



**BUREAU OF THE ROYAL RAINMAKING  
AND AGRICULTURAL AVIATION**



**MINISTRY OF AGRICULTURE AND COOPERATIVES  
BANGKOK, THAILAND**

*PRESENTS*

**50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY**

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## **BUREAU OF THE ROYAL RAINMAKING AND AGRICULTURAL AVIATION**



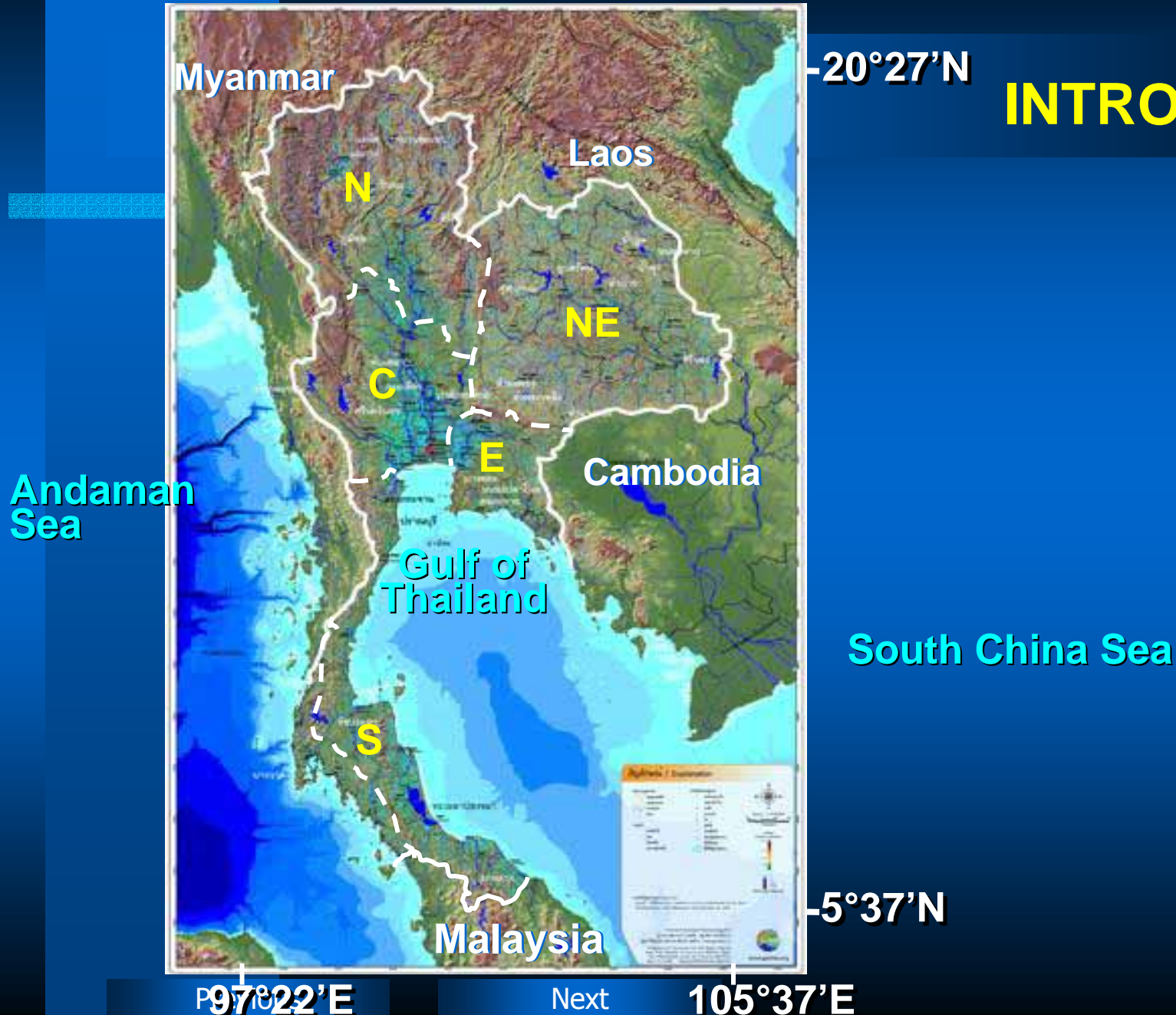
**MINISTRY OF AGRICULTURE AND COOPERATIVES  
BANGKOK, THAILAND**

### **50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY**

- 1. INTRODUCTION**
- 2. PRESENT STATUS**
- 3. CLOUD SEEDING TECHNIQUE**
- 4. SEEDING RESULTS**
- 5. SUMMARY**

# Geography & Topography & Climatology

## INTRODUCTION



97°22'E

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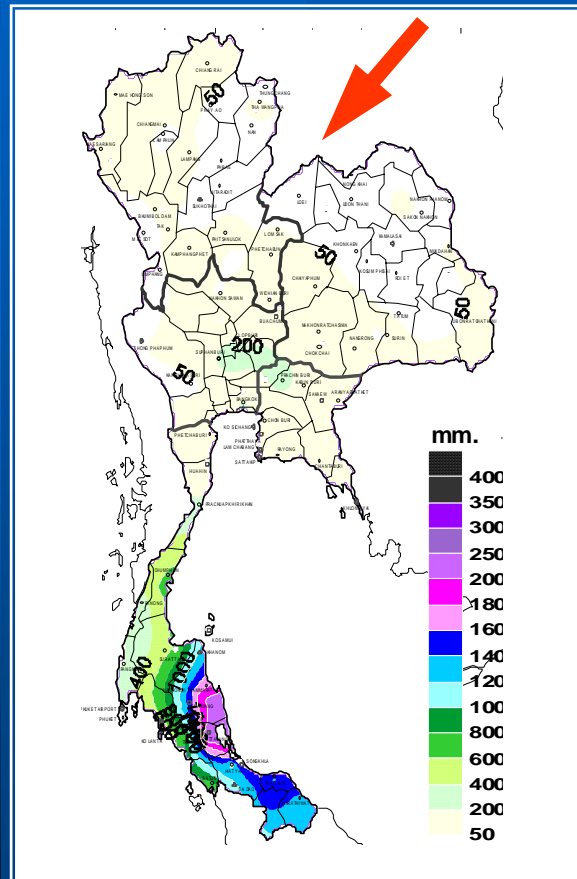
105°37'E

# Geography & Topography & Climatology

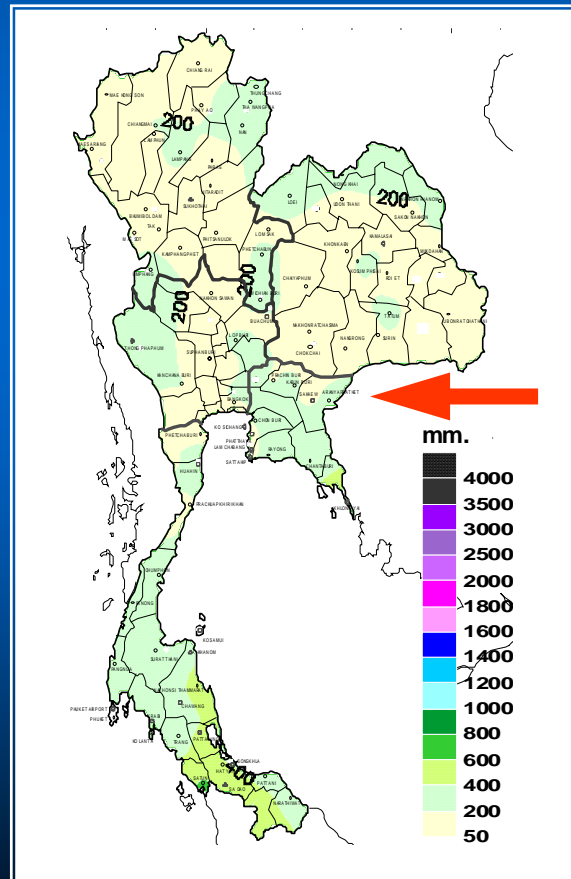
## INTRODUCTION

### Seasonal accumulated rainfall

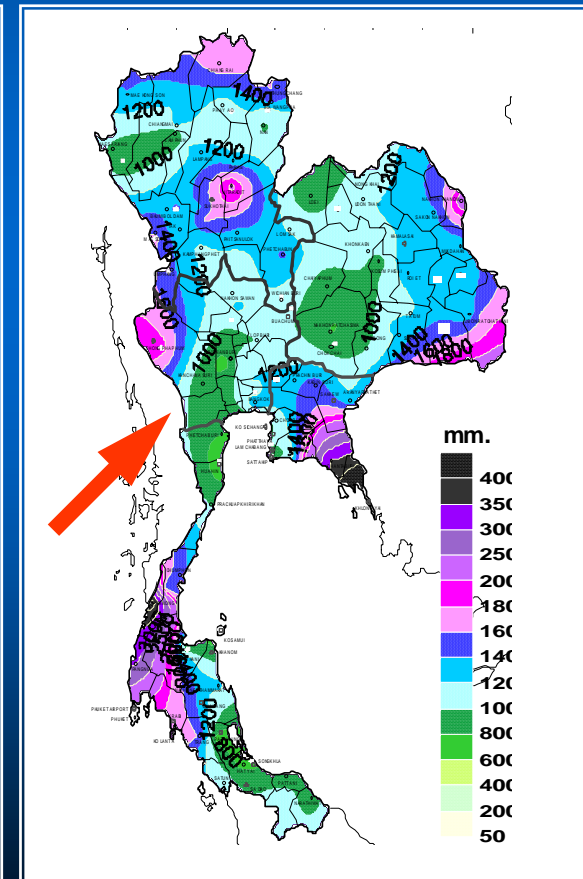
**WINTER**  
**NOV-JAN**



**SUMMER**  
**FEB-APR**



**RAINY**  
**MAY-OCT**



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## 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY



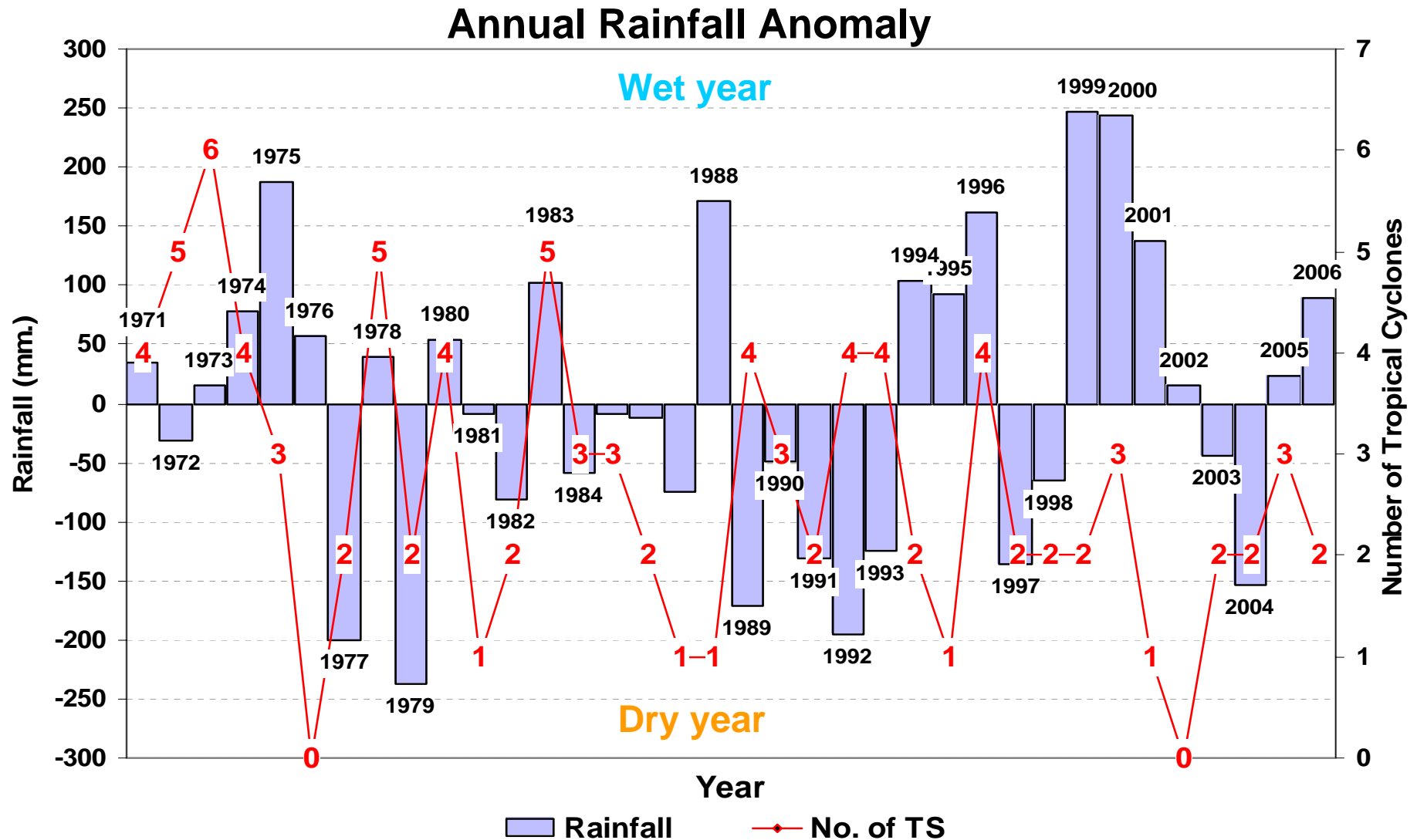
### INTRODUCTION

- The growing need for water appears most heavily related to the needs of expanding population and Thai economy.
- Natural rainfall patterns do not support the needs.
- Drought occurs more frequently and tend to be more severe.



# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

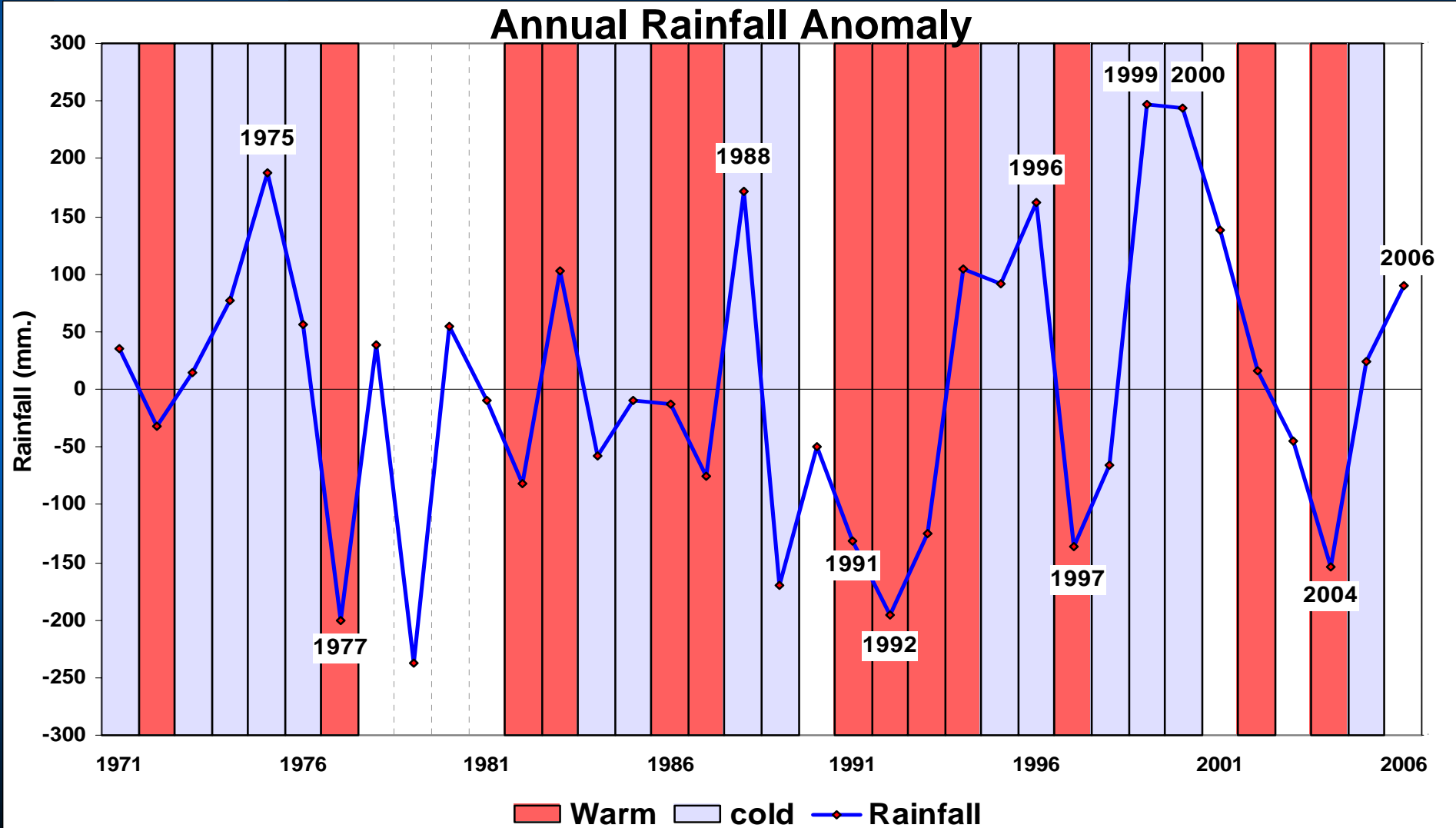
## INTRODUCTION

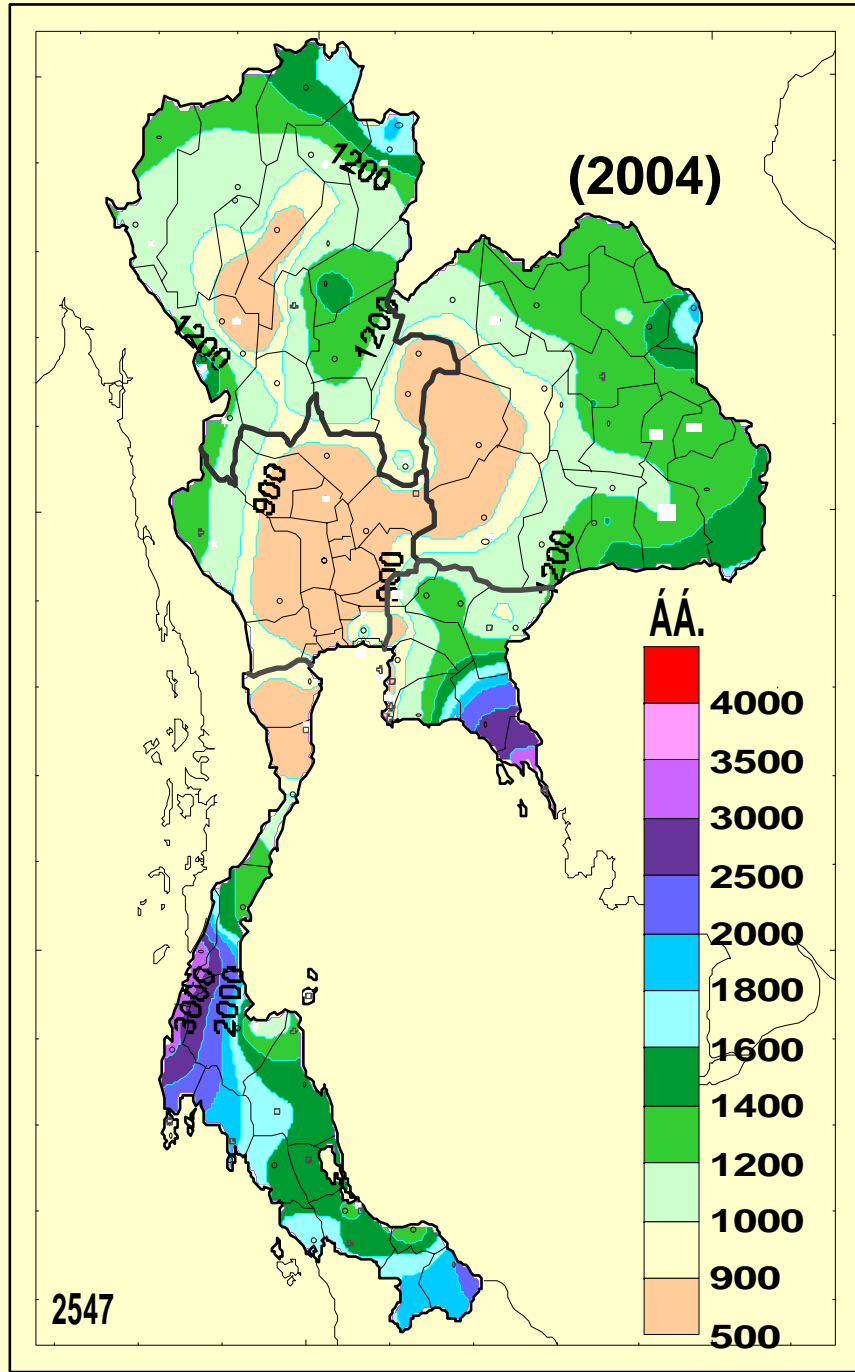
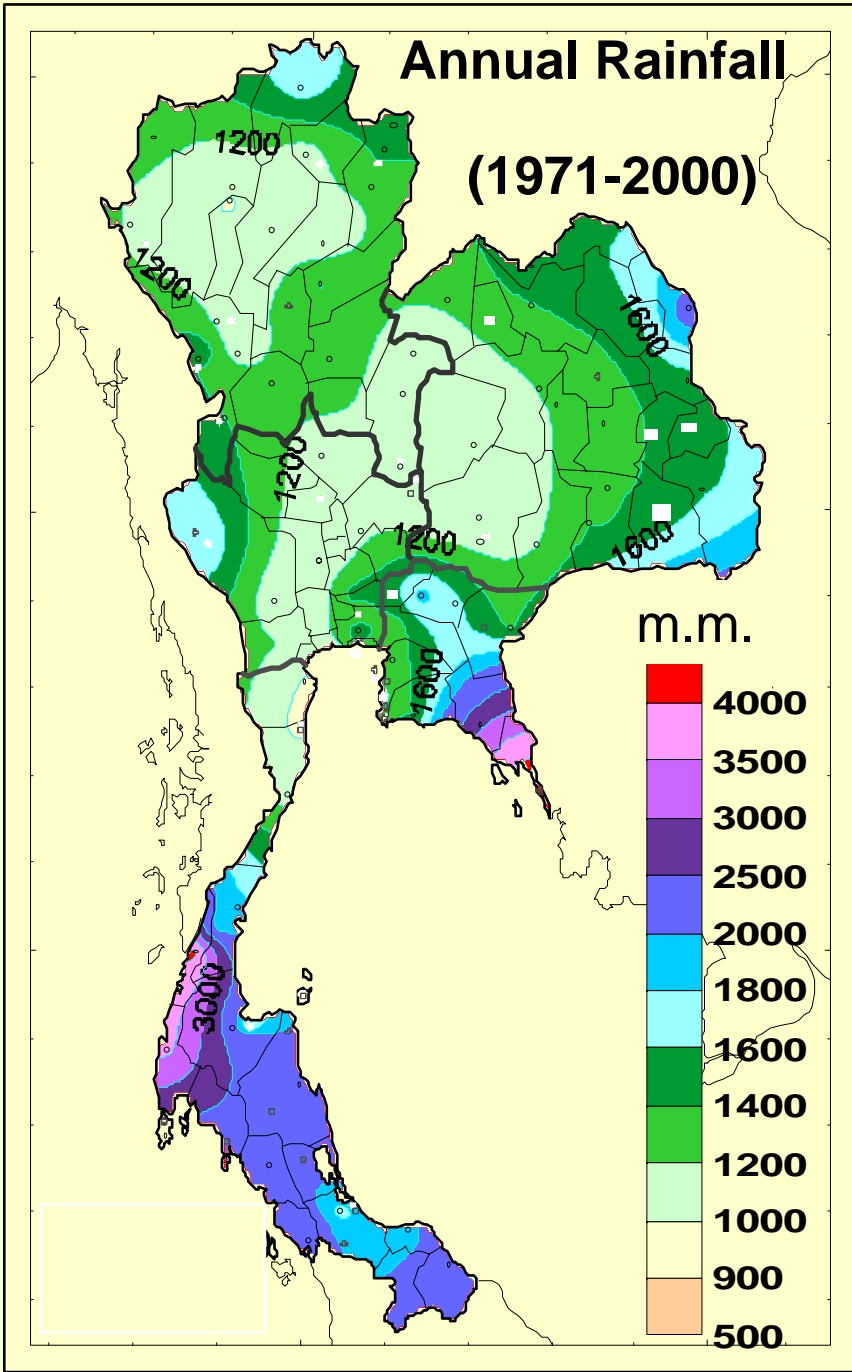




# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

## INTRODUCTION





# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY



## INTRODUCTION

- 1955** Started the concept of rainmaking in Thailand.
- 1969-1971** Conducted the first cloud seeding experiment.
- 1971** Ran the first cloud seeding operation.
- 1975** Established the BRRAA.
- 1989-1998** Conducted the AARRP.
- Up to now** research and operation continue



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# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

## PRESENT STATUS

### FACILITIES

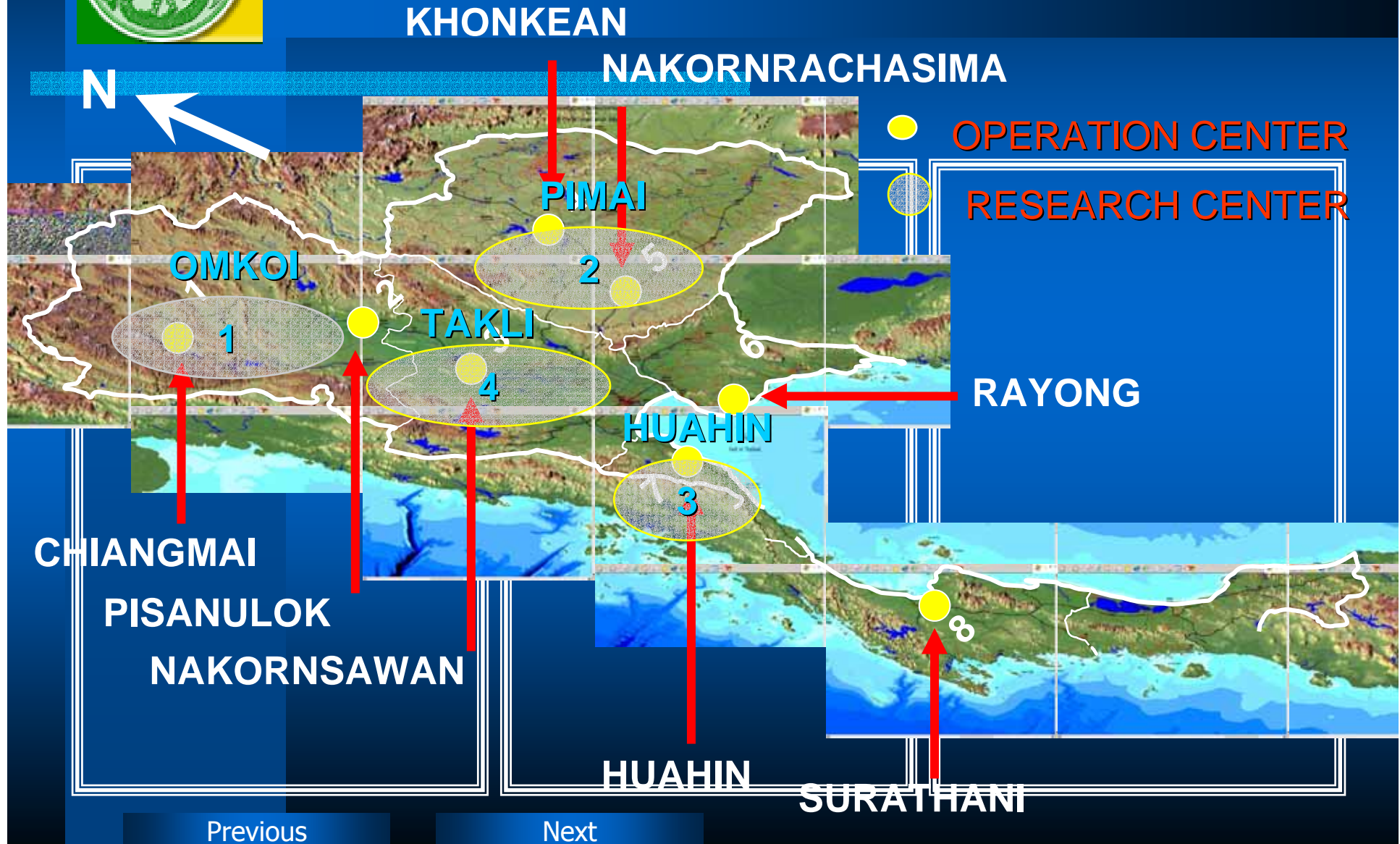
	<b>Personnel:</b>	<b>500</b>	
	<b>Aircraft:</b>	<b>30</b>	
	<b>Operation Center:</b>	<b>8</b>	
	<b>Research Center:</b>	<b>4</b>	
	<b>Airfield:</b>	<b>3</b>	

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# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

## PRESENT STATUS



# THAI CLOUD SEEDING

# MODERN TECHNOLOGY



**WARM CLOUD**

**COLD CLOUD**

**CLOUD PHYSICS**

**RADAR**

**RAIN GAUGE**

**DATA BASE**

**SEEDING POTENTIAL**

**SATELLITE**

**RAWINSONDE**

**ANALYSIS & TRAINING**

- Standard Instruments
- ICAO, IAP, FSI, ICAO Course

Weather Radar Observation  
• S-band Doppler Weather Surveillance Radar System

- Data Base System
- Project Data Analysis Module

- Remote Sensing System
- Cloud Seeding Mission
- Forecasting Mission
- Data Analysis

# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY



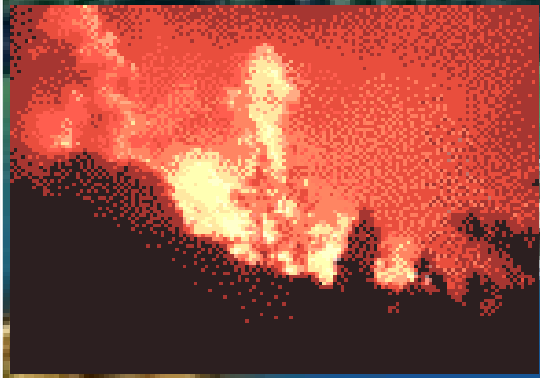
## PRESENT STATUS

### ANNUAL MISSIONS

- FEBRUARY-APRIL: FOREST FIRE SUPPRESSION

- MAY-OCTOBER: FOR AGRICULTURE

- SEPTEMBER-OCTOBER: FILL UP RESERVOIRS



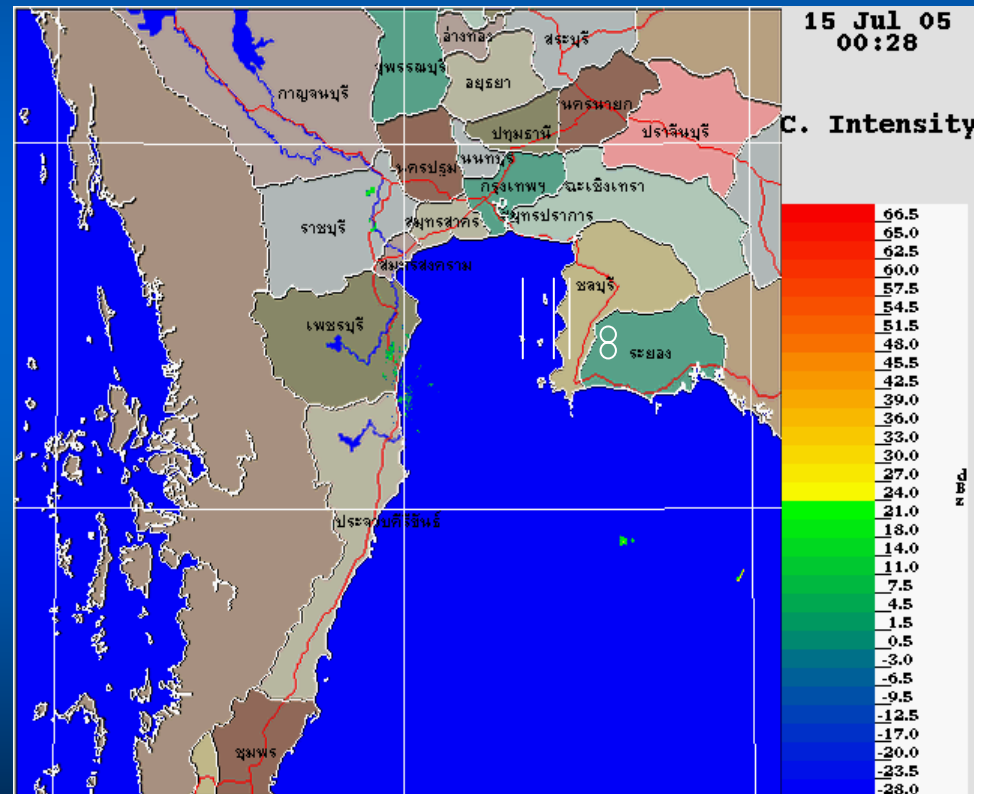
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# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

## PRESENT STATUS

### Weather Radar Network

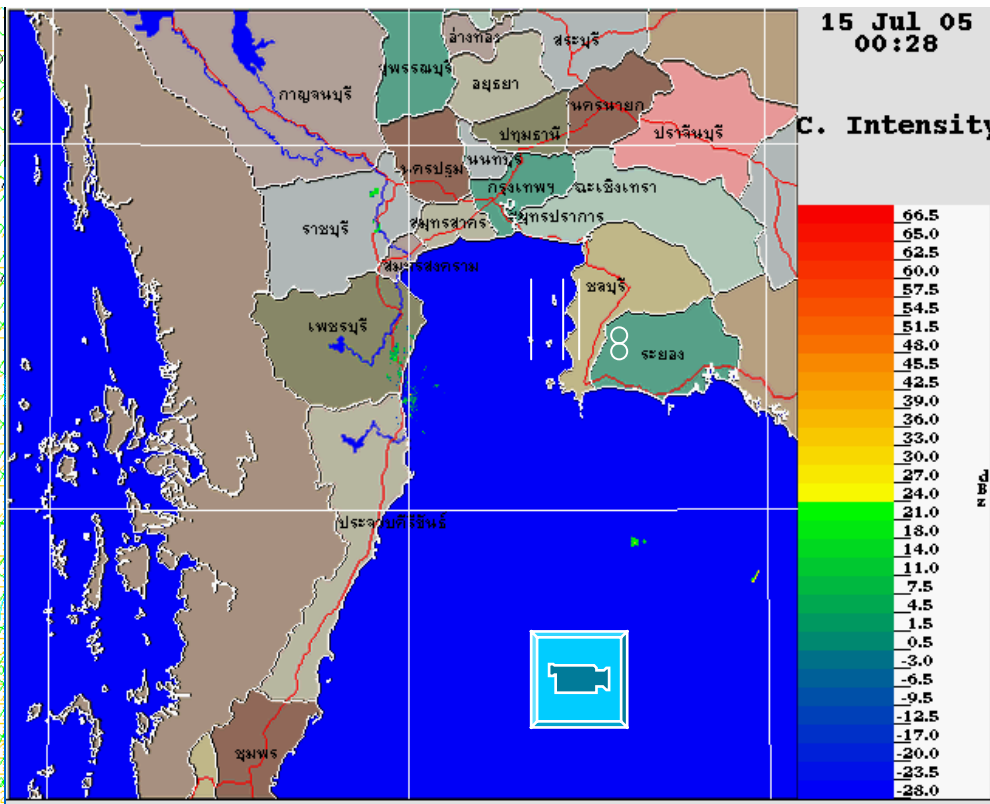
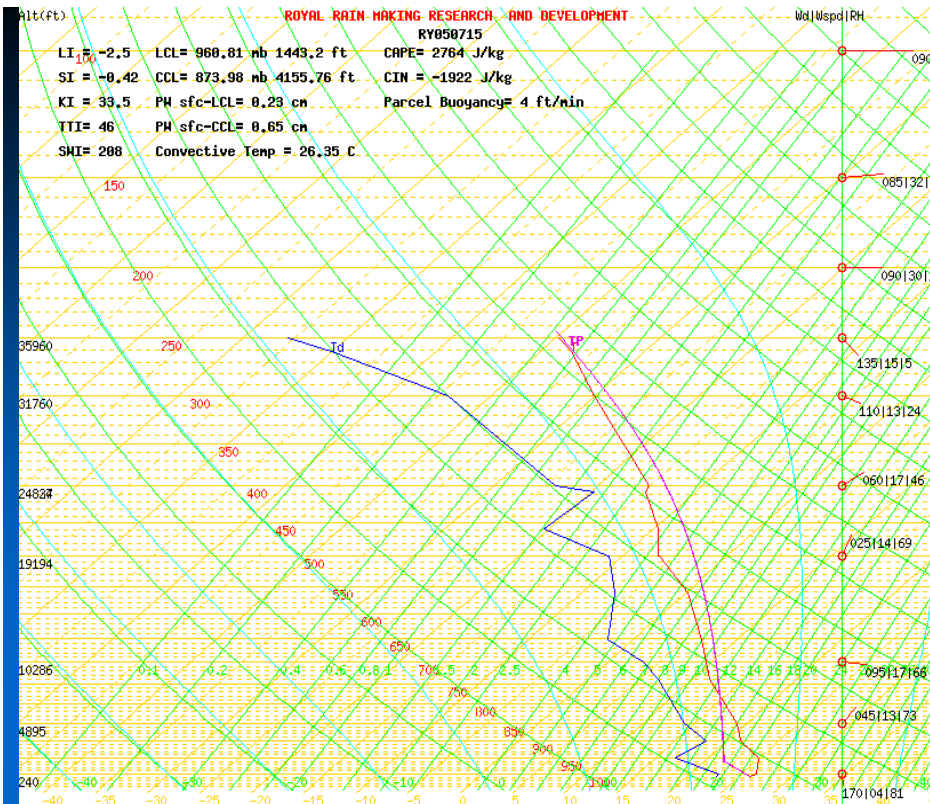


**Product Type:** ppi Corrected Intensity    **Tilt:** 1    **Elevation:** 1.4 Degs

PRF: 250 Hz	Max Range: 240 km	Gates: 240
Gatewidth: 1000 m	Samples: 36	Unfolding: Off
Pulse Width: 2.0 us	Clutter Filter: 2	Range Normalization: On
Site Name: Huahin	Radar Type: DWSR-93S	Antenna Height ASL: 30 m

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## Daily operation data set

**Product Type:** pPI Corrected Intensity    **Tilt:** 1    **Elevation:** 1.4 Degs  
**PRF:** 250 Hz    **Max Range:** 240 km    **Gates:** 240  
**Gatewidth:** 1000 m    **Samples:** 36    **Unfolding:** Off  
**Pulse Width:** 2.0 us    **Clutter Filter:** 2    **Range Normalization:** On  
**Site Name:** Huahin    **Radar Type:** DWSR-93S    **Antenna Height ASL:** 30 m

### แผนปฏิบัติการฝนหลวง รยะอง ประจำวันที่ 2005-07-15

ภารกิจ/ ขั้นตอน	เวลา ว.4	สารฝนหลวง/น้ำหนัก	ระดับ	พิกัด
1/1	10:40-	1 จำนวน 2,500 กก.	6,000 ฟุต	N 12 43 00 E 101 45 00,-N 13 15 00 E 101 45 00
2/3	11:05 น.	1+4 จำนวน 1,000+,1,000	3,000 ฟุต และที่ระดับ	N 12 55 00 E 101 15 00,-,
3/2	11:30 น.	1+4+8 จำนวน	8,000 ฟุต , 8,000 ฟุต	N 13 08 00 E 101 36 00,-,
4/3	12:35 น.	500+1,000+1,000 กก.	2,000 ฟุต	N 12 55 00 E 101 20 00,-,
5/4	12:05 น.	1+3+4 จำนวน	4,000 ฟุต ,5,000 ฟุต	N 12 57 00 E 101 15 00,-,
6/3	15:15 น.	500+500+1,000 กก.	8,000 ฟุต	N 13 22 00 E 101 22 00,-N 13 40 00 E 101 22 00
	15:30-	1+4 จำนวน 1,000+1,500		



## 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

### SEEDING OPERATION RESULTS

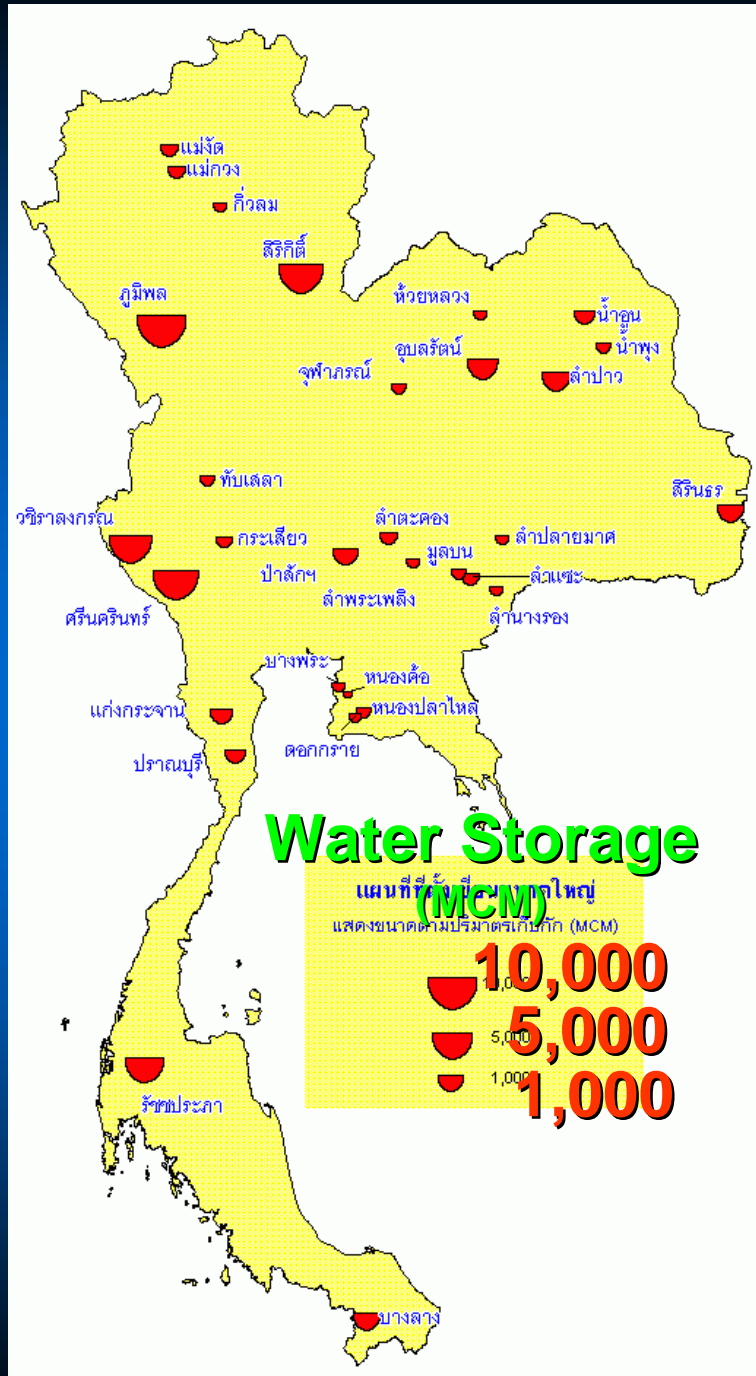
#### 2006 KEY PERFORMANCE INDEX

<b>KPI</b>	<b>TARGET</b>	<b>RESULT</b>
<b>% of rain day/seeded day</b>	<b>90%</b>	<b>96%</b>
<b>Area coverage of rainfall</b>	<b>32 M acres</b>	<b>98 M acres</b>
<b>NO. of reservoirs in which the water storage &gt; 80%</b>	<b>30</b>	<b>28</b>

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# % Water Storage Y 2006



Regions	15 May	31 Oct
N	57	99
NE	44	92
C	36	95
W	71	95
E	47	89
S	64	85
<b>Average</b>	<b>61</b>	<b>95</b>

## 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY



### SEEDING EXPERIMENTAL RESULTS

The Applied Atmospheric Resources Research Program (AARRP) involved the conduct and evaluation of the randomized warm-cloud and cold-cloud seeding experiments in the Bhumipol catchments area in northwestern Thailand.

A warm cloud seeding experiment under AARRP was carried out during 1995-1998. The experiment was designed to test whether the seeding of warm, tropical convective clouds with calcium chloride particles can produce statistically significant increases in rainfall. The experiment was conducted in accordance with a randomized floating single target design

## 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY



### SEEDING EXPERIMENTAL RESULTS

The Applied Atmospheric Resources Research Program (AARRP) involved the conduct and evaluation of the randomized warm-cloud and cold-cloud seeding experiments in the Bhumipol catchments area in northwestern Thailand.

A randomized cold-cloud seeding experiment was carried out during portions of April, May and June in 1994-1998. The physical-statistical design was aimed at determining whether seeding with ejectable, free-fall, silver iodide flares near the tops (temperatures  $-6^{\circ}\text{C}$  to  $-10^{\circ}\text{C}$ ) of vigorous supercooled convective clouds growing within a floating-target area would enhance the rainfall over that area



# 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

## SEEDING EXPERIMENT RESULTS

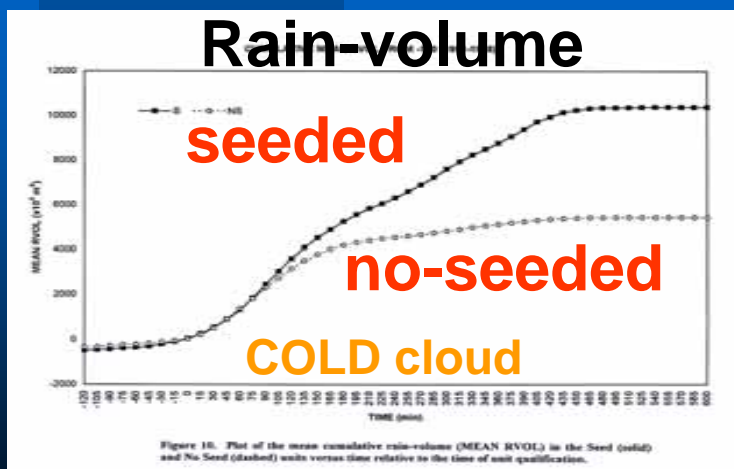
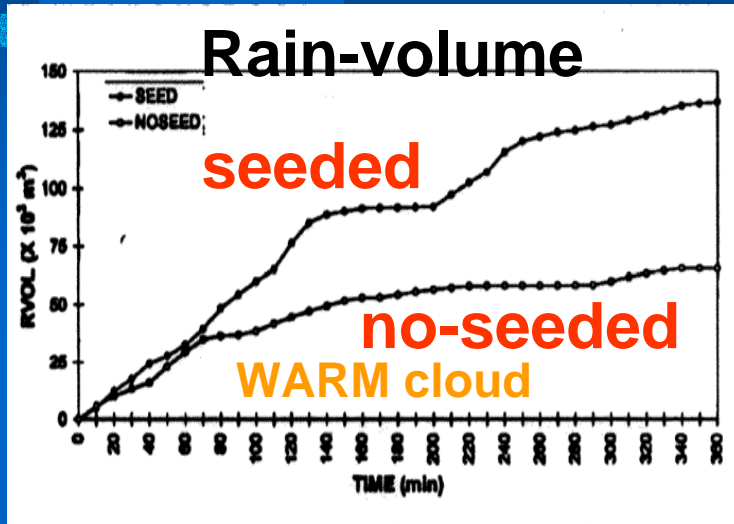


Figure 16. Plot of the mean cumulative rain-volume (MEAN RVOL) in the Seed (solid) and No Seed (dashed) units versus time relative to the time of unit qualification.

### AARRP (1991-1997)

Rain	WARM	COLD
Volume	109	58
Area	84	24
Duration	11	6

% increase over no-seed



## 50 YEARS OF THAILAND CLOUD SEEDING ACTIVITY

### FINAL STATEMENT

The concept of cloud seeding in Thailand was initiated by His Majesty King Bhumibol Adulyadej in 1955. Since then Thailand has been involved with a series of experiments and operational programs to increase rainfall through weather modification. Although a lot more to learn about how the seeding techniques work in Thai clouds it is widely used and provide considerable benefits to the nation's natural resources and economy.

It becomes one of the several ways to solve the water problems and its use are maximized as an integral part of a multi-solution approach to water resources management.