



WEATHER MODIFICATION



Test Technology Symposium '97

Session B:

Advanced Weapon/Instrumentation Technologies

John Hopkins University/Applied Physics Laboratory

by

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POTENTIAL WEATHER MODIFICATION CAPABILITIES

AF 2025



DEGRADE ENEMY FORCES

Precipitation Enhancement

- Flood Lines of Communication
- Reduce PGM/Recce Effectiveness
- Decrease Comfort Level/Morale

Storm Enhancement

- Deny Operations

Precipitation Denial

- Deny Fresh Water
- Induce Drought

Space Weather

- Disrupt Communications/Radar
- Disable/Destroy Space Assets

Fog and Cloud Removal

- Deny Concealment
- Increase Vulnerability to PGM/Recce

Detect Hostile Weather Activities

ENHANCE FRIENDLY FORCES

Precipitation Avoidance

- Maintain/Improve LOC
- Maintain Visibility
- Maintain Comfort Level/Morale

Storm Modification

- Choose Battlespace Environment

Space Weather

- Improve Communication Reliability
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Fog and Cloud Generation

- Increase Concealment

Fog and Cloud Removal

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- Enhance PGM Effectiveness

Defend Against Enemy Capabilities



TREATY ISSUES



- The U. N. Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification, which went into effect 5 October 1978, applies only to “widespread, long-lasting or severe” environmental modifications.
 - » Local, non-permanent changes, such as precipitation enhancement, hail suppression, fog and cloud dispersal, are permitted under the U. N. treaty.
- Since 1978 the official Air Force position has been that weather modification had little utility or military payoff as a weapon of war.
- The official Air Force position needs to be reevaluated:
 - » In the light of 19 years of scientific advances
 - » In the light of advanced weapon systems which are more environmentally sensitive
 - » To prepare against technological surprise

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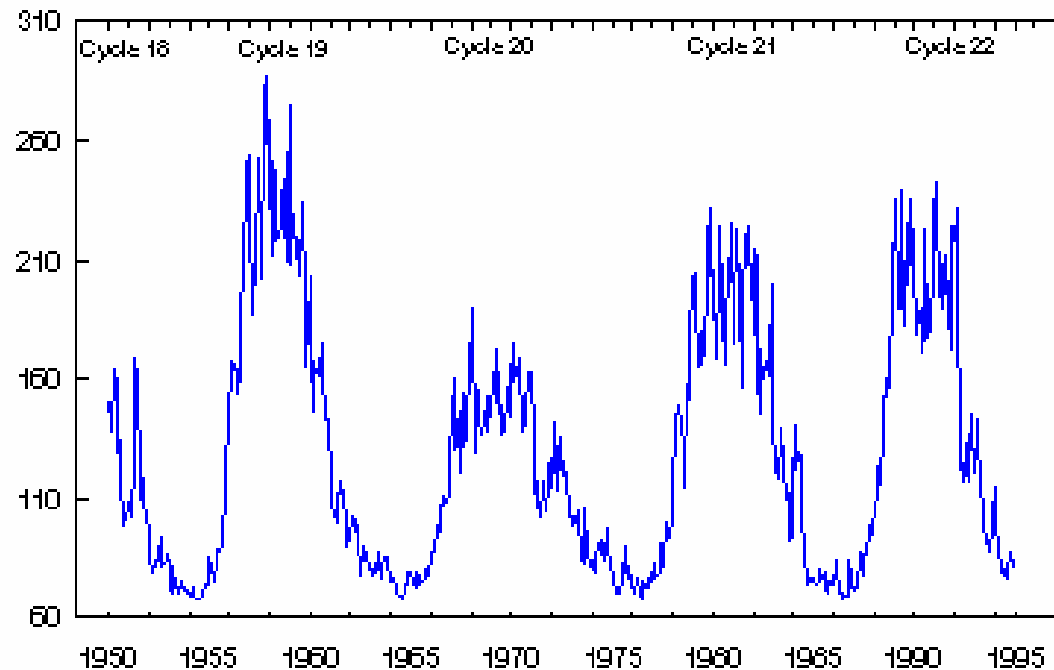
Defend Against Enemy Capabilities



SOLAR ACTIVITY



Monthly Mean 2800 MHz Solar Flux (Observed)
Jan 1950 - Jan 1995



Next Maximum: Jan 1999 **Mar 2000** Jun 2001



HAARP



HIGH FREQUENCY ACTIVE AURORAL RESEARCH PROGRAM



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HISTORY OF AIR FORCE WEATHER MODIFICATION



- **PREVIOUS WEATHER MODIFICATION WORK BY THIS LABORATORY'S PREDECESSORS**
 - FIDO; WW II
 - Clearing of Supercooled Fog at Airfields in Alaska and other cold regions; 50s and 60s
 - Hole Clearing with Carbon Black; 50s and 60s
 - Hole Clearing with Silver Iodide, etc.; 50s through 70s
 - Hole Clearing by Helicopter; 60s and 70s
 - Ho Chi Minh Trail Muddying; 60s and 70s
 - Contrail Suppression; 70s



CLOUD SEEDING



- **WEATHER MODIFICATION USING CARBON BLACK (1)**
 - **Increase Precipitation**
 - » Muddy dirt roads to decrease tractability
 - » Flood fields and small rivers
 - » Decrease troop comfort level
 - » Decrease tractability by snow or freezing rain when the temperature conditions are right
 - **Decrease Precipitation #**
 - » Dry out roads/fields for improved tractability
 - » Deny fresh water to troops in semi-dry regions



CLOUD SEEDING (cont.)



- **WEATHER MODIFICATION USING CARBON BLACK (2)**
 - **Increase Cirrus Cloud Cover**
 - » **Deny visual satellite or high altitude reconnaissance**
 - » **Decrease light level for night time operations**

 - **Dissipate Fog**
 - » **Uncover targets for visual raids**
 - » **Provide visual inspection of damage**
 - » **Provide visual reconnaissance**
 - » **Open airfields for landing / recovery**



STRATEGY FOR RE-EVALUATION OF CLOUD AND FOG MODIFICATION



- **PHYSICS AND CHEMISTRY OF NUCLEATION**
- **CLOUD PHYSICS AND RADIATION**
- **COMPUTERS AND NUMERICAL WEATHER PREDICTION (NWP) MODELS**



MODELING AND SIMULATION



- **WARNING** - MUST TEST AGAINST REAL DATA
 - NUCLEAR WINTER vs NUCLEAR SUMMER
 - US SUPERSONIC TRANSPORT AND OZONE

- WEATHER FORECASTS GET TIMELY FEEDBACK
 - NWP BASIC EQUATIONS CORRECTED EMPIRICAL



CLOUD COVER OVER THE EARTH

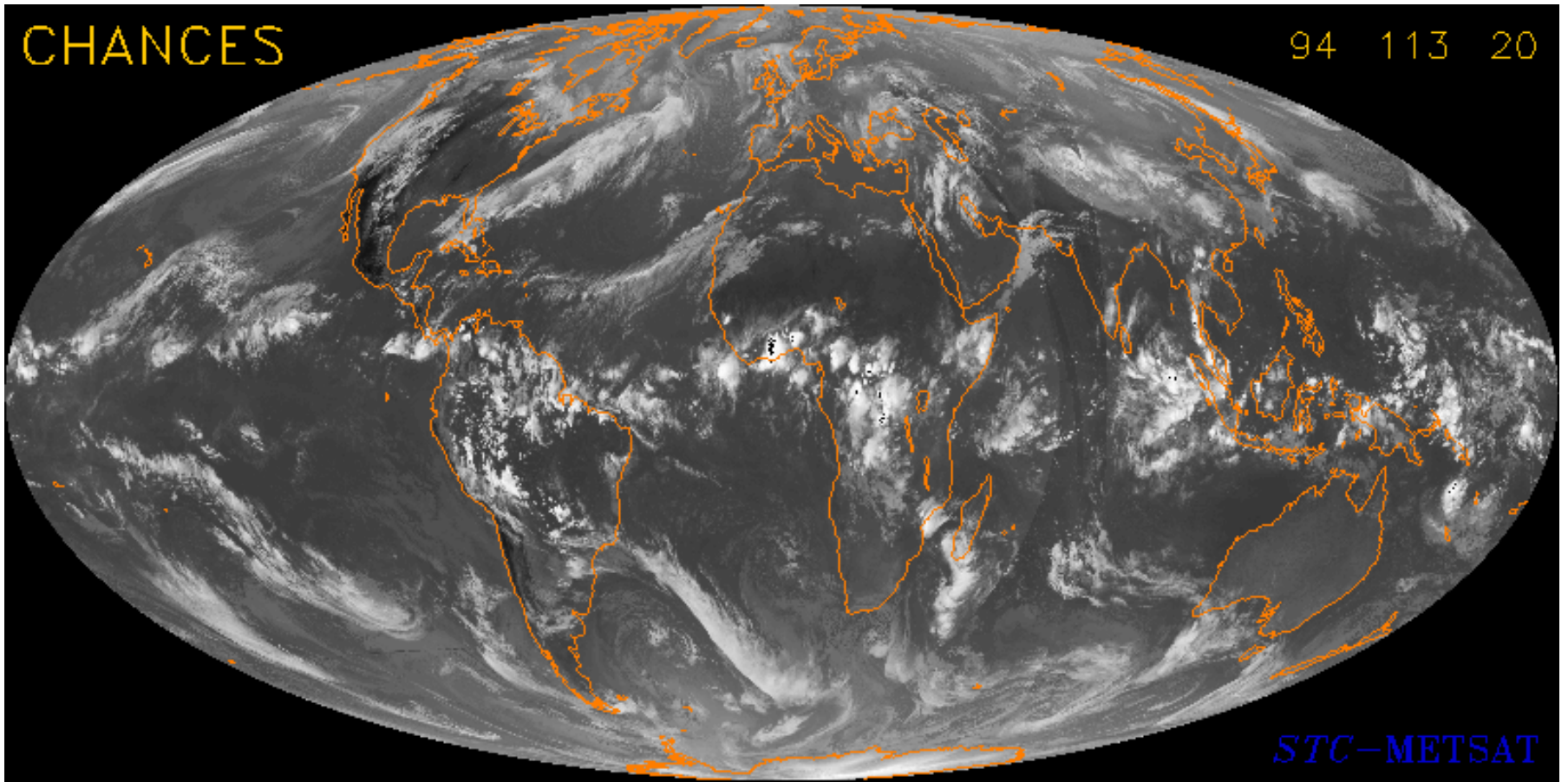


- **CHANCES = CLIMATOLOGICAL AND HISTORICAL ANALYSIS OF CLOUDS FOR ENVIRONMENTAL SIMULATIONS**
 - COMPLETE GLOBAL COVERAGE EVERY HOUR FOR ONE YEAR
 - IR & VISUAL DATA FROM SATELLITES
 - CLOUD/NO CLOUD (C/NC) FOR (5 KM)**2 AREAS
- **SERCAA = SUPPORT OF ENVIRONMENTAL REQUIREMENTS FOR CLOUD ANALYSIS AND ARCHIVES**
 - REAL-TIME COVERAGE FOR OPERATIONAL USE
 - BEING DEVELOPED BY PL/GPA
 - INCLUDES CLOUD HEIGHT INFORMATION



CHANCES IR DATABASE

23 APR 1994, 2000 UTC



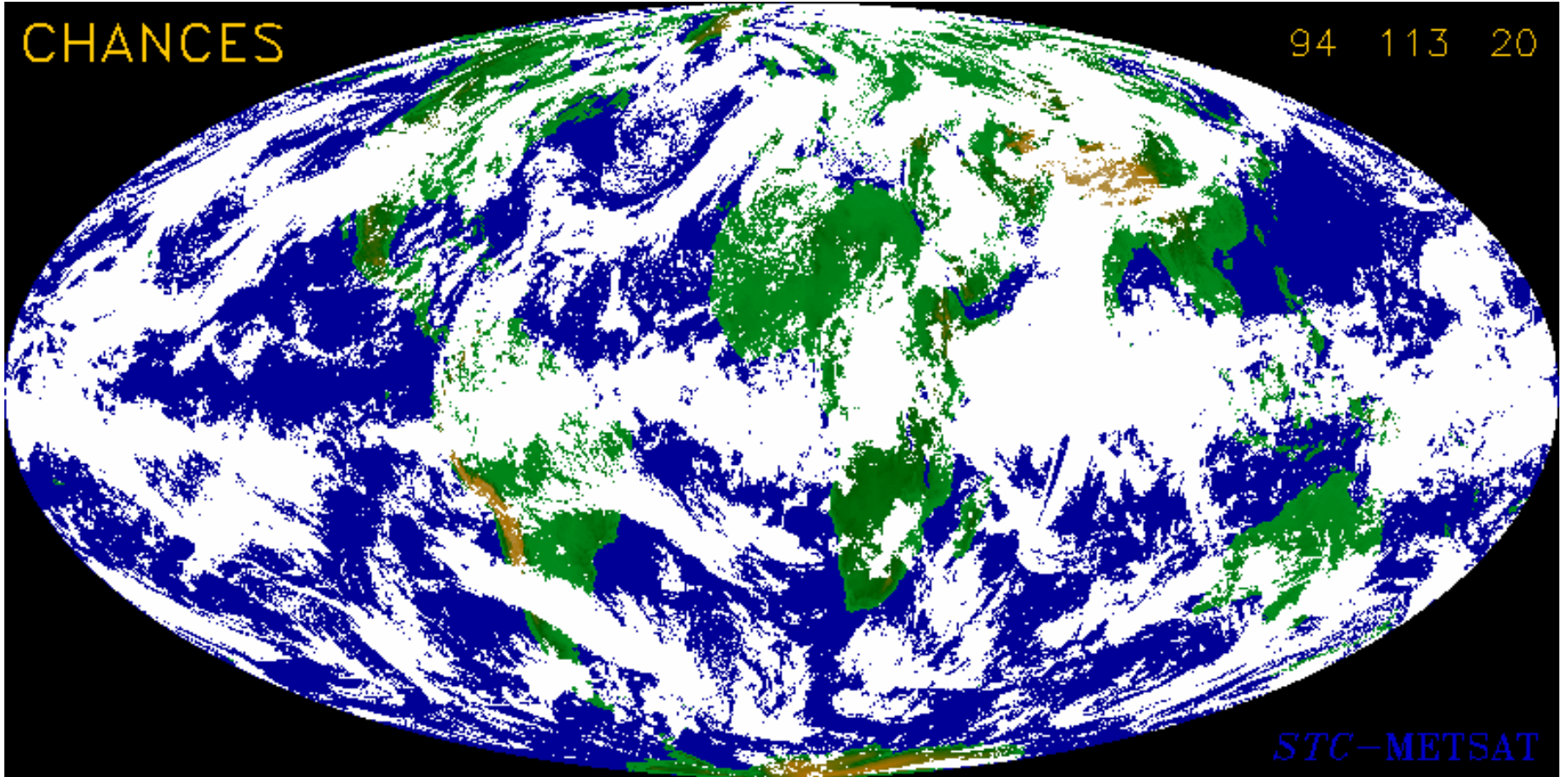
CHANCES C/NC PRODUCT

23 APR 1994, 2000 UTC



CHANCES

94 113 20



STC-METSAT



CLOUD IMPACTS ON DOD OPERATIONS AND SYSTEMS



- **WW II - Aborted Missions, FIDO**
- **VIETNAM - Operation POPEYE**
- **GULF WAR - Aborted Missions**
- **CIDOS - CONFERENCES EVERY 18 MONTHS**
23-25 September 1997, Naval Warfare Center, RI
POC: Donald Chisholm, PL/GPA, 617-377-2975.

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STORM MODIFICATION



- **ENERGY REACHING TOP OF ATMOSPHERE FROM THE SUN**
 - 1340 WATTS/m² = 1340 joules m⁻² sec⁻¹
 - 1.7×10^{17} joules sec⁻¹ \cong 4×10^7 Tons TNT sec⁻¹ = 40 Megatons TNT sec⁻¹
- **SMALL THUNDERSTORM**
 - 7×10^9 joules sec⁻¹ \cong 2 Tons TNT sec⁻¹
- **LARGE SEVERE THUNDERSTORM**
 - 7×10^{11} joules sec⁻¹ \cong 200 Tons TNT sec⁻¹
- **MAJOR STORM SYSTEM**
 - 7×10^{13} joules sec⁻¹ \cong 20 Kilotons TNT sec⁻¹
- **HURRICANE**
 - 7×10^{14} joules sec⁻¹ \cong 200 Kilotons TNT sec⁻¹
- **AVAILABLE MAN RETRIEVED ENERGY SMALL**
- **CHAOS “BUTTERFLY” EFFECT UNPREDICTABLE**



IMPROVEMENTS IN WEATHER FORECASTS



- **SATELLITE WITH 26 IR CHANNELS**
 - 2004 PROJECTED LAUNCH
 - WILL PROVIDE WORLD WIDE VERTICAL TEMPERATURE PROFILES BY 2020
- **CHAOS SEEMS TO BE LIMITED TO ACTIVE REGIONS**
 - LOOK FOR THE “BUTTERFLY”
- **LIMITS OF FORECASTS**

1950	3 DAYS
1997	7 DAYS
2040	14 DAYS
- **MAJOR IMPROVEMENTS IN CLOUD FORECASTS BY 2010**



NEW WEAPON SYSTEMS MORE SENSITIVE TO THE ATMOSPHERE



- **COMPOSITE MATERIALS AND LIGHTNING**
- **ELECTRONIC COMPONENTS AND LIGHTNING**
- **NEED TO INVOLVE WEATHER OFFICERS VERY EARLY**
 - WW II RADAR EXAMPLE
- **THE ATMOSPHERE CAN HELP AS WELL AS HINDER**
 - CLOUDS AND THE AIRBORNE LASER
 - LASER LIGHTNING ROD TO TRIGGER LIGHTNING
 - LASER FOG CLEARING AND HOLE BORING



SUMMARY



- MAJOR IMPROVEMENTS IN SHORT TERM FORECASTS BY 2010
- 14 DAY FORECASTS BY 2040
- CURRENT CAPABILITIES
 - TARGETED FOG DISPERSAL
 - LOCAL CHANGES IN PRECIPITATION
 - CLOUD MODIFICATION - SURVEILLANCE/COVERAGE
 - HOLE BORING
 - CREATE/SUPPRESS CIRRUS/CONTRAILS
 - IONOSPHERIC MODIFICATION
- ENERGY REQUIREMENTS TOO LARGE FOR MAJOR STORMS
- TREATY RESTRICTIONS
- NEW WEAPON SYSTEMS PUSH THE ENVELOPE
 - THE ENVIRONMENT MUST BE CONSIDERED FROM THE START OF THE CONCEPT/DESIGN FOR ALL NEW WEAPON SYSTEMS