# Subseasonal to Seasonal (S2S) Prediction Project

"Bridging the gap between weather and climate"

Co-Chairs:
Frédéric Vitart (ECMWF)
Andrew Robertson (IRI)

5/2/13

# 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

# 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 project office and 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

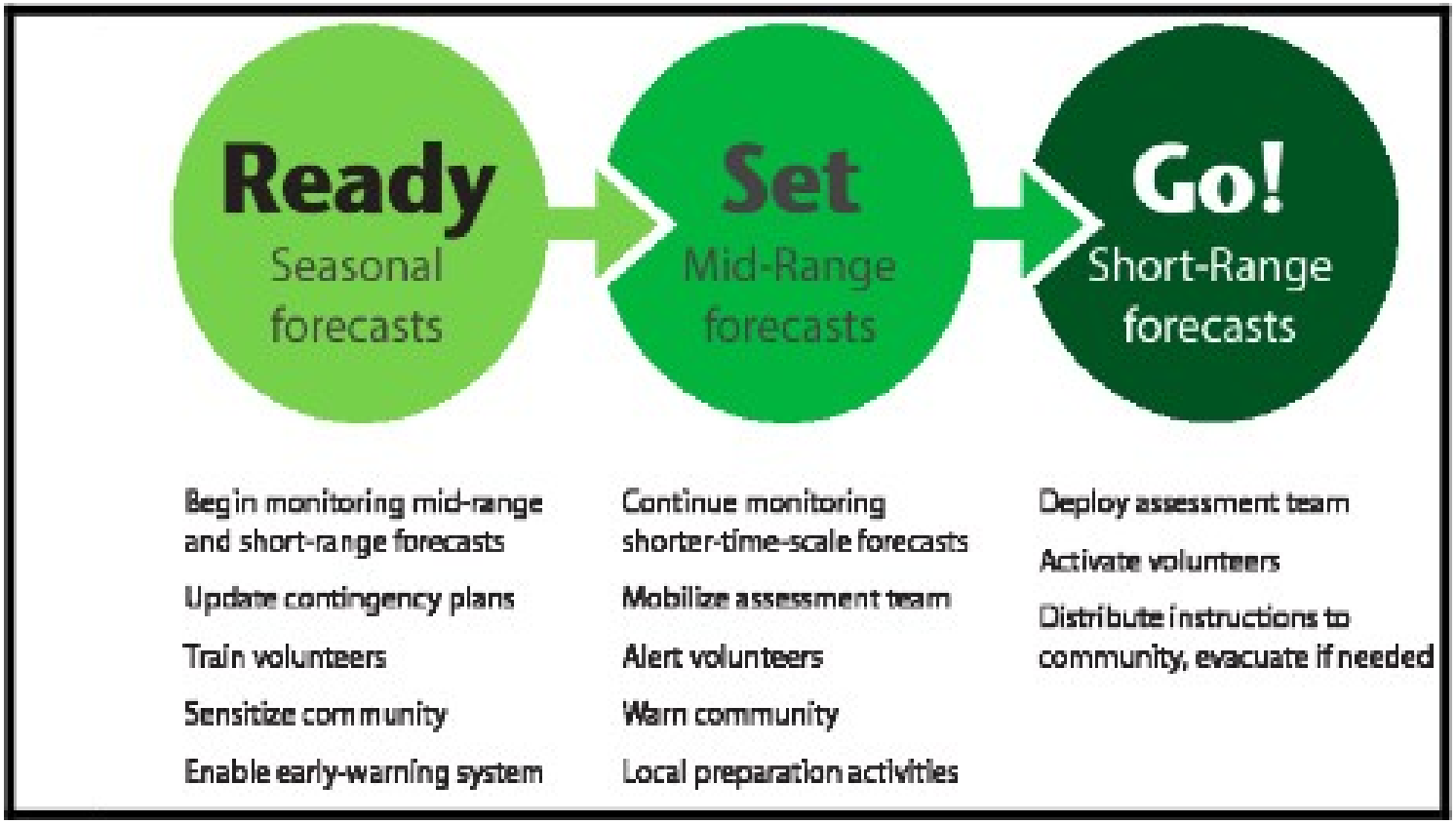
# Sub-seasonal to Seasonal Prediction Planning group

**Co-Chairs:**
Frédéric Vitart (ECMWF)
Andrew Robertson (IRI)

**Members:**
Arun Kumar (NCEP)
Harry Hendon (CAWCR)
Yuhei Takaya (JMA)
Hai Lin (EC)
Alberto Arribas (UKMO)
June-Yi Lee (U. Hawaii)
Duane Waliser (JPL NASA)
Ben Kirtman (UM RSMAS)
Hyun-Kyung Kim (KMA)

**Liaison group:**
*Carolina Vera* (WCRP JSC Liaison)

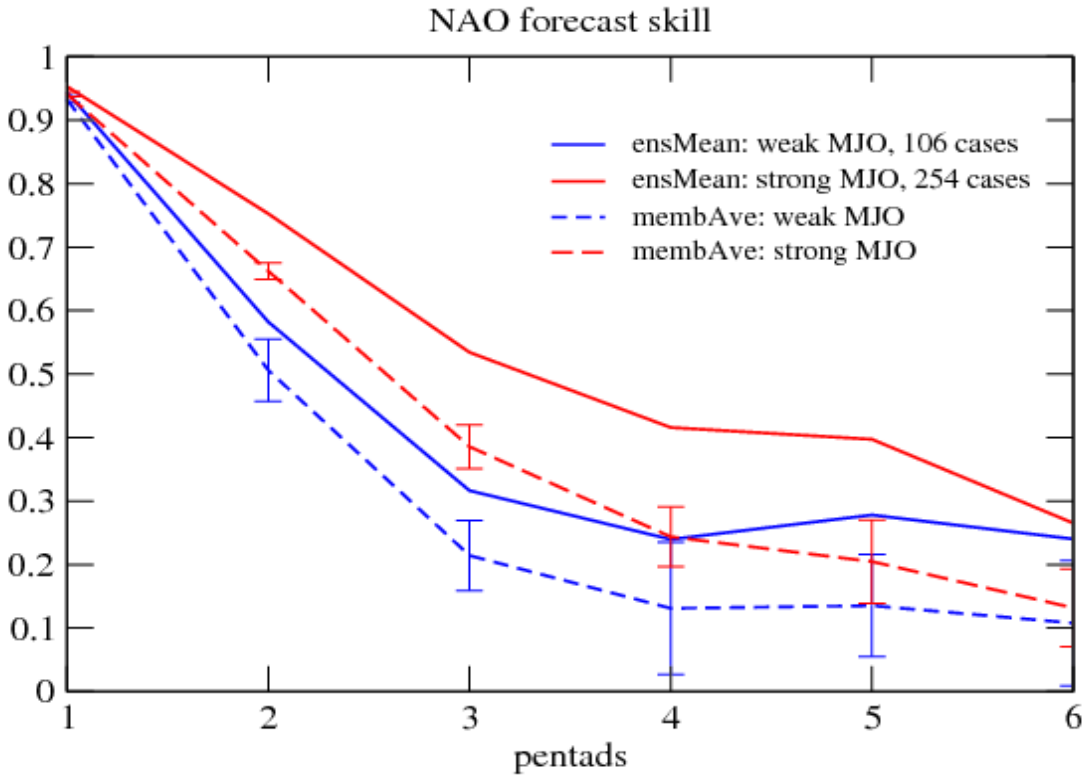
# Opportunity to use information on *multiple* time scales




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

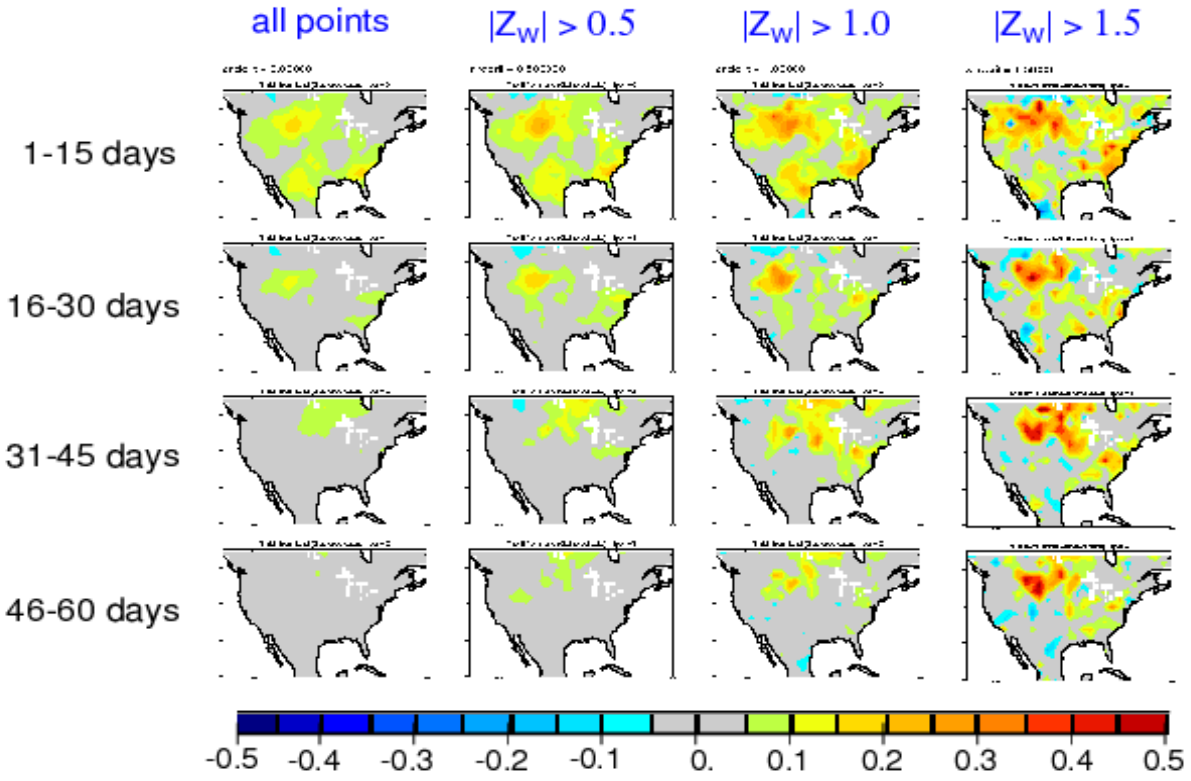
# Simulation of the impact of the MJO on the NAO




**Lin et al, 2010**

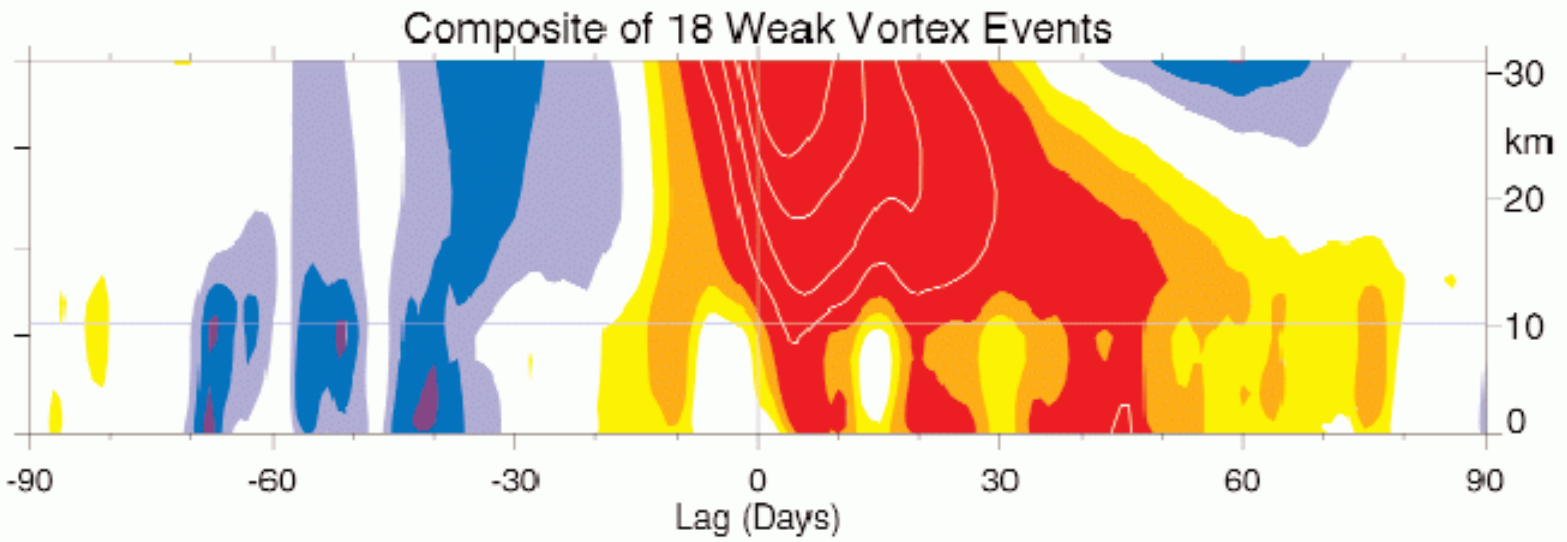
# Impact of soil moisture

**Temperature forecasts: Increase in skill due to land initialization (JJA)**
**(conditioned on Z-score of initial soil moisture anomaly)**




**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**

# 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

# Modelling issues

- Role of resolution
- Role of ocean-atmosphere coupling
- Systematic errors
- Initialisation strategies for subseasonal prediction
- Ensemble generation
- Spread/skill relationship
- Verification

# 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

# Subprojects

- Monsoons
  - e.g., predicting the timing of monsoon onsets and breaks, esp S 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 CBS & SERA; weather-within-climate; capacity building
- Extreme Weather
  - connect with proposed HIW project
  - ‘ready set go’ concept
- Verification
  - propose a set of methods to be applied for verification, and verification topics to be researched, which will include methods for probabilistic predictions.
- Stratosphere-troposphere interaction? Need to

# Creation of a subseasonal forecast database

- Multi-model ensemble prediction systems already exist for medium-range weather and seasonal forecasting:
  - THORPEX Interactive Grand Global Ensemble (TIGGE) for forecasts up to 2 weeks
  - WMO lead centre for long-range forecasts and the Climate-System Historical Forecast Project (CHFP) for seasonal forecasts.

- S2S will create a MEPS database of current operational subseasonal forecasts – now produced at most Global Producing Centres – up to 60 days

- Will provide a powerful community resource to investigate predictability mechanisms, assess skill and usefulness for applications.

# Sub-seasonal real-time Operational Forecast

| | 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 |
| **Met.Fr** | D 0-60 | T127L31 | 41 | monthly | Fix | 1981-2010 | monthly | 11 |
| **SAWS** | D 0-60 | T42L19 | 6 | monthly | Fix | 1981-2001 | monthly | 6 |
| **HMCR** | D 0-60 | 1.1x1.4 L28 | 20 | weekly | Fix | 1981-2010 | weekly | 10 |

# Database proposal

- 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 weeks behind real-time
  - Hindcasts depending on centre (nonuniform)
  - Common 1.5x1.5 degree ERA-interim grid
  - Update frequency depending on centre
- Variables archived: most of TIGGE variables + ocean variables and stratospheric levels
- Include post-processed weekly averages of key fields
- Use of first 2 months of the CHFP seasonal and climate forecasting systems to compare with the archive (above). Need for daily or weekly/pentads archive (??)

# List of vertical level variables to be archived

| | Z | SPEC HUM | T | U | V | W |
|---|---|---|---|---|---|---|
| 1000 | x | x | x | x | x | |
| 925 | x | x | x | x | x | |
| 850 | x | x | x | x | x | |
| 700 | x | x | x | x | x | |
| 500 | x | x | x | x | x | x |
| 300 | x | x | x | x | x | |
| 200 | x | x | x | x | x | |
| 100 | x | x | x | x | x | |
| 50 | x | | x | x | x | |
| 10 | x | | x | x | x | |

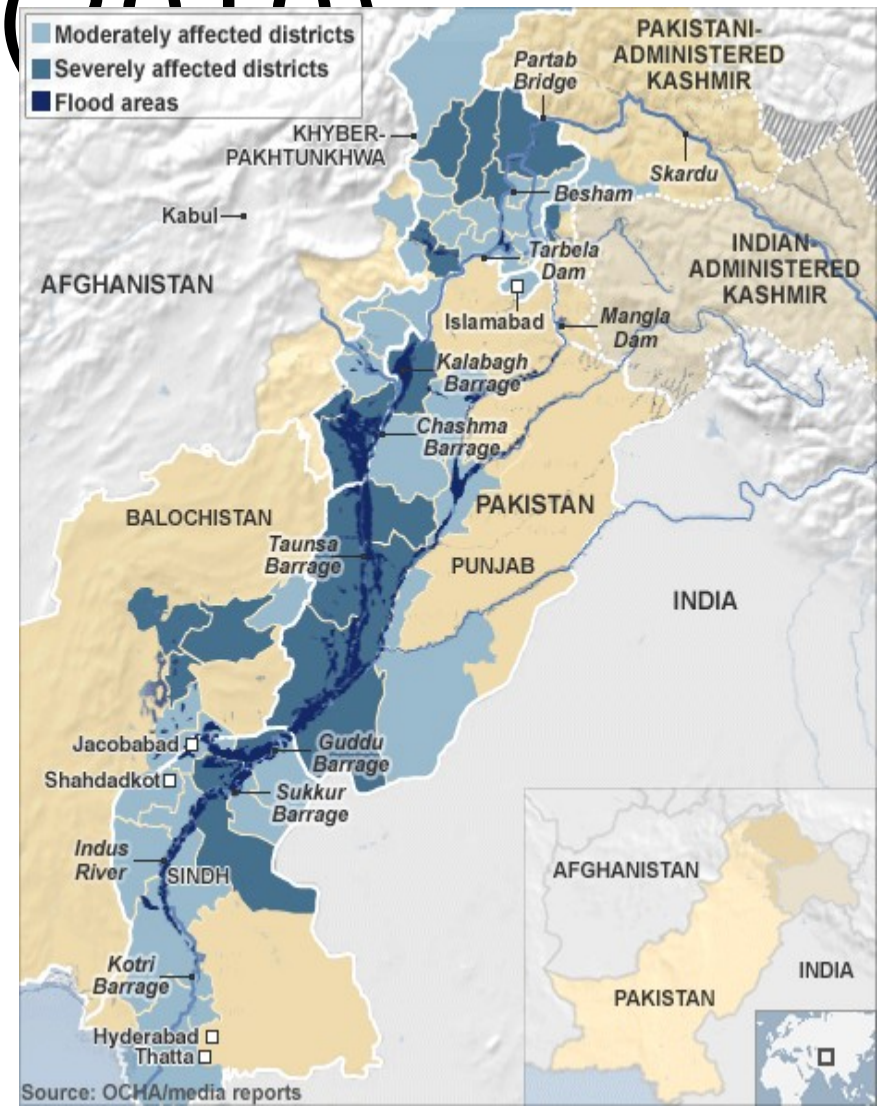
# Demonstration projects

- 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)

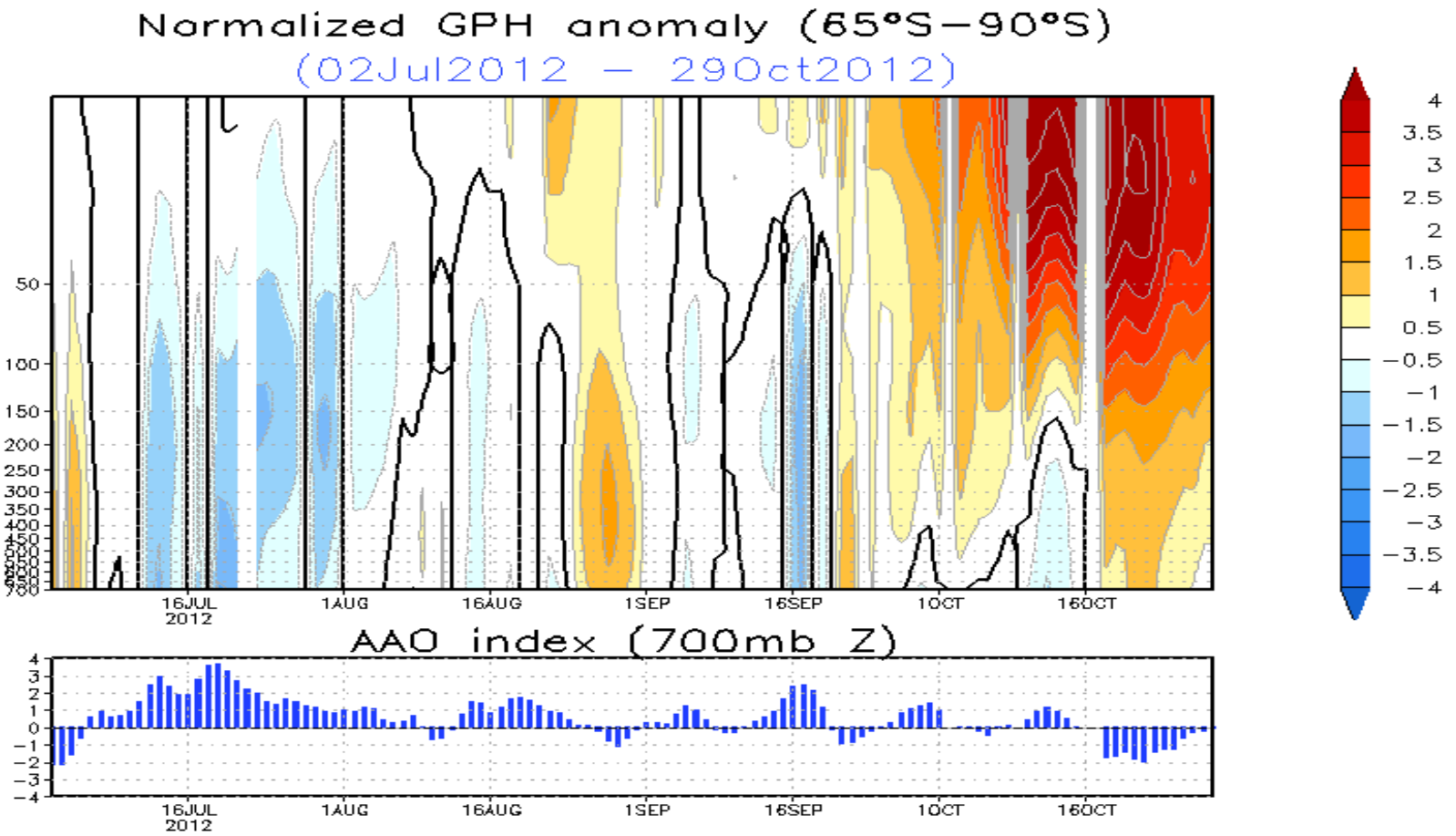


- At least one of the demonstration

# Example : Pakistan Floods (2010)




# Stratospheric Warming




From Harry Hendon

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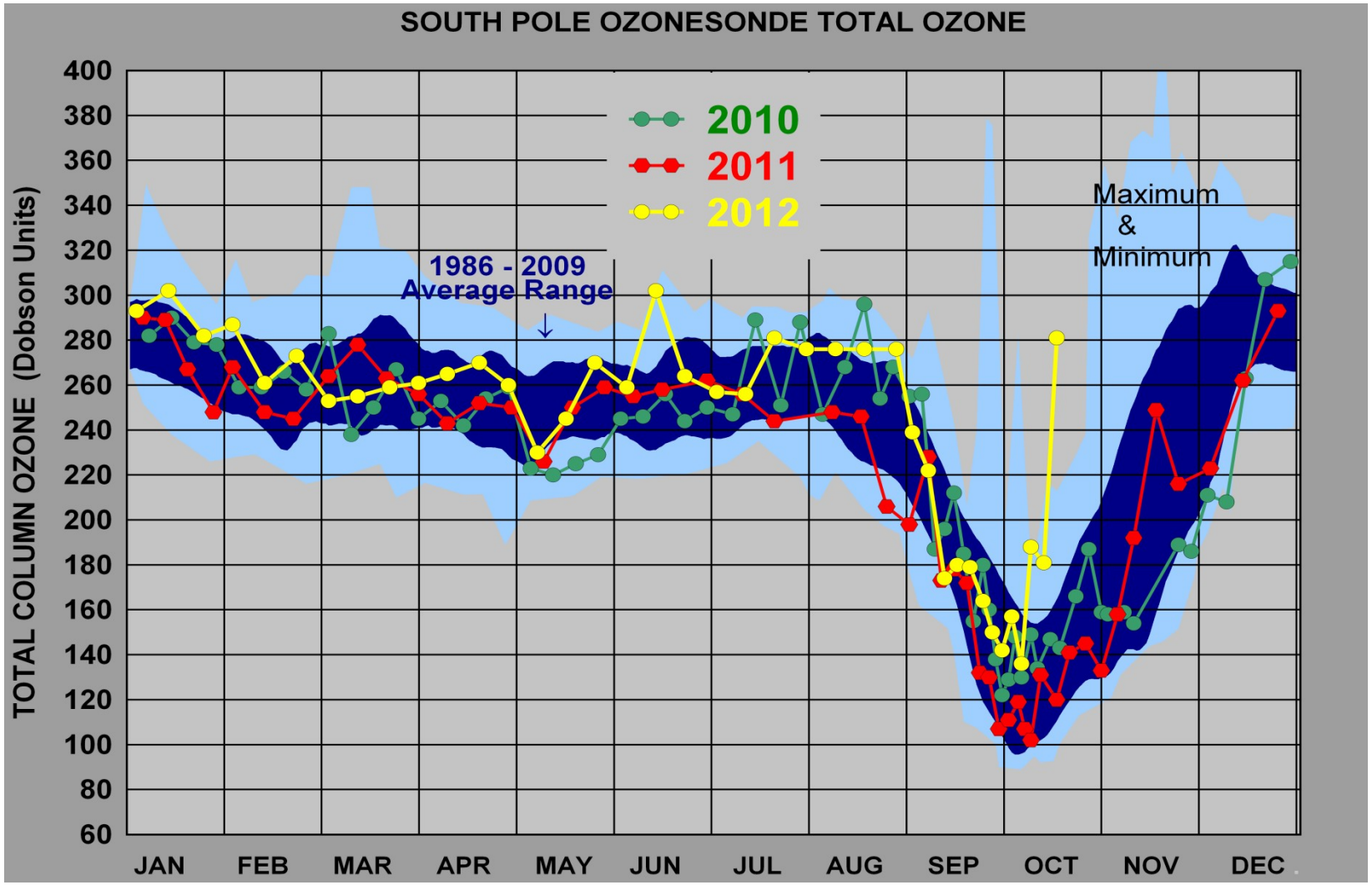
# Stratospheric Warming

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Source: NOAA

# Linkages

- Global Framework for Climate Services
- WGSIP (WCRP)
- CLIVAR and GEWEX including regional panels and WGNE
- Year of Tropical Convection
- CBS
- Verification working groups (SVS-LRF and JWGFVR)
- World Bank and other development/food security organizations
- SNAP?SPARC?

# Next steps

- Invitation to contribute data to the S2S archives being sent to GPCs, WMO members
- S2S Archive Centre being established at ECMWF
- Establishment of International Coordination Office and transition of planning group into S2S Steering Group
- First Science Workshop in Feb 2014

# Subseasonal to Seasonal Prediction Project: bridging the gap between weather and climate

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by Frédéric Vitart[1], Andrew W. Robertson[2] and David L. T. Anderson[1]

Great progress has been made in recent decades on development and applications of medium-range weather forecasts and seasonal climate predictions. The sub-seasonal to seasonal project will bring the weather and climate communities together to tackle the intervening time range, harnessing shared and complementary experience and expertise in forecasting, research and applications, toward more seamless weather/climate prediction systems and more integrated weather and climate services.

From the societal perspective, many management decisions in agriculture and food security, water, disaster risk reduction and health fall into the subseasonal to seasonal time range. However, this time scale has long been considered a "predictability desert", and forecasting for this range has received much less attention than medium-range and seasonal prediction. Recently, research has indicated important potential sources of predictability in this time range through better understanding and representation of atmospheric phenomena such as the Madden–Julian Oscillation, improved coupling with, and initialization of, the land–ocean–cryosphere and stratosphere, new model developments, more comprehensive and reliable observational networks, enhanced data assimilation techniques and increasing computing resources. These improvements are expected to translate into more accurate forecasts.

A number of recent publications (e.g. Brunet et al. 2010) have stressed the importance of, and need for, collaboration between the weather and climate communities to better tackle shared critical issues, and most especially to advance subseasonal to seasonal prediction. At its fifteenth session in November 2009, the WMO Commission for Atmospheric Sciences (CAS) requested that the Joint Scientific Committees of the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP) and the THORPEX[3] International Core Steering Committee set up an appropriate collaborative structure to carry out an international research initiative on this topic and recommended that it be coordinated with future developments in the Global Framework for Climate Services. An Implementation Plan[4] has been written-up on which this article is based.

## Needs from applications

Weather and climate events continue to exact a toll on society despite the tremendous advances and investment in prediction science and operational forecasting over the past century. Weather-related hazards, including early/late onset of rainy seasons and chronic events such as drought and extended periods of extreme cold or heat, trigger and account for a great proportion of disaster losses. From the end-user perspective, the sub-seasonal time scale is important because it lies between the well-established and routine application of weather forecasts in diverse user sectors on the one hand, and the increasing use of seasonal forecasts on the other. Many management decisions, such as in agriculture, fall into the intervening two-weekly to two-monthly time scale, so the development of more seamless weather-to-climate forecasts promises to be of significant societal value, and will augment the regions/situations where there is actionable forecast information. As such, this activity is regarded as a significant contribution of

| | Unit | Abbreviation | Description |
|---|---|---|---|
| Sea surface temperature | K | sstk | Daily Av. 4x |
| Sea surface salinity | psu | ssts | Daily Av. 4x |
| Depth of the 20 deg  isoth. | m | 20d | Daily Av. 4x |
| Sea ice cover | Proportion | ci | Daily Av. 4x |
| Heat content top 300m | Degrees C | tav300 | Daily Av. 4x |
| Salinity in top 300m | psu | sav300 | Daily Av. 4x |
| U surface current | m s-1 | u | Daily Av. 4x |
| V surface current | m s-1 | v | Daily Av. 4x |
| Sea surface height | m | sl | Daily Av. 4x |