Climate Change on small islands

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Coupled ocean-atmosphere models regularly provide insight into the possible climate of the 21st century, warmed up by the anthropogenic greenhouse gas increase. In the next IPCC report (AR5), the CMIP5 experiment will provide a bundle of scenarios, with an average horizontal resolution of 150 km. The CORDEX project will refine the resolution by atmospheric models at 50 km resolution over large continental domains, driven by CMIP5 models at their lateral boundaries and through the sea surface temperature (sst). However, many tropical islands fall outside or too close to the border of the CORDEX domains, and the 50 km is not enough to represent them as land grid points.

The CNRM-CM5 model (Voldoire et al, 2013) is one of the contributors to CMIP5. Its sst has been used to drive, after subtraction of the monthly mean bias, a 50 km resolution version of the atmospheric component of CNRM-CM5, Arpege (Déqué, 2010). The Arpege simulations have been, in turn, used to provide lateral boundary conditions to its limited area version Aladin (Colin et al., 2010). Aladin and Arpege use here exactly the same physics and differ only by horizontal resolution. Aladin is run at 12 km resolution on small domains (typically 1000km x1000km) shown in Figure 1:

- West Indies: includes several French islands of the Caribbean Sea; we consider here Guadeloupe
- French Polynesia: we used 4 squares in the Pacific to represent the various archipelagos, but here, only the square over Tahiti is shown
- Reunion: this domain is slightly larger to include Mauritius and account for the remote effects of the high elevation of the island
- Maldives: this domain is elongated in longitude. None of the islands is resolved at 12 km, so we artificially added 3 land points, in the North, middle and South part; we consider here results for the central part (Male)
- New Caledonia: this is the only island resolved by the AGCM at 50 km. However, we consider here ocean points for Arpege to represent what CMIP5 models do

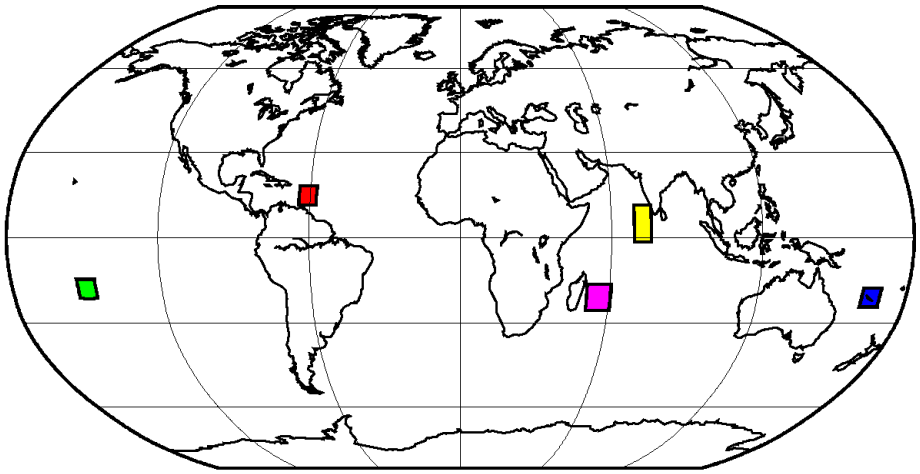

Figure 1: Location of the subdomains for ALADIN-12 km: French Polynesia (green), West Indies (red), New Caledonia (blue), Reunion Island (cyan) and Maldives Archipelago (yellow).

The question we address here is: how far can we rely on CMIP5 results to describe the climate change over our 5 islands. To reduce the uncertainty due to model sensitivity, we apply the IMPACT2C protocol, i.e. we consider the 30 year period over which the global mean temperature is 2°C above preindustrial condition (about 1.5°C above our reference 1971-2000 period). Table 1 shows that the

RCM response is warmer and drier than the GCM response. This can be easily explained by the fact that land points have the possibility to reduce the evaporation and increase temperature, compared to sea points, because of the limited soil moisture. But the RCM includes mountain which can increase precipitation by lifting the moist air masses. Table 1 shows that, beyond this average drying effect, there are strong local differences which involve the orography distribution, the large scale response, the annual cycle, and the RCP scenario. If we consider the sea points surrounding the island in the RCM (not shown), the response in 2m temperature is very close to the response in the GCM. But as far as precipitation is concerned, the response for Noumea, Male and Reunion is closer to the land point response, indicating a resolution dependence rather than an effect of soil drying.

	DJF temperature		JJA temperature		DJF precipitation		JJA precipitation	
	GCM	RCM	GCM	RCM	GCM	RCM	GCM	RCM
Tahiti RCP8.5	**0.9**	**1.3**	**1.1**	**1.4**	**-12**	**-11**	**-8**	**-12**
Tahiti RCP4.5	**0.9**	**1.3**	**1.0**	**1.2**	**-9**	**-4**	**-7**	**-8**
Guadeloupe RCP8.5	**1.0**	**1.2**	**1.1**	**1.4**	**-6**	**-8**	**3**	**8**
Guadeloupe RCP4.5	**0.9**	**1.0**	**1.0**	**1.3**	**-13**	**-14**	**-2**	**3**
Noumea RCP8.5	**1.3**	**1.4**	**0.9**	**1.2**	**-2**	**4**	**-8**	**-30**
Noumea RCP4.5	**1.2**	**1.4**	**0.9**	**1.1**	**-9**	**-2**	**-8**	**-20**
Reunion RCP8.5	**1.3**	**1.7**	**1.3**	**1.6**	**25**	**11**	**9**	**-4**
Reunion RCP4.5	**1.1**	**1.4**	**1.0**	**1.2**	**11**	**6**	**4**	**-4**
Male RCP8.5	**1.2**	**1.4**	**1.3**	**1.3**	**13**	**-1**	**8**	**-2**
Male RCP4.5	**1.1**	**1.3**	**1.3**	**1.3**	**-5**	**-1**	**10**	**-3**

Table 1: 30-year mean climate change for 2m temperature (°C) and precipitation (%) at the 5 locations for the RCP8.5 and RCP2.5 scenarios. The reference period is 1971-2000 and the scenario period is 2031-2060 (RCP8.5) and 2041-2070 (RCP4.5)

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