

Identifying climate information needs for Himalayan India

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Outline

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 - **Glacier Modeling**
 - **Observational Challenges**
 - **Results**
- **Climate Service Part**
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Global Climate Change Key Indicator

Motivation

- Over 800 million people depend on glacier melt water runoff throughout the Hindu-Kush and the Himalayan (HKH) region. The region, also called as “Water tower of Asia”, is the location of several major rivers basins.
- Glaciers in the central and eastern Himalaya strongly depend on the ISMR, whereas the WH is more dependent on the winter precipitation.
- Future climate change scenarios suggest that ISMR will be reduced over the HKH region [Kumar et al., 2013]. Therefore, it is important to assess the glacier retreat under warming scenario.
- Difficult to assess the overall glacier response based on detailed models of individual glaciers over HKH.
- RCMs provide an alternative way in which glaciers are interactively coupled to the atmospheric model component, and their response is therefore fully consistent with the simulated climatic changes.
- $REMO_{glacier}$ is first applied over the region using reanalysis data to test the model quality.



Motivation

- **Given the vital role that the Himalayan region plays, it is important to provide relevant climate change information to local communities and governments that will help society to adapt to future climate and environmental changes.**
- **However, in order to identify what kind of tailored scientific information and products data are actually needed and in what form, a close contact and direct interaction with responsible stakeholders from the region is needed.**



State of Science: Motivation

Interactive role of glaciers in the climate system

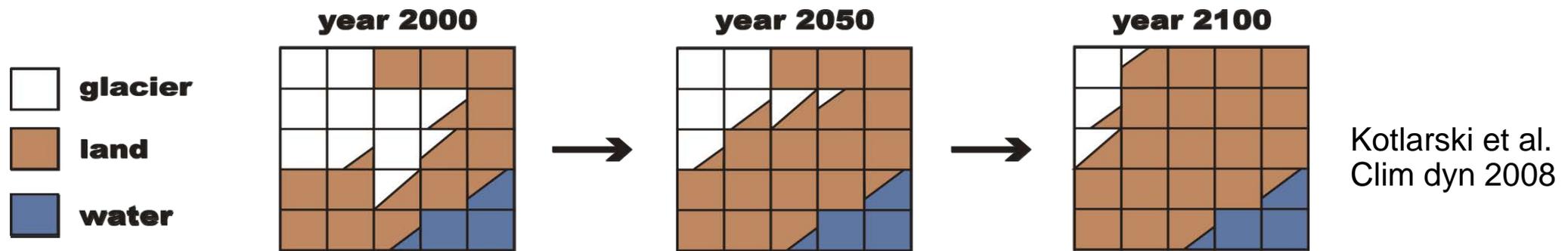
Direct and **indirect** feedback mechanisms

Poor representation in today's climate models

More sophisticated approach is necessary, as contribution of glacial melt-water is important

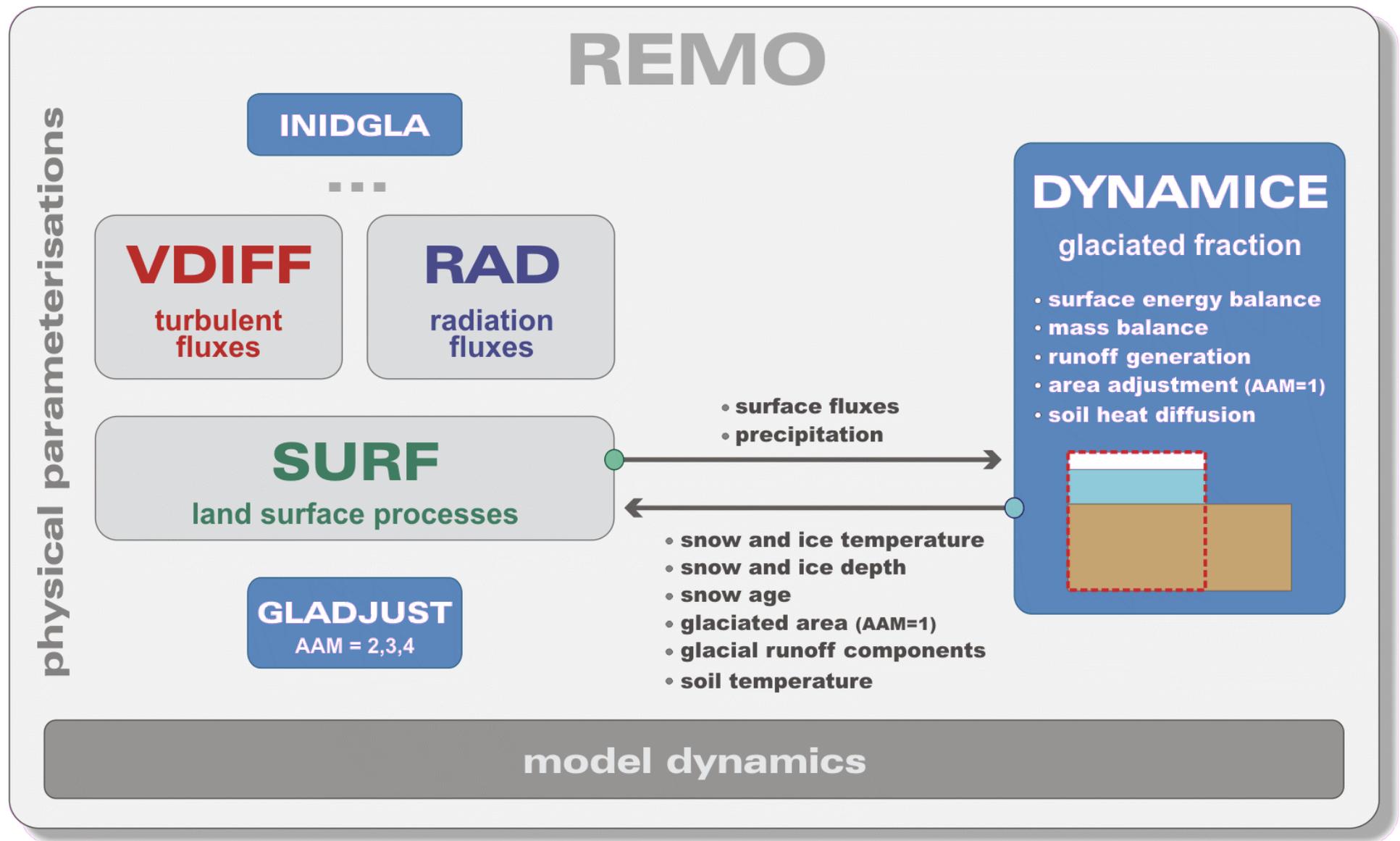
Interactive glacier scheme for regional climate modeling

Glacier mass balance and area changes on a sub-grid scale, accounting for direct physical feedback mechanisms



- Applicable for entire mountain ranges and computationally effective, target resolution: RCM grid cell
- Simplified description and minimum of input data

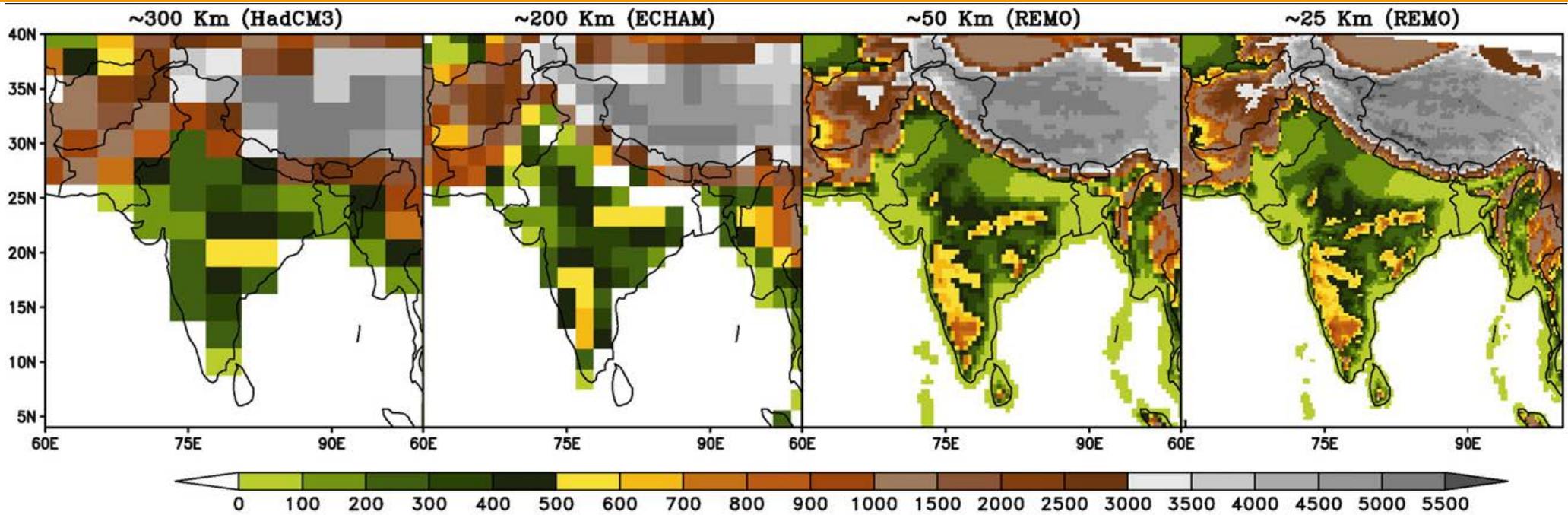
Experiment Setup



(i) 46 New Variables

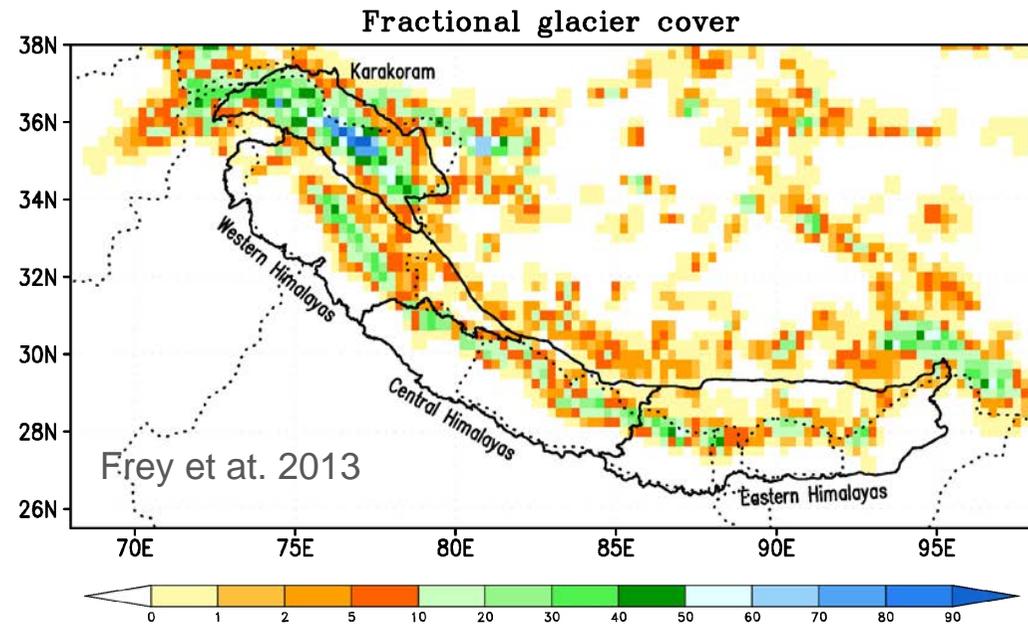
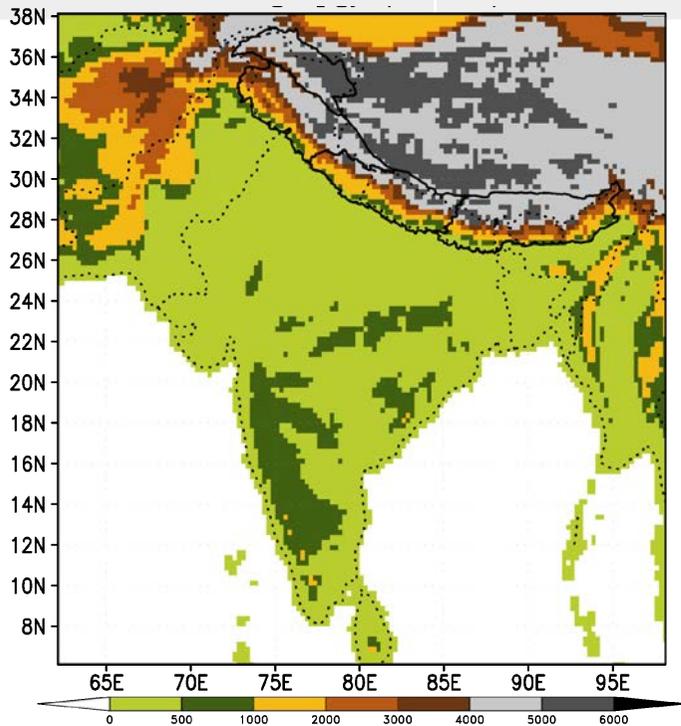
(ii) On/Of Switch

Orography and Monsoon



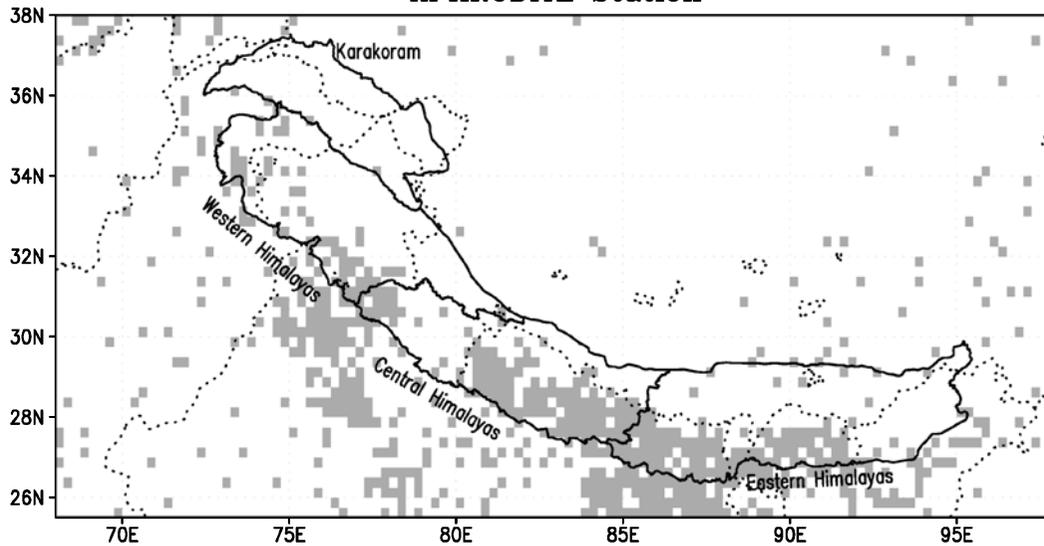
Experiment Setup

RCM	REMO _{glacier}
Resolution	0.22°x 0.22°
Domain	60.125-100.125 & 4.125 -40.125
Period	1989-2008, 2000-2014, 2006-2100
Forcing	ERA1 reanalysis, MPIESM-LR , NorESM [Hist, RCP45/85]

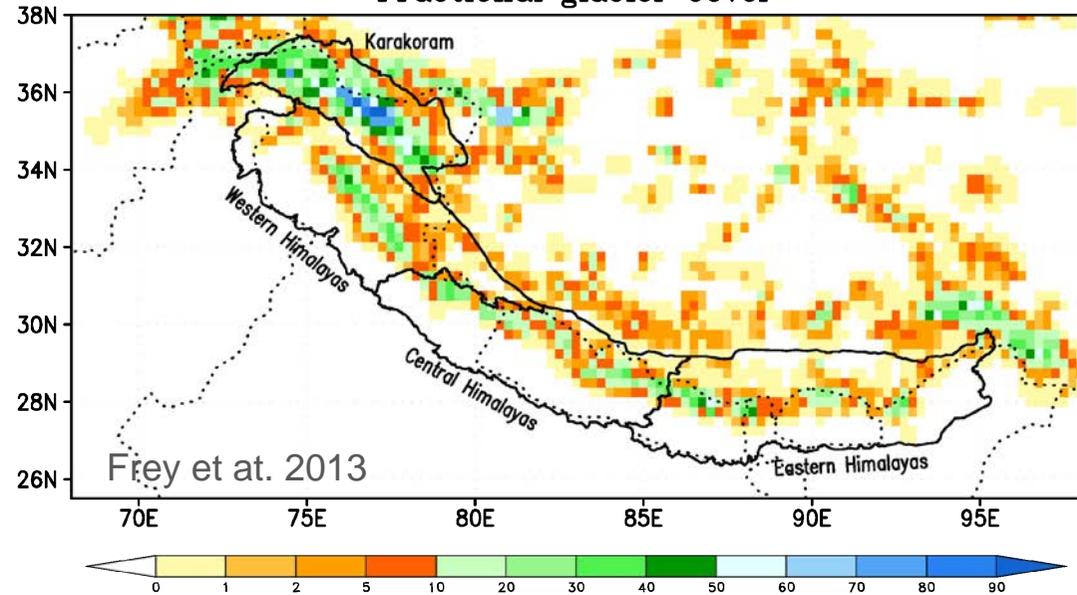


Observation Challenges

APHRODITE Station

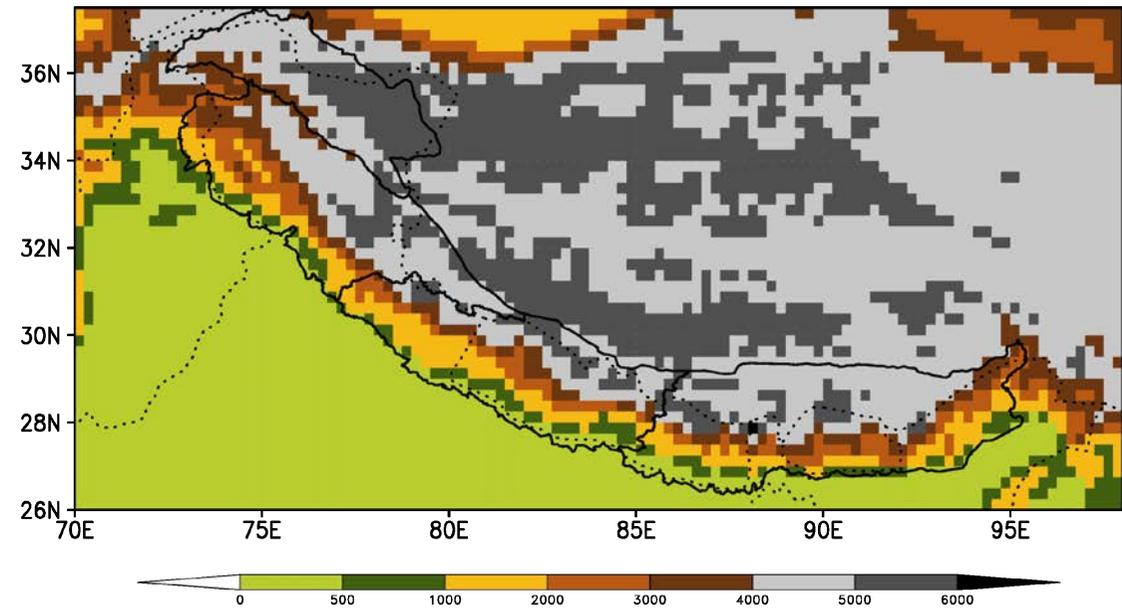
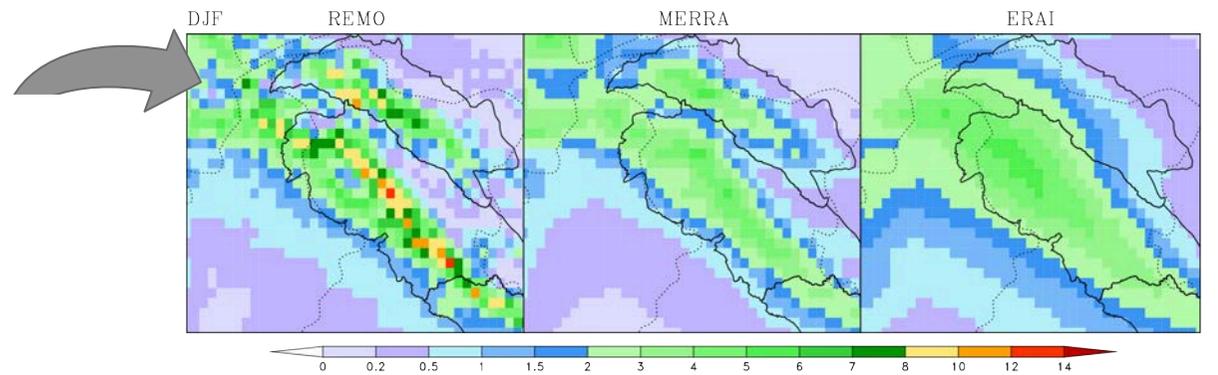
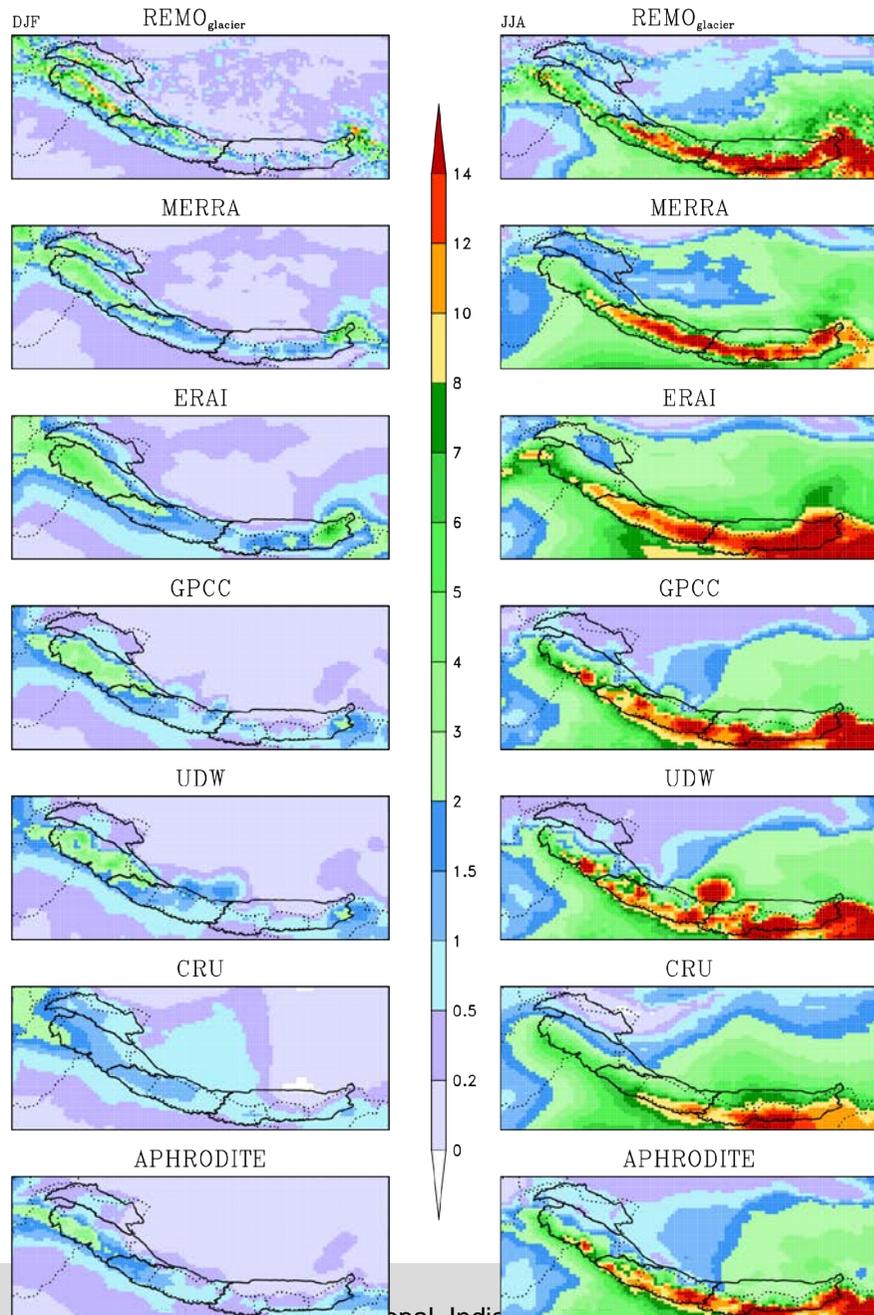


Fractional glacier cover



Limited number of measuring stations over the glacierized region. No gauge station over Karakoram.

Seasonal Precipitation

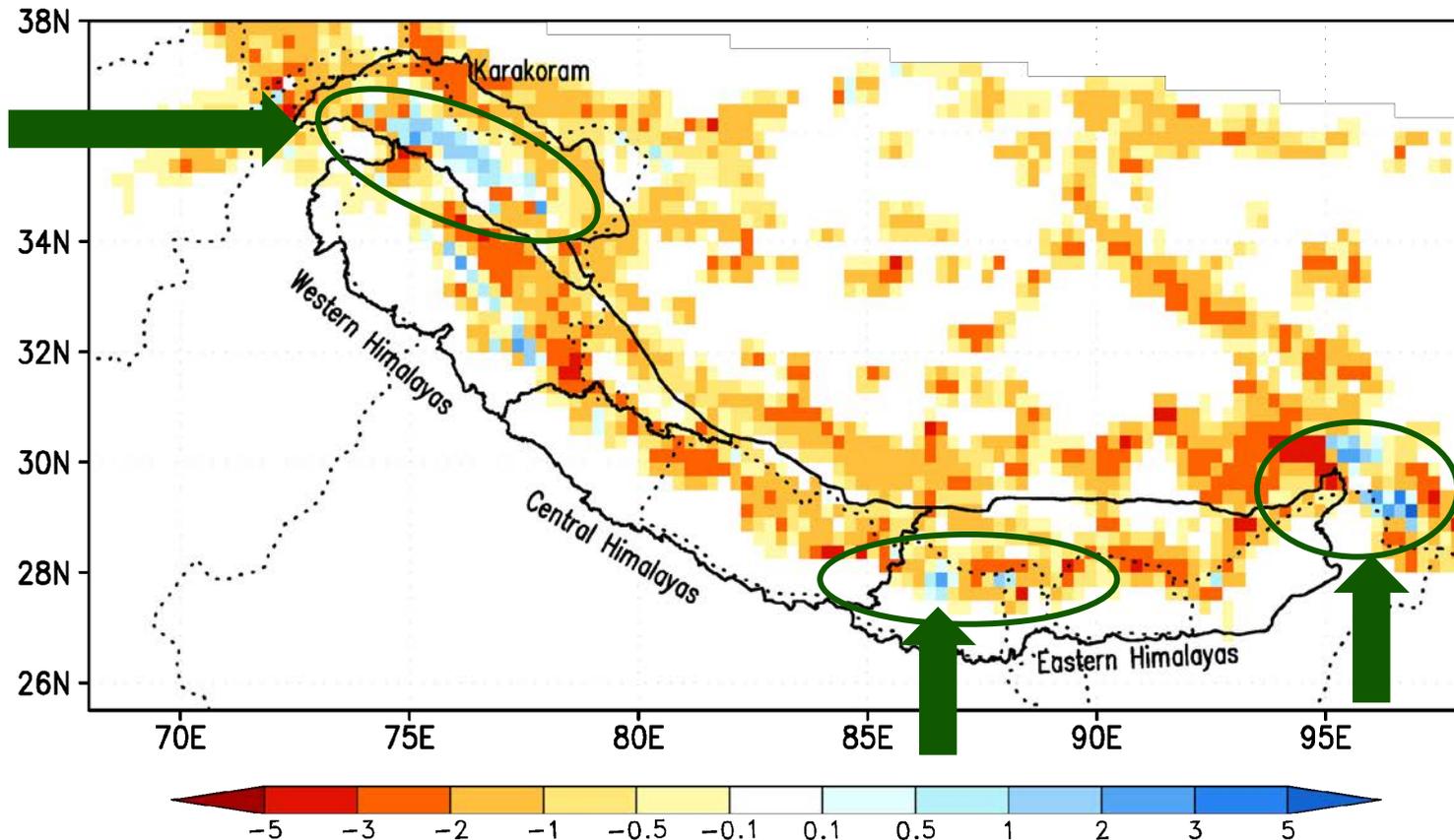


Winter (left) and corresponding summer mean precipitation [mm/d] for REMO_{glacier} and several observational and reanalysis datasets, 1989-2007. Gridded data over Karakoram, is quite unrealistic, apparently due to the limited number of measuring stations and hence systematic gauge undercatch

Kumar et al., 2015, GRL

Annual Mass Balance

“Karakoram anomaly”
is well reproduced.
(Hewitt, 2005; Gardelle
et al., 2012, Nature
Geo-Sc., 2012; Bolch
et al. 2012;)



Simulated mean annual mass balance [m.w.e.] for the period 1989-2008.

Kumar et al., 2015, GRL

RCM Coupled and un-Coupled CORDEX SA simulation

RCM Forcing	REMO (Un-Coupled)	ROM (Coupled: REMO-MPIOM)	Period
ERA40	✓	✓	1958-2001
MPI-ESM_Hist.	✓	✓	1958-2005
ERA Interim	✓	-	1989-2008
MPI-ESM_rcp26	✓	-	2006-2100
MPI-ESM_rcp45	✓	-	2006-2100
MPI-ESM_rcp85	✓	✓	2006-2100
EcEarth_Hist.	✓	-	1958-2005
NorESM	Under preparation for hist., rcp45/85		

Note: REMO CORDEX South-Asia (MPI-ESM) data is available via CORDEX data ESGF node



Stakeholder WORKSHOP ON IDENTIFYING CLIMATE CHANGE INFORMATION NEEDS and Training on Climate modeling and Climate Change Research, Innovation and Services

8-10 April 2015, JNU New Delhi



Lighting the lamp by Honorable Minister (Environment, Forests, and Climate Change, Govt. of India) and dignitaries

Here we present results of a workshop designed to bring together stakeholders from different states of the Indian side of Himalayan arc and an international group of climate scientists in order to discuss how climate change research for this region can be tailored towards the needs of local communities.



Objective

To bring together stakeholders from different states of the Indian side of Himalayan arc and an international group of climate scientists in order to discuss how climate change research for this region can be tailored towards the needs of local communities.

Workshop was organized within the framework of the multidisciplinary international research project GLACINDIA.

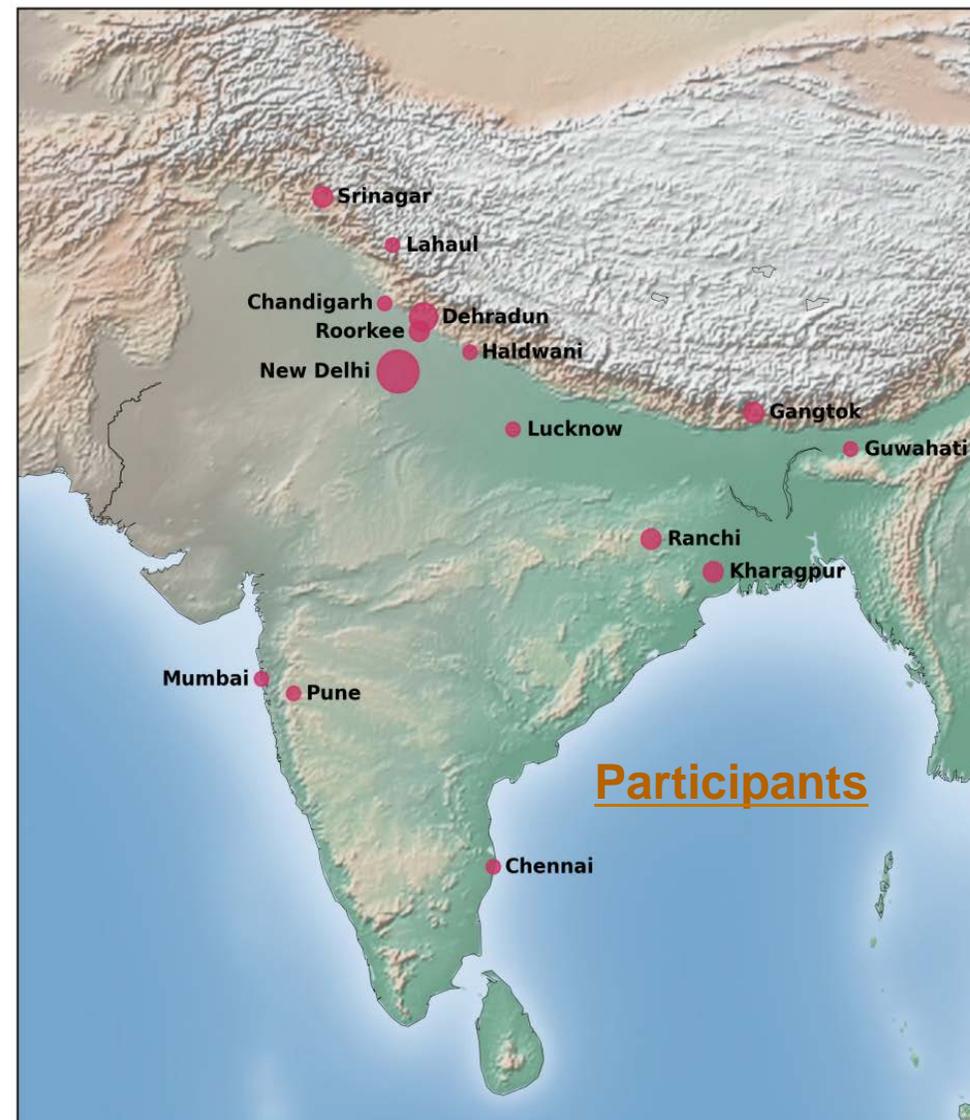
The project focuses on the water-related effects of changes in glacier mass balance and river runoff in western Himalaya.

Target stakeholders : who are directly dependent and interacting with Himalayan ecosystem, as their livelihood depend on these resources along within the administrative and NGO's who are responsible for the Himalayan eco management were targeted.

The stakeholder workshop was followed by a two-day training program on climate modeling and climate change research for early career scientists.



Stakeholder workshop participants information



A major focus of the workshop was given to break-out groups to identify data and information needs.

Based on their backgrounds, participants formed four discussion groups along the key sectors:

- (i) Water**
- (ii) Land use and Agriculture**
- (iii) Ecology**
- (iv) Energy**

In order to guide the discussion within the working groups, two basic questions were offered

1. What types of climate information do you use (e.g. source) and what would you ideally expect?

2. In what form would you like to have the climate information?



1. Water Group

This was the largest group and it was noted by many participants that water is the topic integrating all four groups. **Key points are**

- need for long-term high resolution monsoon data in the form of observational or reanalysis products, as well as projections of the monsoon change, that can be condensed in a form of monsoon pattern change maps or indexes.
- winter precipitation, especially as snow, which determines the amount of water that will be available in following spring for crop growth.
- there is a set of hydrological variables that are urgently needed on basin or even sub-basin scale for adaptation measures in the region e.g. waste water availability in winter, surface water-ground, ground water recharge potential, stream flow, runoff and difference between peak flow and runoff.



2. Land use and Agriculture group

In particular when thinking about agricultural adaptation in the region one has to consider following regionally important activities: adaptation of cropping pattern, crop rotation, fishing, bee keeping.

- **The main climate related variables identified for this sector are: number of rainy days, temperature, rainfall, extreme weather events (high intensity rainfall, droughts) frost days, fog days and snow amount. These variables are required regionally at a “micro-level”.**
- **The reason is the very large orographic gradient in the region, leading to rapidly changing environmental conditions.**



3. Ecology group

- **Data needed at river basin or catchment scale.**
- **Key parameters that are important for ecological studies in the region are flow volume, tree line shift, information about phenology and regeneration, breeding habits/behavior, loss of natural springs, migration/corridors and socio-economic value change and dependency.**
- **Data requirements for this sector repeat those for previous two, with addition of glacier maps with attribute of each layer and projected glacier outlines.**



4. Energy group

Most of the energy in the region is coming from hydro-power of different scales. Hence requirements of this group of stakeholders are quite similar to the Water group.

One of the main additional requirements is construction of longer time series of climate variables for the region, based on, for example, proxy records.



In what form should climate service information be provided?

- **Government and academic scientists need access to the raw data, together with uncertainty information.**
- **Policy makers prefer synthesized information products in condensed form, such as Executive summaries, Fact-Sheets, Web atlases.**
- **NGO members prefer to have more detailed reports on the micro level scale.**
- **Given the specifics of the region, in particular limited literacy and many regional languages, a number of ways to communicate climate information to the general public were suggested: TV shows, mobile phone applications, community radio programs, street plays, display of important weather information in the printed form at all nodal places in the cities and villages.**
- **Engagement of the school teachers and school children in the climate change theme was stressed as an important way of spreading the information.**



Common for all groups

- **Water and related meteorological measurements in the whole Himalayas are quite sparse and almost absent above 3000m. In addition they are carried out by different government agencies (CWC, CGWB, IMD). Access to this data is often limited. Additionally a lack of meta data was identified, also with respect to the general existence of measurements. Given this there is a need for a place (e.g. web portal) where at least meta data can be shared, together with information about data quality.**
- **High resolution data from regional climate models have been classified as being very important for the Himalayan region, since orographic gradients are large and information from medium resolution models are of limited use for adaptation.**



Summary

Glacier Dynamical Model (REMO_glacier)

- For the first time a complete simulation of glacier climate interaction over South Asia is done.
- Over all glacier area change show a decrease, but do show some regions of increase especially over the Karakoram

Stakeholder Workshop

- Water and related meteorological measurements in the whole Himalayas are quite sparse and almost absent above 3000m.
- There is a need for a place (e.g. web portal) where at least meta data can be shared, together with information about data quality.
- High resolution data from regional climate models have been classified as being very important for the Himalayan region, since orographic gradients are large and information from medium resolution models are of limited use for adaptation.



Thank you for your attention!

