WORLD METEOROLOGICAL ORGANIZATION

32nd SESSION OF THE WORKING GROUP ON NUMERICAL EXPERIMENTATION (WGNE-32)

Met Office, Exeter, 9-13 October 2017

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WCRP REPORT 2/2018

Attendees of the WGNE-32 session

Perpetuating the long WGNE tradition…

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PRESENT: Ayrton Zadra, Keith Williams, Oscar Alves, Elena Astakhova, Julio Bacmeister, Francois Bouyssel, Michael Ek, Francois Engelbrecht, Ariane Frassoni, Junichi Ishida, Carolyn Reynolds, Nils Wedi, Gunther Zaengl, Daniel Klocke, John Mc Cormack, Marion Mittermaier, Jon Petch, Xueshun Shen, Steve Woolnough

EXCUSED: Jian Sun, Barbara Casati, D. Kim, R. Roberts, Peter Steinle, Laurie Wilson

WCRP JPS: Michel Rixen

1. Introduction

The 32nd meeting of WGNE was held as part of the Pan-WCRP modelling meeting comprising WGNE, WGCM, WGSIP, OMDP, CORDEX, S2S and DCPP. This document contains notes from the WGNE-only and joint sessions. Notes from the plenary sessions and breakout groups are in the WMAC-6 report.

2. WGNE Session

Joint Working Group for Forecast Verification Research Highlights (M. Mittermaier):
Planning to rewrite training material to focus on hydrology. Verification activities for winter Olympics in 2018 will be minimal compared to Sochi. MesoVICT update: Mesoscale Verification Intercomparison of Complex Terrain is using MAPP-D phase, and has special collections in MWR/WAF. MesoVICT moving in the direction of process-based diagnostics, but needs to do more. JWGFVR is looking to fill 4 vacancies.
A question was asked about using observations. Several components are looking at how to best use observations (satellite observations, model or observation space, use of independent data for verification, data assimilation). This fits best under MesoVICT. Does WGNE want JWGFVR to request a framework to compare models in the absence of overlapping domains (relative to a global benchmark or relative to climatology)?
Mesoscale modeling is moving to process-based studies. WGNE could help with definition of processed-based verification.
The use of 2-m temperature in urban environments is a cross-cutting problem in regional and global models. 2-meter temperature errors can serve as a good indicator of systematic errors in models.

Verification Session:

- **Deterministic HRES and Ensemble Verification Scores (N. Wedi):** Some relatively poor forecasts this past summer for both deterministic and ensemble systems, perhaps due to hurricane activity. High resolution appears to help. Questions still persist of verification against observations vs. analyses. SEEPS precipitation verification decomposition very useful. However, JWGFVR rejected SEEPS score recommendation due to issues with getting a uniform climatology. Extend SEEPS based on TRMM and then GPM (away from coverage for just gauges). YOPP results: most forecasts lose activity by 7 days. Average annual Arctic/Antarctic RMSE steady

reduction over the past years for most centres.. Significant biases in 2m temperature in coastal areas in Arctic and especially in Antarctic, with a large annual cycle in the biases, with standard deviation of forecast error much increased in the winter hemisphere for all centres.

- **TC verification (J. Ishida):** Note that resolution of reported data varies by center. Many centers have northward bias before recurvature. Centers often show shallow bias to the south and deep bias to north in W. PAC. Most centers show improvement over the last two years. TC verification on web site now up. Question: could you compare max 10-m winds and relationship between minimum SLP and max 10-m winds? This would be interesting but difficult due to the extra data needed.
- **QPF Comparison (F. Bouyssel):** There was a discussion of what direction to take this. Focus on resolution (temporal and spatial) or inhomogeneities? Can one center get enough information to do the scores for multiple models? Is it practical for each center to calculate their own scores using a unified data set? JWGFVR moved away from recommending SEEPS because of climatology differences. Lots of work to maintain databases. Is there a way to improve uniformity (same e.g. software)? If this is not the case, it is perhaps not worthwhile to continue this effort.

Global Atmospheric Systems Studies (D. Klocke): Focus on radiation, microphysics, clouds, BL. Will continue to work on parameterization development. Future projects adapting a more integrated view (processes and systems). There will be a grey zone follow-up (from cold air outbreak to deep convection). WGNE and GASS/GLASS should be brought tightly together, build on past successful projects. Upcoming meeting: Understanding and modeling atmospheric processes: 26 February 2018, Lorne, Victoria, Australia. Trying to figure out what the next projects will be. Complaint has been that it too "bottom-up" and therefore somewhat disjointed. Some coordination needed so that we don't get too many efforts.

Global Land/Atmosphere System Study (M. Ek): Goal is better representation of the earth system by focusing on the land, and improving modeling. Project for the intercomparison of land data assimilation systems (PILDAS) needs to be reinvigorated. PILDAS land DA links to WGNE. Lots of data mining potential from previous field projects if observations were put into a format that would facilitate use. Leverage a GCSS-DIME-like approach? Where do ocean/ice models fit into GASS/GLASS world? Single column models have a place in a hierarchy of models.

5th Systematic errors workshop outcomes (A. Zadra and K. Williams): Montreal, June 2017. Posters and presentations available on web site. Problems identified include: convective precipitation, MJO, sub-tropical BL clouds, double ITCZ/ENSO, cloud microphysics, precipitation over orography, fog and low-based clouds. Many presentations on identification of errors but very few solutions. Lots of presentations on stochastic physics, can WGNE support this? Recommend that climate community develop standard metrics like NWP community. Recommend that drag project be extended to consider momentum more generally. WGNE-WGCM to consider an effort to look at surface flux errors. WGNE to ask centers to rank priorities. Priorities are associated with impacts. WGNE can work with PDEF on model error representation. Fog errors need further investigation.

Blue Book and web site (E. Astakhova): Blue book action items listed separately.

Year of Polar Prediction (M. Ek and F. Engelbrecht): CORE started in 2017, first model datasets are available. Possible WGNE contributions: data denial experiments for YOPP SOPs. Antarctic sea ice work. Antarctic relatively ignored, so it is an opportunity.

Applicate (I. Sandu): Advanced Prediction in Polar Regions and beyond: Modelling, observing system design, and Linkages associated with a Changing Arctic Climate: Started on 1 Nov 2016, ends 31 October 2020, first annual meeting 15-17 January 2018 in Barcelona. Additional output from tendencies for process understanding from ECMWF. AOSCM (single column model, U Stockholm) already producing interesting results. Sensitive to coupling and time step. FSOI shows synoptic obs much more important in arctic compared to other regions.

3. Joint Session with WGCM

WGNE/WGCM/WMAC Climate metrics and diagnostics panel (P. Gleckler): Limited set of performance metrics for climate models. Broadened scope by WMAC to include diagnostics. CMIP DECK/historical was established to provide continuity, inspiring ongoing routine benchmarking of models simulations. Provide feedback to model developers through robust analysis code. Large list of community based capabilities (ESMValTool and PCMDI Metrics Package and others). Strive to fill in gaps working with expert groups within WCRP. Also, establish and promote a set of best practices for making results publically available. Need to think about how results are disseminated (modeling community should have a say in this). Game changer is making results available to modeling groups quickly.

- PMP: PCMDI Metrics Package: Diverse suite of robust high level summary statistics objectively comparing models and obs across space and time scales. End-to-end provenance to ensure reproducibility. Having expert teams recommend content. Simulation summaries provided to modeling groups soon after DECK/historical simulations made available via ESGF, includes support to modeling groups. Coordinated model evaluation capabilities (CMEC): make it easier for modeling groups to use multiple packages (PP, ARMDiag, TECA, ILAMB).
- Earth System Model Evaluation Tool (ESMValTool): Complementary to PMP with some intentional overlap. Includes both summary statistics and process diagnostics. Ensures traceability and provenance. 30 contributing institutions. Climdex, CVDP, and SOCCOM and many other packages included. Visualization with FREVA (http://cmip-esmvaltool.dkrz.de/). Can these tools be used to look for interdependencies? Yes if someone can work to include it.
- Obs4MIPS: Obs4MIPS and ana4MIPS available through CoG/ESGF. Challenging to make process for contributing data more efficient. Scope is broadening (higher frequency, data uncertainties, obs ensembles, forward models or simulators, in situ data). Recent efforts include dataset suitability and maturity. Closely coordinated with CMIP6. Q: how hard to evaluate e.g. ocean irregular grids? Will be case dependent, work in progress.

Grand Challenge on clouds circulation and climate sensitivity (M. Webb): Want us to consider gaps and opportunities, relationships to and links between different WCRP and National Programs. Is WGCM committed to organizing regular model hierarchy workshops (cf

Princeton 2016)? Is WGCM willing to help/support/review GCM assessments? Will WGCM promote/oversee the development of a new generation of global high-res coupled models (cloud resolving in atmosphere, eddy-resolving in ocean)? How close are we too global hi-res coupled models? Right now baby steps using hierarchies of models like RCE.

Drag Project (A. Zadra): Goal is to understand what level of parameterization is required to reproduce given phenomena and whether there are processes that are currently not represented in global models. Seeks to further understand intermodal differences in surface stresses (e.g., survey regarding the ancillary files). Extend the WGNE Drag project by comparing the tendencies given by the various parameterizations in regions of maximum uncertainty. Use high-res simulations to understand processes and constrain parameterizations. Use initial tendency diagnostics, nudging techniques, and data assimilation methods, more process-level based evaluations. Use more existing observations. Partitioning between different drag processes, resolved and parameterized (turbulent and orographic) is very uncertain and has been shown to be important. Potential ways forward include momentum transfer (modelling and verification) for YOPP or ocean or coupling component. Drag cannot be observed directly and high resolution modelling may help to understand the partition of processes.

Ensemble Update (J. Ishida and C. Reynolds): Research in ensemble forecasting, ensemble DA, ensemble calibration and post-processing, and model uncertainty or stochastic forcing remains very active. Several groups are continuing to see improvement through better representation of initial condition uncertainty and data assimilation-ensemble prediction system consistency. Work on inclusion of model uncertainty is very active on several fronts, including stochastic tendency perturbations, parameter perturbations, and analysis increment perturbations. Groups are seeing improved ensemble performance through surface perturbations (land and ocean) or coupling. Tropical cyclone intensity forecasting and forecasting on S2S timescales are also a very active area of research. Groups continue to explore trade-offs between resolution and number of members, with findings being application/metric dependent. The use of "fair" scores may be a way to improve efficiency of ensemble development and testing through use of smaller ensembles, but larger ensemble are probably needed in operations for, in particular, extreme events.

Meteo France Fog Campaign (F. Bouyssel): Field campaign planned for south of France (first campaign in winter 2019-2020). First version of a scientific and experimentation plan before end of 2017. Looking for collaboration in terms of instrumentation during field campaign, real time simulations during field campaign, intercomparison project organized after the campaign and research activities.

RELAMPAGO-CACTI Project at CPTEC (A. Frassoni): S. America has mesoscale convective systems associated with LL Jet. Envisioned to be an international multi-agency field program to study multi-scale aspects of intense organized convective systems that produce severe weather in subtropical south America. RELAMPAGO planned for 1NOV-1DEC 2018. CACTI field campaign planned for 1OCT2018-APR2019.

Earth system modeling at ECMWF (N. Wedi): Increasingly strong coupling between component models. IFS, NEMO 3.4, EC-WAM, LIM2 (ice). Coupling is at 1hour. Big impact

(larger diurnal cycle and greater spatial variability) of vertical resolution in ocean (now 1 m with 8 layers in top 10 m). Full coupling in tropics, partial coupling in extratropics helps with getting rid of biases in higher latitudes (gets rid of negative impact at initial time and thereafter in the extra tropics while maintaining positive impact in tropics). Need to look at potential sensitivities in stratocumulus regions. Coupling helps with over-estimate of TC intensity. Efficiency savings in wave model freed up enough resources to include ocean model (ocean is cheap compared to atmosphere). Sea ice initialization improved with OCEAN5 vis OSTIA. DA is weakly coupled, doing research on "outer loop coupling" tested in CERA-20C and CERA-SAT. Research focus on gulf stream separation and transition zone for extended range and seasonal forecasts.

Representing aerosol indirect effects in CESM (J. Bacmeister): CESM with model upgrade and new emissions estimates unable to capture 20th-century warming. Could be an issue with 2nd aerosol indirect effect. Reducing droplet dependence in autoconversion improves simulation (with CMIP5 emissions but still not good with CMIP6 emissions, which have more sulfate emissions over N. America. Model appears to be hyper-sensitive.

Evaluation of convective cloud height at JMA (J. Ishida): JMA developed cloud top height and type product based on Himawari 8 and used for model evaluation. Cloud top heights too high in 5km model which suggested the possibility of entrainment and detrainment (E&D) being too weak. Reducing E&D moderately helps, but reducing too much distorts distribution. New formulation improves precipitation in addition to cloud top height. 2km model also has high CTH bias, perhaps indicating that E&D might still need to be parameterized even if convective transport is fully/partially resolved in convective permitting models. Satellite estimates of cloud top heights are accurate for cumulus but not other clouds.

Numerics of the new Earth System Model at the CSIR (F. Engelbrecht): Variable-resolution earth system model (VrESM), a conformal cubic atmospheric model, is a CSIR-CSIRO collaboration. Focusing on convective rainfall parametrizations, southern African biomass burning and Atlantic stratocumulus clouds. Model has a uniform Jacobian equal area grid. Variable cubic ocean model (VCOM). Excellent scaling. Prognostic aerosols appear to have a detrimental effect similar to what is seen in CAM.

4. Joint session with WGSIP and S2S

MJO Task Force and YMC (S. Woolnough): From a moist-static energy perspective, dominant term is advection of moisture anomalies by mean state flow. Good relationship between mean moisture state and MJO but causality still not determined. Model ability to capture MJO amplitude is getting better. Models still have too many events not propagating through the MC. Ensembles do not exhibit a spread-skill relationship, and all are underdispersive. For coupling, look at fluxes and MSE budget. Boundary layer dry biases can inflate ocean feedbacks to the MJO. One can be getting effect of coupling right for the wrong reason. Next phase: looking at impact in HIWeather (joint with S2S teleconnections project). MJO-storm track modulations by the QBO.

Tropical-extratropical teleconnections on subseasonal timescales (H. Lin): Models in S2S have some common biases in NAO response to MJO. Dipole MJO in the tropics leads to better forecast skill of NAO. YTMIT Virtual Field Campaign questions: What is role of PV streamers? AR research? Influence of stratosphere on MJO?

Aerosol project (A. Frassoni): Studying direct and indirect effects, with three case studies (Egypt dust, China pollution, Brazil smoke). Big impact on direct effect, but not much on indirect effect. Improvement in 2-m temp and in some cases rainfall and 10-m wind speed. Atmospheric model quality key for air quality forecasting. Follow-up: S2S project has plans for an Aerosol project. Forecasts depend on emission models.

5. Joint session with WGSIP, S2S, OMDP

SPARC (J. McCormack): Studies on data assimilation and dynamical coupling. 19 Activities, focus on 5 (DAWG, S-RIP, SNAP, QBOi, DYNVAR). What does research community and WGNE need from DAWG? ERA5 will replace ERA-Interim, generally better in troposphere, mixed bag in stratosphere and mesosphere. SPARC reanalysis intercomparison project (S-RIP) special issue in atmospheric chemistry and physics. QBO intercomparison (QBOi): model QBOs do not penetrate to the lowermost stratosphere and are too narrow (this might influence tropospheric teleconnections, MJO). SNAP will look more at stratosphere-troposphere coupling. SPARC/WGNE going forward could focus on 1) uncertain future of satellite observations, treatment of convection and MJO, treatment of gravity waves, new or better verification tools for extended-range forecast skill in stratosphere-resolving systems.

PDEF (O. Alves): Focusing on stochastic physics, ensemble initial conditions, diabatic processes in meso/synoptic scale dynamics, coupled modeling and assimilation, and assessment of multi-model ensembles and calibration techniques. WGNE-PDEF overlap includes coupled DA and coupled model ensemble initialization, stochastic physics, and post-processing. WGNE and PDEF have already organized two workshops on systematic and stochastic model error. PDEF is encouraging coarse graining experiments.

Initial drifts-shocks (B. Merryfield): WGSIP's long-range forecast transient intercomparison project. Purpose is to enable multi-model inter-comparison studies of transient behaviour of coupled long-range forecast models evolving from observation-based initial conditions. Developing a multi-model online archive of hindcast climatologies and standard diagnostics. What is the influence of different initialization methods on transient behaviour of climate model components and impacts on climate forecast quality? These transients can last a few years although there is less transient behaviour with no sub-surface initialization.

DAOS (C. Cardinali): ECMWF/WWRP workshop on model uncertainty 11-15 April 2016. Better links could be established with e.g. the WGNE workshop on systematic errors and also WMO DA symposium Florianopolis Brazil 2017. Coupled DA workshop at Meteo France in 2016 (weakly coupled DA relatively mature, but strongly coupled still a research frontier). Representation of surface fluxes must be improved. Need to observe cross-domain interfaces

and need field campaigns with co-located observations spanning multiple domains. Need to increase collaboration between field campaigns and modelers. DAOS should advocate and support initiatives like JCSDA JEDI and facilitate development of modern observation databases that can be shared and easily added to.

6. WGNE business and next session

There was an offer to host the next WGNE session at JMA in Japan in fall 2018. Suitable dates will be identified after the meeting via a doodle poll.

APPENDIX A – ACTIONS FROM WGNE-32

Recommendation 1 - for DAOS and JWGFVR to provide guidance on the greater use satellite data for verification.

Recommendation 2 - for JWGFVR to verify T 2m as the next step regarding taking forward document on high resolution verification.

Recommendation 3 - for WGNE members (and colleagues) to submit abstracts to Pan-GASS and GEWEX OSC.

Recommendation 4 - WGNE and DAOS to consider intercomparisons of maps of DA increments for verification and identification of systematic errors.

Recommendation 5 - CMDP & JWGFVR to quantitatively report on ~5yr frequency improvements in climate modelling.

Recommendation 6 – WGNE Drag project to evolve into momentum project.

Recommendation 7 – WGNE to consider designing experiments for the WGSIP shock project.

Recommendation 8 – WGNE members to promote use of TIGGE and TIGGE-LAM.

Recommendation 9 – Modelling centres to consider becoming involved with SIPN-Antarctic.

Recommendation 10 – **Francois Bouyssel** to consider inviting WGNE model intercomparison project following fog field campaign.

Recommendation 11 – WGNE to encourage modelling participation in RELAMPAGO when appropriate.

Recommendation 12 – JWGFVR to be involved with verification for RELAMPAGO.

Recommendation 13 – DAOS and SPARC to develop communications regarding stratospheric DA.

Recommendation 14 – Modelling activities (WGNE, GASS, GLASS) and verification should sit in the centre of WMO science (as opposed to just under WWRP or WCRP).

Recommendation 15 – CMDP and JWGFVR to consider evaluation of climatology of NWP forecasts and forecast ability of climate models (in Transpose-AMIP).

Action 1 – WGNE members to consider submitting centre reports (slides or posters) to Elena Astakhova for WGNE website.

Action 2 - **Co-chairs** to get more information on who will be TC lead centre (JMA/KMA/CMA(?)) before WGNE makes a recommendation.

Action 3 – **Marion Mittermaier** (JWGFVR) to propose a strategy process-based verification and report at WGNE-33.

Action 4 - Nils Wedi to report SEEPS decomposition at WGNE33.

Action 5 – **Marion Mittermaier** to send CBS recommendations document on global deterministic surface verification. WGNE to follow-up next steps for precipitation verification.

Action 6 - **Francois Bouyssel and Carolyn Reynolds** to lead a project on surface fluxes (joint with GASS, GLASS and in discussion with CLIVAR and DAOS). Initial focus will be over oceans. Co-chairs to then support the leaders in encouraging centres to participate.

Action 7 - **Co-chairs** to give more information on systematic errors details for WGNE website.

Action 8 - **Co-chairs** to circulate systematic errors list for prioritisation.

Action 9 - **Carolyn Reynolds and Oscar Alves** to propose a joint project on model uncertainty with PDEF (possibly starting with coarse graining). DAOS to be kept in loop.

Action 10 – **Ariane Frassoni and Francois Engelbrecht** to take forward the Aerosols project joint with S2S (One angle might be use of ORACLES - NASA field campaign over S. African coast – and SAMBBA over S. America).

Action 11 – **Ayrton Zadra and John McCormack** to improve co-ordination regarding momentum project with SPARC.

Action 12 – **WGNE members** to provide Elena Astakhova with email addresses to extend/update mailing list for blue book.

Action 13 – **Elena Astakhova** to add uploading confirmation to website for contributions to Blue book.

Action 14 – **Elena Astakhova** to enable access to preliminary version of Blue book for contributors.

Action 15 – **Elena Astakhova** to transfer 2002-2016 archive to new website.

Action 16 – **WGNE members** to send links of centre websites to Elena Astakhova.

Action 17 – **Leaders of WGNE projects** to provide Elena with information on their projects for the website.

Action 18 – **Ariane Frassoni** to continue to be connection between WGNE and RELAMPAGO project and investigate availability of observational data and liaise over modelling protocol.

Action 19 – **Michel Rixen** to close WMO WGNE website at beginning of January 2018 with a redirect to new website.

Action 20 – **Nils Wedi** to contact OMDP to take forward bringing together cross-timescale community on exascale.

Action 21 – **Nils Wedi** to provide a review of exascale activities at WGNE33.

Action 22 – **Julio Bacmeister** to create climatological maps of precipitation from global NWP forecasts.

Action 23 – **Gunther Zangl** to add EPS details and wallclock time for deterministic forecast to the Modelling Table.

Ongoing actions from WGNE-31

Recommendation 3 - WGNE members to encourage their centers to contribute (at least the tier 1) contributions to the activities of HighResMIP.

Action 10 (more of a recommendation) - WGNE requests centers to submit full resolution model output for TC verification.

Action 19 - **Peter Gleckler** to email the CMDP members to ask a volunteer to join JWGFVR.

Action 27 - **Ariane Frassoni** to request Saulo Freitas to include estimates of statistical significance of the impacts of aerosols in the case studies.

Action 29 - **Francois Engelbrecht** to take forward biomass stratocumulus interactions on climate timescales under CORDEX.

Action 32 - **WGNE members** to check whether their centers are contributing EPS data to JMA lead center.

Ongoing actions from WGNE-29

Action 18 - **Xue Shun** to investigate the availability of additional data from China related to the Beijing aerosol case study. (**Jian Sun** replacing Xue Shun in this action?)