



SPARC Report to the Working Group on Numerical Experimentation (WGNE)

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Exeter, UK



SPARC
Stratosphere-troposphere
Processes And their Role in Climate

WCRP Organization



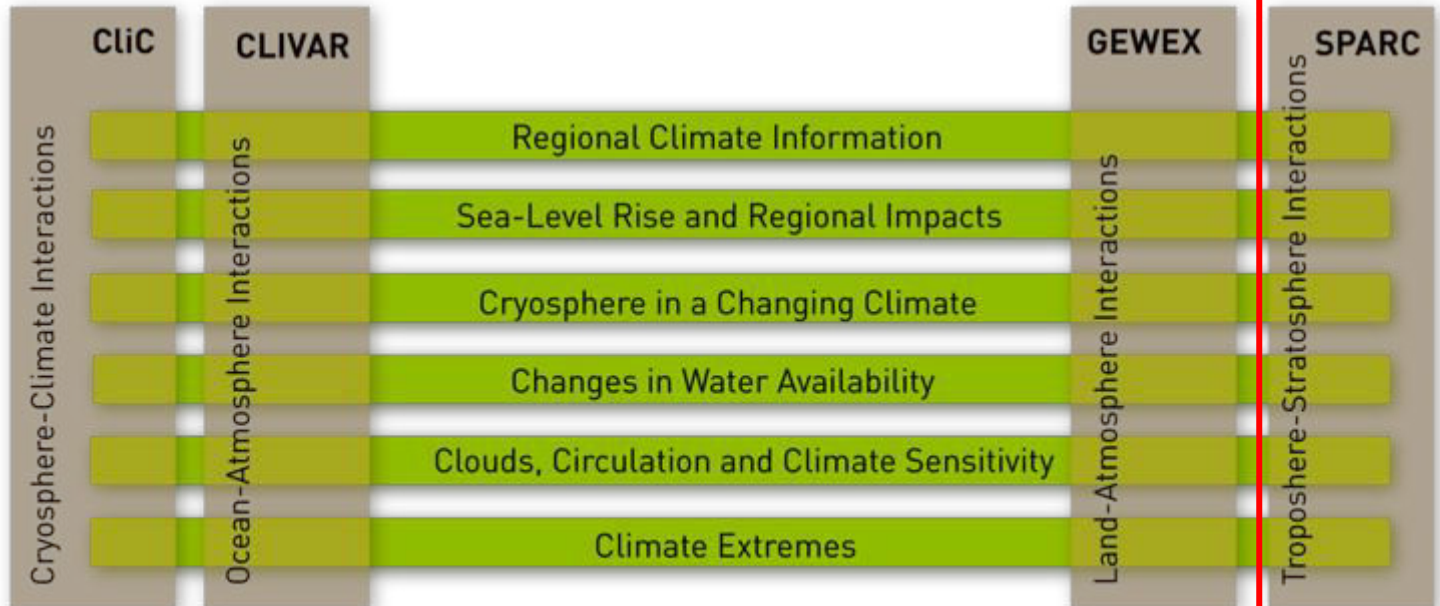
Joint Scientific Committee

Joint Planning Staff

Modeling Advisory Council

Data Advisory Council

Working Groups on: Coupled Modelling (WGCM), Regional Climate (WGRC), Seasonal to Interannual Prediction (WGSIP), Numerical Experimentation (WGNE)



SPARC Tasks Include:

- Research coordination through SPARC activities
- General Assemblies and WCRP Conferences
- Newsletters
- Assessment Reports
- <http://www.sparc-climate.org/>

Next SPARC General Assembly will be 1-5 October 2018 in Kyoto.

Why is the Stratosphere Important for Extended Range Prediction?

Stratosphere &
Mesosphere
10-85 km

Large Angular Momentum Reservoir
Long Radiative/Dynamical Time Scales
Long Memory (weeks to months)

Data assimilation → initialization and verification of models
Dynamical coupling → stratosphere-troposphere teleconnections

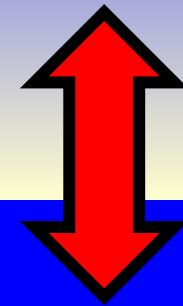
wave momentum &
energy



Troposphere
0-10 km

Short Radiative/Dynamical Time Scales
Short Memory (hours to days)

heat



Ocean

Large Heat Reservoir
Long Time Scales, *Long Memory (months to years)*



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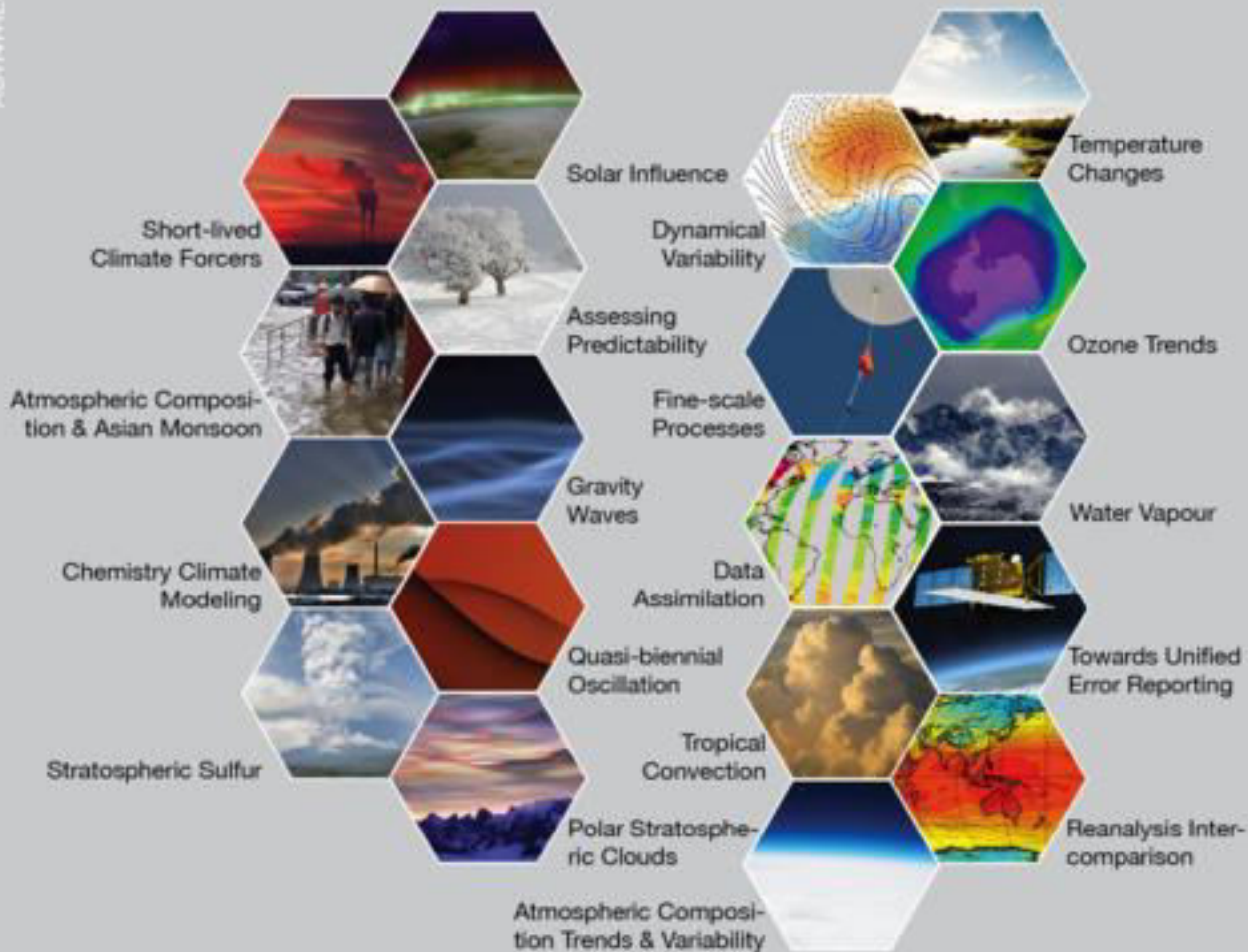


Chemistry & Climate

Atmospheric Dynamics & Predictability

Long-term Climate Records

ACTIVITIES THEMES



SPARC Activities Related to WGNE

1. **DAWG**: Data Assimilation Working Group
2. **S-RIP**: SPARC-Reanalysis Intercomparison Project
3. **SNAP**: Stratospheric Network for the Assessment of Predictability
4. **QBOi**: Quasi-biennial oscillation intercomparison project
5. **DYNVAR**: Dynamics and Variability of the Stratosphere and Troposphere

1. DAWG: Data Assimilation Working Group

Next Meeting: October 25-27 at ECMWF in Reading (Joint with S-RIP)

Themes:

- Development of new observing systems for the middle atmosphere and Observing System Simulation Experiment (OSSE)
- Stratospheric DA in support of assessing trends in the state of the Upper Troposphere/Lower Stratosphere (UTLS)
- New DA techniques and applications for stratospheric data
- SPARC Activity Updates (What are community needs for stratospheric DA?)
- ***Briefing on new ERA5 reanalysis***

ERA5

Replacement for ERA-Interim, currently in production, using:

- a 2016 (rather than a 2006) version of the ECMWF data assimilation system
- ~30km (rather than ~80km) horizontal resolution and 137 (rather than 60) levels
- new analyses of sea-surface temperature and sea-ice concentration
- various new and reprocessed satellite data records

providing:

- hourly output fields (already released for 2010-2016)
- an observational feedback archive
- uncertainty estimates from a 10-member ensemble data assimilation
- a land-surface analysis downscaled to ~9km horizontal resolution

from 1979 onwards, with:

- prompt operational extension forward in time
- a subsequent extension to cover the period from 1950 to 1978

In summary

Performance of ERA5 in the troposphere is generally better than that of ERA-Interim:

- improved global hydrological and mass balance
- smaller biases in precipitation
- refinement of temperature variability and trends
- better fit to observations and better medium-range forecasts

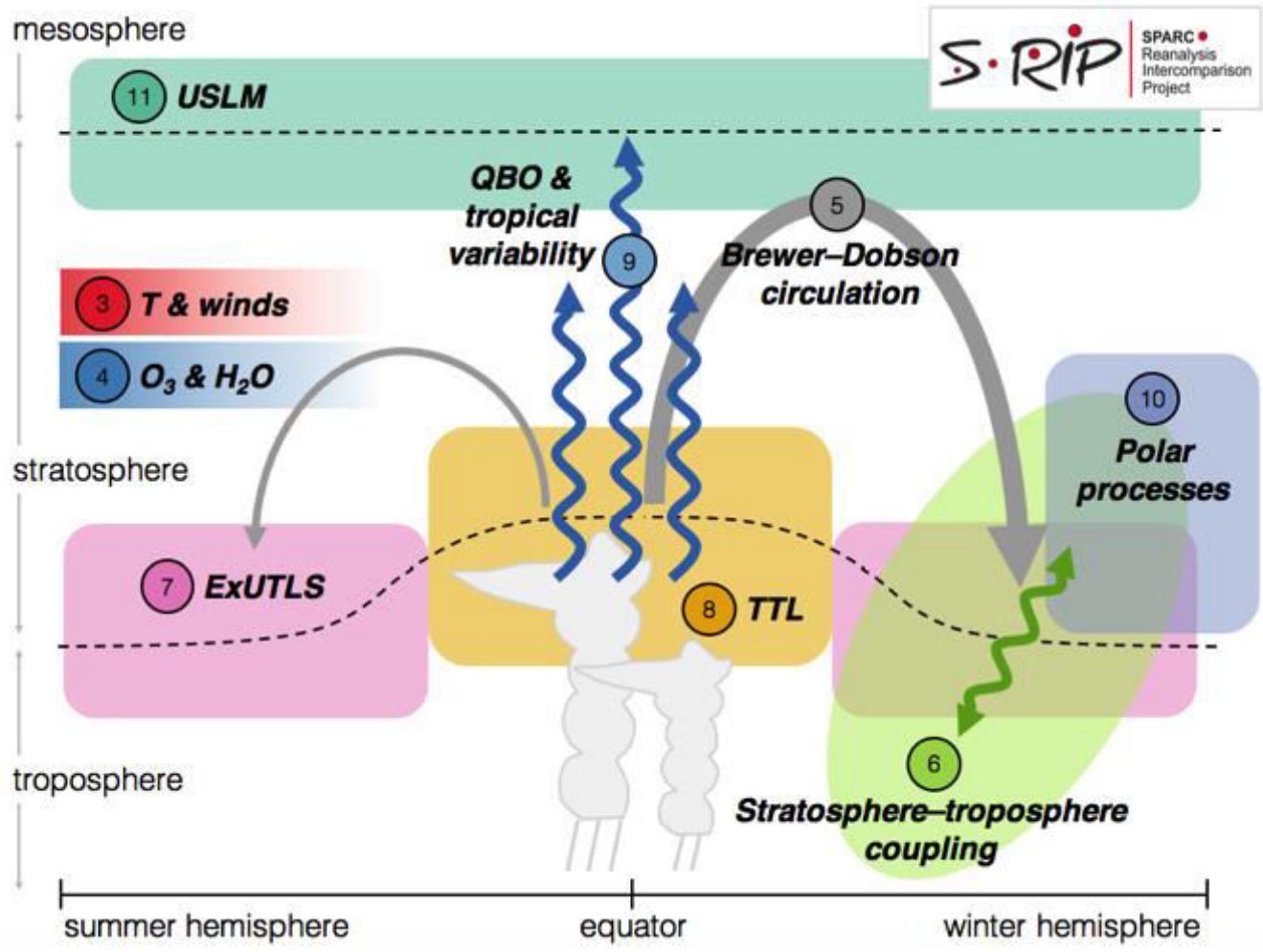
Performance of ERA5 is mixed in the stratosphere and mesosphere:

- better tropopause temperatures and lower-stratospheric humidities in the tropics
- sharper representation of small-scale dynamical features
- better late-winter ozone distributions in the Antarctic
- larger temperature biases, which vary more over time; better from late 2006
- problematic tropical winds at high levels

Prospects:

- good overlap from 2007 should enable merging with ERA-Interim where needed
- issues to be addressed for ERA6 are clear, and progress is already being made

2. SPARC Reanalysis Intercomparison Project (S-RIP)



Slide courtesy of M. Fujiwara

Global atmospheric reanalyses currently available.

Reanalysis Center (Contacts for S-RIP)	Name of the Reanalysis Products
ECMWF (R. Dragani)	ERA-40, ERA-Interim, (ERA-20C), (CERA-20C)
JMA (Y. Harada)	JRA-25, JRA-55
NASA (K. Wargan)	MERRA, MERRA-2
NOAA/NCEP (C. Long, W. Ebisuzaki)	NCEP R-1, NCEP R-2, CFSR
NOAA & Univ. Colorado (G. Compo, J. Whitaker)	(20CR)

Notes:

- ERA-20C, CERA-20, and 20CR: The “surface-input” reanalyses (surface obs. only assimilated)
- The JRA-55 family also includes
 - “JRA-55C” (conventional obs. only assimilated)
 - “JRA-55AMIP” (no obs. assimilated; SST specified)

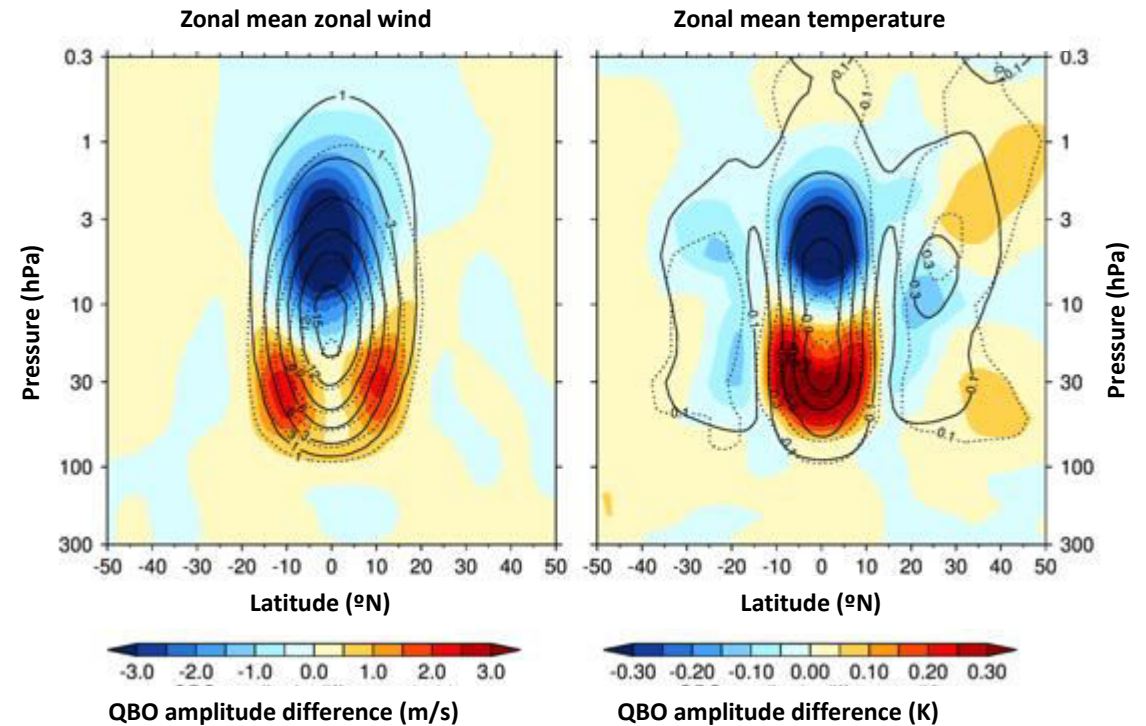
S-RIP Achievements and Plans

- The inter-journal **special issue** on "The SPARC Reanalysis Intercomparison Project (S-RIP)" in Atmospheric Chemistry and Physics (ACP) and Earth System Science Data (ESSD)
 - https://www.atmos-chem-phys.net/special_issue829.html
 - **18 papers** (including those under review) currently
 - Fujiwara et al., "**Introduction to the SPARC Reanalysis Intercomparison Project (S-RIP) and overview of the reanalysis systems**" (for Chaps. 1 & 2)
 - Long et al., "**Climatology and interannual variability of dynamic variables in multiple reanalyses evaluated by the SPARC Reanalysis Intercomparison Project (S-RIP)**" (for Chap. 3)
 - Davis et al., "**Assessment of upper tropospheric and stratospheric water vapour and ozone in reanalyses as part of S-RIP**" (for Chap. 4)
- Will contribute to the 5th International Conference on Reanalysis (ICR5)

3. SPARC-QBOi

- Comparison of GCMs and reanalyses.
- Peak QBO amplitude placed too high (solid lines, opposite) compared to mean reanalyses (dotted)
- Model QBOs do not penetrate to the **lowermost stratosphere** and are **too narrow**
- How do these biases impact tropospheric teleconnection predictability (e.g. **Madden-Julian Oscillation**)?

Model Biases: good enough for teleconnections?



Schenzinger et al, *Geosci. Model Dev.*, 2017

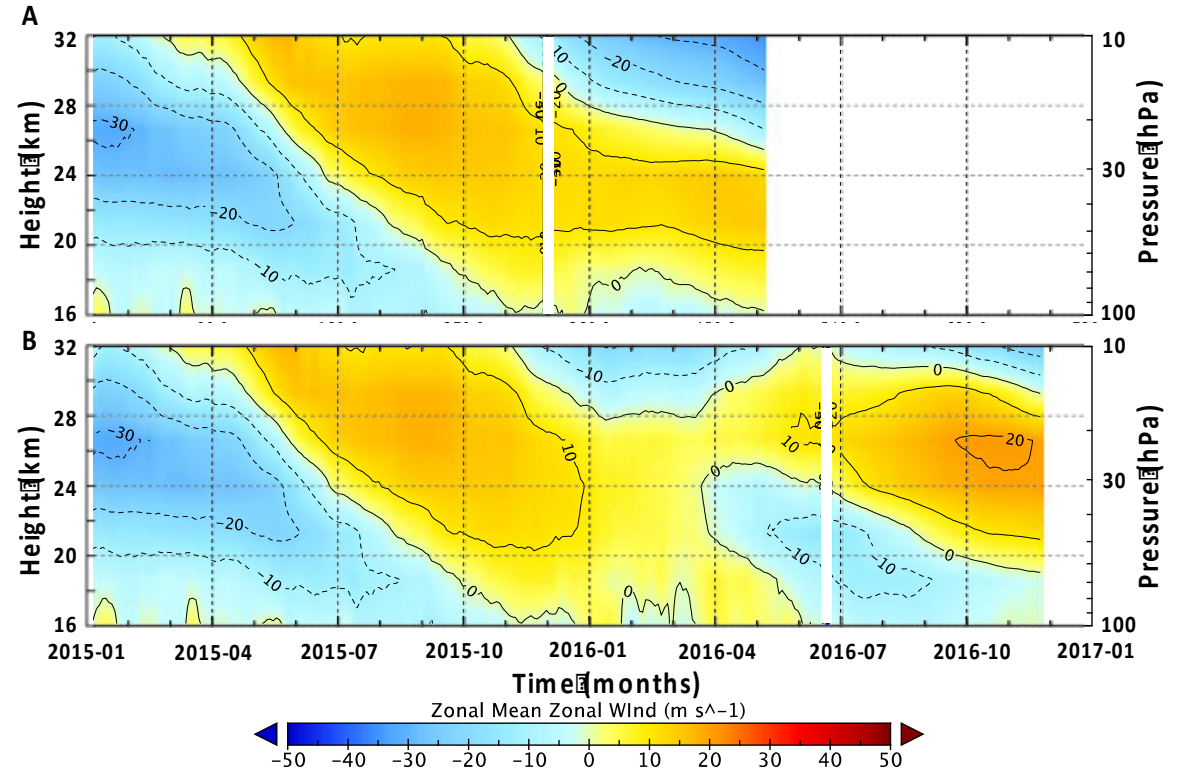
Joint SPARC Dynamics & Observations Workshop, Kyoto, 9-14 October

<http://www.sparc-climate.org/activities/quasi-biennial-oscillation/>

Slide courtesy of S. Osprey

SPARC-QBOi: QBO Disruption a Challenge to Seasonal Forecasting

- QBO was disrupted during 2016
- Extratropical waves responsible for rapid development of westward wind jet within eastward QBO phase
- **Seasonal forecasting centres apparently did not anticipate the disruption in advance**
- The lack of predictability of the disruption has significant implications for the **possible limits** of future seasonal forecasts



Osprey et al, *Science*, 2016

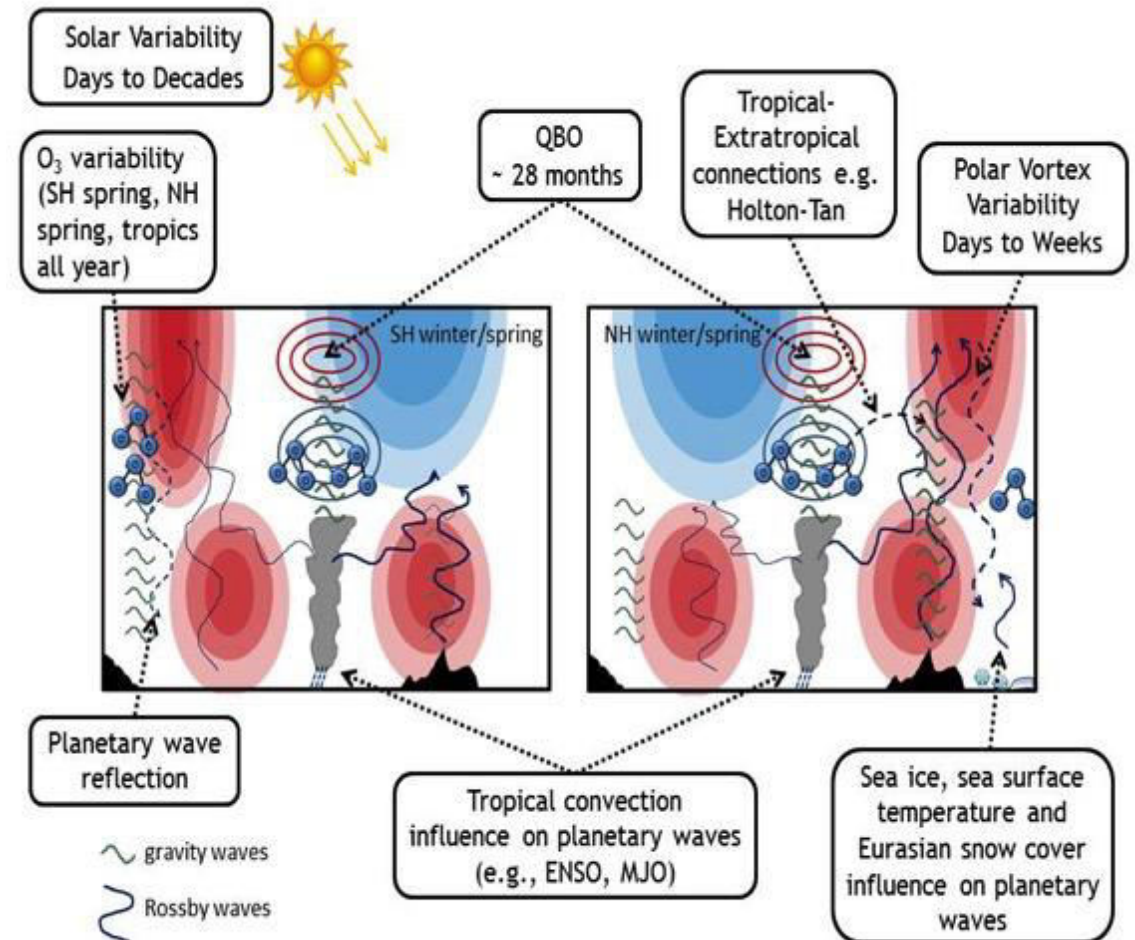
<http://www.sparc-climate.org/activities/quasi-biennial-oscillation/>

Slide courtesy of S. Osprey

4. SNAP Activity

<http://www.sparc-climate.org/activities/assessing-predictability/>

- SNAP is continuing to build on its initial work around understanding the role of the stratosphere in predictability
- Recently we have appointed a new co-lead (Amy Butler) and had a significant shift in the membership of our steering panel
- Work is shifting towards the sub-seasonal timescale and interactions with the S2S project in particular
- There are two main current activities:
 1. Reviewing our current understanding through a chapter in the forthcoming S2S book (example figure here)
 2. An initial study of stratosphere-troposphere coupling on the sub-seasonal timescale led by Daniela Domeisen



Slide courtesy of A. Charlton-Perez

5. Updates from DynVar *Dynamics and Variability of the Stratosphere-Troposphere*

- DynVarMIP A diagnostic model intercomparison project within the CMIP6 (*Gerber and Manzini, GMD 2016*)
 - enhanced diagnostics from c. 10 models, focussing on DECK integrations + targeted runs from other MIPs
 - focus on momentum and heat budgets, and ability to assess the circulation in UTLS and stratosphere
- SPARC DynVar Activity
 - At a crossroads, as the latest efforts culminated in the DynVarMIP. Undergoing renewal in leadership.
 - Anticipate shift in focus to predictability and role of stratosphere-troposphere coupling on surface

<http://www.sparc-climate.org/activities/dynamical-variability/>

Going forward, WGNE/SPARC interactions could focus on:

- Stratospheric DA for initialization & verification
→ sources of “middle atmosphere” obs. now and in the future?
- Treatment of convection (MJO).
- Treatment of gravity waves (resolved & parameterized, orographic & non-orographic).
- New (better?) verification tools for extended range forecast skill in stratosphere-resolving systems.