Sub-seasonal to seasonal Prediction Project

WORLD WEATHER RESEARCH PROGRAMME

THORPEX
An element of the WWRP

WCRP
World Climate Research Programme

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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.

- 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 this 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

Main Goals

The first task of the group will be to prepare an implementation plan which should give high priority to:

- The establishment of collaboration and co-ordination between operational centres undertaking sub-seasonal prediction to ensure when possible consistency between operational approaches to enable the production of data bases of operational sub-seasonal predictions to support the application of standard verification procedures and a wide-ranging program of research.

- Facilitating the wide-spread research use of the data collected for the CHFP (and its associate projects), TIGGE and YOTC for research.

- Sponsorship of a few international research activities

- The establishment of a series of regular workshops on sub-seasonal prediction

Subseasonal to Seasonal Prediction Planning group

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Use of sub-seasonal forecasts in applications

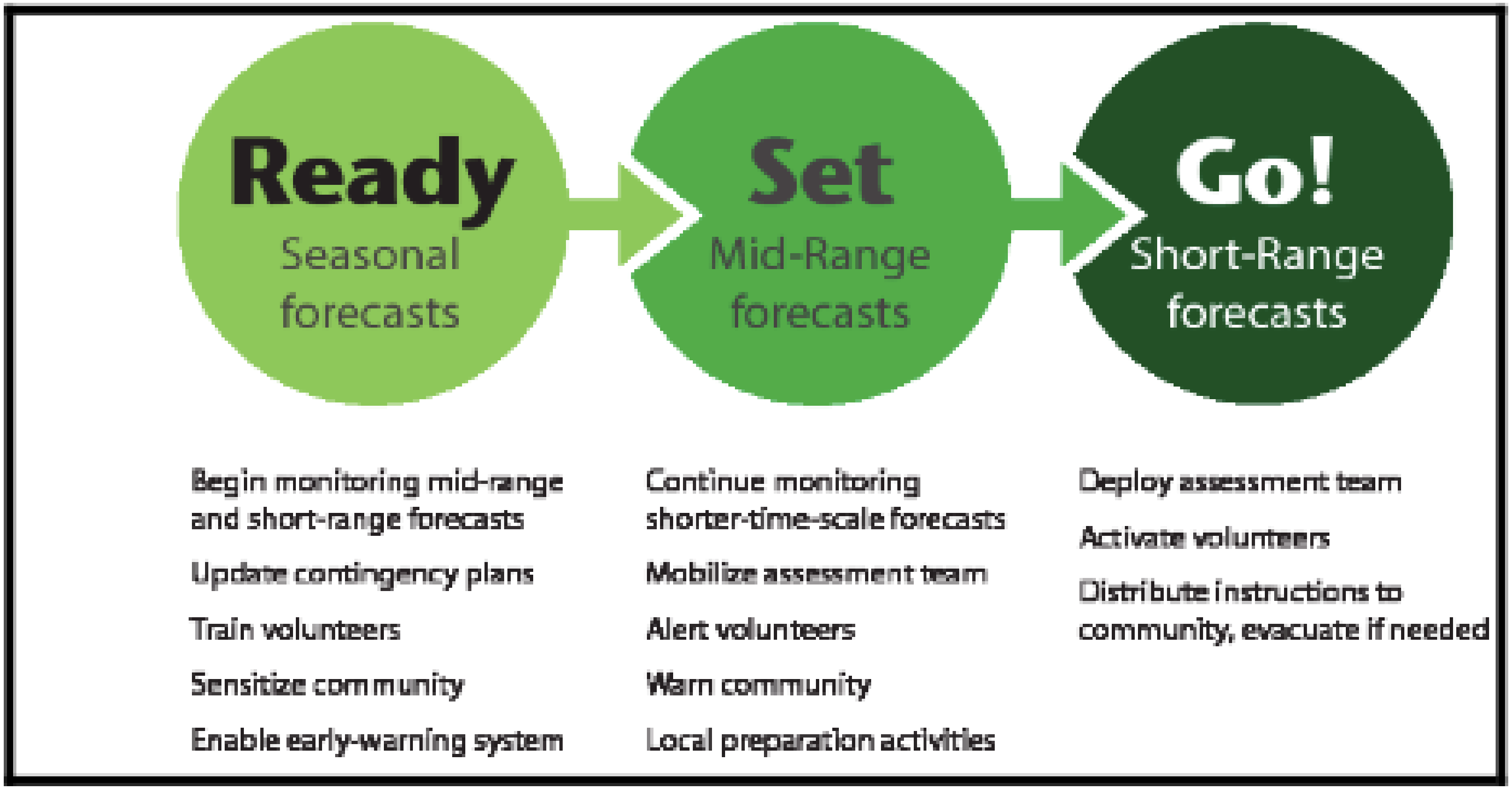
Growing, and urgent, requirement for the employment of sub-seasonal predictions for a wide range of societal and economic applications which include:

- 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

Use of sub-seasonal forecasts in applications

- Weather and climate span a continuum of time scales, and forecast information with different lead times are relevant to different sorts of decisions and early-warning
- In agriculture, for example, a seasonal forecast might inform a crop-planting choice, while sub-monthly forecasts could help irrigation scheduling, pesticide/fertilizer application: both can make a cropping calendar *dynamic.*
- In situations where seasonal forecasts are already in use, sub-seasonal ones could be used as updates, such as for end-of-season crop yields.
- Sub-seasonal forecasts may play an especially important role where initial conditions and intraseasonal oscillation is strong, while seasonal predictability is weak, such as the Indian summer monsoon.

Opportunity to use information on *multiple* time scales



Red Cross - IRI example

Monsoon Onset and Rice Planting in Java, Indonesia

Application aspects of SSI prediction: User-relevant needs

- Availability of long hindcast histories are needed to develop and test regression-based “MOS” and tailoring models, and for skill estimation which is critical to applications.

- Daily data is needed, especially for a few key variables including precipitation and near-surface temperature and windspeed.

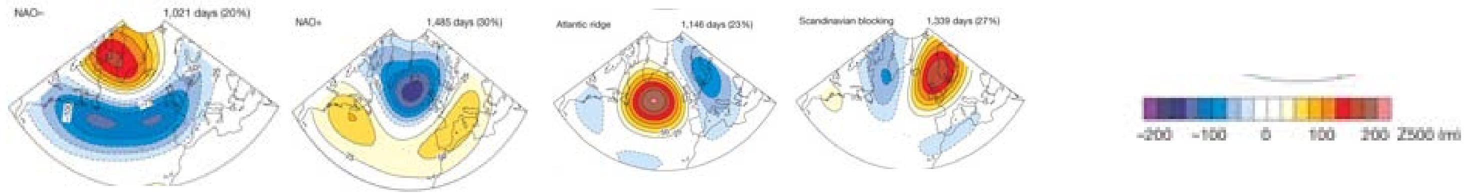
- Issues of open data access to enable uptake

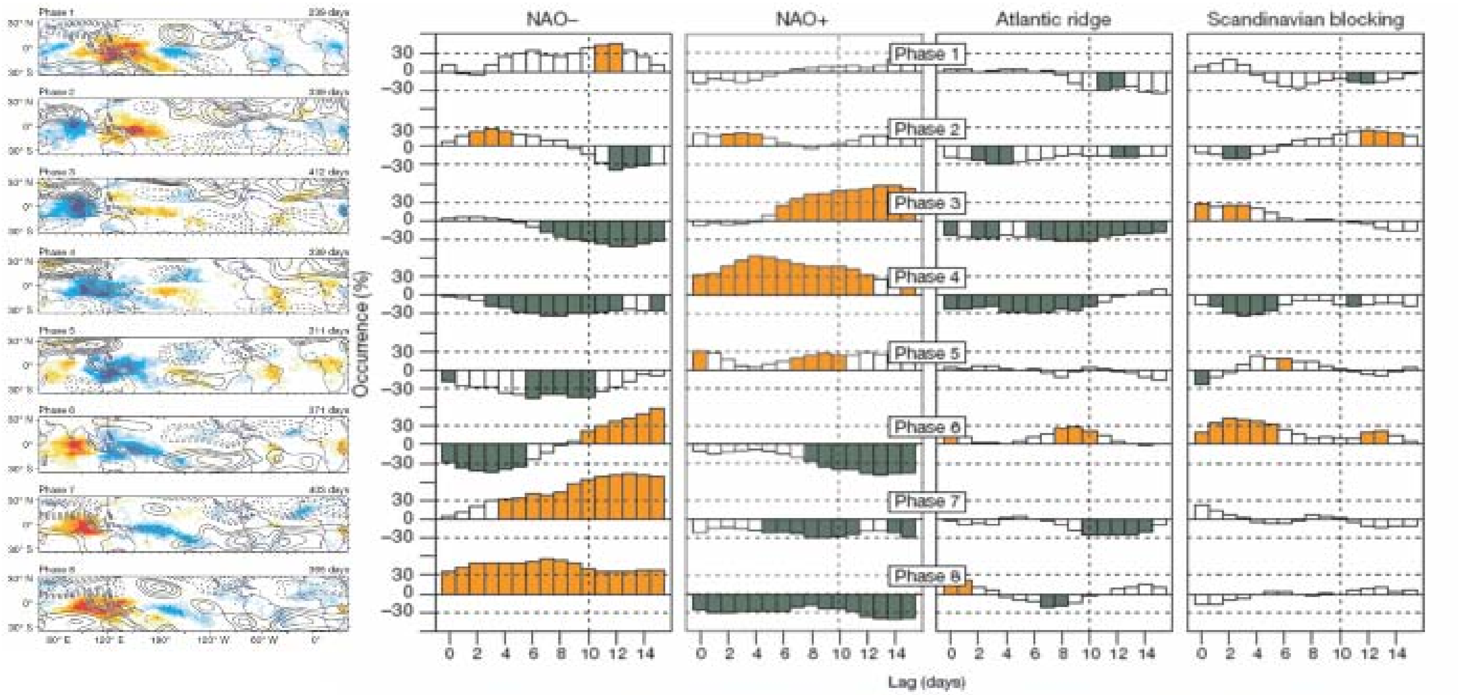
- A particularly difficult time range: Is it an atmospheric initial condition problem as medium-range forecasting or is it a boundary condition problem as seasonal forecasting?

- Some sources of predictability in the sub-seasonal time scale:

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

Impact of the MJO on weather regimes

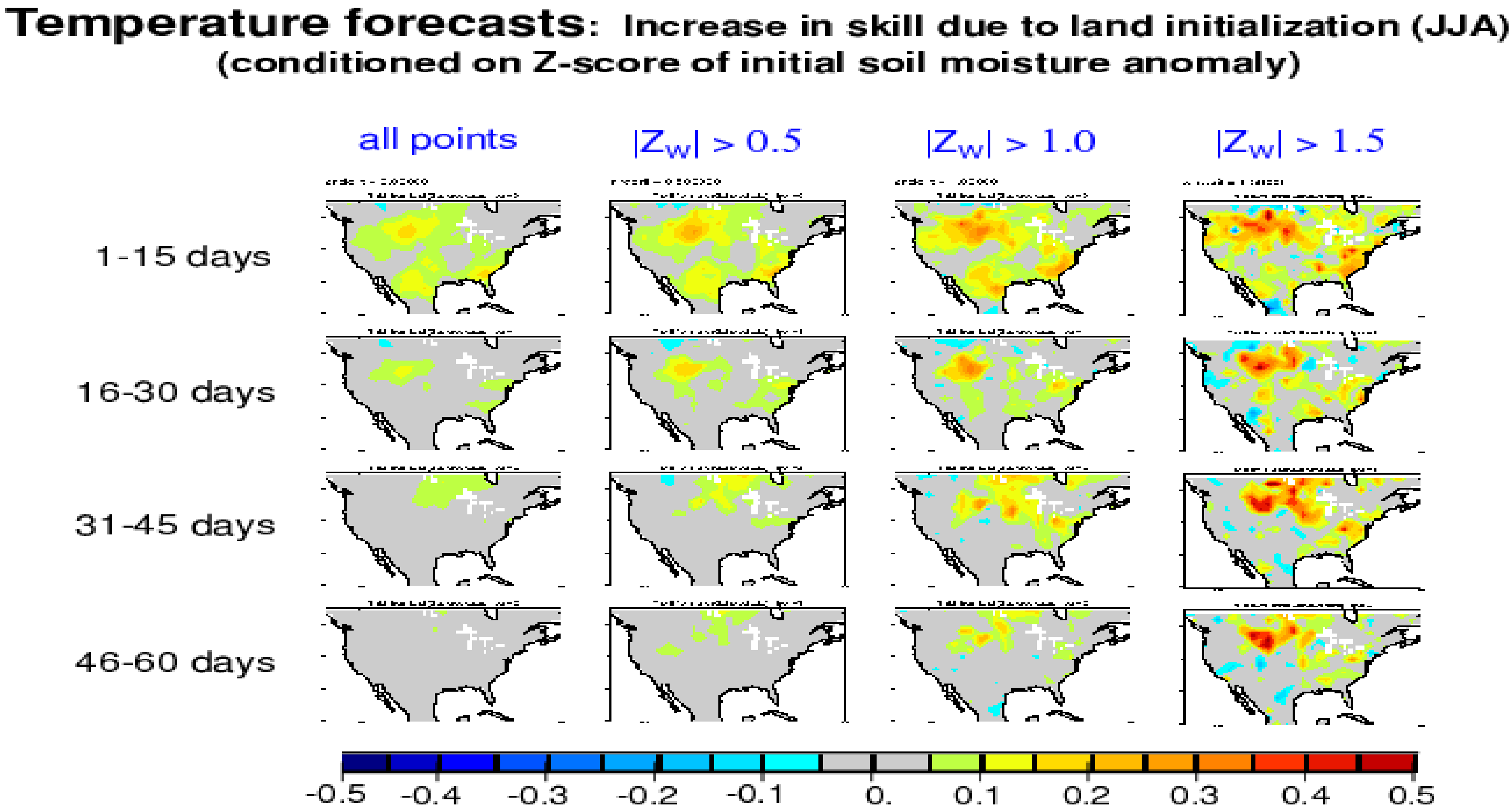




Cassou C,2008: Intraseasonal interaction between the Madden-Julian Oscillation and the North Atlantic Oscillation. *Nature*, **455**, 523-527.

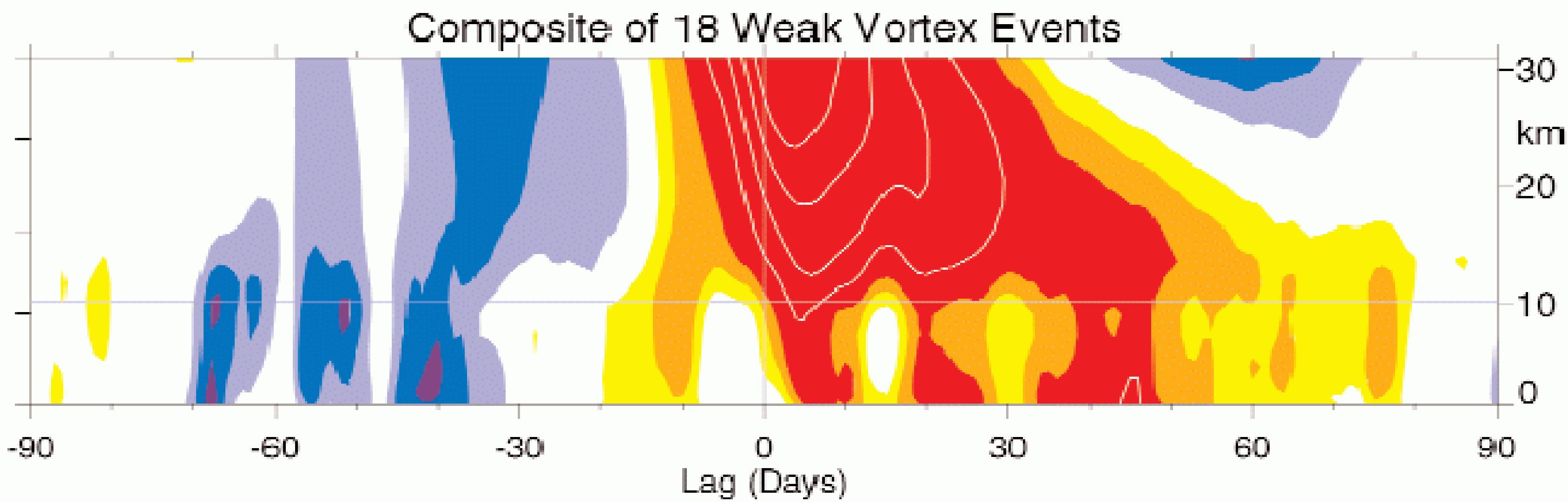
Cassou (2008)

Impact of soil moisture



Koster et al, GRL 2010

Stratospheric influence on the troposphere?



Weather from above. A weakening stratospheric vortex (red) can alter circulation down to the surface, bringing storms and cold weather farther south than usual.

Baldwin and Dunkerton, 2001

Implementation plan: Scientific issues

- Identify sources of predictability at the sub-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
- understanding systematic errors and biases in the subseasonal 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

One of the main recommendations from the Exeter meeting in 2010 was the establishment of a data bases of operational sub-seasonal predictions. Over the past years, a few multi-model databases have been set up:

- **TIGGE (WWRP/THORPEX)** : Medium-range forecasts (day 0-14) from 10 operational centres are collected 2 days behind real-time. Servers: NCAR/ECMWF/CMA.
- **CHFP (WCRP) data archive**: Operational and non-operational seasonal forecast hindcasts from 18 centres.
- **ET-ELRF (CBS)**: Real-time seasonal forecasts archived at KMA/NCEP. Available only to WMO members and only the multi-model combination is available. Limited number of fields available.
- **Field experiments:** real time data for a short period of time
- **Multi-model operational seasonal forecasts:** EUROSIP, APEC Climate Center (Busan)
- **Hindcast experiments:** ENSEMBLES, ISO experiment (APCC) ….

Sub-seasonal forecast database

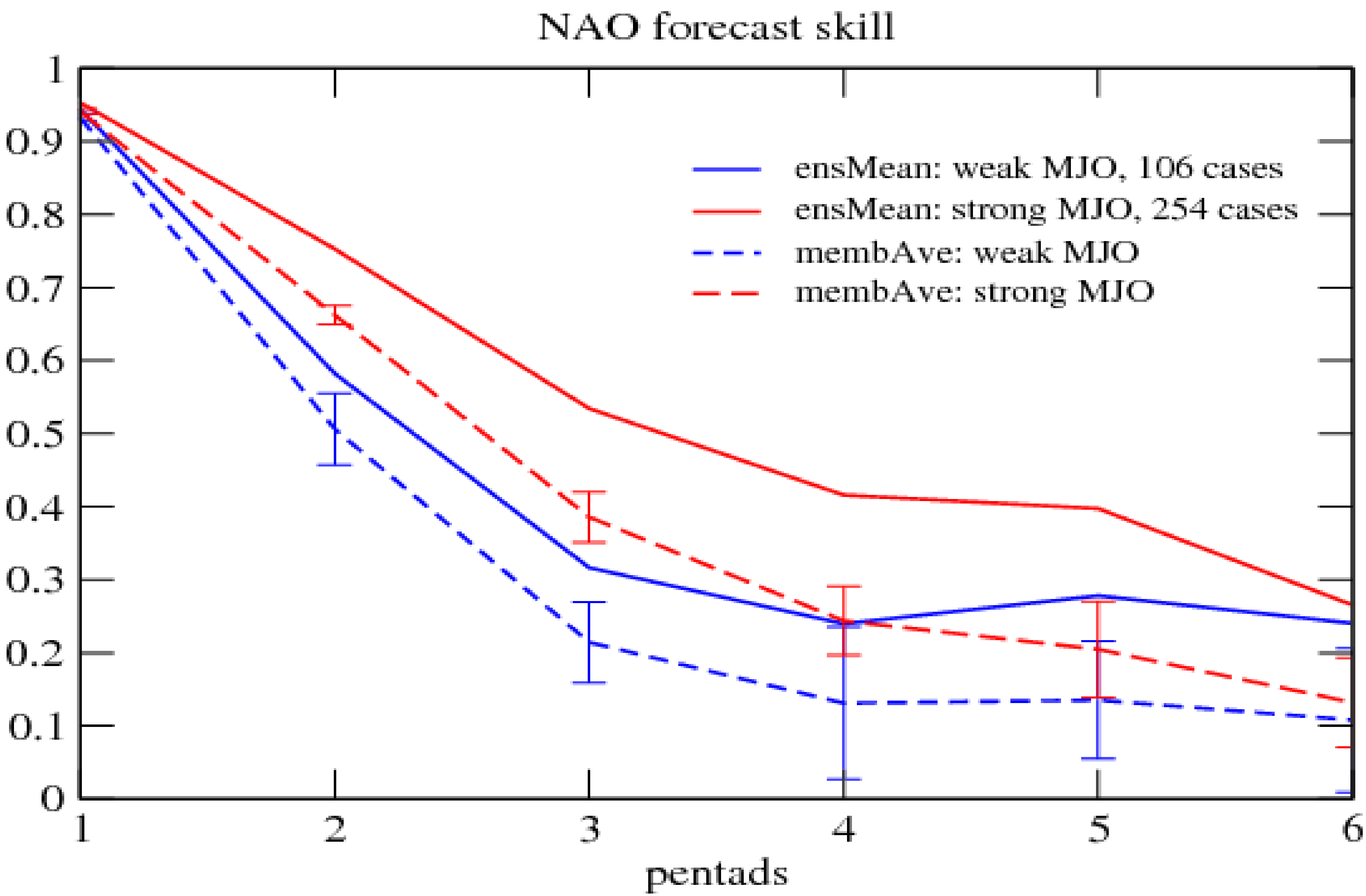
- 10 years ago, only a couple of operational centres were producing sub-seasonal forecasts. Over the past years, a few GPCs have set sub-seasonal forecasting systems.

- 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

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	-	-	-
Met.Fr	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 + hindcasts. 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.

Data volume

Hypothesis:

- 1.5x1.5 degree or less
- 73 variables
- All centres are archiving all the fields.

Total cost (real-time + hindcasts from the 12 GPCs) is estimated to:

- 15TB for the first year
- About 7 TB per year in the following years.

This would represent less than 10% of the TIGGE archiving cost (about 180 TB/year at ECMWF). The fixed imposed resolution should keep the cost about constant from year to year.

The choice of TIGGE protocols and the limited data volume should make it easier centres like ECMWF to access to host this dataset.

Demonstration projects

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

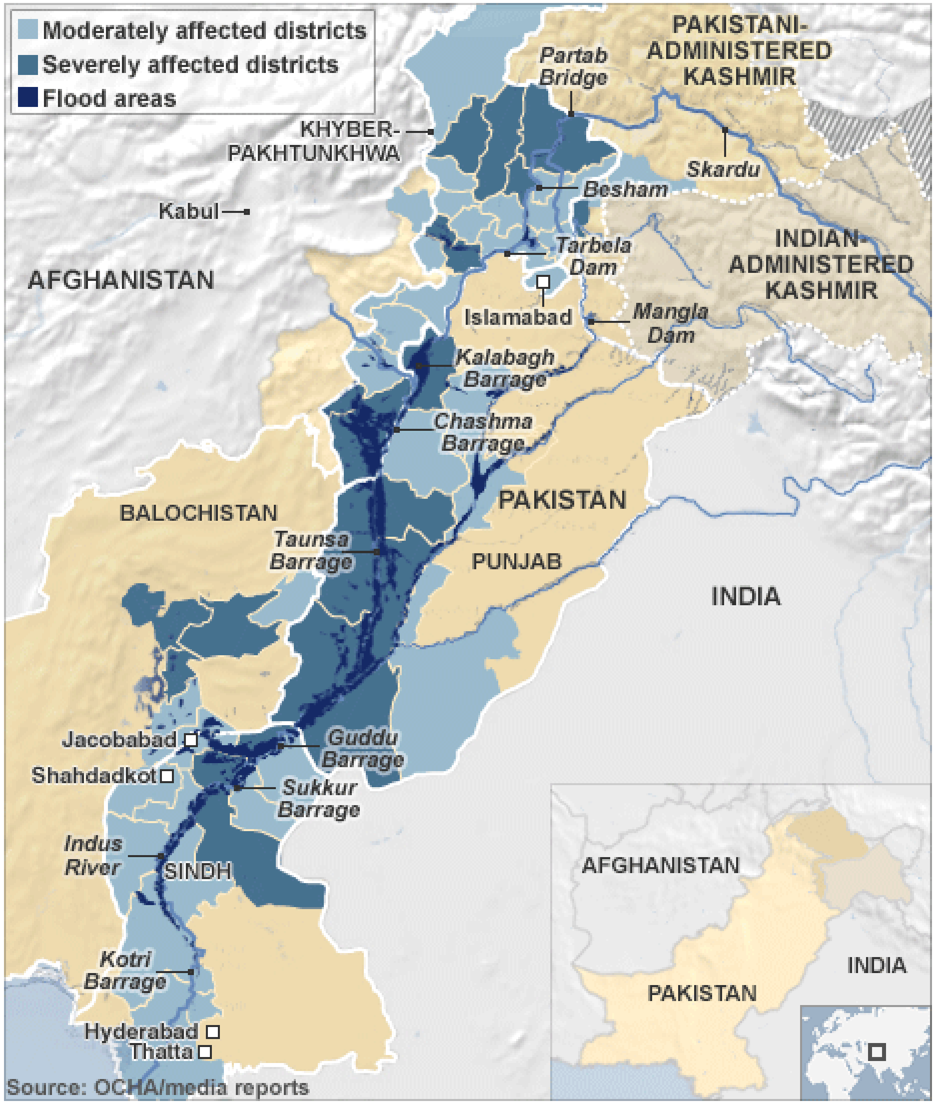
Cases studies could include:

- 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)



Linkages

- Global Framework for Climate Services
- CLIVAR and GEWEX including regional panels and WGNE
- Year of Tropical Convection
- 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.