

# Memorandum

To: Andri Gunnarsson @ Landsvirkjun

From: Ólafur Rögnvaldsson @ Belgingur Ltd.

Date: 28 September 2020

Regarding: Technical description of two different dynamical downscaling time series for Iceland

Belgingur has used dynamical downscaling to create two multidecadal time series of weather for Iceland, named RAV2 and IceBox.

**The RAV2 series** spans the period 1 September 1957 to 31 August 2019. It was created by running V3.6.1 of the WRF atmospheric model (using the AR dynamical core), forced by initial and boundary data from the ERA-40 (for the 1957-1979 period) and ERA-Interim (for the period 1979-2019) re-analysis, created by the ECMWF. The WRF model was run with two domains using a one-way inline nesting. The outer domain resolution was 10 km and domain size was 121x111 points. The inner domain was run at 2 km resolution and the number of grid points was 326x256, cf. Fig. 1. The number of vertical levels was set to 65, with emphasizes on high vertical resolution in the lowest kilometre. Model top was set at 50 hPa. Values of vertical sigma levels are shown in Table 1 and Table 2 shows the choice of model physical schemes.

A customised land-use and topography database was used where we have updated the default USGS 30 arcsec data with high resolution data from the Corine project<sup>1</sup>. High resolution topography data for the Icelandic icecaps come from the University of Iceland (<https://www.hi.is>) and the Icelandic Meteorological Office (<https://www.vedur.is>) and have been extrapolated to a 30 arcsec resolution. The extra-glacial topography data come from Loftmyndir Ltd. (<http://www.loftmyndir.is>) and are extrapolated from a 20x20 meter raster dataset to 30 arcsec resolution. In spite of this, the standard deviation remains less than 5 meters.

These datasets have been combined and converted to the same format as is used by the USGS GTOPO30 dataset. In addition, we have included artificial reservoirs created over the years as part of the domestic build-up of hydropower, cf. Table 3.

Output data from the RAV2 project are available on-line - <http://rav.betravedur.is/RAV2>.

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<sup>1</sup> <https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-corine>, see also [https://www2.mmm.ucar.edu/wrf/src/wps\\_files/updated\\_Iceland\\_LU.tar.bz2](https://www2.mmm.ucar.edu/wrf/src/wps_files/updated_Iceland_LU.tar.bz2) and <http://ftp.betravedur.is/pub/wrf/usgs30sec/RAV2-data>

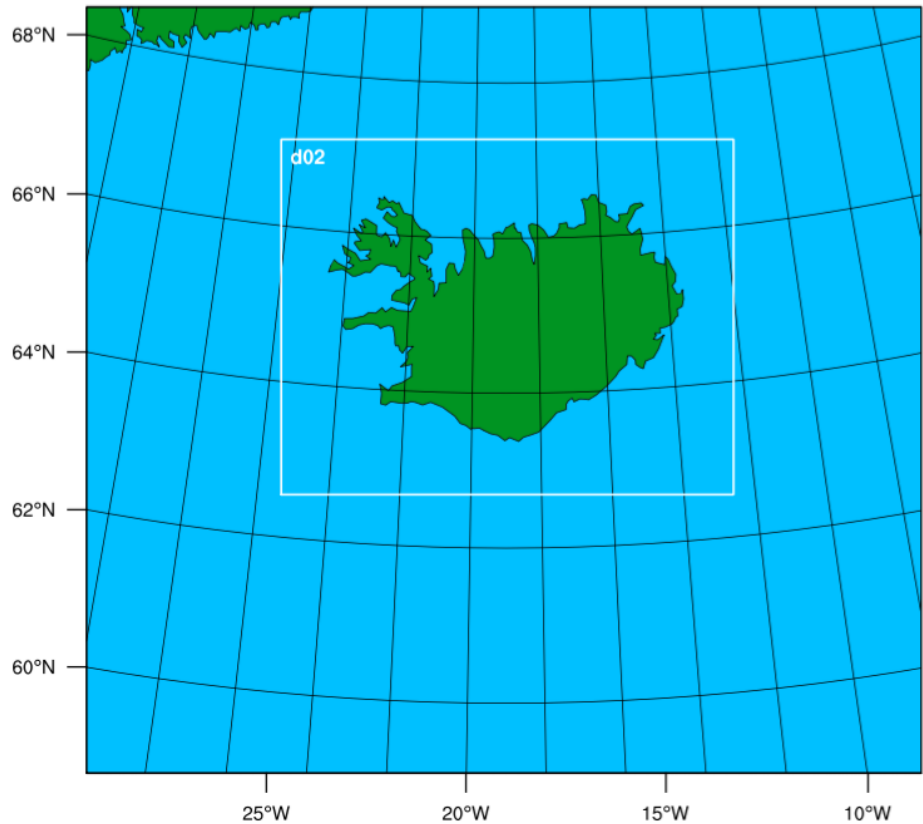


Figure 1: Model configuration for the RAV2 downscaling project. Outer domain has 10 km horizontal resolution (121x111 pts.) whilst the inner domain has 2 km horizontal resolution (326x256 pts.).

eta_levels =	1.00000,	0.99452,	0.99113,	0.98873,	0.98594,	0.98305,
	0.98026,	0.97737,	0.97458,	0.97178,	0.96899,	0.96620,
	0.96341,	0.95783,	0.95095,	0.93923,	0.92752,	0.91581,
	0.90409,	0.87836,	0.85334,	0.82901,	0.80538,	0.77677,
	0.74915,	0.72253,	0.69681,	0.67208,	0.64816,	0.62054,
	0.59412,	0.56052,	0.52124,	0.48455,	0.45045,	0.41874,
	0.38913,	0.36171,	0.31216,	0.29003,	0.26929,	0.25005,
	0.23210,	0.21545,	0.19990,	0.18544,	0.16560,	0.14776,
	0.13170,	0.11735,	0.10439,	0.09272,	0.07906,	0.06720,
	0.05693,	0.04806,	0.04028,	0.03061,	0.02283,	0.01645,
	0.01137,	0.00728,	0.00399,	0.00130,	0.000,	

Table 1: Sigma levels for the RAV2 model configuration, model top is at 50 hPa.

- Microphysics precipitation scheme - Morrison
- Longwave radiation scheme - RRTMG
- Shortwave radiation scheme - RRTMG
- Planetary boundary layer scheme - MYJ
- Cumulus parameterization scheme - Grell-Freitas (outer domain only)
- Surface layer scheme - Monin-Obukhov
- Land surface model scheme - NOAH

Table 2: Choices of physical parameterization schemes for RÁV2

Hydropower reservoirs	Anno
Háslón	2007
Hágöngulón	1998
Blöndulón	1991
Sultartangalón, Hrauneyjafoss	1982
Sigöldulón	1978
Þórisvatnsmiðlun	1973

Table 3: Hydropower reservoirs and the year when they are included in the RÁV2 model configuration.

The IceBox<sup>2</sup> series spans the period 1 September 1995 to 31 August 2019. As with the RAV2 data we used the WRF model and input data from the ECMWF. For this work we used V4.1.2 of WRF with modifications made to the Thompson microphysics scheme (provided by Greg Thompson). As with RAV2 we used a two-domain configuration (cf. Fig. 2) and the modified land-use and topography data described above. Initial and boundary data came from the ERA5<sup>3</sup> and ERA5-Land<sup>4</sup> re-analysis.

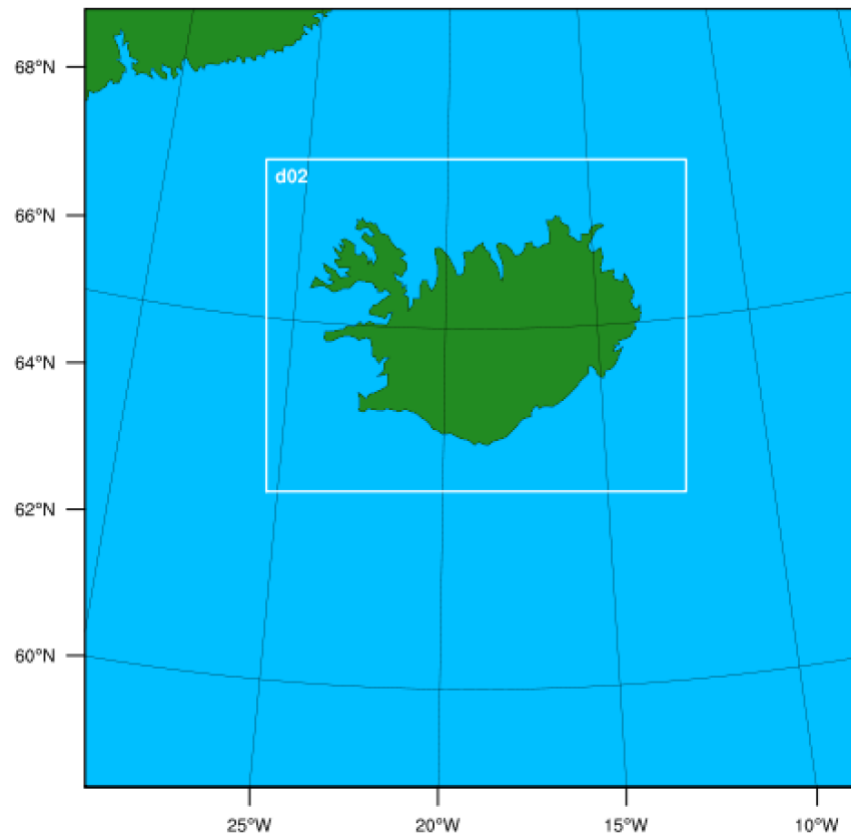


Figure 2: Model configuration for the IceBox downscaling project. Outer domain has 8 km horizontal resolution (151x151 pts.) whilst the inner domain has 2 km horizontal resolution (325x257 pts.).

Table 4 shows the vertical coordination configuration for IceBox and Table 5 lists the physical parameterization schemes used.

<sup>2</sup> IceBox is a research project headed by Statnett SF, the Norwegian transmission system operator - <https://www.statnett.no/en/about-statnett/research-and-development/our-prioritised-projects/icebox>

<sup>3</sup> <https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5>

<sup>4</sup> <https://www.ecmwf.int/en/era5-land>

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eta_levels = 1.0,      0.9946468, 0.9889215, 0.9828001, 0.9762576,
                   0.9692677, 0.9618027, 0.9538340, 0.9453315, 0.9362642,
                   0.9265997, 0.9163048, 0.9053455, 0.8936867, 0.8812929,
                   0.8681283, 0.8541568, 0.8393426, 0.8236505, 0.8070461,
                   0.7894967, 0.7709715, 0.7514425, 0.7308851, 0.7092789,
                   0.6866087, 0.6628655, 0.6380474, 0.6121613, 0.5852233,
                   0.5572610, 0.5283139, 0.4984354, 0.4676941, 0.4361746,
                   0.4039792, 0.3712285, 0.3380622, 0.3046394, 0.2711385,
                   0.2377561, 0.2047062, 0.1723616, 0.1428810, 0.1160447,
                   0.0916478, 0.0694992, 0.0494207, 0.0312464, 0.0148220,
                   0.0
```

Table 4: Sigma levels for the IceBox model configuration, model top is at 100 hPa.

Microphysics precipitation scheme - Thompson aerosol-aware  
 Longwave radiation scheme - RRTMG  
 Shortwave radiation scheme - RRTMG  
 Planetary boundary layer scheme - MYNN level 2.5  
 Cumulus parameterization scheme - Grell-Freitas (outer domain only)  
 Surface layer scheme - Monin-Obukhov  
 Land surface model scheme - NOAH

Table 5: Choices of physical parameterization schemes for IceBox

A detailed comparison of RAV2 and IceBox, as well as various other downscaled model data, for the September 2014 through August 2015 period can be found on-line - <http://rav.betravedur.is/LVC/browse.html>.

We have further run the IceBox configuration for September 2018 through August 2019 using the operational GFS analysis as well as simulating with high-resolution SST data (courtesy of NASA<sup>5</sup>) and the NOAH-MP land surface model (see comparison here - [http://rav.betravedur.is/wrf\\_2018-19/browse.html](http://rav.betravedur.is/wrf_2018-19/browse.html)).

Configuration for the current operational forecasting system for Iceland closely resembles that of IceBox with the exception that we run V3.9.1 of WRF and use the default Thompson scheme (non aerosol-aware). Plans for Q4 2020 are as follows:

- Update to V4.2 of WRF including the customised Thompson code
- Start using high resolution SST data
- Extend the 2018-2019 series, using GFS analysis and high-resolution SST data, to include September 2019 to present

Post-processed output files from the operational forecasting system are disseminated on-line:

- Outer domain, fifteen-day forecast - [http://www.betravedur.is/lv\\_island\\_9km](http://www.betravedur.is/lv_island_9km)
- Inner domain, three-day forecast - [http://www.betravedur.is/lv\\_island\\_2km](http://www.betravedur.is/lv_island_2km)
- Charts, meteograms, tables - <https://belgingur.is>
- Information regarding APIs - <https://github.com/Belgingur/WOD-Documentation/wiki/Getting-Started-With-WOD-APIs>

Geographical input files for RAV2 and IceBox can be found on-line:

- RAV2 dataset - [http://ftp.belgingur.is/wrf/rav2/geo\\_em-files/](http://ftp.belgingur.is/wrf/rav2/geo_em-files/)
- IceBox dataset - [http://ftp.belgingur.is/wrf/icebox/geo\\_em-files](http://ftp.belgingur.is/wrf/icebox/geo_em-files)

<sup>5</sup> <https://earthdata.nasa.gov/learn/articles/tools-and-technology-articles/mur-sst-in-the-cloud>