

Chapter 3

Results

In this chapter, we describe the results of our simulations and analysis. For each sky, the source count model is shown in Table. 3.1, the simulated results of ALMA and SMA with different observation times and array configurations are also shown.

3.1 SMA/ALMA mock observations

For each submillimeter sky, we randomly selected 256 fields from a $1^\circ \times 1^\circ$ region, centered at R.A. = 12.608 and Dec. = 62.236 (the direction toward the Hubble Deep Field North, HDF-N), to carry out SMA/ALMA mock observations using different configurations. The exposure times for each field are 50 hours and 100 hours. The *miriad* tasks are used to carry out mock observations and produce synthesized images. By applying the source finding algorithm described in Section 2.5 on all mock observation images, we have the total number of sources detected, N_d . Fig. 3.1 is an example of SMA mock observations of source count model Sky 3 with 100-hour observation time for different configurations.

Table. 3.2 to 3.7 show the results of SMA mock observations. N_{total} is the total number of input sources in 256 fields of SMA mock observations. Among them, the number of sources brighter than the given significance levels is denoted by N_{th} . N_d is the number of detected sources, N_{good} is the number of real sources among the detected sources.

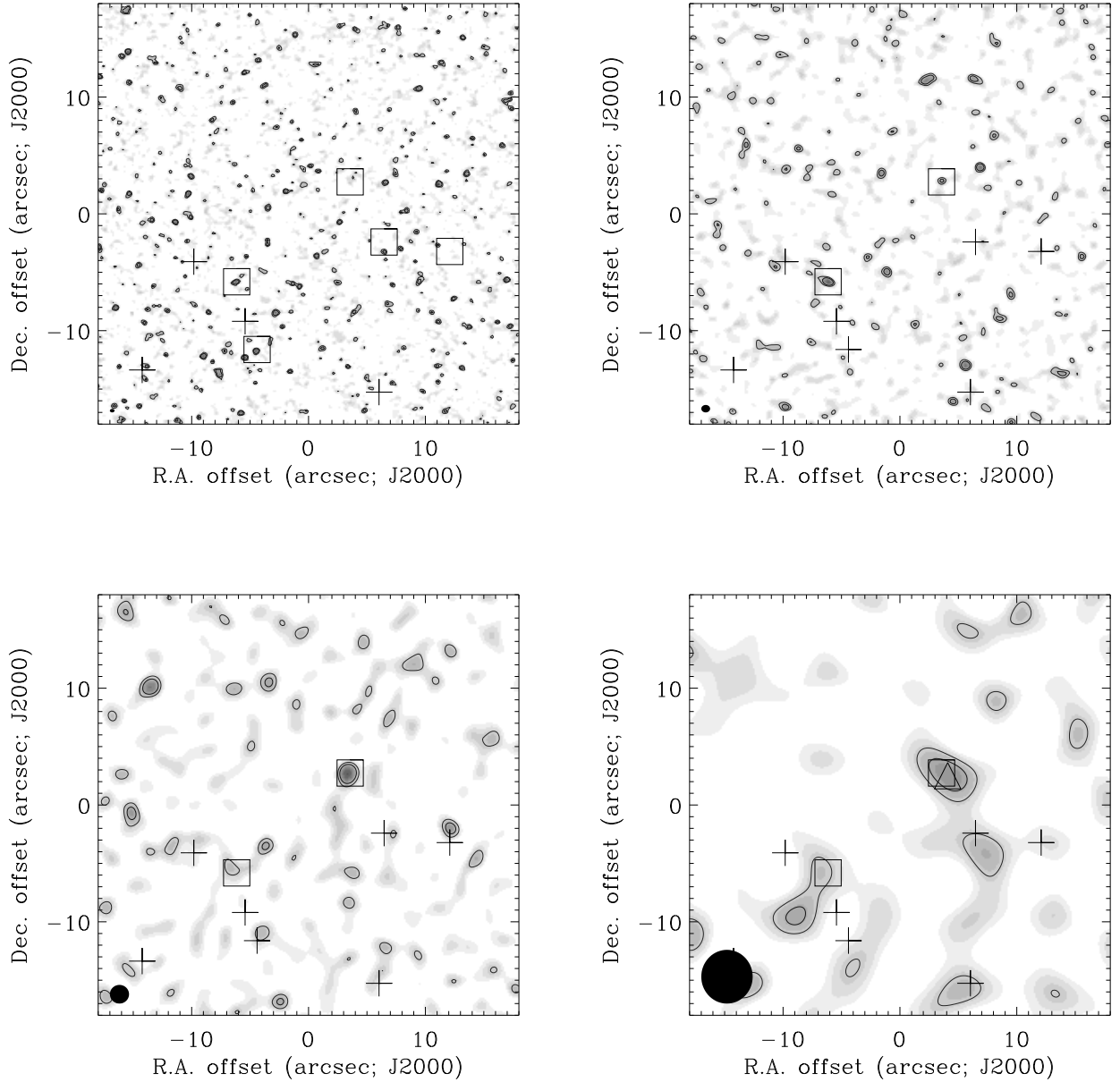


Fig. 3.1 : An example of SMA 100-hour synthesis images of Sky 3. The input sources are plotted as cross ($\text{flux} \geq 3\sigma$) and squares ($\text{flux} < 3\sigma$). The open triangle represents the sources found by source finding algorithm. Images from A, B, C and D configuration are shown in panel (a), (b), (c) and (d), respectively. Contours represent significance levels, 2σ and 3σ , respectively.

Table 3.1: Source count models used to produce submillimeter skies.

Sky	Source count model
1	$N(> S) = \frac{2.03 \times 10^4}{1.033 + S^{2.25}}$
2	$N(> S) = 1.2 \times 10^4 S^{-1.05}$ $= 1.2 \times 10^4 S^{-1.80}$
3	$N(> S) = 1.2 \times 10^4 S^{-0.63}$ $= 1.2 \times 10^4 S^{-1.80}$

Table 3.2. Results of SMA 50-hour mock observations of Sky 1 ($N_{total} = 504$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	419	315	88	304	106	69	226	109	83	202	183	160
2.1	414	267	88	289	93	68	209	98	81	191	165	144
2.2	406	229	88	271	84	64	199	90	76	180	149	132
2.3	400	189	88	261	83	67	183	87	76	172	137	121
2.4	395	168	88	251	81	68	176	74	70	161	121	109
2.5	380	156	88	239	80	68	168	71	69	157	116	105
2.6	377	148	88	231	77	68	163	72	70	148	108	98
2.7	372	140	89	217	79	70	158	73	71	142	98	89
2.8	363	135	87	203	76	71	149	74	71	133	86	81
2.9	354	126	86	197	74	71	142	74	70	124	82	77
3.0	348	116	87	185	70	69	135	72	70	117	80	76
3.1	340	111	87	180	68	67	126	72	70	110	73	66
3.2	333	105	86	173	69	68	119	70	65	107	69	61
3.3	327	100	85	167	68	68	113	68	63	98	64	57
3.4	319	99	84	165	67	66	109	65	59	92	58	52
3.5	315	99	87	159	68	67	104	65	60	87	53	49
3.6	307	98	86	154	66	65	98	63	58	80	53	49
3.7	301	98	87	147	64	64	90	56	53	78	49	46
3.8	291	96	86	142	63	63	86	53	49	73	47	44
3.9	278	96	85	138	60	60	83	51	47	70	45	41
4.0	271	91	82	129	58	58	80	49	46	64	44	38
4.1	263	88	80	122	54	54	75	47	44	59	41	32
4.2	260	85	79	116	51	50	70	48	44	57	39	30
4.3	256	80	77	115	50	49	69	46	43	49	37	28
4.4	250	77	75	109	48	46	61	45	41	47	37	27
4.5	243	74	73	107	47	45	59	45	40	47	35	26
4.6	238	72	72	105	46	44	56	42	38	45	33	25
4.7	232	70	70	97	47	45	54	41	36	45	29	23
4.8	225	69	69	93	45	44	50	38	35	44	26	22
5.0	218	67	67	90	43	43	49	36	32	43	23	19

Table 3.3. Results of SMA 100hr mock observations of Sky 1 ($N_{total} = 487$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	448	477	129	359	163	133	297	137	126	272	276	254
2.1	443	407	128	351	151	130	287	132	124	259	264	243
2.2	438	332	128	337	142	127	276	128	121	251	251	230
2.3	437	281	128	327	138	125	268	126	119	239	239	217
2.4	429	241	128	322	134	124	263	124	118	227	231	209
2.5	418	217	127	312	125	120	253	123	117	216	223	197
2.6	417	199	125	303	121	120	243	116	113	211	209	183
2.7	406	181	123	292	120	119	232	112	110	203	202	173
2.8	403	164	122	285	118	118	226	112	110	198	196	167
2.9	401	154	122	277	118	118	221	107	106	193	189	160
3.0	394	141	120	272	118	118	213	107	105	176	177	147
3.1	387	132	118	266	117	117	207	102	100	166	165	136
3.2	383	125	120	260	118	118	199	97	96	162	149	121
3.3	377	125	120	253	116	116	188	92	91	154	135	111
3.4	371	126	122	247	118	118	180	91	89	149	126	103
3.5	368	125	122	236	118	118	171	89	87	140	115	92
3.6	363	124	121	231	114	114	168	88	86	128	112	86
3.7	357	125	122	226	113	113	160	87	84	121	112	87
3.8	352	122	120	221	113	113	156	82	79	117	104	83
3.9	344	119	118	216	110	110	146	82	79	113	88	73
4.0	339	117	116	214	107	105	139	79	76	105	74	69
4.1	332	116	116	210	105	103	132	79	75	103	71	67
4.2	326	116	116	202	105	101	123	78	75	96	68	64
4.3	325	116	116	194	102	98	120	77	75	95	66	62
4.4	322	115	115	189	100	98	115	73	71	94	65	62
4.5	316	113	113	181	97	95	112	70	69	90	61	57
4.6	310	113	113	175	97	95	107	67	66	84	61	55
4.7	306	112	112	173	92	90	103	65	63	79	57	48
4.8	301	111	111	164	90	89	101	63	61	75	56	46
5.0	295	107	107	163	89	87	98	60	58	73	55	46

Table 3.4. Results of SMA 50hr mock observations of Sky 2 ($N_{total}= 1418$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	714	345	96	347	129	88	246	153	107	224	219	187
2.1	672	276	90	330	116	86	231	135	102	201	202	172
2.2	633	223	89	310	104	84	210	109	90	181	177	150
2.3	600	188	87	293	94	80	192	94	79	164	163	138
2.4	570	169	84	280	91	79	178	85	75	154	146	121
2.5	536	157	84	258	85	73	165	78	70	147	133	111
2.6	521	151	88	249	85	74	157	72	65	142	124	104
2.7	496	142	86	236	78	68	151	68	63	136	110	93
2.8	478	137	86	223	70	66	145	64	62	127	102	88
2.9	466	133	86	208	66	63	135	62	60	118	93	82
3.0	453	125	85	193	63	62	123	63	60	110	87	77
3.1	440	116	83	186	68	66	117	60	57	105	83	73
3.2	425	109	82	173	67	65	112	59	56	104	76	65
3.3	411	104	81	163	66	63	107	60	57	97	72	61
3.4	394	98	81	159	66	64	105	59	55	89	67	56
3.5	372	94	81	154	63	62	99	57	52	85	63	53
3.6	354	92	81	150	63	61	93	54	48	77	63	51
3.7	339	90	80	144	60	58	87	52	47	75	59	46
3.8	332	90	81	136	57	56	84	52	46	66	57	44
3.9	322	91	81	126	54	53	78	49	42	61	50	40
4.0	310	90	80	118	50	48	71	48	42	60	45	37
4.1	304	89	79	116	50	48	67	46	41	57	40	33
4.2	294	88	80	113	48	47	67	46	41	55	40	32
4.3	288	84	78	108	46	46	65	42	38	51	38	30
4.4	277	81	76	106	44	44	62	40	38	46	33	27
4.5	267	76	71	104	42	42	58	39	36	46	30	24
4.6	258	76	72	99	42	42	56	38	35	43	30	24
4.7	251	73	69	95	39	39	50	35	32	41	29	24
4.8	244	73	69	91	39	38	46	33	29	40	29	24
5.0	237	73	69	88	38	37	45	31	27	37	27	22

Table 3.5. Results of SMA 100hr mock observations of Sky 2 ($N_{total}= 1397$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	982	469	160	503	173	138	366	173	151	308	369	321
2.1	932	401	157	472	162	136	343	157	140	289	356	302
2.2	883	361	157	437	151	131	323	150	135	273	340	285
2.3	848	313	157	419	135	124	311	140	128	259	321	261
2.4	818	286	159	401	130	124	297	136	127	249	300	244
2.5	780	258	158	386	127	123	283	130	124	237	279	225
2.6	750	231	156	374	126	124	274	125	119	227	268	214
2.7	724	214	157	359	127	126	263	117	112	216	258	205
2.8	695	200	158	341	124	123	250	107	106	202	249	193
2.9	660	179	152	325	122	121	237	105	103	193	233	177
3.0	635	165	153	318	123	121	227	103	102	183	211	159
3.1	620	158	149	303	123	122	214	99	97	170	198	148
3.2	590	153	144	294	123	121	207	97	96	166	183	138
3.3	567	152	144	285	123	120	200	94	93	154	169	129
3.4	546	146	139	279	116	113	190	95	93	146	153	119
3.5	526	145	138	270	117	115	181	91	91	139	149	113
3.6	510	147	140	263	112	111	174	89	89	131	135	102
3.7	494	145	140	252	111	109	164	88	87	127	126	94
3.8	476	141	136	244	109	105	155	87	86	119	105	79
3.9	465	139	135	234	108	104	154	83	83	114	81	73
4.0	440	138	134	228	105	101	143	82	82	106	73	68
4.1	431	137	133	217	104	99	136	78	78	102	67	64
4.2	419	131	131	212	105	100	131	76	76	101	64	60
4.3	407	129	129	203	104	100	128	75	74	97	63	59
4.4	400	125	125	199	101	98	121	74	72	95	60	55
4.5	393	126	125	189	97	94	115	71	66	94	60	55
4.6	385	124	123	182	92	90	112	71	66	91	60	53
4.7	379	122	122	180	89	88	106	71	64	83	59	50
4.8	373	120	120	173	86	85	103	68	61	81	57	48
5.0	360	119	118	168	83	82	99	68	60	75	56	46

Table 3.6. Results of SMA 50hr mock observations of Sky 3 ($N_{total}= 6990$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	481	333	84	304	126	85	249	149	118	229	203	184
2.1	468	274	86	288	120	86	235	131	109	221	184	170
2.2	452	211	82	281	116	90	229	116	98	204	170	158
2.3	432	163	79	273	111	90	214	108	94	193	163	153
2.4	420	153	82	266	107	90	200	88	83	180	151	139
2.5	405	131	78	260	104	89	187	87	81	165	144	129
2.6	391	132	80	252	102	89	175	79	76	154	133	115
2.7	380	129	80	242	94	83	165	76	73	146	127	106
2.8	367	122	80	231	91	82	157	73	70	143	115	102
2.9	360	113	78	222	83	75	147	69	65	137	107	94
3.0	356	111	79	216	80	77	145	65	62	129	97	82
3.1	353	105	79	203	74	73	136	62	59	122	90	76
3.2	344	96	78	197	72	71	130	63	60	113	82	70
3.3	334	91	77	189	73	72	122	62	58	97	77	64
3.4	323	91	78	176	70	69	115	61	58	95	73	62
3.5	314	89	78	168	70	68	105	62	58	92	70	59
3.6	306	85	75	163	67	66	99	59	54	88	66	56
3.7	295	84	75	154	66	64	91	56	50	81	63	52
3.8	290	84	75	148	62	59	89	54	48	77	57	49
3.9	288	84	75	146	61	57	87	53	48	75	56	47
4.0	282	83	75	142	60	56	83	52	46	72	55	44
4.1	279	81	73	133	59	54	79	51	44	71	50	40
4.2	273	80	72	130	59	54	78	50	44	69	48	38
4.3	269	78	70	126	57	51	77	47	42	64	49	38
4.4	265	74	70	117	57	50	73	44	38	58	43	33
4.5	261	71	67	114	55	49	71	44	38	57	36	28
4.6	257	67	65	109	54	48	65	42	36	55	32	27
4.7	254	64	63	100	50	42	62	40	33	49	31	26
4.8	248	62	61	96	45	38	61	39	32	45	28	23
5.0	242	62	61	91	43	37	58	39	32	43	27	23

Table 3.7. Results of SMA 100hr mock observations of Sky 3 ($N_{total}= 6991$).

σ	A Config.			B Config.			C Config.			D Config.		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	698	474	164	462	163	145	380	184	167	342	344	303
2.1	678	409	162	447	157	144	367	170	164	324	327	282
2.2	661	359	156	436	148	141	354	160	155	307	315	269
2.3	643	293	152	422	144	140	343	153	149	299	307	260
2.4	623	262	150	413	141	139	324	152	147	282	292	245
2.5	600	243	149	402	144	143	313	145	141	269	283	236
2.6	582	222	153	389	142	142	305	141	138	260	276	227
2.7	569	209	156	379	145	145	293	135	132	242	264	209
2.8	550	197	153	370	143	142	281	133	130	228	256	198
2.9	536	185	154	359	142	142	267	131	128	216	250	190
3.0	521	177	158	349	139	139	253	127	122	207	232	174
3.1	514	168	157	336	133	133	240	122	116	197	212	158
3.2	503	163	152	323	129	129	229	115	109	182	195	140
3.3	491	160	151	318	130	130	223	107	103	172	176	132
3.4	483	161	152	310	128	127	211	101	98	156	165	123
3.5	474	157	149	299	126	124	205	97	94	149	159	117
3.6	465	155	147	292	122	120	187	95	93	146	149	111
3.7	459	151	146	283	121	119	179	93	91	141	133	100
3.8	450	145	142	275	119	118	171	91	87	139	125	97
3.9	444	144	142	263	113	112	165	85	82	130	108	92
4.0	438	143	141	252	110	109	156	85	82	125	98	89
4.1	429	140	138	243	108	107	150	84	81	115	93	84
4.2	422	139	137	236	105	104	148	82	79	109	87	76
4.3	415	136	136	229	105	102	141	82	78	103	79	68
4.4	413	135	134	220	101	100	131	79	75	100	76	65
4.5	405	133	132	215	103	101	128	75	73	95	73	63
4.6	400	133	133	209	101	100	125	75	73	92	70	60
4.7	395	132	132	198	96	95	119	73	70	85	67	52
4.8	391	130	130	191	95	94	118	72	69	84	65	51
5.0	382	129	129	181	90	88	113	69	65	79	59	46

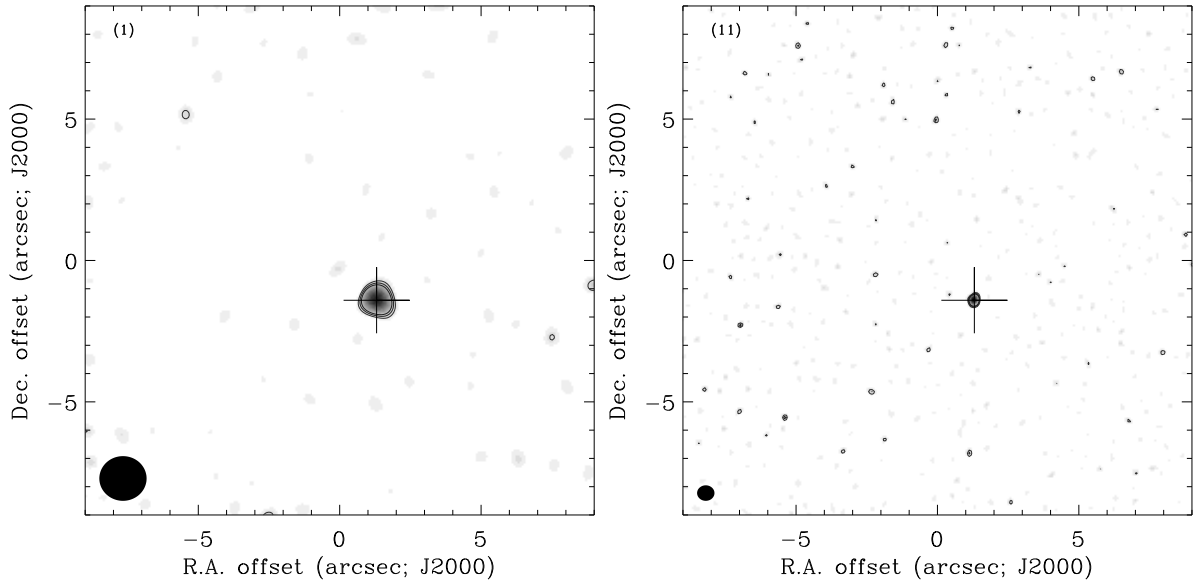


Fig. 3.2 : An example of ALMA 12-hour synthesis images of Sky 1. The synthesis images from configuration 1 (left panel) and 11 (right panel) are shown. Crosses represent sources input and contours represent the detection significance levels 3σ , 4σ and 5σ , respectively.

For ALMA mock observations, we carried out 128 fields, each with the following exposure times, 8, 12 and 24 hours, each mock observation is pointed to Hubble Deep Field South (R.A. =22.54895, Dec. = -60.55074, HDF-S). For each observation field, we produce 2 extra background fields, which contains background sources only and are used to calibrate the detected sources from our source finding program, as described in Section 2.5. Fig. 3.1 shows an example of ALMA mock observations of source count model Sky 1 with exposure time equal to 12 hour using ALMA configuration 1 and 11.

Table. 3.8 to 3.16 show the results of ALMA mock observations. N_{total} is the total number of input sources in 128 fields of ALMA mock observation. Among them, the number of sources which their fluxes are larger than given significance levels is presented as N_{th} . After applying source finding algorithm, N_d is the number of detected sources, N_{good} is the number of real sources among the detected sources.

Table 3.8. Results of ALMA 8hr mock observations of Sky 1 ($N_{total} = 59$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	58	154	46	58	367	40	59	368	45
2.1	57	139	46	58	346	40	58	334	45
2.2	56	124	46	58	330	40	58	308	45
2.3	56	109	46	58	305	40	58	285	45
2.4	55	93	46	57	284	39	58	254	45
2.5	55	87	46	56	256	39	58	236	45
2.6	55	82	46	56	225	39	58	209	45
2.7	54	79	45	55	207	39	58	188	45
2.8	54	73	45	55	189	39	58	169	46
2.9	54	66	45	55	176	39	58	139	46
3.0	54	63	45	55	158	39	58	129	46
3.1	54	59	45	54	138	39	58	118	47
3.2	54	57	46	54	128	39	58	106	47
3.3	54	57	46	54	123	39	58	101	47
3.4	53	57	46	54	107	39	58	91	47
3.5	52	56	46	54	98	39	58	77	47
3.6	52	55	46	54	90	40	57	71	47
3.7	52	55	46	54	85	40	57	65	47
3.8	52	54	45	54	74	40	56	61	47
3.9	52	54	45	53	71	40	56	56	46
4.0	52	51	45	52	66	40	56	50	46
4.1	52	51	45	52	63	40	55	49	45
4.2	52	51	45	52	62	39	55	50	45
4.3	52	50	45	52	63	40	55	46	45
4.4	51	48	45	52	61	39	55	46	45
4.5	51	48	45	52	57	38	55	46	45
4.6	51	48	45	52	55	38	55	45	45
4.7	51	48	45	52	53	38	54	45	45
4.8	50	46	45	52	51	37	54	45	45
5.0	49	45	44	52	50	37	54	45	45

Table 3.9. Results of ALMA 12hr mock observations of Sky 1 ($N_{total} = 64$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	63	85	52	63	71	40	63	133	49
2.1	63	77	52	63	60	40	63	131	49
2.2	63	69	52	63	54	40	63	120	48
2.3	63	62	52	63	49	40	63	119	48
2.4	62	57	52	63	46	40	63	115	48
2.5	62	54	52	63	46	40	63	113	48
2.6	62	53	51	63	44	40	63	112	47
2.7	62	52	50	63	44	40	63	104	47
2.8	62	51	49	62	43	40	63	100	47
2.9	62	48	46	62	42	40	63	102	47
3.0	62	48	46	62	42	40	63	95	47
3.1	62	47	45	62	41	40	63	91	47
3.2	62	46	44	62	42	41	63	76	47
3.3	62	46	44	62	41	40	63	68	47
3.4	62	46	44	62	41	40	63	67	48
3.5	62	46	44	62	41	41	63	67	48
3.6	61	46	44	62	41	41	63	65	48
3.7	61	43	43	62	41	41	63	57	48
3.8	59	45	45	61	43	43	63	56	48
3.9	59	45	45	61	42	42	63	54	48
4.0	57	46	46	60	42	42	63	54	48
4.1	57	45	45	59	42	42	63	54	49
4.2	57	45	45	58	41	41	63	56	51
4.3	57	45	45	58	41	41	62	56	51
4.4	56	45	44	58	41	41	62	56	51
4.5	54	44	44	58	40	40	62	53	51
4.6	54	44	44	58	40	40	62	52	51
4.7	54	44	44	57	40	40	62	50	50
4.8	53	44	44	57	41	41	62	50	50
5.0	53	44	44	56	41	41	62	48	48

Table 3.10. Results of ALMA 24hr mock observations of Sky 1 ($N_{total} = 63$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	62	72	50	62	68	50	63	137	52
2.1	62	66	50	62	67	50	63	124	52
2.2	62	64	50	62	63	50	62	117	52
2.3	62	63	50	62	61	50	62	115	52
2.4	62	60	49	62	60	50	62	109	52
2.5	62	60	49	62	58	50	62	92	52
2.6	62	59	49	62	57	50	62	87	52
2.7	61	59	49	62	57	50	62	86	52
2.8	61	58	49	62	56	50	62	83	52
2.9	61	56	49	62	56	50	62	79	51
3.0	61	54	49	62	55	50	62	74	51
3.1	61	53	49	62	55	51	62	69	51
3.2	61	53	49	62	53	51	62	66	51
3.3	61	53	49	62	53	51	62	62	51
3.4	61	53	49	61	52	51	62	62	51
3.5	60	52	49	61	52	51	62	59	51
3.6	60	50	48	61	52	51	62	57	51
3.7	59	50	48	61	53	52	62	53	51
3.8	59	50	48	61	51	51	62	53	51
3.9	59	49	48	60	51	51	62	53	51
4.0	59	48	47	60	51	51	62	52	50
4.1	59	47	47	60	51	51	62	52	50
4.2	58	47	47	60	51	51	62	52	50
4.3	58	47	47	60	51	51	62	52	50
4.4	58	47	47	60	51	51	62	52	50
4.5	58	46	46	60	51	51	62	52	50
4.6	58	47	46	60	49	49	62	53	51
4.7	58	47	46	60	50	50	62	53	51
4.8	58	46	46	59	50	50	62	54	52
5.0	58	46	46	59	50	50	62	53	52

Table 3.11. Results of ALMA 8hr mock observations of Sky 2 ($N_{total} = 167$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	163	200	78	166	570	73	167	428	75
2.1	162	191	80	166	523	73	167	378	75
2.2	159	183	78	165	476	73	167	345	76
2.3	156	174	77	164	437	71	167	307	76
2.4	155	164	78	163	385	71	167	276	76
2.5	152	152	79	161	352	71	167	251	75
2.6	150	147	80	159	323	72	167	232	74
2.7	146	140	80	158	292	72	167	219	74
2.8	143	127	78	157	265	72	166	212	76
2.9	138	122	77	153	249	73	166	176	77
3.0	134	112	77	152	227	75	166	163	77
3.1	133	107	76	149	217	76	166	154	79
3.2	126	98	70	146	190	75	166	144	81
3.3	122	90	71	141	181	73	165	131	79
3.4	121	82	71	138	168	73	164	117	78
3.5	117	78	72	137	152	70	163	109	78
3.6	117	73	70	132	137	71	163	104	78
3.7	115	68	68	129	132	72	162	98	78
3.8	113	68	68	125	123	71	162	93	76
3.9	112	68	68	124	118	71	159	86	74
4.0	112	67	67	123	114	71	158	87	76
4.1	107	67	66	122	112	71	158	84	76
4.2	106	66	65	119	107	69	158	86	79
4.3	103	65	62	118	103	69	156	84	79
4.4	100	64	61	115	101	69	153	84	79
4.5	99	62	59	114	89	68	152	84	79
4.6	95	60	53	113	80	67	151	81	79
4.7	95	60	53	111	77	66	148	80	78
4.8	93	59	53	110	74	63	145	79	77
5.0	90	59	52	107	69	62	145	77	76

Table 3.12. Results of ALMA 12hr mock observations of Sky 2 ($N_{total} = 173$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	170	141	108	170	122	89	173	224	115
2.1	170	128	107	170	114	89	173	213	115
2.2	170	122	107	170	108	88	173	191	115
2.3	169	119	106	170	103	88	173	185	115
2.4	168	116	106	170	95	88	173	173	115
2.5	168	108	104	170	92	88	173	172	113
2.6	167	107	105	169	89	86	173	165	113
2.7	165	107	105	169	91	88	173	160	113
2.8	163	107	105	169	90	88	172	161	113
2.9	163	107	106	169	90	88	171	160	112
3.0	160	104	103	168	89	88	171	152	111
3.1	160	102	102	167	90	89	171	142	110
3.2	158	102	102	166	91	90	171	136	111
3.3	154	103	101	166	90	90	171	127	109
3.4	152	99	97	163	92	92	171	127	109
3.5	151	97	96	162	92	92	171	125	108
3.6	151	94	94	161	93	93	170	124	108
3.7	146	93	93	159	96	96	170	122	107
3.8	143	94	94	156	98	98	170	118	107
3.9	143	93	93	156	98	98	169	112	107
4.0	139	95	95	156	99	99	169	116	109
4.1	138	94	94	152	97	97	169	117	111
4.2	134	93	92	149	97	97	169	120	114
4.3	132	92	91	148	96	96	169	119	114
4.4	130	92	91	145	95	95	169	117	115
4.5	127	91	89	144	95	95	167	118	115
4.6	125	90	88	140	93	93	167	114	113
4.7	124	90	88	137	93	93	167	114	113
4.8	123	90	87	134	92	90	166	114	113
5.0	122	88	86	131	89	87	166	112	111

Table 3.13. Results of ALMA 24hr mock observations of Sky 2 ($N_{total} = 168$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	166	157	118	168	136	96	168	246	107
2.1	165	155	119	168	129	96	168	231	107
2.2	165	150	118	168	126	95	168	206	107
2.3	165	147	119	168	115	96	168	192	107
2.4	165	144	119	168	112	97	168	183	107
2.5	165	140	119	167	108	98	168	172	106
2.6	164	136	118	167	108	98	168	164	107
2.7	163	132	117	167	108	98	168	163	107
2.8	161	126	114	166	106	98	168	159	107
2.9	160	126	113	166	105	97	168	147	106
3.0	160	125	113	166	104	97	168	144	105
3.1	159	121	111	166	105	98	168	139	105
3.2	159	119	111	165	107	100	168	140	105
3.3	159	118	112	163	107	100	168	135	103
3.4	159	116	111	163	108	102	168	139	106
3.5	157	111	109	163	109	103	168	134	106
3.6	155	109	108	163	109	103	168	128	106
3.7	155	108	108	163	109	103	167	124	108
3.8	154	108	108	163	107	101	167	121	108
3.9	154	108	108	162	107	101	167	121	108
4.0	153	109	109	161	107	101	167	122	109
4.1	152	104	104	160	103	99	167	119	110
4.2	151	104	104	159	102	98	167	118	110
4.3	151	102	102	157	100	97	166	118	110
4.4	150	103	103	155	99	98	166	120	112
4.5	150	102	102	154	98	98	166	118	111
4.6	146	102	101	153	97	97	166	115	109
4.7	143	102	99	152	97	97	166	115	109
4.8	142	98	97	149	96	96	165	113	107
5.0	142	97	97	149	96	96	165	114	108

Table 3.14. Results of ALMA 8hr mock observations of Sky 3 ($N_{total}=872$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	120	193	75	137	598	67	189	988	65
2.1	119	179	75	129	541	68	181	987	66
2.2	118	171	76	125	511	68	178	945	68
2.3	117	160	75	119	455	68	174	934	69
2.4	113	147	74	118	407	67	172	907	70
2.5	111	142	74	118	371	67	169	867	69
2.6	108	134	73	116	334	67	166	786	70
2.7	107	123	73	115	303	67	159	698	70
2.8	105	110	70	112	280	67	156	645	69
2.9	103	102	69	110	257	67	141	564	68
3.0	98	90	68	108	242	67	138	483	68
3.1	96	84	68	107	227	67	131	421	68
3.2	95	78	67	106	213	66	130	370	69
3.3	92	73	66	103	204	65	125	300	68
3.4	89	68	65	101	191	65	120	268	69
3.5	86	68	65	100	171	64	119	223	67
3.6	83	68	64	97	159	65	118	199	70
3.7	79	66	62	95	143	65	118	164	68
3.8	78	63	60	94	126	63	118	144	68
3.9	76	62	60	92	117	63	116	134	67
4.0	74	63	60	90	111	63	115	120	67
4.1	74	64	60	88	104	61	114	110	67
4.2	71	63	58	86	100	60	112	103	67
4.3	69	61	56	84	95	59	110	93	66
4.4	68	61	56	83	88	59	110	85	64
4.5	66	62	55	81	85	58	108	79	62
4.6	66	62	55	79	81	57	108	76	62
4.7	66	60	54	76	75	55	107	72	61
4.8	66	59	53	75	71	54	106	70	62
5.0	65	60	52	73	68	52	104	68	62

Table 3.15. Results of ALMA 12hr mock observations of Sky 3 ($N_{total} = 862$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	139	102	63	157	91	57	212	184	64
2.1	137	98	63	153	83	56	205	169	63
2.2	131	94	64	143	80	56	192	160	62
2.3	126	84	64	139	73	56	188	147	63
2.4	117	78	65	136	67	56	183	142	63
2.5	114	76	66	129	62	56	177	141	64
2.6	111	74	66	122	59	56	172	126	63
2.7	109	74	66	118	59	57	167	118	61
2.8	103	72	65	116	60	57	164	118	62
2.9	101	71	65	113	58	56	161	116	60
3.0	99	69	64	112	56	56	157	109	60
3.1	97	69	65	105	56	55	152	96	61
3.2	92	68	65	103	56	55	146	94	62
3.3	91	67	64	102	56	55	144	94	62
3.4	89	68	63	101	55	55	141	92	62
3.5	88	65	63	96	55	55	138	86	62
3.6	83	65	62	96	55	55	135	87	64
3.7	83	64	62	93	54	54	131	82	65
3.8	80	64	61	91	53	53	123	77	65
3.9	78	60	58	89	53	53	120	78	68
4.0	77	59	57	87	53	52	119	76	68
4.1	75	58	55	85	53	53	116	69	65
4.2	74	53	51	85	53	53	115	70	67
4.3	71	53	50	83	52	52	114	72	68
4.4	69	53	50	82	51	51	114	71	69
4.5	69	53	50	80	51	51	111	68	67
4.6	68	53	50	76	51	49	108	66	66
4.7	66	52	50	73	51	49	104	66	65
4.8	65	51	49	72	50	48	102	65	64
5.0	64	49	48	72	49	46	102	64	63

Table 3.16. Results of ALMA 24hr mock observations of Sky 3 ($N_{total} = 901$).

σ	Config. 1			Config. 11			Config. 29		
	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}	N_{th}	N_d	N_{good}
2.0	166	264	86	167	385	66	237	227	77
2.1	156	265	84	163	389	67	224	213	75
2.2	156	249	87	157	391	67	214	199	76
2.3	151	260	88	153	398	66	207	183	75
2.4	146	253	86	151	424	66	200	178	75
2.5	143	243	86	144	429	65	198	165	75
2.6	138	241	87	140	421	65	192	153	74
2.7	135	239	86	133	425	65	183	149	74
2.8	130	238	83	125	423	65	173	145	75
2.9	122	239	80	124	412	65	167	134	76
3.0	116	234	79	120	390	67	165	122	77
3.1	116	231	78	115	367	67	163	122	78
3.2	115	228	78	113	363	69	161	119	76
3.3	112	232	79	112	337	68	157	114	77
3.4	108	223	78	111	308	69	154	111	78
3.5	107	219	78	110	290	67	153	108	79
3.6	106	201	76	105	275	68	149	107	80
3.7	105	183	75	103	247	67	144	104	80
3.8	103	167	75	102	231	69	142	103	81
3.9	99	152	75	98	211	68	141	102	82
4.0	97	136	74	94	196	68	134	96	81
4.1	95	132	74	93	181	66	129	90	77
4.2	94	122	73	93	161	66	125	88	77
4.3	91	114	73	93	141	65	125	87	77
4.4	91	107	74	92	135	66	124	86	77
4.5	90	98	72	90	126	67	122	81	74
4.6	89	91	71	89	114	68	118	80	74
4.7	89	87	70	89	104	67	115	78	71
4.8	88	84	68	88	96	66	113	77	70
5.0	87	81	66	86	94	66	113	76	69

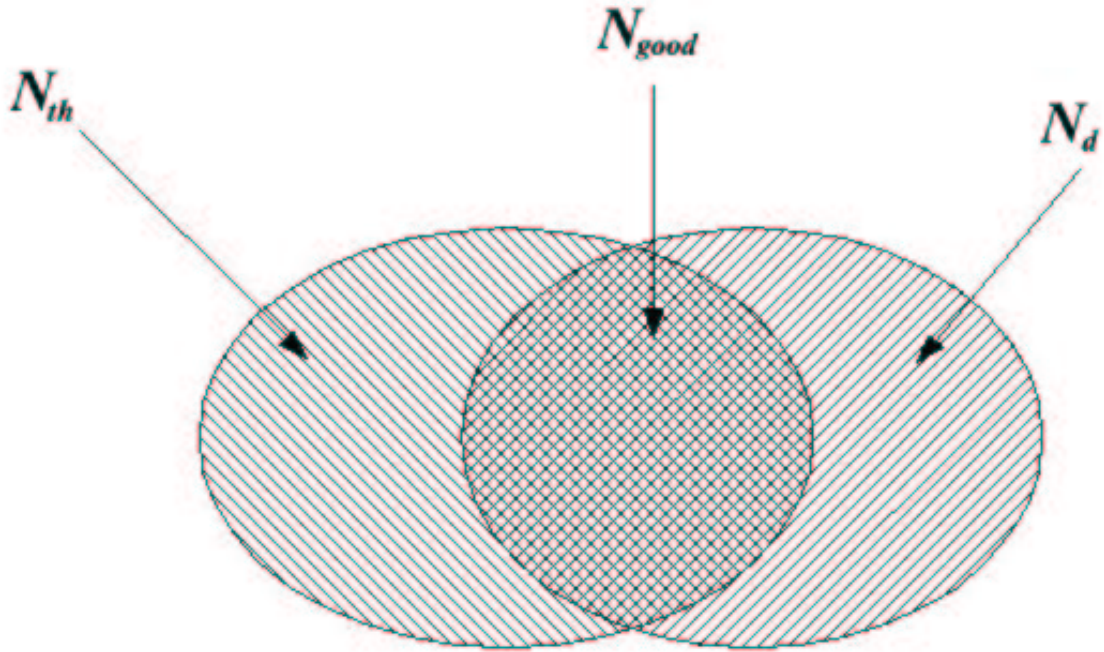


Fig. 3.3 : Relations between N_{th} , N_d and N_{good} .

3.2 Detection ratios of SMA/ALMA

The useful information from the simulations is a realistic estimate of the source detection and false detection ratios for different settings. The detection and false detection ratio are defined respectively by

$$\text{detecting ratio} = \frac{N_{good}}{N_{th}} \quad \text{and} \quad (3.1)$$

$$\text{false detection ratio} = \frac{N_d - N_{good}}{N_d} \quad (3.2)$$

where N_{th} , N_d and N_{good} are defined in Section 3.1.

Then, we can evaluate the correction factor and error propagation factor from the detection ratio (DR) and false detection ratio (FR). We can rewrite the definition of detection ratio,

$$N_{th} = \frac{N_{good}}{DR} \quad (3.3)$$

$$= N_d \frac{(1 - FR)}{DR}. \quad (3.4)$$

Eq. 3.4 shows the correction factor for correcting the detected source counts to expected source counts. Eq. 3.3 can be rewritten as

$$N_{th} = \frac{N_d}{DR} - \frac{N_d - N_{good}}{DR}. \quad (3.5)$$

Therefore, the Poisson noise can be derived.

$$\begin{aligned} \frac{\sqrt{(\sigma_{N_d})^2 + (\sigma_{N_d - N_{good}})^2}}{DR} &= \frac{\sqrt{2N_d - N_{good}}}{DR} \\ &= \frac{\sqrt{2N_d - N_d(1 - FR)}}{DR} \\ &= \frac{\sqrt{N_d(1 + FR)}}{DR} \\ &= \sqrt{N_d} \frac{\sqrt{1 + FR}}{DR}. \end{aligned} \quad (3.6)$$

Thus, Eq. 3.4 becomes

$$N_{th} = N_d \frac{(1 - FR)}{DR} \pm \sqrt{N_d} \frac{\sqrt{1 + FR}}{DR}. \quad (3.7)$$

So, the correction factor and the error propagation factor can be defined as:

$$\text{correction factor} \equiv \frac{(1 - FR)}{DR} \quad (3.8)$$

$$\text{error propagation factor} \equiv \frac{\sqrt{1 + FR}}{DR}. \quad (3.9)$$

Therefore EPFs can be factors that indicate the errors introduced by different settings and observation time. We also calculate the errors of EPFs use the following equations.

$$\begin{aligned} \Delta EPF^2 &= \left(\frac{\partial EPF}{\partial DR} \right)^2 \Delta DR^2 + \left(\frac{\partial EPF}{\partial FR} \right)^2 \Delta FR^2 \\ \Delta EPF^2 &= \left(\frac{1 + FR}{DR^4} \right) \Delta DR^2 + \left(\frac{1}{4(1 + FR)DR^2} \right) \Delta FR^2 \end{aligned} \quad (3.10)$$

where,

$$\begin{aligned} \Delta DR &\equiv \frac{\sqrt{N_{good}}}{N_{th}} \\ \Delta FR &\equiv \frac{1}{N_d} \sqrt{N_{good}} + \frac{N_{good}}{N_d^2} \sqrt{N_d} \end{aligned}$$

For each sky, we can find a setting, including observation time, significance level and configuration, that have the smallest EPF value. This setting is called the *optimal* setting.

Table 3.17. Optimal SMA DRs and EPFs for different skies and observation time.

	Sky 1		Sky 2		Sky 3	
	50-hour	100-hour	50-hour	100-hour	50-hour	100-hour
Configuration	D	D	D	D	D	D
σ	3.0	3.0	3.0	3.0	3.0	3.0
DR	0.65	0.84	0.70	0.87	0.64	0.84
FR	0.05	0.17	0.11	0.25	0.33	0.25
EPF	1.57	1.29	1.50	1.87	1.80	1.33

The curve of DRs and FRs of different submillimeter skies and configurations are plotted as the figures followed. The Figs. 3.4 to 3.9 show the DR/FRs and EPFs of SMA mock observations. Our results show that D configuration have the optimal EPFs. The optimal DRs, FRs and EPFs of SMA mock observations for different skies and configurations are shown in Table. 3.17. Figs. 3.10 to 3.18 show the DR/FRs and EPFs of ALMA mock observations. In the figures of EPFs, the EPFs from configuration 29 are not shown because of its large value of EPFs, comparing with that from configuration 1 and 11. The optimal DRs, FRs and EPFs of ALMA mock observations for different skies and configurations are shown in Table. 3.18.

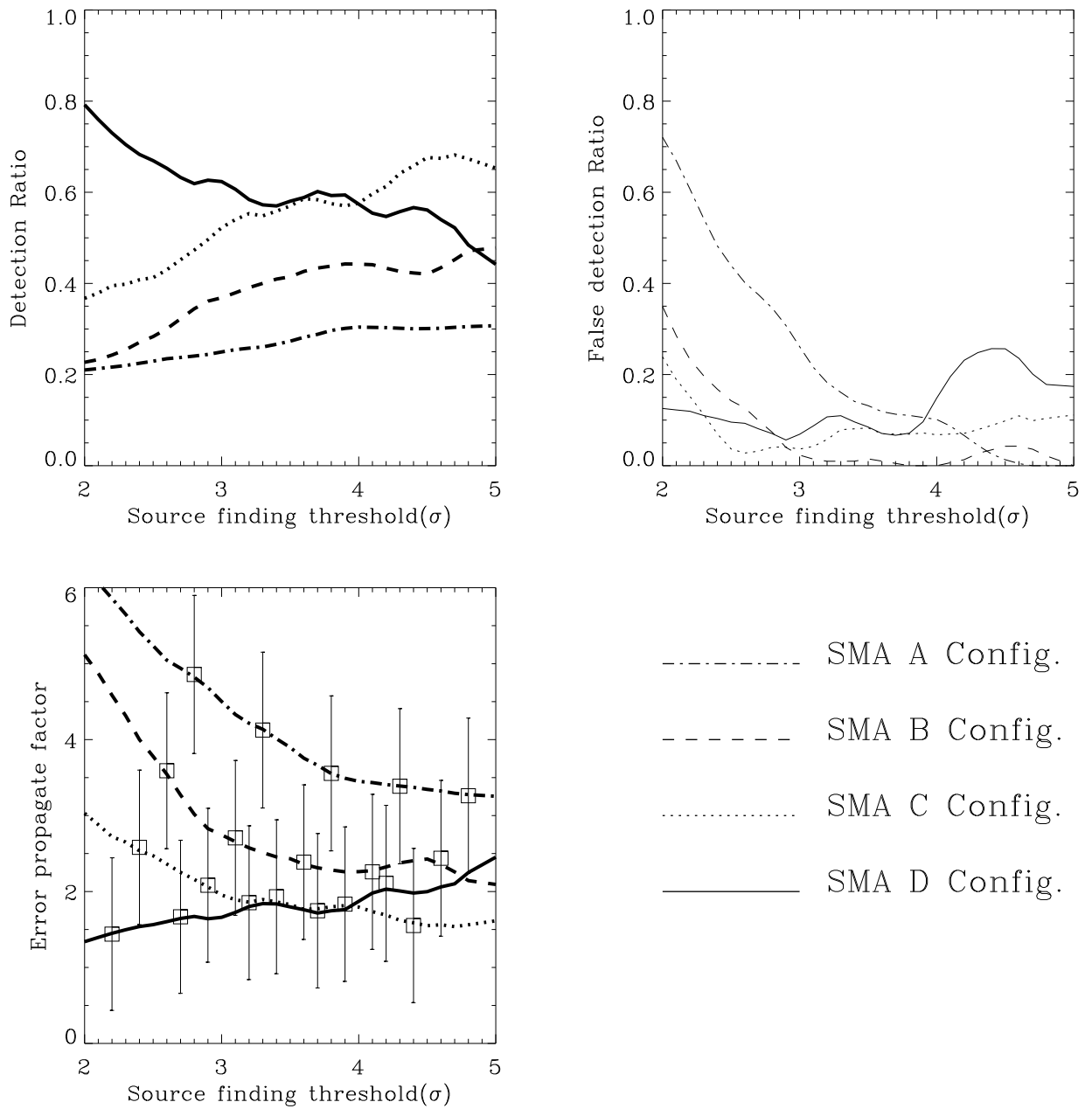


Fig. 3.4 : 50-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 1. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

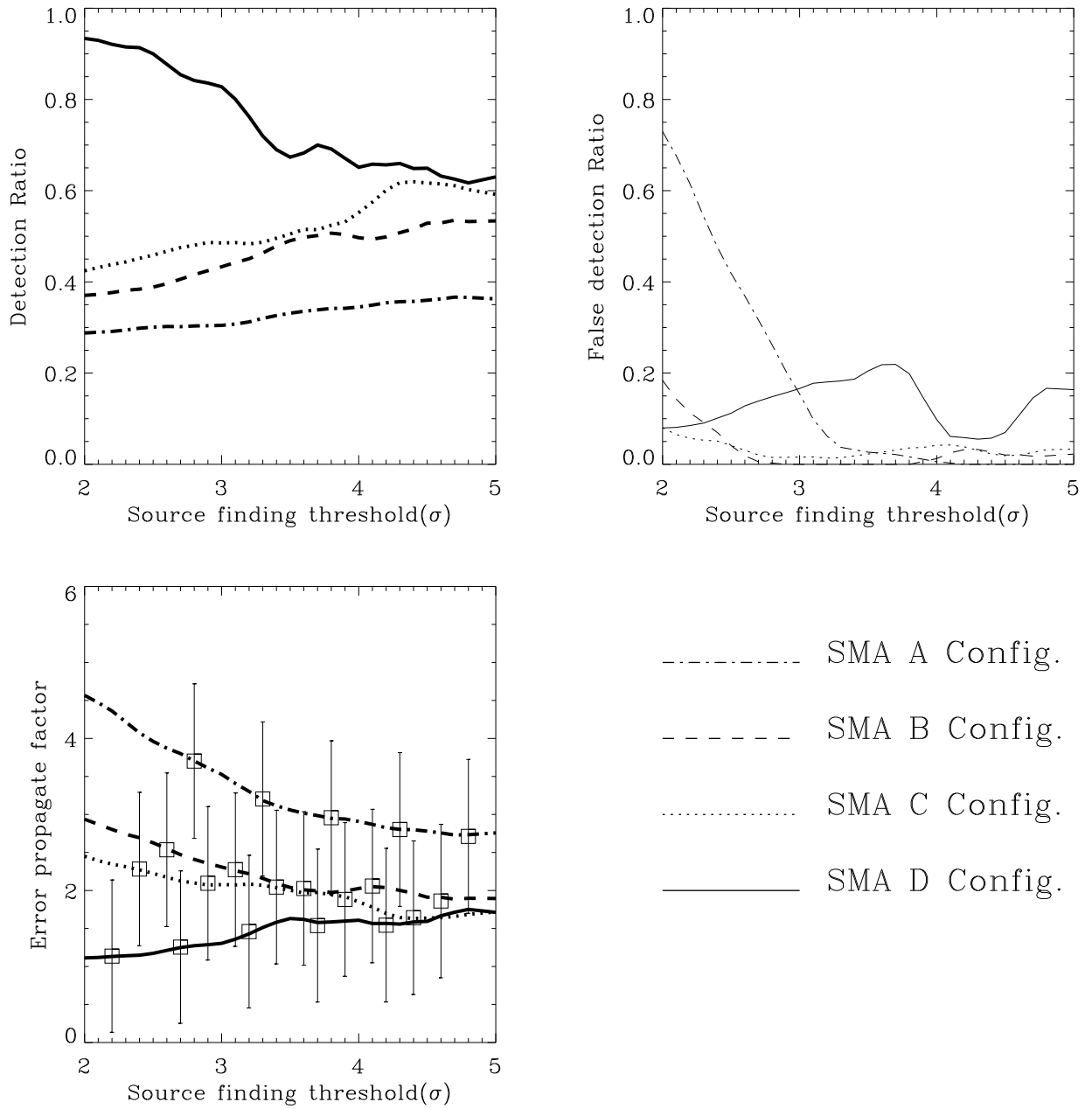


Fig. 3.5 : 100-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 1. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

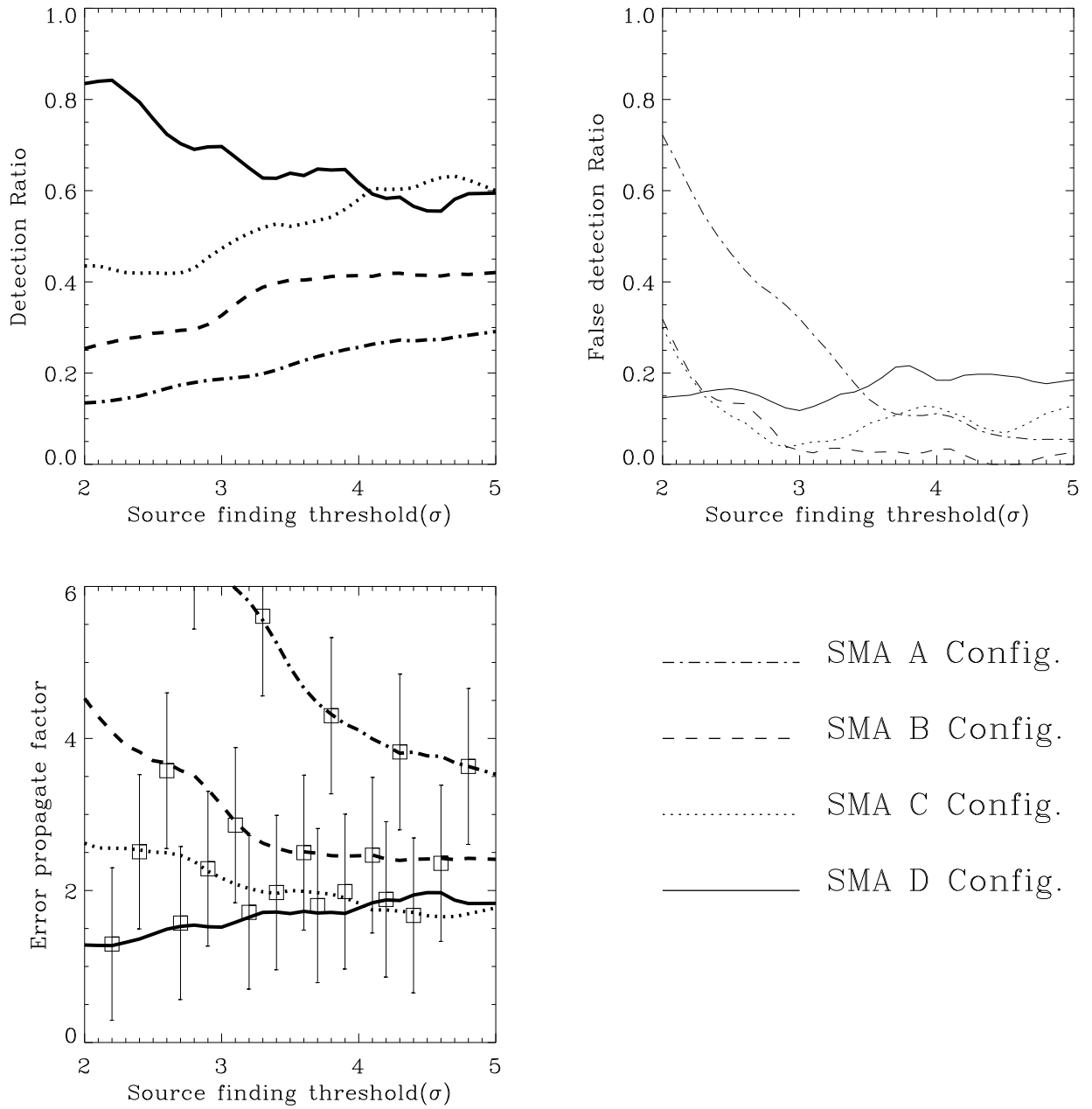


Fig. 3.6 : 50-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 2. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

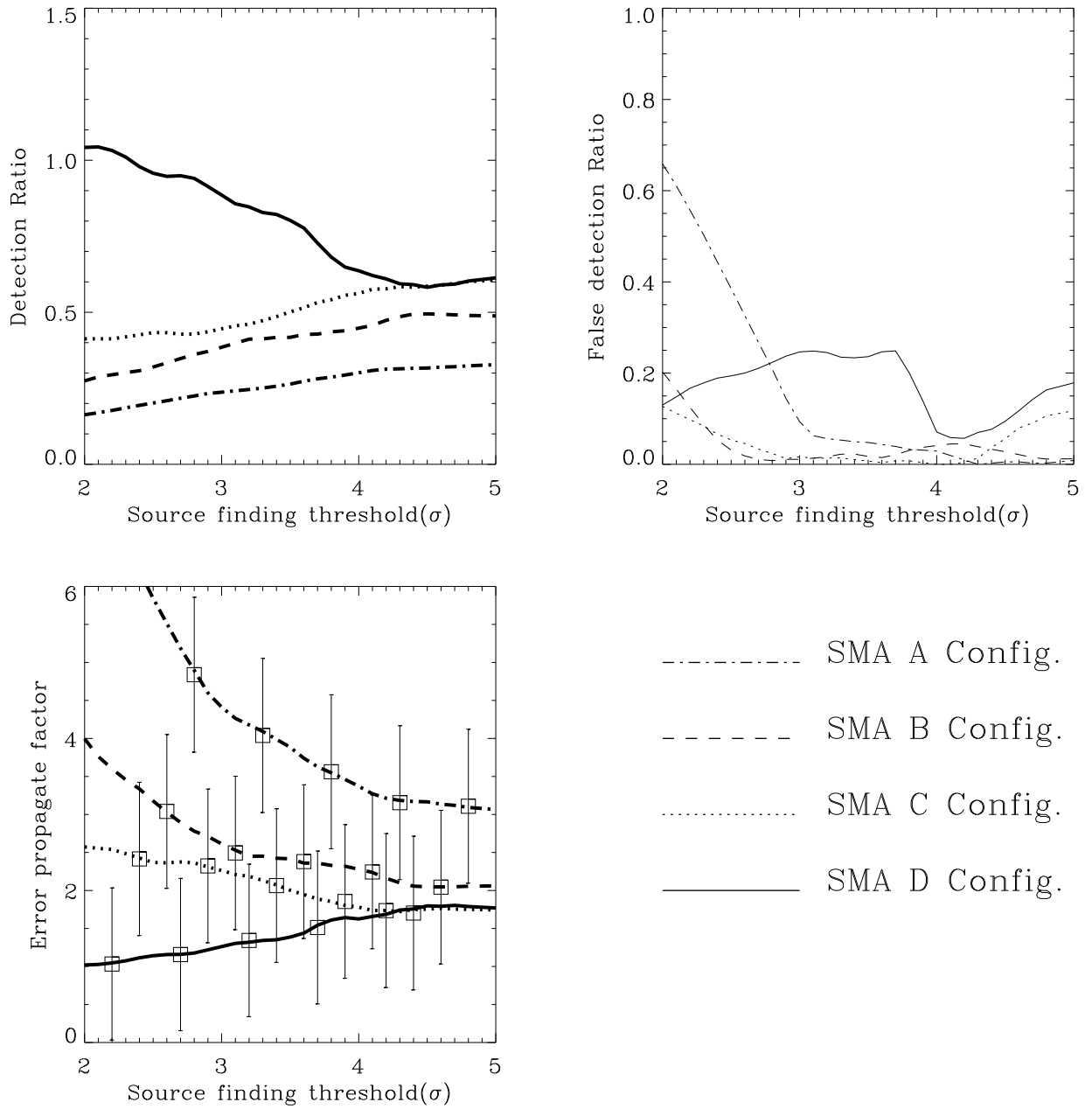


Fig. 3.7 : 100-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 2. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

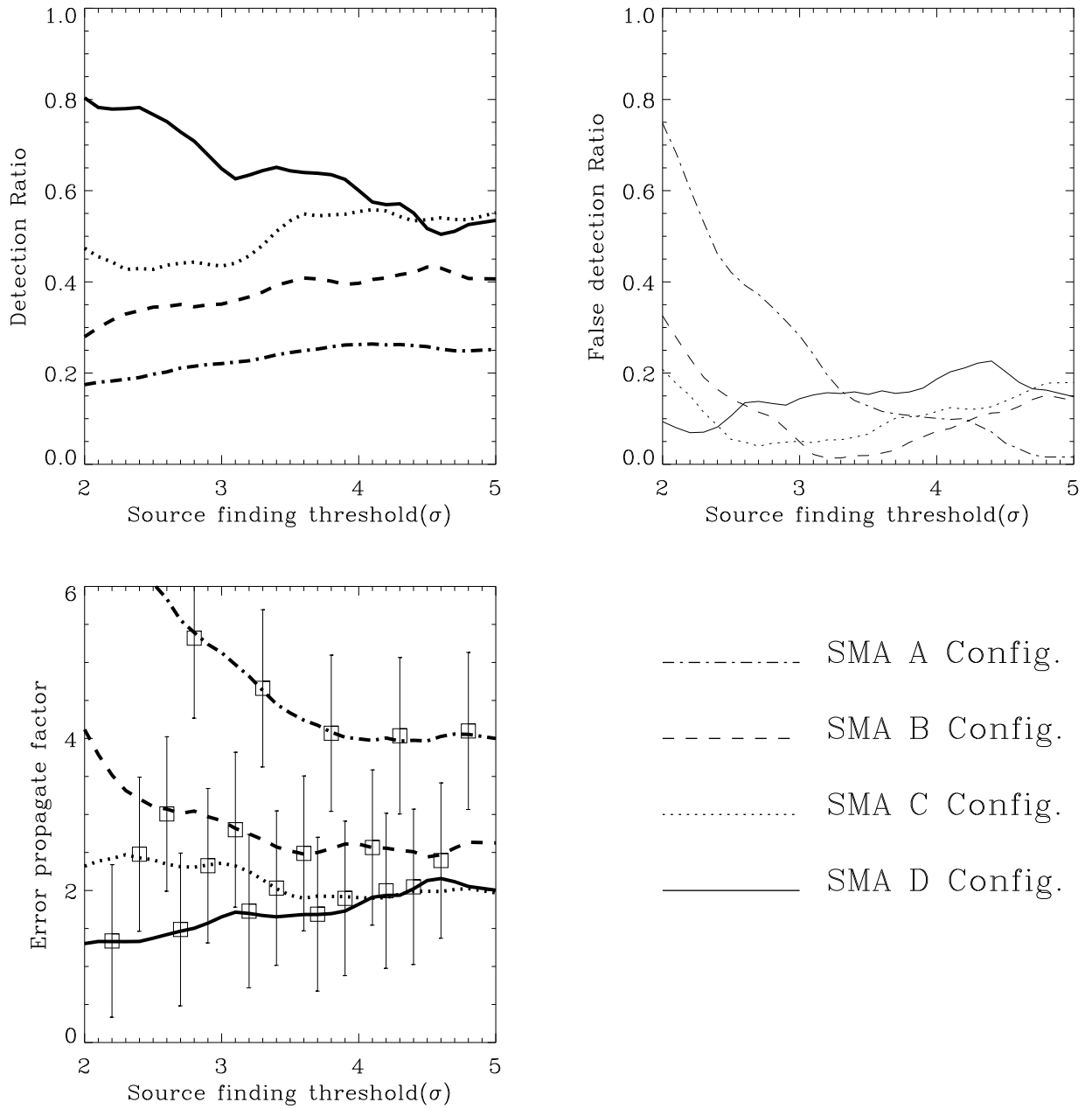


Fig. 3.8 : 50-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 3. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

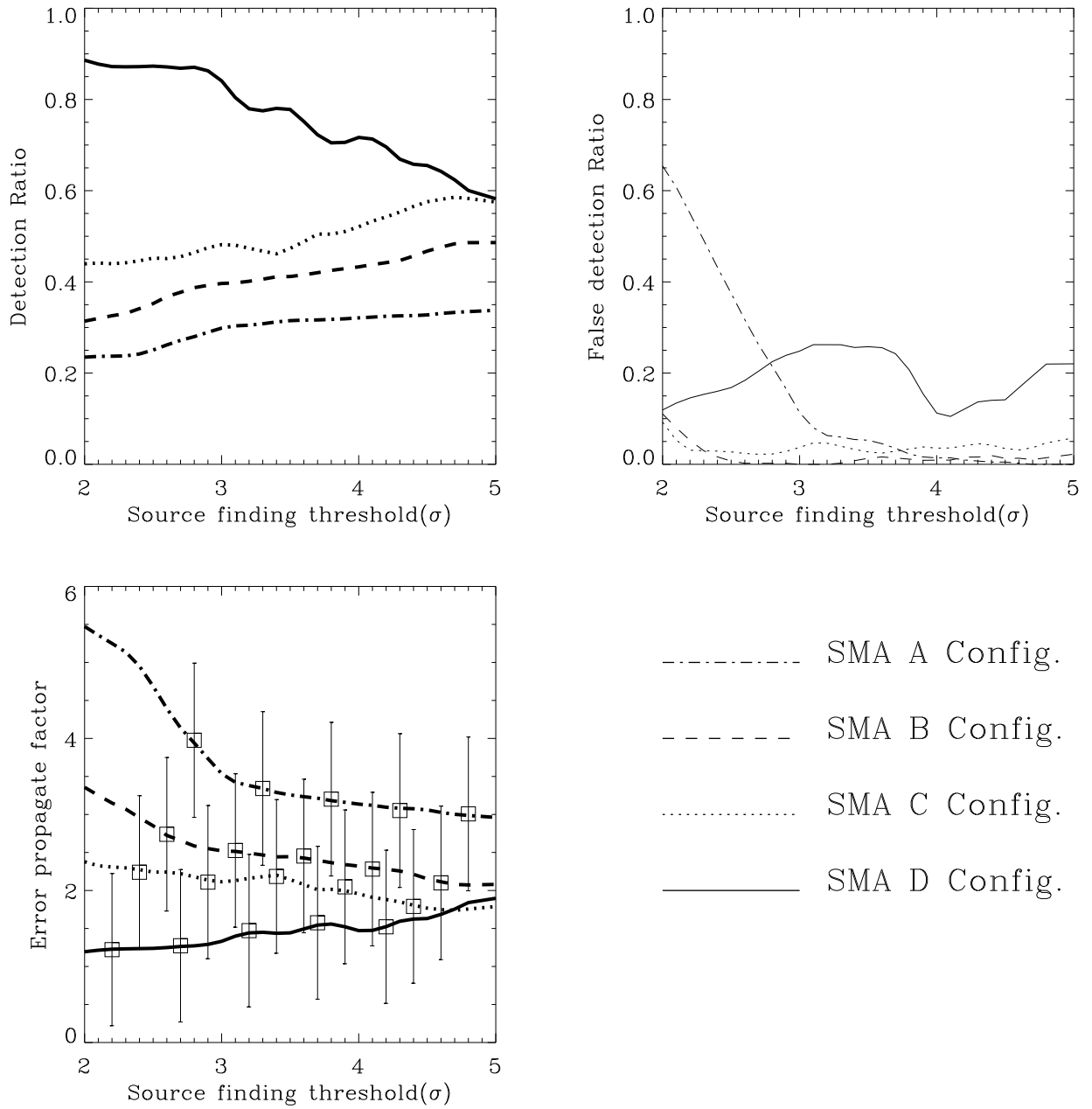


Fig. 3.9 : 100-hour SMA DR/FRs and EPFs with different configurations and σ of Sky 3. The upper panels show the DRs (left) and FRs (right), while lower panel shows the EPFs. The solid, dotted, dashed and dot-dashed curves represents the DR(FR)s of D, C, B and A configurations, respectively.

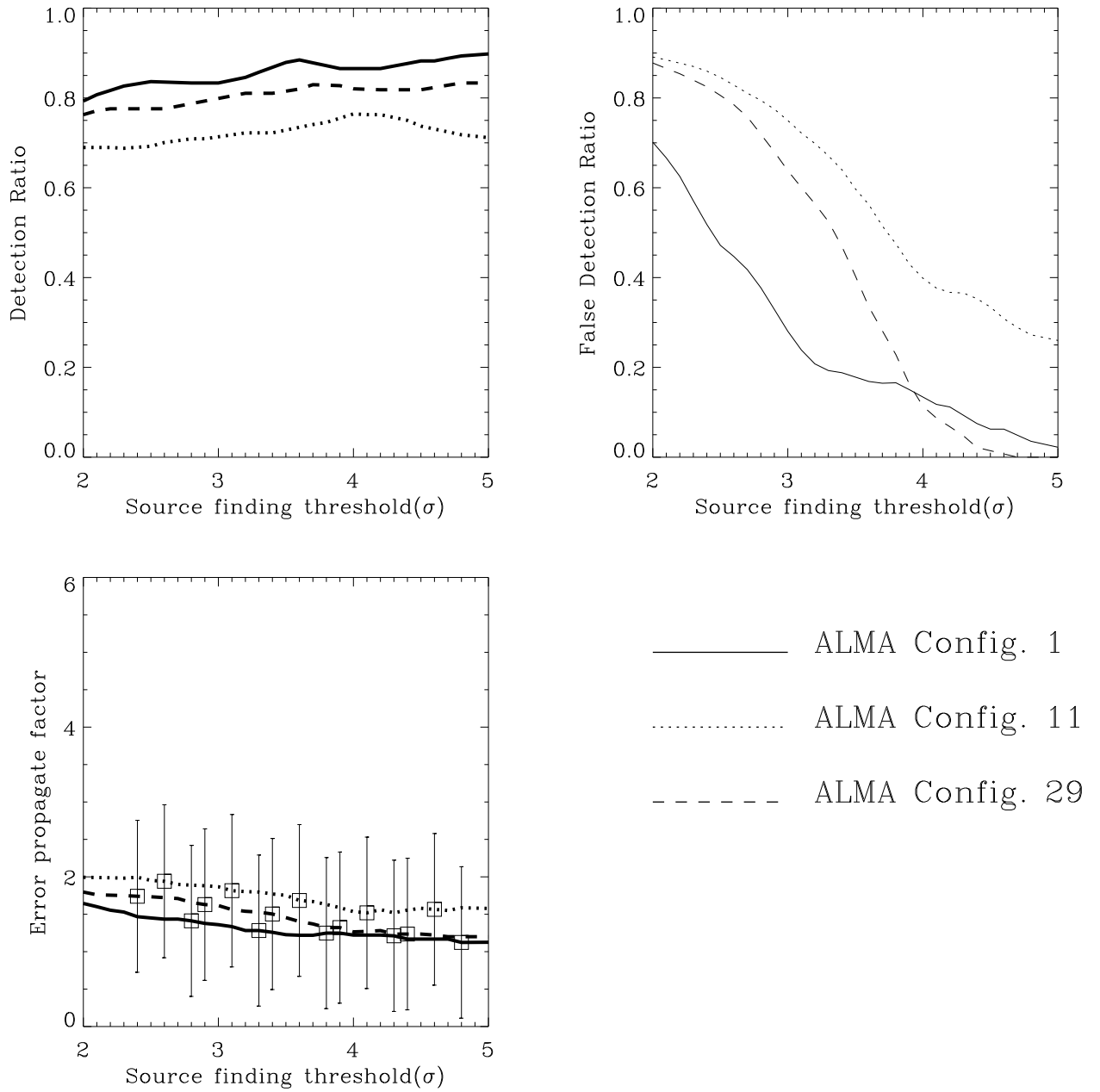


Fig. 3.10 : 8-hour ALMA detection DR/FRs and EPFs with different configurations of Sky 1. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

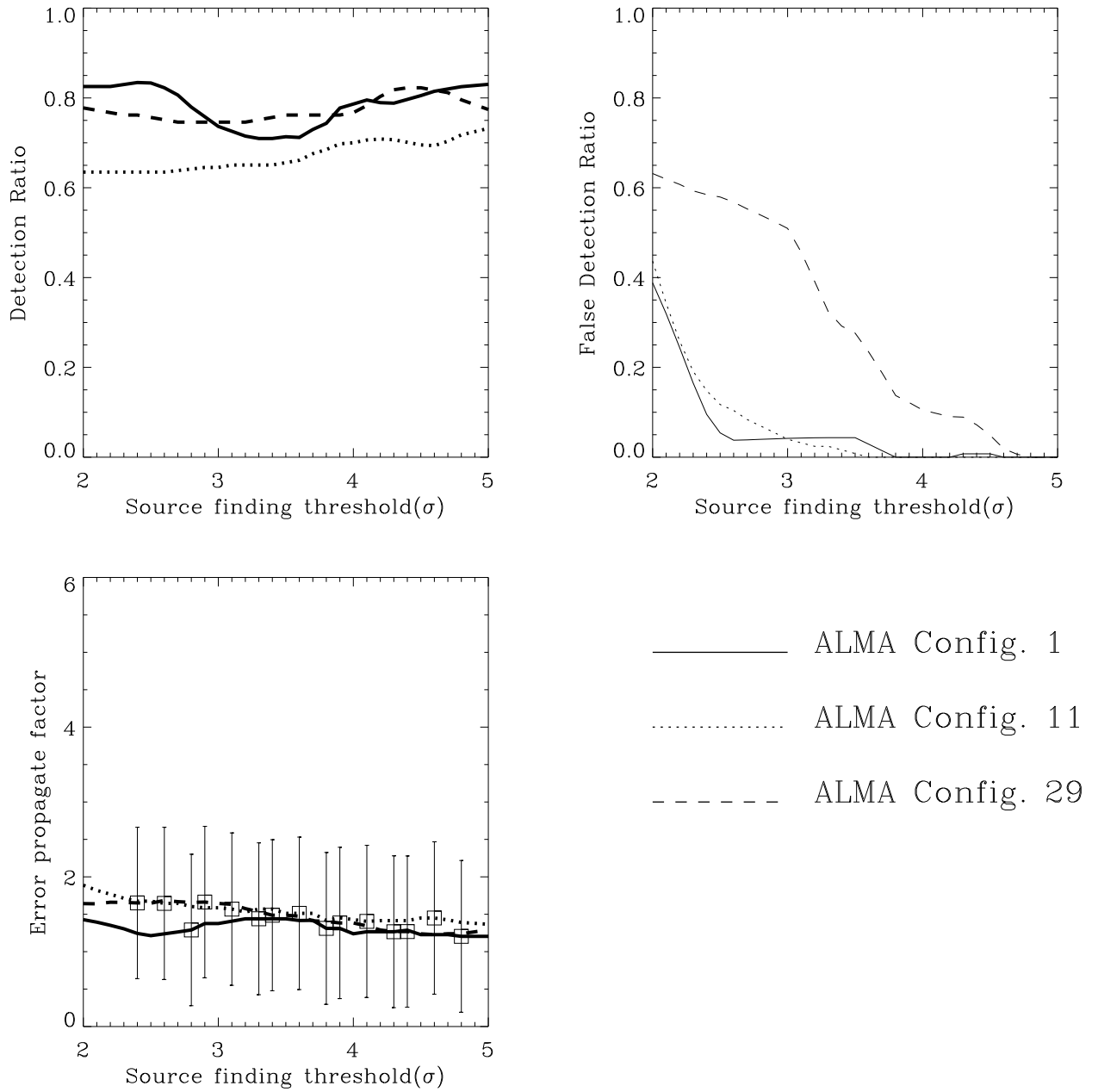


Fig. 3.11 : 12-hour ALMA detection DR/FR and EPFs with different configurations of Sky 1. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

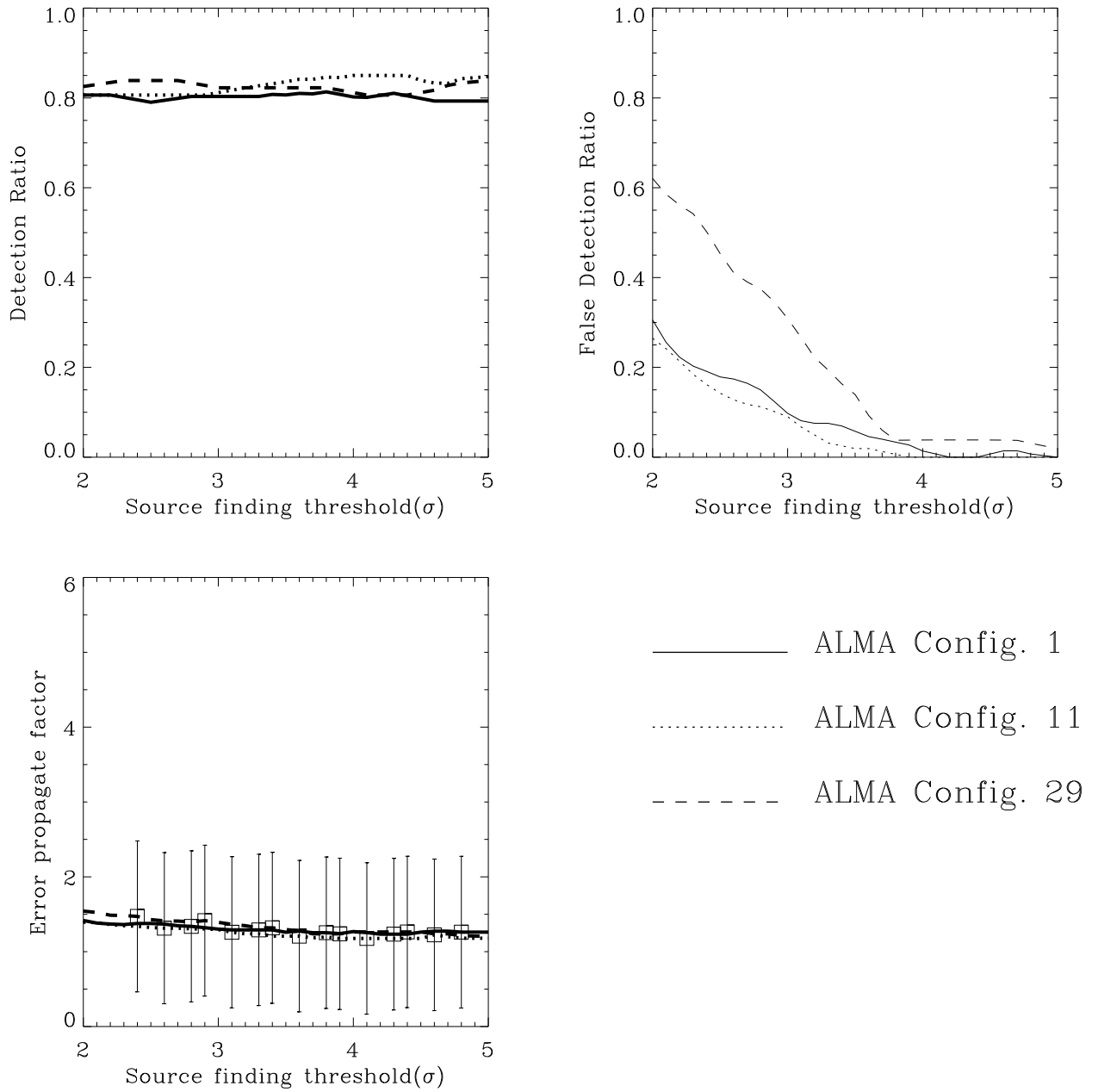


Fig. 3.12 : 24-hour ALMA detection DR/FR and EPFs with different configurations of Sky 1. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

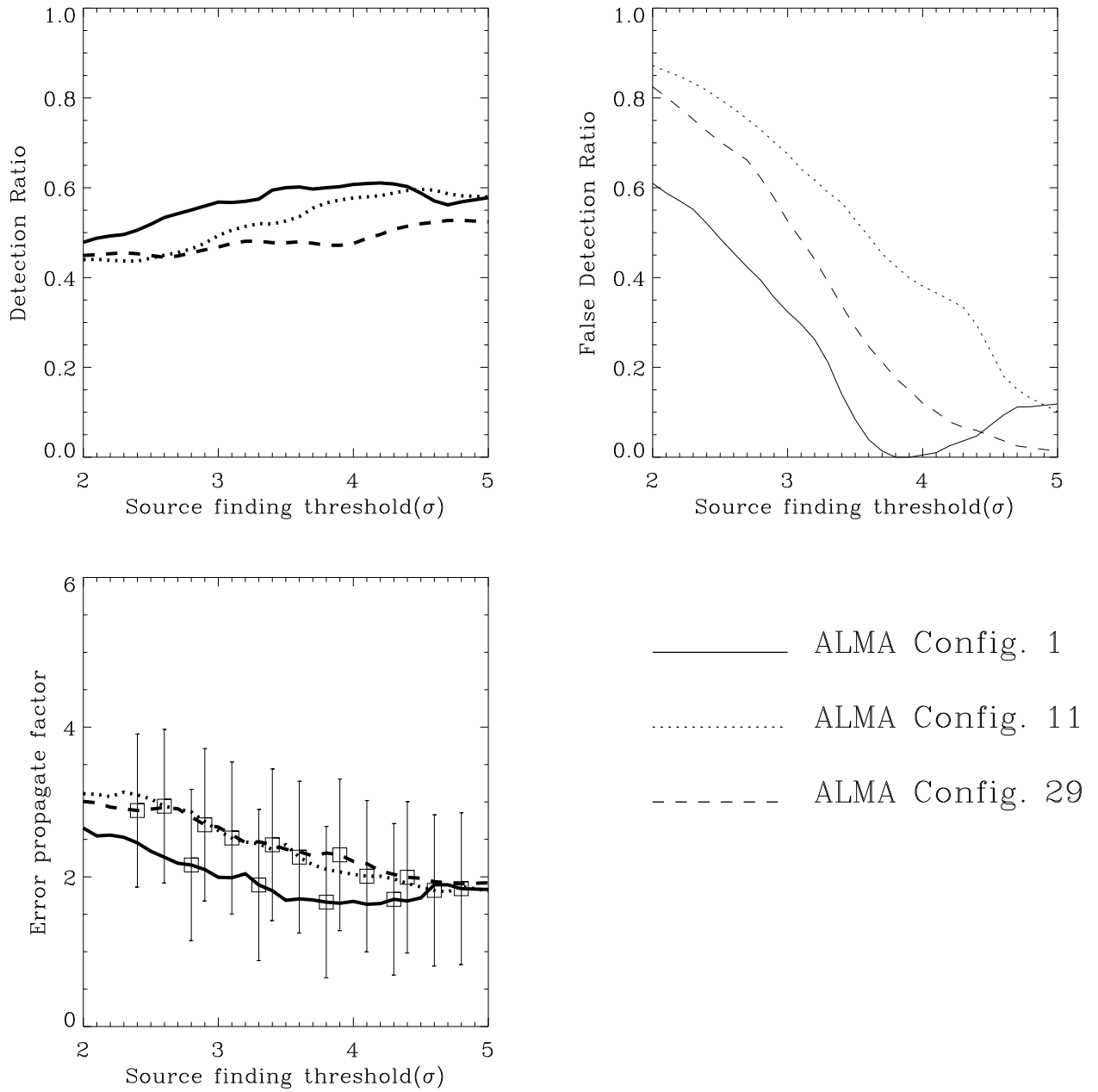


Fig. 3.13 : 8-hour ALMA detection DR/FR and EPFs with different configurations of Sky 2. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

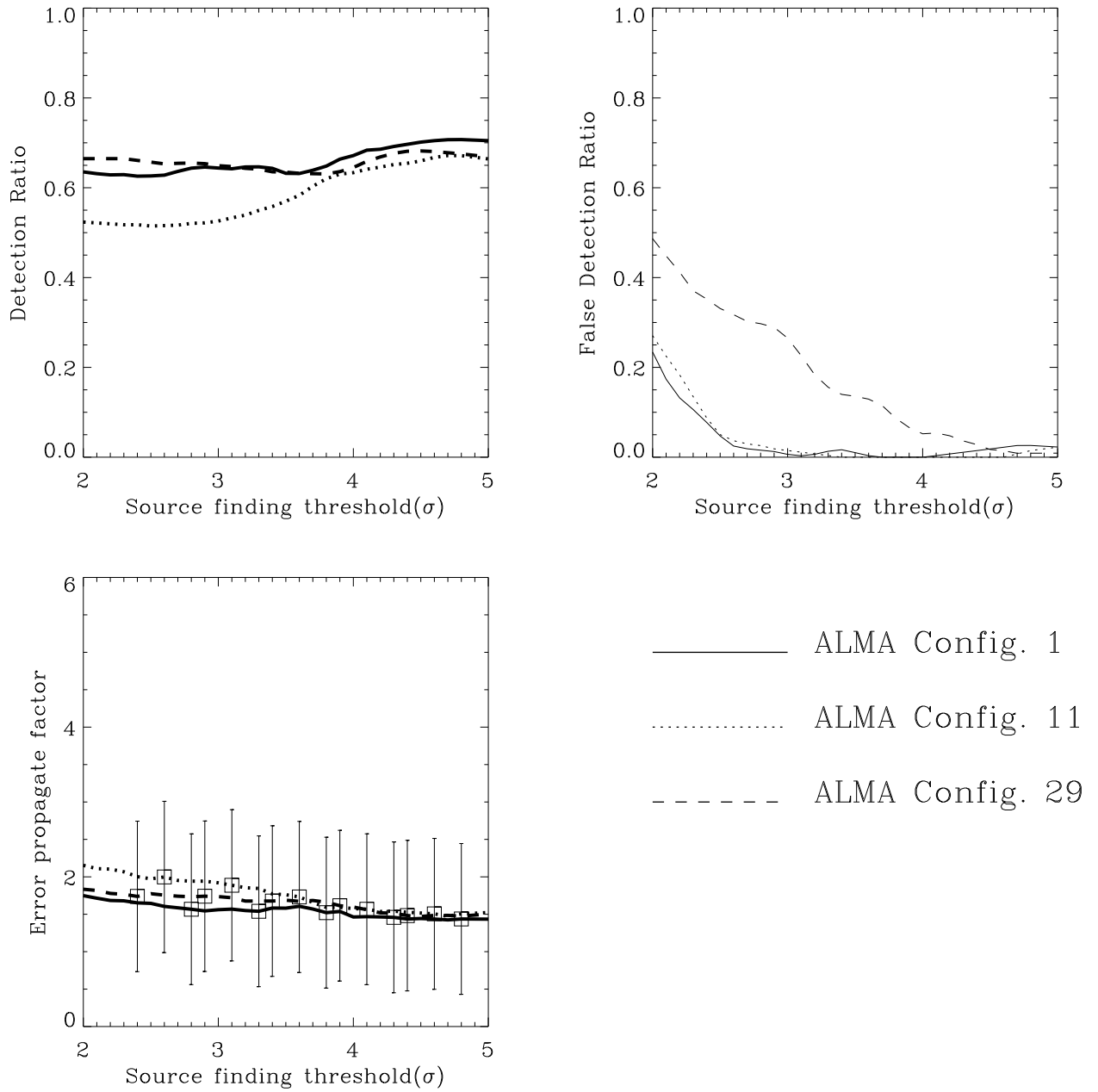


Fig. 3.14 : 12-hour ALMA detection DR/FR and EPFs with different configurations of Sky 2. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

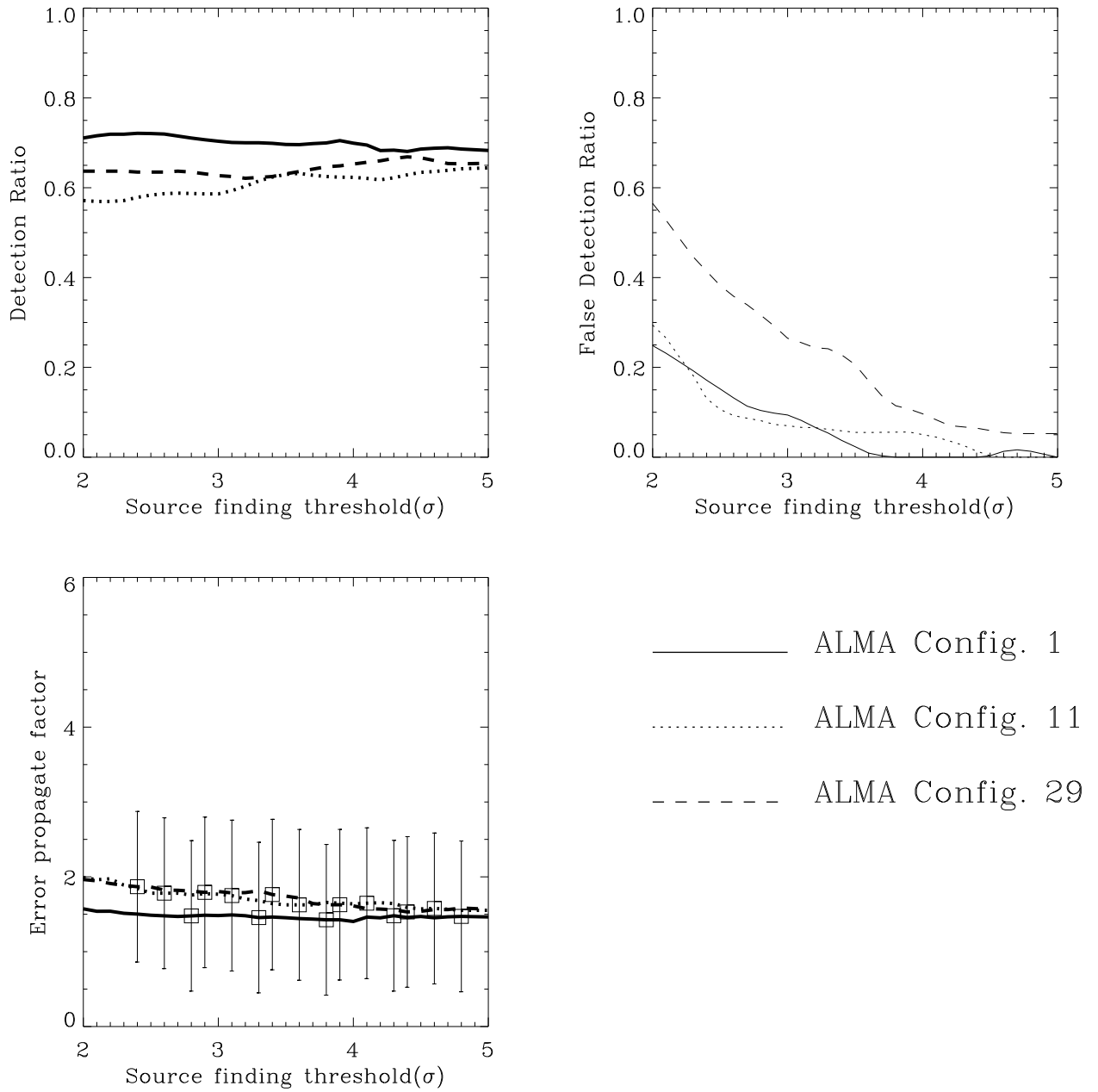


Fig. 3.15 : 24-hour ALMA detection DR/FR and EPFs with different configurations of Sky 2. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

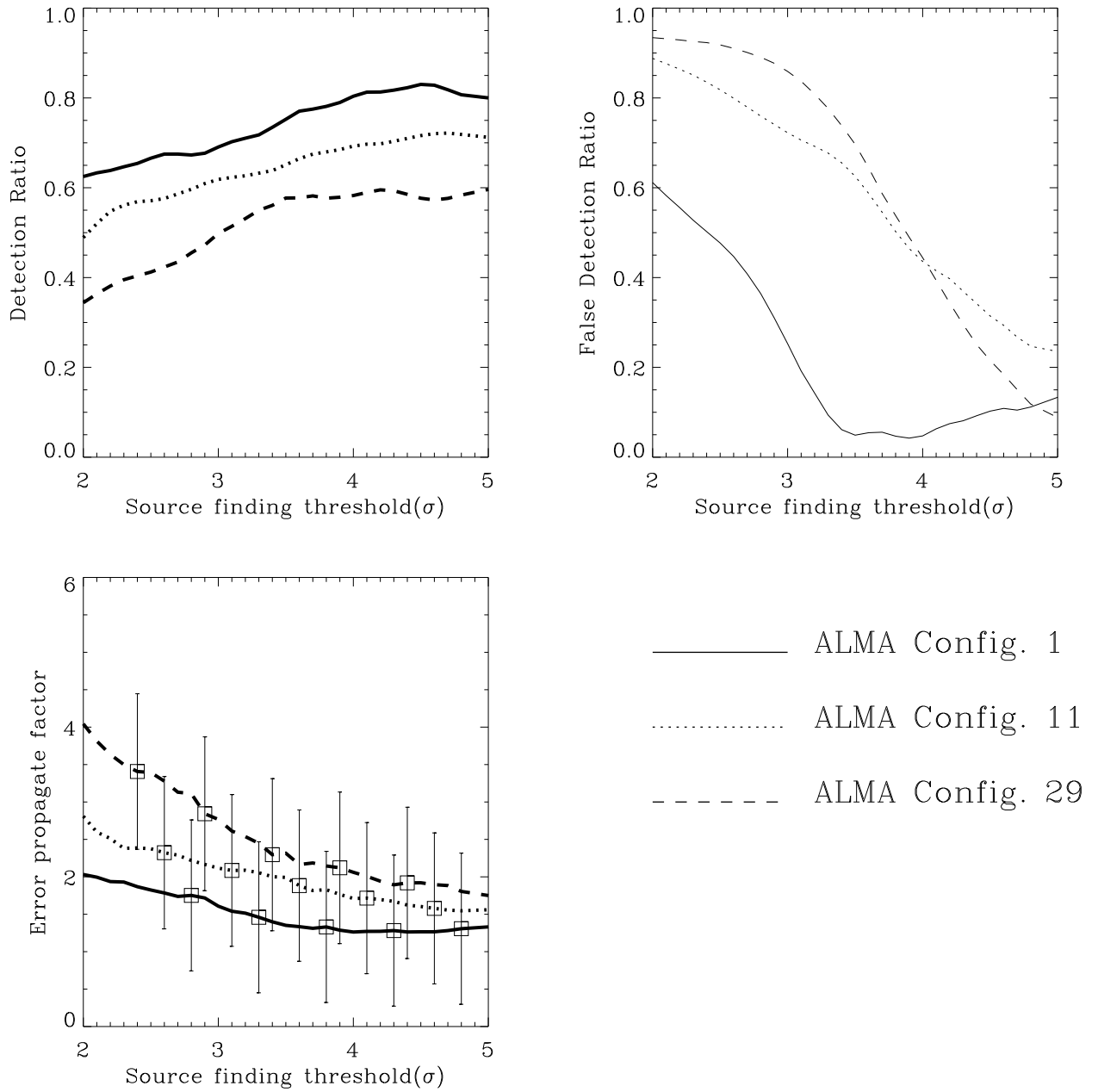


Fig. 3.16 : 8-hour ALMA detection DR/FR and EPFs with different configurations of Sky 3. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

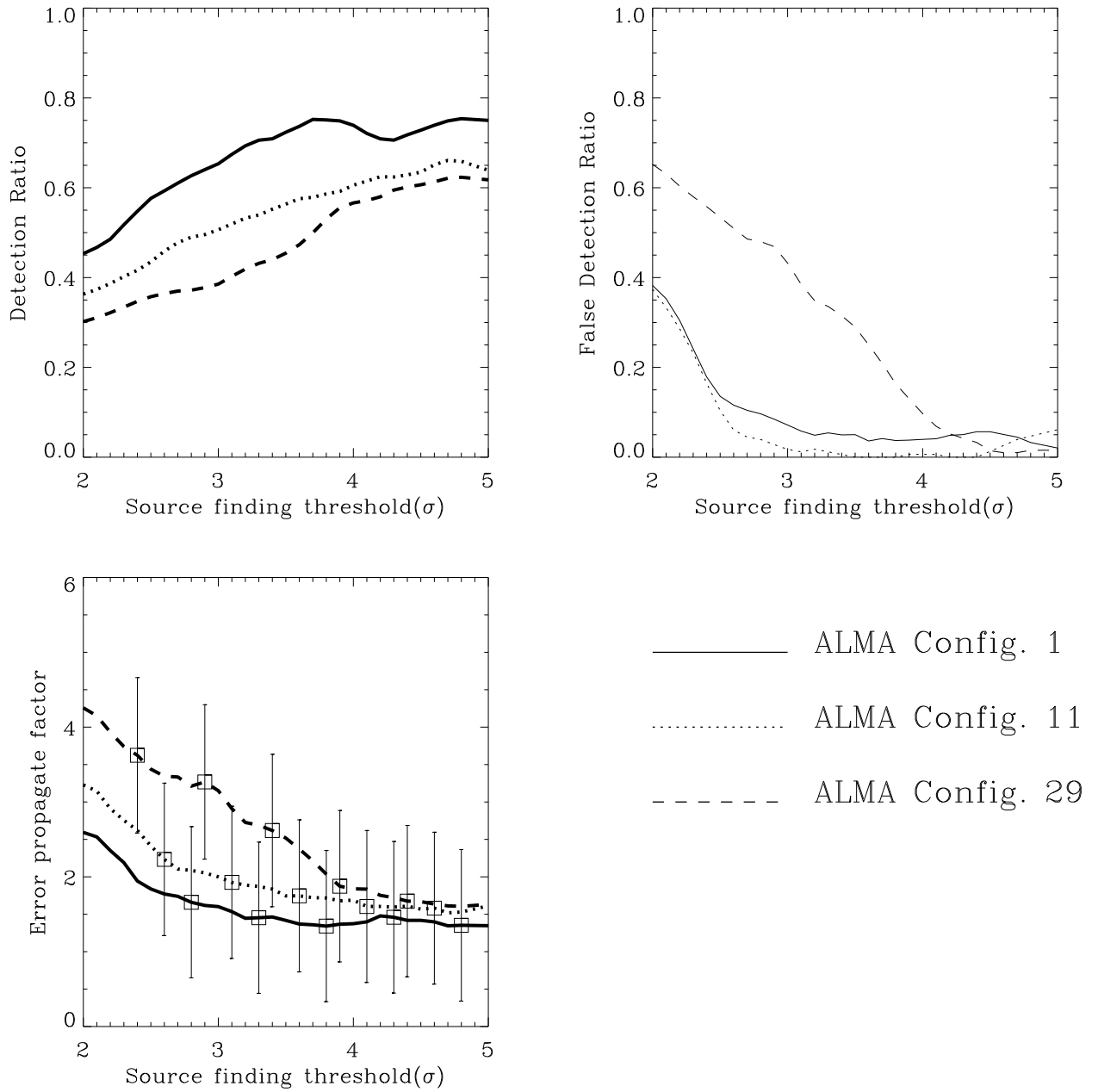


Fig. 3.17 : 12-hour ALMA detection DR/FR and EPFs with different configurations of Sky 3. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

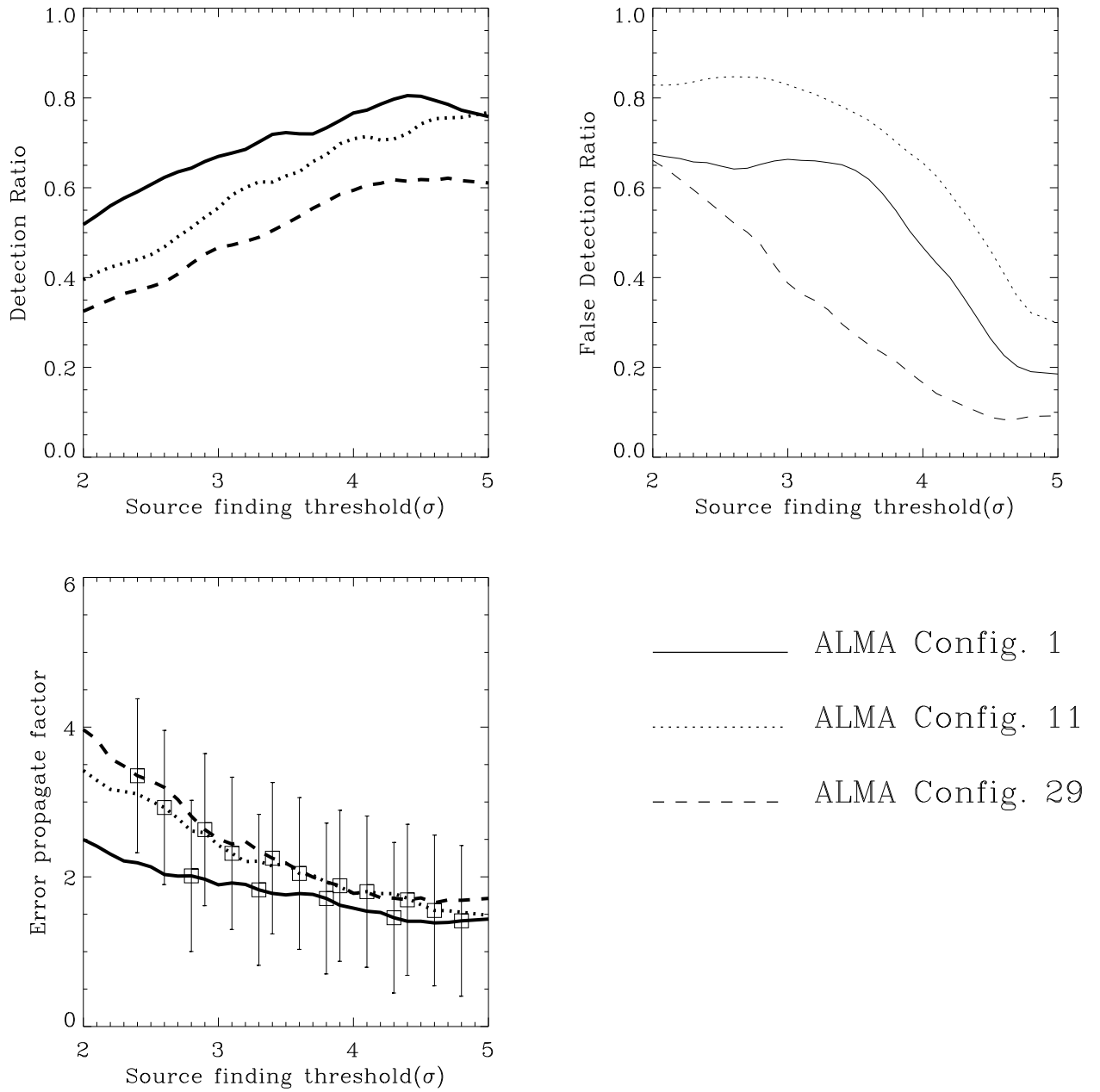


Fig. 3.18 : 24-hour ALMA detection DR/FR and EPFs with different configurations of Sky 3. The DRs and FRs are shown as the upper-left and upper-right panels, respectively. The lower left panel shows the EPFs of different configurations. The solid, dotted and dashed curves represent the results of configuration 1, 11 and 29, respectively.

Table 3.18. Optimal ALMA DRs and EPFs for different skies and observation time.

	Sky 1			Sky 2			Sky 3		
	8-hour	12-hr	24-hr	8-hr	12-hr	24-hr	8-hr	12-hr	24-hr
Config.	1	1	1	1	1	1	1	1	1
σ	3.6	4.0	3.0	3.8	4.0	3.0	4.0	3.8	4.5
DR	0.88	0.81	0.80	0.60	0.70	0.70	0.81	0.76	0.80
FR	0.16	0	0	0	0	0.10	0.05	0.05	0.26
EPF	1.22	1.23	1.31	1.67	1.43	1.50	1.27	1.35	1.40