

Light in Vienna

Outdoor light power and top emitters

- Günther Wuchterl
 - Kuffner-Sternwarte, Wien
 - Thüringer Landessternwarte, Tautenburg
 - IDA Austria

Goals

1. Measure energy content and related CO₂ emission of Vienna's light dome.
2. Distribution of the emission using the top 10 sources of a 10% sample of Vienna's street network.

Method

- Measure energy-flux densities [W/m^2] with Lightmeters.
- Determine brightness with Luxmeters in standard distances.

Primary calibration with Sunlight Island of Lastove, 25.3.

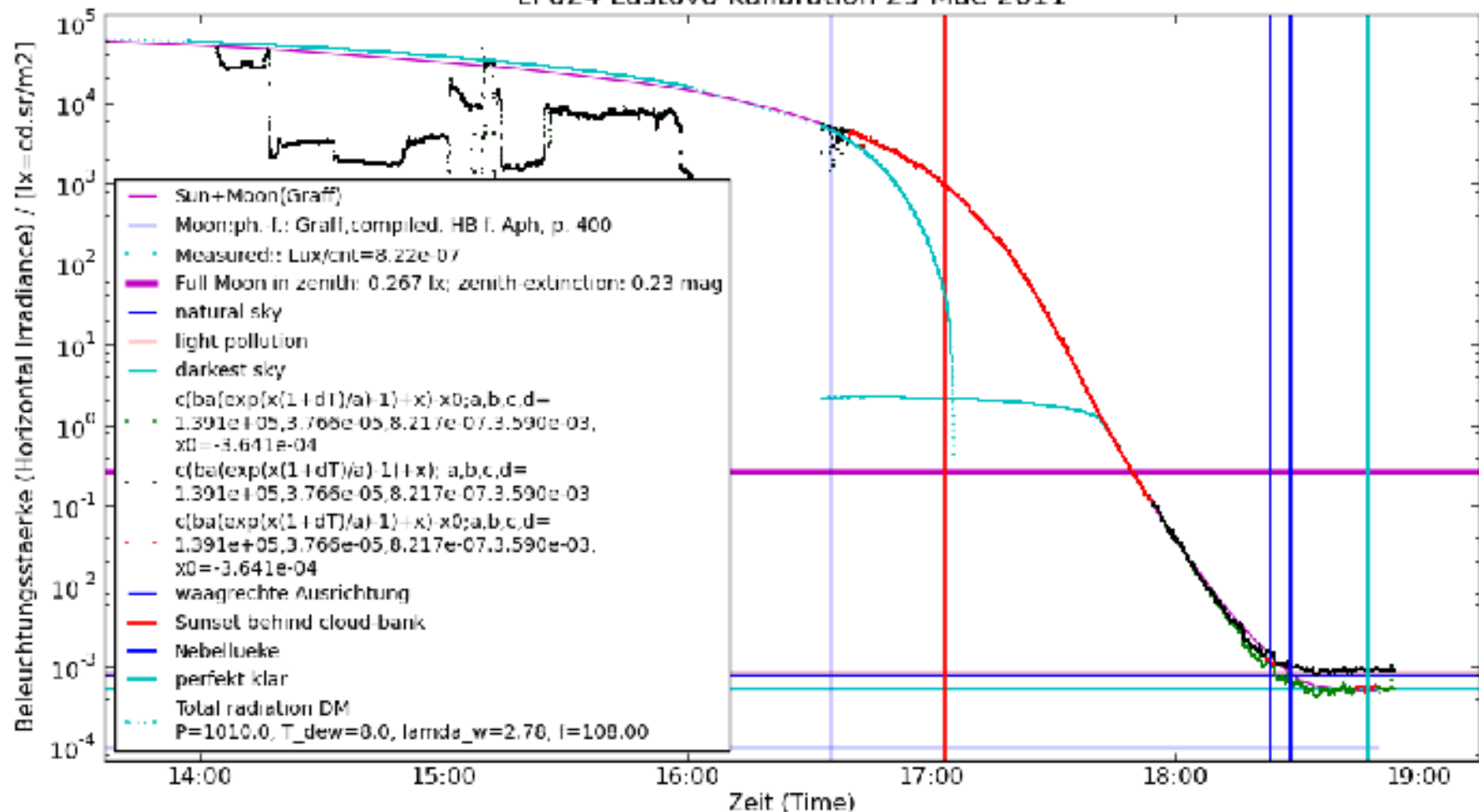
- Total radiation (energy flux density W/m^2)
- Solar constant + standard-atmo + twilight



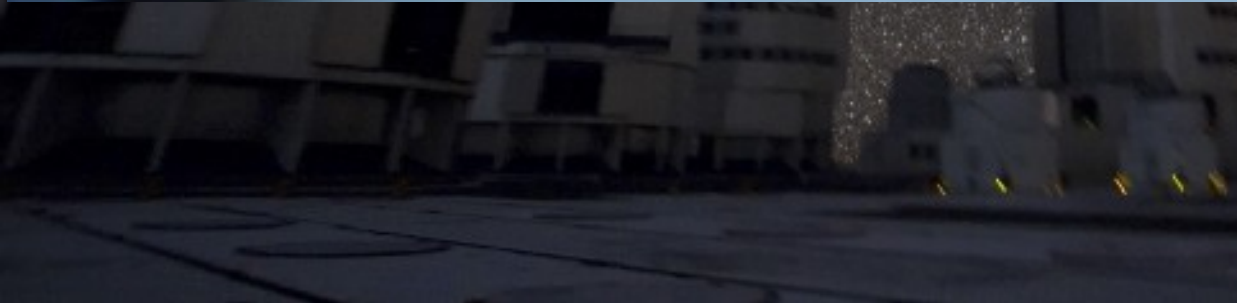
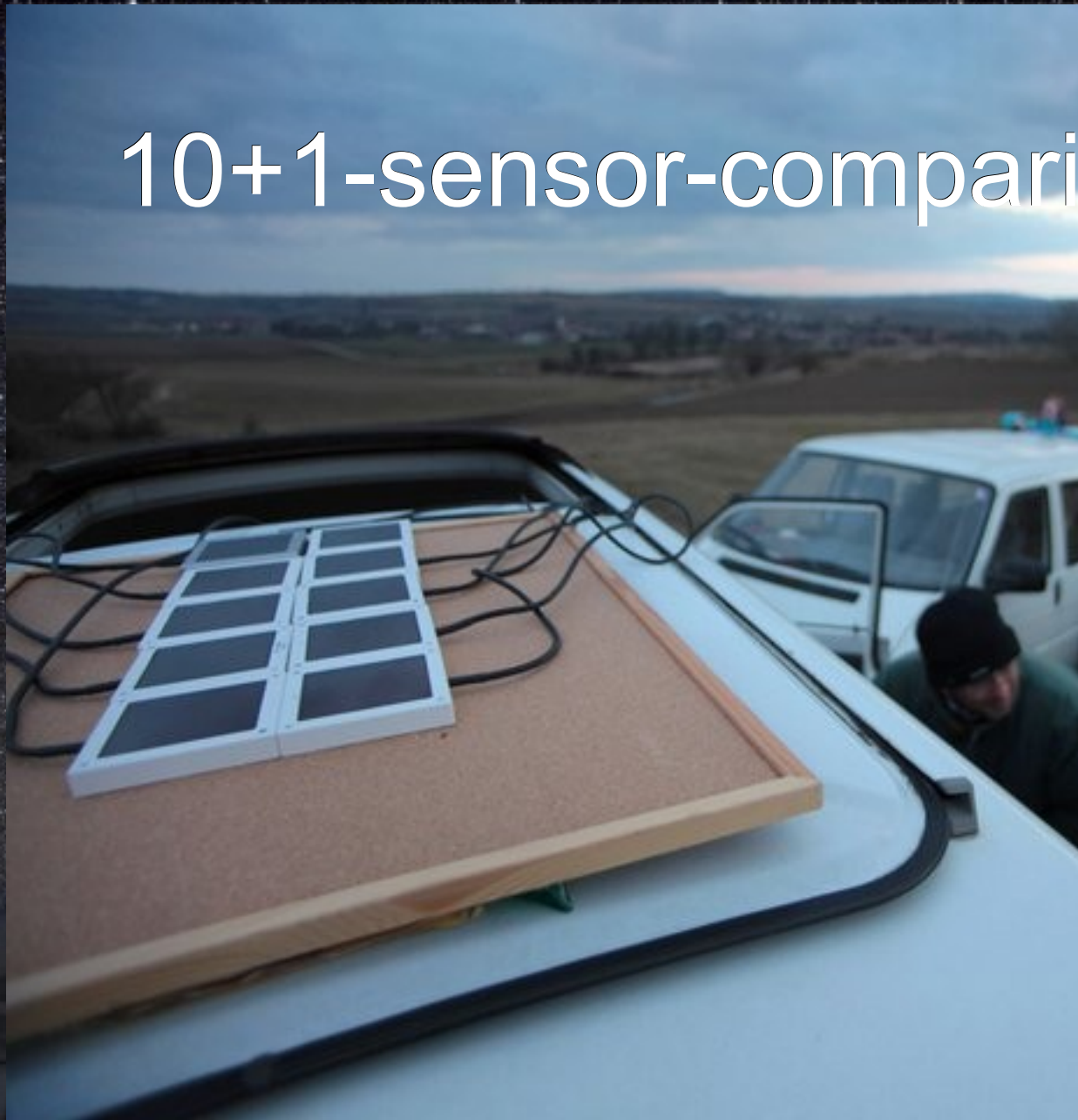
Absolut calibration

Fri Mar 25 13:39:57 2011 to Fri Mar 25 19:53:49 2011

LP024 Lastovo Kalibration 25 Mae 2011



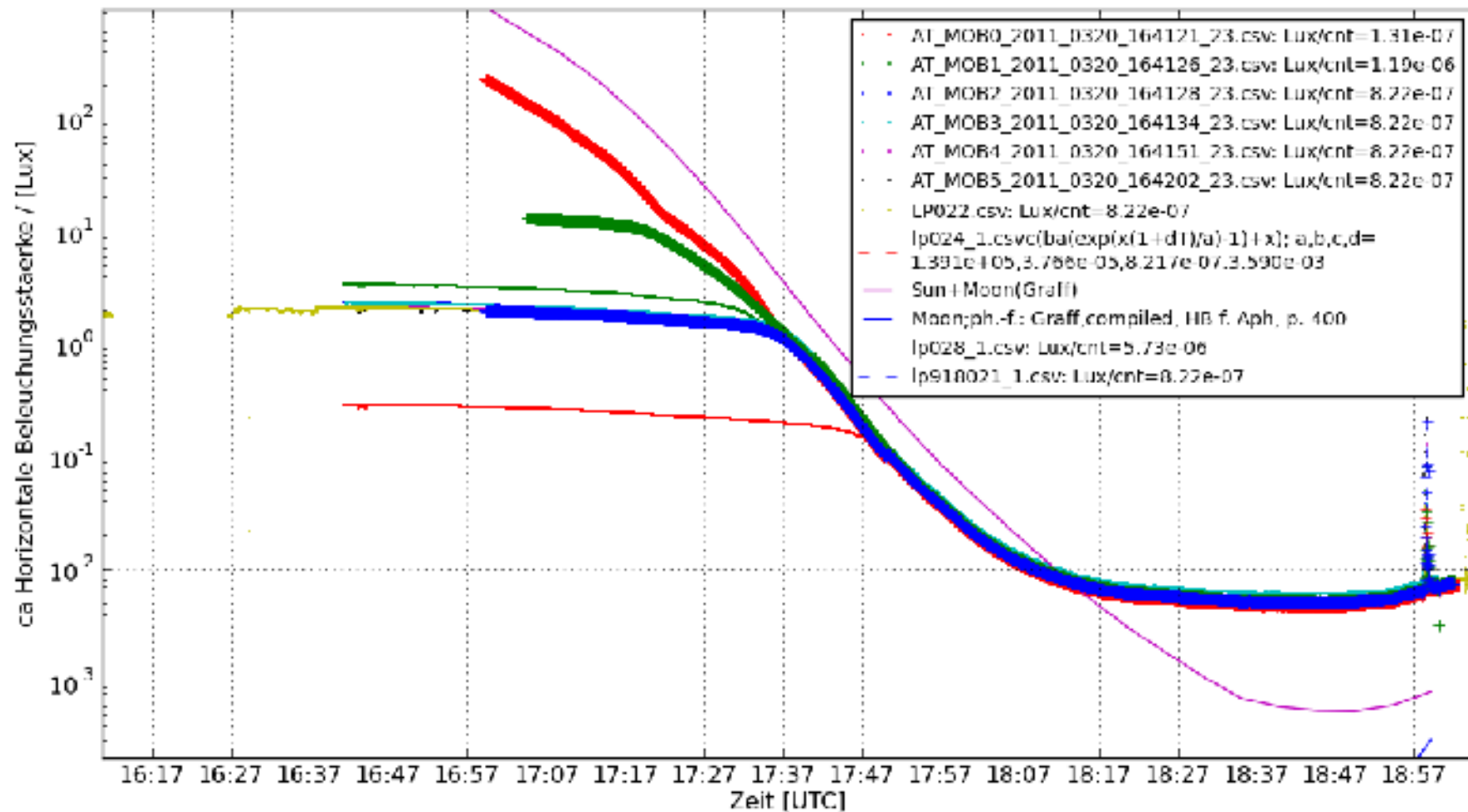
10+1-sensor-comparison Großmugl



Adjust to „solar“-standard

Sun Mar 20 17:59:09 2011 to Sun Mar 20 20:01:59 2011

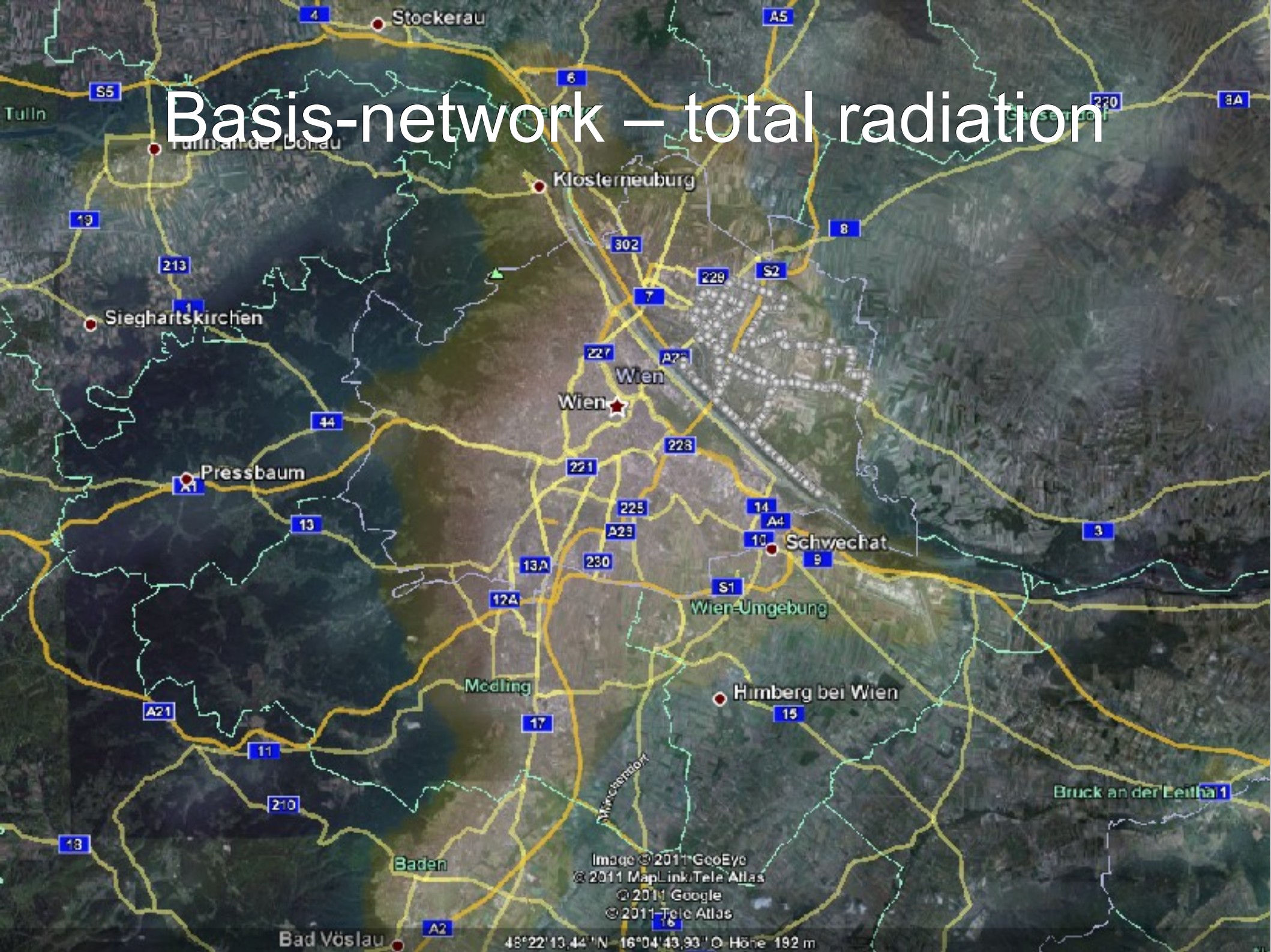
Mugel Test, 20 Mae 2011



Part 1: waste-light-volume Vienna



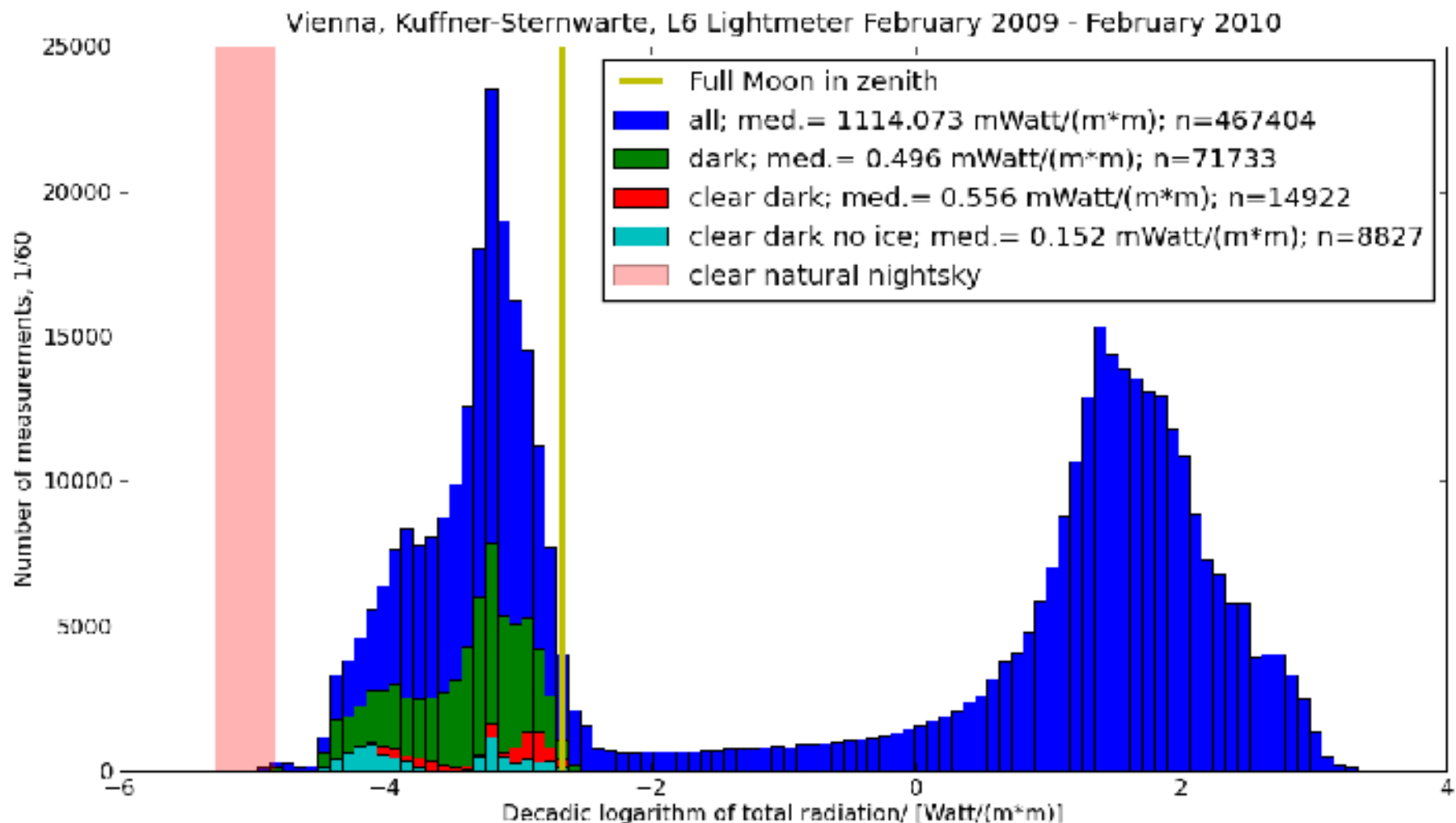
Basis-network – total radiation



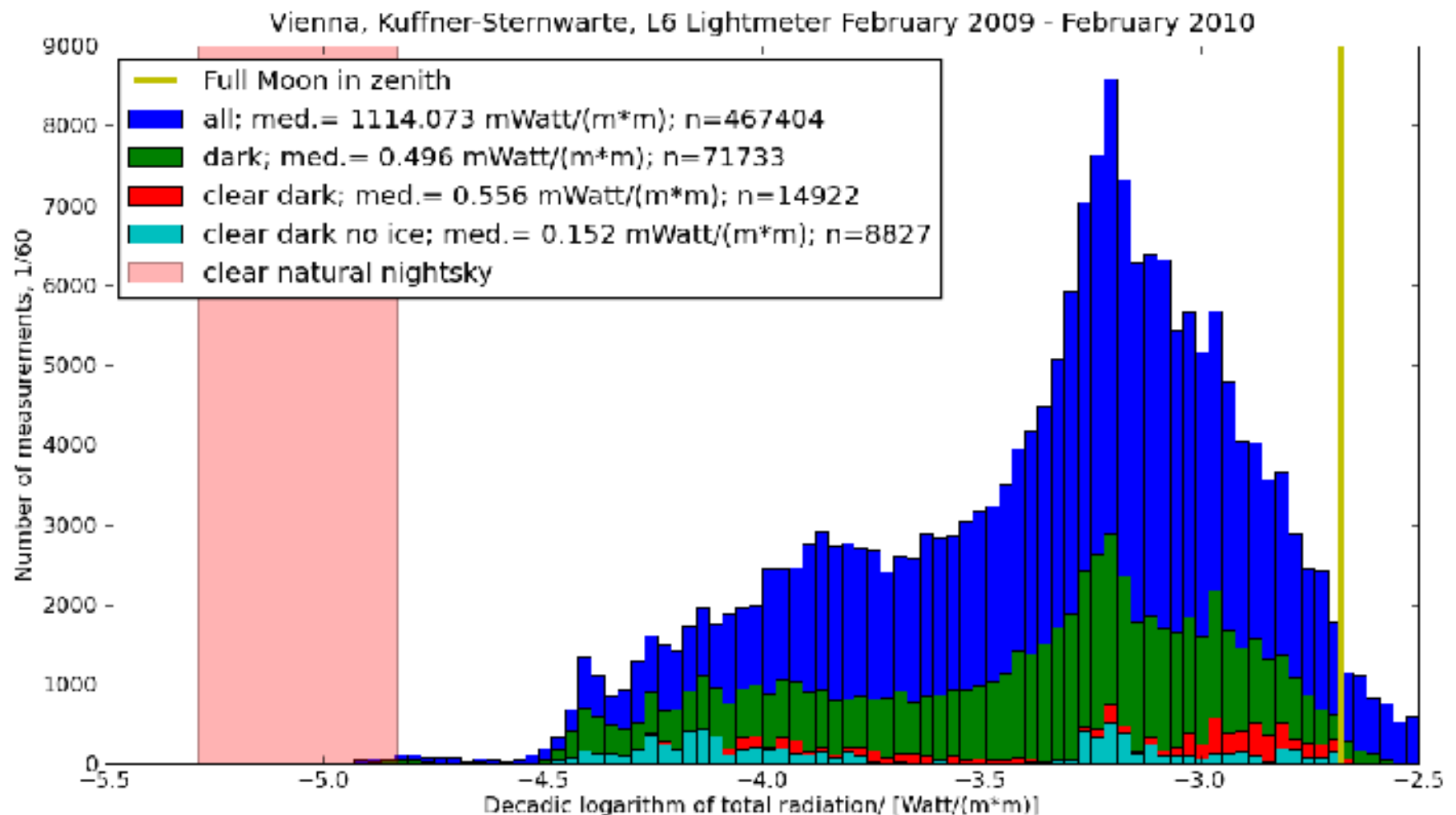
Lightmeter stations



Kuffner-Sternwarte 2009/2010



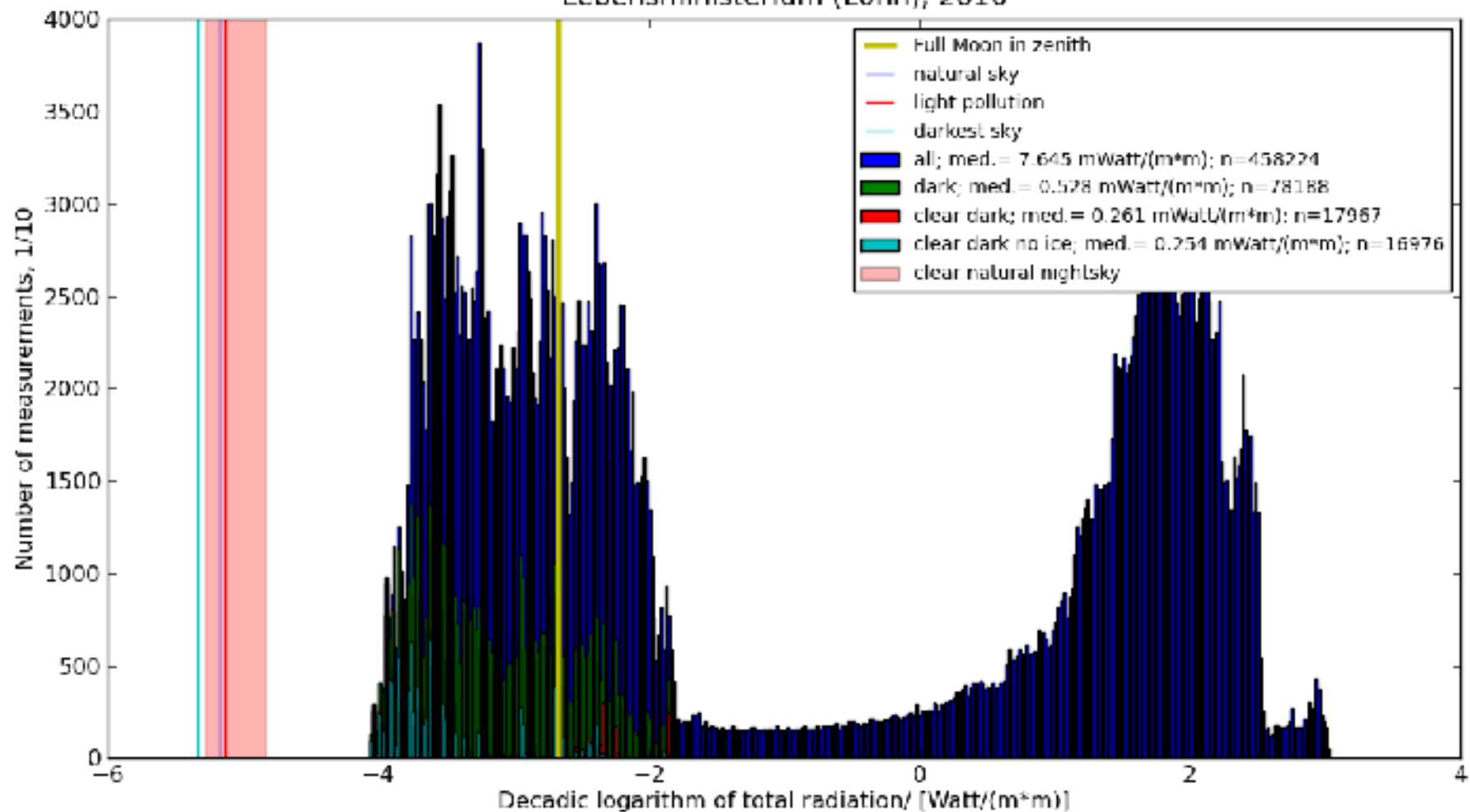
Kuffner-Sternwarte 2009/2010



Vienna centre 2010

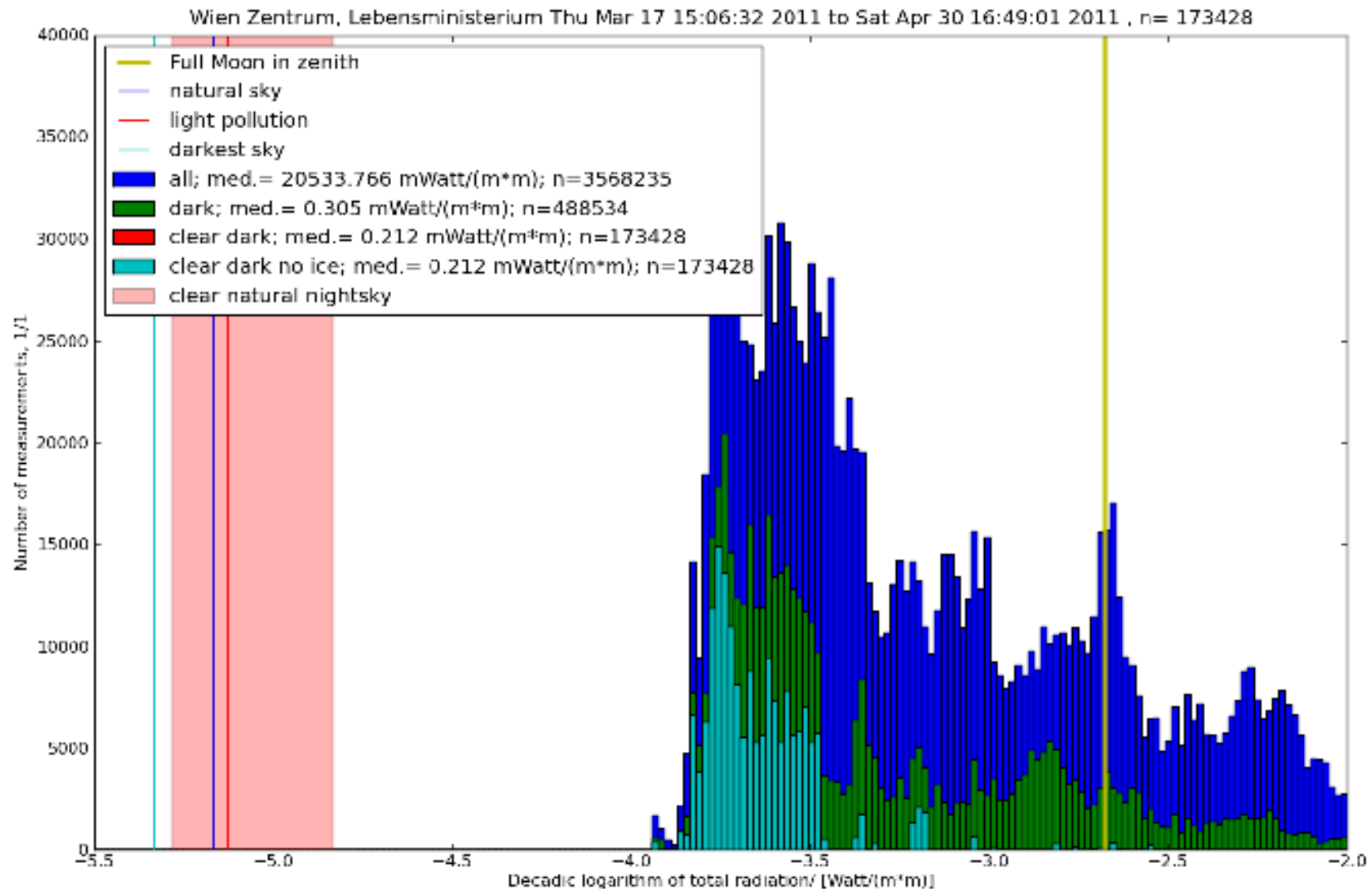
Wed Jun 9 14:10:56 2010 to Thu Dec 2 18:00:00 2010

Lebensministerium (LÖnn), 2010



Nighttime total radiation

Wien Zentrum März/April 2011

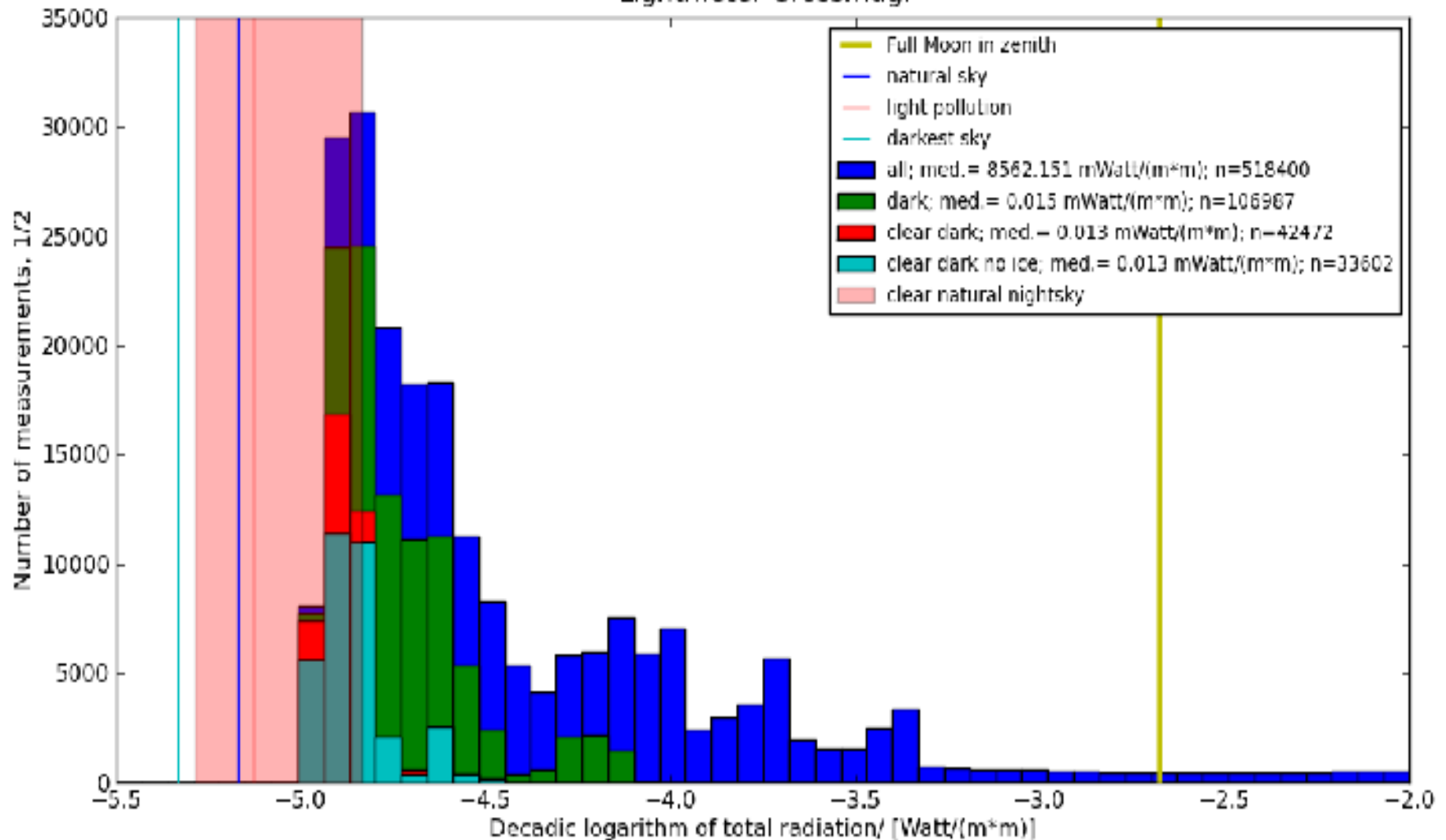


Nighttime total radiation

Grossmugl March/April 2011

Mon Mar 21 00:00:00 2011 to Sat Apr 2 00:59:58 2011

Lightmeter Grossmugl



Dark-time total-radiation-median

moon-less astronomical night

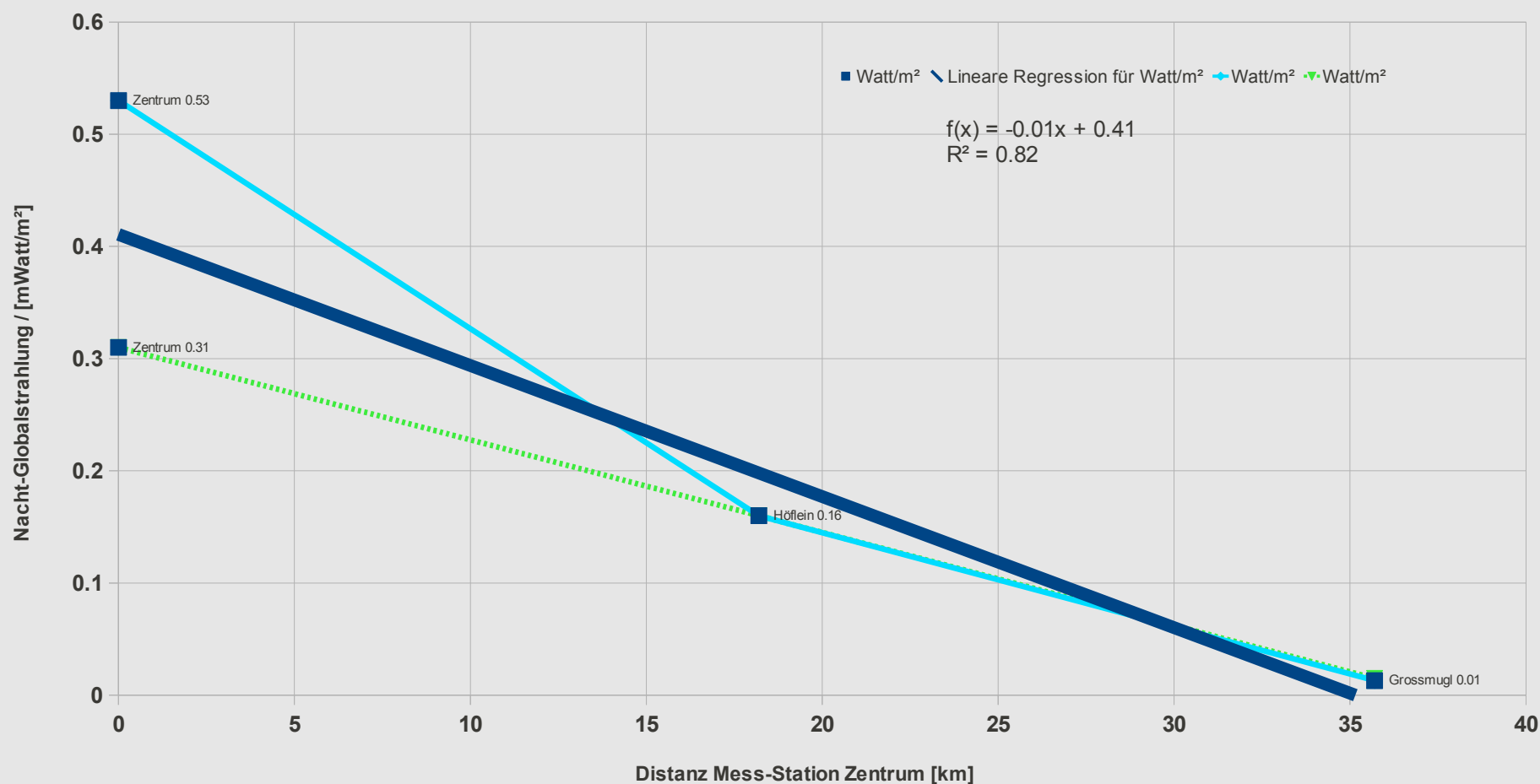
- Centre: 0,31 / 0,53 (winter) mW/m²
- Hoflein: 0,16 mW/m²
- Grossmugl: 0,03 mW/m²
- Nightsky: 0,006 mW/m²

Cut through the Vienna lightcone



Median-lightcone Vienna

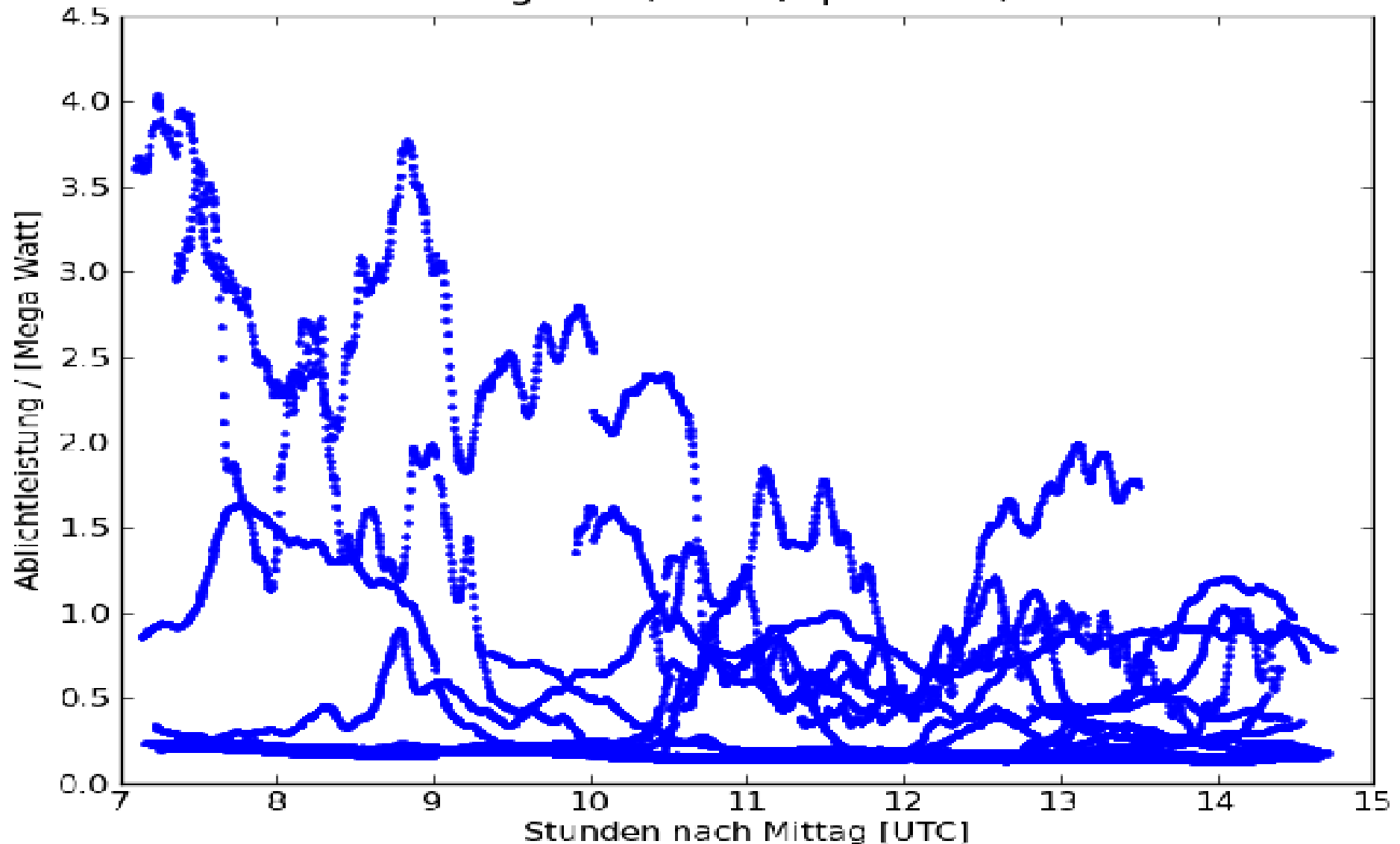
Lichtkegel Wien im Querschnitt



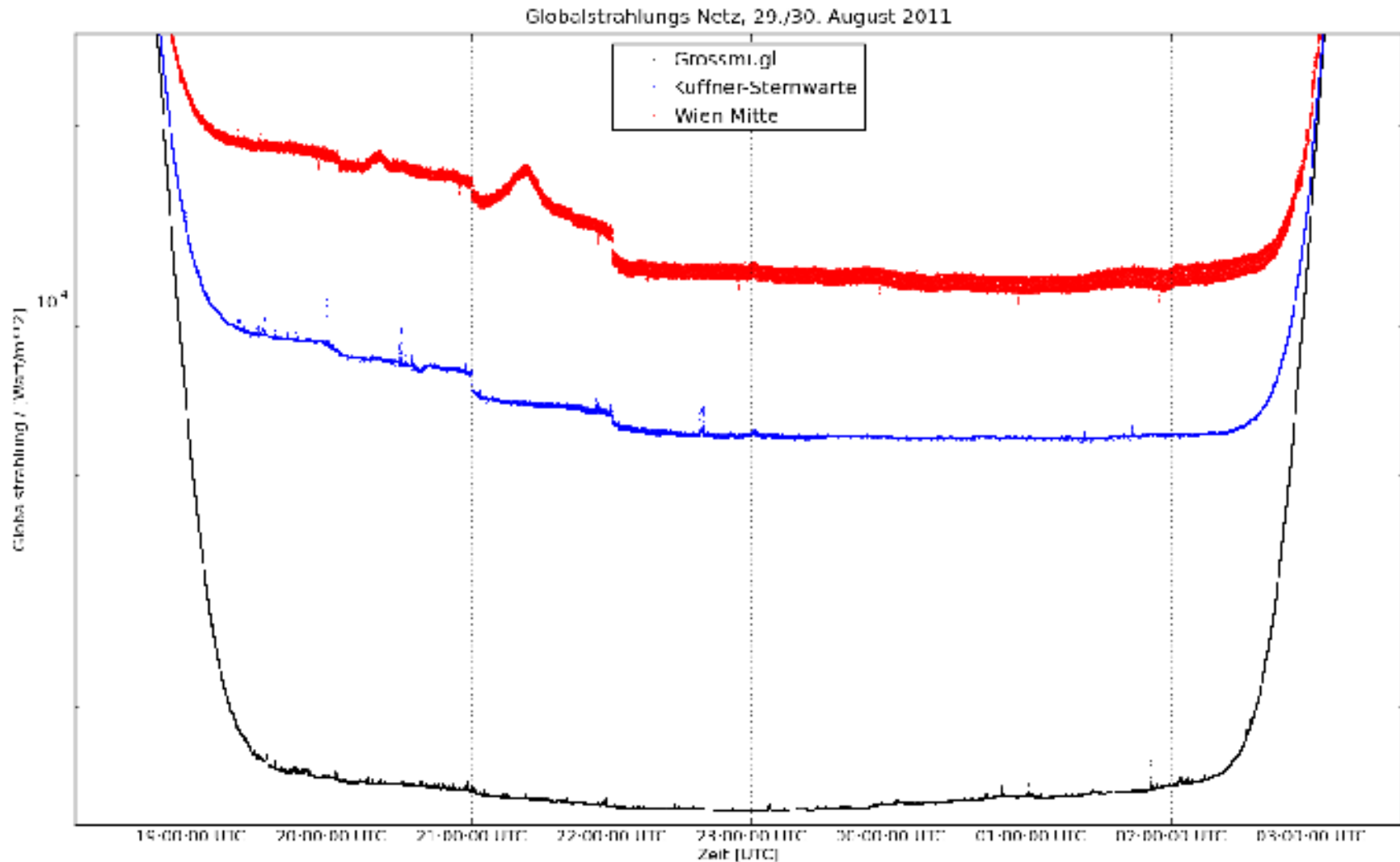
Ground-waste-light power Vienna

2011-03-26 21:54:27.00 - 2011-03-26 21:54:27.00

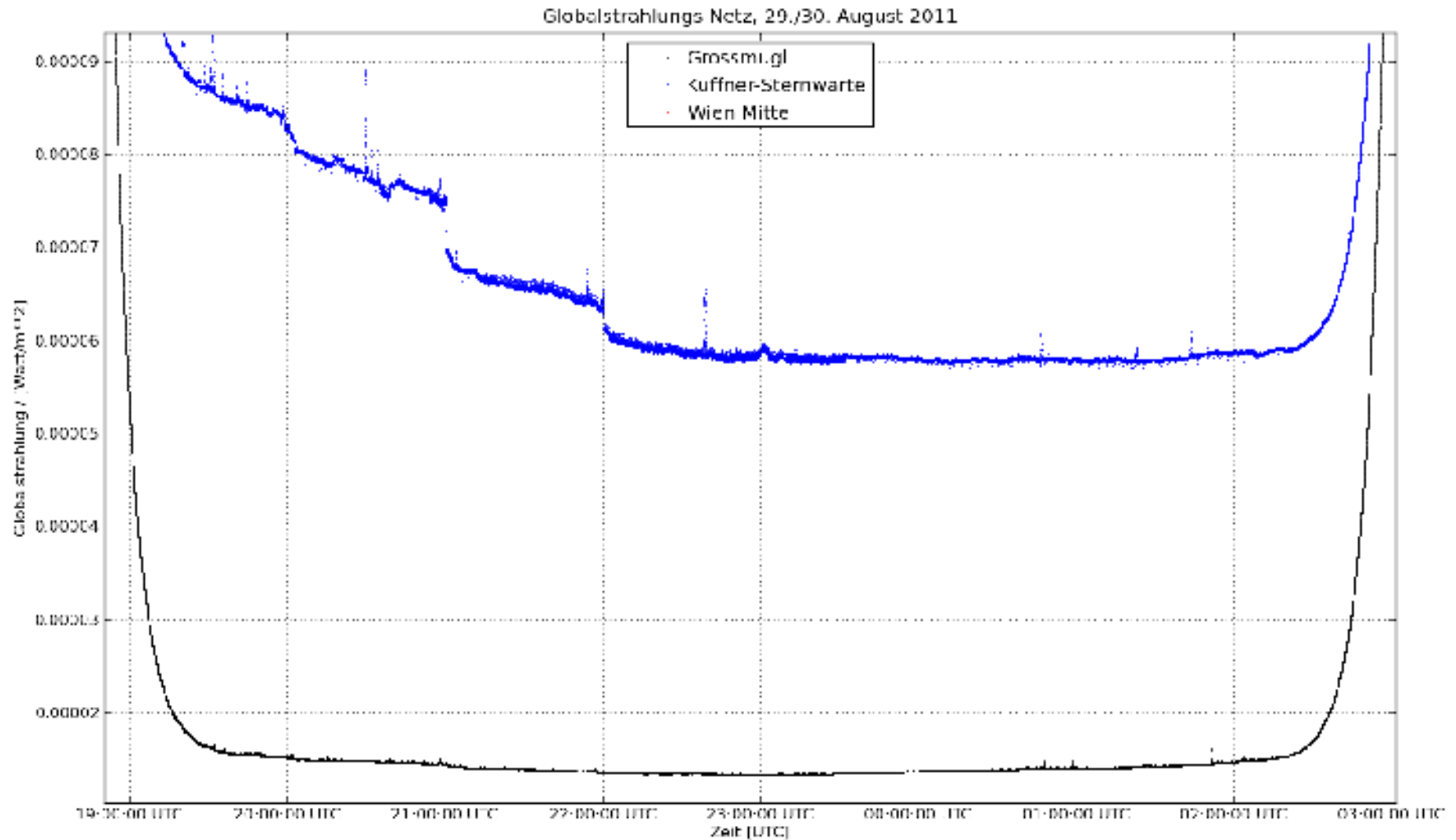
Boden-Ablichtleistung Wien, Maerz/April 2011, mondlose Naechte



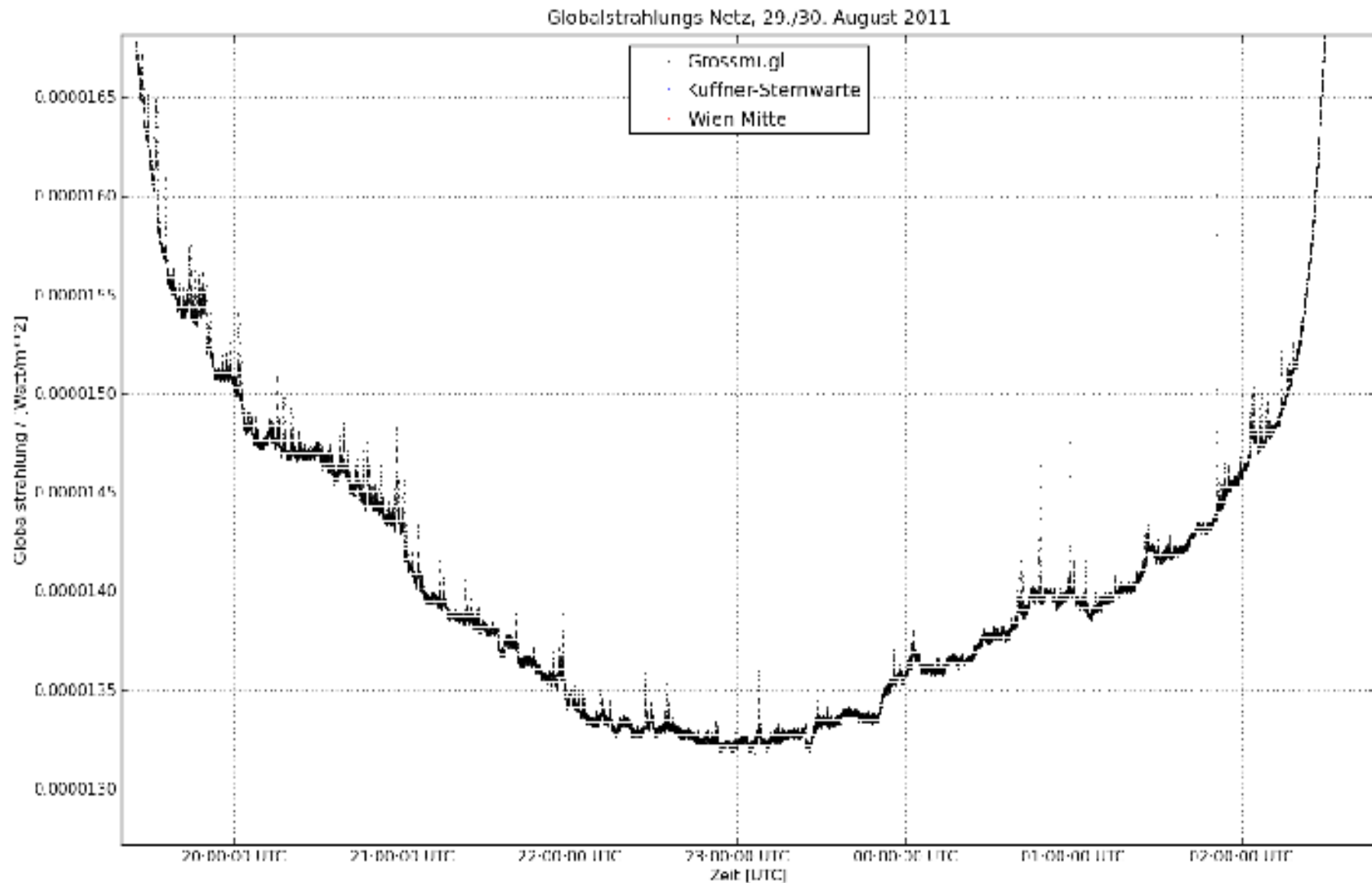
Waste-light to light: Halbschaltung Wien-Zentrum / Kuffner / Grossmugl



Halbschaltung Kuffner-Sternwarte / Grossmugl



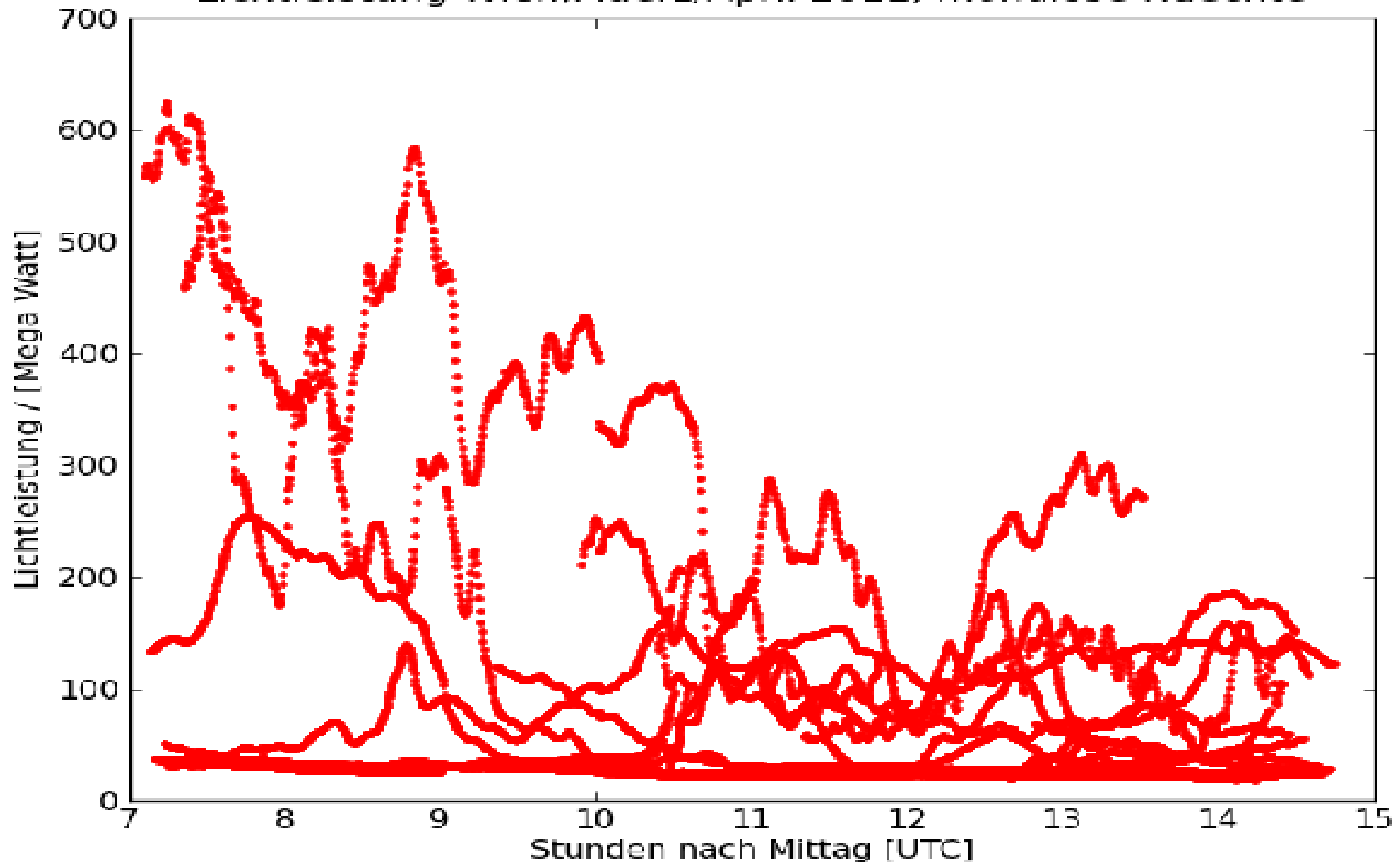
Wiener Halbschaltung @ Grossmugl



Outdoor-lightpower Vienna

2011-03-26 21:54:27.00 - 2011-03-26 21:54:27.00

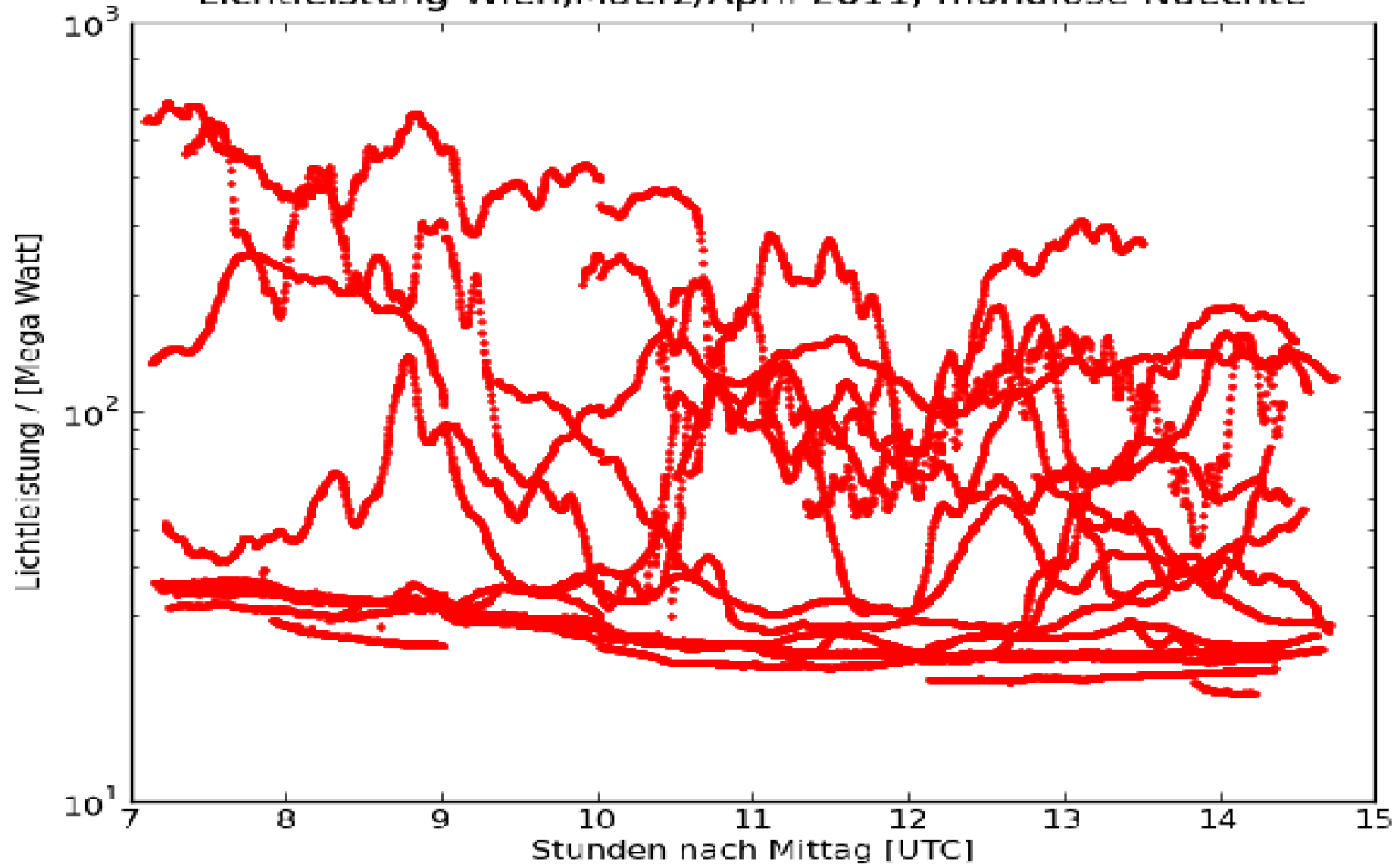
Lichtleistung Wien, Maerz/April 2011, mondlose Naechte



Outdoor-lightpower Vienna

2011-03-26 21:54:27.00 - 2011-03-26 21:54:27.00

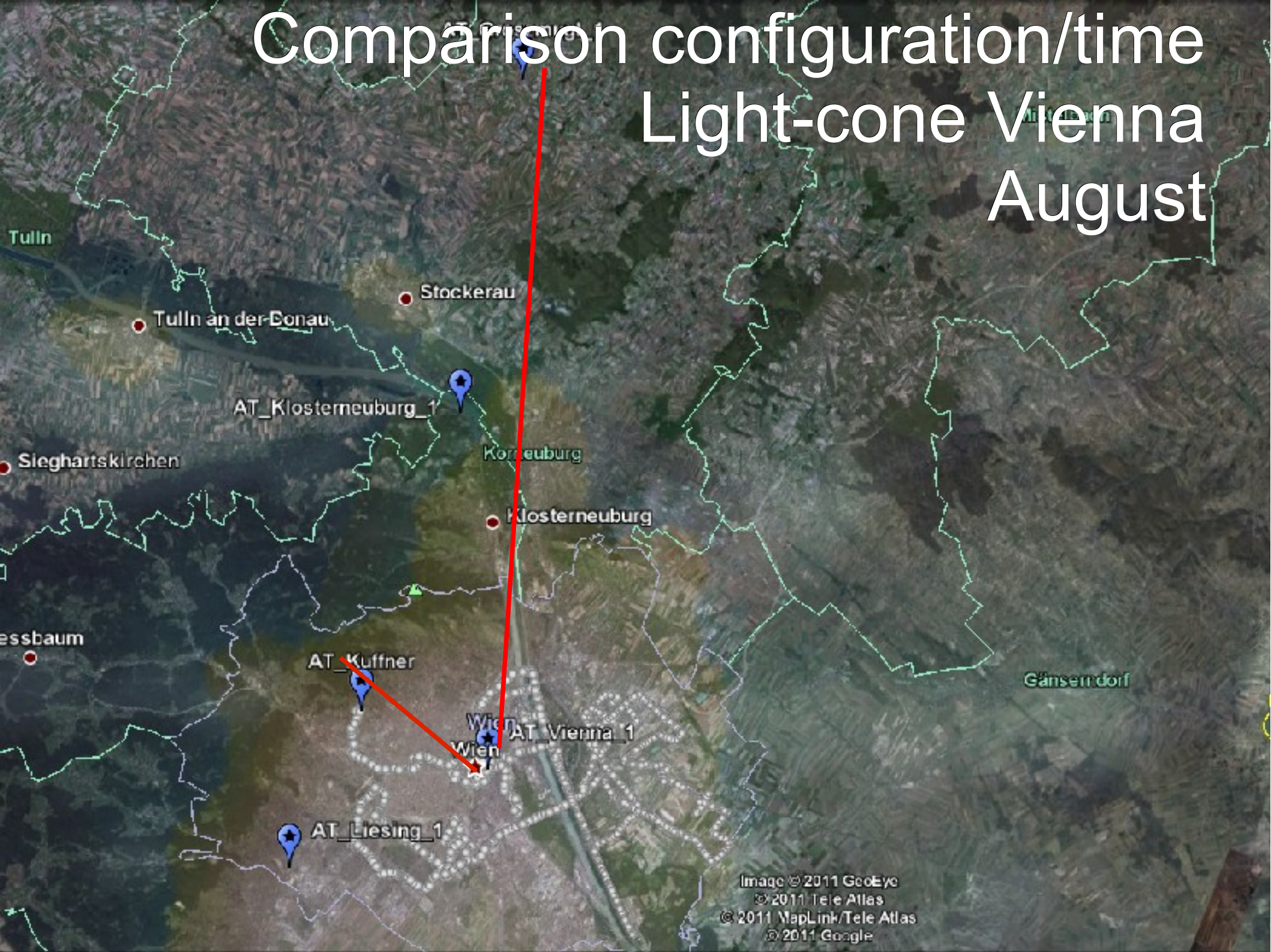
Lichtleistung Wien, Maerz/April 2011, mondlose Naechte



Comparison configuration/time

Light-cone Vienna

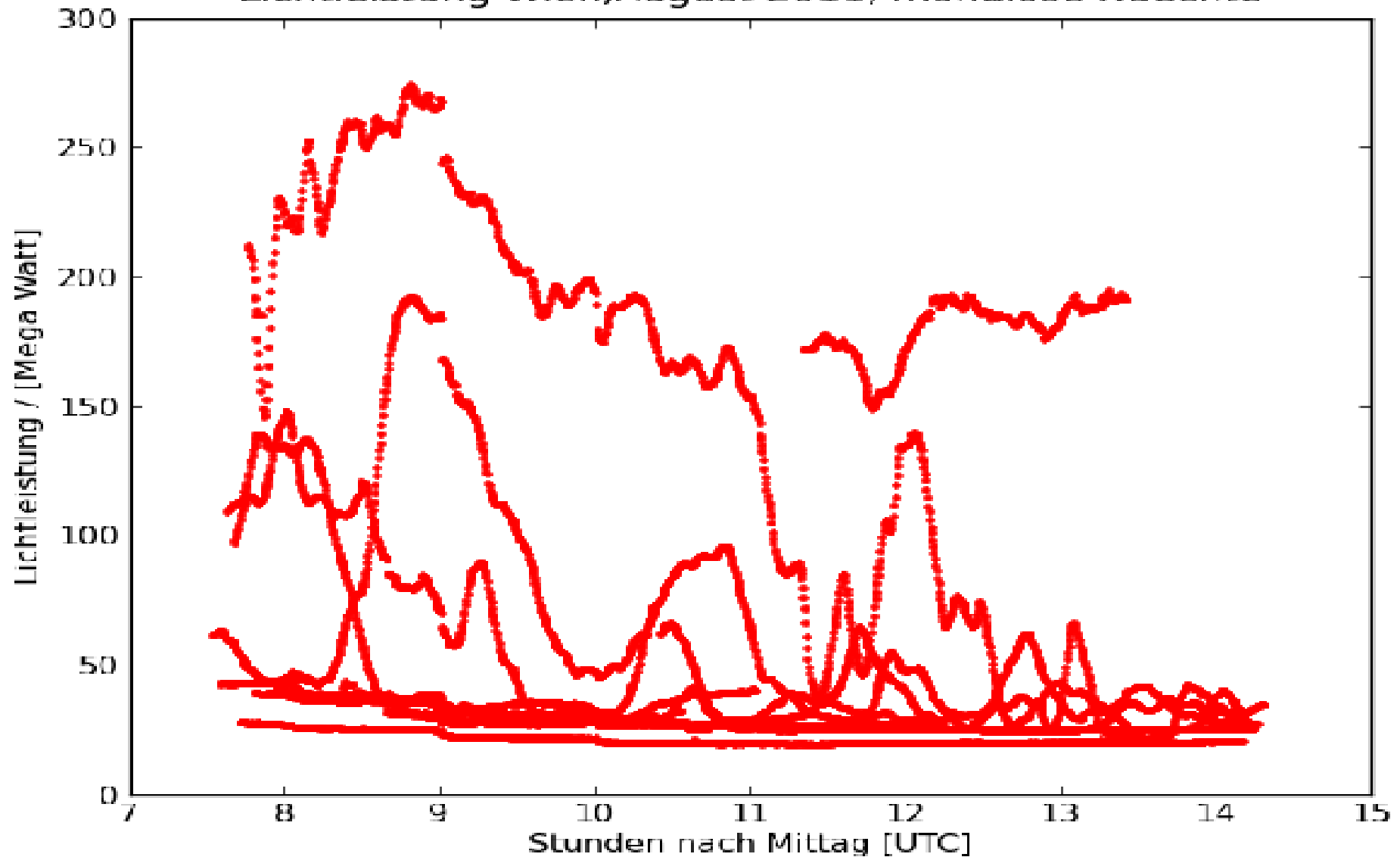
August



Outdoor-lightpower Vienna

2011-08-08 23:21:01.20 - 2011-08-08 23:21:01.20

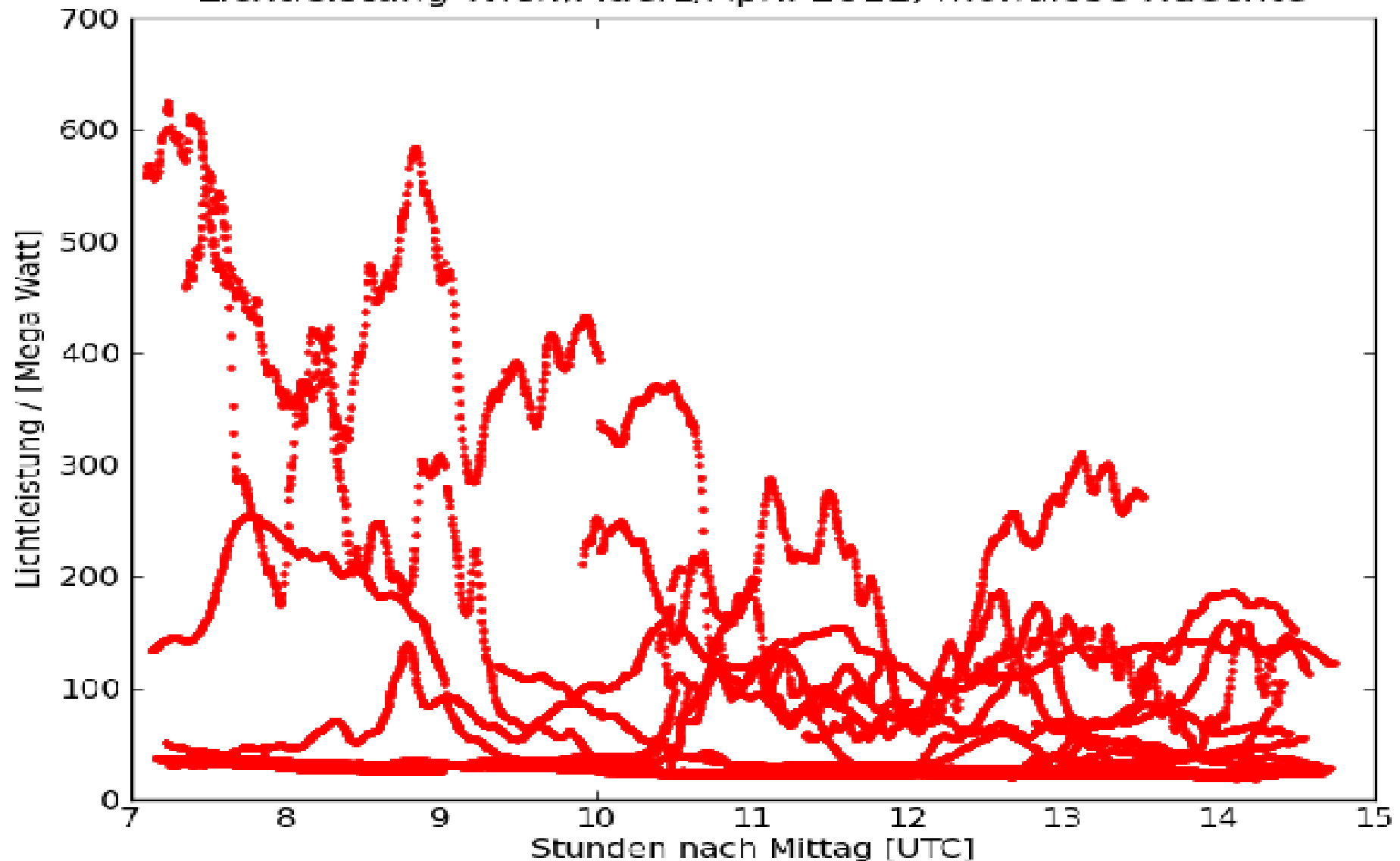
Lichtleistung Wien, August 2011, mondlose Naechte



Outdoor-lightpower Vienna

2011-03-26 21:54:27.00 - 2011-03-26 21:54:27.00

Lichtleistung Wien, Maerz/April 2011, mondlose Naechte



Lightdome Vienna - Energy and CO₂

30 MW ~ annually 100 000 t_{CO2}

Lightdome Vienna - Energy and CO₂

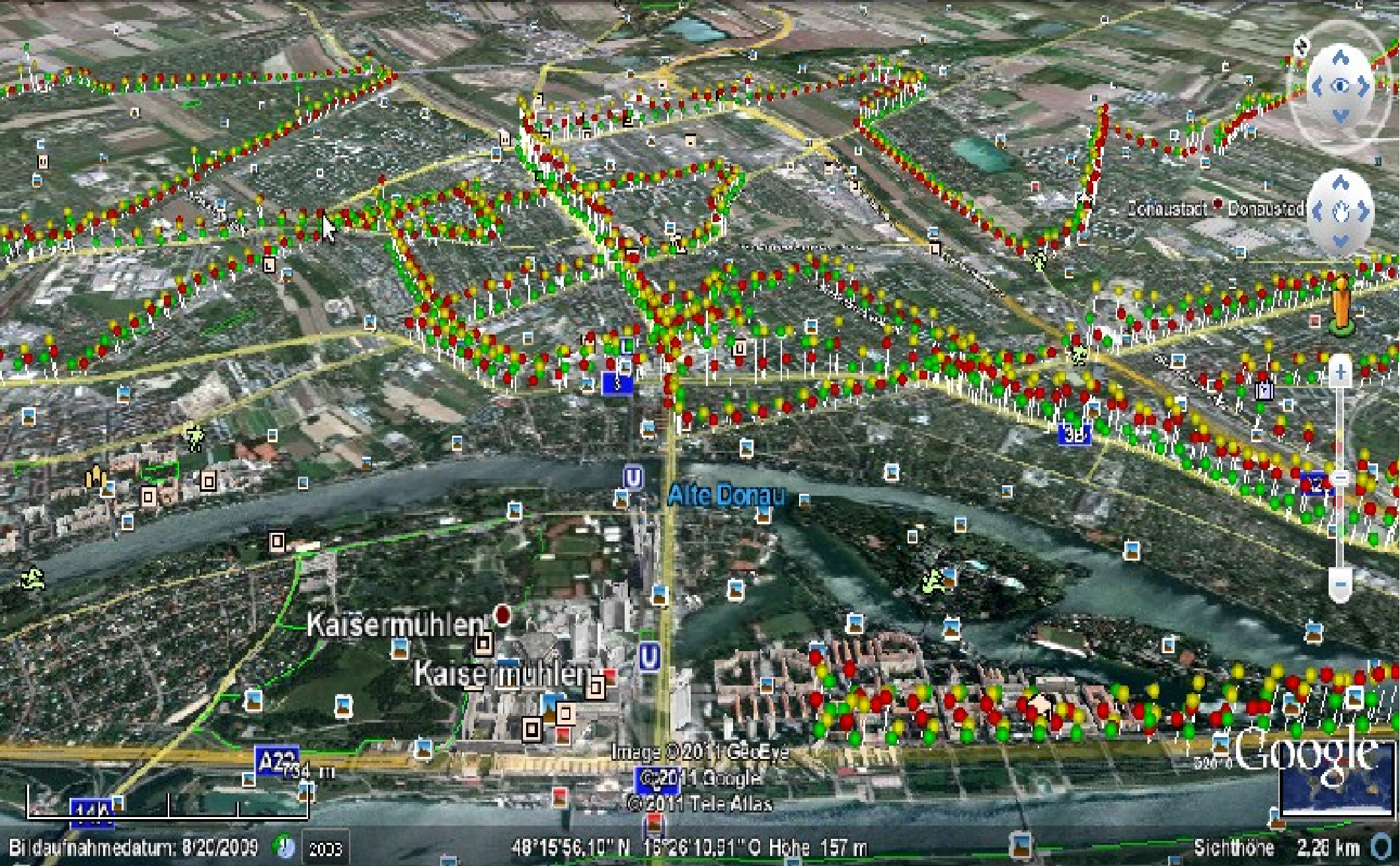
30 MW ~ annually 100 000 t_{CO2}

Part II: Light-mapping Vienna

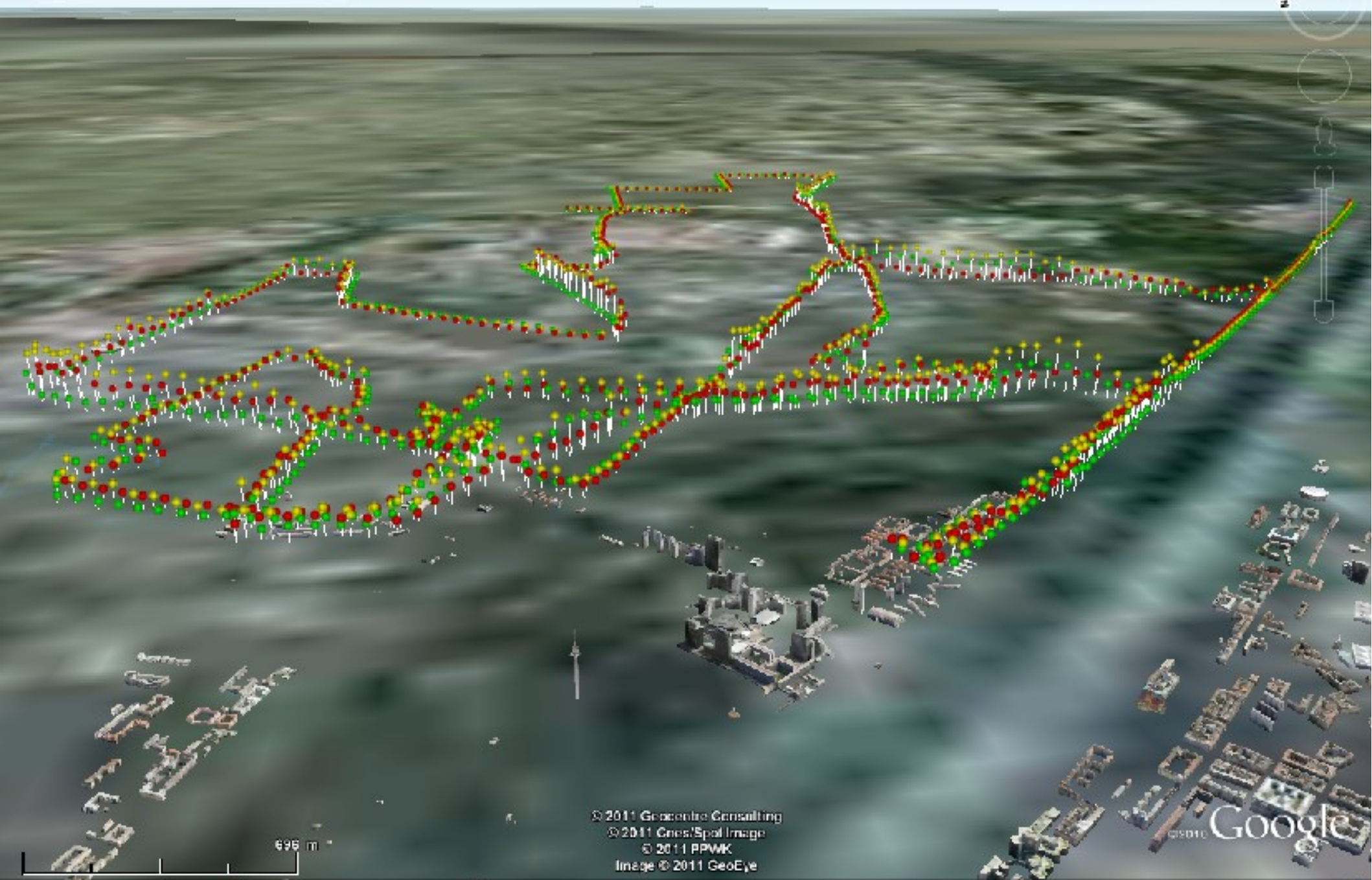
- Light acquisition with car-measurements;
- 10% of road-network = 300 km (384 done);
- Determine peak-values and their locations;
- On-site doc:
 - controll measurements with luxmeters;
 - imaging;
 - description.

Drives

- Lightmeter in three directions,
 - up
 - right
 - left
- rate 10 Hz ~ resolution 3m (30-50 km/h)
- 2 cars: ca 50km per night, 23h-2h
- GPS-position (ca 20-150m)
- HDTV video forward dir. (source identification)



2011/11/20 10:10:10



Determine light-peaks

- $|O, R, L|$;
- R (right Lightmeter) – no approaching traffic, less „stronglight“ (tunnel, underpass, highways);
- sort peaks;
- Appr. 200 candidates: video check;
- Top 10 after exclusion of traffic, reflections, tunnels.

The sample

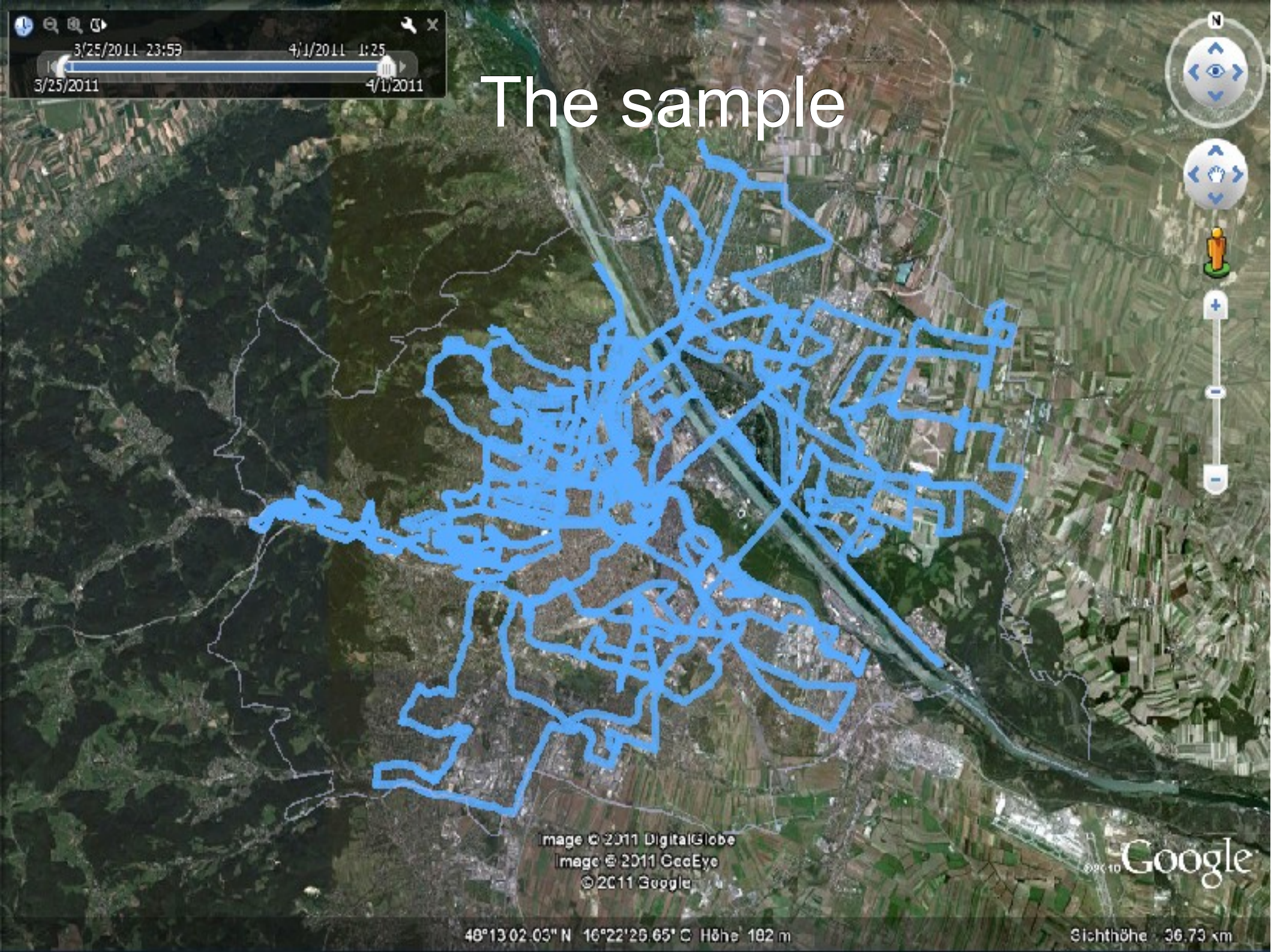


Image © 2011 DigitalGlobe
Image © 2011 GeoEye
© 2011 Google

Google

48°13'02.03" N 16°22'25.65" E Höhe: 182 m

Sichthöhe: 36.73 km

The top ten

from

388,4 of 3012 km ~ 13%

Irradiation measured at 10 Hz ~ 3m

51 km A + 216 km exB + 2745 km GW

Conclusions

- Total outdoor light power > 30 MW
 - $> 2\%$ of Viennas electricity consumption
- Lightdome:
Public : other 3:7
- Light sources from 400 km sample:
Public : other $> 7:3$
- Difference light-dome - light-sources:
 - Efficient public lighting – yes
 - Highways ?
 - Significant part „direct“ into the dome ?

Team

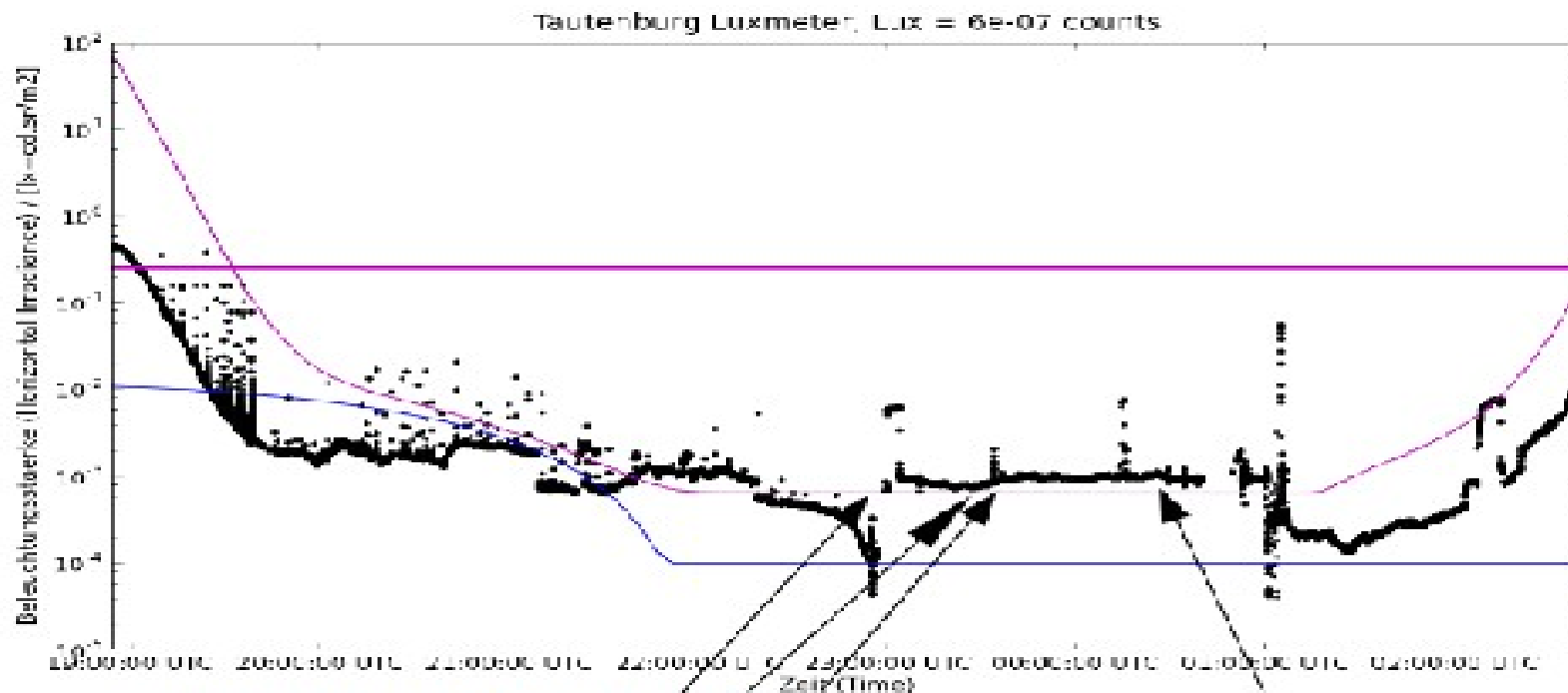
- Andreas Trawöger
- Felix Linhardt
- Manuela Kopper
- Katharina Grand
- Sebastian
Kremshuber
- Maryam Nikbakhti

- Stefan Schober
- Cornelia Wiesinger
- Andreas Chwatal
- Thomas Posch
- Markus Reithofer
- Günther Wuchterl



When brighter is better

Life is not always sunshine ...



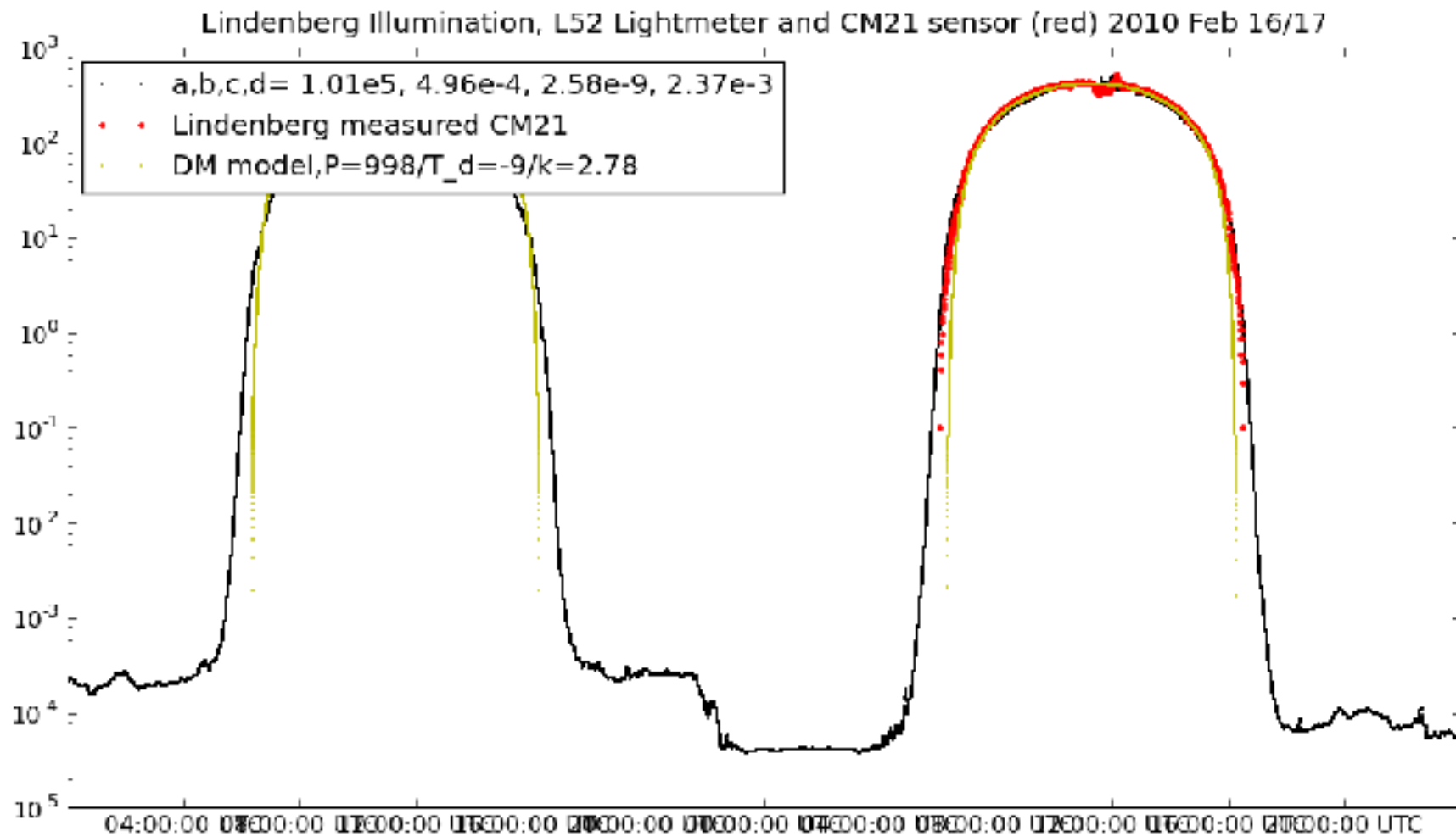
23:00 (01:00 MESZ): Wechsel zum Tisch

23:25 UTC (01:25 MESZ) Jupiter mit Hof

23:30 (01:30) Auftreten der Wolken
Milchstraße im Cyg schimmer durch Stratus-Wolken!

00:27 (02:27) Zenit bedeckt
Keine Sterne

Check with total-rad. measurements



Check with total-rad. measurements At your local weather station!

