# **Age Scale Version 1.1 for the Top 38m of the RICE Ice Core**

## **Overview**

Based on newly evaluated and reevaluated geochemistry data and a stacked isotope record, we propose to update the current RICE Age Scale (AS) 1.0 with a new version – RICE AS 1.1. The key difference is the use of non sea salt sulfate (nssSO4) to evaluate SO4 peaks which are currently used to identify summer peaks. We find that applying this method, we change the following for the top 38m (see also excel spread sheet):

* 12 annual layer counts have been removed
* 2 annual layer counts is added
* 1 year previously considered ‘uncertain’ has been identified as ‘certain’
* v 1.0 had an uncertainty of ± 4 years at 38m, proposed v 1.1 has ± 1.5 uncertain years at the end of the record
* the precise position of peak summer (i.e. Jan) has been adjusted

The uncertainty of the age scale has been reduced and the end year of the time series has changed (from 1894 to 1901), at 1900 the age uncertainty is now +/- 1.5 year.

The v 1.1 AS includes a revised way of reporting uncertain years. Here we count an uncertain layer as a whole year and add +/- 0.5 years of uncertainty for each uncertain year.

The revised RICE AS 1.1 was then compared with two independent records (ERA-I and the age model of the Danish 11m shallow ice core from 1975)

## **Method**

This document describes the method used to update the RICE AS 1.0 for the top 38 m of the RICE ice core (Roosevelt Island, Antarctica; 79.36°S, 161.70°W, 560 m a.s.l.).

We propose that the RICE AS 1.0 dating method over-counts summer peaks. To evaluate this hypothesis, we added nssSO4 to the existing annual layer counting proxies used so far: SO4, water isotopes and Sodium (Na). Na was used to calculate nssSO4. Please note that Na generally produces two peaks per year (Figure 2). On a first principle, nssSO4 peaks were used to identify annual layers (summer peak indicator). A number of minor nssSO4 peaks were identified as uncertain. Here we use nss SO4 to determine whether a particular SO4 should be counted or not. If a nssSO4 peaks is present, we count the SO4 peaks, if absent, the SO4 is considered sub-annual. The difference between RICE AS 1.0 and RICE AS 1.1 is shown in the excel spreadsheet:

**RICE\_Age\_Scale\_v1\_1\_Feb2015\_draft.xls**

All layer counts from March 2014 is still included in the attached excel files, but some of the old layers are no longer associated with a year. These layer counts are called 99999 in the year column (column 2).

Column 1 (step): running number of v1.0 and v1.1 years

Column 2 (year): the value 9999 represents a year that was counted in v1.0 but not in 1.1. Flags for the 9999 deleted layers represents flags from the v1.0 version.

Column 3 (depth): contains the depths (m) of the new, revised annual layer count.

Column 4 (depth; v 1.0 March 2014): contains depths (m) of v 1.0 for comparison

Column 5 (flag): provides an overview on how individual layers were retrained or changed: Flags:

1. Annual Pick v 1.0

2. Uncertain year v 1.0

3. New uncertain year v 1.1

4. Year added v 1.1 (just two years 2010 and 1935, which also are classified as uncertain)

5. Uncertain year in v 1.0 that is elevated to a certain year in v1.1.

Column 6 (adj flag): years where the actual depth of peak summer has shifted slightly indicated by ‘1’

Column 7 (uncertainty): Uncertainty of v 1.1 (+/- 0.5 years per uncertain year).

The RICE ftp-site contains Matlab files that shows plots for each layer count.

ftp://RICEftp@ftp.gns.cri.nz

Folder: Matlab files RICE Age Scale version 1.1 top 38m 2015

Download, load the files and step through the annual counts as an animation in Matlab using the following commands:

% run on of these files

%1

load movie\_M\_1213B\_shallow\_record\_Na.mat

 %2

load movie\_M\_deep\_record\_38m\_Na\_part1.mat

%3

load movie\_M\_deep\_record\_38m\_Na\_part2.mat

%4

load movie\_M\_deep\_record\_38m\_bet\_part1.mat % contains beta-counts from the Danish RID 1975 core

% and run the corresponding code for the selected file:

%1

f=movie\_M\_1213B\_shallow\_record\_Na;

%2

f=movie\_M\_deep\_record\_38m\_Na\_part1;

%3

f=movie\_M\_deep\_record\_38m\_Na\_part2;

% load the matlab animation

implay(f)

To unclutter the layer counting plots, we choose to not include a legend in the figures.

An explanatory legend for the subplots is provided below instead.

Legend subplot 1: Water stable isotope records dD



Legend subplot 2: d-excess

 Same as for dD

Legend subplot 3: Sulfate



Legend subplot 4: Na



### **Comparison with independent records**

Two independently dated time series were used to evaluate whether the proposed RICE AS 1.1 dating method improved relative age uncertainty. These records are:

* ERA-I precipitation data 1979-2011. The RICE accumulation record was compared to the ERA-I precipitation data 1979-2011 (Figure 1).
* RID 11m shallow core dilled in 74/75 and dated using beta-counts.



**Figure 1.** Correlation plot between the RI annual accumulation record, annual ERA-I precipitation (P) and P-E (Evaporation). Where the annual accumulation record is based on the new revised annual layer count v 1.1. Annual P and E averages were calculated from 3-hourly ERA-I high resolution (0.0125° x 0.0125°) forecast data from the grid point that is located closest to the Roosevelt Island drill site.

### **Seasonal cycle for Na and SO4**



**Figure 2.** Seasonal cycle in Na (blue line) from the deep RICE core (8.6-38 m). A bi-annual peak pattern can be seen and the seasonal pattern can still be seen even if only the five years with lowest Na concentration is considered (magenta line).



**Figure 3.** Seasonal cycle in SO4 (blue line) from the deep RICE core (8.6-38 m).

Best Regards,

Daniel Emanuelsson (Daniel.Emanuelsson@vuw.ac.nz)

Nancy Bertler (Nancy.Bertler@vuw.ac.nz)

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Antarctic Research Centre

Victoria University of Wellington and GNS Science