

OSSES for S2S forecast of ocean and atmosphere

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All welcome to participate!!

Why OSES for S2S

Motivation:

S2S forecasts increasingly important for adaptation to climate change.

Both for atmosphere and ocean conditions

Can we provide recommendations on observing system for S2S?

Context:

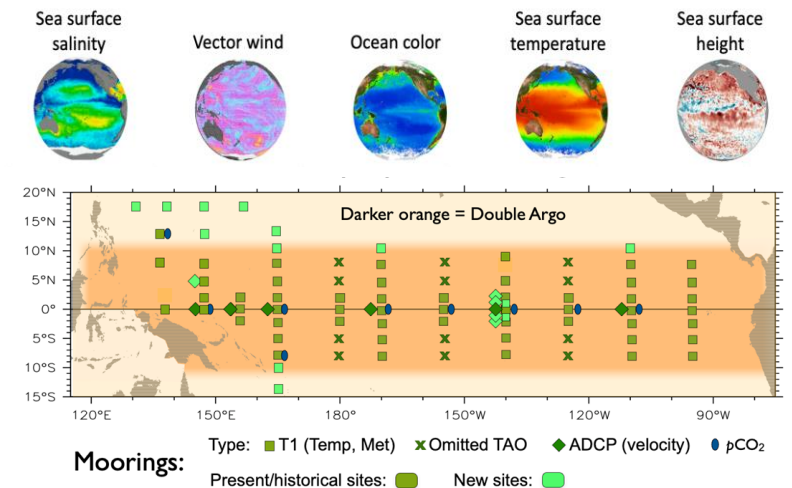
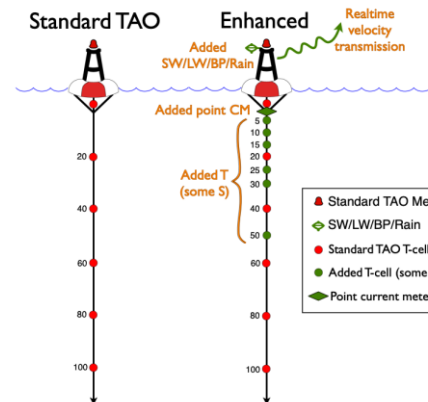
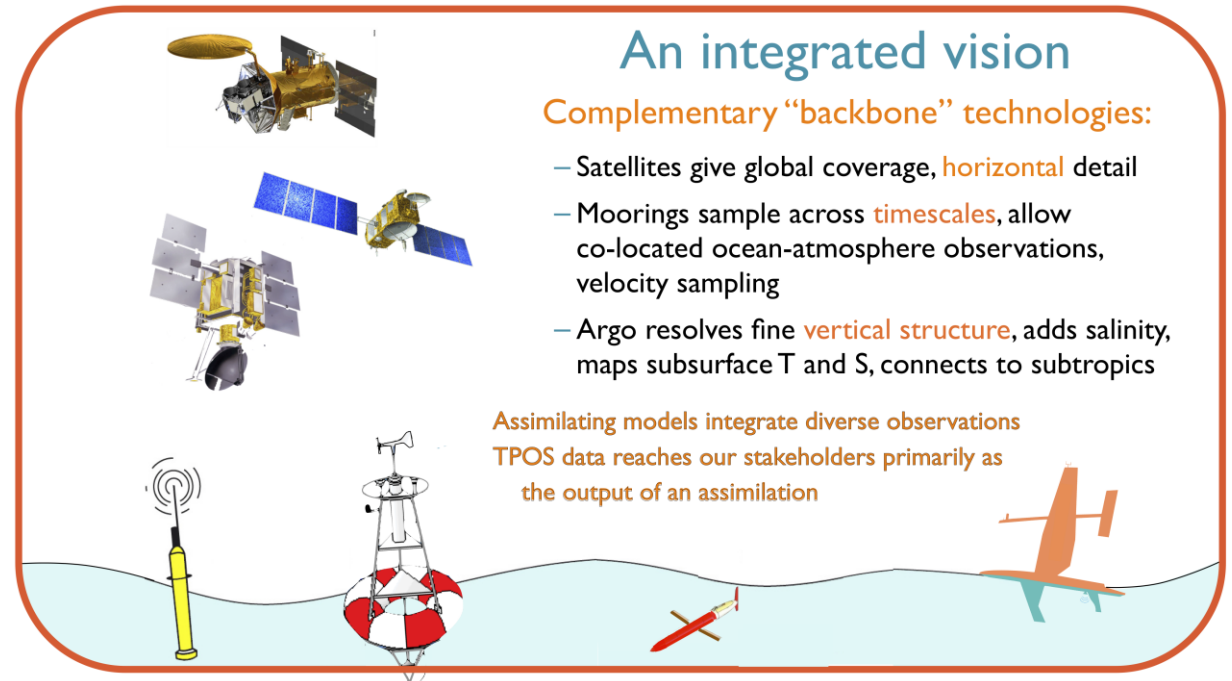
- Strong link with Ocean Reanalyses OSES within SynObs
- Preparedness to evaluate the upcoming TPOS

The 1st phase of OSES for S2S is expected to take place during 2023, and it will serve as a base for the second phase, aiming at the evaluation of new TPOS from 2024.

The OSES will contain 2 components: reanalyses OSES for the preparation of initial conditions and S2S reforecast OSES to assess impact on forecast skill

Sustained observing system. TPOS2020

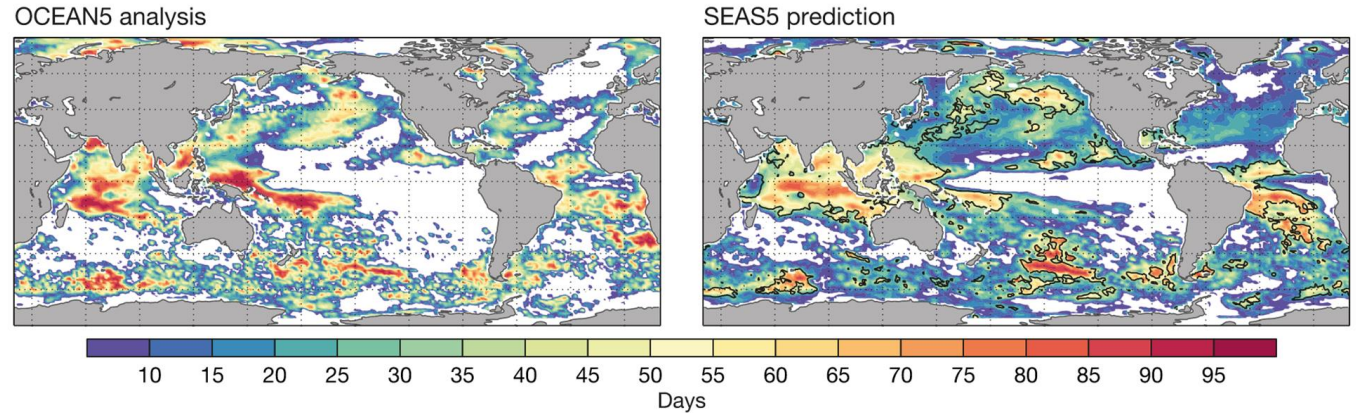
- A great opportunity for advancing process understanding, modelling and data assimilation systems.
- Collocated observations at the ocean-atmosphere boundary covering different regimes will be pivotal for coupled DA efforts.
- Enhanced mooring instrumentation for surface variables and equatorial current profiles and vertical shear
- Double Argo to enable sampling of different time scales
- Synergies between in-situ and remotely sensed observations
- We need to be ready for the uptake of these observations and provide prompt feedback.
- Expected deployment~2024



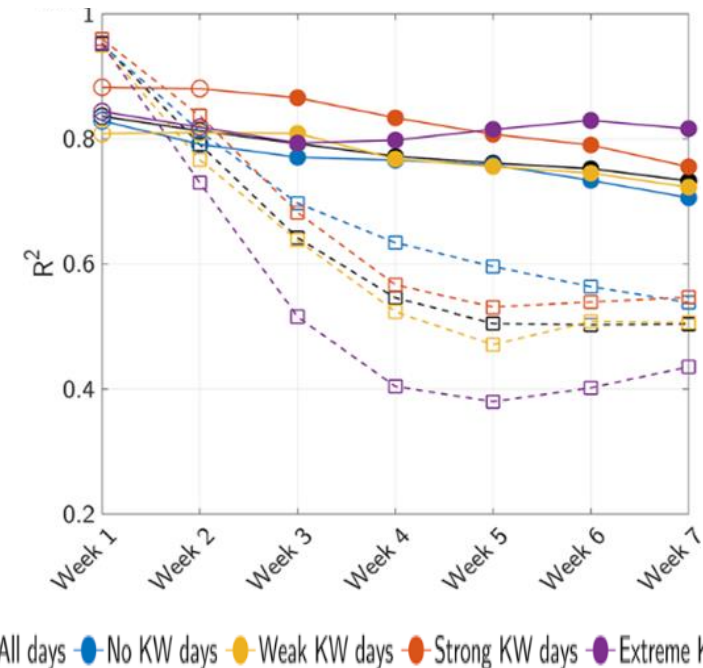
Interest of S2S forecasts

- Prediction of atmospheric and ocean conditions several weeks-months ahead
- Months ahead:
 - ENSO, Indian Ocean Dipole, Sea-Ice and associated atmospheric impacts. Tropical Cyclones.
 - Marine Heat Waves, upwelling areas
- Weeks ahead:
 - MJO, sea-ice and associated atmospheric impacts, monsoons, tropical cyclones
 - Ocean mixed layer, Marine Heat Waves, Coastal Kelvin Waves and Upwelling areas

Seasonal forecast of MHW: Number of days in JJA 2020 exceeding 90% of climatological value. From Balmaseda and DeBoisesson 2021



S2S Skill in predicting Californian Current
From Amaya et al JGR, 2022



ORA OSES: subset of SynObs flagship

ORA OSES

reanalyses and provision of initial conditions for S2S OSES

Oper All	Ocean Model	SST	Argo	Moor	XBT	Alti	BiasC
Ref0 All InSituAlti	Ocean Model	SST	Argo	Moor	XBT	Alti	
NoAlti	Ocean Model	SST	Argo	Moor	XBT		BiasC
SatOnly	Ocean Model	SST				Alti	

SUBSET 1: ORA – OSES only

- Is explicit treatment of model error (BC) needed?
- What is the added value of altimeter?
- Is it possible to assimilate altimeter without In-Situ

REF1 All Insitu	Ocean Model	SST	Argo	Moor	XBT	
NoArgo	Ocean Model	SST		Moor	XBT	
NoMoor	Ocean Model	SST	Argo		XBT	
Argo	Ocean Model	SST	Argo			
NoInsitu	Ocean Model	SST				
None	Ocean Model					

SUBSET 2: ORA – OSES + S2S OSES

- Focus 1: value of InSitu observations, Argo
- Focus 2: Equatorial processes. Prepare for TPOS
- Focus 3: value of SST
- Optional: added value of altimeter with Ref0 and Sat Only

Period of ORA OSES: ?
 Initial conditions of ORA-OSES: ?
 Configuration: as close as possible to operational systems

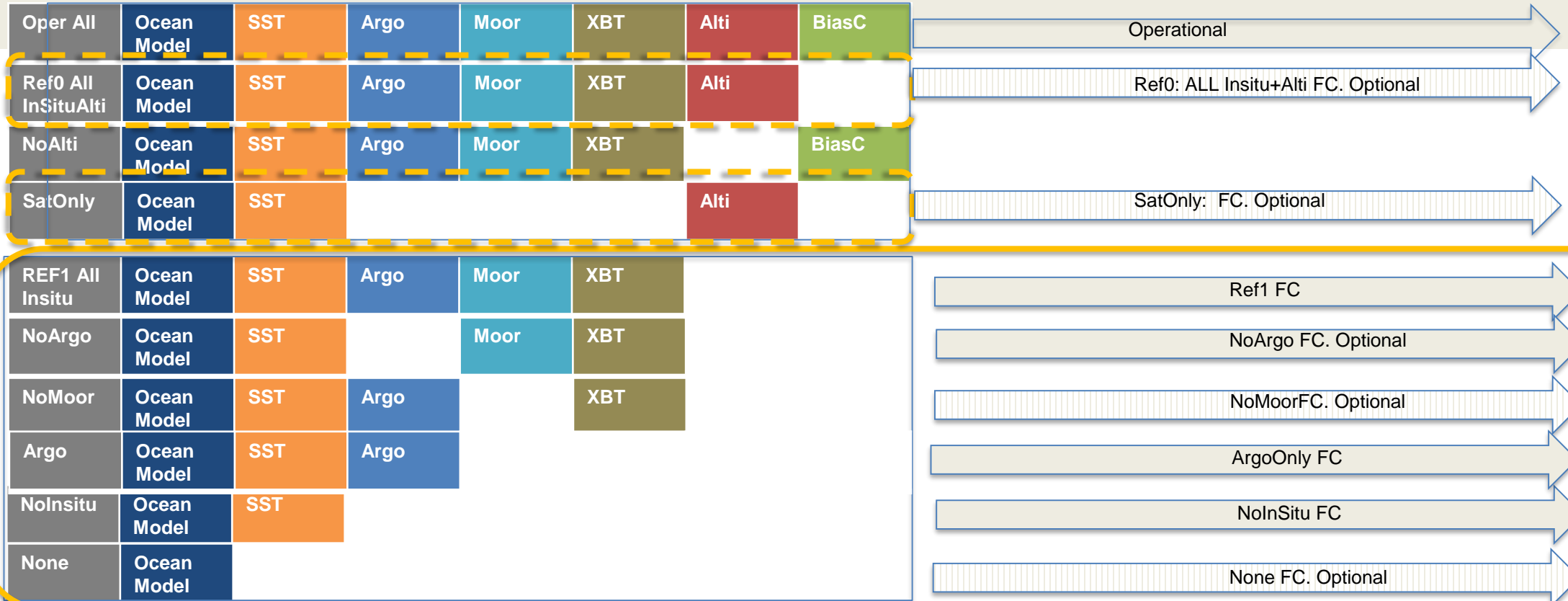
ORA OSES: subset of SynObs flagship

ORA OSES

reanalyses and provision of initial conditions for S2S OSES

FC OSES

Ensemble of coupled re-forecasts



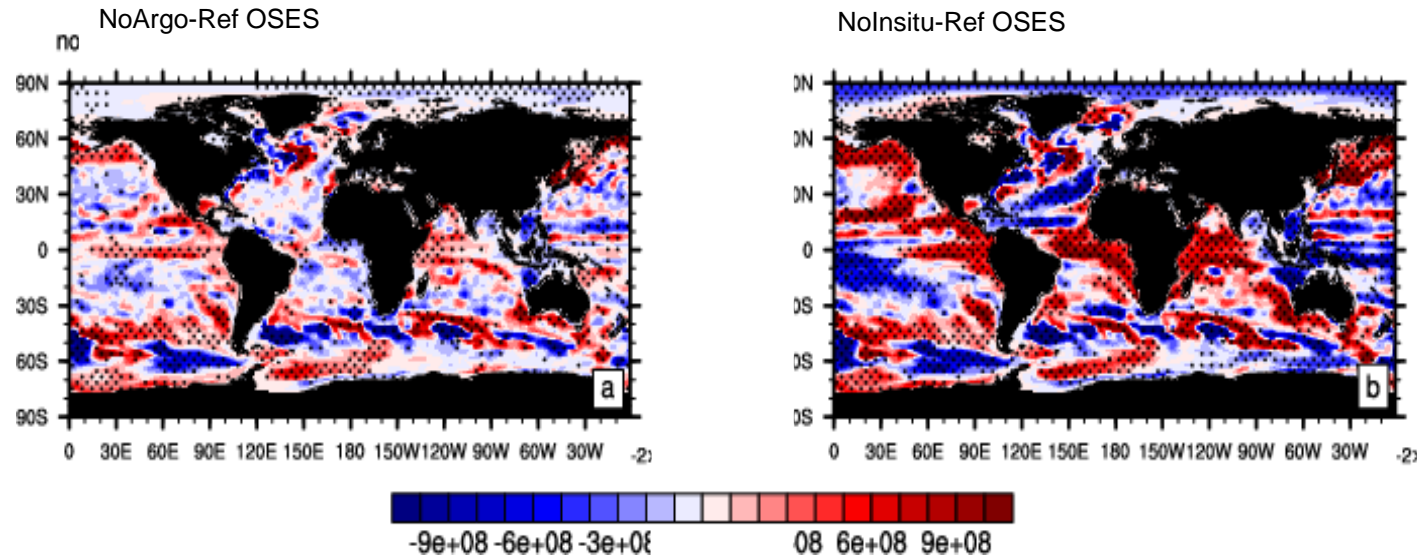
Reforecast Period: 2003-2022

Starting dates:

Monthly forecasts every month

Seasonal forecasts up to 4(6)months Nov/May starts

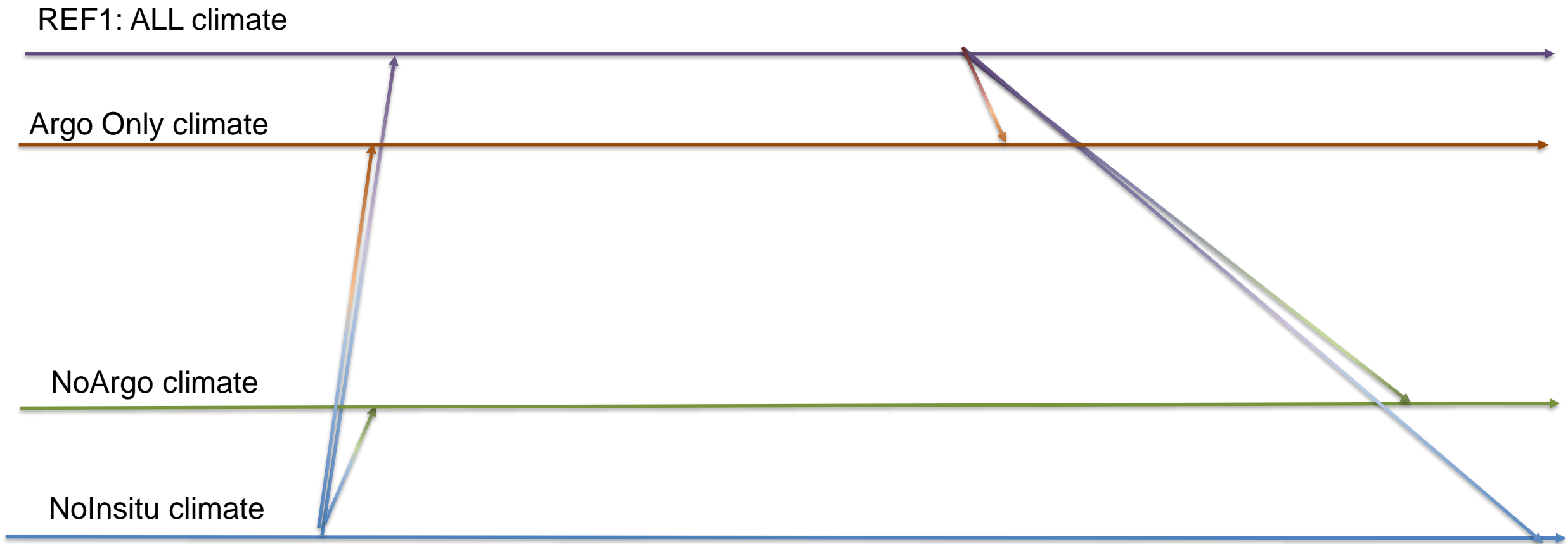
NoArgo versus NoInsitu ORA OSES: Ocean Heat Content 2005-2015



Ocean Heat Content Upper 300m

- NoInsitu impact is larger than NoArgo.
- Is this due to the experimental design? all experiments start from ALL in 1993.
- Likely: due to the long memory of the ocean, the contribution of Insitu prior to Argo period is visible in results
 - But if starting from All in 2003, will be Argo Only be able to constrain the state of the ocean?

Why the initial conditions of the ORA OSES matter?

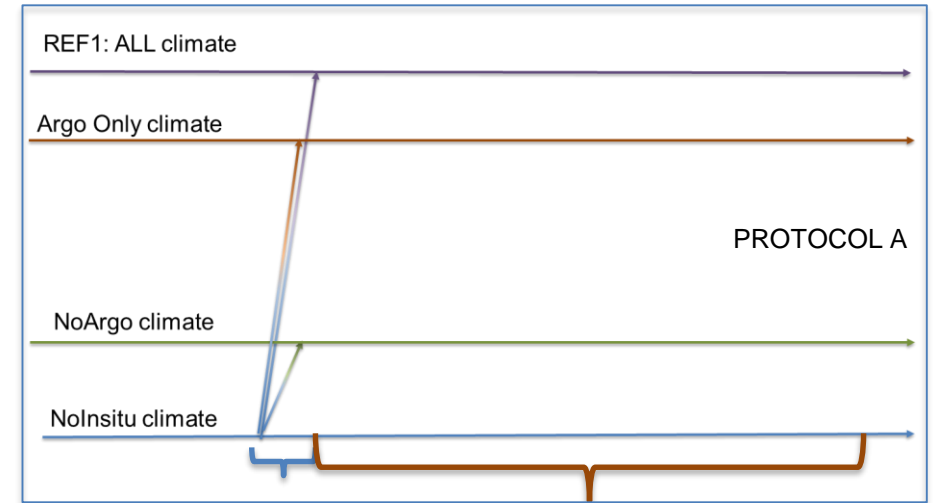


Rate of convergence when assimilating data is faster than rate of convergence in data withdrawal experiments

Possible protocols and starting dates for ORA and FC OSES

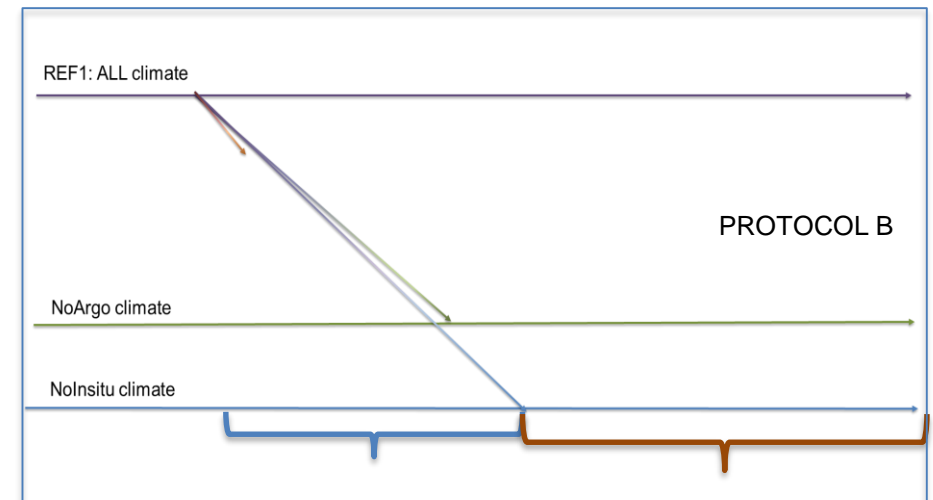
Protocol A:

Period 2000-2022 (present)
Starting from NoIn situ climate
Spinup period 2000-2003
Analysis period 2003-2022



Protocol B:

Period 1993-2022 (present).
Starting from ALL climate
Spindown period 1993-2003
Analysis period 2003-2022



For the production centre to decide. Documentation needed

Output variables for S2S reforecasts (Minimum requirements + Enhancements)

Minimum requirements. Those defined in the S2S data base. To be completed by Diagnostic leaders

Ocean Data in S2S database

Average salinity in the upper 300m
Depth of 20C isotherm
Sea Surface Zonal Velocity
Mean sea water potential temperature in the upper 300 m
Sea Surface Meridional Velocity
Ocean mixed layer thickness defined by sigma theta 0.01 kg/m3
Sea surface height
Sea surface practical salinity
Sea-ice thickness
SST
Sea ice concentration ratio

Atmospheric fields in S2S2 database (subset).

Surface state variables: T2m, U10m
T,U,V,Z,Q (selected pressure levels a subset of S2S
1000,925,850,700,500,300,200,100,50,10)
Surface fluxes (precip, LH,SW,SH, as S2S, wind stress,)
MSLP,Total Cloud cover, OLR, TOA.

Frequency of data (reforecasts):

Daily up to day 7, weekly means until week 4, monthly after that
For MJO, daily OLR, U200, U850
For selected ocean fields (SST,SSH,MLD) daily frequency is desirable

Format and grids:

Atmospheric variables (FC only): provided in the same grid as the S2S database

Ocean variables:

- ORA: 1x1 degree lat/lon grid, netcdf. Template to be provide
- FC: as ORA or as in S2S database. TBD.

Output variables for S2S reforecasts

Recommended Enhancements

•Additional ocean variables

- For ORA OSES: 3D currents and 3D T/S, especially for reanalyses, as well as transports across sections
 - Comparing profiles with current meters
 - Comparison of transports: ITF, AMOC, Florida Straight...
- For FC OSES: Enhanced upper level ocean for Tropical cyclones and air-sea interaction (for forecasts)
 - Upper 30 meters for Marine Heat Waves
 - Upper 100 meters or depth of 26 deg isotherm for Tropical cyclone energy
 - Other definitions of mixed layer and barrier layers (for warm pool interactions)
 - Amplitude and phase of diurnal cycle (TBD)

•Enhanced frequency at mooring locations:

- consider output T/S/U/V/surface variables and flux-related quantities at mooring locations with the same frequency as observations (hourly)
- Need location of new moorings from TPOS2020, so we can output the variables even if the new observing system is not yet deployed

How to proceed?

- Producer centers:
 - ECMWF, NOAA, JMA,
 - If any of you want to participate, please contact Magdalena.Balmaseda@ecmwf.int
- Diagnostics experts:
 - Aneesh Subramanian, Arun Kumar, Matthew Widlansky, Boris Dewitte
 - If you want to engage on the diagnostics, please contact Aneesh Subramanian at aneeshcs@colorado.edu

Next coordination meeting in January-February 2023

- Agree on protocols for production and timelines
- Agree on output variables
- Organize workflows