



**Barcelona
Supercomputing
Center**

Centro Nacional de Supercomputación

Ocean and Ice Initial Conditions for EC-Earth

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Ocean Initial Conditions



GLORYS2v1 reanalysis (1993-2009)

Restarts

- **ORCA025L75** : original restarts extrapolation + empty seas filled climatology
- **ORCA025L46**: vertical interpolation + extrapolation + empty seas filled climatology
- **ORCA1L46**: vertical and horizontal interpolation + extrapolation + empty seas filled climatology

At ECFS `ec:/c3y/restarts_GLORYS2V1/` **ORCA1L46** or **ORCA025L46** or **ORCA025L75**

Restarts from nudging toward monthly means:

Coupled EC-Earth3.0.1 with 3D T and S nudged toward monthly-mean

- **ORCA025L75** : **m01u** , at ECFS `ec:/c3y/restarts_m01u`
- **ORCA025L46** : **m01w**, at ECFS `ec:/c3y/restarts_m01w`
- **ORCA1L46** : **m01x**, at ECFS `ec:/c3y/restarts_m01x`

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GLOSEA5 reanalysis (1990-2013)

Restarts:

- **ORCA025L75** : original restarts after horizontal extrapolation to different mask (using Python script)

At ECFS **ec:/c3e/ORCA025L75/GLOSEA5**

- **ORCA1L46** : vertical and horizontal interpolation + extrapolation using SOSIE software (<http://sosie.sourceforge.net/>)

At ECFS **ec:/c3e/ORCA1L46/GLOSEA5**

More information :

https://dev.ec-earth.org/projects/ecearth3/wiki/Ocean_initial_conditions_for_climate_predictions

ORAS4 reanalysis (1958-2013)

Restarts:

- **ORCA1L46** : vertical interpolation and extrapolation + empty seas filled climatology

At ECFS `ec:/c3y/restarts_ORAS4/ ORCA1L46` or `ORCA025L46` or `ORCA025L75`

More information :

https://dev.ec-earth.org/projects/ecearth3/wiki/Ocean_initial_conditions_for_climate_predictions

ORAP5 reanalysis (1957-2013)

Restarts:

- **ORCA025L75** : original restarts

At ECFS `ec:/c3e/ORCA025L75/ORAP5`

- **ORCA1L46** : vertical and horizontal interpolation + extrapolation using SOSIE software (<http://sosie.sourceforge.net/>)

At ECFS `ec:/c3e/ORCA1L46/ORAP5`

Restarts from nudging toward monthly means:

FUTURE PLAN

More information :

https://dev.ec-earth.org/projects/eearth3/wiki/Ocean_initial_conditions_for_climate_predictions

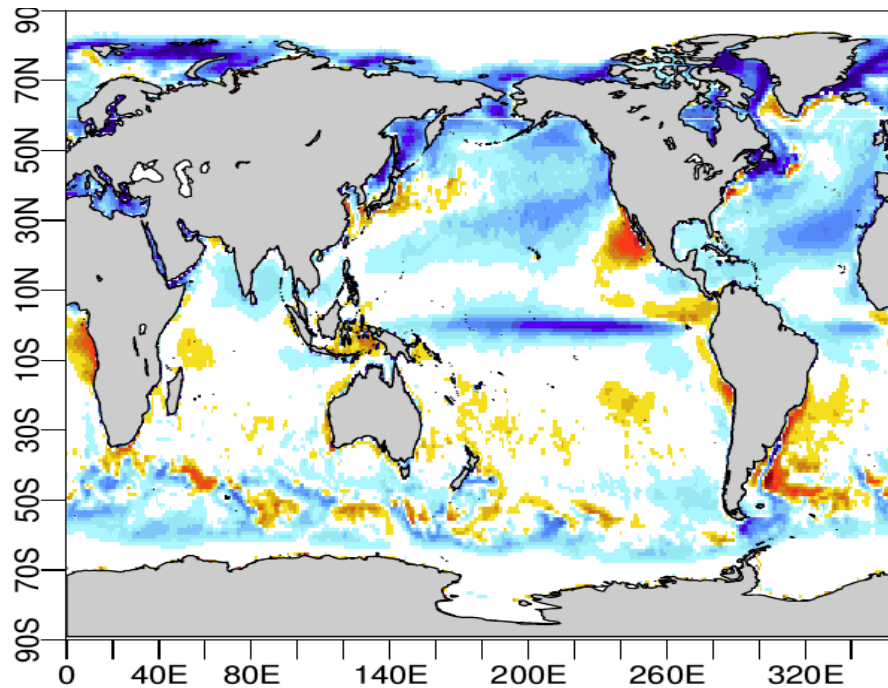
Testing the ocean initial conditions HR(?)

- EC-Earth3.1 in T511L91-ORCA025L75-LIM2 configuration
- Initialization on 1st May every year from 1993 to 2000
- 4 month forecasts
- 5 members
- IFS initialized from ERA-interim with singular vectors to obtain 5 members
- LIM2 initialized from GLORYS 2v1
- NEMO initialized with:
 - GLORYS2v1 restarts **HR-GLORYS2V1**
 - GLOSEA5 restarts **HR-GLOSEA5**

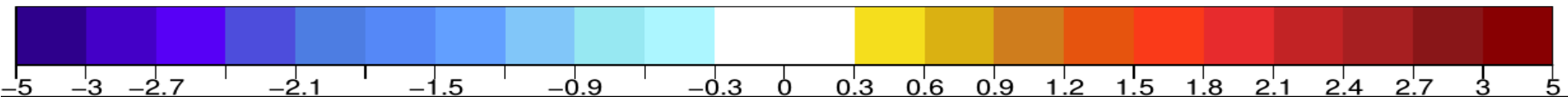
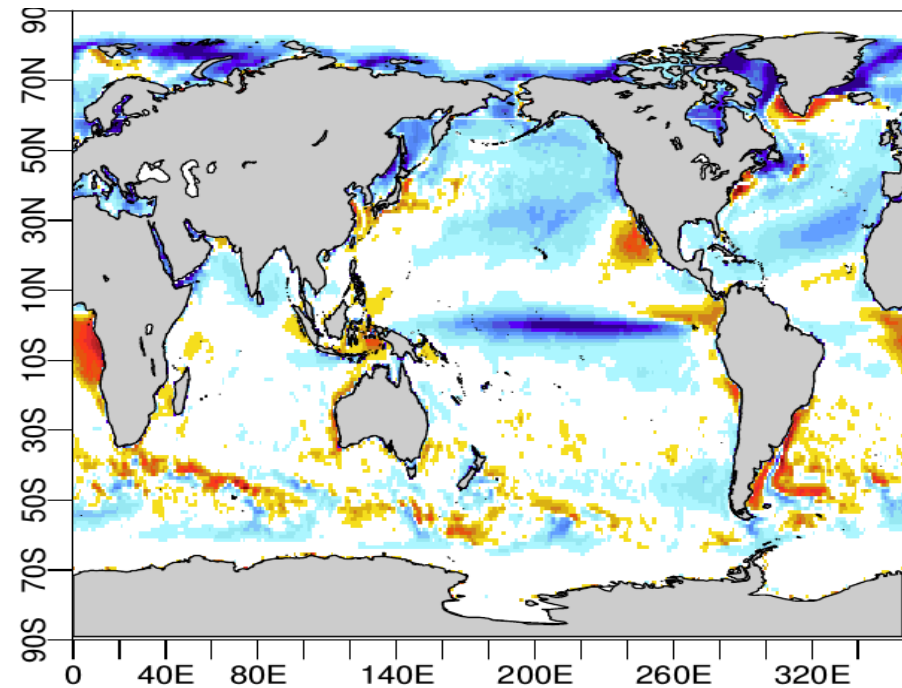
Testing the ocean initial conditions

SST JJA bias: model minus HadISST (Rayner 2003)

HR-GLOSEA5



HR-GLORYS2V1



From GLORYS2v1₍₁₉₉₂₋₂₀₀₉₎ and GLORYS2V3₍₁₉₉₂₋₂₀₁₃₎ reanalysis restarts:

- ORCA025L75
- ORCA1L46

From ORAS4₍₁₉₅₈₋₂₀₁₅₎, ORAP5₍₁₉₇₉₋₂₀₁₃₎, ORAS5_(coming soon) reanalysis restarts:

- ORCA025L75
- ORCA1L46

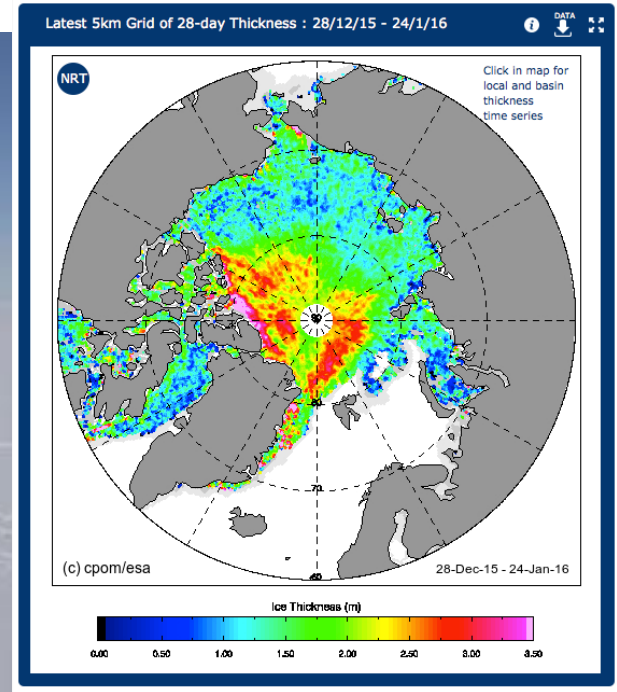
From GLOSEAS5 reanalysis restarts:

- ORCA025L75
- ORCA1L46

Future ocean initial conditions

- **Coupled experiment nudging only the ocean**
- Ocean nudging toward monthly mean ORAP5 (interpolated from HR to standard resolution)
 - 3D T and 3D salinity
 - From 1979 to present
- **Coupled experiment nudging ocean and atmosphere**
 - Ocean nudging toward monthly mean ORAP5 (interpolated from HR to standard resolution)
 - 3D SST and 3D salinity
 - Atmospheric nudging toward 6h Era-interim
 - Winds
 - From 1979 to present

Ice initialization



Restarts:

- **ORCA025** : original restarts
At ECFS `ec:/c3y/restarts_GLORYS/ORCA025`
- **ORCA1** : horizontal interpolation + extrapolation
At ECFS `ec:/c3y/restarts_GLORYS/ORCA1`

More information :

https://dev.ec-earth.org/projects/ecearth3/wiki/Sea_ice_initial_conditions_for_climate_predictions

LIM2:

- **ORCA1** : 5-member sea ice reconstructions obtained by running NEMO-LIM2 nudged toward ORAS4 monthly-mean 3D T and S and forced by
 - DFS4.3 over the 1958-2006 period = **b02s**
At ECFS **ec:/c3y/restarts_b02s**
 - ERA-interim over the 1979-2013 period = **i00v**
At ECFS **ec:/c3y/restarts_i00v**

LIM3 – 1 category:

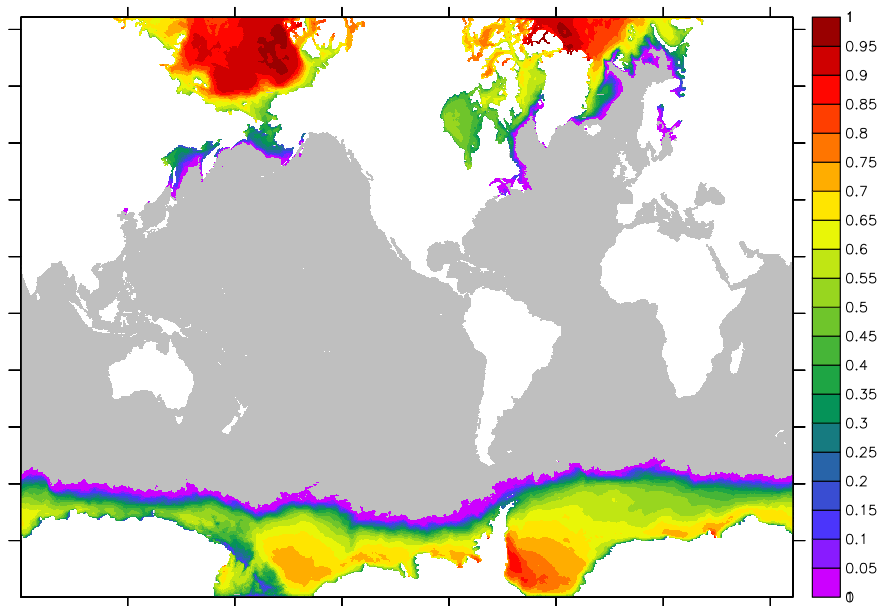
- **ORCA1** : 5-member sea ice reconstructions obtained by running NEMO-LIM3 nudged toward ORAS4 monthly-mean 3D T and S and forced by
 - DFS4.3 over the 1958-2006 period= **i056**
At ECFS **ec:/c3y/restarts_i056**
 - ERA-interim over the 1979-2013 period= **i057**
At ECFS **ec:/c3y/restarts_i057**
- **ORCA025** : 1-member sea ice reconstruction using NEMO-LIM3 forced by DFS4.3 over the 1958-2006 period= **m063**

Coming soon

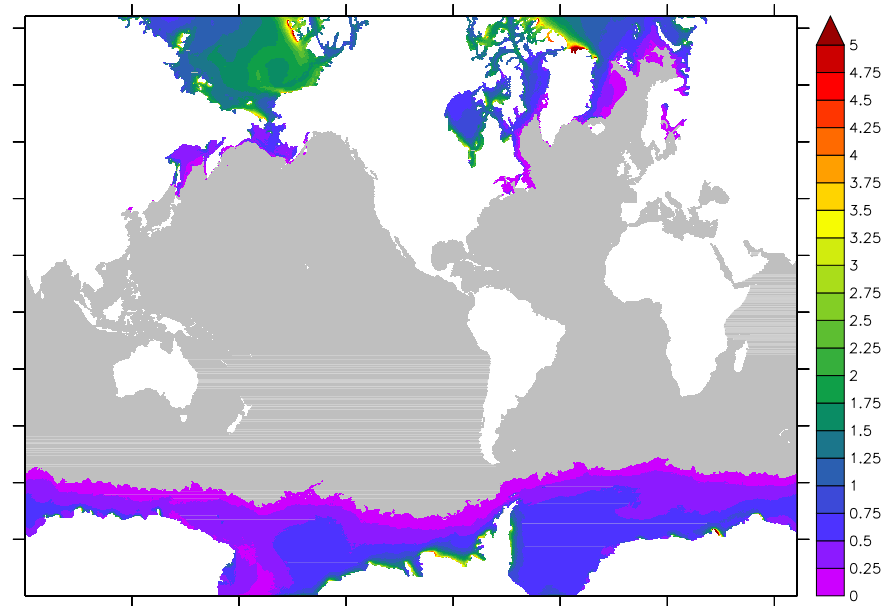
BSC's ORCA025 LIM3 reconstruction

1981-1985 ORCA025L75 NEMOv3.3-LIM3 (1-category sea ice)

Mean sea ice concentration [1]



Mean sea ice thickness [m]



Future sea ice initial conditions

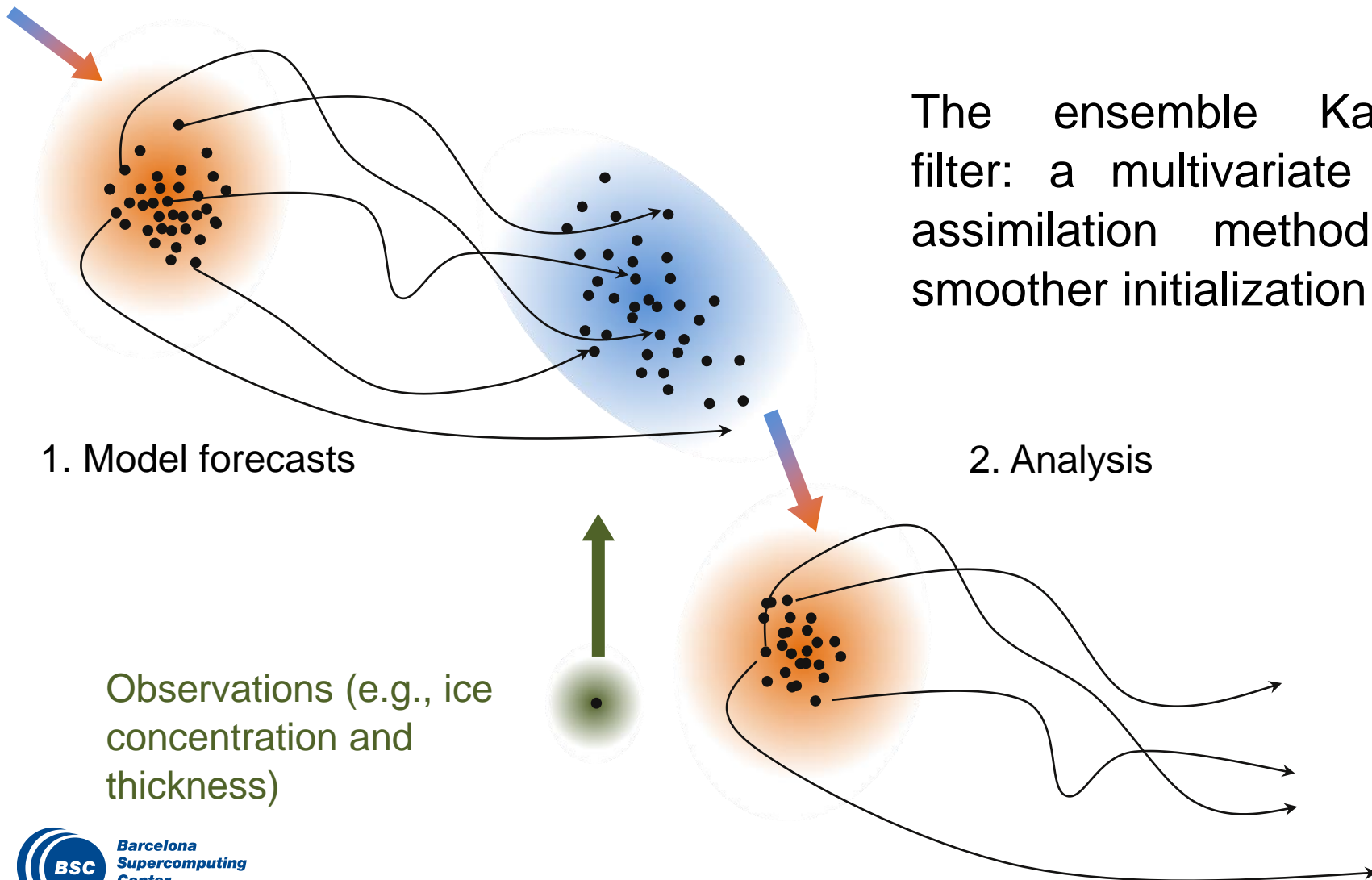
To be produced in the next months

- **5-member sea ice reconstructions** obtained by running NEMOv3.6-LIM3 nudged toward ORAS4 and forced by DFS4.3 and ERA-interim at **ORCA1 and ORCA025*** configuration
- **Reanalysis** using the Ensemble Kalman Filter and sea ice concentration and sea ice thickness observations from the European Space Agency Climate Change Initiative at **ORCA1 and ORCA025*** configurations

* Very high computational expensive!

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Sea Ice Initialization: sea ice data assimilation



The ensemble Kalman filter: a multivariate data assimilation method for smoother initialization

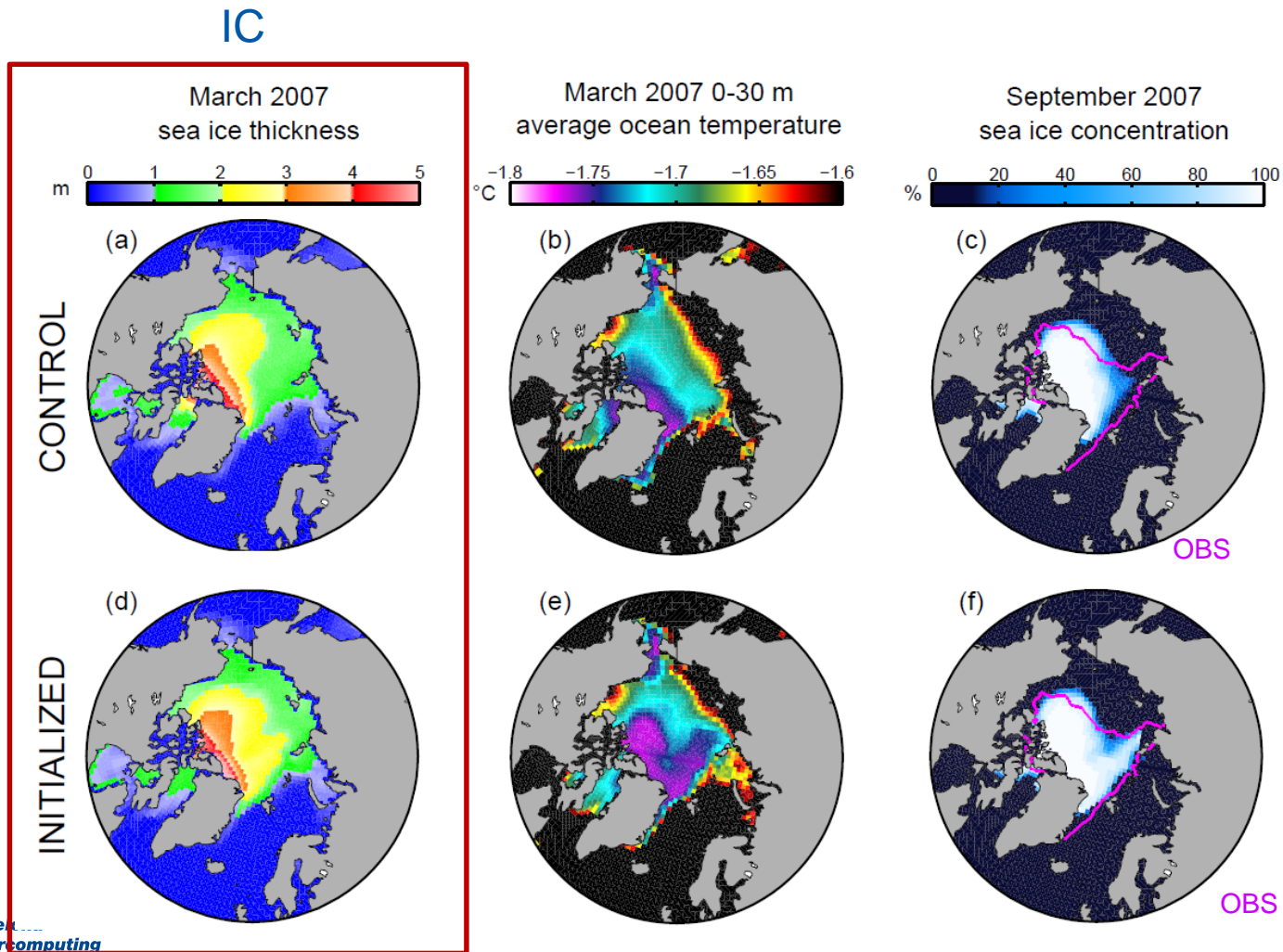
1. Model forecasts

2. Analysis

Observations (e.g., ice concentration and thickness)

Sea Ice Initialization: sea ice data assimilation

Importance of multivariate initialization for seasonal sea ice prediction



Fully-coupled sea ice data assimilation in EC-Earth: the next challenge

- What are the perturbations required to generate adequate spread in EC-Earth during the forecast steps of the assimilation run ?
- Should the atmosphere be updated when sea ice observations are assimilated?
- Can we afford to run the EnKF with less members (CPU time is limited) ?

Summary of the available ocean Initial Conditions

| IC | Period | Configuration | Where to find it |
|------------|-----------|------------------------------------|---|
| ORAS4 | 1958-2013 | ORCA1L46 | ec:/c3y/restarts_ORAS4 |
| ORAP5 | 1979-2013 | ORCA1L46 ORCA025L75 | ec:/c3e/ORCA1L46/ORAP5 ec:/c3e/ORCA025L75/ORAP5 |
| GLORYS2v 1 | 1993-2003 | ORCA1L46 ORCA1L75 ORCA025L75 | ec:/c3y/ORCA1L46/restarts_GLORYS2v1 ec:/c3y/ORCA1L75/restarts_GLORYS2v1 ec:/c3y/ORCA025L75/restarts_GLORYS2v1 |
| GLOSEA5 | 1990-2013 | ORCA1L46 ORCA025L75 | ec:/c3e/ORCA1L46/GLOSEA5 ec:/c3e/ORCA025L75/GLOSEA5 |
| m01x | 1993-2006 | ORCA1L46 | ec:/c3y/restarts_m01x |
| m01w | 1993-2006 | ORCA25L46 | ec:/c3y/restarts_m01w |
| m01u | 1993-2006 | ORCA25L75 | ec:/c3y/restarts_m01u |

Summary of the available sea ice Initial Conditions

| IC | Period | Configuration | Where to find it |
|------------|-----------|------------------|--|
| GLORYS2v 1 | 1993-2003 | ORCA1 ORCA025 | ec:/c3y/restarts_GLORYS2v1/ORCA1 ec:/c3y/restarts_GLORYS2v1/ORCA025 |
| b02s | 1958-2006 | ORCA1 | ec:/c3y/restarts_b02s |
| i00v | 1979-2014 | ORCA1 | ec:/c3y/restarts_i00v |
| i056 | 1958-2006 | ORCA1 | ec:/c3y/restarts_i056 |
| i057 | 1979-2014 | ORCA1 | ec:/c3y/restarts_i057 |

Conclusions

- Large set of ocean and sea ice initial conditions (IC) for climate predictions already available (see details on the EC-Earth development portal)
- On-going work to extend further this set: ORAS4 and GLORYS2v3.
- Analyze the skill when using interpolated ocean IC, using ocean nudging and ocean + atmosphere nudging
- New ORCA025 and ORCA1 sea ice reconstruction
- Generation of sea ice reanalysis at the ORCA1 and ORCA025 configurations based on the Ensemble Kalman Filter planned for the next months



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Thank you

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