NUMERICAL SIMULATIONS OF WINTER STORMS, TROPICAL CYCLONES, AND NOR'EASTERS DURING THE ICE AGE USING THE NCAR WRF MODEL WITH A WARM OCEAN

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ABSTRACT

The National Center for Atmospheric Research (NCAR) Weather Research and Forecasting Model (WRF) was used to simulate several winter storms traveling across Yosemite and Yellowstone National Parks, two tropical storms originating in the Caribbean Ocean, two tropical cyclones in the Arabian Sea, and three nor'easters on the East Coast of North America. The wind speed, precipitation, and pressure fields for each simulated storm compared well with characteristics of the observed storms. The sea-surface temperature of the Pacific, Atlantic, and Arabian Sea were artificially heated by 10°C (18°F) to approximate the conditions following the Genesis Flood and simulations run again. Changes in winds, storm motion, and precipitation were analyzed for the warmer temperature. The current locations of North America, the Arabian Sea, the Caribbean Ocean, and the East Coast of the United States were used in the simulations.

Wind speed and precipitation were dramatically increased for all cases, as much as a six-fold increase in precipitation for the mountains of the western United States and in northeastern North America. The increased precipitation rate would have produced glaciers on the order of 1.1 km (3,000 feet) thick in less than 500 years. Tropical cyclones increased in intensity to become hypercyclones and their tracks significantly altered. Nor'easters were greatly intensified.

These simulations showed that increased sea-surface temperature following the Genesis Flood was the likely cause of the ice age. Heavy snow occurred in the mountains of the western United States and in northeastern North America which explain past glaciation found in these locations. Hypercanes and enhanced nor'easters were fueled by the warm oceans and the deserts of Egypt,

Saudi Arabia, Turkey, Israel, Iraq, and Iran would have likely been much wetter for years after the Genesis Flood.

INTRODUCTION

In the proceedings of the 6th ICC (Vardiman, 2008) proposed using the National Center for Atmospheric Research (NCAR) Mesoscale Meteorology Model (MM5) to determine if glaciers during the ice age inYosemite National Park could be simulated under conditions of a warm ocean. (Oard, 1990) and (Austin *et al*., 1994) argued that heat released from catastrophic processes during the Genesis Flood would have heated the oceans.

The oceans were at least 20°C (36°F) hotter in the past than today derived from drillings of ocean floor sediments and the development of a temperature proxy based on the ratio of stable oxygen isotopes in benthic and planktic foraminifera found in the sediments (Kennett *et al*. 1975; Shackleton and Kennett 1975). The conventional interpretation of these data claims that the oceans were much hotter during the Paleocene and Cretaceous periods. The oceans are believed to have cooled to today's temperatures over a period of 65 million years or so. If the earth is actually only 6,000 years old, however, then these data would indicate the oceans were hot during and following the Genesis Flood and cooled over a period of about 4,500 years.

(Heezen and Tharp, 1977) published images of the ocean floor obtained in the 1960s which show mid-ocean ridges and undersea volcanoes. It is likely these underwater features would have released large quantities of heat during past earth upheavals. Higher sea-surface temperatures would have evaporated larger quantities of water vapor from the oceans, energized mid-latitude storms, hurricanes, and cyclones and precipitated large quantities of rain and snow on the continents.

(Spelman, 1996), and (Vardiman, 1998) previously found that simulations using the global NCAR Community Climate Model (CCM1) with warm sea-surface temperatures (SST) greatly increased the precipitation rate globally. In polar regions and on mountains the precipitation rate was sufficient to explain the formation of thick ice sheets and glaciers in less than 500 years.

Between 2008 and 2012 (Vardiman and Brewer, 2010a; 2010b; 2010c; 2011; 2012a; and 2012b) conducted fine resolution, regional simulations with a warm ocean during the ice age in Yosemite and Yellowstone National Parks, for hypercyclones in the Arabian Sea, hypercanes in the Caribbean and the Gulf of Mexico, and nor'easters off the east coast of North America. Simulations were conducted for SSTs up to 50°C (122°F) but results were not always reported for the hotter temperatures because the model became unstable. The simulations were conducted using the newer NCAR Weather Research and Forecasting (WRF) mesoscale model on the Institute for Creation Research (ICR) 44-node parallel computer system called EPIPHANY. The MM5 model had been superseded by the superior WRF model in 2008. This paper is a summary of the six papers reported in the *Answers Research Journal* from 2008-2012 by Vardiman and Brewer, a brief discussion of the conclusions from the simulations, and recommendations for

further research. For details not included in this summary please refer to the original publications cited in the references.

MAJOR RESULTS OF THE SIMULATIONS

Yosemite—(Vardiman and Brewer, 2010a; 2010b)

A warm, tropical storm during the Christmas holidays of 1996-97 called the *Pineapple Express* was successfully simulated. Simulations for warm sea-surface temperatures in the eastern Pacific Ocean were conducted to find how much precipitation in Yosemite National Park would have been increased by warmer sea-surface temperatures. Figure 1 shows the domain of the simulations in the southwestern United States with a 60° line perpendicular to the Sierra Nevada superimposed on Mt. Hoffman in Yosemite National Park. Figure 2 shows the accumulated precipitation for the simulated Pineapple Express storm as a function of temperature and position relative to Mt. Hoffman. Precipitation in the park was increased by as much as six fold at the highest temperatures.
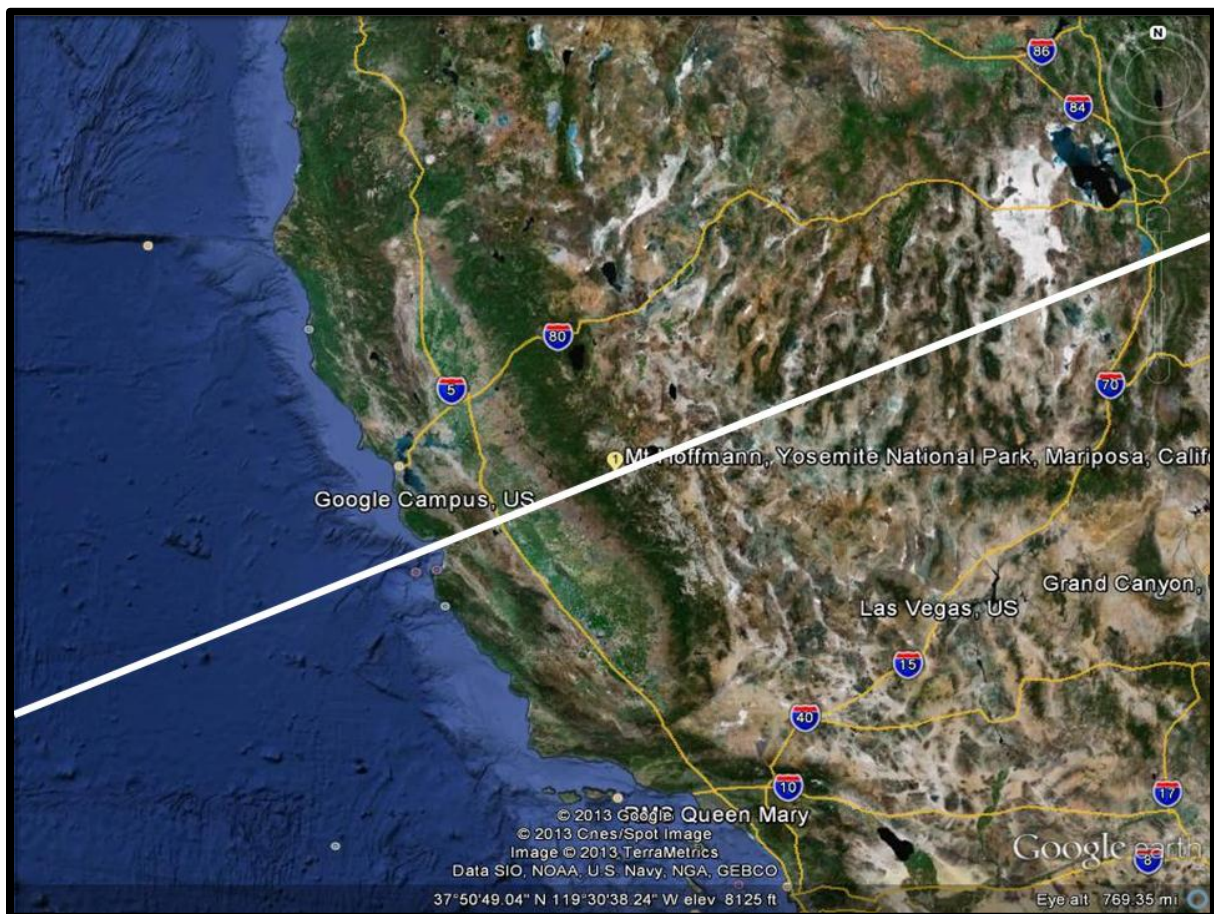

Figure 1. The domain of simulation for the Pineapple Express and Upper-level, low-pressure storms in Yosemite National Park. A 60° line is shown running from southwest to northeast through the center of the Park near Mt. Hoffman. [Google Earth]
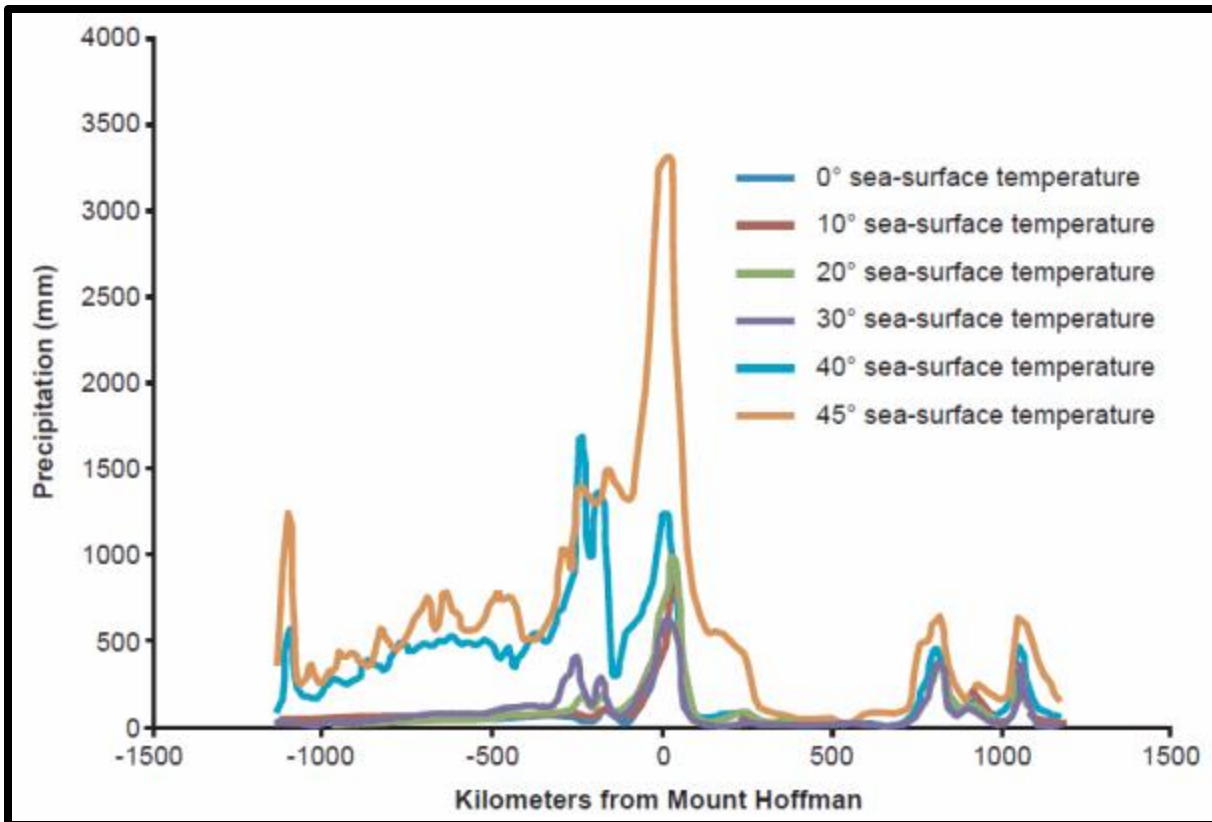
Figure 2. Accumulated precipitation for the simulated Pineapple Express storm as a function of temperature ($^{\circ}$C) along the line relative to Mount Hoffman near the crest of the Sierra Nevada in Yosemite National Park. [Answers Research Journal]

Two types of cold, winter storms were also successfully simulated and reported—a deep upper-level, low-pressure storm and a Rex-blocking pattern storm. Figure 3 shows the accumulated precipitation for the simulated deep upper-level low-pressure storm as a function of temperature relative to Mt. Hoffman. Warm SSTs also increased precipitation from deep upper-level, low-pressure storms in Yosemite National Park and throughout the Sierra Nevada by as much as a factor of six. Regions upwind and downwind of the Sierra Nevada were increased by factors of at least six for warm SSTs, but the magnitude of precipitation was only about 10% of that in the mountains. In addition, much of the precipitation in the valleys away from the mountains may have fallen as rain and would not have contributed to glaciers. Farther north and east on the plains of Canada and the Mid-western United States ice sheets would have formed where the temperatures were much colder.

A clarification is in order about the reference to rain in the preceding paragraph. The rain described in Genesis 7-9 was a heavy, global rain which occurred over 40 days and nights. Following the Genesis Flood any rain that fell was not global and of much less intensity. The snow and rain described in this paper for the ice age was after the Flood and regional in coverage.
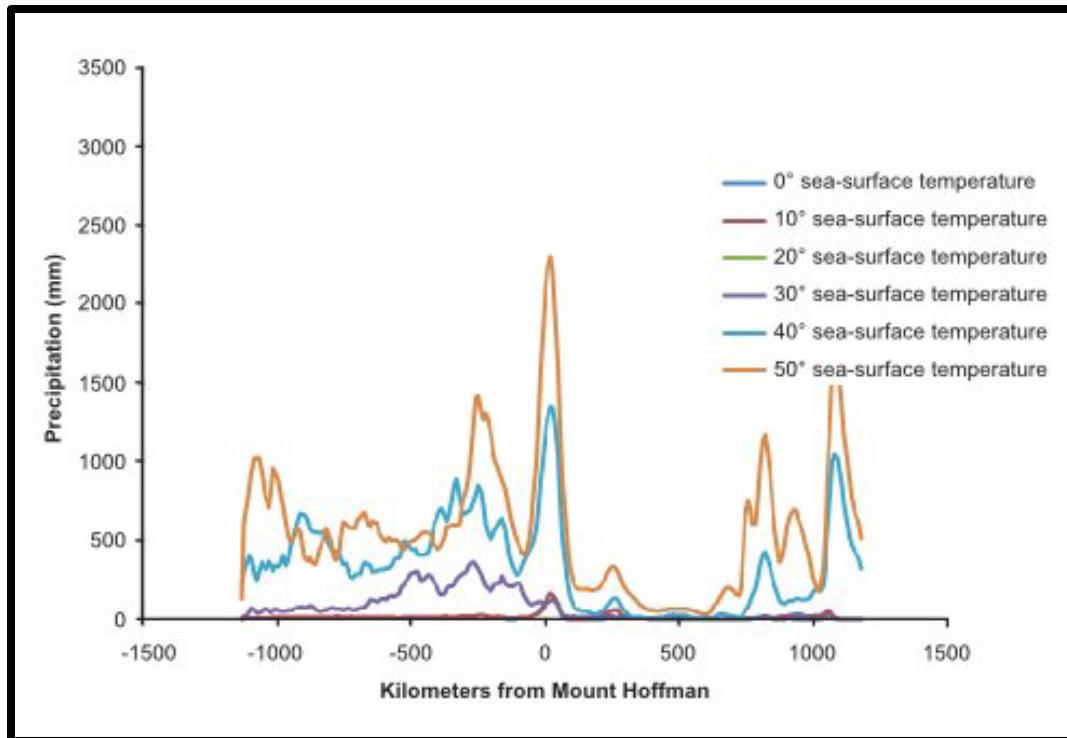
Figure 3. Accumulated precipitation for the simulated deep upper-level, low-pressure
Storm as a function of temperature (^{o}C) relative to Mount Hoffman near the
crest of the Sierra Nevada in Yosemite National Park. [Answers Research Journal]

Precipitation from the Rex blocking pattern storm for warm SSTs was also increased in the
Sierras by a factor of about 6. But, because of a series of factors (minimal enhancement of
precipitation by warm SSTs, intermittent occurrence of storms, limited coverage in the Sierra
Nevada, low frequency compared to deep upper-low type of storms, and the likelihood that Rex
blocking pattern storms did not occur during the ice age) we concluded that the enhancement of
Rex blocking pattern storms did not contribute significantly to glacial growth.

The enhanced snowfall and greater frequency of the deep upper-level, low-pressure storms
appears to be the primary explanation for glaciation in the Sierra Nevada during the ice age in a
young-earth time frame. Paleoclimatic studies indicate that the deserts of the southwestern
United States were much wetter in the past than today. Inland lakes in eastern California,
Nevada, Utah, and Colorado, many of which are now dry or at much lower levels, were full
during the ice age. It is believed that the normal track of the jet stream which steers storms across
the United States was about 1,600 km (1,000 miles) farther south causing more storms to dump
rain and snow on the southwestern mountains and deserts.

If 20 deep, upper-level, low-pressure storms and one Pineapple Express type storm crossed the
Sierra Nevada each year for 100 years during the ice age, the minimum depth of glaciers in
Yosemite National Park in a century was estimated to be at least 1.1 km (3,500 feet). The

enhanced snowfall and greater frequency of storms during the Ice Age appear to be adequate to explain glaciation in the Sierra Nevada in a young-earth timeframe. Glaciers in the mountains kilometers thick could have readily developed in only hundreds of years following the Genesis Flood.

Yellowstone—(Vardiman and Brewer, 2010c)

Glaciers kilometers thick would have also readily developed in the mountains of Yellowstone National Park during the hundreds of years following the Genesis Flood according to the simulations conducted on three types of winter storms—continuous zonal flow, a Gulf of Alaska low, and a plunging western low. The glaciers filled Yellowstone Lake, topped many of the mountains, and flowed down the canyons and valleys. The glaciers in Yellowstone were estimated to be a little shallower than the ones in Yosemite National Park. They were estimated to be a minimum of about 0.9 km (3,000 feet) thick for sea-surface temperatures warmer than 30°C (86°F) over the period of a century.

The continuous zonal flow storm and the Gulf of Alaska low storm produced the greatest amount of snow and dependence upon sea-surface temperature. Figure 4 shows the domain of the simulations in the northwestern United States near Yellowstone National Park along a 45° line running perpendicular to most of the mountainous features. Figure 5 shows the accumulated precipitation upwind and downwind of Yellowstone National Park as a function of sea-surface temperature for the Gulf of Alaska Low case.

Precipitation in the intermountain valleys and plateaus was significantly less, magnifying the difference in precipitation between the mountains and the valleys. This "rain shadow" effect not only occurred downwind of mountain barriers, but also within about 150 km (~100 miles) of the coastline. The cause for heavier precipitation near the Pacific Coast was hypothesized to be increased convection and rising motions in storms over the ocean, with descending motions inland.

These model results support the theory that an ice-free zone extended from north to south in western Canada and the northwestern United States during the ice age, separating the Cordilleran and Laurentide ice sheets and allowing migration from Beringia during the ice age into the North American continent. The difference from the conventional theory of glacier formation is that it happened in just a few hundred years after the Genesis Flood because of the extreme precipitation rates produced by the warm oceans.
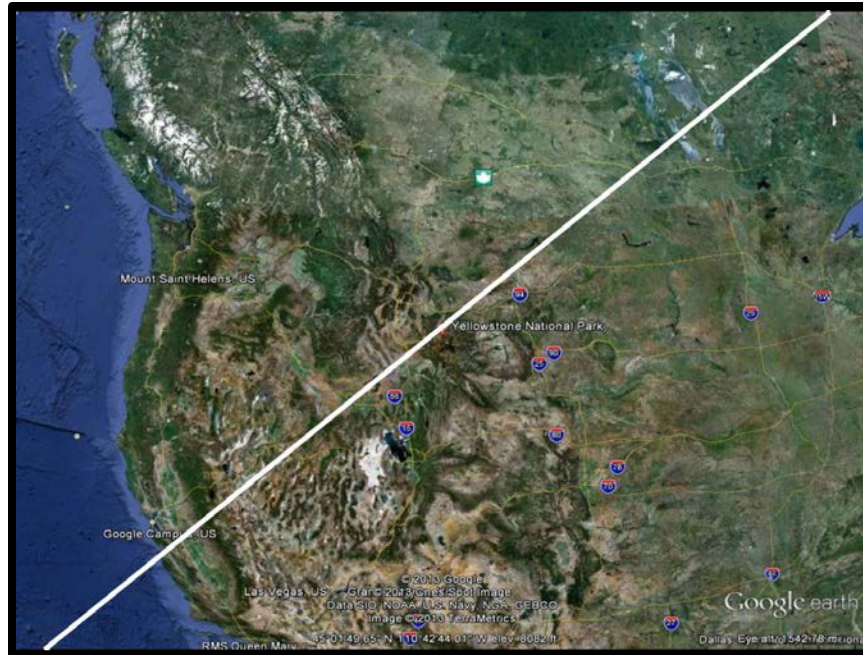
Figure 4. The domain of simulation for the Gulf of Alaska Low case in Yellowstone National Park. A 45° line is shown running from southwest to northeast through The center of the Park. [Google Earth]
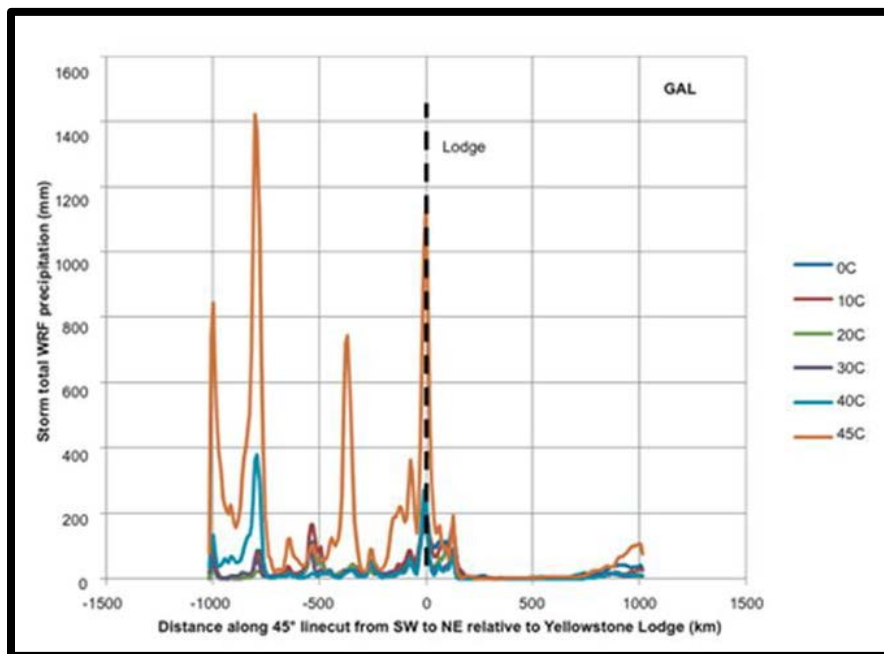

Figure 5. Accumulated precipitation as a function of sea-surface temperature ($^{\circ}$C) relative to distance from the center of Yellowstone National Park for the Gulf of Alaska Low case. The distance runs from southwest to northeast along a 45° line centered on Yellowstone Lake Lodge in the Park. [Answers Research Journal]

Hypercyclones in the Arabian Sea—(Vardiman and Brewer, 2011)

Two cyclones were successfully simulated in the Arabian Sea—Typhoon Gonu in June, 2007 and a nondescript typhoon in June, 2002; identified as TS01a. The size, intensity, path and precipitation from the two cyclones were studied for warm sea-surface temperatures. It was anticipated that the cyclones would simply increase in size and intensity for warmer temperatures but generally follow a path similar to the original cyclones as (Zavacky, 2002) and (Vardiman, 2003) had found for Hypercane Florence in the Gulf of Mexico. More precipitation was expected along the wider and longer paths of the enhanced cyclones as they died out in the surrounding deserts. But, a much larger effect was found. Figure 6 shows the domain of the simulations of Typhoon Gonu and TS01a in the Middle East centered over central Saudi Arabia.
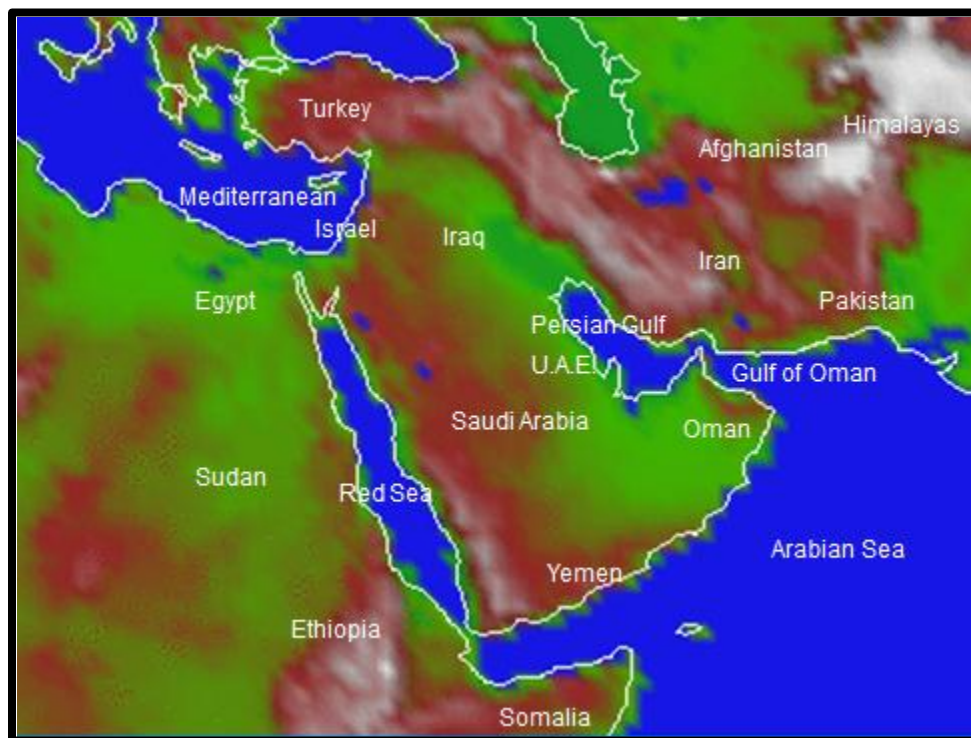

Figure 6. The domain of the simulations of the typhoons in the Middle East centered
on the center of Saudi Arabia. The typhoons approached from the southeast
and made landfall in Oman. [Answers Research Journal]

The warmer Arabian Sea simulated in these studies 1) intensified the cyclones into massive hypercyclones; 2) created large counterclockwise, low-level circulations over the entire Middle East; 3) produced high relative humidity over the Gulf of Oman and the eastern Mediterranean; 4) caused intermittent high relative humidity over all the deserts of the Middle East; 5) precipitated heavy rain over the Arabian Sea and Pakistan; 6) precipitated moderate rain in Egypt, Israel, the Red Sea, Oman, Iran, and Afghanistan; and 7) precipitated light rain throughout the Middle East, watering the deserts.

Figure 7 shows the winds at 5 km (~16,400 feet) above sea level 17 days after the sea-surface temperature in the Arabian Sea during Cyclone Gonu was heated to 40°C (104°F), about 10°C (18°F) warmer than normal. A large counterclockwise circulation centered over Saudi Arabia of about 50 m/s (100 knots) formed and moved smaller circulations (hypercyclones) over the deserts of the Middle East. Note the new hypercyclone over Egypt which moved southward along the west coast of the Red Sea.

Figure 7. Wind speed at 5 km (~16,400 ft) altitude at 00Z on Tuesday, June 19, 2007. Scale is in m/s and contours at intervals of 20 m/s for Hypercyclone Gonu. [Answers Research Journal]

Figure 8 shows the accumulated precipitation over the Middle East for 18 days after the sea-surface temperature was heated. Note the heavy precipitation >760 cm (300 inches) over the Arabian Sea extending inland over Karachi, Pakistan and the lighter precipitation 38 cm (15 inches) over all the deserts of the Middle East.

Throughout the Middle East, these simulations produced much wetter conditions than are now present. There are places in the deserts of North Africa and Saudi Arabia today where no rain has fallen for decades. The only vegetation in these deserts is found at oases located at the foot of wadis or near subterranean sources of water. When occasional rain falls, vegetation springs up quickly, but only lasts for a short time. Under the conditions simulated in this study, it is likely that permanent vegetation would have covered most of the sand and rocky soil in these regions. Hints of historical well-watered lands in Israel and throughout the Middle East seem to be borne out if catastrophic events of the Genesis Flood are taken seriously.
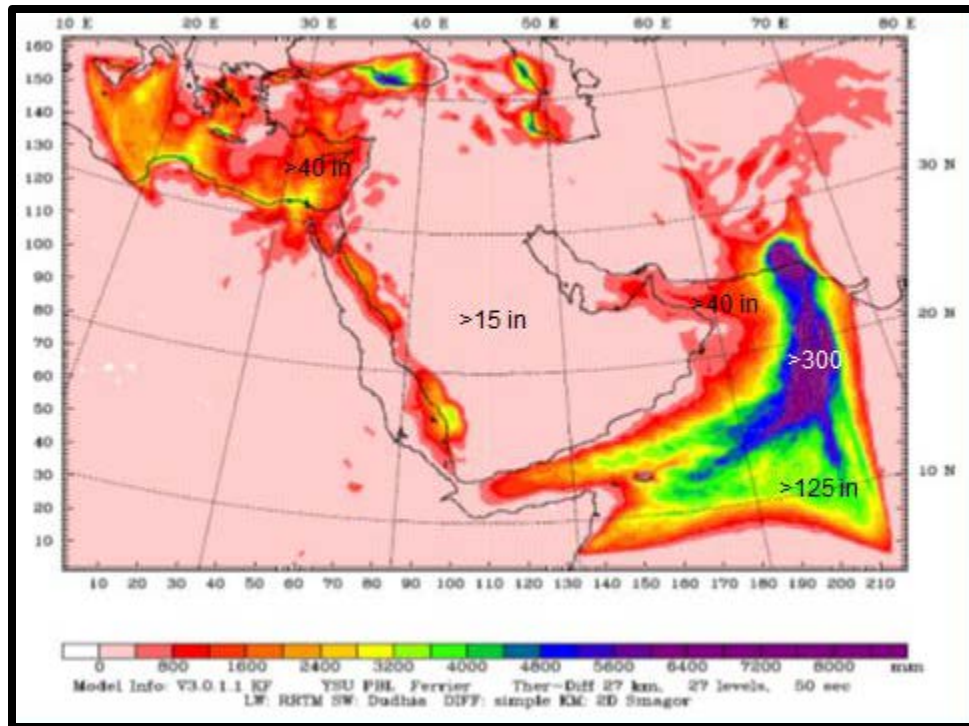
Figure 8. Accumulated precipitation from 00Z, Saturday, June 2 to 00Z, Wednesday, June 20, 2007 for Hypercyclone Gonu. The colored scale and contours are in mm. [Answers Research Journal]

Hypercanes in the Caribbean and Gulf of Mexico—(Vardiman and Brewer, 2012a)

Two tropical cyclones which crossed Florida (Hurricane Charley in 2004 and Tropical Storm Fay in 2008) were simulated using the observed sea-surface temperatures and found to behave closely to the observed tracks and intensities. Hypercanes Charley and Fay were then simulated at elevated sea-surface temperatures of 40°C (104°F) and found to behave entirely differently. Figure 9 shows the domain of the simulations of Charley and Fay centered on Punta Gorda, Florida.

Hypercane Charley

Hurricane Charley was a category 4 hurricane [winds between 56 – 68 m/s (113-135 knots)] that passed over Port Charlotte and Punta Gorda on its way northward over Florida on August 9-15, 2004. The NCAR WRF model was used to simulate Hurricane Charley using observed weather conditions to insure that the model accurately duplicated its intensity and path. The sea-surface temperature was then increased to 40°C (104°F) to simulate a hypercane. A hypercane is an extreme hurricane which would likely develop over hotter sea-surface temperatures present following the Genesis Flood. Simulated Hypercane Charley reached a maximum wind speed of about 80 m/s (160 knots). However Hypercane Charley was incorporated into a much larger

circulation which formed along the entire southern and southeastern coasts of the United States. The temperature difference between the warm ocean surface and the cooler continental surface caused a counterclockwise circulation to develop and strengthen off the East Coast of North American during the 6 days of the simulation.
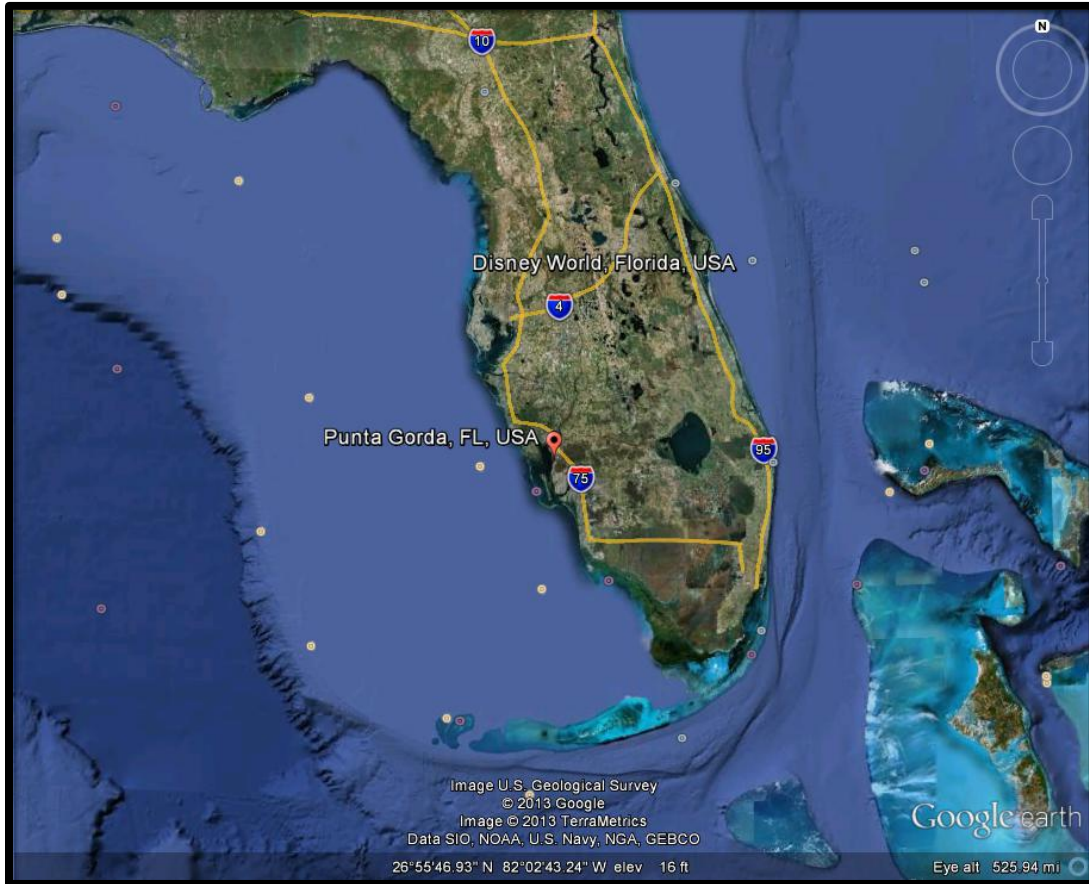

Figure 9. Domain of the simulations for Hurricane Charley and Tropical Storm Fay centered on Punta Gorda, Florida. [Google Earth]

Figure 10 shows the horizontal wind speeds for simulated Hypercane Charley at 5 km (~16,404 feet) above sea level on August 15, 2004, 6 days after the sea-surface temperature was heated to 40°C (104°F). Simulated Hurricane Charley developed from a tropical wave moving westward across the Atlantic and grew into a hurricane near Jamaica but changed its westerly direction of movement to a northeasterly direction when the sea-surface temperature was increased. It was steered by the southeasterly leg of the counterclockwise flow off the west coast of the United States and was incorporated into a major center of circulation off the coast near New York City. Several other counterclockwise centers of circulation developed in the Caribbean and in the Gulf of Mexico and grew into hypercanes, and even in the Pacific Ocean off the coast of Mexico. These centers tended to remain near their source of heat and water vapor in the ocean. Over the continental southeastern United States the return flow was on land from the northeast forming a

doughnut-shaped flow centered on the eastern Gulf of Mexico and Florida. In this "hole" winds were light. The most intense region of the circulation occurred near New York where winds reached 80 m/s (160 kts) as the wind turned around the northeast corner.
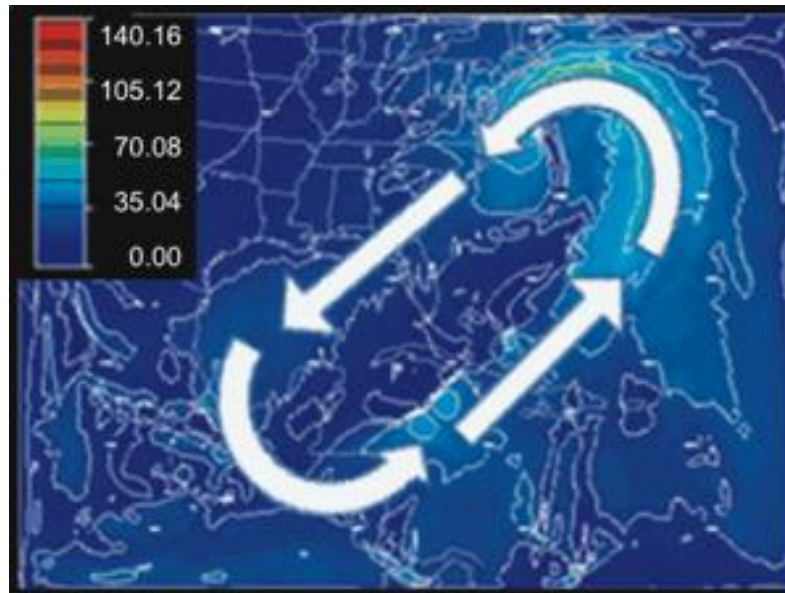

Figure 10. Wind speed at 5 km (16,404 ft) above sea level for Hypercane Charley at 18Z (1400 EDT) on Sunday, August 15, 2004. Scale is in m/s and contours are in 10 m/s (20 knot) intervals. Arrows signify wind direction. [Answers Research Journal]

Figure 11 shows comparisons of the observed, simulated, and hypercane tracks for Charley. The tracks for the observed (x) and simulated (o) cases of Hurricane Charley agreed fairly well. However, for the hypercane case (■) the track diverged strongly to the east. It was steered by the strong southerly winds which developed off the east coast of the United States when the sea-surface temperature was increased. The hypercane moved to a final position off the North Carolina/Virginia coast and remained trapped at the top of the broader circulation formed by the large temperature contrast between the land and the Atlantic Ocean.

The development of superstorms like Hypercane Charley over warm oceans is important because its helps us understand conditions after the Genesis Flood. The heavy winds and precipitation from hypercanes contributed to erosional features of unconsolidated sediments on the continents. It took many years for trees and vegetation to stabilize the soils and prevent heavy rain from eroding upper layers, cutting valleys, and depositing plains. Such hypercanes would also contribute to heavy snowfall to ice sheets along the Northeastern Coast of North America and other locations in the world where they would travel onto the continents.
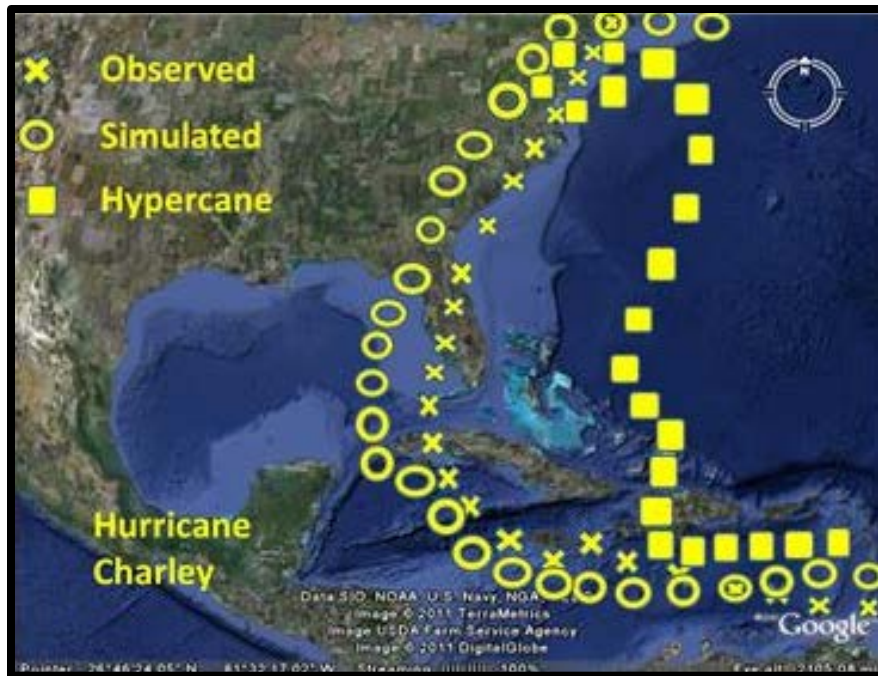
Figure 11. Comparison of the tracks of observed, simulated, and hypercane cases for Hurricane Charley. [Answers Research Journal]

Tropical Storm Fay

Figure 12 shows the results of the simulations for Tropical Storm Fay and Hypercane Fay. The observed and simulated tracks of Tropical Storm Fay diverged in northern Florida. Because tropical storms are not as strongly organized as hurricanes there tracks tend to be more erratic and respond to small changes in the wind field. It's likely that the simulation of Tropical Storm Fay didn't maintain wind fields sufficiently close to the actual conditions to duplicate Fay's track. Hypercane Fay moved in a northwestward direction into the Gulf of Mexico and did not turn northward across Florida like Tropical Storm Fay. Hypercane Fay took up residence in the Gulf of Mexico and formed a major center of circulation for several days. This probably was due to the major change in circulation over the entire East Coast because of the increased temperature contrast between the ocean and continent. A large center of circulation formed off the East Coast of the United States and a secondary circulation intensified in the Caribbean. Winds reached a maximum of 70 m/s (140 knots) in the small circulation in the Gulf of Mexico and 90 m/s (180 knots) in the large circulation off the East Coast of the United States. These large circulations controlled the tracks of tropical storms growing into hypercanes at different locations along the coastline.

Although the counterclockwise circulation off the southern and southestern coasts of the United States developed more slowly and with a slightly different shape for Hypercane Fay than for Hypercane Charley, it contained many of the same features—a large elongated, doughnut-shaped circulation with a northeasterly flow on the southeast side, a southwesterly flow on the

northwest side, and a center with light winds in the "eye" centered over the eastern Gulf of Mexico and Florida.
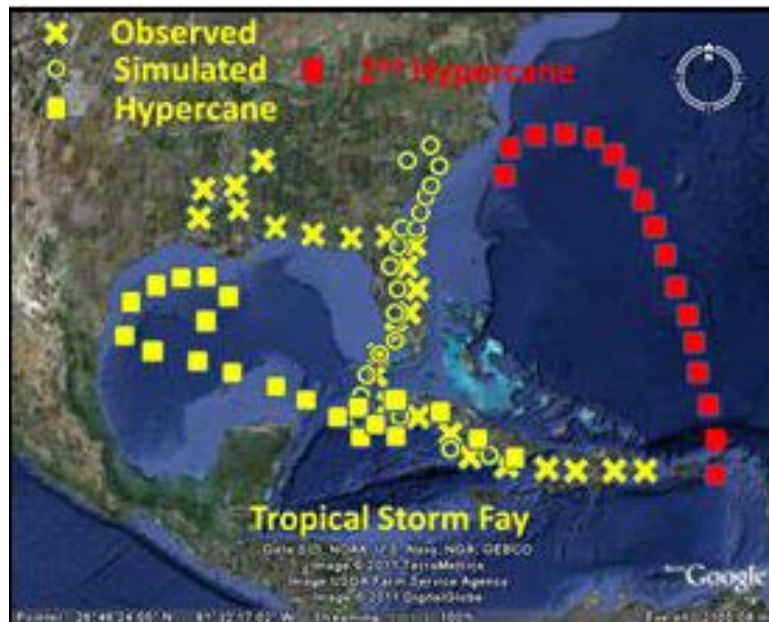

Figure 12. Comparison of the tracks of observed, simulated, and hypercane cases for Tropical Storm Fay. [Answers Research Journal]

It's likely that Hypercane Fay continued its northwestward movement into the Gulf of Mexico during the development of a large-scale circulation because it was about 1,600 km (1,000 miles) farther west when the sea-surface temperature was warmed. Hypercane Fay was near the west end of Cuba when the sea-surface temperature was warmed and Hypercane Charley was south of the Dominican Republic. In both cases their paths were redirected and did not cross Florida. Previous simulations by (Vardiman, 2003) found that small-scale heating of the sea-surface temperature just beneath a hurricane caused it to simply increase in size and intensity but follow the same path as the original hurricane. Consequently, it appears that the location and size of the increased sea-surface temperature patterns strongly affect the wind fields and the movement of hypercanes. The hotter sea-surface temperatures which existed for many years following the Genesis Flood probably greatly increased the size and intensity of hurricanes. And the increase in temperature contrast between the ocean and the continents after the Flood also likely created major differences in wind fields which changed the trajectories of hypercanes as they approached land.

Nor'easters—(Vardiman and Brewer, 2012b)

Numerical simulations were conducted on three recent nor'easters which formed on the East Coast of the United States—two in the spring of 2007 and one in the winter of 2010. The

simulated cases matched the observed cases well. The sea-surface temperature of the Atlantic Ocean, the Gulf of Mexico, and the Caribbean were then heated to 40°C (104°F) and winds and precipitation were found to greatly increase. All three cases showed similar results with only minor differences due to the orientation and intensity of the jet stream. Results for only the March, 2007 St. Patrick's Day nor'easter will be shown. Figure 13 shows the domain of the simulated nor'easters centered on Washington, D.C.
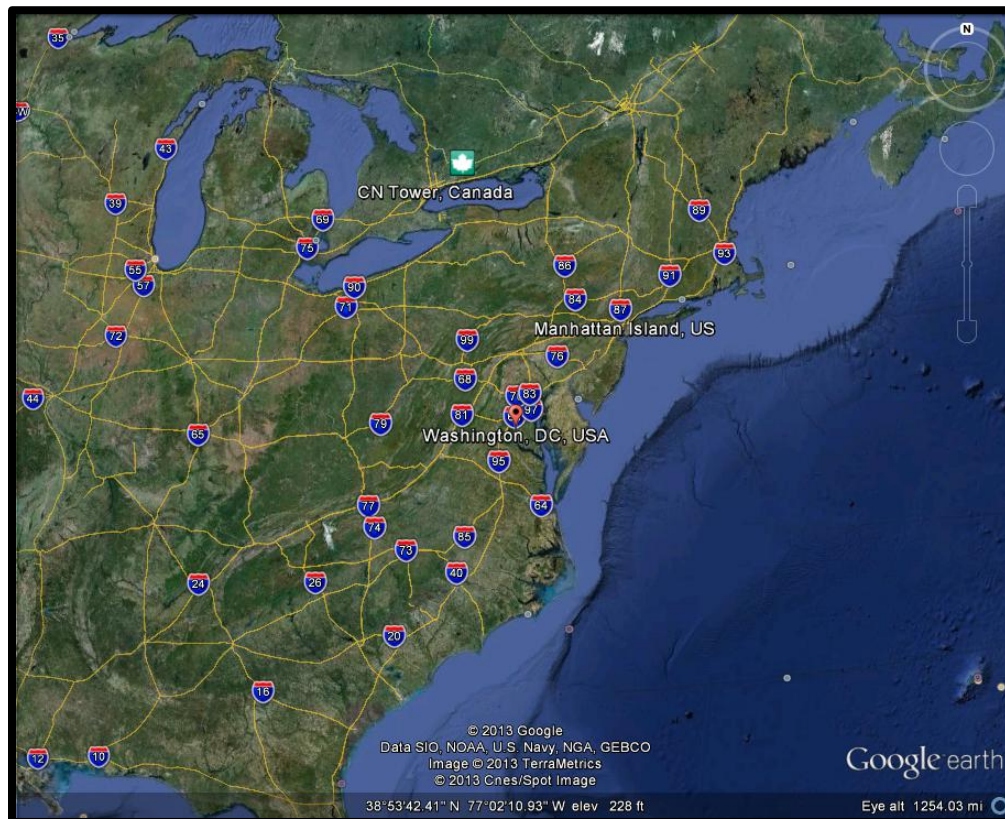

Figure 13. The domain of the simulations for the nor'easters centered on Washington, D.C. [Google Earth]

Figure 14 shows the wind speed at the 1.5 km level (~5,000 ft.) at 20 m/s (40 knot) intervals for the enhanced March, 2007 St. Patrick's Day nor'easter. A high-speed counterclockwise circulation developed off the southeastern coast of Canada and all along the east coast of the United States for the warm sea-surface temperature. Winds were from the northeast along the entire coastline from eastern Canada to Florida. The wind speed exceeded 60 m/s (120 kts) in the Atlantic which was equivalent to a category 4 hurricane. A similar wind pattern along the east coast was found by (Vardiman and Brewer, 2012a) for hurricanes near Florida when enhanced by warm sea-surface temperatures.

Notice that a strong northerly wind flowed over the Great Lakes into the mid-western United States as part of the outer circulation. The wind speed in the main circulation was up to three times that of the actual storm. In addition, the center of the circulation was farther out to sea and farther north than that in the actual storm. Over land the main storm intensity occurred over Quebec and Newfoundland rather than near North Carolina and Virginia as occurred in the actual storm. Severe blizzard conditions would occur under such conditions.

It is possible that the boundaries of the model simulation may have artificially influenced the circulation patterns, particularly near the eastern boundary. Air can flow through the boundaries of the model, but other effects such as pressure, temperature, and divergence interacting with the boundary may have caused some of the irregularities. The most likely cause for such an artificial influence may have been that the warmer sea-surface temperature was specified for a domain that extended only halfway across the Atlantic Ocean. One way to mitigate these effects, if they exist, would be to enlarge the domain to include the entire Atlantic.
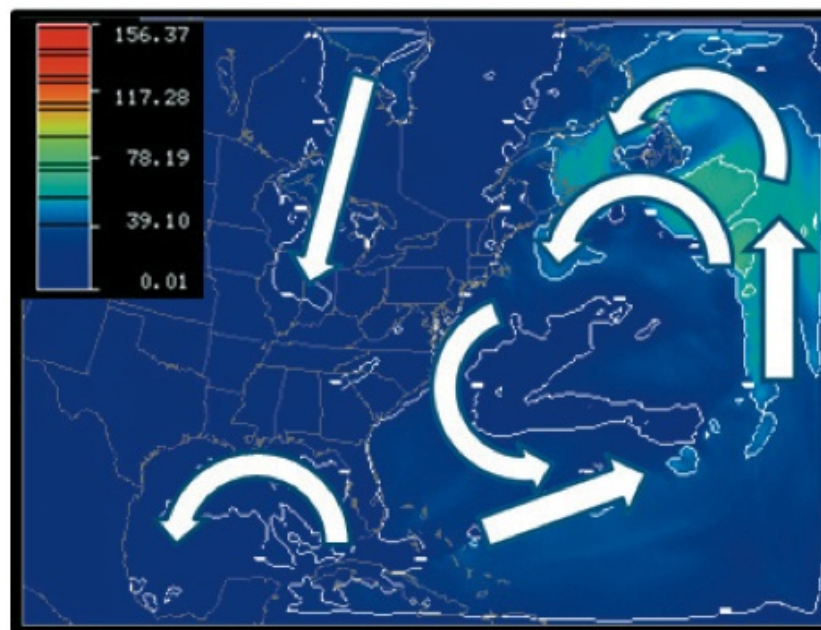

Figure 14. Wind speed at 1.5 km (~5,000 ft above sea level) for the enhanced St. Patrick's Day nor'easter with sea-surface temperature equal to 40°C (104°F) at 1200 UTC (0700 EST) on Saturday, March 17, 2007. Scale is in m/s and contours are in intervals of 20 m/s (40 knots). [Answers Research Journal]

Fig. 15 shows the accumulated precipitation over a 12-hour period on March 17, 2007 for the enhanced St. Patrick's Day nor'easter. Most of the heaviest precipitation occurred far off the east coast in the Atlantic where the storm dynamics were the strongest. The accumulated precipitation

exceeded 1,000 mm (~40 in) water equivalent per 12 hours in several locations over the ocean. The precipitation exceeded 50 mm (~2 in) water equivalent per 12 hours generally over most of eastern North America except in the southern states. In addition, precipitation exceeded 120 mm (~5 in) water equivalent per 12 hours over and around Maine and over 500 mm (20 in) water equivalent east of Boston during the first 12-hour period ending on March 17, 2007. The model calculations showed that over 500 mm (20 in) of snow would have fallen during 24 hours of the enhanced storm over all of Canada and the northeastern United States. This was about the same amount of snow that fell in the actual storm along the east coast. However, the enhanced storm covered all of Canada and the northeastern states rather than just along the coast. In addition, the enhanced storm would have produced 1,200 mm (~50 in) of snow in Maine and Quebec, over twice as much as the actual storm.
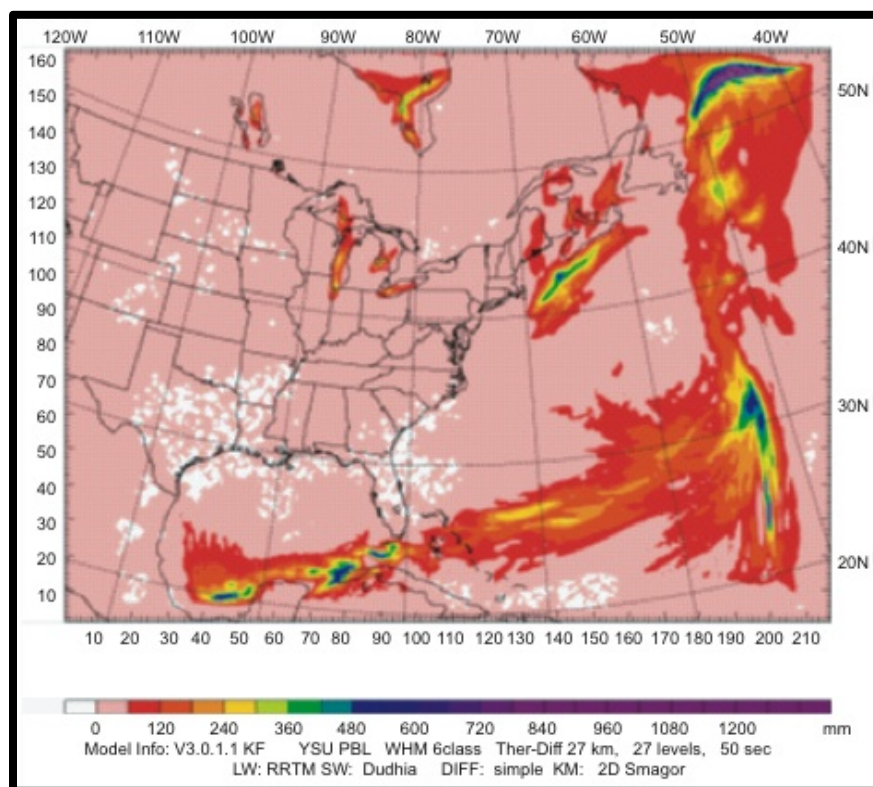

Figure 15. Simulated12-hour accumulated precipitation for the enhanced
St. Patrick's Day nor'easter in mm (~0.04 in) ending at 0000 UTC
on Saturday, March 17, 2007 for a sea-surface temperature equal
to 40°C (104°F). [Answers Research Journal]

When the surface temperature of the Atlantic Ocean was warmed to 40°C(104°F) all three nor'easters were invigorated, wind speeds were increased, new circulation patterns emerged, and precipitation was increased and redistributed. In one of the enhanced cases the winds exceeded a category 5 hurricane. Even with the heaviest precipitation falling over the Atlantic Ocean in

these simulations, the widespread lighter precipitation of about 4 inches per 24 hours over land would have contributed to a significant accumulation of snow during the ice age.

(Vardiman and Brewer, 2010c) suggested that during the ice age following the Genesis Flood a storm formed and moved across the United States every three days all year round. This would have produced an uncompressed snow pack in the northeastern United States of about 61 m (200 feet) per year. Upon compression to solid ice an ice layer would have grown to about 1.2 km (4,000 feet) in 100 years. If bands of additional precipitation were swept around the centers of circulation of enhanced nor'easters off the coast of New England, the accumulation would have been even greater. The additional snow would explain the evidence for a thick Laurentide ice sheet in eastern Canada during a recent ice age.

CONCLUSION

The NCAR WRF model did an excellent job of simulating mid-latitude winter storms on the West Coast of the United States, nor'easters on the East Coast, and tropical cyclones in the Caribbean and the Arabian Sea. Wind speed and precipitation were dramatically increased for all cases when the sea-surface temperature was increased to 40°C (104°F), as much as a six-fold increase in precipitation in several cases. Tropical cyclones increased in intensity to become hypercyclones and their tracks significantly altered. Nor'easters were greatly intensified. In addition, intense regional-scale, counter-clockwise, low-level circulations developed on the East Coast of North America and over the Middle East when the temperature contrast between the continental and ocean surfaces was increased. Heavier precipitation fell over the Middle East.

These simulations showed that increased sea-surface temperature was the likely cause of the ice age. Heavy snow in the mountains of the western United States and northeastern North America explains the evidence for glaciation found in these locations. The deserts of Egypt, Saudi Arabia, Turkey, Israel, Iraq, and Iran would have been much wetter for many years after the Genesis Flood.

The model was less successful when simulating these storms for prescribed sea-surface temperatures greater than 40°C (104°F). The greatest uncertainty in the simulations was the effects of prescribed temperature domains on large-scale circulation patterns near coastlines. The prescribed domains of sea-surface temperatures for simulations of nor'easters, hurricanes in the Caribbean, and typhoons in the Arabian Sea may have been too small. The errors are not thought to be major, but are worrisome.

It is recommended that some of these simulated cases be rerun for larger prescribed sea-surface temperatures domains. A better way to conduct these simulations would be to define a larger domain which contains uniformly warm sea-surface temperatures over the entire Atlantic and

Indian Oceans. It may also be worth rerunning some of the West Coast winter storm cases as well with a larger domain that contains the entire Pacific Ocean, although these cases are not thought to have been affected as much by this affect.

It would also be useful to conduct global simulations with the NCAR WRF model. However, the grid point spacing should be kept small like that used in studies conducted by Vardiman and Brewer if adequate data storage and fast computers can be acquired.

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