

The cause of El Ninos is increased hydrothermal-activity in defined submarine areas – An aperiodic global phenomenon !

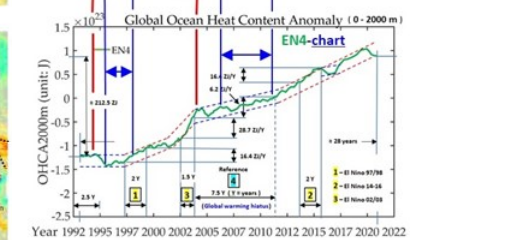
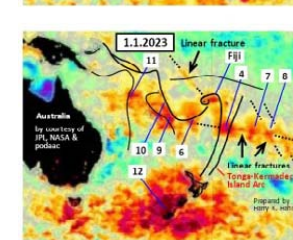
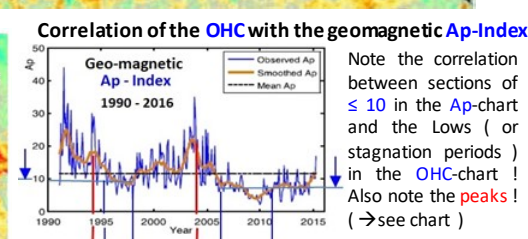
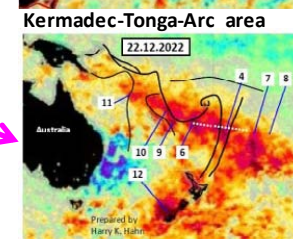
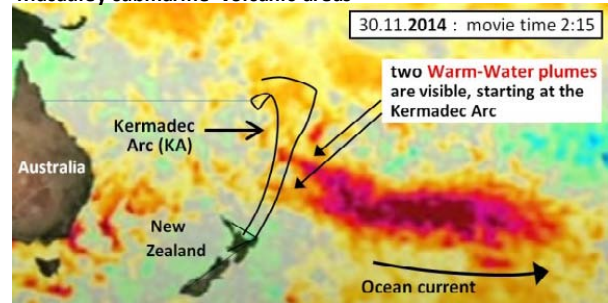
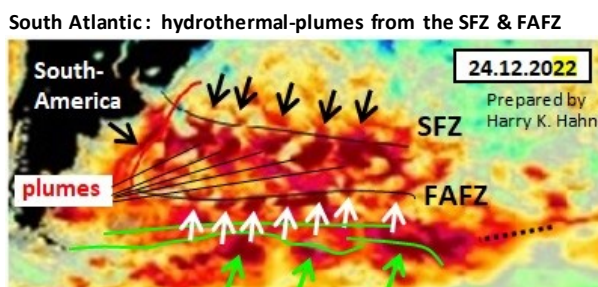
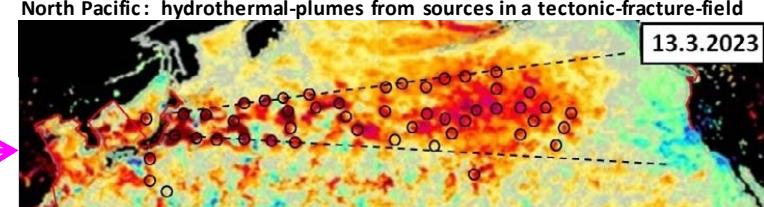
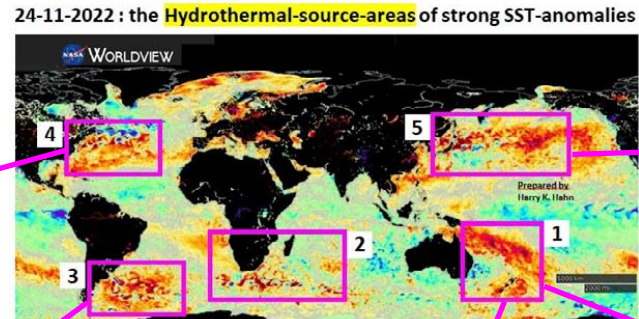
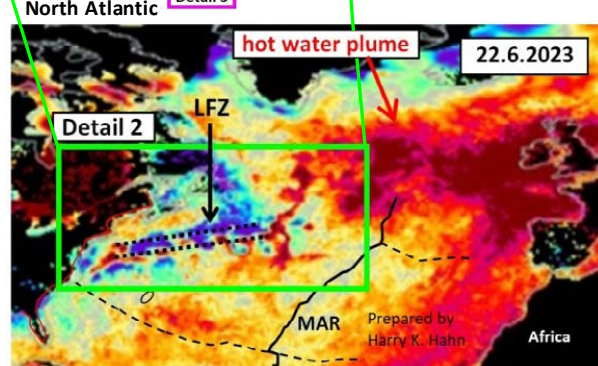
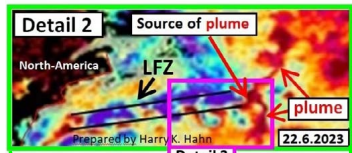
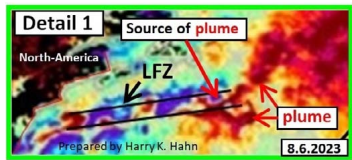
Weblink to the extended version of Part 1 of my Climate-Hypothesis: [Part-1e](#) (with Chapter **C4**) → Please also read [Part 2](#), [Part 3](#) & [Part 4](#)

Abstract : by Harry K. Hahn / Germany - 15.7.2023 - **Note** : This document is not allowed for commercial use !!

The cause of **El Nino**-events is **hydrothermal-water** that rises from submarine volcanic-areas & tectonic-fractures to the ocean-surface ! On the ocean surface this hydrothermal-water appears in the form of growing **plumes** or **blobs** (**sea-surface-temperature** (SST)-anomalies), which then get distributed by the main ocean-currents and by surface-currents. My study will provide first evidence of the real sources of the SST-anomalies which lead to the development of El Ninos. These are hydrothermal sources, which are located for example in the Kermadec-Tonga-Arc (e.g. in the Monowai- & Macauley-Volcanic-areas), New-Hebreds-Trench-area, Nankai-Trough- & Philippine-Plate-area, Salado-Fracture-Zone, Falkland-Agulhas-Fracture-Zone, South-West-Indian-Ridge-area, Mid-Atlantic-Ridge, LFZ, Kane-Fracture-Zone & in the Pacific-Plate east of Japan, to name the important locations

With the **NASA Worldview tool** an analysis of the **sea-surface-temperature** (SST)-anomalies was done for the time-period Oct. 2021 to June 2023, and for the time-periods in which the strong **El Ninos** from 1997/98 & 2014-16 developed. Five areas (**1 – 5**) on the ocean-floor were found where large amounts of **hydrothermal-water** was rising from specific areas on the ocean-floor to the surface at irregular intervals during the mentioned time-periods! **Note**: The irregular hydrothermal-activity in these five areas is a **global phenomenon** !! The hydrothermal-activity comes and goes in a “wave-like-pattern”, which often causes activity in 3 to 5 areas, which are thousands of km apart, **at nearly the same time** !!

As an example I want to mention the period 9.12.2013 to 21.12.2013 (12 days) in which the hydrothermal-activity reached a maximum level in at least four of the five areas (1-5) in this very short time-period ! **Note**: These areas are located in the northern- & southern-Hemisphere. And the hydrothermal-activity, which starts at nearly the same time and reaches a maximum activity at nearly the same time, comes in a “wave-like-pattern” and it seems to move from west to east over the globe. Changes in Earth’s Magnetic Field seem to be the main cause of this increased Hydrothermal- & Volcanic-Activity ! These changes (e.g. geomagnetic jerks) in Earth’s Magnetic Field can be caused either by internal processes which take place near the Core-Mantle-Boundary (CMB), or they can be caused by external events, which are strong geomagnetic-storms caused by solar wind (space-weather). First the geomagnetic-changes (e.g. geomagnetic-jerks) seem to increase seismicity in High-Geothermal-Flux-(HGF)-areas, then with a certain delay hydrothermal-activity, especially along tectonic-fractures, is increasing, which then rises the SST and the Ocean-Heat-Content, and finally causes the El-Ninos. The key to find the hydrothermal- or volcanic-sources, which cause the strong **temperature-anomalies**, is the precise observation of the development of every major anomaly in an animation, from the early beginning of the SST-anomaly, when the first small warm-water-blob appears on the surface ! Please also read [Part 2](#) & [Part 3](#) of my hypothesis which explain the probable causes of the described “global-hydrothermal-activity” in more detail !



Introduction :

The **Sea-Surface-Temperature**-map shows the **Absolut Temperatures of the ocean-surface** at a certain point of time.

It doesn't give us any information where the warm water is coming from, which is slowly heating our oceans and causes climate-change. (→ see the 2. map on the bottom)

But to find out where the **warm water** is coming from, that is causing the **El-Nino-events**, which happen at irregular intervals of **2 to 7 years** and which are mainly responsible for the heating of the ocean water, **we must find the sources of the unusual temperature-anomalies !!**

That's what I did with this study here !

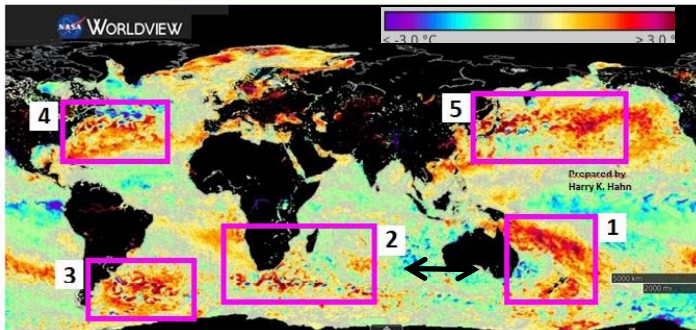
A **temperature anomaly** is a deviation of the surface-temperature in a certain area, in reference to the average of temperatures that were measured in this area over a long reference period (≥ 30 years)

The key to find the hydrothermal- or volcanic-sources, which cause the strong temperature-anomalies, is the **precise observation of the development of an anomaly in an animation from the early beginning when the first small warm water blob appears on the surface !**

→ See examples in **Appendix 1.1** → How to use & see the animations

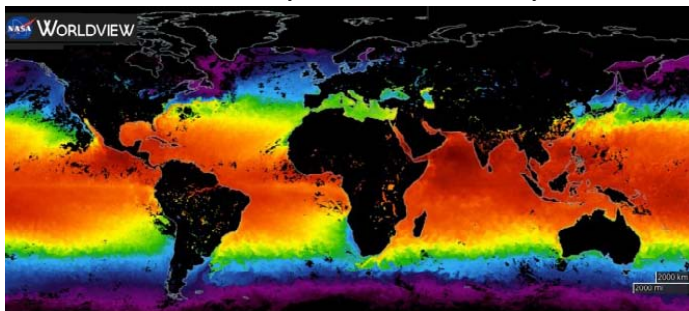
Temperature Anomalies

24-11-2022 : the **Hydrothermal-source-areas** of strong SST-anomalies



Absolut Temperatures (→ for comparison)

Absolut Sea Surface Temperatures – world map



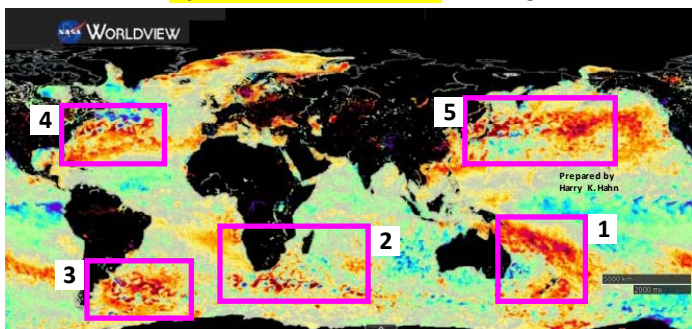
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Overview : In 5 defined areas large amounts of hydrothermal-water rise to the ocean-surface at irregular intervals !

With the NASA Worldview tool an analysis of the **sea-surface-temperature (SST)**-anomalies was done, for the time-period Oct. 2021 to June 2023. → Five areas (1 – 5) on the ocean-floor were found where large amounts of **hydrothermal** -(**hot**)-water rises from the ocean-floor to the surface at irregular intervals!

24-11-2022: the **Hydrothermal-source-areas** of strong SST-anomalies



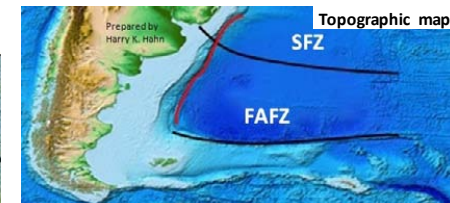
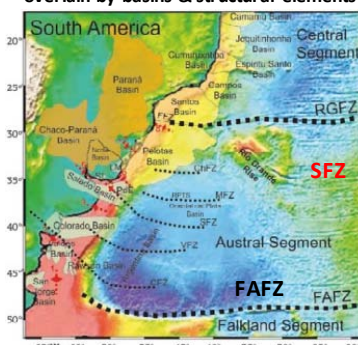
Note : The **hydrothermal**-water that rises to the surface and causes strong & large **SST**-anomalies in these **5 areas** is the main cause (or even the exclusive cause !) of the global **El Nino**-events !!

Note : The irregular **hydrothermal**-activity in the 5 marked areas is a **global phenomenon** !! The activity comes and goes in “waves”, which often cause activity in ≥ 4 areas at the same time !!, with durations of a few days or weeks. The cause for it seem to be **geomagnetic jerks** ! → **Chapter 4**

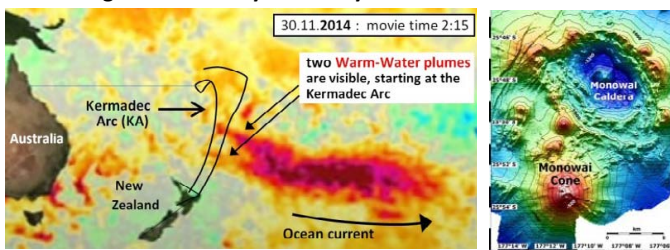
3 South Atlantic : Tectonic Fracture Zones are the source of strong hydrothermal activity in the Argentina-Basin

By analysing the development of the strong **SST**-anomalies which were visible east of Argentina in 2021/22 and in 2013-15, I found clear evidence for ≥ 10 stationary **hydrothermal**-sources (-vents) which are located along the **Salado-FZ (SFZ)**, and located along the **Falkland-Agulhas-Fracture-Zone (FAFZ)** ! The **SST**-anomalies did develop precisely along the mentioned tectonic fracture zones !

Topographical map of SE-South-America overlain by basins & structural elements



2014 : Large SST-anomaly caused by Volcanism Monowai Volcano



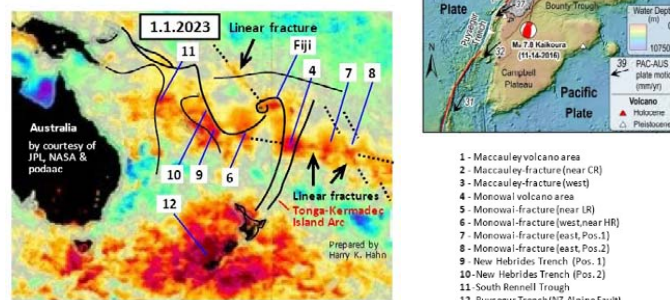
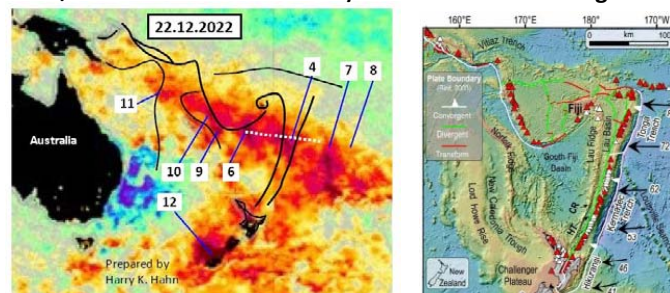
1 SW-Pacific : the Kermadec-Tonga Arc area is a main source of hydrothermal-activity

By analysing the **sea-surface-temperature (SST)**-anomaly map of the SW-Pacific area on selected dates, it becomes clear that the **SST**-anomalies (the strong positive anomalies (red=warmest)) are **purely** the result of **hydrothermal**- and **volcanic**-activity in the **Kermadec-Arc**- & **New-Hebrides-Trench** areas & **South-Rennell-Trough** area !! (→ see images on the left !)

The **SST**-anomalies can clearly be traced to very active **submarine-volcanic**-regions like the **Monowai**- & **Macauley**- Volcanic-areas and to a number of tectonic-fractures & -trenches !

The **SST**- anomaly from 30.11.2014 for example, shows a **very large warm-water plume** that was caused by two **submarine-volcanic**-areas, the **Monowai**- & **Macauley**- Volcanic-areas !

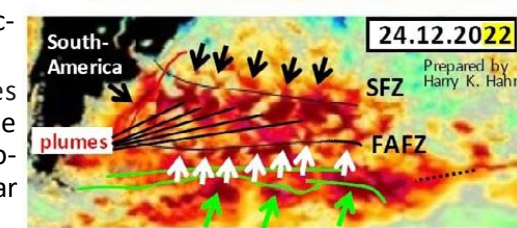
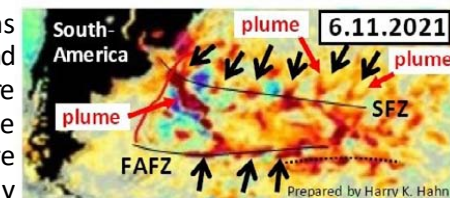
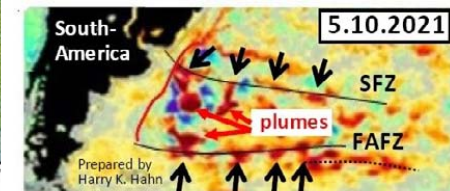
2022/23 Submarine Volcanic activity in the : Kermadec-Tonga Arc



- 1- Maccauley volcano area
- 2- Maccauley-fracture (near CR)
- 3- Maccauley-fracture (west)
- 4- Monowai volcano area
- 5- Monowai-fracture (near LR)
- 6- Monowai-fracture (west/near HR)
- 7- Monowai-fracture (east, Pos.1)
- 8- Monowai-fracture (east, Pos.2)
- 9- New Hebrides Trench (Pos. 1)
- 10- New Hebrides Trench (Pos.2)
- 11- South Rennell Trough
- 12- Puysegur Trench (NZ-Alpine Fault)

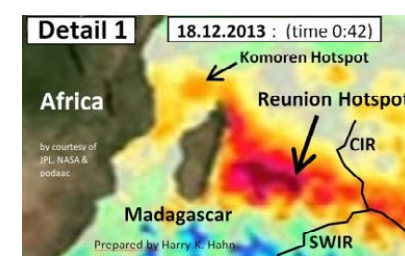
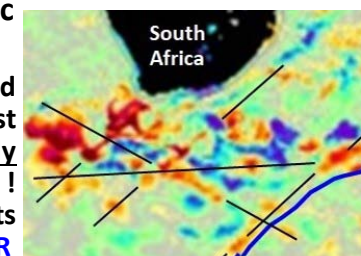
At certain dates the positions of the **hydrothermal vents** and the linear tectonic fractures are easy noticeable, because the **warm water plumes** that were coming from the vents, clearly indicate these tectonic-fractures on the map !

Other hydroth. sources in the area seem to be located near the Rio-Grande Rise and near the continental shelf



2 Southern- & Indian Ocean: Along tectonic fractures hydrothermal-activity is visible

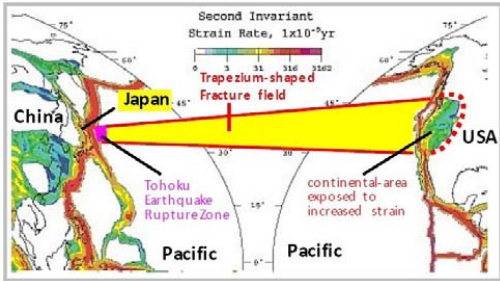
Other strong **hydrothermal**-sources are located along mostly **Linear-Tectonic-Fractures** south-west to south-east of South -Africa. Note the precisely linear **SST**-Anomalies that are visible on the map ! (indicating fractures). Other big **hydrothermal**-vents are located near the **Reunion**-Hotspot and the **SWIR**



5 North Pacific : Hydrothermal-sources in a trapezoid-shaped fracture-field cause strong SST-Anomalies

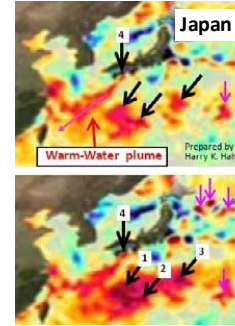
This **trapezoid-shaped** fracture-field with many dozens of aperiodic-active strong **hydrothermal-sources** has a defined Northern- & Southern-borderline. The **SST-anomalies** can be traced to **hydrothermal-vents** located along linear fractures within this **trapezoid-shaped** fracture-field. The fracture-field has a relatively clear defined northern- & southern border. The western-border of the fracture-field is the **Japan Trench** (→Tohoku-area). And its eastern-border is defined by an area in East-USA that is exposed to a high tectonic strain-rate. The whole trapezoid area seems to be exposed to high strain.

Trapezoid-shaped fracture-field between Japan & USA

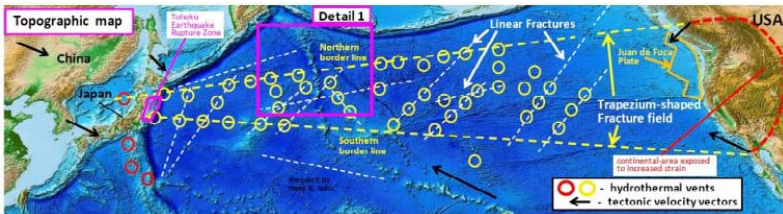


Beside the described trapezoid-shaped source-area, there is **another source-area of hydrothermal vents** which causes strong SST-anomalies in the North-Pacific. (→see image on the right)

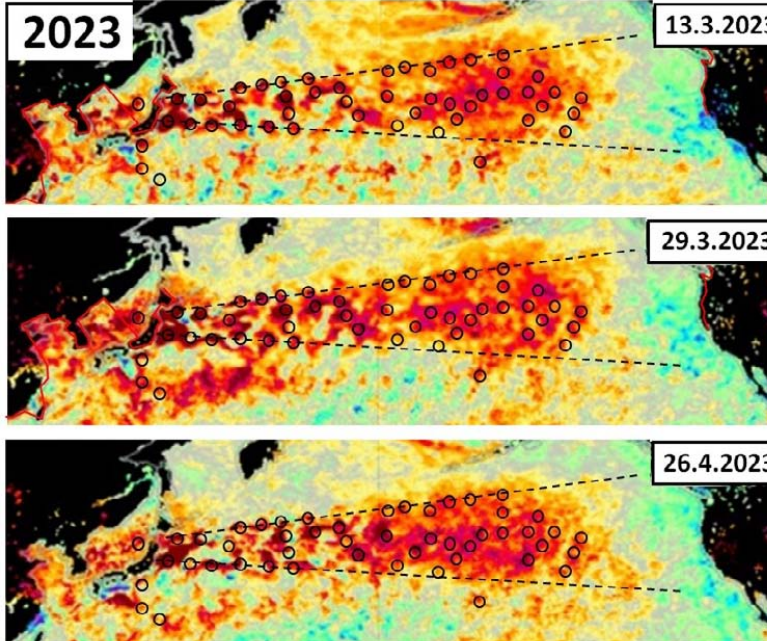
This other source-area is located south of Japan and consists of the Shikoku Basin, the North Kyushu-Palau-Ridge (KPR) and the **Nankai-Trough**. During the 2014-16 El Nino **warm water plumes** were coming from 4 sources in these areas, as the **SST-anomalies** clearly show! →



Trapezoid-shaped fracture-field with hydrothermal-sources and fractures indicated



2023 : SST-anomalies in the N-Pacific with the hydrothermal sources indicated



4 North Atlantic : A hydrothermal source on the ocean floor caused a large SST-anomaly

In June 2023 a very strong **sea surface temperature (SST)-anomaly** developed in the North Atlantic .

This strong **SST-Anomaly**, which has the clear shape of a **warm water plume**, was caused by a strong point-like **hydrothermal source** which is located ~650 km SW of **Cape Race (Newfoundland)**. → see image on the right !

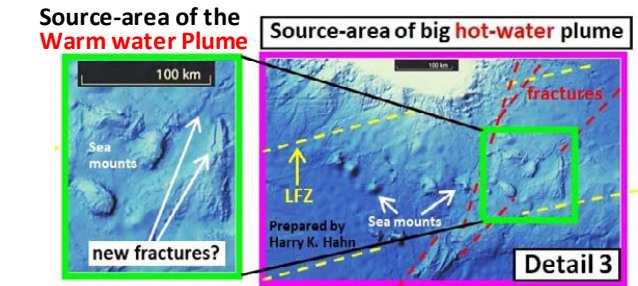
The large **warm water plume** that was caused by this **hydrothermal** source had the size of Western Europe !

The **hydrothermal**-source in all probability is a crack or a volcano that is located on a **Linear Frature Zone (LFZ)**, which must be a deep **tectonic-strike-slip-like-fracture zone** .

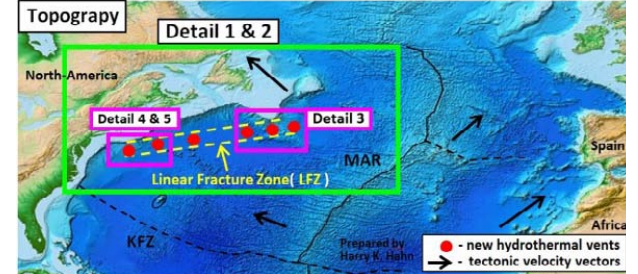
The fact that the big 2023 **SST-anomaly** in the North-Atlantic can precisely be traced to a point-like **hydrothermal**-source is another clear proof, that unusual **warm water**-anomalies in the oceans are purely the result of **hydrothermal**-activity !

Other hydrothermal-vents which also produced **warm water plumes**, are located along the marked **Linear Frature Zone (LFZ)**, along **other Fractures** and along the **Mid-Atlantic-Ridge** But these other hydrothermal-sources (-vents) produced smaller plumes than the giant 2023-plume.

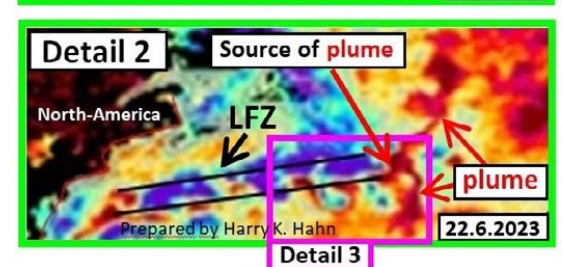
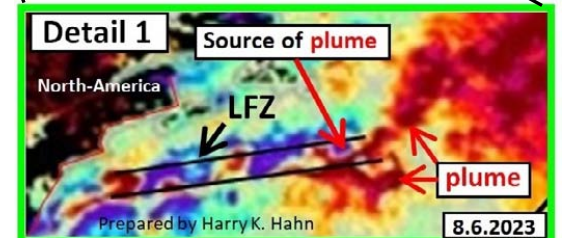
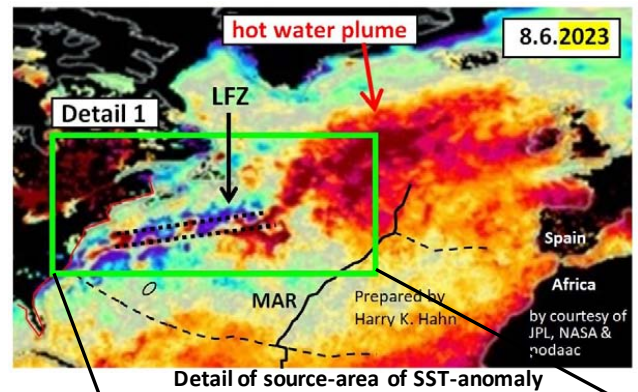
I describe these other hydrothermal-sources (-vents), which caused SST-anomalies during the 1997/98 & 2014-16 El Ninos, on the following pages of this study.



Linear Frature Zone (LFZ) and hydrothermal sources indicated



2023 : SST-anomaly is indicating a big plume & the source area

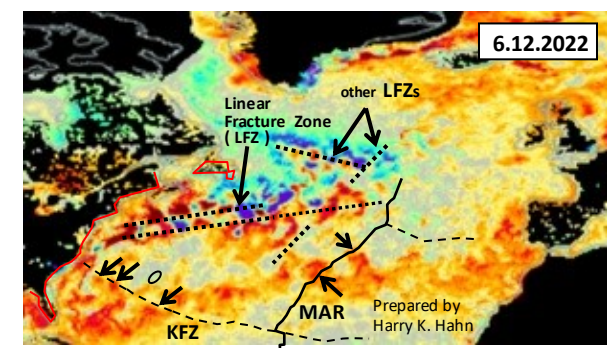
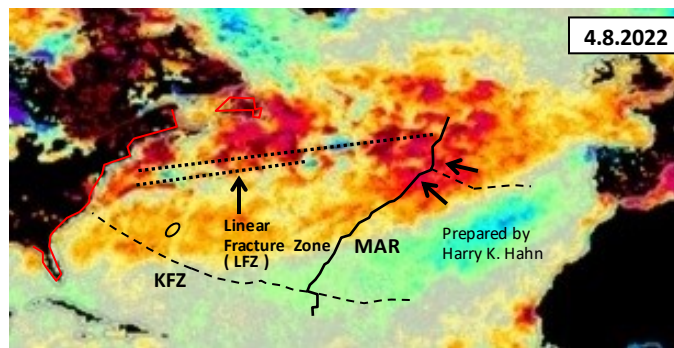
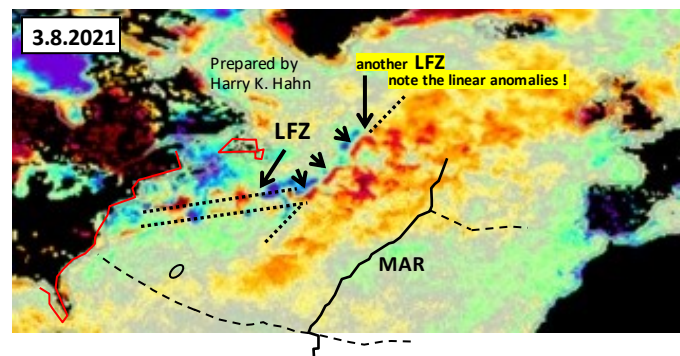
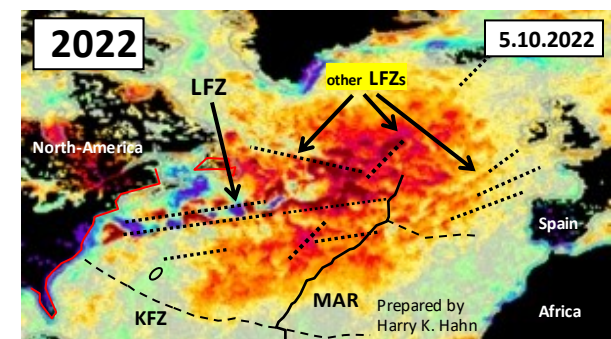
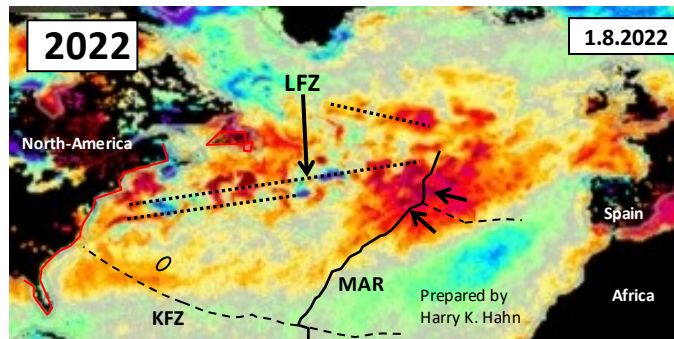
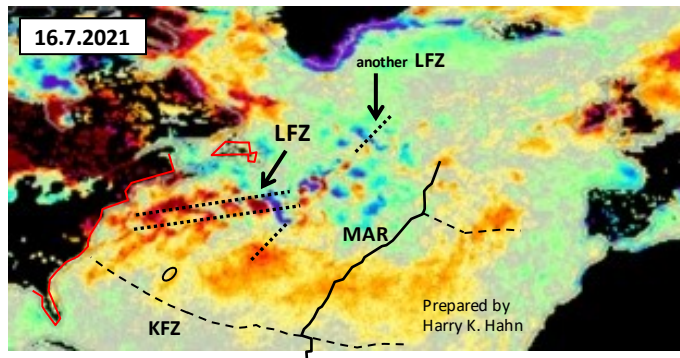
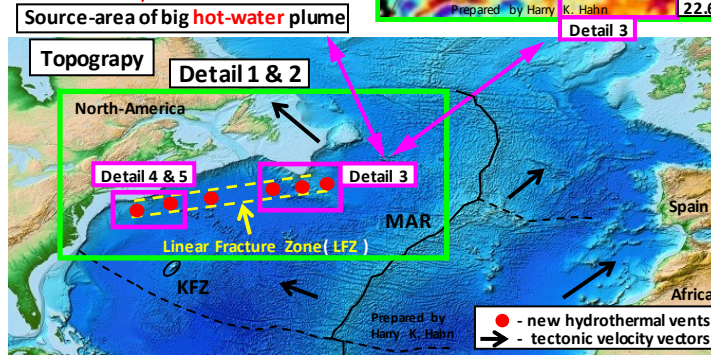
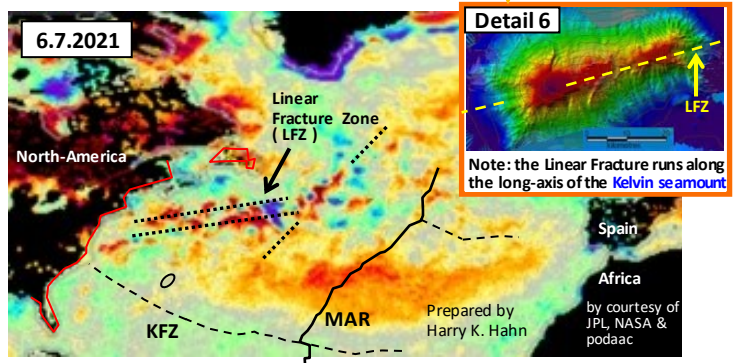
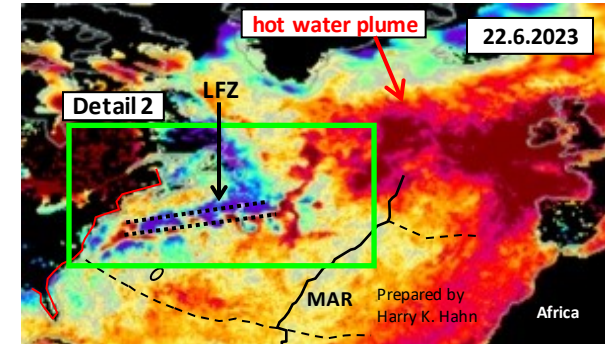
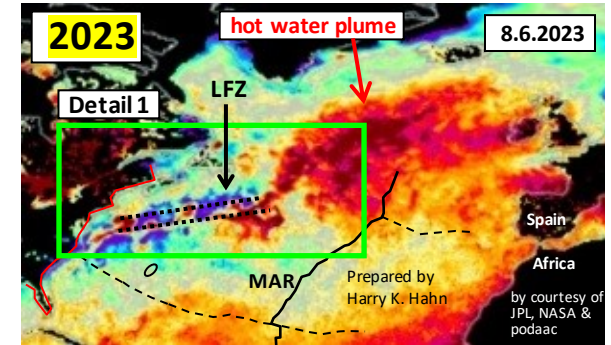
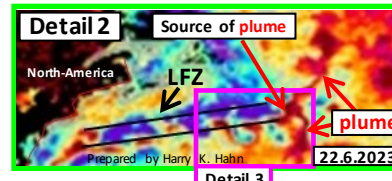
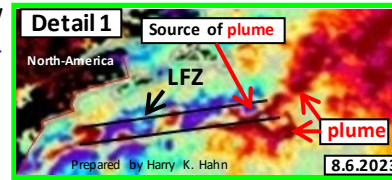
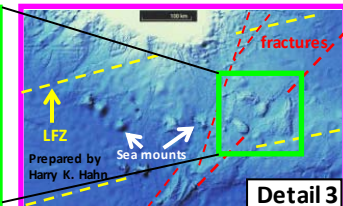


2021-23 : The extreme SST-anomaly in the Atlantic in 2023 was caused by a hydrothermal-source in a deep tectonic-fracture zone

The extreme 2023-SST-anomaly in the Atlantic can be precisely traced to a small area which is located ~650km SE of Cape Race on a long Linear Fracture-Zone (LFZ)

The hydrothermal-source of the extreme 2023-warm-water-plume is located ~650 km SW of Cape Race (Newfoundland) on the marked LFZ, which seems to be a deep strike-slip-fracture which is oriented precisely along the long-axis of the linear-Kelvin Seamount.

Other hydrothermal-vents are located on the Mid-Atlantic-Ridge and on other LFZs.



by courtesy of JPL, NASA & podaac

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Prepared by Harry K. Hahn

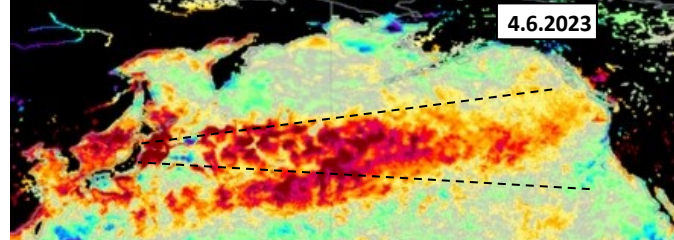
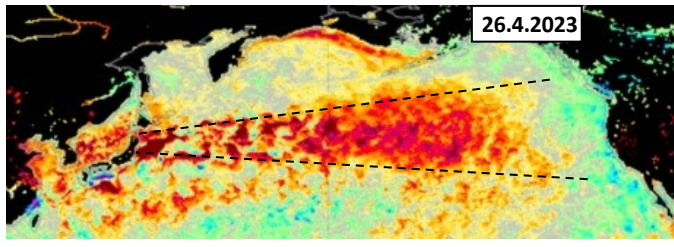
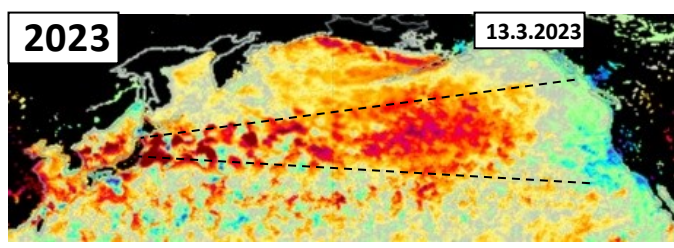
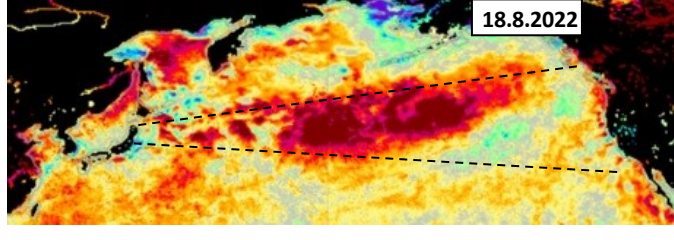
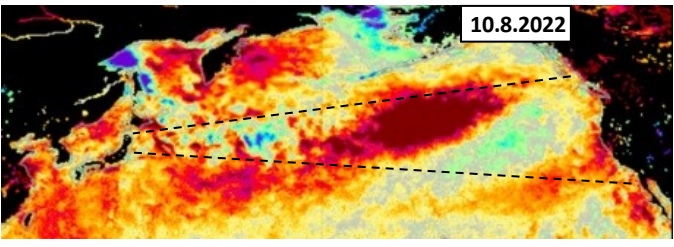
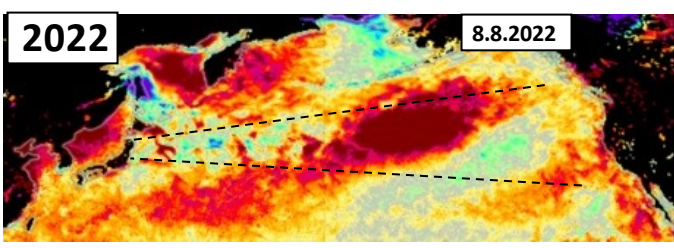
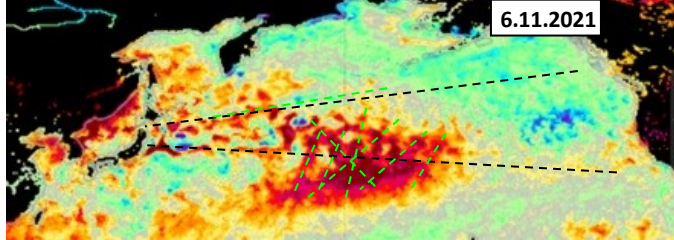
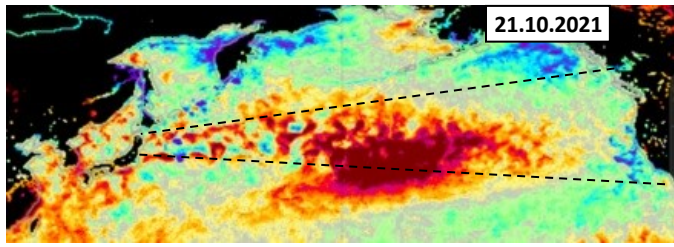
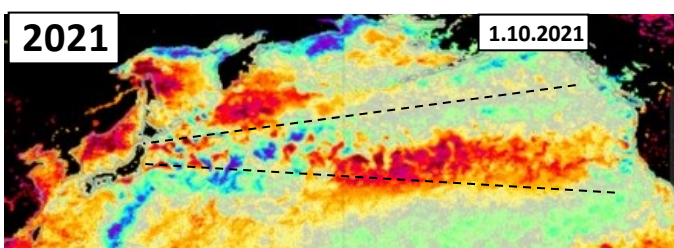
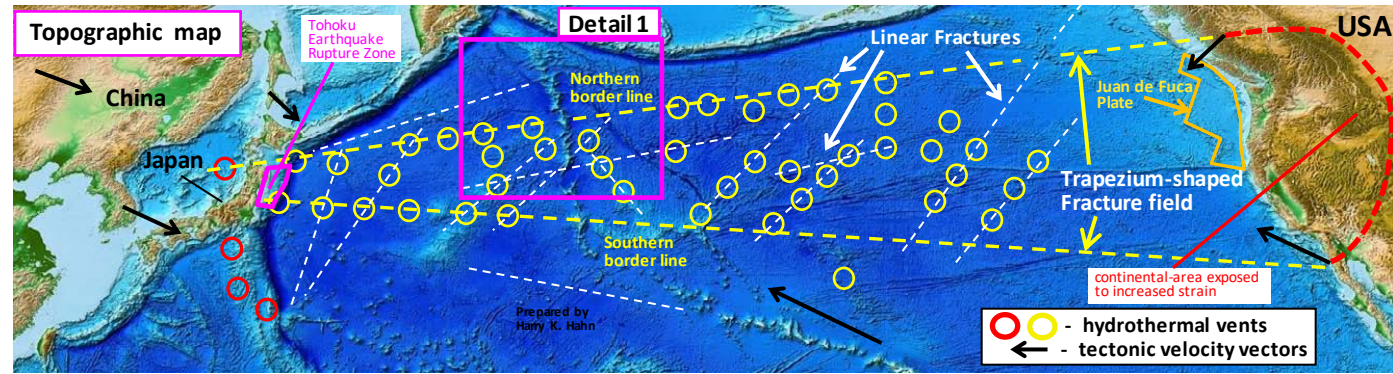
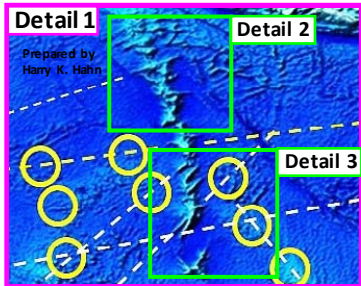
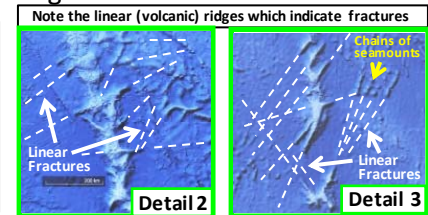
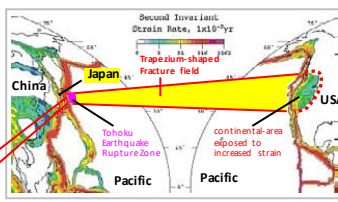
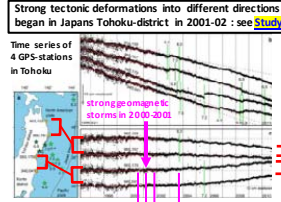
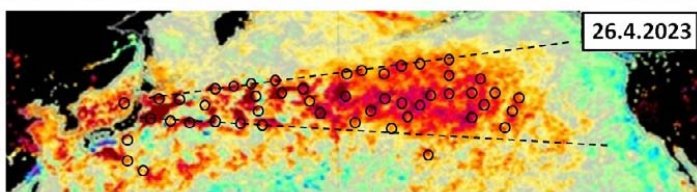
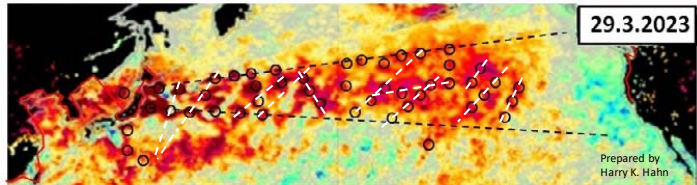
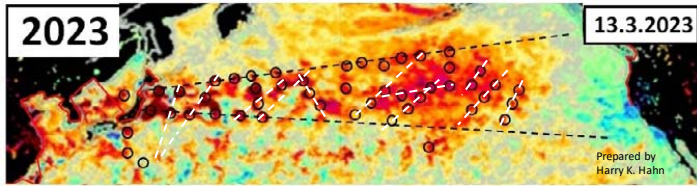
Prepared by Harry K. Hahn

Prepared by Harry K. Hahn

2021-23 : Hydrothermal-sources in a trapezoid-shaped fracture-field on the North-Pacific ocean-floor caused strong SST-Anomalies

Strong SST-anomalies in the North-Pacific can be precisely traced to a **trapezoid**-shaped fracture-field located between the **Japan-Trench** & the East-coast of USA

The **trapezoid**-shaped fracture-field with many dozens of aperiodic-active strong **hydrothermal**-sources has a clear defined Northern- and Southern-borderline. Its left border is the **Japan Trench** and its right border is an area in East-USA exposed to high strain.



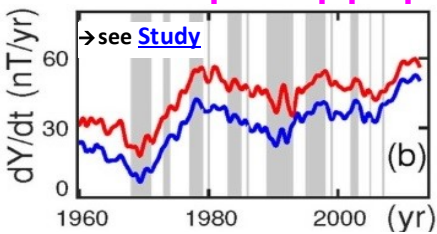
C2 To the probable causes of increased global hydrothermal activity, which leads to El Nino events

→ Changes in **Earth's Magnetic Field** seem to be the main cause of increased Hydrothermal-& Volcanic-Activity on Earth !

These changes (e.g. **geomagnetic jerks**) in **Earth's Magnetic-Field** can be caused either by internal processes which take place near the **Core-Mantle-Boundary (CMB)**, or they can be caused by external events, which are strong **geo-magnetic-storms** caused by solar wind (**space-weather**). The maximum impact of the external events (**geo-magnetic storms**) seems to be around +/-20%, and the impact of internal-effects seems to be around +/-30% (→charts on the left). As internal effect the fast **North-Magnetic Pole Shift** must be mentioned, which showed a very high acceleration between 1993 and 2002.

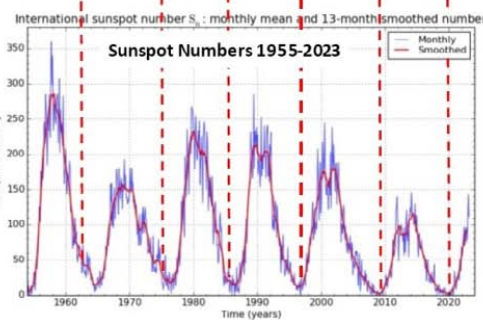
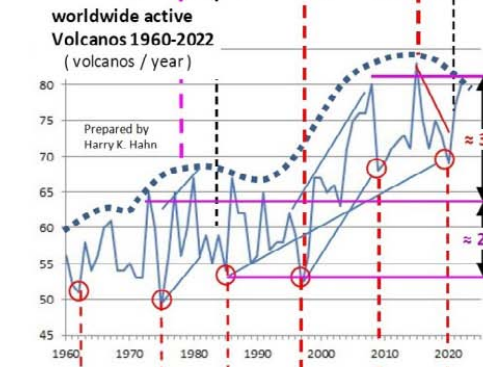
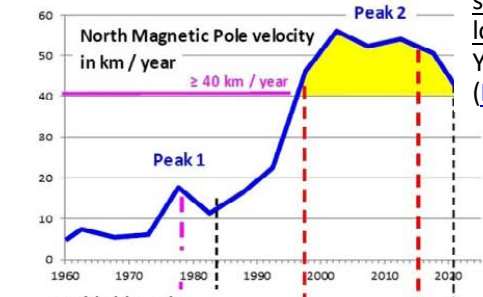
1. derivative of Geomagnetic-Y-component

El Ninos: 82 97 02 14/15



Increased changes in **Earth's magnetic field** caused by internal-processes (→indicated by the 1. derivative of the Y-component) cause increased seismicity (earthquakes) which then lead to increased volcanism & hydrothermal-activity. **Geomagnetic storms** caused mainly during **solar-cycle-maximas** increase this correlation. → **Read Part 2 of my study**

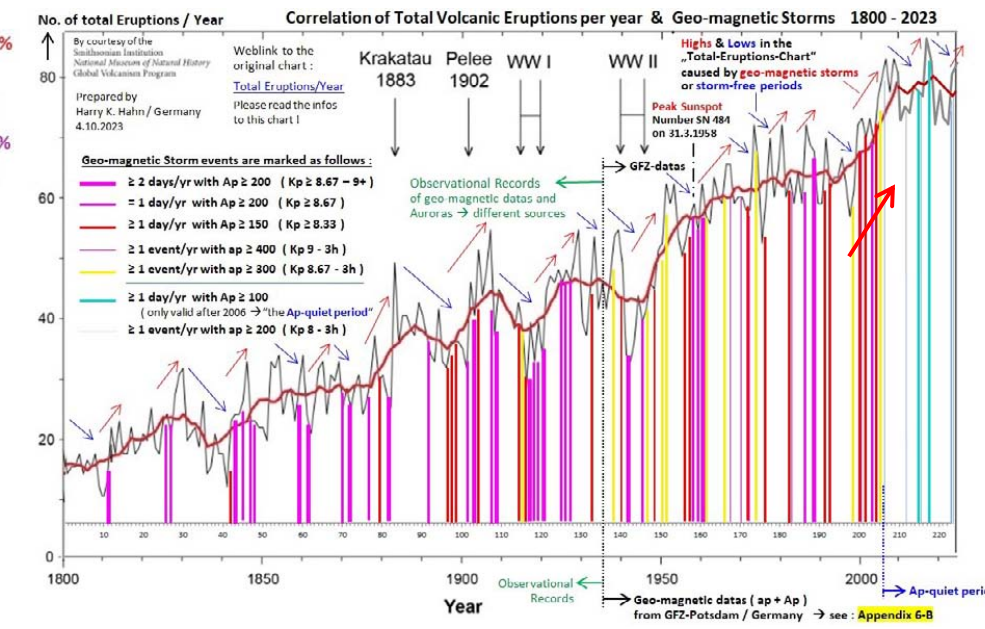
The comparison of the 3 charts on the left indicates that volcanic activity is influenced by shortterm **geo-magnetic effects**, caused by the **sunspot cycles** (=space weather) and by a longterm geo-magnetic effect, the **NMPV**. The chart of the Worldwide Active Volcanos per Year clearly follows a very similar trend as the chart of the **North Magnetic Pole Velocity (NMPV)**. This trend is only interrupted by drops (lows) caused by **sunspot cycle** minimas.



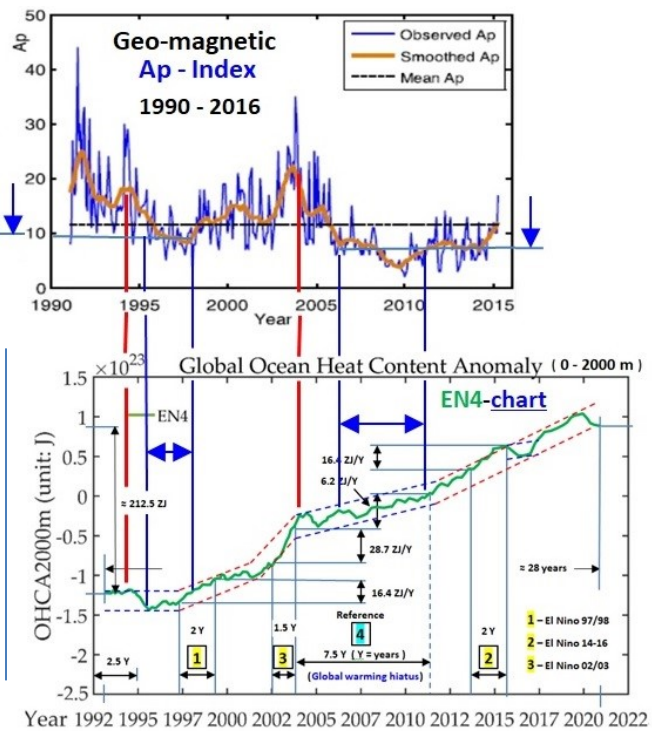
Correlation of "Total Volcanic Eruptions" with "strong Geomagnetic storm-periods" :

Shortly after the occurrence of a strong **Geomagnetic-storm-(period)**, or with a delay of up to 1-2 years, there is a sharp increase in the number of **Total-Volcanic Eruptions** visible in the chart ! (**Highs**, indicated by **red arrows**). And **lows** in the chart correlate with phases where no or very less geo-magnetic storms occurred (→ the **blue arrows**)

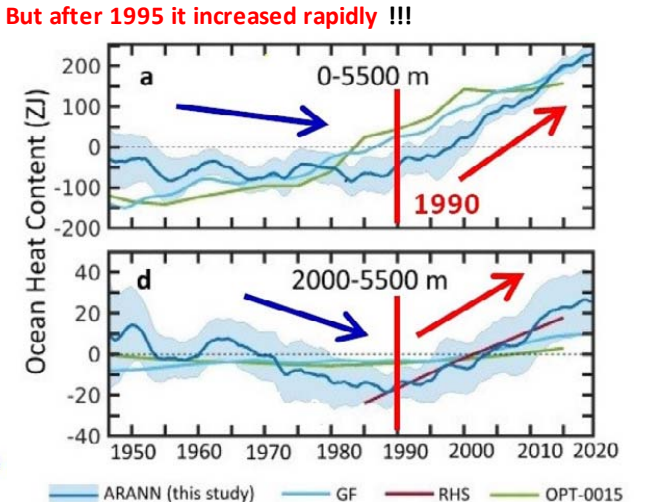
Correlation of -Total Volcanic Eruptions- with -strong Geomagnetic storm-periods- between 1800 and 2023. → Eruptions rise sharply 1-2 yr after geomagnetic storms



Note the correlation between sections of **≤ 10** in the **Ap-chart** and **Lows** (or **stagnation**) in the **OHC-chart** ! Also note the **peaks** ! (→see chart)



The **Ocean Heat Content** in the depth-range 2000-5500 m **did not increase** in the time-period ~1950 to 1990 !! (→ see chart below). **Note** : The **OHC** actually **dropped** in that time-period in the depth-range 2000 - 5500 m !!



The Ocean Heat Content-Chart provides proof that hydrothermal-sources contribute at least $\approx 40\%$ heat to the Oceans !

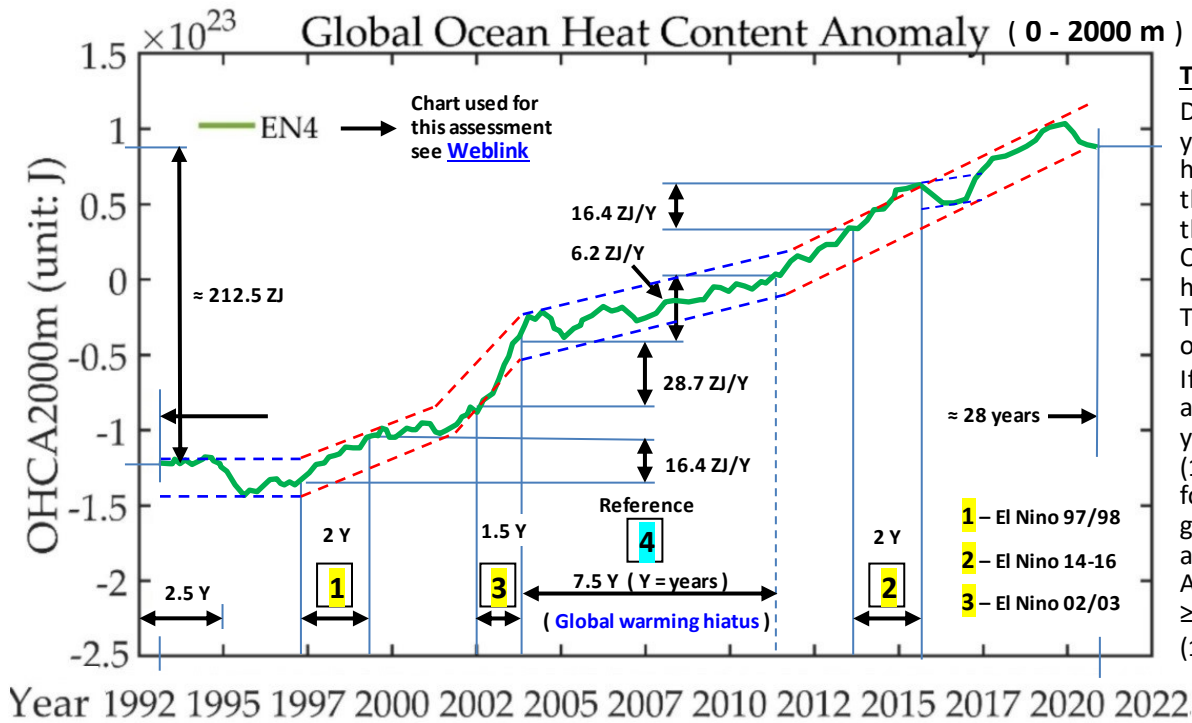
The ocean heat content (OHC) is the energy absorbed and stored by the world's oceans. The current hypothesis says that the main driver of the OHC-increase most likely is "Anthropogenic (human) forcing via rising Greenhouse Gas Emissions". But a look at the diagram of the „Global Ocean Heat Content Anomalies“ clearly indicates that the current official hypothesis is incorrect and incomplete ! And therefore the current "Climate-Change Models" are incorrect too ! There are clearly time-periods (EL Nino events) visible in the chart where the ocean heat-content (and the sea-level !) rises much faster than in other (cooler) periods, by a factor of 2.6 to 4.6 !! This fact can't be explained by the greenhouse-theory alone !! This big difference in heat-input can only be explained by another additional powerful heat-source beside the sun that contributes heat !!!

This other heat-source are hydrothermal-vents & submarine-volcanism on the ocean-floors !!

I have marked four time-periods on the OHC- Chart on the right :

- 1** - El Nino 1997/98 (a 2-year period was selected)
→ Heat input in this time ≈ 16.4 ZJ /Year
 - 2** - El Nino 2014-16 (a 2-year period was selected)
→ Heat input in this time ≈ 16.4 ZJ /Year
 - 3** - El Nino 2002/03 (a 1.5-year period was selected)
→ Heat input in this time ≈ 28.7 ZJ /Year
- For comparison I have picked out a time-period with a low OHC-increase :
- 4** - Reference (for comparison a cool 7.5 year period)
→ Heat input in this time ≈ 6.2 ZJ /Year
- (Note : 1 ZJ/Y = 1×10^{21} Joule / year)

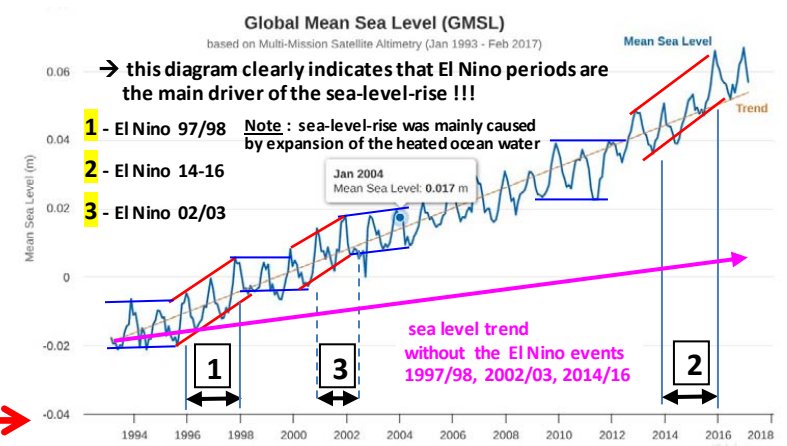
To put the numbers in perspective :
The El Nino events 97/98 & 14-16 added 10.2 ZJ/Y more heat to the world's oceans than the (cooler) years : 2004 - 2011 (→ $16.4 - 6.2 = 10.2$ ZJ)
The El Nino 2002/03 even added 22.5 ZJ/Y more heat !
For comparison : 10.7 ZJ is the energy which the Earth's surface receives from the sun in one day !
 The whole global economy uses 0.58 ZJ/Y
How much hot magma (lava) could add 10.2 ZJ heat to the oceans ? :
Answer : approx. 6375 km³ of hot magma (basalt) which cools down from 1300°C to 27°C (→ $\Delta T = 1000^\circ K$)
 This volume of 6375 km³ corresponds to (is equal to) a cube of magma with the edge-length of ≈ 18.5 km
This is a very realistic scenario !!



The analysis-result :
 During the 5.5 El Nino years (1-3) $\approx 108,7$ ZJ heat were added. In the rest 22.5 years of the ≈ 28 year long OHC-chart, ≈ 103.8 ZJ heat were added. This corresponds to only ≈ 4.61 ZJ per year. If I use this 4.61 ZJ as average added per year without EL Ninos (1-3) which is ≈ 129 ZJ for 28 years. Then the greenhouse-warming adds $129/212.5 \approx 60.7\%$. And EL Ninos added $\geq 39.3\%$ to the OHC. ($103.8 + 108.7 = 212.5$ ZJ)

Note : For my assessment I have used the well established OHC - EN4-Chart (0 – 2000 m) (→ see Info in Appendix 3)
Note : the EN4-Chart (0-2000m) used in the diagram above, was extracted from a study which aimed to reconstruct a new long-time OHC-dataset to better understand climate-events.
 → weblink to this study : LSTM-method Study

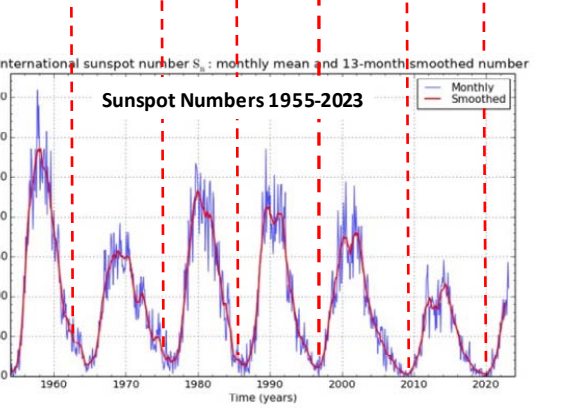
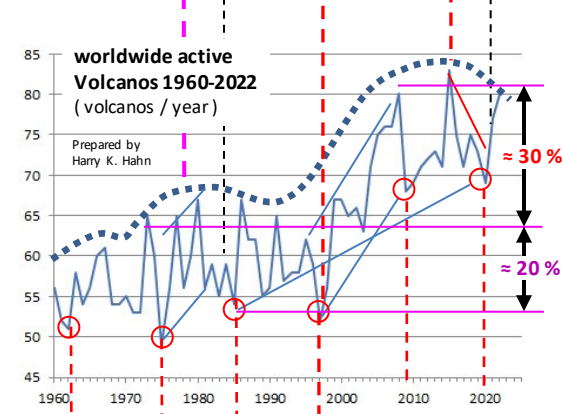
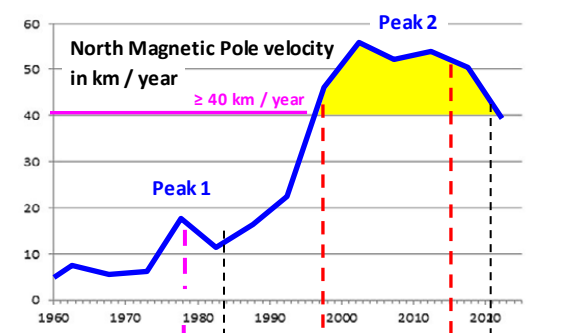
The Global Mean Sea Level (GMSL) diagram on the right also clearly indicates that the El Nino periods are the main driver of the sea-level-rise !!!



Volcanism is correlated to geo-magnetism, HGFA-seismicity, solar-cycles & global warming

A comparison of the 3 charts below indicates that volcanic activity is influenced by **shortterm** geo-magnetic effects, caused by the **sunspot cycle** (=space weather) and by a **longterm** geo-magnetic effect, the **MPV**.

The chart of the **Worldwide Active Volcanos per Year** clearly follows a very similar trend as the chart of the **North Magnetic Pole Velocity (N-MPV)** if we consider a **smoothed chart** of the **Active Volcanos/Year** (dotted line). When the **MPV** reached the wide **Peak 2** with ≥ 40 km/year we can see a **sharp rise & elevation of the volcanic activity**. If we look at the chart of the **worldwide active volcanos per year** we clearly see **sharp rises of activity in the years 1997-99, 2003-07, 2014-15 & 2020-22** interrupted by two drops caused by **sunspot cycle** minimas. Note that we had **El Ninos** events with increased **Sea Surface-temperatures** in the years **97/98, 2003-05, 2007**



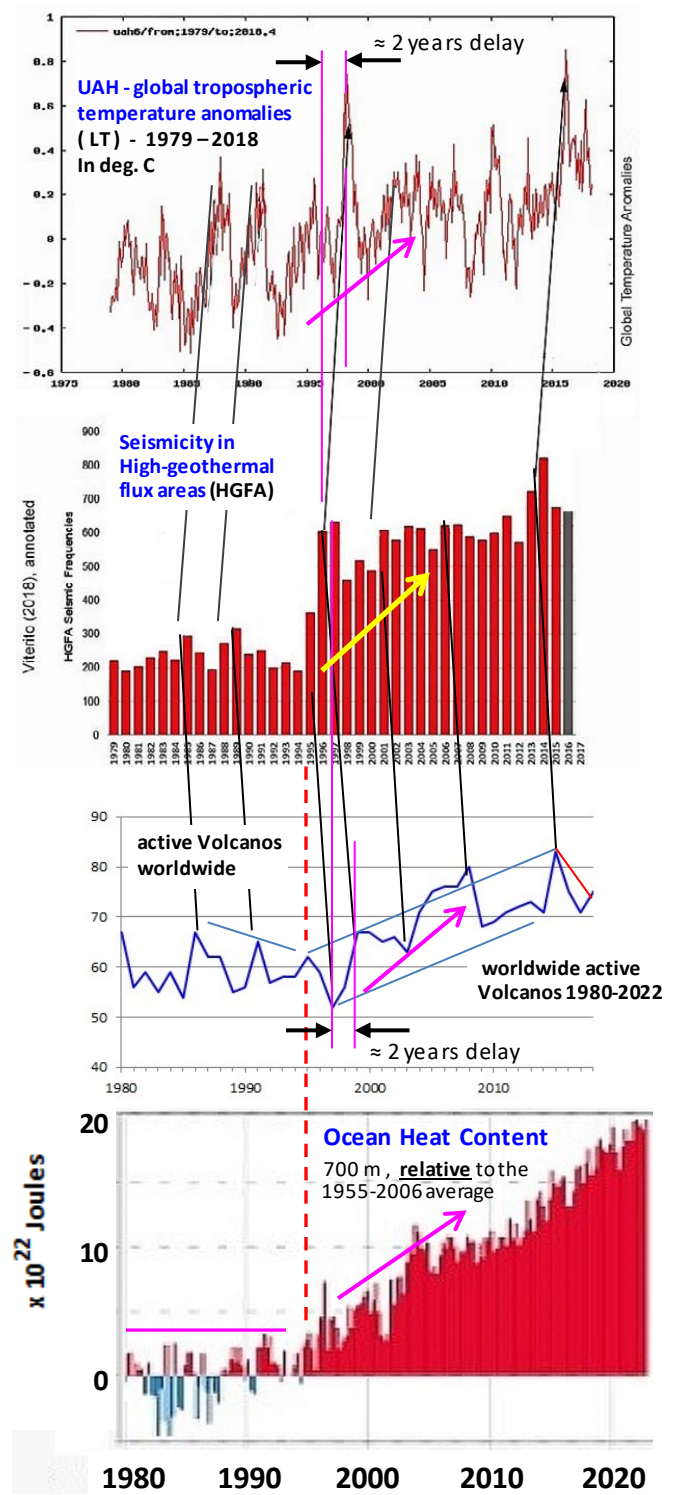
2014-16 and a **new El Nino** episode just started in ≈ 2022 . The impact of the high **MPV** on Volcanism is $\approx 30\%$ and that of **solarcycles** $\approx 20\%$. Further some studies show a clear **correlation of seismic activity in High-geothermal-flux-areas (HGFA) and the Global Warming** of the last few decades (see: [Study & Study-update](#)) \rightarrow see charts \rightarrow **HGF-areas** are all **mid-ocean-ridge-areas** and **geothermically** active areas. It is important to note that there is a **delay of around 2 years between the seismic activity and the reaction of the global climate-system.** (see charts on the right).

There is also a **delay of ≈ 2 years** noticeable **between the seismic-activity in the HGF-areas and the global volcanism** (in the chart represented by **active volcanos per year**) \rightarrow see charts on the right. This delay can be explained by the time needed for magma and/or hydrothermal fluids to rise from Earth's mantle and Earth's crust to the surface, after new fractures have opened up in Earth's crust, caused by increased seismicity resulting from the mentioned geo-magnetic effects. (magnetic pole-speed & **geomagnetic storms**) Further it's important to note that **the distinct jump in seismic activity to a higher level in the HGF-areas**, which we see in the chart in the years **1995-1997**, was followed by a strong increase in the growing-rate of the **Ocean Heat Content** since around 1996 and followed by a strong peak in **global tropospheric-temperature-anomalies** (\rightarrow see charts on the right).

Here are weblinks to infos & studies that also indicate such correlations:

- 1.) - **Correlation between solar activity and large earthquakes worldwide**
- 2.) - **A solar-terrestrial effect influences volcanism & global seismic activity**
- 3.) - **Correlation of geomagnetic anomalies with earthquakes & solar storms**
- 4.) - **Volcanic eruptions are correlated with Solar Activity**
- 5.) - **Links of Volcanic Eruptions to Solar Activity and Solar Magnetic Field**

More weblinks to similar studies under **References** (see last pages)

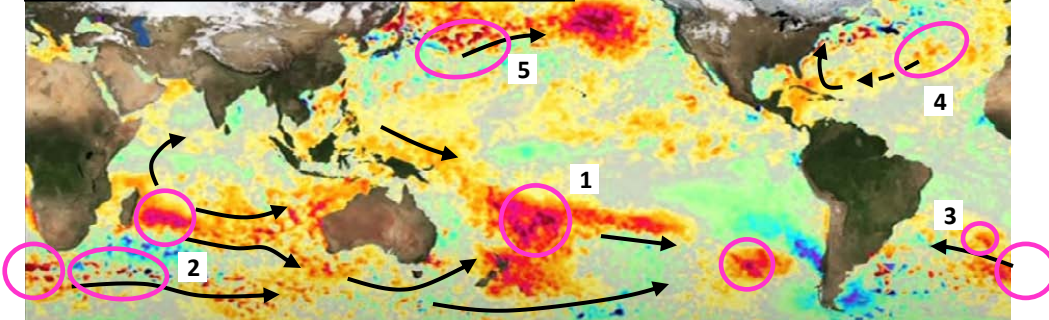


C3 El Nino 2013-15: Analysis of the Migration-paths of hydrothermal-water from the source areas 1 to 5 that was causing the El Nino

Mid of December 2013 (& in 2014 again) hydrothermal-sources located in the source-areas 1 – 5 , near hotspot-areas or mid-ocean-ridges in the Southern- & Northern-hemisphere, became active nearly simultaneously !! and ejected a lot of warm water into the oceans, as the sea-surface temperature anomalies indicate. The best examples are the Monowai- & Macauley- submarine-volcanos in the Kermadec Arc ! After this „global hydrothermal-event(s)“ ocean- and wind-currents distributed & transported the warm water mainly eastward. Most of the warm water finally accumulated in the Pacific off the W-coast of South- & North-America

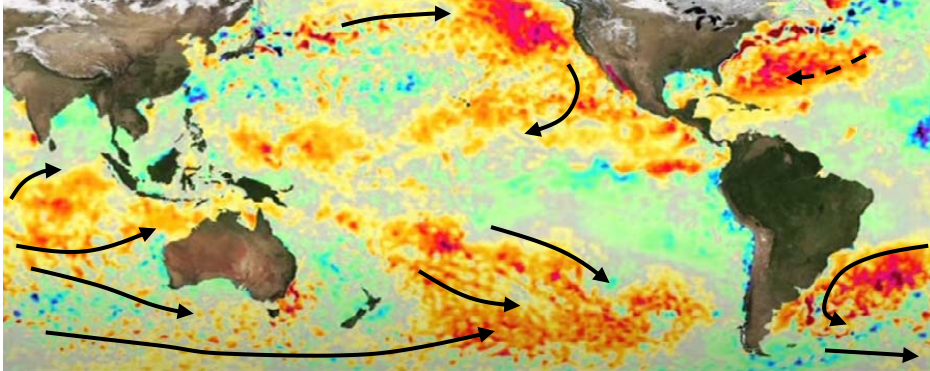
This image shows a crucial scene at the beginning of the El Nino event where we can see the hydrothermal-source areas (pink circles) which are nearly all active at the same time.

El Nino 2014-16 : date : 16.12.2013 – movie time 0:42 → movie : El Nino Watch 2015



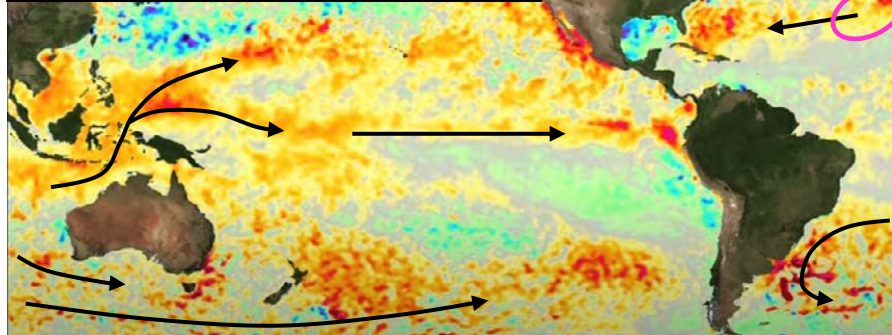
The black arrows on the images show where the warm water from the hydrothermal source areas is migrating to. A large share of it migrates eastward and is accumulating in the Pacific.

El Nino 2014-16 : date : 11.3.2014 – movie time 1:04



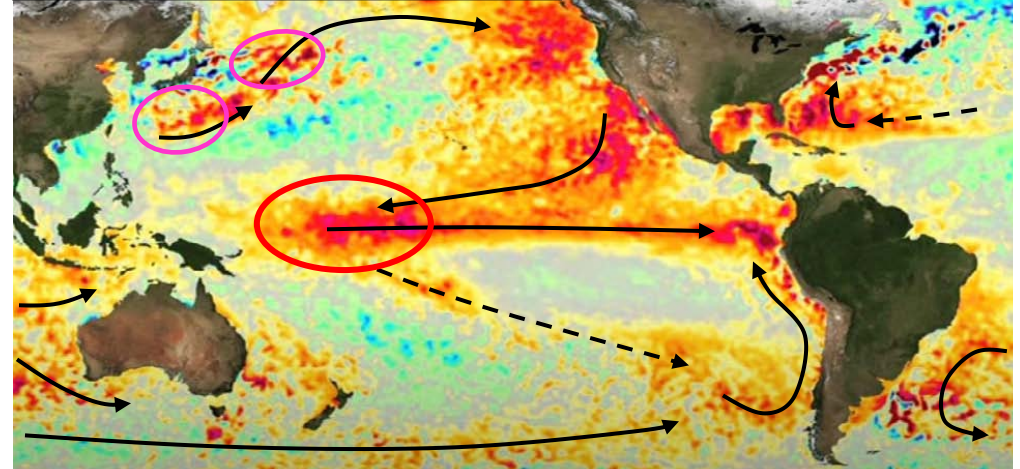
In the time period 25.4. to 10.5. a considerable amount of warm water moved between Indonesia and New-Guinea, from the Indian Ocean to the Pacific

El Nino 2014-16 : date : 3.5.2014 – movie time 1:18



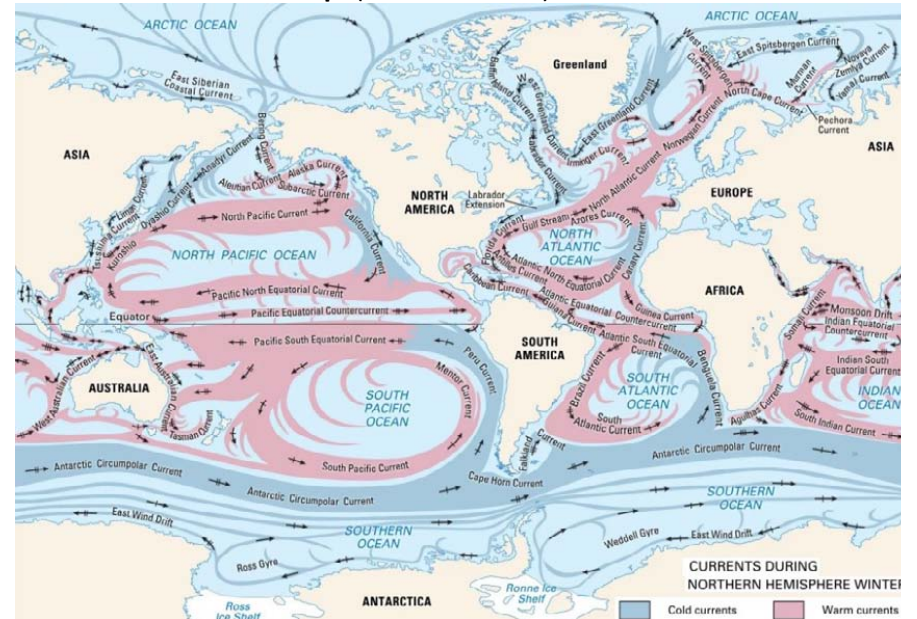
In this image the El Nino event is in full swing. A large amount of warm-water accumulate in the equatorial West-Pacific (red ellipse) and westerly wind bursts transport it to South-America

El Nino 2014-16 : date : 22.4.2015 – movie time 2:53



Note : In the area indicated by the red ellipse warm water accumulates and then gets pushed towards east by westerly wind bursts & cyclone-activity

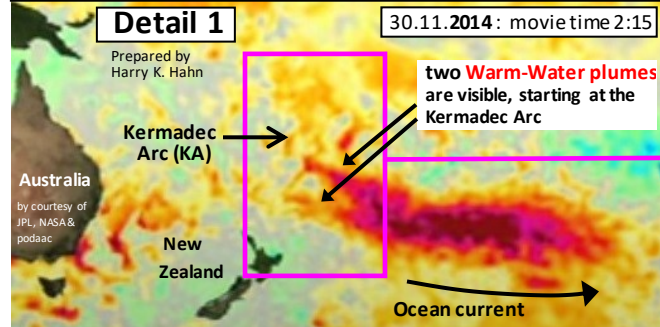
Ocean Currents worldmap (for Reference)



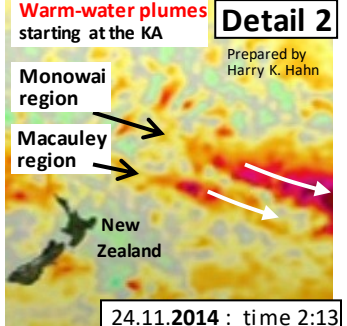
2014 : Two big warm-water plumes caused by the Monowai- & Macauley- Volcanos in the Kermadec-Arc caused large SST-anomalies

The animation of the **Sea-Surface Temperature (SST)**-anomalies of the **2014-16 El Nino** provides **evidence for the real cause of strong SST-anomalies (warm-water Blobs)** ! In the animation it is clearly visible that the cause of the strong anomaly that developed in the time 24.11.-30.11.2014 was **submarine volcanism and/or hydrothermal activity** !! The image sequence from 24.11.-30.11.2014 shows **two warm-water plumes** which were caused by the **Monowai- & Macauley - submarine volcanos** in the **Kermadec Arc (KA)** !

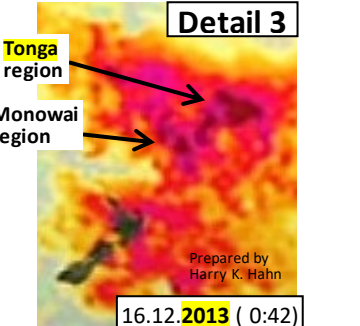
→ video: **El Nino Watch 2015** (video from Nov. 29 - 2015)



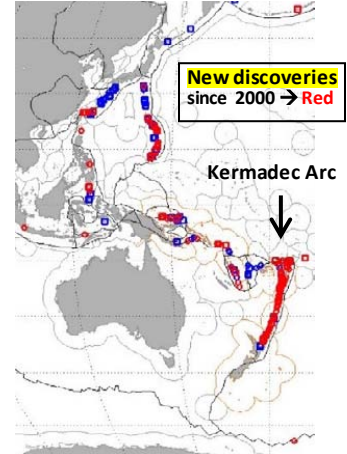
Detail 2 : shows two hydrothermal sources in the **Kermadec Arc (KA)** Probably located in the regions of the **Monowai- & Macauley** volcano



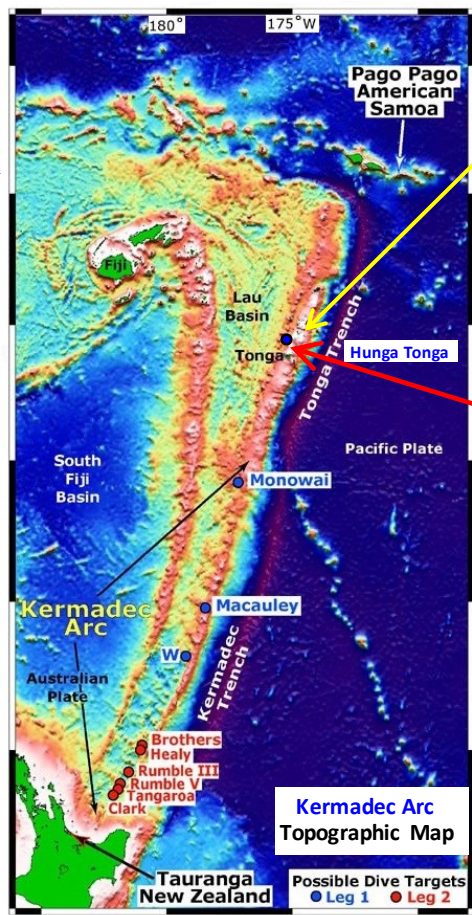
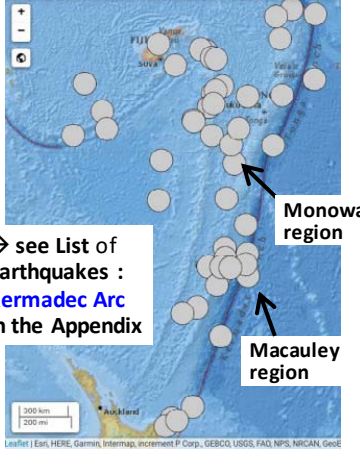
Detail 3 : shows a **different** activity phase of the volcanos of the KA, in which volcanos in the **Tonga-region** & the **Monowai** volcano were active



Submarine hydrothermal venting (volcanism) locations_ West-Pacific



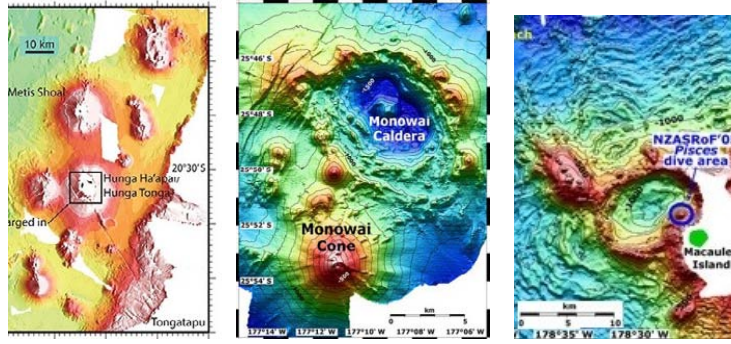
Earthquakes > 7.0 mb in the time 1990-2023.06 in the **Kermadec Arc**



One year before on 16th Dec. 2013 the submarine volcanos in the **Tonga-region** and the **Monowai** volcano were active → see **Detail 3 :**

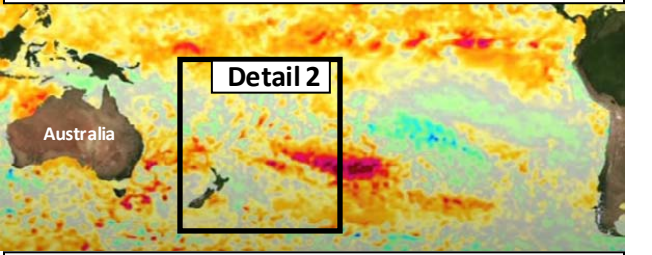
Place of the **Hunga Tonga Volcanic-Explosion** from 2022

Hunga Tonga volcano **Monowai volcano** **Macauley volcano**

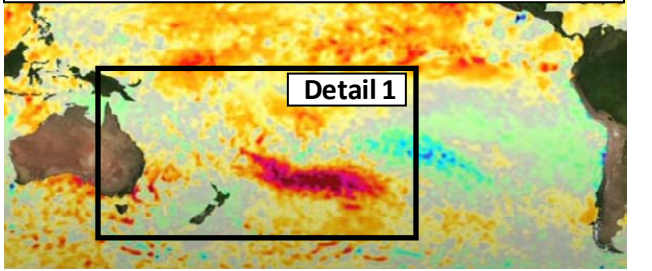


The following images show strong **SST-Anomalies**, which have their origin at submarine volcanic locations in the **Kermadec Arc** → video: **El Nino Watch 2015** (video from Nov. 29 - 2015)

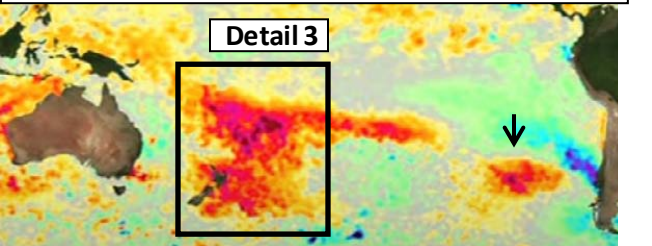
El Nino 2014-16 : image from 24.11.2014 – movie time 2:13



El Nino 2014-16 : image from 30.11.2014 – movie time 2:15

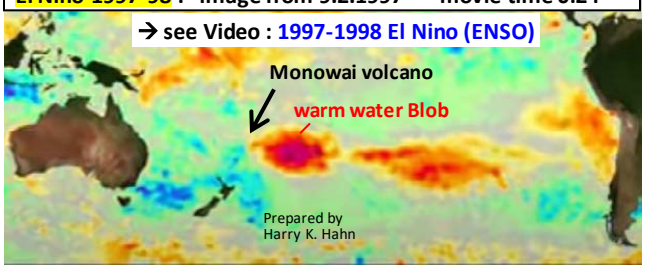


El Nino 2014-16 : image from 16.12.2013 – movie time 0:42



Hydrothermal activity of the **Monowai-volcano** in Feb. 1997

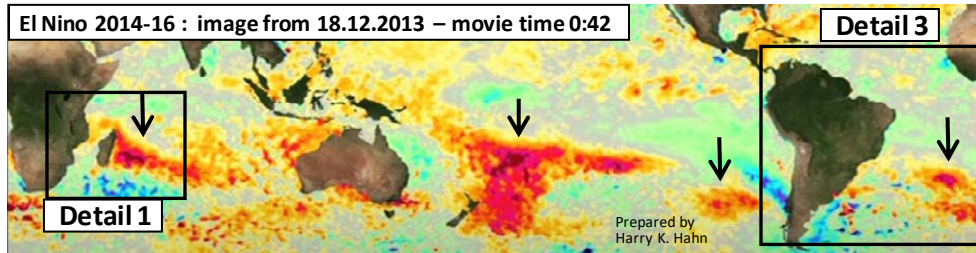
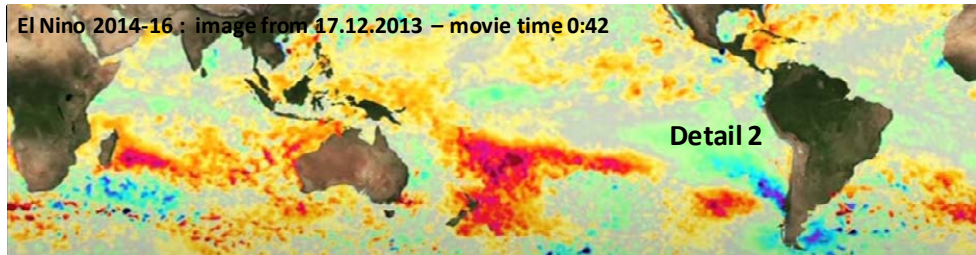
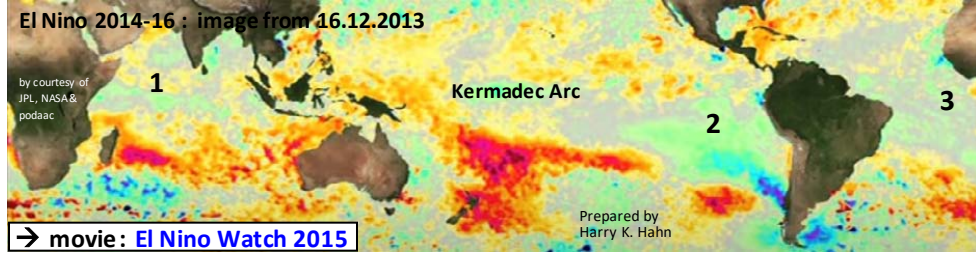
El Nino 1997-98 : image from 9.2.1997 – movie time 0:24



2013 : Large SST-anomalies caused by hydrothermal-sources on 4 very different places at the same time indicate a global phenomenon

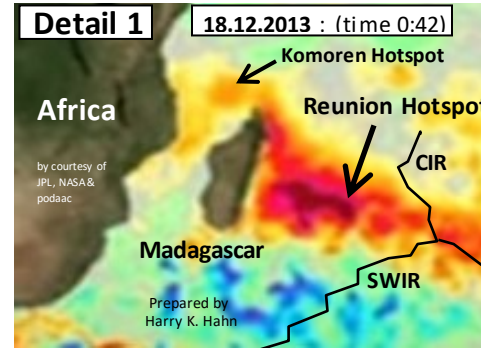
The image sequence below shows the early beginning of the 2014-16 El Nino. The **warm water** which caused the strong El Nino-event at the Pacific-equatorial-region in 2015 already started to accumulate on the surface of the worlds oceans in December 2013 ! **December 2013** is a crucial point in time in order to understand **the real cause of El Ninos**, because this time allowed to notice **the real sources** of the **warm water** that later caused the El Nino SST-anomalies. On the images I marked **4 positions** where **Warm-water Blobs** developed on the surface **at the same time**, which were feed by **submarine volcanism** and/or **hydrothermal-sources** ! For the **Kermadec-Arc-region** I already described the probable hydrothermal sources (→ see previous page). For the other 3 locations marked on the SST-anomaly-map(1-3) I describe the probable **hydrothermal-sources** below.

Note : Important is the fact that on all 4 positions the **volcanic &/or hydrothermal-activity** started & increased nearly at the same time ! **This indicates a global phenomenon !**

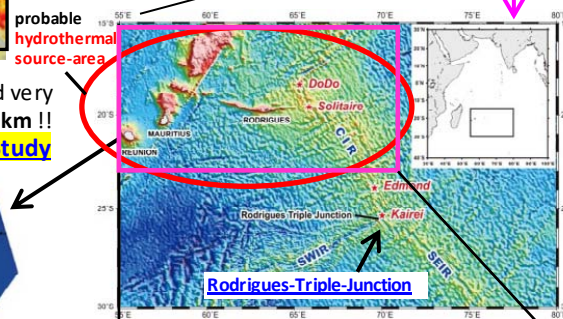
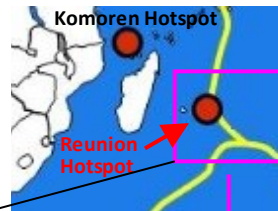


SST-anomaly caused by the Reunion-hotspot :

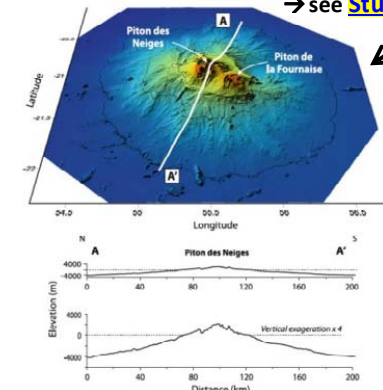
The SST-anomaly that developed east of Madagascar came from **hydrothermal-sources** in the **Reunion-area** (e.g. **Piton de Fournaise, Rodrigues-Ridge, CIR** etc.)



The map below shows the **Reunion hotspot area** and the **4 hydrothermal-fields** DoDo, Solitaire, Edmond & Kairei and the Rodrigues-Ridge, → the **probable hydrothermal source-area** → see **Study2**

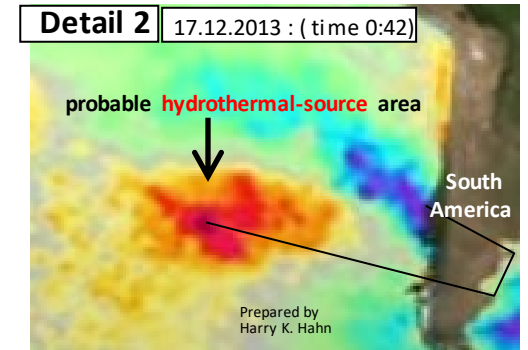


Piton de la Fournaise is a large and very active **shield-volcano** – Base Ø 200 km !! → see **Study**

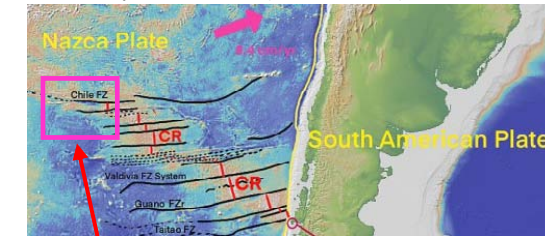


SST-anomaly developed near the Chile Rise :

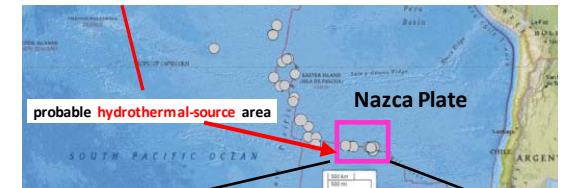
This SST-anomaly (**warm-water Blob**) developed at or near the **Chile Fracture Zone**, which is located at the southern boundary of the **Nazca Plate**. It belongs to the **Chile Rise**, an earthquake-rich fracture zone.



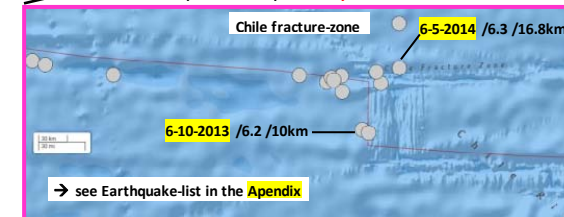
Tectonic Map of the Chile Rise (-fracture zones) in the SE-Pacific



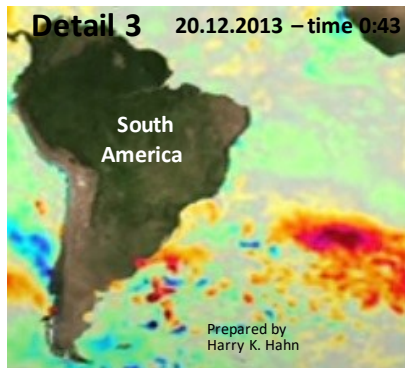
Earthquakes ≥ 6.0 near the probable **hydrothermal-source** area – 1990 to 2023.06



Earthquakes in the possible **hydrothermal-source** area



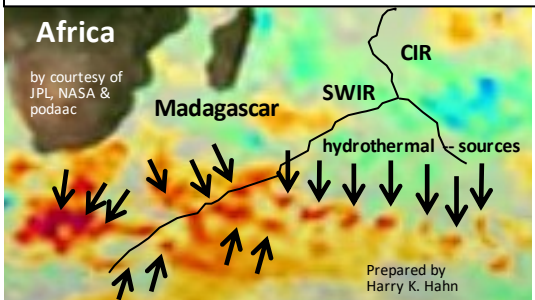
Description of the hydrothermal source visible in **Detail 3** → see next pages !



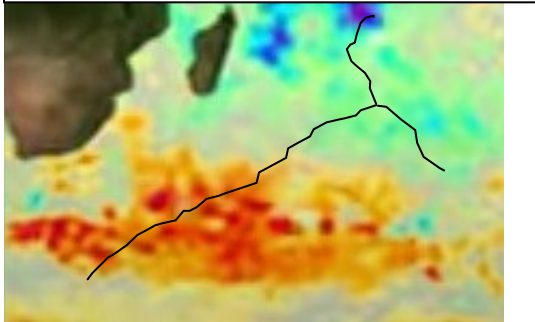
1997 : Hydrothermal-sources near the SWIR & hotspots, caused SST-anomalies

→ Weblink to SST-animation : "1997-1998 El Nino..."

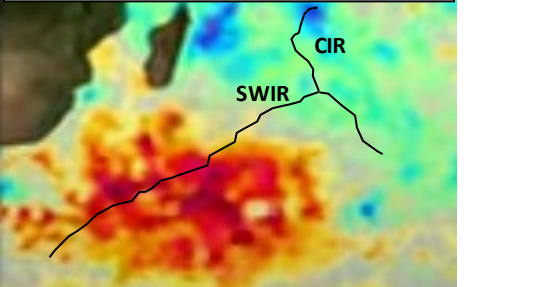
El Nino 1997-98 : date 7.1.1997 - movie time 0:19



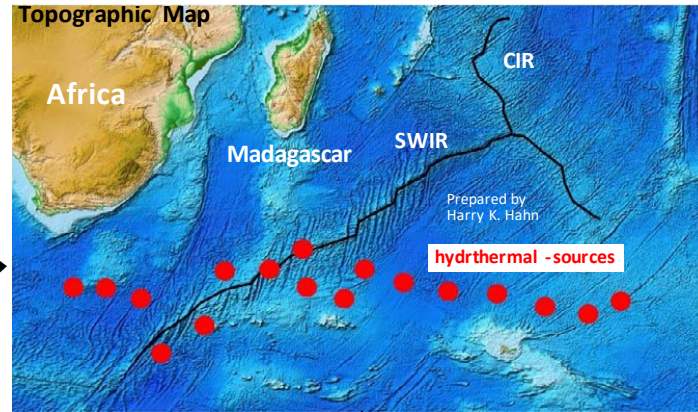
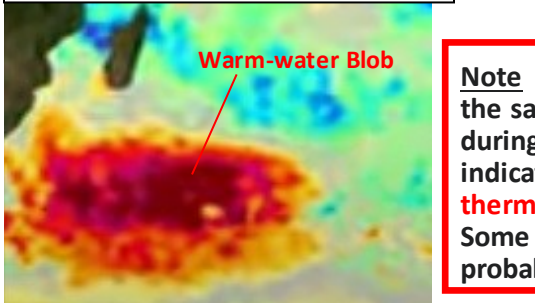
El Nino 1997-98 : date 28.1.1997 - movie time 0:22



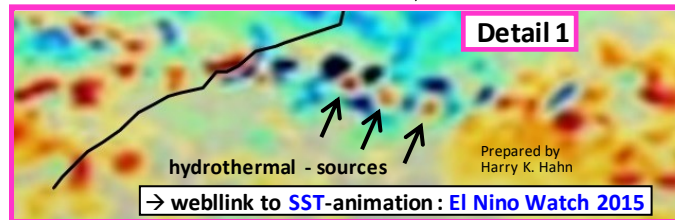
El Nino 1997-98 : date 2.2.1997 - time 0:23



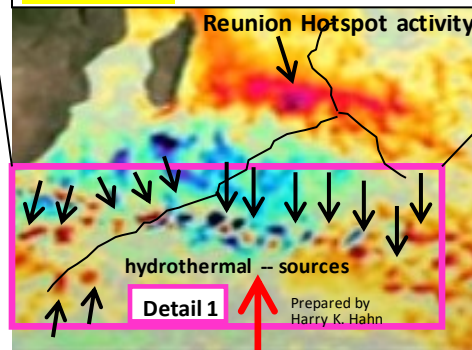
El Nino 1997-98 : date 12.2.1997 - time 0:24



Note : the same pattern !



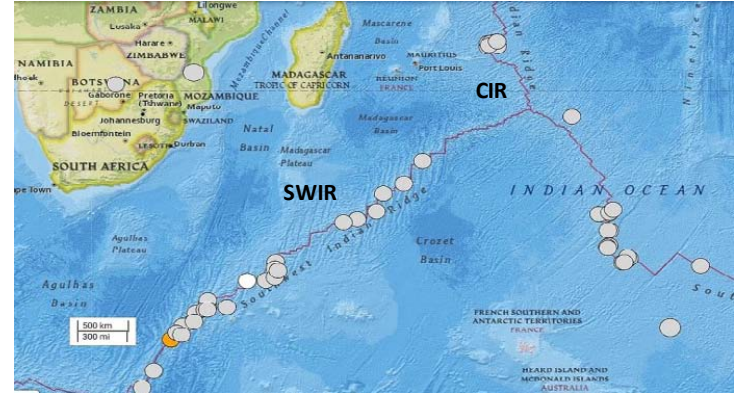
El Nino 2014-16 : date 13.12.2013 - time 0:41



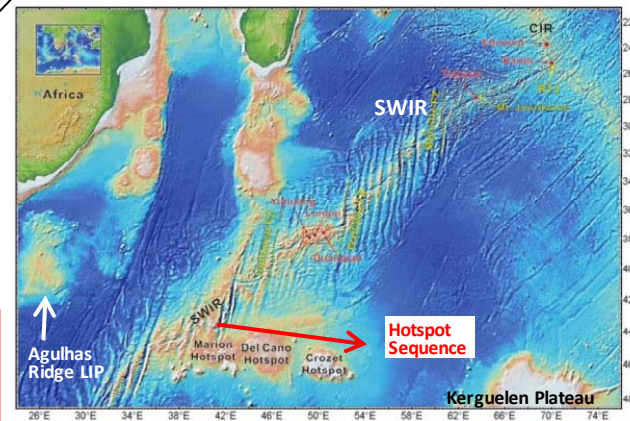
Note : At the start of the 2014-16 El Nino event the same pattern of Warm-water Blobs is visible as during the 1997-98 event ! The small red blobs indicate considerable less intensity of the hydrothermal sources if compared with the 97/98 El Nino. Some sources are inactive. The deep blue blobs probable represent lateral up-welling cold-water.

The large Warm-water Blob that developed south of Madagascar in Jan. & Feb. 1997 during the 1997-98 El Niño was caused by many hydrothermal/volcanic-sources (≥ 16) on the ocean-floor which are located close to the following hotspots : Marion-, Del Cano-Rise-, Crozet-hotspot, and located close to the South-West-Indian-Ridge (SWIR), the Agulhas LIP or the Kerguelen Plateau (LIP) The small red Blobs are no Eddy's on the surface ! These blobs are stationary-hydrothermal sources as the SST-anomalies from 13th Dec. 2013 indicate ! At that date the (nearly) same pattern of red Blobs (→ blobs at nearly the same positions !) is visible ! However here the hydrothermal-sources were considerable less active.

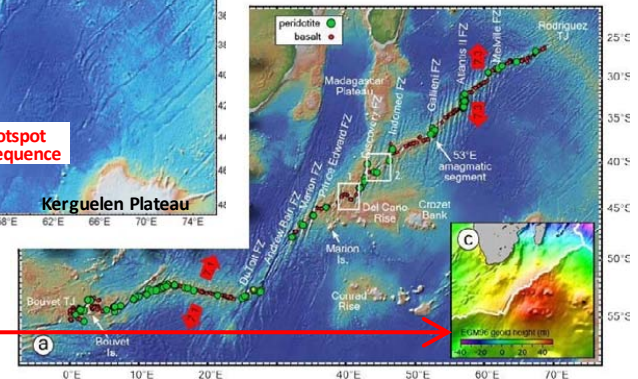
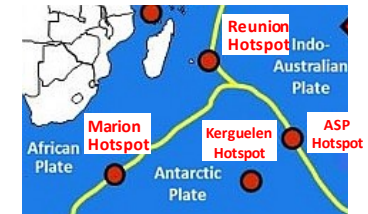
Earthquakes ≥ 6.0 along the plate boundaries – 1990 to 2023.06



Tectonic Map of the South-West Indian Ridge (SWIR)



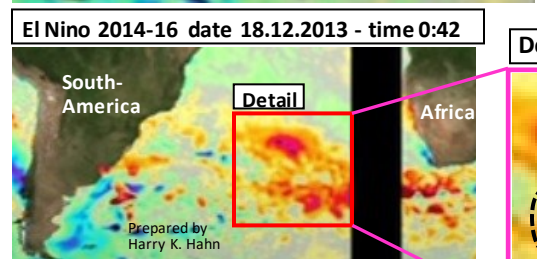
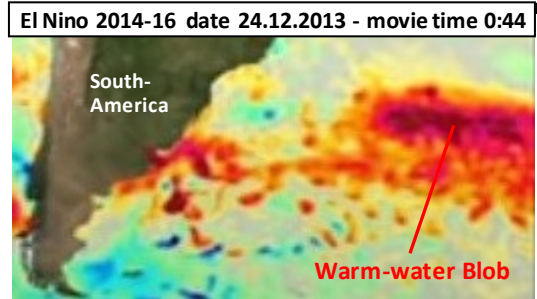
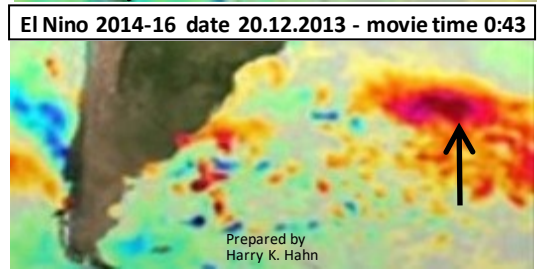
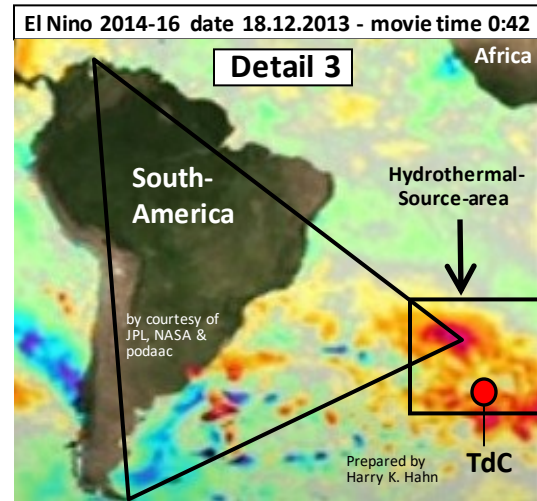
Main Hotspots & Plate Boundaries



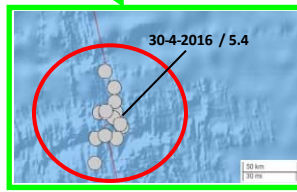
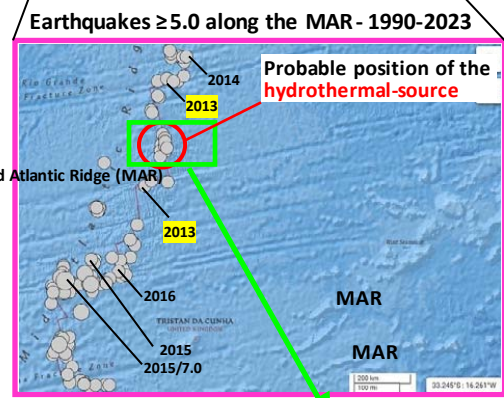
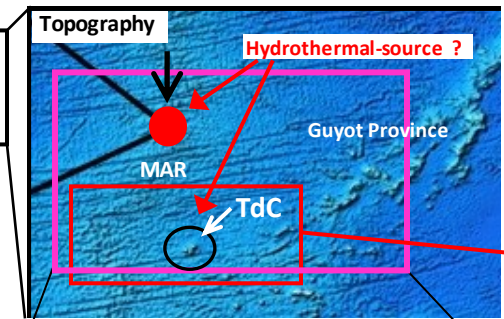
Note the positive Geoid anomaly under the hydrothermal source area !

2014-16 El Nino : SST-anomalies were caused by hydrothermal-sources at tectonic-fractures near the Tristan-da-Cunha hotspot

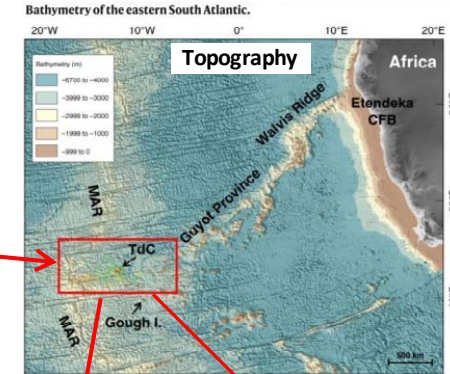
→ weblink to SST-animation : [El Nino Watch 2015](#)



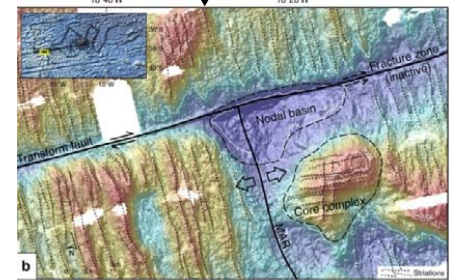
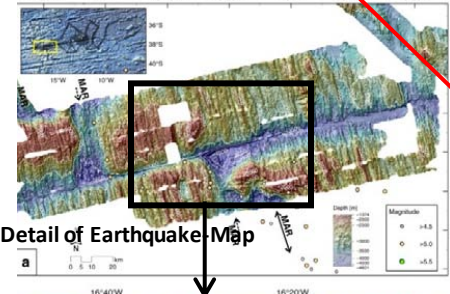
At the beginning of the 2014-16 El Nino event, there was a strong warm-water anomaly developing in the Atlantic Ocean, starting around Dec. 18th 2013 (see images on the left). Like the other strong SST-anomalies of the 2014-16 El Nino this Warm-water Blob in all probability was caused by a strong hydrothermal-event/ submarine volcano on the ocean floor too. Indication for this assumption comes from the fact, that the warm-water anomaly precisely developed above the Mid-Atlantic Ridge (MAR), as the center-point of the SST-anomaly indicates. This point is close to the Rio-Grande Fracture-Zone, which is orientated perpendicular to the MAR. Near the indicated area of the Mid-Atlantic Ridge (MAR) earthquakes >5.0 took place in the time 2013-16. The island Tristan da Cunha is located around 650 km south of the shown warm-water-blob above the MAR. Because this blob developed not far away from the Tristan da Cunha hotspot (TdC) where a large mantle plume is located below Earth's crust, there is the probability that the hydrothermal-water from the TdC was moved a bit northward by currents.



The image from 18.12.2013 shows the second possibility where Tristan da Cunha is the true hydrothermal-source and surface currents accumulated the warm water further North

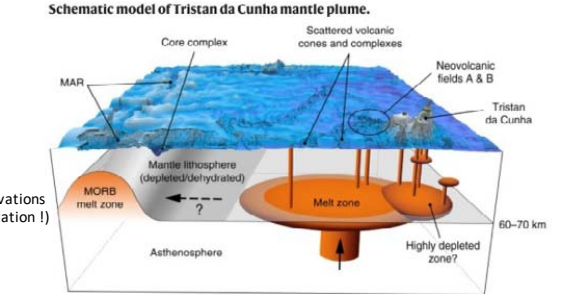


a.) Bathymetry of a Mid-Atlantic Ridge area. Dots mark earthquake epicenters from teleseismic observations
b.) Close-up of an Oceanic-Core-Complex (rotated orientation!) (TTFZ = Tristan da Cunha Fracture Zone System).



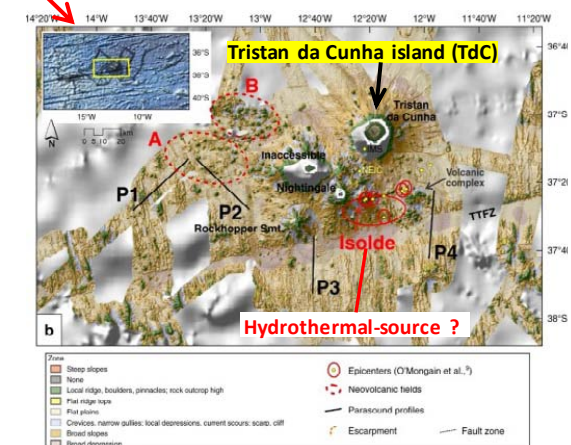
Exploration of the Tristan da Cunha area :

These images are from an exploration around Tristan da Cunha (TdC) that explored the submarine volcanic activity around this island, and which recorded the topography of the MAR-section west of the island. (this is the closest explored area to the hydro-thermal source which I found) → see Study



3D sketch of the lithosphere and potential mantle plume location SW of Tristan da Cunha. The model is based on Geissler et al., Humphreys and Niu, and Schoefer et al.

Benthic Terrain Model - Yellow dots with red ellipses mark local earthquake epicenters associated with submarine volcanic activity in 2004. Areas A and B outline relatively young volcanic fields and lava flows.

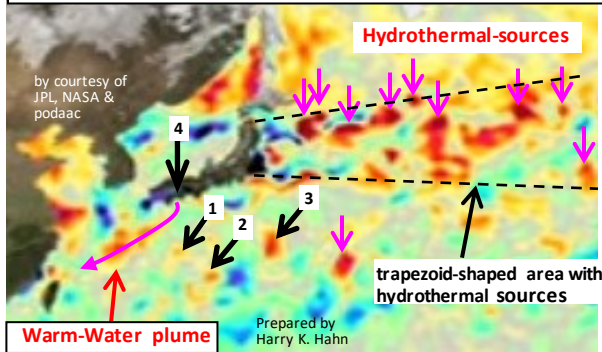


2014-16 El Nino: At least 10 hydrothermal-sources in a trapezoid area east of Japan and ≥ 4 sources south of Japan caused SST-anomalies

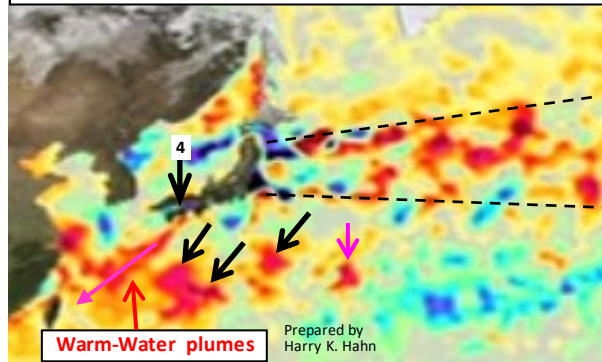
The animation of (SST)-anomalies of the 2014-16 El Nino indicates ≥ 10 hydrothermal/submarine-volcanic-sources in a trapezoid-shaped area east of Japan and ≥ 4 bigger sources south of Japan that caused warm water blobs/plumes ! I marked the approximate positions of these stationary hydrothermal-sources with yellow and red dots on the topographic map. And I will describe the four yellow sources (1-4) in more detail. The probable hydrothermal sources 1 & 2 are located in areas with very thin Earth-crust with $< 5\text{km}$ at Pos.1 ! Source No.3 probably is the Nishinoshima- &/or Torishima (\rightarrow info) -volcanic-area. Source No. 4 is located in the Nankai-Trough-area where an extreme heatflow anomaly was detected. **Note:** The images below show a warm-water plume coming from this area !! For the other red-marked sources no info was found.

\rightarrow weblink to SST-animation : [El Nino Watch 2015](#)

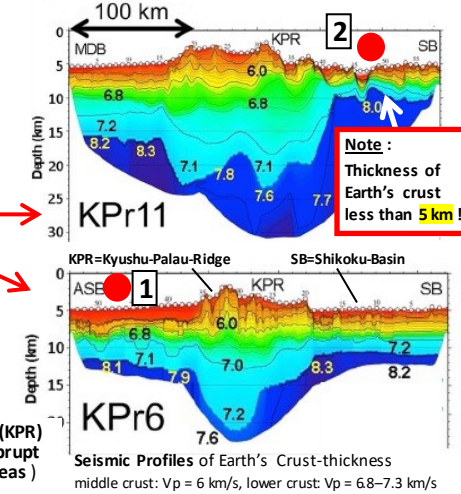
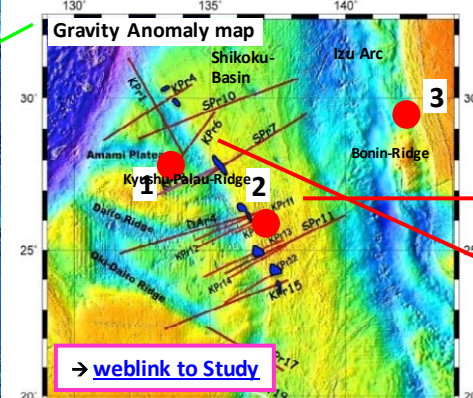
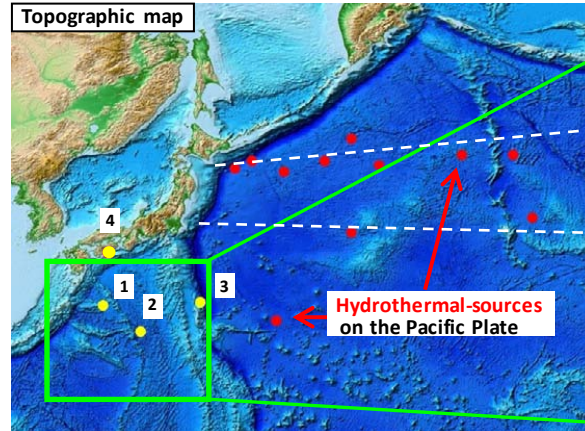
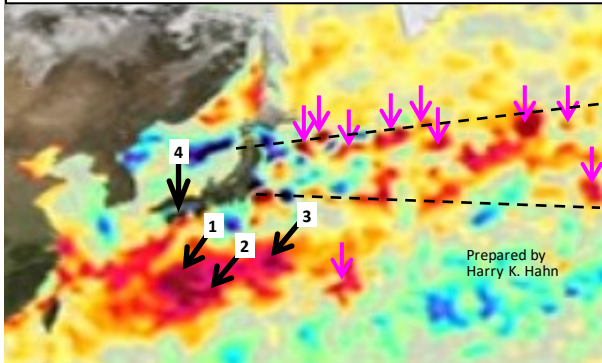
El Nino 2014-16 : image from 29.3.2015 - movie time 2:46



El Nino 2014-16 : image from 4.4.2015 - movie time 2:48



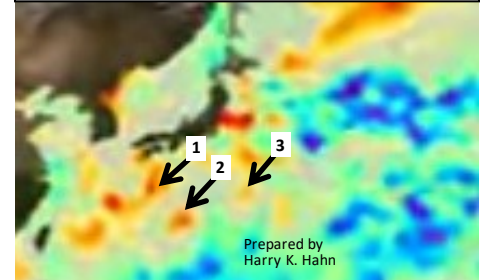
El Nino 2014-16 : image from 6.4.2015 - movie time 2:49



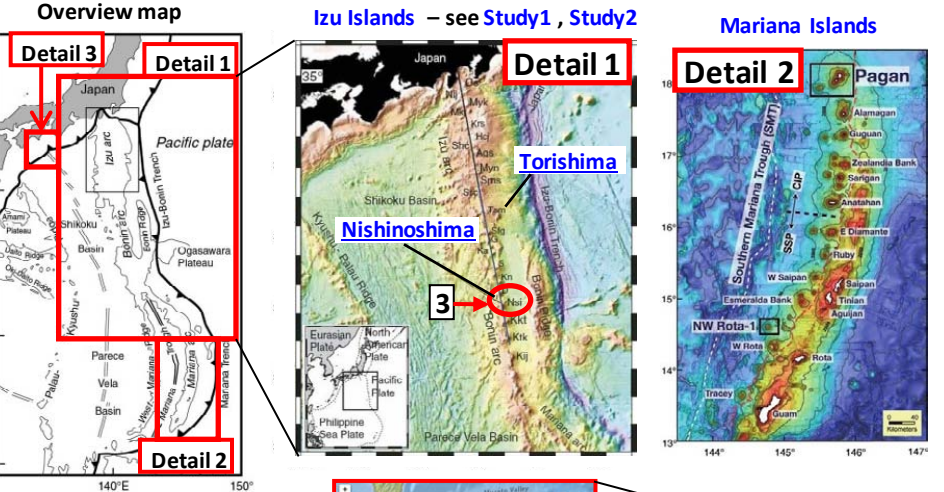
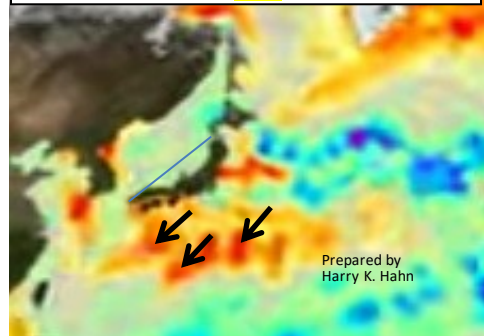
Note : During the 1997-98 El Nino event hydrothermal-sources in the same locations south of Japan were active as during the 2014-16 El Nino !

\rightarrow Weblink to SST-animation : "1997-1998 El Nino..."

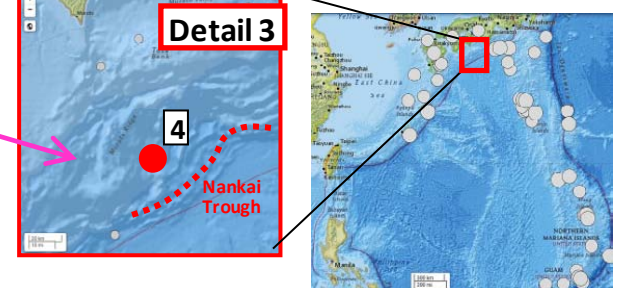
El Nino 1997-98 : 28.4.1997 - movie time 0:34



El Nino 1997-98 : 8.5.1997 - movie time 0:35



Note : An extremely high heat-flow anomaly has been detected in the central part of the Nankai Trough. A possible cause of the anomaly is reheating of the lithosphere by post-spreading thermal activities. \rightarrow [weblink to this Study !](#)

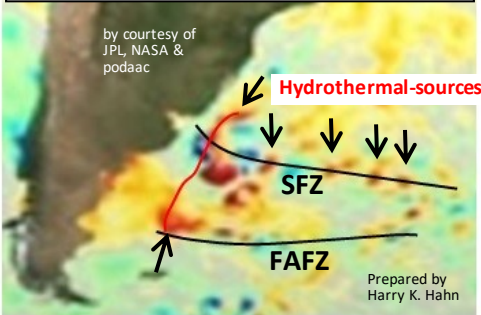


2014-16 El Nino : East of Argentina ≥ 10 hydrothermal-sources caused large SST-anomalies

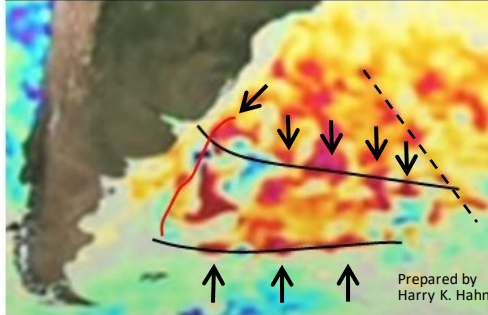
In the animation SST-anomalies of the 2014-16 El Nino I have found ≥ 10 stationary hydrothermal-sources (-fields) on the ocean-floor east of the SE-coast of South-America, which caused warm water blobs/plumes east of Argentina & Brasilia ! Five of these hydrothermal-fields that were particular strong (& durable) are located along the Salado-Fracture-Zone (SFZ) And another 4 - 5 hydrothermal-sources (-fields) are located along the Falkland-Agulhas-Fracture-Zone (FAFZ) (\rightarrow see maps below). Other sources seem to be located in the area of the Rio-Grande Rise and near the continental shelf.

I have marked the approximate positions of these hydrothermal-sources with yellow dots on the topographic map

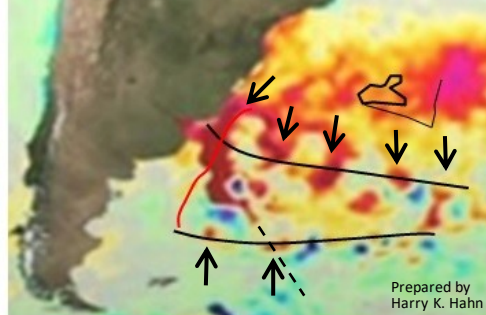
El Nino 2014-16 : 1.12.2013 - movie time 0:36



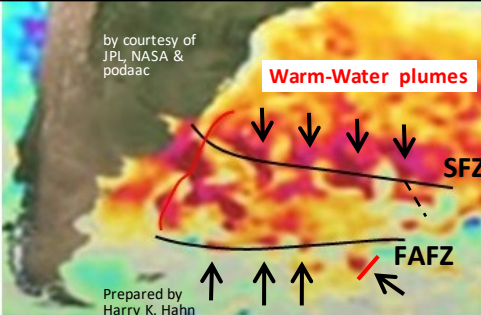
El Nino 2014-16 : 14.4.2014 - movie time 1:13



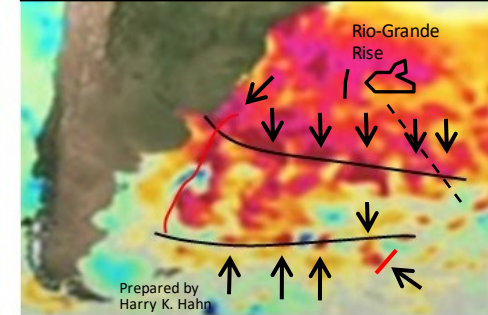
El Nino 2014-16 : 2.11.2014 - movie time 2:07



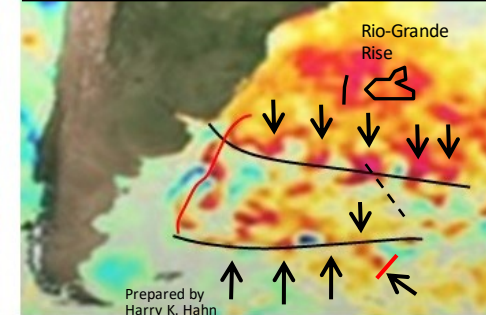
El Nino 2014-16 : 26.12.2014 - movie time 2:22



El Nino 2014-16 : 1.1.2015 - movie time 2:23



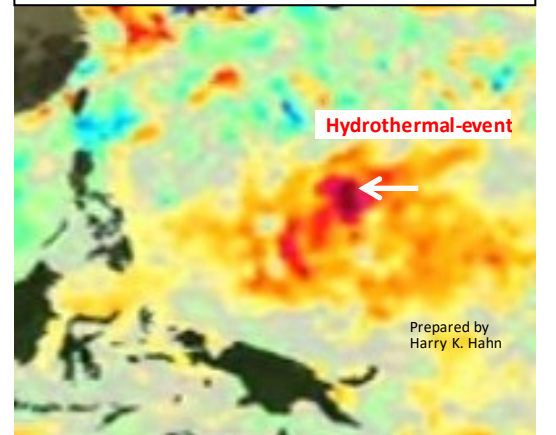
El Nino 2014-16 : 6.1.2015 - movie time 2:24



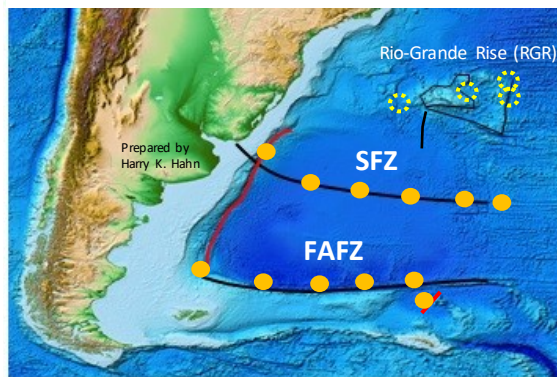
2014 : Eruption in the Mariana Arc

Another hydrothermal-source of the 2014-16 El Nino probably was caused by a submarine eruption-/ hydrothermal-event in the Mariana Arc-area. This is indicated by eruptions of the Ahyi-volcano on 24.4.2014 and by new found volcanic activity in 2015 \rightarrow [Weblink1](#), [Weblink2](#)

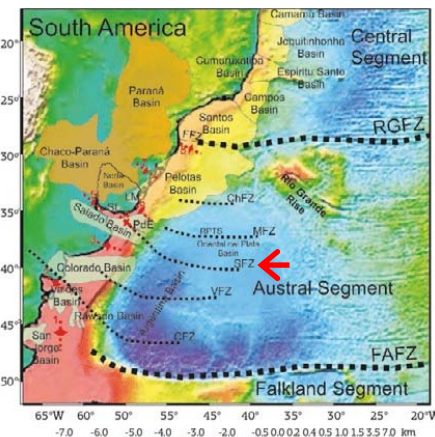
El Nino 2014-16 : date: 27.2.2014 - movie time 1:01



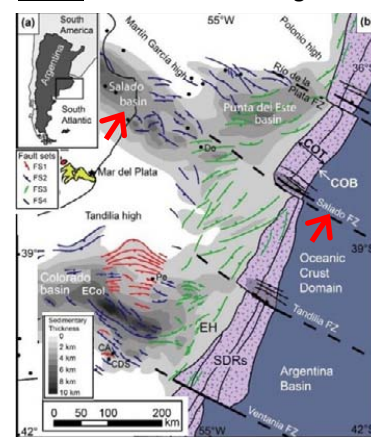
Topographic map with locations of the FAFZ, SFZ & RGR \rightarrow positions of probable hydrothermal sources are marked



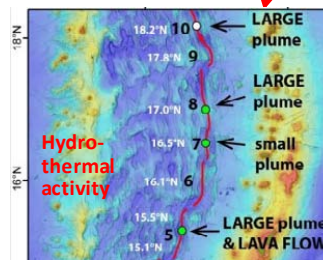
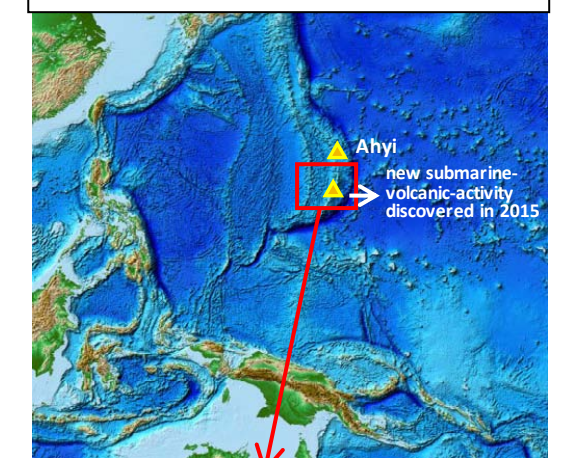
Topographical map of SE-South-America overlain by basins & structural elements



Structural map of the Colorado- and Salado- basins offshore of Argentina



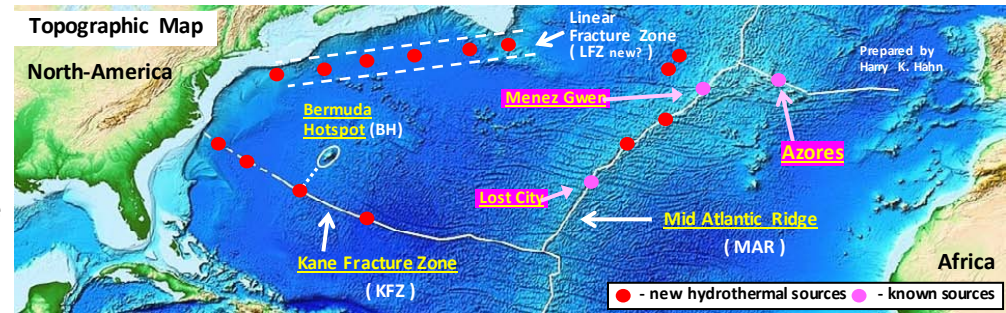
Topographic map + with position of Ahyi- volcano



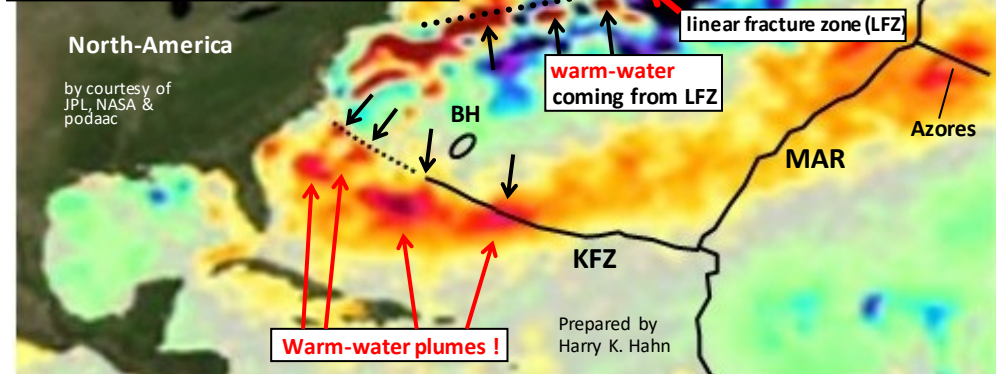
New hydrothermal vents and new lava-flows were discovered in 2015 by an expedition in the shown section of the Mariana-Arc (MA). Note: There are ≥ 60 volcanic-centers (sea-mounts) with ≥ 26 having hydrothermal vents in the MA \rightarrow See: [Weblink](#)

2014-15 : Along the Mid-Atlantic Ridge, Kane Fracture-Zone and a new FZ, hydrothermal-vents caused SST-anomalies (plumes)

SST-anomalies of the 2014-16 El Nino show a number of active hydrothermal-sources (-fields) along the Mid-Atlantic Ridge (MAR), along a (new?) Linear Fracture Zone (LFZ) and along the Kane-Fracture Zone (KFZ) which runs south of the Bermuda Hotspot (BR) from East to West. There were clearly visible warm-water plumes coming from hydrothermal-fields located on the Kane Fracture Zone (KFZ), on the LFZ and on the MAR in 2014 & 2015. Two of the found hydrothermal-fields are already known (Lost City & Menez Gwen) see:→ [Weblink1](#), [Weblink2](#)

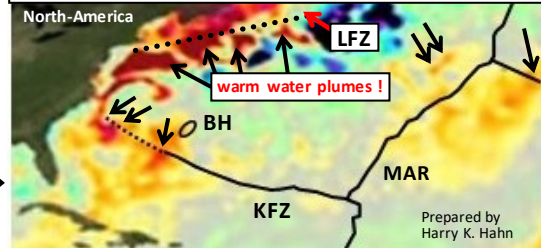


El Nino 2014-16 : date 30.5.2014 - time 1:26

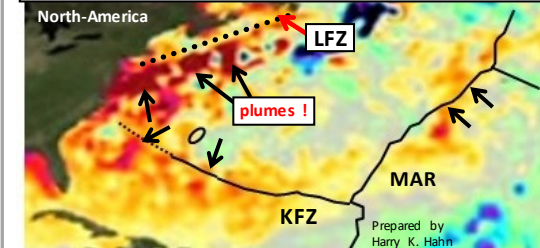


Positions of the ≥ 8 discovered hydrothermal-fields marked on the map →

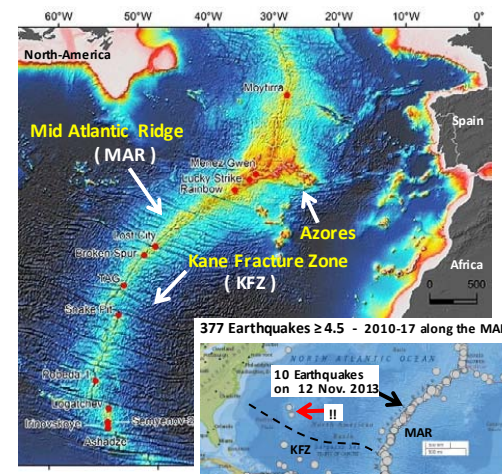
El Nino 2014-16 : 18.5.2014 - movie time 1:22



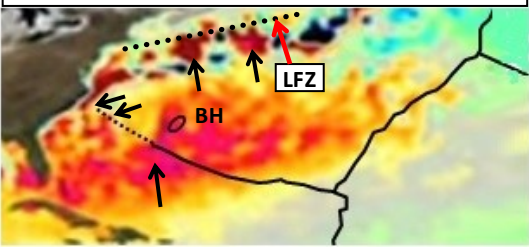
El Nino 2014-16 : 19.5.2015 - movie time 3:00



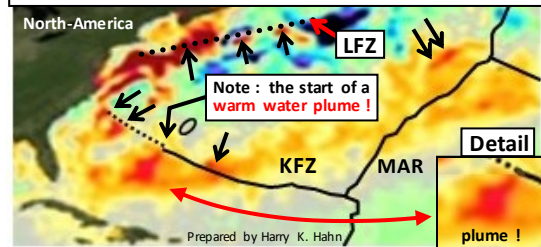
known hydrothermal-fields along the MAR



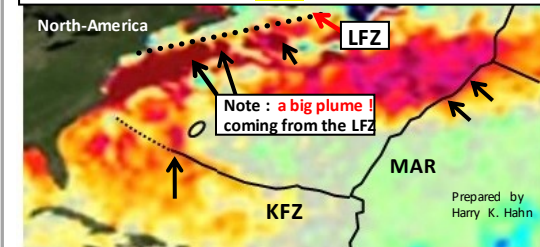
El Nino 2014-16 : 26.2.2014 - movie time 1:01



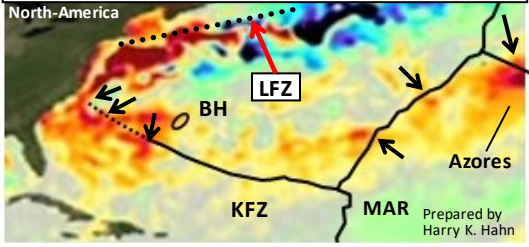
El Nino 2014-16 : 27.5.2014 - movie time 1:25



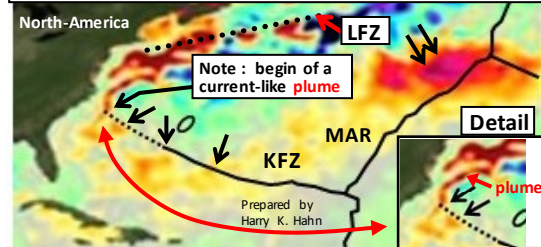
El Nino 2014-16 : 2.6.2015 - movie time 3:04



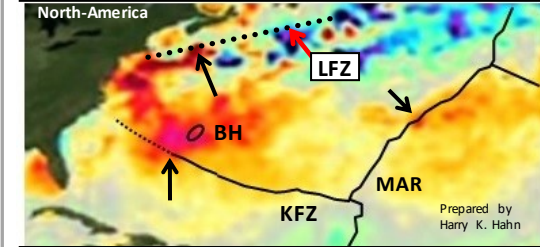
El Nino 2014-16 : 10.5.2014 - movie time 1:20



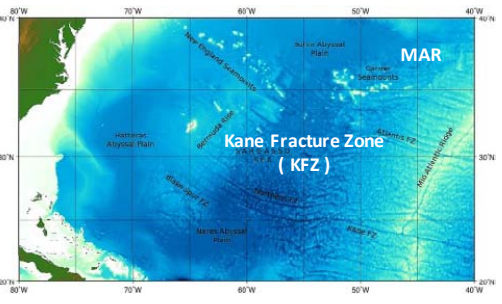
El Nino 2014-16 : 3.6.2014 - movie time 1:27



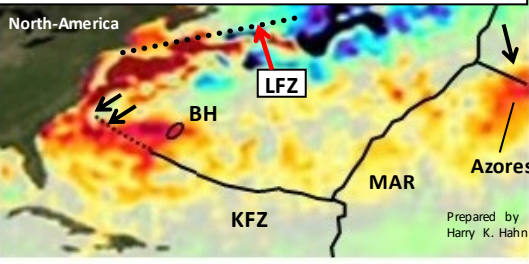
El Nino 2014-16 : 6.7.2015 - movie time 3:13



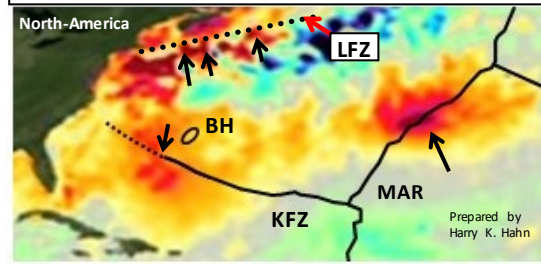
Fracture Zones & Seamount-areas in the NW-Atlantic



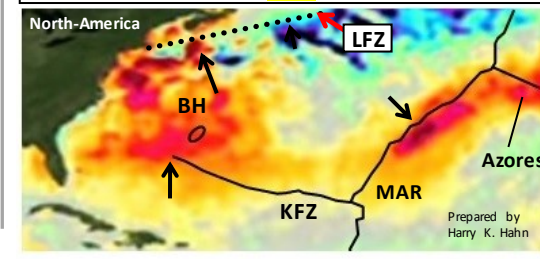
El Nino 2014-16 : 12.5.2014 - movie time 1:21



El Nino 2014-16 : 28.6.2014 - movie time 1:33



El Nino 2014-16 : 11.7.2015 - movie time 3:14



Appendix 1: → How to use the **NASA – Worldview** tool & → How to analyse the **sea surface temperature-anomalies** by yourself

NASA – worldview is a free tool to analyse satellite images from ≥ 1000 data-sets (e.g. sea surface- temperatures, -anomalies, -salinity etc.)

To use this tool please follow these steps :

1.) Register as user on Worldview :

first goto :

<https://www.earthdata.nasa.gov/>

then goto : **Find data**

<https://www.earthdata.nasa.gov/learn/find-data>

then **Register**

This is necessary to be able to use Worldview

then goto : **Eartdata Login :**

https://urs.earthdata.nasa.gov/documentation/for_users/welcome

Now you can start using the map tools.

Goto : **Find Data**

← Then scroll down and clic on : **Worldview**
(see image on the left)

Worldview : (direct weblink)

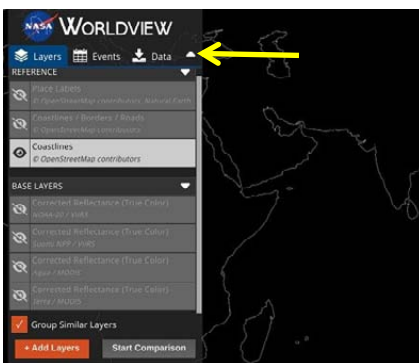
<https://worldview.earthdata.nasa.gov/>

2.) Starting the map tool

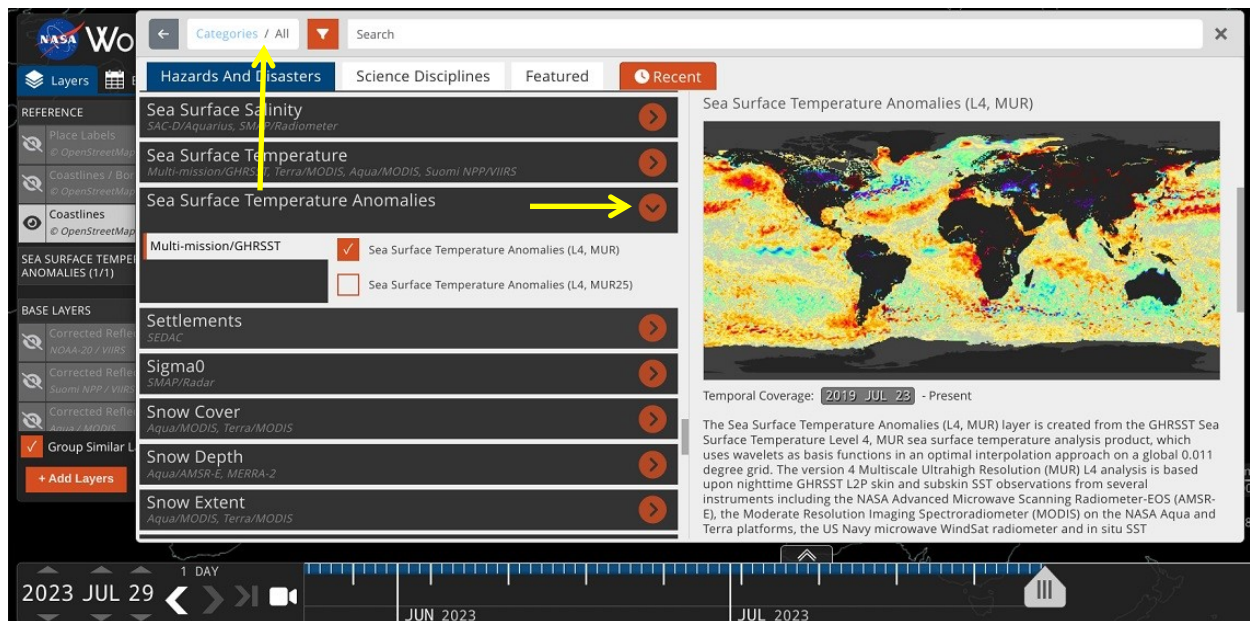
To start the map-tool you must clic on the small arrow (triangular symbol) on the top menue. (→ yellow arrow)
Then the shown menue-list appears.

Disable all lines except of **“Coastlines”**

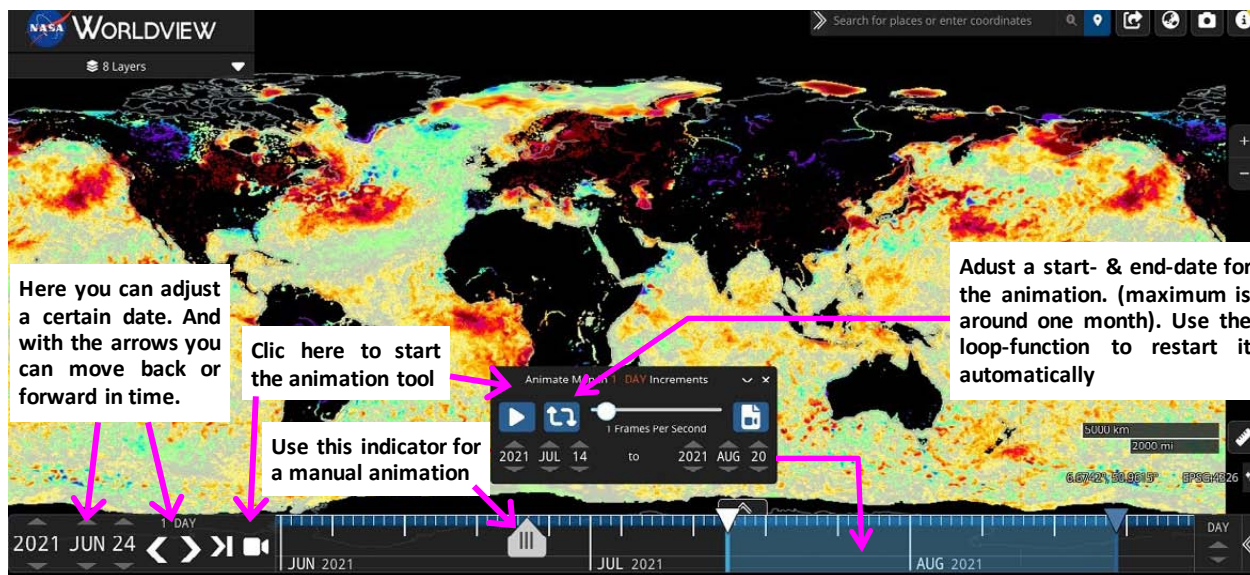
Then clic on **“Add Layers”**



3.) Then select the “Sea Surface Temaperature Anomalies” data-set . → Find that in the Categorie : All



4.) Now you can analyse the “Sea Surface Temaperature Anomalies” of the last few years in detail



Appendix 1.1: → Animations of the Sea-Surface-Temperature-Anomaly worldmap

→ Recommended time-periods for own studies & observations, in order to get a feeling for the described „global-hydrothermal-phenomenon“

1.) see the Animation : El Nino Watch 2015 _ by Nasa/JPL/podaac - 29 November 2015

weblink: https://podaac.jpl.nasa.gov/animations/EINi%C3%B1o_Watch_2015

Interesting is here the time period **9.12.2013 to 21.12.2013** (12 days) in which the hydrothermal-activity reached a maximum level in at least four of the five areas (1-5)

This period corresponds to the movie-sequence 0:40 to 0:44 → This movie-sequence shows the SST-anomalies of the whole December 2013. **Please watch it a few times !**

2.) see the Animation : 1997-1998 El Nino-Southern Oscillation (ENSO) Sea Surface Temperature Anomalies (SSTA) - by Nasa/JPL/podaac - 12 December 2014

weblink: <https://podaac.jpl.nasa.gov/node/592>

Interesting is here for example the time period **15.1.1997 to 15.2.1997** (1 month) in which 3 of the 5 hydrothermally active areas get active and reach a maxima.

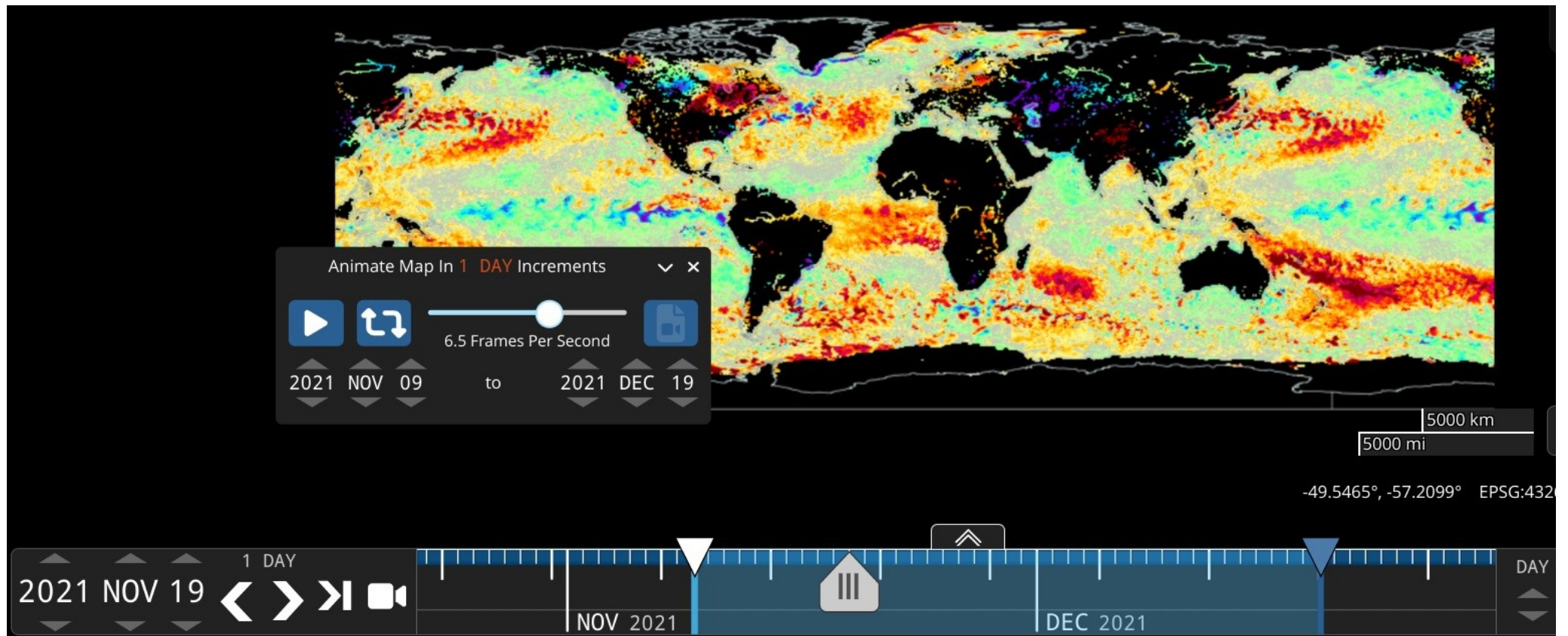
This period corresponds to the movie-sequence ≈ 0:20 to 0:25

3.) use the NASA-Worldview as described on the previous page (Appendix 1) and activate the layer : „Sea Surface Temperature Anomalies (L4, MUR)“

Interesting is here for example the time period **20.11.2021 to 20.12.2021** (1 month) in which 4 of the 5 hydrothermally active areas get active and reach maximum activity.

Just adjust the dates as shown on the image below and activate the „loop-function“ (the blue button with the two arrows) and press start. Adjust a high frame-rate of 6 – 9.

Note that with NASA-Worldview only SST-anomaly datas are available from **23.7.2019** to present . To observe older SST-datas you must watch older NASA-movies, see 1.) + 2.)



Appendix 2: El Ninos and the “warm” Pacific decadal oscillations have the same cause, activity-cycles of hydrothermal-sources on a global scale !

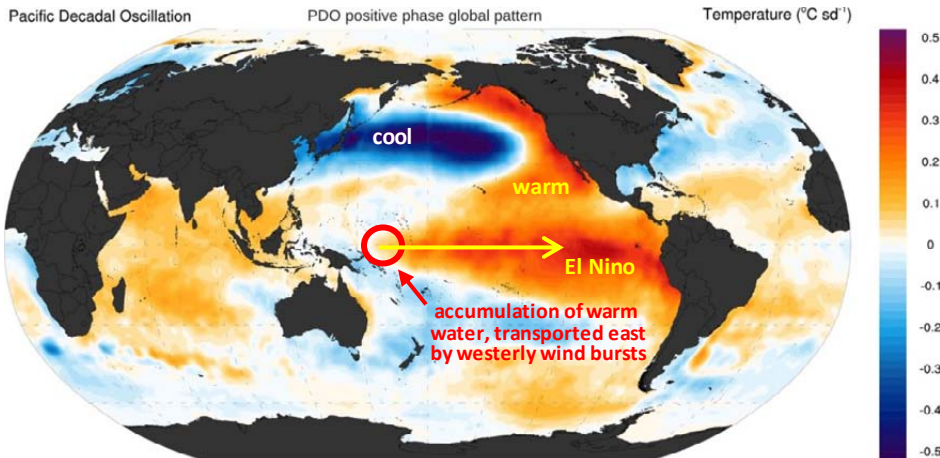
Periodic active hydrothermal-sources on the ocean floor, which are the root-cause of **El Nino** events, also cause “warm” **PDOs** !

→ the **Pacific decadal oscillation (PDO)** is a recurring pattern of ocean-atmosphere climate variability centered over the mid-latitude Pacific-basin. During a "warm, or "positive", phase of the **PDO**, the West-Pacific becomes cooler and part of the eastern ocean warms during a "cool", or "negative", phase, the opposite pattern occurs. (→ see image below !) → the video time **0:03-0:07** shows the **2014 warm-PDO** In early 2014 there was a flip from the cool PDO-phase to the warm **PDO**-phase, which is similar to a long and extended **El Niño** event.

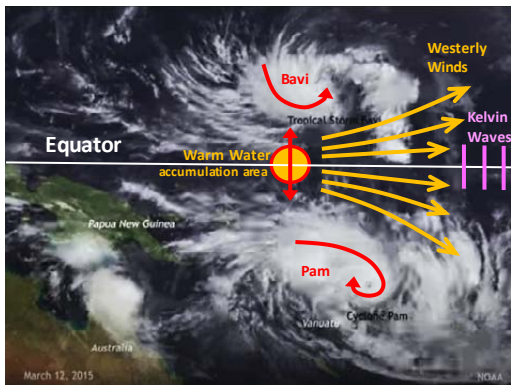
This warm **PDO**-phase caused warm surface-water (the Blob) along the US-west-coast (→ see news article), and record-breaking surface temperatures worldwide in 2014, and it represented in principle the fore-runner (pre-stage) of the **strong 2014-16 El Nino event** !

The start of an El Nino event was indicated by a large area of **warm surface-water** near the **international date-line** (near the **Marshall- & Gilbert-Islands**). In the same area a large **atmospheric convection** was present in association with the development of an unusual amount of early-season **tropical cyclones**. After **Typhoon Higos** developed during February 2015, this indicated the start of an **El Nino**.

The image below shows the **warm-phase** of the **Pacific decadal oscillation (PDO)** and an **El Nino** event. During this **warm-(PDO)** phase the West-Pacific becomes **cooler** and part of the East-Pacific warms. **Both events result from a global event in which many hydrothermal-sources on the ocean floors are active.**



The image shows the **tw in tropical cyclone** (storms) **Pam & Bavi** that formed on both sides of the **equator** in March 2015 → **Movie of Pam & Bavi / Weblink2**



The map below shows the **ocean currents** of the **Pacific Ocean**. The map shows that the **Pacific North Equatorial Current** would normally prevent a transport of **warm water** from the **Marshall islands** to the **west-coast** of the USA. But strong **westerly wind-bursts** can cause **westerly-surface-currents** w → NE



How can hydrothermal-sources cause El Nino events? :

- 1.) A global event in which many hydrothermal-sources on the worlds ocean floors are active causes big amounts of **warm water** that accumulates in the Pacific, especially in the West-Pacific near the **date-line** at the **Equator**.
- 2.) This big amount of **warm water** in the West-Pacific causes big **convection cells** near the **equator** which cause **cyclones** just **north & south** of the equator. Because of the **Coriolis Force** this causes counter-rotating storms which cause strong **westerly-wind-bursts** & **Kelvin-wave-systems** that transport the **warm water** to South-America

Description of the **2014-16 El Nino** event :

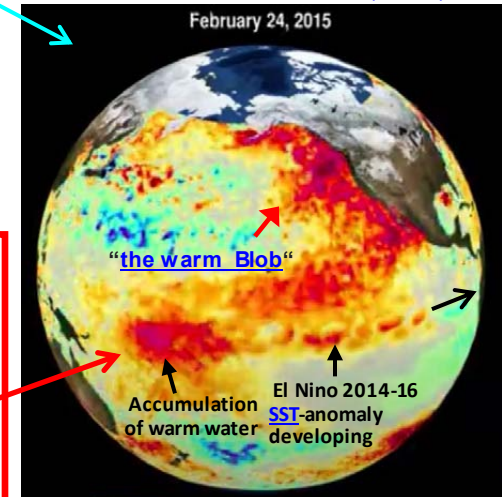
A change of the Pacific climate towards **El Nino** conditions was first indicated in late 2013 by an intense burst of **typhoon**-activity towards the end of 2013, and by persistent **westerly winds** until the begin of 2014 at equatorial Latitudes, which were displaced eastwards towards the **Marshall Islands**.

This **typhoon**-activity and the **Westerly winds** moved **warm water** from the **Marshall- & Gilbert-Island**-area to the US west-coast by June 2014. → this phenomenon was called “**the (warm) Blob**”

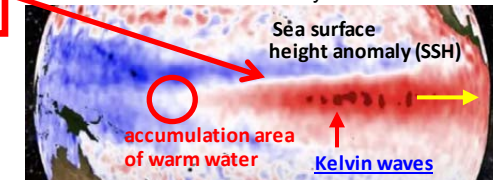
In the equatorial area an intense **easterly**-wind-burst in June 2014 stalled (delayed) the development of an **El Nino** for a few months. Then in January 2015, **westerly wind-burst**-activity picked up again, and the first **Kelvin wave** developed around March and another formed around May. (→ a **Kelvin wave** balances the **Coriolis force** against the **equator**. It is a **wind-generated wave**). More such **Kelvin Waves** developed and moved large amounts of **warm water** from west to east to South-America, along the equator, in the second-half of 2015 and early in 2016.

The first **Kelvin wave** event was caused by **strong westerly windburst** events which were produced by the **twin tropical cyclones** (storms) **Pam & Bavi** that were positioned on both sides of the **equator** in March 2015. More such **twin-cyclone** events, which produced **Kelvin waves**, took place in July, October and in December 2015 into January 2016, causing the 2014-16 El Nino.

→ The image below is from the video : “**Contrasting the 97/98 & 2014-16 El Nino**” The video shows **Sea Surface Temperature anomalies** of the extreme **2014-16 El Nino** and the “end-state” of the **2014 (warm) Blob**

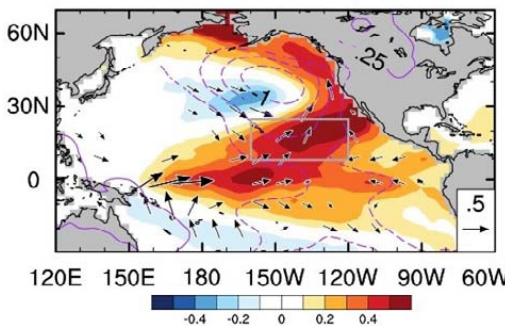


The image below shows the **warm westerly-surface-current** (**Kelvin waves**) that causes the **2014-16 El Nino** indicated by **SSH-anomalies**



→ video: “**MEaSUREs SSH-anomalies V2205**”

C **PMM from SST area ave, w/ ENSO**



Regression of the **Pacific Meridional Mode (PMM)** onto **SST-anomalies** (in °C), surface winds (in m/s, vectors), and sea-level pressure, without removing **ENSO**-(El Nino) Variability → **See this Study**

Appendix 3 : Info to the EN4 (Chart) → subsurface temperature- and salinity- measurements for the global oceans

EN4 → is a subsurface temperature and salinity dataset for the global oceans, spanning 1900 to present at a monthly timestep. It includes two types of data products: (1) a database of quality-controlled *in situ* profiles and (2) a spatially complete analyses at 1 by 1 degree horizontal resolution and 42 depth levels for 83S to 90N. Input data include Argo (Argo, 2000), ASBO (Arctic Synoptic Basinwide Oceanography), GTSP (Global Temperature and Salinity Profile Program) and WOD13 (World Ocean Database). The profiles include quality control flags while the analyses include observation weighting and standard error information.

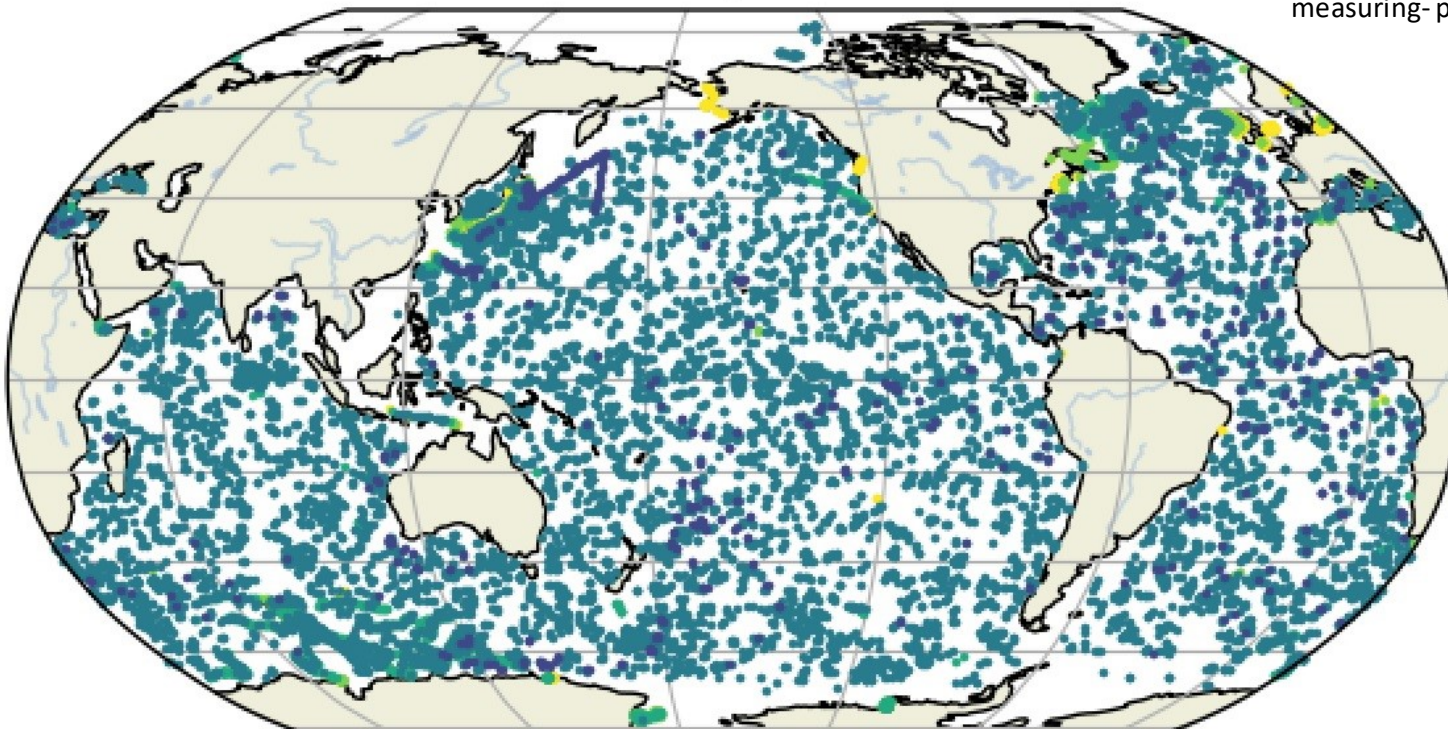
EN4 is used for monitoring ocean heat content and thermosteric sea level, initializing models and forecasts, and satellite data validation, among other applications. Due to the sparseness of ocean observations in some regions and time periods, studies of trends and variability should be approached with caution. Where observations are lacking, EN4 relaxes to a 1970-2000 climatology. Users should check the observation weights when doing such analyses.

See weblink : <https://climatedataguide.ucar.edu/climate-data/en4-subsurface-temperature-and-salinity-global-oceans>

and : [https://en.wikipedia.org/wiki/Argo_\(oceanography\)](https://en.wikipedia.org/wiki/Argo_(oceanography)) → Argo : international program that uses profiling floats

Potential Temperature
20831 profiles

→ Blue dots
represent 20831
measuring- points



References :

Please also read Part 2 & Part 3 of my Climate-Change-Hypothesis :

Weblink: → [Part 2](#): **Changes in Earth's Magnetic Field are a main cause of Volcanism, Earthquakes, HGFA-seismicity & Global Warming** - by Harry K. Hahn

Weblink: → [Part 3](#): **Correlation of Volcanism with geomagnetic-changes (solar storms and North-Pole shift) - List of geomagnetic storms from 1800-2023**

Sources of the Sea-Surface-Temperature (SST)-Anomaly - Maps used in my Analysis :

NASA Worldview: → direct weblink : <https://worldview.earthdata.nasa.gov/> - **Note** : To use Worldview it is necessary to Register !! → see explanation in **Appendix 1 !**

Short explanation: → **How to register**: → first goto : <https://www.earthdata.nasa.gov/> → then goto : **Find data** : <https://www.earthdata.nasa.gov/learn/find-data>

→ then **Register** → then goto : **Eartdata Login** : https://urs.earthdata.nasa.gov/documentation/for_users/welcome

Now you can start using the **Worldview map tools**!.! → Go again to : **Find Data** <https://www.earthdata.nasa.gov/learn/find-data> → Then scroll down and clic on : **Worldview**

Animations (Movies) of the Sea-Surface-Temperature Anomalies of the 1997/98 El Nino and the 2014-16 El Nino :

Animation : El Nino Watch 2015 - by Nasa/JPL/podaac - 29 November 2015

weblink : https://podaac.jpl.nasa.gov/animations/ElNi%C3%B1o_Watch_2015

Animation : 1997-1998 El Nino-Southern Oscillation (ENSO) Sea Surface Temperature Anomalies (SSTA) - by Nasa/JPL/podaac - 12 December 2014

weblink : <https://podaac.jpl.nasa.gov/node/592>

Animation : Contrasting the 1997-98 and 2015-16 El Nino Events - by Nasa/JPL/podaac - 30 September 2016

weblink : https://podaac.jpl.nasa.gov/animations/Contrasting_1997_98_and_2015_16_El_Nino_Events

Animation : MEaSURES Gridded Sea Surface Height anomalies – Version 2205 - by Nasa/JPL/podaac - 15 June 2022

weblink : <https://podaac.jpl.nasa.gov/animations/MEaSURES-Gridded-Sea-Surface-Height-Anomalies-Version-2205>

Studies regarding the Ocean-Heat-Content (OHC) and the fluctuations in the sea-surface-temperature (SST) :

EN4 – Global Ocean Heat Content dataset (chart) - by UCAR

weblink : <https://climatedataguide.ucar.edu/climate-data/en4-subsurface-temperature-and-salinity-global-oceans>

Reconstructing Ocean Heat Content for Revisiting Global Ocean Warming from Remote Sensing Perspectives - Hua Su , Tian Qin, An Wang and Wenfang Lu

weblink : <https://www.mdpi.com/2072-4292/13/19/3799>

20 century cooling of the deep ocean contributed to delayed acceleration of Earth's energy imbalance - by A. Bagnell , T. DeVries

weblink : https://www.researchgate.net/publication/353554359_20_century_cooling_of_the_deep_ocean_contributed_to_delayed_acceleration_of_Earth's_energy_imbalance

An Ocean View of the Global Surface Warming Hiat - by Wei Liu & Shang-Ping Xie

weblink : https://www.researchgate.net/publication/327151730_An_Ocean_View_of_the_Global_Surface_Warming_Hiat

A fluctuation in surface temperature in historical context: reassessment and retrospective on the evidence - by James S Risbey , S. Lewandowsky & others

https://www.researchgate.net/publication/329763956_A_fluctuation_in_surface_temperature_in_historical_context_Reassessment_and_retrospective_on_the_evidence

General : Studies to Hydrothermal-Vents, Submarine-Eruptions, Tectonic-Fracture-Zones, Mantle-Plumes & Large-Igneous-Provinces

On the Global Distribution of Hydrothermal Vent Fields - by Edward T. Baker & Christopher R. German

weblink : <https://www.pmel.noaa.gov/pubs/outstand/bake2544/bake2544.shtml>

Volcanic Eruptions in the deep sea - by Kenneth H. Rubin, S. Adam Soule & others

weblink : https://www.researchgate.net/publication/236589699_Volcanic_Eruptions_in_the_Deep_Sea

Marine Transform Faults and Fracture Zones: A Joint Perspective Integrating Seismicity, Fluid Flow and Life - by Christian Hensen, Joao C. Duarte & others

weblink : <https://oceanrep.geomar.de/id/eprint/46240/1/feart-07-00039.pdf>

Mantle Plumes - by Cinzia G. Farnetani & Albrecht W. Hofmann

<https://www.ipgp.fr/~cinzia/2011-FarnetaniHofmannNEW.pdf>

Low velocity channels in the oceanic asthenosphere from full waveform inversion using Spectral Element Method - by Scott French, Vedran Lekic & B. Romanowicz

Weblink 1 : https://seismo.berkeley.edu/wiki_br/Low_velocity_channels_in_the_oceanic_asthenosphere_from_full_waveform_inversion_using_the_Spectral_Element_Method

Weblink 2 : <https://cs.lbl.gov/news-media/news/2013/new-model-of-earth-s-interior-reveals-clues-to-hotspot-volcanoes/> → see also Weblink 3 : **3D-animation**

Large Igneous Provinces : Crustal Structure, dimensions, and external consequences - by Millard F. Coffin & Olav Eldholm

weblink : http://www.mantleplumes.org/WebDocuments/Coffin94_RevGeophysr.pdf

Studies regarding the described hydrothermal active areas : **1** - **5** → Studies to volcanism, hydrothermal-activity, earthquakes etc. in these areas

1 - South-west Pacific :

Submarine hydrothermal activity along the mid-Kermadec Arc, New Zealand: Large-scale effects on venting - by C. E.J. de Ronde , E.T. Baker and others

weblink : https://www.researchgate.net/publication/235764446_Submarine_hydrothermal_activity_along_the_mid-Kermadec_Arc_New_Zealand_Large-scale_effects_on_venting

Two Decades of Monitoring Hydrothermal Plumes at the Brothers Submarine ArcVolcano, Kermadec Arc, New Zealand - by Walker, S. , de Ronde, C., Baker, E.

weblink : <https://ui.adsabs.harvard.edu/abs/2018AGUFM.V33A..03W/abstract> alternative → [Weblink 2](#)

The largest deep-ocean silicic volcanic eruption of the past century - by REBECCA CAREY, S. ADAM SOULE, MICHAEL MANGA and others

weblink : <https://www.science.org/doi/10.1126/sciadv.1701121>

2019-2020 South Pacific Blob and Antarctica warming in February 2020 - by Wyss W.-S. Yim & Alvin Wong

weblink : https://www.researchgate.net/publication/355158638_2019-2020_South_Pacific_Blob_and_Antarctica_warming_in_February_2020

→ see lecture on YouTube – **movie** : <https://www.youtube.com/watch?v=dxBEIsvlKGo> → **South-Pacific Blob** : start around **6:30** - start of blob description at around 12:20 to 19:00 , and see also the Info to the **North Pacific blob** : → see section **3:45 - 5:15** , caused by the **Nishinoshima submarine volcano**

Earth's deepest earthquake swarms track fluid ascent beneath nascent arc volcanoes - by Lloyd T. White , Nicholas Rawlinson and others
weblink : <https://core.ac.uk/download/pdf/222805845.pdf>

Analysis and Impact of the Hunga Tonga-Hunga Ha'apai Stratospheric Water Vapor Plume - by M. R. Schoeberl , Y. Wang & others
weblink : <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022GL100248>

Tonga's strange volcanic eruption was even more massive than we knew - BY MAYA WEI-HAAS
weblink : <https://www.nationalgeographic.com/science/article/tonga-volcano-largest-eruption-pacific-ocean-tallest-plume#:~:text=Newsletters-,Tonga's%20strange%20volcanic%20eruption>

An examination of the junction between the Solomon Sea Plate, the Bismarck Plates and the Pacific Plate - by Keren Francis 2018
weblink : <https://www.geolsoc.org.uk/~media/shared/documents/education%20and%20careers/Plate%20tectonic%20stories/Keren%20Francis.pdf?la=en>

The Gilbert Islands Earthquake Swarm of 1981-83 (→ 86 earthquake-events had : **mb** > **5.0** & 217 events had : **mb** > **4.0**) - by Thorne Lay & Emile Okal
weblink : https://websites.pmc.ucsc.edu/~thorne/TL.pdfs/LO_Gilbert_PEP1983.pdf

Giant palaeotsunami in Kiribati (Gilbert Islands) in the 16th century : Converging evidence from geology and oral history
weblink : <https://onlinelibrary.wiley.com/doi/10.1111/iar.12417?af=R>

The Melanesian Volcanos – some of the top-10 SO₂ emitting volcanos on Earth are located in this area
weblink : <https://www.volcano-waka-lab.com/volcanoes> or : <https://www.volcano-waka-lab.com/>

2 - Southern-Ocean & Indian-Ocean :

Tectonic Background of Four Hydrothermal Fields Along the Central Indian Ridge - byKyoko Okino , Kentaro Nakamura
weblink : https://link.springer.com/chapter/10.1007/978-4-431-54865-2_11

Influence of the Reunion/Rodrigues Hotspot on the Structure of the Central IndianRidge Near 19\deg S - by Anne Briaes , Marcia Maia
https://www.researchgate.net/publication/241529713_Influence_of_the_ReunionRodrigues_Hotspot_on_the_Structure_of_the_Central_Indian_Ridge_Near_19deg_S

Geology and Morphostructural Evolution of Piton de la Fournaise - by Laurent Michon, Jean-Francois Lenat & others
weblink : <https://hal.science/hal-01147341/document>

Climatic impacts of the SW Indian Ocean Blob - by Wyss W.-S. Yim
weblink : https://www.researchgate.net/publication/337210565_Climatic_impacts_of_the_SW_Indian_Ocean_Blob

Seafloor evidence for pre-shield volcanism above the Tristan da Cunha mantle plume - by Wolfram H. Geissler , Paul Wintersteller , Marcia Maia
weblink : <https://www.nature.com/articles/s41467-020-18361-4>

Widespread Neogene volcanism on Central Kerguelen Plateau, Southern Indian Ocean – by R. A. Duncan, Trevor J. Fallon and others
weblink : https://www.researchgate.net/publication/307531394_Widespread_Neogene_volcanism_on_Central_Kerguelen_Plateau_Southern_Indian_Ocean

3 - South-Atlantic :

Mesozoic breakup of SW-Gondwana and basin formation along the Argentinean Atlantic Margin -

weblink : https://www.researchgate.net/publication/328913550_Mesozoic_breakup_of_SW_Gondwana_and_basin_formation_along_the_Argentinean_Atlantic_Margin

The Agulhas Ridge, South Atlantic: the peculiar structure of a fracture zone - by Gabriele Uenzelmann-Neben & Karsten Gohl

Weblink : <https://core.ac.uk/download/pdf/11753854.pdf>

4 - North-Atlantic :

Submersible observations of the New England Seamounts - by Robert L. Houghton , James R. Heirtzler & others

Weblink : https://www.researchgate.net/publication/226503262_Submersible_observations_of_the_New_England_Seamounts

THE NEW ENGLAND SEAMOUNTS: TESTING ORIGINS - Peter R. Vogt, Naval Research Laboratory, Washington & others

Weblink : http://deepseadrilling.org/43/volume/dsdp43_42.pdf

5 - North-Pacific :

A very long-term transient event preceding the 2011 Tohoku earthquake - Yusuke Yokota & Kazuki Koketsu

Weblink : <https://www.nature.com/articles/ncomms6934>

Extremely high heat flow anomaly in the middle part of the Nankai Trough - by Makoto Yamano , Masataka Kinoshita & others

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Please also read my Hypothesis about the Permian Triassic Impact-Event (PTI) → weblinks to the Parts 1 to 6 of my hypothesis: → available on vixra.org

Weblinks to my studies on → vixra.org : **Part 4 :** <https://vixra.org/abs/2101.0067>

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