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Action Items and Recommendations

JRA-55

- *Endorse JRA-55 activity in framework of OMIP-version 2.*
- *Diagnose and explore strategies for addressing CORE/JRA divergence prior to 80s eg flux differences near Arctic ice edge (Yeager, Who, Danabasoglu, Tsujino).*
- *Distribution of official forcing - via PCMDI - following agreed upon nomenclature. Remove v0.1, v0.2 from PCMDI (Durack, Tsujino).*

Diagnostic OMIP and ocean grids

- *Send feedback for CMIP infrastructure panel on CMIP archive issues (eg sub-sampling annual means, slicing) (All to Griffies by 01 March).*
- *Provide feedback on data OMIP Diagnostic OMIP as part of GMD paper (All to Griffies by 01 March).*

Climate model Spin Up

- *Formulate comments on CMIP6 Protocol - Eyring et al. (2015) paper. Recommend that spin up should be documented and archived. Send also to modeling groups (Hewitt)*

CORE-II Spin Up

- *Revisit NYF objectives and expectations considering also Repeat Annual Forcing and DRAKKAR approach (get reference) (Yeager, Who, Danabasoglu, Tsujino)*
- *Revisit and test sensitivity of CORE-II/OMIP spin up strategy (Yeager, Who, Danabasoglu, Spence, Romanou, Griffies)*

CFCs and Ideal Age

- *Recommend that groups participating in CORE and OMIP to implement CFCs and ideal age following CORE-II forcing protocol*

Antarctic freshwater forcing

- *Report on status of seal hydrography measurements and use in revisiting salinity restoring (Marsland).*
- *Recommendations on Antarctic liquid and solid flux estimates for OMIP-version 2 protocol. Once paper comes through review test approach and form a task force to continue to improve product (Le Sommer).*

Greenland freshwater forcing

- *Invite Helmer and Bamber into discussion (Le Sommer, Ringler)*

Mediterranean Outflow

- *Recommend that groups document how Mediterranean Outflow is implemented, what salinity is at boundary, and diagnose properties of Mediterranean Water as it propagates in the North Atlantic.*

Salinity Restoring

- *Draft set of recommendations (not specification) for salinity restoring that would be preferred choice*

(weak restoring, cap of 0.5 psu). If models chose alternate strategy, should flag and document the approach used.
- *Explore running with no surface salinity restoring. Part of NOAA funded proposal (NCAR, GFDL) testing JRA-55. Test also include other models (Who, Yeager, Danabasoglu)*

CORE bulk formula properties of moist air.
- *For OMIP-version 2 protocol, change latent heat to be dependent on SST.*

Relative v absolute winds
- *Peter Gaube interested in developing a paper on a recommended position going forward, based on state of knowledge. Undertake an internal OMDP review to ensure that the paper comprehensively addresses the debate on what the issues are, pros and cons of using relative or absolute winds (Gaube, Le Sommer, All).*

CORE-II data archive
- *Contribute CORE-II datasets (see 3rd Sept 2014 email from Yeager and Danabasoglu) to NCAR archive using Globus. Send all data as NetCDF monthly means on native grid, using own variable names. Space for 1/4o datasets is available.*

CORE-II Analysis
- *A. Romanou planning CORE-II intercomparison CFC paper. Send email to community with mini proposal and data request (Romanou, Pirani)*

Poster Cluster for OSC
- *All lead authors of CORE-II papers solicited to prepare a poster for a CORE-II poster cluster at the CLIVAR Open Science Conference*

1 Introduction

The 2nd Session of the CLIVAR Ocean Model Development Panel (OMDP) was held on 14-16 January 2016 at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in Yokohama, Japan. OMDP is grateful for the organization of the logistical aspects of the meeting by Yoshiki Komuro. The meeting agenda, links to presentations, and further information are available on the meeting website at http://www.clivar.org/omdp/japan2016.

The meeting was an *extended* OMDP meeting, whereby the invitation to participate was extended to all those directly involved in the development of the Coordinated Ocean-ice Reference Experiments phase II (CORE-II) and the Ocean Model Intercomparison Project (OMIP) protocol as well as those who have been participating in CORE simulations and their analysis. Furthermore, participation was extended beyond those who could travel to Japan in person with a live streaming connection generously provided by the NOAA Modeling, Analysis, Predictions, and Projections (MAPP) Program.

The meeting focused primarily on a detailed evaluation of the new JRA-55 atmospheric forcing product. Presentations and discussions included technical aspects of the JRA-55 reanalysis, the JRA-55/OMDP collaborative evaluation that has been on-going since the OMDP mini workshop on forcing ocean and sea-ice models held in 2015, reviews of applied and / or additional corrections; creation of a normal-year forcing data set; and preliminary simulations forced with the JRA-55 data sets. An important goal of the meeting was to receive input from the wider ocean and climate modelling communities participating in the CORE-II and / or OMIP efforts.

2 JRA-55

2.1 General specifications and performance of the atmospheric reanalysis system (K. Onogi, JMA and Y. Harada, MRI/JMA)

The Japan Meteorological Agency (JMA) conducted the second Japanese global atmospheric reanalysis named JRA-55 (Kobayashi et al. 2015, Harada et al. 2016). It covers the period from 1958 – present with the start date corresponding to when regular radiosonde observations began on a global basis. JRA-55 is the first comprehensive reanalysis that has covered the last half-century since ERA-40 by ECMWF, and is the first one to apply 4D-variational analysis to this period. The main objectives of JRA-55 were to address issues found in previous reanalyses and to produce a comprehensive atmospheric dataset suitable for studies of multidecadal variability and climate change. JRA-55 is also useful for providing atmospheric boundary conditions for an ocean data assimilation and a forward, i.e., non-data-assimilating, ocean model. The presentations introduced the observations, data assimilation system, and forecast model used to produce the JRA-55 data sets as well as the basic characteristics of the JRA-55 product.

JRA-55 has been produced with the low resolution (TL319) version of JMA's operational data assimilation system as of December 2009, which was extensively improved since the Japanese 25-year Reanalysis (JRA-25; Onogi et al. 2007). It also uses many newly available and improved past observations. The sea surface temperature (SST) analysis data for JRA-55 are from the Centennial in situ Observation-Based Estimates (COBE) data set (Ishii et al. 2005), which are basically the same as the one used for JRA-25. The SST analysis has a resolution of 1° latitude and 1° longitude and uses the OI method. Sea-ice concentrations used for JRA-55 are based on the daily data produced for COBE-SST.

The resulting JRA-55 reanalysis product is considerably better than the JRA-25. Two major problems of JRA-25 were a cold bias in the lower stratosphere, which has been diminished, and a dry bias in the Amazon basin, which has been mitigated. The temporal consistency of temperature analysis has also been considerably improved compared to previous reanalysis products. Improvements were found in the representation of atmospheric circulation on the isentropic surfaces and in the consistency of momentum budget based on the mass-weighted isentropic zonal mean method (Iwasaki 1989).

Regarding the representation of climate variability, the frequencies of high spatial correlations with tropical precipitation estimated using TRMM Multi-satellite Precipitation Analysis are clearly higher in JRA-55 than in JRA-25. JRA-55 generally improved the representation of phenomena on a wide range of space–time scales, such as equatorial waves, and transient eddies in the storm track regions, compared with JRA-25 during the satellite era, and improved the temporal consistency compared with the older reanalyses throughout the reanalysis period. The spatial distribution of the long-term temperature trends in JRA-55 is the closest to an observational dataset of global historical surface temperature. Comparisons with radiosonde temperature revealed that JRA-55 has a smaller bias in temperature than the other reanalyses in the extra-tropical Southern Hemisphere winter before 1979.

Some issues are found in JRA-55, such as a warm bias in the upper troposphere, a large upward imbalance in the global mean net energy fluxes at the top of the atmosphere and at the surface, excessive precipitation over the tropics, and unrealistic trends in analyzed tropical cyclone strength. The amplitude of equatorial waves and the Madden–Julian oscillation in JRA-55 is weaker than the other reanalyses. In the stratosphere, there are larger discrepancies between reanalyses for the extra-tropical stratosphere during the Southern Hemisphere winter.

In conclusion, JRA-55 product has generally the best quality in comparison to many reanalyses products, thus enabling its use to force ocean models for the 1958 – present period.

2.2 Development of JRA-55 based surface atmospheric data set for driving ocean-sea ice models (H. Tsujino, JMA-MRI)

One of the fundamental motivations for developing this data set is to simulate recent climate extreme events, such as sea-ice reduction in the Arctic, global warming slow-down apparent in surface temperatures, and on-going El Nino, using ocean – sea-ice models. To understand them in the context of long-term variability, these events should be simulated as an extension of a long-term simulation. For these purposes, surface atmospheric data sets for driving ocean – sea-ice models need to be long, quality controlled, and made available near-real time. Their temporal and spatial resolution should be as high as possible to facilitate simulations with horizontally high-resolution configurations. JRA-55 (Kobayashi et al. 2015) is one of the most recently conducted long-term reanalyses using high resolution (~55 km) atmospheric model and updated assimilation techniques. However, our preliminary evaluation indicates that JRA-55 also needs the same kind of adjustments (bias corrections) as done in CORE for NCEP/NCAR reanalysis and in DRAKKAR for ECMWF reanalyses. Japanese group started a project to produce an atmospheric data set suitable for driving ocean – sea-ice models. Benefitted by supports from international community, methods for adjusting JRA-55 surface state were investigated during 2015. Here, general features, adjustments methods, and assessments of the latest, yet still unofficial, version of the data set are summarized.

The data set covers the period from 1958 to present. Our plan is to update data on near-real time basis. All atmospheric elements necessary for computing surface fluxes are based on the forecast mode of JRA-55. The temporal interval is 3 hours. Data are provided on normal TL319 grid. Because the raw JRA-55 data are provided on a reduced TL319 grid, in which the numbers of longitudinal grid points are reduced for latitudes higher than 41°, we zonally interpolate data to common longitudes for these latitude bands. Elements are downward short and long wave fluxes, precipitation (separated into rain and snow), 10-m vector wind, 10-m air temperature and specific humidity (shifted from their original height at 2 m), and sea level pressure. We apply necessary adjustments on all elements except for sea level pressure. River discharge data are also planned to be provided by operationally running a river model forced by the land surface data of JRA-55.

For the adjustment method, we essentially took the same approach as Large and Yeager (2009) did for producing the CORE-II dataset. First we apply multiplicative or offset factors to the raw surface state variables of JRA-55 forecast. Adjustment factors are monthly climatology. They are applied for the entire dataset period, implying that the general feature of long-term variability in the raw data is retained. This first adjustment is followed by re-adjustment for downward fluxes. Global surface heat and freshwater flux budget (sea ice region excluded) is computed using COBE SST (Ishii et al. 2005) as a lower boundary condition and Large and Yeager (2009) formulae for bulk transfer coefficients and albedo. Then downward short and long wave radiation are re-adjusted so that globally averaged total heat flux is close to zero for the period of 1988-2007. Similarly, precipitation is re-adjusted so that evaporation minus precipitation balances river discharge whose globally averaged value is assumed to be 1.22 kg sec^{-1} as in the CORE-II data set.

The reference data used to adjust atmospheric fields are as follows: CERES-EBAF-Surface Ed2.8 (Kato et al. 2013) for short and long wave radiation; CORE-II for precipitation; International Arctic Buoy Program (IABP) / Polar Exchange at the Sea Surface (POLES) Arctic surface air temperature data

(Rigor et al. 2000) for air temperature over sea ice in the Arctic region; JRA-55 screen-level analysis using 2D-OI (Kobayashi et al. 2015) for air temperature over the ocean and for specific humidity over all oceanic region; and Remote Sensing Systems QuikSCAT Ku-2011 Daily Ocean Vector Winds on 0.25 degree grid version 4 (Ricciardulli et al. 2011) for wind speed and direction. Monthly adjustment factors are determined by comparing monthly climatology of reference data and JRA-55 forecast. Adjustment factors are applied for the entire data set period.

There are several versions (versions 0.2 through 0.4) of the adjusted data set (Version 0.1 is prior to adjustment and is just interpolated from the raw data). Version 0.2 was released in March 2015 as the first release. Updated versions (versions 0.3 and 0.4) were prepared in December 2015 and are currently under further evaluation. Globally averaged heat and freshwater fluxes are confirmed to be in balance for the period of 1984-2006. But some noticeable trends are identified in components. Specifically, there was a transition in latent heat loss before mid-1990s (small) and after year 2000 (large). This is due to a combination of the enhanced wind and the more appropriately corrected moistening bias of JRA-55 after 2000. If the reason of this transition is identified as the specific transition in data assimilation method, time-dependent adjustment factors will be used for the next version.

Preliminary comparisons with in-situ observations by buoys show that surface atmospheric elements of the adjusted data are generally improved compared with the JRA-55 raw data. But air temperature and specific humidity fields near coasts and islands are affected by observations on land which are contained in the JRA-55 screen-level analysis. This warrants further improvement in the adjustment method.

Data set is used to force a global model of JRA-MRI which has been developed for CMIP6. Results in terms of mean state and long-term variability are generally acceptable for JMA-MRI group, but there are some features different than those of a simulation forced by the CORE-II data set. Specifically, the difference in the prescribed sea ice distribution in the pre-satellite period before 1978 between JRA-55 and NCEP/NCAR reanalysis leads to different AMOC variabilities between JRA-55 and CORE forced simulations.

We plan to produce an official release version of the JRA-55 forcing data set along with a citable document in early summer 2016, after considering the above remaining issues identified during the meeting. We welcome any comments and suggestions toward the improvement of the data set.

2.3 Comparison of the general performance of MRI.COM between experiments forced by CORE-II and JRA-55 datasets (S. Urakawa, MRI)

The MRI group has developed an eddy-less global ocean model using MRI.COM which is an ocean general circulation model developed in Meteorological Research Institute, Japan Meteorological Agency. This model has been tuned with the CORE-II forcing dataset and shows reasonable performance in a simulation over five repeating cycles of the CORE-II dataset. Three additional simulations with different versions (JRA-55v0.2, JRA-55v0.3, and JRA-55v0.4) of newly corrected forcing dataset based on JRA-55 have been performed. While the model solutions are quite similar among these four experiments in general, there are some noteworthy differences as listed below:

- Atlantic Meridional overturning circulation (AMOC) is almost the same in magnitude at 45°N and 1000 m depth among four experiments. However, the magnitude of AMOC shows different temporal variability between the CORE-II and JRA-55 experiments. AMOC in the CORE-II experiment has a single peak in 1990s whereas that in the JRA-55 experiments has double peaks in 1970s and 1990s.

- Meridional overturning circulation in the Southern Ocean (SO-MOC) is stronger in the JRA-55 experiments than in the CORE-II experiment. This is probably due to stronger convection in the Weddell Sea in the JRA-55 experiments. It is especially large in the experiment forced with JRA-55v0.3 and the global mean temperature shows a significant cooling trend in this experiment. Too cold air temperature around Antarctica in this version leads to strong convection around Antarctica and unrealistically cold bottom water in the Southern Ocean. This is the reason we do not prefer JRA-55v0.3.
- The SST biases in the region of coastal upwelling significantly are significantly reduced in experiments JRA-55v0.3 and JRA-55-v0.4 compared to those of experiments CORE-II and JRA-55v0.2. This is the reason we do not prefer JRA-55v0.2.

The JRA-55v0.4 experiment shows the best performance in our modeling framework among the JRA-55 experiments, and the datasets of CORE-II and JRA-55v0.4 show similar performance in driving eddy-less global ocean model.

2.4 Evaluation of CESM ocean – sea-ice hindcast experiments forced by JRA-55 data set (S. Yeager, W. Kim, J. Small, G. Danabasoglu, W. Large, NCAR)

Yeager presented an intercomparison of three forced ocean – sea-ice hindcast simulations using the CESM component models (POP and CICE) at nominal 1° horizontal resolution. All three simulations were spun up from rest through 5 cycles of the 52-year forcing period (1958-2009) and were identical apart from the atmospheric forcing data set used. The three experiments and associated forcing data were as follows:

JRA-55: JRA-55v0.3 (Kobayashi et al. 2015; Tsujino, pers. comm.)
CORE-II: (Large & Yeager 2009)
20CR: NOAA/CIRES 20th Century Reanalysis, version 2c (20CRv2c; Compo et al. 2011)

The JRA-55 run utilized adjustments to atmospheric state fields and fluxes as per Tsujino’s version 0.3; the CORE-II forcing was identical to that documented in the papers that make up the CORE-II Virtual Special Issue of *Ocean Modelling*; the adjustments to raw 20CR forcing by S. Yeager have not been documented.

All three forcing data sets give low climatological global net air-sea heat flux when coupled to observed SST and sea ice fraction: JRA-55 (0.0 W/m^2, 1958-2013), CORE-II (+3.6 W/m^2, 1948-2007), and 20CR (+0.1 W/m^2, 1948-2007). Despite this, global mean ocean temperature drift differs substantially between the three hindcast experiments over the 260-year spin up: JRA-55 (~ -0.35°C), CORE-II (~ -0.05°C), and 20CR (~ +0.2°C). The large temperature drift in JRA-55 is associated with a pronounced cooling of the deep Southern Ocean (SO) in the 1st forcing cycle, and then a more gradual cooling of the abyssal Pacific and Indian Oceans. This was traced to a dramatic collapse of the Antarctic ice shelf and extremely deep SO mixed layers in cycle 1. These anomalies were much larger in the 1st forcing cycle than in subsequent cycles, and appear to emanate from the vicinity of the Ross Sea. Despite the deep temperature drift in JRA-55, the mean ocean – sea-ice solution has largely stabilized after 5 cycles: the AMOC shows a reasonable mean strength (~ 17 Sv at 26.5°N), the ACC is too strong (~ 175 Sv); and the sea ice volume and area stabilize at reasonable levels.

Analysis of the mean states from the 5th cycle of JRA-55 reveals a mix of pros and cons relative to CORE-II. Associated with the Southern Ocean spin up issue noted above, the deep ocean is too cold and fresh in JRA-55 compared to PHC climatology, and is much younger than in CORE-II. The Antarctic Bottom Water (AABW) overturning cell is about 50% stronger in JRA-55, and both the AMOC and

Atlantic meridional heat transport are slightly weaker (these may all be related to the SO spin up issue). This degrades the solution compared to observations from the Atlantic. Sea surface salinity shows a noticeable bias increase in the Maritime Continent region (too fresh). On the other hand, there are impressive improvements, i.e., reductions, in the warm SST biases in eastern boundary upwelling zones. The sea ice extent comparison with observations is as good as in CORE-II, and sea ice thickness is enhanced in the central Arctic (this is an important improvement over CORE-II). But, as also noted by other presenters, summer sea ice extent in both hemispheres is too limited, and is even worse than in CORE-II in the Southern Hemisphere.

Comparison of interannual SST correlation scores (with HadISST over 1958-2009) reveals that SST variability is much worse in JRA-55 in the South Indian and Maritime Continent regions. It is unclear if this SST variability is related to the surface fresh bias in that region and needs to be further explored. However, variability in the large-scale zonal SST gradient in the tropical Pacific is better represented in JRA-55 than in CORE-II, because the latter is dominated by a spurious long-term trend associated with a trend in NCEP trade winds. While interannual, wind-driven AMOC variations at 26.5°N are better in JRA-55 than in CORE-II (compared to RAPID observations), there are serious concerns about the fidelity of buoyancy-forced, decadal AMOC variations in JRA-55.

Both CORE-II and 20CR show an upward trend in AMOC strength between the early 1970s and mid-1990s, in line with most other models forced with CORE-II (Danabasoglu et al. 2016). This upward trend in AMOC towards a mid-1990s maximum has been highlighted as the key source of decadal prediction skill in the North Atlantic (Yeager et al. 2012; Yeager et al. 2015). In contrast, the JRA-55 run shows a mid-1970s maximum in AMOC (at 45°N) with a downward trend in subsequent years. The mid-1990s AMOC maximum in CORE-II and 20CR is in line with observed hydrography from the Labrador Sea (Yashayaev 2007) that shows that Labrador Sea Water density reached a peak in the early 1990s (Fig. 1). In the JRA-55 simulation, the peak occurs in the early 1970s, and this was shown to be related to much colder air temperature over the Labrador Sea in JRA-55 compared to CORE-II in the pre-satellite (pre-1979) era. It was speculated that different pre-satellite ice boundary conditions in different reanalyses (JRA-55 vs. NCEP vs. 20CR) may ultimately be responsible for different decadal AMOC variations as well as different SO spin up behaviours.

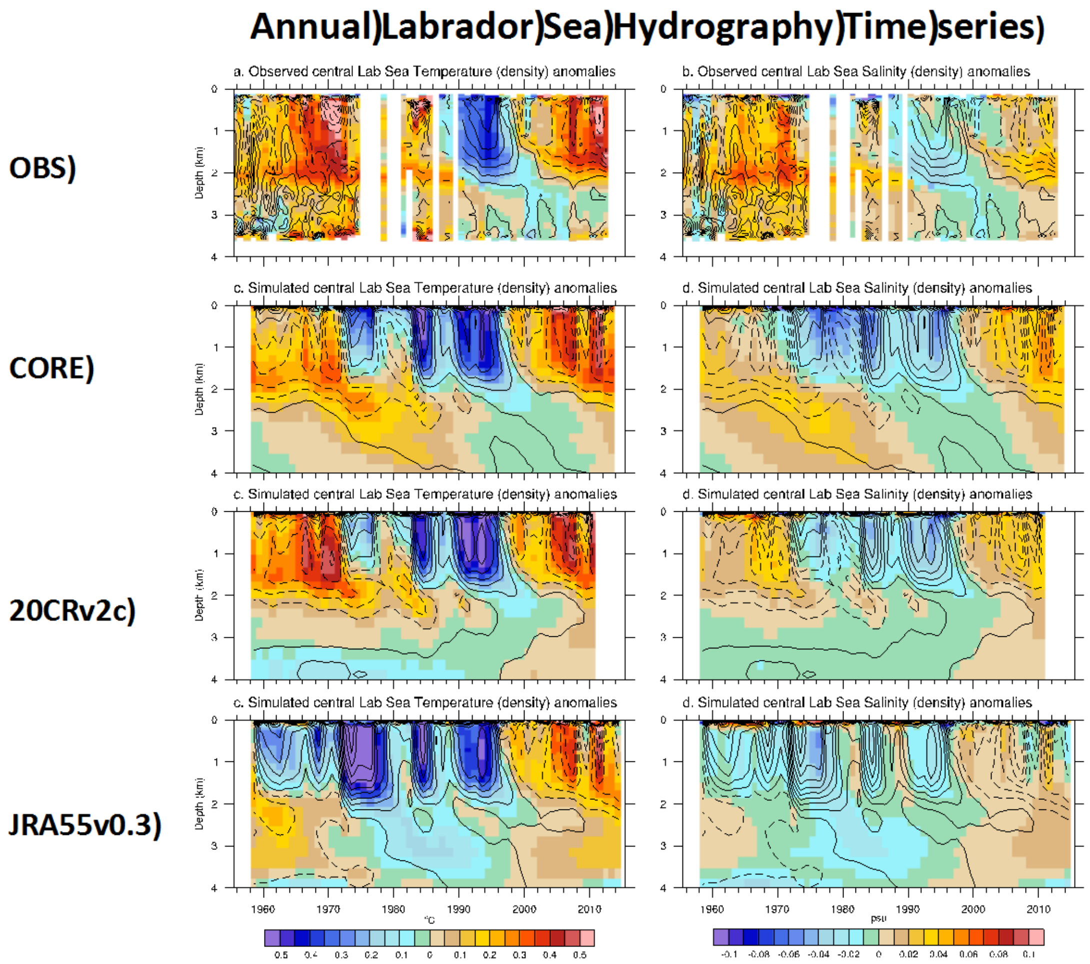

Figure 1: Annual anomalies of potential temperature (left column, shading), salinity (right column, shading), and potential density (σ_2, contoured at 0.01 kg m^{-3}; both columns). First row (OBS) shows hydrographic data from Yashayaev (2007). Remaining rows show output from ocean – sea-ice hindcast simulations.

2.5 Discussion

In addition to the detailed assessments of the solutions from MRI and CESM ocean – sea-ice coupled simulations forced with the JRA-55 data sets in comparison with the solutions with the original CORE-II data set (presented above), Le Sommer, Boning, and Griffies showed some preliminary analysis and evaluation of the JRA-55 data set and solutions from their modeling frameworks. In general, their findings were very similar to those of MRI and CESM. After discussions, the participants agreed on the following action items:

- Endorse JRA-55 activity within OMIP as version 2 (the current CORE-II forcing represents OMIP-version 1).
- Diagnose and explore strategies for addressing various issues identified with the JRA-55 data sets. (Yeager, Kim, Danabasoglu, Tsujino).
- Distribution of official forcing - via PCMDI - following agreed upon nomenclature. Remove v0.1, v0.2 from PCMDI (Durack, Tsujino).

3 OMIP and CMIP

3.1 OMIP and ocean grids

The participants were updated on the status of the endorsed OMIP and the associated GMD paper. There are ongoing discussions within the panel and with the prodder CMIP community regarding if the ocean model output fields should be provided on a model's native grid vs. interpolated to a common, regular longitude-latitude grid with each option has numerous pros and cons. There seems to be consensus for providing some fields, such as temperature, salinity, surface fluxes, on a regular grid for easy initial analysis. The modeling groups can provide the other fields on a model's native grid, but this will be at their peril because such data may not be used as widely as the data provided on a regular grid. Following action items were identified:

- Send feedback for CMIP infrastructure panel on CMIP archive issues (e.g. sub-sampling annual means, slicing) (All to Griffies by 01 March).
- Provide feedback on Diagnostic OMIP as part of GMD paper (All to Griffies by 01 March).

3.2 Climate model Spin Up (H. Hewitt)

Ocean spin-up takes place on multicentennial timescales (SenGupta and England 2004; Banks et al. 2007). Seferian et al. (2015) demonstrate that the length of the spin-up in CMIP5 models can have a dramatic impact on the simulation of biogeochemistry.

Spin-up is an important consideration in ocean-only and coupled model simulations. It is desirable to minimise drift from initial conditions; this will have an impact on short-range forecasts as less drift will allow data assimilation to be more effective and it will allow more realistic simulations of both sea ice and biogeochemistry which can be affected by the underlying ocean conditions. Understanding spin-up allows variability to be separated from the drift and, in coupled models, being close to radiative balance means that global ocean heat content is not drifting.

The protocol for CMIP is in discussion in GMDD (Eyring et al. 2015). Eyring et al. (2015) state the spin-up of the models is performed and discarded. After some discussion, it was agreed that detailed documentation of the spin-up and minimal archiving would be desirable so that the CMIP simulations can be better understood.

OMDP are in a good position to take the lead in understanding ocean spin-up in the CMIP runs and also to develop understanding of how indicative the ocean-only state from OMIP is of the ocean simulation in coupled runs.

- Formulate comments on CMIP6 Protocol - Eyring et al. (2015) paper. Recommend that spin up should be documented and archived. Send also to modeling groups (Hewitt)

4 CORE Protocol

We reviewed several aspects of the CORE protocol that were identified as items that could be improved, considering participants' experiences with the protocol over the past 5+ years. In the following, we list these items along with some details and action items

4.1 Towards a new Normal Year Forcing (NYF) (S. Yeager, W. Kim, J. Small, G. Danabasoglu, B. Large, NCAR)

The considerations that guided the creation of the original NYF (Large & Yeager 2004) were critically reviewed after years of experience using NYF and in anticipation of the need for a new single-year forcing data set for JRA-55-based COREs. The complex spectral averaging technique used to generate NYF was designed to preserve climatological fluxes, but the ostensible benefits of constructing NYF in this way have not been realized in practice. NYF-forced ocean – sea-ice simulations do not, in general, achieve the same equilibrium solution as the interannually-forced ocean – sea-ice simulations. Furthermore, there are serious drawbacks of NYF including that it: yields unrealistic mean sea ice states (it was not designed for over ice), is spatially noisy, does not yield physically-consistent atmospheric state fields, includes radiation and precipitation fields that lack weather variance, and is complicated. Yeager proposed revising the requirements and expectations of a single-year forcing data set for the community such that a well-chosen Repeat Annual Forcing (RAF; i.e., simply cycling over the forcing of a given year) would serve for all key intents and purposes. These are: 1) elimination of forced interannual variability, 2) quasi-climatological (or, non-anomalous) atmospheric state, and 3) well-defined and distributed for coordinated experiments. Preliminary investigation suggests that 2003 may be a good candidate for RAF, but further exploration and testing is needed.

- Revisit NYF objectives and expectations considering Repeat Annual Forcing and DRAKKAR approach (Yeager, Kim, Danabasoglu, Tsujino)
- Revisit and test sensitivity of CORE-II/OMIP spin up strategy (Yeager, Who, Danabasoglu, Spence, Romanou, Griffies)

4.2 CFCs and Ideal Age

- Re-enforce the recommendation that groups participating in CORE and OMIP implement CFCs and ideal age following CORE-II forcing protocol

4.3 Freshwater Forcing

Antarctic freshwater forcing

- Report on status of seal hydrography measurements and use in revisiting salinity restoring (Marsland).
- Provide recommendations on Antarctic liquid and solid flux estimates for OMIP-version 2 protocol. (Le Sommer).

Greenland freshwater forcing

- Invite Helmer and Bamber into discussion (Le Sommer, Ringler)

Mediterranean Outflow

- Recommend that groups document how Mediterranean Outflow is treated, including its salinity properties and the outflow water propagates in the North Atlantic.

Salinity Restoring

- Draft a set of recommendations (not specification) for salinity restoring that would be the preferred choice (e.g., weak restoring, cap of 0.5 psu). If models choose an alternative strategy, they should document the approach used. (Danabasoglu, Yeager, Kim, Griffies)

- Explore running with no surface salinity restoring. (Kim, Yeager, Danabasoglu)

4.4 CORE bulk formula properties of moist air.

- For OMIP-version 2 protocol, change latent heat to be dependent on SST.

4.5 Relative v absolute winds

- Peter Gaube interested in developing a paper on a recommended position going forward, based on state of knowledge. Undertake an internal OMDP review to ensure that the paper comprehensively addresses the debate on what the issues are, pros and cons of using relative or absolute winds (Gaube, Le Sommer, All).

5 CORE-II Analysis

5.1 CORE-II data archive

- Contribute CORE-II datasets (see 03 Sept 2014 email from Yeager and Danabasoglu) to NCAR archive using Globus. Send all data as NetCDF monthly means on native grid, using own variable names.

5.2 CORE-II CFC Analysis (A. Romanou, J. Marshall)

- A proposed new study will examine the central role played by the ocean's meridional overturning circulation in the uptake and sequestration of transient tracers from the CMIP5 & CMIP6 model simulations in comparison with the available CORE-II simulations. First, the skill of the models' response, when forced by observed timeseries of the CFC distributions in the atmosphere, with regards to both surface distributions as well as vertical sections and global inventories will be assessed. Then, what controls different uptakes in the models and connections with overturning patterns will be investigated.
- A. Send email to community with a mini proposal and data request needed for a new study involving analysis of CFCs in the CORE-II simulations (Romanou, Pirani)

5.3 Poster Cluster for the CLIVAR Open Science Conference (OSC)

- All lead authors of CORE-II papers solicited to prepare a poster for a CORE-II poster cluster at the CLIVAR OSC.

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