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Carbon fluxes in spring wheat agroecosystem in India

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Evaluation of ISAM against observations

The sowing date simulated by ISAM is compared against the GGCMI (Global Gridded Crop Model Intercomparison) Phase 3 dataset [Jägermeyr et al., 2021] produced as part of the AGMIP (The Agricultural Intercomparison and Improvement Project). The GGCMI dataset provides a single sowing date, while ISAM simulates the sowing date every growing season. Therefore, we compared the mean sowing date simulated by ISAM for each grid cell from 1980 to 2016 against the sowing date of GGCMI data (Figure S1). We can observe that most parts of the wheat-growing regions have similar sowing dates in both cases except for the northwestern regions. Upon comparing the LAI and growing season simulated by ISAM against the observations, we found that the sowing dates simulated by ISAM are in good agreement with the observations, and perhaps GGCMI data might have a bias in this region.

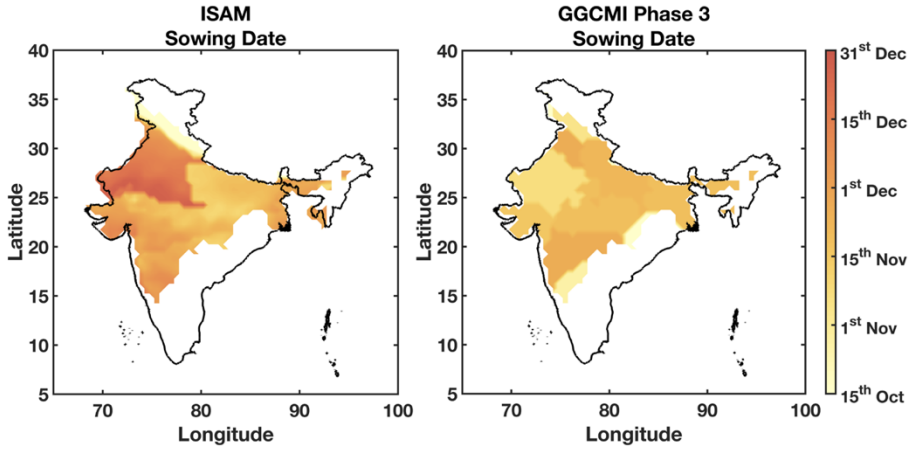

Figure S1: Comparison of sowing date simulated by ISAM against the GGCMI Phase 3 dataset.

The comparison of LAI (Figure S2) shows that the growing season and crop growth are captured reasonably well in most cases. While analyzing the accuracy of the model LAI, we must remember that the grid scale data is compared against the site scale observations. The Fig. S2 also shows the locations of all the spring wheat sites used for ISAM model validation.

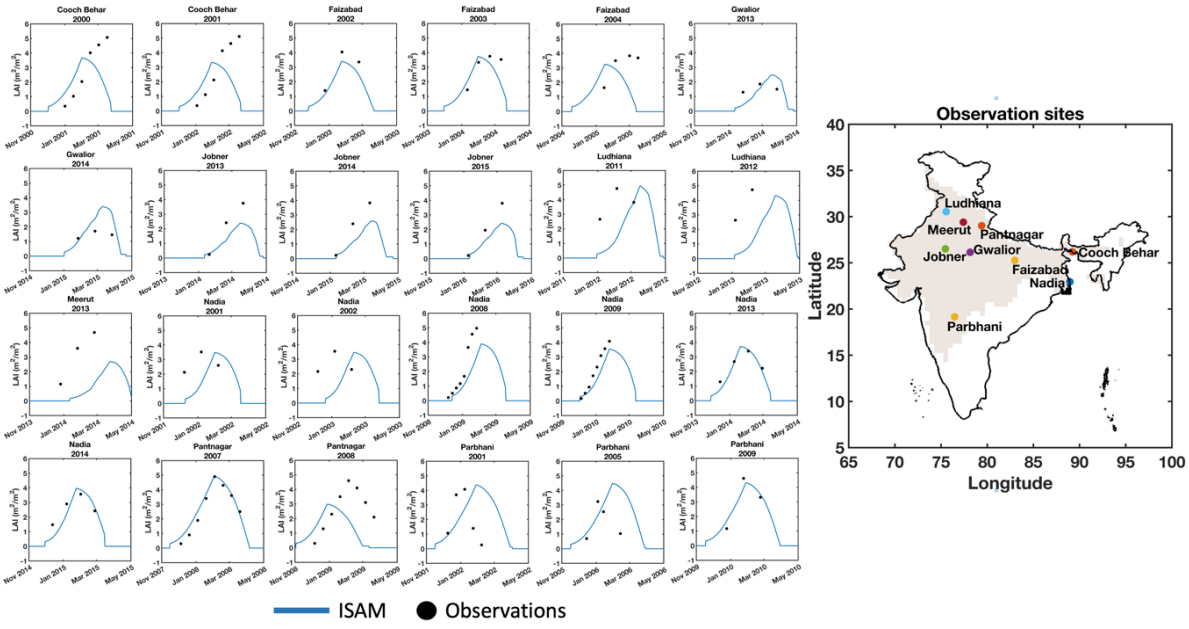

Figure S2: Comparison of site scale LAI observations against ISAM S_{CON} simulations. The map shows the location of the site scale observations.

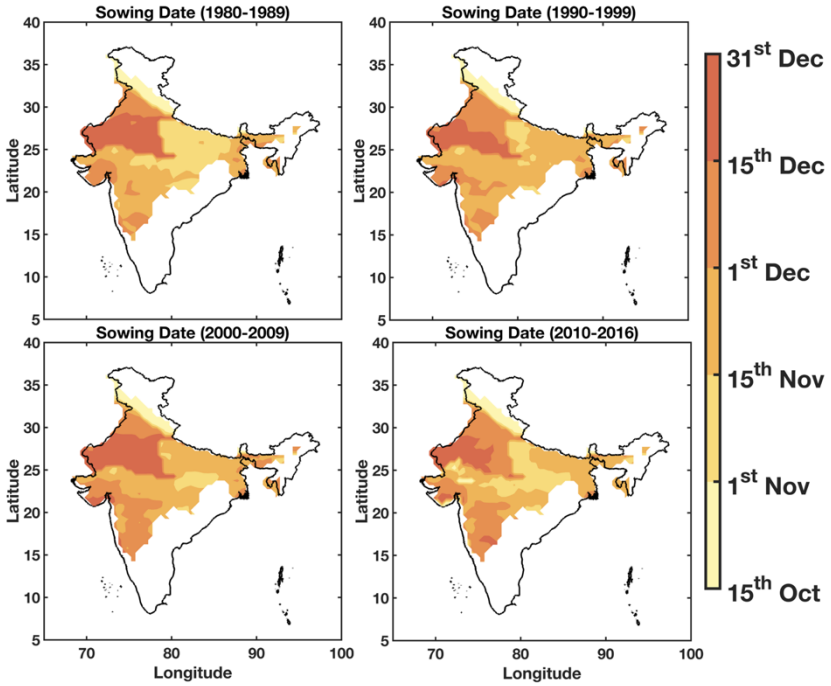

Figure S3: The decadal mean of sowing dates simulated by ISAM.

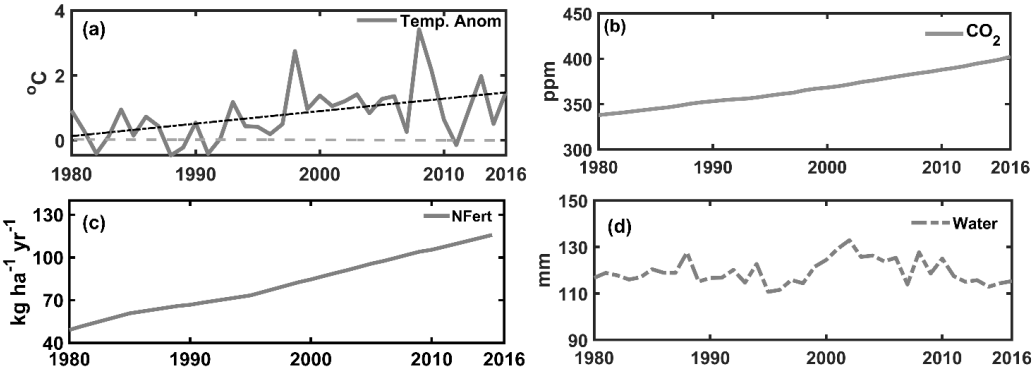

Figure S4: Time series of climate variables (a) Temperature anomaly, (b) Carbon Dioxide and management practice, (c) Nitrogen fertilization, and (d) Anomaly in water available in the root zone (S_{CON} - S_{Water}) during the growing season.

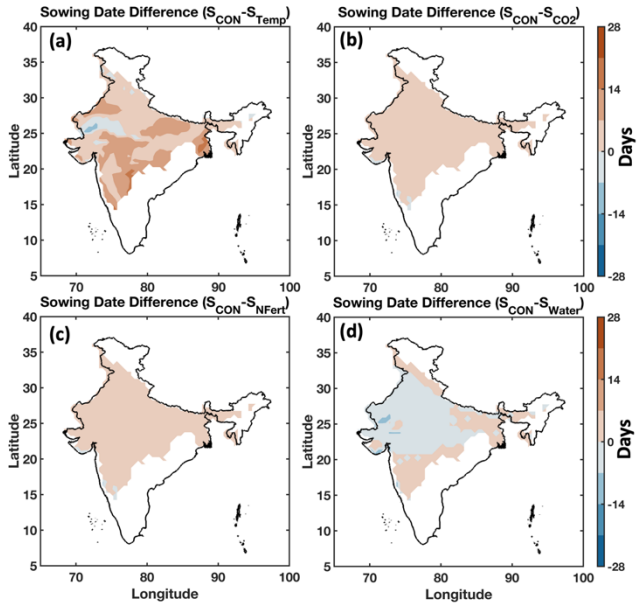

Figure S5: The difference in sowing date caused due to the effect of climatic variables: (a) temperature and (b) [CO_2], and management practices: (c) Nitrogen fertilization and (d) water available.

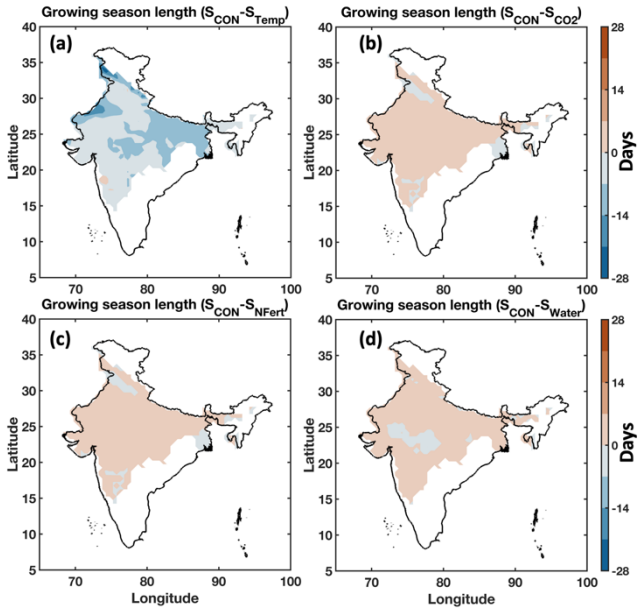

Figure S6: The difference in growing season length caused due to the effect of climatic variables: (a) temperature and (b) [CO_2], and management practices: (c) Nitrogen fertilization and (d) water available.

Table S1: The site details, growing season, and the yield used for the ISAM simulations' validation.

S No	Site Name	Latitude	Longitude	Sowing Year	Yield (kg/ha)	Growing Season Length (days)
1	Cooch Behar	26.19	89.23	2000	3753.67	120
2	Cooch Behar	26.19	89.23	2001	3882.7	121
3	Faizabad	25.26	82.99	2002	4182.33	142
4	Faizabad	25.26	82.99	2003	5082	129
5	Faizabad	25.26	82.99	2004	5152	121
6	Gwalior	26.14	78.15	2013	4309.875	113
7	Jobner	26.51	75.28	2002	4140	129
8	Jobner	26.51	75.47	2013	3676.75	127
9	Jobner	26.51	75.47	2014	3520.25	131
10	Jobner	26.51	75.47	2015	3896	135
11	Ludhiana	30.54	75.56	2011	4571.67	170
12	Ludhiana	30.54	75.56	2012	4579.33	169
13	Meerut	29.4	77.42	2011	3742.495	138
14	Meerut	29.4	77.42	2012	4072.33	142
15	Meerut	29.4	77.42	2013	4206	142
16	Nadia	22.95	88.95	2001	3420	92
17	Nadia	22.95	88.95	2002	3433	124
18	Nadia	22.95	88.95	2008	3175	134
19	Nadia	22.95	88.95	2009	3356	137
20	Nadia	22.95	88.95	2013	3782	126
21	Pantnagar	29.02	79.4	2007	3982.33	126
22	Pantnagar	29.02	79.4	2008	3603.67	126
23	Parbhani	19.16	76.47	2001	2907.22	109
24	Parbhani	19.16	76.47	2005	4450	120
25	Parbhani	19.16	76.47	2009	2761	106

Note: A comprehensive crop dataset for the modeling community to calibrate and validate crop models over the Indian region is created as part of the current study. Here we show the yield and growing season length data of 9 spring wheat sites across 25 growing seasons.

Table S2: Comparison of the carbon flux ratios in various studies

S No	NPP/GPP	Ra/GPP	TER/GPP	Reference
1	0.7385	0.2615	0.5006	This study*
2		~0.3-0.6		Amthor and Baldocchi (2001)
2	0.76	0.24	0.59	Zhang et al. (2020)
3	0.56	0.44	0.60	Aubinet et al. (2009)
4	0.52	0.48	0.57	Aubinet et al. (2009)
5	0.51	0.49	0.71	Demyan et al. (2016)
6	0.54	0.46	0.61	Moureaux et al. (2008)
7	0.55	0.45	0.57	Suleau et al. (2011)
8	0.57	0.43	0.66	Wang et al. (2015)

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