



Norwegian  
Meteorological Institute  
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**POSTER PRESENTATION:  
Comparison of manual precipitation  
observations with automatic observations in  
Oslo and Utsira**



- **Utsira:** An island at the western coast of Norway. Annual precipitation: 1165 mm
- **Oslo (Blindern):** In the northern end of Oslofjorden (Oslo Fiord). Annual precipitation: 763 mm

## Oslo (59° 56' N, 10° 44' E):

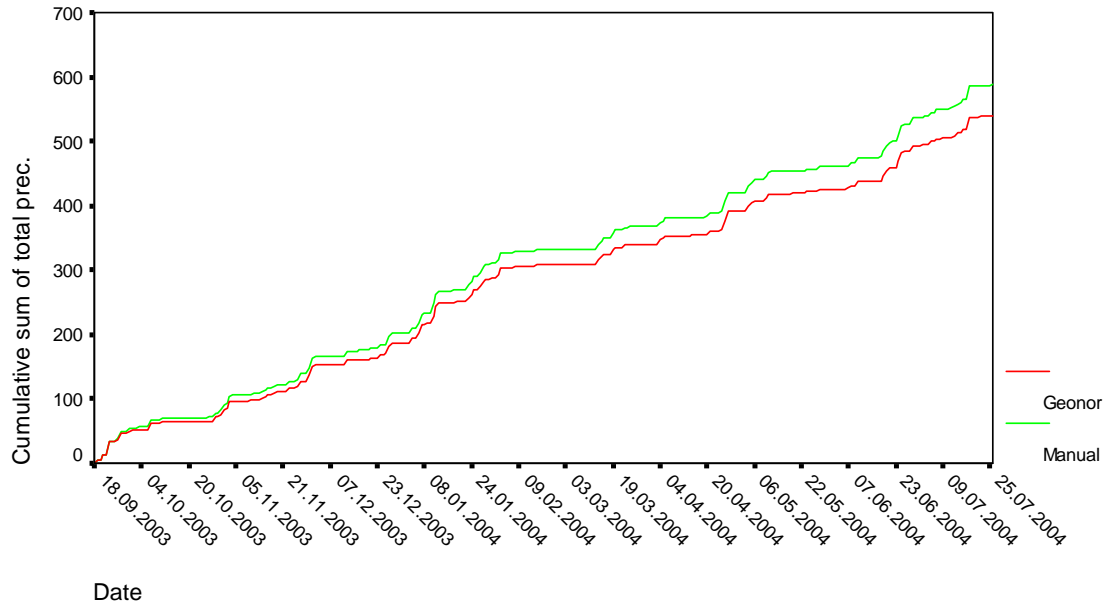


**Figure 1:** Picture showing the manual (to the left) and the automatic (to the right) precipitation gauges.

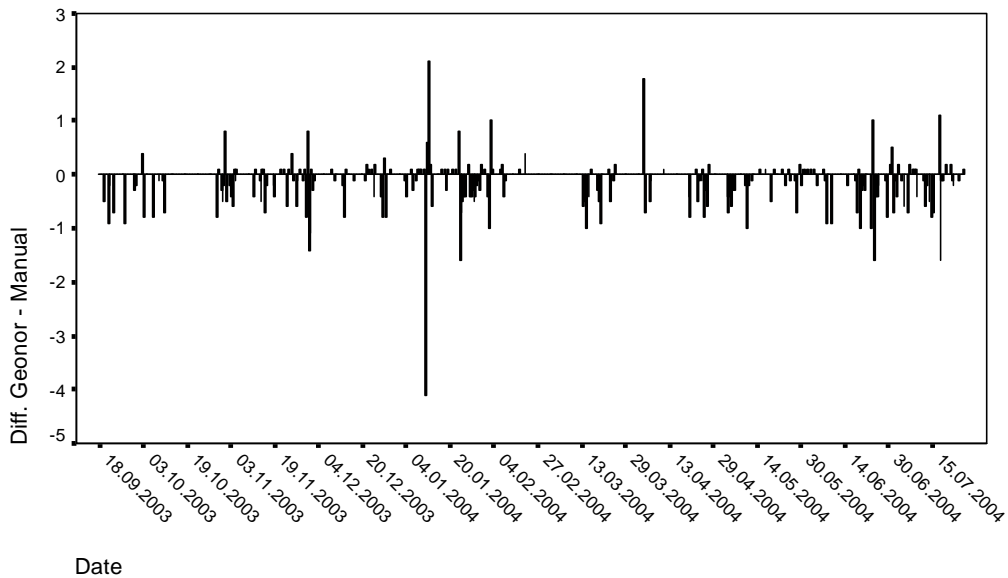
- The data comparison is based on data from September 2003 to July 2004.
- The automatic precipitation gauge is a Geonor T-200

**Table 1:** Monthly precipitation data from Geonor and the manual gauge

Month	No of days	Geonor	Manual	± %
September 2003	13	50.5	54.0	-6.5 %
October 2003	31	25.8	29.6	-12.8 %
November 2003	30	61.0	64.8	-5.9 %
December 2003	31	48.4	53.7	-9.9 %
January 2004	31	102.0	108.9	-6.3 %
February 2004	22	19.9	19.8	-0.5 %
March 2004	31	32.2	36.1	-10.8%
April 2004	30	51.7	54.3	-4.8%
May 2004	31	34.5	39.6	-12.8%
June 2004	30	67.0	74.7	-10.3%
July 2004	31	46.8	51.9	-9.8%
<b>Total</b>	<b>311</b>	<b>539.8</b>	<b>587.4</b>	<b>-8.1 %</b>



**Figure 2:** Cumulative sum of total precipitation



**Figure 3:** The difference (cases) between Geonor and manual gauge from Oslo.

**Table 2:** Number of cases in different precipitation intervals.

Prec. in 12-h period	Number of cases
Precipitation 0.5-1 mm	25
Precipitation 1-2 mm	33
Precipitation 2-5 mm	55
Precipitation 5-8 mm	27
Precipitation 8-10 mm	7
Precipitation > 10 mm	7

There are different reasons for the observed peaks (differences) for each case in figure 3:

- **Time of observation:** If the manual gauge is emptied and checked too early or too late from the correct observation time during a precipitation period, this could influence the differences (peaks).
- **Heavy precipitation period:** In situations with a lot of precipitation registered, the difference may seem considerable, but the percentage difference could be small.
- **Noise:** Electromagnetic disturbances, problems with the logger etc may cause lack of data or strange values from Geonor.
- **Other physical reason (exposure):** This is often the most important and most difficult factor to study.

## Exposure, physical and technical factors

Since there is an observed considerable difference of about 8 % between Geonor and the manual gauge (remembering that the two gauges are placed near each other) we would like to focus at some physical and technical factors:

- *Area of the buckets and level control*

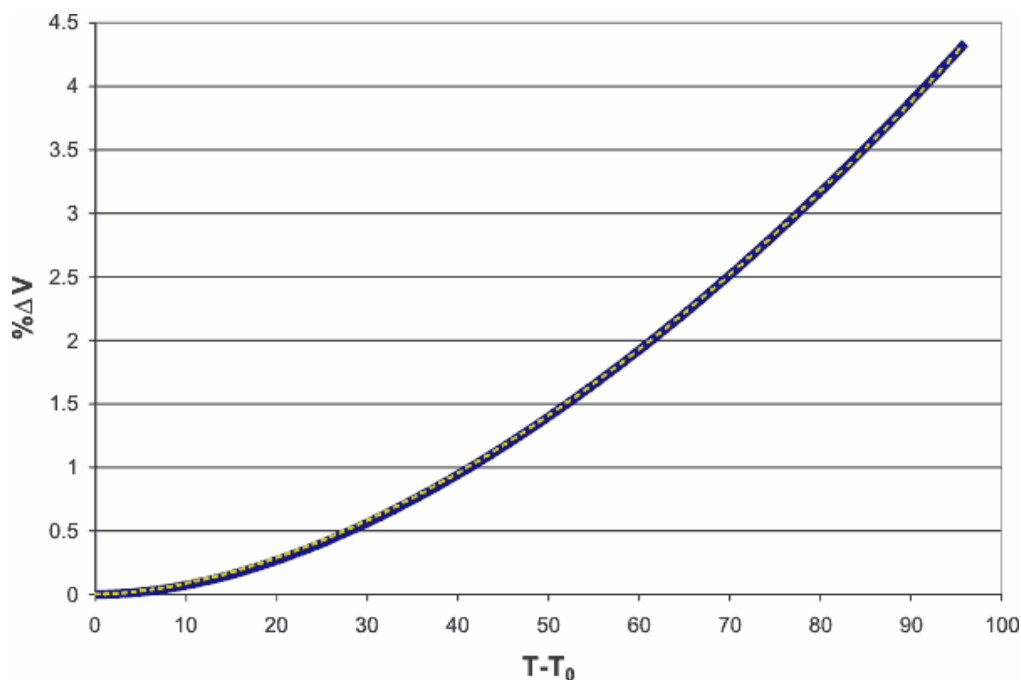
The area at the top of the manual gauge and at the top of Geonor were measured and controlled, and we found no differences. We also checked that both Geonor and manual were in level.

- *Control of the manual measuring equipment*

All equipment being used in the observation and emptying of the manual gauge were controlled. No irregularities were discovered.

- *Volume expansion of water because of an increase in temperature*

Geonor is measuring precipitation based on weight measurements. The manual gauge is on the other hand based on volume measurements. Since water is expanding with an increase in temperature (from 4°C), we would like to find out what effect this could have on our results. Figure 4 presents a change in volume as a function of a change in temperature ( $T - T_0$ ). An increase in the water temperature from 4 to 17 °C, increases the water volume of about 0.13 % (1.3 ‰). This physical effect is obviously not significant for the accuracy to our measurements.



**Figure 4:** Changes in volume as a function of change in temperature.

- *Evaporation*

By studying the data from the “bucket hour-values” from Geonor we see that there is a continuously evaporation from the bucket, despite the layer of oil at the liquid surface. To have a closer look at this evaporation effect we have more closely studied data from March, April and May 2004. The method used in getting an estimate for the contribution from the evaporation is not shown here, but the estimated values are presented in table 3.

**Table 3:** Estimated evaporation from Geonor

Month	Evaporation pr. 12t	Total contribution from evap. in the prec. periods	Monthly measured prec. for Geonor	The new “corrected” monthly prec. values.
<b>Mach</b>	0.060 mm	0.7 mm	32.2 mm	32.9 mm
<b>April</b>	0.065 mm	1.3 mm	51.7 mm	53.0 mm
<b>May</b>	0.102 mm	1.8 mm	34.5 mm	36.3 mm
<b>Total</b>	-	-	<b>118.4 mm</b>	<b>122.2 mm</b>

Looking only at these 3 months and considering no evaporation from the manual bucket, we find that the total difference between Geonor and the manual gauge is -5.6% instead of -8.7%.

But, of course evaporation also is going on from the manual gauge. In most time of the year the manual gauge is equipped with a funnel, and a report (DNMI- ”Klima-desember 1979, no 2”) tells that the evaporation from a similar manual gauge on a regular summer day is under 0.1 mm pr 24h-period (under 0.05 mm pr. 12h-period). We also know that evaporation from Geonor is going on all the time, while the evaporation from the manual gauge only is happening when there is water in the bucket (for instance only the last 2 hours in the 12h-period).

Some of the negative difference between the two gauges may therefore be explained by a more considerable evaporation from Geonor than from the manual gauge (in rain situations).

- ***Test of Geonor string response (calibration values)***

We made a test at Geonor (filling controlled amount of water in bucket) and checked the response from the string frequency on a dry summer day (table 4). The bucket was in level during the test.

**Table 4:** The results from the test measurements of Geonor (Blindern, Oslo).

Amount added: ml/mm	Second value (string frequency)	Minute value (stab. meas. bucket value)	Expected value	Correction
	13311	51,80		
1000 ml /50 mm	15394	100,86	101,80	0,94
1000 ml /50 mm	17210	150,09	150,86	0,77
1000 ml /50 mm	18841	199,39	200,09	0,70
1000 ml /50 mm	20330	248,74	149,39	0,65
1000 ml /50 mm	21707	297,80	298,74	0,94
1000 ml /50 mm	22999	347,19	347,80	0,61
1000 ml /50 mm	24221	396,52	397,19	0,67
1000 ml /50 mm	25375	445,71	446,52	0,81
1000 ml /50 mm	26477	494,91	495,71	0,80
1000 ml /50 mm	27534	544,17	544,91	0,74
1000 ml /50 mm	28548	593,35	594,17	0,82
<b>Mean value (correction)</b>				<b>0,77</b>

The results indicate a correction of 0.61-0.94 mm (mean value: 0,77) pr. 50 mm added water, which means 1.5 % less registered precipitation amount than added into the bucket. These results is a bit surprising, knowing that the correct calibration values to the string is used in the logger.

- ***Wind conditions***

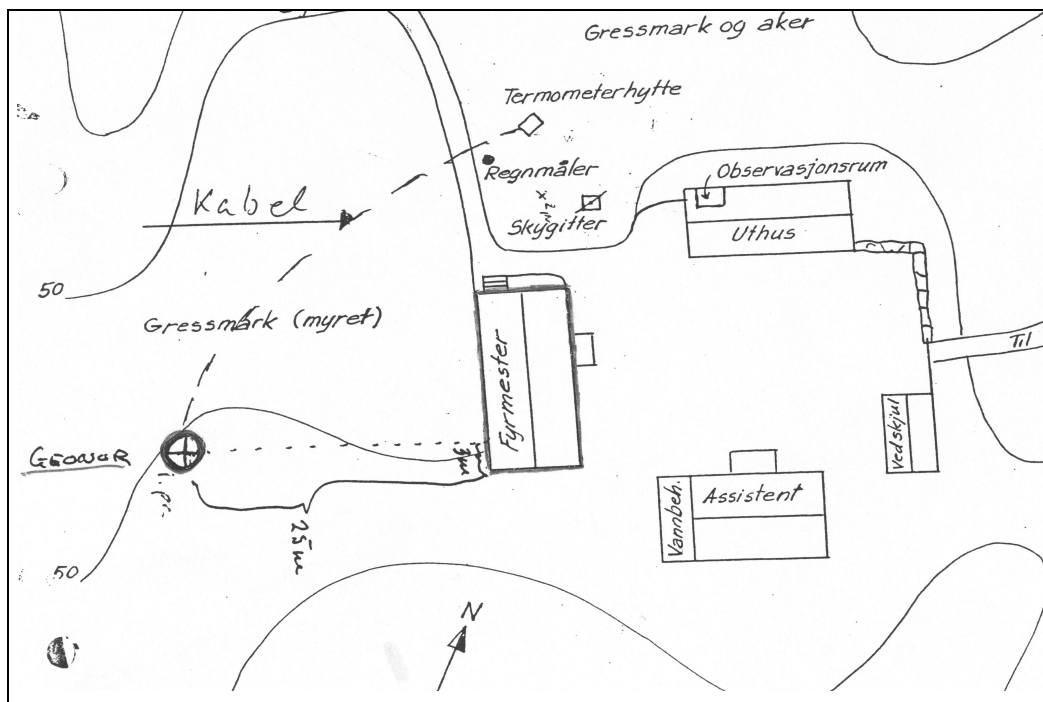
Oslo (Blindern) is not a very windy place. We have studied many of the difference-cases (peaks in figure 3) one by one and looked at other meteorological parameters, for instance wind, but this parameter does not seem to be significant for the observed differences in our cases. We also see that the two gauges are placed close to each other, which means that the exposure should be quite identical.

At SMHI in Sweden they are doing an extended theoretical wind study of Geonor by testing different wind shields. The idea is that the shape of the Geonor-container is creating an upward going wind field, slightly reducing the possible “caught” precipitation, especially slight rain or snow. The results from these tests are not ready.

## Utsira (59° 18' N, 4° 52' E)

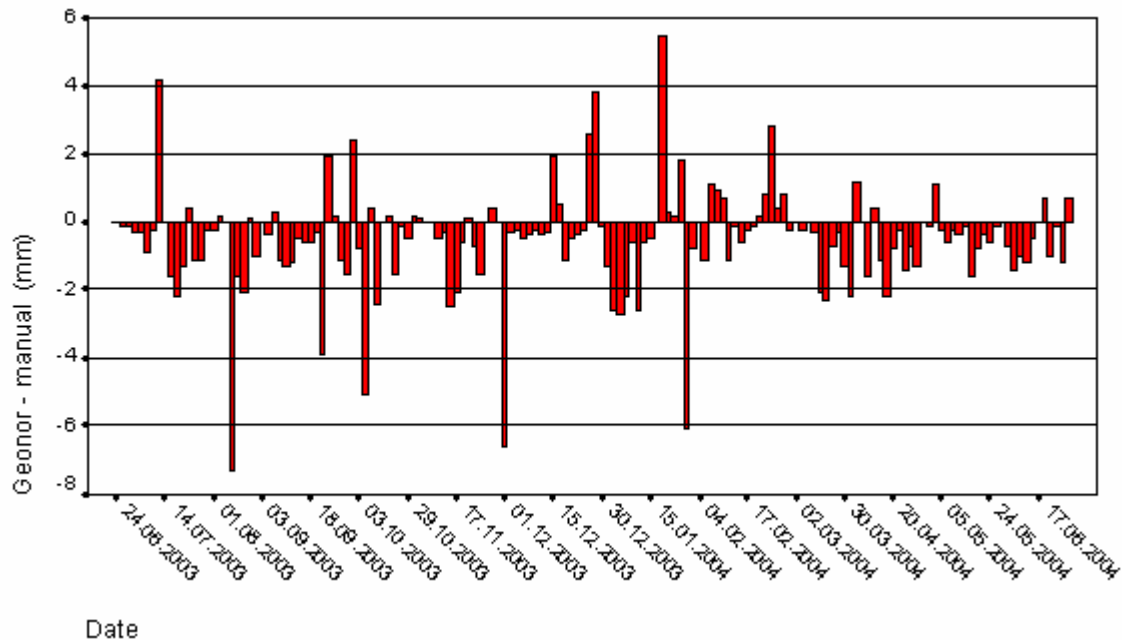


**Figure 5:** Geonor T-200 is placed to the right in the picture, at the bog behind the house. The picture is taken before Geonor was mounted. The manual gauge is placed at the lawn between the houses.



**Figure 6:** The lighthouse station. Geonor is placed to the left. The manual precipitation gauge is placed north of the “Fyrmester” house.

In figure 7 the difference between Geonor and manual gauge for the different cases is presented (period June 2003 to June 2004). Geonor is collecting 1052.6 mm precipitation during the studied period, while the manual gauge is collecting 1130.0 mm, a difference of approximately 7 % (table 5).



**Figure 7:** The difference (cases) between Geonor and manual gauge from Utsira

**Table 5:** The difference between Geonor and the manual gauge.

	<b>Geonor</b>	<b>Manual</b>	<b>Difference</b>
Total amount of precipitation	1052.6	1130.0	-6.85 %

At Utsira Geonor and the manual gauge are located some distance from each other, and we may expect a bit difference in the “catch” of the precipitation because of the local topography and the location to the buildings. Utsira is a very wind exposed station and in precipitation situations it is often very windy. By studying each case (peak) more closely we found that the wind direction during the precipitation periods seemed to have a considerable influence on the “catch” of precipitation at Utsira. We have studied all differences (peaks) in figure 7 greater than 2, totally 18 “negative” cases and 6 “positive” cases. The results are shown in table 6.

**Table 6:** Possible reasons for the observed differences between Geonor and manual gauge

<b>Possible reasons</b> <b>Number of cases</b>	<b>Mainly SE-ly wind (frontal precipitation)</b>	<b>Mainly NW-ly wind (showers)</b>	<b>Wind in sector S to W</b>	<b>Snow/sleet-cases</b>	<b>Geonor-top filled with snow</b>
<b>18 negative cases</b>	13 cases	4 cases	-	-	1 case
<b>6 positive cases</b>	-	-	4 cases	2 cases	-



