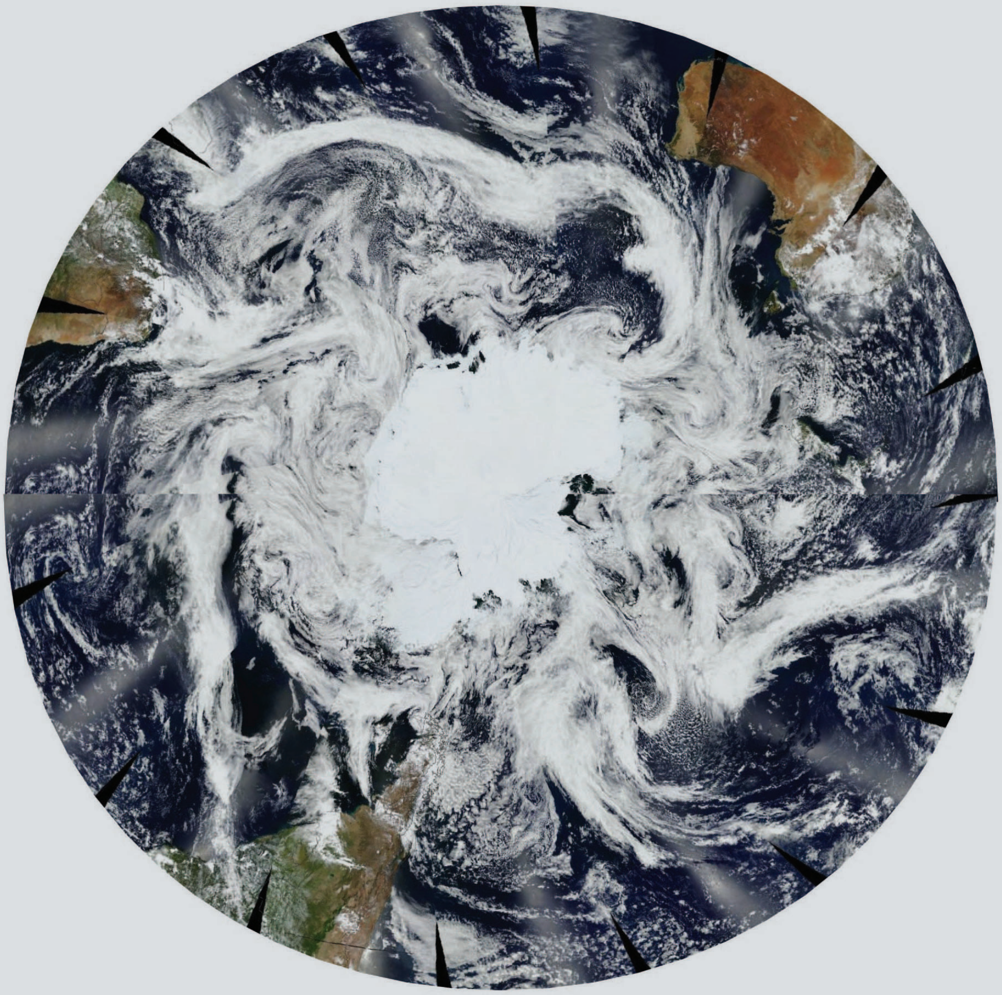

Cloudscaping

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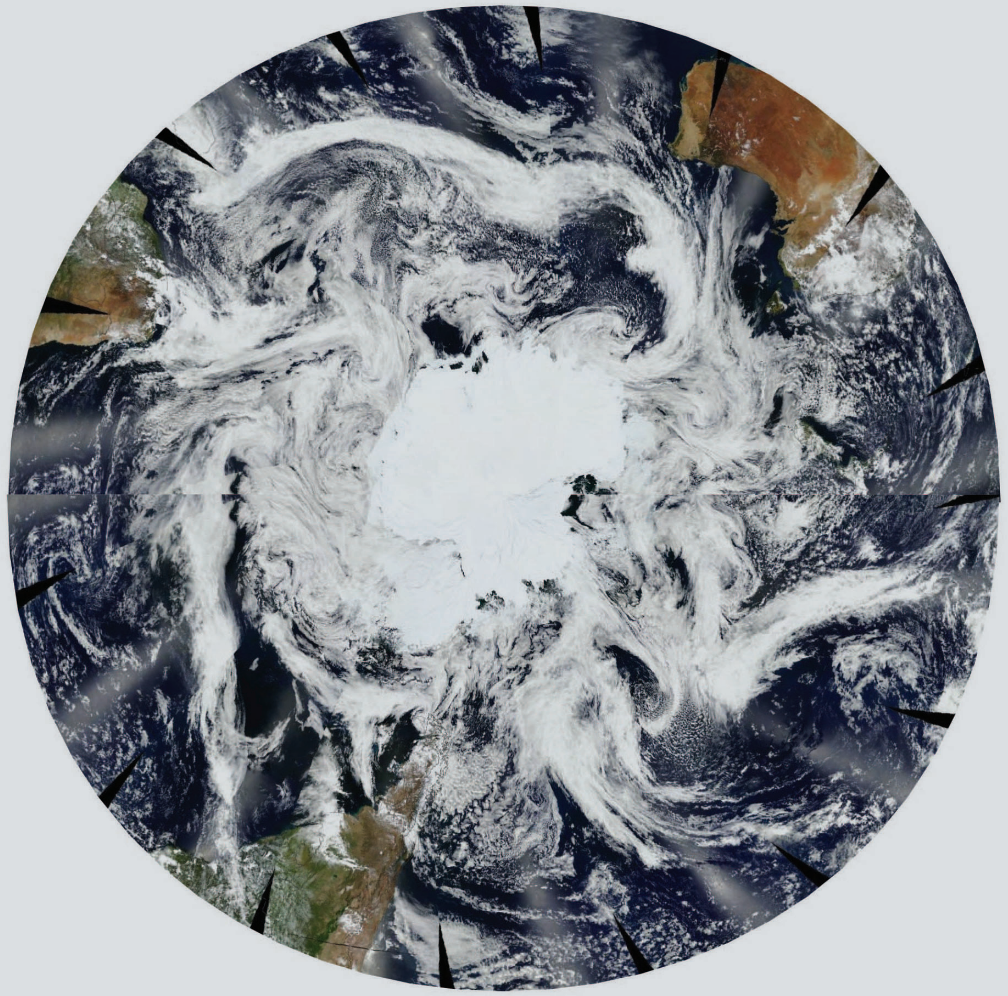
Brief summary.

In an ever changing world, nothing is changing more constantly and rapidly as the weather. It's an integral part of human existence, with enormous implications for our possibility to survive. However, nothing has been as out of reach for humans to alter as the weather, but in the last century this has changed. Unintentionally we have set in motion a large change in our climate that we are now beginning to see the effects of.

This thesis aim at examining the possibility of influencing the weather by altering the clouds and the precipitation through architecture. By altering the clouds it will influence the natural space created by the sky. Through researching the processes needed to create clouds, a scalable platform has been designed. These platforms are able to spray water from the sea up into the clouds, but also to connect to each other for a larger structure. The interconnecting platforms create large architecturally interesting forms, but its output is going to have larger effect. Large pillars of water that form clouds will form the space around it for miles. By creating clouds and rain where there are none or too little, it can revert some of the effects of the climate change on a regional scale. This can be done by resupplying areas that has seen decreases amounts of rainfall, but also by resupplying groundwater basins drained by human overconsumption.

Even besides the different uses it will also shape the space and sky around it. It will create cloudscapes.



Clouds over the southern hemisphere.

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Berndnaut Smilde, Nimbus ll - 2012

Introduction.

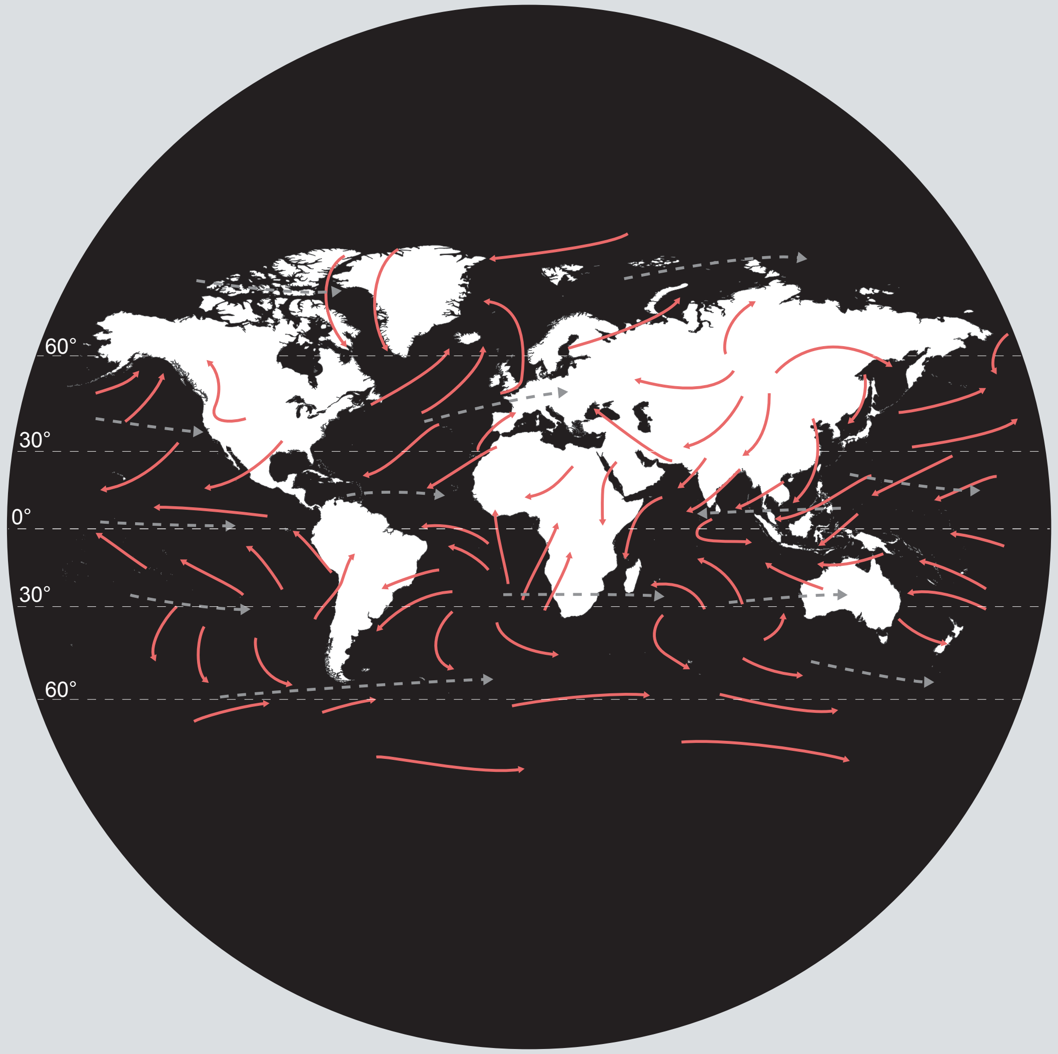
My thesis project started with an idea of how clouds and the sky affects the way we experience room and space in architecture. I thought about the limitations of what an architect control and how this has grown from the house to the city during the last millennia, and from the city to regional planning during the last century. I questioned why this control wouldn't change into global scale in the next century. Not only planning of human settlement and expansion, but also how the climate will affect people. Gaston Bachelard stated in Poetics of Space that "the house protects the dreamer"[1]. The sky has been the subject of many dreams through human history and I see that the possibility to effect the sky would mean that the architect could use it to "protect the dream" that today are threatened by changing weather patterns caused by the climate crisis today. But to change the clouds is an extremely complex process and it borders on what is defined as architecture.

Tetsue Kondo experiment.

Process.

To tackle this problematic from an architectural point of view wasn't an obvious way of approach. By looking into what had been done architecturally, I tried to get an guidance to how to approach the subject. I started to look into the work of Tetsue Kondo, and his installation for the 2010 Venice Biennale. I tried to recreate the installation to see if I could go on from there. As a preparation for the work, I had to understand the processes that affect the clouds and precipitation. Not only the process that formed in the installation, but also the flows of air and particles in the clouds and the atmosphere, the creation of weather fronts and the global movements of weather. A rigorous crash course in meteorology and physics, where every answer opened more questions, made me more self-confident to approach the work of Kondo, and I built a small scale model of his work. This model, which was meant to create an artificial cloud in a closed space, was both a success and a failure. Success, because I created a cloud. Failure because it was a cloud that didn't float.

Discussions with my tutor had raised the question early whether this was architecture and that it would become hard to create an investigation that raised architectural questions. When I presented the model and a booklet containing my initial research two directions for the project became apparent. Either I pushed this into a more technical and scientific project through research and trial and error. Or I took the knowledge I had gain from the research and my experimental model, and used it as a base for a theoretical idea-based architectural project. The midterm critic made it apparent for me that I didn't want to push it into a technical direction, partly because I wasn't as interested in it and it diverted focus from my original idea of the effect of clouds on the architectural space. But also because it would be a project presented by and for people interested and specialized in architecture, not meteorology and climatology. The project still has parts of meteorology and climatology, but the focus will be the architectural space.



Global windmovements.

Process.

How to take the thesis into an architectural idea from what I had at this point wasn't obvious. I looked into what I knew about cloud and wind patterns, but the lack of a site made it difficult to get a comprehensive view of what could be done. I started to look at sites that lacked water, trying to find a use for my thesis, and started to realize that in the areas with a lack of water, it was often compensated by drilling deep wells to extract the groundwater basins. When the groundwater is extracted, it makes the surrounding area more arid, but also it hasten its own demise, since it also allows for saltwater intrusion in the basins, making them useless in a practical sense. Since there was no way of replenish this resource, I saw a use for artificial cloud creation not only to secure peoples supply of fresh water, but also to refill the groundwater basins. I mapped these places and compared it to a mapped view of the global wind patterns in order to localize a site. The wind had to come at a regular direction, to be able to situate the project. Four sites became possible at a first general view; California, southern Spain, the area south of the Kalahari Desert and west Australia. I choose to focus on southern Spain and more specifically on the Almeria Region.

The Almeria region is situated at the base of a chain of mountains, but it's also a semiarid region and interestingly enough one of the largest producers of vegetables in Spain and Europe. Geographically, it's situated at a place where the hot winds from Sahara come down from the stratosphere and then flows over Spain into Europe. They are dry winds at this point, picking up humidity when it passes over the Mediterranean, but they don't gain enough to be able to form cloud before they pass Almeria. This makes the rainfall in Almeria sparse, and agriculture has further increased the demand for the already sparse water. An intervention here would help the region to create a more sustainable agricultural economy. By increasing the humidity in the winds from Sahara, they would be able to form clouds at a much lower altitude and the droplets in the clouds would be able to congregate faster in order for them to fall down as rain, giving the Almeria region its much needed precipitation.

Location of possible sites.

Process.

When I researched the formation of clouds I came upon the Cloud Whitening project lead by Dr. John Latham at Manchester University.[2] The project was presented in 2012 and it aims to increase the reflectivity of the earth in order to reduce the amount of sun energy that increases the temperature of the earth. This is done by promoting the formation of clouds above the oceans by spraying small saltwater particles up into the sky that contracts the humidity of the air and form white clouds. Since the aim of the project is to create white clouds, it disperses the particles by ships that cross the oceans to spread the effect on a large area. I realized I could use this theory as a base for my own project, but alter it to be stationed at one point and supersaturate the sky above it to create more dense clouds, in order to create rain.

With Latham's project as a technological base I started to look at the water demand in the region. My tutor recommended me to look at the produce in the region and to calculate the water requirement of all the grown vegetables in the region. An average harvest requires about 2 242 720 000 m3 each year. Multiplying this with the cost of fresh water in Almeria which is about 0,25 € (a very low figure looking at spain as a whole, it reaches 1.72€ in some regions) makes a yearly cost of about 560 680 000€, which gave me an economic structure to interact with. But calculating the demand gave also the required size of the project. To be able to supply Almeria with water all year around required a structure at the size of 130,000 square meters in active area, equivalent to about 18 football fields. To locate such a structure with an ample supply of saltwater close by, gave an enormous limit to my site-placement. But I realized that by putting the structure on water, I negated the requirement to transport water to the structure, and gave me freedom to place the structure at an optimal site in relation to the sitefocus of my project.

Greenhouses in Almeria.

Process.

I started to look into oil platforms as a guideline of how to put enormous structures on water. The realization of how these enormous structures could traverse the oceans gave me economical flexibility, since I could create a structure that could move when the need was satisfied, but also geographical flexibility to optimize the effect. This was when I came across the ship-classification Panamax, this refers to the maximum size a ship could have to travel through the Panama Canal. Using this limitation as a guide I started to design a platform that was inspired by oil platforms, but instead of extracting oil, it extracted water and sprayed it into the air and formed clouds. A Panamax sized platform would be too small to include the entire 130,000 square meter structure, but it could include a component. The platform were divided into components that could interlock like an enormous floating puzzle to minimize the structure, but still be independent when it traveled to a new site, or to resituate itself when the wind changes.

The technique John Latham proposed to spray water into the air is quite energy dependent. I explored different techniques first to examine the options, but it became apparent that this was the most efficient because of its use of the natural patterns in the air to create rainclouds. To supply the platforms with the required energy I propose to put parabolic troughs on the crest of the greenhouses in Almeria to collect solar energy. By collecting solar energy during the day, when the sun heats the air closes to the ground and makes it rise, and using the power to create clouds during the night when the there is less rising hot air from the ground, I can both effectivize the process to create rain, and gain the required power to supply the platforms.

I believe that combining the cloudspraying technology John Latham proposed, the oil platform and the solar power used in the same region in Spain, it will be possible to create enough clouds to create the necessary rain required to water the Almeria region´s entire farm production and by doing so, start to replenish the almost depleted groundwater basins.

Clouds over the sea.

Rising clouds.

Cloudcreation.

Clouds are created by humid air that rises and cools down, making the water it brings upwards to condensate. When it condensate, it forms particles that falls down. But until the particles combine to form larger droplets, the rising air makes them rise faster then they fall down, giving the illusion that they hover in the air.

The process of cloudcreation starts at the ground. The ground absorb heat from the sun faster than air, and the heated ground then heat the air close to it. This creates an unbalance, where the heated air wants to rise, and cooler air comes down which then also is heated, creating a circulation until the groundtemperature equals the air-temperature above it. The heated air when it rises, absorbs the water that evaporates by the sun. Since hot air can absorb more water than cool air, most moisture is absorbed during the day. The hot humid air then rises upwards since it has more buoyancy than the cooler air above it. When it rises it cools down, partly by temperature conduction, but also because the falling pressure increases the distances of the molecules which makes the temperature fall. A general rule is that the temperature go down 1,65° C per 100 meter altitude you get in the atmosphere. A cloud is created at different altitudes because it has different temperature at ground level and therefore takes longer to cool down the more it has to diminish in temperature. When the hot air reaches a relative humidity of 100% (when the air can´t hold more water and the leftover water has to condensate instead) the base of the cloud is formed by water that condensate on small particles in the air, called nuclei's. This is the reason that the base of the cloud is usually flat, but because this process continues upwards into the cloud, it can reach altitudes of several thousand meters.

Windmap.

Movements inside a cloud.

The small water particles are raised upwards by the rising air, increasing in amounts the higher it comes, when the rising air cools down and the moisture condensates. When the density of the particles increase, more and more of them collides and becomes larger particles that increase in weight. At a certain size they first start to hover, when their size and gravity effects them, but when they become large enough they overcome the rising power of the air and gravity brings them downwards as rain.
The particles in the clouds are very small. They are created around nucleus that are around 0,2 nanometers in diameter, and the average cloud drop is about 0,2 mm in diameter. A drop that is large enough to fall is about 2-5 mm in size. At this size the combination of gravity and the force of the rising airflow deform it to more oblate forms that often are split up to smaller droplets.
These movements happen in a pattern (usually, depending on the type of cloud) with the rising hot air on the sides of the cloud. In the center of the cloud, the small droplets that are created by the rising air, collide more frequently and create larger drops. These larger drops fall down in the center, creating a flow of cooler air going downwards. The hot air on the sides continues upwards and pushes itself above the cold air around the cloud.

The air in a cloud is never still. There is always movement because of the inherent instability of hot and cold air. These movements are usually larger than just one cloud and this is what forms weather fronts of cold and warm air. One way for weather fronts to come into being is when the sun heats the ground and therefore the air above it. When it then rises, it pushes the cold air that moves downwards. When hot air comes inland from the sea, it collides with the downwards pushed cold air which press the hot air upwards. This cools the humid hot air and makes the water it carries to condensate and creates clouds.

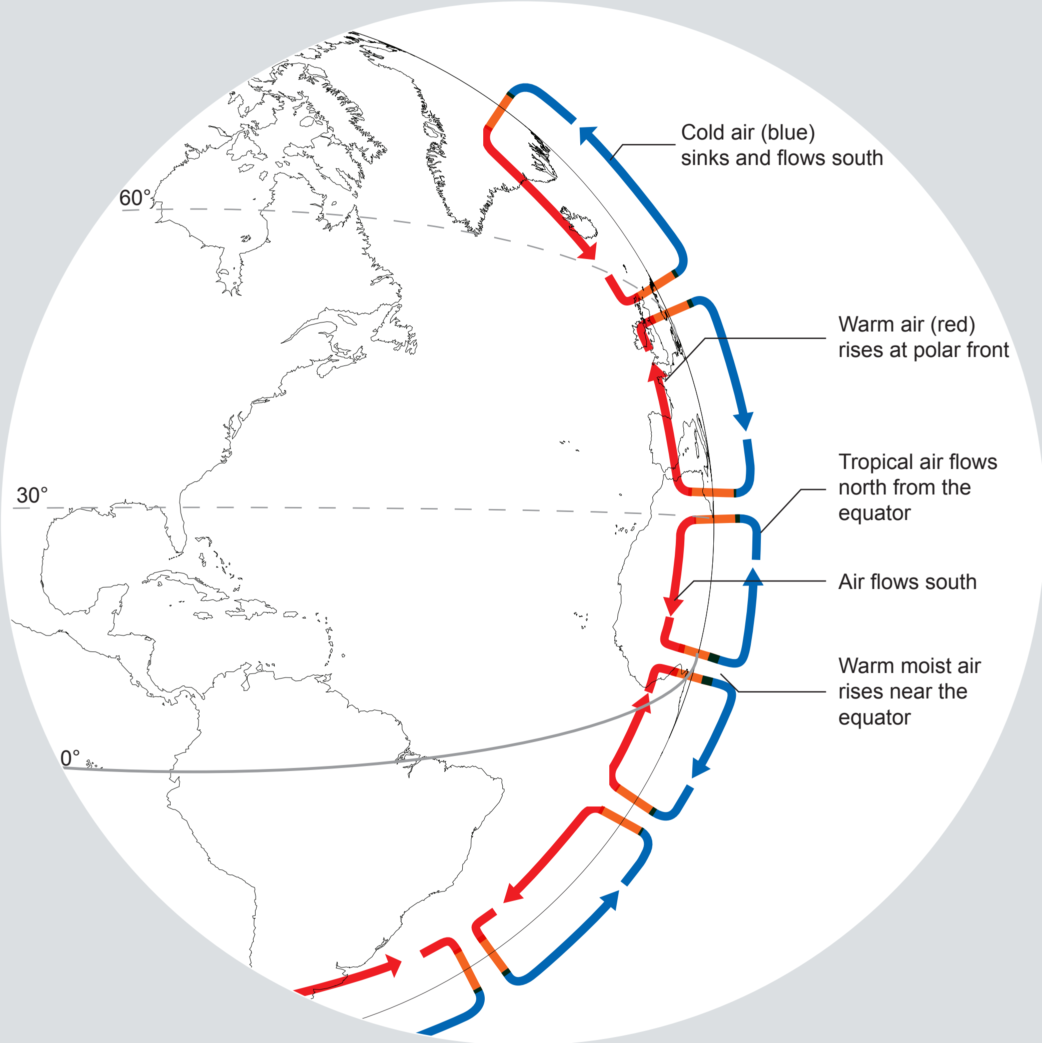


Diagram over global wind phenomena (Hadley Cell).

Factors influencing the weather.

The creation of clouds and flows of winds are not only created at a local scale, but there are global patterns in the flow of the weather. One of the major phenomenon called Hadley´s cell, describes different weather cells that divide the world at a longitudal scale. At every 30° longitude the air rises or falls. At the southern part of Spain this means that the winds come generally from southwest with hot air from Sahara. It hasn't absorbed enough water to create enough clouds at this moment and normally it continues upwards through Europe. By promoting the creation of clouds at this point my project create the possibility for these winds from Sahara to transport the water from the sea to land before it continues upwards to Europe.

There are already ways today to influence the weather and the precipitation, which generally is based on the principle that by adding chemical particles to existing cloud formations, it makes the cloud droplets to combine and fall down as rain. Collectively this is called cloudseeding. It has existed since the 1960s and has been used in the US and Australia to make it rain at time of droughts, and making it snow when there is not enough for alpine resorts to keep their customers. Another known example is the opening of the Olympic Games in Beijing 2008. The clouds outside Beijing where seeded with silver iodine to make it rain and dissolve the clouds in order for a cloud free opening ceremony. Not only silver iodine is used to cloudseed, but also dry ice and liquid propane. Recently other hygroscopic materials have started to be used, such as normal table salt to encourage the water in the air to condensate and form droplets.

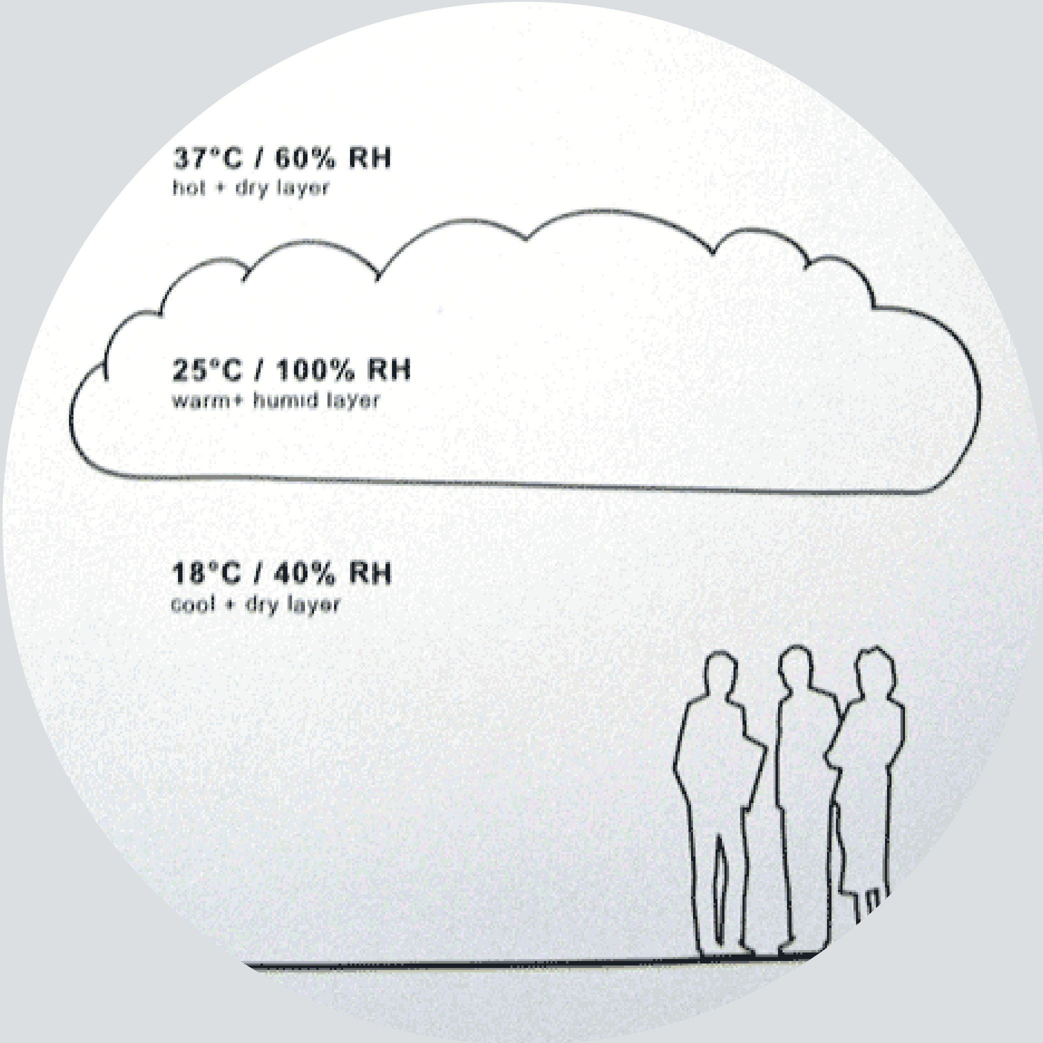


Diagram over Tetsue Kondo´s cloudinstallation.

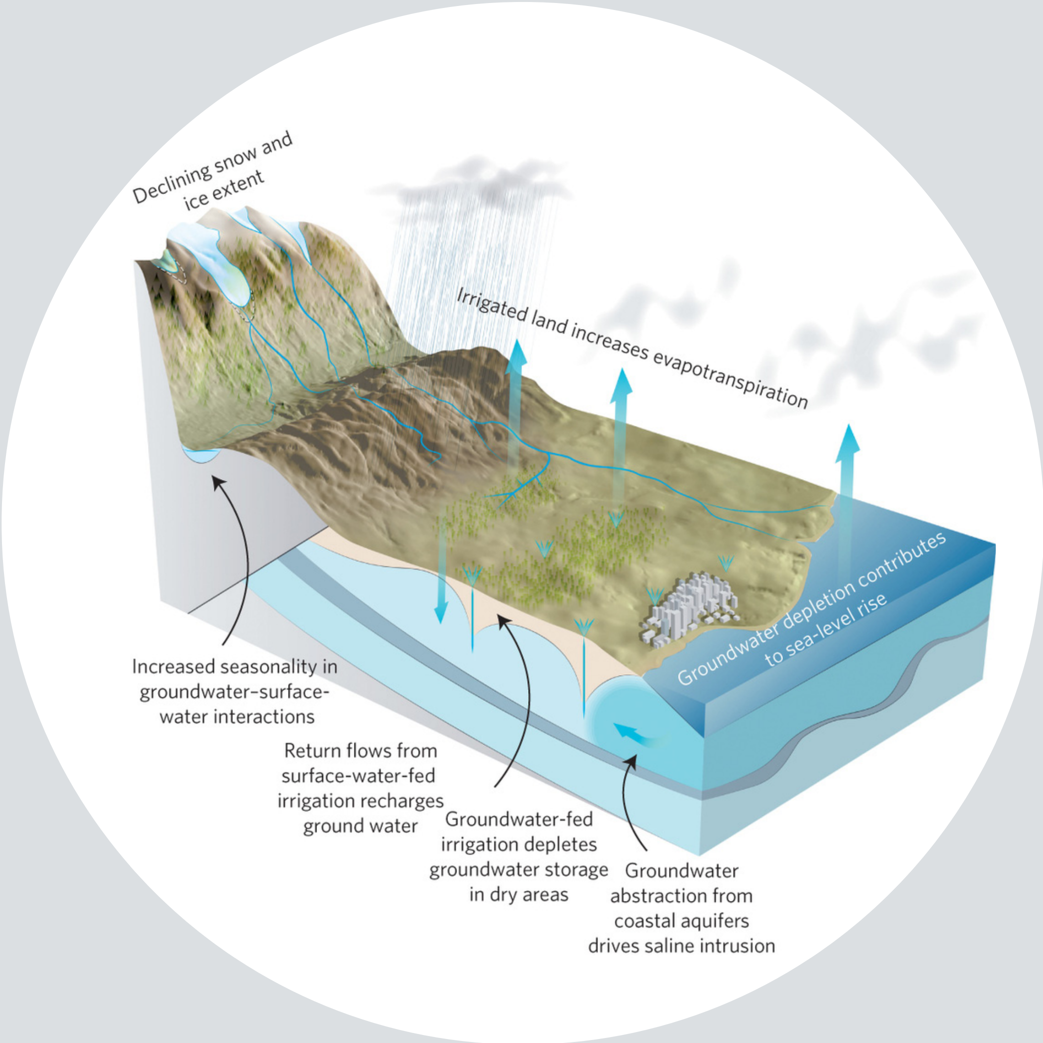
Indoor cloudexperiment.

Tetsue Kondo Architects made an installation at the Venice Biennale 2010, where they created an artificial cloud inside the Arsenale. There have been several experiments with clouds inside a closed space, of various reasons and by different people, but mainly displayed as art installations. Kondo's installation was built with the principle of dividing the air inside Arsenale into three distinct zones. These zones had different temperature and relative humidity. With a cool, dry layer at the bottom that had a temperature of 18° C and 40%RH and a hot and dry layer at the top with 37° C and 60%RH, a warm and humid layer at 25° C with 100%RH was trapped in the middle. In this zone in the middle, a cloud was created that was floating in the air. Visitors was able to walk through the different zones by a walkway, making it possible to walk under, through and above the cloud.

Experimental cloudmodel.

Indoor cloudexperiment.

At the beginning of my thesis I tried to recreate this experiment in a smaller scale in order to test the hypthesis of Kondo. I tried in a smaller and simpler scale, with a model of about 1,5 m3. The structure were composed of three chambers, one large test chamber and two smaller prechambers. The large chamber was supposed to be filled with hot air that had been heated in a secondary chamber with an electric heater installed. At the same time humidifiers filled the air in the third chamber with water. By controlling the flow of air from the smaller chambers and therefore creating layers of air in the larger chamber, I hoped to recreate Tetsue Kondos installation in a smaller and less high-tech way.
I succeeded with creating a cloud, but unfortunately it didn't float. Instead it laid itself at the bottom of the chamber, filling the chamber halfway. I had created a cloud without the air beneath it that would make it fly.
I were able to take alot from this experiment. It gave me a practical experience with the particles moving within a cloud, but also it gave me understanding of what questions that I needed to focus upon with my thesis. The experiment presented a juncture for my thesis. I could go further with the controlled practical experiments, but I felt i pushed the thesis into a less architectural direction, and away from my initial ideas about space and regional architectural control. Instead I wanted to make it more relevant for the world we have today; to make it more site-specific and look into the possibilities presented to solve problems related to rainpatterns.



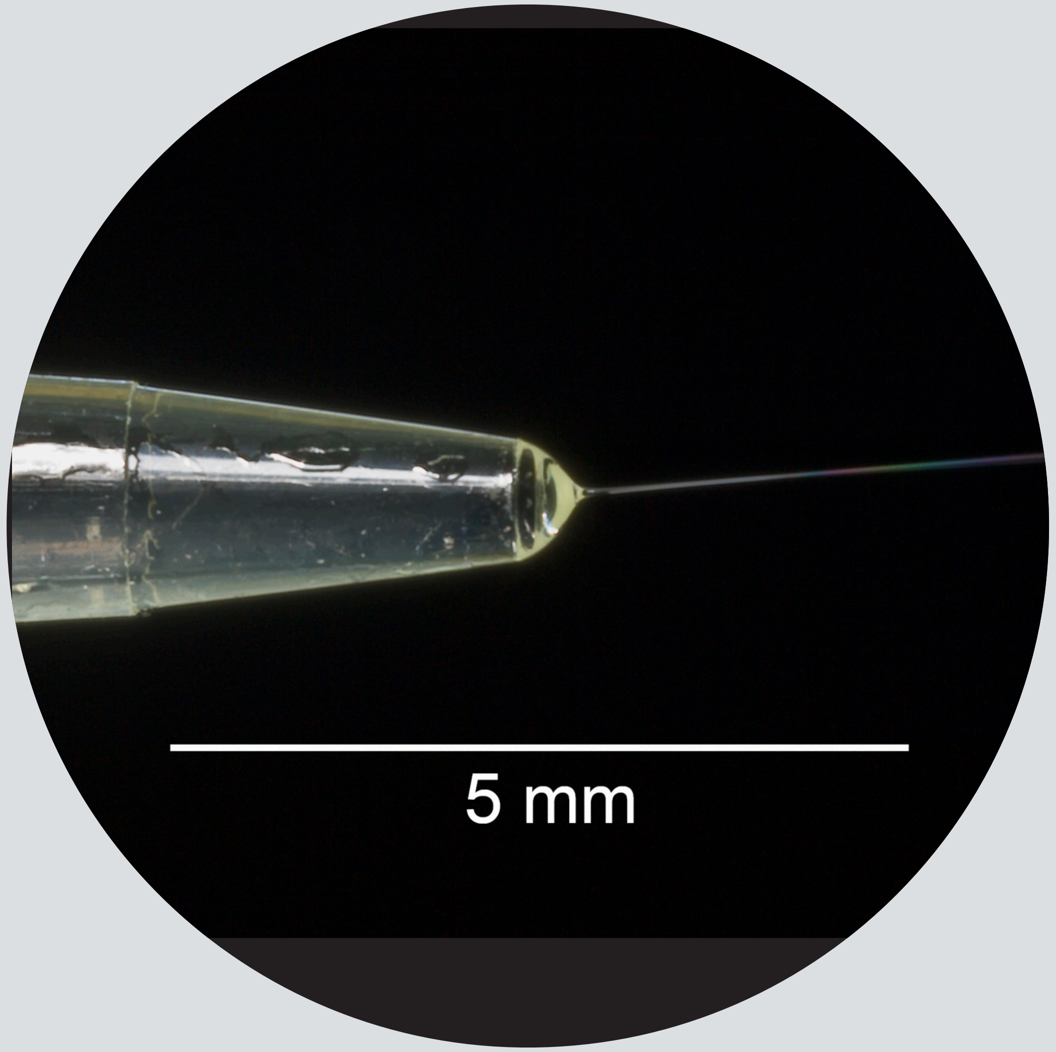
Groundwater cycle.

Problematics of groundwater extraction.

The population surge of the last century, together with the increase of productivity within agriculture, has led to increasing wateruse. Especially agriculture, when producing for a global market are situated in high temperature areas in order to maximize the harvests. These areas often has limited surfacewater and precipitation, and when the demand surpasses the supply, many producers turn to use groundwater, diminishing the reserve. The reason for the limited surfacewater in high temperature areas differ, from higher evaporation that rise and falls at another Hadley cell, to being reliant on irrigation from overused watersources, such as the Jordan.

The continuous uptake of groundwater has a double problematic, because the continuous diminishing of the drinkable groundwater lessens the pressure it has on the saltwater that permeates from the sea. With less pressure, the groundwater is polluted by the saltwater and diminishes the supply even more.
By resupplying the groundwater, not only will you increase the amount of fresh water in the ground, it will also press the saltwater out of the fresh groundwater basins. The only way to resupply the basins is by rain. If you can increase the rainfall in the region you approach the problems in three directions. First you are able to refill the basins by permeating water, secondly you increase the water pressure and thereby expelling the saltwater incursion in the basin. Thirdly, by creating a more reliable fresh water supply from the clouds, you can convince the farmers to use the surface water instead of extracting the precious groundwater.

By strengthening the natural cloud- and precipitation patterns that exists locally, you are able to stabilize the extraction of groundwater and enable the development of sustainable farming and living in places with a shortage of water. This project aims mimic the natural process of the creation of clouds and amplify these processes.



Taylor cone blow-up.

Cloudcreation at a large scale.

To create clouds at a large scale is not an unique idea. Many ideas has been presented that uses cloudcreation in a closed setting, but one of the few that looks into clouds at a atmospherical level is the work of John Latham. John Latham with colleagues published a proposal to use large ships that sprayed small saltwater particles in to the air to encourage the creation of cloud droplets and white clouds. [3] The purpose of this is to increase the reflectivity of the earth, by creating a white cloud cover above the oceans that reflect the incoming sunenergy. Instead of the oceans absorbing this energy by heating up, the project hope, that by letting the clouds reflect the sun-beams, it can decrease the global warming created by the greenhouse effect. This has been deemed the most economical way of battling the climate crisis by Copenhagen Consensus 2009 [4] , a non-profit organization that gathers Nobel laureates and distinguished scientists to evaluate solutions on global problems. Better than expanding and protecting forests as a CO_2 sink, more efficient than a global CO_2 emission tax [5]. I realised that the principle presented by Latham could be used in a different way. By focusing the cloudcreation to saturate the air at a specific site, the saturated clouds could be used to increase rainfall in a controlled way.

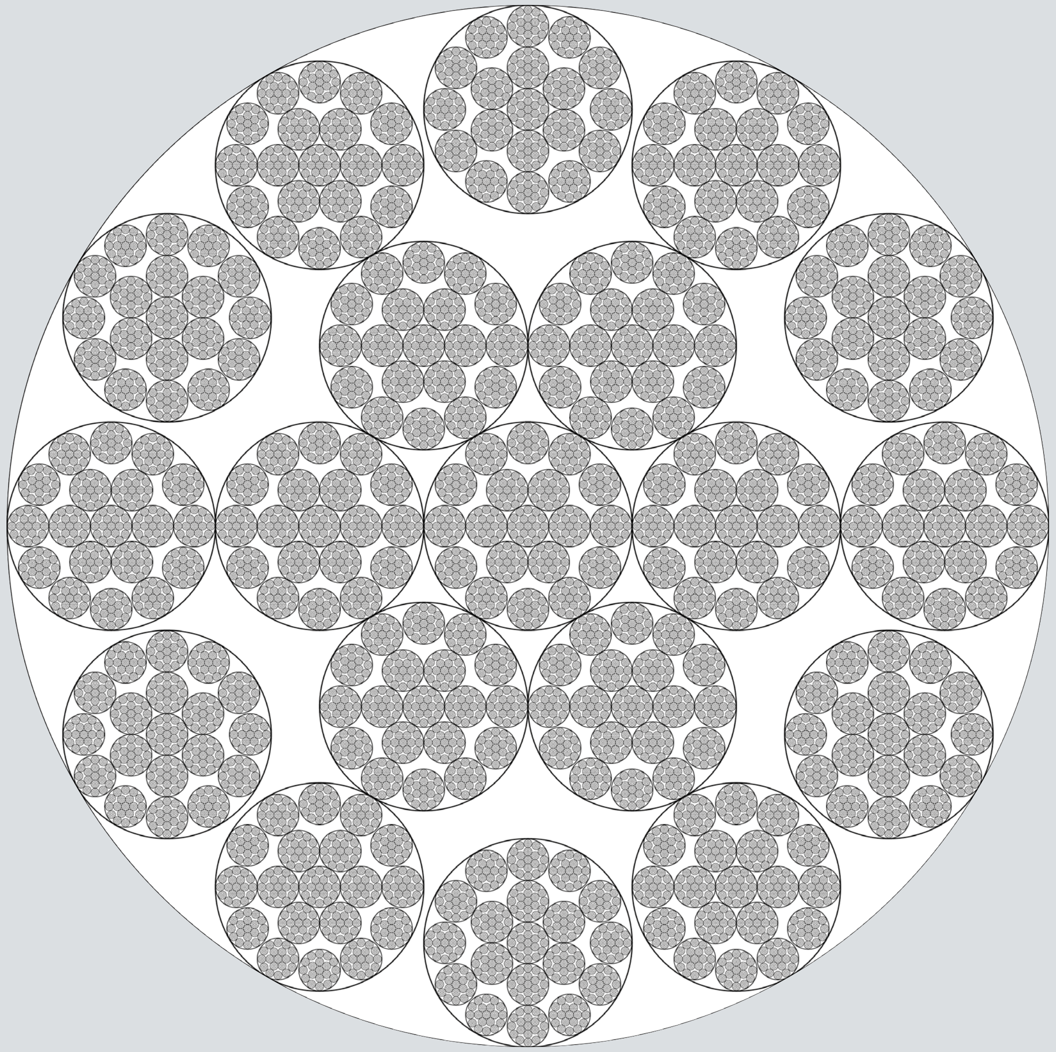


Diagram over multiplication of nanoscale Taylor cone nostrils.

Cloudcreation at a large scale.

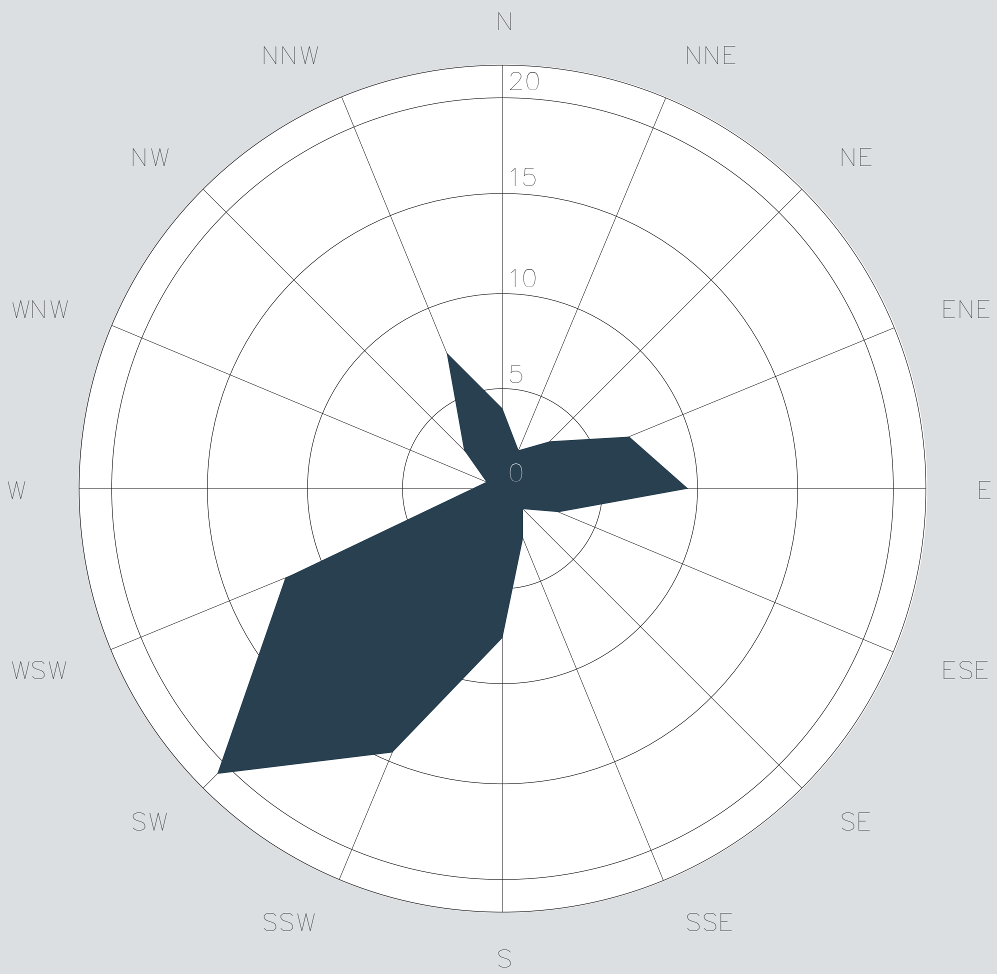
The principle of Lathams thesis is that by making small spray cones that rotate in a special way, small jet sprays are created that particularize the water particles into the size of microns. These “sprays” are 5,6 μm small, and it fits about 100 million nostrils within 1m2. [6] The water in the sprays creates a phenomenon called a Taylor Cone. This is created by leading electricity through the spray nostrils, making it rotate and when the water at the end of the nostrils forms a cone by the centrifugal force, more specifically a 98,6 ° cone, a jetspray is formed that propels the water particles into the air in very small droplets, perfect size to form nuclei’s for water in the air to condensate upon high up in the sky. By using this principle with saltwater, the hygroscopic ability of the salt works in the same way as using salt when you cloudseed. The small particles draws the moisture from the air and forms small droplets. The droplets then start to collide and form larger droplets, until the weight of each droplets collects enough mass to fall down. This consilidation makes for a very energysaving way of transporting water, but also makes the water usable by harvesting the evaporated water from the seas and bring it as rainfall to land.

Sitelocation.

Site.

The project is based at the Almeria region in southern Spain, but it's applicable at many other sites with similar problems. By identifying some key characteristics, such as a general wind direction towards land, a lack of water and with an location close to the sea, I was able to localize four sites; California, the south of Spain, the region south of the Kalahari and west Australia. To be able to focus on the specifics of the site, I choose to focus on one of these, the Almeria region.

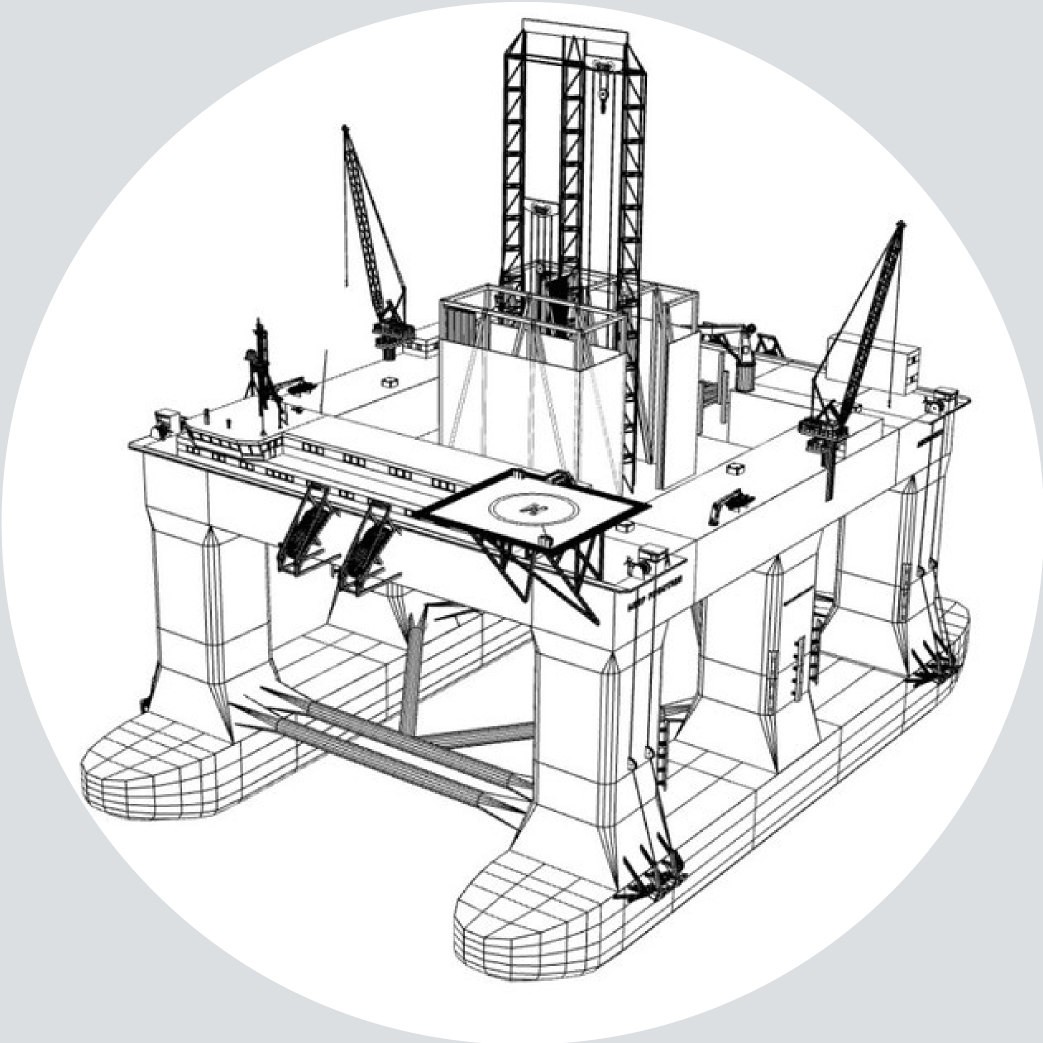
The Almeria region is one of Europe´s biggest producers of vegetables and other produce, grown in greenhouses. These greenhouses are situated in a region that not only gets very sparse amounts of rainfall; the rain it gets is very unreliable and sporadic. To counter this, business and farmers drill wells to tap into the groundwater. A vast majority of these wells are private, and the outtake is very hard to control. To add to the problem, Almerias geological structure is very hard for rain to permeate, making it harder to replenish. It becomes a unsustainable situation, when most of the water used in the region is taken out of the ground, absorbed into the grown tomatoes or other produce, and exported away. The problem has becomed structural as a substantial part of the local economy has grown reliant on the continuous supply of water during the last 30 years. This makes it very hard to stop the outtake without hurting one of the largest economical sectors in the region.



Annually winddirection in Almeria.

Site conditions.

One of the key conditions for the choice of a site was the local windconditions, in order to make use of the natural movements in the atmosphere, and therefor minimizing energyconsumption. The Almeria region has such conditions, where air from the Sahara comes up north and are directed eastwards by the pressure buildup over the Atlantic ocean. The effect is that the wind mainly comes from the southwest. That the wind comes in a very constant direction makes it easier to situate my project, and minimizing required movement.

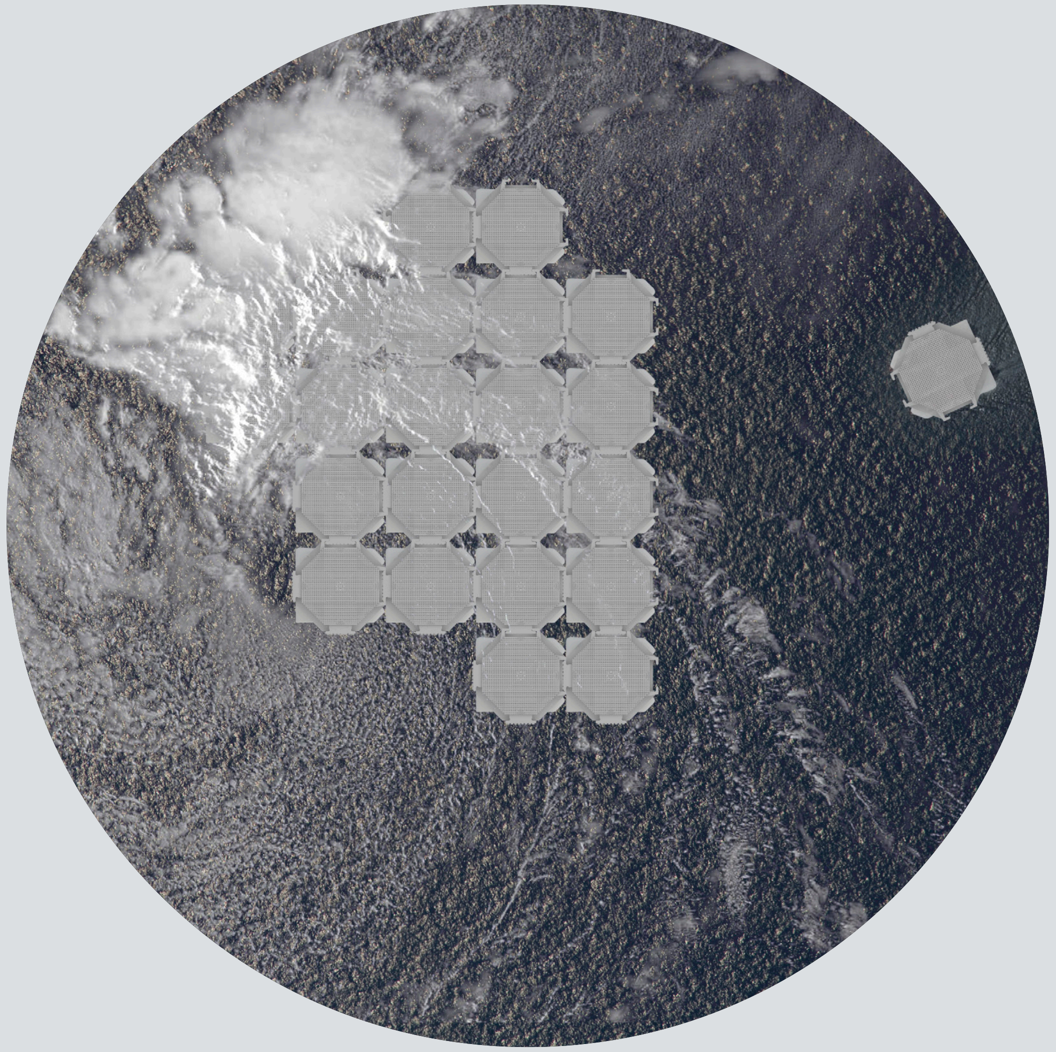


Semisubmersible oilplatform

Platforms.

To be able to situate my project with a large supply of water, more precisely saltwater, I realized that I had to build the project by or on the sea. When I did calculations of how much water I needed to transport from the ocean up in to the clouds and onwards to the site, I started to realize the size of the project. By calculating the required water for crops grown in a greenhouses, and multiplied it with the area of greenhouses in the region i got a rough figure of the water demand. To supply a region like Almeria, I need 2.242.720.000 m3 water to supply the plantations of Almeria in order for the current production to continue without extracting groundwater. A m2 of spraying nostrils like the one Latham presented in his project, could spray 0,00056 m3/sec. Multiplying this with the seconds of a year it increases a lot, to 17671,8785 m3/year to be precise, but this is not enough. To spray 2.242.720.000 m3 water in the air, I needed 126.909 m2 of nostrils.

This is a large building to place by the coast so I started to look into the techniques developed by the oil industry in the form of the oil platform. Semisubmersible platforms are developed for deep-sea drilling, where they can't be anchored at the bottom of the sea. They are gigantic structures that float by using large pontoons that give a stable base for the platform. These pontoons float underneath the surface of the sea, giving a low center of gravity in order for a stable platform for drilling. This is required because of the size of the waves in open sea. But these platforms are designed to be able to propel themselves, very slowly to the position of drilling and then stay there. Using the oilplatform as a base for my project not only creates possibilities to situate my programmed sprays in sufficient numbers, it also creates a possibility to retrofit existent or decommisioned platforms to become cloudcreating platforms.

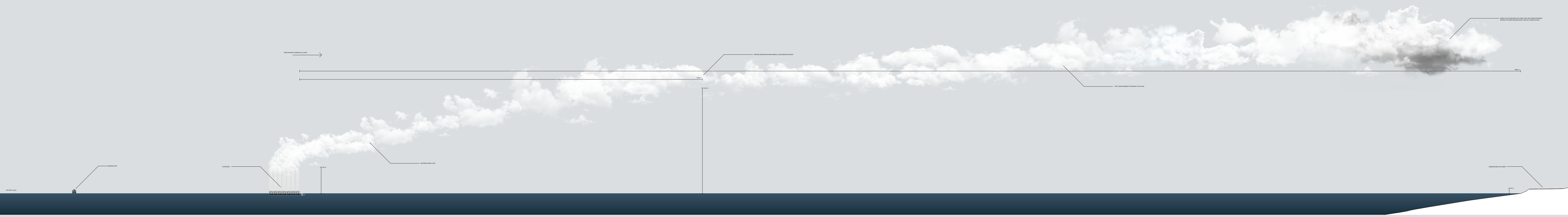


Siteplan.

Size.

To increase the flexibility of the project I wanted it to have the ability to move, in order to be used where it would be most effective, but also for it to be produced not in-site to be able to create an economical benefit. This parameter forced me to look into shipclass specifications, and more precise the measurements for Panamax and New panamax. It's the maximum size a ship can have to be able to travel through the Panama canal. The enormous investment a structure like this requires makes it a good advantage for it to be transportable in order for it to be used at the place where it can be put to the best use.

A platform that fits into the New Panamax is a little bit smaller than a normal drilling platform, but it's still a big platform. A width of 49 meter and a draft of 15.2 meter make, with the design of the project, about 1500 m2 of space for spray nostrils. To be able to have 126.909 m2 you need 50 platforms to spray the water required for the greenhouses in Almeria. The design of the platforms makes it possible for an infinite number of platforms to be connected in order to minimize the maintenance, and to maximize the impact of the collected sprays.



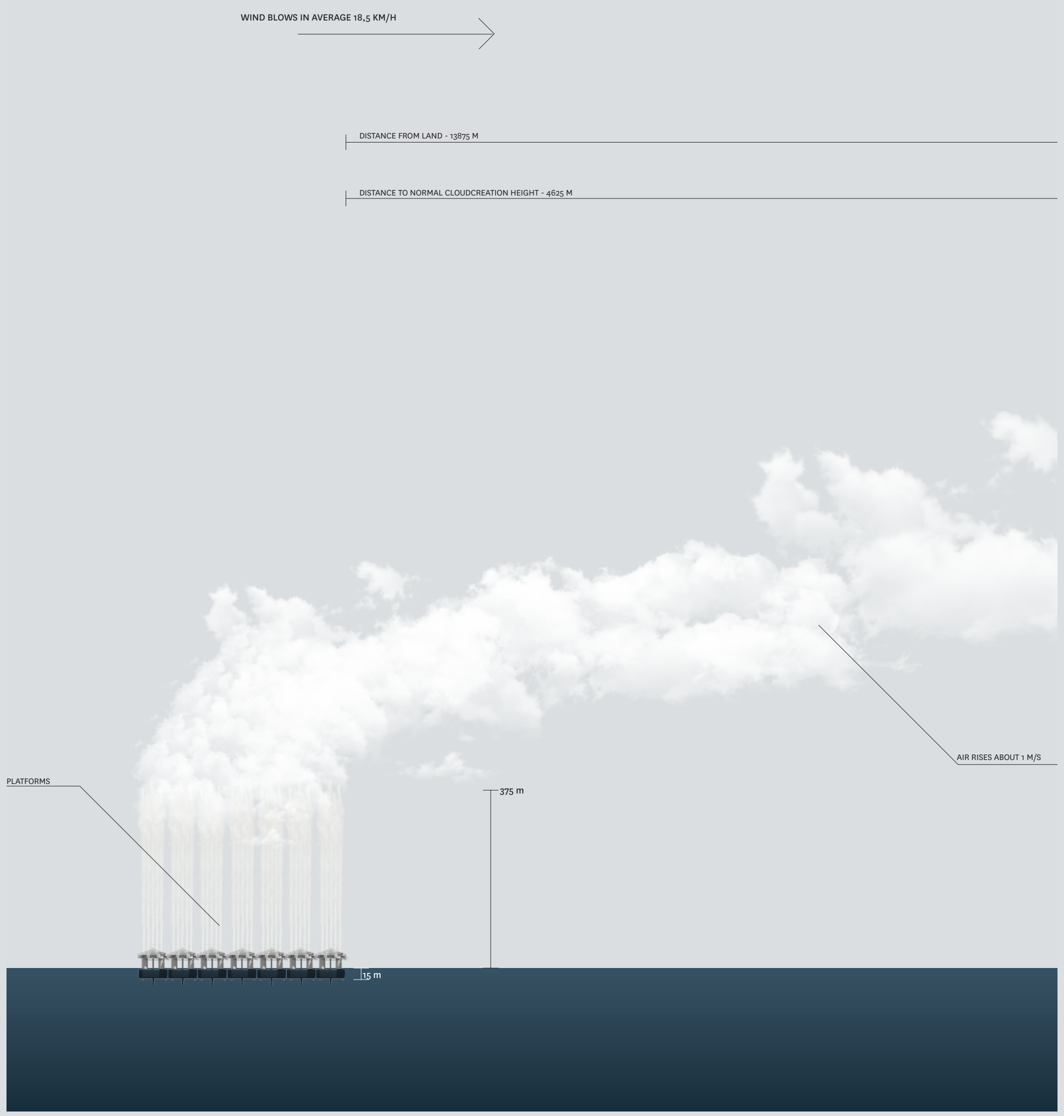
Section of cloudcreation at Almeria.

Visualization.

Cloudscaping Platforms.

Through the use of the knowledge of the semisubmersible platforms, I propose to build Cloudscaping Platforms, which will use the principle brought forward by John Latham to create clouds. These will pump up seawater that will be divided and sprayed through jet sprays up into the sky to make the hot air coming from Sahara saturated with water droplets. When the hot air then rises when it reaches the coast it can create rain where there are none or little. This allows the population and the farmers to fill their need for water from surface water, instead of continuing to extract groundwater for their needs, and allow the groundwater basins to refill. This will make for a more sustainable production and growth of the Almeria region, without compromising the natural environment.

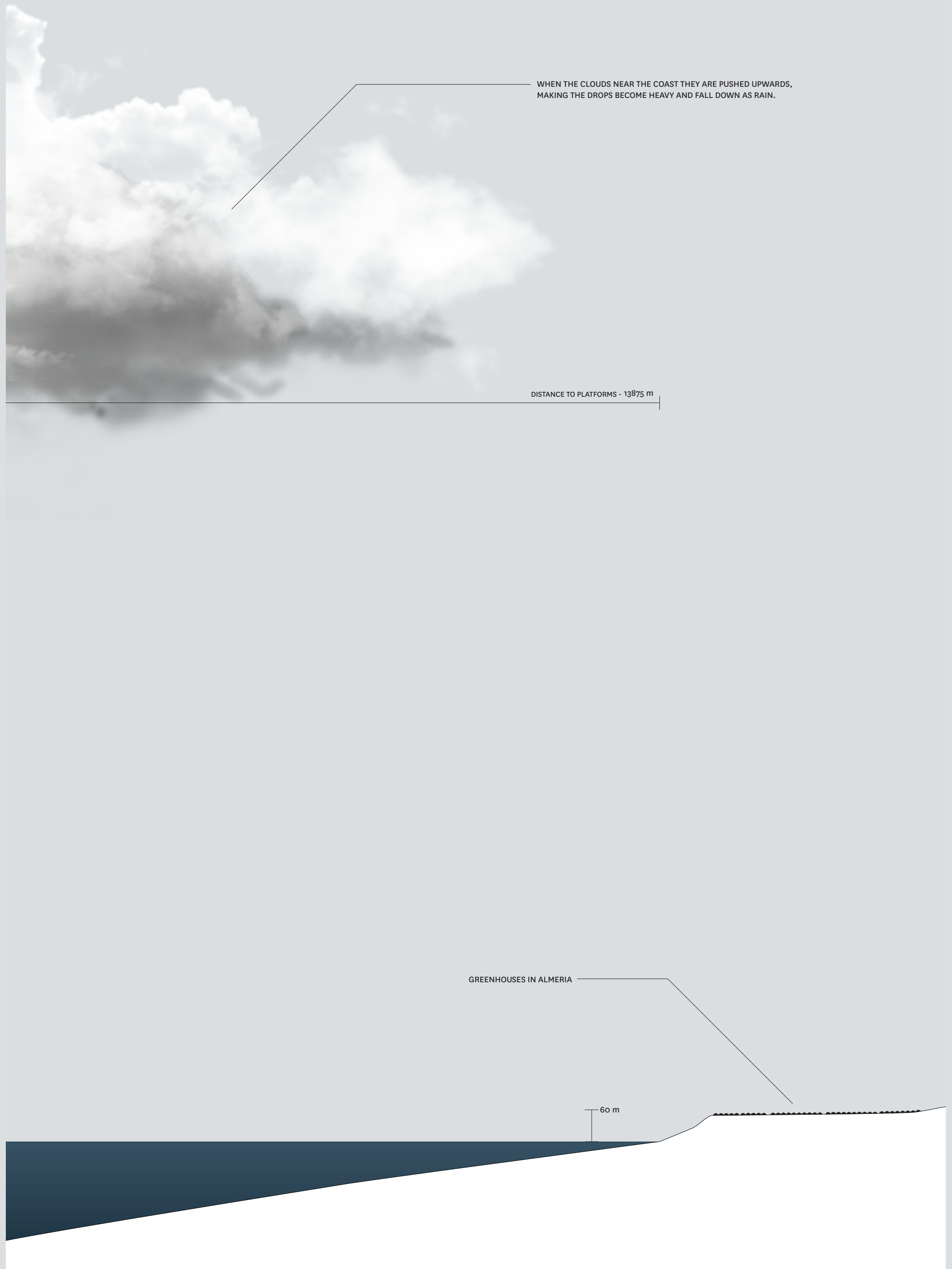
Architecturally, the platforms will be experienced by the enormous jet streams that will spray water up into the sky like large water pillars that stretches from the platforms and up into the sky at the base of the clouds. But it will also change the space at land, when clouds will float inland at night to bring freshwater to the region. The platforms themselves will be quite anonymous at a distance, but close at hand they are still large structure that rest on floating pylons in the sea.



Sitesection, detail.

Cloudpillars.

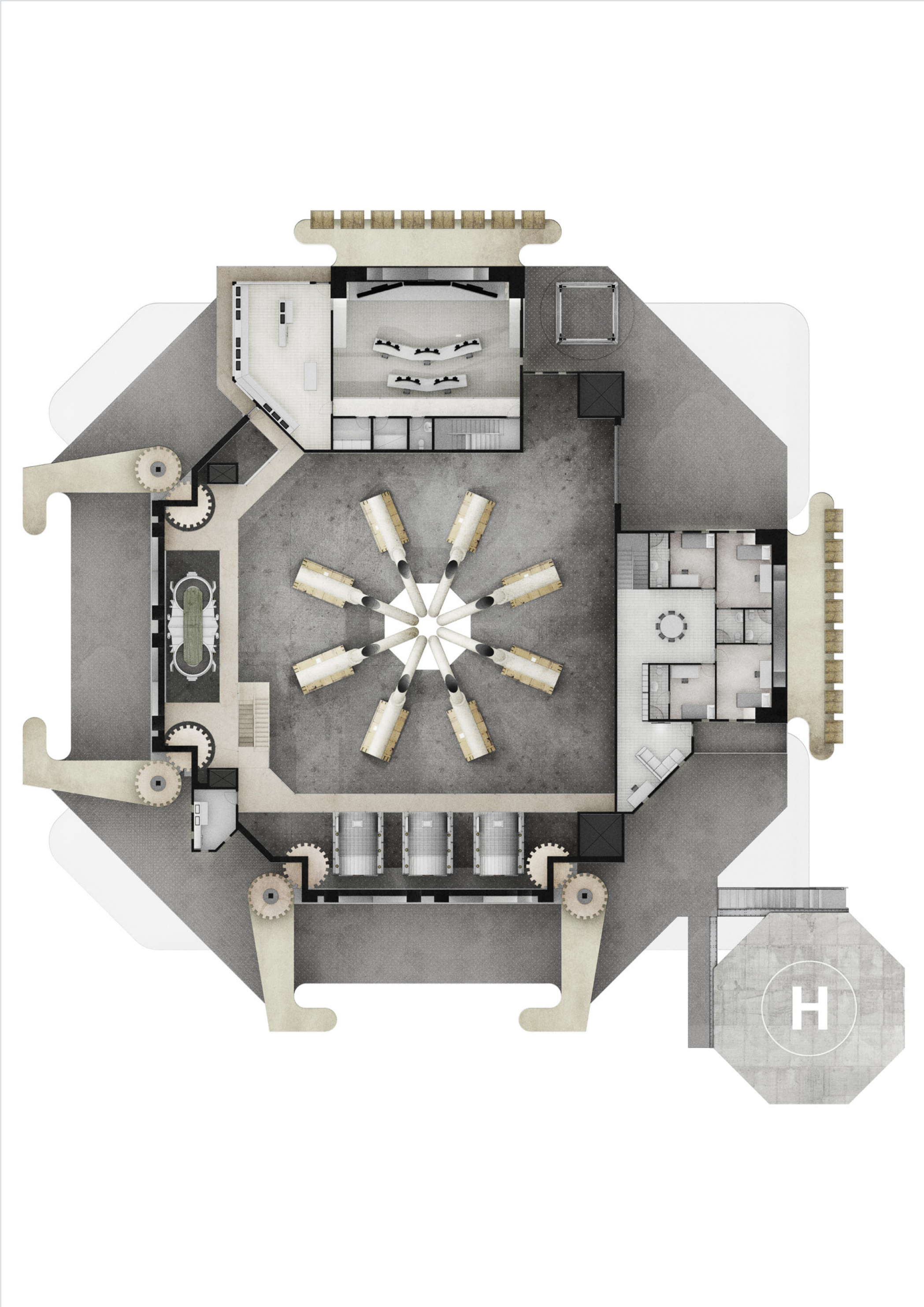
The platforms function by pumping water from the ocean and directing it up towards the millions of nanoscale nostrils on each single platform, These nostrils then spray the water in particle-size upwards. The force of the spray should be enough to bring it upwards about 375 m, and then the natural convection of the air brings it upwards. Average windspeed higher up in the atmosphere is about 18,5 knots, making the cloudpillar drift towards land before it reaches normal cloudcreation height. During this time the particles start to merge and create larger droplets in heavier concentrations. The distance from land is based on this process and can be decreased or increased, depending on how much time is required.



Sitesection, detail.

Watering the Almeria region

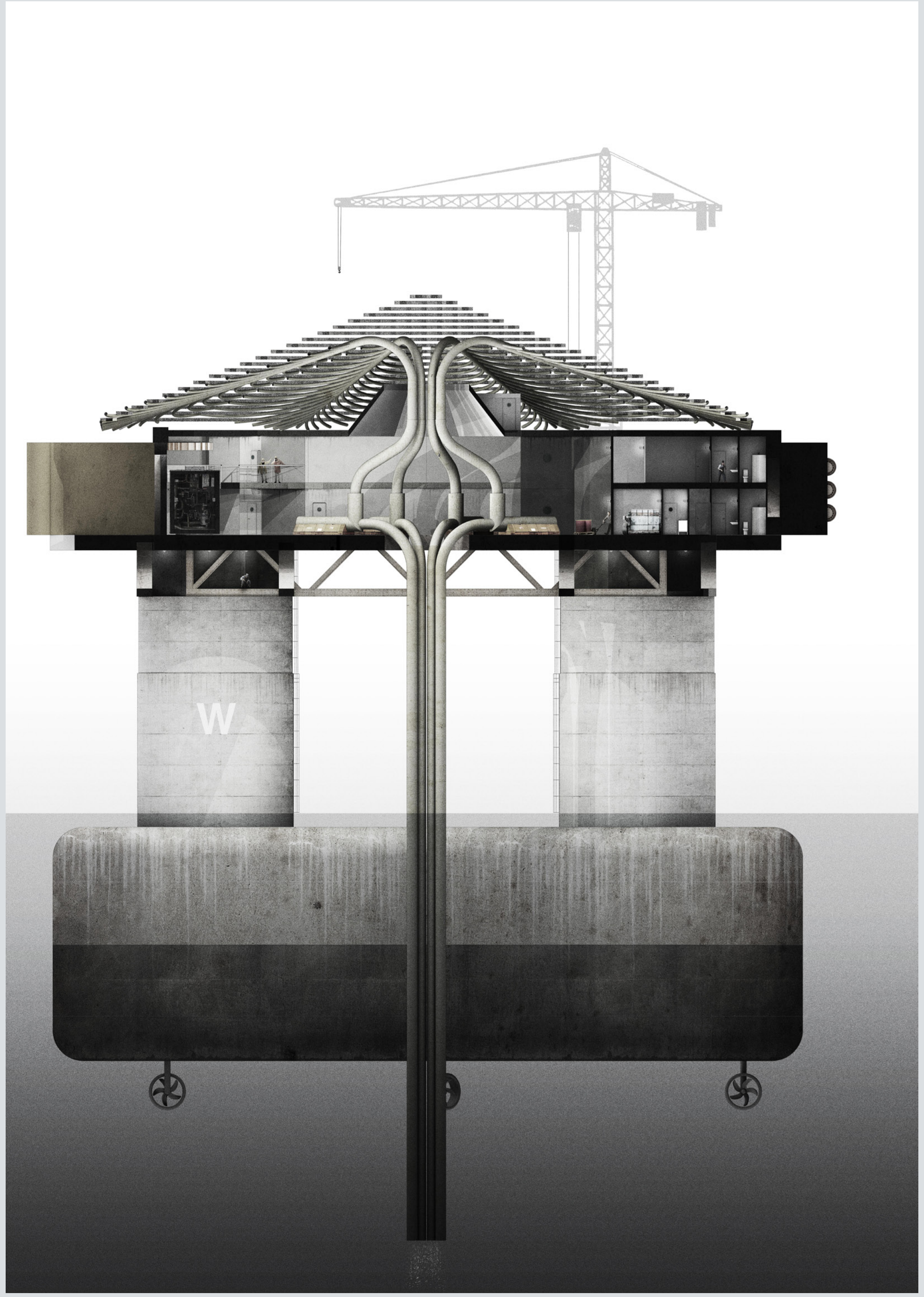
When the air reaches land, it should be pressed even more upwards, when the land air moves out at sea. The droplets that at this time should have concentrate enough to form clouds, are cooled down when they are pressed upwards, which concentrates them even more and forces it to fall down as rain.
The greenhouse production is highly dependent on that the watersupply is constant. This has forced the farmers to rely on wells. The artificial rain creates this constancy, which allow the greenhouses to start to depend on surfacewater instead, reducing the uptake of precious groundwater. The use of rain also gives the groundwater-basins to replenish, securing the nature of Almeria to heal itself.



Plan.

Organization of elements.

The platform is divided into three zones, with the main being the space for pumps and generator required for the platform to function. The habitat zone has space for seven people to live long stretches of time. This requires areas for recreation and cooking with all necessary supply rooms. The second zone is the controlrooms, with not only the bridge that would be used when the platform moves, but also a large controlroom where weatherdata and performance can be processed. Each platform is designed to be able to operate both individually and as a connected part of a larger cluster. This means that there is space not only for workshops, repair facilities and cranes, but also the pontoons are connected by elevator for it to be used as general storage, tanks for fuel storage and for spare bits.



Section.

Waterspray units.

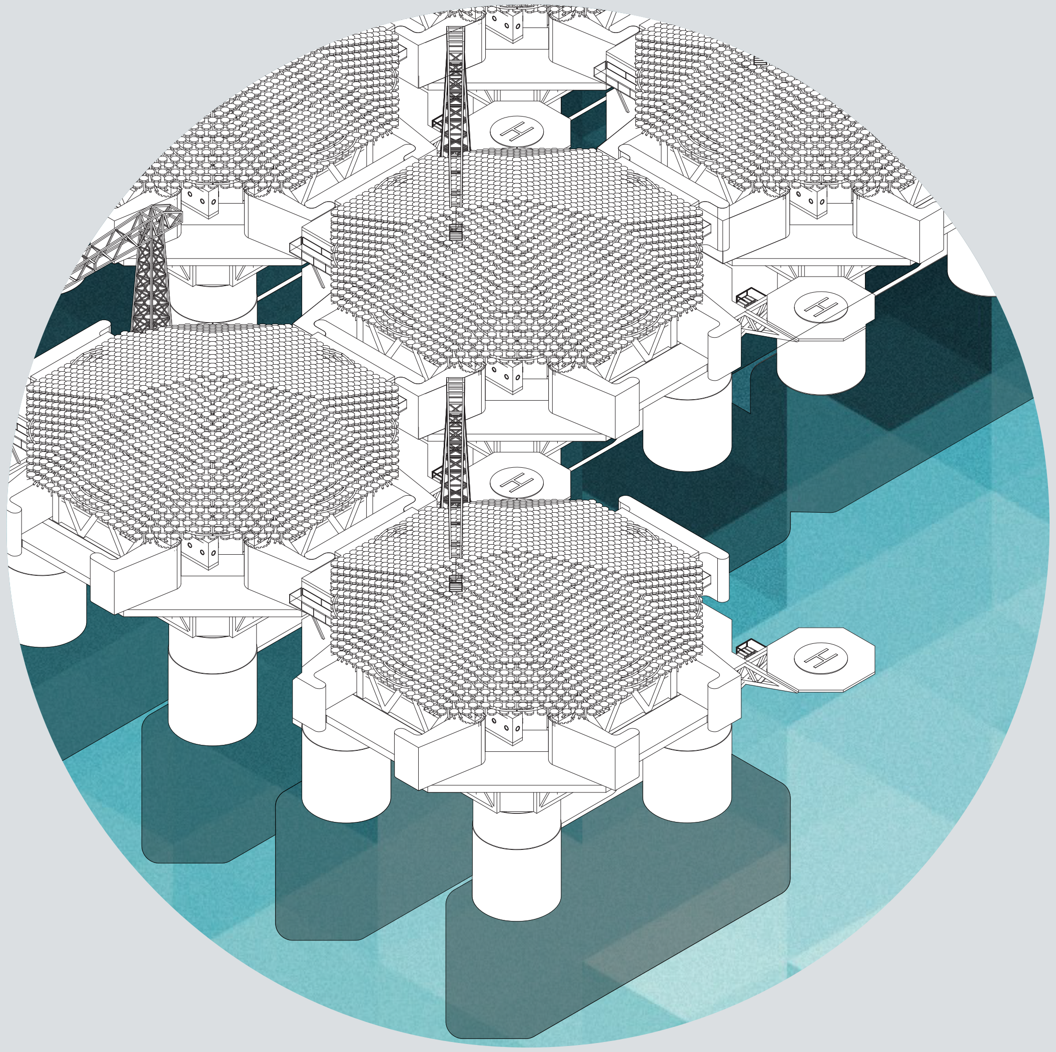
The middle of the octagon is open to make room for the pipes that extract the water from the sea and then divides it upwards into the smaller units that spray the water. The water sprayers are situated as a stylized cone of 98,6 °, as a mimicry of the breakpoint for the nanosprayers, in order to optimize the jetstream creation. To allow for easy maintenance, the sprayers are divided into smaller units, that can be replaced individually, and are reachable by the platforms large crane. New units are small enough to be stored in the pontoons and brought up by elevator. Access to the sprayer units are from below, to allow for service even when the platform is operat-able.

Elevation.

Seaworthiness.

The platforms shape has two driving factors. The height from the sealevel is to allow the platform to avoid heavy waves and therefore be able to operate at open sea. To counter the height, the balance of gravity for the platform has to be low, which is why the pontoons operate in a sunken state and are so massive. Six large propellers provide the power to slowly move the platform, but also for the platform to stay in one place. This is possible by the propellers that are able to rotate and counteract movement.

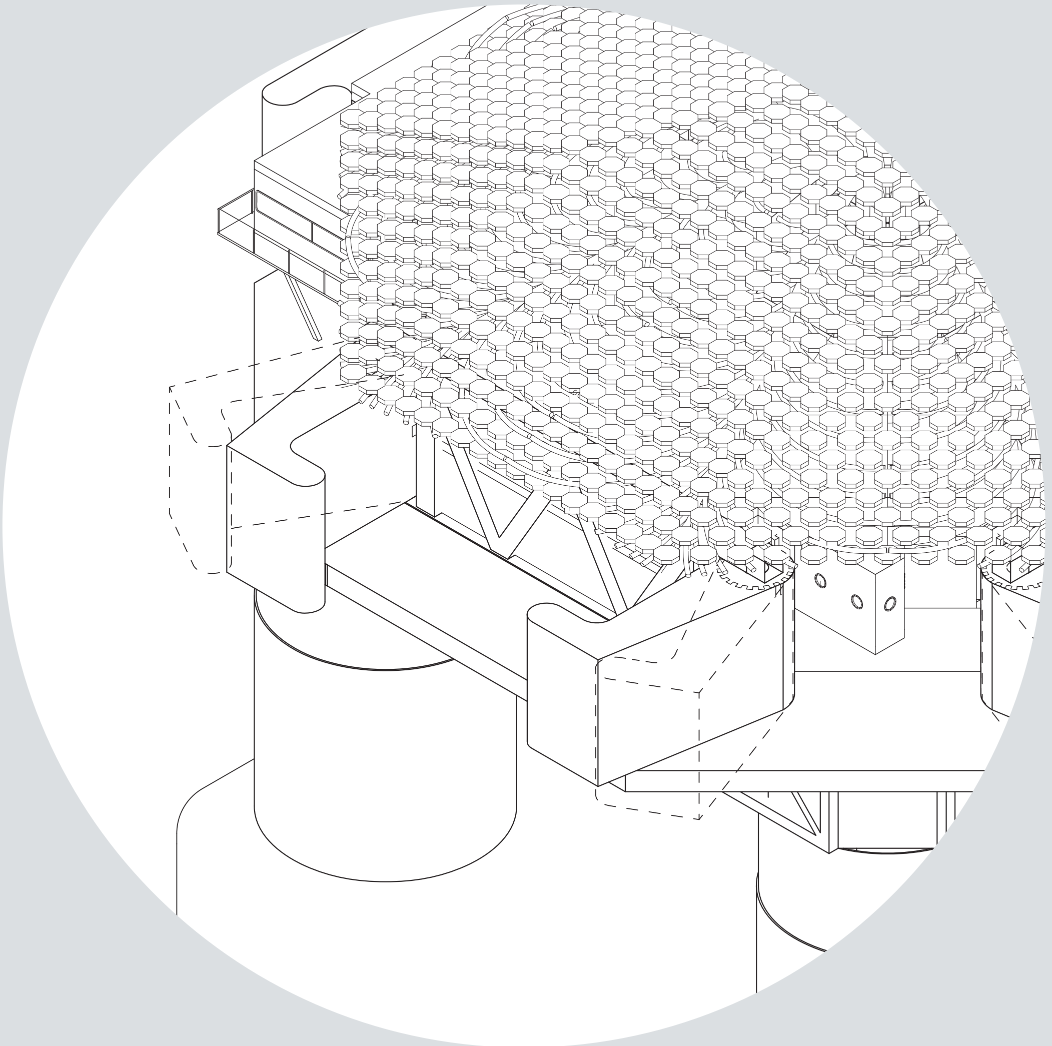
The height of the platform creates a logistical problem, where access is made either by using the crane to lift objects to and from the platform. The other option is by helicopter. For emergencies, this also demands that the lifeboat has to be able to dropped from a high elevation and avoid the pontoons.



Axometric view.

Raised landscape.

The platforms will create a raised landscape, like a big island on pillars, that will be broken down in an octagonal pattern, creating small glades in a forest of water pillars reaching the sky. At the edge of the "island" the in-between space will used as helicopter platforms or loading docks, where the cranes can unload cargo from supply ships. The helipads have direct contact with the living quarters of the platform, and can be used as patios for the workers living at the platforms. Inside of the octagonal grid, the platforms main purpose is to create passage corridors between platforms, and to allow the control section of the platforms to have a view of the jet spraying top of the platform. Underneath each helipad is a lifeboat, in case of a emergency, that not only can be used when the platforms travel separately, but also when they are interconnected, giving a clear path to the sea below.



Axometric view, detail.

Brackets.

Notable in the platforms is the large brackets, two male that has repulsive protection and that can be gripped by another platform. The two female brackets are designed to be able to open, in order for the platform to move close enough for the brackets to take a grip at the other platform. This grip is made for horizontal movement and is open vertically for the platforms to be able to move slightly in order to brace the wave movement. This movement is minimized by making the platform have its center of gravity below water level, but not to create unnecessary strain on the brackets, they will be able to flex.

Diagram over powersupply usage and production.

Powersupply.

To spray water like this into the sky requires alot of energy. Each square meter of sprayers require less than 100 Kw of power [7]. A natural way of supplying this kind of energy is by solarpower. Areas that lack water are often situated in solarenergy strong areas. An optimal solution for supplying the platform would be to install solarcollectors at the top of the greenhouses in Almeria, that would collect power during the day. At night, the platforms could use it when the sun is down, and the heat that has warmed the ground and sea during the day creates stronger rising air. This because that the air changes temperature faster and the heatbalance between the air close to the ground and air layers higher up, is much stronger.

This scheme requires access to batterystorage for the power that are created during the day. If such amount of energystorage isn´t possible, an alternative would be to start the platforms during the day, creating clouds that start to drift towards land. When the solarpanels are in the shade of the inwards drifting clouds, the platforms stop spraying water, and the clouds are limited to what particles that already has been sent up into the air. By situating the platforms longer out to sea, there should be enough particles for them to consolidate and create rain.

Parabolic solarcollector.

Finishing statement.

To sum up the thesis, I would say that the original idea of the architects ability in the future to control the clouds have been a challenging idea to work with. As an architectural take on a problematic usually connected to climatology and meteorelogy, every decision always included the question if this had an architectural value. Further on, every problem and question that became apparent had to be researched from scratch.

The final design is an architectural approach to an infrastructure that could change the living situation of a region, but also change its entire experience of the space around it. The strong appearance of the streams of water that are sprayed into the sky forms a powerful and spectacular panorama and the lack of scale from a distance strengthens this experience. But the strongest result of this thesis is that I think it feasible to create these kinds of platforms.

A critique that became apparent during the process was of the etic values associated with willingly altering the climate. Since climate is a very complex ecosystem that is hard to overview, the effects of an alteration can be hard to foresee. I believe that just because we cant foresee all effects, doesn't make it a reasonal approach to solve a problem. Today we are altering the climate without control, and it has had disastrous effects. To create clouds in the proposed manner, has a mayor difference inherent. It can be shut down with the push of a button, the effects dissipating in the air.

The shear size of the project is also a problematic, since the investment cost become so high. Investments this large has to probarly come from a governmental body, because of the problematic in creating a return on an investment except on a national or regional scale.

Despite the difficulties that the project has to face in order to become reality, I believe it may come a future that allow architects not only to shape the buildings and the landscape, but also the clouds. This project aim to give a glimpse of that future.

Clouds over the mediterranean.

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Early visualisation.