A new WUDAPT averaging technique for improving mesoscale models...in WRF new versions?

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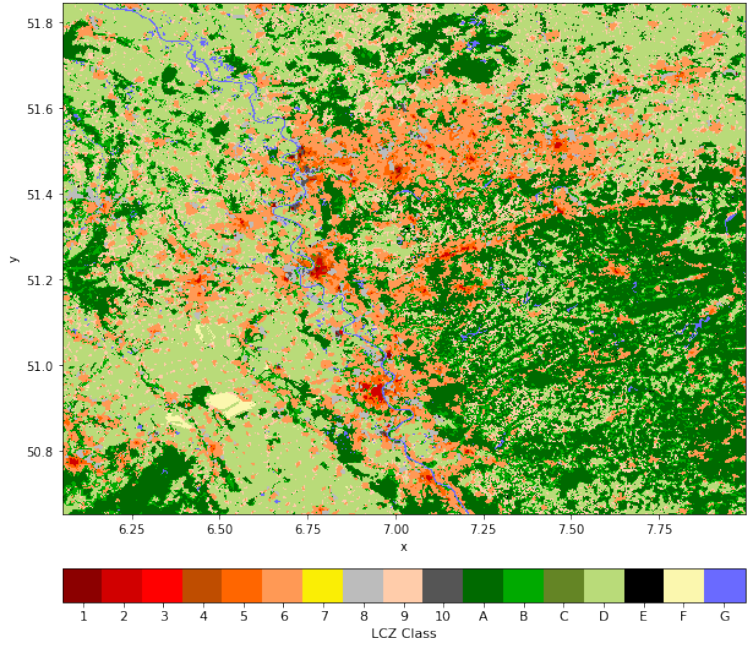


Boulder, January 13, 2023

Objectives

To exploit the new **WUDAPT global map** (Demuzere et al., 2022), recently implemented in WPS by C. HE (previous talk), with the aim to work as best as possible within WRF

Why?

WUDAPT **100 m**, WRF ~ **1 km**...resolution gap!

As a consequence:

- × We categorize urban areas when they actually are more heterogeneous
- × We lose information about urban geometrical/thermal parameters and rural fraction

Idea!

Weighted average of WUDAPT subgrid classification!

What is needed by an UCP (BEP+BEM, SLUCM)

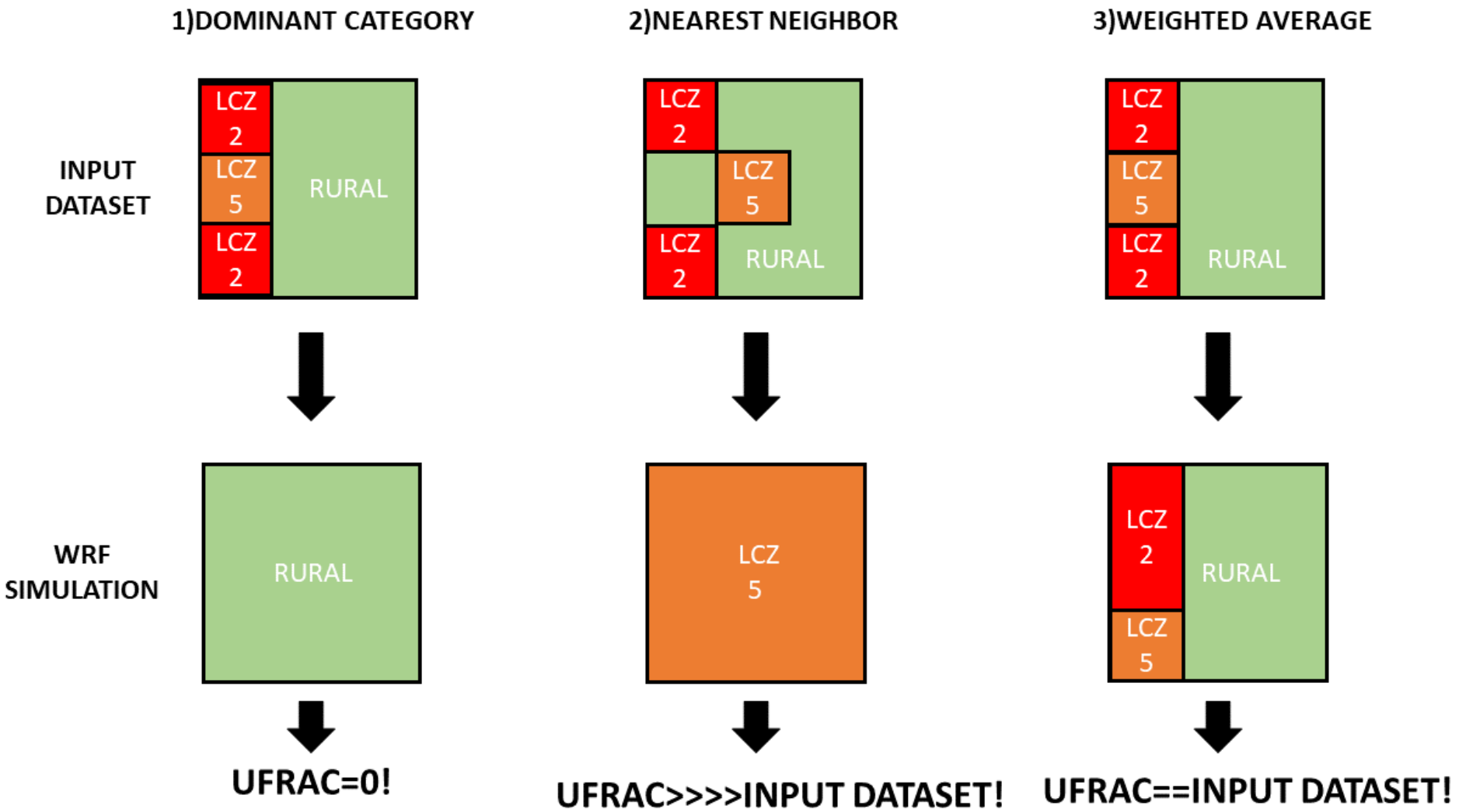
Geometrical parameters (by category or point by point):

- Average Building Height
- Urban fraction (to employ vegetation LSM)
- Building and street widths

Thermal parameters (by landuse category only):

- Street, roof, wall heat conductivity, and capacity
- Street, roof, wall albedo, and emissivity
- Anthropogenic heat released by indoor environments

The issue


1)DOMINANT CATEGORY
2)NEAREST NEIGHBOR
3)WEIGHTED AVERAGE
INPUT DATASET
LCZ 2
LCZ 5
LCZ 2
RURAL
WRF SIMULATION
RURAL
LCZ 5
LCZ 2
LCZ 5
RURAL
UFRAC=0!
UFRAC>>>>INPUT DATASET!
UFRAC==INPUT DATASET!

Timeline - Zonato et al., 2020

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Evaluating the performance of a novel WUDAPT averaging technique to define urban morphology with mesoscale models

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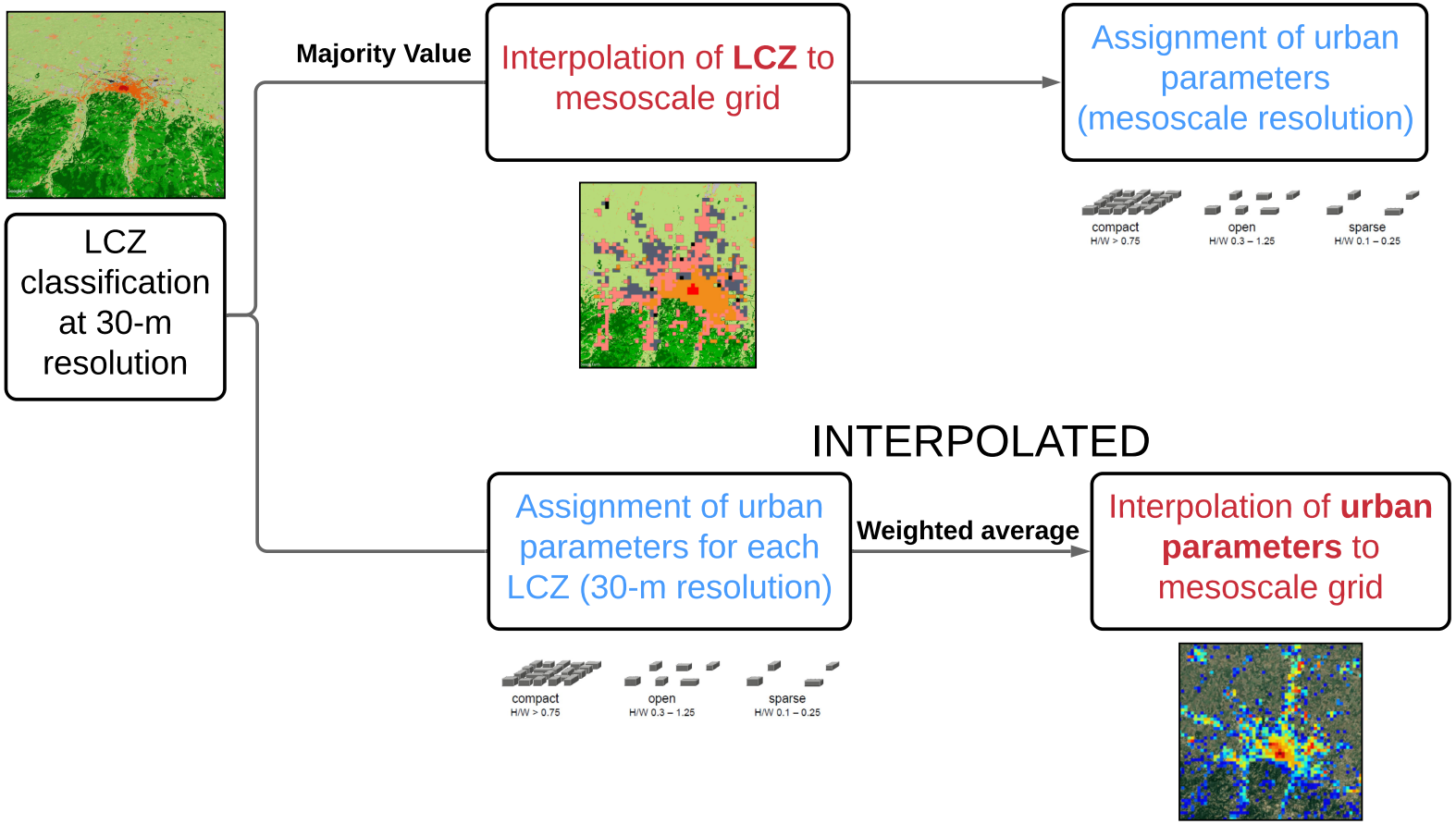
ABSTRACT

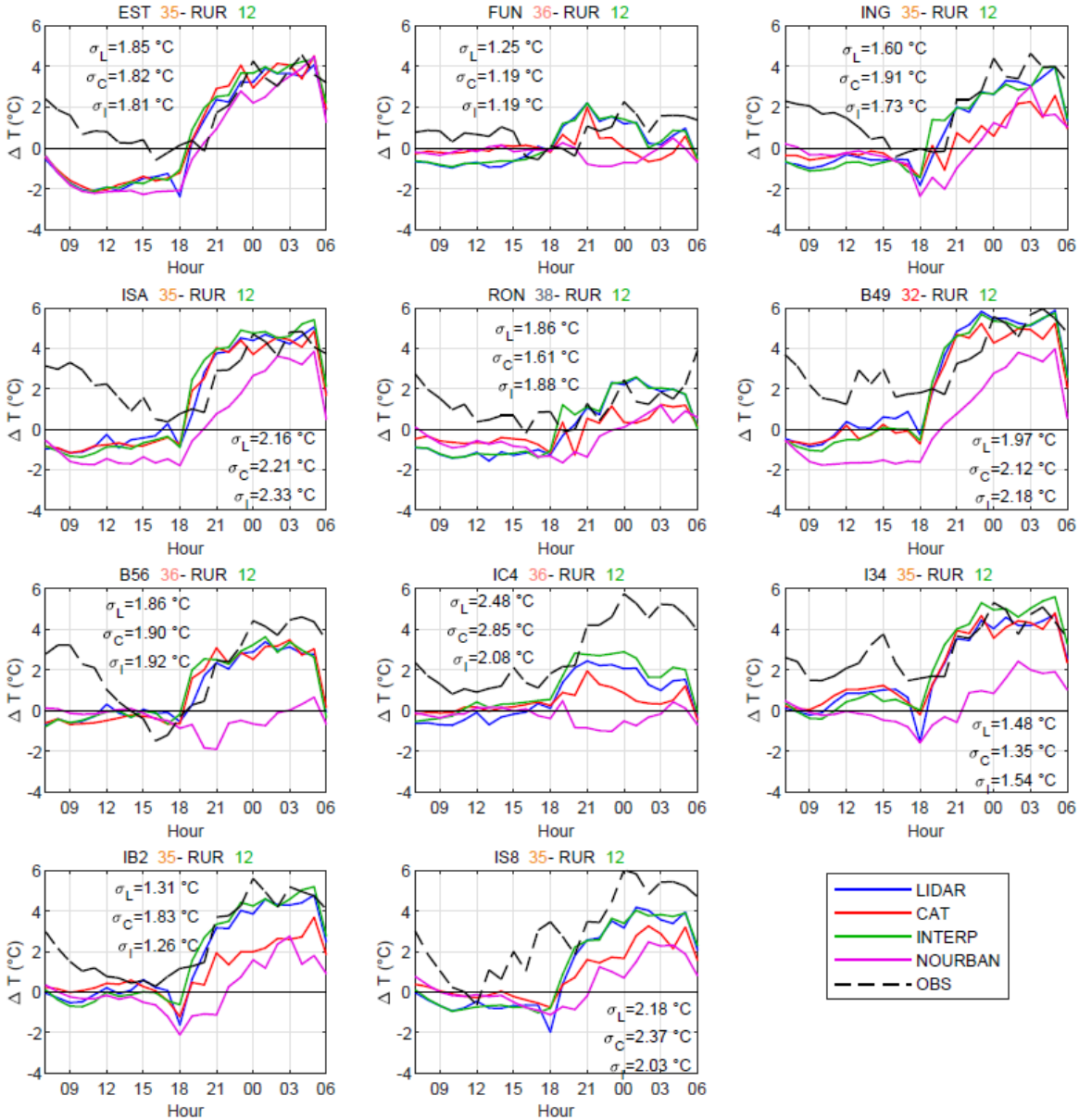
The definition of accurate input datasets, appropriately representing urban morphology characteristics, has been identified as a crucial point for improving the simulation of urban boundary layer (UBL) dynamics by means of mesoscale numerical weather prediction (NWP) models. However, the scarcity of suitable data to adequately describe urban morphology is in many cases a significant obstacle to overcome. For this purpose, the World Urban Database Portal Tool (WUDAPT) framework was developed in order to obtain a standard classification of urban morphology, even in the absence of ad-hoc data for any city.

In the present work, a modified WUDAPT method to define urban morphology is proposed and compared with two state-of-the-art methods, i.e. the standard WUDAPT method and a urban morphology parameters obtained from LIDAR data. In particular, here morphological features of Local Climate Zones (LCZs), resulting from a 30-m resolution WUDAPT classification, are interpolated to NWP cells, providing averaged features of the urban morphology. In this way, the method produces a unique value of the different urban morphology parameters for each model cell. This technique is tested by means of simulations with the Weather Research and Forecasting (WRF) model at 500 m resolution for the city of Bologna (Italy), located in the Po Plain. Simulation output is compared with measurements from weather stations. Results show that

Timeline - Zonato et al., 2020



Timeline - Zonato et al., 2020



Timeline - Demuzere et al, 2022- w2w

W2W: A Python package that injects WUDAPT's Local Climate Zone information in WRF

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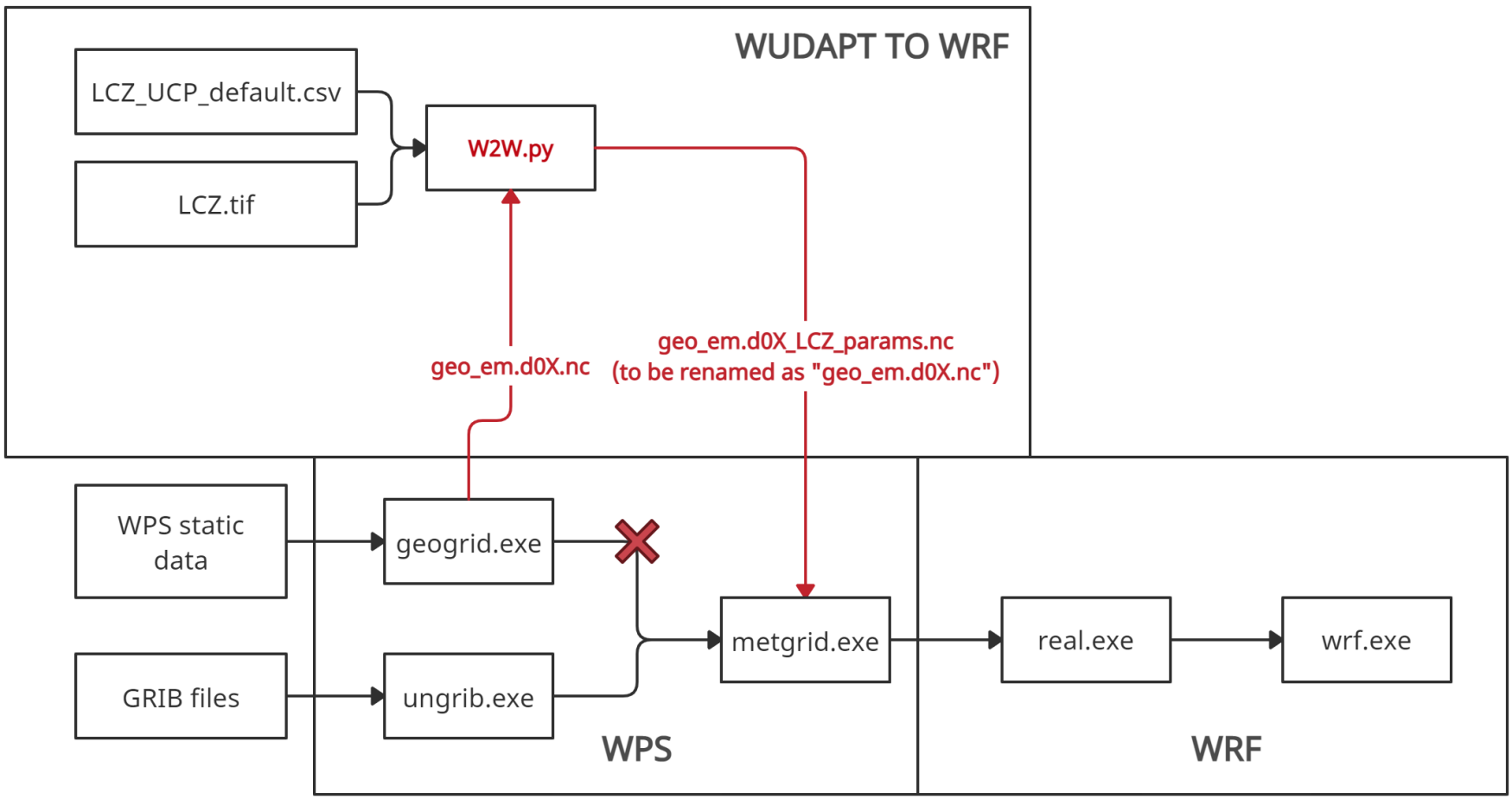
Python tool: **Global LCZ + WUDAPT weighted average**
→provides input urban morphology as geo_em* file

Timeline - Demuzere et al, 2022 - w2w



Timeline - now

What we have?

- ✓ A detailed and consistent LCZ global map at 100 m resolution, **incoroporated within the WPS**;
- ✓ A **method** and a **tool** to exploit this map at typical mesoscale resolutions
- ✓ **Prototypical Urban geometrical parameters** of LCZ
- ✓ the **LANDUSEF** 3D input variable

What is missing in WRF?

2) A way to define the weighted average of urban parameters
3) A way to define the rural landuse within urban areas

The method - **WUDAPT Average in WRF**

What is the aim?

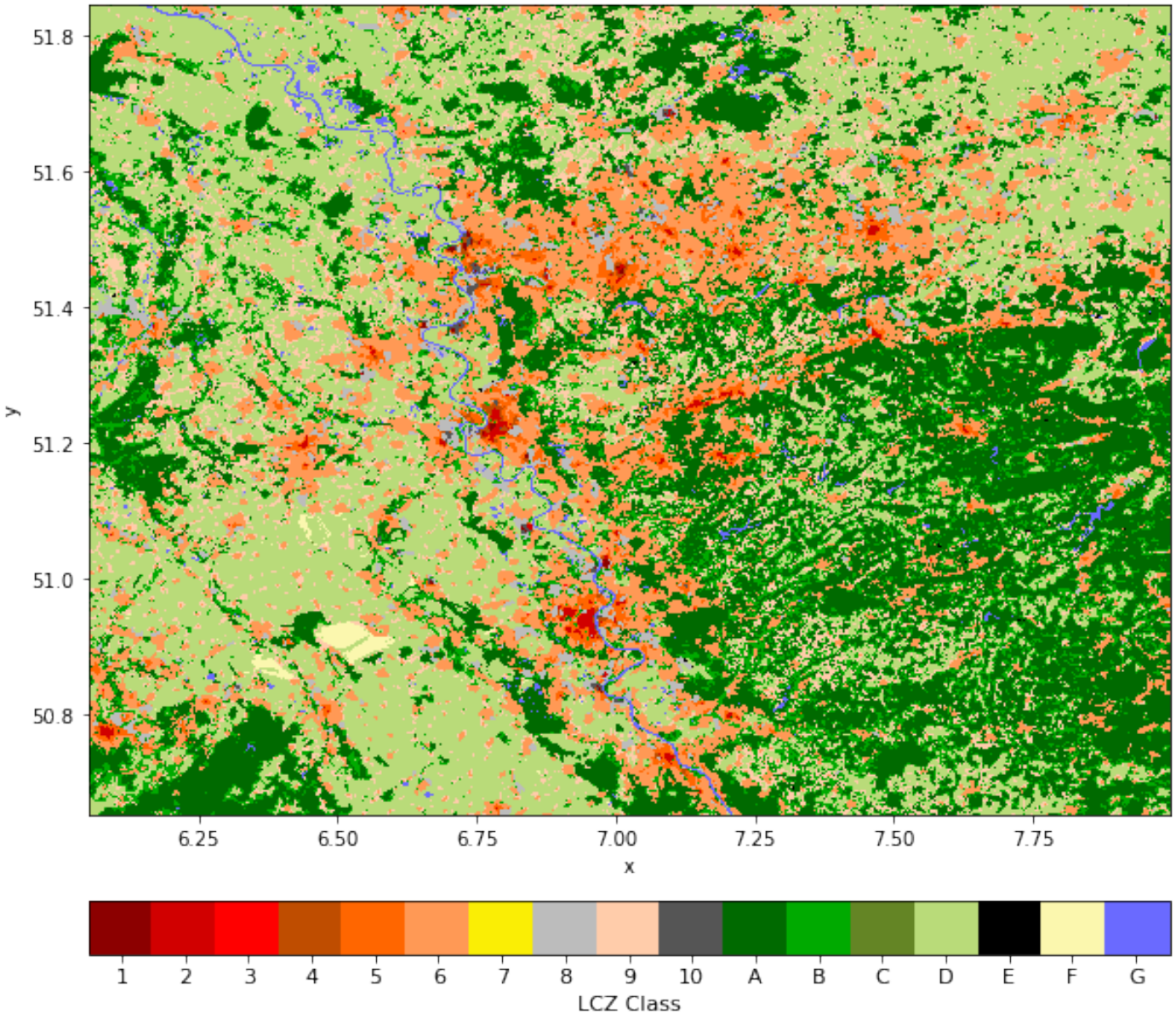
- ✓ To include the weighted average of LCZ within WRF (not in WPS)
- ✓ To calculate urban vegetation from MODIS, since now the **urban fraction** can be arbitrarily chosen

How to do it? (within **module_physics_init.F**)

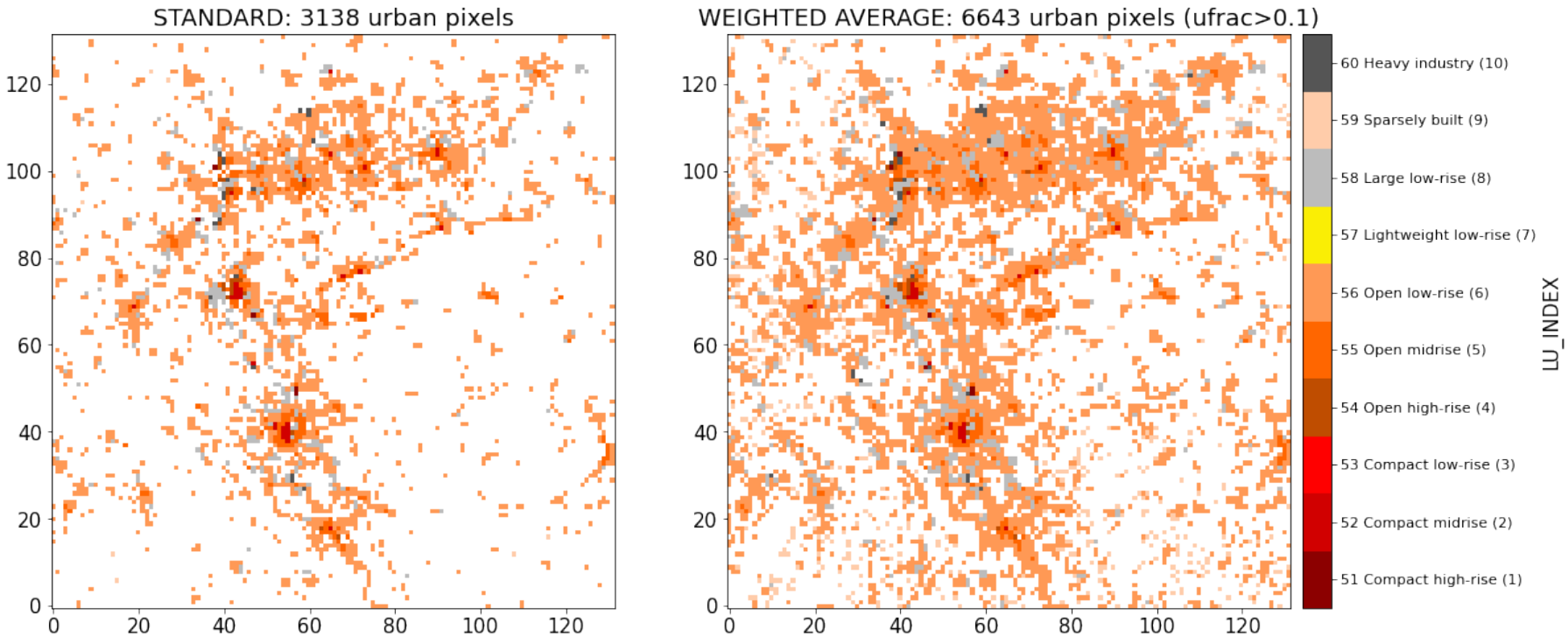
- ✓ To take advantage of the **LANDUSEF** (landuse fraction) variable + the **URBPARM_LCZ.TBL** to calculate, before running the simulation:

  1) the dominant **URBAN category** (whatever the LANDUSE is)
  2) the weighted average of geometrical parameters
  3) the vegetation landuse within urban areas based on MODIS classification

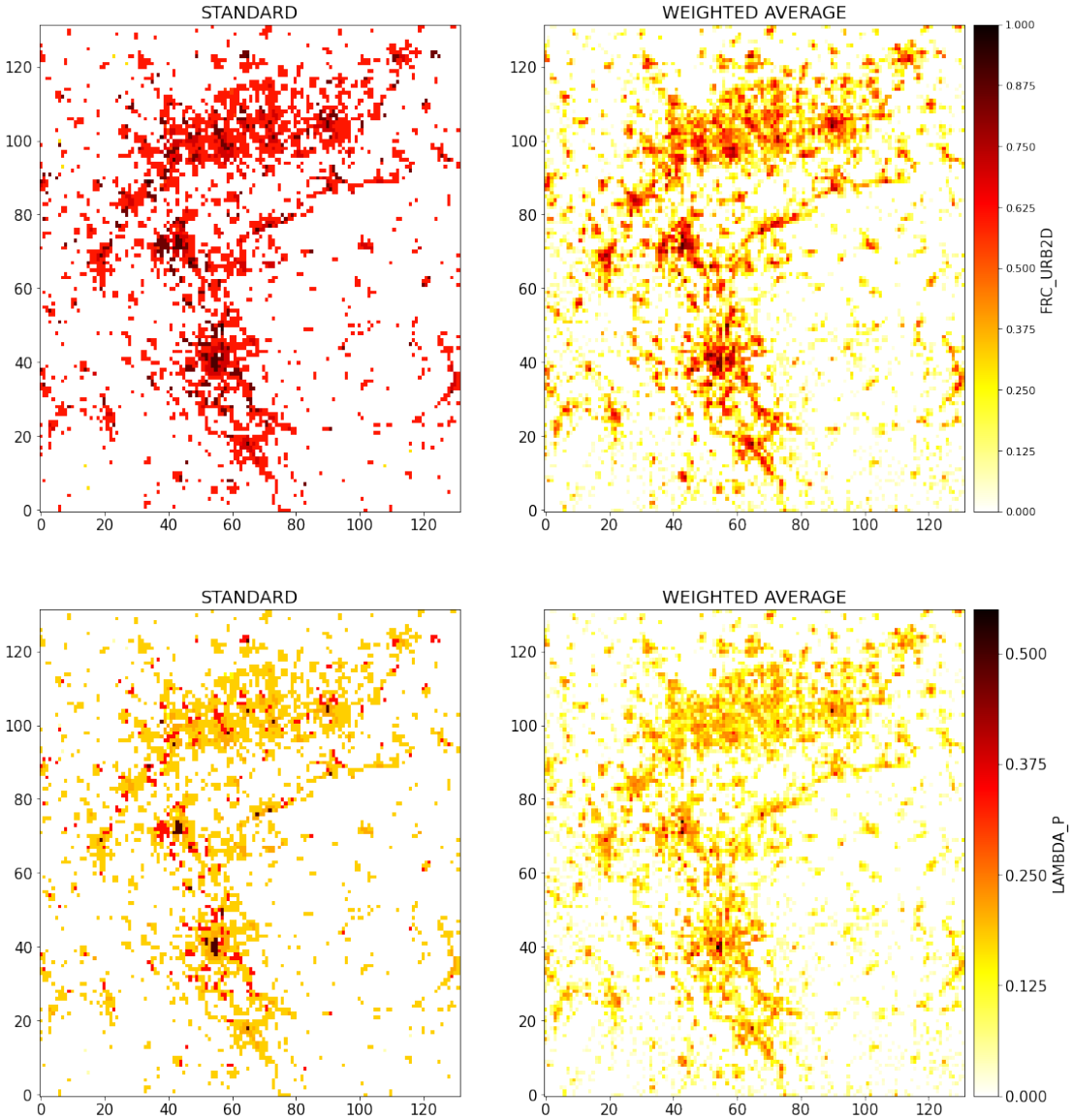
The test case - WUDAPT at 100 m



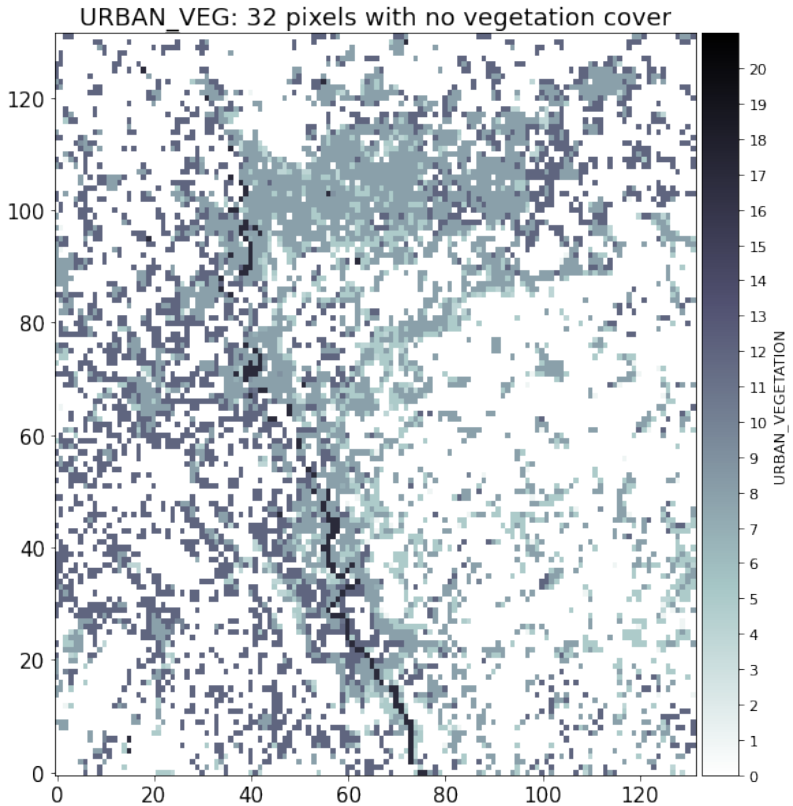
STANDARD vs W.AVERAGE - LU_INDEX



STANDARD vs W.AVERAGE - Geometrical Parameters



STANDARD vs W.AVERAGE - Urban vegetation



if(AT LEAST ONE RURAL) $\longrightarrow$ pick the dominant rural category
else $\longrightarrow$ chosen by the user for all urban cells

To do list:

- ✓ To verify the **likeness** between **w2w** (Demuzere et al., 2022) and **waw** (any idea for a better name?)
- ✓ To run some test simulations to verify the potential improvements
- ✓ (Maybe) to switch **lambdas to distances**? (building widths, street widths?)
- ✓ To make waw suitable with:
  1) Urban canopy parameterizations (BULK, SLUCM, BEP+BEM)
  2) Landuse datasets (NLCD, NUDAPT, USGS)