# Working Group on Seasonal-to-Interannual Prediction (WGSIP)

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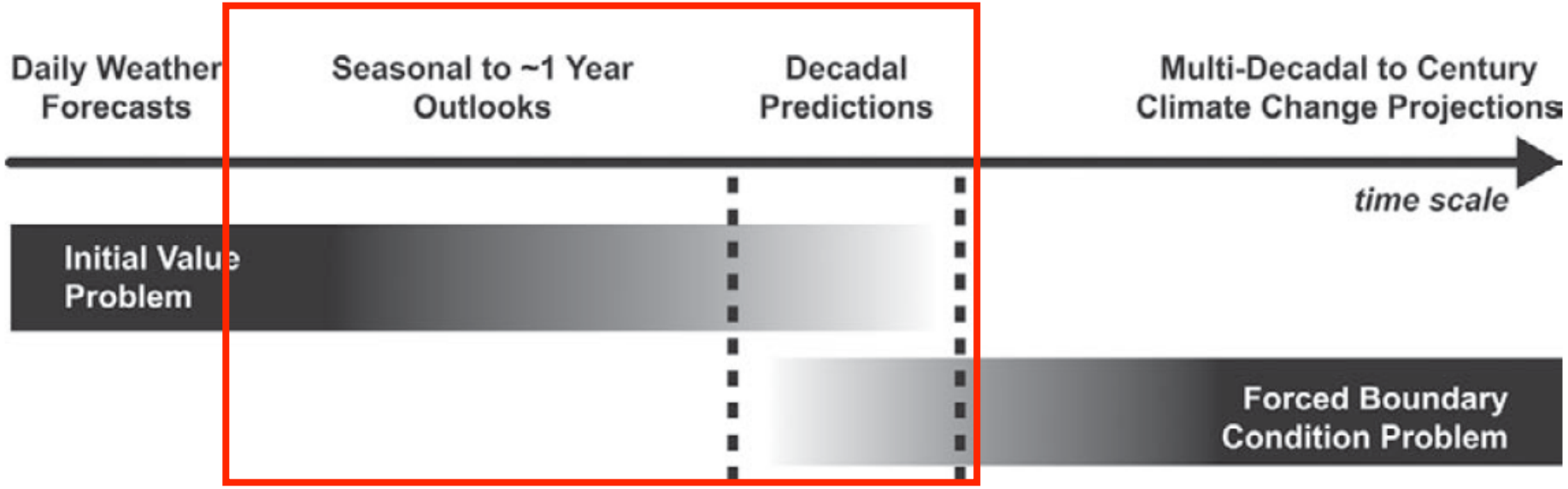
with information from WGSIP, DCPP, S2S, and PPP members

WCRP Secretariat Support: Michel Rixen

# Prediction on climate time scales

Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialization and systematic comparison with a simultaneous reference.




Meehl et al. (2009)

# WGSIP ToR

## Terms of reference

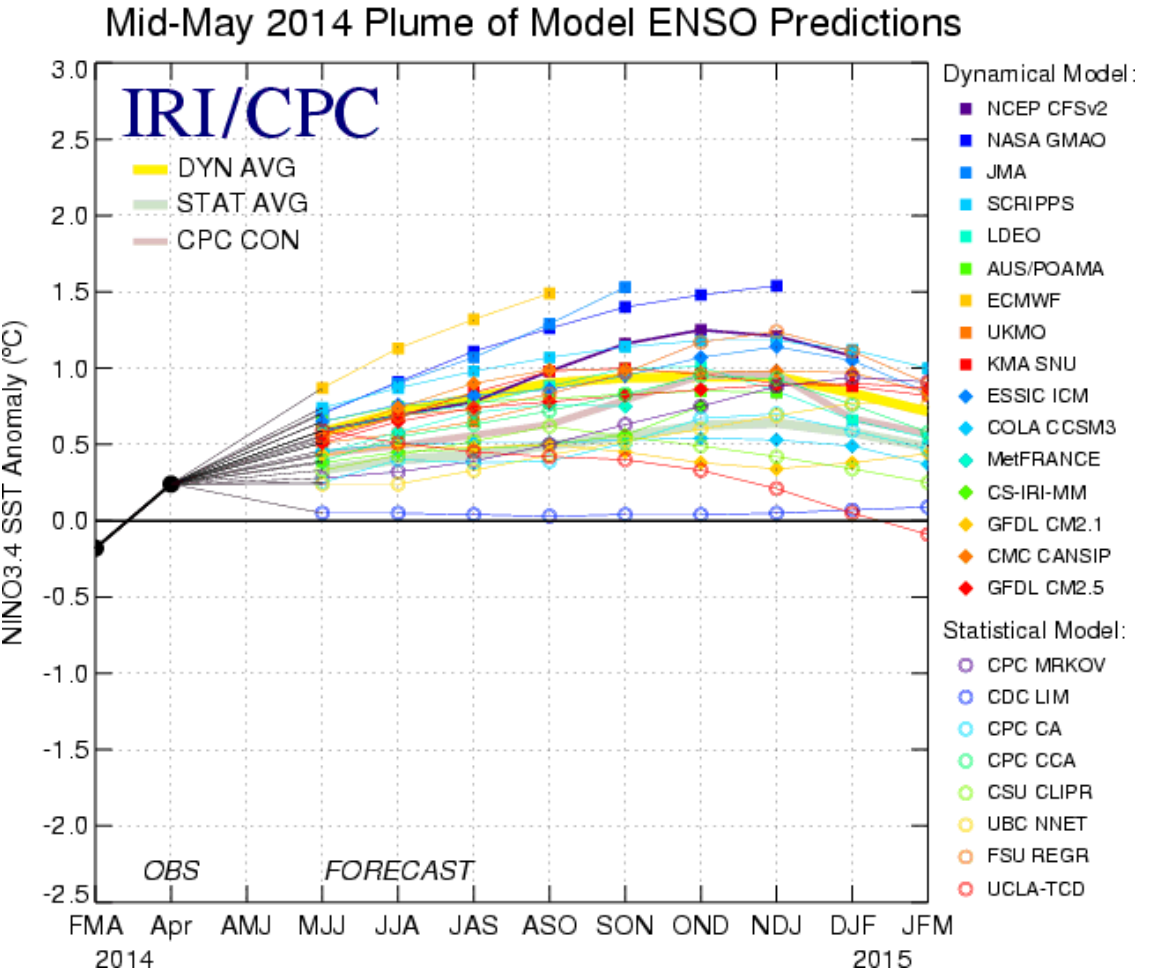
- Develop a programme of numerical experimentation for seasonal-to-interannual variability and predictability, paying special attention to assessing and improving predictions
- Develop appropriate data assimilation, model initialization and forecasting procedures for seasonal-to-interannual predictions, considering such factors as observing system evaluation, use of ensemble and probabilistic methods and statistical and empirical enhancements, and measures of forecast skill
- Foster synergies with the joint WCRP-WWRP project on Subseasonal to Seasonal Predictions to capitalize on both weather and climate scientific knowledge
- Advise the WCRP core projects and the JSC on the status of seasonal-to-interannual forecasting
- Liaise with WGCM, WGRC, WGNE and other relevant groups through WMAC and other channels as appropriate
- Liaise with the WDAC on the adequacy of the observing systems for model assessment and validation

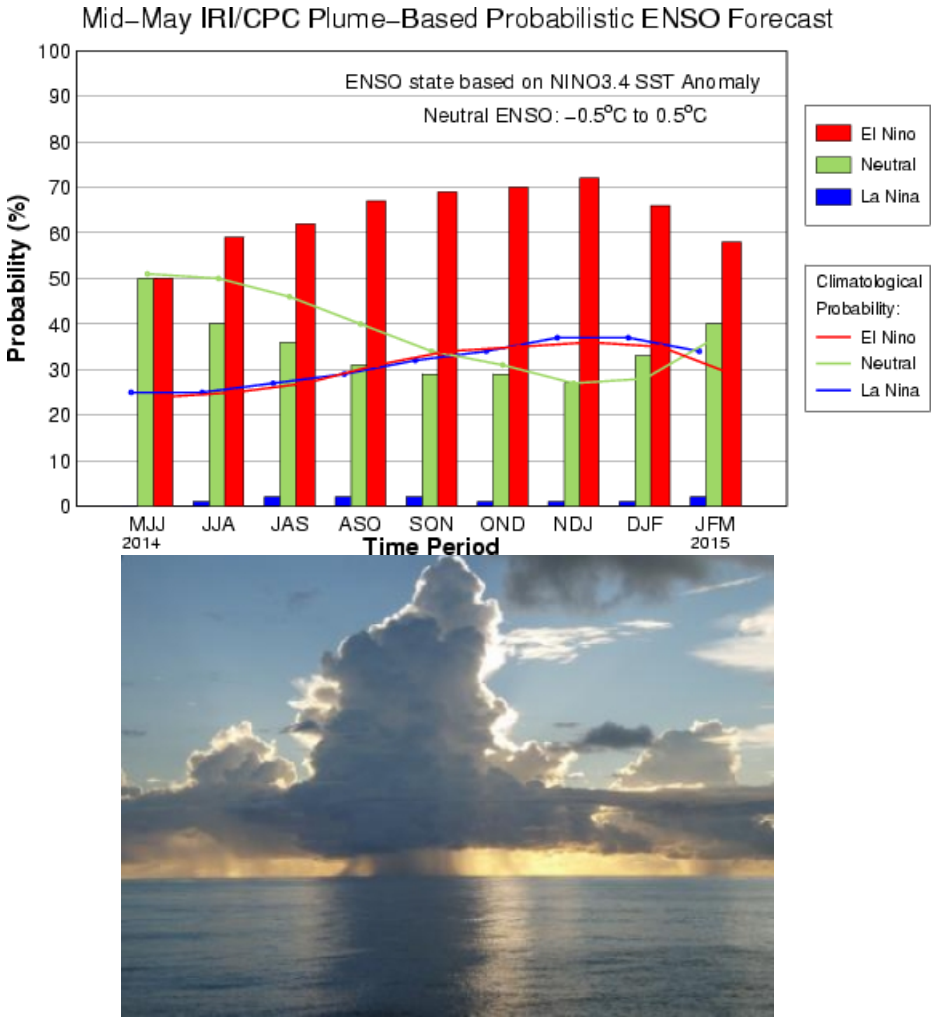
# Some open fronts

- Work on initialisation: initial conditions for all components (including better ocean), better ensemble generation, etc. Link to observational and reanalysis efforts.
- Model improvement: leverage knowledge and resources from modelling at other time scales, drift reduction. More efficient codes and adequate computing resources.
- Calibration and combination: empirical prediction (better use of current benchmarks), local knowledge.
- Forecast quality assessment: scores closer to the user, reliability as a main target, process-based verification.
- Improving many processes: sea ice, projections of volcanic and anthropogenic aerosols, vegetation and land, …
- More sensitivity to the users' needs: going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

# Seasonal forecasting

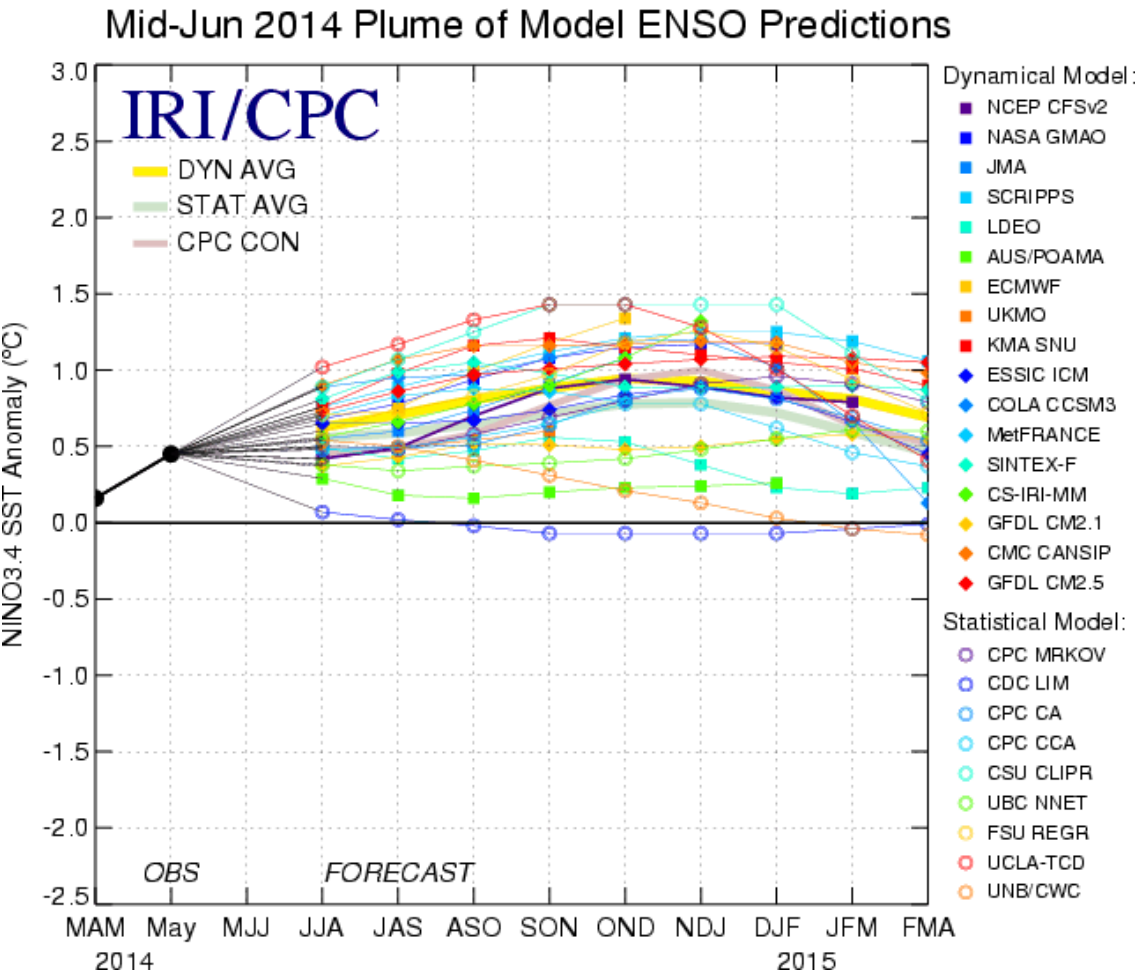
## 2014 ENSO predictions: May start date

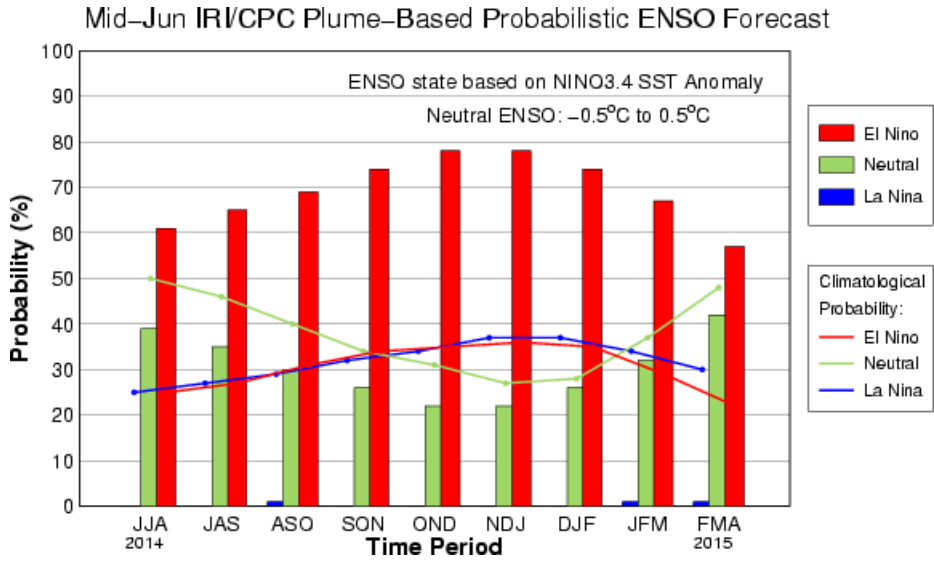


# Seasonal forecasting

## 2014 ENSO predictions: June start date

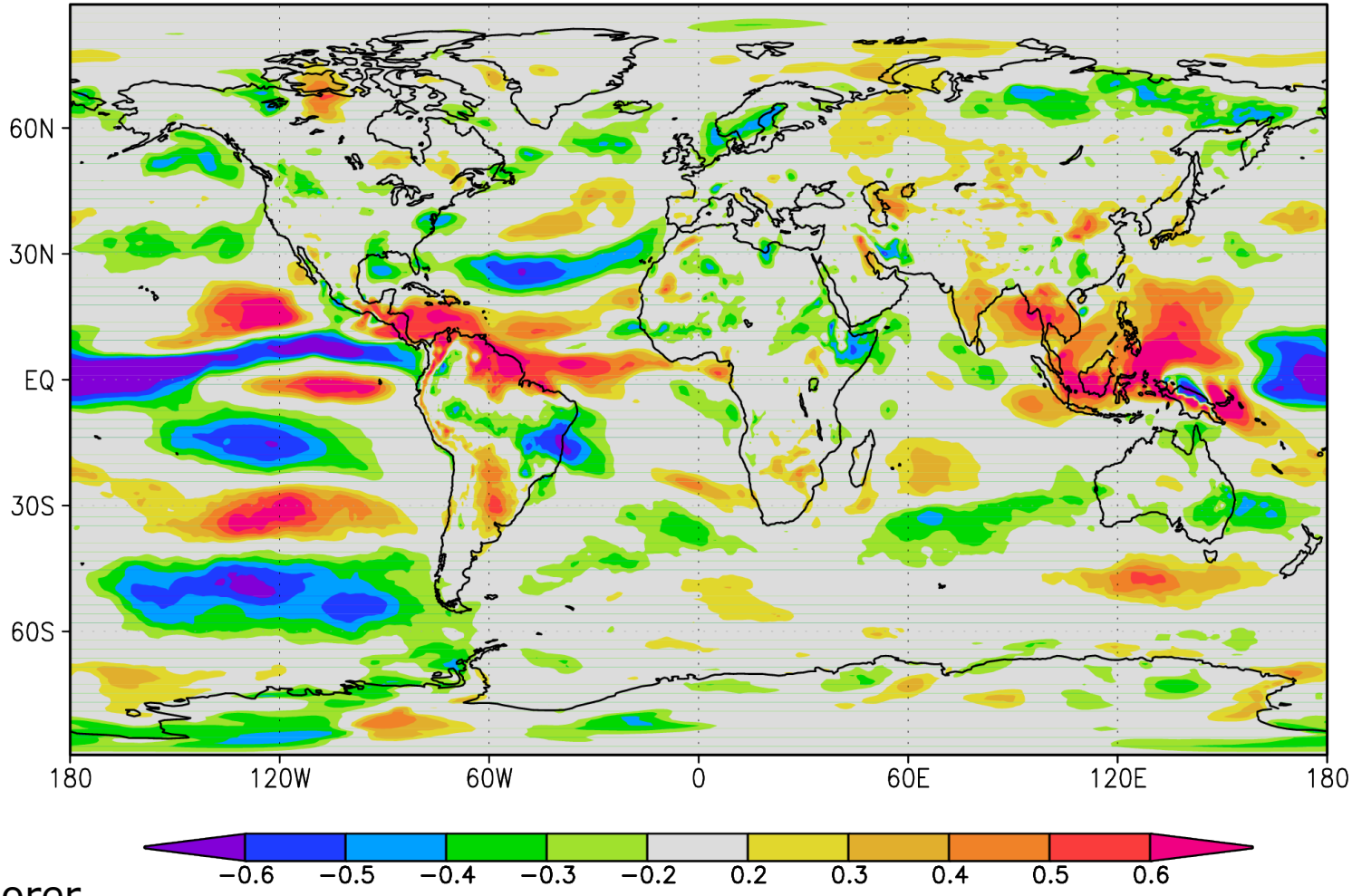



- Community effort
- Probabilistic character, lack of consistency
- Link to operations
- Communication issues

# Seasonal forecasting: impacts

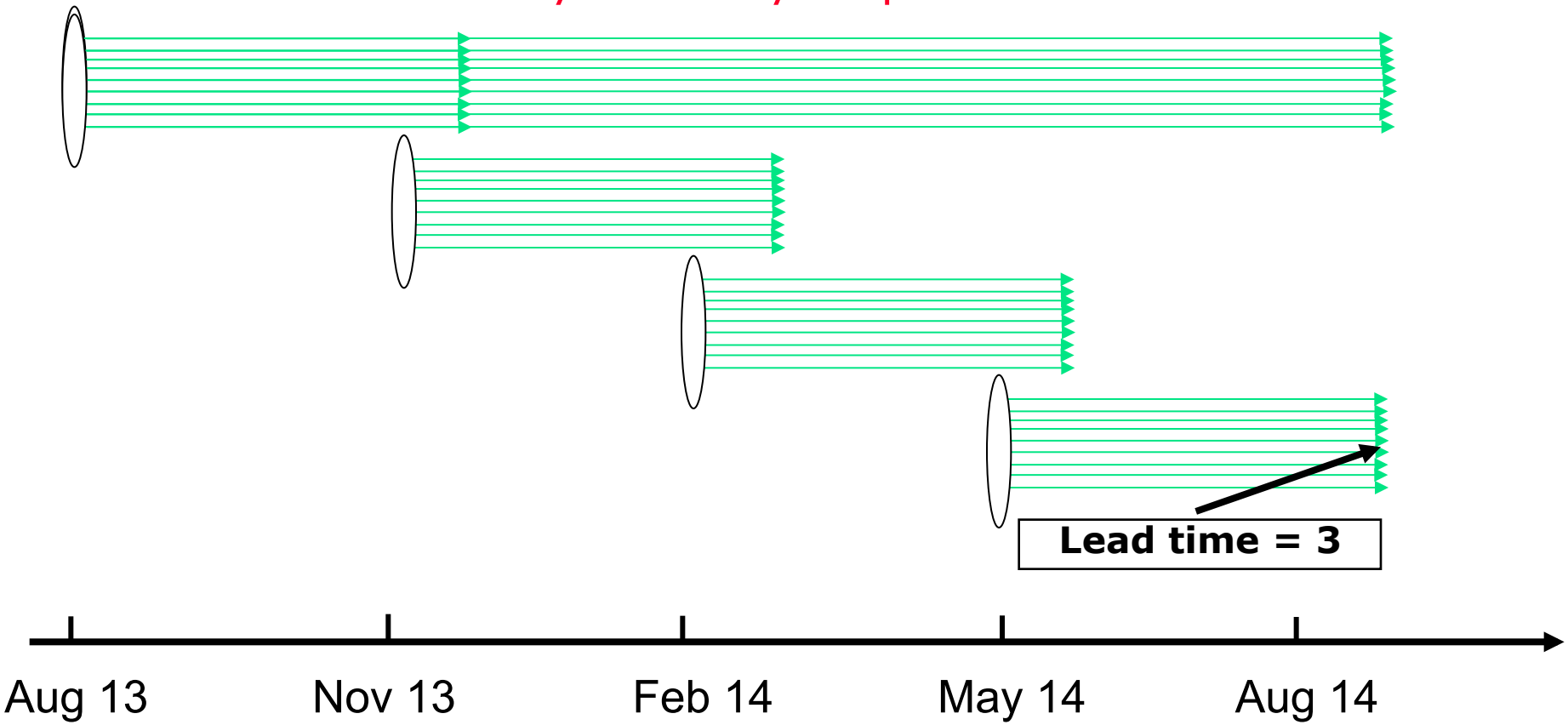
Correlation between the ERAInt 10-metre wind speed and Niño3.4 SST in JJA over 1979-2013.




Climate Explorer

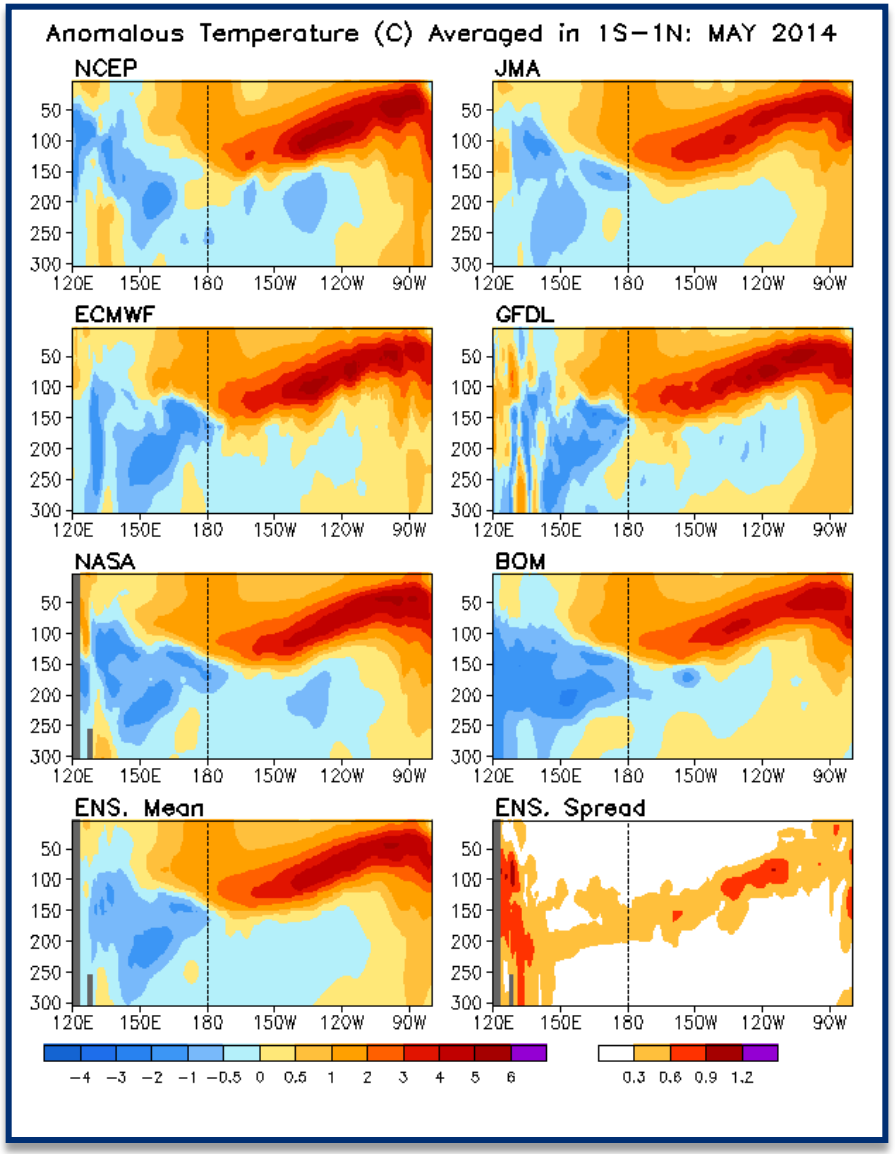
# Ensemble climate forecast systems

In a dynamical ensemble forecast system with coupled initialized GCMs hindcasts (retrospective forecasts) are essential to calibrate the predictions and to estimate forecast quality. Ensembles size typically 10-50 members. Cost for each start date of the month > 100 years of simulation. But consider very seriously empirical methods.



# Initialisation

- Real-time ocean reanalysis comparison. Temperature anomalies along the Equator based on 1981-2010 climatology.
- Large spread in real-time initial conditions (similar message from CLIVAR-GSOP).
- Good observations of the whole system are absolutely fundamental for accurate predictions.




Y. Xue (CPC)

# WGSIP at meetings

- Meetings
  - First international workshop on seasonal to decadal prediction (Météopole, Toulouse, May 2013)
  - WGSIP-16 (Met Office, March 2014), joint with Expert Team on Operational Predictions from Sub-seasonal to Long-Time Scales (ET-OPSLS)
  - Several teleconferences for the consolidation of the DCPP
- Future meetings
  - Pan-CLIVAR/pan-GEWEX meeting (The Hague, July 2014)
  - International workshop on polar-lower latitude linkages and their role in weather and climate prediction (Barcelona, December 2014)
  - WGSIP-17, joint with ICTP summer school and/or PRESAO RCOF (potentially Dakar, May 2015)

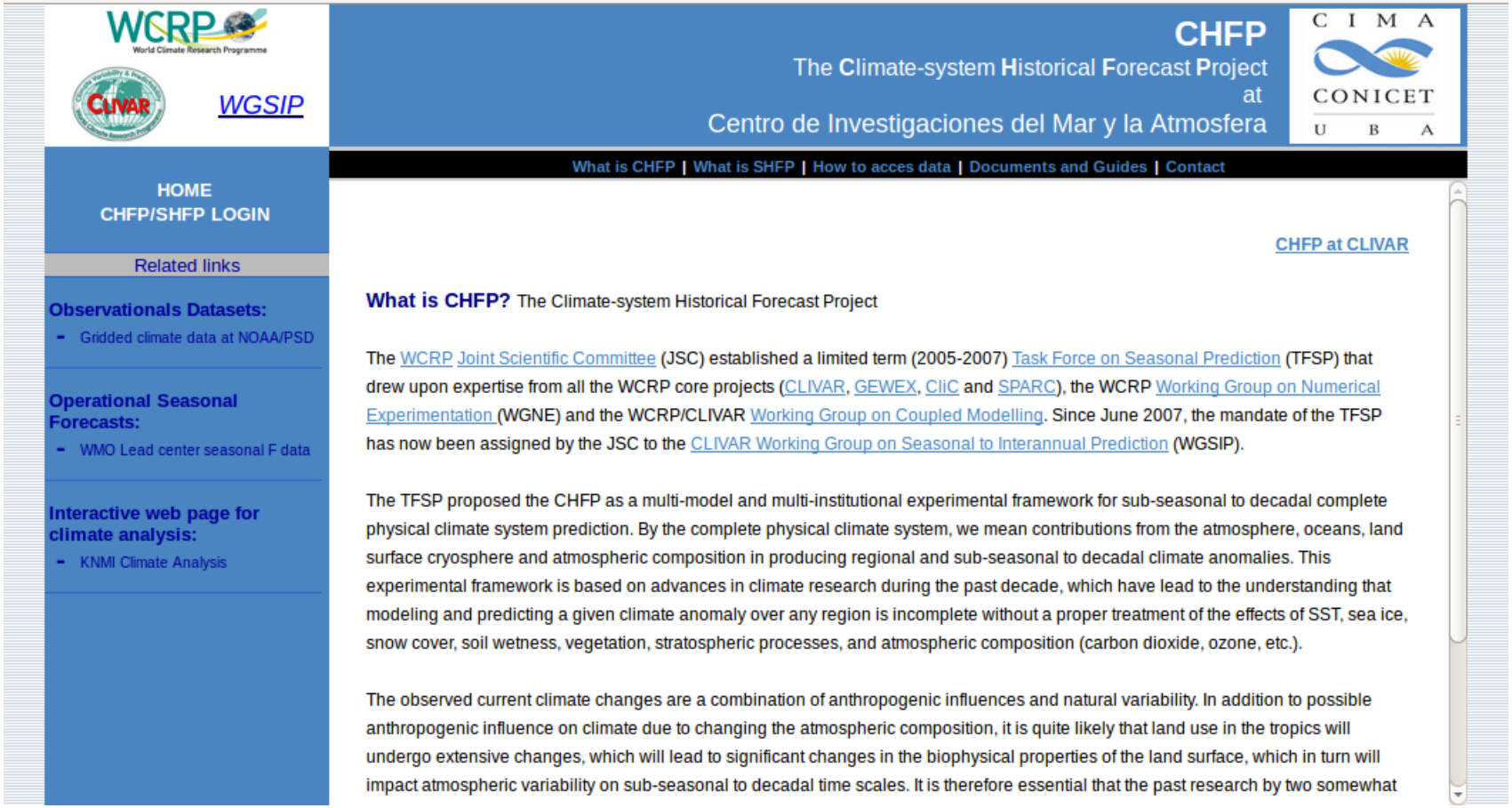
# Seasonal predictions

Dynamical seasonal predictions are regularly made by the global producing centres (GPCs).

WMO Lead Centre for long range forecast multi-model ensembles: www.wmolc.org

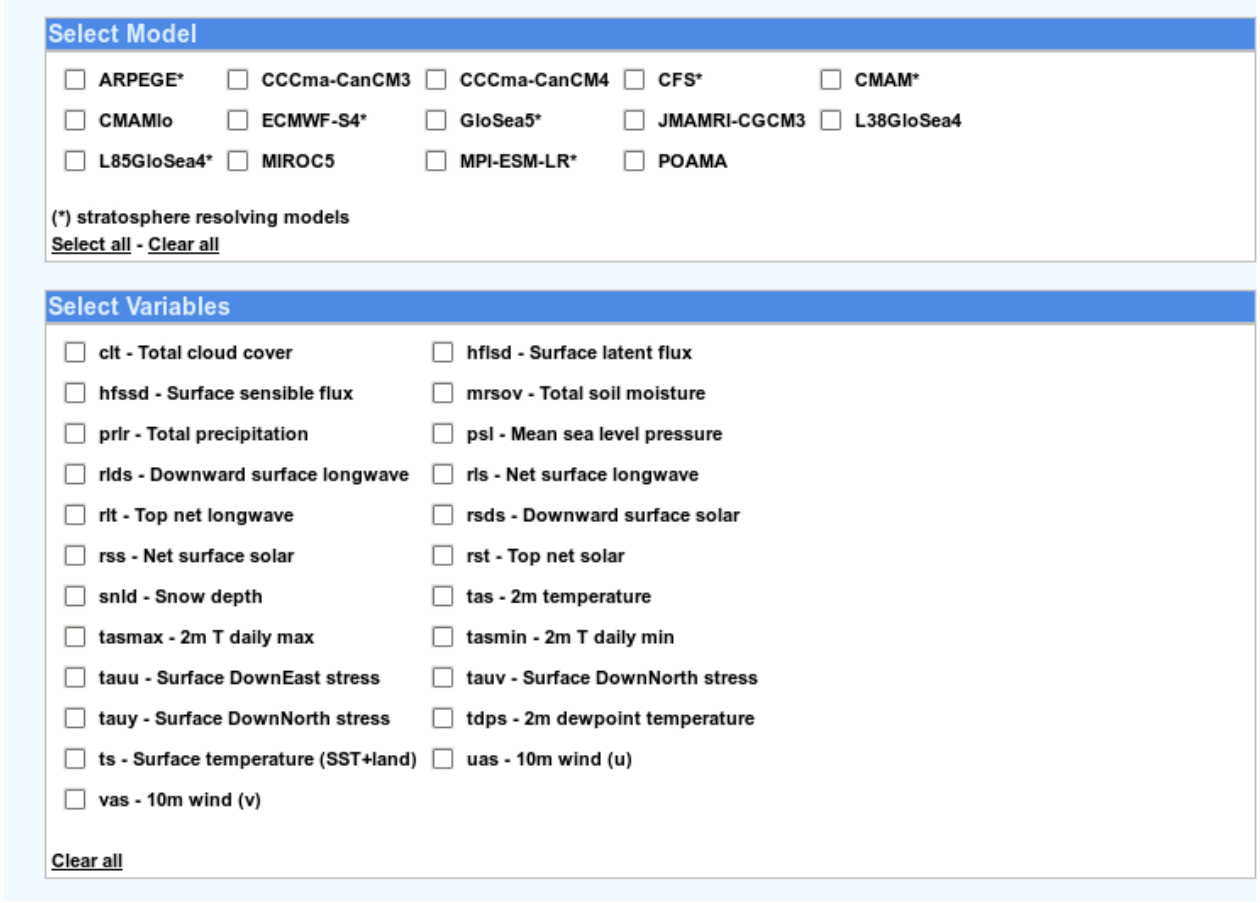
# CHFP

- Climate Historical Forecast Project, the largest repository of multi-model seasonal hindcasts.
- Data server at CIMA http://chfps.cima.fcen.uba.ar/



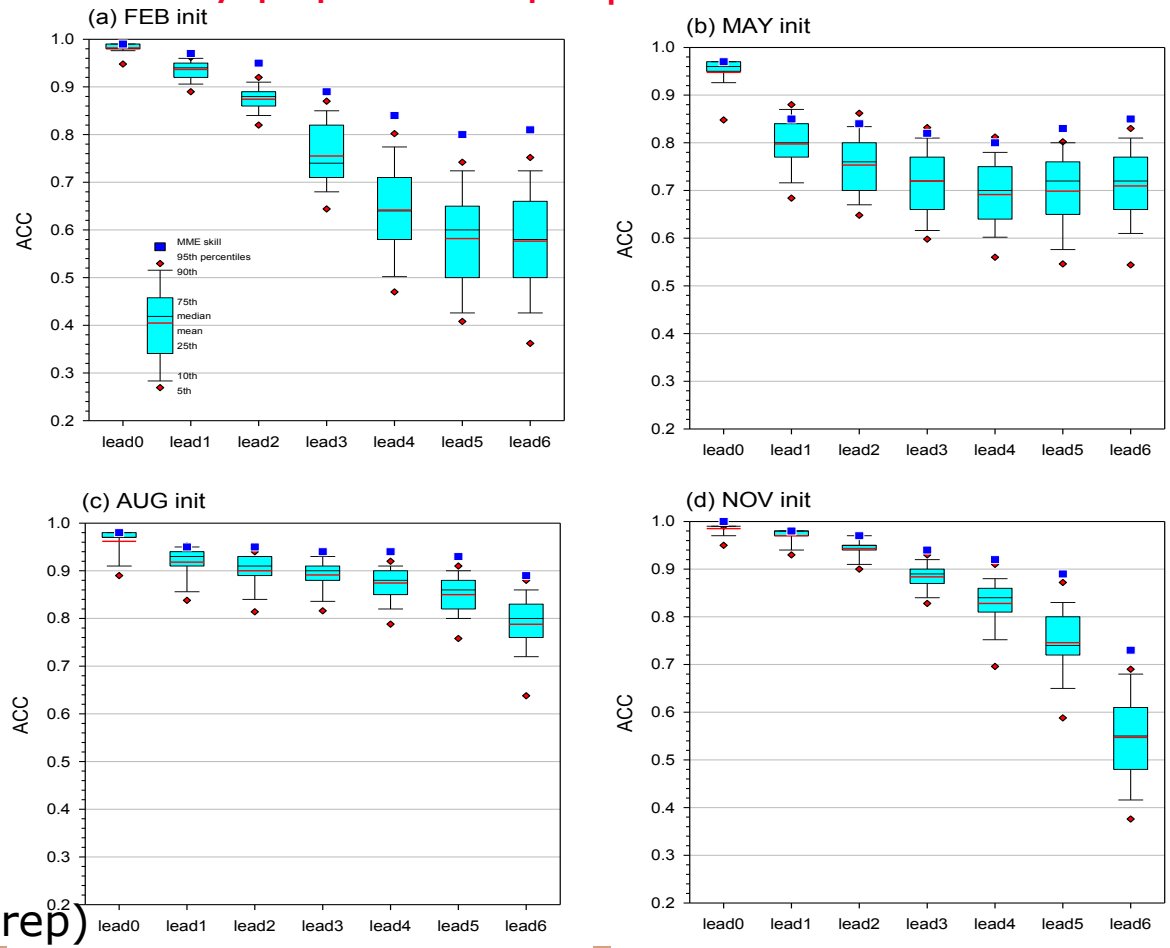
# CHFP

- To include the ENSEMBLES and NMME hindcasts this year.
- To be linked to the IRI data library for use with the CPT in capacity building events; proposal submitted to FE Fast Track Initiative/Cluster Activity call, but not fully accepted.



# CHFP

Niño3.4 correlation for four different start dates as a function of forecast time. The correlation of the multi-model ensemble mean is shown in blue and the distribution of the correlation for each ensemble member with the box-and-whisker plots. A summary paper is in preparation.



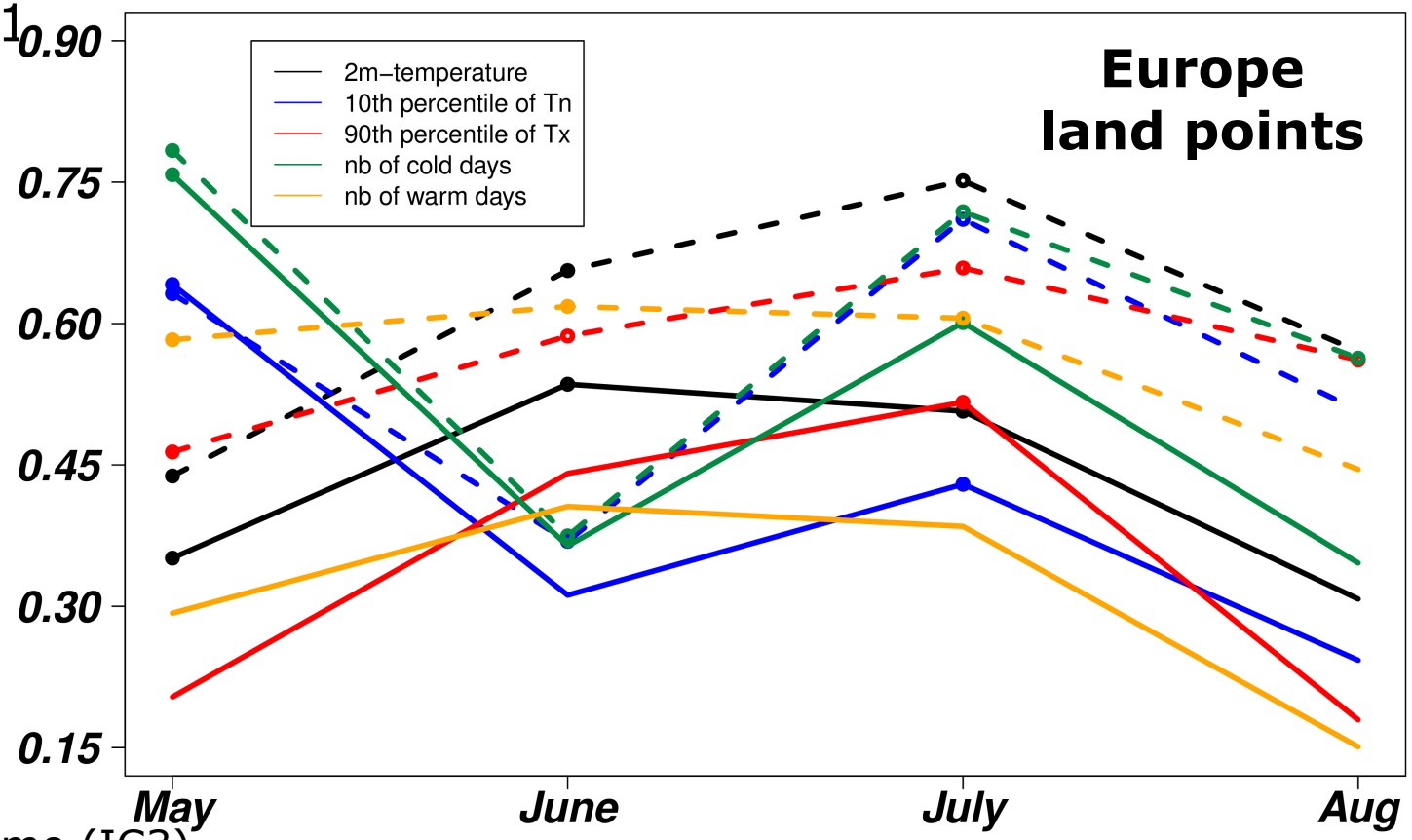

Kirtman et al. (in prep)

# CHFP sub-projects

- Areas of untapped skill were identified at the WCRP 2007 workshop on seasonal prediction.
- Lead to three additional experiments:
  - Land Surface, the **GLACE2** experiment (R. Koster): Soil moisture experiments in seasonal mode. Data for ten different systems available from R. Koster upon request. Transposed to assess impact of snow initial conditions (snowGLACE).
  - Stratosphere, **Stratospheric Historical Forecast Project** (A. Scaife): High top-Low top four-month hindcasts from 1989 starting in May and November.
  - **Sea Ice Historical Forecast Project** (D. Peterson): Six-month predictions starting in May, August and November for case studies with observed and climatological initial sea-ice data (2007/1996). Leading to contributions to the SEARCH Sea Ice Outlook.
- Recently revised with new experiments.

# CHFP sub-projects: GLACE2

GLACE2 Series 1 and Series 2 skill. Correlation of the ensemble-mean for temperature from experiments with realistic (dashed) and climatological (solid) land-surface initialisation. EC-Earth2.3 started in May with initial conditions from ERAInt, ORAS4 and a sea-ice reconstruction over 1979-201




C. Prodhomme (IC3)

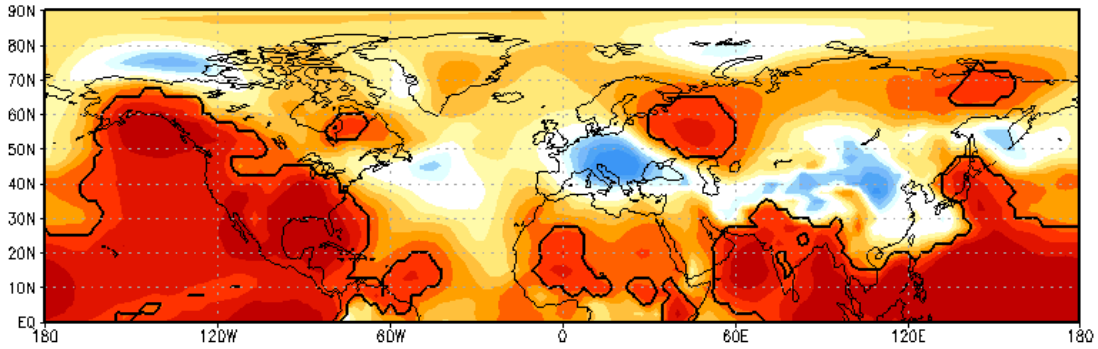
# CHFP sub-projects: StratHFP

High versus low-top ensemble hindcasts. Anomalies of DJF MSLP for the ten winters with stronger ENSO anomalies from the CHFP multi-model ensemble. Link to SPARC-SNAP.

High-top Ensemble

$ACC_{30\text{-}90N}$= 0.47

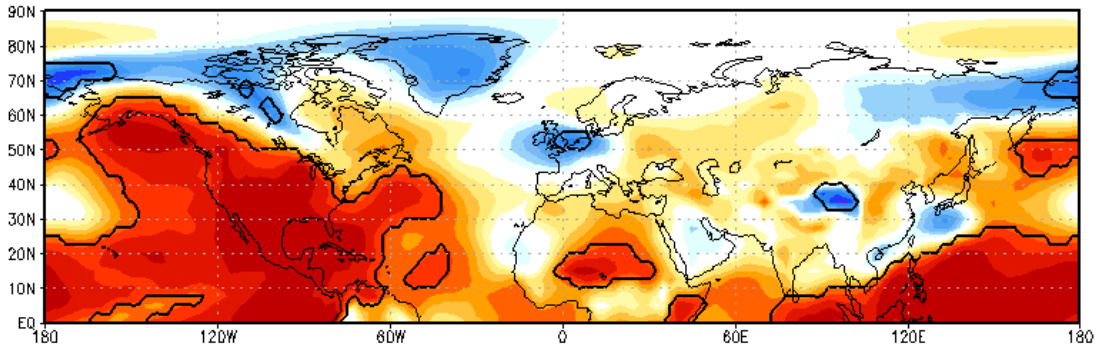
$ACC_{60\text{-}90N}$= 0.36

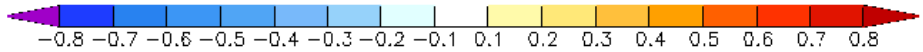



Low-top Ensemble

$ACC_{30\text{-}90N}$= 0.38

$ACC_{60\text{-}90N}$= 0.08




A. Batler, A. Scaife

# THORPEX legacy projects

The subseasonal-to-seasonal (S2S) prediction initiative is a WWRP/WCRP joint initiative with objectives:

- To improve forecast skill and understanding on the sub-seasonal 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 GFCS
- Open data access

| | Time-range | Resolution | Ens. Size | Frequency | 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 | T126L64 | 16 | daily | Fix | 1999-2010 | Once a day | 4 |
| **EC (exp)** | d 0-35 | 0.6x0.6 L40 | 21 | weekly | On the fly | Past 18y | weekly | 4 |
| **CAWCR** | d 0-120 | T47L17 | 33 | 2/week | Fix | 1989-2010 | 3/month | 33 |
| **JMA** | d 0-34 | T159L60 | 50 | weekly | Fix | 1979-2010 | 3/month | 5 |
| **KMA** | d 0-30 | T106L21 | 20 | 3/month | Fix | 1979-2010 | 3/month | 20 |
| **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 | T127L31 | 51 | 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 | weekly | Fix | 1979-2003 | monthly | 10 |

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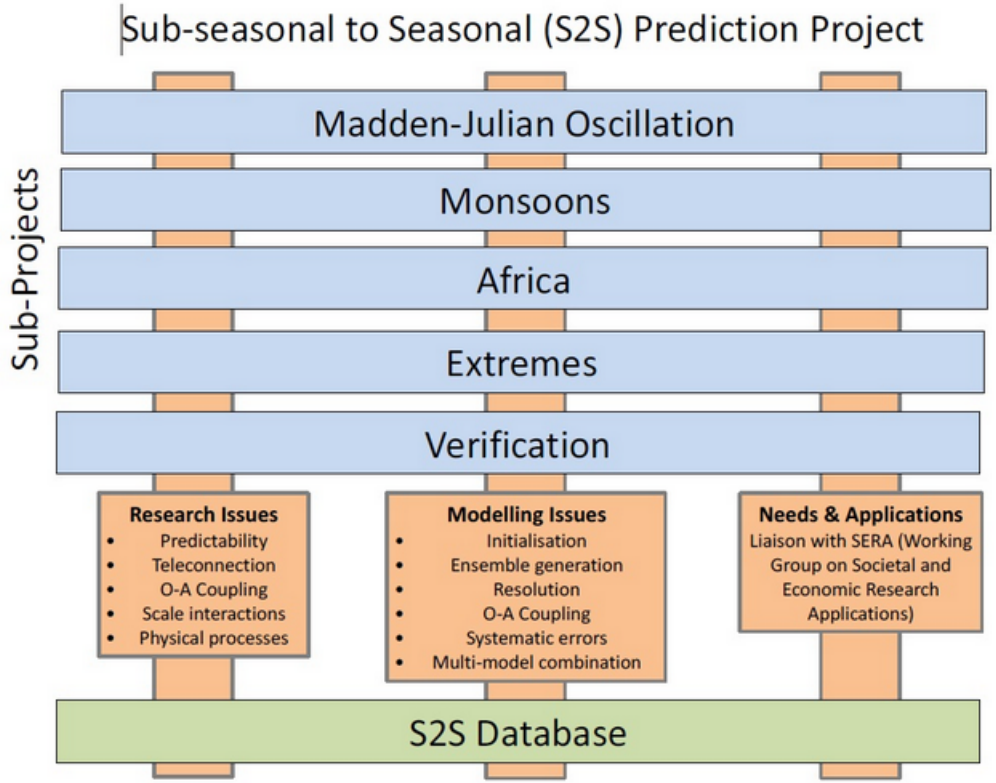
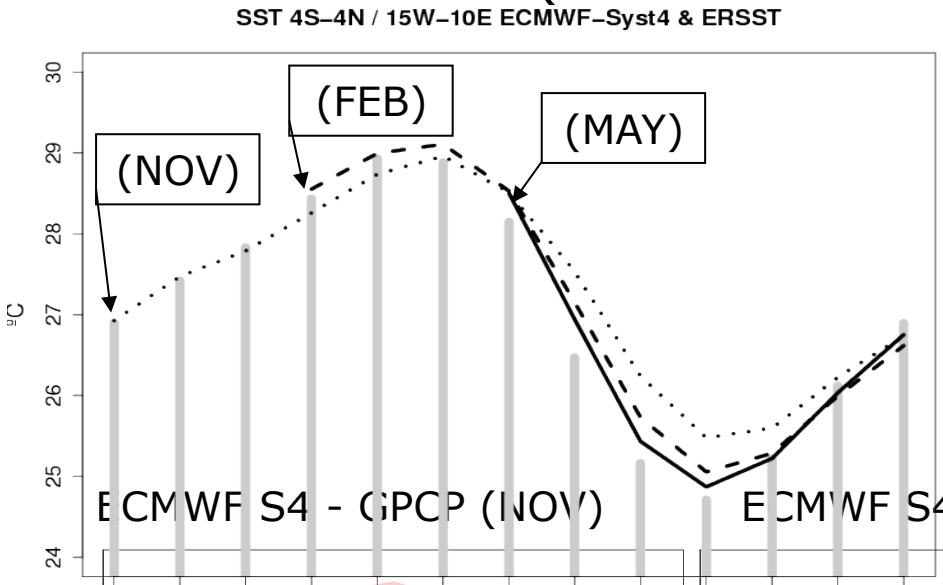


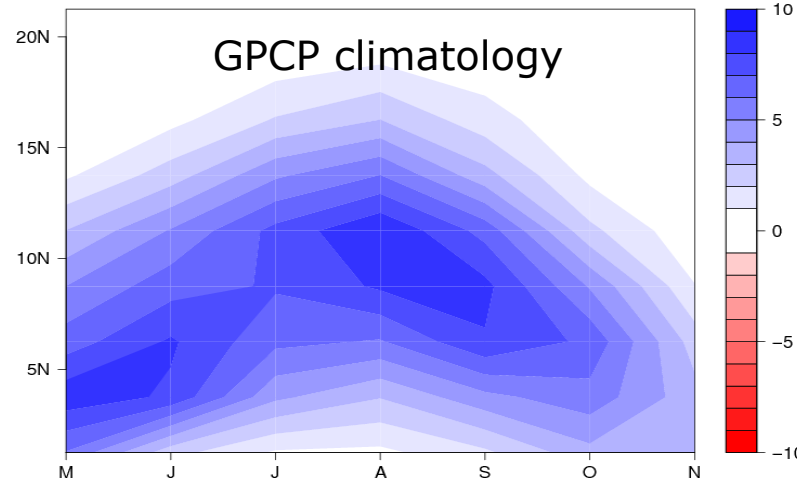
# WGSIP science projects

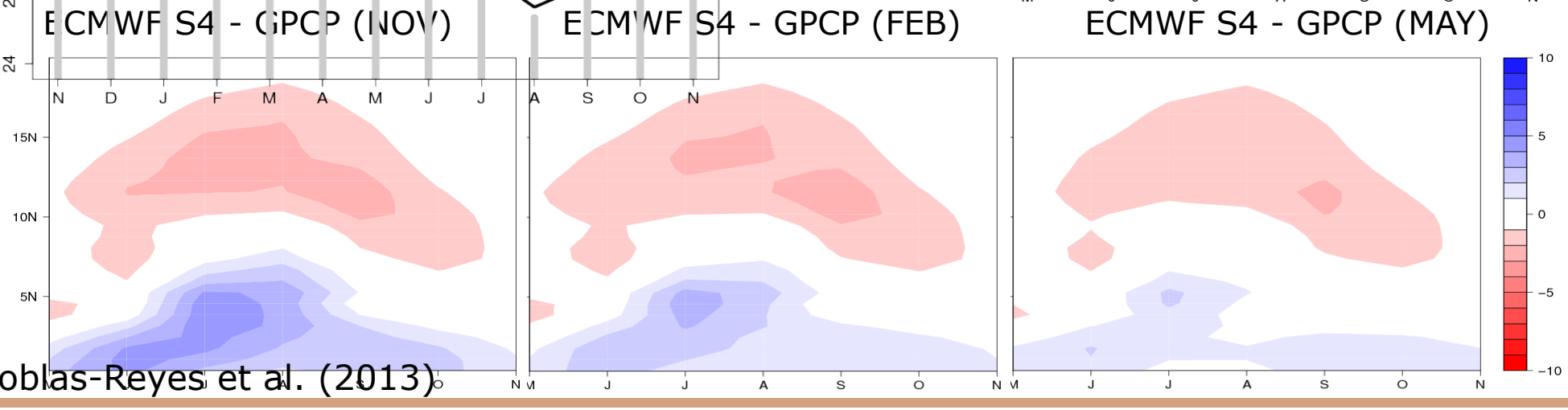
- Leverage resources from the community to analyse the huge amount of experiments already available. Identify key problems that hamper progress in climate prediction. Design new experiments. Link to S2S and other initiatives.
- Lead to three science projects:
  - Model drift/initial shock and model validation within the first month: Mikhail Tolstykh (lead atmosphere), Bill Merryfield (lead ocean) => links to coupled initialisation (note that initialisation is not data assimilation)
  - Interaction/teleconnection between tropics and extratropics: Laura Ferranti, Hervé Douville (co-lead)
  - SNOW Glace: Jee-Hoon Jeong, Yvan Orsolini (co-lead) -> ACTION: Build links with GEWEX and CliC (SnowMIP)
- Inspiring instead of prescribing. Gain visibility among those not familiar with climate prediction.
- Work plans available this autumn.

# Drift: West African Monsoon

Averaged precipitation over 10ºW-10ºE for the period 1982-2008 for GPCP (climatology) and ECMWF System 4 (systematic error) with start dates of November (6-month lead time), February (3) and May (0).



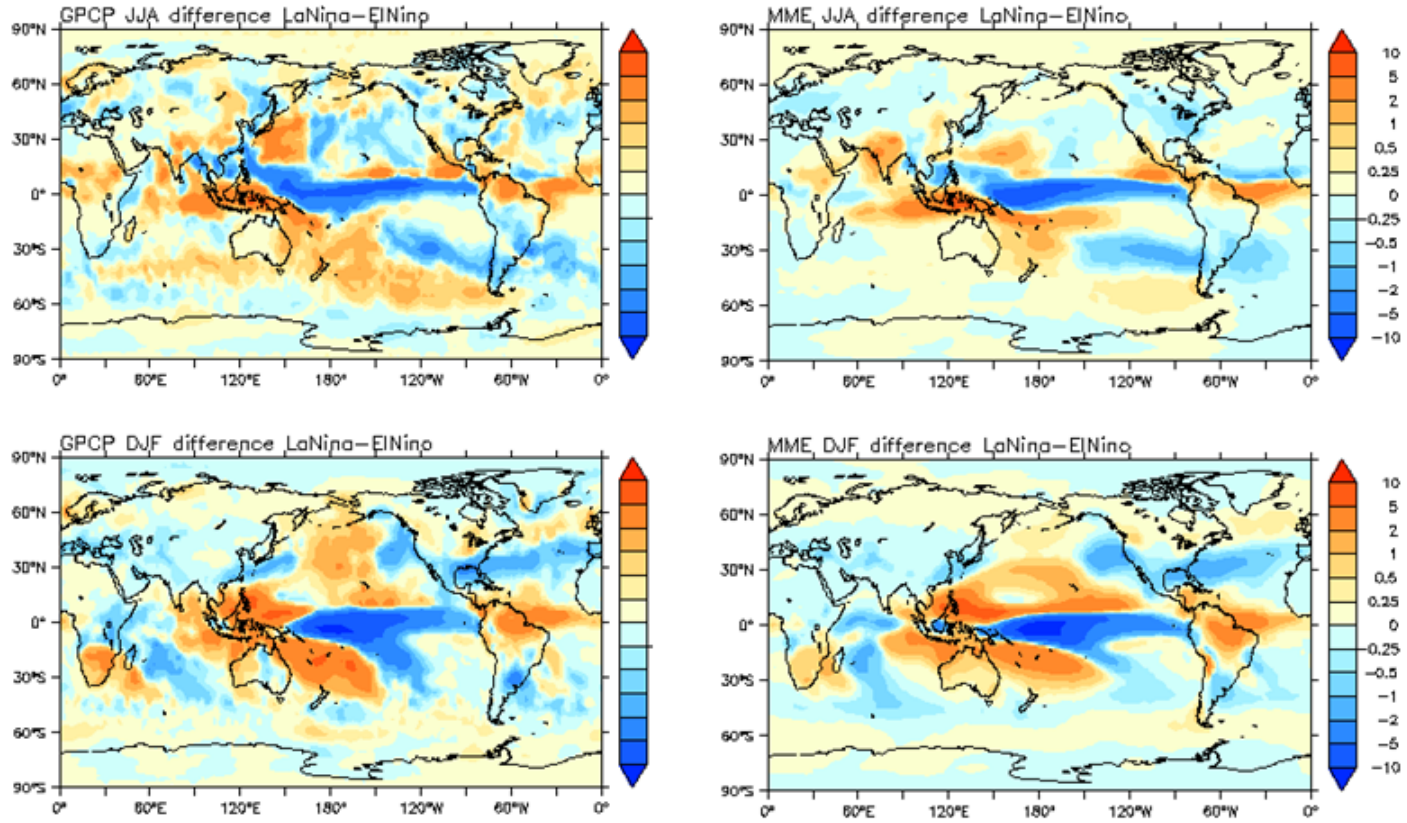




Doblas-Reyes et al. (2013)

# Tropical/extra-tropical links

Composite precipitation differences (La Niña minus El Niño) based on years which observed seasonal mean Nino3.4 exceeds ±1 standard deviation over 1982-2009, from GPCP observations (left) and the CHFP ensemble at 1-month lead time (right), for JJA (top) and DJF (bottom).

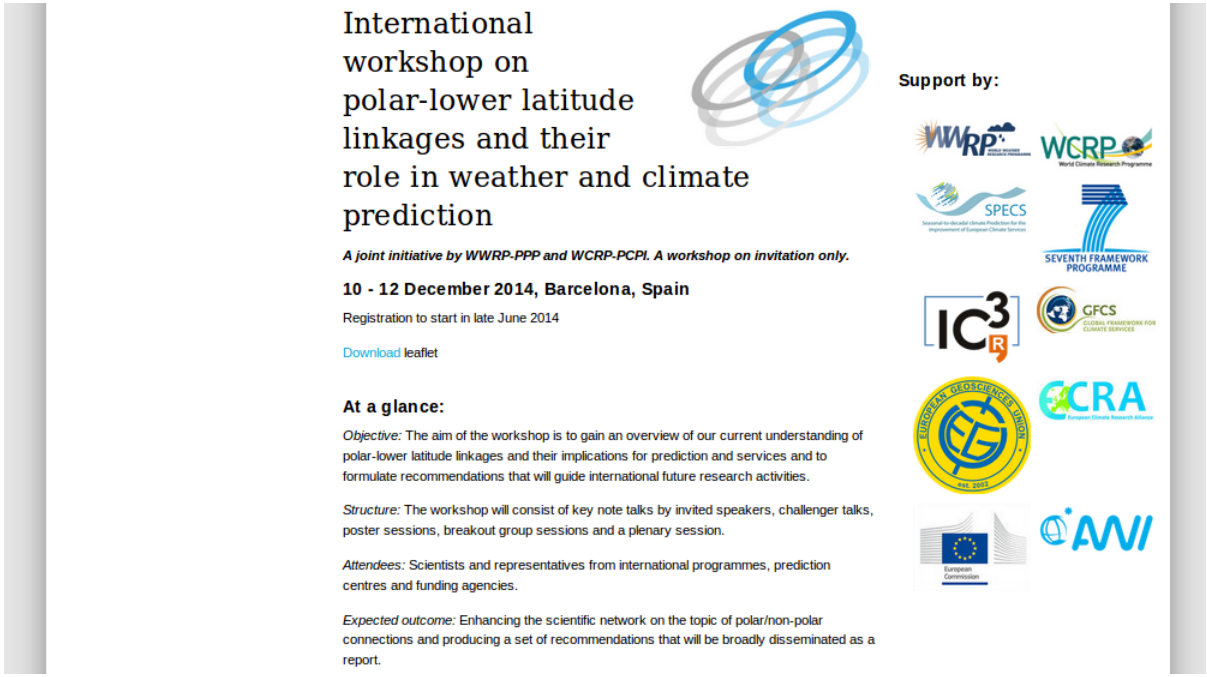



Kirtman et al. (in prep.)

# THORPEX legacy projects

The Polar Prediction Project (PPP) promotes cooperative international research enabling development of improved prediction services for the polar regions, on time scales from hourly to seasonal. This is the hourly to seasonal research component of the WMO Global Integrated Polar Prediction System (GIPPS), and is complementary to PCPI.

WGSIP contributes to the links between polar and non-polar regions (workshop in December) and the organisation of YOPP.



International workshop on polar-lower latitude linkages and their role in weather and climate prediction

***A joint initiative by WWRP-PPP and WCRP-PCPI. A workshop on invitation only.***

**10 - 12 December 2014, Barcelona, Spain**

Registration to start in late June 2014

Download leaflet

**At a glance:**

*Objective:* The aim of the workshop is to gain an overview of our current understanding of polar-lower latitude linkages and their implications for prediction and services and to formulate recommendations that will guide international future research activities.

*Structure:* The workshop will consist of key note talks by invited speakers, challenger talks, poster sessions, breakout group sessions and a plenary session.

*Attendees:* Scientists and representatives from international programmes, prediction centres and funding agencies.

*Expected outcome:* Enhancing the scientific network on the topic of polar/non-polar connections and producing a set of recommendations that will be broadly disseminated as a report.

**Support by:**

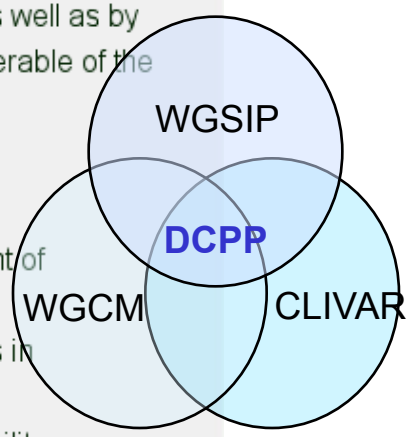
# Decadal prediction

The Decadal Climate Prediction Panel (DCPP) promotes coordinated decadal prediction experimental set ups and informal near-real time exchange of multi-model forecasts. It also organises the decadal MIP towards CMIP6 (with four components, and including consideration of a transpose CMIP).
The DCPP is managed by WGSIP, WGCM and CLIVAR; chair George Boer.

The term "decadal prediction" encompasses predictions on annual, multi-annual to decadal timescales. The possibility of making skilful forecasts on these timescales, and the ability to do so, is investigated by means of predictability studies and retrospective predictions (hindcasts) made using the current generation of climate models as well as by means of statistical approaches. Skilful decadal prediction of relevant climate parameters is a Key Deliverable of the WCRP's Grand Challenge of providing Regional Climate Information.

The DCPP envisions four components:

- ***Hindcasts***: the design and organization of a coordinated decadal prediction (hindcast) component of CMIP6 in conjunction with the seasonal prediction and climate modelling communities
- ***Forecasts***: the ongoing production of experimental quasi-operational decadal climate predictions in support of multi-model annual to decadal forecasting and the application of the forecasts
- ***Predictability and mechanisms***: the organization and coordination of decadal climate predictability studies including the study of the mechanisms that determine predictability
- ***Case studies***: the organization and coordination of case studies to investigate the ability to predict particular climate shifts and variations that have occurred and to identify the processes determining these behaviours



# Decadal prediction

Multi-model real-time decadal prediction exchange will request additional support at CCl16. Very simple: research exercise, we can learn a lot from this; prevent over-confidence from a single model; equal ownership.

http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/decadal-multimodel

## Multi-model decadal forecast exchange

The Met Office coordinates an informal exchange of near-real time decadal predictions. Many institutions around the world are developing decadal prediction capability and this informal exchange is intended to facilitate research and collaboration on the topic.

The contributing prediction systems are a mixture of dynamical and statistical methods. The prediction from each institute is shown below, alongside an average of all the models. When possible, observations for the period of the forecast are also shown. Currently three variables are included: surface air temperature, sea-level pressure and precipitation. These are shown as differences from the 1971-2000 baseline. More diagnostics, including ocean variables are planned for the future. Please use the drop-down menus below to explore the data collected to date.

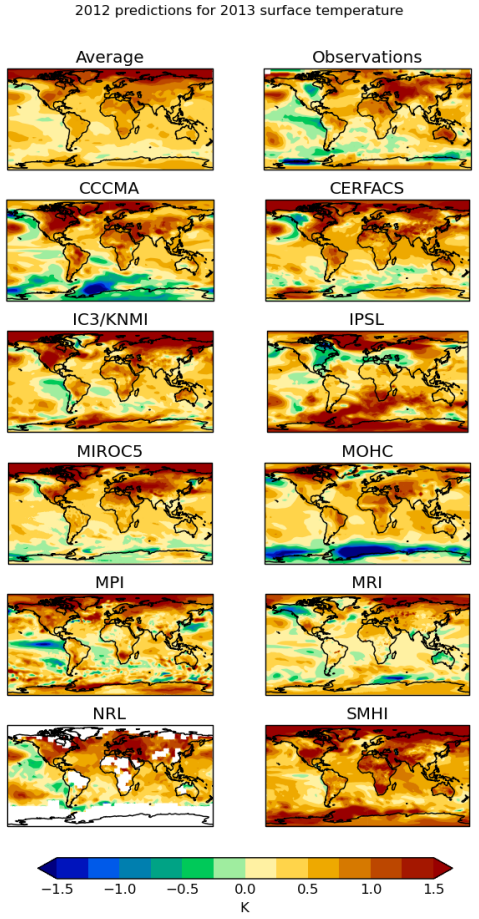
This work is supported by the European Commission SPECS project.

To learn more about decadal forecasts at the Met Office, see our current decadal forecast.

Images last updated 2014-06-25

Issued: 2013 | Period: year 1 | Element: surface air temperature

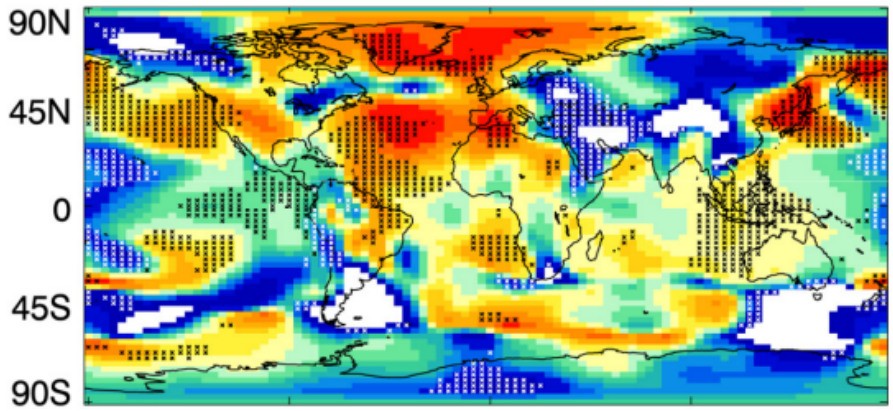
Decadal forecast exchange 2013 predictions for year 1 surface air temperature



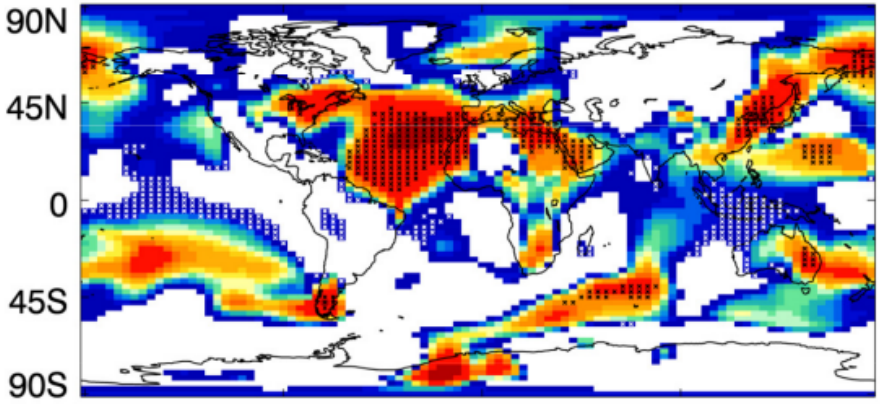
# Decadal prediction

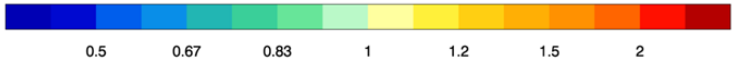
Ratio of predictable components in reality and models (RPC). RPC<1 (blue) ⇒ models **overconfident** (agree with each other but not with reality); RPC>1 (red) ⇒ models **under confident** (unexpected!) ⇒ **also for seasonal NAO**. These results are interpreted as reality is more predictable than models ⇒ models respond too weakly to SSTs? Members are not potential realisations of reality ⇒ affects skill assessment. Can make skilful predictions now, but need mean of large ensemble and to adjust variance. Higher skill possible with improved models.

GloSea5 DJF (months 2-4), MSLP




Multi-model decadal, 2-5 years, MSLP




Eade et al. (submitted)

# Actions from last JSC meeting

## Actions from JSC34:

- ACTION 1: Engage in implementation of the Research, Modelling and Prediction component of GFCS.

  *WGSIP is actively involved in projects like SPECS and EUPORIAS and organises joint meetings with WMO ET-OPSLS. Similarly, DCPP promotes the pre-operational real-time multi-model decadal forecast exchange led by the Met Office. Also, strong participation in RCOFs.*

- ACTION 14: Contribution on s2d to the climate information on regional scales GC.

  *Contributors within the climate prediction community have been identified. Participation in all the relevant discussion meetings and at the WGCR Distillation meeting. CHFP and DCPP key contributors to the GC research.*

- ACTION 17: Provide input to CliC on the structure, goals, and objectives of the Cryosphere GC.

  *Strong connection in sea-ice prediction with PPP and some with PCPI, impact of reducing Arctic sea ice on local and remote circulation, impact of Arctic amplification in remote areas, and snow-cover impacts on atmospheric circulation. Polar teleconnection workshop in Barcelona in December 2014.*

# Actions from last JSC meeting

## Actions from JSC34:

- ACTION 18-19: Organise effective cooperation of research on cryosphere, especially sea-ice and snow.

  *WGSIP is in contact with PPP and PCPI, collaborates in the development of YOPP and intends to involve S2S in sea-ice efforts. Common experiments at seasonal to interannual scales and contribution to the SEARCH Sea-Ice Outlook. Use of new datasets like ESA CCI sea-ice concentration and thickness to initialise and validate forecasts.*

- ACTION 46: Participation in the Tromsø Workshop on the Cryosphere GC.

  *WGSIP was represented.*

- ACTION 53: Engagement in ESGF.

  *Next overheads.*

# Moving towards ESGF

- WGSIP uses the CHFP convention for NetCDF files. This convention (CF compliant) allows aggregation of files and offers a minimum level of experiment documentation.
- The CHFP convention is not compatible with ESGF standards and cannot benefit from the ESGF growing set of tools: data quality control, documentation, catalogues and data node technology, DRS, access compatible for observations and analyses, metrics for evaluation, etc.
- WGSIP is moving towards ESGF adopting the convention developed by the FP7 SPECS project. CIMA personnel has visited IC3 (supported by WCRP) and will rewrite all CHFP data in 2014 using the new convention. CIMA and IC3 will work together to create a WGSIP data node in Argentina.

# Moving towards ESGF

- NMME and some individual institutions are also moving.
- Moving CHFP towards the ESGF technology is relevant to climate services but comes at a substantial cost, especially when it comes to the experiment and forecast system documentation (initialisation methods). Resources.
- The downscaling community is already taking into account this move (VALUE COST action, CORDEX-ESDM) for the downscaling of climate predictions.
- ExArch offered to illustrate examples of the use of generic metrics for scientific evaluation. Communicate the experience to WIP and discuss how to extend it to ESMVal L1-3.
- However, …

# Moving towards ESGF

- However, WGSIP has its spirit divided among research and operations.
- Most of research and operations in some countries handle NetCDF and can relatively easily move to ESGF standards.
- Some research (most importantly S2S, but also the decadal prediction exchange) and most operations use GRIB or even other standards. A natural rejection of ESGF for climate prediction occurs.
- ESGF has still some governance and authority issues, while the GRIB/operational community has a clear governance coordinated by WMO. Big role for IS-ENES.
- Operational climate services (e.g. Copernicus CCS) will implement a solution. How to proceed with this?

# Grand challenges

- Regional climate information: directly involved, the community is expecting to contribute to the sub-seasonal, seasonal (RCOFs) and decadal prediction (real time exchange) components, as well as to the usefulness aspects (bias correction, calibration, combination, downscaling, communication). Tool for climate adaptation.
- Cryosphere in a changing climate: sea-ice predictions and prediction of local and remote impacts of Arctic changes.
- Climate extremes: prediction and attribution of monthly, seasonal and interannual extremes.
- Clouds, circulation, and climate sensitivity: improvement of precipitation and circulation prediction.
- Regional sea level rise: verification of decadal predictions.
- Water Availability: prediction of near-surface variables.

# Summary

- Strong links to operational activities
- Growing number of seasonal hindcasts in the CHFP database (CMIP for seasonal) and revisited coordinated experiments
- Exciting results for extratropical winter predictability and a clear role for the stratosphere
- Three new science projects TO BE ENDORSED BY THE JSC
- Discussion of decadal prediction for CMIP6 jointly with WGCM and CLIVAR
- Real time decadal predictions being exchanged
- Strong links to GCs and THORPEX legacy projects
- Important data dissemination and documentation issues