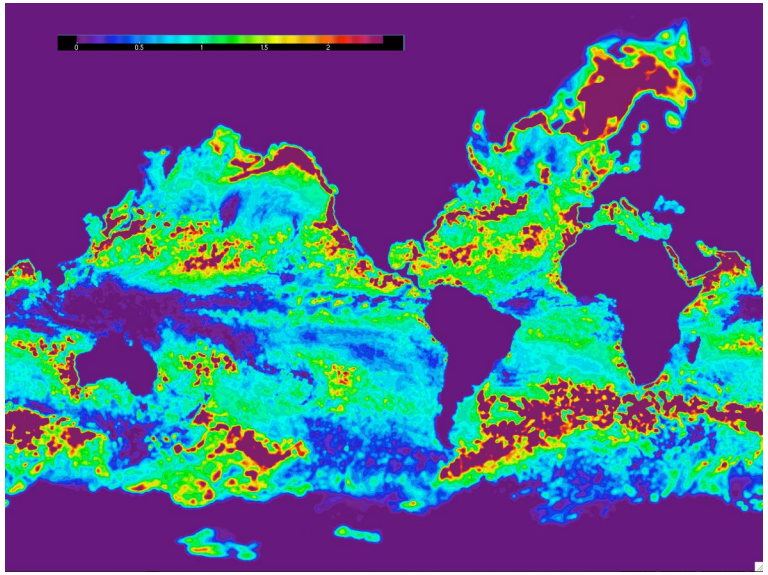
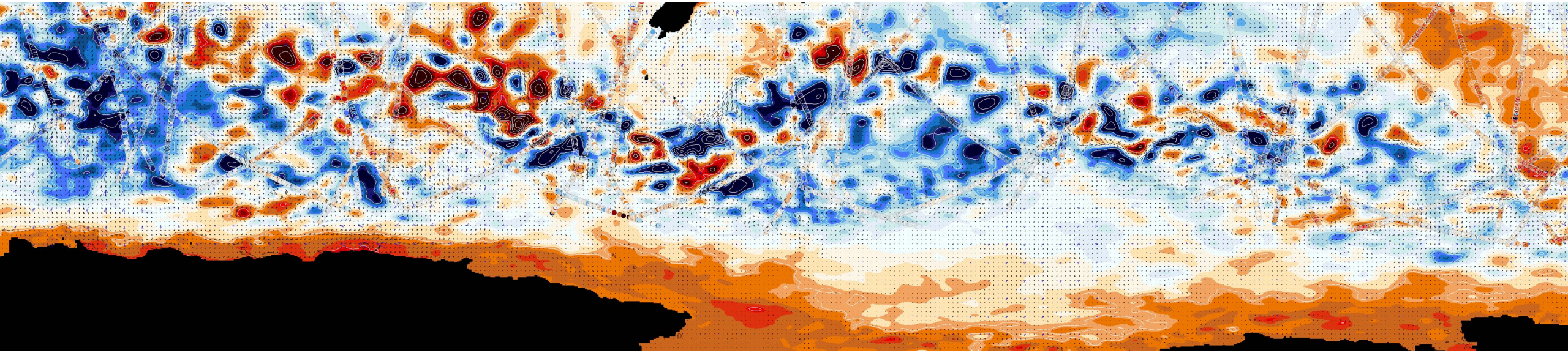
Data Assimilation with ACCESS-OM2-01

Paul Sandery, May 2020

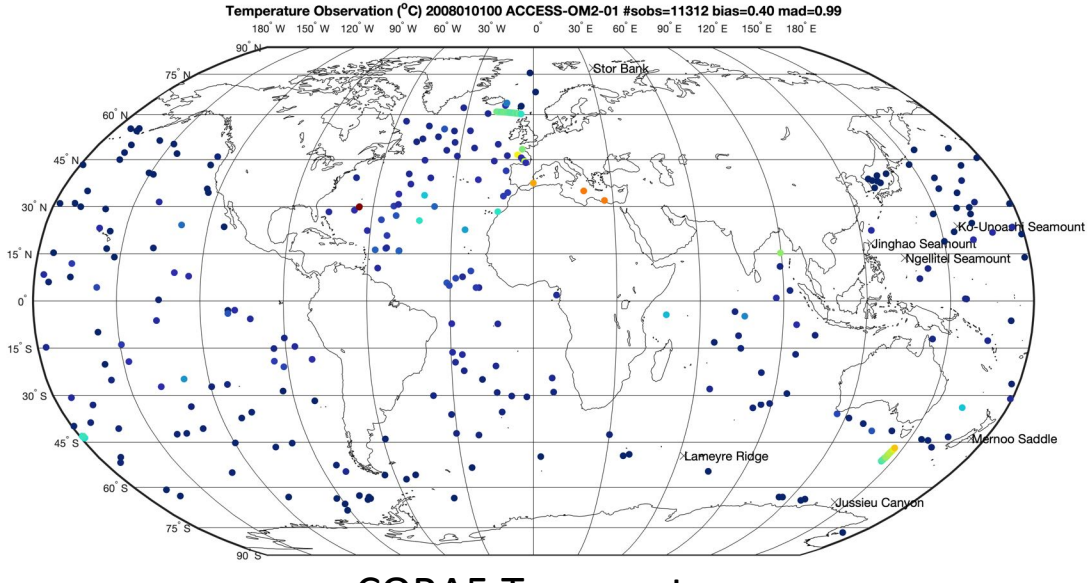
- Constrain OM2 using DA to study error growth and predictability in the coupled ocean-ice system and develop next generation of eddy resolving analyses and forecasts



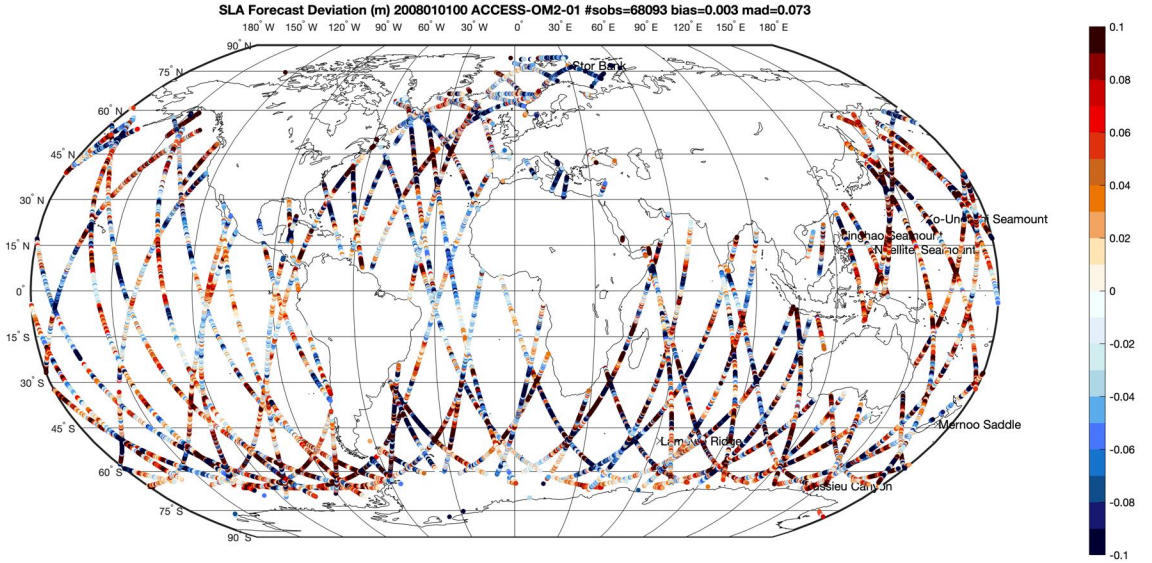
Degrees of freedom signal removed from ensemble by EnKF analysis



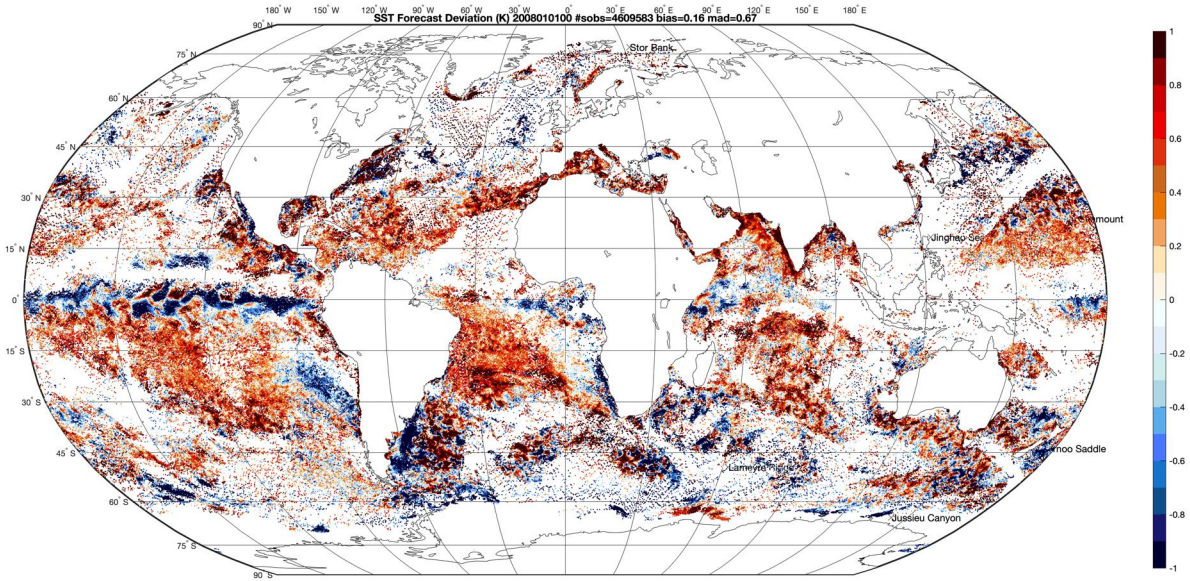
Comparison of IAF to obs 1997021 to 20171026



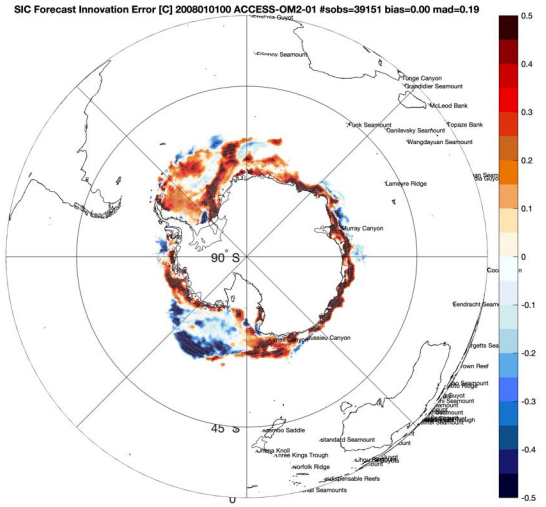
CORA5 Temperature



RADS4 SLA



CCI SST AVHRR AATSR L2

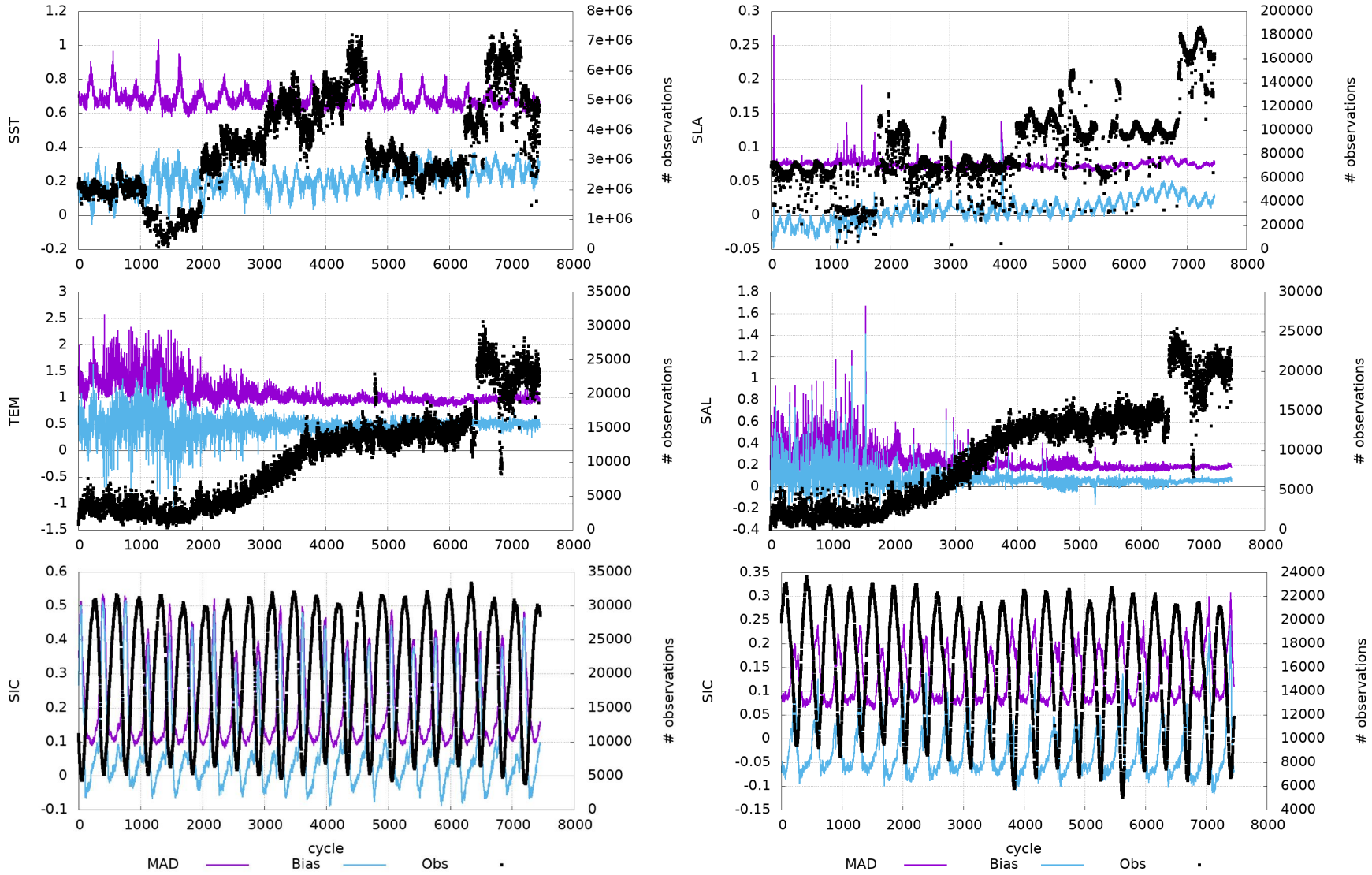


OSISAF SEA ICE CONCENTRATION

OBSERVATIONS

- VIIRS, NAVO, AMRS2, CCI SST
- OSISAF 10-25km sea-ice concentration
- RADS4 altimetry
- CORA5 in-situ T/S + Bureau MMT

Comparison of IAF to obs 1997021 to 20171026



SOFTWARE

Transfer knowledge and software from **DCFP** sea-ice DA

Transfer knowledge and software from **Bluelink** mesoscale ocean DA

318 commits | 37 branches | 0 releases | 13 contributors

Source	Description	Last Modified
ref		
scripts		
src		
launch.sh	latest modifications	Yesterday
README.md	latest modifications	1 hour ago
settings.sh	latest modifications	2 hours ago

README.md

CAFE Ensemble Data Assimilation System for CM21

- This branch is the development stream of the CAFE ensemble data assimilation system based on GFDL CM2.1 set up for gadi at NCI

Installation instructions

1. pull from master repo and checkout reanalysis branch

```
git pull https://CSIRO-ident@bitbucket.csiro.au/scm/df/cm-enkf.git

git checkout 2020_CAFE_CM21_ICE
```

2. put the following modules load commands in your .bashrc file on gadi

```
module load openmpi/4.0.1

module load hdf5/1.10.5

module load netcdf/4.6.3

module load nco/4.7.7
```

3. Copy the following to your path:

- /home/548/pas548/bin/date2dn
- /home/548/pas548/bin/dn2date
- source code for these is in /home/548/pas548/src/dn2date

4. Set the "EXPNAME" variable in "settings.sh' and make any other necessary settings changes.
5. Update "DESCRIPTION" variable in 'settings.sh' outlining the details surrounding the current experiment.
6. Run from the base directory using

./launch

Features

- EnKF-C domains method for coupled data assimilation
- Assimilation of ocean, sea-ice and atmospheric observational data
- Includes latest JRA-55 and OSISAF sea-ice, CCI SST, RADS4 altimetery up to near present
- Atmosphere strongly coupled to ocean and sea-ice observations
- Ocean strongly coupled to ocean and sea-ice observations
- BGC strongly coupled to ocean observations with parameter ensemble spread
- X-day asynchronous DA cycle
- Optional bias correction of SST and SLA
- Multi-parameter sea-ice ensemble
- For further information https://confluence.csiro.au/x/zwA4LQ

Observations

- DIR_AQUARIUS=/g/data/v14/pas548/obs/aquarius/SCI
- DIR_SMOS=/g/data/v14/pas548/obs/smos/smap
- DIR_RADS=/g/data/v14/pas548/obs/RADS4
- DIR_RADS_CSIRO=/g/data/v14/pas548/obs/RADS-IB-CSIRO
- DIR_NAVO=/g/data/v14/pas548/obs/sst
- DIR_WINDSAT=/g/data/v14/pas548/obs/sst
- DIR_PATHFINDER=/g/data/v14/pas548/obs/sst
- DIR_CCI_SST=/g/data/v14/pas548/obs/cci_sst/anon-ftp.ceda.ac.uk/neodc/esacci/sst/data/CDR_v2/A*/L2P/v2.1
- DIR_AMSRE=/g/data/v14/pas548/obs/sst
- DIR_AMSR2=/g/data/v14/pas548/obs/sst
- DIR_CARS=/g/data/v14/pas548/obs/TS-SEP-2011
- DIR_MMT=/g/data/v14/pas548/obs/profiles
- DIR_H8=/g/data/v14/pxs599/H8/L3Cdaily_try2
- DIR_VIIRS=/g/data/v14/pas548/obs/sst
- DIR_JRA55=/g/data/v14/pas548/obs/jra_hybrid_daily/DATA_THIN_3
- DIR_OSISAF=/g/data/v14/pas548/obs/seaice/DATA_ICE
- DIR_ICESST=/g/data/v14/pas548/obs/seaice/DATA_ICE
- DIR_CMEMS=/g/data/v14/pas548/obs/cora50
- DIR_OISST=/g/data/v14/pas548/obs/oisst/DATA
- DIR_PHY=/g/data/v14/rxm599/obs/globcolor
- DIR_HADISST=/g/data/v14/pas548/obs/hadisst/DATA
- DIR_SIH=/g/data/v14/pas548/obs/smos_ice_thickness_north/smos_sea_ice_thickness

sakov / enkf-c

Watch 6 | Star 21 | Fork 10

Code | Issues 0 | Pull requests 0 | Actions | Projects 0 | Security 0 | Insights

EnKF code for DA with large-scale layered geophysical models.

1,071 commits | 1 branch | 0 packages | 1 release | 3 contributors

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

sakov v1.114.0 — Latest commit 584329b 7 days ago

enkf	v1.114.0	7 days ago
README.md	Update README.md	5 months ago
sst-spread.png	cosmetics	3 years ago

README.md

EnKF-C

EnKF-C provides a compact generic framework for off-line data assimilation (DA) into large-scale layered geophysical models with the ensemble Kalman filter (EnKF). Following are its other main features:

- coded in C for GNU/Linux platform;

Decadal Forecasting / aom2-enkf

Watch

Development of the ACCESS-OM2-01 EnKF coupled ocean-ice DA system for BRAN and OceanMAPS

Source

master | aom2-enkf / | Browse | Filter

20 commits | 1 branch | 0 releases | 1 contributor

Source	Description	Last Modified
launch.sh	Initial Commit	17 Apr 2020
local.sh	latest modifications	21 Apr 2020
README.md	latest modifications	21 Apr 2020
run_enkf.sh.in	latest modifications	7 hours ago
settings.sh	latest modifications	Yesterday

README.md

Global ocean-sea-ice data assimilation system

- ACCESS-OM2-01 EnKF system for BRAN2021 and OceanMAPS4
- This branch is the development version created by Paul Sandery (paul.sandery@csiro.au)
- The run scripts were adapted from EnKF-OFAM3 by Pavel Sakov (pavel.sakov@csiro.au)
- The model is from COSIMA (cosima.org.au)

Installation instructions

1. pull from master repo and checkout reanalysis branch

```
git clone https://bitbucket.csiro.au/scm/df/aom2-enkf.git
```

2. put the following modules load commands in your .bashrc file on gadi

```
module load openmpi/4.0.1

module load hdf5/1.10.5

module load netcdf/4.7.1

module load nco/4.7.7
```

3. Copy the following to your path:

- /home/548/pas548/bin/date2dn
- /home/548/pas548/bin/dn2date
- source code for these is in /home/548/pas548/src/dn2date

4. Set the "EXPNAME" variable in "settings.sh' and make any other necessary settings changes.
5. Run from the base directory using

./launch

Features

- Global eddy resolving ocean and sea-ice coupled model based on MOM5 and CICE5
- Forced by JRA-do using YATM
- Ocean and sea-ice strongly coupled DA
- X-day asynchronous DA cycle
- Data assimilation state vector sea-level, temperature, salinity, currents, ice concentration, ice thickness, snow thickness, ice motion
- Observations used are CORA5 T/S, MMT T/S, OSISAF sea-ice, CCI-SST, Navo, AMRS2, AMSRE, VIIRS, RADS4 altimetry up to near present

Observations

- DIR_AQUARIUS=/g/data/v14/pas548/obs/aquarius/SCI
- DIR_SMOS=/g/data/v14/pas548/obs/smos/smap
- DIR_RADS=/g/data/v14/pas548/obs/RADS4
- DIR_RADS_CSIRO=/g/data/v14/pas548/obs/RADS-IB-CSIRO
- DIR_NAVO=/g/data/v14/pas548/obs/sst
- DIR_WINDSAT=/g/data/v14/pas548/obs/sst
- DIR_PATHFINDER=/g/data/v14/pas548/obs/sst
- DIR_CCI_SST=/g/data/v14/pas548/obs/cci_sst/anon-ftp.ceda.ac.uk/neodc/esacci/sst/data/CDR_v2/A*/L2P/v2.1
- DIR_AMSRE=/g/data/v14/pas548/obs/sst
- DIR_AMSR2=/g/data/v14/pas548/obs/sst
- DIR_CARS=/g/data/v14/pas548/obs/TS-SEP-2011
- DIR_MMT=/g/data/v14/pas548/obs/profiles
- DIR_H8=/g/data/v14/pxs599/H8/L3Cdaily_try2
- DIR_VIIRS=/g/data/v14/pas548/obs/sst
- DIR_JRA55=/g/data/v14/pas548/obs/jra_hybrid_daily/DATA_THIN_3
- DIR_OSISAF=/g/data/v14/pas548/obs/seaice/DATA_ICE
- DIR_ICESST=/g/data/v14/pas548/obs/seaice/DATA_ICE
- DIR_CMEMS=/g/data/v14/pas548/obs/cora50
- DIR_OISST=/g/data/v14/pas548/obs/oisst/DATA

Labels

Add unique labels to this repository

EnKF-C user guide

version 1.113.7

Pavel Sakov

June 19, 2014 – April 16, 2020

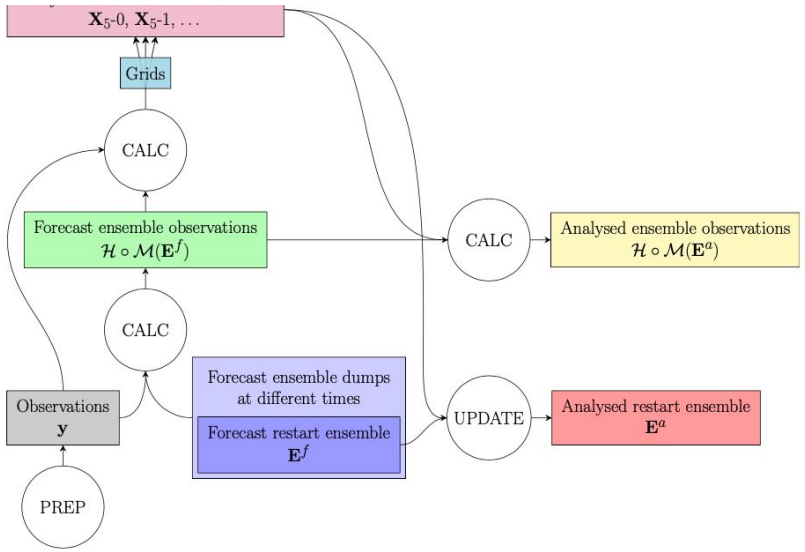


Figure 2.1: The principle diagram of EnKF-C workflow.

The following table lists the most memory-wise important objects.

Object	Typical size[1]	PREP	CALC	UPDATE
observation array	6 GB	•		
super-observation array[2]	1.5 GB	•	•	
ensemble observations[2] $\mathcal{H}(\mathbf{E})$	5 GB × 2		•	
single grid[2,3]	0.4 GB	•	•	
observation K-D trees[2]	0.85 GB		•	
one 3D model field	1 GB		•	
ensemble of one horizontal field	2 GB			•
transform array (I/O, EnKF only)	24 GB[4]			•

(1) for EnKF/OFAM3 system ($3600 \times 1500 \times 51$ grid, 96 members, $5 \cdot 10^7$ observations, $1.3 \cdot 10^7$ super-observations)
(2) stored in shared memory (one instance per compute node)
(3) when defined as a curvilinear grid
(4) with `STRIDE` = 3

The memory footprint of PREP is defined by the size of the `observation` structure array and, in some cases, by curvilinear grids. The memory usage by curvilinear grids is much reduced by parsing them into K-D trees (default from v1.101.4; the only option since v1.106.0) rather than into binary trees. Because PREP is not parallelised (mainly due to lack of robust parallel analog of `qsort` procedure), in practice its memory footprint is rarely a problem.

The footprint of CALC is mainly defined by the size of ensemble observations $\mathcal{H}(\mathbf{E})$. From version 1.74, it has been substantially reduced for multi-core CPUs by storing only one instance of ensemble observations per compute node. This involves using the shared memory and requires MPI-3.

For the EnKF, the footprint of UPDATE is mainly defined by the size of the array of simultaneously updated horizontal model fields. The number of simultaneously updated fields is defined by parameter `FIELDBUFFERSIZE`. Note that larger values of `FIELDBUFFERSIZE` increase computational effectiveness by reducing the number of reads of and interpolations within $\mathbf{X}_5$ arrays. For the [illegible], the footprint of UPDATE is insensitive to `FIELDBUFFERSIZE` (which should be set to 1), and [illegible]ined by the size of the ensemble of horizontal model fields.

prep
calc
update

sakov / enkf-c

Watch 6 | Star 21 | Fork 10

Code | Issues 0 | Pull requests 0 | Actions | Projects 0 | Security 0 | Insights

EnKF code for DA with large-scale layered geophysical models.

1,071 commits | 1 branch | 0 packages | 1 release | 3 contributors

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

sakov v1.114.0		Latest commit 584329b 7 days ago
enkf	v1.114.0	7 days ago
README.md	Update README.md	5 months ago
sst-spread.png	cosmetics	3 years ago

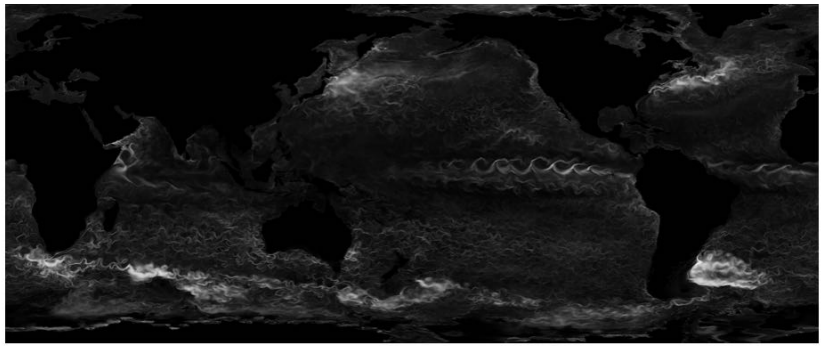
README.md

EnKF-C

EnKF-C provides a compact generic framework for off-line data assimilation (DA) into large-scale layered geophysical models with the ensemble Kalman filter (EnKF). Following are its other main features:

- coded in C for GNU/Linux platform;
- model-agnostic;
- can conduct DA either in EnKF or ensemble optimal interpolation (EnOI) mode;
- permits multiple model grids;
- can handle rectangular or curvilinear horizontal grids, z, sigma or hybrid vertical grids.

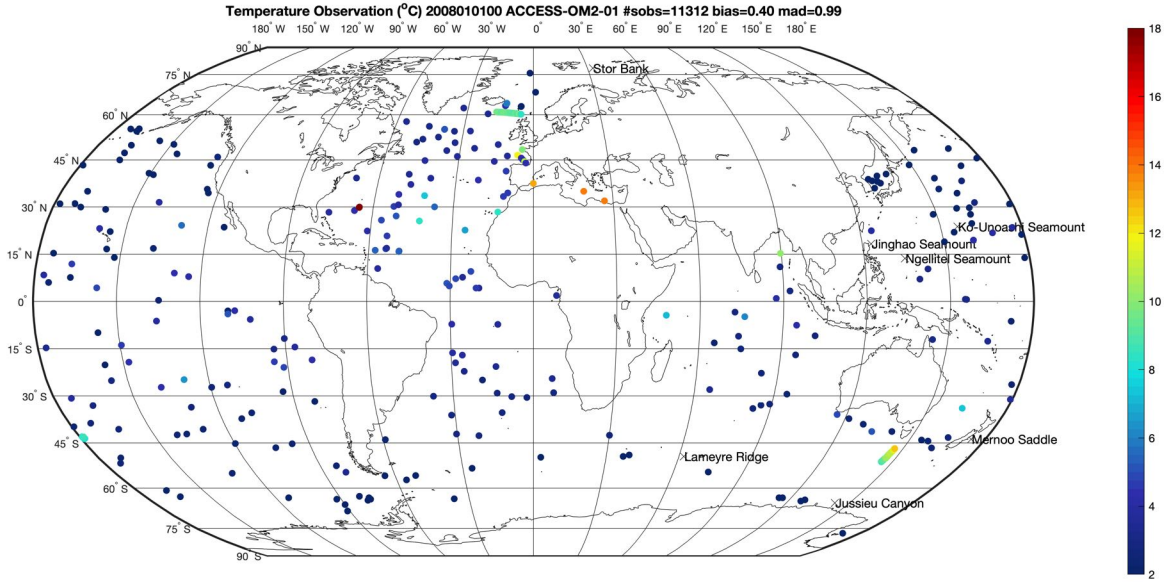
The code is designed to handle as large systems as possible, using shared memory capabilities of MPI-3. Here is a snapshot of ensemble spread of sea surface temperature from the 96-member EnKF ocean forecasting system with MOM5 based OFAM3 model (51 x 1500 x 3600 grid), assimilating about 14M super-observations at each 3-day cycle.



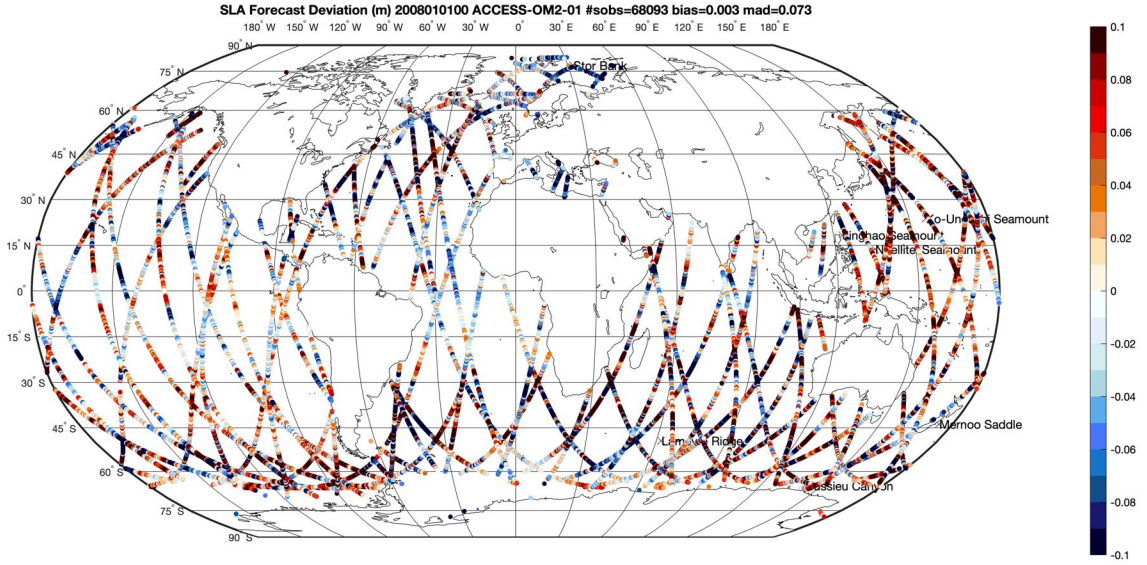
For more information see README and user guide. (An older version of the user guide is also available from arXiv.) Have a feel for how the code works by running the included example.

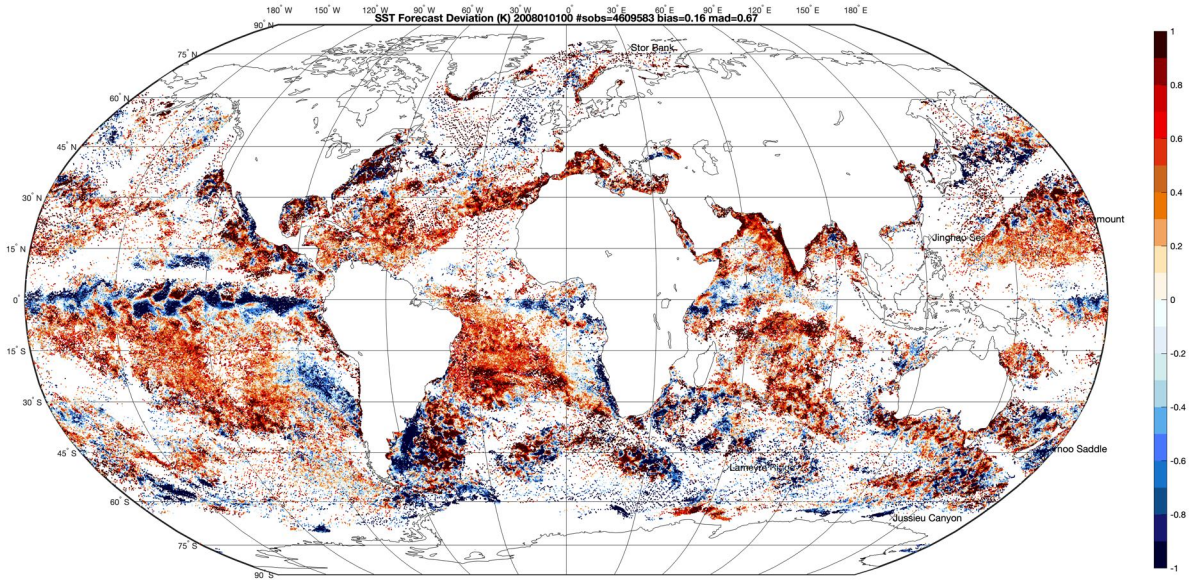
Checkout **EnKF-C** by running `git clone https://github.com/sakov/enkf-c` or `svn checkout https://github.com/sakov/enkf-c` .

CORA 5+MMT T/S



RADS4 SLA

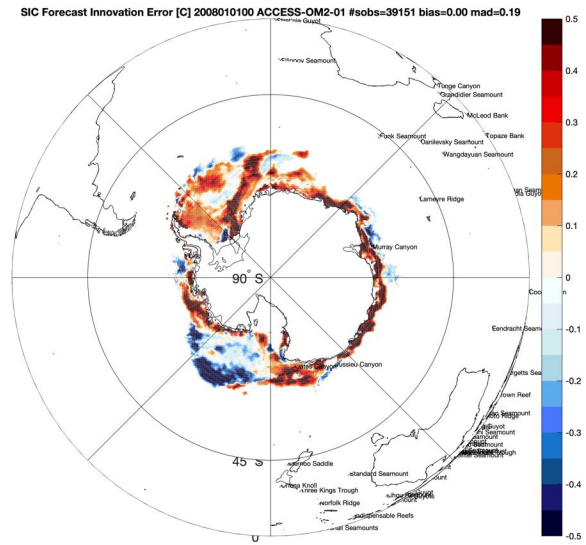




CCI SST AVHRR AATSR L2

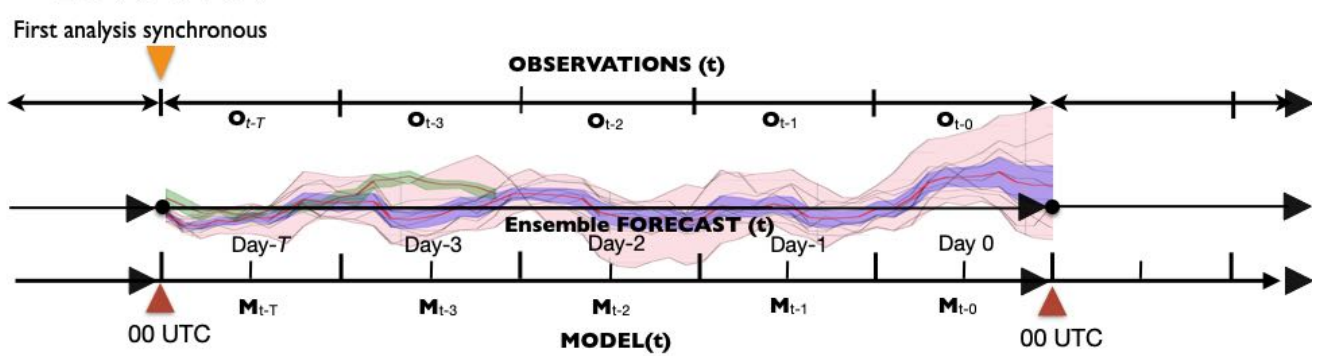
Observations

- VIIRS, NAVO, AMRS2, CCI SST
- OSISAF 10-25km sea-ice concentration
- RADS4 altimetry
- CORA5 in-situ T/S + Bureau MMT



STEPS

- Checkout ACCESS-OM2-O1 IAF from COSIMA github
- Compile, run then extract binaries, namelists, field_tables etc.
- Adapt Pavel Sakov's OFAM3 EnKF scripts designed to run large DA system (->BoM op)
- Preserve model run and directory structure* (not payu)
- Replicate into X member ensemble, run N sequential batches
- Initial ensemble taken from Andy RYF – 96 1st of Januaries*
- EnKF-C Sakov (2020, Bureau of Meteorology)
- Observations* same datasets as for BRAN, OceanMAPS, DCFP Climate Analysis and Forecasting
- Initialisation of ocean and sea-ice state
- Cycle scheme and DA settings
- Prep.out and calc.out
- observations.nc – errors distributed in observation space
- Mem + compute – double-> float, prep, calc, update, om2
- Ensemble mean analysis, spread



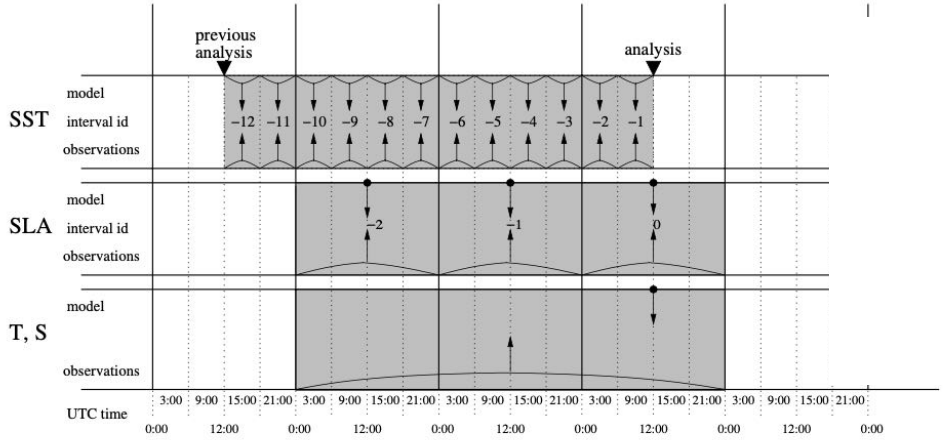


Figure 2.3: Example of observation timing in a MOM based ocean forecasting system.

EnKF-C user guide

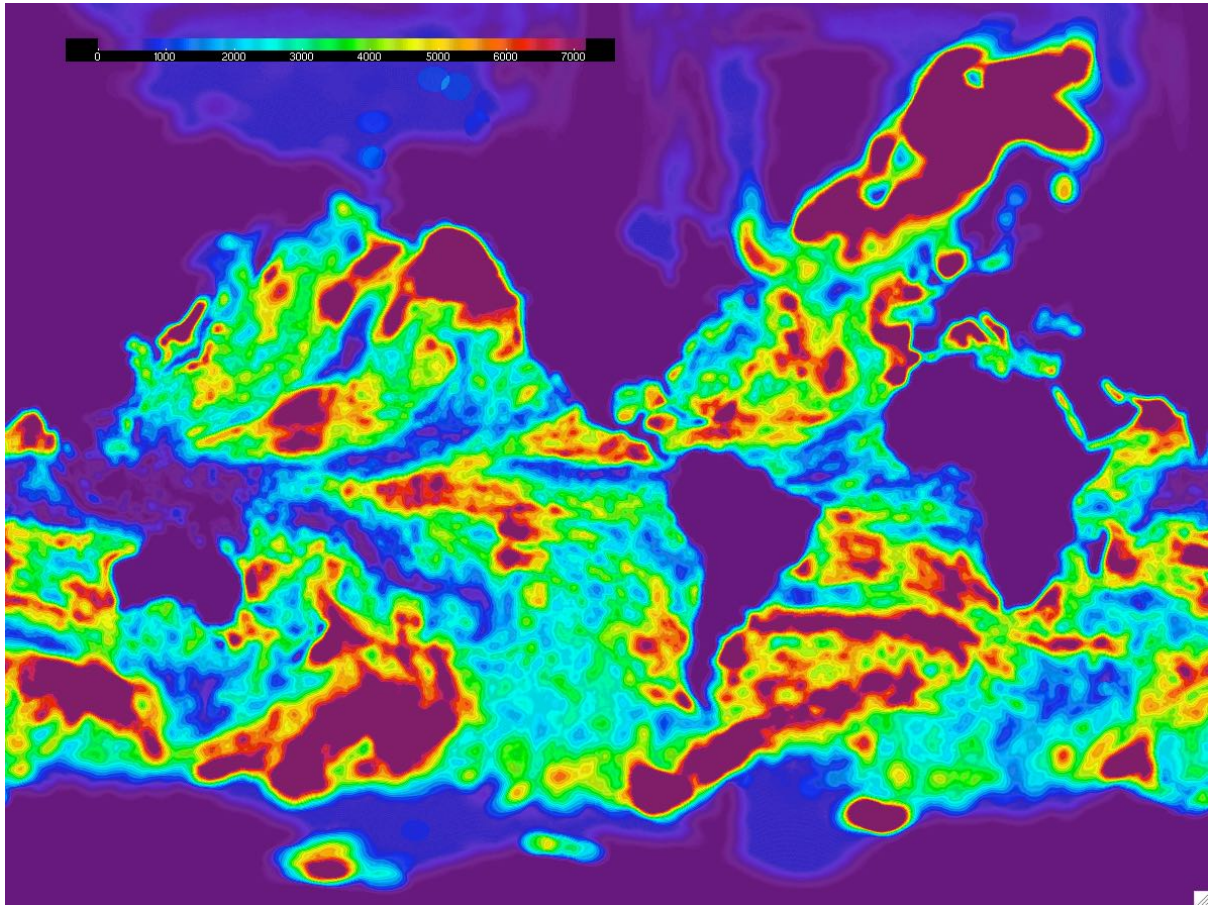
version 1.113.7

Pavel Sakov

June 19, 2014 – April 16, 2020

STEPS

- Checkout ACCESS-OM2-O1 IAF from COSIMA github
- Compile, run then extract binaries, namelists, field_tables etc.
- Adapt Pavel Sakov's OFAM3 EnKF scripts designed to run large DA system (->BoM op)
- Preserve model run and directory structure* (not payu)
- Replicate into X member ensemble, run N sequential batches
- Initial ensemble taken from Andy RYF – 96 1st of Januaries*
- EnKF-C Sakov (2020, Bureau of Meteorology)
- Observations* same datasets as for BRAN, OceanMAPS, DCFP Climate Analysis and Forecasting
- Initialisation of ocean and sea-ice state
- Cycle scheme and DA settings
- Prep.out and calc.out
- observations.nc – errors distributed in observation space
- Mem + compute – double-> float, prep, calc, update, om2
- Ensemble mean analysis, spread



Number of observations for each local analysis

STEPS

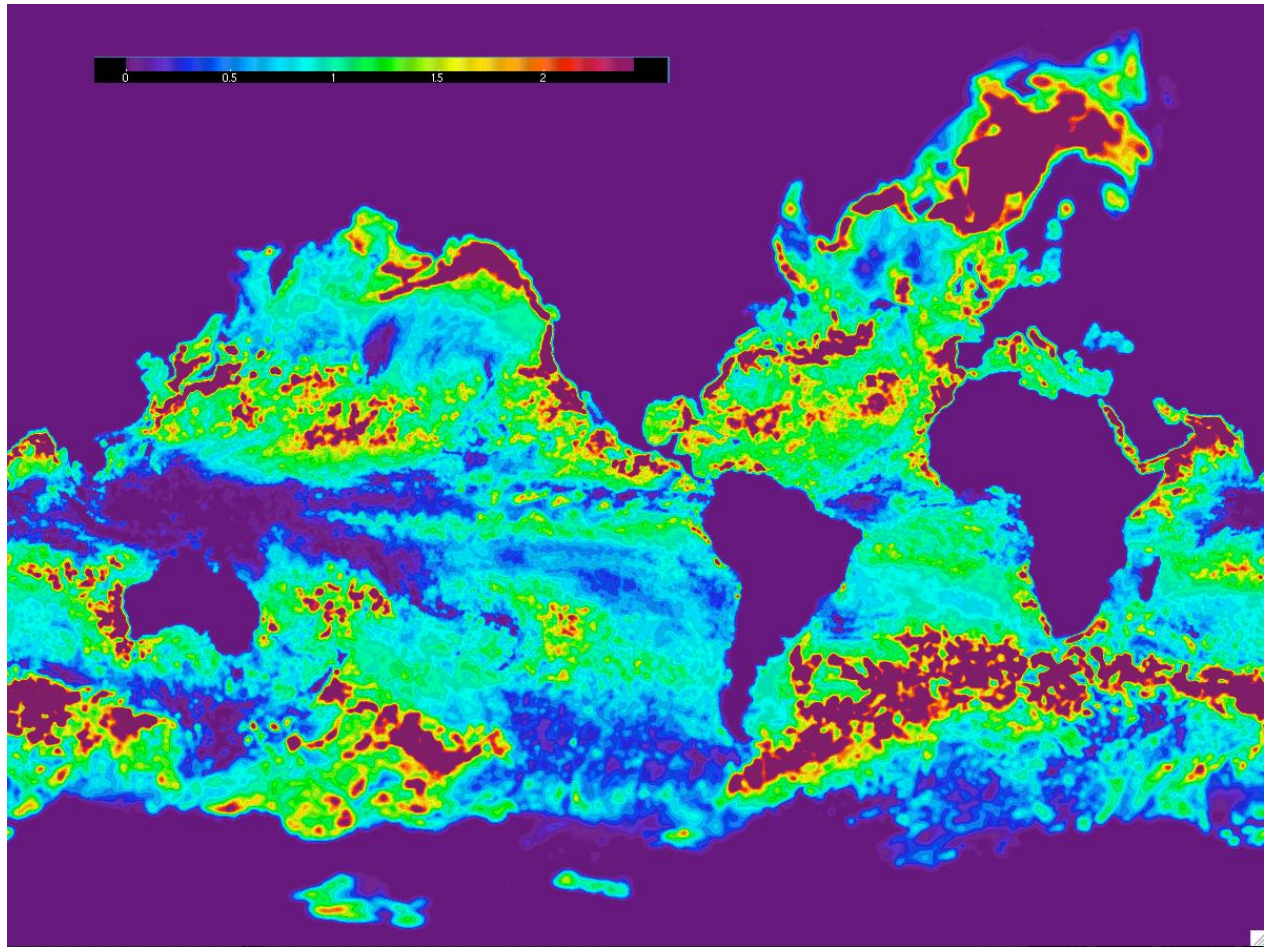
- Checkout ACCESS-OM2-O1 IAF from COSIMA github
- Compile, run then extract binaries, namelists, field_tables etc.
- Adapt Pavel Sakov's OFAM3 EnKF scripts designed to run large DA system (->BoM op)
- Preserve model run and directory structure * (not payu)
- Replicate into X member ensemble, run N sequential batches
- Initial ensemble taken from Andy RYF – 96 1st of Januaries*
- EnKF-C Sakov (2020, Bureau of Meteorology)
- Observations* same datasets as for BRAN, OceanMAPS, DCFP Climate Analysis and Forecasting
- Initialisation of ocean and sea-ice state
- Cycle scheme and DA settings
- Prep.out and calc.out
- observations.nc – errors distributed in observation space
- Mem + compute – double-> float, prep, calc, update, om2
- Ensemble mean analysis, spread

```
 running PREP for EnKF-C version 1.114.0:
 command = "./enkf_prep --consider-subgrid-variability --no-superobing-across-instruments --no-writing-orig-obs enkf.prm"
 dir = "/scratch/v14/pas548/aom2-runs/enkf-01/enkf"
2020-05-06 00:54:17
reading prep specs from "enkf.prm":
  MODE = EnKF
  SCHEME = DEnKF
    ALPHA = 0.7
  MODEL PRM = "model.prm"
  GRID PRM = "grid.prm"
  OBS TYPES PRM = "obstypes.prm"
  OBS PRM = "obs.prm"
  DATE = "9862.5 days since 1990-01-01"
  WINDOWMIN = -2.500
  WINDOWMAX = 0.500
  ENSEMBLE DIR = "/scratch/v14/pas548/aom2-runs/enkf-01/enkf/ensemble"
  ENSEMBLE SIZE = 96
  RFACTOR BASE = 32.0
  INFLATION BASE = 1.0300
  INFLATION MODE = SPREAD LIMITED, MAX RATIO = 1.00
  KFACTOR = 2.0
    LOCRAD  = 150
    LOCWEIGHT =  1
  STRIDE = 3
  FIELDBUFFERSIZE = 1
  REGION Global: x = [0.0, 360.0], y = [-90.0, 90.0]
  REGION Australia: x = [90.0, 180.0], y = [-50.0, 5.0]
  REGION Tasman: x = [146.0, 166.0], y = [-45.0, -23.0]
  REGION Coral: x = [135.0, 165.0], y = [-25.0, 5.0]
  REGION WA: x = [104.0, 142.0], y = [-41.0, -30.0]
  REGION SA: x = [128.0, 142.0], y = [-41.0, -30.0]
  REGION EAC: x = [149.5, 155.5], y = [-37.4, -31.7]
  REGION EQ: x = [0.0, 360.0], y = [-10.0, 10.0]
  REGION SHEM: x = [0.0, 360.0], y = [-90.0, 0.0]
  REGION NHEM: x = [0.0, 360.0], y = [0.0, 90.0]
  REGION NINO34: x = [-170.0, -120.0], y = [-5.0, 5.0]
  NCFORMAT = NETCDF4
  NCCOMPRESSION = 0
  EnKF flags:
    enkf_exitaction  = [BACKTRACE]
    enkf_obstype     = [VALUE]
  enkf_prep compile flags:
    INTERNAL_QSORT_R = [-]
reading observation specs from "obs.prm":
superobing:
   thinned 367915 observations
   18549812 superobservations
 writing superobservations to "observations.nc":
 reading super-observations from disk:
   18549812 observations
   allocating 2225977440 bytes for array of observations
 checking for superobs on land:
   compacting obs:
   deleted 66 observation(s)
 re-writing good superobservations to "observations.nc":
 # obs with increased error due to subgrid variability:
   SLA 21176 (3.96%)
   SST 2657709 (15.61%)
   TEM 1953 (2.20%)
   SAL 1082 (1.67%)
   TEM2 10 (0.12%)
   SAL2 25 (1.26%)
 printing observation summary:
   type    #used    #dropped #out_grd #out_obs #out_wnd #land    #shallow #badbatch#badvalue#thinned #superobs
   ------------------------------------------------------------------------------------------------------------
   SLA     692012   33243    0        0        0        50      33011    0        182      0        534142
   SST     60254225 13255542 0        0        13080832 172985  0        0        1725     9915     17024110
   TEM     1265173  1434     0        0        0        1434    0        0        0        208974   88665
   SAL     1018223  8508     0        0        0        1185    0        0        7323     143202   64693
   TEM2    94601    2623     0        0        0        2623    0        0        0        3377     8236
   SAL2    5001     3149     0        0        0        2567    0        0        582      2447     1984
   SIC     741888   5502     0        0        0        5502    0        0        0        0        741888
   SIT     86028    661362   0        0        0        5502    0        0        655860   0        86028
   total   64157151 13971363 0        0        13080832 191848  33011    0        665672   367915   18549746
2020-05-06 01:00:29
finished
```

prep.out

STEPS

- Checkout ACCESS-OM2-O1 IAF from COSIMA github
- Compile, run then extract binaries, namelists, field_tables etc.
- Adapt Pavel Sakov's OFAM3 EnKF scripts designed to run large DA system (->BoM op)
- Preserve model run and directory structure * (not payu)
- Replicate into X member ensemble, run N sequential batches.
- Initial ensemble taken from Andy RYF – 96 1st of Januaries*
- EnKF-C Sakov (2020, Bureau of Meteorology)
- Observations* same datasets as for BRAN, OceanMAPS, DCFP Climate Analysis and Forecasting
- Initialisation of ocean and sea-ice state
- Cycle scheme and DA settings
- Prep.out and calc.out
- observations.nc – errors distributed in observation space
- Mem + compute – double-> float, prep, calc, update, om2
- Ensemble mean analysis, spread



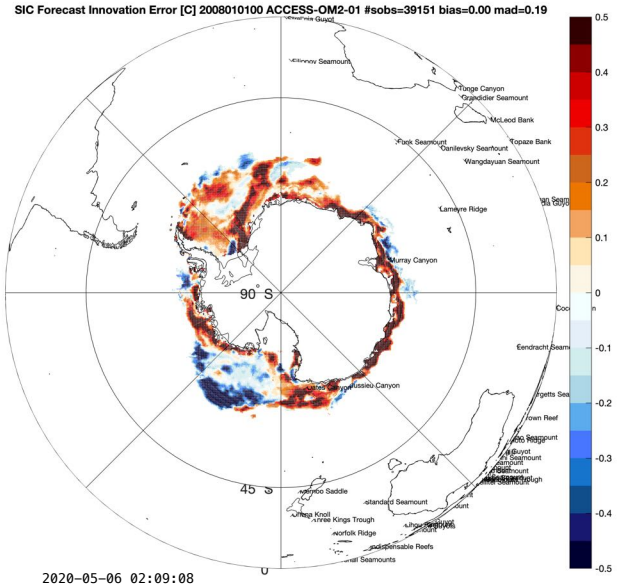
Degrees of freedom signal removed from ensemble by EnKF analysis

STEPS

- Checkout ACCESS-OM2-O1 IAF from COSIMA github
- Compile, run then extract binaries, namelists, field_tables etc.
- Adapt Pavel Sakov's OFAM3 EnKF scripts designed to run large DA system (->BoM op)
- Preserve model run and directory structure * (not payu)
- Replicate into X member ensemble, run N sequential batches.
- Initial ensemble taken from Andy RYF – 96 1st of Januaries.
- EnKF-C Sakov (2020, Bureau of Meteorology)
- Observations* same datasets as for BRAN, OceanMAPS, DCFP Climate Analysis and Forecasting
- Initialisation of ocean and sea-ice state
- Cycle scheme and DA settings
- Prep.out and calc.out
- observations.nc – errors distributed in observation space
- Mem + compute – double-> float, prep, calc, update, om2
- Ensemble mean analysis, spread

calc.out

```
calculating analysed observations:
 2020-05-06 01:31:35
   sorting obs by ij:
   2020-05-06 01:32:41
   updating HE:
   distributing 18549746 iterations:
     48 processes get 386454 or 386453 iterations
     144 processes get 0 iterations
   2020-05-06 01:38:21
 adding analysis innovations and spread to "observations.nc":
 printing observation statistics:
   region obs.type   # obs.  |for.inn.| |an.inn.|   for.inn.   an.inn.  for.spread  an.spread
   ------------------------------------------------------------------------------------------
   Global
         SLA        534142    0.090      0.071      0.056      0.043      0.049      0.042
          -2        178604    0.091      0.072      0.057      0.044      0.049      0.042
          -1        178222    0.090      0.072      0.056      0.043      0.049      0.042
           0        177316    0.088      0.070      0.055      0.042      0.049      0.042
          3a        103820    0.089      0.070      0.054      0.041      0.049      0.042
          c2        101463    0.088      0.071      0.052      0.041      0.050      0.043
          j2        109104    0.092      0.072      0.060      0.046      0.049      0.042
          j3        115898    0.091      0.071      0.059      0.044      0.049      0.042
          sa        103857    0.088      0.072      0.054      0.043      0.049      0.042
         SST      17024110    1.179      0.459      0.385      0.107      1.669      1.185
         -12        788000    1.168      0.405      0.146      0.079      1.745      1.238
         -11        631759    1.173      0.423      0.538      0.186      1.503      1.081
         -10       1848380    1.176      0.434      0.363      0.067      1.790      1.261
          -9       1723552    1.122      0.448      0.503      0.143      1.587      1.134
          -8       1940581    1.228      0.477      0.185      0.024      1.761      1.246
          -7       1510784    1.111      0.452      0.479      0.114      1.563      1.114
          -6       1853946    1.193      0.463      0.385      0.107      1.763      1.244
          -5       1795841    1.168      0.483      0.454      0.136      1.556      1.112
          -4       1826729    1.212      0.489      0.270      0.076      1.755      1.242
          -3       1502700    1.199      0.465      0.481      0.151      1.593      1.136
          -2        877251    1.232      0.447      0.372      0.128      1.764      1.247
          -1        724587    1.142      0.449      0.554      0.189      1.469      1.050
       AMSR-2       3526924    1.170      0.523      0.289      0.023      1.649      1.192
      NOAA-19       1963237    1.182      0.496      0.365      0.131      1.680      1.177
      MetOpA        2280176    1.201      0.475      0.461      0.083      1.695      1.191
       VIIRS        9253773    1.176      0.422      0.407      0.140      1.669      1.183
         TEM          88665    1.100      0.801      0.474      0.361      0.913      0.710
       WMO854          4122    1.306      1.036      0.909      0.698      0.922      0.724
       WMO853          7622    1.005      0.770      0.623      0.390      0.669      0.536
       WMO846         30145    1.038      0.841      0.490      0.391      0.708      0.575
       WMO995          1827    0.977      0.594     -0.492     -0.275      1.262      0.943
      WMO1017           764    0.478      0.413     -0.089     -0.018      0.294      0.244
      WMO1111         13336    1.179      0.521      0.207      0.083      1.702      1.224
      WMO1051             1    0.934      0.871     -0.934     -0.871      2.992      2.023
      WMO1049           107    1.781      0.757     -1.505     -0.673      1.178      0.904
        0-50m         35026    1.197      0.596      0.354      0.166      1.587      1.159
       50-500m        34020    1.276      1.129      0.631      0.538      0.662      0.581
      500-9999m       19619    0.622      0.599      0.419      0.400      0.148      0.134
         SAL          64693    0.190      0.172      0.042      0.036      0.095      0.083
       WMO854          4039    0.290      0.255      0.154      0.129      0.136      0.117
       WMO853          7528    0.165      0.147      0.027      0.022      0.079      0.069
       WMO846         29255    0.175      0.160      0.036      0.032      0.088      0.078
       WMO995          1573    0.286      0.285     -0.065     -0.081      0.159      0.128
       WMO851          2758    0.165      0.146      0.107      0.092      0.070      0.063
        0-50m         17619    0.306      0.273      0.063      0.052      0.191      0.163
       50-500m        28419    0.187      0.169      0.060      0.053      0.087      0.078
      500-9999m       18655    0.084      0.081     -0.005     -0.005      0.016      0.015
        TEM2           8236    1.180      0.840      0.413      0.336      1.103      0.856
       WMO995          2008    1.063      0.574     -0.599     -0.267      1.420      1.052
       WMO820             5    2.624      1.805     -2.624     -1.805      4.529      3.240
       WMO051          1878    0.954      0.729      0.638      0.490      0.927      0.742
       WMO830           191    1.838      1.465     -1.020     -0.718      1.984      1.419
        0-50m          3174    1.330      0.595      0.151      0.036      1.929      1.395
       50-500m         4313    1.132      1.030      0.568      0.507      0.652      0.576
      500-9999m         749    0.820      0.789      0.625      0.619      0.198      0.189
         SAL2           1984    0.357      0.363     -0.119     -0.143      0.210      0.170
       WMO995          1700    0.343      0.350     -0.140     -0.168      0.211      0.169
       WMO830           174    0.616      0.611      0.086      0.088      0.279      0.240
       WMO741           110    0.165      0.159     -0.120     -0.120      0.091      0.083
        0-50m           919    0.595      0.611     -0.304     -0.358      0.380      0.300
       50-500m          982    0.156      0.153      0.050      0.052      0.067      0.062
      500-9999m          83    0.099      0.097     -0.072     -0.069      0.020      0.019
         SIC         741888    0.109      0.109     -0.040     -0.040      0.000      0.000
          -2         247296    0.108      0.108     -0.039     -0.039      0.000      0.000
          -1         247296    0.108      0.108     -0.040     -0.040      0.000      0.000
           0         247296    0.109      0.109     -0.041     -0.041      0.000      0.000
       OSISAF        741888    0.109      0.109     -0.040     -0.040      0.000      0.000
         SIT          86028    0.962      0.248     -0.962     -0.247      1.032      0.745
          -2          28893    0.954      0.246     -0.954     -0.246      1.024      0.740
          -1          28625    0.954      0.242     -0.954     -0.241      1.027      0.742
           0          28510    0.978      0.255     -0.978     -0.255      1.044      0.754
        SSTG          86028    0.962      0.248     -0.962     -0.247      1.032      0.745
```




```
 2020-05-06 02:09:08
 assembling analysis:
   distributing 96 iterations:
     96 processes get 1 iteration, 64 processes get 0 iterations
   eta_t:.
   temp:.
   salt:.
   u:.
   v:.
   aicen:.
   vicen:.
 2020-05-06 02:14:18
 assembling spread:
   eta_t:.
   temp:..........................................................................
   salt:..........................................................................
   u:..........................................................................
   v:..........................................................................
   aicen:.....
   vicen:.....
 2020-05-06 02:16:24
 finished
+ touch /scratch/v14/pas548/aom2-runs/enkf-01/ENKFUPDATE_9862.done


================================================================================
                Resource Usage on 2020-05-06 02:16:44:
   Job Id:             5090169.gadi-pbs
   Project:            p93
   Exit Status:        0
   Service Units:      479.04
   NCPUs Requested:    192                    NCPUs Used: 192
                                           CPU Time Used: 188:21:52
   Memory Requested:   764.0GB                Memory Used: 695.82GB
   Walltime requested: 02:00:00            Walltime Used: 01:14:51
   JobFS requested:    400.0MB                JobFS used: 8.16MB
================================================================================
```

NEXT

- Getting towards completion running ensemble of model states sequentially
- Propagate ensemble and run about 10 cycles to converge system to observations
- Number cores for ensemble 497664
- Should get about 3 x 96 days in about 12 hours on Gadi?
- Onwards with experiments tuning DA so we can start reanalysis and assess ability to run as forecast system

```
[pas548@gadi-login-02 20170101]$ l
total 32G
-rw-r-----   1 pas548 v14  70K May  6 01:00 prep.out
-rw-r-----   1 pas548 v14 112M May  6 01:18 enkf_diag-0.nc
-rw-r-----   1 pas548 v14 112M May  6 01:28 enkf_diag-1.nc
-rw-r-----   1 pas548 v14 112M May  6 01:31 enkf_diag-2.nc
-rw-r-----   1 pas548 v14 1.5G May  6 01:39 observations.nc
-rw-r-----   1 pas548 v14 251K May  6 01:39 calc.out
-rw-r-----   1 pas548 v14  23K May  6 02:16 update.out
-rw-------   1 pas548 p93 275K May  6 02:16 cu-0.o5090169
-rw-r-----   1 pas548 v14    5 May  6 09:10 DAY.txt
-rw-r-----   1 pas548 v14    2 May  6 09:10 CYCLE_ID.txt
-rw-r-----   1 pas548 v14  75M May  6 09:28 bg_eta_t.nc.analysis
-rw-r-----   1 pas548 v14 371M May  6 09:30 bg_vicen.nc.analysis
-rw-r-----   1 pas548 v14 371M May  6 09:30 bg_aicen.nc.analysis
-rw-r-----   1 pas548 v14  41M May  6 09:30 bg_aicen.nc
-rw-r-----   1 pas548 v14  41M May  6 09:30 bg_vicen.nc
-rw-r-----   1 pas548 v14 2.8G May  6 09:51 bg_v.nc.analysis
-rw-r-----   1 pas548 v14 2.8G May  6 09:51 bg_salt.nc.analysis
-rw-r-----   1 pas548 v14 2.8G May  6 09:51 bg_temp.nc.analysis
-rw-r-----   1 pas548 v14 2.9G May  6 09:52 bg_salt.nc
-rw-r-----   1 pas548 v14 2.9G May  6 09:52 bg_temp.nc
-rw-r-----   1 pas548 v14 2.8G May  6 09:52 bg_u.nc.analysis
-rw-r-----   1 pas548 v14 1.4K May  6 09:52 obstypes.prm
-rw-r-----   1 pas548 v14 4.2K May  6 09:52 obs.prm
-rw-r-----   1 pas548 v14  202 May  6 09:52 model.prm
-rw-r-----   1 pas548 v14  877 May  6 09:52 grid.prm
-rw-r-----   1 pas548 v14  604 May  6 09:52 enoi-persist.prm
-rw-r-----   1 pas548 v14 1.1K May  6 09:52 enkf.prm
-rw-r-----   1 pas548 v14  12G May  6 09:53 spread.nc
drwxr-s--- 103 pas548 v14  16K May  6 10:43 ..
drwxr-s---   2 pas548 v14  16K May  7 07:55 .
```