WGNE - *Working Group on Numerical Experimentation*

Summary of WGNE activities

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(WGNE co-chairs)

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

Outline

- Overview of WGNE's mission
- Recent WGNE activities and achievements
- "What WGNE hopes to get out of the Pan-WCRP meeting"

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

1) Dust over Egypt: 4/2012   2) Pollution in China: 1/2013   3) Smoke in Brazil: 9/2012

MJO - Task Force: Real time MJO Index forecast activity using 20 forecast models
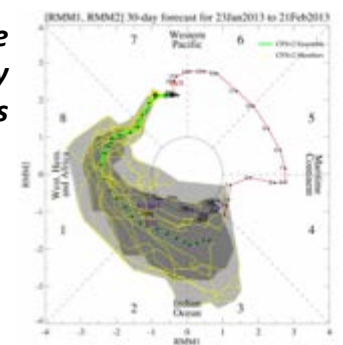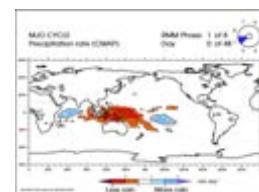
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> fostering the **development of atmospheric circulation models** for use in weather prediction and climate studies on **all time scales**, and **diagnosing and resolving shortcomings**.

- WGNE exists 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)

- WGNE also **monitors advances in data assimilation**; WGNE is the focal point in WCRP for **encouraging/reviewing reanalysis projects**
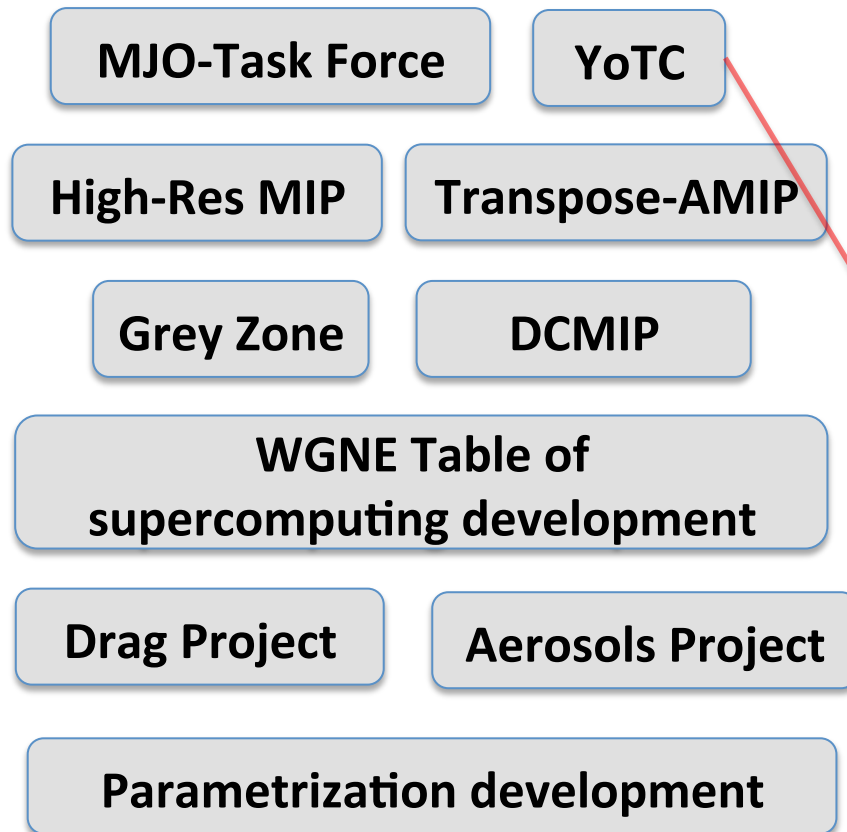
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WGNE activities over recent years

- MJO-Task Force
- YoTC
- High-Res MIP
- Transpose-AMIP
- Grey Zone
- DCMIP
- WGNE Table of supercomputing development
- Drag Project
- Aerosols Project
- Parametrization development

Year(s) of Tropical Convection
- joint WCRP and WWRP/THORPEX activity
- coordinated campaign of observing, modelling and forecasting of organized tropical convection and its influences on predictability
- **WGNE has acted as a focal point for the modelling activities**
- YoTC covered the period 2008-2010
- **modelling activities** resulting from the campaign are **continuing today** including in the **WGNE Transpose-AMIP** project and **WGNE MJO-TF** – GASS diabatic processes experiment
- As part of **WGNE's involvement**, a number of key **operational centres** have made their analyses, forecasts and even parametrization tendency **data available for the YoTC period**
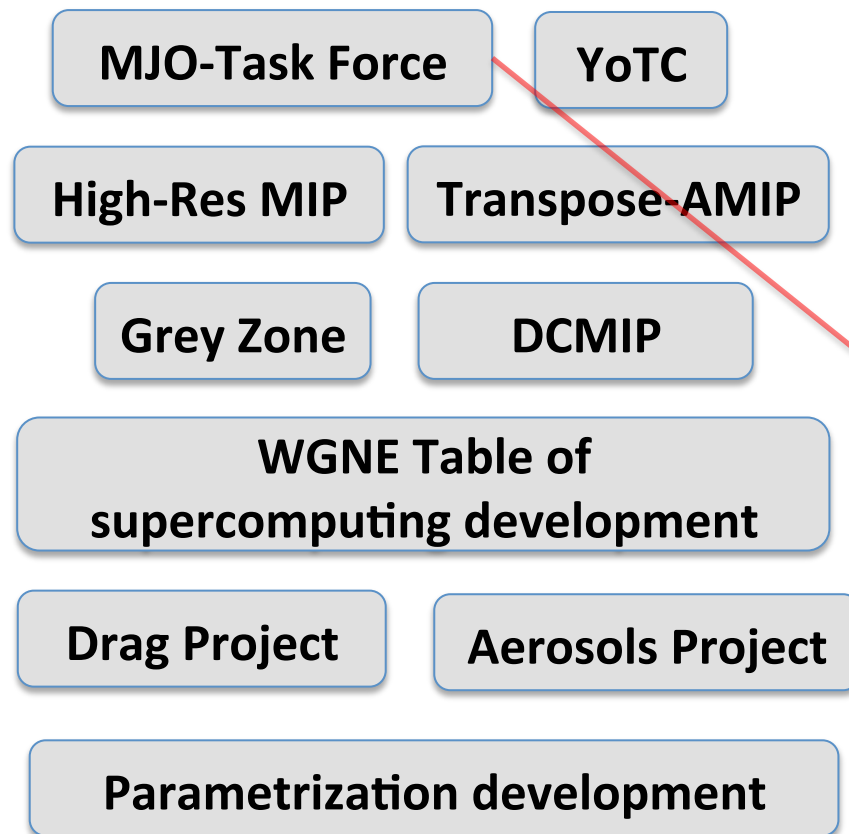
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WGNE Table of supercomputing development

Drag Project

Aerosols Project

Parametrization development

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
  - o **propagation of the MJO** across the Maritime Continent region
  - o **teleconnections** with other parts of the tropics and mid-latitudes.

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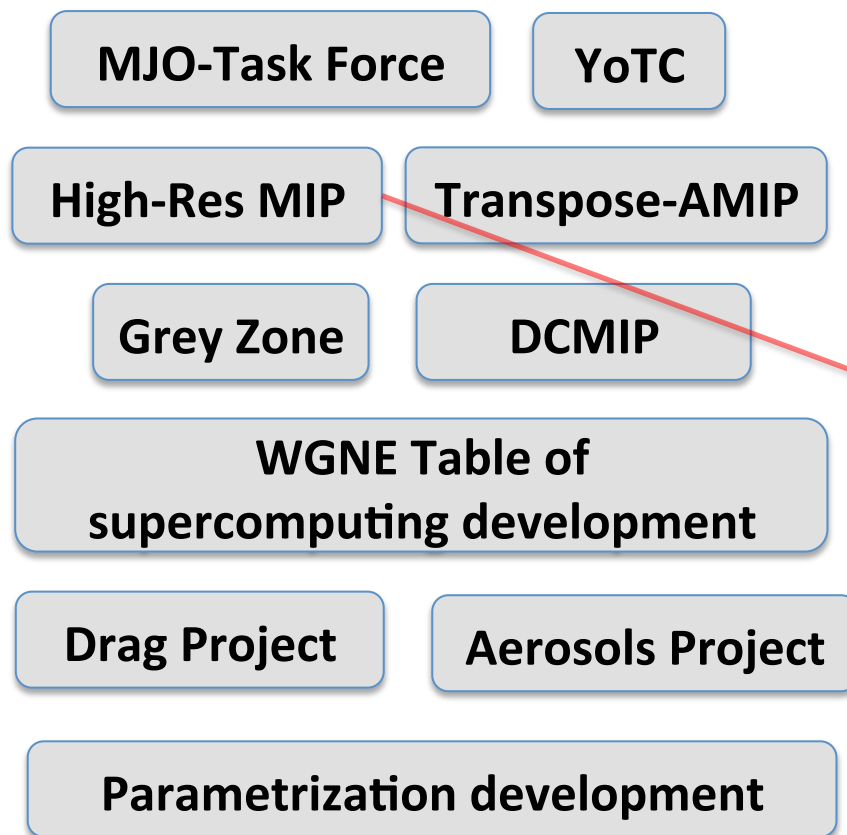
High-res MIP project
- **jointly** developed by **WGNE and WGCM**
- multi-decade simulations of the atmosphere component of **climate models at high (typical weather forecasting) resolutions**
- being used
  - to **identify systematic errors** in climate simulations due to resolution
  - as a basis for development of **parametrization improvements**
- Hi-Res MIP is one of the activities with the **CMIP6** project
- historically, WGNE has coordinated much of the key work to understand the importance of model resolution on simulations
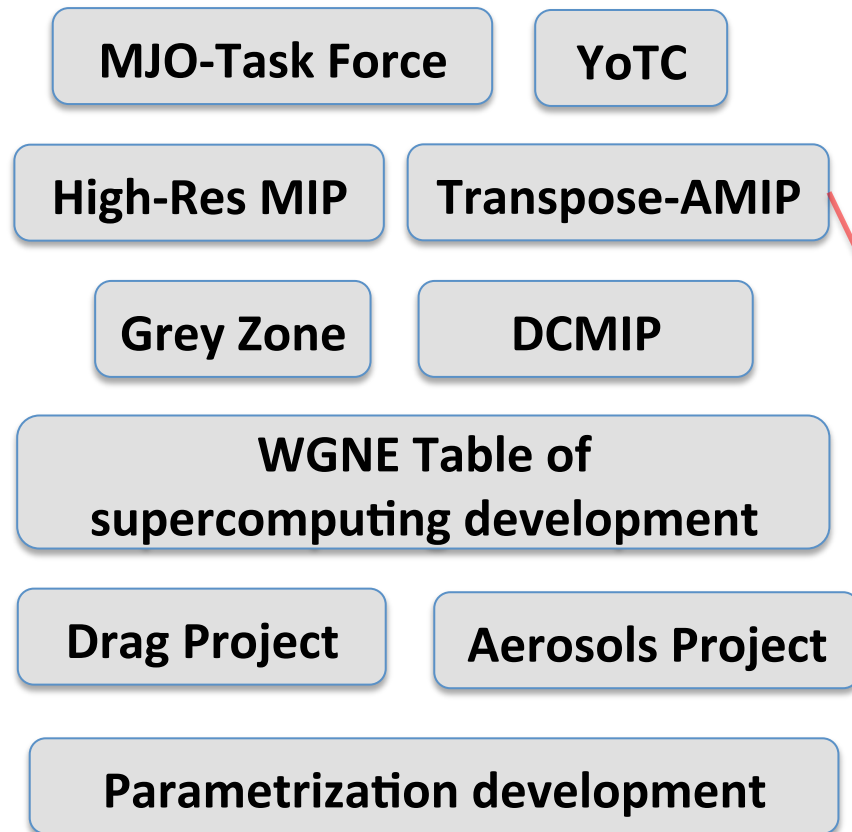
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WGNE activities over recent years

MJO-Task Force   YoTC

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Grey Zone   DCMIP

WGNE Table of supercomputing development

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Parametrization development

Transpose-AMIP project
- counterpart to WGNE's AMIP experiment
- in Transpose-AMIP:
  - models are constrained through initialisation
  - akin to **running climate models in weather forecast mode**
  - allows investigation of initial development / growth of fast systematic errors, where model dynamics are more constrained
  - initially a set of forecast cases from the YoTC period was chosen
- following the success of this coordinated experiment, the **technique is now being adopted in other projects, particularly within GASS**

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WGNE Grey Zone project
- "grey zone" = **model resolution where a process is partially resolved**
- most **often used in the discussion of deep convection** (grey zone between model resolutions of around 100m-20km
- **equally applied to other processes** (boundary layer turbulence, macrophysical cloud properties, etc.) for their own grey zones
- the **WGNE Grey Zone project**
  - set up **with GASS**
  - investigate the possible **development of scale-aware schemes** to operate through these grey zones
  - **continued work** on this project (now largely **taken over by GASS**) is seen as a **priority**
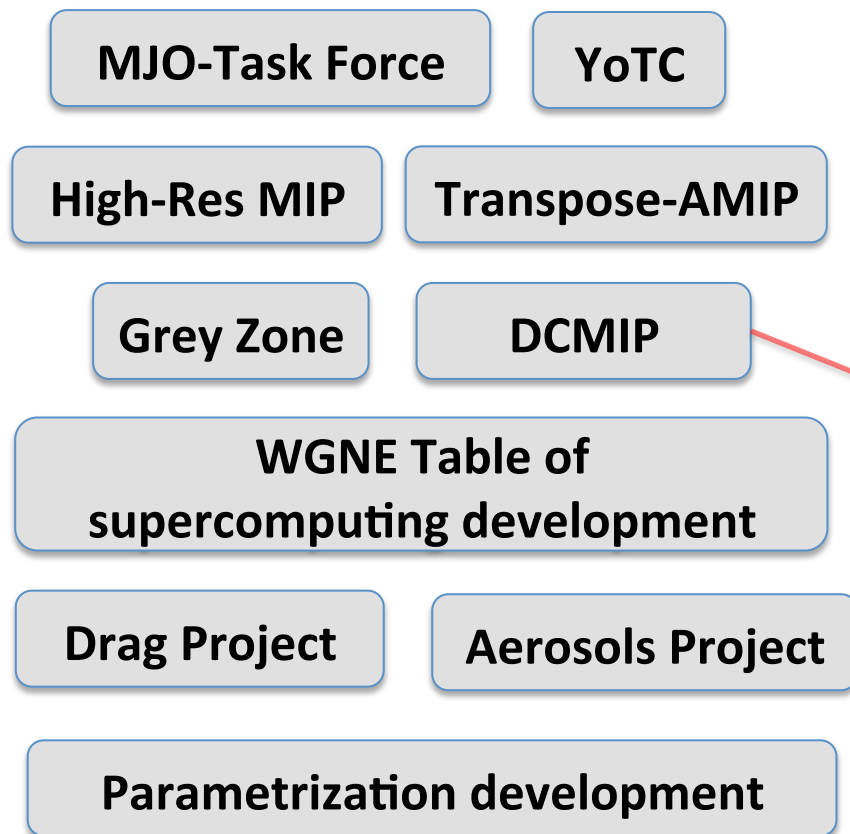
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Dynamical Core MIP
- **WGNE** acts as a **focal point within WCRP** for the **development of dynamical cores**, **DCMIP** being just **one recent activity** in this area.
- DCMIP provided an **intercomparison of different cores**, including
  - an assessment of different grids
  - discretization techniques
  - tracer-conservation
  - dynamics-physics coupling, etc.
- an associated **summer school** was held with DCMIP to
  - increase **expertise** in this area
  - assist the development of **early career scientists** in the field
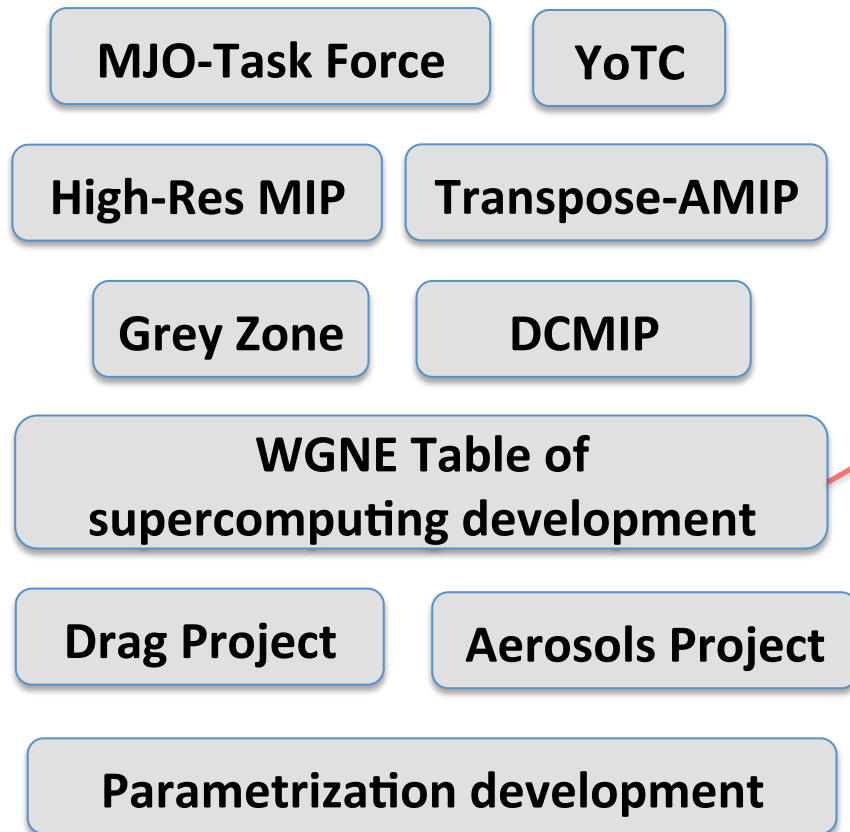
WMO IOC ICSU International Council for Science

WORLD METEOROLOGICAL ORGANIZATION

WCRP World Climate Research Programme

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WGNE intercomparison of supercomputing resources
- linked to the expertise on dynamical cores
- Includes :
  - **comparisons** of how **centres** currently use their supercomputing **resources**
  - **information on likely developments** in supercomputing
- WGNE acts as a conduit for **sharing information** on
  - developments in **computer architecture** and its impact on the **way models are formulated**
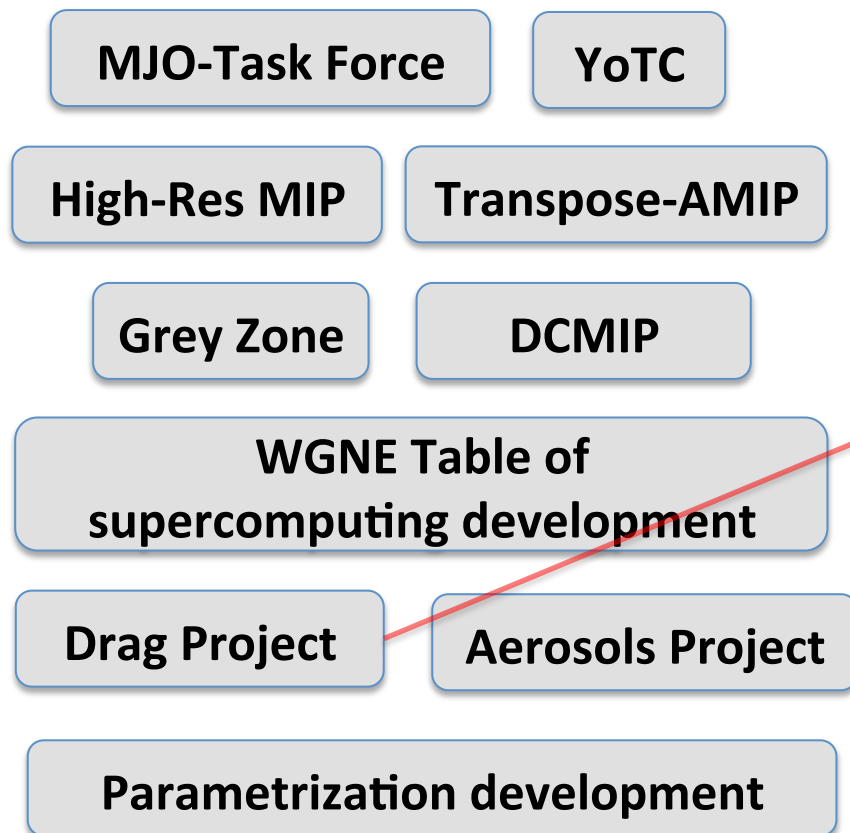 - where work may be required

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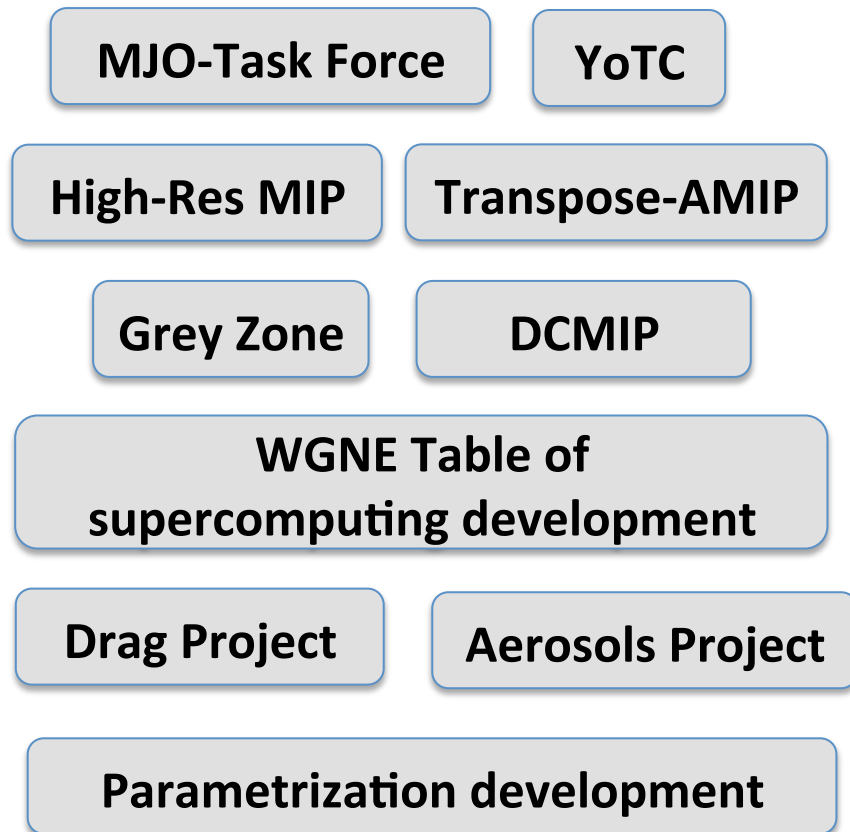Drag Project

Aerosols Project

Parametrization development

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
- **Note: Drag session in Pan-GASS meeting**

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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 looking to partner with other groups to extend the experiment to seasonal predictions**
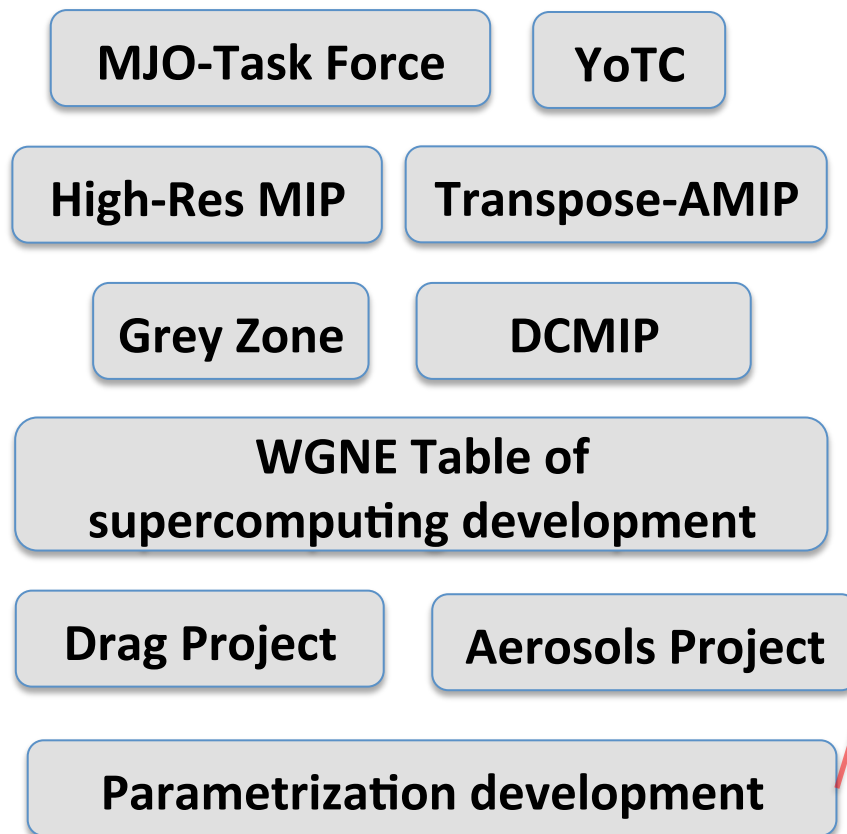
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Parametrization projects
- since 2009, WGNE has had an **increased focus on parametrization development** in models – sharing knowledge of sensitivities and different approaches
- close working relationship with **GEWEX GASS and GLASS** is important
- 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 activities over recent years

Routine model evaluation/ verification

WGNE-WGCM Climate Metrics and Diagnostics Panel

JWGFVR

Links to other groups

WGNE Workshops on Systematic Errors

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.**

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WGNE Workshops on Systematic Errors

Joint WGNE-WGCM Climate Metrics and Diagnostics panel

- based on the value seen in the weather forecasting community of having an **agreed set of metrics** for assessing model performance
- the climate situation is slightly different in that **long range projections cannot be verified**
- however the creation of the panel has kick-started work into the development of
  - various process-orientated metrics
  - software tools
- today, the **panel provides advice** for the development of these **software tools**, and **diagnostics/metrics** within them

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WGNE Workshops on Systematic Errors

Joint Working Group on Forecast Verification Research

- joint initiative of the **WWRP** and **WGNE**
- serves as a focal point for the **development and dissemination of new verification methods** for WWRP
- main objective is to facilitate the development and application of improved diagnostic verification **methods to assess and enable improvement of the quality of forecasts** from **numerical weather and climate models**
- **WGNE** has always encouraged and promoted the **collaboration between JWGFVR and WCRP, in coordination with CBS**

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WGNE Workshops on Systematic Errors

Links to and knowledge-sharing with other groups

Due to its cross-timescale outlook, and the underpinning nature of model development WGNE has links to (but is not limited to):

o Sub-seasonal to Seasonal prediction (**S2S**)
o Working Group on Seasonal to Inter-annual prediction (**WGSIP**)
o High Impact Weather (**HIWeather**)
o Polar Prediction Project (**PPP**)
o Predictability Dynamics and Ensemble forecasting (**PDEF**)
o Data Assimilation and Observing Systems (**DAOS**)
o Stratosphere-troposphere Processes And their Role in Climate (**SPARC**)
o Working Group on Coupled Modelling (**WGCM**)
o Joint Working Group on Forecast Verification Research (**JWGFVR**)
o Working Group on Nowcasting and Mesoscale Research (**WGNMR**)

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WGNE Workshops on Systematic Errors

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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Themes of the 5ᵗʰ WGNE workshop on Systematic Errors

WGNE identified processes that models currently fail to represent accurately:

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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Desired outcomes from this meeting

- get **updates** from and make **links** with **other WCRP groups** on common topics

- set **strategic directions of WGNE activities for coming years**

  o in light of recent WGNE workshop on systematic errors

  o considering links to GASS/GLASS projects

- be able to have our "normal" annual WGNE-32 meeting