



# SPARC Report for WGNE

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WGNE meeting, Toulouse, France, 5-9 November 2012



# Overview

- SPARC and SPARC-WGNE links
- New SPARC activities on reanalyses (S-RIP) and predictability (SNAP)
- Possible new SPARC projects on gravity waves, vertical resolution
- Review of the representation of the stratosphere in global NWP



# What is SPARC?

- WCRP core project: SPARC=Stratospheric Processes And their Role in Climate
- SPARC Tasks:
  - Scientific research coordination.
  - SPARC General Assemblies and WCRP Open Science Conferences.
  - SPARC newsletters.
  - SPARC Assessment Reports.
- SPARC is broadening its scope to include the upper troposphere
- <http://www.sparc-climate.org/>



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# SPARC-WGNE links

- 2010 Oct: First participation of SPARC at WGNE
  - Proposed international collaboration on assessing impact of stratosphere on tropospheric medium range forecasting skill (Jakob)
  - Article on CONCORDIASI project (Rabier) published in SPARC newsletter
- 2011 Feb: WGNE presentation at SPARC SSG meeting (Jakob)
  - Pulido expressed interest in Transpose-AMIP2. Interested in forecast experiments and possibly determining model error due to subgrid scale gravity waves. Needs to know if gravity wave drag from gravity wave parameterizations being saved
- 2011 June: SPARC Data assimilation workshop
  - Presentation on CONCORDIASI (Rabier). SPARC Gravity wave initiative leader (Alexander) attended CONCORDIASI meeting in Oct.
  - Two major activities proposed of relevance to WGNE: Reanalysis intercomparison project (S-RIP), Stratospheric Network on Assessment of Predictability (SNAP)
- 2011 October: WGNE Boulder
  - SPARC presentation. Discussion of S-RIP, SNAP
- 2012 June: SPARC Data assimilation workshop
  - Sessions on S-RIP, SNAP, gravity waves
  - Possible future projects on vertical resolution, gravity waves. WGNE participation?



# SPARC Reanalysis/Analysis Intercomparison Project (S- RIP)

- Plans for this project discussed at WGNE 2011 Workshop
- Now approved by SPARC SSG as new SPARC activity



## Rationale: a need for reanalysis intercomparison

- A coordinated activity to compare reanalysis data sets for various “key” diagnostics & understand the causes of differences
- Use the results to provide guidance on appropriate usage of various reanalysis products in scientific studies
- The reanalysis community will benefit from coordinated user feedback, which can lead to improvements in NextGen reanalysis products
- Establish a close collaboration between the data users and the reanalysis centres
- WRITE FINAL PROJECT REPORT



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# S-RIP Report

Region of interest: UTLS, Stratosphere, Mesosphere

There is fairly good agreement that there should be initial chapters on

- Introduction; Description of the Reanalysis/analysis Systems; Basic Time-series Comparisons
- Ideas for other chapters, which need to be agreed
  - Brewer-Dobson Circulation; Stratosphere-Troposphere Coupling; Upper Troposphere and Lower Stratosphere; Tropical Tropopause Layer; etc, etc

## S-RIP Next Steps

- April/May 2013: Decide structure of S-RIP report and lead authors for chapters (Planning Meeting, Exeter, UK – Scientific Working Group + others)
- Rest of 2013: Start analysing data and writing chapters
- ~2015: complete study and report



# S-RIP

- Implications for WGNE – any feedback?





# Stratospheric Network for the Assessment of Predictability (SNAP)

- Plans for this project discussed at WGNE 2011 Workshop
- Now approved by SPARC SSG as new SPARC activity



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# SNAP Motivation

- Is it stratospheric influence or some other model change that improves tropospheric forecast skill?
- Is the improvement due to improved stratospheric model or to the observations?
- Results are likely model dependent. How generic is this improvement?
- The scientific aims of the project are to quantify:
  - current skill in forecasting the extra-tropical stratosphere,
  - the extent to which accurate forecasts of the stratosphere contribute to improved tropospheric predictability,
  - the partitioning of any gains in predictability with a well-resolved stratosphere between improvements in the estimation of initial conditions and improvements in the forward forecast.
- These questions shall be addressed via multiple models and cases



# SNAP Experiments

- The centrepiece of SNAP will be to design and perform a new intercomparison of stratospheric forecasts
- Focus on 15-30 day ensembles:
  - **Tier I:** Best high – model with a high-top above the stratopause and with all stratospheric processes included
  - **Tier II:** Best Low – standard version of low-top model with parameter settings and physics appropriate for the low-top model, initialised with the same state as the best high run & with same tropospheric levels.
  - **Tier III:** Degraded – model with a low-top but with parameter settings identical to the best high run. High common – best version of high-top model as above but initialised with a standard common analysis (most likely from ECMWF).
- This will also leave a legacy of datasets to be used by a broad community of researchers.



# Outlook for SNAP

- January 2013: form Steering Committee
- Early 2013: write review paper on the role of the stratosphere in predictability (led by Project Manager).
- April 2013: First Workshop (Reading, UK) – review existing science and future directions; design a stratospheric predictability experiment; produce an experimental strategy
- From June 2013: start running stratospheric predictability experiments
- 2015: Peer-reviewed project report, papers



# SNAP

- Implications for WGNE

- Some research groups and NWP centres(\*) have agreed to participate, but more are welcome

- Any feedback?

- (\*) Met Office (UK), BoM (Australia), Environment Canada, MRI (Japan), Naval Research Laboratory (USA), Reading Univ., Exeter Univ., New York Univ.



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# Proposed Vertical Resolution Project

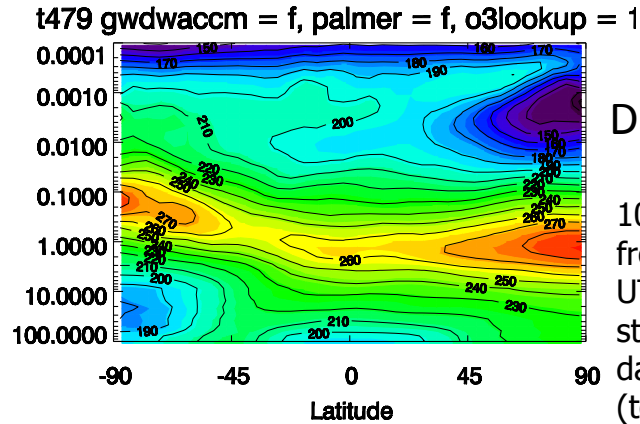
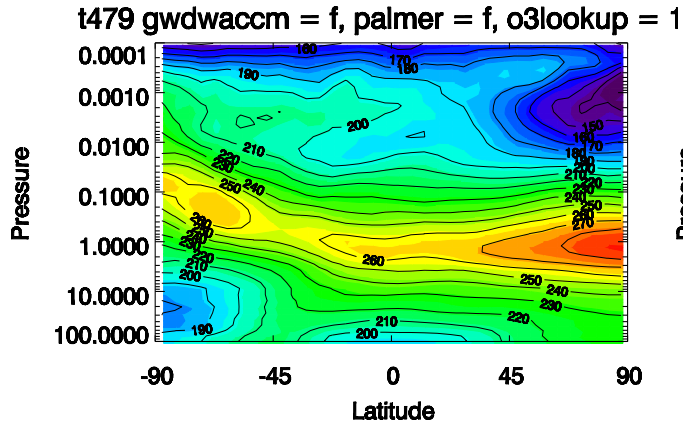
- Marv Geller (SUNY) suggested an organized study be made of the importance of vertical resolution in models in the vicinity of the tropopause. His focus is:
  - How it affects downward propagation of QBO
  - Its possible influence on tropical deep convection
  - proposed mechanisms of TTL cooling (e.g., ozone depletion and stratospheric circulation changes) - improved representations of these processes => improved projections of future tropical cyclone activity (eg Emanuel et al, 2012)
- Other phenomena may benefit from high vertical resolution studies eg:.
  - Very high resolution (~300m) to resolve GW propagation (eg Sato et al)
- **Link to WGNE:** Many tropospheric areas would benefit from enhanced vertical resolution, eg:
  - Boundary Layer
  - Convection
  - Clouds and Radiation



# Vertical resolution – ways forward

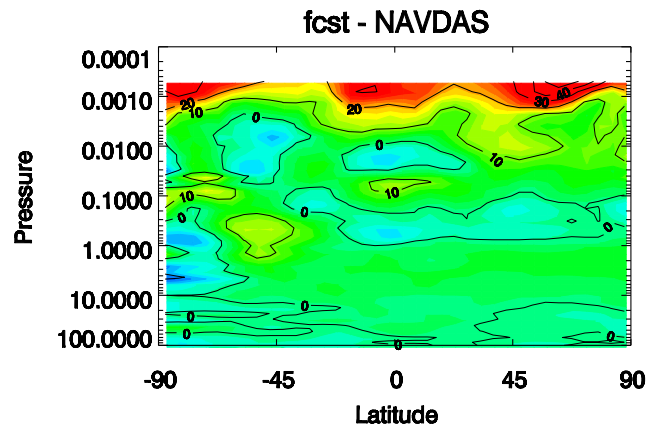
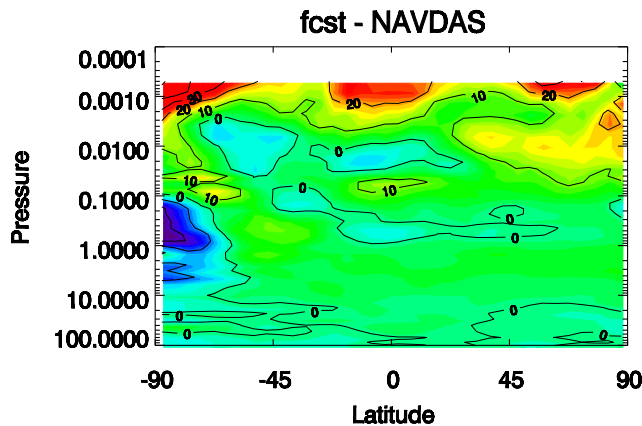
- Is there any desire for a SPARC / WGNE Activity?
- If so, how would it work?
  - Intercomparison or complementary studies?
  - Met Centres to supply controlled experiments (or operational runs with extra diagnostics)?
  - Or, selected groups to work on particular focus areas
- Drawbacks
  - Some developments may progress faster at individual centres than via intercomparisons
  - Can't have too broad a scope – unwieldy
- Start with focused areas (eg gravity waves)? **Add suggestions!**

# Resolved gravity waves v Model Setup



David Siskind, NRL

10 day zonal mean T forecast from NOGAPS-ALPHA from 00 UT June 10th, 2007 with strong high wavenumber damping (timescale = 1.4 hr) (top left) and weak damping (timescale = 5.6 hr) (top right). Bottom panels- differences between forecasts and NAVDAS T analysis on 00 UT June 20th.



- NRL NOGAPS-ALPHA model at a range of horizontal resolutions (T79 to T479) and vertical resolutions (~1 km to ~ 2km).
- Model runs performed with / without parametrized gravity waves
- Winter stratopause & summer mesopause poorly represented, even at T479. Improved results only when the diffusion was tuned to an unrealistically low level





# Gravity Waves Activities

- Results presented at 2012 SPARC DA workshop show there is no fixed answer to the model resolution required to adequately represent gravity waves and their effects. Rather, appropriate resolution depends on the formulation of each individual model.
- 2011 DA workshop recommended setting up a project on intercomparison of the missing body force due to subgrid scale gravity wave drag.
- No specific plans for such a SPARC project yet, but ISSI (Bern) project entitled “Atmospheric Gravity Waves in Global Climate Prediction and Weather Forecasting Applications” (first meeting April 2013, lead: J. Alexander), which will include assessments of missing body force due to gravity waves.
- ISSI work may be first step towards meeting above requirements and starting a (vertical) resolution project



# Intercomparison of operational Stratosphere-resolving global NWP Systems

David Jackson

Thanks to Saroja Polavarapu (CMC), Florence Rabier (Meteo France),  
Chiashi Muroi (JMA), Mikhail Tolstykh (RusHMC)



# Overview

- At 2011 SPARC DA Workshop - proposed summary of representation and impact of stratosphere in global NWP models – way of strengthening SPARC – WGNE links
- Idea is to produce a SPARC report or even a review paper
- Scope:
  - Summary of global NWP model resolutions and domains
  - Performance in the stratosphere (and mesosphere)
  - Impact on tropospheric forecasts

# Summary of global NWP model resolutions and domains

(June 2012)

Centre	Current	Planned
Met Office ECMWF (Euro)	T1279L91, ~-0.01 hPa	T1279L137, ~-0.01 hPa (late 2012)
Met Office (UK)	~25km L70, ~-0.01 hPa	~17km L70 or L85, ~-0.01 hPa
Meteo France	T798L70, 0.05 hPa	No change
DWD (Germany)	20km, L60, 5 hPa	20-40km, L60, 5 hPa, Icosahedral Nonh/static (2013)
RusHMC (Russia)	0.72x0.9, L28, ~ 5 hPa (T169 L31, ~10 hPa)	~0.2x0.225, L51, ~5 hPa (later 0.5-1 hPa) (T339L31, ~10 hPa)
NCEP (USA)	T574L64, 0.266 hPa	T878L64, 0.266 hPa (2012?)
Navy / NRL (USA)	T319L42, 0.04 hPa	T479L60,
CMC (Canada)	0.45x0.3 L80, 0.1 hPa	0.35x0.23, L80, 0.1 hPa
CPTEC/INPE (Brazil)	T299L64	T666L96
JMA (Japan)	T959L60, 0.1 hPa	T959L100, 0.01 hPa (2013?)
CMA (China)	T639L60, 0.1 hPa	50km L36, 10 hPa
KMA (Korea)	~25km L70, ~-0.01 hPa	Follows Met Office
NCMRWF (India)	~25km L70, ~-0.01 hPa	Follows Met Office
BOM (Australia)	~40km L70, ~-0.01 hPa	~25km L70, ~-0.01 hPa (follows Met Office)



# Summary So Far

- Only Germany and Russia have models with UB below 1 hPa level
- All plan to include stratosphere, except China: New model UB will drop to 10 hPa – why?
  - Own model - Non-hydrostatic core
  - New dynamical cores elsewhere – eg Germany, UK
- Benefit to troposphere analysis shown
- Forecast impacts in 1-5 day range:
  - Not shown (UK) – if only model lid changes
  - Shown (Canada) – if model physics + lid changes
- Further vertical extension to mesosphere leads to improved stratosphere (higher lid), but problems from lack of obs, under-resolved tides
- **Spectral + orog GW** schemes most popular



# Next steps

- Initial steps only – by no means complete
- More extensive summary of GW, radiation schemes, numerics, etc, and their impacts?
- Above may not be easy without explicit new experiments
- No definitive model description docs, so task much harder than initially thought
- Seek volunteers to form a team to complete this task



# Discussion Points

- S-RIP: Implications for WGNE – any feedback?
- SNAP: Implications for WGNE
  - Some research groups and NWP centres(\*) have agreed to participate, but more are welcome
  - Any feedback?
- Vertical resolution
  - WGNE participation?
  - If so, where to focus?
- Gravity waves – WGNE interest?
- Stratosphere in Global NWP:
  - WGNE Interest?
  - Offers of help?



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Extra Slides





# Summary of DA approaches

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Method	Current	Future / Planned
4D-Var	ECMWF (weak constraint), Canada, Japan, Korea, Australia, France, NRL, India	
Hybrid Ens/Var	UK (ETKF), France (Ensemble DA)	UK (upgraded ensemble), NCEP (May 2012), NRL, Canada, Australia, ECMWF, France (both Ensemble DA), India, Korea, Australia (ETKF)
LETKF		Germany, Japan, Brazil
Other	Russia (OI), NCEP (SI), China (SI), Brazil (PSAS), Germany (3D-Var)	Russia (3D-Var) China (3D-Var)



# Summary of GW approaches

Method	Current	Planned
Spectral + orog	UK, ECMWF, Canada, India, Korea, Australia, France(?), NRL	UK, ECMWF, Canada, Japan, India, Korea, Australia, France, NRL
Orog only	NCEP, Japan (+RF), China	NCEP, China
RF	Russia	
Other / not known	Brazil, Germany	Russia (convective), Germany, Brazil