

1 Reviewer #2 MINOR REVISION

2
3 Review of the paper: The Rise and Fall of Cloud Seeding in Israel: A History with
4 Lessons for the Future

5 By A. Rangno

6 The paper deals with a number (3) of Israeli cloud seeding experiments that for
7 many years (2 of them) were considered a success story of rain enhancement.
8 Over the years this success story was challenged by a number of papers
9 including the papers co-authored by the present author, which led to bitter
10 exchanges in the open literature.

11
12 RH95 and the exchanges mentioned above were vigorous, exhaustive, but more
13 importantly, had the positive impact of leading the Israel National Water Authority
14 to form an independent panel to examine the effects of operational seeding on
15 runoff into Lake Kinneret (Sea of Galilee).¹ When the panel found no additional
16 runoff due to seeding, the seeding program was terminated.

17
18 Vigorous commentaries can have a beneficial effect and should not be avoided.
19 BAMS once relished these kinds of encounters, ones that stimulate its
20 readership.²

21
22 The present paper tries summarizing these debates and adding some more
23 recent publications strengthening the conclusion that the interpretation of the
24 experiments (Israel 1, 2 and 3) were wrong.

25
26 The paper describes in some detail the errors in the statistical analysis,
27 reiterating points made in the papers he wrote with Hobbs during the 1990's.
28 Furthermore, he concludes that based on a number of more recent
29 measurements the clouds in Israel are not suited for seeding with AgI because
30 they already contain high concentrations of ice crystals.

31
32 In addition, he refers to previous papers showing that the seeding method of
33 seeding along a line in or just below the bases of clouds, is ineffective because of
34 poor dispersion of AgI particles, many of which are washed down by rain.

35
36 I think the paper is important because it sends a message that before doing any
37 cloud seeding experiment, one should make sure the clouds are suited for
38 seeding.

¹ Y. Goldreich, author of *Climate of Israel*, personal communication, 2018.

² “*The Bulletin of the American Meteorological Society (BAMS)* publishes papers on historical and scientific topics that are of general interest to the AMS membership. It also publishes papers in areas of current scientific controversy and debate, as well as review articles.”

40 Also for a more objective and unbiased experiment, a very careful separation
41 should be done between the designers, the operators, the data collectors and the
42 people doing the data analysis.

43

44 Agreed.

45

46 Too, cloud measurements in support of possible future cloud seeding
47 experiments should never be carried out by those associated with prior or current
48 cloud seeding efforts, either.

49

50 In spite of the importance of the paper, I find the tone of the paper too harsh,
51 suggesting or implying that the reports were intentionally biased.

52

53 The tone/harshness has been adjusted downward via omission of text that could
54 have been deemed "harsh."

55

56 I do not believe the early **cloud** reports were intentionally biased. They were
57 carried out by inexperienced researchers who sampled small, newly risen cloud
58 turrets or small complexes that were unrepresentative of those that bring rain to
59 Israel. The average duration of a rain shower in Israel is 23 min. In a 10 ms^{-1}
60 wind, this would require a raining cloud portion of about 14 km in width. The
61 early cloud reports consisted of samples of clouds but only ones of 1-5 km in
62 width (G71, G75). In a 10 ms^{-1} wind, even the widest clouds they cited, 5-km
63 one, would pass in less than 5 min. So, the reports themselves were biased in a
64 sense, but not intentionally IMO.

65

66 Reporting of the Israel-2 experiment was biased (one-sided) and presented as an
67 unambiguous perception of a cloud seeding success when GN81 only presented
68 the 50 mice that were "cured by the treatment" and not reporting "the 50 mice
69 that died from the same treatment."

70

71 In the harshest terms, it was misconduct ("falsification", as defined by several
72 scientific organizations, namely the omission of data that results in an experiment
73 looking better than it really was. How else can we describe what happened?

74

75 Furthermore, I feel that it is a little unfair to claim that the reviewers of the papers
76 published by the cloud seeding groups did not do a good job.

77

78 The text has been re-written to reflect R2's concern. "Good" reviewing may well
79 have taken place by unbiased reviewers who were merely naïve about the
80 temptations to alter or omit data for the sake of proving a cloud seeding success.
81 After all, a cloud seeding success means fame, prestige, and employment.
82 Unless the reviews of the manuscripts in question are released, we can't know
83 for sure how thorough they were. All we do know is that some elements were not
84 investigated thoroughly enough.

85
86 In retrospect, it seems that EXTRAORDINARY reviewing is required for cloud
87 seeding manuscripts! And it needs to be done by a wider panel of experts than
88 we normally think of. Such a panel should include local weather forecasters,
89 statisticians, dispersion experts, cloud physicists. Normal reviewing, let alone,
90 one-sided reviewing by seeding partisans as likely happens, is not good enough;
91 no sentence in an experimenters' cloud seeding manuscript can go unverified.

92
93 This is a sad statement of affairs in the cloud seeding domain, but it is proved via
94 the costly historical cloud seeding detritus around us³.

95
96 The title of the paper is a very catchy but I feel that it should be toned down.

97
98 Hmmm. It seems to be what happened. The Special Editor has also objected
99 to some words in the title. How about, "The Rise and Fall Chapter of Israeli
100 Cloud Seeding, 1961-2010"?

101
102 I do not think that the *original* papers by Gagin and Neumann and their group
103 intentionally biased their results.

104
105 There are two answers to this statement.

106
107 The author agrees wholeheartedly with Reviewer 2's statement regarding all of
108 the early work by the experimenters up through 1975. This writer deems Gagin
109 and Neumann's (1974) article, written in 1972, one of the best texts on the
110 problems posed by cloud seeding experiments. It is circumspect, and
111 preliminary numerical results for the south target were disclosed ("less than 1").

112
113 This same science demeanor was exhibited in prior papers by Neumann et al.
114 1967, and later in Gagin (1975)

115
116 However, by 1976, GN decided to excise the numerical results of the south
117 target, first in their preprint. They also did not perform the crossover evaluation
118 (or at least report the results of it to us) that GN74 deemed so important.

119
120 The absence of the south target results continued with the peer-reviewed GN81.
121 I regret to point out that GN81 was reviewed by Prof. Ruben Gabriel, according
122 to the authors in the acknowledgements.

123

³ In fourteen of 18 peer-reviewed cloud seeding papers published since the modern seeding era began (1946), the "successes" reported by the original experimenters could not be corroborated by outside investigators. (Rangno 1997, unpublished ms, rejected by BAMS, I. Abrams, 1998, personal communication).

124 Consistent with the omission behavior described for Israel-2 is, in view of the
125 several reports of shallow, precipitating clouds (Rangno 1988; Levin 1992; 1994;
126 Levin et al. 1996) and Freud et al. (2015), that the experimenters must have
127 surely observed them with their radars and aircraft-confirmed tops (e.g., Gagin
128 1980). It is noteworthy that Reviewer DR was also examining radar data
129 concurrently (DR, 1980, Master's Thesis⁴). DR can shed light on this enigma.

130

131 Otherwise, do we have more than astounding incompetence, or fraud to choose
132 from? Sorry if I make anyone go apoplectic with this query. I don't apologize for
133 the strong language; I have the same low threshold of misconduct as does our
134 major science organizations.

135

136 It is important to note that some of the people involved in the statistical analysis
137 such as the late Prof. Ruben Gabriel, were first class experts in the field and
138 could not be blamed for poorly evaluating the results presented in the papers.

139

140 The author has great admiration for Ruben Gabriel and emphatically does not
141 believe that he "poorly" evaluated the Israel-1 results. The Gabriel analyses of
142 Israeli 1 (Gabriel 1967a, b) were superb in their thoroughness. He tried to get it
143 right, and we should be thankful that he led the full reporting of Israel-2 and it
144 was not left solely to DR.

145

146 It was a shame for all of us that he was not more than a reviewer regarding
147 Israel-2. I believe we would not be having this discussion had that been the
148 case.

149

150 -----

151 There were unappreciated aspects, however, even in the Israel-1 analyses that
152 cast doubt on seeding efficacy. For example, the high seed/no seed ratios on
153 seeded days in the coastal region (shown in "Map 2" of Gabriel and Baras 1970)
154 that due to logistical considerations, could not have been seeded or barely so
155 (e.g., Neumann et al. 1967; Gabriel 1979).

156 -----

157 The draws in Israel-1 and -2: I was informed by DR that Ehud Shimbursky was
158 the lead statistician of Israel-2. The random list is very different from that of
159 Israel-1 as even a cursory examination will show. Israel-2 has long strings of the
160 *same* random decision; Israel-1 did not. Or, is the Israel-2 list of random
161 decisions is not a truly "random" list at all?

162

163 I am sorry to have to say that it is CRITICAL to certify that Shimbursky's (or
164 Gabriel's, whomever it was who prepared the random seeding day lists for Israel-

⁴ "The characteristics of rain cloud systems in Israel as derived from radar data and satellite images."

165 2) were those that were, in fact, used by the experimenters in view of the odd
166 draw in Israel-2.

167
168 We all know, or should know, how cloud seeders like to seed the big storms to
169 impress their funding public, “yes, we seeded that one.” And seeding the big
170 storms was what happened repeatedly in the Israel-2 experiment as we know
171 from GR90. It would be a huge relief to all to learn that it wasn’t a truly random
172 draw in view of how lopsided it was. Who would conduct a daily randomized
173 experiment if the draw could turn out so badly?

174
175 I do believe that the reports on the measurements were done in honesty but with
176 the use of old and maybe unreliable instruments. The newer measurements with
177 newer and more reliable instruments led to completely different results.

178
179 DR claims in his review that using modern instruments to measure ice particle
180 concentrations makes no difference; they produce “uncertain” ice concentrations,
181 so much so that they can’t even be reported! So, in decades of flying with
182 modern instruments, the HUJ has never been able to measure them accurately.
183 They need help.

184
185 While the rest of the world has measuring and reporting ice particle
186 concentrations in clouds over this time (1990-2015) with modern instruments,
187 using algorithms to reduce the impact of shattering artifacts on ice
188 concentrations, it is apparently beyond the skills of HUJ scientists to do this.

189
190 Or so they claim.

191
192 Or is it that HUJ researchers don’t want to report the high concentrations they
193 have found in the clouds of Israel (as reported by Levin et al. 1996) because it
194 raises questions about seeding potential?

195
196 But that doesn’t explain why GN could not, in observing the tops of Israeli
197 precipitating clouds with their radars in storm after storm, or chatting with IMS
198 forecasters, or standing on a Tel Aviv beach watching modest glaciating clouds
199 roll in off the Mediterranean as this writer did, tell immediately that something
200 was drastically wrong with their low ice-producing cloud reports.

201
202 I think that one of the faults of these experiments was the fact that the same
203 people were doing the seeding, the data collection and the analysis. The WMO in
204 its more recent statements on cloud seeding stressed the need to have
205 independent and separate groups doing each task.

206
207 Amen. This was mentioned in the original concluding section.

208

209 Here are a few specific comments:
210 Throughout the paper the experiments should be called Israel 1, 2, 3 etc. and not
211 Israeli

212
213 This is an interesting comment that required quite a survey. The nomenclature of
214 the experimenters and those who have commented on it has not been
215 consistent:

- 216
- 217 • In the early days the references to those experiments by the
218 experimenters themselves were “Exp. I” and “Exp. II” (e.g., GN76,
219 preprint, GN81, *JAM*).
- 220
- 221 • In 1978, Tukey et al. referred to the first and second experiments in Israel,
222 as “Phase 1” and “Phase 2.”
- 223
- 224 • Kerr (1982, *Science*) referred to them as, “Israeli I and II.”
- 225
- 226 • By 1986, (Gagin, *Meteor. Monogr.*) referred to them as “Israeli 1 and 2.”
- 227
- 228 • Gabriel and Rosenfeld (1990) “Israel I and II”
- 229
- 230 • In Young (1993, Cambridge U. Press), Israeli I and Israeli II.
- 231
- 232 • Rangno and Hobbs (1995): “Israeli I and II.”
- 233
- 234 • Rosenfeld (1998): Israeli-1 etc.
- 235
- 236 • List et al (1999): “Israel I and II.”
- 237
- 238 • Finally, Silverman (2001, *BAMS*) describes them as Israel-1, etc., though
239 in 1986 (*Met. Monogr.*), he referred to them as “Israeli I and II”.
- 240
- 241 • Goldreich (2003, in his book, *Climate of Israel*) terms the experiments,
242 “Israel I”, “Israel II” and “Israel III.” (Roman numerals, no hyphenation).
- 243
- 244 • Freud et al. (2015): “Israel-4”

245
246 -----
247 So, we are left we a bit of a conundrum, or as one might also conclude, much
248 flexibility. For this reason, I have deferred to the preference of Reviewer 2 in the
249 revised ms and now refers to the experiments as “Israel-1” and “Israel-2”, etc.

250

251 In the abstract – Israel 3 was designed to test the effect of the seeding in the
252 south. In this case the length of the seeding line was increased considerably,
253 making the seeding with one or two planes less effective.

254

255 I have added this information to the discussion of Israel-3. There were also
256 many ground generators, though there are no details about how many and where
257 they were that I know of, and how that might have changed over the years.

258

259 Page 1 Line 9 – in addition to the Italian experiment there also was a PEP
260 (Precipitation Enhancement Project) in Spain, sponsored by the WMO. This
261 experiment was designed to test the transferability of the method used in the
262 Israeli experiments. It also showed no effect.

263

264 I thank the reviewer. I had overlooked PEP.

265

266 Page 8 line 84 – I think the criterion was cloud top -8°C 0 . Please check this
267 point.

268

269 Quoting from Gabriel (1967), for Israel 1: “The aircraft takes off whenever cloud
270 conditions appear favorable, but seeding is carried out only after the cloud
271 seeding officer has ascertained that cloud tops reach or exceed the -5°C level.”

272

273 (It is not stated anywhere how this was done at night, but Mr. Rosner, the Israeli
274 Chief Meteorologist, told me that when rain was falling, it was assumed that the
275 cloud tops were at least -5°C or colder. This is not *always* the case, however, as
276 we know from the radar tops in GN74, and from R88.)

277

278 However, -8°C is described as the cloud top maximum temperature criterion for
279 the operational seeding operations that followed Israel-2 (Goldreich 2003, p189).

280

281 It has not been stated in the literature what the highest cloud top temperature
282 criterion was for seeding in Israel-2.

283

284 Lines 198-200 need clarification.

285

286 Sentence has been re-written to clarify the exact temperature range referred to.

287

288 Lines 229-231 not clear.

289

290 Sentence has been re-written to clarify.

291

292 Line 309-311 You need to explain why the results of Sharon is proof that it is a
293 type 1 statistical error.

294

295 This sentence has been re-written to state that the Sharon finding was
296 “compatible with” (not proof of) a synoptic bias (stronger upper level
297 configurations) that produced larger rain areas on seeded days.
298

299 The footnote on page 19 – the word “Operational” is misleading. Operational was
300 used for the time when seeding was done on every rainy day and not in a
301 randomized way.
302

303 This was a quote taken directly out of Neuman et al. 1967. I was reluctant to
304 change it for that reason. However, I’ve added a parenthetical “clarification” so
305 that’s it not misconstrued as an operational project.
306

307 Line 341 – Israel 2 was a randomized experiment between the North Target
308 against a control upwind near the coast. At the same time the seeding was
309 randomized against the southern target area. The first publication of the results
310 referred only to the North versus control, reporting positive rain enhancement.
311 The second publication by Gabriel and Rosenfeld referred to the cross-over
312 randomized experiment which showed no effect. It should be stressed that this
313 point was debated and questioned often, because the general understanding
314 was that Israel 2 was supposed to be a second test or re-confirmation of the
315 reported success of Israel1.
316

317 The feeling was that by doing the analysis with a single target (North VS control)
318 it did not follow the original plan (personal communication with the late Bernie
319 Silverman and Roland List).
320

321 Agreed, “did not follow the original plan(s).” In the present manuscript and in
322 GN74 all the several evaluation methods that were planned for Israel-2 were
323 described. Only one evaluation was reported, however.
324

325 Subsequent review of the original plans for Israel 2 based on a few protocols of
326 the Israel National Precipitation Commission hinted (but to my understanding still
327 left some questions in mind) that the original objective of Israel 2 was to test the
328 North Target vs the control and not a re-confirmation of Israel 1. In any case, the
329 fact that the seeding line in the North in Israel 2 was moved eastward, in order to
330 form the control nearer the coast, indicates that it could not have been
331 considered a duplicate of Israel 1
332

333 Line 366 were not able.....
334

335 Silverman (2001) documented that Israel-2 was designed as a cross-over
336 experiment but also one with a target/control aspect for the north target⁵. Israel-2

⁵ Silverman (2001) wrote that he had obtained a “certified” translation of the design document (in Hebrew) that he obtained from the Israel Rain Committee.

337 was regularly referred to as a confirmation of Israel-1 experiment (e.g., Tukey et
338 al. 1978, GN81, among many others).

339

340 I think we can forgive them, however, since the “apparent” increases in rain
341 reported from the target/control evaluation were so similar to Israel-1 when both
342 targets were combined. GN81 themselves pointed out that Israel-2 was “not an
343 exact (emphasis in the original) confirmation of Israel-1, while stating elsewhere
344 on several occasions that Israel-2 confirmed the results of Israel-1.

345

346 Line 413 The seeding line in Israel 3 was much longer than in Israel 2, thus
347 comparison between the two is not appropriate.

348

349 I thank the reviewer for this additional information. The text has been re-written.

350

351 Line 451 as much as

352

353 I thank the reviewer for catching that; a sign of exceptional reviewing!

354

355 Line 503 – The arguments used in the design of the Israeli experiments was that
356 there WAS similarity between the two target areas. The correlation between
357 these areas was taken into consideration when they calculated the number of
358 seeded days needed to get statistical significant results.

359

360 Line 514 -I am not sure this is correct. Prof. Neumann was closely connected
361 with the IMS and I cannot believe that the IMS was not aware of the experimental
362 design. This is especially true since a representative of the IMS was always a
363 member of the Israel National Precipitation Commission.

364

365 My discussions with IMS personnel only concerned the cloud top temperatures at
366 which rain began to fall from Israeli clouds, forecasts, and, “was the storm I
367 experienced unusual?” I worked within the IMS only on fair weather days; I
368 traveled (chased) all over central and northern Israel during storms making obs,
369 taking photos. So, I am not sure where the thought comes from that I discussed
370 the design of the Israel experiments with the IMS comes from.

371

372 Line 525 - ...also be used...

373

374 I thank the reviewer again for a sharp eye.

375

376 Based on my comments above I suggest accepting the paper [provided the](#)
377 [author tones down what seems like personal criticisms.](#)

378

379 The author thanks Reviewer 2 for his overall positive assessment of a difficult
380 manuscript, but that I need to “tone down personal criticisms.”

381

382 Boy, in describing the events in the progression in the reporting of the Israel
383 experiments accurately, it is possible that the descriptions will appear “personal”
384 when it is pointed out that GN did not follow standard science protocol or our
385 AMS guidelines for reporting “new results”, such as those in the ongoing Israel-3
386 experiment.

387

388 I am not sure that anything can be done about this. I removed several
389 sentences that might have seemed redundant (“turning the screw?”) in this
390 regard.

391

392 He should also address the minor points mentioned above.

393

394 I hope I have done this in a manner that is acceptable to Reviewer 2.

395

396 Since the intention is that the paper be used by future cloud seeding planners, I
397 would suggest making reference to the WMO guideline and statement on
398 weather modification.

399

400 I have searched hard copies of the WMO magazine and the WMO web site and
401 have not located such a statement. Moreover, the WMO has still not responded
402 to my request for help in finding that statement as of many months ago.

403

404 If comments have been provided as separate files they are attached to this e-
405 mail message.

406 You may also access uploaded files on-line by [logging into Editorial Manager](#) and
407 clicking on "View Attachments".