Soil & Surface activities

COSMO Consortium Report

Juergen Helmert / DWD, Jean-Marie Bettems / MeteoSwiss

43rd EWGLAM Meeting, 2021

See https://www.cosmo-model.org/content/tasks/workGroups/wg3b/default.htm

WG3b activities

- Introduce *mire* parameterization (in COSMO v6, work on external parameters required)
- Introduce *dynamic* vegetation : PT VAINT (on-going)
- Modelisation of *urban effects* : PT AEVUS 2 , PP CITTA' (in COSMO v6, on-going)
- Modelisation of *snow pack* : PT SAINT (in COSMO v6 and ICON dev, on-going)
- *Snow pack analysis* (on-going)

- Tools : *calibration* of unconfined parameters (PP CALMO-MAX) (ended, future unclear)
- Tools : production of *external parameters* (EXTPAR) (permanent, growing importance)
- Tools : *offline* soil & surface module (TERRA standalone) (consolidation required)

Schweizerische Eidgenossenschaft
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Swiss Confederation

Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

En route to a 'new' operational multi layer snow cover scheme for COSMO & ICON.

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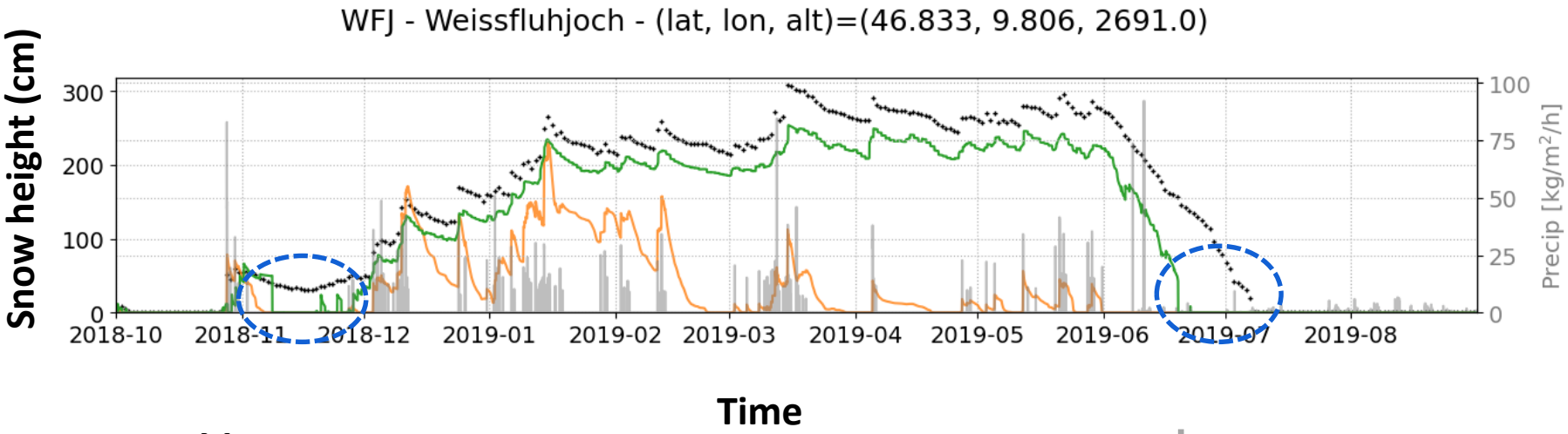
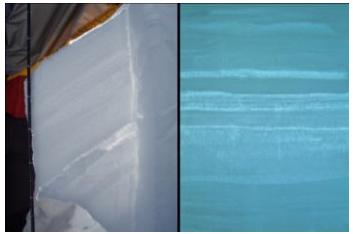
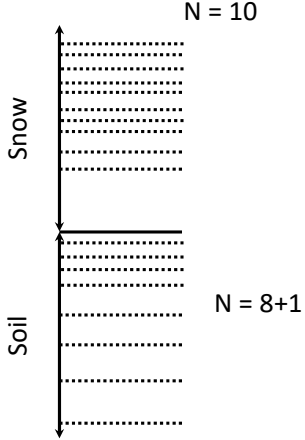
So what? Why do we need a ‘new’ model?



SNOWPOLINO – SNOWPACK's little 'brother'

Layering ($n_{def.}$ = 25)

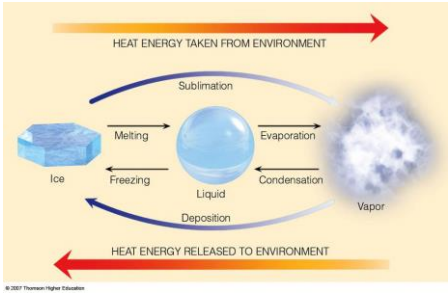




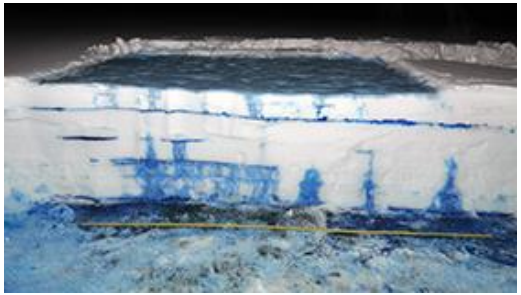
1D heat equation

$$\frac{\partial T}{\partial t} = a\frac{\partial^2 T}{\partial x^2};\quad 0 \le x \le L;\quad t > 0$$

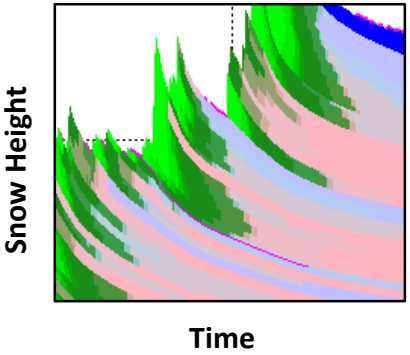
Phase Changes



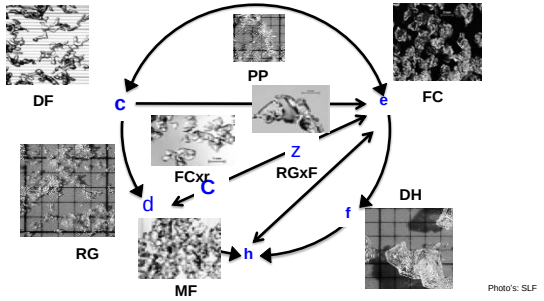
Water transport



Settling/Densification



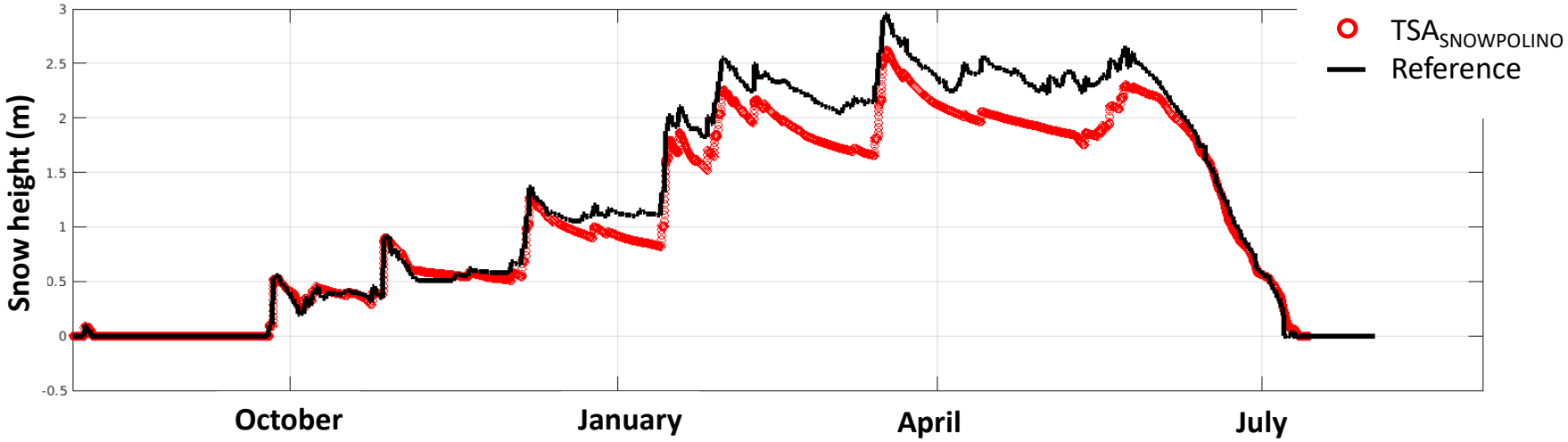
Metamorphism



Photos's: SLF

Local and regional verification (CH) - H_SNOW_{TSA}

TSA – TERRA Stand Alone; measured forcing

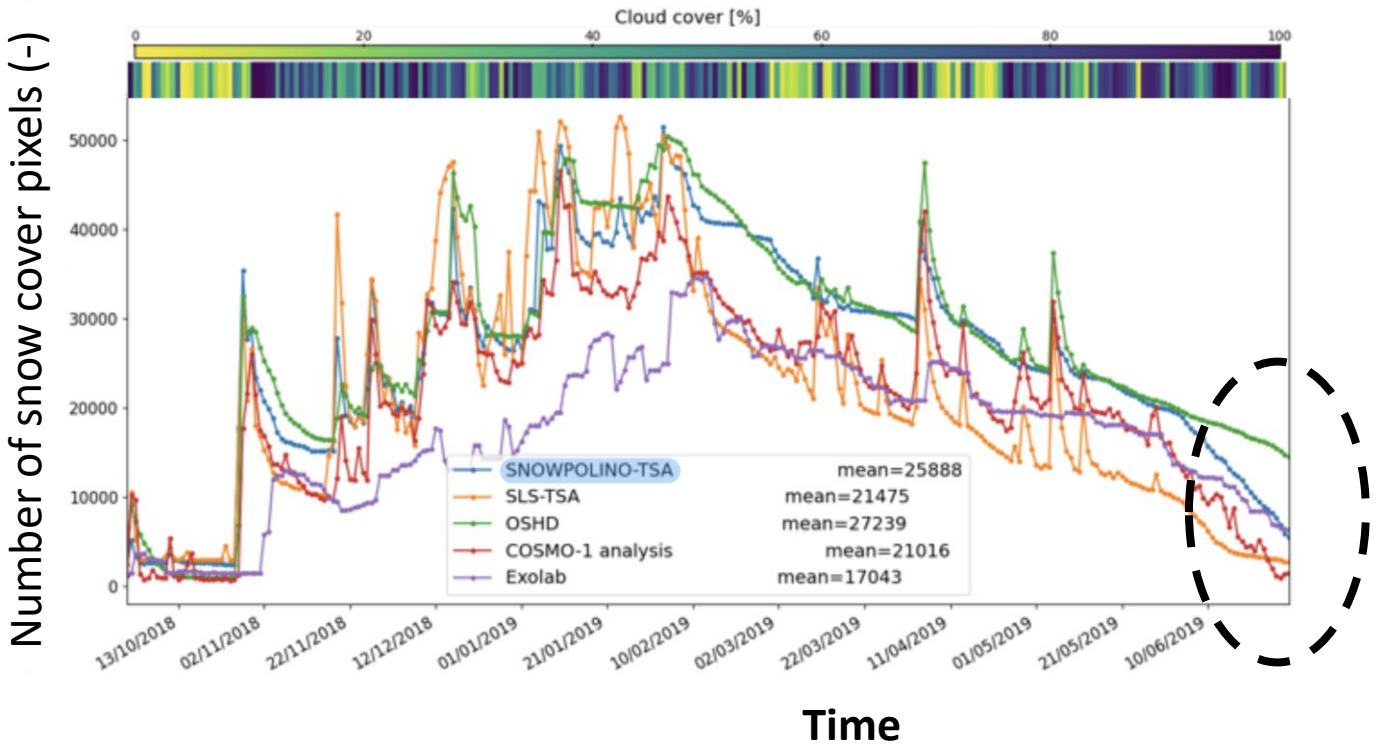


Winter 2020/21 (Weissfluhjoch)

Local and regional verification (CH)

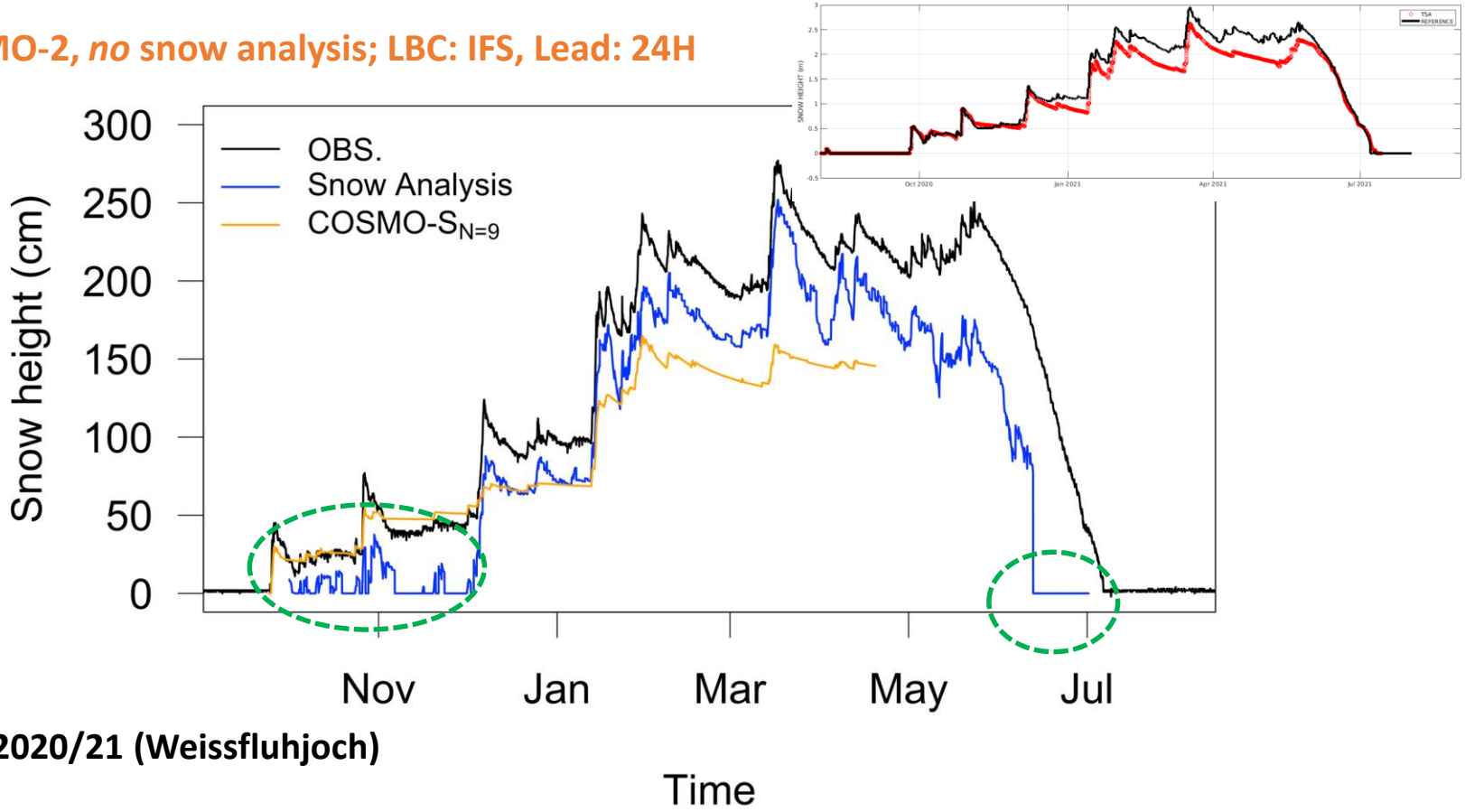
TSA – TERRA Stand Alone; COSMO-1 Analysis

OSHD as reference



Local and regional verification (CH) - H_SNOW

COSMO-2, *no* snow analysis; LBC: IFS, Lead: 24H



Winter 2020/21 (Weissfluhjoch)

Conclusions – COSMO & ICON

COSMO

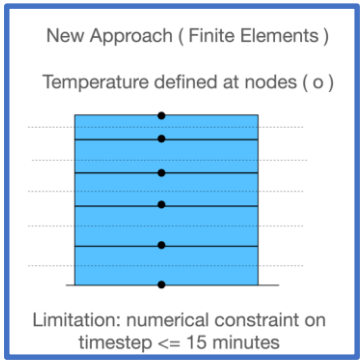
- Fully coupled GPU Version merged with master (will be part of COSMO-6.0)
- Local/regional validation shows sound results in terms of snow height and surface temperature (not shown).
- Comparable results to current snow analysis (snow mask).
- Full (season) e_suite and verification pending

ICON

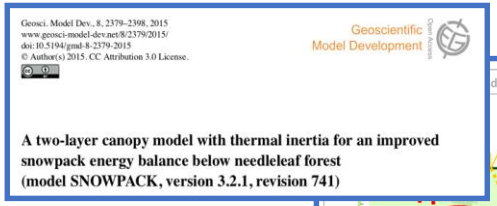
- Implemented into ICON
- Comparable results to COSMO-S
  Current obstacles:
  - Unknow snow related pitfalls.
  - Code is not ready for vector machine. (major)
  - I/O needs to be implemented (minor)
  - Editorial changes needed. (minor)

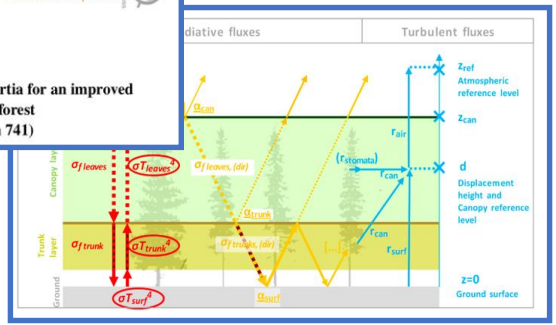
Outlook – additional ‘numerics & physics’

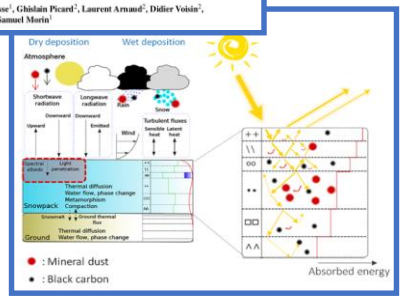
- **Fully implicit solver for heat equation**



- **Snow canopy interactions**







- **Aerosol and their impact on snow**

Urban modelling

- **PT AEVUS & AEVUS2 (10.2017 – 06.2021)**
  - Implementation, validation, calibration of an urban parametrization scheme and of the associated external parameters for operational NWP applications
  - Based on TERRA-URB developed by H. Wouters (Wouters et al, 2016), implemented in the COSMO model
- **PT CITTA' (07.2021 – 12.2023)**
  - Implementation of ***TERRA_URB in ICON***
  - Provision of new ***urban canopy parameters***
  - Test and applications in 6 different countries
  - Further scientific developments

AEVUS 2 Paper

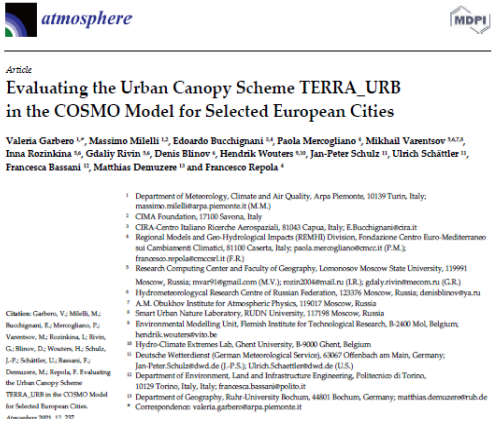
Paper presents evaluation results of the **Terra Urb scheme in high-resolution simulations** with a recent COSMO model version(recent COSMO version 5.05 with TU scheme) for selected European cities: **Turin, Naples and Moscow**.

Additional sensitivity tests have been performed in order to evaluate the **ICON-like turbulence scheme** developed in COSMO and the **use of a new skin-layer temperature scheme**.

The novelty of the work lies in

- use of the recent model version,
- uniform approach for setting up numerical experiments and for the evaluation applied for all different cities.

Please download the paper at the following link:
https://www.mdpi.com/2073-4433/12/2/237/htm



atmosphere

MDPI

Article

Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities

Valeria Garbero [1,*], Massimo Milelli [1,2], Edoardo Bucchignani [3,4], Paola Mercogliano [4], Mikhail Varentsov [5,6,7,8], Inna Rozinkina [5,6], Gdaliy Rivin [5,6], Denis Blinov [6], Hendrik Wouters [9,10], Jan-Peter Schulz [11], Ulrich Schättler [11], Francesca Bassani [12], Matthias Demuzere [13] and Francesco Repola [4]

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Citation: Garbero, V.; Milelli, M.; Bucchignani, E.; Mercogliano, P.; Varentsov, M.; Rozinkina, I.; Rivin, G.; Blinov, D.; Wouters, H.; Schulz, J.-P.; Schättler, U.; Bassani, F.; Demuzere, M.; Repola, F. Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities. Atmosphere 2021, 12, 237.

The effect of TU combined with the ICON-like turbulence and skin temperature schemes provides a substantial improvement in capturing the UHI intensity and improving air temperature forecasts for urban areas. It should be noted that model sensitivity to the change of physical schemes is smaller for Moscow than for Turin and Naples.

Description of LCZs classes – ECOCLIMAP-SG

Dataset/*Producer*	Classes*	Descriptions
ECOCLIMAP-SG/*CNRM*	 24. LCZ1: compact high-rise	• Strong built-up NDVI <= 0.2 and high rise buildings (3D roughness 50-100m) • Strong built-up NDVI <= 0.2 and very high rise buildings (3D roughness > 100m)
	 25. LCZ2: compact midrise	• Continuous urban fabric (from CLC) • Strong built-up NDVI <= 0.2 and medium rise buildings (3D roughness 25-50m)
	 26. LCZ3: compact low-rise	• Strong built-up NDVI <= 0.2 and low rise buildings (3D roughness <25m)
	 27. LCZ4: open high-rise	n.a. - Despite the class is included in the legend of ECOCLIMAP-SG, the data are not available in the European map. Technical documentation doesn't provide further details.
	 28. LCZ5: open midrise	• Medium built-up 0.2 < NDVI <= 0.3 (o 6)
	 29. LCZ6: open low-rise	• Light built-up 0.3 < NDVI <= 0.4
	 30. LCZ7: lightweight low-rise	n.a. - Despite the class is included in the legend of ECOCLIMAP-SG, the data are not available in the European map. Technical documentation doesn't provide further details.
	  31. LCZ8: large low-rise	• Industrial or commercial unit, Airports (from CLC) • Built-up with highly reflecting roof (associated to productive and commercial use) • Roads
	 32. LCZ9: sparsely built	• Road and rail networks and associated land, Mineral extraction sites, Dump sites, Construction sites, Green Urban Areas, Sport and leisure facilities (from CLC) • Very light built-up NDVI > 0.4
	33. LCZ10: heavy industry	• Port areas (from CLC)

**Stewart I.D., Oke T.R., 2012. Local Climate Zones for Urban Temperature Studies. Bull Am Meteorol Soc., 93(12):1879-1900. doi:10.1175/BAMS-D-11-00019.1*

C. Apreda (CMCC)

Milan

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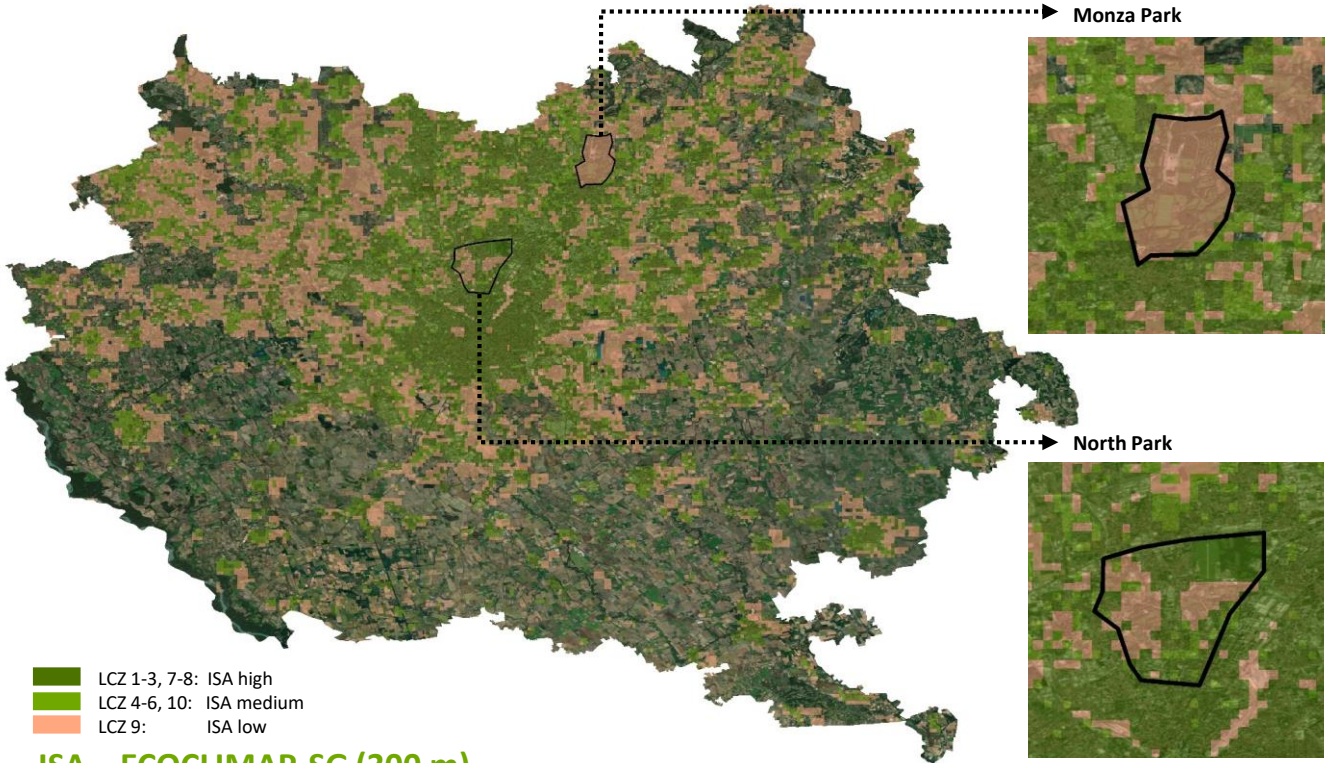
Milan



ISA – ECOCLIMAP-SG (300 m)

C. Apreda (CMCC)

PT VAINT – Dynamic vegetation

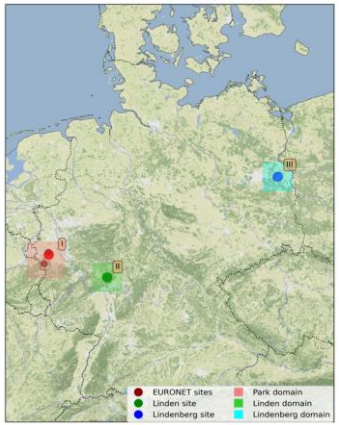
Goal : improve representation of seasonal phenology cycle and of stomatal conductance in TERRA

- Implement canopy photosynthesis and stomatal regulation module
- Implement carbon allocation and plant growth module
- Implement heterotrophic respiration and litter/soil carbon module

Status

- Ball-Berry **stomatal resistance approach** (Ball and Berry, 1991) instead of Jarvis approach (Jarvis, 1976);
- Farquhar (1980) and Collatz (1992) algorithms for **leaf photosynthesis**
- "**Two-big leaf**" approach (Thornton and Zimmermann, 2007) instead of "one-big leaf" (Doms et al, 2018)

Research domains



Result examples