Guest editorial

Welcome to the December 2017 issue of the UM Newsletter. It is customary at this time of year to look back and reflect on at the year gone by, which going by this newsletter has been a busy one for the partnership as well as being a busy one for me.

In the Spring, I left GMED to lead the new Research to Operations (R2O) area in Weather Science, since when I have become more involved in the RMED activity. In June I attended both the GMED and RMED UM workshops, and have been impressed by the ongoing evaluation of our new model configurations, particularly the prototype Regional Atmosphere RA1.

The primary focus of R2O is the coordination of model upgrades and their handover into the parallel suite. In the summer, the implementation of PS39 was a significant milestone in the utilisation of the Met Office HPC. We have since handed over upgrades into PS40 and are already planning major upgrades for PS41. We are also reviewing our trialling and evaluation processes and the technical handover of upgrades, and are keen to learn lessons from other modelling centres. In May, R2O's Mike Thurlow spent three weeks in Melbourne working on suite portability and in future we hope to make increased use of the nwpscience project on the Science Repository Service. This work should then be of benefit to the partnership as well as to the Met Office. For more information on R2O, please see the "Recent Movements" section of the newsletter (alongside a picture of R2-D2 - a reference to the D2 wing of the Met Office where R2O are based). Hopefully we'll be slightly clearer than R2-D2; unlike C3-PO, however, I won't tell you the precise odds of successfully navigating a parallel suite!

— David Walters, Head of Research to Operations, Met Office

Announcements

21-23 February 2018, Melbourne, Australia

In-person UM board meeting, Global Coupled modelling workshop on Southern Ocean bias and tropical convection, LFRIC technical and investment workshop. If you are interested in any of these events, please contact UM Collaboration team.

26 Feb-2 Mar 2018, Lorne, Australia

2^{nd} Pan-GASS conference on Understanding and Modelling Atmospheric Processes.

UM User workshop, 11-15 June 2018, Exeter, UK

Further announcements will be made early 2018.

UM User tutorial, 4-9 June 2018, Exeter, UK

Further announcements will be made early 2018. Contact João Teixeira if you would like to attend this training.

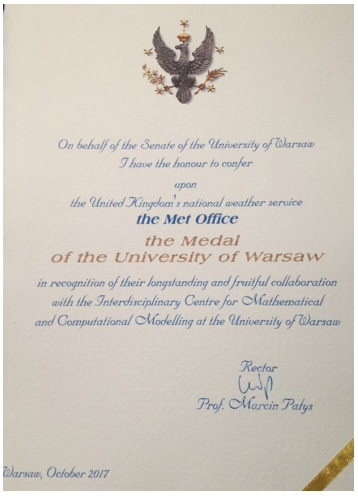
Events

20 years of UM and NWP at ICM

On 11th October 2017, the Interdisciplinary Centre for Mathematical and Computational Modelling (ICM), UM Partner at the University of Warsaw, held the Twenty Years of meteo.pl conference to celebrate 20 years of UM and NWP at ICM.

ICM has been using the Unified Model as a regional weather model, centred over Poland, since 1997. The ICM Technology Centre in the outskirts of Warsaw provides the compute power to perform simulations with the UM using forcing data provided by the Met Office via the Initialisation Data Service (IDS). This enables ICM to provide weather forecasts to the public on www.meteo.pl and to investigate the performance of the UM over Central/Eastern Europe.

The Met Office has been awarded the Medal of the University of Warsaw in recognition of longstanding and fruitful collaboration with the ICM. During the event, the medal was presented to Dale Barker who gave a talk about current collaboration and challenges ahead.



— Bjoern Hendrik Fock, Met Office

UM Partners LFRic workshop, 4-6 July, 2017

UM Partners LFRic workshop was organized as a part of the activities to promote the collaboration of scientists and developers to contribute towards activities involving exascale development around the GungHo dynamical core and LFRic software framework and to advance capability in this area. The meeting held during 4-6 July, 2017 and hosted by NCMRWF at Ministry of Earth Sciences, New Delhi was attended by 20 scientists from the Bureau of Meteorology Australia, ICM Poland, Met Office UK, NCMRWF India, NIWA New Zealand, Korean Meteorological Administration and STFC UK in person as well as remotely.

The aims were:

1. To speed up with GungHo/LFRic/PSyclone developments and to develop plans
2. To introduce everyone to the current working practices for these projects
3. To explore where there is common ground between the work needed to be done for GungHo/LFRic/PSyclone and the interest/expertise of the delegates
4. For everyone to get to know each other as well as possible in 3 days with the aim to make subsequent remote correspondence as successful as possible
5. To discuss the challenges of working together (exploring options for visits of varying length as well as effective remote collaborations)
6. To start to draw up more or less detailed work plans and next steps

It was agreed in the workshop that in about 3 months' time there would be a kick-off meeting by video conference. In order to participate in the kick-off meeting, each partner would:

1. Build and run LFRic
2. Provide some form of communication within their organisation
3. Draw up a resourced work plan
4. Where appropriate, suggest members of their organisation who could offer their services as reviewers
5. In order to explore the new model, create some mini-apps and (where appropriate) commit them to the trunk for general use and development

More information on this workshop can be found at LFRic Workshop pages in the Collaboration TWiki.

— E.N. Rajagopal, NCMRWF

UM Users Workshop, Exeter, UK 14-16 June 2017

Update on UM Partners Status and Plans

More than 90 participants attended the 11th UM User workshop in Exeter 14-16 June, to share UM Partners status and plans with the user community, but also to help plan contributions to joint model and technical infrastructure developments. As for the convective scale workshop, drop-in sessions were offered to learn more about the various Trac environments on the Met Office Science Repository Service (MOSRS) to help improve communication and information sharing. Global Model Evaluation and Development

The Thursday was dedicated to progress reports from Process Evaluation Groups and Working Groups for Global Coupled modelling activities, including a session to develop common tools for evaluation. The highlight was a 75% reduction in the Southern Ocean warm bias between GC2 and GC3.1. The Met Office presented plans for GA8/GC4/GO8/GSI9. A final discussion reviewed a list of critical/high priority model problems. These will be reviewed by the proposed new Global Coupled Model Programme board.

Land Surface DA

A group met in parallel on Thursday to discuss partners' plans for operational land surface DA and NASA LIS plans, and to discuss future potential collaborations, including trying out the LVT (Land Verification Toolkit), the verification package that comes with LIS.

Technical Infrastructure

The UM User Workshop Technical Infrastructure (TI) day took place on Friday 16 June and comprised three sessions. The first "Research to operations - improving resilience", provided an opportunity to hear about plans and challenges at the Met Office and BoM in improving the transitioning of NWP science capabilities from research to operational. This session included updates from the Met Office HPC Optimisation team on improving the performance of high-resolution global model forecasts and future hardware challenges outlined by a representative from Cray. The second session "Underpinning activities", gave updates on recent UM systems development over the previous 12 months, previous and future developments within Rose/Cylc infrastructure, improvements to suite site portability and TI activities across UK Universities led by NCAS-CMS. The last session "Priority technical areas", focused on tools for monitoring and verifying NWP trials, development of an NWP observation capability, developments in Ancillaries Tools and Suites (ANTS) and an update on ECMWF ODB developments and NCMRWF.

A subsequent brief discussion of TI issues raised during the day and earlier sessions included a lively debate about the merits of git over svn, the challenges for research to operations across the partnership and the recent successes of improving suite site portability in the various research suites.

Following the TI presentations, the workshop discussed "Working practices and collaboration tools" informed by the results of a collaboration tools survey completed by workshop participants. Key themes identified in the survey included: i) undertaking better management of content on the collaboration twiki w.r.t Met Office Science Repository Service; ii) identification/delivery of new capability to better share content as an alternative to the collaboration twiki static web; iii) opportunities to improve collaboration by migrating to Microsoft Office 365; iv) the benefits of face-to-face workshops.

Many thanks also to all involved, all presentations are available on the collaboration twiki.

— Charline Marzin, Met Office

2^{nd} Convective Scale Workshop, Exeter, UK 12-14 June 2017

The UM Partnership sponsored a second Convective Scale Modelling workshop in Exeter 12-14 June 2017 following the first held in Singapore in February 2016. The sessions and discussions were aligned with the Joint UM Partnership Science programme for Regional Model Evaluation and Development. More than 70 participants attended and took part in planned and many other interesting impromptu discussions

Latest plans for the upcoming release of tropical and mid-latitude regional atmosphere configurations (RA1-T and RA1-M), the RMED toolbox, new nested suite capabilities and updates on parameterisation schemes, convective scale DA, sub-km modelling and climate applications were discussed. Partners shared results and plans on RMED case studies and sensitivity experiments using the latest science configurations, new methods to test models against radars and plans for convective scale ensemble and very high resolution systems.

On Wednesday morning, the four RMED partner working groups met and agreed plans for the coming year. The Coordination WG agreed to coordinate partner's contributions to testing and evaluating RA1-M and RA1-T over their region, the RMED verification WG is planning for testing the first release of the RMED toolbox to enable future co-developments. The Convection WG reviewed how to take forward its 6 agreed joint priority areas, and sub-groups will be working in more detail to look at testing new schemes for RA over different regions, using radar data to look at rainfall intensity, distribution and cell statistics, and understand why convection initiates too early in the tropics. A spin-off group met to propose a new working group on the use of convective scale ensembles, the scope of this group will be refined in the next few months.

Many thanks to everyone involved in the sessions and discussions. All material is available on the RMED TRAC wiki pages.

— Charline Marzin, Met Office

- **UM Users Tutorial, Exeter, UK 05-09 June 2017**
  The 9^{th} UMUT took place between the 5^{th} and 10^{th} of June 2017, at the Met Office in Exeter. There is a TWiki page for this event where you can find all information and presentations that were part of this year's event. 18 participants from 11 organisations of the UM Partnerships spent the week in Exeter. Users were from a wide range of backgrounds in both weather and climate, with interests ranging from regional modelling, aerosols and atmospheric chemistry to satellite data assimilation and numerical weather prediction.

  This year's UM User Tutorial saw an increase of the time dedicated to the practical exercises and it had the introduction of assignment topics, where attendees could choose from accordingly to their interests. Moreover, staff from across various Met Office science groups presented several topics over the course of the week, including data assimilation, climate configurations and ensemble prediction, which were reinforced through a number of hands-on exercises. In addition, participants gave short talks about their own work.

— João Teixeira, Met Office

UM, Parallel Suite and Technical Infrastructure News

UM version 10.9 (Tropical Typhoon) has now been released

The UM10.9 has now been released!!!

This release saw 177 tickets committed to the trunk, of which 49 were science developments.

This release sees significant contributions in the following areas:

- An initial capability to write diagnostic output to netCDF files, work led by NCAS, University of Reading.
- Introducing a 32-bit physics capability; within this release Large scale precipitation is considered.
- The roll out of a new qsat.
- Extension of shumlib to include 'grid rotation' functionality.
- The initialisation of idealised models is now performed by the Reconfiguration.
- Many Optimisation changes, particularly improving OpenMP scaling. For more information on performance improvments have a look at the trac wiki page on Optimisation performance improvements seen in UM10.9.
- The *um_parvars* module has been made PRIVATE and only objects declared in that module can be inherited from it. If compiling a branch fails with an "[item] not found" message after upgrading to vn10.9, and the same file in vn10.8 contains a USE um_parvars statement, it's probable your code is missing a USE statement.

In a little more detail:

NetCDF writing

This is a significant change to allow writing of certain fields directly to netCDF format without intermediate file formats for research use (this is not approved for production or operational use). Requests for support should go to the code owner.

Currently this implementation uses a place-holder translation table. The intention is to update the translation table to take data from Metarelate so it is consistent with Iris over the forthcoming months Running some rose ana comparison tasks, specifically the CompareFFandNC analysis tasks, requires a version of Python that is compatible with the netCDF4 Python library. At present, this means that Python 2.7 or above is required.

32-bit physics

Please see 32bit_physics for a commentary of the work thus far.

Shumlib

Shumlib is the collective name for a set of libraries used by the UM, the UK Met Office's Unified Model, that may be of use to external tools or applications where identical functionality is desired. The hope of the project is to enable developers to quickly and easily access parts of the UM code that are commonly duplicated elsewhere, while also benefiting from any improvements or optimisations that might be made in support of the UM itself.

This makes the UM Limited Area Models, Reconfiguration and some Utilities link to the external Shumlib library for grid rotation functionality (standard lat-long to and from rotated equatorial grids). Therefore for UM vn10.9, Shumlib version shumlib-2017.10.1 is required.

Each UM installation must install Shumlib libraries prior to being able to use the UM. External partner sites' UM administrators will need to read through the Shumlib installation guide to create these libraries. For Intel compilers, the Shumlib library behaves best if compiled with a floating-point semantics setting of -fp-model precise or -fp-model strict. Idealised Reconfiguration

Previous UM versions executed the code to initialise idealised test cases in the first timestep of the model, effectively overwriting the start dump. Ticket #1824 moves this logic to the Reconfiguration where existing control structures for initialising a dump can be taken advantage of, reducing the complexity of the first model timestep.

UM atmosphere dumps now support Cartesian coordinates and additional vertical profiles, for transmitting idealised grid structures between the Reconfiguration and the model. A new Reconfiguration-only namelist, *&recon_idealised*, contains many idealised settings that were previously read by the model.

This work is the end of a large effort from the UM System Team to try and rationalise this area, and opens the Reconfiguration to the addition of further idealised functionality.

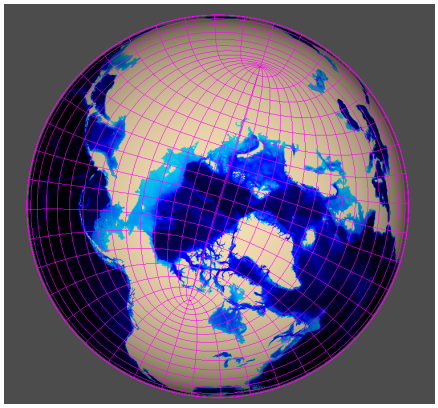
For more information on this UM release have a look at the Release Notes.

Adding Curvilinear Regridding to ANTS

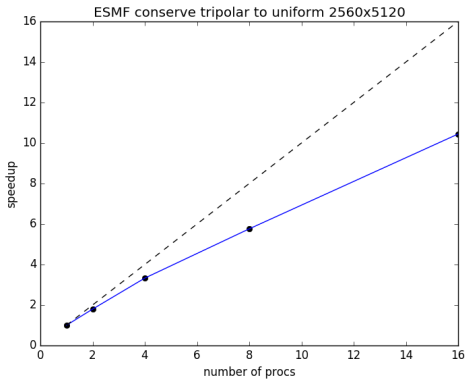
The Ancillary Tools and Suites (ANTS) creates UM ancillary files, leveraging Python and Iris to interpolate data from a source grid to a UM target grid in the process. The grids involved can be lat/lon, rotated pole (with 1D coordinates), or full curvilinear (with 2D coordinates). Prior to this project ANTS could not properly handle general curvilinear grids such as the ORCA tripolar grid - a current real-world use-case (Figure 1).

We evaluated and compared several potential regridding tools and, based on results, we implemented support for ESMF (Earth Systems Modeling Framework) in ANTS. ESMF can handle general curvilinear grids; it supports conservative, area weighted interpolation (suitable for cell-centred fields); and it has a Python interface.

Conservative interpolation on curvilinear grids is relatively expensive as it involves computing the overlap between grid cells that are not aligned. In simpler rectilinear cases, regridding tools like ESMF are expected to be much slower than rectilinear-only tools, and their memory footprint will be much higher. Accurate general regridding, however, is becoming increasingly important and we expect that parallel regridding will mitigate these performance issues in the future (see below for initial results with MPI).

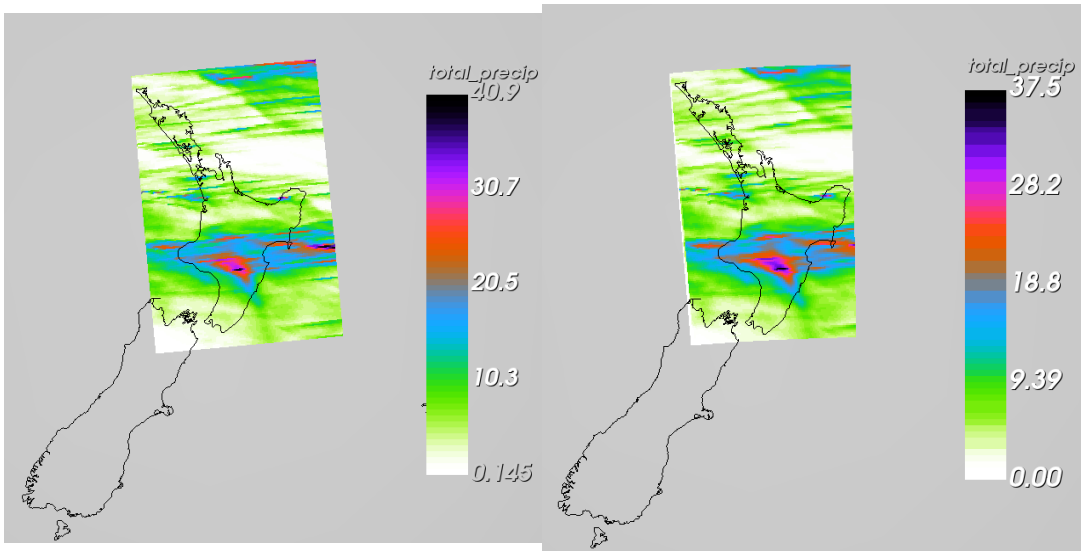


(a) Coordinate folding at the northern latitudes.



(b) Parallel speedup of 10x achieved with 16 MPI processes.

Figure 1 - Tripolar grid from the ORCA model.



(a) Source data.

(b) Target, regridded data.

Figure 2 - Regridding precipitation data in *mm* from the rotated pole grid of the New Zealand Convective Scale Model (NZCSM) onto a latitude-longitude grid, using ESMF in ANTS.

Results

The new API can be used via `from ants.regrid import ConservativeESMF`. It has:

- A constructor that takes source and target cubes and computes interpolation weights. Only the horizontal grids of these cubes are used (data and other coordinates are left untouched).

  ```
  rgrd_factory = ConservativeESMF()
  rgrd = rgrd_factory.regridder(src_cube, tgt_cube)
  ```

- A call method that applies the interpolation weights to an input cube and produces an output cube. The input cube must have the same horizontal grid as the source cube, but it can have additional axes and auxiliary coordinates – the weights are applied to each "level" of the input data independently.

  ```
  # apply the weights
  out_cube = rgrd(inp_cube)
  ```

Computing the interpolation weights typically takes orders of magnitude more time and memory than the second step, but with the new API it is easy to re-use the weights across different elevations, time steps and

even datasets.

Figure 2 shows an example of conservative curvilinear regridding using the ESMF implementation in ANTS.

Future Work
ESMF supports parallel regridding, a capability that is not currently exposed in ANTS. ESMF's domain decomposition framework is still a work in progress, but we found that it is already extremely beneficial for grids with millions of cells – 16 MPI tasks gave a speed-up of 10x for a tripolar grid (Figure 1b). Another possibility would be to rely on ANTS's decomposition framework to split the domain into sub-domains and run different regridding instances in parallel. Using either or both approaches will allow ANTS users to scale up conservative regridding to any grid resolution, given enough computing cores. Further investigating these options and their impact on performance and memory will help inform how extensively ESMF can meet the requirements of ANTS.

We hope that the present implemention of ESMF regridding will ultimately be moved to Iris to increase exposure.

For details and results of the project to evaluate tools and implement support for conservative interpolation of data on curvilinear grids in ANTS, please see the full report.

— Alex Pletzer, NIWA

Met Office's PS39 is now live

This summarises the main changes that users of raw and post-processed model data may expect to see from the changes introduced to models and systems at PS39.

- **Global -** Major resolution increase to 10km, which will provide more accurate forecasts, particularly near the surface. It will also enable better use of observations to produce a more accurate and detailed analysis, with associated forecast improvements. Better initialisation of snow in the model will improve surface temperature forecasts during the spring thaw.
- **MOGREPS-G -** Major resolution increase to 20km and 50% increase in ensemble members (18) out to 7 days. This will produce more accurate forecasts, especially of near-surface variables. Increased ensemble members have a strong benefit to probability forecast for most fields due to improved spread and better sampling of the forecast uncertainty.
- **UKV -** Major DA upgrade from 3-hourly 3DVAR to hourly cycling 4DVAR. The new hourly runs to T+12 (01,02,04,05,07,08,10,11,13,14,16,17,19,20,22,23Z) will supplement the existing T+54 (00,06,09,12,18,21Z) and T+120 (03,15Z) runs. Some benefit to nowcasting performance due to the hourly cycling. This is because UKPP is now able to ingest earlier forecast range data and the error growth rate is relatively large in the first 6 hours or so. Input to BestData can be supplied on average 2 hours 'fresher' from the hourly cycle ie from t+2 onwards, rather than from t+4 onwards in a 3-hour cycle. The other significant change is to the model with the addition of moisture conservation. This change greatly reduces the frequency with which the model produces unphysically large precipitation rates. The UM is also upgraded to UM10.6.

  Summer: Improvement to Precipitation RPS, with a reduction in the over-forecasting bias. Improvement to Temperatures with forecast RMS error reductions of between 1 and 2%. Reduction in cloud amounts
  Winter: Improvement to cloud base height. Improvement to temperature at longer forecast ranges. Improvement to Precipitation RPS.

  The reduction in cloud amounts is most noticeable under high pressure conditions and the PS39 performance during early April 2017 was much better than OS38; with large improvements to temperature due to the reduction in spurious cloud.
- **MOGREPS-UK -** Improved UKV analysis from which to centre around and inclusion of moisture conservation in the model lead to a large improvement to MOGREPS-UK temperatures in Winter.
- **GloSea -** The number of GloSea5 hindcast members is due to increase late January 2017. This will see the number of hindcast members per start date go from 3 members to 7 members. This will also mean an increase in hindcast members that are run each day - moving from 10 members to 23 members.
- **Coupled DA -** Both atmosphere and ocean configurations in the coupled DA suite have been upgraded to be consistent with the PS39 Global Model NWP and PS39 global FOAM respectively. In addition numerous technical changes have been made to the suite, particularly to the post-processing, so that it is

ready to provide products to Copernicus Marine in early July. Some scheduling changes have also been made to make more use of late arriving ocean observations. Verification of the ocean output continues to show the system out-performing global FOAM for SSTs at short lead times, and the OS38 degradation vs FOAM for sea level anomaly statistics is no longer present.

The UM Partnership Communication Review Group

Following the GMED workshop held at NIWA in February 2017, the UM Partner Board (UMPB) recommended a small group representing Core Partners review communications across the partnership and give recommendations for improvement. The UM Partnership Communication Review Group's inaugural meeting took place in September 2017 and was attended by:

- Mike Naughton (BoM)
- Rachel Law (CSIRO)
- Hyuncheol Shin (KMA)
- Stuart Moore (NIWA)
- Raghavendra Sreevathsa (NCMRWF)
- Charline Marzin, Keir Bovis and George Pankiewicz(Met Office)

The group agreed its terms of reference as:

- The group should comprise a single representative from each Core Partner, should identify barriers to communication and share knowledge on new and existing infrastructure available in mitigation.
- Its scope will consider communication issues arising from the Joint UM Partnership Science and Technical Infrastructure programmes with the aim of enhancing the effectiveness of the collaborative contributions.
- The group will report directly to the UMPB providing highlight reports of progress and escalate issues when appropriate.
- Wherever possible, the group should maintain a strategic view on developments within their area. As such, representatives should be drawn from institution's science modelling communities.
- The group should aim to reflect the views of their institution by routinely sampling opinion through consultation, interview and/or questionnaires to better inform the direction of the group.
- Annually review these terms of reference and the group's future status.

Activities the group is keen to focus on initially include:

- Review the opportunities offered by Office 365 in the cloud for collaborative working
- Review video-conferencing giving recommendations on improvements to infrastructure and how they could be improved.
- Provide input to any review of future use of the collaboration twiki
- Compile a list of issues for consideration by the group around communication.
- Consider requirements for inventories to better share information about the UM Partnership community (expertise, projects, scientific tools, systems...)
- Consider requirements for flowcharts to share best collaborative working practices

If you have any comments or items you would like the group to consider, please contact Keir Bovis.

— Keir Bovis, Met Office

Research and Model Development News

Update on GA8

GA8 will be the next science configuration of the Global Atmosphere model and will build upon GA7, which was released in January 2016. The development of GA8 is documented in gmed#256 and the latest configuration is GA7#256.7. GA8 will include improvements to convection, microphysics, boundary-layer and land surface schemes. Particular science highlights include:

- the inclusion of a "prognostic based convective entrainment rate" that improves the diurnal cycle of convection over land (Figure 1) and produces realistically more intense instantaneous precipitation rates (see gmed#199 and Willett and Whitall, 2017);
- the introduction of the Liu et al, 2008 spectral dispersion that improves the simulation of the first aerosol indirect effect and consequently reduces the bias in cloud droplet effective radius (gmed#192);
- a new riming parametrization that increases the liquid water content at mid- and high-latitudes and hence reduces shortwave flux biases in the Southern Ocean (gmed#181);
- and a revised roughness parametrization for marginal sea-ice that reduces the excessive drag around Antarctica and improves NWP forecasts in this region (gmed#194).

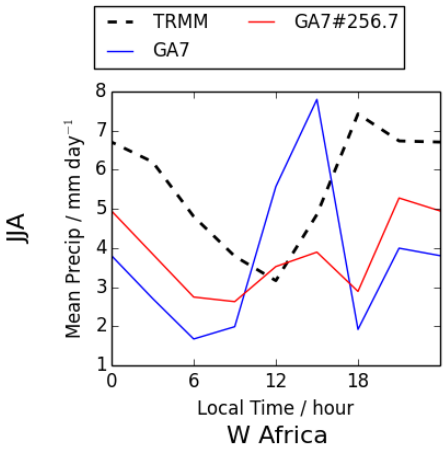


Figure 1: Diurnal cycle of precipitation rate (mm/day) in JJA from west Africa (10W-10E,5N-15N) in the N96 atmosphere/land-only climate simulations presented showing GA7#256.7 (red), GA7 (blue) and TRMM (black)

The climate performance of the latest development configuration, GA7#256.7, is competitive with that of GA7 in atmosphere only simulations. The mean spatial distribution of precipitation is improved (Figure 2) with beneficial increases over the maritime continent and the eastern tropical Atlantic ocean and beneficial decreases over the equatorial Indian ocean and the western tropical Atlantic ocean. The top of atmosphere short wave fluxes are also improved (Figure 3) with reduced biases over the Southern Ocean and a reduced hemispheric imbalance. Tropical Tropopause Layer (TTL) biases are increased but sensitivity tests suggest that we should be able to address these through tunings to the convection scheme and convective cloud. Early results from coupled atmosphere-ocean simulations show a reduced warm bias in the sea surface temperature in the Southern Ocean as a result of the reduced surface downward SW flux.

Work towards GA8 is currently focused on the NWP performance. To that end, we are running and assessing full data assimilation (DA) trials of GA6.1 (which is the current operational global NWP configuration at the Met Office), GA7 and GA7#256. GA7#256.7 is not as good as GA6.1 or GA7 in terms of the large-scale circulation but there are improvements to near-surface weather. A substantial amount of work is being done on understanding the interactions between the atmospheric model and the DA, and on understanding the error characteristics and error budgets of each of the model configurations.

It should be stressed that the performance of the GA development package, currently GA7#256.7, will not necessarily reflect the final performance of GA8: we are, however, aiming to retain the positive impacts whilst minimising any negative impacts. We are aiming to freeze GA8 in early 2018 but that will be dependent on achieving an acceptable level of both NWP and climate performance.

For more information please contact Martin Willett (martin.willett@metoffice.gov.uk Manager of Global Atmospheric Model Development).

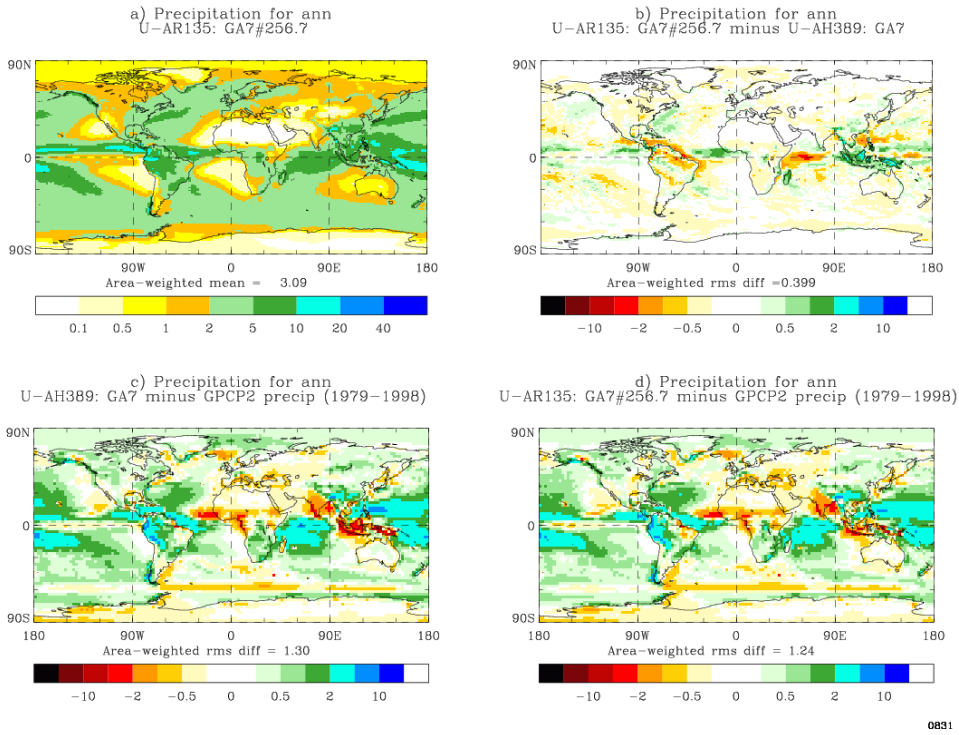


Figure 2: Annual mean precipitation rate (mm/day) in the N96 atmosphere/land-only climate simulations presented showing GA7#256.7 (top left), the difference from GA7 (top right) and the bias compared to GPCP observations in GA7 (bottom left) and GA7#256.7 (bottom right)

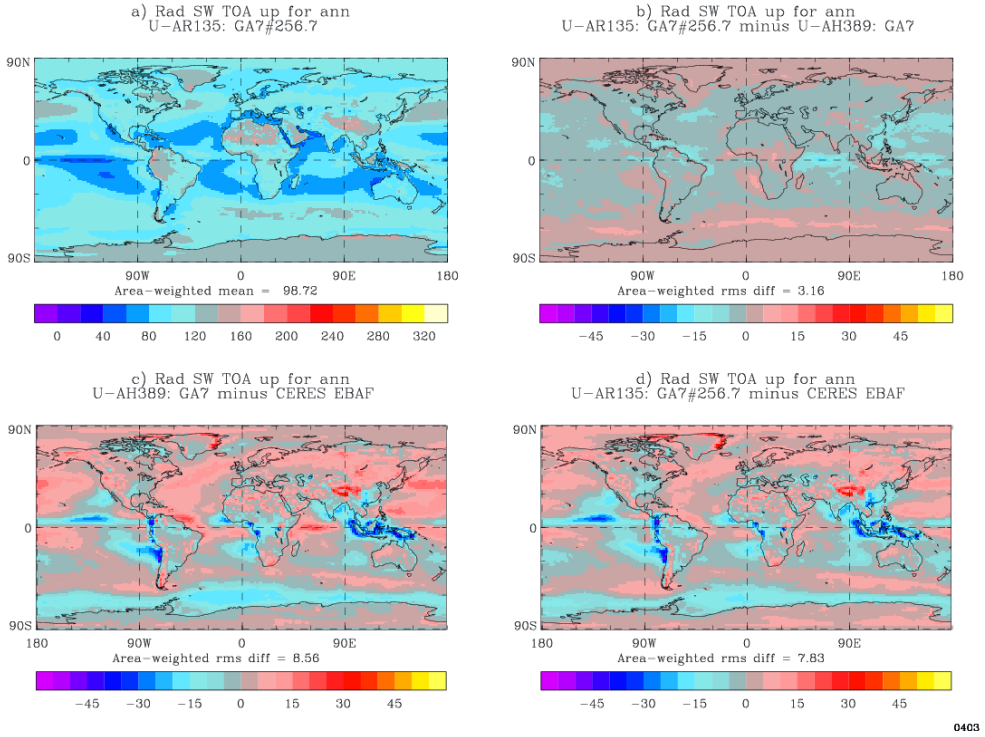


Figure 3: Annual mean outgoing shortwave flux (Wm^{-2}) in the N96 atmosphere/land-only climate simulations presented showing GA7#256.7 (top left), the difference from GA7 (top right) and the bias compared to CERES-EBAF observations in GA7 (bottom left) and GA7#256.7 (bottom right)

References

Liu, Y., Daum, P. H., Guo, H., and Peng, Y.: Dispersion bias, dispersion effect, and the aerosol-cloud conundrum, Environ. Res. Lett., 3,) 045 021, https://doi.org/10.1088/1748-9326/3/4/045021, 2008.

Walters, D., A. Baran, I. Boutle, M. Brooks, J. Edwards, K. Furtado, P. Hill, A. Lock, J. Manners, C. Morcrette, J. Mulcahy, C. Sanchez, C. Smith, R. Stratton, W. Tennant, L. Tomassini, K. Van Weverberg, M. Willett, S. Vosper, J. Browse, A. Bushell, M. Dalvi, P. Earnshaw, R. Essery, N. Gedney, S. Hardiman, B. Johnson, C. Johnson, A. Jones, G. Mann, S. Milton, H. Rumbold, A. Sellar, M. Ujiie, M. Whitall, K. Williams and M. Zerroukat, "The Met Office Unified Model Global Atmosphere 7.0/7.1 and JULES Global Land 7.0 configurations", Geosci. Model Dev. Discuss., submitted.

Willett, M., and Whitall, M.: A Simple Prognostic based Convective Entrainment Rate for the Unified Model: Description and Tests. Met Office Forecasting Research Technical Report 617.

— Martin Willet, Met Office

Future sea ice component for Global Coupled configurations

The current hierarchy of Global Coupled (GC) physical climate models make use of the Los Alamos sea ice model (CICE) developed in the US at the Los Alamos National Laboratory (LANL). Several years ago LANL announced that they would no longer be developing CICE in its current format and that the latest version of the model, CICE5 used within HadGEM3-GC3, would be the last to be supported. Sea ice development at LANL is now focussed on their new MPAS-CICE sea ice model being developed as part of the Department of Energy's (DoE) Accelerated Climate Modeling for Energy (ACME) project.

Over the last few years work has been ongoing at the Met Office to determine a sea ice modelling strategy, given this background. This strategy is now in place and at a Met Office Science Management Committee meeting earlier this year it was agreed that the future of sea ice modelling will be aligned with our ocean model NEMO.

Since the inception of NEMO the LIM sea ice model has been the official consortium sea ice model but several other sea ice models - including CICE and GELATO - have been used with NEMO. Under the guise of the newly formed NEMO Sea Ice Working Group the NEMO Consortium members, along with several other sea ice development groups using NEMO, have agreed to pool their resources to create a new unified sea ice model for NEMO. Technically this will be achieved by taking the current LIM3 sea ice model and merging in the aspects of CICE and GELATO required by the partners. The code will sit within the existing NEMO repository in place of LIM and will be renamed European Sea Ice Model (ESIM) to reflect the wider collaboration involved. A 2-year plan for development of the NEMO sea ice model has been drawn-up with the aim to have the new model finalised by March 2019.

At the Met Office we plan to have a working version of the HadGEM3 coupled model using a prototype NEMO sea ice model within the next year. The intention then is that the new NEMO sea ice model will be used with the GO8 global ocean configuration of NEMO to form the basis of the UK's contribution to CMIP7 and the physical basis for UKESM2. In the meantime we shall continue to use the CICE model and support its use within HadGEM3. In particular the current CICE5 GSI8 configuration, the sea ice component of the GC3 coupled model, will be used - both with the HadGEM3 physical climate model and the UKESM1 - for our contributions to CMIP6 and IPCC AR6.

— Ed Blockley, Met Office

Convective Scale RA1 Model Configuration

A new strategy is being adopted for Regional Atmosphere model development, similar to the global atmosphere development process. This is focused **on two key model configurations** which, wherever possible, should be adopted for use in NWP operations, climate applications and research projects. We have designed a formal process by which the development of these configurations will be managed on an annual cycle. The Regional Atmosphere (RA) model development process is concerned with:

- **RA-M: The mid-latitude configuration of the model.** This is currently based on the configuration of the UK NWP model (UKV and MOGREPS-UK).
- **RA-T: The tropical configuration of the model.** This is currently largely based on the configuration of the model developed within the SINGV project, since to date this has led the way in our tropical

modelling.

There are a small number of differences between these two configurations which relate to choices in the physical parametrization schemes. Whilst ideally these would be unified into a single model version (and ultimately that is the goal), for pragmatic reasons we are likely to need to maintain the two versions for the time being. Currently, the key differences in the prototype version 1 of RA-M and RA-T are the vertical level set, cloud parametrization scheme and stochastic perturbations in the boundary-layer scheme that relate to the triggering of convection

We are currently mid-way through the first annual cycle which will deliver the first RA versions, RA1-M and RA1-T in February 2018. The UM partnership is actively contributing to the evaluation of prototype versions of RA1-M and RA1-T by running case studies over their domains, and results are being collated on the Met Office Science Repository Service. The Met Office will implement RA1-M operationally in the UK NWP models in PS41.

Following the release of RA1 we will review the process, and plan for developing RA2 with an aim to chill a version by Summer 2018.

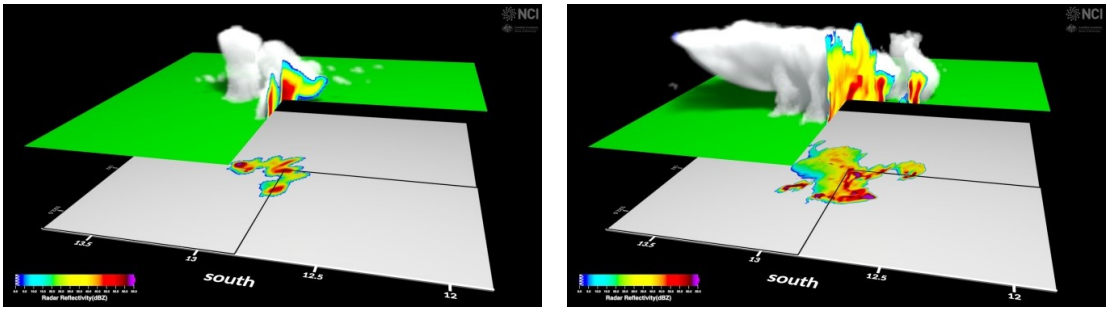
— Stuart Webster & Mike Bush, Met Office

RMED work at the Bureau

The Bureau is actively engaging in RMED activities, with contributions to numerous working groups and the Regional Atmosphere (RA) testing program. Along with other UM partners and the Met Office, the Bureau are currently testing prototype RA1 configurations to provide guidance on RA model performance over domains of interest. Bureau case studies cover a range of synoptic weather types from fog and cold air outbreaks to supercell thunderstorms, east coast lows and tropical mesoscale convective systems. The list of case studies and early results can be found in the RMED trac wiki test cases page..

At the Bureau, local testing of new science in the prototype RA1 models is providing a deeper understanding of what UM configurations are optimal for the six Australian convective-scale NWP domains that span the tropics to the midlatitudes. Through this RA testing and evaluation, the Bureau's RMED work is contributing to the development of the Bureau's next generation of convective-scale NWP systems.

In addition to testing the protoRA1 configurations in the Australian region, research at the Bureau is contributing to the RMED Convection Working Group. Much of the focus of this work at the Bureau has been on understanding the organisation of tropical convection in the convective-scale UM using a Darwin squall line case study. Squall lines are a common feature of Darwin weather and while the 1.5 km SingV3.0 model can simulate the observed squall line, the convective organisation is incorrect. As can be seen in the Figure 1, the 1.5 km model simulates convective cells that have a wide area of high radar reflectivity and are quite circular, an indication that the convection is under resolved. In contrast, a 400 m simulation produces convection aligned across the wind direction with extensive trailing stratiform cloud, both of which compare more closely with observations.



(a) 1.5 km horizontal grid length (b) 400 m horizontal grid length

Figure 1: Radar reflectivity volumes for the 1.5 km horizontal grid length simulation on the left, and the 400m simulation on the right. Surface radar reflectivities are plotted on the lower plane.

The 1.5km resolution simulated squall line shows convection forming on the trailing edge of the propagating

storm, rather than on the leading edge as is observed by radar. The under resolved convection at 1.5 km resolution leads to larger and stronger updrafts that produce a gravity wave response that is likely too strong in this resolution model. Due to the steering flow, this gravity wave propagates upstream and induces warming and drying of the environment that prevents deep convection from developing on the leading edge of the storm. The finer resolution 400m simulation seems to better resolve turbulent mixing, leading to more diluted updraft cores and larger areas of weaker updrafts, which together with the enhanced rear-inflow jet, allow the convective system to develop into a more realistic quasi-linear squall line. Participating in the RMED Convection Working Group provides an enhanced opportunity to collaborate with scientists from the Met Office and around the partnership to contribute to a better understanding and improvement of the convective-scale UM.

Acknowledgements *Stu Webster for providing the nesting suite, Drew Whitehouse from NCI for generating the figures and the RMED Convection WG for constructive feedback.*

— Charmaine Franklin, Bureau of Meteorology

Simulating Hurricane Irma

On September 5^{th}, as Hurricane Irma bore down on the island of Barbuda as a category 5 hurricane, the Met Office set up an experimental convection permitting ensemble with the intention of providing additional forecast guidance to the UK Government's overseas territories and also, as part of an on-going collaboration, to the National Weather Service in the USA. This was built on a convection permitting ensemble capability had only just been set up for the Southeast Asia region two weeks earlier. However, within 48 hours the forecast output, which was comprised of a suite of forecast products and web pages, was being made routinely available to the Met Office Global Guidance Unit (GGU) forecasters, who used this additional information when compiling their forecast advisories.

The CP ensemble was run at 4.4 km resolution, used the proto RA1-T configuration, was run out to T+120 twice per day, and was nested inside the 18 members of the MOGREPS-G global model ensemble from the most recent run. The domain was chosen to be sufficiently big that there would be minimal influence on the hurricane's evolution from the lateral boundary conditions. Furthermore, no perturbations were applied to the model physics parameters within the 4.4 km model and so, effectively, the only perturbations within the convection permitting ensemble were those inherited from the MOGREPS-G initial conditions.
With this capability in place, the 4.4 km ensemble was run for Hurricane Irma twice daily from 6th September 00z. Hurricanes Jose and Maria quickly followed on from Irma, and so the ensemble forecast and plotting suites were run for these hurricanes as well (with appropriate displacements to the limited area model domain). A subjective assessment of these real-time forecasts suggests that the CP ensemble was consistently providing added value, both in terms of forecast track and intensity, over MOGREPS-G (its driving global model ensemble), see Figure 1 for the Maria example.
For more information have a look at the presentation on Convective-scale ensemblesor Hurricanes Irma, Jose and Maria and related animations

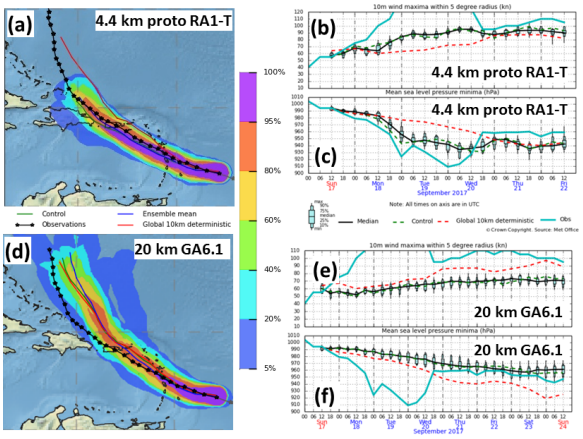


Figure 1: Summary statistics for ensemble forecasts initialised 12UTC 17/09/2017 for Hurricane Maria. (a) map of the strike probabilities (of Maria passing within 120 km) derived from 5 day forecasts of the 4.4 km ensemble. The black line shows the observed location of Maria, with a dot added every 6 hours. (b) as (a), but for the corresponding latest 18 members of the driving MOGREPS-G ensemble, which were run out for 7 days rather than 5.

— Stuart Webster, Met Office

Jiyoung 2 year secondment at the Met Office

I have been working at the Met Office for 2 years as a visiting scientist from Korea Meteorological Administration. I can recall vividly how my heart pounded for the first time because UKMO has been an object of admiration since I started to study atmospheric science.

I was filled with eager anticipation, much like a teenager going on a blind date.

I have investigated tropopause and stratospheric temperature and humidity errors, the representation of the large-scale energy and water cycles, and teleconnections from tropical sea surface temperature anomalies in the Unified Model (UM). I have continued to explore the development and cause of the temperature and humidity error at the tropopause, recently with a particular focus on the role of ozone which has resulted in a paper being submitted. I have also started to use similar analysis techniques to investigate the cause of the high latitude tropopause cold bias. In addition, I have added new diagnostics to one of the UM evaluation tools, Auto-assess, to evaluate the large scale energy transports and finally have undertaken sensitivity experiments to explore the role of sea surface temperature errors over the tropical Indian Ocean and West Pacific on global teleconnections to assess the impact of convection in the region on the large scale circulation.

For two years I have been in discussion with many people in the Met Office, especially in GMED diagnostic meeting. It was a great chance to learn how to share various points of view. My work on the tropopause biases forms part of a wider group of people looking into these errors - the Tropical Tropopause Layer Process Evaluation Group (TTL PEG). Whenever I had some trouble in diagnostic techniques, Paul Earnshaw gave me many help. Martin Willett, an expert on convective processes, advised on the hydrological cycle investigations and I have worked with Sean Milton and Maria Carvalho on the teleconnection studies. Sean Milton is calm and patient leader.

I extend my heartfelt gratitude to Keith Williams. He guided me well in my research and future direction of work.

Working in Met Office has been quite a valuable time in my life.

I really would like to thank everyone for their help.

— Jiyoung Oh, Korea Meteorological Administration

Getting closer to UKESM1

UKESM1 is almost here, we are expecting to see its freeze in January 2018. Currently the UKESM has now all the planned science capabilities now included and all components coupled together. What remains before finalising the model is to calibrate the fully coupled system to achieve good performance across a range of observed climate indicators, such as radiative fluxes, temperature and rainfall.

For more information on UKESM development have a look at the UKESM Newsletter

Met Office News

MONSooN 2

As covered in the last newsletter, iMonsoon, the joint Met Office / NERC collaborative environment, has been successfully migrated to a new HPC. We have also agreed and signed a new contract with NERC. This has been a more complex migration than previous changes of HPC; the previous 4 incarnations of Monsoon were on a standalone system. The new Monsoon service is run within a collaboration trust zone on the much larger Met Office Cray XC40 'XCS'. Implementing this architecture required a number of issues to be resolved, including changing a large number of usernames.

We are also providing a NERC-only service NEXCS in this zone, which has half the compute of Monsoon, but does not include post-processing facilities or access to the MASS data archive.

Existing projects have been migrated successfully, but owing to the 5-fold increase in compute - 550 Broadwell nodes (36 cores) are available - we are still looking for more projects to run on this service, as long as they are in line with JWCRP objectives.

More information on Monsoon and how to apply, can be found in MONSooN Suport Twiki . Requests for NEXCS - the NERC-only project resource should be made through the standard NERC process.

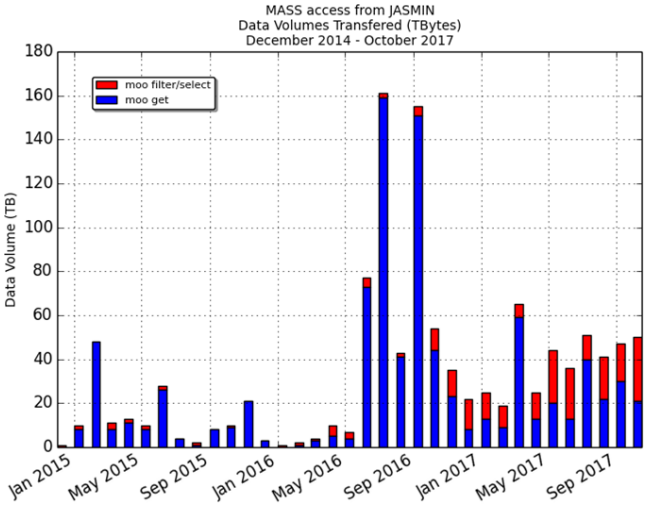
— AJ Watling, Monsoon Technical Lead, Met Office

Access to MASS data archive

We are pleased to announce that from 30th October 2017 Met Office staff have had access to the Met Office MASS data archive from ECMWF supercomputers.

Access to MASS (the Met Office data tape archive) has been achieved through an extension of MOOSE (the Met Office developed front-end to MASS) to allow Met Office employees to both read from and write to MASS. Access is only possible for Met Office staff, with various security measures within MOOSE to control access to datasets, and data passes over a recently upgraded network link that joins ECMWF and the Met Office.

Collaborators and Met Office staff can already have both read and write access from the Monsoon system, and read-only access is possible from the JASMIN system. Currently over 200 registered users from across the UM Partnership and UK environmental sciences community are regularly reading data from MASS on JASMIN, typically transferring over 1TB of data each day over a network link joining the Met Office and JASMIN. Plans are in place to increase the size of this network link in the coming months.



If you have any queries about accessing data from MASS, please contact either Katie Kerr, Met Office Collaboration Service Manager, or Roger Milton, Scientific Collaboration Technical Lead for details.

— Roger Milton, Scientific Collaboration Technical Lead

Recent Movements at the Met Office

Stuart Bell was the Head as Weather Science IT and has now retired from his duties at the Met Office.

Tim Johns was the Manager of Global Coupled Model Development and has now retired from his duties at the Met Office.

Glenn Greed has left his role as UM system manager to be the new Head of Weather Science IT.

Simon Vosper has left his role as Head of Atmospheric Processes and Parametrizations to be the new Director of Meteorological Science.

Keith Williams has left his role as Manager of Model Evaluation and Diagnostics to be the new Head of Atmospheric Processes and Parametrizations.

Martin Willett is now the new Manager of Global Atmospheric Model Development.

Prince Xavier is now the new Manager of Model Evaluation and Diagnostics.

Tim Graham is now the new Manager of Global Coupled Model Development.

David Walters has left his role as Manager of Global Atmospheric Model Development to be the new Head of Research to Operations (R2O).
This is a new team within Science which is responsible for the delivery, monitoring and support of scientific components of the operational NWP suite. They work with other teams in Foundation and Weather Science to develop the operational NWP suite, contributing directly to the research where appropriate. They also liaise closely with operational teams in TIS and FSD to understand and support their needs and requirements.

Areas of specific responsibility are:

- Coordination and delivery of upgrades to global and regional NWP suites through the Parallel Suite process
- Data assimilation for Earth System (i.e. non-atmospheric) model components and regional reanalysis
- Development and evaluation of regional (convection permitting) configurations of the Unified Model
- Development and maintenance of data assimilation and observation processing software

Conferences and Papers

New Zealand Meteorological Society Workshop in Dunedin at the start of November:

- **Trevor Carey-Smith (NIWA):** Changes in extreme rainfall depths over NZ due to climate change
- **Olaf Morgenstern (NIWA):** Earth System Modelling under the Deep South National Science Challenge
- **Jonny Williams (NIWA):** NZESM modelling on New Zealand's New supercomputers!
- **Yang Yang (NIWA):** Effects of gravity wave parameterization for different model resolutions

9^{th} Asia-Pacific Conference on Wind Engineering - Auckland on 4-7th December:

- **Stuart Moore (NIWA):** Application of very high resolution Numerical Weather Prediction to assessing wind damage during TC Winston
- **Stuart Moore (NIWA):** Application of very high resolution Numerical Weather Prediction to assessing wind damage during TC Winston

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.