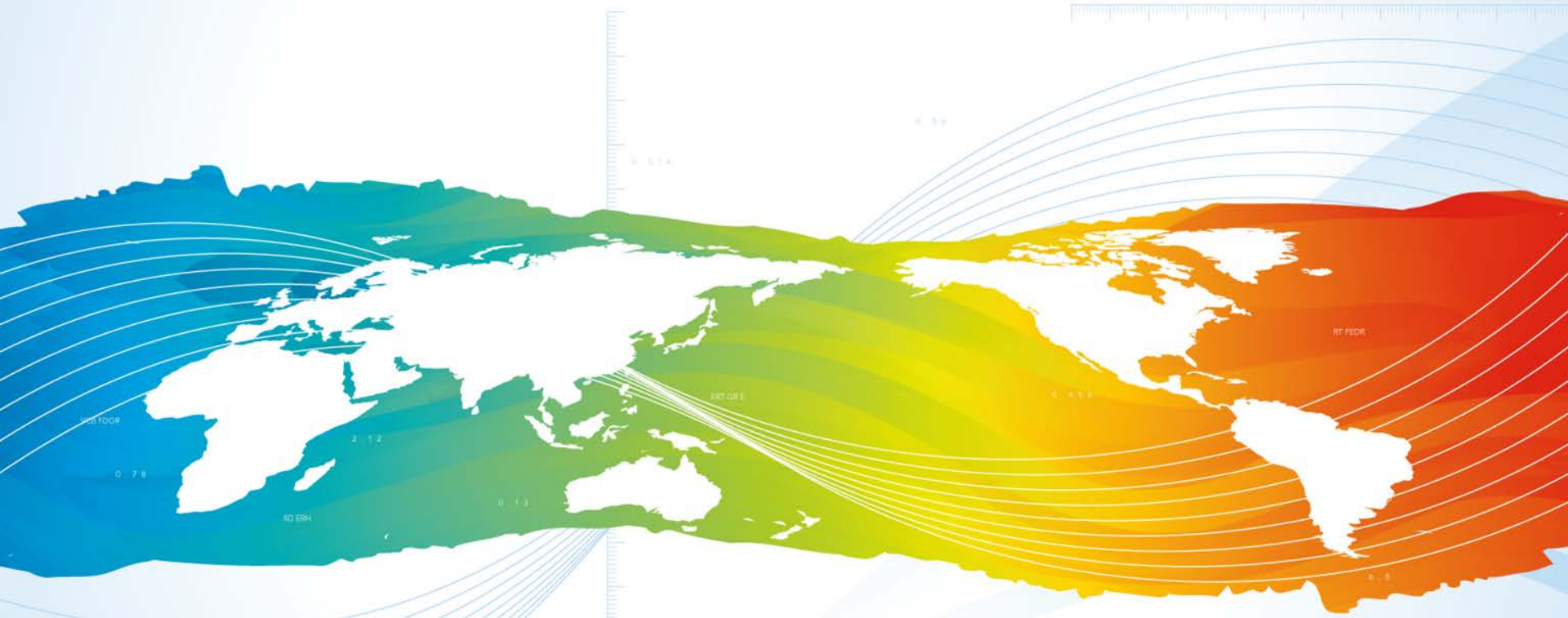
MERCATOR OCEAN
French and European operator in operational oceanography



Mercator Ocean
Ocean Forecasters

Mercator Ocean
Ocean Forecasters

Arctic Ocean & Nordic seas reanalysis Project.

Atelier Glaciologie 25 Juin 2013

1) **Status of the Mercator operational systems for sea ice.**
2) **The reanalysis project.**

The background

Operational systems
The global configurations

- ORCA2 : Global 2° , Operational since 2003 → real time for seasonal forecasts applications. Stopped.
- ORCA1 : **Global 1° ,** Operational since **2012** → real time for seasonal forecasts application (initial conditions). Replacing the previous 2° resolution system. Operationnal in 2012. Configuration test for sensitivities experiments.
- ORCA025 : **Global ¼°** , Operational since **2005** → real time (50 vertical levels) & reanalysis (75 vertical levels). Interannual experiments production and sensitivities experiments (atmospheric forcing, vertical mixing, sea ice …) DRAKKAR & GLORYS projects.
- ORCA12 : **Global 1/12° ,**Operational since **2011** → real time and interannual experiments production and, recently, sensitivities experiments (mesoscale variability). DRAKKAR project.
- BIOMER 1° : **PISCES 1°** , Operational since **2012** → real time (50 vertical levels) ; off-line coupling to operational global ¼°

All the systems (not BIOMER1) use NEMO/LIM & the SEEK filter with altimetry, SST and in situ T/S data assimilation. No assimilation of and under sea ice.

Current status of sea ice in the new real time global 1/12° operational system.

Mercator Ocean
Ocean Forecasters

V1 MyOcean (February 2011)

Model

- NEMO1.09
- CLIO Bulk formulation
- 24H Forcing
- LIM2_VP + damping of the ice/ocean momentum flux
- TKE
- Constant depth for light extinction

Assimilation

- …
- …
- …
- RTG SST
- …
- …

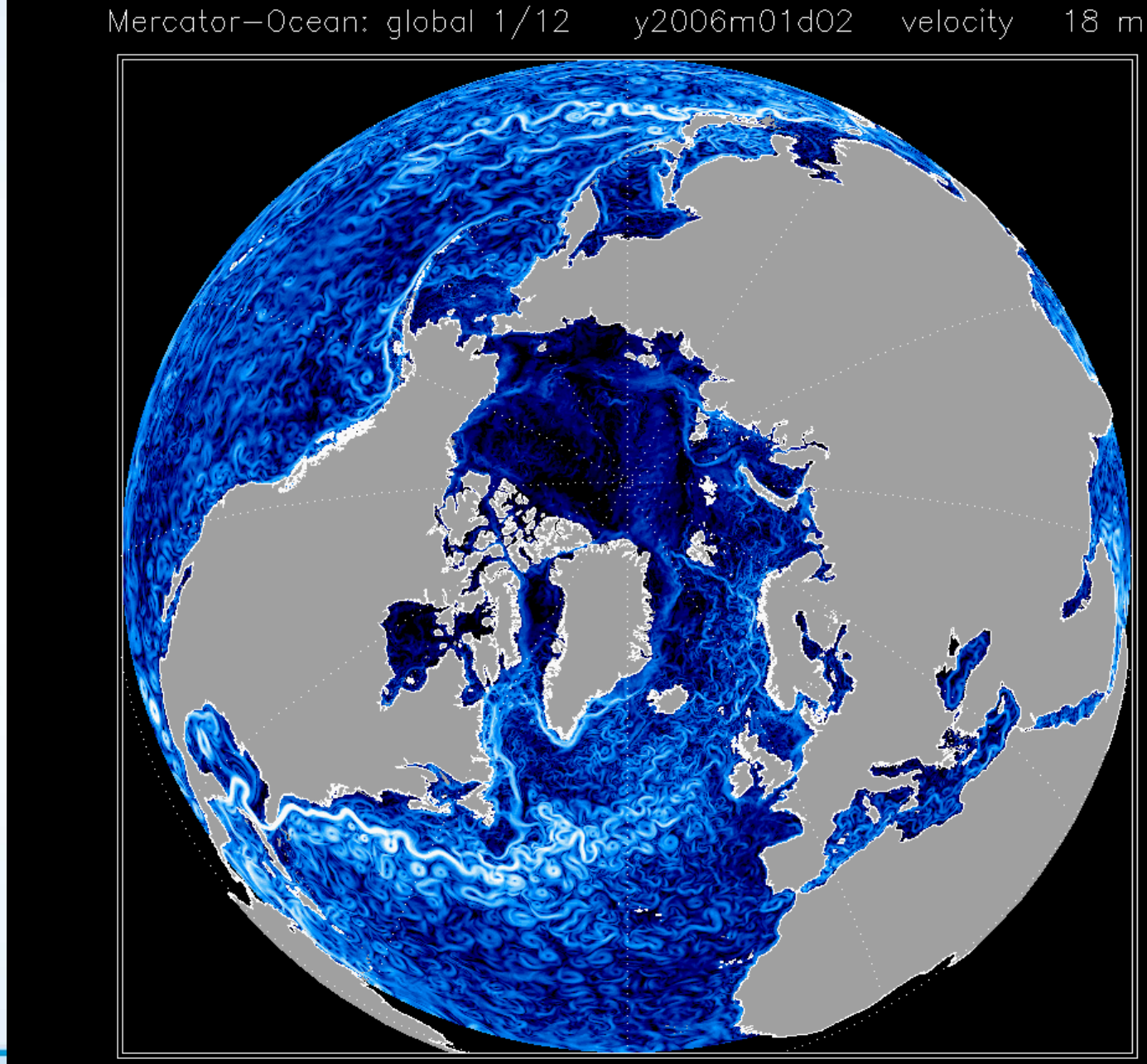
V3 MyOcean2 (April 2013)

Model

- NEMO3.1
- CORE Bulk formulation
- 3H Forcing + analytical diurnal cycle
- LIM2_EVP + full resolved ice/ocean momentum flux
- Changed TKE parameters
- Ocean colour for depth of light extinction

Assimilation

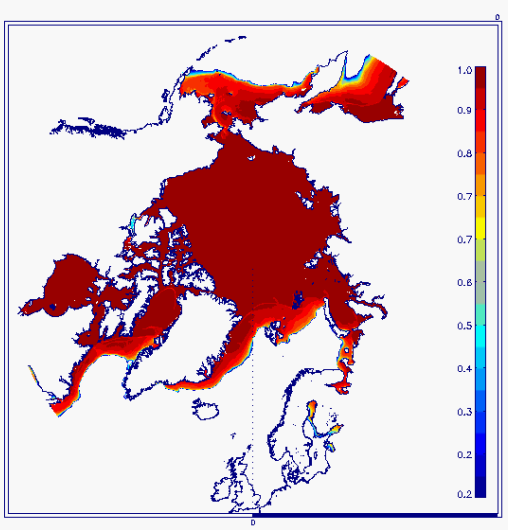
- IAU
- 3D-Var bias correction
- MDT CNES-CLS09 adjusted
- AVHRR+AMSRE SST
- Obs. errors higher near the coast and on shelves
- Increase envisat errors > 65° N


Mercator–Ocean: global 1/12 y2006m01d02 velocity 18 m

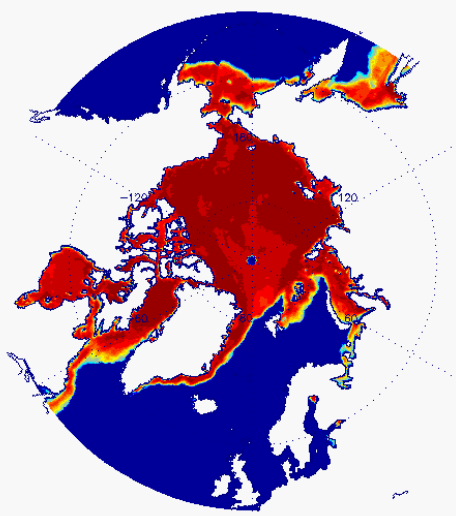
Current status of sea ice in the new real time global 1/12° operational system.

Arctic sea ice (no assimilation).

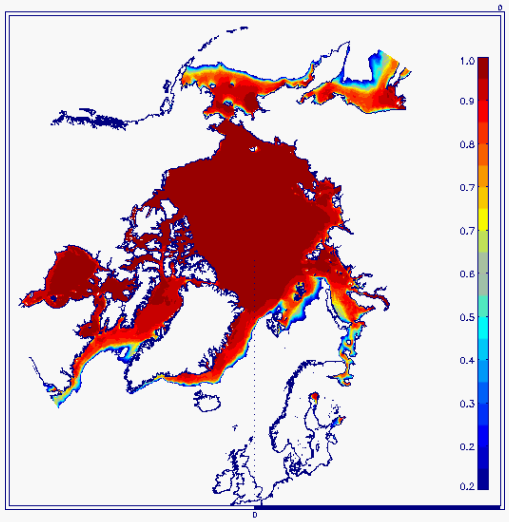
Global 1/12° MyOcean



Obs. IFREMER/CERSAT



Global 1/12° MyOcean2

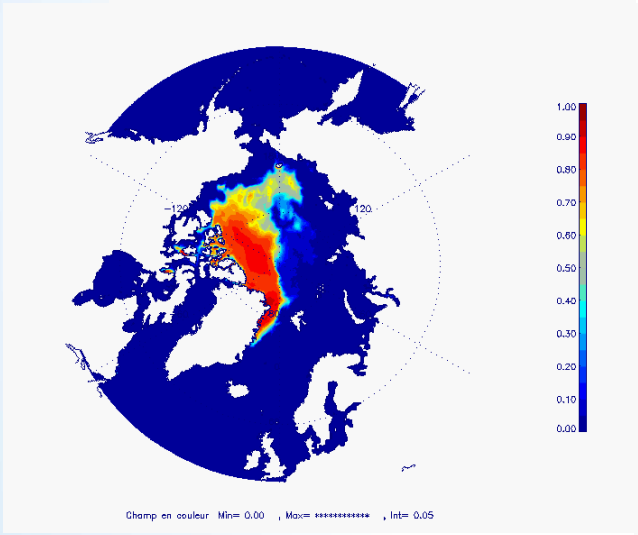


March 2012

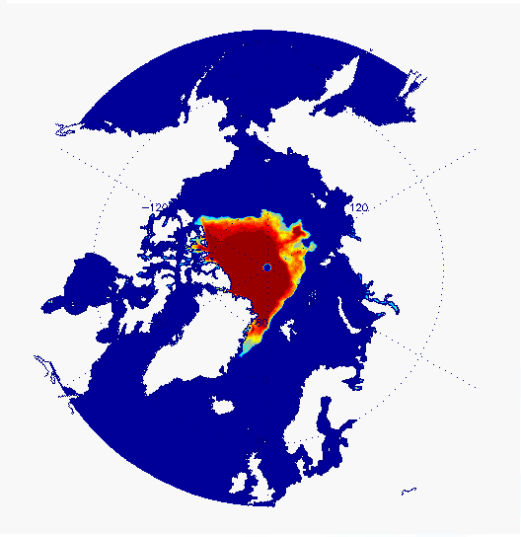
Current status of sea ice in the new real time global 1/12° operational system.

Arctic sea ice (no assimilation).

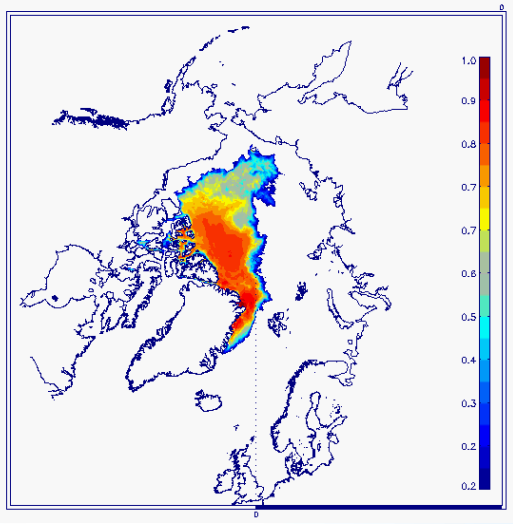
Global ¼° MyOcean2



Obs. IFREMER/CERSAT



Global 1/12° MyOcean2

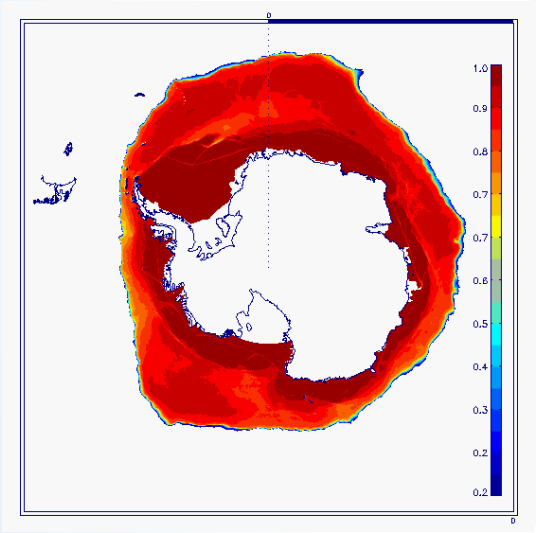


September 2012

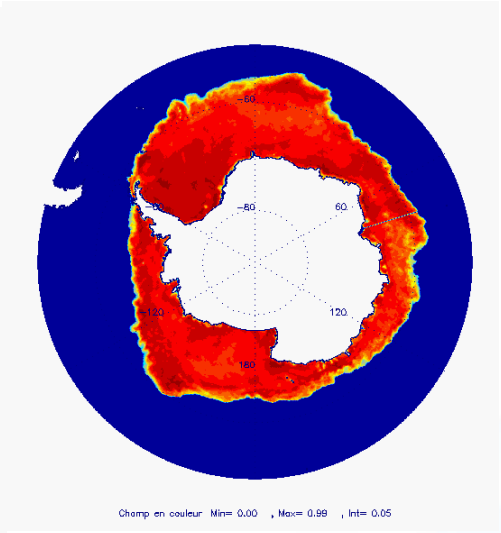
Current status of sea ice in the new real time global 1/12° operational system.

Antarctic sea ice (no assimilation).

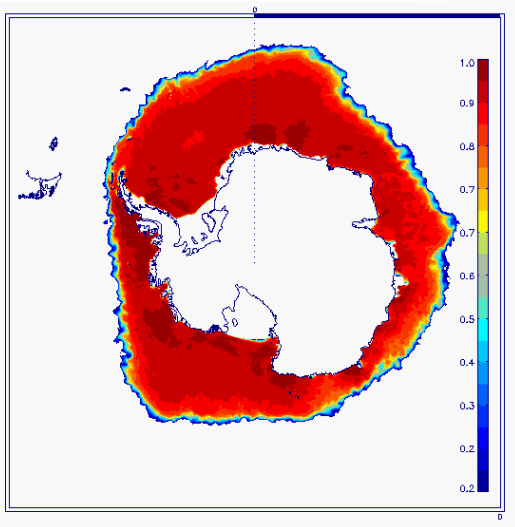
Global 1/12° MyOcean



Obs. IFREMER/CERSAT



Global 1/12° MyOcean2



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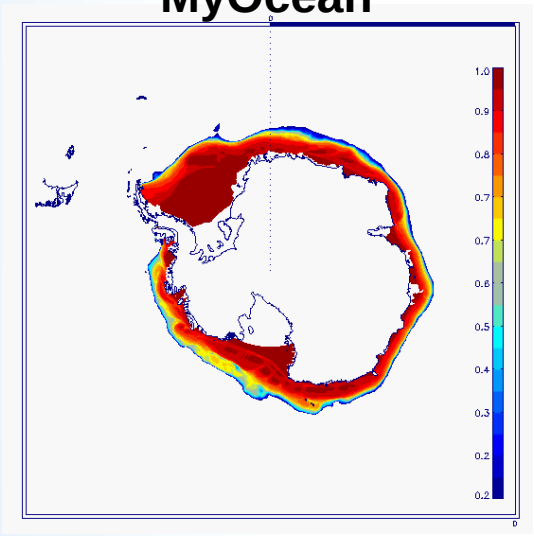
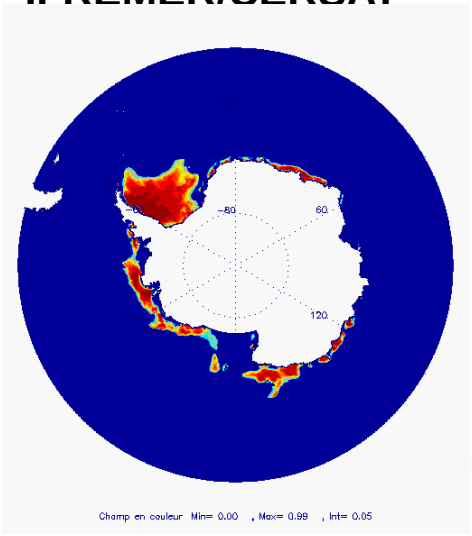
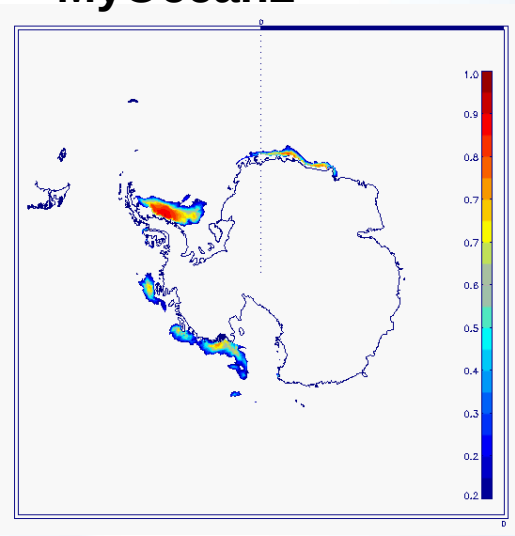
Global 1/12° MyOcean



Obs. IFREMER/CERSAT



Global 1/12° MyOcean2



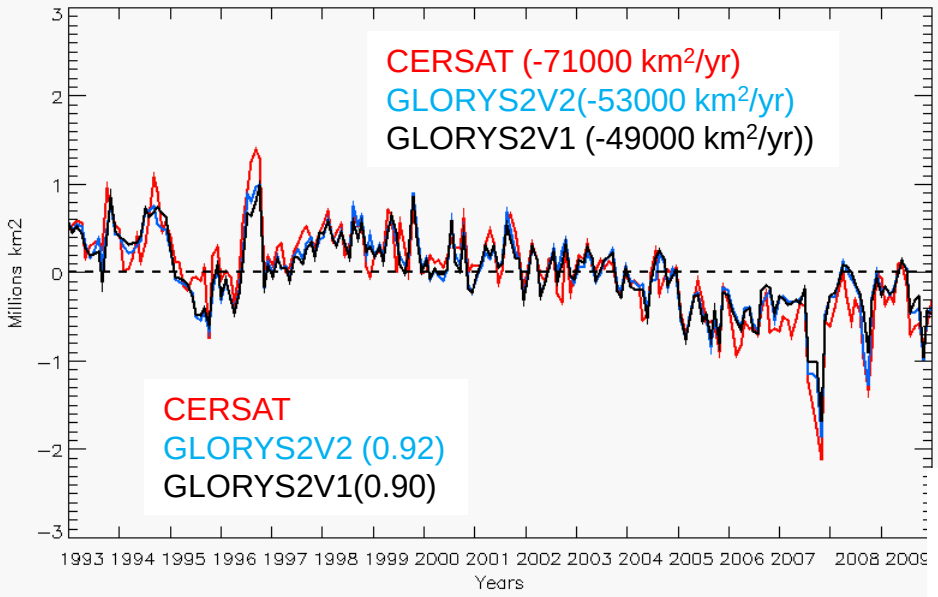
February 2012

Current status of operational system : oceanic reanalysis
Sea Ice Interannual Variability 1993-2009

Mercator Ocean
Ocean Forecasters

Arctic Ocean

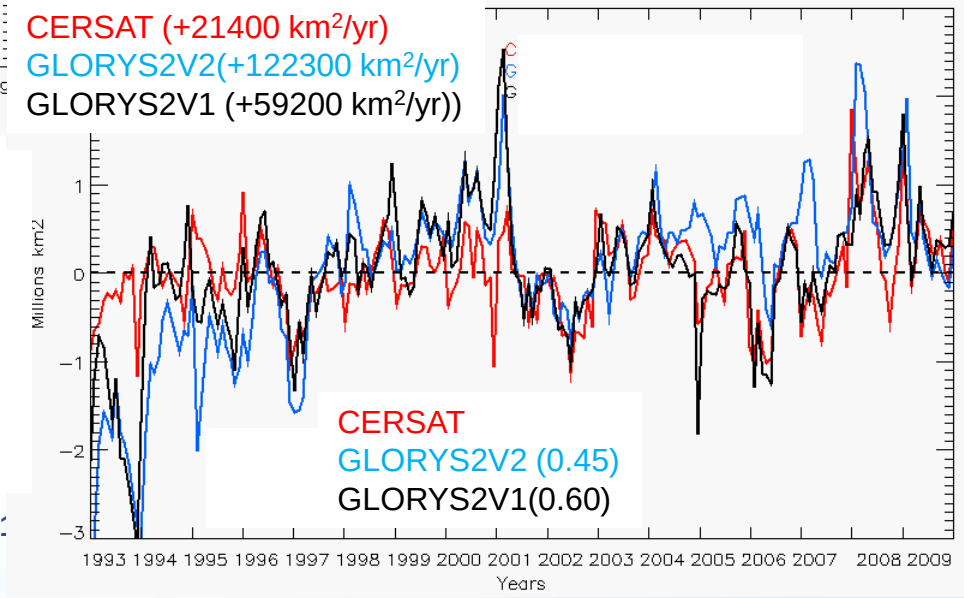
Sea Ice Extent Monthly Anomaly 1993-2009



Arctic Ocean

- ✓ Strong correlation with obs
- ✓ Trend in accordance with obs

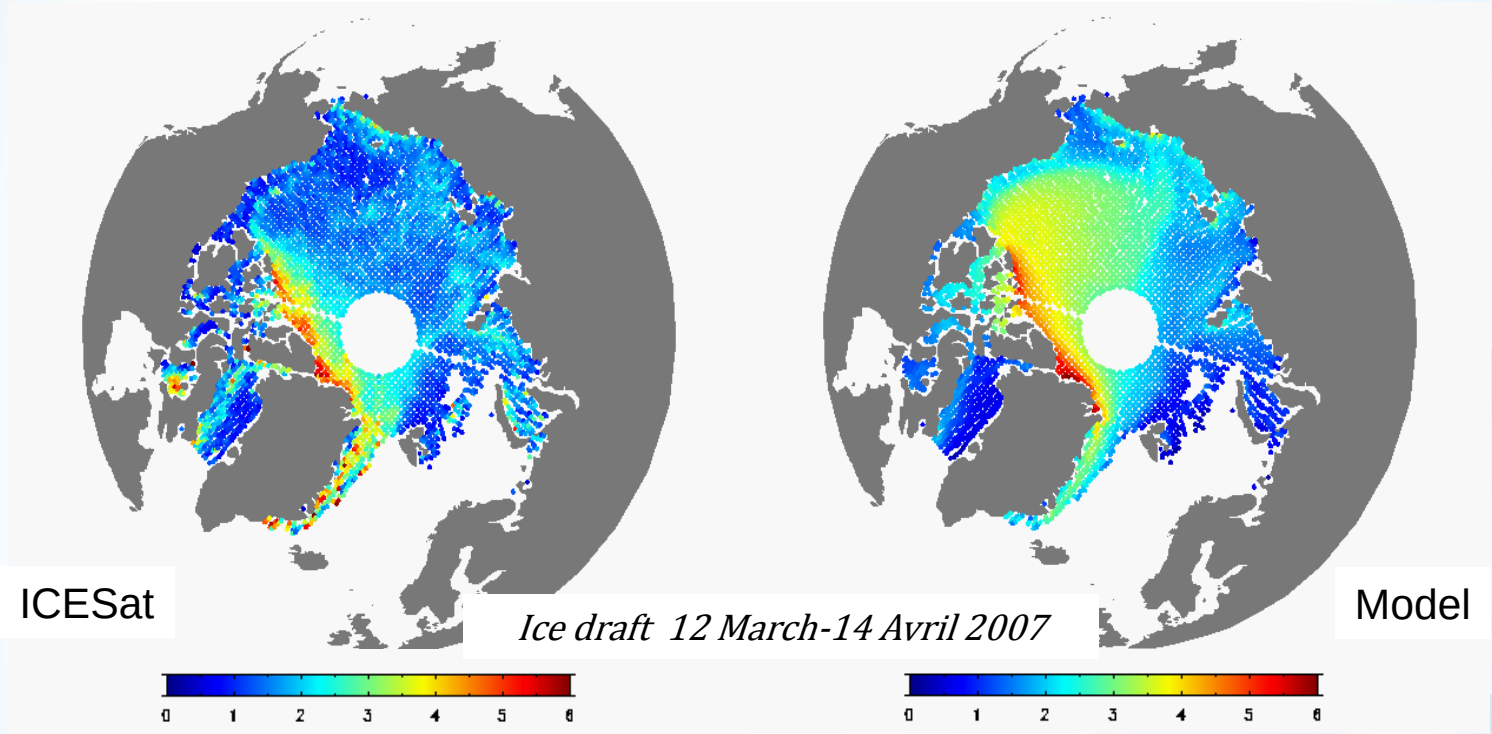
Antarctica



Antarctica

- ✓ Benefit from 3H forcing
- ✓ No significant trend over 1993-2009
- ✓ Interannual variability is dominant
- ✓ No significant decadal variability
- ✓ Initial conditions to be improved
- ✓ Peculiar strong events in summer 1993 and 2001.

Current status of operational system : oceanic reanalysis
Validation of sea ice thickness 1993-2009

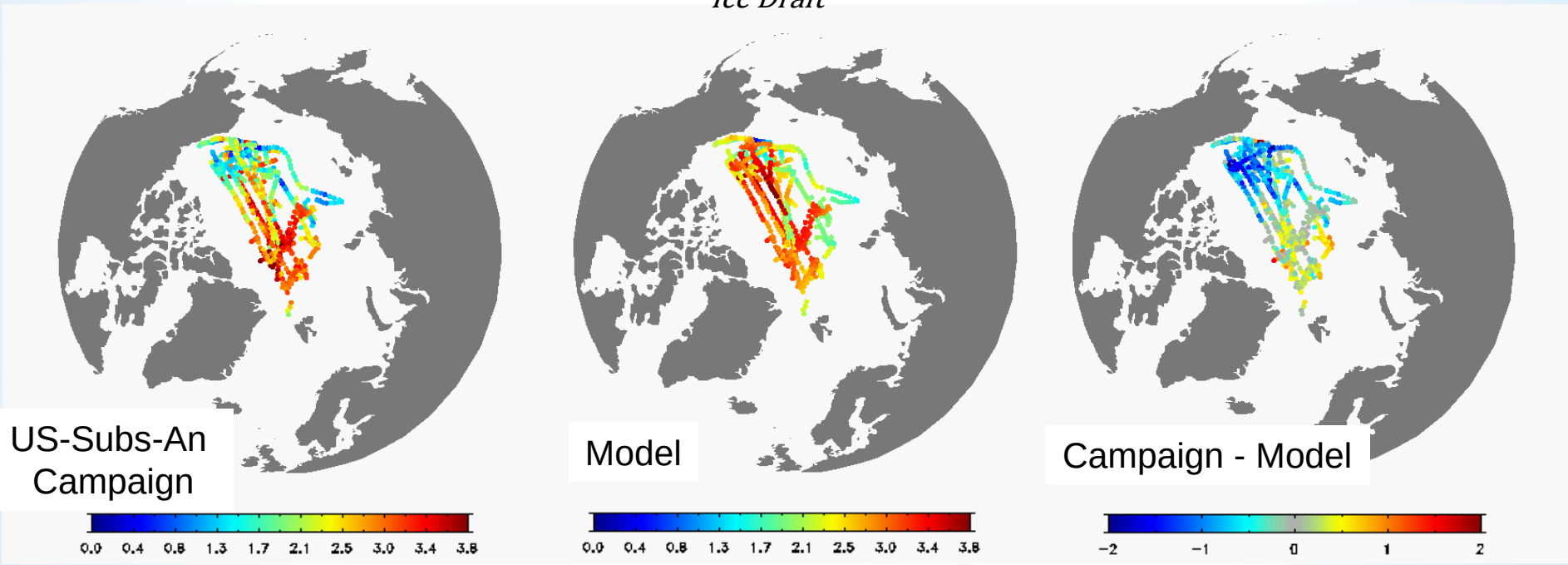


Ice draft 12 March-14 Avril 2007

- Realistic maximum north of the Canadian Archipelagoe
- Eurasian Basin, Kara and Laptev Seas OK
- Strong overestimation in the Canadian Basin
- Weak transports in the straits

Current status of operational system : oceanic reanalysis
Validation of sea ice thickness 1993-2009

Ice Draft

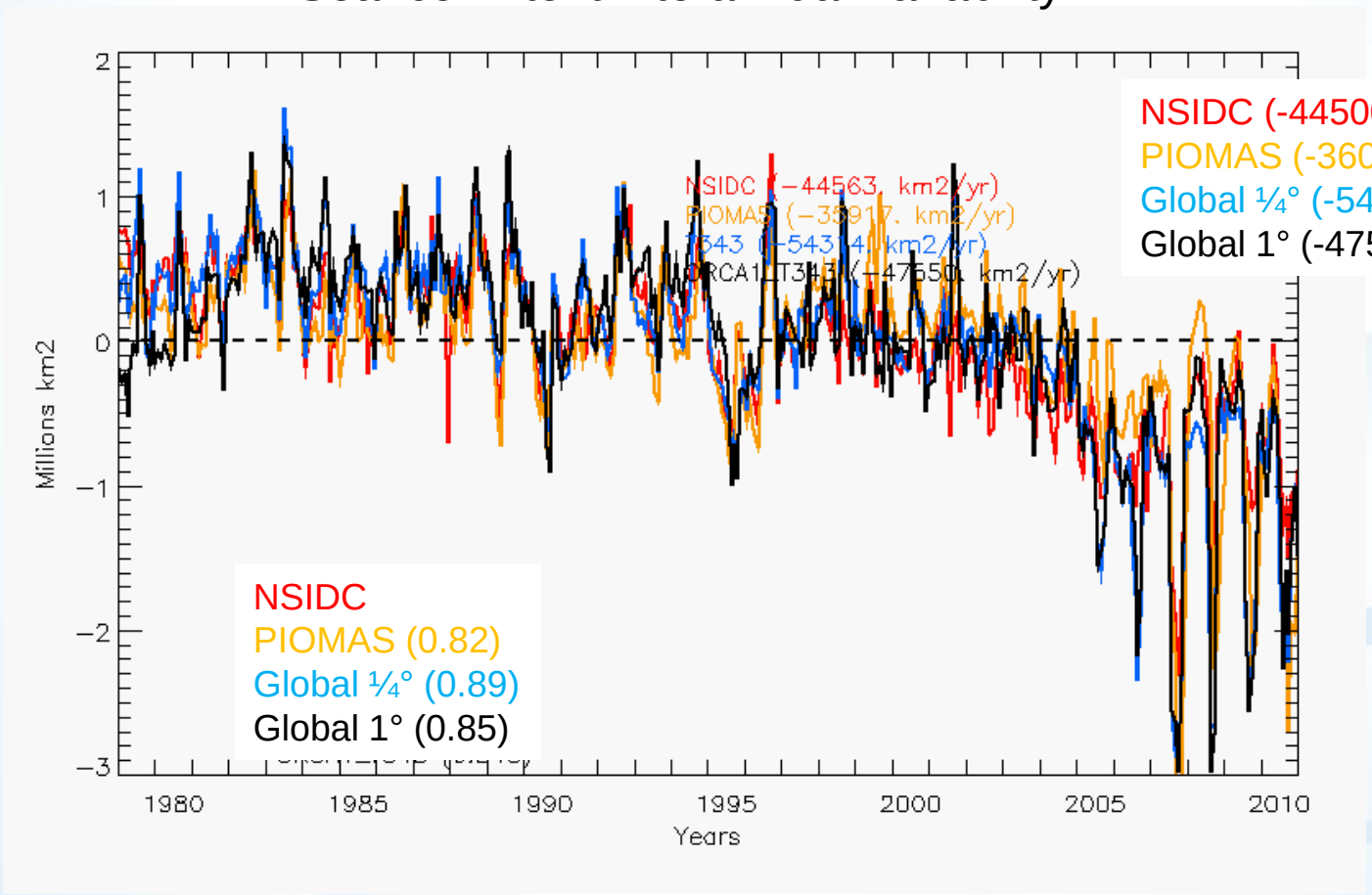


- Light underestimation in the Eurasian Basin
- Clear overestimation in the Canadian Basin

Preparation of the global ¼° 1979-2012 reanalysis.

Mercator Ocean
Ocean Forecasters

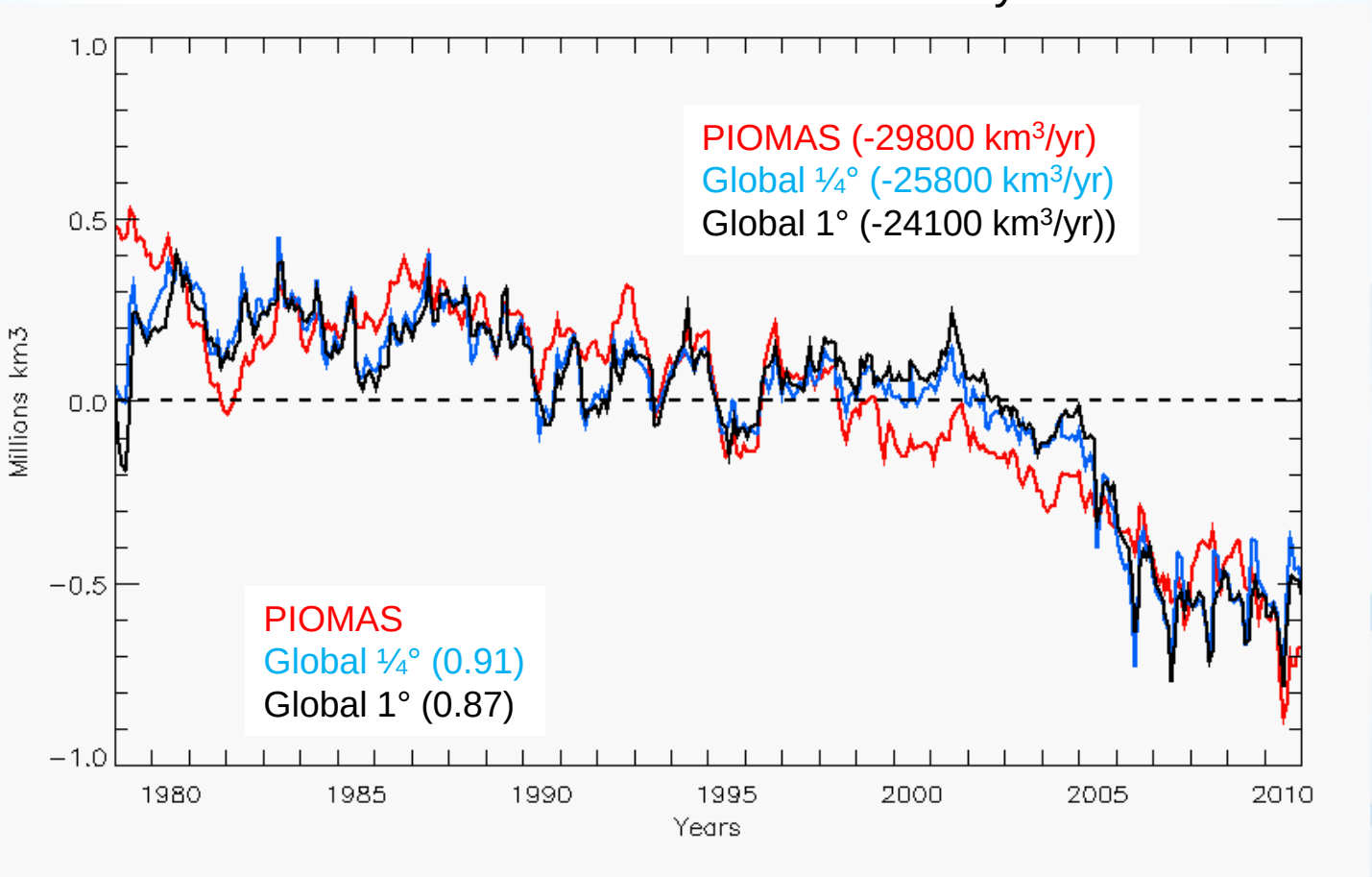
Sea Ice Extent Interannual Variability



Preparation of the global ¼° 1979-2012 reanalysis.

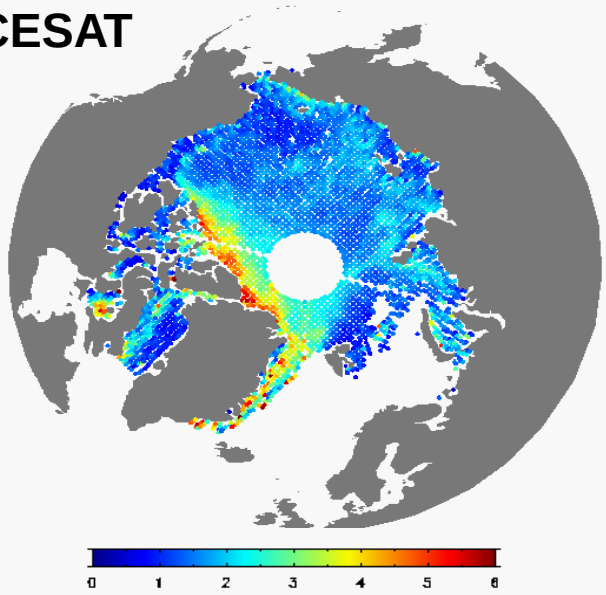
Mercator Ocean
Ocean Forecasters

Sea Ice Volume Interannual Variability



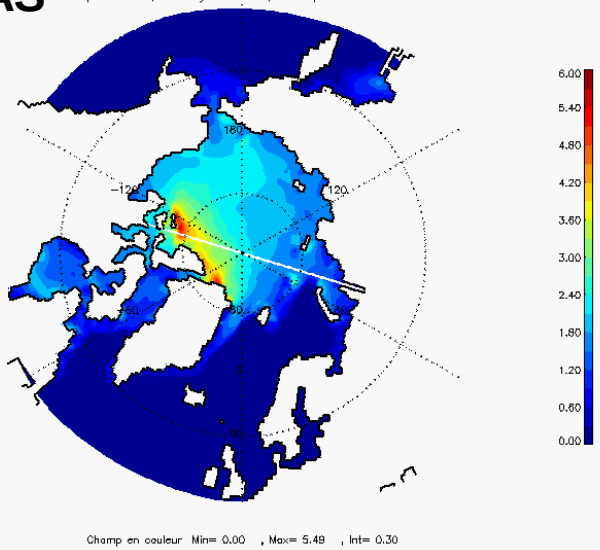
Preparation of the global ¼° 1979-2012 reanalysis.

ICESAT

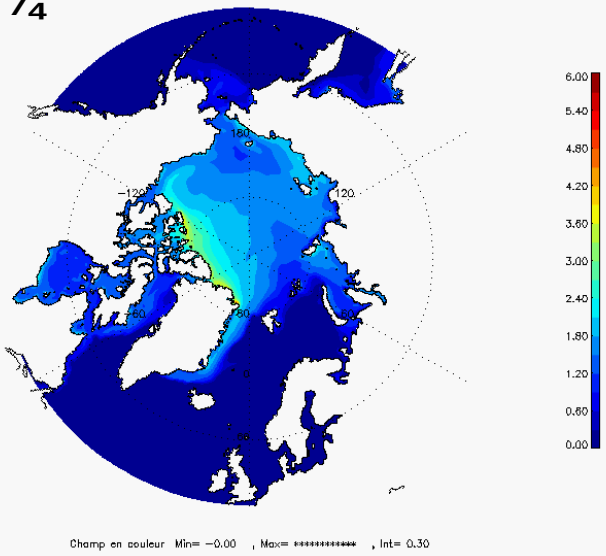


March 2007

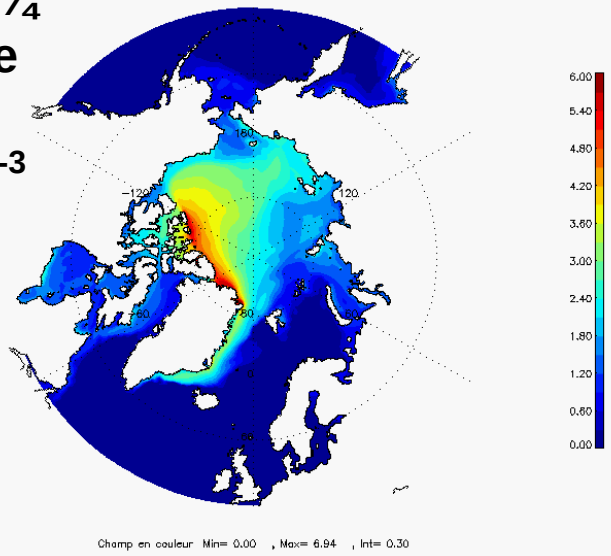
PIOMAS



Global ¼°



Global ¼° Air/ice drag $1.510.^{-3}$



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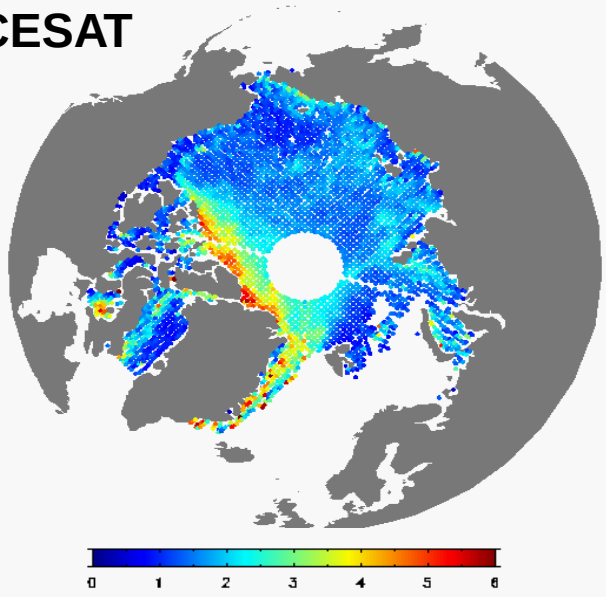
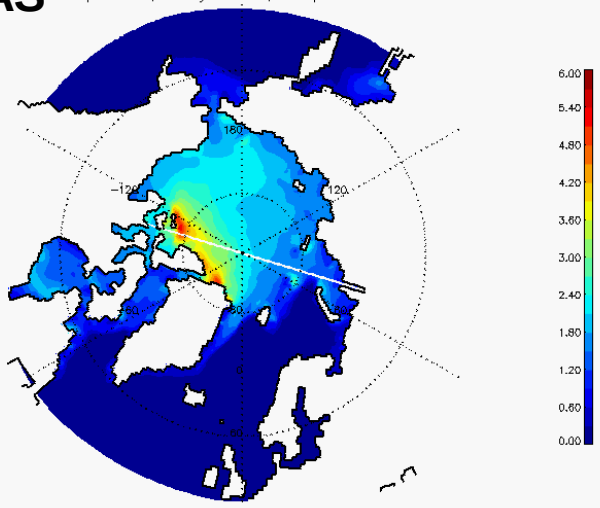
ICESAT

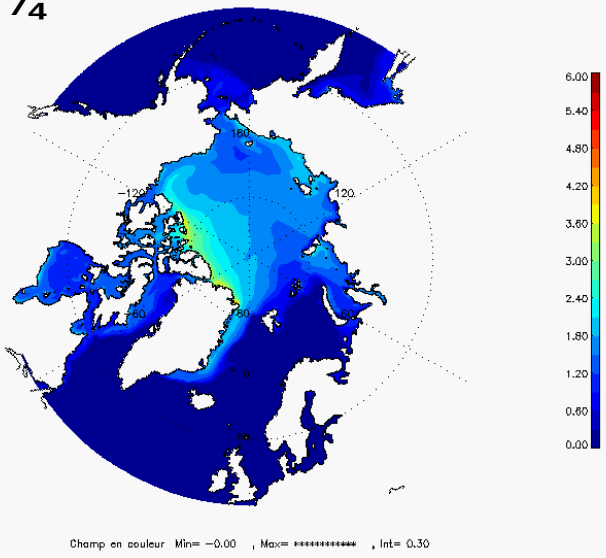


PIOMAS

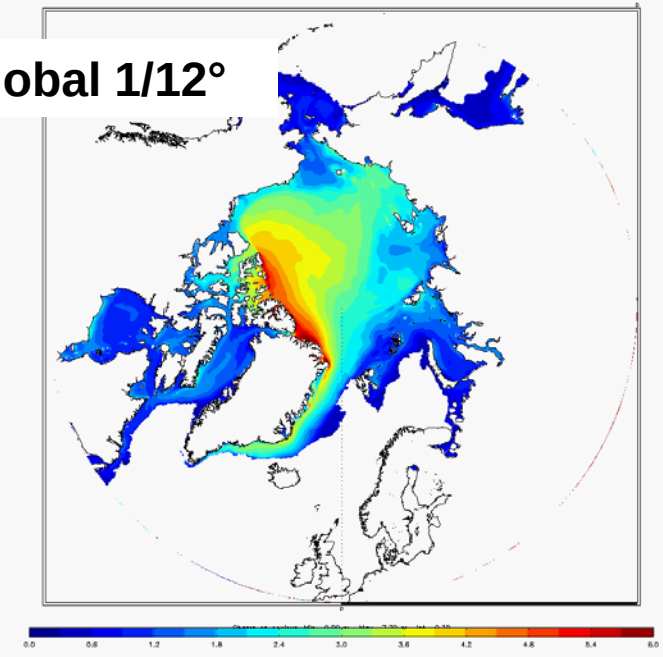


March 2007

Global ¼°



Global 1/12°



The context of the reanalysis project

Open Call in the « Groupe Mission Mercator-Coriolis » (GMMC) framework.

Goal : enhance and favour collaborations and exchanges between research community and operational teams.

One of the thematics proposed is the **Operational Monitoring of the Arctic Ocean Climate Change.**

« …. The anticipation of the impacts linked to this climatic evolution needs a reinforcement of the monitoring capacities over the Arctic Ocean, … A proposal is expected on this subject, under letter of intention or a PPR (Projet Partenariat Renforcé) form. … Collaborations with canadians people are strongly encouraged … »
« The objective would be to improve the capacities of the operational monitoring over the Arctic Ocean from synoptic scales to medium range and/or seasonal forecasts »
« Planned works will concern ocean/ice modelling, in situ and satellite observations, assimilation schemes, air/sea exchanges, biogeochemistry coupling, and improvment of the reanalysis at high latitudes ».

Letter of intention has been approved and fincanced in 2012.
The project : gathering people around a reanalysis project dedicated to the Arctic Ocean & the Nordic seas.

People involved until now.

C. Provost[1], G. Garric[2], C.-E. Testut[2], E. Greiner[2,3], F. Girard-Ardhuin[4], L. Mémery[5], J-C. Gascard[1], J. Paul[2,6], C. Lique[7], P. Brasseur[8], R. Bourdallé-Badie[2], J. Chanut[2], M. Chevallier[2,9], D. Ruiz-Pino[1], C, Coatanoan[4], M.-H. Rio[3], M. Ablain[3], M. Vancoppenolle[1], Y. Drillet[2], N. Ferry[2], C. Régnier[2], L. Zawadski[2], G. Smith[10], F. Dupont[10], J. Weiss[8], T. Fichefet[11], F. Massonnet[11] & D. Salas y Melia[9].

[1]LOCEAN (UPMC, Paris), [2]Mercator Océan (Toulouse), [3]CLS (Toulouse), [4]IFREMER (Brest), [5]LEMAR (Brest), [6]Links(Toulouse), [7]Univ. Oxford (UK), [8]LGGE (Grenoble), [9]Météo France (CNRM, Toulouse), [10]EC (Montréal, Canada), [11]UCL (Louvain-la-Neuve, Belgique).

The outlines

Preparation of the PPR proposal.
Need to be submitted by early september 2013 and lasts for 3 years.
Financial support concern only conferences, meetings, …
Three meetings already organised

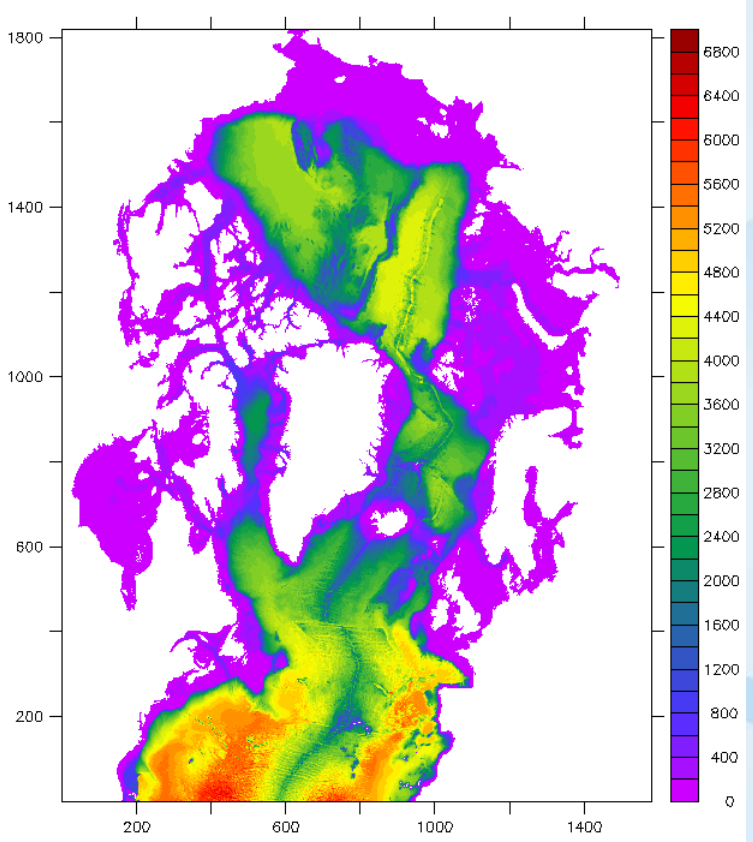
Outlines of the project :

- Production of two reanalysis dedicated to Arctic Ocean & Nordic seas :
  - ✓ At 1/12° including the 2007-2014 periods.
  - ✓ At ¼° including the 1979-2014 periods.
- Create a strong link between observation community and modelling/assimilation groups.
- Identify and retrieve data over the Arctic Ocean.
- Scientific objectives : freshwater storage, vertical mixing, inflow/outflow, sea ice volume, impact of the observation network, primary production, CO2, …

The outlines

Configuration/NEMO-LIM

- CREG 1/12° (2-6km) + 75L / NEMO3.5 but assimil
  & CREG configuration not handled at Mercator Oce
- LIM2_EVP ; tests with LIM3 (assimilation interface
- Research part : Sea ice rheology (Grenoble, Louva
- Vertical mixing GLS (see Romain's talk)
- Research part : hybrid vertical coordinates (J. Char
  Badie), double-diffusion tests.
- No tides and no waves/ice interactions planified
- Boundaries conditions:
  - Bering strait : ~0.8Sv (literature, Canada, TOPA
    Buffer zone for ice.
  - 26°N/Gibraltar : GLORYS2V3.
- Initial conditions :
  - October 2006 : Sea ice : sea ice fraction (IFREM
    global ¼° hindcasts; Temperature & Salinity (T/S
    MIMOC?
  - January 1979: Sea ice : sea ice fraction (NSIDC)
    (Levitus98).



Source: G. Smith, Env. Canada, Montréal

The outlines

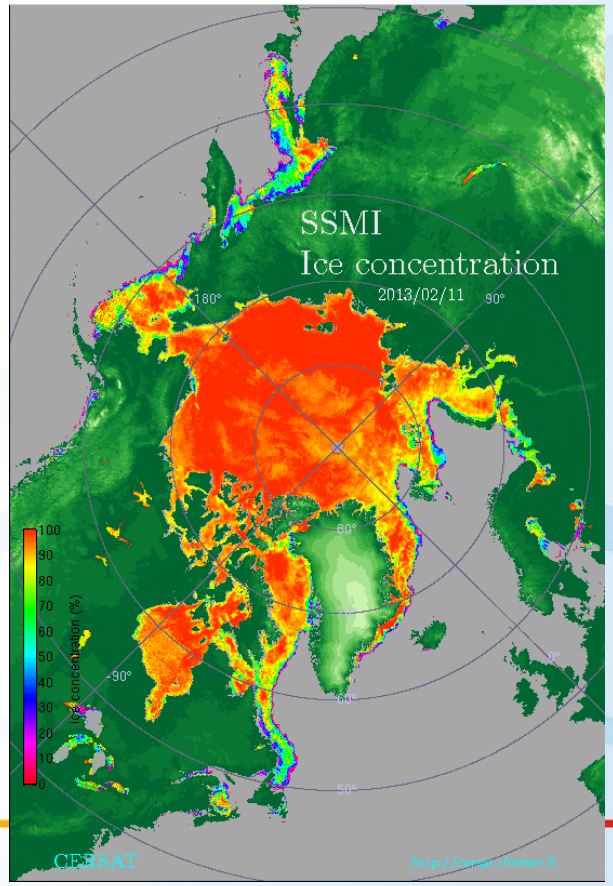
Atmospheric forcing :

- 2007-2014: ERA-Interim (0.7°, 70km) 3H/24H (diurnal analytical cycle) + correction?
- 2007-2014: ECMWF IFS (0.14°, 16km) 3H/24H (diurnal analytical cycle) + correction?
- 2007-2014: GEM (33km)?
- 1979-2014 : ERA-Interim (0.7°, 70km) 3H/24H (diurnal analytical cycle) + correction?
- Formulation Bulk COARE over ocean & CLIO over sea ice
- Runoffs : climatological → implementation of interannual signal from ISBA/TRIP planned.
- Greenland and glaciers freshwater fluxes from GRISLI model ? GRACE ?.

The outlines

Obervations

- Sea Ice
  - Concentration (SIC) : 12.5km (IFREMER/CERSAT) (Assimilation + Validation)
  - Speed : 62,5km (CERSAT) or 31,25km (available from 2002) (Validation)
  - Surface roughness (~ thickness proxy) 12,5km (validation)
  - Thickness CDR in situ data (validation)
  - Thickness from CRYOSAT2? SMOSice ?
  - Snow depth data ? (validation)
  - CIS data ?



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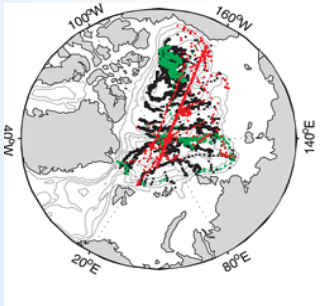
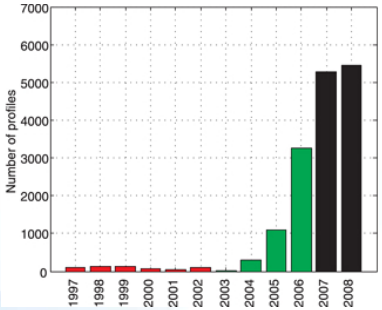
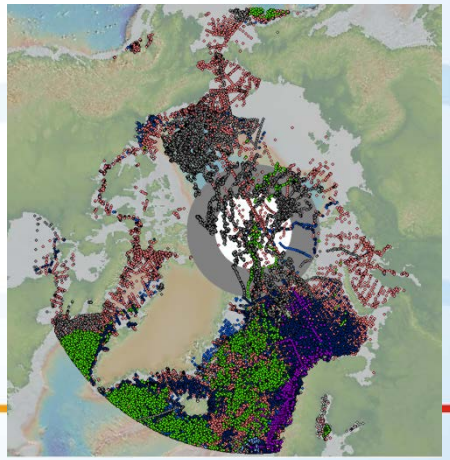
  - CIS data ?
- In situ T/S :
  - IPY, DAMOCLES : shelves data to be process (LOCEAN → Coriolis)
  - IAOOS, Arcticnet, IMR, … data to be retrieved (LOCEAN/Mercator/Coriolis/Canada?)
  - ARGO (CORA) over open ocean, seals data (Assimilation/Validation)
  - Data processing at Coriolis.





Données disponibles provenant des projets IPY & DAMOCLES.

Données disponibles provenant du portail du projet européen MyOcean.
Total of 221324 vertical profiles ; 90% from GTS, US-NODC and Argo floats.



The outlines

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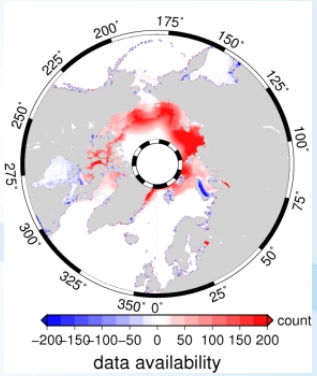
  - ARGO (CORA) over open ocean, seals data (Assimilation/Validation)
  - Data processing at Coriolis.
- SST
  - AVHRR ¼° (Assimilation) OSTIA ? (Validation)
- Altimetry (CLS) (see M-H. Rio's talk) Assimilation)
  - Product (> 50°N) L3 & L4 delayed time1993-2010 ;
  - Product (> 50°N) L3 real time 2011-2012 with different standard
  - MDT, wait for GOCE ?



Altimetry data availability 1993-2012 compared to SSALTO/DUACS products.

The outlines

Assimilation

- SAM2V1 with ice fraction assimilation (implemented in GLORYS2V3 → see Charles-Emmanuel's talk) & SST assimilation.
- 2007-2014 : mutlivariate anaysis with in situ and altimetry data.
- Modes : from GLORYS2V3 from CREG4 & ORCA12 for CREG12.
- Research part : anamorphosis approach.
- Not ready for velocities.

Biogeochemistry

- PISCES online
- Main target : 1979-2014 with CREG4;
- Need good physics : vertical mixing, shelves/basin exchanges, solar penetration (pelagos/benthos coupling), inflow/outflow.
- Need of PISCES calibration for Arctic specificities.
- Biogeochmistry in sea ice : not ready
- CHINARE campaign data (LOCEAN)

Validation/OSE/OSSE

- Diffusion criterion should meet the scientific objectives.
- Sensitivities experiments : large scale bias correction, experiments with and without in situ (OSSE), with and without altimetry, …