



A guide to high-frequent data assimilation with NorESM2

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DA implementations for NorCPM

Offline (NorESM1,NorESM2)

- *Stop & Restart*
NorESM and DA separate executables running sequent.
- *Disk-based communication*
between model and DA via modifying full restart files
- *Components: ocn¹², ice¹, lnd¹*
- *DA freq.:* monthly (slow model init. & read/write of full restarts)

Semi-online (NorESM2)

- *Pause & resume (hack)*
NorESM and DA separate executables running in parallel
- *Disk-based communication* via reading/writing «reduced» restart files
- *Components: ocn, lnd, (ice, atm)*
- *DA freq.:* (sub-)daily, monthly

Results on next slides!

Online (NorESM2/2.5/3)

- *Pause & resume (NCAR)*
DA fully integrated part of NorESM and runs in same job
- *MPI-based communication*
between model and DA
- *Components: ocn, lnd, ice, atm*
- *DA freq.:* (sub-)daily, monthly

COMING
SOON

Daily ocean data assimilation with NorESM2 (*preliminary results*)

Test using daily assim. of satellite SSTs and monthly assim. of T/S profiles

› Three 10-member ensembles with NorESM2-LM

- FREE (no assimilation) 800 cpu-h/sim-yr, 4 sim-yrs/d, 128 pes/member
- MONTHLY (monthly SST + monthly T/S)
- DAILY (daily SST + monthly T/S) daily assimilation increases cost by 50%

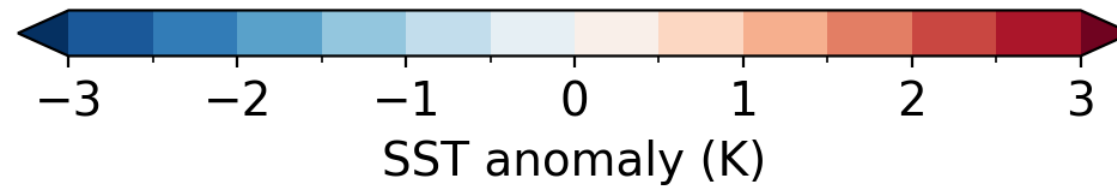
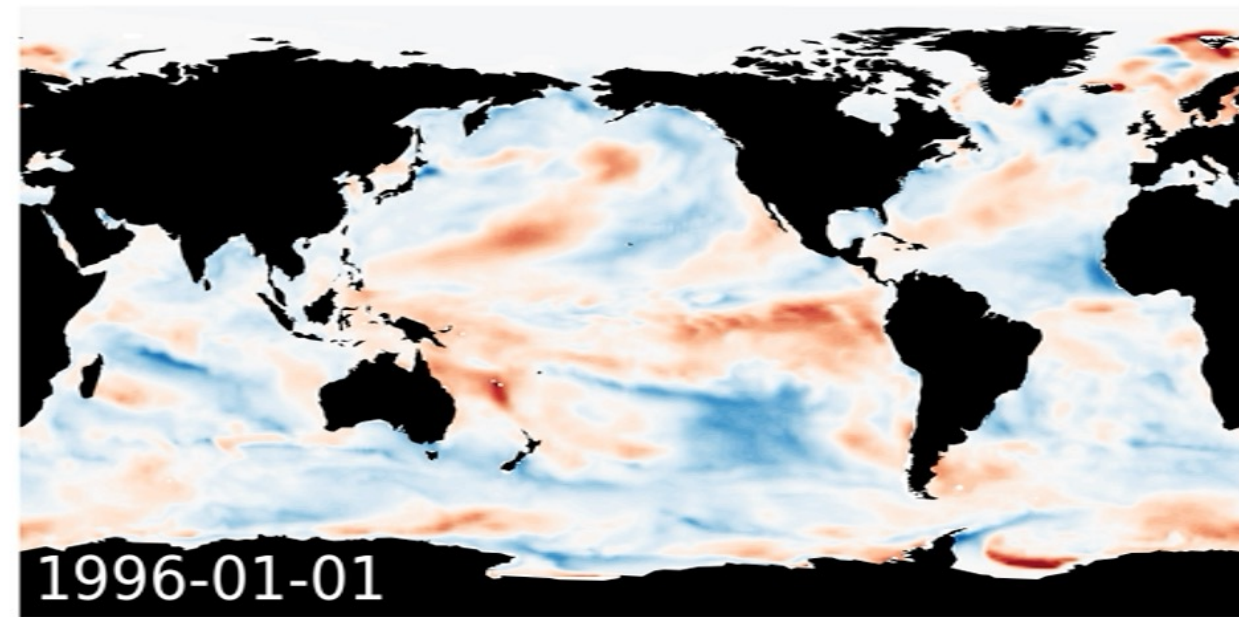
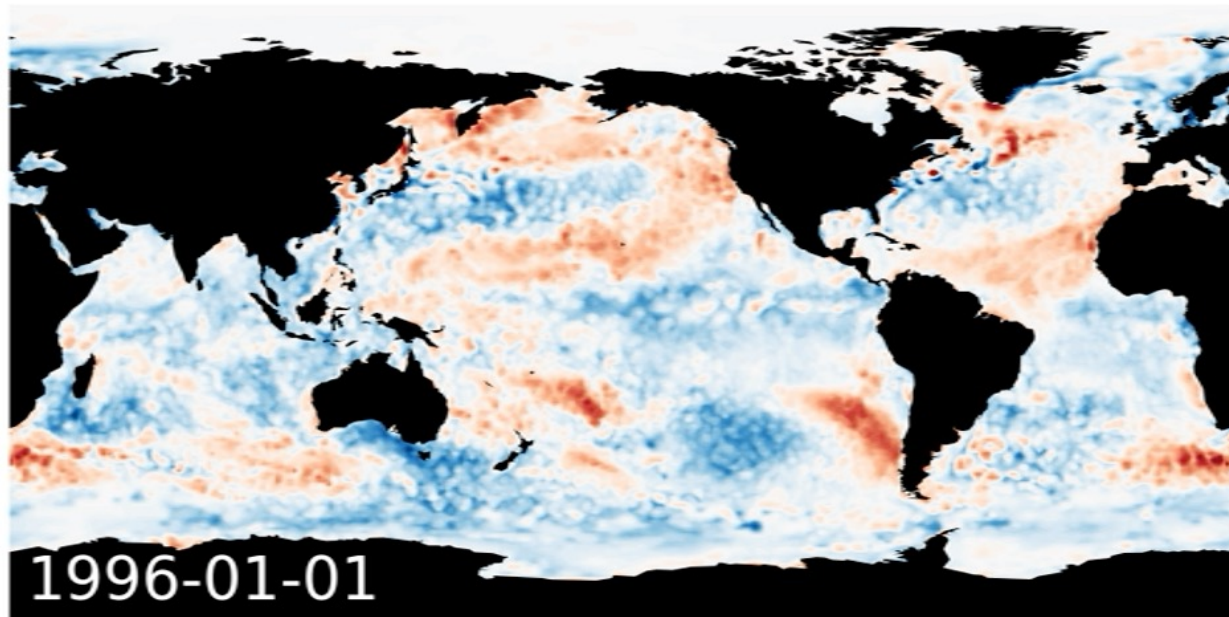
› 1996-2003 coverage (will only show results from first year)

› EnKF anomaly assimilation with 1980-2010 reference period

Assimilation of daily SST and monthly T/S observations – obs vs free run

OISST

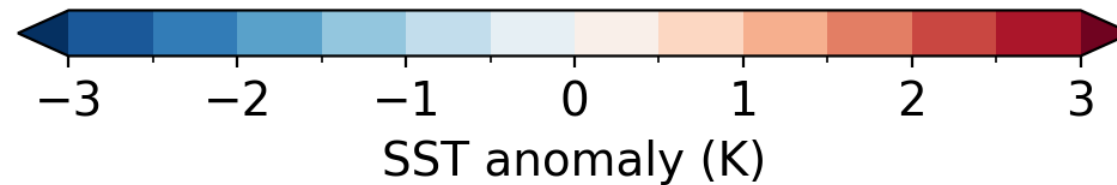
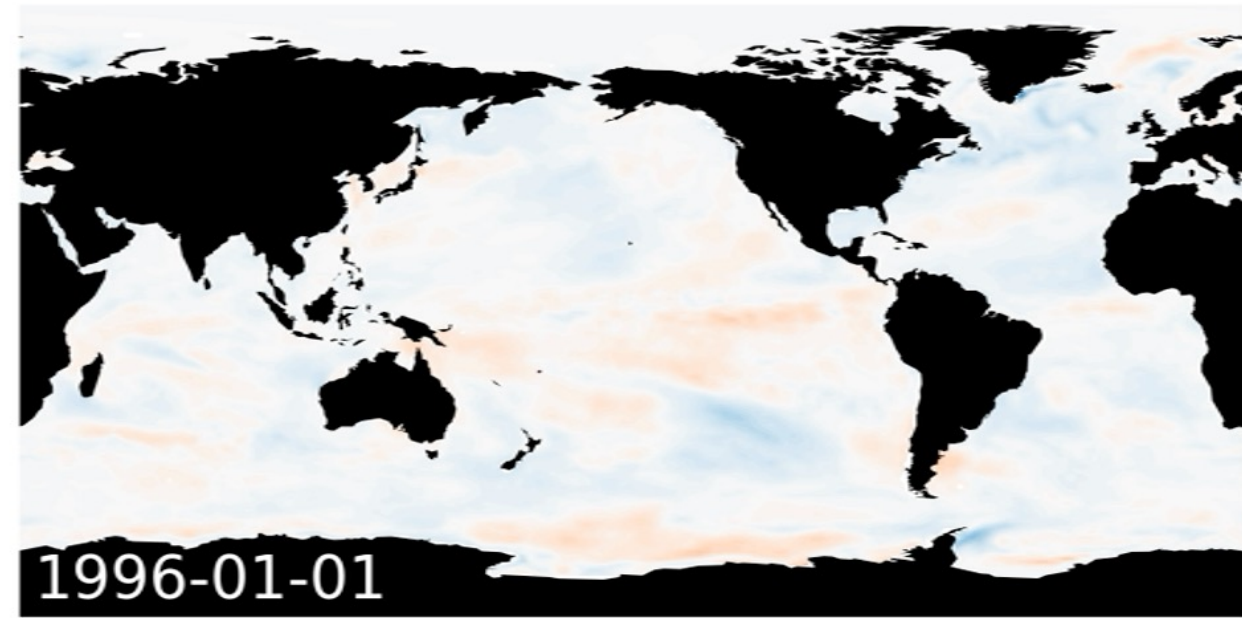
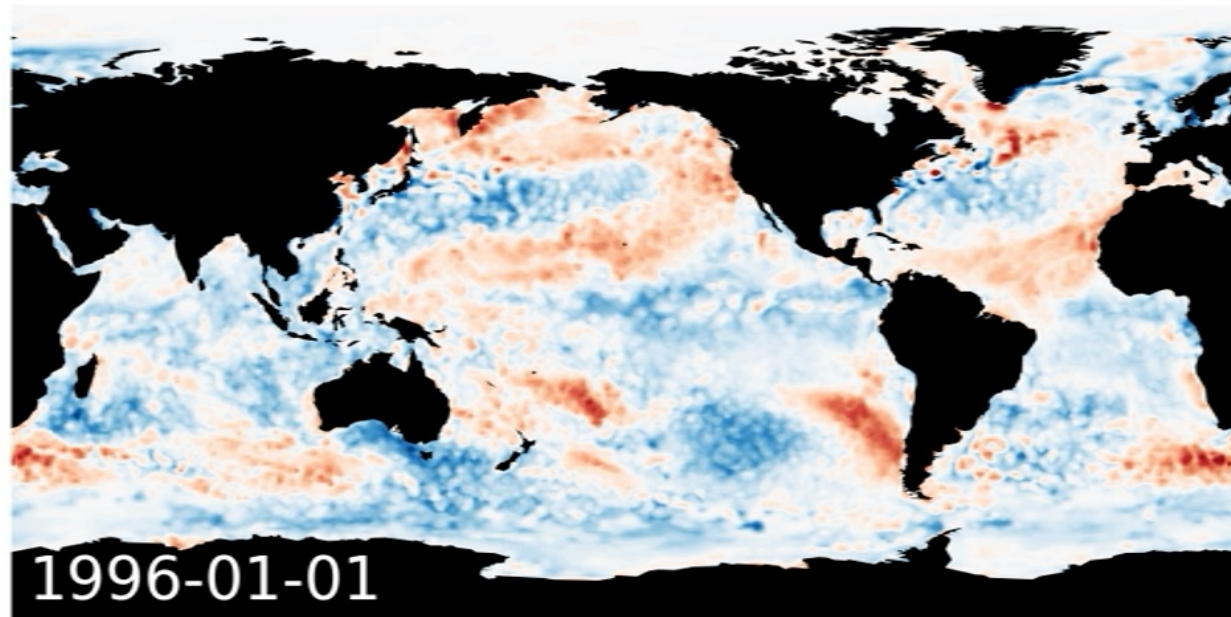
FREE (member 1)



Assimilation of daily SST and monthly T/S observations – obs vs monthly assimilation

OISST

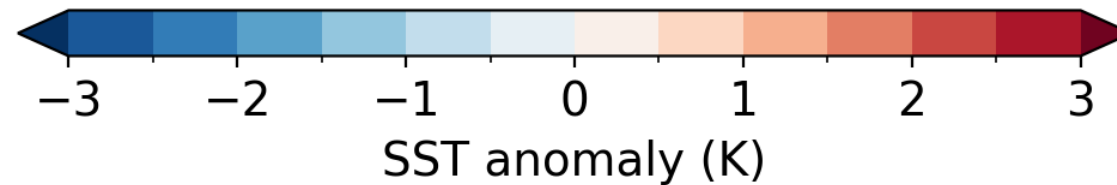
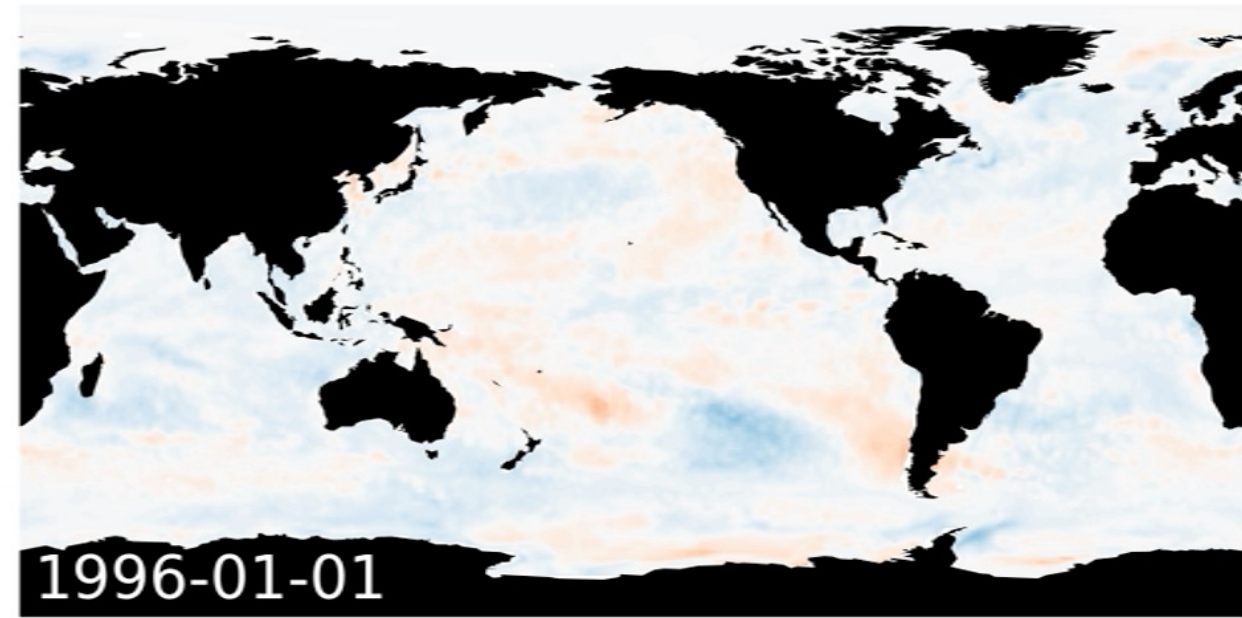
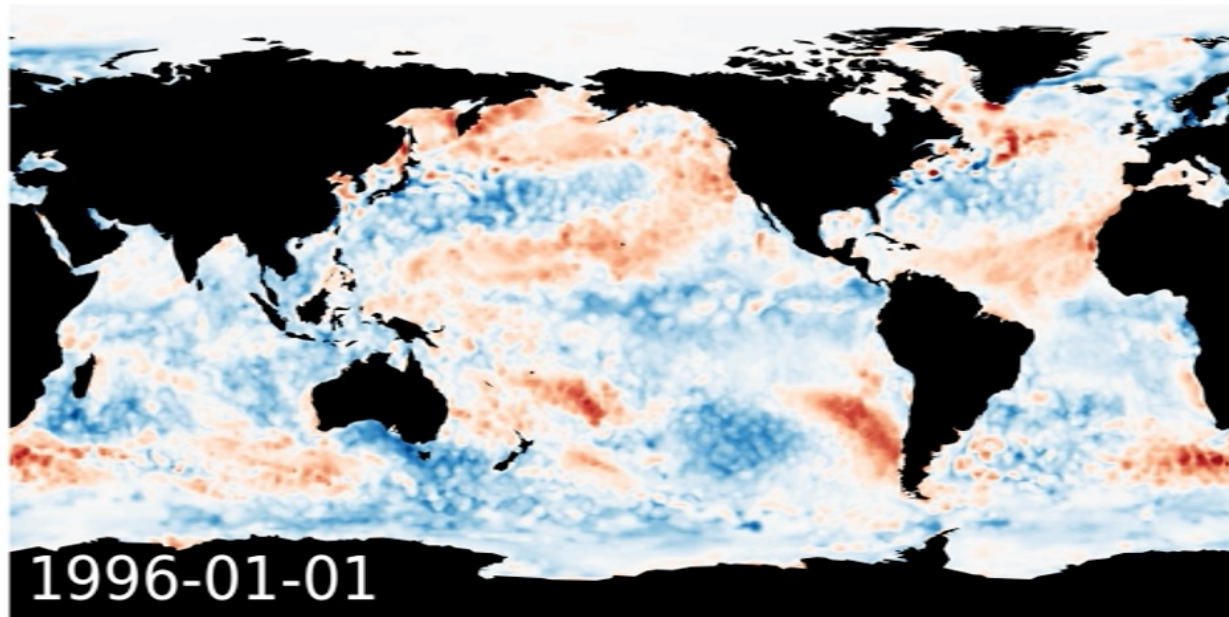
MONTHLY (ensemble mean)



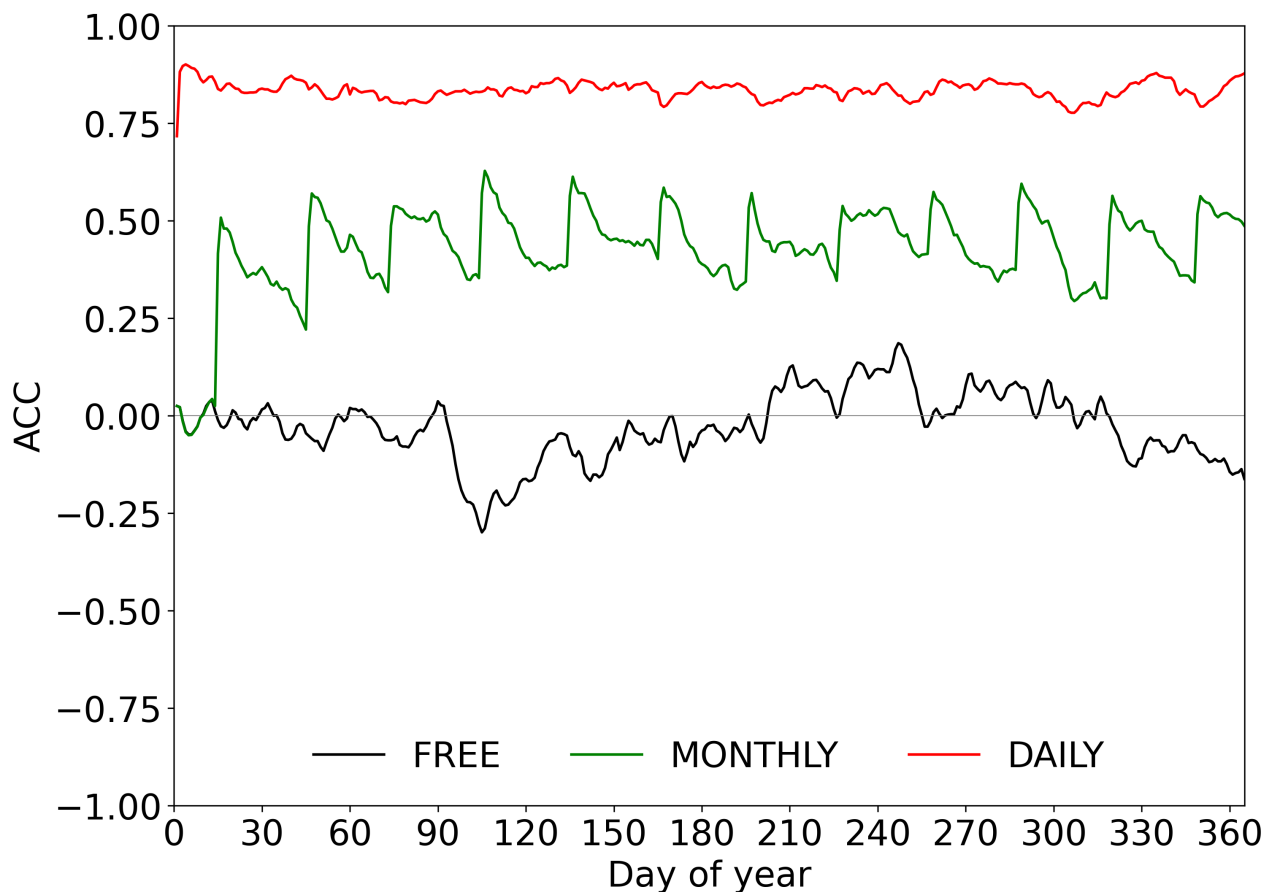
Assimilation of daily SST and monthly T/S observations – obs vs daily assimilation

OISST

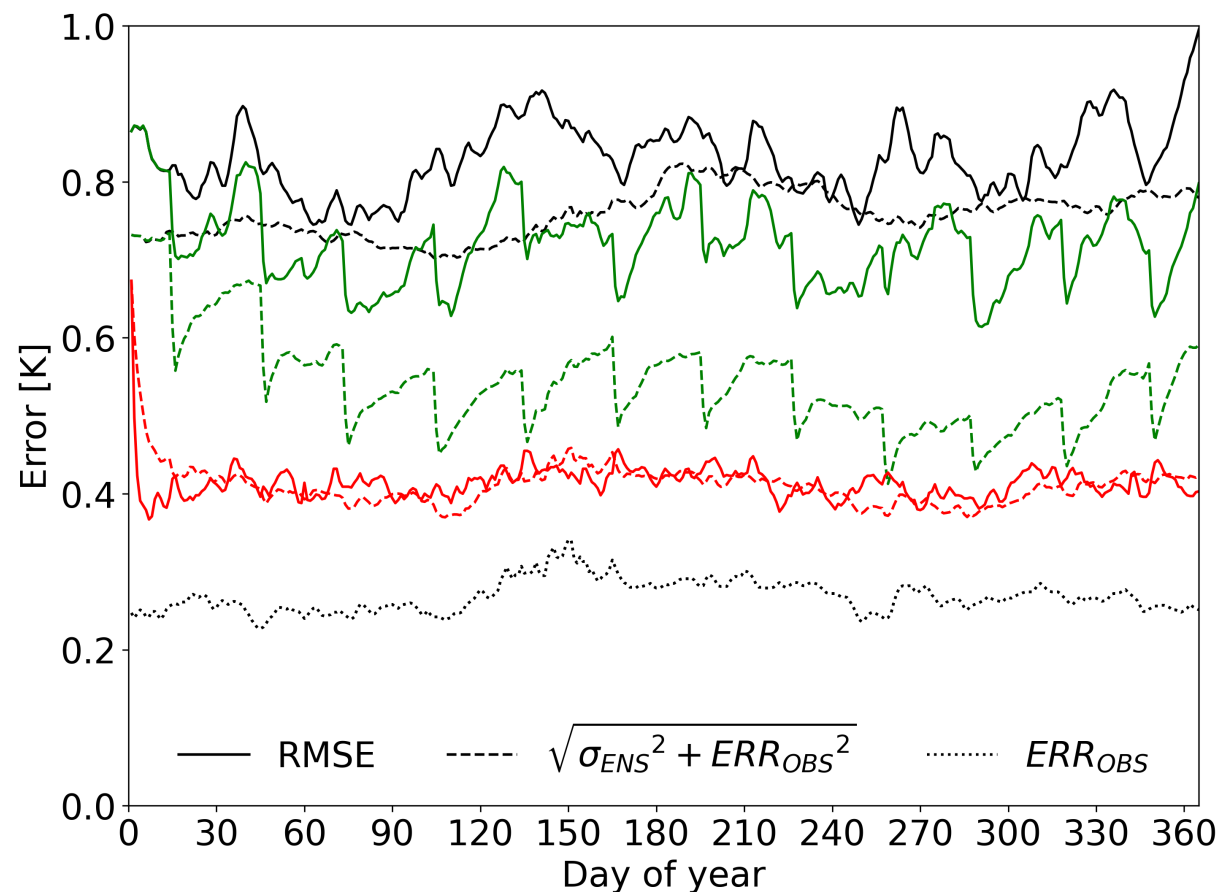
DAILY (ensemble mean)



Assimilation of daily SST and monthly T/S observations – global statistics (spatial averages)



ACC = pattern correlation (area weighted)



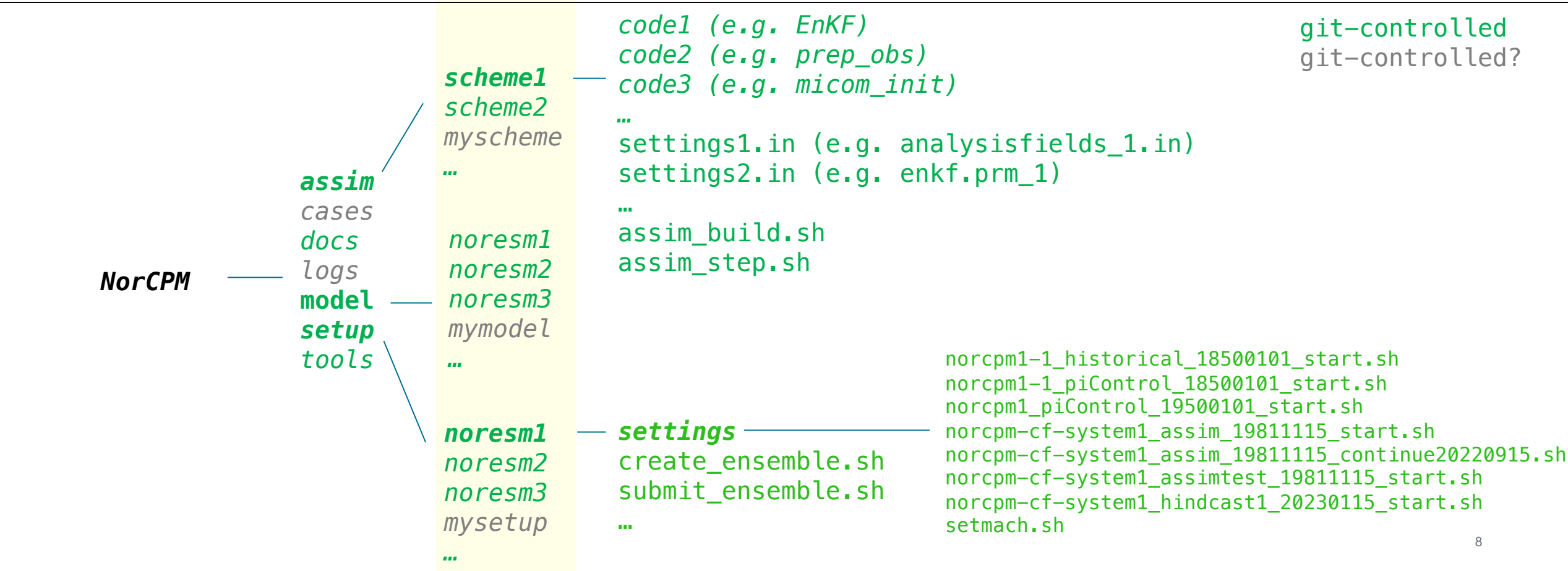
RMSE = root mean square deviation (area weighted)

ERR_{OBS} = observation error (area weighted)

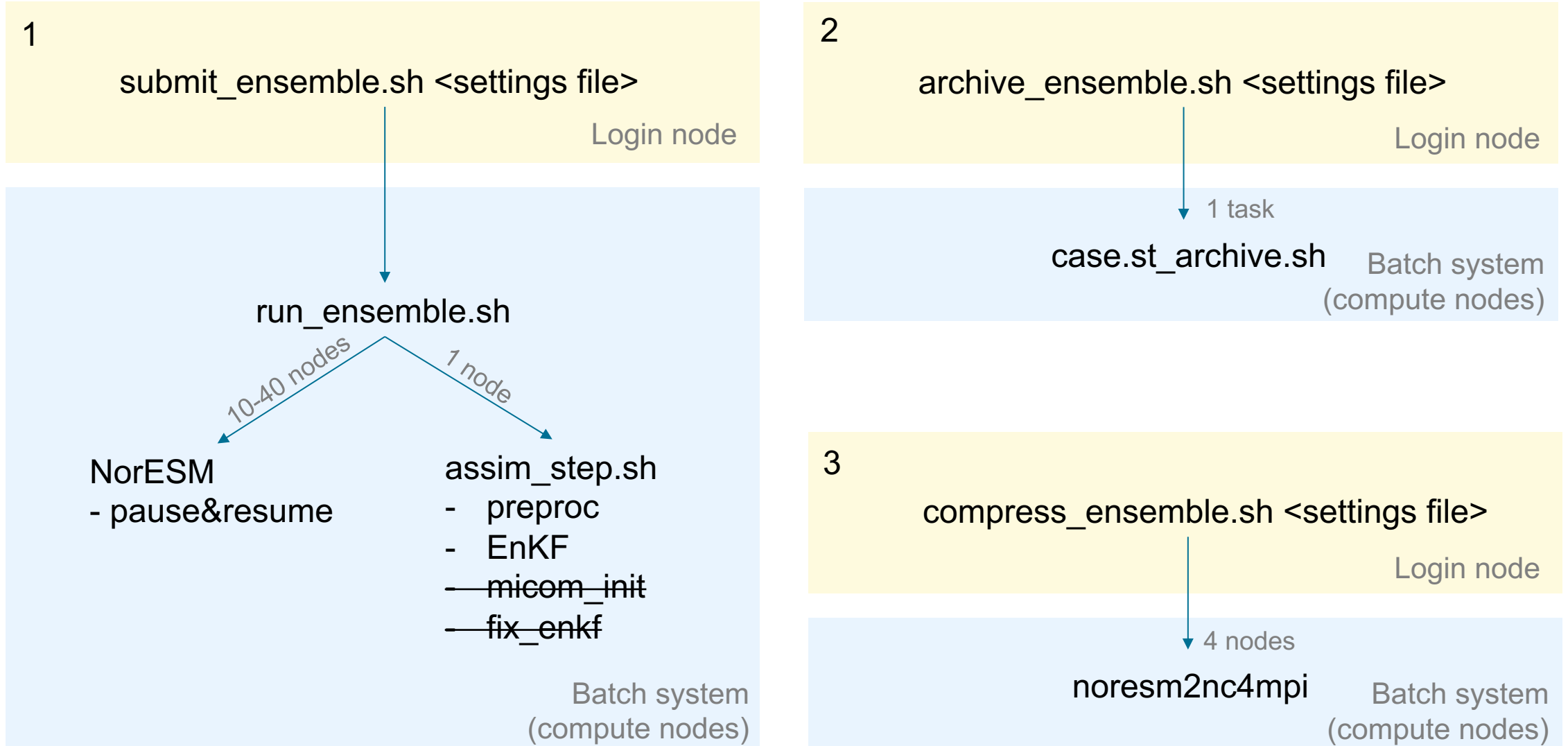
σ_{ENS} = ensemble spread (area weighted)

NorCPM repository with revised structure <https://github.com/NorESMhub/NorCPM>

- supports **multiple ESM versions, assimilation schemes and experiment setup environments**
- multiple users can contribute to the same repository without interfering with each other's work
- flexible, well-structured and organized; fully version controlled
- suitable for use with NorESM1, NorESM2 and later versions



Workflow



Mini-tutorial for performing a daily assimilation experiment using NorESM2-LM

Install NorCPM in the nn9039k project space

```
mkdir -p /cluster/projects/nn9039k/people/$USER  
cd /cluster/projects/nn9039k/people/$USER  
git clone ssh://git@github.com/NorESMhub/NorCPM.git NorCPM  
(or "git clone https://github.com/NorESMhub/NorCPM.git NorCPM")
```

Install NorESM2

```
cd /cluster/projects/nn9039k/people/$USER/NorCPM/setup/noresm2  
./install_noresm2.sh
```

Set up a NorESM2-LM assimilation test experiment with 10 members

```
./create_ensemble.sh settings/noresm2-lm_odaday_19960101.sh
```

Submit experiment

```
./submit_ensemble.sh settings/noresm2-lm_odaday_19960101.sh
```

Customizing NorESM2 (cpu settings, source code, diagnostic output)

NorCPM/setup/noresm2/user_mods contains NorESM2 customization folders

noresm2-lm_128pes

noresm2-lm_640pes

noresm2-lm_clmda_128pes

noresm2-lmesm_128pes

Each customization folder contains

- env_mach_pes.xml: specifies pes/cpu settings
- SourceMods: customized source code should be placed there
- user_nl_*: user namelists used to customize diagnostic output

Can create new customization folder and point to it in experiment settings file (next slides)

Settings file – experiment and job settings

```
# experiment settings
: ${EXPERIMENT:=noresm2-lm_odaday} # case prefix, not including _YYYYMMDD_memXX suffix
: ${MEMBER1:=1} # first member
: ${ENSSIZE:=10} # number of members
: ${COMPSET:=NHISTfrc2} # need to switch compset at start of 2015
: ${USER_MODS_DIR:=$SETUPROOT/user_mods/noresm2-lm_128pes}
: ${RES:=f19_tn14}
: ${START_DATE:=1996-01-01} # YYYY-MM-DD

# job settings
: ${STOP_OPTION:=years} # units for run length specification STOP_N
: ${STOP_N:=1} # run continuesly for this length
: ${RESTART:=7} # restart this many times
: ${WALLTIME:='96:00:00'} # for debugging use '00:59:00 -qos=devel'
: ${ACCOUNT:=nn9039k}
: ${MAX_PARALLEL_STARCHIVE:=30}
```

Settings file – initialisation option 1: guessed reference case names

```
# initialisation settings – ref. cases guessed from REF_CASE_PREFIX, REF_CASE_SUFFIX_MEMBER1
: ${RUN_TYPE:=branch}
: ${REF_CASE_PREFIX:=noresm_ctl_19700101_19700101}
: ${REF_CASE_SUFFIX_MEMBER1:=_mem01}
: ${REF_PATH_LOCAL:=$INPUTDATA/ccsm4_init/${REF_CASE_PREFIX}}
: ${REF_DATE:=1996-01-01}
```

- reference case names guessed from REF_CASE_PREFIX and REF_CASE_SUFFIX_MEMBER1
- number of references cases >= ENSSIZE
- RUN_TYPE can be either “branch” or “hybrid”
- available ref dates for NorESM2-LM: 1975, 1985, 1996, 2015

Settings file – initialisation option 2: explicitly specified reference case names

```
# initialisation settings
: ${RUN_TYPE:=hybrid}
: ${REF_CASE_LIST:='noresm_ctl_19700101_19700101_mem01 noresm_ctl_19700101_19700101_mem02
noresm_ctl_19700101_19700101_mem03 noresm_ctl_19700101_19700101_mem04
noresm_ctl_19700101_19700101_mem05 noresm_ctl_19700101_19700101_mem06
noresm_ctl_19700101_19700101_mem07 noresm_ctl_19700101_19700101_mem08
noresm_ctl_19700101_19700101_mem09 noresm_ctl_19700101_19700101_mem10'}
: ${REF_PATH_LOCAL:=/cluster/work/users/${USER}/restarts}
: ${REF_DATE:=$START_DATE}
: ${ADD_PERTURBATION:=1} # only for RUN_TYPE=hybrid
```

- reference case names specified with REF_CASE_LIST
- reference cases cycled if their number is < ENSSIZE
- ADD_PERTURBATION=1 adds atmospheric perturbation if RUN_TYPE=1

Settings file – initialisation option 3: single reference case, multiple reference dates

```
# initialisation settings
: ${RUN_TYPE:=hybrid}
: ${REF_CASE:=N1850frc2_f09_tn14_20191113}
: ${REF_PATH_LOCAL:=$INPUTDATA/ccsm4_init/${REF_CASE}}
: ${REF_DATE_LIST:='1500-01-01 1505-01-01 1510-01-01 1515-01-01'}
: ${ADD_PERTURBATION:=1} # only for RUN_TYPE=hybrid
```

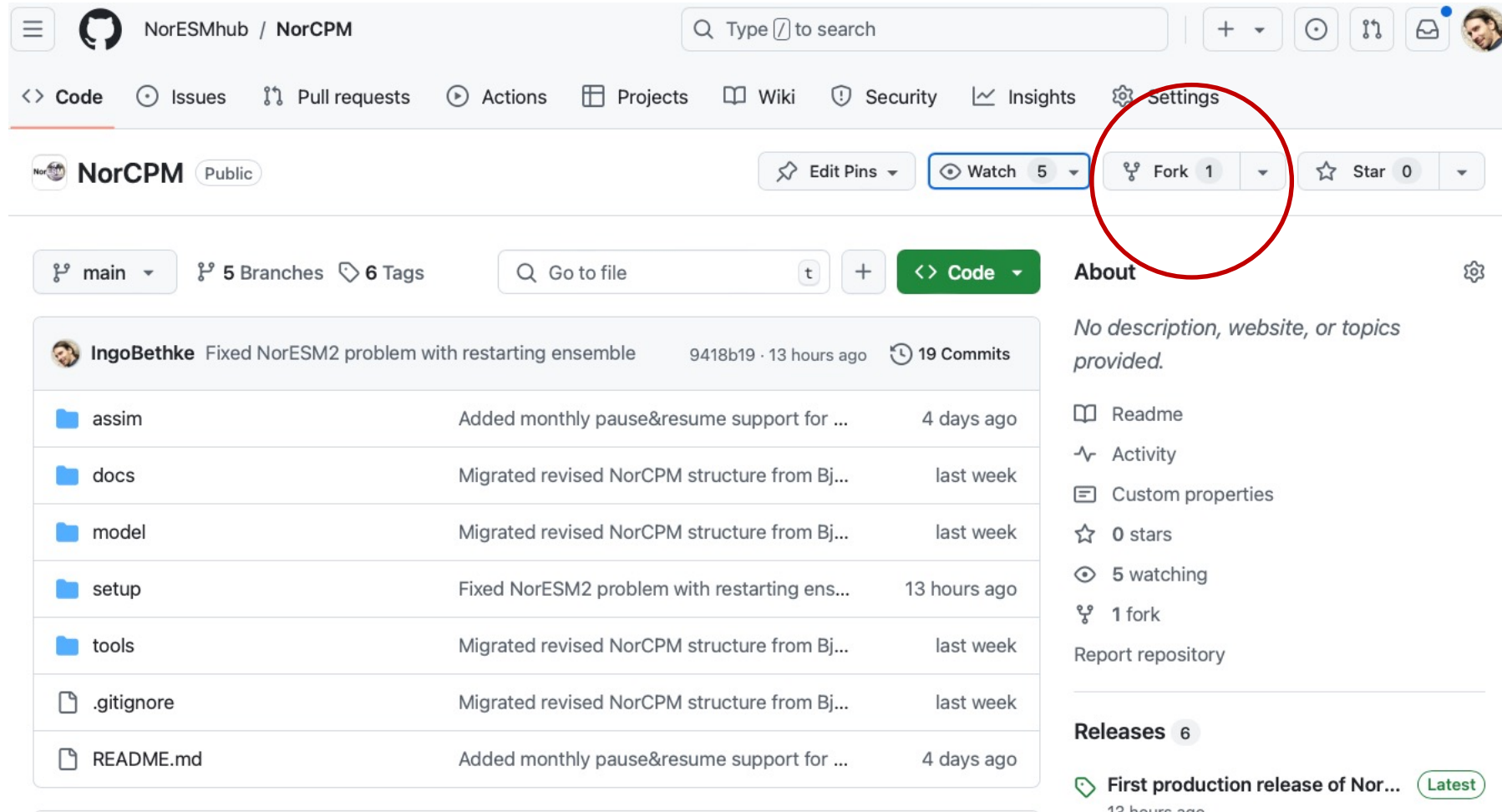
- reference case specified with REF_CASE or REF_CASE_LIST
- references dates specified with REF_DATE_LIST
- references dates cycled if number of dates < ENSSIZE
- RUN_TYPE must be “hybrid”

Settings file – assimilation

```
# assimilation settings
: ${ASSIMROOT:=$SETUPROOT/../../assim/enkf_noresm2_oda}
: ${MEAN_MOD_DIR:=$INPUTDATA_ASSIM/enkf/$RES/NorESM2-LM-CMIP6}
: ${NTASKS_DA:=128}
: ${NTASKS_ENKF:=108}
: ${OCNGRIDFILE:=$INPUTDATA/ocn/blom/grid/grid_tnx1v4_20170622.nc}
: ${OBSLIST:='TEM SAL SST'}
: ${PRODUCERLIST:='EN422 EN422 NOAA'}
: ${FREQUENCYLIST:='MONTH MONTH DAY'}
: ${REF_PERIODLIST:='1980-2010 1980-2010 1980-2010'}
: ${COMBINE_ASSIM:='0 0 1'}
```

How to contribute to NorCPM

- Step 1: create fork NorESMhub/NorCPM in your personal github space



The screenshot shows the GitHub repository page for NorESMhub / NorCPM. The repository is public and has 5 watchers and 1 fork. The 'Fork' button is highlighted with a red circle. The repository contains several files and folders, including 'assim', 'docs', 'model', 'setup', 'tools', '.gitignore', and 'README.md'. The 'About' section on the right indicates that there is no description, website, or topics provided for this repository.

Repository Header:

- Repository: NorESMhub / NorCPM
- Search: Type / to search
- Navigation: Code, Issues, Pull requests, Actions, Projects, Wiki, Security, Insights, Settings
- Repository Info: NorCPM (Public)
- Actions: Edit Pins, Watch (5), Fork (1), Star (0)

Repository Content:

- main branch, 5 Branches, 6 Tags
- Go to file
- Code

File/Folder	Description	Commit Time
assim	Added monthly pause&resume support for ...	4 days ago
docs	Migrated revised NorCPM structure from Bj...	last week
model	Migrated revised NorCPM structure from Bj...	last week
setup	Fixed NorESM2 problem with restarting ens...	13 hours ago
tools	Migrated revised NorCPM structure from Bj...	last week
.gitignore	Migrated revised NorCPM structure from Bj...	last week
README.md	Added monthly pause&resume support for ...	4 days ago

About:

- No description, website, or topics provided.
- Readme
- Activity
- Custom properties
- 0 stars
- 5 watching
- 1 fork
- Report repository

Releases:

- 6 releases
- First production release of Nor... (Latest)

How to contribute to NorCPM

- Step 2: log on to Betzy and clone NorCPM from your personal github space

```
mkdir -p /cluster/projects/nn9039k/people/$USER  
cd /cluster/projects/nn9039k/people/$USER  
git clone ssh://git@github.com/<my github user>/NorCPM.git NorCPM
```

IMPORTANT: Before you can use "ssh://git@github.com" form Betzy, you need to create a public ssh-key on Betzy and upload the key to your github profile.

How to contribute to NorCPM

- Step 3: apply changes to your local NorCPM clone on Betzy

How to contribute to NorCPM

- Step 4: synchronize your fork with the latest NorESMhub/NorCPM state

The screenshot shows the GitHub interface for the repository 'IngoBethke / NorCPM'. The repository is public and was forked from 'NorESMhub/NorCPM'. The main branch is 'main', and there is 1 branch and 0 tags. The repository is up to date with the upstream 'NorESMhub/NorCPM:main'. A red circle highlights the 'Sync fork' button, which is used to synchronize the fork with the latest state of the upstream repository. The repository has 19 commits and 0 stars. The file list shows folders 'assim', 'docs', 'model', 'setup', and 'tools', and files '.gitignore' and 'README.md'. The right sidebar shows the 'About' section with no description, website, or README provided, and the 'Releases' and 'Packages' sections with no published releases or packages.

Code Pull requests Actions Projects Wiki Security Insights Settings

NorCPM Public
forked from [NorESMhub/NorCPM](#)

main 1 Branch 0 Tags
Go to file

This branch is up to date with [NorESMhub/NorCPM:main](#).
Contribute Sync fork

IngoBethke Fixed NorESM2 problem with restarting ensemble 9418b19 · 14 hours ago 19 Commits

assim	Added monthly pause&resume support for ...	4 days ago
docs	Migrated revised NorCPM structure from Bj...	last week
model	Migrated revised NorCPM structure from Bj...	last week
setup	Fixed NorESM2 problem with restarting ens...	14 hours ago
tools	Migrated revised NorCPM structure from Bj...	last week
.gitignore	Migrated revised NorCPM structure from Bj...	last week
README.md	Added monthly pause&resume support for ...	4 days ago

About
No description, website provided.
Readme
Activity
0 stars
0 watching
0 forks

Releases
No releases published
[Create a new release](#)

Packages
No packages published
[Publish your first package](#)

How to contribute to NorCPM

- Step 5: synchronize your local NorCPM clone with your github fork

```
git pull
```

How to contribute to NorCPM

- Step 6: commit your changes to your local NorCPM clone

```
git add .  
git status  
git commit -m 'my commit message'
```

How to contribute to NorCPM

- Step 8: push the changes from your local NorCPM clone to your github fork

```
git push
```


How to contribute to NorCPM

- Step 9: issue pull request for applying changes from your fork to NorESMhub/NorCPM

The screenshot shows the GitHub interface for the repository 'IngoBethke / NorCPM'. The repository is a fork of 'NorESMhub/NorCPM'. The main branch is 'main', and it is 1 commit ahead of the upstream 'NorESMhub/NorCPM:main'. A red circle highlights a notification box that says 'This branch is 1 commit ahead of NorESMhub/NorCPM:main. Open a pull request to contribute your changes upstream.' with a green 'Open pull request' button. The repository has 20 commits, 0 stars, 0 watching, and 0 forks. The file list includes 'assim', 'docs', 'model', 'setup', 'tools', '.gitignore', and 'README.md'.

Navigation: IngoBethke / NorCPM

Search: Type / to search

Code Pull requests Actions Projects Wiki Security Insights Settings

NorCPM Public

forked from NorESMhub/NorCPM

main 1 Branch 0 Tags

Go to file

Code

About

No description, website provided.

Readme Activity 0 stars 0 watching 0 forks

Releases

No releases published

Create a new release

Packages

No packages published

Publish your first package

This branch is 1 commit ahead of NorESMhub/NorCPM:main

Contribute Sync fork

IngoBethke Added instructions for NorESM2 initialization

assim Added mo

docs Migrated r

model Migrated r

setup Fixed NorE

tools Migrated revised NorCPM structure from Bjerknes...

.gitignore Migrated revised NorCPM structure from Bjerknes...

README.md Added instructions for NorESM2 initialization to R...

20 Commits

4 days ago

last week

last week

14 hours ago

last week

last week

1 minute ago

This branch is 1 commit ahead of NorESMhub/NorCPM:main

Open a pull request to contribute your changes upstream.

Open pull request

How to contribute to NorCPM

- Step 10: merge pull request (only for maintainers)

GitHub repository page for NorESMhub / NorCPM. The 'Pull requests' tab is highlighted with a red circle. The repository shows a commit by IngoBethke titled 'Fixed NorESM2 problem with restarting ensemble' with 19 commits. The file list includes assim, docs, model, setup, tools, .gitignore, and README.md.

GitHub pull request page for 'Added instructions for NorESM2 initialization to README.md. #3'. The 'Merge pull request' button is highlighted with a red circle. The page shows a comment by IngoBethke and a status message indicating that the branch has no conflicts with the base branch.

Current status

- ready-to-use NorESM2 setup with daily SST assimilation and monthly T/S assimilation
- initial conditions available for 10 members for years 1975, 1985, 1996, 2015
- must switch from historical to scenario compset in 2015

Coming soon

- more restart members and restart dates for NorESM2-LM
- combined historical-scenario compset that allows running 1850-2100
- how-to-guide for contributing via github
- «full-online» assimilation setup developed by Ping-Gin