Statistical Analysis for Prediction of Monsoon Variability

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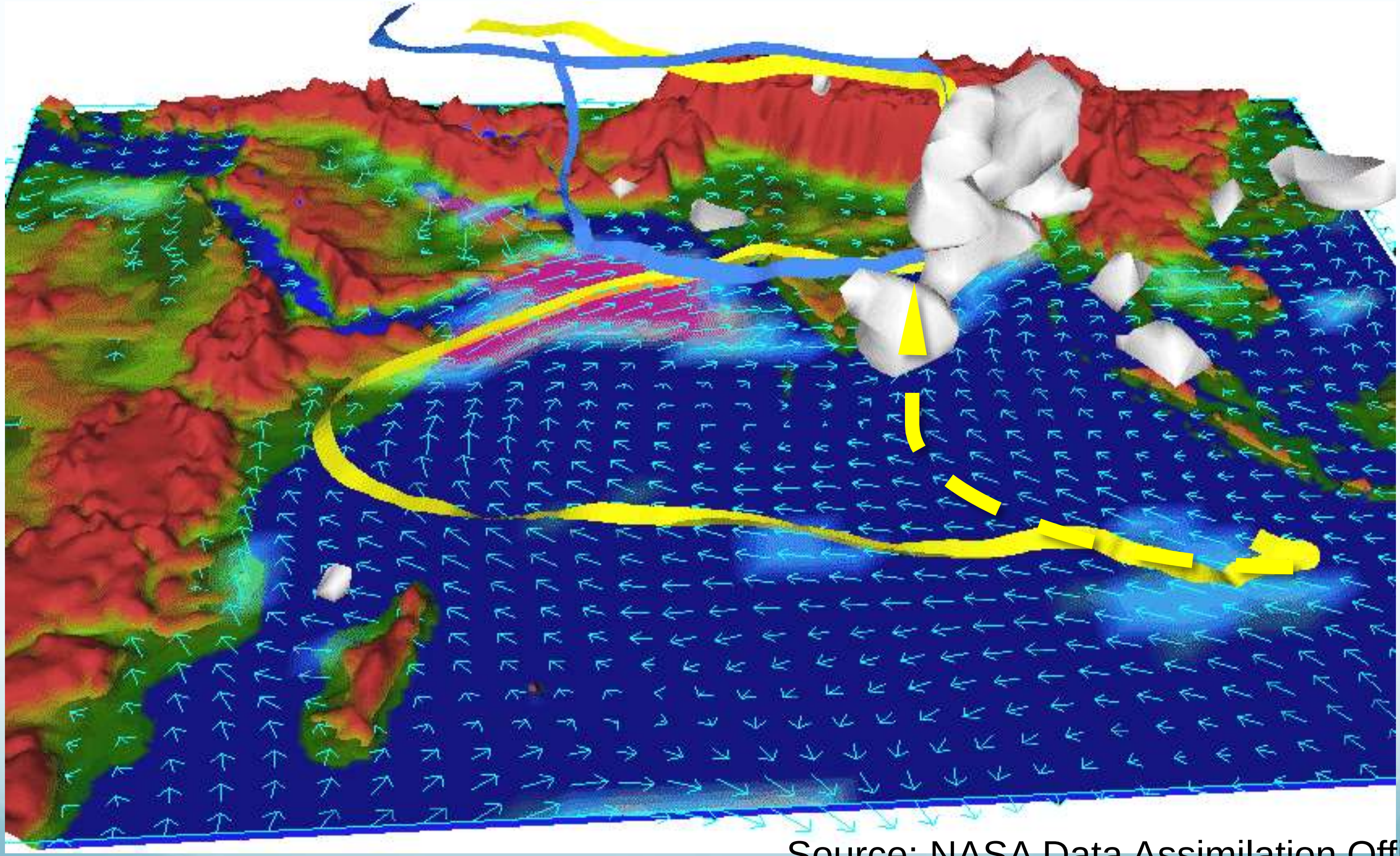
Indian Summer Monsoon, June 1988

Air from the eastern Indian Ocean (ye) and air descending over Arabia (bl) converge in the Somali jet. Low at 30S from MJO.



Source: NASA Data Assimilation Office

Time Series Analysis for 30 Subdivisions (1876-2011)

1. Following DelSole and Shukla (2006), we analyze the influence of winter and spring

- ENSO, IOD, NAO, SAM, QBO signals for 1958-2011 (1876-2011)

on interannual rainfall variability for

- each subdivision using leave-one-out and k-fold cross validation.

2. Grouping subdivisions for predictions over larger area, then "zooming in" by calculating residuals.

3. Taking recent improvements of dynamical models into account (DelSole and Shukla, 2012), we estimate the relationship of

- SST, wind speed and direction, and moisture flux divergence

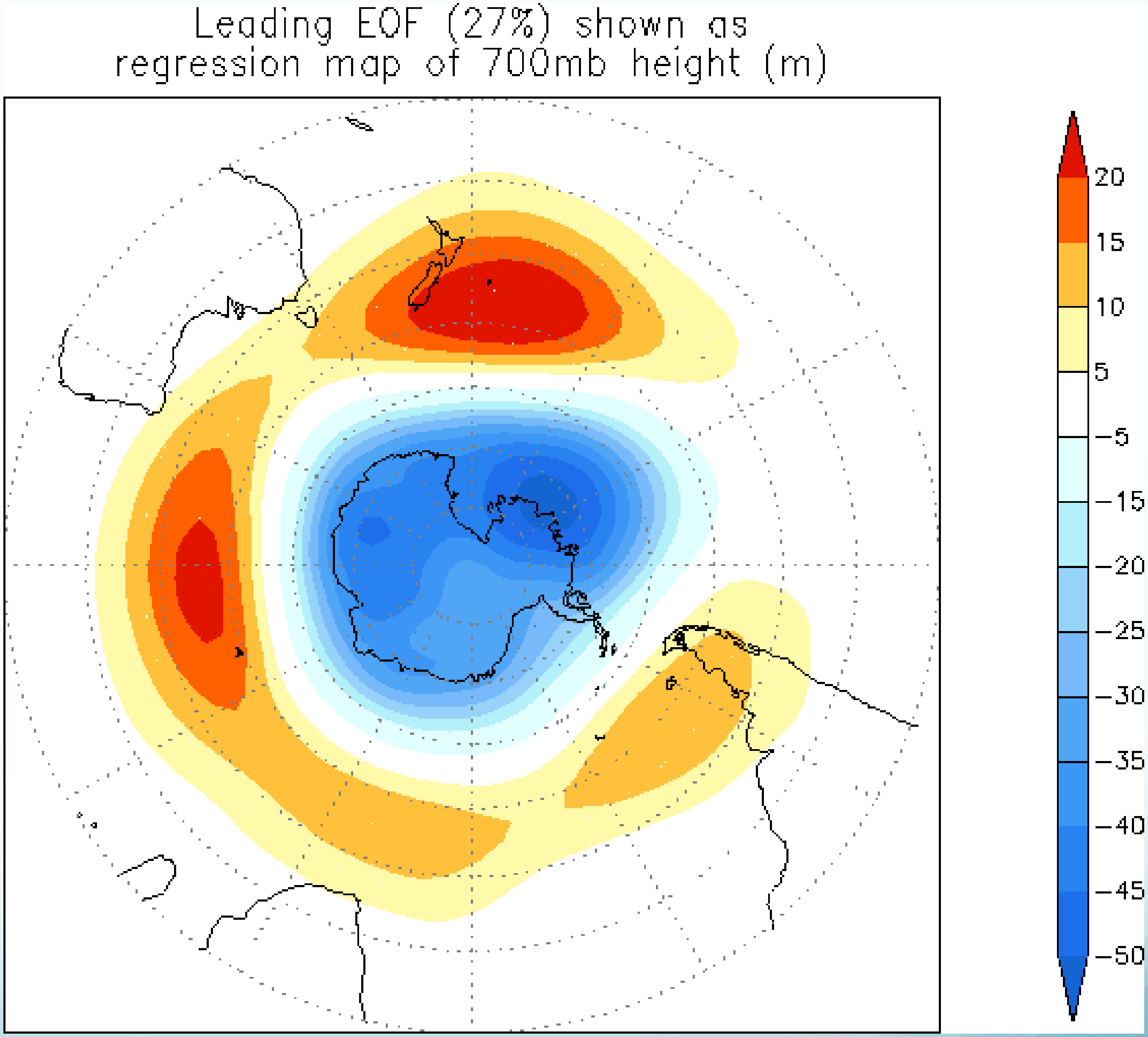
on interannual rainfall variability for

- each subdivision in each summer month.

Southern Annular Mode & Quasi-Biennial Oscillation-Related to Indian Monsoon?

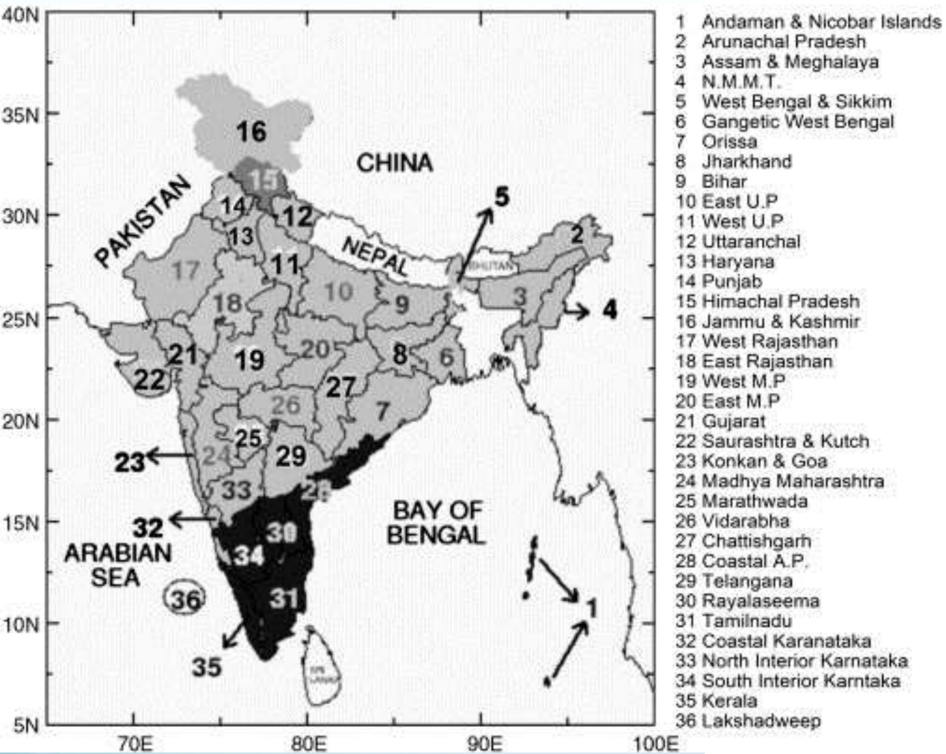
SAM (Mascarene High): Gao et al. 2013

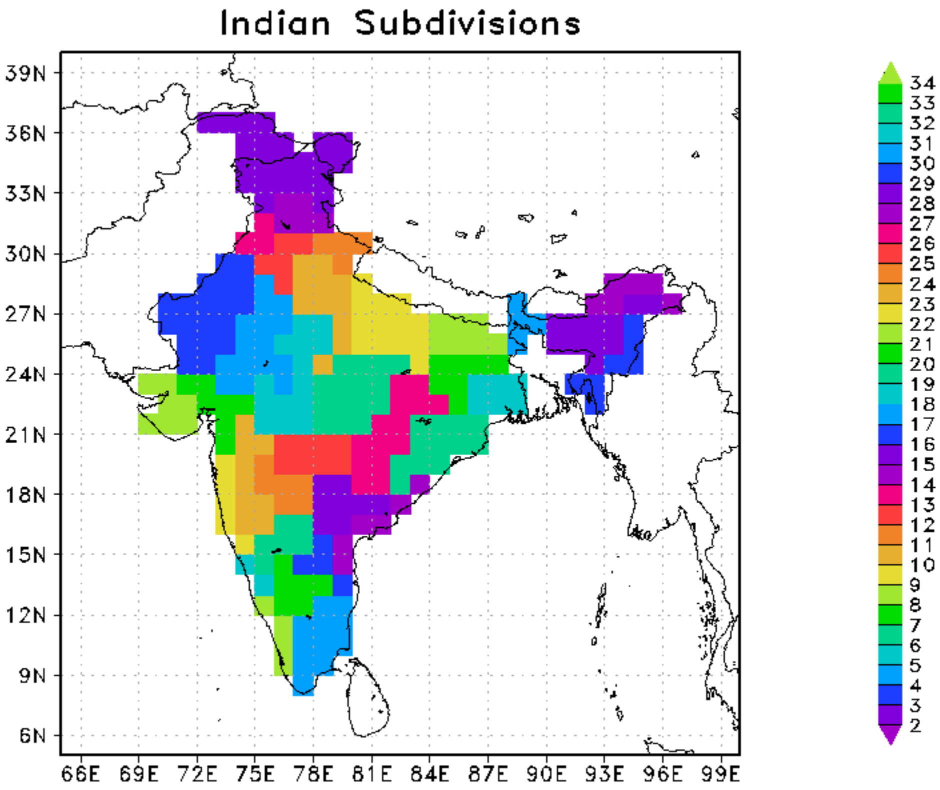
QBO: DelSole and Shukla 2006, Liess and Geller 2012



http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/aao/aao.loading.shtml

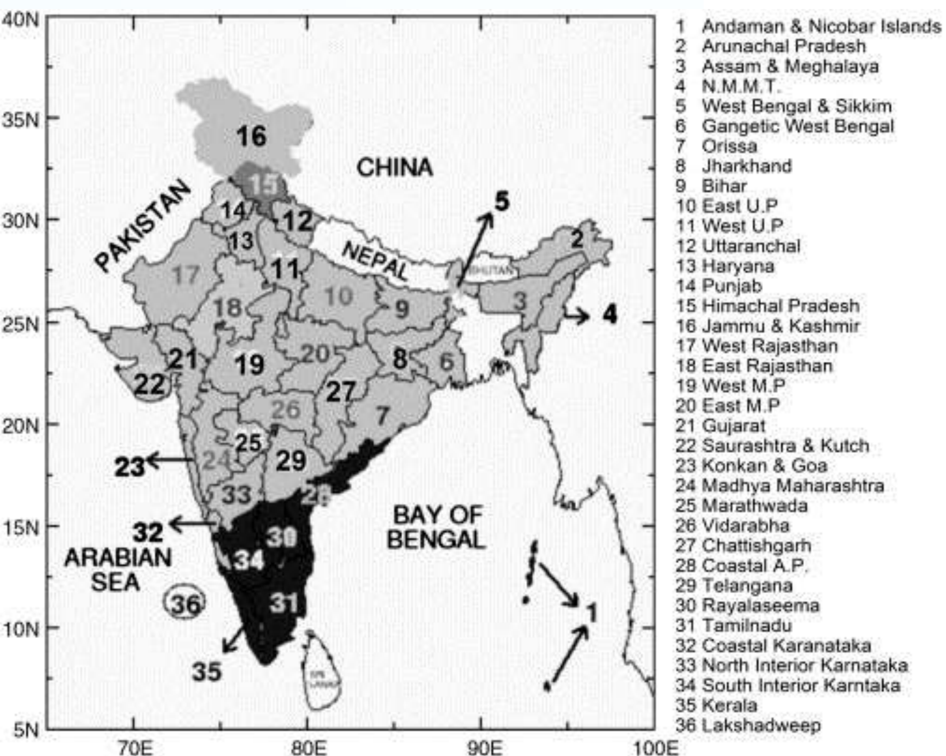
India – Subdivisions on 1°x1° grid



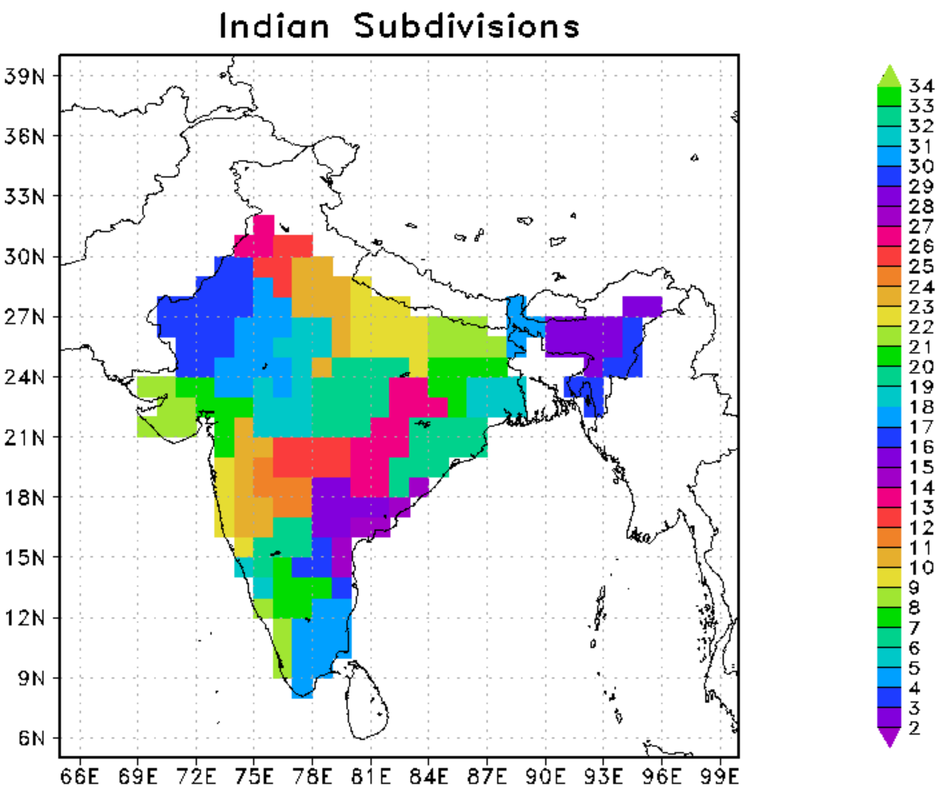


(Naidu et al., 2011)

India – Subdivisions on 1°x1° grid



(Naidu et al., 2011)



ftp://www.tropmet.res.in/pub/data/rain/13Jun2012/30-SUBDIVRF-REV1.TXT

DelSole and Shukla (2006) and others: 16 co-variates

- **b) dtend:** Darwin sea-level pressure tendency: March-April-May average minus December- January-February average (see Shukla and Paolino, 1983)
- **c) nino34mam:** NINO3.4 (Pacific surface temperature over 170°W-120°W, 5°S-5°N), March- April-May average. (Hadley Center, Rayner et al., 2003, http://hadobs.metoffice.com/hadisst/)
- **d) naojf:** NAO (sea-level pressure difference between Gibraltar and Stykkisholmur, Iceland) January-February mean. (University of East Anglia; available from www.cru.uea.ac.uk)
- **e) naoam:** NAO (sea-level pressure difference between Gibraltar and Stykkisholmur, Iceland): April-May mean. (same as d)
- **g) wpacmam:** SST averaged in the western Pacific region 120°E-160°E, 5°S-5°N, March-April- May average (same as c).
- **h) eindmam:** SST averaged in the eastern Indian Ocean region 70°E-100°E, 5°S-5°N, March-April-May average (same as c).
- **i) arabmam:** SST averaged in Arabian Sea region 50°E-70°E, 5°N-15°N, March-April-May average (same as c).
- **j) teurodjf:** Eurasian surface temperature (30°E-50°E, 60°N-70°N), December-January-February average. (Jones and Moberg 2003)
- **k) tindiamam:** Indian surface temperature (55°E-75°E, 25°N-35°N), March-April-May average (same as j).

- **l) sam_jf:** Southern Annular Mode, January-February average
- **m) sam_ma:** Southern Annular Mode, March-April average
- **n) snowcov_a:** Snowcover over Eurasia, April in sq m.
- **o) qbo_70hPa_jf:** Quasibiennial Oscillation at 70 hPa, January-February average
- **p) qbo_70hPa_fm:** Quasibiennial Oscillation at 70 hPa, February-March average
- **q) qbo_70hPa_ma:** Quasibiennial Oscillation at 70 hPa, March-April average
- **r) iodmam:** Indian Ocean Dipole, March-April-May average

k-Fold Errors (1958-2011, 1876-2011)

*Non-significant results for **9** subdivisions

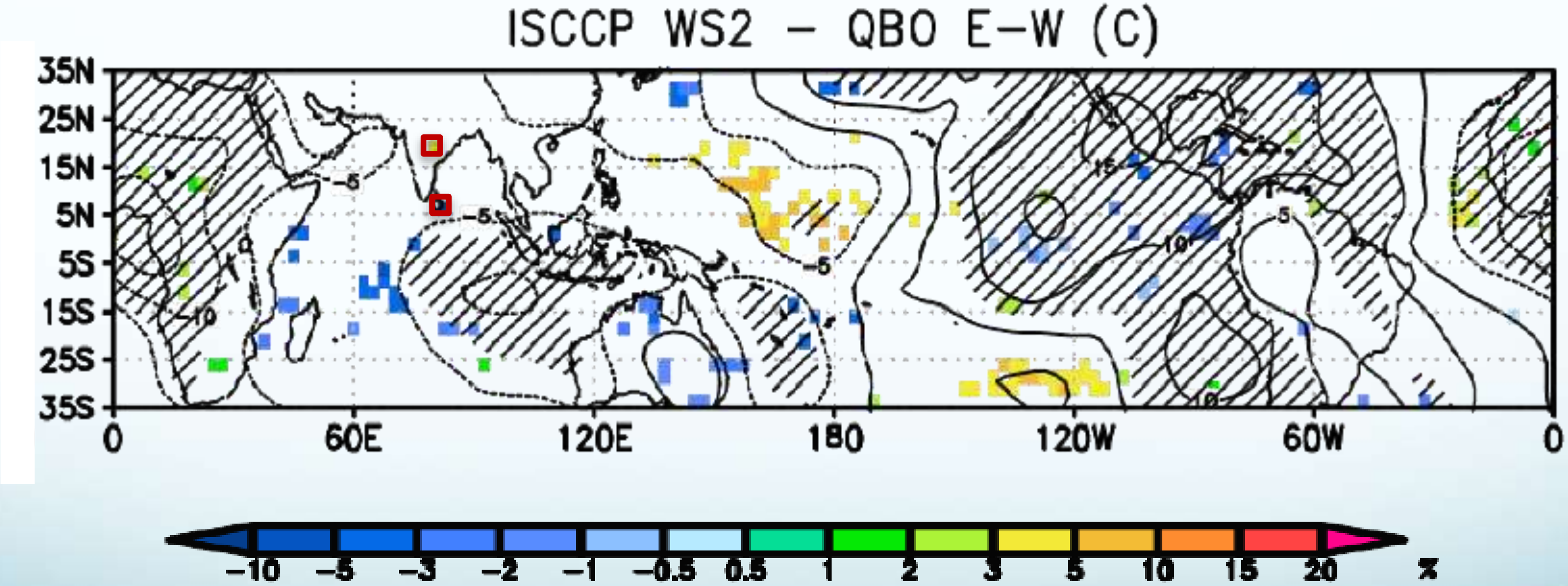
	mean rmse (cm)	std. dev (cm)	corr.
3*	22.54	22.52	0.18
4	**16.94**	**16.95**	**0.21***(NAOjf,arabmam)**
5	**30.75**	**30.75**	**0.32**
6	**18.20**	**18.24**	**0.36**(QBOfm, iodmam)**
7*	17.23	17.26	0.24
8	**19.00**	**19.03**	**0.34**
9*	19.36	19.33	0.28**(snow)
10	**15.93**	**15.96**	**0.45**(QBOma)**
11*	15.90	15.94	0.30**(SAM_ma, iodmam)
13*	13.98	14.01	0.31
14	**16.21**	**16.24**	**0.50**
17	**8.70**	**8.72**	**0.56**
18	**13.61**	**13.64**	**0.39**
19	**15.97**	**15.99**	**0.33**
20	**17.46**	**17.50**	**0.41**(QBOma)**
21*	25.77	25.81	0.28
22*	19.42	19.46	0.13
23	**37.15**	**37.24**	**0.42**
24*	10.45	10.46	0.28
25	**15.05**	**15.08**	**0.64**
26	**16.14**	**16.16**	**0.50**(SAM_ma)**
27	**19.46**	**19.47**	**0.35***(NAOjf,teurodjf)**
28	**11.41**	**11.43**	**0.42**(dtend, QBOma)**
29	**15.66**	**15.69**	**0.48**(dtend, QBOma)**
30	**11.10**	**11.10**	**0.41**(dtend, QBOma)**
31	**6.96**	**6.97**	**0.38**
32	**48.84**	**48.91**	**0.36**(dtend, iodmam)**
33	**10.44**	**10.47**	**0.35**(teurodjf, QBOma)**
34	**8.95**	**8.96**	**0.35**(teurodjf, iodmam)**
35*	35.28	35.34	0.11
ALL India	**7.80**	**7.80**	**0.39**

Weights from k-Fold (1958-2011, 1876-2011)

	dtend	nino34 mam	naojf	naoam	wpac mam	eind mam	arab mam	teurodjf	tindia mam	sam_jf	sam_ma	snow cov_a	qbo_70 hPa_jf	qbo_70 hPa_fm	qbo_70 hPa_ma	iod mam
3					-8.43	3.22										
4			-2.10				-5.15									
5	-5.58			-9.16												
6			7.57											-4.40		4.27
7				3.43	3.71			4.74								
8		-5.49						6.78								
9*		-7.48					5.70					3.31				
10			6.57	-6.49											-5.10	
11*				-4.91							3.48					-4.93
13	-4.67			-3.81												
14			6.34	-5.84		-4.45										
17	-3.67		2.90													
18	-4.40					-3.00		3.56								
19	-7.52					-12.62	10.18									
20			2.93												-6.35	
21*			-5.45				5.30	11.54								
22*						5.31										
23	-14.44				-13.23		13.84									
24			-3.88				3.38	5.14								
25	-11.00			-2.57			5.93									
26	-8.33								3.90		-4.63					
27			-4.80			-7.49		5.39								
28	-5.12			-2.98											2.85	
29	-7.85														3.33	-1.71
30	-5.09						2.94								4.45	
31	-1.42	-1.20														
32	-22.63							11.62								15.34
33			-6.39					5.97							2.85	
34			-4.12					5.42								-2.14
35*								5.71								
India	-3.04						0.68	2.69								

Impact of QBO (70 hPa zonal wind) on Deep Convection and Hadley Circulation

WS2 = growing deep convection (shaded)
200 hPa velocity potential (hatched)



(Liess and Geller, JGR, 2012)

Time Series Analysis for 30 Subdivisions (1876-2011)

1. Following DelSole and Shukla (2006), we analyze the influence of winter and spring

- ENSO, IOD, NAO, SAM, QBO signals for 1958-2011 (1876-2011)

on interannual rainfall variability for

- each subdivision using Leave-One-Out and k-fold cross validation.

→ **2.** Grouping subdivisions for predictions over larger area, then "zooming in" by calculating residuals.

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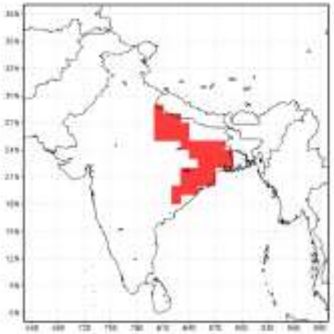
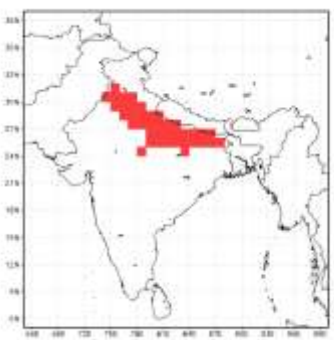
- each subdivision in each summer month.

Grouping Subdivisions by Main Co-Variate: East and North

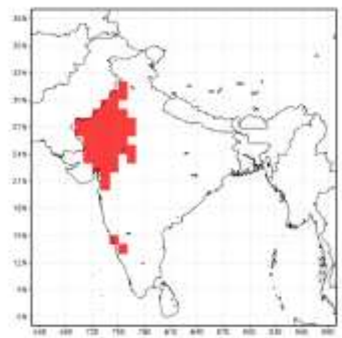


1958-2011 9-fold cross val.	Precip. Obs.	**teuro_djf**		qbo_fm		qbo_mam		nino_mam		**teuro_djf + nino_mam**		**teuro_djf + qbo_fm**		**teuro_djf + qbo_mam**	
	RMSE	RMSE	CORR	RMSE	CORR	RMSE	CORR	RMSE	CORR	RMSE	CORR	RMSE	CORR	RMSE	CORR
6.Gangetic WB	20.21	19.92	0.13	20.35	0.01	20.45	-0.05	20.44	0.07	20.05	0.19	19.86	0.16	19.92	0.15
7.Orrisa	17.21	17.77	0.07	18.04	-0.1	18.09	-0.12	18.53	-0.23	18.28	0.01	17.82	0.08	17.84	0.08
8.Jharkhand	20.14	19.1	0.28	20.18	0.05	20.1	0.07	20.07	0.13	18.82	**0.34**	19.15	0.28	19.06	0.3
10.East UP	18.23	18.17	0.14	17.91	0.2	17.94	0.19	17.8	0.22	17.44	0.3	17.65	0.27	17.67	0.26
Group 6,7,8,10	13.96	12.91	**0.33**	13.52	0.2	13.59	0.17	13.57	0.22	12.46	**0.43**	12.53	**0.4**	12.55	**0.4**

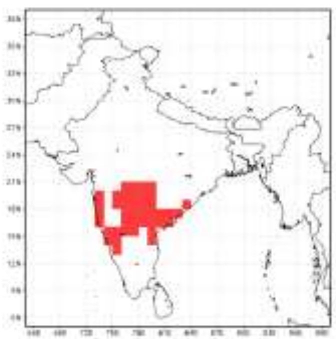


1958-2011 9-fold cross val.	Precip. Obs. RMSE	**NAO_am**		NAO_jf		**NAO_am & NAO_jf**	
		RMSE	CORR	RMSE	CORR	RMSE	CORR
9.Bihar	20.23	20.78	0.03	21.13	-0.15	20.92	0.06
10.East UP	18.23	17.88	0.2	18.07	0.17	17.15	**0.35**
11.West UP	17.13	17.16	0.05	17.48	-0.37	17.53	-0.02
13.Haryana	13.96	14.43	0.05	14.59	-0.26	14.68	0.01
14.Punjab	17.95	18.65	0.07	18.15	0.18	17.57	**0.32**
Group 9, 10,11,13,14	12.76	12.38	0.27	12.79	0.15	11.8	**0.4**

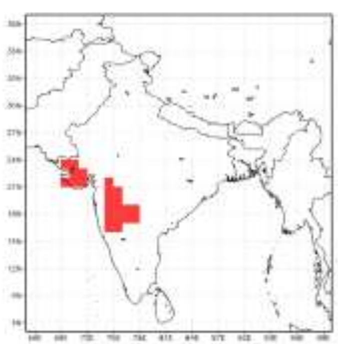
Grouping Subdivisions by Main Co-Variate: West and South



1958-2011 9-fold cross val.	Precip. Obs.	teuro_djf		dtend		teuro_djf & dtend	
	RMSE	RMSE	CORR	RMSE	CORR	RMSE	CORR
14.Punjab	17.95	18.23	0.18	18.69	0.02	17.87	0.25
17.West Rajasthan	10.34	10.53	0.06	10.19	0.22	9.81	**0.33**
18.East Rajasthan	14.68	14.69	0.09	14.73	0.1	14.2	0.25
21.Gujarat	26.6	26.49	0.18	27.77	-0.03	26.91	0.17
32.Coastal Karnatak	50.31	50.97	0.05	49.56	0.17	49.38	0.22
Group 14,17, 18, 21, 32	15.04	14.67	0.27	14.95	0.21	13.78	**0.42**



1958-2011 9-fold cross val.	Climatic RMSE	dtend	
		RMSE	CORR
23.Konkan & Goa	41.28	38.01	0.29
25.Marathwada	18.7	16.68	**0.49**
26.Vidharbha	18.06	16.62	**0.34**
28.Coastal AP	12.32	12.1	0.25
29.Telangana	17.31	16.07	**0.38**
32.Coastal Karnatak	50.31	49.56	0.17
33.North Int. Karnataka	12.26	12.36	0.11
Group 23 ,25 ,26, 28, 29, 32 ,33	18.23	16.31	**0.43**



1958-2011 9-fold cross val.	Precip. Obs.	dtend		arabmam		dtend & arabmam	
	RMSE	RMSE	CORR	RMSE	CORR	RMSE	CORR
22.Saurasht.& Kuchch	21.21	20.62	-0.1	20.5	0.03	20.56	0.07
24.Madhya Maha.	11.99	12.8	-0.06	12.45	0.14	12.45	0.17
25.Marathwada	18.7	16.68	**0.49**	18.74	0.2	15.53	**0.58**
Group 22,24,25	14.48	13.79	**0.34**	14.29	0.23	12.91	**0.47**

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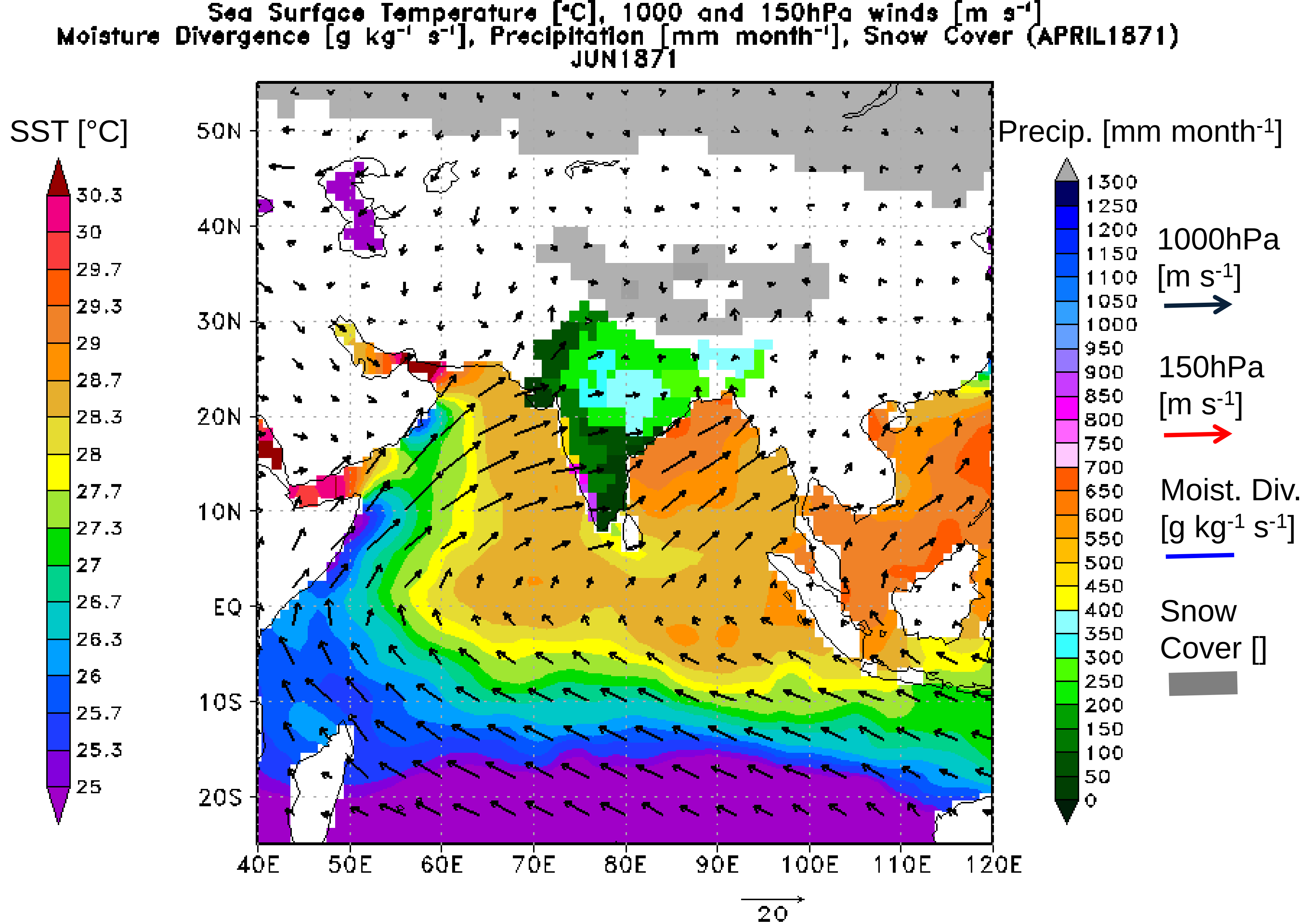
Sea Surface Temperature [°C], 1000 and 150hPa winds [m s⁻¹]
Moisture Divergence [g kg⁻¹ s⁻¹], Precipitation [mm month⁻¹], Snow Cover (APRIL1871)
JUN1871
SST [°C]
30.3
30
29.7
29.3
29
28.7
28.3
28
27.7
27.3
27
26.7
26.3
26
25.7
25.3
25
50N
40N
30N
20N
10N
EQ
10S
20S
40E
50E
60E
70E
80E
90E
100E
110E
120E
20
Precip. [mm month-1]
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
1000hPa [m s-1]
150hPa [m s-1]
Moist. Div. [g kg-1 s-1]
Snow Cover []

Bansod et al. (2012) and others: 17 co-variates

a) **Uwnd_tibet_200:** zonal wind at 200 hPa level over Tibetan anticyclone region (40°E-100°E, 25°N-45°N),

b) **Uwnd_India 100:** tropical easterly jet (zonal wind) at 100 hPa level over India (60°E-100°E, 10°N-20°N),

c) **Vwnd_arabian:** meridonal wind at 850hPa level over Arabian Sea (55°E-70°E, 10°N-20°N),

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d) **Uwnd_arabian:** as c), but zonal wind,

e) **sst_arabian:** as c), but sea surface temperature,

f) **dir_arabian:** as c), but wind direction,

g) **sdiv_arabian:** as c), but moisture flux divergence,

h) **kinE_arabian:** as c), but kinetic energy,

i-n) ***_bengal:** as c-h, but for Bay of Bengal (80°E-95°E, 10°N-20°N),

o) **IOD:** Indian Ocean Dipole

p) **SOI:** Southern Oscillation Index

q) **SAM:** Southern Annular Mode

June: Leave-One-Out Errors (1958-2011)

*Non-significant results for **3** subdivisions

	mean rmse (cm)	std. dev (cm)	corr.
3	**9.57**	**9.66**	**0.34**
4*	9.04	9.12	0.29
5*	11.03	11.14	0.25
6	**7.73**	**7.81**	**0.58**
7	**5.56**	**5.61**	**0.68**
8	**7.77**	**7.84**	**0.64**
9	**7.09**	**7.15**	**0.45**
10	**5.48**	**5.53**	**0.64**
11	**4.43**	**4.47**	**0.66**
13	**3.16**	**3.19**	**0.50**
14	**4.09**	**4.13**	**0.54**
17	**3.25**	**3.28**	**0.35**
18	**3.92**	**3.96**	**0.54**
19	**4.79**	**4.84**	**0.57**
20	**6.90**	**6.97**	**0.62**
21	**9.04**	**9.12**	**0.39**
22	**5.35**	**5.40**	**0.46**
23	**16.00**	**16.15**	**0.42**
24	**4.41**	**4.45**	**0.55**
25	**5.24**	**5.29**	**0.36**
26	**5.68**	**5.73**	**0.53**
27	**7.04**	**7.10**	**0.67**
28	**3.40**	**3.43**	**0.70**
29	**3.82**	**3.85**	**0.53**
30	**3.86**	**3.89**	**0.67**
31	**2.03**	**2.05**	**0.66**
32	**22.02**	**22.23**	**0.46**
33*	4.84	4.89	0.21
34	**3.48**	**3.51**	**0.49**
35	**17.44**	**17.61**	**0.35**
ALL India	**1.82**	**1.84**	**0.84**

June: Leave-One-Out Weights (1958-2011)

	IOD	SAM	SOI	sst_ arabian	sst_ bengal	dir_ arabian	dir_ bengal	kinE_ arabian	kinE_ bengal	sdiv_ arabian	sdiv_ bengal	Uwnd_ arabian	Uwnd_ bengal	Uwnd_ India 1	Uwnd_ tibet_2	Vwnd_ arabian	Vwnd_ bengal
3			-3.59								3.85			-2.83			
4*			-2.11											-4.32			1.94
5*						-4.19		-9.98				14.89					
6							2.23					6.36		3.48			
7							2.25	5.29						2.27			
8												5.14				3.43	3.14
9						-2.71						5.39				1.50	
10						-2.42						7.47		1.95			
11						-2.76						4.79				2.98	
13			1.29									2.39		2.18			
14								1.53								1.94	1.45
17				2.63	-1.66			1.80									
18	1.43							2.95		1.25							
19				3.11						1.93		5.25					
20				2.36			2.15					6.29					
21				4.54			-2.13					5.99					
22				2.26			-2.18					3.85					
23												9.44			4.86		
24										1.75		3.49	-3.31				
25						2.36					2.80					-1.42	
26						4.00					2.22				1.63		
27								5.94			-2.14						2.33
28						1.41			7.83				-8.82				
29	-1.20					1.74											2.20
30									8.24				-1.17				
31								-0.95	5.42				-5.84				
32				6.46				18.49								-7.57	
33*						1.79							-1.82				
34						1.75		6.76				-8.60					
35				5.23					26.28				-17.97				
ALL India												2.33				0.84	1.46

JJAS: Leave-One-Out Errors (1958-2011)

*Non-significant results for 4 subdivisions

	mean rmse (cm)	std. dev (cm)	corr.
3	**21.31**	**21.51**	**0.40**
4*	17.93	18.10	0.06
5	**27.80**	**28.06**	**0.42**
6*	19.76	19.94	0.25
7	**14.30**	**14.44**	**0.56**
8	**16.53**	**16.69**	**0.57**
9*	20.83	21.03	0.27
10	**15.14**	**15.28**	**0.56**
11	**14.55**	**14.68**	**0.54**
13	**11.21**	**11.31**	**0.60**
14	**14.69**	**14.82**	**0.58**
17	**9.85**	**9.94**	**0.34**
18	**13.25**	**13.37**	**0.44**
19	**14.61**	**14.75**	**0.53**
20	**16.24**	**16.39**	**0.54**
21	**21.85**	**22.06**	**0.58**
22	**18.98**	**19.16**	**0.46**
23	**38.48**	**38.85**	**0.38**
24	**10.93**	**11.04**	**0.42**
25	**16.58**	**16.74**	**0.47**
26	**15.88**	**16.03**	**0.48**
27	**16.72**	**16.87**	**0.59**
28	**10.69**	**10.80**	**0.51**
29	**16.15**	**16.30**	**0.38**
30	**9.37**	**9.45**	**0.66**
31	**6.06**	**6.11**	**0.52**
32	**45.82**	**46.25**	**0.44**
33*	11.92	12.03	0.25
34	**9.38**	**9.47**	**0.47**
35	**29.55**	**29.82**	**0.54**
ALL India	**6.08**	**6.14**	**0.70**

JJAS: Leave-One-Out Weights (1958-2011)

	IOD	SAM	SOI	sst_ arabian	sst_ bengal	dir_ arabian	dir_ bengal	kinE_ arabian	kinE_ bengal	sdiv_ arabian	sdiv_ bengal	Uwnd_ arabian	Uwnd_ bengal	Uwnd_ India 1	Uwnd_ tibet_2	Vwnd_ arabian	Vwnd_ bengal
3					7.64											-11.38	
4*							5.43		-4.39		2.20				2.54		
5							8.48		-2.84								7.22
6*												7.88		5.17			
7								5.77					5.14			5.51	
8	4.69	-4.45						11.63									
9*									1.83								
10			5.74					-19.72				27.56					
11									-6.26			9.48					6.95
13								-28.96				35.69	-8.66				
14			8.25									7.87				-5.76	
17							-3.73	3.57		3.37							
18								6.24		6.12					-2.84		
19								8.18		8.23			3.79				
20										4.68		13.73			3.69		
21								17.39	-8.24								6.86
22						6.62		42.53				-4.15					
23			8.39			9.28											15.25
24			3.59		5.15	4.35											
25			7.75		7.27	5.25											
26							-4.28	11.14		6.56							
27					-6.12			1.27									4.57
28			3.89						18.83				-2.80				
29			5.83					4.65		5.33							
30		-3.45							21.84				-27.63				
31					-3.34								-4.93				2.74
32			13.96			14.23											2.19
33*			4.18														
34			4.77					13.32				-13.17					
35			11.27						14.97								11.27
ALL India			2.25									4.69					2.87

Conclusions Pt. 1

- k-fold cross validation for 5-year intervals is an alternative measure for predictors to Leave-One-Out: a) it uses less co-variates (2-3) b) it is less prone to overfitting.
- Some co-variates show inconclusive results (positive and negative weights at different subdivisions) and should be treated carefully.
- Including a) snow cover over Europe, b) SAM, c) IOD, and d) QBO at 70 hPa improves statistical prediction of interannual monsoon variability – correlations are significant in all subdivisions but Bihar, Western Uttar Pradesh, Haryana, Saurashtra & Kutch, and Kerala (9, 11, 13, 22, 35) – but LOO results have to be treated with care.
- Grouping subdivisions by their dominant co-variate reduces forecast error and can be a first step to more local prediction.

Conclusions Pt. 2

- Next to SOI, wind direction, U-wind, and moisture divergence over the Arabian Sea, and V-wind over the Bay of Bengal are related to the Indian Summer monsoon precipitation over many subdivisions.
- SSTs, kinetic energy over the Arabian Sea and Bay of Bengal, and other local variables produce inconclusive results due to weights with opposing signs.
- SAM plays a small role, mostly during July.

Future Work

- Use output from dynamical prediction models as predictors to downscale ISMR to each subdivision and weekly forecasts. E.g.: ECMWF, UKMO, Meteo France, CMCC, IFM-GEOMAR (DelSole and Shukla 2012); NCEP CFSv2 (Zuo et al. 2013, Pattaniak et al. 2013).
- Include spatial dependencies and orography via clustering and nearest-neighbor approaches.

Leave-One-Out Errors (1958-2011, 1876-2011)
*Non-significant results for 8 subdivisions

	mean rmse (cm)	std. dev (cm)	corr.
3	**19.87**	**19.94**	**0.21***(wpacmam value)**
4	**17.01**	**17.07**	**0.23***(arabmam)**
5*	30.10	30.38	0.21
6	**19.13**	**19.31**	**0.34**
7	**16.38**	**16.53**	**0.34**(QBOma)**
8	**19.10**	**19.28**	**0.33**
9*	20.32	20.51	0.19
10	**16.30**	**16.46**	**0.46**(QBOma)**
11*	16.69	16.84	0.26**(SAM, IODneg)
13*	13.39	13.52	0.31
14	**15.95**	**16.10**	**0.48**
17	**9.92**	**10.02**	**0.30**
18*	14.24	14.38	0.28
19	**16.28**	**16.43**	**0.36**
20*	18.84	19.02	0.22**(QBOma instead of NAOjf, eind?)
21	**25.63**	**25.87**	**0.30**
22*	19.26	19.33	0.20***(dtend)
23	**39.28**	**39.64**	**0.36**
24	**11.21**	**11.32**	**0.39**
25	**15.23**	**15.37**	**0.58**
26	**16.65**	**16.80**	**0.40**
27	**19.37**	**19.44**	**0.35***(NAOjf,TEURODjf)**
28	**11.41**	**11.51**	**0.41**
29	**15.96**	**16.11**	**0.42**
30	**11.54**	**11.65**	**0.41**
31	**7.06**	**7.08**	**0.22***(NINO34)**
32	**49.06**	**49.51**	**0.31**
33	**9.98**	**10.08**	**0.59**
34	**9.81**	**9.90**	**0.41**
35*	36.59	36.73	0.14***(NAO,wpac,eind)
ALL India	**7.77**	**7.85**	**0.42**

Weights from Leave-One-Out (1958-2011, 1876-2011)

	dtend	nino34 mam	naojf	naoam	wpac mam	eind mam	arab mam	teurodjf	tindia mam	sam_jf	sam_ma	snow cov_a	qbo_70 hPa_jf	qbo_70 hPa_fm	qbo_70 hPa_ma	iod mam
3					-5.43											
4							-4.84									
5*				-9.82		6.70										
6			7.93		3.89											
7	5.67			3.56				4.55					-3.91			
8		-5.49						6.78								
9*			8.93	-6.88				-7.72								
10		-3.65	5.53	-5.53										-5.26		
11*				-4.96							3.48					-4.93
13*	-4.67			-3.81												
14	-5.93		6.97	-5.21		-6.85			3.22							
17	-3.43							2.58								
18*	-4.40					-3.00		3.56								
19	-7.41		3.82		-3.41	-12.50	12.22						-			
20*															-6.44	
21	-6.36						6.98	8.62								
22*	-3.33						4.36									
23	-15.24				-16.87		11.14		1.61							
24		-6.89	-4.89		-6.28	1.25		5.86								
25	-1.84						6.19									
26	-8.44								4.19							
27			-4.89			-7.49		5.39								
28	-3.26	-8.45	-4.19		-6.58	9.41		5.31								
29	-6.93	-9.86			-9.76	9.94										
30	-3.16	-9.16	-5.54		-5.74	6.93	5.73	6.26	-4.48							
31	-1.74	-1.97	-1.25													
32	-15.55	-21.74			-2.21		3.87	15.37	-14.53							
33		-9.77	-7.33		-1.56	12.97		6.81								
34		-6.53	-4.94		-7.48	8.63		6.25								
35*			4.40		-9.49	8.30										
India	-3.33	-3.27			-3.48		3.94	2.99								