Supplementary material for

The transport and distribution of polycyclic aromatic hydrocarbons (PAHs) across the Hengduan Mountains, southwest China

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Text S1: Detailed information of Sample Analysis

Chemicals and supplies： The solvents n-Hexane and Methylene Chloride employed in extraction and cleanup were ultra resi-analyzed grade. *n*-hexane was purchased from Merk KGaA (Germany) and methylene chloride was purchased from J.T. Baker (USA). Silica gel (100-200 mesh, Qingdao Marine Chemical, China) was baked at 550 ℃ for 12 h and then activated at 180 ℃ for 2 h for the follow-up PAHs purification. Aluminum oxide and Florisil®TLR (Sigma-Aldrich, USA) used for PAHs purification were baked at 450 ℃ for 20 h and 180 ℃ for 16 h, respectively. Anhydrous sodium sulfate (Guaranteed reagent. Tianjin Jingke Chemical Research Institute, China) employed was cleaned at 550 ℃ for 4 h. Also K-D concentrated bottle were baked at 400 ℃ for 4 h.

A PAH mixture standard, a surrogate mixture standard, and the internal standard 2-fluorobiphenyl were obtained from Accustandard (New Haven, CT). The PAH mixture standard contained 16 individual compounds, namely: naphthalene (NAP), acenaphthylene (ACY), acenaphthene (ACP), fluorine (FLR), phenanthrene (PHE), anthracene (ANT), fluoranthene (FLT), pyrene (PYR), benz[a]anthracene (BaA), chrysene (CHR), benz[b]fluoranthene (BbF), benz[k]fluoranthene (BkF), benz[a]pyrene (BaP), indeno[1,2,3-cd]pyrene (IcdP), dibenzo[a,h]anthracene (DahA), and benzo[ghi]perylene (BghiP). The surrogate deuterated PAHs including naphthalene-d8 (NAP-d8), acenaphthene-d10 (ACP-d10), phenanthrene-d10 (PHE-d10), chrysene-d12 (CHR-d12) and perylene-d12 (PER-d12).

Pretreatment process： The soil was ground and the vegetable were crushed after

freeze-dried. 5 g soil samples or 2 g lichen samples were accurately weighted and mixed with about 8 - 10 g Anhydrous sodium sulfate. The mixture was spiked with surrogates and extracted using mixed solvents of hexane and dichloromethane (1:1, v/v) by accelerated solvent extraction (Dionex ASE350, USA) under a temperature of 100 ℃ and a pressure of 1500 psi. Then the extraction was transferred to specimen bottle and concentrated to about 1 ~ 2 mL by a rotary evaporator.

The concentrated extraction was purified with a composite column fitted with 6 g 3% deactivated silica gel, 4 g 2% deactivated aluminum oxide, and about 5 g anhydrous sodium sulfate from bottom to up. The procedure was as follows. The column was pre-eluted with 30 mL hexane. After that, the concentrated extraction was injected and eluted using a mixture of hexane: dichloromethane (3:2, v/v). Then the extraction was concentrated to about 1 ~ 2 mL by a rotary evaporator once more. For lichen, GPC was extra used to further purify and the detailed process can be found in Yang et al (2013). Finally, the effluent was concentrated to a constant volume 0.5 mL by a rotary evaporator and a high-purity nitrogen stream, and 2-fluorobiphenyl as the internal standard was added before instrumental analysis.

Instrumental analysis： PAHs was analyzed on an Agilent-7890 gas chromatograph-5975 mass spectrometer (GC-MS) equipped with an electron ionization (EI) source in selected ion monitoring (SIM) mode. A DB-5 MS capillary column (30 m × 0.25 mm i.d × 0.25 μm film thickness) was used for separation. The oven temperature process was operated as follows : initial 60 ℃ for 1min, 8 ℃/min to 310 ℃, and held for 35 min. The temperature of the injector was 280 ℃ and two microliters of the extracts

were injected in the pulsed splitless mode. Helium was used as the carrier gas with a constant flow of 1 mL/min. The MS ion source, quadrupole and inter face temperatures were 300, 180, 310 ℃.

Table S1. The detail information of sampling sites.

ID	Latitude(N)	Longitude(E)	Altitude(m)	TOC or lipid content (%)	
				Soil	Lichen
1	25.9692	100.0902	2006	2.75	1.98
2	26.3177	99.9936	2198	3.11	0.93
3	26.6058	99.9394	2270	3.96	1.39
4	26.7732	100.03	2904	3.13	1.31
5	26.8636	100.0374	2566	2.02	2.93
6	26.9183	100.0494	1930	1.17	0.33
7	27.2627	100.01	2078	3.37	2.01
8	27.4885	99.8040	3195	2.94	4.41
9	27.7542	99.7092	3318	NA	2.69
10	28.0709	99.4945	3159	1.55	2.61
11	28.1398	99.4461	2594	NA	NA
12	28.1416	99.4287	2168	5.74	1.37
13	28.2725	99.1922	2830	1.97	1.99
14	28.2785	99.1762	3066	16.98	2.03
15	28.3515	99.0696	4217	10.94	2.11
16	28.4448	98.9514	3507	10.98	1.53
17	28.4795	98.8542	3010	10.23	2.37
18	28.7223	98.6854	2202	2.19	0.81
19	28.98	98.6310	2270	2.47	0.67
20	29.1670	98.6518	3175	2.67	1.25
21	29.2633	98.6792	4246	12.55	2.53
22	29.2996	98.6811	3635	2.44	1.80
23	29.6154	98.5806	3902	3.86	4.41
24	29.7053	98.5628	3972	6.00	2.95
25	29.7167	98.4550	2684	2.65	0.96
26	29.55264	98.3160	3910	5.18	1.21
27	29.5571	98.2044	3686	5.17	0.84
28	29.6379	98.1387	4237	12.15	2.40
29	29.7104	98.0036	5094	5.92	1.23
30	29.7268	97.9748	4812	2.90	1.94
31	29.6511	97.8843	3798	2.36	0.79
32	29.8514	97.6847	3922	4.72	4.67
33b	29.9576	97.5347	4015	12.42	3.68
33a	29.9577	97.5090	3987	NA	NA
34	30.1539	97.3551	4087	3.61	1.67
35	30.2316	97.2793	4119	3.82	0.56
36	30.4368	97.1833	4238	4.86	1.39

37	30.5717	97.0854	4357	3.16	NA
38	30.6811	97.2516	4179	8.26	2.29
39	30.7580	97.3644	3114	2.39	0.88
40	30.9914	97.3269	3186	3.03	0.94
41	31.1087	97.1925	3254	NA	0.93
42	31.1832	97.0191	3431	8.45	1.68
43	31.0912	96.9973	3978	5.66	1.21
44	31.0766	96.9490	4582	7.45	1.40
45	31.1067	96.8761	4044	8.67	2.61
46	31.2582	96.5968	3827	11.48	1.71
47	31.5147	96.3544	4073	5.80	2.29
48	31.8414	96.3118	4104	5.32	2.13
49	31.9696	96.4156	4209	13.00	2.53
50	32.1780	96.5113	3623	3.45	NA
51	30.1195	97.2810	4165	2.74	1.08
52	30.1207	97.2928	3745	4.12	0.70
53	30.0862	97.2920	3083	3.22	0.46
54	30.0621	96.9711	3172	2.65	0.31
56	29.9384	96.6643	3784	8.96	1.14
56	29.7253	96.7171	4204	4.52	0.79
57	29.5469	96.7762	4187	2.25	0.51
58	29.4567	96.7964	3908	3.98	0.84
59	29.3731	96.9113	4528	5.69	2.23
60	29.3424	97.0585	4379	4.87	1.84
61	29.3211	97.1227	4105	NA	1.85
62	29.1959	97.1972	3364	NA	1.73
63	29.1071	97.2693	3129	7.49	2.23
64	29.0363	97.3688	2925	15.20	2.02
65	28.8968	97.4633	2693	1.11	2.66
66	28.7029	97.4669	2376	3.85	0.91

Table S2. Comparison of the concentrations（ng/g）of PAHs in this study with the urban regions of India and China, and other remote areas.

Site	Sampling year	Matrix	Range (mean) (ng/g)	References
Hengduan Mts.	2012	soil	59.8-1163.3 (222.5)	This study
Central TP	2010	soil	0.4-26.7	(Yuan et al., 2015)
TP	2011	soil	56.3±45.8	(Wang et al., 2013)
Qinghai-Tibetan plateau	2005 and 2006	soil	51.8±38.5	(Tao et al., 2011)
Southeast TP	2021	soil	3.29-119 (31.4)	(Wei et al., 2023)
Southeast TP	2010	soil	201±126	(Yang et al., 2013)
Western TP	2014	soil	14.4-119 (35.1)	(Zhou et al., 2018)
Changbai mountain	2009	soil	38.5-443.6	(Zhao et al., 2015)
Dawangling alpine ecosystem	2013	soil	93.9-802 (252)	(Shi et al., 2014)
Central Italian alps	2007	soil	6.1-80.3 (20)	(Tremolada et al., 2009)
Costa rican	2005	soil	1-36 (5)	(Daly et al., 2007)
Western Canada	2004	soil	2-789	(Choi et al., 2009)
Nepal Kathmandu	2004	soil	145-6273	(Aichner et al., 2007)
Agra India	NA	Soil	8250	(Masih et al., 2012)
Hengduan Mts.	2012	lichen	174.4-3362 (871)	This study
Southeast TP	2010	lichen	253±89	(Yang et al., 2013)
Pyrenees mountain	2005	lichen	228-6596 (726)	(Blasco et al., 2011)
Dolomites	2011	lichen	186-2130 (758)	(Nascimbene et al., 2014)
Western TP	2014	lichen	38.0-133 (84.6)	(Zhou et al., 2018)
Southeast TP	2021	moss	37.5-192 (89.5)	(Wei et al., 2023)

Table S3. Component pattern for PAHs and environmental parameters in O-Horizon soils.

Factors	Factor 1	Factor 2
Lantitude	0.958	-0.141
Longtitude	-0.971	0.193
Altitude	0.967	-0.239
TOC	0.207	0.894
$\sum_{16}$PAHs	0.510	0.723
Loading	61.96%	28.73%

Figure S1. The distribution of PAHs in soil and lichen from south-to-north transect.

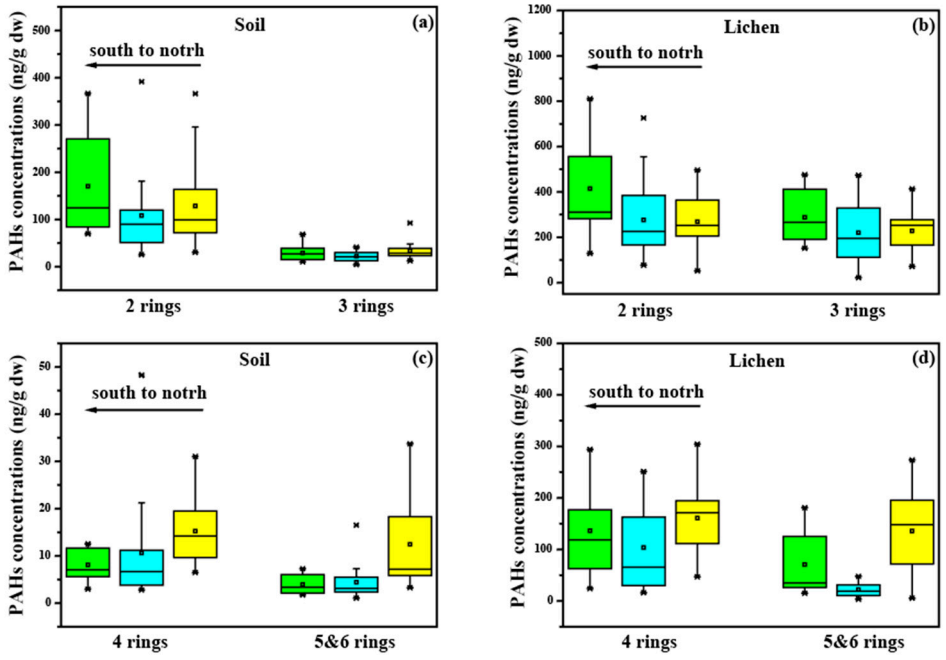
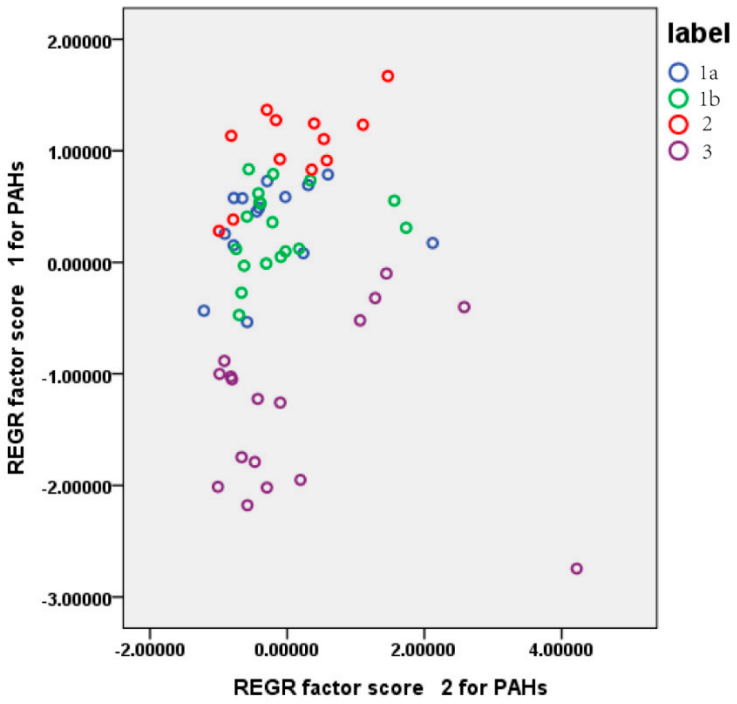
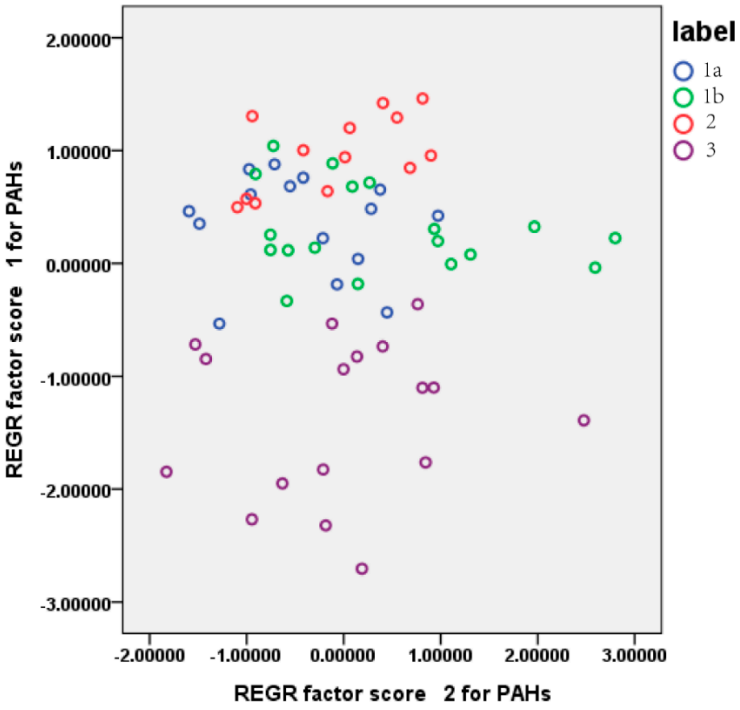


Figure S2. The PCA results of PAHs in soils (A) and lichen (B).

A: soils



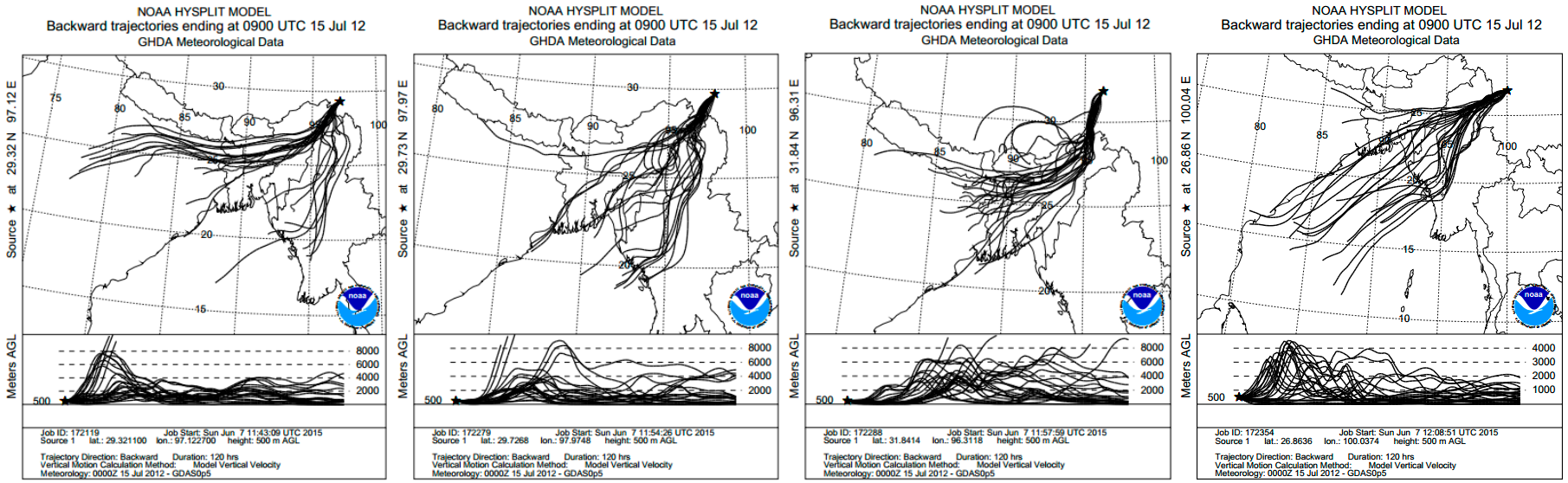
B: lichen



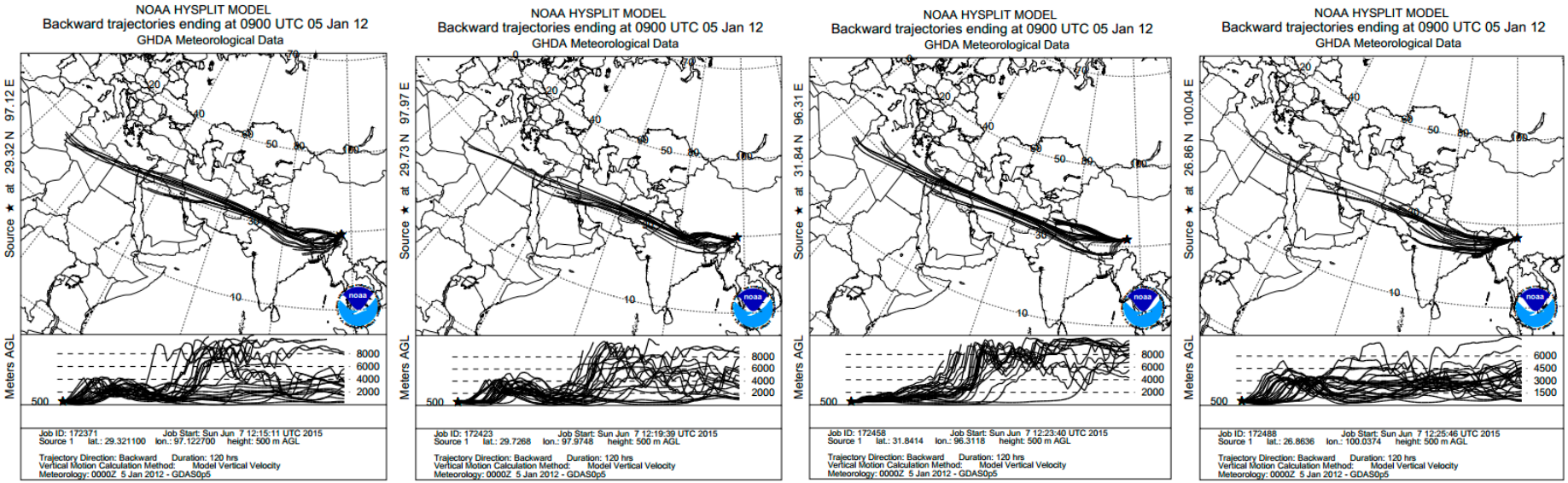
The number1a, 1b, 2, 3 in label represent the sub-area 1a, sub-area 1b, sub-area 2, sub-area 3

Figure S3. The air back trajectories of representative points in Summer (A), in Winter (B), and in later Summer (C).

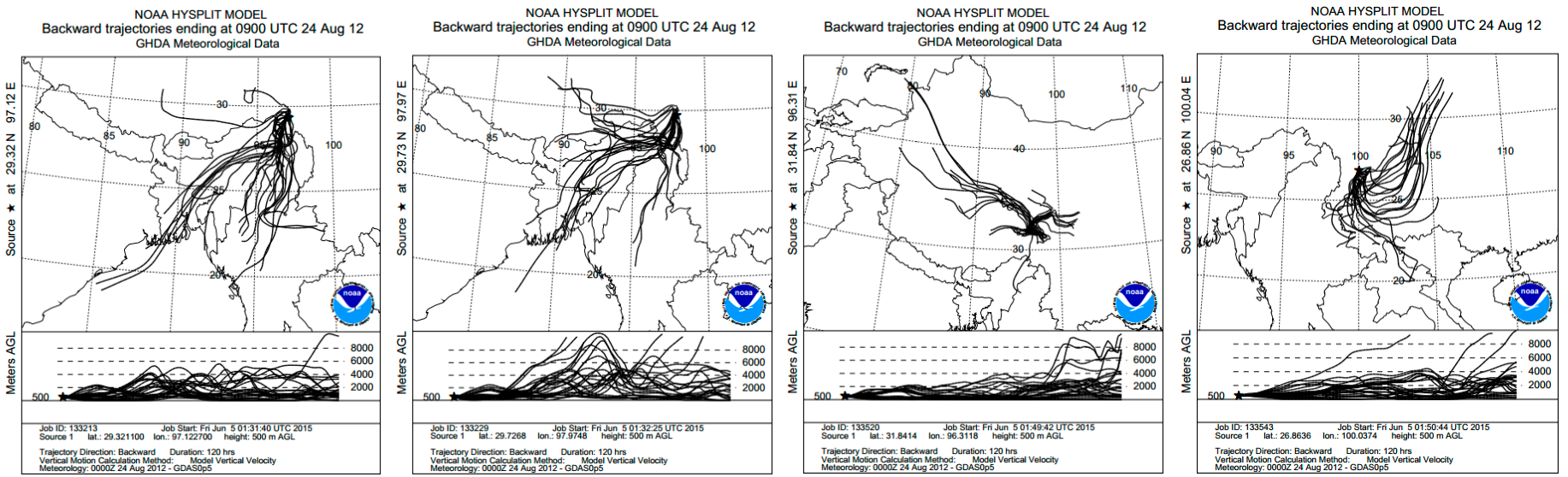
A:



B:


NOAA HYSPLIT MODEL
Backward trajectories ending at 0900 UTC 05 Jan 12
GHDA Meteorological Data
Source ★ at 29.32 N 97.12 E
Meters AGL
Job ID: 172371 Job Start: Sun Jun 7 12:15:11 UTC 2015
Source 1 lat.: 29.321100 lon.: 97.122700 height: 500 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 5 Jan 2012 - GDAS0p5
NOAA HYSPLIT MODEL
Backward trajectories ending at 0900 UTC 05 Jan 12
GHDA Meteorological Data
Source ★ at 29.73 N 97.97 E
Meters AGL
Job ID: 172423 Job Start: Sun Jun 7 12:19:39 UTC 2015
Source 1 lat.: 29.7268 lon.: 97.9748 height: 500 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 5 Jan 2012 - GDAS0p5
NOAA HYSPLIT MODEL
Backward trajectories ending at 0900 UTC 05 Jan 12
GHDA Meteorological Data
Source ★ at 31.84 N 96.31 E
Meters AGL
Job ID: 172458 Job Start: Sun Jun 7 12:23:40 UTC 2015
Source 1 lat.: 31.8414 lon.: 96.3118 height: 500 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 5 Jan 2012 - GDAS0p5
NOAA HYSPLIT MODEL
Backward trajectories ending at 0900 UTC 05 Jan 12
GHDA Meteorological Data
Source ★ at 26.86 N 100.04 E
Meters AGL
Job ID: 172488 Job Start: Sun Jun 7 12:25:46 UTC 2015
Source 1 lat.: 26.8636 lon.: 100.0374 height: 500 m AGL
Trajectory Direction: Backward Duration: 120 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 5 Jan 2012 - GDAS0p5

C:



The air back trajectories of A, B, and C are all in order for sub-area 1a, sub-area 1b, sub-area 2 and sub-area 3

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