Project no. GOCE-CT-2003-505539

Project acronym: ENSEMBLES

Project title: ENSEMBLE-based Predictions of Climate Changes and their Impacts

Instrument: Integrated Project

Thematic Priority: Global Change and Ecosystems

M2B.18: Agreement on who will be producing probabilistic projections for which case-study regions/variables/temporal/spatial scales, how and from what GCM/RCM inputs

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Start date of project: 1 September 2004 Duration: 60 Months

Organisation name of lead contractor for this deliverable: UEA

Revision [1]

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the Consortium (including the Commission Services)	

In order to meet Milestone D2B.18, the table of statistical downscaling methods first shown in deliverable D2B.2 and updated in D2B.14, has been further updated. Two new columns have been added to show output formats and plans for output archiving/availability.

Background information to the output formats is provided in deliverable D2B.18 which is based on a user questionnaire. The need to provide users with a better indication of the final outputs to be produced by RT2B was one of the motivations for setting milestone M2B.18.

The table below provides a summary of the statistical downscaling methods to be used in WP2B.2 and their outputs. Note that it does not list methods implemented in the ENSEMBLES web-based statistical downscaling service (www.meteo.unican.es/ensembles).

Further discussion is required with RT3 partners to finalise the probabilistic outputs that will be produced from RCM data using the ensemble strategy designed in WP3.3 (deliverable D3.4.2, due at month 54). A Gaussian Kernel algorithm will be used to construct continuous PDFs from the discrete RCM output. The focus will be on seasonal temperature and precipitation for the Rockel sub-European regions. It is anticipated that the GA5 in October 2008 will provide a good opportunity for this cross-RT discussion.

Group/Method	Predictands	Predictors	Brief description of method and references	Source of predictors	Region(s)/predictand datasets which will be downscaled	Outline of how uncertainties will be addressed and/or probabilistic projections & ensemble averages derived	Output formats: list of formats that will be used, e.g., time series, PDFs/CDFs, response surfaces etc (see D2B.18 for background information)	Output archiving/availability
ARPA-SIM: Regression, conditioned by circulation	Prec, Tmin, Tmax (mean values and extreme event frequency)	Z500, T850, MSLP, RH850 (monthly means)	CCA for scenarios: Barnett and Preisendorfer, 1987; von Storch *et al*., 1993 The CCA technique finds pairs of patterns e.g., correlation between two corresponding pattern coefficient is maximized. In order to reduce noise, before the CCA, the data sets are projected on EOFs (empirical orthogonal functions) and only those explaining the most of the total observed variance are retained. The most important CCA pairs are then used in a multivariate linear model to estimate the predictand anomalies from the predictor anomaly field.	ERA40 Multi-model ensembles of CTL & scenario CGCM experiments	Region: N-Italy Data-set: Aeronatica Militare, daily data	Production of ensembles of downscaled predictions.	Time series, box plots, PDF, map of changes	Ouput data can be uploaded on the central RT2B portal, a local (ARPA-SIM) web page will be produced to describe and summarize the results, but we have no possibility to make available a local web site to share data.
ARPA-SIM: Regression, conditioned by circulation	Prec, Tmin, Tmax (mean values and extreme event	Z500, T850 (monthly means)	BLUE+MLR/MOS for seasonal: Thompson, 1977; Pavan *et al.*, 2005	ERA40 Multi-model seasonal ensemble	Region: Italy Data set: UCEA daily analysis	Production of calibrated ensemble of downscaled	Time series, box plots, PDF, map of changes	Ouput data can be uploaded on the central RT2B portal, a local (ARPA-SIM) web page

	frequency)			CGCM hindcasts		predictions.		will be produced to describe and summarize the results, but we have no possibility to make available a local web site to share data.
FIC: two-step analogue method	Daily precipitation and temperatures.	Z1000, Z850, Z500; Thickness (1000 / 500 hPa and 1000 / 850 hPa); Temperature of the previous days (the predictand is used later as predictor). 6 hour values or at least daily values.	Two-step analogue method, in which (1) the 'n' most similar days to the day being simulated are selected from a reference data set and (2) predictands / predictors relationships are obtained from the 'n' days data set (performing different analyses, including multiple regressions), and applied to the problem day	Reanalysis (ERA40) and multi-model GCM ensembles.	Predictands: T max, Tmin and daily precipitation, both for gridded datasets (ENSEMBLES 0.22 deg rotated and 0.50 deg.) Regions: Europe.	The method already addresses some uncertainties (developed within STARDEX). We plan to work on uncertainties consideration and quantification, as described in D2B14 (relaxing resolutions, analysing the range of applicability of the method). The method can produce daily probabilistic output (from a single input), and from that daily probabilistic output for multi-model GCM ensembles, we plan to obtain final probabilistic projections. We	Time Series	We can upload the outputs where it is decided (e.g., University of Cantabria web portal)

						plan to work on SDSM weighting with other SDS groups within ENSEMBLES, coordinated by Radan Huth		
GKSS conditional stochastic weather generator	Daily marine surface wind (also hourly possibly)	Principal Components (PC) of monthly SLP	Step1:Multi linear regression (MLR) with PC of SLP to estimate monthly surface winds. Step2:Autoregressive moving average processes (ARMA) are used to generate daily wind speeds from monthly wind speeds. Busuioc and von Storch, 2003., Torres et al. 2004	ERA-40	RCM wind as a surrogate for the real wind climate from ENSEMBLES runs are used. We focus on the North and Baltic Sea region, with special interest on coastal and open sea areas.	Production of ensembles with respect to various RCM wind fields as input for fitting the MLR statistical model.	Results will be available as timeseries of wind data	Results will be stored locally at the backup system on the GKSS and will be available on request and/or on a data server within the ENSEMBELS (e.g. RT2B regional scenarios portal)
IAP: regression, conditioned by circulation	Daily temperature (possibly also daily precipitation)	500, 1000 hPa heights (or SLP), 850 hPa temperature, 1000/500 hPa thickness, for precip., also some humidity-related variable	Days are stratified by classification based on circulation patterns, within each class multiple linear regression is performed; Huth *et al*., 2007 (Huth, R., Kliegrová, S., Metelka, L. (2007): Nonlinearity in statistical downscaling: does it bring an improvement for daily temperature in	Reanalysis for training, GCM control + perturbed ensemble for producing scenarios	Europe, data from ECA&D project – for all IAP methods	Different methods produced by IAP with different predictor sets and different parameters (e.g., no. of PCs, CCA pairs) are taken for a single GCM output, weighted by several characteristics of their performance; uncertainty due	PDFs	On request from Radan Huth, IAP

			Europe? *Int. J. Climatol.* doi: 10.1002/joc.1545			to SDS model selection and parameters is compared with other sources of uncertainty		
IAP: neural network	Daily temperature	500, 1000 hPa heights (or SLP), 850 hPa temperature, 1000/850 hPa thickness, for precip., also some humidity-related variable	Multilayer perceptron with one hidden layer, inputs are either PCs of predictor(s) or their gridpoint values; Huth *et al*., *2007*	As above	As above	As above	PDFs	On request from Radan Huth, IAP
IAP: conditional stochastic weather generator	Precipitation, min and max temperature, solar radiation	N/A	Precipitation occurrence simulated by two-state Markov chain, precip. amount by gamma distribution, other variables by normal distribution; all is conditioned on variability on a monthly scale; Dubrovsky *et al*., 2004	As above	As above	As above	PDFs	On request from Radan Huth, IAP
IAP: multiple linear regression	Daily temperature (possibly also daily precipitation)	500, 1000 hPa heights (or SLP), 850 hPa temperature, 1000/500 hPa	Multiple linear regression with stepwise screening of gridpoint values; Huth, 2002	As above	As above	As above	PDFs	On request from Radan Huth, IAP

		thickness, for precipitation, also some humidity-related variable						
KNMI: nearest neighbour resampling	Multi-site daily RCM precipitation and temperature	Same as predictands	KNMI will concentrate on the use of nearest-neighbour resampling to generate long stable time series which can be used to determine the exceedance probabilities of very rare multi-day extreme events (1 in 1000 year extremes). See Leander and Buishand, 2007, J. Hydrol., 332, 487-496.	GCM/RCM ensembles	This method is not typical dynamical or statistical downscaling. Scaling to relevant hydrological subcatchments in the Rhine basin.	Previous studies have shown that the uncertainty related to the driving GCMs is generally larger than that related to the RCMs (various GCMs in the ensemble is therefore probably more important than various RCMs). Probabilistic projections (conditional on certain emission scenarios) in terms of return periods or extreme quantiles can be obtained from the GCM/RCM ensemble (i.e. nearest-neighbour resampling applied to each GCM/RCM ensemble	1) Long time series of (bias corrected) daily precipitation and temperature on a spatial resolution of hydrological subcatchments in the Rhine basin (average size ~ 1000 km^2). 2) Ranges (or possibly PDFs) of changes in extreme quantiles of basin average 10-day precipitation amounts in winter and other relevant precipitation characteristics.	Long time series will be made available to Dutch stakeholders and Ensembles partners through the KNMI website (details are not yet known). Information and a link to these data can be included on the RT2B regional scenarios portal.

						member) but will also depend on the weights that can/should be assigned to the used GCMs and RCMs or to the GCM/RCM pairs. Previous studies also show that the change in future extreme river discharges is very sensitive to the change of the relative variability of 10-day precipitation (CV10) in winter.		
NIHWM: EVT modelling conditioned by circulation	Daily discharge level in the Danube lower basin (possibly also daily temperature and precipitation, drought indices)	Low frequency PCs of MEOF of the geopotential at 500 hPa, 500-1000 hPa and SLP (monthly). Also predictors as NAO (monthly) and daily temperature over Europe.	The extreme value theory (EVT) is applied for the study of daily discharges incorporating covariates: NAO and first 10 principal components of MEOF decomposition. Two methods are applied for fitting the data to an extreme - value distribution: *block maxima* and *peaks over thresholds* (POT). Details : Mares et al.,	Reanalysis (ERA-40). We intend to apply method for predictors from GCM/RCM.	4 hydrological stations from the Danube lower basin; daily timescale-but presentation of results will focus on the spring season.	For the models with same inputs, used for predictors, uncertainties will be quantified calculating informational conditioned entropy between historical data simulated by models and observations.	PDFs, Maps, graphics, threshold exceedences, quantiles, return period	Selected results available via the regional portal.

			2008					
NIHWM: Non-homogeneous hidden Markov Models	Daily discharge level in the Danube lower basin and daily precipitation along Danube basin	Low frequency components of MEOF, SVD, or circulation types of the atmospheric fields over Atlantic-European region: SLP, Z850, T850, SH850, RH850 (daily values).	The method is applied in two steps: - A hidden Markov model (HMM) is fitted to daily precipitation/ discharge level. - A non-homogeneous HMM (NHMM) is then applied to precipitation / discharge level associated with the predictors from the atmospheric circulation over Atlantic - European region. (Mares et al., 2008: Contribution submitted to JPCE).	ERA-40 ECA&D GCM - control and scenarios	Discharge levels at 4 hydrological stations from the Danube lower basin; Precipitation from 19 stations along Danube basin.	As above	Maps, graphics, probabilities (transition and emission) matrices.	Selected results available via the regional portal.
NMA: conditional stochastic weather generator	Daily precipitation	Monthly means: -SLP (sea level pressure); -specific humidity (ideally at 1000, 950, 850, 700 hPa). -instability index (using specific humidity, temperature and potential	Mixture between a two-state first order Markov chain and a SDS based on CCA (Busuioc and von Storch, 2003). Precipitation occurrence is described by a two-state, first order Markov chain and the variation of precipitation amount on wet days is described by two gamma distribution parameters. The four	-Reanalysis for calibration; multi-model GCM ensembles to produce local probabilistic climate change scenarios; 6-7 GCMS are planned to be used (FUBEMA, CNRM,	Daily precipitation time series but the results are presented at seasonal scale (including some indices related to extreme events) at 10-15 stations for the southern Romania	-considering ensembles of multi-SDSs obtained by various combinations of predictors giving similar skill over two independent observed data set (validation intervals); -calculating 90% confidence intervals for downscaled values from	-tables with the seasonal changes for various precipitation indices (including extreme indices) at each stations; -PDFs for some selected stations and for some parameters will be also explored.;	-changes of selected indices for a few selected stations will be available for a link to the RT2B portal.

		temperature at 850 and 500hPa)	parameters (two transition probabilities and two gamma distribution parameters) are linked by the large scale predictors through the CCA model. Other linear models will be also tested (e.g., CCA for seasonal precipitation).	BCM2, ECHAM-DMI, INGVSX, ECHAM5, HadCM);		multi-runs (e.g.1000 runs) of each SDS; -comparison with some RCM output climate change scenarios (1-2 RCMs will be considered or averaged RCM outputs as they are available from RT3 over Romania) for some appropriate downscaled parameters		
UEA: stochastic weather generator	Daily precipitation, Tmax, Tmin	Grid-point change fields (mean, std. dev etc) for daily precip., Tmax, Tmin	First-order, infinite-state Markov chain model. Secondary variables are all dependent on precipitation. Model parameters are perturbed using predictors'. Kilsby et al., 2007.	Change factors will be taken from the WP2B.1 RCM runs	5 mainland European stations (Linkoeping, Karlstad, Basel, Beograd, Timisoara), plus 4 UK stations (Ringway, Coltishall, Heathrow, Eskdalemuir). Daily timescale – but presentation of results will focus on seasonal indices of extremes.	PDFs, CDFs etc., will be constructed following the CRANIUM approach: http://www.cru.uea.ac.uk/cru/projects/cranium/. Weighting schemes from RT3 will be tested.	PDFs and CDFs	Available from the RT2B regional scenarios portal, in a similar layout as earlier results based on PRUDENCE outputs - http://www.cru.uea.ac.uk/projects/ensembles/crupdfs/