Table 1 World Emission products requirements

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
CO2 – point sources	'light cross-sectional flux method applied to each OCO-2 orbit with a moving window'	Kg/s	Emissions retrieved from the CoCO2 project from OCO-2 and OCO-3 quality-filtered XCO2 bias-corrected retrievals provided by NASA	C3S ERA5 Met data, coal and steel plant data from https://globalenergymonitor.org	Emitters are considered within 250 km	Global, but the spatial density is biased towards China and India	N/A	N/A (surface emissions)	2014-2022	16-day orbital cycles but eligible tracks are subject to restrictive data selection.	Instantaneous, but not less than 16 days. Emitters considered 7 hours from the enhancement (subject to Met and atmospheric conditions).	Phase 2 : No Update planned	Phase 2 : No Update planned	1 ktCO2/h	Mostly random, 50% standard deviation	All delivered data have been quality-filtered upstream	Text	Point sources map	Free	[Chevallier, F., 2022,](#) [Zheng et al., 2020,](#)	LSCE: F Chevallier (frederic.chevallier@lsce.ipsl.fr) and G Broquet (gregoire.broquet@lsce.ipsl.fr)	2
CO2 - regional inversions	Derivation of the CO2 emissions from the NOx and CO regional inversions based on emission ratios from inventories at national or province, monthly scales and for large sectors of activity	ktCO2	No CO2 modeling and data assimilation. Product derived from a conversion of the NO2 and CO regional inversions	Carbon monitor - CEDS inventory	0.5x0.5°	Europe, and Eastern China	N/A	Estimate of the emissions at the surface; cf NO2 and CO regional inversions	2019-ongoing	N/A	Monthly	Yearly	9 Months for Europe, 12 months for East China	-	To be derived as a side product	N/A (cf uncertainties)	Scientific format (NetCDF,), country budgets in txt files	Map with covered regions and chart visualization of regional emissions time series	Upon request, with disclaimer and licence agreement	[Fortems-cheiney and Broquet (2022)](#)	LSCE: A. Fortems-Cheiney (audrey.fortems@lsce.ipsl.fr) and G. Broquet (gregoire.broquet@lsce.ipsl.fr)	

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
CH4 - point sources	Deep-Learning Detections and Mass Balance Enhancement	Kg/s	TROPOMI Level-2 methane mixing ratio bias corrected data product	C3S ERA5 Met data	Emitters are considered within 15 x 15km	Onshore, mid-latitudes regions ([20, 55] degrees and [-40, -20] degrees latitude)	N/A	Atmospheric column coverage of Sentinel-5P sensor (TBC)	2019-ongoing	Daily	Up to daily (subject to Met and atmospheric conditions)	Project phase 1: 1 year and phase 2: 6 months	Phase 1: 1 year and by phase 2: 6 months to 1 year (due to licencing issues)	5 to 25 metric tons CH4/h (subject to location and wind speed)	Spatial: 15 kilometers. Flux estimate: +/- 50% relative uncertainty on average	Threshold on QA-value of TROPOMI pixels, C3S ERA5 wind data quality indicators, quantification error flag	Tabular (csv), Scientific (NetCDF), Image (JPEG)	Point sources map	Upon request, with disclaimer and licence agreement	Lauvaux et al. (2022)	KAYRROS. C. Giron, Kayrros (c.giron@kayrros.com)	1
CH4 - regional, basin scale inversions	Inverse Modeling of Methane Concentration	tCH4	TROPOMI Level-2 methane mixing ratio bias corrected data product	C3S ERA5 Met data	Constrained by TROPOMI pixel (7 x 5.5km). Aggregated at basin-scale (typically a few hundreds of kilometers)	Highly emissive fossil fuel production basins: Permian, Anadarko, Appalachian shale basins, Middle East, Central Asia, South African and Bowen coal basins. Onshore only.	N/A	Atmospheric column coverage of Sentinel-5P sensor (TBC)	2019-ongoing	Daily	Monthly, quarterly and yearly	Project phase 1: 1 year and phase 2: 6 months	Phase 1: 1 year and by phase 2: 6 months to 1 year (due to licencing issues)	-	+/- 30% on yearly emissions figures, depending on TROPOMI coverage (number of cloud-free available images during a year)	Threshold on TROPOMI Coverage (number of cloud-free available images during a month/quarter/period), C3S ERA5 wind data quality indicators	Scientific format (GeoJSON), Tabular (csv), Image (JPEG)	Map with covered regions and chart visualization of regional emissions time series	Upon request, with disclaimer and licence agreement	-	KAYRROS. C. Giron, Kayrros (c.giron@kayrros.com)	
CH4 - global	Variational inverse modeling of the atmospheric transport and chemistry	Kg/s/m2	GOSAT (different products) and in situ network	C3S ERA5 Met data (wind fields)	1.9x3.75°	Globe but mostly emissions over land	Transport model has 39 levels to calculate OH sink (but emissions only inverted at the surface)	Atmospheric column coverage of GOSAT sensor (TBC)	2009-Ongoing	3-day	Weekly	Project phase 1: 1 year and phase 2: 6 months (Operationally could be done monthly, depending on the retrieval of product used)	Phase 1: 1 year and phase 2: 6 months	-	Highly variable – depending on space and time	Quality flags of GOSAT products	Scientific format (NetCDF)	Map of fluxes	Upon request, with disclaimer and licence agreement	Marielle Saunois et al. (2020)	LSCE X. Lin (xinlin.res@gmail.com)	
NH3 - point sources	Mass-balance	kg/s	IASI	C3S ERA5 Met data	Constrained by the circular to elliptical IASI pixel – 12km diameter at nadir. Attributed to a single	Global, provided for ~100 point sources	IASI measures total columns; surface emissions will be derived	IASI measures total columns; surface emissions will be derived	2008-2022	Daily	Yearly for strong point sources (5-year basis for weaker point sources)	Phase 2 : No Update planned	Phase 2 : No Update planned	10-2 kg/s (depending on thermal contrast, lifetime and	Highly variable – depending on space and time	-	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agree	Van Damme et al. (2018), Nature 564, 99-103 Van	ULB: L. Clarisse, ULB (lieven.clarisse@ulb.be) M. Van Damme, ULB (martin.va	5

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
					latitude/ longitude pair.									vertical distribution)					ment	[Damme et al. (2021), Environ. Res. Lett., 16, 055017](#)	n.damme@ulb.be)	
NH3 - regional inversions	Mass-balance	Kg/s/m2	IASI	C3S ERA5 Met data	Coherent emission regions (e.g., Po Valley, Central US)	Global, provided for Coherent emission regions (e.g., Po Valley, Central US)	IASI measures total columns; surface emissions will be derived	IASI measures total columns; surface emissions will be derived	2008-ongoing	Daily	Weekly (climatology calculated over the IASI timeseries)	Yearly	Phase 1: 1 year and phase 2: 6 months	-	Highly variable – depending on space and time	-	Tabular (csv) or Scientific (NetCDF)	Timeseries	Upon request, with disclaimer and licence agreement	[Van Damme et al. (2018), Nature 564, 99-103](#) [Van Damme et al. (2021), Environ. Res. Lett., 16, 055017](#)	ULB: L. Clarisse, ULB (lieven.clarisse@ulb.be) M. Van Damme, ULB (martin.van.damme@ulb.be)	
NH3 - global	Finite difference mass-balance (FDMB)	Kg/s/m2	IASI		Up to 2022: 1.3° x 2.5°, in early 2023: 1x1°	Global with focus on land emissions	Transport model has 79 levels, but emissions only inverted at the surface	IASI measures total columns; surface emissions will be derived	2019-ongoing	Daily	Daily	Yearly	Phase 1: 1 year phase 2: 6 months	To be evaluated in the project	Highly variable – depending on space and time	IASI NH3 quality flag	Scientific format (NetCDF)	Map of fluxes	Upon request, with disclaimer and licence	Unpublished (developed in World Emission)	LSCE (Pramod Kumar ; Didier Hauglustaine) pramod.kumar[@lsce.ipsl.fr](#); didier.hauglustaine@lsce.ipsl.fr	
SO2 - point sources	Divergence	Emissions in mass per time (kg/s)	TROPOMI sulfur dioxide total vertical column data (COBRA)	C3S ERA5 Met data (wind fields)	Constrained by TROPOMI pixel (3.5 x 5.5 Km).	Global, excluding polar regions (50°S to 72°N; high latitudes: only summer), subject to cloud coverage and adverse atmospheric conditions	N/A	N/A	2018-ongoing	Daily	Yearly (seasonal for good atmospheric conditions)	Yearly	Phase 1: 6 months and phase 2: 3 months	30 kt / year	+/- 50% relative on average	internal quality check; only quality assured results included in output	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agreement	Beirle et al., 2019; Beirle et al., 2021	MPIC (Steffen Beirle; steffen.beirle@mpic.de; Adrian Jost; adrian.jost@mpic.de)	6
SO2 - global	Finite difference mass-balance (FDMB)	Kg/s/m2	TROPOMI (possibly OMI)	C3S ERA5 met data	Up to 2022: 1.3° x 2.5°, in early 2023: 1x1°	Global with focus on land emissions	Transport model has 79 levels, but emission	Atmospheric column coverage of Sentinel-	2019-ongoing	Daily	Daily	Yearly	Phase 1: 1 year phase 2: 6 months	-	Highly variable – depending on space	TROPOMI SO2 quality flag	Scientific format (NetCDF)	Map of fluxes	Upon request, with disclaimer	Unpublished (developed in World Emission)	LSCE (Pramod Kumar ; Didier Hauglustaine)	

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
							s only inverted at the surface	5P sensor (TBC)							and time				and licence		pramod.kumar@lsce.ipsl.fr; didier.hauglustaine@lsce.ipsl.fr	
NOx - point sources	Divergence	Emissions in mass per time (kg/s)	TROPOMI Level-2 nitrogen dioxide tropospheric column data product (PAL or reprocessing)	C3S ERA5 Met data (wind fields)	Constrained by TROPOMI pixel (3.5 x 5.5 Km). ~200 point sources	Global, excluding polar regions (50°S to 72°N; high latitudes: only summer), subject to cloud coverage and adverse atmospheric conditions. Provided for ~50 point sources	N/A	N/A	2018-2021	Daily	Yearly (seasonal/monthly for good atmospheric conditions)	Phase 2 : No Update planned	Phase 2 : No Update planned	3 kt / year (1 kt / year for good conditions)	+/- 50% relative on average	internal quality check; only quality assured results included in output	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agreement	Beirle et al., 2019; Beirle et al., 2021	MPIC (Steffen Beirle; steffen.beirle@mpic.de)	3
NOx - hotspots (megacities and conurbations)	Lifetime / emission fit	Emissions in mass per time (kg/s)	TROPOMI Level-2 nitrogen dioxide tropospheric column data product (PAL or reprocessing)	C3S ERA5 Met data (wind fields)	A single emission estimation is provided for each megacity/conurbation	Selected megacities/ conurbations of interest. Provided for up to 20 megacities/ conurbations	N/A	N/A	2019-ongoing (might be extended back to 2005 based on OMI data)	Daily	Yearly (seasonal/monthly for good atmospheric conditions)	Phase 2 : No Update planned	Phase 2 : No Update planned	100 kt / year	+/- 50% relative on average	internal quality check; only quality assured results included in output	Tabular (csv) or Scientific (NetCDF)	Hotspots map	Upon request, with disclaimer and licence agreement	Beirle et al., 2011; Liu et al., 2022	MPIC (Steffen Beirle; steffen.beirle@mpic.de)	
NOx - regional inversions	Variational inverse modelling of the atmospheric chemistry transport at mesoscale to derive the emissions from satellite NO2 observations (correct	kteqNO2	Phase I: OMI QA4ECV + TROPOMI-PAL (2019-onwards) tropospheric NO2 Phase II: TROPOMI-2.4 (2019-onwards) tropospheric NO2	ECMWF-IFS operational forecasts; MEGAN biogenic NOx emissions ; LMDZ-INCA boundary conditions ; Carbon monitor - CEDS inventory	0.5x0.5°	Europe, Eastern China	N/A for the emissions; N/A for the tropospheric columns we assimilate; variable vertical resolution of the model (17 terrain following levels from the surface up to	Assimilation of NO2 tropospheric columns / Estimate of the emissions at the surface	2019-ongoing	Daily		Yearly	9 Months for Europe, 12 months for East China	-	To be derived as a side product	N/A (cf uncertainties)	Scientific format : NetCDF, (country budgets in txt files)	Map with covered regions and chart visualization of regional emissions time series	Upon request, with disclaimer and licence agreement	Fortems-cheiney and Broquet (2022)	LSCE: A. Fortems-Cheiney (audrey.fortems@lsce.ipsl.fr) and G. Broquet (gregoire.broquet@lsce.ipsl.fr)	

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
	ion of a prior knowledge from inventories to fit the observations)						200 hPa)															
NOx - global	Finite difference mass-balance (FDMB)	Kg/s/m2	TROPOMI		Up to 2022: 1.3° x 2.5°, in early 2023: 1x1°	Global with focus on land emissions	Transport model has 79 levels, but emissions only inverted at the surface	Atmospheric column coverage of Sentinel-5P sensor (TBC)	2019-ongoing	Daily	Daily	Yearly	Phase 1: 1 year phase 2: 6 months	-	Highly variable – depending on space and time	TROPOMI QF	Scientific format (NetCDF)	Map of fluxes	-	Unpublished (developed in World Emission)	LSCE (Santanu Halder ; Didier Hauglustaine) santanu.halder@lsce.ipsl.fr; didier.hauglustaine@lsce.ipsl.fr	
CO - regional inversions	Variational inverse modelling of the atmospheric chemistry transport at mesoscale to derive the emissions from satellite CO observations (correction of a prior knowledge from inventories to fit the observations)	ktCO	MOPITT v8J and MOPITT v9J surface data s	ECMWF-IFS operational forecasts; MEGAN biogenic NOx emissions ; LMDZ-INCA or CAMS boundary conditions ; Carbon monitor - CEDS inventory	0.5x0.5°	Europe, Eastern China	N/A for the emissions; N/A for the total columns or surface data we assimilate; variable vertical resolution of the model (17 terrain following levels from the surface up to 200 hPa)	Assimilation of CO total columns or surface satellite data / Estimate of the emissions at the surface	2019-ongoing	2-3 days (MOPITT)	Monthly	Yearly	9 Months for Europe, 12 months for East China	-	To be derived as a side product	N/A (cf uncertainties)	Scientific format :NetCDF (country budgets intxt files)	Map with covered regions and chart visualization of regional emissions time series	Upon request, with disclaimer and licence	Fortems-cheiney and Broquet (2022) Fortems-Cheiney et al. (ACPD, 2023)	LSCE: A. Fortems-Cheiney (audrey.fortems@lsce.ipsl.fr) and G. Broquet (gregoire.broquet@lsce.ipsl.fr)	7
CO -	Variatio	Kg/s/	MOPITT and	C3S ERA5	1.9x3.75°	Global with	Transpor	Atmosph	2000-	Weekly	Monthly	Yearly	Phase 1:	-	Highly	-	Scientific	Map of	Upon	Zheng et	LSCE	

Product Name (Specie-level)	Methodology	Units	Data source	Auxiliary data	Horizontal spatial resolution	Horizontal spatial coverage	Vertical spatial resolution	Vertical spatial coverage	Temporal coverage	Temporal resolution (satellite revisit)	Temporal resolution (product)	Frequency update (product)	Latency (Product delivery update)	Detection threshold	Uncertainty on flux rate estimates	Quality flags	Data format	Data Visualization in platform	Access to data	Reference	Point of contact	Stakeholders Priority
global	nal inverse modeling of the atmospheric transport and chemistry	m2	possibly IASI CO columns	Met data (wind fields)		focus on land emissions	t model has 39 levels to calculate OH sink and secondary CO production, but emissions only inverted at the surface	eric column coverage of MOPITT and IASI sensor (TBC)	ongoing				1 year and phase 2: 6 months		variable – depending on space and time		format (NetCDF)	fluxes	request, with disclaimer and licence	al. (2019)	Tsinghua University Bo Zheng (bozheng@sz.tsinghua.edu.cn)	
CH3OH - point sources	Mass-balance	kg/s	IASI	C3S ERA5 Met data	Constrained by the circular to elliptical IASI pixel – 12km diameter at nadir. Attributed to a single latitude/longitude pair.	Mainly in Asia. Provided for ~15 largest point sources	IASI measures total columns; surface emissions will be derived	IASI measures total columns; surface emissions will be derived	2008-ongoing	Daily	Averaged over the 2007-2021 IASI timeseries			To be evaluated in the project	Highly variable – depending on space and time	-	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agreement	Franco et al. (2018) JGR Atmos., 123, 13,963–13,984.	ULB. B. Franco, ULB (bruno.franco@ulb.be) L. Clarisse, ULB (lieven.clarisse@ulb.be)	8
C2H2-- point sources	Mass-balance	kg/s	IASI	C3S ERA5 Met data	Constrained by the circular to elliptical IASI pixel – 12km diameter at nadir. Attributed to a single latitude/longitude pair.	Mainly in Asia. Provided for ~15 largest point sources	IASI measures total columns; surface emissions will be derived	IASI measures total columns; surface emissions will be derived	2008-ongoing	Daily	Averaged over the 2007-2021 IASI timeseries			To be evaluated in the project	Highly variable – depending on space and time	-	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agreement	-	ULB. B. Franco, ULB (bruno.franco@ulb.be) L. Clarisse, ULB (lieven.clarisse@ulb.be)	4
C2H4- point sources	Mass-balance	kg/s	IASI	C3S ERA5 Met data	Constrained by the circular to elliptical IASI pixel – 12km diameter at nadir. Attributed to a single latitude/longitude pair.	Global, provided for ~50 point sources	IASI measures total columns; surface emissions will be derived	IASI measures total columns; surface emissions will be derived	2008-ongoing	Daily	Averaged over the 2007-2021 IASI timeseries			To be evaluated in the project	Highly variable – depending on space and time	-	Tabular (csv) or Scientific (NetCDF)	Point sources map	Upon request, with disclaimer and licence agreement	-	ULB. B. Franco, ULB (bruno.franco@ulb.be) L. Clarisse, ULB (lieven.clarisse@ulb.be)	

Other data will be used or provided in some other ways. Near-surface atmospheric water vapour (H2O) content retrievals from satellites will be used to constrain the emissions from the residential cooling sector for global and regional emission products, and to interpret anomalies of NMVOC emissions from plants during drought episodes. Particular Matter (PM) emissions will not be formally inverted as top-down gridded products but adjusted from top-down precursor emissions (NOx, SO2, VOCs) and primary emissions over large areas to match satellite AOD. Carbon Dioxide (CO2) at global level is routinely distributed by CAMS