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
- Intercept Enemy Transmissions
- Revitalize Space Assets

Fog and Cloud Generation

- Increase Concealment

Fog and Cloud Removal

- Maintain Airfield Operations
- 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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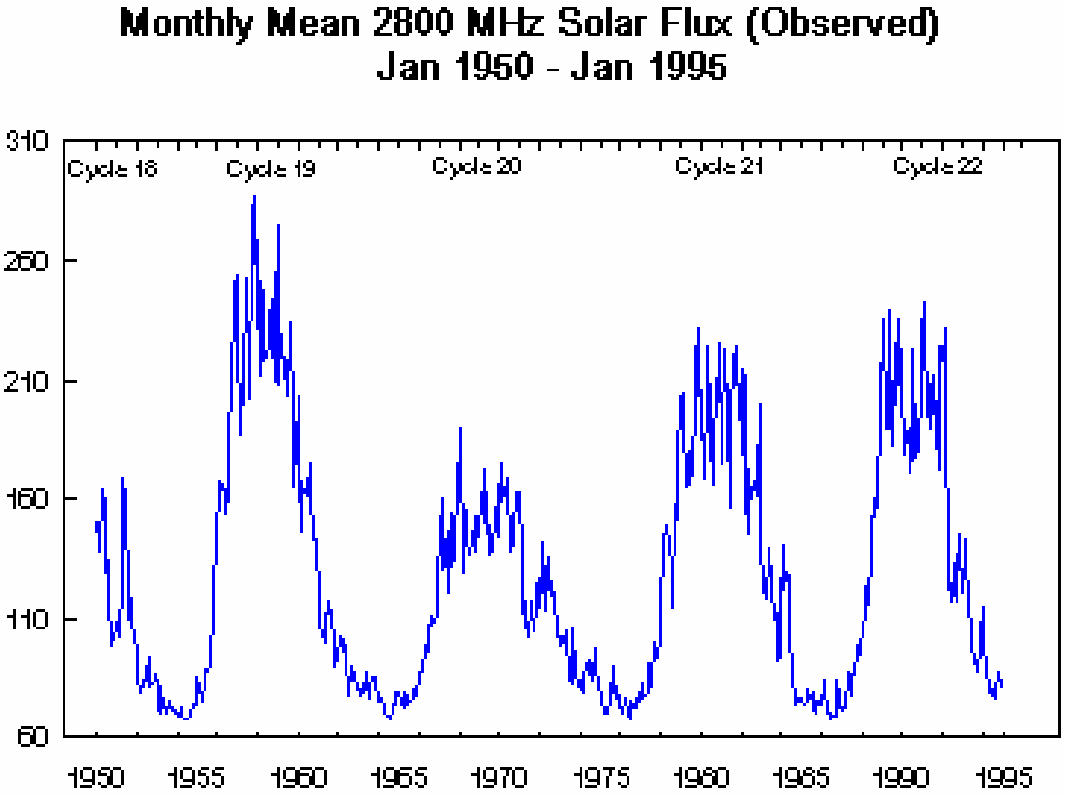
SOLAR ACTIVITY



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

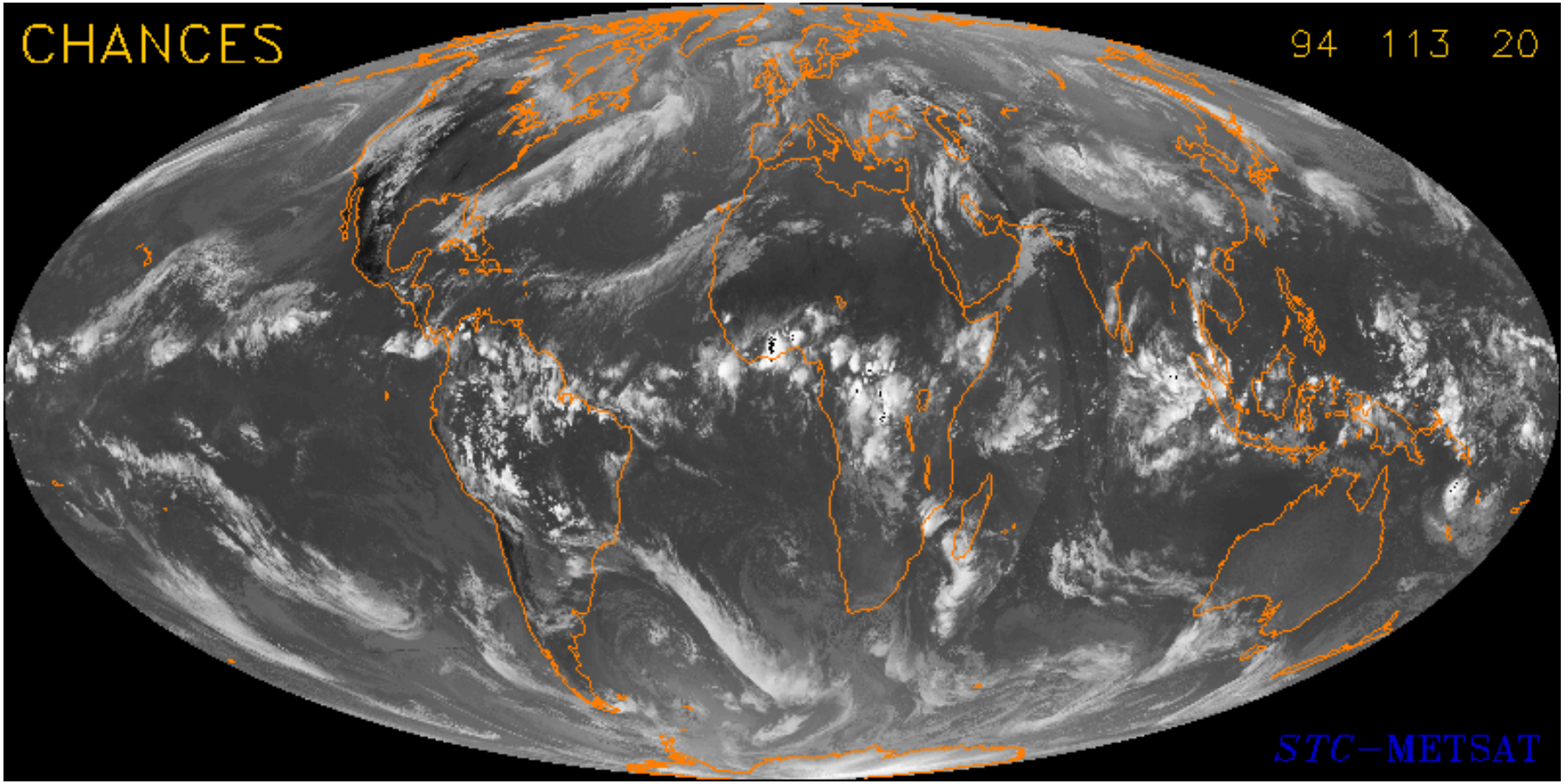
- **WEATHER FORECASTS GET TIMELY FEEDBACK**
  - NWP BASIC EQUATIONS CORRECTED EMPIRICAL

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
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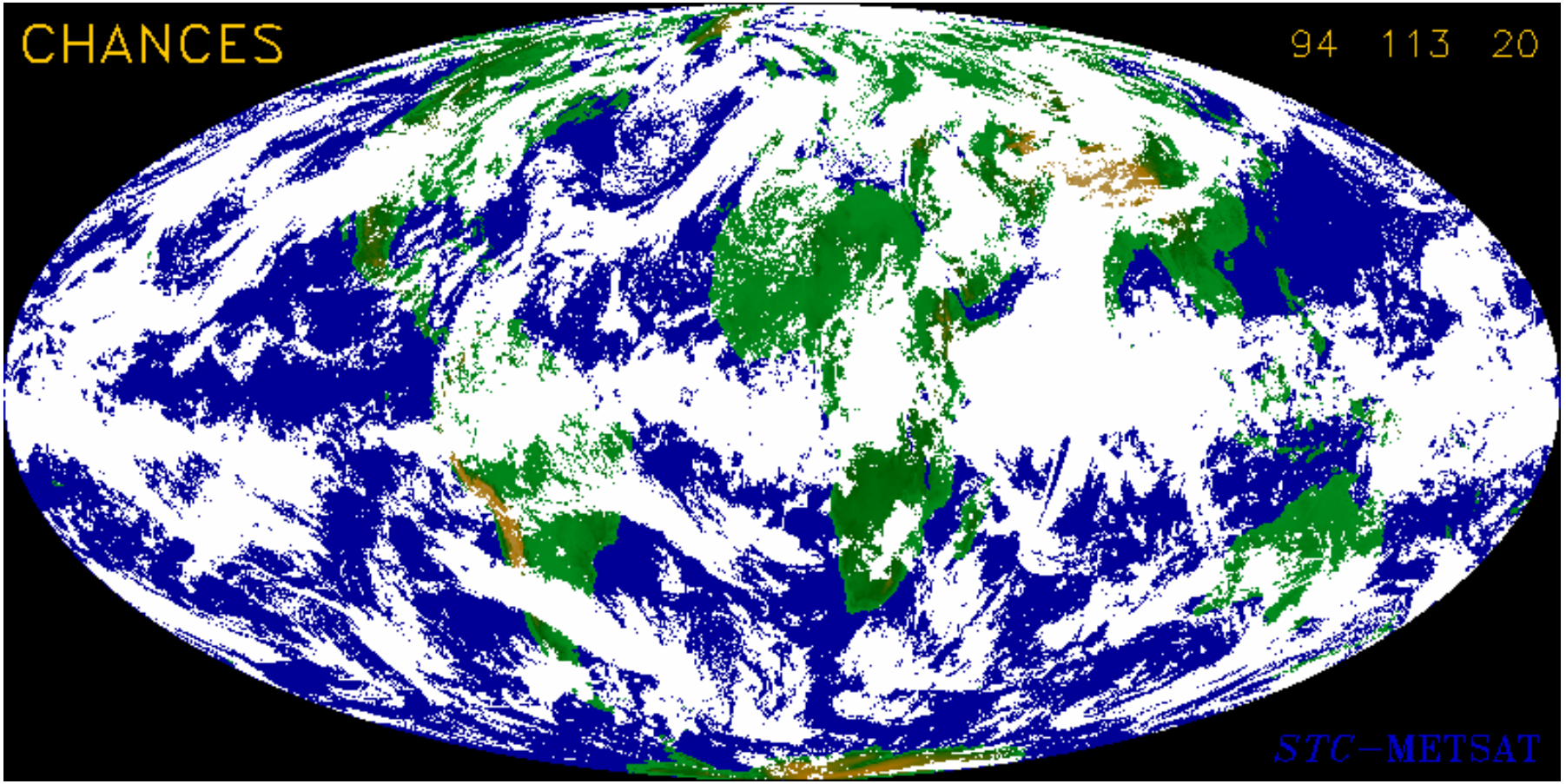

CLOUD IMPACTS ON DOD OPERATIONS AND SYSTEMS

- **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/m^2 = 1340 joules m^{-2} sec^{-1}**
  - **1.7×10^{17} joules $sec^{-1} \cong 4 \times 10^7$ 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