



World Meteorological Organization

Weather • Climate • Water

# From Urban Meteorology, Climate and Environment Research to Urban Integrated Services

A Baklanov<sup>1</sup>, CSB Grimmond<sup>2</sup>, D Carlson<sup>1</sup>, D Terblanche<sup>1</sup>,  
V Bouchet<sup>3</sup>, B Lee<sup>1</sup>, G Langendijk<sup>1</sup>, RK Kolli<sup>1</sup>, A Hovsepyan<sup>1</sup>

*1 World Meteorological Organization (WMO), Geneva, Switzerland*

*2 University of Reading, Reading, UK*

*3 Environment Canada, Montreal, Canada*

**ICUC9, Toulouse, France, 20-25 July 2015**



Weather • Climate • Water

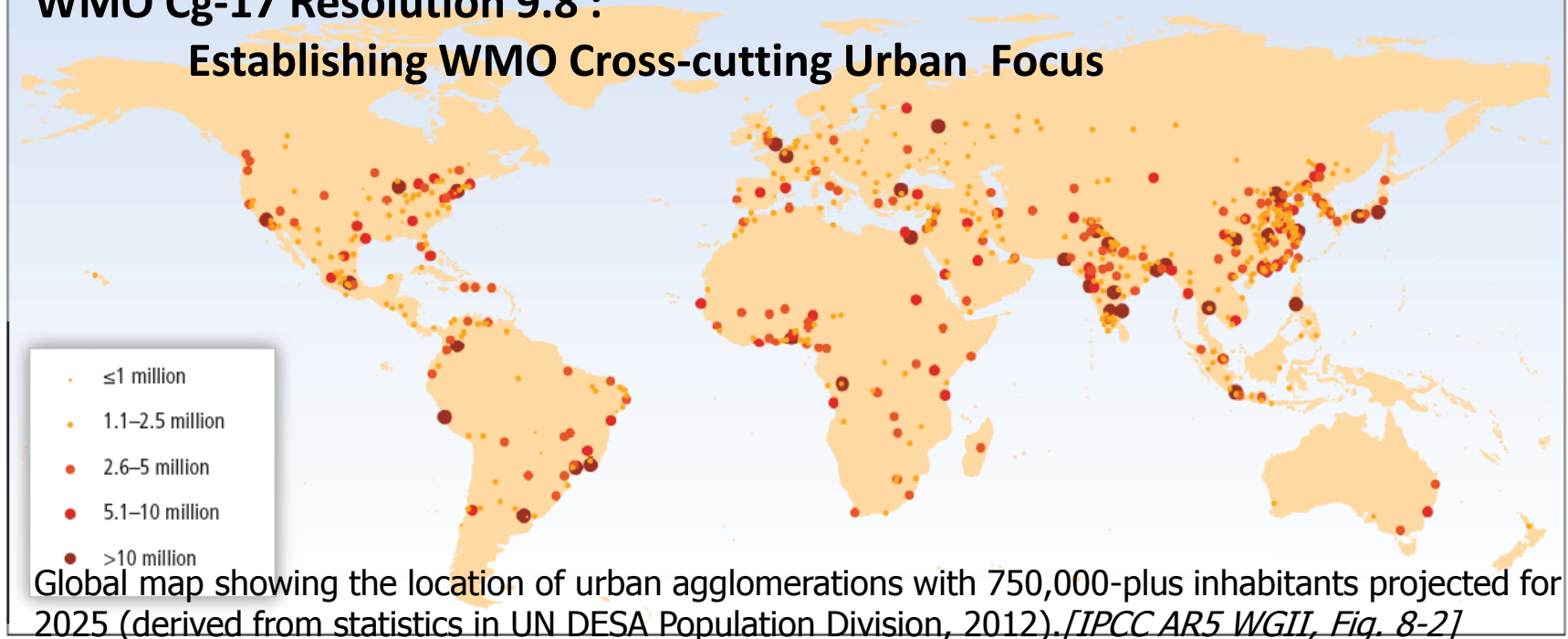




# Risks in the urban environment:

- flooding;
- poor air quality;
- sea-level rise;
- extreme heat/cold and human thermal stress;
- energy and water sustainability;
- public health problems caused by the previous.

## WMO Cg-17 Resolution 9.8 : Establishing WMO Cross-cutting Urban Focus







# Urban Issues at WMO

- UN-wide new Urban Agenda is being developed (HABITAT-III is planning in 2016)
- Urbanization is one of the agreed priorities in the WMO Strategic Plan 2016-2019
- Resolution 9.8/1 (Cg-17): ESTABLISHING WMO CROSS-CUTTING URBAN FOCUS
- Integrated approach providing weather, climate, water and related environmental services tailored to the urban needs
- Many other urban related cross-cutting activities to be integrated/coordinated, e.g. GAW (GURME), GFCS, WWRP (HIW), WCRP, WCAS, PWSP
- Cg-17: To set priorities and provide guidance on the development of service delivery strategy to address urban needs





# CAS-16 priority: **Urbanization: Research and services for megacities and large urban complexes**

- Integrated Urban Weather, Water, Environment and Climate Services
- Focus on impact based forecast and risk based warnings
- Scientific issues: Requirements for observations; Near-real-time data assimilation; Coupling of air quality, meteorological, surface, hydrological processes; Seamless approach: scale interaction; High-resolution modelling: 'grey zone'.
- GURME: integral part of urban research and services





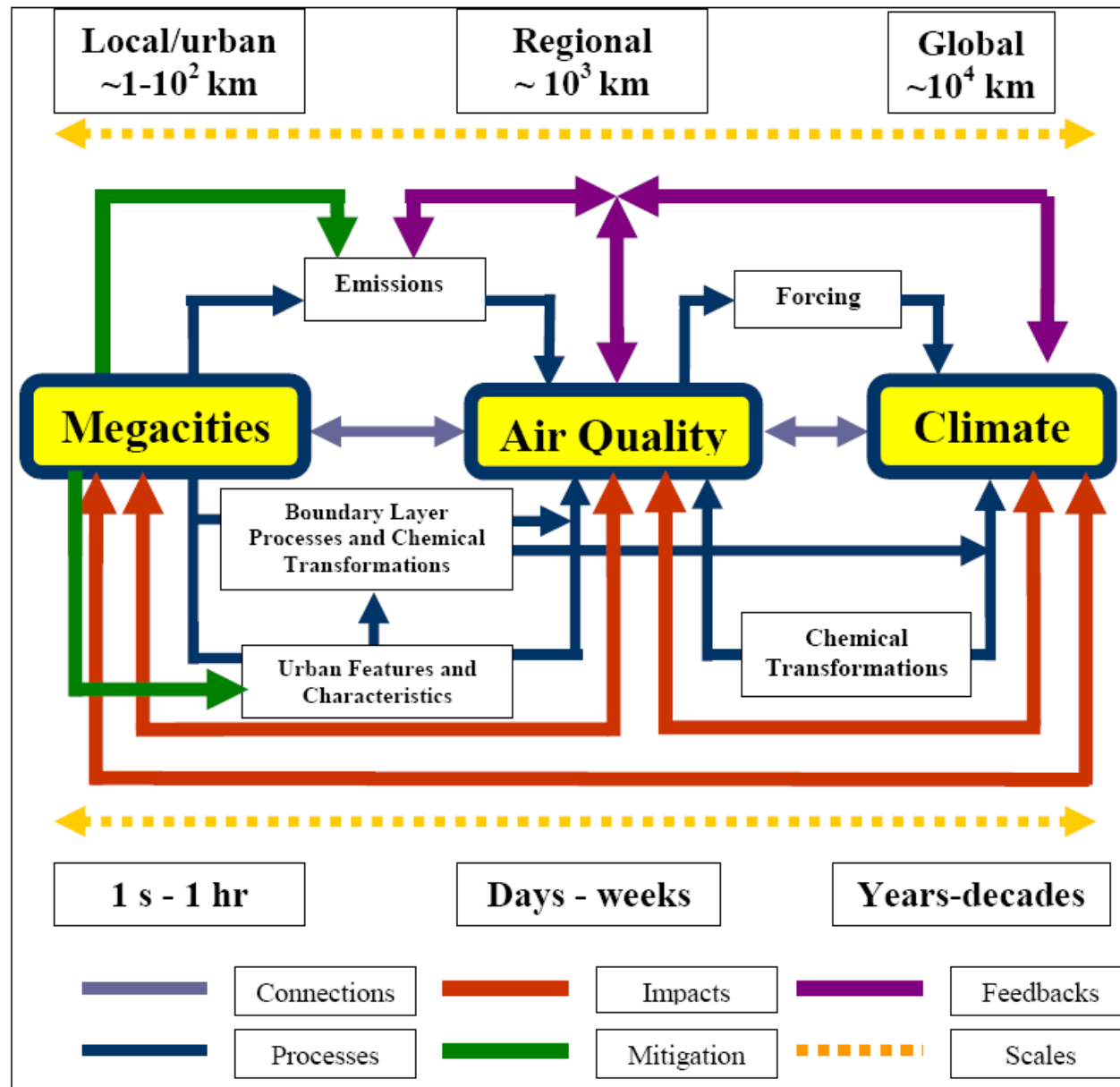


# Connections between Megacities, AQ, Weather and Climate

main feedbacks, ecosystem, health & weather impact pathways, mitigation

- Science - nonlinear interactions and feedbacks between emissions, chemistry, meteorology and climate
- Multiple spatial and temporal scales
- Complex mixture of pollutants from large sources
- Scales from urban to global
- Interacting effects of urban features and emissions
- FUMAPEX Integrated UAQIFS: in 6 EU cities

**Nature, 455, 142-143 (2008)**





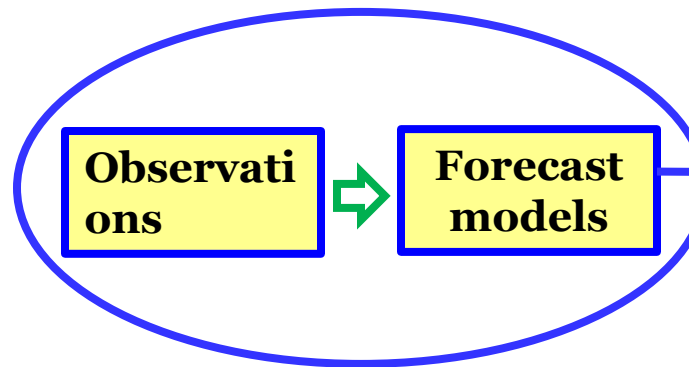






# GURME Pilot Project (MHEWS Shanghai) (EXPO-2010)

- Enhanced observing system
- Enhanced air quality & weather forecasting (heatwaves, AQ, +)
- Field experiment (jointly with NCAR)
- Workshop activities



Heat wave and cold spell forecast

UV forecast

Ozone forecast

Haze forecast

Pollen forecast

Bacterial Food Poisoning

Influenza forecast

Heat index, Sunstroke, and Diarrhea forecast for EXPO 2010

*Lead by Tang Xu, SMB*





# METROPOLITAN AIR QUALITY AND WEATHER FORECASTING SERVICES



**SAFAR project, India**  **Lead by Gufran Beig**



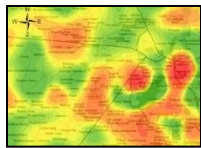
**AIR-Now & AIR-Tomorrow**



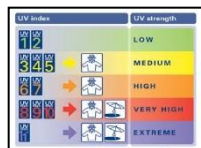
**Weather -Now & -Tomorrow**



**Health Advisories**



**City Pollution Maps**



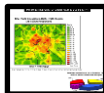
**UV Index-Skin Advisory**



**Air Quality Monitoring**



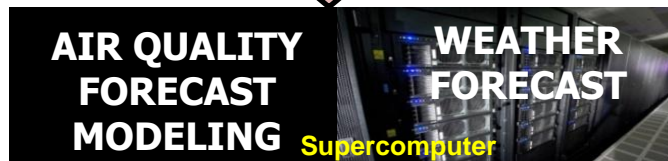
**Weather Monitoring**



**Emission inventory Development**



**Surface topography & land use study**



**PRODUCTS**

**Translate Science to Public**

**SERVICES**

## BENEFIT TO END -USER

- Protecting Human **Health**
- Agricultural yield Benefits to **Farmers**
- **Awareness** of impact of AQ & Weather
- Basis for **mitigation** strategies

## RESEARCH

- Explore **Chemical-Weather**
- Improve Weather & AQ **Forecasting Skill**
- Development of **Emission** scenario
- Short Term **Climate** Change



**Web Portal**



**E-mail Alerts**



**SMS Alerts**



**Digital Display**



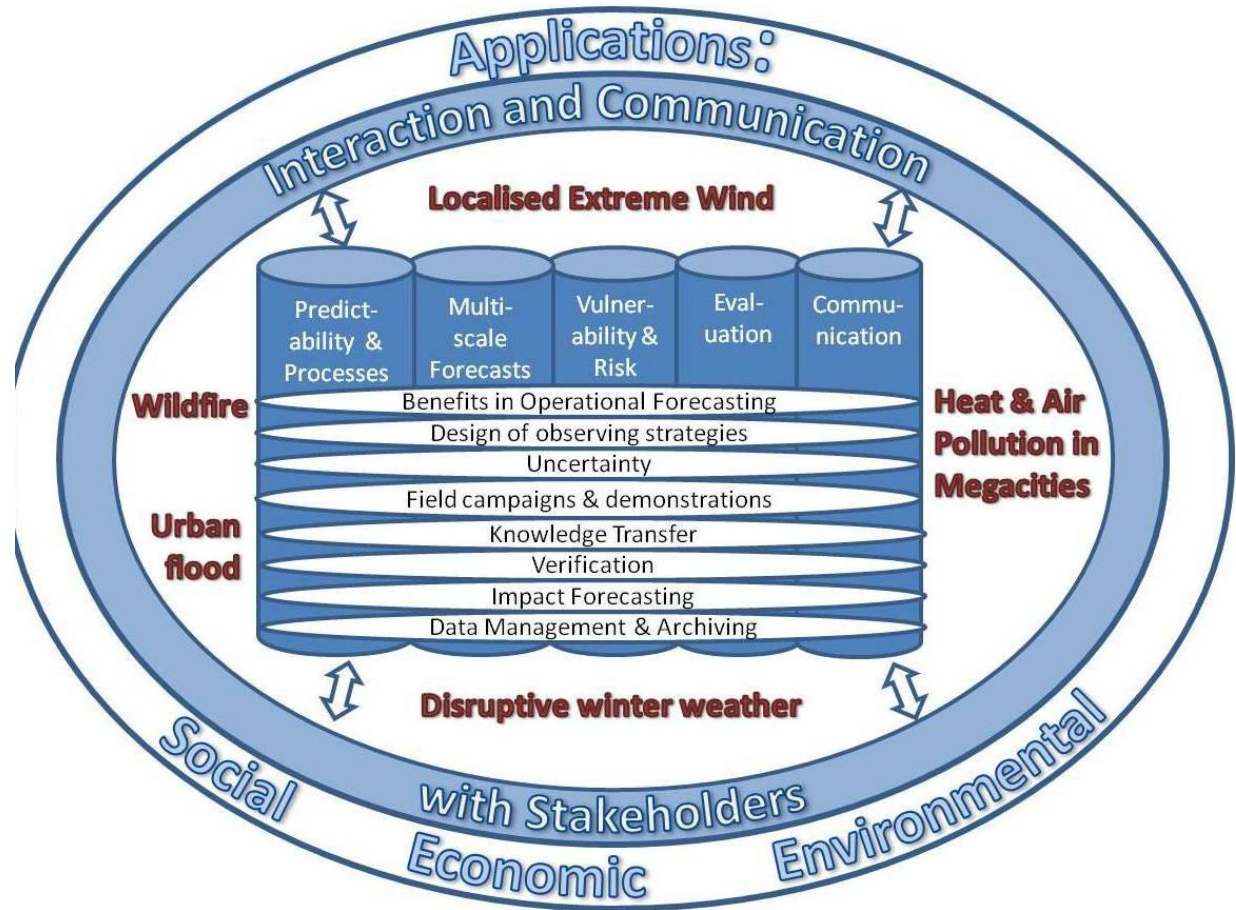
**TV /Radio**





# Partnerships in Urban Modelling

- Collaborations with WWRP such as HiWeather project and WCRP to be developed
- Continuing with existing collaborations on integrated/on-line modelling systems







# High Impact Weather Project



**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.

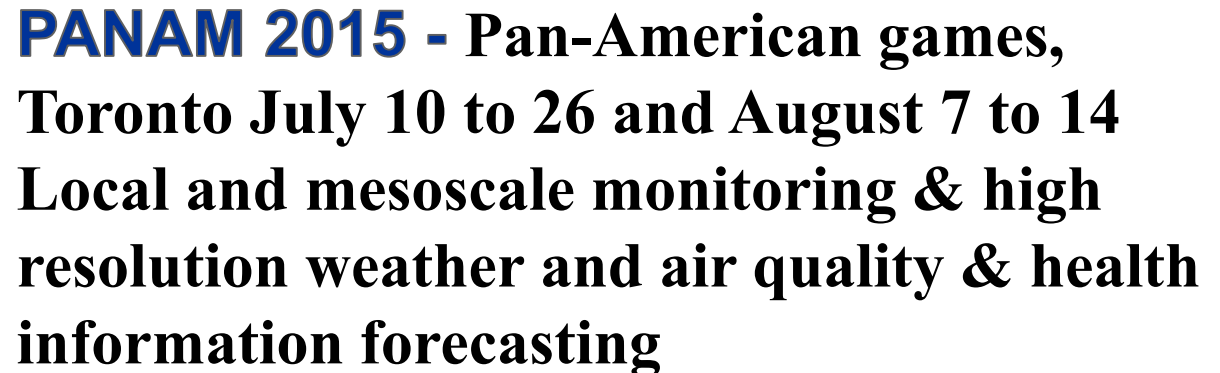
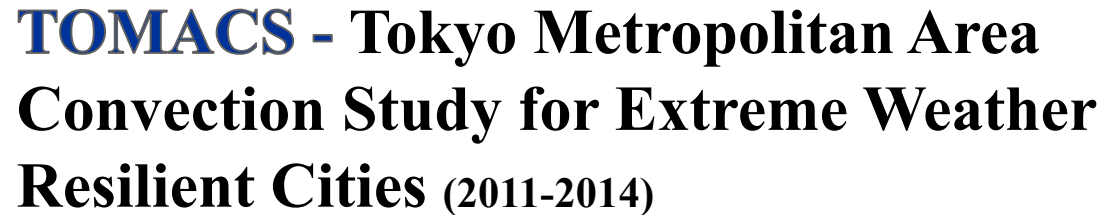
**Urban Heat Waves & Air Pollution:** Reducing mortality, morbidity and disruption from extreme heat & pollution in the megacities of the developing and newly developed world.



**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.











Environment  
Canada

Environnement  
Canada

# Pan Am 2015 NWP Integrated System

**2.5 km National  
CMC-Operations**  
4 runs / day

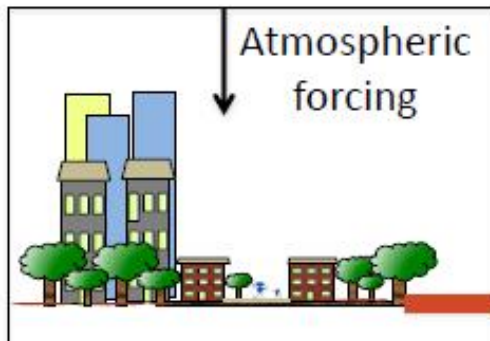
*Upper-air  
lcs and LBCs*

**1 km  
554 x 554**

**GEM-LAM  
Cascade  
(real-time)**

**250 m  
824 x 824**

**GEM-SURF (200 m)**

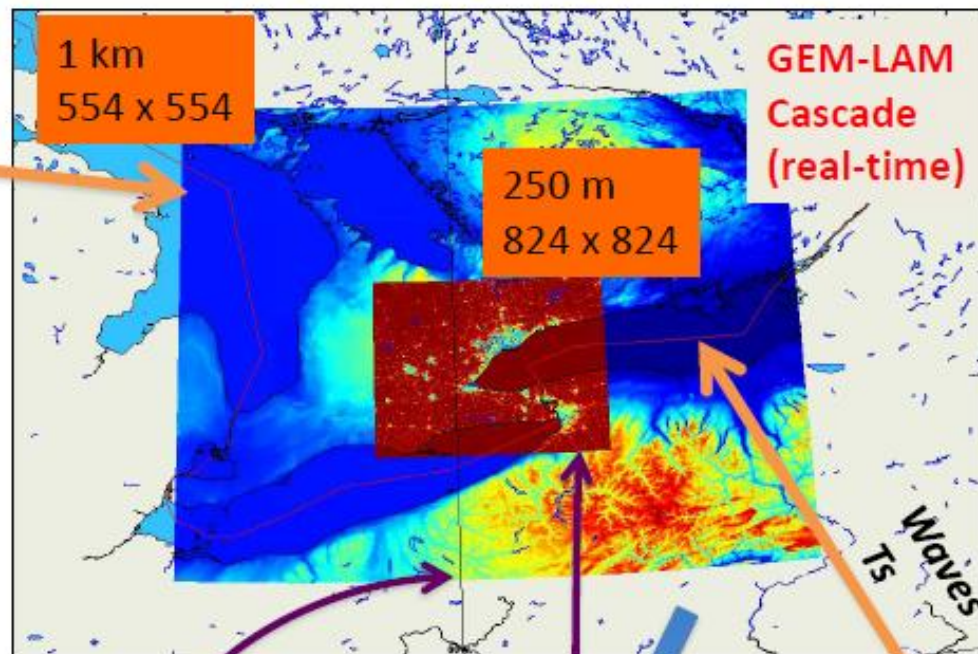


Canopy/soil physical processes

- TEB (urban)
- SVS (vegetation), or ISBA

**Continuous cycle → daily surface forcing**

Belair and Leroyer



Wall, Road, Roof : Ts  
Soil : T, w, snow

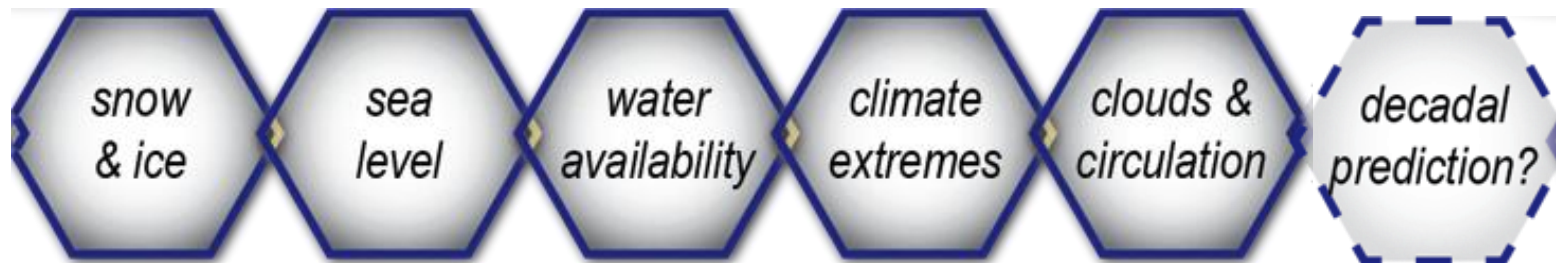
**Surface Initial conditions**

**NEMO (lakes)**  
*optional*

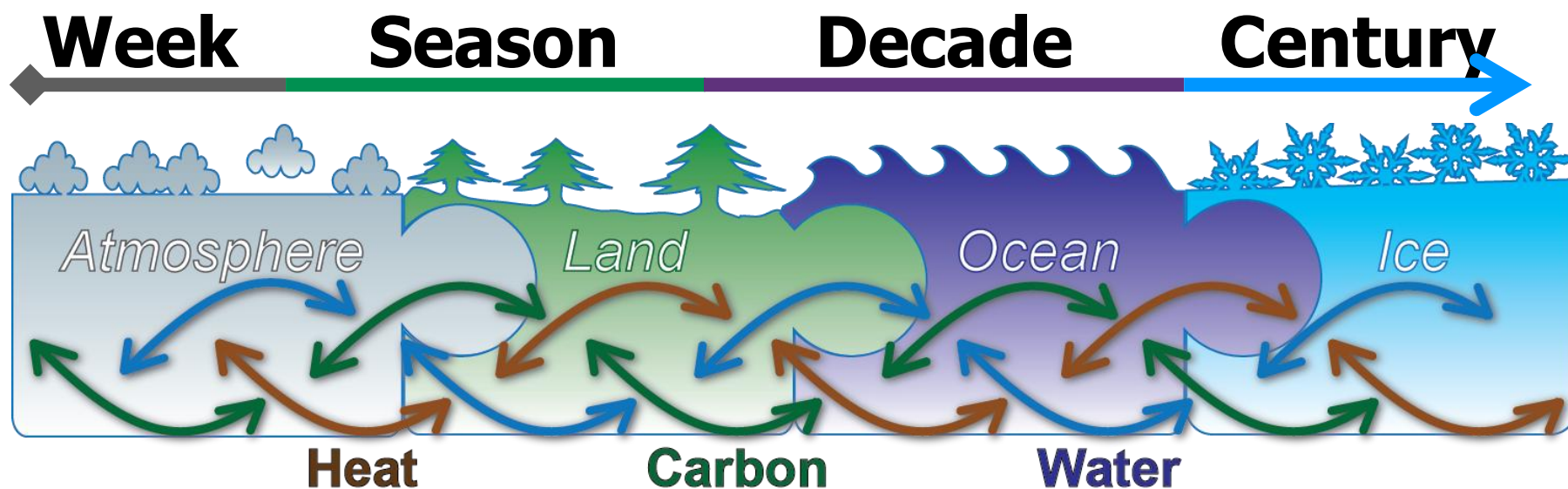
**Outputs & derived products :**

- **Outdoor thermal comfort indices :**  
UTCI, WBGT, PHS (heat stress)
- **High impact weather :** heavy rain, strong wind
  - Fog / visibility





*from data to regional information?*












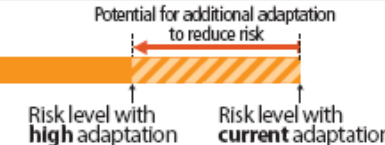














# Coast, Cities, and Climate

- Example: current & future climate risk in New York  
*[IPCC AR5 WGII, Table. 8-6]*

**Table 8-6** | Current and indicative future climate risks for Dar es Salaam, Durban, London, and New York City.

Climate-related drivers of impacts											Level of risk & potential for adaptation	
 Warming trend	 Extreme temperature	 Precipitation	 Extreme precipitation	 Damaging cyclone	 Drying trend	 Flooding	 Snow cover	 Sea level	 Storm surge	 Ocean acidification		
New York City												
Key risk		Adaptation issues & prospects					Climatic drivers		Timeframe		Risk & potential for adaptation	
Coastal zone systems (very high confidence)  [8.2]		NYC is highly vulnerable to coastal storm events and sea level rise associated flooding. Integration of infrastructure and policy changes with opportunity to enhance ecosystem service services is possible.					  			Very low	Medium	Very high
									Present			
									Near term (2030 – 2040)			
									Long term (2080 – 2100)			
									2°C			
									4°C			
Terrestrial ecosystems and ecological infrastructure (high confidence)		Promotion of ecosystem restoration efforts consistent with the current degraded state of most of NYC's ecosystem function. A need exists for continued land use protection of the city's water supply region.					 			Very low	Medium	Very high
									Present			



# Coast, Cities, and Climate

- Example: current & future climate risk in New York

## Adaptation policy setting & implementation requires:

- Sound understanding on climate variability, change and implications
- Interdisciplinary, long-term data collection and analysis systems; along with an inclusive, transparent process for stakeholder engagement to interpret the data
- Reliable prediction of weather and climate prediction in various time scales, with acceptable credibility & uncertainties
- Etc.

Table 8-6 | Current and indicative future climate risks for Dar es Salaam, Durbai, London, and New York City.










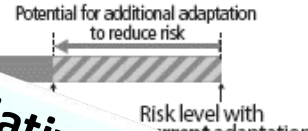


Key risks	Adaptation issues & prospects	Climatic	Timeframe	Risk & potential for adaptation		
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[8.2]			4°C			
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New York City									
<b>Key risk</b>		<b>Adaptation issues &amp; prospects</b>						<b>Timeframe</b>	
<b>GC-Extremes</b> Heavy Precipitation / Draught Heatwave / Storm [8.2]		NYC is highly vulnerable to coastal storm events and sea level rise associated flooding. Integration of infrastructure and policy changes with opportunity to enhance ecosystem service services is possible.						Very low	Medium
								 Near term (2030 – 2049)	
								 Long term (2080 – 2100)	
								2°C 4°C	
<b>Terrestrial ecosystems and ecological infrastructure</b> (high confidence)		<b>GC-Water Availability</b> Promotion of ecosystem restoration efforts consistent with land use change in most of NYC's ecosystem function. A need exists for continued land use protection of the city's water supply region.						Very low	Medium
								Present	Very high

(Regional) Climate Information

Initiative for Comprehensive Planet Data

GC-Snow & Ice

GC-Regional Sea Level



# Coast, Cities, and Climate

**Emphasis on developing & providing science-based climate information**

- New partnership (e.g. WWRP / HIW)
- Considering local/user relevance
- Leveraged by communication

Risk in New York

**Additional Climate Information**

Warming trend	Extreme temperature	Precipitation	Extreme precipitation	Damaging cyclone	Drying trend	Flooding	Snow cover	Sea level
<p><b>GC-Extremes</b></p> <p><b>Heavy Precipitation / Draught</b></p> <p><b>Heatwave / Storm</b></p> <p><b>GC-Snow &amp; Ice</b></p> <p><b>GC-Regional Sea Level</b></p> <p><b>GC-Water Availability</b></p>								
<p><b>New York City</b></p> <p><b>Key risk</b></p> <p>Coastal zone systems (very high confidence)</p> <p>[8.2]</p> <p><b>Adaptation issues &amp; prospects</b></p> <p>NYC is highly vulnerable to coastal storm events and sea level rise associated flooding. Integration of infrastructure and policy changes with opportunity to enhance ecosystem service services is possible.</p> <p>Terrestrial ecosystems and ecological infrastructure (high confidence)</p> <p>Promotion of ecosystem restoration efforts consistent with the integration of most of NYC's ecosystem function. A need exists for continued land use protection of the city's water supply region.</p>								
<p><b>Level of risk &amp; potential for adaptation</b></p> <p>Potential for additional adaptation to reduce risk</p> <p>Risk level with current adaptation</p> <p>Timeframe</p> <p>Very low Medium</p> <p>Near term (2030 - 2049)</p> <p>Long term (2080 - 2100)</p> <p>2°C 4°C</p> <p>Present</p> <p>Very low Medium Very high</p>								




# Coast, Cities, and Climate

**Challenges, one of many:**

**Multi-scale, Multi-components  
data collection, assimilation and  
modelling**

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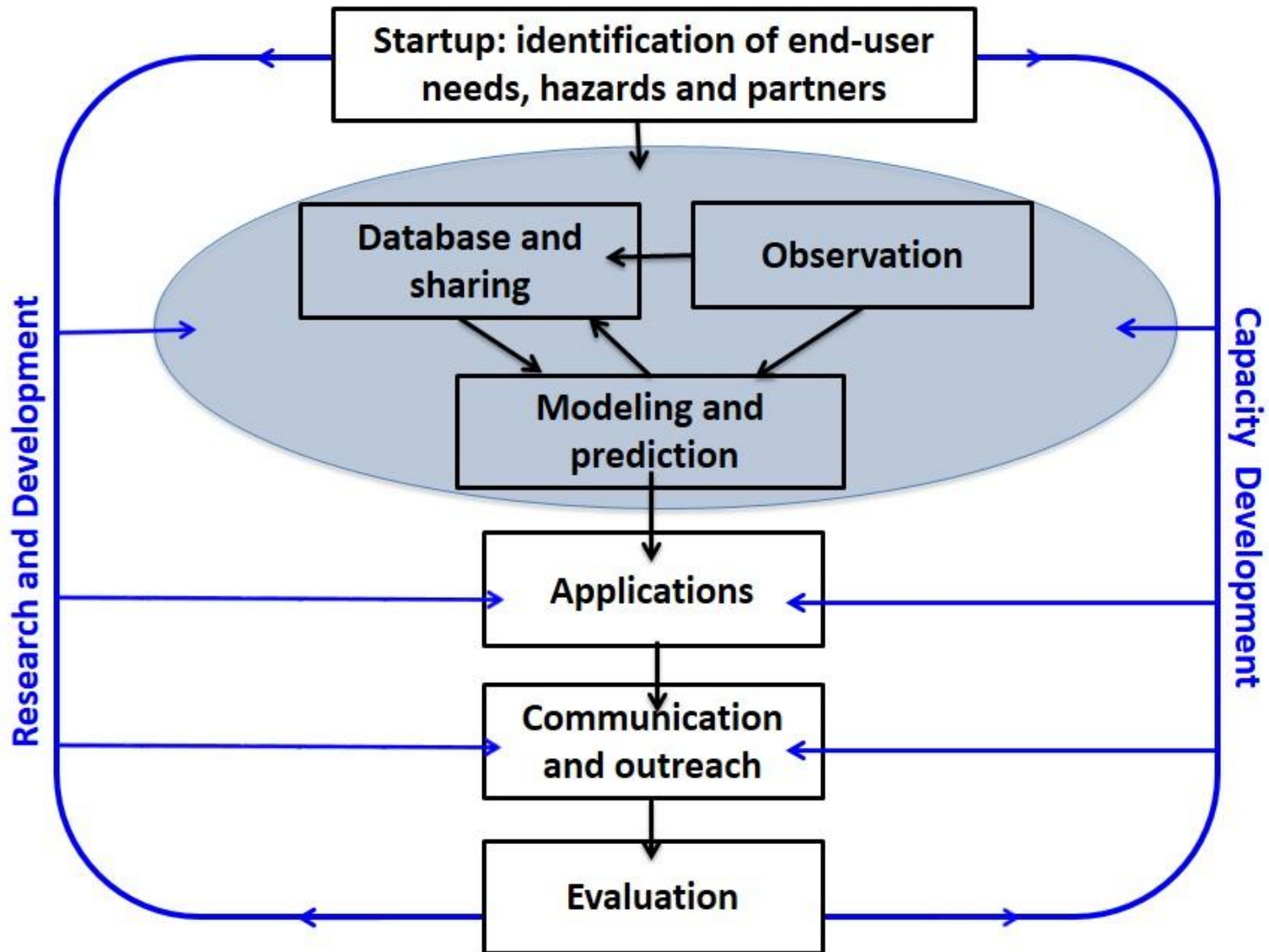
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Warming trend	Extreme temperature	Precipitation	Extreme precipitation	Damaging cyclone	Drying trend	Flooding	Snow cover	Sea level	Storm surge	Ocean acidification	Risk level with high adaptation	Risk level with current adaptation

- opportunistic data sources from different sectors
- high resolution weather
- storm surge models
- hydrologic models
- economic models
- ...
- coupled regional models
- air quality simulations
- ecoscape models
- transportation models





# Components of to the development an Integrated Urban Weather, Environment and Climate Service (IUWECS)

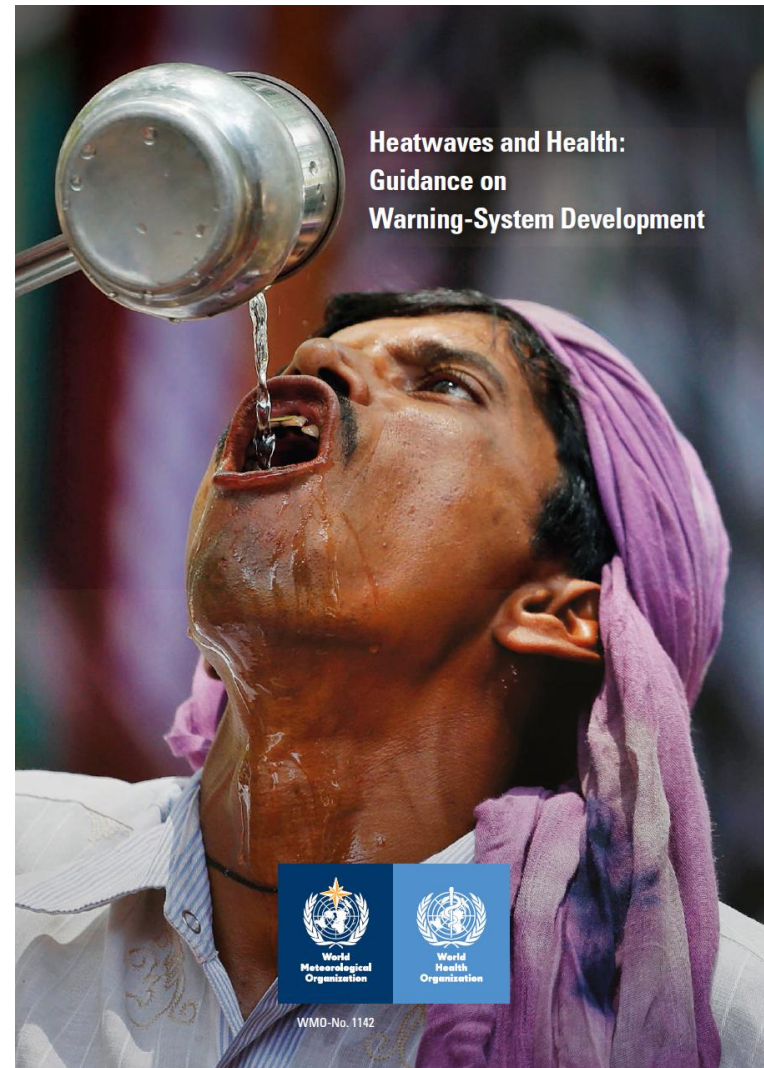






# World Climate Applications and Service (WCAS)

- heat wave health early warning systems
- climate services for renewable energy and climate-resilient energy systems
- capacity development for implementation of climate-services.
- Climate Services Information System (CSIS) including products, operational practices and toolkits including for the urban sector
- Climate risk and sector-specific climate indices
- Guidance on climate risk management
- User interface for climate information
- Tailored climate information
- Regional and national climate outlook forums with possibility for urban sector Engagement.







## World Meteorological Organization



A United Nations Specialized Agency  
Working together in Weather, Climate and Water



***Thank you for your attention***

Web: <http://www.wmo.int>

Email: [abaklanov@wmo.int](mailto:abaklanov@wmo.int)