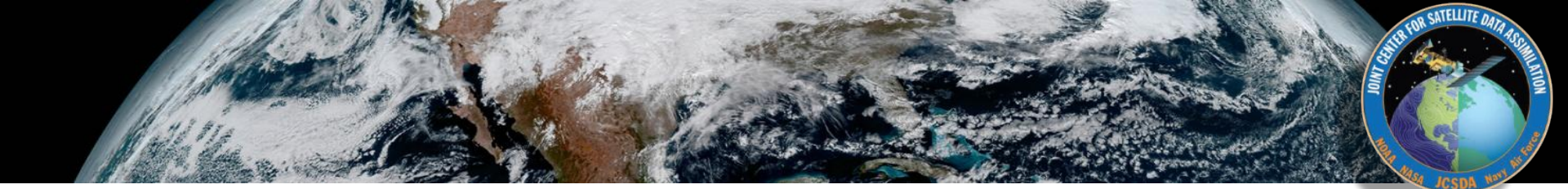
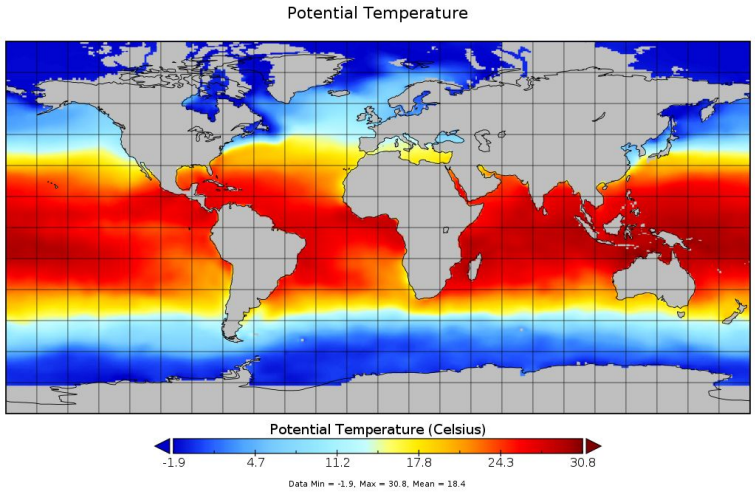


Marine Applications (SOCA)

JEDI Academi November 15, 2018

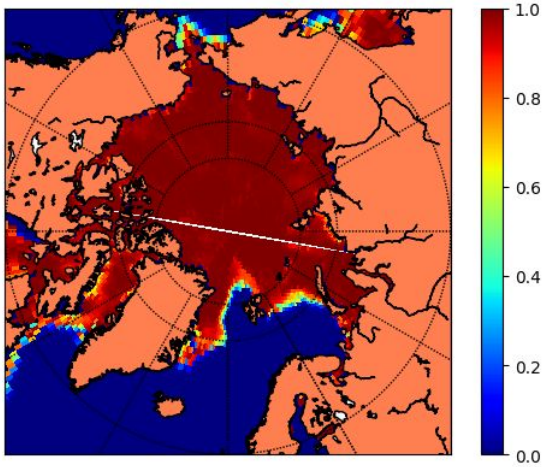
Marine Models

Global MOM6 (360x210x63)

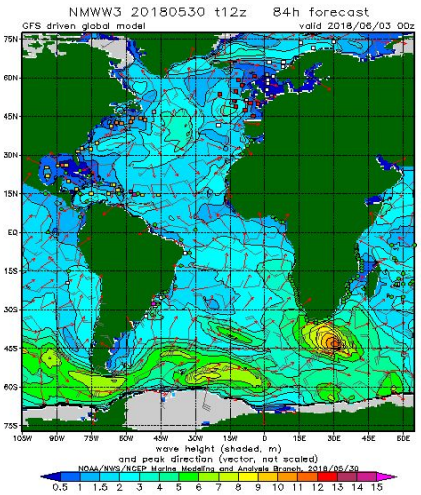


~~SIS2~~ (360x210x7 layers x5 categories)

CICE5

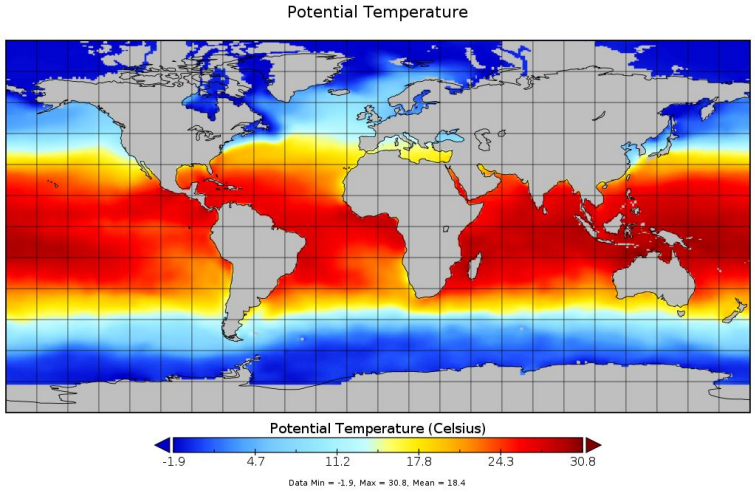


Wave watch III



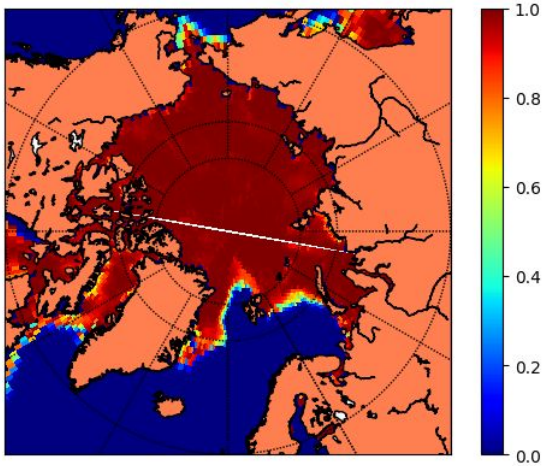
Coupled Ocean Sea-ice interface to JEDI

Global MOM6 (360x210x63)



~~SIS2~~ (360x210x7 layers x5 categories)

CICE5



Target system for the Coupled Ocean and sea-ice:

A flavor of 3DVAR with ocean and ice strongly coupled through B.

SOCA (Sea-ice Ocean Coupled Assimilation)

Geometry:
Assumes ocean and ice tracers are co-located

State, Increment:
Include ocean and sea-ice variables

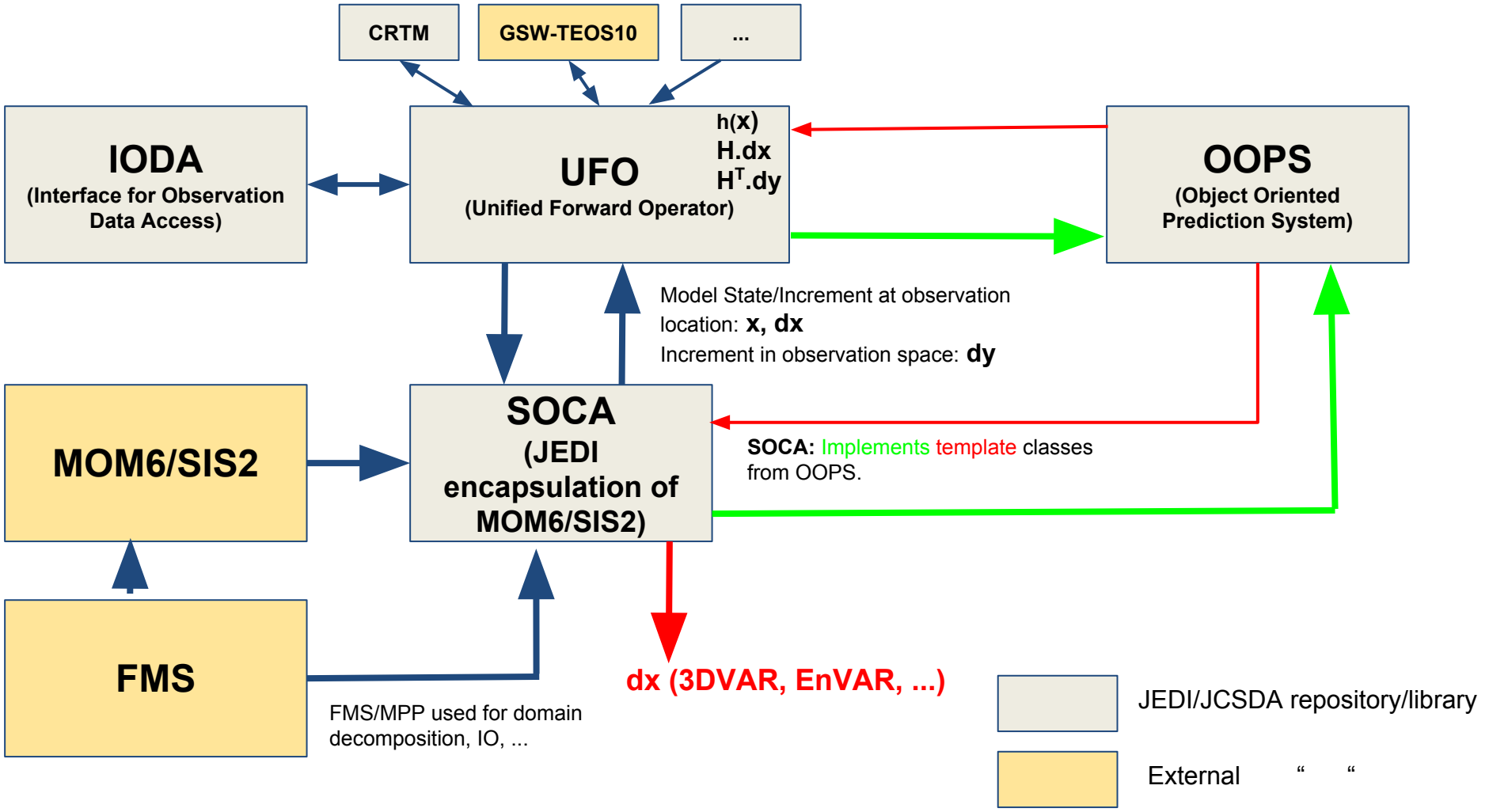
Variable Change:
Basic Ocean and sea-ice balance operators

ErrorCovariance:
BUMP based

Model:
Overrated!

JEDI encapsulation of MOM6 and a generic sea-ice model

JEDI encapsulation of MOM6-SIS2 (switching to CICE5): Repositories/libraries



Building blocks of SOCA

Anatomy of soca by looking at the unit testing:

Test #1: test_soca_forecast
Test #2: test_soca_socaerror_init
Test #3: test_soca_enspert
Test #4: test_soca_geometry
Test #5: test_soca_linearmodel
Test #6: test_soca_state
Test #7: test_soca_modelaux
Test #8: test_soca_model
Test #9: test_soca_increment
Test #10: test_soca_errorcovariance
Test #11: test_soca_balance
Test #12: test_soca_bkgerr
Test #13: test_soca_vertconv
Test #14: test_soca_hofx
Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

soca/test/CMakeLists.txt

~ Minimum required to be able to run the JEDI based Ocean DA applications

Building blocks of SOCA

Anatomy of soca by looking at the unit testing: “Model/Pseudo Model”

Test #1: test_soca_forecast
Test #2: test_soca_socaerror_init
Test #3: test_soca_enspert
Test #4: test_soca_geometry
Test #5: test_soca_linearmodel
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Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

Building blocks of SOCA

Anatomy of soca by looking at the unit testing: B matrix

Test #1: test_soca_forecast
Test #2: test_soca_socaerror_init
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Test #14: test_soca_hofx
Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

Static ocean sea-ice B matrix:

$$B = KDC_v^{\frac{1}{2}} C_h C_v^{\frac{1}{2}^T} DK^T$$

Building blocks of SOCA

Anatomy of soca by looking at the unit testing: B matrix

Test #1: test_soca_forecast
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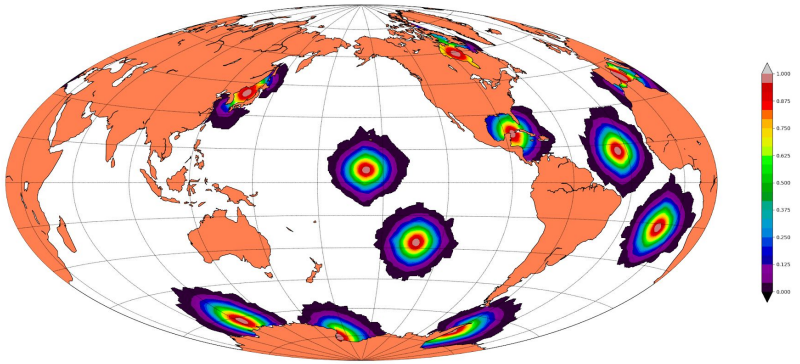
Test #14: test_soca_hofx
Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

Initialization of the horizontal convolution operator in B

BUMP based, all credits to Benjamin Menetrier

$$B = KDC_v^{\frac{1}{2}} C_h C_v^{\frac{1}{2}^T} DK^T$$



Building blocks of SOCA

Anatomy of soca by looking at the unit testing: B matrix

Test #1: test_soca_forecast
Test #2: test_soca_socaerror_init
Test #3: test_soca_enspert
Test #4: test_soca_geometry
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Test #14: test_soca_hofx
Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

soca/test/CMakeLists.txt

soca/test/executables/TestErrorCovariance.cc

soca/test/executables/TestVariableChange.cc

Building blocks of SOCA

Anatomy of soca by looking at the unit testing: Increment

Test #1: test_soca_forecast
Test #2: test_soca_socaerror_init
Test #3: test_soca_enspert
Test #4: test_soca_geometry
Test #5: test_soca_linearmodel
Test #6: test_soca_state
Test #7: test_soca_modelaux
Test #8: test_soca_model
Test #9: test_soca_increment
Test #10: test_soca_errorcovariance
Test #11: test_soca_balance
Test #12: test_soca_bkgerr
Test #13: test_soca_vertconv
Test #14: test_soca_hofx
Test #15: test_soca_3dvar
Test #16: test_soca_3dfgat
Test #17: test_soca_3dhybrid

soca/test/CMakeLists.txt

soca/test/executables/TestIncrement.cc

Marine UFOs

	Nonlinear	Linear (tangent)	Adjoint	
Sea-ice Fraction		Done	Done	Anna Shlyaeva
“ Thickness	Done	Done	Done	
Sea Surface Height		Done	Done	Jili Dong
Insitu Temperature	Done	Done	Done	Steve Penny
Practical Salinity		Done	In progress	Innocent Souopgui
Sea Surface Temperature		Done	Done	Travis Sluka
Diurnal SST	In progress	Not started	Not started	Santha Akella
Sea Surface Salinity	Not started	Not started	Not started	
Significant Wave Height	Done	In progress	In progress	Stylianos Flampouris

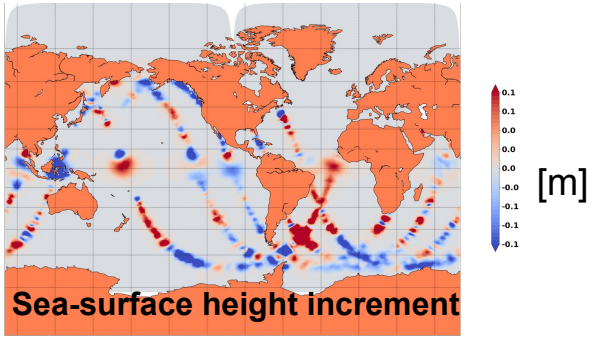
\+ Guillaume Vernieres and Rahul Mahajan

3DVAR/3DEnVAR: Science?

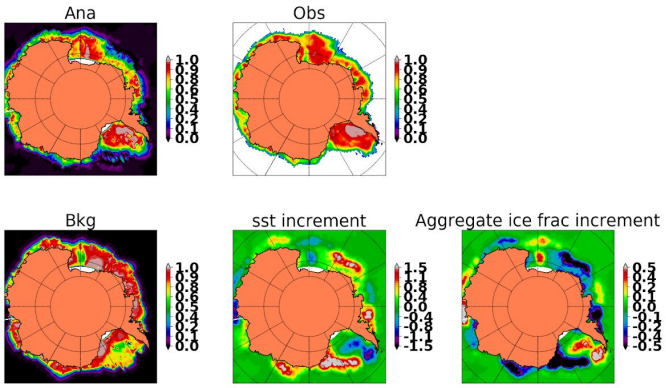
Sea-ice Ocean Coupled Assimilation

- 6 observation operators for the ocean and sea-ice
- JEDI encapsulation of ocean and sea-ice models (MOM6 and generic sea-ice)
- Prototype Assimilation system (3DVAR/EnVAR)

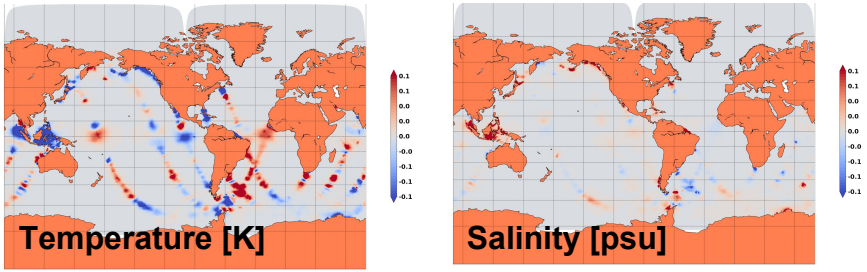
Multivariate increment (sea surface height, 3D temperature & salinity) resulting from the assimilation of Jason-3 absolute dynamic topography



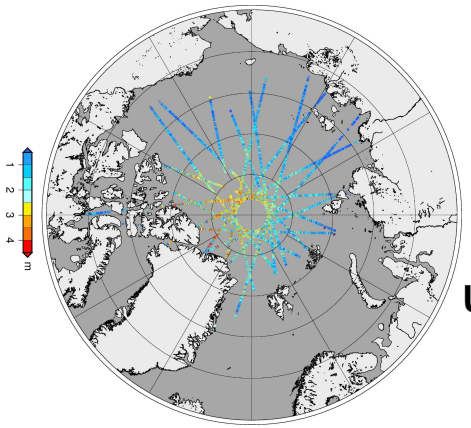
Coupled increment (sst & ice-fraction) resulting from the assimilation of sea-ice concentration.



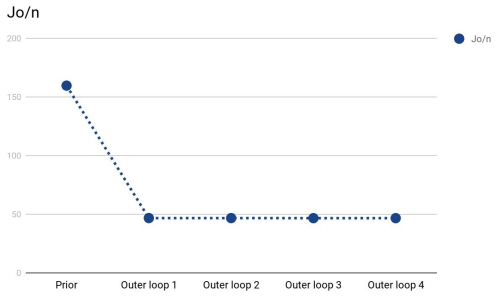
Water column average increment



3DVAR/3DEnVAR: Science?



Sea-ice thickness Level 2 processing (Alfred Wegener Institute). Data set provided courtesy of Dr. Sinéad Louise Farrell.

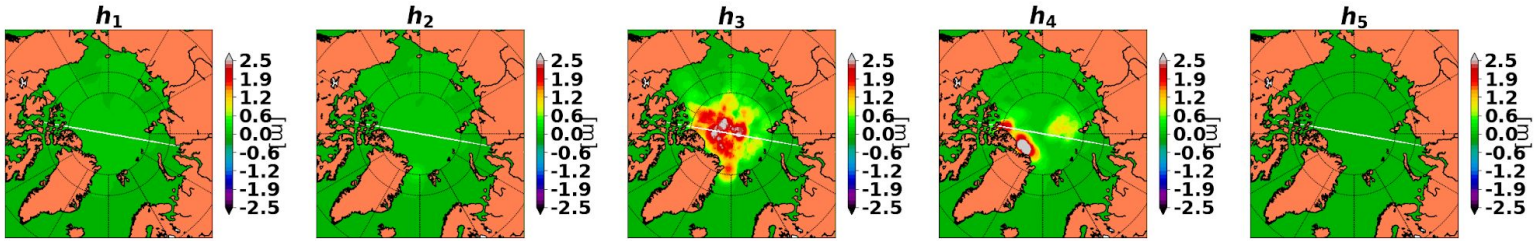


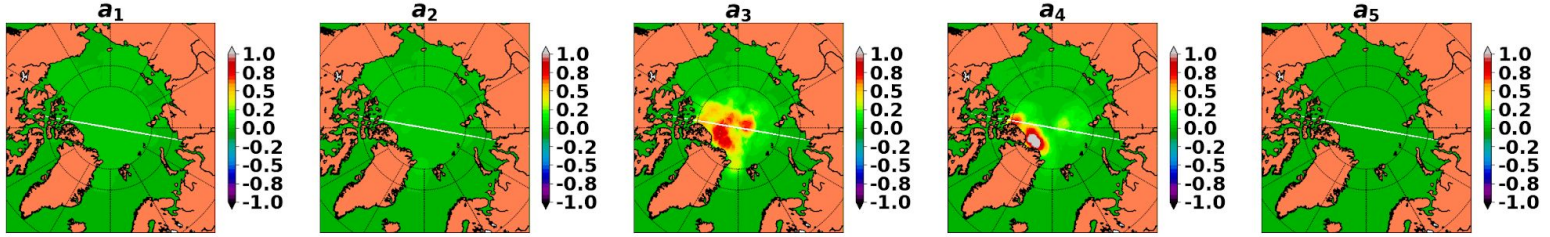
UFO

NL: $\mathrm{h}(c_1, ..., c_{N_c}, h_1, ..., h_{N_c}) = \sum_{n=1}^{n=N_c} c_n h_n$

TLM: $\delta h(\delta c_1, ..., \delta c_{N_c}, \delta h_1, ..., \delta h_{N_c}) = \sum_{n=1}^{n=N_c} (c_n^{traj} \delta h_n + h_n^{traj} \delta c_n)$

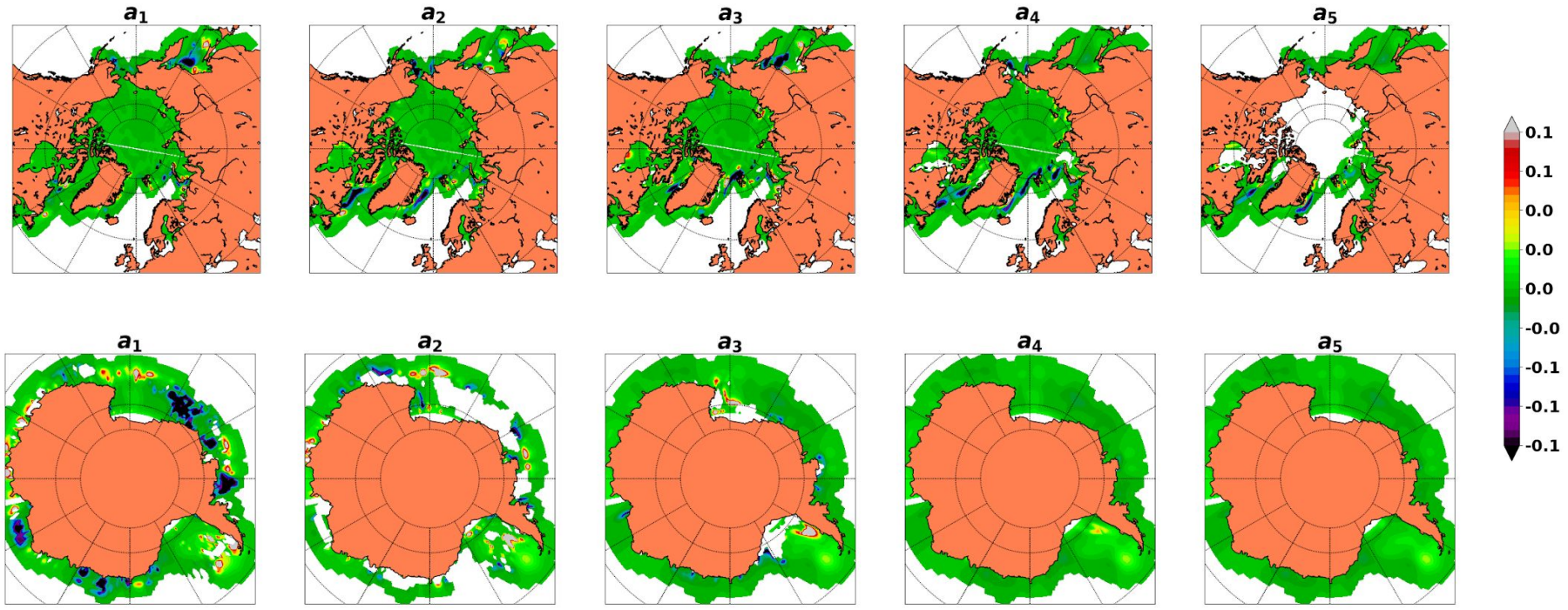
AD:
$$\delta \hat{c_n} = \delta \hat{c_n} + h_n^{traj} \delta h$$
$$\delta \hat{h_n} = \delta \hat{h_n} + c_n^{traj} \delta h$$





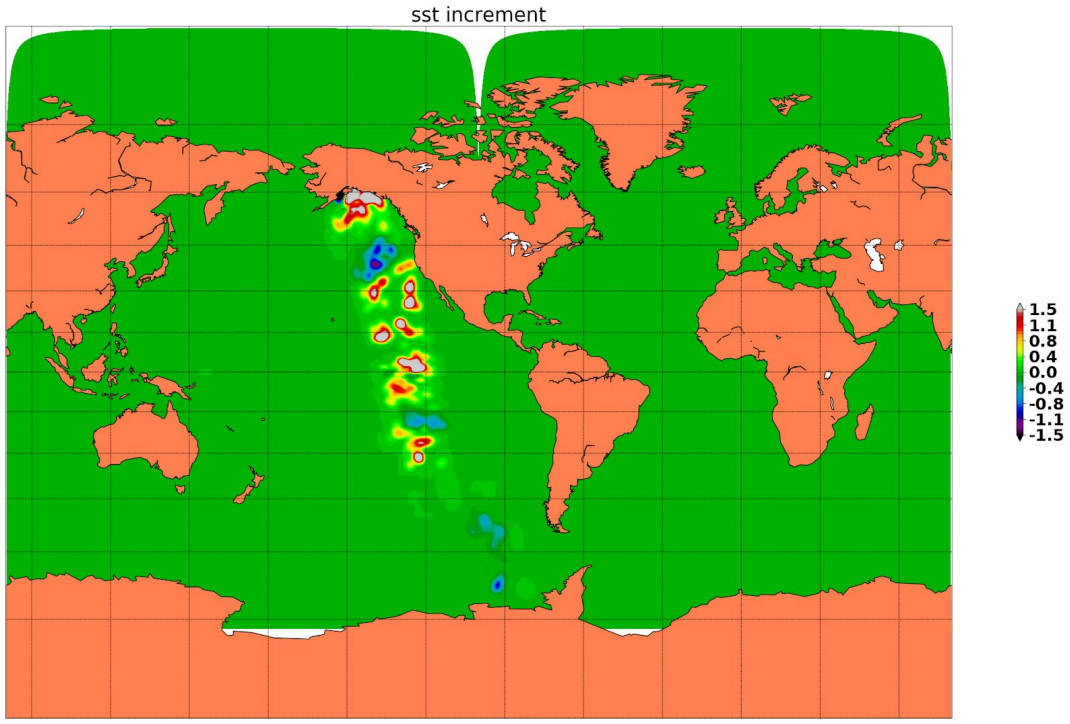
3DVAR/3DEnVAR: Science?

Sea-ice fraction increment for each category.
Observations: Level 4 sea-ice fraction (NOAA)

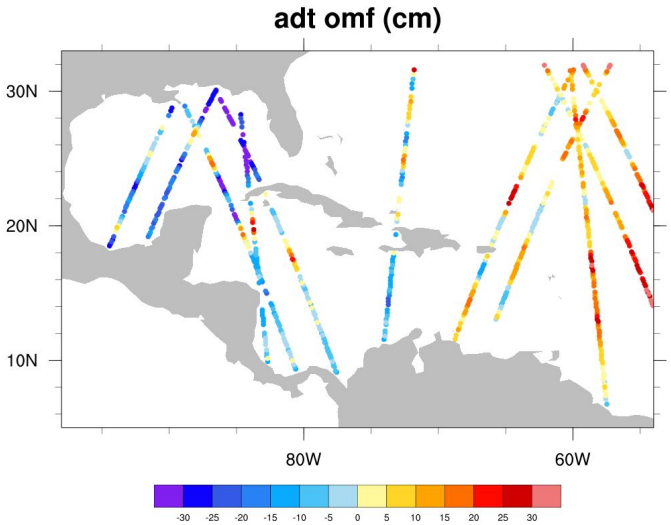


3DVAR/3DEnVAR: Science?

SST increment
Observation: AVHRR, NOAA-19
L2b sst)



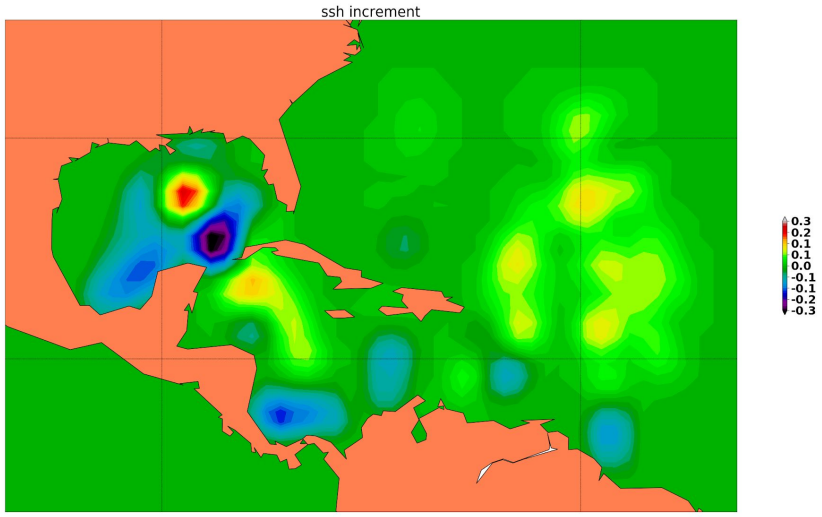
3DVAR/3DEnVAR: Science?



Innovation (o-f) of ADT with HYCOM background;

SSH increment

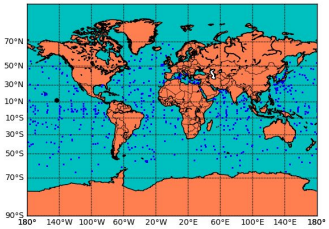
Observations: Absolute dynamic topography from Jason-2-3, CryoSat-2



3DVAR/3DEnVAR: Science?

Background
Analysis at the end of each outer loop
Observations

Example of Argo observing network



ARGO
Lon=-143.00199890
Lat=12.0570001602