Guest editorial by

Welcome to the latest addition of the UM newsletter. I hope that you find it informative and useful.
As some people will be aware, I will be moving to be Director of Research at ECMWF in the summer. This has probably put me in reflective mood - and, in that vein, this newsletter really brought home just how far the UM partnership has come, with an ever increasing list of projects, meetings and activities that allow us all to achieve more together than we could possibly do on our own. In the coming years I can only see both the opportunities and need for co-ordinating efforts across institutions and countries growing, as the scientific and technical challenges get ever more complex at the same time as the societal need for improved weather and climate information increases. Hence I wish the partnership every success for the future, and confidently predict that it will go from strength to strength.

— Andy Brown - Director of Science, Met Office

Event Announcements

- **Global Model Evaluation & Development Workshop , Wellington, New Zealand 21-23 February 2017:**

Global model prediction across weather, seasonal/decadal and climate timescales is at the heart of weather and climate services delivered from the Met Office and partners in the UM Partnership. To accelerate progress in global modelling there is a requirement to (i) Identify and understand the sources of key model systematic errors across timescales that currently limit predictability, and (ii) accelerate pull through of underpinning global model developments in resolution, dynamics and physical parametrisations. With the increasing complexity/resolution of global models it is more important than ever that the UM community work together efficiently to address challenges and exploit the opportunities in the next 10 years (e.g Exascale HPC architectures (GungHo & LFRIC), improving tropical performance through improved convective parametrisations, research on sub-10km prediction (grey-zone) and realising the benefits of coupling the oceans and atmosphere on NWP timescales). Building on the existing GMED processes this workshop will explore the development of a refreshed joint programme of global physical model development & evaluation to exploit new opportunities and address key model performance issues through optimal use of resources and skills available across the UM partnership.

More information on this can be found at the Global modelling science workshop Trac Wiki page

— Sean Milton, Met Office

- **UM User Tutorial (UMUT) 2017:**

  The date of the 9^{th} UMUT has been set and will take place 5-9 June 2017 at the Met Office in Exeter. As in previous years this is a week long event with a mixture of practical and presentation sessions. The Tutorial is aimed at experienced numerical model users wishing to run the UM suite operationally as well as research scientists with a good understanding of numerical modelling who wish to use the UM suite for research. Keep this date in mind if you wish to attend. Further information will be disclosed closer to the event. If you are interested in participating in this event please contact the UM_collaboration@metoffice.gov.uk including your name, organisation and area of interest from the proposed topics, by the 31^{st} of March 2017:

  - Global Climate configurations of the UM;
  - UM physics and parameterisations;
  - User Interfaces for OPS and VAR (data assimilation);
  - Global NWP configurations of the UM and case studies;
  - UM Downscaling and Nested suites;
  - Land surface model - JULES
  - Ancilary data
  - Verification - Ver and VerPy
  - Data analysis and visualisation using Python - Iris

- **2^{nd} Convective Scale Modelling workshop, 12-14 June 2017:**

  A convective scale modelling workshop will precede the UM User workshop in June, following up the work initiated in the first convective scale modelling workshop in Singapore February 2016. It will be held at the Met Office, Exeter. Participation at the convective scale modelling workshop will be by invitation, but please contact Mike Bush if you would like to participate.

- **UM User Workshop, 14-16 June 2017:**

  The 11^{th} UM user workshop will take place 14-16 June 2017 at the Met Office, Exeter, and is open to all users of the UM. The programme will include sessions around Technical Infrastructure, global model Process Evaluation Groups and land surface modelling and DA. A registration form for the workshop will be available on the Workshop TWiki.

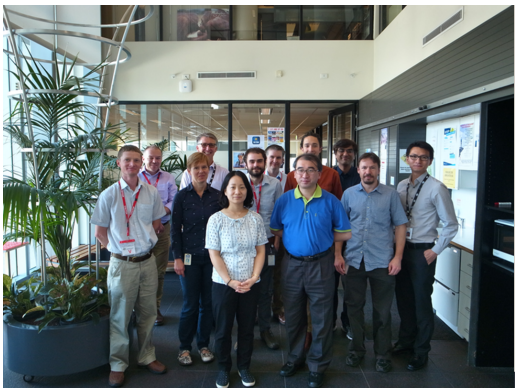
Other Events and Visits

- **UM Partnerships Regional Reanalysis Workshop 2016:**

An inaugural two-day Regional Reanalysis Workshop was held at the Australian Bureau of Meteorology in Melbourne between the 1^{st} and 2^{nd} December 2016. Funded by the UM Partnership Fund, the aims of the workshop were to:

- discuss relevant activities by Partners;
- agree priorities for work that will advance reanalysis capabilities;
- agree methods of working across Partners to optimize our collaboration in this area

The workshop was attended by representatives from the Australian Bureau of Meteorology, Korean Meteorological Administration and the New Zealand National Institute of Water and Atmospheric Research. Scientists from the Indian National Centre for Medium Range Weather Forecasting also joined sessions by videoconference. Each of these institutes is planning or has already started running a reanalysis for their own region.
Various aspects in undertaking reanalyses were discussed including improving the portability of standard Rose suites, sharing common tools to post-process and visualise reanalysis products and considerations in the use of observational data and reanalyses verification. The workshop was also an opportunity to build links and to share experiences and motivation for the reanalyses.



Full details of the workshop programme be found in the Workshop TWiki page. The presentations are now available on the CAWCR Annual Workshop 2016 website.

— Keir Bovis, Richard Renshaw and Peter Jermey, Met Office

- **International Workshop on Seasonal Forecasting for UM Partnership:**

The "International Workshop on Seasonal Forecasting for UM Partnership" was held in Jeju, Republic of Korea on 11-13 October 2016. The workshop was followed by a Steering Committee Meeting for the Joint Operational Seasonal Forecast System.

The Joint Operational Seasonal Forecast System is a collaboration between the Met Office, the Korean Meteorological Administration and the Australian Bureau of Meteorology which aims to jointly develop and run the Met Office's operational seasonal forecast system (GloSea5) in each centre; and to share the operational output in real-time to improve forecast quality.

At the workshop there were also representatives from Korean academia, China Meteorological Administration and the National Centre for Medium Range Weather Forecasting (India).

The workshop was opened by Professor Cho, Director-general of NIMS. There were sessions on the current status of each centre, initialisation, sub-seasonal and seasonal prediction. The talks showed the great breadth of research occurring in the UM partnership and in Korean academia.

There was also a breakout session for group discussions. Three groups were formed covering: technical, initialisation and model performance issues. Each group was challenged to raise issues with the current seasonal forecast system and suggest potential improvements or experiments. These recommendations were used in the Steering Committee Meeting to set priorities for the next year of the collaboration.

The Steering Committee selected 4 priorities for the next year: improve the initialisation of the land surface in the operational system; improve the organisation and sharing of datasets; increase the interaction with the

coupled model development process; and collaborate on KMA led attribution experiments for summer 2016.

The workshop was a huge success and the Steering Committee has agreed to repeat the workshop in the future.

— Craig MacLachlan, Met Office and Hyun-Suk Kang, KMA

- **UM Training at KMA:**

Funded through the Unified Model Partnership, two Met Office scientists visited KMA to provide user training. The training sessions were held at KMA in Seoul from the 28^{th} to the 30^{th} of September 2016 and at the National Institute of Meteorological Sciences in Jeju from the 4^{th} to 6^{th} of October.

The training contents focused on the UM, Rose, Cylc, and data analysis using Python and Iris. The sessions consisted mostly of hands-on exercises, using a simple example suite with the global model. Exercises using the UM nesting suite were particularly interesting and well received by the participants, particularly at the National Institute as the approach of Typhoon Chaba made for a particularly exciting and useful exercise. The set up of the nesting suite to predict the typhoon's approach to Jeju Island in real-time proved to be one of the most fascinating parts of the week.

Many of KMA staff understood the importance of the infra-structure and basic knowledge about Rose and Cylc. The carefully designed sessions based on experience of the UM Partnership team, were extremely helpful for the understanding of the course contents and provided interesting exercises.

KMA infra-structure team provided a pre-training course using on-line material, which was helpful in making the training even more effective.

This Unified Model Partnership training visit was very good and had very satisfactory comments from the attendees. I'd like to close this with one of the attendee's review: "I can use Rose/Cylc more conveniently, and also visualize easily with Iris after the training course". Finally, I thank to João Teixeira and Bjeorn Fock for their efforts.

— Yoonjae Kim , KMA

- **UM Training at NCMRWF:**

A training workshop on UM and its infrastructure was conducted at NCMRWF during September 5^{th} to 9^{th}, 2016 for 60 scientists from NCMRWF.

The course was led by João Teixeira and Bjeorn Fock from the Met Office with support from the UM partnership and by Raghavendra Sreevathsa, Jayakumar and Ankur Gupta from NCMRWF. The course focused on running UM suites, introduction to STASH and nested suites, post processing and visualization with Iris and python and advanced topics on suite writing.

The workshop also focussed on best working practices.

This training resulted in 32 NCMRWF scientists being given access to the Met Office Shared Repository Service.

— Raghavendra Sreevathsa, NCMRWF

UM, Parallel Suite and Technical Infrastructure News

- **Access to MASS from JASMIN reaches 150 registered users**

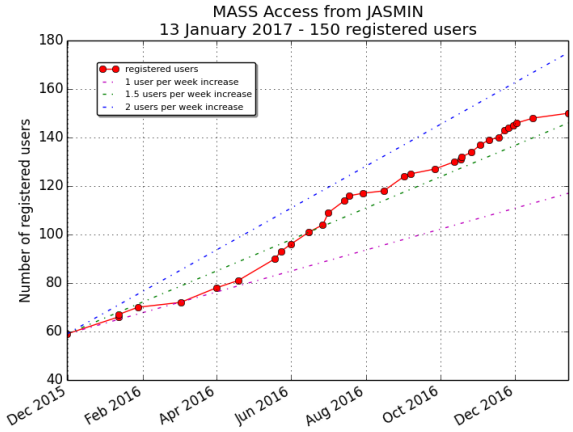
Since launching in the autumn of 2014 there has been a gradual but sustained take up of the external access to MASS service, and earlier this month we registered our 150^{th} user.

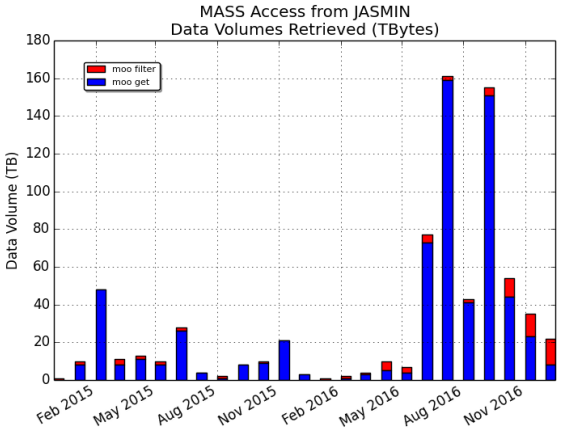
The service gives scientists on the JASMIN system (run by STFC and hosted at the Rutherford Appleton Laboratory) read-only access to the Met Office MASS archive. By allowing external users to help themselves to the actual data they want, when they need it, Met Office scientists are either freed from copying large datasets to their research partners, or able to access their own data and utilise the computational resources available to them on JASMIN more effectively.

We are typically adding access for one and a half to two users every week.

The volumes of data transferred are also increasing, with peaks and troughs being associated with different project activities, we can see that the total data volume we are sharing with our collaborators is growing . The graph below shows the split between straight-forward whole-file retrievals from MASS ("get" in MOOSE parlance) and retrievals in which server-side thinning of the data takes place prior to transfer ("filter" or "atomic access"). This equates to a substantial saving in the purchase of USB disks and scientists' time being spent copying data.

With the increasing volume of data being transferred, we need to keep a close eye on the utilisation of our dedicated private Met Office - JASMIN network link. Currently it is a 1 Gbps link provided by JANET, and





is the same size as the main connection for the whole of the rest of the Met Office to the internet. We're now exporting almost 1TB per day.

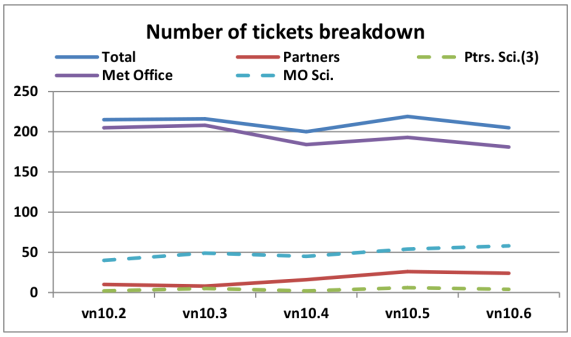
For information on how to get access visit the instructions page on how to apply for a Met Office MASS account.

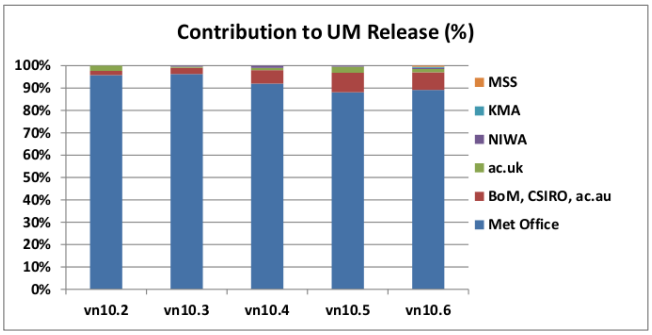
— Roger Milton, Met Office

- **UM version 10.6 (Quick Quarajel) has now been released**

UM10.6 is the 7^{th} stable release of the UM on the shared repository. This release has been dominated by three themes: OpenMP tickets updating UM routines, a large number of new diagnostics, many required required for future CMIP6 runs and a good sprinkling of science functionality advances. Many of these tickets have been delivered by the external UM community. Please note, as forewarned in the UM10.5 release notes, new dynamics has now been retired.

The release of this version included 24 contributions from UM Partners, with BoM, NCI and CSIRO owning two thirds. This constitutes a doubling of partner contributions when compared to earlier (10.2) releases.





For a complete list of what makes part of this UM release please refer to the UM10.6 release notes on the Met Office Shared Repository Services.

- **Met Office's PS38 is now live**

The Met Office upgraded the global and UK model to OS38 on 08 Nov 2016, these are described at the Met Office news pages for global model improvements and upgrades to the high resolution UK models respectively. The extended forecast range for the UK model implied a change in global model output, which will enable us to provide hourly boundary conditions up to T+120 on the 00Z and 12Z cycles.

A refined horizontal resolution of Met Office's global model is planned for PS39. Further information on PS39 is available from nwpscience pages.

- **NCAS analysis and visualisation tools: cf-python and cf-plot**

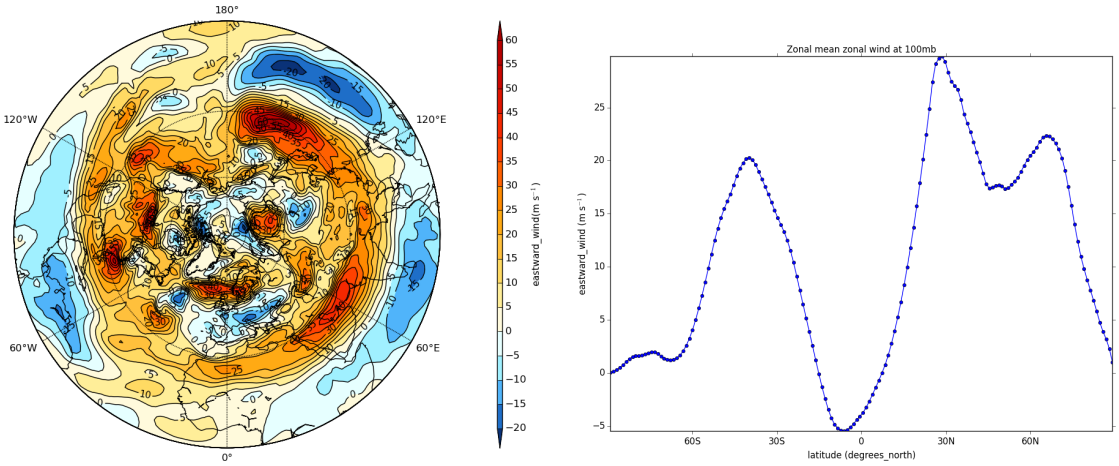
  cf-python is a python package which reads, writes, creates and manipulates datasets. It is fully compliant with the Climate and Forecast (CF) metadata conventions (version 1.5) and can read data stored in CF-netCDF and both Met Office (UK) PP and fields format files. It is not strict in enforcing the CF conventions, supporting the reading of files that are not fully CF-compliant and allowing the subsequent addition of metadata as required. cf-python supports data operations including dataset aggregation; arithmetic; statistics; and latitude-longitude and Cartesian conservative regridding using the high-performance Earth System Modelling Framework regridding library.

  cf-python operations are not memory limited as its memory handling functionality allows multiple fields larger than available memory to be manipulated without any extra work by the user.

  cf-plot is a python package built on cf-python that visualises CF fields with contour, vector or line plots. The package allows easy control of colour tables and plot positioning. By default the colour maps used are perceptually uniform, which means that the perceived intensity of the colours varies linearly with the numerical scale.

  Both cf-python and cf-plot are metadata-aware, meaning that they make full use of a field's metadata (such as which axes it has) to simplify the analysis, and all operations preserve metadata. For example, cf-python and cf-plot will automatically determine which axes of a field correspond to the latitude and longitude coordinates from the field's metadata. Consequently operations such as regridding a field to the grid of another field, which would be relatively complex, can be performed in a single line, and output data retains input metadata.

  cf-python and cf-plot are both open-source and free to install as conda packages and from the python package index.



Examples of cf-plot visualisations of cf-python fields. In each case the plot is a "one-line" command which infers all the information it requires from the field's data and metadata.

— David Hassell, Andy Heaps, Bryan Lawrence, Charles Roberts, NCAS, University of Reading

Research and Model Development News

- **Parametrization of Convection (ParaCon) Project:**

The ParaCon programme is a five-year joint NERC-Met Office collaboration with the Universities of Cambridge, Exeter, Leeds and Reading with the aim of significantly improving the representation of convection across model scales from 1km-100km. Funding started in June 2016. Here is our latest science news.

Using the Gibbs function for model thermodynamics:

Moist thermodynamics is complicated, and the approximations made in numerical models are often inconsistent, leading to spurious sources of energy and entropy. Consistency can be ensured by systematically deriving all thermodynamic quantities from the Gibbs function. This approach also gives great flexibility: different equations of state can be obtained by changing only the Gibbs function. A vertical slice ENDGame-like code has been used to show the feasibility and flexibility of the approach. Figure 1 shows vertical slices of (equivalent) potential temperature at t = 1000s from four variants of a standard buoyant bubble test case:

- dry air;
- saturated air;
- incompressible fluid;
- pseudo-incompressible fluid.

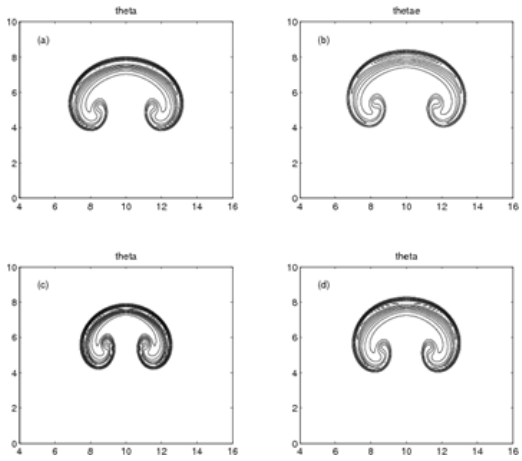


Figure 1: Vertical slices of (equivalent) potential temperature at t = 1000s from four variants of a standard buoyant bubble test case: (a) dry air; (b) saturated air; (c) incompressible fluid; (d) pseudo-incompressible fluid.

— John Thuburn, University of Exeter

Improving cumulus parametrisations using a fully Lagrangian cloud model:

The representation of cumulus convection is responsible for some of the largest uncertainties in both Numerical Weather Prediction and climate modelling. Detailed cloud models such as the Met Office/NERC Cloud model (MONC) are crucial in improving parametrisations of convection and microphysics. However, even these large-eddy models are sensitive to the choice of grid resolution and numerical scheme. Moreover, running long simulations over large domains can be prohibitively expensive in terms of computational cost.

David Dritschel (University of St Andrews), Steven Böing, Doug Parker (University of Leeds) and Alan Blyth (University of Leeds/NCAS) have been working on a new and potentially revolutionary approach to these problems. They have developed an efficient computational method in which both dynamics and cloud processes are modelled explicitly using Lagrangian parcels. An efficient grid-based solver is used to compute parcel velocities. First results show that this Moist Parcel-In-Cell (MPIC) method compares well with MONC. Moreover, the MPIC method has a number of advantages over traditional methods. MPIC is likely to be significantly cheaper for the same effective resolution, and mixing processes are explicitly represented through stretching, splitting and recombination of parcels. This offers a step-change in the ability to control Lagrangian conservation of parcel properties, minimizes numerical diffusion and enables the efficient representation of small-scale features such as the ones in the Figure 2.
This work was initially funded by the EPSRC Maths Foresees network. Within the ParaCon programme, MPIC will be used alongside MONC to study entrainment, mixing at the cloud edge and rain formation. Eventually the aim is to integrate these two cloud models.

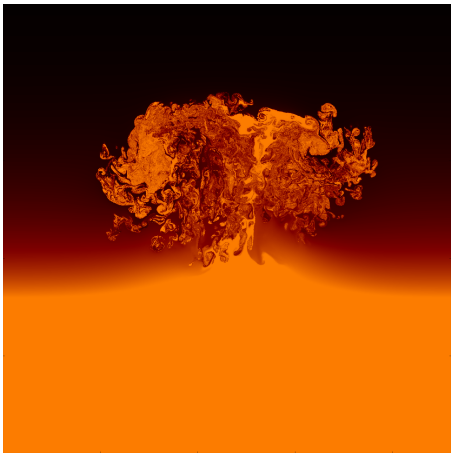


Figure 2: Part of a cross-section of total specific humidity in an MPIC simulation. This simulation ran on just 8 CPU cores.

— David Dritschel (University of St Andrews), Steven Böing, Doug Parker (University of Leeds) and Alan Blyth (University of Leeds/NCAS)

Cold pool parametrisation:

An idealised study of the fluid dynamics of cold downdraughts (Rooney 2015) has paved the way towards creating a new cold-pool parametrisation for the Unified Model. The new parametrisation allows cold pools to flow across columns, providing a boost to the triggering of new convective events.
The scheme takes its initial buoyancy forcing from the properties of convective downdraughts. Scaling relations describing cold-pool evolution have been adapted from the idealised study for use in a model in which information on flow origins is not retained. Cold-pool interaction is also modelled. The system in some ways resembles a cellular automaton, but with a physical underpinning. It has been coded and tested both in a stand-alone configuration, (see Figure 3), and in an initial Unified Model implementation which has been added to the UM code repository.
The model could also be used in future to represent similar flows in different contexts, such as dust storms, dispersion of dense gases, or the spread of convective anvils.

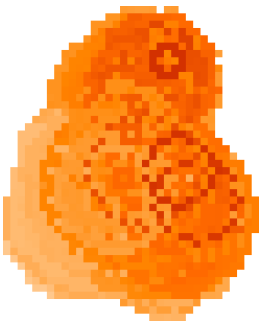


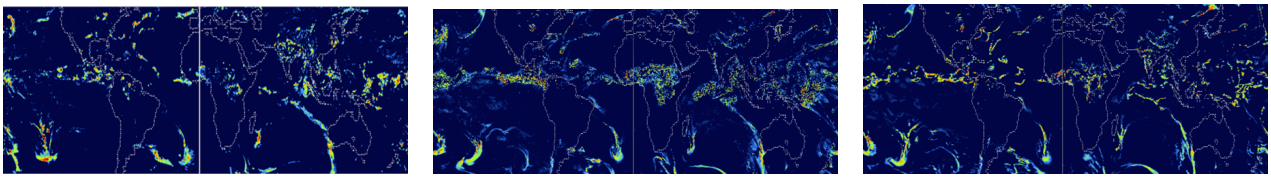
Figure 3: A snapshot of the buoyancy of a 2D field of cold pools in the stand-alone model, forced by a group of moving downdraughts. Darker colours indicate colder (more negatively buoyant) air.

— Gabriel Rooney, Met Office

Improving the representation of sub-grid moist convection in the UM:

A number of major changes to the UM convection parametrization are being developed, aiming to address some long-standing problems with the convection scheme:

– **Timestep intermittency.** The existing scheme tends to "switch on and off" from one timestep to the next in an unphysical way. It triggers convection based on whether a lifted parcel can overcome the Convective Inhibition (CIN), but determines the mass-flux and rainfall rate using a separate parcel ascent and "convective closure" calculation based on Convective Available Potential Energy (CAPE). The scheme is intermittent because the convective heating from one timestep typically increases the CIN so much that convection can't trigger at all on the next timestep. A number of inconsistencies between the triggering and closure calculations were identified and addressed, and crucially the closure has been rewritten with an improved numerical scheme which implicitly accounts for the increase in CIN due to the convective heating. This was found to remove most of the timestep intermittency of the convection scheme.



(a) TRMM (b) GA7 (c) GA7 + new convection scheme

Figure 4: snapshot of instantaneous surface precipitation rate on day 5 of a global N320 forecast test; (top) TRMM satellite-based estimate, (middle) GA7 control simulation, and (bottom) a simulation with the modified convection parametrization.

– **Its tendency to trigger convective rainfall too homogeneously.** When averaged over one or two hours, the global UM tends to produce too-light convective rainfall over much too large an area. This is true over the tropical oceans generally, and over tropical land during the day. This is because the convection scheme lacks representation of processes that cause convection to occur more easily where pre-existing deep convection is already occurring (e.g. forced uplift by cold-pools).. A simple modification has been implemented, in which the parcel kinetic energy (KE) used to overcome the CIN is increased as a function of a prognostic field measuring recent convective activity. This has yielded dramatic improvements in the organisation of parametrized convection in global UM tests, with much less widespread but heavier, more persistent rainfall in the tropics. An example of the changed character of tropical rainfall with the new scheme is shown in Figure 4. In a further development, a prognostic cold-pool model is being implemented in the UM (Gabriel Rooney), which will calculate the triggering kinetic energy used in this scheme in a more physically-based way.

– **Its lack of scale-awareness.** Convection-permitting models (e.g. the UKV, SINGV and East Africa model) exhibit some deficiencies due to the convective updrafts being poorly resolved, even at these scales. But the existing UM convection scheme is not appropriate for representing the smaller, unresolved updrafts in these models because it is designed to represent the whole spectrum of cumulus updrafts (including the deep convective storms which are resolvable). It therefore degrades the performance if used in convection-permitting models, producing much too widespread light rainfall as described above. The convection scheme has been modified to make the triggering of parametrized convection scale-aware and stochastic. At higher resolution, more of the over-turning in the boundary layer is resolved, so that the sub-grid KE available for triggering sub-grid convection is reduced. The amount of sub-grid KE also becomes more unpredictable, as we expect only a small sample of over-turning cells per grid-box. This motivates a stochastic treatment in which the parcel KE used for triggering convection is drawn from a probability density function (PDF). As the model grid-size decreases, the mean of the PDF is reduced, but the variance increases relative to the mean, so that the triggering of parameterised convection becomes less likely but more sporadic. Initial tests incorporating this modified convection parametrization in the UKV show improved onset of small showers, more realistic organisation of convective storms / squall-lines, and reduced "blobbiness". An example snapshot of the new convection scheme's behaviour in a UKV forecast is shown in Figure 5.

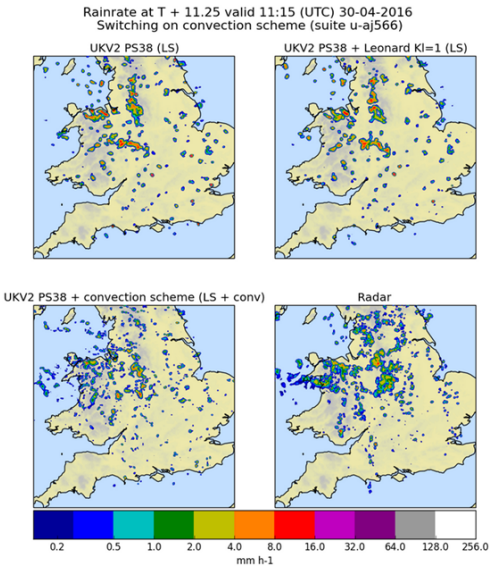


Figure 5: snapshot of surface precipitation rate on a day of April showers in 2016, for (top-left) UKV PS38, (top-right) UKV PS38 with improved sub-grid turbulent fluxes from the "Leonard terms", (bottom-left) UKV PS38 with scale-aware parameterised convection, and (bottom right) radar-estimated rain-rates.

While the scheme is already showing considerable promise, some further modifications are planned shortly. These include:

– Incorporating a new prognostic cold-pool model into the scheme.
– Improving the treatment of convective cloud;
– Allowing the convective heating profile to adapt more in response to upper-level instability, via "adaptive entrainment". Getting the shape of the convective heating profile right is thought to be important for simulating large-scale tropical waves, such as the MJO.

A comprehensive set of tests are being planned to inform the modifications, and tune the model, with the aim of including the revised scheme in the GA9 global model configuration. For more information, please contact Mike Whitall (Michael.whitall@metoffice.gov.uk).

— Mike Whitall, Kirsty Hanley, Alison Stirling, Met Office

• LIS, a new software framework for Land Surface Data Assimilation:

The NASA Land Information System (LIS) is a software framework for high performance terrestrial hydrology modelling and data assimilation developed with the goal of integrating satellite and ground-based observational data products and advanced modelling techniques to produce optimal fields of land surface states and fluxes.

The land surface modelling software suite consists of three modelling components: LDT (Land Data Toolkit), LIS (Land Information System) and LVT (Land Verification Toolkit).

– *Land surface Data Toolkit (LDT)*, a formal environment that handles the data related requirements of LIS including land surface parameter processing, geospatial transformations, consistency checks, data assimilation preprocessing and observation bias correction.

- *Land Information System (LIS)*, the modelling system that encapsulates physical models, data assimilation algorithms, optimization and uncertainty estimation algorithms and high performance computing support.
- *Land surface Verification Toolkit (LVT)*, a formal model verification and benchmarking environment that can be used for enabling rapid prototyping and evaluation of model simulations by comparing against a comprehensive suite of in-situ, remote sensing and model and reanalysis data products.

More info and documentation can be found at NASA LIS webpage

After a comprehensive evaluation, the Met Office has decided to adopt the LIS as its Land Surface Data Assimilation framework, to replace its current system SURF. Technical, scientific and long-term aspects have been considered before making this decision, and several benefits were found:

- Access to a mature and flexible system backed by a large development team and wider community;
- Open source system that is equally attractive to the UM community and academia and will allow collaboration across a wide field;
- An Ensemble Kalman Filter system, consistent with our long-term plans;
- Capability to use new observation types and benefit from each others developments;
- Access to tools for processing observations, including CDF matching preprocessor, radiative transfer models, and under development a neural net to use L-band radiances;
- Use of related tools, LDT and LVT for evaluation.

Met Office plans are to maintain current algorithms and observations in operations before starting to explore new LIS capabilities. This presents a challenge as some of the key features available on SURF are not present in LIS and will need to be implemented:

- Assimilation of screen-level temperature and humidity.
- EKF algorithm and linearisation of the observation operator ('H').
- Assimilation of different observation types in parallel.

UM partner USAF 557th Weather Wing has been using LIS for more than 10 years in their operations and, as part of their UM implementation, they will support NASA, working with the Met Office, to implement this extra functionality.

Transition to operations is expected to take 2 to 3 years. During this time, and for a period afterwards, the Met Office will continue to support SURF. Ongoing activities for SURF include the EKF for regional domains and an Optimal Interpolation analysis scheme for snow cover and depth.

— Breogan Gomez and Richard Renshaw, Met Office

• NCMRWF Moving towards Coupled Modelling for Seamless Prediction

National Centre for Medium Range Weather Forecasting (NCMRWF) under Ministry of Earth Sciences (MoES), India is progressing closer towards coupled modelling system for seamless prediction.

Recently during November 2016, Met Office scientists, Livia Thorpe and João Teixeira, visited NCMRWF and worked closely with NCMRWF scientists to implement the GC2 coupled system at N216L85 atmosphere and ORCA25L75 configuration on IBM iDataPlex based HPC system.

Indian monsoon weather/climate processes being a fully atmosphere-ocean-land-ice coupled phenomenon, use of a coupled model at NCMRWF is highly desirable for forecasting across scales from days-to-season. During 2016, NCMRWF in collaboration with Met Office has already implemented the NEMO based global ocean initialization system to be used in coupled modelling. In the medium range NCMRWF has already made operational global 17 km UM and regional 4 km UM based models with global data assimilation system. A 1.5

km regional model has also been tested over India during monsoon 2016 season, which will be used for high impact weather systems.

The GC2 based higher resolution (N512) coupled modelling system will be used for experimentation with coupled NWP and also in studies on Monsoon Intra-Seasonal Variability (MISV), which is a key factor influencing both Medium-Range and Seasonal monsoon forecast skill. NCMRWF and Met Office are also partners in multi-institutional collaborative NERC-MoES projects INCOMPASS and BoBBLE to understand and improve the land-surface and Bay of Bengal air-sea interaction processes in monsoon. Inclusion of stratospheric processes to examine its links to monsoon variability and predictability will be possible with this coupled modelling system. How the cryosphere (Arctic-Antarctic Sea-Ice and Himalayan snow/glaciers) affects monsoon is another priority research area, where high resolution initialized coupled model will be an important tool.

— Ashis Mitra, NCMRWF

- **HadGEM3-GC3.1 Released**

The HadGEM3-GC3.1 (hereafter GC3.1) configuration has now been released. GC3.1 has primarily been developed for a target atmospheric model resolution of 60 km (N216) and ocean resolution of 0.25° (hereafter N216O025). In addition to this effort, a lower resolution version of GC3.1 has also been developed as the physical model core of UKESM1. The reduced resolution is necessary in order to make UKESM1, with its additional Earth system components, feasible to run for centennial timescale experiments such as planned in the CMIP6 project. This lower resolution version of GC3.1 employs an atmospheric resolution of 140 km (N96) and ocean resolution of 1° (hereafter N96O1). Both models employ the same number of vertical levels, in the atmosphere (85) and ocean (75).

A detailed analysis of both N216O025 and N96O1 will appear soon in the peer-reviewed literature.

This configuration solved or reduced the impact of the following issues:

- Aerosol radiative forcing over 20^{th} Century too strongly negative cf IPCC estimates, leading to negative total effective radiative forcing (ERF) from pre-industrial to present.
- Improvements to ERF delivered alongside net TOA acceptably close to zero in pre-industrial run ($\pm 0.5\, Wm^{-2}$)
- Arctic sea ice too thick, compromising Arctic climate projections
- Low resolution (N96/ORCA1) version of the model needs to be developed with acceptable climate for UKESM1 and other CMIP6 applications

Detailed information on the improvements done for GC3.1 can be found in the UKESM newsletter article:

- HadGEM3-GC3.1: The physical coupled model core of UKESM1 now froze;
- Improving aerosol processes and radiative forcing in preparation for UKESM1.

Met Office News

- **MONSooN and the New Cray HPC**
  Shortly, MONSooN users will have access to a portion of the 11^{th} most powerful supercomputer in the world, the XCS (source top500 Nov. 2016 list). This is situated in a dedicated new building in Exeter's Science Park, close to Met Office HQ. Though they won't get to use all of it, we do anticipate a 5-fold increase in capability, from 116 to around 600 nodes.

  This will come at the start of a new contract with NERC, and we want to take the opportunity to name the new service Monsoon2.

  Currently we expect a dual running period in March and full cut over by 1st April.

  Other improvements we wish to put in after the initial change of HPC, probably over the following 12 months:

  - We want to review Authentication and Authorisation methods, balancing ease of use against the security constraints that ensure the system is available and reliable.
  - We want to review how the Rose/Cylc infrastructure is set up; as more people use this rather than the UMUI and PUMA, we're aware the initial setup was not optimal! In particular there are often severe slow-downs when using the local Rose server.

  — AJ Watling, Met Office

Discussion and Feedback

Please contact João Teixeira if you have any comments or queries regarding this newsletter, or if you have any suggestions or articles that you would like to share in the next issue of the UM User Newsletter.