



**South East European Virtual Climate Change Center**

**Research and Development Agenda in Serbia and  
South East Europe: CCFAP-A as a contribution to the  
WMO RA VI RCC-Network Highly Recommended  
Functions, RCOF process and GFCS**

*Milan Dacić, RA VI RCC-SEEVCCC*

# Outline

**R&D and Capacity Building under UNFCCC**

**WMO Capacity Development**

**GCOS Action Plan**

**WCRP Program**

**WMO RA VI RCC-Network: Implementation plan**

**RCOF**

**SEE-CCFAP for Adaptation**

**Required R&D**

**Preliminary R&D Agenda for SEE**

**RHMSS R&D Program**

# R&D and CB under UNFCCC

UNFCCC

ARTICLE 4

COMMITMENTS

1. All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:

(g) Promote and cooperate in scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to the climate system and intended **to further the understanding** and to **reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies**;

# R&D and CB under UNFCCC

UNFCCC

ARTICLE 5

RESEARCH AND SYSTEMATIC OBSERVATION

In carrying out their commitments under Article 4, paragraph 1(g), the **Parties shall**:

(a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at **defining, conducting, assessing and financing research**, data collection and systematic observation, taking into account the need to minimize duplication of effort;

(b) Support international and intergovernmental efforts to strengthen systematic observation and **national scientific and technical research capacities and capabilities**, particularly in developing countries, and to promote access to, and the exchange of, data and analyses thereof obtained from areas beyond national jurisdiction; and

(c) Take into account the particular concerns and needs of developing countries and cooperate in **improving their endogenous capacities and capabilities to participate** in the efforts referred to in subparagraphs (a) and (b) above.

# R&D and CB under UNFCCC

## CB Framework

- All SEE countries are signatories to the UNFCCC and they have the corresponding obligations. The execution of these obligations implies that a country should have the human, organizational, institutional and scientific resources for the development of the tasks and functions on a permanent basis.
- The majority of the SEE countries are faced with an insufficient institutional framework, limited human resource capacities and scarce financial resources, due to their difficult socio-economic situation. Without external assistance these countries have difficulties in building capacities required for appropriate implementation of the UNFCCC.
- In 2001, the Conference of the Parties to the UNFCCC adopted **two frameworks** that address the needs, conditions and priorities of **developing countries** and **countries with economies in transition**. This Capacity building framework sets out the scope of, and provides the basis for, action in capacity building related to the implementation of the Convention that will, in a coordinated manner, assist them in promoting sustainable development while meeting the objective of the Convention. **It serves as a guide for the Global Environment Facility (GEF) as an operating entity of the financial mechanism.** Multilateral and bilateral bodies, and other intergovernmental organizations and institutions are encouraged to take into account this framework in their consultations with developing countries when supporting capacity-building activities related to the implementation of the Convention.
- Durban Forum: Because of capacity-building's cross-cutting nature, information on the issue tends to be fragmented and not readily available. The creation of the **Durban Forum on Capacity-building reflects the need for a dialogue among all stakeholders involved in capacity-building.** Besides filling in the information gaps, this dialogue also provides an overview of the type of capacity-building support provided and the corresponding implementation efforts by Parties. The dialogue is a tool to improve the monitoring and review of the effectiveness of capacity-building within the international climate change regime.

# WMO Capacity Development

The need for WMO capacity development assistance is **grounded on the Convention of the World Meteorological Organization** (WMO) which recognizes that Members need to work with each other and with other organizations to coordinate, standardize, improve and encourage efficiencies in the exchange of information to further their application to the needs of society.

# WMO Capacity Development

## WMO Strategic Plan 2012–2015 (WMO-No. 1069)

- Strategic Thrust 1: Improving service quality and service delivery
- Strategic Thrust 2: Advancing scientific research and application, as well as development and implementation of technology
- Strategic Thrust 3: **Strengthening capacity-building**
- Strategic Thrust 4: Building and enhancing partnerships and cooperation
- Strategic Thrust 5: Strengthening good governance

# WMO Capacity Development

## WMO Capacity Development Strategy

### Capacity Development Vision

- Stronger NMHSs to meet society's need for information on weather, climate and water for the safety and well-being of people throughout the world.

### Capacity Development Mission

- To facilitate a holistic and integrated approach to sustainable Capacity Development of NMHSs especially in developing countries, LDCs and SIDSs through: advocacy, education and training, outreach, partnerships and resource mobilization, **demonstration and pilot projects**, service delivery and **research**.

The CDS recognizes that there are four types of NMHSs capacity: institutional, infrastructural, procedural and human resources. These four dimensions of capacities are distinct yet inter-related and **must be considered holistically** to achieve sustainable capacity development.



# WMO Capacity Development

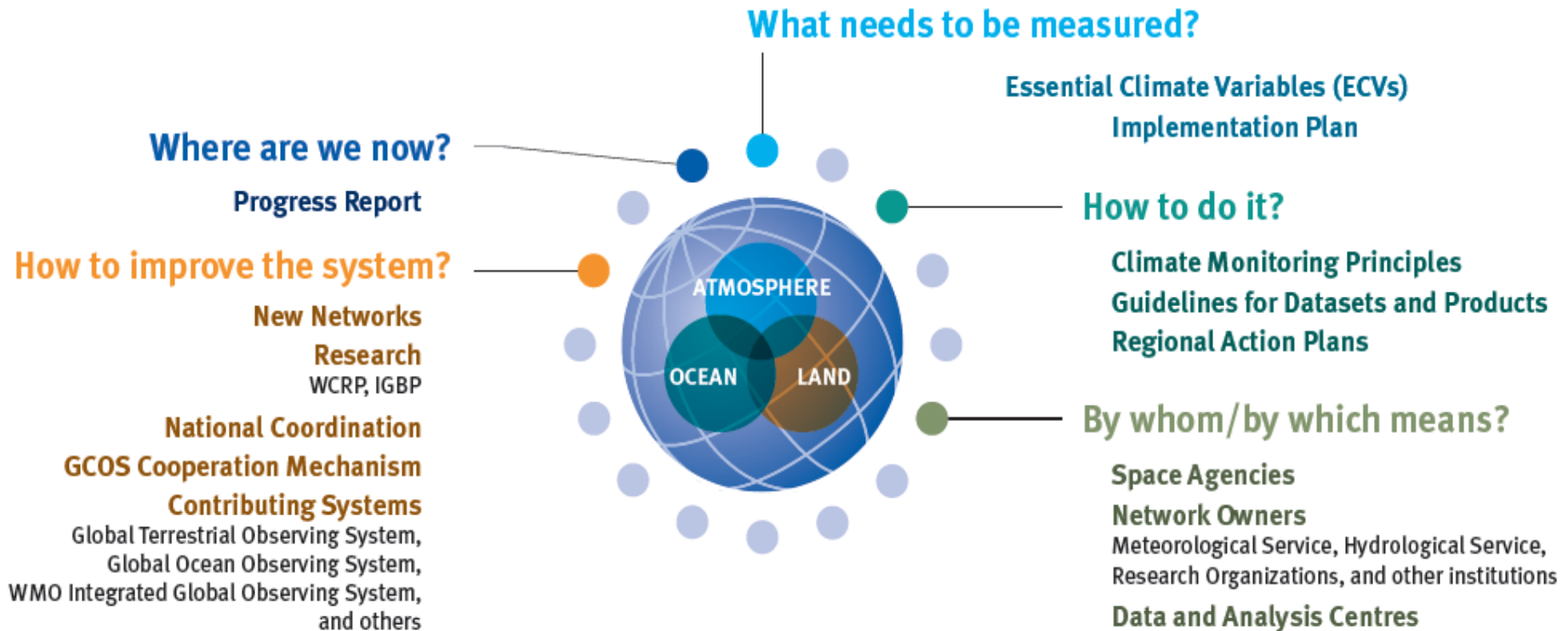
## COORDINATING AND ACCELERATING PREDICTION RESEARCH

### Rationale

- There is a growing societal demand for environmental predictions that include a broad range of space and time scales, and that include a complete spectrum of physical, chemical and biological processes (e.g., meteorology, oceanography, hydrology, biogeochemistry, ecosystems, air quality, fisheries, coastal zone science...). Meeting this demand necessitates a unified approach that will challenge the traditional boundaries of weather, climate, water and environmental science in terms of the interactions of the bio-geophysical systems, the supporting computational infrastructure and science, and how these forecasts are communicated to society.

**WMO Executive Council decided to identify seamless weather, climate, water and environmental prediction and services as a major focus in WMO activities.**

# GCOS ACTION PLAN



# GCOS ACTION PLAN

**Table 1: Essential Climate Variables that are both currently feasible for global implementation and have a high impact on UNFCCC requirements**

Domain	Essential Climate Variables
<b>Atmospheric</b> (over land, sea and ice)	<p><b>Surface:</b><sup>8</sup> Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget.</p> <p><b>Upper-air:</b><sup>9</sup> Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance).</p> <p><b>Composition:</b> Carbon dioxide, Methane, and other long-lived greenhouse gases<sup>10</sup>, Ozone and Aerosol, supported by their precursors<sup>11</sup></p>
<b>Oceanic</b>	<p><b>Surface:</b><sup>12</sup> Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton.</p> <p><b>Sub-surface:</b> Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.</p>
<b>Terrestrial</b>	<p>River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.</p>

# WCRP Program

## WCRP Grand Science Challenges

- Clouds, Circulation and Climate Sensitivity
- Cryosphere in a Changing Climate (Changes in Cryosphere)
- Science Underpinning the Prediction and Attribution of Extreme Events (Climate Extremes)
- Regional Climate Information
- Sea-Level Rise and Regional Impacts
- Changes in Water Availability

## WCRP Unifying Themes

- Modelling Theme
- Observation and Analysis Theme
- The WCRP Plan and Activities for Education and Professional Development

# WCRP Program

WCRP Research Priorities Include:

- **Quantify** and communicate **uncertainties** in climate change information/knowledge;
- Focus on regional and intra-seasonal to inter-annual, and decadal climate prediction/projection;
- Address climate information needs for adaptation planning, mitigation strategies, and assessing risks of climate variability and change;
- Promote and enable timely, reliable, and easy access to climate information and knowledge; and
- Support education, training and development of next generation of climate experts.

# WMO RA VI RCC-Network Implementation Plan

www.wmo.int/pages/prog

www.wmo.int/pages/prog/dra/eur/documents/RCC%20Network/WMO-RAVI-RCC-Implementation-Plan.pdf

ORGANISATION MÉTÉOROLOGIQUE MONDIALE  
CONSEIL RÉGIONAL VI (EUROPE)  
BUREAU DU PRÉSIDENT



WORLD METEOROLOGICAL ORGANIZATION  
REGIONAL ASSOCIATION VI (EUROPE)  
OFFICE OF THE PRESIDENT

---

## RA VI RCC Network -- Implementation Plan --

### Content:

- 1 Introduction
- 2 Background
- 3 The RA VI RCC Network
  - 3.1 Current structure
  - 3.2 General remarks
  - 3.3 Open items
  - 3.4 Further schedule
- 4 Concluding remarks

### Annexes:

- A The RA VI Pilot RCC Node on Climate Data: Services and providers
- B The RA VI Pilot RCC Node on Climate Monitoring: Services and providers
- C The RA VI Pilot RCC Node on Long-range Forecasting: Services and providers

# WMO RA VI RCC-Network Implementation Plan

(highly recommended functions)

## Research and development

- The RCC/ECA&D research and applications agenda addresses the following questions:
  - How does climate change manifest itself in Europe?
  - Is the probability of extremes changing and how should this be assessed?
  - How good are climate models when they are confronted with observations?
  - Which integrated climate change monitoring products are required to serve the full range of application sectors in Europe within a global context?
- Promote studies of regional climate variability and change, predictability and impact in the Region and sub-regions (Netherlands, Norway, Serbia)
- Survey of specifications observational network for climate monitoring (ECSN)
- Promote the use of proxy climate data in long-term analyses of climate variability and change (Netherlands, Norway)
- **Climate R&D agenda, esp. on downscaling methods** (Norway, Serbia, Sweden, Turkey, Netherlands) and climate models (Serbia-SEE/VCCC)
- **Consider outcomes of CCI ET on Research Needs in Seasonal Forecasting including its Applications: Guidelines on consensus methods and best practices for downscaling** (France)
- Promote studies of regional climate variability and change, predictability and impact in the Region and sub-regions [Netherlands, Norway, Serbia (SEE/VCCC)]
- Consider, in general, activities/services of the following initiative: SEE/VCCC (host: Serbia)

# RCOF

The ultimate goal of the forums is to promote the development of end-to-end processes that ensure that forecasts reach end users in a format appropriate for optimal decision-making. To achieve this goal, the following priorities may be identified:

- Shape and implement a **research agenda for applications**, informed by user needs
- Shape and implement a **research agenda for forecasts**, informed by scientific developments, covering applications, methodology, downscaling, and verification
- Identify and address **gaps that constrain the wider use of climate information**
- Examine the extent to which current Forum **predictions can be (?) downscaled** to smaller local regions.
- Undertake further analyses of the value obtained through use of Forum products.



# RCOF

## (Capacity Building Summary)

- Supplement Forum-type training with a range of on-going professional development courses and activities, while ensuring institutional commitment to the training and deployment of personnel.
- **Re-examine national needs for computing technology.**
- Develop a cadre of sector-specific intermediaries for improved, sector-specific product translation and dissemination.
- Develop sector-specific databases, research capabilities and dissemination through specific products based on translated predictions.

# SEE-CCFAP-A - Outline

- Rationale for the Belgrade Initiative for enhancement of SEE cooperation in climate change - the process
- Requirements for Scientific Capacity Building in SEE
- International CB frameworks in Climate Change - Capacity building under CCFAP, UNFCCC and WMO
- Sci-work of the SEE Virtual Climate Change Center - SEEVCCC
- SEEVCCC priorities in addressing capacity building in climate change ... some examples

# **Belgrade Initiative for enhancement of SEE cooperation in climate change - Rationale**

- Most of SEE countries face problems with responding to the obligations under the United Nations Framework Convention on Climate Change.
- Their problem is twofold: They are faced with growing damage caused by meteorological, hydrological and climate extremes and catastrophes, and on the other hand, they have to cope with poverty and necessity for development.
- In addition, the SEE countries have limited access to knowledge, technology and financing, and have a great need of capacity building and development (systemic, institutional and individual), that has to be coupled with the requirements of the stabilization and association process to the EU.
- These are the key reasons for launching the Belgrade Initiative on climate change that is expected to provide region-driven climate change framework action in SEE and establishment of an adequate research-to-policy interface.

# Requirements for Scientific Capacity Building in SEE

An important, non-exhaustive list of common capacity needs, covering all three dimensions of capacity building (systemic, institutional and human), considering diverse aspects of climate change issues (observations and measurements, vulnerability and adaptation, understanding of the climate change issue – education, training and awareness, mitigations, transfer of technology, climate change strategy and action plans, negotiating capacity, cross-cutting issues and cross-convention synergies) is as follows:

- An overall short and long-term climate policy framework at the national and regional level;
- Trained individuals with analytical skills to evaluate impact assessments and identify abatement and adaptation options (especially in non-energy sectors), undertake vulnerability assessment and adaptation planning, evaluate barriers to specific policies, and introduce the economic dimension to Vulnerability and Adaptation (V&A) policy planning;
- Training of individuals who can identify phenomena and impacts attributable to climate change and separate these from impacts caused by other events (natural climatic variability, socioeconomic conditions, etc.);
- Technical staff conversant with theories and models for various aspects of climate change, as well as for capturing cross cutting issues, relationships and mutual influences of sector policies;
- Academic human resources for education in climate change economics and policy;
- Advanced economic and market instruments.

# Requirements for Scientific Capacity Building in SEE

## Key Objectives and Areas for initial Action Under SEE/CCFAP:

- Improvement of observations, monitoring of climate variability and climate change, climate data base management and data exchange;
- Research and Development/applications of climate models and downscaling techniques and employment of information and data on projected climate change;
- Reduction of Climate related Risks;
- Improving the integration of socio-economic information in climate impacts and vulnerability studies;
- Development of Sub-regional programs supporting national capacity-building and awareness raising in the target countries.

# Requirements for Scientific Capacity Building in SEE

*Under SEE/CCFAP Project of the Belgrade Initiative, different areas were identified where research is needed. These can be grouped as follows:*

- *Climate observations, monitoring and forecasting* – There is a need for high quality observations, reference datasets and reanalysis of historical data, climate change detection studies, trend analyses, process research, data assimilation, model development and testing. Development a sub-regional SEE climate alert system with the objective to support introduction of climate information and predictions into early warning and disaster prevention systems. Early warning systems are one way of reducing vulnerability and enhancing adaptive capacity to weather events and climate change. Socio-economic data are also necessary. Sufficient funding for this activities is essential to provide the basis for scientific progress and policy-relevant results.

# Requirements for Scientific Capacity Building in SEE

- *Climate modeling and scenarios* - There is a need for development of climate change scenarios using climate models especially those that provide sub-regional and regional specificities, such as regional climate models SEEVCCC-RCM (climNMM-B), PRECIS, etc. Increased spatial resolution of climate models is also planned. Regional and local impact studies require the spatial scale of climate models to be reduced to 10km.

# Requirements for Scientific Capacity Building in SEE

- Provision of capacity building workshops to adopt, calibrate and validate the impact models for agriculture, water resources and biodiversity, which are to be used for assessment of climate change impacts



# Belgrade Initiative - Common SEE research priorities in addressing climate change

- Collaborative research on physical and ecological impacts of climate change in the following sectors: Public Health, Safety and Emergency Preparedness; Water Resources Management, Freshwater Quantity and Quality, Water Supply Including Hydro Energy Potential; Agriculture and Forestry; Land Use, Building and Transportation; Tourism; Biodiversity and Ecosystems; Education, Training and Public Awareness.
- Collaborative research on the formation of the extreme events, their magnitude and frequency, as well as their consequences.
- Collaborative research of the vulnerability of the natural resources and human systems to climate change.
- Collaborative research of weather and water hazards, climate extremes and disasters in SEE region, related risks mapping and risks management.
- Collaborative research of cost/benefit of structural and non/structural paths for adaptation.

# SEEVCCC priorities in addressing Capacity Building in climate change as part of CCFAP, UNFCCC, and WMO frameworks

Under South East European Climate Change Framework Action Plan for Adaptation and WMO RA VI RCC Implementation Plan the following common priorities have been identified:

- Improvement of collection, management, exchange, access to, and use of the observational data and other relevant information on current and historical climate and its impacts to SEE;
- Development the capacity to produce climate forecast and climate watch through humane resources development, training activities, education and training events organized by the SEVCCC in cooperation with the WMO and partners, national and international institutions;
- Promotion of the climate research and development/application of climate models, access to and use of information and data on projected climate change for SEE;
- Promotion of the understanding of the impacts of climate change, vulnerability and adaptation to climate change;
- Development and implementation of sub-regional and bilateral programmes for research, education and training and other forms of capacity building under the existing international framework and the development of regional partnerships proposed by the SEE/CCFAP-A;
- Capacity building activities undertaken within these international frameworks should maximize synergies between the World Meteorological Organization, other international organizations and Conventions, and global environmental agreements aiming at strengthening the capacity of existing national and sub-regional institutions dealing with climate change.

# South East European Virtual Climate Change Center SEEVCCC - Roles and responsibilities within WMO RA VI RCC-Network

- The WMO Regional Association VI (Europe) at its Fifteenth Session held in Brussels, 18 to 24 September 2009, adopted the Resolution 4.2/1 (XV-RA VI) on Establishment of a Regional Climate Centre-Network in RA VI (RA VI RCC-Network) and support Capacity Building through Strategic Partnerships and cooperation, basic infrastructure and human capacity development; and enhancing resource mobilization in the Region.
- The SEEVCCC hosted by NMHS of Serbia is one of the participating institutions and its mandatory and high recommended functions and priorities related to Operational LRF, Climate Monitoring, Data services, Training and capacity building, Coordination, Research and Development and Climate Applications are defined under the WMO RA VI RCC-Network Implementation Plan.

## **Primary goals of the SEEVCCC center are to:**

- Contribute to the European RA VI RCC-Network - Strengthen the climate network (monitoring, watch, assessment, LRF, data) through operational and highly recommended R&D functions
- Contribute in enhancing the capacities of NHMSs from the region to improve the skill through training, guidelines, support RCOF mechanisms - SEECOF, etc.
- Serve as and End-user liaison (through the SEECOF process).
- Perform R&D and cooperate across disciplines and agencies, link with academic community, to provide multidisciplinary effective sector-specific climate products and services.
- Contribute to cross-cutting issues, Enable stronger visibility of NMHSs in climate related areas.
- Build/enhance partnerships.

# Required R&D

## Background and Rationale:

There is a growing societal demand for environmental predictions that include a broad range of space and time scales, and that include a complete spectrum of physical, chemical and biological processes (e.g., meteorology, oceanography, hydrology, biogeochemistry, ecosystems, air-quality, fisheries, costal zone science...). Meeting this demand necessitates a unified approach that will challenge the traditional boundaries of weather, climate, water and environmental science in terms of the interactions of the biogeophysical systems, the supporting computational infrastructure and science, and how these forecasts are communicated to society.

# Required R&D – Executive Council Task Team (EC-RTT) on Research

## Background and Rationale (cnt'd):

WMO Executive Council decided to identify **seamless weather, climate, water and environmental prediction and services** as a major focus in WMO activities. EC established to this effect a **Research Task Team** with a mandate to propose a strategy focusing on strengthening prediction research and related scientific assessments in support of enhanced climate, weather, water and environmental services in the next decade.

**Reference:** “Challenges and opportunities in research to enable improved products and new services in climate, weather, water and environment”, A Report of the Executive Council Task Team (EC-RTT) on Research Aspects of an Enhanced Climate, Weather, Water and Environmental Prediction Framework, WMO/TD-No. 1496, June 2009.

# Required R&D

## Background and Rationale (cnt'd):

With the overall goal to strengthen and promote the linkages between climate, weather, water and environmental research to enable National Meteorological and Hydrological Services and other related organizations to provide improved services in the next decade, the Research Task Team was guided by the following terms of reference: **Propose a strategy focusing on strengthening prediction research and related scientific assessments in support of enhanced climate, weather, water and environmental services in the next decade; ...**

## References:

- Shukla, J., R. Hagedorn, B. Hoskins, J. Kinter, J. Marotzke, M. Miller, T. Palmer, and J. Slingo (2009) Revolution in climate prediction is both necessary and possible. A Declaration at the World Modelling Summit for Climate Prediction. BAMS, February 2009.
- Brunet et al. (2007) Toward a Seamless Process for the Prediction of Weather and Climate: The Advancement of Sub-seasonal to Seasonal Prediction. White paper developed by the climate and weather research community on a seamless approach to weather/climate prediction and services delivery.  
[http://www.wmo.int/pages/prog/arep/wwrp/new/documents/wp1\\_thorpex\\_wcrp.pdf](http://www.wmo.int/pages/prog/arep/wwrp/new/documents/wp1_thorpex_wcrp.pdf)

# Required R&D

## Background and Rationale (cnt'd):

Most WMO sponsored or co-sponsored programmes and organizations contribute in a meaningful way to the development of prediction research, **stretching across weather, climate, water and air quality applications** of today; prediction research that has the **potential to provide a full suite of environmental predictions** of tomorrow. Whilst the breadth of environmental prediction extends beyond the remit of WMO, it is the atmosphere that provides the fastest and most fundamental linking mechanisms across the coupled physical-biological-chemical components of the Earth system.

# Required R&D

## Background and Rationale (cnt'd):

There is a **NEED FOR A MAJOR CHANGE IN THE PARADIGM FOR PREDICTION RESEARCH**: Over past 30 years, climate modelling has progressed from atmospheric models with a simple representation of the oceans to fully coupled Earth system models complete with biological and chemical processes... (many research and operational centres around the world now produce numerically-based **seasonal predictions** using observed initial conditions that **extend beyond the period of conventional deterministic predictability** ).

The traditional **boundaries** between weather forecasting, seasonal forecasting and climate prediction are **fast disappearing** since progress made in one area can help to accelerate improvements in the other... (**many of the processes are common to all time scales**).



# Required R&D

## General Recommendation

**Coordinating and Accelerating Prediction Research:** Develop a unified approach to multidisciplinary weather, climate, water and environmental prediction research, step up high-performance computing investments to accommodate the increasing complexity and detail of models, accelerate the development, validation and use of prediction models ...

In the longer term, the **World Climate Modelling Summit** advocated the establishment of one or more **multi-national centres** with a corresponding thousand fold increase in current computing capacity (World Modelling Summit, 2009, Shukla et al., 2009).

# Required R&D

## Specific Recommendations

Follow the recommendations of HYMEX, HEPEX and the second phase of AMMA to develop stronger links with these efforts and develop a general strategic vision to **address the broader issue of collaboration between weather and hydrological research, including coupled meteorology/hydrology models for weather and climate prediction.**

The increasing availability of rainfall predictions at catchment scale as the resolution of regional models increases, allowing direct coupling of meteorology and hydrology.

***INTERACTIVELY COUPLED WEATHER AND  
HYDROLOGY PREDICTION SYSTEMS***

# Required R&D

## *Specific Recommendations*

The **forecasting of air pollution in urban areas** is an important service in order to allow the population to take precautions on a daily basis and to identify policy measures to reduce emissions so that pollution target levels can be met. Changes in climate and changes in emissions are also likely to change air quality in the future.

Provide global coordination of projects to incorporate aerosols and ozone as radiatively and cloud/precipitation active constituents in operational analysis and prediction systems, and thereby, enhance predictive capability for societal use.

***APPLICATION OF AIR POLLUTION PREDICTIONS AND ANALYSIS TO PROBLEMS OF HUMAN HEALTH, ECOSYSTEMS, CLIMATE CHANGE AND THE CYCLING OF GREENHOUSE GASES***

# Required R&D

## Specific Recommendations

Now it is becoming clear that aerosols, in particular, through their role in direct radiative forcing, indirect radiative forcing and precipitation formation (WMO/IUGG Review; 2009), need to be included internally in numerical weather prediction models. Much like water components, they are highly variable in time and space in the troposphere (generally residence times of 3 to 14 days) and therefore cannot be represented by climatological distributions.

***PROVIDE GLOBAL COORDINATION OF PROJECTS TO INCORPORATE AEROSOLS AND OZONE AS RADIATIVELY AND CLOUD/PRECIPITATION ACTIVE CONSTITUENTS IN OPERATIONAL ANALYSIS AND PREDICTION SYSTEMS, AND THEREBY, ENHANCE PREDICTIVE CAPABILITY FOR SOCIETAL USE.***

# Required R&D

## Specific Recommendations

New resources would accelerate the development of seamless coupled model and data assimilation systems for the benefit of weather and climate applications. One mechanism to achieve this is through the various **re-analysis** projects which are designed to **provide a historical record for weather and climate studies**.

Future-generation reanalysis projects would increasingly not rely only on operational forecast systems but benefit from an **interdisciplinary** weather-climate research programme on **data-assimilation** methodologies (Brunet et al. 2007).

***TAKE AN INTERDISCIPLINARY WEATHER-CLIMATE APPROACH ON DATA- ASSIMILATION METHODOLOGIES IN FUTURE REANALYSIS PROJECTS.***

# Required R&D – WMO EC-RTT (Research) 2009

## *Specific Recommendations*

***INTERACTIVELY COUPLED WEATHER AND  
HYDROLOGY PREDICTION SYSTEMS***

***APPLICATION OF AIR POLLUTION PREDICTIONS AND  
ANALYSIS TO PROBLEMS OF HUMAN HEALTH,  
ECOSYSTEMS, CLIMATE CHANGE AND THE CYCLING OF  
GREENHOUSE GASES***

***PROVIDE GLOBAL COORDINATION OF PROJECTS TO  
INCORPORATE AEROSOLS AND OZONE AS RADIATIVELY  
AND CLOUD/PRECIPIATION ACTIVE CONSTITUENTS IN  
OPERATIONAL ANALYSIS AND PREDICTION SYSTEMS, AND  
THEREBY, ENHANCE PREDICTIVE CAPABILITY FOR  
SOCIETAL USE.***

***TAKE AN INTERDISCIPLINARY WEATHER-CLIMATE  
APPROACH ON DATA- ASSIMILATION METHODOLOGIES IN  
FUTURE REANALYSIS PROJECTS.***

# Preliminary R&D Agenda for SEE

## Action in Serbia and SEE

Ministers of Environment from SEE, WMO Secretary-General, President WMO RA VI, WCRP Director, NMHS Directors, and experts from many countries of Europe and the USA, gathered at the **Ministerial Meeting “Climate Change Research for Environmental Protection, Adaptation and Risk Reduction”**, Belgrade, April 13, 2011, which followed the **International expert meeting “SEE Research Framework in Regional Climate Modeling for 2012-2017”**, 11-13 April 2011, Belgrade, Serbia.

Ministers expressed their concern arising from the increasing scientific evidence for the adverse impacts of climate change and increasing risk of the sea level rise, changes in the frequency, location and intensity of extreme weather events and other adverse impacts of climate change, **with changes over southern Europe being among the most detrimental within Europe**;

Ministers further recognized that adaptation to climate variability and change in South East Europe is necessary in order to reduce their negative effects, which requires urgent better undertaking based on and guided by **the best available scientific knowledge**.

# Preliminary R&D Agenda for SEE





# Preliminary R&D Agenda for SEE



# Preliminary R&D Agenda for SEE



# Preliminary R&D Agenda for SEE

Two parts:

**Part A – Numerical prediction model developments: 5-year framework plan for investigation**

**Part B – Earth modeling subsystems:**

**Final goal:** Integrated Earth Modelling System suitable for seamless weather and climate prediction on different temporal and spatial scales

# Preliminary R&D Agenda for SEE

## Part A – Numerical prediction model developments: 5-year framework plan for investigation

Over the next five years, the following issues pertaining to m-physics are expected to be addressed:

1. Are SVAT models with “sandwich” canopy adequate?
2. Dynamic vegetation
3. Improved ways of handling snow age, density and heat conduction
4. Impact of urban canopy and its representation
5. Numerical methods for non-stationary, transitional regimes
6. Horizontal movement of subsurface water (soil moisture)
  - Do we know enough about it?
  - Scale dependency? Can it be ignored on some scales and not on others?
  - Impact of the size of nested domain?
7. Improved parameterization of gravity wave drag
8. Improved cloud-radiation interaction depending on resolution
9. Parameterization of convection at “convection allowing” scales (single digit resolutions) and the precipitation bias control in long integrations

# Preliminary R&D Agenda for SEE

**An important issue for regional climate studies and downscaling is how good is the communication between driving models and regional models, i.e.,**

- Can all the necessary information be passed through lateral boundary conditions?
- Is scale dependant nudging necessary?
- Does the regional domain size matter?

# Preliminary R&D Agenda for SEE

## Part B – Earth modeling subsystems:

1. Modeling of aerosols
2. Full dynamic hydrology modelling
3. Ocean sub-model
4. Land surface, ice and ocean surface as lower boundary conditions
5. Ocean assimilation

## R&D Program

### Government of Serbia's **Regulation on the establishment of a Programme of Meteorological and Hydrological Research and Development Activities for the 2013 – 2017 period**

#### **MISSION of the Republic Hydrometeorological Service of Serbia - RHMSS**

Securing the permanent functioning and development of the hydrometeorological Early Warning System, including its components: observational network, computational and telecommunication systems, analytical and prognostic system, on the benefit of and various economy sectors in Serbia and society at large. Improving the role and presence of RHMSS in international collaborative efforts in hydrometeorology.

#### **VISION of the Republic Hydrometeorological Service of Serbia – RHMSS**

RHMSS as a national hydrometeorological service, also executing the mandatory functions of the sub-regional virtual climate change center (SEEVCCC) under the WMO RA VI RCC-Network, is to make every effort to comply with the international quality standards in all of its areas of work, and thereby gain high confidence and esteemed position as a reliable partner and provider of meteorological, climate and hydrological data and services.

In order to follow its Mission and Vision, the RHMSS drafted and submitted to the Government approval the **Regulation on the establishment of a Programme of meteorological and hydrological research and development activities for the 2013 – 2017 period**, which, if implemented, will substantially contribute to the set goals.

# RHMSS R&D Program

R&D THEMES FOR RHMSS	
<b>NUMERICAL WEATHER AND CLIMATE PREDICTION AND CLIMATE CHANGE</b>	
<b>1. Numerical weather prediction</b>	<ul style="list-style-type: none"> <li>1) System of nowcasting and very short-range (up to 12 hours) weather forecasts and warnings</li> <li>2) Specialized nowcasting and very short-range forecasts and warnings</li> <li>3) Meteorological observations database for the needs of the nowcasting and very short-range weather forecasts system</li> <li>4) Short-range (12-72 hours) and medium-range (72-240 hours) weather forecast system</li> </ul>
<b>2. Climate monitoring and climate forecasts</b>	<ul style="list-style-type: none"> <li>1) Climate monitoring</li> <li>2) System of monthly and seasonal climate forecasts (up to 7 months in advance)</li> </ul>
<b>3. Verification of forecasts</b>	<ul style="list-style-type: none"> <li>1) Forecasting products verification system</li> </ul>
<b>4. Climate modelling, climate change projections and impact assessment</b>	<ul style="list-style-type: none"> <li>1) Development of a new generation regional climate model</li> <li>2) Impact assessment of climate variability and climate change</li> <li>3) Development of the sub-regional South East European Virtual Climate Change Center – SEEVCCC</li> </ul>
<b>5. Satellite and radar meteorology</b>	<ul style="list-style-type: none"> <li>1) Application of meteorological satellite data in weather forecasting</li> <li>2) Assimilation of meteorological radar data</li> </ul>



# RHMSS R&D Program

<b>APPLIED METEOROLOGY AND CLIMATOLOGY</b>	
<b>1. Aeronautical meteorology</b>	1) Terminal area forecast
	2) Verification of aeronautical weather forecasts
	3) Specialized training of staff
	4) Aeronautical aerodrome climatological information
<b>2. Agricultural meteorology</b>	1) Drought monitoring and early warning
	2) Research of the impact of weather and climate extremes on agriculture
<b>3. Applied climatology, urban and technical meteorology</b>	1) Meteorological disaster risk assessment
	2) Digital Climate Atlas of Serbia
<b>HYDROLOGY</b>	1) Development of hydrological models
	2) Development of hydrogeological models

# Conclusion

- Sub-regional SEE collaboration needed (division of work, burden sharing)
- Improved Involvement of Developing Country (or EITs) Scientists in International Research Projects.
- Focus on distilling research advances into user-friendly products specially at the regional level that can be readily made available and, through training activities, enable their use by those needing information.
- Linking Research, Operation and Service Delivery: Develop closer linkages between research, operations and users through Forecast Demonstration Projects (FDPs) that accelerate technology transfer.
- The extraordinary complexity of the modelling tools that are needed over the next decades, as well as their rapidly increasing needs for observations and supercomputing power, is forcing a complete re-examination of the prediction process, with the view of containing optimizing the costs of production.
- **Joint/shared super computing facility** is required by the SEE region which will serve through the SEE-NMHSs for both, the National Multy-Hazard Early Warning Systems, as well as Climate variability and change operations/production for the benefit of different national economy sectors.

Thank you.