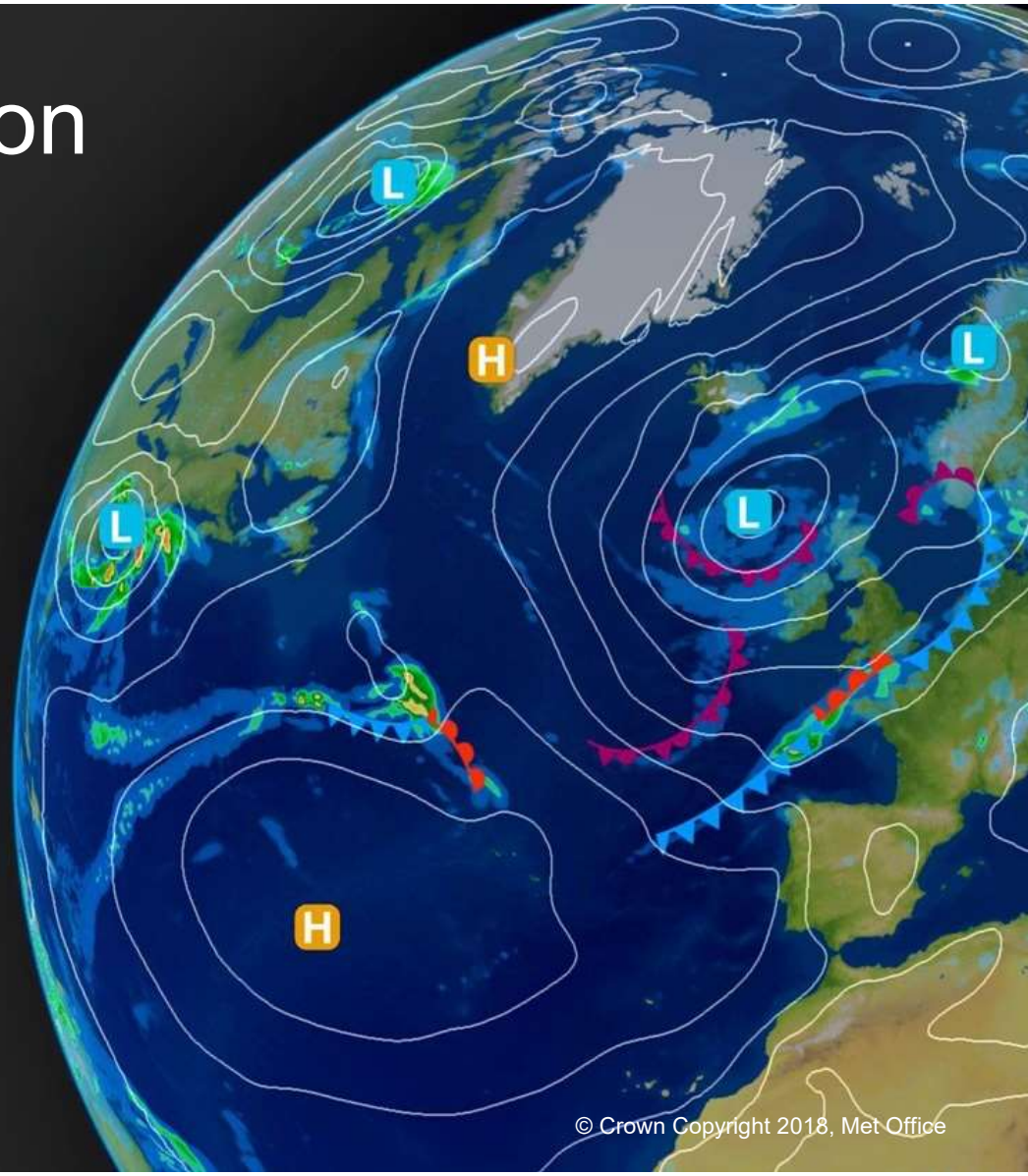
Physics Break-out session

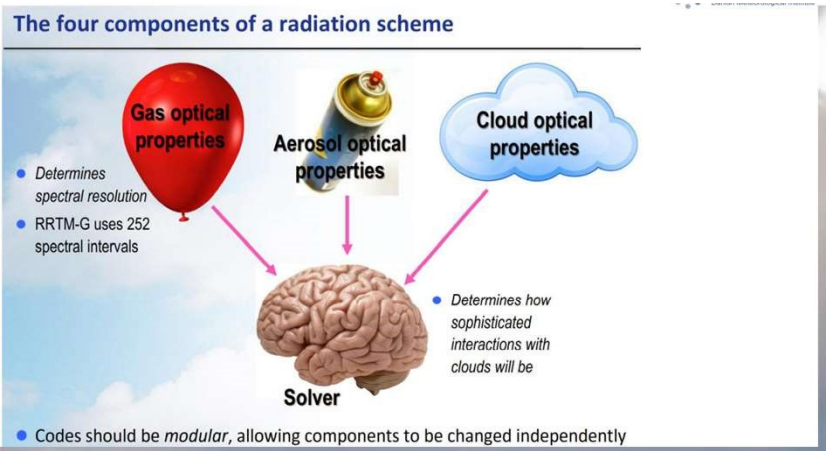
43rd EWGLAM and 28th SRNWP meeting

30th September 2021

Chaired by Mike Bush

Peter Ukkonen, Karl-Ivar Ivarsson, Jenny Bjorg Engdahl, Marvin Kähnert, Eric Bazile, Emily Gleeson, Dmitrii Mironov, Marion Mittermaier, Jeanette Onvlee, Matthias Raschendorfer, Laura Rontu, Jenn Brooke, Humphrey Lean





ESCAPE 2

A targeted machine learning approach to accelerate radiation computations

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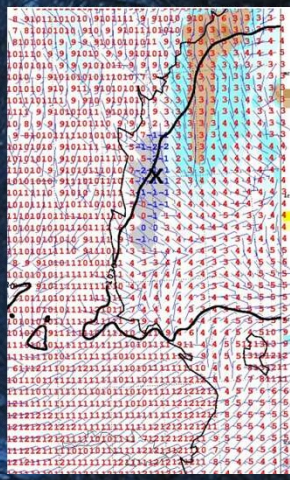
Take-home message

- Climate and weather models make poor use out of modern computer hardware
- NNs can be faster than traditional parameterizations, but focusing on less exact, more empirical components may give good results mor easily
- Refactoring existing codes could also go a long way
- We combined the two to speed up a new radiation scheme by ~3x on CPUs and GPUs, seemingly without losing accuracy
- RTE+RRTMGP-NN is designed to be a usable replacement of the original code

Microphysics and radiation improvements regarding fog and low clouds (for HARMONIE AROME)

Karl-Ivar Ivarsson and Kristian Pagh Nielsen, EWGLAM meeting September 2021



- The problems addressed here, and some ways to mitigate them.
- A typical case with too much fog over sea, and another one with too little low clouds.
- Summary

- Too much fog, especially over sea.
- In case of fog, the temperature in the fog layer is often unrealistically low.
- Under prediction of low clouds (mostly in anti-cyclone weather regimes)

Summary

- Reduction of too excessive fog can be achieved by reducing the cloud liquid number concentration, changing the size distribution in such way that the sedimentation rate increases and by improving the radiation scheme.
- Increasing low clouds can be obtained by increasing VSIGQSAT. With LHGT_QS this is possible without increasing fog. ECUME6 gives also more low clouds.

Acknowledgements: The authors wishes to thank Emily Gleeson, Sander Tijm, Bent Hansen Sass, Wim de Rooij and Sebastián Contreras Osorio, for valuable input and suggestions for the testing and development.

Improved predictions of supercooled liquid water and atmospheric icing in the HARMONIE-AROME weather prediction model

Norwegian Meteorological Institute

Bjørg Jenny Kokkvoll Engdahl

Thesis conclusions

Modified important processes

Leads to increased

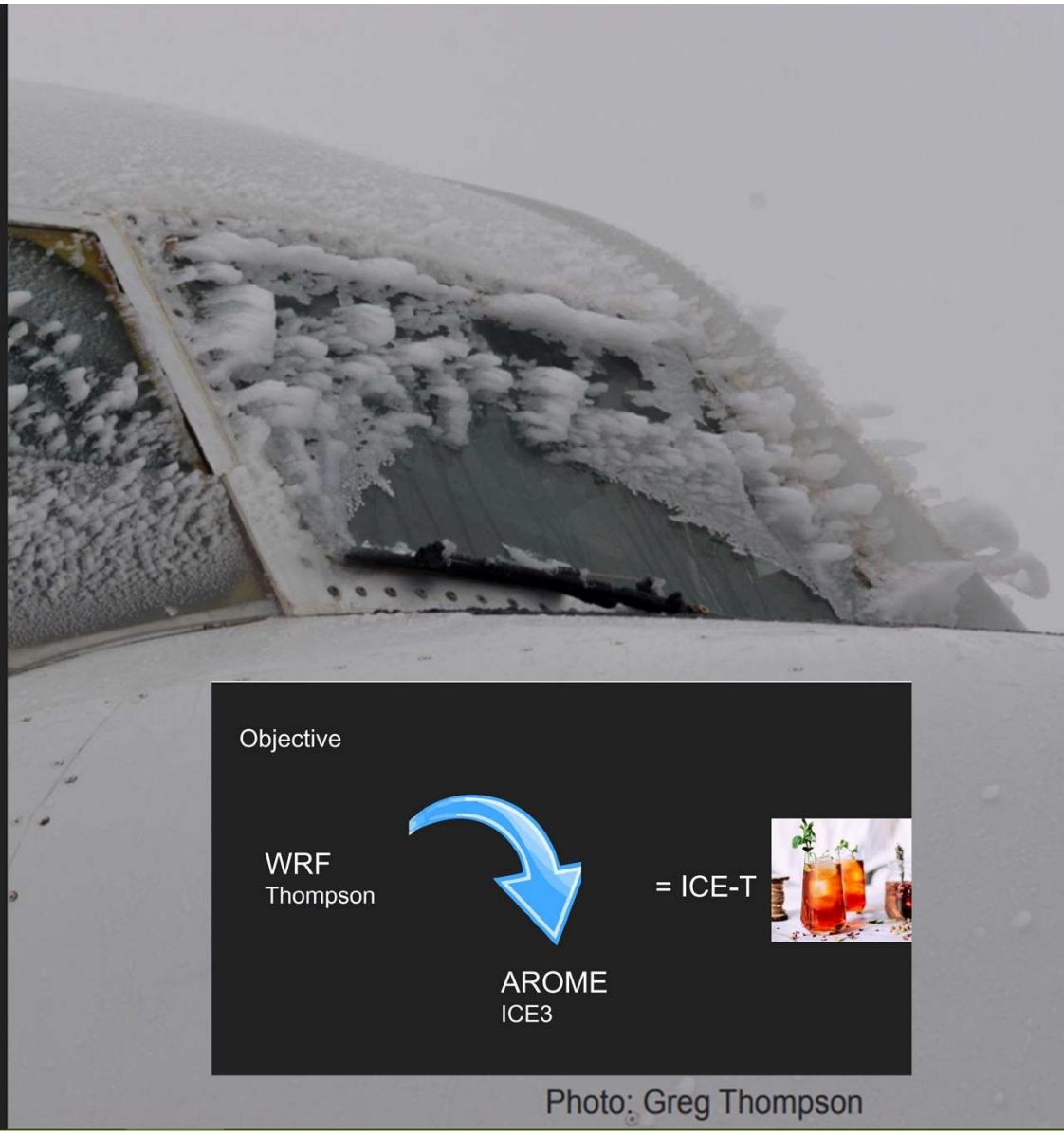
- supercooled liquid water
- ice loads
- forecasts of icing

Better match

- ice loads
- hit rates
- satellite

Supercooled liquid water could still be underestimated

Shift in precipitation pattern



Development of the nocturnal stable boundary layer in AROME-Arctic

- Marvin Kähnert (University of Bergen/Met.no)
- Sodankyla measurement site. DDH tool. Extract model data at Sodankyla and surrounding points every timestep.
- ISBA DF vs Ref
- Model cannot catch up with observed drop in model temperature. Physics or dynamics? Ref: Physics is the major player. Split the physics into radiation and turbulence. Turbulence is the major player.
- With ISBA DF this changes. Now the dynamical part is equally important with physics. Also radiation is now more important than turbulence.

Proposed discussion topics

1. **Stable boundary layer**

2. **Physics at hectometric scales**

3. Making code robust for new/mixed architectures (e.g. gpu ready)

4. The application of machine learning to physics parametrizations e.g. the options for sharing the collection of (observational) European datasets which we could all use for ML applications

5. The work on an improved European-scale physiography

6. More advanced treatments of aerosols and microphysics (e.g. use of near real time aerosols - further discussion from Laura's talk)

SBL thoughts (Dmitrii)

- (i) Clear goals should be set right away and working hypotheses should be formulated.
- (ii) Careful planning is required (what to run, which regimes to explore, etc.), and priorities should be set.
- (iii) Prioritization: It should be clearly understood from the very beginning that we do not solve all SBL-related problems.
- Data analysis should be the very first step in our initiative to get an idea of what is wrong with the SBL and which issues are most pressing.

SBL – Observational campaigns

- In general, observational data are clearly vitally important.
- MOSAIC (Arctic) https://mosaic-expedition.org/
- LIAISE (Spain) SBL work is being led by Joan Cuxart
- Significant European involvement already in LIAISE already, however with the extension of the LIAISE deployment until July 2022 there could be opportunity for new involvement?

SBL and surface heterogeneity

- For GABLS4 there is a LES intercomparison (Couvreux et al. 2020)
- Homogeneous surface ... however with heterogenous surface you increase the complexity with interaction between dynamics horizontal scales, turbulence and the surface parametrization
- The number of heterogeneity types is nearly unlimited, but we can concentrate on some types where we have at least preliminary understanding of what is going on.

Prospects for SBL collaboration

- (i) use of LES and DNS data (Sullivan and Mironov) to attempt to account for the effect of surface thermal heterogeneity on the structure and mixing properties of the SBL (enhanced mixing etc.);

- (ii) some ideas as to how to explore the effect of SGS orography on the SBL structure and transport properties.

- The above points address only some SBL-related issues.
- We have some concrete ideas which surely do not deal will all facets of a huge SBL problem but may help to initiate a targeted (small-size) cooperative effort.

Hectometric resolution

- Lack of observations for validation and also data assimilation
- Model stability. Impressive results from ACCORD/Meteo France in terms of steepness of slope (70 degrees!) the model can cope with
- Expectations of forecasters – too high!
- Start with easier variables such as wind?
- Stakeholders are often interested in variables such as fog which is hard to forecast!

Prospects for collaboration

- For the hectometric scales, what are the opportunities for larger field experiments which people can use for a joint exercise on validation of their models?
- TeamX could be a good opportunity to compare hectometric resolution
- The sharing of modelling study results and experience around the consortia is perhaps the most useful thing we can do now in terms of collaboration.

Met Office **Please get in touch if interested in collaborating!**

Wessex Summer Convection experiment (WesCon)

Steven Abel, Paul Barrett, Jeremy Price (OBR)
Humphrey Lean, Kirsty Hanley (RMED)
Tim Darlington (Obs R&D)
Alison Stirling (APP)
Thorwald Stein (University of Reading)

Observational campaign to study UK summertime convection

Observations target the pre-convective environment and the resulting convective, dynamical and cloud structures and precipitation fields

Dataset at high enough resolution and over sufficient spatial scale to challenge O(100m) and O(1km) grid-spacing convection permitting models and scale aware convection parameterisations.