Some reflections on PEP-SSP3 (1979-1981) and on where weather modification efforts stand now.

Gabor Vali

Valladolid, May 7, 2005

Región Aérea 1ª. ALA NR. 37 (1)

QUEDA AUTORIZADO PARA TRABAJAR EN (2)
BASE AEREA DE VILLANUBLA

Nombre Dr. GABOR
Apellidos VALI
Nacido en HUNGRIA el 22-10- de 1936
Profesión Profesor de Universidad
Domicilio Sta. Teresa, 11, 2º D.

Firma del Interesado.

Villanubla, a 7 de marzo de 1979

El Cmt. Jefe Seguridad (3)

(1) Base Aérea o Dependencia.
(2) Lugar de trabajo.
(3) Firma del Cte. de la Base o Jefe de Dependencia.

Evidence of the great collaboration by the Base Area de Villanubla. 1979.

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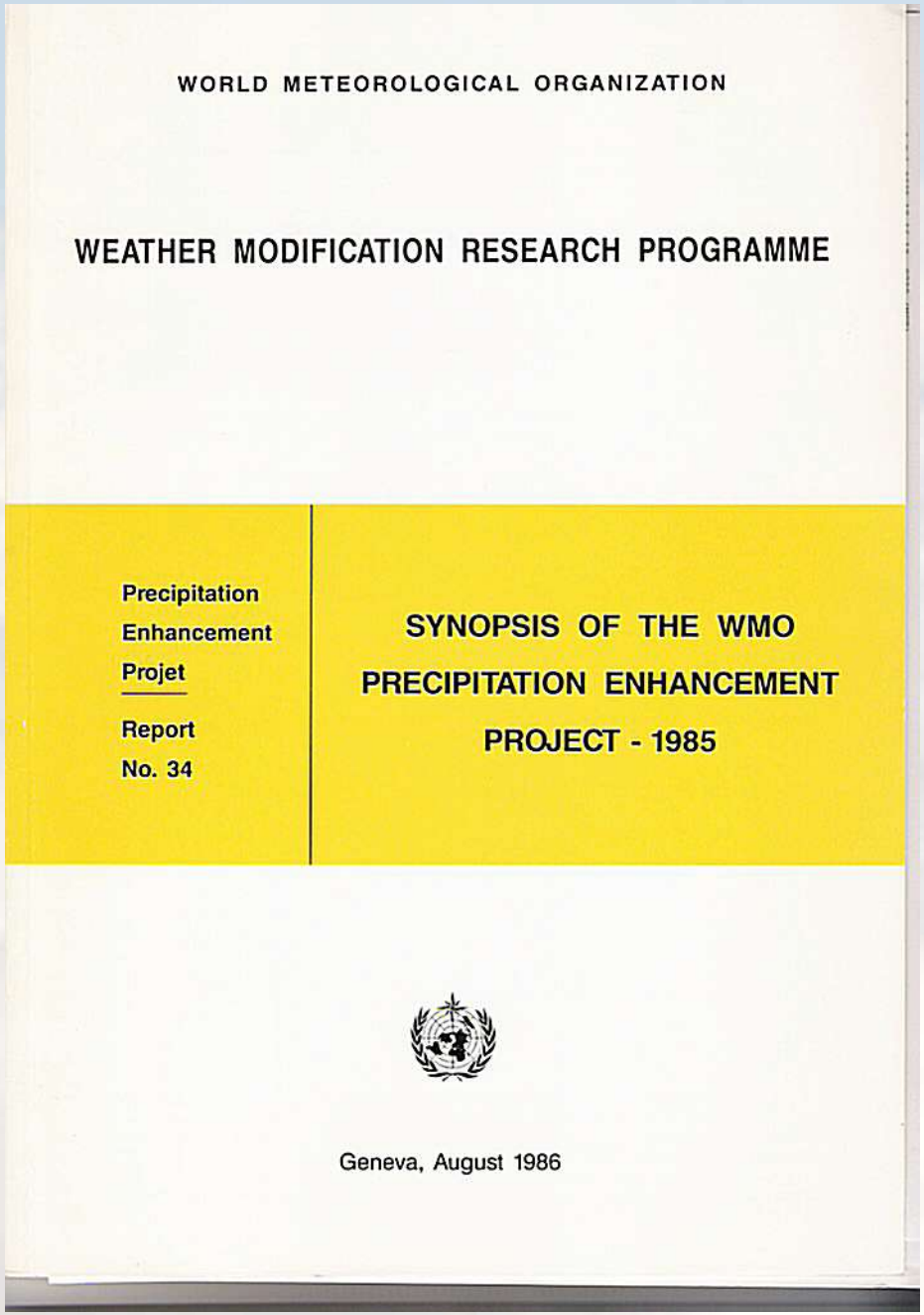

Seedability

aircraft: “Maybe Index”

radar: vertical profile

wind inhomogeneity

models: comparisons

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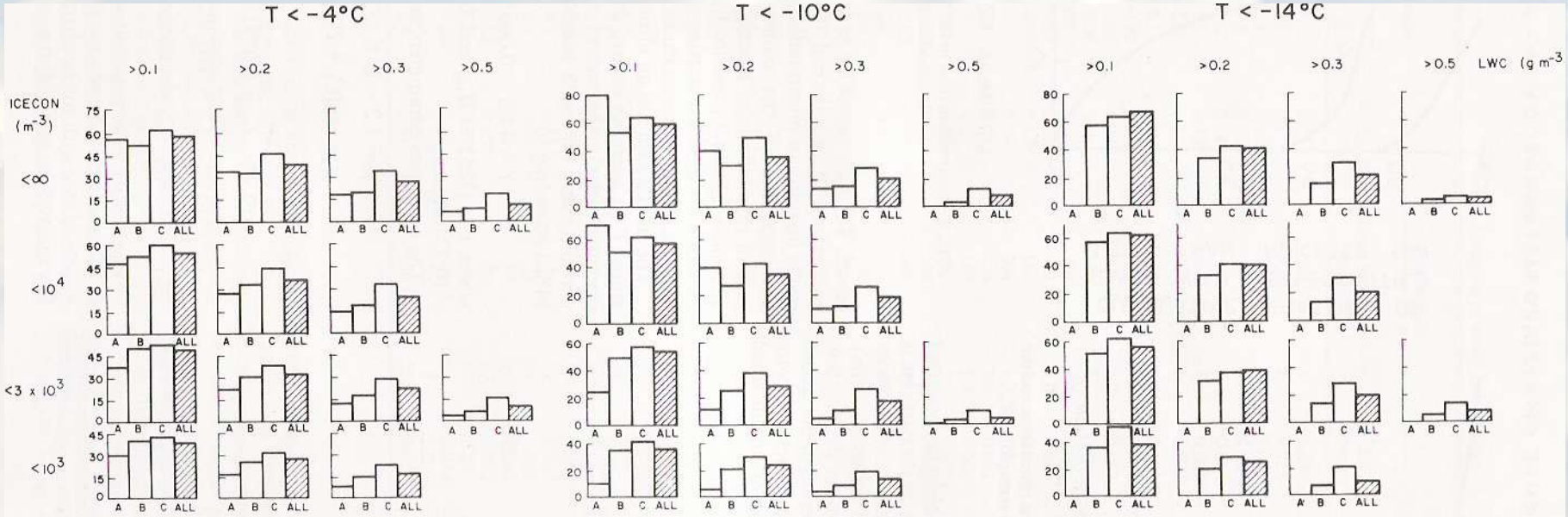

FIG. 5. Summary of LWC and ice particle concentrations (ICECON) observed in the "regions of potential." Data from all clouds within the region are included, not only the persistent LWC zones directly observed. The heights of the histogram columns show the percentage of cloud volume (regions with >10 cm^{-3} droplet concentration) along the flight track which had LWC and ICECON within the limits specified at the top and the left of the graph. Data are presented by cloud class (A, B and C) and for the combination of all classes. The stratification by temperature refers to the temperature at the sampling level. Total data included in the graph are 3259 km of cloud penetration, roughly divided as 20%, 40% and 40% among cloud classes A, B and C.

Vali,1983 PEP Report, also Vali, Koenig and Yoksas, 1988.

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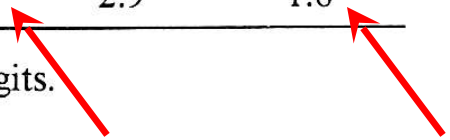
TABLE 5. Estimated annual precipitation increases for seeding over February to May season.*

Cloud class	Avg. natural precipitation (mm)	Precipitation increase			
		Pool model		Stream model	
		(mm)	(% annual)	(mm)	(% annual)
(a) Seeding Daytime Only					
A		0.035	0.035	0.069	0.068
B		0.14	2.0	0.53	7.6
C		0.70	2.7	1.4	5.5
All		0.87	0.55	2.0	1.2
(b) Seeding Day and Night					
A	100.8	0.065	0.064	0.13	0.13
B	7.0	0.20	2.8	0.76	11
C	25.6	1.0	3.9	2.0	7.8
All	160.0	1.2	0.75	2.9	1.8

* Figures rounded to two significant digits.



Vali, Koenig and Yoksas, 1988, J. Clim. Appl. Meteor.

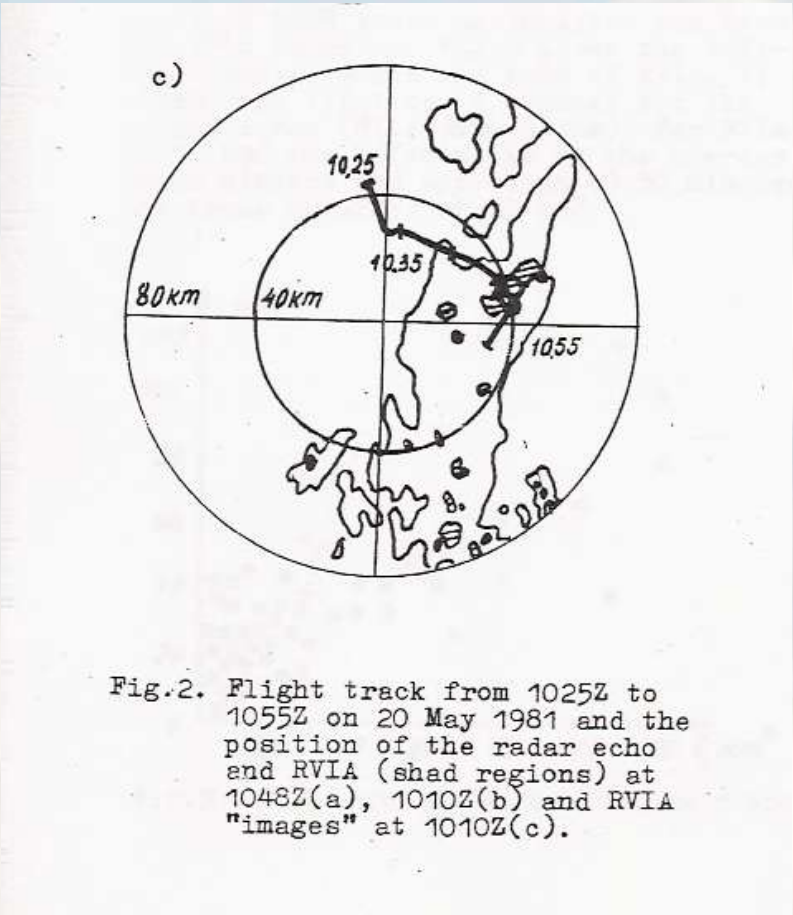


Fig.2. Flight track from 1025Z to 1055Z on 20 May 1981 and the position of the radar echo and RVIA (shad regions) at 1048Z(a), 1010Z(b) and RVIA "images" at 1010Z(c).

Potential for rainfall increase for Feb-May season:

class	**7.6%**
class C	**34%**
average	**17%**

Koloskov, Melnichuk and Sedunov, 1984 Tallin Cloud Physics Conference
Burtsev, koloskov and Melnichuk, 1985 Honolulu Wx. Mod. Conference

my view from the perspective of 25 years:

Perhaps the major contribution of PEP is the idealistic perspective it presented on how weather modification as science should be approached:

(i) assesment based on measurements and modeling,

(ii) not forced by local need or politics

(iii) broad representation of diverse expertice and open debate

It also proved how expensive and difficult this path is.

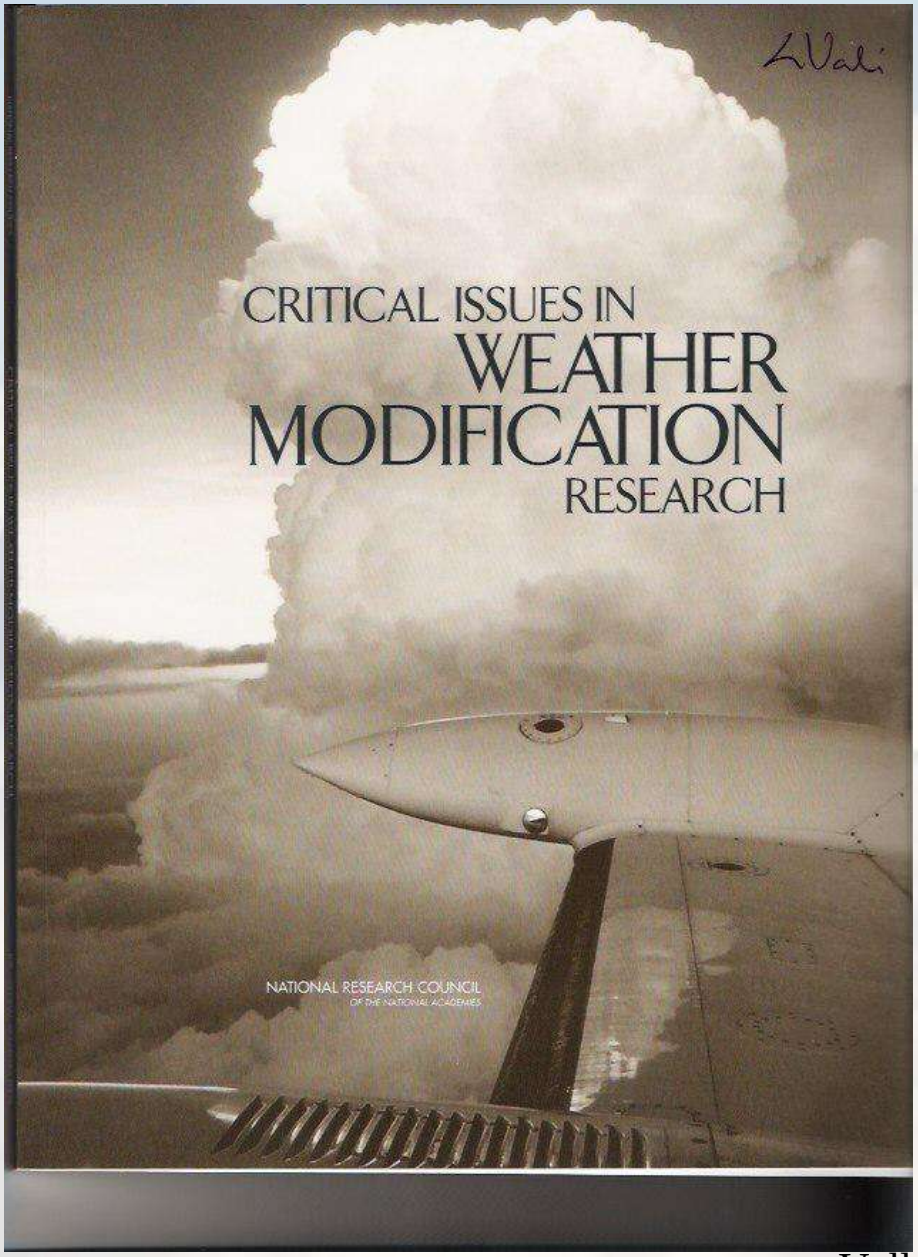
Valladolid, May 7, 2005

"The Atmospheric Sciences

Entering the Twenty-First Century"

1998, Board on Atmospheric Sciences and Climate

"Weather modification research appears to have stagnated. Demonstration of a better understanding of the natural precipitation process, in a verified quantitative model, could revive this area of research by providing a basis for developing and testing hypotheses and for assessing the likely effects of modification programs." (page 93)



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“Critical Issues in Weather Modification Research”

2003, Board on Atmospheric Sciences and Climate

“The Committee concludes that there still is no convincing scientific proof of the efficacy of intentional weather modification efforts. In some instances there are strong indications of induced changes, but this evidence has not been subjected to tests of significance and reproducibility. ..... Despite the lack of scientific proof, the Committee concludes that scientific understanding has progressed on many fronts ....” (pg. 3)

“Critical Issues in Weather Modification Research”

2003, Board on Atmospheric Sciences and Climate

“Operational weather modification programs ... exist in more trhan 24 countries, and there were at least 66 operational programs being conducted in 10 states across the United States in 2001. ...

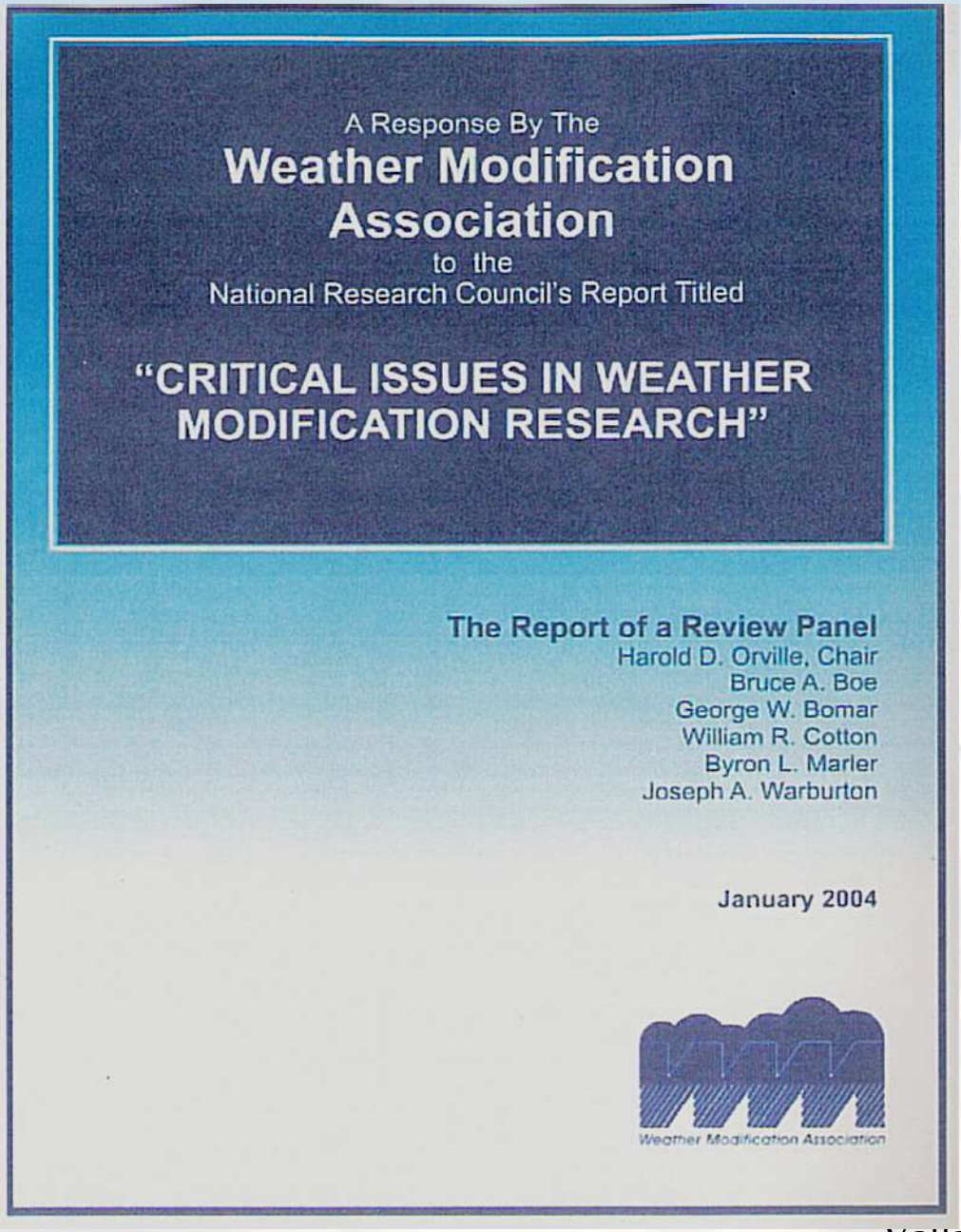
After reaching a peak of $20 million per year in the late 1970s, support ... has dropped to less than $500,000 per year.” (pg. 2)

“Critical Issues in Weather Modification Research”

2003, Board on Atmospheric Sciences and Climate

“Clearly, there is a paradox in these divergent trends. The federal government is not willing to fund research to understand the efficacy of weather modification technologies, but others are willing to spend funds to apply these unproven techniques. Central to this paradox is the failure of past cloud-seeding experiments to provide an adequate verification... The catch-22 ensues ....” (pg. 2)

Recommendations are for “renewed commitment” and “coordinated national program to conduct a sustained research effort”



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“A response by the Weather Modification Association”

2004

“ **We support .....** ***But we argue that the coordinated national program should also support exploratory and confirmatory field studies in weather modification. It should capitalize on operational cloud seeding programs, and use them as a basis for testing models, and developing new statistical methods for evaluating the efficacy of those operations.”*** (pg. 4)

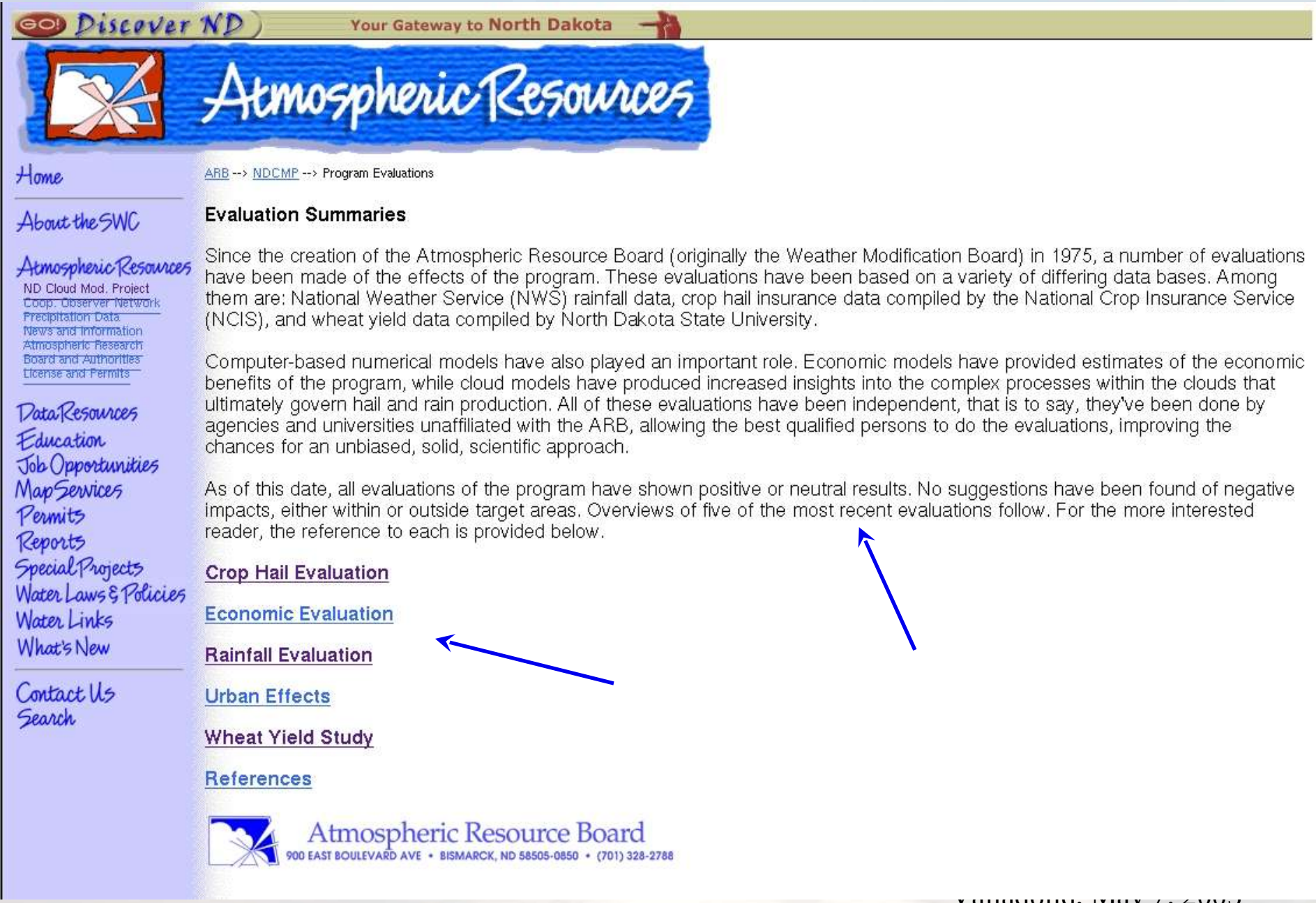
“Indeed, if the NRC panel were to hold inadvertent weather modification and climate change to the same high standard, they could only conclude that there is ‘no convincing scienctific proof’ for either.” (pg. 8)

“A response by the Weather Modification Association”

2004

Cites evidence and indications for:

- **hailfall reduction of ~50% accompanied by rainfall increases**
- **wintertime precipitation increases of 10-15% from orographic clouds**
- **more rain and longer lifetime of seeded convective clouds**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ARB --> NDCMP --> Program Evaluations
Evaluation Summaries
Since the creation of the Atmospheric Resource Board (originally the Weather Modification Board) in 1975, a number of evaluations have been made of the effects of the program. These evaluations have been based on a variety of differing data bases. Among them are: National Weather Service (NWS) rainfall data, crop hail insurance data compiled by the National Crop Insurance Service (NCIS), and wheat yield data compiled by North Dakota State University.
Computer-based numerical models have also played an important role. Economic models have provided estimates of the economic benefits of the program, while cloud models have produced increased insights into the complex processes within the clouds that ultimately govern hail and rain production. All of these evaluations have been independent, that is to say, they've been done by agencies and universities unaffiliated with the ARB, allowing the best qualified persons to do the evaluations, improving the chances for an unbiased, solid, scientific approach.
As of this date, all evaluations of the program have shown positive or neutral results. No suggestions have been found of negative impacts, either within or outside target areas. Overviews of five of the most recent evaluations follow. For the more interested reader, the reference to each is provided below.
Crop Hail Evaluation
Economic Evaluation
Rainfall Evaluation
Urban Effects
Wheat Yield Study
References
Atmospheric Resource Board
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Rainfall

Perhaps the earliest evaluation of the effects of cloud seeding on summertime clouds over the plains was produced by Changnon and Huff (1972). A model was developed at the Illinois State Water Survey which projected the increases in precipitation likely to be realized by cloud seeding, based on efforts in Illinois. That model, along with projections specifically developed for North Dakota by Eddy and Cooter (1979), were used by North Dakota State University researchers to develop an estimation of the economic benefits of the North Dakota program (Schaffner, et al. 1983). This evaluation indicated that, for the six most prevalent crops in western North Dakota (wheat, oats, barley, sunflowers, corn grain, and flax), benefits from the additional one inch of rainfall obtainable by cloud seeding ranged from $3.63 to $6.21 per acre, depending upon the region of the state involved. (Figure 5)

The most recent evaluation of rainfall in and near the project areas examined NWS rainfall data for seven years, 1976-82 (Johnson 1985). Figure 6 illustrates the rain gauge coverage used in a typical season. Three areas were defined for each storm event: the multi-county target areas (Target), the regions downwind of the Targets (Downwind), and the areas neither in the target nor downwind (Control).

Some of the more interesting findings of this analysis showed:

1. Evidence of an overall increase in precipitation downwind of the target (relative to the control area), especially notable in July (15% increase, significant at the 0.08 level).

2. Evidence of increase in the target areas on days with heavier rains (14% increase significant at the 0.13 level).

Other findings showed additional increases both in and downwind of the target areas, correlated at various (generally lower) confidence levels with upper air features. The report concluded that, "It appears that seeding for hail suppression in the mode employed in North Dakota likely increases rainfall."

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SPECTRA Southern Plains Experiment in Cloud Seeding of Thunderstorms for Rainfall Augmentation

The Southern Plains Experiment in Cloud Seeding of Thunderstorms for Rainfall Augmentation (SPECTRA) Project represents a collaborative effort between various organizations in an effort to continue research that has begun in the area of hygroscopic and glaciogenic seeding. Cloud physics measurements using a new Texas based cloud physics aircraft are being conducted throughout Texas, southeastern New Mexico, and Oklahoma in an effort to resolve underlying questions about the seeding efficacy in these regions. The first phase of the project investigates the sizes and concentrations of cloud condensation nuclei (CCN) at cloud base and how these CCN in turn affect the microphysical structure of clouds and precipitation processes. The second phase involves in situ observations of clouds seeded using hygroscopic and glaciogenic materials under known aerosol backgrounds obtained from previous aircraft CCN sampling.

Participants:	Role in the SPECTRA project:	Contact person:
tdlr	The Texas Department of Licensing and Regulation is the State of Texas agency administering the Federal grant for conducting rain-enhancement research activities. TDLR is charged by law with regulating the use of weather modification in the state as well as promoting the development of new cloud seeding technologies. The 2002-03 grant from the U. S. Bureau of Reclamation, in the amount of $850,000, is being used to accomplish various tasks under both Phase I and Phase II. TDLR provides SPECTRA with the administrative and technical oversight required by law. TDLR staff negotiates, and administers, subcontracts for the use of equipment (aircraft, instrumentation) as well as the deployment of field personnel (scientists, pilots, technical staff). The agency also serves as liaison between the research team and the various rain-enhancement projects being operated by water conservation districts and weather modification associations in the state.	George Bomar Manager, State Weather Modification Program GBOMAR@license.state.tx.us
OWRB		

Weather project aims to moisten dry land

(China Daily by Liang Chao)

Updated: 2004-02-28 00:45

...

"Cloud seeding or artificial rain-making, hail and fog-dispersing techniques will also be used to help improve ecosystem and control forest fires, secure freeway transportation and success of key social events like the Beijing 2008 Olympic games and the 2010 Shanghai World Expo," Qin Dahe, the top official at the China Meteorological Administration, said Friday during a national conference in Beijing aimed at co-ordinating such operation.

"The scope of China's weather modification is ranked as the first of its type in the world today with strong government financial backing," Qin said.

Last year, 413 million yuan (US$49 million) was injected into the operation.

In 2003 alone, more than 3,800 rocket launchers, about 7,000 antiaircraft guns and many airplanes were put into use for various weather modification operations to enhance precipitation in more than 1,800 counties throughout China. More than 35,000 people were involved.

Qin made it clear that "in the years ahead, such operations will enable

Valladolid, May 7, 2005

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my view ??

Experimentation, with repeatable and significant results, is too difficult and costly for weather modification, due to both the variability of clouds and the small magnitude of the expected outcome.

Models, and their input parameters from measurements, are not reliable enough as bases for predicting changes of the order of 10%.

There is also growing evidence - in addition to the maritime to continental difference - that dust, factory effluents and cities alter precipitation formation.

There is very little that can be said about the "downwind" effects of localized changes on whatever scales.

Doing their best to evaluate wx. mod. activities, many have come to believe in positive results.

Widespread use is almost guaranteed due to need for water, loss from hail, etc.

So, while scientists focus on uncertainties and on ways to resolve them, and thereby making slow progress, others go ahead and use the tools they find promising.

Will massive use of cloud seeding also lead to new insights and greater credibility??