WORKING GROUP REPORT

Report of the sixteenth session of the Working Group on Seasonal to Interannual Predictions

UK Met Office, Exeter, 10-12 March 2014

June 2014

WCRP Report No. 9/2014

Attendees at the joint WGSIP/ET-OPSLS session

Attendees at the WGSIP session

WGSIP members: Adam Scaife, Francisco Doblas-Reyes, Swadhin Behera, Hervé Douville, Laura Feranti, Jee-Hoon Jeong, Ben Kirtman (remotely), Arun Kumar, Bill Merryfield, Ousmane Ndiaye, Yvan Orsolini, Andy Robertson, Celeste Saulo, Mickhail Tolstykh, Adrian Tompkins, Tamaki Yasuda

Additional ET-OPSLS members: Richard Graham, Caio Coelho, Asmerom Beraki, Jean-Pierre Ceron, Bertrand Denis, David Jones, Suhee Park, Yuhei Takaya, Peiqun Zhang

Invitees: Alberta Arribas, George Boer, Anka Brookshaw, Matt Palmer, Drew Peterson, Anna Pirani, Sonia Seneviratne (remotely), Cath Senior, Doug Smith, David Stephenson, Peter Stott

WMO Secretariat: Michel Rixen, Rupa Kumar Kolli, Peter Chen

1. Introduction

a. Welcome, introductions and local arrangements – WGSIP and ET-OPSLS Co-chairs

WGSIP and ET-OPSLS co-chairs welcomed all participants and thanked them for attending this joint session. The purpose of the joint meeting was to foster increased links between research and operational aspects of long-range forecasting and to agree on joint actions that will help tailor research to operational needs. The joint session began with an overview of the work of the ET-OPSLS and WGSIP teams and an update on the implementation of the Global Framework for Climate Services (GFCS). The joint session was presented with a wide range of research activities in sub-seasonal, seasonal and multi-annual to decadal prediction as well as research into user application, and reports on the activities of individual Global Producing Centers for long-range forecasts (GPCs).

The full report of the Joint CBS/CCl ET-OPSLS session is available at http://www.wmo.int/pages/prog/www/CBS-Reports/documents/FinalReport_v1_25Aprr2014_final-master.doc.

b. Overview: WMO ET-OPSLS – R. Graham/C. Coelho

Richard Graham provided an overview of the WMO ET-OPSLS (Expert Team on Operational Predictions from Sub-seasonal to Longer Time-Scales), a joint CBS/CCl team which aims at guiding development of infrastructure for long-range forecasting and on improving forecast products and their availability to Members. The infrastructure currently comprises 12 Global Producing Centers of Long-Range Forecasts (GPCs) and associated 2 Lead Centers (LC) on forecasts (KMA and NCEP) and verification (BoM and CMC). These GPC and LC products are essential for RCCs and RCOFs. The need for

improved availability of products and verification information, longer lead time, capacity development and communication between research and operations was highlighted.

Discussions focused on the difficulty to derive a consensus forecast in some objective way. It was also suggested to look at predictability and possible product synergies between CHFP and GPCs. The suitability of global models to derive regional information was emphasized.

c. Overview: WGSIP - A. Scaife/F. Doblas-Reyes

Adam Scaife gave the overview of WGSIP on behalf of the WGSIP Co-Chairs. WGSIP contributes mainly to the WCRP Grand Challenge 1 to provide skilful regional climate predictions and projections across timescales. As many WGSIP members are also from WMO recognized Global Producing Centers, the research and development carried out under WGSIP also feeds into the WMO Global Framework for Climate Services. WGSIP members co-organized the first international meeting on Seasonal to Decadal Prediction which was hosted in Toulouse in 2013. CHFP is progressing with 14 hindcast sets now stored at CIMA with increasing numbers of users and multimodel results starting to emerge. In particular, the hindcasts show evidence of predictability of the NAO and AO in some models. WGSIP subprojects on the stratosphere and sea ice are now nearing completion with papers being written on each. There is also significant activity on multimodel decadal predictions with the CMIP6 protocol already being discussed and real time exchanges of forecasts being carried out once per year in association with WGSIP and the EU SPECS project.

Discussions pointed to the yet unclear causal contribution of the stratosphere to improved skill and it was noted that SHFP is only an ensemble of opportunity. WGSIP may possibly expand its scope with new projects on teleconnections, ocean, model drift.

d. GFCS implementation – R. Kolli/M. Rixen

R. K. Kolli provided an update on the GFCS implementation, emphasizing the initial priority areas and the 8 guiding principles. The Climate Services Information System pillar is the means of delivery of climate data and products comprising global, regional and national centers and entities. Regional climate centers and Regional Climate Outlook Forums are essential components of this pillar. Pilot projects are being launched at national level (in Africa in particular) and at regional level (Asia, Caribbean, SIDS, Polar regions). The current project compendium includes 40 proposed initiatives with a total budget of CHF 140 million.

M. Rixen presented the new WCRP structure now including a WCRP Data Advisory Council (WDAC), and a WCRP Modeling Advisory Council (WMAC) on which WGSIP is represented to better address climate science in service

to society and GFCS priorities. The WCRP community has identified 6 Grand Challenges (GC) representing the major science foci of the program for the 3-5 years ahead.

The Research, Modeling and Prediction pillar of the GFCS represents an important initiative in the context of WGSIP, especially regarding bridging the gaps between science and services, the seamless suite of climate products, understanding the unknown predictability and skill of current systems, and the lack of a comprehensive approach to quantifying uncertainties.

It was noted that the compendium of GFCS project is a living document, being updated as opportunities arise.

2. Activities update

a. GPC Beijing – Peiqun Zhang

Peiqun Zhang provided an update on their current extended (45 days) and long-range (7-11 months) system, and their initialization and ensemble generation strategy. Products are supporting the RCCs, NHMS and RCOFS. Verification on MJO and BSISO indices are being performed. Graphical products are disseminated freely on the BCC website. Digital data are available on request at http://cmdp.ncc.cma.gov.cn/nccdownload/en_cgcm.php.

It was noted that the NCEP analysis was found to be more suitable than their own NWP analysis.

b. GPC CPTEC – Caio Coelho

This presentation provided an update on the following seasonal forecast activities performed by GPC CPTEC: 1) The Brazilian multi-model seasonal forecast system developed in partnership between CPTEC, the Brazilian Meteorological Service (INMET) and Ceará State Meteorology and Water Resources Foundation (FUNCEME); 2) The most recent update performed in EUROBRISA multi-model system; and 3) Regionally downscaled seasonal forecasts produced at CPTEC (ETA model for South America at 40 km x 40 km spatial resolution) and (under development) Brazilian Regional Atmospheric Modelling System (BRAMS) downscaled seasonal forecasts for South America at 30 km x 30 km spatial resolution. The Brazilian (CPTEC/INMET/FUNCEME) multi-model, EUROBRISA and ETA forecast products are routinely produced and used in monthly national climate outlook forums in Brazil and in regional climate outlook forums in South America, demonstrating healthy national and international regional cooperation in

providing access to a number of products in addition to mandatory GPC forecast products.

Discussions pointed to the benefit of a multi-model approach, not being restricted to particular models, the issue in using GloSea because of the shorter calibration period available and the challenges of the steep topography over the Andes.

c. GPC ECMWF - Laura Feranti

ECMWF produces operational extended range forecasts since 2004. In the current configuration, a 51 member ensemble is integrated for 32 days twice a week (Monday and Thursday 00Z). The skill has steadily improved over the past 10 years. A large part of the improvement in the northern Extra-tropical skill scores can be attributed to improved MJO predictions.

ECMWF issues single model and multi-model seasonal predictions every month. The ECMWF seasonal forecast system (http://www.ecmwf.int/products/forecasts/seasonal/documentation) is characterized by high levels of skill for ENSO forecasts and more reliable predictions for extra-tropical regions in comparison with the previous operational system.

Current research includes studies on: stochastic physics and its impact in the mean climate, land surface initializations, predictability of the Arctic Oscillation and the role of initial conditions. Experimentation with dynamical sea-ice is in progress as well as studies to assess the impact of increased resolution in both ocean and atmospheric components.

It was noted that the dependence on ensemble size can be verified from signal-noise ratios and that ENSO results may depend on the big 1997 El-Niño. Ocean and sea-ice improvements are tentatively scheduled for 2015.

d. Environment Canada - W. Merryfield

The Canadian Seasonal to Interannual Prediction System (CanSIPS) was developed at CCCma, and implemented operationally as Environment Canada's monthly to multi-seasonal forecast system in December 2011. It is a two-model system based on CCCma coupled climate models CanCM3 and CanCM4, with 10-member ensembles from each model. CanSIPS provides the GPC Montreal contribution to the WMO LRF MME, and also contributes to the North American Multi-Model Ensemble (NMME) and APEC Climate Center seasonal forecast compendia.

Current efforts to assess CanSIPS performance include studies of the quality of its land initial conditions, which are obtained through the response of the CLASS land model to the assimilation of temperatures, winds and moisture from 6-hourly analyses by the atmospheric model. Comparisons with available

data products and in situ observations indicate that both soil moisture (SM) and snow water equivalent (SWE) are initialized reasonably realistically, although switching from assimilation of ERA reanalyses for hindcast to CMC products in real-time operations caused a gradual drift in SM initial conditions that has been corrected through application of seasonally dependent bias corrections in the models. Skill in predicting SWE is surprisingly high, likely reflecting the tendency for anomalies to persist through the snow season.

Current R&D activities include experimental forecasts of 12-month means (2014 is predicted with a probability of >50% to be the warmest year on record due to long term trends combined with a forecast El Nino), and an effort has begun to downscale CanSIPS forecasts to the 0.22 degree CORDEX North America grid using the CanRCM4 regional climate model.

A comprehensive guide to CanSIPS forecasts, verifications and skill measures is provided by the CanSIPS Explorer (http://www.cccma.ec.gc.ca/cgi-bin/data/seasonal_forecast/sf2 , username: cccmasf, password: seasforum).

It was noted that the warming hiatus was continuing pretty much into 2015 in the model.

e. Update on NMME – B. Kirtman (remotely)

The North American Multi-Model Ensemble Experiment (NMME) is nearing the end of phase-1 of the project.
Phase-I monthly data is available from the IRI at http://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/ and at the CHFP data server.

Phase-2 data data products to the production ESG-NCAR Gateway continues. Current data products include portions of the daily, monthly and 6 hourly output from CanCM3, CanCM4, GEOS-5 and CFSV2 models. NMME data products can be accessed at https://www.earthsystemgrid.org/search.html?Project=NMME. Data access is available without registration.

The paper Kirtman et al. 2014: "The North American Multi-Model Ensemble (NMME): Phase-1 Seasonal to Interannual Prediction, Phase-2 Toward Developing Intra-Seasonal Prediction" will be published in the April issue of the Bulletin of the American Meteorological Society. The article is available online at the AMS journals website.

Two new versions of the GFDL model, "GFDL-FLORa06" and "GFDL-FLORb01", have been added to the NMME forecasts this month. These are transitional versions between CM2.1 (the current "GFDL" model included in NMME) and CM2.5, which is under development.

Forecast from CCSM4 will be 'real-time' starting in May 2014.

More details about the NMME project and links to data and real-time forecast products are available at http://www.cpc.ncep.noaa.gov/products/NMME/

It was noted that improvements over Europe between CCSM3 and CCSM4 version are mainly due to changes in the atmospheric model and land initialization for longer ranges.

f. IC3 – F. Doblas-Reyes

IC3's Climate Forecasting Unit (CFU) is very active in the field of climate-prediction (seasonal to decadal) research. Its main objective consists in advancing climate prediction by improving the forecast quality of the EC-Earth climate forecast system, which is also used to further the understanding of the sources of predictability, assessing the forecast quality of as many operational and research experiments as possible, calibrating and combining the predictions and furthering the development of climate services with a special focus on the field of renewable energies. The CFU is currently coordinating the European project SPECS and undertaking one of the most ambitious exercises to assess the impact of global model resolution on the improvement of forecast skill.

It was noted that EC-Earth and IFS developments undergo a periodic review every 3-4 years.

g. ICTP – A. Tompkins

Adrian Tompkins provided an update on the ECMWF/ITCP pilot operational dynamical malaria forecasting system in Africa. Climate drivers of malaria include rainfall, temperature, relative humidity and wind. Climate observations are used to create an analysis of entomological and epidemiological conditions in order to initialize the malaria forecasts and establish epidemic and endemic malaria zones. Pan-continental test show potential skill out to 3 months and beyond. Preliminary results from Uganda show good agreement between VECTRI analysis and sentinel data with a clear signal of climate drivers. Disparities are due to forecast uncertainties as well as socio-economic factors and interventions. Next steps include a proposal to EUAID, an extension to EUROSIP, the inclusion of stochastic physics for VECTRI to account for model uncertainty and further model developments to account for immunity, interventions and coupling to WISDOM.

It was noted that the malaria prediction skill stems mainly from the temperature prediction skill and that the rainfall bias correction is based on EOFs.

h. INM RAS – M. Tolstykh

The current state of the seasonal forecasts at Hydrometeorological Research Centre of Russia (HMCR) and Inst. of Numerical Mathematics Russian Academy of Sciences were presented by M.Tolstykh. These forecasts are done with the SL-AV model developed jointly by the Inst. of Numerical Mathematics RAS and HMCR. Operational forecasts sent to WMO site for global producing centers and APCC multi-model ensemble are based on the SL-AV model with persistent SST anomalies. There is also an experimental coupled model using the Inst. of Numerical Math. ocean model INMOM (used in CMIP5) showing promising results for reforecasts. More work is needed to run the coupled model with real-time initial ocean data.

The SL-AV model using persisted SST anomalies shows quite reasonable results in reproducing some extratropical circulation features, i.e NAO but the source of this skill remains unclear. However, the tropical circulation has some deficiencies currently. Work is underway to improve the model.

i. IRI - A. Robertson

Recent climate-related activities at IRI include new flexible formats for probabilistic seasonal forecasts of precipitation and temperature that enables user-specified quantiles of the forecast distribution to be specified. The IRI MME uses a pattern-based correction of ensemble means with equal weighting of models. Parametric distributions have also been fitted to the ENSO plume. Drought index predictions using a statistical-dynamical approach in which a statistical (persistence) forecast of the SPI to be used where dynamical models show no signal/skill have been implemented over North America. Assessment of potential seasonal predictability over India shows much higher values for daily rainfall frequency, as opposed to mean daily intensity, with seasonal total rainfall lying in between.

It was noted that reliability diagrams are included in the CPT. Discussions pointed to the difficulty to derive consensus forecasts by mixing dynamical and statistical products.

j. JMA/MRI and GPC Tokyo - T.Yasuda and Y. Takaya

The new version of the JMA/MRI seasonal prediction system using a coupled atmosphere-ocean model is being developed. The system consists of TL195L60 of the JMA atmospheric model and global ocean model (MRI.COM) including a sea-ice model. Some improvements of reproducibility related to model developments are achieved. This system will replace the current operational system in 2015. The new version of one month operational prediction system was introduced in 6 March, 2014. This system includes an upgrade of the model resolution (~55 km), a stochastic physics scheme,

higher resolution SST/sea ice boundary conditions and JRA-55 analysis for hindcast initial conditions. Improvements in almost all aspects are confirmed by the comprehensive verification. The performance gain corresponds to roughly a lead time of 1 day. A new product will be available from the Tokyo Climate Center soon.

Discussions pointed to the challenges in predicting the PDO on decadal time-scales and the need to issue decadal predictions on a yearly basis.

k. JAMSTEC - S. Behera

The climate forecasts suggest development of a warm event in the tropical Pacific and the SINTEX-F of JAMSTEC like many other climate models predicts a weak El Nino in the summer of 2014. In the Indian Ocean sector, the spread is quite large and hence it is not clear if simultaneously there will be a positive Indian Ocean Dipole during that time. In the subtropics and mid-latitudes of the Southern Hemisphere, climate variations are characterized by regional dipole modes observed in SST anomalies. A few model experiments using SINTEX-F are conducted to understand tropical and extra-tropical influences on the subtropical dipoles and their predictabilities. It is noted that the subtropical dipoles tend to occur irrespective of the existence/non-existence of tropical variability though most of those are found to be associated with the Antarctic Oscillation. In addition to those basin scale phenomena, SINTEX-F has shown skill to predict the Ningaloo Nino, a recently found regional climate mode off Northwest Australia.

The question arose as to whether assimilate sub-surface data versus surface ocean data to reduce model initial shocks.

l. GPC Melbourne – David Jones

Current seasonal outlooks for Australia are based on the dynamical climate model POAMA 2.4M, which includes the BoM Atmospheric model BAM v3, the Australian Community Ocean Model (ACOM) v2 and a simple land surface model. LRF products are available to other GPCs, RCCs and NMHSs. Forecasts are provided to the LRF Lead Centre, LC MME and APCC. Hindcasts have been verified following the Standardized Verification System, but there is some lag with the new system. Systems are scientifically documented. A new GPC website has been produced. The BoM is heavily involved in training and capacity building activities in the South Pacific

Discussions emphasized the sensitivity of the Brier skill score to the ensemble size.

m. MétéoFrance (and GPC Toulouse) – J.P. Céron/H. Douville

A brief summary of recent research activities, mostly conducted in the framework of the FP7 SPECS project, and of recent diagnostics developed in the operational framework of the Toulouse GPC has been presented. Sensitivity tests to horizontal resolution in both atmospheric and oceanic components of the CNRM-CM5 climate model have been conducted, showing a robust positive impact (mostly of increasing the atmospheric resolution from T127 to T359) on tropical (except in boreal spring) and extratropical (including NAO) scores over the 1993-2009 hindcast period. Preliminary results of the forthcoming system 5 (including a stochastic dynamic scheme and new atmospheric physics) to be used in EUROSIP have been also shown with significant improvements in the tropical scores over the 1979-2010 hindcast period. Recent ensembles of 1979-2012 coupled experiments consisting of nudging the SST or prescribing the wind stress over the tropical Pacific have been also presented, showing the substantial contribution of the tropical Pacific variability to the recent global warming hiatus. Finally, original diagnostics (upper level tropical divergence, north Atlantic weather regimes, daily precipitation) have been presented that are helpful for both better interpreting the predicted large-scale anomalies and warning about the increased risk of high-impact weather events over France.

The GPC Toulouse consist of a distributed forecasting suite including Arpege T127L31 coupled to NEMO 1º and using the ECMWF atmospheric and Mercator ocean analysis producing 7 months-long forecasts via 51 members and delivering both deterministic and probabilistic products. It was noted that the issuance date of GPC products is critical for the operations of the RCCs and RCOFs. New model diagnosis and associated evaluations on stream function and velocity potential are being used for the high troposphere. Velocity potential gives insight into the atmospheric response in terms of Hadley-Walker circulation anomalies while the stream function gives complementary insight into the atmospheric response to tropical forcing (especially in terms of teleconnections with mid-latitudes).

n. GPC Montreal – Bertrand Denis

The Canadian Seasonal to Interannual Prediction System (CanSIPS) has been developed at CCCma and is operational at CMC since Dec 2011. It consists of two models CanCM3 and CanCM4 with 10 ensemble members. The hindcast verification period is 1981-2010 and the forecast range is 12 months with initialization at the start of every month without time lag. The forecasts contribute to WMO WMO (https://www.wmolc.org/), NMME (http://www.cpc.ncep.noaa.gov/products/NMME/), APCC MME (https://www.wmolc.org/), IRI ENSO plumes and the real-time decadal experiment coordinated by the Met Office (provided directly by CCCma). Recent improvements include the calibration of the probability forecasts and

soil moisture bias correction. CanSIPS data sets are publicly available free of charge on the CMC and CCCma servers.

It was suggested to rerun operational forecast in research mode to investigate e.g. the sensitivity of precipitation to various soil moisture schemes.

o. NCEP (GPC Washington) - A. Kumar

GPC Washington's current dynamical seasonal prediction is based on the National Centers for Environmental Predictions (NCEP's) Coupled Forecast System (CFSv2). The CFSv2 is run operationally at the NCEP and was implemented in March 2011. The atmospheric component of the CFSv2 is the NCEP Global Forecast System (GFS) with a horizontal resolution of T126 (~100 km) spectral truncation. There are 64 vertical levels in the atmospheric model with the top level at 0.26 hPa. The oceanic component of the CFS is the GFDL Modular Ocean Model V.4. The domain of MOM4 is almost global extending from 74^{o}S to 64^{o}N. The meridional resolution of the ocean model is $1/4^{o}$ between 10^{o}S and 10^{o}N, and gradually increases in the extratropical latitudes becoming fixed $1/2^{o}$ poleward of 30^{o}S and 30^{o}N. The zonal resolution is $1/2^{o}$. Hindcasts and forecasts for CFS.v2 are initialized from the Climate Forecast System Reanalysis (CFSR).
For calibrating and bias correcting real-time prediction, an extensive set of hindcasts is available. For CFSv2 seasonal hindcasts, four runs for nine target months were made every five days starting January 1st. The real time forecast configuration includes four-daily runs for 10 months, and forecast is constructed based on a 40-member lagged ensemble comprising of latest seasonal forecasts from past 10 days. More information is available from http://cfs.ncep.noaa.gov.

p. NILU - Y. Orsolini

Recent findings on the influence of the Eurasian snowpack on sub-seasonal to seasonal predictability were discussed, through its forcing of atmospheric teleconnections. Many observational and model studies have indicated that the autumn Eurasian snow cover in particular, influences circulation patterns over the North Pacific and North Atlantic. The highly successful international GLACE initiative was aimed at assessing the soil moisture impact on sub-seasonal to seasonal forecasts in the warm season. Dedicated simulations following the GLACE methodology have been adapted to quantify the snow impact in the cold season in the same fashion. A potential important application is to determine how the snowpack contributed to maintain the exceptional negative NAO phase during the recent cold winters over Eurasia.
This methodology can also be used to estimate the impact of the springtime snowpack over the Himalaya-Tibet region onto the Indian summer monsoon onset, and a new joint project of bilateral collaboration between Norway and India is under way, focusing on the monsoon prediction and its impact on the hydrological cycle.

A new national project in Norway is aimed at better assessing the role of sea ice and snow on seasonal predictions at high and mid latitudes. Its main focus is on the North Atlantic and Arctic sectors, and on developing a coupled ocean-atmosphere Norwegian Climate Prediction model.

The question arose of a possible unusual distribution of snow in 2009.

q. GPC Pretoria – Asmerom Beraki

GPC Pretoria has implemented a new global ensemble forecasting system (EPS) comprising AGCM and OAGCM supporting sub-seasonal to seasonal climate forecasts and contributing the National GFCS roadmap. Research activities focus primarily on system improvements and access and uptake of LRF products by users. The 10 members EPS consists of the ECHAM4.5 AGCM and MOM3 OGCM initialized with realistic atmosphere (NCEP/DOE reanalysis, ocean (MMES SST) and land (CPC observed soil moisture) states. The hindcast period covers 1982-2009.

It was noted that soil moisture is initialized off-line from NCEP.

r. GPC Seoul – Suhee Park

The operational LRF system of GPC-Seoul is a 2-tier system. GPC-Seoul provides forecasts of 6 variables to WMO LC-LRFMME and verification results to WMO LC-LRFSVS. In June 2010, KMA and UK Met Office established a collaborative agreement for a joint seasonal forecasting system, GloSea5, which is the fifth version of the Met Office ensemble prediction system for seasonal forecasting, and is based on the latest version of HadGEM3. It includes the UM (Met Office Unified Model) for the atmosphere, JULES (Joint UK Land Environment Simulator) for the land surface, NEMO (Nucleus for European Modeling of the Ocean) for the ocean, CICE (Los Alamos National Laboratory) for sea-ice and OASIS (CERFACS) for the coupling. Seasonal forecasts are updated monthly and monthly forecasts are updated weekly. It was noted that GPC-Seoul and GPC-Exeter use different initial conditions for the atmospheric and land surface model, and stochastic physics, leading to regional differences in products.

The potential to share the 14 years of hindcasts was noted. The question arose whether the spread stems from the grand ensemble or the stochastic physics.

s. SNWS (ANACIM) - O. Ndiaye

West Africa is one of the regions in the world where climate variability is the highest. The variability could be perceived in rainfall at all time scales from decadal to daily. Rainfall variability has strong impact on livelihood: vector

born disease (malaria), food security (agriculture, livestock,…) and water (hydro power, floods). Most of sub-Saharan agriculture is rain-fed and sustain the economy and livelihood. With limited economic and natural resources the population needs to well plan their agricultural activities which occurs within 3 to 4 months only during the year. The Senegalese national weather service (ANACIM) in partnership with the CGIAR program Climate Change Agriculture and Food Security (CCAFS) and government institutions working on rainfall and with food security partners to demonstrate the added value of climate information in agriculture at local level in the district of Kaffrine. During this project climate information is produced by the weather service then tailored by a local trans-disciplinary working group (GTP) where local authority and decision makers, agriculture extension, livestock, seed growers, NGOs, farmers association, pest disease control, forestry, rural radio, … all sit. This group tailors the forecast according to the actual situation and then draw actionable information for farmers. This information is then communicated through rural radio, bulletins, text messaging and social gathering. This Early Warning System was very successful, according to an external evaluation, in outreaching farmers and now it is being upscale to other sites.

The question arose whether climate change is challenging traditional wisdom and knowledge and which of the monthly or seasonal forecasts on monsoon onset are more useful for farmers. The relative importance of massive rains against small rains spread over time was raised in this context.

t. UKMO (GPC Exeter) - A. Scaife

Adam Scaife explained that the Met Office has now implemented their Global Seasonal Forecast System 5. This new system has 0.25° grid spacing in the global oceans and less then 1° spacing in the atmosphere. He showed results from 24 member hindcasts for winter in which the NAO is predictable with an unprecedented correlation score for the surface NAO of 0.62. Interestingly, the signal to noise ratio in the model appears to be anomalously small. Nevertheless, this led to predictability of other quantities such as daily storm counts and wind speed over both Europe and North America. Similar high scores were found for the Southern Annular Mode. As well as providing data to the WMO Lead Centre at KMA, the Met Office also distribute this data to a growing list of governmental users, other meteorological centers, private users such as those in the Energy Sector and other multimodels such as EUROSIP and the US IMME. The Met Office decadal hindcasts are being tested at similar resolution in 2014.

u. CNU/Korea – J.-H. Jeong

The Chonnam National University (CNU), Korean Polar Research Institute (KOPRI), and the Korea Meteorological Administration (KMA) are developing a winter climate seasonal prediction system. Based on an atmosphere-only GCM, this system includes a land surface initialization including snow depth and statistical prediction model of Arctic sea ice concentration. The impacts of

snow initialization on wintertime surface air temperature prediction are assessed with 10-year long hindcast experiments. Considerable predictability increases up to 2 months ahead are found over many parts of Northern Hemispheric continent. A statistical model based on season-reliant EOF technique is developed to estimate the Arctic sea ice concentration used as a boundary condition for the prediction period. Compared with a dynamical prediction, this model shows higher skill in predicting both total sea-ice extent and spatial distribution of sea-ice anomalies. The prediction system successfully simulated the severe cold winters over East Asia in the recent years.

The question arose as to whether snow initialization has some influence on the Arctic.

v. Further discussion and review of actions on requirements, synergies, and transitioning research to operations

Key activities requiring greater liaison between WGSIP and the ET-OPSLS were identified as below.

- **Independent verification of seasonal forecasts from Regional Climate Outlook Forums**: it was noted that verification was performed by RCOFs themselves, and that independent verification of the African consensus forecasts had been published. The idea would be to verify all forecasts from RCOFs with a sufficiently long record using a common methodology. Ideally a comparison against objective (dynamical and/or statistical) methods should also be included.
- Coordination of verification methods: it was noted that CBS had developed the Standard Verification System for Long-Range Forecasts (SVSLRF). The SVSLRF diagnostics used are not universally used by the research community (e.g. in sub-seasonal or multi-annual decadal prediction research). It was agreed that adopting the SVSLRF as far as possible for other timescale research would assist in transitioning forecasts on these ranges into operations.
- It was noted that a number, but not all, of the **GPCs contribute their forecasts to the WGSIP's Climate Historical Forecast Project (CHFP)** research database. Those GPCs not contributing to date were encouraged to do so.
- It was noted that there is a large proliferation of operational multi-model seasonal forecast information, including forecasts from: LC-LRFMME, NMME, EUROSIP, APCC. It was agreed that a means of synthesis of this information was needed. Perhaps this could happen through the vehicle of the Global Seasonal Climate Update (GSCU).
- It was noted that the WCRP/WWRP-THORPEX S2S research project and the parallel activity of the ET-OPSLS to bring exchanges of subseasonal forecasts into an operational activity was a key opportunity to guide research to inform the shape of the operational climate services. It was noted that the ET-OPSLS has a Task Team for

this activity and it was suggested this should include membership from WGSIP.

- The urgency of developing predictions of rainy season onset was noted. It was also noted that some centers had begun research work in this area and started trials of forecasts with users. WGSIP were encouraged to foster research in this area to gain results and trial products from a number of forecasting systems.
- The importance of increased geographical detail in seasonal forecasts in order to gain information at the level of decision-making was noted. In contrast, there is little research activity in the area of RCM downscaling of seasonal forecasts and advancing the status to operational level.
- It was noted that at the CBS/CCl workshop on Operational Long-range forecasting it was recommended to introduce a regular workshop on operational long-range forecasting to allow RCCs and RCOFs to gain updates on prediction systems and to share operational experience. It was agreed that the meeting should be open with WGSIP members encouraged to participate.

3. WGSIP session introduction

a. Introduction to new members

Co-chairs welcomed new WGSIP members Jee-Hoon Jeong from Chonnam National University, Korea, Mikhail Tolstykh from the Russian Academy of Sciences and Tamaki Yasuda from the Meteorological Research Institute, Japan.

b. Adoption of agenda

The agenda was adopted without any substantive changes.

c. Review of WGSIP15 actions, JSC34 and conference call – Co-Chairs

WGIP15 actions and actions resulting from the conference call in Sept 2013 were reviewed and have been incorporated and updated in Appendix B.

d. WCRP and WMAC Update – M. Rixen

The WCRP community has identified 6 Grand Challenges (GC) representing the major science foci of the WCRP for the 3-5 years ahead. In particular the

effort on “Regional Climate Science” recognizes major gaps in providing seamless climate information at regional scale. This effort is led jointly by CLIVAR and the WCRP Working Group on Regional Climate and involves WGSIP.

The Future Earth call for proposals on Fast Track Initiatives and Cluster Activities with deadline 4 April 2014 was highlighted.

WMAC2 and the JSC34 endorsed the Earth System Grid Federation (ESGF) as the future pan-WCRP model-data dissemination mechanism within the program. Initially adopted by the CMIP community, this archiving system is now being also used by CORDEX. WGSIP is planning to migrate to this infrastructure soon. The sister initiative on observations aka obs4MIPs brings satellite data to the same archive and aims at expanding to many observational products. A kick-off meeting is being planned on 29 April – 1 May 2014 at NASA HQ, Washington, USA with data providers to explore possible contributions.

WMAC is currently planning a Summer School on model development for June 2015 at MPI in Hamburg, and developing a Model Development Prize in close collaboration with WWRP.

Some important upcoming meetings were briefly reviewed, such as the pan-GEWEX meeting in The Hague, Netherlands, 14-17 July 2014, the WWRP Open Science Conference in Montreal, 16-21 August 2014, and the Climate Symposium in Darmstadt, Germany, 13-17 October 2014.

e. WGSIP Update – A. Scaife/F. Doblas-Reyes

See item 1c.

4. Decadal predictions and beyond

a. Decadal forecast exchange for real time forecasts – D. Smith

Many climate centers have now developed a decadal forecasting capability using coupled models initialized with observations. This was primarily done to inform the IPCC fifth assessment report, which for the first time has a chapter on near term climate predictions. To assess the likely skill of forecasts, historical tests were performed following the CMIP5 protocol. However, most centers are also producing quasi-operational forecasts, updated each year in near real time. These are potentially very valuable for informing the Global Framework for Climate Services (GFCS). Recognizing this the WMO have recommended that these forecasts should be gathered together, to assess uncertainties and provide a consensus multi-model forecast for the coming

years, thereby avoiding over-reliance on individual models. The Met Office has therefore coordinated an informal “Decadal Forecast Exchange” which has been updated each year since 2011, and is now served online at http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/decadal-multimodel.

The question arose regarding the respective role of forcing vs teleconnection to El-Niño in the North Atlantic. It was also suggested to serve data in real time and to further progress decadal prediction research towards ‘operational’ status with help from the ET-OPSLS.

b. The Decadal Prediction Project (DCPP) – G. 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. Skillful decadal prediction of relevant climate parameters is a Key Deliverable of the WCRP's Grand Challenge of providing Regional Climate Information.

The Decadal Climate Prediction Project 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 via the Decadal Forecast Exchange above
- *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 behaviors

Many scientific and practical questions are involved. The understanding of the physical processes that govern the long timescale predictability of the climate system is vital to improving decadal predictions and these are explored using observations, climate model studies and the results of decadal hindcasts. The analysis of available observations for initializing forecasts, the improvement of the models used in the production of the forecasts, post processing of forecasts including bias adjustment, calibration and multi-model combination, together with the production and application of probabilistic decadal forecasts of modest skill, are all involved in the research and development efforts contributing to the DCPP.

The Decadal Climate Prediction Panel, in conjunction with the WGSIP, WGCM and CLIVAR, is a focus for the coordination of the scientific and practical aspects of the DCPP. A draft of the design of the four DCPP

components under development and a Survey will seek the reactions and advice of potential participants.

Discussions were focused on the cost of decadal simulation and the difficult choice between "no information for the future" (NIFF) experiments and those assuming knowledge of future volcanoes eruptions. A possible compromise would be to address both with simulations limited to 5 years. Further consultation on this issue with the community will be required.

c. WGCM CMIP6 brief – C. Senior

Cath Senior recalled the WGCM mission, which is to review and foster the development of coupled ocean-atmosphere and Earth System Models by coordinating model intercomparison experiments, in particular those contributing to our understanding of processes and feedbacks in the climate system. The new CMIP6 effort will focus on the origin and consequences of systematic model biases, the response of the Earth System to forcings and future climate changes given climate variability, predictability and uncertainties in scenarios. The new CMIP structure will comprise a set of CMIP ongoing model Development, Evaluation and Characterization of Klima (DECK) experiments (AMIP 1979-2010, pre-industrial control, 1% per year CO2 to quadrupling, instantaneous 4xCO2, historical runs through the 21st century) complemented by specialized intercomparison experiments ("MIPs") using the same standards and infrastructure and addressing WCRP Grand Challenges and science questions. A WGCM Infrastructure Panel (WIP) will oversee the standards and governance for MIPs and use of the Earth System Grid Federation. Feedback on CMIP6 is currently being solicited from projects and Grand Challenges and the community with deadline Sept 2014.

It was pointed out that MIPs will have some very specific technical details to be sorted out by the WIP and CMIP panels. Another question was about the interaction with the application community, which links also to the climate service potential contribution of decadal predictions.

5. CHFP database

a. CHFP analyses and draft paper – B. Kirtman (remotely)

Ben Kirtman presented the first draft of the CHFP analysis paper. The following suggestions were made:
- add reliability diagrams for 2m temperature and precipitation for extra tropics
- move ENSO into section 4

- include multi-models to all figures to show added-value of multi-models
- confirm that only CHFP database data are included in the paper
- add some bullet points text for section 4 (inputs from Adam Scaife, Francisco Doblas-Reyes)
- include Indian Ocean Dipole figures (inputs from Swadhin Behera)
- verify completeness/accuracy of model table 1 (Celeste Saulo, Bill Merryfield, Andy Robertson)

b. CHFP database – C. Saulo

The Climate Historical Forecast Project is a living data set maintained by CIMA (Centro de Investigaciones del Mar y la Atmósfera, Argentina) and growing steadily since the last WGSIP session. It now includes 14 different hindcasts from 9 main Centres:

1. Météo-France CNRM/GMGEC/EAC
2. Canadian Centre For Climate Modelling and Analysis, Environment Canada
3. Climate Prediction Center NOAA, USA
4. ECMWF
5. UK- Met office
6. Meteorological Research Institute – Japan Meteorological Agency
7. Atmosphere and Ocean Research Institute, The University of Tokyo
8. The Max Planck Institute for Meteorology Earth System Model, Germany
9. Centre for Australian Weather and Climate Research, Australia

Our most recent updates have been the inclusion of MIROC5 monthly and daily data until 2011 and the inclusion of the ECMWF-S4 monthly data until 2010. Also, after institutional arrangements, including the acquisition of extra storage capacity, CIMA agreed to host the ENSEMBLES monthly means data archive, that will be transferred from ECMWF to CIMA in 2014.
The CHFP/SHFP database has 59 registered users, and this data collection has been employed by researchers from a wide variety of institutions, all around the world. Still, it has been emphasized the need of further dissemination of this effort in order to increase its use by the research community.

Database web portal: http://chfps.cima.fcen.uba.ar/

Contact: chfp@cima.fcen.uba.ar

c. CHFP MIROC - T. Yasuda

MIROC is one of two Japanese CGCMs that contribute to the CHFP experiments. The MIROC team performed seasonal forecast experiments

using MIROC5 based on CHFP configuration. It was shown that the prediction skill of ENSO (NINO3.4 SST) is good, in particular for predictions started from February and May. This is caused by improved cumulus scheme and good reproducibility of zonal advection feedback. Several extended studies using CHFP experiments such as predictability for two types of ENSO and impact of SST in the tropical North Atlantic on the ENSO prediction were conducted.

d. Data formats, ESGF, obs4MIPs – F. Doblas-Reyes

Responding to the request received by WGSIP at the last JSC of exploring ways to integrate climate predictions in the ESGF, the SPECS project has prepared a convention to make climate predictions in NetCDF compatible with the standards designed by CMIP. This convention, which builds upon the experience of CMIP5 and collects the latest developments of CORDEX (e.g. use of NetCDF4), introduces some new concepts such as the double time coordinates (with a single time dimension) and is fully CF compliant. SPECS has also produced the corresponding documentation, a table of experiments (indispensable for the inclusion in the ESG) and a patch for CMOR2. It is recommended that the CHFP data are ported to use this new convention, which might require extra resources made available to CIMA (SPECS offered to help with this task), and for the convention to be the standard for the decadal MIP under discussion within DCPP. The fact that the S2S decided to use GRIB2, has a limited number of ocean and sea-ice variables (with low priority) and hasn't considered yet a link to ESGF might be a source of trouble for the climate-prediction community because it will have to deal with data in two very different formats. S2S should be encouraged to make progress with its plan to make data available in NetCDF.

UKMO confirmed their intention to implement an OpenDAP solution for S2S data. The main differences between the CHFP format and the new ESGF compatible format are the use of NetCDF4 (compressed), the use of two time dimensions, and several global attributes.

6. CHFP sub-projects

a. Ice Historical Forecast Project – D. Peterson

Only a few seasonal prediction systems have an observation-based initialization of sea ice including Environment Canada, UK Met Office and NCAR/NCEP. IceHFP aims to examine the sensitivity to initialization of sea ice. Several recent studies suggest a link between autumn Arctic ice decline and a preference towards anti-cyclonic circulation in winter, pointing to a possible contribution to recent severe European winters. The IceHFP methodology focused on 2007 ice observations and climatology and included

Met Office, MPI, MétéoFrance, CCCma and IC3 participants. Multiple models were combined to show effects of ice initialization. Winter circulation has blocking pattern over Northern Eurasia when sea-ice was depleted.

The polar-nonpolar teleconnection workshop was suggested as an opportunity to discuss the possible way ahead WGSIP ice-related efforts.

b. Land surface impacts on seasonal forecasts - H. Douville

A brief synthesis of both recent and on-going research activities in this field has been presented. While there is both statistical and numerical evidence of local and remote land surface impacts on monthly to seasonal climate predictability, many studies suffer from a number of limitations such as the lack of statistical significance, stationarity or physical understanding in the empirical predictions, and the lack of reproductibility (from one model to another), the missing or poorly constrained land surface processes in the dynamical predictions. Recent results however suggest that further sensitivity studies are needed using coupled ocean-atmosphere rather than atmosphere-only climate models in which realistic versus climatological land surface conditions are prescribed, not only for snow mass or soil moisture but for all land surface variables (including groundwater and vegetation) that exhibit a significant memory at monthly to seasonal timescales. Despite the forthcoming GSWP3 initiative that could provide the requested multi-decadal (model-dependent) land surface reanalysis, there is however no current plan for coordinated sensitivity experiments beyond the on-going European SPECS activities.

Discussions addressed interactive vegetation, highlighting the need for leaf area index to reflect at least partially the meteorological conditions. In general land surface temperature memory is smaller than that of soil moisture. A possible GLACE3 project could address soil moisture, vegetation and snow cover.

c. Stratosphere Historical Forecast Project - A. Scaife/A. Butler

Amy Butler (material presented by A.Scaife) has been coordinating analysis of the CHFP data with SPARC colleagues. Of the fourtheen hindcast sets in CHFP we are in the fortunate position of having seven high top (good stratospheric representation) and seven low top (poor stratospheric representation) sets. This ensemble of opportunity indicates that model biases in the troposphere and stratosphere are well correlated and that high top models show significant predictability of the AO while low top models do not. There is a general increase in extratropical forecast skill for surface quantities in high top models and at least some of this appears to originate from ENSO teleconnections, which are better represented in high top models. Amy Butler is leading a multi model paper on the results and contributions are welcome.

d. Update on the predictability of NAO - A. Scaife

See item 2t.

e. Possible initiatives – F. Doblas-Reyes

WGSIP had three sub-projects under CHFP: IceHFP, StratHFP and GLACE2. Initial discussions within the WGSIP community and stakeholders pointed to the following follow-on activities or scientific projects for WGSIP offering synergies with the S2S project:

- Interactions between tropics and extratropics
- Drift/initial shock and verification within the first month
- Monsoon onset and daily precipitation
- Risk maps for unprecedented events and prediction of extremes
- Others: climate services (malaria), verification, ocean aspects (oceanHFP, data availability, impact of resolution, surface fluxes), etc.

Subsequent discussions resulted in corresponding actions as summarized in Appendix B.

7. Related initiatives

a. Polar Prediction Project (PPP) – F. Doblas-Reyes

PPP is the hours to seasonal research component of the Global Integrated Polar Prediction System (GIPPS), the Polar Climate Predictability Initiative (PCPI) being the seasonal to decadal (and beyond) contribution to GIPPS. The rationale is based on the idea that the poles are an integral part of the Earth system and it is expected that, in the Arctic, over $100 billion in investment is expected in the coming decade. Research areas include: (i) service oriented (SERA), (ii) forecasting systems, and (iii) underpinning research. The International Coordination Office for Polar Prediction (ICO) is based at the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research, and is led by Thomas Jung with Neil Gordon supporting as a consultant. The PPP implementation and science plans are now available from its web site http://polarprediction.net. One of the focus of the PPP is the organization of the Year of Polar Prediction (YOPP), which is centered in 2017-2018, but has a long preparatory phase. Another focus is on improving observation and modeling of sea-ice, which is critical to improved polar prediction, including at seasonal time scales. There are concentrated efforts within PPP on sea-ice prediction (which has a big impact on atmospheric predictions), the linkage between polar and lower-latitude regions and an emphasis on improved availability of polar observations.

b. Subseasonal-to-Seasonal Predictions (S2S) project – A. Robertson

The Sub-seasonal to Seasonal (S2S) Prediction Project

This WWRP/WCRP project is a legacy of THORPEX and was formally launched in November 2013 and will run initially for five years. It will target the forecast range between two weeks and a season. Its goals are: (1) to improve forecast skill and understanding on the sub-seasonal to seasonal timescale with special emphasis on high-impact weather events; (2) To promote the initiative's uptake by operational centers and exploitation by the applications community; and (3) to capitalize on the expertise of the weather and climate research communities to address issues of importance to the Global Framework for Climate Services. It will include a database with an archive of forecasts from about 12 operational centers in near real time. The project implementation plan is available for more details: http://www.wmo.int/pages/prog/arep/wwrp/new/documents/S2S_Implem_plan_en.pdf.

Possible topics for WGSIP-S2S collaboration which could be linked to the newly proposed WGSIP scientific projects were discussed including:

- Teleconnections – "stationary" (ENSO) vs transient (MJO), e.g. with blocking & NAO
- Drift/initial shock and verification of the first month – both WGSIP and S2s use coupled models
- Data dissemination – sharing of data and strategies between groups, dissemination to users in similar formats
- Verification – reference datasets, minimum hindcast lengths, ensemble sizes, MME approaches, spatial methods
- GFCS – e.g. support of NMHSs, RCCs, RCOFs, capacity building workshops

c. CLIVAR update, Climate Dynamics Panel – A. Pirani

The CLIVAR Climate and Oceans: Variability, Predictability and Change Project is the WCRP project on ocean-atmosphere interactions with objectives to improve the understanding the causes of climate variability on intra-seasonal to centennial time-scales, improving predictions of climate variability and change, improving the atmosphere and ocean components of Earth-System Models, and extending the observed climate record. The Ocean Model Development Panel (formerly WGOMD) is running the second phase of the Coordinated Ocean-ice Reference Experiments (CORE-II), a hindcast framework for understanding seasonal, inter-annual, and decadal variability, providing decadal prediction initial conditions and for model development. Coordinated observing system, process and modelling studies are improving the understanding of variability and change, as presented in the Atlantic, Indian and Pacific Ocean basins, addressing long standing coupled model biases, aspects of improved predictability and understanding of impacts over

land. A CLIVAR-GEWEX Monsoons Panel is being formed, integrating previous CLIVAR regional monsoons activities (VAMOS, ACP, AAMP), with the objective, amongst others, of coordinating /advising pan-WCRP numerical experimentation groups (WGSIP, WGCM, CMIP6 planning) on modelling priorities for advancing monsoon research

In addition to the project's core activities that are being carried forward by its panels, CLIVAR has initiated a series of Research Foci. These are areas primed for progress in the next 5-10 years that will benefit significantly from enhanced CLIVAR coordination, currently:

- Intraseasonal, Seasonal and Interannual Variability and Predictability of Monsoon Systems
- Decadal Variability and Predictability of Ocean and Climate Variability
- Science Underpinning the Prediction and Attribution of Extreme Events
- Marine Biophysical Interactions and Dynamics of Upwelling Systems
- Sea-Level Rise and Regional Impacts
- Consistency Between Planetary Heat Balance and Ocean Heat Storage
- ENSO in a Changing Climate

CLIVAR Research Foci topics are expected to evolve and expand in response to the research community's priorities and needs for internationally coordinated activities. CLIVAR's on-going and future activities, and their implementation will be discussed at the 2014 Pan-CLIVAR meeting that will be held in The Hague, The Netherlands on 16-18 July 2014, contributing towards the preparation of the CLIVAR Achievements Report and the new CLIVAR Science Plan and Implementation Strategy.

d. Africa Climate Conference – O. Ndiaye

Most climate initiatives and programmes in Africa have been the initiatives of communities outside the continent. These last years the African climate scientific community has grown a lot. Being aware of the role of climate information, a group of African climate scientists from inside and the diaspora have launched an initiative during the Africa Climate Conference in collaboration with WRCP and ACPC ACPC - the Africa Climate Research for Development (CR4D) Agenda. The objective of this initiative is to coordinate climate research in Africa and to address urgent information needs and to deliver operational climate services for policy makers, adaptation planners and vulnerable communities in Africa. The CR4D is a pan-African climate research program based on proposals in key areas where gaps were identified such as: «Climate Information Partnerships for Resilience and Early Warning», « African Climate Data and information System» and «Enhance seasonal and sub-seasonal predictability and its application». One important milestone that is currently in progress to produce a white paper on past and current initiatives, mechanisms and coordination of climate research for development in Africa.

e. 2nd WCRP-ICTP Summer School – A. Pirani

The WCRP-ICTP Summer School is a new WCRP initiative on capacity growth that has been proposed as a collaboration with the Abdus Salam International Center for Theoretical Physics (ICTP), to train students with outstanding research potential on WCRP Grand Challenges topics, to foster the emergence of research leaders in the developing world and to stimulate the growth of the community on key emerging science topics. The school is designed for around 30 students with 10+ faculty, assistants present for at least one if not both weeks, to foster close mentoring and good working relationships. Lectures occur in the mornings, with occasional lectures in the evenings. The afternoons and remaining evenings are devoted to the practical application of the material covered in the lectures, accomplished through a set of research problems. These form the core of the school and serve to produce an important part of its long term legacy, with teams of about 5 students working with faculty and additional advisors on one of the problems for the duration of the school. The expectation is that at least some of these projects would lead to peer-reviewed publications.

The 1st WCRP-ICTP Summer School on Attribution and Prediction of Climate Extremes will be held on 21 July - 01 August 2014 at the ICTP, Trieste, Italy. The course is co-chaired by F. Zwiers and S. Seneviratne and has a WGSIP-led seasonal to decadal prediction of extremes component taught by F. Doblas Reyes and A. Kumar. The 2nd WCRP-ICTP Summer School on Climate System Prediction and the Delivery of Actionable Regional Climate Information is set to take place in 2015, hosted by ANACIM, Dakar, Senegal. The motivation is:

- to increase capacity in WCRP Grand Challenge on the provision of regional climate information
- to improve of forecasting systems and operations (GPCs, ACMAD, AGRHYMET, PRESAO, NHMS
- to deliver actionable climate information in support of the Global Framework on Climate Services (GFCS).

We seek a WGSIP and WGRC lead to implement this summer school on the GC on Regional Climate Information, in collaboration with other interested partners that include GFCS, ACMAD, NHMS, GPCs, AGRHYMET, AMMA, S2S, IRI. The summer school is also a WCRP contribution to the Africa Climate Research for Development Agenda. We propose that the 17th Session of WGSIP is held jointly to the summer school.

f. Update on the EU SPECS and EUPORIAS projects - F. Doblas-Reyes

SPECS http://www.specs-fp7.eu aims to undertake research and dissemination activities to deliver a new generation of European climate forecast systems, with improved forecast quality and efficient regionalization

tools to produce reliable, local climate information over land at seasonal-to-decadal time scales, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders. The improved understanding and seamless predictions are expected to offer better estimates of the future frequency of high-impact, extreme climatic events and of the prediction uncertainty. It tries to ensure interoperability so as to easily incorporate their application in an operational context, provide the basis for improving the capacity of European policy making, industry and society to adapt to near-future climate variations and a coordinated response to some of the GFCS components. To achieve these aims, SPECS is promoting several international activities such as a range of coordinated global climate prediction experiments that try to assess the impact of initializing the different components (sea-ice, land surface), as well as the benefits of improved representation of physical processes (stratosphere) and of enhanced resolution. A package to perform forecast quality assessment and empirical/statistical downscaling is being written using the R language and starting to be distributed publicly. Besides, SPECS is creating a new standard to encode climate predictions in NetCDF that will bring climate predictions into the ESGF orbit, closing the gap with the community working in long-term climate change. SPECS is part of a larger endeavor funded by the European Commission, ECOMS, which includes, among other projects, the EUPORIAS project http://www.euporias.eu, and that acts as a think tank that advices the Commission on new relevant aspects of climate research. EUPORIAS is the SPECS counterpart for climate services, both projects being developed with a close joint coordination. This project intends to improve our ability to maximize the societal benefit of the new technologies developed in SPECS. Working in close relation with a number of European stakeholders, EUPORIAS wants to develop a few fully working prototypes of climate services addressing the need of specific users. The time horizon is set between a month and a year ahead with the aim of extending it towards the more challenging decadal scale. EUPORIAS will increase the resilience of the European Society to climate change by demonstrating how climate information can become directly usable by decision makers in different sectors. Both SPECS and EUPORIAS have a large base of stakeholders and are engaging with communities outside Europe in an attempt to contribute with this coordination to some of the WGSIP objectives.

g. The GSOP/GODAE Ocean Reanalysis Intercomparison Project – M. Palmer

The Ocean Reanalyses Intercomparison Project (ORA-IP) is a joint activity initiated by the GODAE Ocean View and CLIVAR-GSOP (Global Synthesis and Observations Panel) communities. Over 20 ocean reanalysis products from various international research institutions have been assessed across the following variables: steric height, sea level, ocean heat content, 20°C isotherm depth, mixed layer depth, salinity, surface fluxes and transports, AMOC at 26°N and sea-ice. The first results from this intercomparison activity have been published in issue 64 of the CLIVAR Exchanges newsletter

(http://www.clivar.org/publications/exchanges). Signal-to-noise ratios (ensemble mean signal vs ensemble spread) have been investigated to inform what ocean metrics might be well resolved in the context of climate monitoring, and identify regions that require improved observation and/or modeling. For a number of variables the ensemble average outperforms any single analysis when compared to reference data sets. The ensemble have also been used in the context of specific scientific research questions - such as establishing historical relationships between the NAO and mixed layer depths in the North Atlantic and the robustness of the recently reported increase in deep ocean heat uptake during the 2000s. Full-length research articles are currently being invited for special issue of Climate Dynamics (nominal deadline is end of June 2014).

The discussion highlighted the need for independent observations to verify working hypotheses such as those on the hiatus, and for studies analyzing the impact of reanalysis on seasonal to interannual predictions. The link between this initiative and the need for improved ocean initial conditions for the WGSIP activities was also discussed.

8. Miscellaneous

a. Grand Challenge on Regional Climate – F. Doblas-Reyes

The WCRP's Grand Challenge on Regional Climate ultimately intends to respond to the question "Can we provide skillful regional climate predictions at seasonal to decadal time scales and reliable and actionable long term regional climate change projections?" The grand challenge is organized in four scientific frontiers:

- Frontier 1: Intraseasonal and seasonal predictability and prediction. Identify and understand phenomena that offer some degree of intra-seasonal to inter-annual predictability, and skillfully predict these climate fluctuations and trends
- Frontier 2: Decadal variability, predictability and prediction. Identify and understand phenomena that offer some degree of decadal predictability and skillfully predict these climate fluctuations and trends
- Frontier 3: Reliability and value of long-term regional climate change projections. Provide reliable regional climate projections for the 21st century and beyond for use in Impact, Adaptation and Vulnerability (IAV) studies as a basis for the development of response (adaptation, mitigation) strategies to climate change
- Frontier 4: Definition of usefulness: informing risk management and decision making. Provide information that constitutes a solid and targeted basis for decision making concerning risk management and response options in specific sectors and contexts, also through active and two-way involvement with stakeholders WGSIP's activities are linked to frontier's 1, 2 and 4. An open discussion should be started within the community to

come up with specific activities where climate prediction can be seen as a source of regional climate information on range of time scales: sub-seasonal (S2S, PPP), seasonal-to-interannual (WGSIP) and decadal (DCPP), with overlaps between them.

Discussions noted that the framing of Regional Climate Information GC could be improved and is currently difficult to implement. WGSIP sees the need to provide input that reflects the activities and progress of climate prediction and how they contribute to the development of climate services for short-term adaptation. WGSIP intends to work on suggestions on improvements.

b. Ocean analysis and TAO array – A. Kumar

In recent years the TAO array in the equatorial tropical Pacific has been in severe decline with data return at ~40% level. Decline in data returns has potential for influencing real-time monitoring of El Niño–Southern Oscillation (ENSO) and its prediction. To assess the ocean observing system in a "Tropical Pacific Observing System for 2020 (TPOS 2020)" was organized in La Jolla, CA, USA, 27-30 January, 2014. The aim of the workshop was to evaluate the requirements for sustained observations, and how existing and new technologies can be used in combination to meet observing needs. Since the design of the TAO/TRITON array, the requirements for observations have evolved, and so have the available observing technology. One of the recommendations from the workshop was to establish a task team on modeling, and assimilation to assess the influence of TPOS 2020 on monitoring and predictions. The goals of this particular task team are closest to the goals of the WGSIP.
ENSO monitoring and prediction being one of the fundamental underpinnings of the seasonal prediction (and hence of importance to WGSIP), it was proposed that WGSIP organize an activity on comparing operational ocean analysis that are maintained for seasonal prediction. Such a coordinated activity will help inform the development of TPOS 2020, and assess the influence of ongoing developments in the ocean observing system in the Pacific.

Subsequent discussions confirmed the WGSIP endorsement related to:

- *sustaining tropical Pacific observing system*
- *TPOS task team 4*
- *ocean analysis inter-comparison efforts*

WGSIP will also look into providing systematic ocean outputs of seasonal runs.

c. Pan-GEWEX and pan-CLIVAR meetings – S. Seneviratne (remotely) and A. Pirani

A GEWEX Science Conference will be held 14-17 July in The Hague, Netherlands (http://gewex.org/2014conf/home.html) including sessions on "Modeling, predicting, and attributing climate extremes", "Progress and challenges for predicting monsoon precipitation", and "The role of land parameters (and land cover change) on weather and climate prediction". GEWEX new themes will cover land use and cover modeling within CMIP6, high-resolution modeling, carbon-water cycle interactions, surface energy and water balances and water isotopes. This event will be followed by a Pan-GEWEX meeting on 17-18 July, also jointly with CLIVAR on Friday 18 July, with discussions on extreme events and large-scale circulation, predictability and air-sea fluxes. The GWEX SSG and Joint GEWEX-CLIVAR SSG meeting will be held on Saturday 19 July. The presentation ended with results from a recent publication (Seneviratne et al, Nature Climate Change, 2014) on the increasing extreme temperature over land contrasting with the apparent pause on mean temperature over the last decade.

It was suggested that a follow-on GLACE3 experiment would be ideally led by a SPECS person.

The 2014 Pan-CLIVAR Meeting will be held on 16-18 July, in parallel to the GEWEX Conference and the Pan-GEWEX meeting, towards the development of the CLIVAR Science Plan and Implementation Strategy for the next 5 to 10 years. There will be plenary sessions addressing future CLIVAR aspects, and breakout sessions on key components of CLIVAR, in particular the Research Foci topics, and integrating observing system, process studies and model development studies. A joint Pan-CLIVAR/Pan-GEWEX session will address cross-project coordination and collaboration on Extremes and Monsoons research.

d. Seasonal Forecasting and attribution – P. Stott

The question of the importance of attribution was posed in the context of climate change adaptation. Attribution statements can be made about individual climate events by examining the changed probability. A recent publication in BAMS reports on the application of attribution science to recent extreme weather events. It was stressed that climate change made some events more likely, some other less likely. There is no evidence for strong human influence in all weather extremes, as natural variability also plays an important role. Examples were provided on the Iberian winter drought and the extreme rainfall in 2011 in New Zeeland. The European Climate and weather events (Eucleia) project aims at interpreting and attributing extreme events in Europe. Current limitations to achieve this include the limited test cases, conflicting results, model limitations, biases and poorly sampled observational data sets. Five PF7-SPACE projects have been paving the way for a Copernicus Climate Change Service (ERA-CLIM2, UERRA, QA4ECV, CLIPC and EUCLEIA). The Attribution of Climate-related Events (ACE) effort of the Hadley Centre explores perturbed physics with and without anthropogenic forcing to examine changes in the likelihood of events given modes of internal variability.

9. WGSIP Business

a. Review of planned meetings/events including next WGSIP session

NCEP, Météo-France and ANACIM offered to host the next session in 2015. The Russian Academy of Sciences offered to host the 2016 session.

b. Memberships

It was recommended to consult the panel ahead of the next session to review memberships. An open announcement to target specific expertise could be envisaged, if agreed by the JSC. However, Celeste Saulo is rotating off and preference was to secure some continuous engagement from CIMA.

c. Review of Draft actions list

The draft action list from the session was reviewed and can be found in Appendix B.

APPENDIX A - List of contacts

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APPENDIX B – ACTION list

Joint WGSIP16 / ET-OPSLS session

1. Check what verification of real-time forecast issued by RCOFs has been done (Richard Graham, Andrew Robertson)

2. Invite WGSIP (and maybe S2S) to attend RCOFS workshops (annually or every 2 years) (Rupa Kumar Kolli, Michel Rixen, summer 2014)

3. Ask which new groups can contribute to CHFP (Celeste Saulo, Francisco Doblas-Reyes, Adam Scaife)
- GPC Beijing – Peiqun Zhang
- GPC CPTEC – Caio Coelho
- GPC Moscow – Mikhail Tolstykh
- JMA/MRI (add new version)
- CNU/Korea – Jee-Hoon Jeong
- GPC Pretoria – Asmerom Beraki
- GPC Seoul – Suhee Park

4. Ask which GPCs can send more daily data (to study monsoon onset) and sea-ice variables (for the Polar Prediction Project) (Celeste Saulo)

WGSIP 16 session

CHFP

5. ECMWF to send ENSEMBLES data, check with Andy Brady (Laura Ferranti, summer 2014)

6. Check which version of CFS is already uploaded and which one comes with NMME (Celeste Saulo)

7. Add the the CHFP the year when the simulation set was created (Celeste Saulo with help of all)

8. Add information about each simulation (10 lines) and initialization method (burst or lagged) (Celeste to send a message with help of all contributors, April 2014)

9. Publicize CHFP in GFCS and Future Earth newsletters (Michel Rixen, summer 2014)

10. Design a WGSIP poster (Andrew Robertson, Celeste Saulo, summer 2014)

11. Encourage ET-OPSLS GPC to submit hindcast data for RCOF process (Adam Scaife, Richard Graham, April 2014)

12. Change name JMA/MRI CGM3 into JMA/MRI CGM (Celeste Saulo, Tamaki Yasuda, April 2014)

13. Flag ENSEMBLES models in database as done for high/low top models (Celeste Saulo, summer 2014)

14. Send CHFP format specifications to Matt Palmer for potential storage of ORA-IP in CHFP (Celeste Saulo, April 2014)

15. Send SPECS sample files to IRI to check if they are readable with the CPT (Francisco Doblas-Reyes, April 2014)

16. Future Earth funding for reformatting the CHFP data server to comply with IRI data library (Andrew Robertson, summer 2014)

17. Develop Nature Data paper (Adrian Tompkins, to inform in April 2014)

18. Contact PREFACE EU project to encourage use of CHFP for tropical Atlantic (Yvan Orsolini, April 2014)

CMIP

19. Consult with all WGSIP members to provide feedback to Veronica on CMIP new structure (cf EOS paper) (George Boer and WGSIP co-chairs, summer 2014)

20. Publicize Decadal Forecast Exchange within WGSIP (Adam Scaife)

ESGF

21. Seek feedback from PCMDI on CMOR2 (Francisco Doblas-Reyes, Michel Rixen, April 2014)

New science projects

22. Ensure the coherence between the science projects and the S2S activities (Adam Scaife, Francisco Doblas-Reyes, summer 2014)

23. SNOW Glace: Jee-Hoon Jeong (co-lead), Yvan Orsolini (co-lead), Hervé Douville

24. Interaction/teleconnection between tropics and extratropics: Laura Ferranti (co-lead), Hervé Douville (co-lead), Adam Scaife, Swadhin Behara, Francisco Doblas-Reyes

25. Model drift/initial shock and verification within the first month: Mikhail Tolstykh (lead atmosphere), Bill Merryfield (lead ocean), Adam Scaife, Tamaki Yasuda, Francisco Doblas-Reyes

26. Skill of monsoon (including intraseasonal variability and monsoon onset, in collaboration with S2S): CLIVAR monsoon panel (Anna Pirani to follow-up), Adrian Tompkins, Yvan Orsolini, Ousmane Ndiaye

27. Ocean diagnostics (e.g. high resolution issues, surface fluxes, issues related to ocean syntheses, studies in support of the observing system): Swadhin Behera

28. Climate services: Adrian (malaria), Andrew Robertson (Africa project, GFCS, RCOFs), Swadhin Behara, Ousmane Ndiaye

TAO

29. Design a protocol for ocean data withholding experiments on TAO array (Arun Kumar, May 2014)

Other Business

30. DCPP meeting funding (George Boer, Michel Rixen)

31. Next meeting Doodle poll (Michel Rixen)