CFORCE: Creating the Next Generation Datasets for Forcing Ocean – Sea-ice Coupled Models

2024 CESM OMWG WINTER MEETING

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Coordinated Ocean-ice Reference Experiments (COREs)

Stephen M. Griffies [a,*], Arne Biastoch [b], Claus Böning [b], Frank Bryan [c], Gokhan Danabasoglu [c], Eric P. Chassignet [d], Matthew H. England [e], Rüdiger Gerdes [f], Helmuth Haak [g], Robert W. Hallberg [a], Wilco Hazeleger [h], Johann Jungclaus [g], William G. Large [c], Gurvan Madec [i], Anna Pirani [j], Bonita L. Samuels [a], Markus Scheinert [b], Alex Sen Gupta [e], Camiel A. Severijns [h], Harper L. Simmons [k], Anne Marie Treguier [l], Mike Winton [a], Stephen Yeager [c], Jianjun Yin [d]

NCEP – NCAR re-analysis-based datasets (Large & Yeager 2004 & 2009)

11 manuscripts with 20+ participating groups

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Coordinated Ocean-ice Reference Experiments (CORE-II)

Edited by
- Stephen M Griffies
- Will Perrie

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Coordinated Ocean-ice Reference Experiments (COREs) were proposed by the WCRP/CLIVAR Working Group on Ocean Model Development (WGOMD) as a venue for comparing global ocean-sea ice models run under a common prescribed atmospheric state, with boundary fluxes computed via the same bulk formulae. CORE simulations complement the coupled climate and earth system models run for the Coupled Model Intercomparison Project (CMIP). Efforts across a broad community of modelling groups have produced CORE simulations (CORE-II) using 60 years (1948-2007) of inter-annual forcing, with details of the protocol and participating groups available from the WGOMD website (http://www.clivar.org/wgomd/core/core-2).

This Special Issue of Ocean Modelling aims to document aspects of the CORE-II simulations, publishing papers which compare simulations across a suite of models as well as to observation analyses where available.

These multi-decadal ocean simulations are useful for:

- Evaluation, understanding, and improvement of the ocean components of Earth system models;
- Investigation of mechanisms for seasonal, inter-annual, and decadal variability;
- Attribution of ocean-climate events;
- Evaluation of robustness of mechanisms across models;
- Bridging observations and modeling, by complementing ocean reanalysis from data assimilation approaches; and
- Providing initial conditions for the ocean and sea-ice components of coupled Earth system prediction simulations.

Geosci. Model Dev., 9, 3231–3296, 2016
www.geosci-model-dev.net/9/3231/2016/
doi:10.5194/gmd-9-3231-2016

Geoscientific Model Development
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OMIP contribution to CMIP6: experimental and diagnostic protocol for the physical component of the Ocean Model Intercomparison Project

Stephen M. Griffies[1], Gokhan Danabasoglu[2], Paul J. Durack[3], Alista
Eric P. Chassignet[5], Enrique Curchitser[6], Julie Deshayes[7], Helge Dr
Jonathan M. Gregory[10], Helmuth Haak[11], Robert W. Hallberg[1], Pat
David M. Holland[14], Tatiana Ilyina[11], Johann H. Jungclaus[11], Yoshi
William G. Large[2], Simon J. Marsland[16], Simona Masina[17], Trevor
James C. Orr[20], Anna Pirani[21], Fangli Qiao[22], Ronald J. Stouffer[1],
Hiroyuki Tsujino[24], Petteri Uotila[25], Maria Valdivieso[26], Qiang Wan

Geosci. Model Dev., 10, 2169–2199, 2017
https://doi.org/10.5194/gmd-10-2169-2017

Geoscientific Model Development
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Biogeochemical protocols and diagnostics for the CMIP6 Ocean Model Intercomparison Project (OMIP)

James C. Orr[1], Raymond G. Najjar[2], Olivier Aumont[3], Laurent Bopp[1], John L. Bullister[4], Gokhan Danabasoglu[5], Scott C. Doney[6], John P. Dunne[7], Jean-Claude Dutay[1], Heather Graven[8], Stephen M. Griffies[7], Jasmin G. John[7], Fortunat Joos[9], Ingeborg Levin[10], Keith Lindsay[5], Richard J. Matear[11], Galen A. McKinley[12], Anne Mouchet[13,14], Andreas Oschlies[15], Anastasia Romanou[16], Reiner Schlitzer[17], Alessandro Tagliabue[18], Toste Tanhua[15], and Andrew Yool[19]

Ocean Modelling 130 (2018) 79–139

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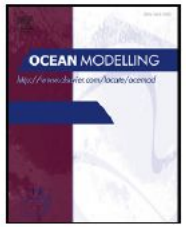

JRA-55 based surface dataset for driving ocean–sea-ice models (JRA55-do)

. Justin Small[b], Who M. Kim[b],
Jonathan L. Bamber[d], Mats Bentsen[e],
rique Curchitser[h],
, Yayoi Harada[a], Mehmet Ilicak[e,o],
shiki Komuro[c], William G. Large[b],

Geosci. Model Dev., 13, 3643–3708, 2020
https://doi.org/10.5194/gmd-13-3643-2020

Geoscientific Model Development
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Evaluation of global ocean–sea-ice model simulations based on the experimental protocols of the Ocean Model Intercomparison Project phase 2 (OMIP-2)

Hiroyuki Tsujino[1], L. Shogo Urakawa[1], Stephen M. Griffies[2,3], Gokhan Danabasoglu[4], Alistair J. Adcroft[3,2], Arthur E. Amaral[5], Thomas Arsouze[5], Mats Bentsen[6], Raffaele Bernardello[5], Claus W. Böning[7], Alexandra Bo
Eric P. Chassignet[8], Sergey Danilov[9], Raphael Dussin[2], Eleftheria Exarchou[5], Pier Giuseppe Fogli[10], Baylor Fox-Kemper[11], Chuncheng Guo[6], Mehmet Ilicak[12,6], Doroteaciro Iovino[10], Who M. Kim[4], Nikolay Koldunov[13,9], Vladimir Lapin[5], Yiwen Li[14,15], Pengfei Lin[14,15], Keith Lindsay[4], Hailong Liu[14,15], Matthew C. Long[4], Yoshiki Komuro[16], Simon J. Marsland[17], Simona Masina[10], Aleksi Nummelin[6], Jan Klaus
Yohan Ruprich-Robert[5], Markus Scheinert[7], Valentina Sicardi[5], Dmitry Sidorenko[9], Tatsuo Suzuki[16], Hiroaki Tatebe[16], Qiang Wang[9], Stephen G. Yeager[4], and Zipeng Yu[14,15]

Geosci. Model Dev., 13, 4595–4637, 2020
https://doi.org/10.5194/gmd-13-4595-2020

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Impact of horizontal resolution on global ocean–sea ice model simulations based on the experimental protocols of the Ocean Model Intercomparison Project phase 2 (OMIP-2)

Eric P. Chassignet[1], Stephen G. Yeager[2], Baylor Fox-Kemper[3], Alexandra Bozec[1], Frederic Castruccio[2], Gokhan Danabasoglu[2], Christopher Horvat[3], Who M. Kim[2], Nikolay Koldunov[4], Yiwen Li[5], Pengfei Lin[5], Hailong Liu[5], Dmitry V. Sein[4,6], Dmitry Sidorenko[4], Qiang Wang[4], and Xiaobiao Xu[1]

Unfortunately, the Japanese Reanalysis (JRA-55) product has been discontinued – the latest month is ~January 2024.

After discussions, ECMWF ERA5 Reanalysis has been chosen as the new product for the next generation of ocean – sea-ice forcing datasets.

Why ERA5?

Required features of a forcing dataset include:

- A trusted reanalysis product.
- Spatial and temporal resolutions of the datasets must be as sufficient as possible for forcing high-resolution (e.g., eddying, coastal) ocean and sea-ice models. (0.25^{o} and hourly)
- All forcing datasets must be up-to-date / near real time. (daily)
- Going back in time as far back as possible. (1940 – present)
- Buy-in / support / collaboration from the institution producing the reanalysis product.
- Institutional commitment for continued production of the reanalysis datasets.
- No redistribution issues.

We will be receiving funding for this effort from the US Department of Energy (DOE) and the US National Oceanic and Atmospheric Administration (NOAA).

NSF NCAR, NOAA GFDL, and DOE LANL will lead this effort in strong collaboration with the OMDP and international ocean modeling community.

The project aims to follow the approach used in the creation of the previous versions of the dataset (e.g., Tsujino et al. 2018), but will address identified issues to the extent possible….

- Repeating the forcing cycle

In discussions with the CMIP Panel for inclusion of OMIP in CMIP7

Products

Datasets: A complete dataset in netCDF for forcing ocean – sea-ice simulations for the 1940-present period for use of the world-wide community in their evaluations and benchmarking of ocean and sea-ice models.

Scripts and Tools: Open-access scripts and tools (python-based) extendable for use in creation of future datasets, for example with ERA-6.

Manuscript: A manuscript describing the dataset and the adjustments used. This manuscript will serve as the primary reference for this dataset.

Possible Additional Products

A consistent land model forcing dataset

Repeat Year Forcing (RYF) dataset

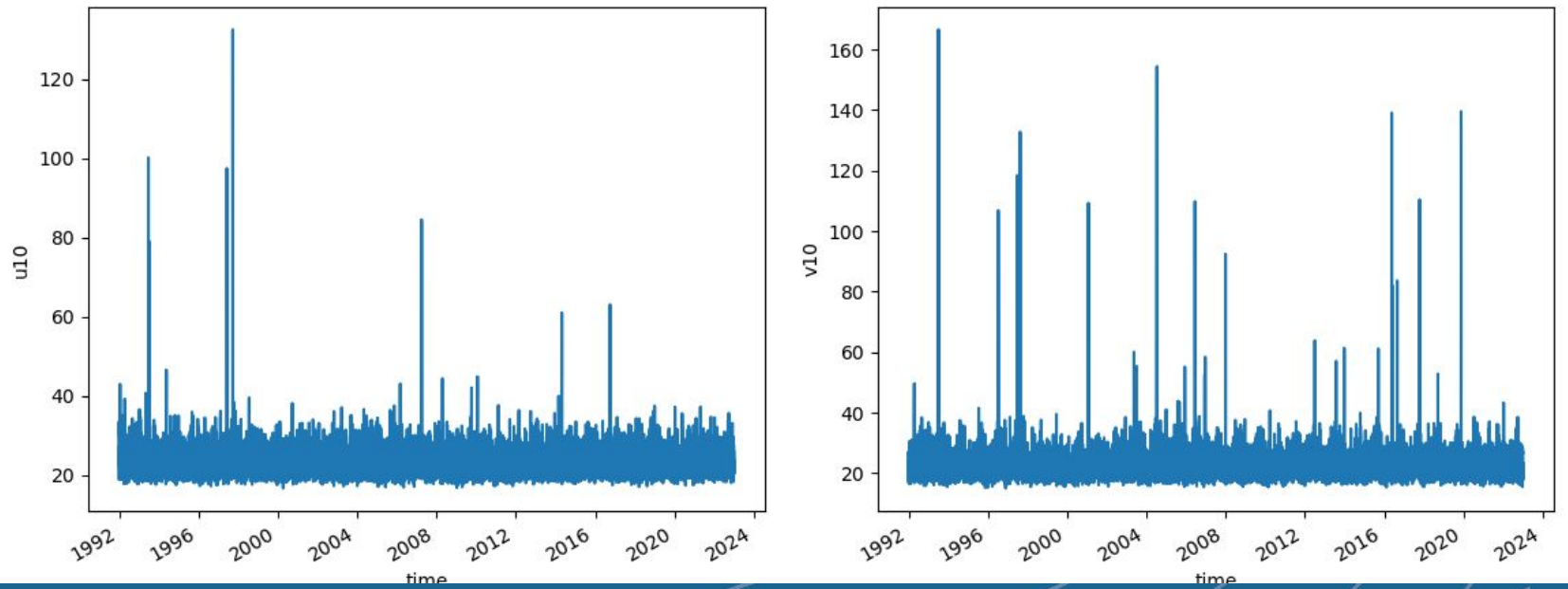
OMIP-Future for O-FAFMIP

Some Known Issues with the Raw ERA5 Datasets

Very Large 10-m Winds: “A few times per year, the 10-m winds become unrealistically large in a particular location, which varies amongst a few apparently preferred locations. The largest values seen so far are about 300 ms^{-1}. This problem occurs towards the end of the data assimilation windows (9-21 UTC and 21-9 UTC) because of an instability in the analysis method.”

“From 19 February 2020 onwards, the ERA5 system has examined the 10m wind components and if the magnitude of either component exceeds 50 ms^{-1}, then the analysed parameters are replaced with the "4v" parameters.”

Credit: Tahya Weiss-Gibbons (University of Alberta)



Some Known Issues with Raw ERA5 Datasets

General Warm Bias

There is a net positive heat imbalance in the product that needs to be corrected.

Too warm surface temperatures in the northern North Atlantic / Arctic that result in decline of sea ice and very warm ocean surface temperatures. In one effort, the sea-ice largely disappeared. Surface temperatures have biases of up to +14C.

A similar issue exists in the Antarctic, but unclear how far north this issue goes to impact the Southern Ocean temperatures and sea-ice.

Both issues appear to arise from the lack of snow cover assimilation in the ERA5 product. Each group has their own way of fixing this issue by reducing surface temperatures in an ad-hoc way (?).

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