The ISA Procedure for Climate Cooling

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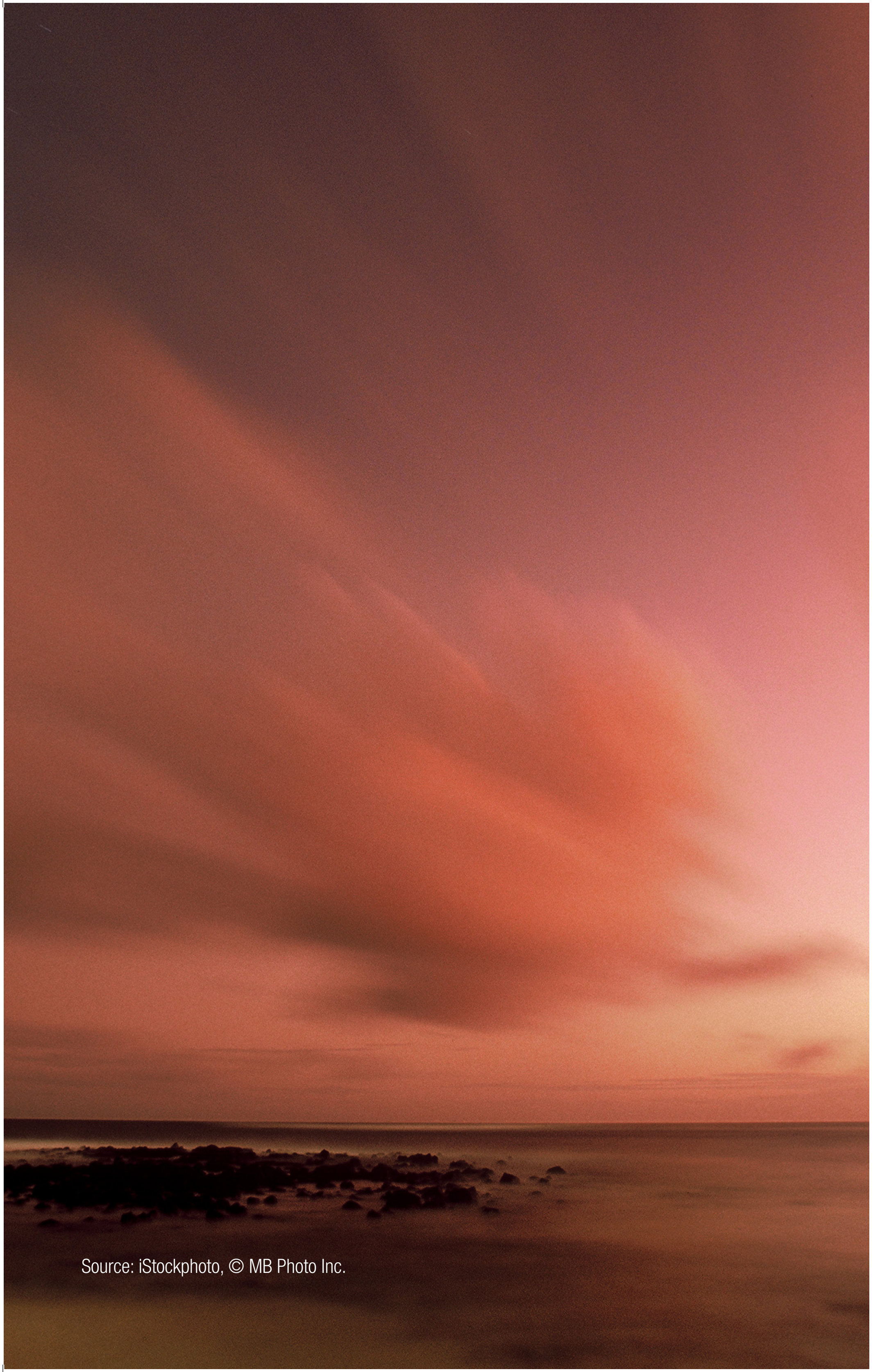

Source: iStockphoto, © MB Photo Inc.

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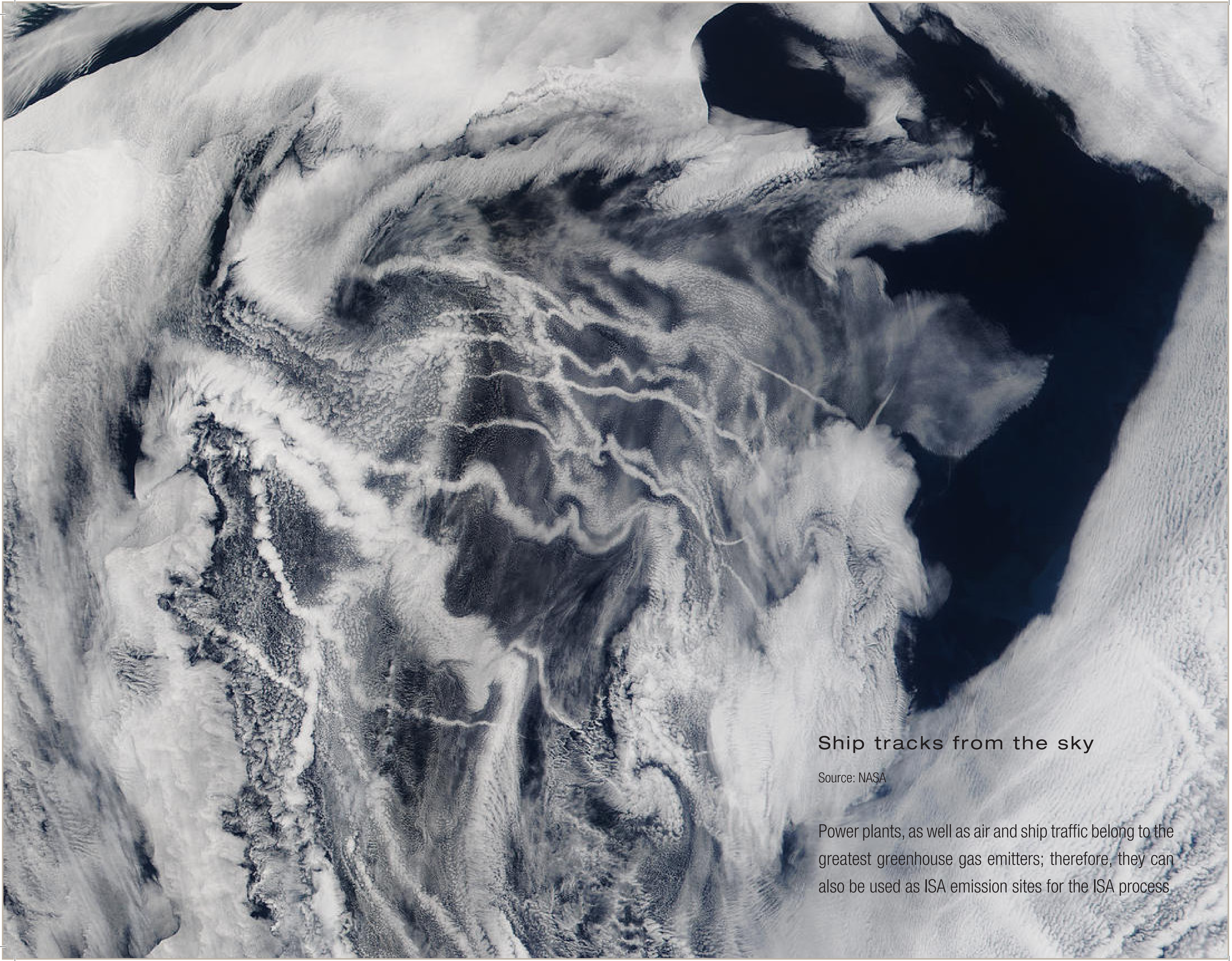

Ship tracks from the sky

Source: NASA

Power plants, as well as air and ship traffic belong to the greatest greenhouse gas emitters; therefore, they can also be used as ISA emission sites for the ISA process.

Abstract

The following report is a contribution to climate protection and constitutes a procedure for climate protection that will prevent a further increase of greenhouse gases.
The procedure is based on specific chemical and biological processes that reduce CO_2 and methane.
This is achieved through releasing a solid or gaseous iron compound into the atmosphere by means of combustion or carrier gases.

Iron additives, e.g. ferrocene, are added to the fuel of air and water vehicles. Such additives can also be combusted in power stations to condition waste gases and emissions from cooling towers. Gaseous iron salt can also be added to carrier gases, e.g. waste gases.

Both variants of the procedure, the addition of iron additives to fuel and propellants or the addition of gaseous iron salt trigger the subsequent procedural steps.

The next steps in the process take place very effectively in the atmosphere, though sunlight and clouds do play a crucial role.
During the procedure, Iron Salt Aerosols (ISA) are generated through a series of complex physical and chemical reactions.

The ISA causes the oxidation of methane and other carbon-containing greenhouse gases into CO_2.
Sunlight boosts the reactions of the ISA in the troposphere.

Furthermore, ISA forms particularly white clouds with increased solar reflection, which aid climatic cooling.
The next steps take place in the ocean. The ISA fall as precipitation and fertilize the green plankton, thus ensuring an increase in organic substances in the ocean food chain. During this process, CO_2 is converted into sediment-bound fuel and limestone.

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1) ISA (I = Iron, S = Salt, A = Aerosol) = artificial and natural iron salt aerosols and the (hence) resulting secondary-aerosol products in the troposphere.

Introduction

Several major volcanic eruptions, such as the eruption of Mount Pinatubo in 1991, resulted in a cooling effect. This was caused by the ash and gases contained in the volcanic ash clouds.

Today, we know that the cause of this is not only the sulphuric acid aerosol that blocks the sunlight, but rather the high proportion of ISA in the ash cloud. These activate the break up of methane photochemically by releasing chlorine atoms1) and hydroxyl radicals into the atmosphere and initiating a reduction of CO_2 by increasing algae growth in the ocean2).

Ice core samples from the Antarctic and Greenland have shown that it was exactly this photochemical-bionic process that triggered the ice ages. Loess dust clouds carrying ISA moved through the atmosphere acting as a trigger. The ISA procedure allows this natural phenomenon to be simulated efficiently, and more importantly, economically, in a controlled way. Since it was directly proven that methane is decomposed by natural volcanic eruption clouds1), the ISA procedure began receiving a lot of attention and will become now the subject of intense investigations in atmosphere and climate science3).

1) A. Baker et al.: Investigation of chlorine radical chemistry in the Eyjafjallajökull volcanic plume using depletions in non-methane hydrocarbons; Geophysical Research Abstracts, 13, EGU2011-3376 (2011)

2) S. Duggen et al.: S. Duggen et al.: Subduction volcanic ash can fertilize the surface ocean and stimulate plankton growth: Evidence from biogeochemical experiments and satellite data; Geophysical Research Letters 34, L01612, doi10.1029/2006GL027522 (2007)

3) Preparations are under way to quantify the action of the ISA process on the tropospheric methane decomposition. These appropriate geoscientific verification measures will be done by scientists of a well-known atmospheric chemistry research insitute of a German university.

The strengths of the worldwide-patented ISA procedure for climate cooling are as follows:

- Reduction of CO_2 by the increased generation of marine organisms
- Reduction of methane through the production of radical oxidisers
- Reduction of soot and organic compounds by catalytic oxidation
- Minimisation of soot emissions from incinerators through improved combustion
- More light reflection from clouds due to increased condensation nuclei density

An effective alternative in emissions trading!

Effectiveness of the procedure

An annual increase in the concentration of greenhouse gases such as CO_2 and methane causes climate change that remains uncontrollable even today. The consequences of this are natural catastrophes and unpredictable effects on global development, as well as incalculable costs for the global economy.

Saving energy alone will not solve the problem. Until now there have been no economically and ecologically sound procedures for tackling climate change. The ISA procedure can break up the greenhouse gases CO_2 and methane by using simple combustion processes or seawater electrolysis. All types of combustion processes can be used, e.g. in power stations and in air, water and land vehicles , or excess electricity in the case of electrolysis from offshore wind farms.

This process has been developed based on the natural effects of:

a) climatic cooling through ISA-bearing ash clouds from large volcanic eruptions and
b) the global effect of drifting ISA-bearing loess clouds, which triggered the ice ages.

Eruption of the Eyjafjallajökull volcano

Source: iStockphoto, © Jochen Scheffl

Only when the eruption cloud has become transparent for sunlight can the iron salt on the ash particles develop its effect on methane decomposition

What exactly were the changes caused by volcanic ash clouds, for example after the eruption of Pinatubo in 1991 and after Laki in 1783, or through the loess dust clouds that triggered the ice age?

- Global decrease in CO_2 concentration
- Global decrease in methane concentration
- Global temperature decrease
- Global increase in cloud cover

What were the fundamental causes of these changes?

The complex reaction of the ISA-bearing dust (=aerosol) caused:

- new formation of chlorine and hydroxyl radicals in the troposphere;
- a break up of methane and similar gases due to chlorine and hydroxyl radicals;
- a break up of CO_2 due to the fertilisation of algae with ISA-bearing dust in the ocean.

The ISA procedure is both closely related to and a derivative of the natural processes of climate formation caused by ISA-bearing dust. An essential part of this is the global distribution of an ISA-bearing aerosol that, when used appropriately, has several fundamental advantages over natural ISA-bearing dust:

- a much greater effect on the climate;
- a much smaller mass and lower concentration in the air;
- no dangerous consequences for human health;
- has no disadvantages for any water or land based ecosystems.

How does the ISA procedure work?

ISA can be added to wind, airflow, exhaust or waste gases from power stations or to land and water vehicles. There are two different variants of the procedure, A and B:

Variant A takes place when additives containing iron, e.g. ferrocene, are added to fuel oil or propellants and then combusted. This produces the finest iron-containing aerosol. When it is discharged into the atmosphere the aerosol transforms with waste gas components, e.g. sulphur dioxide, and air components, e.g. oxygen, into an ISA under the effect of sunlight.

Variant B involves the electrolysis of saltwater, e.g. seawater, which is available in unlimited quantities in offshore wind farms. Also advantageous here are the salt lakes frequently found in desert areas, where electrical energy can be produced from sunlight. Saltwater electrolysis can also be carried out in modes of transport or in power stations.

Chlorine is freed by electrolysis and reacts with hot scrap iron to create iron(III) chloride gas. When released into the atmosphere, the iron(III) chloride gas is converted into ISA by means of condensation and hydrolysis.
ISA in the atmosphere activates the oxidation of methane and other similar climate gases through a series of complex chemical, photochemical and biological reactions. After sinking into the ocean, these convert CO_2 into sediment-bound fuel and limestone.

An example to clarify the effect of the ISA procedure:
On a flight from Frankfurt to Tokyo, an A 380 aeroplane uses 310 m^3 of kerosene, approximately 30 kg ferrocene additives or around 30 kg iron(III) chloride gas. 1 kg of ferrocene additives or 1 kg iron(III) chloride gas remove approximately 25 t CO_2 (= 25 t CO_2 greenhouse gas

equivalents) and approximately 5 t methane (equal to around 100 t CO_2 greenhouse gas equivalent), all together this is 125 t CO_2 greenhouse gas equivalent.
In this way, approximately 30 x 125 t = 3800 t CO_2 equivalents are removed during the flight; however, the kerosene combustion only releases 856 t CO_2. Thus, the flight causes a net reduction equivalent to 3000 t CO_2.
Additionally, the ferrocene additive ensures complete combustion and a minimal amount of soot.

It is not necessary to burn the ferrocene additive in the plane's engine, or to release the iron(III) chloride gas into the atmosphere during the flight to initiate this effect.

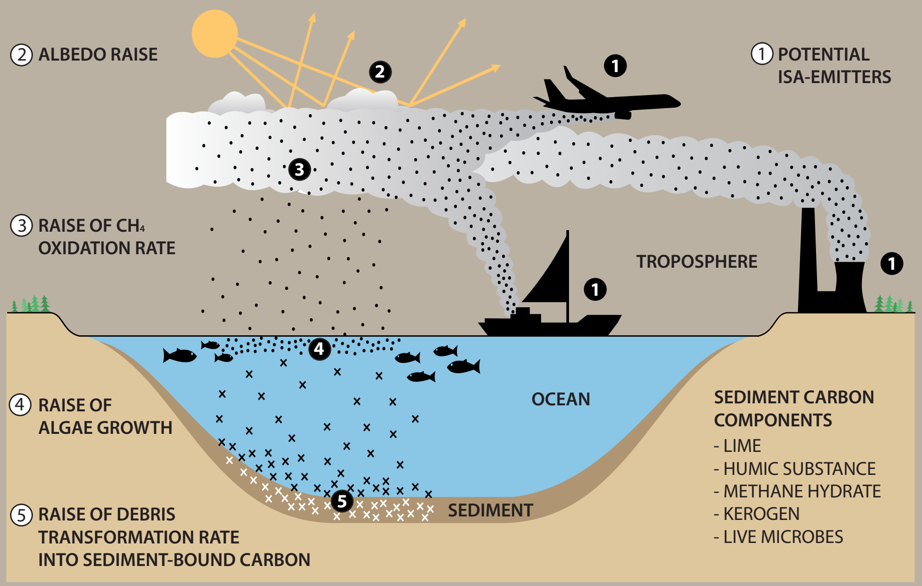
The effect of the ISA procedure is not restricted by spatial limitations as it is self-activated within the atmosphere and continues into the oceans below. This means that the same effect can also be triggered by means of an ISA facility, which could be situated in a convenient location on the continent or float on the ocean.

Because the ISA comprises effective condensation nuclei, it can form particularly white clouds that reflect light extremely well. This has an additional cooling effect.

Currently, 25 billion tonnes of CO_2 equivalents are generated globally each year as a result of various anthropogenic combustion processes. An input of around 100,000 t of iron as ISA would eliminate pollution from these greenhouse gases worldwide. This would make the ISA procedure economically and financially viable.

CO_2 and CH_4 Burial by Iron Salt Aerosol (ISA)

Introduction of a permanent raise of the CH_4 oxidation rate, cloud-albedo and
CO_2-transformation into sediment-bound carbon by ISA



ISA-Process

Technical Production of Atmospheric Iron Salt Aerosol (ISA)

Variant A

- combustion of an oil iron additive mixture
- iron(III) oxide aerosol fluegas mixture
- emission into the atmosphere
- conversion of iron(III) oxide aerosol by light and chemical reaction

Variant B

- salt water electrolysis
- reaction of chlorine gas with hot iron scrap
- gaseous iron(III) chloride
- emission into the atmosphere
- conversion of gaseous iron(III) chloride by condensation and hydrolysis

iron salt aerosol (ISA)

Functional model

Depending on the humidity, ISA is an aerosol comprising droplets or particles. These droplets or particles coagulate with the sea salt aerosol. Depending on the age of the sea salt aerosol, these contain either more or less chloride; chloride aerosols convert into sulphate aerosols. The sea salt aerosols lose their chloride through contact with sulphuric acid aerosols or nitrogen oxides. In the atmosphere one converts into the other, more chemical processes take effect within a cloud than outside it. Aerosols exist in a solid, fluid or semi-fluid state. Chameleon-like, these states change from one to the other and can, for example, freeze quickly but incompletely to form ice and then thaw again just as quickly.

The ISA procedure as a process allows itself to be closely incorporated into operational procedures and eco systems, or conversely, it can be kept completely separate.

Because of this, no disruption can be caused to either economic technical operations or the interconnected natural eco systems of the troposphere, the earth's surface and the ocean. Apart from the low costs of process stage 1, the process cycle does not put any strain on existing economic or natural systems. On the contrary, the process actually supports these systems and makes their sustainable development possible.

Subsequently, the individual processes are also carried out in their natural sequence. Because the individual steps interlock and run parallel to each other, the sequence essentially correlates to the process cycle. Additionally, reports on climate cooling will be given for each respective stage.

Process stages of the ISA procedure

In the following text, the ISA process variants will be referred to by the abbreviations A and B.

Process stage 1 A: technical component

Production of ferrocene1 and its incorporation in combustible materials and fuels.

Combustion of the additive-enhanced fuel in a vehicle motor, in the exhaust of a vehicle or at a specially-built static or floating combustion sites. In this process, a solid iron oxide aerosol is formed, which is distributed in a waste gas phase together with CO_2, water vapour and sulphur dioxide.

Release of iron oxide aerosols combined with waste gases into the troposphere.

Process stage 1 A: natural content - without technical assistance.

Conversion of the photocatalytically reactive iron oxide aerosol with the waste gas sulphur dioxide, oxygen and further air ingredients and sunlight into iron containing sulphate, nitrate and chloride salt aerosol (ISA).

Contributions to climate cooling generated during the combustion phase of process stage 1A:

The addition of additives results in a 1.5 to 2 % improvement in combustion with substantially lower soot emissions. It also causes a 1.5 to 2 % reduction in CO_2 emissions at the same output. Lower emissions of the greenhouse gas CO_2 on the one hand and lower soot emissions on the other both contribute independently to climate cooling. The production of soot and incompletely combusted hydrocarbons can be completely eliminated by the addition of additives and avoiding the abrupt cooling of hot combustion gases.

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1) The process cycle is usually demonstrated with the additive ferrocene. Iron additives with similar characteristics can be used in the same way.

Process stage 1 B: technical component

Generation of chlorine gas by means of seawater electrolysis. Channelling a chlorine gas through heated scrap iron produces iron(III) chloride gas, which is released into the atmosphere by means of a carrier gas. This process is beneficial wherever natural salt water and electricity are both readily available, e.g. at sea, at offshore wind farms, at salt lakes in the deserts, at solar power stations. This process can also be utilised onboard ships or in aeroplanes, where the airflow or exhaust stream can be used as a carrier gas to release the iron(III) chloride.

Process stage 1 B: natural component - without technical assistance

Conversion of iron(III) chloride gas by means of cooling and hydrolysis in the humid atmosphere into a hygroscopic iron chloride salt aerosol (ISA)

Process stage 2: natural - without technical assistance

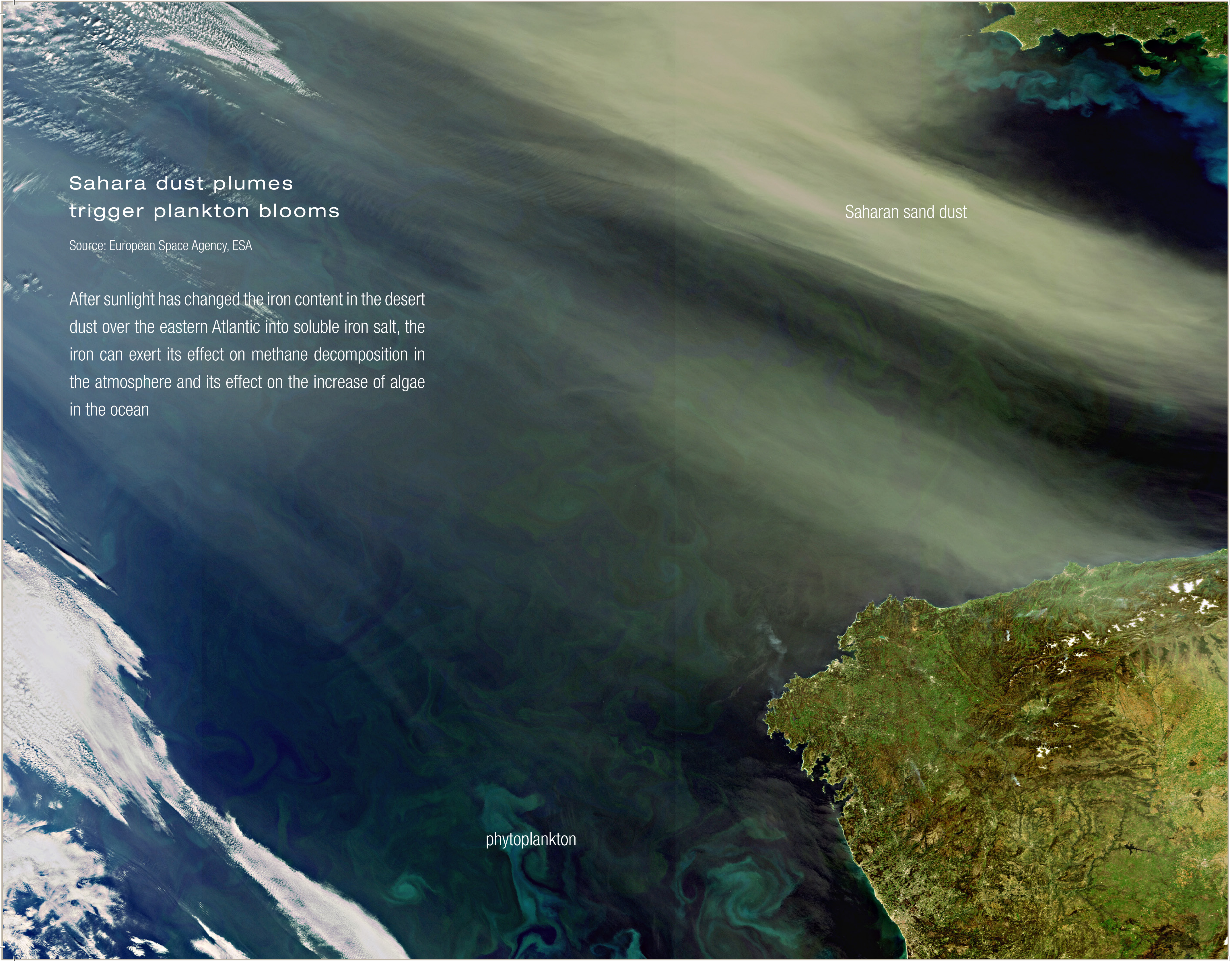
Easily oxidisable organic non-methane substances in the air oxidise on the photolytically active ISA1) in the clouds. This oxidation assists the oxidation process through free radicals in the atmosphere, thereby reducing the use of atmospheric hydroxyl and chlorine radicals originating from UV rays. This leads to an additional increase in the concentration of radicals in the atmosphere.

Contribution to climate cooling in process stage 2:

The increase in the atmospheric concentration of radicals decreases the amount of the greenhouse gas methane in the atmosphere.
The organic non-methane substances in the air also function as a greenhouse gas. Therefore, the effective removal of these on the ISA also has an additional cooling effect.

1) This reaction is also known as the “Photo Fenton Reaction”, a versatile oxidation used in technical processes

Sahara dust plumes trigger plankton blooms



Source: European Space Agency, ESA

After sunlight has changed the iron content in the desert dust over the eastern Atlantic into soluble iron salt, the iron can exert its effect on methane decomposition in the atmosphere and its effect on the increase of algae in the ocean

Process stage 3: natural - without technical assistance

The production of chlorine and hydroxyl radicals in the sunlit and photolytically active ISA1) raises the concentration of these radicals in the troposphere. The ISA prevents water-soluble atmospheric chlorine content being washed out as chloride and hydrogen chloride by converting it to slightly hydrophilic chlorine radicals by oxidation. This leads to an increase in the concentration of chlorine radicals in the troposphere.

In addition to chlorine radicals, ISA combines with sea salt aerosol to form bromine radicals. Apart from being a health hazard, ozone is also an effective greenhouse gas. Bromine radicals break down ozone in the troposphere into oxygen. Sea salt aerosol and ISA remain confined to the lowest level of the atmosphere, the troposphere, therefore leaving the stratospheric ozone layer unaffected.

Contribution to climate cooling in process stage 3:

The production of chlorine radicals is of particular importance in terms of climate cooling because these are 100 times more reactive in methane destruction than hydroxyl radicals are. Therefore methane is converted into the greenhouse gas CO_2, the inherent greenhouse effect of which is about 20 times less. This effect, alongside the increase of albedo in process stage 4, probably makes the most significant contribution to cooling in this process stage.

Process stage 4: natural - without technical assistance

The troposphere's ISA content initiates denser and more extensive cloud cover due to the duplication of available cloud condensation neuclei2). This increases sunlight reflection, which in turn causes a significant additional climate cooling effect.

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1) The production of chlorine and hydroxyl radicals is an indication of the Photo Fenton Reaction

2) D. Rosenfeld et al.: Flood or drought: How do aerosols affect precipitation? Science, 321, pp. 1309-1313 (2008)

Contributions to climate cooling in process stage 4:

The hygroscopic ISA causes an increase in the concentration of cloud condensation nuclei. This leads to:

a) cloud formation, even when relative humidity levels are low and
b) to an increase in fog droplet density.

Both of these effects lead to an increase in sunlight reflection (albedo) and subsequently to climate cooling.

Process stage 5: natural – without technical assistance

ISA are transferred from the troposphere into the upper ocean layer by rain or snow precipitation; the ISAs can be in either a fluid or solid state depending on relative humidity and temperature.
The transferral of iron content to metabolic processes in the assimilating algae and bacteria in the upper layer of the ocean. Because iron is a rare element here, this process improves the living conditions of these and other organisms in the food chain by leading to an increase in mass. The greenhouse gas CO_2 is absorbed by the organisms as hydrogen carbonate. During oxygen production, the CO_2 carbon is incorporated into the organic substance of cells or, accordingly, bodies, and excreted as inorganic calcite and aragonite in the form of shells and skeletons.

Contributions to climate cooling in process stage 5:

The break down of the greenhouse gas CO_2 in the atmosphere results in climate cooling. The increase in oxygen concentration in the atmosphere results in an increase in the atmospheric oxidation potential. This raises the photocatalytic efficiency of the iron salt aerosol with respect to a more efficient initiation in the break down of atmospheric reducing agents.

The activation of assimilating organisms stimulates their volatile metabolic emissions, releasing dimethylsulfide and dichlormethane.

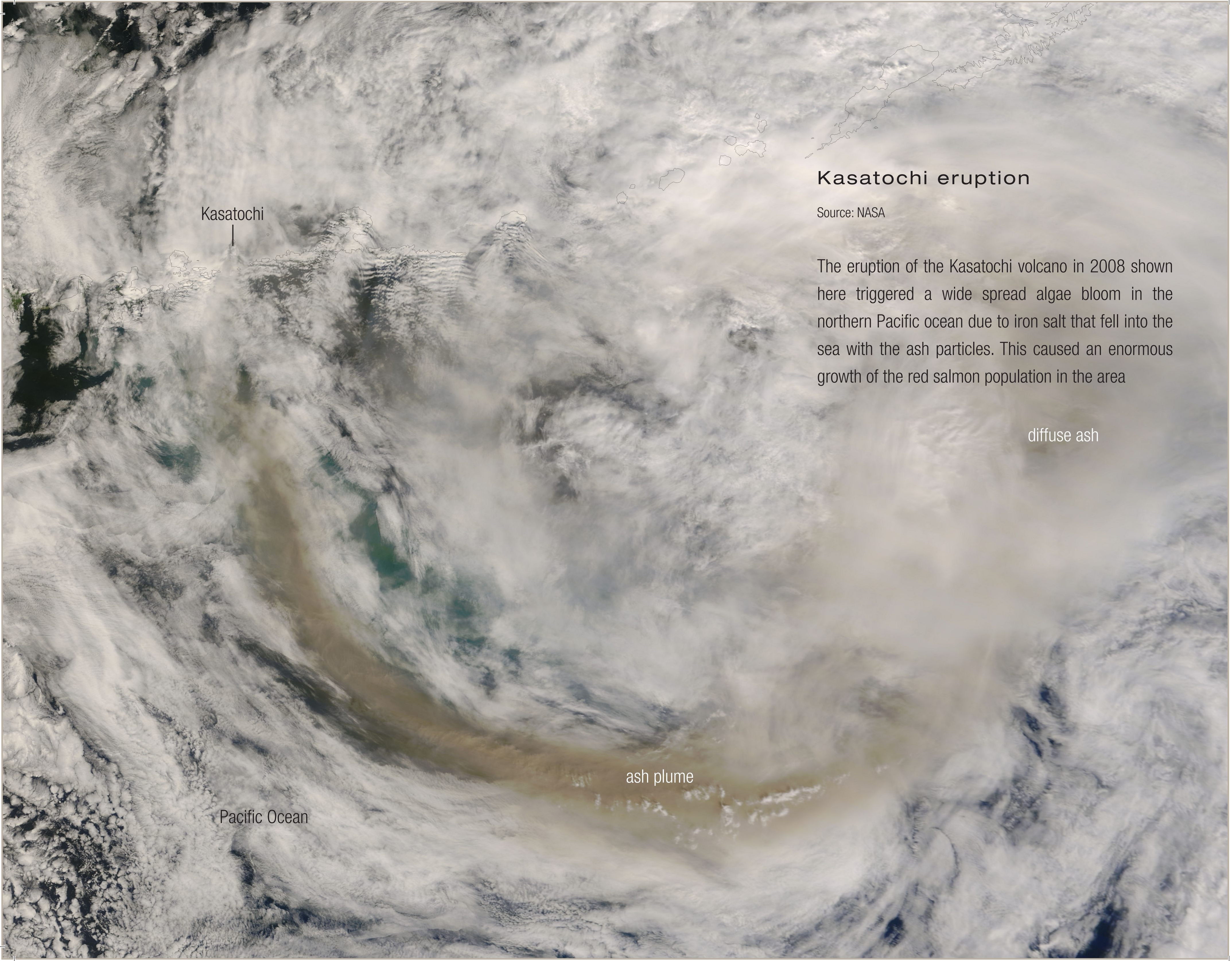
The end products of the tropospheric oxidation of these metabolites are sulphuric acid and chloride, which assist the increase of albedo through cloud build up, while chloride aids methane reduction. Both effects have a cooling influence on the climate.

Process stage 6: natural - without technical assistance

Reflecting the triggered increase in the mass of dead organisms, excrement and leftover organic substances, including inorganic shell and skeletal remains, build sediment on the sea bed. This initially resulted from the dead organisms in the food chain, starting with phytoplankton. Here, organic substances produced during the digestion process are converted into solid methane hydrate, wax and humus, and finally from the latter into kerogen, a crude oil precursor. In particular, the reduction of sulphate and the further reduction processes during sediment formation lead to additional limestone precipitation of the dissolved CO_2. Stable sediment is formed from the limestone fossils, precipitated limestone, organisms and methane hydrate.

Contributions to climate cooling in process stage 6:

The fundamental contributions to climate cooling from process stage 6 are not only based on the binding process of the former greenhouse gas carbon in the “ISA sediment” but also on the function of this sediment as a renewable energy source: Its enrichment with methane ice and other organic energy sources contributes to the sustainable generation of renewable energy. These renewable energy sources, whose eco-friendly retrieval from the ocean is currently being developed, will gain importance in the era after fossil fuel resources have been exhausted. The exclusive use of renewable energy sources minimises the build up of greenhouse gases and therefore maximises climate cooling.



Kasatochi eruption

Source: NASA

The eruption of the Kasatochi volcano in 2008 shown here triggered a wide spread algae bloom in the northern Pacific ocean due to iron salt that fell into the sea with the ash particles. This caused an enormous growth of the red salmon population in the area

Questions and answers to each process stage

This chapter summarises the descriptions of the individual process stages to a short synopsis. Detailed descriptions can be found in the chapter “Process stages of the iron salt aerosol procedure”.

Process stages 1A and 1B

1A: Ferrocene is produced and added to fuels.
The fuel mix is combusted, creating solid iron oxide aerosol.
The mixture of aerosol and waste gas containing iron is released into the troposphere. In the troposphere, the iron oxide aerosol reacts in the sunlight with other atmospheric components of waste gas and air to form iron sulphate, nitrate and chloride salt aerosol (ISA).

1B: Iron(III) chloride vapour is produced and released into the troposphere.
Cooling and chemical reactions result in the formation of an iron chloride salt aerosol (ISA).

Question:
How expensive are ferrocene and iron(III) chloride? Is their production expensive?

Answer:
Ferrocene is an industrial product that is easy to manufacture. It is currently used as an additive in fuel oil or in diesel oil for ships. It provides a low-soot, complete combustion, which is therefore more environmentally friendly.
The price of ferrocene is currently around 50 EUR/kg. Correspondent to growing demand the cost of ferrocene will be reduced to a fraction of today’s price. The price of iron(III) chloride is under 5 EUR/kg.

Question:
How much ferrocene or iron(III) chloride is required to hinder global warming or to initiate climatic cooling?

Answer:
After the Pinatubo eruption, the specific amount of CO_2 conversion as a result of the ISA in the volcanic ash cloud be calculated. The calculation takes into account:

- the global increase of oxygen in the atmosphere;
- the global decrease in CO_2 concentration
- the total amount of water soluble iron in the ash aerosol that fell into the Pacific.

The specific amount of methane oxidation by ISA was estimated by taking into consideration the advantageous physical and chemical characteristics of ISA in comparison to natural dust particles. The global decrease in methane concentration, following an initial increase after the Pinatubo ash fallout, was also taken into account.

The calculated amount of CO_2 and methane, whose conversion into organic carbon or into CO_2 can be triggered by the equivalent amount of iron, can be used to estimate the additive ferrocene.

Humans are responsible for the global emission of 25 billion tonnes of carbon-containing greenhouse gases each year and this could be eliminated by the utilisation of around 100,000 t of iron in the form of iron salt aerosol. This roughly corresponds to the consumption of three times the mass of ferrocene or iron(III) chloride, thus each about 300,000 t per year.

Question:

If the combustion of ferrocene as a fuel additive is already a known practice; how can a procedure be patent protected when it comprises exactly this combustion process?

Answer:

The conventional construction of the tropospheric airspace is inappropriate for the purpose of climate cooling. This is because its enrichment with ISA from natural as well as anthropogenic sources occurs in a sporadic or irregular and uncontrolled way. Natural sources include volcanic eruptions, dust storms, meteor strikes and cosmic dust. Anthropogenic sources include steel works, foundries, fuel and fuel additives.

Because of this, the airspace must be enriched with a sustainable dose of ISA averaged over time and space to make it suitable for the purpose of climate cooling.

It is only in this way that it is possible to determine a constant average concentration of iron-salt aerosol. This dose is measured so that the desired target climatic parameters are kept sustainably stable.

Question:

How high is the concentration of ISA in the atmosphere while the ISA procedure is being carried out? Could it have any adverse effects on our health or the environment?

Answer:

Transport and energy production are concentrated in the northern hemisphere of our planet. In the event that the ISA procedure is coupled with transportation (aeroplanes and ships) and energy production (power stations and offshore wind farms), the ISA concentration will be at its highest here. Under the worst immission conditions, the iron concentration amounts to 20 nanograms per cubic meter of air. However, these immission conditions will only prevail when the entire quantity of iron-containing aerosols from the 300,000 tonnes yearly of combustible ferrocene remain in the troposphere and do not sink. It is assumed that the source of ISA emissions can be configured in such a way that the layer of air close to the surface of the continents will not be polluted by the ISA.

In research undertaken by the Fraunhofer Institute for Aerosol Research in Hannover, the effects of iron concentration in breathable air have been tested by various experiments on animals. Even the constant inhalation of air with an iron concentration of around 0.5 milligrams per cubic metre1) did not show any negative effects on the respiratory organs or any other health problems.

An iron concentration in the air of around 0.5 milligrams per cubic meter is approximately 25,000 times higher than the 20 millionths of a milligram per cubic meter that would arise under the most unfavourable immission conditions.

This concentration would be far below the concentration of fine dust that is permitted in our cities, even below the levels that occur in the countryside, far away from the cities. Even the iron content or the harmful soot particles in this dust is far above the aerosol concentrations that can occur in our ISA particles.

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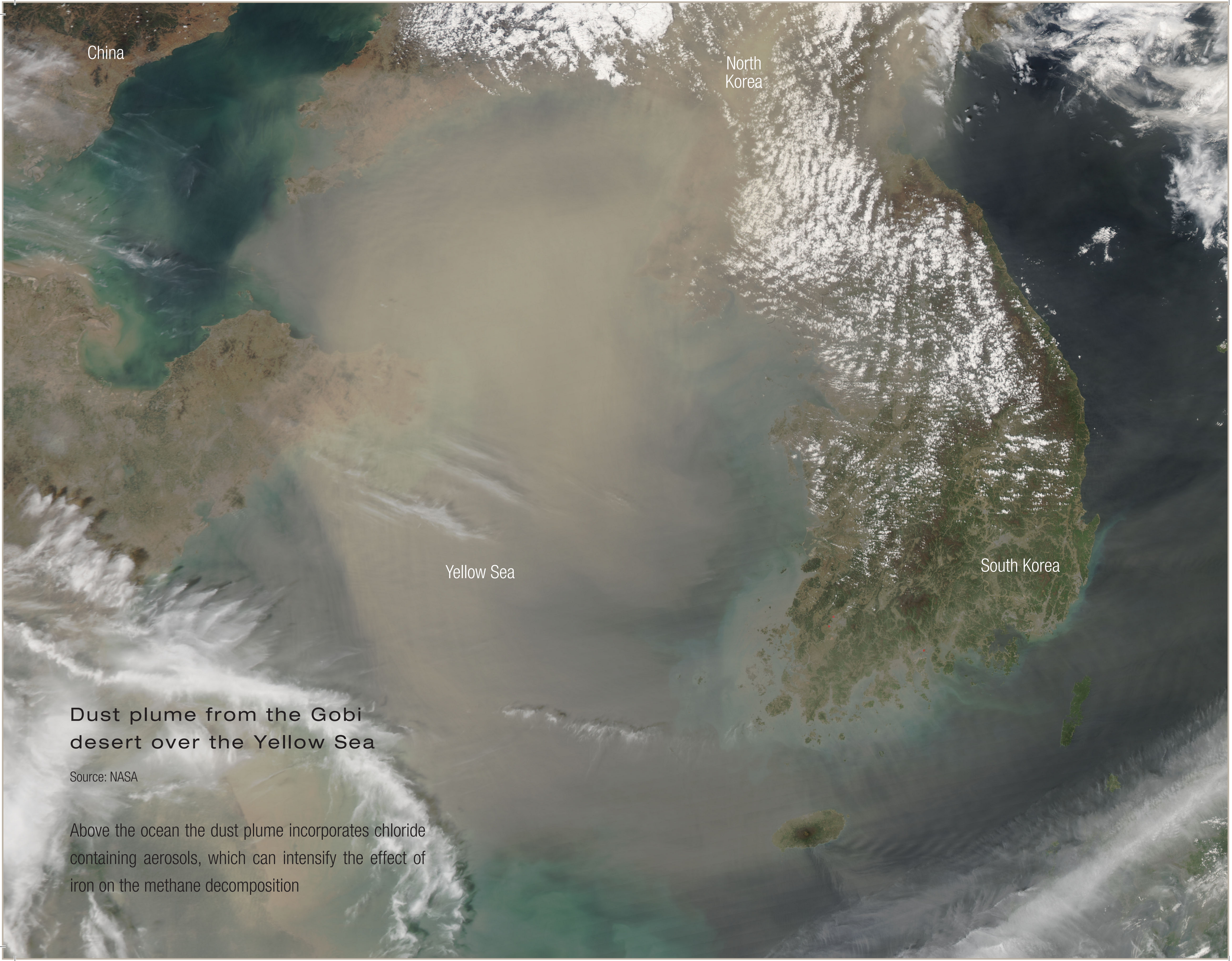
1) L. Peters et al.: Investigations of chronic toxic and carcinogenic effects of gasoline exhausts deriving from fuel without and with ferrocene additive; Inhalation Toxicology, 12, Supplement 2, pp. 63-82; ISSN: 0895-8378



Dust plume from the Gobi desert over the Yellow Sea

Source: NASA

Above the ocean the dust plume incorporates chloride containing aerosols, which can intensify the effect of iron on the methane decomposition

On the contrary: the majority of combustion processes will be improved by the ISA procedure because they will emit less soot and incompletely combusted organic compounds. The iron-containing aerosol ensures that carcinogenic substances such as soot and nitroaromatics from vehicle exhausts as well as ozone and organic peroxyacetyl nitrate from photosmog can be broken down quickly or prevented from forming. From this point of view the utilisation of the ISA procedure will even result in a decrease of several cancers.

Question:

Higher emissions could be triggered by carrying out the ISA procedure near land, e.g. in cooling towers and power stations, in docking and departing ships and aeroplanes during landing and take off. How can exposure of the population to emissions sources such as these be avoided?

Answer:

In power stations, ISA emissions are produced when gases containing iron oxide or iron(III) chloride are introduced together with hot waste gases in the atmosphere. Except during periods of thermal inversion, thermal buoyancy can raise smoke gases to heights of well over 1000 m. During periods of thermal inversion, when such buoyancy values cannot be achieved, the release of waste gases containing ISA is stopped.

For ships, the ISA emissions can be shut down directly in front of the harbour entrance.

For aeroplanes during landing or take off similar procedures can be used so that the ISA emission only takes place when the aircraft is at a height of more than 1000 m above ground. This means that exposing the population to high ISA emissions can be completely avoided.

The major advantage of the ISA procedure is that it does not necessarily have to be operated at the actual sources of greenhouse gas emissions. It can be initiated in places that are particularly advantageous, these can be far from human habitation, e.g. on a platform in the South Pacific, on a ship or from an aeroplane in the upper troposphere.

The ISA procedure can take place during suitable weather conditions e.g. at a power station. In this way, the operator is able to prevent disturbance from sinking smoke gases originating from ISA.

If it is determined that the procedure, despite all contrary indications, does have grave negative consequences for human health then the ISA procedure can be immediately shut down or cut back. Thus it is possible to immediately counter any negative effects.

Question:

Due to the iron content of the combustion gases released by the ISA procedure, is it possible that the sky will change to a rusty or yellow colour, similar to that of Mars' iron dust atmosphere?

Answer:

No, even in close proximity to the exhaust funnels of a ship, in the exhaust stream of an aeroplane or from the chimney of a power station, no yellow iron shimmer can be detected. This is because the iron concentration in the exhaust gases is somewhere between 10 and 100 milligrams per cubic meter.

Currently, modern cruise ships use fuel enhanced with ferrocene additives to prevent the passengers being disturbed by the sooty black waste gases from the ships' chimneys. Today, their exhaust fumes already have an iron concentration of between 10 and 100 milligrams per cubic meter, without being a noticeable yellow colour. They only stand out because they appear invisible in comparison to conventional diesel exhaust fumes as these are coloured grey by soot.

Process stage 2

It is mainly within clouds that organic substances oxidise directly on the ISA. This results in the under-consumption of chlorine and hydroxyl radicals and can raise their concentration in the troposphere.

Question:

Can the direct oxidation of the organic substances in ISA only occur within the clouds?

Answer:

No, direct oxidation can of course also occur outside of the clouds. Outside of the clouds, ISA exists predominantly as solid particles. Inside the clouds, ISA exists mainly as droplet aerosol or on ice crystals as a liquid freeze-concentrated film with a high salt concentration. Additionally, hydrogen peroxide concentration is higher inside than outside the cloud formations. Under these conditions, the Photo Fenton Oxidation on the ISA can take place more effectively inside the cloud than outside.

Process stage 3

Hydroxyl groups, hydrogen peroxide and chloride also oxidise on the ISA. This has the additional effect of increasing the concentration of chlorine and hydroxyl radicals in the troposphere.

Question:

Has it been scientifically proven that the photochemical reactions between ISA and substances in the air result in new production of radicals that initiate methane breakdown, or rather result in the increase in concentration of radicals that trigger methane break down? Has it been proven that hydroxyl and chlorine radicals break down methane?

Offshore wind park

Source: iStockphoto, © Sergiy Serdyuk

Surplus electric energy from offshore wind, wave and tidal power plants can be used for the production of iron salt aerosols

Answer:

It has been proven that the breakdown of methane in the troposphere occurs exclusively through hydroxyl and chlorine radicals. Equally, it has been proven that the production of hydroxyl and chlorine radicals on iron salts takes place in natural clouds and fog droplets. Finally, investigations into volcanic ash clouds have proven that the production of radicals causes the massive break down of methane and other hydrocarbons[1].

The corresponding photochemical reactions and the so-called Photo Fenton Reactions of iron salt have been successfully used for years to eradicate problematic substances in water purification.

The large amount of evidence of the correlation of the respective atmospheric content of dust, CO_2 and methane as well as temperature during ice and warm ages over the last million years demonstrates this. This evidence comes from ice core samples taken from the Antarctic and Greenland as well as sediment core samples taken from the Pacific.

The chemical and physical conditions in the troposphere, aside from temperature and humidity, are subject to constant change and differ sharply according to the vertical distance from the surface of the sea, or rather from the earth's surface and location. Therefore, the exact effects can only be determined after the ISA procedure has been carried out. We assume that the actual doses of ISA required will be a lot lower than current estimations, which are purely based on the effect of the ISA-bearing volcanic ash from the Pinatubo volcano on the break down of CO_2 and methane.

Process stage 4

The ISA content in the troposphere, linked to condensation nuclei, increases the density of the cloud cover; an additional cooling effect develops due to the increase in sunlight reflection.

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1) A. Baker et al.: Investigation of chlorine radical chemistry in the Eyjafjallajökull volcanic plume using depletions in non-methane hydrocarbons; Geophysical Research Abstracts, 13, EGU2011-3376 (2011)

Question:

Will the implementation of the ISA procedure result in a fundamental change to cloud cover? Will blue skies and sunshine become rarer?

Answer:

No, that is not anticipated. The essential change to cloud cover is their higher reflection potential. That means that viewed from above the clouds containing ISA will appear whiter, while from below they will appear darker. The global relationship between cloud-covered and cloud-free area will probably increase by less than 10 %.

Process stage 5

The ISA falls as precipitation and enters the metabolic process of ocean, increased algae growth occurs.

Question:

Many water soluble substances, e.g. hydrogen chloride released during methane oxidation, are rapidly washed out of the atmosphere by precipitation. Does this also apply to the salts in ISA? This could significantly reduce the retention period of ISA.

Answer:

Aerosols made from hygroscopic substances, including ISA, act as condensation nuclei; this is highly beneficial in cloud formation. In contrast to lower condensation nuclei densities, clouds with a sufficiently high condensation nuclei density are formed from tiny fog droplets, which, in contrast to large fog droplets can no longer coagulate. A build up of precipitation in clouds that consist of such tiny fog droplets is only possible when they can build ice crystals out of tiny fog droplets. This reduces the speed at which the ISA can be washed out of the troposphere.

Also, the leaching of ISA droplets caused by precipitation such as rain or snow is less likely to occur than the leaching of gaseous substances e.g. hydrogen chloride. This is due to the lower diffusion-speed of such droplets.

Question:

What is happening to algae growth, are we experiencing an algae catastrophe? Will the eutrophication of the oceans cause massive changes to ocean ecosystems through the formation of extended anaerobic zones?

Answer:

Unlike climatic cooling proposals that involve the direct fertilisation of algae with ship loads of iron salt, which can only be applied to a tiny portion of the ocean surface, the ISA procedure uses the entire surface of the ocean.

This means that only a very small dose reaches the surface. The additional exposure for one square meter of ocean surface within a year is around just 30 mg/m^2. Based on the volume of the ocean's photic zone, which reaches up to 200 m below the surface, an additional iron input of 0.15 mg/m^3 occurs. This would stimulate algae growth globally.

The resulting algae production is low in coastal regions and regions where upward currents prevail because it is in these areas that algae growth by means of natural eutrophication dominates.

Algae production resulting from ISA dominates in deep sea regions marked by their iron deficiency.

As an organic carbon, this algae production creates an additional organic mass in the food chain. Based on 30 mg/m^2 of additional iron, this can achieve a maximum of 643 tonnes of organic carbon per km^2 of ocean surface each year1).

This corresponds to an average daily formation of 9 mg C per day and per m^3 organic mass within the photic zone1).

1) According to literature, 1 iron atom can result in the conversion of 100,000 CO_2 carbon atoms to organically bound carbon.

Atom mass of iron (Fe): 56 g
Atom mass of carbon (C): 12 g

Consequently, 56 g Fe iron can convert 12 g x 100,000 g CO_2-C into organic C = 1,200,000 g C
30 mg Fe /m² per year corresponds to 30 mg Fe /m² / 56.000 mg = 0.00054 Fe atom mass/m² per year

Hence the mass CO_2-C per m² and year convertible to organic C can be calculated by: 0.00054 Fe atom mass/m² x 1,200,000 g = 643 g C/year = 0.643 kg C/year = 0.000643 t C/year

Hence the mass CO_2-C per km² and year convertible to organic C, can be calculated by: 0.000643 t C/year m² x 1,000,000 m²/km² = 643 t C/year km²

Hence the mass CO_2-C per km² and day convertible to organic C, can be calculated by: 643 t C/year km² / 365 days/year = 1.76 t C/day km²

Hence the mass CO_2-C per m² and day, convertible to organic C, can be calculated by: 1.76 t C/day km² / 1,000,000 m²/km² = 1.76 g C/day m²

The mass CO_2-C per m³ and day convertible to organic C can be calculated assuming an average thickness of the photic zone in the ocean of around 200 m:1760 mg C/day m² / 200 m = 9 mg C/ day m³

Power plants, as well as air and ship traffic belong to the greatest greenhouse gas emitters; therefore, they can also be used as ISA emission sites for the ISA process

Source: iStockphoto, © Marko Doering photography

At such a low rate of additional organic carbon generation, the new formation of anaerobic regeneration phases, or rather the shifting of boundaries between aerobic and anaerobic phases, is only to be expected in such ocean localities where anaerobic or sulphur-reducing phases exist from the outset.

Process stage 6

Dead organisms and released carbon dioxide are converted into methane hydrate, kerogen and limestone in the sediment.

Question:

What happens to the methane hydrate on the ocean bed; since the publication of the novel "The Swarm" lots of people could ask this?

Answer:

The iron salt is spread very evenly across the surface of the ocean. This means that additional ISA iron will account for no more than 30 milligrams per square meter of ocean surface each year. Therefore, this cannot result in a locally concentrated, permanent algae bloom, which could then result in instable methane hydrate enrichment in the sediment below. The short term decomposition of methane hydrate and other methane gas emissions as a result of the ISA procedure is therefore impossible. On the contrary, the probability of sediment slides and the temperature-controlled break down of methane hydrate is increased by unchecked global warming caused by continuously increasing global temperatures. This results in dangerous bubble swarms and the emission of explosive clouds of methane gas.

The patented ISA*-process represents the only known and patented process that reduces methane (at relatively low costs). Furthermore it has the potential to reduce other greenhouse gases (CO_2, Ozone):

- Key target groups are companies in the field of energy (power plants, oil industry), aircraft industry and in the maritime sector.
- This patent has been applied internationally. It has already been confirmed in Australia, Russia, China, India, Japan and USA. The permission in Europe is already committed.
- Every company that is able to apply the ISA-process successfully and get it certified for CO_2-emission trading, will benefit strongly from the enormous profit potential, while at the same time helping to protect our climate.

*ISA = Iron Salt Aerosol