Creating a living archive of Aotearoa New Zealand's (global) climate model data

Dr Jonny Williams, Dr Alexander Pletzer, Dr Hilary Oliver

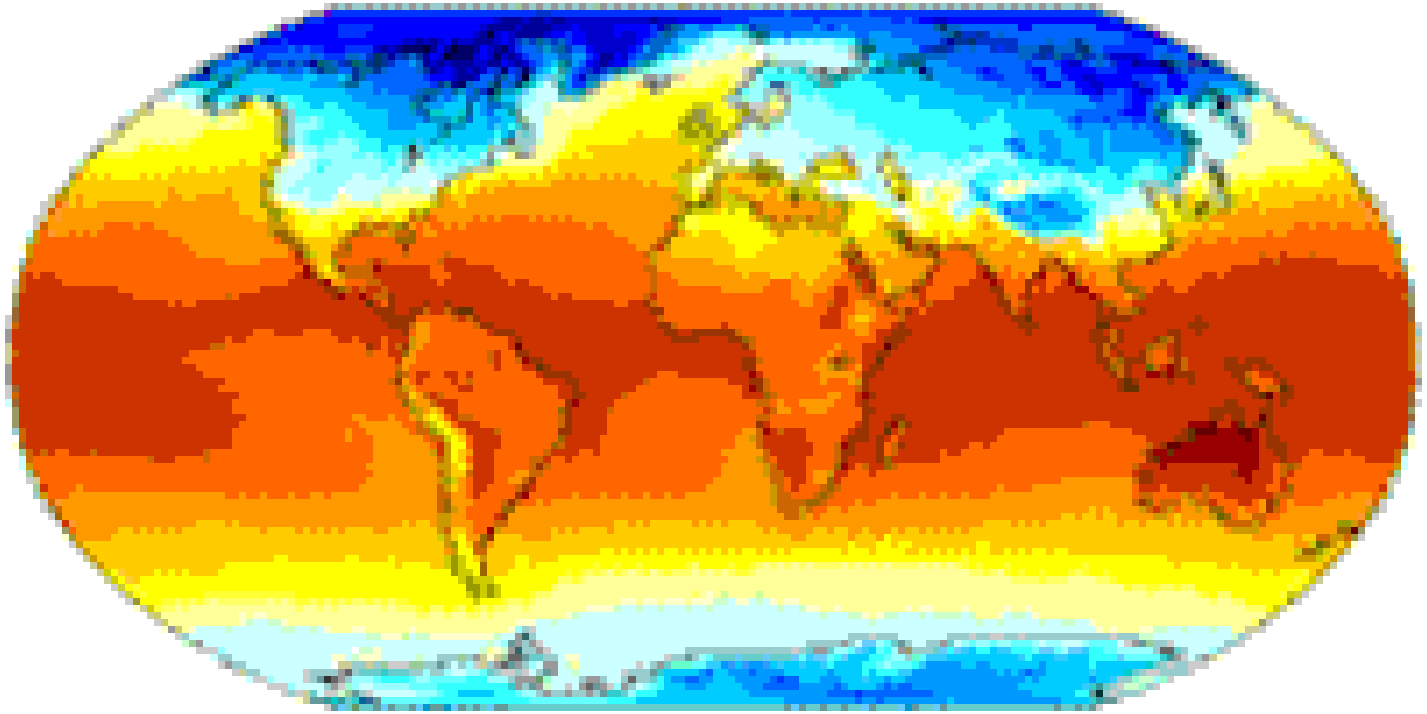
images from wikipedia ‘bath, somerset’

- ko avon te awa
- he kaipūtaiao āhaurangi ahau, kei taihoro nukurangi e mahi ana
- ko bath i ingarangi tōku kainga tūturu, engari e noho ana ahau ki te whanganui-ā-tara
- ko jonny williams tōku ingoa

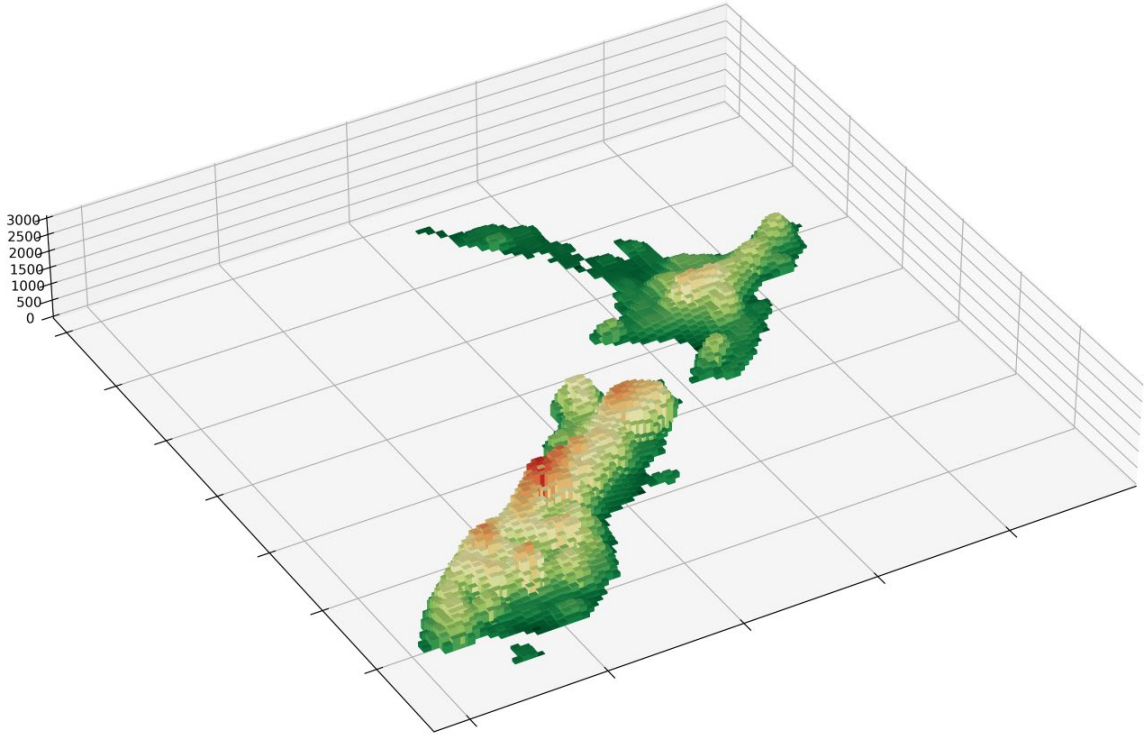
images from wikipedia ‘bath, somerset’

- my river is the avon
- i’m a climate scientist at niwa
- i’m from bath in england but i live in wellington now
- my name is jonny williams

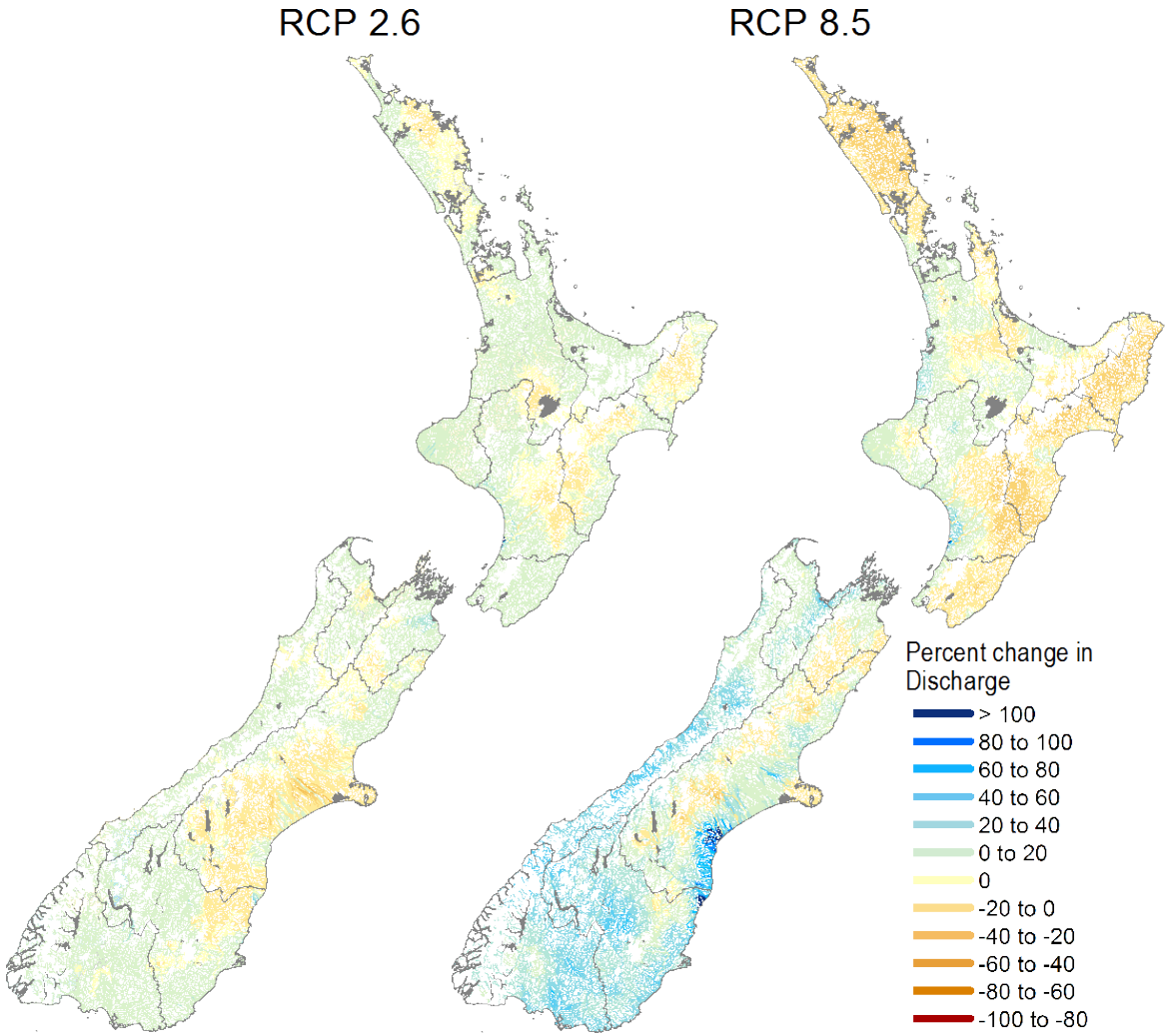
climate models



global modelling in this talk but there's more…

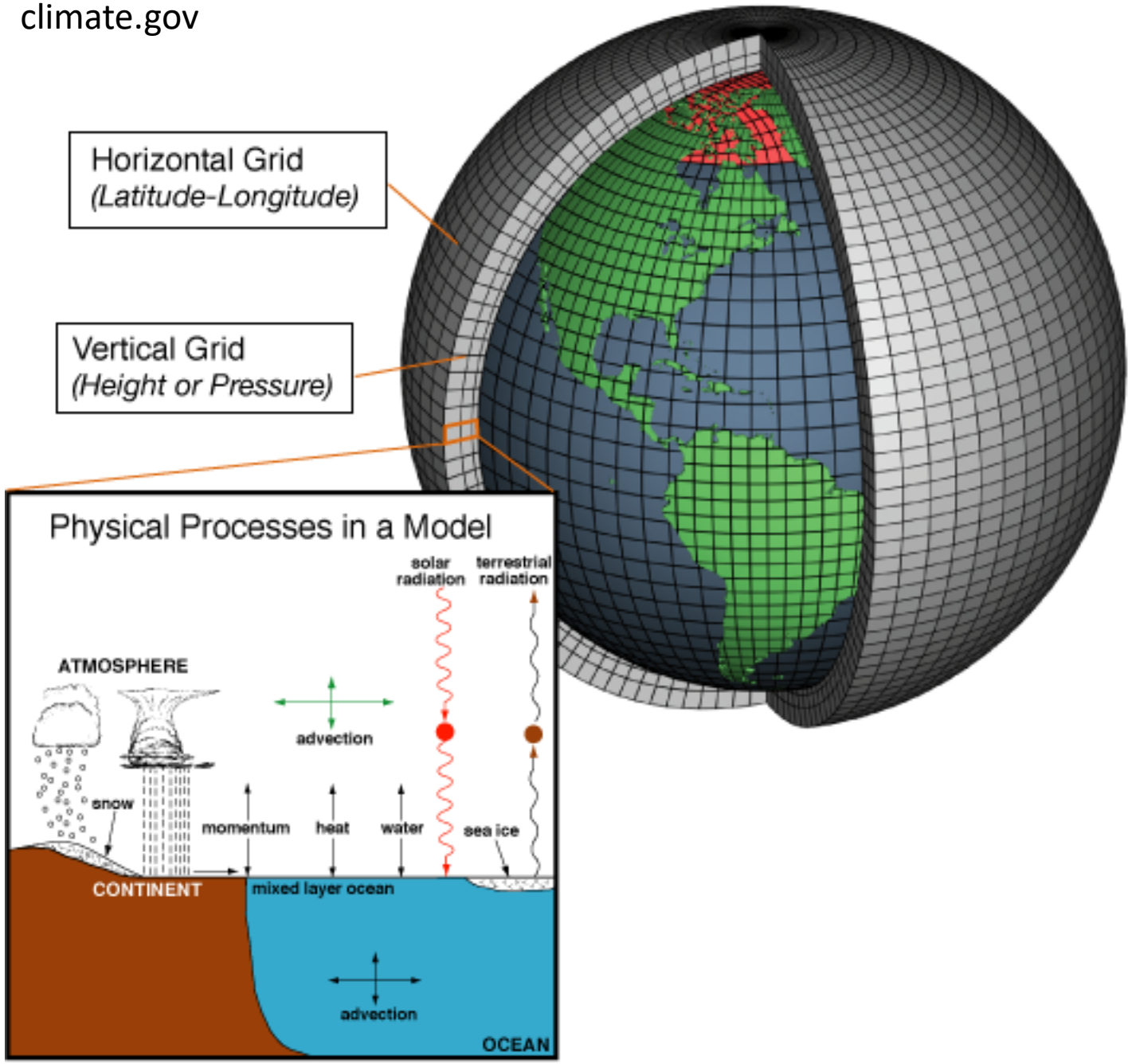


regional atmospheric modelling
stephen stuart & abha sood

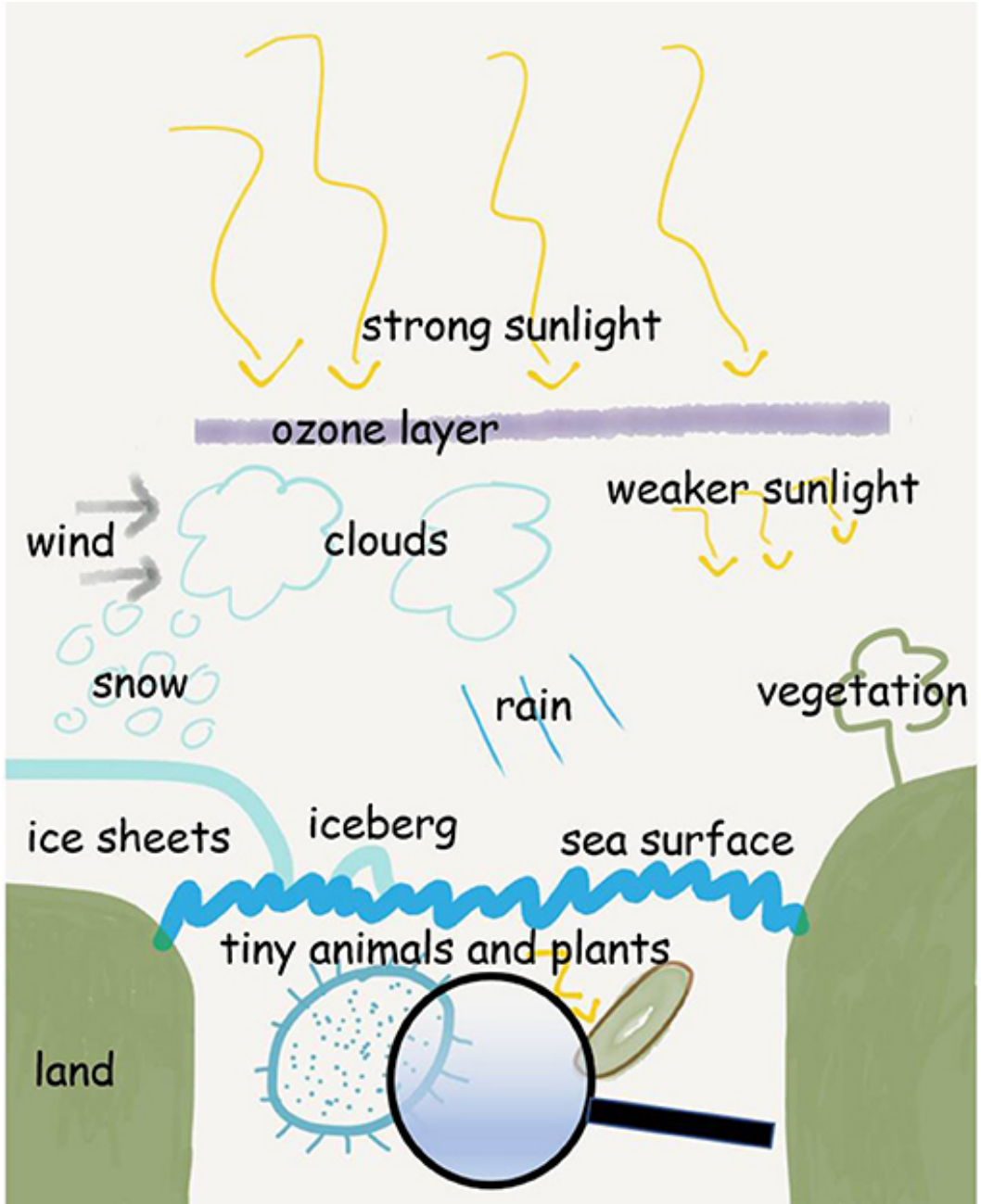


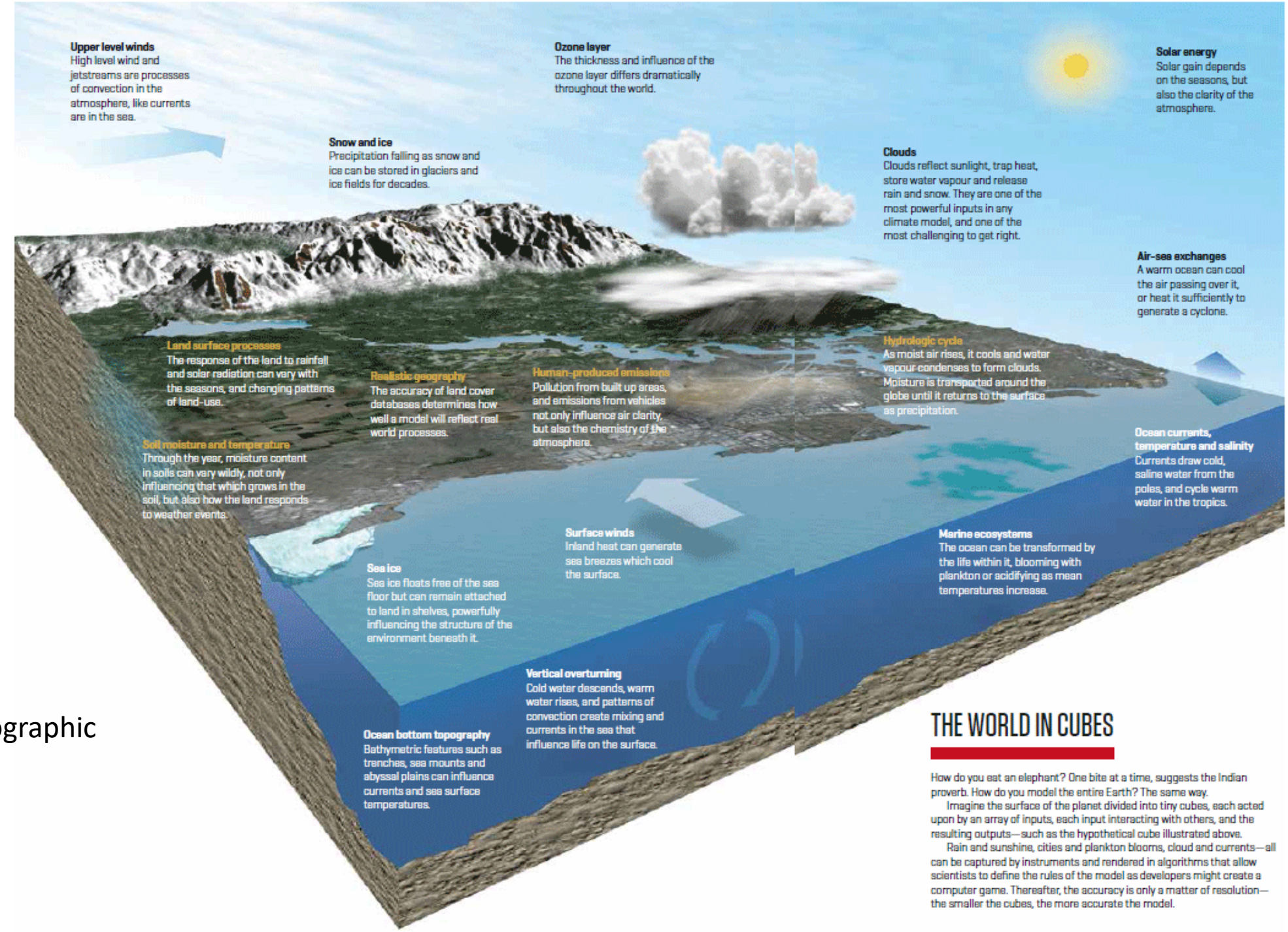
hydrological modelling
christian zammit & colleagues

climate.gov



williams, frontiers for young minds, 2020





nz geographic

THE WORLD IN CUBES

How do you eat an elephant? One bite at a time, suggests the Indian proverb. How do you model the entire Earth? The same way.

Imagine the surface of the planet divided into tiny cubes, each acted upon by an array of inputs, each input interacting with others, and the resulting outputs—such as the hypothetical cube illustrated above.

Rain and sunshine, cities and plankton blooms, cloud and currents—all can be captured by instruments and rendered in algorithms that allow scientists to define the rules of the model as developers might create a computer game. Thereafter, the accuracy is only a matter of resolution—the smaller the cubes, the more accurate the model.

Computing the Climate: Building a Model World

Authors

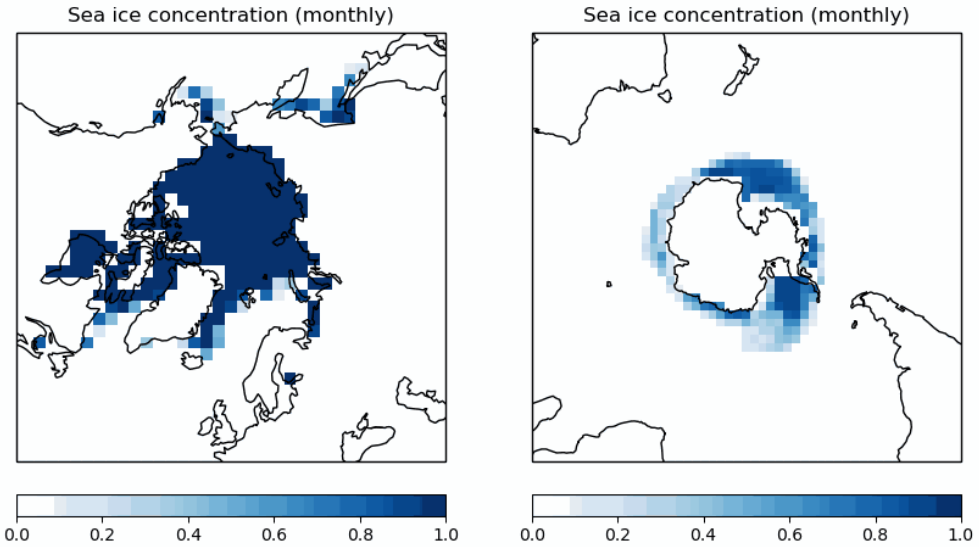
 Jonny Williams

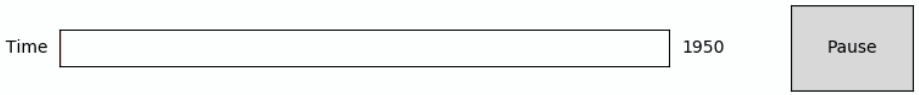
Young Reviewers

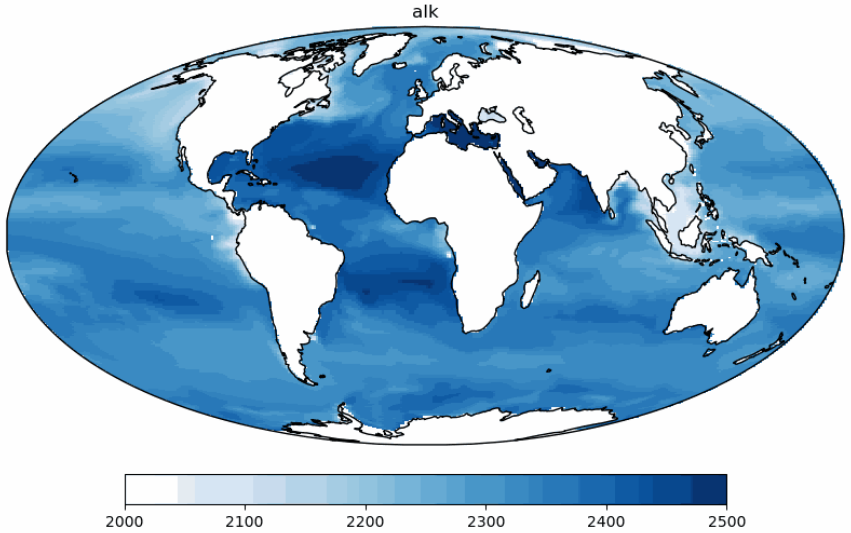
 Nicolas  Omer

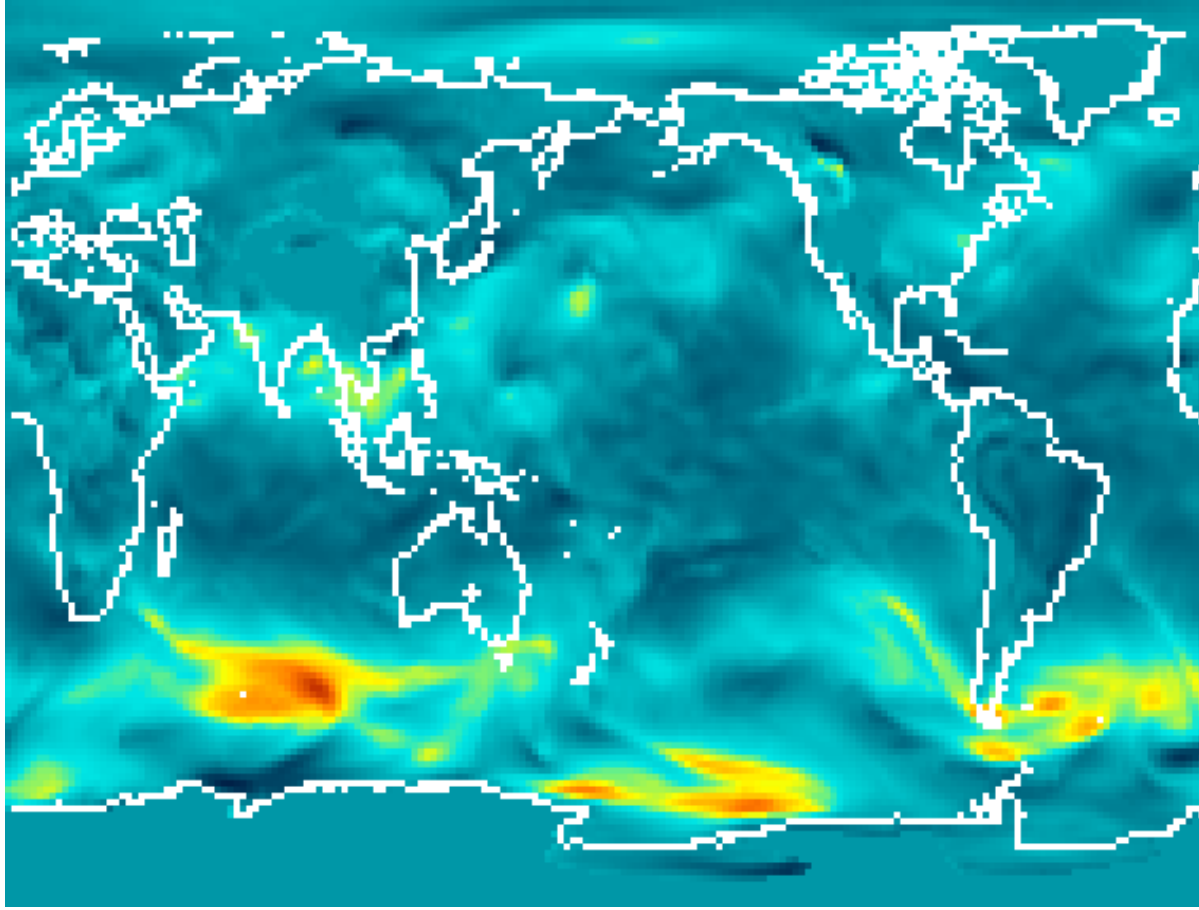
nzesm


COMMON HOUSEHOLD
BISCUITS & SLICES
OF NEW ZEALAND
GINGER CRUNCH
Zingiber chumblorides
LOUISE SLICE
Elevenses regina
SQUIGGLE
Hokipokus prima
PINK WAFER
Lattice lamina
AFGHAN
Cacao coraflaxus ssp. Walnutii
GINGERNUT
Cupotea rex
PEPPERMINT SLICE
Menthos stratum
SHORTBREAD
Sensibilis crumblii
BELGIUM BISCUIT
Piquancium fuchsia
RAISIN BISCUIT
Deceptus terribloides
MELTING MOMENT
Custurdis betwixtus
SULTANA PASTY
Disappointus minora
MARSHMALLOW SLICE
Stickimitts maxima
CARAMEL SLICE
Treatus majora
CAMED CREME
Oreo novae-zelandiae
MALLOWPUFF
Chocolatum rotunda
PEANUT BROWNIE
Goober deliciosa
LOLLY CAKE
Smashenchillus simplex
HUNDREDS & THOUSANDS
Centium millena
SHREWSBURY
Lickalda jamoffit
ANZAC BISCUIT
Lestree forgetum
illustrated by Giselle Clarkson


Sea ice concentration (monthly)
Sea ice concentration (monthly)
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0


Time
1950
Pause


alk
2000
2100
2200
2300
2400
2500



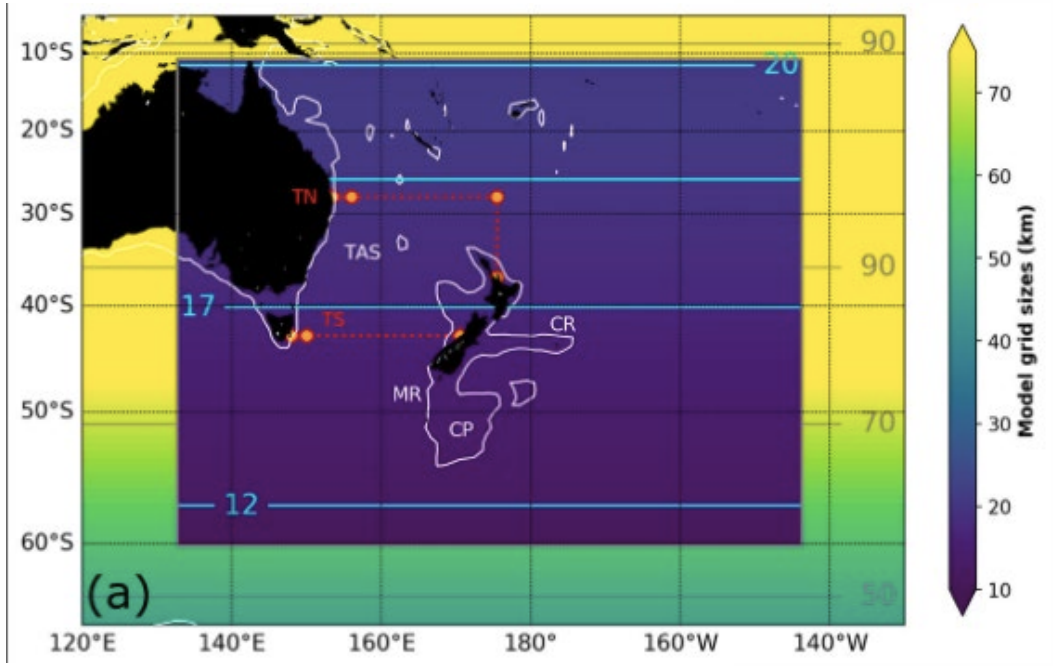
JAMES | Journal of Advances in Modeling Earth Systems

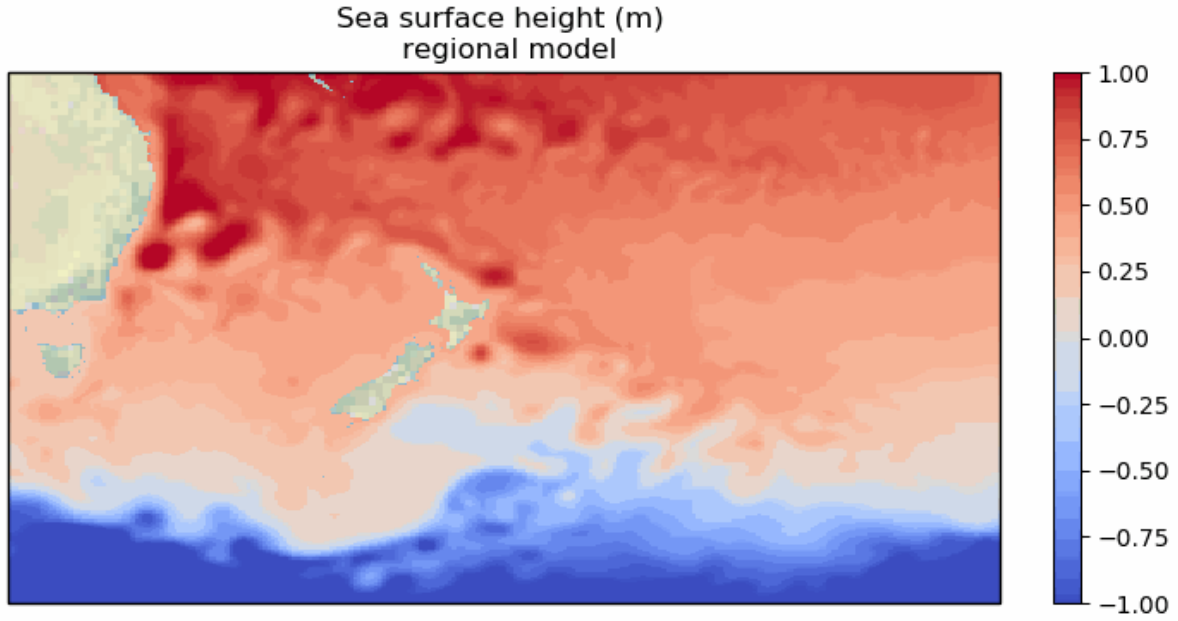
Research Article | Open Access

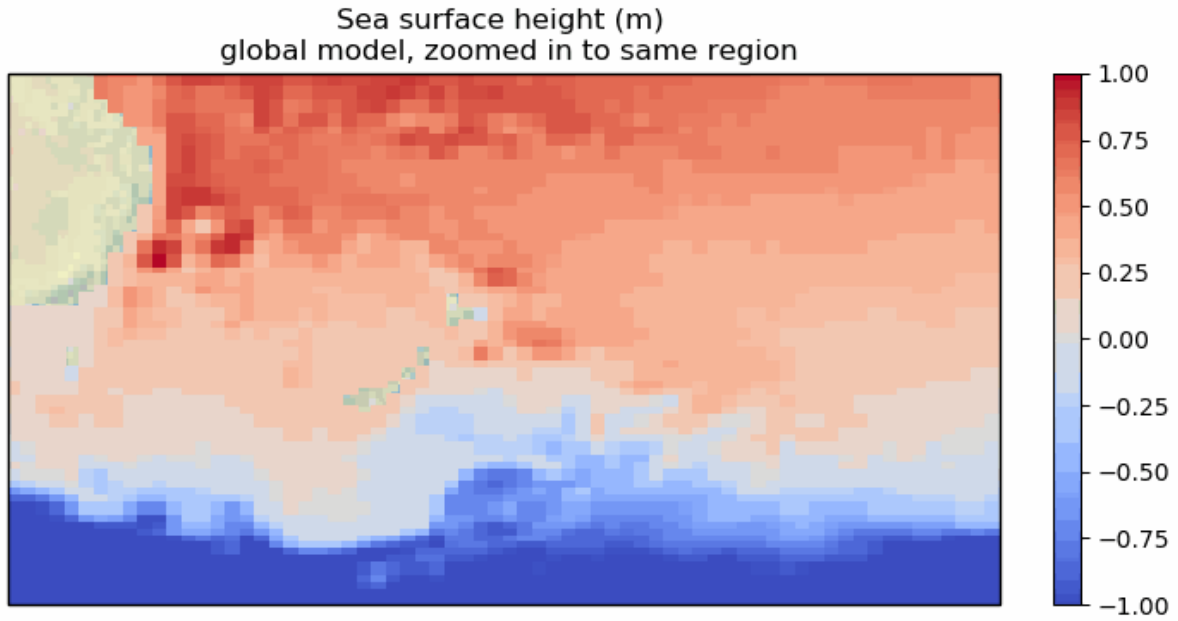
Local Grid Refinement in New Zealand's Earth System Model: Tasman Sea Ocean Circulation Improvements and Super-Gyre Circulation Implications

Erik Behrens, Jonny Williams, Olaf Morgenstern, Phil Sutton, Graham Rickard, Michael J. M. Williams

First published: 09 June 2020 | https://doi.org/10.1029/2019MS001996 | Citations: 2







validation; zooming in on the data

atmosphere

NZESM vs UKESM — Mozilla Firefox

File Edit View History Bookmarks Tools Help

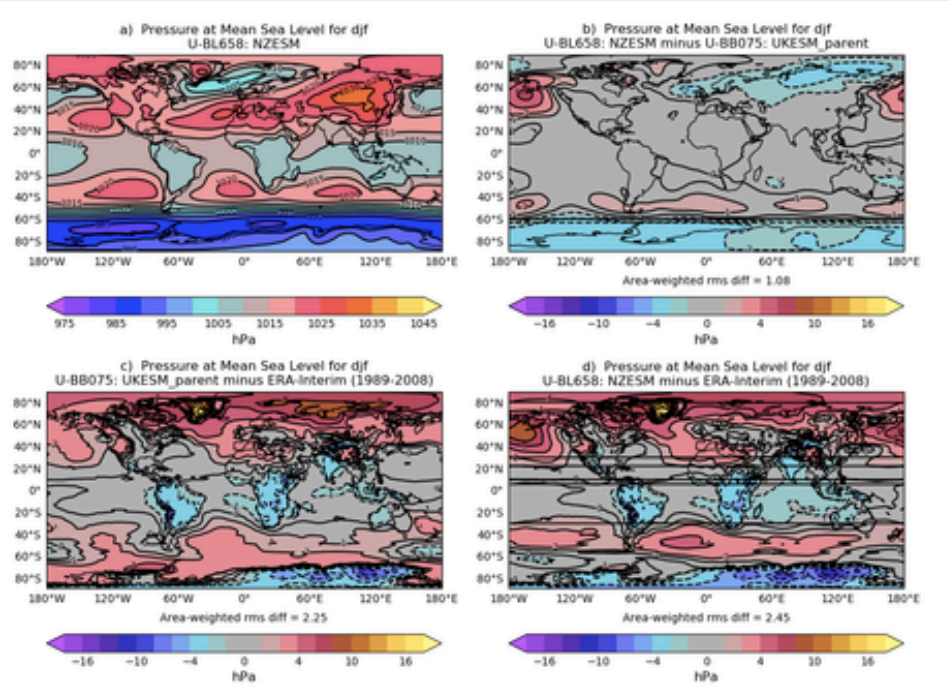
NZESM vs UKESM

file:///scale_wlg_persistent/filesets/home/williamsjh/public_html/auto_assess/valnote/u-bl6

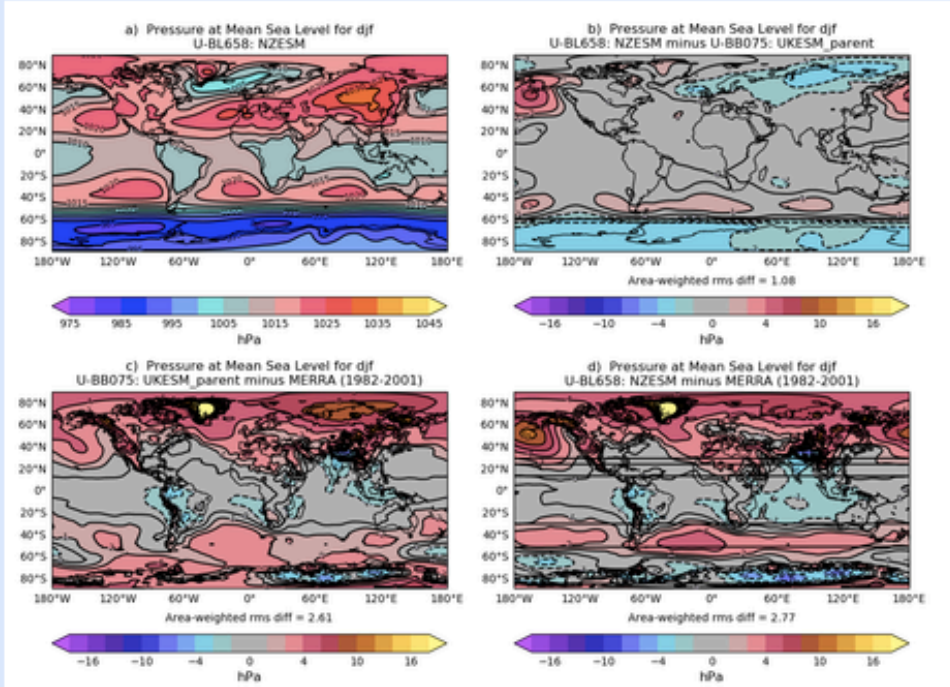
NZESM vs UKESM

Plot browser | All plots | Core plots | Land surface | Summary table | Documentation | Global means | Speed test

PMSL djf (v era-interim)



PMSL djf (v merra)



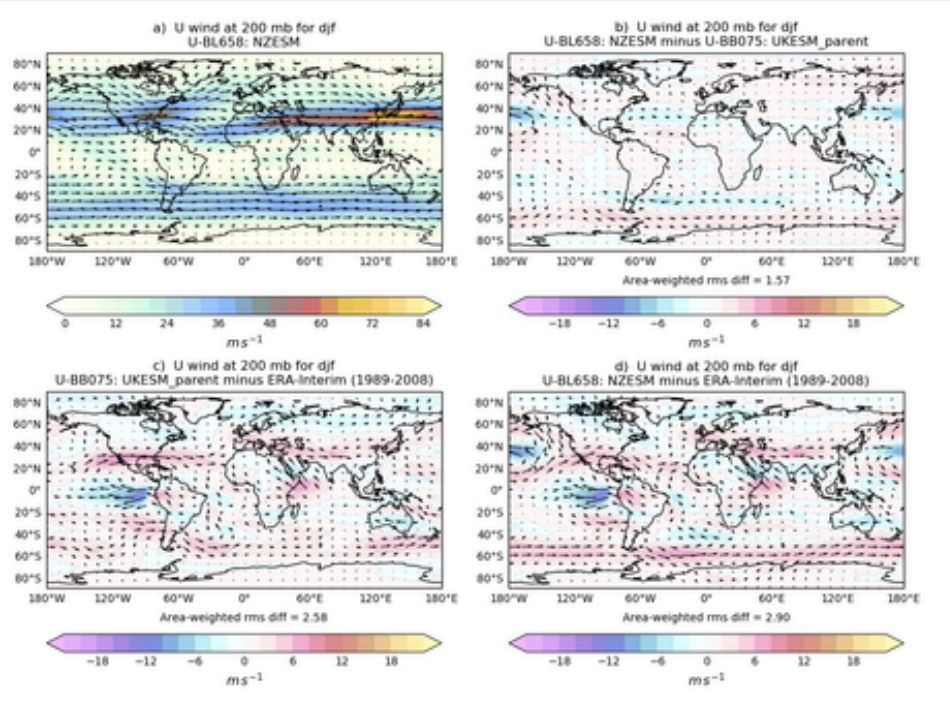
NZESM vs UKESM — Mozilla Firefox

File Edit View History Bookmarks Tools Help

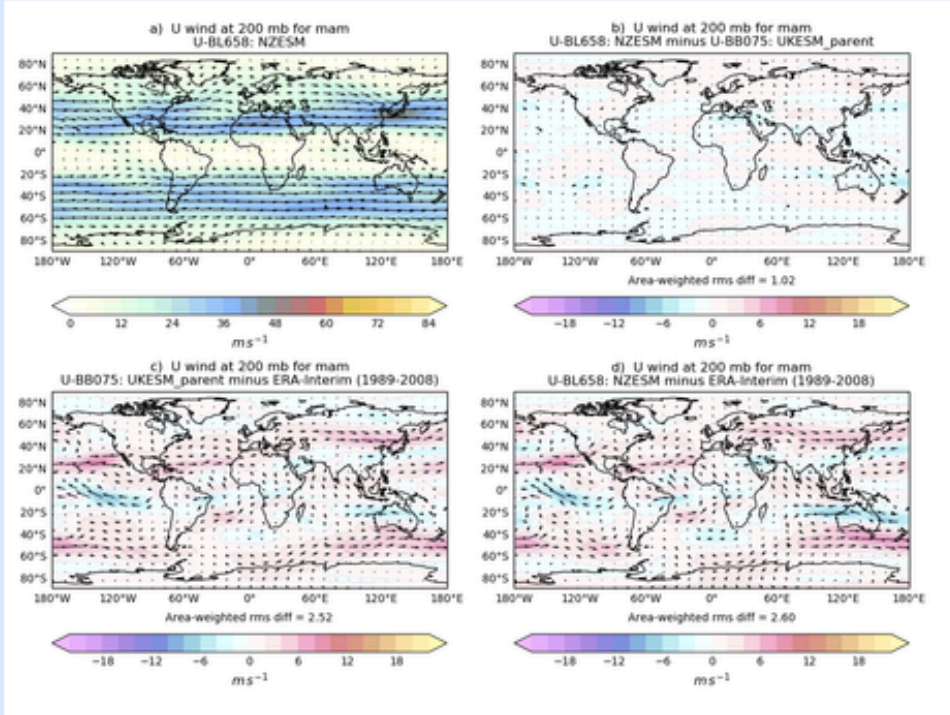
NZESM vs UKESM

file:///scale_wlg_persistent/filesets/home/williamsjh/public_html/auto_assess/valnote/u-bl6

200mb winds djf (v era-interim)

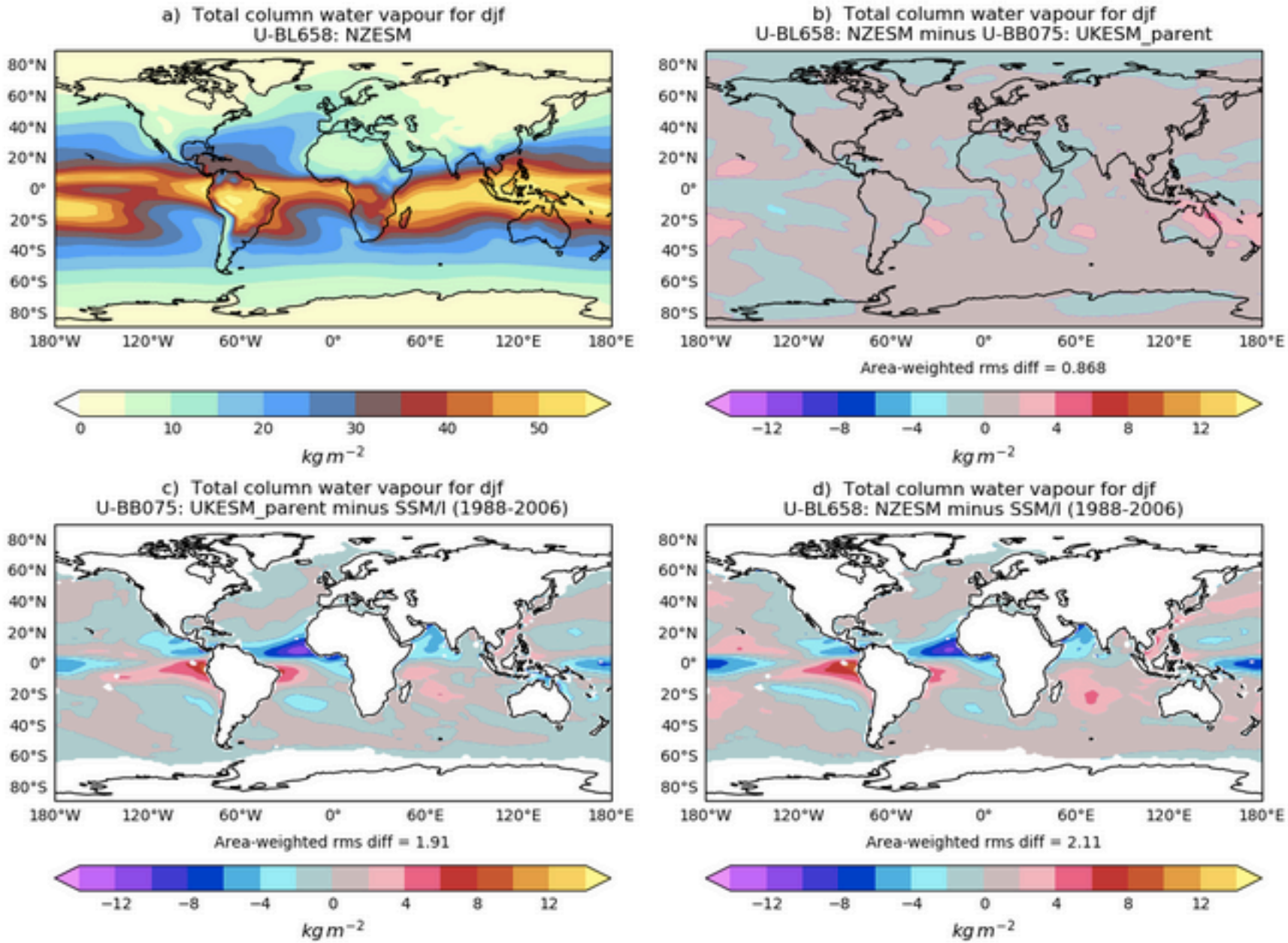


200mb winds mam (v era-interim)

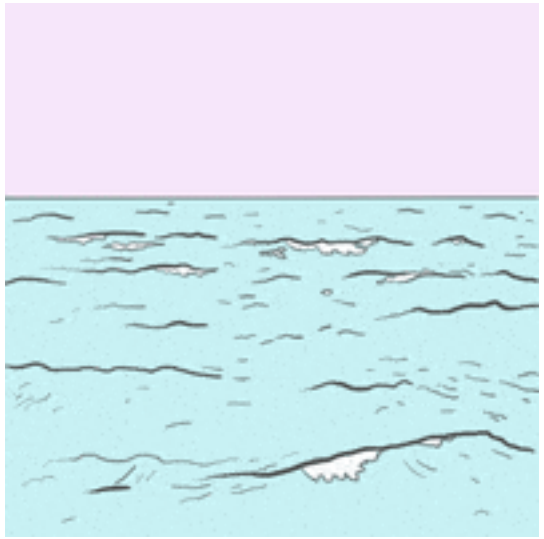


200mb winds jja (v merra)

200mb winds jja (v era-interim)


a) Total column water vapour for djf
U-BL658: NZESM
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
180°W
120°W
60°W
0°
60°E
120°E
180°E
0
10
20
30
40
50
kg m⁻²
b) Total column water vapour for djf
U-BL658: NZESM minus U-BB075: UKESM_parent
Area-weighted rms diff = 0.868
−12
−8
−4
0
4
8
12
kg m⁻²
c) Total column water vapour for djf
U-BB075: UKESM_parent minus SSM/I (1988-2006)
Area-weighted rms diff = 1.91
kg m⁻²
d) Total column water vapour for djf
U-BL658: NZESM minus SSM/I (1988-2006)
Area-weighted rms diff = 2.11
kg m⁻²

ocean



Assessment of:
bl658 (1950/01/01 - 2014/12/30)
vs.
bb075 (1950/01/01 - 2014/12/30)

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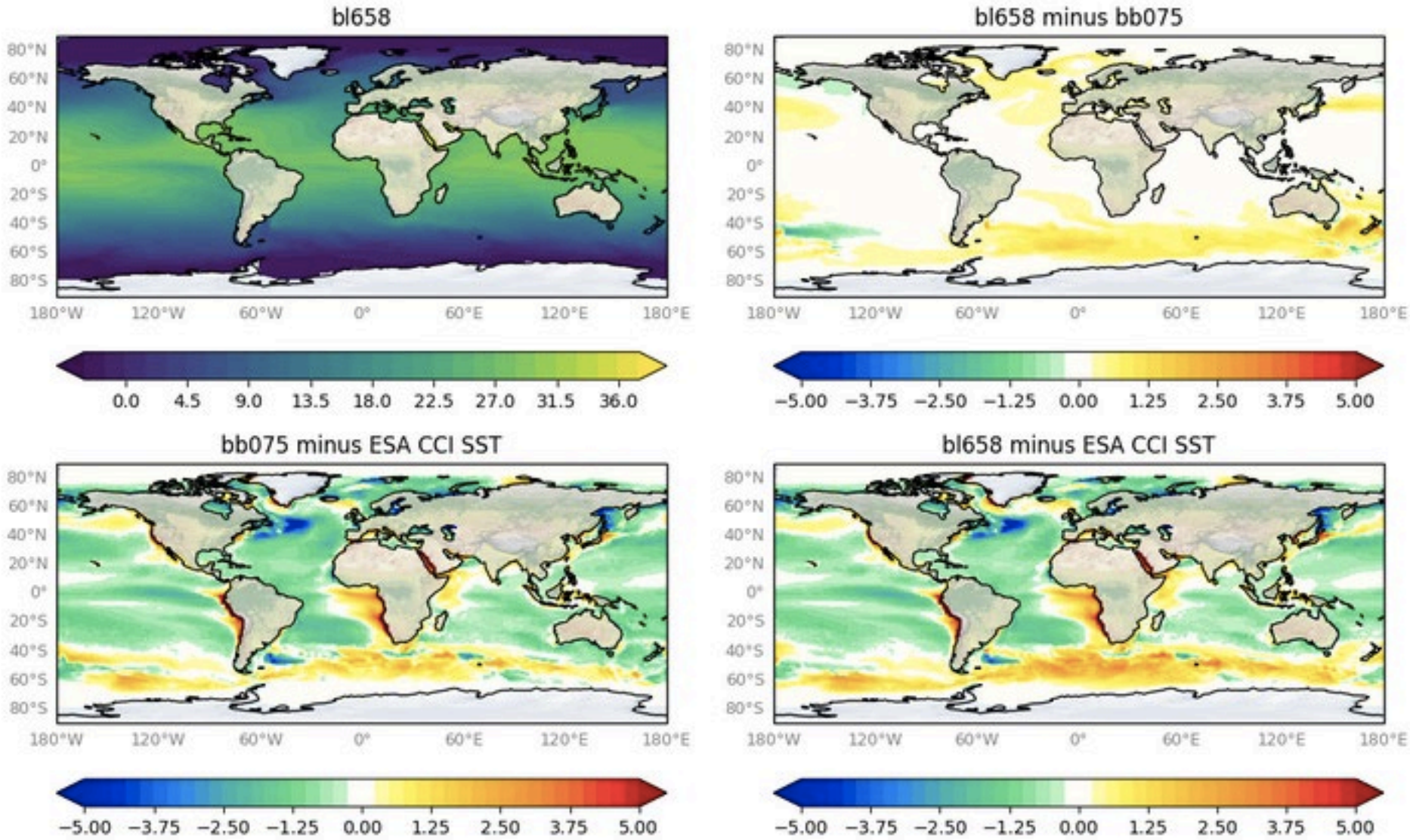
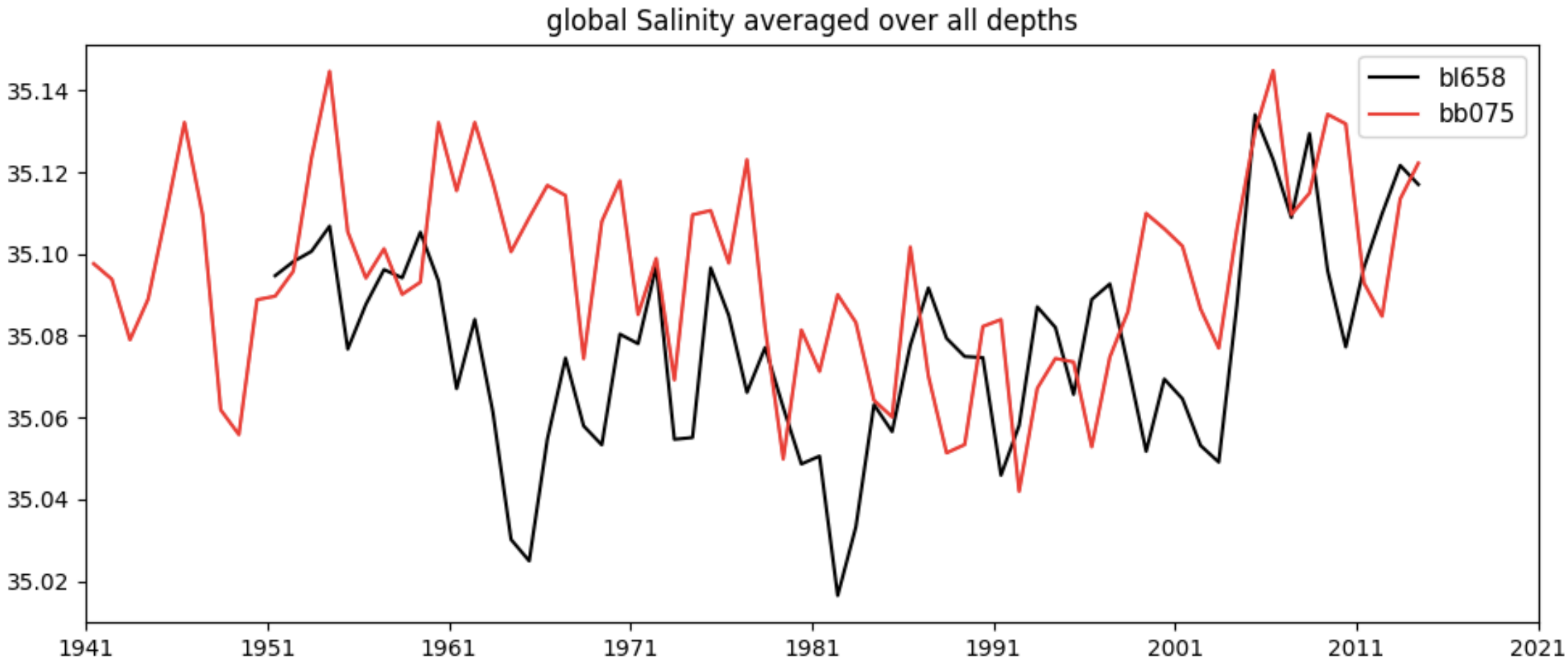
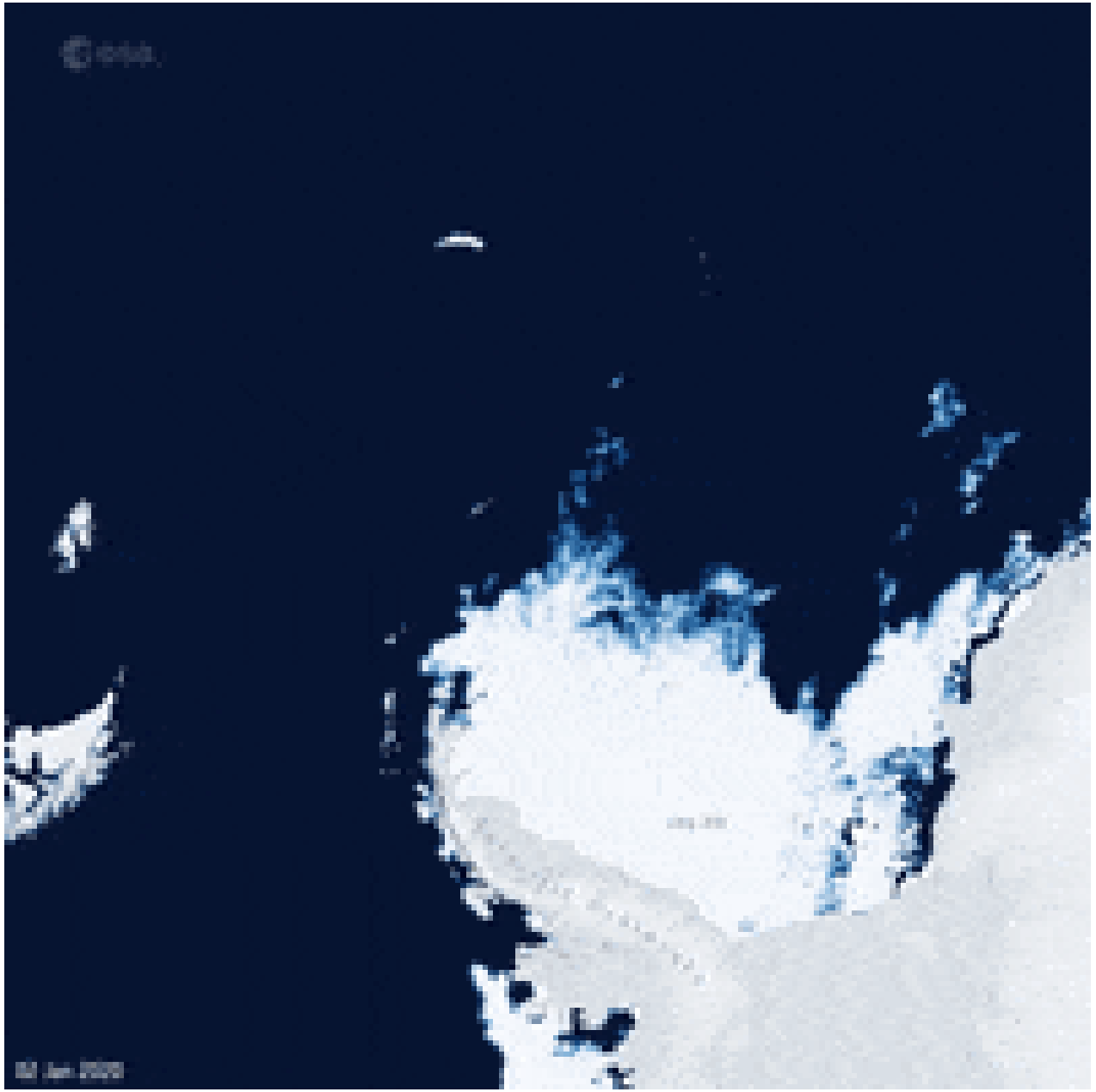
bl658: NZESM1.0, historical (observed solar cycle)
bb075: UKESM1.0, historical

Index


bl658
bl658 minus bb075
bb075 minus ESA CCI SST
bl658 minus ESA CCI SST
80°N
60°N
40°N
20°N
0°
20°S
40°S
60°S
80°S
180°W
120°W
60°W
0°
60°E
120°E
180°E
0.0 4.5 9.0 13.5 18.0 22.5 27.0 31.5 36.0
−5.00 −3.75 −2.50 −1.25 0.00 1.25 2.50 3.75 5.00


global Salinity averaged over all depths
bl658
bb075
35.14
35.12
35.10
35.08
35.06
35.04
35.02
1941
1951
1961
1971
1981
1991
2001
2011
2021

sea ice



Assessment of:
bl658 (1950/01/01 - 2014/12/30)
vs.
bb075 (1950/01/01 - 2014/12/30)

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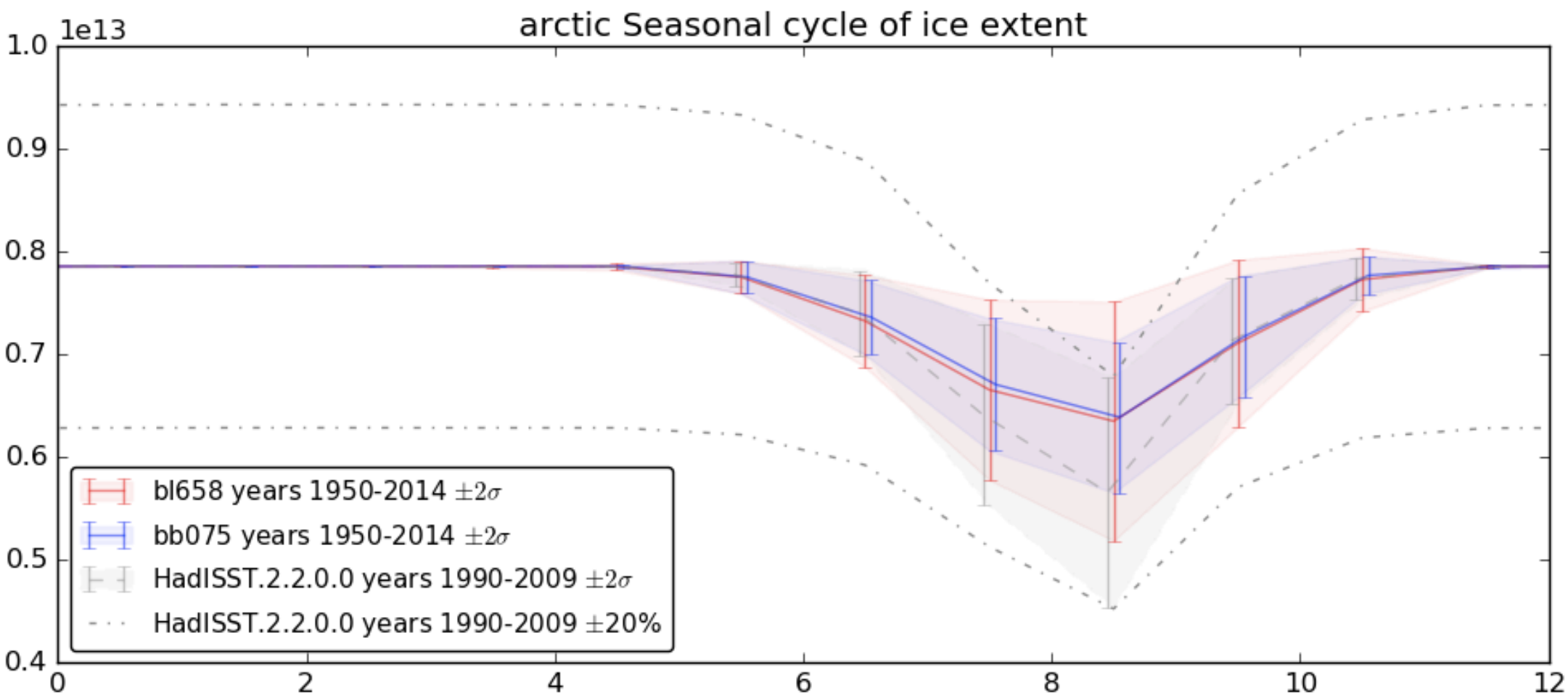
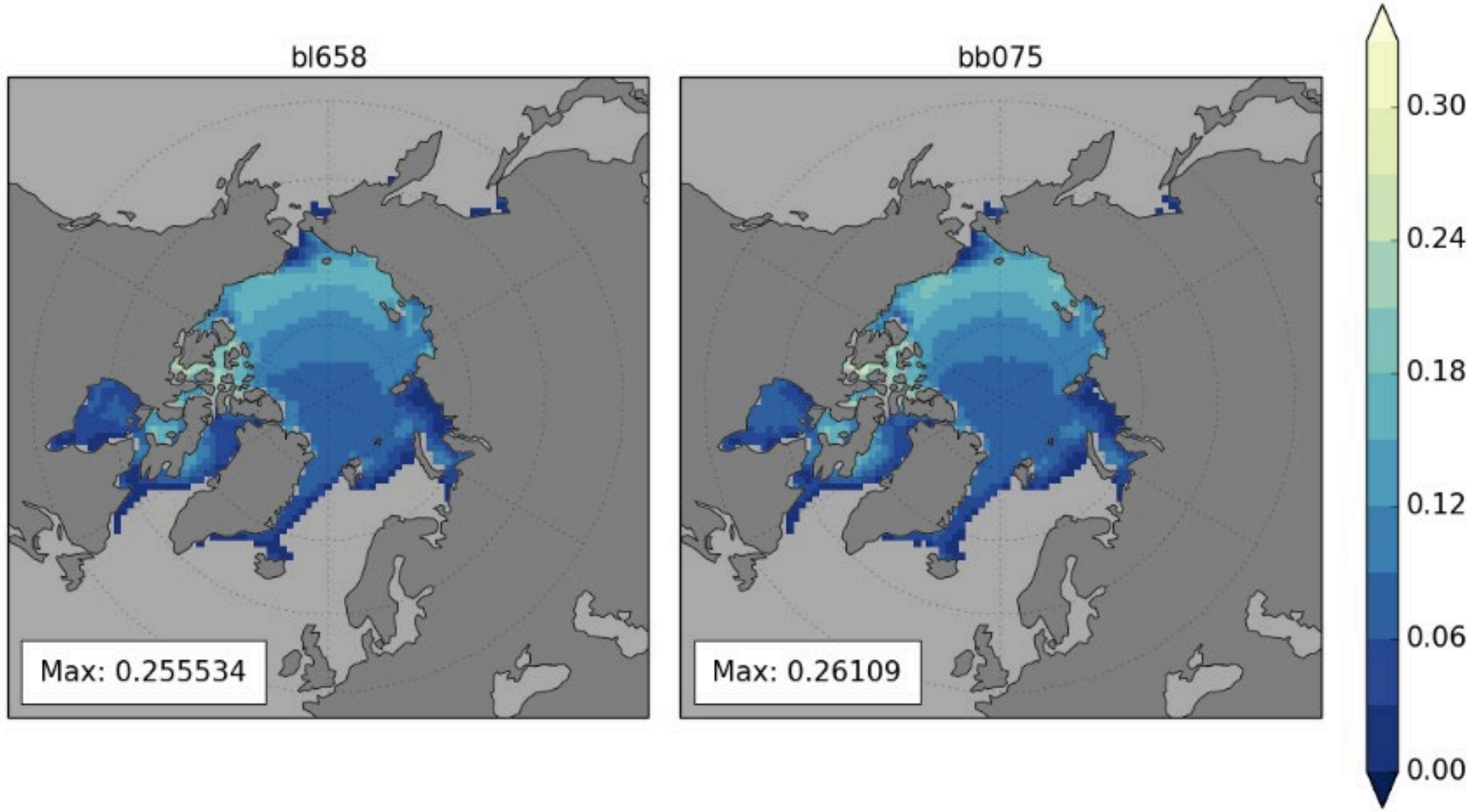
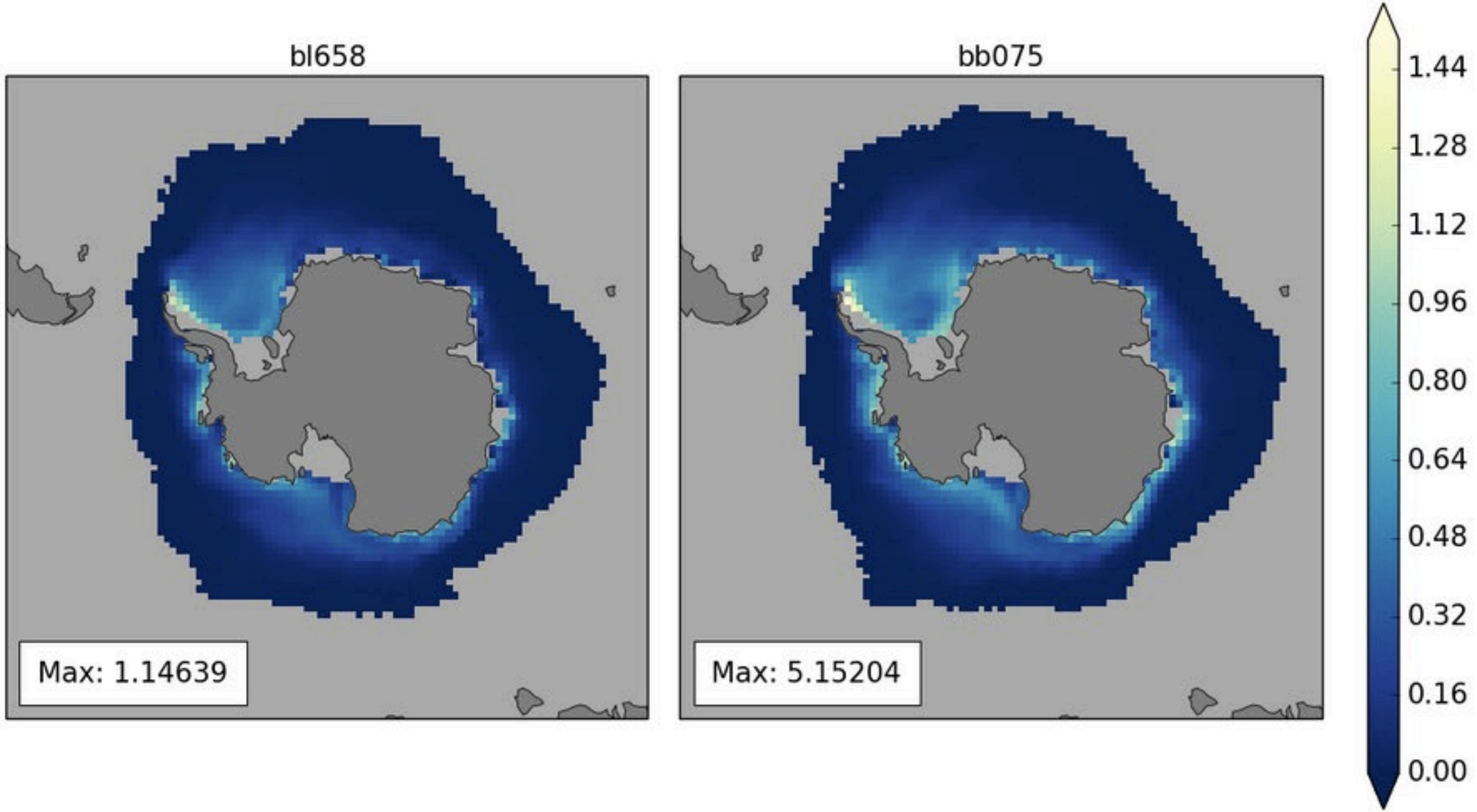
bl658: nzesm1.0, historical (observed solar cycle)
bb075: ukesm1.0, historical

Index


arctic Seasonal cycle of ice extent
1e13
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0
2
4
6
8
10
12
bl658 years 1950-2014 ±2σ
bb075 years 1950-2014 ±2σ
HadISST.2.2.0.0 years 1990-2009 ±2σ
HadISST.2.2.0.0 years 1990-2009 ±20%


bl658
bb075
Max: 0.255534
Max: 0.26109
0.30
0.24
0.18
0.12
0.06
0.00


bl658
bb075
Max: 1.14639
Max: 5.15204
1.44
1.28
1.12
0.96
0.80
0.64
0.48
0.32
0.16
0.00

long term data archival

Home
Submit a request

Getting Started

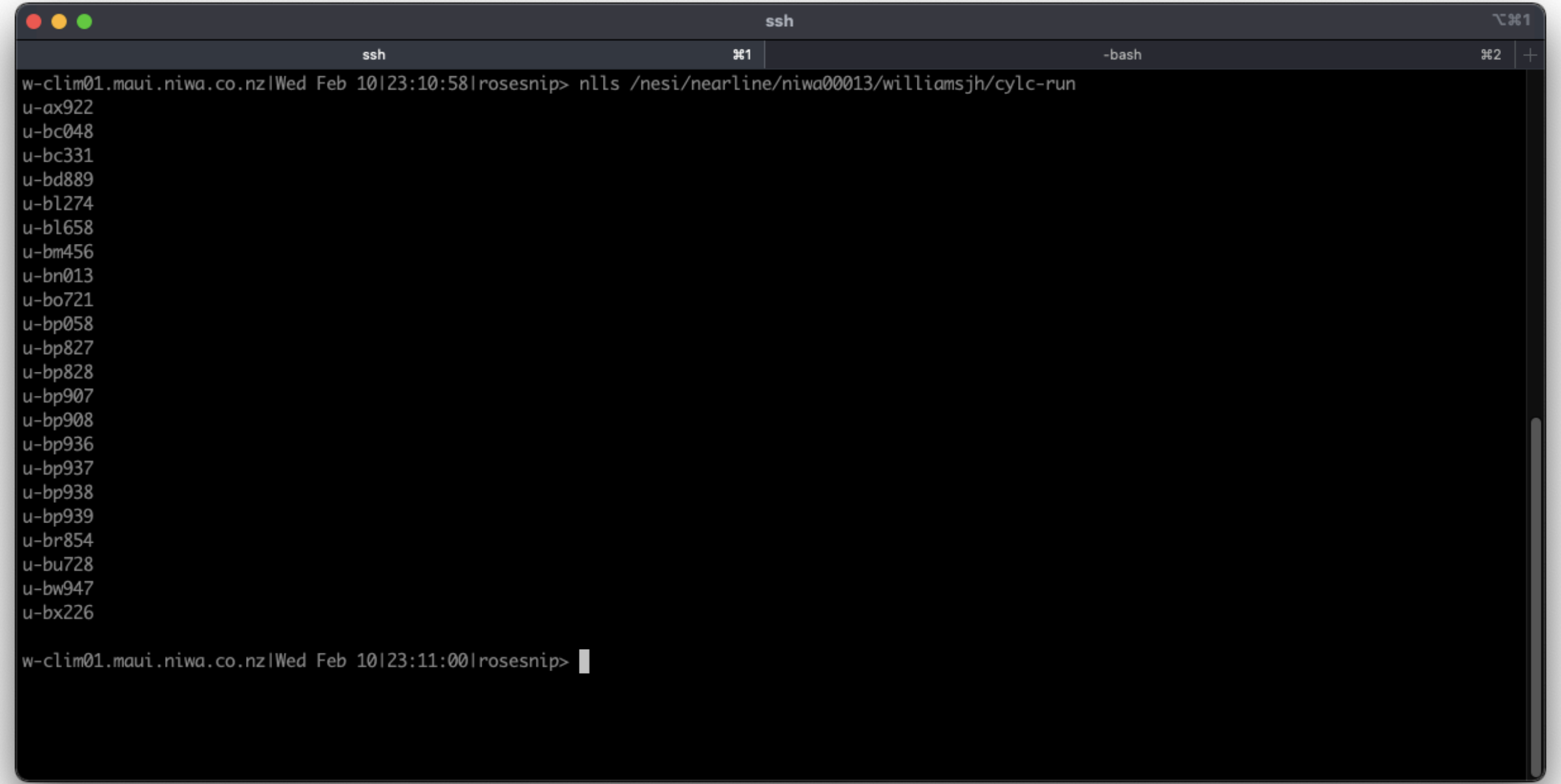
Accounts, Projects and Allocations
Accessing the HPCs
First Steps
Getting Help
Cheat Sheets

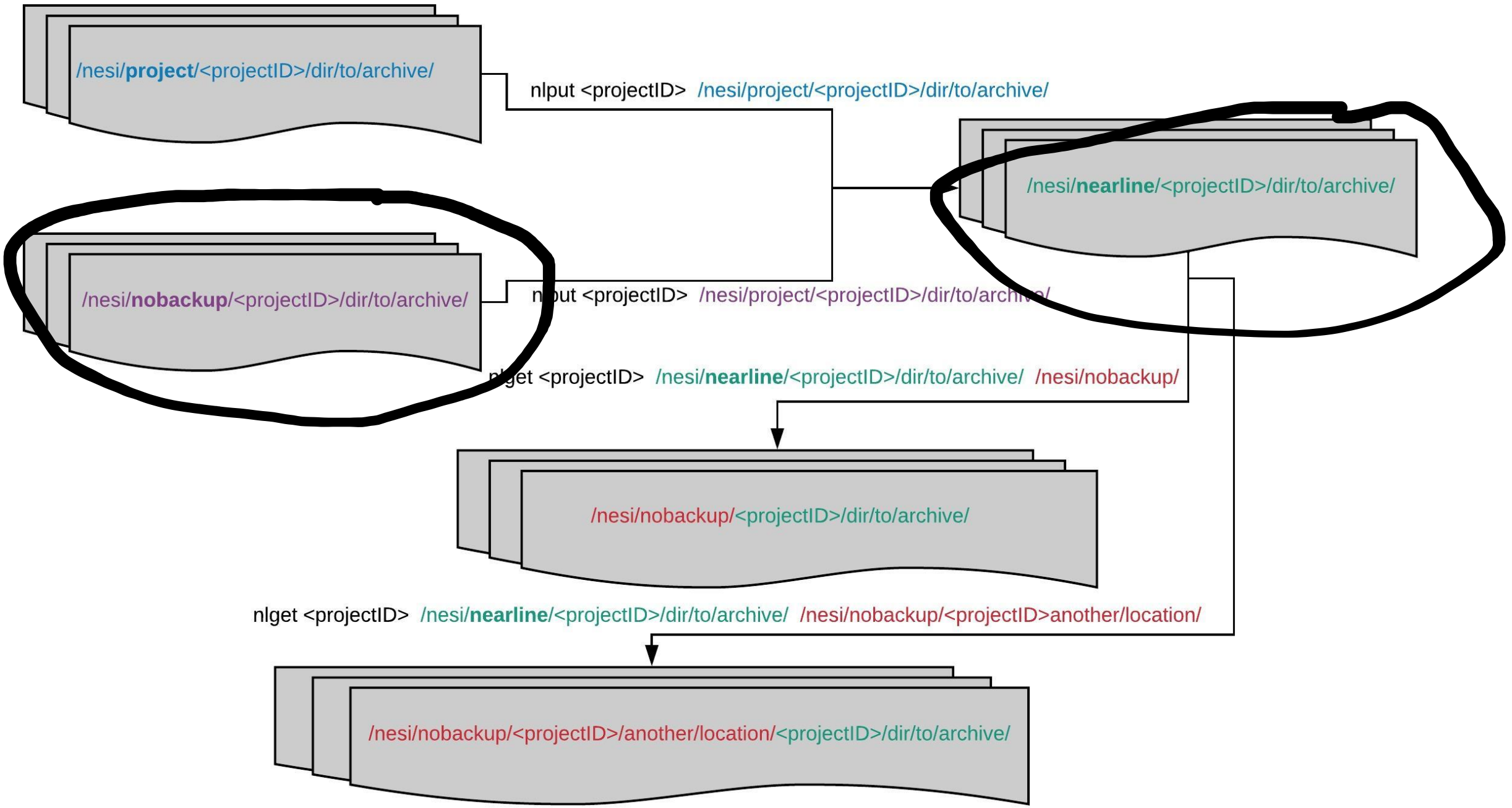
Scientific Computing

The NeSI High Performance Computers
Supported Applications
Running Jobs on Māui and Mahuika
Profiling and Debugging
HPC Software Environment
Terminal Setup

Long-Term Storage Service

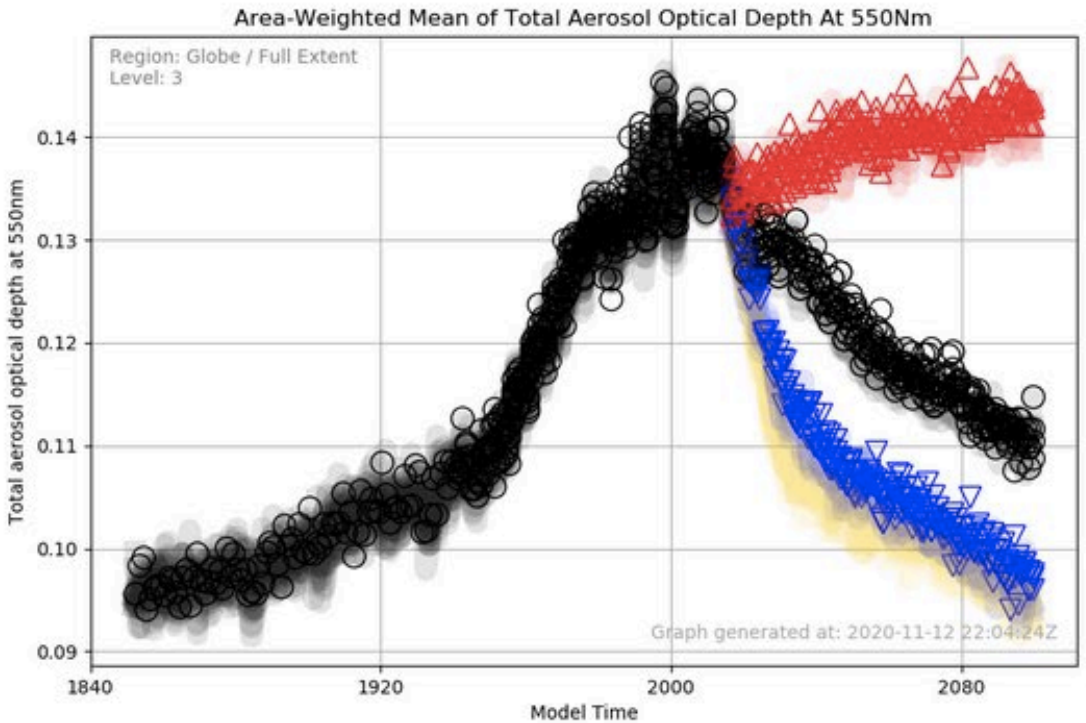
Last updated 27 January 2021 15:15

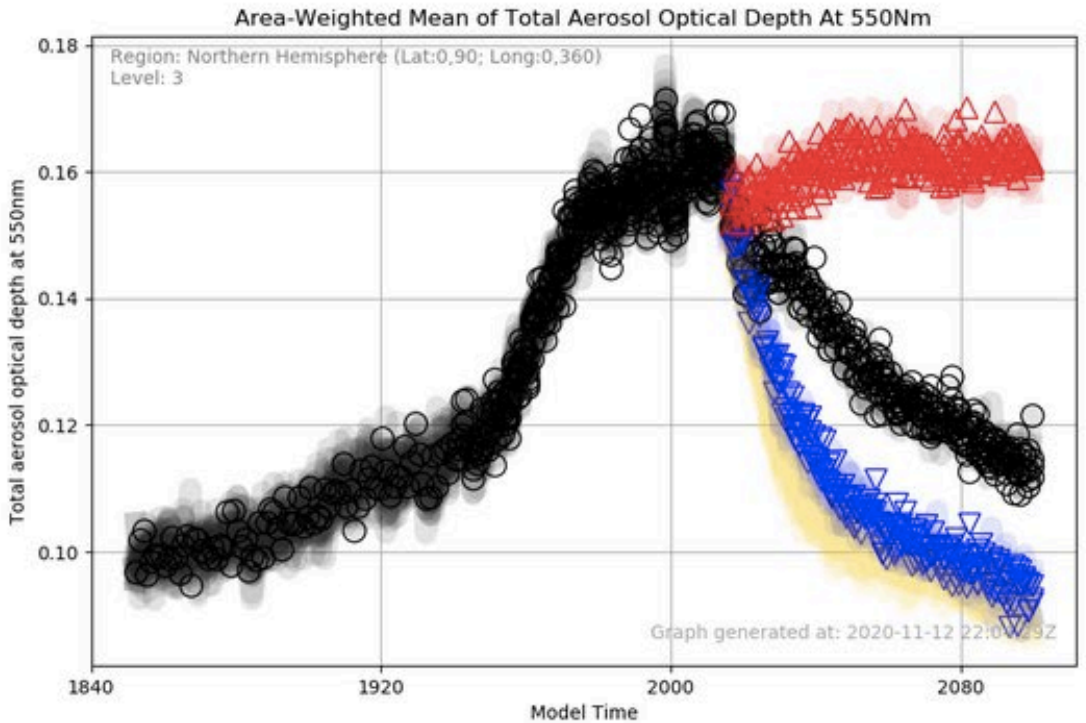

ssh
⌥⌘1
ssh
⌘1
-bash
⌘2
w-clim01.maui.niwa.co.nz|Wed Feb 10|23:10:58|rosesnip> nlls /nesi/nearline/niwa00013/williamsjh/cylc-run
u-ax922
u-bc048
u-bc331
u-bd889
u-bl274
u-bl658
u-bm456
u-bn013
u-bo721
u-bp058
u-bp827
u-bp828
u-bp907
u-bp908
u-bp936
u-bp937
u-bp938
u-bp939
u-br854
u-bu728
u-bw947
u-bx226
w-clim01.maui.niwa.co.nz|Wed Feb 10|23:11:00|rosesnip>

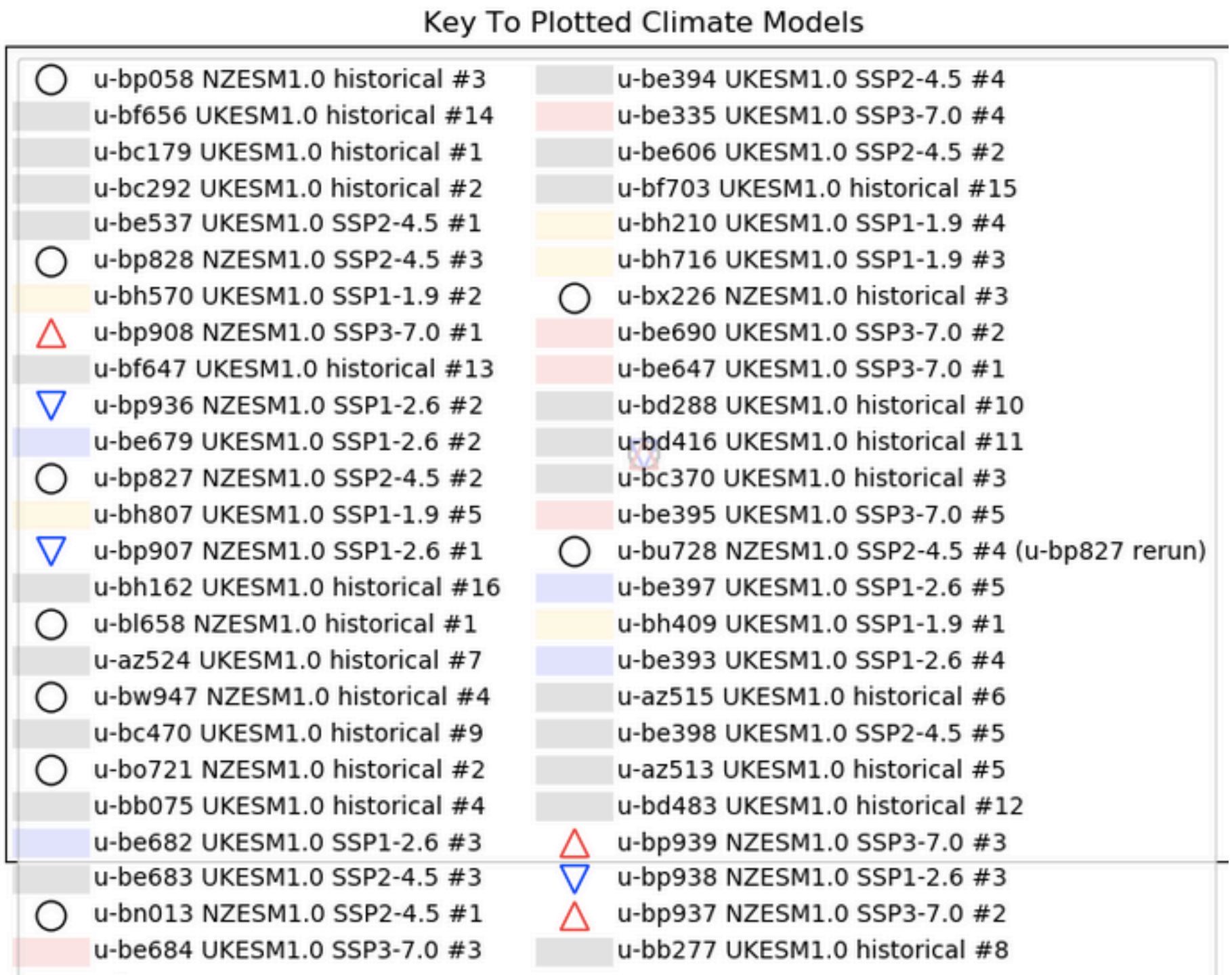

/nesi/project/<projectID>/dir/to/archive/
nlput <projectID> /nesi/project/<projectID>/dir/to/archive/
/nesi/nearline/<projectID>/dir/to/archive/
/nesi/nobackup/<projectID>/dir/to/archive/
nlput <projectID> /nesi/project/<projectID>/dir/to/archive/
nlget <projectID> /nesi/nearline/<projectID>/dir/to/archive/ /nesi/nobackup/
/nesi/nobackup/<projectID>/dir/to/archive/
nlget <projectID> /nesi/nearline/<projectID>/dir/to/archive/ /nesi/nobackup/<projectID>another/location/
/nesi/nobackup/<projectID>/another/location/<projectID>/dir/to/archive/

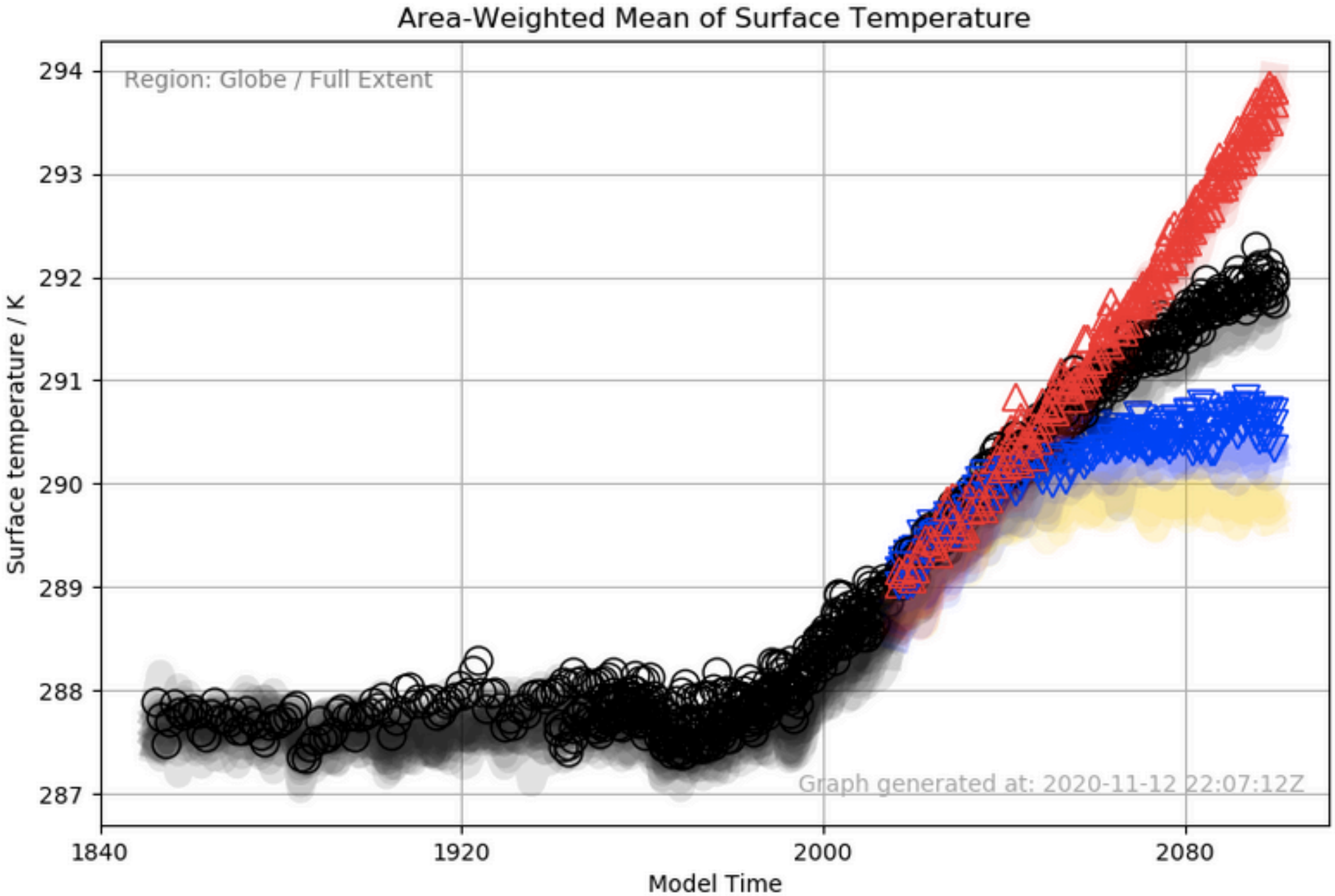
afterburner

Climate Model Monitor v2.0.0b7 Output

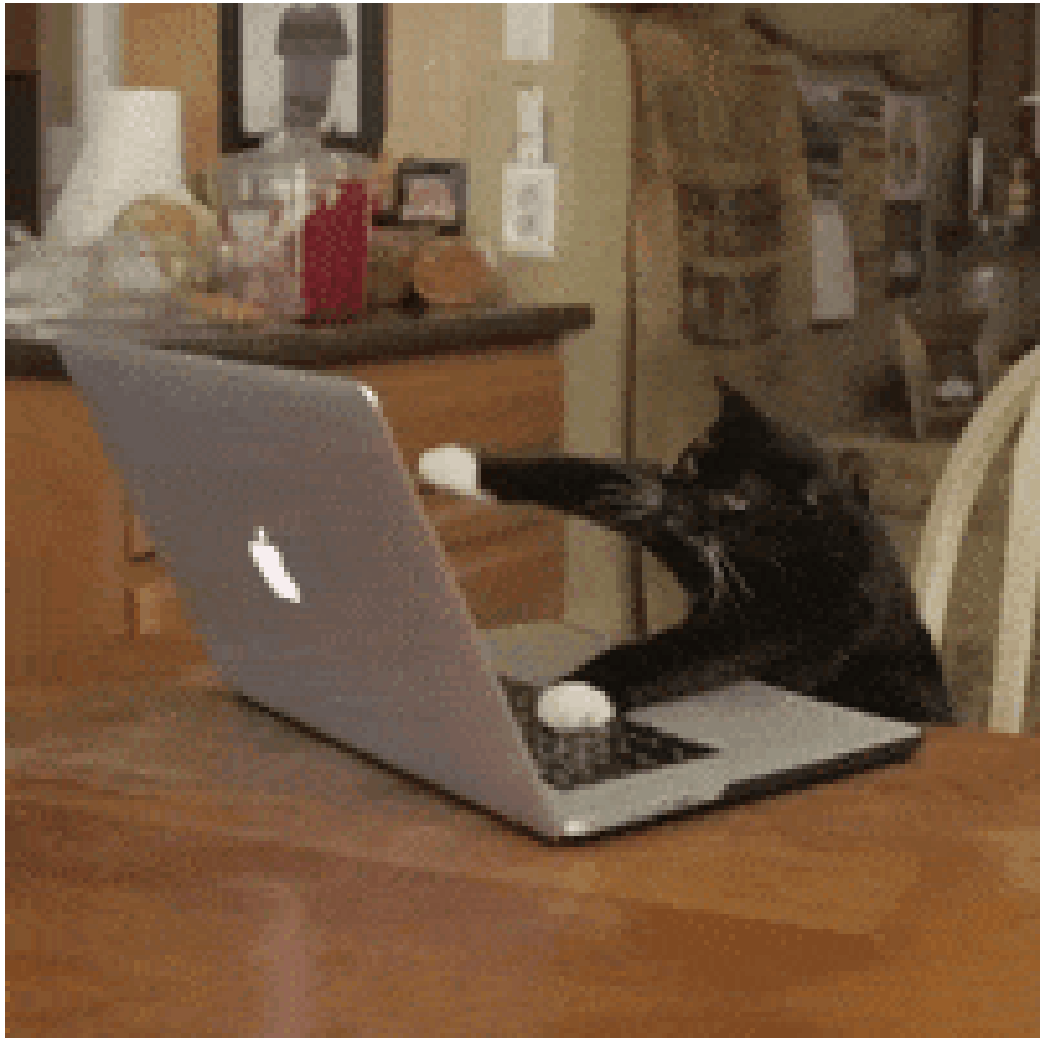


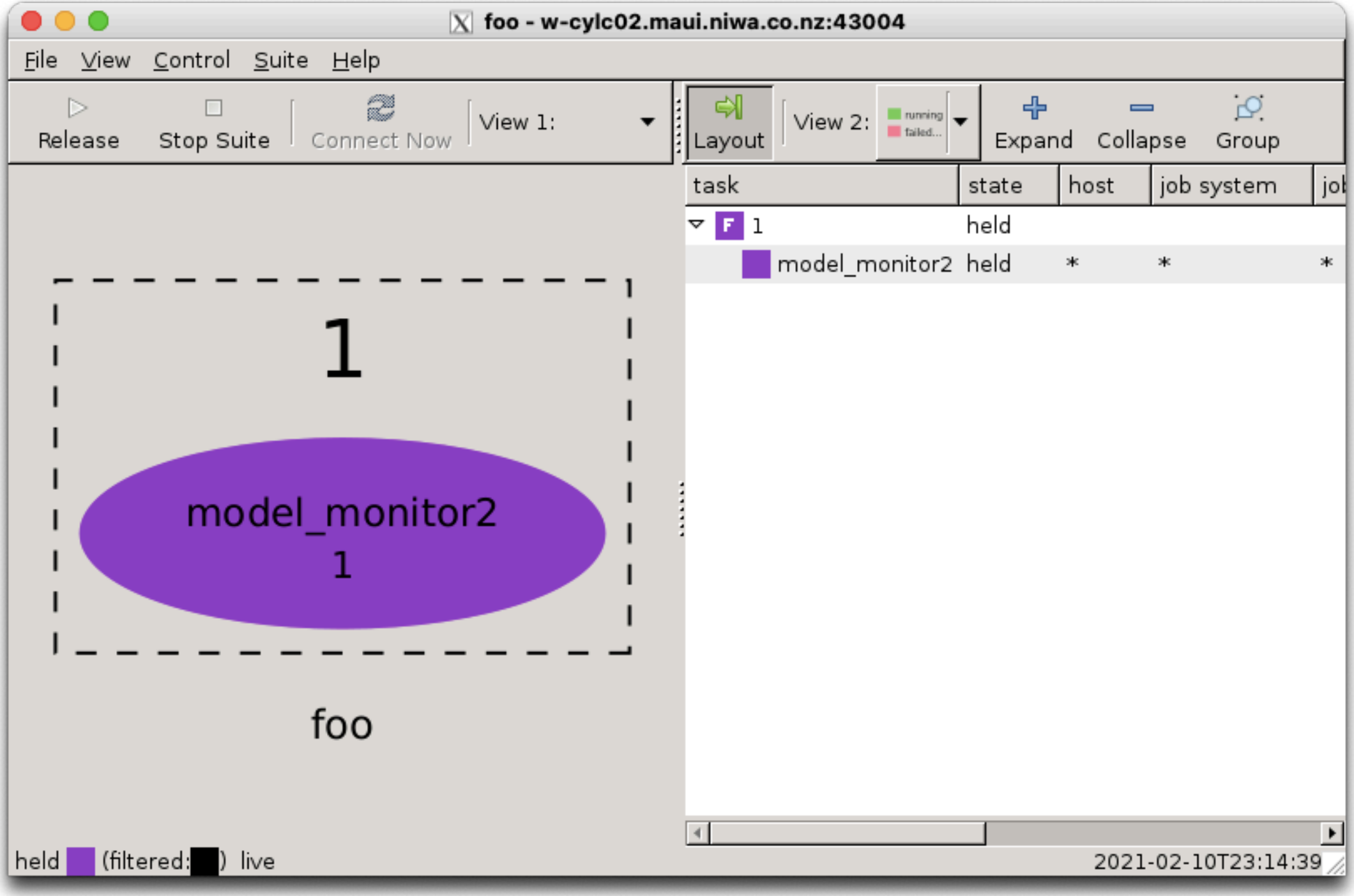


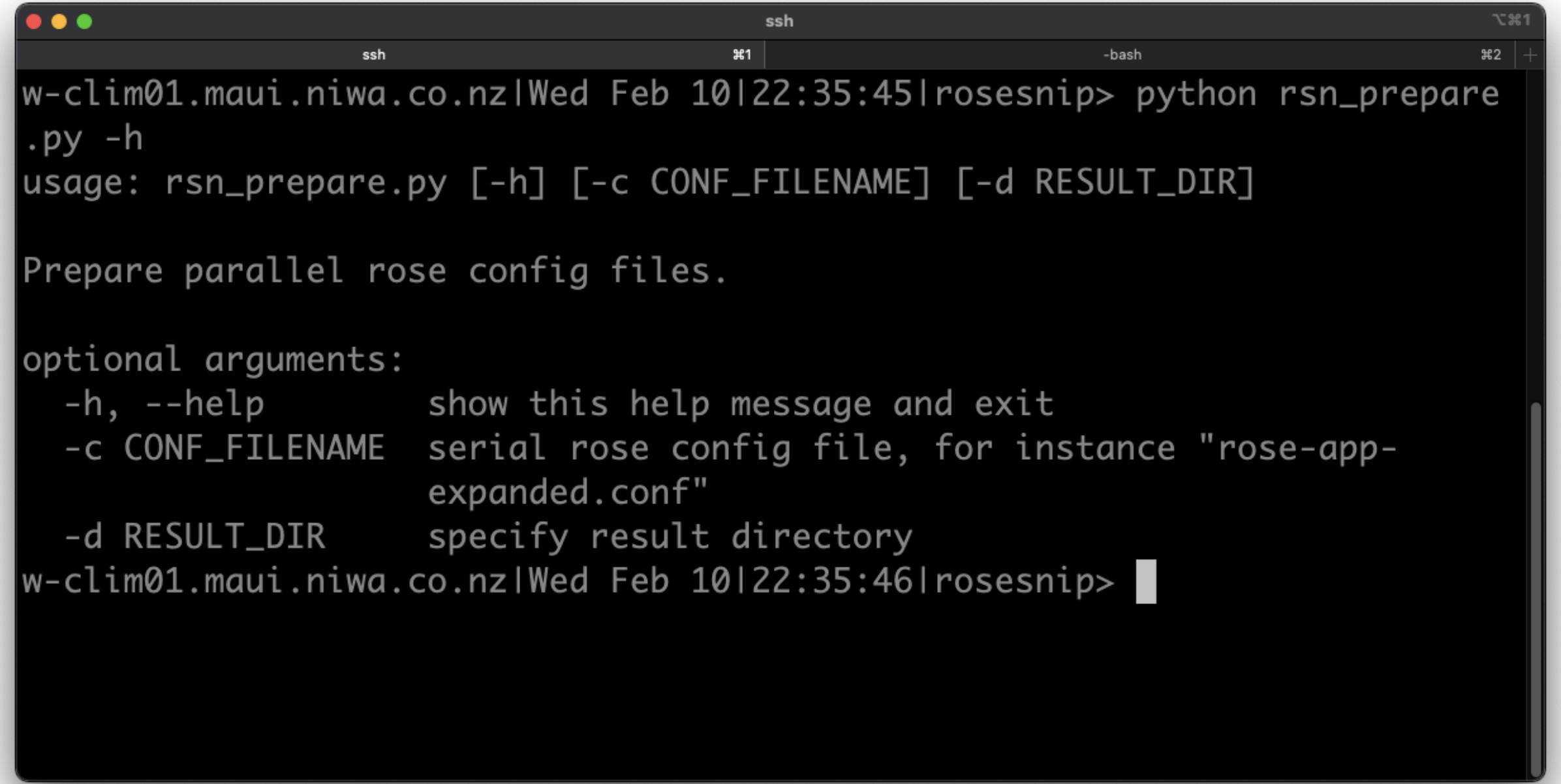

Key To Plotted Climate Models
u-bp058 NZESM1.0 historical #3
u-bf656 UKESM1.0 historical #14
u-bc179 UKESM1.0 historical #1
u-bc292 UKESM1.0 historical #2
u-be537 UKESM1.0 SSP2-4.5 #1
u-bp828 NZESM1.0 SSP2-4.5 #3
u-bh570 UKESM1.0 SSP1-1.9 #2
u-bp908 NZESM1.0 SSP3-7.0 #1
u-bf647 UKESM1.0 historical #13
u-bp936 NZESM1.0 SSP1-2.6 #2
u-be679 UKESM1.0 SSP1-2.6 #2
u-bp827 NZESM1.0 SSP2-4.5 #2
u-bh807 UKESM1.0 SSP1-1.9 #5
u-bp907 NZESM1.0 SSP1-2.6 #1
u-bh162 UKESM1.0 historical #16
u-bl658 NZESM1.0 historical #1
u-az524 UKESM1.0 historical #7
u-bw947 NZESM1.0 historical #4
u-bc470 UKESM1.0 historical #9
u-bo721 NZESM1.0 historical #2
u-bb075 UKESM1.0 historical #4
u-be682 UKESM1.0 SSP1-2.6 #3
u-be683 UKESM1.0 SSP2-4.5 #3
u-bn013 NZESM1.0 SSP2-4.5 #1
u-be684 UKESM1.0 SSP3-7.0 #3
u-be394 UKESM1.0 SSP2-4.5 #4
u-be335 UKESM1.0 SSP3-7.0 #4
u-be606 UKESM1.0 SSP2-4.5 #2
u-bf703 UKESM1.0 historical #15
u-bh210 UKESM1.0 SSP1-1.9 #4
u-bh716 UKESM1.0 SSP1-1.9 #3
u-bx226 NZESM1.0 historical #3
u-be690 UKESM1.0 SSP3-7.0 #2
u-be647 UKESM1.0 SSP3-7.0 #1
u-bd288 UKESM1.0 historical #10
u-bd416 UKESM1.0 historical #11
u-bc370 UKESM1.0 historical #3
u-be395 UKESM1.0 SSP3-7.0 #5
u-bu728 NZESM1.0 SSP2-4.5 #4 (u-bp827 rerun)
u-be397 UKESM1.0 SSP1-2.6 #5
u-bh409 UKESM1.0 SSP1-1.9 #1
u-be393 UKESM1.0 SSP1-2.6 #4
u-az515 UKESM1.0 historical #6
u-be398 UKESM1.0 SSP2-4.5 #5
u-az513 UKESM1.0 historical #5
u-bd483 UKESM1.0 historical #12
u-bp939 NZESM1.0 SSP3-7.0 #3
u-bp938 NZESM1.0 SSP1-2.6 #3
u-bp937 NZESM1.0 SSP3-7.0 #2
u-bb277 UKESM1.0 historical #8

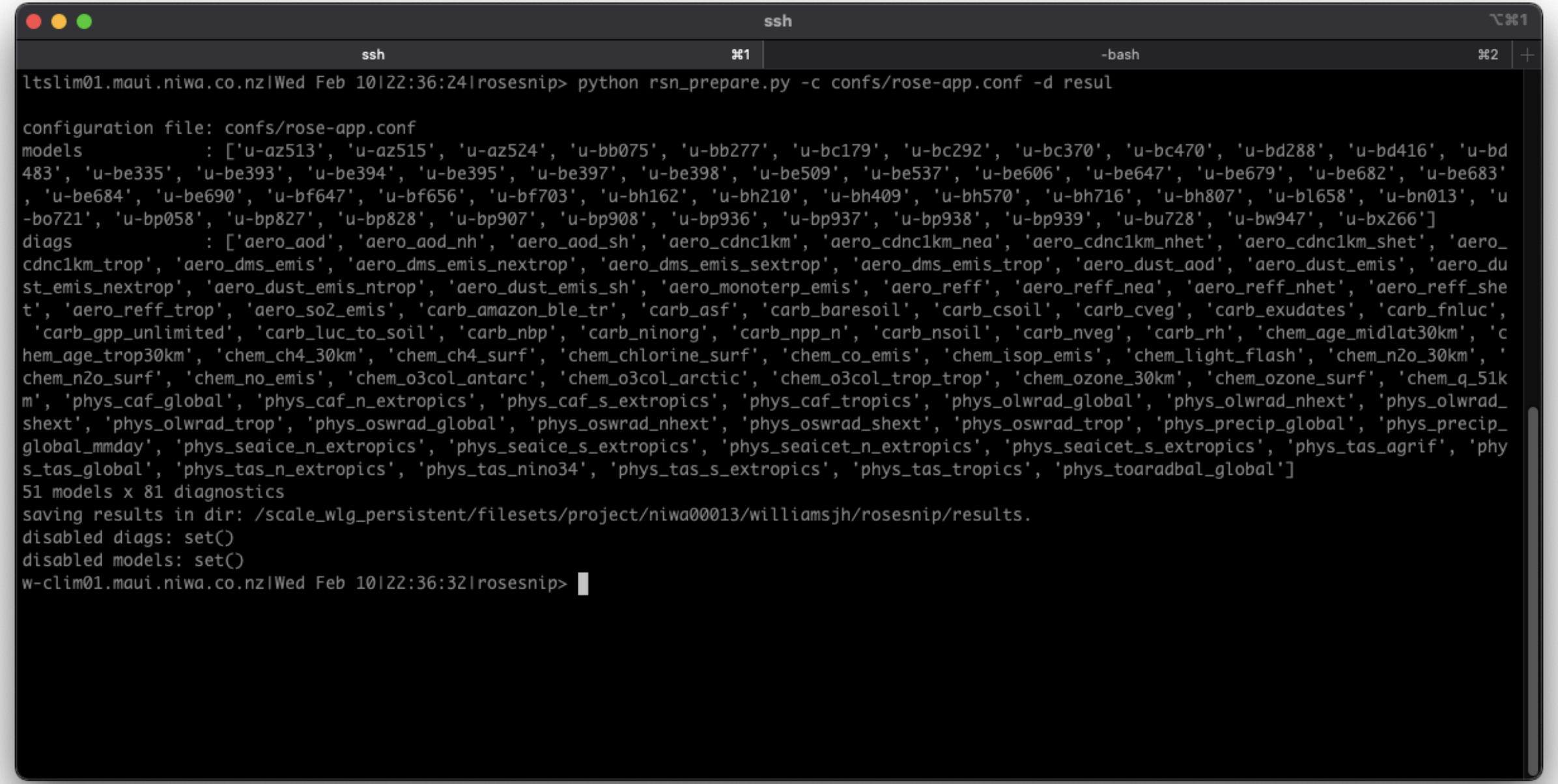

Area-Weighted Mean of Surface Temperature
Region: Globe / Full Extent
Surface temperature / K
294
293
292
291
290
289
288
287
1840
1920
2000
2080
Model Time
Graph generated at: 2020-11-12 22:07:12Z

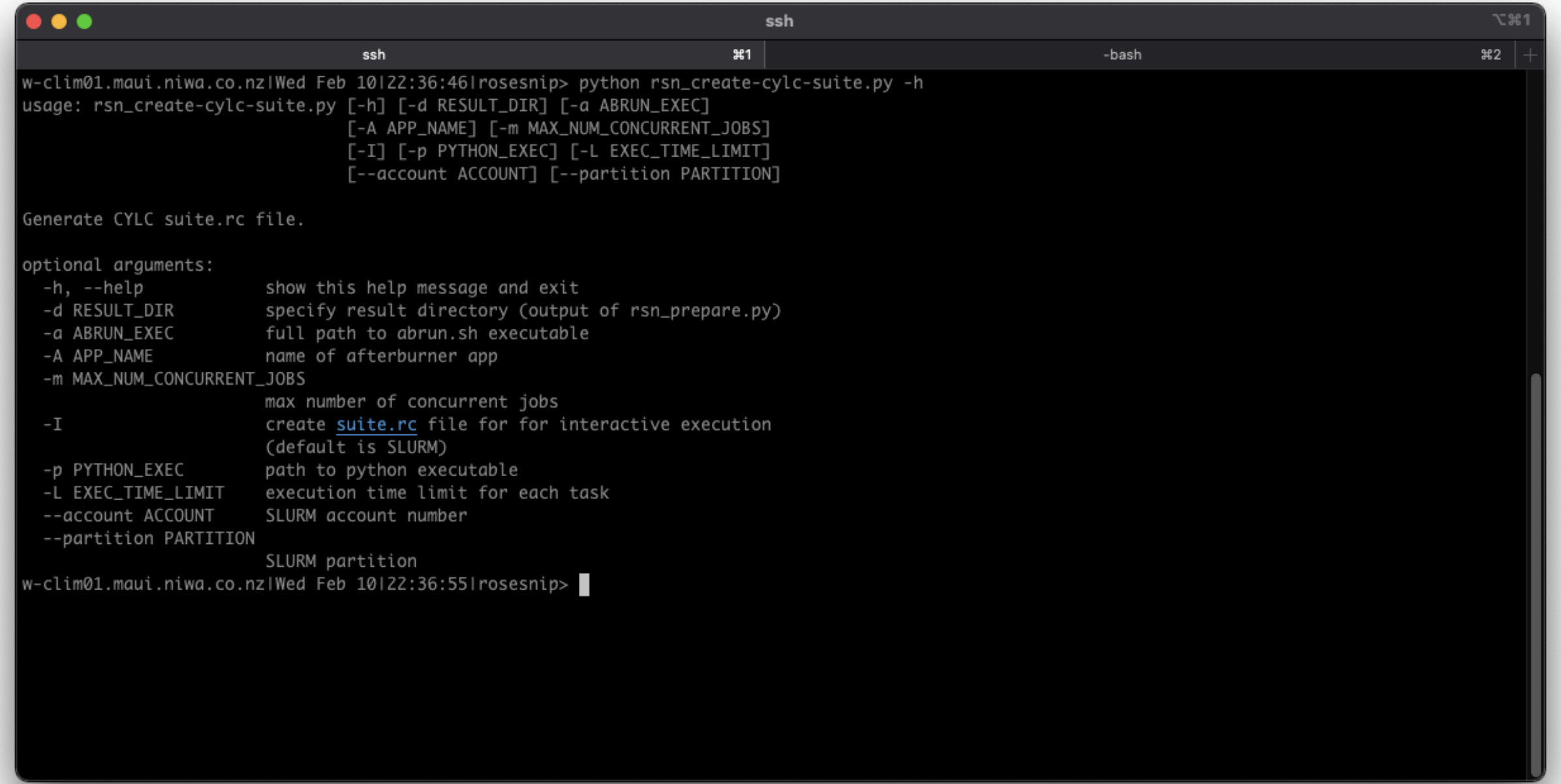
how did nesi help here?

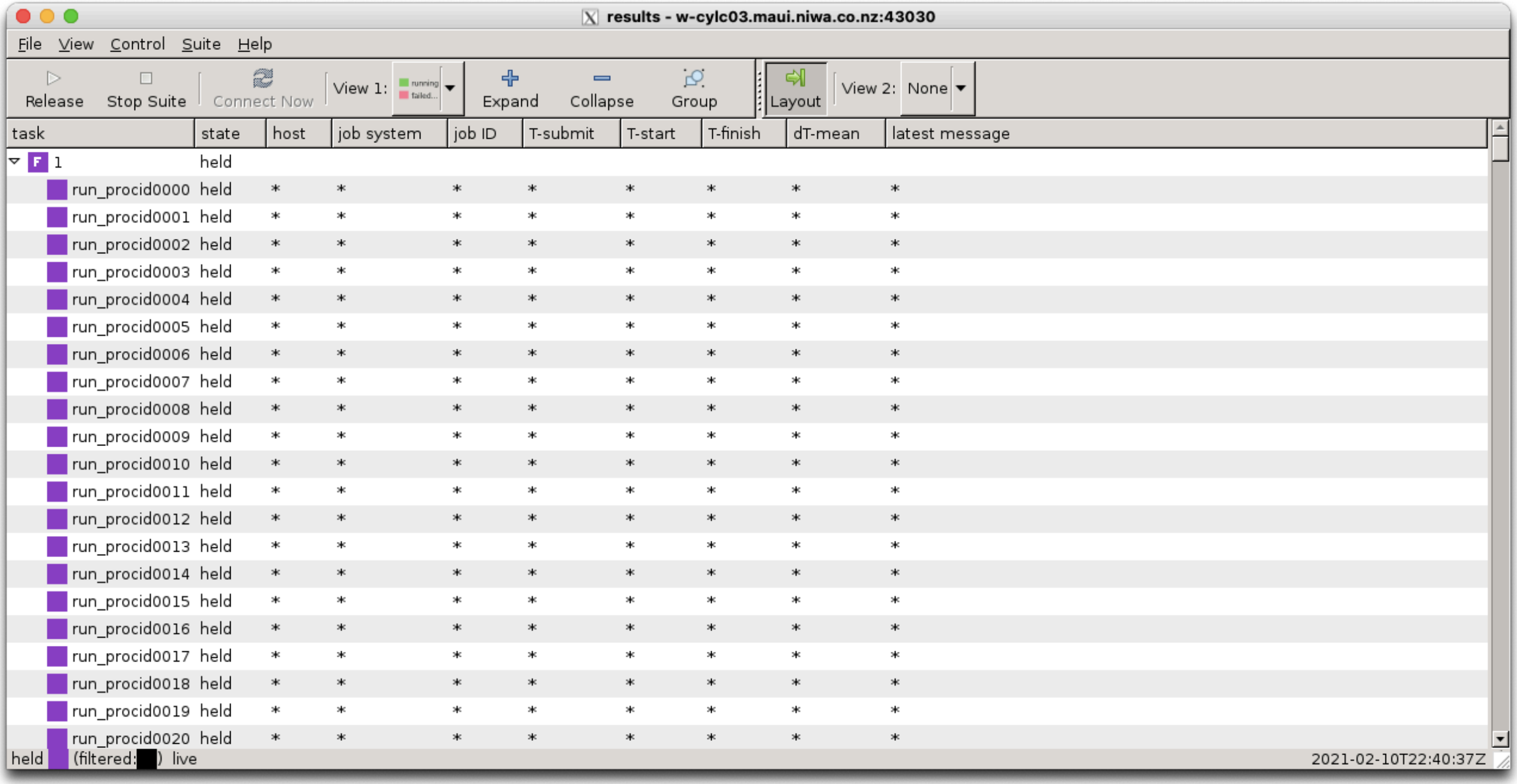



foo - w-cylc02.maui.niwa.co.nz:43004
File View Control Suite Help
Release
Stop Suite
Connect Now
View 1:
Layout
View 2:
running
failed...
Expand
Collapse
Group
task
state
host
job system
1
held
model_monitor2
held
*
*
*
1
model_monitor2
1
foo
held
(filtered:
) live
2021-02-10T23:14:39


ssh
⌥⌘1
ssh ⌘1
-bash ⌘2
w-clim01.maui.niwa.co.nz|Wed Feb 10|22:35:45|rosesnip> python rsn_prepare
.py -h
usage: rsn_prepare.py [-h] [-c CONF_FILENAME] [-d RESULT_DIR]
Prepare parallel rose config files.
optional arguments:
-h, --help show this help message and exit
-c CONF_FILENAME serial rose config file, for instance "rose-app-
expanded.conf"
-d RESULT_DIR specify result directory
w-clim01.maui.niwa.co.nz|Wed Feb 10|22:35:46|rosesnip>


ssh
ssh ⌘1
-bash ⌘2
ltslim01.maui.niwa.co.nz|Wed Feb 10|22:36:24|rosesnip> python rsn_prepare.py -c confs/rose-app.conf -d resul
configuration file: confs/rose-app.conf
models : ['u-az513', 'u-az515', 'u-az524', 'u-bb075', 'u-bb277', 'u-bc179', 'u-bc292', 'u-bc370', 'u-bc470', 'u-bd288', 'u-bd416', 'u-bd483', 'u-be335', 'u-be393', 'u-be394', 'u-be395', 'u-be397', 'u-be398', 'u-be509', 'u-be537', 'u-be606', 'u-be647', 'u-be679', 'u-be682', 'u-be683', 'u-be684', 'u-be690', 'u-bf647', 'u-bf656', 'u-bf703', 'u-bh162', 'u-bh210', 'u-bh409', 'u-bh570', 'u-bh716', 'u-bh807', 'u-bl658', 'u-bn013', 'u-bo721', 'u-bp058', 'u-bp827', 'u-bp828', 'u-bp907', 'u-bp908', 'u-bp936', 'u-bp937', 'u-bp938', 'u-bp939', 'u-bu728', 'u-bw947', 'u-bx266']
diags : ['aero_aod', 'aero_aod_nh', 'aero_aod_sh', 'aero_cdnc1km', 'aero_cdnc1km_nea', 'aero_cdnc1km_nhet', 'aero_cdnc1km_shet', 'aero_cdnc1km_trop', 'aero_dms_emis', 'aero_dms_emis_nextrop', 'aero_dms_emis_sextrop', 'aero_dms_emis_trop', 'aero_dust_aod', 'aero_dust_emis', 'aero_dust_emis_nextrop', 'aero_dust_emis_ntrop', 'aero_dust_emis_sh', 'aero_monoterp_emis', 'aero_reff', 'aero_reff_nea', 'aero_reff_nhet', 'aero_reff_shet', 'aero_reff_trop', 'aero_so2_emis', 'carb_amazon_ble_tr', 'carb_asf', 'carb_baresoil', 'carb_csoil', 'carb_cveg', 'carb_exudates', 'carb_fnluc', 'carb_gpp_unlimited', 'carb_luc_to_soil', 'carb_nbp', 'carb_ninorg', 'carb_npp_n', 'carb_nsoil', 'carb_nveg', 'carb_rh', 'chem_age_midlat30km', 'chem_age_trop30km', 'chem_ch4_30km', 'chem_ch4_surf', 'chem_chlorine_surf', 'chem_co_emis', 'chem_isop_emis', 'chem_light_flash', 'chem_n2o_30km', 'chem_n2o_surf', 'chem_no_emis', 'chem_o3col_antarc', 'chem_o3col_arctic', 'chem_o3col_trop_trop', 'chem_ozone_30km', 'chem_ozone_surf', 'chem_q_51km', 'phys_caf_global', 'phys_caf_n_extropics', 'phys_caf_s_extropics', 'phys_caf_tropics', 'phys_olwrad_global', 'phys_olwrad_nhext', 'phys_olwrad_shext', 'phys_olwrad_trop', 'phys_oswrad_global', 'phys_oswrad_nhext', 'phys_oswrad_shext', 'phys_oswrad_trop', 'phys_precip_global', 'phys_precip_global_mmday', 'phys_seaice_n_extropics', 'phys_seaice_s_extropics', 'phys_seaicet_n_extropics', 'phys_seaicet_s_extropics', 'phys_tas_agrif', 'phys_tas_global', 'phys_tas_n_extropics', 'phys_tas_nino34', 'phys_tas_s_extropics', 'phys_tas_tropics', 'phys_toaradbal_global']
51 models x 81 diagnostics
saving results in dir: /scale_wlg_persistent/filesets/project/niwa00013/williamsjh/rosesnip/results.
disabled diags: set()
disabled models: set()
w-clim01.maui.niwa.co.nz|Wed Feb 10|22:36:32|rosesnip>


ssh
ssh ⌘1
-bash ⌘2
w-clim01.maui.niwa.co.nz|Wed Feb 10|22:36:46|rosesnip> python rsn_create-cylc-suite.py -h
usage: rsn_create-cylc-suite.py [-h] [-d RESULT_DIR] [-a ABRUN_EXEC]
[-A APP_NAME] [-m MAX_NUM_CONCURRENT_JOBS]
[-I] [-p PYTHON_EXEC] [-L EXEC_TIME_LIMIT]
[--account ACCOUNT] [--partition PARTITION]
Generate CYLC suite.rc file.
optional arguments:
-h, --help show this help message and exit
-d RESULT_DIR specify result directory (output of rsn_prepare.py)
-a ABRUN_EXEC full path to abrun.sh executable
-A APP_NAME name of afterburner app
-m MAX_NUM_CONCURRENT_JOBS
max number of concurrent jobs
-I create suite.rc file for for interactive execution
(default is SLURM)
-p PYTHON_EXEC path to python executable
-L EXEC_TIME_LIMIT execution time limit for each task
--account ACCOUNT SLURM account number
--partition PARTITION
SLURM partition
w-clim01.maui.niwa.co.nz|Wed Feb 10|22:36:55|rosesnip>


results - w-cylc03.maui.niwa.co.nz:43030
File View Control Suite Help
Release
Stop Suite
Connect Now
View 1:
Expand
Collapse
Group
Layout
View 2:
None
task state host job system job ID T-submit T-start T-finish dT-mean latest message
1 held
run_procid0000 held * * * * * * * *
run_procid0001 held * * * * * * * *
run_procid0002 held * * * * * * * *
run_procid0003 held * * * * * * * *
run_procid0004 held * * * * * * * *
run_procid0005 held * * * * * * * *
run_procid0006 held * * * * * * * *
run_procid0007 held * * * * * * * *
run_procid0008 held * * * * * * * *
run_procid0009 held * * * * * * * *
run_procid0010 held * * * * * * * *
run_procid0011 held * * * * * * * *
run_procid0012 held * * * * * * * *
run_procid0013 held * * * * * * * *
run_procid0014 held * * * * * * * *
run_procid0015 held * * * * * * * *
run_procid0016 held * * * * * * * *
run_procid0017 held * * * * * * * *
run_procid0018 held * * * * * * * *
run_procid0019 held * * * * * * * *
run_procid0020 held * * * * * * * *
held (filtered:) live
2021-02-10T22:40:37Z

afterburner in summary

- using the nesi consultancy service enabled us to speed up our afterburner simulations by a factor of about 37
- that meant that we could watch our simulations evolve during the run
- this is essential for runs which are so extremely computationally (and financially) expensive

deep south metadata archive

New Zealand Earth System Model (NZESM) - historical climate simulation 1950 - 2014, ensemble member #1

Download Metadata XML

Creator:	Jonny Williams, ORCID: 0000-0002-0680-0098, email: jonny.williams@niwa.co.nz, Ph: 0064 (4) 386-0303
Description:	This is member #1 of the New Zealand Earth System Model (NZESM) historical climate simulation ensemble.
Subject:	Keywords: Deep South, NZESM, UKESM, climate, simulation, modelling, historical
Publisher:	Jonny Williams, ORCID: 0000-0002-0680-0098, email: jonny.williams@niwa.co.nz, Ph: 0064 (4) 386-0303
Modified:	January 2020 2020/06/29
Type:	dataset
Format:	NetCDF (https://en.wikipedia.org/wiki/NetCDF) and UK Met Office PP (https://en.wikipedia.org/wiki/PP-format#:~:text=The%20PP%2Dformat%20(Post%20Processing,Kingdom\'s%20national%20weather%20service.&text=These%20files%20are%20binary%20streams,other%2C%20more%20portable%2C%20formats.)
Language:	N/A
Source:	NeSI \'nearline\' data storage archive (www.nesi.org.nz).

future

- publicly accessible data?
- we want researchers to use our data so do get in touch!
- data availability workshops - watch this space or contact me!
  - jonny.williams@niwa.co.nz

summary, conclusions

- we are able to monitor our climate model runs ‘live’
- we have a reliable long-term archive using the nesi nearline system
- we have point and click website containing climate information for the atmosphere, ocean and sea ice components of the nzesm
- we will be running data availability workshops in the near future; get in touch if you want to join in!

thanks

- deep south national science challenge
- nesi
- uk met office unified model partnership
- you, for your attention
- www.twitter.com/jonnyhtw