S2S Prediction Project
Real Time Pilot (RTP) Workshop

15th – 17th November 2022, Online

Lightning Talks

- Linda Hirons - GCRF African SWIFT ‘Using co-production to increase the appropriate use of S2S forecasts in Africa’
- Thea Turkington - S2S for DRR ‘S2S for Disaster Risk Reduction in Southeast Asia’
- Mike DeFlorio - Atmospheric Rivers ‘Experimental subseasonal forecasting of Western US atmospheric rivers & ridging to benefit water management’
- Daniele Mastrangelo - Operational agreement between Italian Civil Protection Agency & CNR-ISAC
- Matthew Janiga - Navy Earth System Prediction Capability
- Ed Blanchard-Wrigglesworth - S2S forecasts for Sea Ice Prediction
- Christopher Cunningham - Tailoring subseasonal predictions for EWS to support Public Health Management in the Brazilian Amazon
- Angel Munoz - NextGen-Nut: Predicting children undernutrition in Central America with the S2S Real Time Pilot

Linda Hirons

GCRF African SWIFT ‘Using co-production to increase the appropriate use of S2S forecasts in Africa’

Using co-production to increase the appropriate use of sub-seasonal forecasts in Africa

Linda Hirons
Cheikh Dione and Steve Woolnough…. et al.

GCRF African SWIFT's (Science for Weather Information and Forecasting Techniques) overarching goal deliver a step change in African weather forecasting capability from hourly to seasonal timescales, and build research capability to continue forecasting improvements in Africa for the foreseeable future. [Nov 2017 – Mar 2022]

GCRF AFRICAN SWIFT

SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES

WP6: Sub-seasonal to seasonal (S2S) prediction

1) **Drivers:** to identify sources of predictability for African rainfall on sub-seasonal timescale
2) **Skill:** assess the skill of operational S2S prediction systems
3) **Capacity Building:** to build research capability in the UK and Africa to inform the development of operational forecast products on the sub-seasonal timescale for decision making across a range of sectors

S2S forecasting testbed

FIGURE A: The building blocks of co-production (building on models developed by AMMA-2050, Visman et al., 2017b and KCL engagement in two BRACED consortia projects in Visman et al., 2018 and WISER 2017)

The building blocks of co-production

Co-production: brings together different knowledge sources, experiences and working practices to jointly develop new knowledge for addressing societal problems of shared concern.

Forecasting testbed: a forum where prototype forecast products are co-produced and operationally trialled in real-time.

S2S testbed Kick-off: *18th – 22nd November 2019; ICPAC Headquarters, Ngong, Kenya*

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

GCRF

S2S forecasting testbed operational groups

	O1	O2	O3	O4	O5	O6
Operational partner	**ACMAD**	**ICPAC**	**GMet**	**KMD**	**NiMet**	**ANACIM**
Location; Type	Niger; pan-Africa	Kenya; EA regional	**Ghana;** NMHS	**Kenya;** NMHS	**Nigeria;** NMHS	**Senegal;** NMHS
Supporting University	-	-	KNUST	UoN	FUTA	UCAD
Key user organisations	CAPC-AC, WHO	FSNWG	MoFA	KenGen, Brookside	IFAD	MWG
Key user sector	Disaster risk reduction; Health	Food security	Agriculture	Energy, Agriculture	Agriculture	Agriculture

GCRF AFRICAN SWIFT
SCIENCE FOR WEATHER INFORMATION AND FORECASTING TECHNIQUES

https://africanswift.org
S2S testbed co-production outputs

Peer-reviewed outputs

- **Hirons et al. 2021.** Using co-production to improve the appropriate use of sub-seasonal forecasts in Africa. *Climate Services.* 23. 100246. ISSN 2405-8807. doi: https://doi.org/10.1016/j.cliser.2021.100246
- **Endris, H. S. et al. 2021.** Evaluation of the skill of monthly precipitation forecasts from global prediction systems of the Greater Horn of Africa. *Weather and Forecasting,* 36 (4). Pp 1274-1298. . ISSN 0882-8156 doi: https://doi.org/10.1175/WAF-D-20-0177.1
- **de Andrade. F. M, 2021.** Subseasonal precipitation prediction for Africa: forecast evaluation and sources of predictability. *Weather and Forecasting*. 36 (1). pp. 265-284. ISSN 0882-8156 doi: https://doi.org/10.1175/WAF-D-20-0054.1
- **Lawal et al 2021.** Progress and challenges of demand-led co-produced sub-seasonal to seasonal (S2S) climate forecasts in Nigeria. *Frontiers in climate.* 3. 712502. ISSN 2624-9553. doi: https://doi.org/10.3389/fclim.2021.712502
- **Mutai et al 2021.** Understanding the role of user needs and perceptions related to sub-seasonal and seasonal forecasts on farmers decisions in Kenya: a systematic review. *Frontiers in climate.* doi: https://doi.org/10.3389/fclim.2021.580556
- **Gudoshava et al 2022** Application of real time S2S forecasts over Eastern Africa in the co-production of climate services. *Climate Services*, 27. 100319. ISSN 2405-8807 doi: https://doi.org/10.1016/j.cliser.2022.100319
- **Dione et al 2022.** Improved sub-seasonal forecasts to support preparedness action of Meningitis outbreak in Africa. *Climate Services*, 28 100326. doi: https://doi.org/10.1016/j.cliser.2022.100326
- **Igri et al 2022.** The current state of regional-scale climate services across Central Africa. *Climate Services*. Submitted.
- **Hirons et al 2022**. Experiences of co-producing S2S forecast products for agricultural application in Kenya and Ghana. *Weather.* Submitted.

Non-peer-reviewed outputs

- Hirons et al. S2S policy brief: Exploiting sub-seasonal Forecast Predictability in Africa: A key to sustainable development. https://doi.org/10.5518/100/72
- Hirons et al. ECMWF newsletter article on importance of African access to data for effective co-production.

https://www.ecmwf.int/en/newsletter/168/news/real-time-access-sub-seasonal-forecasts-africa

- Hirons et al. SWIFT co-production case study in the WMO state of climate services report 2021.

https://library.wmo.int/doc_num.php?explnum_id=10826 P33.

- Visman et al. Co-production policy brief. Institutionalising co-production of weather and climate services: Learning from the African SWIFT and ForPAc projects. https://doi.org/10.48785/100/99

Thea Turkington

S2S for DRR ‘S2S for Disaster Risk Reduction in Southeast Asia’

S2S for Disaster Risk Reduction In Southeast Asia: S2S SEA Pilot Project

February 2020 – October 2022

Product providers	Product Users	Support	
ASMC	The AHA Centre	RIMES	UN ESCAP

ASEAN: Association of Southeast Asia Nations

Are standard regional S2S products useful for disaster management in Southeast Asia? YES

ASMC
ASEAN SPECIALISED METEOROLOGICAL CENTRE

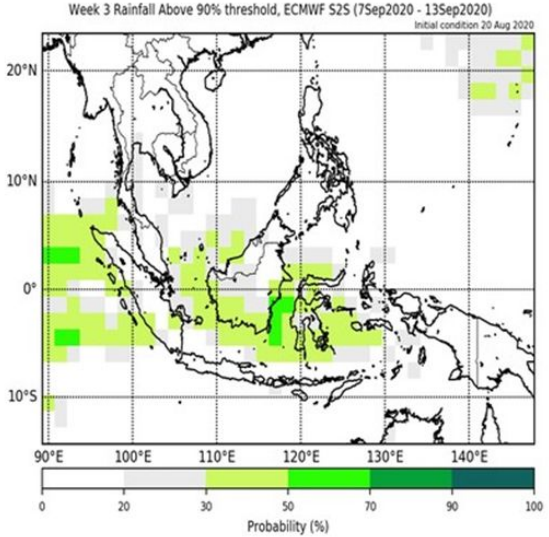
AHA CENTRE
ONE ASEAN ONE RESPONSE

RIMES

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

Are standard regional S2S products useful for disaster management in Southeast Asia? YES

- **Set up of the project:**
  - Two weeks send guidance document, with supporting information (100 + plots) in google drive
  - Meetings/questionnaires every few months to discuss products, how can improve
- **Major lessons learnt**:
  - Challenges: differences in predictive skill and reporting of disasters in region, institutional connections, communication = takes time
  - Opportunities: Not a lot of false alarms, demand for products
- **Next Steps**:
  - Working on new product for inclusion in DMRS
  - Feedback also to be incorporated in other ASMC products
- **Usefulness of the S2S RTP**:
  - Very useful – rather than focusing on case studies, can prepare forecasts without the benefit of hindsight
  - Year + can assess the various monsoon seasons



Increase chance of heavy rainfall three weeks out: disasters reported in Sumatra, Borneo, Sulawesi

ASMC ASEAN SPECIALISED METEOROLOGICAL CENTRE

AHA CENTRE ONE ASEAN ONE RESPONSE

RIMES

UNITED NATIONS ESCAP Economic and Social Commission for Asia and the Pacific

Mike DeFlorio

Atmospheric Rivers ‘Experimental subseasonal forecasting of Western US atmospheric rivers & ridging to benefit water management’

Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Experimental Subseasonal Forecasting of Atmospheric Rivers and Ridging Events to Benefit Western U.S. Water Management

Collaborating Institutions:

Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

Jet Propulsion Laboratory
California Institute of Technology

DEPARTMENT OF WATER RESOURCES · STATE OF CALIFORNIA ·

Participants: Michael J. DeFlorio, Michael L. Anderson, Luca Delle Monache, Peter B. Gibson, F. Martin Ralph, Duane E. Waliser

S2S Real Time Pilot Workshop Lightning Talk; 15 November 2022

UC San Diego | SCRIPPS INSTITUTION OF OCEANOGRAPHY

Motivation: Western U.S. water managers need better S2S forecasts of precipitation

From Days to [illegible] ...i-Scale Weather and

Water Management Decision Support Needs

- Reservoir
- Flood Em
  Response
- Situationa

Identify Vulnerabilities
Develop Adaptation Strategies
Prioritize Implementation

Physical Processes Impacting Predictability

"Wea... ...nate"

daily to w... ...decadal to century

The water level in Lake Oroville near Enterprise Bridge in Butte County, California, was 52% below its historical average level when this photograph was taken, on 23 October 2015. Credit: Zack Cunningham/California Department of Water Resources

Better Subseasonal-to-Seasonal Forecasts for Water Management

Emerging methods that improve precipitation forecasting over weeks to months could support more informed resource management and increase lead times for responding to droughts and floods.

By Michael J. DeFlorio, F. Martin Ralph, Duane E. Waliser, Jeanine Jones, and Michael L. Anderson

Adapted from Merryfield ...

Image credits: Ralph et al. 2019; NOAA; NOAA; Josef Friedhuber

DeFlorio, M. J., F. M. Ralph, D. E. Waliser, J. Jones, and M. L. Anderson (2021): **Emerging methods supporting water management at subseasonal-to-seasonal (S2S) lead times.** *EOS, 102*, https://doi.org/10.1029/2021EO159749.

RTP Project Goals and Outcomes

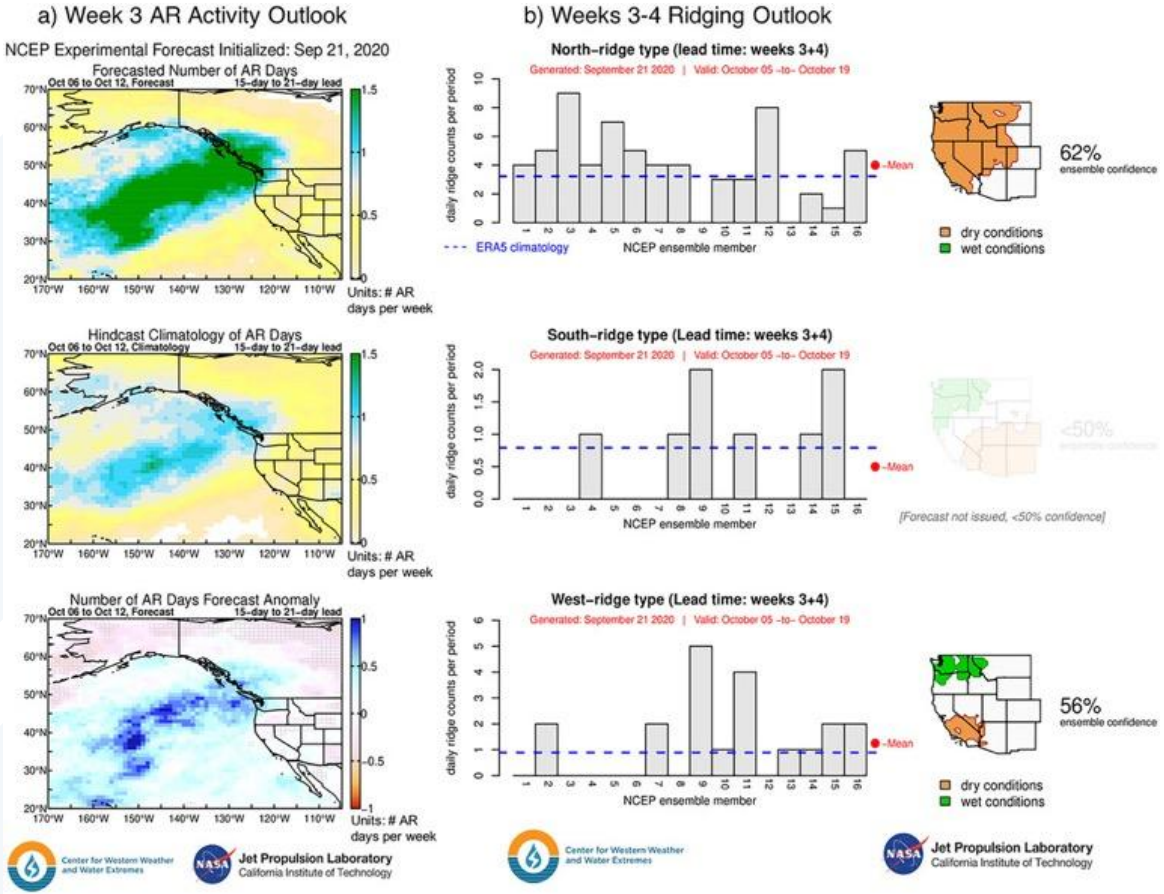


Fig. 5 from White et al. 2022 (BAMS)

- Objective: produce experimental S2S prediction products for atmospheric rivers (ARs) and ridging events, supported by research and hindcast skill assessments
- ARs and ridging are a focal point for western U.S. S2S prediction due to their strong influence on the presence and absence of wintertime precipitation
- Stakeholders at California Department of Water Resources provided input on both research methodology and experimental forecast product display

cw3e.ucsd.edu/s2s_forecasts

Daniele Mastrangelo

Operational agreement between Italian Civil Protection Agency & CNR-ISAC

Operational agreement between Italian Civil Protection Department and CNR-ISAC

National Research Council of Italy
Institute of Atmospheric Sciences and Climate

Daniele Mastrangelo
Piero Malguzzi

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Luca Delli Passeri

ISAC collaborates with the Italian Civil Protection Department (DPC, agreement renewed up to 2024) providing its S2S forecasts:

- graphical forecast outputs issued through a public website
- participation to the periodical meetings of a national expert panel led by DPC

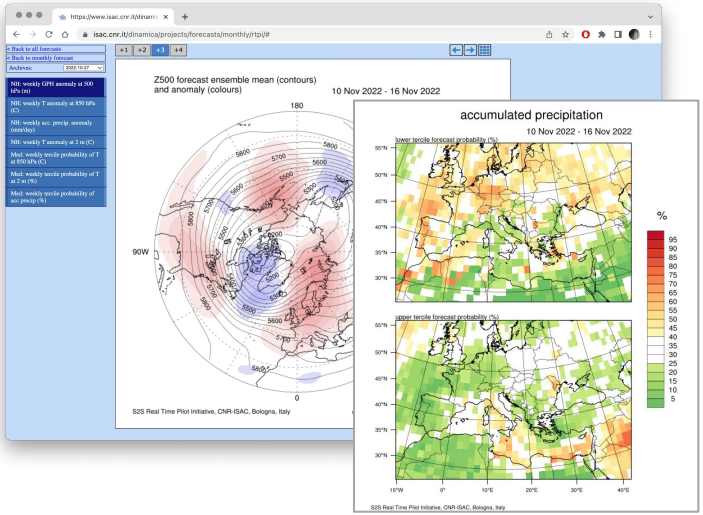
S2S Newsletter, No. 17, Aug 2021

RTPI project run within the ISAC-DPC agreement to enhance the S2S forecast information provided to DPC:

experimental multimodel (ISAC-ECMWF) ensemble forecast issued on a weekly basis

Multi-model ensemble

- Z500, T850, T2m, Precip fields from Thursday forecasts
- weekly means, W1–W4, starting at day 0
- anomaly maps of Z500, T850, T2m, Precip
- tercile-based probabilistic maps of T2m and Precip



https://www.isac.cnr.it/dinamica/projects/forecasts/monthly/rtpi/

Fire risk

CANADAIR	VVF	1	GENOVA
CANADAIR	VVF	4	CIAMPINO
CANADAIR	VVF	1	CAPODICHINO
CANADAIR	VVF	4	LAMEZIA TERME
CANADAIR	VVF	3	OLBIA
CANADAIR	VVF	2	TRAPANI
S-64	VVF	1	PRETURO L'AQUILA
S-64	VVF	1	CAPODICHINO
S-64	VVF	1	SCALEA
S-64	VVF	1	REGGIO CALABRIA
S-64	VVF	1	COMISO
AB-412/AB-205	EI	2	VITERBO
AB-412	EI	1	CAGLIARI-ELMAS
AB-412	EI	1	LAMEZIA
UH-90	EI	1	RIMINI
AB-212	MM	1	CATANIA
HH-139	AM	1	TRAPANI
HH-139	AM	1	DECIMOMANNU
NH-500	C.C.	1	RIETI
NH-500	C.C.	1	ROMA-URBE
AB-412	VVF	1	PONTECAGNANO
AB-412	VVF	1	VIGGIANO
AB-412	VVF	1	LAMEZIA TERME
AB-412	VVF	1	CATANIA

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Water resources
Drought risk

https://www.isprambiente.gov.it/pre_meteo/idro/SeverIdrica.html

Multi-model ensemble technique

- weighted combination (“superensemble”) of ISAC ensemble (41 members) and ECMWF ensemble (51 members) real-time forecasts
- whole training dataset: 235 forecasts initialized on common dates from 30 mar 2015 to 26 Sept 2019
- weighting coefficients a_1 and a_2 obtained by minimizing the squared mean difference with ERA5 reanalysis over a time period of about 5 months (for the 2015–2019 period ≈ 90-100 forecasts) centered on the initialization date d
- forecast anomaly computed by removing the reference ERA5 climate for the forecast initialization date

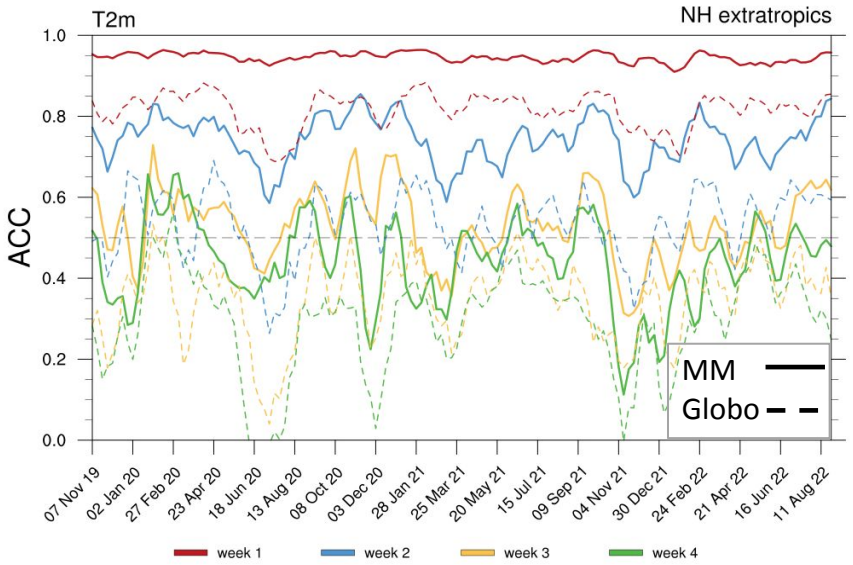
$$MM(i,j,w,d) = a_1(i,j,w,d)\mathrm{M}_1(i,j,w,d) + a_2(i,j,w,d)\mathrm{M}_2(i,j,w,d) - C(i,j,w,d)$$

pros

- training set made up of forecasts, no reforecasts
- reference climate, to compute anomalies as needed, from reanalysis
- very low computational cost
- effective calibration technique when used on a single model

cons

- less efficient with precipitation (non Gaussian variable)
- not straightforward use of weights to produce the multi-model distribution
- sensitive to the best performing model



Matthew Janiga

Navy Earth System Prediction Capability

Multi-Model Comparisons of Subseasonal Tropical Prediction Skill and Real-Time Applications (Lightning Talk)

Matthew A. Janiga[1], Stephanie Rushley[2], Kurt Hansen[2], Carolyn A. Reynolds[1]

Naval Research Laboratory Marine Meteorology Division[1]
National Research Council[2]

matthew.janiga@nrlmry.navy.mil

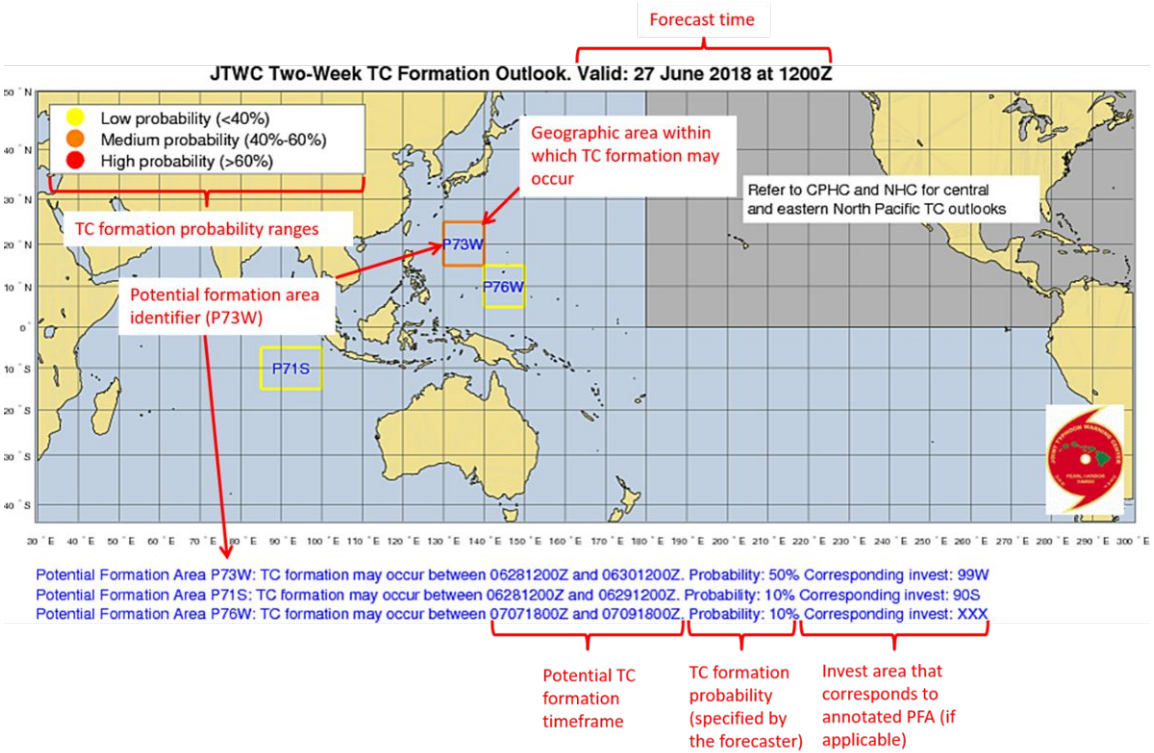
Nov 15th 2022

Acknowledgments: We gratefully acknowledge the support of the Chief of Naval Research through the NRL Base Program, Extended-Range Tropical Cyclone Prediction 6.2 (PE 62435N). Computational resources were supported in part by a grant of HPC time from the Department of Defense Major Shared Resource Centers, Stennis Space Center, MS.

U.S. NAVAL RESEARCH LABORATORY

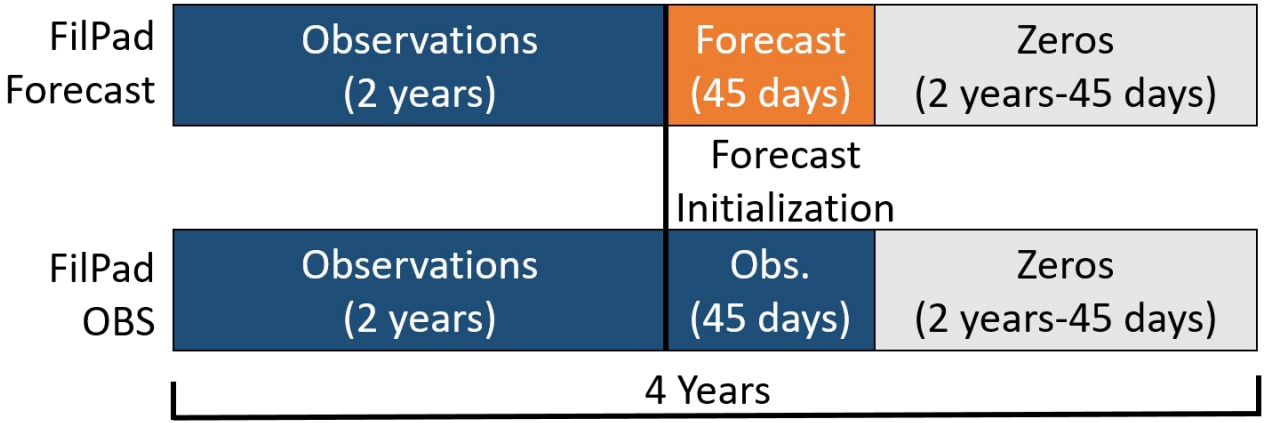
Joint Typhoon Warning Center Extended-Range TC Outlooks

The Joint Typhoon Warning Center (JTWC) is producing subjective two-week and three-week genesis forecasts using both public and Navy ESPC forecasts.



U.S. NAVAL RESEARCH LABORATORY

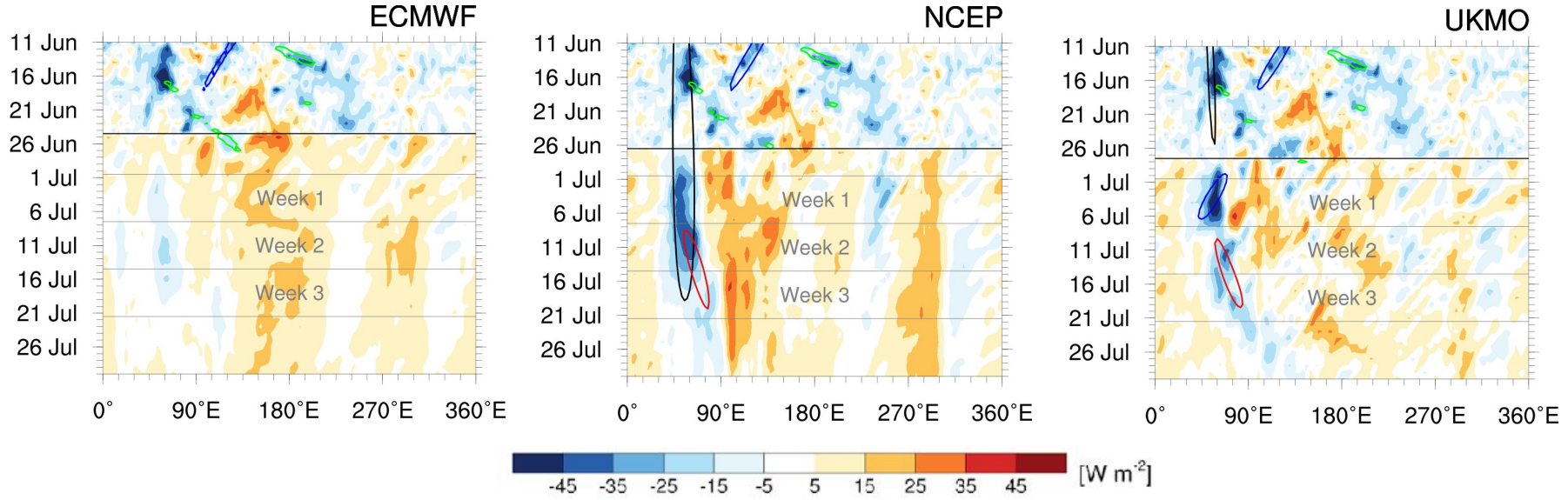
Real-Time Wavenumber-Frequency Filtering Methodology



Following Janiga et al. (2018), wavenumber-frequency filtering was applied to real-time S2S model forecasts.

U.S. NAVAL RESEARCH LABORATORY

Example of Wavenumber-Frequency Filtered OLR Forecast



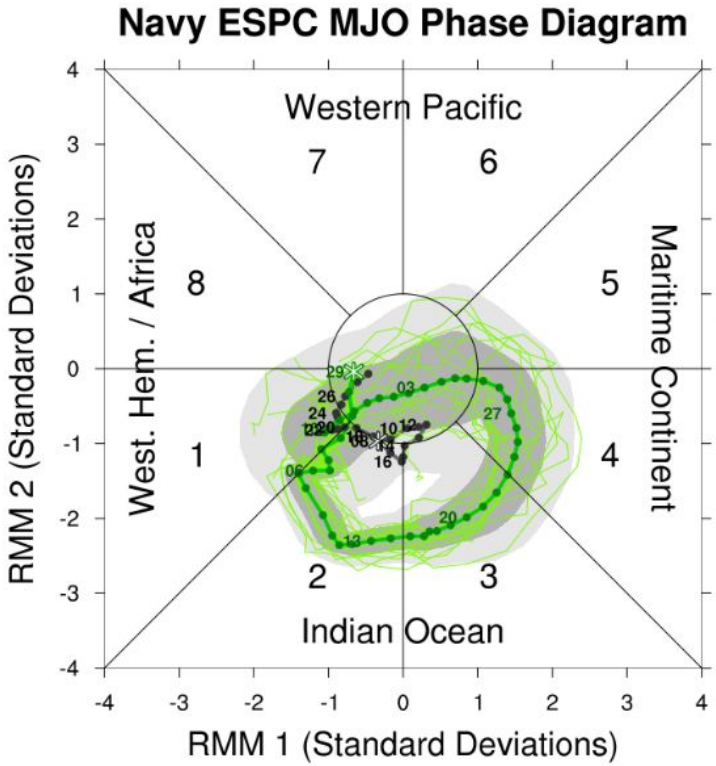
- Low-Frequency
- MJO
- ER
- Kelvin

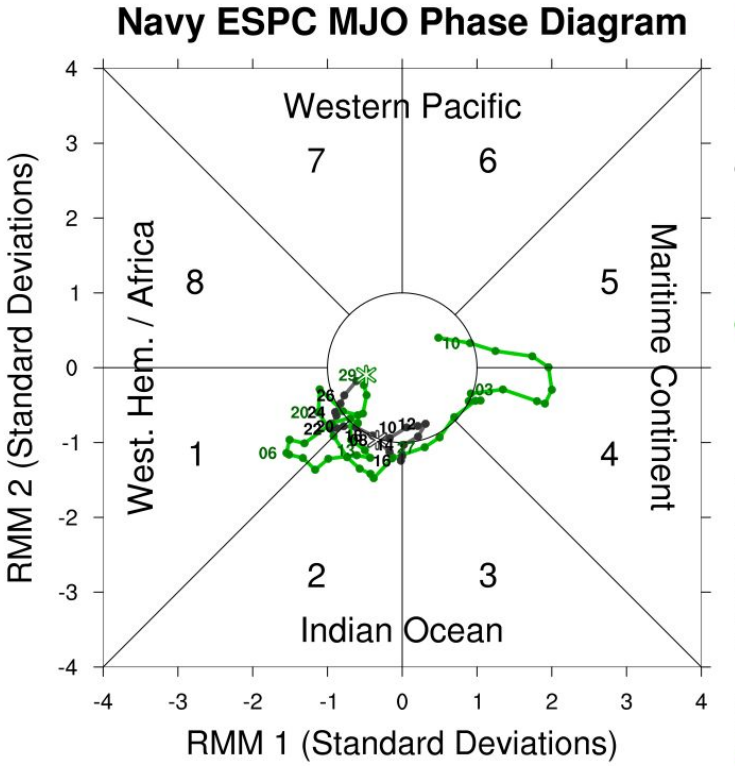
15°S-15°N averages. Filtered fields contoured every -15 W m^{-2}.

- ECMWF (51 members) initialized 2020-06-24
- NCEP (16 Members) initialized 2020-06-26
- UKMO (4 Members) initialized 2020-06-27

U.S. NAVAL RESEARCH LABORATORY

Navy ESPC Products
2020/06/28 Initialization – Verification





Ed Blanchard-Wrigglesworth

S2S forecasts for Sea Ice Prediction

S2S forecasts for sea ice prediction

Ed Blanchard-Wrigglesworth[1], Cecilia Bitz[1], Nic Wayand[1,2], Marie McGraw[1,3], Robin Clancy

[1]Department of Atmospheric sciences, University of Washingon; [2]Amazon; [3]University of Colorado

-We used the S2S to build a forecast portal and assess S2S sea ice forecast skill for the 2nd phase of the Sea Ice Prediction Network.

-Project ran over 2018-2021* at the University of Washington.

-We used both the S2S RTP (2018-2021) and the S2S archive (1999-2014) to assess sea ice forecast skill.

-We produced two papers (Wayand et al, 2019; McGraw et al, 2022). The S2S RTP was fundamental.

-*As of November 2022, we have a grant pending with NSF to expand project.

Christopher Cunningham

Tailoring subseasonal predictions for EWS to support Public Health Management in the Brazilian Amazon

Tailoring subseasonal predictions for EWS to support Public Health Management in the Brazilian Amazon

- Christopher Cunningham, Adriana Cuartas, Liana O. Anderson, Luciana Londe (Cemaden)
- Nicholas P. Klingaman (University of Reading)
- Foster Brown (Acre's Federal University; Woods Hole-USA)
- Paulo Henrique Valadares and Ianca Ribeiro (Acre's Federal University)
- Caio Coelho, Gilvan Sampaio (INPE)
- Mariana Matera Veras (Medical School - USP)

Project started: Nov/2019

End: begin to end with the pandemic

Project aim:

The objective of the project was to assess the potential usefulness of sub-seasonal forecasts as an integral part of an Alert System, in the context of a Climate Service focused on Disaster Risk Reduction in Acre.

Project deliverables:

An objective evaluation of S2S models (UKMO, CFS and BAM) predicting heatwaves.

Engaging the academic community (graduate students) in the important task of assessing and predicting heatwaves.

What we miss: Reveal the role of sub-seasonal forecasts in disaster preparedness (HEALTH) activities.

S2S RTP was helpful in the process of sensibilizing the stakeholders

(health-related services)

Ángel G. Muñoz

NextGen-Nut: Predicting children undernutrition in Central America with the S2S Real Time Pilot

NextGen-Nut: Predicting children undernutrition in Central America with the S2S Real Time Pilot

Ángel G. Muñoz
agmunoz@iri.columbia.edu

Team:
González Romero, Muñoz, Mendoza Silvestre, Rosas García, Alabweh, Mason

Columbia Climate School
International Research Institute for Climate and Society

Infant Acute Undernutrition

* Over 48% of children under 5 in Guatemala are undernourished.

* 46.7% of children under 5 affected by stunting, reaching 70% in rural indigenous areas.

* Adverse consequences for child survival and long-term well-being.

* Far-reaching consequences for human capital, economic productivity, and national development overall.

* Need for monitor & prediction system for financing anticipatory action!

See more about this system here:
https://sesan.iri.columbia.edu

The International Research Institute for Climate and Society
González Romero et al., (2020, and in prep), White et al. (2022)

Infant Acute Undernutrition

S2S RTP

GOBIERNO de GUATEMALA | SECRETARÍA DE SEGURIDAD ALIMENTARIA Y NUTRICIONAL DE LA PRESIDENCIA DE LA REPÚBLICA | Columbia World Projects | Monitoreo

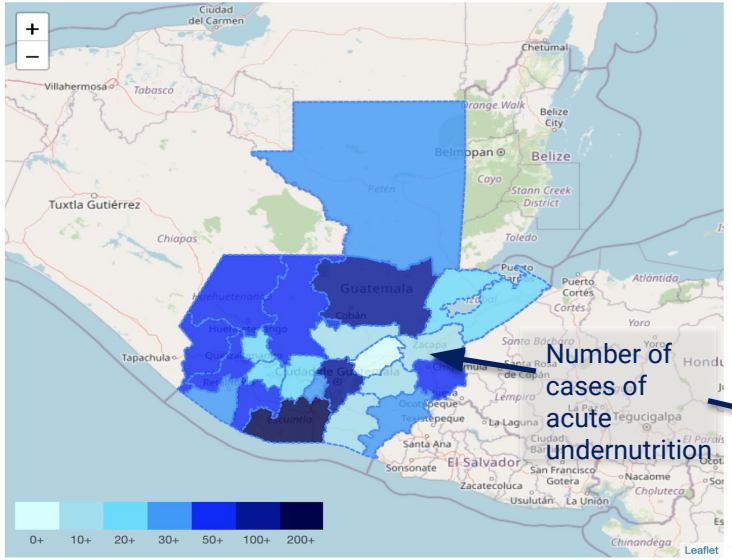
Modelo NextGen de Pronóstico de Desnutrición Aguda

El Instituto Internacional de Investigación para el Clima y la Sociedad (IRI por sus siglas en inglés), a través del proyecto ACToday, ha trabajando con distintas instituciones en Guatemala para apoyar al país en alcanzar el Objetivo de Desarrollo Sostenible número 2. Junto con la Secretaría de Seguridad Alimentaria y Nutrición de Guatemala (SESAN), ambas instituciones han trabajado conjuntamente para desarrollar una herramienta que permita obtener de forma automatizada, un pronóstico probabilístico del número del número de casos de desnutrición aguda infantil en función de una combinación de pronósticos de precipitación a escala estacional (próximos 3-6 meses) y sub-estacional (1 a 6 semanas). Este modelo probabilístico, se nutre de un nuevo sistema de generación de pronósticos (NextGen) desarrollado por el IRI.

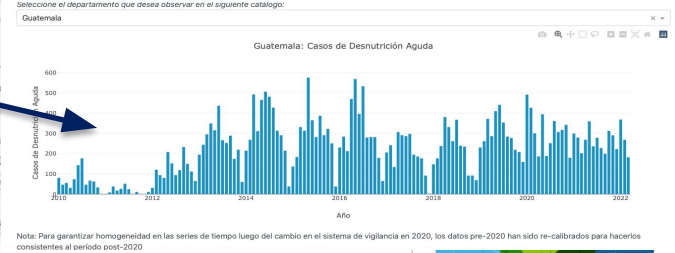
Más sobre NextGen

Desnutrición Aguda en Niños Menores a 5 años

Histórico nacional de casos reportados por MSPAS



Number of cases of acute undernutrition



* The NextGenNut system was *co-developed* with the **Secretariat for Food Security and Nutrition of Guatemala (SESAN)**

* Predictions based on climate and *socio-economic* patterns

* It allows for visualization of historical cases per department, and monthly predictions (*values and probabilities*) 4 months ahead of time

See more about this system here: https://sesan.iri.columbia.edu

The International Research Institute for Climate and Society

González Romero et al., (2020, and in prep), White et al. (2022)

25 YEARS

How does it work?

Hierarchical approach to select best models

Model	Predictor(s)	lag (mo)	BIC	τ
1	R	-4	144357734.0	0.540
2	FDD	-4	144359058.6	0.491
3	YMaize	-4	144382235.2	0.267
4	BBeans	-4	144383270.7	0.294
5	Coffee	-3	144396520.4	0.099
6	R,YMaize	-4,-4	144352354.3	0.559
7	R,BBeans	-4,-4	144350579.0	0.571
8	R,Coffee	-4,-3	144354089.7	0.554
9	R,YMaize,BBeans	-4,-4,-4	**144344286.5**	**0.590**
10	R,BBeans,Coffee	-4,-4,-3	144347540.8	0.573
11	R,YMaize,Coffee	-4,-4,-3	144352071.6	0.556
12	R,YMaize,Beans,Coffee	-4,-4,-4,-3	**144344240.3**	**0.587**

Table 1: Simple and multiple linear regression model configurations, selection and skill assessment. Lag is indicated in months. Model selection is conducted using the Bayesian Information Criterion (BIC). Forecast skill is assessed using Kendall's τ (forecast discrimination), via a retroactive forecast approach, using the first 50% of the period for training, and 50% for out-of-sample verification.

Forecast strategy

Month	Source of predictors
+1	Obs (-4 months)
+2	Obs (-3 months)
+3	Obs (-2 months)
+4	Obs (-1 months)
+5	Obs (present month)
+6	Fcst (+1 months)

Rainfall from the S2S RTP
Projected Ymaize, Bbeans (persistence)

See more about this system here:
https://sesan.iri.columbia.edu

The International Research Institute for Climate and Society
González Romero et al., (2020, and in prep), White et al. (2022)

How does it work?

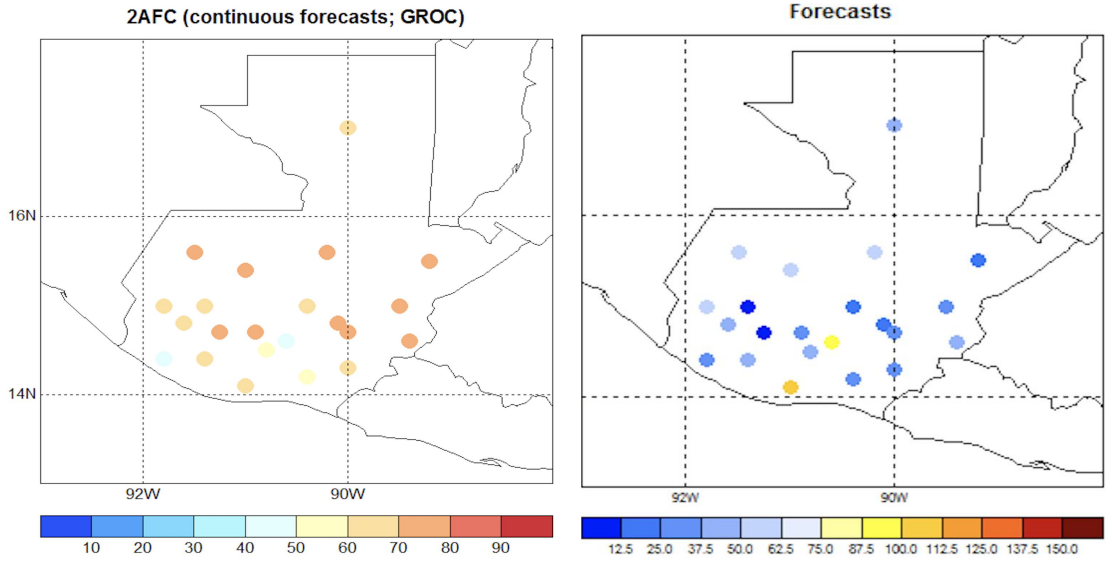
S2S RTP

Rainfall
Price of Maize
Price of Beans
Price of Coffee

+

Acute undernutrition
(kids under 5-yr;
standard WHO index)

NextGenNut



See more about this system here:
https://sesan.iri.columbia.edu

The International Research Institute for Climate and Society
González Romero et al., (2020, and in prep), White et al. (2022)