



Technical documentation for the ClimEx CRCM5 Large Ensemble (v2.0)

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1 Important notes

1.1 Terms of use

- References, credits, and technical information to include for the ClimEx CRCM5 Large Ensemble (CRCM5-LE) are provided in the ‘Terms of use’ document.

1.2 Experimental framework and overview of the results

A general description of the ClimEx CRCM5 Large ensemble is provided in the following paper:

- Leduc, M., A. Mailhot, A. Frigon, J. Martel, R. Ludwig, G.B. Brietzke, M. Giguère, F. Brisette, R. Turcotte, M. Braun, and J. Scinocca, 2019: The ClimEx Project: A 50-Member Ensemble of Climate Change Projections at 12-km Resolution over Europe and Northeastern North America with the Canadian Regional Climate Model (CRCM5). *J. Appl. Meteor. Climatol.*, 58, 663–693, <https://doi.org/10.1175/JAMC-D-18-0021.1>

1.3 Data use: removing the spin-up time

As described in Leduc et al. (2019), a spin-up period in the beginning of each simulation should be discarded from analysis, as the CRCM5 and CanESM2 models need some time to forget their initial conditions. More specifically, the analysis period should be:

- **1955-2099** for all simulations driven by CanESM2 (kb*, kc*, kd* and ke*). The first five years (1950-1954) should not be considered for analysis in order to obtain 50 independent members from the driving model CanESM2.
- **1980-2013** for all simulations driven by the ERA-Interim reanalysis. The first year (1979) should not be considered in order to account for the CRCM5 spin-up.



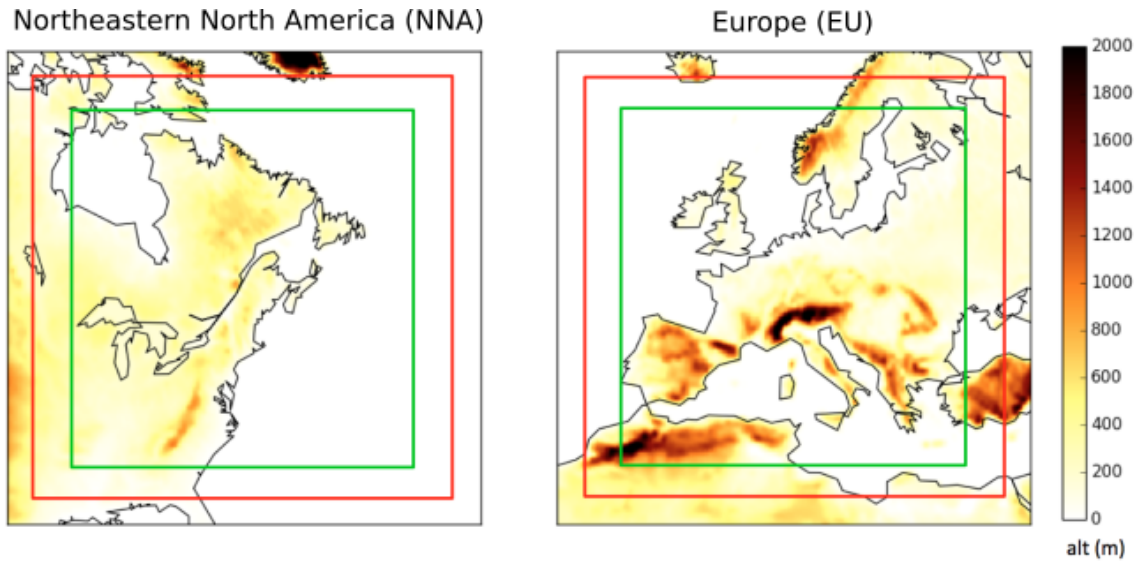


Figure 1: Integration domains (380x380 grid points) used by CRCM5 to produce the ClimEx large ensemble. Are also shown the "free domain" (340x340 grid points, in red) where the model is technically free from direct imposition of lateral boundary conditions. Finally, the "analysis domain" (280x280, in green) is the region where are archived all the output fields.

2 Simulations and terminology

Table 1: List of CRCM5 simulations produced within the ClimEx project.

N	Name	Domain	Pilot	Run period	Analysis period	Spectral nudging
1	kfa	EU	ERA-I	1979-2013	1980-2013	no
1	kfc	EU	ERA-I	1979-2013	1980-2013	yes
1	kfb	NNA	ERA-I	1979-2013	1980-2013	no
1	kfd	NNA	ERA-I	1979-2013	1980-2013	yes
50	kba-kcx	EU	CanESM2	1950-2099	1955-2099	yes
50	kda-kex	NAA	CanESM2	1950-2099	1955-2099	yes

Table 2: Table of correspondence between the CanESM2 and CRCM5 ensemble runs terminologies.

	GCM Family	GCM Member	RCM Member	Domain
1	historical-r1	r1i1p1	kba	EU
2	historical-r1	r2i1p1	kbb	EU
3	historical-r1	r3i1p1	kbc	EU
4	historical-r1	r4i1p1	kbd	EU
5	historical-r1	r5i1p1	kbe	EU
6	historical-r1	r6i1p1	kbf	EU
7	historical-r1	r7i1p1	kbj	EU
8	historical-r1	r8i1p1	kbh	EU
9	historical-r1	r9i1p1	kbi	EU
10	historical-r1	r10i1p1	kbj	EU
11	historical-r2	r1i1p1	kbk	EU
12	historical-r2	r2i1p1	kbl	EU
13	historical-r2	r3i1p1	kbn	EU
14	historical-r2	r4i1p1	kbn	EU
15	historical-r2	r5i1p1	kbo	EU
16	historical-r2	r6i1p1	kbp	EU
17	historical-r2	r7i1p1	kbq	EU
18	historical-r2	r8i1p1	kbr	EU
19	historical-r2	r9i1p1	kbs	EU
20	historical-r2	r10i1p1	kbt	EU
21	historical-r3	r1i1p1	kbu	EU
22	historical-r3	r2i1p1	kbv	EU
23	historical-r3	r3i1p1	kbw	EU
24	historical-r3	r4i1p1	kbx	EU
25	historical-r3	r5i1p1	kby	EU
26	historical-r3	r6i1p1	kbz	EU
27	historical-r3	r7i1p1	kca	EU
28	historical-r3	r8i1p1	kcb	EU
29	historical-r3	r9i1p1	kcc	EU

Table 2: (continued)

	GCM Family	GCM Member	RCM Member	Domain
30	historical-r3	r10i1p1	kcd	EU
31	historical-r4	r1i1p1	kce	EU
32	historical-r4	r2i1p1	kcf	EU
33	historical-r4	r3i1p1	kcg	EU
34	historical-r4	r4i1p1	kch	EU
35	historical-r4	r5i1p1	kci	EU
36	historical-r4	r6i1p1	kcj	EU
37	historical-r4	r7i1p1	kek	EU
38	historical-r4	r8i1p1	kcl	EU
39	historical-r4	r9i1p1	kcm	EU
40	historical-r4	r10i1p1	kcn	EU
41	historical-r5	r1i1p1	kco	EU
42	historical-r5	r2i1p1	kcp	EU
43	historical-r5	r3i1p1	kcq	EU
44	historical-r5	r4i1p1	ker	EU
45	historical-r5	r5i1p1	kes	EU
46	historical-r5	r6i1p1	kct	EU
47	historical-r5	r7i1p1	kcw	EU
48	historical-r5	r8i1p1	kev	EU
49	historical-r5	r9i1p1	kew	EU
50	historical-r5	r10i1p1	kcx	EU
1	historical-r1	r1i1p1	kda	NNA
2	historical-r1	r2i1p1	kdb	NNA
3	historical-r1	r3i1p1	kdc	NNA
4	historical-r1	r4i1p1	kdd	NNA
5	historical-r1	r5i1p1	kde	NNA
6	historical-r1	r6i1p1	kdf	NNA
7	historical-r1	r7i1p1	kdg	NNA
8	historical-r1	r8i1p1	kdh	NNA
9	historical-r1	r9i1p1	kdi	NNA
10	historical-r1	r10i1p1	kdj	NNA
11	historical-r2	r1i1p1	kdk	NNA
12	historical-r2	r2i1p1	kdl	NNA
13	historical-r2	r3i1p1	kdm	NNA
14	historical-r2	r4i1p1	kdn	NNA
15	historical-r2	r5i1p1	kdo	NNA

Table 2: (continued)

	GCM Family	GCM Member	RCM Member	Domain
16	historical-r2	r6i1p1	kdp	NNA
17	historical-r2	r7i1p1	kdq	NNA
18	historical-r2	r8i1p1	kdr	NNA
19	historical-r2	r9i1p1	kds	NNA
20	historical-r2	r10i1p1	kdt	NNA
21	historical-r3	r1i1p1	kdu	NNA
22	historical-r3	r2i1p1	kdv	NNA
23	historical-r3	r3i1p1	kdw	NNA
24	historical-r3	r4i1p1	kdx	NNA
25	historical-r3	r5i1p1	kdy	NNA
26	historical-r3	r6i1p1	kdz	NNA
27	historical-r3	r7i1p1	kea	NNA
28	historical-r3	r8i1p1	keb	NNA
29	historical-r3	r9i1p1	kec	NNA
30	historical-r3	r10i1p1	ked	NNA
31	historical-r4	r1i1p1	kee	NNA
32	historical-r4	r2i1p1	kef	NNA
33	historical-r4	r3i1p1	keg	NNA
34	historical-r4	r4i1p1	keh	NNA
35	historical-r4	r5i1p1	kei	NNA
36	historical-r4	r6i1p1	kej	NNA
37	historical-r4	r7i1p1	kek	NNA
38	historical-r4	r8i1p1	kel	NNA
39	historical-r4	r9i1p1	kem	NNA
40	historical-r4	r10i1p1	ken	NNA
41	historical-r5	r1i1p1	keo	NNA
42	historical-r5	r2i1p1	kep	NNA
43	historical-r5	r3i1p1	keq	NNA
44	historical-r5	r4i1p1	ker	NNA
45	historical-r5	r5i1p1	kes	NNA
46	historical-r5	r6i1p1	ket	NNA
47	historical-r5	r7i1p1	keu	NNA
48	historical-r5	r8i1p1	kev	NNA
49	historical-r5	r9i1p1	kew	NNA
50	historical-r5	r10i1p1	kex	NNA

3 List of archived variables

Table 3: List of archived variables for the ClimEx CRCM5 large ensemble, with Δt being the archiving frequencies for the Europe (EU) and northeastern North America (NNA) domains. The last column gives the type of data archive: (I) instantaneous value provided every archival time, (M) mean value during the archival period and (N) or (X) for miNimum or maXimum value between archival times. The choice of CRCM5 variables to be archived was made to comply with the needs of hydrological studies in the context of the ClimEx project. We archived additional variables that could be useful in other applications, but limitations on the total volume of data have restricted their number.

NetCDF Name	Δt EU	Δt NNA	Description	Units	Type
<i>2-D variables</i>					
capei		3h	Convective Available Potential Energy	J kg ⁻¹	I
clt	day	day	Total Cloud Fraction	%	M
clwvi		day	Condensed Water Path	kg m ⁻²	I
dds	3h	3h	Near-Surface Dewpoint Depression	K	I
evspsbl	day	day	Evaporation	kg m ⁻² s ⁻¹	M
evspsblland	day	day	Water Evaporation from Land	kg m ⁻² s ⁻¹	M
hfls	day		Surface Upward Latent Heat Flux	W m ⁻²	M
hfss	day		Surface Upward Sensible Heat Flux	W m ⁻²	M
hurs	3h	3h	Near-Surface Relative Humidity	%	I
huss	3h	3h	Near-Surface Specific Humidity	1	I
lfirt		day	Lake Floor Temperature	K	I
lif		day	Lake Ice Fraction	%	I
lit		day	Lake Ice Thickness	m	I
lmlthick		day	Lake Mixed-Layer Thickness	m	I
lmlt		day	Lake Mixed-Layer Temperature	K	I
mrfs0	day	day	Soil Frozen Water Content	kg m ⁻²	I
mrro	day	day	Total Runoff	kg m ⁻² s ⁻¹	M
mrros	day	day	Surface Runoff	kg m ⁻² s ⁻¹	M
mrso	day	day	Total Soil Moisture Content	kg m ⁻²	I
mrsos	day	day	Moisture in Upper Portion of Soil Column	kg m ⁻²	I
prc	3h	day	Convective Precipitation	kg m ⁻² s ⁻¹	M
prdc		day	Deep Convective Precipitation	kg m ⁻² s ⁻¹	M
prfr		day	Freezing Rain	kg m ⁻² s ⁻¹	M
pr	1h	1h	Precipitation	kg m ⁻² s ⁻¹	M
prlp	3h	day	Liquid Precipitation	kg m ⁻² s ⁻¹	M
prrp		day	Refrozen Rain	kg m ⁻² s ⁻¹	M
prsn		day	Snowfall Flux	kg m ⁻² s ⁻¹	M
prw		day	Water Vapor Path	kg m ⁻²	I



Table 3: (continued)

NetCDF Name	Δt EU	Δt NNA	Description	Units	Type
ps	3h	3h	Surface Air Pressure	Pa	I
psl	3h		Sea Level Pressure	Pa	I
rlds	3h		Surface Downwelling Longwave Radiation	W m-2	M
rlus	3h		Surface Upwelling Longwave Radiation	W m-2	M
rlut	3h		TOA Outgoing Longwave Radiation	W m-2	M
rsaa	3h		Shortwave Radiation Absorbed by Atmosphere	W m-2	M
rsds	3h	3h	Surface Downwelling Shortwave Radiation	W m-2	M
rsdt	3h		TOA Incident Shortwave Radiation	W m-2	M
rsus	3h		Surface Upwelling Shortwave Radiation	W m-2	M
rsut	3h		TOA Outgoing Shortwave Radiation	W m-2	M
sfcWindmax	day	day	Daily Maximum Near-Surface Wind Speed	m s-1	X
snc	day	day	Snow Area Fraction	%	I
snd	day		Snow Depth	m	I
snw	day	day	Surface Snow Amount	kg m-2	I
tas	3h	3h	Near-Surface Air Temperature	K	I
tasmax	day	day	Daily Maximum Near-Surface Temperature	K	X
tasmin	day	day	Daily Minimum Near-Surface Temperature	K	N
ts	day	day	Surface Temperature	K	I
uas	3h	3h	Eastward Near-Surface Wind	m s-1	I
vas	3h	3h	Northward Near-Surface Wind	m s-1	I
<i>3-D Atmospheric variables</i> (at 1000, 925, 850, 700, 500 and 200 hPa)					
hus	3h	3h	Specific Humidity	1	I
ta	3h	3h	Air Temperature	K	I
ua	3h	3h	Eastward Wind	m s-1	I
va	3h	3h	Northward Wind	m s-1	I
zg	3h	3h	Geopotential Height	m	I
<i>3-D Soil variables</i> (9 layers from surface to bedrock)					
mrfls	day	day	Soil Layer Frozen Water Content	kg m-2	I
mrsls	day	day	Water Content of Soil Layer	kg m-2	I



Table 4: List of invariant fields for the ClimEx CRCM5 large ensemble. These fields are enclosed into invariant simulations labeled as kax and kay for the EU and NNA domains respectively.

NetCDF Name	Description	Units
areacella	Atmosphere Grid-Cell Area	m ²
bedrock	Bedrock Depth	m
clayfrac	Clay Fraction	%
cropFrac	Crop Fraction	%
grassFrac	Grass Fraction	%
lakeFrac	Lake Area Fraction	%
ldpth	Lake Depth	m
orogf	Filtred Orography	m
sandfrac	Sand Fraction	%
sftgrf	Grounded Ice Area Fraction	%
sftlf	Land Area Fraction	%
sftof	Sea Area Fraction	%
treeFracPrimDec	Total Primary Deciduous Tree Fraction	%
treeFracPrimEver	Total Primary Evergreen Tree Fraction	%
urbanFrac	Urban Fraction	%
wetlandFrac	Wetland Fraction	%

