SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2016
Project Title:	Use and value of ECMWF short-range and seasonal forecast products for developing countries in terms of end-user impact variables
Computer Project Account:	SPITP4DC
Principal Investigator(s):	Adrian Tompkins ………………………………………………………
Affiliation:	Abdus Salam International Institute for Theoretical Physics (ICTP)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……………………………………………………… ………………………………………………………
Start date of the project:	1 January 2016
Expected end date:	31 December 2018

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	300,000	219718	400 000	0
Data storage capacity	(Gbytes)	100Gb		100 Gb	

Special Project SPITP4DC Annual Report

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1 Summary of project objectives

The projects examines the scope for operational seasonal forecasting of health risks in developing countries, with the primary interest concerning the prediction of malaria transmission and develop products that may be useful for the end-user he (bias corrected) monthly EPS and SYSTEM4 seasonal forecast system to the ICTP dynamical malaria model VECTRI. The precipitation and temperature forecasts then lead to forecasts of malaria transmission intensity, prevalence rates and eventually also actually hospital case data. The project will set up the pilot system, examine the skill in the target countries using hindcast datasets, analyze if improvements can be made including non-climatic factors, and finally, but most importantly, work directly with the ministry of health in the target countries to develop and hone end-user products that are directly useful to stakeholders and decision makers.

2 Summary of problems encountered

None

3 Summary of results of the current year (July-June)

3a Migration model

In order to improve the forecasting system, a better treatment of popoulation mobility was deemed necessary. Thus an agent based agent-based migration model was developed, based on a gravity model adapted to represent overnight journeys.

Each agent makes journeys involving overnight stays to either regular or random locations, with journey and destination probabilities taken from a mobile phone dataset statistics of journeys involving overnight stays in Senegal.

Preliminary results of the agent based model in terms of the number of individuals arriving in a location per square km per day are shown for Senegal, with categories divided into 10% percentiles (Fig. 1). These results are published in Tompkins and McCreesh (2016). The model predicts the highest journey flux to/from Dakar as expected, but also identifies the high flux from the western, more highly populated provinces in the vicinity of Dakar, as well as parts of Casamance. In Tompkins and McCreesh (2016), these results are compared to the original phone dataset. The aim is now to couple this model to the ECMWF-based malaria prediction system.

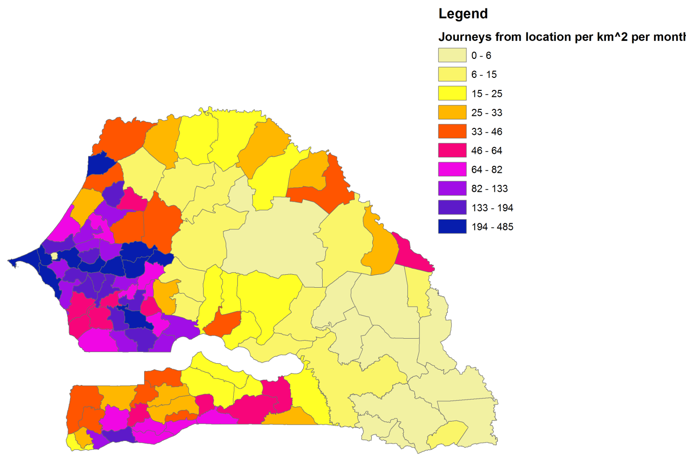

Figure 1. Preliminary results of the WISDOM model simulations. Units are individuals per square km arriving per month at each location divided into approximate 10 percentile categories.

3b Genetic Calibration Algorithm

As malaria model uncertainty is not yet taken into account in the ensemble forecasting system, a method was required for incorporating model parameter uncertainty, which would also be useful for parameter calibration.

Therefore a constrained genetic algorithm was developed to calibrate the process parameters of the VECTRI malaria model. The constraint restricts the calibration to search within a parameter space of defined uncertainty for each parameter or climate variable, analogous to the departure cost function of 4DVAR. After showing that the calibration process can result in an acceptable simulation of malaria case variability monitored at a plantation in the highlands of Kenya, experiments were conducted with the system to ascertain which of the driving climate or the malaria model uncertainty was key to malaria simulation spread, which are now submitted to PLOS for consideration Tompkins and Thomson (2016). The next step is to apply this system to the calibration of the forecast system (and possibly also to the IFS itself).

An example analysis of the genetic algorithm is shown for a simulation in the highlands of west Kenya. This is using climate observations to drive the malaria model. The model is able to reproduce the seasonality of malaria well as well as getting many of the outbreak years. Refer to the paper manuscript for full details. The next step is to implement the system at ECMWF.

4 Use of computer resources

219,000 CPU during the reporting period for radiation code developments. Extensive use planned for late 2016 to test GA code.

5 List of publications/reports

The following list gives the articles relevant to this report:

- Preliminary ensemble work reported in Tompkins et al. (2016b)
- Preliminary forecast system evaluation: Tompkins et al. (2016a)

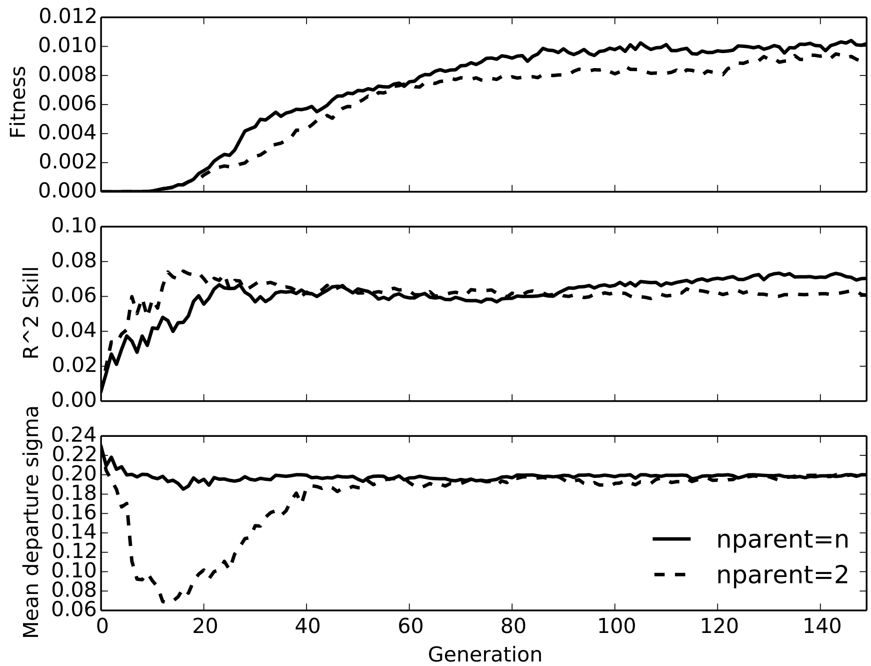

Figure 2. Adjustment of the ensemble mean likelihood fitness function (arbitrary units), r^2 correlation and a measure of the mean scaled parameter departure for the case where $\beta = m$ (written n in legend) and $\beta = 2$.

- Migration work reported in Tompkins and McCreesh (2016)
- Genetic algorithm ensemble calibration and model parameter calibration: Tompkins (2016) and Tompkins and Thomson (2016).

Tompkins, A. M., 2016: Towards seamless seasonal to climate simulation using a genetic algorithm for model calibration: initial experiments with the Lorenz system. *Q. J. R. Meteorol. Soc.*, **2016**, in preparation.

Tompkins, A. M., F. Di Giuseppe, F. J. Colоń-González, and D. B. Namanya, 2016a: A planned operational malaria early warning system for Uganda provides useful district-scale predictions up to 4 months ahead. *Climate services for health: Case studies of enhancing decision support for climate risk management and adaptation.*, J.Shumake-Guillemot, and L.Fernandez-Montoya, Eds., WHO/WMO Geneva, 130–131, URL http://ane4bf-datap1.s3-eu-west-1.amazonaws.com/wmocms/s3fs-public/WHO-WMO_Case_Studies_draft_FULL_2.pdf?i3omNE2N2V7_nX1uYYg6bvqnaR1kiwMn.

Tompkins, A. M., L. Larsen, N. McCreesh, and D. M. Taylor, 2016b: To what extent does climate explain variations in reported malaria cases in early 20th century Uganda? *Geospat. Health*, **11**, 10.4081/gh.2016.407, URL http://geospatialhealth.net/index.php/gh/article/view/407.

Tompkins, A. M., and N. McCreesh, 2016: Migration statistics relevant for malaria transmission in Senegal derived from mobile phone data and used in an agent-based migration model. *Geospat. Health*, **11**, doi:10.4081/gh.2016.408, URL http://geospatialhealth.net/index.php/gh/article/view/408.

Tompkins, A. M., and M. C. Thomson, 2016: Uncertainty in malaria simulations due to initial condition, climate and malaria model parameter settings investigated using a constrained genetic algorithm. *Plos One*, **2016**, submitted.

6 Summary of plans for the continuation of the project

In the next 12 months the plans are to:

- Implement GA calibration technique in IFS system
- Couple VECTRI with WISDOM economic cyclic migration model
- Improve model infrastructure, possibly migrating code deck from SMS to ECFLOW.