Sky Clarity Comparison between Riga and Metsähovi SLR Stations

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Definitions and Goals

- **Sky Clarity** (Atmospheric transparency) can be defined and measured by the difference between the sky temperature and the ambient air temperature at ground level.

  This temperature difference is directly related to the cloudiness level.

- Metsähovi and Riga SLR stations uses 'off the shelf' commercial sensors with the purpose of:
  - Real time sky clarity monitoring.
  - Rain/Snow Alert.
  - Day/Night/Twilight Status.

- Combined with All-Sky cameras, the SLR observer can monitor the sky situation and optimize the tracking schedule on real time without leaving the control room.

Definitions and Goals

- The Sky Clarity data **also** can be used to:

  1.- Refine the clarity ranges used for local cloud cover level classification.

  2.- Determine local cloudiness levels yearly patterns.

  3.- Haze detection in real time, It's possible?

  4.- Study the common clarity statistics between Riga and Metsähovi, towards the goals of:

  optimize simultaneous tracking,

  including future bistatic space debris tracking.

- An associated long-term future development:

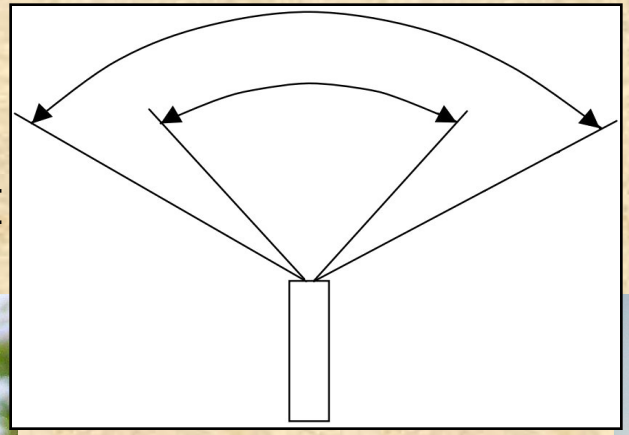
  Real time clarity/cloud cover exchange between stations: Methods and formats.

Geographical Situation

Hardware used

Riga FOV: HW: 89.6°
10%HW:110°

Riga: Aurora Cloud Sensor III
+All-Sky Camera



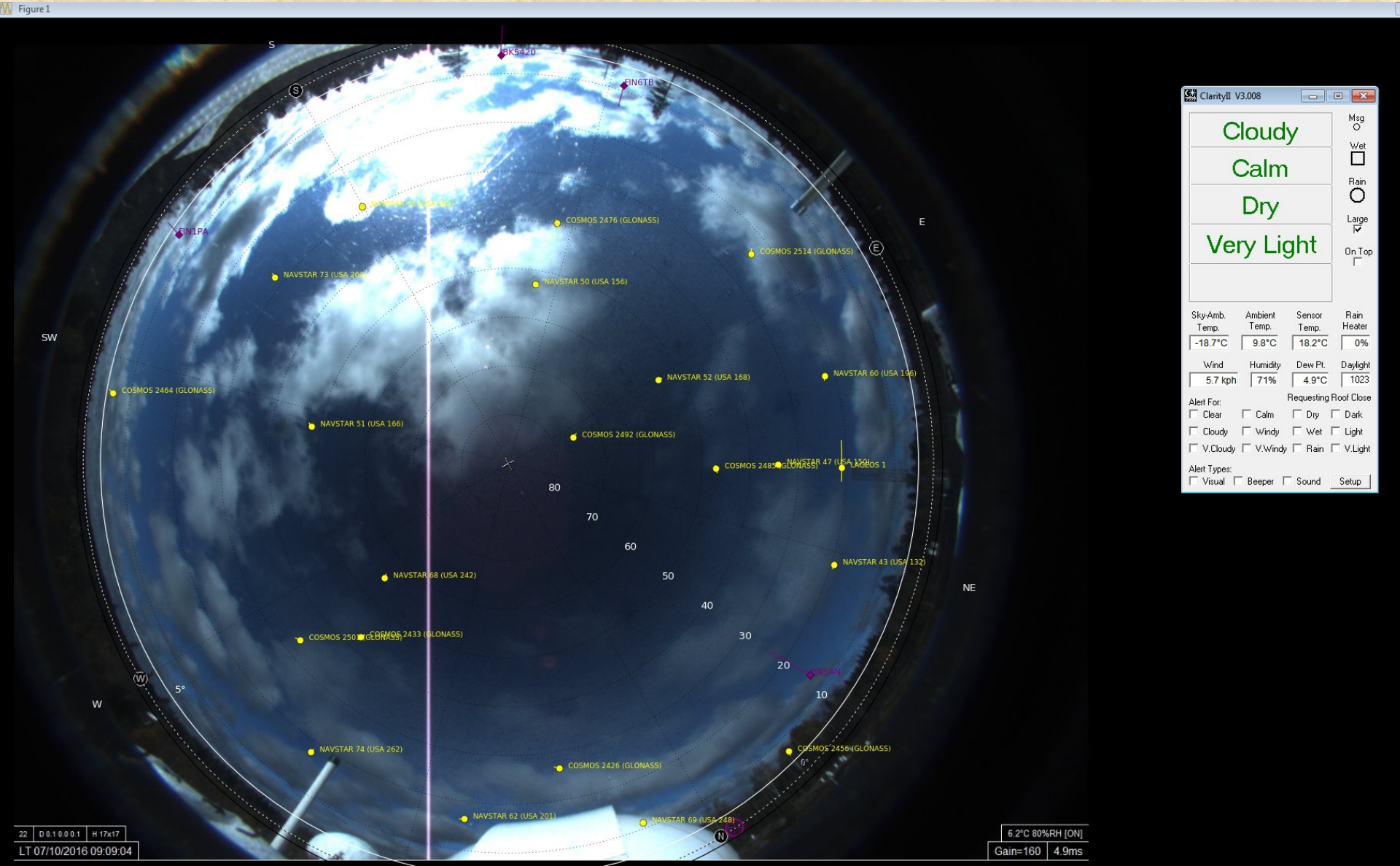
Metsahovi FOV: HW~80°
10%HW:~120°

Metsähovi:
Boltwood Cloud Sensor II

Riga: All Sky Cam
Moonglow Technologies
Metsähovi: All-Sky Camera
Alcor OMEA-2.0M-HCA

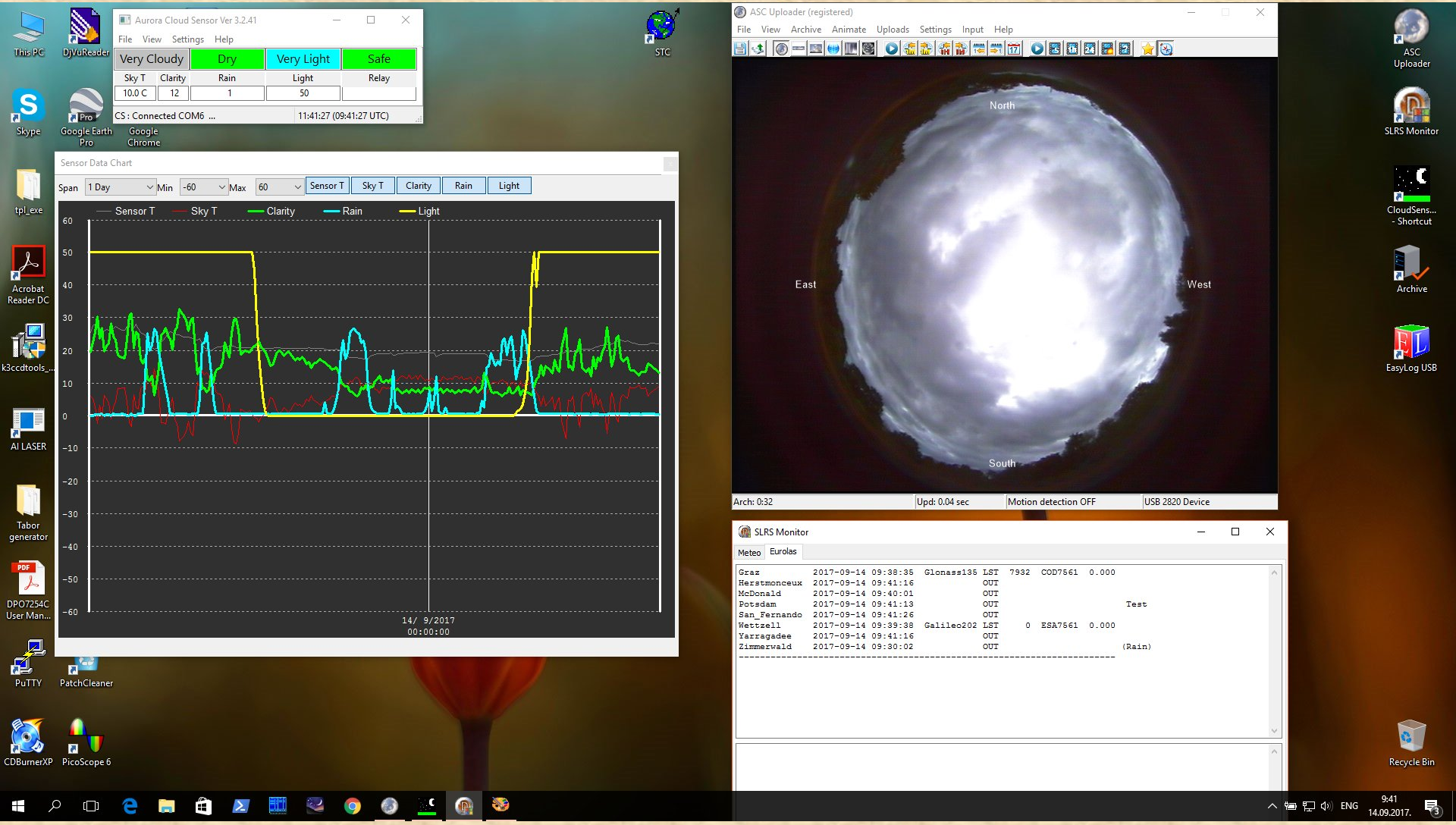
Software used

Metsähovi



Software used

Riga



Basic Info

- Riga Aurora Sensor start: 2017-02-07
- Metsahovi Boltwood data: since 2014
- Data Span used: 2017-03-15 to 2017-09-08 (178 days, 4272 hours)
- Common data processed: 148 days, 3048 hours (71.3%)*

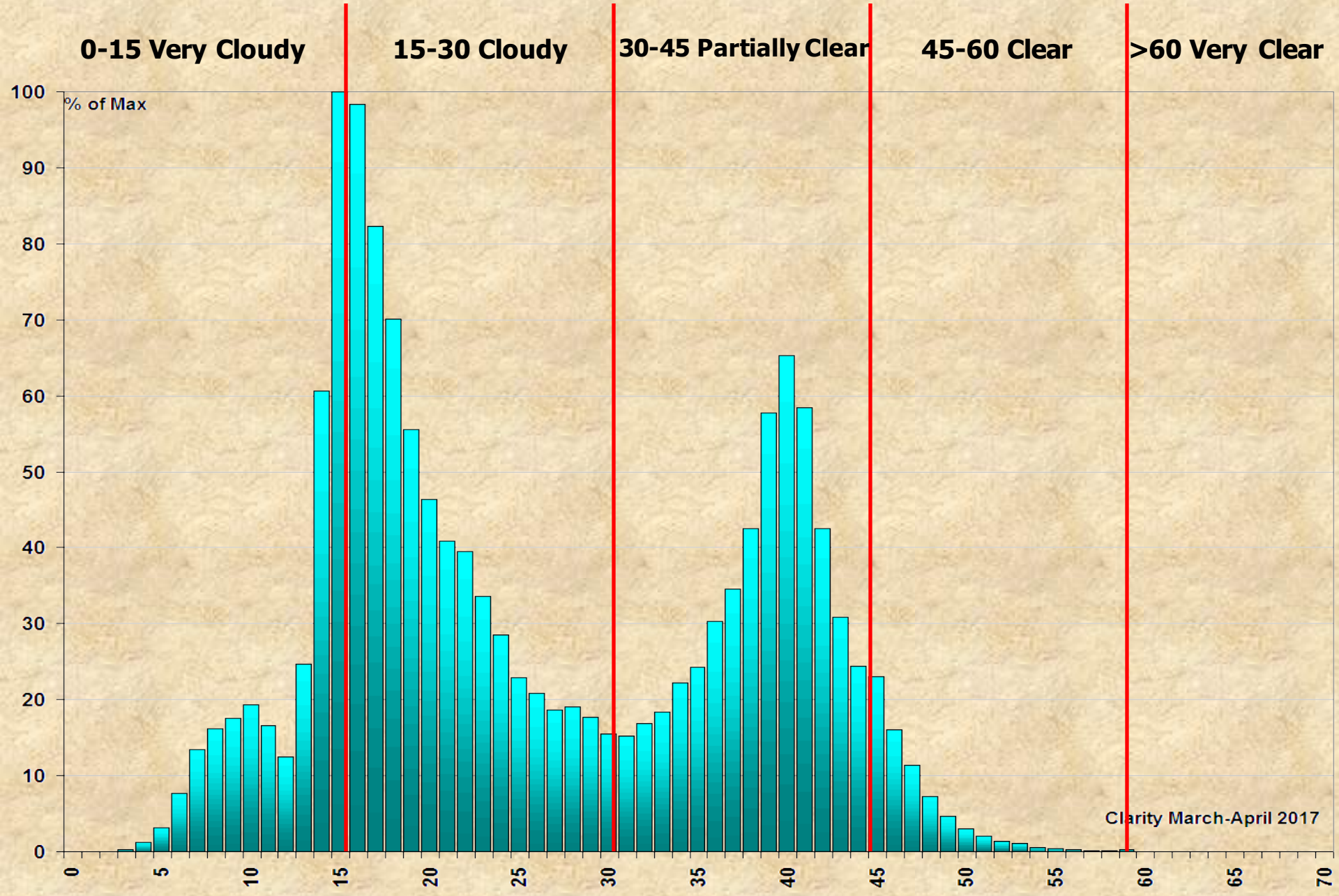
- Max/Min Clarity instantaneous values:
- Riga: **67.7** (2017-05-09, 09:33:16), **-8.6** (2017-07-26, 05:34:03)
- Metsähovi: **68.2** (2017-05-03, 10:51:00), **-1.4** (2017-03-20, 01:49:00).

- Max/Min Clarity hourly mean values:
- Riga: **54.2** (2017-02-07, 8h), **2.5** (2017-07-27, 1h)
- Metsähovi : **56.0** (2017-06-29, 5h), **-0.1** (2017-03-20, 2h)

*Metsähovi sensor location changed on 2017-08-30 at 7UTC due to construction work

*Metsähovi data from 2017-02-07 to 2017-03-14 was corrupted

Refine the clarity levels

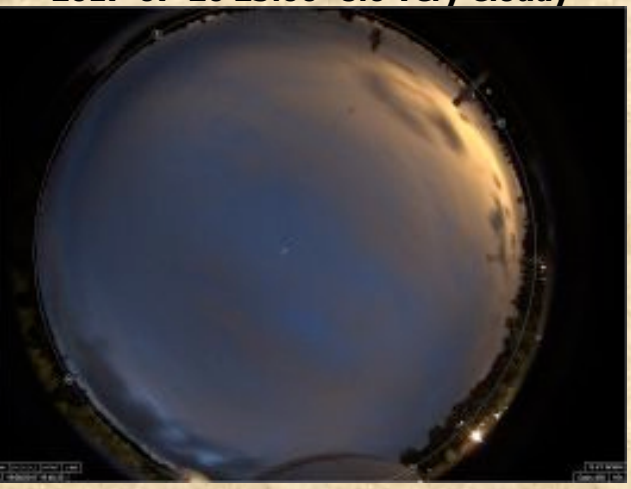


Clarity Values Examples

2017-07-26 23:00 -8.6 Very Cloudy

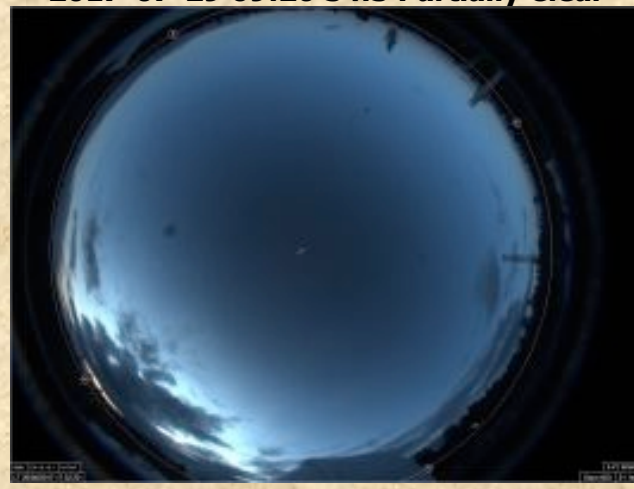
2017-08-02 14:40 19.4 Cloudy

2017-07-29 09:20 34.3 Partially Clear



2017-08-19 19:39 28.1 Cloudy

2017-03-27 18:50 40.5 Partially Clear



2017-08-26 17:34:00 48.1 Clear

Haze?

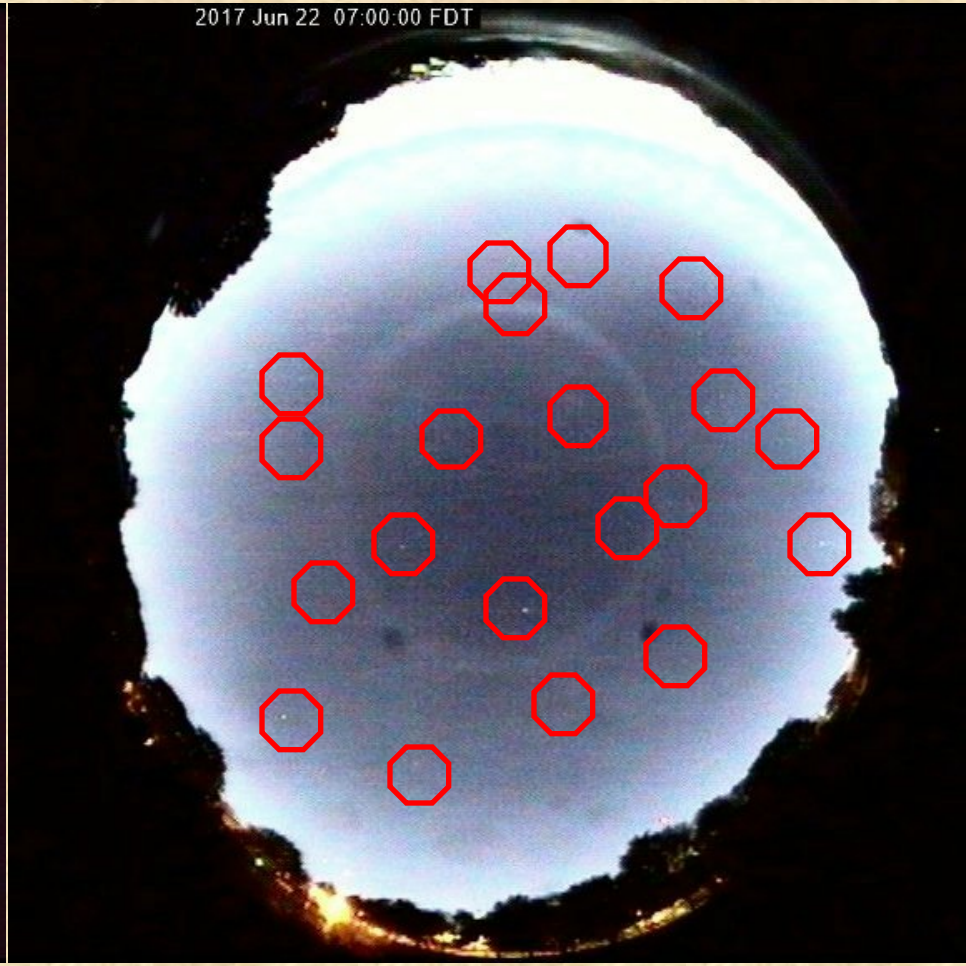
- All-Sky image of 2017-06-22 at 04:00 UTC
- Clarity value reported: **0.3**
- Sensor temperature: 19.1
- Sky temperature: 18.9

Visible stars marked in red

Contrast enhanced image

Haze?

Visible stars marked in red



Clarity 1.4

Contrast enhanced image

Data Flow

Riga

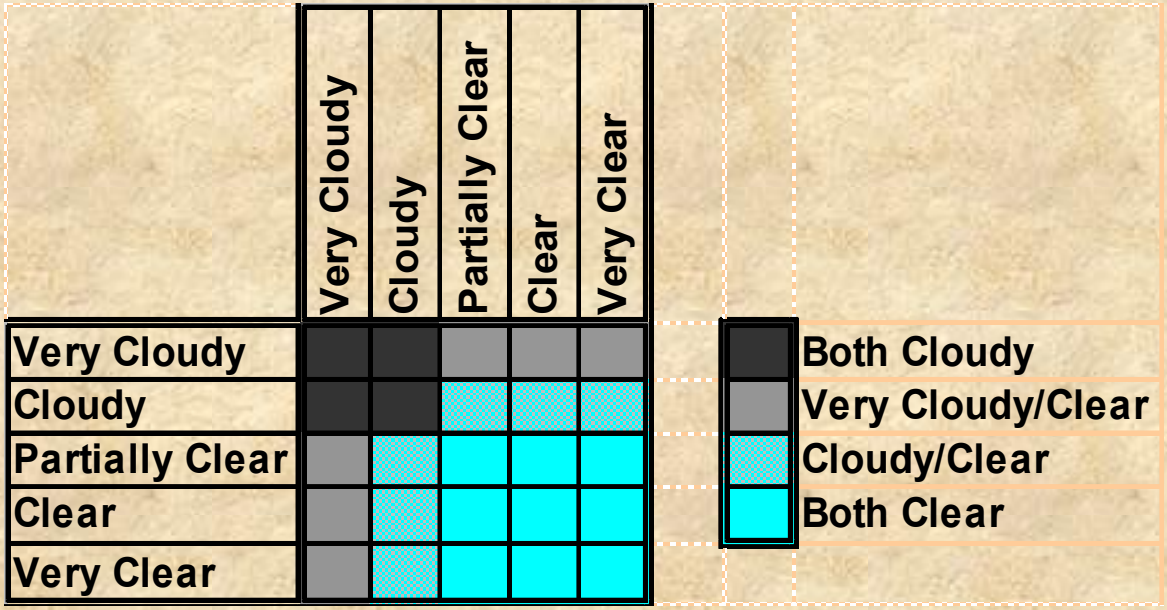
- Raw Data File
- Daily Raw Data File
- Hourly Mean Values Daily Data File

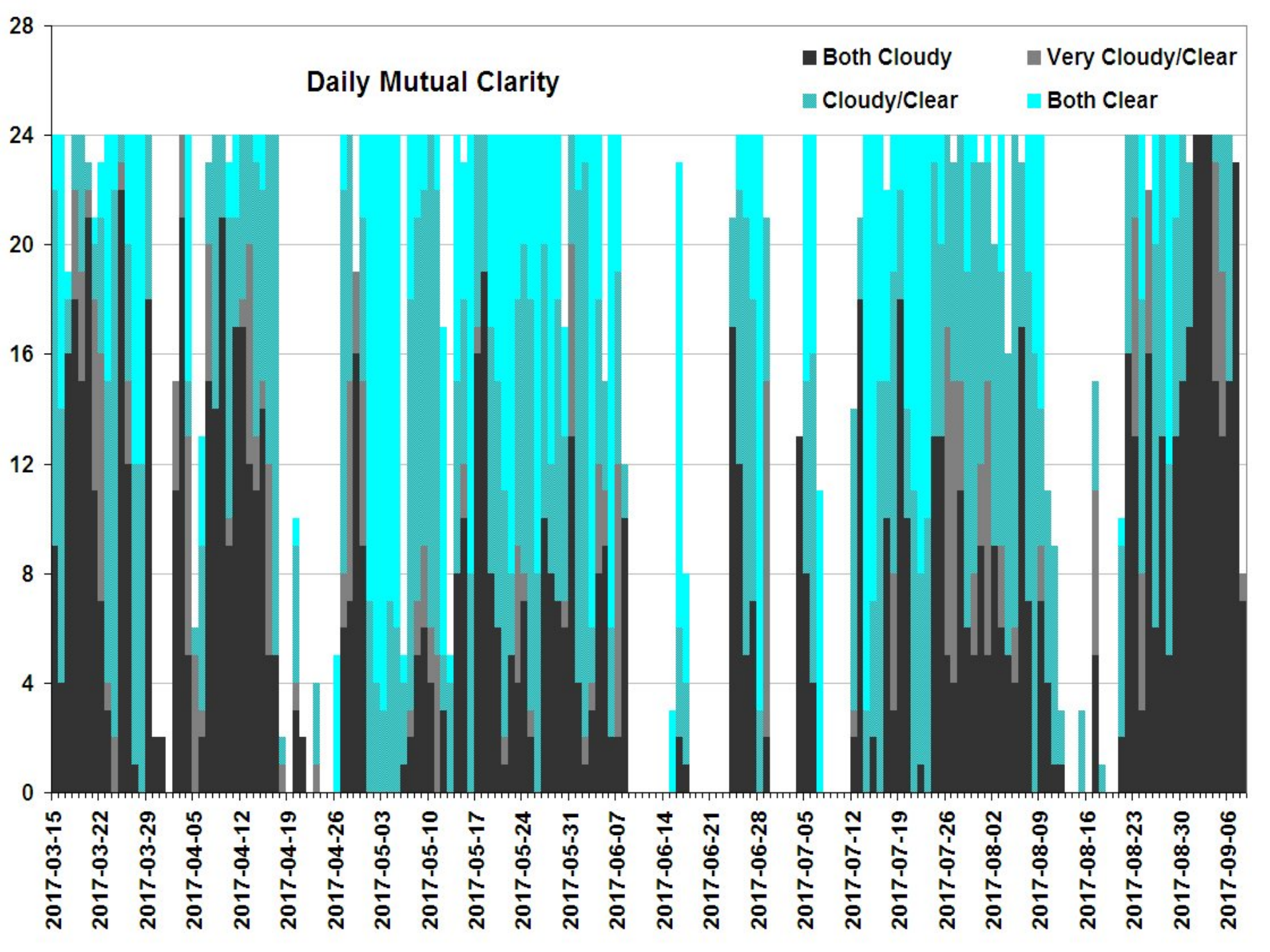
Metsahovi

- Raw Data File
- Daily Raw Data File
- Hourly Mean Values Daily Data File

<== common format ==>

- Matched Hourly Clarity Daily File
- Cloudiness Scale Added
- Daily Cloudiness Array Data
- Daily Matched Cloudiness Data




Daily Mutual Clarity
Both Cloudy
Very Cloudy/Clear
Cloudy/Clear
Both Clear
28
24
20
16
12
8
4
0
2017-03-15
2017-03-22
2017-03-29
2017-04-05
2017-04-12
2017-04-19
2017-04-26
2017-05-03
2017-05-10
2017-05-17
2017-05-24
2017-05-31
2017-06-07
2017-06-14
2017-06-21
2017-06-28
2017-07-05
2017-07-12
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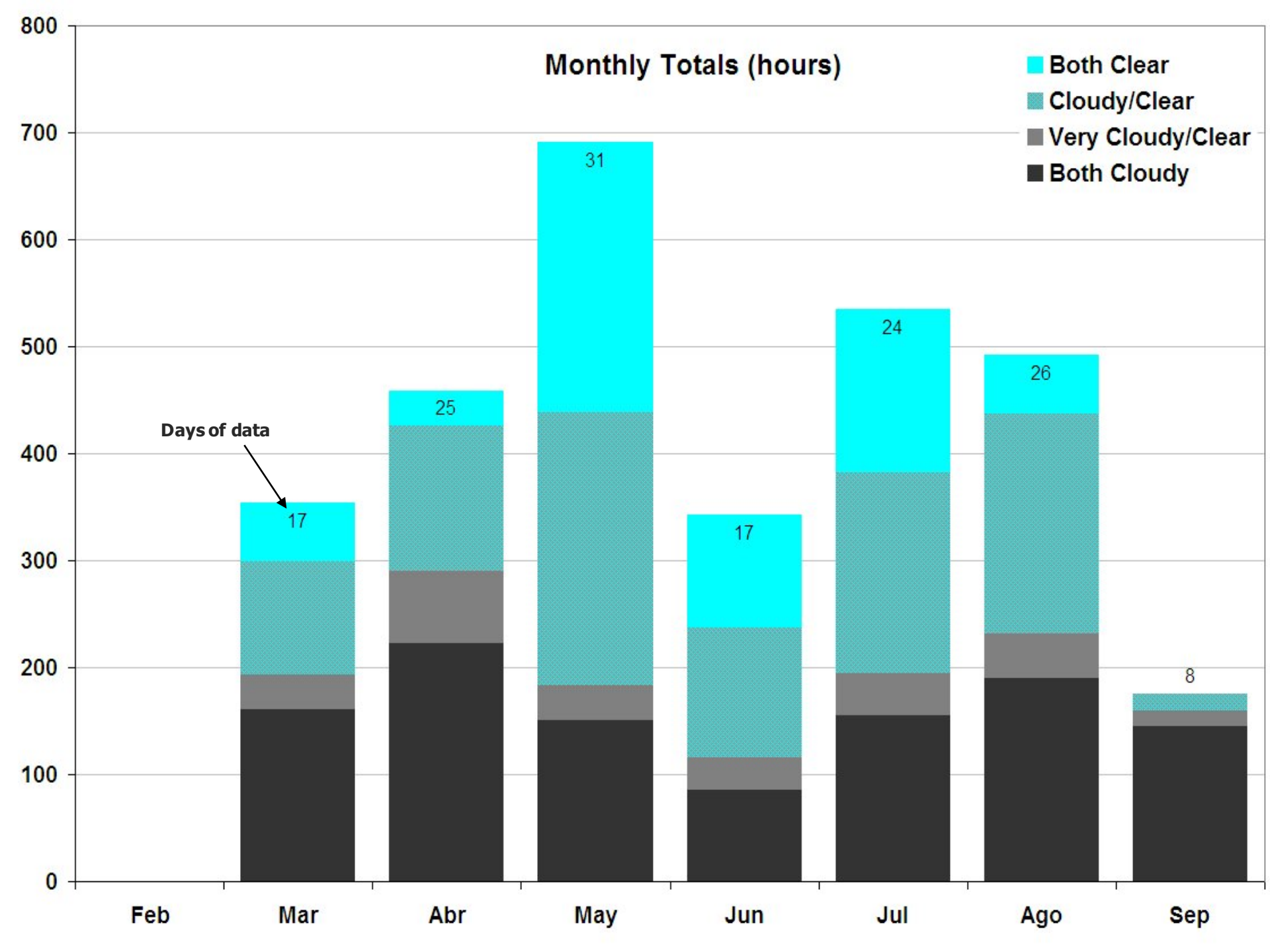
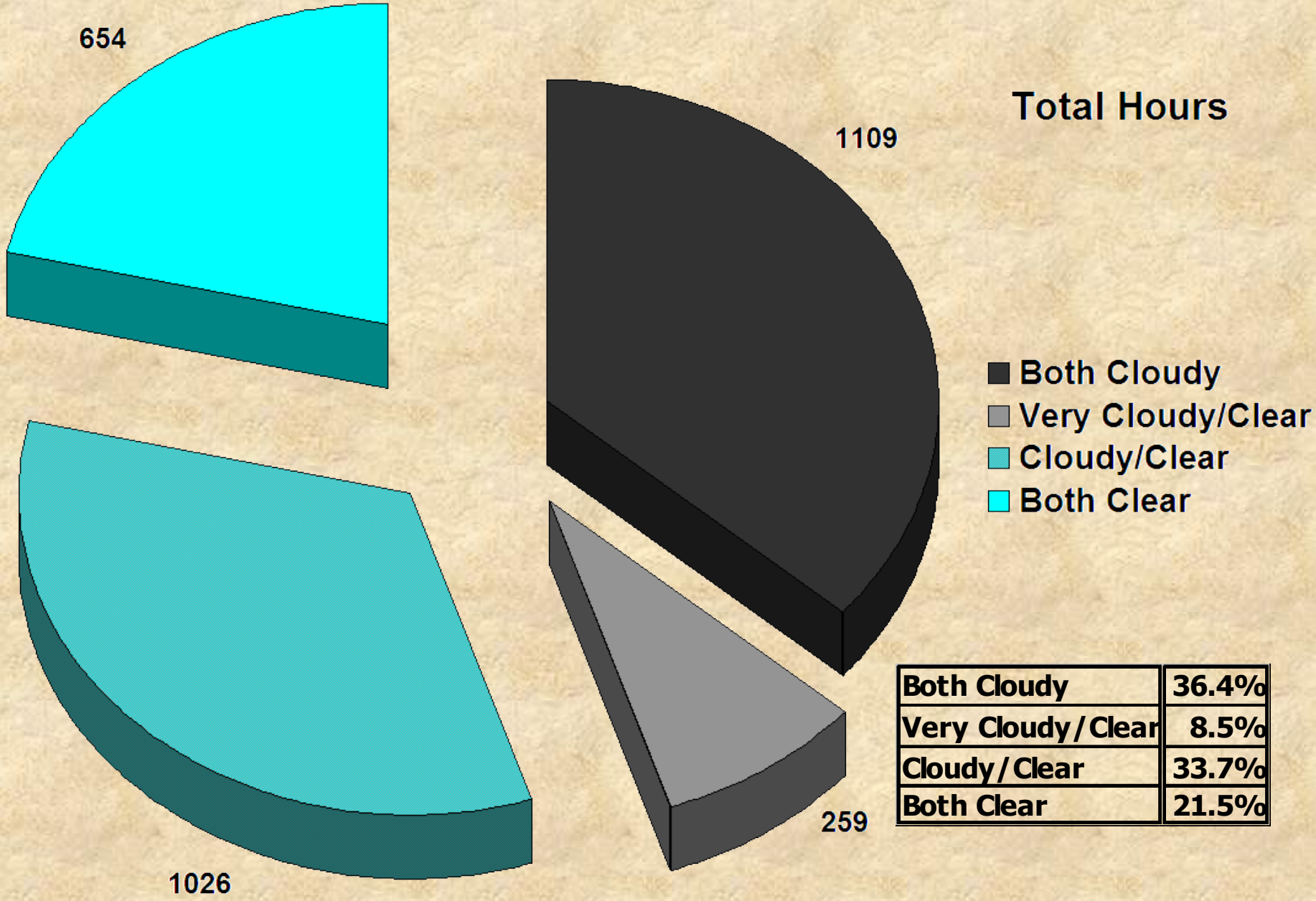
2017-07-26
2017-08-02
2017-08-09
2017-08-16
2017-08-23
2017-08-30
2017-09-06

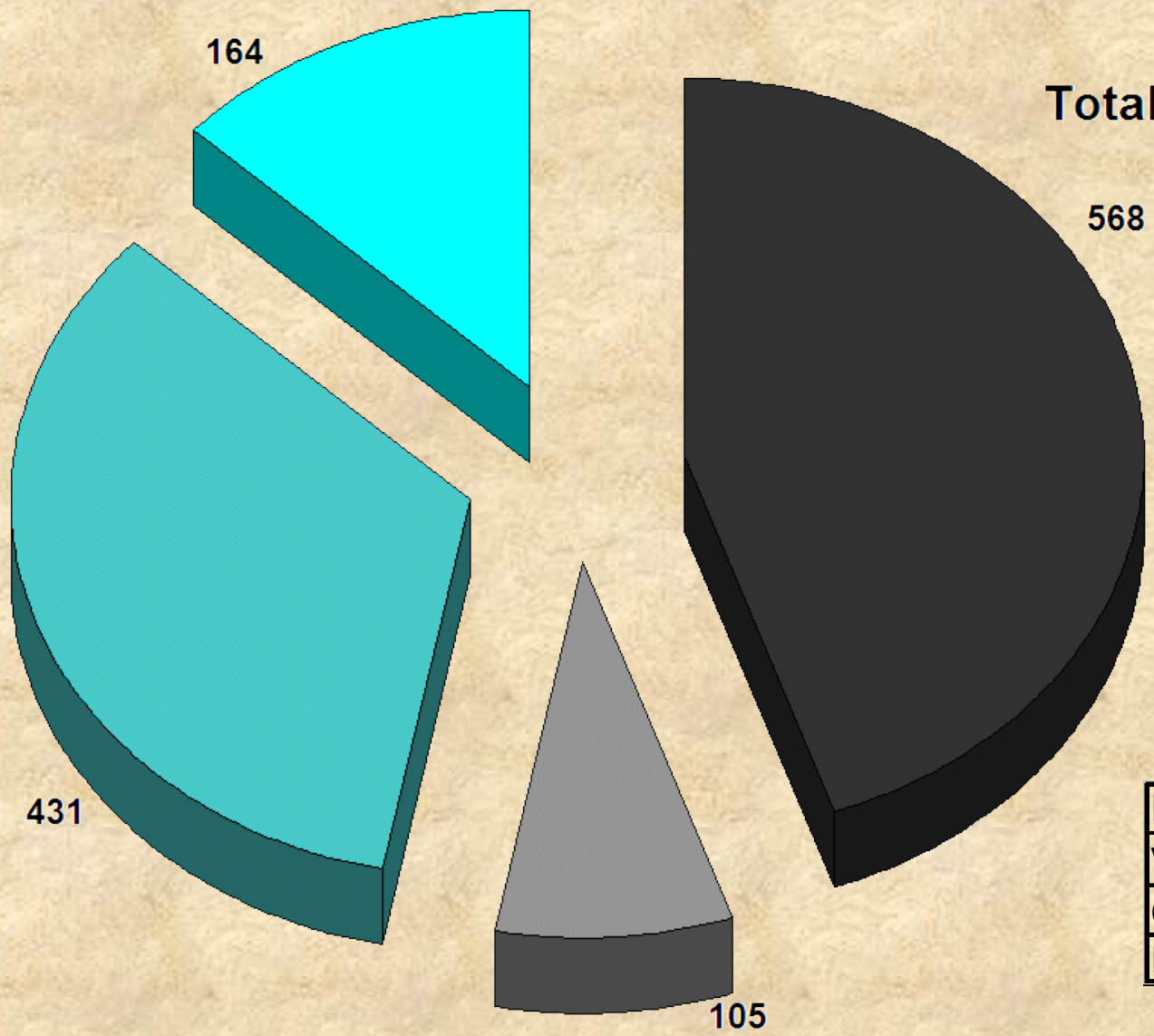

Monthly Totals (hours)
Both Clear
Cloudy/Clear
Very Cloudy/Clear
Both Cloudy
800
700
600
500
400
300
200
100
0
Days of data
17
25
31
17
24
26
8
Feb
Mar
Abr
May
Jun
Jul
Ago
Sep

24 h Statistics



Both Cloudy	36.4%
Very Cloudy/Clear	8.5%
Cloudy/Clear	33.7%
Both Clear	21.5%

Night/Twilight Statistics



Both Cloudy	44.8%
Very Cloudy/Clear	8.3%
Cloudy/Clear	34.0%
Both Clear	12.9%

Next Steps

- Explore the Clarity bin size effect on final statistics.
- Use sub-hour resolution (20 min).
- Process all the night-only clarity subsets.
- Yearly results report, including more plots.
- Continue searching for possible haze examples.
- and…

Next Steps

- Take out the bugs from data!

Conclusions

- We show the use of sensor(s) data to compile both the individual station long term clarity statistics and the common clarity conditions for Riga and Metsähovi.
- The common clarity data can be useful for the evaluation of simultaneous tracking, in particular bistatic space debris mode, between Riga and Metsähovi.
- The need to explore if the clarity data and all-sky views can be used in real time to detect high altitude haze conditions.
- Recommend to all stations having clarity sensors to carry out this type of processing, in particular close stations pairs considering doing regular simultaneous tracking on purpose.
- Standardizing the *real-time clarity exchange information* is a problem to be addressed in the future.