Background/Problem area
The increasing interest in packaging and other elements made of corrugated cardboard (e.g. purchase displays or decorations) goes hand in hand with the question of a precise interpretation of the material. The challenge for manufacturers and users of corrugated cardboard is particularly the structural behaviour over a long period and under changing climatic conditions. Qualitative statements about the long-term structural behaviour of corrugated containers are currently given only by time consuming and costly long-term studies. Due to these conditions, these tests are only used in rare cases. The design of the packaging is therefore usually based on simple calculations, such as the McKee-formula. These include only quasi-statically determined material parameters, general geometric relationships and are coupled with the assumption of many conditions (e.g. the ratio of height must agree to scope). In order to ensure a certain degree of security for the package, the results are subjected to general safety factors. Detailed considerations of climate- and long-term loads do not take place. Corrugated cardboard is a hygroscopic material and loses almost half of its strength with an increase in humidity from 50% to 90%. The following, inaccurate interpretation of corrugated packaging in the current sense will lead either to oversizing (waste material) or a failure (damage) by climatic or long time stress. An optimized use of the material does not take place in most corrugated containers.

Objectives/Research results
The aim of the project is to develop a continuum mechanics justified method for calculating the climate-dependent creep characteristics of corrugated containers by means of short-term tests, performed with different loading rates. The method sets the focus of research on the material-specific behaviour of corrugated cardboard with respect to long-term and climate stress. Therefore it is possible to perform an application-oriented design of the packaging and dispense as far as possible on time and cost-intensive long-term tests on the packaging. In this way, a link between tests on the material and the behaviour of the packaging is prepared.

Therefore, the following subordinate targets are to be achieved:

- Creation of a viscoelastic material model and derivation of a creep model for the material,
- Conducting speed differentiated short-term tests on specimens of corrugated board for determining viscous material characteristics and integration into the creep model,
- Comparing the calculation results with long-term studies on specimens,
- Determining the viscoelastic component of deformation and the influence of defined climatic conditions,
- FEM calculation and comparison with practical BCT measurements on packaging.

Application/Economic benefits
An optimal size of corrugated cardboard packaging would save material as well as minimize damages within shipping. The method will lead to a proper design of the wall thicknesses of corrugated containers through the accurate knowledge of the long-term behaviour under different climatic conditions.

In many applications it will be possible to dispense on an undefined increase of the wall thickness for security purposes. Other cases will show that the current interpretation would result in a damage that can be prevented with the correct dimensioning.

Period of time: 01.10.2015 – 30.09.2017

Remarks
The research project IGF 18876 BG is being funded by the German Federal Ministry of Economic Affairs and Energy (BMWi) and is carried out in collaboration with Prof. Sadlowsky, BFSV Hamburg.