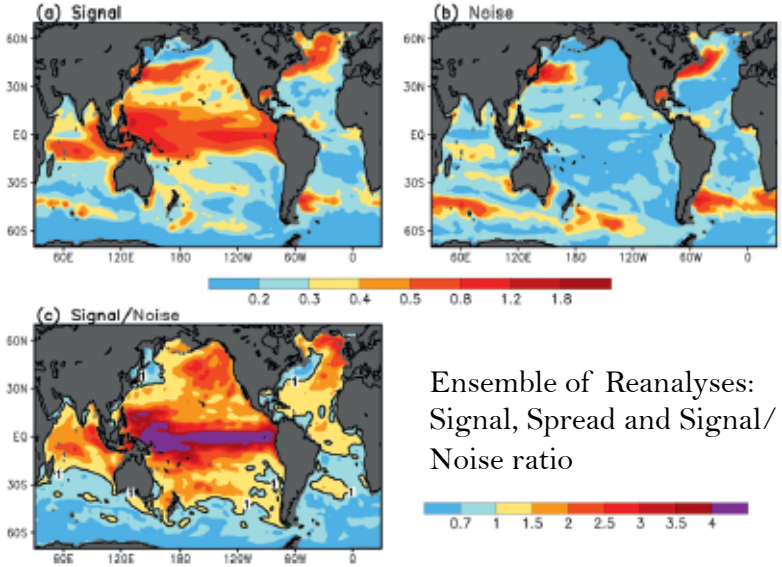
CLIVAR GSOP/GODAE Ocean View Ocean Reanalysis Inter-comparison ORA-IP

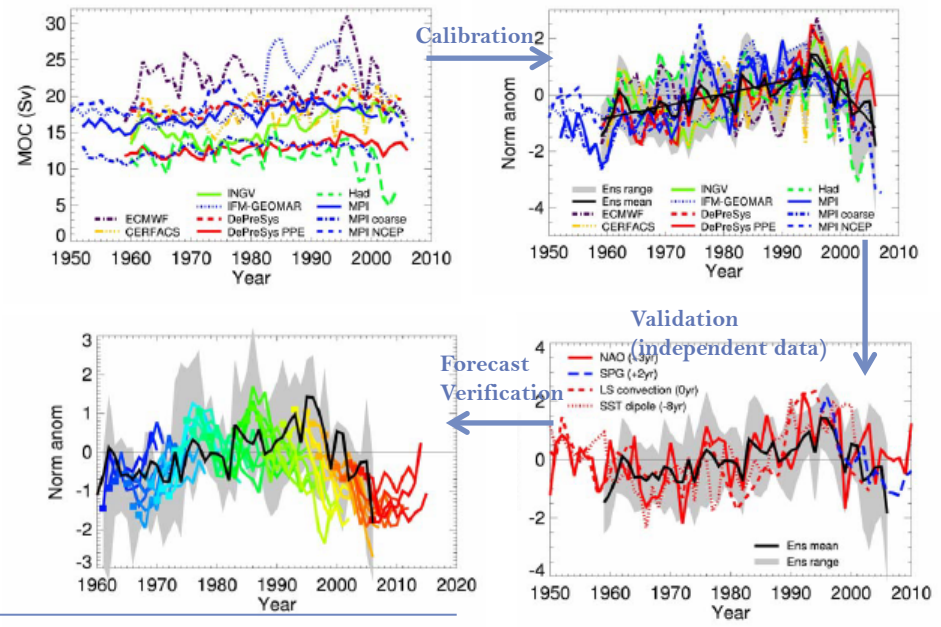
Progress so far
What next?

Xue et al, J.C., 2012: **Upper ocean heat content**

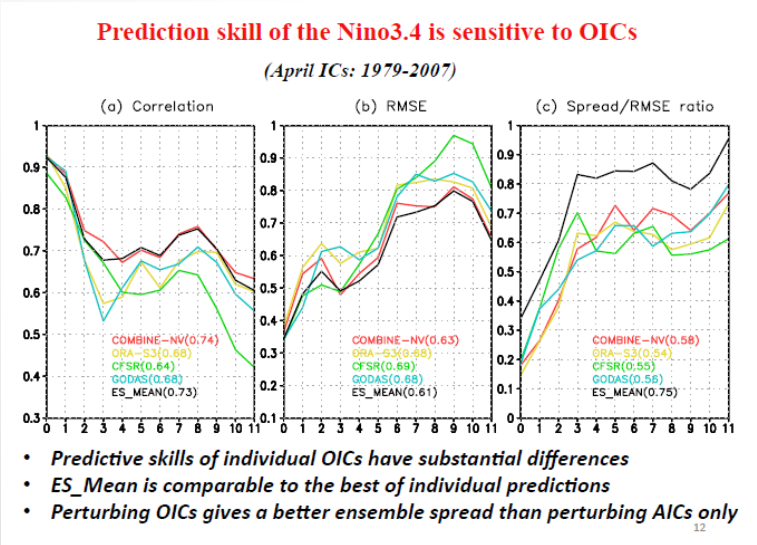


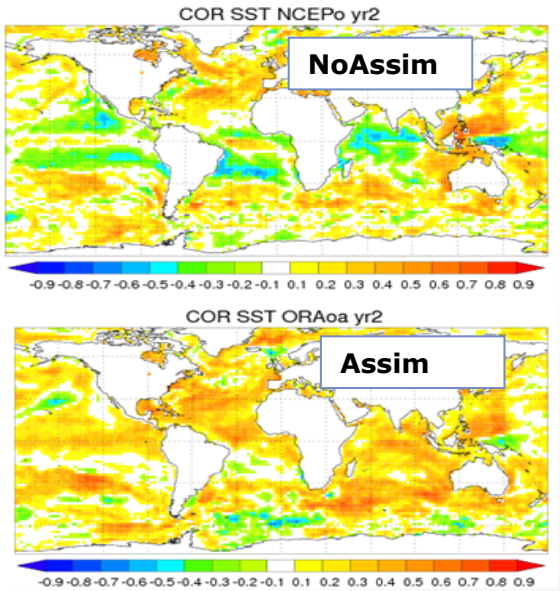
Ensemble of Reanalyses: Signal, Spread and Signal/ Noise ratio

Polhmann et al, Clim Dyn 2013
AMOC calibration for verification



Zhu et al GRL 2012, Clim Dyn 2013
Multi-Analysis Ensemble (MAE) Seasonal Fc Initialization





Polhmann (pc) Impact of using ocean reanalysis in the **initializaton of decadal forecasts**

Why another intercomparison?

- **Reanalyses production is an on-going activity**

  New vintages are produced approximately every 5 years, as improved methodology, quality controlled observation repositories and forcing fluxes are available.

  In about 2013 we had a new vintage of reanalyses including
  - Improved quality controlled observations (XBT corrections, Argo corrections and black lists)
  - Improved-extended forcing fluxes
  - Improved models and methods (higher resolution, coupled, better tuned)

- **Need assess progress, learn lessons, exploit resources and ask questions for future improvement.**

- **Need to facilitate the use of the reanalyses by other communities**

- **Need to prepare for quasi-real time monitoring of the ocean**

Current OCEAN Reanalysis Intercomparison (ORA-IP)

- **GODAE/CLIVAR GSOP** communities: high resolution, real time and climate

- **Organization: Voluntary non-funded activity**
  - Producers groups (provide requested data in specified format/grid)
  - Processing groups (formulate data requests and process a given variable)

- **Workshop at ECMWF on July 2013 with limited scope (1,2 below)**
  1. **Open assessment of products**
     - Identify signal to noise ratio
     - Identify relevant indices for climate monitoring
     - Contribute process studies
     - Identify gaps in observing system
     - Identify deficiencies with current generation of data assimilation system
     - Dissemination of results and publications:
  2. **Facilitate data access and usage** (data repositories of the reanalysis ensemble)
  3. **Real time monitoring of relevant indices**. It should naturally follow up this ORAIP. But it is likely to need more dedicated resources.

CLIVAR GSOP/GODAE Ocean View Ocean Reanalysis Inter-comparison (ORA-IP)

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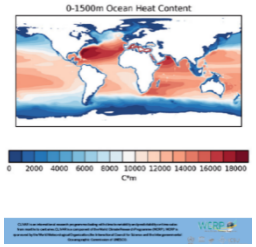
Maria Valdivieso (UoReading)
Andrea Storto (CMCC)
Gregory Smith (Environment Canada)
Matthew Palmer (UK MetOffice)
Fabrice Hernandez (Mercator Ocean)
Li Shi (BMRC)
Keith Haines (UoReading)
Tony Lee (JPL)
Yosuke Fujii (MRI-JMA)
Alicia Karspeck (NCAR)
Kirsten Wilmer-Becker (MetOffice)
And All Reanalysis Providers

Variable	
Ocean Heat Content	MetOffice
Steric Height	CMCC
Sea Level	Mercator Ocean
Surface Heat Fluxes	University Reading
Mixed Layer Depth	MRI/JMA
Salinity	CAWCR
Depth of 20 degree Isotherm	Mercator Ocean
Sea Ice	Env Canada

AMOC **NCAR**

MyOcean ¼ degree **CMCC**

- 6 Observation only products
- 13 Low resolution models
- 8 High resolution models (1/3 or ¼ degree)
- 4 Coupled DA products
- 6 Long reanalyses, starting 1950's



Summary Paper

Balmaseda, M.A. et al., The Ocean Reanalysis Intercomparison project (ORA-IP) J.Op.Oceanogr. Volume 8, supplement 1, 9 June 2015

Special Issue Climate Dynamics:

7 papers accepted so far, 2 under revision
+ other papers with sensitivities

http://www.clivar.org/sites/default/files/documents/Exchanges64.pdf

The Ocean Reanalyses Intercomparison Project (ORA-IP)

Product	Forcing	Configuration	Data Assim. Method
ARMOR3D[ab] CLS	N/A	1/3° Obs-Only (T/S/SSH/U/V)	OI (SLA/MDT/T/S/SST)
CFSR[cd] NOAA NCEP	Coupled DA	1/2° MOM4 coupled	3DVAR (T/S/SST/SIC)
C-GLORS05V3[e] CMCC	ERAi corr+ Bulk	1/2° NEMO3.2	3DVAR (SLA/T/S/SST/SIC)
ECCO-NRT[f] JPL/NASA	NCEP-R1 + CORE Bulk	1° MITgcm	KF-FS (SLA/T)
ECCO-v4[gh] MIT/AER/JPL	ERAi+CORE Bulk	1° MITgcm	4DVAR (SLA/SSH/T/S/SST)
EN3 v2a[i] Hadley Center	N/A	1° Obs-Only (T/S)	OI (T/S)
GECCO2[j] U. of Hamburg	NCEP-R1+Bulk	1°×1/3° MITgcm	4DVAR (SLA/T/S/MDT/SST)
ECDA[kl] GFDL/NOAA	Coupled DA	1/3° MOM4 coupled	EnKF (T/S/SST)
GloSea5[mn] **UK MetOffice**	ERAi+CORE Bulk	1/4° NEMO3.2	3DVAR (SLA/T/S/SST/SIC)
MERRA Ocean GSFC/NASA/GMAO	Merra + Bulk	1/2° MOM4	EnOI (SLA/T/S/SST/SIC)
GODAS[o] NOAA NCEP	NCEP-R2 Flux.	1°×1/3° MOM3	3DVAR (SST/T)
GLORYS2V1(G2V1) Mercator Océan	ERAi corr+CORE Bulk	1/4° NEMO3.1	KF+3DVAR (SLA/T/S/SST/SIC)
GLORYS2V3(G2V3) Mercator Océan	ERAi corr+ CORE Bulk	1/4° NEMO3.1	KF+3DVAR (SLA/T/S/SST/SIC)
K7-ODA(ESTOC)[p] JAMSTEC/RCGC	NCEP-R1 corr. Flux	1° MOM3	4DVAR (SLA/T/S/SST)
K7-CDA[q] JAMSTEC/CEIST	Coupled DA	1° MOM3 coupled	4DVAR (SLA/SST)
LEGOS[r] LEGOS	N/A	1/4° Obs-Only (SL)	OI+EOF (SLA/SSH)
NODC[s] NODC/NOAA	N/A	1° Obs-only (T/S)	OI (T/S)
PEODAS[t] CAWCR(BoM)	ERA40 to 2002; NCEP-R2 thereafter. Flux	1°×2° MOM2	EnKF (T/S/SST)
ORAS4[uv] ECMWF	ERA40 to 1988; ERAi thereafter. Flux.	1° NEMO3	3DVAR (SLA/T/S/SST)
MOVE-C[w] MRI/JMA	Coupled DA	1° MRI.COM2 coupled	3DVAR (SLA/T/S/SST)
MOVE-G2[x] MRI/JMA	JRA-55 corr+ Bulk	0.5°×1° MRI.COM3	3DVAR (SLA/T/S/SST)
MOVE-CORE[yz] MRI/JMA	CORE.2 Bulk	0.5°×1° MRI.COM3	3DVAR (T/S)
SODA[aa] U. of Maryland and TAMU	ERA40 to 2002; ERAi thereafter. Bulk	1/4° POP2.1	OI (T/S/SST)
UR025.4[ab] U. of Reading	ERAi + CORE Bulk	1/4° NEMO3.2	OI (SLA/T/S/SST/SIC)
AVISO[cc] CLS	N/A	1/4° Obs-Only (SSH/SLA)	OI (SLA)
SLCCI[dd] ESA	N/A	1/4° Obs-Only (SSH)	OI (SSH)

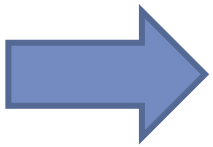
ORA-IP Objectives

- To Quantify Signal/Noise from Ensemble ✓
- To gain insight into the ocean variability and trends ✓
- To identify current deficiencies ✓
- To measure progress
- To exploit existing multi-ORA ensemble
  - For climate indicators
  - For model validation
  - For real-time monitoring
  - For initialization of coupled models

Next: make ORAIP variables publicly available, with version control

Imperatives

- To Investigate further the processes leading to the “signal” and the deficiencies leading to “the uncertainty”
- To measure progress.
- To exploit existing multi-ORA ensemble
  - For model validation
  - For initialization of coupled models



- **A data repository for reanalysis**
- **Agreed metrics for validation of reanalyses**

ORAIP Data Repository: a strawman proposal (I)

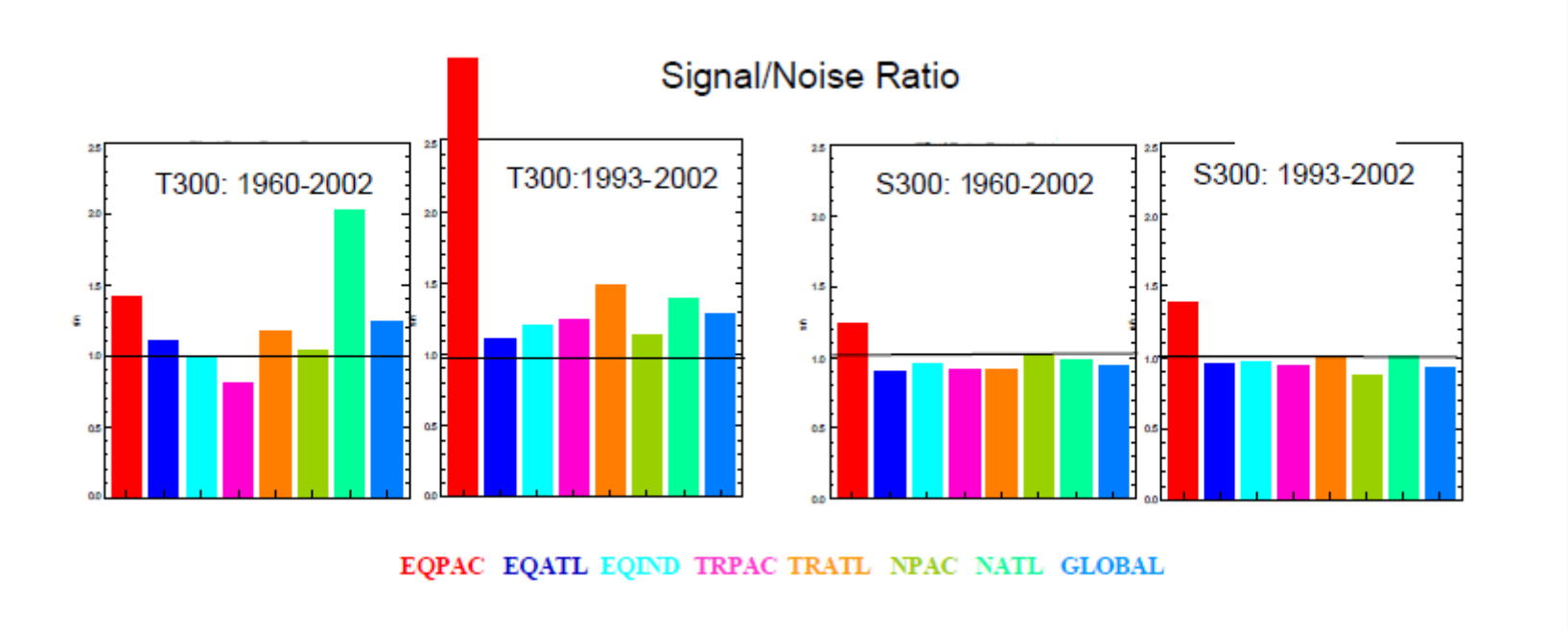
- Reanalysis.org provides pointers to individual reanalyses.
  - Responsibility lies with the production centres
- ORA-IP repository consisting only of variables that have been intercompared
  - Individual variables, Ensemble mean and variance
  - Useful to measure progress
  - Possibility of finishing the intercomparison (for instance, sea-level)
  - Useful for multi-variate analyses
  - Useful to validate climate models
  - Data is “almost” ready
  - More in next slide
- Leave the uniform and comprehensive archive of ocean reanalyses to well funded agencies (like Copernicus Services)

ORAIP Data Repository: a strawman proposal (II)

- ORA-IP repository consisting only of variables that have been intercompared
  - Entry ORAIP-version N. We can call it ORAIP1 (ORAIP0 was the first one)
  - Attributes:
    - Version Number,
    - Ensemble: EnsMean, Ens SDV, ens members (number and name).
    - Variabie (OHC, Steric height…)
    - Link to ClimDyn papers with evaluation.
    - More variables can be added as they are being intercompared
  - Site: University of Hamburg Ocean reanalyses portal (?)
  - If agreed, we nee to:
    - Identify responsible for doing the work (COST?)
    - Agree with Uni of Hamburg
    - Ask processing-centers to provide the data they used.
    - Store the data in the server with given attributes.

Previous GSOP Re-analysis intercomparison

Led by Detlef Stammer ~2006-2009



Robustness of upper ocean heat content

More uncertainty in salinity

Large spread in Atlantic MOC

Stammer et al, Oceanobs09, 2010
Lee et al, OceanObs09, 2010
Lee et al, Oceanography, 2009
Xue et al, JClim, 2012

ORAIP Reanalyses Metrics

- **Metrics for multi-ora:**
  - **S2N + validation of ensemble mean**

- **Metrics for individual reanalyses**

  - Fit to assimilated obs (spatial stats): Needed, but usually not discerning and misleading (different obs go to different reanalyses),

  - Fit to independent data: velocities, transports, bottom pressure, tide gauges

  - Temporal statiistics (long-time series, either assimilated or not):
    - Altimeter SL, grace bottom pressure, surface currents.
    - In –situ mooring,ocean-sites
    - Sea-Ice thickess in future
    - Tracers?
  - Forecast skill when possible.
  - Other assimilation metrics, like (FG-O)/(An-O) error ratio.
  - Water mass properties.

  - Other poorly observed but constrained by physics: Check for unrealistic solutions

    - Deep ocean trends/spin up
    - Transports