Environment Canada Environnement Canada

Canada

Drag Project report

WGNE-30 – College Park, USA

Ayrton Zadra

RPN – Environment Canada

23-26 March 2015

Project design

Field to be compared: **surface stress***

$$\vec{\tau} = (\tau_x, \tau_y)$$

In a typical forecast model, it is partly resolved and partly parametrized:

$$\begin{aligned} \vec{\tau} &= \vec{\tau}^{res} + \vec{\tau}^{phy} \\ \vec{\tau}^{res} &= p_s \vec{\nabla} h = \text{resolved orographic stress} \\ \vec{\tau}^{phy} &= \text{subgrid (physics) stress} \end{aligned}$$

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* *Surface stress* = force parallel to the surface, per unit area, as applied by the wind on the earth's surface (land or water).

Project design

Main goal: compare the **parametrized** or physics component of this surface stress, i.e. the stress from parametrizations such as the planetary boundary layer (**PBL**) and the subgrid orographic (**SGO**) schemes.

$$\vec{\tau}^{phy} = \vec{\tau}^{pbl} + \vec{\tau}^{sgo}$$

$$\vec{\tau}^{pbl} = \text{stress from PBL scheme}$$

$$\vec{\tau}^{sgo} = \text{stress from subgrid orographic scheme(s)}$$

Basic output requested: x- and y-components of the parametrized stress, in units of N/m2, averaged over the 1st day (24h) of a month of forecasts. The months proposed were Jan and Jul 2012.

Project design

Optional output

- **Break down** the physics stress into its various contributions (e.g. PBL, gravity-wave drag, low-level blocking, etc.). This partition varies from one model to another, but all models include one **PBL** scheme and one-or-more orographic schemes (a combination of which defines the model's **SGO** contribution).

- Produce **separate 6-h averages** over the 00-06, 06-12, 12-18 and 18-24 UTC periods, so that the diurnal cycle of stresses could also be investigated.

- Provide averages of the **resolved stress**; or, alternatively, the topography elevation and averages of the surface pressure field.

- Provide averages of wind components **U and V at 850 hPa**.

Participants

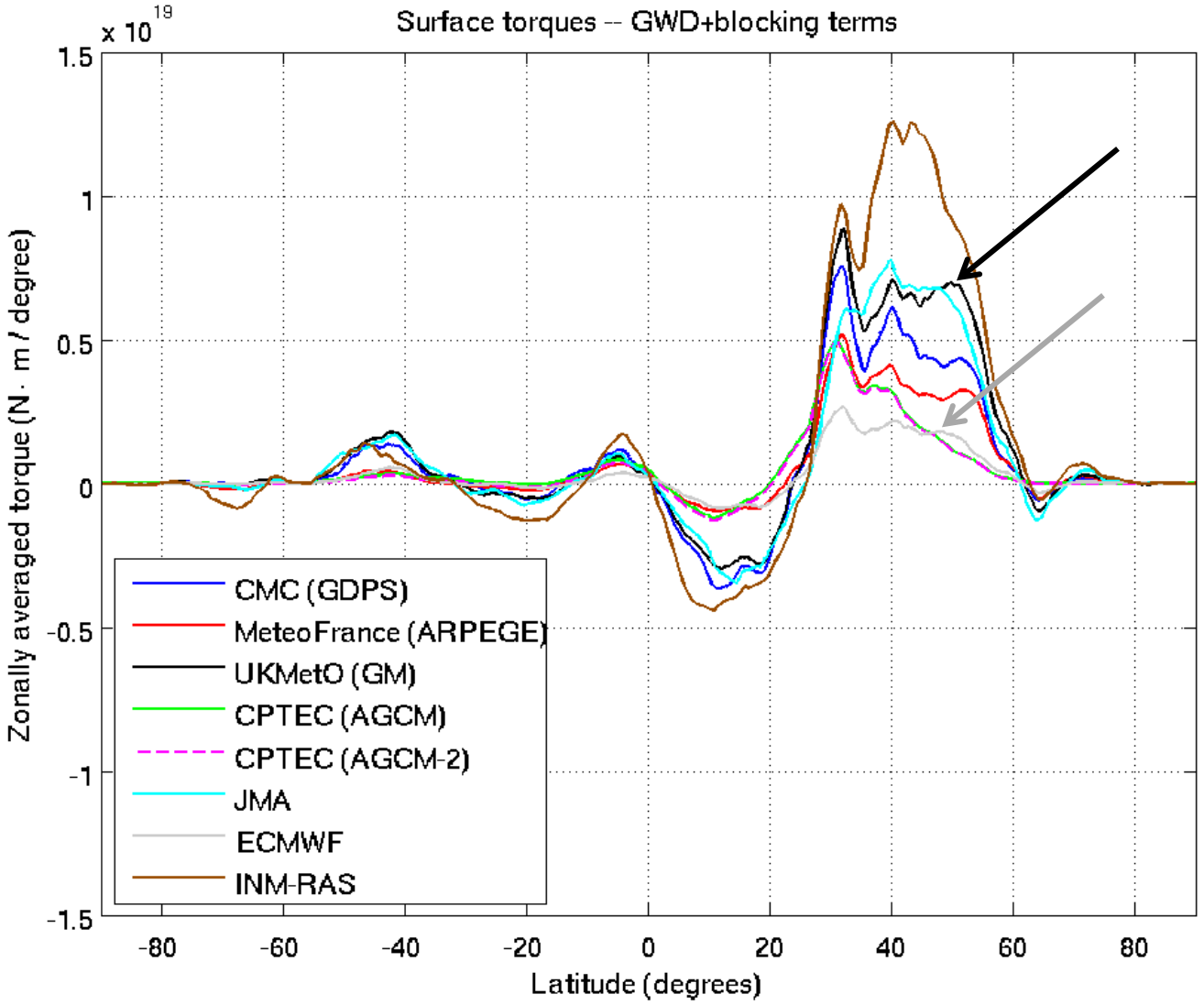
Table 1: Participating models

model name	resolution	center	stress components provided
GDPS	25km	CMC	pbl, gwd, blc, res
ARPEGE	10-60km	Meteo-France	pbl, sgo
GM	25km	UK MetOffice	pbl, sgo
IFS	15km	ECMWF	pbl, sgo, res
GSM	20km	JMA	pbl, lgw, sgw, res
ACCESS	40km	Australian BOM	pbl, gwd, blc
AGCM	45km	CPTEC	pbl, gwd, res
AGCM-2	45km	CPTEC	pbl, gwd, res
SL-AV	80km	HMCR	pbl, sgo
CAM-5	100km	UCAR	pbl, gwd, tms

*Note: Interest shown by DWD as well (GME model, contact Kohler Martin).

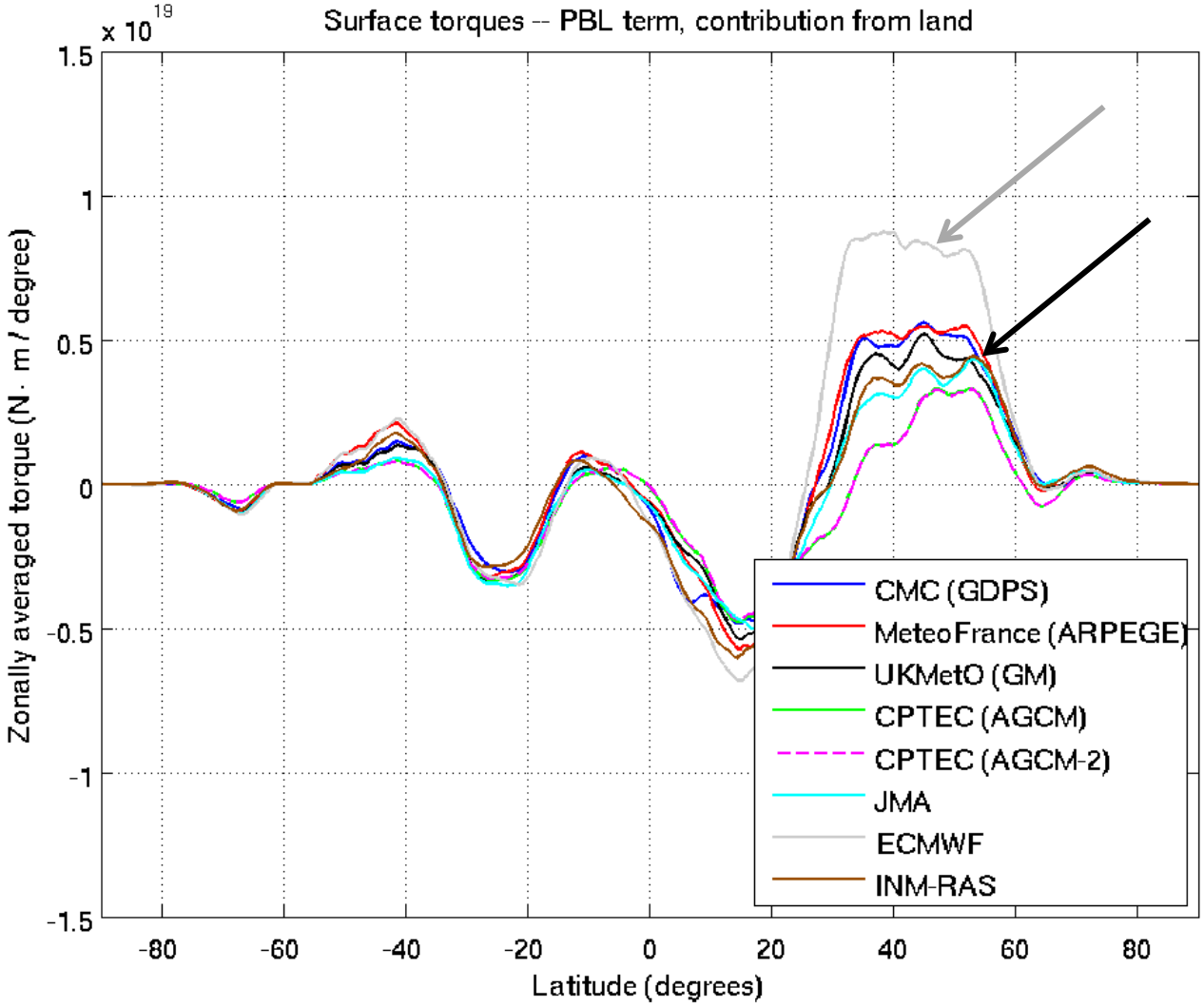
WGNE DRAG-project, torque inter-comparison Step0-24 January 2012

subgrid orography



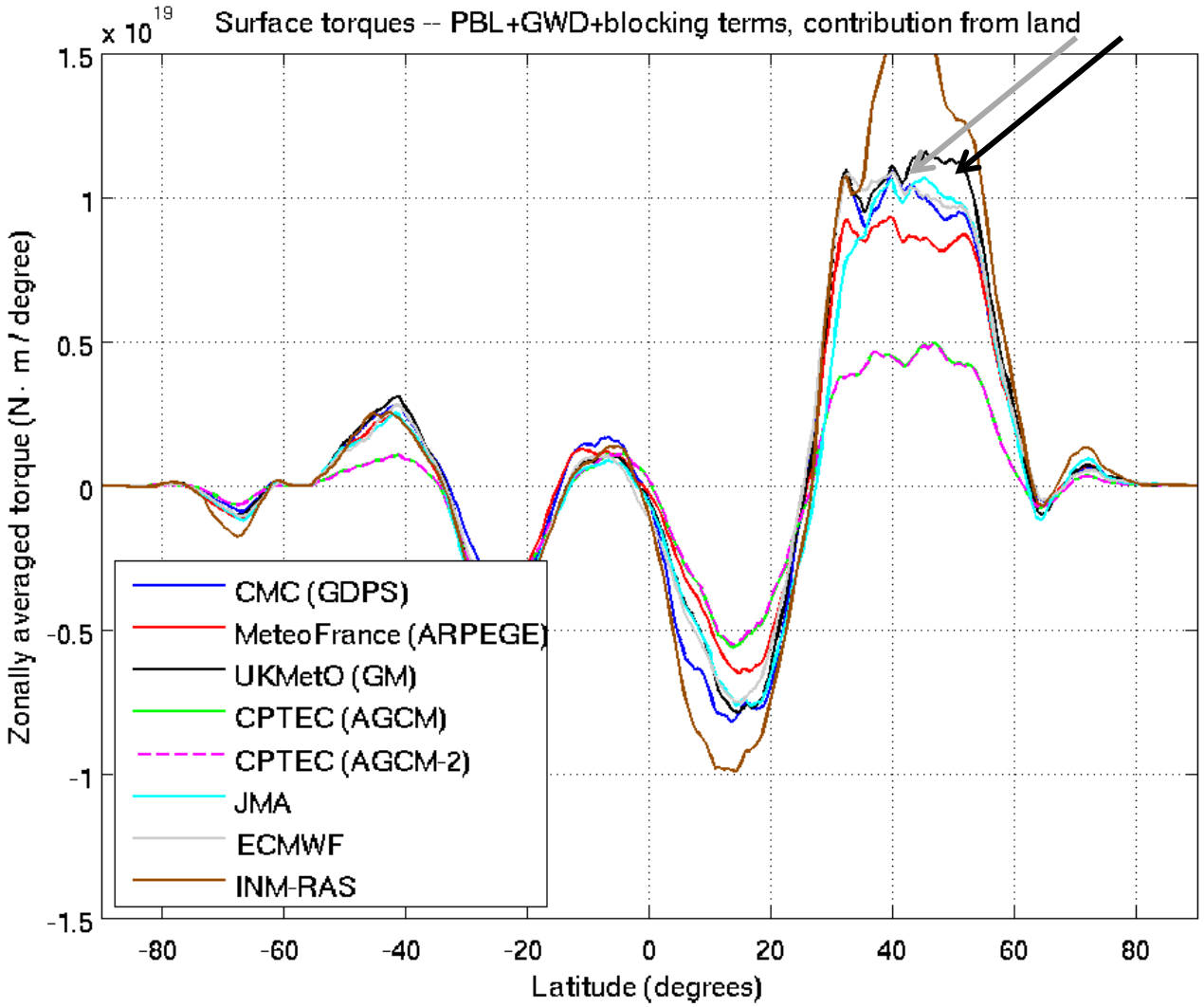
WGNE DRAG-project, torque inter-comparison Step0-24 January 2012

Boundary layer



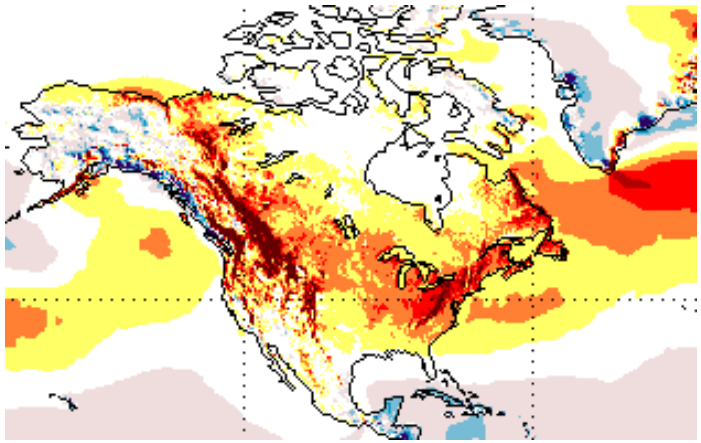
WGNE DRAG-project, torque inter-comparison Step0-24 January 2012

Boundary layer + subgrid orography

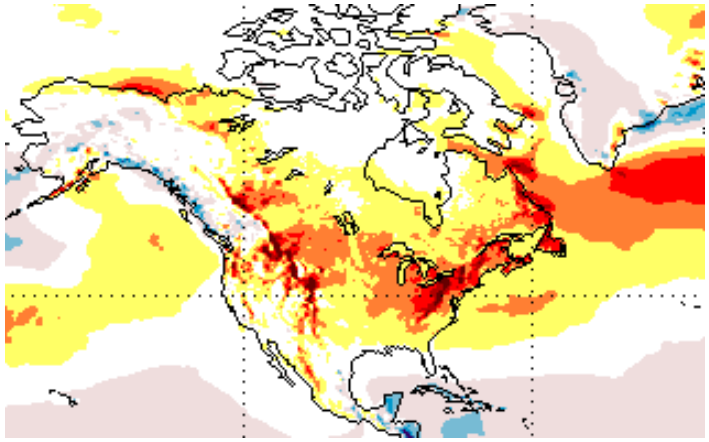


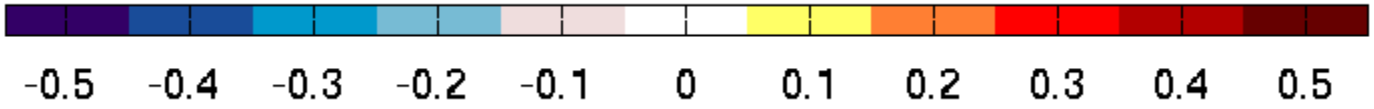
WGNE DRAG-project
inter-comparison of stress fields

IFS (ECMWF)



UM (UKMetO)





u-component of PBL stress (N/m2) – Jan 2012 – 00-24h average

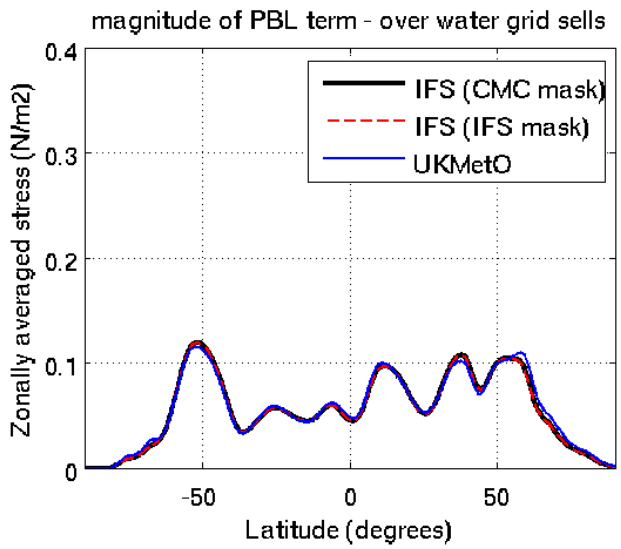
Recent developments

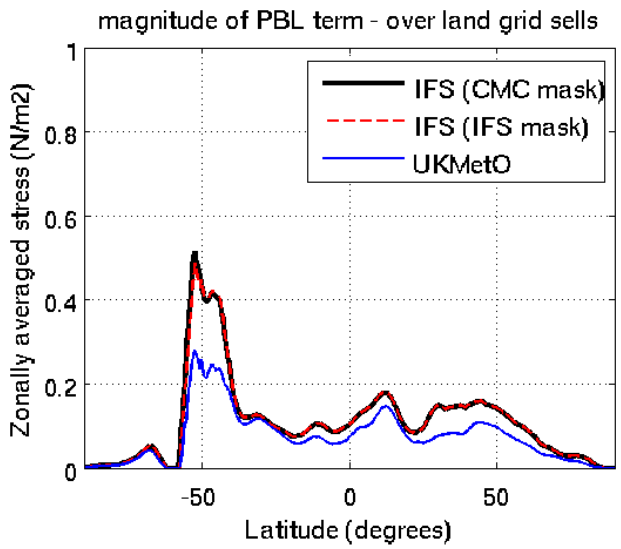
- Discussions with various of the participants & contributors:
  - 21st Symposium on Boundary Layer and Turbulence (Jun 2014, Leeds, UK)
  - World Weather Open Science Conference (Aug 2014, Montreal, Canada)

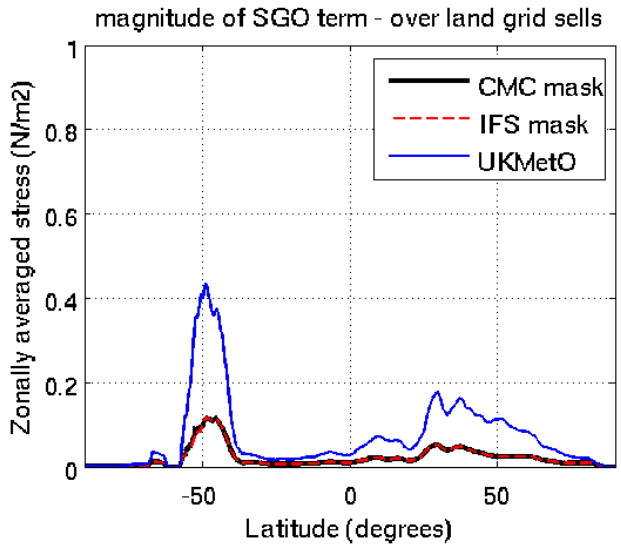
- Some suggestions for future work
  - exchange / inter-comparison of ancillary fields
  - use a high-resolution simulation (idealized conditions or not) to understand partition of processes
  - design a SCM experiment to compare parametrizations
  - use observations from super-sites to evaluate models

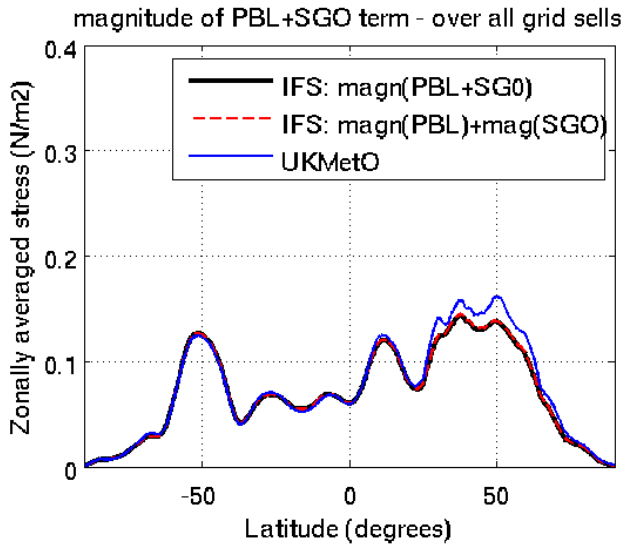
- Validation exercise (with Irina Sandu, ECMWF) – see next slide

Validation exercise: IFS vs UM model (many thanks to Irina Sandu, ECMWF)









Upcoming workshop at Univ. Reading – an opportunity to engage a larger community

- ***Workshop on Angular Momentum Budget***
- 20-22 April 2015 at Univ. Reading
- organized by Dr. T. Shepherd
- AZ received invitation to participate and present / represent the WGNE Drag Project, and discuss possible collaborations and future steps
- A few other contributors to the Drag Project will also participate (see agenda in the next slides)

Draft agenda of the Workshop on Angular Momentum Budget

Session 1

11:15 - 11:30 Alan Plumb (MIT): TBA

11:30 - 11:45 Geoff Vallis (Exeter): Jet shifts in a warming climate

11:45 -12:00 Gang Chen (Cornell): Quantifying the eddy-zonal flow interactions in the atmosphere

12:00 – 12:15 Isla Simpson (Columbia): Seasonal and longitudinal variations in the mid-latitude circulation response to global warming

Session 2

13:45-14:00 Tapio Schneider (ETHZ): Momentum constraints on the Hadley circulation and ITCZ: Some open questions

14:00-14:15 Inna Polichtchouk (Reading): Sensitivity of tropical and extratropical circulation to air-sea roughness in aquaplanet simulations

14:15 -14:30 Tiffany Shaw (Chicago): Momentum transport and the summertime circulation

14:30- 14:45 Tim Woollings (Oxford): Ocean influence on the Atlantic jet and storm track

Draft agenda of the Workshop on Angular Momentum Budget

Session 3

15:45 – 16:00 Peter Hitchcock (Cambridge): The angular momentum budget during and following stratospheric sudden warmings

16:00 – 16:15 Gavin Esler (UCL): A simple nonlinear model of sudden stratospheric warmings

16:15 – 16:30 James Cho (Queen Mary): TBA

16:30 – 16:45 Peter Read (Oxford): Angular momentum in Venus' atmosphere - problems and prospects?

Session 4

09:15-09:30 Ayrton Zadra (Environment Canada): The WGNE drag project: preliminary results and future plans

09:30 – 09:45 Irina Sandu (ECMWF): Impact of surface drag on short range NWP forecasts

09:45-10:00 Simon Vosper (Met Office): Using high-resolution simulations to assess orographic drag parametrization schemes

10:00 -10:30 Discussion

Draft agenda of the Workshop on Angular Momentum Budget

Session 5

11:00-11:15 John Thuburn (Exeter): Angular momentum conservation in numerical models

11:15-11:30 Anton Beljaars (ECMWF): TBA

11:30-11:45 Felix Pithan (Reading): Orographic forcing and North Atlantic jet tilt in GCMs

11:45-12:00 Miguel Teixeira (Reading): Linear theory for gravity wave momentum fluxes in directionally sheared hydrostatic flow over elliptical mountains

Session 6

13:45 Panel discussion on possible international collaborations