

Impacts of erratic snowfall on apple orchards in Kashmir Valley, India

By Rashid et al. 2020

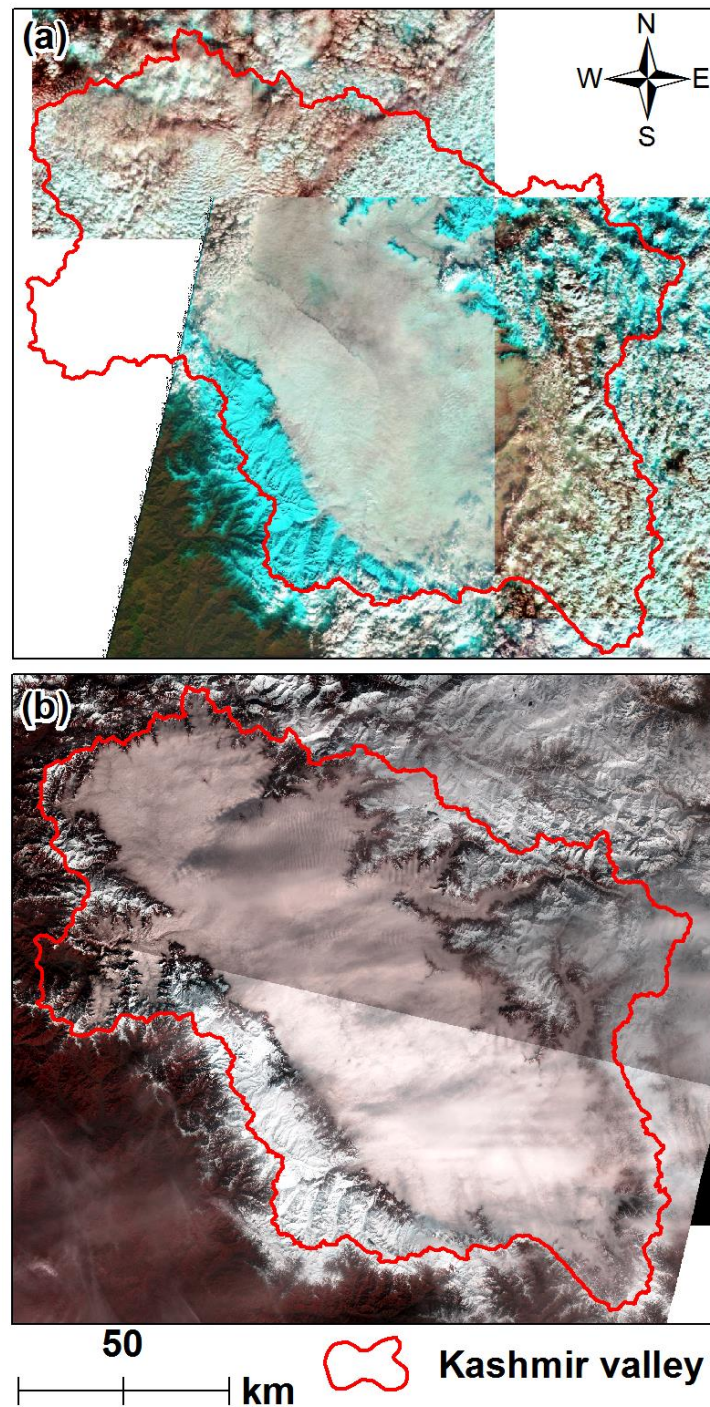


Figure 1. (a) November 2018 snow extent and (b) November 2019 snow extent as observed from Sentinel 2A and Landsat satellites.

Scene ID's

Sentinel 2A: L1C_T43SDT_A017591_20181104T054006, L1C_T43SET_A017591_20181104T054006, L1C_T43SDU_A008654_20181102T055242

Landsat OLI: LC08_L1TP_149037_20191111_20, LC08_L1TP_149037_20181108_20

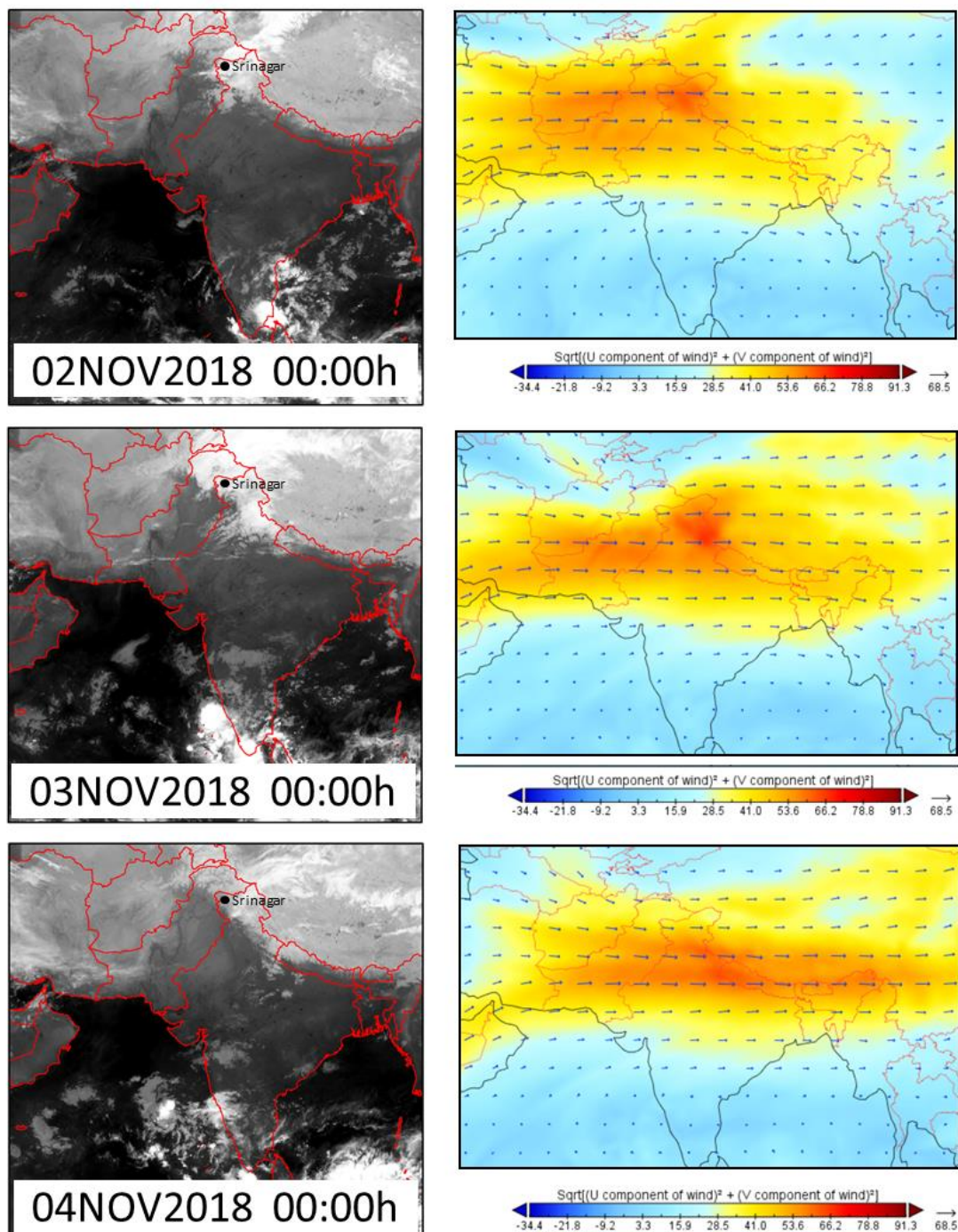


Figure S2. Left column: Temporal evolution of the cloud as observed by INSAT-3D imagery for 0000 UTC for 2nd, 3rd, and 4th, November, 2018. Right column: ERA-5 derived upper level winds at the same moment.

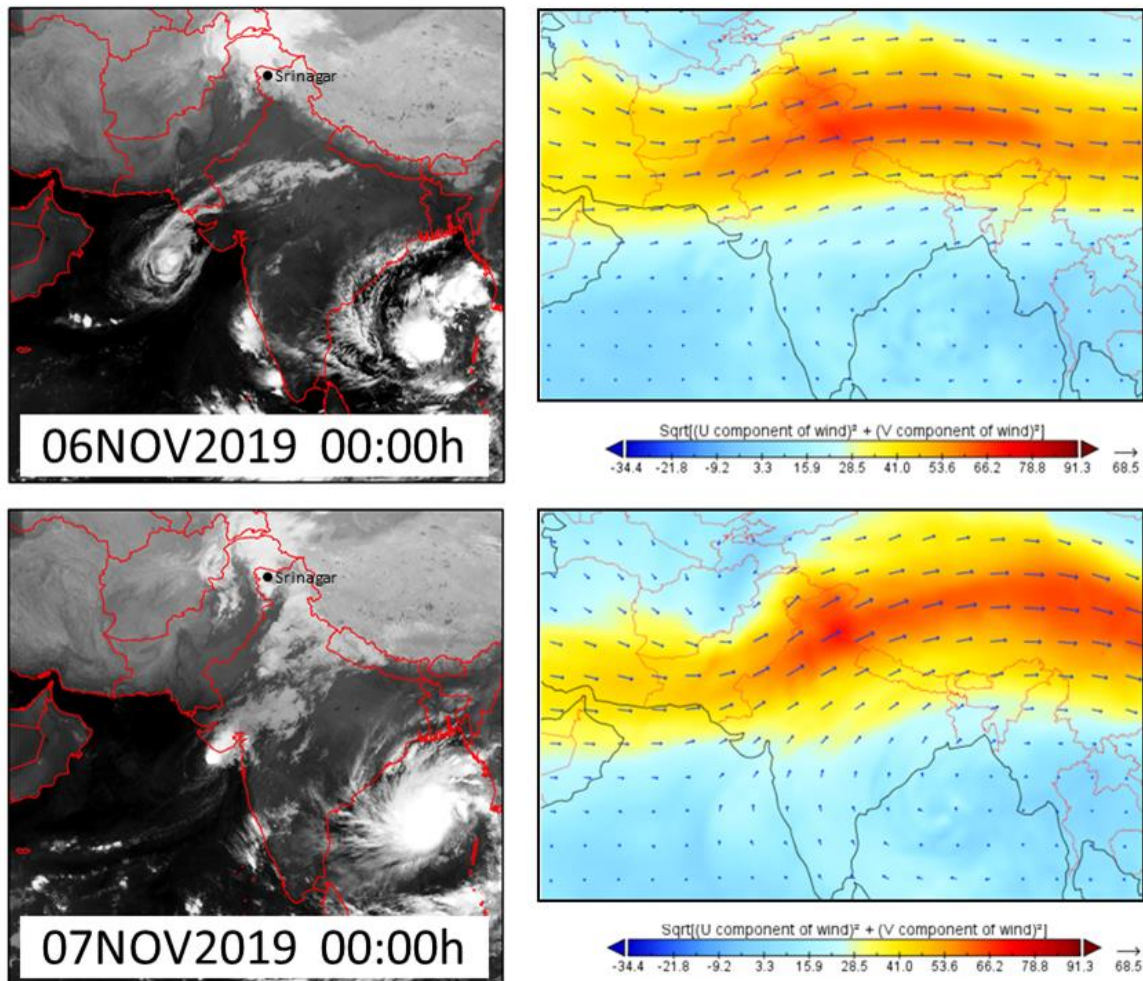


Figure S3. Left column: temporal evolution of the cloud as observed by INSAT-3D imagery for 0000UTC of 6th and 7th November, 2019. Right column: ERA-5 derived upper level winds at the same moment.

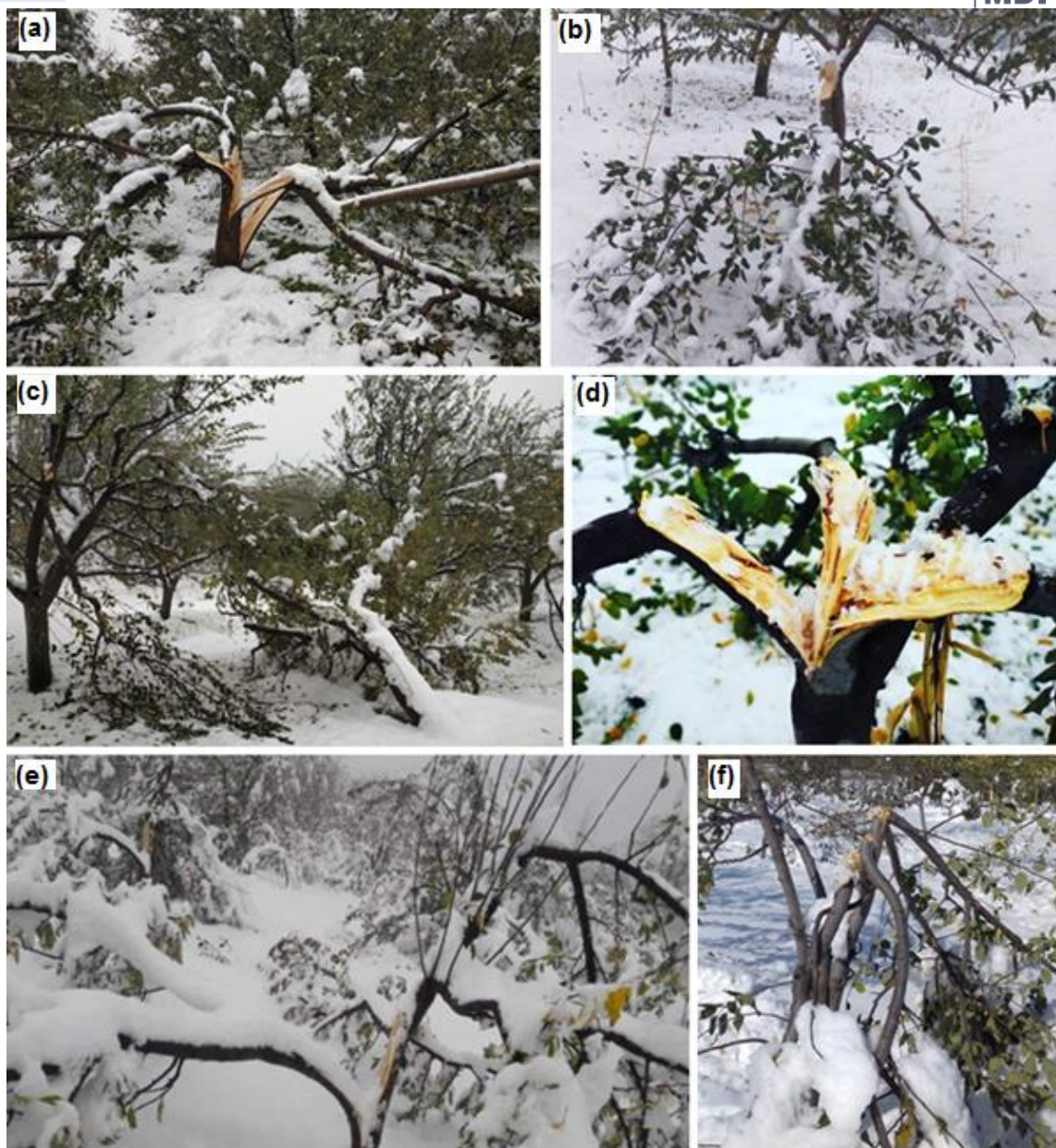


Figure S4: Field photographs showing damages to the Apple orchards in the snowfall events of 2018 and 2019.

Source:

- a) <https://www.dailyexcelsior.com/snowfall-harvest-season-damages-crop-orchards/>
- b) <http://www.knskashmir.com/Relief-announced-for-damaged-apple-orchards-grossly-inadequate--MLA-Shopian-31546>
- c) <https://www.newindianexpress.com/nation/2018/nov/04/first-snowfall-in-november-in-nine-years-pushes-kashmir-to-darkness-damages-apple-orchards-1894255.html>
- d) <https://kashmirlife.net/snowfall-orchard-costs-to-spiral-up-gradually-190976/>
- e) <https://www.newindianexpress.com/nation/2018/nov/04/first-snowfall-in-november-in-nine-years-pushes-kashmir-to-darkness-damages-apple-orchards-1894255.html>
- f) <https://www.dailyexcelsior.com/snowfall-harvest-season-damages-crop-orchards/>



Figure S5: Field photographs showing damage caused by untimely snowfall to the fruit during harvesting.

Source:

- a) <https://boldnewsonline.com/wp-content/uploads/2018/11/apple-and-snow.jpg>
- b) <https://www.downtoearth.org.in/news/climate-change/frost-bites-apple-in-kashmir-62509>
- c) <https://thewire.in/agriculture/kashmirs-fruit-orchards-have-been-ravaged-by-unseasonal-autumn-snowfall>
- d) <https://kashmirilife.net/jk-bank-creates-rs11-cr-distressed-relief-fund-for-snow-affected-apple-farmers-192942/>

**Table 1.** Field-measured snow depth for 2018 and 2019 November snowfall events.

S. No	Sampling location	Snow depth (cm)	
		2018	2019
1	Bangus	30.48	60.96
2	Kalaroos	12.7	30.48
3	Auwoora	16.51	45.72
4	Dardpora	16.51	45.72
5	Chowkibal	12.7	45.72
6	Hyhama	16.51	30.48
7	Chinjamula	16.51	45.72
8	Toasmaidan	99.82	106.68
9	Seedaw	60.96	45.72
10	Pir Ki Gali	121.92	152.4
11	Kulgam	7.62	30.48
12	Ganderbal	10.16	30.48
13	BabanagreeWangatt	15.24	30.48
14	Ganiwan	15.24	30.48
15	Sumbal	15.24	30.48
16	Srinagar	11.43	30.48
17	FaqirGujri	13.97	30.48
18	Nawakadel	5.08	30.48
19	Budgam	13.97	30.48
20	Budgam-Humhama	11.43	30.48
21	Budgam-Beerwah road	11.43	30.48
22	Yousmarg	13.97	76.2
23	Nagam- Charisharif road	13.97	30.48
24	Pakharpora	13.97	45.72
25	Kandajan-Nowgam	13.97	30.48
26	Khag	30.48	60.96
27	Drang	30.48	45.72
28	Khansaeb	13.97	45.72
29	Raithan	21.59	30.48
30	Nilnag	21.59	60.96
31	Kulan	22.86	30.48
32	Rezan	22.86	30.48
33	Anantnag	22.86	38.1
34	Bijbehara	22.86	30.48
35	Pahalgam	30.48	60.96
36	Aru	30.48	60.96
37	Gulmarg	60.96	91.44
38	Kapran	30.48	60.98
39	Khrew	15.24	30.48
40	Kokernag	30.48	60.98
41	Kund	30.48	45.72
42	Pattan	7.62	30.48



43	Qazigund	30.48	45.72
44	Rafiabad	7.62	45.72
45	Shangus	30.48	45.72
46	Aharbal	38.1	45.72
47	Sheeri	7.62	30.48
48	Shopian	30.48	45.72
49	Shopian-Bijbehara	45.72	40
50	Shopian-Kulgam	30.48	40
51	Sopore	5.08	30.48
52	Tangmarg	30.48	45.72
53	Tral	5.08	45.72
54	Verinag	30.48	60.96
55	Wanpoh	20.32	30.48
56	Herporashopian	76.2	76.2
57	Babareshi	35.56	60.96
58	Pulwama	30.48	30.48
59	Shopian-Pulwama road	30.48	32
60	Bandipora-upper reaches	10.16	45.72
61	Bandipora	7.62	30.48
62	Baramulla	5.08	30.48
63	DH Pora	5.08	45.72
64	Doorru	30.48	60.96
65	Frislan	30.48	60.96

Table S2. District-wise area under orchards in Kashmir Valley

District	Orchard area (km ²)	% age	Area damaged (km ²)
Anantnag ^S	144.6	10.88	60.47
Bandipora ^N	28.94	2.18	45.71
Baramulla ^N	305.03	22.94	17.29
Budgam ^C	109.87	8.26	14.09
Ganderbal ^C	35.81	2.69	2.16
Kulgam ^S	171.083	12.87	99.45
Kupwara ^N	84.97	6.39	88.23
Pulwama ^S	214.52	16.14	34.88
Shopian ^S	218.94	16.47	69.48
Srinagar ^C	15.74	1.18	1.75
Total	1329.50	-	433.53

C=Central Kashmir, N=North Kashmir and S=South Kashmir

Table S3. Zone-wise orchards area of Kashmir Valley

Zones	Area (km ²)	% age	Area damaged (km ²)	% damage
North Kashmir	418.94	31.51	151.2	36.10
South Kashmir	749.14	56.35	264.3	35.28
Central Kashmir	161.42	12.14	18.0	11.16

Table S4. Changes (in absolute and %) of temperature and geopotential values after the events based on ERA 5 dataset (average over the region 33.3° - 34.3° N and 74.3°- 75°E).

Day	Actual Values				Drop (in %)			
	2018_temp	2019_temp	2018_z500	2019_z500	2018_temp	2019_temp	2018_z500	2019_z500
Day "0"	3.6	57	5683.3	5675.9	62.1	36.0	2.0	1.5
Day "1"	2.6	2.1	5709.3	5669.2	73.0	75.8	1.6	1.7
Day "2"	3.0	3.1	5720.3	5726.8	69.0	64.7	1.4	0.7
Day "3"	4.2	5.1	5786.3	5759.4	56.4	42.6	0.2	0.1
Day "4"	6.6	5.1	5794.6	5751.1	31.0	41.9	0.1	0.2
Day "5"	6.8	5.1	5767.4	5747.0	29.3	42.2	0.6	0.3
Average 5 days	9.6	8.9	5800.2	5764.7				
before the event								