



# **ECRA General Assembly 2015**

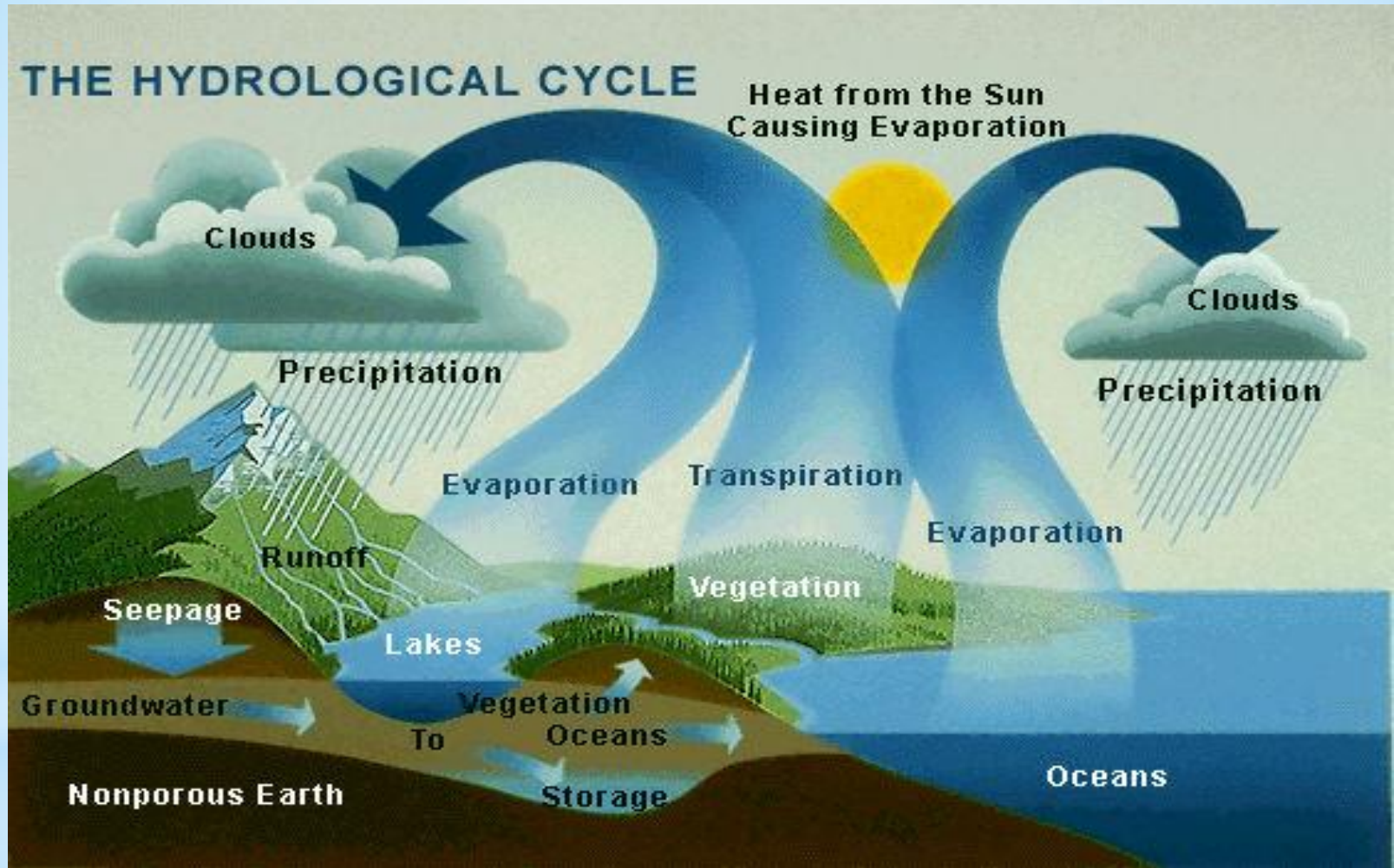
**“New knowledge for risk reduction”**

*25/26 March 2015*

*Square Brussels Meeting Centre*

[www.ecra-climate.eu](http://www.ecra-climate.eu)

# Changes in the Hydrological Cycle



# Changes in the Hydrological Cycle

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Changes in the hydrological cycle are due to

- Climate change
- Changes in ocean and atmospheric circulation
- Changes in atmospheric composition
- Changes in the land use / land cover
- Changes in terrestrial and marine vegetation
- Changes in subsurface water distribution

And, in turn, affect climate dynamics

# Changes in the Hydrological Cycle

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The components of the hydrological cycle **react in a different way** to climate change, sometimes amplifying each other's action, sometimes giving rise to negative feedbacks. In addition, variations in the hydrological cycle often take place at **regional or even local scale** (such as variations in ecosystem composition or runoff processes) but **can trigger modifications that have an upscale effect**, possibly leading to regional or even global changes in the water cycle.



# ECRA Pilot Workshop

## CHANGES IN THE HYDROLOGICAL CYCLE

**Dates:** 5-6 March 2012  
**Location:** Aula Marconi, CNR Headquarters, P.le Aldo Moro 7, Rome, Italy  
**Organization:** Antonello Provenzale, ISAC-CNR, Italy  
Paolo Ruti, ENEA UTMEA, Italy  
**Website:** <http://www.ecra-climate.eu/index.php/collaborative-programmes/hydrocycle>  
**Registering:** This workshop is organized by the European Climate Research Alliance.  
Please register with Mrs. D. Scaravaglio, [d.scaravaglio@isac.cnr.it](mailto:d.scaravaglio@isac.cnr.it)

### Goals of the workshop:

- Review the present understanding of the variability and change of the hydrological cycle in regions where strong ocean-atmosphere or land-atmosphere interactions take place
- Review ongoing research activities and projects
- Discuss the limits and improvements in the observational system and model improving strategies
- Identify critical knowledge gaps

**We invite contributions on processes related to observed and modelled changes in the hydrological cycle (including CMIP5-CORDEX).  
In particular, the impact of these processes in the Mediterranean area  
and in high-altitude regions will be addressed.**

# Changes in the Hydrological Cycle

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## Key topics of the Collaborative Program

The CP intends to foster the study of the changes of the hydrological cycle at global and regional scale, emphasizing on the following cross-linked set of research tasks:

- *Global/regional precipitation changes and runoff*
- *Aerosols and the hydrological cycle*
- ***Hydrological cycle and precipitation in mountain areas***
- *Changes in the hydrological cycle in the Mediterranean region*
- ***Interaction between climate and ecohydrological/land surface processes***

# Changes in the Hydrological Cycle

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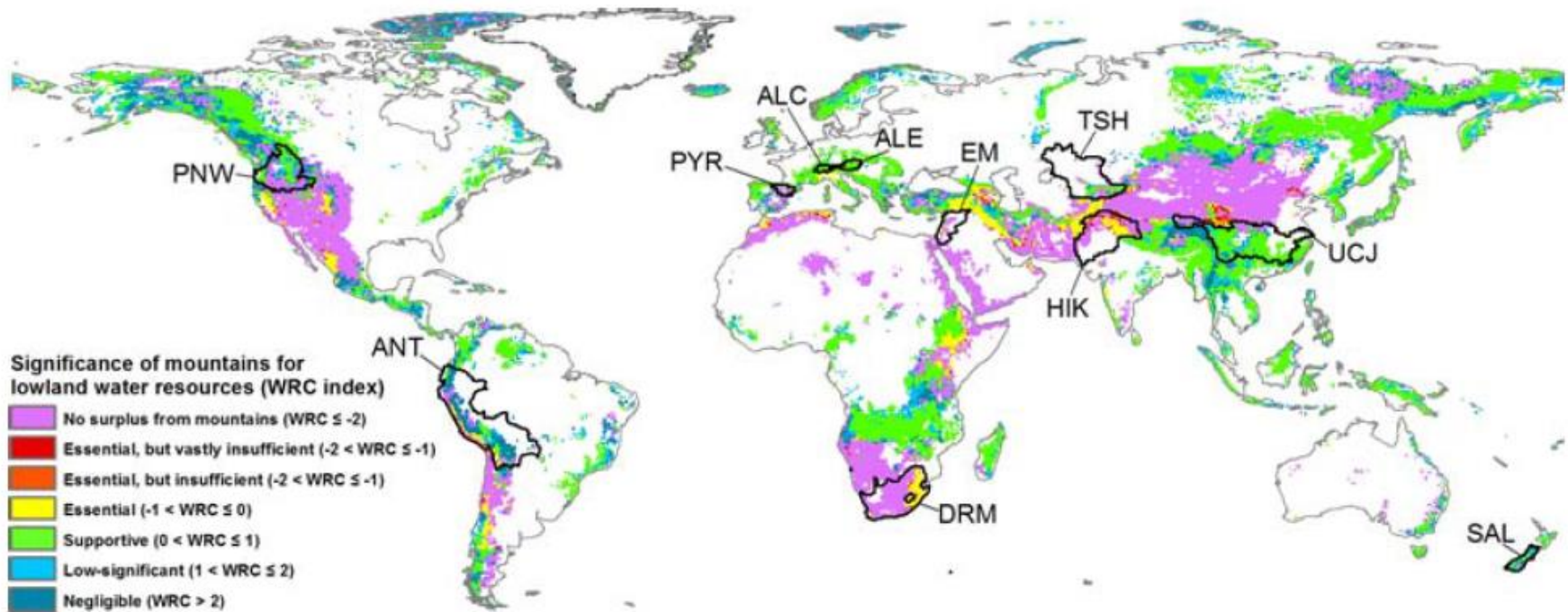
## *Changes of the hydrological cycle in mountain areas:*

- Glacier retreat – loss of water reservoirs
- Decrease of duration and thickness of snow cover, including effects on ecosystems
- Changes in precipitation regimes (e.g., Indian monsoon)
- Changes in aquifers (especially karstic)
- Slope stability and landslides
- Elevation Dependent Warming



# Changes in the Hydrological Cycle

***Mountains are the water towers of downstream areas***



Viviroli et al, 2011



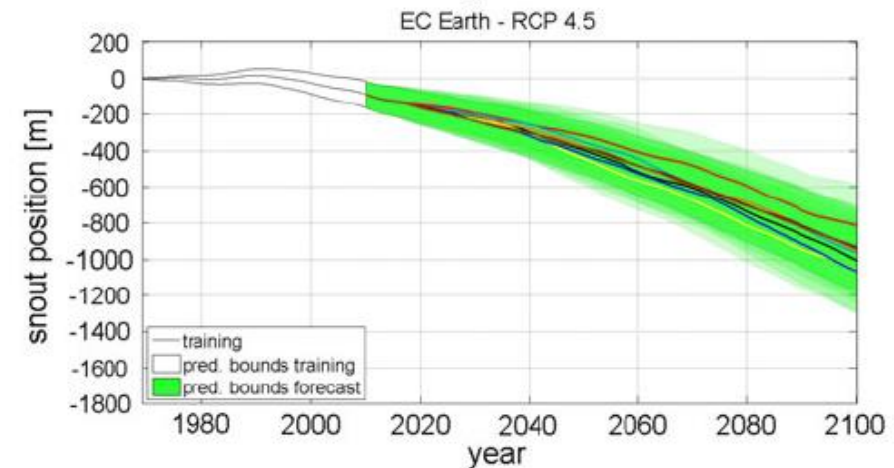
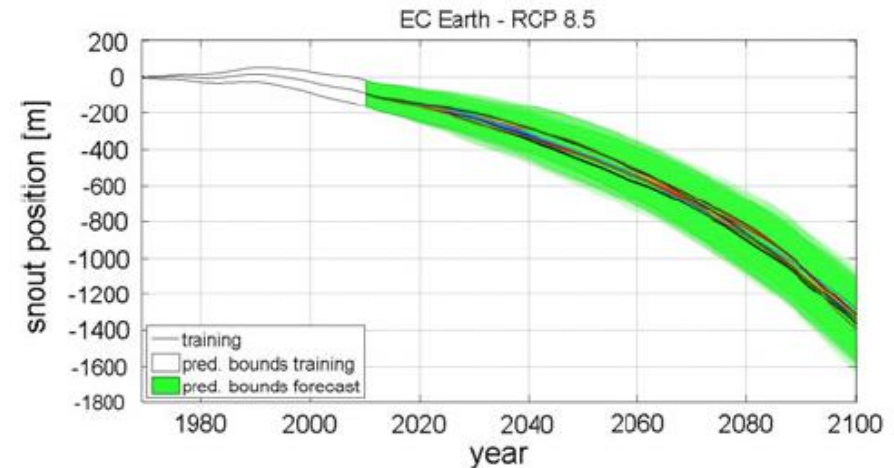
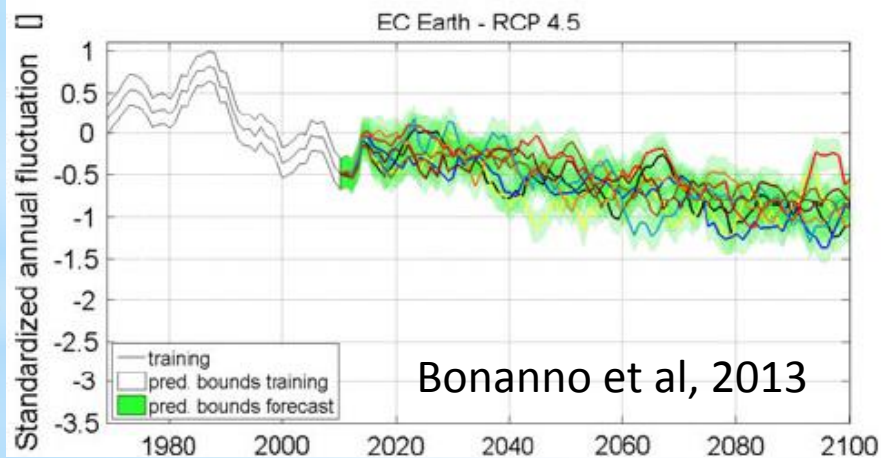
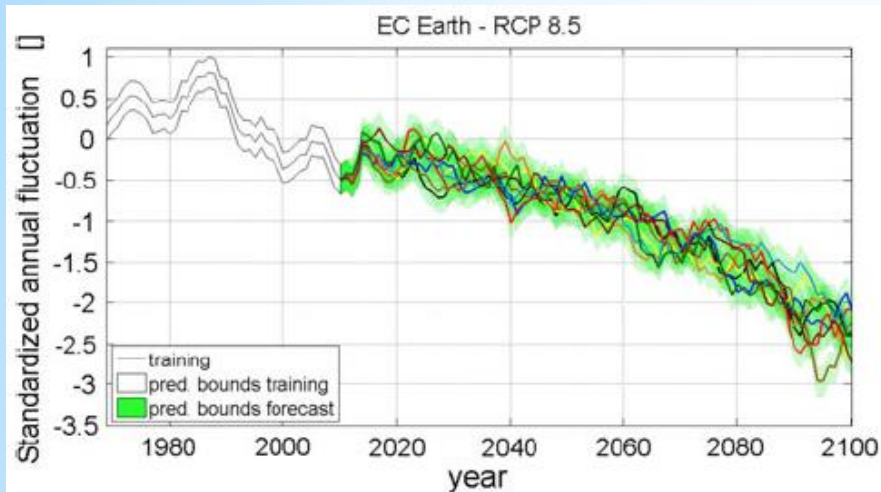
# Changes in the Hydrological Cycle

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## *Changes of the hydrological cycle in mountain areas:*

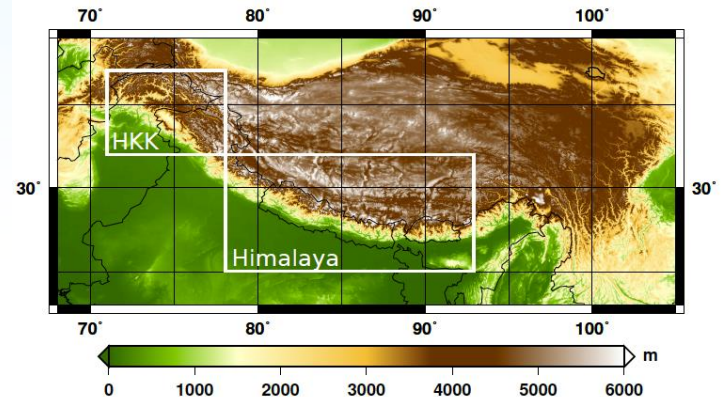
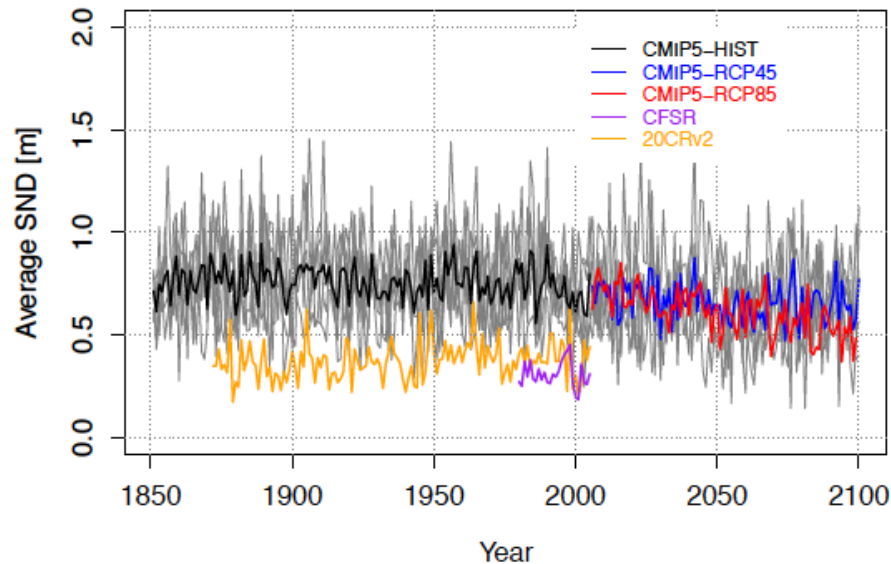
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# Changes in the Hydrological Cycle

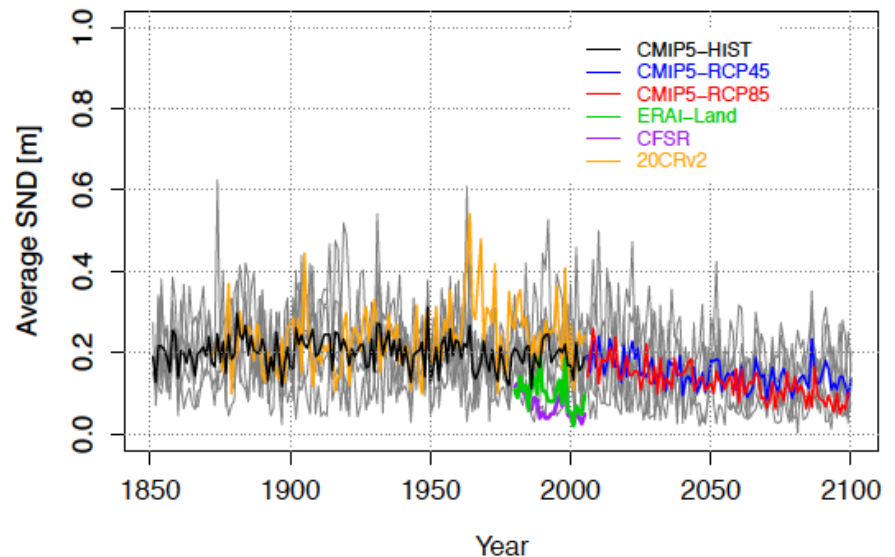


# Changes in the Hydrological Cycle

DJFMA snow depth projections – HKK above 1000 m a.s.l.



DJFMA snow depth projections – Himalaya above 1000 m a.s.l.



Snow Cover Depth – Water Equivalent

Terzago et al, 2014



# The changing mountains of Europe: water resources and ecosystems at risk

Hosted by Patrizia Toia, MEP Italian Social Democrats  
Tuesday 15 October 2013, 12:30 – 14:00 (including lunch)  
European Parliament Members' Restaurant, Brussels

- What are the observed and expected impacts of climate change on European mountain regions?
- What are the effects of mountain water cycle change in fore- and lowland areas?
- How do mountain ecosystems respond to changes in climate and the hydrological cycle?
- What are the socio-economic impacts of climate and ecosystem changes in European mountains?



**Martin Beniston** University of Geneva  
**Maria del Carmen Llasat** University of Barcelona  
**Elisa Vuillermoz** Ev-K2-CNR  
**Wolfram Mauser** LMU Munich



Organised by **Ralf Ludwig** and **Antonello Provenza**



# Changes in the Hydrological Cycle

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## *Interaction between climate and ecohydrological/land surface processes*

Concept of (temporal and spatial) **cross-scale interactions**:

A crucial aspect of the changes in the hydrological cycle and in the interaction between atmospheric dynamics and surface eco-hydrological processes.

# Changes in the Hydrological Cycle

## *Interaction between climate and hydrological/land surface processes*

### Baseline:

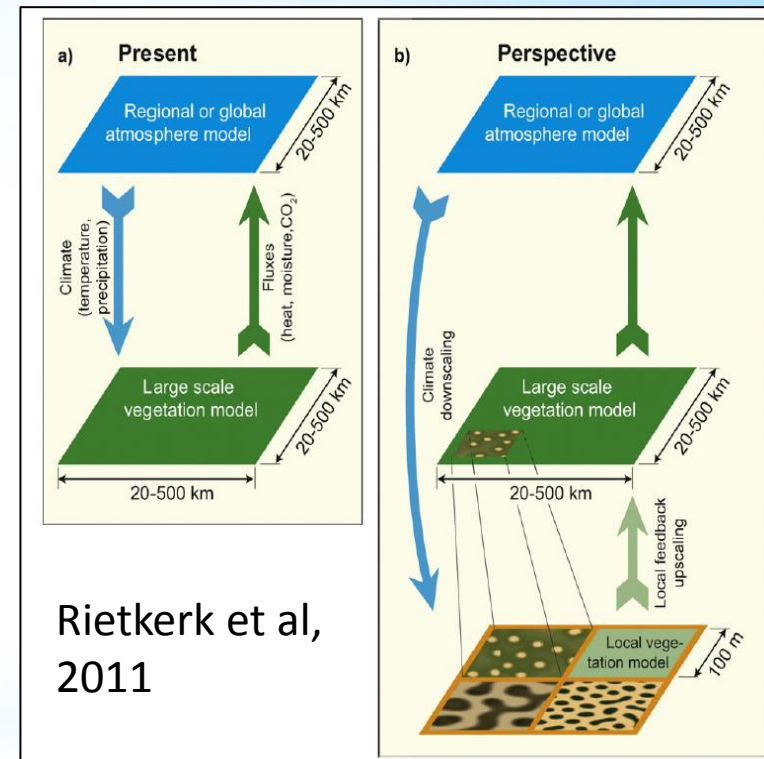
Climate and the hydrological cycle are strongly coupled with land surface and ecosystem processes

### Problem:

Scale mismatch between climatic variability, usually resolved at rather large spatial scales, and the much smaller scales of land surface processes

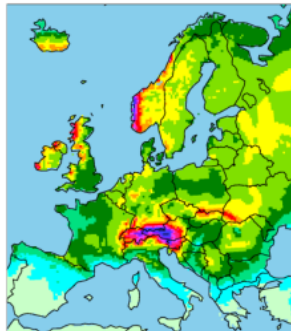
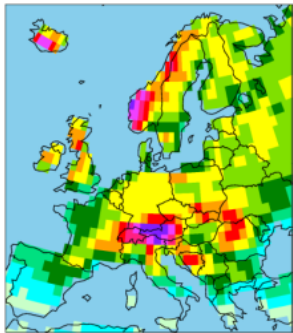
### Open questions:

- **Upscaling** and incorporation of small-scale ecosystem and land surface changes in climate models?
- **Downscaling** of climate information to properly drive land surface / ecosystem responses
- Assessing the impact of **small-scale heterogeneities** on climate variability



# Cross-scale Interactions in the Continental Water Cycle

The workshop focuses on innovative modeling approaches on:



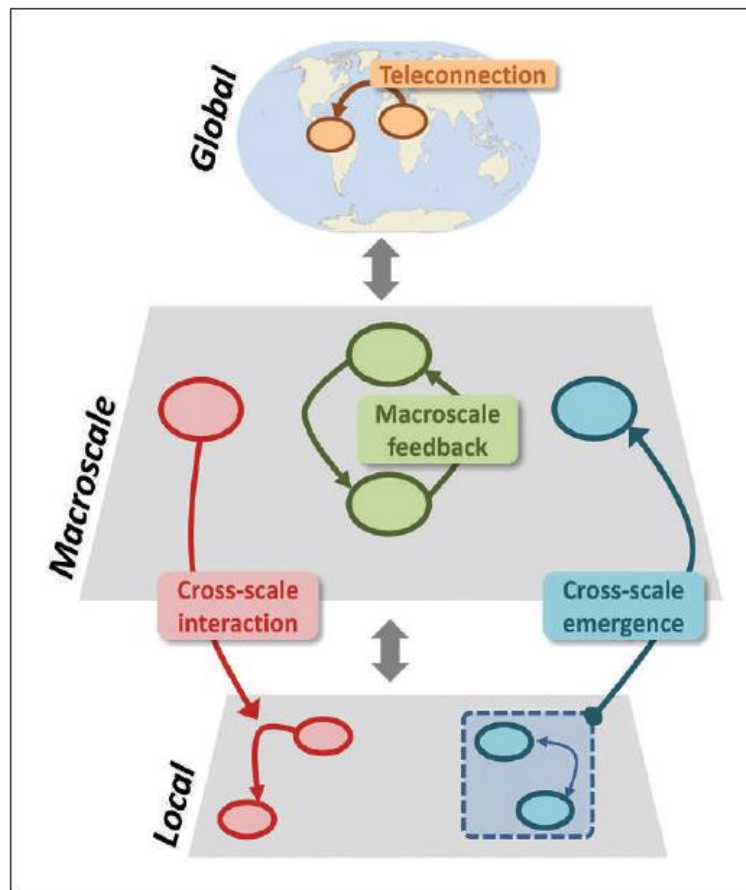
- Topic 1: Climate downscaling methods for assessing impacts on the water cycle and on ecosystems
- Topic 2: Atmosphere-soil-vegetation interaction at multiple scales
- Topic 3: Extreme precipitation events and their effects on eco-hydrological systems
- Topic 4: Cross-scale interaction and macrosystem eco-hydrology

The workshop is intended to bring together researchers interested in advancing science by exchanging on recent findings and current limits in the above mentioned topics. Participants are invited to discuss their latest research findings in presentations (~25 min) or posters. The format of the 2-day-event is meant as a forum to exchange, discuss and to contribute to a joint publication, shaping and proposing the future research directions in the field.

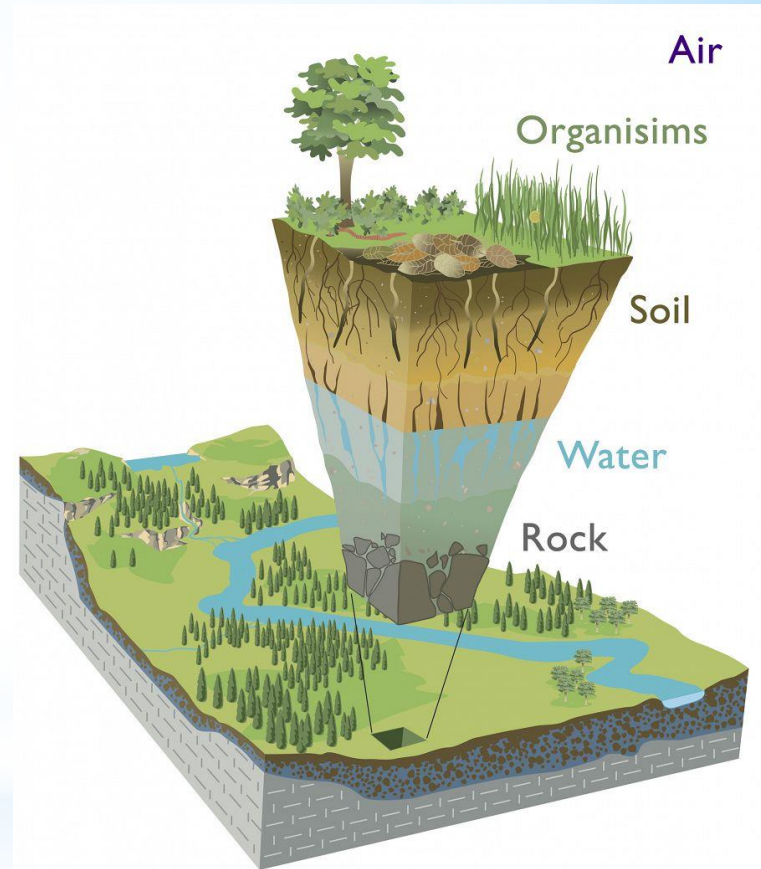
Dates: 30-31 October 2014  
Location: CNR Headquarters, Piazzale Aldo Moro, 7 – 00815 Rome, Italy  
Organization: Ralf Ludwig, LMU; Antonello Provenza, ISAC-CNR  
Website: [www.ecra-climate.eu](http://www.ecra-climate.eu)  
Registration: [events@ecra-climate.eu](mailto:events@ecra-climate.eu) (or contact the organizers; participation is free of charge)

# Changes in the Hydrological Cycle

## Macrosystem Ecology and Cross-scale interactions



Heffernan et al 2014



***Earth's Critical Zone***



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*Ongoing: A Hydro-CP summary/review paper is in preparation*

***Challenges for the near future:***

- Identify modes of operation besides meetings and discussions: working groups, specific topics, joint technical papers, common roadmap?***
- Identify funding sources (COST, H2020, etc) to make ideas and collaborations operational (discussion at the end of tomorrow session)***

**New coordinator in place of AP: Elisa Palazzi, CNR-ISAC**

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*Thank you for your attention*