

# QBOi

Quasi-Biennial Oscillation Initiative

James Anstey, Neal Butchart, Kevin Hamilton & Scott Osprey

# Some background

- Modelling of the QBO has progressed from simplified models through to complex general climate models
- However, since Takahashi et al (1996) debatably progress has slowed:
  - CMIP3 – 1 GCMs having a QBO
  - CCMVal-2 – 2 internally, 7 nudged, the rest nothing
  - CMIP5 – 4 GCMs having a QBO
  - Charlton-Perez et al 2013, 27 models high-top and low-top models
- NWP forcing development of high-top models
- Need to address QBO in high-top models.
- QBOi emerged as a SPARC activity in 2015

# Achievements 2016

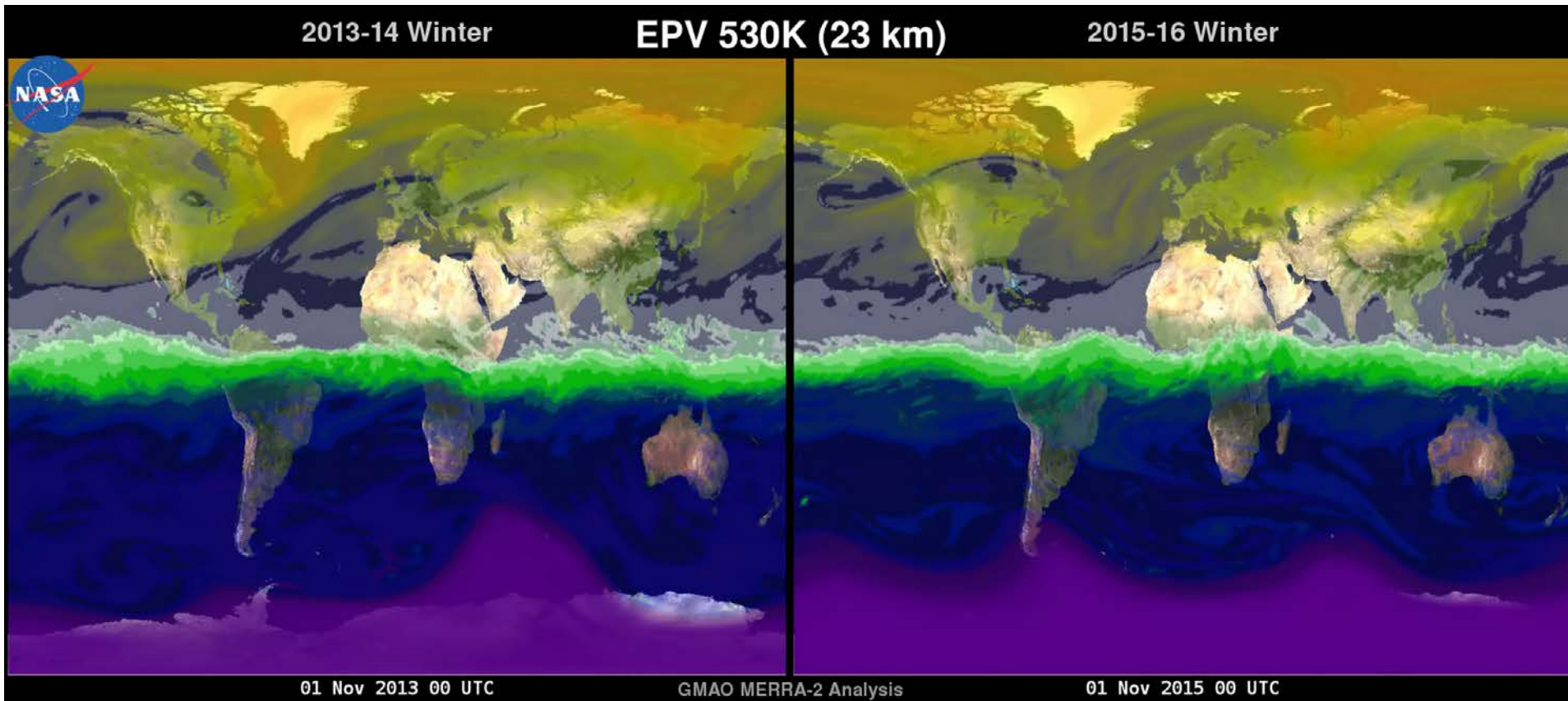
- Second Workshop held in Oxford, UK, 26-30 September 2016
- Unanticipated paper resulting from unprecedented QBO behaviour during 2016 (Osprey et al, 2016, *Science*)
- Metrics paper, outflow from Victoria 2015 being submitted to GMDD
- Co-funding obtained from Belmont-forum JPI-Climate

# SPARC QBO Workshop 26-30 September 2016 Oxford

- 50 Participants
- 3 early career scientists
- Keynote Speakers
  - Peter Haynes
  - Adam Scaife
  - Geoff Vallis
  - Juergen Kurths
  - Ted Shepherd
- Themes
  - Teleconnections
    - 2016 disruption
  - Group reports
  - Observations & Reanalyses
  - Composition & Transport
  - Idealised Simulations
- Breakout Sessions
- GOTHAM Project
- Synthesis – Mark Baldwin



# QBO Disruption 2016 – MERRA-2



Courtesy of Larry Coy

# Breakout Session – Outstanding Science (1)

## **QBO dynamics**

What governs lack of robustness of climate change response?

How predictable is the QBO? (What is the predictability limit?)

QBO-SAO interaction? Does the SAO synchronize the QBO?

Equatorial waves relevant to the QBO – breakdown by wave type?

Sources of QBO-driving waves (MJO, ENSO, in GW parametrization schemes)

Adequacy of non-orographic GWD parametrizations? (Wake up call?)

## **Composition and transport**

How important is ozone feedback on the QBO dynamics? Transport barriers: look at QBO effect on tracer transport? Geoengineering effect.

Water vapour tape recorder



# Breakout Session – Outstanding Science (2)

## **QBO Disruption**

Should there be new experiments focused on predicting the disruption?

Is it more likely under climate change?

What are the mechanisms? Why shallow? ENSO influence? One thing or many things?

## **Teleconnections**

Is Holton-Tan real? Is it strong? Let's not neglect the Southern Hemisphere.

What is mechanism of coupling between high-low lats? What QBO biases matter?

Is there a robust impact on tropical convection? Are there other important teleconnections?

Two-way interactions between QBO and other regions?

# QBOi Phase One Models & Experiments

Group	Model Name	Contacts	experiments	CEDA
<b>IPSL-LMD</b>	LMDz6	Francois Lott	5	
<b>MOHC-NCAS</b>	HadGEM3-A	Andrew Bushell, Neal Butchart, Scott Osprey	1,2,3,4,5	
<b>ECMWF</b>	IFS	Tim Stockdale	1,5	
<b>CCCma</b>	AGCM3-CMAM	James Anstey, John Scinocca, Charles McLandress	1,2,3,4,5	✓
<b>MIROC</b>	MIROC-AGCM	Yoshio Kawatani	(1), 5	
<b>MIROC</b>	MIROC-ESM	Shingo Watanabe	1, 5	
<b>NCAR</b>	CAM5	Jack Chen, Yaga Richter	1,2,3,4	
<b>NCAR</b>	WACCM	Rolando Garcia, Yaga Richter	1,2,3,4	
<b>MRI-JMA</b>	MRI-ESM2	Kohei Yoshida, Hiroaki Naoe, Seiji Yukimoto	1,2,3,4,5	✓
-	-	-	-	
<b>NRL</b>	NAVGEM	John McCormack	5*	
<b>MPI</b>	MPI-ESM-MR	Holger Pohlmann, Elisa Manzini, Hauke Schmidt	(1 ,4, 5*)	
<b>ISAC-CNR</b>	MA-ECHAM5	Chiara Cagnazzo, Federico Serva	1	
<b>JMA</b>		Takafumi Kanehama	1, 5	



# QBOi Phase One Experiment Papers (1)

- Experiment outline paper
- This paper will document the design of the five experiments that resulted from the Victoria 2015 workshop, the participating models, and the available diagnostics. It will serve as a reference for subsequent scientific papers using the QBOi multi-model ensemble
- Geophysical Model Development

QBOi INTRODUCTION QUESTIONNAIRE EXPERIMENTS PARTICIPANTS GCMS LINKS MEETINGS

## QBOi Experiments

Updates for the QBOi discussion Forum 'QBOi Discussions' can be found at [qboiexperiments.blogspot.co.uk](http://qboiexperiments.blogspot.co.uk)

- ★ Overview
- ★ Experiment List and Goals
- ★ Experiment Details
- ★ Additional Experiments
- ★ Output and Diagnostics
- ★ Project Participation & Acknowledgements

**QBOi experimental protocol**  
**Version 1.0** Drafted by John Scinocca, Tim Stockdale & Francois Lott  
**Version 1.21** Drafted by John Scinocca, Tim Stockdale, Francois Lott, Scott Osprey, Neal Butchart, Andrew Bushell, and James Anstey.  
**Version 1.22** Update to include ozone dataset recommended for high-top models  
**Version 1.23** Clarification of update to high-top models, also including recommendation for ozone climatology. Update of short-name for convective precipitation flux (prc) (17-03-2016)

# QBOi Phase One Experiment Papers (3)

**Paper 1:** Multi-model comparison and evaluation for the present climate based on a coordinated set experiments.

*Experiments: 1 (AMIP)*

*Co-leads: Andrew Bushell, Verena Schenzenger, Scott Osprey*

*Contributors: Yaga Richter, John Scinocca, Charles McLandress, Lesley Gray, Neal Butchart, Rolando Garcia...*

**Paper 2:** Robustness of QBO's response to climate forcing.

*Experiments: 2 (present-day), 3 (2xCO<sub>2</sub> and +2K SST), 4 (4xCO<sub>2</sub> and +4K SST)*

*Co-leads: Yaga Richter, Neal Butchart*

*Contributors: Jack Chen, John Scinocca, Charles McLandress, James Anstey, Rolando Garcia...*

# QBOi Phase One Experiment Papers (2)

**Paper 3:** QBO mean-flow forcing in initialized experiments. Predictability in different models, given same start dates.

*Experiments: 5 / 5A (hindcasts)*

*Co-leads: Adam Scaife, James Anstey, Tim Stockdale*

*Contributors: Young-Ha Kim, Shingo Watanabe, Yoshio Kawatani, Javier García-Serrano*

**Paper 4:** Tropical waves.

*Experiments: 5 / 5A (hindcasts), 1 (AMIP)*

*Co-leads: Laura Holt, Francois Lott, Rolando Garcia*

*Contributors: Young-Ha Kim, Yoshio Kawatani, Rolando Garcia*

**Paper 5:** Teleconnections (Holton-Tan). Main outcome of teleconnections breakouts (Thurs) seems to be that initial focus should be on Holton-Tan.

*Experiments: 2 (present-day)*

*Co-leads: Yaga Richter, James Anstey*

*Contributors: Isla Simpson, Hiroaki Naoe...*

# Experiment Extensions?

- Extending ensemble size and/or run lengths
  - Expt 2 for Holton-Tan
  - Expt 5 for longer range predictability (and Holton-Tan?)
- Sensitivity tests
  - separating stratosphere and tropospheric climate change effects
  - El Nino / La Nina perturbations
- Role of ozone
  - Ozone recovery specify in Exp 3, 4
  - Ozone feedback on QBO (models that can run with chemistry)

Is there a need for *coordinated* experiments on these?

*Examples:*

- QBO disruption. Many groups interested in forecasting.
- Long-term predictability of the QBO
- Liaise with Decadal Prediction Project?
- Very high resolution experiments? (e.g. WRF model)



### **Data**

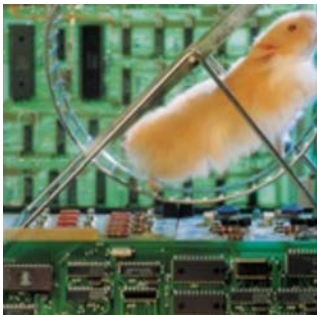
Access & store  
data via project  
Workspaces

### **Transfer**

JASMIN designed for  
large data transfers



# Centre for Environmental Data Analysis



### **LOTUS**

Batch & parallel processing

### **Virtual Machines**

Produce or analyse  
data JASMIN  
Analysis Platform



# Summer School autumn 2017 (1)

## Extreme El Nino:

- ENSO dynamics, what creates extreme El Nino's, what are the impacts of normal El Nino's and extreme El Nino, How do these signals propagate through the atmosphere, How good are the models? Application of network methods. [Eric Guilyardi](#), [Francois Lott](#)...

## Mid-Latitude Flow:

- Basics of Rossby waves, jet-storm track interactions, quasi-stationary Rossby waves & blocking, persistent extremes, Winter vs summer circulation, Application of network methods. [Dim Coumou](#), [Giorgia di Capua](#)...

## Stratospheric Teleconnections:

- QBO, polar vortex, application of network methods. [Scott Osprey](#), [Lesley Gray](#), [Catrin Gellhorn](#), [Shingo Watanabe](#), [Marlene Kretschmer](#)...

## Monsoons:

- Basic drivers and variability, connections with ENSO and mid-lat flow, extreme flooding events, application of network methods. [Raghavan Krishnan](#), [Ramesh Vellore](#), [Bo Wu](#)...

## Integration:

- Interaction of teleconnections. Non-stationarity. Future projections, Application of network methods. [All](#)

# Summer School autumn 2017 (2)

## **Complex Networks Basics** ([Pyunicorn](#))

- learn CN basics & working with Pyunicorn. Students work in small groups (~5?) and get an exercise introduced in one of the lectures. **Reik Donner, Jonathan Donges...**

## **Casual Effect Networks** ([Tigramite](#))

- learn basics of working CEN & Tigramite. Students work in small groups and follow an exercise introduced in one of the lectures. **Reik Donner, Jakob Runge...**

## **Distributed Climate Computing** ([Climateprediction.net](#))

- learn basics of working with CPDN. Students work in small groups and follow an exercise introduced in one of the lectures. **Sarah Sparrow, David Wallom...**



# External Funding – COST Action

Contact: Juan Anel

- COST Action for networking activities
- Funding (130k€/yr) up to 4 years
- Research stays, meetings, workshops, summer schools, publications/public engagement,
- EU countries, near-EU countries and International Partner countries
- Past COST projects:
  - Towards a more complete assessment of the impact of solar variability on the Earth's climate (TOSCA) | 12 May 2011 - 11 May 2015
  - Data Exploitation and Modeling for the Upper Troposphere and Lower Stratosphere | 09 September 2002 - 08 September 2006
  - Atmospheric Water Vapour in the Climate System (WaVaCS) | 05 October 2007 - 04 October 2011
- Next deadline is 7 December but application can be submitted at *any time*

# Going Forward in 2017

- Uploading Phase 1 experiment data to CEDA (Dec 2016)
- Core Phase 1 papers completed by June 2017
  - QJRMS Special Collection
- Sept/Oct 2017 Workshop to discuss core paper results, other analyses and project status
- First workshop North America (Victoria, Canada), second in Europe (Oxford, UK), third in Asia? (Japan?)