SOFOG3D – UK Met Office update on UM model comparison with observations

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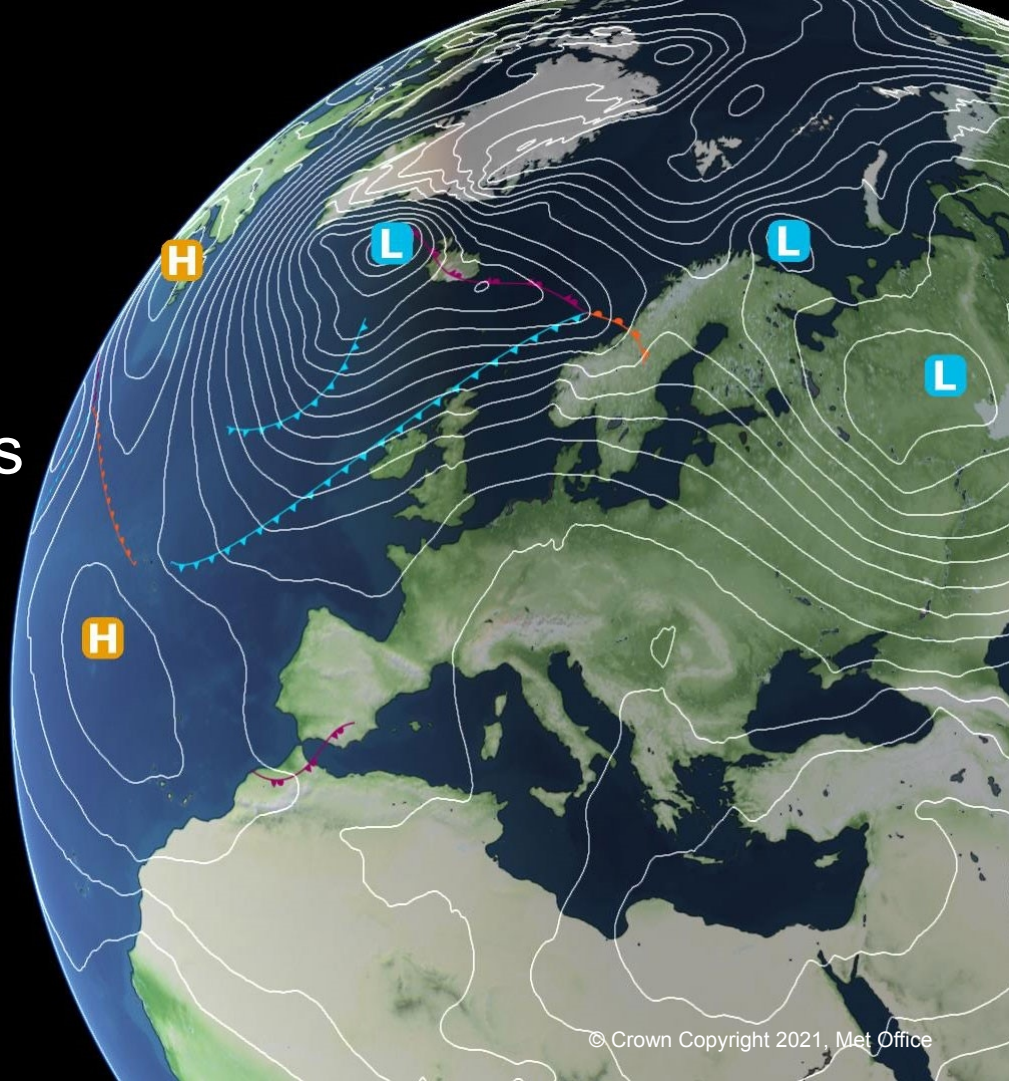
30th March 2021



Outline

(1) Comparison of observations and model runs at various resolutions

(2) Selection of case studies

(3) Case study pt1 – 2019-12-05 and 2019-10-29
    (i) VERA – an alternative visibility scheme

(4) Case study pt2 – 2020-02-08 – Stratus Fog

(5) Recurring temperature discrepancies between observations and model

(6) Conclusions and Further work

Initial Model runs

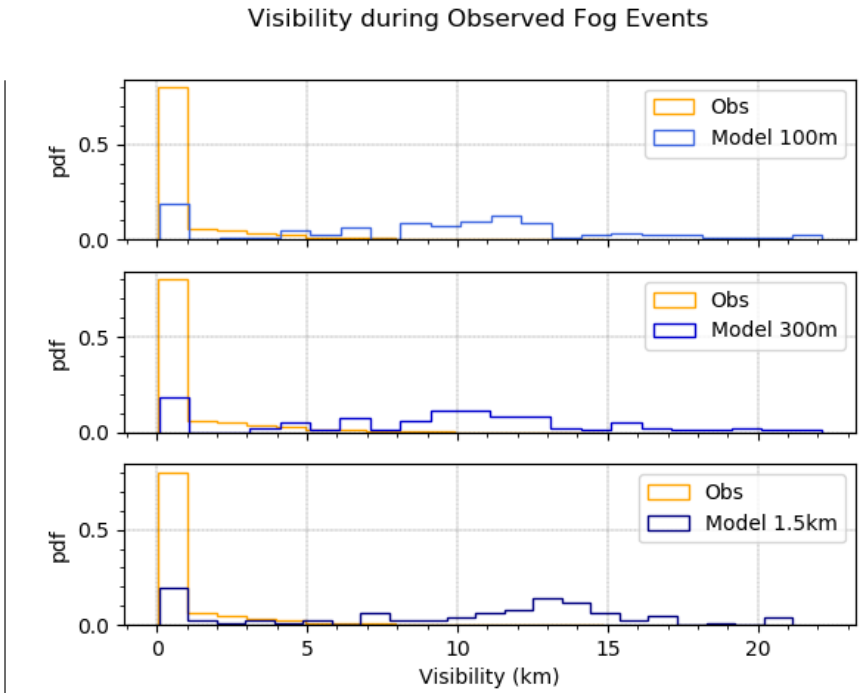
- UM deterministic model ran @ 100m, 300m, and 1.5km resolutions
- Initially on 70 model levels
- Level 1 corresponds to 5m
- Additional outputs at 1.5m, i.e. visibility, temperature, RH
- Run from 1200UTC on day x until 2300UTC on x+1
- Model run at each resolution for 20 different dates

Model Resolution

From the 20 dates, periods of observed fog were identified (on 11 dates), i.e. visibility dropped below 1km in the observations.

Visibility during these fog events was plotted as a PDF for the observations (orange), 100m, 300m, and 1.5km model resolution, respectively (blue).

No significant difference in fog prediction between the model resolutions.



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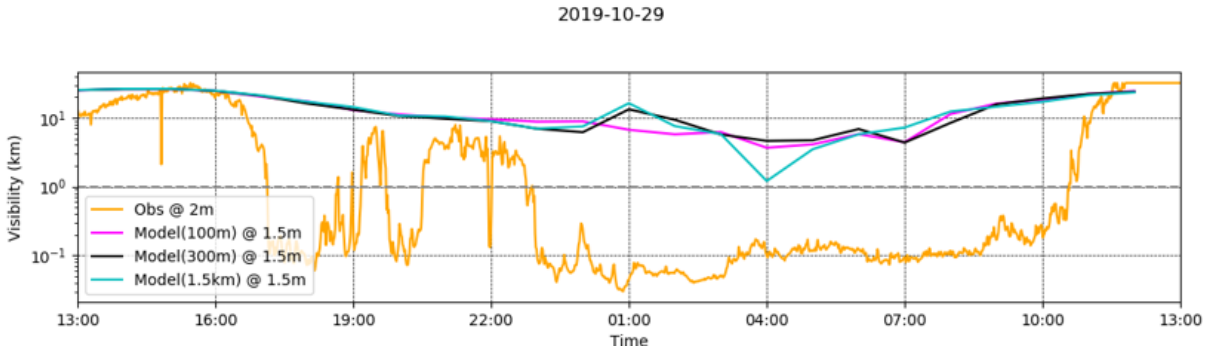
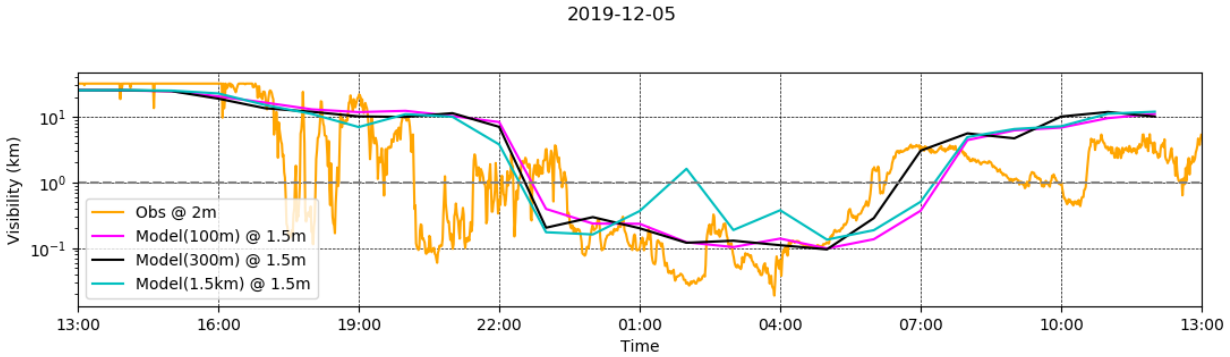
Case Study Selection

- **29th to 30th October 2019** (persistent fog in obs, no fog in model)
- **5th to 6th December 2019** (persistent fog in obs and model)
- **5th to 6th January 2020** (IOP 6 – persistent fog in obs)
- **11th to 12th January 2020** ('null' case in obs)
- **8th to 9th February 2020** (IOP 11; stratus fog in obs and model; and IOP 11)
- **7th to 8th March 2020** (IOP 14; fog in obs)
- **A date where fog was indicated by model but was not observed** – so far unable to identify a case like this

Case studies 2019-10-29 & 2019-12-05





- In both cases shallow fog was initially observed over the site – this had transformed into deep adiabatic fog by the early hours.
- However deterministic model only forecast fog during the 2019-12-05 case (and not until hours after fog was initially observed)

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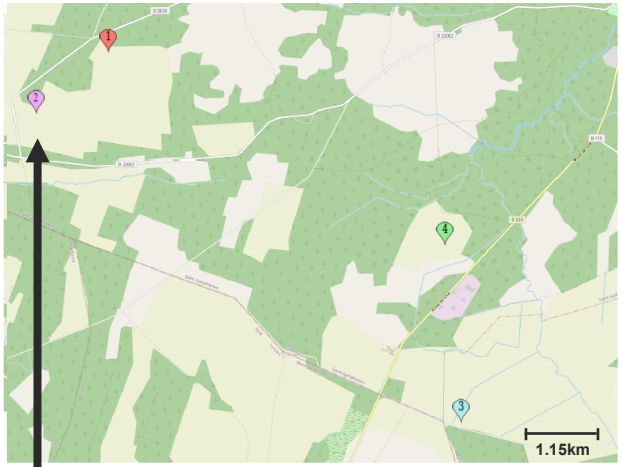
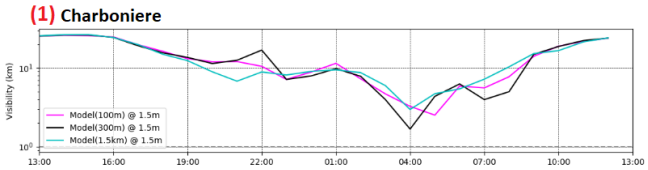
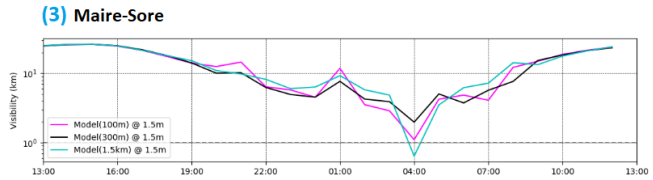
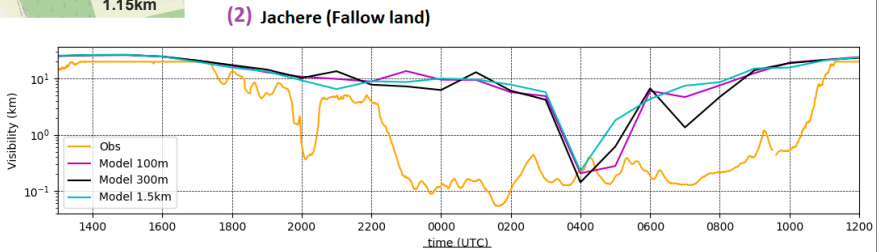
Case study 2019-10-29



Some fog forecast in more ‘open’ area – but still not enough

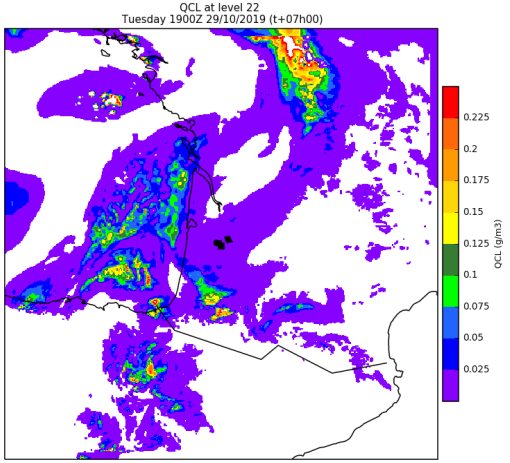


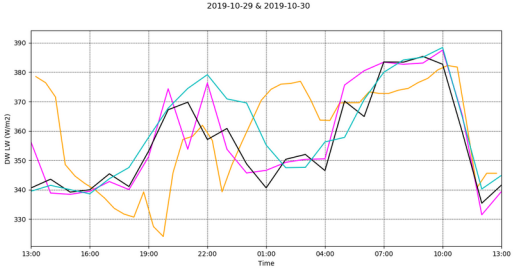




Why didn’t fog form on the 2019-10-29?

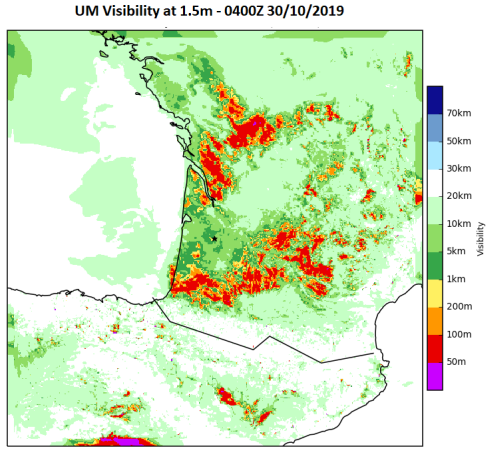
Too much cloud between 1.5km and 2.5km altitude?

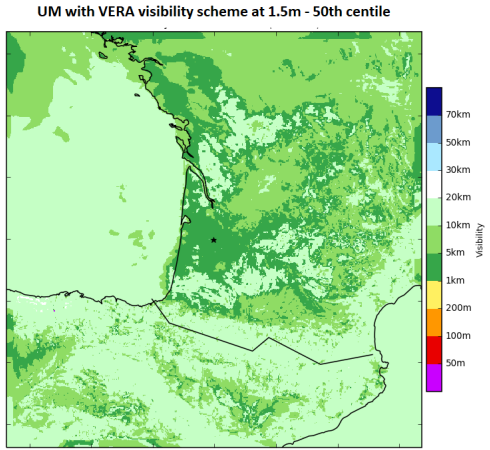


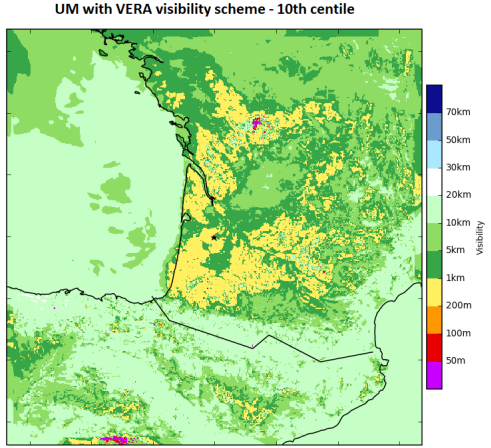


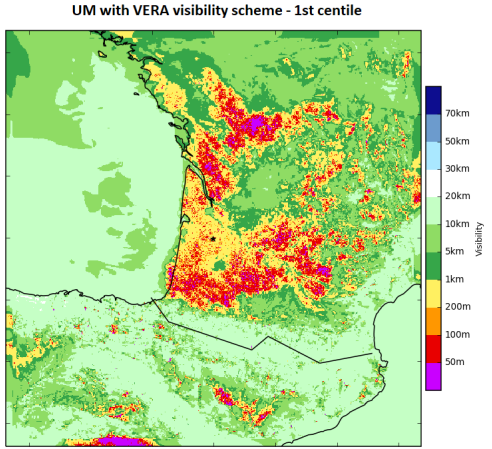
Case study 2019-10-29

- VERA – an additional visibility estimate
- **UM visibility** diagnostic scheme uses **monodisperse aerosol** (set size, number concentration, hygroscopy) - either all or none of the aerosol particles are activated into water droplets.
- **VERA** uses **polydisperse aerosol** particles (log-normal size distribution and triangular hygroscopy distribution)
- Synthetic noise added to VERA to generate a set of possible visibilities…
- Outputs: probabilities of vis below specific thresholds, and centiles of these.

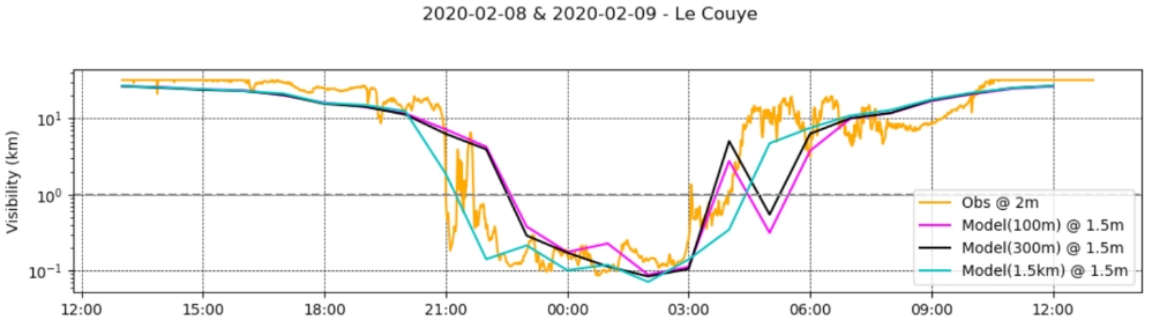


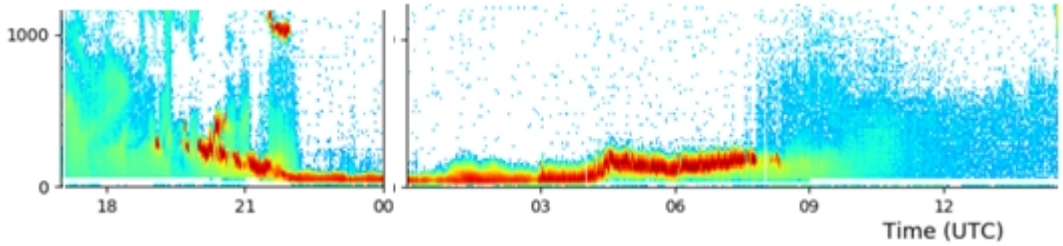




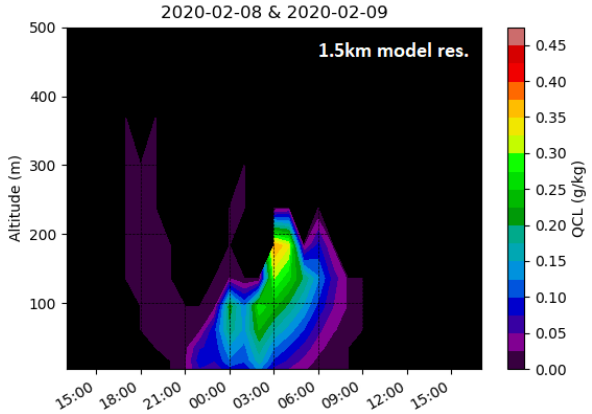


Case study 2020-02-08 – Stratus Fog





- Lidar and 1.5km model QCL both show a layer coming down from 300/350m and reaching the surface at around 2200UTC.
- The stratus fog then lifts off between 0400UTC and 0500UTC.
- 100m & 300m resolutions ‘shifted’ by an hour.



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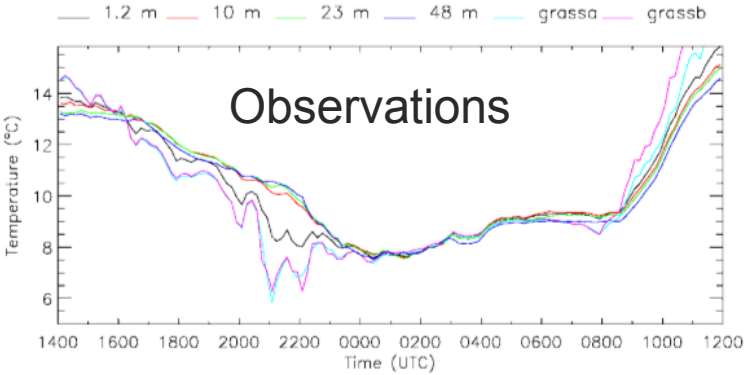
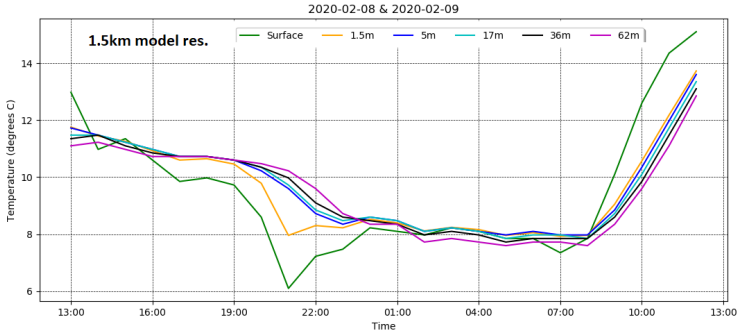
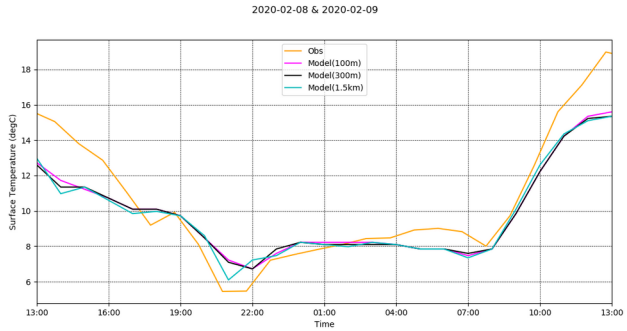
Case study 2020-02-08 – Stratus Fog

Both model and obs showed an adiabatic profile by midnight

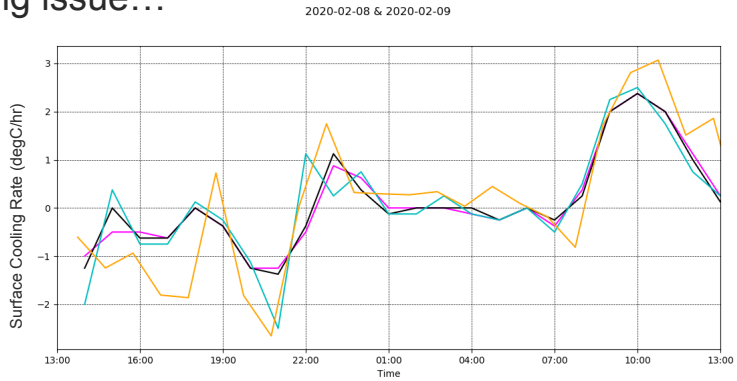




And minimum surface temps around the same for model and obs – and mirror each other fairly well after 1800.



But cooling before this time isn't as pronounced in model…. This is a recurring issue…



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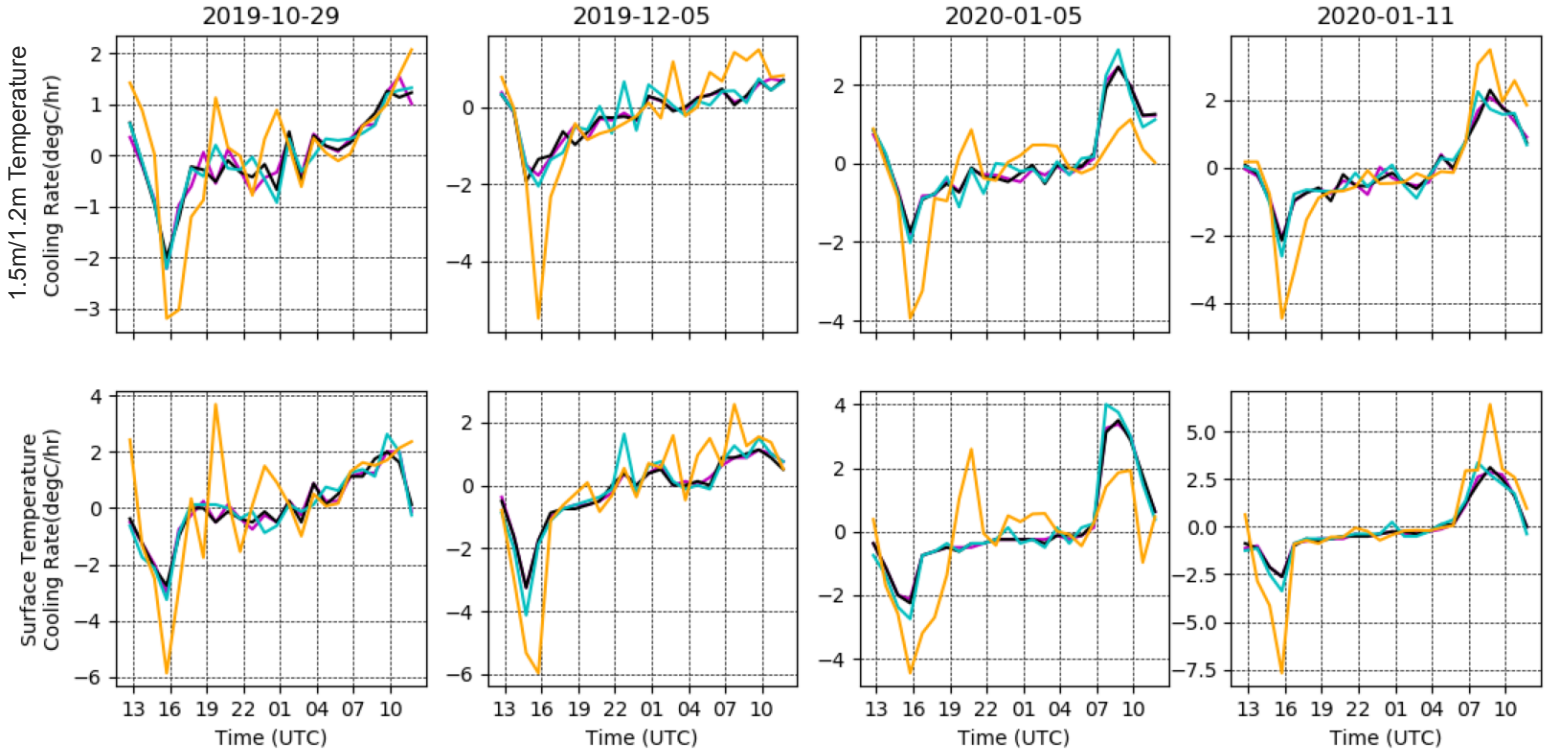
Cooling Discrepancies

- Recurring issue – not as much cooling in the late afternoon/early evening in the model – at both the surface and 1.5m/1.2m temp.



Could these be affecting the initial onset of fog?

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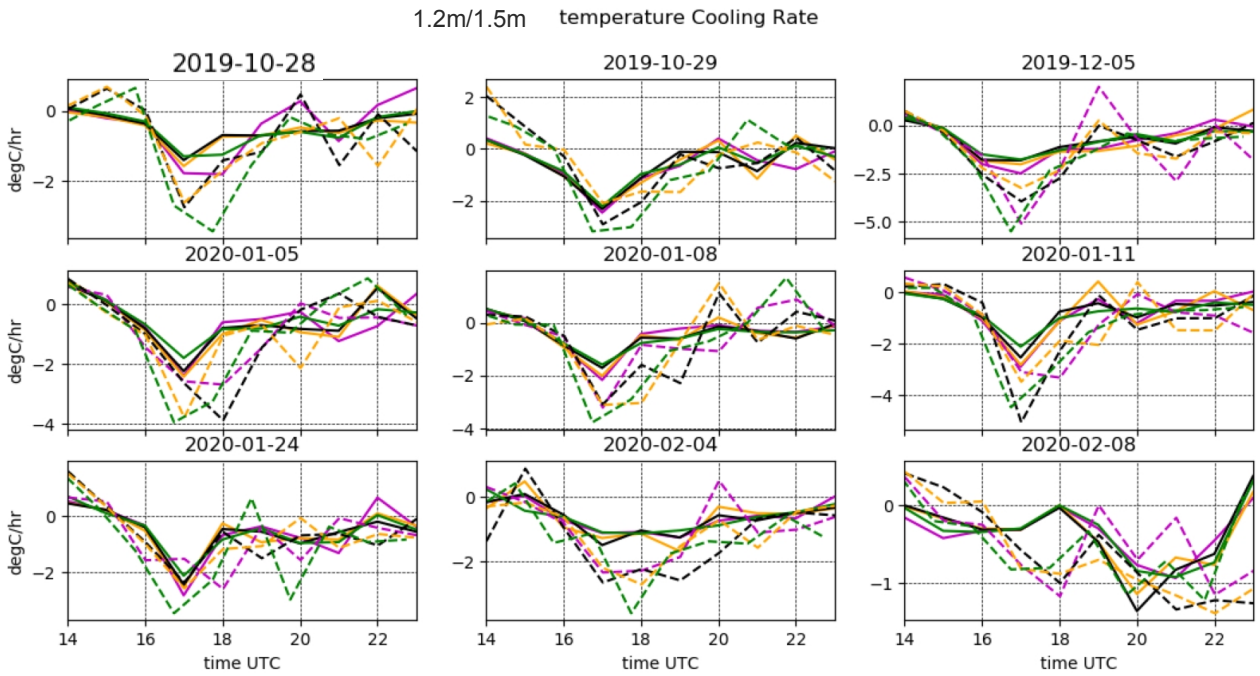
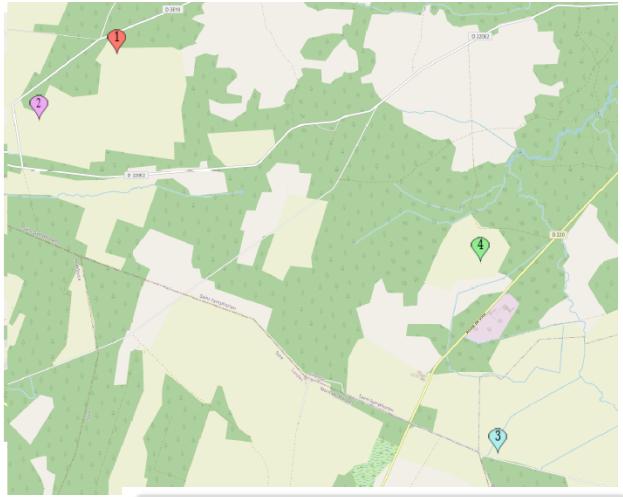
Cooling Discrepancies

- Continues to be an issue at sites which are less sheltered – and for many dates

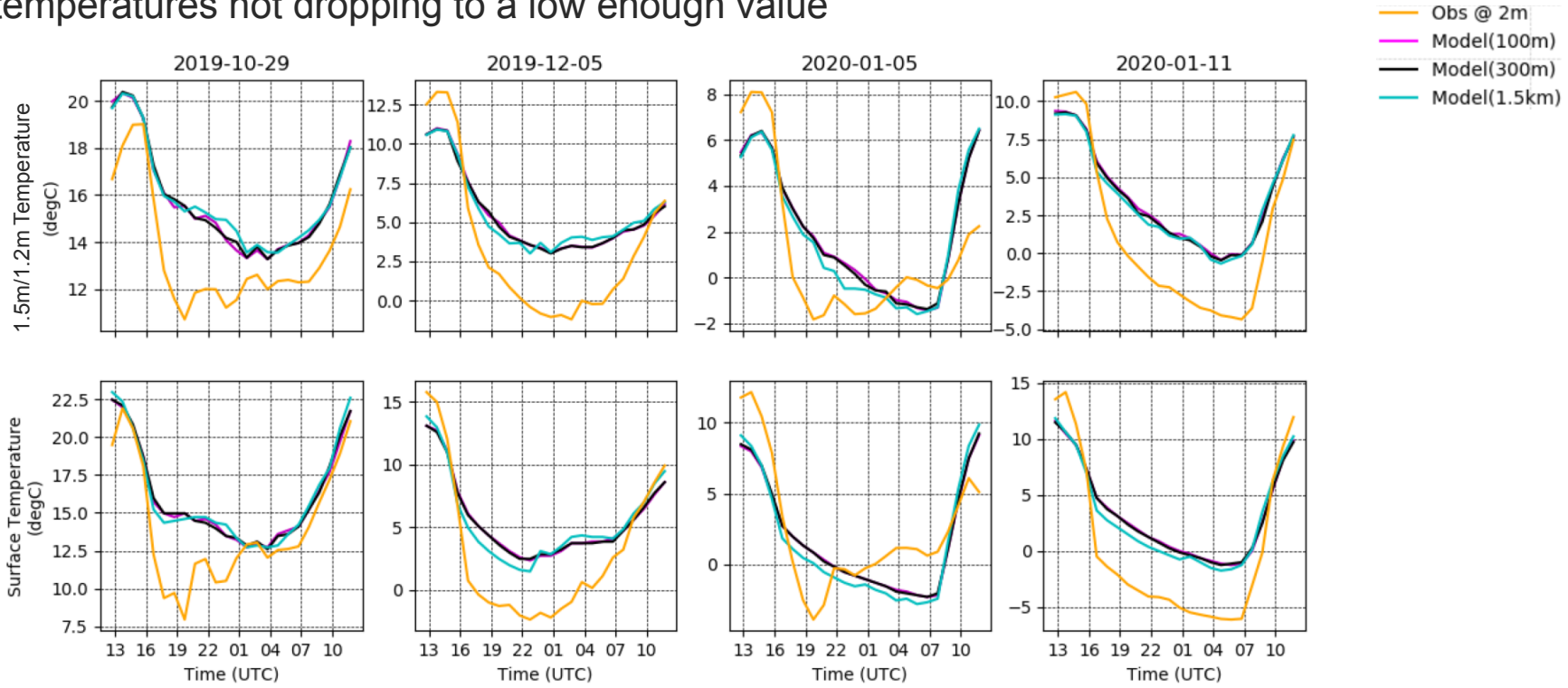




(1) Charbonniere
(2) Jachere
(3) Maire-Sore
(4) Le Couye
Model (100m res.)
Obs

Temperature Discrepancies

… additionally…discrepancy in both surface temperatures and 1.5m/1.2m temperature due to model temperatures not dropping to a low enough value



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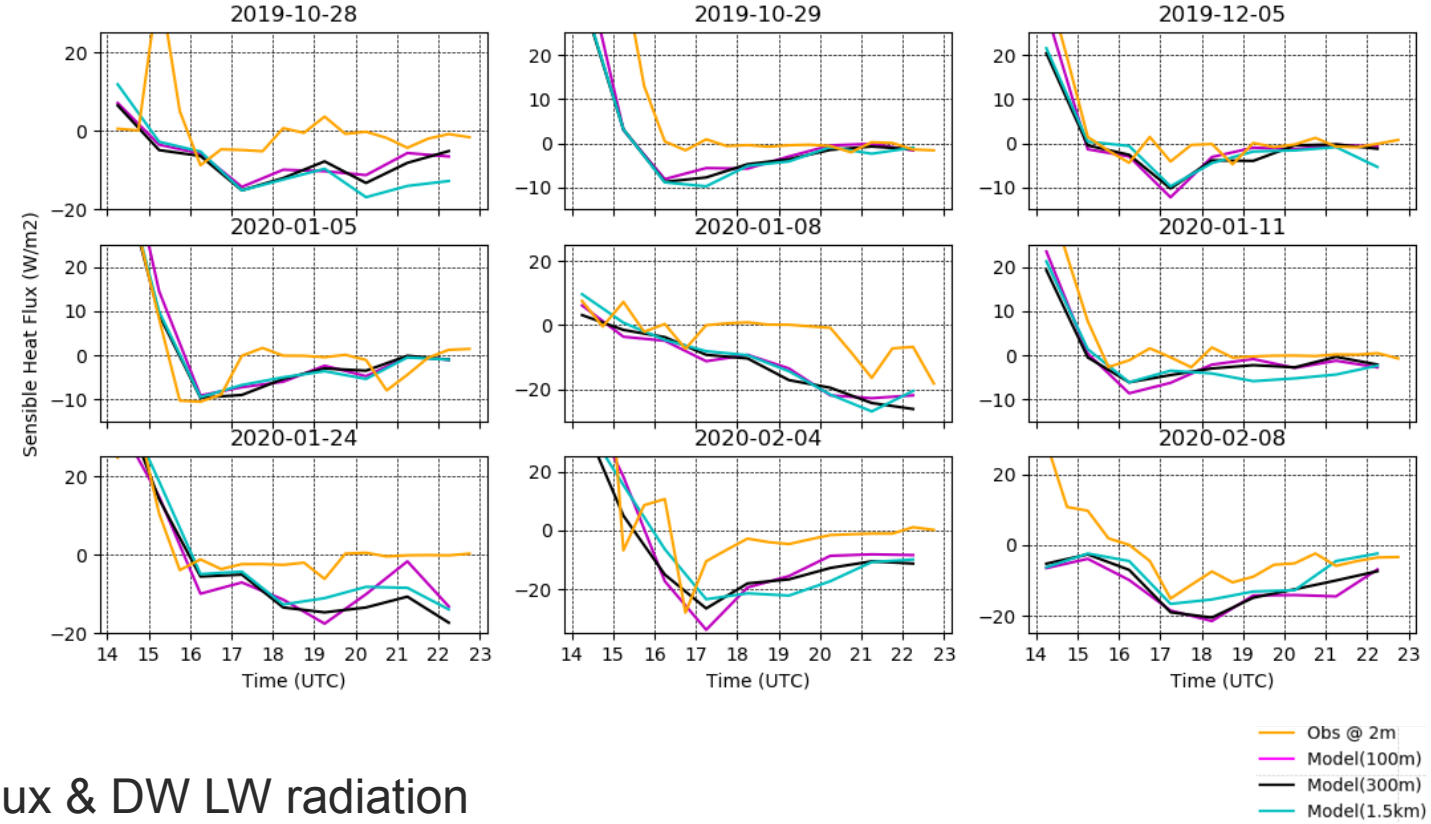
Temperature Discrepancies – Sensible Heat

Sensible Heat flux at surface – model values tending towards more negative values during late afternoon/early evening….

More sensible heat towards surface in model



To do… Soil heat flux & DW LW radiation

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Conclusions and Future Work

- Model tends to under-predict fog events
- But doesn't appear to be creating fog where it hasn't been observed
- No significant difference between model resolutions
- Model doesn't cool enough in the late afternoon/early evening - and temperatures don't drop low enough

- Further investigation into temperature bias
- Use data from other field sites
- Look at model data where levels have been doubled to 140
- And look at model data where a bi-modal cloud scheme has been implemented
- Repeat visibility pdf at different model resolutions using LANFEX data and compare to SOFOG plots – does the orography have an impact?

Any Questions?