문서번호 APCC-출장-16-0427(2016-05-02)

TRAVEL REPORT FORM
출장보고서

결재	선임연구원	팀장	부서장	원장
	05/02 이우섭	05/02 김옥연	05/02 김형진	05/02 정홍상
협조	팀장			
	05/02 김해정			

I. **Reporter** 보고자

Department 소속	Position 직위(직급)	Name 성명	Travel Date 날짜	Note 비고
연구본부	선임연구원	김대하	2016.4.17.~2016.4.24.	
연구본부	선임연구원	이진영	2016.4.17.~2016.4.23.	
연구본부	박사후연구원	장상민	2016.4.16.~2016.4.24.	
연구본부	선임연구원	이우섭	2016.4.16.~2016.4.24.	
연구본부	선임연구원	박경원	2016.4.16.~2016.4.24.	
연구본부	선임연구원	전종안	2016.4.16.~2016.4.24.	
연구본부	선임연구원	오지현	2016.4.16.~2016.4.23.	

II. **Major Activities** 주요업무 수행내용

1. Main Contents and Activities 주요내용 및 활동

- 오스트리아 비엔나에서 개최된 “European Geoscience Union General Assembly 2016”에 참석하여 기상, 기후, 농업, 및 수자원과 관련하여 발표 및 토론을 진행함.

가. 학 회 명: European Geoscience Union General Assembly 2016

나. 일정/장소: 2016.4.17.~2016. 4. 22.(5일) / Austria Center Vienna in Vienna, Austria

다. 발표제목 및 발표세션

발표자	발표세션	발표제목
김대하	HS4.4 Drought and Water scarcity	Drought trends indicated by evapotranspiration deficit over the contiguous United States during 1896-2013
이진영	HS4.4 Drought and Water scarcity	Drought index forecasting using remote sensing and long-range forecast data based on machine learning techniques
장상민	AS1.8 Precipitation	Development of radar-satellite blended QPF (Quantitative Precipitation Forecast) Technique for heavy rainfall
이우섭	AS1.20 Dynamic meteorology	Interannual variability of heat wave in South Korea and their connection with large-scale atmospheric circulation
박경원	NH6.4 Natural Hazard	Development of flood prediction system using satellite data and GIS system
전종안	SSS10.1/HS5.12 Irrigated agriculture	Modelling of peach tree (Prunus persica) full blooming dates using APCC MME seasonal forecasts
오지현	SA1.15 Tropical Meteorology	Momentum Budget Analysis of Westerly Wind Events Associated with the Madden-Julian Oscillation during DYNAMO

2. Relevance to APEC Climate Center's Activities 결론 및 소감

- AGU 학회와 더불어 EGU 학회도 지속적으로 회원들의 참여가 늘어나고 있음.
- 가뭄과 물부족을 다룬 연구에서 기존의 기상학적, 농업적, 수문학적 가뭄의 발생과 영향을 다루는 연구에서 더 나아가 가뭄의 비용 계산을 위한 영향 함수의 개발, 효율성과 형평성의 조화, 가뭄 리스크 회피에 대한 연구 경향이 돋보였음.
- 이들 연구와 APCC의 가뭄 연구와 접목 가능성이 높은 것으로 평가되었으며 향후 연구 계획에 반영코자 함.
- 기후자료를 수문 모델에 사용하는데 필요한 다양한 기법에 대한 논의와 함께 극한 기상과 기후변화로 인해 야기되는 수문 현상 (가뭄, 홍수)에 대한 대응에 관한 내용이 발표의 주를 이루었음.
- 특히 유럽연합의 Horizon 2020의 후원으로 착수된 두 개의 프로젝트, BINGO (Bringing INnovation to onGOing water management – a better future under climate change) 와 IMPREX (Improving PRedictions and management of hydrological Extremes) 와 관련된 연구자들의 참여가 활발하였음. 유럽연합의 상이한 시간 규모와 관련한 수문 분야의 재난에 대한 대응 체계를 파악할 수 있음.
- 이러한 두 시간 규모의 이음새라 할 수 있는 계절내 예측 자료를 전지구 수문모형 (VIC, PCRGLBWB)에 활용한 Princeton 대학교의 Wanders 박사의 연구는 향후 APCC SCoPs 모델로부터 생산된 계절내 예측 자료의 활용성을 높이는데 참고가 될 수 있음. (포스터 파일 첨부)
- 극한기상(폭염, 한파등)의 발생과 원격상관지수의 연관성을 파악하여, 극한현상의 예측성 향상에 대한 다수의 연구결과들이 있었음.
- 극한 기상의 발생원인 규명에 대한 연구들을 토대로, 동아시아 폭염의 발생 원인을 이해하고

향후 극한기온 메커니즘 분석에 도움이 될 것으로 판단됨.

- 본 학회에서는 농업(과수원예분야)에 APCC 계절예측자료를 활용하는 방안을 제안하고 적용한 결과를 발표하였는데, 특히, 계절예측자료를 응용분야에 적용하는 방안에 대해 많은 관심을 보임.
- 토양내 수분 및 탄소의 생지화학적 작용에 대한 연구가 많이 발표 되었는데, 이러한 작용에 대한 이해는 온실가스(Greenhouse gases, GHGs)배출 및 토양 탄소 격리(Soil carbon sequestration)에 관한 연구를 수행하는 데 필수적이며, 향후 APCC가 이러한 온실가스에 대한 연구를 수행 및 확대가 필요할 것으로 판단 됨.
- 수자원분야에서 자료동화기법을 활용하여 수문자료의 품질을 향상시키는 발표가 다수 있었으며, 현재 APCC에서도 기후분야에서 주로 이용되는 기법인데, 수자원 및 농업 등 응용분야에도 확대 적용하는 연구가 필요할 것으로 보임.
- 홍수 위험대응 및 재난 관리 분야에서 기상학, 수문학, 수력학 등을 연계한 통합적인 홍수 예측 모델 개발 연구가 이루어지고 있으며, 수치 기상 모델과 글로벌 규모의 위성 강수를 이용하여 정확도를 개선하는 연구가 진행되고 있음. 현재 APCC 수자원분야에서 진행하고 있는 연구와 유사한 부분이 많으므로, 차별성을 부각시키고 정확도를 개선하여 해당 분야에서 선점할 수 있는 결과를 도출할 필요가 있음.
- 작년에 발사된 GPM 위성의 기후변화 활용에 대한 연구들이 많이 발표되었으며, 또한 기후변화에 따른 지구관측에 대한 융합연구가 활발히 진행되고 있음.
- 기회가 된다면 APEC 기후센터도 EGU와 AGU 학회에 부스를 설치하여 APCC의 활동에 대해서 설명한다면, 기관 홍보 및 관련 연구에 많은 도움이 될 것으로 판단됨.

III. References 참고사항

(with attachment of any information or report in case of attendance of conferences, workshops and meetings) 학술대회, 워크숍, 회의 등 참석 시 관련 정보 및 문서 첨부

1. Presented and Collected Materials 주요 수집자료

2. Suggestions and Remarks 건의사항

European Geosciences Union General Assembly 2016

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Drought trends indicated by evapotranspiration deficit over the contiguous United States during 1896-2013

Daeha Kim and Jinyoung Rhee
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Evapotranspiration (ET) has received a great attention in drought assessment as it is closely related to atmospheric water demand. The hypothetical potential ET (ETp) has been predominantly used, nonetheless it does not actually exist in the hydrologic cycle. In this work, we used a complementary method for ET estimation to obtain wet-environment ET (ETw) and actual ET (ETa) from routinely observed climatic data. By combining ET deficits (ETw minus ETa) and the structure of the Standardized Precipitation-Evapotranspiration Index (SPEI), we proposed a novel ET-based drought index, the Standardized Evapotranspiration Deficit Index (SEDI). We carried out historical drought identification for the contiguous United States using temperature datasets of the PRISM Climate Group. SEDI presented spatial distributions of drought areas similar to the Palmer Drought Severity Index (PDSI) and Standardized Precipitation Index (SPI) for major drought events. It indicates that SEDI can be used for validating other drought indices. Using the non-parametric Mann-Kendall test, we found a significant decreasing trend of SEDI (increasing drought risk) similar to PDSI and SPI in the western United States. This study suggests a potential of ET-based indices for drought quantification even with no involvement of precipitation data.

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Development of flood monitoring system using satellite data and geographic information system

Kyungwon Park (1), Sangmin Jang (2), Seongkyu Lee (3), Sunkwon Yoon (4), and Yongchul Shin (5)

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The natural disaster of heavy rainfall and Typhoon are increased damage of property and human life in urban area with the impact of climate change. Therefore the accurate observation and short-term forecast of heavy rainfall by satellite is very important for reduce damage from severe storms and Typhoon. This study develops a method for precipitation retrieval algorithm and rain/no rain cloud classification system using Korea geostationary satellite images and GPM(Global Precipitation Mission) DPR(Dual Precipitation Radar) and GMI(GPM Microwave Imager) sensors. The new algorithm used to validation compared with ground station and radar data for Busan city flood case at August 25, 2014.

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A Momentum Budget Analysis of Westerly Wind Events Associated with the Madden–Julian Oscillation during DYNAMO

Ji-Hyun Oh (1), Xianan Jiang (2,3), Duane Waliser (2,3), Mitchell Moncrieff (4), Richard Johnson (5), and Paul Ciesielski (5)

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Three Madden-Julian Oscillation events during Dynamics of the Madden–Julian Oscillation (DYNAMO) field campaign were investigated to understand the contributions of the dynamical processes involved in the wind evolution associated with the MJO over the Indian Ocean (IO). The DYNAMO field campaign was conducted from October 2011 to February 2012 over the IO to shed light on the initiation of the MJO. Based on European Centre for Medium-Range Weather Forecasts analysis, a momentum budget analysis of three MJOs that occurred in late October, late November, and late December shows that westerly acceleration at lower levels associated with the MJO active phase generally appears to be maintained by the pressure gradient force (PGF), which could be partly canceled by meridional advection of the zonal wind. Westerly acceleration in the midtroposphere tends to be mostly attributable to vertical advection.

In particular, the dynamical contribution of synoptic-scale equatorial waves to the WWEs is illuminated by diagnosing the MJO in November (MJO_2), accompanied by two WWEs (WWE1 and WWE2) spaced a few days apart. Unlike other WWEs during DYNAMO, horizontal advection is more responsible for the westerly acceleration in the lower troposphere for WWE2 than the PGF. Different interactions between the MJO_2 envelope and convectively coupled waves (CCWs) can be responsible for different developing processes among WWEs.

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Interannual Variability of Heat Wave in South Korea and theirs Connection with Large-Scale Atmospheric Circulation Pattern

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This study investigates the interannual variation of heat wave frequency (HWF) in South Korea during the past 42 years (1973-2014) and examines its connection with large-scale atmospheric circulation changes. Korean heat waves tend to develop most frequently in late summer during July and August. The leading Empirical Orthogonal Function (EOF) accounting for 50% of the total variance shows a mono-signed pattern over South Korea, suggesting that the dominant mechanisms responsible for the heat wave are linked in a spatial scale much larger than the nation. It also exhibits a regional variation with more occurrences in the southeastern inland area. The regression of the leading principal component (PC) time series of HWF with large-scale atmospheric circulation identifies a north-south dipole pattern between the South China Sea and Northeast Asia. When this large-scale circulation mode facilitates deep convection in South China Sea, it tends to weaken moisture transport from the South China Sea to Northeast Asia. Enhanced deep convection in the South China Sea triggers a source of Rossby wave train along southerly wind that generates positive geopotential height anomalies around Korea. The anomalous high pressure pattern is accompanied by large-scale subsidence in Korea, thereby providing a favorable condition for extreme hot and dry days in Korea. This study highlights that there is a decadal change of the relationship between Korean heat waves and large-scale atmospheric circulation patterns. The tropical forcing tends to be weakened in the recent decade, with more influences from the Arctic variability from the mid-1990s.

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Drought index forecasting using remote sensing and long-range forecast data based on machine learning techniques

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Three machine learning models based on Decision Tree, Random Forest, and Extremely Randomized Trees were developed and compared to spatial interpolation based on multiquadric spline to forecast drought indices of the 6-month Standardized Precipitation Index (SPI6) and the 6-month Standardized Precipitation Evapotranspiration (SPEI6) in ungauged areas. Input variables of the Normalized Difference Vegetation Index (NDVI), the Normalized Difference Water Index (NDWI), daytime Land Surface Temperature, and nighttime Land Surface Temperature were used to represent the initial condition and the Multivariate ENSO Index and the Arctic Oscillation Index were included in order to consider large-scale atmospheric circulation. Six-month accumulated precipitation and potential evapotranspiration ending the target month were also included as input variables. The long-range forecast data were used to fill the 6-month precipitation and potential evapotranspiration during future periods and compared to the cases that use climatological data as baseline results. Classification of drought categories were performed and evaluated for the locations of 61 of Automated Synoptic Observing System gauges in South Korea. In conclusion, machine learning-based methods performed better than the interpolation method, and the methods using climatology data outperformed the methods based on long-range forecast. Although the contribution of long-range forecast for drought forecasting was not yet large, the application of machine learning modelling using remote sensing data contributed to the enhancement of drought forecasting skill. Drought forecasting based on the long-range forecast is expected to outperform the performance based on climatological data as the skill of the long-range forecast improves.

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Development of Radar-Satellite Blended QPF (Quantitative Precipitation Forecast) Technique for heavy rainfall

Sangmin Jang, Sunkwon Yoon, Jinyoung Rhee, and Kyungwon Park
APEC Climate Center, Busan, Republic Of Korea

Abstract:
Due to the recent extreme weather and climate change, a frequency and size of localized heavy rainfall increases and it may bring various hazards including sediment-related disasters, flooding and inundation. To prevent and mitigate damage from such disasters, very short range forecasting and nowcasting of precipitation amounts are very important. Weather radar data very useful in monitoring and forecasting because weather radar has high resolution in spatial and temporal. Generally, extrapolation based on the motion vector is the best method of precipitation forecasting using radar rainfall data for a time frame within a few hours from the present. However, there is a need for improvement due to the radar rainfall being less accurate than rain-gauge on surface. To improve the radar rainfall and to take advantage of the COMS (Communication, Ocean and Meteorological Satellite) data, a technique to blend the different data types for very short range forecasting purposes was developed in the present study. The motion vector of precipitation systems are estimated using 1.5km CAPPI (Constant Altitude Plan Position Indicator) reflectivity by pattern matching method, which indicates the systems' direction and speed of movement and blended radar-COMS rain field is used for initial data. Since the original horizontal resolution of COMS is 4 km while that of radar is about 1 km, spatial downscaling technique is used to downscale the COMS data from 4 to 1 km pixels in order to match with the radar data. The accuracies of rainfall forecasting data were verified utilizing AWS (Automatic Weather System) observed data for an extreme rainfall occurred in the southern part of Korean Peninsula on 25 August 2014. The results of this study will be used as input data for an urban stream real-time flood early warning system and a prediction model of landslide.

Acknowledgement
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Modelling of Peach Tree (Prunus persica) Full Blooming Dates Using APCC MME Seasonal Forecasts

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Due to global warming, recently, bud-burst and flowering dates of fruit crops have become earlier and the abnormal climate increases the variabilities of temperature in spring, suggesting that the risk of frost damage has increased. However, the full blooming date prediction model for peach tree used by the Rural Developmental Administration (RDA) were developed using only one cultivar (Youmyeong) and observations from a station (Suwon). This model might not adequately reflect the characteristics of peach cultivars or local orchards. the objectives of this study were to develops the site-and cultivar-specific blooming date prediction models for major peach cultivation regions and cultivars and presents a framework for applications of the APEC Climate Center Multimodel Ensemble (APCC MME) seasonal datasets.Developmental rate (DVR), and Sequential dormancy models (Chill day, New chill day, and fraction-time models) were used to develop the locally tailored full blooming date prediction models for major peach cultivars. For the development of these models, bud-burst and full blooming dates of peach tree for 5 cultivars (Cheonhong, Youmyeong, Changbangjosaeng, Cheonjoongdo, and Janghowon) were collected from the 6 major peach cultivation sites: Chuncheon, Suwon, Cheongwon, Cheongdo, Naju, and Jinju. For the chill day model, those measures for the entire dataset regardless the location and cultivar were 2.31%, 0.79, and 3.36 day for MAPE, R2, RMSE, respectively. For the new chill day model, those values (2.19%, 0.82, and 3.16 day for MAPE, R2, RMSE, respectively) were slightly better than those of the chill day model. The model results showed that the new chill day model was found slightly highest performance than others. Based on the considerations of the predictability of the statistical downscaling method and the observed periods of the full blooming dates at each site, we determined that the APCC MME seasonal datasets were applied for the new chill day model for the Changbangjosaeng and Youmyeong cultivars at the Suwon site. The values of the goodness-of-fit measures using the selected synthetic daily maximum and minimum temperatures reflecting APCC MME seasonal datasets and selected were worse than those using those collected from the Suwon station. It is concluded that further work was recommended that the predictability of APCC MME seasonal forecasts should be improved to reduce the prediction errors of full blooming dates of peach trees.

The value of the North American Multi Model Ensemble phase 2 for sub-seasonal hydrological forecasting

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Introduction

Water scarcity is a globally occurring phenomenon with large impacts on society and nature. With sufficient skill, high temporal resolution sub-seasonal predictions could help to reduce the impact of water scarcity. Here, we investigate the skill of four sub-seasonal forecast models from phase 2 of the North American Multi-Model Ensemble experiment (NMME-2) for sub-seasonal hydrological predictions using reforecasts for the period 1981-2011.

Material and Methods

We use the output from four available NMME-2 to produce bias-corrected sub-seasonal hydrological forecasts with PCR-GLOBWB. The models used in the analysis are: CanCM3, CanCM4, FLOR-B01 and CCSM4. The skill of the NMME-2 models is determined by a comparison between the forecast and an Ensemble Prediction System (ESP) and an Auto-correlation function model (ACF), both derived from resampling of historically observed precipitation and temperature timeseries. Finally, a equally (WeightedEqual) and unequally weighted (Weighted) ensemble forecast are derived from the NMME models.

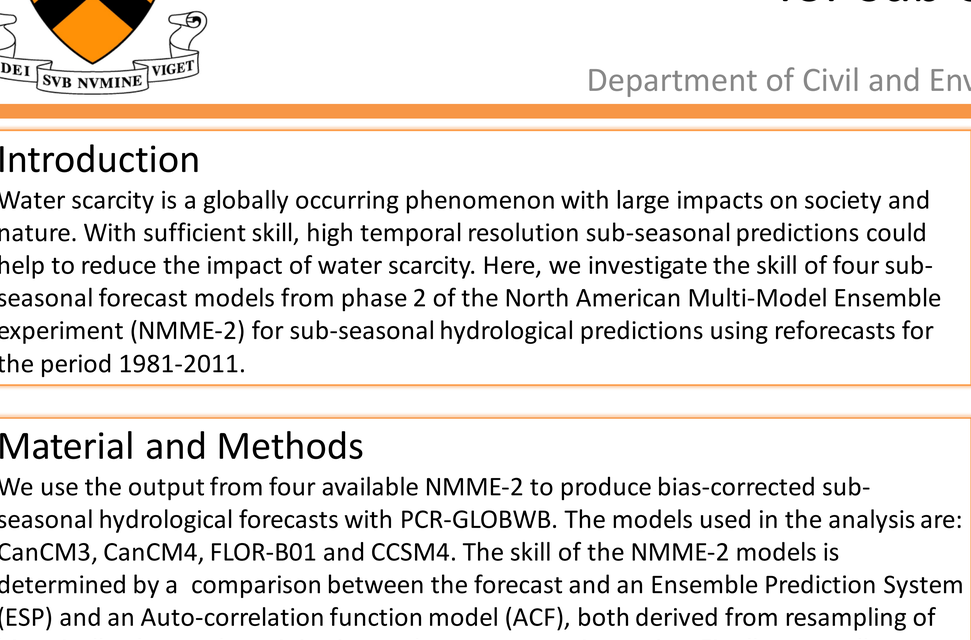

Fig 1. Anomaly correlation for discharge forecasts with a 3 month lead. Correlation for all initialization months are aggregated

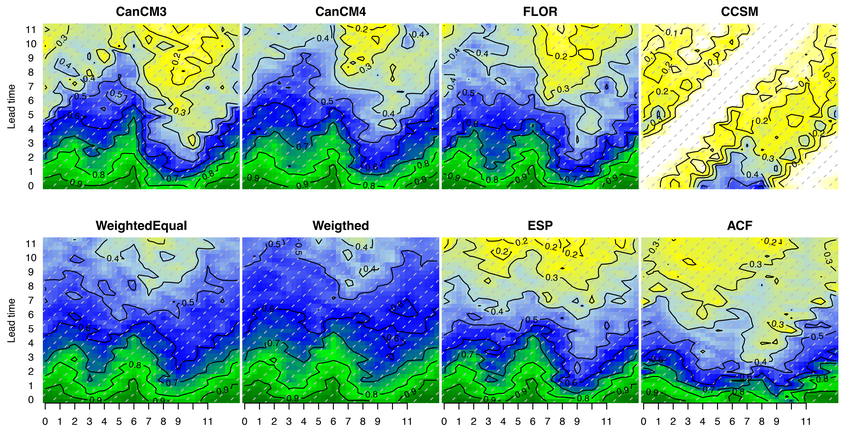

Fig 2. Anomaly correlation for discharge forecasts for the Colorado river, the x-axis provides the target month and the y-axis show the lead. Colors identical to Fig. 3. Dashed line indicate the anomaly correlation line for a forecast initialized in a specific month.

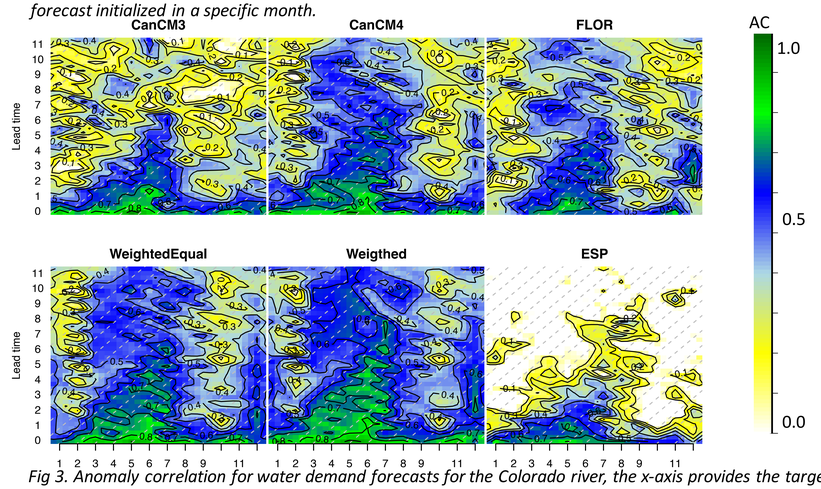

Fig 3. Anomaly correlation for water demand forecasts for the Colorado river, the x-axis provides the target month and the y-axis show the lead. Dashed line indicate the anomaly correlation line for a forecast initialized in a specific month.

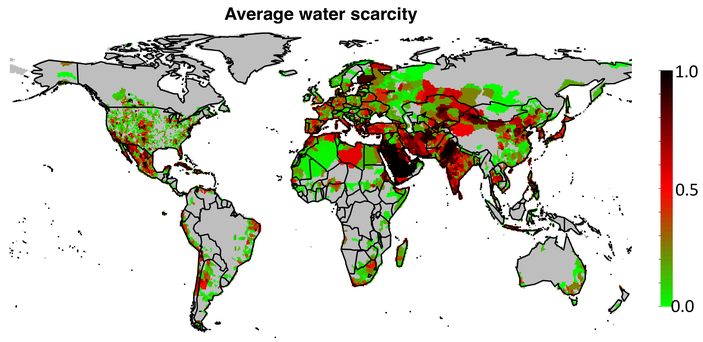

Fig 4. Global average annual water scarcity, where demand is plotted as the fraction of availability. 0 indicate no demand, 1 indicates a demand higher than availability. Grey areas indicate data with Insignificant or no water demand

Results

- High initial skill of the ESP.
- High and significant skill can be found in the NMME forecasts (Fig. 1).
- NMME model skill exceeds the skill from an ESP.
- Highest quality forecast for tropics (e.g. Brazil Fig. 1) and for longer lead times (Fig. 2).
- Initial conditions determine most of the skill for the short leads (Fig 2-3).
- NMME can be applied to forecast water scarcity and water demand (Fig. 3-4).

Conclusion and future work

Our analysis shows that the individual NMME phase 2 sub-seasonal forecasts have strong skill over the tropics, however, improvements are hampered by the high initial skill of the ESP. The strongest improvements are found in the tropics and for the longer lead time (> 3 months), indicating that for short leads the impact of the initial conditions determines most of the forecast skill in the hydrological predictions. These results show that it is possible to accurately forecast water availability and demand for lead times up to 1 year (depending on the region) with the use of the NMME phase 2 forecasts. The next step will be to implement the output of these sub-seasonal forecasts into decision support systems to assess their quality for end-user applications. This could significantly improve the usability of sub-seasonal forecasts and their impact on decision making for agricultural water use and reservoir management.

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