Earthquakes Linked to 2003 European Heat Wave: Implications for Global Warming - Evidence in the Adriatic and Mediterranean Basins (Revisited)

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ABSTRACT

New evidence reveals: 1.) Clustered earthquake patterns at the base of the lithosphere/upper mantle concentrated mostly within the ocean basins. 2.) Followed by Sea Surface Temperature (SST) anomalies hypothesized to originate from underlying magma generation and seafloor heat release during hydrothermal venting. Joule heating at the base of the lithosphere created from electrical emanations deep within the core-mantle-boundary manifest as clustered earthquakes could provide the driving mechanism for elevated temperatures. Clustered earthquake swarms at 10km depths, which burst pulse over short, several days- to week-periods appear correlated to subsequent Sea Surface Temperature (SST) anomalies and a reversal in Adriatic Sea circulation. Authors suggest this and other like events may be the natural drivers of global warming.

Keywords: Earthquakes, Sea Surface Temperature Anomaly, Heat Wave, Adriatic, Global Warming.

1. INTRODUCTION

Sea Surface Temperature (SST) anomaly patterns lag earthquake clusters consistent with studies on thermal energy migration rates. Thermal transfer rates above 33km depths were determined at 0.15km/day [1, 2]. Thus, heat transfers from 10 km depths in the Adriatic and Mediterranean regions take about 67 days or 2 months, which is consistent with approximate timing of subsequent SST anomaly patterns. The timing of these events appears directly correlated to changes in Adriatic circulation and the anomalous heat wave in the 2003 European summer. Thermal energy from Adriatic events are hypothesized to have triggered a two-week reversal of ocean circulation patterns in the Adriatic. The circulation changed from counterclockwise to clockwise, consistent with an anomalous burst of geothermal flow. These shallow (base of the lithosphere) clustered earthquakes found in National Earthquake Information Center[1] (NEIC) data sets are compared to National Ocean and Atmospheric Administration (NOAA) SST satellite anomaly data[2].

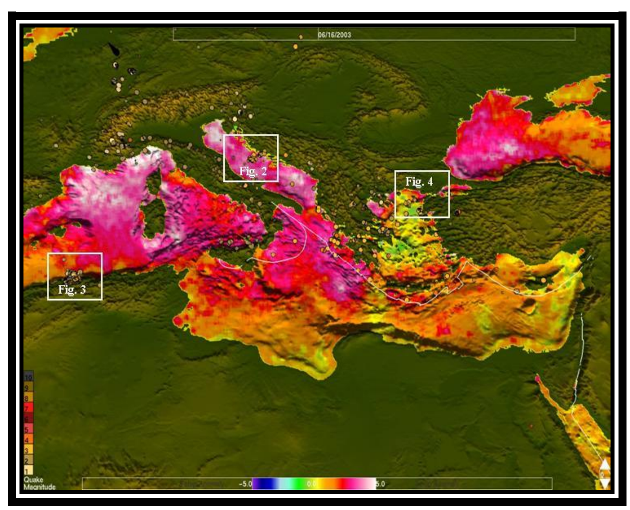

Figure 1. Mediterranean SST Anomaly Map Indicating 2003 Summer Heat Wave. Adriatic Inset - Fig. 2. North African Inset -Fig. 3. Turkish Straits Inset –Fig. 4. (Climate Scope)

[1] http://neic.usgs.gov/

[2] http://www.osdpd.noaa.gov/PSB/EPS/SST/climo.html

2. CASE STUDIES

Adriatic (Figs. 1a-d), North African (Figs. 2a-d, Algeria) and Turkish Strait (Figs. 3a-d) earthquake events in 2003 had SST anomaly lag periods of months, weeks, to no lag period respectively (Table -1). The differing time lags are likely related to thinner crust, shallower focus earthquakes (NEIC data indicate 10km depths), or lithosphere facture zone (North Anatolian Fault) connectivity to the surface as evident in the Turkish Strait event.

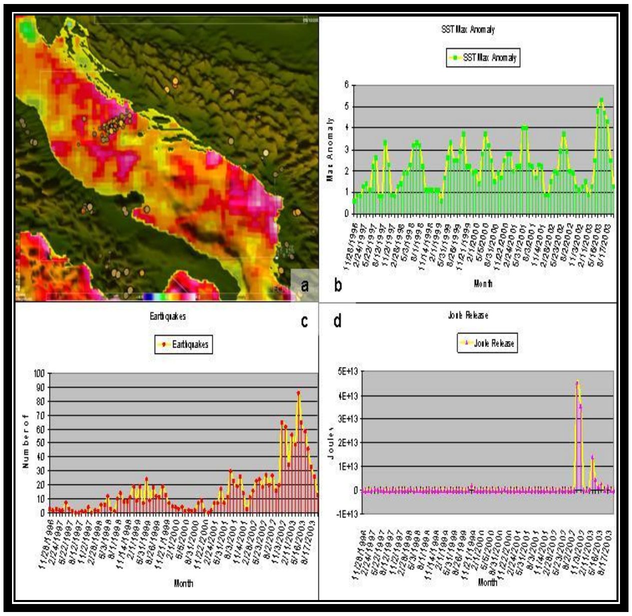

Figure 2(a). Adriatic earthquakes and anomalous SST's May 2003. (b). SST Max. Anomaly/month indicating anomalies > 5° C lasting several months in 2003. (c). Following earthquake events beginning late 2002 and early 2003. (d). Coincident joule energy release. (Climate Scope)

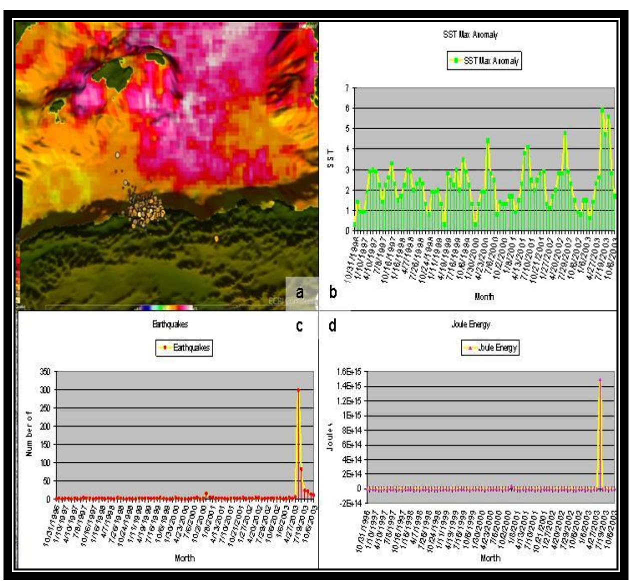

Figure 3(a). North African (Algerian) earthquakes and SST's during June 2003. Note: Max SST Anomaly trend in white strikes northeast directly away from earthquake cluster. (b). SST Max. Anomaly/month indicating anomalies > 5° C lasting months in 2003. (c). Following earthquake events in May 2003. (d). Coincident joule energy release. (Climate Scope)

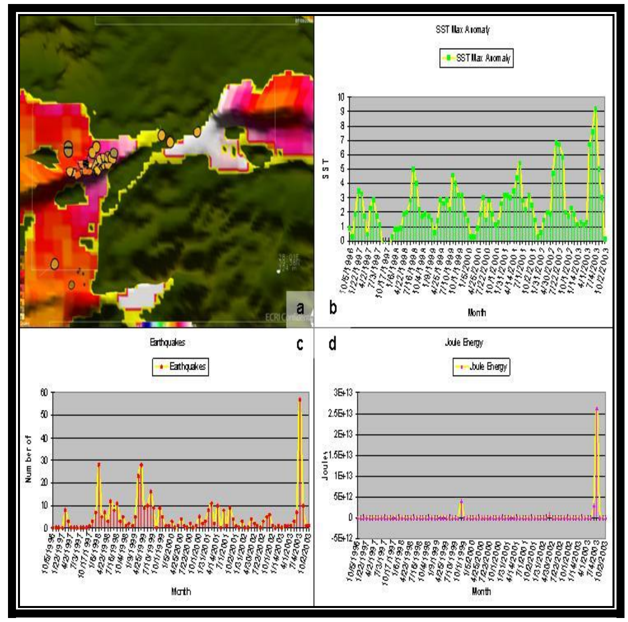

Figure 4(a). Earthquakes to the west and simultaneous SST anomalies east and south of Turkish Straits along the North Anatolian Fault system. (b). SST Max. Anomaly/month indicating an anomaly > 9° C in July 2003 occurring simultaneously. (c) Earthquake events in July 2003. (d). Coincident joule energy release. (Climate Scope)

Table -1.

Area	EQ Begin	SST Begin
Adriatic	27 Mar 03	2 Months
North Africa	21 May 03	< Month
Turkish Strait	May-June 03	Immediate

3. DATA AND METHODOLOGY

Multi-Channel Sea Surface Temperature (MCSST) data derived from the 5-channel Advanced Very High-Resolution Radiometers (AVHRR) on board the NOAA -7, -9. -11 and -14 polar orbiting satellites are weekly averaged for both the ascending pass (daytime) and descending pass (nighttime). Each daily measurement of MCSST (Multi-Channel Sea Surface Temperature) data is filtered to subtract the historical average or mean (Reynolds climatology), showing anomalous temperatures associated with events such as El Nino. MCSST data exists wherever a grid cell is located over water and NASA's satellite imagery is used in all grid cells over land. The resultant image shows real world imagery over land and color-mapped sea surface temperatures over water bodies. The color ramp uses the high intensity white, reds and oranges to indicate warmer temperatures and blues and greens to indicate cooler temperatures. This data is processed daily by the Naval Oceanographic Office's - Warfighting Support Center (WSC). Processed grids are automatically transferred to servers maintained by the Major Shared Resource Center (MSRC) for conversion into imagery. This processed data was also provided in bulk to our researchers for the 1996-2003 interval displayed in data mining applications developed for Earth Climate Research Institute (ECRI) scientists.

Data mining software technology (Climate Scope) developed by Haas, 2003) allows the end user to interactively explore time series data such sea-surface temperature and seismic information in a user-friendly environment, enabling simple on-the-fly visualization and analysis of time-varying oceanographic events within global-scale data. Data is assimilated into a fluid 3-D landscape that includes hi-resolution bathymetry, satellite imagery, and geospatial boundaries such as plate boundaries. In its general form, ClimateScope™ has broad applications for time varying 1-D point data sets (such as seismic points) and 2-D area data (such as temperature) displayed with respect to 3-D elevation. This application reads web-based text output from the NEIC database. The data represents earthquake epicenter locations displayed in real time and allows one to correlate the seismicity with bathymetry and SST anomaly data. Statistics are also collected about the data within the user's field-of-view. As the visualization progresses in time, statistics about the current levels of seismic energy (See: Joule Energy Calculation) and temperature anomalies are printed line-by-line, simultaneously animated, and the time series are statistically tracked in regional areas over static bathymetry data making interrelationships between data sets more obvious. Any range of the printed statistics can then be selected and pasted into separate spreadsheet or other plotting applications. The concept is based upon modern storage technology coupled with standard accepted data processing procedures in a portable, extensible fashion. This allows analyst to interactively "mine" the data. Data are assembled adhering to industry and international standards. The system consists of hardware, data, and software designed to demonstrate data mining concepts with insights into tectonic climate modulation and global warming.

The Joule Energy Calculation used in the data mining technology uses calculations from[3] U. S. Geological Survey Open-File Report 98-767. "In seismology, the energy of the vibrations produced by an earthquake can vary enormously. The total energy of the seismic waves generated by the smallest earthquake that could be located by a local network of seismometers is about 2,000 joules (J). The largest earthquake ever recorded released 11,200,000,000,000,000,000 J of energy as seismic waves and was observed on seismometers all around the World. As you can imagine, it is not very convenient dealing with numbers that have such a large range. On the Richter magnitude scale, the magnitude of a 2,000 J event is minus 1.0 while the magnitude of the largest recorded earthquake was 9.5. The relationship between earthquake energy and magnitude is said to be logarithmic because the equation relating energy and magnitude includes a logarithmic term. For energy, E, in joules, the equation is: log E = 1.5 M + 4.8 (this is log to the base 10). Or expressed another way: E = 10 raised to the power (1.5 M + 4.8) Or: Magnitude, M = (log E - 4.8)/1.5."

4. HEAT AND CO_2 BUDGETS

ECRI calculations indicate that episodic thermal plumes appear capable of yielding energy on the order of 60,000 MW (mega heat-plumes) and hence could easily explain observed SST anomalies. Plumes containing 10^{12} to 10^{14} J/s are able to rise from a depth of 4-5 kilometers to the ocean's surface. Heat fluxes of this magnitude represent temporally varying boundary conditions. Such events would be expected to impact climate, ocean circulation, atmospheric, and ocean acoustic propagation. Episodic hydrothermal source heat could well explain the entire ocean basin warming since 1955. "~ 60% of the entire release of endogenous energy is manifested like geothermal heat flow… an estimate of the total energy released from 1955 through 1995… [is] 9.76 x 10 to 22 Joules i.e. ~ 10 to 23 Joules… the error bars are very large and basically unknown… the prime heat supply to Etna and Vesuvius increased by ~ 500-600% during the last ~ 5 centuries. That is if you make an average over ~ 5 centuries, you get a value that is ~ 2.5 - 3 times smaller than the present actual prime heat supply to such volcanoes…since the ~7.54 x 10 to 23 W value was estimated by using averaged data, and since the Earth seems to be at present still in the increasing side of a heartbeat, for sure the estimated ~ 10 to 23 Joule value that I inferred is a lower (rather than an upper) limit, a reasonable guess being ~ a few times to (more likely) several times 10 to 23 Joules." [4] Episodic heat flux shift thermocline depths, alter ocean currents, significantly change seawater properties such as salinity, dissolved gases, mineralization, and generate environments that can either be conducive to or hostile to the growth and distribution of biological organisms (i.e. plankton).

According to Owen and Rea (1985) [3]:

> "Our calculations indicate that sea floor hydrothermal activity is a significant factor in the present-day CO_2 budget…. sea floor hydrothermal activity may fluctuate through time by an order of magnitude… We suggest here that CO_2 -induced climate changes have occurred, that they were caused by pulsations in the intensity of sea-floor hydrothermal activity induced by tectonic rearrangements of sea-floor spreading centers, and that the most obvious example of this process occurred in the early Eocene…. We suggest that increased tectonism and a warming climate are cause and effect. Recalculation of the carbonate mass balance model yields a doubling of CO_2 in the oceans and thus a doubling of CO_2 in the atmosphere… The data indicate that a several fold increase in sea-floor hydrothermal activity, occasioned by the early Eocene tectonic activity, caused a CO_2 induced global greenhouse effect… changes in global climate, reduction in the intensity of atmospheric circulation…"

5. DATA INTERPRETATION

Multiple earthquake clusters in 2003 appear to drive increases in SST anomaly magnitudes, geospatial extent, and duration. Manifestations of this phenomenon may be observed in clustered earthquake swarms at the base of the lithosphere, at 10-33km depths. Burst pulses over several days to weeks appear to precede subsequent Sea Surface Temperature (SST) anomalies within days or months after observed seismic swarms. Episodic seafloor hydrothermal activity has been linked to climate change in the past [3]. SST anomaly patterns overlying earthquake events are hypothesized to be the result of

[3] https://pubs.usgs.gov/of/1998/ofr-98-0767/tabletop.pdf

[4] Giovanni Gregori letter to Bill Orr (June 2002).

increased heat emission from seafloor volcanic extrusions and/or associated hydrothermal venting. The three regional examples above provide compelling evidence for geophysical links to the European heat wave experienced in summer 2003 and implications for a geophysical driver of global warming and ocean circulation reversals. Current measurements (1995) in the Straits of Otranto [4] conclude that "bottom water outflow… is highly correlated with the temperature". Data indicates slackening and reversals of the entire water column are associated with temperature increases. Earthquakes in the Aegean Sea region also peak during this period, increasing the total seismicity for the Mediterranean region and overall seismic energy within the northern hemisphere increases. Higher seismic activity within the northern hemisphere may explain the sudden melting occurring in the Artic region and other associated global warming phenomenon recently observed.

6. THEORETICAL CONSIDERATIONS

New theoretical constructs consider the possible electrical nature of clustered earthquake phenomena [5, 6] coupled to solar-wind or plasma stream forces. The geophysical links to ocean/atmospheric dynamics are considered by geodynamic analogs to ocean/atmosphere models in surge tectonics [7, 8] providing a new framework for climate modeling [9, 10, 11]. Solar interactions with the earth's orbital parameters are hypothesized to generate these electro-magnetic/gravitational induced surges. Geophysical links to orbital parameters, such as gravitational changes [12, 13], inner core rotation speeds [14], Chandler Wobbles [15], warming/cooling trends such as the "Great Pacific Climate Shift"[5] [16] in the mid-1970's are suggested on the basis of their correlation to preceding Core-Mantle-Boundary-Events (CMBE's).

7. CONCLUSIONS

How *can earthquakes induce changes in the global climate?* Seismicity preceding anomalous SST is reviewed, however critics might say there is insufficient evidence because in some cases there are seismic swarms and no SST anomalies. A means of overcoming this criticism is carefully examined during the European heat wave in the summer of 2003. Table-1 provides recent examples from the Mediterranean and Adriatic in 2003. It is hypothesized that shallow clustered earthquake events may induce deep ocean thermal convection by the aforementioned joule heating mechanism, creating magma extrusion and hydrothermal venting. This in affect may overturn ocean circulation patterns on an episodic basis. Magnitudes vary based on electrical energy inputs being generated by inner core jerks or CMBE's. Episodic changes in ocean temperature and height patterns, along with atmospheric pressure are teleconnected globally to internal geoid, gravity, and solar coupled magnetic field changes associated with CMBE earthquake generation. This may affect weather patterns, hurricane formation, tornadoes, and ocean/atmospheric circulation.

In the examples illustrated, timing of earthquakes to local warming events and SST anomalies may be much more than coincidence and are suggested by authors to drive global warming and ocean circulation reversals. Increases in seismic activity are known to cause increases in venting rates and temperatures along the East Pacific Rise (EPR), [17, 18] and Juan de Fuca [20, 21] ridges. Increases in seismicity have also been documented to signal an approaching El Nino phase up to six months or more beforehand on the EPR [19]. These time lags are consistent with shallow lithosphere thermal transmigration times observed, and these patterns are repeated several times in data sets since 1964 and are unexplained by current geophysical models. Impacts of this discovery and associated research should enhance the understanding of forcing mechanisms within the climate system. A "unified" research approach toward predicting severe weather and global climate change based on tectonic links to the climate system could improve modeling and predictive abilities within the earth sciences. Understanding components of tectonic modulation in earth-ocean-atmosphere-space-coupled models should enhance predictive abilities in General Circulation Models (GCMs). This research may open a new body of science, creating a paradigm shift in the understanding of our planet's climate, enhancing a multi-disciplinary approach to climate research.

8. REFERENCES

[1] Blot, C., Volcanisme et sismicite dans les arcs insulaires. Prevision de ces phenomenes. *Geophysique* 13, ORSTOM, Paris, p206, 1976.

[2] Blot, C., D.R. Choi, J.C. Grover, Energy transmigration from deep to shallow earthquakes: A phenomenon applied to Japan –Toward scientific earthquake prediction-, *New Concepts in Global Tectonics-Newsletter*, Eds. J.M. Dickens and D.R. Choi, No. 29, p3-16, Dec., 2003

[3] Owen, R.M., and D.K. Rea, Sea-Floor Hydrothermal Activity Links Climate to Tectonics: The Eocene Carbon Dioxide Greenhouse, *Science* 11Jan, V. 227, p166, 1985.

[4] Poulain, P.-M., M. Gačić, and A. Vetrano, Current measurements in the Strait of Otranto reveal unforeseen aspects of its hydrodynamics. *EOS Trans. AGU*, **77** (36), 345-348, 1996.

[5] Gregori, G.P., Galaxy-Sun-Earth Relations: The dynamo of the Earth, and the origin of the magnetic field of stars, planets, satellites, and other planetary objects. In *Wilson A., (ed.), 2000. The first solar and space weather conference. The solar cycle and terrestrial climate*. *ESA SP-463*, 680 pp., European Space Agency, ESTEC, Noordvijck, The Netherlands, p. 329-332, 2000.

[6] Gregori, G.P., Galaxy-Sun-Earth Relations: The origins of the magnetic field and of the endogenous energy of the Earth, *Arbeitskreis Geschichte Geophysik, ISSN:1615-2824,* Science Edition, W. Schroder, Germany, 2002.

[7] Meyerhoff, A.A., Taner, I., Morris, A.E.L., Martin, B.D., Agocs, W.B., and Meyerhoff,H.A., 1992. Surge tectonics: a new hypothesis of Earth dynamics, In: *New Concepts in Global Tectonics*. eds. S. Chatterjee and N. Hotton III. pp. 309-409. Lubbock. Texas Tech University Press.

[5] http://www.21stcenturysciencetech.com/articles/ocean.html

[8] Meyerhoff, A.A., Taner, I., Morris, A.E.L., Agocs, W.B., Kamen-Kaye, M., Bhat, M.I., Smoot, N.C., and Choi, D.R. 1996. *Surge Tectonics: A New Hypothesis of Global Geodynamics.* ed. D. Meyerhoff Hull, Kluwer Academic Publishers. 317 pp.

[9] Leybourne, B.A., and M.B. Adams, 1999, Modeling mantle dynamics in the Banda Sea triple junction: Exploring a possible link to El Nino Southern Oscillation. Marine Technology Society Oceans '99 Conference Proceedings, Seattle, Washington, pp. 955-966, Sept. 1999.

[10] Leybourne, B.A., and M.B. Adams, El Nino tectonic modulation in the Pacific Basin. Marine Technology Society Oceans '01 Conference Proceedings, Honolulu, Hawaii, Nov. 2001.

[11] Leybourne, B.A., Surge theory weighs in on the balance of evidence in the debate on global warming. *Global Warming XII Abstracts*, Cambridge, UK, World Resource Review, pp 167-188, June 2002.

[12] Orr, W.C., Is there another potent source of global climate change other than solar radiative or anthropogenic forcing? *White Paper: Earth Climate Research Institute (ECRI),* Aug. 15, 2001, Revised - Mar. 19, 2002.

[13] Orr, W.C. and B.A. Leybourne, Episodic Hydrothermal Global Climate Change. *Earth Climate Research Institute (ECRI)*, May 28, 2002.

[14] Huy, M.L., M. Alexandrescu, G. Hulot, and J.-L. Le Mouel, On the characteristics of successive geomagnetic jerks, *Earth, Planets, Space,* **50**, 723-732, 1998.

[15] Macmillan, S., and J.M. Quinn, The derivation of the World Magnetic Model 2000, *Brit. Geol. Surv. Tech. Rep. WM/00/ 17R,* 2000.

[16] Stevenson, R.E., Yes, the ocean has warmed; no, it's not global warming, *Science and Technology Magazine*, 2000.

[17] Walker, D.A., Seismicity of the East Pacific: correlations with the Southern Oscillation Index? *EOS Trans. AGU*. **69**, 857, 1988.

[18] Walker, D.A., More evidence indicates link between El Ninos and seismicity. *EOS Trans. AGU.* **76** (33), 1995.

[19] Walker, D.A., Seismic Predictors of El Nino Revisited. *EOS Trans. AGU,* **80** (25), 1999.

[20] Johnson, H.P., M. Hutnak, R.P. Dziak, C.G. Fox, I. Urcuyo, J.P. Cowan, J. Nabelek, and C. R. Fisher, Earthquake-induced changes in a hydrothermal system on the Juan de Fuca mid-ocean Ridge, *Nature,407,* 174-177, 2000.

[21] Johnson, H.P., R.P. Dziak, C. R. Fisher, C.G. Fox, and M.J. Pruis, Earthquakes' Impact on hydrothermal systems may be far-reaching, *EOS Trans. AGU,* **82** (21), 233-236, 2001.