CLIMATE CHANGE:

PERSPECTIVE FROM THE POLAR REGIONS

ENVIRONMENTAL & WATER RESOURCES INSTITUTE

USMA, WEST POINT

SEPTEMBER 20th, 2005

PALMER BAILEY

TODAY'S PLAN

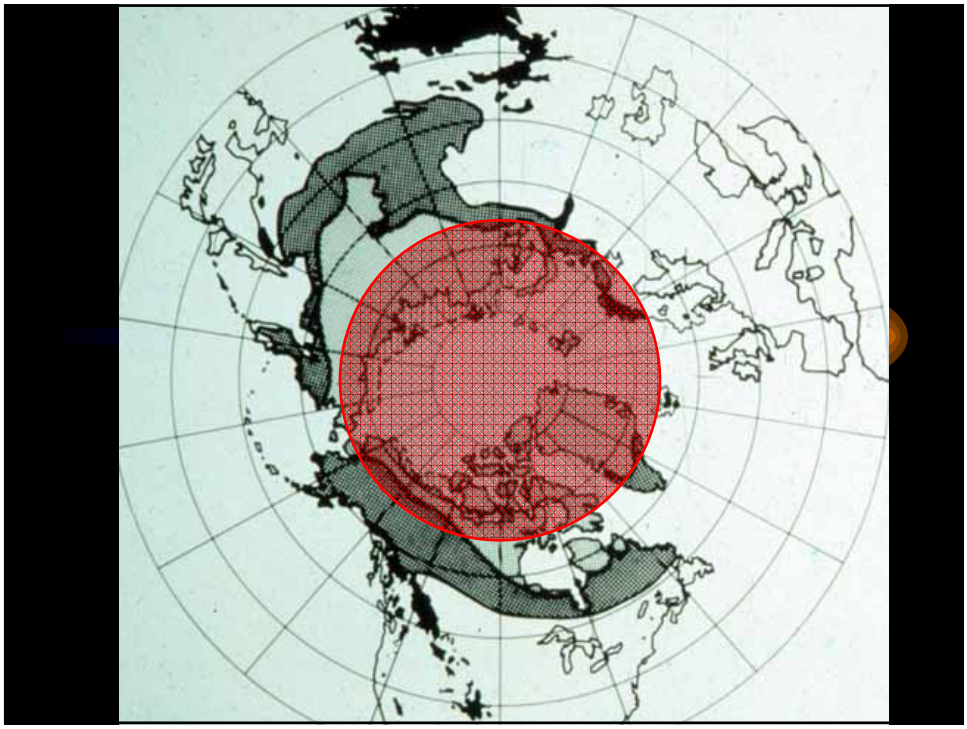
- DESCRIPTION OF THE POLAR REGIONS
  - THE ARCTIC
  - ANTARCTICA
- THEIR INVOLVEMENT IN CLIMATE CHANGE
  - HISTORICAL OVERVIEW
  - COMMENTS ON THE CURRENT SITUATION

WHY THE POLAR REGIONS?

WHAT'S UP THERE
ANYWAY?

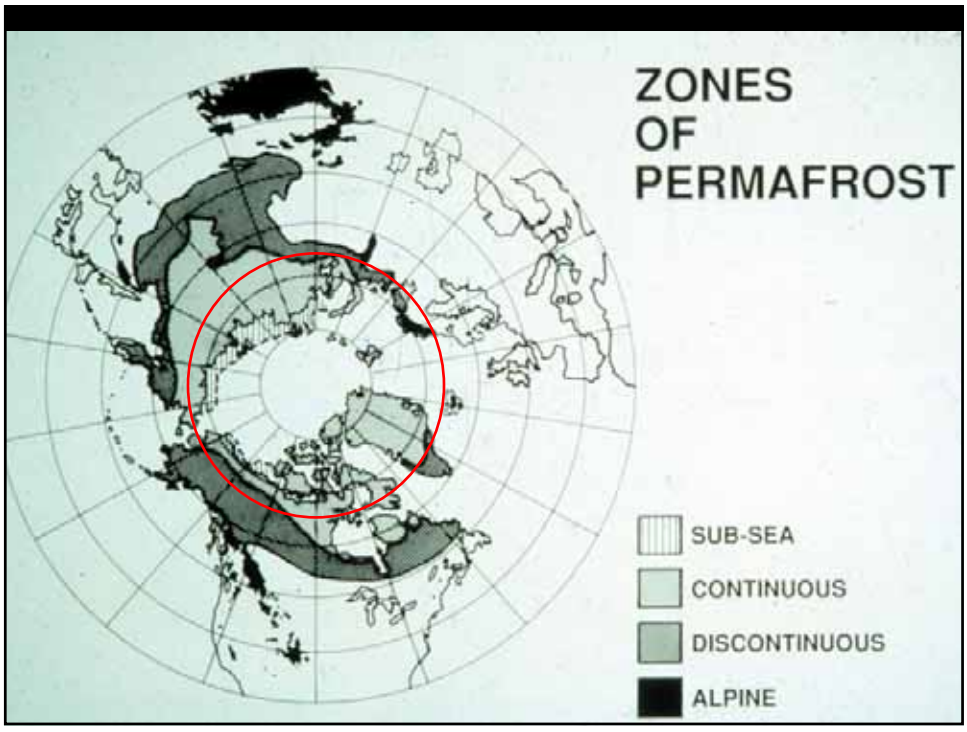
THE ARCTIC

A COLD OCEAN
SURROUNDED BY LAND

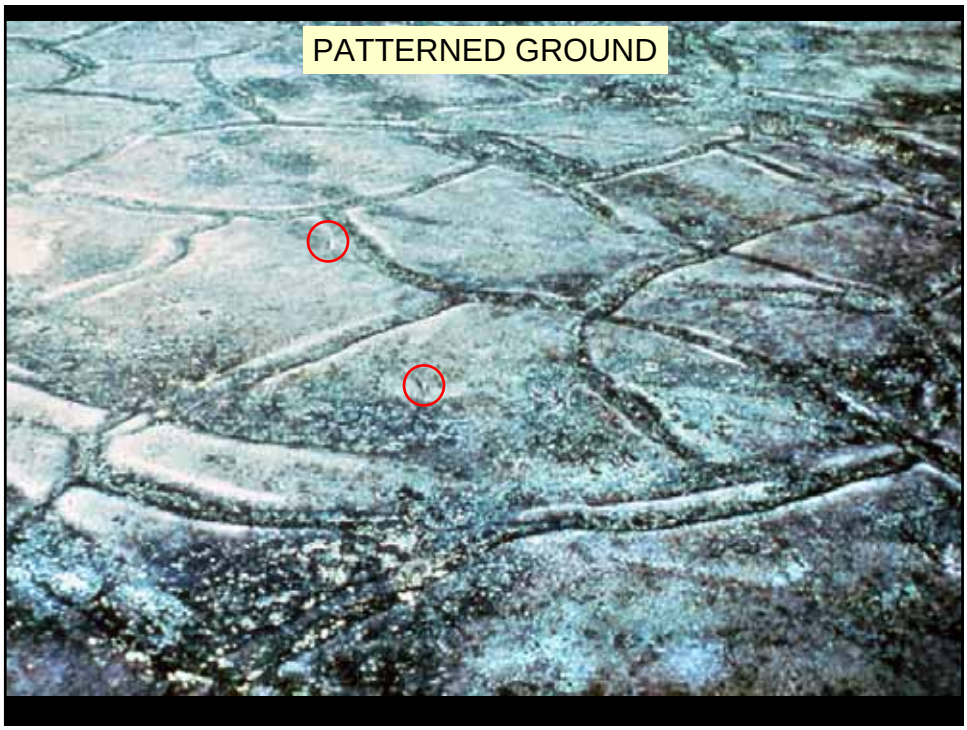


AREAS OF THE ARCTIC

- TAIGA
- TUNDRA
- ICY OCEAN


ZONES
OF
PERMAFROST
SUB-SEA
CONTINUOUS
DISCONTINUOUS
ALPINE


DRUNKEN FOREST


PATTERNED GROUND


SOLIFLUCTION

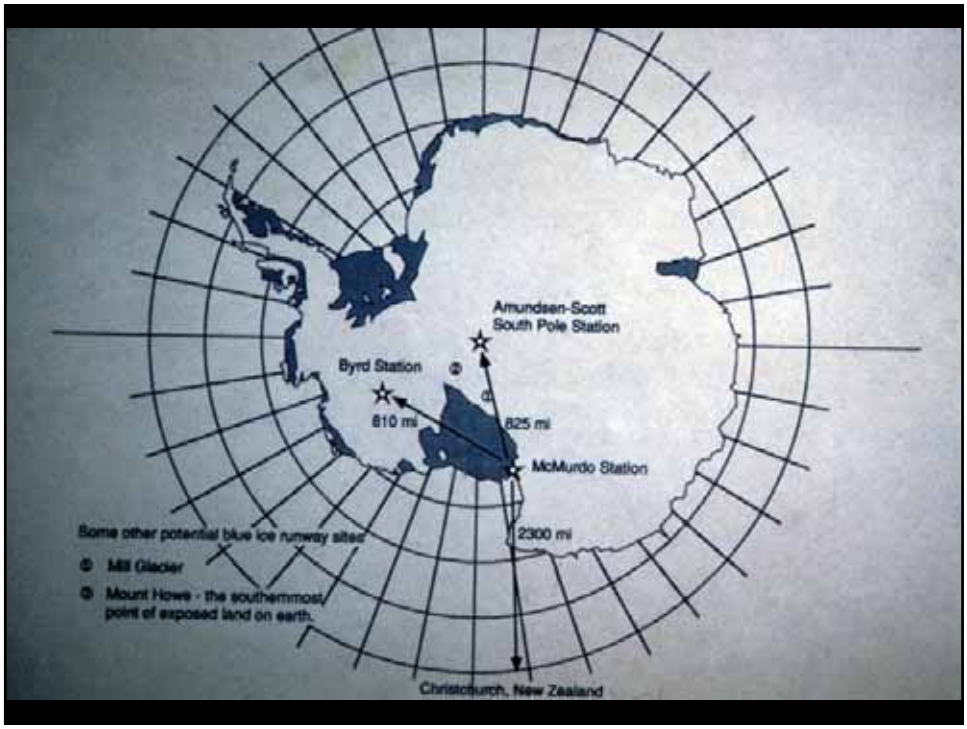

BARROW, ALASKA

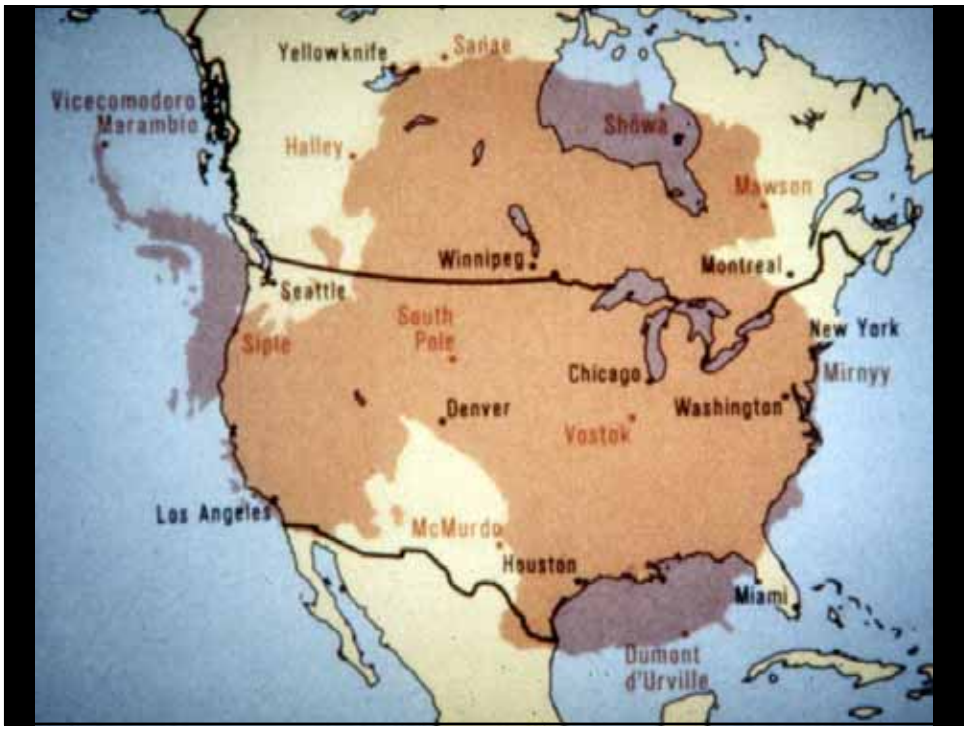

DEAD HORSE, ALASKA

RAILROAD
ON
PERMAFROST

THE ANTARCTIC

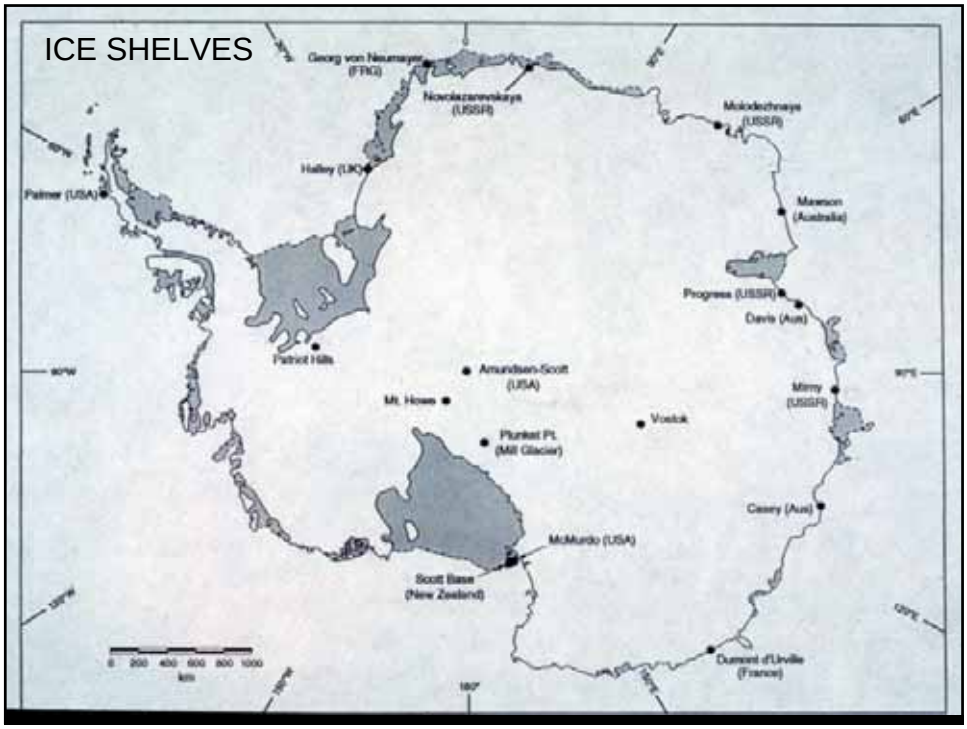
A COLD LAND
SURROUNDED BY OCEAN

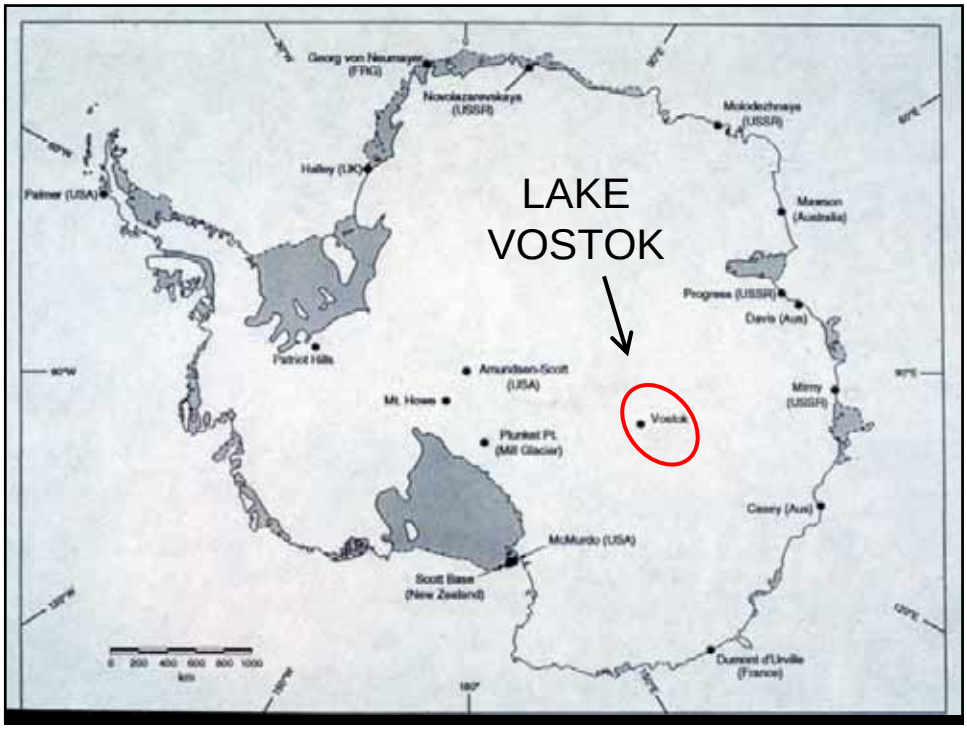

Amundsen-Scott
South Pole Station
Byrd Station
810 mi
825 mi
McMurdo Station
2300 mi
Some other potential blue ice runway sites:
Mill Glacier
Mount Howe - the southernmost point of exposed land on earth.
Christchurch, New Zealand


Yellowknife
Sarige
Vicecomodoro Marambio
Halley
Showa
Mawson
Winnipeg
Montreal
Seattle
South Pole
Siple
New York
Chicago
Mirnyy
Denver
Washington
Vostok
Los Angeles
McMurdo
Houston
Miami
Dumont d'Urville

AREAS OF THE ANTARCTIC

- GLACIER (97%)
- BARREN LAND (3%)
- ICE SHELVES


ICE SHELVES
Georg von Neumayer (FRG)
Novolazarevskaya (USSR)
Molodezhnaya (USSR)
Halley (UK)
Palmer (USA)
Mawson (Australia)
Progress (USSR)
Davis (Aus)
Patriot Hills
Amundsen-Scott (USA)
Mt. Howe
Mirny (USSR)
Vostok
Plunket Pt. (Mill Glacier)
Casey (Aus)
McMurdo (USA)
Scott Base (New Zealand)
Dumont d'Urville (France)
0 200 400 600 800 1000
km


LAKE
VOSTOK
Georg von Neumayer (FRG)
Novolazarevskaya (USSR)
Molodezhnaya (USSR)
Halley (UK)
Palmer (USA)
Mawson (Australia)
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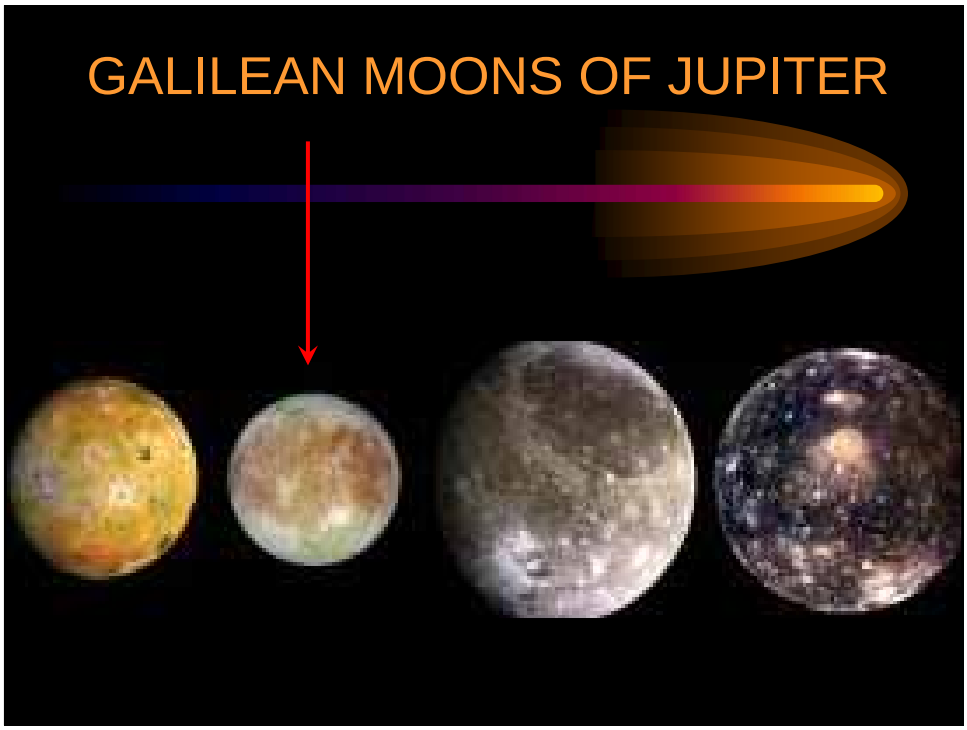
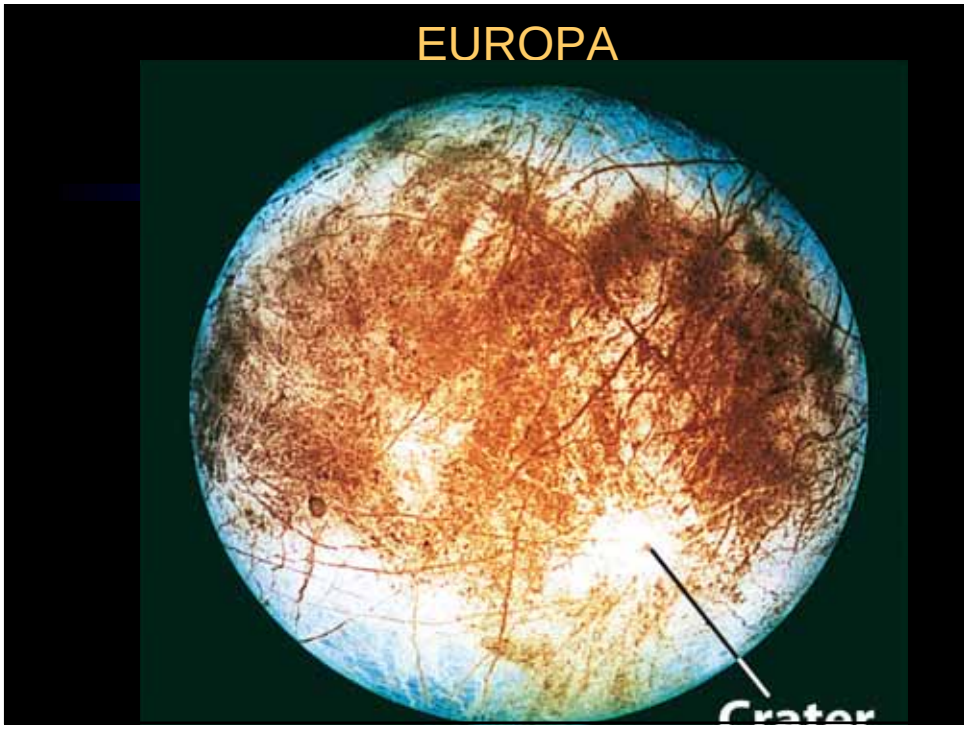
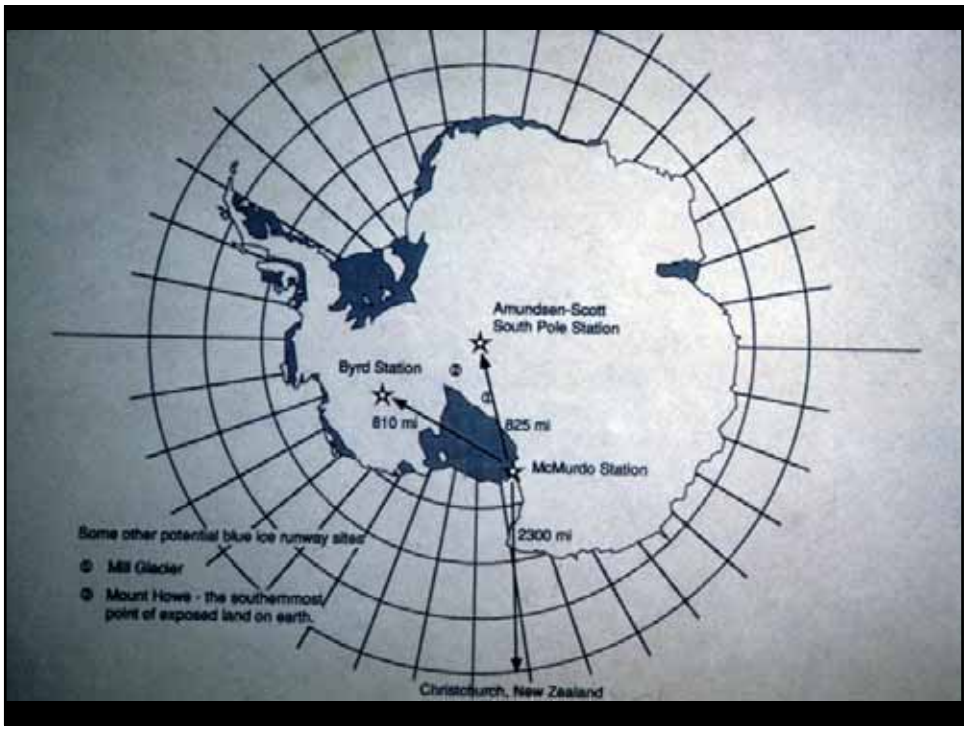

GALILEAN MOONS OF JUPITER


EUROPA
Crater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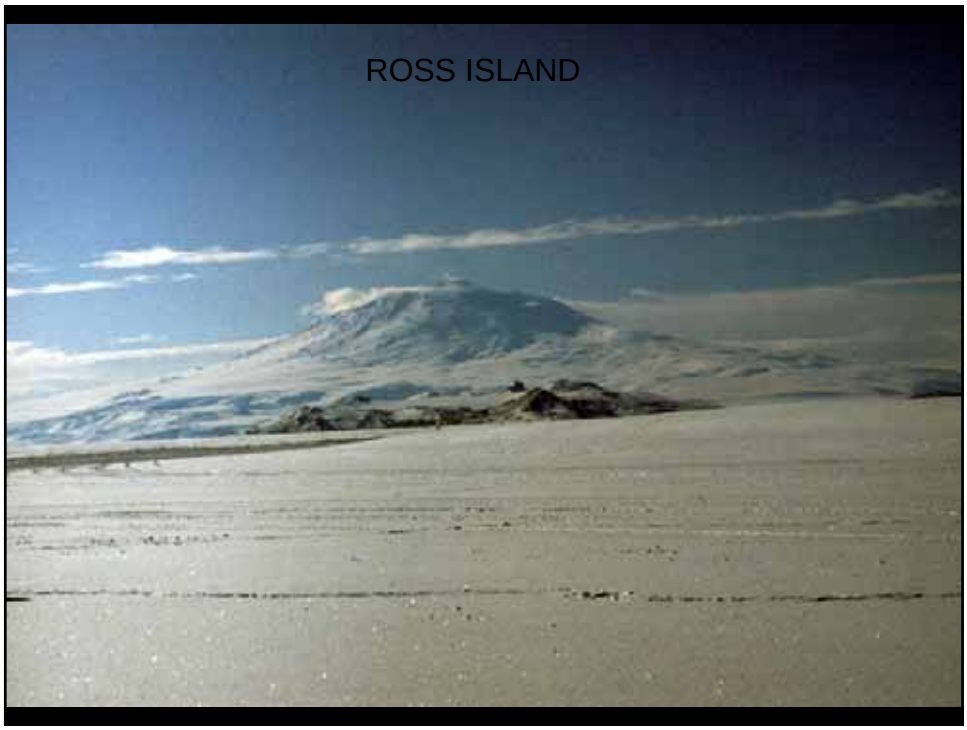
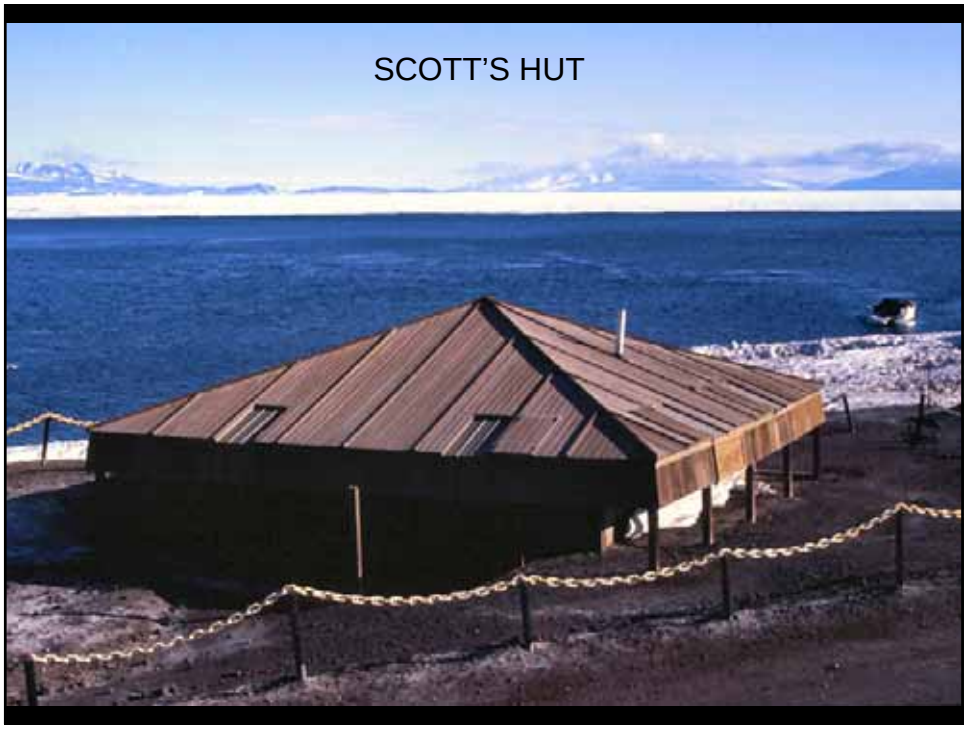
South Pole Station
Byrd Station
810 mi
825 mi
McMurdo Station
2300 mi
Some other potential blue ice runway sites
© Mill Glacier
Mount Howe - the southernmost point of exposed land on earth.
Christchurch, New Zealand

MOST SOUTHERLY OPEN WATER

ROSS ISLAND



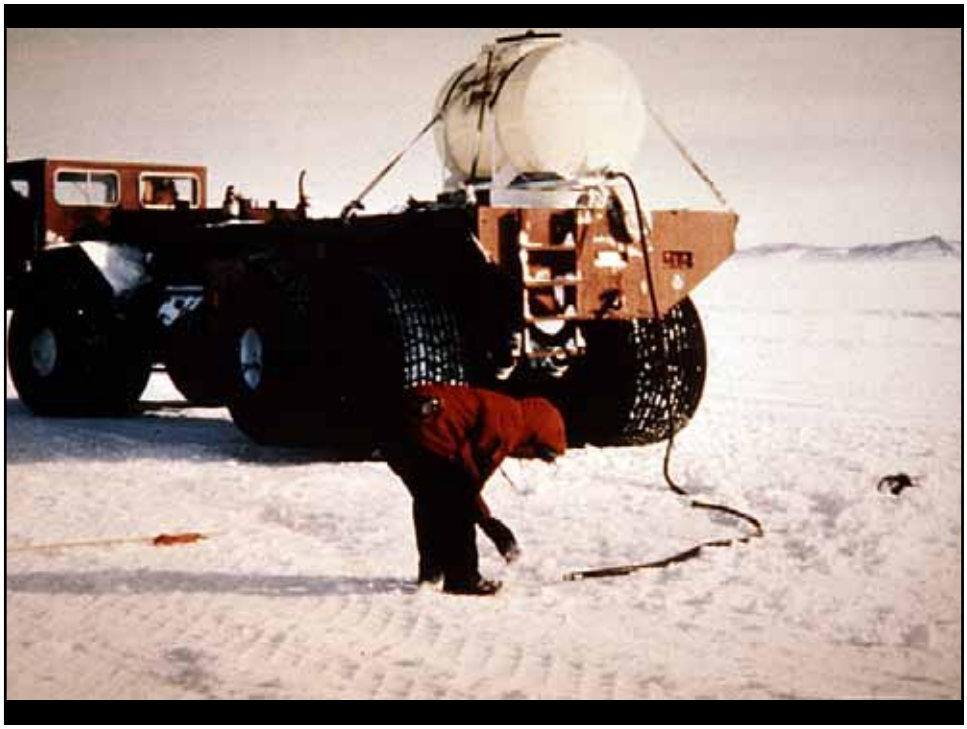
SCOTT'S HUT




CATERPILLAR


U.S. ANTARCTIC PROGRA


NEW YORK AIR GUARD

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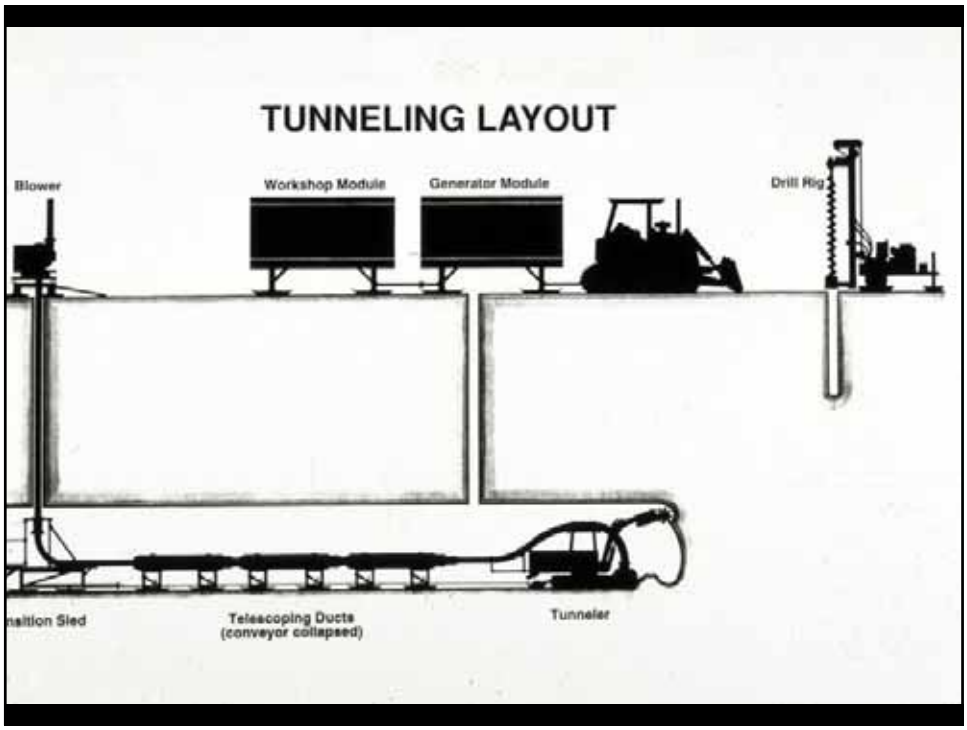
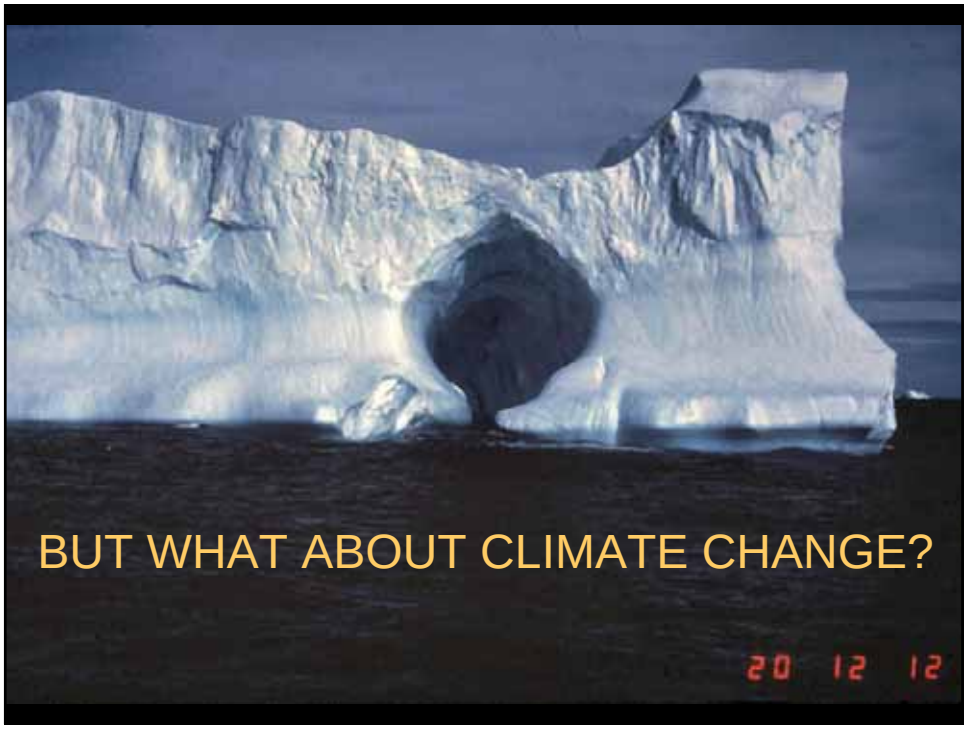

TUNNELING LAYOUT
Blower
Workshop Module
Generator Module
Drill Rig
Telescoping Ducts
(conveyor collapsed)
Tunneler



THE BIG QUESTION

IS THE CLIMATE CHANGING?

THE EASY ANSWER

YES

(IT ALWAYS HAS. WHY SHOULD IT STOP NOW?)

CONTROLS FOR CLIMATE

1. OUTPUT OF THE SUN
2. THE PLANET'S ORBIT
   - SIZE
   - CHARACTERISTICS
3. ATMOSPHERE
4. CIRCULATION SYSTEMS
   - LIQUID WATER
   - ARRANGEMENT AND SIZE OF CONTINENTS

EARTH'S CLIMATE
AT THE SCALE OF BILLIONS OF YEARS

- INCREASE IN SOLAR OUTPUT

GENERALLY BALANCED BY

- DECREASE IN ATMOSPHERE GREENHOUSE EFFECT

EARTH'S CLIMATE
THE LAST 100 MILLION YEARS

- GLOBAL SAUNA
- GRADUAL GENERAL COOLING

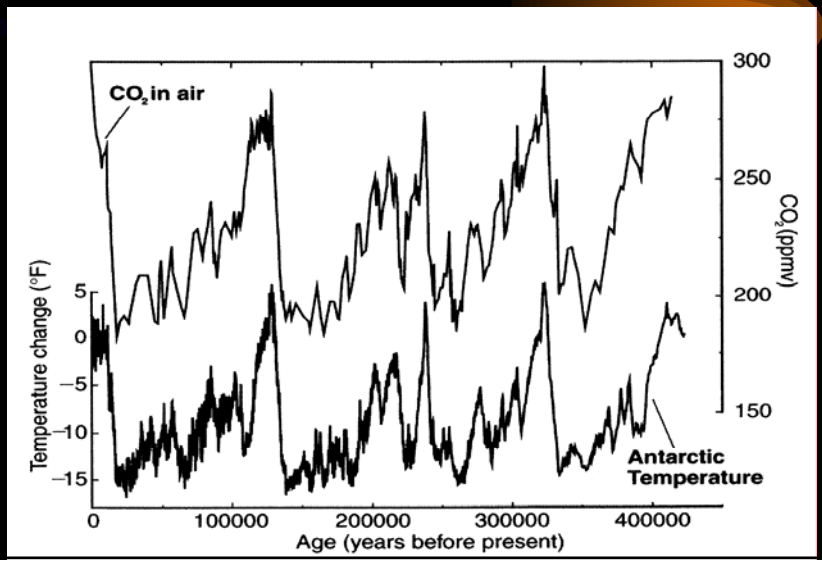
EARTH'S CLIMATE
THE LAST FEW MILLION YEARS

- GLACIAL CYCLES OF ~ 100,000 YEARS
  - 90,000 YEARS FLUCTUATING ICE AGE
  - 10,000 YEARS OF WARMER CLIMATE
- SMALLER PEAKS AT 41,000 AND ~23,000 YEAR INTERVALS

THESE CYCLES ARE DRIVEN BY THE MOTION OF THE EARTH IN ITS ORBIT

- 100,000 YEARS –
  HOW CIRCULAR IS THE EARTH'S ORBIT
- 41,000 YEARS –
  THE TILT OF THE EARTH'S AXIS
- ~23,000 YEARS –
  WHICH WAY THE AXIS POINTS

ANTARCTIC TEMPERATURE AND CO_2 LEVELS FROM DEEP ICE CORE AT VOSTOK STATION



EARTH'S CLIMATE
THE LAST HUNDRED THOUSAND YEARS

- GENERALLY WILD ABRUPT FLUCTUATIONS
  OFTEN > 20 OR 30° F

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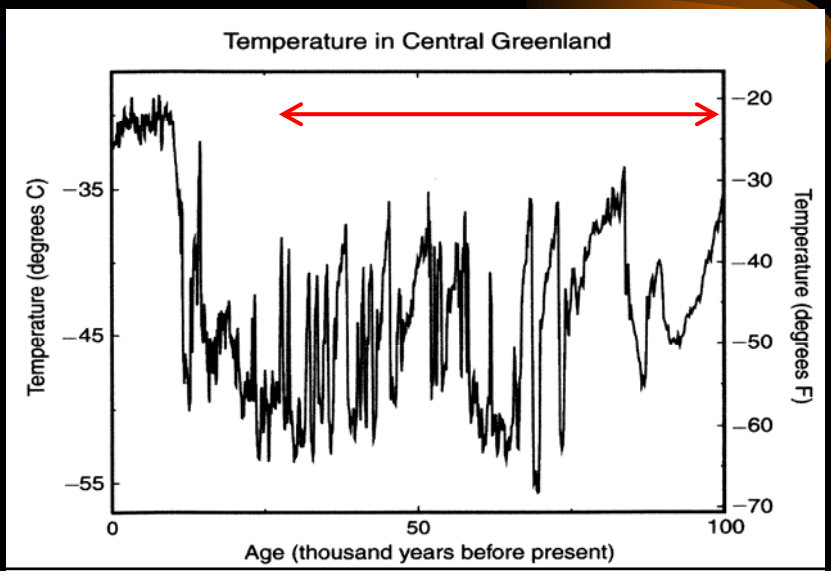

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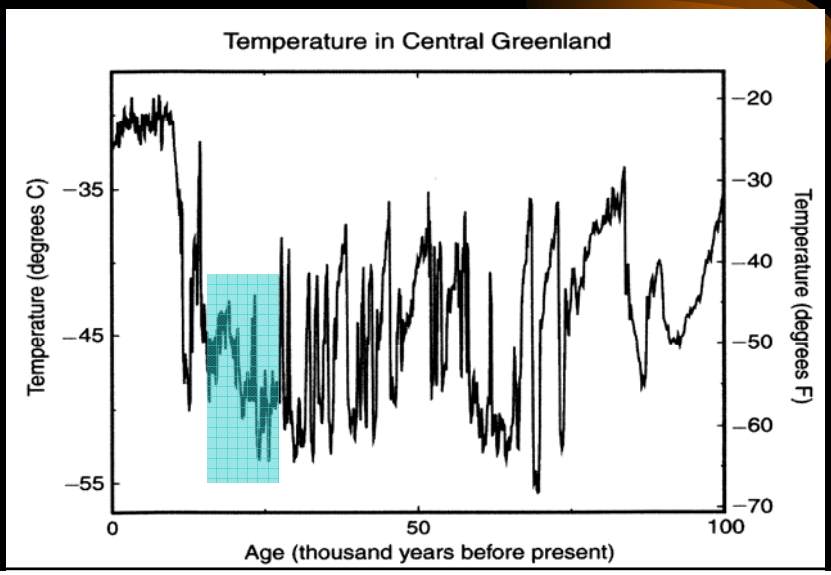

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  OF COLD, ~ 40° F COLDER THAN NOW

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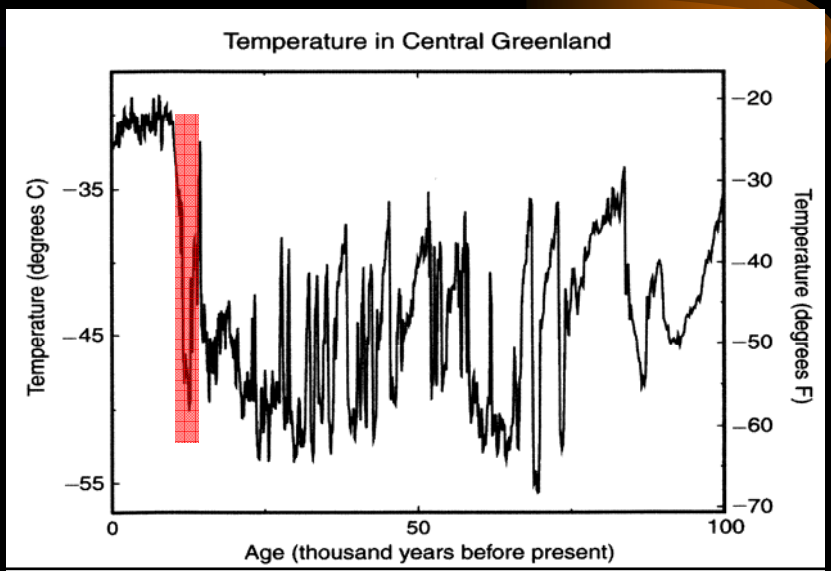

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- WARM JUMP, FOLLOWED BY 1,300 YEARS
  OF COLD, ~ 40° F COLDER THAN NOW
- VERY FAST WARMING FOLLOWED BY
  > 10,000 YEARS OF STABLE WARM CLIMATE

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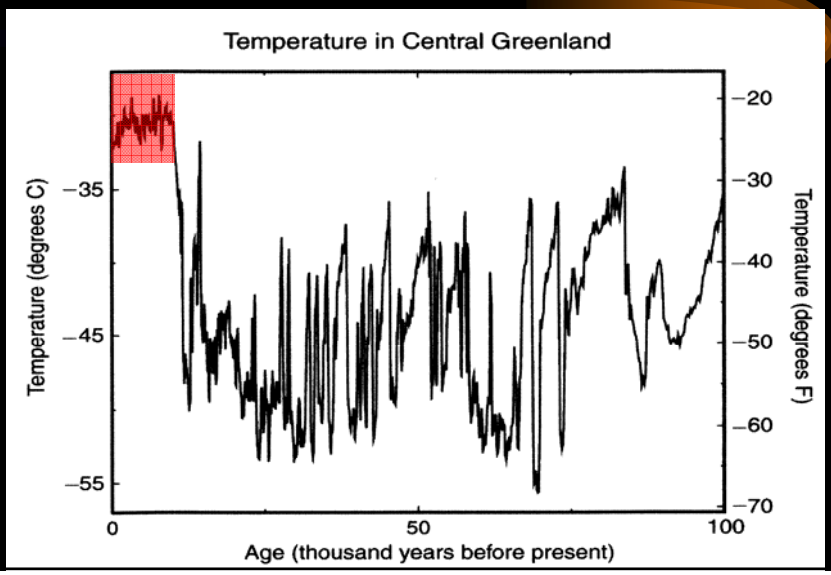
THE LAST HUNDRED THOUSAND YEARS



EARTH'S CLIMATE
THE LAST TWO THOUSAND YEARS

- FAIRLY COOL LATE IN THE FIRST MILLENNIUM
- MEDIEVAL WARM PERIOD
  ABOUT 900 AD TO 1300 AD

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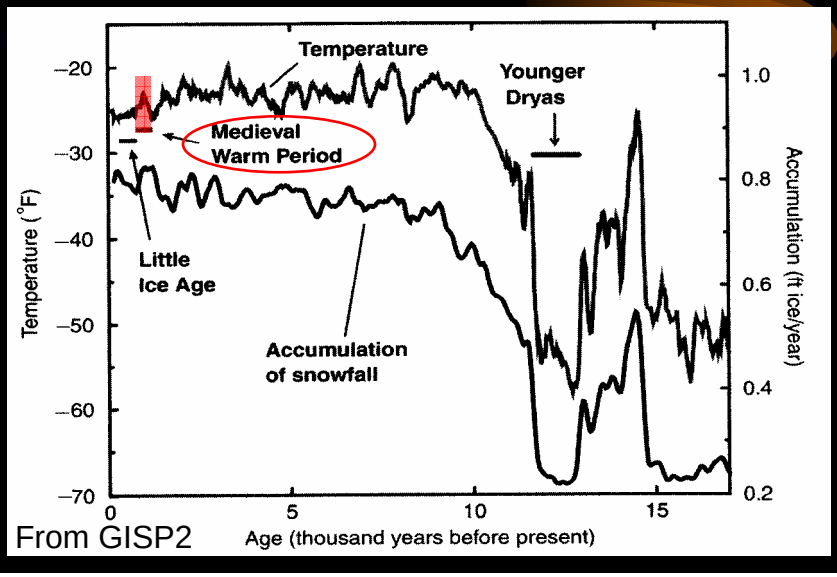

From GISP2

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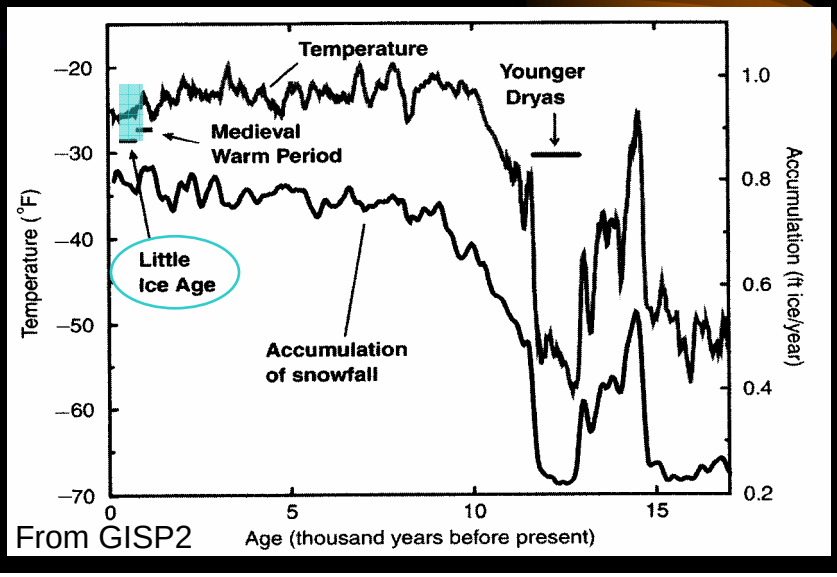

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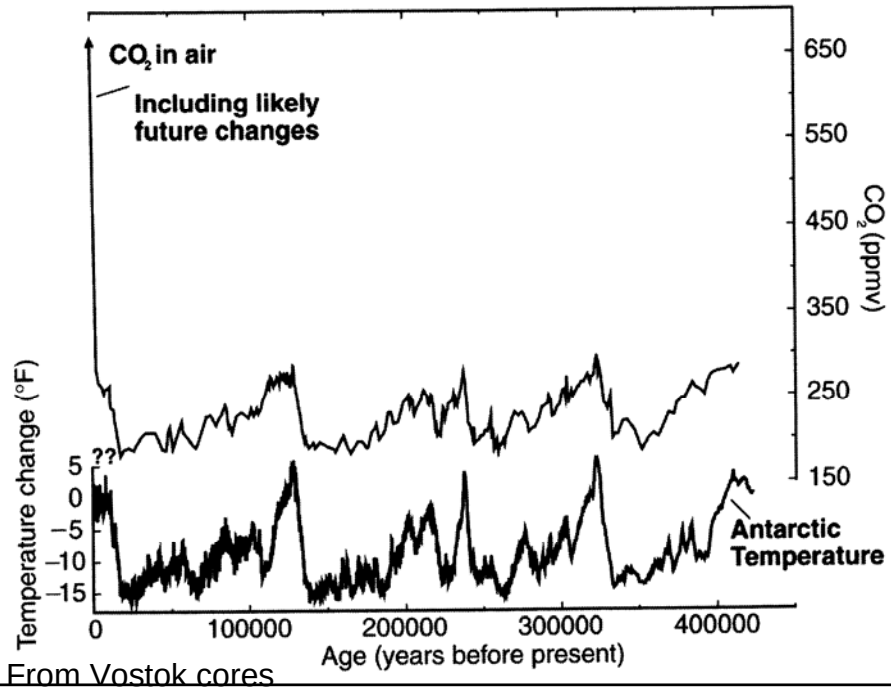
- GRADUAL WARMING DURING LAST COUPLE OF CENTURIES



From Vostok cores

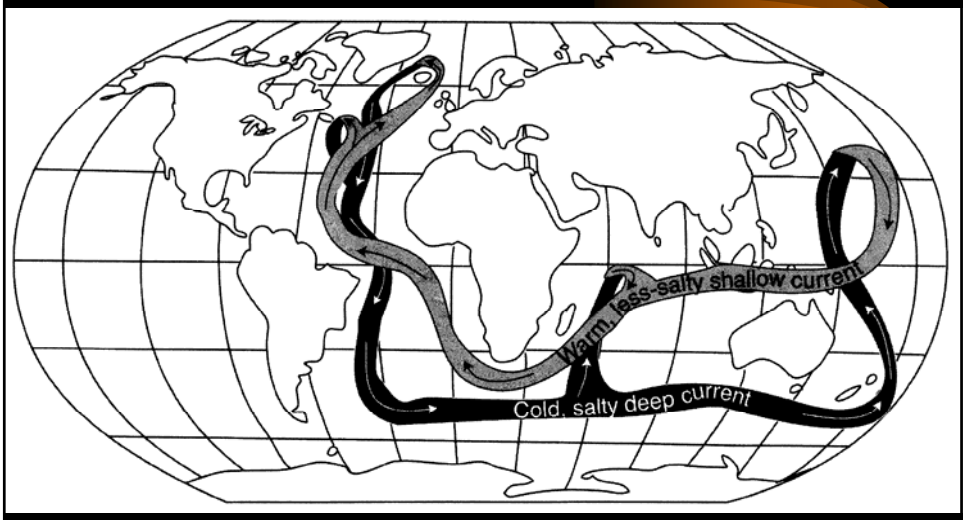
WHAT DOES THE FUTURE HOLD?

PROBABLY CONTINUED WARMING

- WARMER CLIMATE IS ASSOCIATED WITH HIGHER LEVELS OF CO_2 IN THE ATMOSPHERE
  - WAS 180 TO 300 ppm IN PAST
  - CURRENTLY >380, INCREASING ~3 ppm/yr

BUT THERE WILL BE SURPRISES !!

ONE WILD CARD
THERMALHALINE CIRCULATION



FROM ALLEY (2000)

HUMAN-ENHANCED GLOBAL WARMING

THE TRIGGER TO THE NEXT ICE AGE?