

PHOS4DTOOLS:

## Reconstructing the daylight conditions in an insula of antique Pompeii

A. Noback<sup>1</sup>, J.M. Monteoliva Peralta<sup>2,3</sup>, L.O. Grobe<sup>2</sup>

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**Engineering and Architecture**

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## Goals





## Overview

Preparation of model and software

Initialisation and simulations

GIS import

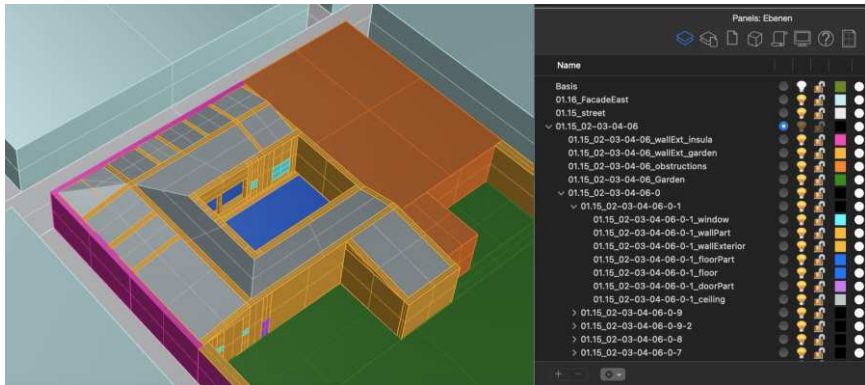
Application of thresholds

Validation



## Preparation of model and software

## 3D Model



1 `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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<sup>1</sup>IGDG file from <https://www.ladybug.tools/epwmap/>  
Slide 7/31, 30<sup>th</sup> August 2023 (last update September 4, 2023 NOA).

## 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



python  
powered





## Initialisation and simulations

## Initialise, convert model, and set up zones

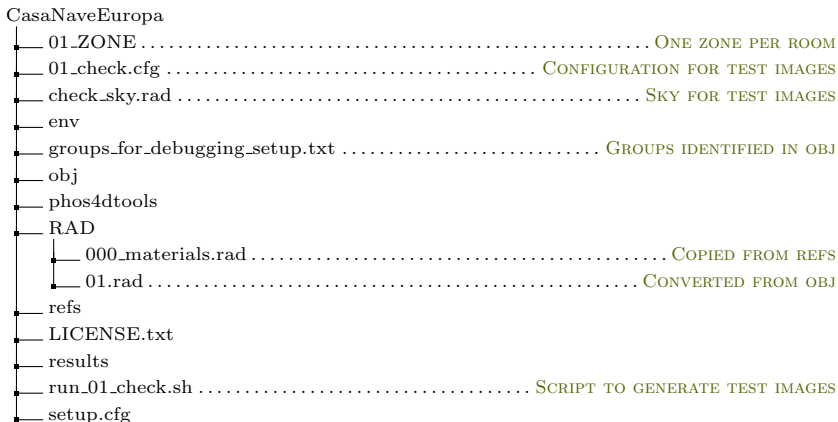
13 `phos4dtool newdir`

```
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`

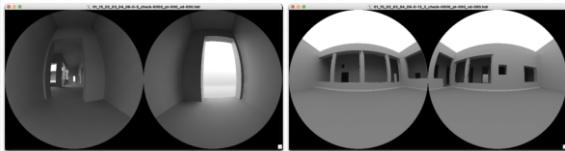


## Initialised model structure



## 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
<b>Monte Mario / Italy zone 2</b>	<b>EPSG:3004</b>
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**

Variante 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 (F8K) Koordinate 1613211,2 4875650,8 Maßstab 1987 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\_100cmHtsv  
 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:   
 DMS coordinates  
 No geometry (attribute only table) Geometry CRS: EPSG:3004 - Monte Mario / Italy zone 2

**Layer Settings**

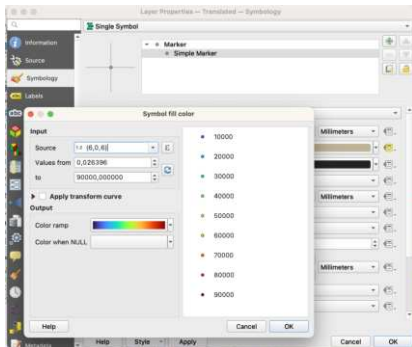
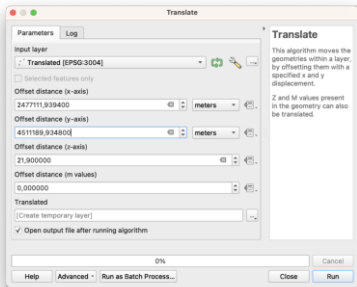
**Sample Data**

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

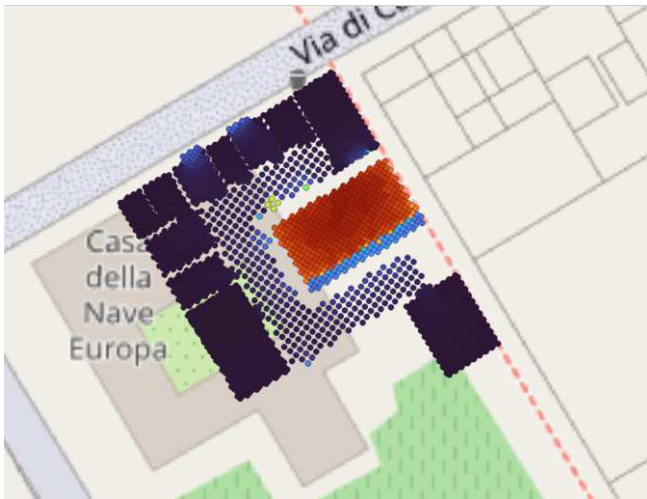
Buttons: Help, Add, Close



## 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 calcColumns(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)

```

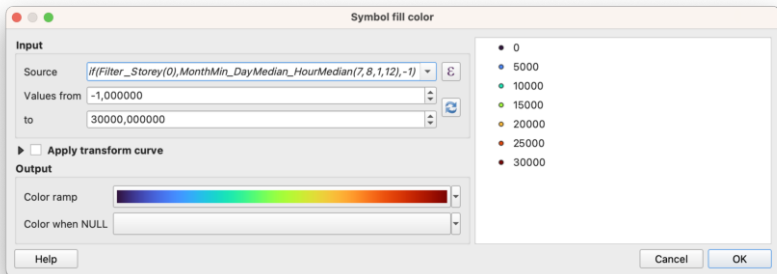
## Python helper functions 2

```
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=calcColumns(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

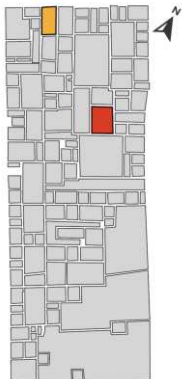




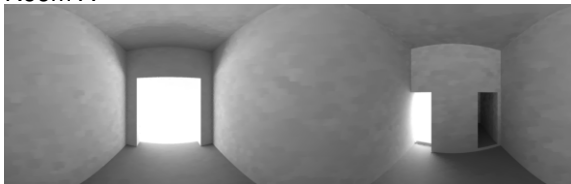
## Objectives and chosen data

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

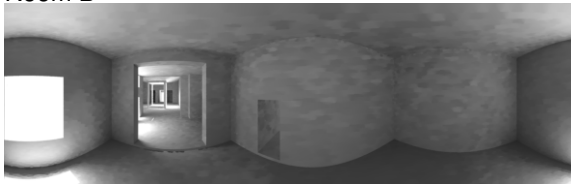
## Parameter convergence



Room A



Room B



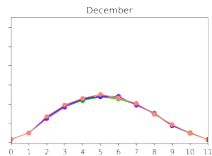
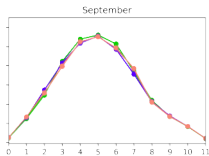
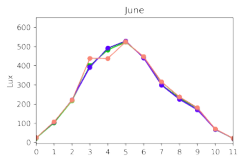


## Parameter convergence

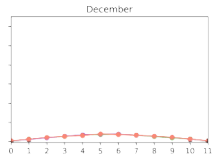
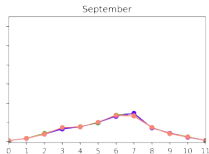
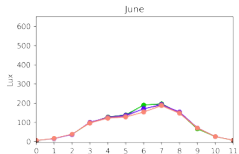
1. Room A: *phos4dtool* with *-ab 10000*, *-ab 40000*, *-ab 160000*
2. Room B: *phos4dtool* with *-ab 10000*, *-ab 40000*, *-ab 160000*

## Parameter convergence

### Room A



### Room B



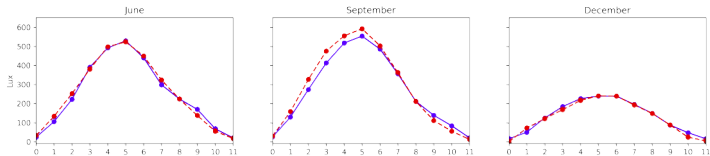


## Plausibility

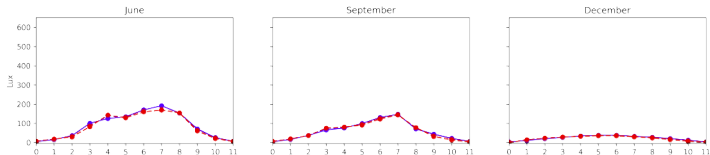
1. Room A: *phos4dtool* with *-ab 40000* vs gendaylit
2. Room B: *phos4dtool* with *-ab 40000* vs gendaylit

## 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.

Working Group Members:

Lars O. Grobe, Stephen Wasilewski, Juan M. Monteoliva Peralta, Andreas Noback (daylight research)

Claudia Mächler, Clemens Brünenberg (building history)

Julian Hollaender, Franziska Lang, Jane Kreiser (archaeology)

Roxana Kath, Charlotte Schubert (ancient history)

[https://www.archaeologie.architektur.tu-darmstadt.de/forschung\\_klarch](https://www.archaeologie.architektur.tu-darmstadt.de/forschung_klarch)

