 %, 20.10 %, 24.27 % in subtropical districts and 6.09 %, 2.91 % for subtemperate districts. In fourth fortnight of lockdown, the change observed was 5.92 %, -3.81%, -9.49 % for subtropical districts and 7.27 %, 2.51 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of -1.50 % in subtropical zone and 8.28 % in subtemperate zone of Jammu province. Absolute humidity expresses the water vapor content of the air using the mass of water vapor contained in a given volume of air and is related to change in temperature and air pressure. In subtropical districts, at a constant air pressure, with decrease in temperature, the absolute humidity has also increased but in sub-temperate districts with decrease in air pressure along with temperature the absolute humidity has increased to a certain extent. This means the absolute humidity is changing when the volume of air is changing and even though mass of water vapor is high in air [24].

3.8 Density of Air (ρ)

Air Density values were analyzed on fortnightly basis and descriptive coefficients are depicted in Table 8. The fortnight analysis showed a significant impact of lockdown on density of air in both subtropical and subtemperate zones (Fig. 8). The deviation percentage compared to mean values of lockdown vs. year 2019 was 0.87 % for Jammu, Kathua, Samba subtropical districts and 0.00 %, -0.97 % for Rajouri and Udhampur subtemperate districts. During 2nd fortnight, deviation percentage observed was 0.00 %, 0.88 %, 0.88 % for subtropical districts and 0.00 %, -0.92 % for subtemperate districts.

Table 8. Descriptive coefficients of Density of Air (kg m^3) during complete lockdown in comparison to Year 2019

Parameters		Subtropical Zone						Subtemperate Zone			
Timeline	Analytics	Jammu		Kathua		Samba		Rajouri		Udhampur	
		Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019	Lockdown	2019
1st Fortnight Analysis	Lowest	1.14	1.12	1.14	1.12	1.14	1.12	1.08	1.07	1.07	1.07
	Highest	1.15	1.16	1.15	1.16	1.15	1.16	1.11	1.14	1.10	1.14
	Mean	1.15	1.14	1.15	1.14	1.15	1.14	1.09	1.09	1.08	1.09
	S.E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	S.D	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
	C.V	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.01
	Kurtosis	0.90	-0.23	-2.09	-0.23	-2.09	-0.23	0.09	6.59	-0.33	6.59
	Skewness	-1.67	-0.05	-0.46	-0.05	-0.46	-0.05	0.57	2.35	0.34	2.35
2nd Fortnight Analysis	Lowest	1.11	1.11	1.11	1.11	1.11	1.11	1.07	1.07	1.05	1.07
	Highest	1.15	1.15	1.15	1.15	1.15	1.15	1.09	1.10	1.08	1.10
	Mean	1.13	1.13	1.14	1.13	1.14	1.13	1.08	1.08	1.07	1.08
	S.E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	S.D	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	C.V	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Kurtosis	1.89	0.32	0.14	0.32	0.14	0.32	0.54	1.80	-1.13	1.80
	Skewness	-0.29	0.62	-0.46	0.62	-0.46	0.62	0.00	1.20	-0.33	1.20
3rd Fortnight Analysis	Lowest	1.11	1.11	1.11	1.11	1.11	1.11	1.06	1.07	1.05	1.07
	Highest	1.13	1.13	1.13	1.13	1.13	1.13	1.08	1.08	1.07	1.08
	Mean	1.13	1.12	1.13	1.12	1.13	1.12	1.07	1.07	1.06	1.07
	S.E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	S.D	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
	C.V	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
	Kurtosis	0.18	6.50	0.18	6.50	0.18	6.50	1.33	0.50	-0.39	0.50
	Skewness	-0.98	0.00	-0.98	0.00	-0.98	0.00	0.00	1.57	0.00	1.57
4th Fortnight Analysis	Lowest	1.11	1.11	1.11	1.11	1.11	1.11	1.06	1.06	1.05	1.06
	Highest	1.13	1.12	1.14	1.12	1.14	1.12	1.08	1.08	1.08	1.08
	Mean	1.12	1.12	1.12	1.12	1.12	1.12	1.06	1.07	1.06	1.07
	S.E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	S.D	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01
	C.V	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01
	Kurtosis	4.00	0.73	0.83	0.73	0.83	0.73	1.47	-1.04	3.19	-1.04
	Skewness	0.00	-1.62	0.66	-1.62	0.66	-1.62	1.50	-0.22	1.60	-0.22

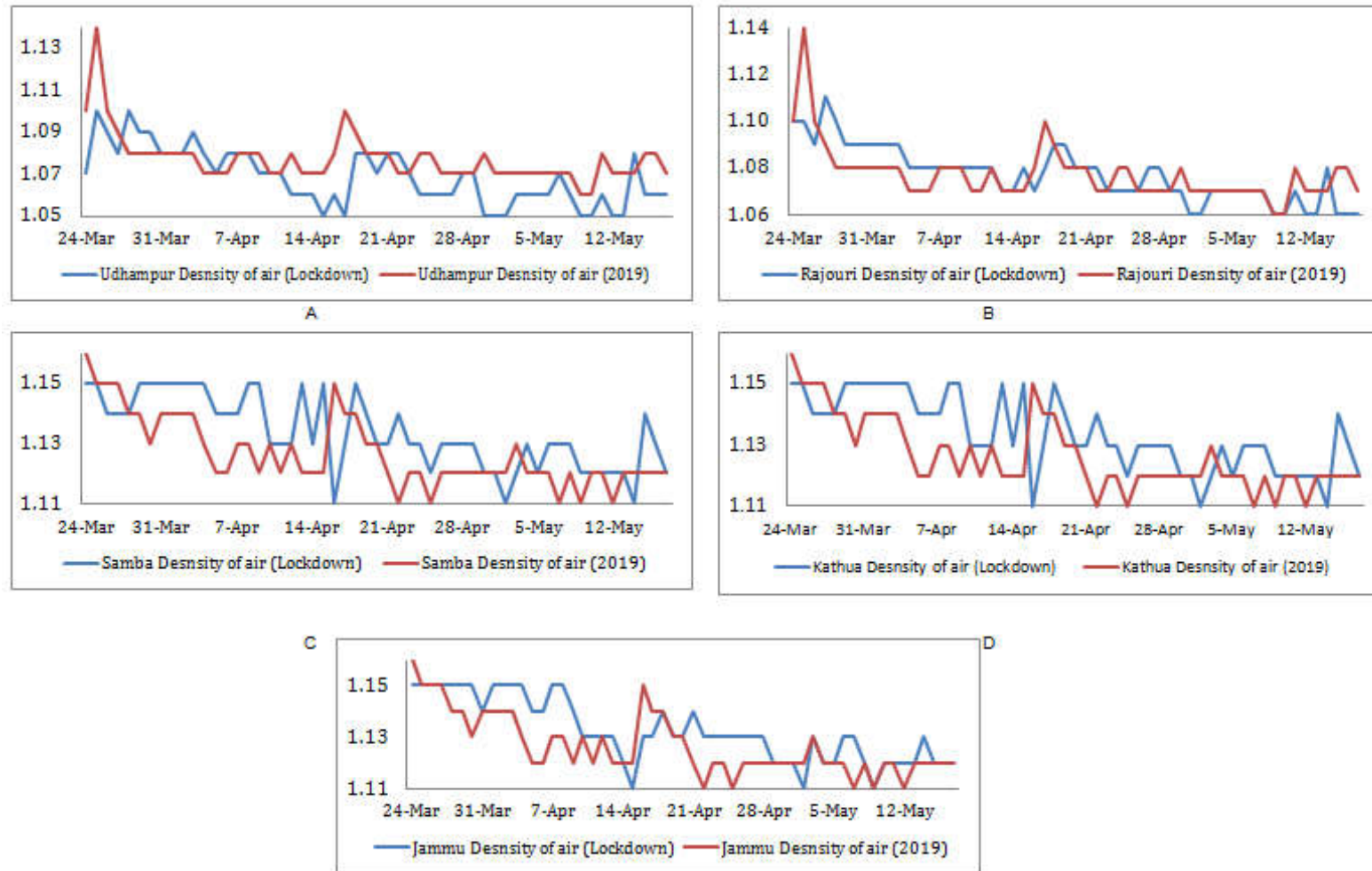


Fig. 8. Effect of complete lockdown on Density of Air and variation with Year 2019 in Subtemperate Zone (a. Udhampur b. Rajouri) and Subtropical Zone (c. Samba, d. Kathua e. Jammu)

Table 9. Correlation of coefficients among water vapors during complete lockdown for year 2020 (Jammu Subtropical Zone)

	Ambient Temperature	Relative Humidity	Mixing Ratio	Saturated Mixing Ratio	Enthalpy	Dew Point	Pressure of Dry Air	Density of air
Relative Humidity	-0.69**							
Mixing Ratio	0.37**	0.39**						
Saturated Mixing Ratio	0.98**	-0.70**	0.32*					
Enthalpy	0.78**	-0.11	0.86**	0.74**				
Dew Point	0.38**	0.36**	0.95**	0.32*	0.83			
Pressure of Dry Air	0.15	-0.39**	-0.37**	0.19	-0.13	-0.36**		
Density of Air	-0.97**	0.63**	-0.42**	-0.95**	-0.80**	-0.42**	-0.12	
Absolute Humidity	0.35**	0.39**	0.96**	0.30*	0.82**	0.92**	-0.39**	-0.38**

**Correlation is significant at 1% level of significance; *Correlation is significant at 5% level of significance

Table 10. Correlation of coefficients among water vapors during complete lockdown for year 2020 (Rajouri Subtemperate Zone)

	Ambient Temperature	Relative Humidity	Mixing Ratio	Saturated Mixing Ratio	Enthalpy	Dew Point	Pressure of Dry Air	Density of air
Relative Humidity	-0.82**							
Mixing Ratio	0.87**	-0.44**						
Saturated Mixing Ratio	0.99**	-0.83**	0.85**					
Enthalpy	0.97**	-0.65**	0.97**	0.95**				
Dew Point	0.87**	-0.46**	0.98**	0.84**	0.95**			
Pressure of Dry Air	-0.70**	0.37**	-0.81**	-0.69**	-0.78**	-0.79**		
Density of Air	-0.97**	0.78**	-0.86**	-0.95**	-0.94**	-0.86**	0.71**	
Absolute Humidity	0.83**	-0.45**	0.93**	0.81**	0.91**	0.91**	-0.77**	-0.81**

**Correlation is significant at 1% level of significance; *Correlation is significant at 5% level of significance

Table 11. Correlation of coefficients among water vapors during complete lockdown for year 2020 (Udhampur Subtemperate Zone)

	Ambient Temperature	Relative Humidity	Mixing Ratio	Saturated Mixing Ratio	Enthalpy	Dew Point	Pressure of Dry Air	Density of air
Relative Humidity	-0.35**							
Mixing Ratio	0.54**	0.58**						
Saturated Mixing Ratio	0.99**	-0.34*	0.55**					
Enthalpy	0.78**	0.30*	0.95**	0.78**				
Dew Point	0.56**	0.57**	0.98**	0.56**	0.94**			
Pressure of Dry Air	-0.53**	-0.12	-0.57**	-0.53**	-0.62**	-0.54**		
Density of Air	-0.92**	0.30*	-0.51**	-0.91**	-0.72**	-0.53**	0.61**	
Absolute Humidity	0.47**	0.59**	0.95**	0.47**	0.88**	0.93**	-0.57**	-0.42**

**Correlation is significant at 1% level of significance; *Correlation is significant at 5% level of significance

Table 12. Correlation of coefficients among water vapors during complete lockdown for year 2020 (Kathua subtropical Zone)

	Ambient Temperature	Relative Humidity	Mixing Ratio	Saturated Mixing Ratio	Enthalpy	Dew Point	Pressure of Dry Air	Density of air
Relative Humidity	-0.39**							
Mixing Ratio	0.45**	0.63**						
Saturated Mixing Ratio	0.97**	-0.40**	0.43**					
Enthalpy	0.69**	0.27*	0.83**	0.67**				
Dew Point	0.23	0.32*	0.53**	0.20	0.40**			
Pressure of Dry Air	-0.37**	-0.50*	-0.82**	-0.39**	-0.69**	-0.47**		
Density of Air	-0.96**	0.27*	-0.54**	-0.93**	-0.74**	-0.32*	0.46**	
Absolute Humidity	0.40**	0.67**	0.99**	0.38**	0.81**	0.51**	-0.82**	-0.49**

**Correlation is significant at 1% level of significance; *Correlation is significant at 5% level of significance

Table 13. Correlation of coefficients among water vapors during complete lockdown for year 2020 (Samba subtropical Zone)

	Ambient Temperature	Relative Humidity	Mixing Ratio	Saturated Mixing Ratio	Enthalpy	Dew Point	Pressure of Dry Air	Density of air
Ambient Temperature	-0.40**							
Relative Humidity	0.31**	0.70**						
Mixing Ratio	0.99**	-0.36**	0.36**					
Saturated Mixing Ratio	0.64**	0.42**	0.89**	0.66**				
Enthalpy	0.38**	0.55**	0.83**	0.38**	0.85**			
Dew Point	0.68**	0.31*	0.80**	0.70**	0.94**	0.67**		
Pressure of Dry Air	-0.80**	0.32*	-0.26	-0.79**	-0.53**	-0.33*	0.34*	
Density of Air	0.35**	0.67**	0.98**	0.39**	0.91**	0.84**	-0.61**	-0.30*
Absolute Humidity	0.40**	0.34*	0.70**	0.40*	0.68**	0.57*	-0.81**	-0.33*

**Correlation is significant at 1% level of significance; *Correlation is significant at 5% level of significance

While analyzing the 3rd fortnight data, subtropical region depicted significant deviation in values; highlighting change of 0.89 % in subtropical districts and 0.00 %, -0.93 % for subtemperate districts. In fourth fortnight of lockdown, the change observed was 0.00 % for subtropical districts and -0.93 % for subtemperate zones.

Cumulative analysis highlighted significant deviation of -0.29 % in subtropical zone and -0.46 % in subtemperate zone of Jammu province. Density of air changes with altitude and temperature. In subtropical and subtemperate zones, temperature is changing causing significant drop in air pressure compared to year 2019 [25,26].

Correlation of coefficients among water vapors has been analyzed using Pearson's Correlation test for each district falling under subtropical and subtemperate zone of Jammu region. (Table 9-13).

4. CONCLUSION

Deviations in water vapors signify the positive impact of lockdown. With variation in relative humidity and continuous drop in air temperature, complete lockdown has favored the plausible outcomes in every parameter whether it's related to heat exchange or water presence in air. The improved parameters are not only depicting the improved air quality and temperature but also predicting a healthier ecosystem for long term sustainability and productivity. However, it's not affordable to implement complete lockdown from economical point of view but taking into consideration the lockdown in phases, weekend lockdown like strategies can create a sustainable movement of economy and environment. Lockdown worldwide has not only provided a clear picture of nature but also has delivered an aspect to respect the calls of mother earth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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