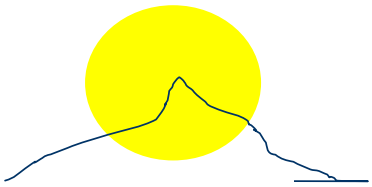

HighNoon Delivery Report

Title	Climate simulations for 1989-2050
Work Package Number	1
Delivery number	1.3
Relative task(s)	T1.2,T1.4 and M4
Organization	
Author	Andy Wiltshire (WP Leader) Camilla Mathison Jeff Ridley Pankaj Kumar Daniela Jacob
Function	
Related to deliverable number(s)	D1.4
Date of completion	
Name Work Package Leader	Andy Wiltshire
Submission Date	28-102010

To complete by the Coordinator

Date of approval by the Coordinator	3-11-2010
Date of listed	15-11-2010

This report relates to an ensemble of simulated regional climates for the HighNoon program. Four Regional Climate Model (RCM) simulations have been completed for the Indian Sub-continent for the SRES A1B scenario. The ensemble consists of two RCMs (HadRM3 and REMO), driven by two GCMs simulations (HadCM3Q0 and ECHAM5 realisation 3)

Regional Climate Projection Dataset:

This report describes the available data for use in the WP2 hydrological modeling and for general use within for the project.

The standard available data (monthly and daily) are available from ftp://fur.wur.nl under WP1. Usernames and passwords for the ftp site have previously been circulated. The data are provided in CF compliant NetCDF format (self-describing format) on a common 0.25 degree resolution for a limited Ganges domain (Figure 1):

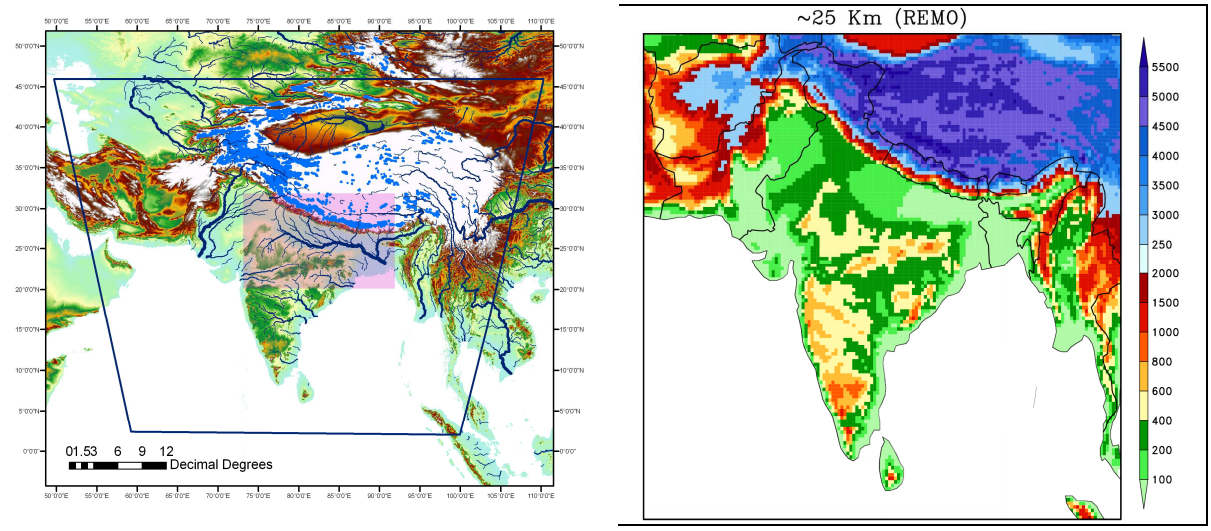

Figure 1: Left panel, domain used for the HadRM3 regional climate model runs of the region (blue box). The shaded region is the Ganges sub-area considered in this study. Right panel show the REMO topography.

Grid definition:
(76 nx, 48 ny)
20.125N - 31.875N
73.125E – 91.875E

Both the RCMs are simulated on rotated pole grid at 0.22^0 x 0.22^0 (~ 25 x 25 Km). However, the data for HighNoon partners has been provide on regular lat-lon limited area domain.

Data are provided for a number of variables necessary for driving offline hydrology models as described below. In the case of fluxes, (precipitation, sensible heat, etc.) the direction of flux is positive from the atmosphere to the surface, i.e. precipitation is a positive flux. The netcdf files are all self-describing so within the data structure information on the grid and time variables will be found. However, please be aware that HadCM3 uses a 360-day year and ECHAM5 the Gregorian calendar. HadCM3 data will therefore have a constant 30-day month, whilst ECHAM5 will have varying month length and leap years. This information is contained in the netcdfs.

Currently data from 1970 to 2050 are available from the REMO model and 1989 to 2050 for HadRM3 HadCM3Q0. The HadRM3 ECHAM5 run currently extends to 2037 and is at the time of writing still running on the supercomputer.

The HadRM3 variables (monthly and daily means) are:

air_pressure_at_sea_level. (Pa)
air_temperature at 1.5m (K)
convective_rainfall_rate. (kg/m2/s)
convective_snowfall_flux. (kg/m2/s)
large_scale_rainfall_rate. (kg/m2/s)
large_scale_snowfall_flux. (kg/m2/s)
precipitation_flux. (kg/m2/s)
relative_humidity at 1.5m (%)
specific_humidity at 1.5m (kg/kg)
surface_air_pressure. (Pa)
net_downward_longwave_flux. (W/m2)
surface_downwelling_shortwave_flux. (W/m2)
wind_speed. (m/s)

Additional daily variables:
Daily max air_temperature at 1.5m (K)
Daily min air_temperature at 1.5m (K)

The REMO variables (monthly and daily means) are

Total_Precipitation (mm/hr)
Snowfall (mm/hr)
10m_U_Wind (m/s)
10m_V_Wind (m/s)
Temp_2m (Kelvin)
TMAX_2m (Kelvin)
TMIN_2m (Kelvin)
Latent_Heat (W/m2)
Sensible_Heat (W/m2)
SW_Down (W/m2)
LW_Down (W/m2)
SH_2m (Kg/Kg)
RH_2m (fractional)
Total_Cloud_Fraction (fractional)

Notes on NetCDF:

NetCDF is the only data format available and is the standard for dealing with large multi-dimension data. A number of tools are freely available from the web. A particularly useful command line tool is Climate Data Operators available from
https://code.zmaw.de/projects/cdo

Short Summary of Projections:

The simulations show a consistent temperature rise of approx. 1.5K for 2031-2050 relative to the 1989-2009 baseline period for the Ganges region (Table 1). The globally projected temperature rise over the same period is approx 1K, implying the Ganges region is warming faster than the global mean. The greatest warming is generally occurring in the mountainous region and is probably related to changing surface albedo due to a reduced snow duration (Figure 3).

The projected changes in precipitation are more uncertain with ECHAM5 driven RCMs suggesting no overall signal in precipitation against a large natural variability (Figures 4 and 5). HadCM3 driven RCMs suggest an increase in precipitation. In general the signal to noise ratio for precipitation is low, this makes it very difficult to identify the climate signal in relative short runs (1989-2050). Summary statistics are therefore not presented for this period. To overcome this the model runs are being extended out beyond 2050, and in the case of REMO the simulations have been initialized from 1970. This allows for longer climatological means to be calculated and an increased level of warming increasing the signal to noise ratio and correspondingly the confidence in the simulated level of change. Figure 6 and Table 2 present the REMO simulated 30 year means relative to 1970 to 2000.

An additional report is available which deals with the model uncertainty.

	HadRM3	REMO
HadCM3Q0	1.7	1.45
ECHAM5	Not yet available	1.7

Table 1: Projected change in annual mean temperature (K) for 2031-2050 relative to 1989-2009.

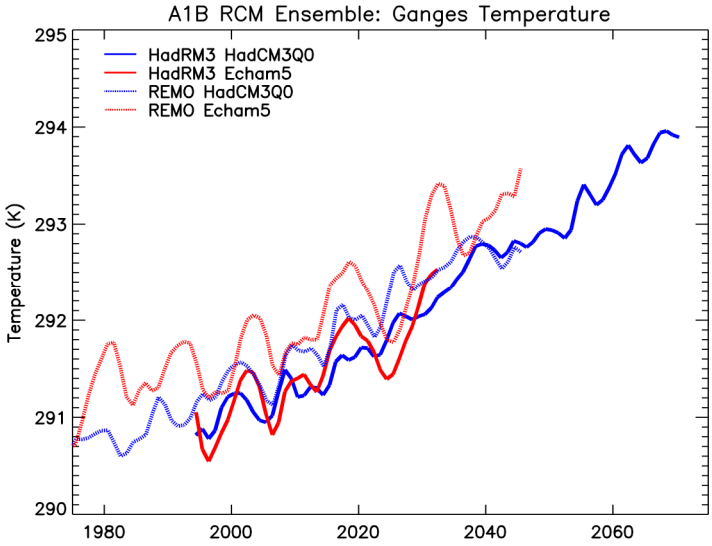

Figure 2: Area-averaged temperature projections from the RCM ensemble for the Ganges region (land-only). Curves are 10-year Gaussian smoothed.

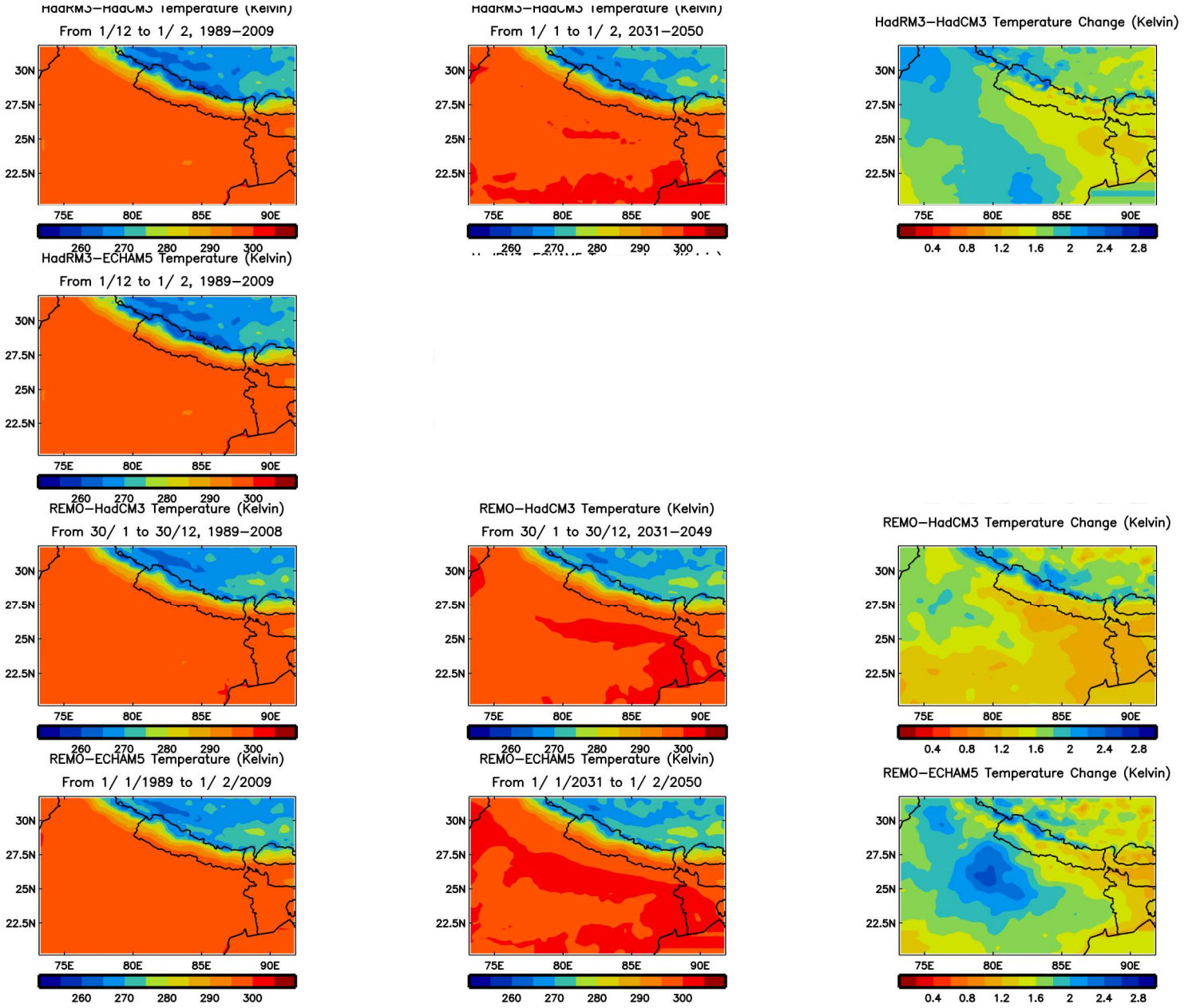

Figure 3: Simulated temperature and temperature change from the RCM ensemble for the SRES A1B Scenario.

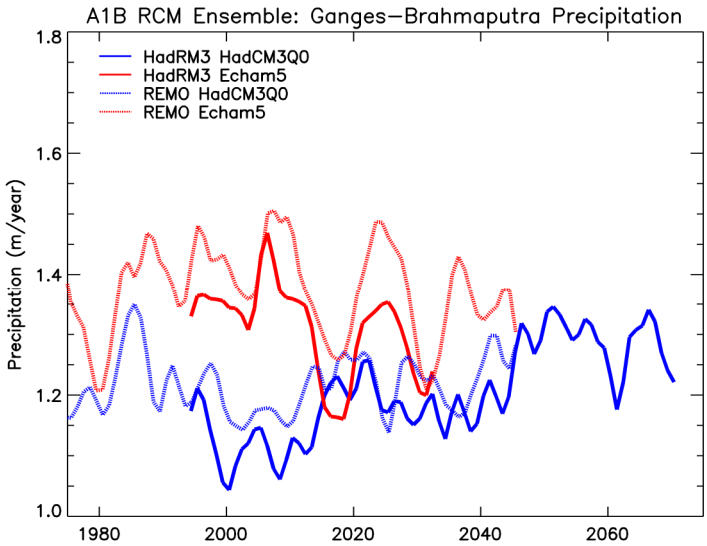

Figure 4: Area-averaged precipitation projections from the RCM ensemble masked for the Ganges region (land only). Curves are 10-year Gaussian smoothed.

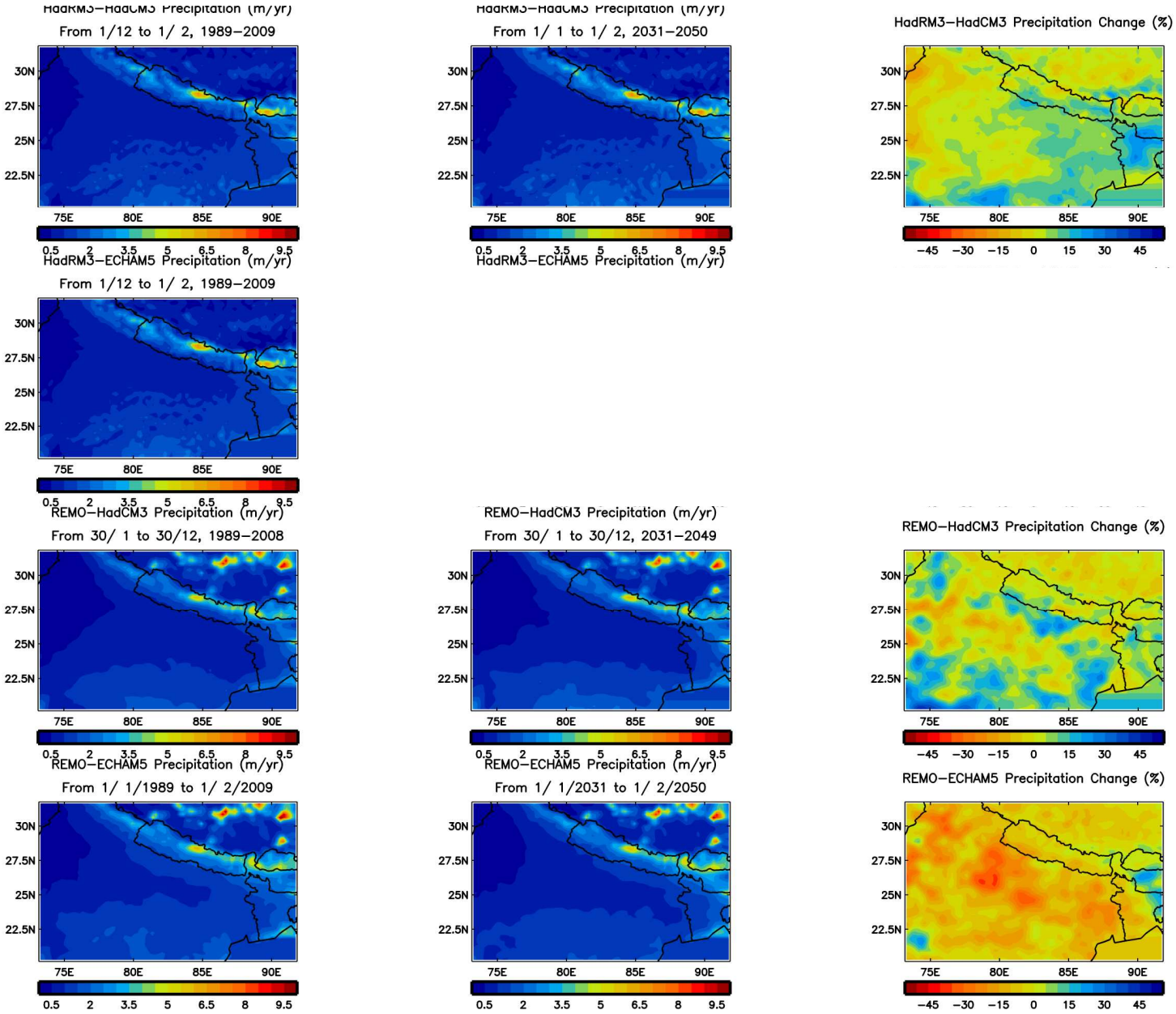

Figure 5: Figure 3: Simulated precipitation and precipitation change from the RCM ensemble for the SRES A1B Scenario.

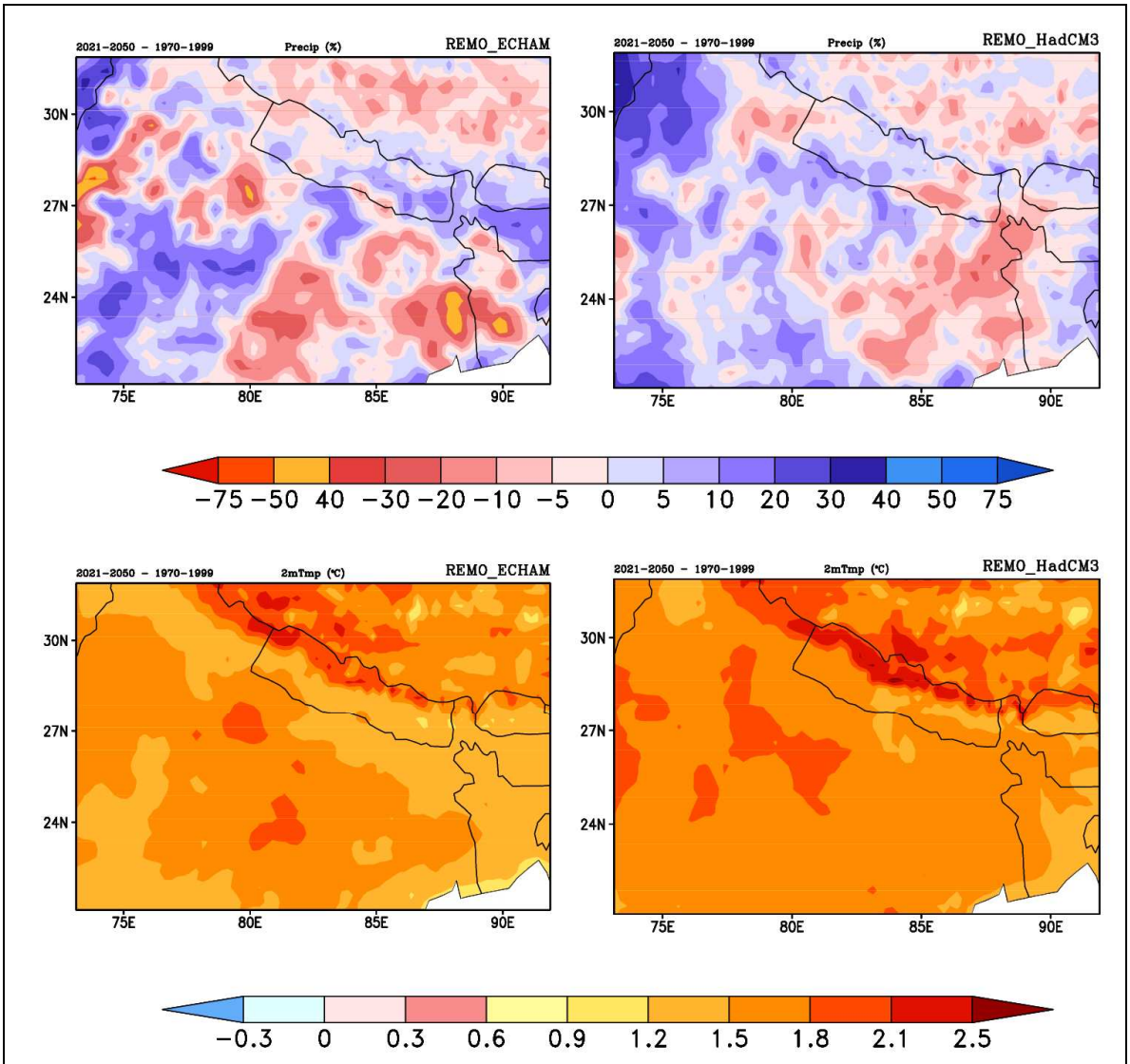

Figure 6: Spatial pattern of annual mean precipitation and 2m temperature over Ganges domain for two time slices 2001 to 2020 (left panels) and 2021 to 2050 (right panels) with respect to control climate 1970-1999 for the two REMO simulations. Top panels represent the precipitation and bottom temperatures.

	Precipitation relative difference (%) (Fur - Ctrl)*100/Ctrl		Temperature (^{0}C)	
	(2001-2020) - (1970-1999)	**(2021-2050) (1970-1999)**	**(2001-2020) - (1970-1999)**	**(2021-2050) - (1970-1999)**
ECHAM	3.19	5.13	0.46	1.36
HadCM3	5.61	5.24	0.46	1.45
GCM_Ensemble	4.83	5.47	0.46	1.38
REMO_ECHAM	0.95	0.9	0.62	1.52
REMO_HadCM3	-2.29	1.04	0.75	1.67
REMO_Ensemble	-0.42	0.96	0.68	1.6

Table 2: Summary statistics from the REMO model relative to the 1970-1999 period.