# EARTH SCIENCES

## 'STORM GLASS' IS A SOLAR INFLUENCE DETECTOR. STRUCTURING OF WATER CLUSTERS IN 'STORM GLASS' UNDER THE SOAR EXPOSURE AND WHEN MOOVING IN SPACE

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https://doi.org/10.5281/zenodo.15536079

**Abstract**

In the 19th century, it was discovered that camphor dissolved in the water-ethanol solution forms crystals, which quantity constantly changes at different periods of time even at a constant temperature. Since no one doubted that this phenomenon was caused by weather changes, a sealed glass ampoule with such a solution was called Storm Glass. But in the 20th century it became clear that this phenomenon has a more complex mysterious nature and is not suitable for predicting the weather. It was studied in detail, but the real reason remained unclear. We have recently discovered that fluctuations in solar activity and distribution of solar energy around the Earth have a very strong influence on the stability and size of water clusters. Therefore, the same solution of water in organic solvents can consist of a small number of large clusters, or large number of small clusters. This also occurs in the water-ethanol solution in 'Storm Glass'. Since camphor is soluble in ethanol and insoluble in water, it crystallizes out of solution under strong solar influence, when water clusters are decomposed and small, and dissolves again when the influence of the Sun decreases and water clusters reunite. Therefore, Storm Glass really reacts to changes in the weather, but not atmospheric, but space weather. Studying the influence of the Sun on Storm Glass in different places unexpectedly led to the discovery of another unique phenomenon. When Storm Glass moves through space, water clusters quickly become structured, their number decreases and camphor crystals noticeably dissolve. This happens quickly, within 10-20 minutes after the start of movement. This phenomenon also depends on solar exposure.

**Keywords:** storm glass, solar influence, water clusters, structuring, space weather.

### Introduction

In the 19th century, it was discovered that camphor dissolved in a water-ethanol solution, containing also $NH_4Cl$ and $KNO_3$, forms crystals, which quantity constantly changes over different periods of time. [1] Since this occurs even at a constant temperature, no one doubted that this mysterious phenomenon has something to do with weather changes, therefore, for a long time they tried to use it to predict the weather, and a sealed glass ampoule with such a solution was called 'Storm Glass'.

In the 20th century the understanding gradually matured that this phenomenon has a more complex nature, associated with some unknown external influence and is not suitable for predicting the weather. In 1990, Nakamoto and Hiroi experimentally showed that changes in the appearance of crystals are not caused by changes in atmospheric pressure, humidity, or electric and magnetic fields, but solely by changes in temperature. [2] No correlation was found between changes in crystallization and changes in weather useful for weather forecasting. In 2008, after studying the growth and shape of the crystals only the effect of temperature was again recorded. [3] However, temperature affects all crystallizations equally, and the number of crystals in Storm Glass varies greatly even at a constant temperature, so the true reason for this mystery has remained unclear.

Until now, no one could have imagined that the cause of this mysterious phenomenon could lie outside the Earth and that fluctuations in solar influence can exert an extremely strong effect on water, which is a key component in Storm Glass. Such an extraterrestrial influence on water is evidenced by another fundamental phenomenon recently discovered. We have found that solar radiation breaks hydrogen bonds between water molecules and destroys water clusters. For this reason, due to constant fluctuations in solar activity and distribution of solar energy due to the rotation of the Earth around its axis and around the Sun, the hydrolytic activity of the same solution of water in an organic solvent is very dynamic as it can contain either a large number of small active clusters or a small number of large passive clusters. For example, the rate of hydrolysis of triethyl phosphite [$(EtO)_3P$] in water-acetonitrile solution can vary up to 200 times over 11-year solar cycle, displaying also diurnal and very large annual variations. [4] (Fig. 1) Thus, the rate of this reaction is an accurate indicator of the intensity of the Sun's impact on the Earth.

Decomposition of water clusters may be explained by the influence of muons which are constantly generated in the upper atmosphere by the solar wind. This is confirmed by the fact, that during the solar eclipse the hydrolytic activity of water clusters significantly decreases. [4] Muons reach the surface of the Earth and penetrate to some depth underground. Their amount and energy, modulated by the solar activity and position of the Sun in the sky, strongly influence the hydrolytic activity of water clusters. [5]

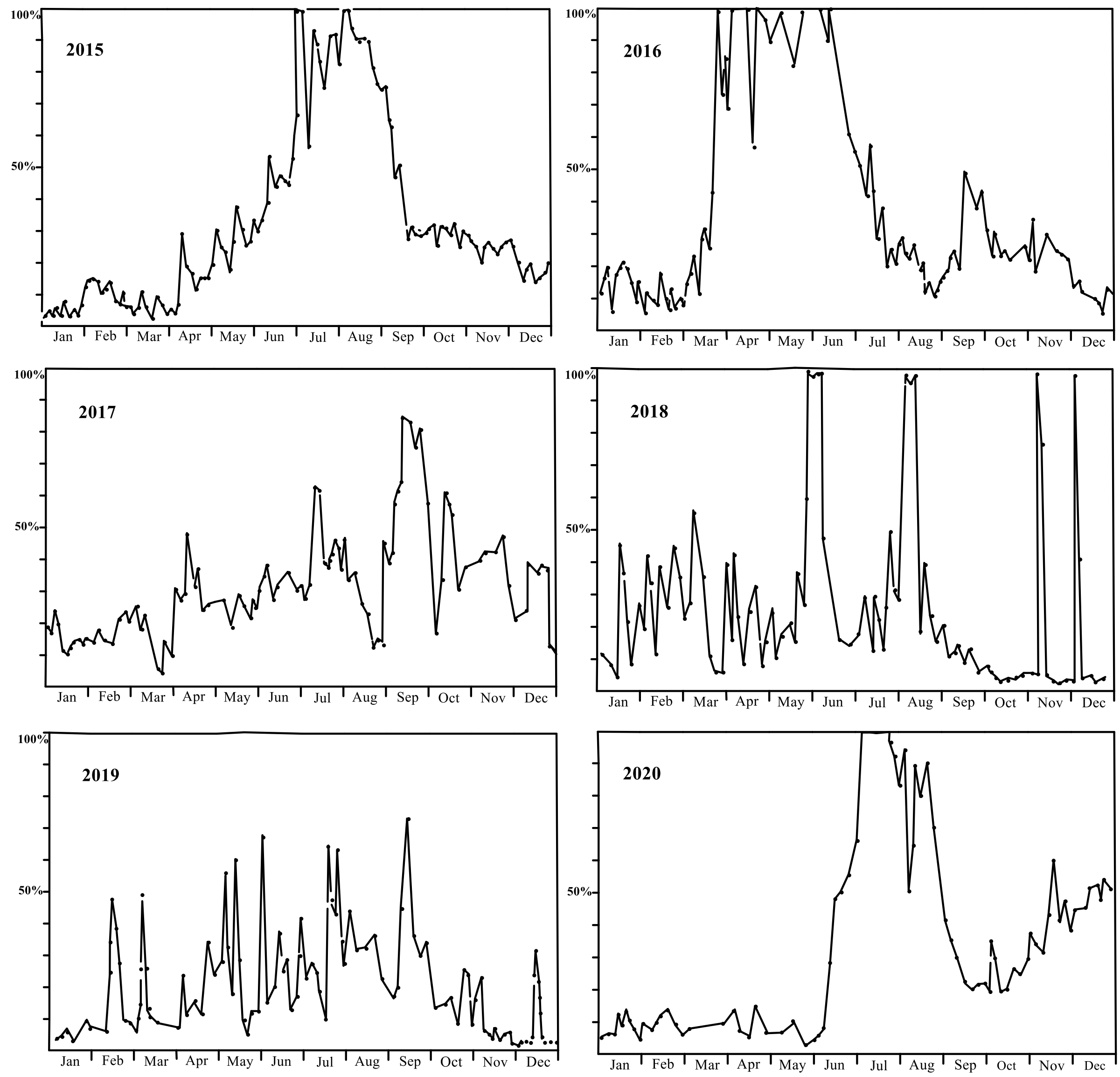


***Fig. 1**. Variations of the rate of hydrolysis of triethyl phosphite in acetonitrile in 2015-2020 at 50º North latitude. This period includes the second half of the 24-th solar cycle 2015-2019 and the first year 2020 of the 25-th cycle.*

**Results and discussion**

Regular measurements of the rate of hydrolysis of triethyl phosphite for 6 years 2015-2020 (Fig. 1) showed that under the influence of the Sun, the hydrolytic activity of water and the rate of hydrolysis of triethyl phosphite change all the time at a constant temperature. The dynamics of these changes appeared to be very similar to the changes in the amount of camphor crystals in the Storm Glass, indicating that variations in solar influence may be the common cause of these phenomena. Large fluctuations in the size and concentration of water clusters in an organic solvent should significantly affect not only the hydrolytic activity of the water-acetonitrile solution, but also the dissolving ability of the water-ethanol solution in Storm Glass. Camphor is well soluble in ethanol and insoluble in water, therefore its solubility in a water-ethanol solution strongly depends on the quantity and size of water clusters, which constantly vary in very large limits under the solar influence. Under strong solar influence, when water clusters decompose and their concentration increases, camphor crystallizes from water-ethanol solution, and when the influence of the Sun decreases water clusters reunite, their number in ethanol decreases and camphor crystals dissolve again.

To confirm that solar influence is the common cause of these two phenomena, it was important to discover the simultaneity of their manifestations. Measurements of the rate of hydrolysis of triethyl phosphite by water clusters in acetonitrile were carried out while simultaneously monitoring the number of camphor crystals in Storm Glass. It was found that as the rate of triethyl phosphite hydrolysis increases, the number of camphor crystals in Storm Glass also increases. However, the sensitivity of these two phenomena to the solar influence is very different. The rate of hydrolysis of triethyl phosphite responds very dynamically to even small and short changes in the structuring of clusters under the solar influence and can be quickly and accurately measured by nuclear magnetic resonance. In contrast, in Storm Glass the crystallization of camphor from the solution and its dissolution occurs much more slowly and can only be assessed visually. Therefore, the simultaneity of these phenomena is clearly manifested during strong and abrupt changes in solar influence and the intensity of the muon flux. The experiments were carried out in Kyiv and Bremen at 50° and 53° northern latitude respectively. At such a distance from the equator, the rate of hydrolysis of triethyl phosphite in acetonitrile and the amount of camphor crystals in Storm Glass were always higher in summer than in winter. The coordination of these two phenomena was especially evident in 2015, 2016 and 2020, when the difference in solar influence between summer and winter was particularly large. (Fig. 1)

Long-term measurements of the rate of hydrolysis of triethyl phosphite showed that the structuring of water molecules in clusters depends on the degree of shielding of solar influence and therefore can be different in the open air and underground. [4] It also depends on the position of the Sun in the sky and can differ markedly even in different places in a large building. [5,6] It was logical to assume that shielding of the solar influence underground will increase the size of water clusters also in water-ethanol solution. This should lead to a decrease in their concentration in Storm Glass and to the dissolution of camphor crystals. This assumption was experimentally confirmed in Kiev, where one metro station is located at the depth of 105 meters. In July 2020, during strong solar exposure, the number of camphor crystals underground was significantly lower than on the surface. At the same time, for comparison, the hydrolysis of triethyl phosphite in acetonitrile was carried out, which also proceeded much more slowly underground than on the surface.

It is important to note that outdoors under the brightly shining Sun the temperature was higher than underground, but despite this, camphor dissolved underground and crystallized on the surface. This proves that the solar radiation exerts a strong influence on Storm Glass. It is also important that in the open air and underground, the change in the solubility of camphor in water-ethanol solution in Storm Glass agrees with the change in the rate of hydrolysis of triethyl phosphite in water-acetonitrile solution. In these different experiments, only water is a common component. This indicates that fluctuations in solar activity can affect all processes in which structured water molecules take part.

Careful and long-term observation of Storm Glass in different places unexpectedly led to the discovery of another very interesting unique phenomenon. It has been found that camphor crystals can quickly dissolve when Storm Glass moves through space. This happened within 15-20 minutes when moving in any direction, on any type of transport, and even at walking speed. This new phenomenon also depends on the intensity of solar influence and is well noticeable when the amount of camphor sediment is quite large. It is interesting to note that after the Storm Glass stops moving, camphor remains dissolved for quite a long time and the initial number of its crystals, with constant solar influence, can only be restored the next day.

The rapid dissolution of camphor when moving in space may indicate the presence of some field or lines of force, the intersection of which can cause the structuring of water clusters and an increase in ethanol concentration. Assumptions about the existence of some lines of force have already been made by other scientists (Hartmann Lines, Curry Lines, Benker Lines) however they could not be detected with measuring devises.

We also studied the dissolution of camphor when Storm Glass moved around in different places in the same room. It was found that crystals dissolve even when moved within 0.5 $m^2$, for example, when rotated in a horizontal plane in a circle with a diameter of 70-80 cm. This means that if Hartmann lines exist, they do not affect the dissolution of camphor. This conclusion is further supported by the fact that dissolution of camphor also occurred if the Storm Glass was moved 1 meter up and down vertically for 30 minutes.

The dissolution of camphor in a water-ethanol solution of Storm Glass when moving in space can only occur due to an increase in the concentration of ethanol and a decrease in the concentration of water clusters. This means that movement in space should cause the structuring of water clusters and a decrease in their number due to an increase in their size. Obviously, this occurs under the influence of the Sun. This is evidenced by the fact that when moving Storm Glass in a large building, the rate of dissolution of camphor is approximately 1.5 times slower than in the open air, and at night it can be several times slower than at noon.

The influence of the Sun on the structurization of water clusters in Storm Glass is confirmed by an increase in the number of camphor crystals after irradiation with hard ultraviolet light. Ultraviolet light also destroys water clusters. This is confirmed by the strong acceleration of the hydrolysis reaction of triethyl phosphite in acetonitrile. After 5 minutes of irradiation of this reaction in a NMR-tube with a 9 W ultraviolet lamp, its rate can increase up to 100 times.

**Influence of salts**

By measuring the rate of hydrolysis of triethyl phosphite in a water-acetonitrile solution, we found that the presence of salts greatly promotes the structuring of water molecules. The size of water clusters increases, and their concentration in solution and hydrolytic activity decrease. [4] Therefore, ammonium chloride and potassium nitrate ($NH_4Cl$, $KNO_3$) in water-ethanol solution of Storm Glass perform an important function. Small water clusters, after the decrease in the influence of the Sun, combine faster, and the solubility of camphor is accelerated. Without these salts, visualization of the effect of solar exposure on water in Storm Glass would be significantly weakened.

**Materials and methods**

**Solar influence on Storm Glass.**

Two identical Storm Glass vessels containing the same amount of camphor sediment were placed underground at a depth of 105 meters and on the surface. Due to shielding of solar influence underground, camphor dissolves more strongly and the number of its crystals becomes less than on the surface. These changes are clearly visible during periods of high solar influence, when the amount of camphor crystals in the Storm

Glass is large, and the degree of shielding of solar influence underground is high. With low solar influence, camphor dissolves and the difference in the number of its crystals in the two Storm Glasses decreases or disappears. Away from the equator, this experiment should be carried out in summer, when strong solar influence is more common.

**Solar influence Solar influence on the hydrolysis of triethyl phosphite.** Two 5 mm NMR-tubes containing 400 mg of acetonitrile, oriented vertically, were placed outdoors away from large buildings and underground. In 30 minutes, fresh water (7 mg) was added to them and mixed briefly by shaking. In 10 minutes, 25 mg of triethyl phosphite was added and mixed briefly by shaking. The reaction rate was determined by measuring the integral intensities of the signals in the $^{31}$P-NMR spectra. Commercial acetonitrile containing 0.02% water was used. The NMR-tubes should be protected from light by a cardboard screen.

**Conclusions**

Solar cosmic rays have a strong influence on the self-organization of water molecules, as well as on the stability, size and concentration of water clusters in organic solvents. For this reason, the solubility of camphor and the amount of its crystals in Storm Glass constantly change at constant temperature. In the open air and underground the solar influence is different and the change in the solubility of camphor in water-ethanol solution in Storm Glass is consistent with the change in the rate of hydrolysis of triethyl phosphite in water-acetonitrile solution. In these different experiments, only water is a common component. This indicates that fluctuations in the intensity of the solar influence on the Earth can affect all processes in which structured water molecules take part. Thus, Storm Glass is a detector of the solar influence and can be considered as a chemical weather indicator, but not atmospheric, but space weather.

The structuring of water clusters as they move through space requires additional study in different places on Earth, at different latitudes and during different periods of the 11-year solar cycle. This could yield important results for biology, physics and environmental science.

**Competing interest**

There are no conflicts to declare.

**Acknowledgements**

The author is grateful to the Alexander von Humboldt Foundation and thanks Prof. Gerd-Volker Röschenthaler for the opportunity to confirm this phenomenon in Germany at the Jacobs University in Bremen.

**References**:

1. R. Fitzroy, The Weather Book, Longman, Green, Longman, Roberts, and Green, London, 1863, p. 439.
2. Y. Nakamoto, M. Hiroi, Bull. Kobe Univ. Mercantile Mar. (Japanese) 38 (1990) 143.
3. Y. Tanaka, K. Hagano, T. Kuno, K. Nagashima, Pattern formation of crystals in storm glass, Journal of Crystal Growth 310 (2008) 2668
4. I. V. Shevchenko, Self-organizations of water molecules over 11-year solar cycle, Journal of Molecular Liquids 355 (2022) 118866. https://doi.org/10.1016/j.molliq.2022.118866
5. I. V. Shevchenko, Influence of the Sun on water. Dependence on geometry of solution and its position in space, Journal of Molecular Liquids 379 (2023) 121681. https://doi.org/10.21203/rs.3.rs-2379206/v1
6. I. V. Shevchenko, Structuring of water clusters under the solar influence and their coping by bulk water, Journal of Molecular Liquids 393 (2024) 123576. https://doi.org/10.1016/j.molliq.2023.123576