Subseasonal to Seasonal (S2S) Prediction Project

"Bridging the gap between weather and climate"

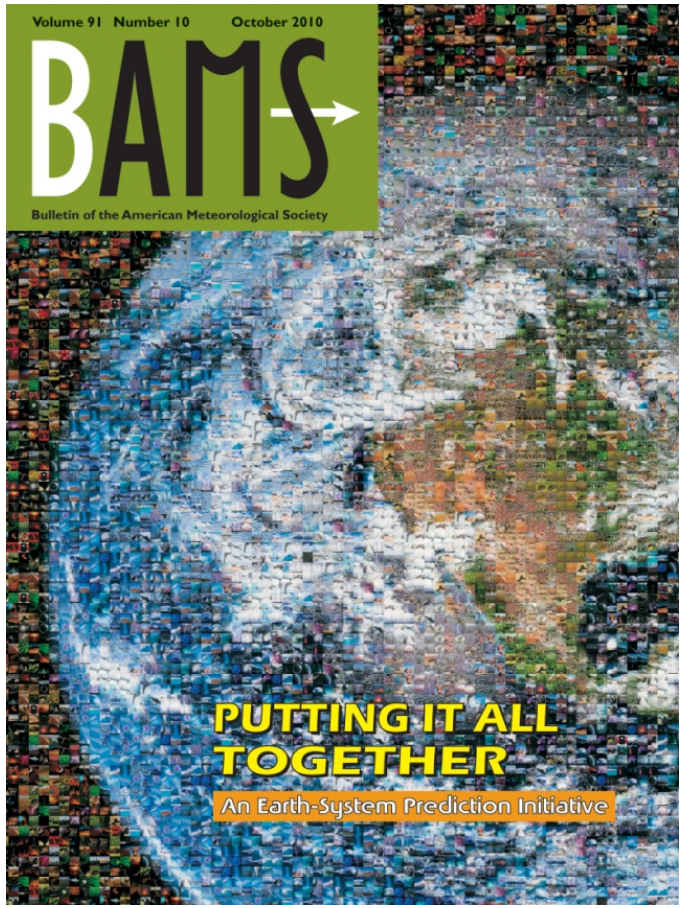
S2S Co-Chairs: Frédéric Vitart (ECMWF) and Andrew Robertson (IRI)
WWRP JSC Chair: Gilbert Brunet (Met Office and EC)
WGSIP Co-Chairs: Adam Scaife and Francisco Doblas-Reyes

WCRP JSC Committee 34th Session, Brasilia, Brazil, 27-31 May 2013

Putting it All Together

World Meteorological Organization (WMO), World Weather Research Programme (WWRP), World Climate Research Programme (WCRP), International Geosphere-Biosphere Programme (IGBP), Global Climate Observing System (GCOS), and natural-hazards and socioeconomic communities.

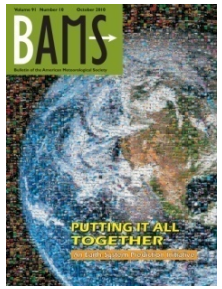
- An Earth-System Prediction Initiative for the Twenty-First Century (Shapiro et al., BAMS 2010)
- Addressing the Complexity of the Earth System (Nobre et al., BAMS 2010)
- Collaboration of the Weather and Climate Communities to Advance Subseasonal-to-Seasonal Prediction (Brunet et al., BAMS 2010)
- Toward a New Generation of World Climate Research and Computing Facilities (Shukla et al., BAMS 2010)



Proposed Joint Research Objectives between WCRP and WWRP

- Seamless weather/climate prediction with Multi-model Ensemble Prediction Systems (MEPSs)
- The multi-scale organisation of tropical convection and its two-way interaction with the global circulation
- Data assimilation for coupled models as a prediction and validation tool for weather and climate research
- Utilization of sub-seasonal predictions for social and economic benefits

Collaboration of the Weather and Climate Communities to Advance Subseasonal-to-Seasonal Prediction (Brunet et al., BAMS 2010)

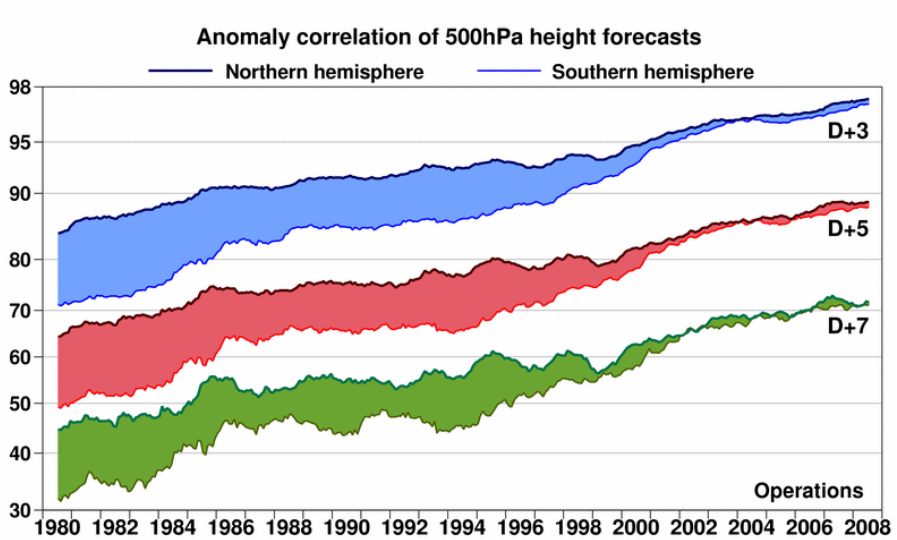


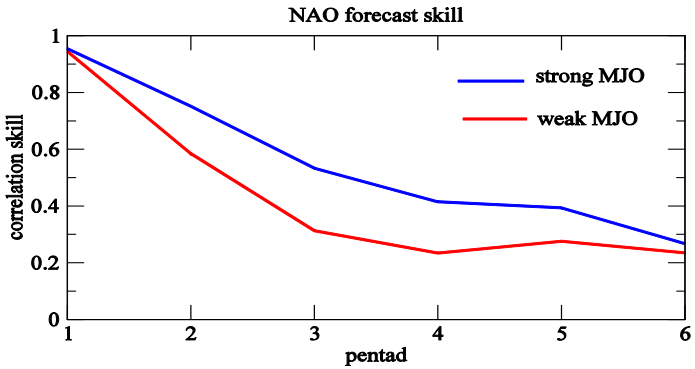
Predicting the sub-seasonal variability

• The sub-seasonal variability (AO, PNA, Atlantic blockings, …) controls significantly the distribution of high-impact weather (like the Atlantic storm track) in the Northern Hemisphere.

Baroclinic variability (80%)

Sub-seasonal variability
(dim. ~ 12, 20%)





Medium-range forecasting the 500hPa height with the ECMWF deterministic prediction system

Extended-range forecasting of the NAO with the Canadian GEM Monthly ensemble prediction System

Background

- 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 subseasonal prediction.
- A WCRP/WWRP/THORPEX workshop was held at Exeter in Dec 2010 which recommended formation of a Planning Group to write an implementation plan for an S2S project under WCRP-WWRP-THORPEX sponsorship
- The implementation plan was written in 2012, was endorsed by the WWRP and WCRP JSCs, and creation of the **Subseasonal to seasonal prediction project** was approved by the WMO Executive Council, which also approved the creation of a trust fund for sub-seasonal to seasonal prediction.
- Term of references 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.

Sub-seasonal to seasonal Prediction Project

WWRP WORLD WEATHER RESEARCH PROGRAMME

WCRP World Climate Research Programme

THORPEX An element of the WWRP

Subseasonal to Seasonal Prediction Planning group

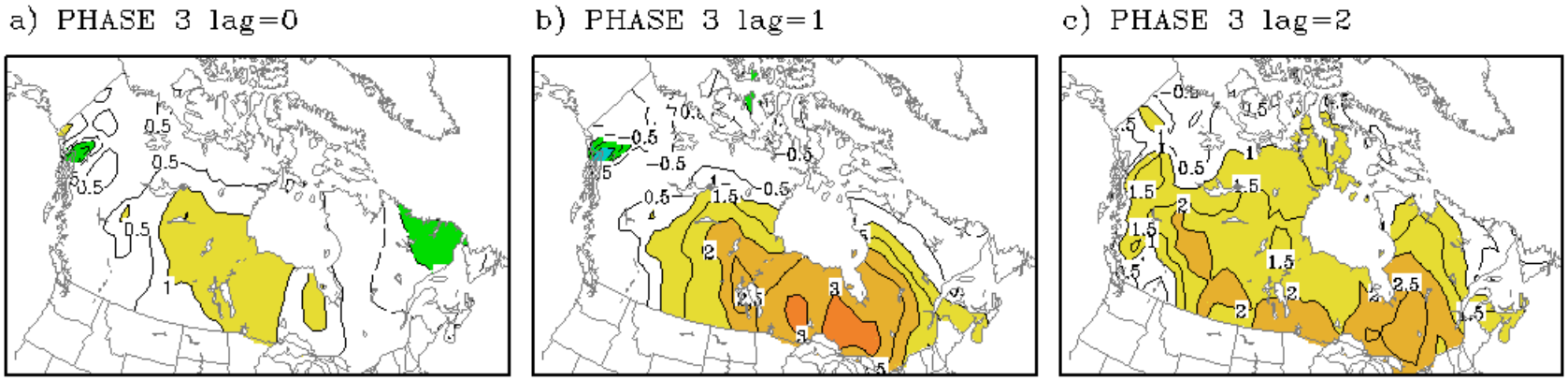
Sub-seasonal to seasonal prediction	David Anderson (consultant)	
Planning Group		
Co-Chair	Frédéric Vitart	ECMWF (WWRP)
Co-Chair	Andrew Robertson	IRI (WCRP)
	Arun Kumar	CPC/NCEP
	Harry Hendon	CAWCR CSIRO/BoM
	Yuhei Takaya	JMA
	Hai Lin	EC
	Alberto Arribas	UKMO
	June-Yi Lee	IPRC
	Duane Waliser	NASA
	Hyun-Kyung Kim	KMA
	Ben Kirtman	IGES/COLA
Liaison Group	Carolina Vera	WCRP JSC Liaison
	Richard Graham	UKMO CBS
	Jean-Pierre Ceron	Meteo-France CCL
	Barbara Brown	SERA/Verification
	Steve Woolnough	NCAS GASS

Objectives

- To improve forecast skill and understanding on the subseasonal to seasonal timescale with special emphasis on high-impact weather events
- To promote the initiative's uptake by operational centres and exploitation by the applications community
- To capitalize on the expertise of the weather and climate research communities to address issues of importance to the Global Framework for Climate Services

MJO connection to Canadian surface air temperature: high-impact weather?

Lagged winter SAT anomaly in Canada



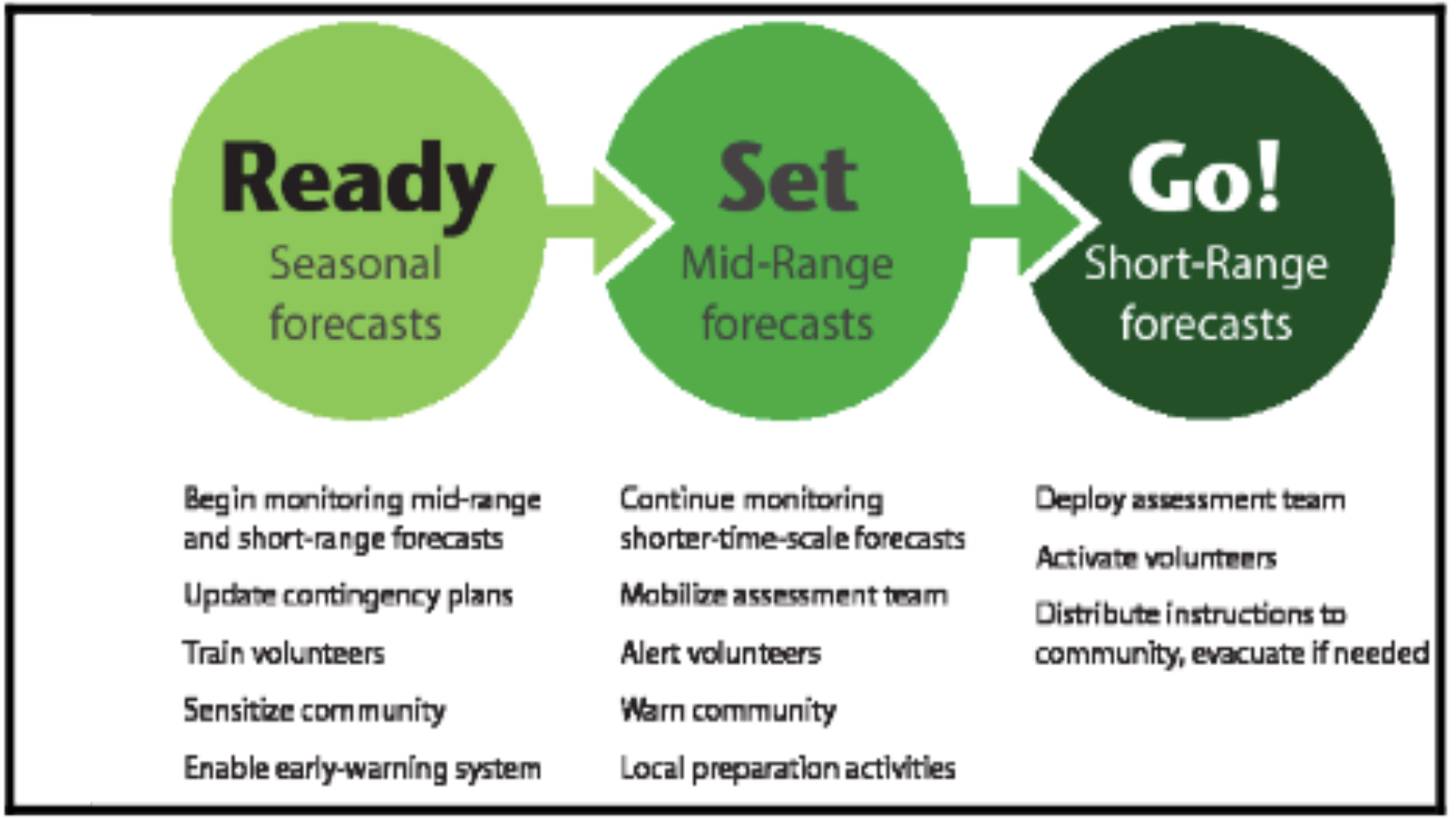
Significant warm anomaly in central and eastern Canada 1-2 pentads after MJO phase 3

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
- Agriculture particularly in developing countries — e.g. wheat and rice production
- River-flow — for flood prediction, hydroelectric power generation and reservoir management for example
- Disease planning/control — e.g. malaria, dengue and meningitis
- Humanitarian Planning and Response to disasters

Opportunity to use information on *multiple* time scales



Red Cross - IRI example

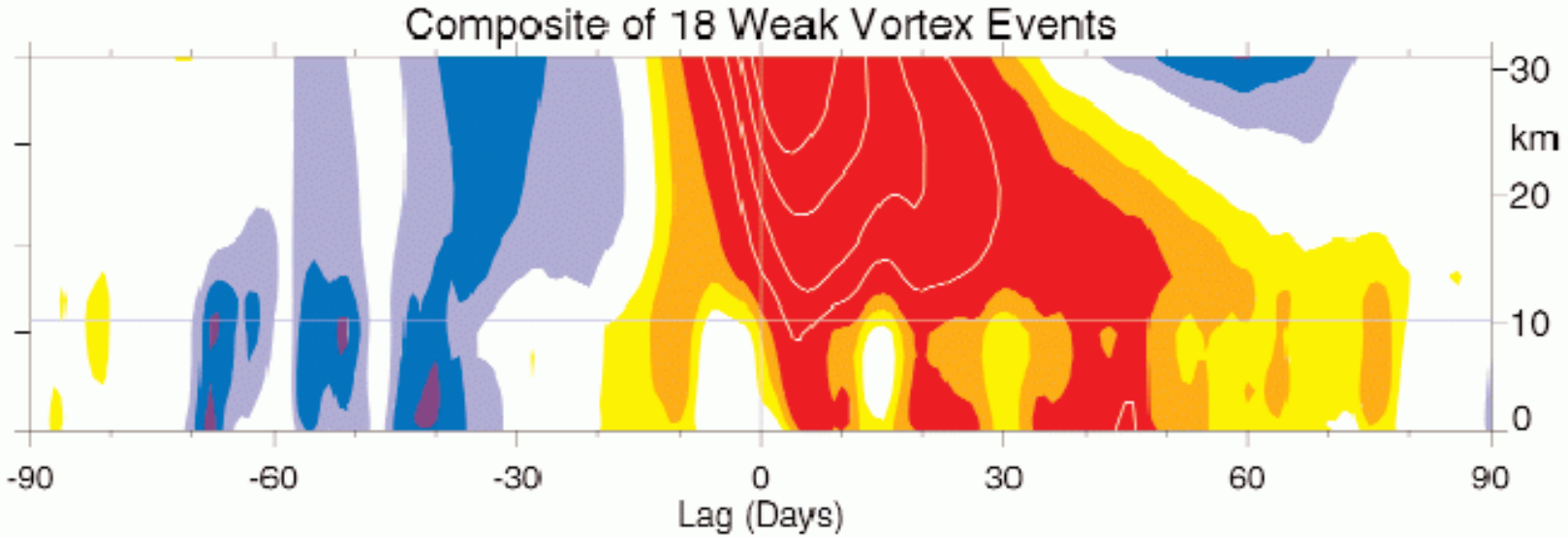
S2S research priorities

- Evaluate potential predictability of subseasonal events, including identifying windows of opportunity for increased forecast skill
- Understand systematic errors and biases in the subseasonal to seasonal forecast range
- Compare, verify and test multi-model combinations from these forecasts and quantify their uncertainty
- Focus on some specific extreme event case studies

Bridging the gap between Climate prediction and NWP

- 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?
- It is a higher dimension problem than seasonal prediction (2-3 to relatively to a dozen of degrees of freedom in the NH).
- More in Kirtman, B., D. Anderson, G. Brunet, I.-S. Kang, A. Scaife and D. Smith, 2013: *Prediction from weeks to decades*. G. R. Asrar and J. W. Hurrell, Eds. *Springer*, in press.
- 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

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

S2S Modelling issues

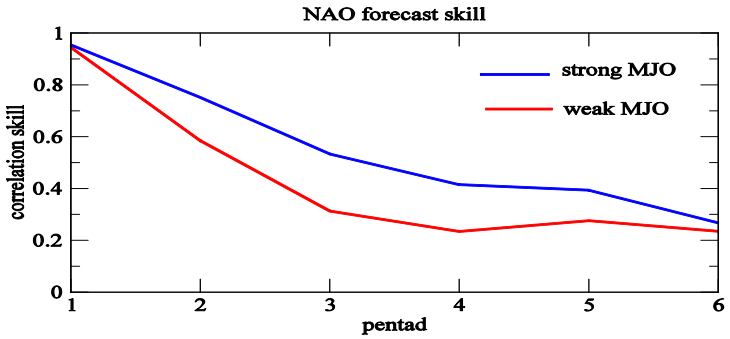
- Role of resolution
- Role of Ocean-atmosphere coupling
- Systematic errors
- Initialisation strategies for sub-seasonal prediction
- Ensemble generation
- Spread/skill relationship
- Design of forecast systems
- Verification

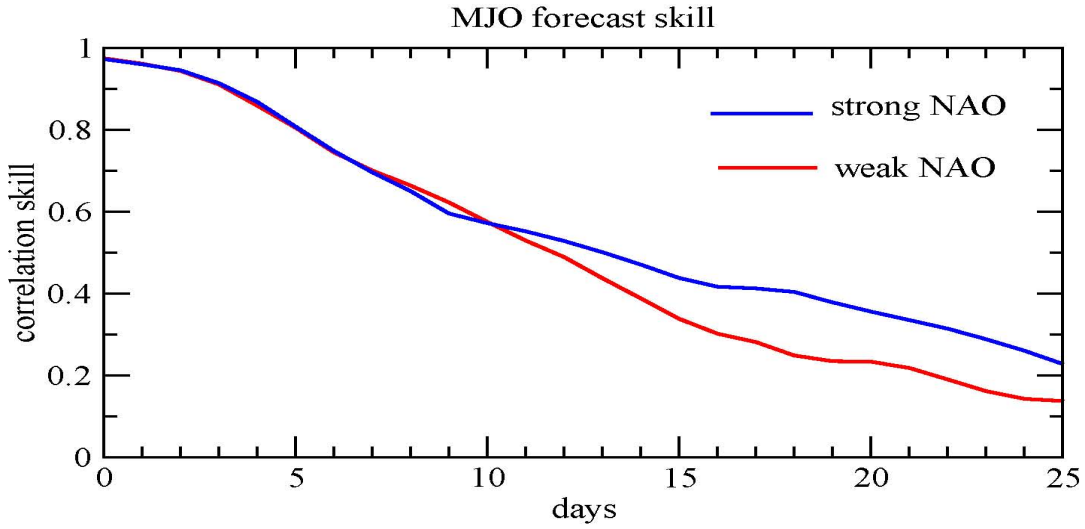
S2S Sub-seasonal forecast database

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

- 10 years ago, only a couple of operational centres were producing sub-seasonal forecasts. Over the past years, a few Global Prediction Centers (GPC) have set sub-seasonal forecasting systems.

Forecasting MJO and NAO with the Canadian GEM Forecasting System: mid-latitude and tropical interactions.





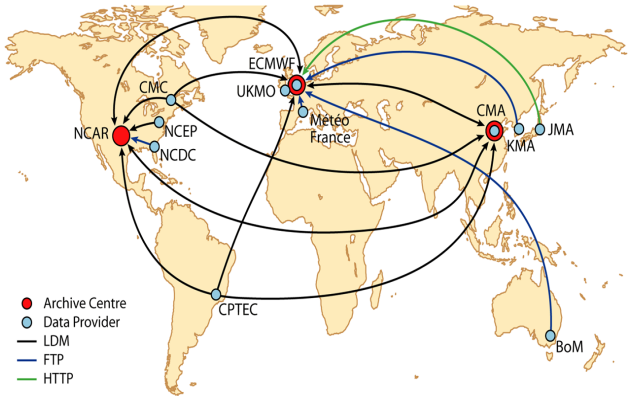
Lin et al., GRL,2010; Lin et al., GRL, 2011

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						
KMA	D 0-30	T106L21						
CMA	D 0-45	T63L16						
CPTEC	D 0-30	T126L28						
Met.Fr	D 0-60	T63L91						
SAWS	D 0-60	T42L19	6	monthly	Fix	1981-200	monthly	6

Creation of a S2S subseasonal forecast database

- Multi-model ensemble prediction systems (MEPS) already exist for medium-range weather and seasonal forecasting:
  - THORPEX Interactive Grand Global Ensemble (TIGGE) for forecasts up to 2 weeks;



  - WMO lead centre in KMA is responsible for real time long-range forecasts from monthly to seasonal timescales;
  - Climate-System Historical Forecast Project (CHFP) for seasonal hindcasts.

Creation of a S2S subseasonal forecast database

- S2S will create a MEPS database of current operational subseasonal forecasts – now produced at most Global Producing Centres – up to 60 days
- It will not be to issue forecasts – rather it will be lagged by about 1 month relative to real time and will provide a powerful community resource to investigate predictability mechanisms, assess skill and usefulness for applications.

S2S Subprojects

- Monsoons
  – e.g., predicting the timing of monsoon onsets and breaks, especially South Asia

- MJO
  – teleconnections, including those to middle latitudes, tropical cyclone modulation; passage over the Maritime Continent and its interaction with the diurnal cycle of rainfall over islands (w/MJO-TF/GEWEX GASS)

- Africa
  – link to WMO CBS & WWRP SERA; weather-within-climate; capacity building

- Verification
  – propose a set of methods to be applied for verification, and verification topics to be researched, which will include methods for probabilistic predictions.

- Extreme Weather
  – case studies
  – predictability of extreme weather – links with WWRP HIW project.

Extreme Weather: S2S Demonstration projects

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

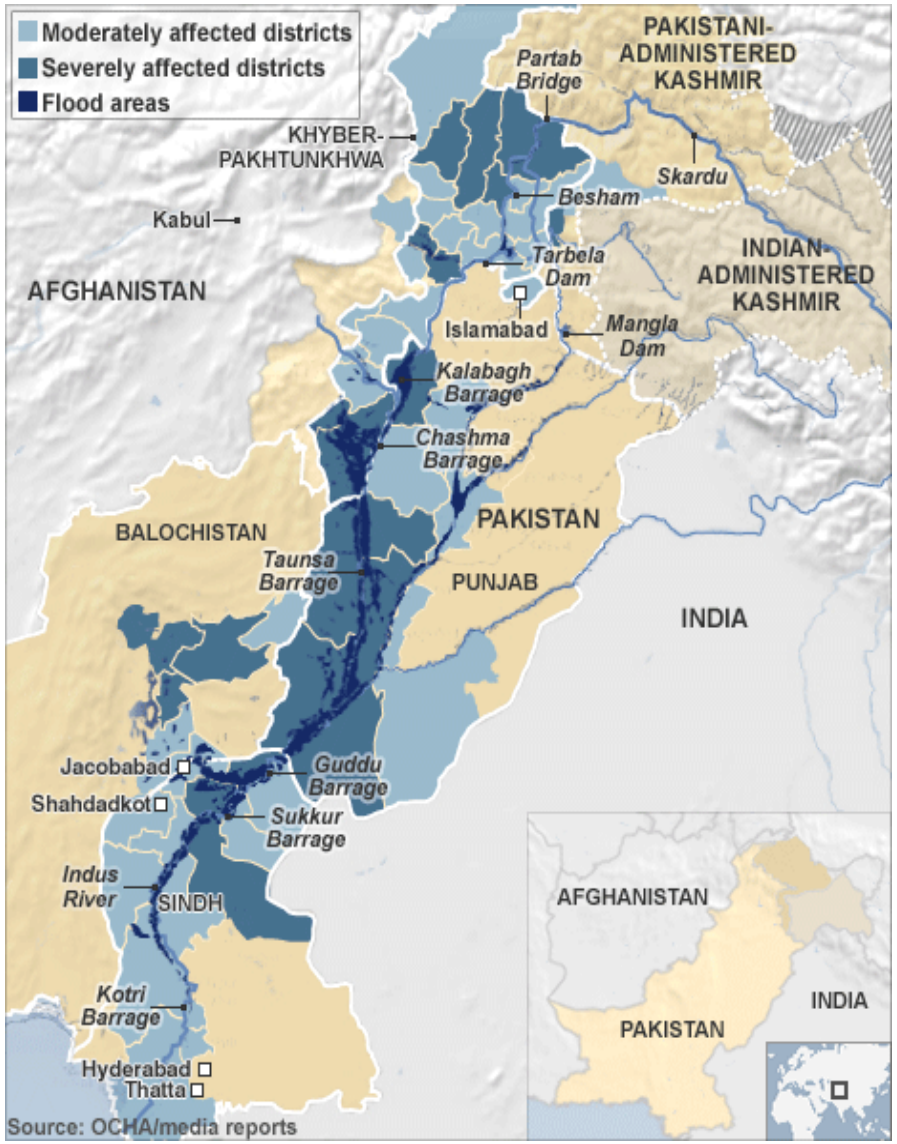
Cases studies could include:

- Pakistan floods (2010) concurrent with the Russian heat wave
- Australian floods (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.

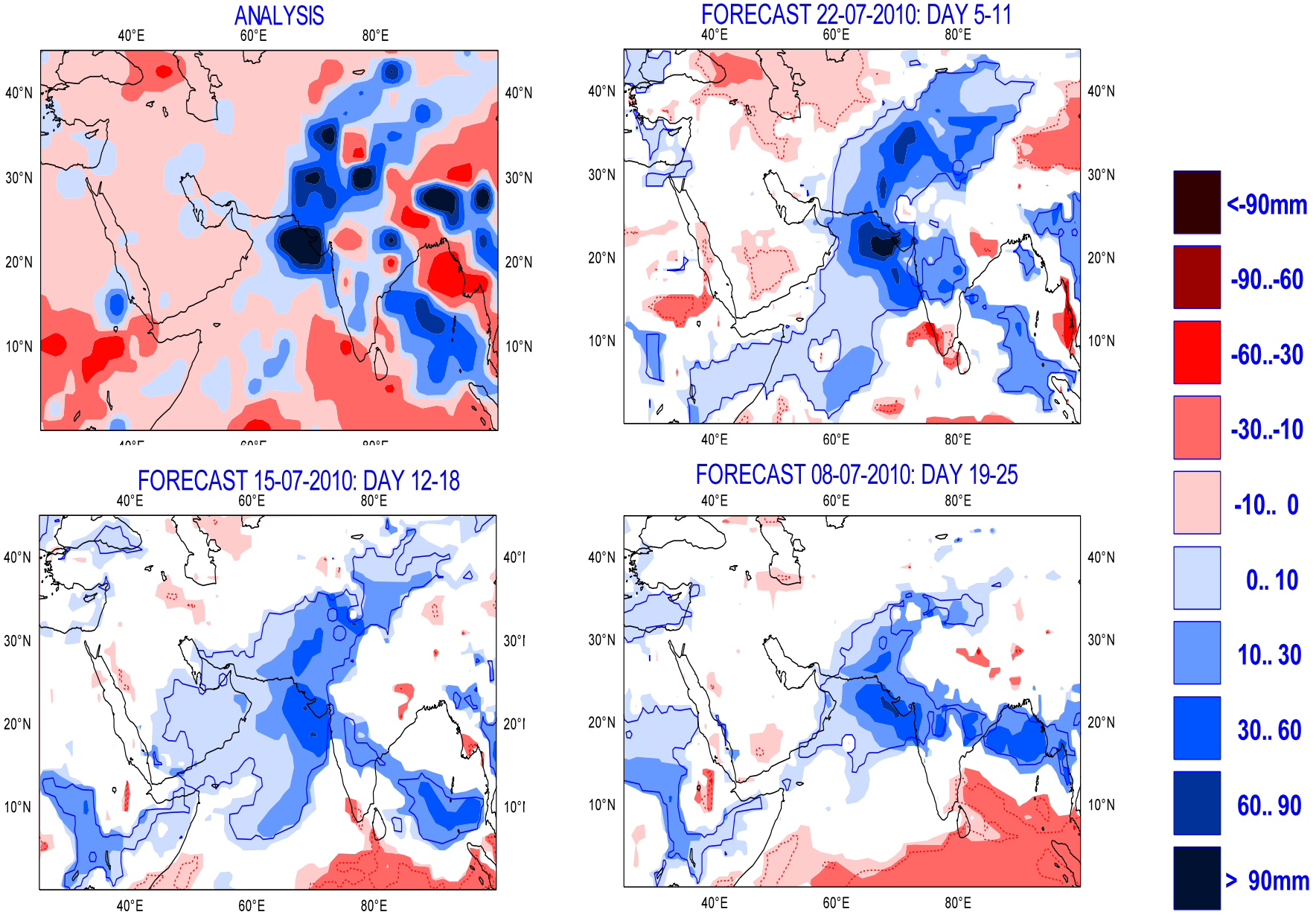
The models could be archived near real-time during a limited period of time with additional fields being archived. The period chosen could coincide with test bed studies from other projects (e.g. polar project).

Example : Pakistan Floods (2010)



Sub-seasonal Prediction of Pakistan Floods (2010)

Precip anomalies : 26 July– 01 August 2010



S2S 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)
- WWRP Polar Prediction Project
- World Bank

S2S Next steps

- Invitation to contribute data to the S2S archives being sent to GPCs, WMO members
- S2S Archive Centre being established at ECMWF and mirrored elsewhere
- Establishment of International Coordination Office at KMA and transition of planning group into S2S Steering Group
- First Science Workshop in Feb 2014 at NCEP "Sources of subseasonal predictability, windows of opportunity for applications"