World Weather Research Programme (WWRP) Report

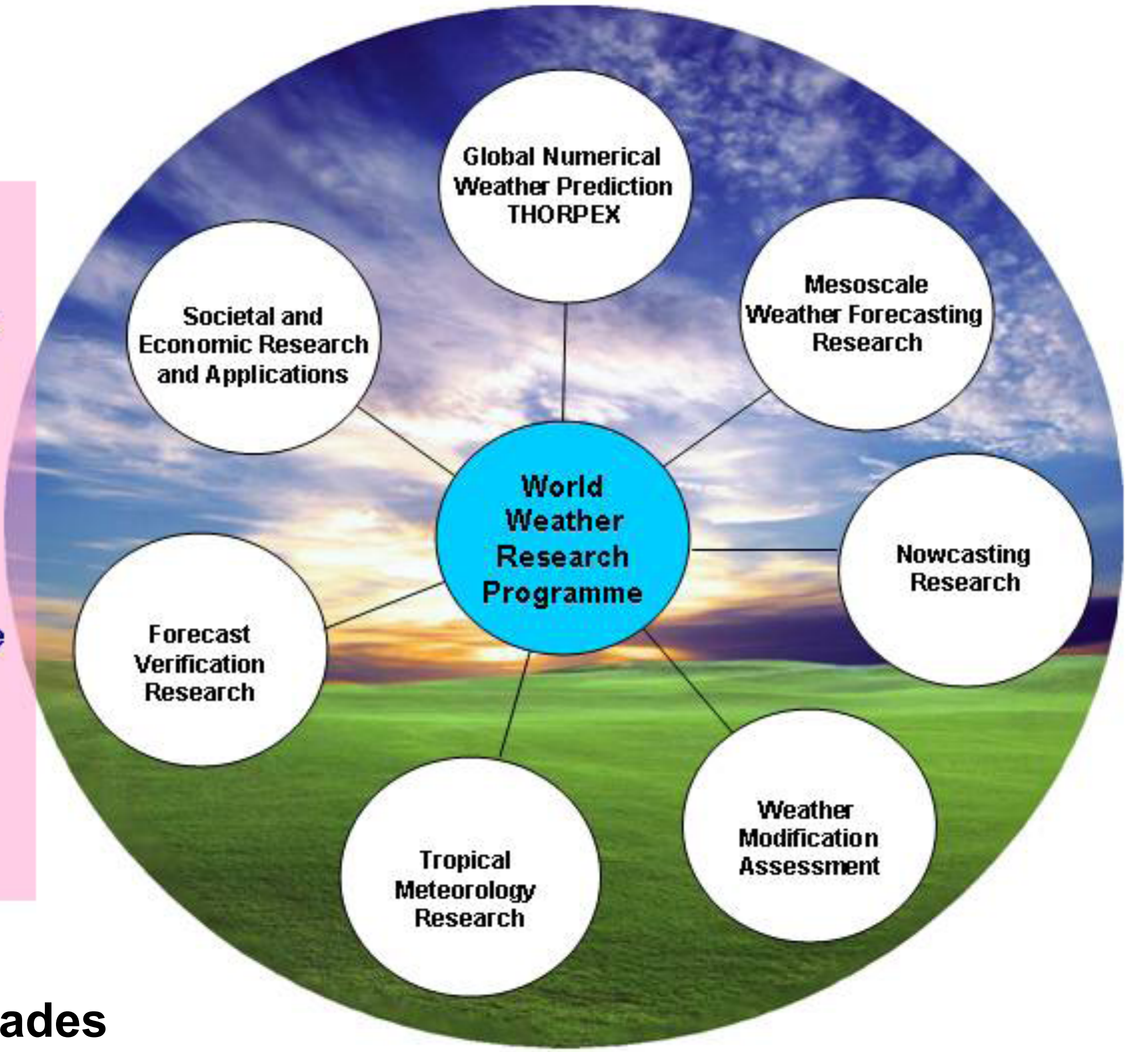
Gilbert Brunet
WWRP/JSC Chair

July 19, 2012
Beijing, China

WWRP WORLD WEATHER RESEARCH PROGRAMME

Major Partners

- Joint Working Group on Numerical Experimentation (WGNE)
- World Climate Research Programme (WCRP)
- WMO Weather and Disaster Risk Reduction Services
- Global Atmosphere Watch (GAW)
- WMO Integrated Global Observing System (WIGOS) and Information System (WIS)
- The International Council for Science (ICSU): Integrated Research on Disaster Risk (IRDR)
- Hydrological Research Community
- Ocean Observations and Modelling Research Community



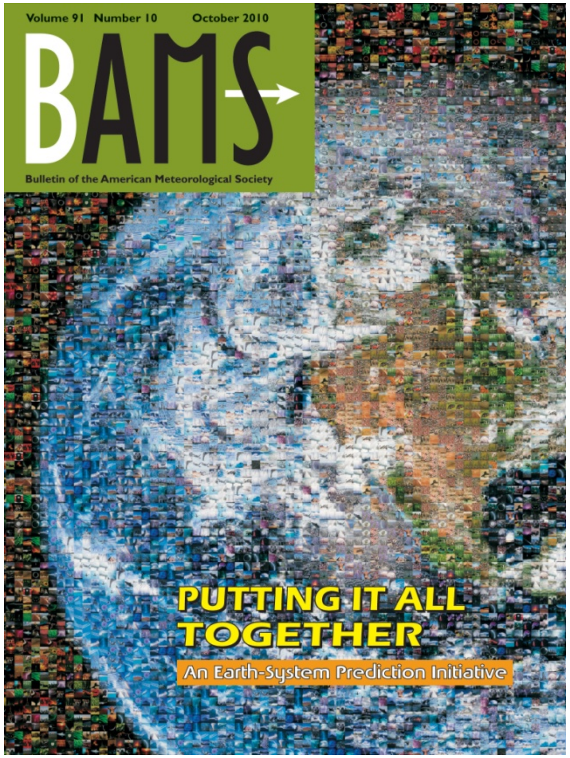
OSC Monograph
Prediction from Weeks to Decades

Ben Kirtman, David Anderson, Gilbert Brunet, In-Sik Kang, Adam Scaife and Doug Smith

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.)
- Addressing the Complexity of the Earth System (Nobre et al.)
- Collaboration of the Weather and Climate Communities to Advance Subseasonal-to-Seasonal Prediction (Brunet et al.)
- Toward a New Generation of World Climate Research and Computing Facilities (Shukla et al.)



Sub-seasonal to seasonal Prediction Project

Background

- Several operational centres are now producing sub-seasonal forecasts. 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

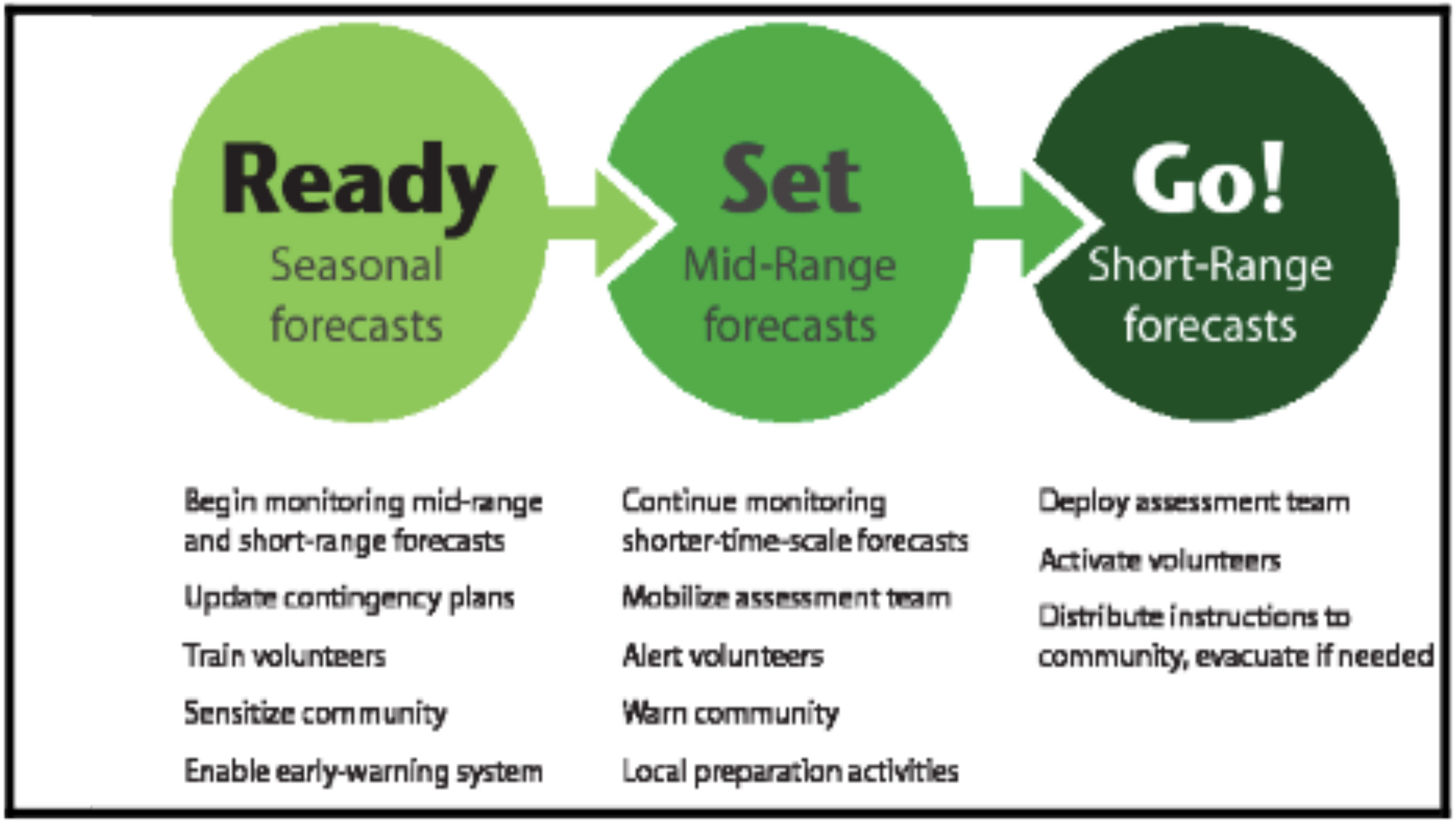
The first task of the group was to prepare an implementation plan giving high priority to:

- 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

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

Opportunity to use information on *multiple* time scales

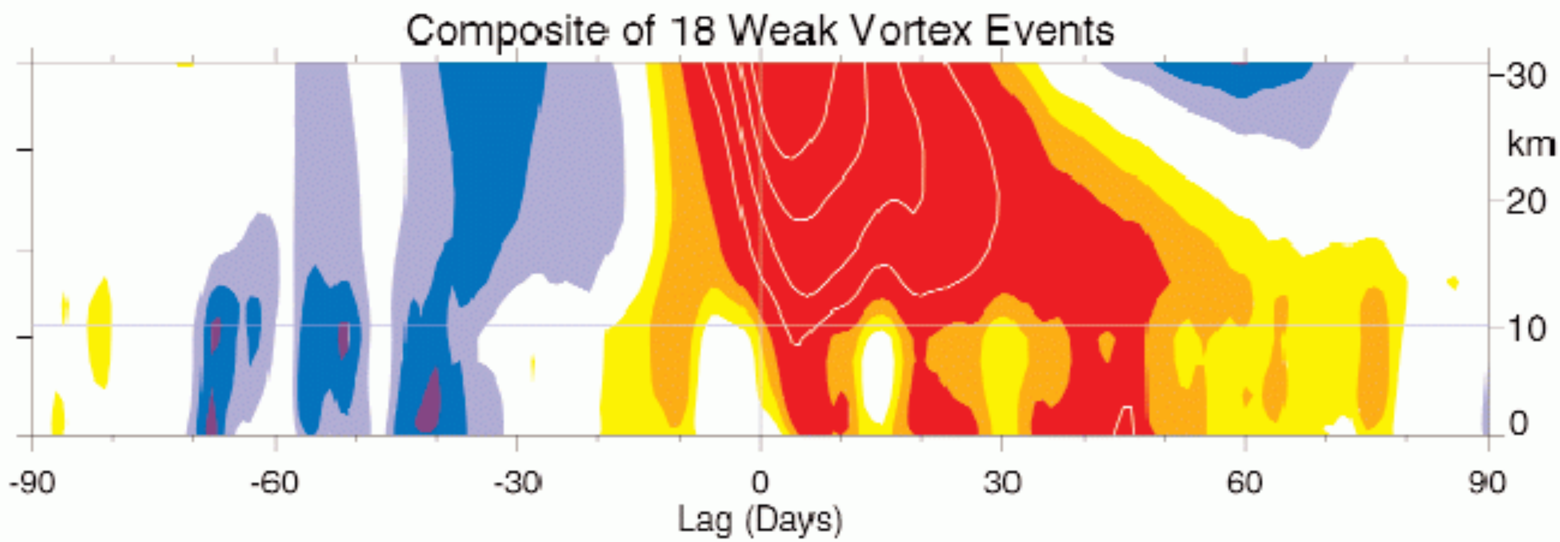


Red Cross - IRI example

- **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**

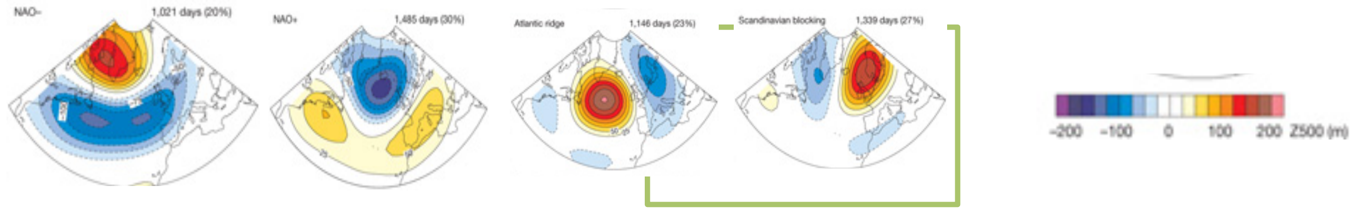
Stratospheric influence on the troposphere?

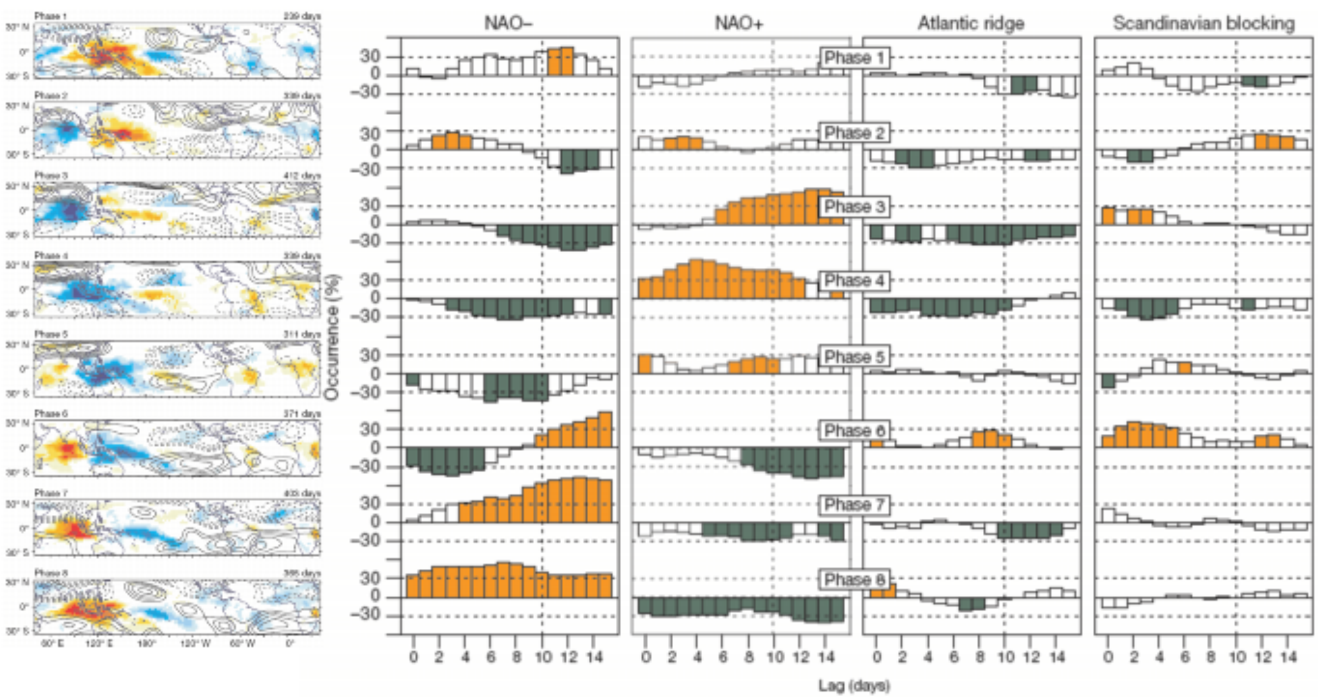


Weather from above. A weakening stratospheric vortex (red) can alter circulation down to the surface, bringing storms and cold weather farther south than usual.

Baldwin and Dunkerton, 2001

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)

Scientific issues

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

Modelling issues

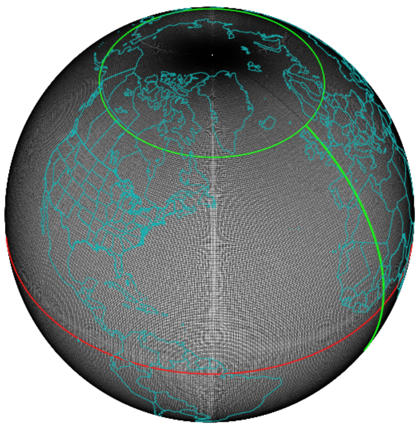
- Role of resolution
- Role of ocean-atmosphere coupling
- Systematic errors
- Initialisation strategies for sub-seasonal prediction
- Ensemble generation
- Spread/skill relationship
- Design of forecast systems
- Verification

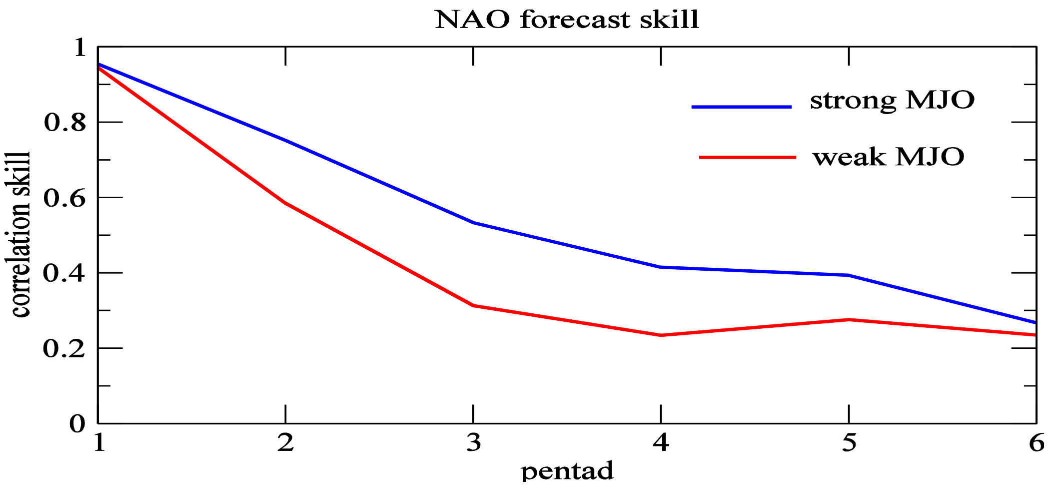
Sub-seasonal forecast database

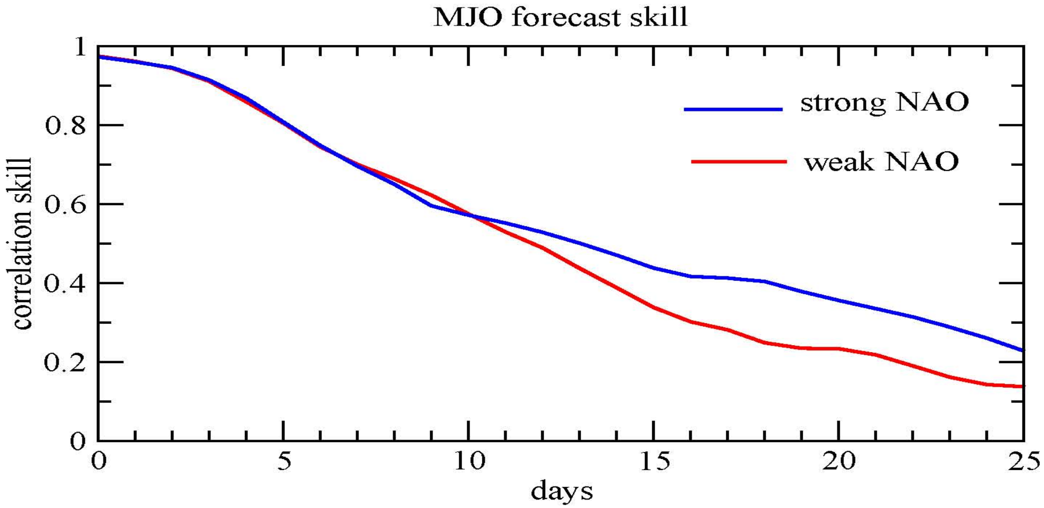
- Numerical models have shown significant improvements in sub-seasonal prediction over the past years (e.g. MJO).

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

Forecasting MJO and NAO with the Canadian GEM Monthly Forecasting System (Lin and Brunet 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	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

Demonstration projects

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

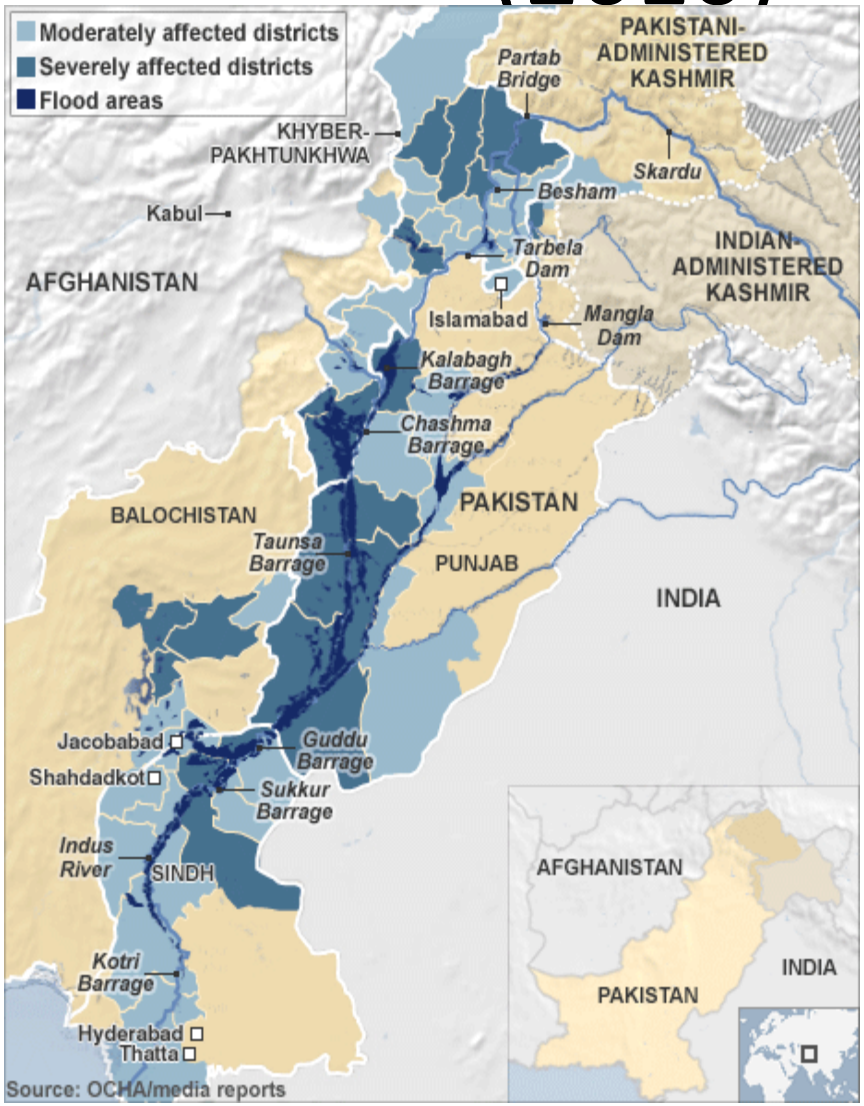
Cases studies could include:

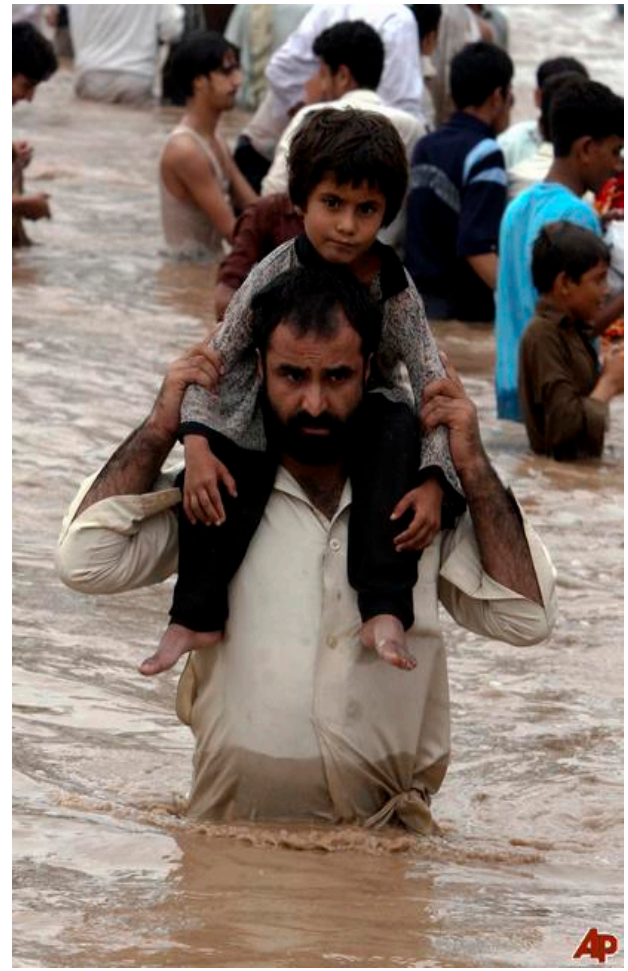
- Pakistan floods (2010) concurrent with the Russian heat wave
- Australian floods (2011)
- European Cold spell (2011)
- Monsoon event (ongoing discussion with CMA; WCRP panel monsoon)

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 or monsoon RDP).

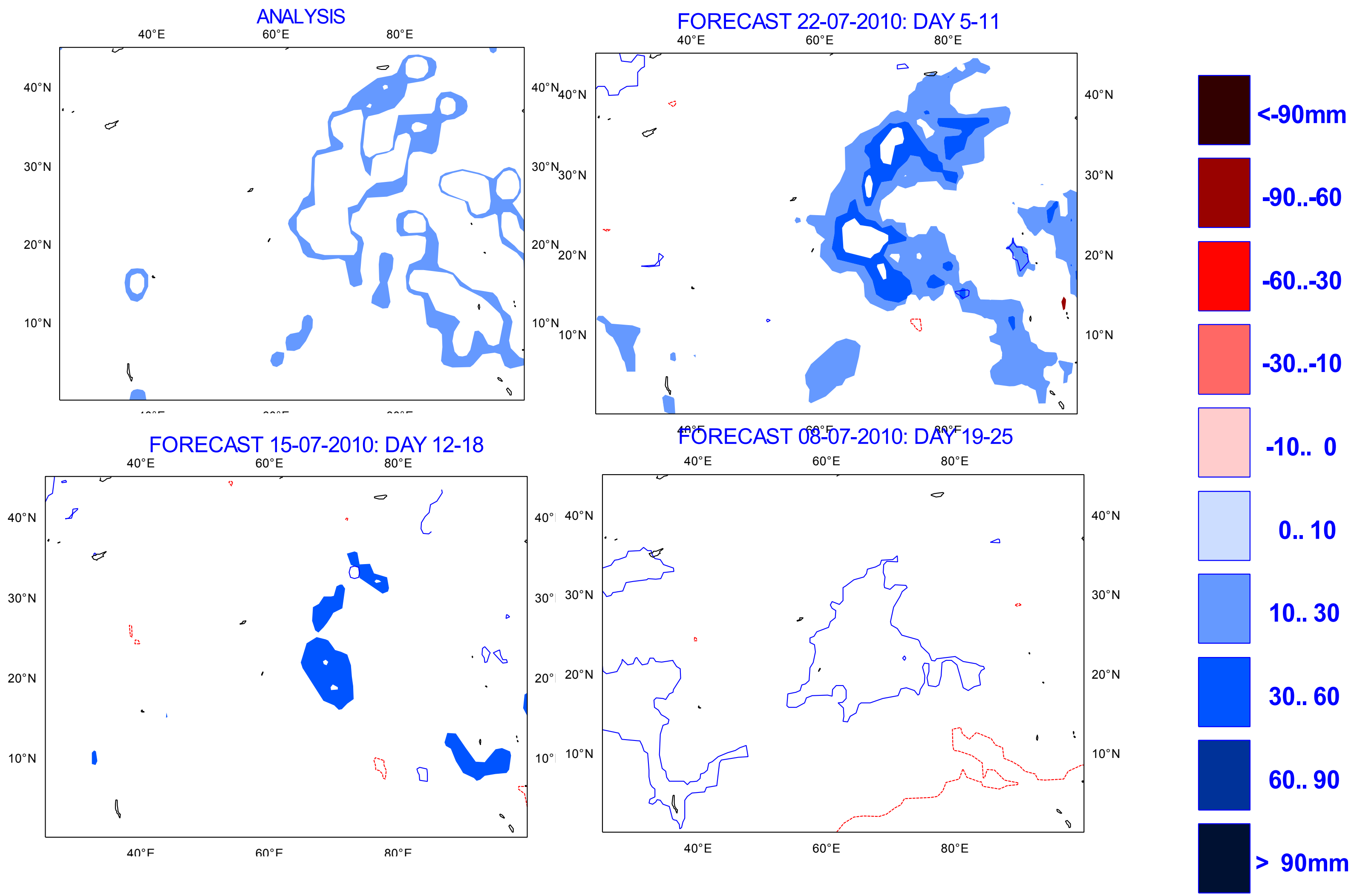
Example : Pakistan Floods (2010)





Sub-seasonal Prediction of Pakistan Floods (2010)

Precip anomalies : 26 July– 01 August 2010



Linkages

- July 2012: WMO EC approves "of a new project on sub-seasonal to seasonal prediction in cooperation with WCRP"
- Global Framework for Climate Services
- WWRP, WGSIP, MJO Task Force and GEWEX including regional panels and WGNE
- Year of Tropical Convection
- CBS
- Verification working groups (JWGFVR)
- World Bank

WWRP WORLD WEATHER RESEARCH PROGRAMME

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.

The WWRP Polar Prediction Project

Background

- November 2009: CAS recommended establishment of an IPY legacy project
- October 2010: WMO EC-PORS formulated proposal for a Global Integrated Polar Prediction System (GIPPS)
- October 2010: WWRP and WCRP workshops were held in Norway
- September 2011: THORPEX ICSC endorsed polar prediction project
- September 2011: Formation of a steering group
- December 2011: 1st SG meeting (implementation plan)
- March 2012: 2nd SG meeting (implementation and science plan)
- July 2012: EC „approves establisment of a polar prediction project...“

Steering Group

Chair:

Thomas Jung, Germany

Members:

Peter Bauer, UK

Chris Fairall, USA

David Bromwich, USA

Trond Iversen, Norway

Marika Holland, USA

Brian Mills, Canada

Pertti Nurmi, Finland

Ian Renfrew, UK

Gregory Smith, Canada

Gunilla Svensson, Sweden

Mikhail Tolstykh, Russia

Ex-officio members:

Francisco Doblas-Reyes, Spain

Peter Lemke, Germany

Administrative support:

Neil Gordon, New Zealand

Stefanie Klebe, Germany

2nd Steering Group Meeting, Montreal 27-28 March 2012

Mission Statement

Promote cooperative international research enabling development of improved prediction services for the polar regions, on time scales from hourly to seasonal.

This constitutes the hourly to seasonal research component of the WMO Global Integrated Polar Prediction System (GIPPS).

Research Areas

Services

Societal and Economic Research Applications (SERA)	Verification

Underpinning research

Predictability and Diagnostics	Teleconnections

Forecasting system development

Observations	Modelling
Data Assimilation	Ensemble Forecasting

Research priorities

- Understand the specific needs for and evaluate the use of enhanced prediction information and services in polar regions;
- Establish and apply verification methods appropriate for polar regions;
- Determine predictability of the weather and identify key sources of forecast errors in polar regions;
- Improve knowledge of two-way linkages between polar and lower latitudes, and their implications for global prediction;
- Improve representation of key polar processes in (coupled) models of the atmosphere, land, ocean and cryosphere;
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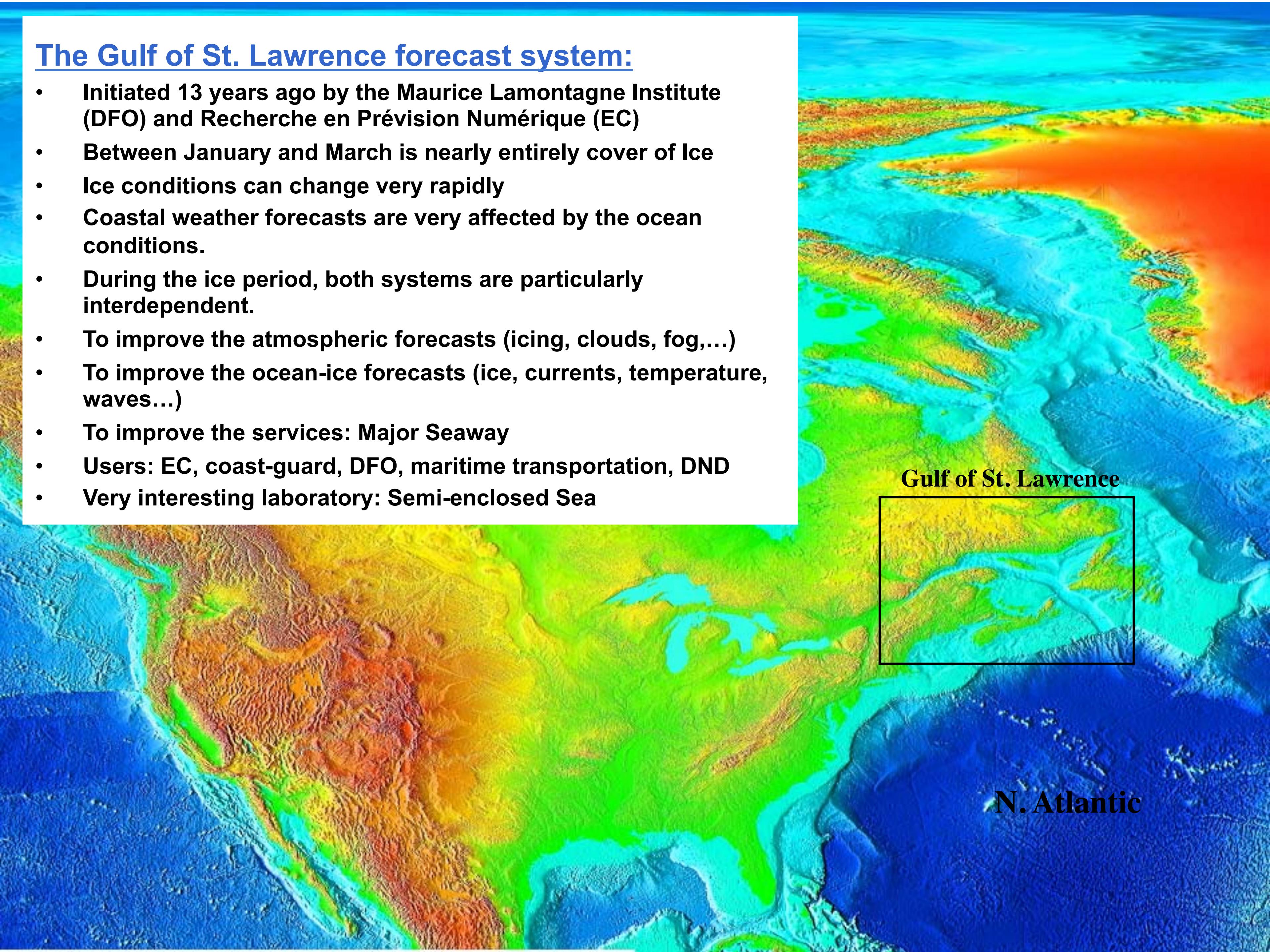
The Gulf of St. Lawrence forecast system:

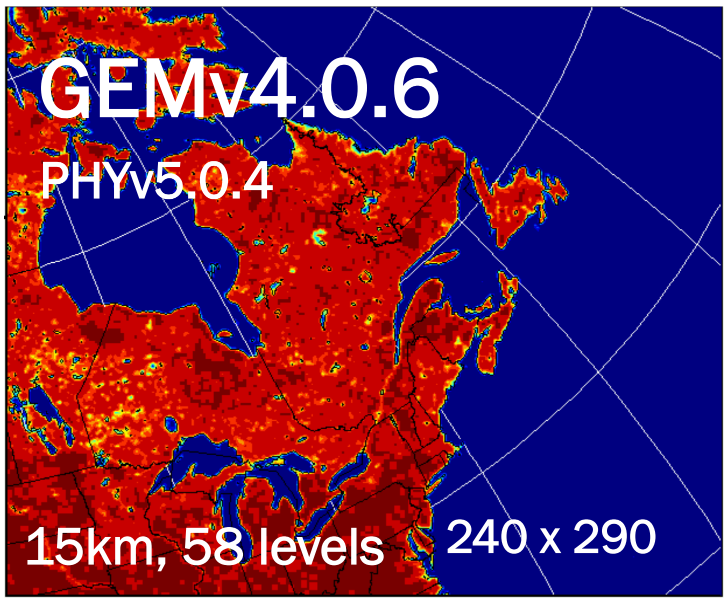
- Initiated 13 years ago by the Maurice Lamontagne Institute (DFO) and Recherche en Prévision Numérique (EC)
- Between January and March is nearly entirely cover of Ice
- Ice conditions can change very rapidly
- Coastal weather forecasts are very affected by the ocean conditions.
- During the ice period, both systems are particularly interdependent.
- To improve the atmospheric forecasts (icing, clouds, fog,…)
- To improve the ocean-ice forecasts (ice, currents, temperature, waves…)
- To improve the services: Major Seaway
- Users: EC, coast-guard, DFO, maritime transportation, DND
- Very interesting laboratory: Semi-enclosed Sea



The GSL coupled system, v2.0.4

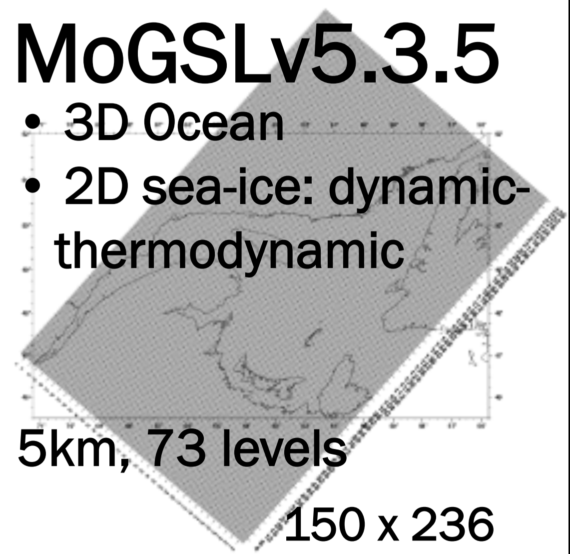
Gossip2 - P2G_MV

SST, ice fraction, mask
ice temperature & thickness



Timestep = 450s

Coupling timestep = 450s



Timestep = 225s

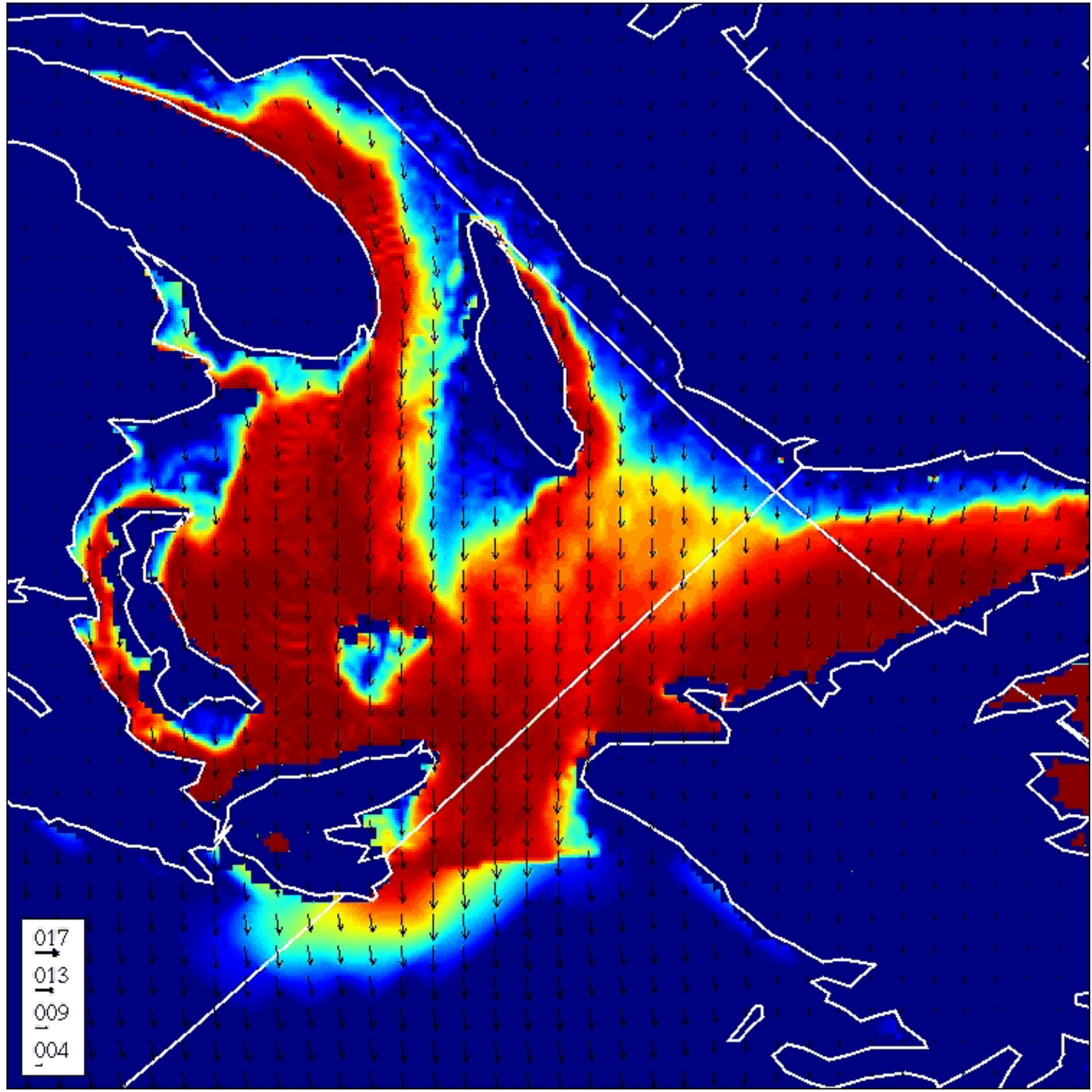
Gossip2 - P2G_MV

Air & dew point temp., wind
solar & IR flux, precipitation

Atmosphere-Ocean-Ice
An interesting Case

Ice fraction
48h forecast
2 way coupled

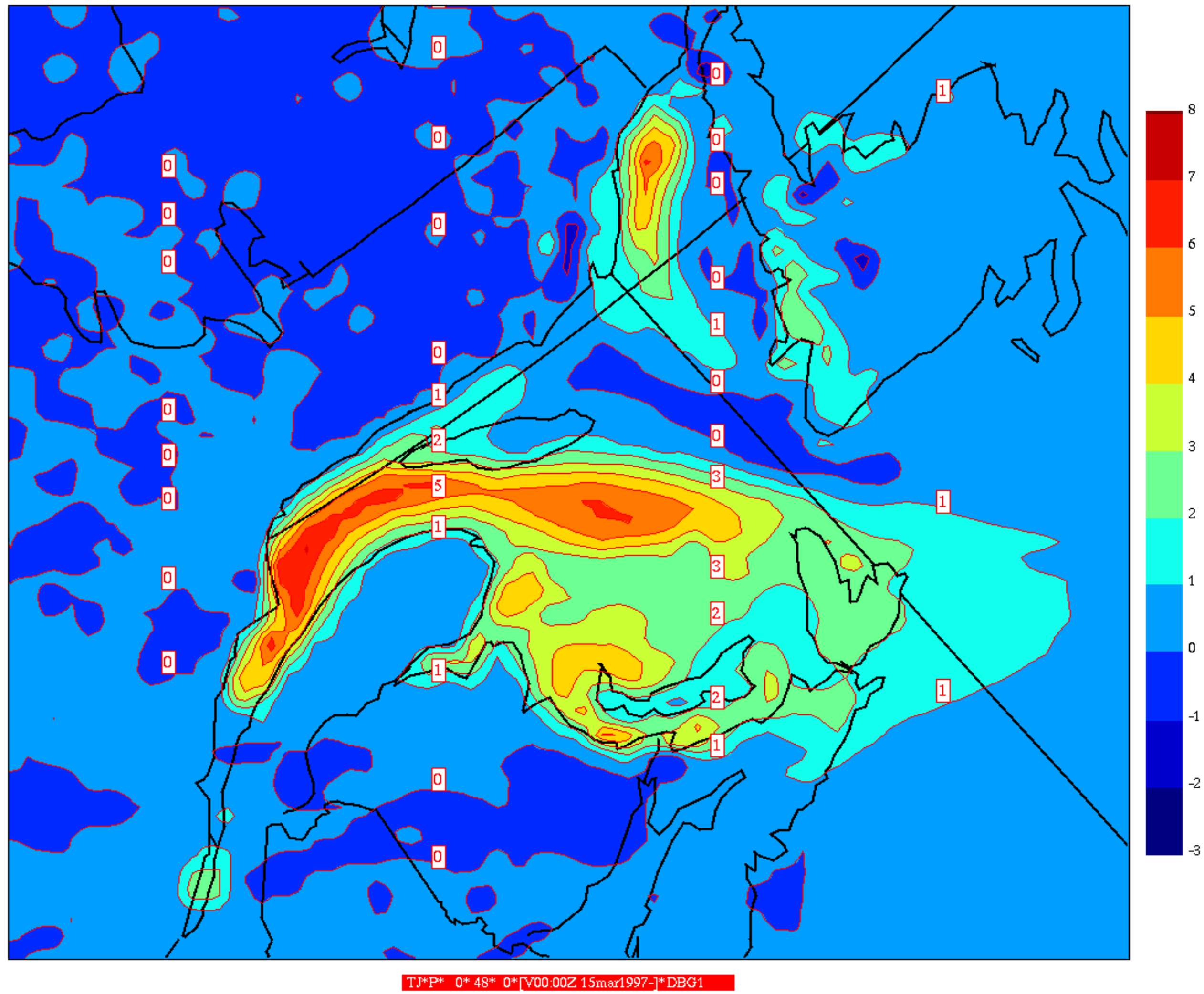
Case: Particularly interesting given that the intense atmospheric circulation that dramatically changed the ice conditions
in only 48 hours was preceded by a cold and relatively quiet period.



Impact on surface air temperature

Difference Air temp.
Coupled – Uncoupled

(NB: Impact on surface fluxes and cloud cover.)



Role of Sea Ice in Medium-Range Weather Forecasting

T2m Difference: Observed Minus Persisted Sea Ice

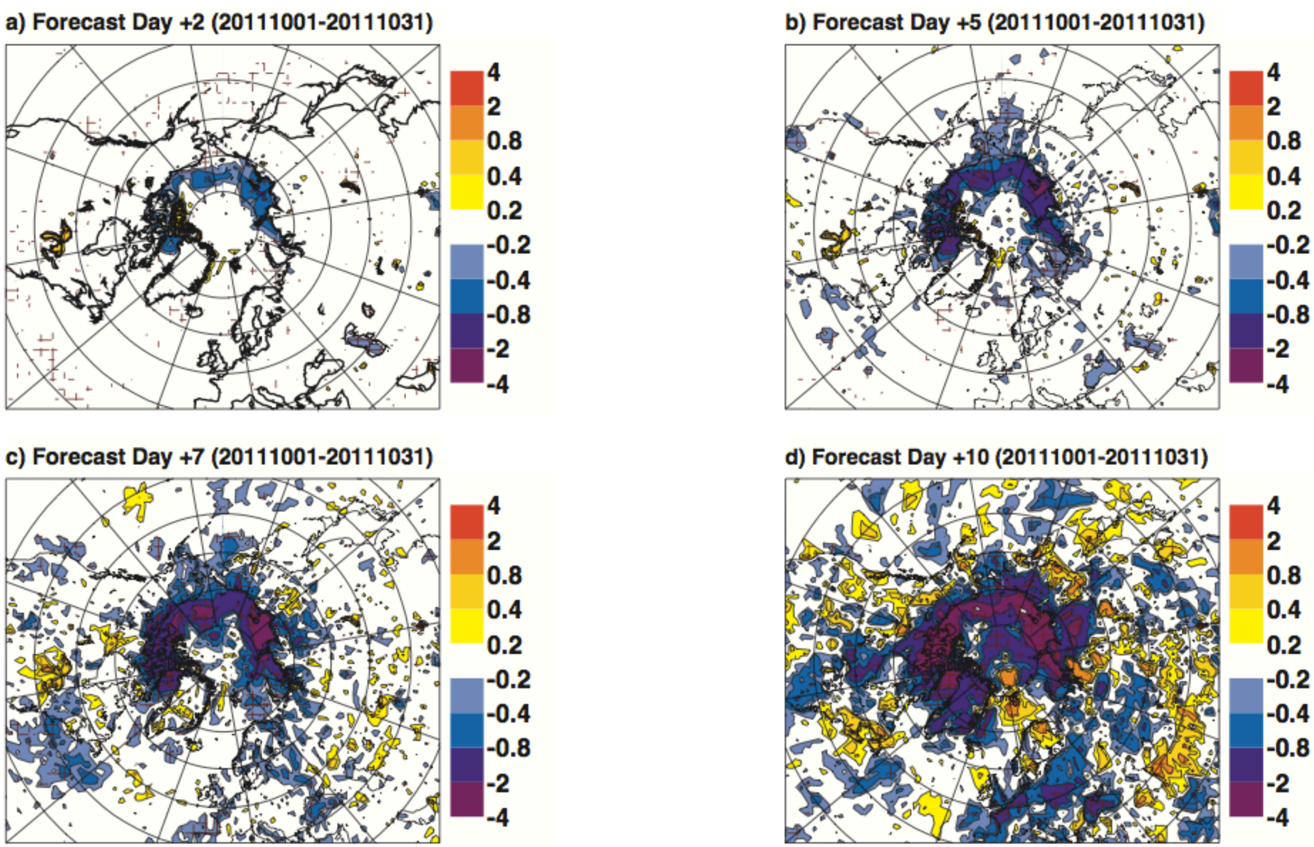


Figure courtesy of P. Bauer (ECMWF)

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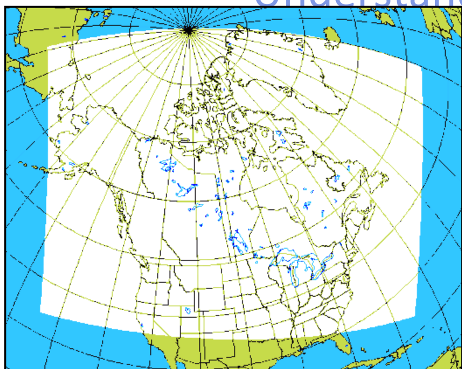

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Implementation

- Steering group representing both the research and operational communities
- Effective collaboration with other partners such as WCRP and IASC
- An intensive observation and modelling effort, termed the Year of Polar Prediction(YOPP), to advance polar prediction
- Establishment and exploitation of special research data sets
- A series of science workshops on polar prediction
- A strong educational component, which will be jointly implemented with the Association of Polar Early Career Scientists (APECS)
- A project office to coordinate day-to-day project activities
  - A generous offer of Alfred Wegener Institute. GIPPS project office?

Year of Polar Prediction (YOPP)

- Intensive observational *and* modelling period
- Involves different initiatives (e.g. MOSAiC)
- Observations
  - Observing system design (e.g. data denial)
  - Model development
- Numerical experimentation
  - Special data sets (e.g., process tendencies)
  - High-resolution modelling
  - Transpose-AMIP
  - Post-processing of extra fields (SSF data base)
- SERA: Monitoring of forecast use in decision making
- Tentatively scheduled for the period 2017-2018

YOPP: Time line

Preparation Phase	YOPP 2017-2018	Consolidation Phase

Preparation Phase

- Establish planning group
- Carry out YOPP planning workshop
- Develop strategy
- Carry out preparatory research
- ...

Consolidation Phase

- Analysis of YOPP data
- Operational implementation of YOPP findings
- Reanalysis
- ...

Summary

- Steering group has been established
- Two steering group meetings have taken place
- Substantial progress on writing Implementation and Science plan
-

Month	Milestone
Jul 2012	Send out draft Implementation Plan
Aug 2012	Send out draft Science Plan
Sep 2012	Feedback from the community
Oct 2012	Finalize plans
Nov 2012	Launch of Polar Prediction Project with associated International Project Office

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Merci!

Thank you!

SERA

Goal: Understand and evaluate the use of enhanced prediction information and services in polar regions

- Link with forecast user community (two-way)
- Communication of risk, opportunity and uncertainty across user types
- Estimation and analysis of historic and current use
  - Develop/test framework to define and assess *expected* polar and lower-latitude benefits in relation to cost

Verification

Goal: Establish and apply verification methods appropriate for polar regions

- Verify existing forecasting systems in the polar regions
- Develop key performance headline measures with polar relevance to monitor progress
- Devise methods that can be used to verify user-relevant key weather and climate phenomena in polar regions (e.g. blizzards and fog visibility)

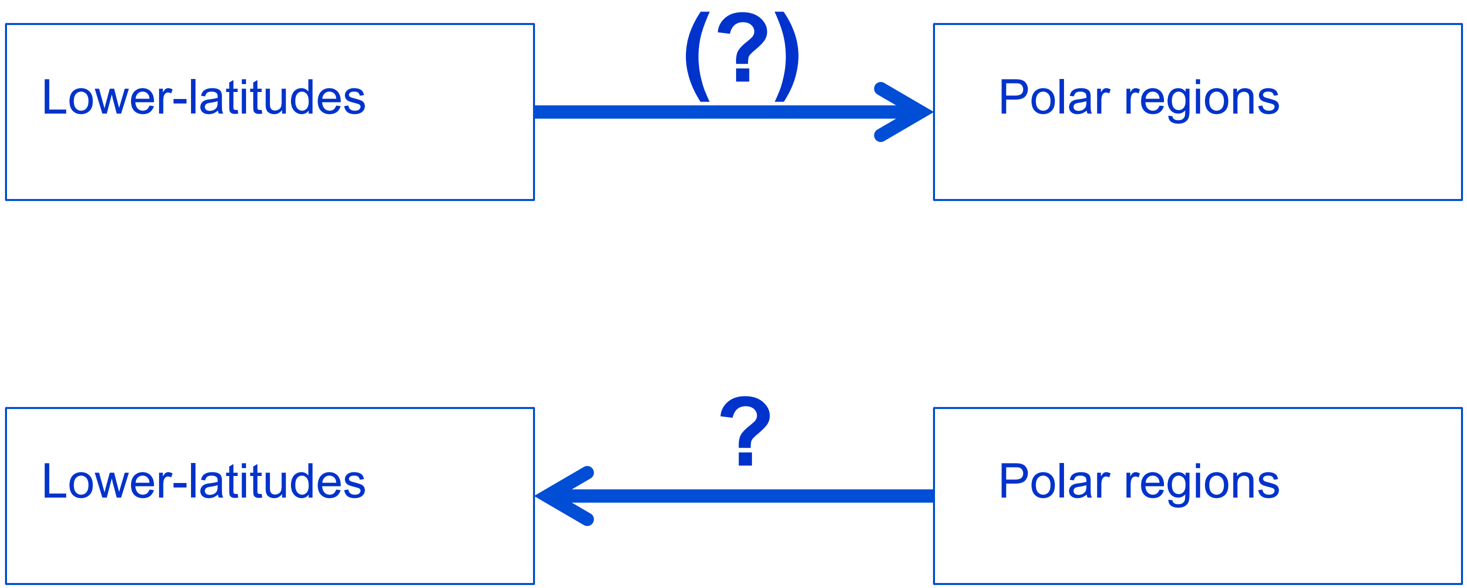
Predictability and Diagnostics

Goal: Determine predictability and identify key sources of forecast errors in polar regions

- Determine
  - mechanisms providing predictability
  - Instabilities of the polar climate system
  - Structure of imperfections (analysis and model error)
- Apply/develop diagnostic techiques that help to understand model error at the process level
- Central: Explore the role of sea ice (time

Teleconnections

Goal: Improve knowledge of two-way teleconnections between polar and lower latitudes, and their implications for polar prediction



Modelling

Goal: Improve representation of key processes in models of the polar atmosphere, land, ocean and cryosphere

- Improve representation of key dynamical and physical processes (e.g. PBL, sea ice rheologies)
- Develop stochastic parametrizations
- Explore the role of horizontal and vertical resolution
- Develop coupled model systems across all forecast ranges

Role of Sea Ice in Medium-Range Weather Forecasting

T2m Difference: Observed Minus Persisted Sea Ice

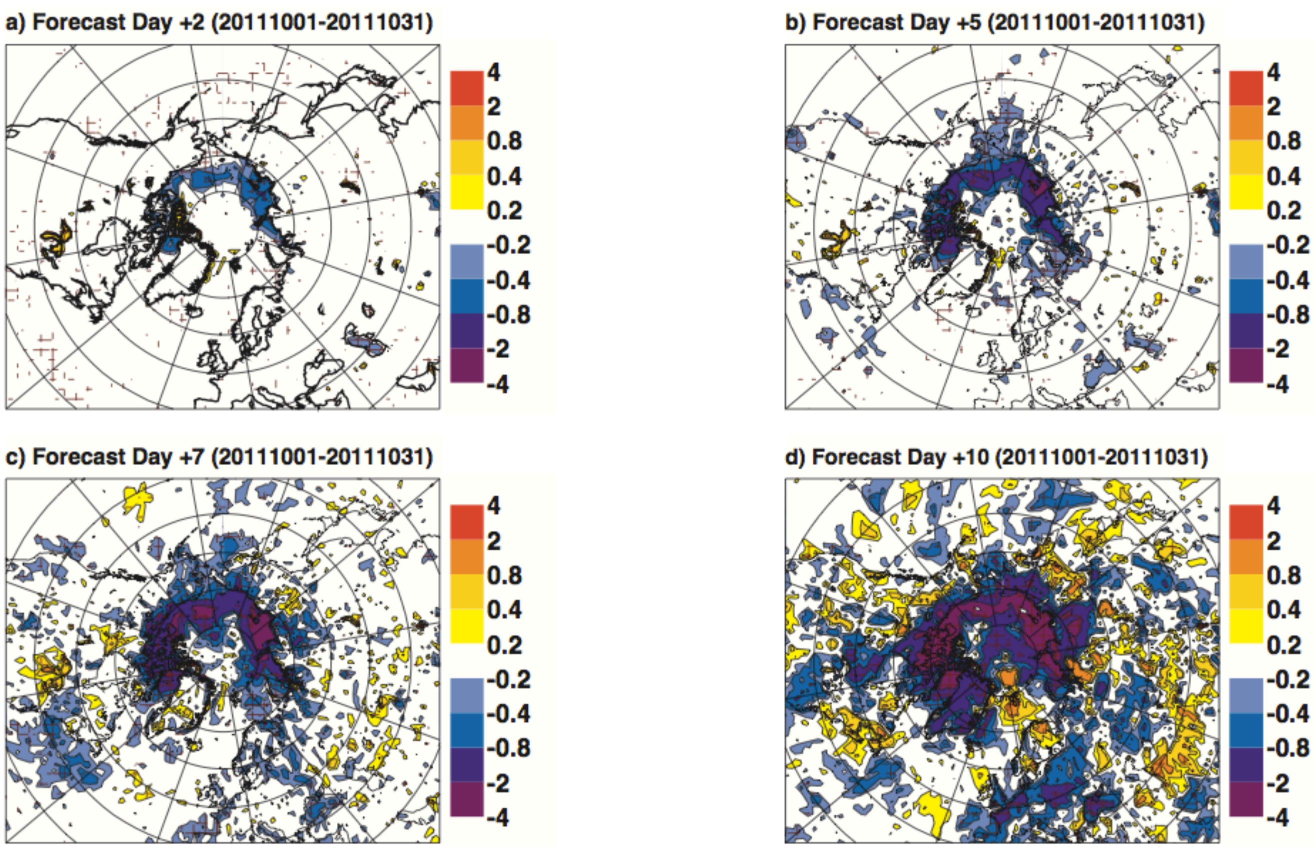


Figure courtesy of P. Bauer (ECMWF)

Ensemble forecasting

Goal: Develop and exploit ensemble prediction systems with appropriate representation of initial and model uncertainty for polar regions

- Assess performance of existing EPSs and LAM-EPSs in polar regions
- Improve initial perturbation methods for the atmosphere
- Develop initial perturbation methods for sea ice, ocean and land surface models
- Develop methods to account for model uncertainty

Data Assimilation

Goal: Develop data assimilation systems that account for the unique character of the polar regions

- Evaluate existing analysis and reanalysis data sets
- Develop improved background error covariance matrices for the polar regions (PBLs, sea ice, ...)
- Develop coupled data assimilation schemes
- Develop data assimilation schemes with representation of model uncertainty

Observations

Goal: Provide guidance on optimizing polar observing systems, and coordinate additional observations to support modelling and verification

- Provide observations for
  - forecast initialization
  - model development activities
  - forecast verification
- Assess the sensitivity of analysis and forecast accuracy to observation data usage and error formulations (OSE, adjoint sensitivities)

Strategies to Achieve Research Goals

- Develop strong linkages with other initiatives
- Strengthen linkages between academia, research institutions and operational prediction centres
- Establish linkages with space agencies and other data providers
- Establish and exploit special research data sets
- Promote interactions and collaboration between research and stakeholders

- Thank you!
- Merci!
- 多谢