



Urban SIS: Climate information for European cities

What is behind Urban SIS?

Urban SIS is a proof-of-concept project within Copernicus Climate **Change Service** (C3S 441 Lot 3) providing city specific climate data and impact indicators to principally the infrastructure and health sectors acting in European cities. The demonstration of Urban SIS results is made for three 110x100 km² areas centered over Stockholm, Bologna

Urban SIS output

The **ECVs** can be accessed and downloaded as gridded time series or receptor point time series for use as input to further downscaling or impact modelling. Urban SIS also offers a series of *statistical indicators* for each ECV – e.g. daily/monthly/annual averages and extreme values. There is also available a list of more user-friendly *impact indicators* which have been specified by the infrastructure and health sectors, e.g. rainfall extremes given as Intensity-Duration-Frequency (IDF) curves, area reduction factors for precipitation intensity, Thom indices for heat waves, exceedances of EU air quality directive etc.

and Amsterdam/Rotterdam.



Concept

The Urban SIS information is based on climate re-analysis and climate scenario data, downscaled to be useful for individual cities. The **Essential Climate Variables** (ECVs) proposed for urban downscaling include hourly $\sim 1 \times 1 \times 10^{2}$ fields of:

- precipitation (also expressed as snow)
- water vapor
- urban temperature
- wind speed and direction
- surface radiation budget
- regional background concentrations of NO₂, O₃, PM_{10} and $PM_{2.5}$
- regional scale soil moisture and river discharge

The ECVs are delivered for a historical 5-year period and for a climate scenario with two 5-year windows, one representing present and the other future conditions. The basic forcing for the urban downscaling are:

Name

Name	Onic
Air temperature* (T2M)	°C
Air temperature* (T2Murban)	°C
Air temperature* (T2Mnature)	°C
Air temperature* (T layer 1)	°C
Air temperature* (T layer 2)	°C
Air temperature* (T layer 3)	°C
Precipitation (15 min)	mm
Precipitation (hourly)	mm
Relative humidity*	%
Wind* (at 10 m)	m/s
Wind* (at layer 1)	m/s
Wind* (at layer 2)	m/s
Wind* (at layer 3)	m/s
Gustiness	
Boundary layer height	m
Friction velocitu (u*)	
Temperature scale (T*)	
Roughness length (z0)	
Snowfall	mm
O3 concentration	µg/m3
NO2 concentration	µg/m3
PM10 concentration	µg/m3
PM2,5 concentration	µg/m3
Global radiation	w/m2
Direct shortwave radiation	w/m2
Diffuse shortwave radiation	w/m2
Local runoff	mm/h
Surface runoff	mm/h
Evapotranspiration	mm
River discharge	m³/h
Soil moisture	mm
Snow cover	m

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Historical period: UERRA reanalysis (HARMONIE output 11x11 km²) over Europe)

Climate scenario: GCM EC-Earth model output for RCP8.5 and prescribed SST (IPSL) 1980-2065, regionally downscaled over Europe with HARMONIE to 20x20 km².



Principles for the generation of Urban SIS ECV and impact indicator output

The urban climate downscaling is performed with HARMONIE AROME. Urban SIS has strongly improved the land-use input to the HARMONIE submodels SURFEX and TEB, based on Urban ATLAS, OpenStreetMap and Leaf Area Index (LAI) data from Copernicus Global Land Service. To complete the ECVs, the air quality dispersion model MATCH and the hydrological model HYPE use HARMONIE AROME downscaled data as meteorological forcing. In order to assure full consistency between all ECVs, the boundary conditions for MATCH and HYPE are produced by pan-European model runs performed prior to the urban downscaling.

For more information

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Urban SIS Impact Indicators

Category		Group	Explanation	Period	Unit	Threshold
Health	Air quality	Air pollutant concentration	99.8th percentile of hourly NO2 concentration	yearly	µg m-3	200 µg m-3
			Yearly average NO2 concentration	yearly	µg m-3	40 µg m-3
			Yearly average PM2.5 concentrations	yearly	µg m-3	25 µg m-3
			Yearly average PMID concentrations	yearly	$\mu g m - 3$	40 µg m-3
			Sour percentile of daily average PMID concentrations	ually	µg m-s	50 µg m-3
			SOMO35	yearly	days*µg m- >	35 ppb
		Air pollution exposure	Persons exposed to NO2 conc $>$ AO EU hourly limit value	vearly	3 nersons	200 µg m-3
			Persons exposed to NO2 conc. > AO EU hourly limit value	vearly	persons	40 µg m-3
			Persons exposed to PM2.5 conc > AQ EU hourly limit value	yearly	persons	25 µg m-3
			Persons exposed to PM10 conc. > AQ EU hourly limit value	yearly	persons	40 µg m-3
			Persons exposed to OM10 conc. > EU daily llimit value	yearly	persons	50 µg m-3
			Persons exposed to O3 concentrations $>$ EU daily target	yearly	persons	120 µg m-3
			Persons exposed to 03 concentrations > WHO quidelines	voarly	nersons	100 µg m-3
			Persons exposed to NO2 concentrations > EU hourly limit	vearly	persons	200 µg m 3
			value			
			Persons exposed to NO2 conc. > AQ EU yearly limit value	yearly	persons	40 µg m-3
		Annual deaths due to NO2 and	Mortality, all-cause, long-term No2 and PM2.5 exposure	yearly	deaths per	
		PM2.5 long-term exposure	Annual deaths due to 02 chart term expective	voarly	year doothe nor	
		short-term exposure	Annual deaths due to 05 short term exposure	yearry	vear	
			Annual deaths per 100,000 inhabtants due to $=3$ short term	yearly	deaths/100,	
			exposure		000	
				.	inhabitants	
	Heat stress	Hot days	Degree days > 75thpercentile	yearly	degree*days	
		Annual heat related deaths	Annual heatrolated deaths	yearly	doaths/voar	75th norcont
		Annual field related deatins	Annual field leatins	yearry	ucatils/ year	ile at position
						of an official
						weather
						station
			Annual heatrelated deaths per 100,000 inhabitants	yearly	deaths/(yea	/5th percent
					inhabitants)	of an official
					in the break to y	weather
						station
	Discomfort	Thom Discomfort Index	Thom discomfor index	yearly		
		Universal Thermal Climate	Universal Thermal Climate Index	yearly		
		Frequency of tronical nights	Tropical Nights	vearly		
Enerav	Enerav	Heating and cooling degree	Heatin degree days	vearly	°C dav	17
	consumption	days	Cooling degree days	yearly	°C day	20
			Degree days	yearly	°C day	
	Solar operav	Solar incolation	Chartyawa calar incolation	Avorago		
	Solar energy			monthly values		
				for modelling	MJ m-	
				period	2month-1	
Infrastructure	Flooding	Short duration extreme	Maximum precipitation intensity	Selected		
		precipitation		accumulation		
				from 15 min to		
				24 h	mm AP-1	
		Short-duration extreme	IntensityDurationFrequency (IDF) curve	Selected	mm AP-1	
		precipitation		accumulation		
		intensity/duration		from 15 min to		
				24 h		
			Areal Reduction Factors (ARFs)	Selected		
				accumulation		
				periods (AP)		
				74 h		
	Soil	Soil temperature	Soil temperature	mounthly	°C	
	Green	Growing season length	Leaf on date	yearly	day of year	
	infrastructure		Leaf off date	yearly	day of year	
			Growing season length	yearly	number of	
			Growing degree days	monthly	°C davs	10° C
			Senscence degree days	monthly	°C days	10° C
		Drought periods	Drought duration	yearly	days	20%
					al	percentile
	i ransport	Frost days	rrost days	yearly	days	
	m asu uctui e	Zero-crossings	Number of days on both sides of 0 °C	vearly	davs	
Non-sector	Temperature	Daily maximum, minimum and	Daily max air temperature	daily		
specifik	-	average air temperature	Daily min air temperature	, daily	~し °C	
			Daily mean air temperature	dailv	°C	
			Yearly maximum of daily temperature range	yearly	°C	
	Snow cover	Snow cover indicators	Number of days (per vear) with a snow cover > 1 cm	yearly	davs	1 cm
			Mean annual maximum snow cover depth	yearly	, cm	



