



WWRP and HIWeather

Michael Riemer

(SG member HIWeather (WWRP core project) and
Waves to Weather (potential WWRP joint project))

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with material from Paolo Ruti, Brian Golding and Yali Luo



WWRP

The World Weather Research Programme is the WMO's mechanism to foster and progress cooperative international research for improved weather and environmental prediction services from minutes to seasons strengthening academic-operational partnerships around the world

more accurate and reliable
forecasts from minutes to seasons

enhance society's resilience to
extreme weather and the value of
weather information for users

**HOW COULD HIWEATHER
CONTRIBUTE TO GEWEX**

KEY OUTCOMES AND ON-
GOING PROJECTS OF THE
WORLD WEATHER
RESEARCH PROGRAMME

**A SEAMLESS EARTH SYSTEM
SCIENCE** BRIDGING GEOPHYSICAL
SPHERE AND SOCIAL SPHERE
TOWARDS SERVICE ORIENTED
SCIENCE

Key Outcomes & On-going projects

- Advancement in science of predictability, ensemble prediction, data assimilation, high-resolution NWP, and nowcasting
- Major Field Campaign and dedicated regional projects from research to forecast demonstration (for ex. Mesoscale Alpine Programme, Olympic Games, IPY, YOTC, T-PARC, CONCORDIASI)
- Data Infrastructure for research: THORPEX Interactive Grand Global Ensemble (TIGGE), S2S database

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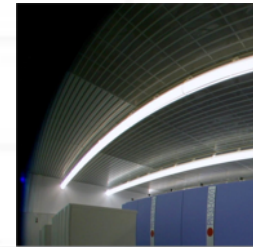
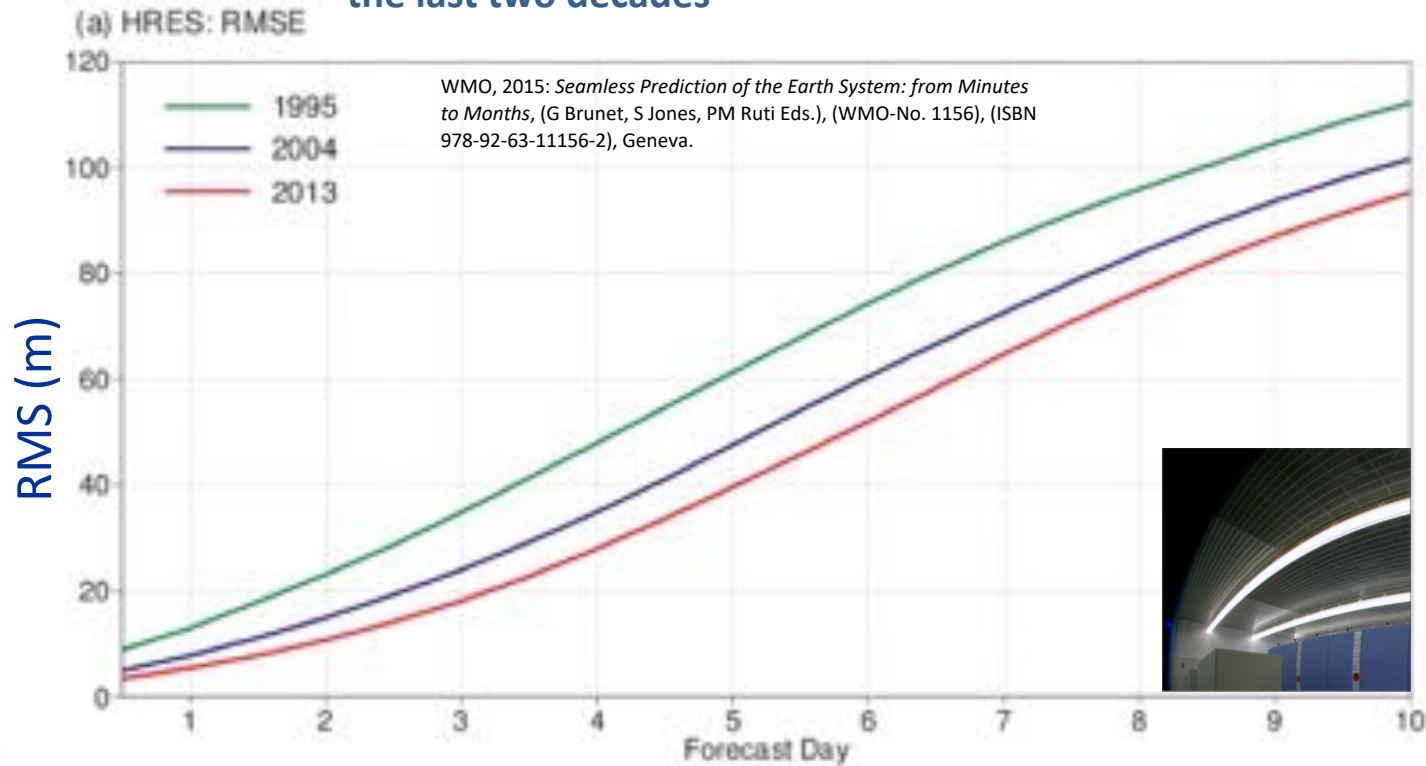
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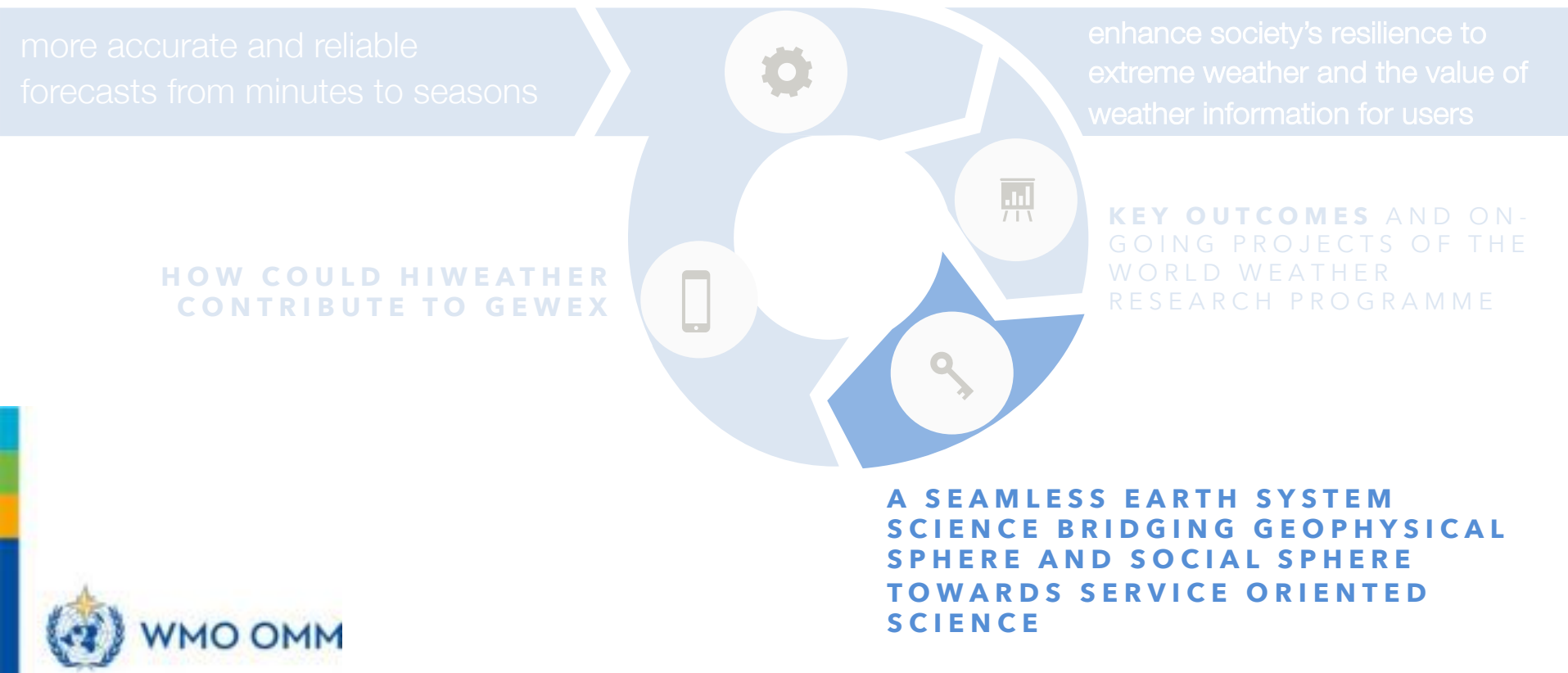
Improving the skill – big resources

ECMWF's forecast Z500hPa extra-tropical error growth over the last two decades



Seamless Earth System Science

- **Society's exposure to extreme weather calls for a seamless Earth System science**
- **Integration of understanding and predictive capabilities of natural hazards across all elements of the value chain**
- **Cross-fertilization of techniques across disciplines, i.e. bringing together physical, statistical and social science approaches to risk management.**

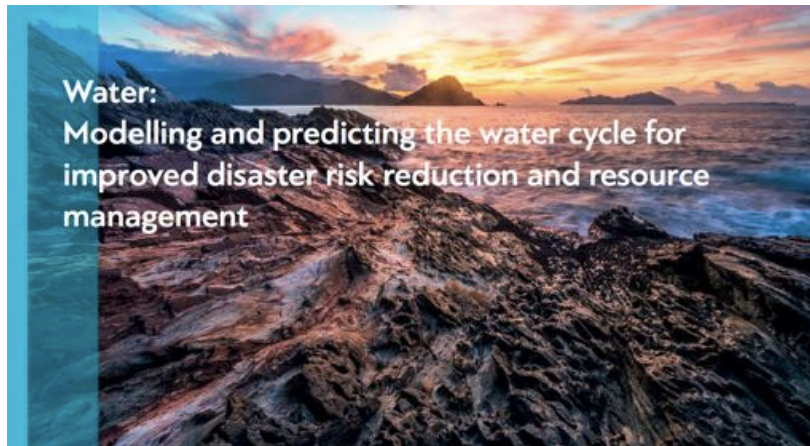


WWRP foci of Earth System Science

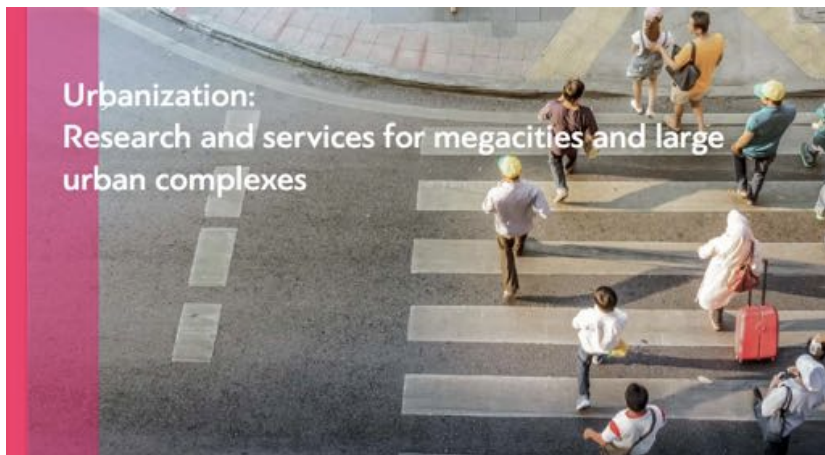
High-impact Weather:
Toward impact-based forecasts in a
variable and changing climate



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



Urbanization:
Research and services for megacities and large
urban complexes



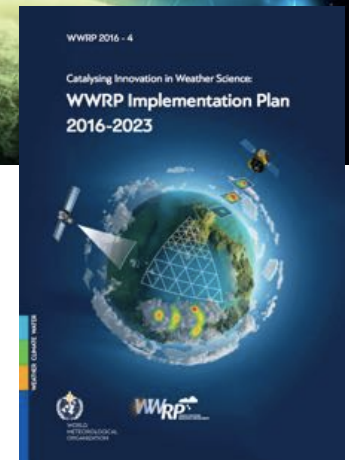
Evolving Technologies:
Their impact on science and their use



WWRP foci of Earth System Science



A guide to catalyze innovation



High Impact Weather Project



WWRP core project

10-year project, kick-off 2016

co-chairs: Brian Golding, David Johnston

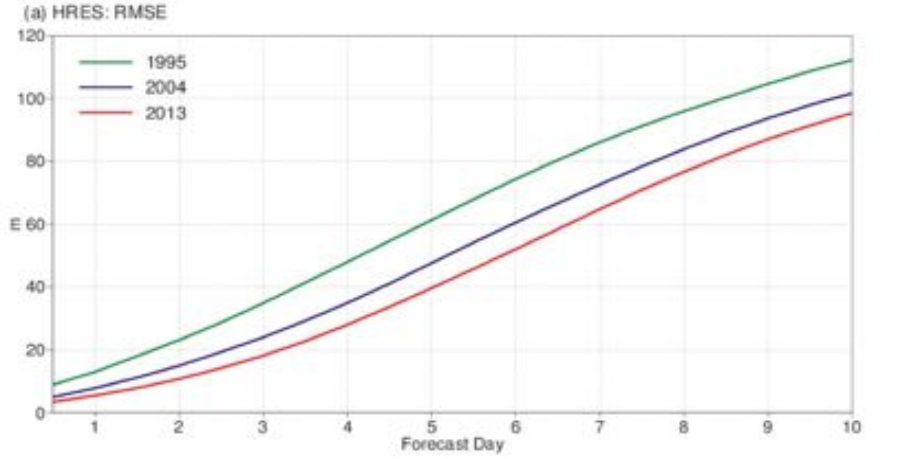
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In 2017, despite dramatic improvements in *weather forecasts, communication technology* and *disaster management*,

weather-related disasters

- ☠ Killed ten thousand people
- ☠ Affected one hundred million people
- ☠ Caused three hundred billion dollars of damage



- Promote cooperative international research
- to achieve a dramatic increase in resilience to high impact weather, worldwide,
- through improving forecasts for timescales of minutes to two weeks and
- enhancing their communication and utility in social, economic & environmental applications

HIWeather hazards



Urban Flood:

Mortality, morbidity, damage & disruption from flood inundation by intense rain, out-of-bank river flow, coastal wave & surge overtopping and from consequent urban landslides.

Disruptive Winter Weather:

Mortality, morbidity, damage & disruption from snow, ice and fog to transport, power & communications infrastructure.



HIWeather hazards



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Wildfire:

Mortality, morbidity, damage & disruption from wildfires and their smoke.

Urban Heat Waves & Air Pollution:

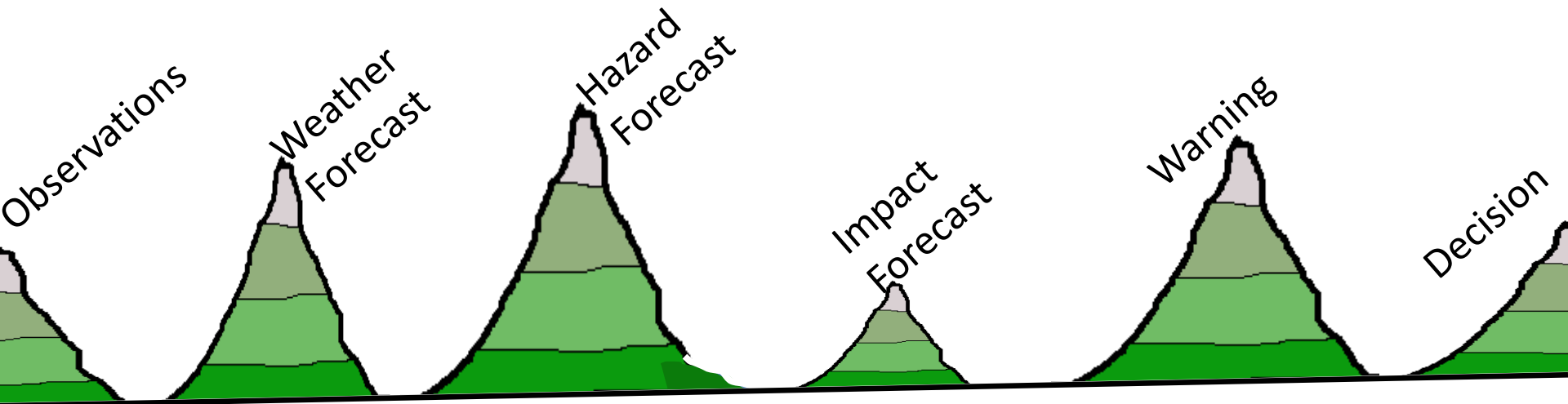
Mortality, morbidity & disruption from extreme heat and pollution in the megacities of the developing and newly developed world.



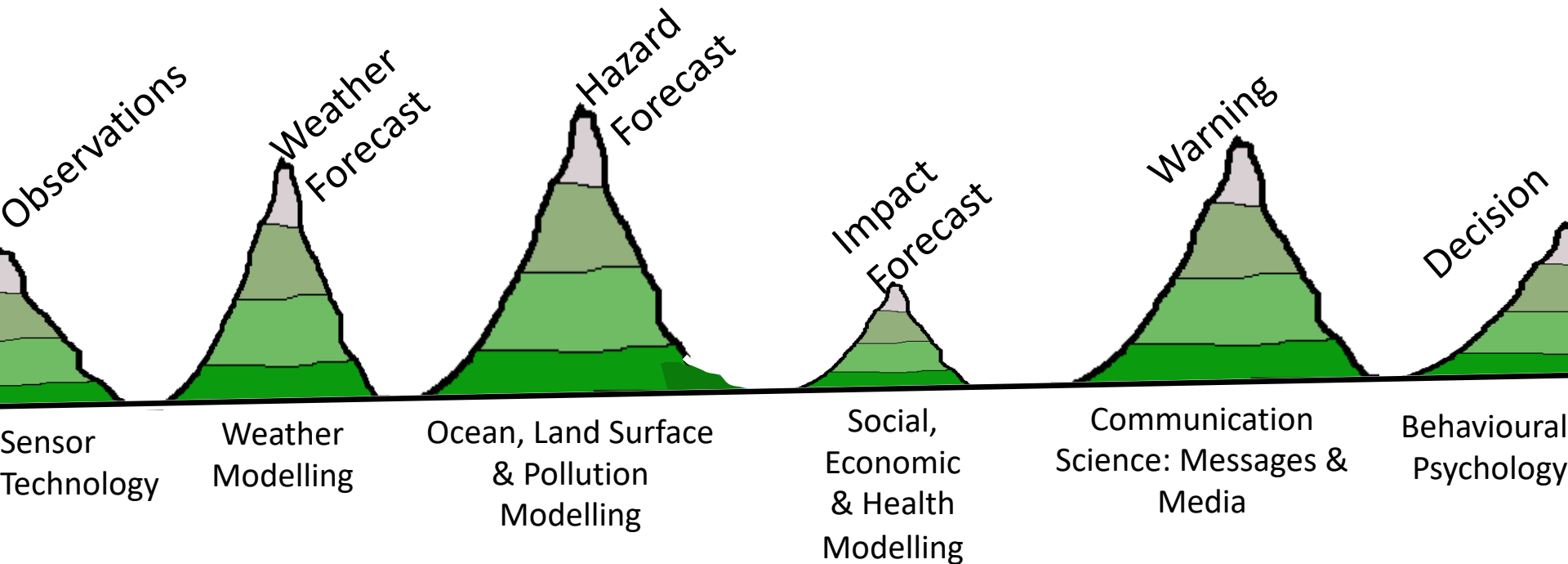
Extreme Local Wind:

Mortality, morbidity, damage & disruption from wind and wind blown debris in tropical & extra-tropical cyclones, downslope windstorms and convective storms, including tornadoes.

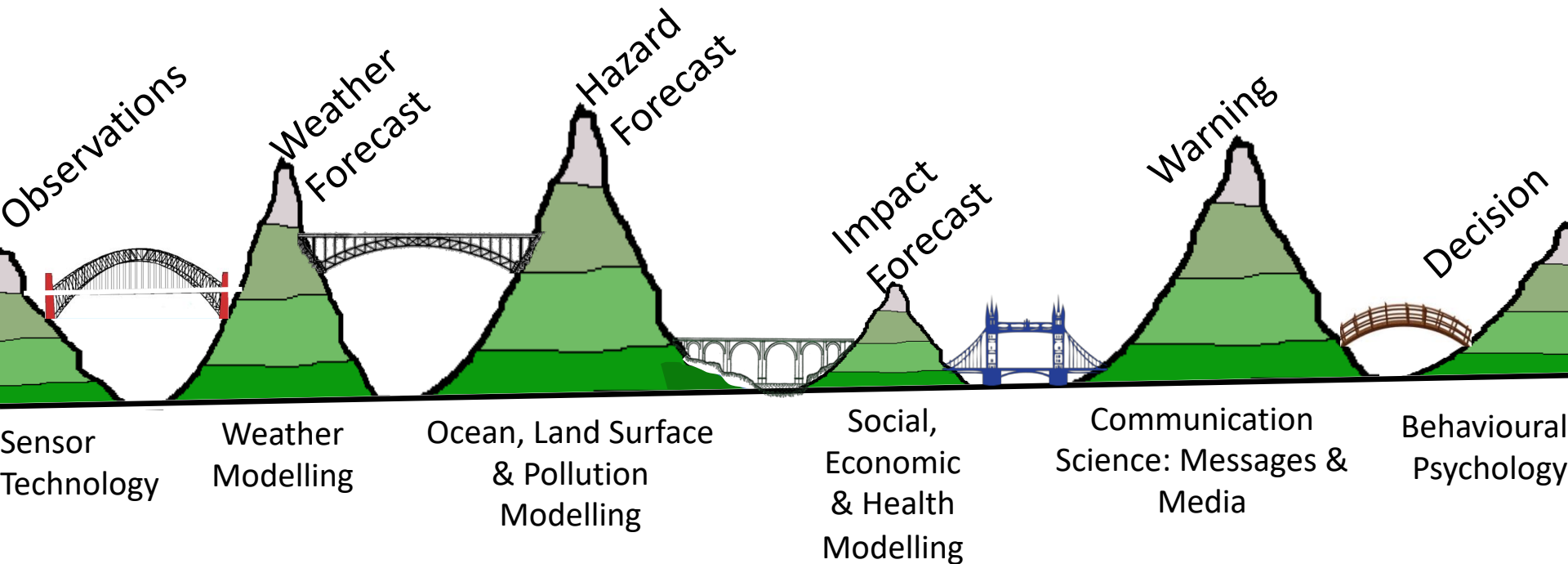
Warning Value Chain



Warning Value Chain



Warning Value Chain

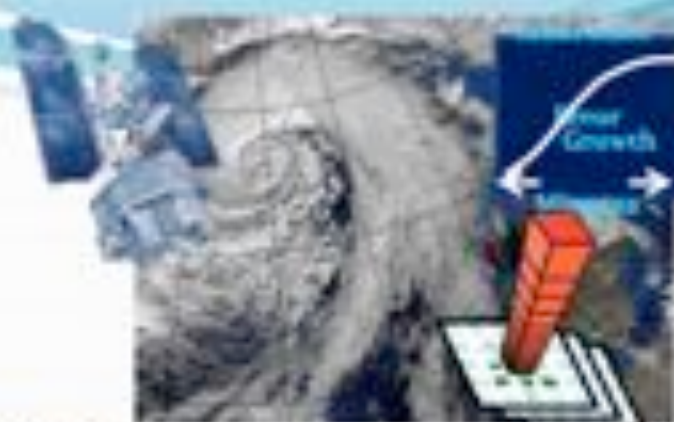


Bridges represent inter-disciplinary
&/or inter-agency communication

Research Areas

Predictability & Processes:

Initiation and evolution of hazard-related weather systems and associated predictability



Multi-scale Forecasting:

Multi-scale prediction of weather hazards in coupled modelling systems



Human Impacts, Vulnerability & Risk:

Hazard impacts on individuals, communities and businesses, assessing their vulnerability and risk



Communication:

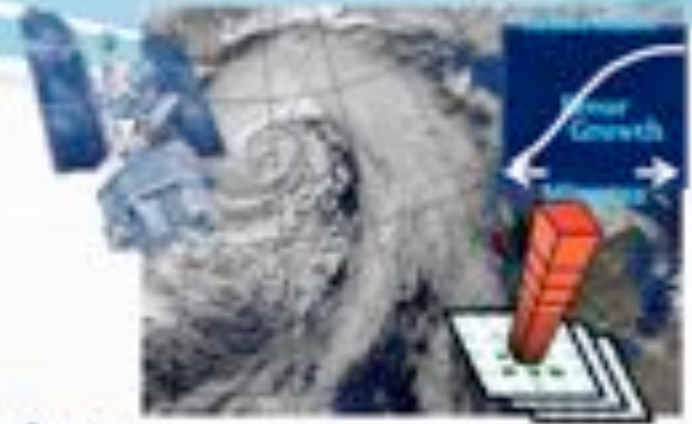
Achieving more effective responses to forecasts through better communication of hazard risk warnings



Research Areas

Physical sciences

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Initiation and evolution of hazard-related weather systems and associated predictability



Multi-scale Forecasting:
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Human Impacts, Vulnerability & Risk:

Hazard impacts on individuals, communities and businesses, assessing their vulnerability and risk

Evaluation:

Measure skill and value of forecasts and warnings at all stages of production to focus research in weak areas and support users in developing responses



Communication:
Achieving more effective responses to forecasts through better communication of hazard risk warnings

Social sciences



Research Areas

Physical sciences

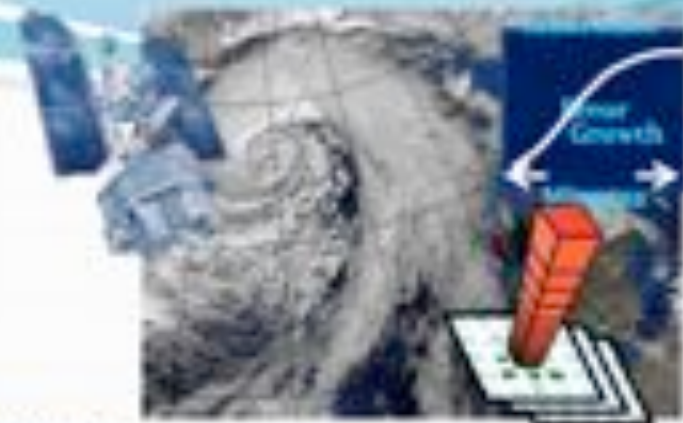
Inter-disciplinary approach is unique potential of HIWeather ... but also a challenge.

Social sciences

Research Areas

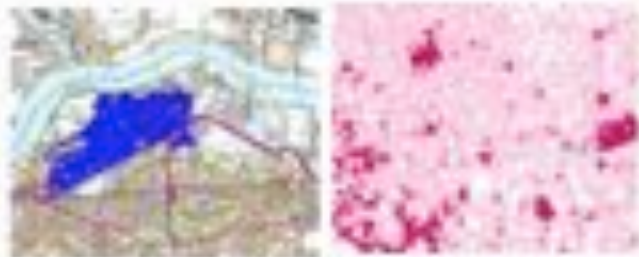
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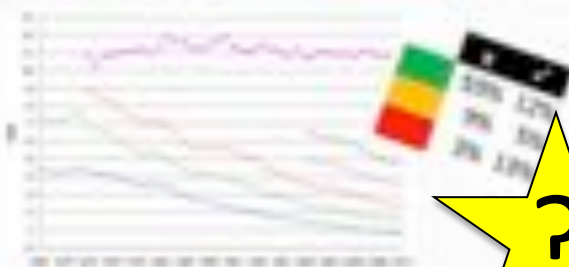
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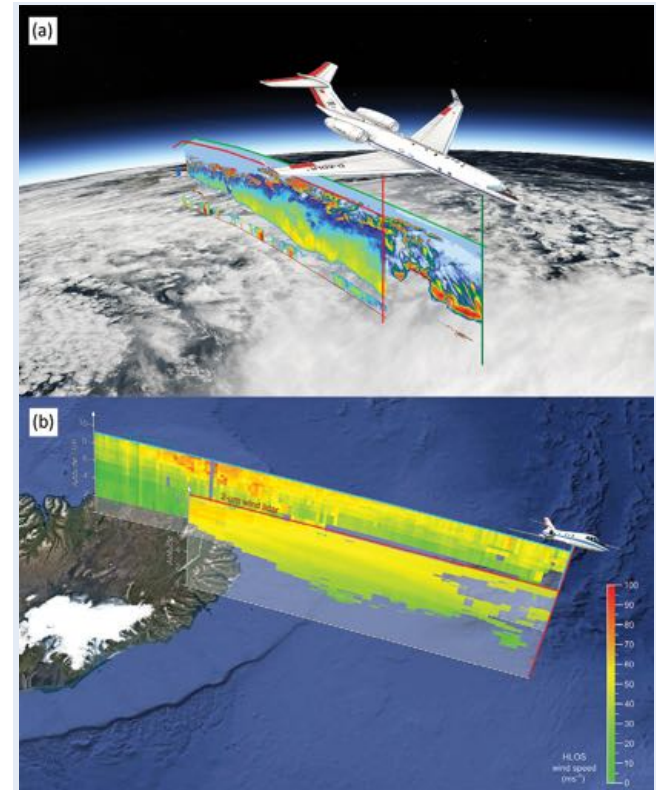
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Bull. Amer. Meteor. Soc. (2018)

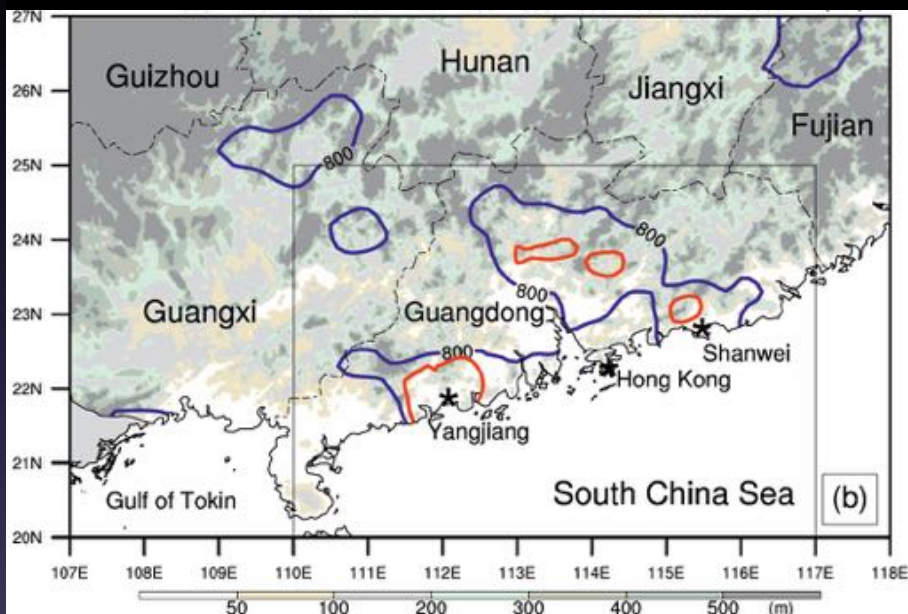
A map of the North Atlantic region showing wind patterns and PV values. The map includes the outlines of North America, Europe, and Greenland. A large blue arrow indicates a strong wind flow from the west. A dashed green line outlines a region labeled '3'. A solid blue line outlines a region labeled '4'. A solid yellow line outlines a region labeled '2'. A solid red line outlines a region labeled '1'. The text 'PV > 2 PVU' is in the top right, and 'PV < 2 PVU' is in the bottom right.

- Impact of cloud processes on jet
- Mixed-phase and cirrus clouds
- Moisture structure in PBL



Southern China Monsoon Rainfall Experiment (SCMREX, 2014-20) - A WMO/WWRP RDP

Topography and 800-, 1000-mm
contours of Rainfall (mm)
in Apr-Jun, 1981-2012



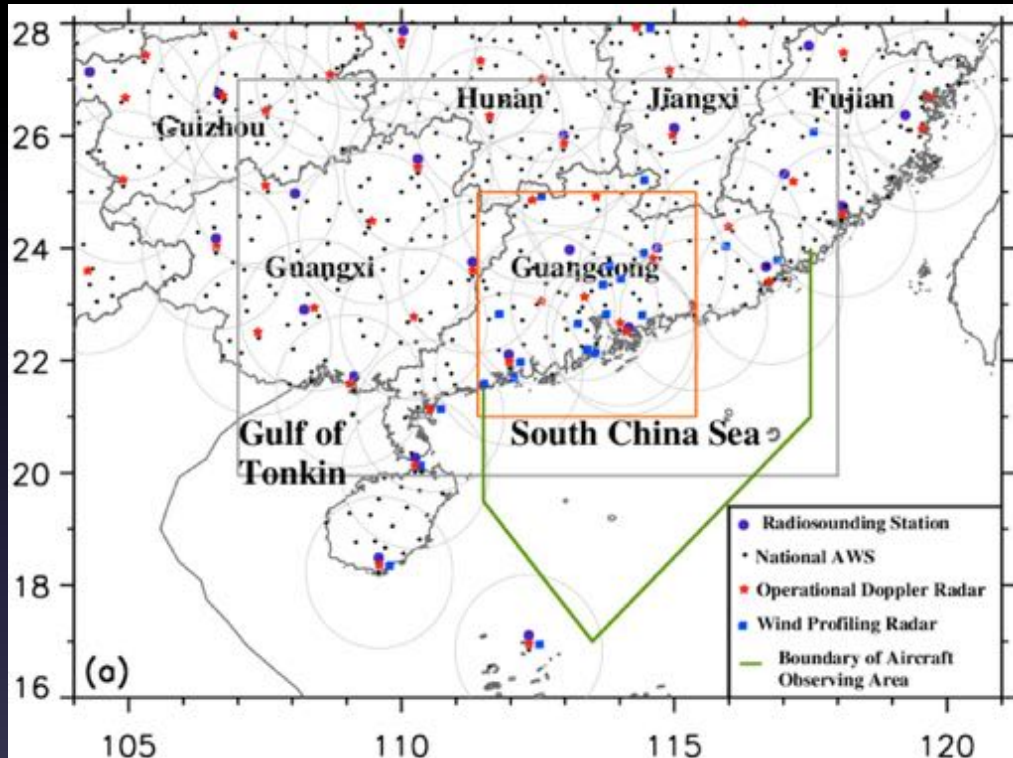
- Luo, Zhang, Wan, et al., 2017, *Bull. Amer. Meteor. Soc.*
- <http://exps.cma.cn/scmrex>

Scientific Objectives

- *To better understand development of the heavy-rain-producing storms in Southern China during the pre-summer rainy season*
 - Processes governing convective initiation & development
 - Storm-internal processes
- *To improve QPF skill by*
 - better understanding multi-scale precipitation processes
 - DA impact study, model physics scheme improvement, and ensemble forecast experiments at convection-permitting scale

SCMREX Field Campaigns

Distribution of major Facilities

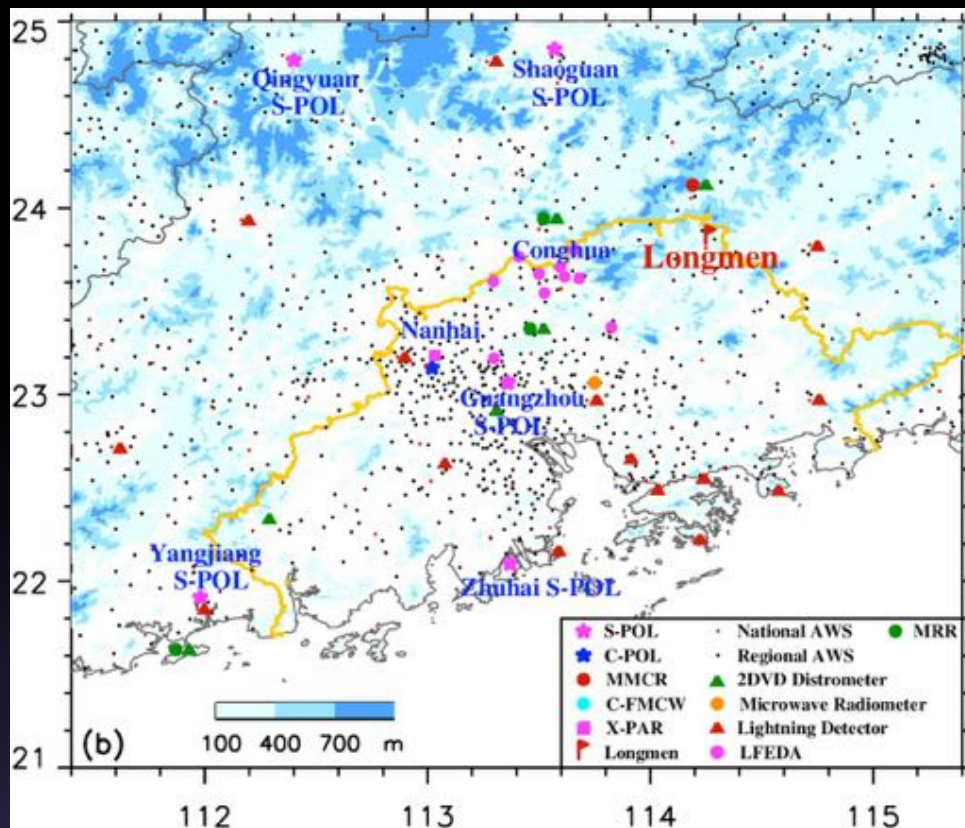


- About 2700 extra soundings
- 8 radiosonde stations

IOPs: May-Jun

Field Campaign Participants

- State Key Laboratory of Severe Weather (LaSW), Chinese Academy of Meteorological Sciences (CAMS)
- Institute of Tropical and Marine Meteorology, CMA, Guangzhou (ITMM)
- Institute of Heavy Rain, CMA, Wuhan (IHR)
- Nanjing University (NJU)
- Chengdu University of Information Technology (CUIT)
- Hong Kong Observatory (HKO)
- Guangdong Meteorological Bureau (5 operational S-POLs)
- Guangxi Meteorological Bureau
- Hainan Meteorological Bureau



Major Instruments

- Dual-Polarization Radar (1 X-POL, 2 C-POLs, 5 fixed S-POLs)
- C-band frequency-modulated continuous-wave radar (C-FMCW)
- Ka-band Cloud Radars (CRs)
- Micro Rain Radar (MRR)
- Microwave Radiometer (MR)
- 2-D Video Disdrometers (2DVD)
- Laser-optical Disdrometer
- Laser Ceilometer (Ceilometer)
- X-band Phased-array Radar (X-PAR)
- Total-sky Cloud Imager (TCI)
- Precipitation Particle Imager (PPI)
- Cloud Condensation Nuclei Counter (CCNC)
- Aerodynamic Particle Sizer (APS)
- Lightning Low-frequency E-field Detection Array (LFEDA)

◆ Operational Networks

- Dual-POL radar
- Wind profiler

◆ 3 super sites

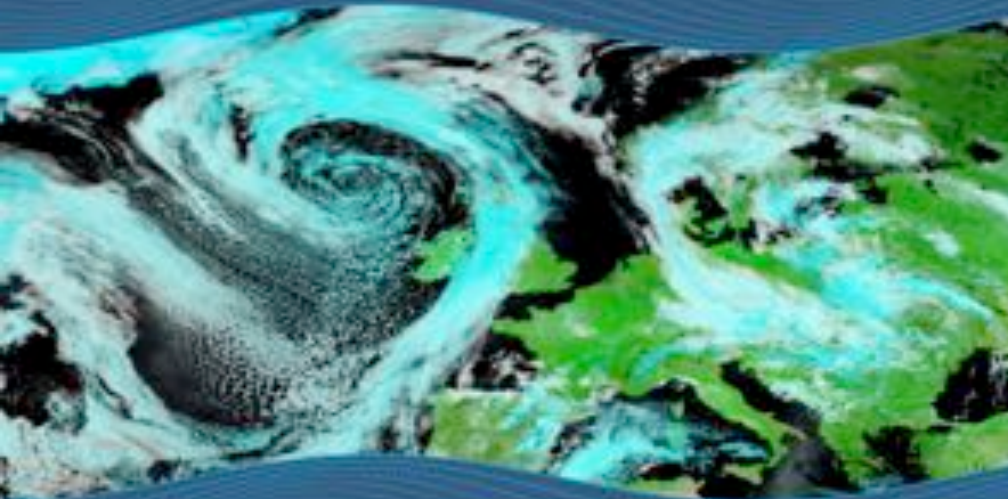
- Cloud/prec. vertical structure (Longmen)
- Fast-evolving storms (Nanhai)
- 3D lightning processes (Conghua)



COLLABORATIVE RESEARCH CENTER 165

WAVES TO WEATHER

Interdisciplinary Platform for Basic Research into
Predictability, Atmospheric Dynamics, and Clouds



20 individual projects

25 PIs

> 30 project scientists

since 2015

Funding horizon: until 2027

(subject to two reviews)

- Microphysics and precip type/ hail
- Convection and surface interaction
- Clouds and radiation
- Tropical convection and DA
- Microphysics and dynamics
- Tropical cyclones and tropical rainfall



Prof. Dr. George C. Craig (Spokesperson)
Ludwig-Maximilians-Universität München



Prof. Dr. Volkmar Wirth
Johannes Gutenberg-Universität Mainz



Prof. Dr. Peter Knippertz
Karlsruher Institut für Technologie



Summary

- Potential for cooperation:
 - “Precipitation is where all WMO science can come together”
 - Grand Challenge: Weather & Climate Extremes
 - Seamless Earth System Approach
- Consideration of WWRP Implementation Plan in WCRP/GEWEX strategy
- On project level: e.g. GASS, GLASS < -- > HIWeather