ClimateBasis Monitoring Program

Nuuk Basic
2010

Project no.: B53-05

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Introduction

The ClimateBasis monitoring program in Nuuk is part of the Nuuk Basic Research Project (NERO). The aim of NERO is to contribute to the monitoring of changes in the low arctic environment and to improve the understanding of the composition, function and dynamics of the ecosystem in the low arctic.

The ClimateBasis monitoring program includes collection, quality control and communication of data, which describes the climate at the research station in Kobbefjord.

In 2010 the ClimateBasis monitoring program includes two climatological measuring stations; Climate Station 1 (Asiaq no. 652) and Climate Station 2 (Asiaq no. 653), two hydrometric stations; Hydrometric Station 1 (Asiaq no. 650) and Hydrometric Station 2 (Asiaq no. 651) and three diver stations, diver station H3, H4 and H5 (Asiaq no. 654, 655 and 656). For a description see The ClimateBasis Manual for Nuuk Basic (Iversen and Thorsøe, 2009). This report only contains information about Climate Station 1, Climate Station 2 and Hydrometric Station 1.

Asiaq, Greenland Survey, is responsible for the operation of ClimateBasis. The Danish Energy Agency finances the ClimateBasis monitoring program.

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1 Measuring Program 2010, Climate Stations

An overview of the measuring program for station 652 and station 653 during 2010 can be seen in Table 1.1:

Table 1.1 Overview of measuring program for st. 652 and st. 653, 2010.

Parameter	Sensor Type	Sensor Height (m.a.t.)	Measuring Range	Sensitivity (resolution)	Accuracy	Data Stored in the Data logger[1]	
						Average/sum	Sample/max/min
Air Temperature	Vaisala HMP 45D	2 m	-40 - +60 °C	0.1 °C	+/- 0.4 °C	$[0;30]_{10\ sec}^{30\ min}$ Average	$[-]_{10\ sec}^{30\ min}$ max/min
Relative Humidity	Vaisala HMP 45D	2 m	0.8 - 100 %RH	0.1 %	+/- 3 %	$[0;30]_{10\ sec}^{30\ min}$ Average	
Air Pressure at Station	Campbell Scientific PTB101 B	1.5 m	600 - 1060 hPa	0.1 hPa	+/- 4 hPa	$[0;30]_{10\ sec}^{30\ min}$ Average	
Wind Speed	Met One 034B	10 m	0.4 - 49 m/s	0.1 m/s	+/- 0.12 m/s (>10.1 m/s 1.1%)	$[0;10]_{10\ sec}^{10\ min}$ Average	$[-]_{10\ sec}^{30\ min}$ max/min
Wind Speed	Theodor Friedrichs & Co 4034.0000	2 m	0.5 - 60 m/s	0.1 m/s	+/- 0.3 m/s	$[0;10]_{10\ sec}^{10\ min}$ Average	$[-]_{10\ sec}^{30\ min}$ max/min
Wind Direction	Met One 034B	10 m	0 - 360°	0.5°	+/- 4°	$[0;10]_{10\ sec}^{10\ min}$ Average	$[-]_{10\ sec}^{30\ min}$ at max wind
Short Wave Radiation, Incoming and Outgoing	CNR1	2 m	0 - 1000 W/m^2	0.6 – 2.7 W/m^2	+/- 10 % for daily sums	$[0;5]_{10\ sec}^{5\ min}$ Average	
Long Wave Radiation, Incoming and Outgoing	CNR1	2 m	+/-250 W/m^2	0.3 – 1.1 W/m^2	+/- 10 % for daily sums	$[0;5]_{10\ sec}^{5\ min}$ Average	
UV-B	Solar Light 501A	2 m	0 - 583 mW/m^2	< 0.583 mW/m^2	+/- 5 % for daily total	$[0;5]_{10\ sec}^{5\ min}$ Average	
Net Radiation	NR Lite	2 m	+/- 2000 W/m^2	0.7 W/m^2	+/- 10 %	$[0;5]_{10\ sec}^{5\ min}$ Average	
PAR	Kipp & Zonen PAR Lite	2 m	0 - 3700 $\mu mol/(S*m^2)$	1.2 – 1.8 $\mu mol/(S*m^2)$	+/- 10 %	$[0;5]_{10\ sec}^{5\ min}$ Average	
Relative Vegetation Index	Skye Inst. SKR110	2 m	<500 $\mu mol/m^2/s$	100 $\mu mol/m^2/s$	+/- 3 - 5 %	$[0;5]_{10\ sec}^{5\ min}$ Average	
Precipitation	Ott Pluvio	-	0 - 99.99 mm	0.05 mm/h		$[0;60]_{10\ sec}^{60\ min}$ sum	$[-]_{10\ sec}^{x\ min}$ Sample
Snow Depth	Campbell Scientific SR50	-	0.5 - 10 m	0.1 mm	+/- 1 cm or 0.4 %		$[0;179]_{-}^{180\ min}$ Sample

[1)] Data stored in the data logger is given as $[a;b]_c^d$, where 'd' is the interval between outputs written to the data logger, 'c' is the interval between scans of the sensor, 'a' and 'b' are minutes into the interval between output. Average values are found by averaging data values measured with interval c between 'a' and 'b'. Sample values are measured 'a' minutes into the interval between output.

2 Inspections of the Stations during 2010

Asiaq technicians visited the Nuuk Basic climate stations on one occasion in 2010. Six additional visits to the stations were carried out by other Asiaq personnel. A summary of the work done on each station is given below.

2.1 Time Line and Summary of Events for st. 652

2010-01-01	Start of quality check period
2010-01-07	Download data, removal of non-functioning radio antenna and modem, precipitation reference record.
2010-04-28	Download data via CF-card, precipitation reference record.
2010-05-17	Replace and format CF-card, time adjusted, precipitation reference record.
2010-06-16/17	Technicians visit: Data collection, replacement of Net Rad. (NR Lite and CNR1), RVI, and PAR sensor. Extra battery box and battery added to the station along with the installation of radio and modem. Ball bearings on wind sensor replaced and any sensors that were not level were levelled. Installation of UVB reference sensor and reference tests at both arrival and departure.
2010-06-25	Download data, upload new program with correct multiplication factors for radiation sensors, visual check, collection of UVB reference sensor, power supply and data logger enclosure.
2010-07-08	Download data, remove radio from station, precipitation reference record.
2010-09-30	Download data, visual check, height measurement of snow depth instrument, precipitation reference record.
2010-12-31	End of the quality check period

2.2 Time Line and Summary of Events for st. 653

2010-01-01	Start of quality check period
2010-01-07	Download data, removal of non-functioning radio antenna and modem, precipitation reference record.
2010-04-28	Download data, precipitation reference record
2010-05-17	Download data, time adjusted, precipitation reference record.
2010-06-16/17	Technicians visit: Data collection, replacement of Net Rad. (NR Lite and CNR1), RVI, and PAR sensor. Extra battery box and battery added to the station along with the installation of radio and modem. Ball bearings on wind sensor replaced and any sensors that were not level were levelled. Reference test at both arrival and departure.
2010-06-25	Download data, upload new program with correct multiplication factors for radiation sensors and visual check.
2010-07-08	Download data, remove radio from station, precipitation reference record.
2010-09-30	Download data, visual check, height measurement of snow depth instrument, precipitation reference record.
2010-12-31	End of the quality check period

2.3 The Results of the Reference Tests at st. 652

Table 2.1 Arrival and departure reference tests 2010-06-16 at st. 652.

Parameter	Unit	2010-06-16 Arrival			2010-06-17 Departure		
		Logger	Reference	Time	Logger	Reference	Time
Wind speed 10 m	m/s	1.99	2.00	21:35	4.52	5.00	22:16
Wind direction 10 m	Degree	208	211	21:37	211	211	22:13
Relative Humidity 2 m	%	50	51	21:24	55	56	16:36
Wind speed 2 m	m/s	2.60	0.80	21:28	7.45	7.00	16:50
Air temperature 2 m	°C	11.75	12.83	21:24	13.68	12.68	16:36
Precipitation	mm	-	(13.1 cm)	21:49	-	(9.0 cm)	17:02
Air pressure	hPa	1003.7	1003.6	21:27	998.8	998.7	16:37
Logger temperature	°C	14.73	-	21:11	14.06	-	16:38
Battery	V	12.19	12.07	21:33	11.99	11.90	16:38
CNR1 Short Wave in	W/m^2	38.26	42.67	20:50	87.85	140.51	16:30
CNR1 Short Wave out	W/m^2	4.33	2.86	21:11	13.00	14.83	16:45
CNR1 Long Wave in	W/m^2	87.94	-	20:50	15.55	-	-
CNR1 Long Wave out	W/m^2	16.49	-	21:11	3.92	-	-
PAR	$\mu mol/m^2/s$	109.25	-	-	332.35	-	-
UVB	W/m^2	-	-	-	-	-	-
RVI 660 nm	$\mu mol/m^2/s$	-	-	-	-	-	-
RVI 730 nm	$\mu mol/m^2/s$	-	-	-	-	-	-
Snow Depth	m	0	0	21:44	0	0	16:51
Distance to snow	m	-	-	-	-	-	-

Table 2.2 Arrival and departure reference tests 2010-09-30 at st. 652.

Parameter	Unit	2010-09-30 Arrival			2010-09-30 Departure		
		Logger	Reference	Time	Logger	Reference	Time
Precipitation	mm		(16.2 cm)	~12:00		(16.2 cm)	~12:00
Snow Depth	m	0	0	~12:00	0	0	~12:00
Distance to Snow	m	1.835	1.798	~12:00	1.835	1.798	~12:00

2.4 The Results of the Reference Tests at st. 653

Table 2.3 Arrival and departure reference tests 2010-06-16 at st. 653.

		2010-06-16 Arrival			2010-06-17 Departure		
Parameter	**Unit**	**Logger**	**Reference**	**Time**	**Logger**	**Reference**	**Time**
Wind speed 10 m	m/s	2.52	1.00	23:19	4.84	4.00	18:06
Wind direction 10 m	Degree	214	220	23:17	220	220	18:06
Relative Humidity 2 m	%	50	49	22:36	55	55	17:42
Wind speed 2 m	m/s	3.01	2.00	22:34	5.20	5.00	18:02
Air temperature 2 m	°C	13.30	12.86	22:36	15.05	14.22	17:41
Precipitation	mm	-	(12.7 cm)	23:24	-	-	-
Air pressure	hPa	999.7	1002.8	22:33	994.5	998.8	17:40
Logger temperature	°C	13.59	-	23:26	14.97	-	-
Battery	V	11.70	11.68	23:27	11.64	11.78	18:01
CNR1 Short Wave in	W/m^2	2.04	2.80	22:48	124.37	90.72	17:57
CNR1 Short Wave out	W/m^2	4.01	2.74	22:54	11.29	13.25	17:55
CNR1 Long Wave in	W/m^2	51.27	-	22:54	22.55	-	17:57
CNR1 Long Wave out	W/m^2	12.52	-	22:54	5.30	-	17:55
PAR	$\mu mol/m^2/s$	10.11	-	22:48	218.8	-	17:57
UVB	W/m^2	-	-	-	-	-	-
RVI 660 nm	$\mu mol/m^2/s$	-	-	-	-	-	-
RVI 730 nm	$\mu mol/m^2/s$	-	-	-	-	-	-
Snow Depth	m	0	0	23:22	0	0	17:58
Distance to snow	m	-	-	-	-	-	-

Table 2.4 Arrival and departure reference tests 2010-09-30 at st. 653.

		2010-09-30 Arrival			2010-09-30 Departure		
Parameter	**Unit**	**Logger**	**Reference**	**Time**	**Logger**	**Reference**	**Time**
Precipitation	mm		(17.0 cm)	~12:00		(17.0 cm)	~12:00
Snow Depth	m	0	0	~12:00	0	0	~12:00
Distance to Snow	m	1.825	1.806	~12:00	1.825	1.806	~12:00

2.5 Time Line and Summary of Events for st.650

2010-01-01	Start of quality check period
2010-01-07	Download data, winter discharge measurement, water level reference record.
2010-02-22	Winter discharge measurement, water level reference record.
2010-04-21	Winter discharge measurement, water level reference record, levelling between reference points 650-2006-01 and KobbefjordFix.
2010-09-30	One diver and one baro diver added to the station. Water level reference record.
2010-10-27	Discharge measurement with salt dilution method compared with discharge measurement with current meter. Water level reference record. Technicians visit: Download data, add battery box and an extra battery to the station, arrival and departure reference tests.
2010-12-16	Winter discharge measurement, water level reference record.
2010-12-31	End of the quality check period

2.6 The Results of the Reference Tests at st. 650

Table 2.5 Arrival and departure reference tests 2010-10-27 at st. 650.

		2010-10-27 Arrival			2010-10-27 Departure		
Parameter	**Unit**	**Logger**	**Reference**	**Time**	**Logger**	**Reference**	**Time**
Air temperature 2m	°C	1.39	1.36	9:12	1.39	1.42	10:48
Water level 1	m	3.34	-	9:08	3.16	-	10:45
Water level 2	m	3.05	-	9:08	3.04	-	10:45
Water temperature 1	°C	2.10	-	9:08	2.19	-	10:45
Water temperature 2	°C	1.58	-	9:08	1.66	-	10:45
Logger temperature	°C	1.86	-	9:08	2.65	-	10:45
Battery	V	10.43	10.74	9:50	11.66	12.21	10:51

3 Processing of Climatological Data

The aim of the data processing is to establish one data series of high quality for each measured parameter.
The data processing includes the following steps:

1. Any necessary corrections of the data are performed.
2. Data exceeding the physical limits for the given parameter are removed.
3. Comparison of data from sensors measuring the same parameter (when available) and/or from sensors measuring related parameters is used to identify outlying records. Also the reference tests are included in the data evaluation.
4. If possible the data series from each station are adjusted or corrected using regression, interpolation or arithmetic's. Gaps created due to editing are filled in step 5.
5. Data from each station are normally combined by averaging data from each station. In case of missing data correlated values are included in the average:

Data on both stations	Only data on St.652	Only data on St.653	No data
½(St.652+St.653)	½(St.652+ St.653=αSt.652+β)	½ (St.653+ St.652=αSt.653+β)	No data

List of correlations used in case of missing data on one of the stations:

Table 3.1 Station 652=coefficient*(Station 653)+offset.

	2007-10-22 to 2008-12-31		2009-01-01 to 2009-12-31		2010-01-01 to 2010-12-31	
	coefficient	**offset**	**coefficient**	**offset**	**coefficient**	**offset**
ATA	0.992172	0.0249843	0.99269	0.0502895	0.994208	-0.0148016
ATM	0.993406	0.00985542	0.993978	0.0356167	0.99469	-0.0241818
ATN	0.990167	0.0340104	0.990945	0.0615894	0.993327	-0.008033
RH					0.990234	-1.03823
QFE					1.00017	-0.149847
UVB					1.0137	$-1.1904*10^{-4}$

Table 3.2 Station 652=coefficient*(Station 653)+offset. The sensors for these parameters were replaced during the annual station maintenance visit.

	2010-01-01 to 2010-06-16		2010-06-17 to 2010-12-31	
	coefficient	**offset**	**coefficient**	**Offset**
LRI	1.06499	-20.3904	1.0461	-14.8944
SRI	0.984584	-0.426526	1.03439	0.495935
PAR			1.0011	0.577684
WS12[1]	1.00757	-0.0074		
WS16[2]	0.988001	0.018173		
WSM12[1]	0.9889	0.0595		
WSM16[2]	0.9915	0.0166		

1) Correlation based upon 121 days of data. 2) Correlation based upon 114 days of data.

Table 3.3 Station 652=coefficient*(Station 653)+offset. These parameters have a pronounced different winter and summer correlation.

	Snow Cover		No Snow Cover				Snow Cover	
	2010-01-01 to 2010-04-19		2010-04-20 to 2010-06-16		2010-06-17 to 2010-11-07		2010-11-08 to 2010-12-31	
	Coefficient	Offset	Coefficient	Offset	Coefficient	Offset	Coefficient	Offset
SRO	0.868834	0.56110	0.839008	0.40836	0.943356	0.36135	1.06888	0.03226
LRO	0.994348	4.11685	0.890184	39.3865	0.971565	12.2794	0.963704	11.7011
NR2	1.2361	9.70674	1.02966	0.87506	1.03956	-0.4749	1.00694	0.34658
RVI660nm	1.00846	0.09338	1.01111	-0.10796	0.97704	-0.0676	0.970026	-0.0239
RVI730nm	1.00622	0.08591	0.892298	-0.02791	0.885312	-0.0248	0.975428	0.00091

Table 3.4 Station 652=coefficient*(Station 653)+offset. Correlations during different periods with snow.

	2010-01-01 to 2010-04-28		2010-11-07 to 2010-11-21		2010-12-11 to 2011-01-10	
	coefficient	offset	coefficient	Offset	coefficient	Offset
SD	0.881249	-0.0327196	1.12283	-0.0843333	1.27601	-0.144128

A short description of the data processing for each parameter is given below. The figures with regression lines display edited data. The production time series are stored in the Greenland Ecosystem Monitoring Database.

The data processing includes data from the period 2010-01-01 to 2010-12-31.

3.1 Air Pressure

The air pressure is measured at station 652 and station 653. The logged air pressure data reflect the air pressure at the position of the sensor (no altitude correction).

Station 652, air pressure, 1.5 meters above terrain

- 45 records are missing (0.3% of all data records in the quality check period)
- No measurements lie outside the interval [900 hPa; 1100 hPa]
- No records were deleted.

Station 653, air pressure, 1.5 meters above terrain

- 2217 records are missing (12.7% of all data records in the quality check period)
- No measurements lie outside the interval [900 hPa; 1100 hPa]
- No records were deleted.

KOB, air pressure, 1.5 meters above terrain

- 42 records are missing

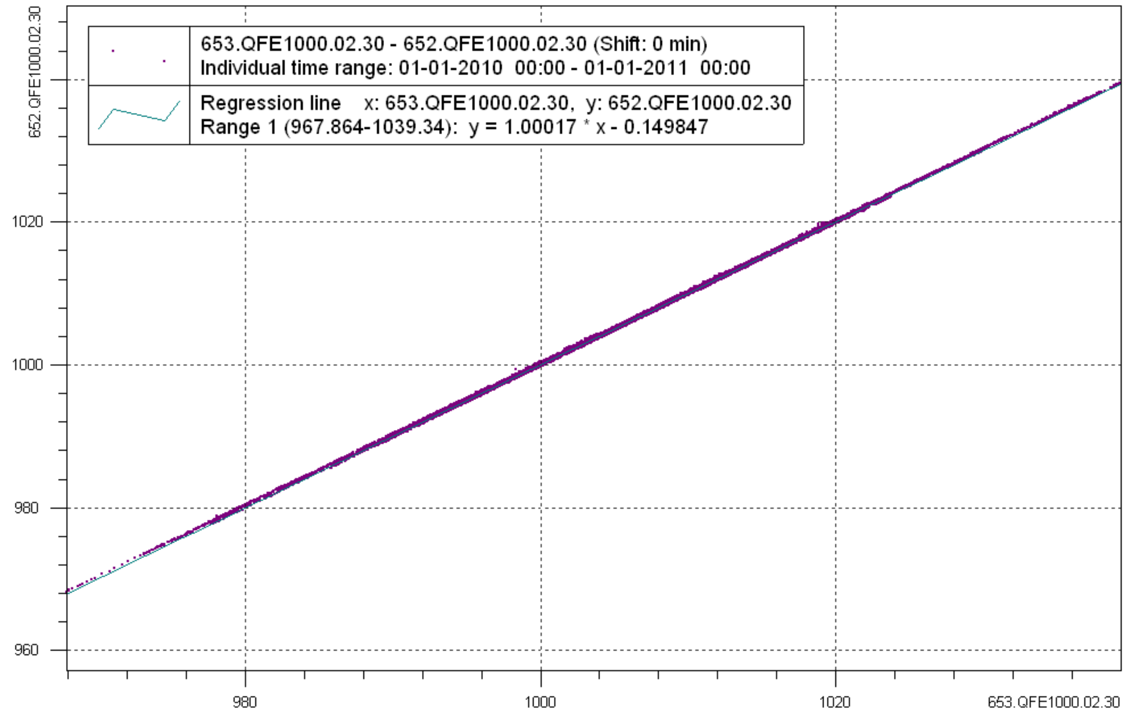


Figure 3.1 Air pressure measured at station 652, y, as a function of air pressure measured at station 653, x. The regression line is given in Table 3.1.

3.2 Air Temperature

The air temperature is measured 2 meter above terrain at station 652 and station 653.

The air temperature is measured using temperature probes housed in radiation shields. The radiation shields are not artificially ventilated due to the limited power supply at the stations. Studies show that this may give too high temperature measurements in case of calm winds and clear sky, Andersson & Mattisson (1991), Arck & Scherer (2001). Correction for this possible error has not been performed.

After comparison with reference tests since the establishment of the stations in 2007 and after comparison with station 650, data from both station 652 and station 653 have been adjusted for an incorrect offset. Data from station 652 has been adjusted by +0.75 °C during the entire measurement period of 2007-2010. Data from station 653 has been adjusted by +0.8 °C during the entire measurement period of 2007-2010.

<u>Station 652, air temperature, 2 meters above terrain</u>
- 45 records are missing (0.3% of all data records in the quality check period).
- No records lie outside the interval [-40°C; 25°C].
- No records were deleted.
- Data has been adjusted by +0.75 °C.

<u>Station 653, air temperature, 2 meters above terrain</u>
- 2218 records are missing (12.7% of all data records in the quality check period).
- No records lie outside the interval [-40°C; 25°C].

- 1 record was deleted.
- Data has been adjusted by +0.8 °C.

KOB, air temperature, 2 meters above terrain
- 42 records are missing.

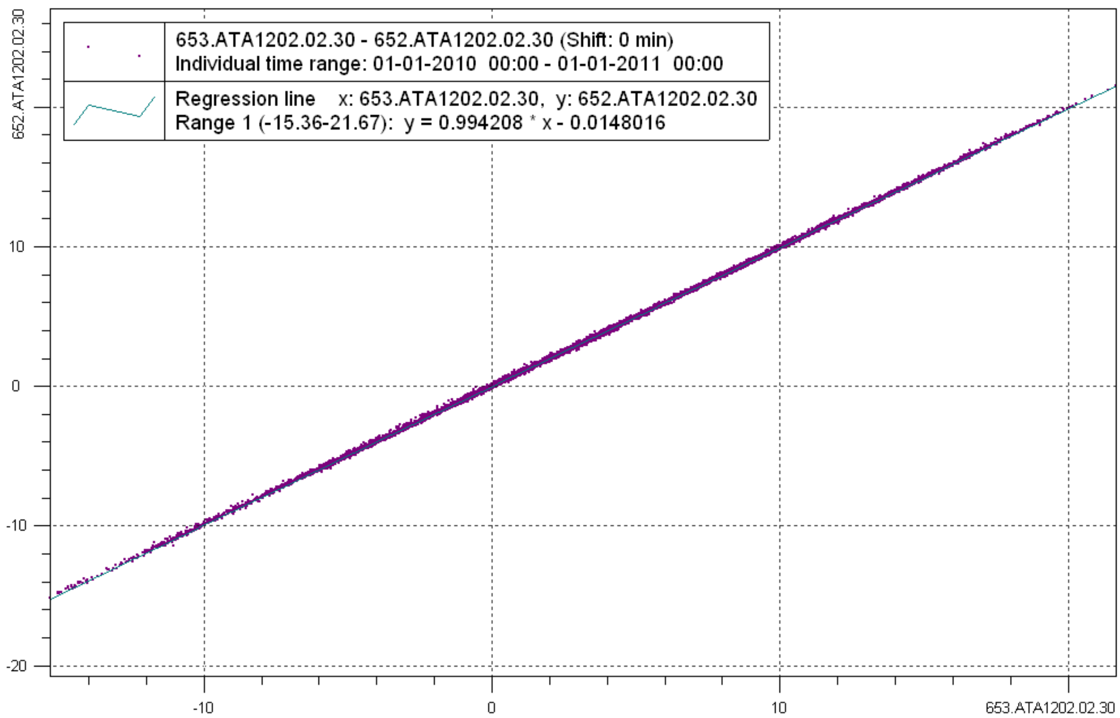


Figure 3.2 Average air temperature measured at station 652, y, as a function of air temperature measured at station 653, x. The regression line is given in Table 3.1.

3.3 Relative Humidity

The relative humidity is measured by the same sensor units as the air temperature.

Station 652, relative humidity, 2 meters above terrain
- 45 records are missing (0.3% of all data records in the quality check period)
- 0 measurements lie outside the interval [15%; 104%]
- No records were deleted.
- On average station 652 measures 1.9% lower relative humidity than station 653 (calculation does not include 2010-02-05 to 2010-03-22). This difference is lower during the summer.

Station 653, relative humidity, 2 meters above terrain
- 2217 records are missing (12.7% of all data records in the quality check period)
- 0 measurements lie outside the interval [15%; 104%]
- No records were deleted.
- On average station 653 measures 1.9% higher relative humidity than station 652 (calculation does not include 2009-08-06 to 2009-10-15). This difference is lower during the summer.

KOB, relative humidity, 2 meters above terrain

- 42 records are missing.
- 0 records are outside the interval [15%; 104%].
- 7 records differ more than ±6 % from station 652 and station 653.

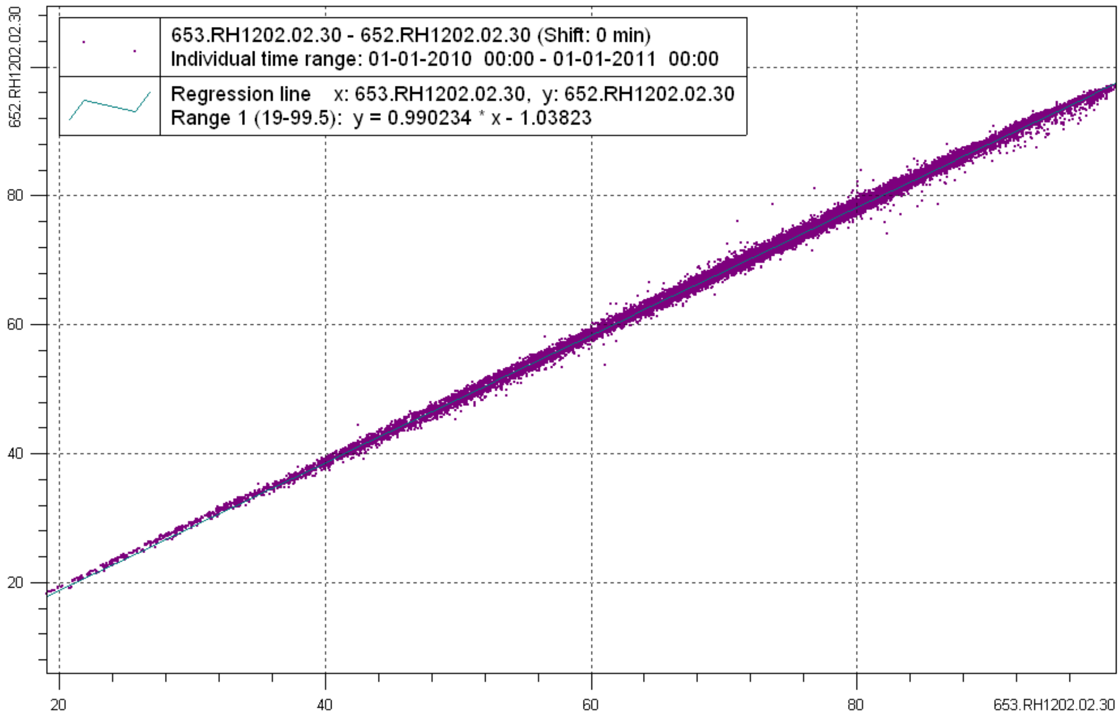


Figure 3.3 Average relative humidity measured at station 652, y, as a function of relative humidity measured at station 653, x. The regression line is given in Table 3.1.

3.4 Wind Speed, 2 m

Station 652, wind speed, 2 meters above terrain

- 131 records are missing (0.25% of all data records in the quality check period)
- 22 records were deleted due to long periods with zero wind speed
- 0 records were deleted due to unrealistic values
- 0 records were deleted due to suspect values

Station 653, wind speed, 2 meters above terrain

- 6649 records are missing (12.65% of all data records in the quality check period)
- 106 records were deleted due to long periods with zero wind speed
- 0 records were deleted due to unrealistic values
- 28296 records were deleted due to suspect values (16/6 – 31/12)

KOB, wind speed, 2 meters above terrain

- 150 records are missing
- During the period of June 16 to December 31, 2010, values are copied directly from station 652.

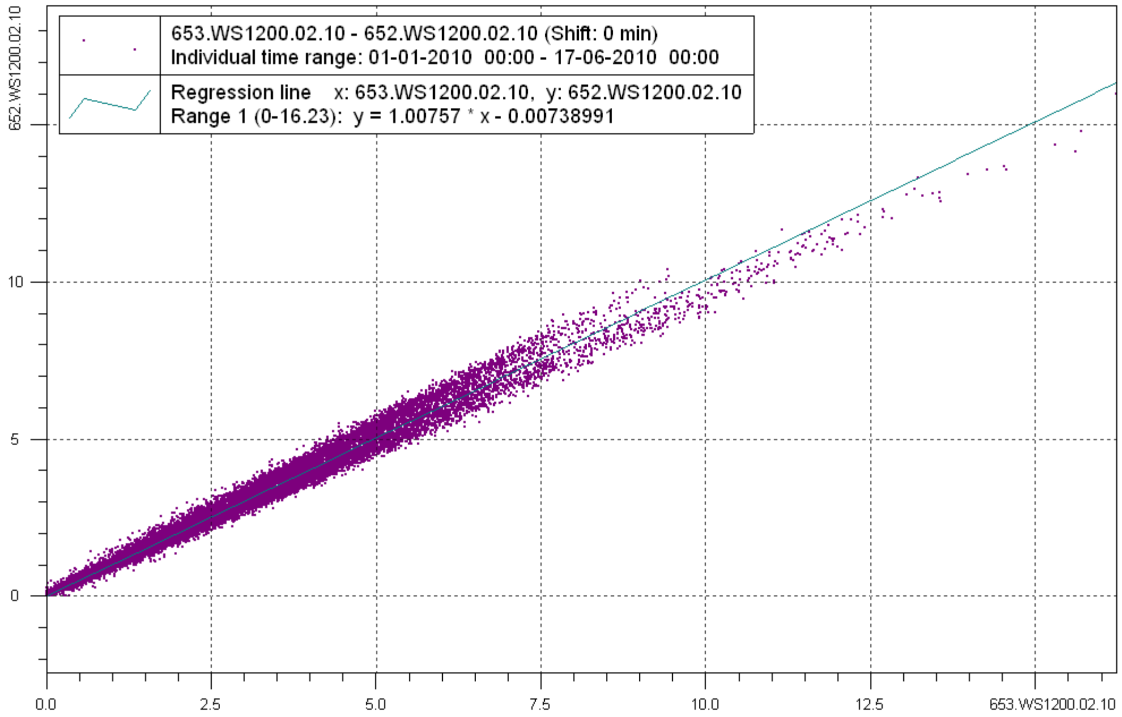


Figure 3.4 Wind speed measured 2 m above ground at Kobbefjord station 652, y, as a function of wind speed measured 2 m above ground level at Kobbefjord station 653, x. The regression line is given in Table 3.2.

3.5 Wind Speed, 10 m

Station 652, wind speed, 10 meters above terrain

- 131 records are missing (0.3% of all data records in the quality check period)
- 2173 records were deleted due to long periods with zero wind speed
- 1 record was deleted due to unrealistic value
- 28406 records were deleted due to suspect values (16/6 – 31/12)

Station 653, wind speed, 10 meters above terrain

- 6649 records are missing (12.7% of all data records in the quality check period)
- 178 records were deleted due to long periods with zero wind speed
- 0 records were deleted due to unrealistic values
- 0 records were deleted due to suspect values

KOB, wind speed, 10 meters above terrain

- 1420 records are missing
- During the period of June 16 to December 31, 2010, values are copied directly from station 653.

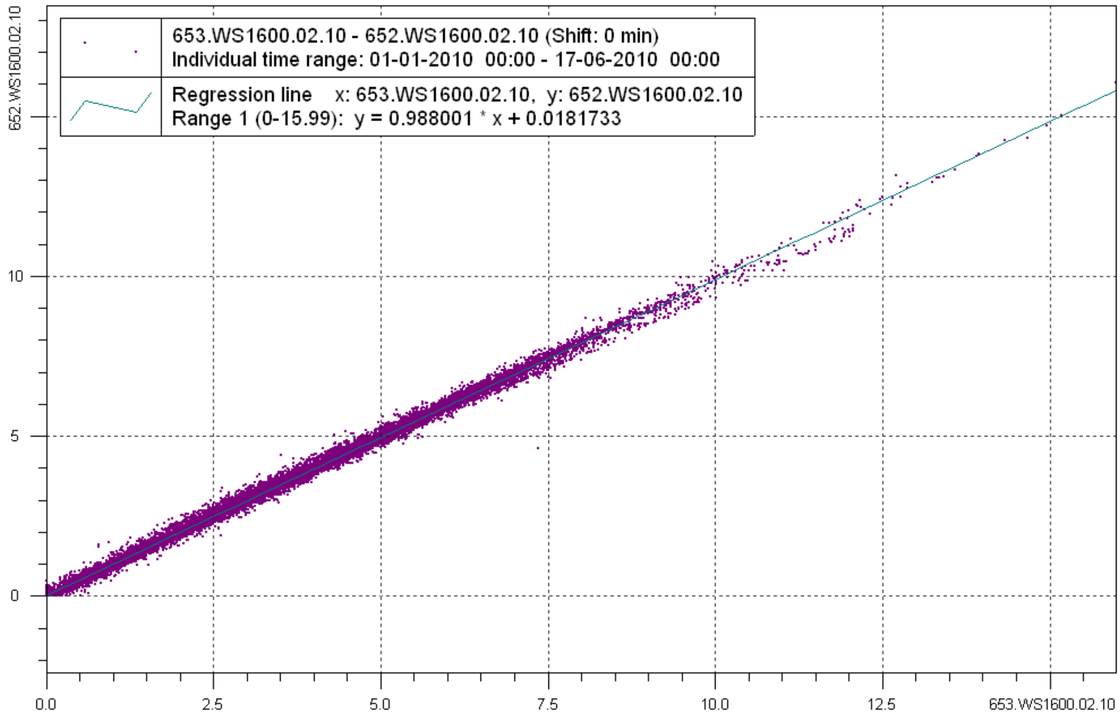


Figure 3.5 Wind speed measured 10 m above ground at Kobbefjord station 652, y, as a function of wind speed measured 10 m above ground level at Kobbefjord station 653, x. The regression line is given in Table 3.2.

3.6 Wind Direction, 10 m

Wind direction is measured 10 meters above terrain at station 652 and 653. The wind direction is relative to geographic north. The combined time series is calculated as the interior bisector of the two measured wind directions. When only one station produces valid data these wind direction records are copied directly to the final time series.

Station 652, wind direction, 10 meters above terrain

- 5099 records are missing (9.70% of all data records in the quality check period). Out of these missing records, 4966 are missing due to zero wind speed.
- 0 measurements lie outside the interval [0^o; 360^o]
- 0 records were deleted

Station 653, wind direction, 10 meters above terrain

- 7036 records are missing (13.39% of all data records in the quality check period). Out of these missing records, 387 are missing due to zero wind speed.
- 0 measurements lie outside the interval [0^o; 360^o]
- 0 records were deleted

KOB, wind direction, 10 meters above terrain

- 1587 records are missing

3.7 Incoming Short Wave Radiation

The incoming short wave radiation is measured 2 meters above terrain at both station 652 and station 653. The incoming short wave radiation is measured with a four component Kipp & Zonen net radiometer (CNR1), which measures short wave radiation with wavelengths 300 to 2800 nm. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

Station 652, incoming short wave radiation, 2 meters above terrain

- 261 records are missing (0.2% of all data records in the quality check period)
- 332 records were deleted as the sensor was covered with snow
- 33462 records (32.8% of the data) showed negative incoming radiation and 14690 records (14.0% of the data) were positive in cases where the sun was more than one degree below the horizon. These records were set to zero.
- 65 records (0.1% of the data) had higher values than the maximum theoretical direct incoming radiation (when this report refers to *the maximum direct incoming radiation* it is calculated according to Gray and Male (1981), with a transmissivity of the atmosphere of 1, i.e. no absorption or reflection of radiation through the atmosphere). In cases where a data record exceeded the theoretical value and the theoretical value is higher than 25W/m^2, these records were replaced by linear regression with values from station 653. In case station 653 should also have recorded a value higher than the theoretical maximum then the record was set to equal the theoretical maximum.

Station 653, incoming short wave radiation, 2 meters above terrain

- 13297 records are missing (12.6% of all data records in the quality check period)
- 86 records were deleted as the sensor was covered with snow
- 29794 records (28.3% of the data) showed negative incoming radiation and 11781 records (11.2% of the data) were positive in cases where the sun was more than one degree below the horizon. These records were set to zero.
- 47 records (0.04% of the data) had higher values than the maximum theoretical direct incoming radiation. In cases where a data record exceeded the theoretical value and the theoretical value is higher than 25W/m^2, these records were replaced by linear regression with values from station 652. In case station 652 should also have recorded a value higher than the theoretical maximum then the record was set to equal the theoretical maximum.

KOB, incoming short wave radiation, 2 meters above terrain

- 581 records are missing

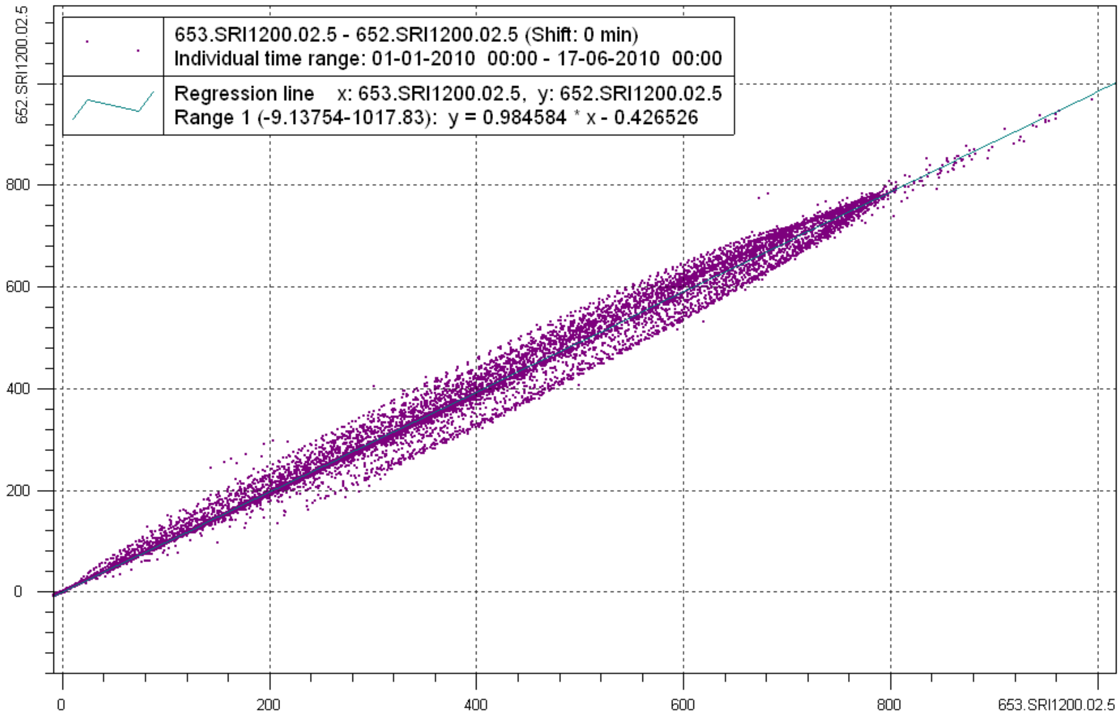


Figure 3.6 Incoming short wave radiation (W/m^2) measured at station 652, y, as a function of incoming short wave radiation measured at station 653, x. The regression line is given in Table 3.2.

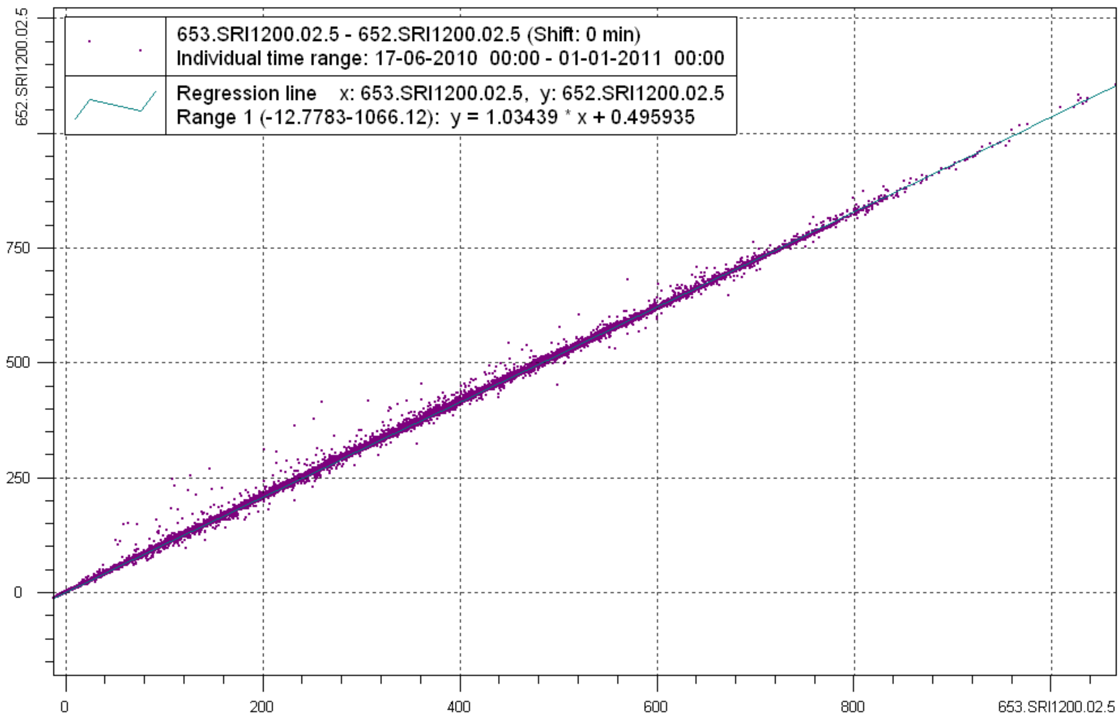


Figure 3.7 Incoming short wave radiation (W/m^2) measured at station 652, y, as a function of incoming short wave radiation measured at station 653, x. The regression line is given in Table 3.2.

3.8 Outgoing Short Wave Radiation

The outgoing short wave radiation is measured 2 meters above terrain at both station 652 and station 653. The outgoing short wave radiation is measured with a Kipp & Zonen four component net radiometer (CNR1), which measures short wave radiation with wavelengths 300 to 2800 nm. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

Station 652, outgoing short wave radiation, 2 meters above terrain

- 261 records are missing (0.2% of all data records in the quality check period)
- 6649 records (6.3% of the data) showed negative outgoing radiation and 42367 records (40.3% of the data) were positive in cases where the sun was more than one degree below the horizon. These records were set to zero.
- 2135 records (2.0% of the data) exceeded the maximum theoretically possible direct incoming radiation. This error was mainly observed at low sun heights (i.e. < 25 W/m^2) where there is a possibility that the downward sensor both receives direct and reflected light.
- 162 records were deleted due to peak values not observed at station 653.

Station 653, outgoing short wave radiation, 2 meters above terrain

- 13297 records are missing (12.6% of all data records in the quality check period)
- 6704 records (6.4% of the data) showed negative outgoing radiation and 42950 records (40.9% of the data) were positive in cases where the sun was more than one degree below the horizon. These records were set to zero.
- 1894 records (1.8% of the data) exceeded the maximum theoretically possible direct incoming radiation. This error was mainly observed at low sun heights (i.e. < 25 W/m^2) where there is a possibility that the downward sensor both receives direct and reflected light.
- No records were deleted

KOB, outgoing short wave radiation, 2 meters above terrain

- 214 records are missing

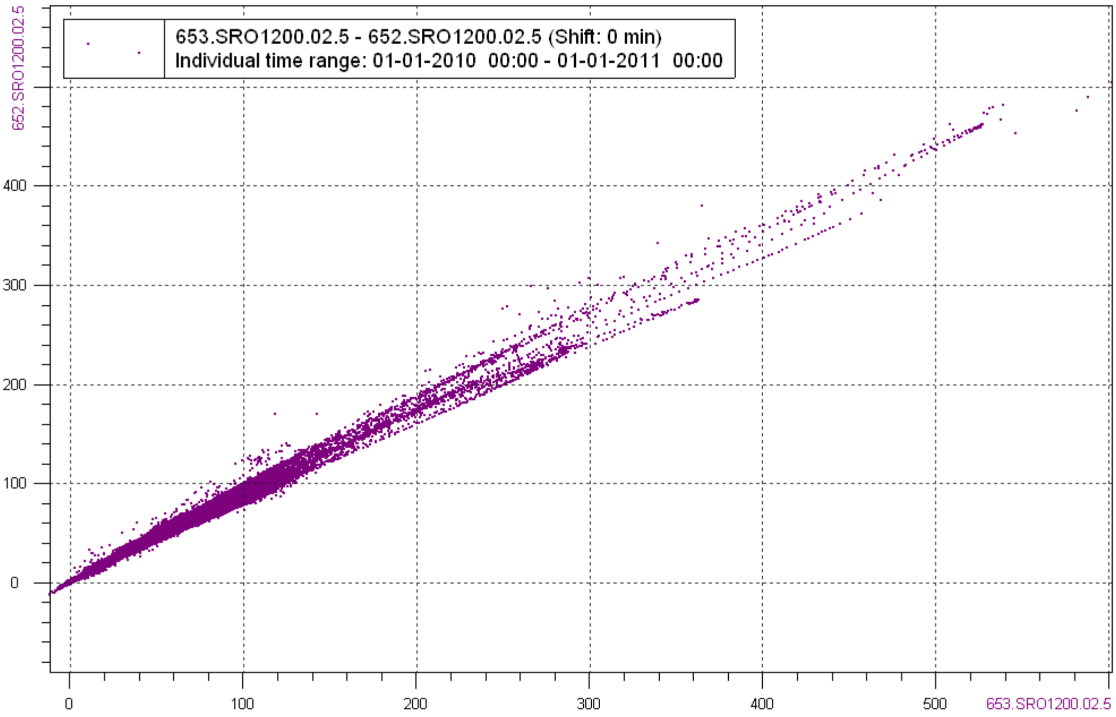


Figure 3.8 Outgoing short wave radiation measured at station 652, y, as a function of outgoing short wave radiation measured at station 653, x. The different regression lines based on different ground cover conditions and sensor calibrations are given in Table 3.3.

3.9 Incoming Long Wave Radiation

The incoming long wave radiation is measured 2 meters above terrain at both station 652 and station 653. The incoming long wave radiation is measured with a Kipp & Zonen four component net radiometer (CNR1), which measures long wave radiation with wavelengths 5 to 50 µm. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

Station 652, incoming long wave radiation, 2 meters above terrain
- 261 records are missing (0.2% of all data records in the quality check period)
- 4495 records (4.3% of the data) were deleted as they were affected by either snow or water on the surface of the sensor. Field observations confirm that the raw measurement, before temperature correction, becomes insensitive and around zero when the temperature is covered with snow).

Station 653, incoming long wave radiation, 2 meters above terrain
- 13297 records are missing (12.6% of all data records in the quality check period)
- 3656 records (3.5% of the data) were deleted as they were affected by either snow or water on the surface of the sensor.

KOB, incoming long wave radiation, 2 meters above terrain
- 3576 records are missing

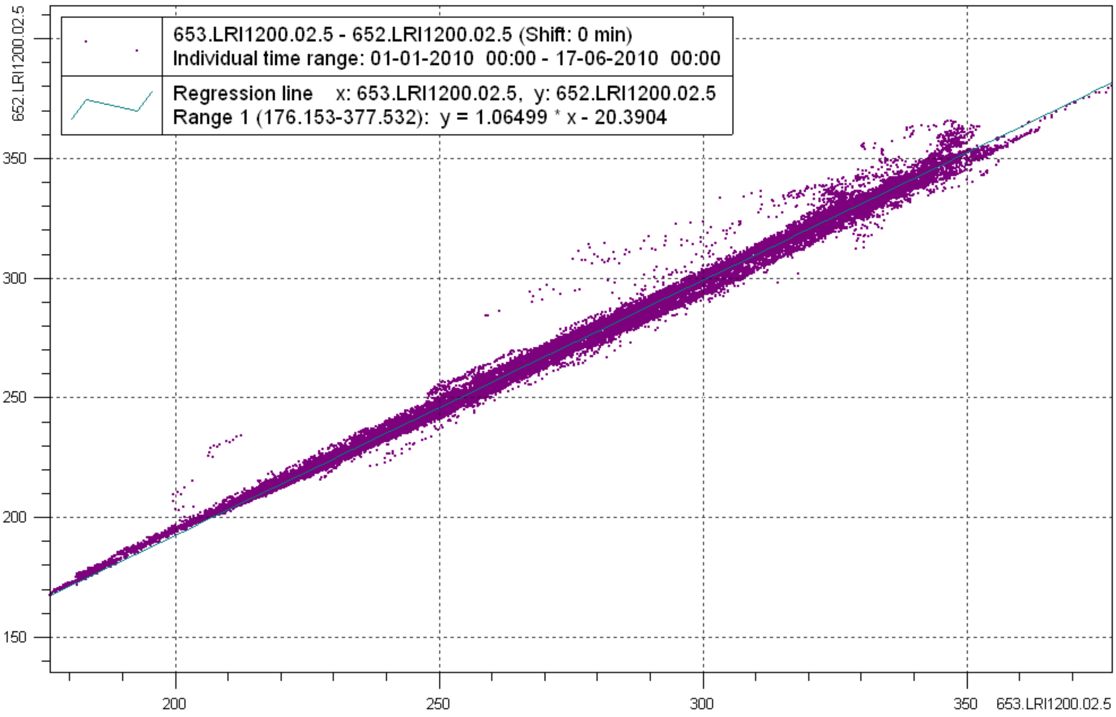


Figure 3.9 Incoming long wave radiation (W/m^2) measured at station 652, y, as a function of incoming short wave radiation measured at station 653, x. The regression line is given in Table 3.2.

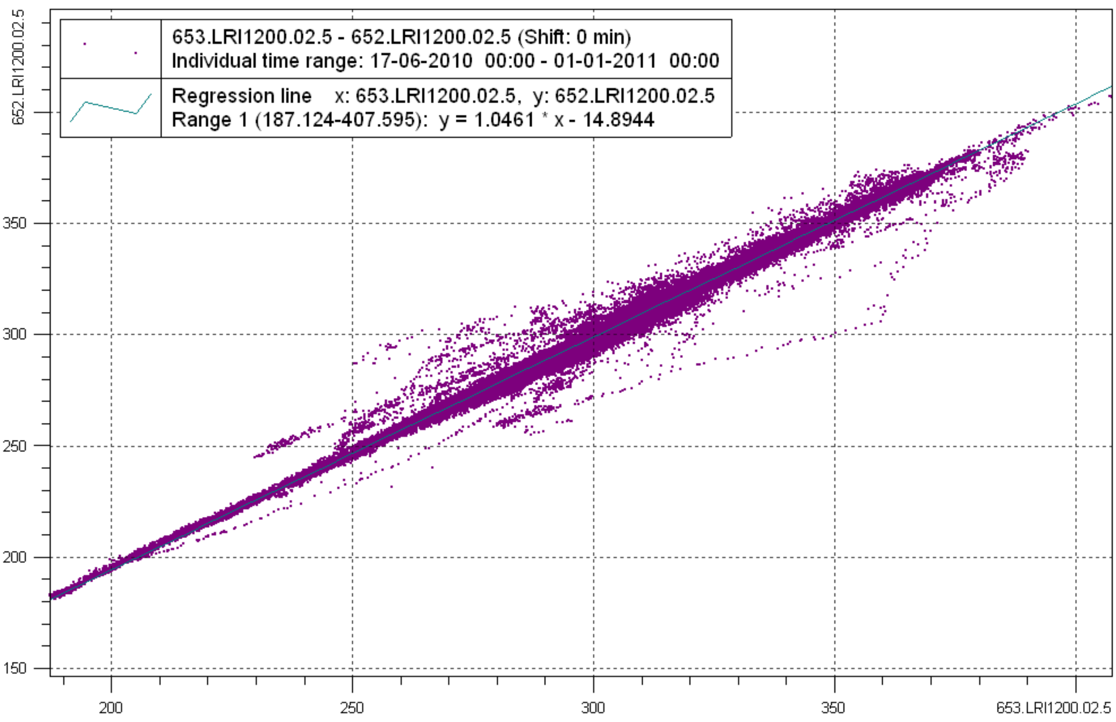


Figure 3.10 Incoming long wave radiation (W/m^2) measured at station 652, y, as a function of incoming short wave radiation measured at station 653, x. The regression line is given in Table 3.2.

3.10 Outgoing Long Wave Radiation

The outgoing long wave radiation is measured 2 meters above terrain at both station 652 and station 653. The outgoing long wave radiation is measured with a Kipp & Zonen four component net radiometer (CNR1), which measures long wave radiation with wavelengths 5 to 50 µm. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

<u>Station 652, outgoing long wave radiation, 2 meters above terrain</u>
- 261 records are missing (0.2% of all data records in the quality check period).
- No records were deleted.

<u>Station 653, outgoing long wave radiation, 2 meters above terrain</u>
- 13297 records are missing (12.6% of all data records in the quality check period)
- No records were deleted.

<u>KOB, outgoing long wave radiation, 2 meters above terrain</u>
- 249 records are missing

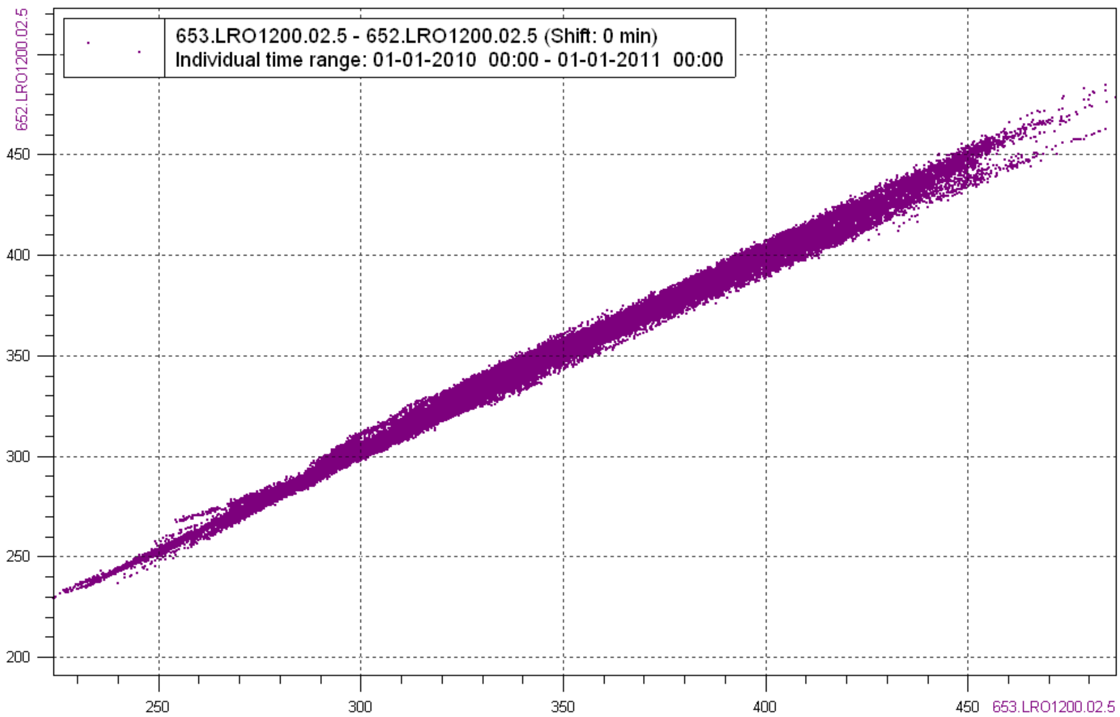


Figure 3.11 Outgoing long wave radiation (W/m²) measured at station 652, y, as a function of Outgoing long wave radiation measured at station 653, x. The different regression lines based on different ground cover conditions and sensor calibrations are given in Table 3.3.

3.11 Photosynthetic Active Radiation (PAR)

The photosynthetic active radiation (PAR) is measured 2 meters above terrain at station 652 and station 653. PAR is measured with a Li-Cor quantum sensor, which measures the radiation with wavelengths between 400 and 700 nm. The sensor has app. the same sensitivity (spectral response) to all wavelengths in this interval.

Station 652, photosynthetic active radiation, 2 meters above terrain
- 261 records are missing (0.3% of all data records in the quality check period)
- 42 records were negative, and 49930 records (47.5% of the data) were positive when the sun was more than 1 degree under the horizon. These values were set to zero.
- 106 records were deleted as the sensor was covered with snow

Station 653, photosynthetic active radiation, 2 meters above terrain
- 13297 records are missing (12.6% of all data records in the quality check period)
- 1270 records (1.2% of the data) were negative, and 27519 records (26.2% of the data) were positive when the sun was more than 1 degree under the horizon. These values were set to zero.
- 35127 records (33.4% of the data) were deleted as the sensor measured considerably less than st. 652. This is most likely due to the sensor not being level.
- 109 records were deleted as the sensor was covered with snow

KOB, photosynthetic active radiation, 2 meters above terrain
- 265 records are missing
- During the period of 2010-01-01 to 2010-06-16 data is only from st. 652.

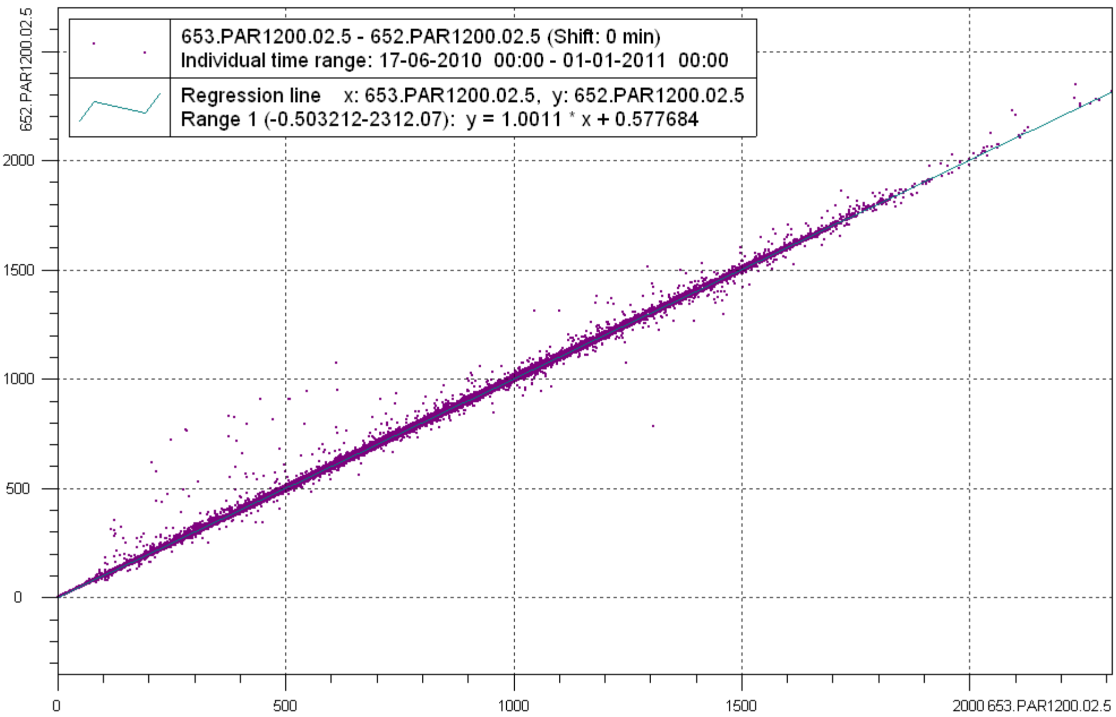


Figure 3.12 Photosynthetical active radiation (μmol/(s*m^2)) measured at station 652, y, as a function of Photosynthetical active radiation measured at station 653, x. The regression line is given in Table 3.2.

3.12 UVB

The ultraviolet radiation (UV-B) is measured 2 meter above terrain at station 652 and station 653. The UV-B has since June 2008 been measured with a Solar Light UV-

Biometer.
The UV-B measurement depends on the temperature of the sensor. Due to the limited power supply at the station the sensors built-in thermostat have not been used. In the data processing the measurements are thus compensated for the deviation of the temperature of the sensor from 25 °C according to the formula given by the manufacturer, Solar Light Co Inc. (1991). This compensation is carried out by program routines in the data logger.

Station 652, ultraviolet radiation measured, 2 meters above terrain

- 261 records are missing (0.25 % of all data records in the quality check period)
- All measurements lie inside the interval [0 W/m^2; 0.1452 W/m^2]
- No records were deleted but the UVB radiation was set to zero when the sun was more than 1 degree below the horizon. This affects 49950 records corresponding to 47.5 % of all data in the quality check period.
- The UVB records were tested against a reference sensor mounted next to the UVB sensor in the period from 2010-06-17 to 2010-06-25, see Figure 3.13. All UVB records at station 652 with the current sensor were adjusted according to the displayed regression line.

Station 653, ultraviolet radiation measured, 2 meters above terrain

- 48315 records are missing (46.0 % of all data records in the quality check period)
- All measurements lie inside the interval [0 W/m^2; 0.1205 W/m^2]
- 35018 records were deleted as they were unrealistic due to logger issues (33.3 % of all data records in the quality check period)
- The UVB radiation was set to zero when the sun was more than 1 degree below the horizon. This affects 1248 records corresponding to 1.2 % of all data in the quality check period
- The UVB records were tested against a reference sensor mounted next to the UVB sensor in the period from 2010-06-17 to 2010-06-25, see Figure 3.14. All UVB records at station 653 with the current sensor were adjusted according to the displayed regression line.

KOB, ultraviolet radiation measured, 2 meters above terrain

- 222 records are missing (0.21 % of all data records in the quality check period)

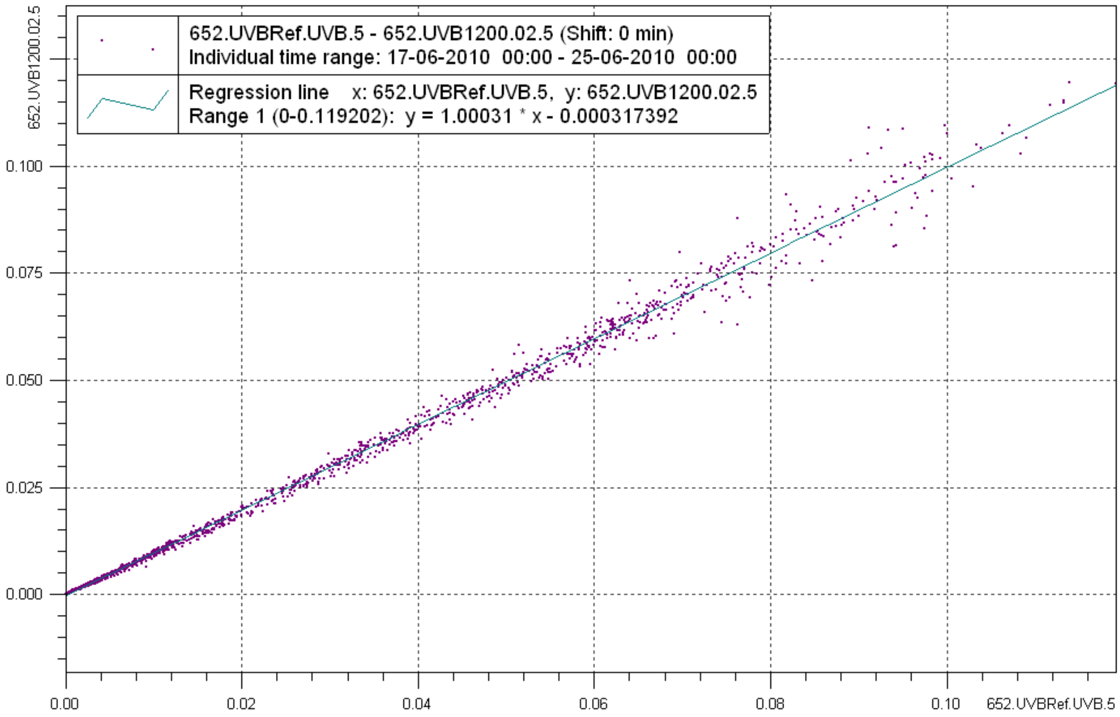


Figure 3.13 UVB radiation (W/m^2) measured at station 652, y, as a function of UVB radiation measured with UVB_ref, x.

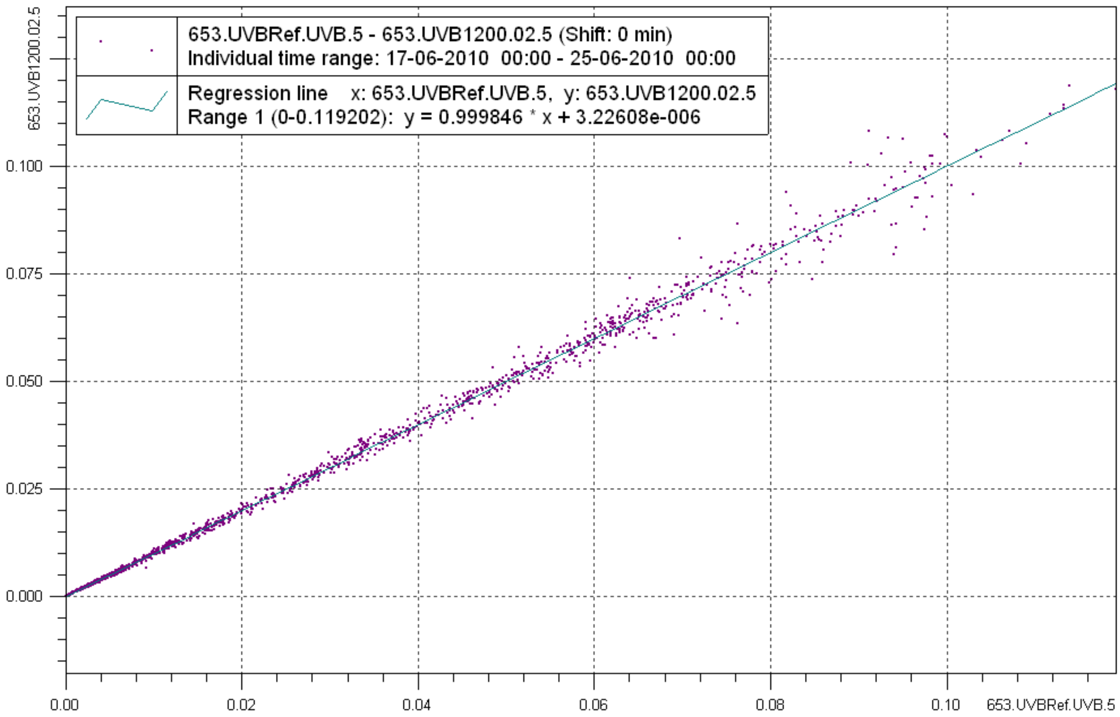


Figure 3.14 UVB radiation (W/m^2) measured at station 653, y, as a function of UVB radiation measured with UVB_ref, x.

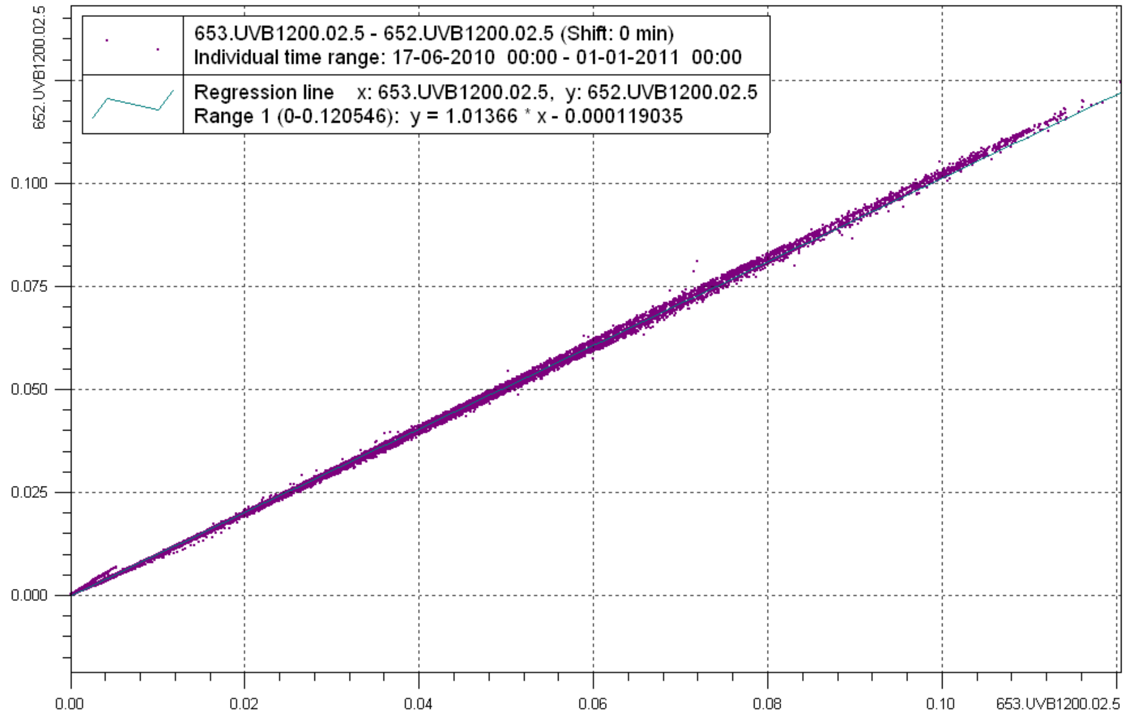


Figure 3.15 UVB radiation (W/m^2) measured at station 652, y, as a function of UVB radiation measured at station 653, x. The regression line is given in Table 3.1.

3.13 Net Radiation (CNR1)

The net radiation is calculated from the four quality checked time series of short-, long-, in- and outgoing radiation. The CNR1 instrument (pyrradio-/pyrgeometer) measures the difference between incoming and outgoing radiation with wavelengths in two spectral ranges; 300 to 2800 nm and 5 to 50 µm, i.e. both short wave and long wave radiation. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

<u>KOB, net radiation (CNR1), 2 meters above terrain</u>

- 3576 records are missing (3.4% of all data records in the quality check period).

3.14 Net Radiation (NR-lite)

The net radiation is measured 2 meters above terrain at station 652 and station 653. The net radiation is measured with Kipp & Zonen net radiometer (NR Lite), which measures the difference between incoming and outgoing radiation with wavelengths 0.2 to 100 µm, i.e. both short wave and long wave radiation. The sensor has app. the same sensitivity (spectral response) to all wavelengths in the interval.

As the sensor measures the long wave radiation it is to some degree sensitive to the wind speed, due to convective cooling by the wind. The measurements are compensated for the effect of the wind in accordance with the formula given by Campbell Scientific (2002).

Net radiation records are prone to errors under certain conditions. Duchon and Brotzge (2000) describe different conditions that might compromise the quality of the records with the NR-lite, such as snow, rain, frost, dew, debris on the sensor etc. This quality check has evaluated whether or not the records are affected by rain or snow.

Station 652, net radiation (NR-lite), 2 meters above terrain
- 261 records are missing (0.2% of all data records in the quality check period)
- 19418 records were deleted (18.5% of all data records in the quality check period) as the sensor was affected by precipitation and/or a large deviation from the CNR1 sensor

Station 653, net radiation (NR-lite), 2 meters above terrain
- 13297 records are missing (12.6% of all data records in the quality check period)
- 18014 records were deleted (17.1% off all data records in the quality check period) as the sensor was affected by precipitation and/or a large deviation from the CNR1 sensor

KOB, net radiation (NR-lite), 2 meters above terrain
- 18014 records are missing

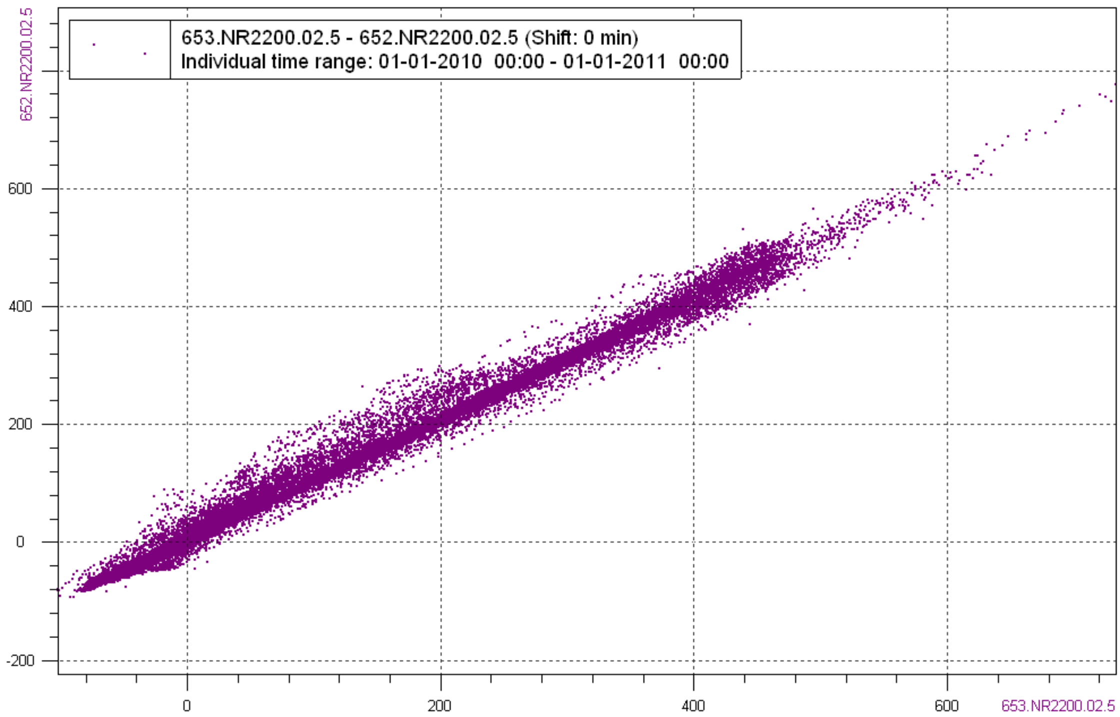


Figure 3.16 Net radiation data measured at station 652, y, as a function of net radiation data measured at station 653, x. The different regression lines based on different ground cover conditions and sensor calibrations are given in Table 3.3.

3.15 Albedo

The albedo is calculated from the quality checked incoming and outgoing short wave radiation and is calculated for 2010.

Two time series are produced:
- A 5 minute time series that calculates the albedo when the sun height is higher than -1 degree and both the incoming and outgoing short wave radiation are positive.
- A 1440 minute time series that computes the albedo at solar noon as a proxy for day values; see Sicart, J. E. et al. 2001. The reason for this is that the albedo varies with the incidence angle of the short wave radiation, i.e. more short wave radiation is reflected at low sun heights. Also the relative uncertainties of radiation records increase with decreasing light intensity.

<u>KOB, albedo, 2 meters above terrain, calculated 5 minute values</u>
- 51135 records are missing (48.6% of all data records in the quality check period). Out of these records, 49990 records are missing because the sun was more than one degree below the horizon.

<u>KOB, albedo, 2 meters above terrain, calculated day values</u>
- 5 records are missing (1.4% of all data records in the quality check period)

3.16 Relative Vegetation Index

The RVI-sensor measures the reflection of near infra-red radiation (NIR, 730 nm) and visible radiation (VIS, 660 nm). RVI is an acronym for Relative vegetation Index and can be used to compute a Normalized Difference Vegetation Index (NDVI) that covers a numeric span from -1 to 1. Very dense rain forest has a NDVI close to 1: NDVI = (NIR-VIS)/(NIR+VIS).

Four time series are produced:
- A 5 minute time series with reflected radiation in the near infra-red spectrum (730 nm).
- A 5 minute time series with reflected radiation in the visual spectrum (660 nm).
- A 60 minute time series with calculated NDVI
- A day time series. The NDVI is calculated at solar noon and is used as a proxy for day values.

<u>Station 652, RVI660nm, 2 meters above terrain</u>
- 260 records are missing (0.2% of all data records in the quality check period)
- 50353 records (47.9 % of the data) are negative and 928 records (0.9% of the data) were positive when the sun was more than one degree below the horizon. These values were set to zero.

<u>Station 652, RVI730nm, 2 meters above terrain</u>
- 260 records are missing (0.2% of all data records in the quality check period)
- 12339 records (11.7% of the data) are negative and 2244 records (2.1% of the data) are positive when the sun is more than one degree below the horizon. These values are set to zero.

<u>Station 653, RVI660nm, 2 meters above terrain</u>

- 13297 records are missing (12.6% of all data records in the quality check period).
- 39409 records (37.5% of the data) are negative and 10292 records (9.8% of the data) are positive when the sun is more than one degree below the horizon. These values are set to zero.

Station 653, RVI730nm, 2 meters above terrain

- 13297 records are missing (12.6% of all data records in the quality check period).
- 24917 records (23.7% of the data) are negative and 10847 records (10.3% of the data) are positive when the sun is more than one degree below the horizon. These values are set to zero.

KOB, RVI660nm, 2 meters above terrain

- 249 records are missing.

KOB, RVI730nm, 2 meters above terrain

- 249 records are missing.

KOB, NDVI, 2 meters above terrain, calculated 60 minute mean values

- A 60 minute mean is only calculated when all source data records within the hour are greater than zero. Therefore the 60 minute mean was not calculated for 4614 records (52.7% of the data).

KOB, NDVI, 2 meters above terrain, calculated day values

- One value is missing due to station maintenance.

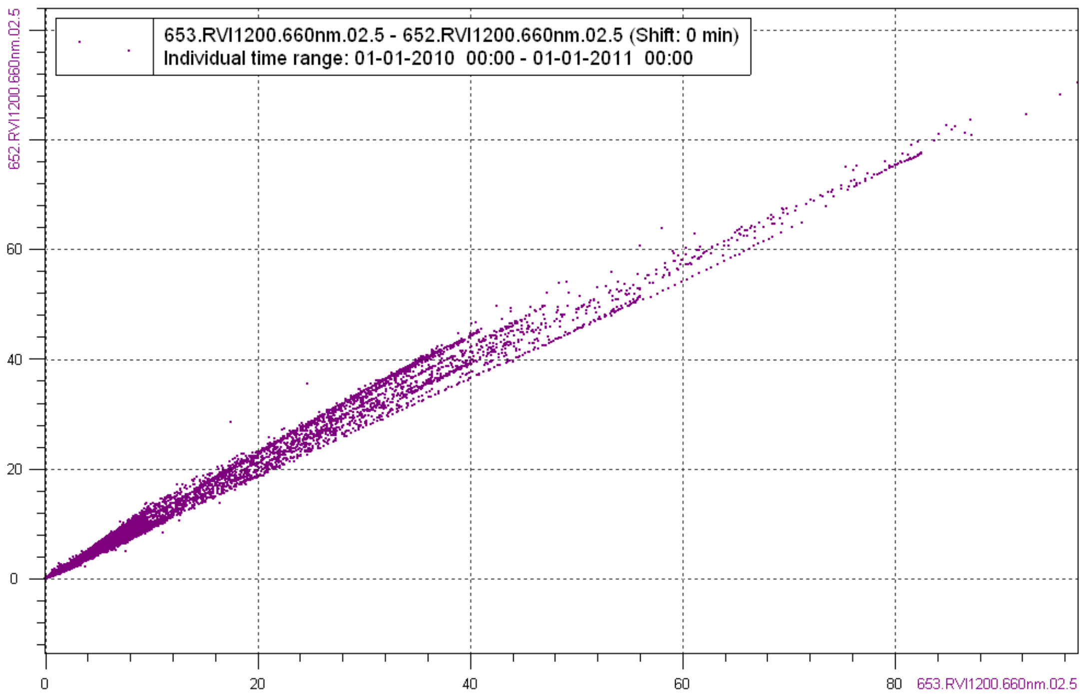


Figure 3.17 RVI660nm measured at station 652, y, as a function of the RVI660nm measured at station 653, x. The different regression lines based on different ground cover conditions and sensor calibrations are given in Table 3.3.

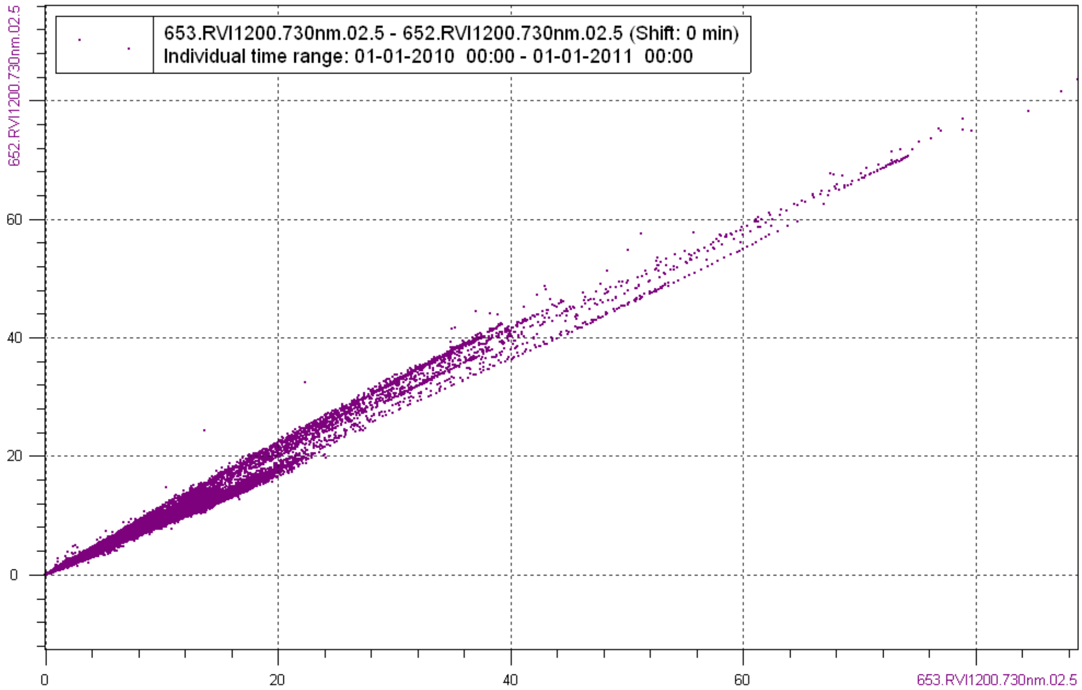


Figure 3.18 RVI730nm measured at station 652, y, as a function of the RVI730nm measured at station 653, x. The different regression lines based on different ground cover conditions and sensor calibrations are given in Table 3.3.

3.17 Precipitation

The precipitation is recorded with Ott Pluvio rain gauges. At both stations, the gauges have a tendency to produce false pulses, especially in moderate to high wind conditions. These periods have been identified during the quality check by comparison to relatively humidity, short wave incoming radiation, and daily recorded weather observations in Nuuk. During precipitation events both gauges were in good agreement and it was rare that false pulses would occur in both gauges at the exact same time.

Reference records of the water quantity in the bucket of each rain gauge were taken throughout 2010. At the times reference records were taken, both antifreeze and oil were present in the gauge bucket to prevent both freezing and evaporation of the gauge's contents. The reference records are in good agreement with the quality controlled data during the summer months. However, during the winter months the reference records show less precipitation than the quality controlled data. This indicates that the quality controlled precipitation data from Kobbefjord might be slightly higher than the actual precipitation. The timing of the precipitation events is accurate.

Station 652, precipitation

- 22 records are missing (0.3% of all data records in the quality check period)
- 459 records were deleted due to faulty measuring, accounting for 260. 7 mm.
- 1114 records were replaced with zero, accounting for the removal of 624.2 mm. This corresponds to 31.8% of the recorded precipitation.

- The reference records of 2010-04-28 and 2010-06-16 show that 135.0 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 119.8 mm (12.7% less) during the same time period.
- The reference records of 2010-07-08 and 2010-09-30 show that 295.8 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 299.4 mm (1.2% more) during the same time period.
- The reference records of 2010-09-30 and 2011-01-10 show that 185.8 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 271.2 mm (46% more) during the same time period.

Station 653, precipitation

- 1108 records are missing (12.6% of all data records in the quality check period)
- 98 records were deleted due to faulty measuring, accounting for 120.0 mm.
- 924 records were replaced with zero, accounting for the removal of 415.8 mm. This corresponds to 51.9% of the recorded precipitation.
- The reference records of 2010-04-28 and 2010-06-16 show that 128.3 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 119.8 mm (7.1% less) during the same time period.
- The reference records of 2010-07-08 and 2010-09-30 show that 287.5 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 299.4 mm (4.1% more) during the same time period.
- The reference records of 2010-09-30 and 2011-01-10 show that 197.5 mm of precipitation fell into the gauge between these dates. The KOB quality controlled data shows 271.2 mm (37% more) during the same time period.
- 2009-12-17.

KOB, precipitation

- 46 records are missing

3.18 Snow Depth

Station 652, snow depth

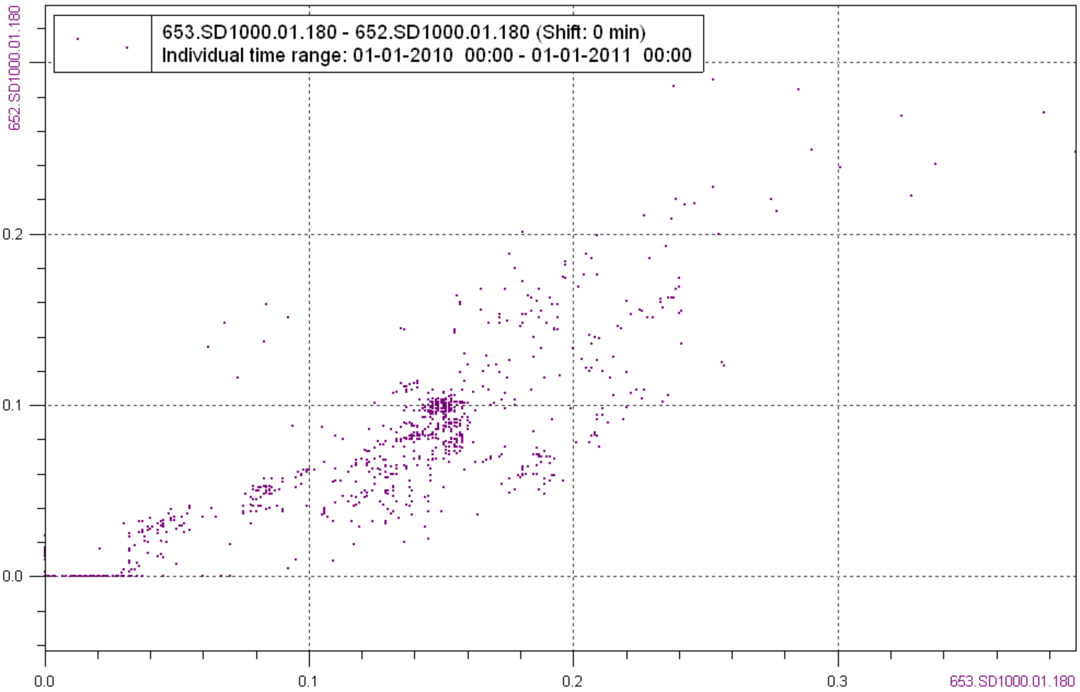
- 8 records are missing (0.3% of all data records in the quality check period)
- 2 measurements lie outside the interval [0.000 m; 1.835 m]
- 2 records were deleted as they were outside of the interval
- All values between 2010-04-28 21:00 and 2010-11-06 00:00, as well as between 2010-11-21 09:00 and 2010-12-10 18:00 were replaced with zero as there was no snow under the sensor during these time periods.

Station 653, snow depth

- 371 records are missing (12.7% of all data records in the quality check period)
- 24 measurements lie outside the interval [0.000 m; 1.895 m]
- 25 records were deleted as they were outside the interval or erroneous.
- All values between 2010-05-05 09:00 and 2010-11-07 15:00, as well as between 2010-11-22 00:00 and 2010-12-10 09:00 were replaced with zero as there was no snow under the sensor during these time periods.

KOB, parameter, measurement height

- 11 records are missing



Figur 19 Snow depth measured at Kobbefjord station 652, y, as a function of snow depth measured at Kobbefjord station 653, x. The regression lines during different snow conditions are given in Table 3.4

4 Measuring Program 2010, Hydrometric Station 650

The ClimateBasis monitoring program in Nuuk Basic monitors hydrology at five sites in Kobbefjord. For further description see The ClimateBasis Manual for Nuuk Basic (Iversen and Thorsøe, 2009).

This report describes data from the central drainage basin, st. 650, where a reliable summer stage-discharge relation has been established after the 2009 season. For st. 651, st. 654, st. 655 and st. 656 not enough discharge measurements have yet been carried out to produce reliable stage-discharge-relations (Q/h-relations). Therefore data from these stations are not presented.

An overview of the hydrological data measuring program at st. 650 during 2010 is given in Table 4.1.

Table 4.1 Parameter, senor type, sensor height above terrain, sensor specifications and aggregations method for st. 650.

Parameter	**Sensor Type**	**Sensor Height (m.a.t.)**	**Measuring Range**	**Sensitivity (resolution)**	**Accuracy**	**Data stored in the data logger** [1]	
						Average/sum	Sample/max/min
Air Temperature	Campbell 107-L	2 m	-35 - +50 °C	0.1 °C	+/- 0.4 °C	$[0;30]_{10\,sec}^{30\,min}$ Average	$[-]_{10\,sec}^{30\,min}$ max/min/sample
Water Level 1	Drück PTX1730		1.5 – 35 mH_2O	0.01 m	+/- 0.25%		$[-]_{10\,sec}^{60\,min}$ sample
Water Level 2	Drück PTX1730		1.5 – 35 mH_2O	0.01 m	+/- 0.25%		$[-]_{10\,sec}^{60\,min}$ sample
Water Temperature 1	Campbell 107-L		-35 - +50 °C	0.1 °C	+/- 0.4 °C		$[-]_{10\,sec}^{60\,min}$ sample
Water Temperature 2	Campbell 107-L		-35 - +50 °C	0.1 °C	+/- 0.4 °C		$[-]_{10\,sec}^{60\,min}$ sample

1) Data stored in the data logger is given as $[a;b]_c^d$, where 'd' is the interval between outputs written to the data logger, 'c' is the interval between scans of the sensor, 'a' and 'b' are minutes into the interval between output. Average values are found by averaging data values measured with interval c between 'a' and 'b'. Sample values are measured 'a' minutes into the interval between output.

5 Processing of Hydrological Data

As with climate data, the aim of data processing of the hydrological data is to establish one data series of high quality for each measured hydrological parameter.

The data processing for stage (water level) data includes the following steps:

1. The manual and precise measurements of water level are structured, and for each measurement the positions of the pressure transducers are calculated relative to a reference point at the station.
2. Necessary corrections of the data are performed. Erroneous data are deleted and sudden erroneous changes in water level caused by sudden shifts in the sensor position are corrected.
3. Additional changes in sensor position caused by either a slow physical or electronic signal drift of the sensor are corrected by linear interpolation between manual stage measurements.
4. The corrected water level is transformed to a relative height system where the reference point has a height of 100 meters.
5. Finally all valid water level data from the station are combined by averaging the measured water level from the different transducers.

The data processing and calculation of a Q/h-relation includes the following steps:

1. The discharge measurements are quality checked and assessed.
2. When enough discharge measurements are carried out at different water levels and over the range of normally registered water level, a Q/h-relation is established. If not enough measurements have been carried out or there is a lack of measurements in some of the normally registered water level, preliminary Q/h-relations can be established. The Q/h-relations are established according to ISO 1100-2, 1998.

5.1 Discharge Measurements

In 2010 six discharge measurements have been carried out at st. 650. Four of the measurements were carried out during winter when the outlet was influenced by snow and ice. The two measurements carried out during the summer were done on the same day by two different methods and therefore the measurements are not independent of each other.

With the measurements carried out in 2010 the manual discharge measurements span over all the measured water level with discharges ranging from 0.07 to 10.16 $m^3 s^{-1}$ (discharges under ice free conditions range from 0.13 to 10.16 $m^3 s^{-1}$). This is unchanged in comparison with 2009. The total measured span in the water level under ice free conditions in 2006 to 2010 is 0.67 m.

5.2 Q/h-relation

In 2009 a new Q/h-relation was calculated based upon a total of 17 discharge measurements; see Equation 1 and Figure 5.1. For further description of the Q/h-relation, see Iversen et. al. 2010. All of the discharge measurements made during ice free conditions in 2010 are in good accordance with the Q/h-relation.

Equation 1 $$Q = 33.54(h - 98.68)^{1.8947}$$

As there are discharge measurements in the total span of the registered water level, the Q/h-relation is considered final.

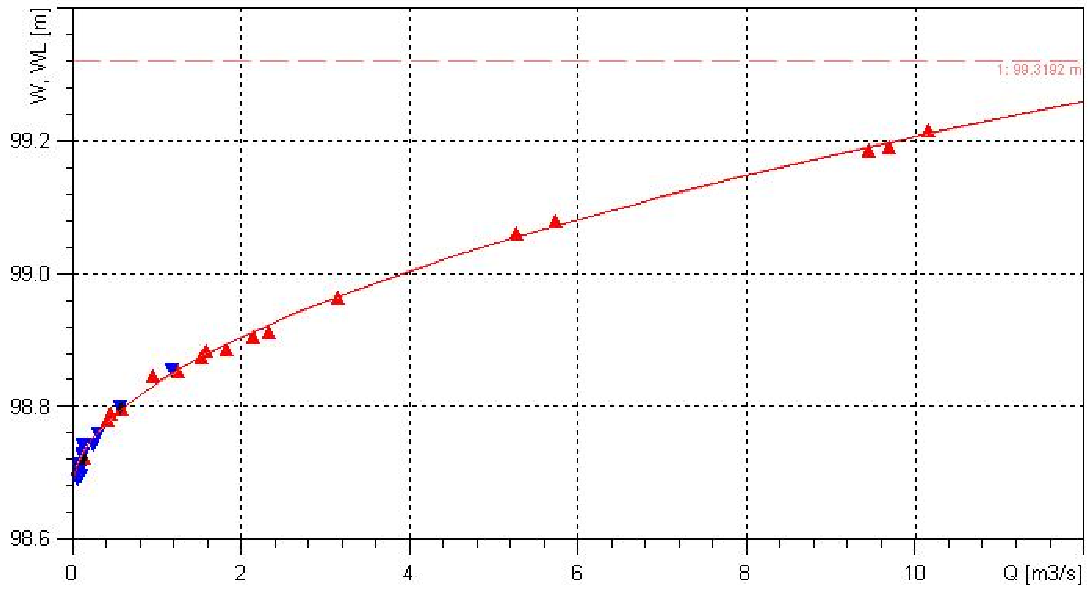


Figure 5.1 Q/h-relation for H1, $Q = 33.54(h-98.68)^{1.8947}$. All discharge measurements from June 2006 to February 2010 are shown. Red triangles – discharge measurements used in Q/h-relation, blue triangles – discharge measurements not used in Q/h-relation.

5.3 River Water Discharge at st. 650

In 2010 the period with ice/snow free conditions at the outlet was approximately from 20 April to 11 November, and again from 21 November to 10 December. Discharges calculated beyond this period are estimated.

The total discharge from st. 650 during the hydrological year from 1 October 2009 to 30 September 2010 was 22.9 million m^3, which is 42 % lower than in 2008/2009 and 30 % lower than in 2007/2008. The total discharge corresponds to a runoff of 739 mm when assuming that the drainage basin covers 31 km^2. The majority of the snow pack melted and drained through the river during the first 15 days of May. June and July were relatively dry months with little variation in discharge. Due to a very wet month of August, two high peaks occurred during the month with the peak discharge recorded on 30 August caused by a rain event. Due to a warm autumn discharge levels did not drop significantly below 0.5 $m^3 s^{-1}$ until 1 November. Discharge steadily dropped to 0.2 $m^3 s^{-1}$ by 20 November. On 21 November water levels began rising again due to warm temperatures and rainfall that completely melted the snow pack in low lying areas. This caused discharge to peak at 4.4 $m^3 s^{-1}$ on 3 December. After colder temperatures and snow fall returned to Kobbefjord around 6 December, discharge levels steadily decreased to 0.4 $m^3 s^{-1}$.

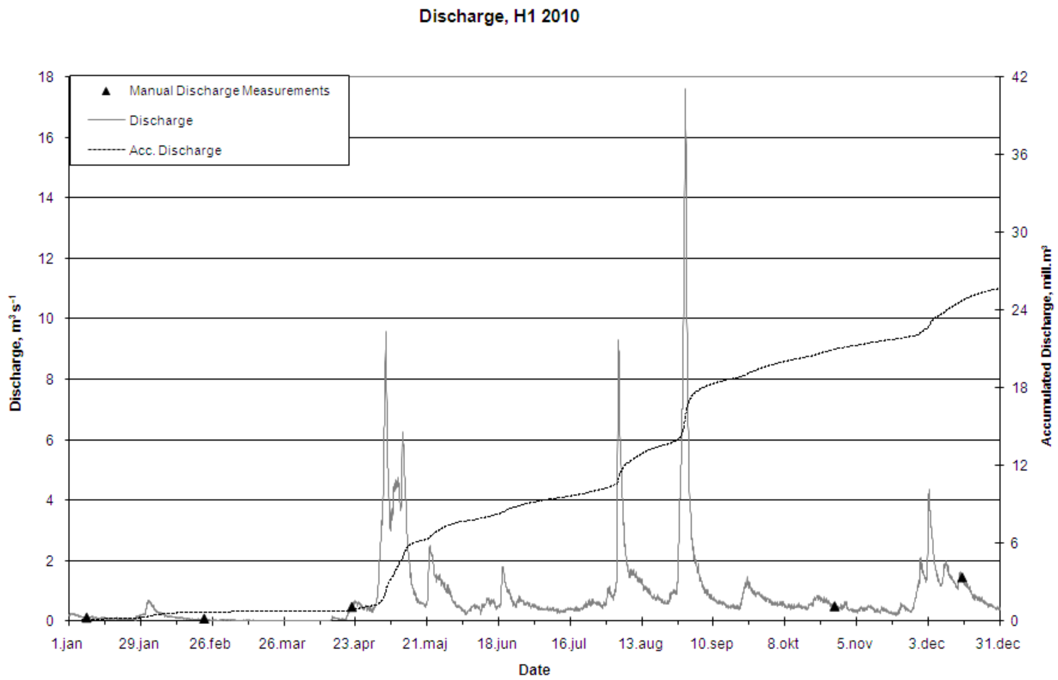


Figure 5.2 Discharge and accumulated discharge from st. 650 2010. Manual discharge measurements carried out during 2010 are shown with black triangles.

A comparison of discharge with precipitation has been made for the hydrological year 2009/2010. The precipitation at the meteorological stations, C1 and C2, was 832 mm while the runoff from st. 650 equaled 739 mm. There can be many reasons for the difference between precipitation and runoff. Although the Q/h-relation provides estimates of runoff during ice and snow conditions, there remains uncertainty. Other factors to take into consideration are difficulties in measuring precipitation (the technical aspect and geographic distribution), glacial runoff and evaporation. In addition there is need for increased knowledge about the hydrological processes in the low arctic area in Kobbefjord.

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