Rijksinstituut voor Volksgezondheid
en Milieu
*Ministerie van Volksgezondheid,
Welzijn en Sport*

Meetnet Hemelhelderheid Nederland

IGOV | 31 oktober 2013

Rijksinstituut voor Volksgezondheid en Milieu
Ministerie van Volksgezondheid, Welzijn en Sport

Inhoud

1. Voorgeschiedenis
2. Meetnet, lokaties, apparatuur, kalibratie
3. Meetresultaten
4. Bruikbaarheid data

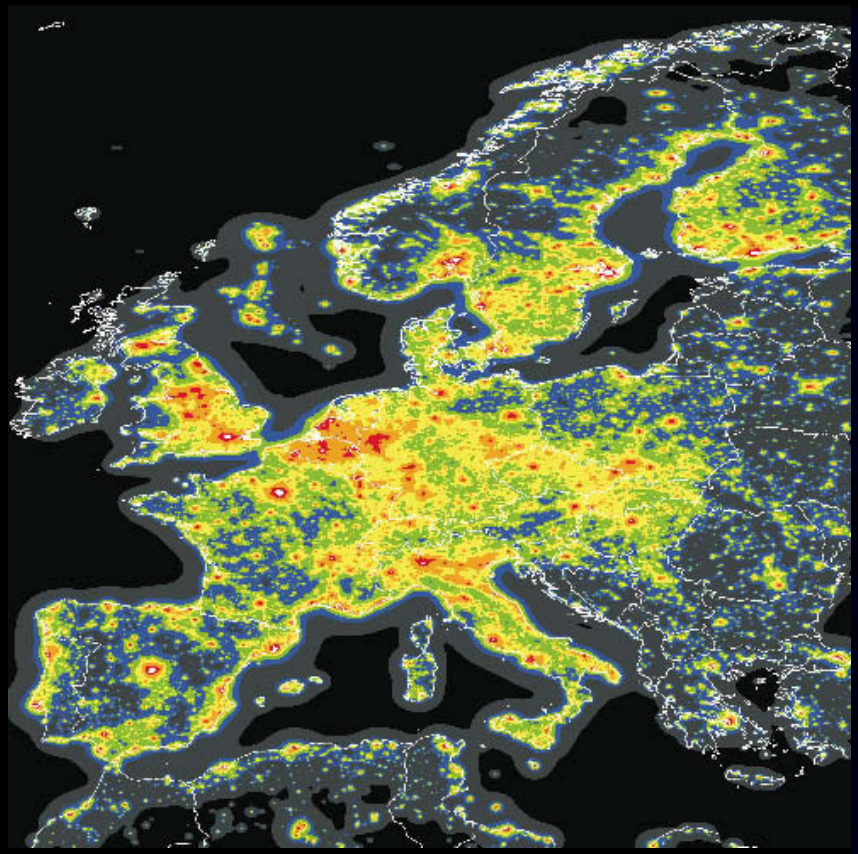
Achtergrond

- 2010:
  - Provincies + VROM: IPO-PRISMA project “donkerte”
    -> welke bestuurlijke mogelijkheden hebben we om iets aan donkertebeleid te doen?
  - VROM: wij maken beleid
    -> RIVM, kunnen jullie voor ons de lichtemissie in Nederland gaan monitoren?
  - Start hemelhelderheidsmetingen Cabauw
  - wolkenhoogte, wolkenbedekkingsgraad, aerosolen

- 2011: Light Pollution and the Absence of Darkness

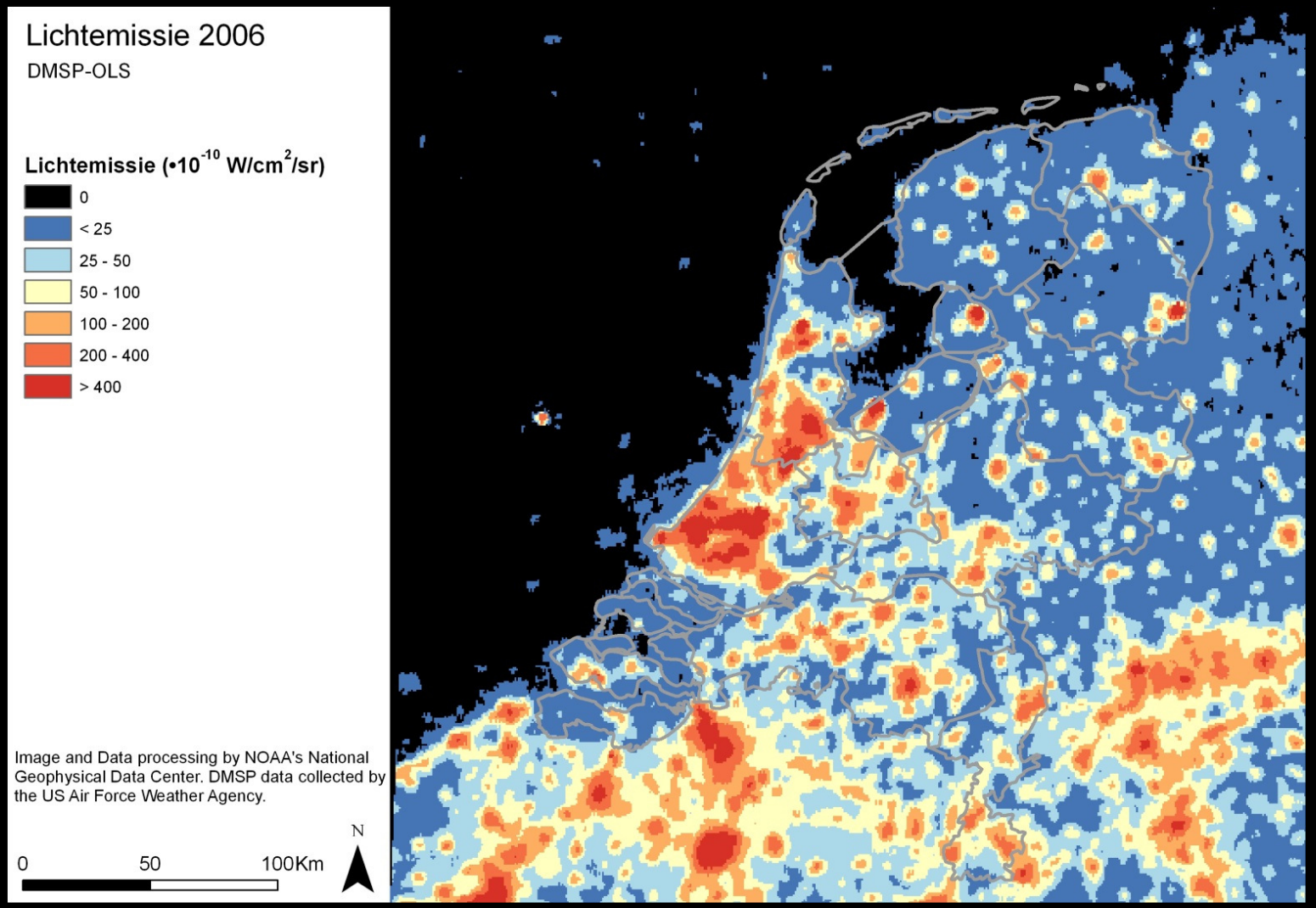
- Metingen CESAR
- Meetnet Hemelhelderheid Nederland
- Veldonderzoek lichtuitstoot brongebieden
- Model valideren en mogelijk verbeteren -> blootstelling
- Literatuuronderzoek effecten flora&fauna NL
- Literatuuronderzoek nachtelijke verlichting -> gezondheidseffecten
- Hinderbelevingsstudie

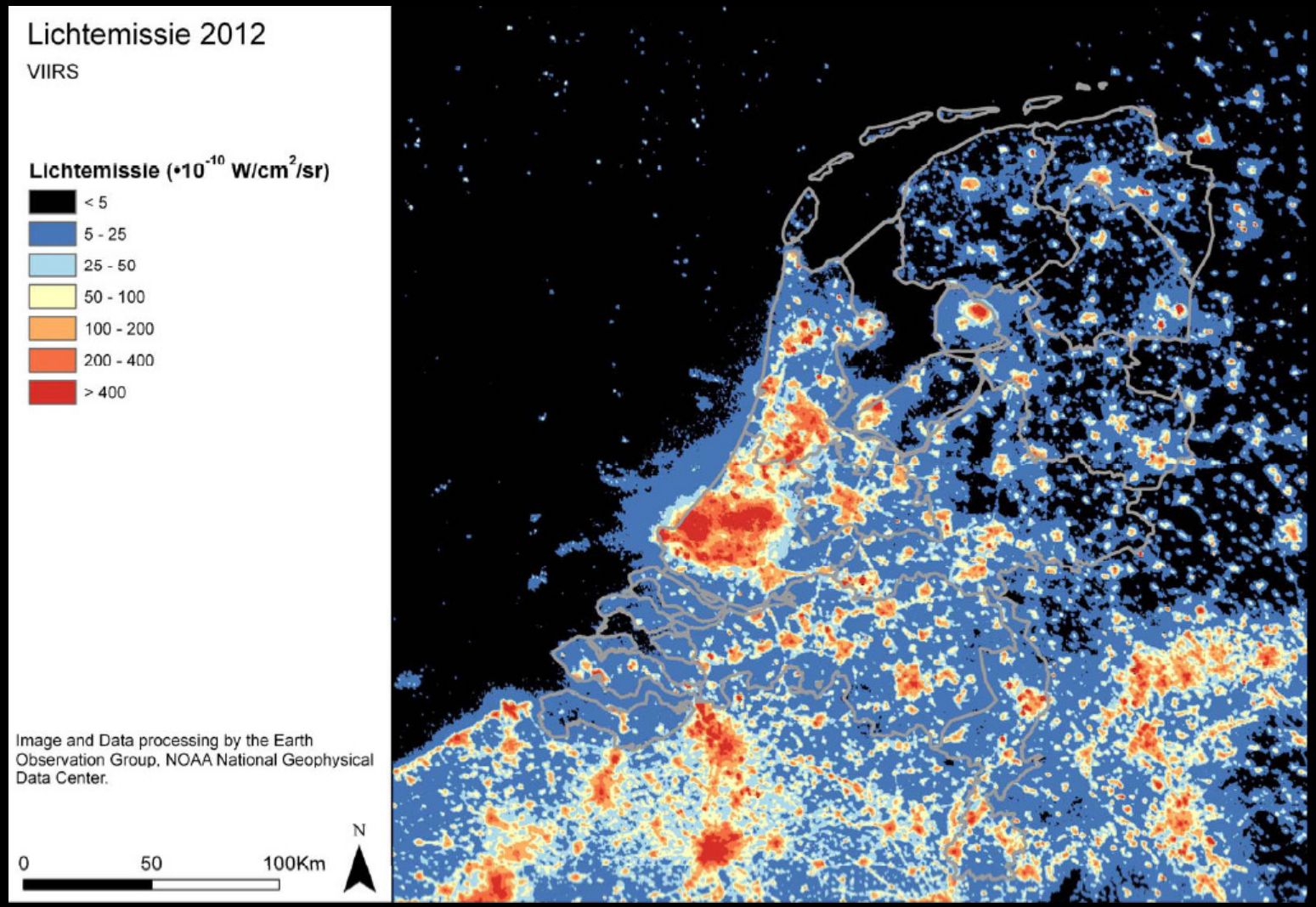
Night sky brightness



Cinzano et al.

Light emission

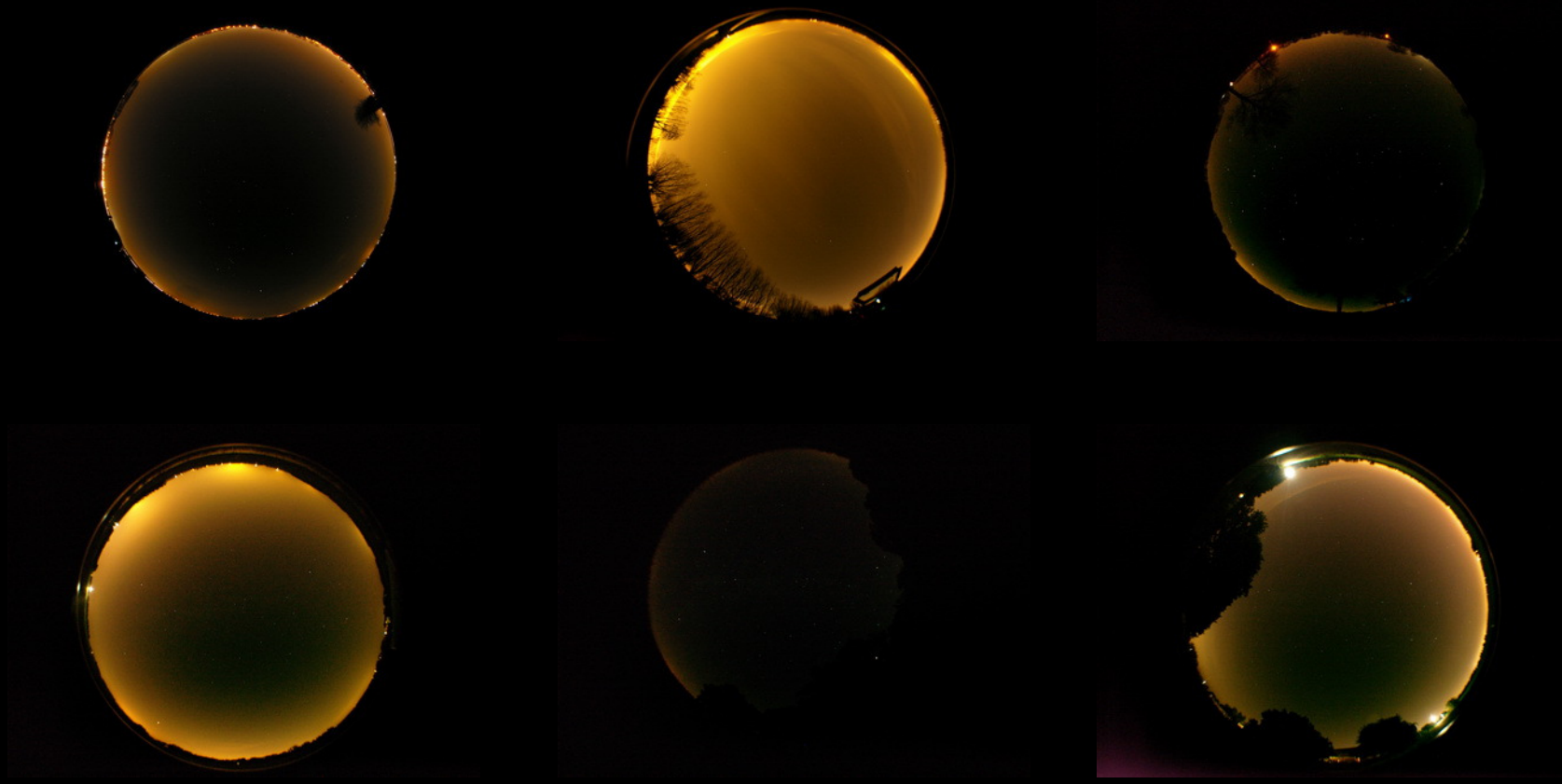

Lichtemissie 2006
DMSP-OLS
Lichtemissie (•10-10 W/cm2/sr)
0
< 25
25 - 50
50 - 100
100 - 200
200 - 400
> 400
Image and Data processing by NOAA's National Geophysical Data Center. DMSP data collected by the US Air Force Weather Agency.
N
0
50
100Km


Lichtemissie 2012
VIIRS
Lichtemissie (•10-10 W/cm2/sr)
< 5
5 - 25
25 - 50
50 - 100
100 - 200
200 - 400
> 400
Image and Data processing by the Earth Observation Group, NOAA National Geophysical Data Center.
N
0
50
100Km

Modellering

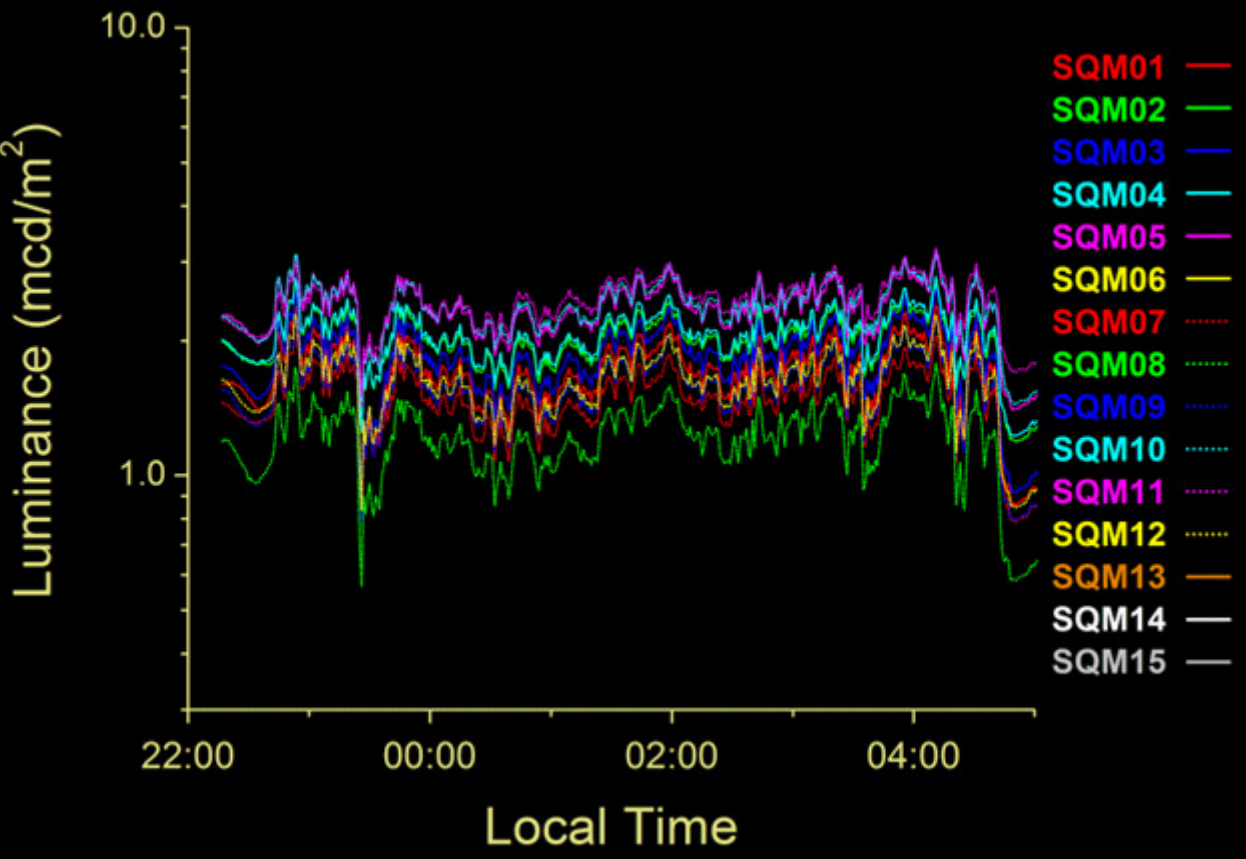
Input ➔	**Model** ➔	**Output**
Licht emissie (satelliet data)	Garstang, Cinzano, etc.	Luminantie in zenith (hemelhelderheid)
Licht emissie (armaturen)	GeoLicht (Provincies + I&M)	▪ Luminantie in zenith (hemelhelderheid) ▪ Horizonvervuiling

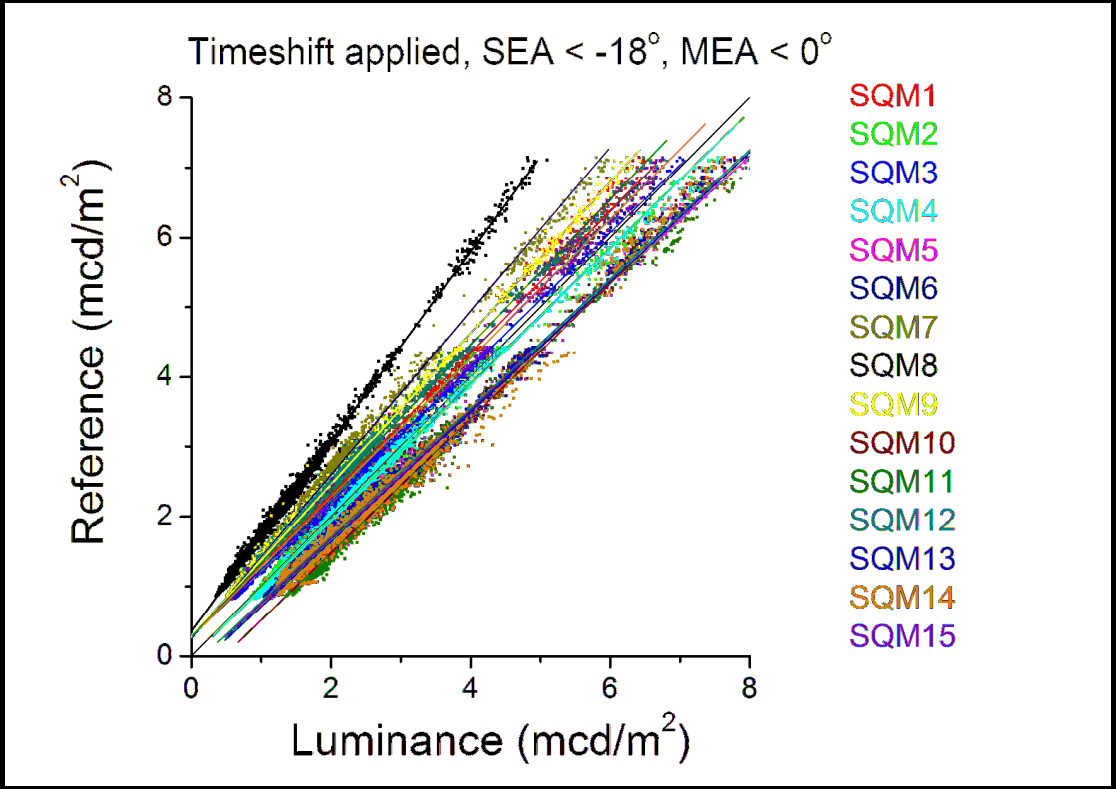
Hemelhelderheid - all sky cam

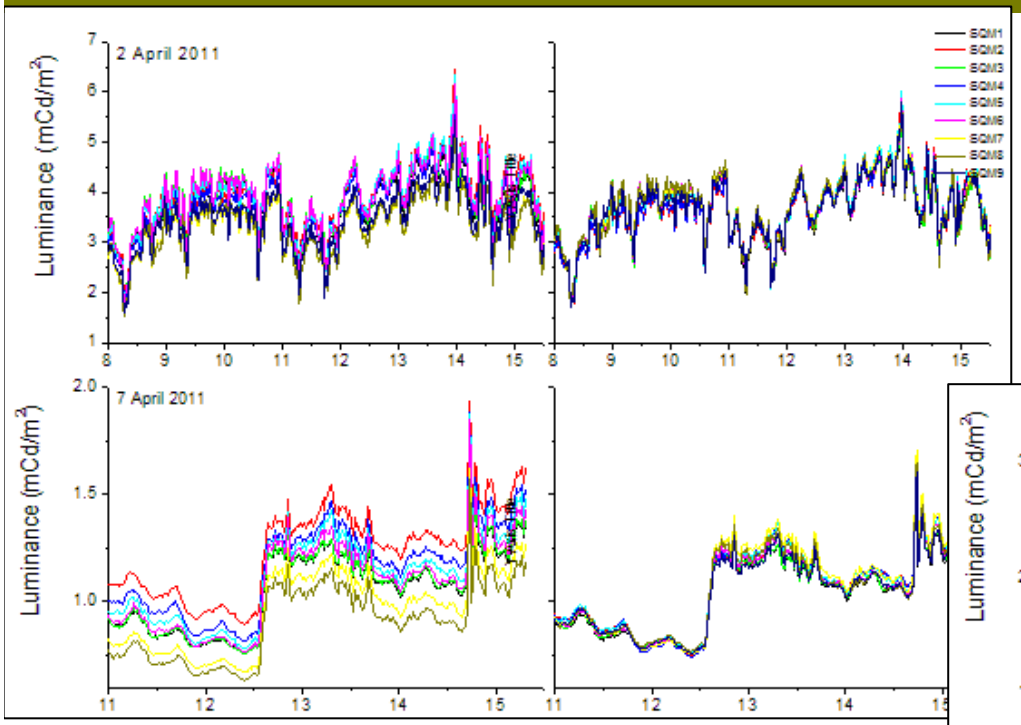


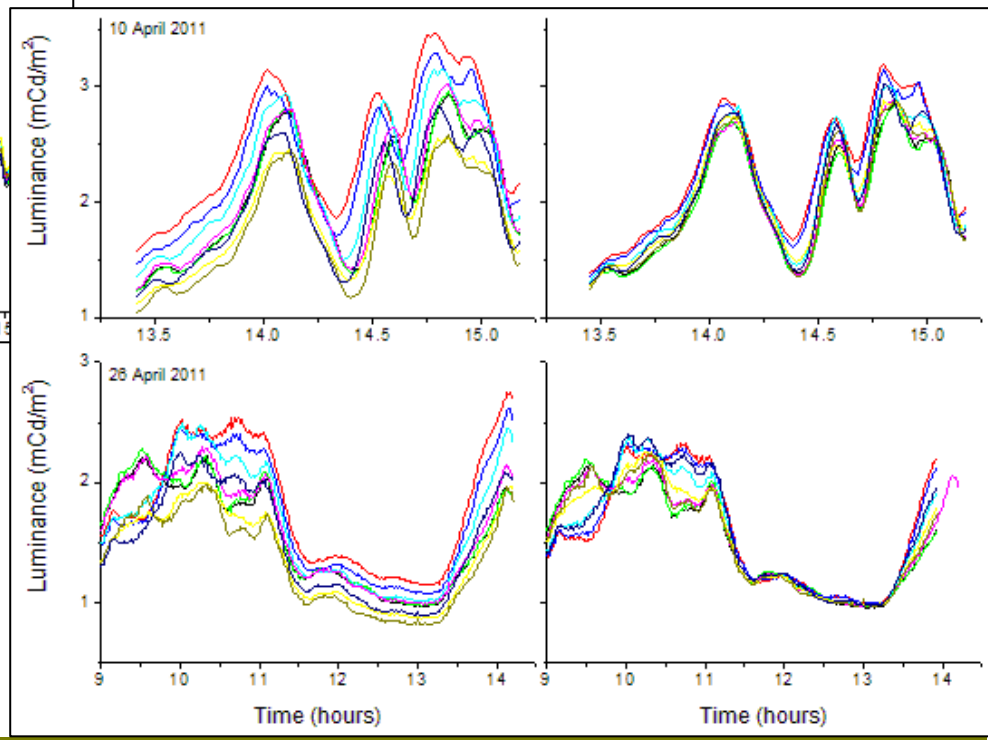
Hemelhelderheid - sky quality meter

Intercalibratie van 9 SQM’s

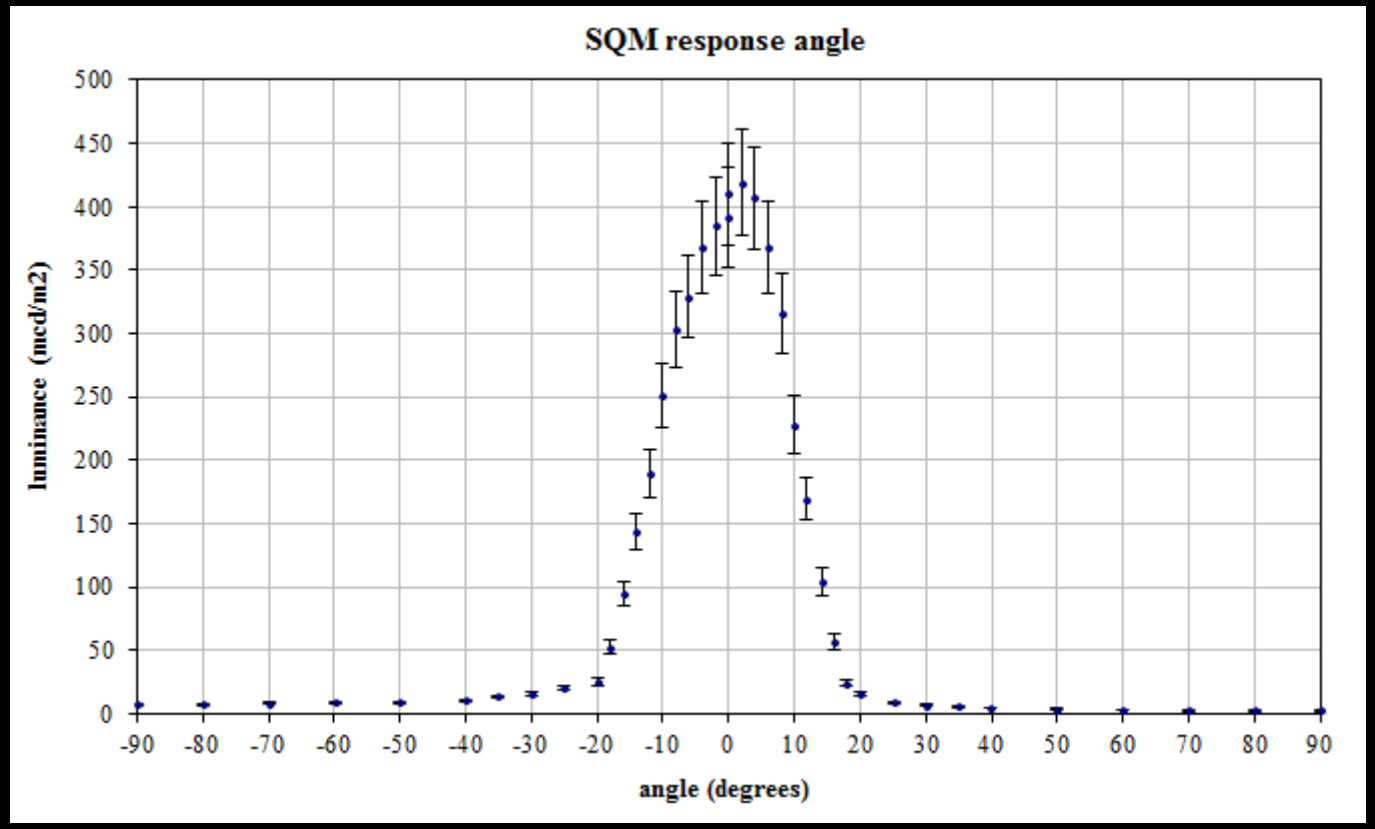

10.0
1.0
Luminance (mcd/m^2)
22:00
00:00
02:00
04:00
Local Time
SQM01
SQM02
SQM03
SQM04
SQM05
SQM06
SQM07
SQM08
SQM09
SQM10
SQM11
SQM12
SQM13
SQM14
SQM15


Timeshift applied, SEA < -18°, MEA < 0°
Reference (mcd/m2)
Luminance (mcd/m2)
0
2
4
6
8
SQM1
SQM2
SQM3
SQM4
SQM5
SQM6
SQM7
SQM8
SQM9
SQM10
SQM11
SQM12
SQM13
SQM14
SQM15

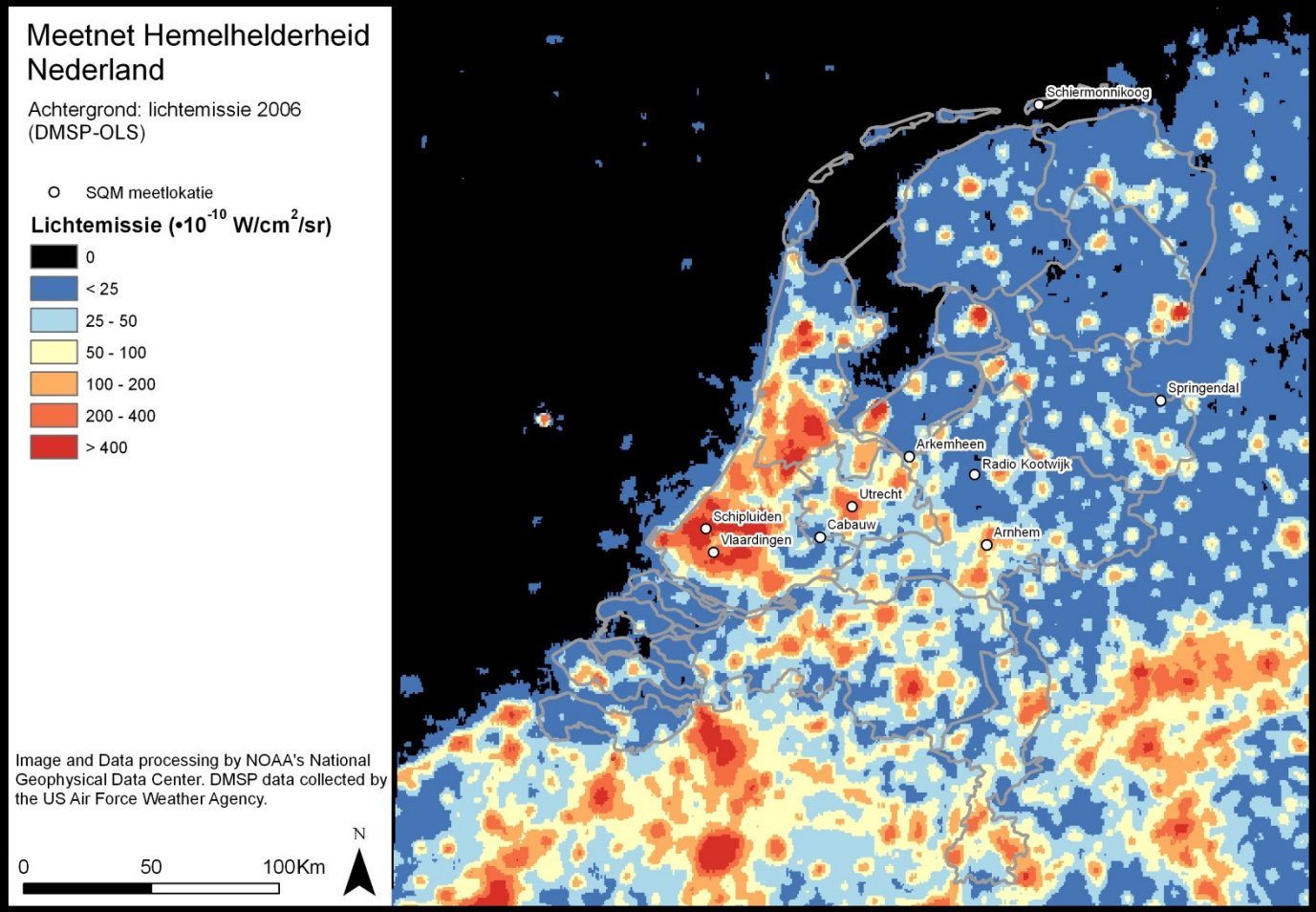




Intercomparions of nine sky brightness detectors, P.N. den Outer, D.E. Lolkema, M. Haaima, G.R. van der Hoff, H. Spoelstra & W. Schmidt, Sensors 2011,11, 9603-9612


SQM response angle
luminance (mcd/m2)
500
450
400
350
300
250
200
150
100
50
0
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
angle (degrees)

Meetnet Hemelhelderheid Nederland



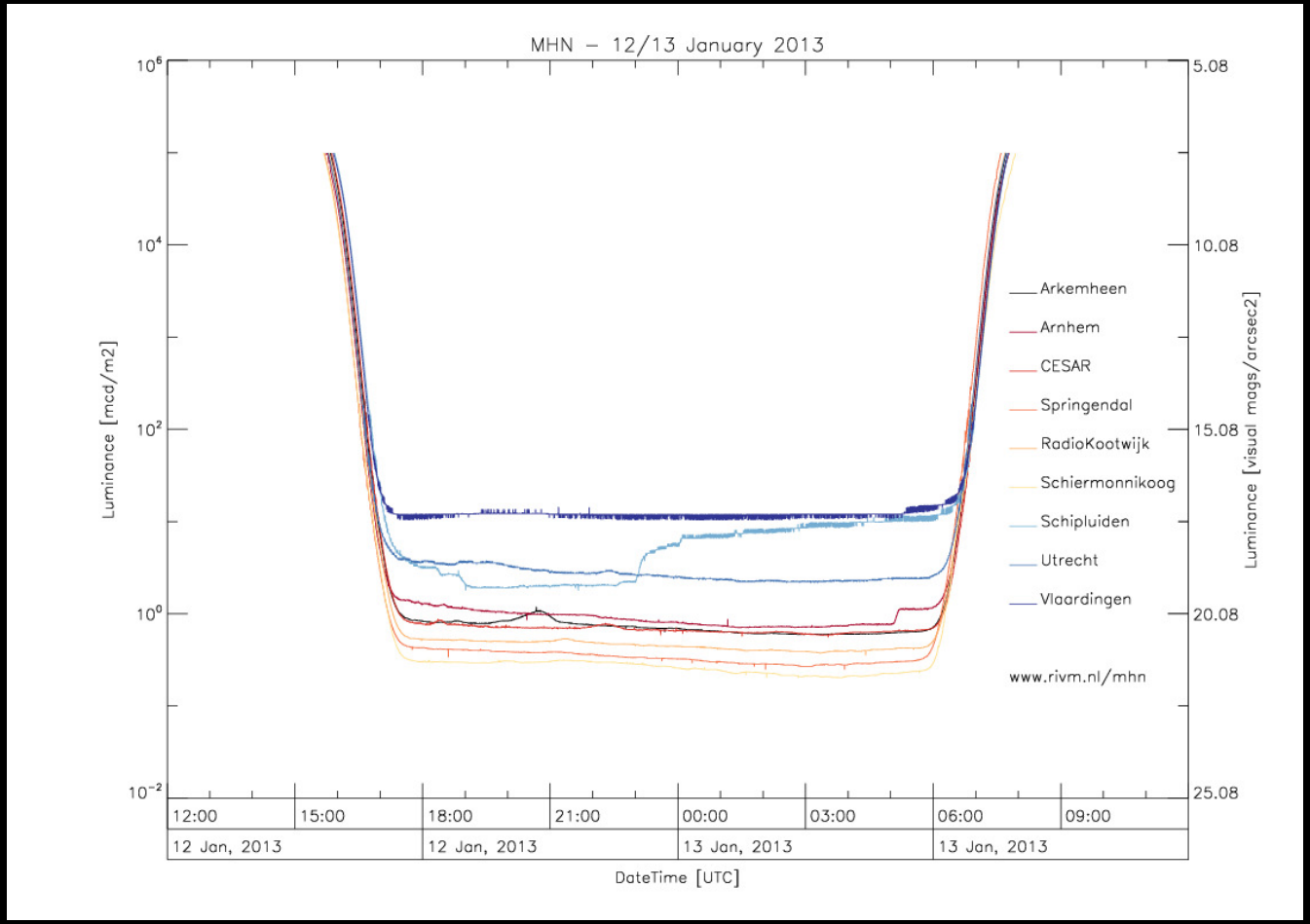
1. Arkemheen
2. Arnhem
3. CESAR
4. Springendal
5. Radio Kootwijk
6. Schiermonnikoog
7. Schipluiden
8. Utrecht
9. Vlaardingen


Stoomgemaal "Hertog Reijnout"


VAISALA

What are typical zenith luminances?

Place	Luminance (mcd/m^2)
Dark place, no artificial lighting, no sun, no moon	< 0.25
City of Amsterdam, clear night	8
CESAR (rural) clear night	1.1
CESAR (rural) cloudy night	> 25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Luminance [visual mags/arcsec2]
DateTime [UTC]
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Arnhem
CESAR
Springendal
RadioKootwijk
Schiermonnikoog
Schipluiden
Utrecht
Vlaardingen
www.rivm.nl/mhn
12:00
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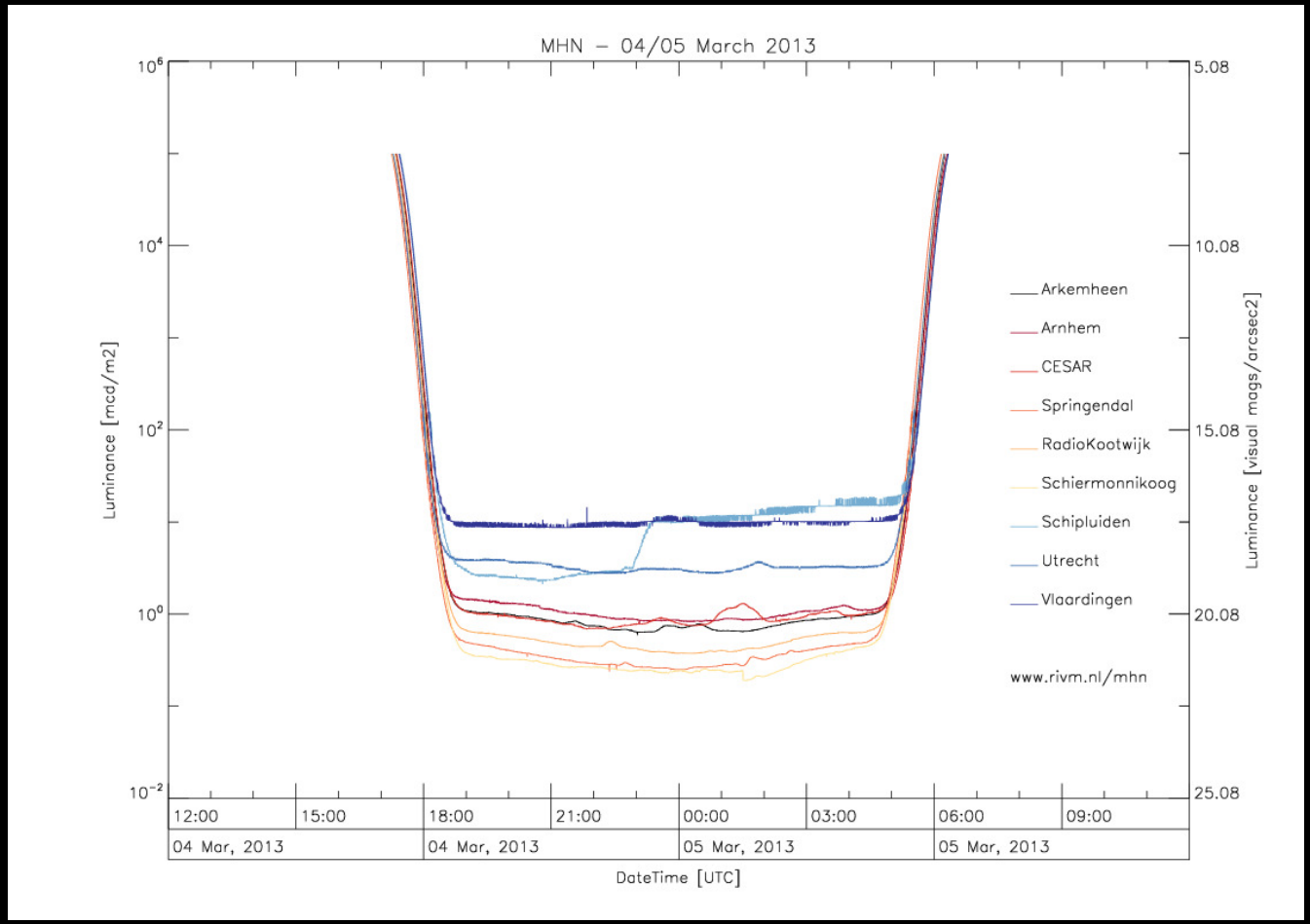
09:00
12 Jan, 2013
12 Jan, 2013
13 Jan, 2013
13 Jan, 2013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CESAR
Springendal
RadioKootwijk
Schiermonnikoog
Schipluiden
Utrecht
Vlaardingen
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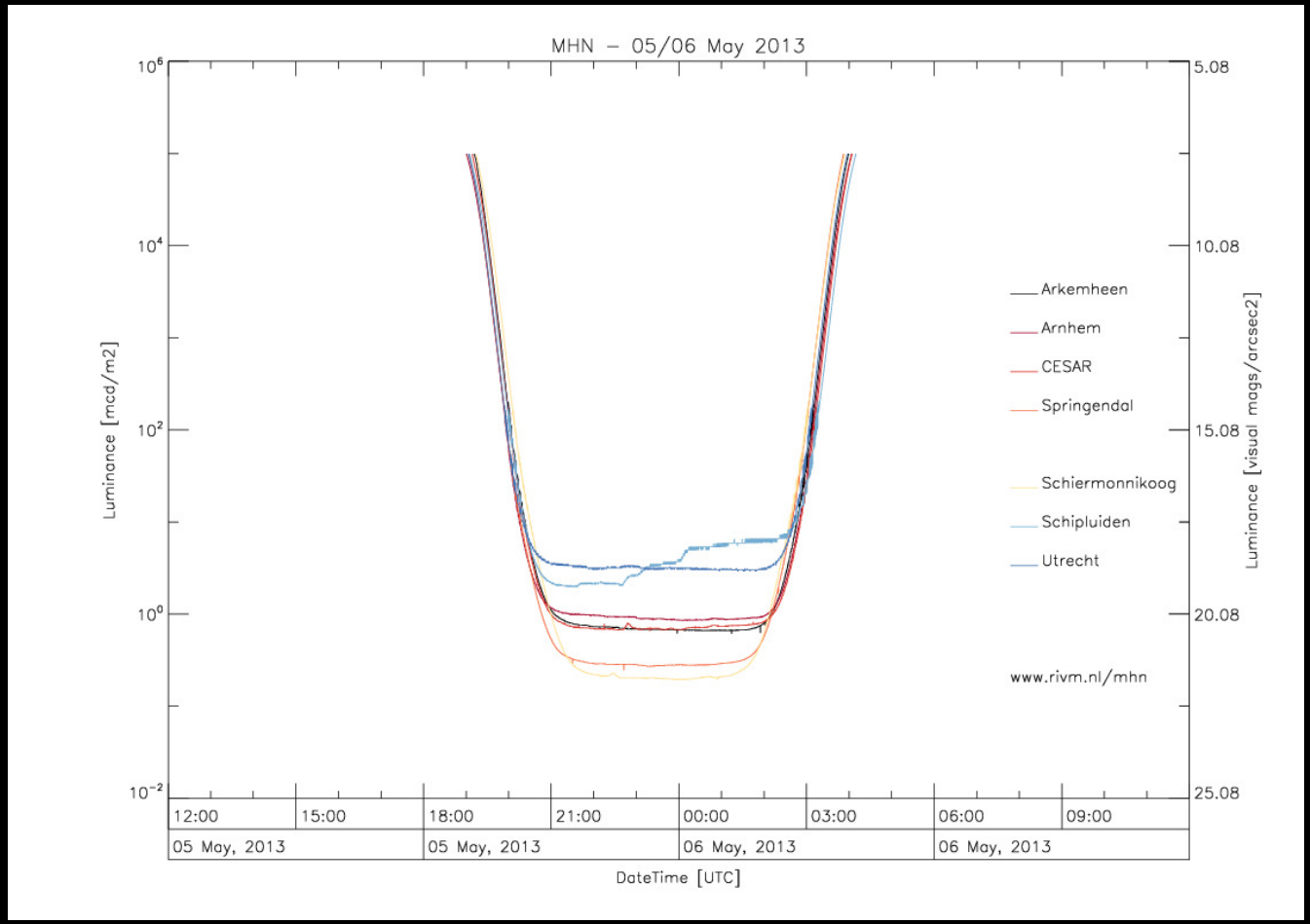
04 Mar, 2013
04 Mar, 2013
05 Mar, 2013
05 Mar, 2013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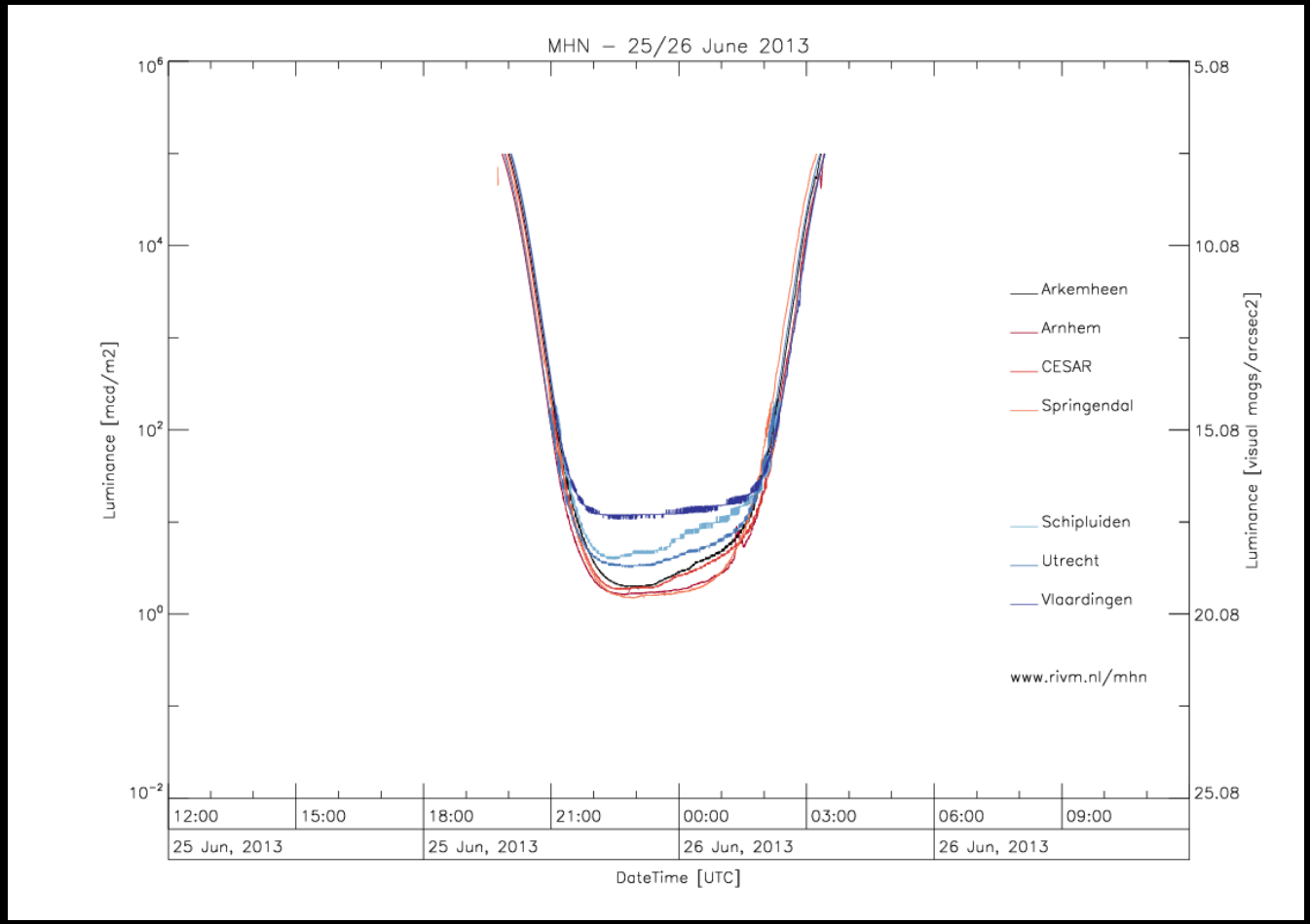
06 May, 2013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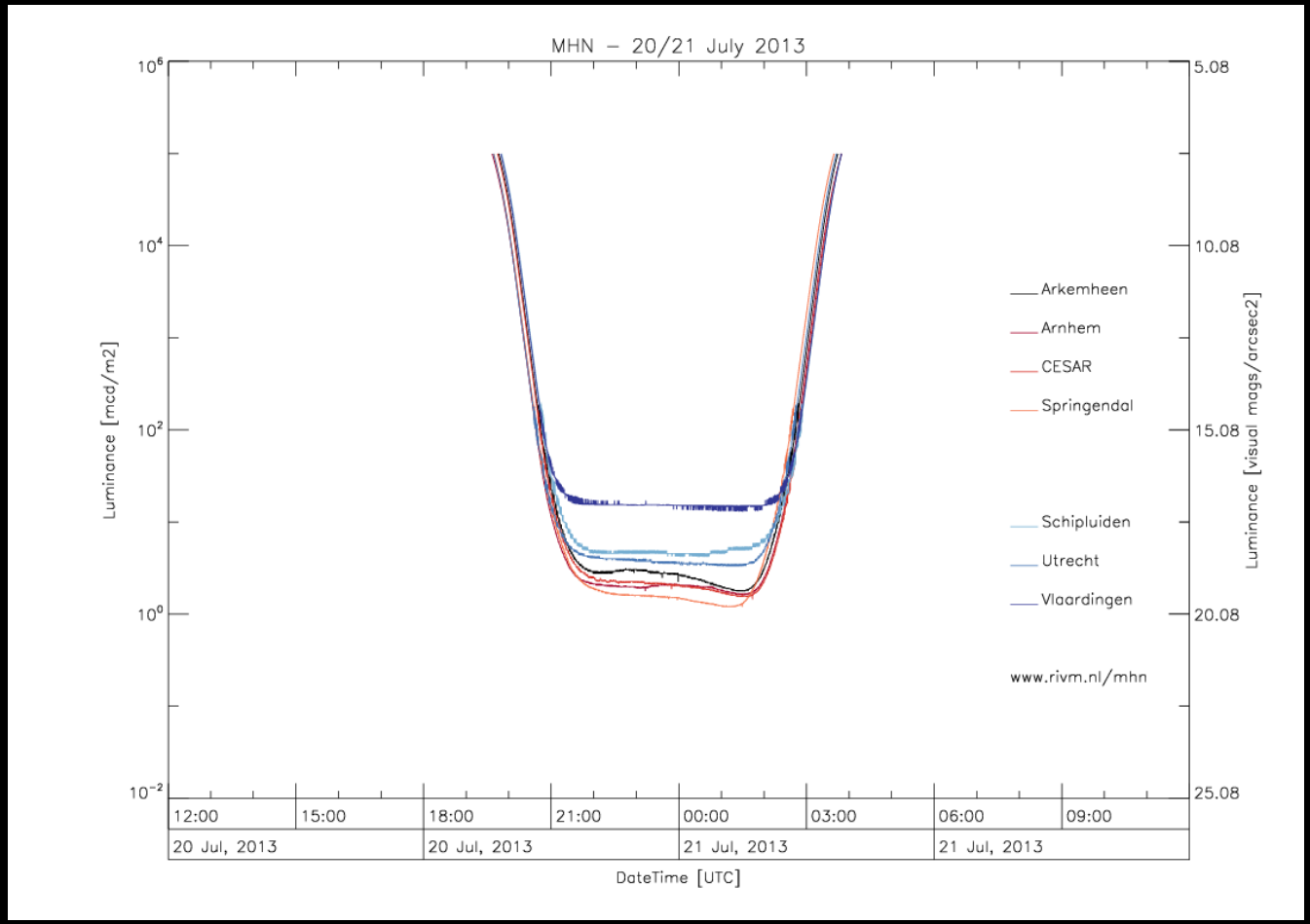
25 Jun, 2013
26 Jun, 2013
26 Jun, 2013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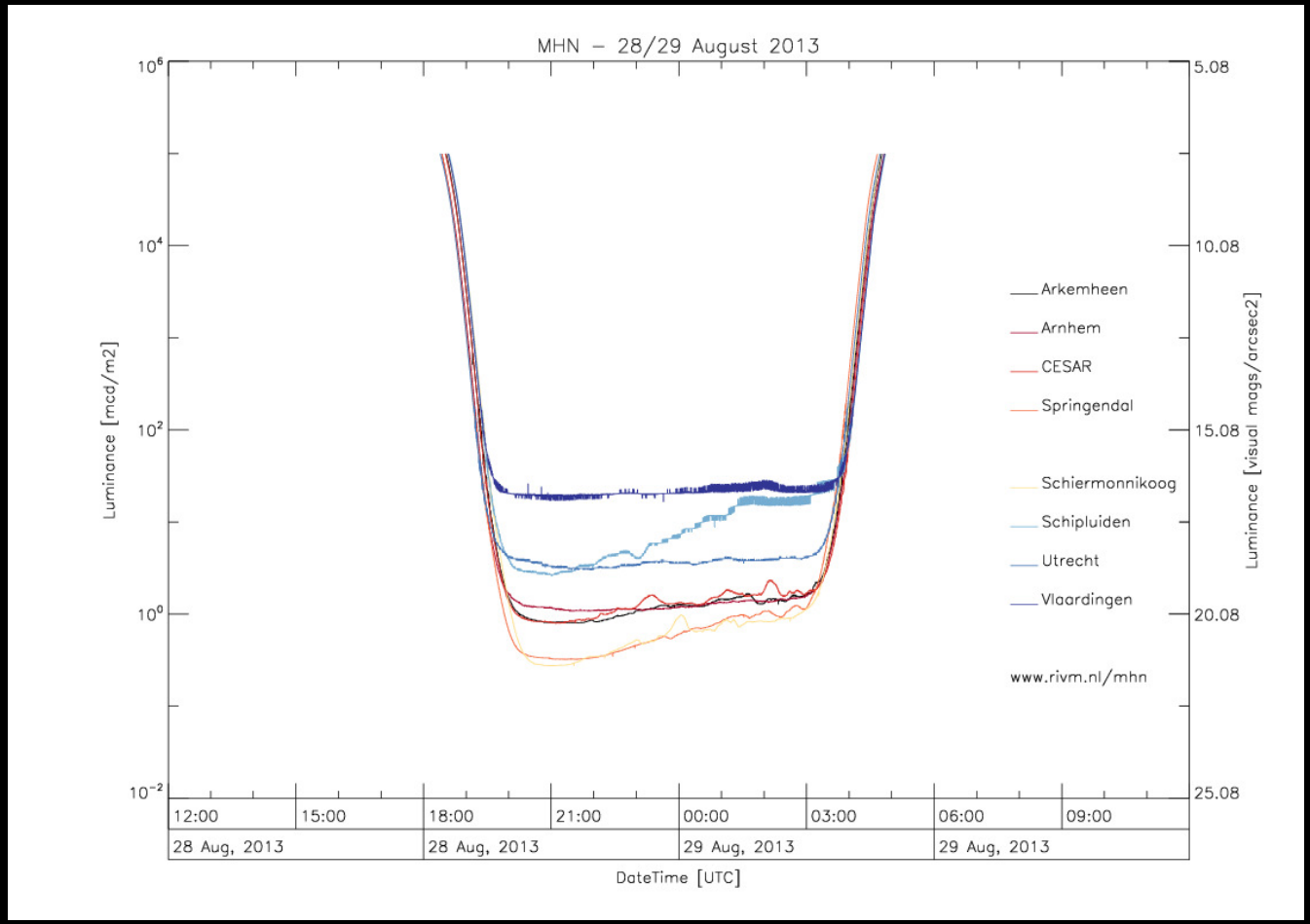
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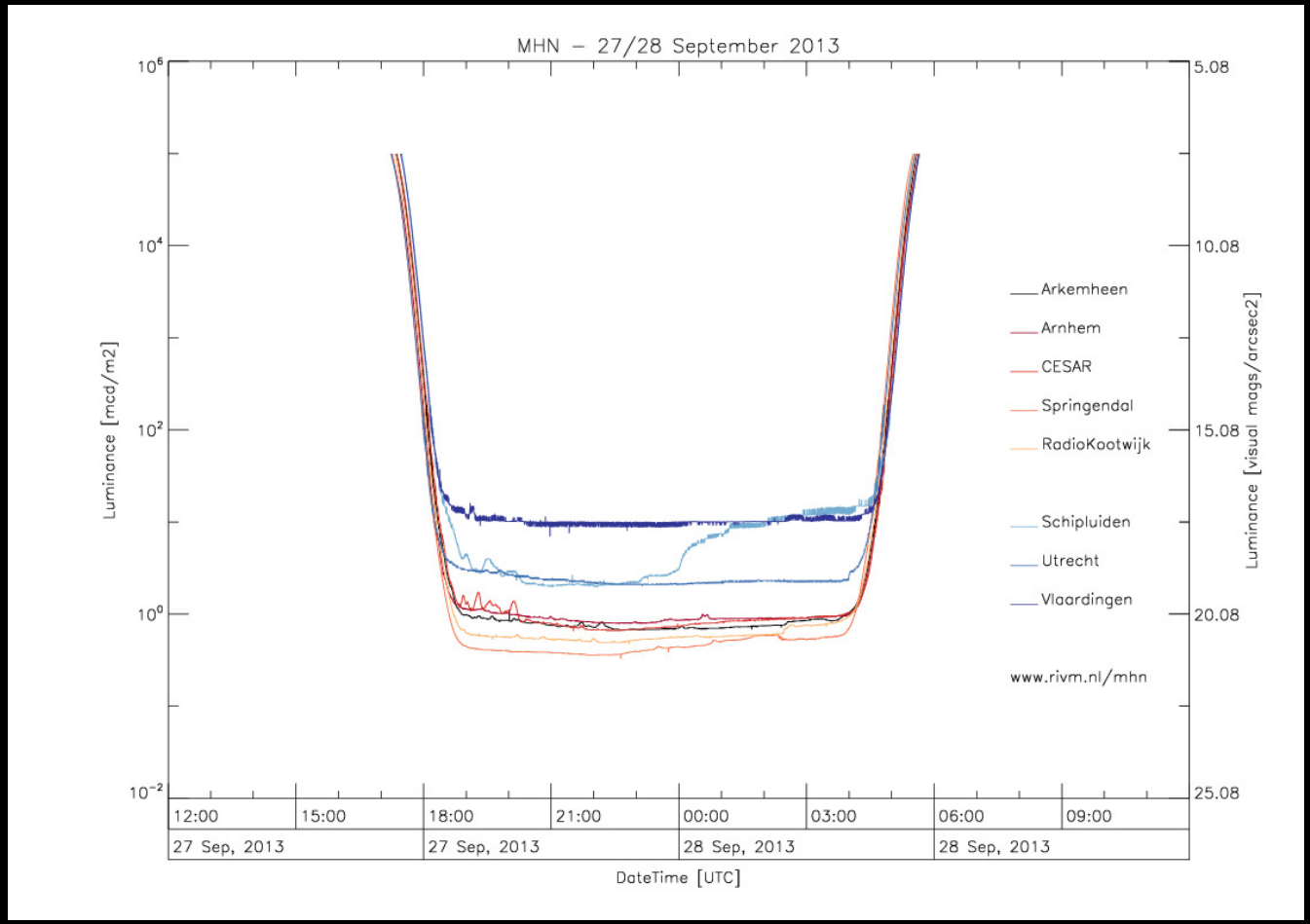
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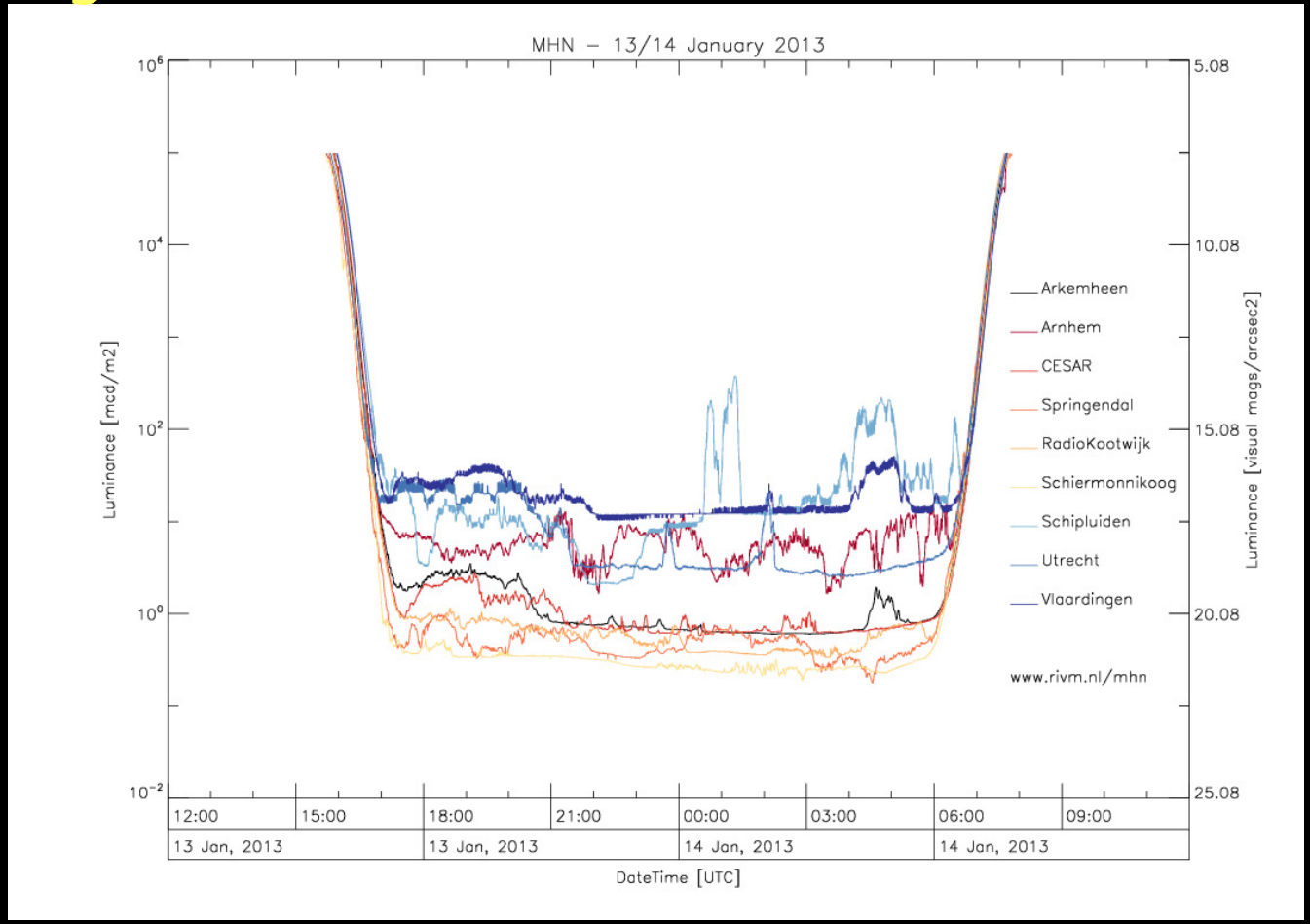
28 Sep, 2013

bewolking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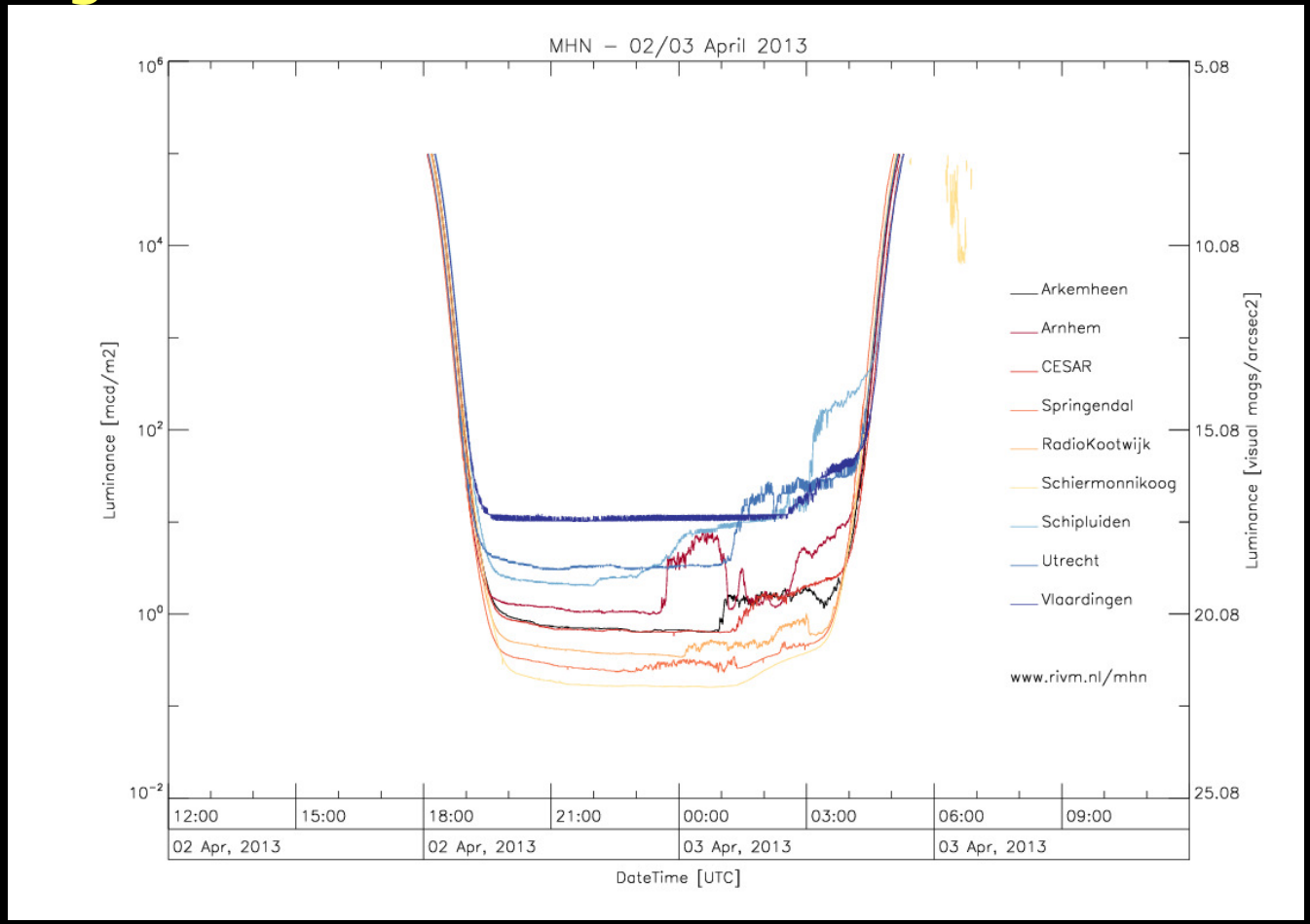
bewolking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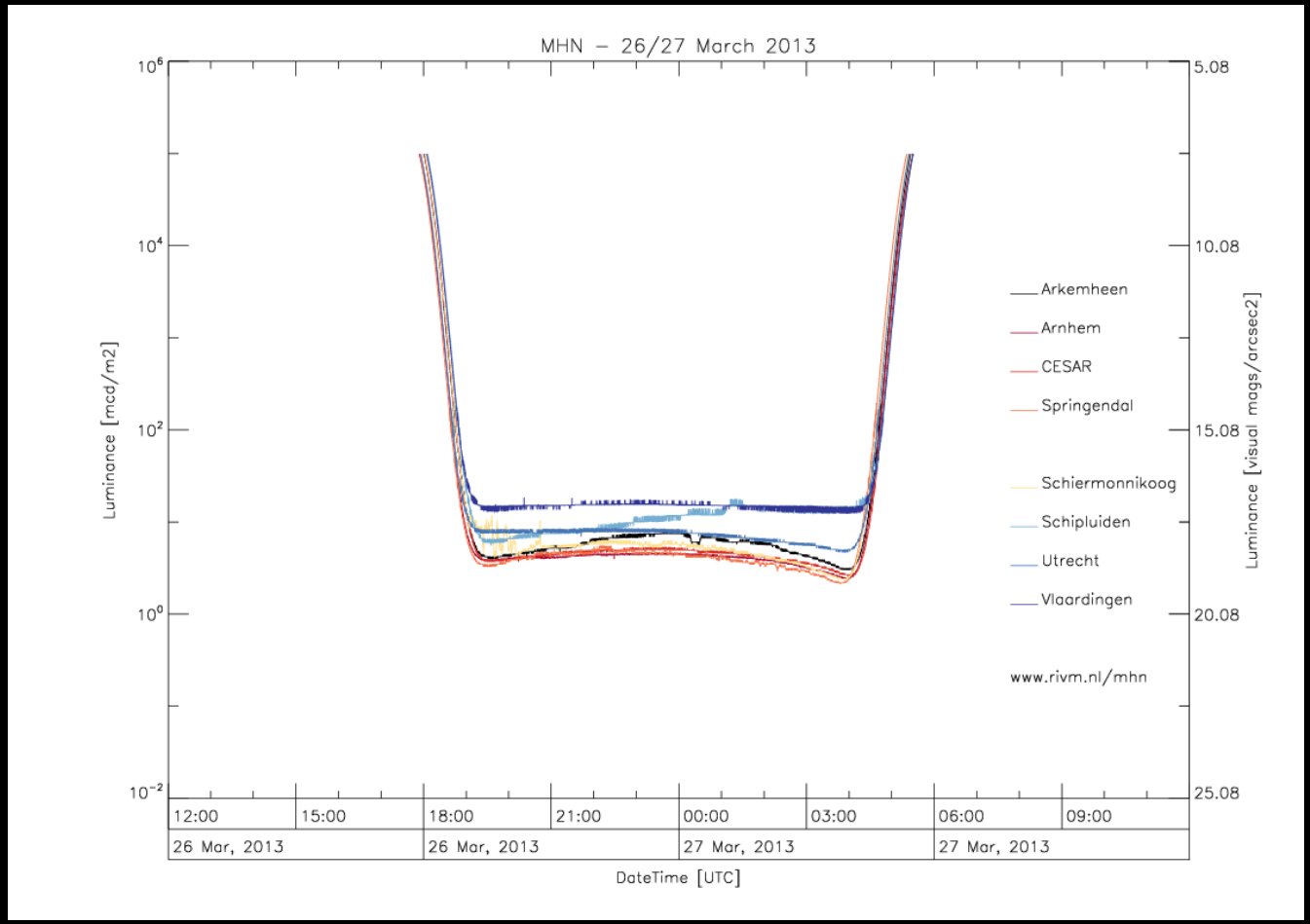
maan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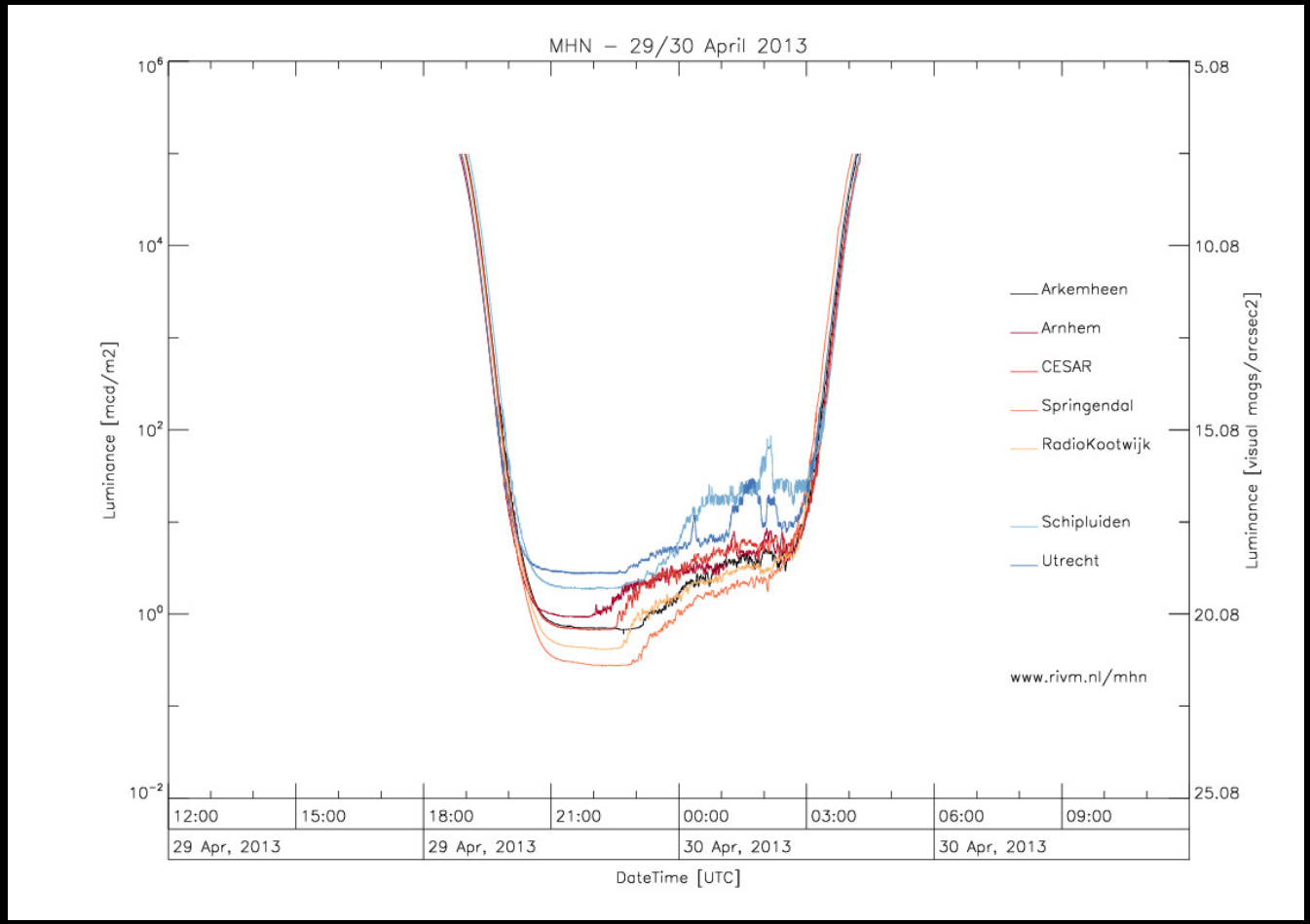
maan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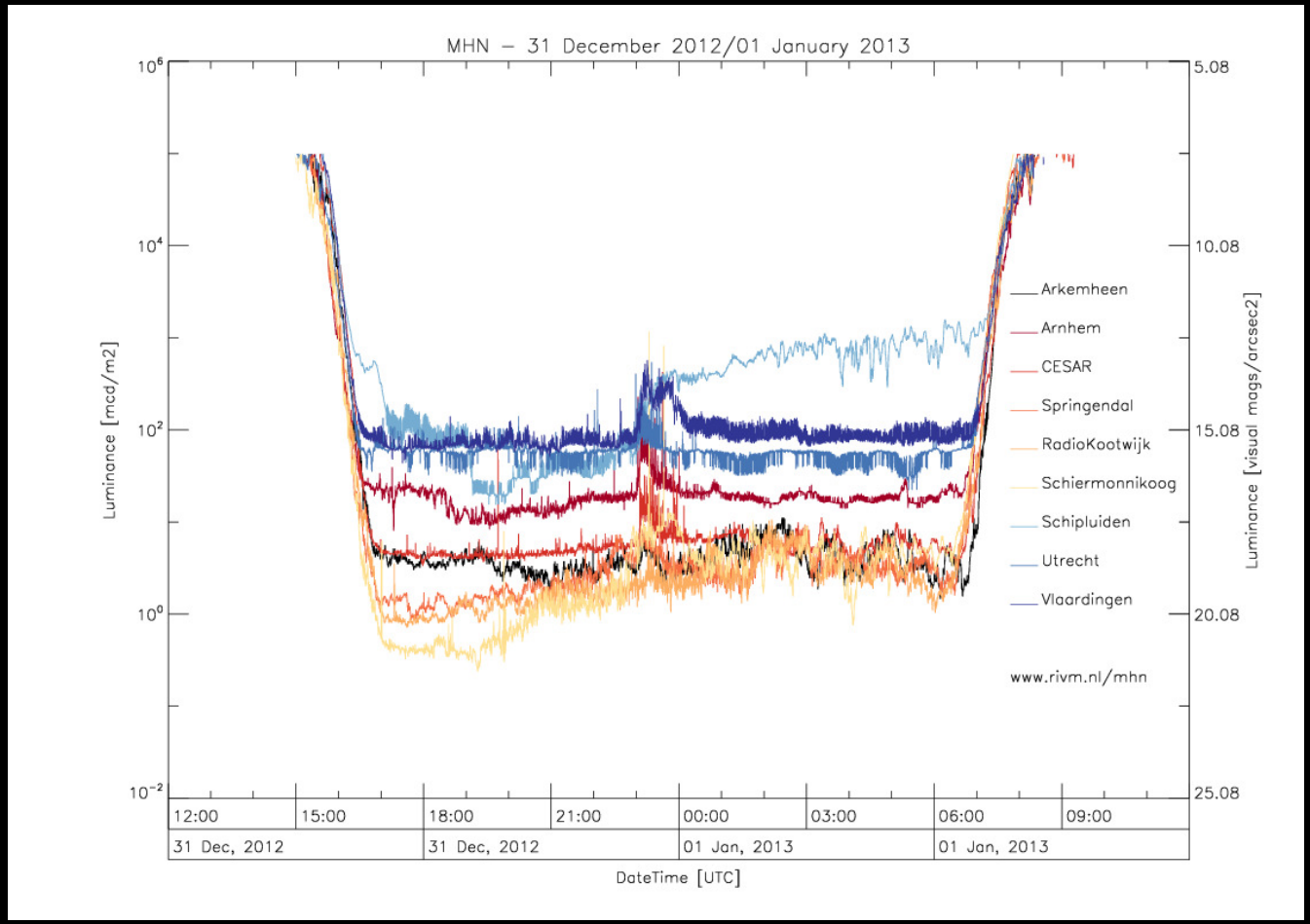
31 dec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Schipluiden
Utrecht
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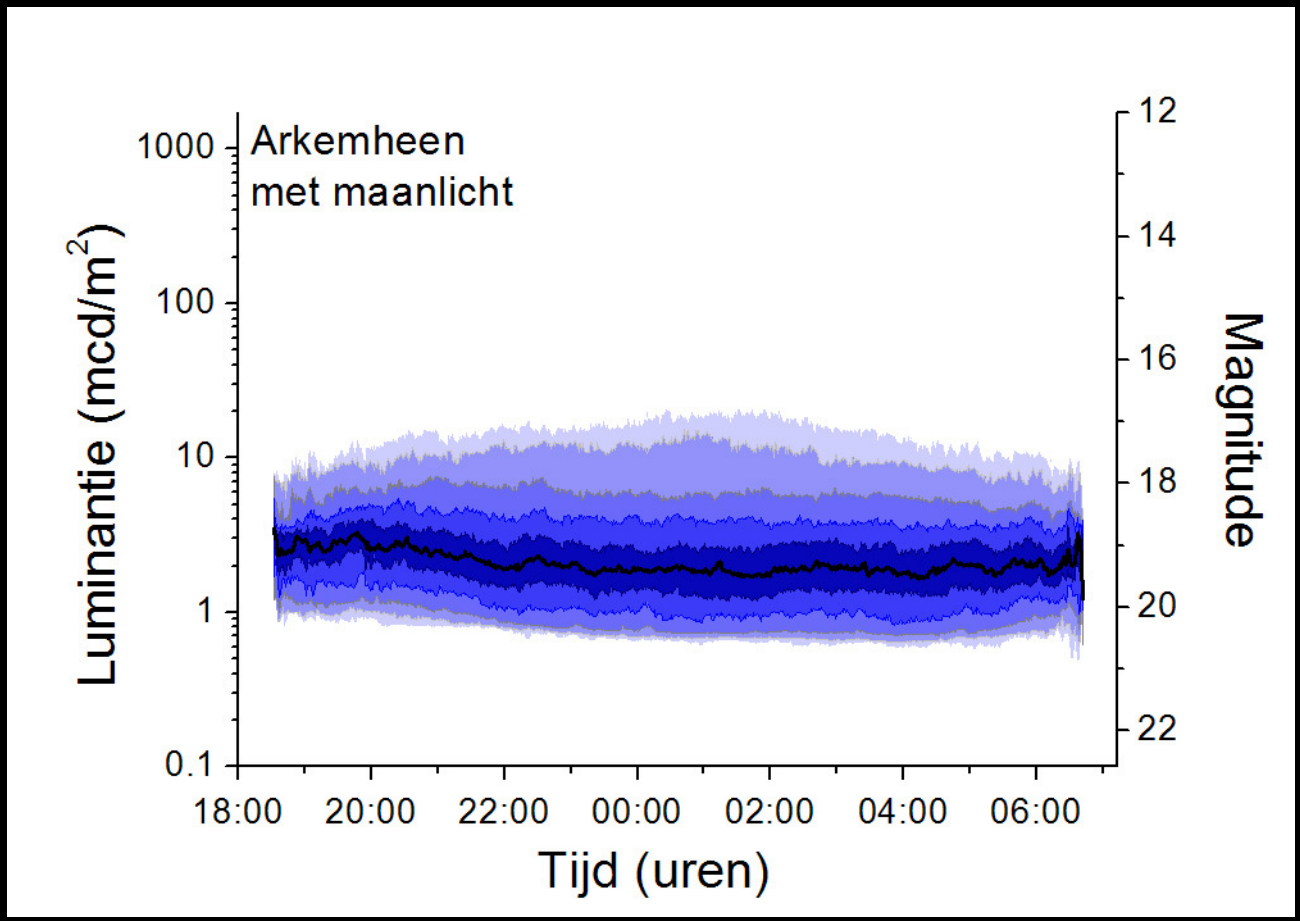
Arkemheen
met maanlicht
Luminantie (mcd/m^2)
1000
100
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0.1
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Magnitude
18:00
20:00
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02:00
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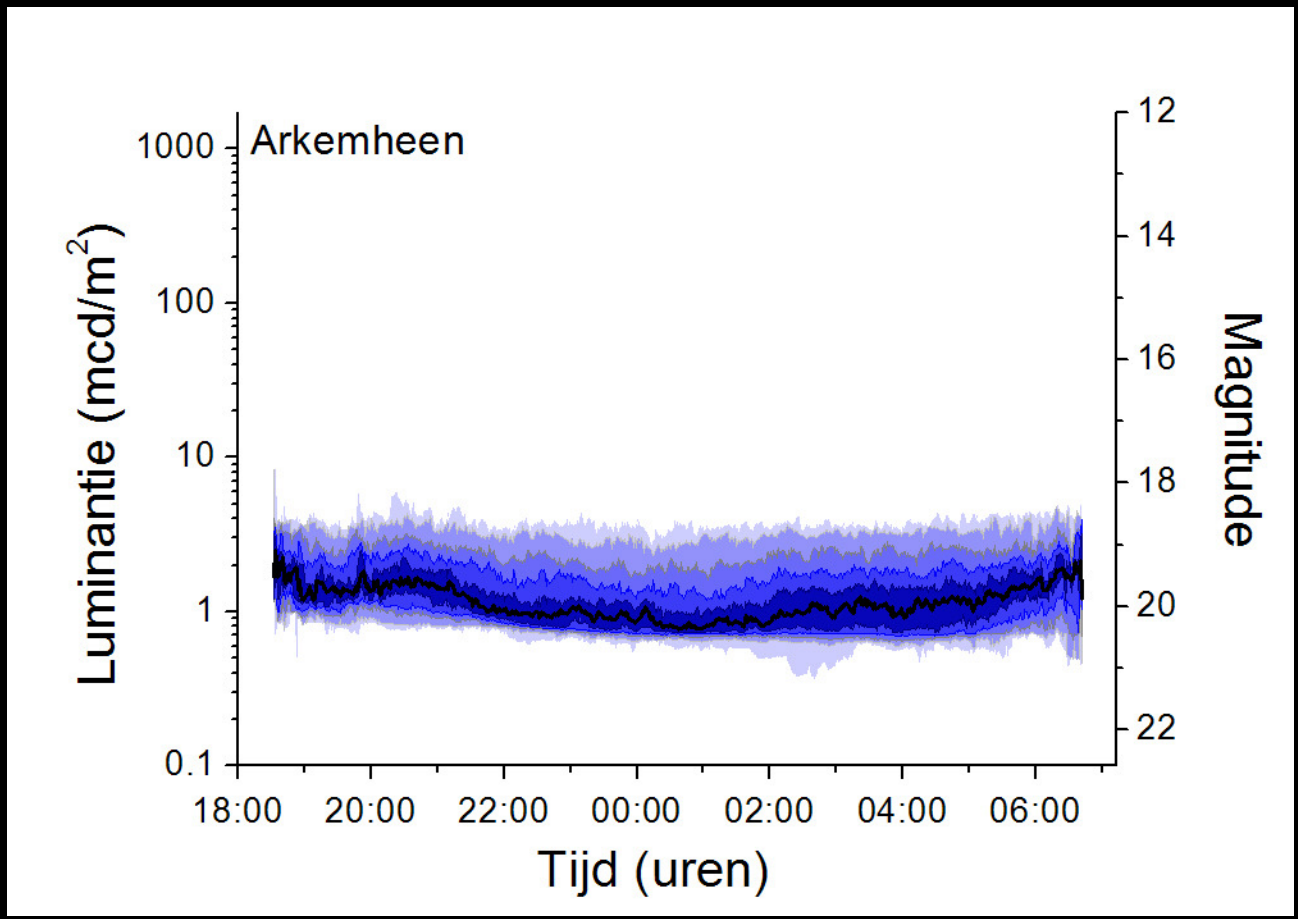
06:00
Tijd (uren)


Arkemheen
Luminantie (mcd/m^2)
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0.1
Magnitude
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16
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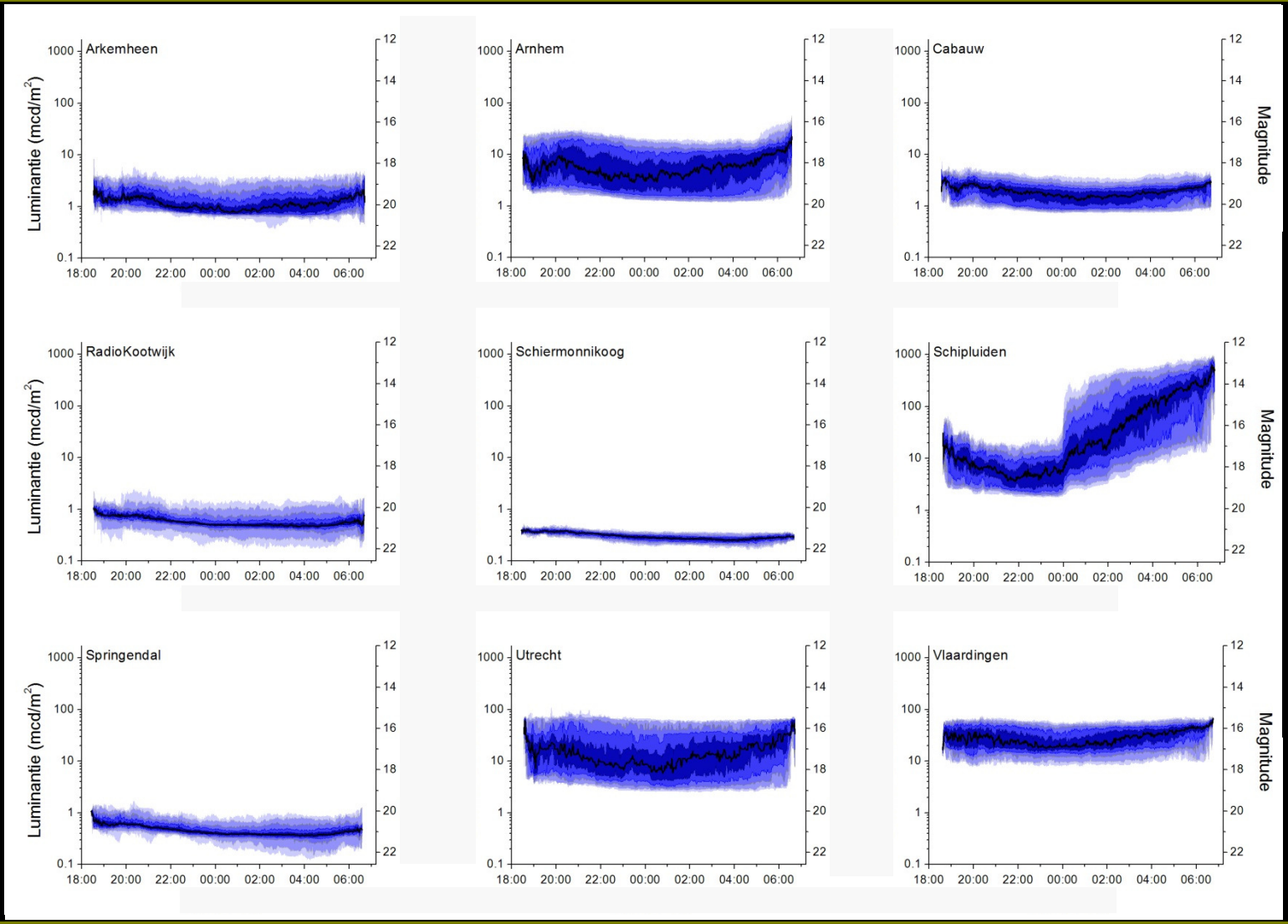
06:00
Tijd (uren)


Arkemheen
Arnhem
Cabauw
RadioKootwijk
Schiermonnikoog
Schipluiden
Springendal
Utrecht
Vlaardingen
Luminantie (mcd/m²)
Magnitude
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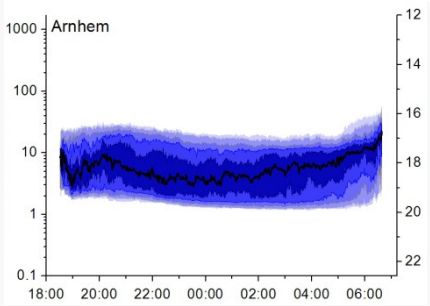
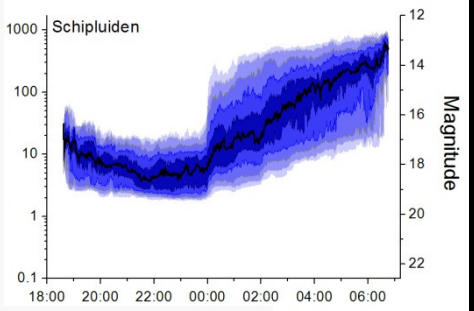
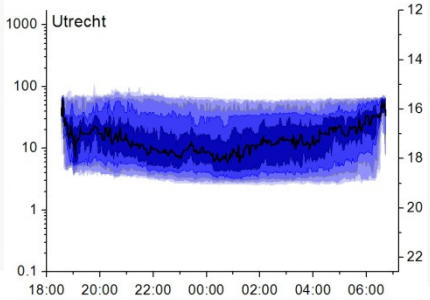
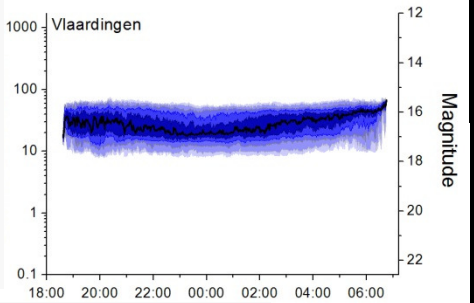
populated areas

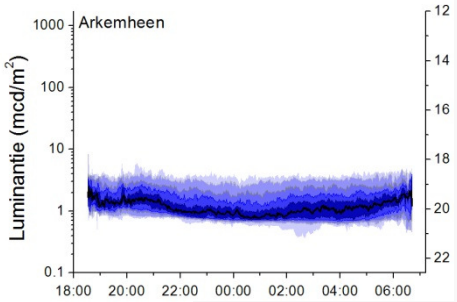


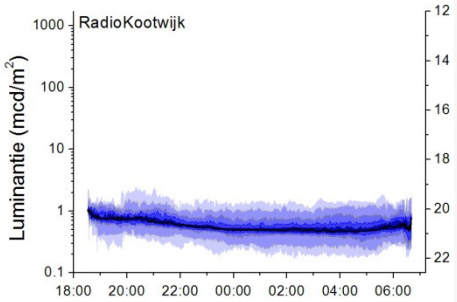


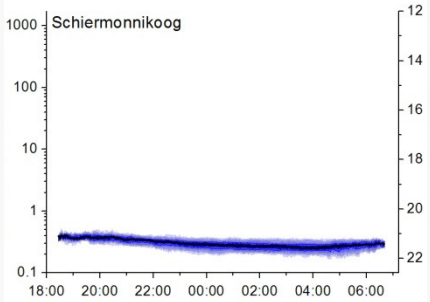


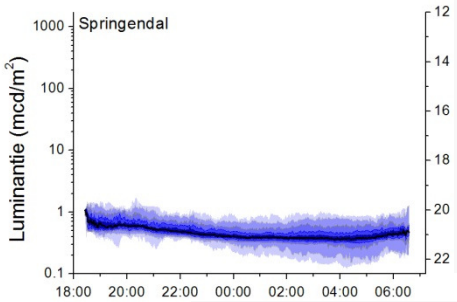


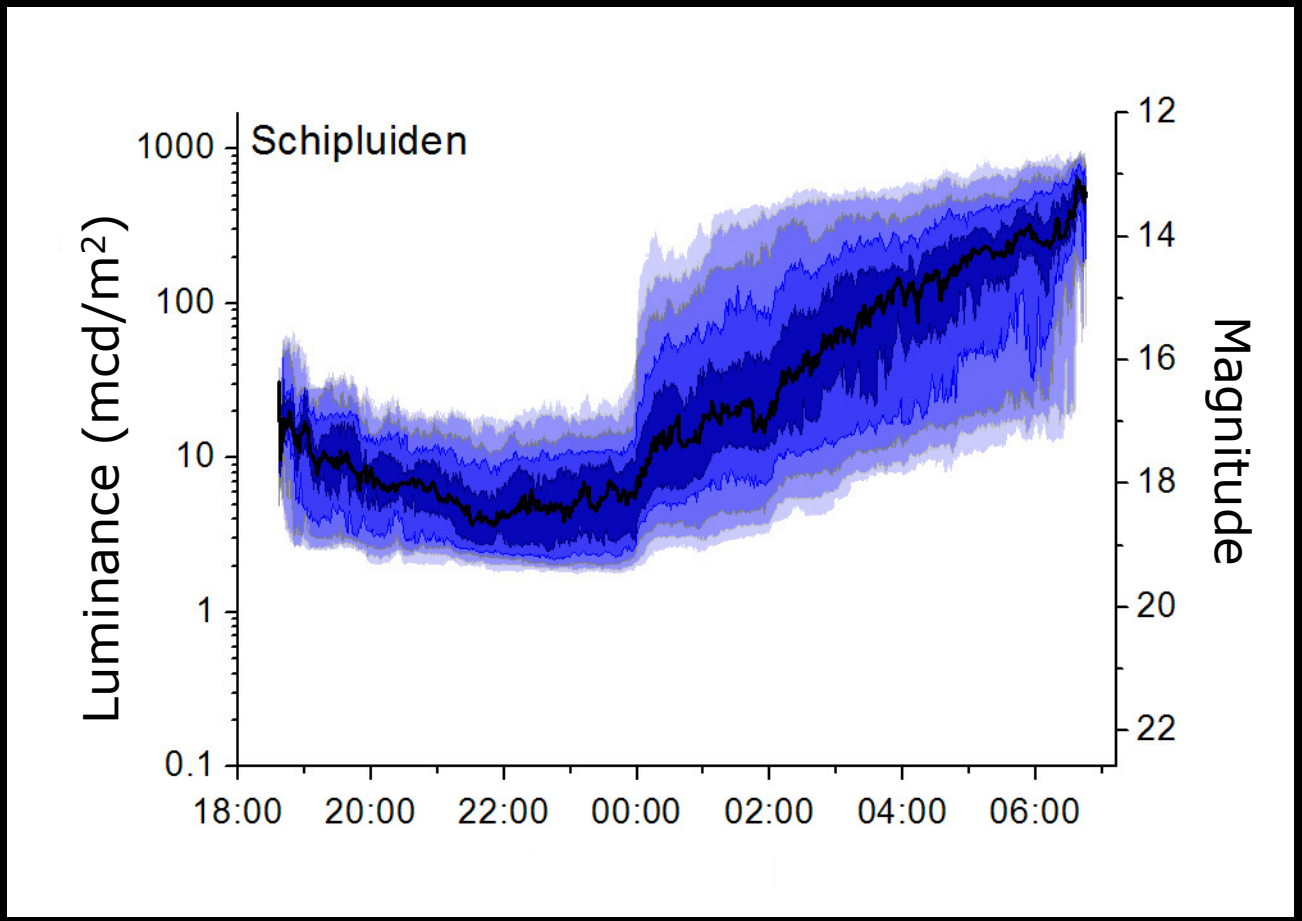
Nature areas "natura 2000"










Schipluiden
Luminance (mcd/m²)
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0.1
18:00
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02:00
04:00
06:00
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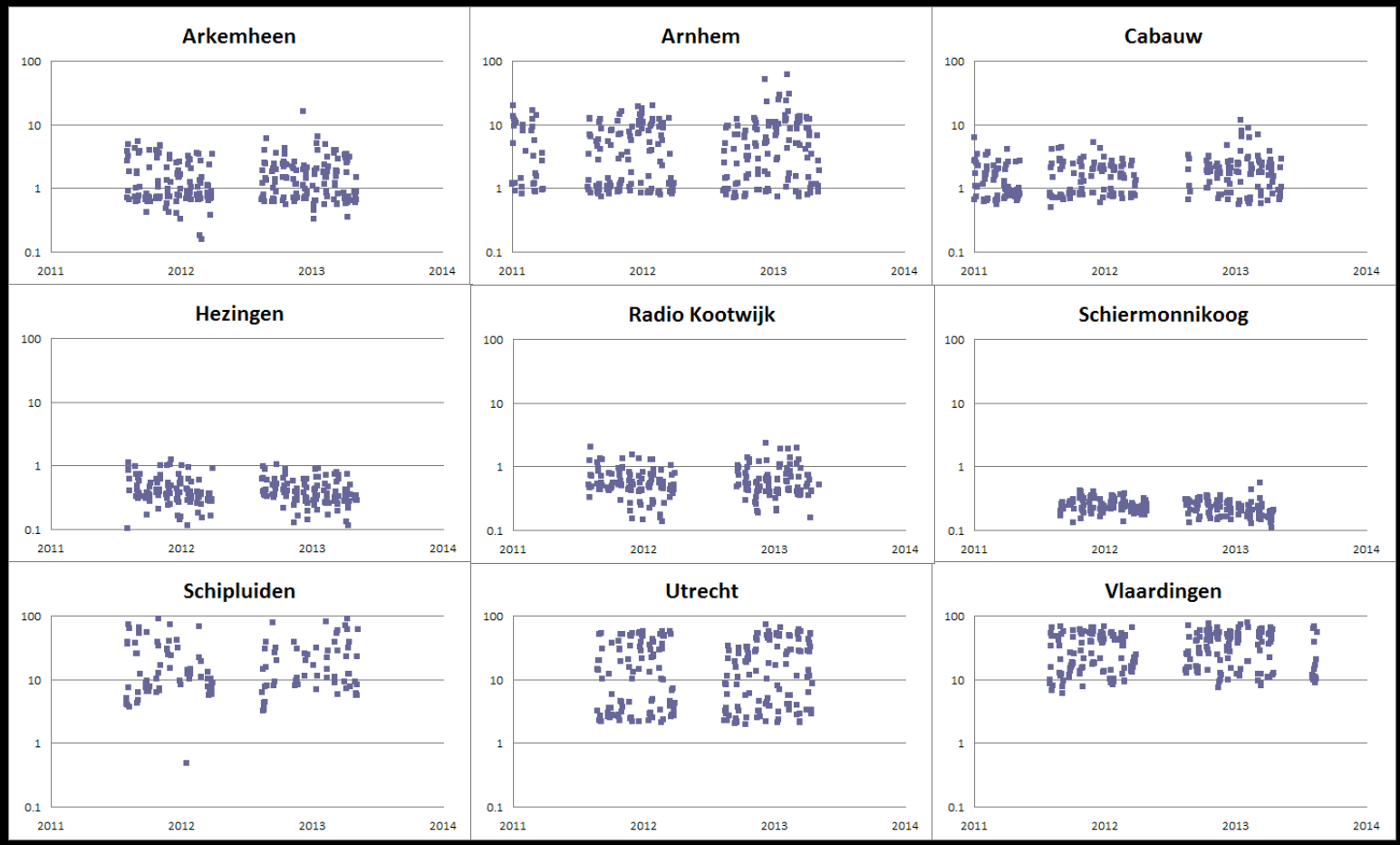
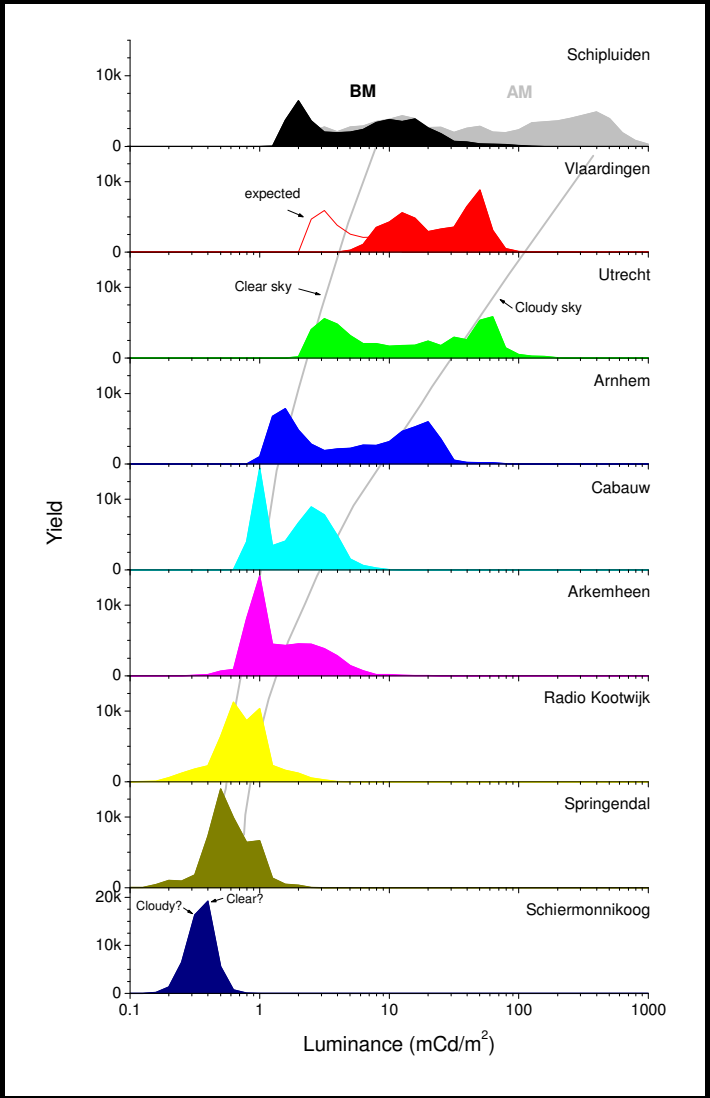
14
16
18
20
22
Magnitude


Arkemheen
Arnhem
Cabauw
Hezingen
Radio Kootwijk
Schiermonnikoog
Schipluiden
Utrecht
Vlaardingen
100
10
1
0.1
2011
2012
2013
2014


Schipluiden
BM
AM
Vlaardingen
expected
Utrecht
Clear sky
Cloudy sky
Arnhem
Cabauw
Arkemheen
Radio Kootwijk
Springendal
Schiermonnikoog
Cloudy?
Clear?
10k
0
20k
Yield
0.1
1
10
100
1000
Luminance (mCd/m^2)

Bruikbaarheid data MHN:

• Verschillen en variaties van hemelhelderheid op verschillende lokaties zijn goed te monitoren met relatief goedkope middelen

• Invloed lokale regelgeving op lichtemissie en gevolg op hemelhelderheid is goed te meten

• Relatie hemelhelderheid en wolkenhoogte/bedekkingsgraad

• Verbetering IPO-licht model

• Lange termijn monitoring zou toe -of afname in hemelderheid kunnen aantonen.