UKESM General Assembly

Science Talks – Session C

Jonny Williams

NIWA

NIWA

Taihoro Nukurangi

Jonny Williams, UKESM LTSM, 17th June 2020 - UKESM data processing on JASMIN from 19,000km away

Dr Jonny Williams

Staff search

Contact

Dr Jonny Williams

Position: Climate Scientist
Phone: +64-4-386-0303
Location: Wellington
Science Centres: Atmosphere, Climate

Qualifications:

MSci, PhD

Biography:

Jonny Williams studied physics at Imperial College London and has a PhD in computational physics from the University of Bath. Before moving to NIWA in 2015, Jonny worked as a scientist for the UK Met Office, an environmental consultant working with public and private organisations and stakeholders, and as a paleoclimate researcher at Bristol University. His research underpins and supports the earth system modelling capability of New Zealand researchers and the wider Deep South National Science Challenge. Jonny is a qualified Software Carpentry instructor and has a particular interest in science communication and visualisation.

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About NIWA

Decision makers at all levels are seeking pragmatic, evidence-based advice from environmental experts. NIWA's science provides high quality insights to underpin important decisions, and innovative solutions.

About us

- Our company
- Our mission
- Our people
- Statement of Core Purpose
- Statement of Corporate Intent
- Our partners & funders
- Annual reports
- Careers at NIWA
- Organisational responsibility

Our company

NIWA, the National Institute of Water and Atmospheric Research, is a Crown Research Institute established in 1992. It operates as a stand-alone company with its own Board of Directors and Executive.

Our mission

NIWA's mission is to conduct leading environmental science to enable the sustainable management of natural resources for New Zealand and the planet.

Our people

Find out more about our board, management teams, and key National Centre contacts. To locate individuals working at NIWA simply use our site search above.

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NeSI
New Zealand eScience Infrastructure

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- Who we are
- Background
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About Us

New Zealand eScience Infrastructure (NeSI) enables researchers across a wide range of communities and disciplines to tackle large or highly complicated problems and to investigate scientific challenges that were previously impossible. NeSI makes approaching these problems easier for researchers through offering a specialised platform of computational and analytics software and services powered by supercomputers, and placing strong emphasis on support and training alongside the raw power of its technology platform.

NeSI is a national collaboration of the University of Auckland, the University of Otago, Manaaki Whenua - Landcare Research, NIWA, and the Ministry of Business, Innovation and Employment (MBIE).

Our Structure

The NeSI Governance Board is made up of representatives from each major investor, as well as an independent Chair and an independent director with international research infrastructure leadership experience.

Our Support Team is comprised of experts who provide computational science support and work directly with investigators to improve their research productivity on NeSI platforms.

Our Background

NeSI is an unincorporated body, with investment from New Zealand universities, Crown Research Institutes and the Crown, through the Ministry of Business, Innovation and Employment.

The investors are the University of Auckland, NIWA, Manaaki Whenua - Landcare Research, the University of Otago, and the Ministry of Business, Innovation and Employment. Legally, the University of Auckland engages in contracts on behalf of the members.

Read more about our background including our original Investment Case and most recent Business Case.

Climate, Freshwat

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REANNZ

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Moving data, mobilising knowledge.

We provide a specialist network, tools and services to enable NZ's scientists, researchers and educators to connect, collaborate and contribute.

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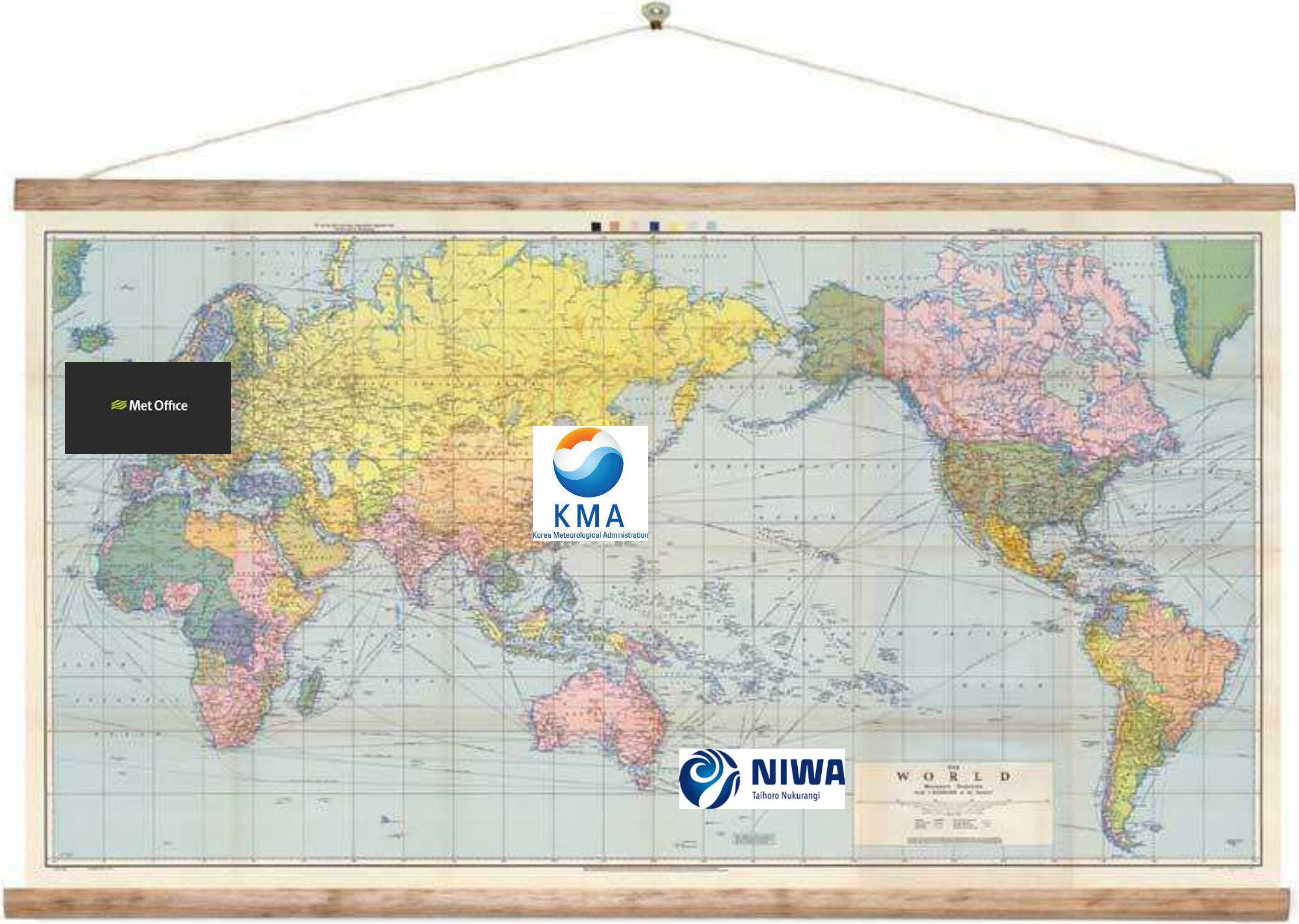
72	35	350,000	71,884
petabytes transferred over REANNZ network in the last year	% total traffic growth year-on-year	researchers, academics, educators, innovators, staff & students have access to REANNZ's network	devices in NZ expected to connect via eduroam in 2019/20



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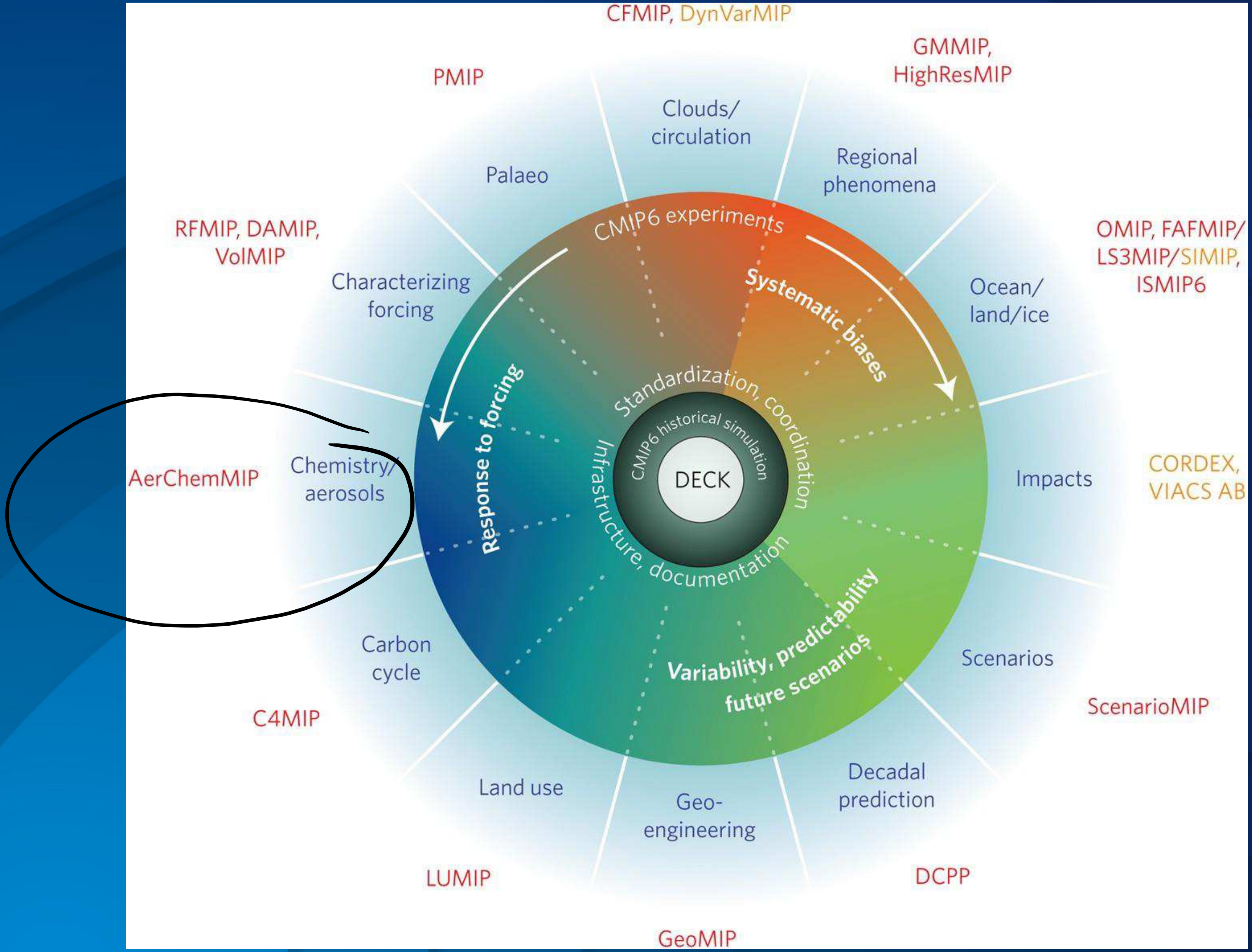

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Geosci. Model Dev., 10, 585–607, 2017
www.geosci-model-dev.net/10/585/2017/
doi:10.5194/gmd-10-585-2017

Geoscientific Model Development
Open Access
EGU

AerChemMIP: quantifying the effects of chemistry and aerosols in CMIP6

William J. Collins[1], Jean-François Lamarque[2], Michael Schulz[3], Olivier Boucher[4], Veronika Eyring[5], Michaela I. Hegglin[1], Amanda Maycock[6], Gunnar Myhre[7], Michael Prather[8], Drew Shindell[9], and Steven J. Smith[10]

[1]Department of Meteorology, University of Reading, Reading, RG6 6BB, UK
[2]National Center for Atmospheric Research, Boulder, CO, USA
[3]Norwegian Meteorological Institute, Oslo, Norway
[4]Laboratoire de Météorologie Dynamique, IPSL, Université Pierre et Marie Curie/CNRS, Paris, France
[5]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[6]School of Earth and Environment, University of Leeds, Leeds, UK
[7]CICERO – Center for International Climate and Environmental Research Oslo, Oslo, Norway
[8]University of California, Irvine, CA, USA
[9]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA
[10]Joint Global Change Research Institute, Pacific Northwest National Laboratory, 5825 University Research Court, Suite 3500, College Park, MD 20740, USA

Correspondence to: William J. Collins (w.collins@reading.ac.uk)

Received: 1 June 2016 – Discussion started: 12 July 2016
Revised: 16 December 2016 – Accepted: 4 January 2017 – Published: 9 February 2017

Climate, Freshwater & Ocean Science

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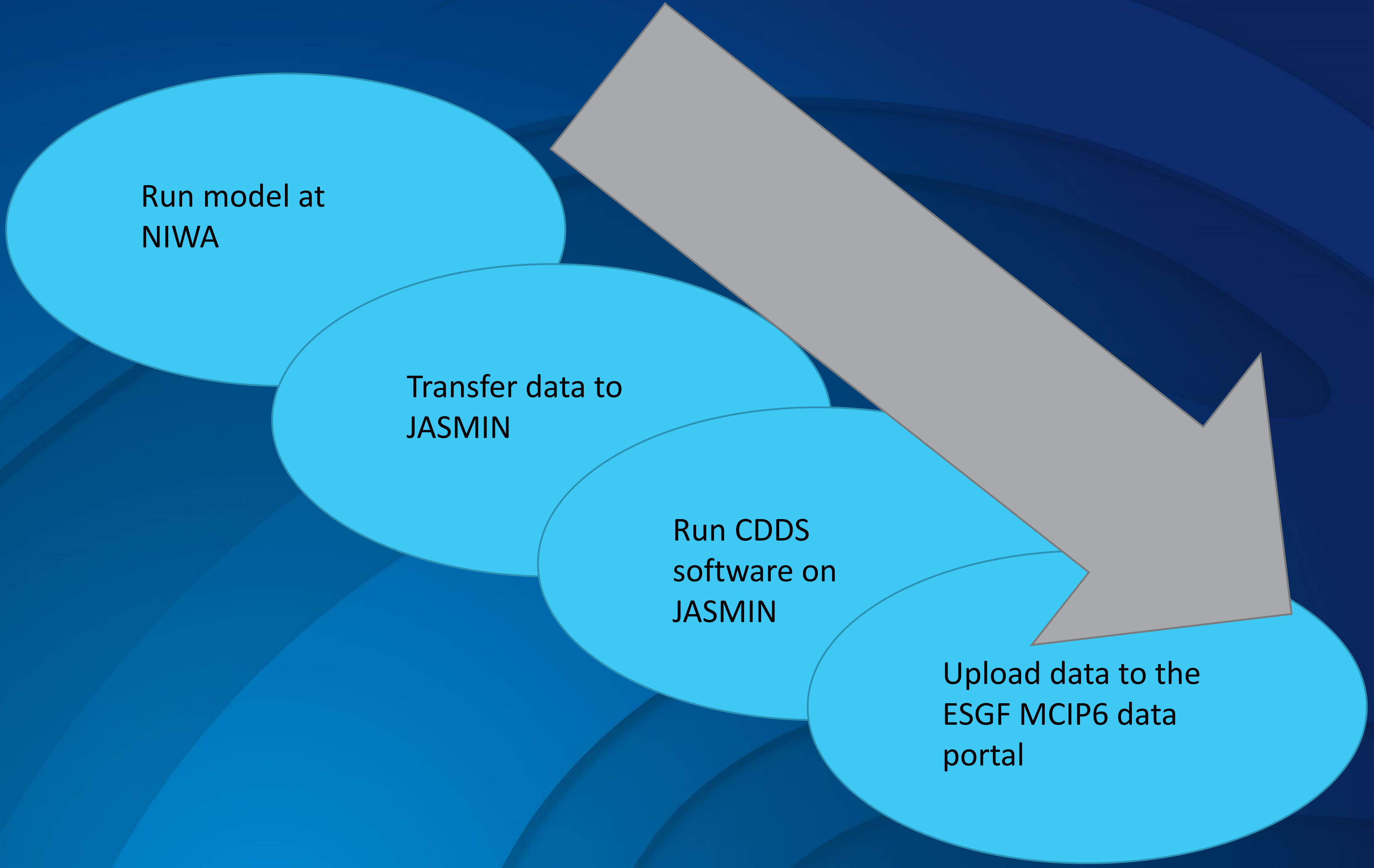
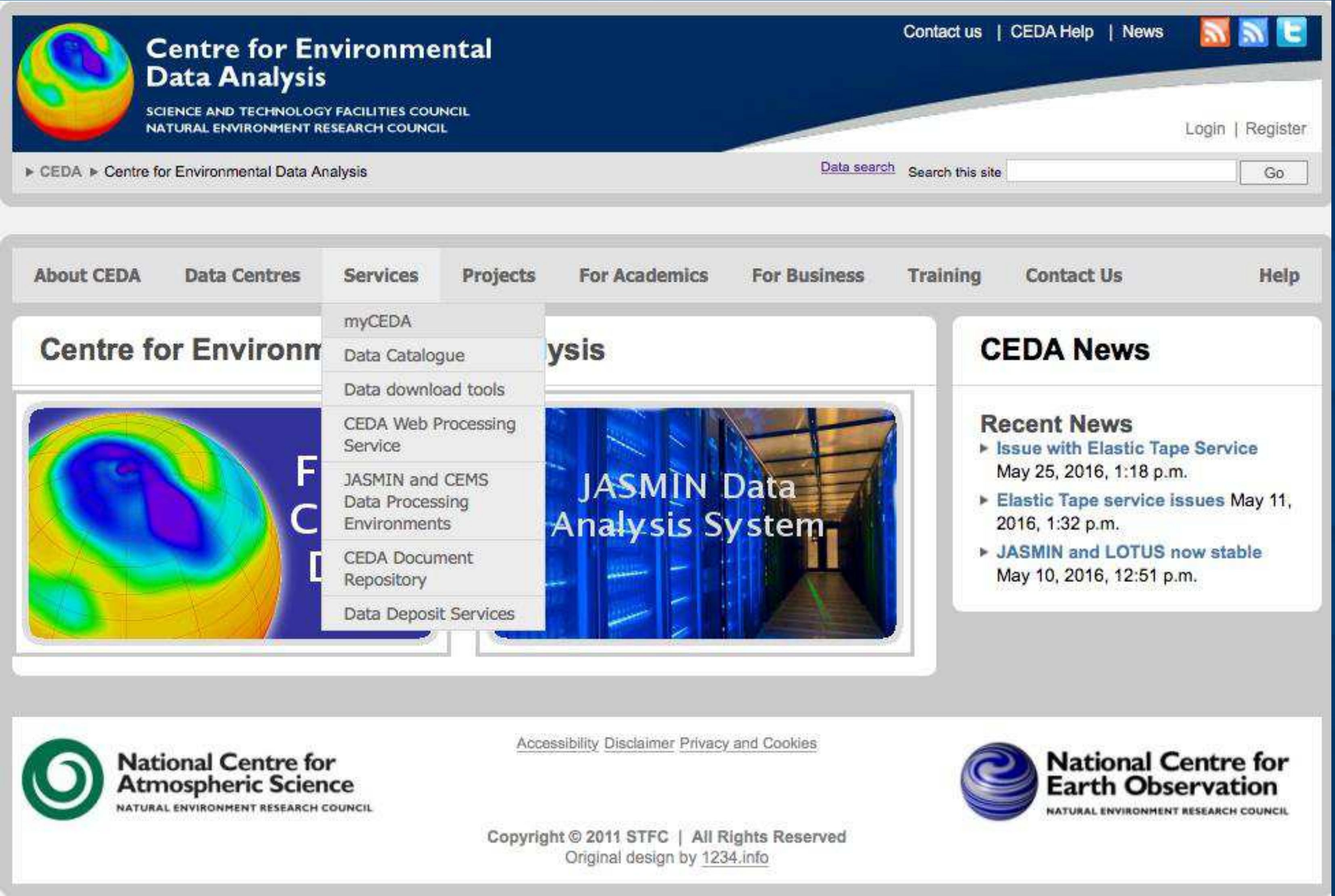

Run model at NIWA
Transfer data to JASMIN
Run CDDS software on JASMIN
Upload data to the ESGF MCIP6 data portal

- We need to shift (regularly and reliably) ~10TB to the JASMIN platform.
- Doing this using rsync was simply too slow to be a viable solution.



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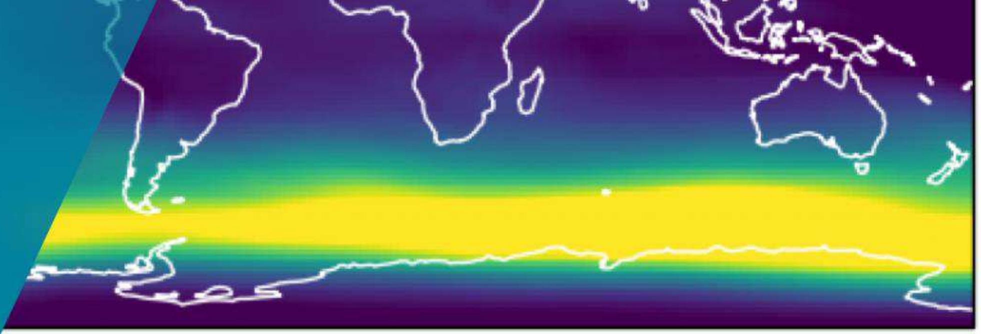
Climate modellers transfer 11 terabytes in 24 hours

NIWA climate scientist Dr Jonny Williams sent a massive 11 terabytes of data to research counterparts in the UK.



Caption: Dr Jonny Williams

When NIWA climate scientist Dr Jonny Williams sent a massive 11 terabytes of data to research counterparts in the UK, he didn't give the size of the transfer a second thought. The REANNZ advanced network seamlessly delivered the entire dataset within 24 hours, and without scrambling or dropping data.

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NeSI launches national scientific Data Transfer platform

Jana Makar
jana.makar@nesi.org.nz
Level 10, 70 Symonds St,
Auckland, New Zealand

Contact

NeSI's national Data Transfer platform — operated in partnership with Globus, REANNZ and multiple NZ institutions — is now available for users to move data to and from NeSI quickly and easily.

Since 2014, NeSI has partnered with Globus to offer a high-speed option for transferring large and distributed data nationally and internationally. Over that time, NeSI has been working with New Zealand research institutions to facilitate data transfer to and from existing and new Globus Data Transfer Nodes (DTNs).

Last year, NeSI reviewed its data transfer offering and has now implemented a new and improved service designed for use with NeSI's national HPC platforms.

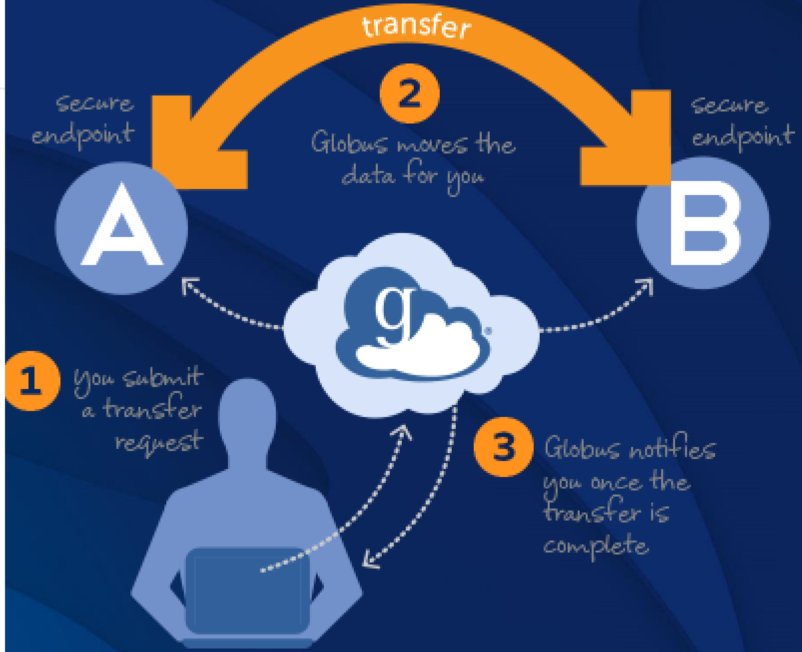
NeSI has plumbed Globus DTNs directly into its new infrastructure platform, enabling access to data on both Māui and Mahuika HPC systems hosted at NIWA, as well as at data storage and research facilities at AgResearch, the University of Auckland, and the University of Otago.

These DTNs act as an interface between Globus' worldwide network of other endpoints.

"Bringing this new platform online has truly been a collaborative effort, involving collaborations with international partner Globus, national advanced network provider REANNZ, and several innovative research institutions across the country," says Nick Jones, Director of NeSI.

It didn't take long for the platform's performance to be tested. In May 2018, tens of millions of files and hundreds of terabytes of data were moved over REANNZ's network as the first wave of NeSI users' research data was migrated from the Pan cluster at the University of Auckland to the new Mahuika supercomputer in Wellington, hosted at NIWA. It was a record-setting moment for REANNZ and a testament to the enhanced capabilities and performance of NeSI's new data transfer platform.

Data transfer nodes



In my experience, globus is about 100 times faster than rsync.

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globus
a uchicago non-profit service

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What We Do

Globus is a non-profit service for secure, reliable **research data management**.

With Globus, subscribers can **move, share, & discover data** via a single interface – whether your files live on a supercomputer, lab cluster, tape archive, public cloud or your laptop, you can manage this data from anywhere, using your existing identities, via just a web browser.

Developers can also use Globus to **build applications and gateways** leveraging our advanced identity management, single sign-on, search, authorization, and automation capabilities.

Click to enlarge

What can I do with Globus?

- **Transfer files:** From kilobytes to petabytes, with Globus you can efficiently, reliably, and securely move data between systems within your site or across an ocean
- **Share files with others:** All you need is an email address to share data with colleagues – Globus manages authentication and access
- **Develop applications and gateways:** Our open REST APIs and Python SDK empower you to create an integrated ecosystem of research data services, applications, and workflows

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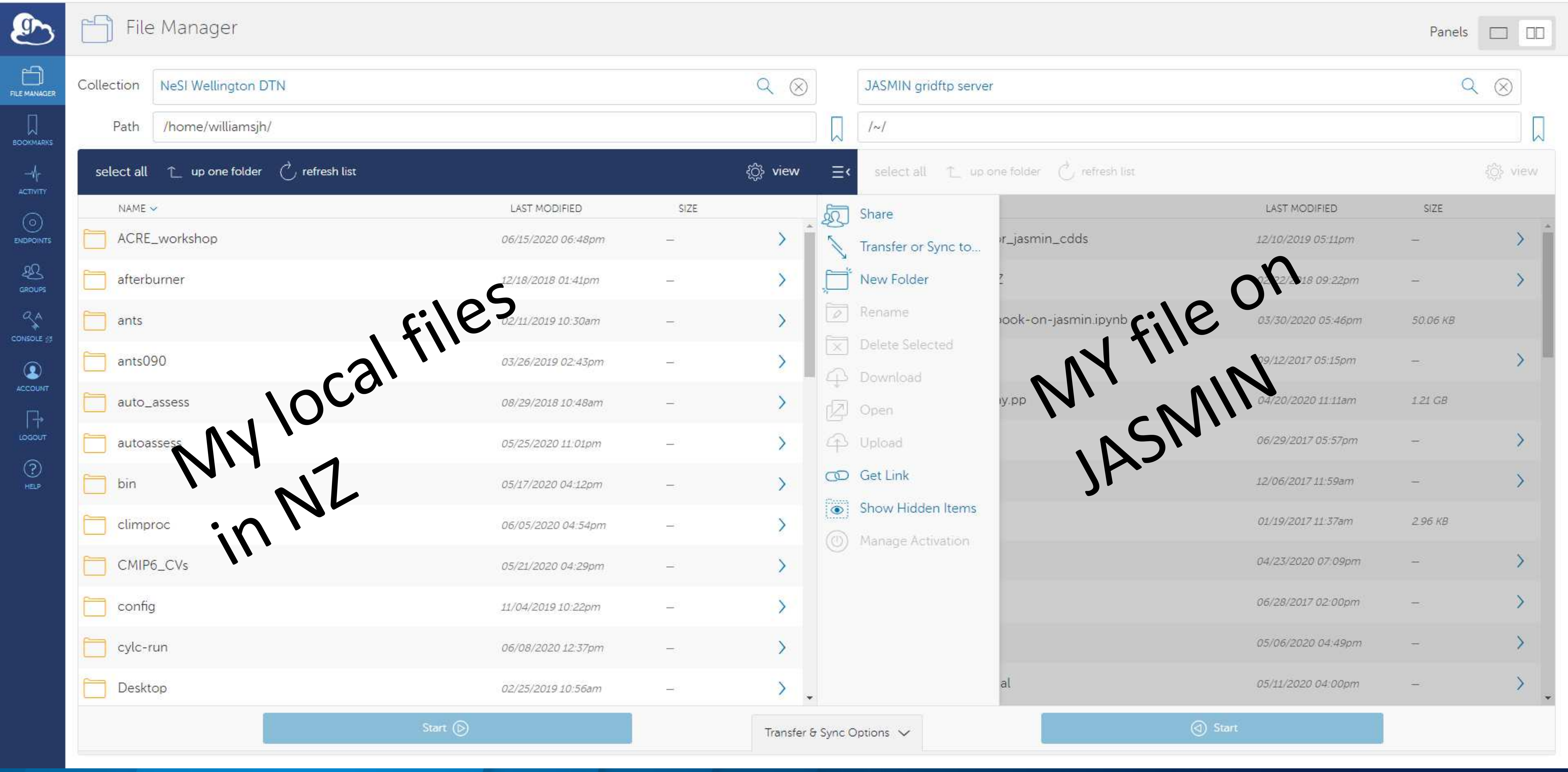
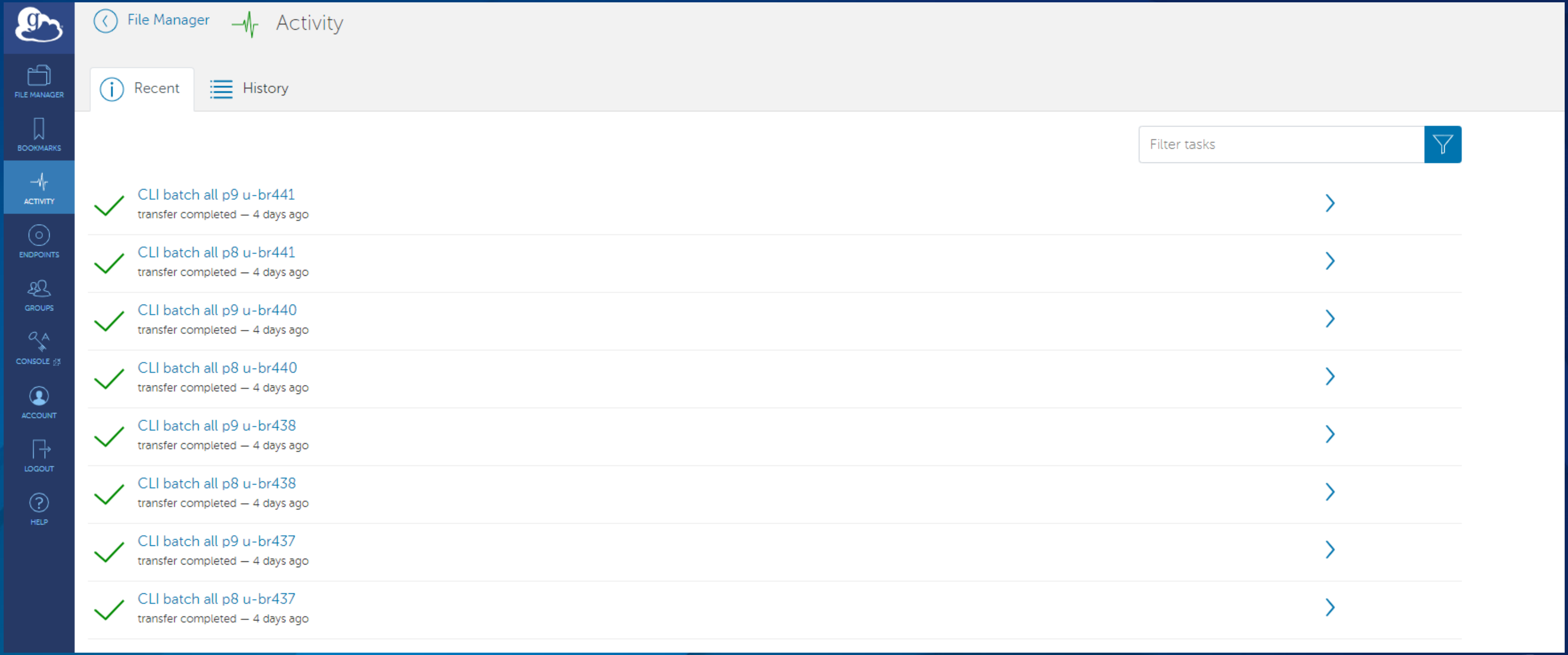
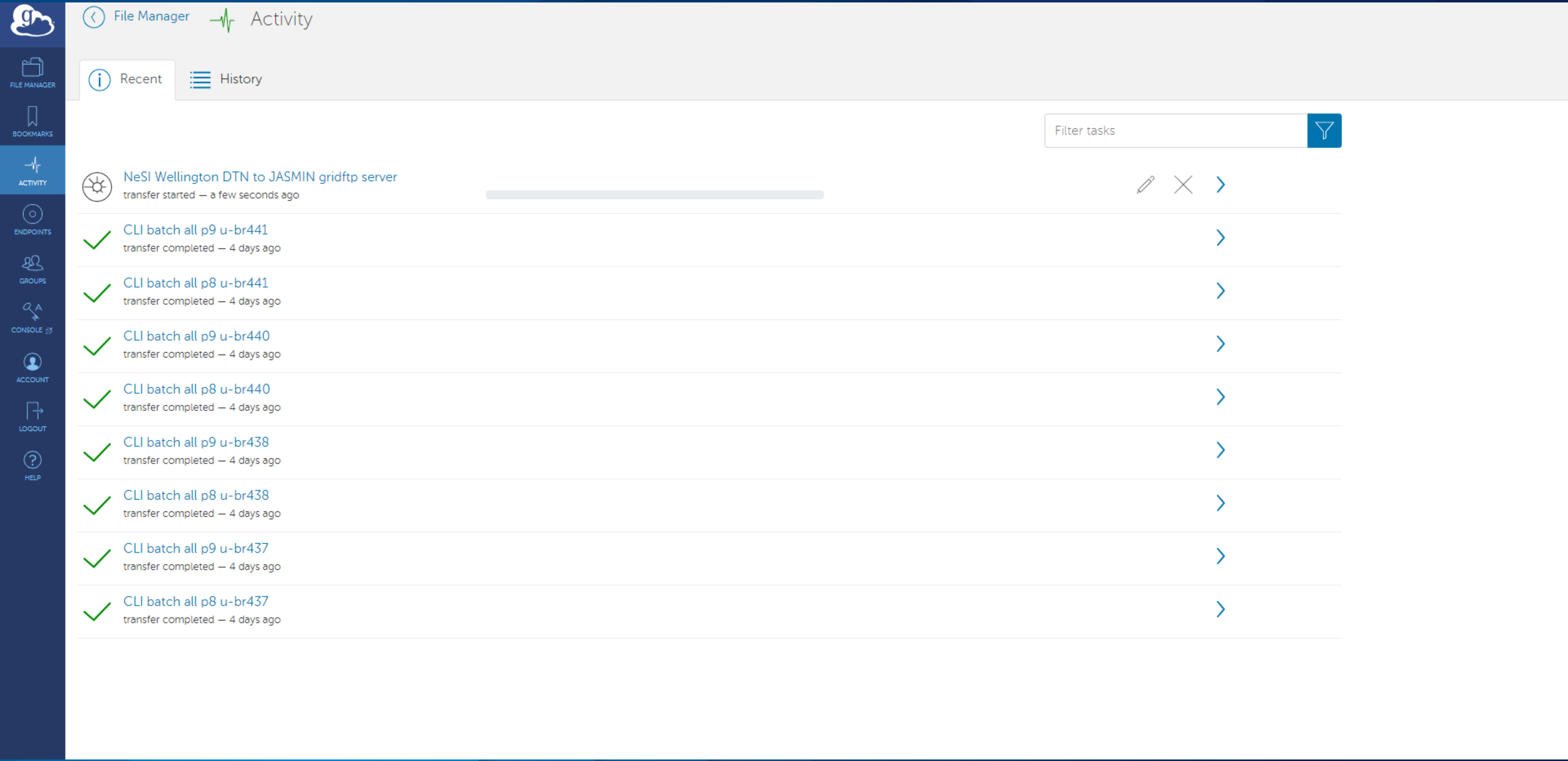


File Manager
Panels
FILE MANAGER
BOOKMARKS
ACTIVITY
ENDPOINTS
GROUPS
CONSOLE
ACCOUNT
LOGOUT
HELP
Collection
NeSI Wellington DTN
JASMIN gridftp server
Path
/home/williamsjh/
/~/
select all
up one folder
refresh list
view
NAME
LAST MODIFIED
SIZE
ACRE_workshop 06/15/2020 06:48pm
afterburner 12/18/2018 01:41pm
ants 02/11/2019 10:30am
ants090 03/26/2019 02:43pm
auto_assess 08/29/2018 10:48am
autoassess 05/25/2020 11:01pm
bin 05/17/2020 04:12pm
climproc 06/05/2020 04:54pm
CMIP6_CVs 05/21/2020 04:29pm
config 11/04/2019 10:22pm
cylc-run 06/08/2020 12:37pm
Desktop 02/25/2019 10:56am
Share
Transfer or Sync to...
New Folder
Rename
Delete Selected
Download
Open
Upload
Get Link
Show Hidden Items
Manage Activation
12/10/2019 05:11pm
03/30/2020 05:46pm 50.06 KB
04/20/2020 11:11am 1.21 GB
06/29/2017 05:57pm
12/06/2017 11:59am
01/19/2017 11:37am 2.96 KB
04/23/2020 07:09pm
06/28/2017 02:00pm
05/06/2020 04:49pm
05/11/2020 04:00pm
Start
Transfer & Sync Options
My local files in NZ
MY file on JASMIN

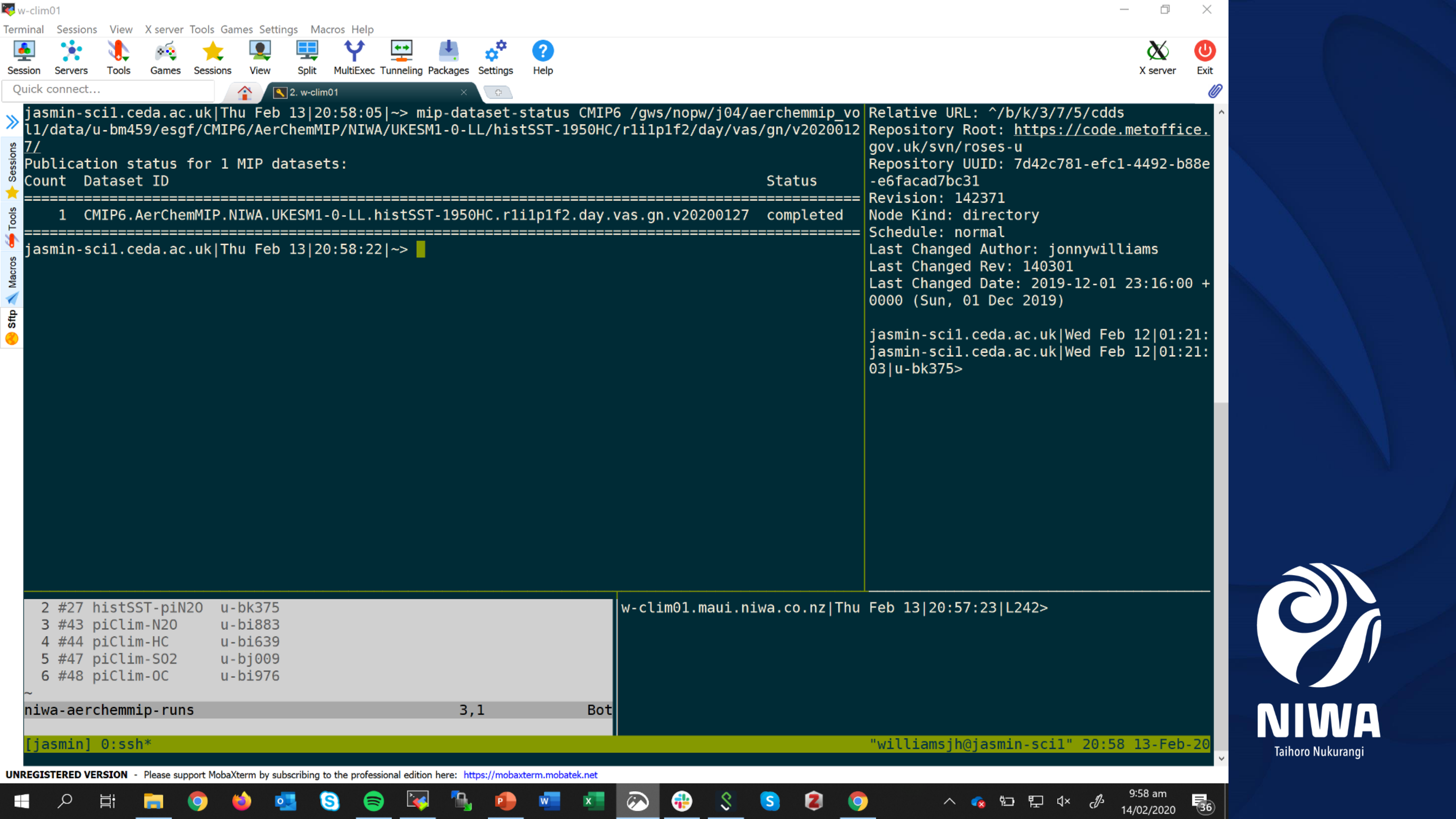

FILE MANAGER
BOOKMARKS
ACTIVITY
ENDPOINTS
GROUPS
CONSOLE
ACCOUNT
LOGOUT
HELP
File Manager
Activity
Recent
History
Filter tasks
CLI batch all p9 u-br441
transfer completed — 4 days ago
CLI batch all p8 u-br441
transfer completed — 4 days ago
CLI batch all p9 u-br440
transfer completed — 4 days ago
CLI batch all p8 u-br440
transfer completed — 4 days ago
CLI batch all p9 u-br438
transfer completed — 4 days ago
CLI batch all p8 u-br438
transfer completed — 4 days ago
CLI batch all p9 u-br437
transfer completed — 4 days ago
CLI batch all p8 u-br437
transfer completed — 4 days ago


File Manager
Activity
FILE MANAGER
BOOKMARKS
ACTIVITY
ENDPOINTS
GROUPS
CONSOLE
ACCOUNT
LOGOUT
HELP
Recent
History
Filter tasks
NeSI Wellington DTN to JASMIN gridftp server
transfer started — a few seconds ago
CLI batch all p9 u-br441
transfer completed — 4 days ago
CLI batch all p8 u-br441
transfer completed — 4 days ago
CLI batch all p9 u-br440
transfer completed — 4 days ago
CLI batch all p8 u-br440
transfer completed — 4 days ago
CLI batch all p9 u-br438
transfer completed — 4 days ago
CLI batch all p8 u-br438
transfer completed — 4 days ago
CLI batch all p9 u-br437
transfer completed — 4 days ago
CLI batch all p8 u-br437
transfer completed — 4 days ago

Command line works too

```
#!/usr/bin/env bash

. ~/.profile

export userid=$1
export suite=$2
export stream=$3 # e.g. p7 not ap7

echo $suite
echo $userid

cd /home/$userid/cylc-run/$suite/share/data/History_Data/

echo 'I am now here ->' $PWD

rm in.txt ; for file in *a.${stream}*.pp; do echo $file ;  echo -ne "$file $file\n" >> in.txt ; done

export destination=/gws/nopw/j04/aerchemmip_vol3/data/$suite/a$stream/

globus transfer $globus_nesi:/home/$userid/cylc-run/$suite/share/data/History_Data/ $globus_jasmin:$destination --batch --label "CLI batch all ${stream} ${suite}" < ./in.txt

rm ./in.txt
```

```
scripts/globusbatch                                                    7,1           All
"~/scripts/globusbatch" 22L, 580C
```


w-clim01
Terminal Sessions View X server Tools Games Settings Macros Help
Session Servers Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help X server Exit
Quick connect...
2. w-clim01
jasmin-sci1.ceda.ac.uk|Thu Feb 13|20:58:05|~> mip-dataset-status CMIP6 /gws/nopw/j04/aerchemmip_vol1/data/u-bm459/esgf/CMIP6/AerChemMIP/NIWA/UKESM1-0-LL/histSST-1950HC/r1i1p1f2/day/vas/gn/v20200127/
Publication status for 1 MIP datasets:
Count Dataset ID Status
1 CMIP6.AerChemMIP.NIWA.UKESM1-0-LL.histSST-1950HC.r1i1p1f2.day.vas.gn.v20200127 completed
jasmin-sci1.ceda.ac.uk|Thu Feb 13|20:58:22|~>
Relative URL: ^/b/k/3/7/5/cdds
Repository Root: https://code.metoffice.gov.uk/svn/roses-u
Repository UUID: 7d42c781-efc1-4492-b88e-e6facad7bc31
Revision: 142371
Node Kind: directory
Schedule: normal
Last Changed Author: jonnywilliams
Last Changed Rev: 140301
Last Changed Date: 2019-12-01 23:16:00 +0000 (Sun, 01 Dec 2019)
jasmin-sci1.ceda.ac.uk|Wed Feb 12|01:21:
jasmin-sci1.ceda.ac.uk|Wed Feb 12|01:21:03|u-bk375>
2 #27 histSST-piN2O u-bk375
3 #43 piClim-N2O u-bi883
4 #44 piClim-HC u-bi639
5 #47 piClim-SO2 u-bj009
6 #48 piClim-OC u-bi976
niwa-aerchemmip-runs 3,1 Bot
w-clim01.maui.niwa.co.nz|Thu Feb 13|20:57:23|L242>
[jasmin] 0:ssh* "williamsjh@jasmin-sci1" 20:58 13-Feb-20
UNREGISTERED VERSION - Please support MobaXterm by subscribing to the professional edition here: https://mobaxterm.mobatek.net
9:58 am
14/02/2020
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CDDS
Climate Data Dissemination System

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wiki: CDDSOperationalProcedure_v1_3

Start Page | Index | History

CDDS Operational Procedure (v1.3)

The definitions of the italicised phrases can be found in the Glossary.

Use `<script> -h` or `<script> --help` to print information about the script, including available parameters.

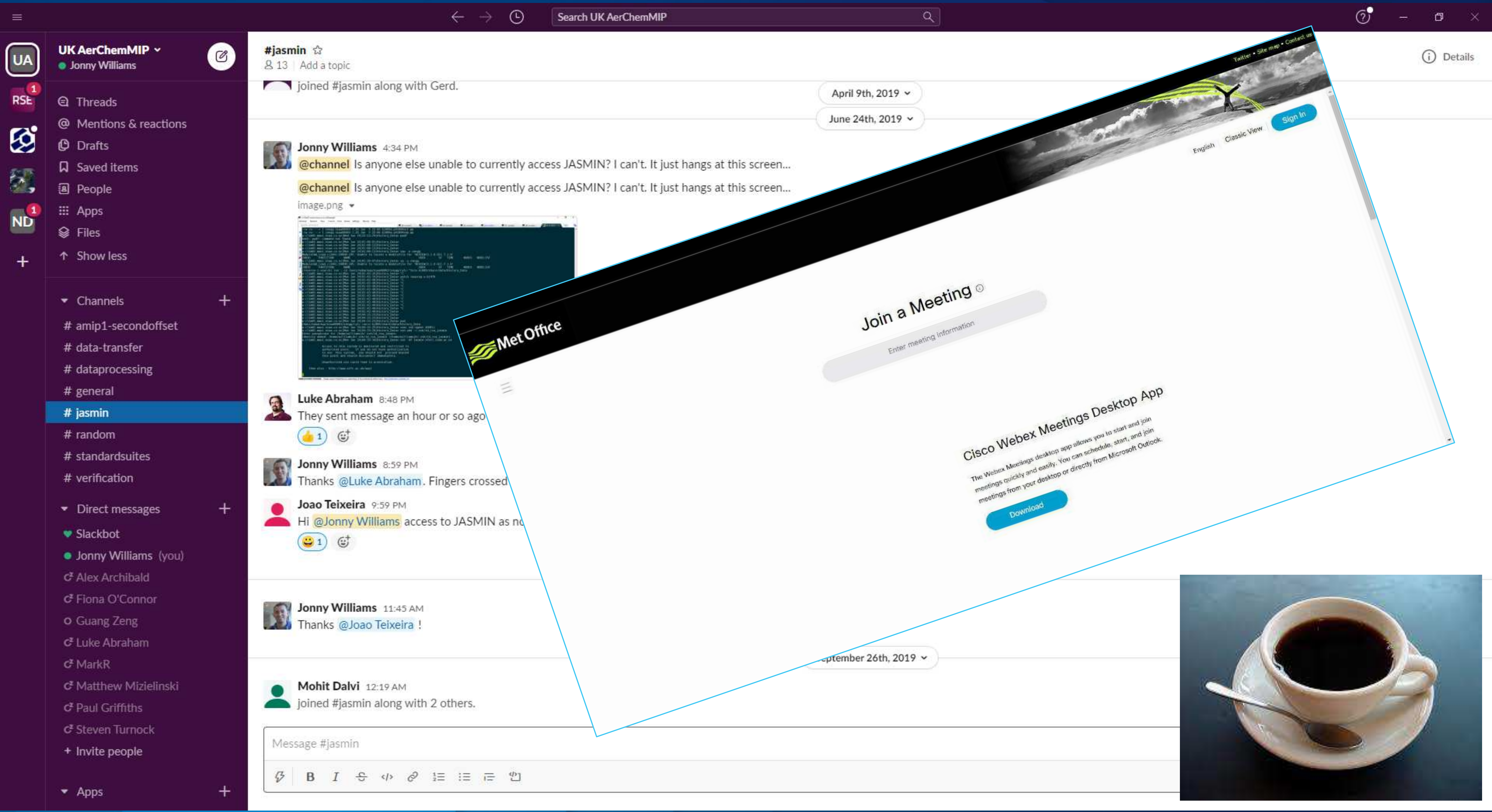
A simulation for the pre-industrial control from UKESM will be used as an example in these instructions.

- Requirements
- Set up the CDDS operational simulation ticket
- Set up CREM
- Activate the CDDS install
- Run CDDS Prepare
  - Create the request JSON file
  - Create the CDDS directory structure
  - Generate the requested variables list
- Run CDDS Extract
- Run CDDS Configure
- Run CDDS Convert
- Run CDDS QC
- Run CDDS Transfer
- Run CDDS Teardown

Changes relative to CDDS v1.2

The operational procedure for working with CDDS v1.2 can be found here.

- Changes to all CDDS tools at v1.3.1
  - Moved from the production-os41-1 scitools environment (iris v1.13) to the production_legacy-os43-1 (iris v2.2) environment.
- Changes to Extract;
  - When using `cdds_extract_spice` the database name no longer required.
  - E-mails from cdds@metoffice.gov.uk indicating success or failure are no longer sent.
- Changes to QC;
  - Creation of `approved` symlink no longer required -- variables that fail the QC check should be deactivated in the *requested variables file* instead.
- Changes to Transfer;
  - New robust `cdds_store_spice` tool for archiving data has been developed to replace `cdds_transfer_spice`.


Search UK AerChemMIP
UK AerChemMIP
Jonny Williams
Threads
Mentions & reactions
Drafts
Saved items
People
Apps
Files
Show less
Channels
amip1-secondoffset
data-transfer
dataprocessing
general
jasmin
random
standardsuites
verification
Direct messages
Slackbot
Jonny Williams (you)
Alex Archibald
Fiona O'Connor
Guang Zeng
Luke Abraham
MarkR
Matthew Mizielinski
Paul Griffiths
Steven Turnock
Invite people
Apps
#jasmin
13 | Add a topic
Details
joined #jasmin along with Gerd.
April 9th, 2019
June 24th, 2019
Jonny Williams 4:34 PM
@channel Is anyone else unable to currently access JASMIN? I can't. It just hangs at this screen...
@channel Is anyone else unable to currently access JASMIN? I can't. It just hangs at this screen...
image.png
Luke Abraham 8:48 PM
They sent message an hour or so ago
Jonny Williams 8:59 PM
Thanks @Luke Abraham. Fingers crossed
Joao Teixeira 9:59 PM
Hi @Jonny Williams access to JASMIN as no
Jonny Williams 11:45 AM
Thanks @Joao Teixeira !
eptember 26th, 2019
Mohit Dalvi 12:19 AM
joined #jasmin along with 2 others.
Message #jasmin
Met Office
English
Classic View
Sign In
Join a Meeting
Enter meeting information
Cisco Webex Meetings Desktop App
The Webex Meetings desktop app allows you to start and join meetings quickly and easily. You can schedule, start, and join meetings from your desktop or directly from Microsoft Outlook.
Download

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World Climate Research Programme

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- **MIP Era** +
- **Activity** +
- **Model Cohort** +
- **Product** +
- **Source ID** +
- **Institution ID** −
  - [x] NIWA (1270)
- **Source Type** +
- **Nominal Resolution** +
- **Experiment ID** +
- **Sub-Experiment** +
- **Variant Label** +
- **Grid Label** +
- **Table ID** +
- **Frequency** +
- **Realm** +
- **Variable** +
- **CF Standard Name** +
- **Data Node** +

WARNING: Not all models include a variant "r1i1p1f1", and across models, identical values of variant_label do not imply identical variants! To learn which forcing datasets were used in each variant, please check modeling group publications and documentation provided through ES-DOC.

CMIP6 project data downloads are unrestricted. Downloads should be performed with the -s option to a wget script without the need to login. When using this method for download, ensure you are not using additional options, eg. -s and -H should never be combined.

Enter Text: Search Reset Display 10 results per page [More Search Options]

Show All Replicas Show All Versions Search Local Node Only (Including All Replicas)

Search Constraints: NIWA

Total Number of Results: 1270
-1- 2 3 4 5 6 Next >>
Please login to add search results to your Data Cart
Expert Users: you may display the search URL and return results as XML or return results as JSON

1. **CMIP6.AerChemMIP.NIWA.UKESM1-0-LL.histSST-1950HC.r1i1p1f2.AERmon.cheaqpso4.gn**
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   Version: 20200127
   Total Number of Files (for all variables): 2
   Full Dataset Services: [Show Metadata] [List Files] [WGET Script] [Show Citation] [PID] [Globus Download] [Further Info]
2. **CMIP6.AerChemMIP.NIWA.UKESM1-0-LL.histSST-1950HC.r1i1p1f2.AERmon.chegpso4.gn**
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   Version: 20200127
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   Full Dataset Services: [Show Metadata] [List Files] [WGET Script] [Show Citation] [PID] [Globus Download] [Further Info]
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   Version: 20200127
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   Full Dataset Services: [Show Metadata] [List Files] [WGET Script] [Show Citation] [PID] [Globus Download] [Further Info]
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   Version: 20200127
   Total Number of Files (for all variables): 2
   Full Dataset Services: [Show Metadata] [List Files] [WGET Script] [Show Citation] [PID] [Globus Download] [Further Info]
6. **CMIP6.AerChemMIP.NIWA.UKESM1-0-LL.histSST-1950HC.r1i1p1f2.AERmon.c3h8.gn**

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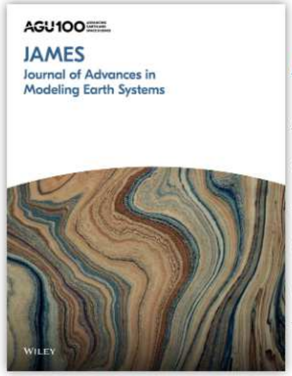
- So far we have processed p4, p5, p6 and pu streams of our 6 simulations:
  - p4 is monthly.
  - p5 is monthly.
  - P6 is daily.
  - pu is monthly.
- We will soon be beginning the processing of p7, p8 and p9
  - p7 is 6 hourly.
  - p8 is 3 hourly.
  - p9 is hourly.
- Although these are much more frequent, the STASH list is much smaller.

JAMES | Journal of Advances in Modeling Earth Systems



Accepted Articles

Accepted, unedited articles published online and citable. The final edited and typeset version of record will appear in the future.

e2019MS001946

Implementation of UK Earth system models for CMIP6

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... See fewer authors

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- **Summary**
  - Globus is awesome and fast.
  - The full data flow from running the simulations to uploading the CDDS-processed data to JASMIN is fully functioning.

Thanks for your attention

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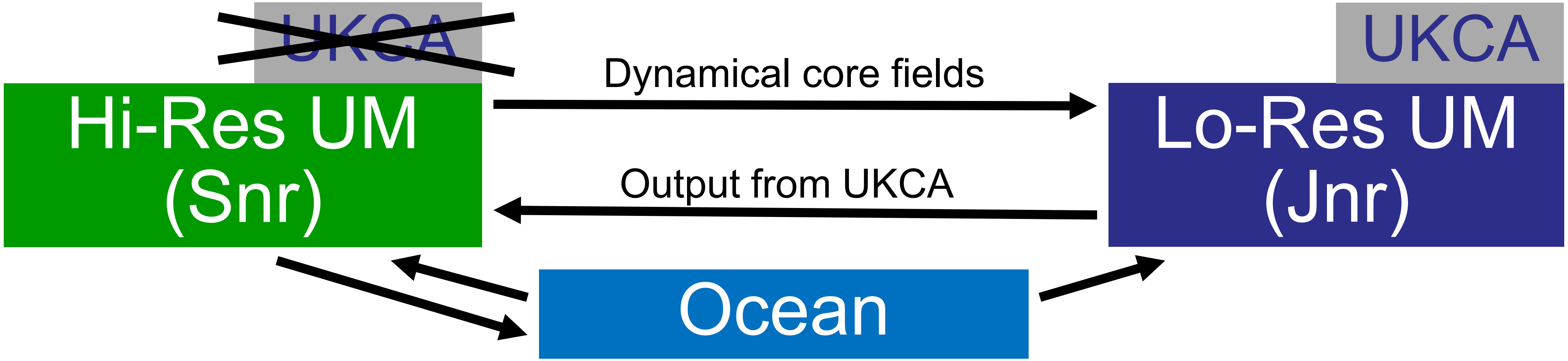
Marc Stringer

NCAS

UKESM-hybrid: focusing resolution where it's most needed

Marc, Richard, Mohit Dalvi, Colin, Colin & Jane

Chemistry & Aerosol (calculated in UKCA) are important, but computationally expensive



We're running: UKESM-hybrid N96 N48 ORCA1 & UKESM-hybrid N216 N96 ORCA025

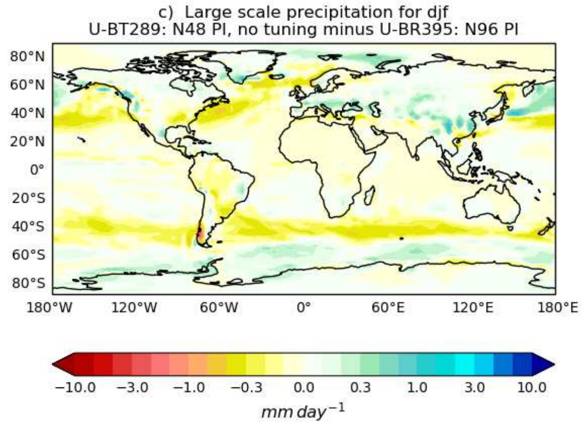
Whistle stop tour of hybrid model

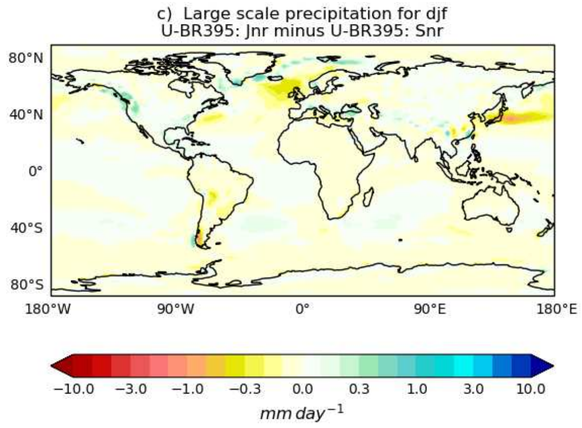
- Nodes for stand alone UM replaced: ~60% for Snr; ~40% for Jnr
- For the same resources/nodes, UKESM-hybrid is ~65% faster than UKESM
- OASIS3-MCT + bilinear remapping (important later) used to transport, re-grid and overwrite fields between Snr <-> Jnr
- Coupling between Snr<->Jnr is every model hour
- Fields used to lock physical atmosphere of Jnr to Snr: U, V, Θ, Π, soil temperature + moisture + unfrozen & frozen moisture fraction.
  - Locking water fields is ongoing research
- What matches well between Snr and Jnr: U, V, Θ, Π, sensible heat flux and fields only depending on these.

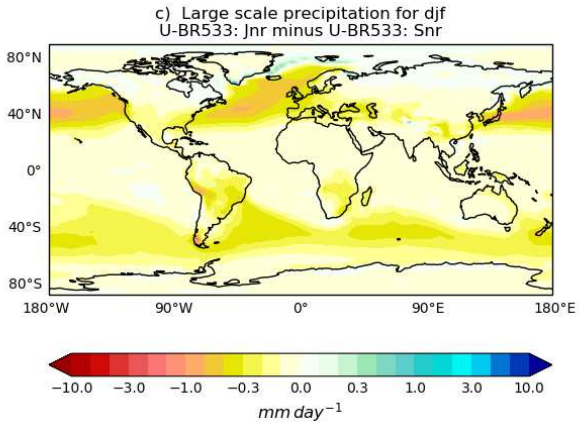
DJF precipitation (40 year average): N96-N48

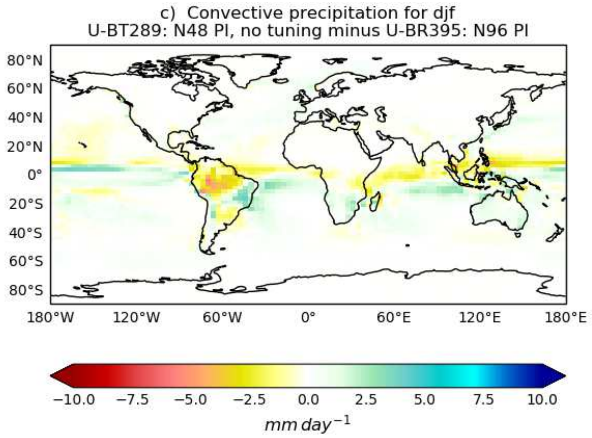
Large-scale (top) and convective (bottom) precipitation. For hybrid runs, only coupling Snr->Jnr, not Jnr->Snr, i.e. UKCA on for Snr.

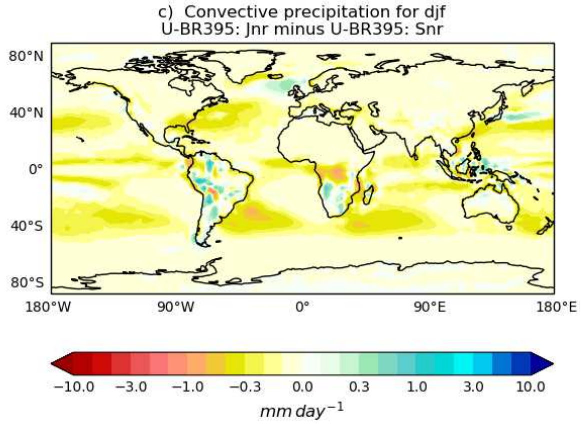
Stand alone N48	Overwriting U, V, ϴ, Π & soil	Overwriting water & cloud as well

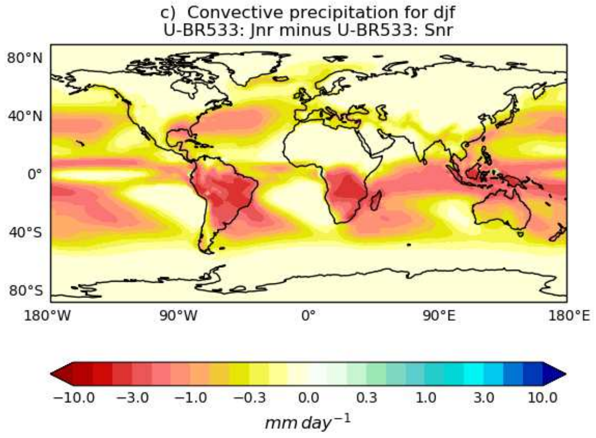








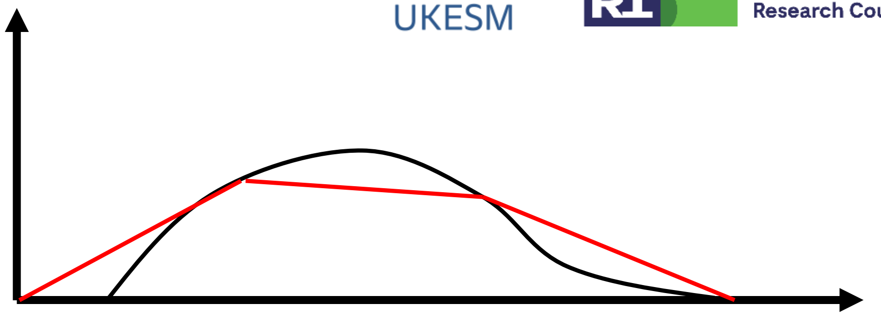




Future work

What we're likely to do

- Try bicubic remapping with OASIS3-MCT
- Evaluation with AMIP jobs across all resolutions
- Remove radiation from Snr (for extra speed)



Linear remapping suppressing convection

What we might do

- Further speed-up options
  - Reduce Snr to dynamical core
  - Reduce vertical levels in Jnr
  - Remove stratosphere from Snr
- Snr as limited area model over Himalayas – in hope that higher resolution here will improve global circulation.

Till Kuhlbrodt

NCAS

Time-dependent regional features of ocean heat uptake in CMIP6 ESMs

Till Kuhlbrodt[1], Aurore Voldoire[2], Matthew Palmer[3], Rachel Killick[3], and Colin Jones[1]

[1] National Centre for Atmospheric Science, UK
[2] CNRM, Université de Toulouse, Météo-France, CNRS, France
[3] Met Office Hadley Centre, UK

17 June 2020

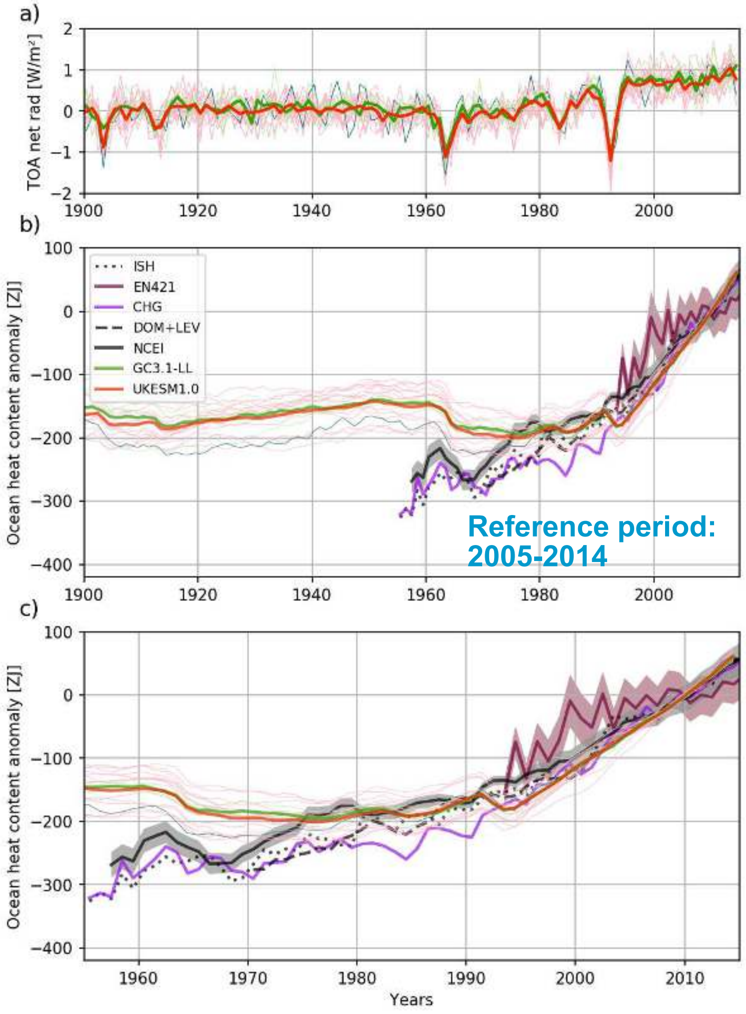
Historical OHC change, global, full-depth

- **UK models:** Global ocean warming rate since 1975 ~realistic for full-depth ocean; slightly too large after 1991
- No ocean heat uptake 1965 to 1975, in contrast to observations that show about 70 ZJ OHU in this time.
- **CNRM models:** closer to observations, especially CNRM-ESM2-1. Warming rate after 1991 slightly too small.
- UK models have a larger (negative) aerosol forcing and a larger (positive) GHG forcing

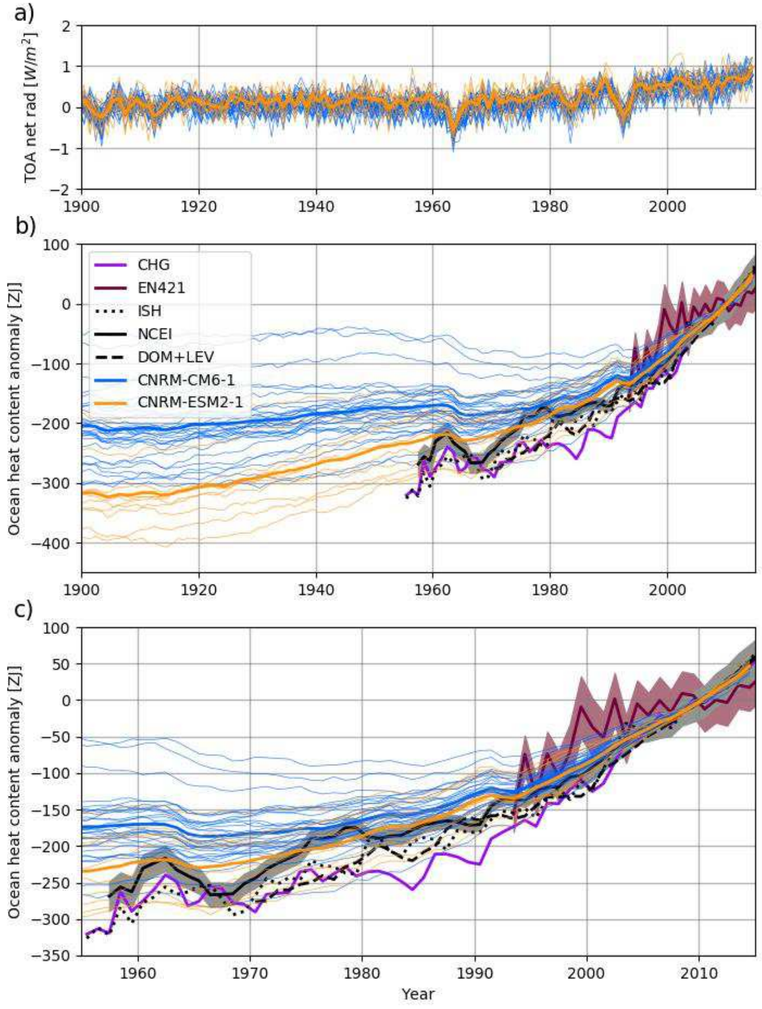
Eff. Radiative forcing in 2014 [W m^{-2}]

Model	UKESM 1	HadGEM3-GC3.1-LL	CNRM-ESM2-1	CNRM-CM6-1
F_{ANT}	1.61	1.81	1.59	1.50
F_{WMGHG}	2.89	3.09	2.41	2.64
F_{AER}	-1.13	-1.10	-0.82	-1.21

UK models

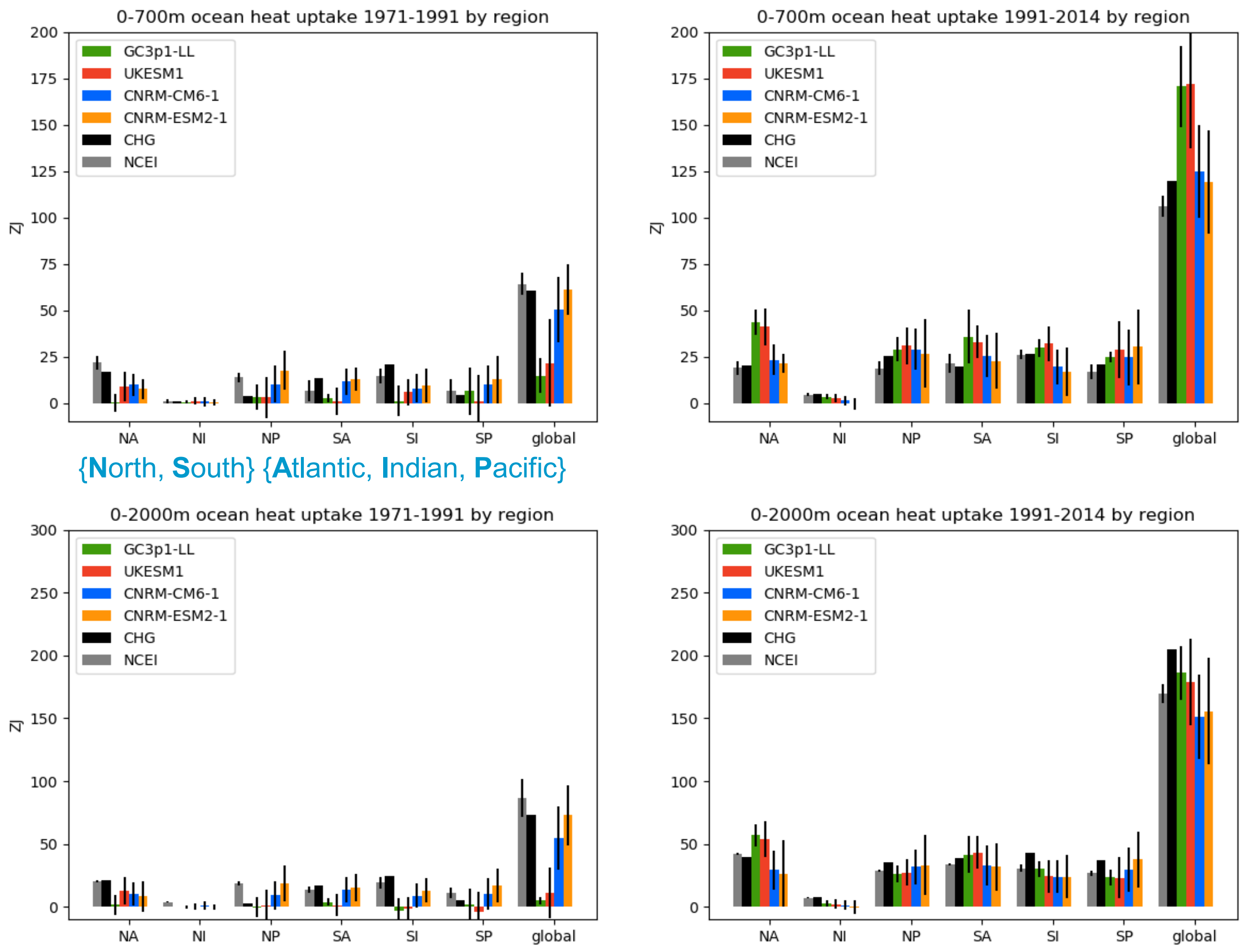


CNRM models



Regional ocean heat uptake

- 0-700 m layer: CNRM models mostly within observational uncertainty, slightly too warm in the Pacific
- 0-700 m layer: UK models much too cold before 1991, much too warm after, especially in the Atlantic
- Before 1991 UK models are too cold in all basins. After 1991, the excessive warming happens only in the Atlantic basins.



Global/ regional ensemble spread analysis

Global OHU

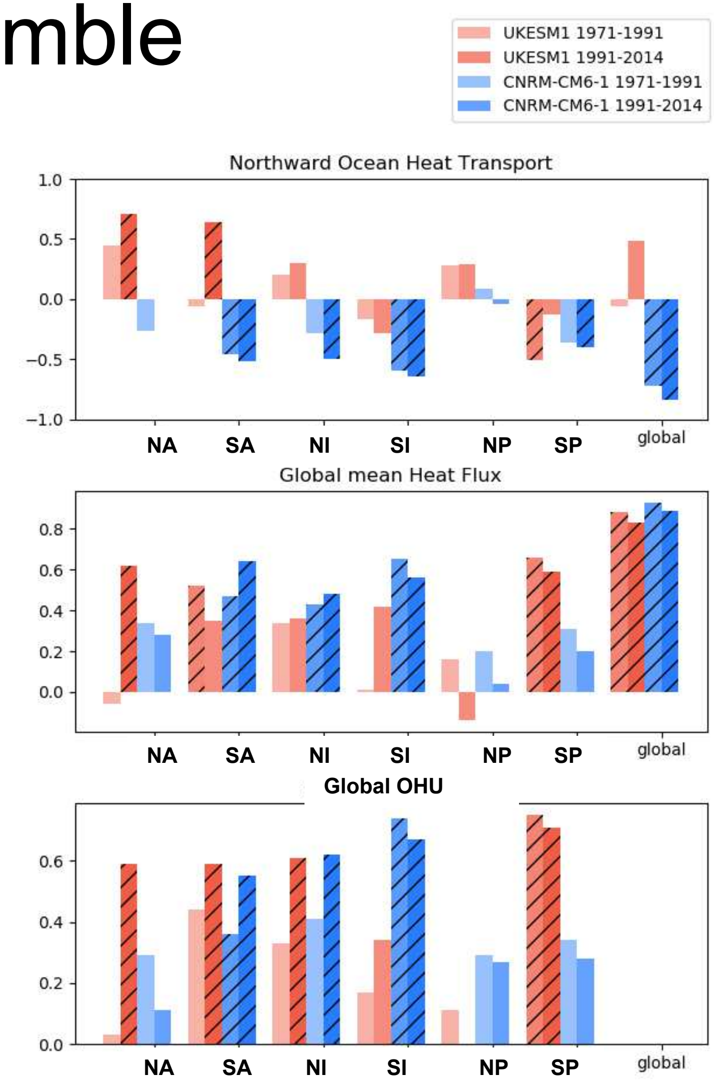
- **UKESM1:** before 1991, only SP OHU correlates with global OHU. After 1991, it's SP and both Atlantic basins
- **CNRM:** SA and SI correlate with global OHU throughout

Global northward heat transport (0°)

- **UKESM1:** negative correlation with SP OHU before 1991, positive correlation with OHU in both Atlantic basins after 1991
- **CNRM:** negative correlation with global and regional OHU throughout

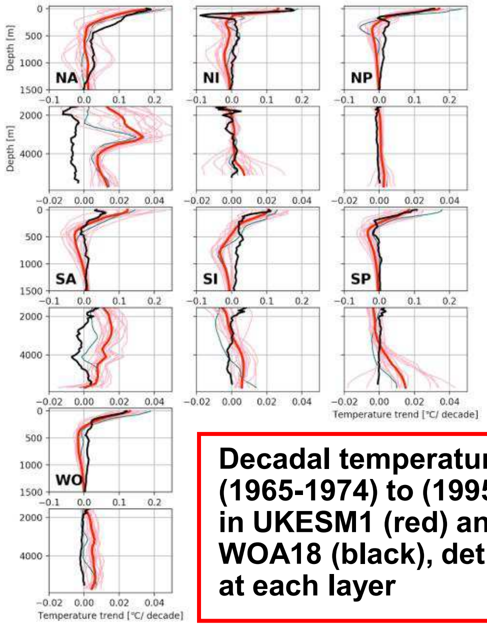
Conclusion

- In UKESM1, global OHU is dominated by the SP before 1991. After 1991, the global MOC transports heat to the NA where it accumulates (reduced surface heat loss).
- In the CNRM super-ensemble, global OHU is dominated by the Southern Ocean throughout. The heat transported into the NA is lost to the atmosphere
- The ocean component in all models is the same – reason for the difference probably in coupled centennial variability modes



{North, South} {Atlantic, Indian, Pacific}

Ensemble spread correlation between regional 0-2000m OHU and (top) northward heat transport at the Equator (b) global mean surface net heat flux (positive when the net flux is downward), (bottom) global mean 0-2000m OHU. Hatching indicates significant correlation coefficients ($p < 0.05$).



Decadal temperature trend (1965-1974) to (1995-2004) in UKESM1 (red) and WOA18 (black), detrended at each layer

Regionally:

Huge simulated warming in deep North Atlantic.

Strong warming and large variability in the abyssal South Pacific.

Mid-depth cooling trend mostly in Southern Hemisphere.

James Keeble

NCAS

Evaluating stratospheric ozone and water vapor changes in CMIP6 models from 1850–2100

James Keeble

Keeble, J., Hassler, B., Banerjee, A., Checa-Garcia, R., Chiodo, G., Davis, S., Eyring, V., Griffiths, P. T., Morgenstern, O., Nowack, P., Zeng, G., Zhang, J., Bodeker, G., Cugnet, D., Danabasoglu, G., Deushi, M., Horowitz, L. W., Li, L., Michou, M., Mills, M. J., Nabat, P., Park, S., and Wu, T.: Evaluating stratospheric ozone and water vapor changes in CMIP6 models from 1850–2100, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1202, in review, 2020.

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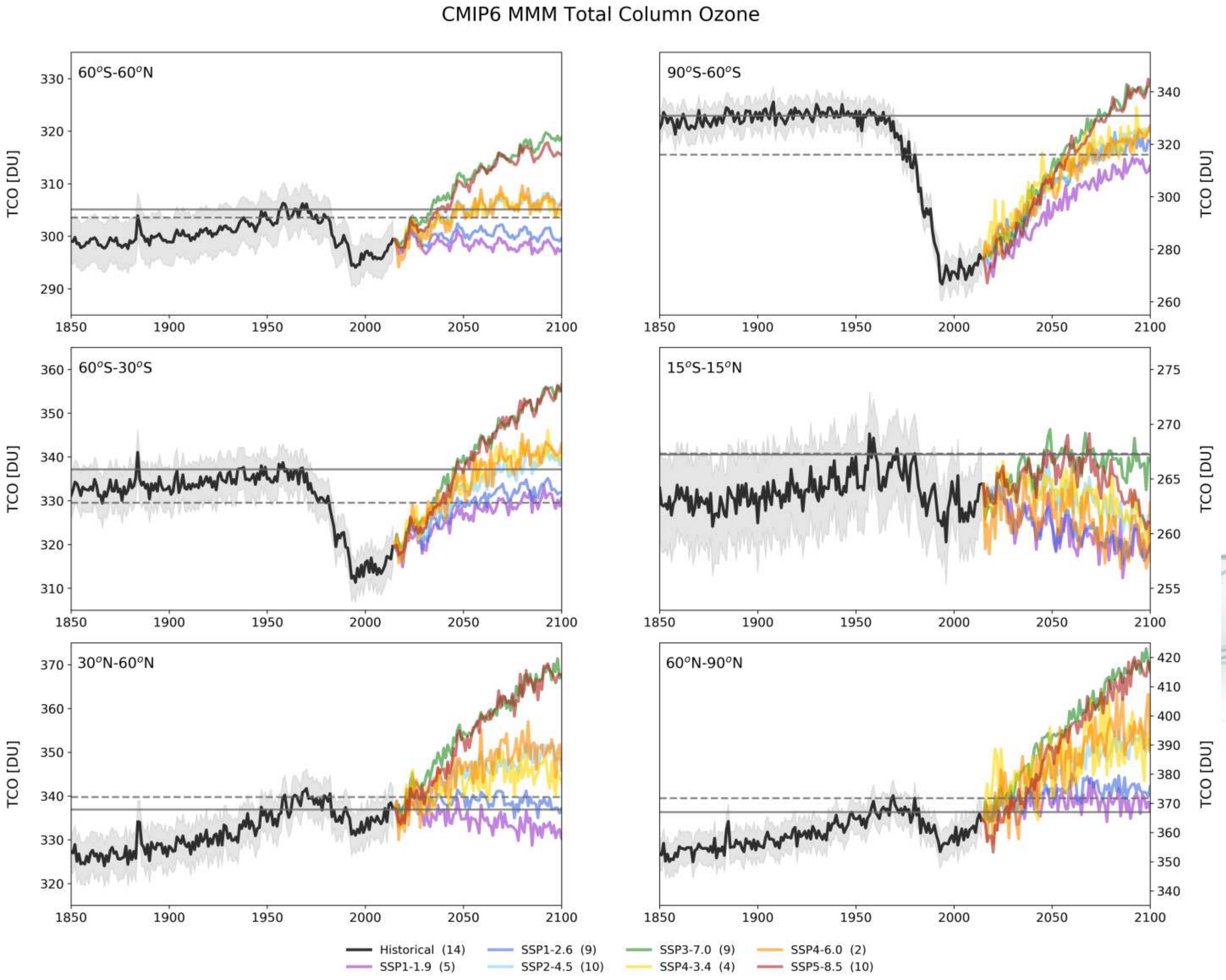
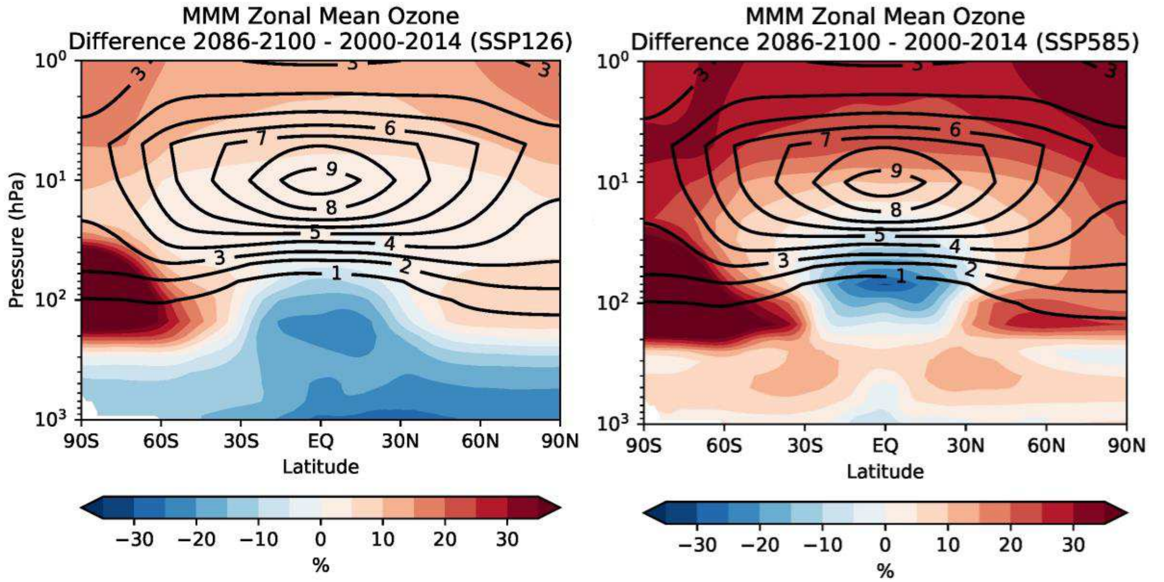
Total Column Ozone (CMIP6 Multi Model Mean)





Above: Zonal mean ozone difference between end of century and present day for SSP1-2.6 (left) and SSP5-8.5 (right)

Left: CMIP6 multi model mean evolution of total column ozone for different latitude ranges

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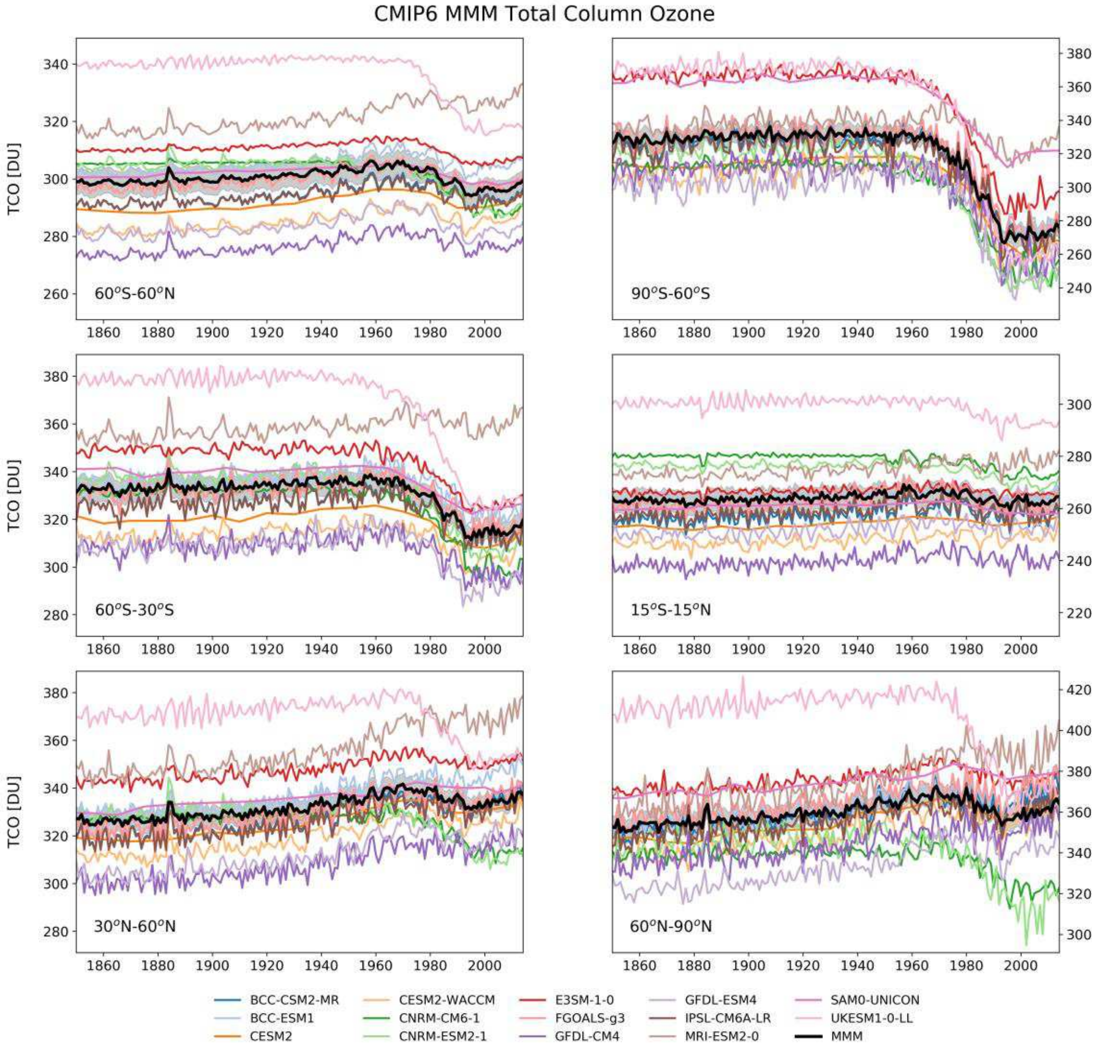
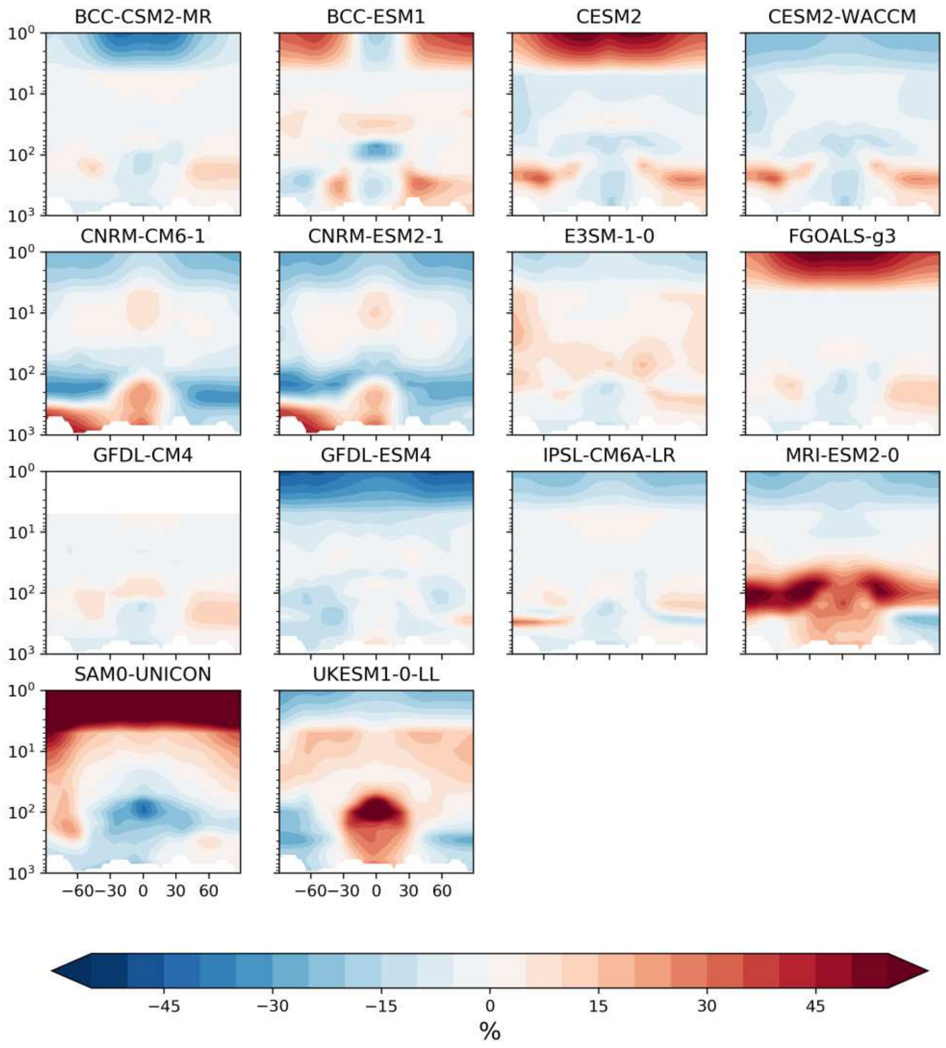
Total Column Ozone (CMIP6 Individual Models)



Left: Evolution of Total Column Ozone in individual CMIP6 models over the historical period (1850-2014)

Right: Zonal mean difference between each individual CMIP6 model and the CMIP6 MMM for the present day (2000-2014)



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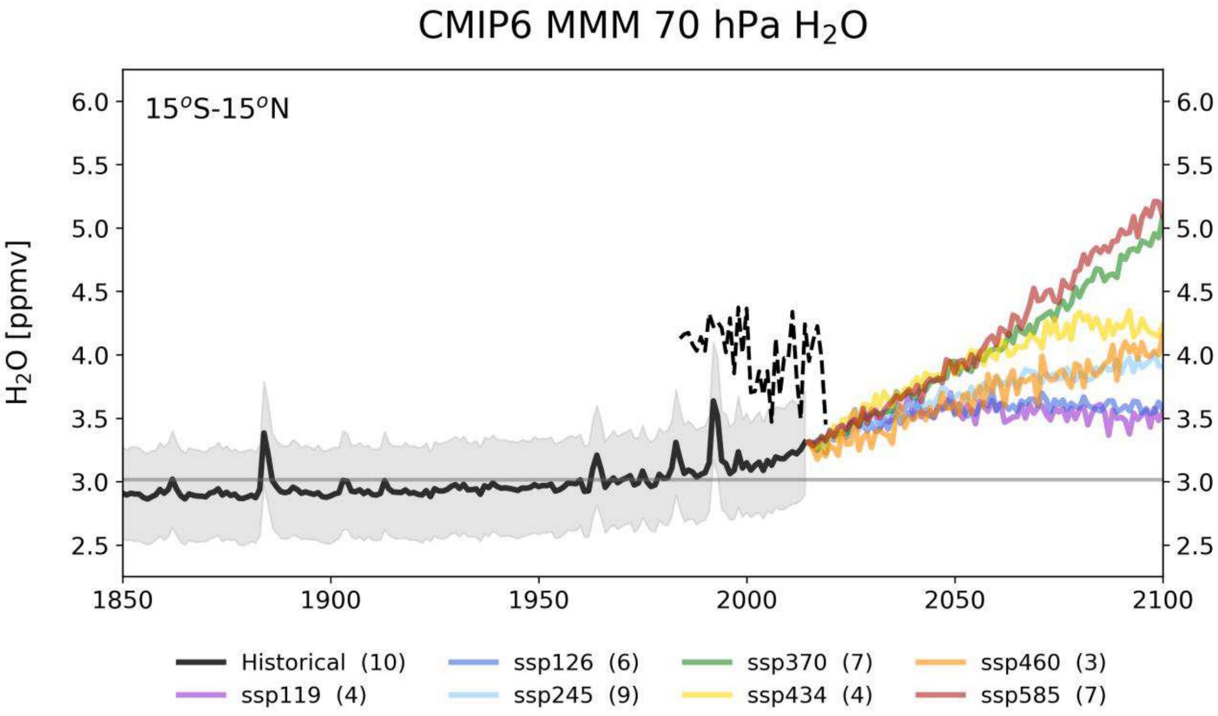
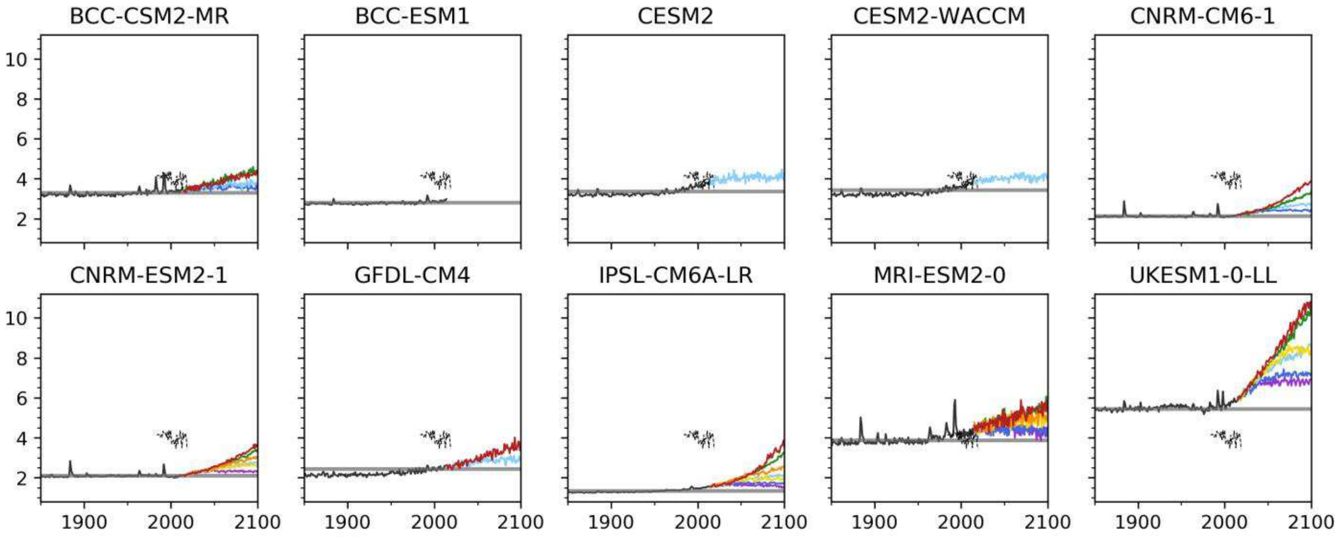
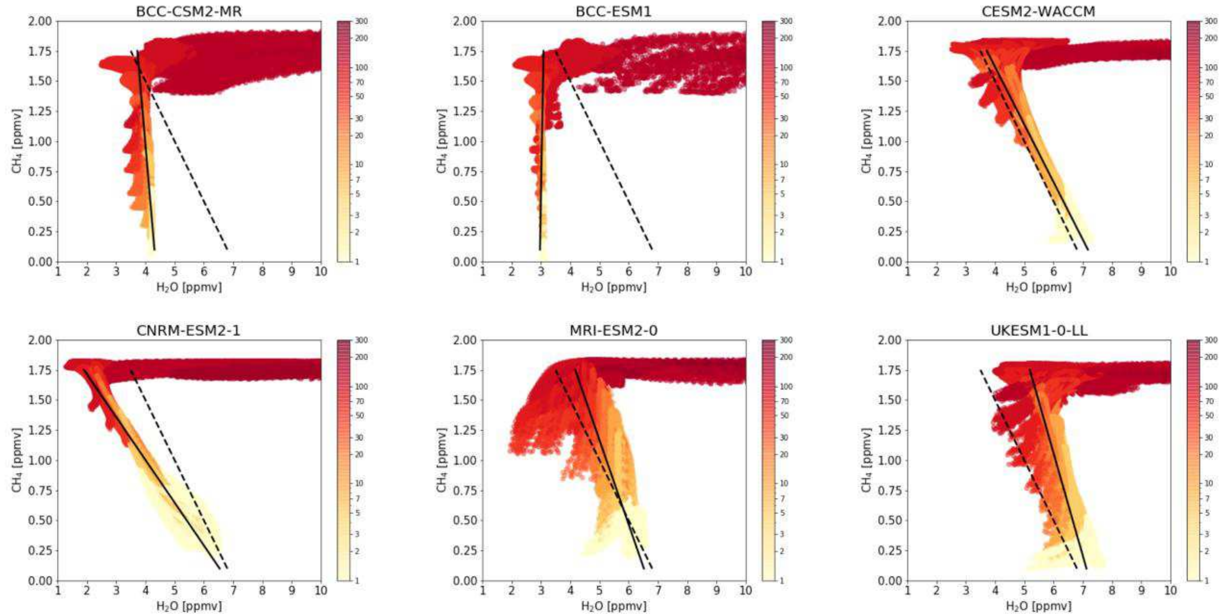
Stratospheric Water Vapour







Above: H2O CH4 tracer tracer plot

Left: Total column ozone for individual CMIP6 models in the historical period (1850-2014) for different latitude ranges

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Leighton Regayre

University of Leeds

Institute for Climate & Atmospheric Science
SCHOOL OF EARTH AND ENVIRONMENT

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UKESM GA2020
A perturbed parameter ensemble of UKESM-A to understand aerosol forcing

Ken Carslaw, **Leighton Regayre**

Leeds: Kirsty Pringle, Jill S Johnson, Dan Grosvenor, Hamish Gordon, Masaru Yoshioka, Ananth Ranjithkumar, Carly Reddington

CEMAC: Chris Symonds, Mark Richardson

Oxford: Lucia Deaconu, Tom Langton, Duncan Watson-Paris, Haochi Che, Philip Stier

Met Office: Jane Mulcahy, David Sexton, John Rostron, Ben Johnson, Steven Turnock, Mohit Dalvi, Alejandro Bodas-Salcedo

NCAS: Grenville Lister, Alex Archibald

What we know from previous PPE analyses

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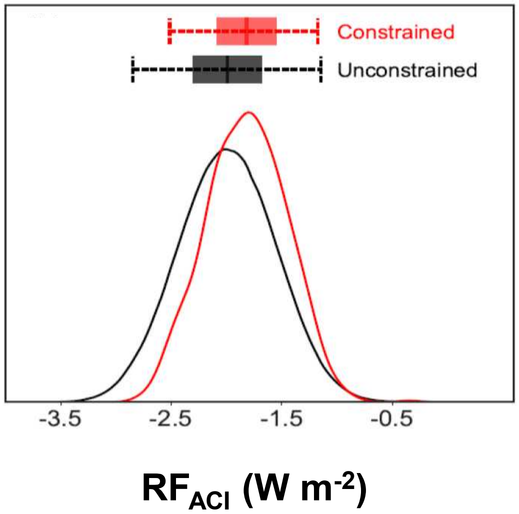
AER PPE
26 aerosol parameters
HadGEM3-GA4.0

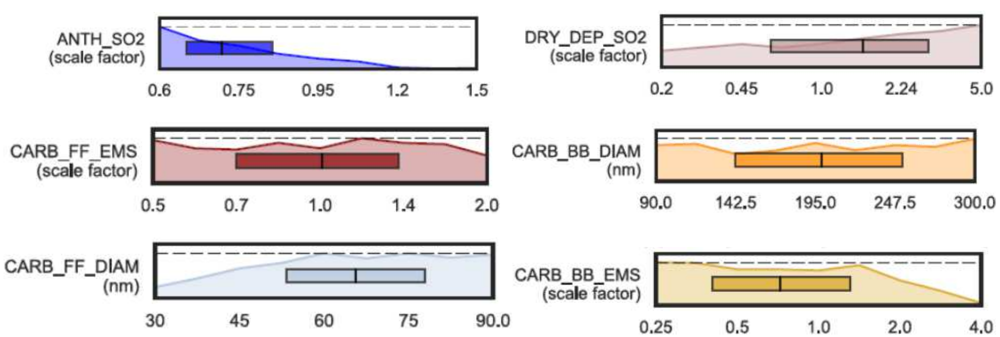
We can **constrain aerosol forcing**, using a diverse set of measurements (over 9000)



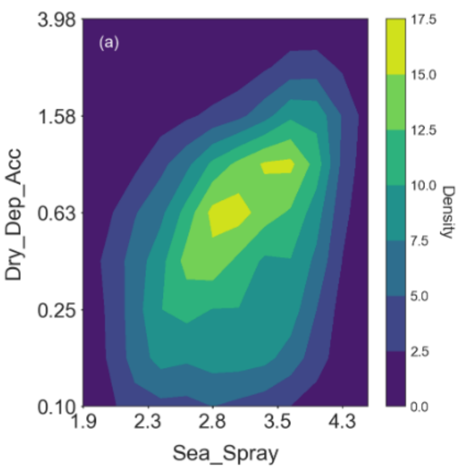
AER-ATM PPE
27 aerosol and physical atmosphere parameters
HadGEM3-GA4.0

Inter-annual variability, spatial and temporal representation errors limit constraint efficacy

We cannot tightly constrain globally perturbed **anthropogenic emission parameters**



Model equifinality (compensating parameter effects) limits constraint efficacy



Regayre et al., ACPD, 2019

Features of the A-CURE UKESM1 PPE

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- UKESM1-A 11.2 with model structural developments
- 55 parameters
- Aerosol emission, process and deposition parameters
- Physical atmosphere parameters (clouds, radiation, precipitation)
- Regional anthropogenic emission parameters
- 2-stage PPE creation to filter out poor model variants
- 2016-2017 meteorology with 2014 (CMIP6) anthropogenic emissions
- High time frequency output to match campaign data
- A community resource: We welcome collaborations and wider use of the PPE

Preliminary A-CURE UKESM1-A PPE analysis

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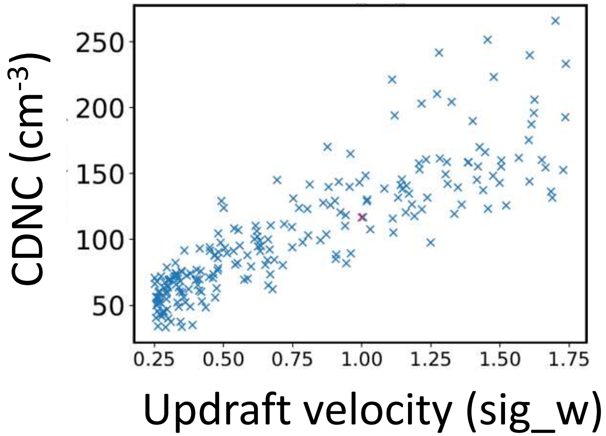
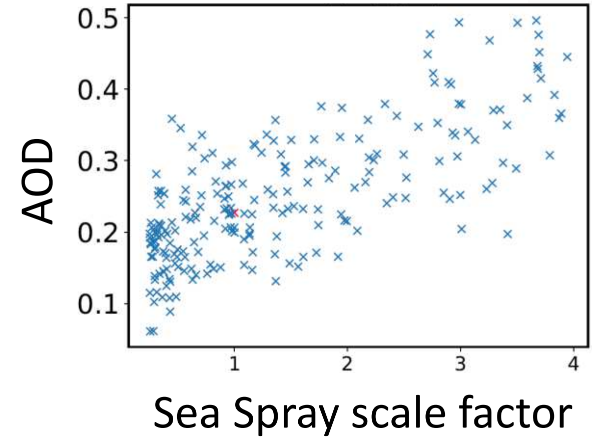
For some variables, we can readily identify the **key sources of uncertainty**

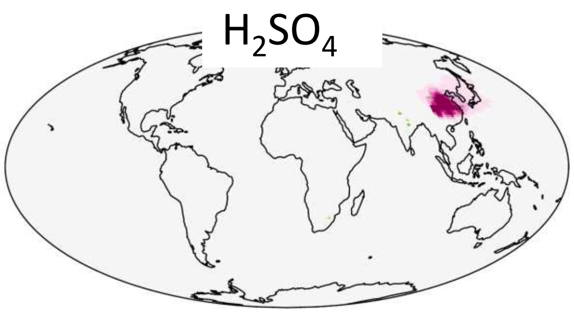




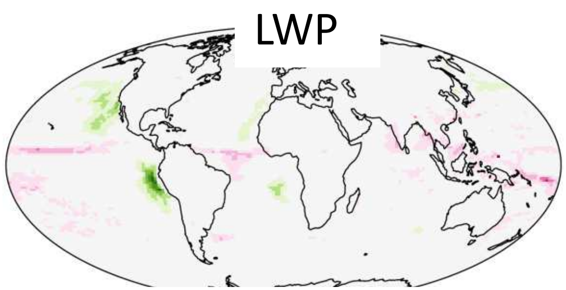
Effects of **regional anthropogenic emission scale factors** can be localised

Parameters can have **compensating regional effects**

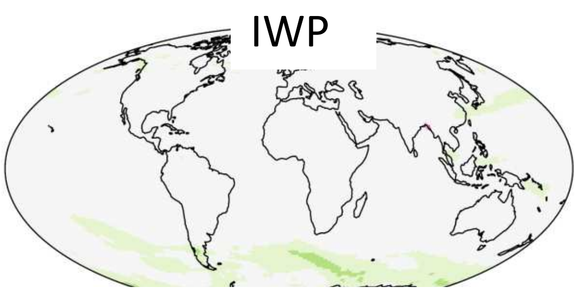
UKESM1 **structural changes** may be an important source of uncertainty



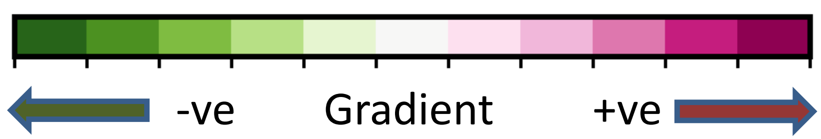
Chinese SO2 emission scale factor



Cloud top entrainment rate (a_ent_1_rp)



Primary marine organic emissions scale factor



Rob Parker

NCEO

Climate and Earth system change at different levels of global mean warming

Colin Jones (NCAS), Ranjini Swaminathan (NCEO), **Rob Parker (NCEO)**, Doug Kelley (CEH), Jeremy Walton (MOHC), Yongming Tang (MOHC)

+ many others (at NCAS, CEH, NCEO, MOHC, NOC, PML)

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UKESM

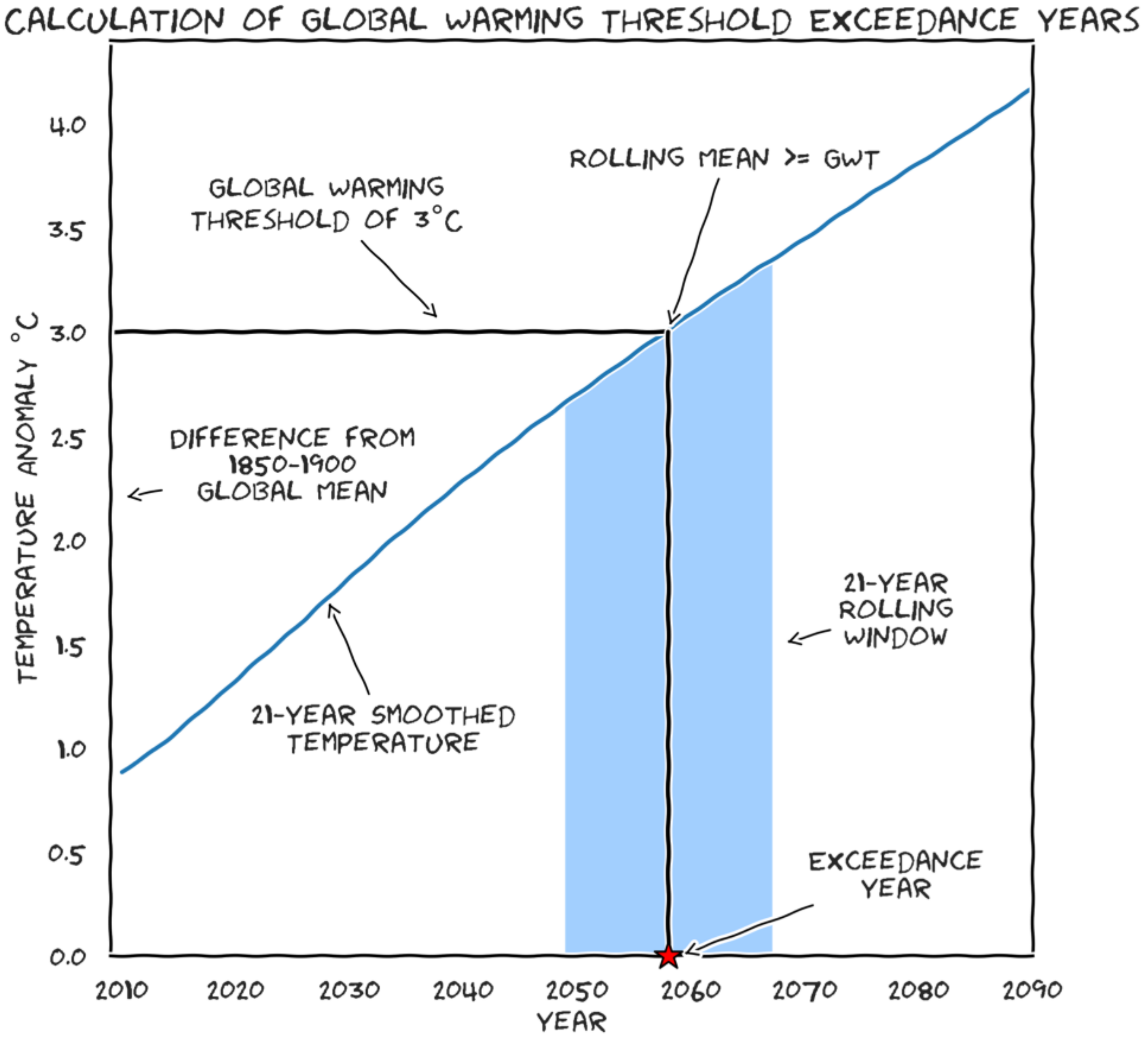
Natural Environment Research Council

Global Warming Thresholds

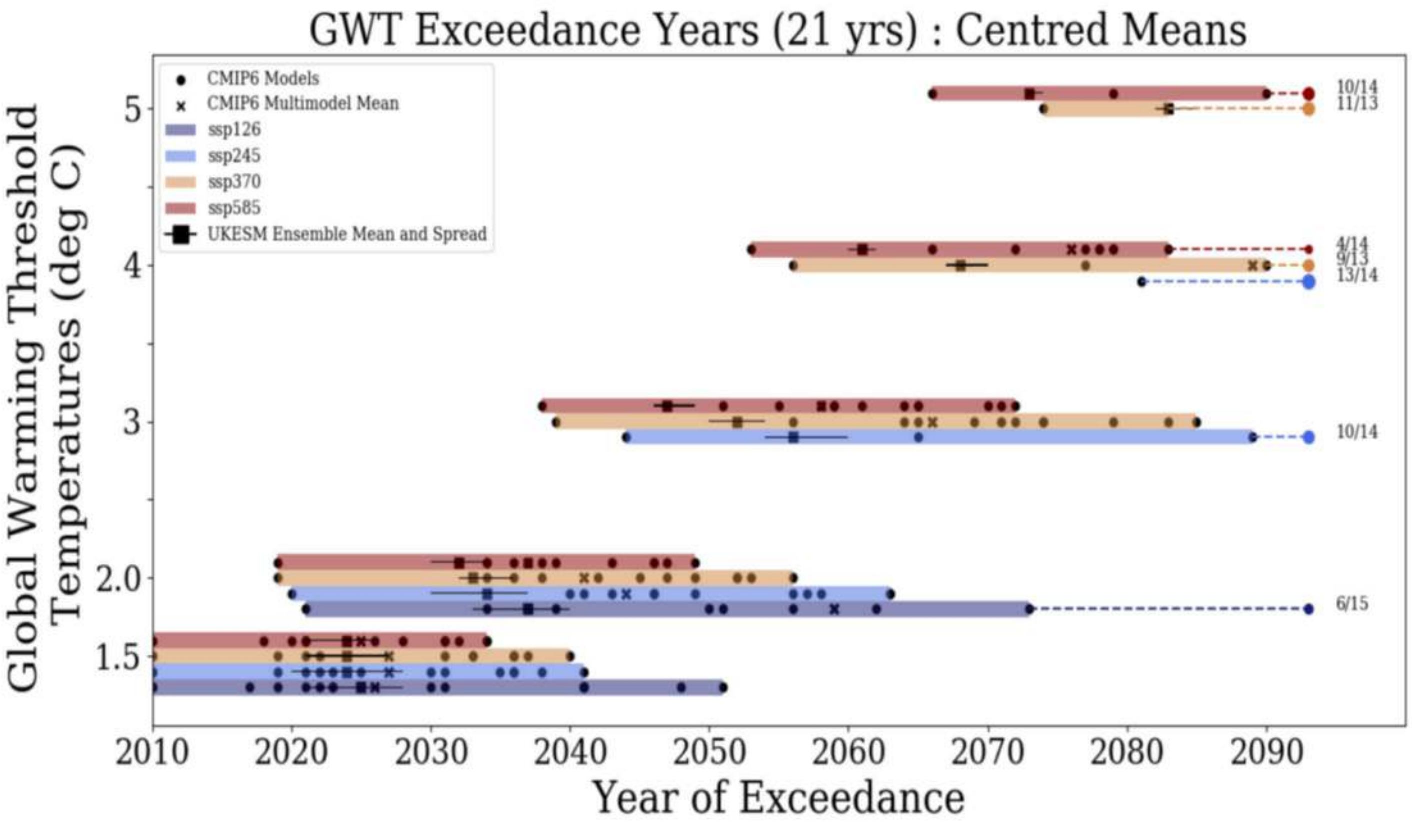
In addition to analysing the temporal evolution of climate change, we can also ask:

- How will the climate & Earth system look at **different levels** of global mean warming ?
- What **regional changes** (and associated **impacts**) might be avoided if global warming is limited to X°C instead of Y°C?
- Analyse changes in the **coupled Earth system** at different levels of global warming; using the UKESM1 and the ScenarioMIP multi-model ensemble

We identify the year a UKESM1 simulation exceeds a global warming threshold (GWT) relative to it's own 1850-1900 climate and using 21 year centred mean climate states.

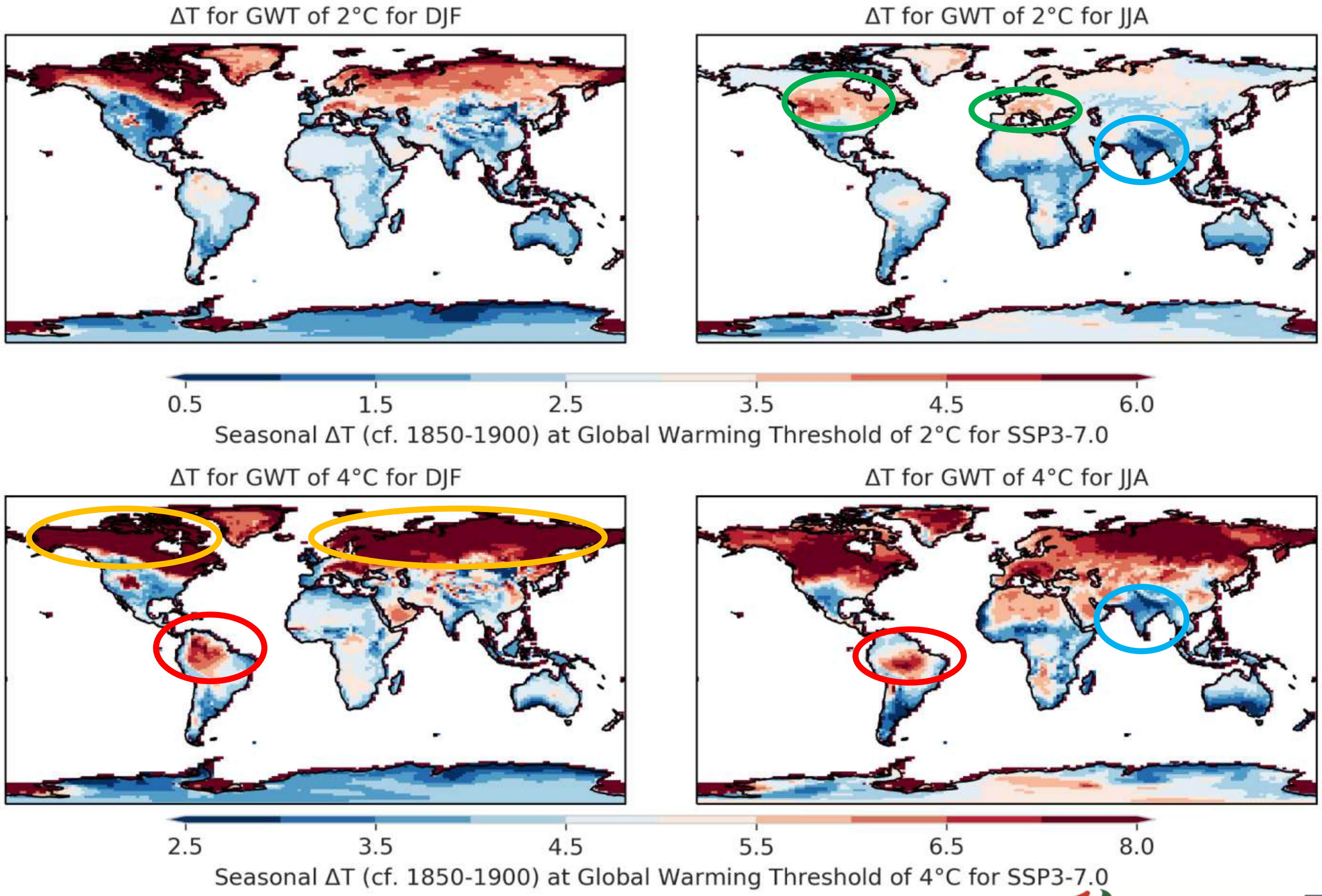


Year of GWT exceedance



Exceedance years calculated for UKESM1 and a number of CMIP6 models Using four scenarioMIP Tier 1 SSPs

Spatial seasonal patterns of surface warming at GWT = 2°C and GWT = 4°C



Summer warming amplified by ~75% Central Europe & Mediterranean & central N. America at GWT= 2°C

Indian subcontinent warms less than the global mean during summer monsoon

High latitude winter warming exceeds 8°C at GWT=4°C

~50% or more amplification of mean warming over Amazon at 4°C

Summary and Next Steps

- Establish the significance of changes compared to internal (natural) variability
- Sensitivity of changes per GWT to different SSP pathways.
- Extend to other variables; e.g. precipitation minus evaporation, soil moisture
- Extend to higher time frequencies; *e.g. heatwaves, droughts, extreme rainfall, wind storms etc*
- Extend to impacts-relevant metrics; *e.g. drought duration, water availability, warm/humid nights etc*
- Focus on sensitive regions; *e.g. Mediterranean, Amazon, Northern latitudes, monsoon systems.*
- Consider co-variability of changes/impacts across the coupled Earth system;
  e.g. heatwaves/droughts & changes in vegetation, carbon uptake, air quality (all interactive in UKESM1)
- Expand to marine changes and associated impacts
- Expand to use the CMIP6 multi-model ensemble