

Supplement of Ann. Geophys., 38, 123–135, 2020
<https://doi.org/10.5194/angeo-38-123-2020-supplement>
© Author(s) 2020. This work is distributed under
the Creative Commons Attribution 4.0 License.



Supplement of

Magnetospheric Multiscale observations of energetic oxygen ions at the duskside magnetopause during intense substorms

Chen Zeng et al.

Correspondence to: Chi Wang (cw@spaceweather.ac.cn) and Suping Duan (spduan@nssc.ac.cn)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

Table S1. Mean values of the O^+ (1-40 keV), H^+ (1 eV-40 keV) density, the O^+ , H^+ particle fluxes for energies at ~1 keV, ~10 keV, ~20 keV and ~35 keV in the magnetopause boundary layer during intense substorm (AE>500nT). And the corresponding mean values of the MMS locations (Rx, Ry and Rz), three components of the interplanetary magnetic field (IMF Bx, By and Bz), solar wind dynamic pressure and AE index during magnetopause boundary layer crossings. The 0 and 1 indicate the events occurred during the expansion phase and recovery phase of intense substorm, respectively.

Magnetopause boundary layer crossing time interval	N_{O^+} (cm^{-3}) (1-40keV)	N_{H^+} (cm^{-3}) (1eV-40keV)	O^+ Flux 1 keV	H^+ Flux 1 keV	O^+ Flux 10 keV	H^+ Flux 10 keV	O^+ Flux 20 keV	H^+ Flux 20 keV	O^+ Flux 35 keV	H^+ Flux 35 keV	Position (R_E)			IMF (nT)			Psw (nPa)	AE (nT)	Phase
											Rx	Ry	Rz	Bx	By	Bz			
2015-09-07/07:05-07:10	0.142	1.237	37.230	274.289	42.911	725.507	21.682	601.114	6.157	459.269	4.786	4.033	-1.749	-3.089	4.256	-9.451	2.205	629.545	1
2015-09-07/17:55-18:05	0.091	11.613	35.929	29,934.206	15.230	586.124	12.633	230.363	4.931	149.602	1.574	10.879	-4.372	1.612	3.605	-8.888	3.528	941.545	1
2015-09-07/20:55-21:05	0.046	3.080	31.220	7,061.769	6.990	79.934	2.187	21.917	0.848	5.694	-0.197	10.206	-3.186	-0.145	6.852	-8.408	4.132	835.909	0
2015-09-09/08:35-08:45	0.599	14.406	179.469	42,735.070	76.019	496.719	29.063	251.542	6.214	149.610	5.276	5.971	-3.318	1.373	1.760	-7.910	3.937	606.364	1
2015-09-09/12:39-12:45	0.107	7.842	31.637	16,483.012	17.698	564.204	9.887	325.903	2.622	177.350	4.423	8.870	-5.536	-0.763	-4.249	-7.456	2.322	741.714	0
2015-09-09/13:15-13:25	0.056	14.047	37.296	21,678.069	10.373	400.182	9.180	261.400	2.946	128.748	4.174	9.219	-5.621	-1.215	-3.233	-7.225	1.959	637.091	1
2015-09-09/13:45-13:55	0.064	9.041	36.773	11,580.033	12.045	306.715	6.542	137.802	1.541	50.572	3.981	9.458	-5.636	-1.345	-2.694	-7.194	2.721	1,038.273	1
2015-09-09/14:25-14:35	0.043	10.241	38.495	18,815.151	8.119	375.745	4.932	222.822	1.523	124.868	3.661	9.802	-5.586	-1.339	-1.984	-6.619	3.493	1,139.000	0
2015-09-09/15:35-15:43	0.059	14.944	32.768	26,134.293	11.508	377.701	8.116	236.275	2.112	144.860	3.097	10.279	-5.335	-3.020	0.044	-6.352	2.803	1,005.556	1
2015-09-09/18:40-18:50	0.040	5.551	29.022	12,149.427	8.418	553.067	4.270	240.704	1.273	87.097	1.367	10.756	-4.066	-2.744	-1.611	-6.038	3.342	856.545	0
2015-09-10/19:10-19:20	0.046	20.640	37.101	22,002.970	7.806	378.786	3.024	309.229	0.979	230.639	1.186	10.628	-3.867	7.841	-9.592	-5.740	8.139	869.000	1
2015-09-11/09:55-10:05	0.328	9.543	97.676	22,705.922	33.864	597.728	12.118	382.099	3.356	258.424	5.403	7.128	-4.424	-5.303	3.485	-5.553	5.864	689.364	1
2015-09-14/10:05-10:15	0.049	9.756	42.821	23,447.125	9.140	320.256	3.622	173.490	1.014	100.230	5.727	7.250	-4.631	-2.813	7.955	-5.338	3.104	542.727	0
2015-09-14/15:27-15:40	0.025	11.241	37.334	26,970.368	4.851	363.691	2.780	177.241	1.334	82.722	3.760	10.031	-5.403	-4.193	1.985	-5.086	1.990	1,048.786	0
2015-09-18/08:30-08:35	0.045	16.843	40.623	18,853.343	9.521	264.591	4.352	164.118	0.978	99.159	6.314	6.066	-3.600	0.493	3.490	-5.050	3.223	602.667	0
2015-09-19/07:43-07:48	0.054	17.642	62.590	43,832.709	9.269	521.361	3.712	396.036	1.121	227.670	6.344	5.414	-2.997	2.262	-7.480	-4.958	4.010	851.833	0
2015-09-20/06:35-06:45	0.102	14.666	80.937	35,712.553	10.240	1,163.906	7.678	602.357	2.772	325.489	6.154	4.352	-2.088	-9.394	6.299	-4.925	7.106	752.091	0
2015-09-20/11:55-12:10	0.434	7.442	80.124	16,341.032	71.086	400.462	28.091	240.984	6.978	143.438	5.999	8.204	-5.510	-5.784	5.480	-4.753	2.717	521.188	0
2015-09-20/13:08-13:15	0.016	10.544	30.954	13,836.314	6.678	73.363	2.834	31.369	0.886	15.220	5.589	8.763	-5.685	-8.054	1.125	-4.638	2.098	722.750	0
2015-09-20/15:10-15:30	0.096	5.629	33.507	16,883.659	15.966	248.980	13.872	116.136	4.277	81.692	4.632	9.612	-5.452	-6.761	2.044	-4.557	1.932	904.381	0
2015-09-20/15:50-16:00	0.060	6.365	31.734	13,611.068	13.464	271.933	8.134	136.969	2.675	88.419	4.272	9.815	-5.250	-6.335	2.445	-4.505	2.251	797.455	1
2015-09-23/09:30-09:40	0.029	9.385	38.675	21,243.013	4.903	309.771	2.772	95.593	1.145	43.088	6.868	6.745	-4.430	7.346	-1.930	-4.083	2.180	578.000	0
2015-10-03/07:20-07:35	0.085	8.665	36.580	17,494.913	13.027	347.510	4.431	224.319	1.304	114.122	7.924	5.148	-3.039	-6.693	6.429	-4.080	1.711	530.188	0
2015-10-03/15:30-15:35	0.018	15.300	42.059	29,640.560	4.033	420.373	2.519	229.615	0.974	104.451	5.831	8.840	-5.035	-4.737	-3.845	-3.942	2.385	775.500	1
2015-10-04/09:20-09:30	0.059	3.884	29.528	9,586.658	16.949	123.538	3.718	43.133	1.314	13.713	8.147	6.287	-4.297	-7.468	5.159	-3.925	0.994	551.818	1
2015-10-08/16:38-16:42	0.035	4.557	28.378	11,347.393	6.925	813.632	6.872	146.593	3.493	54.523	5.487	8.618	-4.415	-0.558	-0.594	-3.753	2.023	697.600	0

2015-10-09/15:05-15:10	0.019	4.821	28.371	11,498.846	4.675	214.226	1.982	112.652	0.769	103.451	6.614	8.263	-4.885	-4.038	-2.435	-3.748	2.116	953.833	1
2015-10-10/07:10-07:15	0.022	2.286	33.746	6,406.791	4.691	228.993	1.733	135.324	0.981	71.948	8.680	4.768	-2.840	-5.092	0.693	-3.577	0.923	780.667	1
2015-10-14/13:20-13:25	0.015	4.510	27.982	9,757.235	4.640	135.480	1.699	73.304	0.789	35.535	8.026	7.321	-4.898	-2.128	-0.328	-3.520	1.980	516.333	1
2015-10-18/15:05-15:10	0.197	7.830	48.944	21,293.363	32.270	322.094	14.575	181.302	2.758	71.246	7.280	7.500	-4.400	-3.192	1.093	-3.458	1.998	615.667	1
2015-11-08/14:20-14:25	0.093	4.278	38.996	14,081.292	14.963	129.709	9.067	71.091	3.005	36.468	8.552	5.343	-3.136	-6.512	6.132	-3.220	1.213	624.167	1
2015-11-16/14:20-14:25	0.179	10.410	69.184	38,612.681	23.719	222.091	8.483	125.696	1.865	65.743	8.490	4.580	-2.588	-3.225	3.158	-3.075	1.458	873.667	0
2016-09-26/13:40-13:45	0.035	4.052	32.605	9,870.575	5.268	165.454	1.733	111.824	0.829	56.191	3.195	7.324	-5.318	-4.700	4.693	-2.880	3.153	517.500	0
2016-09-28/14:47-14:52	0.132	2.220	35.432	6,675.883	28.059	320.423	19.565	211.106	6.172	169.569	2.981	8.561	-5.387	-2.267	4.780	-2.842	4.364	1,304.667	0
2016-09-28/21:15-21:20	0.077	1.753	43.496	3,805.188	9.287	112.467	4.182	73.255	1.516	44.468	-0.244	11.499	-2.821	-4.660	4.937	-2.667	3.760	613.667	1
2016-09-29/16:10-16:15	0.009	2.720	38.925	6,683.875	5.114	159.368	2.688	78.244	1.808	49.182	2.494	9.773	-5.082	-5.688	0.307	-2.359	2.123	832.667	1
2016-09-30/18:15-18:20	0.007	1.568	25.038	4,772.589	4.238	162.619	1.574	78.375	0.727	35.685	1.602	11.027	-4.141	0.817	4.380	-2.348	2.217	1,034.667	1
2016-10-01/19:00-19:05	0.008	4.288	31.446	9,139.342	3.659	111.740	1.563	73.806	0.773	53.333	1.344	11.294	-3.720	-4.800	3.188	-2.095	1.950	818.333	1
2016-10-02/19:45-19:50	0.007	2.386	26.212	5,245.227	3.428	307.222	1.602	176.983	0.862	92.688	1.076	11.445	-3.302	-2.505	0.973	-1.883	2.417	601.000	0
2016-10-02/20:40-20:45	0.009	0.992	27.296	2,920.964	4.557	153.313	1.936	61.723	0.889	24.041	0.581	11.491	-2.882	-3.963	4.312	-1.826	2.665	797.667	1
2016-10-10/19:05-19:10	0.019	10.806	48.495	9,451.304	2.594	265.243	1.072	148.461	0.726	49.174	2.444	11.242	-3.219	-1.855	-5.317	-1.755	4.380	515.000	0
2016-10-16/19:15-19:20	0.010	2.132	31.153	4,993.229	3.109	353.942	1.365	117.251	0.841	54.955	3.088	11.085	-2.730	1.180	-1.388	-1.723	3.363	511.000	1
2016-10-24/17:00-17:05	0.013	10.196	35.503	14,807.722	3.488	396.836	1.874	218.140	0.908	95.626	5.228	10.248	-3.330	-4.968	-2.340	-1.521	2.084	615.167	1
2016-10-25/19:35-19:40	0.110	3.711	48.360	11,192.526	14.878	286.085	7.982	129.610	2.818	85.624	3.871	10.630	-1.845	-7.228	-2.135	-1.263	4.426	533.833	1
2016-10-26/20:30-20:35	0.077	1.376	40.532	4,397.794	8.588	268.889	4.054	166.867	1.901	96.013	3.352	10.428	-1.329	-3.675	1.825	-1.085	2.458	611.667	1
2016-10-27/09:55-10:00	0.039	1.300	29.068	4,507.753	9.425	147.744	4.256	31.553	1.359	7.836	7.079	5.093	-3.753	-1.590	1.937	-1.040	2.018	602.000	1
2016-10-27/13:20-13:25	0.007	4.775	28.087	10,389.690	3.113	184.251	1.421	62.515	0.938	26.536	6.941	8.013	-4.363	-4.160	1.272	-0.552	1.482	857.000	1
2016-10-30/10:38-10:42	0.041	6.901	35.680	19,376.901	9.000	294.194	5.035	42.561	1.908	7.614	7.540	5.815	-3.895	0.767	5.597	-0.323	1.958	590.200	0
2016-10-30/14:19-14:24	0.027	2.302	27.364	6,457.850	6.944	125.662	3.486	53.454	1.281	31.814	7.037	8.650	-3.938	-2.507	5.683	-0.082	1.280	689.500	0
2016-11-01/14:25-14:30	0.026	4.780	35.876	12,501.479	8.350	89.432	4.044	43.039	1.145	25.107	7.238	8.656	-3.735	-5.298	3.512	-0.010	1.678	825.500	0
2016-11-03/15:00-15:05	0.013	8.588	34.976	11,027.917	5.616	133.266	1.749	70.526	0.731	32.264	7.255	8.917	-3.352	-3.302	1.390	0.455	1.705	538.833	1
2016-11-10/18:00-18:05	0.099	10.036	42.347	17,276.490	15.741	978.148	10.028	521.538	4.633	198.498	6.326	9.367	-1.185	4.717	-12.147	1.289	3.937	505.833	1
2016-11-24/18:34-18:39	0.146	12.607	56.746	21,853.488	18.622	210.170	6.624	131.102	1.690	65.935	6.552	7.823	0.411	-4.878	8.120	1.738	4.230	980.333	1
2016-12-09/17:55-18:00	0.066	14.206	48.722	27,833.406	9.397	406.408	4.492	104.636	1.806	66.431	7.119	5.964	1.317	2.483	-4.498	2.095	2.928	867.000	0
2016-12-11/16:05-16:15	0.008	8.925	31.344	15,876.745	2.633	183.658	1.090	91.379	0.773	58.836	8.833	5.651	0.869	1.319	-3.365	2.790	2.884	561.364	1
2016-12-21/16:40-16:45	0.040	26.924	53.825	57,299.640	4.415	516.426	2.647	122.863	1.432	47.428	7.969	4.424	1.650	-8.322	6.352	3.475	5.648	1,652.833	0
2016-12-26/15:00-15:05	0.013	12.586	34.978	27,348.612	3.768	476.602	1.189	67.514	0.682	15.257	9.381	3.479	1.533	-4.730	0.708	4.402	2.380	793.000	0