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

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(1) Overview of model setup and methodology

(2) Categorized list of case studies
   - focusing in this presentation mainly on radiation fog cases
   - but we do also have stratus fog cases and null cases

(3) Sensitivity tests
   • Output from different model configurations
   • Effect of changing setup parameters

(4) VERA output – a different visibility scheme

(5) Conclusions and Further work
Methodology
comparisons and tests

• We use measurements primarily from **Le Couye**
  • Plus some comparisons with the nearby (slightly more open) **Jachere** site
• We categorize periods as: radiation fog/no fog/stratus fog
• We evaluate the standard model against these measurements for visibility and other relevant parameters
• We test sensitivity to various existing model options, including cloud, aerosol and surface options
• We also compare with a new stochastic diagnostic visibility scheme (VERA)
Overview of model setup

- UM deterministic model ran initially @ 100m, 300m, and 1.5km resolutions
- Previous presentation discussed these runs [UKMO model vs obs 20210330](#)
- Only results from 1.5km horizontal resolution shown in this presentation

- Vertical grid: standard 70 model levels
  - Level 1 corresponds to 5m
  - Additional diagnostic outputs at 1.5m: visibility, temperature, RH

- Run (for selected dates) from 1200UTC on day x until 2300UTC on x+1
Categorization of different types of events

Observed stratus fog events

• 5th to 6th January 2020
• 8th to 9th February 2020
• 7th to 8th March 2020

Null case (no observed fog)

• 11th to 12th January 2020

Observed radiation fog events

• 28th to 29th October 2019
• 29th to 30th October 2019
• 31st October to 1st November 2019
• 5th to 6th December 2019
• 4th to 5th January 2020
• 8th to 9th January 2020
Sensitivity test one – using different model configurations

1. Current operational configuration
2. Same as 1 but using a bimodal-cloud scheme
3. Same as 2 but using a double-moment microphysics scheme (CASIM)
4. Same as 3 but changing the aerosol climatology (aerosol more interactive)

Links to further info given on final slide
Output from different model configurations

- More fog when bi-modal cloud scheme and CASIM are used
- Stratus fog better predicted than radiation fog
- Fog formed during 'null' case
Screen-level temperatures drop lower when CASIM and bi-modal cloud schemes are used, probably due to less cloud.

Screen temperatures generally too high during radiation fog cases...

...but not necessarily in Stratus fog.
Additionally... wind speed and WW generally too high

Model wind speed and WW closest to observations on 2019-10-29 and 2019-12-05 – fog also predicted for these dates

Output from different model configurations
Sensitivity test two – changing set-up parameters

**Aim:** Reduce skin and near-surface temperatures

**How:** Effectively modifying bare soil fraction to limit turbulent exchange between atmosphere and surface
Effect of changing setup parameters

Result of change in set-up – Le Couye

(2) Temp reductions

(3) More fog formed
However temperatures more comparable at Jachere – Jachere temperature reductions up to double those at Le Couye

But model temperatures still generally too high at Le Couye

Le Couye – after change in set-up

Jachere – after change in set-up

Warmer at Le Couye – due to model averaging over the grid box whereas obs are local?
Effect of changing setup parameters with reduction in screen-level temperature, model now formed fog during each radiation fog case at Jachere.
Very briefly.... VERA is a new visibility scheme (B Claxton)

- VERA uses polydisperse aerosol particles (lognormal 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.
Conclusions from these comparisons

• Met Office UM has been run using more sophisticated visibility, cloud, and microphysics schemes as tests

• Standard model (control) tends to under-predict radiation fog events – but when a bi-modal cloud scheme and/or a double-moment microphysics scheme (CASIM) are implemented:
  • Fog is more willing to form
  • Skin and near-surface temperatures can drop lower
  • Low/mid level cloud (higher than 200m) is less persistent

• Model doesn’t cool enough in the late afternoon/early evening before an observed radiation fog event
  • Forcing a cooler surface T leads to enhanced fog formation
  • Even after this forcing, the surface temperature is still too high in the model output during evenings that were followed by observed radiation fog events at Le Couye

• Model vertical velocity variance WW looks too high (certainly at Le Couye)

Future work

• Further investigation into temperature bias based on tile temperatures rather than grid-box values.
• Investigate alternative ways to reduce skin and near-surface temperature
• More detailed look at the Stratus fog cases
Acknowledgement: Merci beaucoup to all who have been involved in the collection and provision of data at the Jachere site!

Any Questions?

Links to further information:
• Bi-modal cloud scheme I
• Bi-modal cloud scheme II
• VERA paper in progress – for VERA info contact bernie.claxton@metoffice.gov.uk

Links to model schemes jenna.thornton@metoffice.gov.uk
The fraction bare soil exposed to the atmosphere on vegetated tiles is related to the LAI as:

Here we increase $k_{ext}$ from 1 to 4 (?).

Reducing $F_{soil}$ weakens the thermal coupling between the soil and atmosphere.

Appendix – additional plots
VERA – Stratus and 'null'

Appendix – additional plots
Soil Heat Flux – ra3_p3arcl and obs only – before and after change of set-up parameter

Appendix – additional plots
Temperature Profiles – 28th to 29th October 2019 radiation fog case

Le Couye – before change in set-up

Le Couye – after change in set-up
Skin temperatures – Radiation fog cases

Le Couye – before change in set-up

Le Couye – after change in set-up

Appendix – additional plots
Temperature Profiles – 29th to 30th October 2019 radiation fog case

Le Couye – before change in set-up

Le Couye – after change in set-up
Temperature Profiles – 28th to 29th 2019 October radiation fog case

Appendix – additional plots
Temperature Profiles – 29th to 30th October 2019 radiation fog case

Jachere – before change in set-up

Jachere – after change in set-up

Appendix – additional plots
Temperature Profiles – 8th to 9th February 2020 stratus fog case

Le Couye – before change in set-up

Le Couye – after change in set-up

Appendix – additional plots
Temperature Profiles – 11th to 12th January 2020 null case

Jachere – before change in set-up

Jachere – after change in set-up

Appendix – additional plots
Appendix – additional plots

Wind Speed and Vertical Velocity Variance

Jachere – after change in set-up
Appendix – additional plots