Observations

Type	Number	After SO	Asynchronous
Track SLA	$9 \cdot 10^4$	$4 \cdot 10^4$	Yes
SST (Reynolds)	$6 \cdot 10^3$	"	No
SST (OSTIA)	$2 \cdot 10^6$	$2.2 \cdot 10^5$	No
In-situ T	$2 \cdot 10^4 + 1.5 \cdot 10^4$	$6 \cdot 10^3$	No
In-situ S	$2 \cdot 10^4 + 1.5 \cdot 10^4$	$6 \cdot 10^3$	No
Ice conc. (AMSR)	$1.6 \cdot 10^5$	10^5	No
Ice drift (CERSAT)	$6 \cdot 10^3$	"	Yes
Total	$2.3 \cdot 10^6$	$4 \cdot 10^5$	

EnKF code

EnKF code at NERSC (FORTRAN 90):

- Available through https://svn.nersc.no/enkf/
- Code is fully parallel MPI for: X5 calculation & model update
- Analyses scheme EnKF, DEnKF (Square-root scheme)
- Local framework with localization radius (tapering inov with Gaspari and Cohn)
- Obs cov matrix considered diagonal
- All obs assimilate sequentially during the same call
- For each model point, solve analysis in min(ensemble-size,obs-space)
- Use ensemble inflation
- Moderation (if ensemble spread and observation error does not intercept, inflate obs error)
- Inflate obs error when updating covariance
- Parameter estimation
- Output of diagnostic (netcdf):
    - Inov, forecast, obs and super-obs (value and accuracy)
    - Degree of Freedom of Sigmal, and Spread reduction factor
    - Point output (X5, S=HA', inov obs …)

Input file
Example

Enkf.prm (input file)

```
&method
  methodtag = "DEnKF"
/
&ensemble
  enssize = 100
/
&localisation
  locfuntag = "Gaspari-Cohn"
  locrad = 300.0     Effective radius 90 km
/
&moderation
  infl = 1.01          Ensemble inflation
  rfactor1 = 1         To allow a slow start (for reanalysis)
  rfactor2 = 2.0       Overestimate obs error for updating covariance
  kfactor = 2.0        Moderation
/
&files
  jmapfname = "jmap.txt"    Optimisation of MPI distribution among proc
  pointfname = "point2nc.txt" Possibility of full output for given point
  meansshfname = "meanssh.uf" Assimilate anomaly of SSH
/
&prmest
  prmestname = "msshb", "sstb"  parameter estimation
  prminfl = 1.03, 1.07   Inflation for the respective parameter
/
```

EnKF code

Code assumes :

- Input output in binary/ASCII format
- Assume model grid :
  - Conformal mapping (bipolar)
  - hybrid coordinate for profile assimilation

A parallel version of the code is used for NorESM (Norwegian Earth system model with micom) which works with:

- Netcdf I/O (no assembling)
- Any type of grid (bipolar, tripolar and regular)

Code run in 3 steps:

-1 proc : Prepare observation (pivot point, superobing, profile passed in hybrid coordinate) 2 min

-24 proc: Assimilate observation (Initialization 7 min, Analysis 19 min, 22 min update)

-8 proc : Post Processing (assemble output, cut-off unrealistic values); 18 min

Mod State

Variables to be updated are given in a input file (analysisfields.in)
No model state → more freedom

u	1	28	
v	1	28	
temp	1	28	
saln	1	28	
dp	1	28	(aka. layer thick.)
ubavg	0	0	(barotropic velocity)
vbavg	0	0	
pbavg	0	0	(Barotropic pressure)
dpmixl	0	0	(mixed layer depth)
icec	0	0	
hice	0	0	
sstb	0	0	(sst bias)
msshb	0	0	(ssh bias)

3-dimensional

2-dimensional

Mod measurement

```
type measurement
    real d                  ! Measurement value
    real var                ! Error variance of measurement
    character(len=OBSTYPESTRLEN) id ! Type, can be one of those:
                            ! 'SST' 'SLA' 'ICEC' 'SAL' 'TEM'
                            ! 'GSAL' 'GTEM' 'TSLA'
    real lon                ! Longitude position
    real lat                ! Latitude position
    real depth              ! depths of position
    integer ipiv            ! i-pivot point in grid
    integer jpiv            ! j-pivot point in grid
    integer ns              ! representativity in mod cells (meas. support)
                            ! ns=0 means: point measurements
    real a1                 ! bilinear coefficient (for ni=0)
    real a2                 ! bilinear coefficient
    real a3                 ! bilinear coefficient
    real a4                 ! bilinear coefficient
    logical status          ! active or not
    integer i_orig_grid     ! KAL - orig grid index for ice drift
                            ! processing
    integer j_orig_grid     ! orig grid index
    real h                  ! PS - layer thickness, sorry for that
    integer date            ! FanF - age of the data
    integer orig_id         ! PS - used in superobing
  end type measurement
```