

Tropical Cyclone Energy Matrix over North Indian Ocean

**Regional Specialised Meteorological Centre (RSMC)
India Meteorological Department
Mausam Bhavan, Lodi Road, New Delhi - 110003**

Regional Specialised Meteorological Centre (RSMC), New Delhi, has prepared average Velocity Flux, Accumulated Cyclone Energy (ACE) and Power Dissipation Index (PDI) of cyclonic disturbances (Depression and above) and tropical cyclones (cyclonic storm and above) for different seasons and year as a whole over the Bay of Bengal(BOB), Arabian Sea(AS) and North Indian Ocean (NIO) from 1990 to the present.

These are presented in Table1 to Table 4 for cyclonic disturbances (Depression and above) and Table 5 to Table 8 for tropical cyclones (cyclonic storm and above). For details about the data and for referring this data for further research the following publication may kindly be referred.

Mohapatra, M. and V. Vijay Kumar., 2016, 'Interannual Variation of Tropical Cyclone Energy Matrix over North Indian Ocean, Climate Dynamics, DOI.10.1007/s 00382-016-3150-3.

Table 1: Annual Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index (PDI) (knot³) of cyclonic disturbances (Depression and above) over the BOB, AS and NIO

Period	Annual								
Basin	BOB			AS			NIO		
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	4175	211825	14790875	1735	88575	5566375	5910	300400	20357250
1983	1355	69675	4287875	250	6250	156250	1605	75925	4444125
1984	4154	244658	20146166	370	9850	264250	4524	254508	20410416
1985	3445	115225	4138375	760	24650	856750	4205	139875	4995125
1986	1230	32700	889500	225	6375	181875	1455	39075	1071375
1987	3245	107225	3891125	0	0	0	3245	107225	3891125
1988	3235	197975	16979125	490	14200	413500	3725	212175	17392625
1989	5910	444450	43331250	390	10950	309750	6300	455400	43641000
1990	4481	246069	19169423	228	6552	189972	4709	252621	19359395
1991	3930	210240	16678830	0	0	0	3930	210240	16678830
1992	4683	225861	14263047	1455	46425	1531875	6138	272286	15794922
1993	822	41004	2441658	810	33650	1565250	1632	74654	4006908
1994	1993	117141	8616157	1280	50250	2104375	3273	167391	10720532
1995	2526	115912	6738024	670	22100	754000	3196	138012	7492024
1996	2932	121054	5641408	1160	47150	2123000	4092	168204	7764408
1997	4647	173879	7767033	320	9350	274250	4967	183229	8041283
1998	2252	94404	4488908	2995	144025	8408875	5247	238429	12897783
1999	2990	190200	16886750	1733	145767	13582913	4723	335967	30469663
2000	3259	153403	9005281	0	0	0	3259	153403	9005281
2001	420	12050	354750	2541	162787	12848649	2961	174837	13203399
2002	1805	57525	1921625	495	14725	447375	2300	72250	2369000
2003	2530	110400	5364250	505	22925	1105375	3035	133325	6469625
2004	2092	84304	4101658	2270	89350	3767750	4362	173654	7869408
2005	3100	99500	3353500	125	3125	78125	3225	102625	3431625
2006	3125	133425	7716875	550	22550	957250	3675	155975	8674125
2007	3255	178775	13411125	2281	148607	12249589	5536	327382	25660714
2008	2857	138329	7834033	305	7775	198875	3162	146104	8032908
2009	1850	61900	2180000	455	13575	427625	2305	75475	2607625
2010	2585	115875	6276125	2805	153125	9421125	5390	269000	15697250
2011	1895	76325	3832625	1720	46750	1285750	3615	123075	5118375
2012	935	28675	923375	395	12325	394625	1330	41000	1318000
2013	6990	377200	26396250	400	11500	332500	7390	388700	26728750
2014	2110	114800	7912000	1990	122000	8893000	4100	236800	16805000
2015	1055	28925	823625	4570	310250	25519000	5625	339175	26342625
2016	3930	147000	6393750	275	6875	171875	4205	153875	6565625
2017	3685	164025	9029125	0	0	0	3685	164025	9029125
2018	3975	154975	7024875	3720	201150	12599250	7695	356125	19624125
2019	3320	230350	18726500	8045	549175	45587375	11365	779525	64313875
2020	2890	191900	17225500	1940	77150	3579500	4830	269050	20805000
2021	2395	89275	3893125	2195	127875	8657375	4590	217150	12550500
2022	3855	129575	4799625	620	16200	428000	4475	145775	5227625

2023	6425	359925	26068625	8590	621400	48140500	15015	981325	74209125
------	------	--------	----------	------	--------	----------	-------	--------	----------

Table 2: Annual Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index (PDI) (knot³) of cyclonic disturbances (Depression and above) over the BOB, AS and NIO during pre-monsoon season (March- May)

Period	Pre-Monsoon Season								
	BOB			AS			NIO		
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	1160	97850	9423500	0	0	0	1160	97850	9423500
1983	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0
1985	665	29525	1386125	435	16525	653625	1100	46050	2039750
1986	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0
1989	1305	118325	12205125	390	10950	309750	1695	129275	12514875
1990	1849	164717	16497943	0	0	0	1849	164717	16497943
1991	1920	154090	15050580	0	0	0	1920	154090	15050580
1992	420	12850	400500	0	0	0	420	12850	400500
1993	0	0	0	0	0	0	0	0	0
1994	1478	94566	7535282	0	0	0	1478	94566	7535282
1995	700	19000	520000	0	0	0	700	19000	520000
1996	110	3050	85250	0	0	0	110	3050	85250
1997	942	58004	4051158	0	0	0	942	58004	4051158
1998	465	20325	982875	0	0	0	465	20325	982875
1999	0	0	0	1733	145767	13582913	1733	145767	13582913
2000	355	10975	356125	0	0	0	355	10975	356125
2001	0	0	0	1901	142087	12172649	1901	142087	12172649
2002	115	3325	96625	495	14725	447375	610	18050	544000
2003	1620	74750	3813750	0	0	0	1620	74750	3813750
2004	1052	56354	3344408	925	42075	1968625	1977	98429	5313033
2005	0	0	0	0	0	0	0	0	0
2006	1180	81050	6289750	0	0	0	1180	81050	6289750
2007	390	12600	441000	0	0	0	390	12600	441000
2008	1477	94279	6366283	0	0	0	1477	94279	6366283
2009	995	35025	1306625	0	0	0	995	35025	1306625
2010	720	32550	1542000	1785	88175	5074875	2505	120725	6616875
2011	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0
2013	1265	46275	1776125	0	0	0	1265	46275	1776125
2014	200	5000	125000	0	0	0	200	5000	125000
2015	0	0	0	0	0	0	0	0	0
2016	710	25250	937250	0	0	0	710	25250	937250
2017	770	31050	1349250	0	0	0	770	31050	1349250
2018	110	3050	85250	2070	115400	7666500	2180	118450	7751750
2019	2200	171050	15181000	0	0	0	2200	171050	15181000
2020	1700	156150	16082750	0	0	0	1700	156150	16082750
2021	955	45325	2495125	1185	80625	6207375	2140	125950	8702500

2022	1650	61650	2554500	0	0	0	1650	61650	2554500
2023	2715	222575	20423625	0	0	0	2715	222575	20423625

Table 3: Annual Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index(PDI) (knot³) of cyclonic disturbances (Depression and above) over the BOB, AS and NIO during monsoon season (June-September)

Period	Monsoon Season								
	BOB			AS			NIO		
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	1830	72700	3765750	175	4375	109375	2005	77075	3875125
1983	385	10675	298375	250	6250	156250	635	16925	454625
1984	1250	31250	781250	175	4375	109375	1425	35625	890625
1985	855	23175	662625	0	0	0	855	23175	662625
1986	945	24225	623625	0	0	0	945	24225	623625
1987	1255	35325	1036375	0	0	0	1255	35325	1036375
1988	735	19425	517125	490	14200	413500	1225	33625	930625
1989	1140	33900	1063500	0	0	0	1140	33900	1063500
1990	1194	32436	882306	0	0	0	1194	32436	882306
1991	1075	28375	754375	0	0	0	1075	28375	754375
1992	1090	30700	871000	525	16825	562125	1615	47525	1433125
1993	0	0	0	0	0	0	0	0	0
1994	0	0	0	510	18400	706500	510	18400	706500
1995	350	8750	218750	0	0	0	350	8750	218750
1996	555	20025	749625	445	18175	810625	1000	38200	1560250
1997	2975	90475	2831375	0	0	0	2975	90475	2831375
1998	170	4850	139250	1295	84375	6088625	1465	89225	6227875
1999	540	12950	317250	0	0	0	540	12950	317250
2000	100	2500	62500	0	0	0	100	2500	62500
2001	25	625	15625	455	14925	493625	480	15550	509250
2002	0	0	0	0	0	0	0	0	0
2003	135	3675	100875	0	0	0	135	3675	100875
2004	615	17325	491625	785	27175	1008875	1400	44500	1500500
2005	610	18100	548500	125	3125	78125	735	21225	626625
2006	1760	46550	1240250	550	22550	957250	2310	69100	2197500
2007	1415	39575	1115375	1636	129632	11689714	3051	169207	12805089
2008	275	7625	213125	200	5000	125000	475	12625	338125
2009	260	7550	220250	150	3750	93750	410	11300	314000
2010	0	0	0	1020	64950	4346250	1020	64950	4346250
2011	770	18950	477500	95	2275	54875	865	21225	532375
2012	0	0	0	0	0	0	0	0	0
2013	435	9575	213375	0	0	0	435	9575	213375
2014	380	10400	287000	565	22425	925375	945	32825	1212375
2015	825	22275	630375	735	26825	1015875	1560	49100	1646250
2016	415	9725	230875	175	4375	109375	590	14100	340250
2017	400	10150	261250	0	0	0	400	10150	261250
2018	850	22300	595750	0	0	0	850	22300	595750
2019	0	0	0	2410	148800	9921250	2410	148800	9921250

2020	0	0	0	720	23700	872250	720	23700	872250
2021	755	23675	774125	835	42875	2340625	1590	66550	3114750
2022	670	17500	463000	290	7050	172250	960	24550	635250
2023	355	9825	275125	6455	463425	35483375	6810	473250	35758500

Table 4: Annual Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot2) and Power Dissipation Index (PDI) (knot3) of cyclonic disturbances (Depression and above) over the BOB, AS and NIO during post-monsoon season (October- December)

Period	Post Monsoon Season								
	BOB			AS			NIO		
Basin	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	1185	41275	1601625	1560	84200	5457000	2745	125475	7058625
1983	970	59000	3989500	0	0	0	970	59000	3989500
1984	2904	213408	19364916	195	5475	154875	3099	218883	19519791
1985	1925	62525	2089625	325	3125	78125	2250	65650	2167750
1986	285	8475	265875	225	6375	181875	510	14850	447750
1987	1990	71900	2854750	0	0	0	1990	71900	2854750
1988	2500	178550	16462000	0	0	0	2500	178550	16462000
1989	3465	292225	30062625	0	0	0	3465	292225	30062625
1990	1438	48916	1789174	228	6552	189972	1666	55468	1979146
1991	935	27775	873875	0	0	0	935	27775	873875
1992	3173	182311	12991547	930	29600	969750	4103	211911	13961297
1993	822	41004	2441658	810	33650	1565250	1632	74654	4006908
1994	515	22575	1080875	770	31850	1397875	1285	54425	2478750
1995	1476	88162	5999274	670	22100	754000	2146	110262	6753274
1996	2267	97979	4806533	715	28975	1312375	2982	126954	6118908
1997	730	25400	884500	320	9350	274250	1050	34750	1158750
1998	1617	69229	3366783	1700	59650	2320250	3317	128879	5687033
1999	2450	177250	16569500	0	0	0	2450	177250	16569500
2000	2804	139928	8586656	0	0	0	2804	139928	8586656
2001	395	11425	339125	185	5775	182375	580	17200	521500
2002	1690	54200	1825000	0	0	0	1690	54200	1825000
2003	775	31975	1449625	505	22925	1105375	1280	54900	2555000
2004	425	10625	265625	560	20100	790250	985	30725	1055875
2005	2490	81400	2805000	0	0	0	2490	81400	2805000
2006	185	5825	186875	0	0	0	185	5825	186875
2007	1450	126600	11854750	645	18975	559875	2095	145575	12414625
2008	1105	36425	1254625	105	2775	73875	1210	39200	1328500
2009	595	19325	653125	305	9825	333875	900	29150	987000
2010	1865	83325	4734125	0	0	0	1865	83325	4734125
2011	1125	57375	3355125	1625	44475	1230875	2750	101850	4586000
2012	935	28675	923375	395	12325	394625	1330	41000	1318000
2013	5290	321350	24406750	400	11500	332500	5690	332850	24739250
2014	1530	99400	7500000	1425	99575	7967625	2955	198975	15467625
2015	230	6650	193250	3760	281550	24456250	3990	288200	24649500
2016	2805	112025	5225625	100	2500	62500	2905	114525	5288125
2017	2515	122825	7410625	0	0	0	2515	122825	7410625
2018	3015	129625	6343875	1650	85750	4932750	4665	215375	11276625
2019	1120	59300	3545500	5635	400375	35666125	6755	459675	39211625
2020	1190	35750	1142750	1220	53450	2707250	2410	89200	3850000

2021	685	20275	623875	175	4375	109375	860	24650	733250
2022	1535	50425	1782125	330	9150	255750	1865	59575	2037875
2023	2920	116950	5111500	2135	157975	12657125	5055	274925	17768625

Table 5 Annual Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index (PDI) (knot³) of cyclonic disturbances (Cyclonic storm and above) over the BOB, AS and NIO

Period	Annual								
	BOB			AS			NIO		
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	2365	165625	13594375	930	65550	4878750	3295	231175	18473125
1983	840	54550	3830250	0	0	0	840	54550	3830250
1984	2204	193458	18785666	0	0	0	2204	193458	18785666
1985	1485	61375	2624625	225	10125	455625	1710	71500	3080250
1986	45	2025	91125	0	0	0	45	2025	91125
1987	1925	99725	5433875	0	0	0	1925	99725	5433875
1988	1595	154275	15805625	0	0	0	1595	154275	15805625
1989	3880	389800	41848000	0	0	0	3880	389800	41848000
1990	2187	181969	17360463	0	0	0	2187	181969	17360463
1991	1950	158340	15309330	0	0	0	1950	158340	15309330
1992	2558	165986	12563672	495	19125	750375	3053	185111	13314047
1993	487	31579	2174533	550	26850	1386250	1037	58429	3560783
1994	1738	109866	8407282	960	41650	1887000	2698	151516	10294282
1995	1256	82062	5828774	370	13850	525250	1626	95912	6354024
1996	1767	89229	4764783	620	32450	1719500	2387	121679	6484283
1997	1957	96429	5524783	0	0	0	1957	96429	5524783
1998	1192	64604	3644908	1825	111925	7520875	3017	176529	11165783
1999	2085	148050	15515000	1598	142092	13482038	3683	290142	28997038
2000	1834	91178	7022406	0	0	0	1834	91178	7022406
2001	140	4900	171500	2121	150937	12511899	2261	155837	12683399
2002	785	29925	1168625	175	6125	214375	960	36050	1383000
2003	1725	87875	4729125	390	19600	1008750	2115	107475	5737875
2004	912	57404	3232158	1490	67450	3148250	2402	124854	6380408
2005	1360	53650	2149000	0	0	0	1360	53650	2149000
2006	1230	83200	6375750	405	18325	833625	1635	101525	7209375
2007	1500	130250	12058500	1501	125957	11588839	3001	256207	23647339
2008	1832	109654	7024658	0	0	0	1832	109654	7024658
2009	800	32600	1355000	120	4850	198000	920	37450	1553000
2010	1580	89750	5591000	1180	71350	4602250	2760	161100	10193250
2011	790	47950	3088000	70	2450	85750	860	50400	3173750
2012	240	9700	396000	180	6500	235500	420	16200	631500
2013	4855	323175	25004125	0	0	0	4855	323175	25004125
2014	1695	111025	8130375	1275	95825	7873875	2970	206850	16004250
2015	180	6500	235500	3710	286900	24878750	3890	293400	25114250
2016	1935	95325	5040375	0	0	0	1935	95325	5040375
2017	1980	121150	7953750	0	0	0	1980	121150	7953750

2015	0	0	0	0	0	0	0	0	0
2016	445	18125	743125	0	0	0	445	18125	743125
2017	580	26650	1261750	0	0	0	580	26650	1261750
2018	0	0	0	1570	102150	7312750	1570	102150	7312750
2019	2025	166625	15067875	0	0	0	2025	166625	15067875
2020	1600	153600	16016500	0	0	0	1600	153600	16016500
2021	60	36000	2300000	1060	77000	6110000	1120	113000	8410000
2022	700	36000	1830000	0	0	0	700	36000	1830000
2023	2715	222575	20423625	0	0	0	2715	222575	20423625

Table 7 Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index (PDI) (knot³) of tropical cyclones (Cyclonic storm and above) over the BOB, AS and NIO during monsoon season (June- September)

Period	Monsoon Season								
	BOB			AS			NIO		
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	750	45250	3060000	0	0	0	750	45250	3060000
1983	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0
1985	120	4850	198000	0	0	0	120	4850	198000
1986	0	0	0	0	0	0	0	0	0
1987	165	6875	289125	0	0	0	165	6875	289125
1988	0	0	0	0	0	0	0	0	0
1989	180	8100	364500	0	0	0	180	8100	364500
1990	0	0	0	0	0	0	0	0	0
1991	205	8525	359125	0	0	0	205	8525	359125
1992	0	0	0	160	6500	268000	160	6500	268000
1993	0	0	0	0	0	0	0	0	0
1994	0	0	0	320	13200	563000	320	13200	563000
1995	0	0	0	0	0	0	0	0	0
1996	390	15450	621750	250	12700	655750	640	28150	1277500
1997	430	17250	712750	0	0	0	430	17250	712750
1998	0	0	0	1150	80150	5965000	1150	80150	5965000
1999	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0
2001	0	0	0	280	9800	343000	280	9800	343000
2002	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0	0
2005	140	4900	171500	0	0	0	140	4900	171500
2006	0	0	0	405	18325	833625	405	18325	833625
2007	0	0	0	1501	125957	11588839	1501	125957	11588839
2008	0	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0	0
2010	0	0	0	1020	64950	4346250	1020	64950	4346250

2011	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	435	19025	835875	0	0	0	435	19025	835875
2015	180	6500	235500	550	21900	883750	730	28400	1119250
2016	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0
2020	0	0	0	265	12125	575875	265	12125	575875
2021	1700	168000	16900000	1470	146000	14600000	3170	314000	31500000
2022	0	0	0	0	0	0	0	0	0
2023	0	0	0	6330	460300	35405250	6330	460300	35405250

Table 8 Velocity Flux (knot), Accumulated Cyclone Energy (ACE) (knot²) and Power Dissipation Index (PDI) (knot³) of tropical cyclones (Cyclonic storm and above) over the BOB, AS and NIO during post-monsoon season (October-December)

Period	Post Monsoon Season								
	BOB			AS			NIO		
Basin	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
YEAR	VF	ACE	PDI	VF	ACE	PDI	VF	ACE	PDI
1982	540	24950	1180500	930	65550	4878750	1470	90500	6059250
1983	840	54550	3830250	0	0	0	840	54550	3830250
1984	2204	193458	18785666	0	0	0	2204	193458	18785666
1985	775	28875	1087375	0	0	0	775	28875	1087375
1986	45	2025	91125	0	0	0	45	2025	91125
1987	1000	46300	2181250	0	0	0	1000	46300	2181250
1988	1595	154275	15805625	0	0	0	1595	154275	15805625
1989	2580	268300	29410500	0	0	0	2580	268300	29410500
1990	459	20283	940491	0	0	0	459	20283	940491
1991	275	10975	444875	0	0	0	275	10975	444875
1992	2383	159861	12349297	335	12625	482375	2718	172486	12831672
1993	487	31579	2174533	550	26850	1386250	1037	58429	3560783
1994	345	17725	941625	640	28450	1324000	985	46175	2265625
1995	1256	82062	5828774	370	13850	525250	1626	95912	6354024
1996	1377	73779	4143033	370	19750	1063750	1747	93529	5206783
1997	700	24500	857500	0	0	0	700	24500	857500
1998	857	47679	2751533	675	31775	1555875	1532	79454	4307408
1999	1965	164675	16238625	0	0	0	1965	164675	16238625
2000	1684	109078	7729906	0	0	0	1684	109078	7729906
2001	140	4900	171500	100	3350	112750	240	8250	284250
2002	785	29925	1168625	0	0	0	785	29925	1168625
2003	520	25450	1282000	390	19600	1008750	910	45050	2290750
2004	0	0	0	625	27175	1233625	625	27175	1233625
2005	905	37725	1591625	0	0	0	905	37725	1591625
2006	105	3675	128625	0	0	0	105	3675	128625

2007	1365	124175	11785125	0	0	0	1365	124175	11785125
2008	440	17800	728000	0	0	0	440	17800	728000
2009	200	8100	332000	120	4850	198000	320	12950	530000
2010	965	60025	4126625	0	0	0	965	60025	4126625
2011	790	47950	3088000	70	2450	85750	860	50400	3173750
2012	240	9700	396000	180	6500	235500	420	16200	631500
2013	3950	285800	23454500	0	0	0	3950	285800	23454500
2014	1260	92000	7294500	1275	95825	7873875	2535	187825	15168375
2015	0	0	0	3160	265000	23995000	3160	265000	23995000
2016	1490	77200	4297250	0	0	0	1490	77200	4297250
2017	1400	94500	6692000	0	0	0	1400	94500	6692000
2018	1925	98975	5477375	1385	78675	4742375	3310	177650	10219750
2019	855	52125	3347625	5035	400475	36744625	5890	452600	40092250
2020	325	13325	551125	735	40775	2368875	1060	54100	2920000
2021	440	14000	480000	0	0	0	440	14000	480000
2022	630	26900	1770000	0	0	0	630	26900	1770000
2023	2920	116950	5111500	2135	157975	12657125	5055	274925	17768625