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Dear Planning Inspectorate,

Invalid analysis of Thermals

It is my professional opinion that the submissions to the Examining Authority, prepared by Nova Fluid Mechanics and Pager Power for PVDP, **do not** prove that thermals triggered by the proposed Botley West Solar Farm will not affect primary radar reflections from aircraft. The RANS CFD methods used are not capable of simulating the large rising masses of buoyant, heated air associated with thermal plumes. Consequently, the conclusions made are not valid, and should not allay the concerns expressed by London Oxford Airport and RAF Brize Norton. The precautionary principle, that one should in no way increase danger, holds.

Notes

1. I am a retired Professor in Engineering Science at the University of Oxford. As a Mechanical Engineer at Oxford, I have over 40 years research experience in turbomachinery, aerodynamics and heat transfer and have published widely in the field. I was a glider pilot and have flown in many thermals,

2. A useful introduction to atmospheric thermals can be found in Wikipedia – Thermals. I have appended it to this submission.

3. The two submissions to the ExA referred to are:

17.14 Thermal Impact Report (PDF, 5MB) From Photovolt Development Partners (PVDP) on behalf of SolarFive Ltd 23 October 2025
17.15 Thermal Plume Primary Radar Refraction (PDF, 144KB) From Photovolt Development Partners (PVDP) on behalf of SolarFive Ltd 23 October 2025

4. The RANS (Reynolds Averaged Navier-Stokes) methods used by Nova Fluid Mechanics are not capable of simulating the distinct, unsteady bodies of rising hot air characteristic of thermals. They are good for predicting boundary layer flows over rough surfaces, and this is all Nova has done. Consequently, the simple thermal analysis used by PagerPower using the Nova results is not valid for thermals. A notable failing of Nova's study is that the zero wind velocity case, highly relevant to thermals, is not presented. To more accurately predict thermals would require using more advanced CFD tools such as LES (Large Eddy Simulation) or DNS (Direct Numerical Simulation).

Yours sincerely,
Prof. Martin L G Oldfield, B.E., B.Sc., D.Phil., ASME Fellow.

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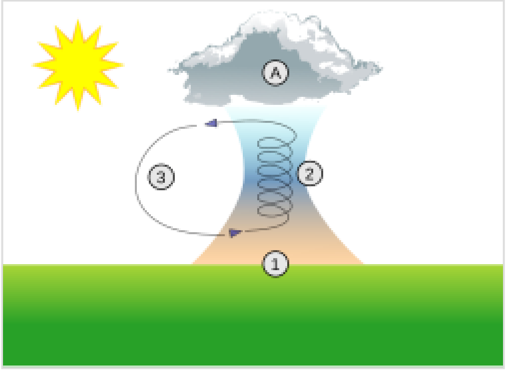
Thermal

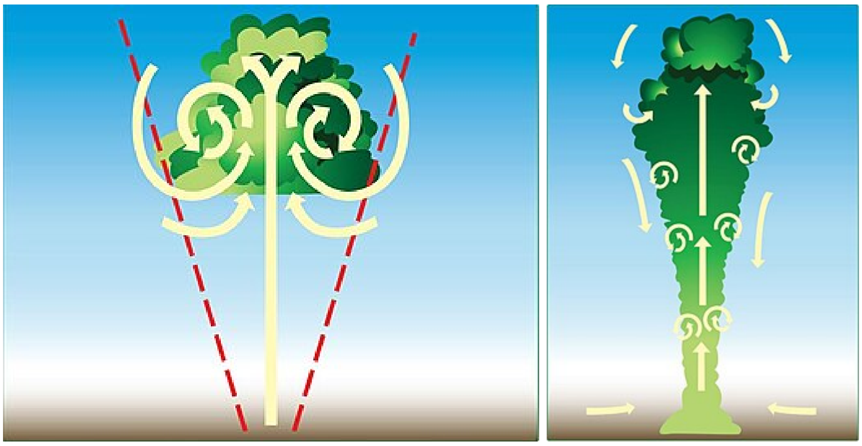
A **thermal column** (or **thermal**) is a rising mass of buoyant air, a convective current in the atmosphere, that transfers heat energy vertically.[1] Thermals are created by the uneven heating of Earth's surface from solar radiation, and are an example of convection, specifically atmospheric convection.



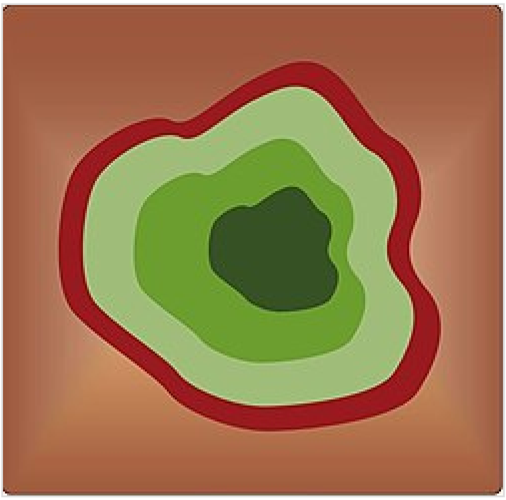
Example of a thermal column between the ground and a cumulus

Thermals on Earth

The Sun warms the ground, which in turn warms the air directly above.[2] The warm air near the surface expands, becoming less dense than the surrounding air. The lighter air rises and cools due to its expansion in the lower pressure at higher altitudes. It stops rising when it has cooled to the same temperature, thus density, as the surrounding air.


Bubble or vortex ring thermal model (left), and column or plume thermal model (right)

Associated with a thermal is a downward flow surrounding the thermal column. The downward-moving exterior is caused by colder air being displaced at the top of the thermal.


Thermal cross section with stronger lift (rising air) in darker shades of green, while red is sink (descending air).

The size and strength of thermals are influenced by the properties of the lower atmosphere (the *troposphere*). When the air is cold, bubbles of warm air are formed by the ground heating the air above it and can rise like a hot air balloon. The air is then referred to as unstable, as it's suitable for forming thermals. If there is a warm layer of air higher up, an inversion can prevent thermals from rising high and the air is said to be stable, as mature thermals can't form.

Thermals are often indicated by the presence of visible isolated cumulus clouds at the top of the thermal. Cumulus clouds are formed by the rising air in a thermal as it ascends and cools, until the water vapor in the air begins to condense into visible droplets. When a steady wind is present, thermals and their respective cumulus clouds can align in rows oriented with wind direction, sometimes referred to as "cloud streets" by soaring and glider pilots.

The condensing water releases latent heat energy allowing the air to rise higher. Very unstable air can reach the level of free convection (LFC), rising to great heights, condensing large quantities of water and forming convective clouds causing showers or even thunderstorms. The latter are dangerous to any aircraft flying through or nearby.

Thermals are one of the many sources of lift used by soaring birds and gliders to soar.

Thermals beyond Earth

Thermals are also seen elsewhere in the Solar System. On Mars, for example, thermals are often seen in the form of dust devils, carrying dust instead of water vapor. Thermals are also seen on the Sun, typically forming hexagonal convective prisms (Bénard cells).

See also

- Air current
- Atmospheric thermodynamics
- Cumulus cloud
- Gliding
    - Hang gliding
- Thermal energy

References

1. "Glider Flying Handbook, FAA-H-8083-13A" (https://www.faa.gov/sites/faa.gov/files/regulations_policies/handbooks_manuals/aviation/glider_handbook/faa-h-8083-13a.pdf) (PDF). *FAA government handbooks*. U.S. Dept. of Transportation, FAA. 2003. pp. 9–6, 9–7. Retrieved 21 January 2021.
2. Bradbury, Tom (2000). *Meteorology and Flight: Pilot's Guide to Weather (Flying & Gliding)*. A & C Black. ISBN 0-7136-4226-2.

External links

- What do thermals look like? (http://www.rcsoaring.com/docs/thermals_2006.pdf) - *Thermal Structure and Behavior* by Wayne M. Angevine
- Time-lapse video of clouds caused by thermals forming and decaying (https://bookergc.blogspot.com/2008/04/thermal-formation-and-decay.html)