Catalyzing Innovation in Weather Science: the World Weather Research Programme

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World Weather Research Division

and the WWRP SSC, Working Groups and Projects

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

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World Meteorological Organization
Organisation météorologique mondiale

The World Weather Research Programme

WMO's mechanism to foster and progress cooperative research for improved weather and environmental prediction services from minutes to months

Mission

"The WMO World Weather Research Programme (WWRP) promotes international and interdisciplinary **research for more accurate and reliable forecasts from minutes to seasons**, expanding the frontiers of weather science **to enhance society's resilience** to high-impact weather and the **value of weather information for users**. WWRP aims at Seamless Prediction by increasing convergence between weather, climate and environmental approaches. WWRP **strengthens academic – operational partnerships** and interdisciplinary collaborations, and enhances **the role of Early Career Scientists**

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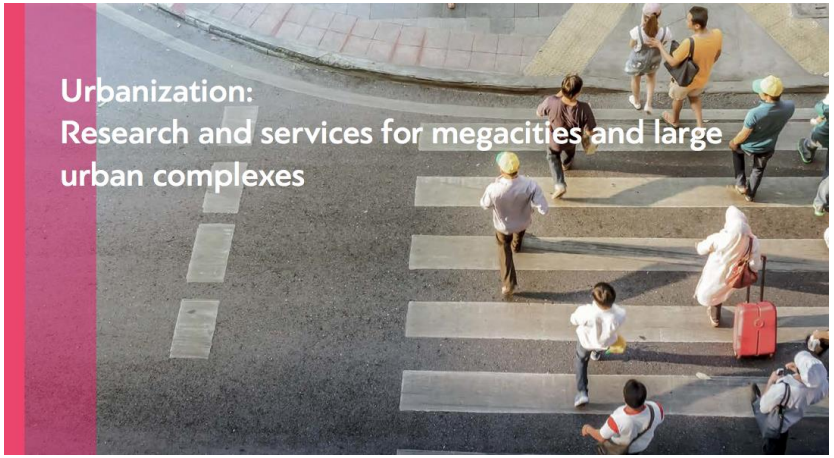
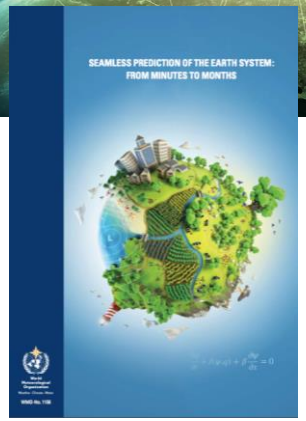
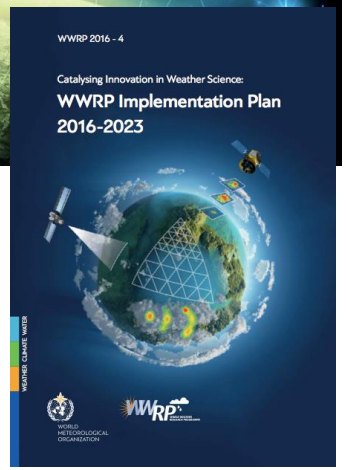
WWRP WORLD WEATHER RESEARCH PROGRAMME

WWRP activities focus on four challenges



A guide to catalyze innovation





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WWRP Action Areas

Societal Challenges

HIGH IMPACT WEATHER	WATER	URBANIZATION	NEW TECHNOLOGIES

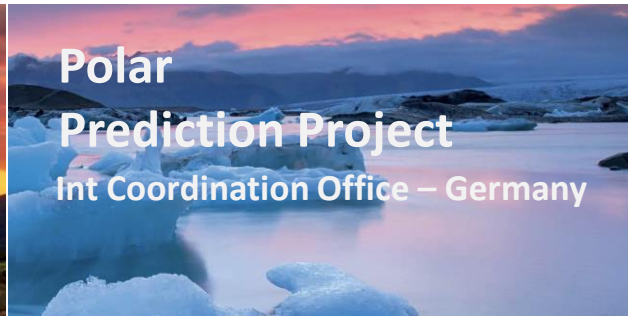
Action Areas

Address Limitations Uncertainty Fully Coupled Applications Verification Attribution	Integrated Water Cycle New Observations Precipitation Processes Hydrological Uncertainty	Understand Needs Observations & Processes Urban Prediction	Advanced Methods Support Facilities Tools New Observations Future GOS

Objectives and Concrete Activities

Each Action Area comes along with a set of objectives.
Concrete Activities have been defined that will ensure to achieve the objectives and make progress in the action areas.

Three Core Projects



World Health Organization
ICSU International Council for Science
UKaid from the British people
IRDR Integrated Research on Disaster Risk
WMO OMM
CREWS CLIMATE RISK & EARLY WARNING SYSTEMS
GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES
European Commission
ARCTIC COUNCIL
ECMWF
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission

WWRP Structure

Scientific Oversight & Management

Scientific Steering Committee

World Weather Research Division at WMO Secretariat

WWRP Working Groups

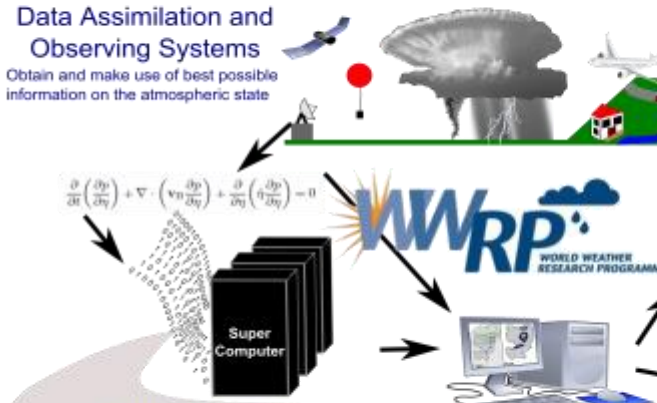
Tropical Meteorology
Identify and support research initiatives on tropical cyclones and monsoons

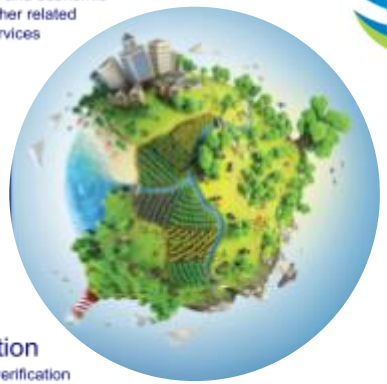
Predictability, Dynamics and Ensemble Forecasting
Advance the science of dynamical meteorology, predictability ensemble forecasting, promoting the development of ensemble applications

Weather Modification
Promote scientific practices in weather modification

Data Assimilation and Observing Systems
Obtain and make use of best possible information on the atmospheric state

Socio-Economic Research Applications
Advance the social and economic application of weather related information and services





WCRP-JSC / CAS Working Group on Numerical Experimentation
Foster the development of atmospheric circulation models and resolve shortcomings

Nowcasting and Mesoscale
Promote prediction on the mesoscale for short time scales considering models and observations

Verification
Develop and apply new verification techniques to help improving quality of forecast models
(joint WG with World Climate Research Programme)

WWRP Core Projects

Polar Prediction

Subseasonal-to-Seasonal S2S Prediction Project

High Impact Weather

Sand&Dust Storm

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WWRP WORLD WEATHER RESEARCH PROGRAMME

WWRP Regional Portfolio

FORECAST DEMONSTRATION PROJECTS

REGIONAL DEVELOPMENT AND INNOVATION PROJECTS

REGIONAL SCIENCE AND TECH TRANINGS

INVOLVING ACADEMIA AND PRIVATE SECTOR

OPEN INNOVATION AND TECHNOLOGY SCOUTING

NURTURING FUTURE TALENTS

Integrating regional and national needs into iinternational science plans through a continuous interactions with WMO members

20 **More than 20 global and regional research projects**

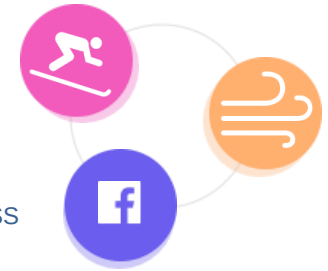
50 **More than 50 countries engaged**

100 **More than 100 Mil Dollars mobilized**

OLYMPIC GAMES

TROPICAL CYCLONES

HAZARDS AND SOCIAL AWARNESS



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High-impact Weather: Toward impact-based forecasts in a variable and changing climate

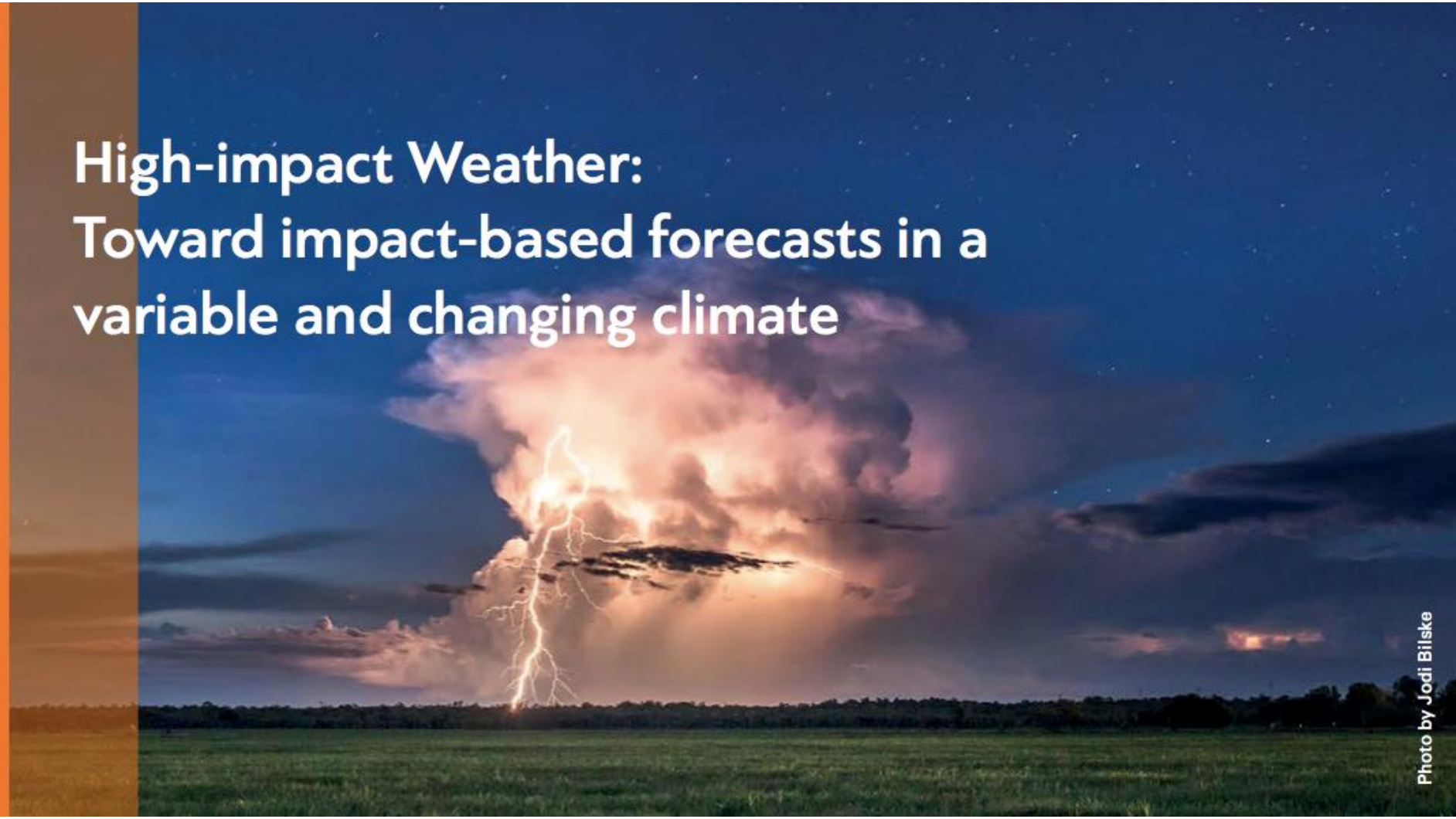

Photo by Jodi Bilske

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Action Areas 1: Address Limitations

Increase knowledge of the physical and social factors limiting the capability to predict, communicate and mitigate the impacts of high-impact weather events; identify how these limitations can be overcome; demonstrate the resulting improvements for specific high-impact weather events at lead times from minutes to seasons, from global to local, for different users in different parts of the world

- Use diagnostic and verification information to identify capabilities and limitations in predictions of high-impact weather at lead times from minutes to seasons.
- Through targeted research on specific meteorological processes associated with high-impact weather (e.g.convection, surface interactions, etc.) improve understanding of those processes, and where possible develop the observational, algorithmic and numerical capacity to better predict them.
- ……

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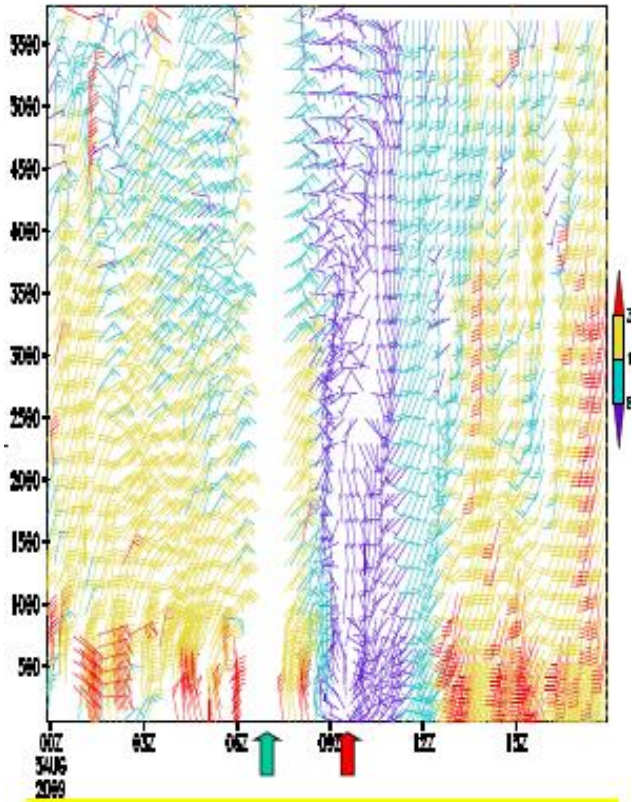
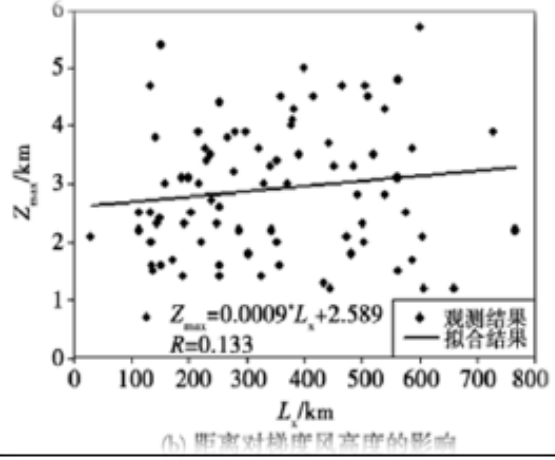
Action Areas 1: Address Limitations

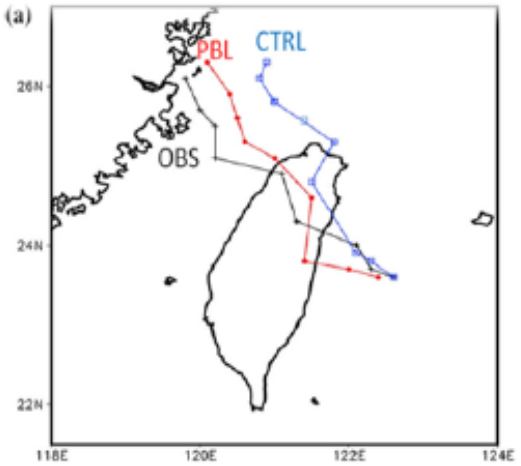
EXOTICCA Observations lead to better representation of Tropical Cyclone PBL in NWP model

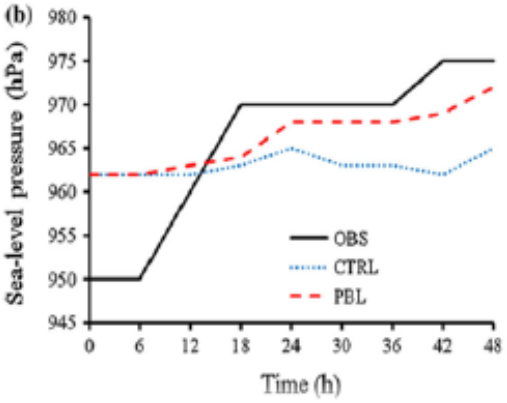


PBL more than 5km (during landfalling)



Modify the definition of PBL in HWRFV3.3 (YSU) based on field campaign data





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Action Areas 2: Uncertainty

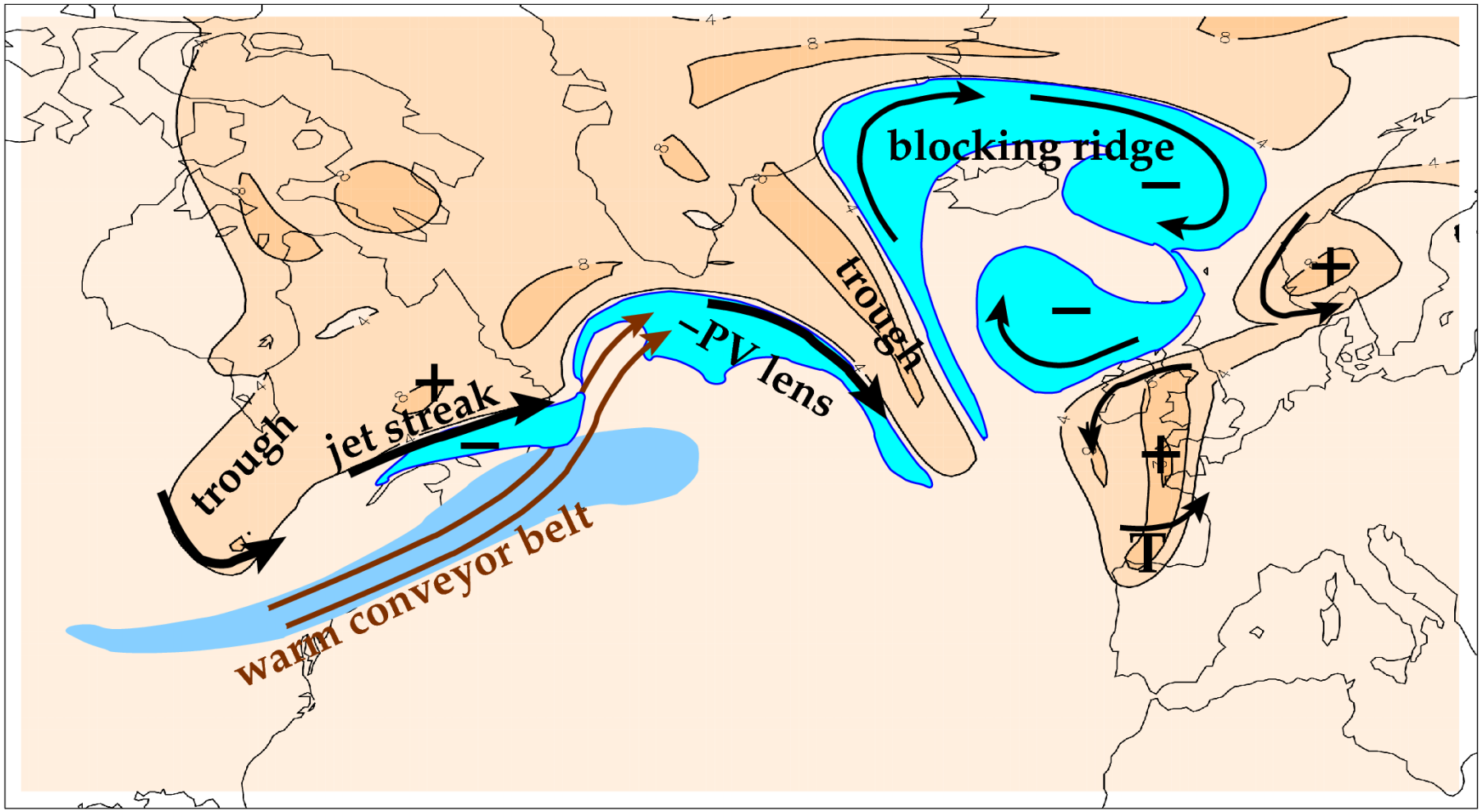
Identify, characterize and quantify analysis and forecast uncertainty using advanced probabilistic methods, and develop corresponding data channels and communication mechanisms which support decision-making under uncertainty

- Quantitative descriptions of the uncertainty of the initial state, its evolution forward in time.
- Improve the resolution and reliability of ensemble-based meteorological predictions
- Co-design communication mechanisms of uncertainty with users
- Improved diagnostics and verification tools from high-resolution ensembles that assist operational forecasters

Action Areas 2: Uncertainty

Overarching scientific aim of NAWDEX:

to quantify the effects of diabatic processes on disturbances to the jet stream near North America, their influence on downstream propagation across the North Atlantic, and consequences for high-impact weather in Europe.



Water:
Modelling and predicting the water cycle for improved disaster risk reduction and resource management

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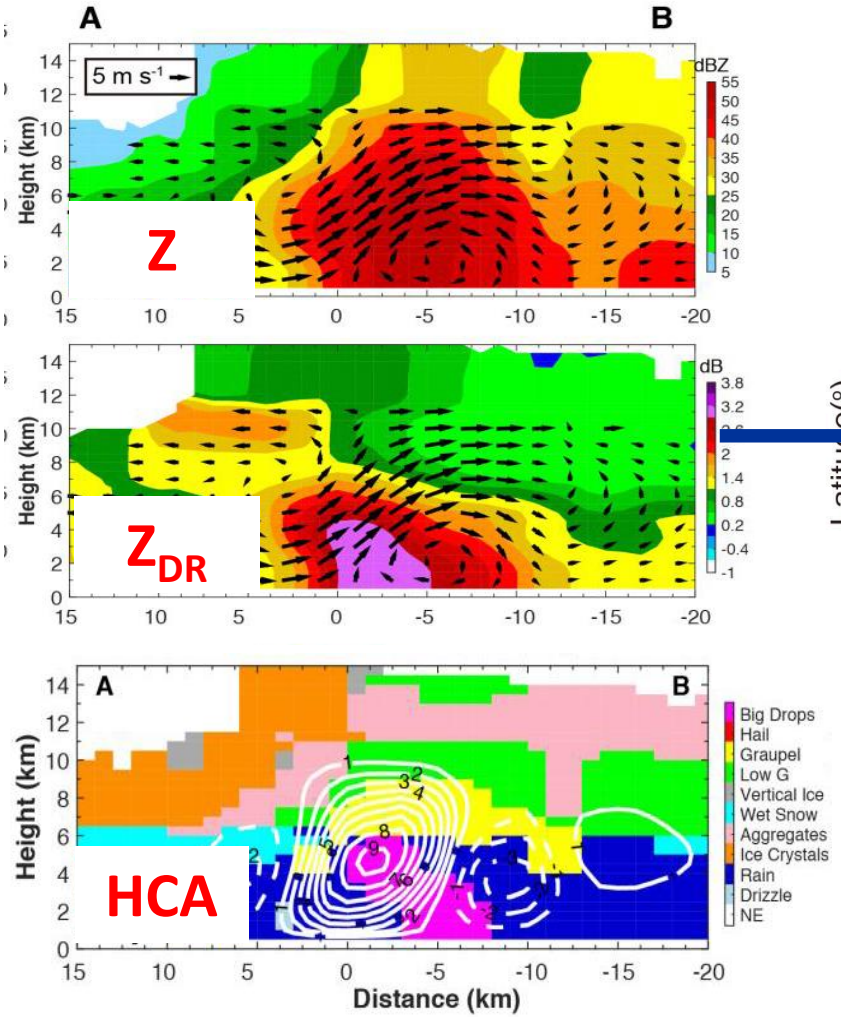
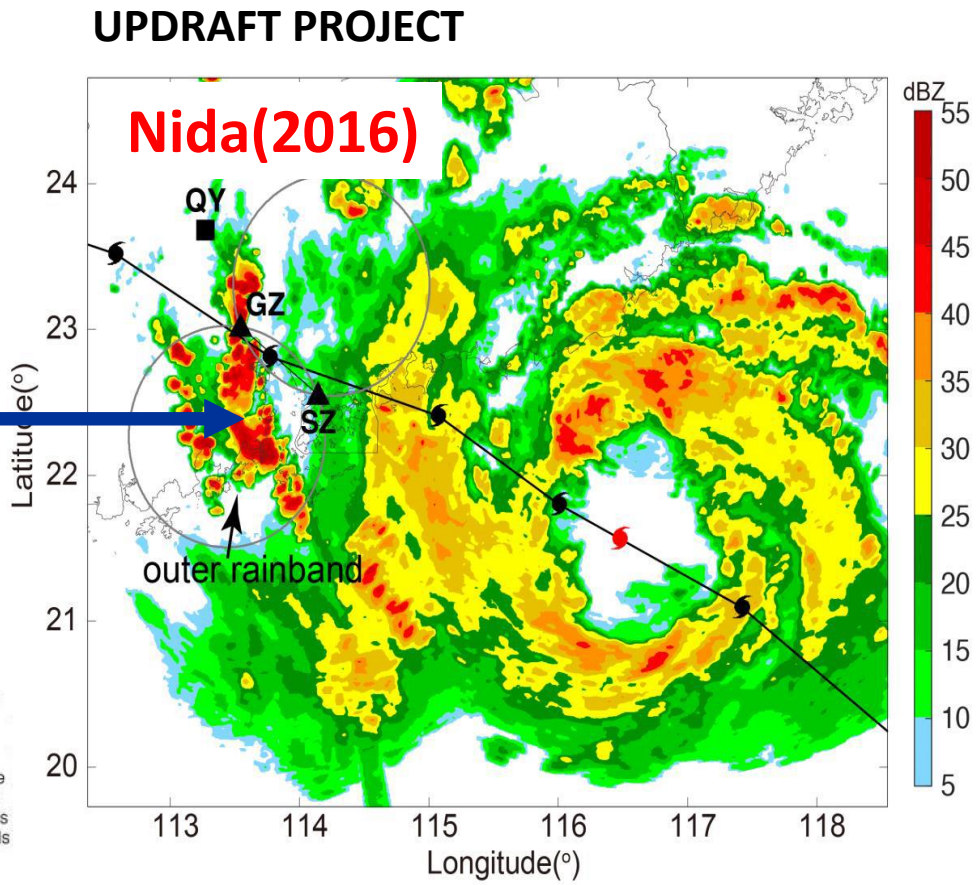
Action Area 9: Precipitation Processes

Improve understanding, observation and modelling of aerosol, cloud and water vapour aspects of precipitation processes, with a view to improved estimation and predictions of precipitation

- Develop new/better convective parameterizations for non-convection-permitting models (which remain relevant).
- In collaboration with GAW improve the understanding of aerosol activation in the atmosphere and how this affects radiative forcing of weather and climate & cloud processes
- Make improvements to model physics and related data assimilation for improving rainfall processes

Action Areas 9: Precipitation Processes





Wu and Zhao,2018@MWR

The ice-phase microphysical processes are important pathways of particle growth in the outer rainbands where riming contributes significantly to heavy rain.

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Evolving Technologies:
Their impact on science and their use

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Action Areas 15: Support Facilities

Enhance access to services (observations, model output, data collection and pre-processing and global models) that require exceptional HPC and data handling

- Continue to support TIGGE, S2S, and similar data collection efforts, to enable and accelerate research worldwide
- In light of increasing data volumes, develop policies and methods for distributed data archival/ retrieval
- Develop and share (open source) tools and lessons-learned for handling and pre-processing such datasets and developing applications
- Make available to the international community model datasets in formats suitable for post-processing and verification

Subseasonal-to-Seasonal S2S Prediction Project

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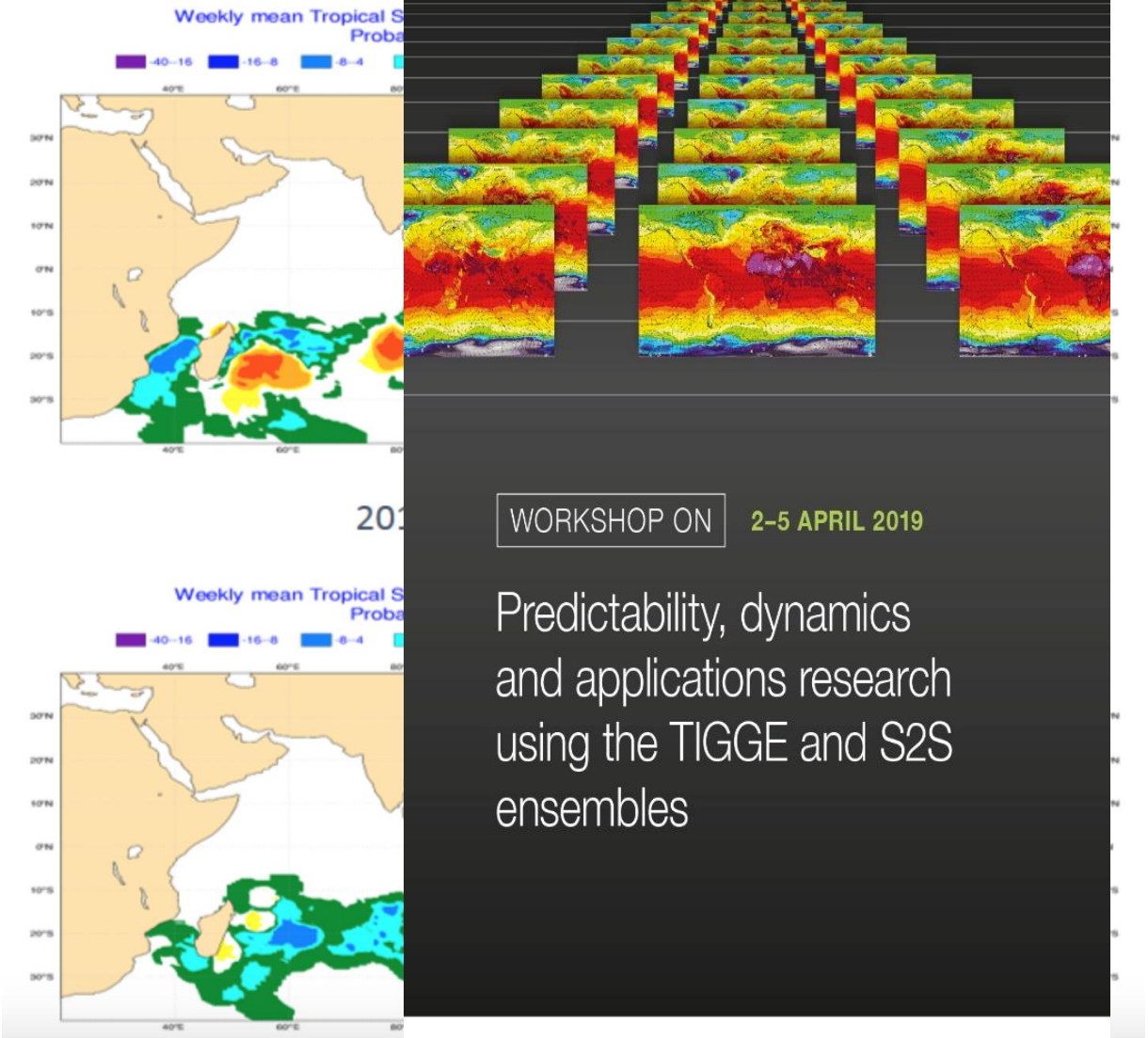

WORKSHOP ON **2–5 APRIL 2019**

Predictability, dynamics and applications research using the TIGGE and S2S ensembles

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ECMWF S2S Prediction Project TIGGE WCRP World Climate Research Programme WWRP

New Action Area:
Extreme-scale computing and data handling

Develop and share methodologies and technologies for the cost-effective production of forecasts and the collection/dissemination of large data volumes with increasingly complex high-resolution prediction systems across all scales.

- Establish scientific methodologies exploring enhanced parallelism and reduced data movement when employing extreme-scale HPC infrastructures.
- Support standardisation of portable code structures and programming models ensuring efficiency and code readability, and exploiting the future range of processor and system-level technologies; including metrics for code testing, performance analysis and benchmarking.
- Design portable data handling frameworks for observational data pre-processing and model output post-processing as well as product dissemination.

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New Action Area: extreme-scale computing and data handling

- Support open and distributed, cloud-based computing and data management infrastructures dealing with all steps in the forecast production workflow, including easy access, information discovery and visualization for end-users.
- Support adaptation of artificial intelligence methods (e.g. deep learning) to facilitate increasingly diverse observational data processing, user-dependent information extraction from increasingly complex model output data, and development of surrogate model components reducing computational cost.
- Establish capacity building and training at the interface between applied science and computational science to facilitate uptake of new technologies and methodologies by community.

COMMENT

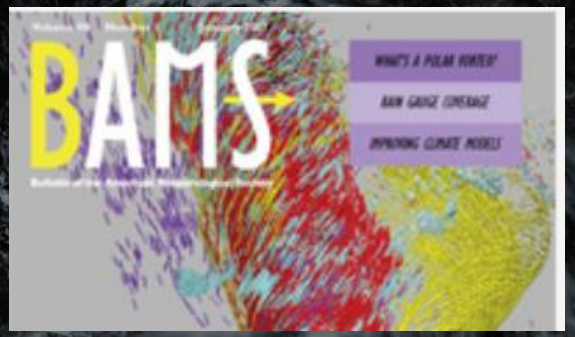
Five priorities for weather and climate research

Science Summit key outcomes (Nature, vol 552, Dec 2017)

More than 100 experts and more than 50 countries met in Geneva last October for the Science Summit and CAS-17 session, discussing and agreeing on five priorities:

1. Deliver Science for Services
2. Build Seamless Models
3. Improve Infrastructure
4. Nurture a Diverse Workforce
5. Build New Partnerships

becoming a landmark in moving Earth System science forwards.



Modes of collecting and delivering weather and climate information are evolving.

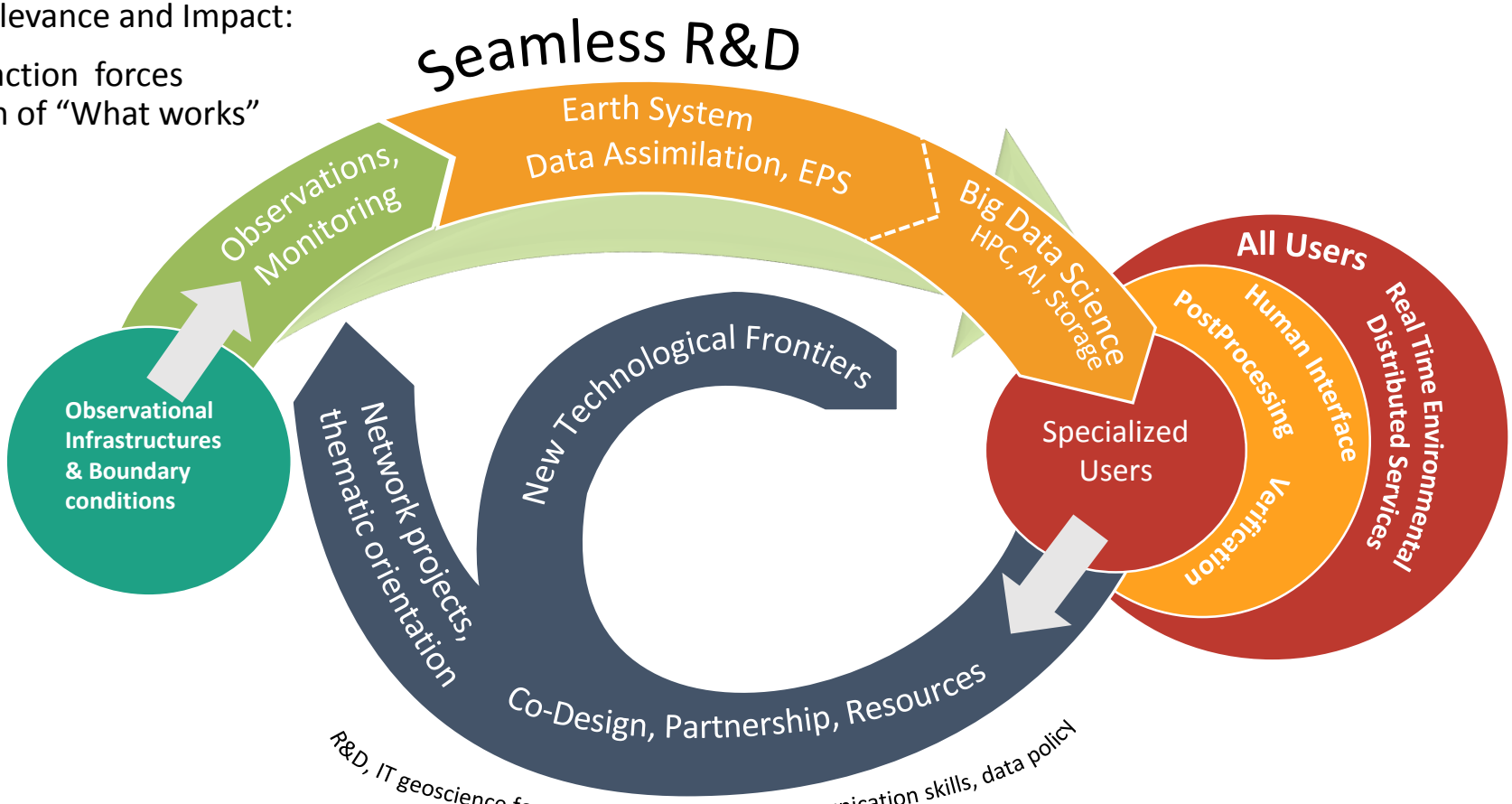
Business and non-profit organizations are increasingly supplying weather and climate services.

Data now stem from a broader range of sources, such as mobile-phone apps and smart devices.

SCIENCE FOR SERVICES JOURNEY

Quality, Relevance and Impact:

User Interaction forces exploration of “What works”



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Thank you
Merci

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