

GROMIT project: GROund coupled heat pumps MITigation potential

NERC research grant



Anne Verhoef on behalf of the GROMIT team
Department of Soil Science, University of Reading

GROMIT team

- **UoR/NCAS-Climate** (land surface modelling & fieldwork):
Raquel Garcia-Gonzalez, Bruce Main, Pier Luigi Vidale, Anne Verhoef
- **Nottingham University** (modelling of GCHPs): *Yupeng Wu* & Guohui Gan
- **BGS** (Groundwater modelling): Majdi Mansour & Andrew Hughes
- **CEH-Wallingford** (UK 1 km driving data): Eleanor Blyth & Jon Finch
- **EarthEnergy Ltd** (GCHP expertise): Robin Curtis

Aim: To investigate and optimise the CO₂ mitigation potential of horizontal GCHPs under current and future UK environmental conditions

GCHPs and environmental factors

Key variables: soil moisture content and **soil temperature**

- Infiltration Rates / Evaporation
- Energy balance/ground water level; vary in time and space)
- Water (vapour) flux, induced by heat extraction/rejection
- Thermal regime
- Thermal soil properties
- Soil water freezing/melting

Largely affected by climate, soil texture & vegetation

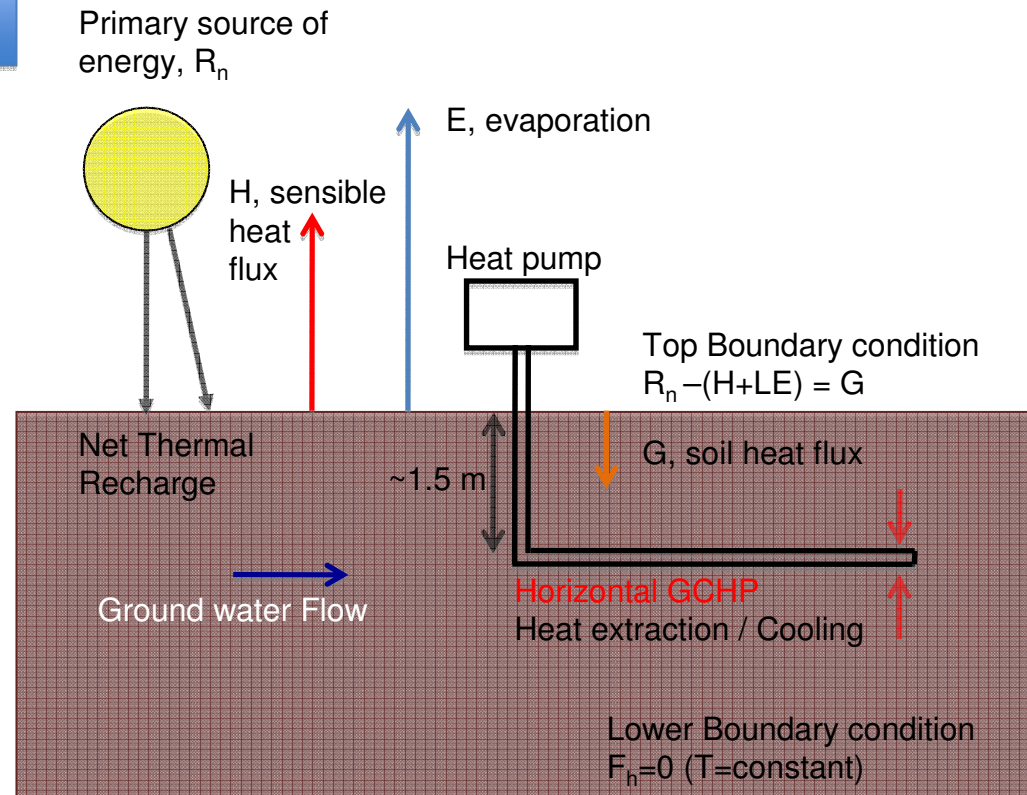
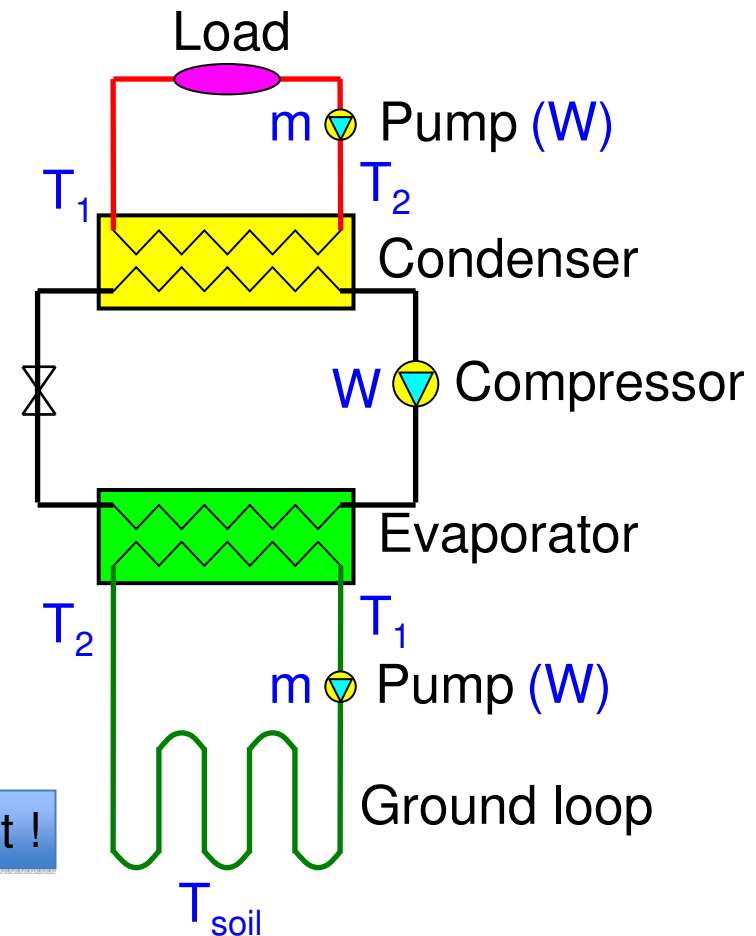


Diagram: Heat and water exchange processes near GCHP

GCHP-related technical & design factors

- Type of horizontal GCHP
- Spacing of loops
- Installation depth
- Back-filling material
- Fluid in HE
- Pumps

Will affect COP, together with soil environment !

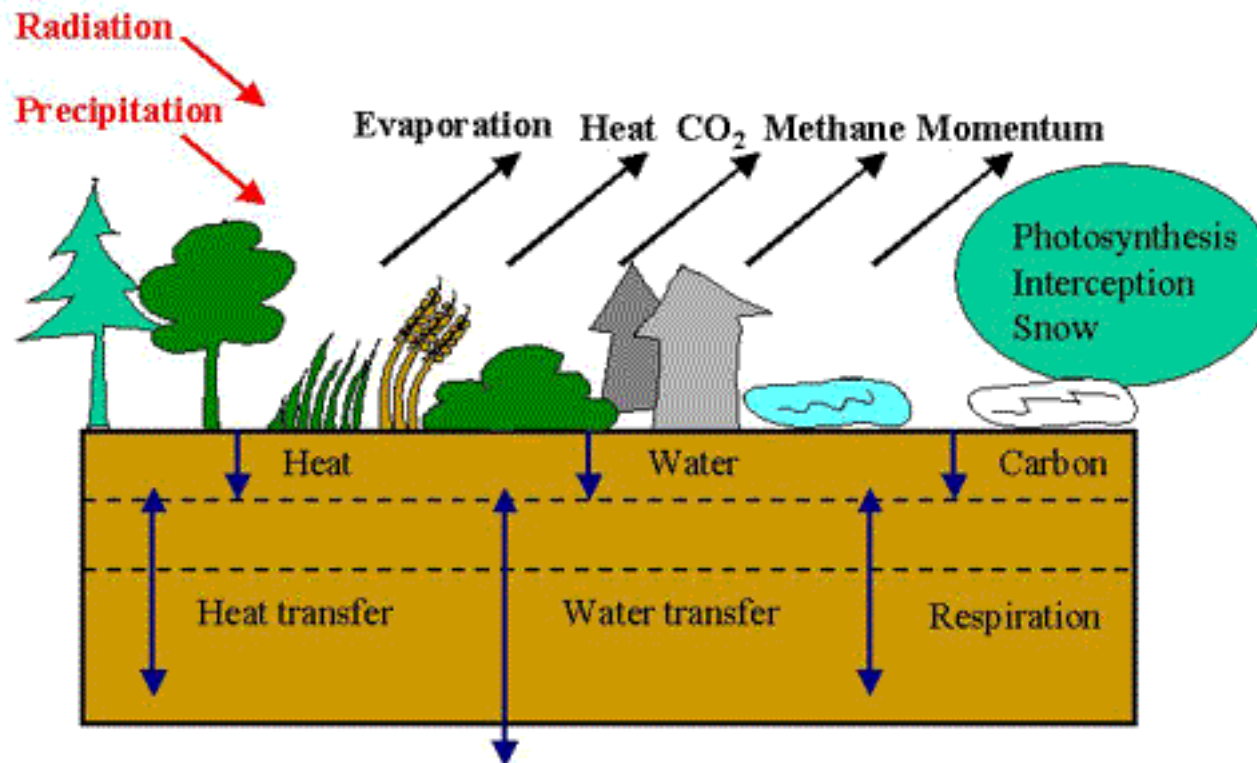


Courtesy of: Yupeng Wu,
Nottingham University

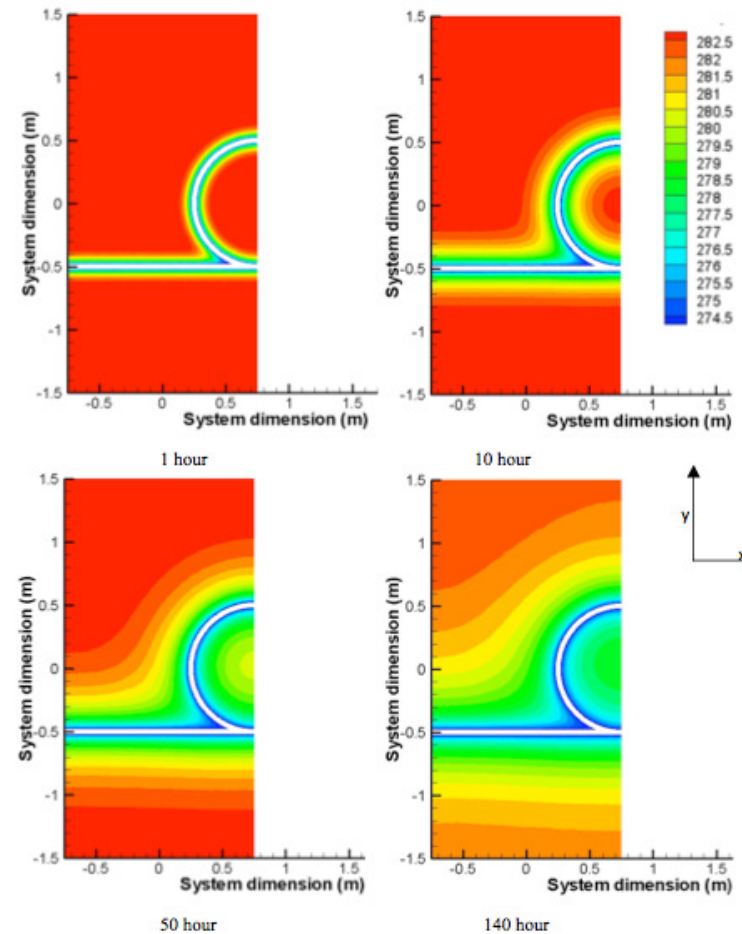
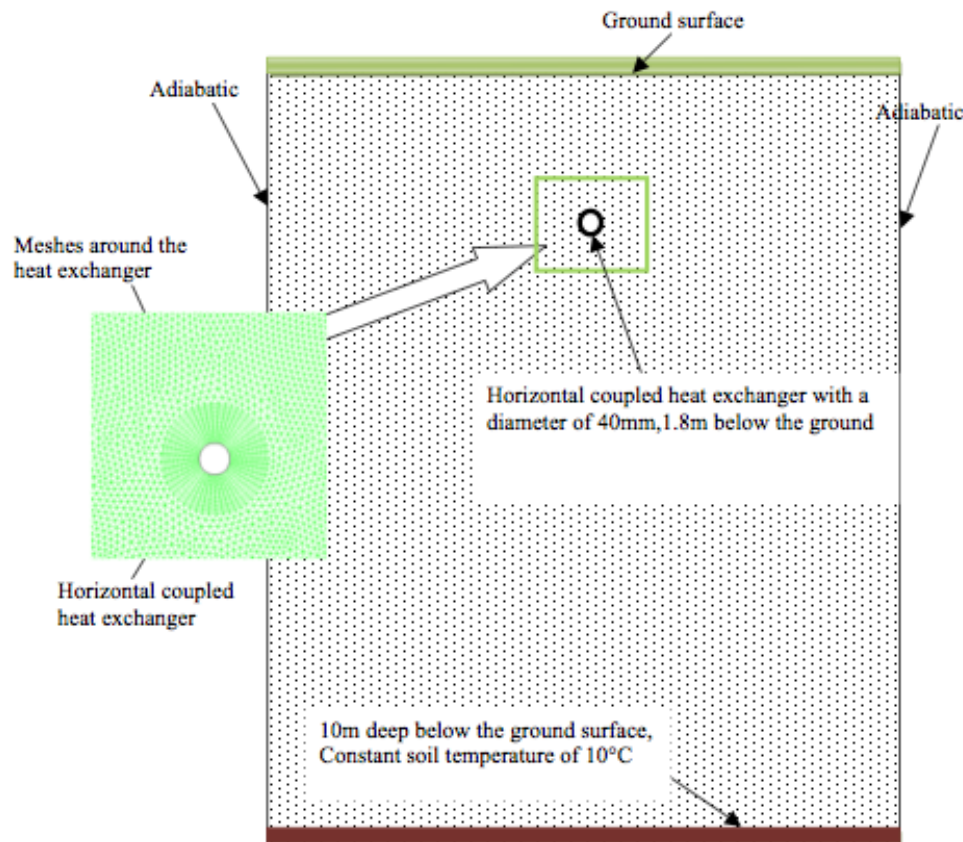
Project approach

- Model development (combined Land surface-Groundwater-GCHP model)
- Experimental campaigns (UK field sites)
- Model simulation
 - Driving variables (UK 1 km grid)
 - Verification
 - Sensitivity - Varying model parameters
 - Climate change impact – COP under future environmental conditions
 - Climate change scenarios (UKCIP)
- Dissemination

Land surface model



GCHP modelling

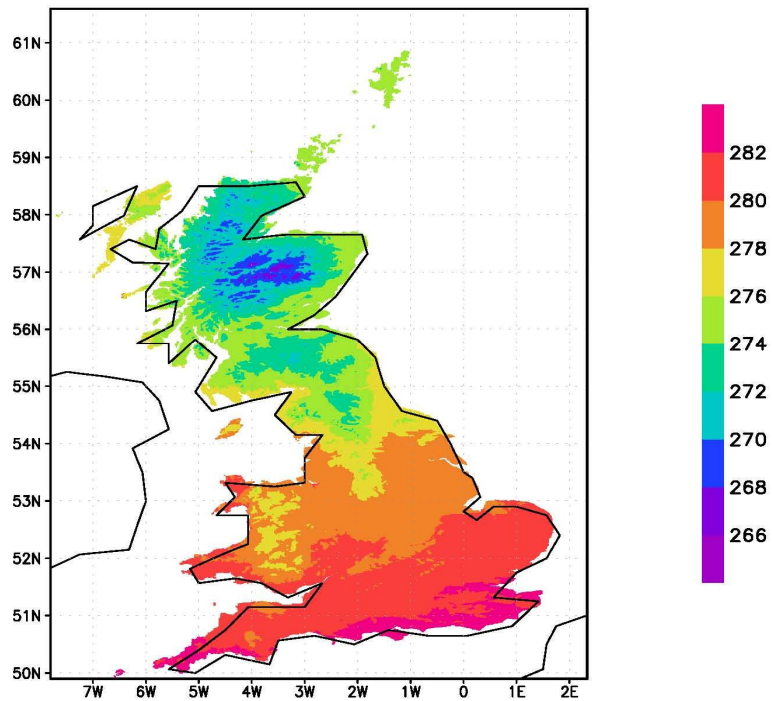


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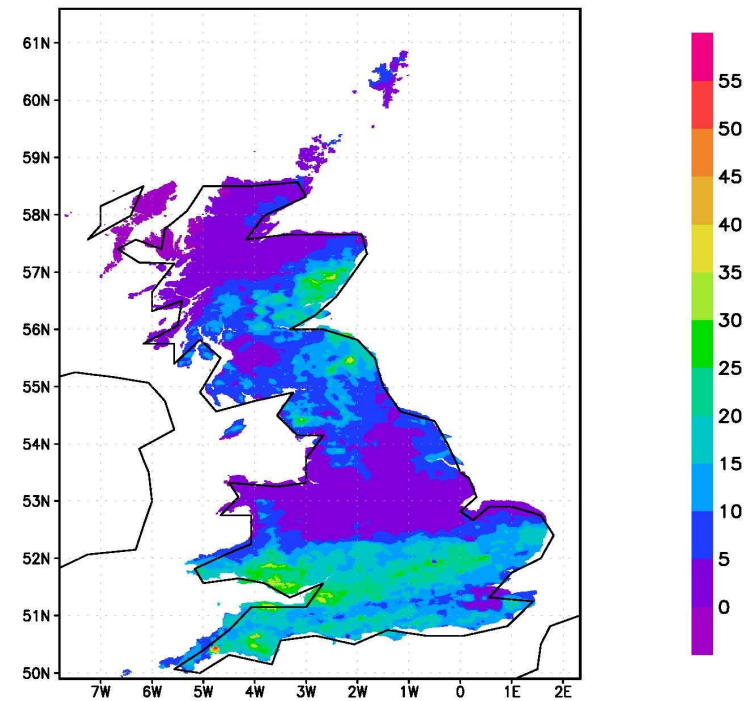
Plan view of isotherms generated from prediction for a
slinky heat exchanger, at 1, 10, 50 and 140 hours

UK driving variables

Air Temperature (K)
1 January 2003



Rainfall Rate ($\text{kg m}^{-2} \text{d}^{-1}$), 1
January 2003



Courtesy of: Tongfei Zhang, CEH-Wallingford

UK soil textures

The National soil map,
NATMAP (NSRI)

Soil texture

Soil properties such as:

- Dry bulk density
- Hydraulic properties
- Thermal properties



Field campaign started 2th October 2009, near Oxford



- GCHP Profile
over ~ 1m:
- 8 Thermistors
- 6 Thetaprobes

Cooling near the slinky due to heat extraction... how will this affect the water and heat transfer and hence the performance of GCHP...



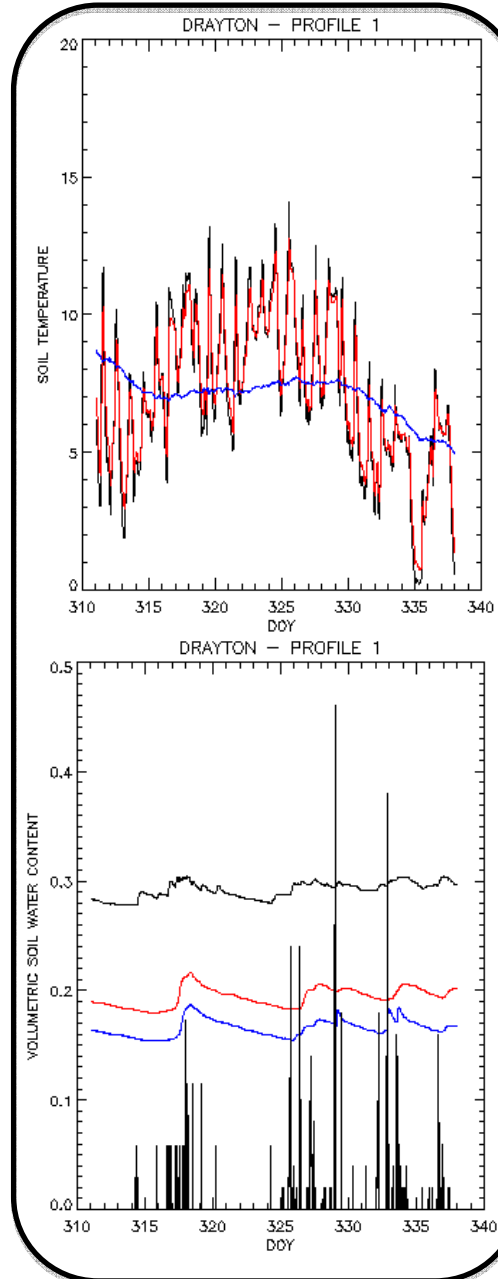
4 trenches every 5 m

2 Profiles:

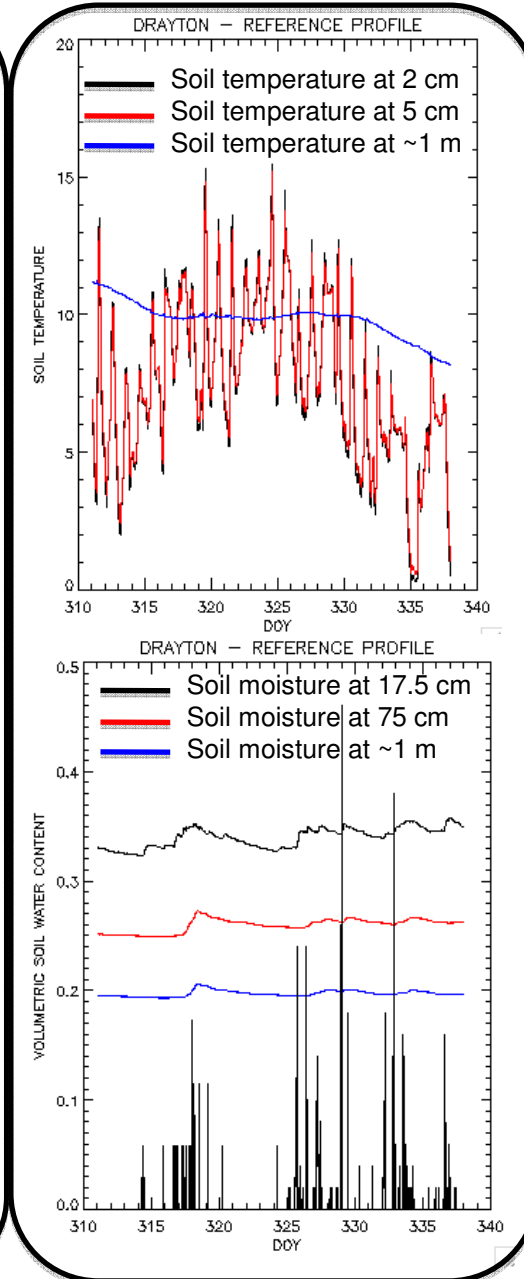
- GSHP profile
- Reference profile



GCHP PROFILE



REFERENCE PROFILE



Conclusions

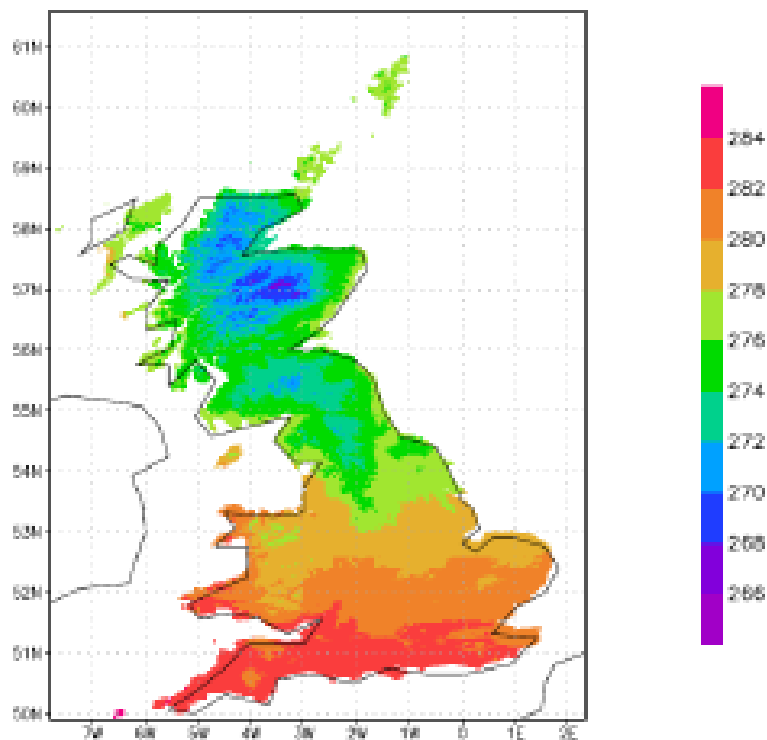
GROMIT is an excellent opportunity to address many unexplored issues related to horizontal GCHP performance in the UK

- Any questions/suggestions?
- Do you have a field-site available???

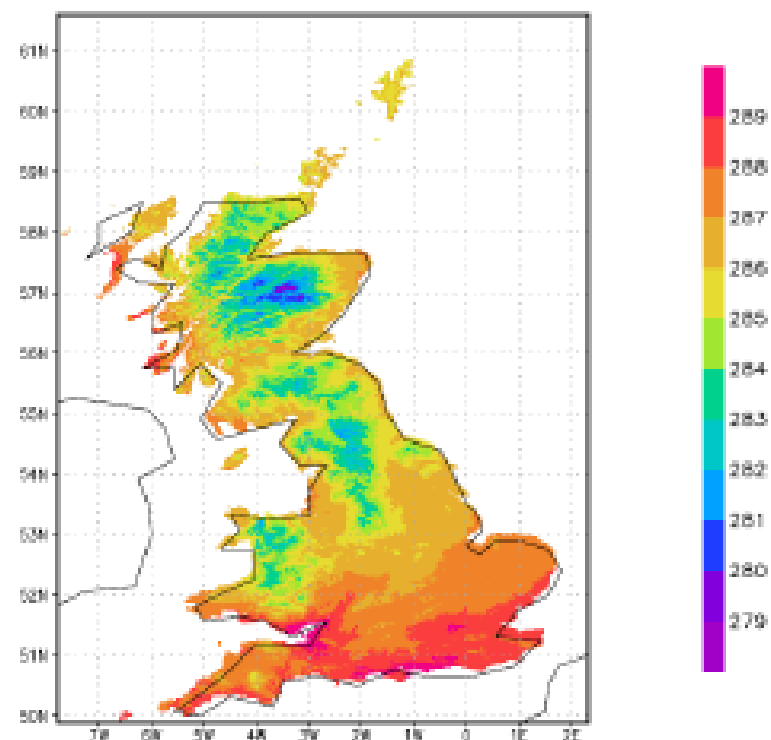
Thank you for listening!

UK driving variables

Surface temperature, 1 January 2003



Surface temperature, 1 July 2003



Courtesy: Tongfei Zhang, CEH-Wallingford