Purpose-driven practicable predictability

Sarah Jones

and many colleagues at DWD
and the
World Weather Research Programme

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

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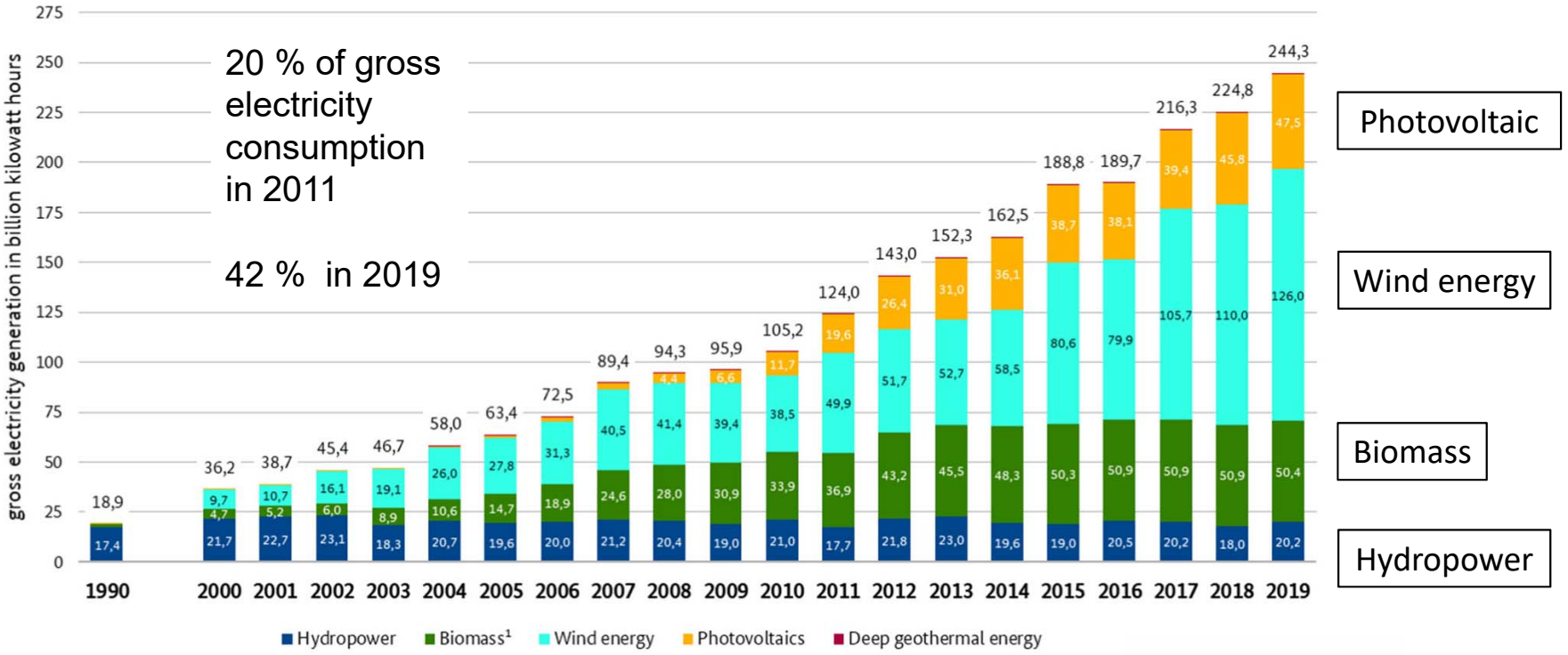
World Meteorological Organization
Organisation météorologique mondiale

Germany‘s electricity production from renewable energy (1990 – 2019)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



¹ incl. solid, liquid and gaseous biomass, sewage sludge and the biologic fraction of waste (in waste incineration plants estimated at 50 %, from 2008 only municipal waste)

BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as of February 2020

Federal Ministry for Economic Affairs and Energy

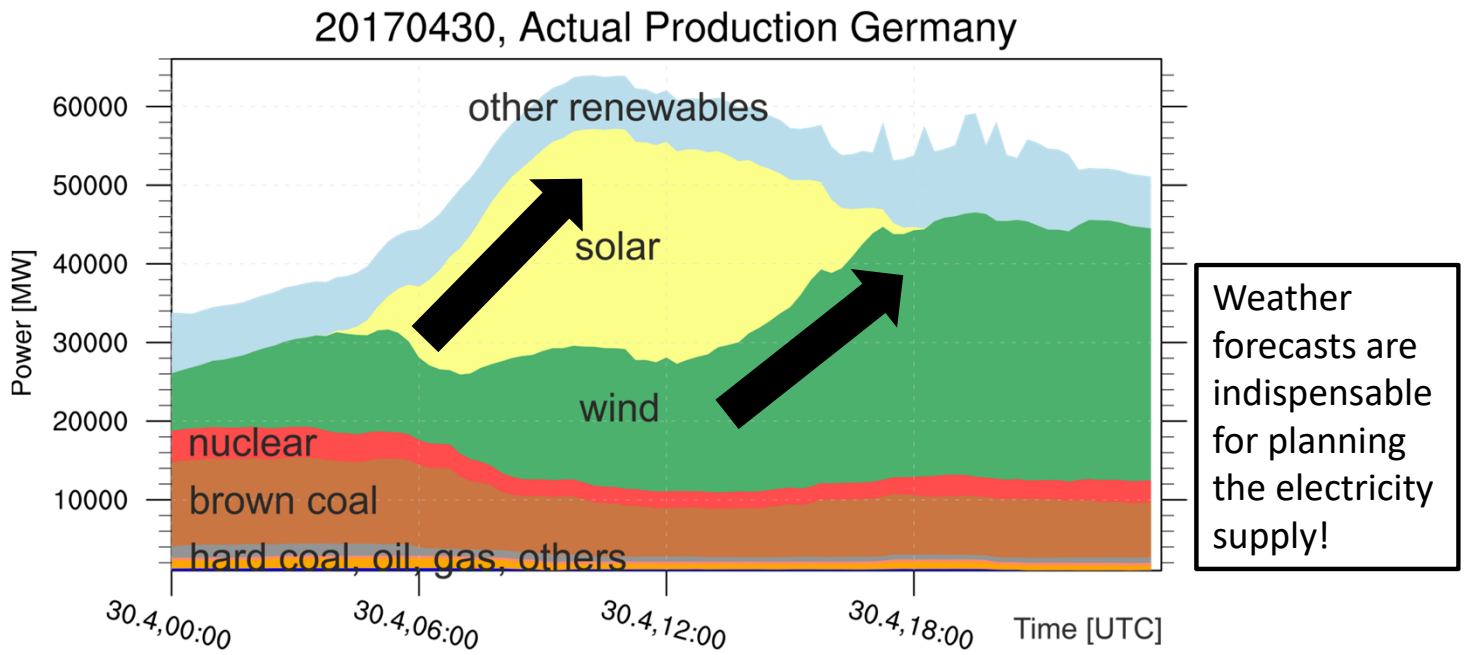
AGEE Stat

Balancing the electricity grid

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Example Sunday, 30 April 2017:

➔ Renewables cover 64 % of Germany's daily electricity demand



Weather forecasts are indispensable for planning the electricity supply!

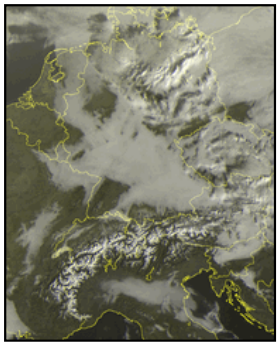
Data source: ENTSO-E Transparency Platform (2017)

Working with stakeholders to identify critical weather situations

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Photovoltaic:

- Fog
- Snowcover
- Small-scale clouds
- **Mineral Dust**

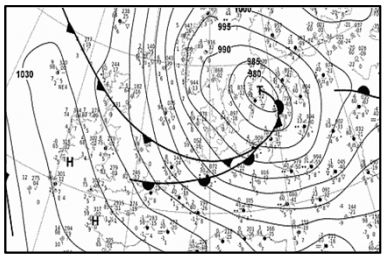


Quelle: http://de.sat24.com/de

Quelle: http://www.solarserver.de/solar-magazin/solar-interview/photo-voltaik-im-winter-aktuelle-expertentipps-fuer-betreiber-von-solarstromanlagen.html

Wind energy:

- Daily cycle (LLJ)
- Fronts (Power down)
- Icing (Turbines, Power lines)
- Turbulence in boundary layer
- Changing weather (Gradients)

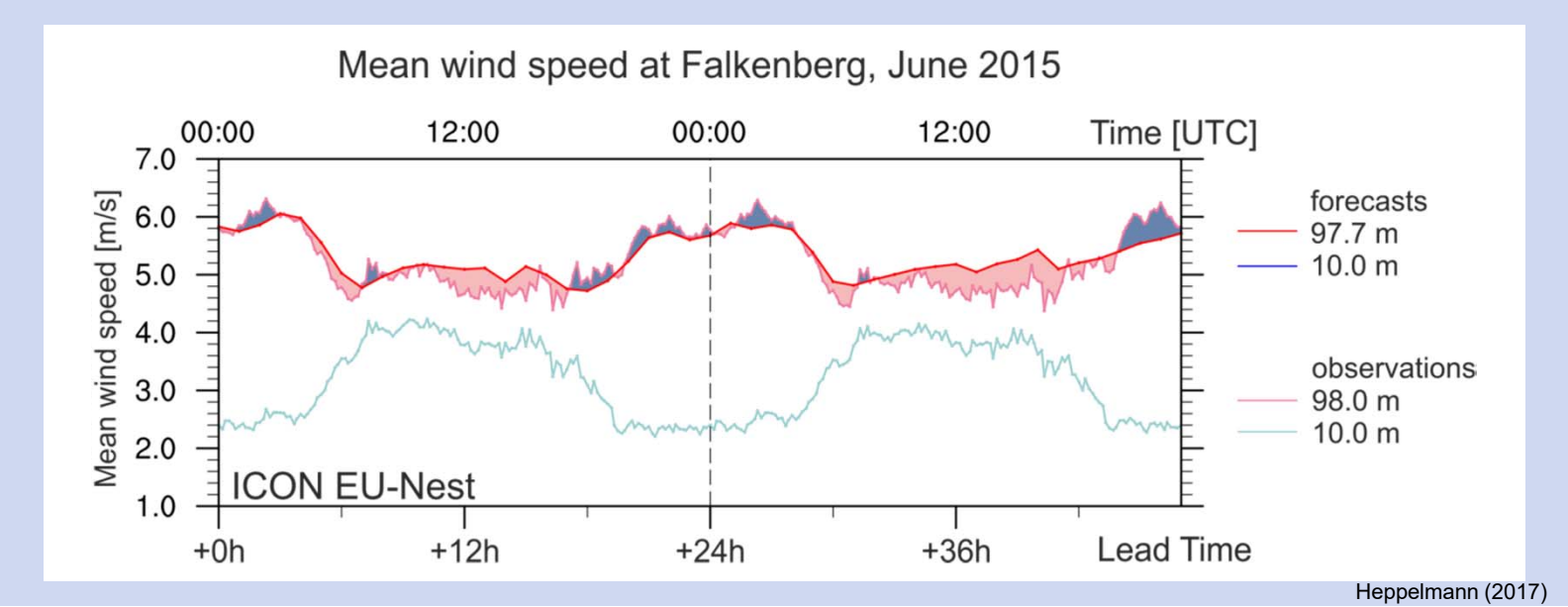


Quelle: http://www.pennenergy.com/articles/pennenergy/2014/12/wind-power-smart-anti-icing-system-for-rotor-blades.html

Improving prediction systems – a probabilistic earth system approach

➔ Diurnal cycle in boundary layer generates wind power production ramps

➔ Deficits in numerical weather prediction for diurnal cycle and nocturnal Low Level Jets

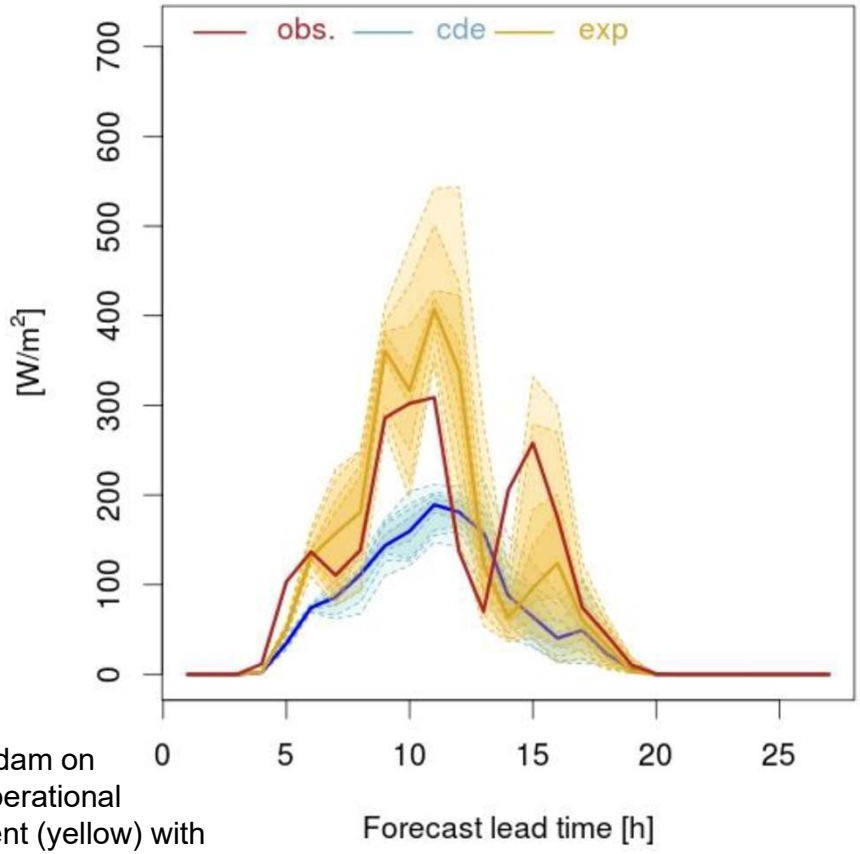


Heppelmann (2017)

➔ Improved low-level jets in model predictions visible in power forecast

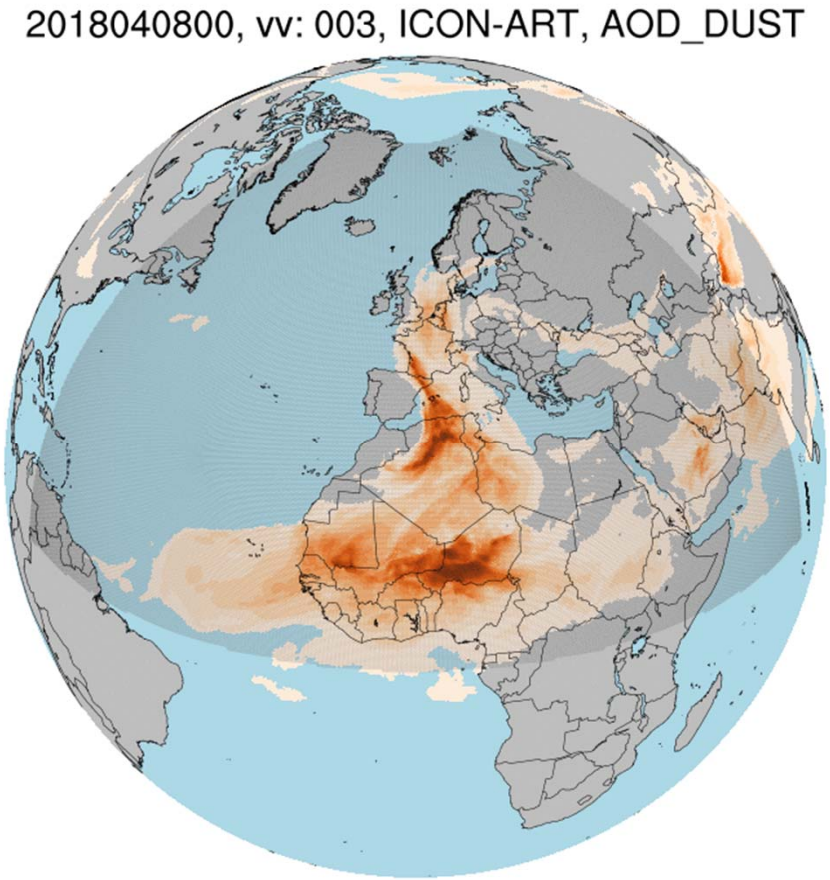
Improving prediction systems – a probabilistic earth system approach

- ➔ Forecasts of solar radiation highly sensitive to fog and low cloud – a major challenge for NWP models
- ➔ Probabilistic information from ensemble prediction systems essential
- ➔ Improvements through changes in boundary layer turbulence and ensemble generation methods



Measured solar radiation (red) in Potsdam on 02.08.2016. Quantile forecasts with operational COSMO-DE-EPS (blue) and experiment (yellow) with new turbulence scheme and perturbation

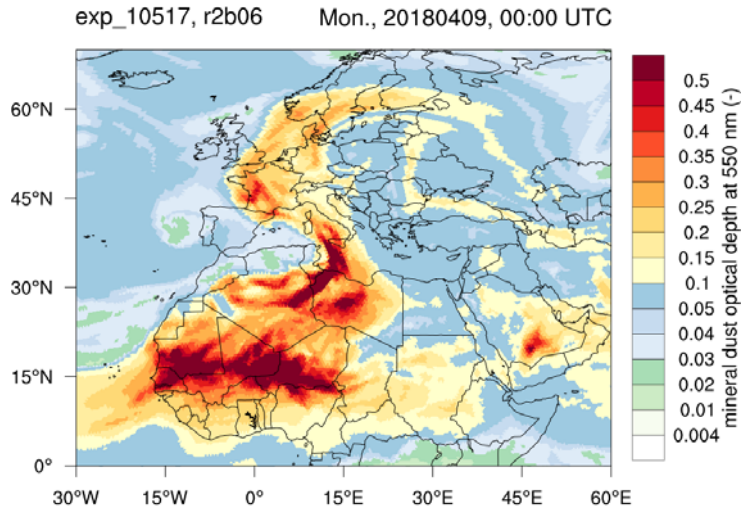
Improving prediction systems – a probabilistic earth system approach



➔ Saharan Mineral Dust outbreaks reduce photovoltaic power over Germany

➔ Representation in NWP models improves forecasts

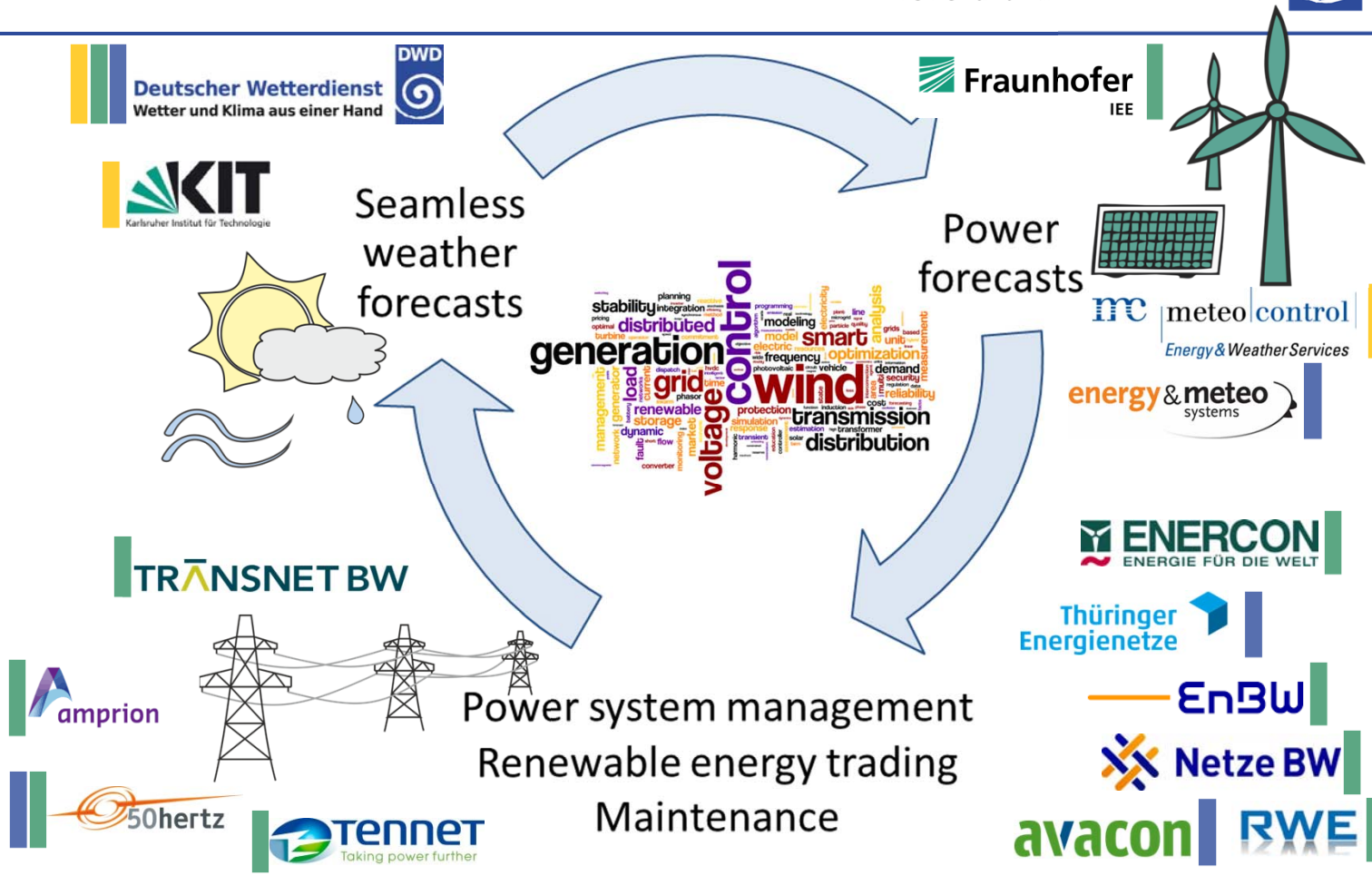
ICON-ART



Eight years of collaborative research projects

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

- ★ Partners from operational and academic research organisations, transmission system operators, private companies
- ★ Interagency cooperation
- ★ Industry and Research Platform meets every six months



Probabilistic product development with users

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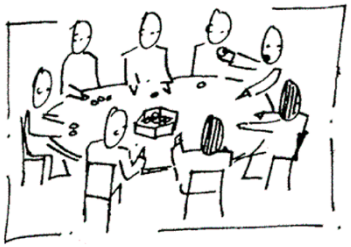
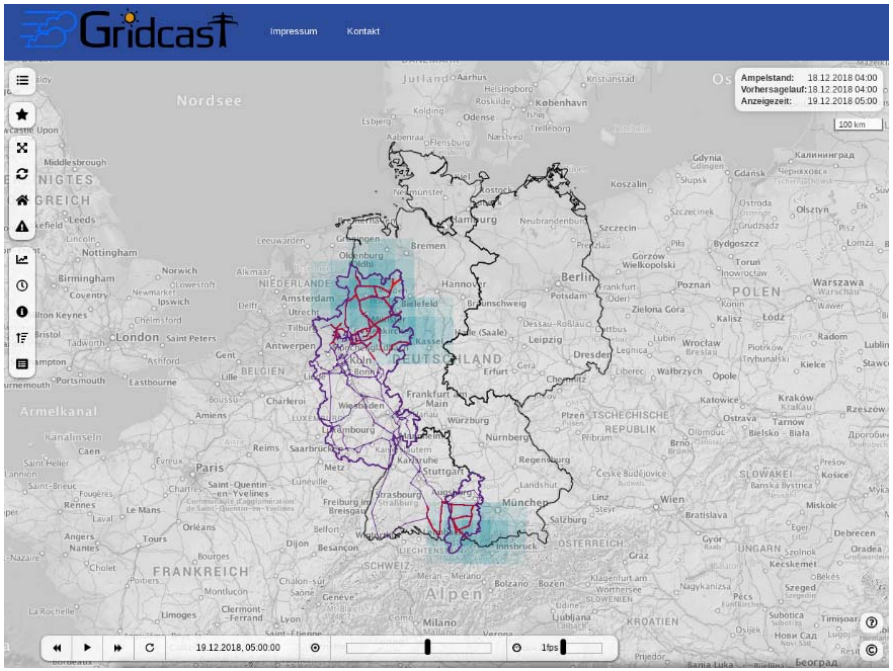
- ★ User dialogue essential for mutual understanding of possibilities and limitations
- ★ Collaboration with social and behavioural scientists for better understanding of users decision making under uncertainty
- ★ User dialogue stimulates identification of further needs
  - ↳ Development of warning information based on data from ensemble prediction systems, probabilities explicitly requested!

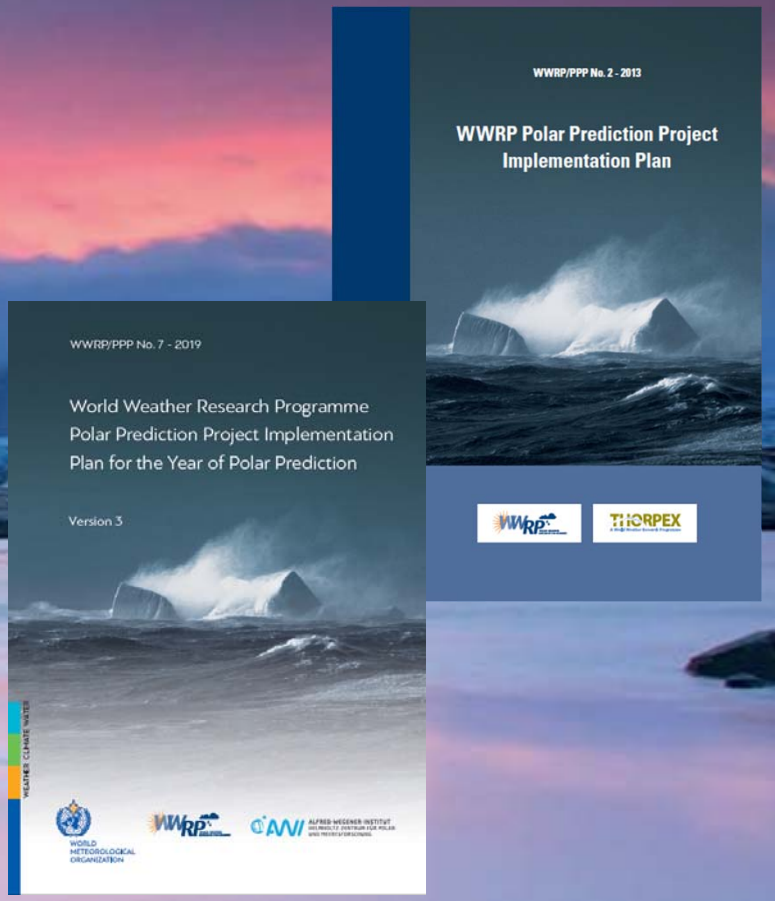


Probability for the highlighted grid sections to experience adverse weather conditions triggering conductor vibrations (e.g. freezing rain and wind)



Polar Prediction Project

Promote cooperative international research enabling development of improved weather and environmental prediction services for the polar regions, on time scales from hourly to seasonal



Chair: Thomas Jung, AWI

Project Office: Alfred Wegener Institute, Germany

Met Office | Environment Canada / Environnement Canada | Norwegian Meteorological Institute | Deutscher Wetterdienst – Wetter und Klima aus einer Hand | Australian Government Bureau of Meteorology

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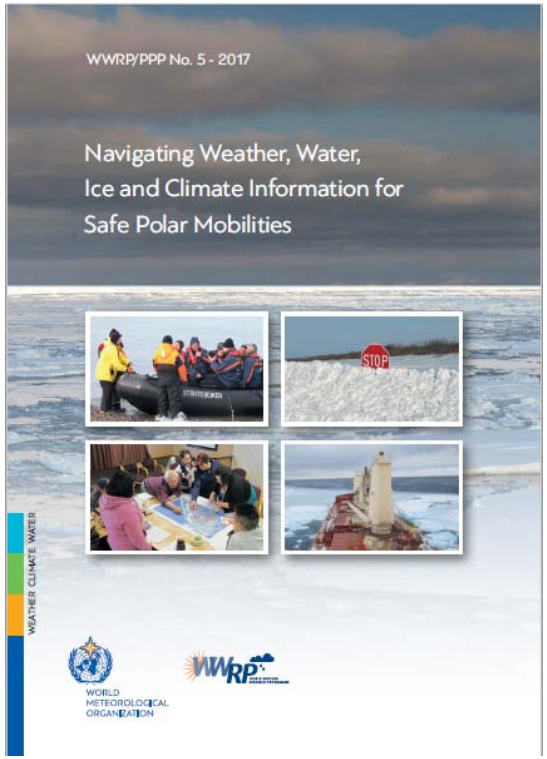
WWRP World Weather Research Programme

Year of Polar Prediction (YOPP) User Engagement: engaging expertise on Societal and Economic Research Applications



- „This report ... aims to explore how weather, water, ice and climate information is currently being used and produced in the Polar Regions, by whom, and for what reasons.“
- „The report also identifies, frames and articulates important areas of research related to the use and provision of environmental prediction services that should be prioritized and further developed during, and beyond, the Year of Polar Prediction (YOPP, 2017–19).“

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WWRP WORLD WEATHER RESEARCH PROGRAMME

Assessing quality of predictions based on user needs

The Integrated Ice Edge Error (IIEE)

- Responding to need for information on ice-edge, not just ice coverage
- Provides a basis for probabilistic verification
- Ground breaking work - Winner of the International Forecast Metric Verification Challenge

Dr. Helge Gößling, AWI
(Foto: Martina Buchholz)

Geophysical Research Letters, Volume: 43, Issue: 4, Pages: 1642-1650, First published: 02 February 2016, DOI: (10.1002/2015GL067232)

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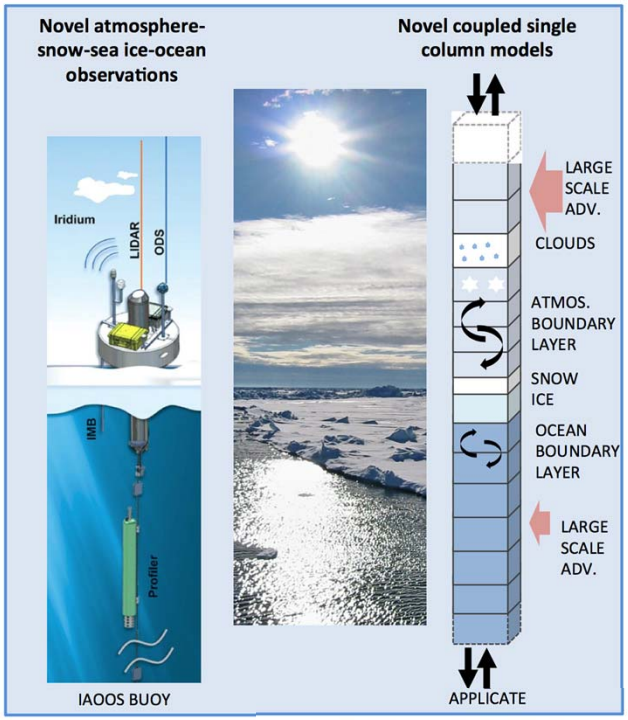
WWRP WORLD WEATHER RESEARCH PROGRAMME

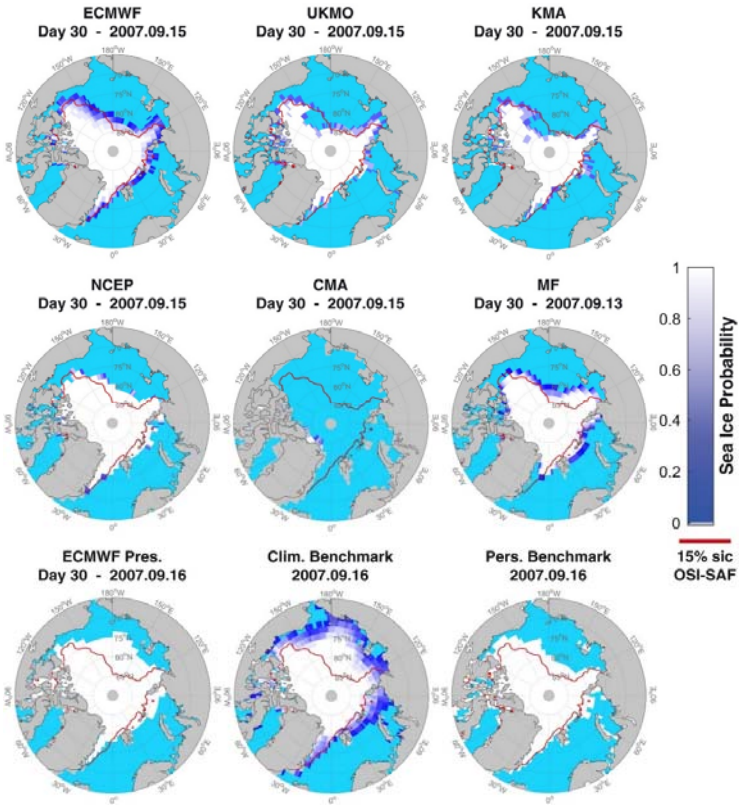
A coupled Earth System Approach is essential

Novel observations and coupled single column models



APPLICATE.eu
Advanced prediction in polar regions and beyond

Bright Prospects for Arctic Sea Ice Prediction on Subseasonal Time Scales



Geophysical Research Letters, Volume: 45, Issue: 18, Pages: 9731-9738,
First published: 19 September 2018, DOI: (10.1029/2018GL079394)

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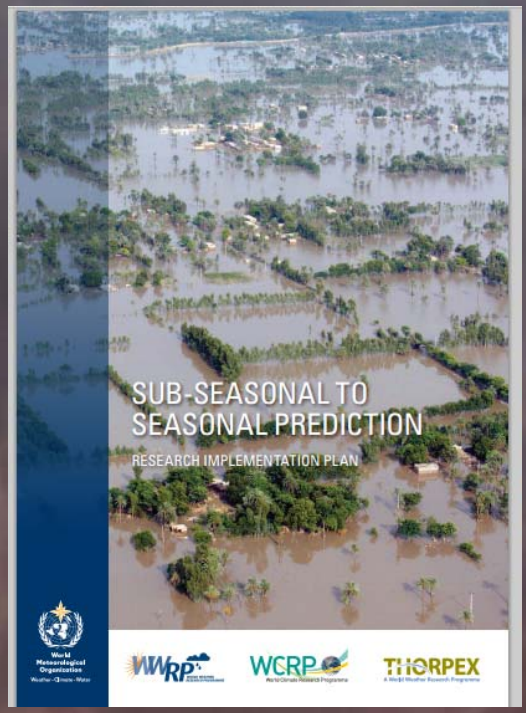
Sub-seasonal-to-Seasonal prediction project

Evaluate potential predictability of sub-seasonal events through a multi-model approach.
Understand systematic errors and biases in the sub-seasonal to seasonal forecast range
Focus on specific extreme event case studies increasing resilience and improving adapting capacity.

Co-chairs: Frédéric Vitart (ECMWF), Andrew Robertson (IRI)

Project Office: KMA/NIMR

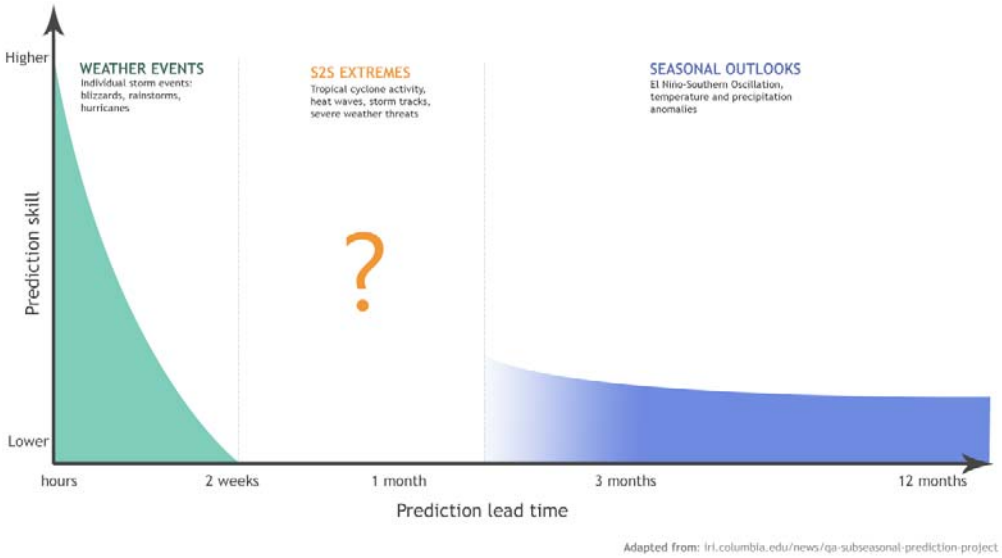


WWRP World Weather Research Programme

WCRP World Climate Research Programme

WMO OMM | Met Office | Environment Canada Environnement Canada | Deutscher Wetterdienst Wetter und Klima aus einer Hand DWD | Australian Government Bureau of Meteorology

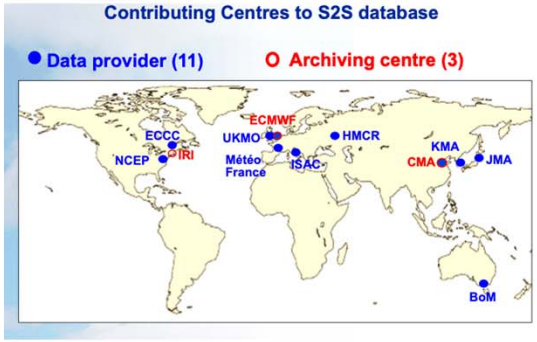
Prediction Gap



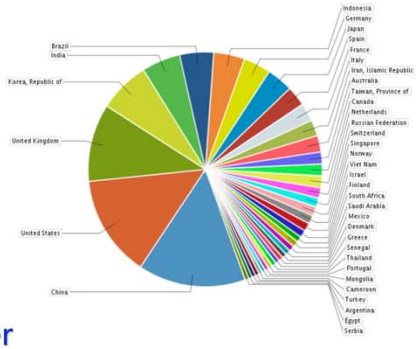
The forecast range between weather forecasts and seasonal outlooks was long thought to be a **"predictability desert"** with little forecast skill.

Many **management decisions** in agriculture and food security, water, disaster risk reduction and health fall into this **gap**.

database – a WMO research infrastructure



ECMWF S2S Server



Over 1000 active users of ECMWF archive
With ~500TB retrieved since 2015.

S2S Database Models

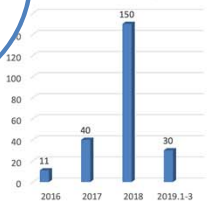
Forecasts / Hindcasts

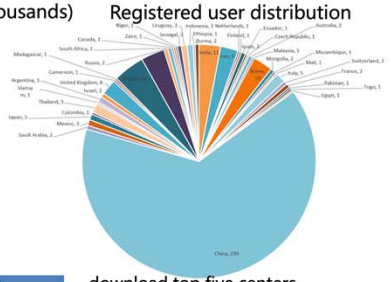
Status on 5th January 2018	Time range	Resolution	Ens. Size	Frequency	Re-forecasts	Rfc length	Rfc frequency
BoM (ammc)	d 0-62	T47L17	3*11	2/week	fix	1981-2013	6/month
CMA (babj)	d 0-60	T106L40	4	daily	fix	1994-2014	daily
CNR-ISAC (isac)	d 0-32	0.75x0.56 L54	41	weekly	fix	1981-2010	every 5 days
CNRM (lfpw)	d 0-32	T255L91	51	weekly	fix	1993-2014	2/month
ECCC (cwao)	d 0-32	0.45x0.45 L40	21	weekly	on the fly	1995-2014	weekly
ECMWF (ecmf)	d 0-46	Tco639/319 L91	51	2/week	on the fly	past 20 years	2/week
HMCR (rums)	d 0-61	1.1x1.4 L28					
JMA (rjtd)	d 0-33	TI479/TI319L					
KMA (rksl)	d 0-60	N216L85					
NCEP (kwbc)	d 0-44	T126L64					
UKMO (egrr)	d 0-60	N216L85					

Forecasts available 3 week
Currently ~70 Tbytes

137 articles using S2S DB

CMA S2S Data Server





Data download (TB)

year	amount of data
2016	1.9
2017	3.1
2018	3.2
2019.1-3	20.7

download top five centers
ECMWF, CMA,BOM,UKMO, NCEP
download top five parameters
t, u,v, mx2t6, gh

S2S Database in IRI Data Library

- Over 2/3 of the S2S database is archived at IRI, including MJO indices
- Kept up to date
- Allows server-side and "lazy" computation to analyze the data according to user requests (eg weekly averaged anomalies of ensemble means, EOFs …)
- Good for low-bandwidth situations
- OpenDAP
- Includes RMM indices

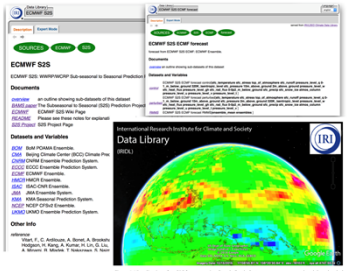


Figure 1. Visualization of an S2S forecast using Google Earth. Data was post processed and downloaded from the IRI Data Library.

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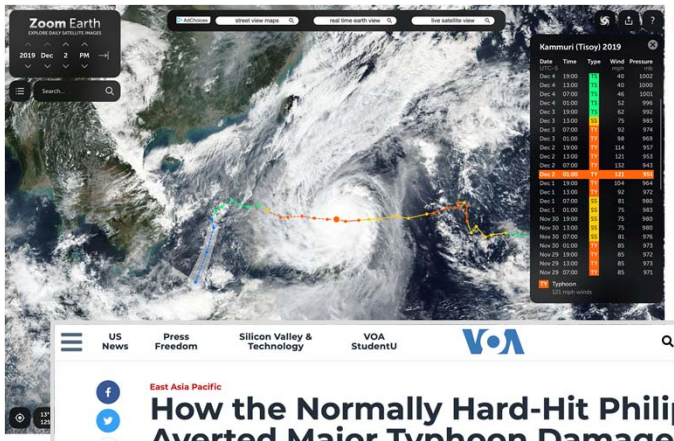
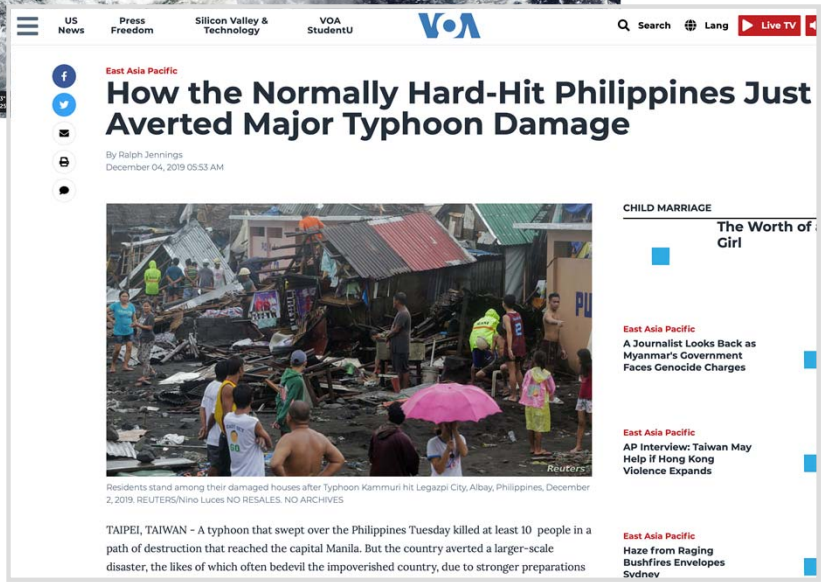
WCRP World Climate Research Programme

Forecasts of Typhoon Kammuri (Tisoy)





US News | Press Freedom | Silicon Valley & Technology | VOA StudentU | Search | Lang | Live TV

East Asia Pacific

How the Normally Hard-Hit Philippines Just Averted Major Typhoon Damage

By Ralph Jennings
December 04, 2019 05:53 AM

Residents stand among their damaged houses after Typhoon Kammuri hit Legazpi City, Albay, Philippines, December 2, 2019. REUTERS/Nino Luces NO RESALES. NO ARCHIVES

TAIPEI, TAIWAN – A typhoon that swept over the Philippines Tuesday killed at least 10 people in a path of destruction that reached the capital Manila. But the country averted a larger-scale disaster, the likes of which often bedevil the impoverished country, due to stronger preparations

CHILD MARRIAGE
The Worth of Girl

East Asia Pacific
A Journalist Looks Back as Myanmar's Government Faces Genocide Charges

East Asia Pacific
AP Interview: Taiwan May Help if Hong Kong Violence Expands

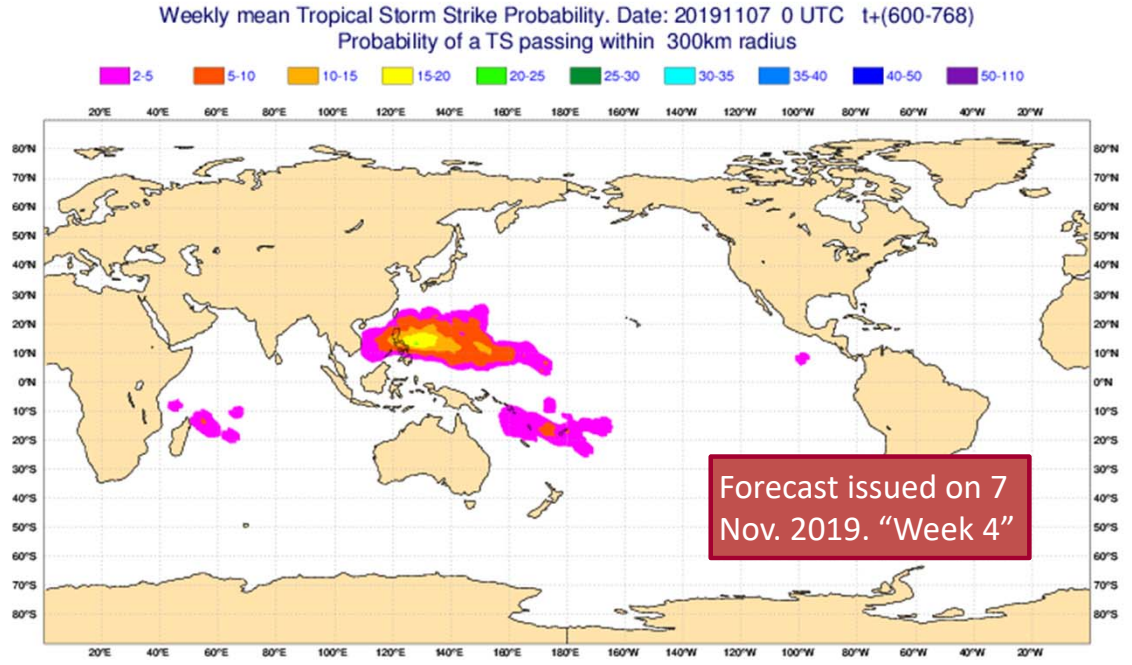
East Asia Pacific
Haze from Raging Bushfires Envelopes Sydney

Multi-Model Tropical storm Strike Probability

Start date: 7 Nov. 2019 – Day 26-32

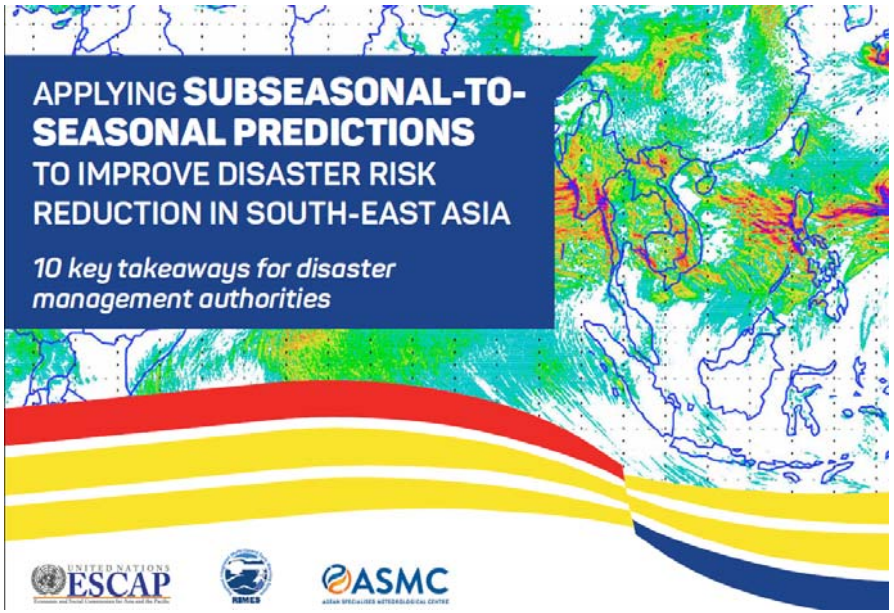
Verification date: 2-8 December 2019

BoM/CMA/CNRM/ECCC/ECMWF/HMCR/ISAC/JMA/NCEP/UKMO



Enhanced strike probability predicted over 3 weeks in advance

Second Phase:
database enhancement, research activities and real-time pilots



Real-time pilot: S2S for Disaster Risk Reduction in Southeast Asia

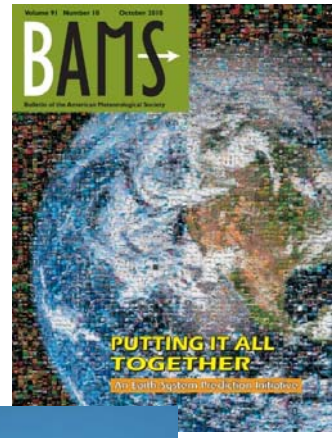
Source: Based on original figure created by Jiyul Shin, 2019.

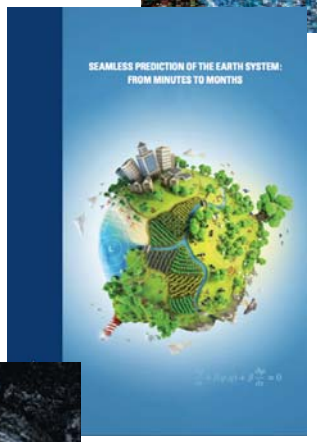
https://www.unescap.org/resources/applying-subseasonal-seasonal-predictions-improve-disaster-risk-reduction-south-east-asia

Seamless Earth System Prediction Approach

Originally defined at the intersection of weather and climate

……. now considers all compartments of the Earth system as well as disciplines of the weather-climate-water-environment value chain (monitoring and observation, models, forecasting, dissemination and communication, perception and interpretation, decision-making, end-user products) to deliver tailor-made information on weather, climate, water and environment from minutes to centuries and from global to local.





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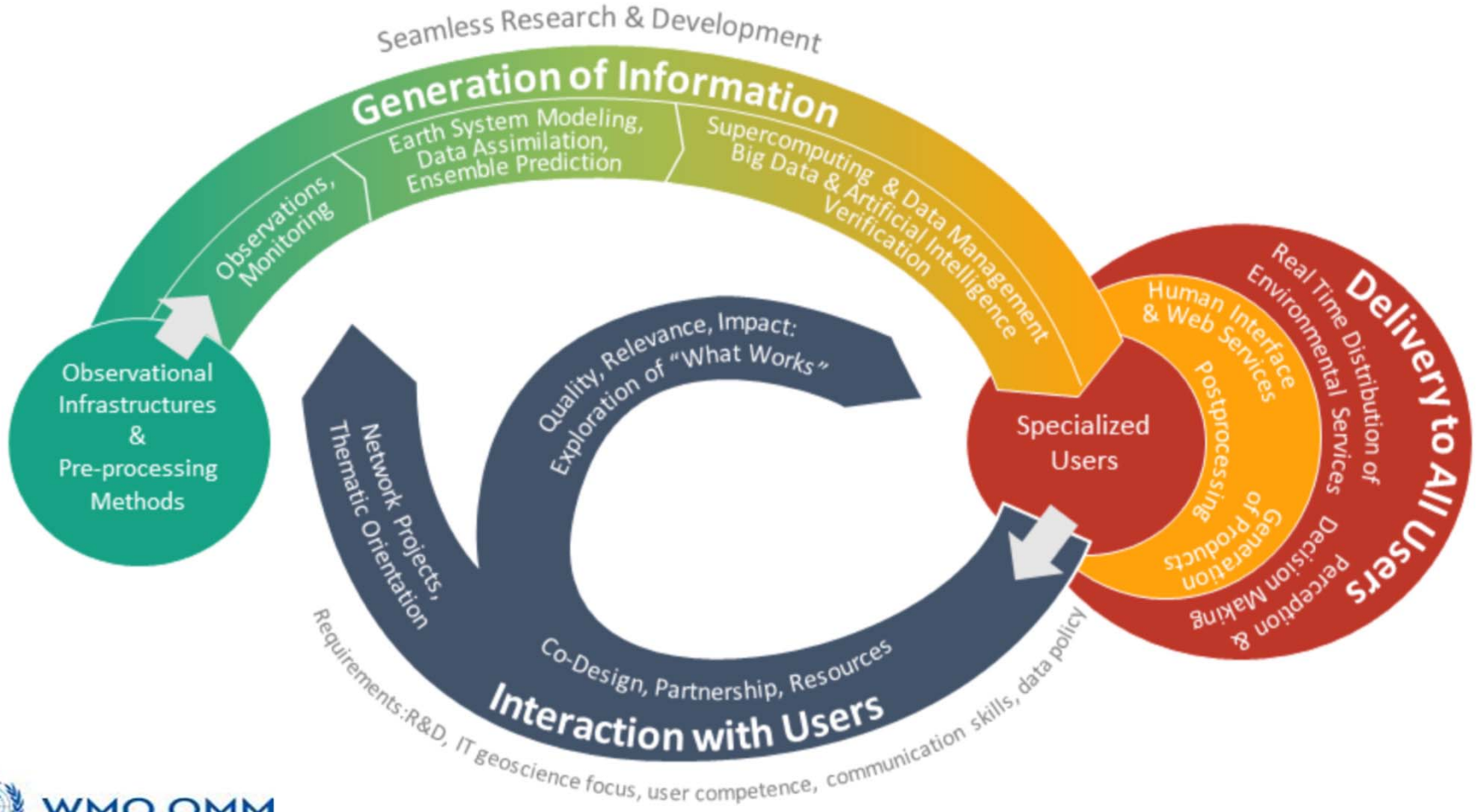
The Earth System Science you need to make your life safer and better



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Ruti et al., BAMS 2019. DOI 10.1175/BAMS-D-17-0302.1

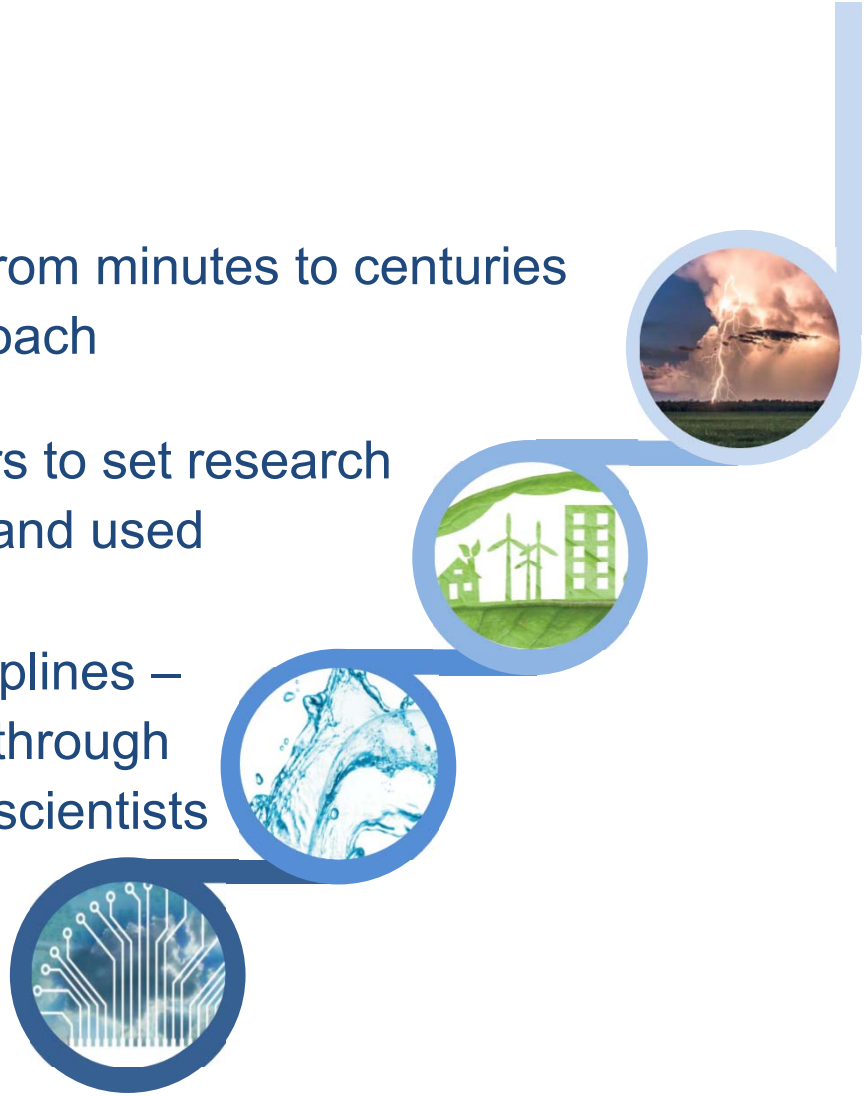
Future perspectives

Advancing Seamless Earth System Predictability from minutes to centuries to meet societal needs through a value cycle approach

Ensuring co-design between users and researchers to set research priorities and ensure advances are useful, usable and used

Working in partnership: internationally, across disciplines – agencies – organisations - research communities, through private-public engagement, engaging early career scientists

Utilizing new technologies and maintaining global predictive infrastructure



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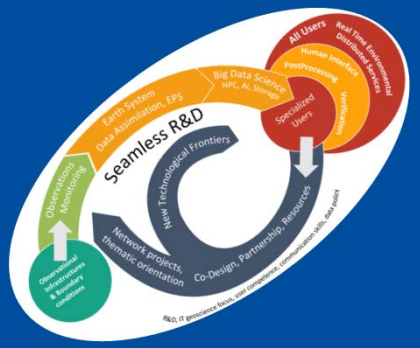

Thank you
Merci

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TEMPS CLIMAT EAU

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World Meteorological Organization
Organisation météorologique mondiale