

## The Working Group on Numerical Experimentation (WGNE)



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(WGNE co-chairs)



Environment and  
Climate Change Canada

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# WGNE - Working Group on Numerical Experimentation

→ fostering the **development of atmospheric circulation models** for use in weather prediction and climate studies on **all time scales**, and **diagnosing and resolving shortcomings**.

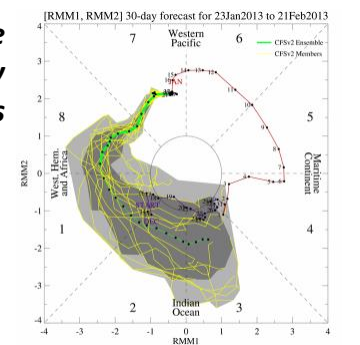
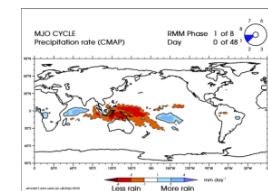
*Objectives are achieved through*

- Identification of **systematic errors** common to many models.
- Sharing **diagnostic tools and techniques** to get to the root of the error.
- Sharing knowledge around **sensitivity of errors to model formulation** (parametrizations, dynamical core, etc.).
- Work with other groups (e.g. GASS & GLASS) to **develop solutions**.

*Cases of strong or persistent events of aerosol pollution studied by the WGNE Aerosols project*



*MJO - Task Force: Real time MJO Index forecast activity using 20 forecast models*



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→ fostering the **development of atmospheric circulation models** for use in weather prediction and climate studies on **all time scales**, and **diagnosing and resolving shortcomings**.

- WGNE has existed for **over 30 years**

- WGNE reports to both

*WCRP Joint Scientific Committee (JSC)*

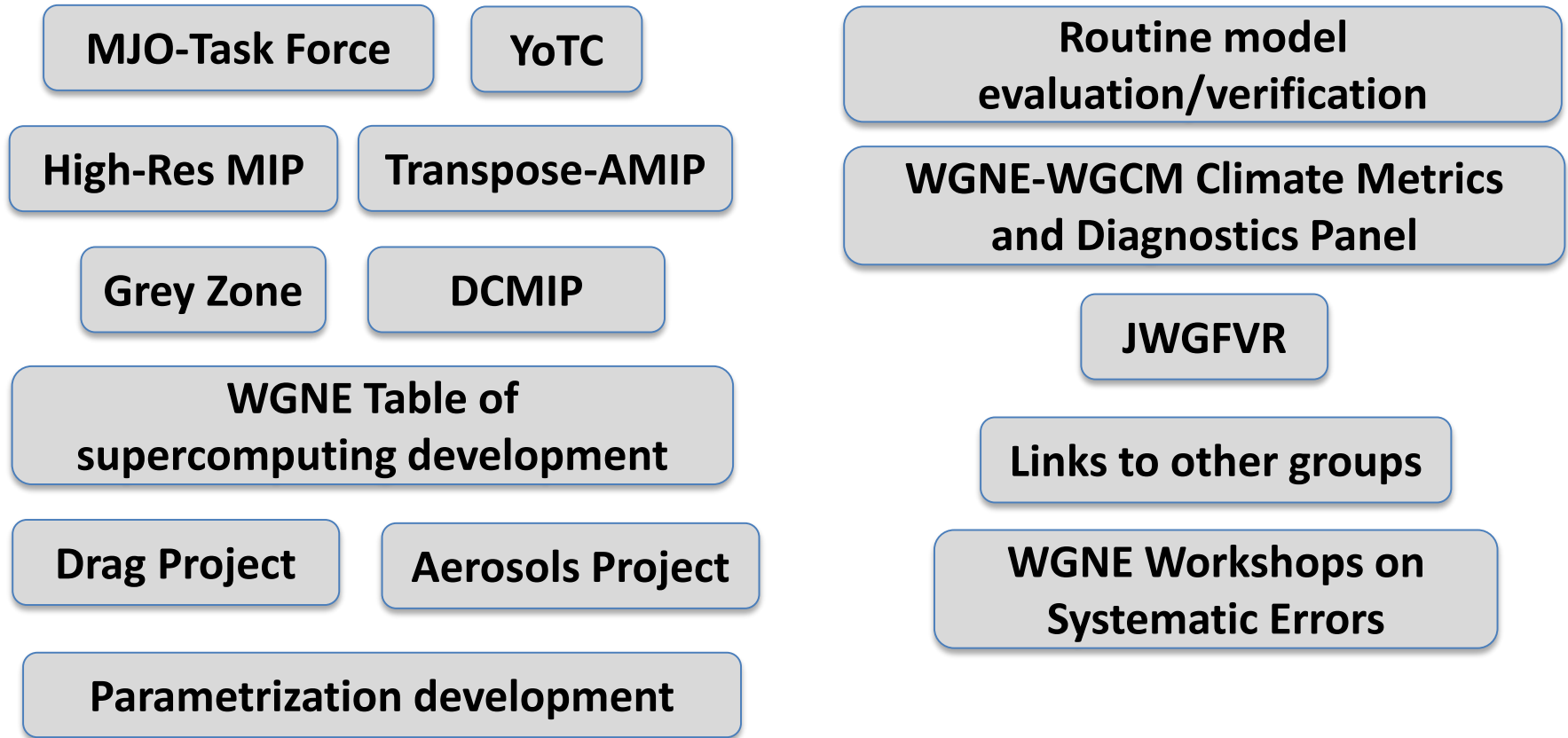
*WMO Commission for Atmospheric Sciences (CAS)*



- WGNE has been a **pioneer of seamless work** (e.g. developing the AMIP and Transpose-AMIP methodologies)

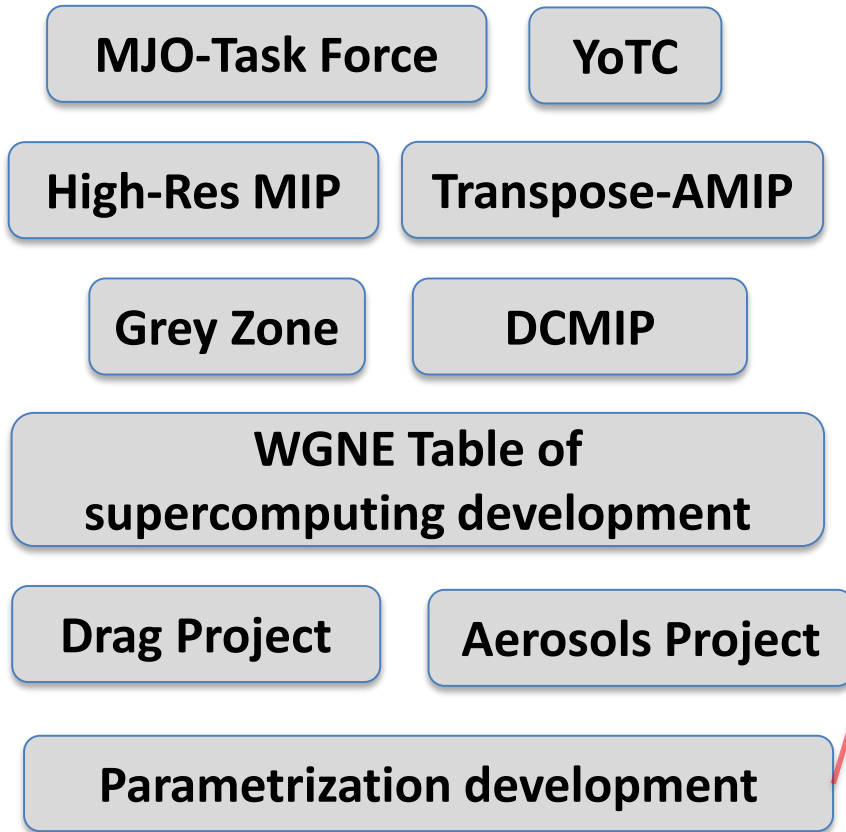
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## WGNE activities over recent years



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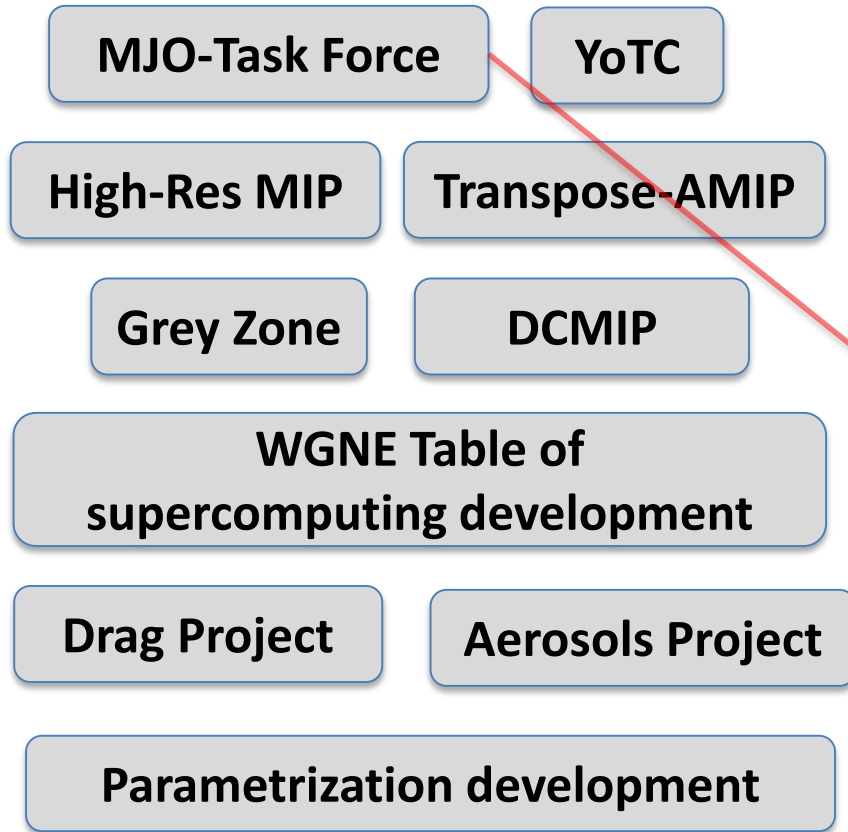


### Parametrization projects

- since 2009, WGNE has had an **increased focus on parametrization development** in models – sharing knowledge of sensitivities and different approaches
- close working relationship with **GEWEX GASS and GLASS** is important
- WGNE hopes to continue to **strengthen this in the future with more joint projects on parametrization development**, targeting **common systematic errors**

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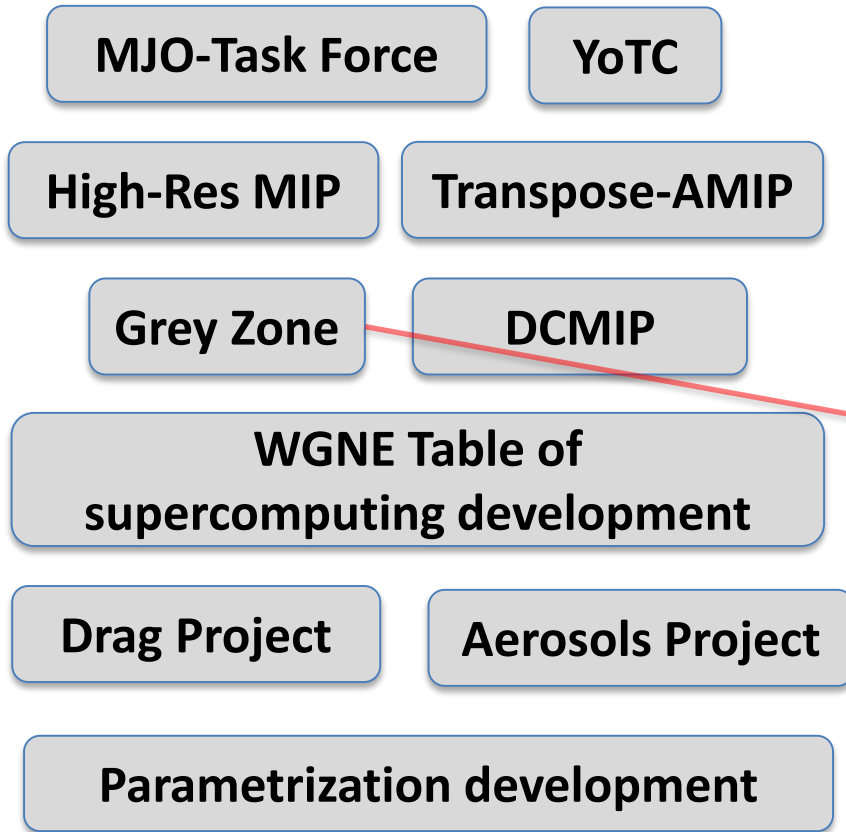


### WGNE MJO-Task Force

- goal is to **improve the representation and the predictive skill of the MJO** and related phenomena in weather and climate models
- 5 sub-projects:
  - i) Process-orientated **diagnostics**
  - ii) **Evaluation** of real time forecasts
  - iii) **Assessment** of intraseasonal variability in **CMIP models**
  - iv) **Joint MJO-TF – GASS diabatic processes experiment**
  - v) Investigation of MJO **air-sea interaction**
- in the coming years, focus will be around
  - **propagation of the MJO** across the Maritime Continent region
  - **teleconnections** with other parts of the tropics and mid-latitudes.

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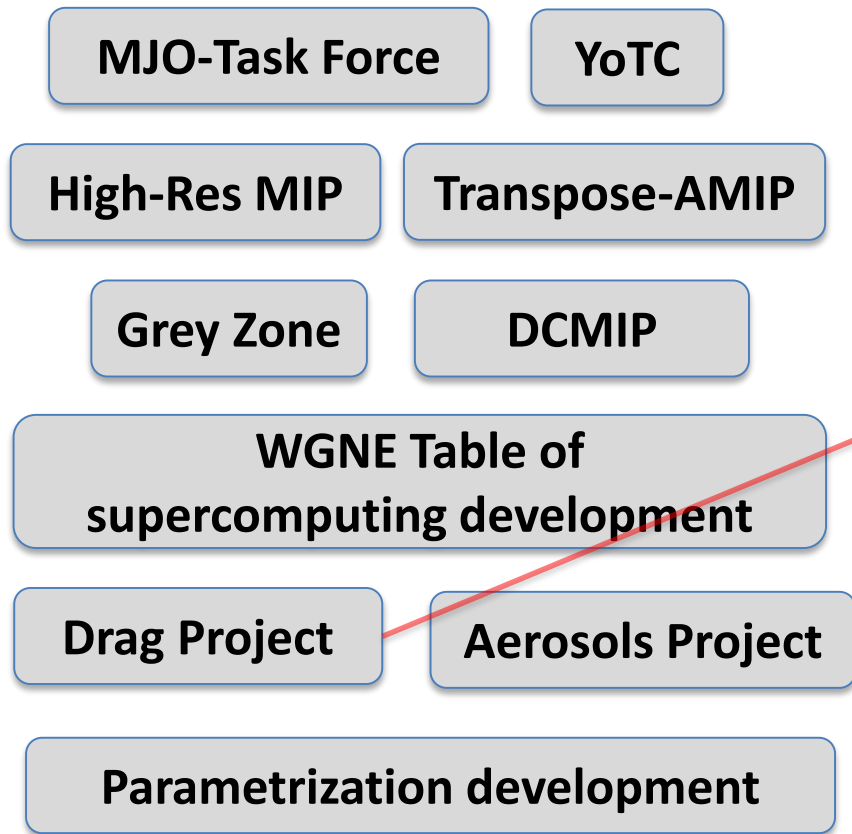
### WGNE Grey Zone project

- set up **with GASS**. Initial project focussed on a cold air outbreak case.
- investigate the possible **development of scale-aware schemes** to operate through these grey zones .
- **continued work** on this project is seen as a **priority**.
- Although initially considering deep convection, also need to consider grey zones for other processes.
- **GASS Grey Zone II white paper** has been proposed by Tomassini et al.



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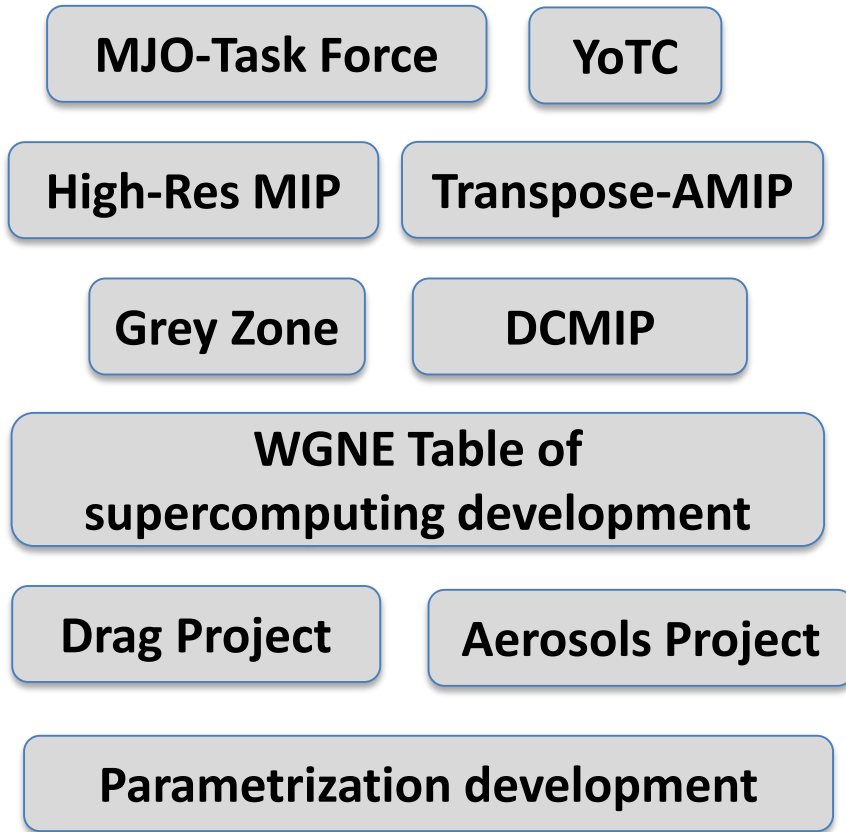
### WGNE Drag Project

- to explore the parametrized component of **surface stress** and its **partitioning between schemes** (e.g. PBL, sub-grid orography).
- found to **vary significantly between models**; notable **impact on circulation & predictability**
- Following the **2016 ECMWF / WCRP / WWRP workshop on drag processes** (partly supported by SPARC / WGNE / GASS), 3 main **areas of research** were identified:
  - i) better **theoretical understanding**
  - ii) better understanding of **inter-model differences**
  - iii) use **high-res simulations + observations + new techniques** to understand model errors and **improve/constrain representation of drag** in models.



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### WGNE Aerosols Project

- investigation into the **role of aerosols in short range weather forecasting**
- **building on the findings in the climate community** of the importance of fully interactive aerosols in model simulations
- key challenge: real-time **initialisation** of the aerosols
- project showed some **limited benefits**
- however these may be more considerable in extended forecasts => **WGNE is partnering with S2S to extend the experiment to seasonal predictions**

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### Model evaluation

- **key activity** of WGNE is the **routine evaluation and verification of models**
- **traditionally** this has been in terms of **'outcome' metrics** of model performance such as those overseen by **CBS** (e.g. forecast root-mean-square-error of 500hPa geopotential height)
- sometimes hard to go from these metrics to identifying errors in model processes
- WGNE is **increasingly considering more process-orientated metrics and diagnostics** such as
  - **tropical cyclone track and intensity errors**
  - **precipitation errors in terms of intensity, structure, location, timing, etc.**

**Routine model  
evaluation/verification**

**WGNE-WGCM Climate Metrics  
and Diagnostics Panel**

**JWGFVR**

**Links to other groups**

**WGNE Workshops on  
Systematic Errors**

# WGNE - *Working Group on Numerical Experimentation*

## WGNE activities over recent years

### WGNE-WSE

- identification of systematic errors amongst weather and climate models
- WGNE has organised 5 well attended workshops on Systematic Error1:
  - 1st Toronto, 1998**
  - 2nd Melbourne, 2000**
  - 3rd San Francisco, 2007**
  - 4th Exeter, 2013**
  - 5th Montreal, 2017**bringing weather and climate communities together to discuss common issues
- E.g. an outcome from the 2013 WGNE-WSE was the need to focus on surface fluxes, especially over the oceans and polar regions. Since then a number of field campaigns (e.g SOCRATES Southern Ocean and Year(s) of Polar Prediction campaigns) have made this a priority

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**WGNE Workshops on  
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# WGNE - Working Group on Numerical Experimentation

## 5<sup>th</sup> WGNE Workshop on Systematic Errors (WSE)

*Zadra et al. (2017) Systematic Errors in Weather and Climate Models: Nature, Origins, and Way Forward. BAMS. <https://doi.org/10.1175/BAMS-D-17-0287.1>*

### **Themes:**

**Atmosphere-land-ocean-cryosphere interactions:** errors in the representation of surface fluxes and drag processes; stable boundary layer issues; impact of coupled modeling.

**Clouds and precipitation:** cloud-radiative feedback problem; tropical convection issues; representation of low clouds, especially at high latitudes; excess low accumulations of precipitation; underestimation of precipitation extremes; summer continental precipitation; precipitation over orography.

**Resolution issues:** dependence of systematic errors on model resolution; grey zones of physical parametrizations.

**Teleconnections:** errors in the simulation of interactions between high-latitudes, mid-latitudes and tropics.

**Metrics and diagnostics:** emphasis on novel techniques (e.g. process-based diagnostics; use of data assimilation or coupled modeling) to diagnose and measure systematic errors.

**Model errors in ensembles:** characterization of ensemble spread and identification of systematic errors in multi-model ensembles and ensemble prediction systems; evaluation of stochastic representations.

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## Summary of key systematic errors from the 5<sup>th</sup> WGNE WSE:

- **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.*
- **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**.

*To do: Prioritise this list*

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## ***Recommendations from 5<sup>th</sup> WGNE WSE:***

- 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.
- More research is required on how to represent model uncertainty.
- 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.

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- WGNE 32 agreed that the drag project should evolve into momentum project and SPARC have expressed an interest in being involved. Sandu et al. are leading a GASS white paper on Surface drag and momentum transport.
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Francois Bouyssel (*Meteo-France*) and Carolyn Reynolds (*NRL*) are initiating a project on surface fluxes. Initial focus will be over oceans.

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- More research is required on how to represent model uncertainty.
- Encourage community to make use of S2S drifts database.
- Diagnostics to discuss a joint project on model uncertainty (possibly starting with coarse graining).
- Coordinated analysis of common biases.
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# WGNE - *Working Group on Numerical Experimentation*

WGNE is the sum of its members and exofficios

We ask all members to play an active role and contribute (e.g. by leading/participating in projects)

**Thank you** to all the WGNE members for the work you do



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