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Lodging Code to the UM Trunk

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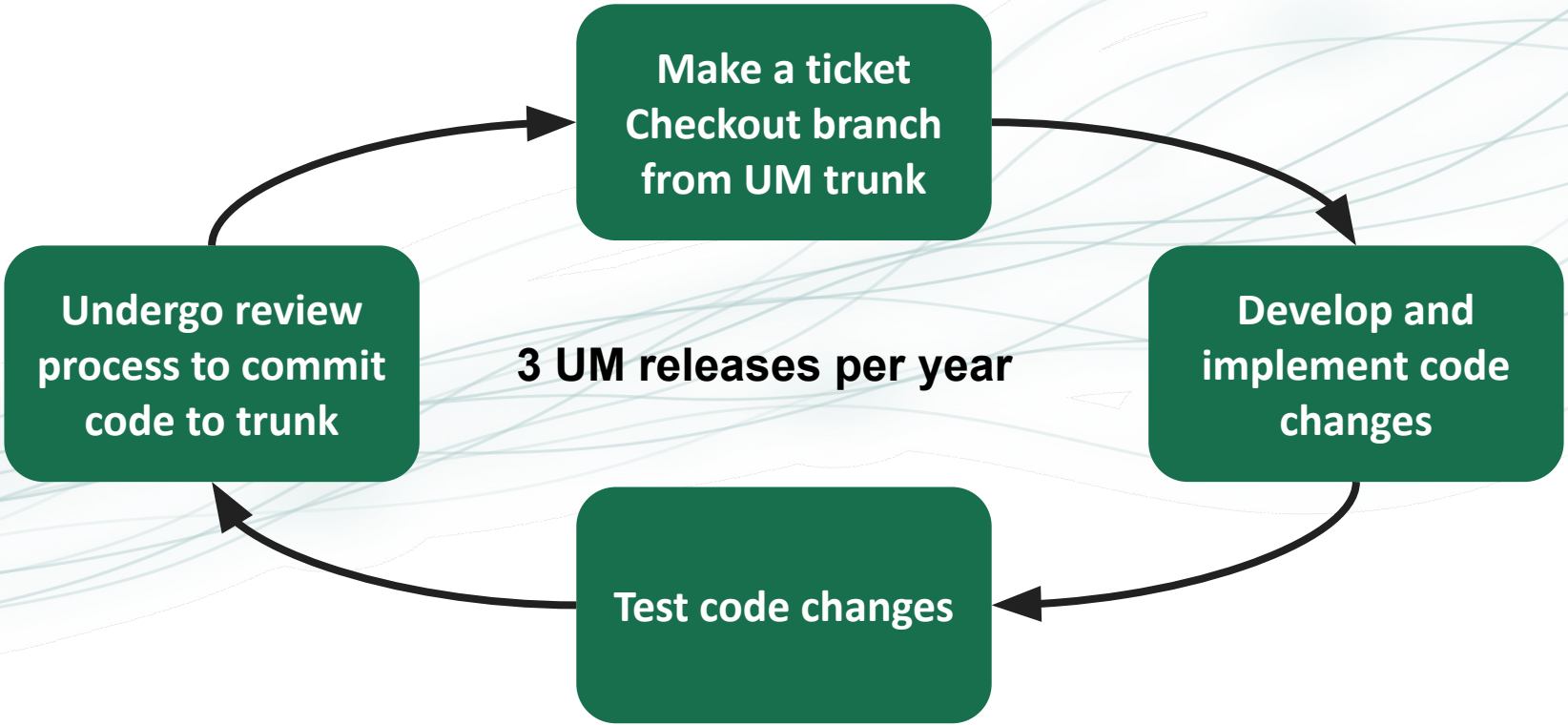
- The Unified Model development process
- Best practice
- Testing with standalone suites
- AutoAssess, Valnote, & the UKCA Evaluation Suite
- rose-stem

The Met Office Unified Model

- Approximately 900,000 lines of code (mainly Fortran), with a particular set of coding standards
- Over 200 active developers
- Uses the *Rose* graphical namelist editor and the *Cylc* workflow engine, with the code held in subversion repositories, managed using *FCM*

Met Office Unified Model development process



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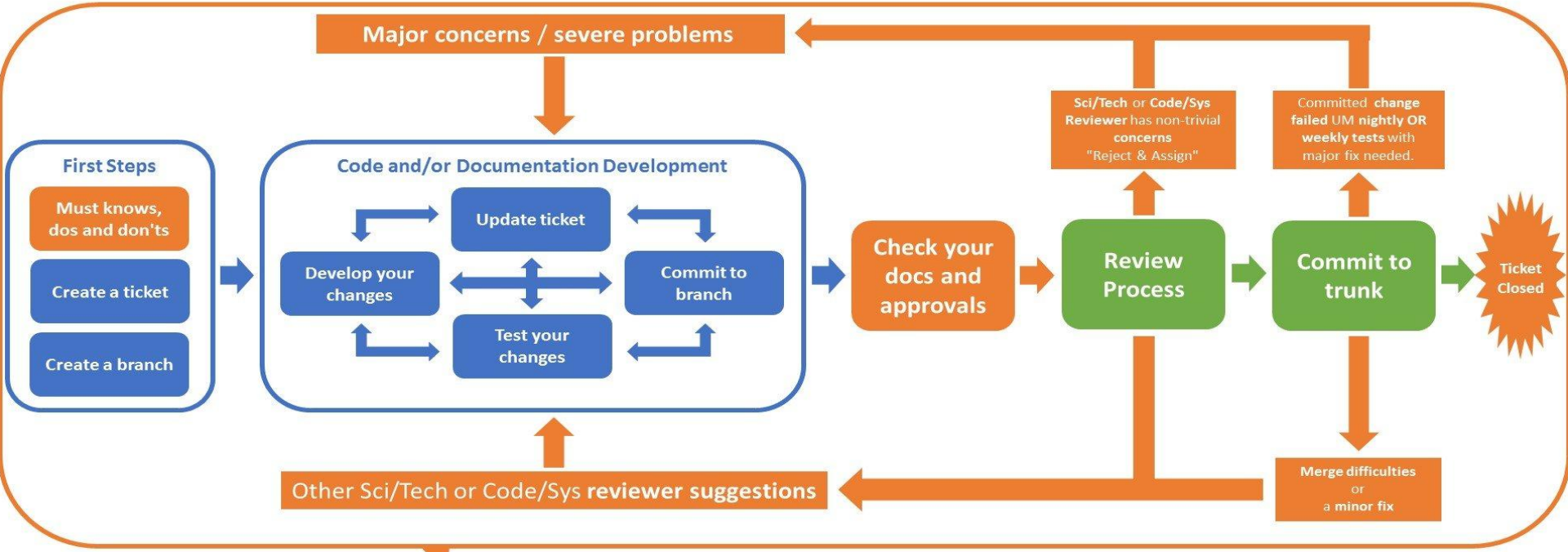
Best Practice

1. Read the UM Development Working Practices:

   https://code.metoffice.gov.uk/trac/um/wiki/working_practices

2. Start early - where possible, begin developing as soon as you can
3. Talk with others at the earliest opportunity, specifically to
    a. Discuss large changes with the Code Owner (i.e. me) to see if your approach fits within current plans
    b. If you can, find a Sci/Tech reviewer who will be familiar with the code area you are changing and the reasons for it, and discuss with them what plots/metrics etc. they would like you to provide
        i. If necessary, the Code Owner will be the Sci/Tech reviewer
    c. Find someone to run rose-stem tests for you, if needed/possible

UM Development Working Practices



Dealing with linked changes

- JULES
- SOCRATES
- CASIM
- NEMO/CICE/IOIPSL or MOCI
- AUX files

Concurrent testing, documentation and code changes

Escalation

Problems getting your changes through the process?

Key

- Things to pay attention to
- Your responsibility
- Reviewer responsibility

Best Practice

These practices can seem very complex and difficult to engage with. They are designed to work with a production code that needs to be run daily and updated regularly.

Remember

DON'T PANIC

if you need help and advice, I'm very happy to give it, as are many others who have been through the process. It is rewarding to get code on the trunk and in use by others. Once code is on the trunk it can then be considered by science configurations, e.g. GA or UKESM.

Code development process

- Science changes often require testing with long simulations that will take several weeks or more to run
  - Diagnostics are then run through *AutoAssess*, *Valnote, & UKCA Evaluation Suite* tools to produce many plots of standard metrics
- Try not to make your code changes larger or smaller than they need to be - too big and they may have difficulty going through review, and too many similar small changes add unnecessary overhead
- All code changes must be tested using the *rose-stem* utility, using a set of standard tests that protect UM configurations from accidental changes
  - If a configuration is not tested regularly it is at risk of breaking
- **You must be able to show that your change works when turned on and doesn't *break** anything when turned off**

Code development process

As well as your ticket and code changes, you may need to:

- Make changes to documentation (UMDPs)
- Make changes to other (non-UKCA) routines
- Make a new test in rose-stem
- Make changes to Rose metadata (how the GUI looks & behaves)
- Make changes to output (STASHmaster files)

You will need to discuss your changes with:

1. The Code Owners of all code sections affected
2. The Reviewers of your code (Sci/Tech and Code/System, i.e. UMSys)
3. Owners of any rose-stem configurations where answers change
4. Other teams, e.g. optimisation, for approval
5. Other codes, e.g. JULES, SOCRATES, for linked changes

Testing with Standalone Suites

Different testing suites for UKCA climate jobs exist:

- 20-year Global Atmosphere
  - GLOMAP-mode with offline-oxidants only
  - Output designed to be used with AutoAssess & Valnote

- 20-year TS2000 AMIP suite
  - UMvn11.0 onwards
  - StratTrop chemistry
  - Free-running and nudged configurations available
  - Output designed to be used with UKCA Evaluation Suite

https://www.ukca.ac.uk/wiki/index.php/GA7.1_StratTrop_suites

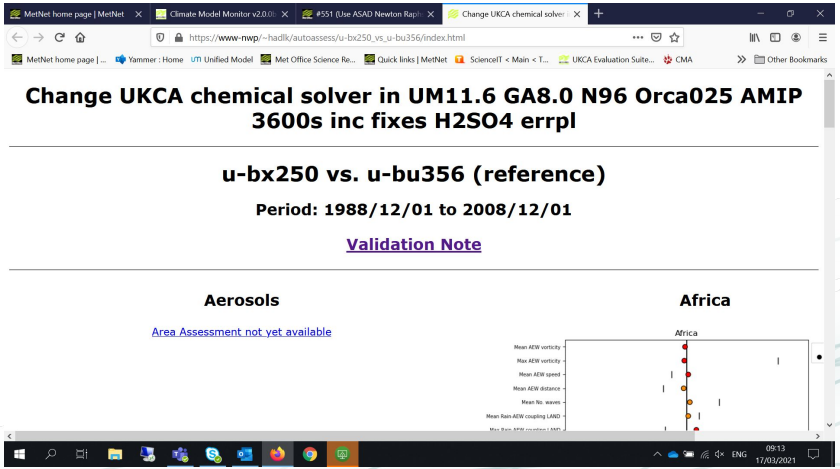
Testing with Standalone Suites

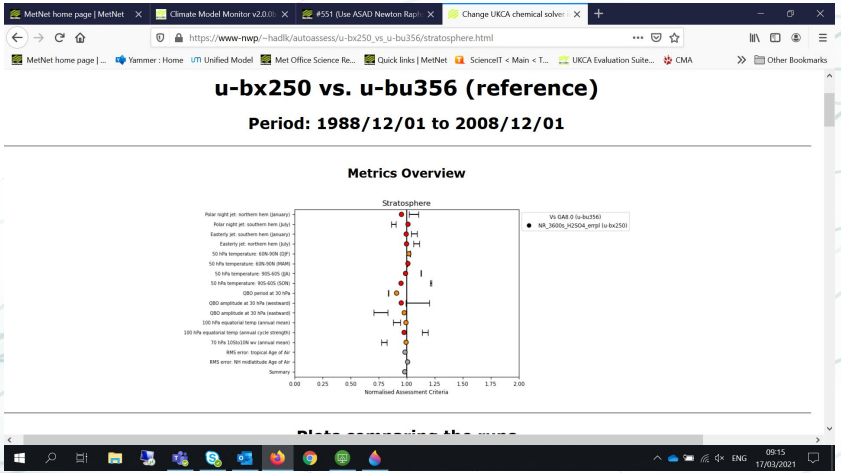
- 2-day short suite
  - UMvn10.6 onwards
  - GLOMAP-mode with offline-oxidants
  - StratTrop
  - CRI-Strat (vn11.8 onwards)
  - Runs a series of tests
    - KGO
    - Restartability (NRUN vs. NRUN-CRUN)
    - OpenMP
    - Rigorous

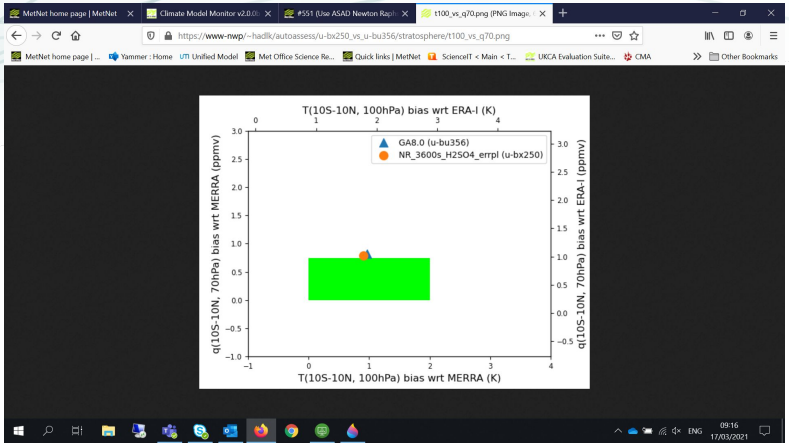
    https://www.ukca.ac.uk/wiki/index.php/Rose-UKCA_suites

- You may also need to test in AQUM suites if your code changes also affect AQUM output

AutoAssess







Compares your development run in GA suite against a control

Current lack of Aerosols in standard assessment

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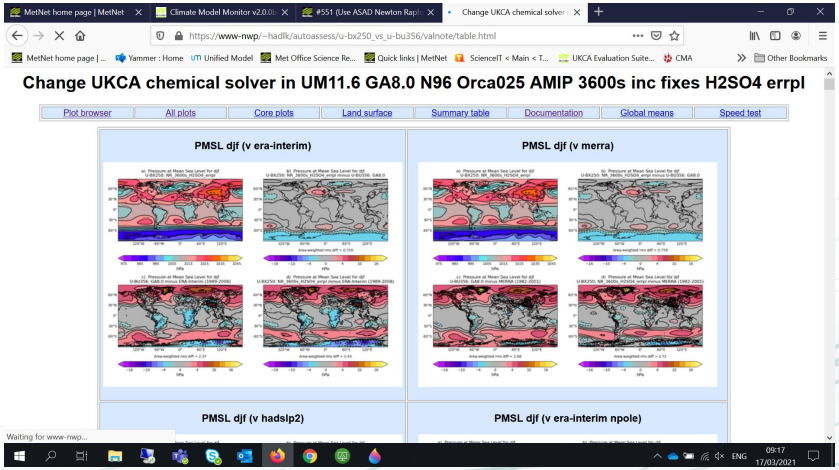
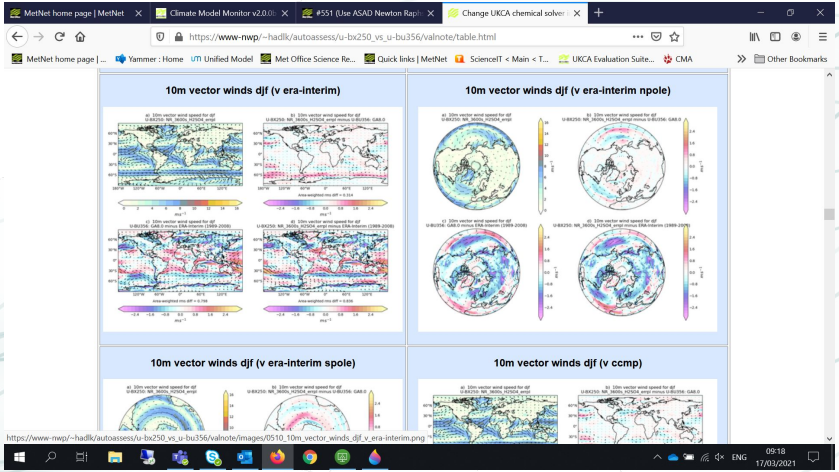
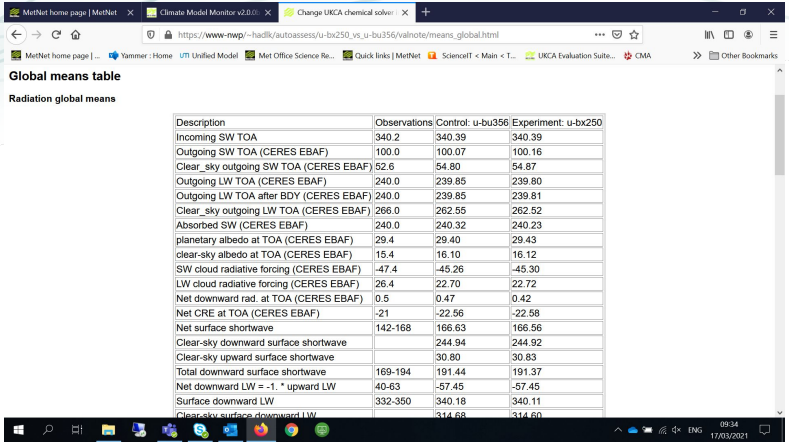
Validation note







Global means table

Radiation global means

Description	Observations	Control: u-bu356	Experiment: u-bx250
Incoming SW TOA	340.2	340.39	340.39
Outgoing SW TOA (CERES EBAF)	100.0	100.07	100.16
Clear_sky outgoing SW TOA (CERES EBAF)	52.6	54.80	54.87
Outgoing LW TOA (CERES EBAF)	240.0	239.85	239.80
Outgoing LW TOA after BDY (CERES EBAF)	240.0	239.85	239.81
Clear_sky outgoing LW TOA (CERES EBAF)	266.0	262.55	262.52
Absorbed SW (CERES EBAF)	240.0	240.32	240.23
planetary albedo at TOA (CERES EBAF)	29.4	29.40	29.43
clear-sky albedo at TOA (CERES EBAF)	15.4	16.10	16.12
SW cloud radiative forcing (CERES EBAF)	-47.4	-45.26	-45.30
LW cloud radiative forcing (CERES EBAF)	26.4	22.70	22.72
Net downward rad. at TOA (CERES EBAF)	0.5	0.47	0.42
Net CRE at TOA (CERES EBAF)	-21	-22.56	-22.58
Net surface shortwave	142-168	166.63	166.56
Clear-sky downward surface shortwave		244.94	244.92
Clear-sky upward surface shortwave		30.80	30.83
Total downward surface shortwave	169-194	191.44	191.37
Net downward LW = -1. * upward LW	40-63	-57.45	-57.45
Surface downward LW	332-350	340.18	340.11
Clear-sky surface downward LW		314.68	314.60

Also compares both GA runs against MERRA or ERA-Interim

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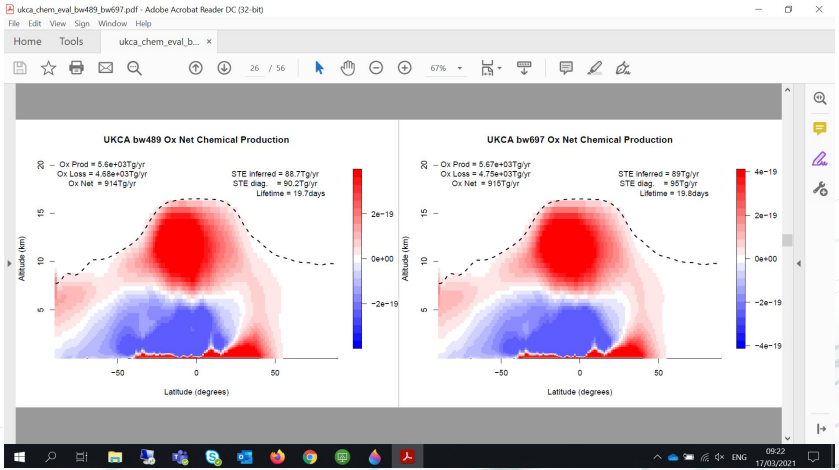
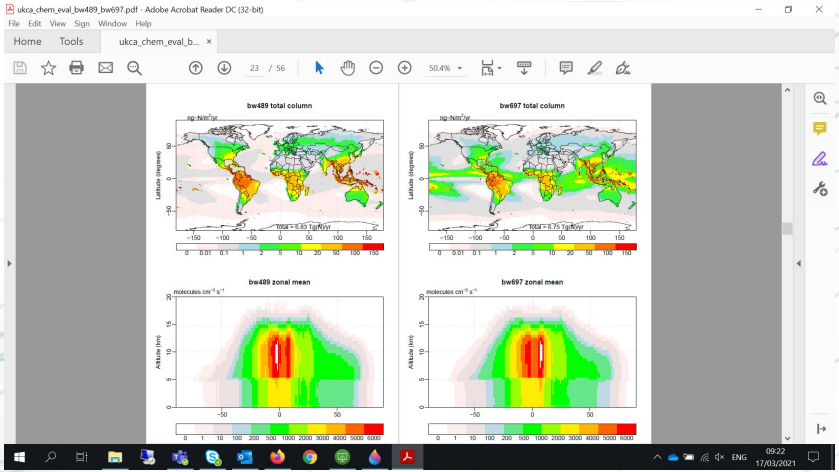
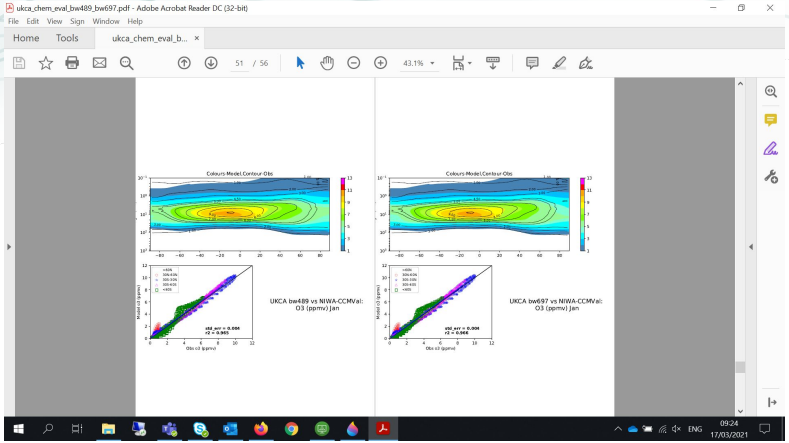
UKCA Evaluation Suite





Compares output from your suite against various observational datasets



Currently Aerosol Evaluation Suite is IDL-based - will now no longer work at the Met Office

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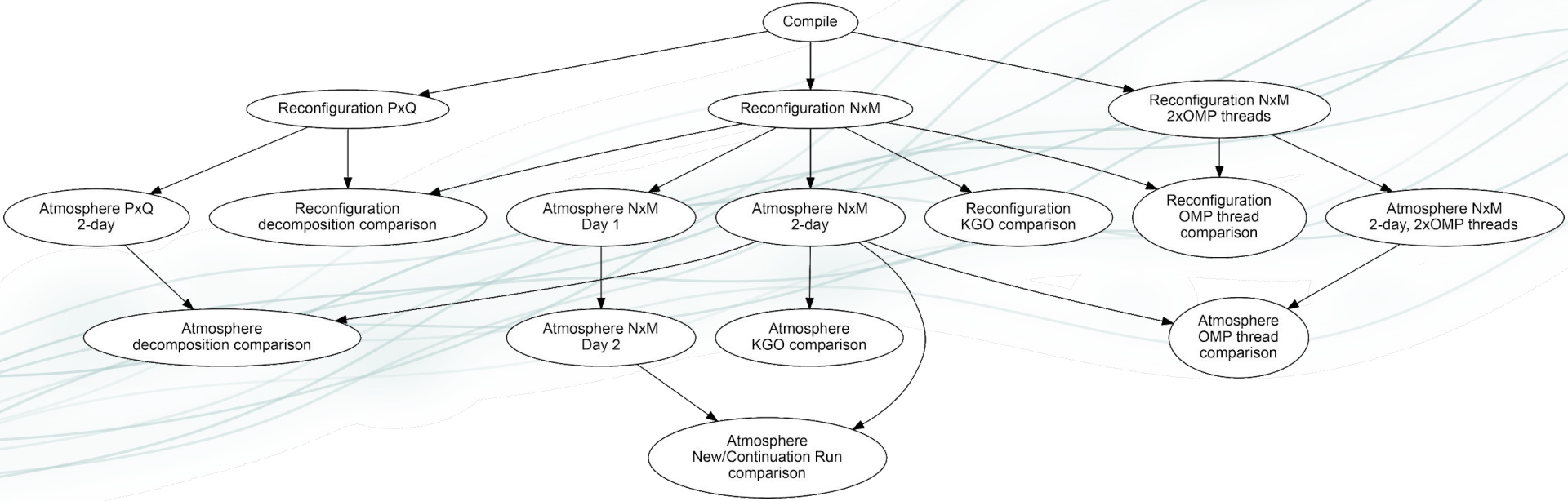
rose-stem

- At vn11.9 there are 273 UM testing jobs
  - 194 HPC (180 Cray, 6 GCC/Intel, 8 GNU)
  - 79 Linux (47 GCC/Intel, 26 GCC/PGI, 6 Clang/Intel)
- 54 additional restart file creation tests (35 Cray HPC, 19 GCC/Intel Linux)
- These tests include “KGO”, Restartability, OpenMP, & processor decomposition tests, with a range of optimisation levels
  - high, fast, safe, debug, rigorous
- There are 28 UKCA climate tests (StratTrop & CRI-Strat) using Cray and GNU, & 11 AQUM tests
- Further tests for code standards, metadata, utilities, creation of boundary conditions, etc.

rose-stem - Met Office testing framework



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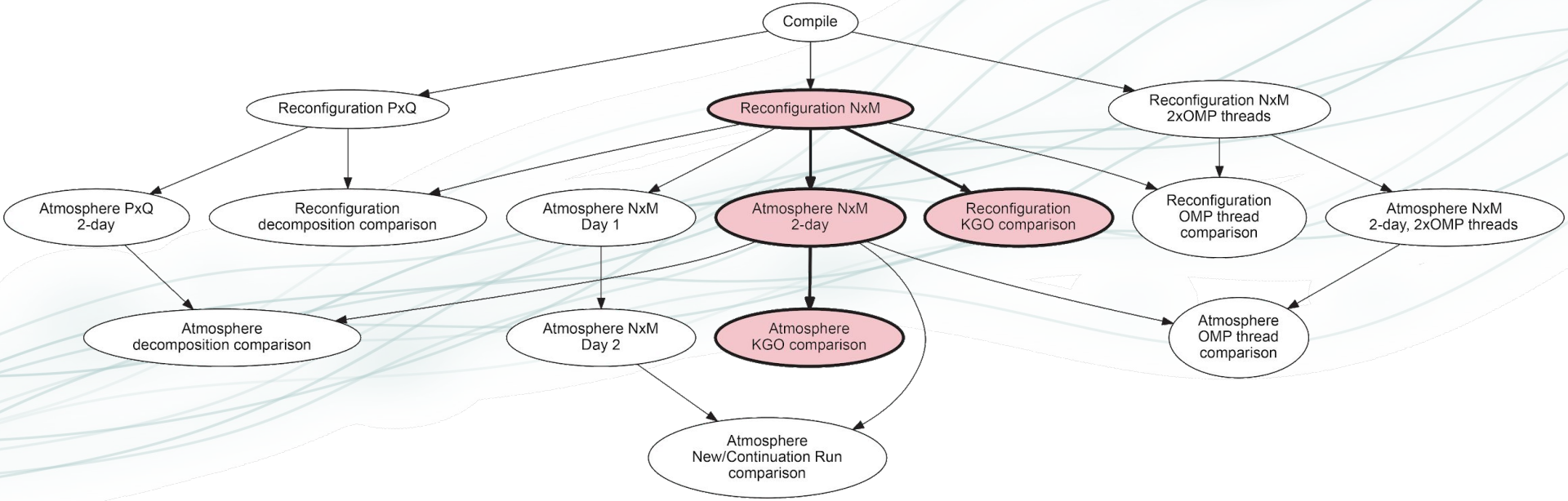
rose-stem - “Known Good Output” or KGO tests



Also test with different levels of compiler optimisation

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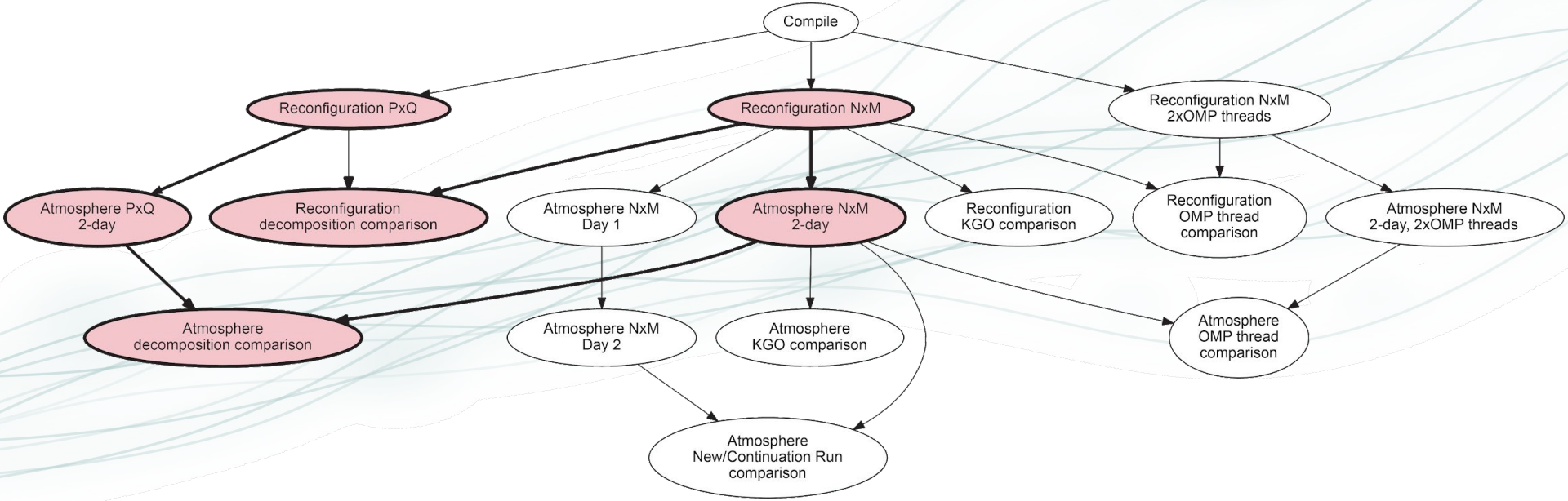
rose-stem - processor decomposition tests



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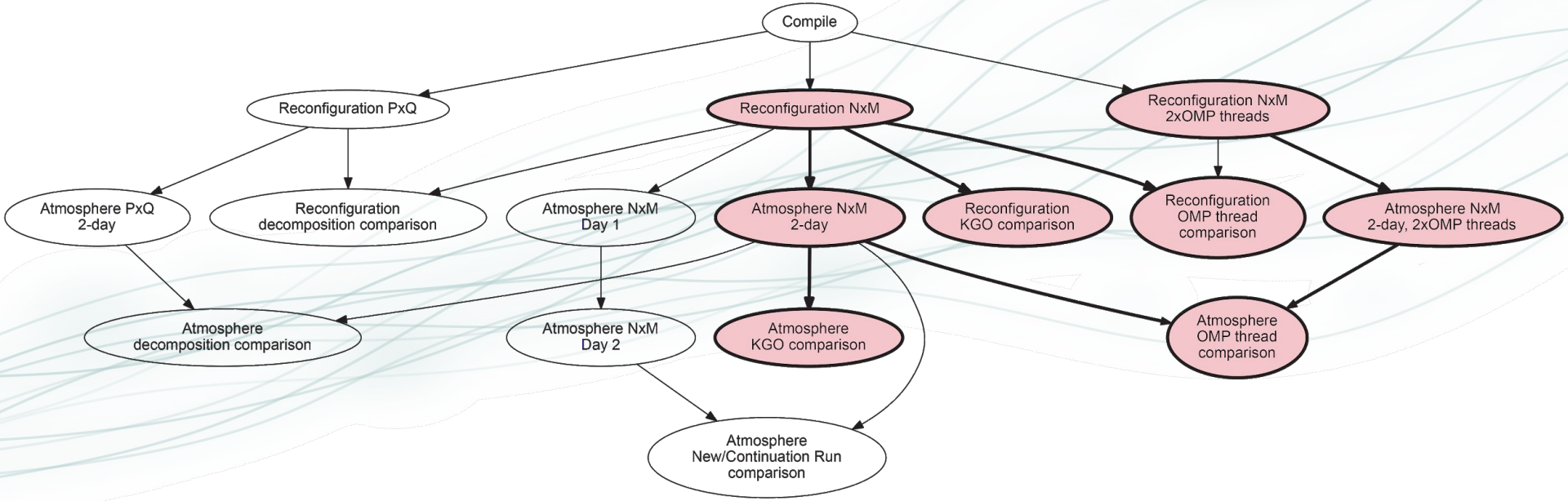
rose-stem - OpenMP tests



KGO should be identical with or without OpenMP

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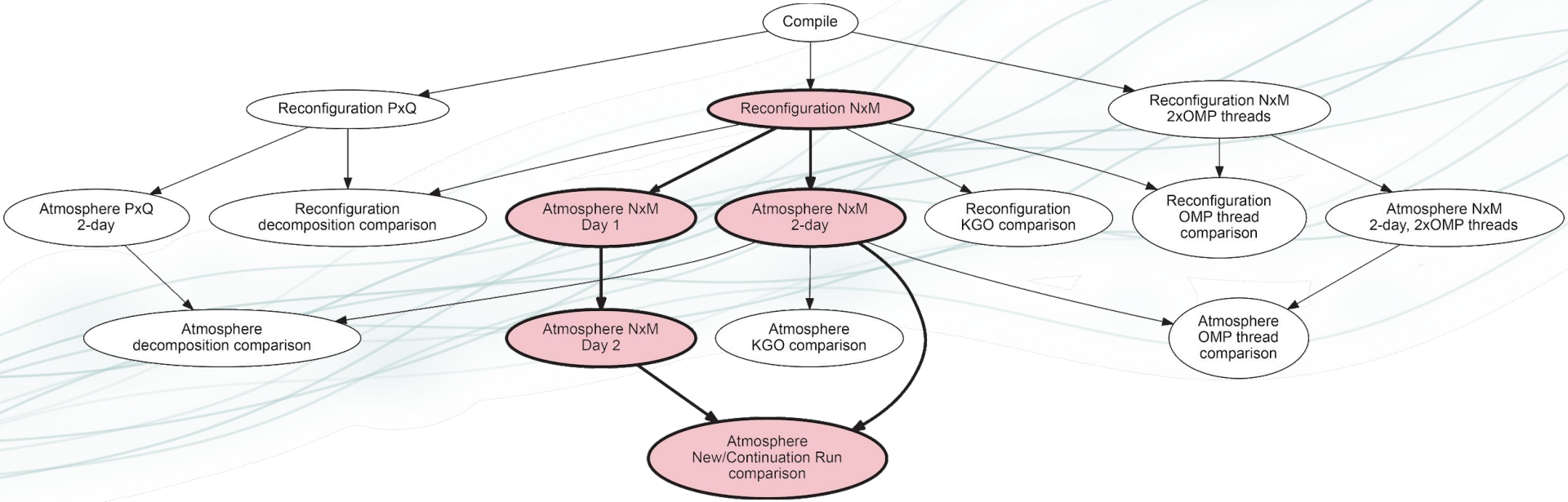
rose-stem - restart tests



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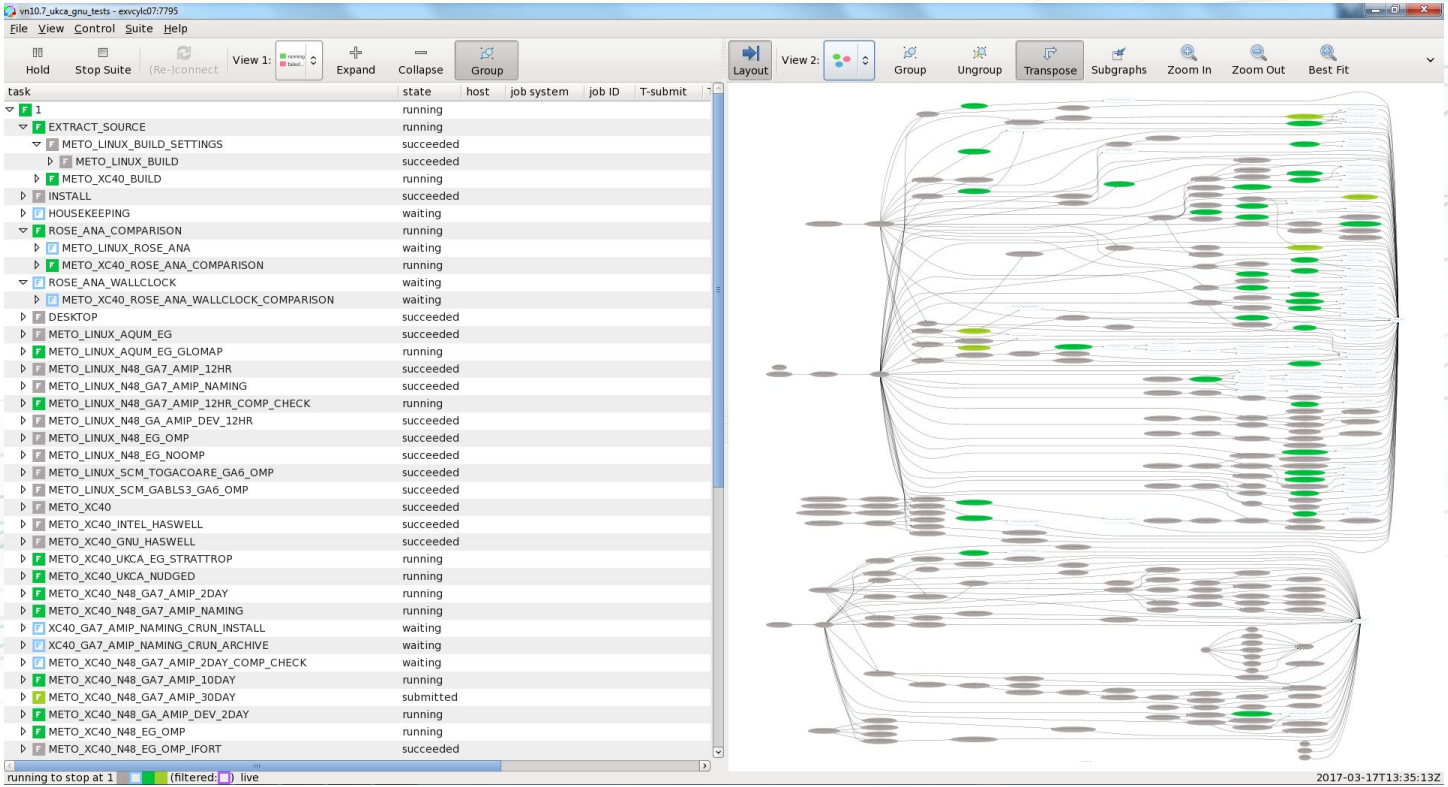
rose stem --group=developer,ukca



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Preparing your Trac Ticket

All these standard jobs, assessment tools, and rose-stem tests have been designed to automate, as much as possible, the online documentation you need to prepare when making a change. This is held in the **Trac Ticket**, and will cover

1. A description of the change and why its being made
2. Links to the UM code (& documentation paper) changes
3. A “Ticket Summary” detailing approvals given & tests performed
4. Potentially a “Ticket Details” page with further information

The Reviewers will then add “Sci/Tech Review” and “Code/System Review” pages, detailing their reviews and any questions/issues they have found. **You will need to respond to these before the ticket can proceed to the next stage.**

Example: Ticket um:#5713

Modify ↓

#5713 closed enhancement (fixed)

Opened 8 months ago
Closed 6 months ago

Update UKCA lightning NOx settings

Reported by:	lukeabraham	Owned by:	lukeabraham
Milestone:	~~UM11.8 (Oct 20)~~	Component:	General
Severity:	significant	Keywords:	UKCA, collab:ncas, collab:cambridge, collab:csiro, macro, kgo, SR:jonathanwilkinson CR:joemancell
Cc:	jonathanwilkinson, ashokluhar		

Description (last modified by jonathanwilkinson) Δ

Reply

Ashok Luhar and colleagues at CSIRO have made some developments to the existing Price & Rind Lightning NOx scheme, which will be implemented here.

The change involves changes to the flash frequ updated scaling factors. These increase the nu

Further information on the motivation behind th scaling factor (`lightnox_scale_fac`) shou change, to keep lightning NOx emissions at arc

The `ukca_strattrop_exp` rose-stem test j for this job needs to be updated.

UMvn11.7 branch: main/branches/dev/lukeabra

ticket/5713/TicketDetails

ticket/5713/TicketSummary

ticket/5713/SciTechReview

wiki: ticket / 5713 / TicketDetails

Ticket Details #~~5713~~

Author: Luke Abraham

Branch

main/branches/dev/lukeabraham/vn11.7_ukca_lnox_updates

Documentation

Motivation

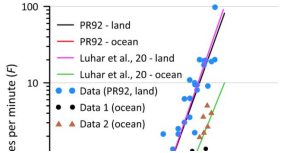
Luhar et al. (2020) has re-calculated the flash frequency scaling factors used for the Price & Rind (1992) parameterisation. The equations are of the form

$$F = A\,H^B$$

where F is the flash frequency (/min), and A and B are given as:

Formulation	Region	A	B
Price & Rind (1992)	Land	3.44e-05	4.90
	Ocean	6.40e-04	1.73
Luhar et al. (2020)	Land	2.40e-05	5.09
	Ocean	2.00e-05	4.38

The Luhar et al. values are derived from the observations show in the figure below (adapted from Luhar et al. 2020):



wiki: ticket / 5713 / TicketSummary

Up | Start Page | Index | History

Ticket Summary #~~5713~~

Author: Luke Abraham

To be completed prior to Sci/Tech review *and updated* as required during the review process.

All developers are reminded to follow the detailed UM working practices

Branch

Code branch `fcm:um.x_br`
vn11.7_ukca_lnox_updates

Documentation branch `fcm:um_doc.x_br` *Does this change require a UMDP update and has it been built?*
vn11.7_ukca_lnox_updates_doc
umdp_035_t5713.pdf
umdp_084_t5713.pdf

Test branch *When is a test branch required?*
r88139_ukca_lnox_updates

Testing

The bare minimum that will be accepted is the `--group=developer` but many, if not most, changes will need to test other groups to ensure they meet reviewer expectations. For example, `--group=ukca` , `--group=jules` , `--group=casim` etc. Please see: the available Met Office groups or the groups available at your site.

- If you are a UM collaborator and unsure if your change will alter model evolution or diagnostics in model configurations not contained in your local rose stem test suite please request that either a Met Office collaborator or UM System team member run a wider selection of model configurations on your behalf (Note that for all changes the code reviewer will always run at least the Met Office developer tests on your behalf).

```
--group=developer,ukca
```

Impact of change

Will this maintain results (model output and evolution) in all UM model configurations?	**YES**
Will this maintain results (model output and evolution) in all the tests held within the rose-stem test jobs (including small execs)? (the 'all' group)	**NO***
If this change adds/alters UM diagnostic(s), has evidence been supplied to show that it bits compares across procs and that an appropriate packing choice has been made in the stashmaster? *where applicable*	**YES**
How does your change impact upon required resources; memory and runtime? A link to table of resource values for rose stem jobs for each UM version can be found at the top of the relevant version standard jobs page	No change - see below

Ticket should provide sufficient detail for others to understand the reason for the change.

Remember to pass the ticket to your reviewers when ready, they will not know about it otherwise. They may pass it back to you with questions/concerns. The comments section will show this “conversation” back and forth.

`https://code.metoffice.gov.uk/trac/um/ticket/5713`

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Timescales

There is around 2.5 months following a UM release before the next **Code Review deadline** - the date by which a ticket needs to have been passed to the Code/System Reviewer (it can still undergo the Code/System Review after this date).

However, it will take time to prepare your ticket, do your code changes, & write the documentation. There is a minimum level of work required that is quite high.

Any science runs required will also take around 2-to-3 weeks to complete and then need to be plotted. If you do not “break” any rose-stem tests things are easier.

Plan for at least a month (real time) before your ticket could go to Sci/Tech Review, and then allow for at least a week turnaround there.

The best time to start developing a change is immediately following a UM release. Do NOT wait until the last minute.

UMvn12.0 Code Review Deadline is **21st May** (14th May for Approvals)

Conclusions

- UM code development can seem complicated and daunting if you have not done it before
- The reason why it is this complicated is because the UM is developed and used frequently by many people, and so there are lots of checks to ensure that when code is added it is coded in the best way and does what it is supposed to do
    - Things still fall through the cracks though!
- The best way to develop a change is to start early and talk to others about what you are doing
- We are happy to help you through the process - UKCA has been very successful in having code changes made by many people from inside and outside the Met Office