



# Ready-to-use setup for high-frequent EnKF assimilation with NorESM2

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# Introduction & first results

## 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: ocn<sup>12</sup>, ice<sup>1</sup>, lnd<sup>1</sup>*
- *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*)

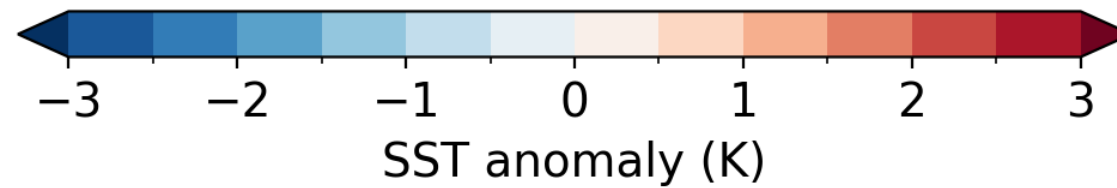
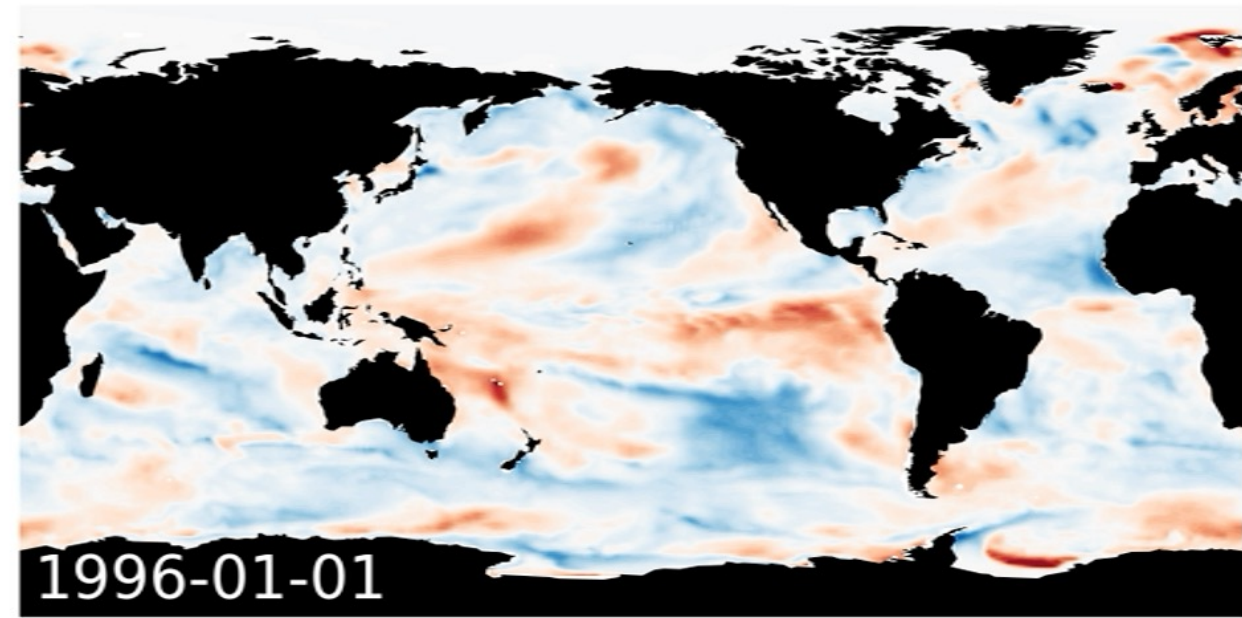
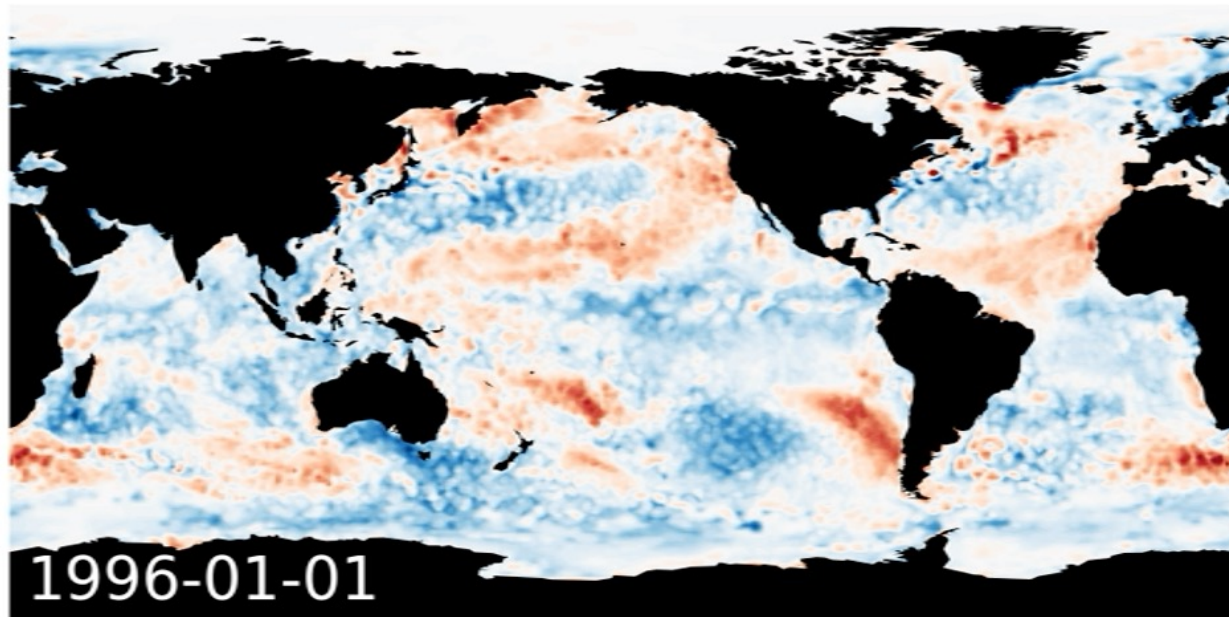
## **Test using daily assim. of satellite SSTs and monthly assim. of T/S profiles**

- › Three 10-member ensembles with NorESM2-LM
  - FREE (no assimilation)
  - MONTHLY (monthly SST + monthly T/S)
  - DAILY (daily SST + monthly T/S)
- › 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

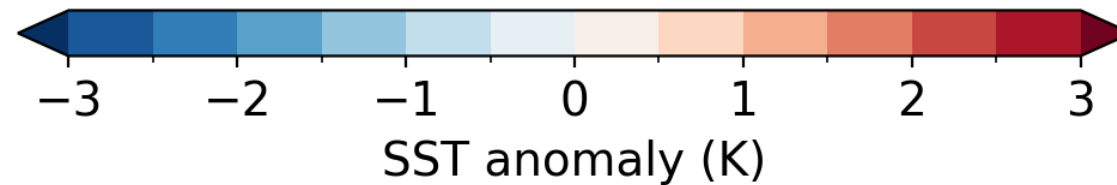
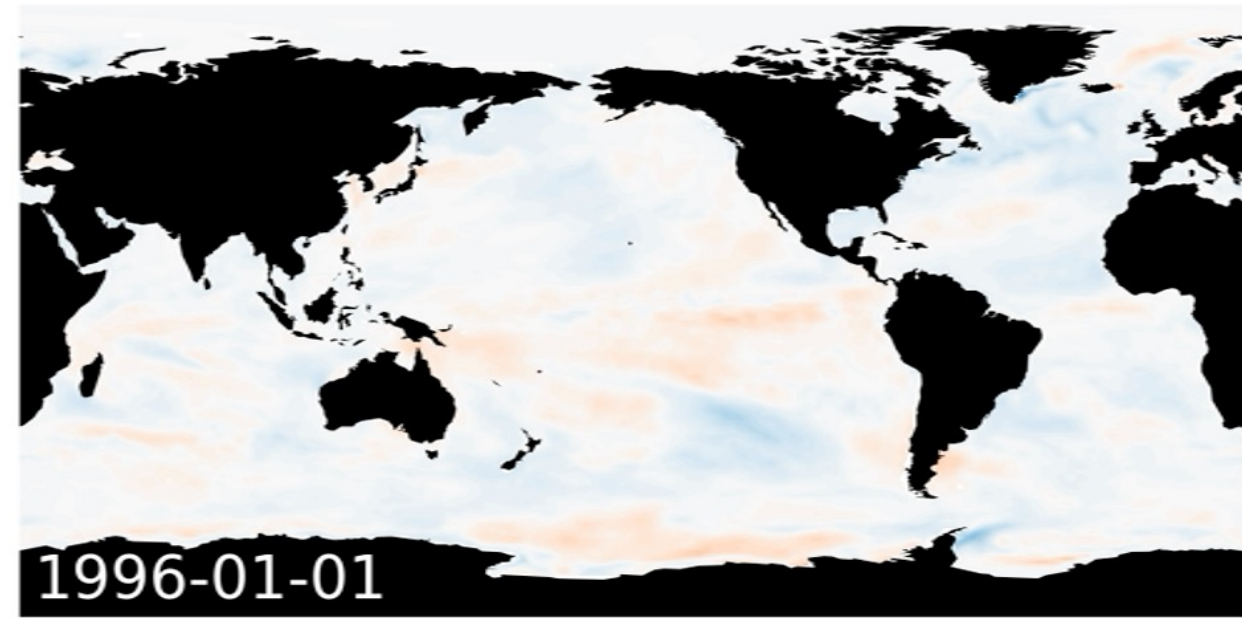
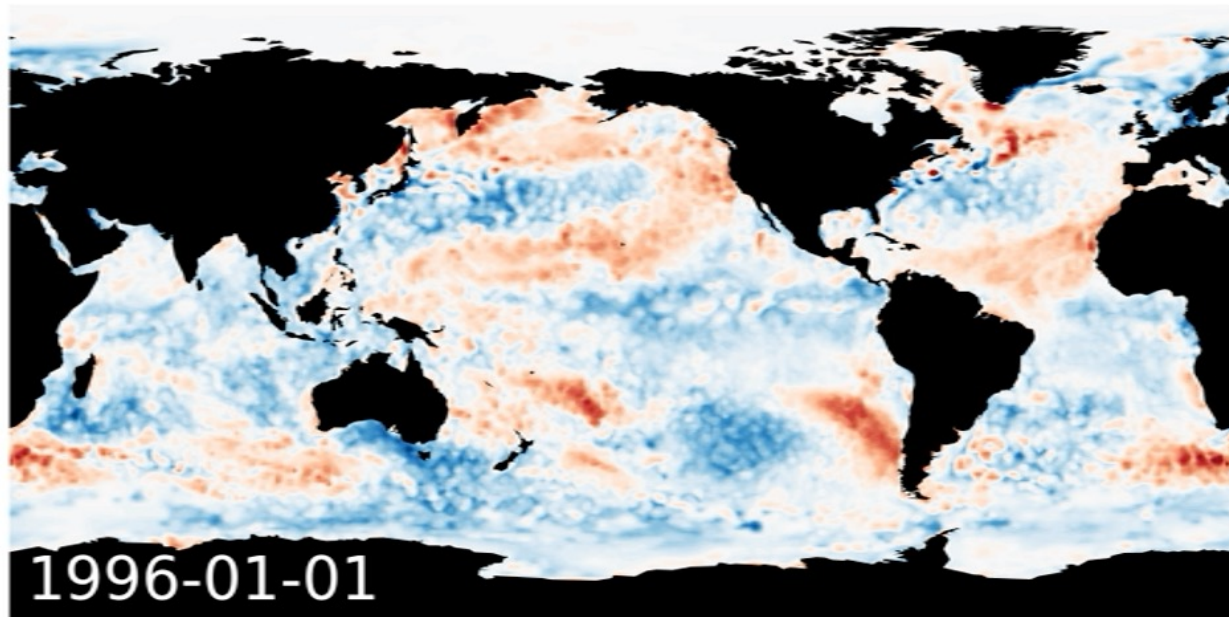
FREE (member 1)



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

OISST

MONTHLY (ensemble mean)

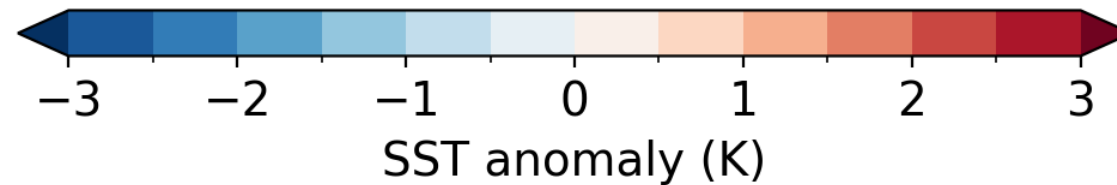
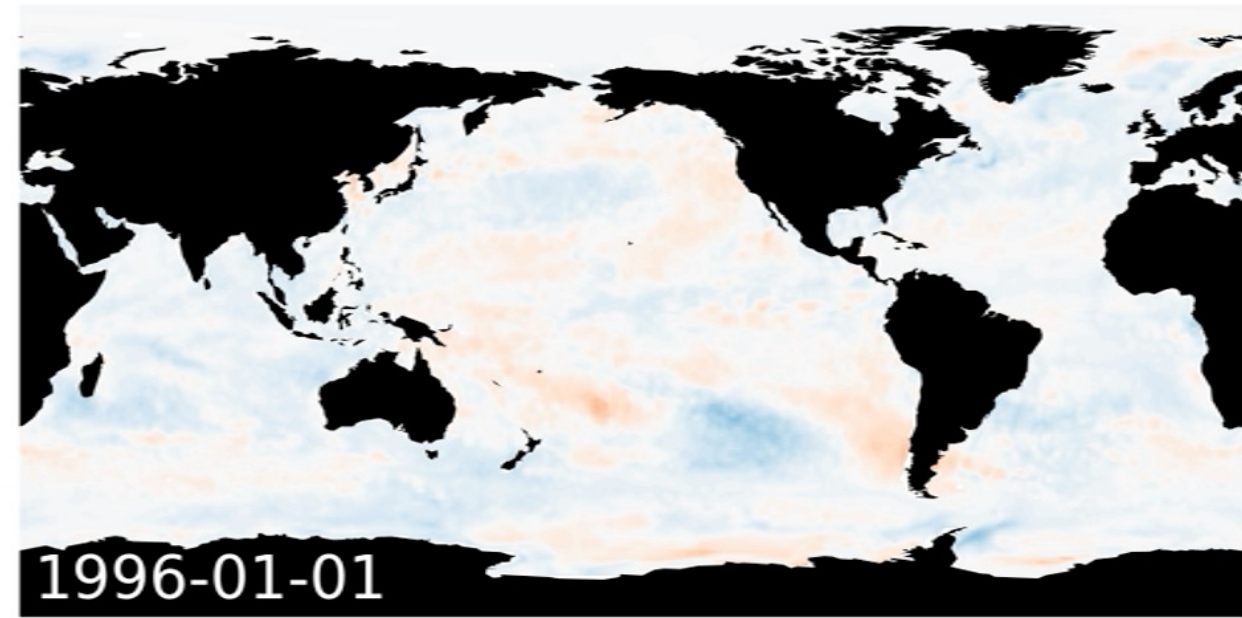
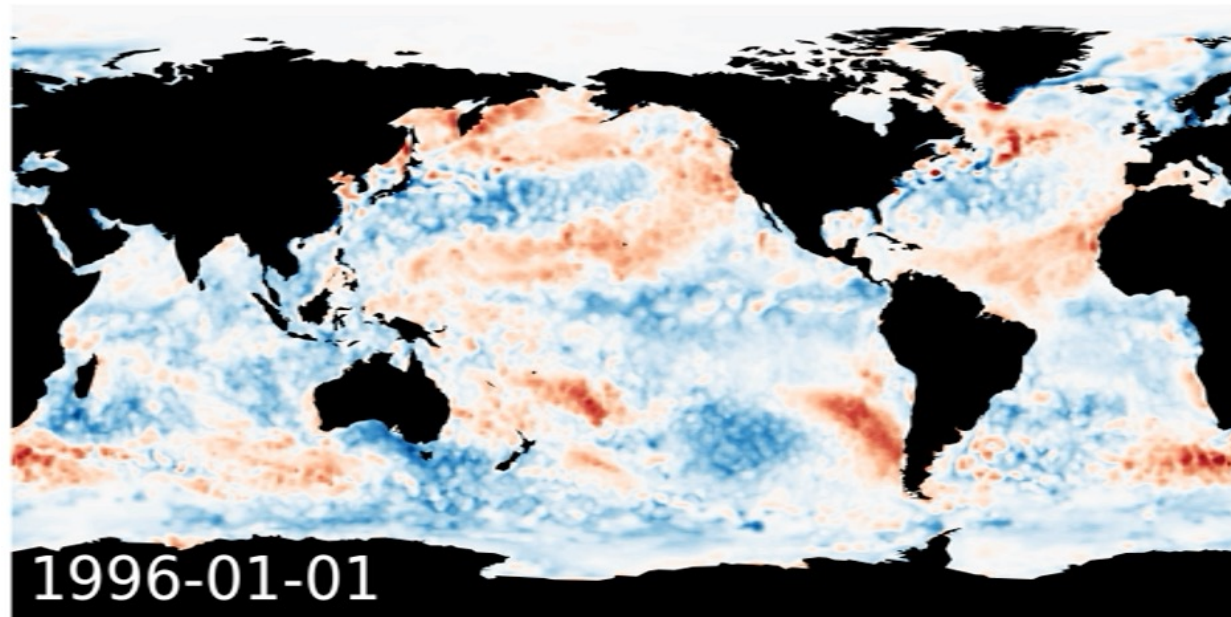




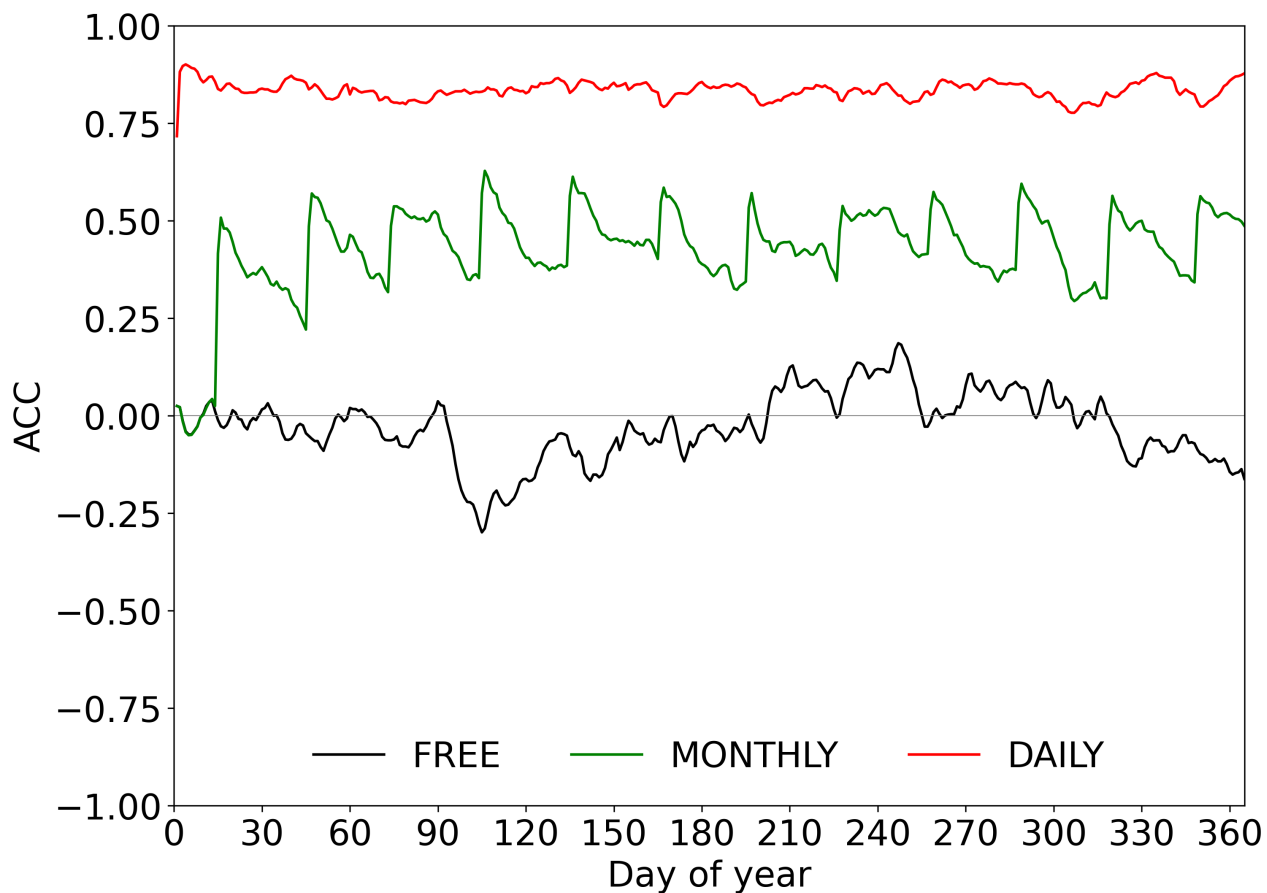
# Assimilation of daily SST and monthly T/S observations – obs vs daily assimilation

OISST

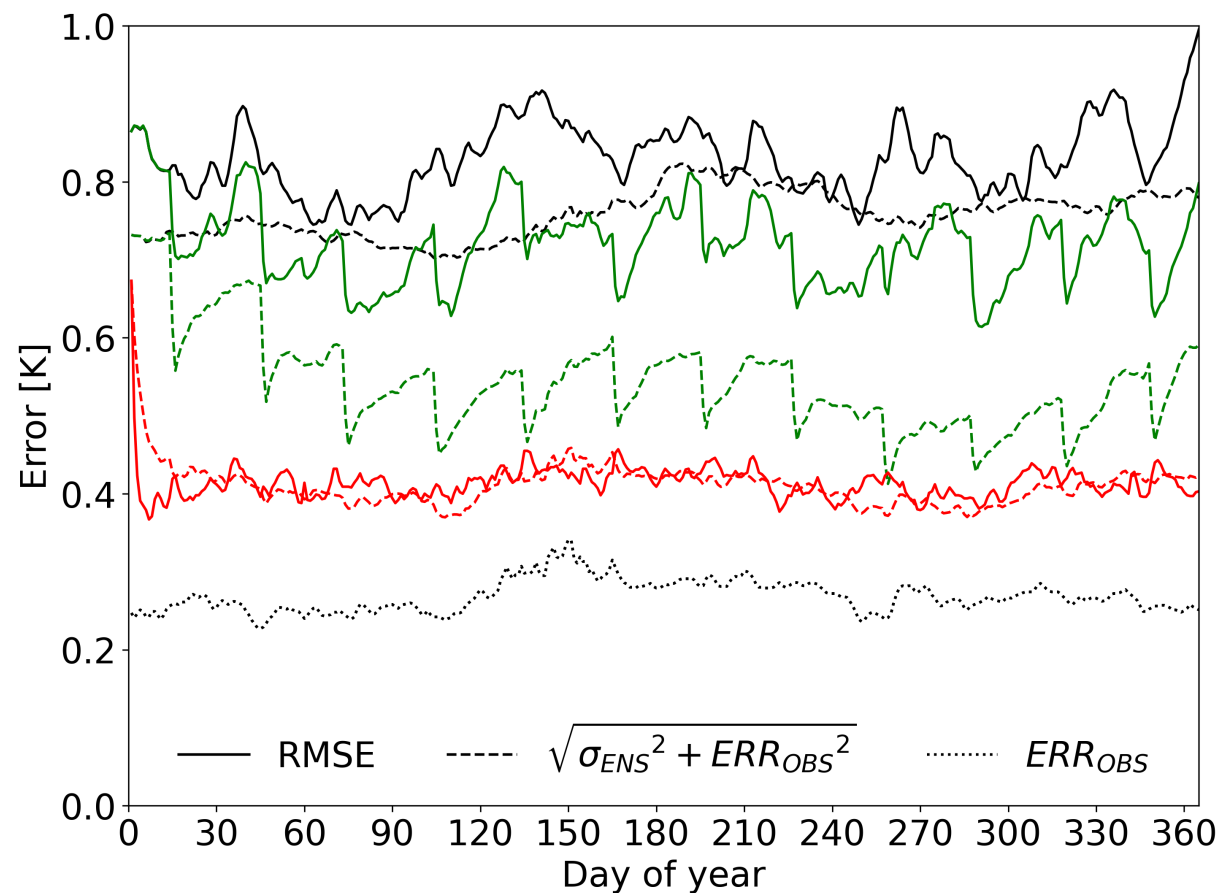
DAILY (ensemble mean)



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



*ACC = pattern correlation (area weighted)*



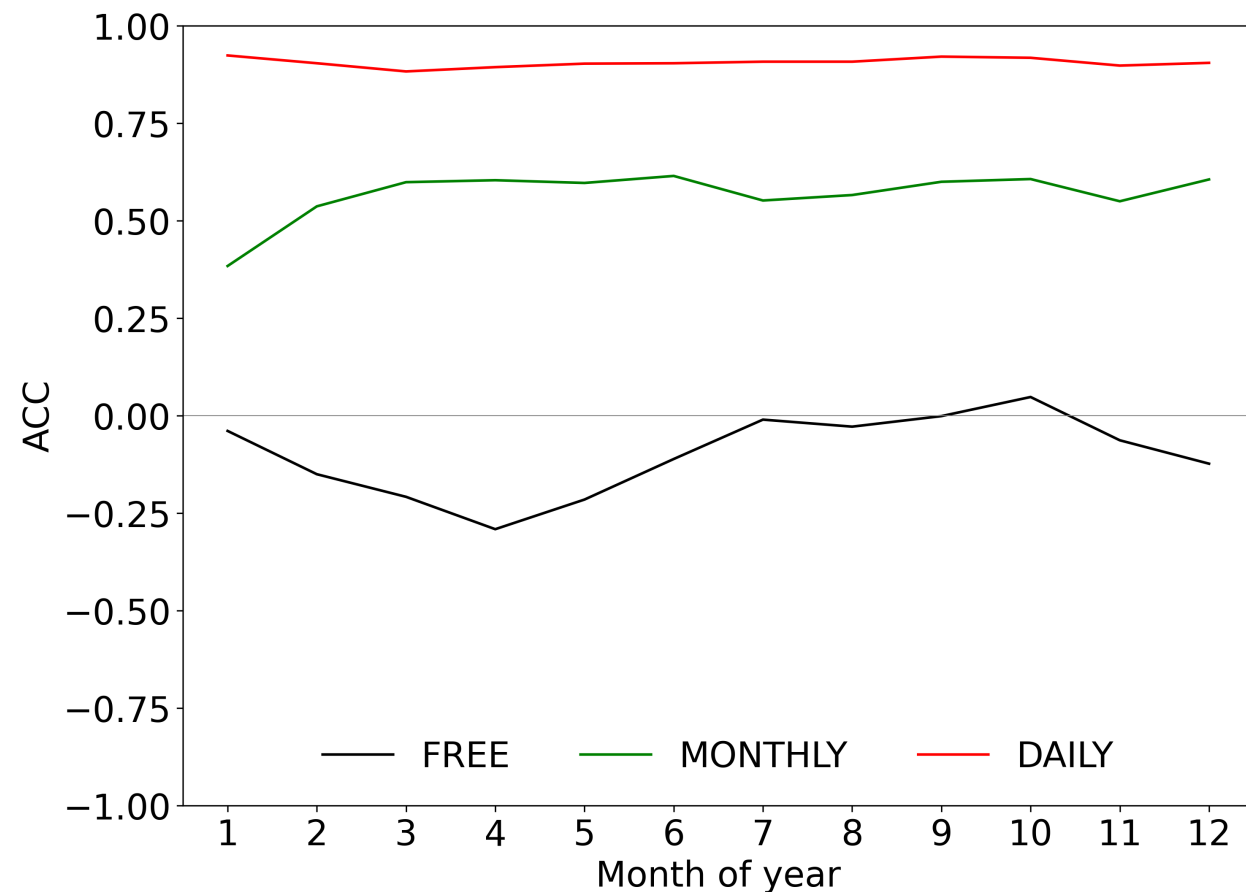
*RMSE = root mean square deviation (area weighted)*

*$ERR_{OBS}$  = observation error (area weighted)*

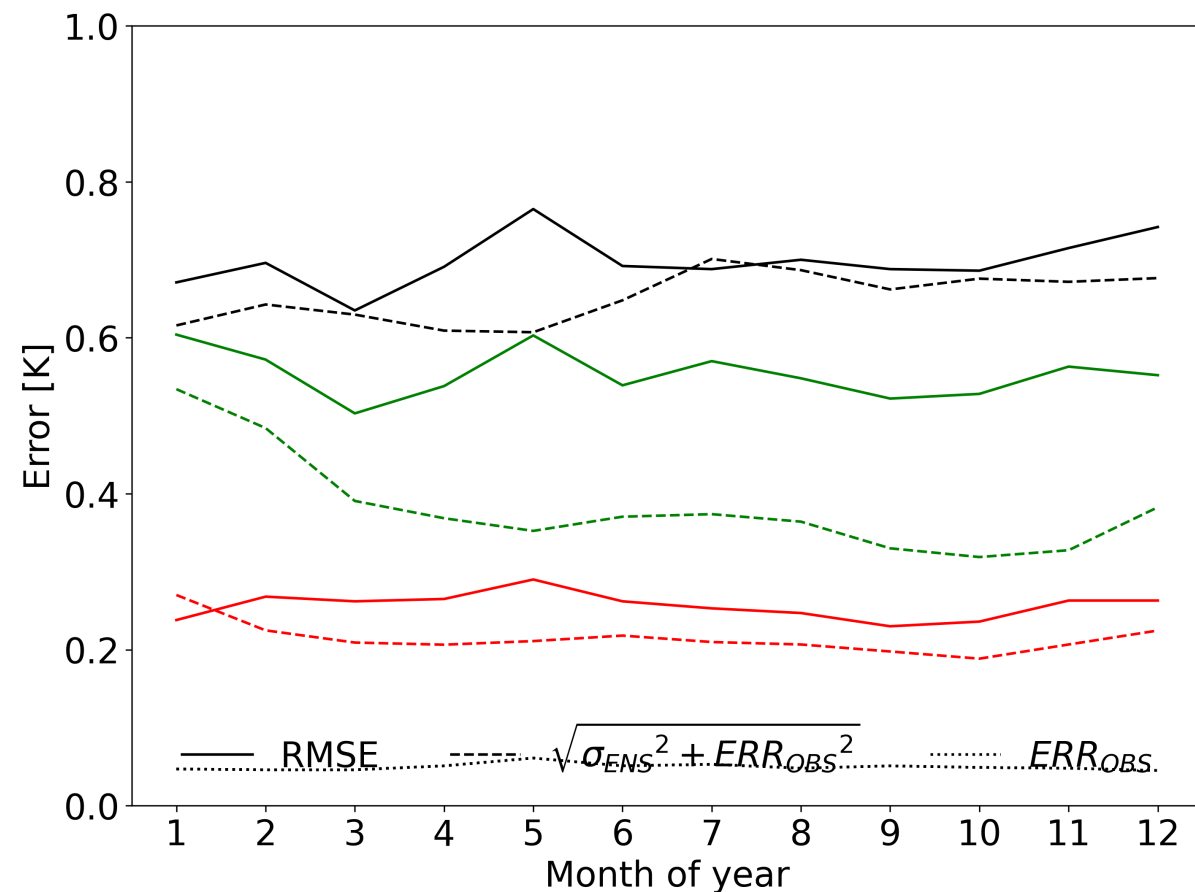
*$\sigma_{ENS}$  = ensemble spread (area weighted)* <sub>8</sub>



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



*ACC = pattern correlation (area weighted)*

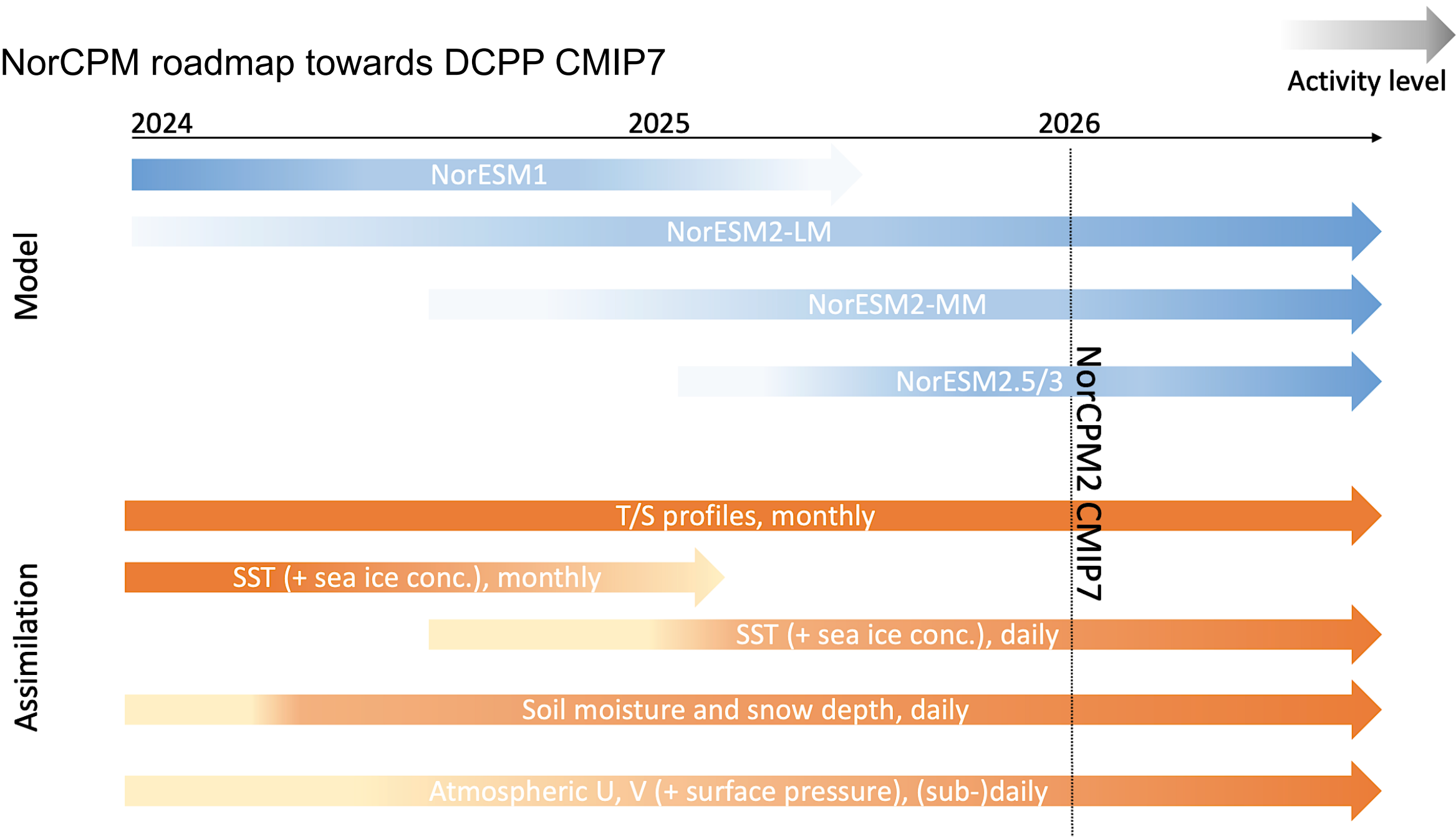


*RMSE = root mean square deviation (area weighted)*

*$ERR_{OBS}$  = observation error (area weighted)*

*$\sigma_{ENS}$  = ensemble spread (area weighted)*

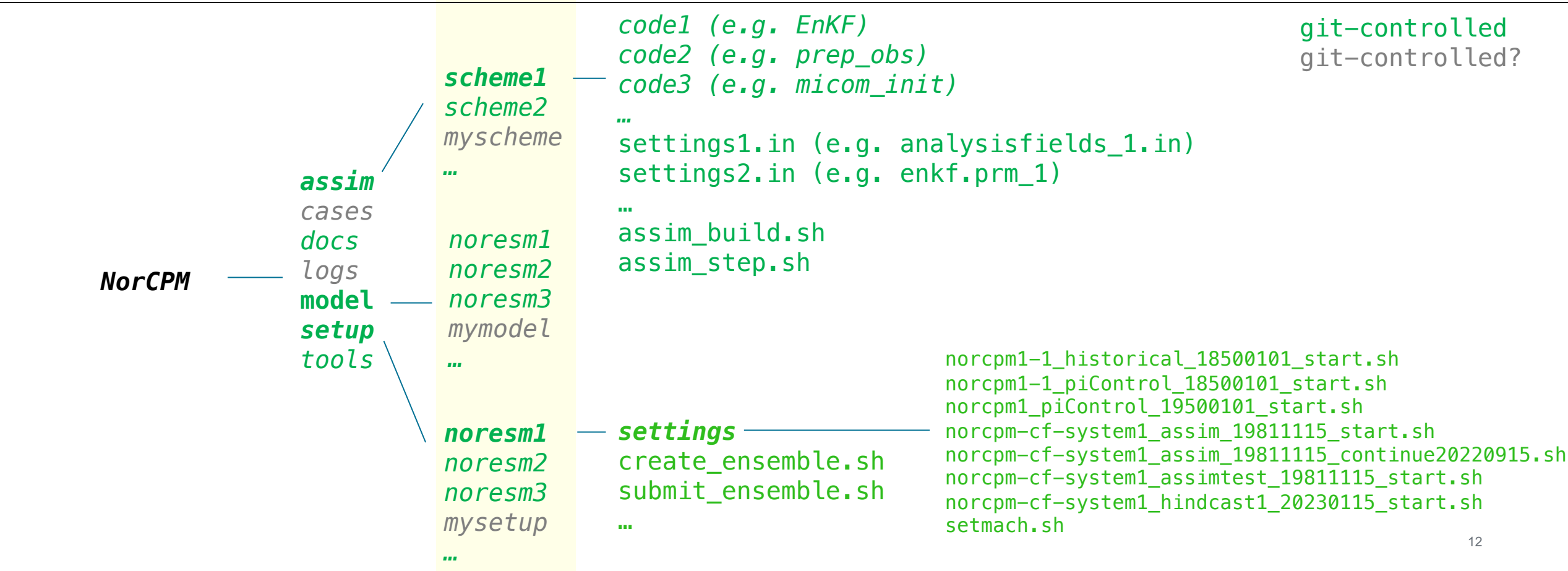
# NorCPM roadmap towards DCPP CMIP7



# User guide

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



# 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 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

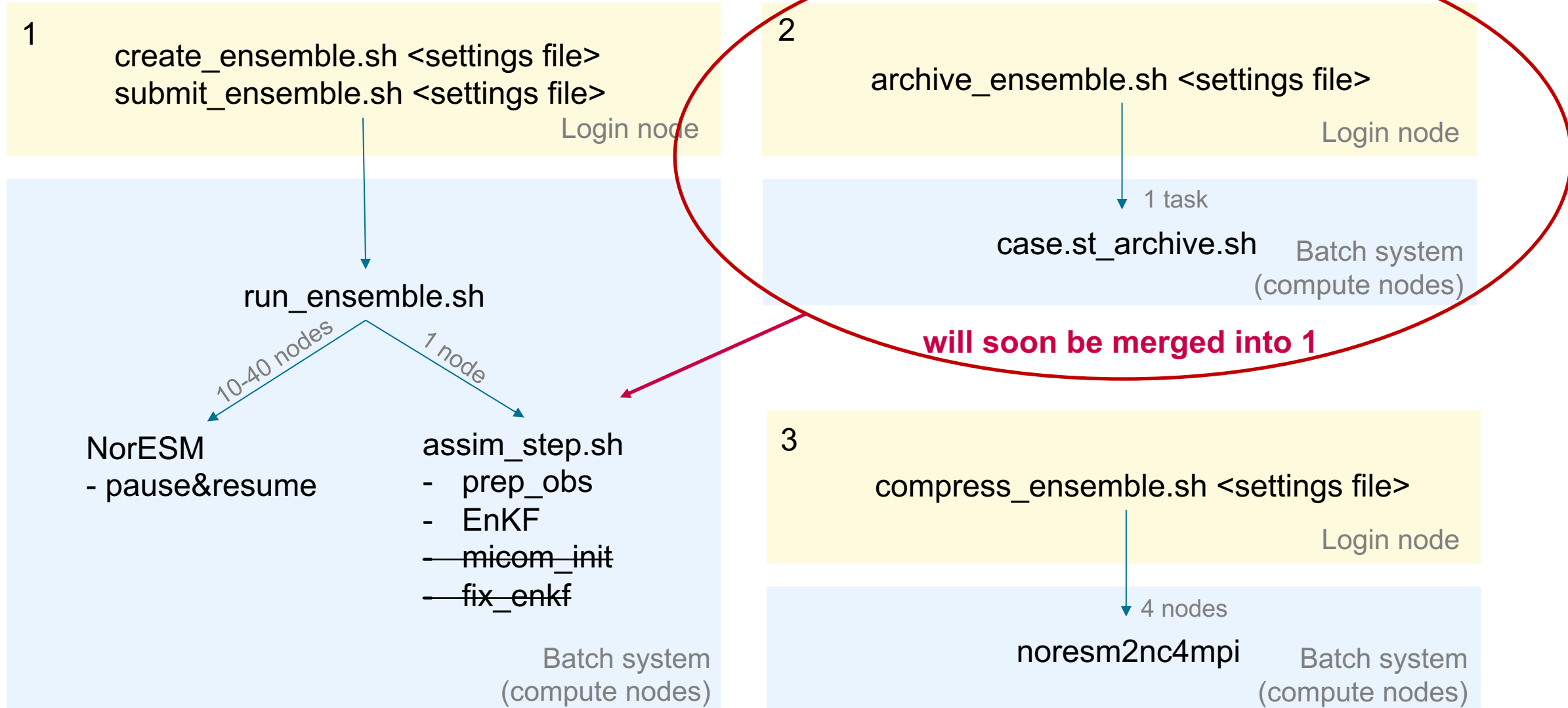
```
./create_ensemble.sh settings/noresm2-lm_odaday_19960101.sh
```

## Submit experiment

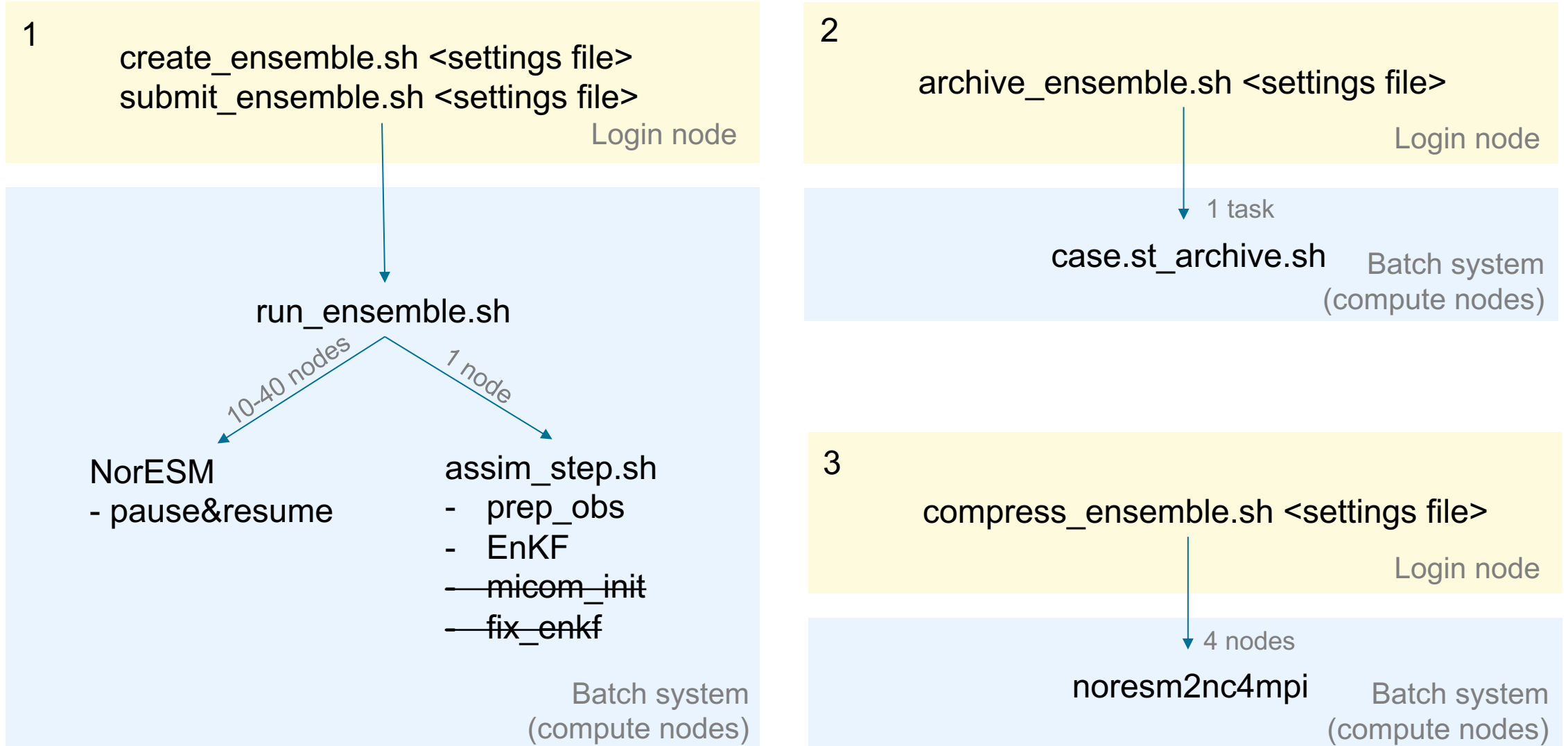
```
./submit_ensemble.sh settings/noresm2-lm_odaday_19960101.sh
```



# Workflow



# Workflow



## 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}}
: ${REF_DATE:=$START_DATE}
```

- reference case names guessed from REF\_CASE\_PREFIX and REF\_CASE\_SUFFIX\_MEMBER1
- number of references cases  $\geq$  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
```

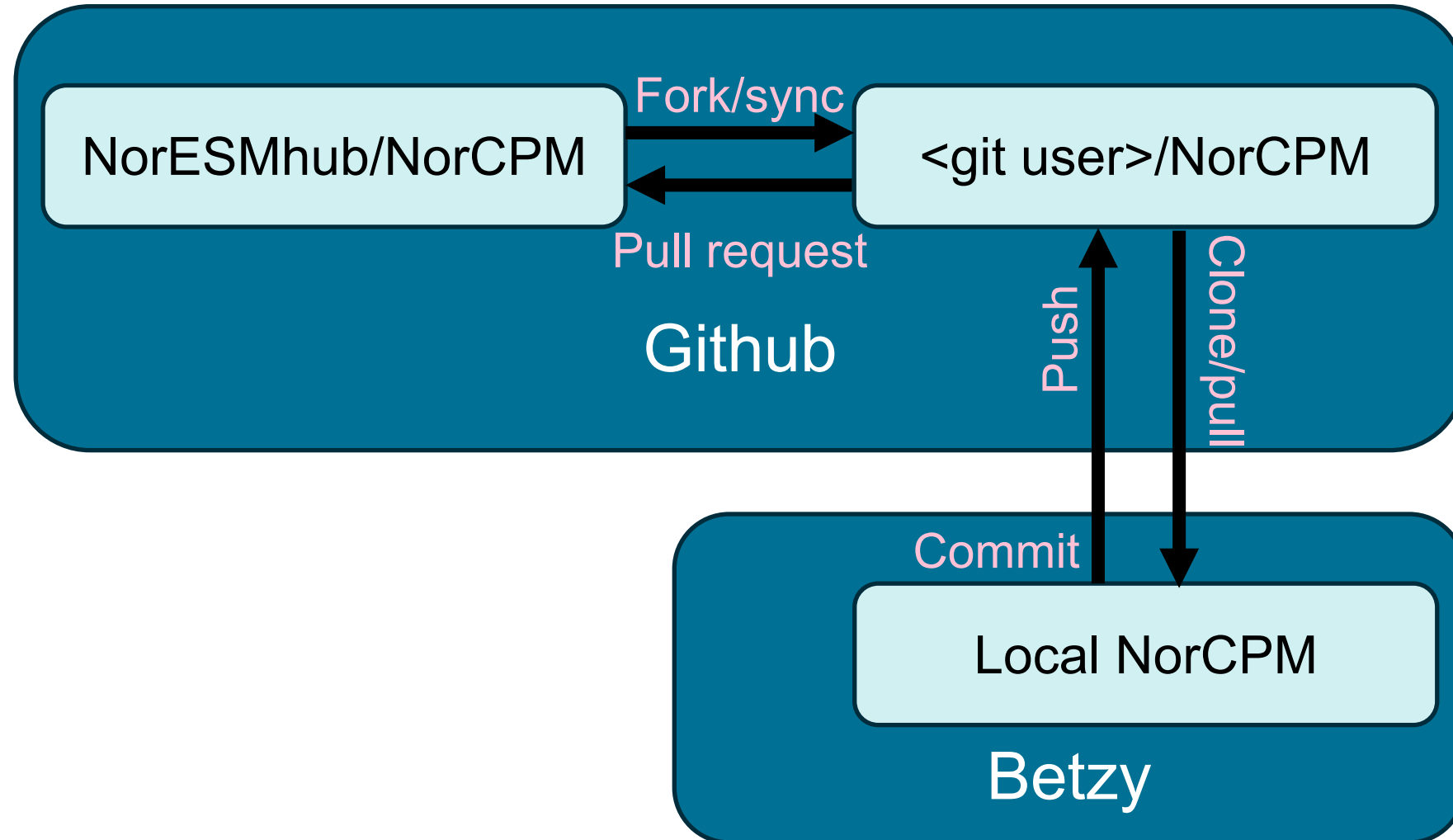
- reference case specified with REF\_CASE or REF\_CASE\_LIST
- references dates specified with REF\_DATE\_LIST
- references dates cycled if number of dates < ENSIZE
- RUN\_TYPE must be “hybrid”

## 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'}
```

# Developer guide

## How to contribute to developing NorESMhub/NorCPM



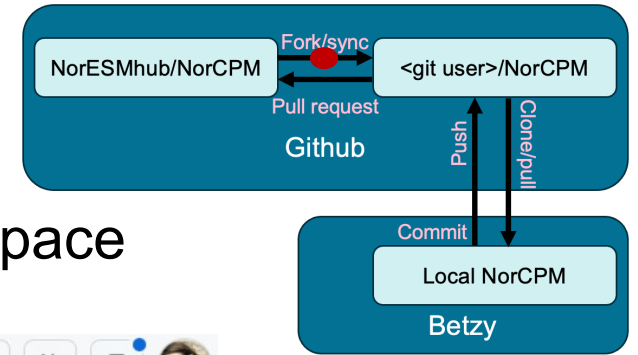


# How to contribute to developing NorESMhub/NorCPM

- 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 circled in red. The repository contains several files and folders, including 'assim', 'docs', 'model', 'setup', 'tools', '.gitignore', and 'README.md'. The commit history shows a recent commit by IngoBethke titled 'Fixed NorESM2 problem with restarting ensemble'.

File/Folder	Description	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



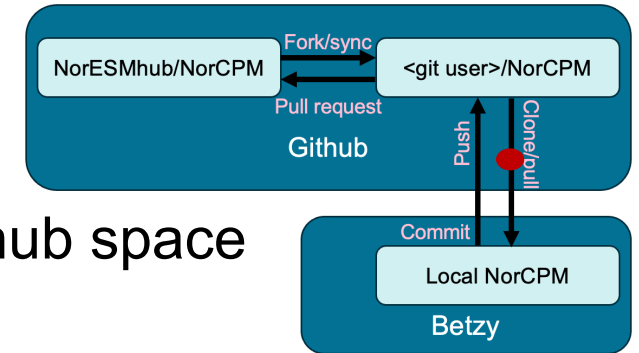
## How to contribute to developing NorESMhub/NorCPM

- 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
```

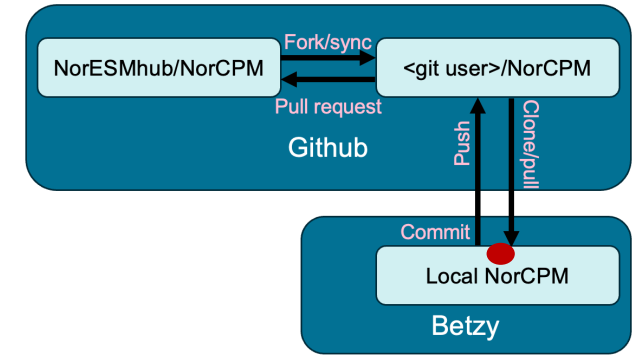
```
git clone ssh://git@github.com/<my github user>/NorCPM.git NorCPM
```



**IMPORTANT:** Before using "ssh://git@github.com" from Betzy, create a public ssh-key on Betzy and upload the key to your github profile.

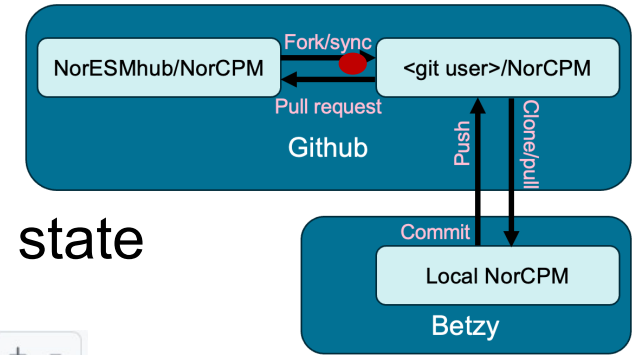
## How to contribute to developing NorESMhub/NorCPM

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



# How to contribute to developing NorESMhub/NorCPM

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



main 1 Branch 0 Tags

Go to file

Code

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**

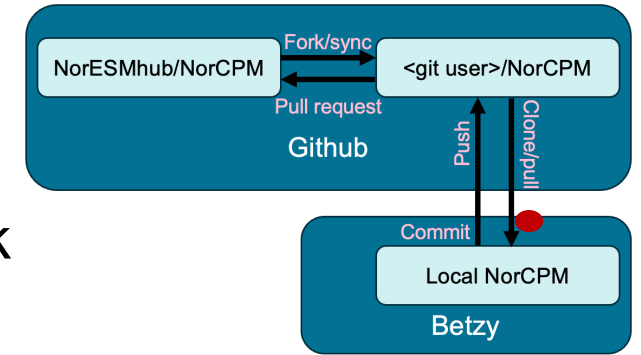
No packages published

[Publish your first package](#)

## How to contribute to developing NorESMhub/NorCPM

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

```
git pull
```

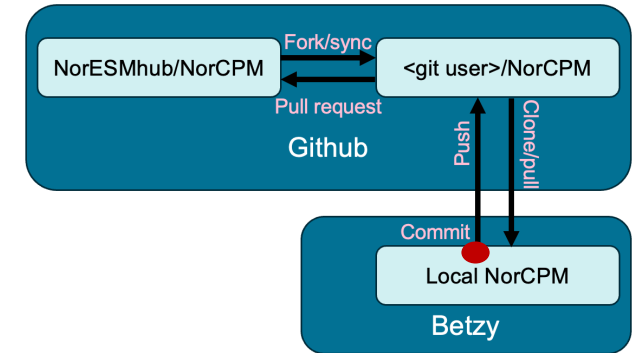




## How to contribute to developing NorESMhub/NorCPM

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

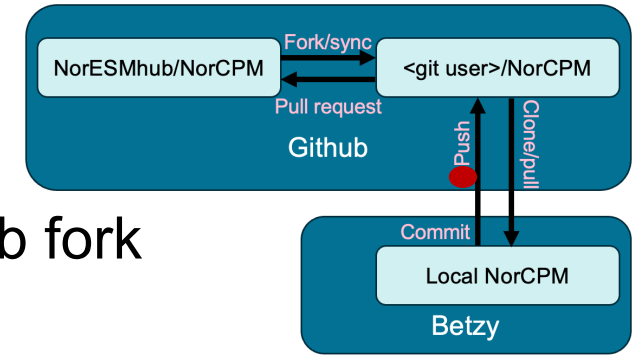
```
git add .  
git status  
git commit -m 'my commit message'
```



## How to contribute to developing NorESMhub/NorCPM

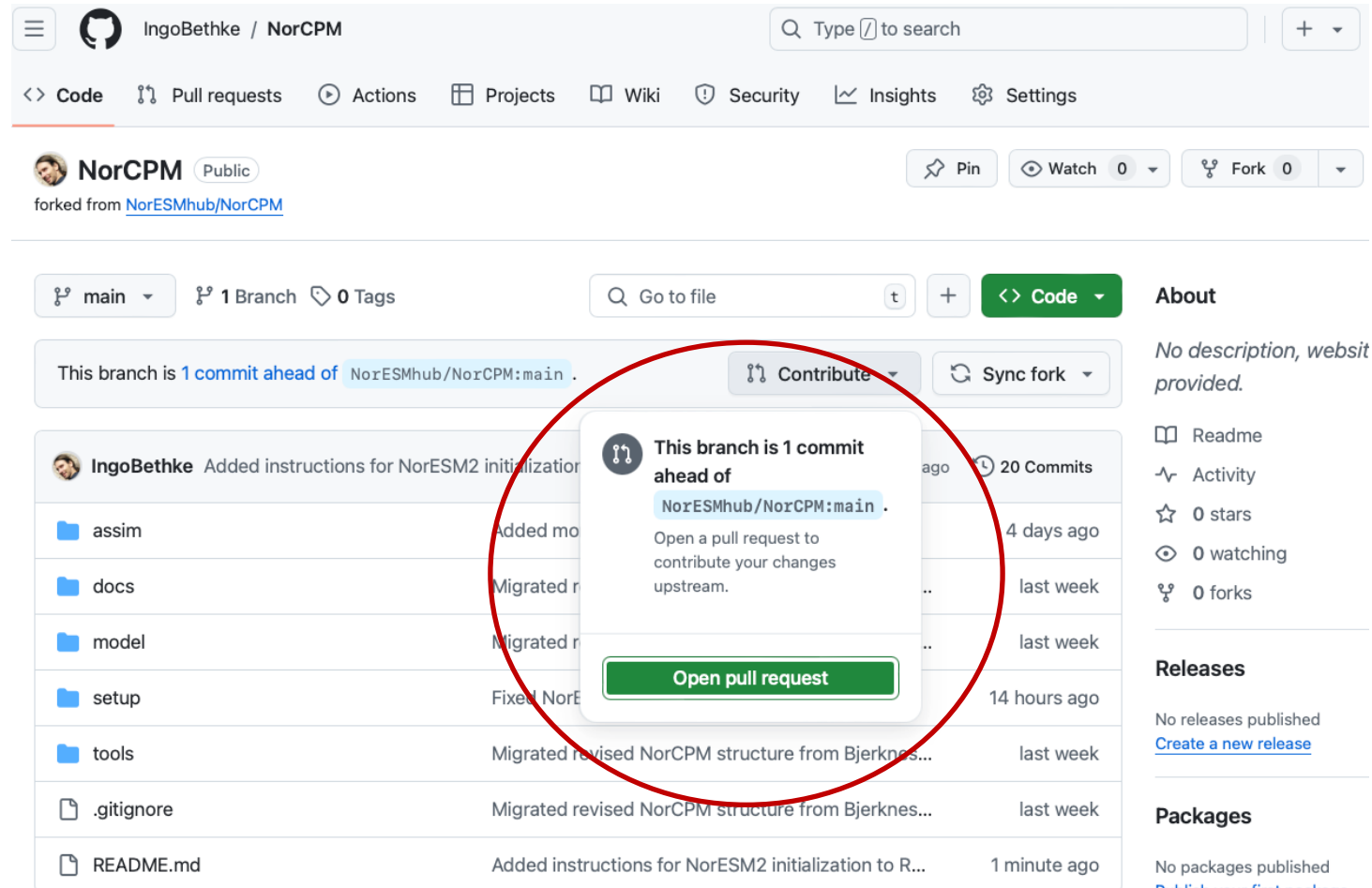
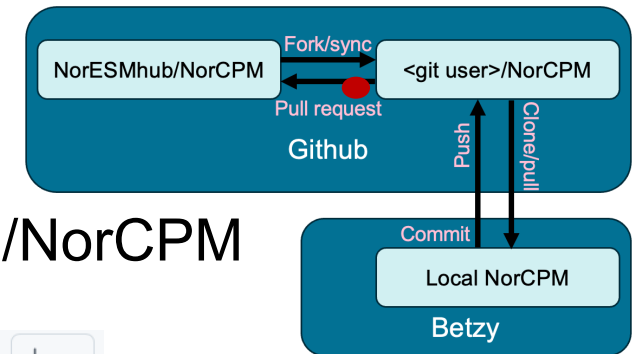
- Step 8: push changes from your local NorCPM clone to your github fork

`git push`



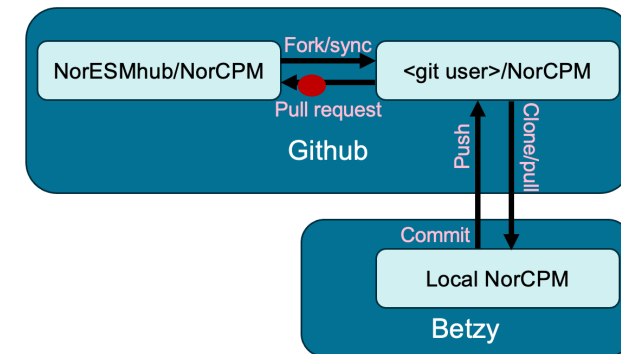
# How to contribute to developing NorESMhub/NorCPM

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



# How to contribute to NorCPM

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



**Your main branch isn't protected**  
Protect this branch from force pushing or deletion, or require status checks before merging. [View documentation.](#) [Protect this branch](#)

**main** 5 Branches 6 Tags

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

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

**About**  
No description, website provided.

**Releases** 6  
First production release 14 hours ago  
[+ 5 releases](#)

**Packages**

**Added instructions for NorESM2 initialization to README.md. #3**

[Open](#) IngoBethke wants to merge 1 commit into `NorESMhub:main` from `IngoBethke:main`

Conversation 0 Commits 1 Checks 0 Files changed 1

**IngoBethke** commented 6 minutes ago  
No description provided.

**Continuous integration has not been set up**  
[GitHub Actions](#) and [several other apps](#) can be used to automatically catch bugs and enforce style.

**This branch has no conflicts with the base branch**  
Merging can be performed automatically.

[Merge pull request](#) You can also [open this in GitHub Desktop](#) or view [command line instructions](#).

## 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
- git-workflow for contributing new developments

## Coming soon

- more restart members and restart dates for NorESM2-LM
- combined historical-scenario compset that allows running 1850-2100
- support for 1991-2020 reference period (in addition to 1980-2010)
- «full-online» assimilation setup developed by Ping-Gin