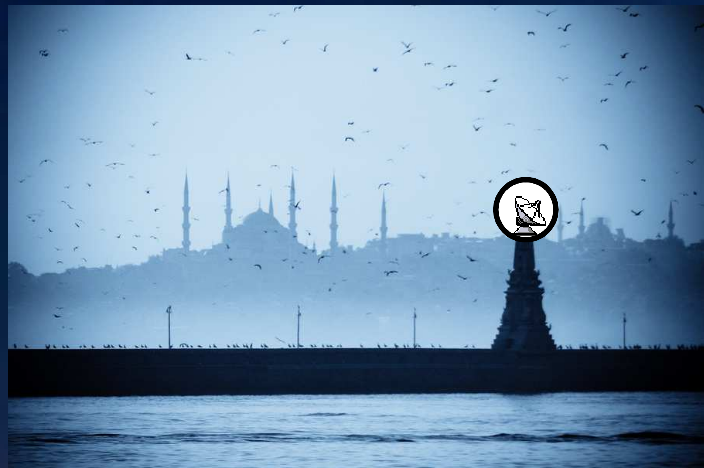
Turkish State Meteorological Service

The Gauge Adjustment to Time-Cumulated Radar Rainfall in the Event of a Flood



Kurtuluş ÖZTÜRK and Fırat BEŞTEPE

Outlines

- Description of Event
- Methodology
- Research Outputs
- Summary and Conclusion
- Future Work

Description of Event

- The İstanbul radar, C band Doppler located at 378 m (tower of 20 m)
- 33 automated raingages in the circular area (18 used), the radius of which is 120 km with the radar location as being the center.

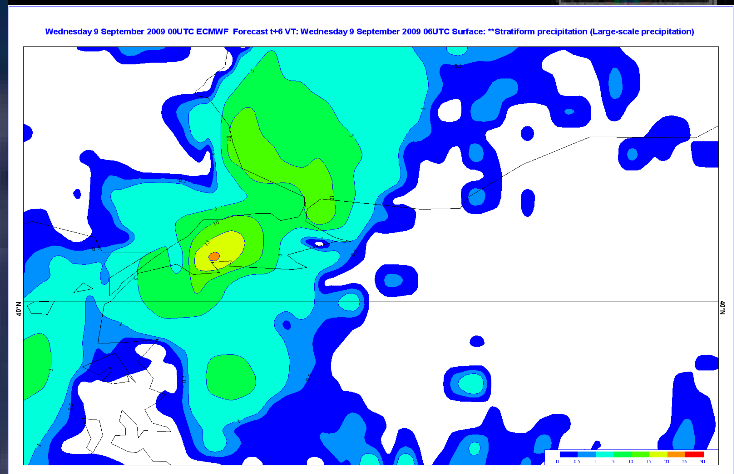
Ruler
Line
Path
Polygon
Circle
Radius:
120,16
Kilometers
Area:
45.408,14
Square Kilometers
Circumference:
756,12
Kilometers
Mouse Navigation
Clear
17050
KIRKLARELİ
LÜLEBURGAZ TAR.İŞL.
ÇATALCA RADAR
17608
ÇERKEZKÖY
ÇORLU
ÇORLU MEYDAN
KUMKÖY-KİLYOS
SARIYER
ŞİLE
AKOM HADIMKÖY
AKOM ÇANTA
AKOM MERKEZ
AKOM ÖMERLİ
AKOM KAMİLOBA
AKOM OLİMPİYAT
AKOM AKSARAY
17632
TEKİRDAĞ
(Tekirdag)
17634
ATATÜRK HAVALİMANI
İSTANBUL BÖLGE
SABİHA GÖKÇEN
BÜYÜKADA
KARTAL
GEBZE
17066
17067
YALOVA MEYDAN
ÇINARCIK
ERDEK
17633
17663
17661
17110
BANDIRMA MEYDAN
BANDIRMA
MUDANYA
17112
17116
17118
17673

Description of Event

The rain event occurred between 08.09.2009 and 09.09.2009 is the most extreme rain event during last 80 years in the Thracian region, city of Istanbul and vicinities. It caused a devastating flood; 41 people were killed and millions of dollars were lost.

Description of Event

Between 09.09.2009 00:00 UTC and 09.09.2009 06:00 UTC, 134 mm rain was recorded in Bandirma while 130 mm was measured in Erdek in 6 hours.



Methodology

- Preliminary analysis was done to test the performance and reliability of rain gauges employed in this study.
- Six different rain gauge integrations from 10 minutes to 12 hours were evaluated and compared with the Parsivel disdrometers collocated with some of these rain gauges.

Methodology

- Error sources : beam shielding, orography, spatial and temporal variability of rainfall.
- A regression equation with three variables is generated.

WMR Method

- To eliminate the temporal variability, the variables are selected as time-independent parameter and total rainfall is used.

- The assessment factor (AF) is the ratio of total radar rainfall (R) to the gauge rainfall (G)

$$(AF)_j = \frac{\sum\sum (R)_j}{\sum\sum (G)_j}$$

$$(AF)_j(dB) = a_0 + a_D.log(D_j) + a_{HV}.(HV_{min})_j + a_{HG}.HG_j$$

Gabella *et al.*, 2000

D : the distance between radar and raingage (related to beam broadening)

HV_{min} : the minimum height above the raingage that the target is visible from the radar (related to beam shielding)

HG : the topographical height of raingage (related to orography)

j : raingage number

- R-G data pairs are regressed by minimizing the residuals and weighted by w =1, w =R and w =G

- With the obtained coefficients, the estimated logarithmic AF function is generated, and then it is anti-transformed to non-logarithmic AF

$$\sum\sum(R_c)_j = \frac{\sum\sum(R)_j}{(AF_e)_j}$$

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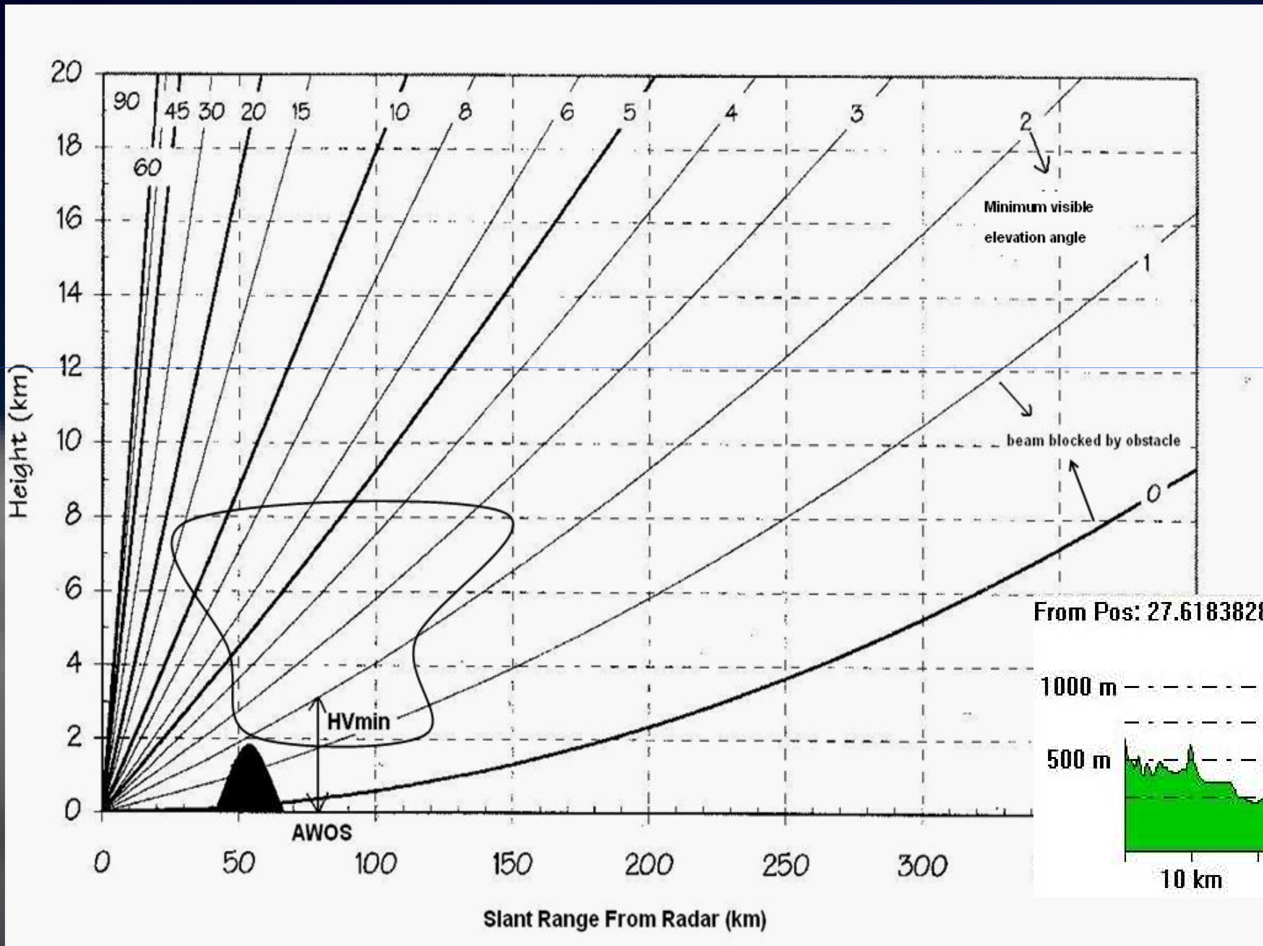
$$H = \sqrt{r^2 + R'^2 + 2rR' \sin\phi} - R' + H_0$$



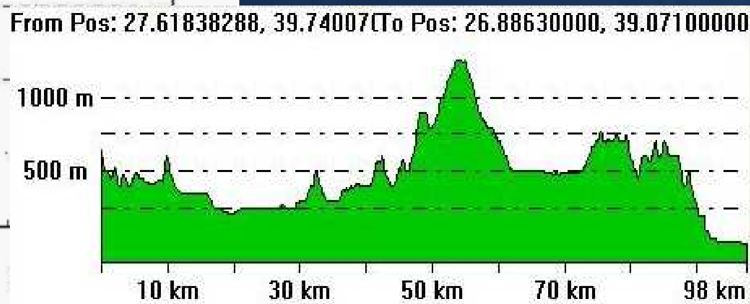
r : the distance between the radar and the point of interest

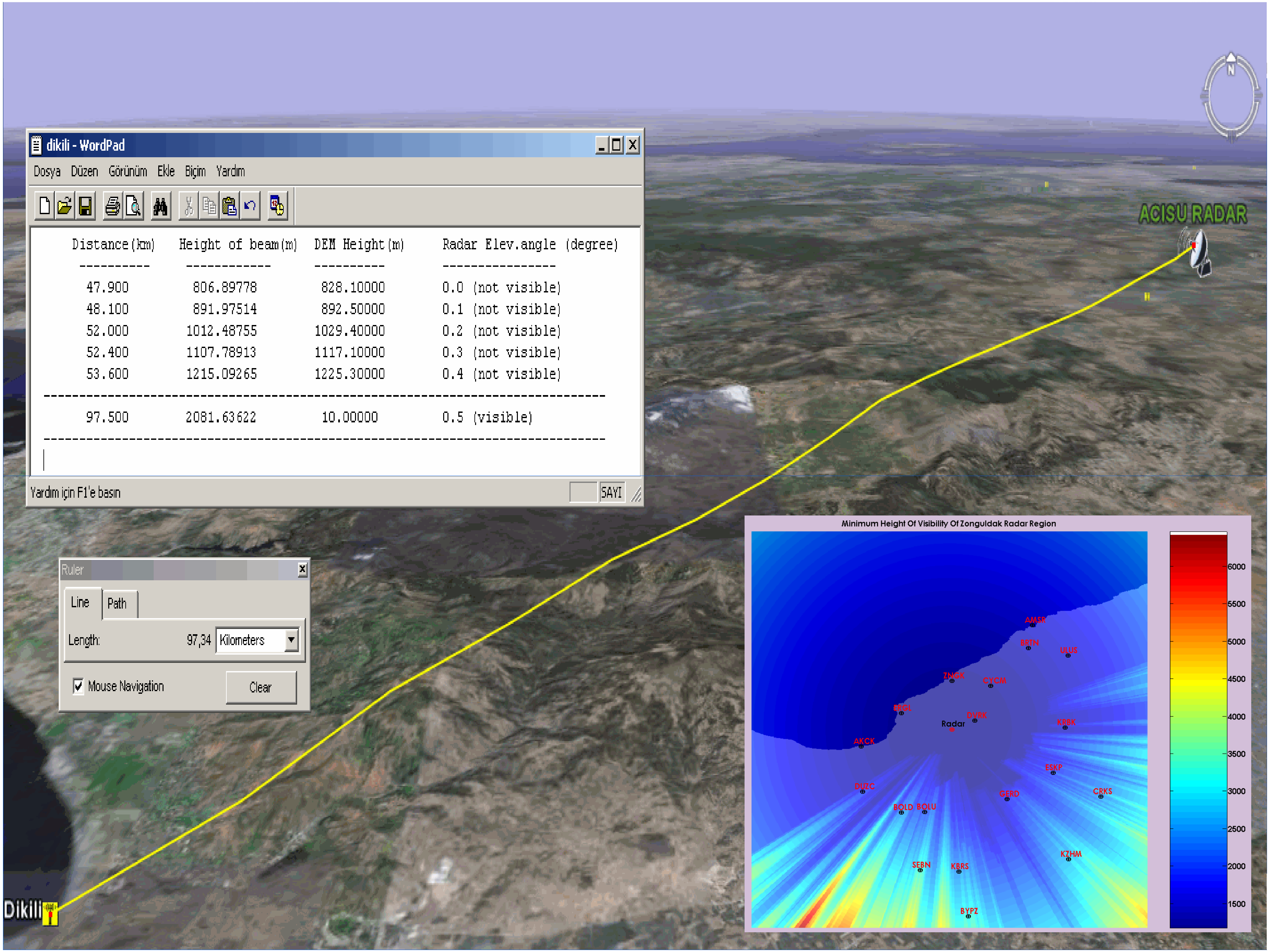
ϕ: the elevation angle of the radar beam

H_0: the height of the radar antenna above sea level

R: is the earth's radius.

R'=4R/3.



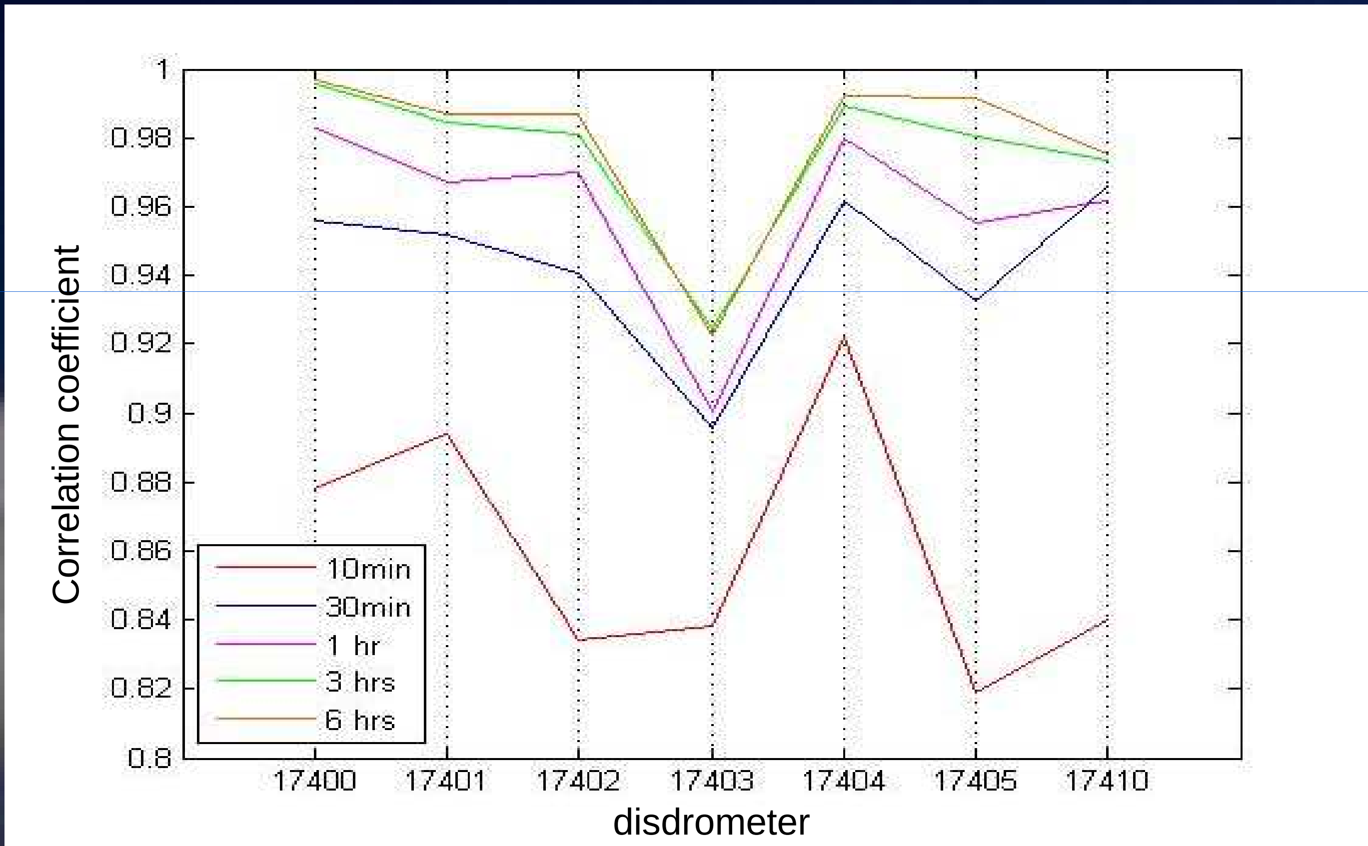

dikili - WordPad
Dosya Düzen Görünüm Ekle Biçim Yardım
Distance(km) Height of beam(m) DEM Height(m) Radar Elev.angle (degree)
47.900 806.89778 828.10000 0.0 (not visible)
48.100 891.97514 892.50000 0.1 (not visible)
52.000 1012.48755 1029.40000 0.2 (not visible)
52.400 1107.78913 1117.10000 0.3 (not visible)
53.600 1215.09265 1225.30000 0.4 (not visible)
97.500 2081.63622 10.00000 0.5 (visible)
Yardım için F1'e basın
SAYI
ACISU RADAR
Ruler
Line
Path
Length:
97,34
Kilometers
Mouse Navigation
Clear
Dikili
Minimum Height Of Visibility Of Zonguldak Radar Region
Radar
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500

Employing rain gauge observations and radar estimates, multi-parameter regression equation is derived and used to find the gauge-adjusted radar rainfall estimates.

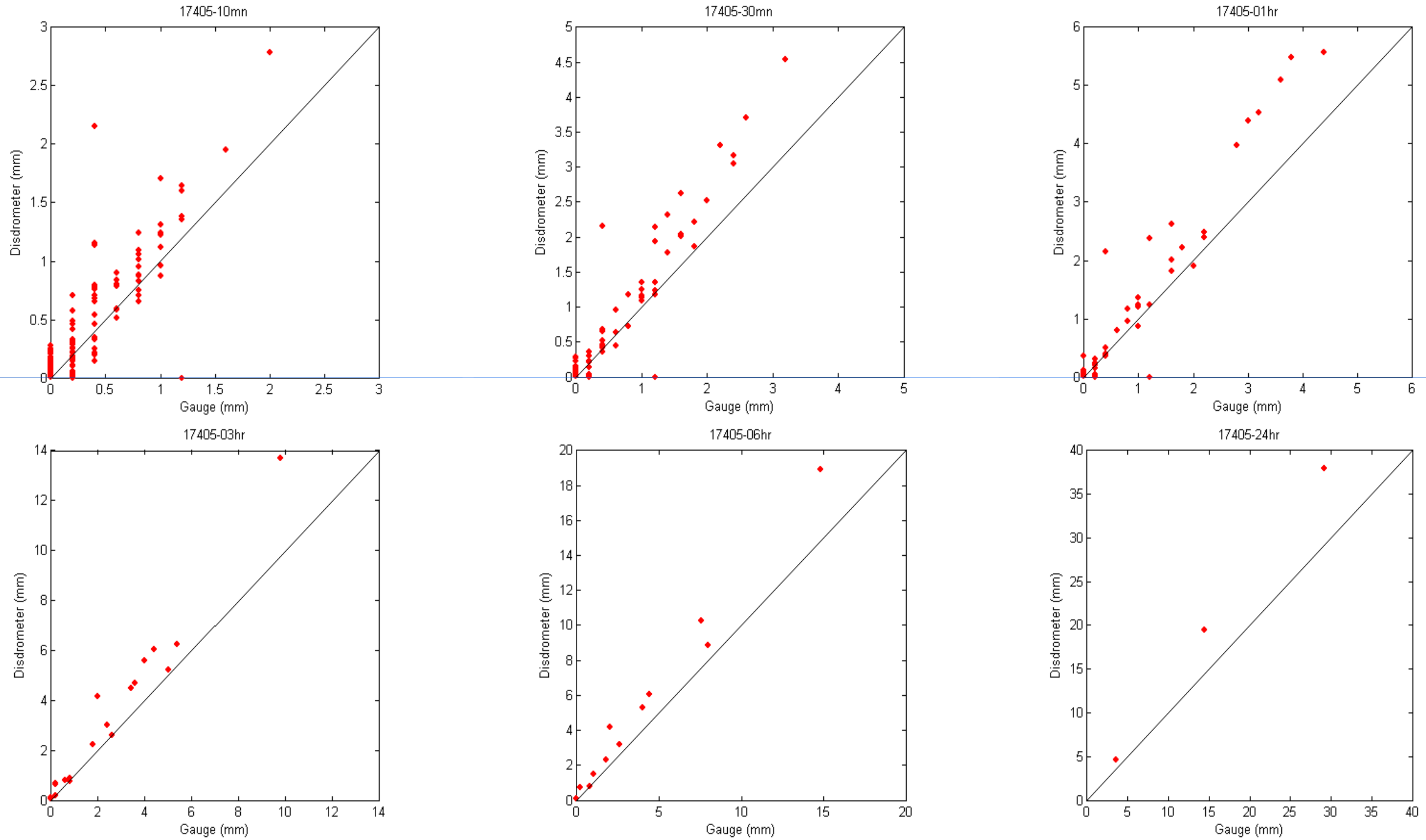
$$(AF)_j(dB) = -0.189 - 2.645\log(D_j) - 0.296(HV_{\min})_j + 23.643HG_j$$

Research Outputs

Comparison of integrations



Scatter plots: disdrometer 17405 (comparison of integrations)



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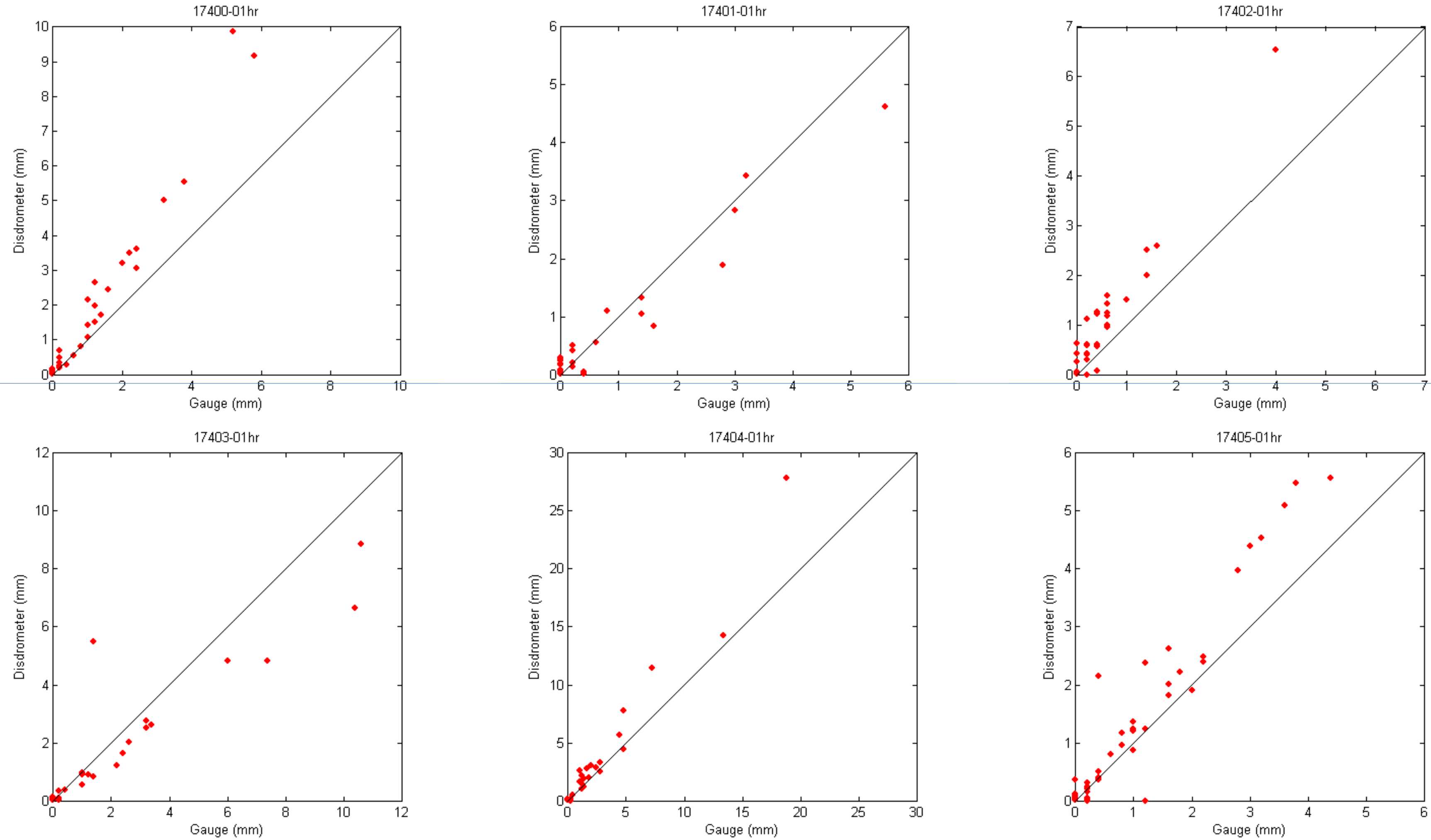
Scatter plots: 1 hour integration (comparison of disdrometers)



Integration Period	Station #	# of pairs	gauge_mean (mm)	disd_mean (mm)	SDEV (mm)	RMSE (mm)	PAB (mm)	r (mm)
	17400	72	0.547	0.795	0.314	0.398	0.543	0.878
10 min	17401	36	0.611	0.488	0.238	0.265	0.350	0.894
	17402	47	0.349	0.530	0.270	0.323	0.728	0.834
	17403	59	1.007	0.797	0.692	0.717	0.375	0.838
	17404	90	0.851	1.082	0.637	0.674	0.392	0.922
	17405	94	0.502	0.606	0.318	0.333	0.436	0.819
	17410	26	0.492	0.671	0.332	0.371	0.589	0.840
	17400	37	1.065	1.648	0.634	0.855	0.585	0.956
	17401	20	1.100	0.910	0.314	0.360	0.276	0.952
	17402	30	0.547	0.941	0.427	0.576	0.808	0.941
	17403	32	1.856	1.501	1.063	1.104	0.343	0.896
	17404	41	1.868	2.436	1.372	1.469	0.385	0.962
	17405	49	0.963	1.226	0.493	0.554	0.388	0.932
	17410	16	0.800	1.135	0.353	0.478	0.485	0.966
	17400	24	1.642	2.560	1.135	1.441	0.569	0.983
	17401	15	1.467	1.260	0.419	0.455	0.235	0.967
	17402	23	0.713	1.288	0.572	0.802	0.871	0.970
	17403	20	2.970	2.418	1.443	1.511	0.328	0.901
	17404	25	3.064	4.012	1.998	2.175	0.358	0.980
	17405	36	1.311	1.691	0.642	0.738	0.378	0.955
	17410	15	0.853	1.237	0.327	0.497	0.493	0.962
	17400	15	2.627	4.141	2.479	2.834	0.587	0.996
3 hours	17401	10	2.200	2.018	0.474	0.485	0.155	0.984
	17402	16	1.025	1.923	0.905	1.254	0.941	0.981
	17403	12	4.950	4.049	2.090	2.195	0.297	0.924
	17404	15	5.107	6.732	3.598	3.837	0.349	0.989
	17405	17	2.776	3.640	1.014	1.309	0.313	0.981
	17410	11	1.164	1.736	0.394	0.685	0.523	0.973

Station	Rain (mm)										
	Gauge Pixel	Pixel 1	Pixel 2	Pixel 3	Pixel 4	Pixel 5	Pixel 6	Pixel 7	Pixel 8	MEAN	STDEV
CORLU MEYDAN	10.65	11.51	11.34	10.41	11.24	10.97	10.15	10.99	11.26	10.95	0.46
CORLU	5.26	5.23	5.29	5.56	5.47	5.56	6.34	6.62	6.64	5.77	0.59
TEKIRDAG	3.14	3.16	3.23	3.00	3.28	3.35	3.01	3.40	3.57	3.24	0.19
KUMKOY-KILYOS	18.46	19.85	21.34	20.42	24.74	24.36	20.68	22.39	22.95	21.69	2.09
ATATURK AIRPORT	5.25	5.07	4.36	4.21	3.96	3.05	3.95	4.14	2.46	4.05	0.88
SARIYER	10.96	9.44	8.77	10.32	9.57	8.66	13.64	12.34	8.86	10.28	1.74
BANDIRMA	**26.20**	31.85	27.25	34.38	44.22	35.86	39.03	**60.45**	51.58	**38.98**	11.35
OLIMPIYAT	**37.87**	30.83	31.40	36.71	27.39	23.51	32.97	27.71	**22.95**	**30.15**	5.27
AKSARAY	1.76	1.86	2.11	1.82	2.33	3.39	1.65	3.13	4.72	2.53	1.03
TERKOS	15.95	18.24	17.09	15.15	18.21	18.80	13.68	13.48	14.62	16.13	2.03
AKOM CENTER	10.65	11.35	10.85	10.07	11.45	11.89	8.99	10.55	11.77	10.84	0.92
CANTA	26.85	27.74	27.02	26.44	28.26	27.44	25.25	24.82	23.94	26.42	1.45
KAMILOBA	29.00	27.28	31.18	21.44	24.42	29.58	21.29	22.10	24.43	25.64	3.75
HADIMKOY	36.96	35.99	35.78	39.58	37.19	36.02	38.49	36.31	34.17	36.72	1.59
GÖZTEPE	3.53	3.87	3.55	2.58	3.67	3.78	0.70	2.29	3.59	3.06	1.04
IST.UN.DENIZ BIL.	1.84	1.97	2.55	2.11	2.10	2.46	3.39	2.93	3.18	2.50	0.56
ERDEK	27.97	27.90	27.53	27.37	26.63	26.27	25.94	25.81	25.64	26.78	0.92
FLORYA	11.17	8.13	7.18	10.91	10.04	7.31	9.59	11.93	7.61	9.32	1.81

Statistics

Radar-Gauge comparison	AME (mm)	RMSE (mm)
$R - G$	**19.77**	**31.17**
$R_c - G$ (w=1)	9.42	15.37
$R_c - G$ (w=G)	8.07	12.39
$R_c - G$ (w=R)	7.85	11.22
$R_c - G$ (w=R) HV-out	7.93	12.34

Radar-Gauge comparison (RMSE)	BEFORE (mm)	AFTER (mm)
Case 1 (10.10.2011)	21.13	15.13
Case 2 (15.01.2012)	18.25	11.17

Summary and Conclusion

- Agreement between gauge-disdrometer improves with increasing time span.
- Agreement above 0.9 at all stations for one-hourly rainfall integration.

- Pixel-based SCR algorithm reduced RMSE and AME remarkably for all regressions.

- The best RMSE is obtained when W=R is used. AME decreased 60% while RMSE decreased 64% where weight factor is taken W=R for six-hourly integration. Employing same equation for other cases RMSE decreased 28% for Case 1 and 38% for Case 2.

- Rain around Bandırma and Olimpiyat gauge stations has higher deviation than the others. It indicates that the rain can show variability in a small-scale area (2.25 km^2) and average rain may deviate from the original value 67% even though our case is not a convective case.

- It is clear that more deviation may be expected between neighbor pixels during convective events. This deviated number may also affect the Assessment Factor (AF), regression equation, corrected rain and the success of the correction method adversely.

Future Work

- Dense tipping bucket gauge network (30 site-3 collocated at each site) will be installed soon to have reliable-gap free ground database.
- 6-months field campaigns for each radar sites.
- Real-time corrected rain product (PSCR) – already developed, real-time adaptive algorithm is being developed.


OBRIGADO...