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Canada

Report on the 5th WGNE Workshop on Systematic Errors

Ayrton Zadra and Keith Williams

Pan-WCRP Modelling Groups Meeting
UK Met Office, Exeter, United Kingdom, 9-13 October 2017

WGNE WSE-2017

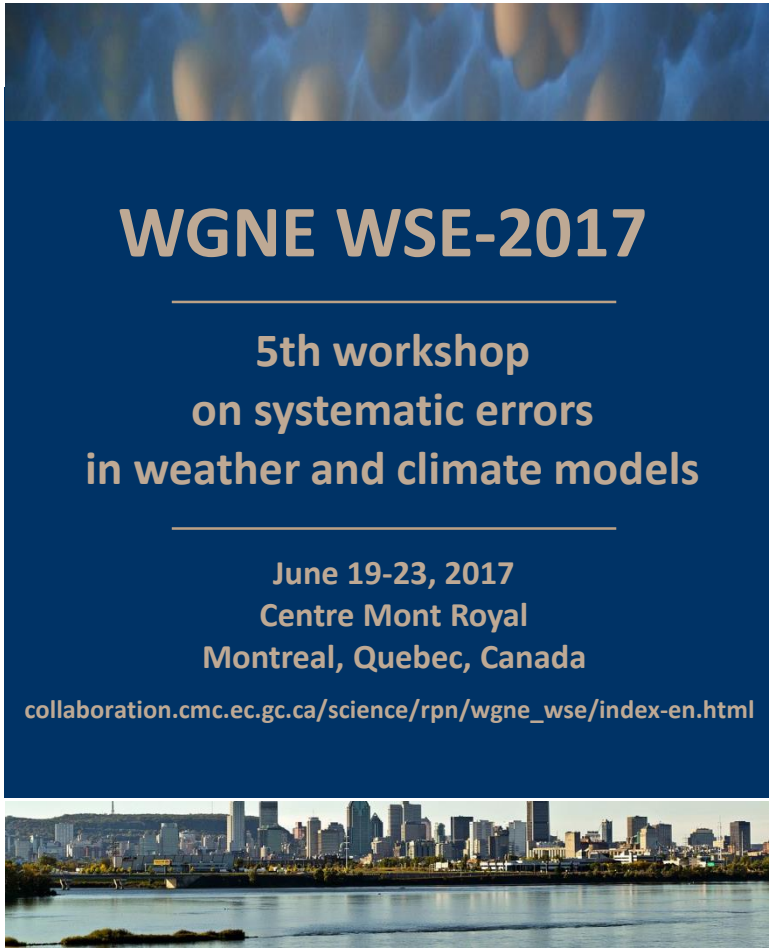
- hosted by ECCC
- co-sponsored by WMO/WCRP, NOAA/MAPP, Ouranos

Science steering committee:

Keith Williams (WGNE co-chair)
Barbara Casati (JWGFVR)
Greg Flato (WGCM)
Nils Wedi (WGNE)
Bill Merryfield (WGSIP)
Francois Bouyssel (WGNE)
Hai Lin (S2S)
Mike Ek (WGNE, GEWEX, GLASS)
Eric Maloney (MDTF)
Kazuo Saito (MRI-JMA)
Judith Berner (PDEF)

WMO liaison: Michel Rixen (WCRP)

Local organizer: Ayrton Zadra (WGNE co-chair)



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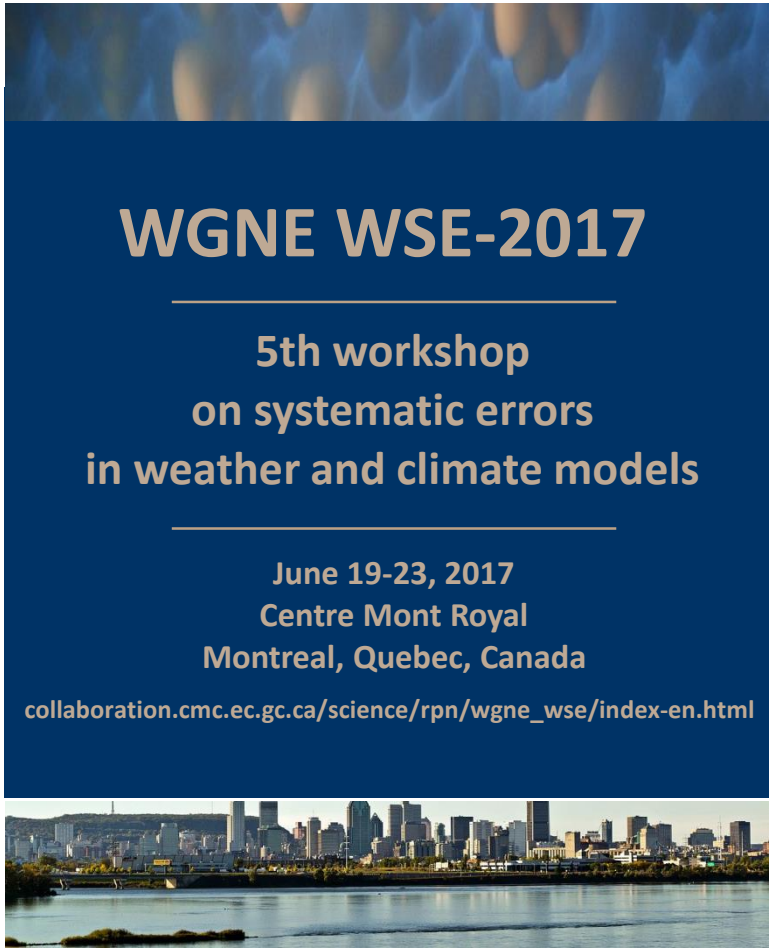
Some statistics:

- 13 keynote presentations (by invitation)
- ~230 abstracts submitted
- 166 abstracts accepted:
  - 132 posters
  - 34 oral
- 10 early-career scientists (ECS) received financial support from WCRP
- various ECS activities
- Note: most presentations and posters available on the workshop website.



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Themes and Keynote Speakers

Atmosphere-land-ocean-cryosphere interactions

- Gianpaolo Balsamo, European Centre for Medium-Range Weather Forecasts.
  Representing Earth Surface Processes and Uncertainties in Global Forecasting: which way to errors' reduction?
- Irina Sandu, European Centre for Medium-Range Weather Forecasts.
  How uncertainties in surface drag impact the large-scale circulation.

Clouds and precipitation

- Stephen Klein, PCMDI, Lawrence Livermore National Laboratory.
  Climate Modeling Challenges Related to Global Cloud Feedbacks.
- David Neelin, University of California at Los Angeles.
  Convective transition statistics for climate model diagnostics.
- Masashi Ujiie, Japan Meteorological Agency.
  Recent activities for fixing compensating errors in parametrisation schemes of the JMA operational global model.

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Themes and Keynote Speakers

Resolution issues

- Christoph Schär, Institute for Atmospheric and Climate Science, ETH Zürich.
  Towards Convection-Resolution Climate Modeling.
- Prashant Sardeshmukh, University of Colorado at Boulder.
  Is ultra-high model resolution necessary to improve probabilistic predictions?

Teleconnections

- John Fyfe, Environment and Climate Change Canada.
  Links between low, mid, and high latitudes.
- David Straus, George Mason University.
  Understanding Tropical – Extratropical Interactions and the MJO.

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Themes and Keynote Speakers

Metrics and diagnostics

- Peter Gleckler, PCMDI, Lawrence Livermore National Laboratory.
  Systematic errors across space and time scales and their relevance to future projections of climate change.
- Marion Mittermaier, UK Met Office.
  Ensemble versus deterministic performance at km-scale.

Model errors in ensembles

- Mark Rodwell, European Centre for Medium-Range Weather Forecasts
  Improving flow-dependent reliability - a route to more useful ensemble forecasts.
- Emilia Sanchez-Gomez, Centre européen de recherche et de formation avancée en calcul scientifique (CERFACS).
  Model drift analysis to understand the causes of systematic errors in climate prediction systems.

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Desired outcomes from the workshop

- Sharing novel diagnostic techniques for identifying (the cause of) systematic errors.
- Noting where there are gaps in our observational and/or modelling systems which hamper understanding of systematic errors.
- Agreeing the current key systematic errors in weather and climate models.
- Discovering where work is progressing to address systematic errors and connecting those working on similar problems.
- **Identifying gaps where new projects are required (e.g. with GASS/GLASS).**
- Inform the strategy of WGNE for the coming years.

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Summary of key systematic errors - I:

- **Convective precipitation** (diurnal cycle, organisation of convective systems, precipitation intensity distribution, relationship with CWV, SST, Omega, MSE, etc.).
- **MJO** – propagation across the MC, response to mean errors & teleconnections elsewhere.
- **Sub-tropical boundary layer cloud** (too little, too bright) and their variation with large scale parameters (SST, EIS, Omega, etc.). Can have a coupled component/feedback (upwelling, evap., etc.).
- **Double ITCZ/ENSO** – possibly a complex combination of ENSO extension, cloud-ocean interaction, representation of TIWs.
- **Cloud microphysics** – especially mixed-phase, supercooled liquid cloud and warm rain.
- **Precipitation over orography** – distribution and intensity.
- **Fog and low-based cloud** – no systematic errors identified but is hard to forecast.

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Summary of key systematic errors - II:

- **Tropical cyclones** sometimes too intense at high resolutions. Wind-pressure relationship errors.
- Biases, variability and predictability of large-scale dynamics very sensitive to **surface drag**. CMIP5 mean circulation errors consistent with too little drag.
- Representation of the **heterogeneity of the soil**.
- Current stochastic physics schemes, whilst beneficial, don't necessarily sufficiently capture all aspects of **model uncertainty.**
- **Surface turbulent and radiative flux** errors (incl. surface wind stress, evaporation, etc.).
- **Diurnal cycle of surface temperature**.
- Variability and trends in historical **external forcings**.
- Mid-latitude **synoptic regimes and blocking**.
- **Teleconnections through the stratosphere**.

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Summary of key themes - I:

- Bottle-neck in parametrization development. Is more automated tuning required? Use of GASS-like model hierarchy? Use of DA (e.g. analysis increments)?
- Convective permitting resolutions now being used across timescales.
- Although high resolution is beneficial, is it necessary? Idea of running at high resolution and low precision for probabilistic predictions.
- Partitioning of drag between schemes quite different between models. WGNE drag project has prompted considerable research in this area.
- Land surface models have many tunable parameters. How to deal with this?
- Earth surface important predictability element for environmental prediction.
- Forcing of stand-alone component models (land and ocean) might be best done in a nudged coupled simulation. Flux adjustment could be a useful diagnostic tool for coupled model errors.

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Summary of key themes - II:

- Stochastic physics shown to improve several model systematic errors across timescales, although which errors are improved and by how much is model specific.
- SPPT could act as a useful diagnostic tool to point to systematic errors.
- Future development of stochastic physics could involve stochastically representing sub-grid variability (e.g. Convective triggering). However current schemes benefit from the length scale used – why is this?
- Hierarchy of decadal, seasonal and T-AMIP simulations useful for investigating coupled model errors.
- Developing community weather and climate evaluation codes. What framework/governance needed?
- Continued development of process orientated diagnostics is welcome.
- Understanding of observations/analyses is essential for diagnosing systematic error.
- Teleconnections from tropical variability potentially important for mid-lat subseasonal predictability.

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Recommendations:

- WGNE-WGCM to prioritise errors.
- Extend drag project to consider momentum more generally and consider representation of orography, etc.
- Consider setting up a group or extend drag group to look at surface flux errors.
- Encourage community to make use of S2S drifts database.
- Discuss with S2S/WGSIP regarding extension of aerosols project to seasonal timescale.
- Consider a cross weather-climate group looking at initial tendency analysis of common biases.
- Hold another WSE in 4-5 years time, possibly inviting submissions on solutions rather than just problems.