Description of HadGEM3-GC2.0-v20190305 C3S contribution

1. Forecast system version

System name: GloSea5-GC2-LI

First operational forecast run: 2 April 2019

2. Configuration of the forecast model

Is it a coupled model? Yes: Atmosphere, land, ocean and sea-ice.

Coupling frequency: 3-hourly coupling between atmosphere-land and ocean--sea-ice.

The coupled model Global Coupled 2 (GC2) is described in Williams et al, 2015.

2.1 Atmosphere and land surface

Model	Met Office Unified Model (UM) - Global Atmosphere 6.0 Joint UK Land Environment Simulator (JULES) - Global Land 6.0
Horizontal resolution and grid	N216: 0.83 degrees x 0.56 degrees (approx 60km in mid-latitudes)
Atmosphere vertical resolution	85 levels
Top of atmosphere	85km
Soil levels	4 Level 1 : 0 - 0.1 m Level 2 : 0.1 - 0.35 Level 3 : 0.35 - 1.0 m Level 4 : 1.0 - 3.0 m
Time step	15 minutes

Detailed documentation:

JULES documentation

Global Atmosphere 6.0 & Global Land 6.0: Walters et al, 2017

2.2 Ocean and cryosphere

Ocean model	NEMO v3.4 - Global Ocean 5.0
Horizontal resolution	ORCA 0.25
Vertical resolution	L75

Time step	22.5 minutes
Sea ice model	CICE v4.1 - Global Sea-Ice 6.0
Sea ice model resolution	ORCA 0.25
Sea ice model levels	5 categories + open water
Wave model	N/A
Wave model resolution	N/A

Detailed documentation: NEMO documentation, CICE documentation

Global Ocean 5.0: Megann et al, 2014

Global Sea Ice 6.0: Rae et al, 2015.

3. Initialization and initial condition (IC) perturbations

3.1 Atmosphere and land

	Hindcast	**Forecast**
Atmosphere initialization	ERA-Interim	Met Office Global Hybrid 4D-VAR
Atmosphere IC perturbations	None	None
Soil moisture & temperature initialization	Met Office JULES-JRA55 analysis	Met Office JULES-JRA55 analysis
Snow initialization	Met Office JULES-JRA55 analysis	Met Office JULES-JRA55 analysis
Unperturbed control forecast?	No	No

Detailed documentation:

Met Office Global Hybrid 4D-VAR: Clayton et al, 2013

3.2 Ocean and cryosphere

	Hindcast	**Forecast**
Ocean initialization	GloSea Ocean Sea-Ice Analysis (GS-OSIA)	Forecast Ocean Assimilation Model (FOAM)
Ocean IC perturbations	No	No
Unperturbed control forecast?	No	No

Detailed documentation:

The GS-OSIA and the FOAM system both use the Nucleus for European Modelling of the Ocean data assimilation system (NEMOVAR). This is a 3d-VAR data assimilation scheme. The GS-OSIA uses different surface forcing (ERA-interim) and observation sets as it is a historical analysis. FOAM uses surface forcing from the Met Office Global NWP model and real-time observations.

The common NEMOVAR system is described in Blockley et al, 2014. Details of the GS-OSIA can be found in MacLachlan et al, 2015.

4. Model uncertainties perturbations:

Model dynamics perturbations	None

Model physics perturbations	Atmosphere stochastic physics scheme, SKEB2
If there is a control forecast, is it perturbed?	No control

Detailed documentation:

SKEB2: Bowler et al, 2009

5. Forecast system and hindcasts

Forecast frequency	daily
Forecast ensemble size	2 per day
Hindcast years	24 (1993-2016)
Hindcast ensemble size	7 per start date
Hindcast start dates	1, 9, 17, 25 of each month
On-the-fly or static hindcast set?	on-the-fly

6. Where to find more information

GloSea5 system:

- MacLachlan, C., Arribas, A., Peterson, K. A., Maidens, A., Fereday, D., Scaife, A. A., Gordon, M., Vellinga, M., Williams, A., Comer, R. E., Camp, J., Xavier, P. and Madec, G. (2015), Global Seasonal forecast system version 5 (GloSea5): a high-resolution seasonal forecast system. Q.J.R. Meteorol. Soc., 141: 1072–1084. doi:10.1002/qj.2396
- Seasonal prediction at the Met Office
- Upgrades to the Met Office Seasonal Forecast System

Model description references:

- Williams, K. D., Harris, C. M., Bodas-Salcedo, A., Camp, J., Comer, R. E., Copsey, D., Fereday, D., Graham, T., Hill, R., Hinton, T., Hyder, P., Ineson, S., Masato, G., Milton, S. F., Roberts, M. J., Rowell, D. P., Sanchez, C., Shelly, A., Sinha, B., Walters, D. N., West, A., Woollings, T., and Xavier, P. K.: The Met Office Global Coupled model 2.0 (GC2) configuration, Geosci. Model Dev., 8, 1509-1524, https://doi.org/10.5194/gmd-8-1509-2015, 2015.
- Walters, D., Boutle, I., Brooks, M., Melvin, T., Stratton, R., Vosper, S., Wells, H., Williams, K., Wood, N., Allen, T., Bushell, A., Copsey, D., Earnshaw, P., Edwards, J., Gross, M., Hardiman, S., Harris, C., Heming, J., Klingaman, N., Levine, R., Manners, J., Martin, G., Milton, S., Mittermaier, M., Morcrette, C., Riddick, T., Roberts, M., Sanchez, C., Selwood, P., Stirling, A., Smith, C., Suri, D., Tennant, W., Vidale, P. L., Wilkinson, J., Willett, M., Woolnough, S., and Xavier, P.: The Met Office Unified Model Global Atmosphere 6.0/6.1 and JULES Global Land 6.0/6.1 configurations, Geosci. Model Dev., 10, 1487-1520, https://doi.org/10.5194/gmd-10-1487-2017, 2017.
- Megann, A., Storkey, D., Aksenov, Y., Alderson, S., Calvert, D., Graham, T., Hyder, P., Siddorn, J., and Sinha, B.: GO5.0: the joint NERC–Met Office NEMO global ocean model for use in coupled and forced applications, Geosci. Model Dev., 7, 1069-1092, https://doi.org/10.5194/gmd-7-1069-2014, 2014.
- Rae, J. G. L., Hewitt, H. T., Keen, A. B., Ridley, J. K., West, A. E., Harris, C. M., Hunke, E. C., and Walters, D. N.: Development of the Global Sea Ice 6.0 CICE configuration for the Met Office Global Coupled model, Geosci. Model Dev., 8, 2221-2230, https://doi.org/10.5194/gmd-8-2221-2015, 2015.

Initialisation references:

- Clayton, A. M., Lorenc, A. C. and Barker, D. M. (2013), Operational implementation of a hybrid ensemble/4D-Var global data assimilation system at the Met Office. Q.J.R. Meteorol. Soc., 139: 1445–1461. doi:10.1002/qj.2054
  Blockley, E. W., Martin, M. J., McLaren, A. J., Ryan, A. G., Waters, J., Lea, D. J., Mirouze, I., Peterson, K. A., Sellar, A., and Storkey, D.: Recent development of the Met Office operational ocean forecasting system: an overview and assessment of the new Global FOAM forecasts, Geosci. Model Dev., 7, 2613-2638, https://doi.org/10.5194/gmd-7-2613-2014, 2014.