基于 OMI 的亚洲地区对流层 NO_2 高分辨率反演产品 POMINO v2.1 及其与其他产品的定量对比

补充材料

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表 S1 卫星探测器及其运行时间和空间分辨率

Table S1 Available time and spatial resolution of satellite instruments

探测器	GOME	SCIAMACHY	OMI	GOME-2(A)	EMI	TROPOMI
运行时间	1995-2003	2002-2012	2004-	2007-	2018-2020	2018-
星下点的空间分辨率/km^2	320×40	60×30	24×13	80×40	12×13	3.5×7(5.5)[1]

1. 2019 年 8 月 6 日之前，TROPOMI 的空间分辨率 3.5×7km^2，之后提高到 3.5×5.5km^2。

表 S2 POMINO 从 v2.0.1 到 v2.1 版本更新的敏感性试验结果（采样一致）

Table S2 Results of sensitivity tests (pixel information and RAA) of POMINO updates from v2.0.1 to v2.1 under same sampling criteria

		像元形状的影响	相对方位角的影响	二者协同影响
NO_2 垂直柱浓度的相对差	7 月	0.003%	1.2%	1.4%

异	12 月	0.004%	3.7%	3.7%

表 S3 POMINO 从 v2.0.1 到 v2.1 版本更新的敏感性试验结果（采样不一致）

Table S3 Results of sensitivity tests (pixel information and RAA) of POMINO updates from v2.0.1 to v2.1 under different sampling criteria

		参考组（POMINO v2.1）	像元形状和数据量的影响	相对方位角的影响	二者协同影响
NO_2 垂直柱浓度的相对差异	7 月		3.8%	1.2%	5.7%
	12 月		3.2%	3.7%	7.0%
有效像元数据量	7 月	244277	233088	238404	230958
	12 月	175454	171310	179348	175012

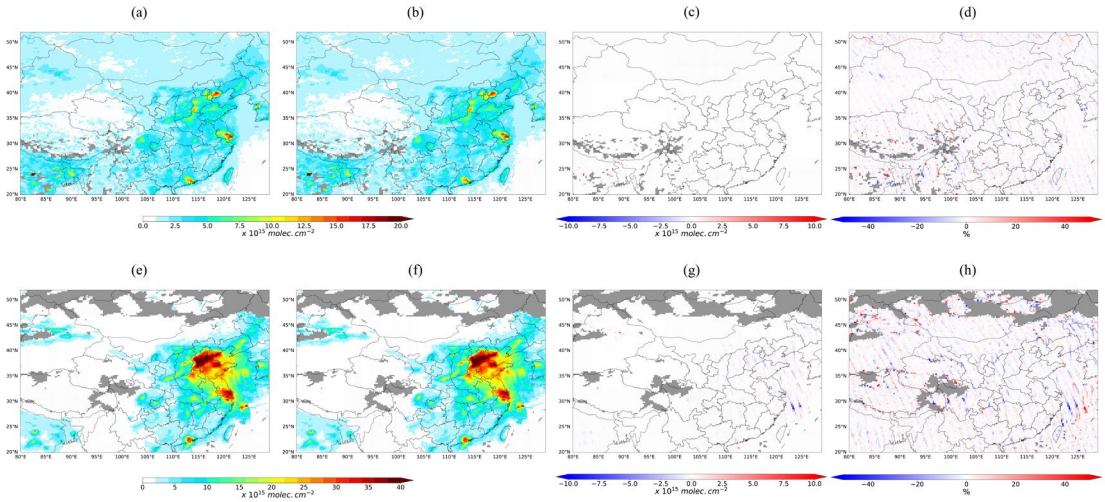

图 S1 2017 年 7 月（a）POMINO v2.1 和（b）读取 DOMINO 像元参数反演的 NO_2 垂直柱浓度空间分布，以及后者相对于前者的绝对差异（c）和相对差异（d）。（e-h）同年 12 月的结果。结果基于 POMINO v2.1 的云辐射分数进行一致采样

Fig.S1 Spatial distribution of tropospheric NO_2 VCDs of POMINO v2.1 (a) and sensitivity test with pixel information from DOMINO (b), and spatial distribution of absolute and relative difference of sensitivity test to POMINO v2.1 (c-d) in July 2017. (e-h) are results in December 2017. All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1

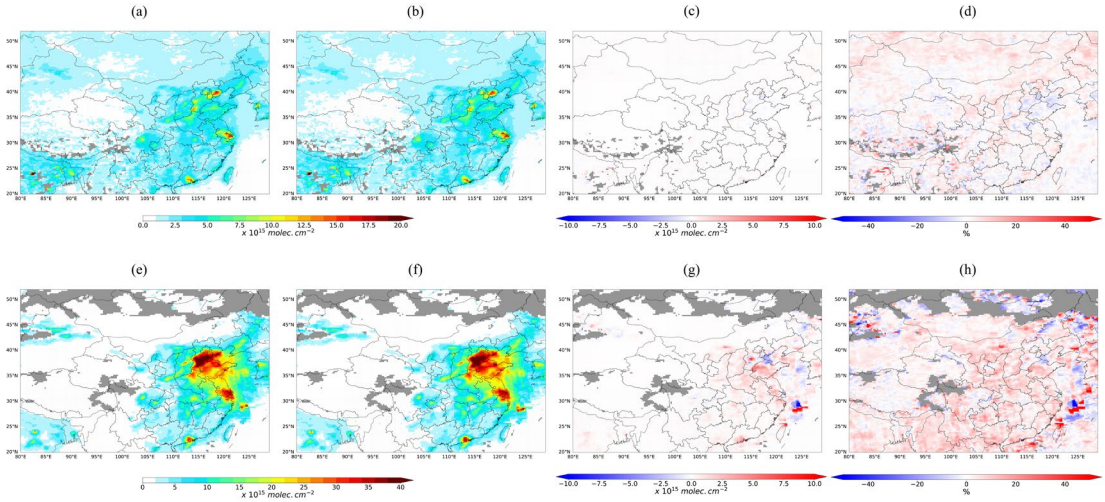

图 S2 2017 年 7 月（a）POMINO v2.1 和（b）采用相对方位角补角反演的 NO_2 垂直柱浓度空间分布，以及后者相对于前者的绝对差异（c）和相对差异（d）。（e-h）同年 12 月的结果。结果基于 POMINO v2.1 的云

辐射分数进行一致采样

Fig.S2 Spatial distribution of tropospheric NO_2 VCDs of POMINO v2.1 (a) and sensitivity test where RAA is the complementary angle of true value (b), and spatial distribution of absolute and relative difference of sensitivity test to POMINO v2.1 (c-d) in July 2017. (e-h) are results in December 2017. All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1

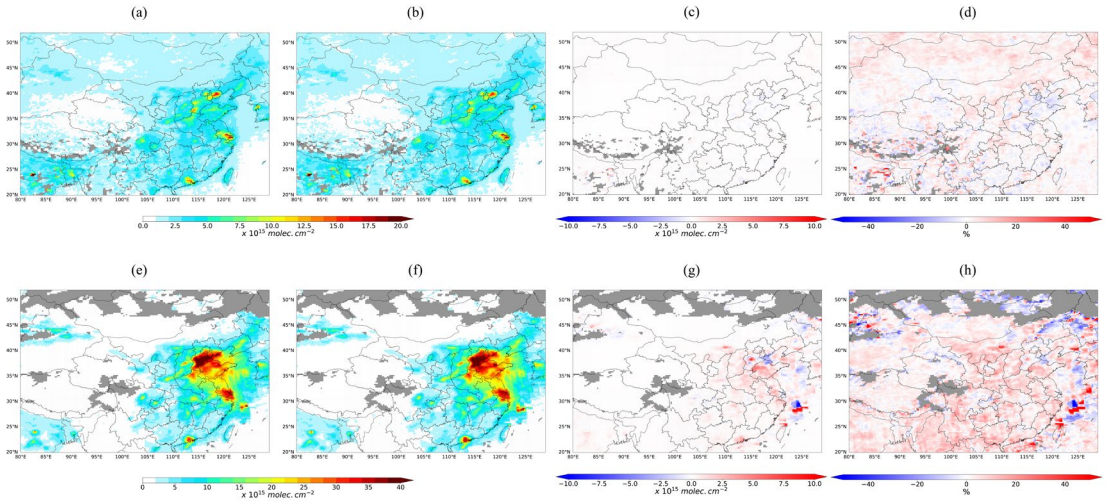

图 S3 2017 年 7 月（a）POMINO v2.1 和（b）读取 DOMINO 像元并使用相对方位角补角反演的 NO_2 垂直柱浓度空间分布，以及后者相对于前者的绝对差异（c）和相对差异（d）。9（e-h）同年 12 月的结果。结果基于 POMINO v2.1 的云辐射分数进行一致采样

Fig.S3 Spatial distribution of tropospheric NO_2 VCDs of POMINO v2.1 (a) and sensitivity test where RAA is the complementary angle of true value with pixel information from DOMINO (b), and spatial distribution of absolute and relative difference of sensitivity test to POMINO v2.1 (c-d) in July 2017. (e-h) are results in December 2017. All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1

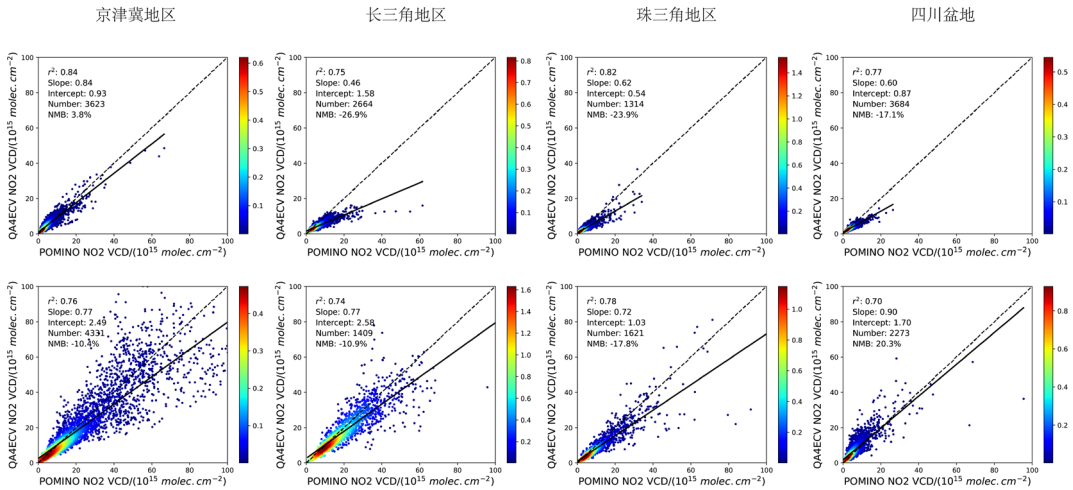

图 S4 QA4ECV 与 POMINO v2.1 对流层 NO_2 垂直柱浓度 L2 数据在京津冀、长三角、珠三角和四川盆地地区的散点图。第一行是 2017 年 7 月的结果，第二行是 2017 年 12 月的结果。所有像元均基于 POMINO v2.1 的云辐射分数进行一致采样，图中每个点对应一个有效像元，每个点的颜色对应归一化的分布概率密度，颜色越亮，散点分布的数密度越大

Fig.S4 Scatterplots for level-2 tropospheric NO_2 VCDs between QA4ECV and POMINO v2.1 over Beijing-Tianjin-Hebei (first column), Yangtze River Delta (second column), Pearl River Delta (third column) and Sichuan Basin (fourth column). The first and second row are results in July and December 2017, respectively. All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1. Each dot corresponds to a valid pixel, and its color shows the normalized distribution probability density

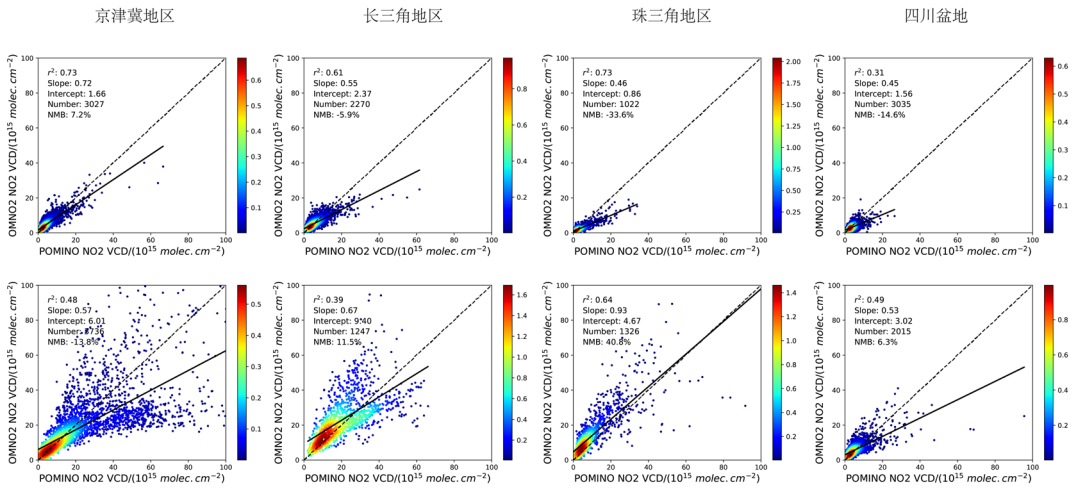

图 S5 与图 S4 相同，展示了 OMNO2 v4 与 POMINO v2.1 对流层 NO_2 垂直柱浓度在这四个地区的散点图

Fig.S5 Scatterplots for level-2 tropospheric NO_2 VCDs between OMNO2 v4 and POMINO v2.1 over Beijing-Tianjin-Hebei (first column), Yangtze River Delta (second column), Pearl River Delta (third column) and Sichuan Basin (fourth column). Others are the same as fig.S4

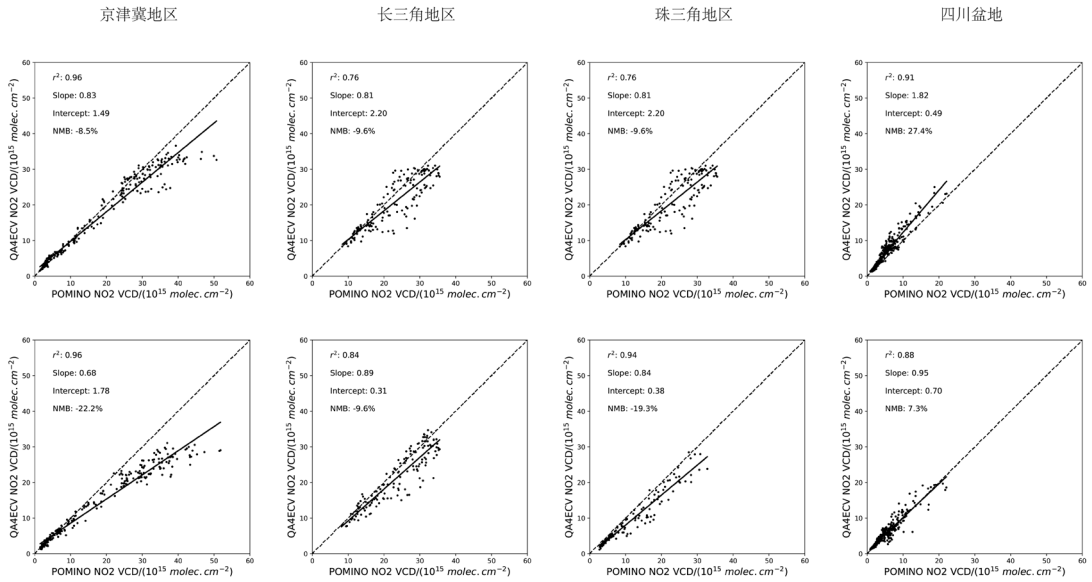

图 S6 采样一致（第一行）与采样不一致（第二行）的情况下，2017 年 12 月 QA4ECV 与 POMINO v2.1 对流层 NO_2 垂直柱浓度在京津冀、长三角、珠三角和四川盆地地区的散点图。图中每个点对应一个 0.25°×0.25°的格点的 L3 月均值数据

Fig.S6 Scatterplots for level-3 monthly averages of tropospheric NO_2 VCDs between QA4ECV and POMINO v2.1 over Beijing-Tianjin-Hebei (first column), Yangtze River Delta (second column), Pearl River Delta (third column) and Sichuan Basin (fourth column) in December 2017. Each dot corresponds to a 0.25°×0.25° grid cell

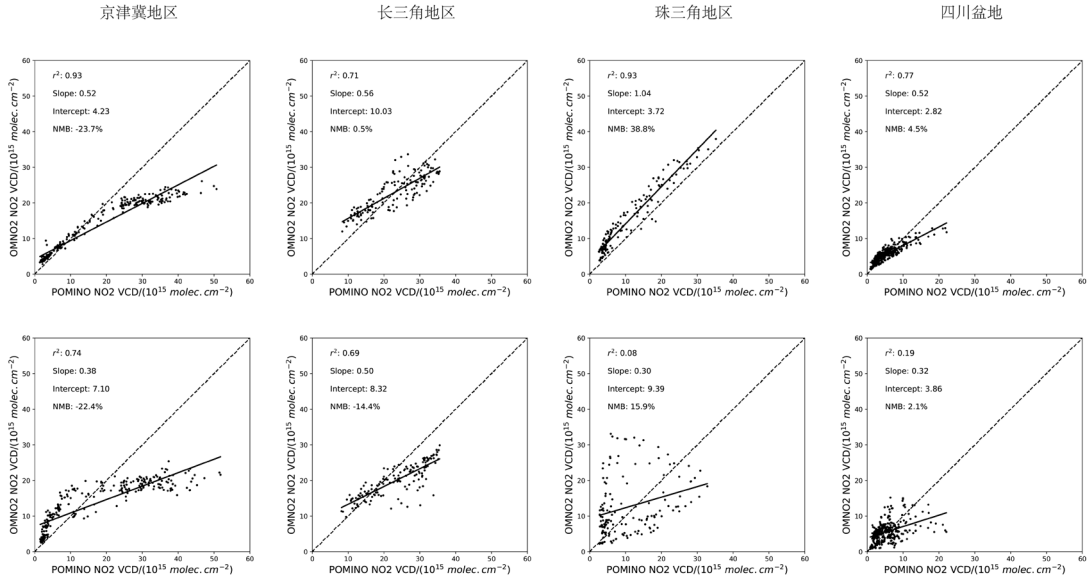

图 S7 与图 S6 相同，展示了 2017 年 12 月 OMNO2 v4 与 POMINO v2.1 对流层 NO_2 垂直柱浓度在这四个地区的散点图

Fig.S7 Scatterplots for level-3 monthly averages of tropospheric NO_2 VCDs between OMNO2 v4 and POMINO v2.1 over Beijing-Tianjin-Hebei (first column), Yangtze River Delta (second column), Pearl River Delta (third column) and Sichuan Basin (fourth column) in December 2017. Others are the same as fig.S6

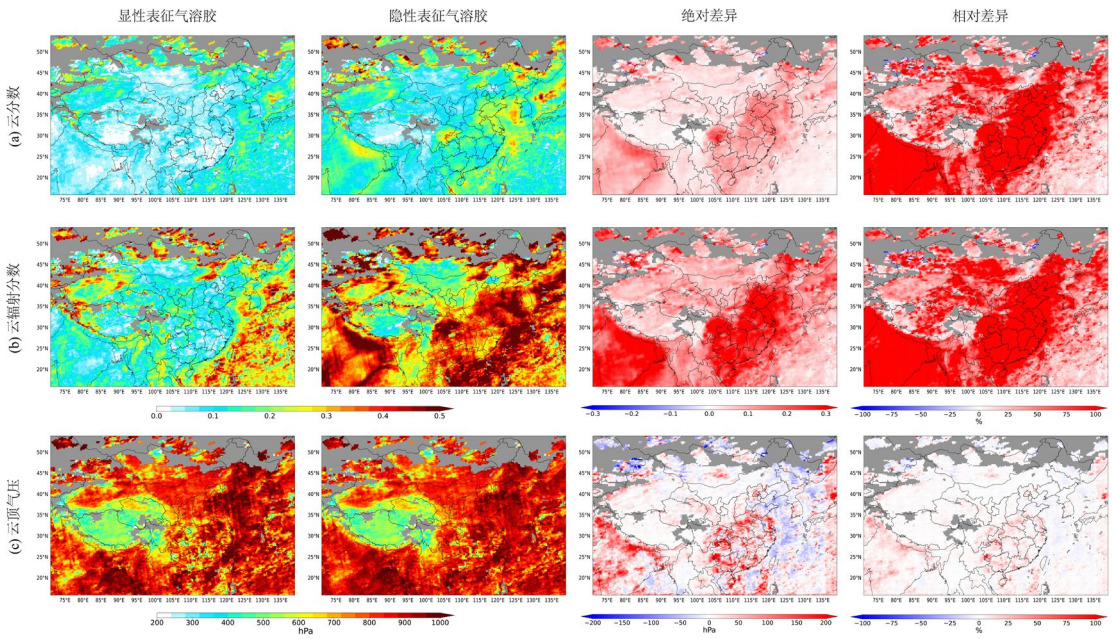

图 S8 2017 年 12 月分别通过显性（即 POMINO v2.1）和隐性表征气溶胶反演得到的（a）云分数，（b）云辐射分数和（c）云气压（单位：hPa）的空间分布，以及对应的绝对差异和相对差异。结果基于 POMINO

v2.1 的云辐射分数进行一致采样

Fig.S8 Spatial distribution of cloud fraction (first row), cloud radiance fraction (second row) and cloud pressure (unit: hPa) (third row) from POMINO v2.1 with explicit aerosol correction (first column) and sensitivity test with implicit aerosol correction (second column), and corresponding absolute and relative difference of sensitivity test to POMINO v2.1 (third and fourth column). All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1

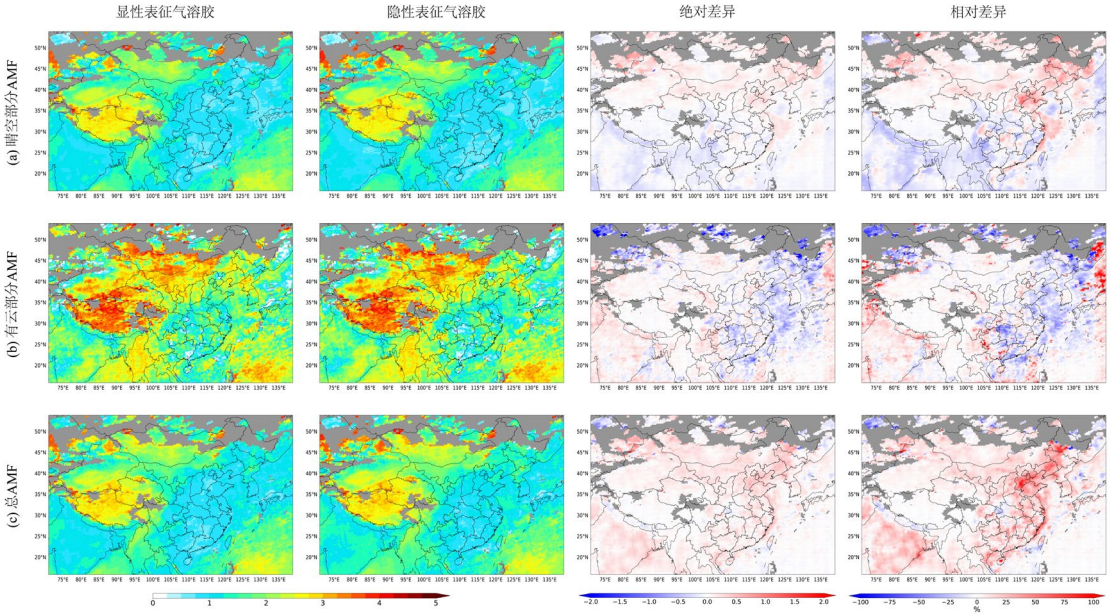

图 S9 2017 年 12 月分别通过显性（即 POMINO v2.1）和隐性表征气溶胶反演得到的（a）晴空部分的 AMF，（b）有云部分的 AMF 和（c）总 AMF 的空间分布，以及对应的绝对差异和相对差异。结果基于 POMINO v2.1 的云辐射分数进行一致采样

Fig.S9 Spatial distribution of clear-sky AMF (first row), cloudy-sky AMF (second row) and total AMF (third row) from POMINO v2.1 with explicit aerosol correction (first column) and sensitivity test with implicit aerosol correction (second column), and corresponding absolute and relative difference of sensitivity test to POMINO v2.1 (third and fourth column). All valid pixels are sampled based on cloud radiance fractions of POMINO v2.1

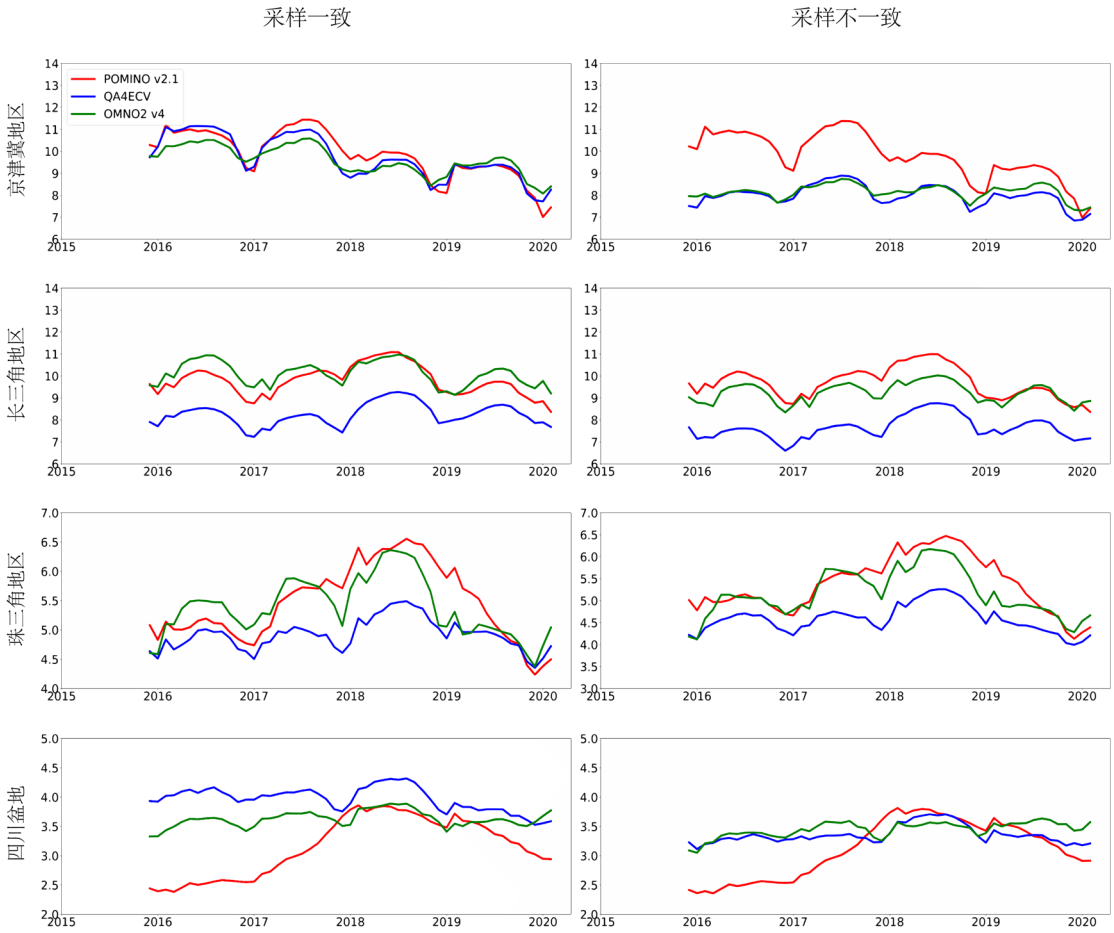

图 S10 在采样一致（第一列）与采样不一致（第二列）的情况下，采用 12 个月滑动平均得到的京津冀、长三角、珠三角和四川盆地地区对流层 NO_2 垂直柱浓度的时间序列（单位：$\times 10^{15}$ molec.cm^{-2}）。图中每个点代表前 12 个月的浓度平均值。红色、蓝色和绿色曲线分别对应 POMINO v2.1、QA4ECV 和 OMNO2 v4 的结果

Fig.S10 Time series of 12-month moving averages of tropospheric NO_2 VCDs in Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta and Sichuan Basin 2015-2020 under same sampling (based on cloud radiance fractions of POMINO v2.1, left column) and different sampling (based on cloud radiance fractions of each product, right column) criteria (unit: $\times 10^{15}$ molec.cm^{-2}). Red, blue and green lines represent POMINO v2.1, QA4ECV and OMNO2 v4, respectively