

## Second meeting of the WWRP PDEF working group, Met Office, Exeter

Minutes of meeting, 25-26 April 2016

PDEF WG attending: Craig Bishop (NRL, USA), John Methven (U Reading, UK), Judith Berner (NCAR, USA), Masayuki Kyouda (JMA, Japan), Mark Rodwell (ECMWF), Susanne Theis (DWD, Germany), Munehiko Yamaguchi (JMA, Japan), Oscar Alves (BoM, Australia), Paolo Ruti (WWRP)

PDEF WG apologies: Olivia Rompainen-Martius (U Bern, Switzerland), Zhiyong Meng (U Peking, China), Manuel Fuentes (ECMWF as TIGGE chair)

Meeting guests: Richard Swinbank (Met Office), Neill Bowler (Met Office), George Craig (LMU, Germany), Robert Neal (Met Office), Peter Bauer (ECMWF), Anca Brookshaw (ECMWF), Huw Lewis (Met Office), Tim Johns (Met Office), David Walters (Met Office)

### 1. Organisation of the meeting

### 2. Quick review of objectives of working group and 5 challenge areas:

- Stochastic representation of the effect unresolved processes in numerical models
- Construction of ensemble initial conditions
- Interactions of diabatic processes with meso/synoptic scale dynamics
- Assessment of multi-model ensembles and calibration techniques
- Coupled modelling & assimilation

### Actions & Decisions from 1st PDEF WG meeting and outcomes

**Action 1.3.1:** PDEF WG to provide feedback on WWRP science implementation plan by October

WHO: co-chairs. DEADLINE: October 2015.

Done.

**Action 1.3.2:** Secretariat and co-chairs to request TIGGE providing centres to include information on forming storms in CXML messages (initially using location / time as identification and subsequently discuss a naming convention).

WHO: RS & PR. DEADLINE: Sept 2015.

Done by some centres and being archived at NCAR data portal.

**Action 1.4.1:** It was agreed that the designated PDEF representative (OM) should participate in HIWeather conference calls, reporting to PDEF co-chairs.

WHO: Olivia Martius. DEADLINE: October 2015.

Done.

**Action 1.4.2:** JM is attending the YOPP summit meeting. JM to clarify how best the PDEF group might support PPP, reporting back to co-chairs.

WHO: John Methven. DEADLINE: July 2015.

YOPP Summit attended and report included in report from PDEF to WWRP SSC.

**Action 1.6.1:** All members to publicise the TIGGE-LAM database to their national research communities and at international conferences.

WHO: All members. DEADLINE: Before next PDEF meeting.

Ongoing.

**Action 1.6.2:** The working group welcomed the possibility of FNMOC ensemble prediction data to the TIGGE database. CHB, YZ to ensure necessary support is provided by NRL and NCDC, and secretariat to assist if necessary with the provision of a WMO identifier for the data.

WHO: Yuejian Zhu and Craig Bishop. DEADLINE. No deadline

**Action 1.6.3:** Secretariat and TIGGE panel co-chair to discuss how to organize all weather-related ensemble databases at the international level and organise a plan.

WHO: Secretariat and Manuel Fuentes DEADLINE. Long term.  
S2S database using similar template to TIGGE.

**Action 1.7.1:** The working group agreed that stochastic physics should be part of the planned WGNE workshop on systematic model errors. OA to liaise with WGNE, as a first step towards organising the relevant workshop session(s).

WHO: Oscar Alves. DEADLINE: as soon as possible, by October 2015.

Initial discussions opened. Now need to propose a session on stochastic physics organised by PDEF.

**Action 1.7.2:** A small task team to review possibility of running high-resolution models for coarse graining experiments for stochastic physics studies. Reporting to PDEF cochairs.

WHO: Judith Berner, Mark Rodwell and Craig Bishop (with George Craig).

DEADLINE: October 2015.

Ongoing. See actions from this meeting.

**Action 1.8.1:** JM and OM are attending SPARC meeting on storm tracks. JM and OM to discuss possible PDEF collaborations with WCRP, including transpose-AMIP style experiments spanning NAWDEX, and diabatic effects on storm tracks, then reporting to PDEF co-chairs.

WHO: John Methven and Olivia Martius. DEADLINE: September 2015.

Meeting attended and presentation given on NAWDEX and proposing initial conditions studies with climate models for NAWDEX campaign period.

**Decision 1.8.2:** The PDEF working group supported plans to hold an international workshop on blocking next Spring.

Blocking workshop held 6-8 April 2016 at the U of Reading.

**Action 1.9.1:** It was agreed that PDEF could play an advisory role in improving ensemble methods in coupled systems, coupling methods, and the multi-model approach. A PDEF representative should participate in future S2S teleconferences, reporting to PDEF cochairs.

WHO: Oscar Alves. DEADLINE: October 2015.

Done.

### 3. Review of activities on stochastic representation of the effect unresolved processes in numerical models

**Judith Berner** (challenge champion) reported on recent activities. PDEF co-organised a workshop on model error at the ECMWF organised into 4 themes:

1. Fundamental ideas
2. Diagnosing model error
3. Operational stochastic physics schemes
4. Latest research

Discussions were organised into 3 working groups and each group has written a report with recommendations for ECMWF is being published on the ECMWF website.

**Mark Rodwell** discussed strategies for inferring model error and techniques for diagnosing the structure of errors in relation to key features in the atmospheric flow (e.g., jet stream meanders, blocks, cyclones). Key diagnostics included the analysis increments in a feature-relative frame, for example indicating consistent error in the model representation of heating (too low in altitude). Also novel diagnostics such as the EDA (ensemble of data assimilations) reliability budget which illustrates the largest residual (mismatch between spread and forecast error) where regional CAPE is large and convection is likely to take place. Rossby wave source diagnostics used to show that upper level horizontal divergence advects the PV gradient across the jet stream and helps to hold block stationary.

**Action 2.3.1:** Outcomes of model error workshop collated as a report and presented on the ECMWF website. PDEF to write an additional page explaining the value of coarse-graining [MR & JB]. Report to co-chairs including a summary of literature [JB & CB].

**Action 1.7.1 continued:** Organise stochastic session in WGNE systematic error workshop [OA & JB].

**Action 1.7.2 ongoing:** Advocate experimental design for coarse-graining studies that can be applied in a common framework across different models. Using high resolution model data to compile tendencies within larger grid boxes and aim to parameterise tendencies. Compare PDF of high res tendencies with low res model. Updated action is to propose such experiments at NCAR using the MPAS model at very high resolution and then evaluate using the new experimental design [JB].

**Action 2.3.2:** Suggest setting up some similar experiments with NICAM in Japan. To be introduced by PDEF WG. More concrete experimental design is required. [MY & MK].

#### **4. Review of activities on construction of ensemble initial conditions**

**Craig Bishop** (challenge champion) outlined the status of operational ensemble initial condition methods and the ad hoc adjustments that are used to achieve better spread-skill relationships. He discussed how the techniques applied make fundamental assumptions about the variables, such as Gaussianity of distributions, and he highlighted the situations where this is inappropriate and new techniques are required. A key example is the mixing ratio of constituents which is positive definite where new filters were proposed based on gamma distributions. There are still inherent problems that need addressing such as the transform from observation space to model space.

**Neill Bowler** described the rationale behind the design of the new hybrid En-4DEnVar system in development at the Met Office and some initial results from it. One attractive aspect is to drive for consistency between the assumptions made regarding uncertainty in the data assimilation system and in construction of ensemble members, including the ensemble of analyses used as initial conditions. A surprising finding was that the perturbed observations scheme is making almost no difference to forecasts. The ramifications of this are to be investigated in the Met Office and other forecast systems.

#### **5. Review of activities on interactions of diabatic processes with meso/synoptic scale dynamics**

**John Methven** (challenge champion) described recent activities under this area:

1. JM represented PDEF at the PPP Year of Polar Prediction Summit (Geneva, July 2015). Coupling with the surface and boundary layers is a particular issue for prediction in polar regions.
  - a. JM & OM attended the SPARC workshop on storm tracks (Grindelwald, Aug 2015). The meeting brought together researchers from across the dynamics community ranging from climate simulation to weather phenomena modelling, theory and observations. JM presented the scientific plan for NAWDEX and suggested "TRANSPOSE-NAWDEX" – running climate models from analyses during the NAWDEX campaign period to examine process representation, especially the jet stream and cloud. Tiffany Shaw (SPARC co-chair) has led a perspective paper in Nature Geoscience synthesising meeting outcomes.

- b. OM & Giacomo Masato initiated a joint PDEF/SPARC workshop on blocking and JM, Tim Woollings & Ben Harvey helped to deliver the meeting (with support from IAMAS, WCRP, ERC, NCAS and universities of Reading and Bern). There were 106 participants from 22 nations (50 institutes). The meeting spanned 3 days (6-8 April 2016) and discussed:
  - a. Dynamical characteristics of blocking and diagnostics
  - b. Impacts of blocking and recent trends in data
  - c. Representation in models and response to forcing
 The meeting committee will write a SPARC newsletter article and a perspective paper on blocking arising from discussions at the meeting.
- 2. NAWDEX campaign planning workshop took place April 4-5 2016 in preparation for the field campaign 19 Sep-16 Oct 2016. Three aircraft (HALO, DLR Falcon and SAFIRE Falcon) are committed in addition to diverse ground-based observations from the UK, France, Iceland, Canada and Norway. Groups working at the campaign base in Iceland will come from Germany, Switzerland, France, UK, USA and Iceland.

**George Craig** described the structure and goals of the new DFG-funded collaborative research centre “Waves to Weather” that started in November 2015. It consists of 18 projects in predictability and dynamics with 24 PIs, 6 postdocs and 23 PhD students starting in the first 4 year phase. The 3 main science foci are:

1. Upscale error growth (km-scale to synoptic weather systems)
2. Cloud-scale uncertainties (interaction between cloud processes & dynamics)
3. Predictability of local weather

Cross-cutting activities are:

- a. Visualisation (of uncertain information)
- b. Campaign data (NAWDEX in phase 1)
- c. Ensemble tools

George gave an illustration of characterising predictability from a km-scale ensemble conditional on the convective timescale associated with the large-scale environment of convection.

**Action 2.5.1:** Encourage use of the NAWDEX campaign period for the investigation of the processes in NWP models and the origins of model error **[JM]**

**Action 2.5.2:** Output tendencies (partitioned by process) from the operational ECMWF ensemble during the NAWDEX campaign. Used for case studies looking at model error. Other potential diagnostics include analysis increments and EDA applied to NAWDEX period. Phenomenon-based composites maybe necessary to compile statistics over many similar situations. **[MR]**

**Action 2.5.3:** Investigate the possibility of data denial experiments using NAWDEX data for campaign period and who will be able to conduct those experiments. Further discussion required with DAOS, Met Office, ECMWF and Waves to Weather group **[JM]**.

**Action 2.5.4:** Run workshop on the role of diabatic processes in weather systems at the Royal Met Soc conference on “High impact weather and climate” in Manchester, July 2016 **[JM]**.

**Action 2.5.5:** Consider follow on meeting from blocking workshop. Strong support from participants for a repeat workshop in 2-3 years time. Also, potential to convene a session on blocking in IAMAS conference (Cape Town, Aug 2017).

## 6. Review of activities on multi-model ensembles and calibration techniques

**Munehiko Yamaguchi** (challenge champion) summarised recent work utilising multi-model ensembles which is of direct relevance for the WWRP projects: PPP, S2S and HIW. Examples include characterising multi-model ensemble skill for the Arctic and Antarctic, modulation of TC activity by the Madden-Julian Oscillation and probabilistic predictions of extreme events such as flash floods across South Africa.

Munehiko also described the use of TIGGE products in the SE Asia SWFDP and the RDP for NW Pacific tropical cyclones. In particular, data from the ECMWF control member forecast is now available in near real-time (about 12 hour delay) on the GTS in BUFR format for use in TC forecasts and early warning.

Munehiko presented results of a search of articles using TIGGE data in AMS and Wiley journals, including the nature of the science addressed. He found 59 papers in AMS journals and 33 in Wiley (mainly QJRMets and GRL).

**Robert Neal** described ensemble forecasting applications being developed by the weather impacts team at the Met Office and the way in which this feeds into the national severe weather warning service in the UK. This includes modelling hazard impacts, the associations between high impact weather and large-scale weather regimes (with a view to longer-range predictability), feature-based applications (e.g., tropical cyclones) and a new global hazard map. Aspects here are particularly relevant to the HIW project, including compilation of impacts data for evaluation of global hazards and how to evaluate impacts-based warning matrices (e.g., hazard likelihood versus impact).

**Action 2.6.1:** Change title and remit of this challenge to reflect the need to consider applications in order to generate meaningful probabilistic forecast products for users. The suggested title is, “**Assessment of ensemble forecasts and adding value to them**” [MY & co-chairs].

**Action 2.6.2:** Write up summary of TIGGE papers and put onto TIGGE portals. This includes an annual update of publications using TIGGE [MY].

**Action 2.6.3:** PDEF to recommend to WWRP that ensemble tropical cyclone forecasts with forming tropical cyclone information be available in real-time in order to benefit operational tropical cyclone forecasting and early warning. [co-chairs]

**Action 2.6.4:** Ensure link from ECMWF TIGGE portal to NCAR portal for TC data (in CXML) [MK].

**Action 2.6.5:** Appoint Munehiko as champion of this challenge area.

## 7. Summaries of PDEF related research from WG members that are in attendance

**Masa Kyouda** reported on the latest work on medium-range forecasts for extreme weather. Only JMA and NOAA produce 2-week outlooks for the likelihood of hazardous weather. For example, the probability that the 7-day average evening temperatures are lower than a threshold for a window starting at lead times of 5-8 days. This is tailored by the agricultural research institute to produce an important metric for rice crops under the pilot project with the meteorological service and the main registered users are farmers. The pilot project enhanced a) dialogue & sharing

knowledge, b) joint technology development, and c) spread of best practices. In the future other forecast centres should aim to issue forecasts for the likelihood of extreme events on sub-seasonal to seasonal timescales.

**Susanne Theis** described recent work with convection-permitting limited-area ensembles, including those contributing to the TIGGE-LAM archive. Andrea Montani has studied the probabilistic forecast skill for 5 out of 7 TIGGE-LAM ensembles sharing a common region (Germany). This was a challenge due to the different rotated grids used by the models and the need to transform and interpolate to a common grid. This is a hindrance to users.

Susanne highlighted the challenges associated with utilization of ensemble forecasts and illustrated the problems inherent with presenting maps of probability which can be readily misinterpreted or are ambiguous (e.g., low probability associated with scattered thunderstorms could indicate the large spacing between individual storms in all ensemble members or the appearance of storms in only one ensemble member). Some alternative representations were suggested. Another problem relates to the use of diagnostics of ensemble mean and spread (e.g., point location forecasts) which hides the temporal behavior associated with individual forecast members. For example, the interest in ramping of wind power generation. It highlights the need for users to ingest data from individual ensemble members and pass this through risk/hazard models to calculate quantitative probabilities for decision making.

**Action 2.7.1:** Input suggestion to HIW that we produce guidelines on interpretation of probabilistic forecast charts for high impact weather **[ST]**

## **8. Idea development session for advancing research on PDEF Foci.**

(Reported in relevant sections of the minutes.)

## **9. Actions from WWRP SSC (PR): 0900-1000**

PR outlined the WWRP Implementation Plan 2016-2023 and the 4 societal challenges and associated action areas. The matrix of action areas being covered by the WWRP projects and WGs was discussed including identification of gaps.

**Action 2.9.1:** Co-chairs to input to WWRP implementation plan (within input from WG) & provide a Gantt chart of PDEF activities on the two year time horizon **[co-chairs]**.

## **10. Links with other projects, WGs, etc**

The group received reports from the 3 WWRP projects:

10.1. HIWeather project (George Craig)

10.2. Polar Prediction Project (Peter Bauer)

10.3. S2S project (Anca Brookshaw)

**Action 2.10.1:** PDEF to provide input to PPP before their YOPP planning meeting in Reading, 5-9 Sep 2016. PPP requests recommendations from PDEF regarding the

design of experiments for YOPP and also any commitment to execute relevant experiments. PPP will send PDEF some more specific ideas relating to the scientific hypotheses being tested during YOPP. JM to attend that meeting as representative of PDEF. **[co-chairs]**

**Action 2.10.2:** Ask S2S co-chairs to recommend that researchers use TIGGE data to complement S2S data for short-range at higher resolution. Evidence suggests that this is particularly pertinent to the emergence of systematic model error which often occurs within 3 days. The contrast between the NWP and S2S prediction systems would be informative.

**Action 2.10.3:** S2S has requested suggestions for novel diagnostics that can be applied routinely to S2S model data. PDEF to report back to S2S **[co-chairs]**. CHB: Spoke to Frederick Vitart after meeting. He was very keen to have Rossby wave packet tracking diagnostics inserted into S2S. Particularly, diagnostics pertaining to interactions between the tropics and extra-tropics.

**Action 2.10.4:** PDEF to recommend to the leaders of the YTMIT initiative of S2S (Year of Tropics and Mid-Latitude Teleconnections) that they link their plans and experimental designs with the polar-low-latitude interactions activity of YOPP (under PPP) and share results. **[OA & co-chairs]**

## **11. TIGGE and TIGGE-LAM**

**Manuel Fuentes** reported on the usage of TIGGE and TIGGE-LAM (presented by **MR** at the meeting).

It was suggested that PDEF could write a short document that provides advice on how best to utilize ensemble forecasts in developing countries which currently do not have investment in a forecasting system. This maybe access and processing of the global forecasts via TIGGE, or circumstances in which limited area downscaling from a global ensemble might be a valuable approach. The workshops and training offered to Asian Pacific countries could be a model example.

**Action 2.11.0:** CB has entered into discussions with Dr Benjamin Lamptey, Deputy Director-General of the African Centre of Meteorological Applications for Development (ACMAD) on strategies for promulgating and verifying/evaluating convective scale simulations from Africa's four regional centers. First step is to get deterministic forecasts going. Follow-on step is ensembles and the ensemble configuration.

**Action 2.11.1:** PDEF to propose scientific questions that could be used to promote the use of TIGGE and TIGGE-LAM by the scientific community (as S2S has done for their new archive). **[all]**

## **Joint session of DAOS & PDEF**

### **12. Short presentations (5-10 minutes) from the two WGs, PPP, HIW and S2S (13:00-13:30)**

- DAOS (Carla Cardinali)
- PDEF (Craig Bishop)

- PPP (Peter Bauer)
- HIW (Jenny Sun/Brian Golding/George Craig)
- S2S (Anca Brookshaw)

Links from PDEF to projects discussed above. In the joint session the focus was on activities that could help PDEF and DAOS to deliver together. In particular, NAWDEX was mentioned as an activity where input from the DAOS group on the value of additional campaign observations for reducing ensemble spread is needed (see action 2.5.3).

**Action 2.12.1:** Consider cross-representation between DAOS and PDEF when WG meetings are not in the same location. Exchange meeting agenda and minutes. **[co-chairs]**

### **13. Review of activities on coupled modelling and assimilation**

**Action 2.13.1:** Organise coupled model & DA workshop in South Africa as part of IAMAS conference in Cape Town, Aug 2017. Need to find co-convenor from ocean DA. **[Craig, Oscar]**. CHB Update: Prof. Andrew Moore (UCSC) has agreed to co-convene the meeting – hopefully it will move forward now. Continue Action 1.7.2.

### **14. Next meeting**

Options discussed. Option A. Monterey? Month of April/May? June in Montreal (WGNE model error) – option decided no good because 5 day meeting already.

### **Consolidated list of actions from 2<sup>nd</sup> PDEF WG meeting**

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**WHO: Yuejian Zhu and Craig Bishop. DEADLINE. No deadline**

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