

PHOS4DTOOLS:

Reconstructing the daylight conditions in an insula of antique Pompeii

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Engineering and Architecture

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Goals



Overview

Preparation of model and software

Initialisation and simulations

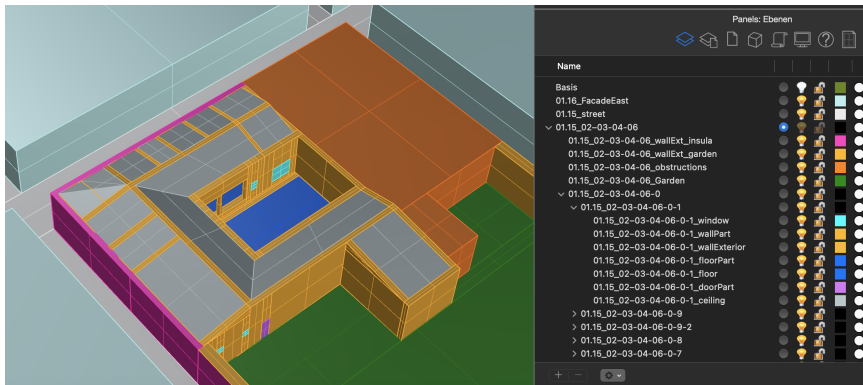
GIS import

Application of thresholds

Validation

Preparation of model and software

3D Model



```
planemod = .*(floor).*
```

3D Model

Resulting layer name in OBJ:

```
1 g 01_15_02_03_04_06 01_15_02_03_04_06_0 01_15_02_03_04_06_0_8 \  
2 01_15_02_03_04_06_0_8_wallPart
```

Material definition:

```
1 #refs/materials.rad  
2 void plastic wallPart  
3 0  
4 0  
5 5 .35 .35 .35  
6 0 0
```

Get model data

```
git clone https://c4science.ch/source/CasaNaveEuropa.git
```

CasaNaveEuropa

- ├── obj
 - └── CasaNaveEuropa.obj RECONSTRUCTION MODEL
- ├── refs
 - └── basepoint.txt CENTER
 - └── ITA_Napoli-Capodichino.162890_IGDG.epw WEATHER FILE¹
 - └── material.rad MATERIAL DEFINITIONS
- └── LICENSE.txt CC BY-4.0 LICENSE



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¹IGDG file from <https://www.ladybug.tools/epwmap/>

Install raytraverse and phos4dtool

```
2 cd CasaNaveEuropa
3 python3 -m venv env
4 source env/bin/activate
5 pip install --upgrade pip
6 pip install raytraverse
7 git clone https://igit.architektur.tu-darmstadt.de\
8     /phos-4d/phos4dtools.git
9 pip install ./phos4dtools
10 deactivate
11 source env/bin/activate
12 phos4dtools --version
```



$\Phi\Omega\Sigma$ 4D



Initialisation and simulations

Initialise, convert model, and set up zones

13 **phos4dtool newdir**

CasaNaveEuropa

| | |
|---------------------|------------------------|
| — env | VIRTUAL ENVIRONMENT |
| — obj | |
| — phos4dtools | FROM GIT |
| — RAD | FOR CONVERTED MODEL |
| — refs | |
| — LICENSE.txt | |
| — results | FOR SIMULATION RESULTS |
| — setup.cfg | EDITABLE CONFIGURATION |

14 **phos4dtools -c setup.cfg setup obj/CasaNaveEuropa.obj**

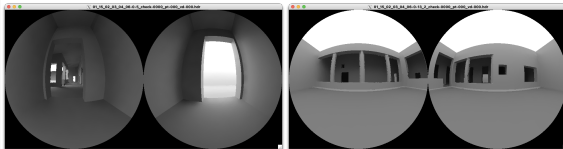
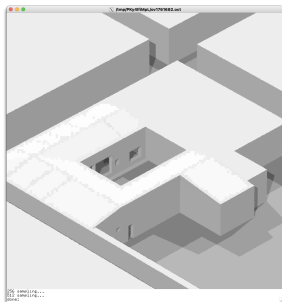
Initialised model structure

```

CasaNaveEuropa
├── 01_ZONE ..... ONE ZONE PER ROOM
├── 01_check.cfg ..... CONFIGURATION FOR TEST IMAGES
├── check_sky.rad ..... SKY FOR TEST IMAGES
├── env
├── groups_for_debugging_setup.txt ..... GROUPS IDENTIFIED IN OBJ
├── obj
├── phos4dtools
├── RAD
│   ├── 000_materials.rad ..... COPIED FROM REFS
│   └── 01.rad ..... CONVERTED FROM OBJ
├── refs
├── LICENSE.txt
├── results
├── run_01_check.sh ..... SCRIPT TO GENERATE TEST IMAGES
└── setup.cfg
    
```

Check the model

```
15 objview RAD/*  
16 chmod ug+x run_01_15_02_03_04_06_check.sh  
17 ./run_01_15_02_03_04_06_check.sh  
18 ximage check_images/*
```



Run simulation and export

```
19 phos4dtools -c setup.cfg run \
20     01_15_02_03_04_06_ZONE/01_15_02_03_04_06-0-13.rad
21 phos4dtools summarize "results/*.npz"
```

- ▶ This produces one tab-separated file per metric.
- ▶ '#' indicates comment lines.
- ▶ Each non-comment line comprises the zone name, the sample location, the represented area, and 144 columns of time-step data (12 months x 12 temporal hours).

```
1 # Each zone reduced to minimum 4 points a side [...]
2 # columns (times) are written as (month, day, period) [...]
3 # zone x y z area (1, 0, 1) [...] (12, 0, 12)
4 01_15_02_03_04_06-0-1 6.56333021 6.39218376 0.001
5 1.01539138 8.5368 28.12 56.753 [...] 12.143
```

GIS import

Set up the project in QGIS

*Unbenanntes Projekt — QGIS

Projekteigenschaften — KBS

Koordinatenbezugssystem (KBS)

☐ Kein KBS (oder unbekannte/nicht-Erd-Projektion)

Filter

Kürzlich benutzte Koordinatenbezugssysteme

| Koordinatensystem | AutoritätsID |
|-------------------------------------|------------------|
| WGS 84 / Pseudo-Mercator | EPSG:3857 |
| Monte Mario / Italy zone 2 | EPSG:3004 |
| WGS 84 | EPSG:4326 |
| ETRS89 / UTM zone 32N | EPSG:25832 |
| ETRS89 / UTM zone 32N (zE-N) | EPSG:4647 |
| ETRS89 / UTM zone 33N | EPSG:25833 |
| WGS 84 / UTM zone 33N | EPSG:32633 |
| DHDN / 3-degree Gauss-Kruger zone 2 | EPSG:31466 |

Vordefinierte Koordinatenreferenzsystem

☐ Veraltete KBS verbergen

| Koordinatensystem | AutoritätsID |
|-----------------------------------|--------------|
| Minna / Nigeria West Belt | EPSG:26391 |
| Monte Mario (Rome) / Italy zone 1 | EPSG:26591 |
| Monte Mario (Rome) / Italy zone 2 | EPSG:26592 |
| Monte Mario / Italy zone 1 | EPSG:3003 |
| Monte Mario / Italy zone 2 | EPSG:3004 |

Monte Mario / Italy zone 2

Eigenschaften

- Einheiten: Meter
- Statisch (hängt vom einem plattenfixierten Datum ab)
- Überirdischer Körper: Earth

Help Apply Cancel OK

Suchmuster (¶K)

Koordinate 1613211,2 4975650,8 Maßstab 1:987 Vergrößerung 100% Drehung 0,0 °

Load data into GIS

Import by adding a new "delimited text" layer, EPSG:3004

Data Source Manager | Delimited Text

File name: /lars/NextcloudTUD/fg-klarch_phos4d/Konferenzen - Publikationen/Radiance_Workshop/CasaNaveEuropa/results/export_all_month-median_100cmH.tsv

Layer name: export_all_month-median_100cmH Encoding: UTF-8

Record and Fields Options

Number of header lines to discard: 2 ☐ Decimal separator is comma

☒ First record has field names ☒ Trim fields

☒ Detect field types ☐ Discard empty fields

Custom boolean literals

True: False:

Geometry Definition

☒ Point coordinates X field: x Z field:

☐ Well known text (WKT) Y field: y M field:

☐ No geometry (attribute only table) ☐ DMS coordinates

Geometry CRS: EPSG:3004 - Monte Mario / Italy zone 2

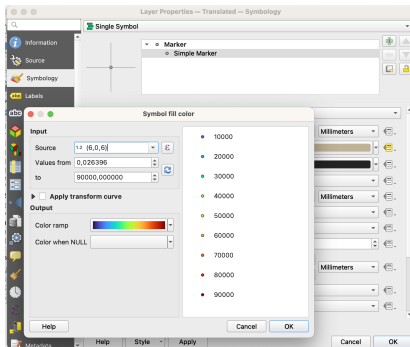
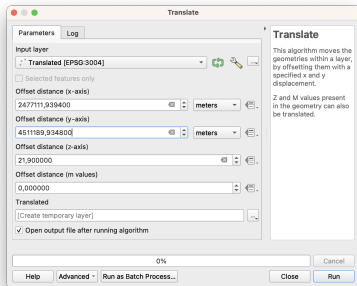
Layer Settings

Sample Data

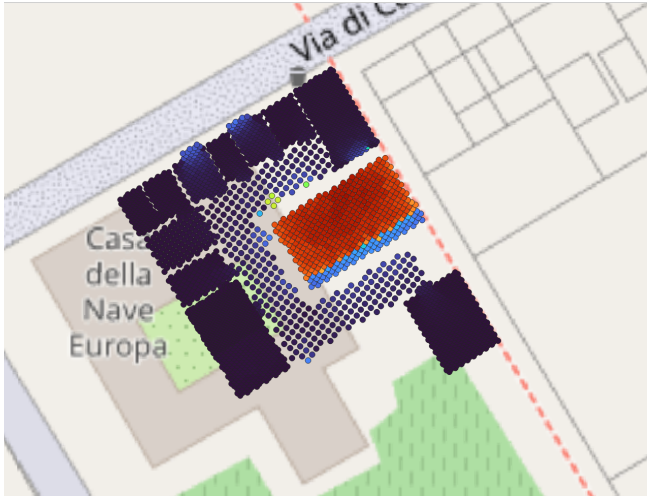
| # zone | x | y | z | area | (1,0,1) | 1,2 D |
|--------|----------------------------------|------------|-------|------------|---------|-------|
| 1 | 01 15 02 03 04 06-0-1 6.20414394 | 6.00735987 | 0.001 | 0.07810703 | 7.1038 | 21.75 |

Buttons: Add Close

Translate and visualize data



Visualize one time step



Application of thresholds

Python helper functions 1



Add some Python snippets for filtering and data-reduction.

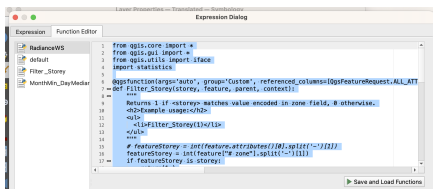
```

1 from qgis.core import *
2 from qgis.gui import *
3 from qgis.utils import iface
4 import statistics
5
6 def calcColumnsns(startMonth, endMonth, startHour, endHour):
7     indices=[]
8     for monthIdx in range(startMonth-1, endMonth):
9         for hourIdx in range(startHour-1, endHour):
10             indices.append(monthIdx*12+hourIdx+5)
11     return(indices)
    
```

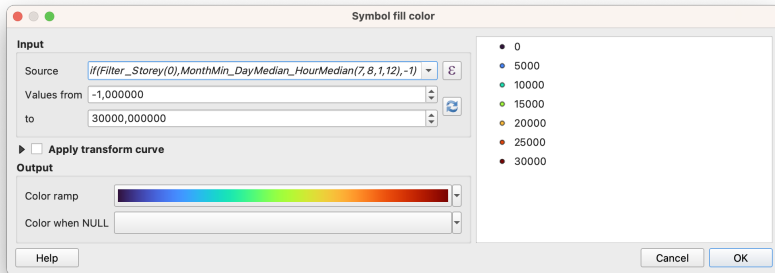

Python helper functions 2

```
12 @qgsfunction(args='auto', group='Custom',
13             referenced_columns=[QgsFeatureRequest.ALL_ATTRIBUTES])
14 def MonthMin_DayMedian_HourMedian(startMonth, endMonth, startHour,
15             endHour, feature, parent, context):
16     indices=calcColumnns(1, 12, 1, 12) # fill with all values
17     hourlyVals=[feature.attributes()[idx] for idx in indices]
18     monthIndices=range(startMonth-1,endMonth)
19     monthlyMinima=[]# for each hour min monthly value
20     for hourIdx in range(startHour-1, endHour):
21         monthVals=[] # monthly values for one hour
22         for monthIdx in monthIndices:
23             monthVals.append(hourlyVals[monthIdx*12+hourIdx])
24             monthlyMinima.append(min(monthVals))
25     med=statistics.median(monthlyMinima)
26     return(med)
```

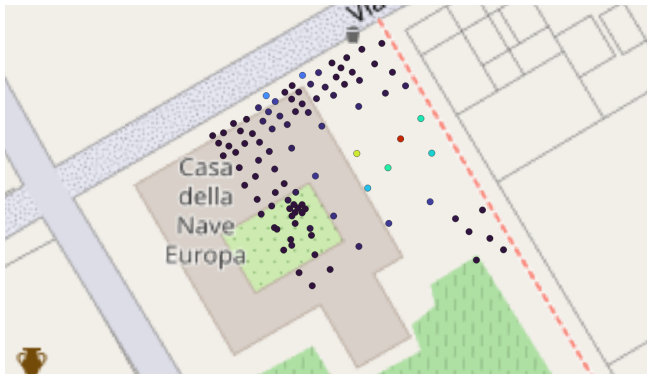
QGIS expression



Add some Python snippets for filtering and data-reduction.



Visualize thresholded data

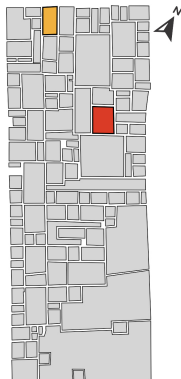


Validation

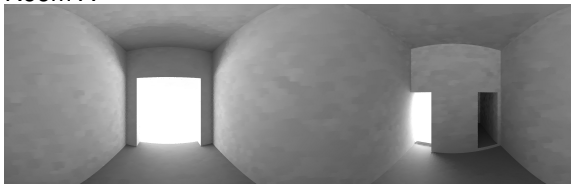
Objectives and chosen data

1. Sufficient parametrization by phos4dtool (convergence)
2. Comparability with conventional Radiance simulation (plausibility)

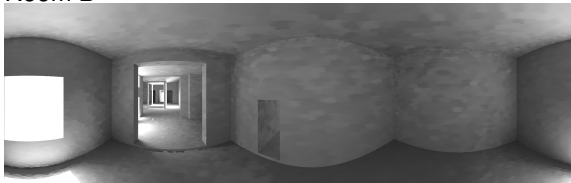
Parameter convergence



Room A



Room B

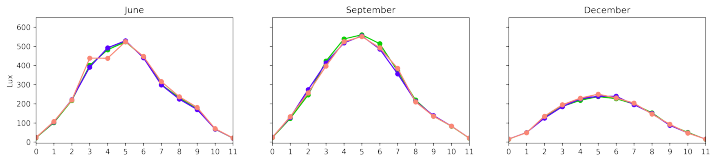


Parameter convergence

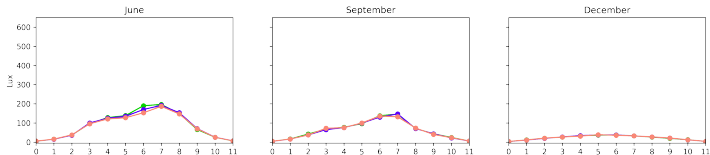
1. Room A: *phos4dtool* with *-ab 10000*, *-ab 40000*, *-ab 160000*
2. Room B: *phos4dtool* with *-ab 10000*, *-ab 40000*, *-ab 160000*

Parameter convergence

Room A



Room B

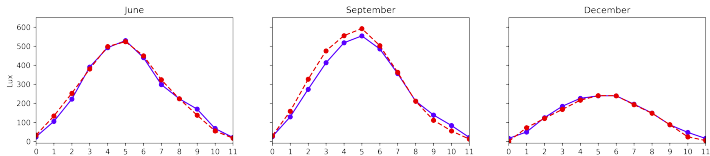


Plausibility

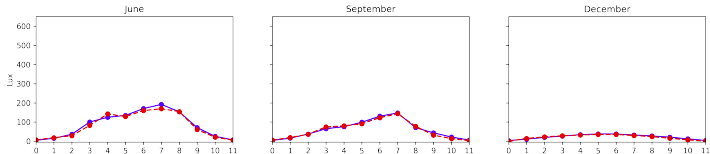
1. Room A: *phos4dtool* with *-ab 40000* vs gendaylit
2. Room B: *phos4dtool* with *-ab 40000* vs gendaylit

Plausibility

Room A



Room B



Phos 4D is a collaboration of **Technische Universität Darmstadt**, **Universität Leipzig** and **Lucerne University of Applied Sciences and Arts**, funded by the German Federal Ministry of Education and Research.

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https://www.archaeologie.architektur.tu-darmstadt.de/forschung_klarch

