THE ATMOSPHERIC VORTEX ENGINE

A proposal for the utilization of updraft systems to sustainably generate electrical power, reduce global warming and increase rainfall

Presentation by

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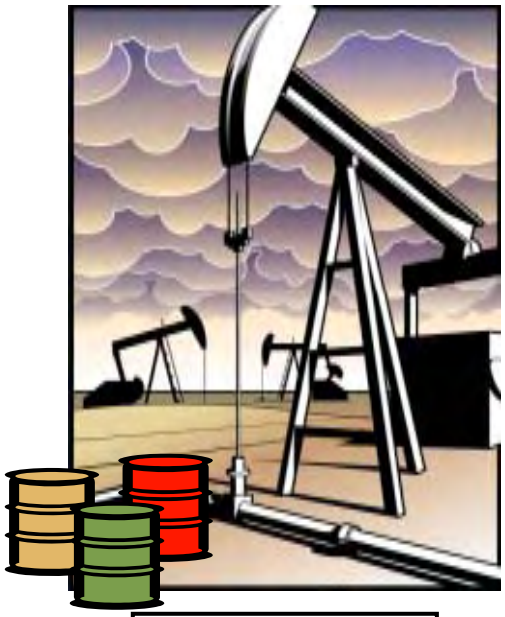
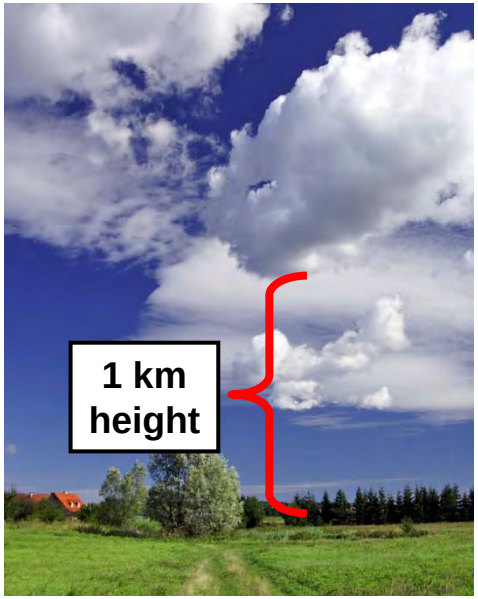
A Comparison of Earths' Stored Energy Resources

Crude Oil Reserves



7.3 x 10^{21} J

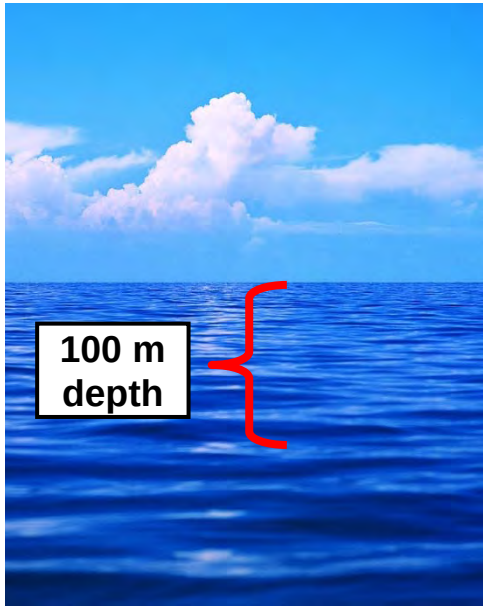
Latent heat of water vapor in the bottom kilometer of the atmosphere



13 x 10^{21} J

Heat content of tropical ocean water

100 m layer, 3°C



130 x 10^{21} J

Replenishment times

10^9 years

10 days

100 days

Assumptions / Calculations

Crude Oil Reserves

$$1200 \cdot 10^9 \; bbl \quad [1]$$

$$\times 6100 \cdot 10^6 \; \frac{J}{bbl} \quad [2]$$

$$= 7.3 \times 10^{21} \; J$$

[1] World Crude Oil and Natural Gas Reserves, January 1, 2007, Energy Information Administration

[2] Energy Calculator, Energy Information Administation, http://www.eia.doe.gov

Latent heat of water vapor

in the bottom kilometer of the atmosphere

$$10 \frac{kg}{m^2} \quad [3]$$

$$\times 2.5 \cdot 10^6 \; \frac{J}{kg} \quad [4]$$

$$\times 510 \cdot 10^{12} \, m^2 \quad [5]$$

$$= 13 \times 10^{21} \; J$$

[3] Assuming 10 kg/m^2 average moisture content in the bottom 1 km of the atmosphere

[4] Latent heat of water vapour

[5] Surface area of the earth

Heat content of tropical ocean water

100 m layer, 3°C

$$1000 \frac{kg}{m^3} \times 100 \; m \quad [6],[7]$$

$$\times 4190 \frac{J}{kg \cdot K} \times 3°C \quad [8],[9]$$

$$\times 510 \cdot 10^{12} \, m^2 \times 20\% \quad [10]$$

$$= 130 \times 10^{21} \; J$$

[6] density of water

[7] Assuming 100 m depth

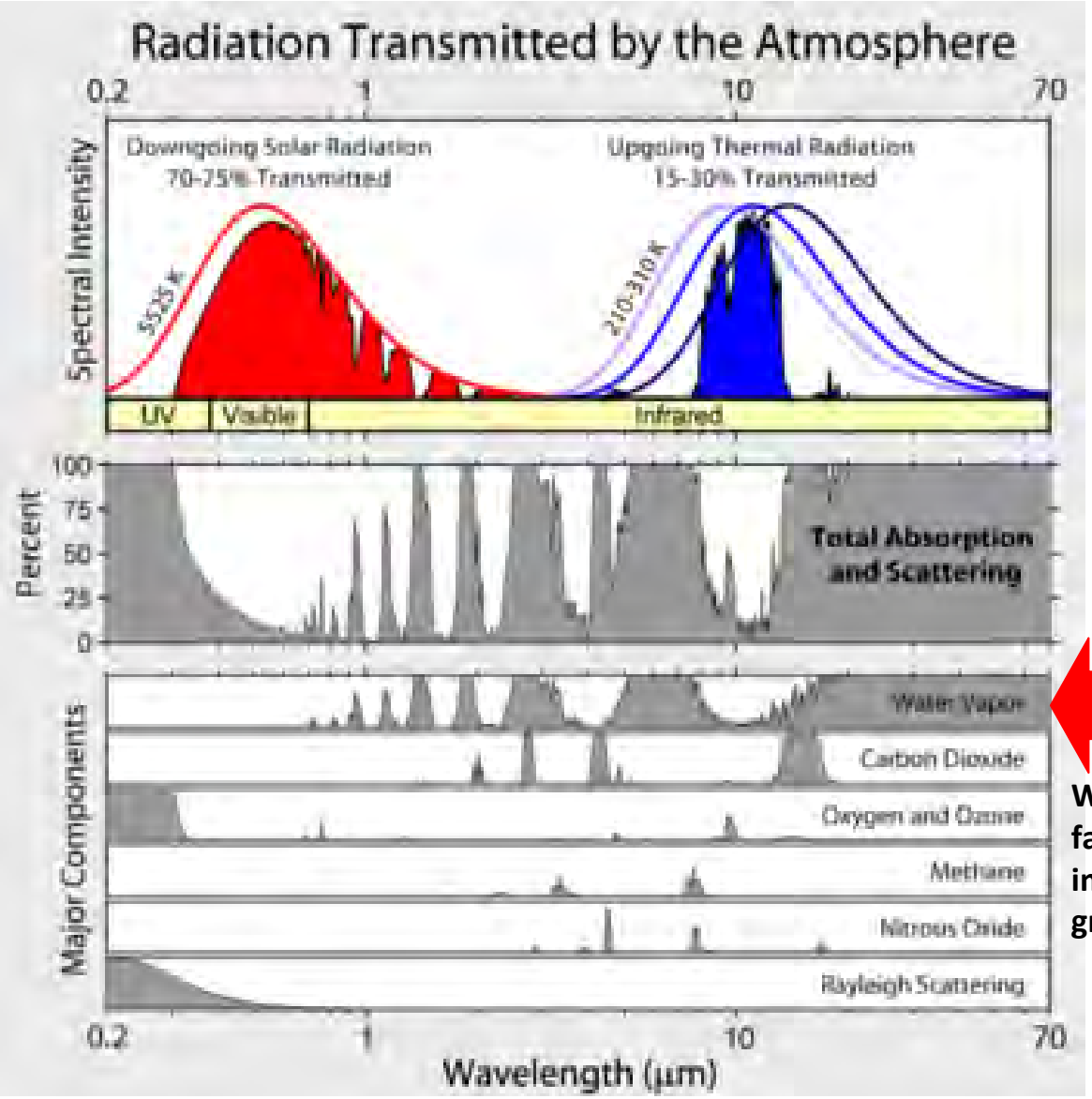
[8] sensible heat of water

[9] Assuming 3°C

[10] Assuming the area of earths' tropical oceans = Area of earth x 20%

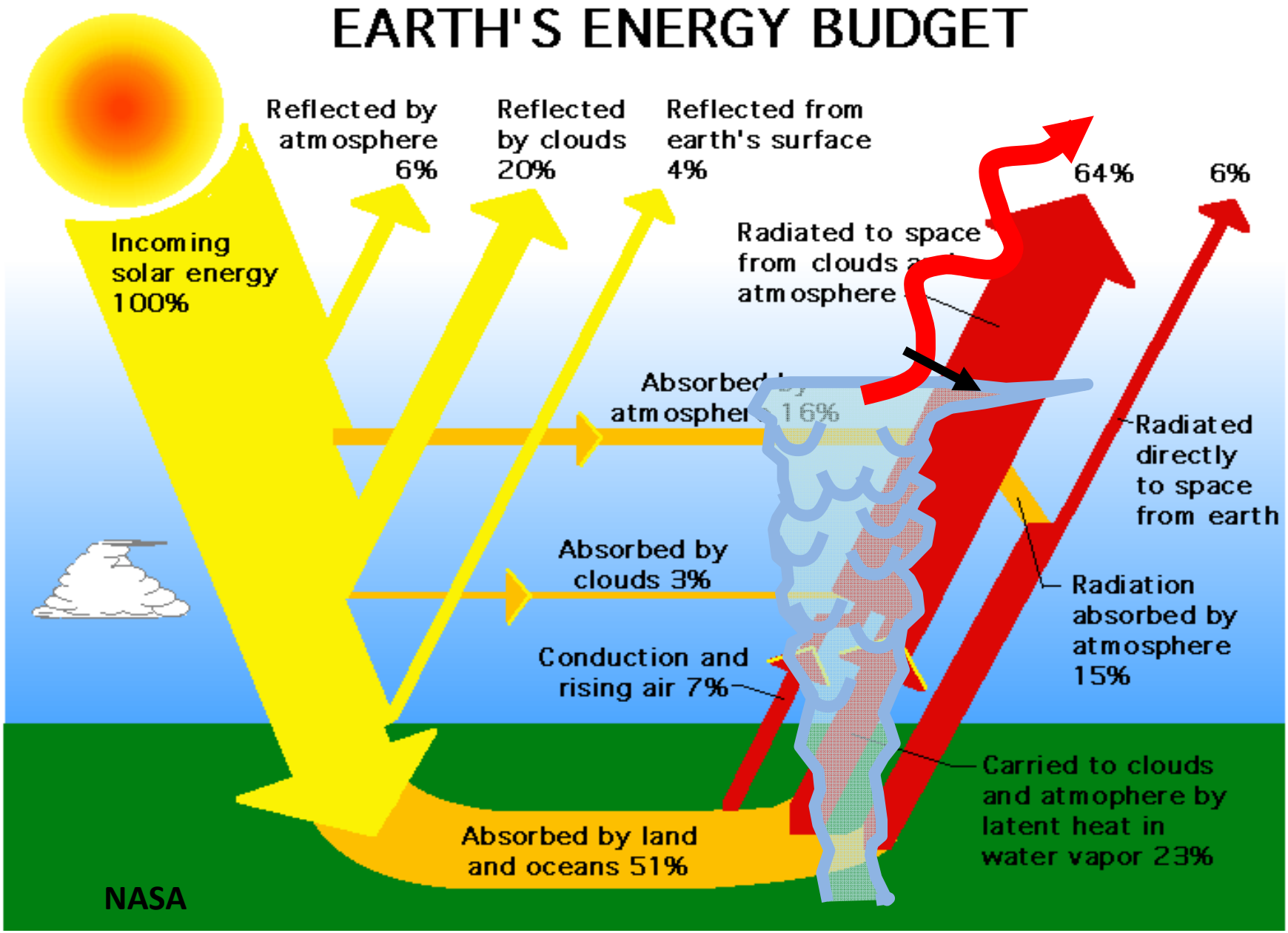
Eric Michaud

The Greenhouse Effect



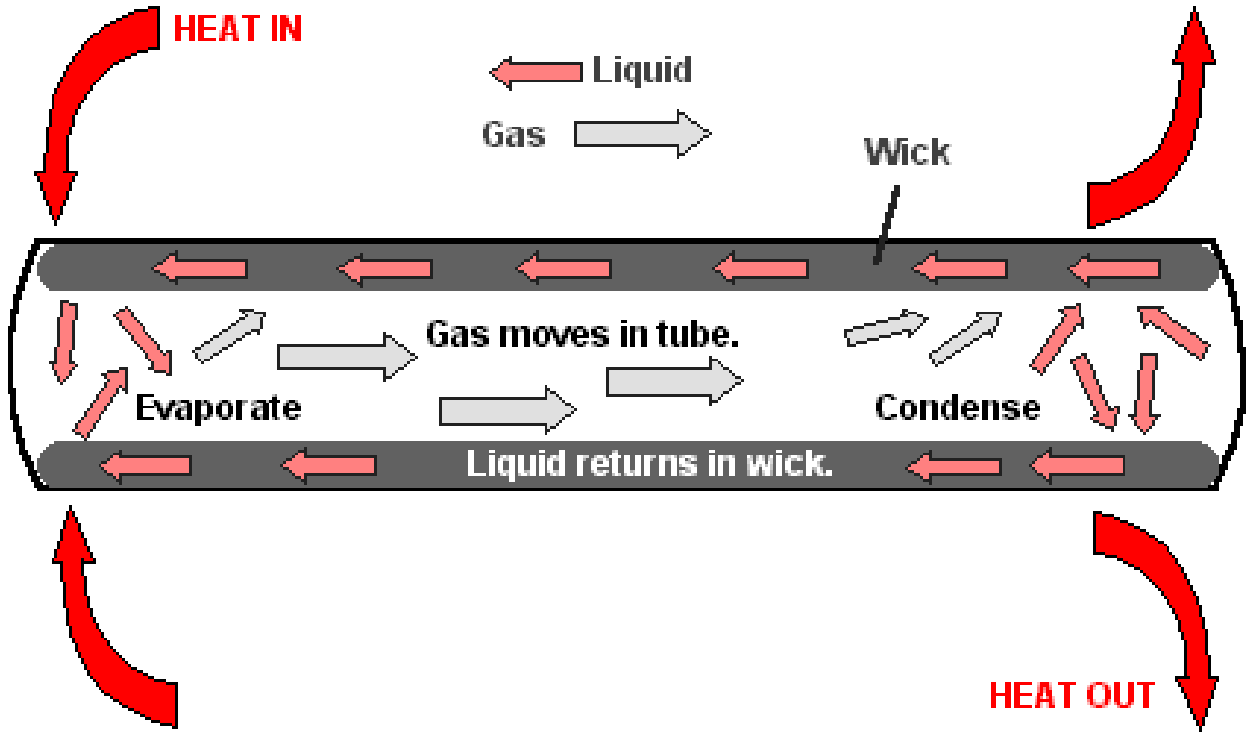
Water vapour is by far the most important greenhouse gas

NASA



Convection of water vapour through the Troposphere provides by far the most effective single way in which Earth's heat can eventually be re-radiated to Space.

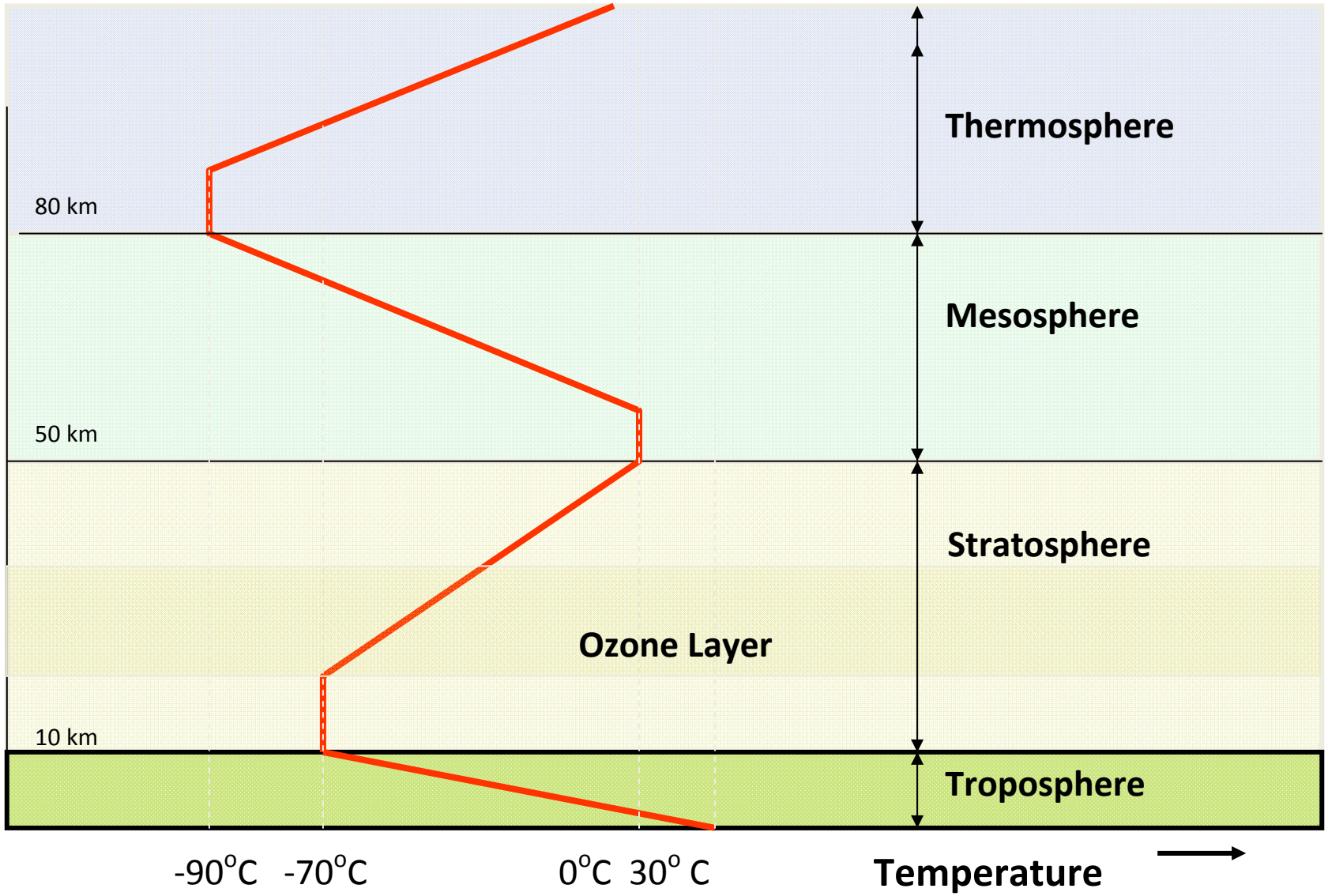
The Heat Pipe



Nature's "Heat Pipe"

Convection processes such as storms, cyclones and tornados are the primary means of effectively pumping heat out of the ocean, into the atmosphere, and lifting it to where it can be re-radiated into space, thereby mitigating the heat build-up that otherwise occurs.

The Atmospheric Temperature Profile



SIMPLIFIED GRAPH OF ATMOSPHERIC TEMPERATURE PROFILE

The Troposphere

"The troposphere is the lowest region of the Earth's atmosphere, where masses of air are very *well mixed* together and the temperature decreases with altitude."

"The air is heated from the ground up because the surface of the Earth absorbs energy and heats up faster than the air. The heat is mixed through the troposphere because on average the atmosphere in this layer is slightly unstable."

http://www.windows.ucar.edu/tour/link=/earth/Atmosphere/layers_activity_print.html&edu=high

The vortex engine is a proposed system to enhance the transmission of energy through the troposphere

First, the Vortex Engine's cousin: the Solar Updraft Tower

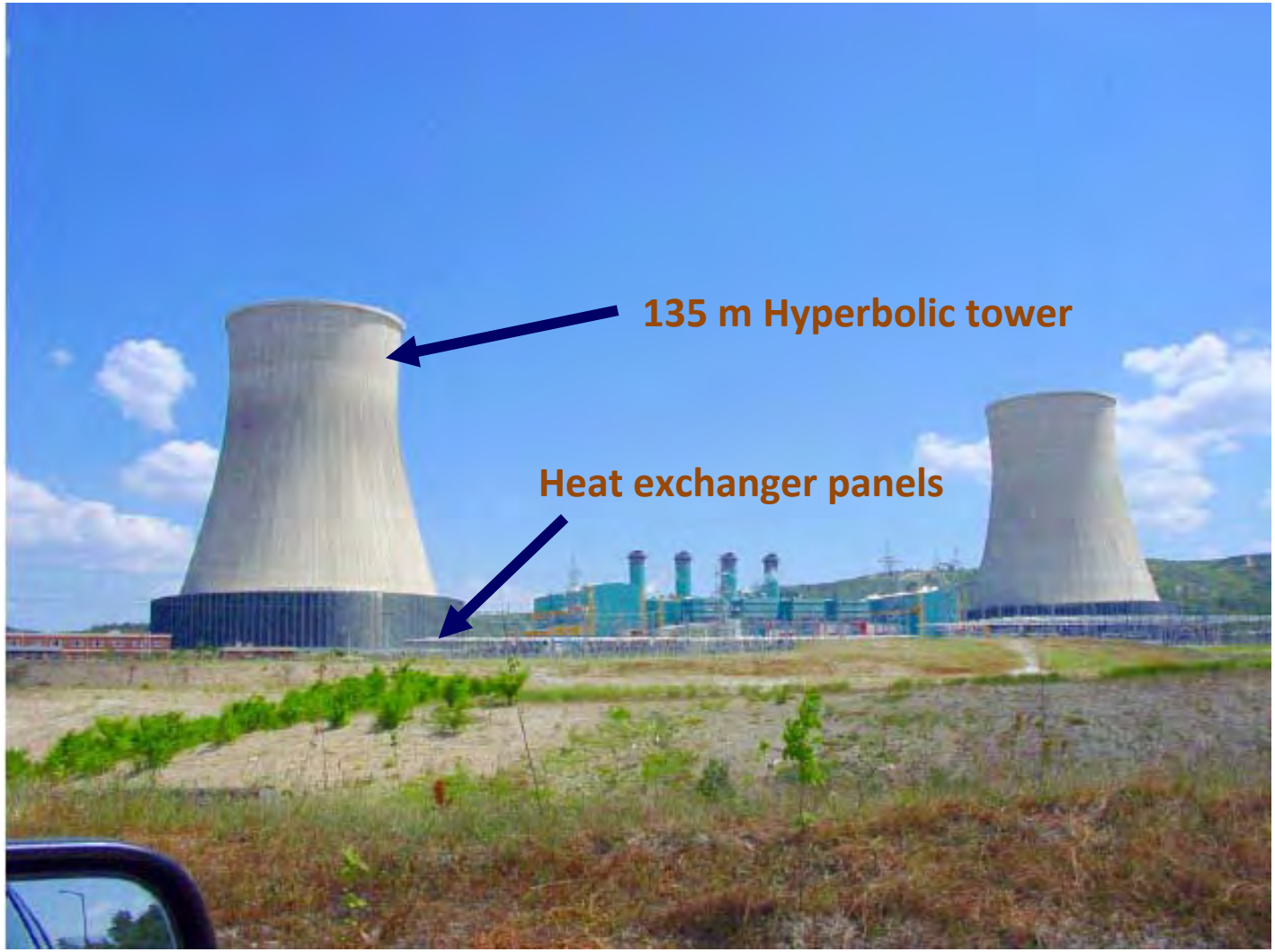
Solar Chimney

Manzanares
200 m high, 10 m diameter
Collector 0.04 sq. km
50 kw, 130 J/kg, 1 Mg/s
Spain 1982 to 1989

Enviromission
1000 m high, 100 m diameter.
Collector 40 sq km
200 MW, 300 tonne/sec
Australia / US

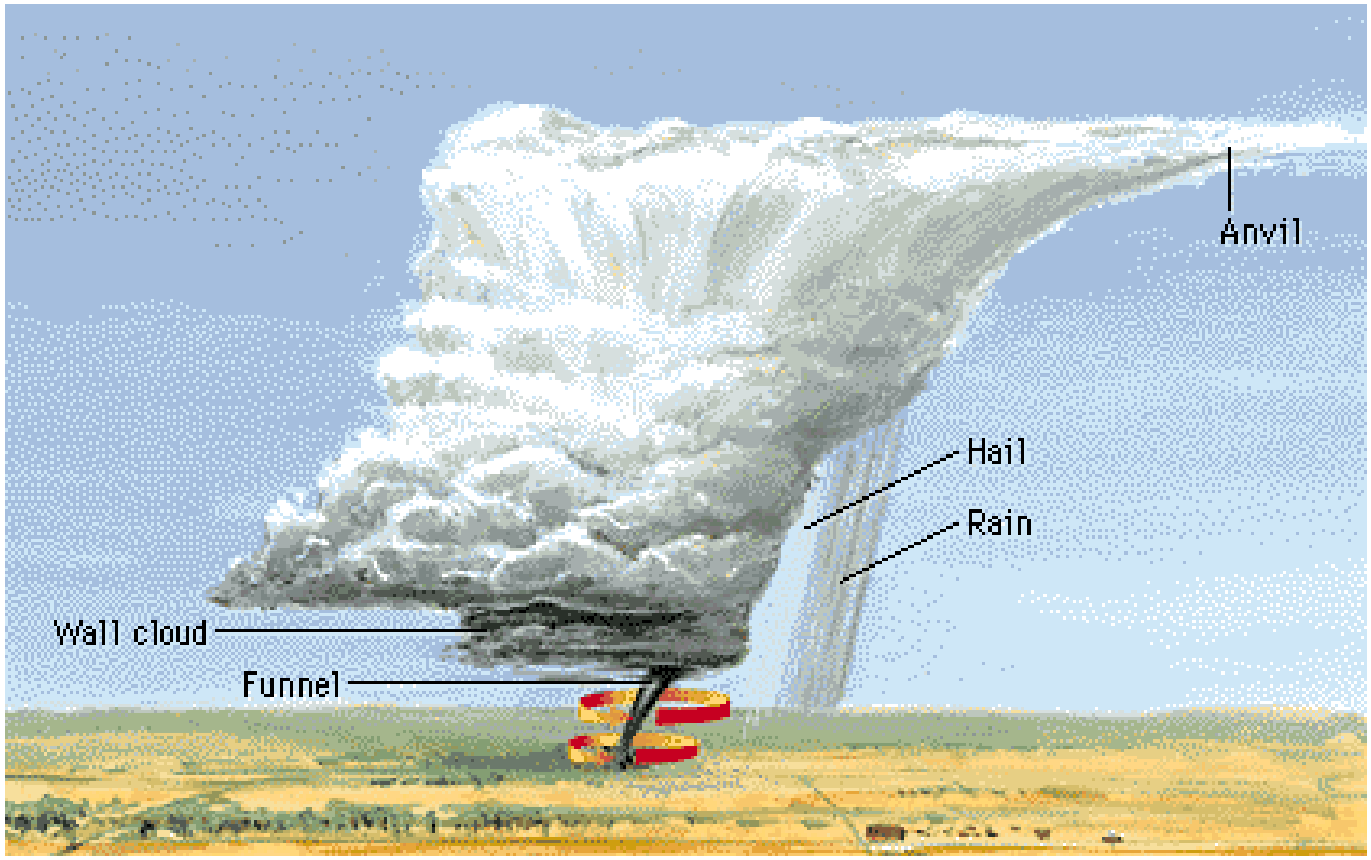
Enviromission in Australia and Solarmission in the US are proposing to build a 200 MWe solar-thermal power station.

1400 MW CCGT Power Station with Dry Cooling Towers



The Cooling Tower Developer, GEA, is looking at incorporating a vortex flow in their design in order to enhance the updraft.

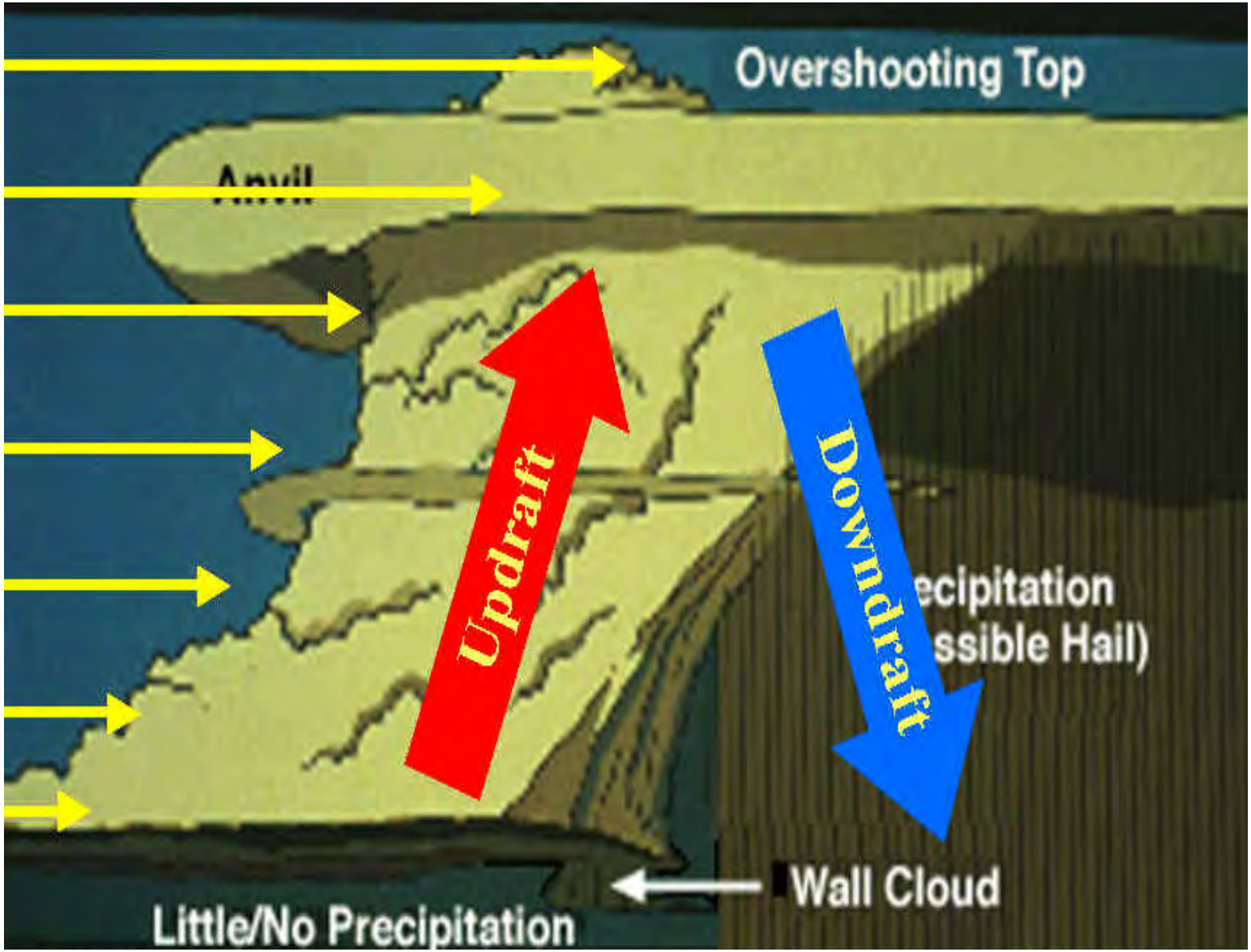
Vortices in Nature



World Book

The tornado is a highly effective mechanism through which Nature acts to convey humid boundary layer air to the top of the Troposphere where precipitation is initiated. The "anvil" is formed when it reaches the tropopause, the interface with the stratosphere.

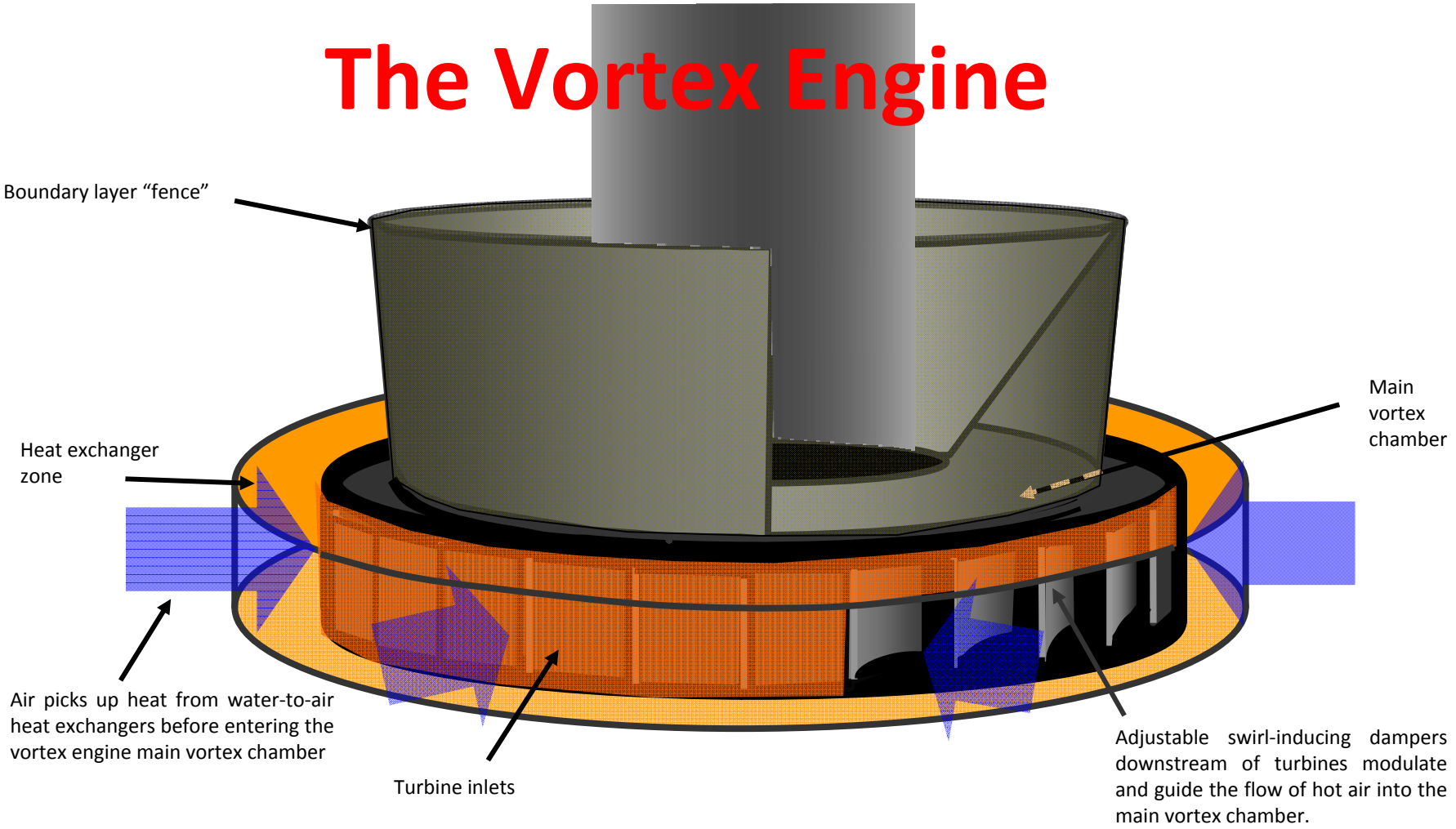
The Supercell



The Supercell

ROGER EDWARDS

The Vortex Engine



The vortex chimney generated by the vortex engine can be regarded as a natural “worm hole” which is able to link the high and low temperature strata of the troposphere, thereby releasing the energy contained in atmospheric water vapour.

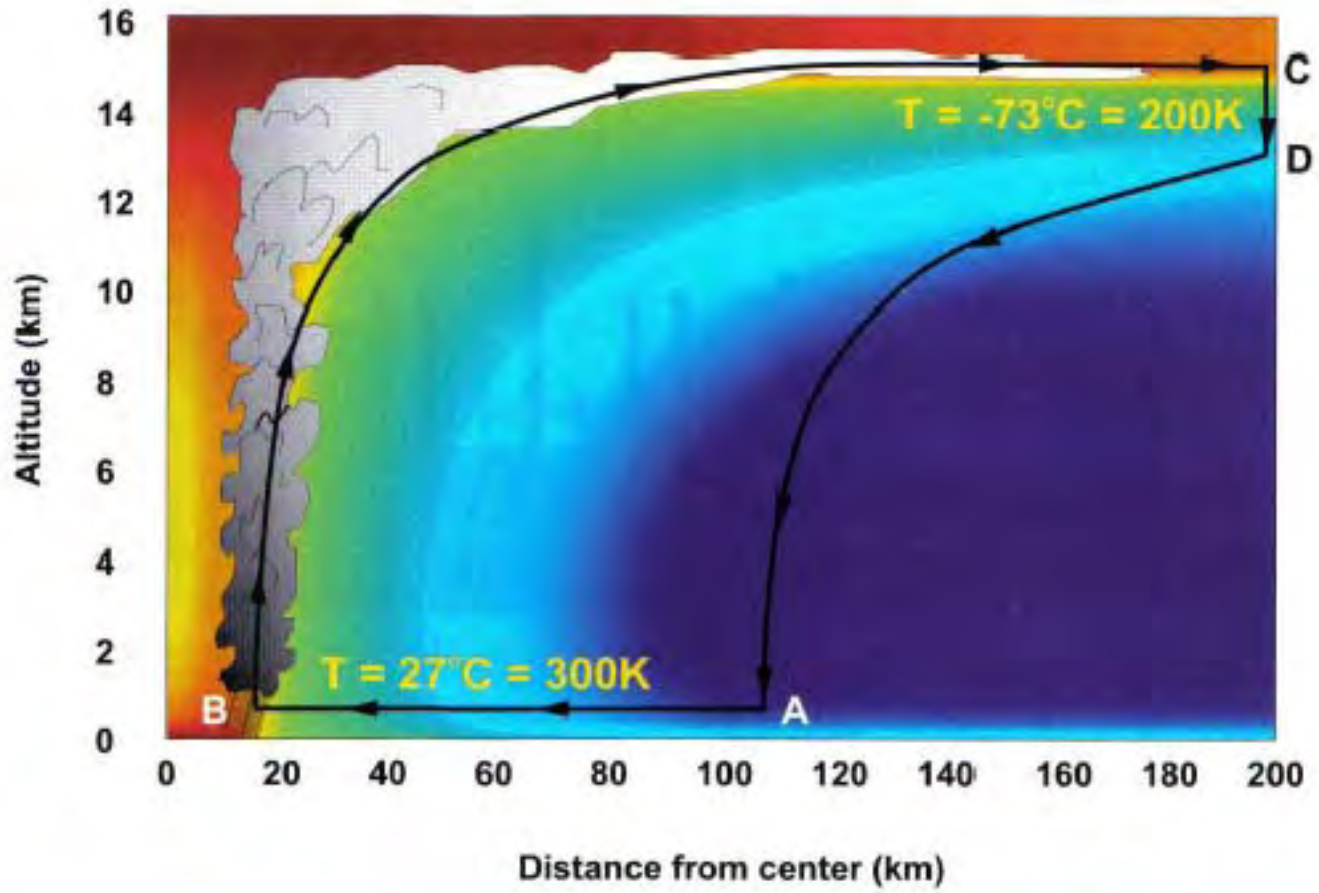
The Positive Feedback Effect Within a Vortex

1. Warm air "rises" towards the centre (the eye) of the centrifugal field as it is less dense. It is also more buoyant in the Earth's gravitational field and hence rises vertically when it reaches the eye.
2. Atmospheric water vapour, which has a mass density about 63% that of air at the same temperature and pressure, is also displaced towards the centre of the centrifugal field and rises vertically once in the eye.
3. Centrifugal force reduces the pressure at the centre of the centrifugal field. Low pressure again means low density and hence high buoyancy. A buoyant gas has inherent potential energy.
4. As the air/vapour mixture progresses to the low-pressure eye, some water vapour condenses, releasing latent heat. The typical tornado "funnel" is visible because of the condensed water droplets.

Each of the above acts to create a strongly buoyant updraft within the eye and hence a self-sustaining natural "chimney" effect.

Just as the potential energy of elevated water can be used to drive hydroelectric turbines, so too the potential energy of a warm air/vapour mixture can drive wind turbines.

A Tropical Cyclone seen as a Carnot Cycle



Efficiency $n = 1 - Tc / Th = 1 - 200/300 = 33\%$

Source: Divine Wind by Kerry Emanuel

Atmospheric Water Content

- It has been estimated that only 2% of the atmospheric water content is in the form of clouds. The remaining 98% is in the form of water vapour.
- At 1% average water content, the lowest one kilometre of the atmosphere above the Australian continent contains in the region of 100 billion tonnes of water.

The increasing number and severity of tropical cyclones and tornadoes in some regions is arguably a pointer to Earth's need to dump heat to Space.

That's fine, but we need to learn to control the location, frequency and intensity of the process… hence the need for vortex engine research

Why Won’t it Run Away?

The humidity of the surrounding field would be kept below the critical level at which the vortex would be self-sustaining. Only after passing geothermal steam through the vortex engine heat exchangers would the energy level become super-critical. The “boundary layer fence” would act to quarantine the vortex from the surrounding boundary layer except for allowing flow of air through the control dampers and turbines.

What Sort of Power Will Be Produced?

Based on a similar total power to an average tornado and an overall system efficiency of around, say, 20%, a power output of 200 MW could be expected per engine.

How much precipitation can be expected?

A 200 MW vortex engine is expected to generate around 20,000 tonne of precipitation per day, assuming 1% atmospheric water content and evaporation losses of around 50% in falling to earth.

If it falls within a radius of 10 km, this would theoretically amount to only about 30 mm per annum. There is some reason to believe this may be amplified by natural processes.

Advantages of Convective Vortex Systems

- Reduced CO_2 emissions
- Zero fossil fuel use – instead utilization of stored solar energy within atmospheric water vapour and air
- Increased precipitation over land means increased plant growth and subsequent photosynthesis – hence natural sequestration of CO_2
- Increased heat radiation to space – hence <u>global cooling</u>
- Significantly increased terrestrial Albedo

Will it Work?

‘Nilton Renno, a professor at the department of atmospheric, ocean and space sciences at the University of Michigan, has spent his career studying tornadoes and water spouts. He says there is no reason why Michaud’s vortex engine wouldn’t work.’

”The concept is solid,” says Renno.

…‘Still, Renno is not without reservations. He’s particularly concerned about the ability to control such a powerful monster.’

‘“The amount of energy is huge. Once it gets going it may be too hard to stop,” he says.’

The Toronto Star July 21 2007

This is where research and development engineering is needed…

“What’s necessary at this point is to do proofs of concept,” says professor Kerry Emanuel, the hurricane expert at MIT. “[Michaud’s] idea is pretty simple and elegant. My own feeling is that we ought to be pouring money into all kinds of alternative energy research. There’s almost nothing to lose in trying this...”

ODE Magazine March 2008

Uh Oh… Lightning!

Harnessing the vortex principle will not be easy, and the risks are significant.

On the other hand there is a strong argument that research must be carried out to determine its viability.

Questions

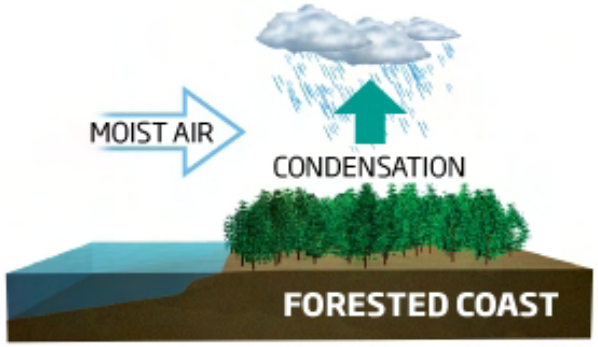
Forest Rainfall Generation

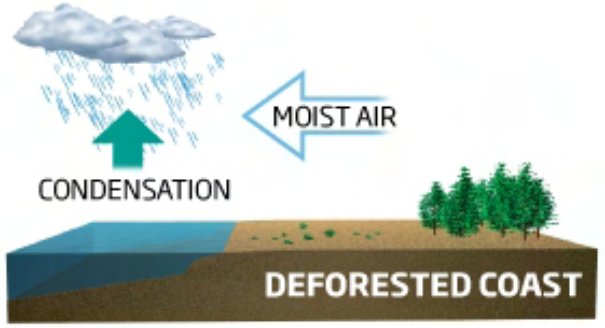
Biotic pump

A controversial theory could explain how large volumes of water reach thousands of kilometres inland

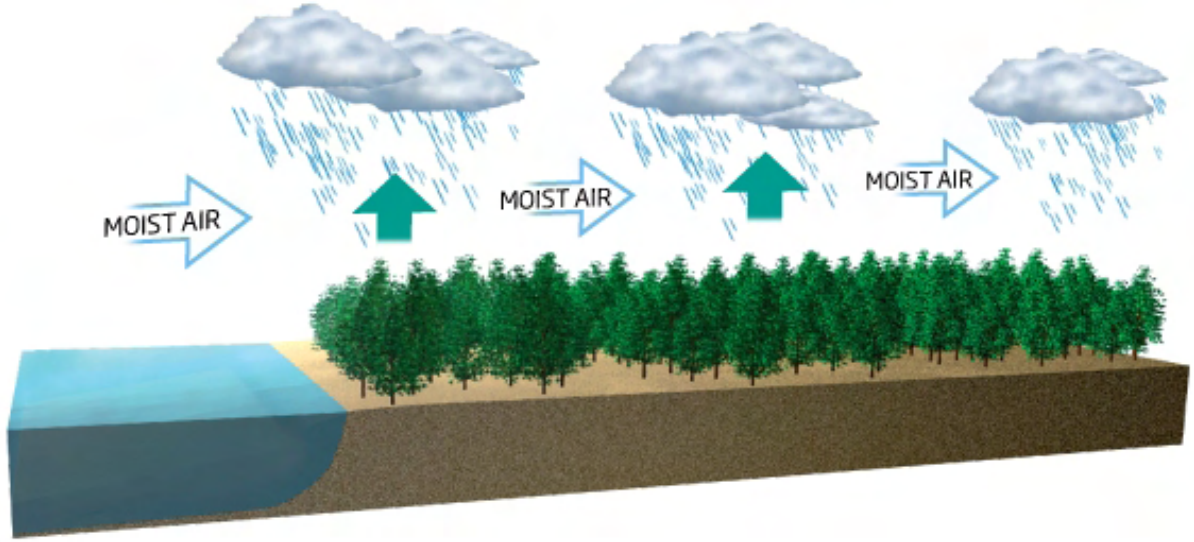
Water vapour over coastal forests condenses to form droplets and clouds. This lowers local air pressure and sucks in moist air from the ocean

If coastal forests are cut, the winds reverse





On a large continent with a forested coast, the rain exported inland helps the forest expand. This process repeats itself, sustaining forest right into the continent's heart

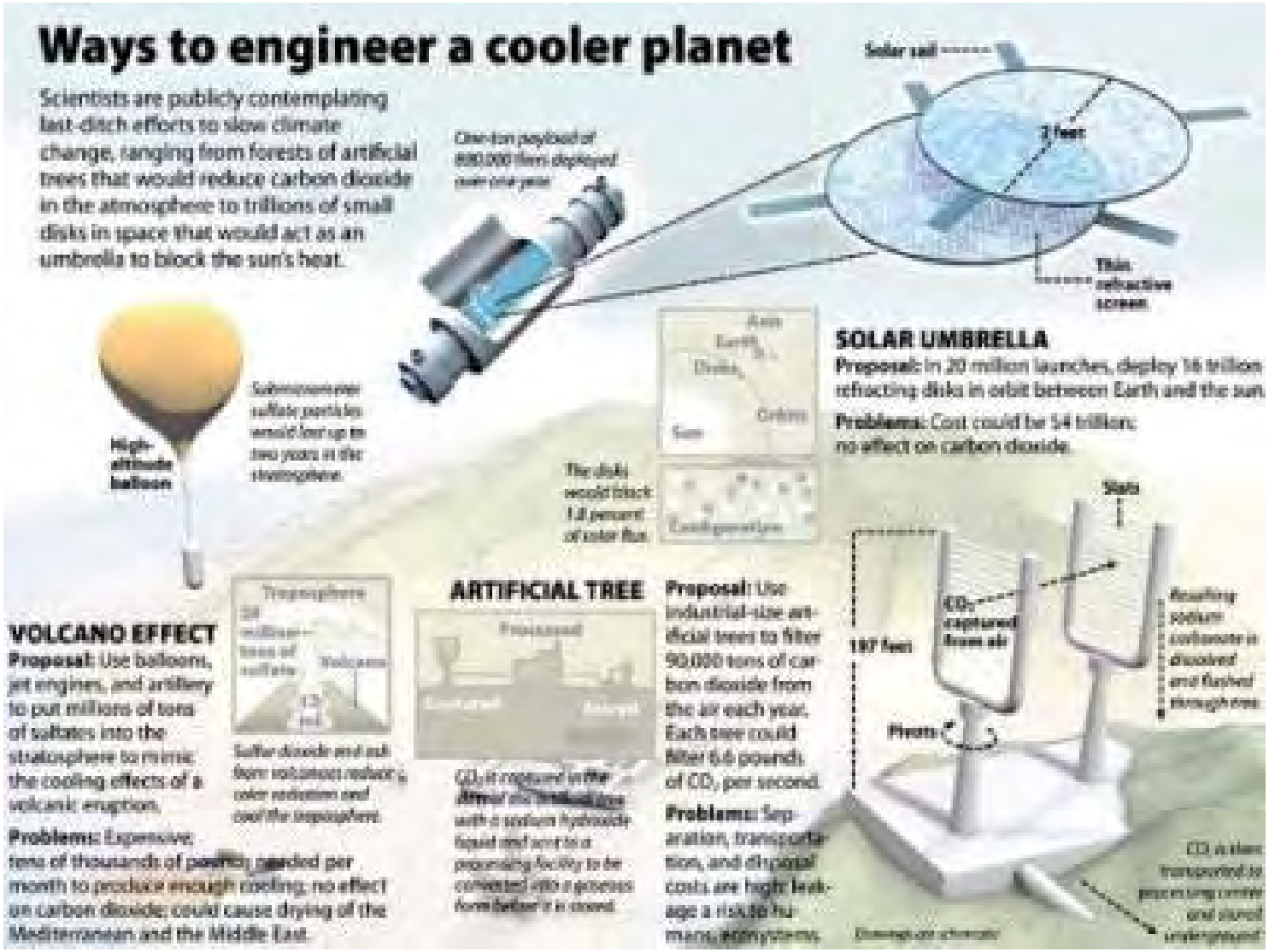


Rainforest Evaporation

The volumes of water involved in this process can be huge. More moisture typically evaporates from rainforests than from the ocean. The Amazon rainforest, for example, releases 20 trillion litres of moisture every day.

New Scientist 01 April 2009

Geoengineering Proposals



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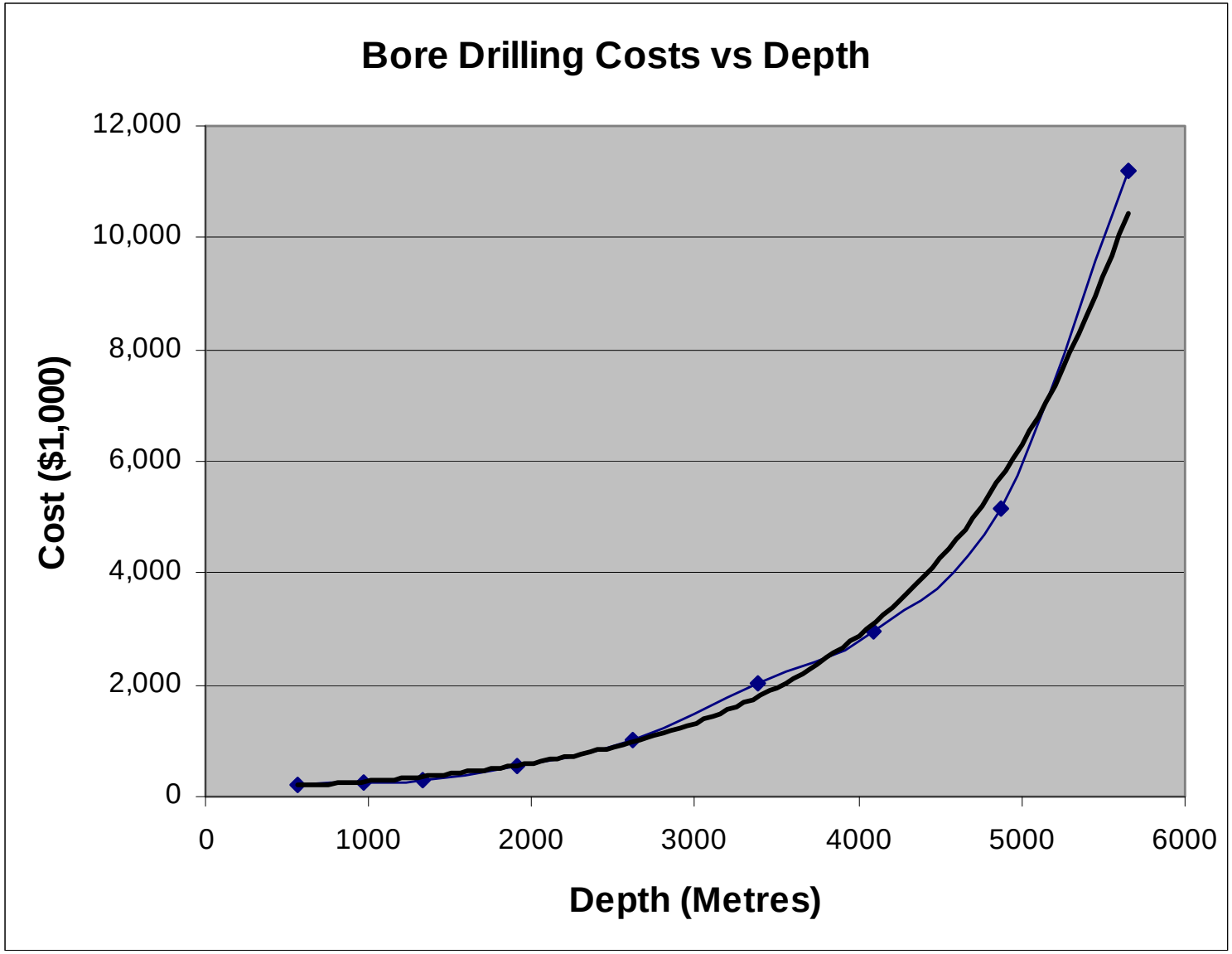
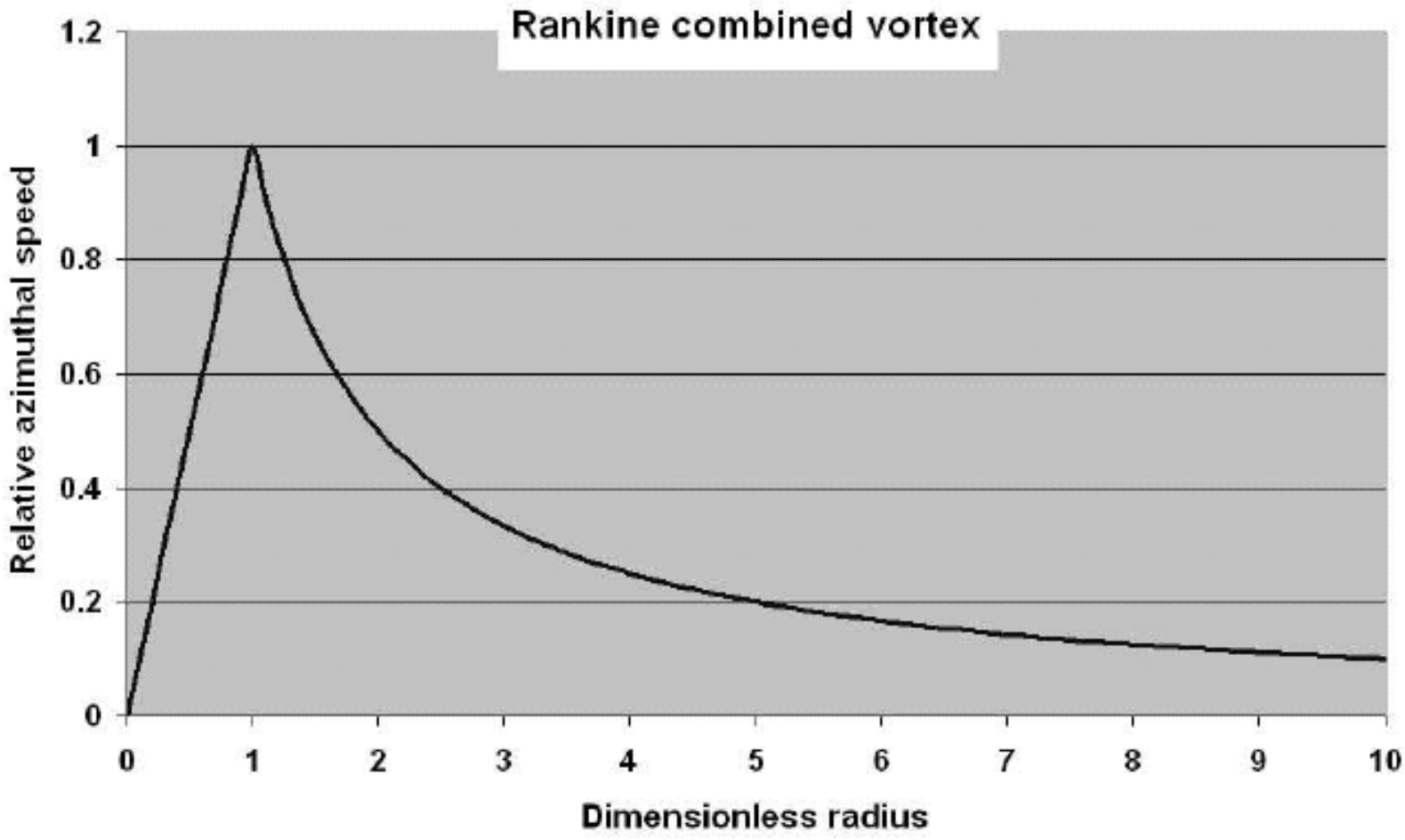
Geothermal



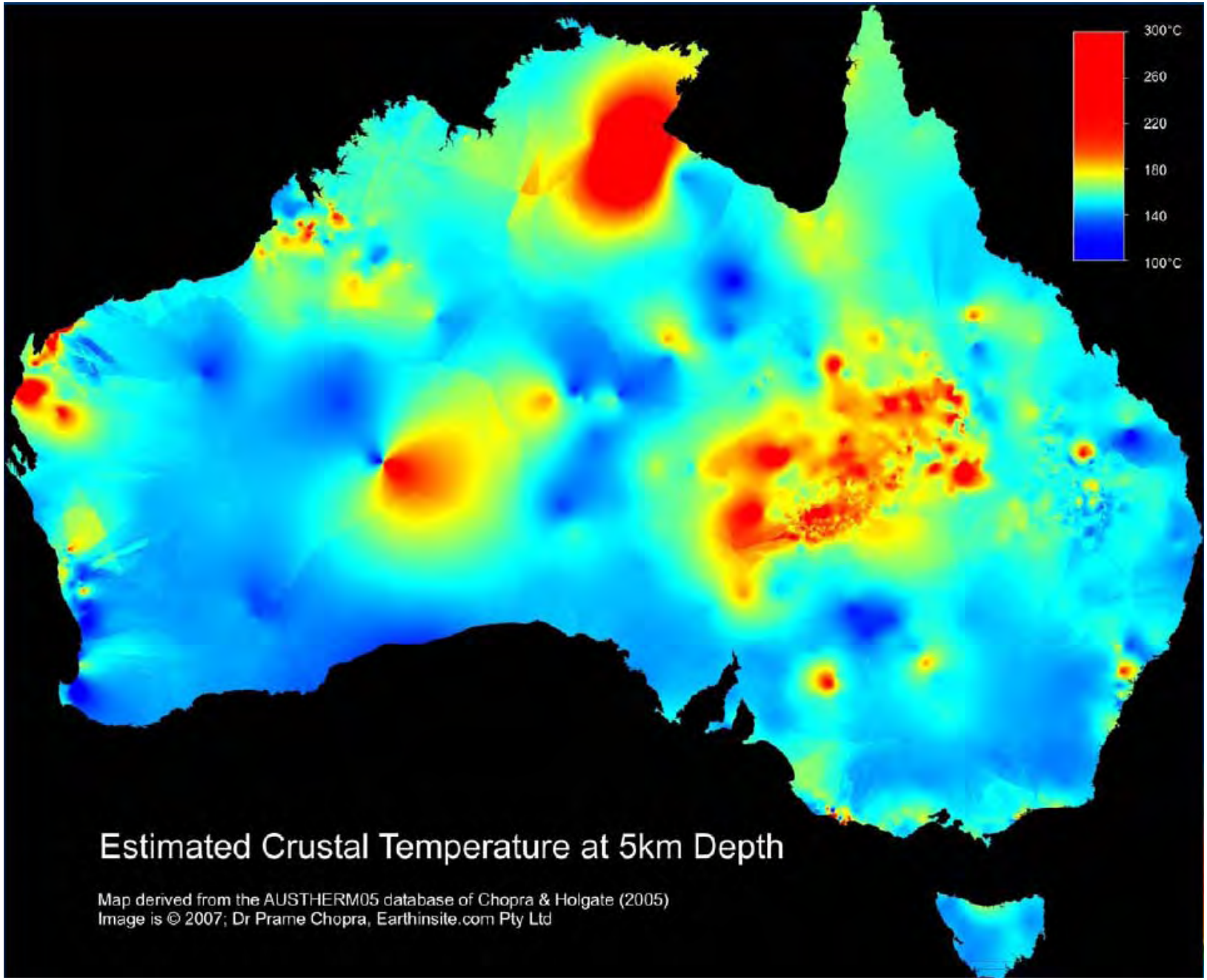
(source: A Comparison of Geothermal with Oil & Gas Well Drilling Costs – MIT)

Power station flue gas discharge through a cooling tower

Wet scrubber installed within natural-draft dry cooling tower



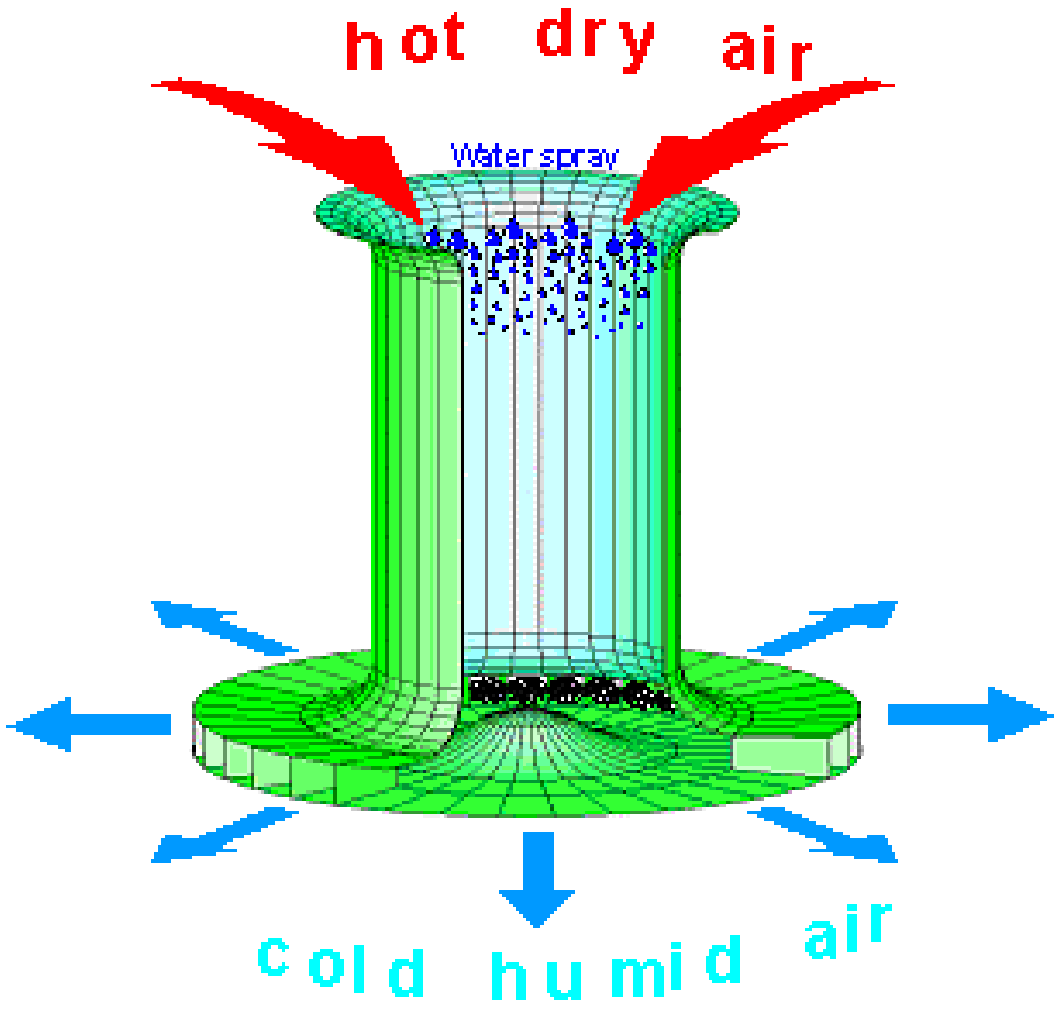
Qualitative tangential velocity profile

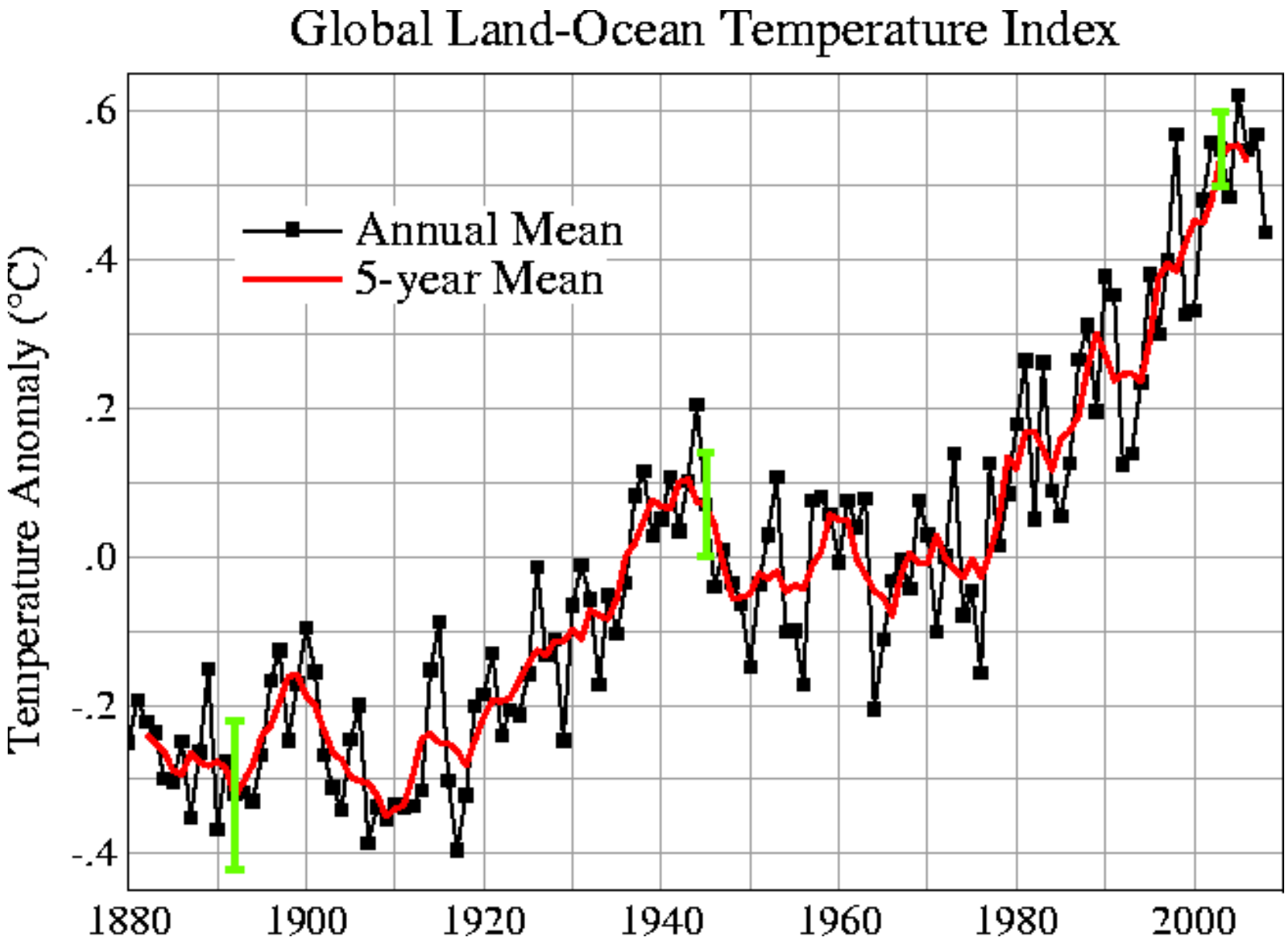

300°C
260
220
180
140
100°C
Estimated Crustal Temperature at 5km Depth
Map derived from the AUSTHERM05 database of Chopra & Holgate (2005)
Image is © 2007; Dr Prame Chopra, Earthinsite.com Pty Ltd

Cross Winds

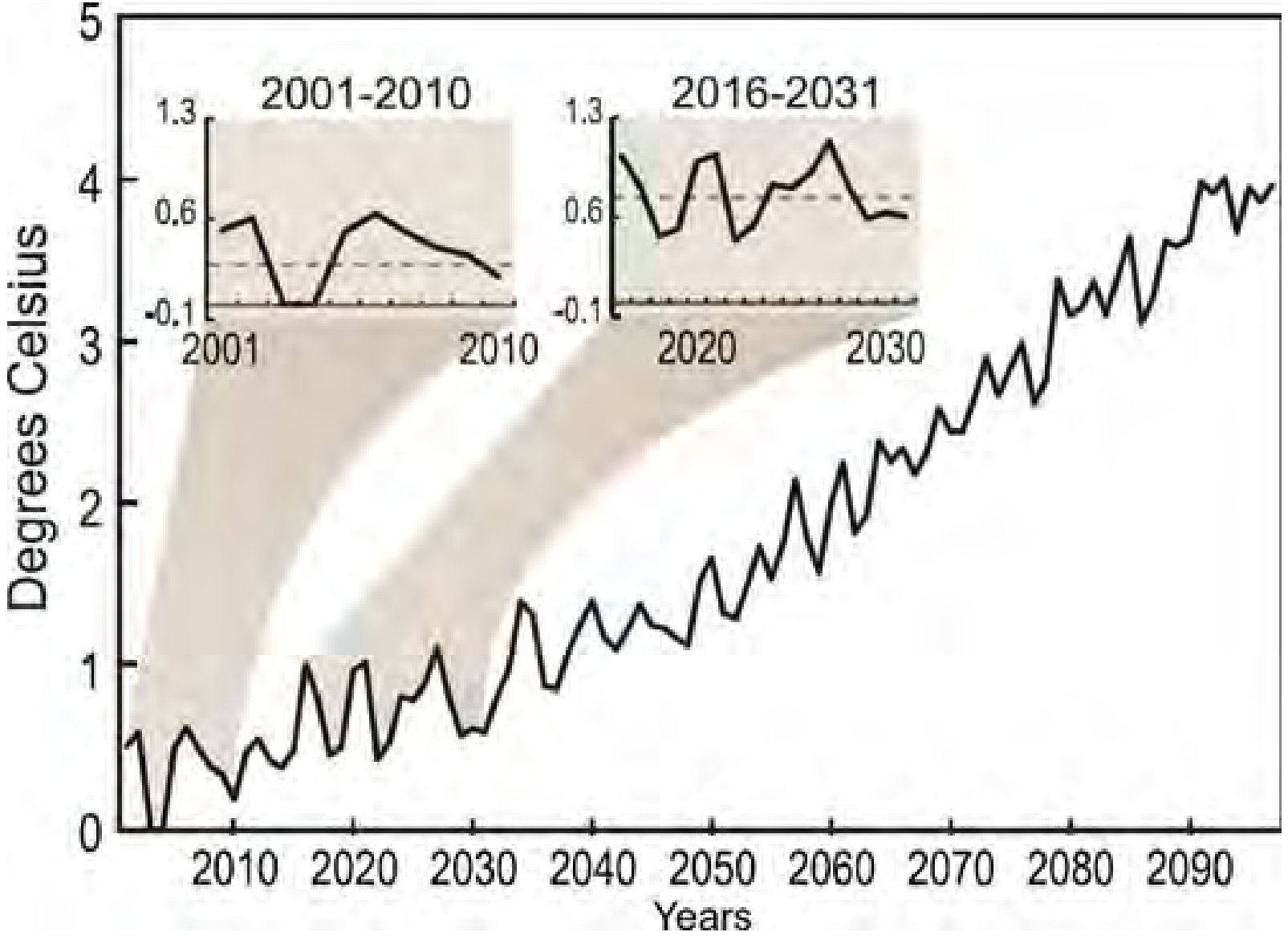
If strong cross winds (say >50 km/hr) were to occur, the system would be shut down and the fall-back position would be to utilise wind turbines in the area surrounding the vortex engine to generate power.

Energy Towers





New Scientist / Wikipedia



New Scientist - Has Global Warming Really Stopped? April 8, 2009