Model output and post-processing

Yanchun He

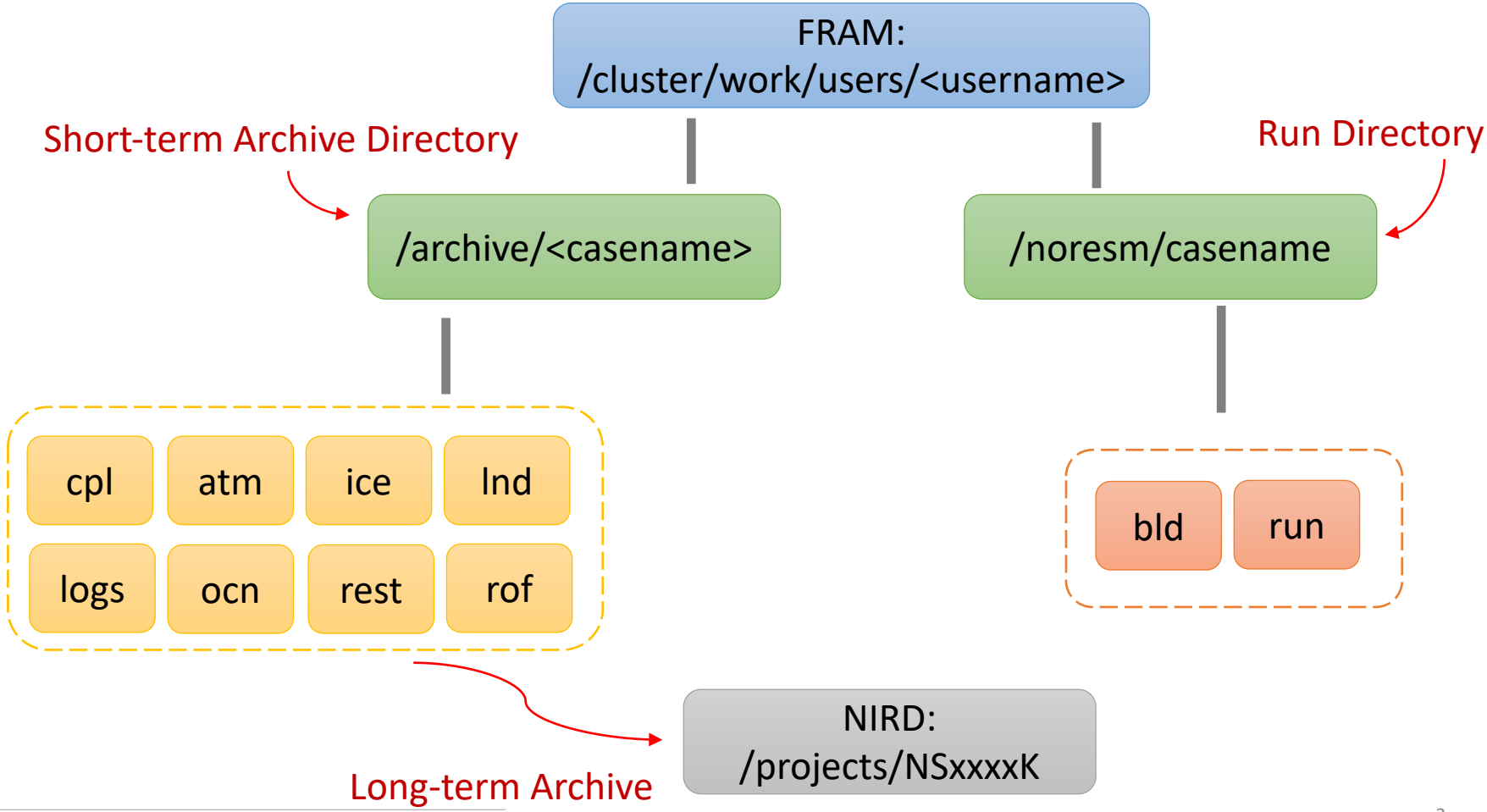
yanchun.he@nersc.no

The Nansen Senter

Outline

- Format of NorESM output
- netCDF Operators (NCO) and Climate Data Operators (CDO)
- Quick-use tools: ncview, panoply, ImageMagick, ghostview, xxdiff
- Introduction to NCL
- post-processing of special variables
- NorESM Diagnostic Tool Package
- Exercise on stand-alone post-processing scripts
- Exercise on NorESM Diagnostic Tool Package

Format of NorESM output



Introduction

NorESM Diagnostic Package:
... is a NorESM model evaluation tool written with a set of scripts (bash, NCL etc) to provide a general evaluation and quick preview of the model performance with only one command line.

The tool package consists of:

- CAM_DIAG: (NCAR's AMWG Diagnostics Package)
- CLM_DIAG: (CESM Land Model Diagnostics Package)
- CICE_DIAG: snow/sea ice volume/area
- HAMOCC_DIAG: time series, climaotology, zonal mean, regional mean
- MICOM_DIAG: time series, climatologies, zonal mean, fluxes, etc

Simple-to-use

```
# in your .bashrc alias*
diag_run='/projects/NS2345K/noresm_diagnostics_dev/ bin/diag_run'
```

```
# run this wraper script without parameters shows basic usage
$ diag_run
```

```
-------------------------------------------------
Program:
/projects/NS2345K/noresm_diagnostics_dev/bin/diag_run
Version: 6.0
-------------------------------------------------
Short description:
A wrapper script for NorESM diagnostic packages.

Basic usage:
diag_run -m [model] -c [test case name] -s [test case start yr] -e [test case end yr]
diag_run -m [model] -c [test case name] -s [test case start yr] -e [test case end yr] -c2 [cntl case name] -s2 [cntl case start yr] -
e2 [cntl case end yr]
…
…
```

NOTE: use /projects/NS2345K/*noresem_diagnostics/bin/diag_run after the workshop*

Two types of analysis

- Compare model with observations

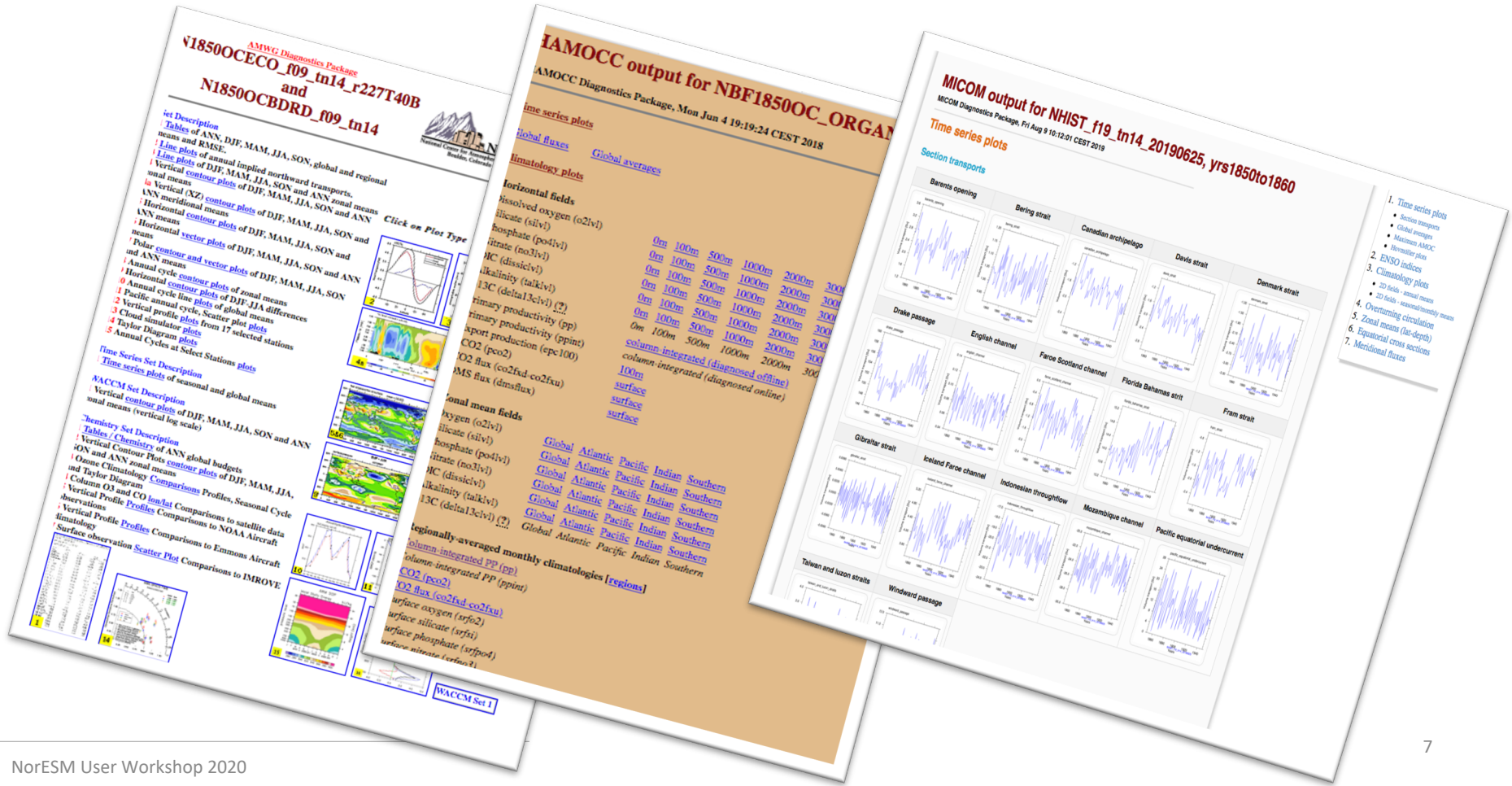
```
yanchun@tos-spw08:~$ diag_run --model=cam,cice,micom \
--case1=CASENAME1 \
--start_year1=51 \
--end_year1=100 \
--input-dir1=/PATH/TO/MODEL/FOLDER \
--output-dir=/PATH/TO/PUT/OUTPUT/DATA \
--web-dir=/PATH/TO/PUT/CREATED/WEBPAGES \
```

- Compare model with another model simulation

```
yanchun@tos-spw08:~$ # :~$ diag_run --model=cam,cice,micom \
--case1=CASENAME1 \
--start_year1=51 \
--end_year1=100 \
--input-dir1=/PATH/TO/MODEL/FOLDER1 \
--case2=CASENAME2 \
--start_year2=2 \
--end_year2=50 \
--input-dir2=/PATH/TO/MODEL/FOLDER2 \
--output-dir=/PATH/TO/PUT/OUTPUT/DATA \
--web-dir=/PATH/TO/PUT/CREATED/WEBPAGES \
```

View results on webpage

http://ns2345k.web.sigma2.no/noresm_diagnostics/



Some more about…

About history of the tool...

- 2014-2017, Detelina Ivanova

✓ Import the NCAR Diagnostic Package (CAM, CLM, CICE)

✓Write MICOM diagnostic with Matlab

- 2017-2018, Johan Liakka

✓ Rewrite the MICOM diagnostic with NCL

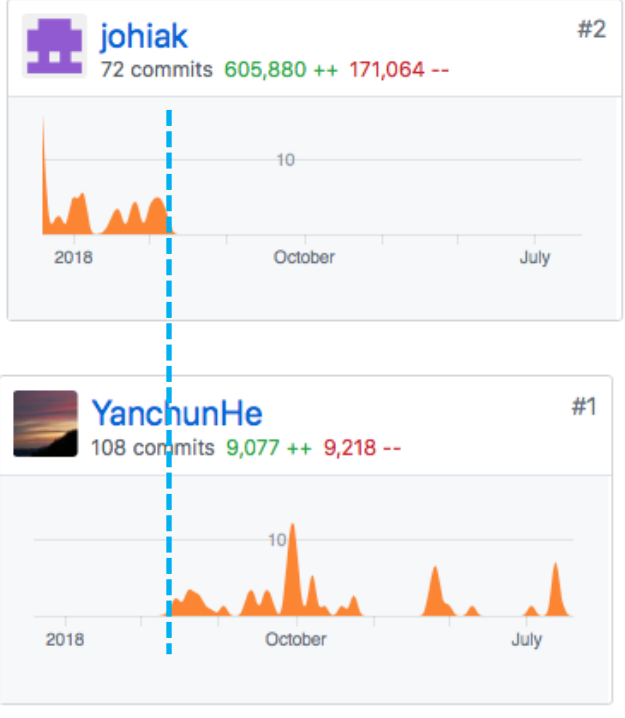
✓ Create HAMOCC diagnostics

✓Create wrapper script for all components

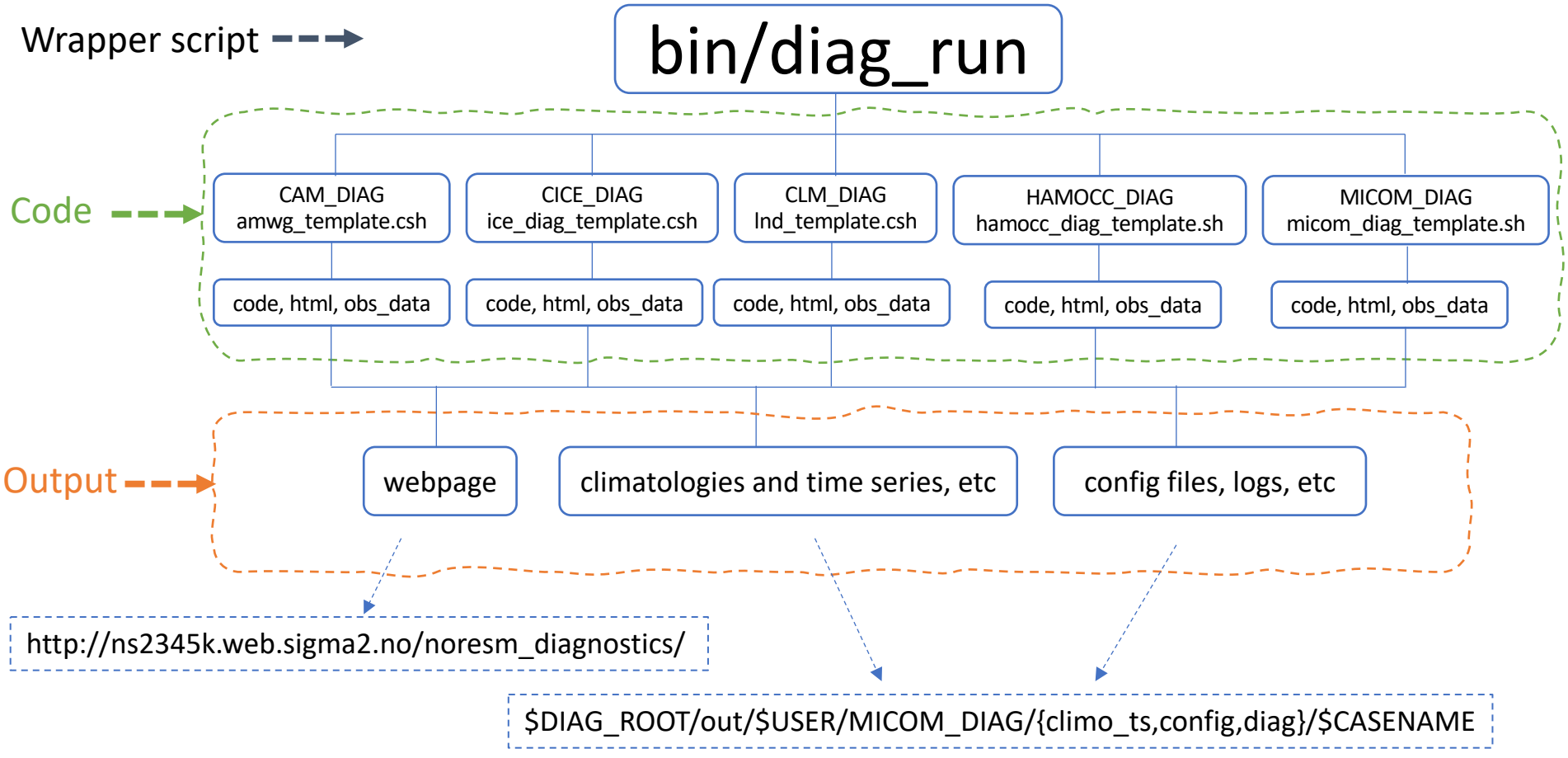
- 2018-2019, Yanchun He

✓ Add more functionalities.

✓ Performance and interface improvements



Code structure



About the code

Where is it?

- Github: https://github.com/NordicESMhub/NoresmDiagnostics
- NIRD: /projects/NS2345K/noresm_diagnostics
- FRAM: /cluster/NS2345K/noresm_diagnostics
  (The temporally mounted NS2345K disk will be removed on 9th of Sept.)

If you want to install your own copy? (not recommended)

```
$ git clone https://github.com/NordicESMhub/NoresmDiagnostics
```

Note: all the obs_data are not in the github repository, you should manually copy or link it

Documentation: https://noresm-docs.readthedocs.io/en/latest/modeldiagnostics.html

How to contribute?

- Report bugs/suggestions to me by e-mails: yanchun.he@nersc.no
- Open an issue ticket on the github respository.
- Fork the repository and send a "Pull" request on Github.
- Do NOT directly modify /projects/NS2345K/noresm_diagnostics/*

Outlook

- **The NorESM Diagnostic Tool will be continuously developed and improved.**
- **The ESMValTool will be updated to Version 2 to support the CMIP6 data.**

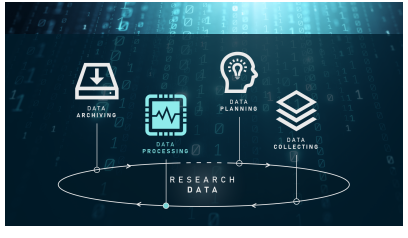
  "The Earth System Model eValuation Tool (ESMValTool) is a community diagnostics and performance metrics tool for the evaluation of Earth System Models (ESMs) that allows for routine comparison of single or multiple models, either against predecessor versions or against observations." (www.esmvaltool.org)

- **The Climate Variability Diagnostics Package (CVDP) is planned to installed and supported.**

  "CVDP is an analysis tool, developed by NCAR, that documents the major modes of climate variability in models and observations, including ENSO, Pacific Decadal Oscillation, Atlantic Multi-decadal Oscillation, Northern and Southern Annular Modes, North Atlantic Oscillation, Pacific North and South American teleconnection patterns"
  (www.cesm.ucar.edu/working_groups/CVC/cvdp)

- **The above-mentioned diagnostic tools will try to be integrated with NIRD Toolkit service**

  "The NIRD Toolkit offers a self-service portal in which our scientists may choose various tools and computational capacity needed for their research"
  (www.sigma2.no/content/nird-toolkit)



Stand-alone post-processings

Regrid CAM vertical levels

Convert hybrid pressure-sigma layers to pressure levels, using NCO & CDO

```
1.  # Extract variable
2.  ncks -O -v ${VAR},ilev $filename var_tmp.nc
3.  # Add layer interface 'ilev' as bounds of vertical coordinate 'lev'
4.  ncatted -a bounds,lev,c,c,"ilev" var_tmp.nc
5.  # Interpolate from hybrid sigma-pressure to pressure levels
6.  cdo ml2pl,3000.,5000.,7000.,10000.,15000.,20000.,25000.,30000.,35000.,40000., \
        var_tmp.nc var_ml2pl.nc
7.  # Convert Pa to hPA
8.  ncap2 -O -s 'plev=plev/100' var_ml2pl.nc var_ml2pl.nc
9.  # Change the "units" from Pa to hPa
10. ncatted -a units,plev,m,c,"hPa" var_ml2pl.nc
11. # Make zonal mean
12. cdo -s zonmean var_ml2pl.nc var_ml2pl_zm.nc
13. # View result
14. ncview var_ml2pl2_zm.nc &
```

Rotate MICOM vectors from i,j to lat/lon

Rotate MICOM's vectors along i/j to lat/lon directoin

```
# Use NCO
1.  # Extract ubaro,vbaro
2.  ncks -O -v ubaro,vbaro $filename uv.nc
3.  # Add vector angle to micom variable file
4.  ncks -A -v angle grid.nc uv.nc
5.  # Generate roated new verctors
6.  ncap2 -O -s "urot=ubaro*cos(angle)-vbaro*sin(angle);vrot=ubaro*sin(angle)+vbaro*cos(angle)" \ uv.nc uvrot.nc
7.  # View the data
8.  ncview uvrot.nc

# Use NCL (or matlab, fortran, etc)
1.  gid     = addfile("grid.nc","r")
2.  angle   = gid->angle
3.  fid     = addfile("micom_output.nc","r")
4.  U       = fid->mxlu
5.  V       = fid->mxlv
6.  Urot    = U*cos(angle)-V*sin(angle)
7.  Vrot    = U*sin(angle)+V*cos(angle)
```

Regrid MICOM grid to 1x1 deg

Interpolate from curvlinear grid to global 1x1 (nxn) grid

1. # Regrid data
2. ncks -A -v plat,plon ../grid/grid_tnx1v4.nc micom_sst_2010-2014_ann.nc
3. cdo -O remapbil,global_1 micom_sst_2010-2014_ann.nc micom_sst_2010-2014_ann_1x1d.nc

4. # Make difference between model and observation
5. ncdiff -O micom_sst_2010-2014_ann_1x1d.nc HadISST_sst_2010-2014mean.nc sst_diff.nc

Hands-on session

Task 1

Task1.1 Set up the environment

```
# login nird
$ ssh -Y -l username login.nird.sigma2.no
# append in your .bashrc alias
$ echo "# add alias for diag_run" >> ~/.bashrc
$ echo "alias diag_run='/projects/NS2345K/noresm_diagnostics_dev/bin/diag_run'" >> ~/.bashrc
$ source ~/.bashrc
```

Logon FRAM: ssh -l username fram.sigma2.no
cd /cluster/work/users/$USER/archive
rsync -vazu /cluster/work/users/$USER/archive/
login.nird.sigma2.no:/projects/NS2345K/noresm/cases/

Log on FRAM:
mkdir -p tos-project1/NS2345K/noresm/cases/$USER
cp -r /cluster/work/users/$USER/archive/YOUR_CASE_NAME /tos-project1/NS2345K/noresm/cases/$USER/

Task 1

Task1.2 Model-obs comparison of a fully coupled simulation

```
# Compare model to observation
$ diag_run  -m all -c CASENAEME -s START_YEAR -e  END_YEAR -i INPUT -o OUTPUT –w WEBPAGE
$ diag_run -m all -c N1850OC_f19_tn14_noresm-dev -s 1 -e 2

$ diag_run -m all -c NHIST_f19_tn14_20190710 -s 2010 -e 2014 -i /projects/NS2345K/workshop/cases &>~/diag_run.log1 &
```

Task1.3 Model-model comparison

```
# Compare model to model
$ diag_run  -m all -c1 CASENAEME1 -s1 START_YEAR1 -e1  END_YEAR1 -c2 CASENAME2 -s2 START_YEAR2 -e2 –END_YEAR2 -i1 INPUT1 -i2 INPUT2 -o OUTPUT –w WEBPAGE
$ diag_run  -m all -c1 NHIST_f19_tn14_20190710 –s1 2010 -e1 2014 –i1 /projects/NS2345K/workshop/cases -c2 N1850_f19_tn14_20190621 -s2 1750 -e2 1754 -i2 /projects/NS2345K/workshop/cases &>~/diag_run.log2 &
```

View results at: http://ns2345k.web.sigma2.no/noresm_diagnostics_dev/$USER

Task 2

Task2.1, Diagnose only ocean component with passive mode -p

```
$ diag_run -m micom -c NHIST_f19_tn14_20190710 -s 2010 -e 2013 \
                -i /projects/NS2345K/workshop/cases  -p
```

Task2.2, Switch on only some sets, e.g. set_1 and set_3, and switch off other sets

$ change: set_1=1, set_3=1, others =0, in /projects/NS2345K/noresm_diagnostics_dev/out/$USER/MICOM_DIAG/micom_diag_template.sh

Task2.3, Plot only part of the period of a simulation, instead of the whole period.Only plot part of the time series between xxx and xxx

Change /projects/NS2345K/noresm_diagnostics_dev/out/$USER/MICOM_DIAG/micom_diag_template.sh

TRENDS_ALL=0
FIRST_YR_TS1=2010
LAST_YR_TS1=2012

Task 3

Task 3.1 Find out where are the climo_ts, config, logs, diag locates, and understand these processed data

e.g.,
/projects/NS2345K/noresm_diagnostics_dev/out/$USER/MICOM_DIAG

Task 3.2 How to edit the source code and apply your change?

Copy your revised code to, e.g., .,
/projects/NS2345K/noresm_diagnostics_dev/out/$USER/MICOM_DIAG
, and change micom_diag_template.sh

Task 4

4.1 Regrid hybrid pressure-sigma layers of CAM to pressure levels

~~*step1: copy the script to ~/workshop/task4.1*~~

step2: run /projects/NS2345K/workshop/task4.1/task4.1.sh

4.2 Rotate MICOM vectors from i,j direction to lat/lon direction

~~*step1: copy the script to ~/workshop/task4.2*~~

step2 run : /projects/NS2345K/workshop/task4.2/task4.2.sh

ncl /projects/NS2345K/workshop/task4.2/task4.2.ncl

4.3 Remap MICOM curvilinear tnx1v4 grid to global 1x1 grid and compare with observations

~~*step1: copy the script to ~/workshop/task4.3*~~

step2: run /projects/NS2345K/workshop/task4.3/task4.3_regrid_scalar.sh

~~*step3: run /projects/NS2345K/workshop/task4.3/task4.3_regrid_vector.sh*~~

Thank you for your participation!