The World Weather Research Programme

Paolo Ruti, Chief World Weather Research Division
Sarah Jones, Chair Scientific Steering Committee
WMO research time line


WMO the specialized agency of the United Nations for meteorology

World Weather Watch

GARP (Global Atmospheric Research Programme) established by WMO (World Meteorological Organization)

Conduct of GARP Regional Experiments:
- GATE: GARP Atlantic Tropical Experiment
- MONEX: Monsoon Experiment
- ALPEX: Alpine Experiment
- AMEX: Air Mass Transformation Experiment

WCRP, World Climate Research Programme (WMO, ICSU)

WGNE, Working Group on Numerical Experimentation

WWRP (World Weather Research Programme) established in cooperation with GEWEX. MAP & Sidney2000

THORPEX (Observing System and Predictability Experiment) established as a WWRP Working Group
Improving the skill – big resources

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

(a) HRES: RMSE

RMS (m)

Forecast Day

A seamless approach to predictions

Resolution

Earth Observation

Computing Resources

Duration and/or Ensemble size

Complexity
WWRP Societal Challenges

URBANIZATION
HIGH IMPACT WEATHER
WATER
NEW TECHNOLOGIES
WWRP Structure

WWRP Working Groups

- Tropical Meteorology: Identify and support research initiatives on tropical cyclones and monsoons
- Data Assimilation and Observing Systems: Obtain and make use of best possible information on the atmospheric state
- Predictability, Dynamics and Ensemble Forecasting: Advance the science of dynamical meteorology, predictability ensemble forecasting, promoting the development of ensemble applications

WWRP Core Projects

- Polar Prediction
- S2S Prediction Project
- High Impact Weather
- Sand & Dust Storm

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)
Overarching goals

• Towards Environmental Prediction, integrating modeling components (hydrology, sea-ice, ocean, atmospheric composition) to improve forecasting systems
  → Ex. Polar Prediction Project

• Towards a seamless predictive capability, developing a unified approach to advance environmental prediction from minutes to months and seasons, from global to local, for different users
  → Ex. Sub-seasonal to Seasonal Prediction Project

• Towards impacts forecasting, building community resilience in the face of increasing vulnerability to extreme weather events, through a better understanding of communication and decision-making processes
  → Ex. High-Impact Weather Project
High Impact Weather Project

• Increasing resilience to Urban Flood, Wildfire, Urban Heat and Air Pollution in Megacities, Localised extreme wind, Disruptive winter weather through improving forecasts for timescales of minutes to two weeks and enhancing their communication and utility in social, economic and environmental applications

• Implementation Plan (2015-2024) approved by WWRP SSC

• Links to WCRP through quantifying vulnerability and risk assessment, and for response to High Impact Weather in a changing climate.
Urban vulnerability a challenge for predictions

Urban agglomerations at risk of multiple natural hazards (2025)
HIWeather targets

**Urban Flood**: Reducing mortality, morbidity, damage and disruption from flood inundation by intense rain.

**Disruptive Winter Weather**: Reducing mortality, morbidity, damage and disruption from snow, ice and fog to transport, power & communications infrastructure.

**Wildfire**: Reducing mortality, morbidity, damage and disruption from wildfires & their smoke.

**Urban Heat Waves & Air Pollution**: Reducing mortality, morbidity and disruption from extreme heat & pollution in the megacities of the developing and newly developed world.

**Extreme Local Wind**: Reducing mortality, morbidity, damage and disruption from wind & wind blown debris in tropical & extra-tropical cyclones, downslope windstorms & convective storms, including tornadoes.

Scope defined by a set of hazards
Countries Involved in Research and Capacity Building

> 20
Global and Regional Research Projects

50 +

4
Highest Achievements

THORPEX The Observing System
Research and Predictability Experiment

AMMA
African Monsoon Multidisciplinary Analysis

HYMEX Hydrological Cycle Experiment

MAP Mesoscale Alpine Programme

SYDNEY 2000 OLYMPIC GAMES

PPP The Polar Prediction Project

HIW High Impact Weather Project

S2S Sub-Seasonal to Seasonal Prediction

HIW High Impact Weather Project

Unprecedented capacity to integrate millions of daily data in predictions

Innovative solutions in high performance computing and data storage

Today’s 6-day forecast is as accurate as 4-day twenty years ago

Ensemble forecasting became the cornerstone of nowadays prediction
Regional Development Research Projects

- **Southern China Monsoon Rainfall Experiment (SCMREX)**
  Chinese Academy of Meteorological Sciences (Hong Kong, Japan, Australia, US, Korea). 2013-2018.

- **Beijing Study of Urban-impacts on Rainfall and Fog/haze (SURF) project.** Institute of Urban Meteorology CMA, Beijing (USA, Australia, Japan, Finland) 2014-2017

- **Remote sensing of electrification, lightning and meso-scale / micro-scale processes with adaptive ground observation (RELAMPAGO)** Argentinian Met Service (USA, ...) 2017-2020

- **HIGH impact Weather IAke sYstem (Highway).** WMO, UK, East African Countries. 2017-2020
Southern China Monsoon Rainfall Experiment

To better understand development of the heavy-rain-producing convective systems in Southern China during early summer, focusing on the roles of:

- PBL processes and underlying surface;
- meso-scale circulations in association with fronts;
- microphysical processes

To improve Quantitative Precipitation Forecast skill by

- better understanding multi-scale precipitation processes,
- assimilating high-resolution observations into numerical models,
- convection-permitting (1-3km) ensemble experiments.
May June Field Campaign: 2014-15-16

- **Convective scale**
  - Radiosonde sounding station (23)
  - GPS/MET water vapor station (85)
  - national-level AWSs (366)

- **Synoptic scale**
  - wind-profiling radar (21 operational, 2 portable)
  - air-borne observations

- **Mesoscale**

Gulf of Tonkin

South China Sea
Beijing Study of Urban-impacts on Rainfall and Fog/haze

- Evaluate & improve high-resolution (~1 km resolution) numerical urban-weather forecast-models
- Enhance the applications of urban weather forecasts of stakeholders/end users for societal and economic developments
- Specific objectives of Summer heavy rainfall & Winter-aerosol field studies: Better understand Beijing urban, terrain, convection & aerosol interactions convection-permitting (1-3km) ensemble experiments.

Beijing 2012

Beijing 2013
2016 Summer Campaign (Ongoing)

- **Wind profiler (S)**: 16
- **Wind profiler (O)**: 3
- **Wind profiler (R)**: 2
- **Wind profiler (I)**: 1
- **Flux tower (O)**: 6
- **Flux tower (I)**: 4
- **Radiometer (O)**: 10
- **Aerosol lidar (I)**: 2
- **Doppler lidar (I)**: 1
- **Radiosonde (O)**: 4
- **GPS Radiosonde (IOP only)**: 6
- **S/C Band radar (O)**: 6
- **X-band radar (O)**: 6
- **Ceilometer (O)**: 10

**S**: data sharing site
**O**: Operational site
**R**: Rental instruments
**I**: IUM’s instruments

On truck in July then move to SHA in August.

Moved from Sidaoxue to Tanhekou if possible.
Remote sensing of electrification, lightning and meso-scale / micro-scale processes with adaptive ground observation

Argentina
- Has one of the highest frequencies of lightning in the world
- Extreme flooding
- Produces some of the largest hail in the world

RELAMPAGO Field experiment to understand:
- Convection initiation processes
- Intensification and upscale growth of convection
- Generation of hazardous weather
Remote sensing of electrification, lightning and meso-scale / micro-scale processes with adaptive ground observation
HIGHWAY Principles

HIGHWAY

HIGH impact
Weather
lAke
sYstem

- Nowcasting capacity enhancement (observational network enhancement)
- Improving the local capacity to receive and handle with high-frequency satellite information and high-resolution modelling (4 km)
- Pilot projects with end-users (i.e. Rescue, Aviation)
- Capacity building infrastructural component, ... enhancement through fellowship, improved links with local universities (key topics, verification services, tailoring products)
Suggested Field campaign phased approach

some ideas (adapted from other field campaigns, e.g. AMMA)...

- **EOP**
  - Special Observation Period
  - Includes investment in obs networks rather than temporary equipment
  - > 10 yrs

- **SOP**
  - Long Observation period
  - Includes investment in obs networks rather than temporary equipment
  - > 10 yrs

- **Number of pilot phases or ‘Extra Observation periods’. Tests equipment, small deployment/quick start, builds logistical relationships**

**WISER PRINCIPLE ➔ A learning programme**
Key Messages

HIGH IMPACT WEATHER – GEWEX EXTREME GC
CATALOGUING EXTREMES
LINKING EXTREME VALUE ANALYSIS TO WEATHER EVENTS
HINDCAST AND FORENSIC ANALYSIS
WEATHER/CLIMATE EXTREMES & COMMUNICATION

REGIONAL DEVELOPMENT– REGIONAL HYDROCLIMATE PROJECTS
A SEAMLESS APPROACH TO REGIONAL SCALE
INVOLVING GLOBAL ATMOSPHERIC SYSTEM STUDIES & GLOBAL LAND ATMOSPHERE SYSTEM STUDY
COORDINATION WHERE/WHEN POSSIBLE (HYMEX EX ...)
SYNERGIES WITH DONORS
What successful people read before bed?

Google: seamless prediction WMO
https://www.wmo.int/media/content/seamless-prediction-minutes-months
Thank you
Merci