Sub-seasonal to seasonal Prediction Project

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Background

- There is a need to fill the gap between medium-range and seasonal forecasting and link the activities of WCRP and WWRP (E.G. Brunet et al, 2010)

- The WMO Commission of Atmospheric Sciences (CAS) requested at its 15th session (Nov. 2009) that WCRP, WWRP and THORPEX set up an appropriate collaborative structure for sub-seasonal prediction.

- A WCRP/WWRP/THORPEX workshop was held at Exeter (1-3 December 2010).

  www.wcrp-climate.org/documents/CAPABILITIES-IN-SUB-SEASONAL-TO-SEASONAL PREDICTION-FINAL.pdf

Planning Group

- The creation of the planning group follows a main recommendation from the WWRP/THORPEX/WCRP workshop at the UK Met Office (1-3 December 2010).

- The planning group was established in 2011

  Sponsors: WCRP-WWRP-THORPEX

- Kick-off meeting: 2-3 December 2011

- An Implementation plan has been written:

http://www.wmo.int/pages/prog/arep/wwrp/new/documents/Implementation_plan_V6.4_nolinenos.pdf

- An article describing the project will appear in the next issue of the WMO Bulletin

- Next group meeting 5-7 Feb. 2013- UK Met Office - Exeter

Sub-seasonal to Seasonal Prediction Planning group

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Liaison group:

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Richard Graham (UKMO, CBS)
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Barbara Brown (JWVGR)
Steve Woolnough (GEWEX/GASS)

David Anderson (WMO consultant)

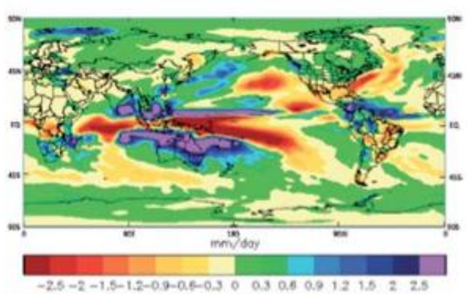
Sub-seasonal to seasonal flyer

BACKGROUND

Forecasting for the sub-seasonal time range has so far received much less attention than medium-range and seasonal prediction, as it has long been considered a "predictability desert". Recent research has indicated important potential sources of predictability through better representation of atmospheric phenomena such as the Madden–Julian Oscillation and improved coupling with, and initialization of, the land–ocean–cryosphere and stratosphere.

From the end-user perspective, the sub-seasonal to seasonal time range is a very important one, as many management decisions in agriculture and food security, water, disaster risk reduction and health fall into this range.

Better understanding of these potential sources of predictability together with improvements in model development, data assimilation and computing resources should result in more accurate forecasts.



Seasonal forecast of precipitation for December 2010 and January and February 2011, issued by the UK Met Office in September 2010. The purple region over Australia indicates increased rainfall.

RESEARCH PRIORITIES

The sub-seasonal to seasonal prediction initiative will involve the following:

- Evaluating the potential predictability of sub-seasonal events, including identifying windows of opportunity for increased forecast skill, with special emphasis on high-impact weather events
- Understanding systematic errors and biases in the sub-seasonal to seasonal forecast range
- Comparing, verifying and testing multi-model combinations from these forecasts and quantifying their uncertainty
- Focusing on some specific extreme event case studies, such as the Russian heatwave of 2010, the floods in Pakistan in 2010 and Australia in 2011, and the European cold spell of 2012

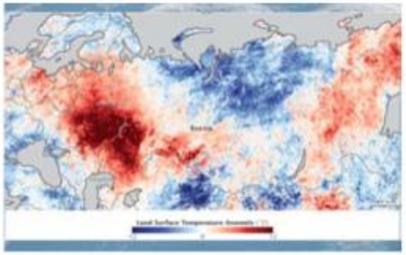
Drought in Africa

IMPLEMENTATION

The proposed WWRP/THORPEX–WCRP joint research project to improve forecast skill and understanding on the sub-seasonal to seasonal timescale will require the following:

- The establishment of a project office and a steering group
- The establishment of a multi-model database consisting of ensembles of sub-seasonal (up to 60 days) forecasts and supplemented with an extensive set of re-forecasts following THORPEX Interactive Grand Global Ensemble protocols
- A series of dedicated science workshops on sub-seasonal to seasonal prediction, starting with "Sources of predictability at the sub-seasonal timescale – windows of opportunity for applications"
- Appropriate demonstration projects based on some recent extreme events and their impacts, in conjunction with the WWRP Working Group on Societal and Economic Research and Applications

This challenging project will require five years, after which the opportunity for a five-year extension will be considered.



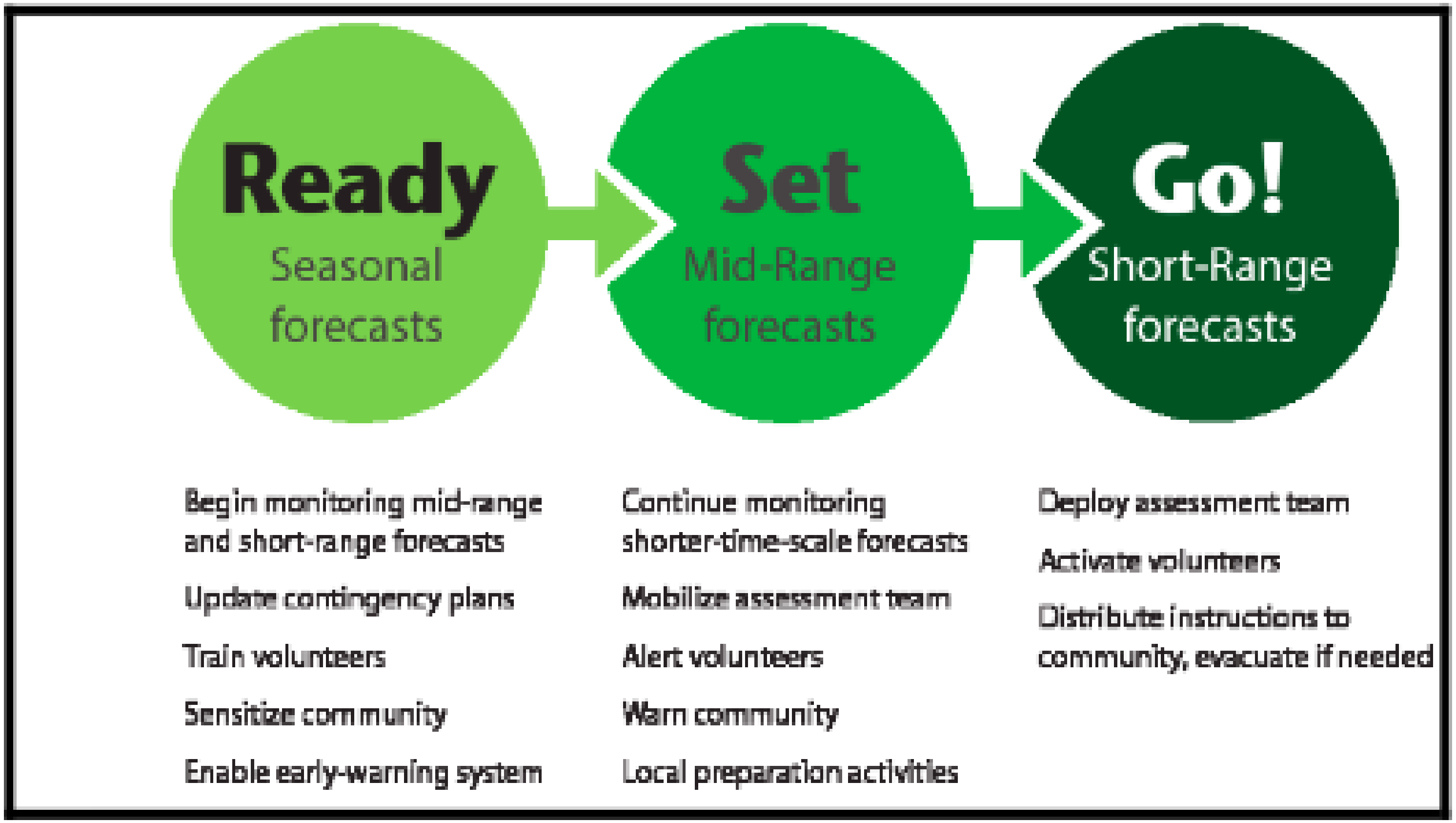
Temperature anomaly during Russian heatwave in 2010; more than 10°C warmer than normal near Moscow

Use of sub-seasonal forecasts in applications

Growing, and urgent, requirement for the employment of sub-seasonal predictions for a wide range of societal and economic applications which include:

- Warnings of the likelihood of severe high impact weather (droughts, flooding, wind storms etc.) to help protect life and property
- Humanitarian Planning and Response to disasters
- Agriculture particularly in developing countries — e.g. wheat and rice production
- Disease planning/control — e.g. malaria, dengue and meningitis
- River-flow — for flood prediction, hydroelectric power generation and reservoir management for example

Opportunity to use information on *multiple* time scales



Red Cross - IRI example

Bridging the gap between Climate and weather prediction

- A particularly difficult time range: Is it an atmospheric initial condition problem as medium-range forecasting or is it a boundary condition problem as seasonal forecasting?

- Some sources of predictability :

  - The Madden Julian Oscillation
  - Sea surface temperature/Sea ice
  - Snow cover
  - Soil moisture
  - Stratospheric Initial conditions
  - Atmospheric Dynamical processes

Implementation plan: Scientific issues

- Identify sources of predictability at the sub-seasonal to seasonal time-range
- Prediction of the MJO and its impacts in numerical models
- Teleconnections - forecasts of opportunity
- Monsoon prediction
- Rainfall predictability and extreme events
- Polar prediction and sea-ice
- Stratospheric processes

Implementation plan: Modelling issues

- Role of resolution
- Role of Ocean-atmosphere coupling
- Systematic errors
- Initialisation strategies for sub-seasonal prediction
- Ensemble generation
- Spread/skill relationship
- Design of forecast systems
- Verification

Research priorities

The project will involve:

- evaluating the potential predictability of sub-seasonal events, including identifying windows of opportunity for increased forecast skill. Specific attention will be paid to the risk of extreme weather, including tropical cyclones, droughts, floods, heat waves and the waxing and waning of monsoon precipitation.

- understanding systematic errors and biases in the sub-seasonal to seasonal forecast range

- comparing, verifying and testing multi-model combinations from these forecasts and quantifying their uncertainty

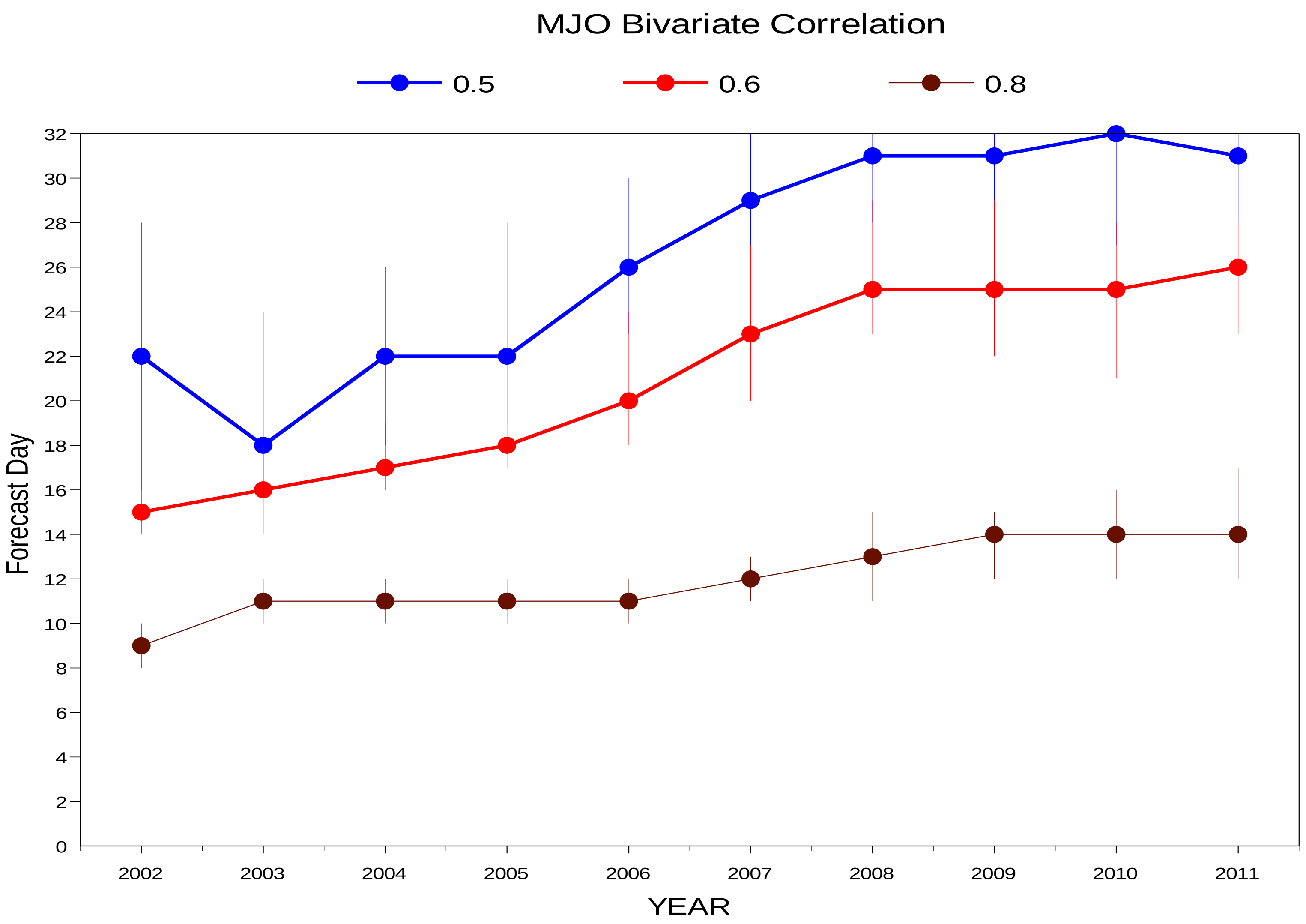
- focussing on some specific extreme event case studies, such as the Russian heat wave of 2010, the Pakistan floods in 2010, Australian floods of 2011, European cold spell in 2012, as demonstration projects

Sub-seasonal forecast database

- 10 years ago, only a couple of operational centres were producing sub-seasonal forecasts. Over the past years, a few GPCs have set sub-seasonal forecasting systems.

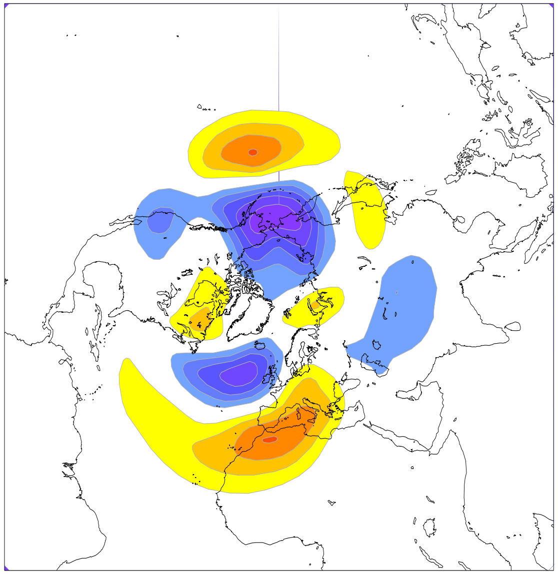
- Numerical models have shown significant improvements in sub-seasonal prediction over the past years (e.g. MJO).

Examples of improvements in MJO prediction

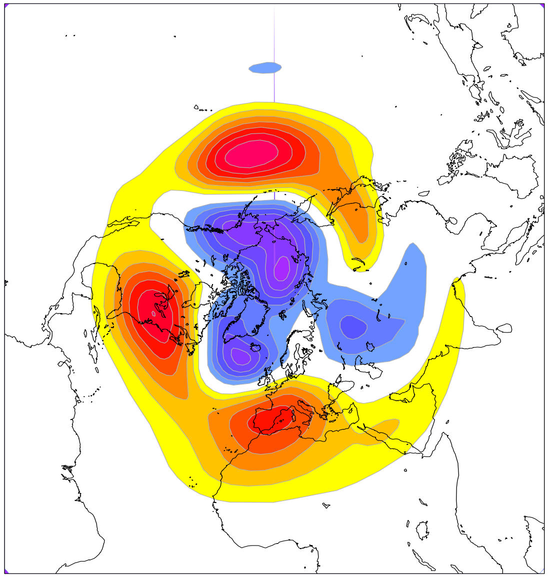


Impact of the MJO on the N. Extratropics

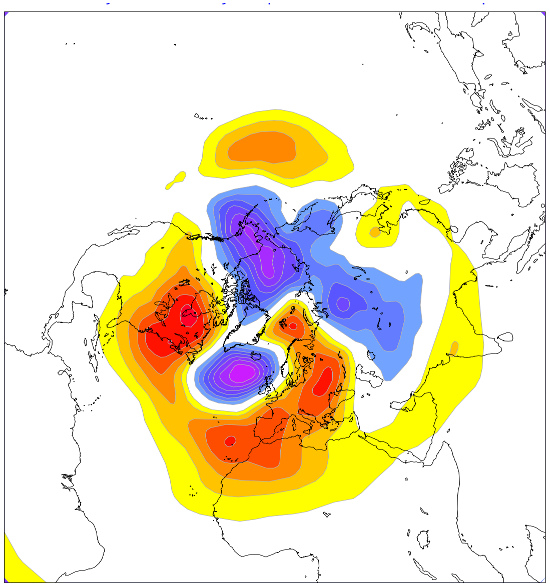
2002



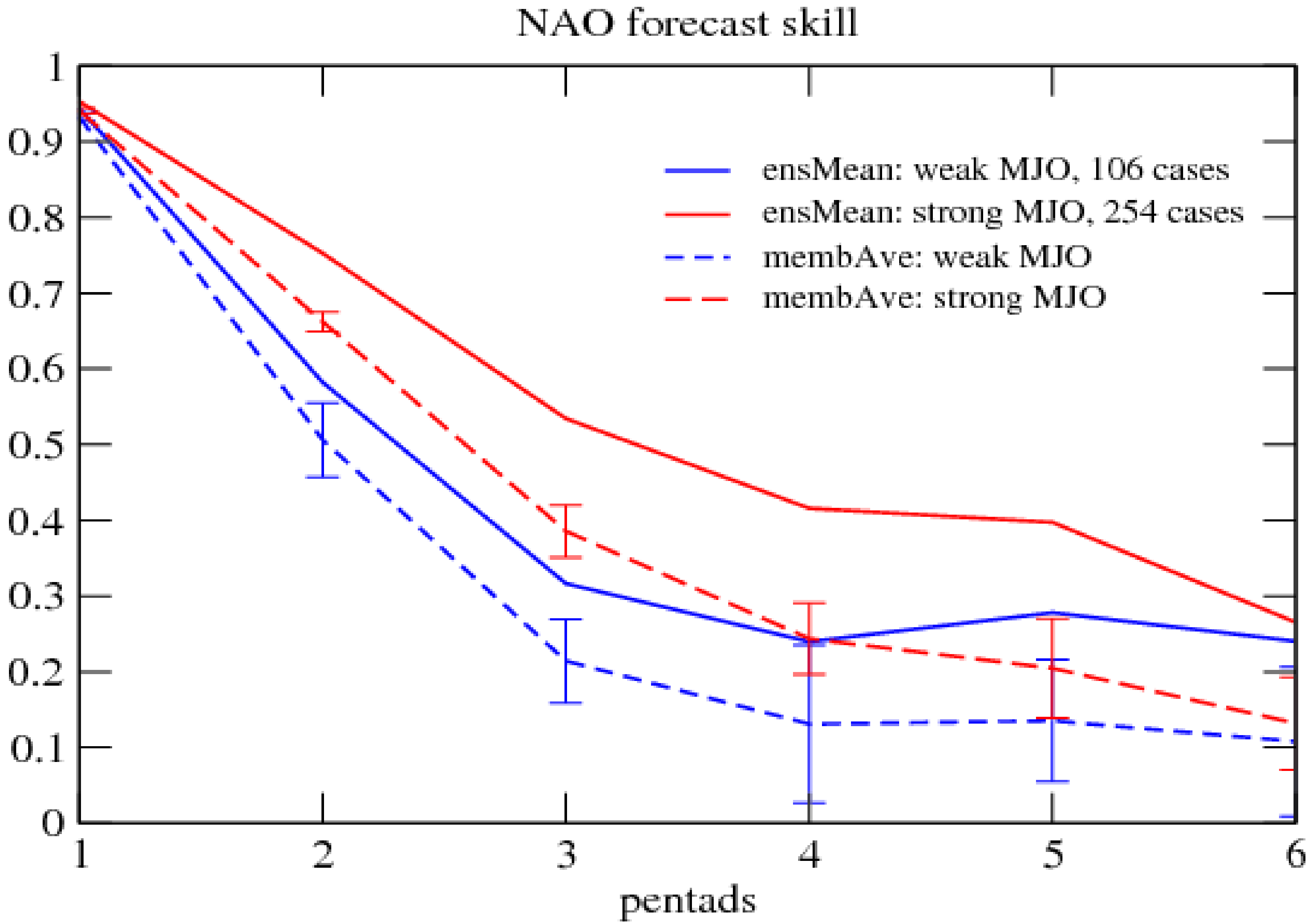
2011



ERA Interim



Simulation of the impact of the MJO on the NAO



Lin et al, 2010

Sub-seasonal real-time Operational Forecasts

	Time-range	Resol.	Ens. Size	Freq.	Hcsts	Hcst length	Hcst Freq	Hcst Size
ECMWF	D 0-32	T639/319L62	51	2/week	On the fly	Past 18y	weekly	5
UKMO	D 0-60	N96L85	4	daily	On the fly	1989-2003	4/month	3
NCEP	D 0-60	N126L64	16	daily	Fix	1999-2010	daily	4
EC	D 0-35	0.6x0.6L40	21	weekly	On the fly	Past 15y	weekly	4
CAWCR	D 0-120	T47L17	33	weekly	Fix	1989-2010	3/month	33
JMA	D 0-34	T159L60	50	weekly	Fix	1979-2009	3/month	5
KMA	D 0-30	T106L21	20	3/month	Fix	1979-2010	3/month	10
CMA	D 0-45	T63L16	40	6/month	Fix	1982-now	monthly	48
CPTEC	*D 0-30*	*T126L28*	*1*	*daily*	*No*	-	-	-
Meteo-France	*D 0-60*	*T63L91*	*41*	*monthly*	*Fix*	*1981-2005*	*monthly*	*11*
SAWS	*D 0-60*	*T42L19*	*6*	*monthly*	*Fix*	*1981-2001*	*monthly*	*6*
HMCR	*D 0-60*	*1.1x1.4 L28*	*10*	*monthly*	*Fix*	*1979-2003*	*monthly*	*10*

Proposal for a sub-seasonal database

- Use TIGGE protocol (GRIB2) for archiving the data. The data should also be available in NETCDF for the WCRP community.
- Archive daily means of real-time forecasts + reforecasts. Real-time forecasts 3 or 4 weeks behind real-time
- Variables archived: most of TIGGE variables + ocean variables and stratospheric levels
- 1.5x1.5 degree grid or lower once a week.

Use of the first 2 months of the CHFP seasonal and climate forecasting systems to compare with the archive (above). Need for daily or weekly/pentads archive.

Demonstration projects

A few case studies to demonstrate that using sub-seasonal to seasonal predictions could be of benefit to society.

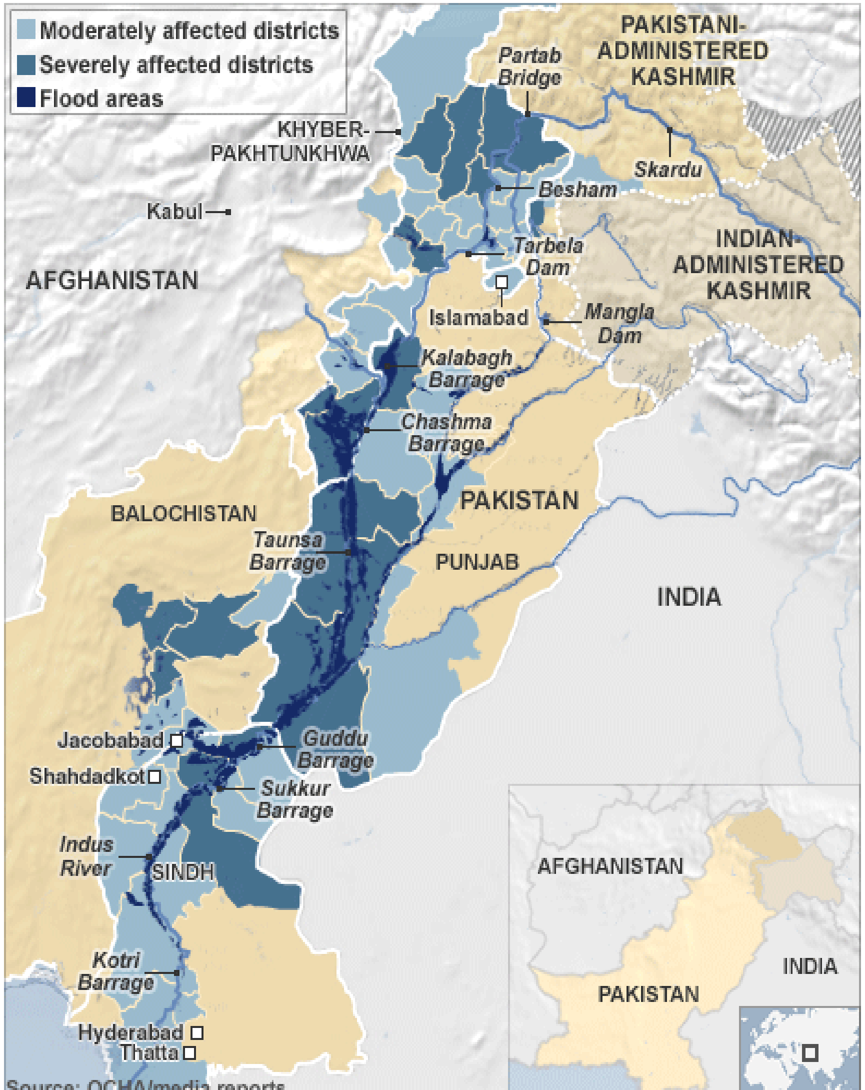
Cases studies could include:

- Pakistan floods (2010) concurrent with the Russian heat wave
- Australian floods (2009 or 2011)
- European Cold spell (2011)

At least one of the demonstration projects should be in real-time, which is often the best way to foster collaborations between the research and application communities.

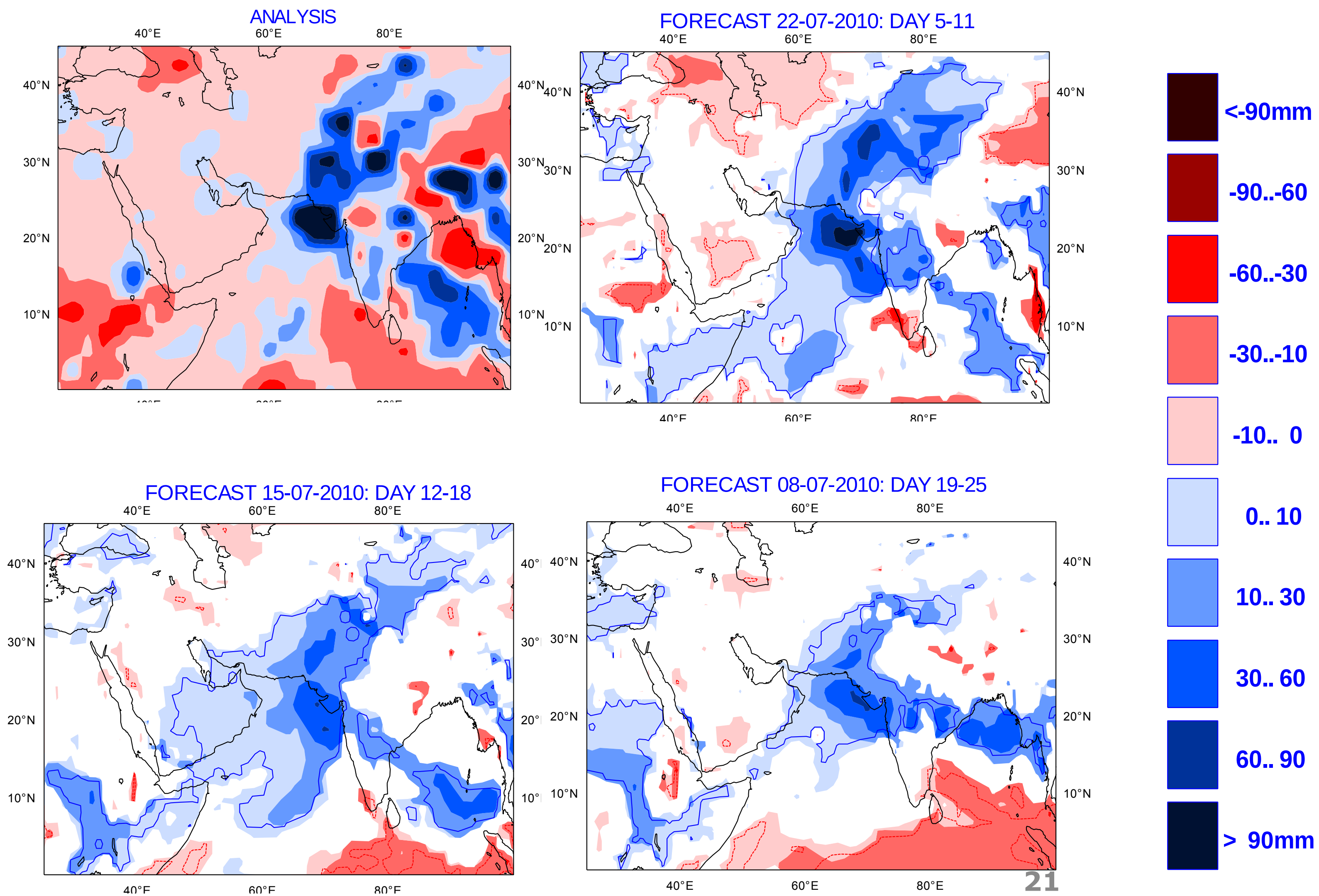
The models could be archived near real-time during a limited period of time with additional fields being archived. The period chosen could coincide with test bed studies from other projects (e.g. polar project).

Example : Pakistan Floods (2010)



Sub-seasonal Prediction of Pakistan Floods (2010)

Precip anomalies : 26 July– 01 August 2010



Linkages

- Global Framework for Climate Services
- WGSIP
- CLIVAR and GEWEX including regional panels and WGNE
- Year of Tropical Convection – MJO-TF
- CBS
- Verification working groups (SVS-LRF and JWGFVR)
- World Bank

Main recommendations

- The establishment of a project Steering group

- The establishment of a project office

- The establishment of a multi-model data base consisting of ensembles of subseasonal (up to 60 days) forecasts and re-forecasts

- A major research activity on evaluating the potential predictability of subseasonal events, including identifying windows of opportunity for increased forecast skill.

- A series of science workshops on subseasonal to seasonal prediction.

- Appropriate demonstration projects based on some recent extreme events and their impacts

This project will require 5 years, after which the opportunity for a 5 year extension will be considered.

Recent developments

- The WMO executive council has approved the creation of a sub-seasonal to seasonal prediction project. It also approved the creation of a project office and a trust fund for sub-seasonal to seasonal prediction.

- The implementation plan has been validated by the WCRP and WWRP JSCs

- The terms of reference of the sub-seasonal to seasonal group have been drafted:

- The project will last 5 years , starting in 2013 with the option to extend based on a review of progress, achievements and remaining gaps.

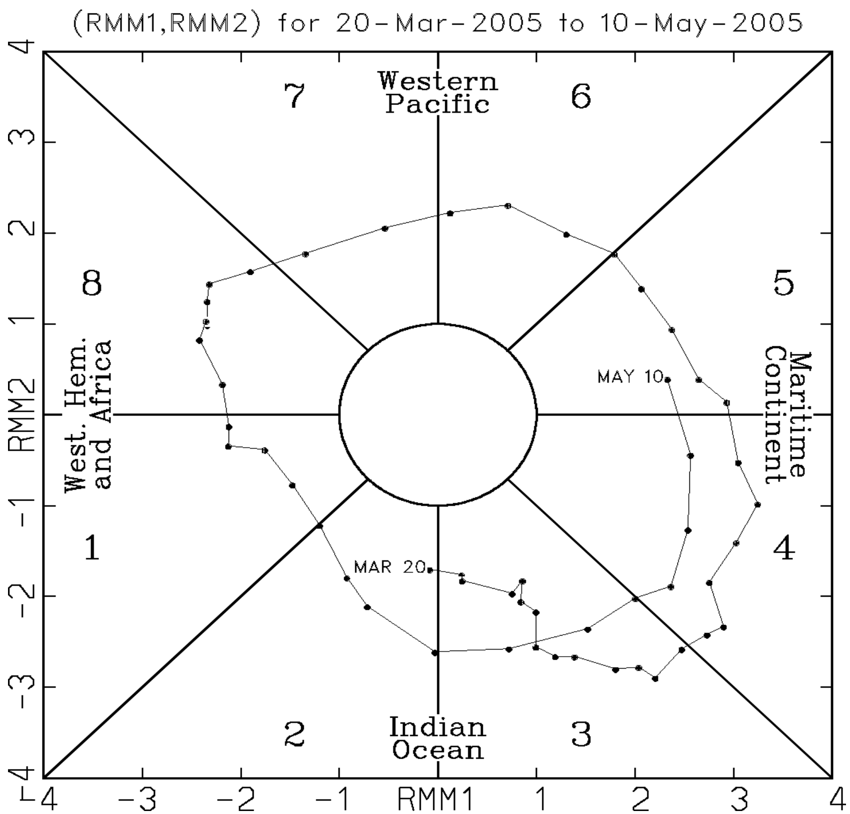
- The sub-seasonal to seasonal Project Team (S2S-PT) will be formed soon

Possible Links With WGNE

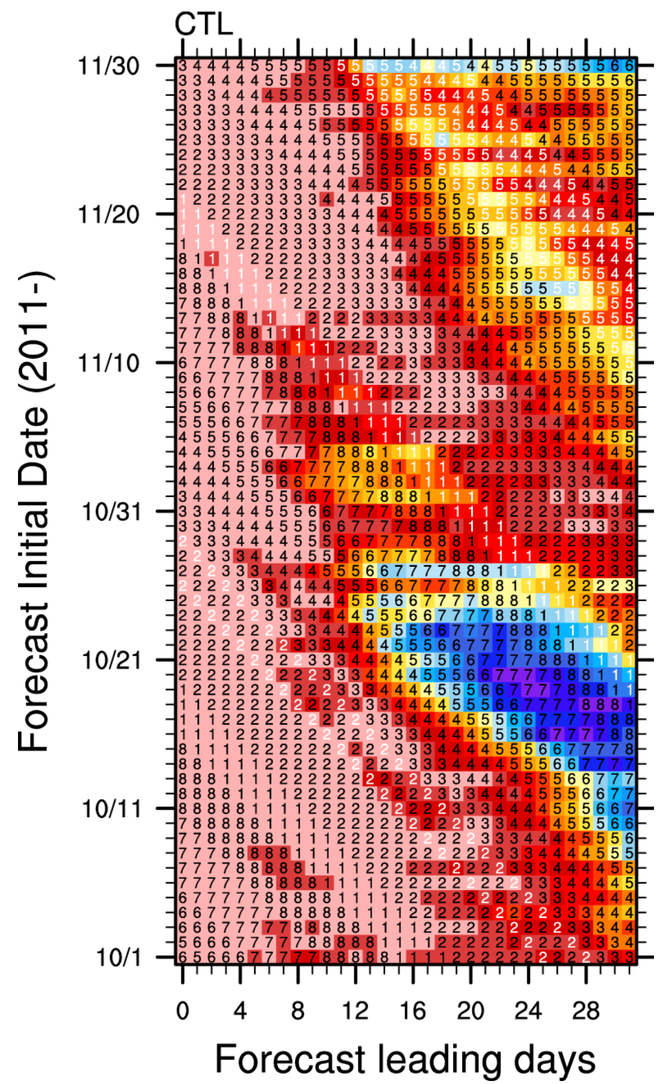
Possible topics

- Model errors (e.g. Monsoon, MJO Maritime Continent Barrier..)
- Ocean/sea-ice/qtmosphere coupling
- Simulqtion qnd prediction of extrem events
- Representation of tropic-extratropical teleconnections in GCMs
- Stratosphere-troposphere coupling (SSW-QBO..)
- Aerosols (e.g. Saharan dust, volcanoes, etc..)

Example of Model Errors: Maritime Continent Barrier

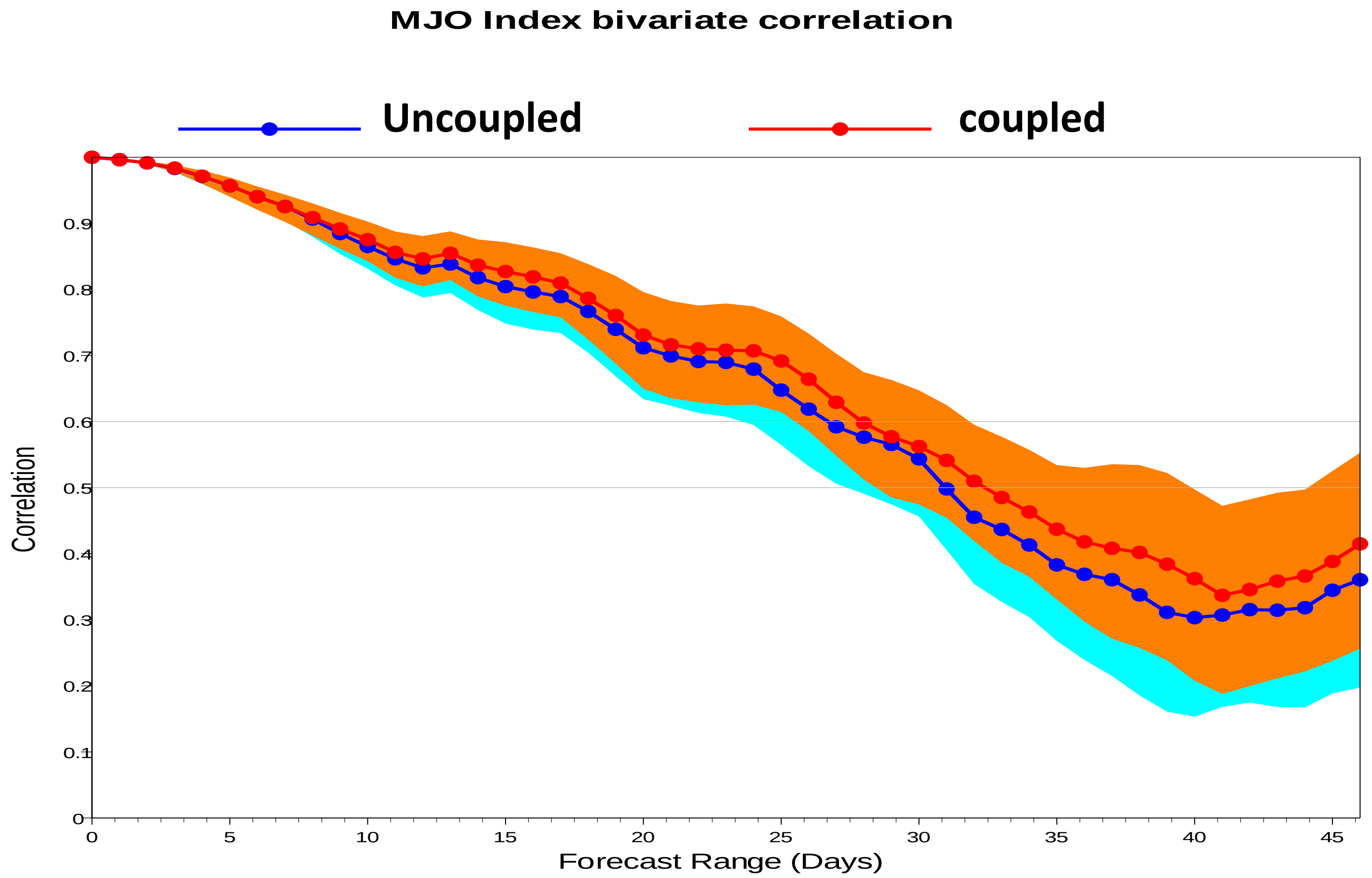


Wheeler and Hendon (2004)



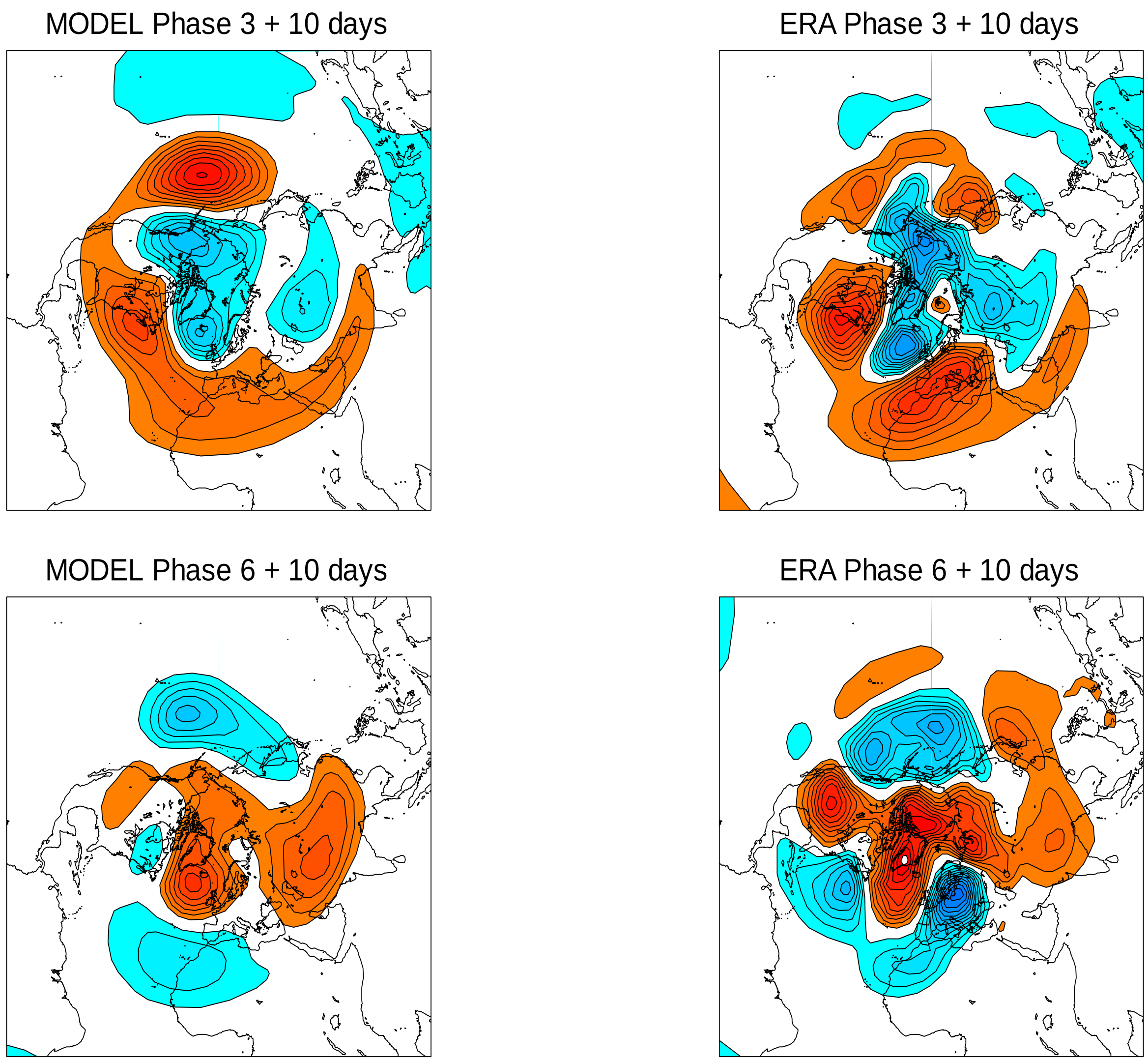
Courtesy Jian Ling

Coupling from Day0



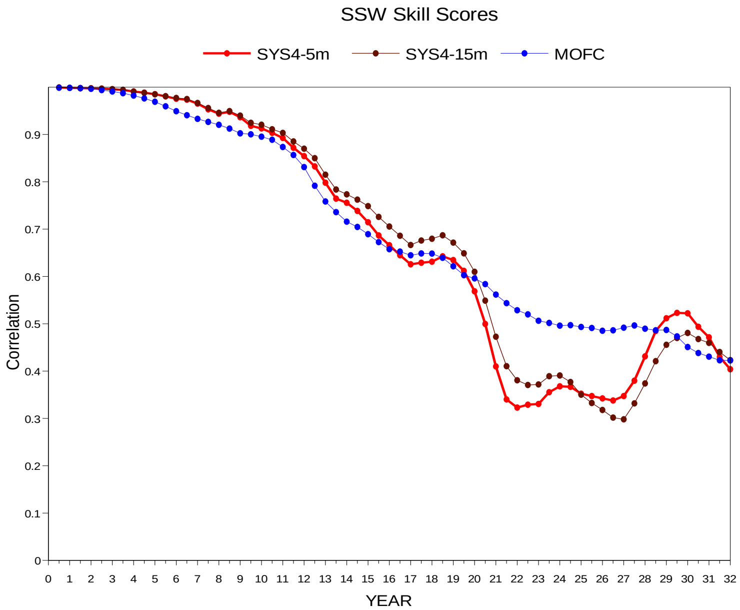
MJO Teleconnections

Impact on Z500 – NDJFM 1989-2008

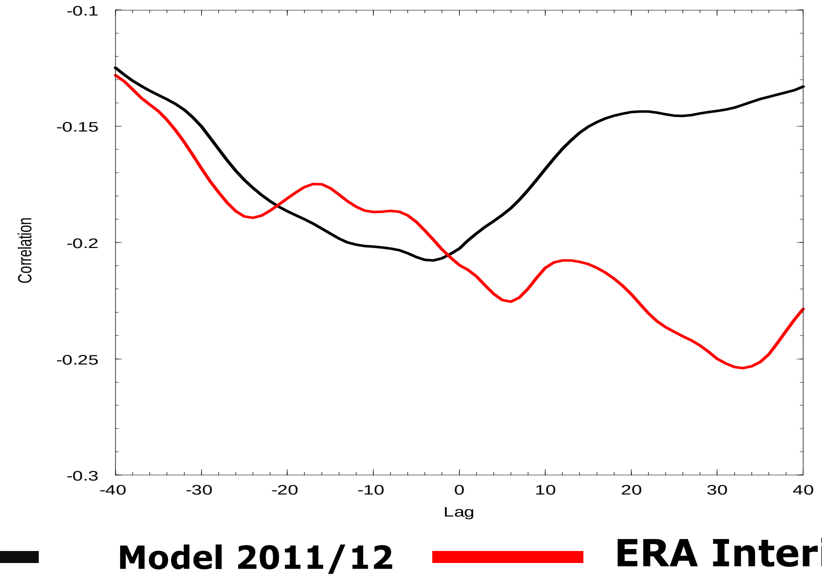


Interval = 5 metres

Stratospheric Sudden Warming



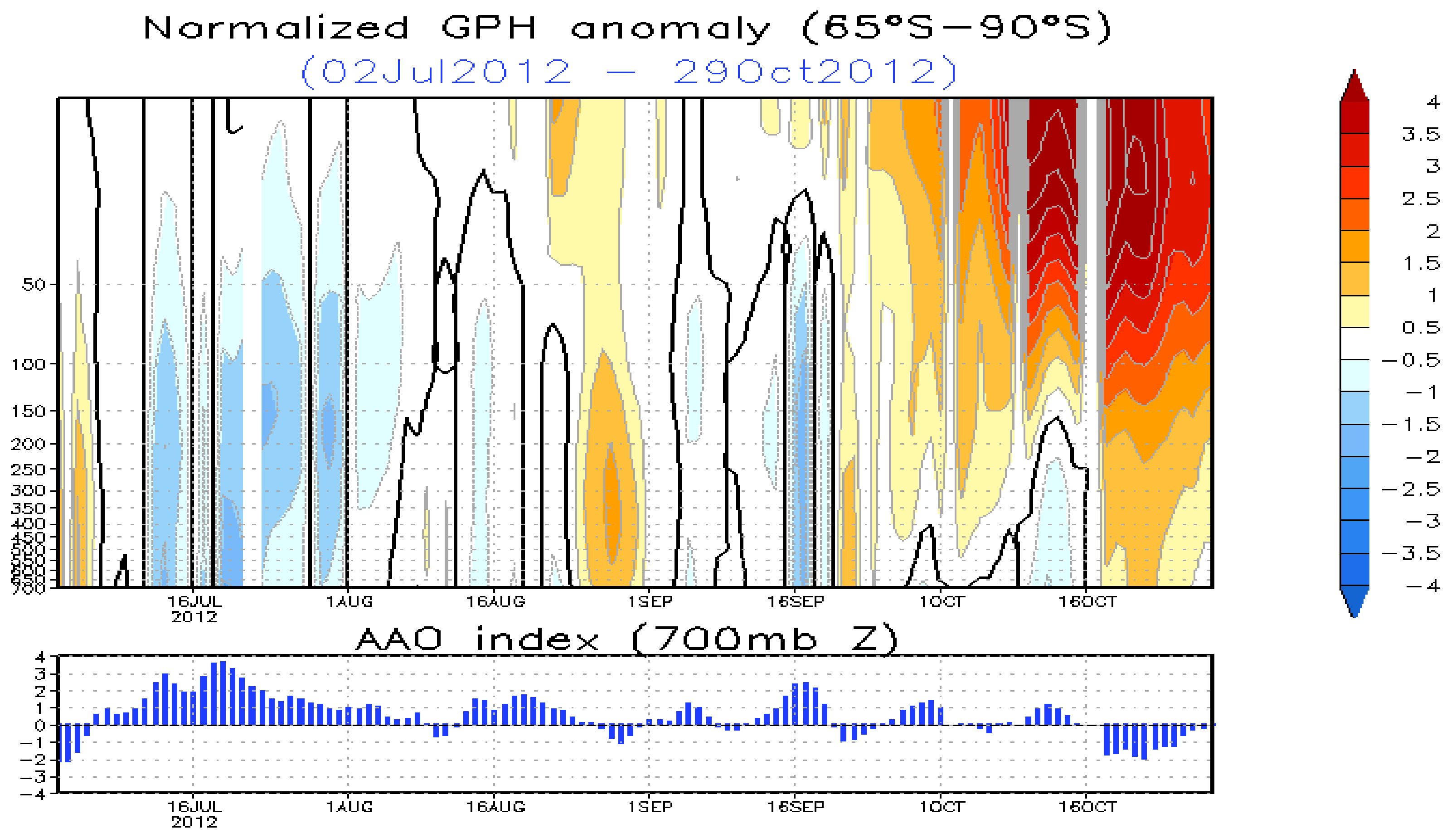
Lag Correlation – NAO-SSW



- **Skill of about 2-weeks**

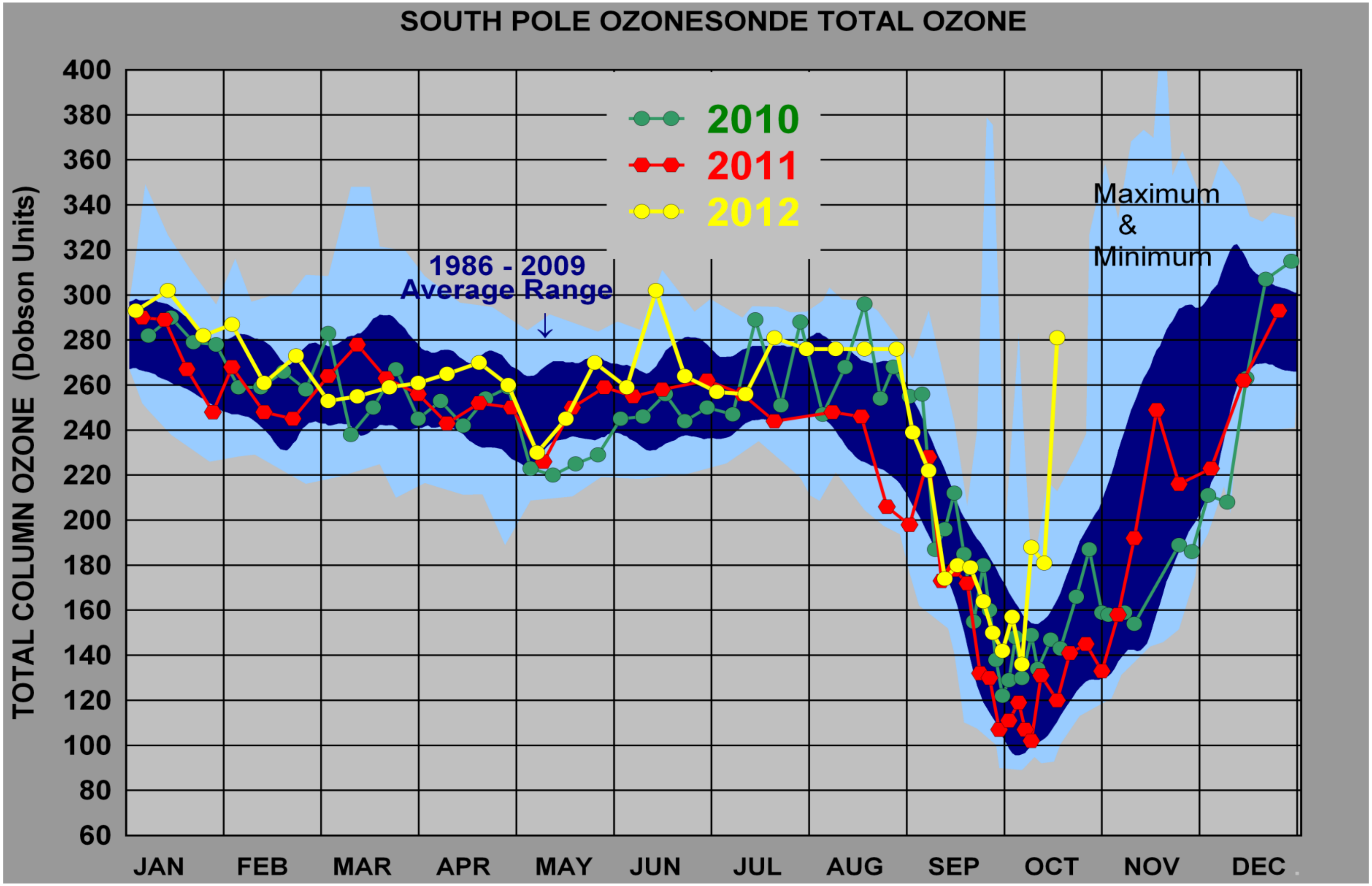
- **In this model, the impact of stratosphere on troposphere seems weaker than in Era Interim.**

Stratospheric Warming



From Harry Hendon

Stratospheric Warming



Source: NOAA