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EC-Earth Meeting, FMI,
Helsinki,
May 29-31, 2017

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EC-Earth Climate Prediction Working Group

Etienne Tourigny

and the Climate Prediction Group at BSC

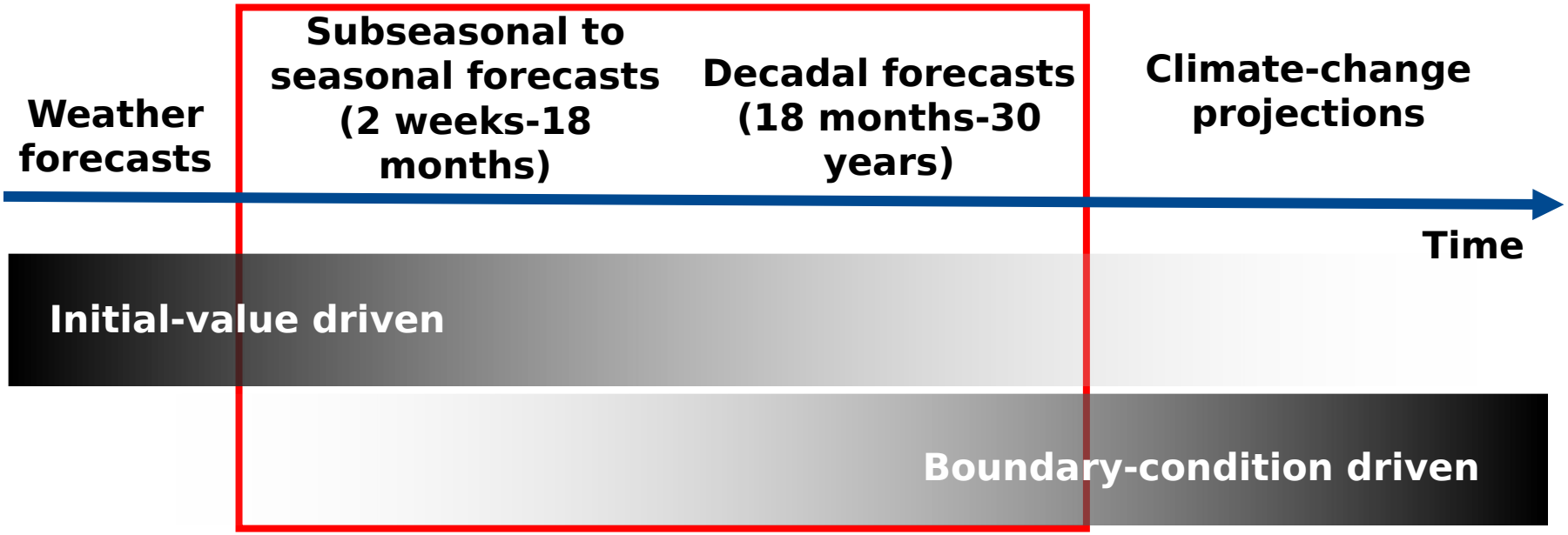
V. Guemas, F. Doblas-Reyes, R. Bilbao, O. Bellprat L. Brodeau, R. Cruz-García, E. Exarchou, N. Fučkar, J. García-Serrano, M. Ménégoz, C. Prodhomme, V. Sicardi, F. Massonnet, J.C. Acosta Navarro

Overview

- Climate prediction with EC-Earth
- Initial conditions for CP
- CMIP6 plans at BSC CP Group
- DCPP

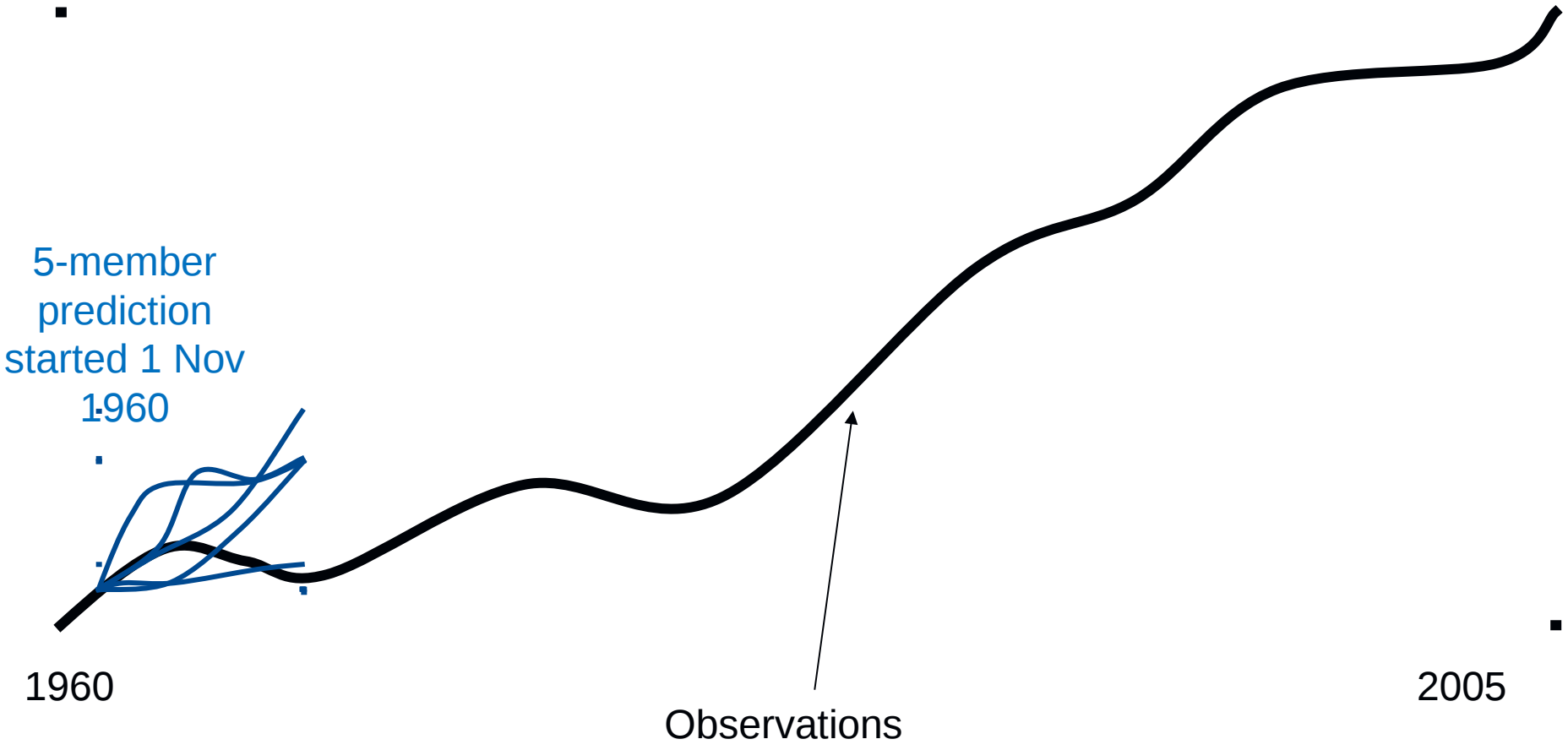
Climate prediction time scales

Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison with a simultaneous reference.

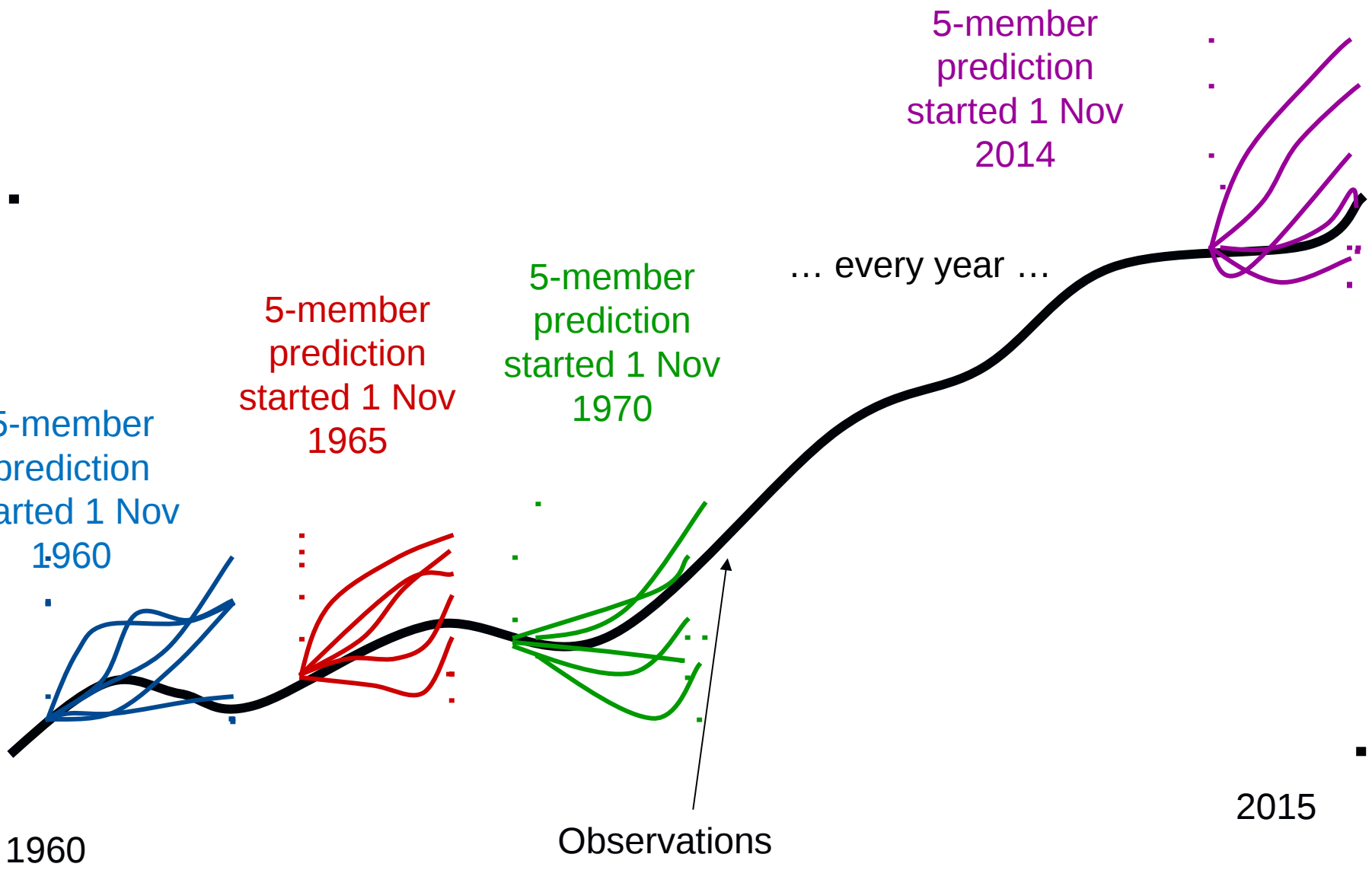


Adapted from Meehl et al. (2009)

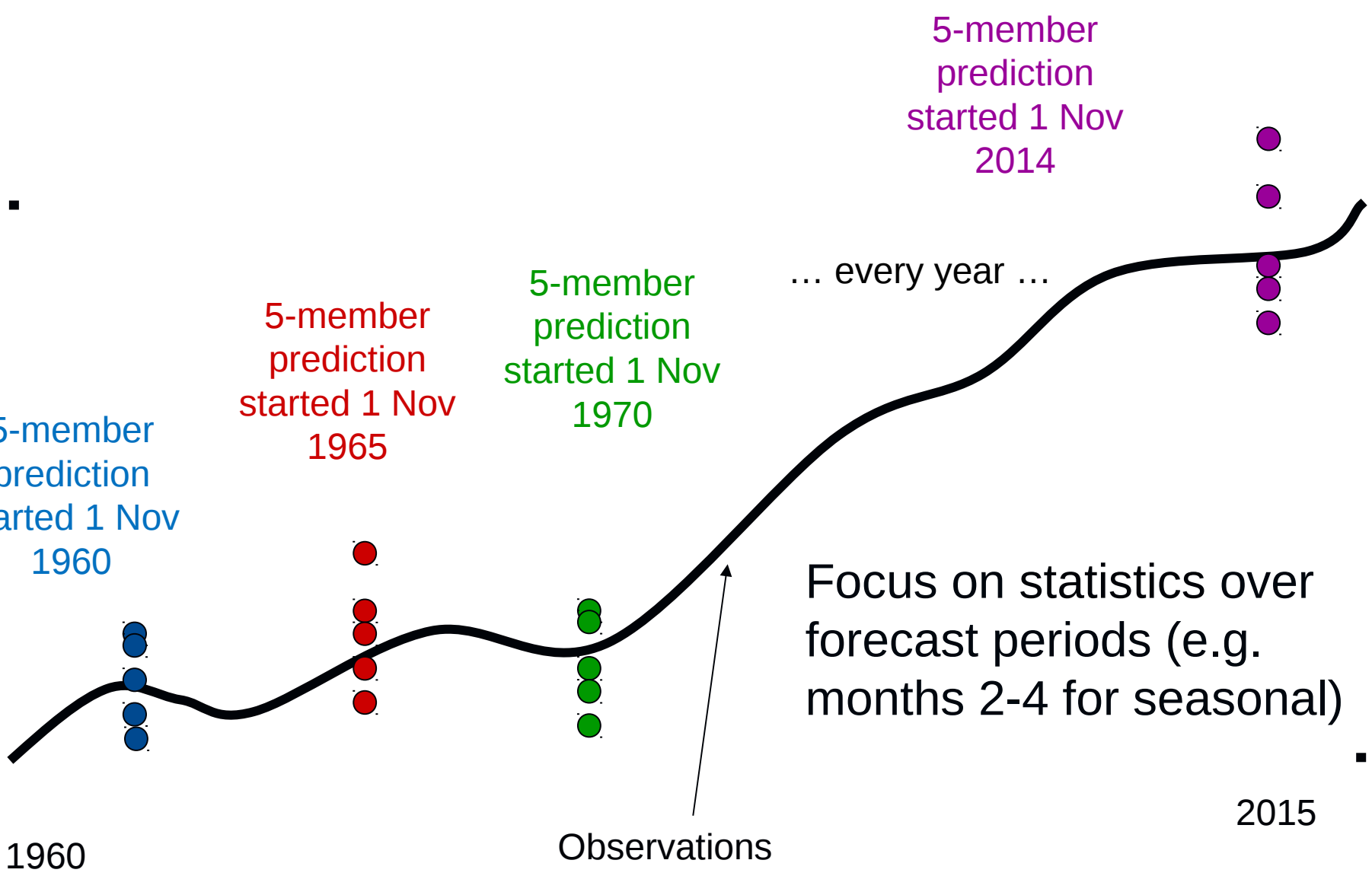
Climate prediction experiments



Climate prediction experiments

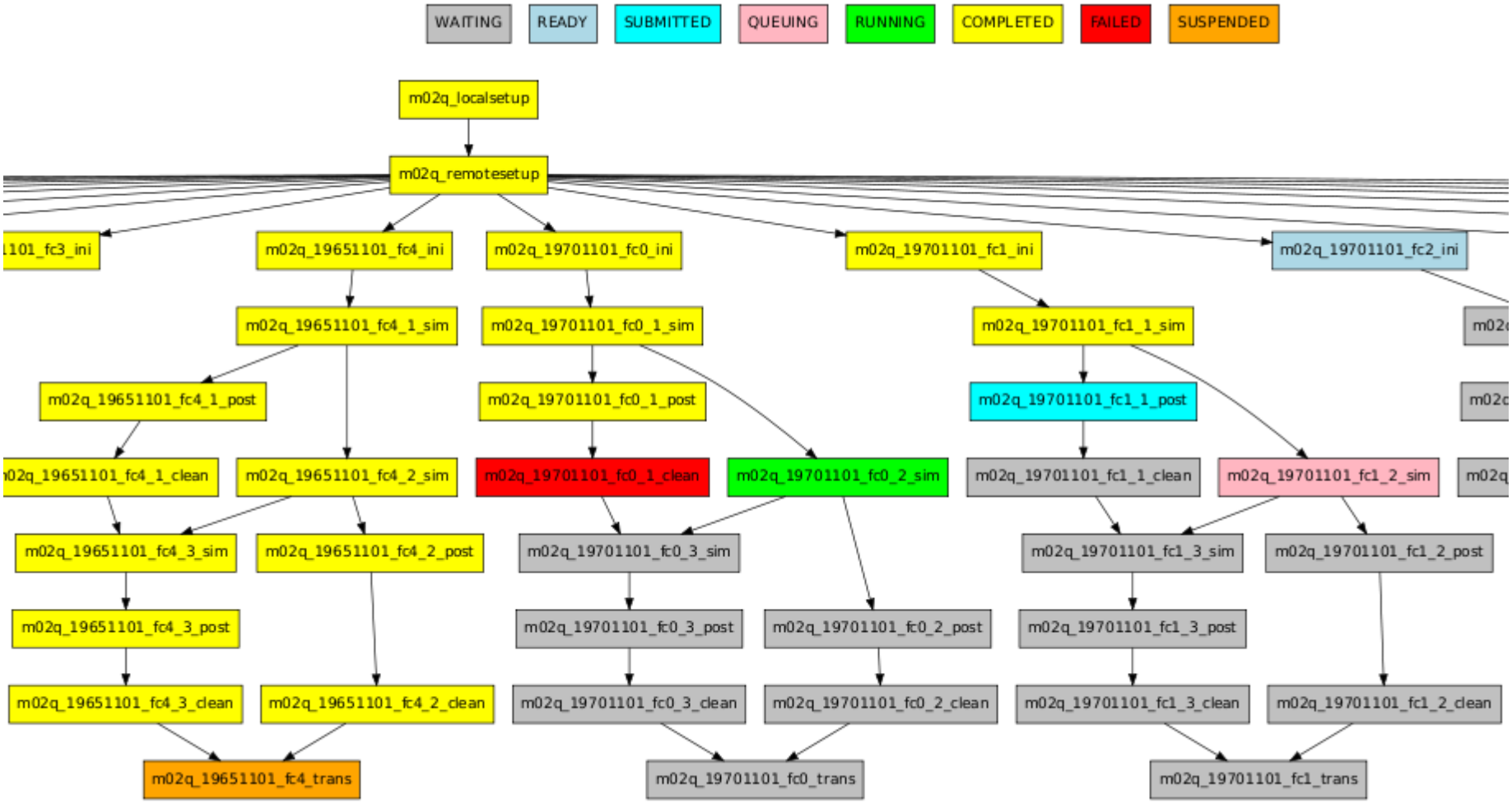


Climate prediction experiments



Focus on statistics over forecast periods (e.g. months 2-4 for seasonal)

Climate Prediction Workflow



Forecasts with EC-Earth 3.2.2

Atmosphere Reanalysis (ERA-Interim)
Interpolated with PrepIFS

7 months

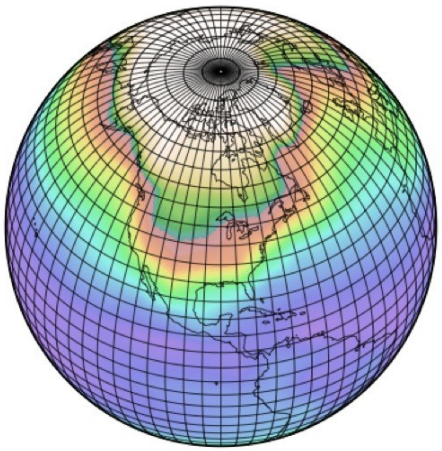
10 Members

01/05/1992 01/11/1982 01/11/2015

Ice Reanalysis (IC3/BSC)
LIM3 forced by ERA-int with ocean nudged toward ORAS4

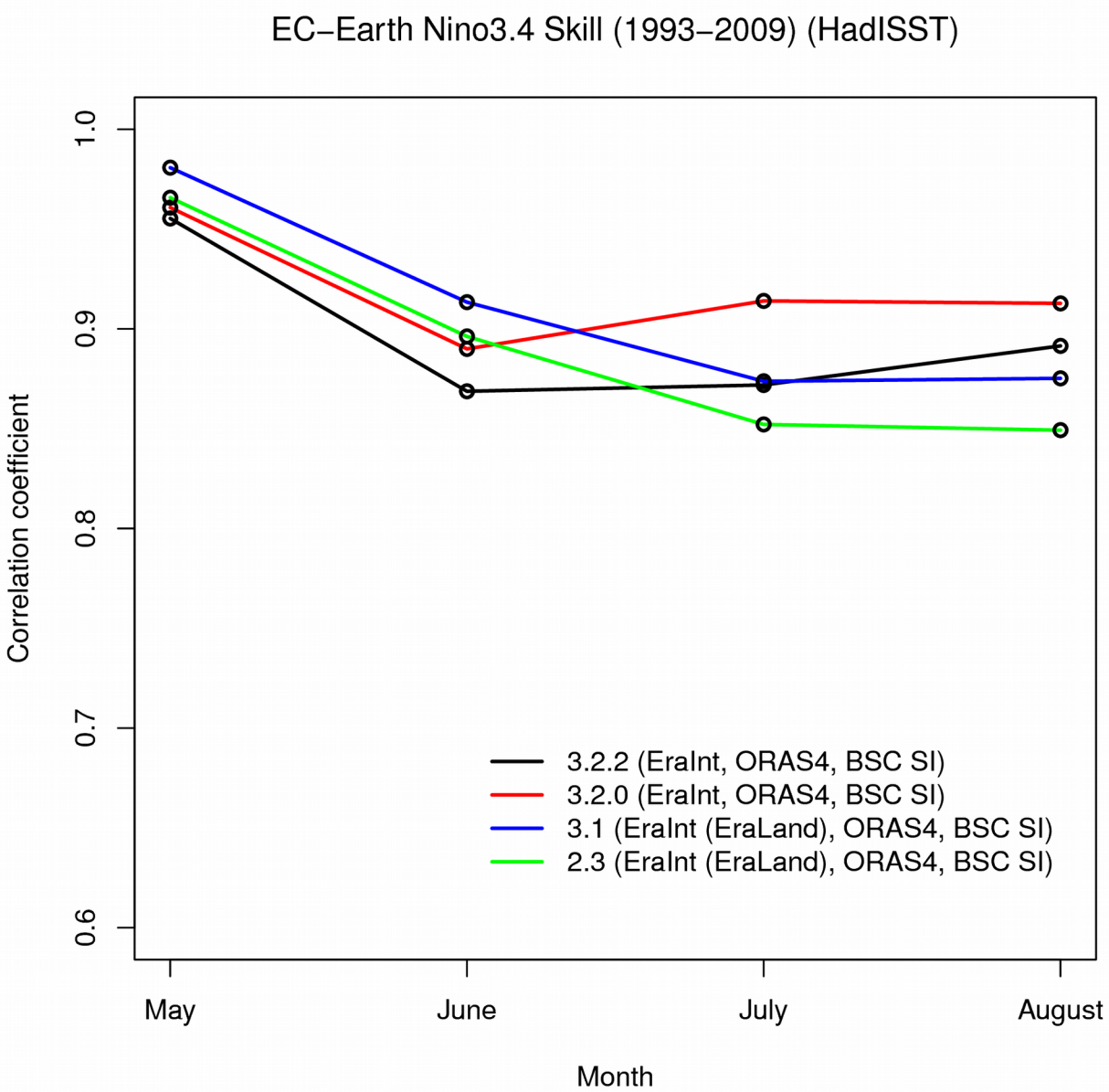
Ocean reanalysis (ORAS4)
Interpolated

Land reanalysis (ERA-Land)

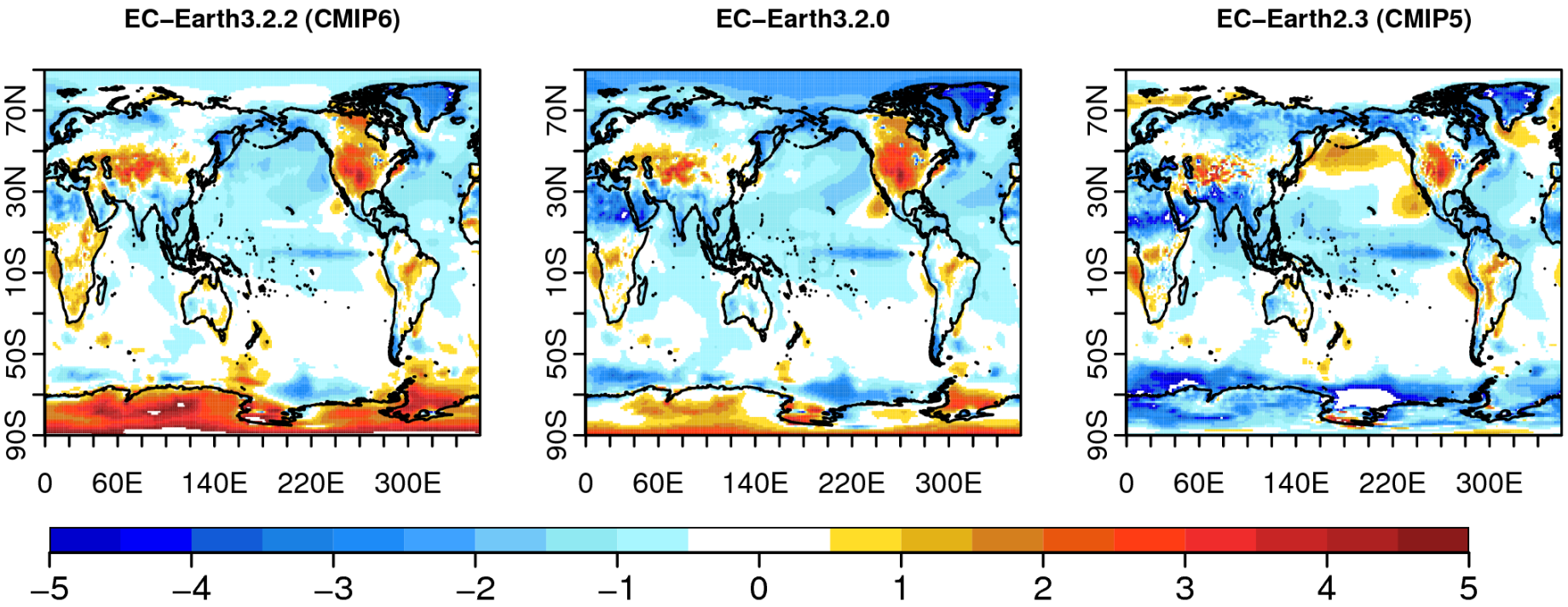


EC-Earth coupled model
- **NEMO 3.6: ORCA1L75-LIM3**
- **IFS 36r4: T255L91**
- **Version 3.2.2**

JJA (1993-2009) Niño3.4 skill



JJA (1993-2009) SAT bias (°C)



JJA (1993-2009) SAT skill

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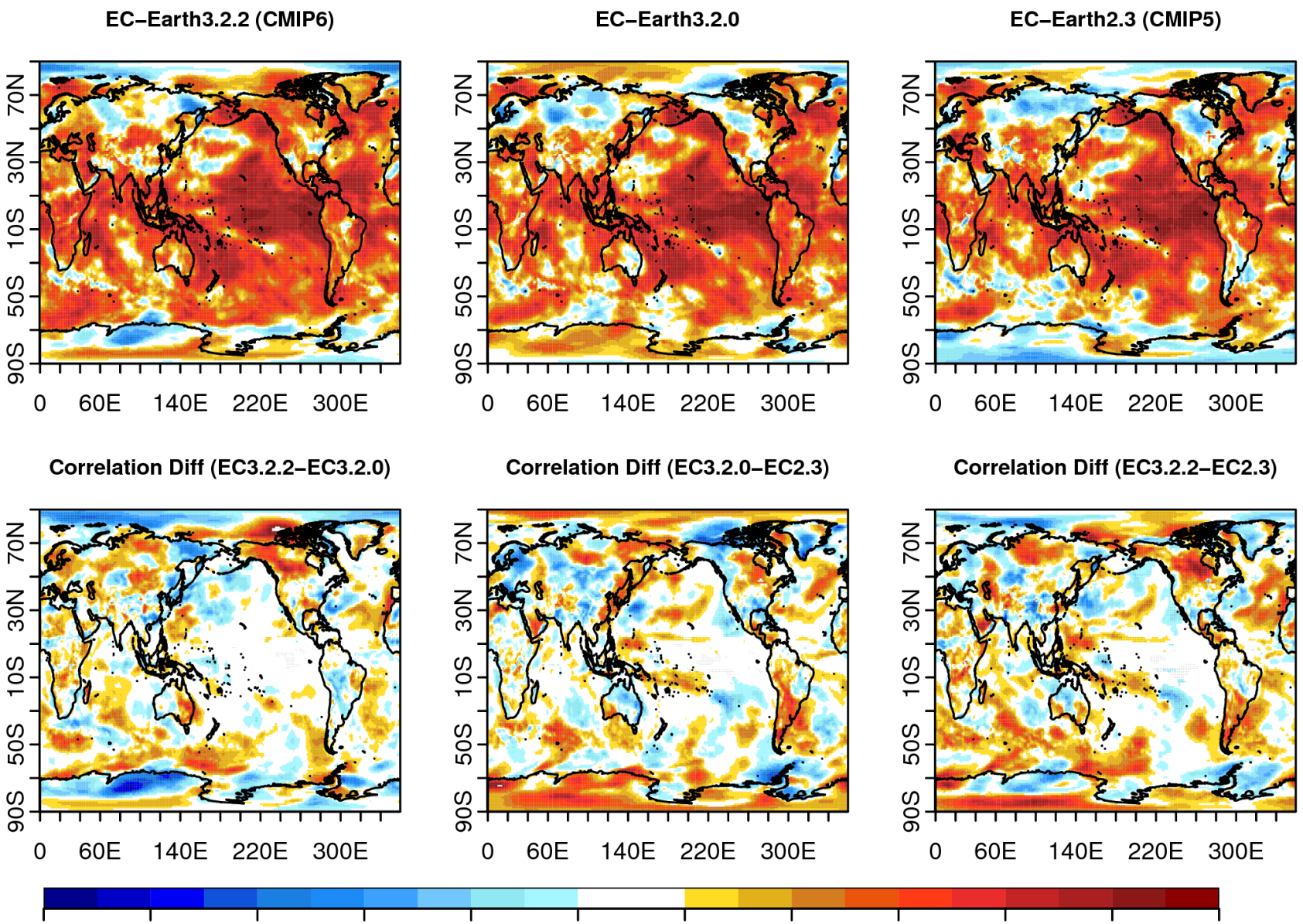
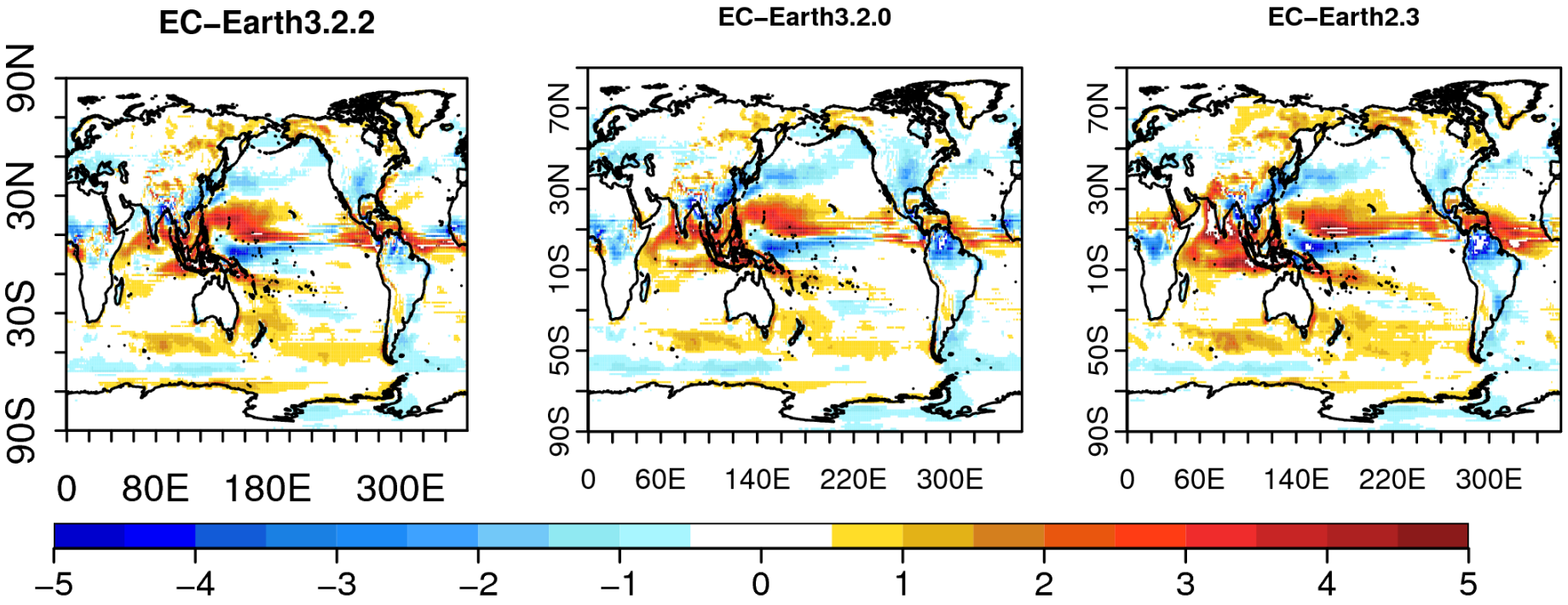
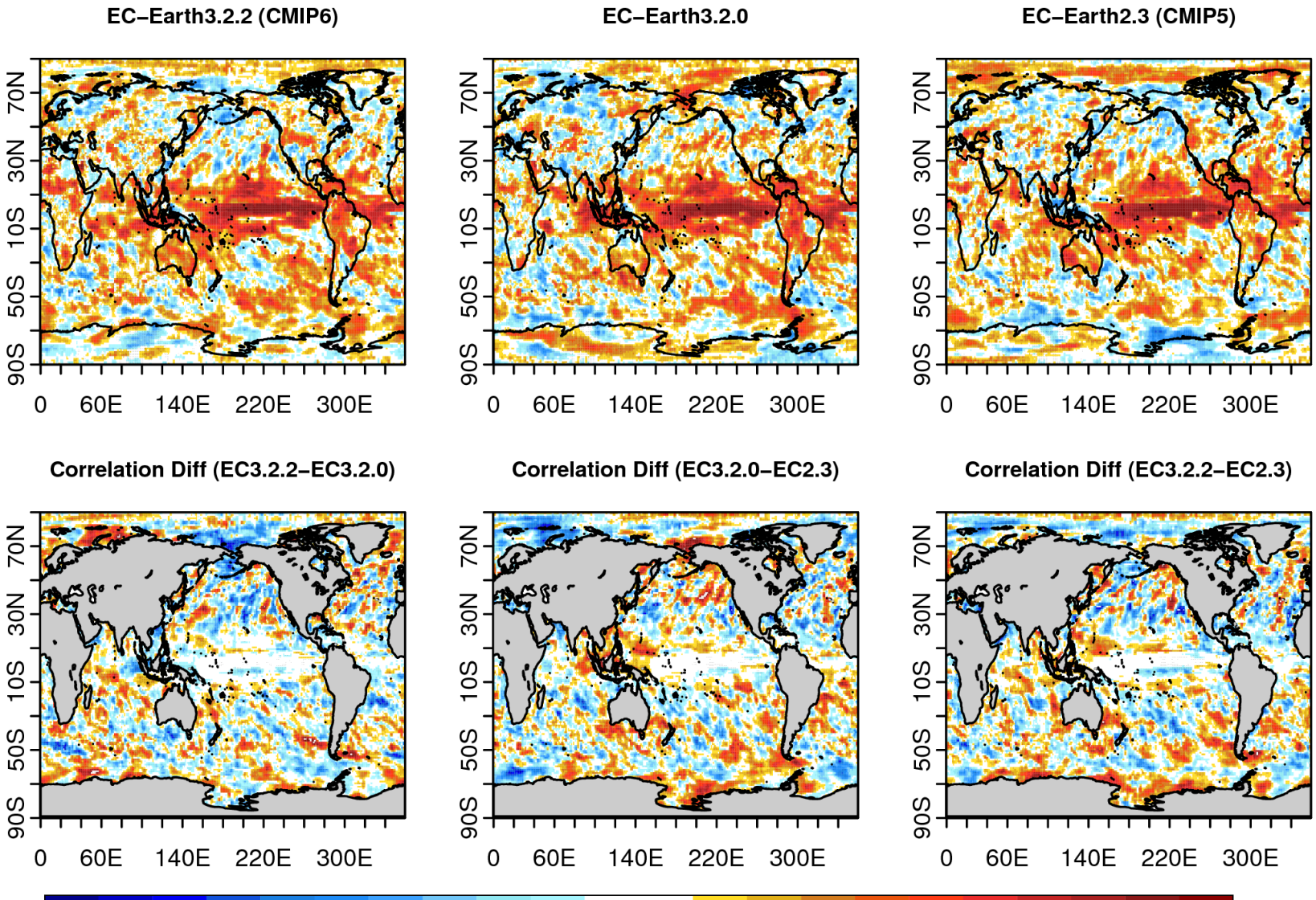
EXCELENCIA SEVERO OCHOA



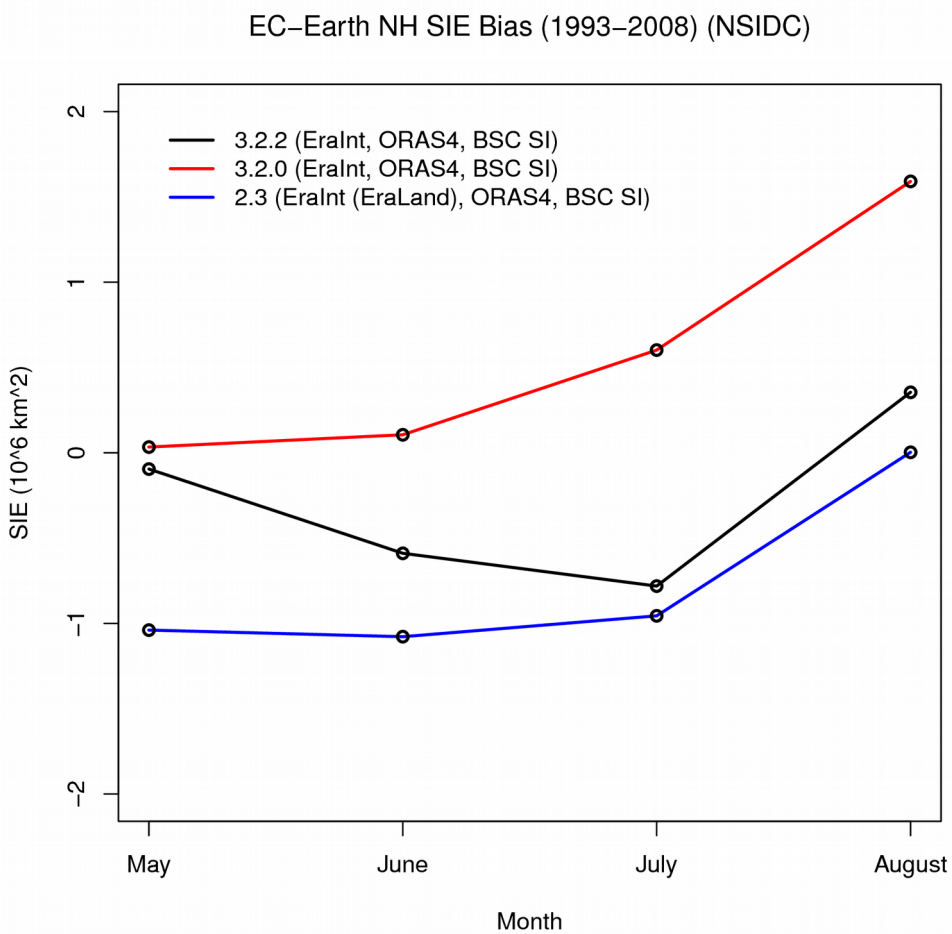
JJA (1993-2009) Precip. Bias (mm/day)

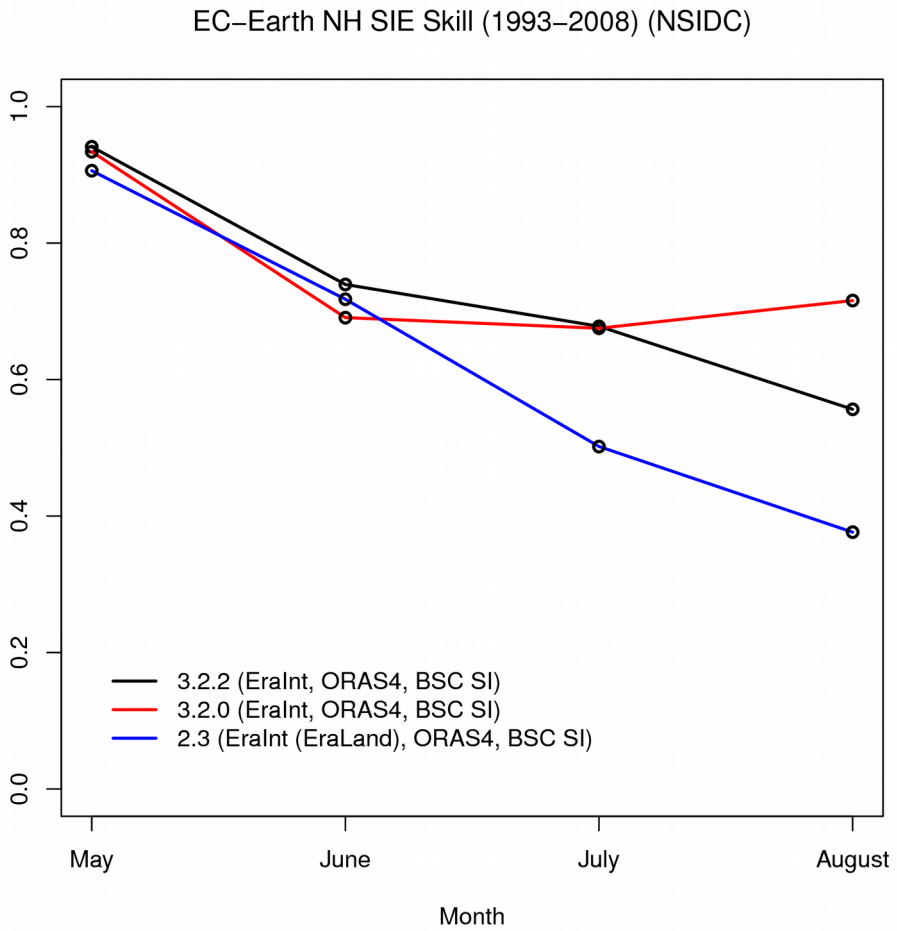


JJA (1993-2009) Precip. Skill



JJA (1993-2009) Arctic Sea Ice extent





Initial conditions for climate prediction

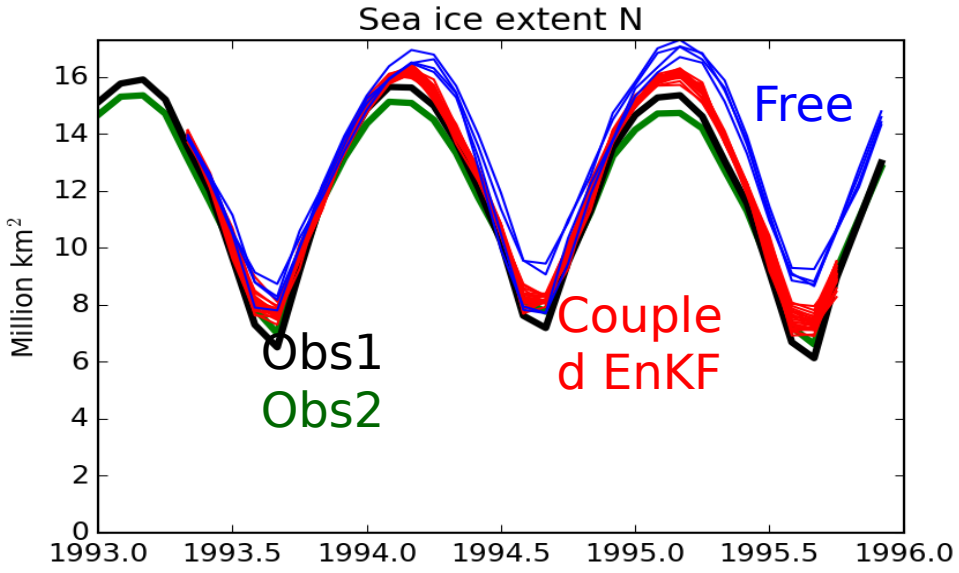
- Atmospheric initial conditions are interpolated from ERA reanalyses (ERA-Interim, 40, 20C)
- Generated using prepIFS with FULLPOS for three different resolutions of IFS. FULLPOS conducts a physical interpolation and therefore ensures little model drift.
- We are investigating how to generate these without relying on prepIFS, open to suggestions!!!
  - Using FULLPOS inside EC-Earth IFS to read the ERA files and interpolate them at the required vertical levels
  - Using conservative vertical interpolators such as CDMS or python scripts promoted by Glenn Carver
  - running the IFS component of EC-Earth nudged to atmospheric reference files, to generate both atmospheric and land surface fields
  - Land surface surface ICs could be done with offline HTESSEL runs

Initial conditions for climate prediction

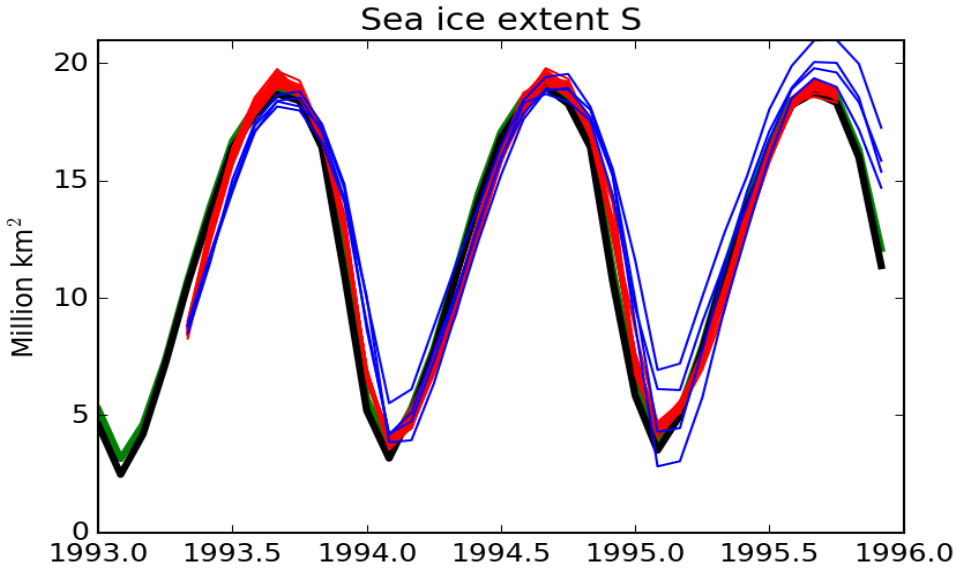
- Atmosphere:
  - 1960 - 2015 using ERA-40 (1960-1978)
  - ERA-Interim (1979-2015)
  - ERA-Land (1979-2015) - forced by GPCP, replaces surface model fields (E. Dutra)
  - 10-member (SST perturbation), Start dates each year in February, May, August, November
- Ocean:
  - ORAS4 interpolated/extrapolated 5-member restarts in the configuration ORCA1L75 covering the 1958-2013 period, at ECFS ec:/c3y/restarts_ORAS4
  - Many more available, and more can be produced easily
- Sea Ice:
  - 5-member ORCA1 reconstructions
  - 1-member ORCA1 and ORCA025 reconstructions
  - 24-member ORCA1 reconstructions with sea ice data assimilation (done using NEMO or EC-Earth)
  - ORCA025 reconstruction under development
  - Work by F. Massonet and N. Fuckar

Generation of sea ice initial conditions with the Ensemble Kalman Filter in EC-

François Massonnet (UCL/BSC)
N. Fučkar (BSC)



NH SIE



SH SIE

A prototype coupled data assimilation scheme has been developed

- SIC is assimilated monthly in EC-Earth3.2
- The EnKF provides a good constraint on sea ice extent

DCPP – Decadal Prediction at BSC

- Initial Conditions:
  - prepared by BSC (atmosphere, ocean, sea ice)
  - for all years 1960-present
  - 4 start dates : **November**, February, May, August
- Component A : Decadal hindcasts (6000 years)
  - Every year from 1960-present
  - Starting in November of every year
  - 5 members, extended to 10
  - 5 year predictions, extended to 10 years
- Component B : Semi-operational decadal forecast (100 years)
  - 10 years x 10 members

DCPP – Decadal Prediction at BSC

- Component C - Volcano effects on decadal prediction (M. Menegoz)
- Component C - Idealized impact of AMV/Pacemaker experiments, also for PRIMAVERA (R. Bolbao)
- Carbon cycle :
  - LPJ-Guess for seasonal-to-decadal prediction of fire risk (E. Tourigny)
  - PISCES for ocean CO2 uptake (V. Sicardi, R. Bernardello)
- “Extra” seasonal prediction hindcasts
  - Use the first months of the decadal runs initialized in November
  - Run short (4 month) predictions initialized in February, May, August
- High Resolution Hindcasts (optional, 3000 years)
  - 5 members, IF we obtain the hours from PRACE (as part of ENES) and only after we have completed everything else (HiResMIP and DCPP standard)

Breakout Session & conclusions

- EC-Earth 3.2.2 (untuned) hindcasts slightly better than 2.3 (CMIP5)
- Many ICs available for climate prediction experiments, ongoing work to produce atm. + land conditions independently and more sophisticated methods (assimilation)
- Workflow manager is essential for seasonal prediction experiments
- BSC leading DCPP efforts
  - Component A : more members could help, if may members
  - Component C : other partners could help in sensitivity experiments and the carbon cycle, discussed in the Land & Vegetation working group
- Beyond CMIP6 – can we have a full-fledged ESM model which does seasonal / decadal / climate with a more complex land surface/dynamic vegetation model?

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Thank you!

For further information please contact
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