

# Statistical Analysis and Modelling (SAM)

The main aspects the SAM group is focussing on are

- **Natural Climate Variability.**

- Interdecadal variability in the 600+ year experiment with the ECHAM1/LSG model.
- Detection of anthropogenic climate change.
- Intraseasonal variability in atmosphere and ocean.
- Identification of subsystems (PIPs).
- Storminess in the North Atlantic in the past 100 years.
- **Staff:** S. Gualdi, H. Heyen, M. Junge, V.W. Kharin, F. Kwasniok, D. Schriever, J. von Storch
- **Diplomand:** H. Reichardt

- **Possible Implications of Climate Change** with the sub-aspects “Impact on Hydrology, Regional Oceanography and Ecology”, and “Interaction of Economy, Society and Climate”.

- **Staff:** J. Dippner, S. Güss, F. Kauker, D. Müller-Navarra, V. Ocaña
- **Diplomand:** M. Stolley

- **Lustsolo:** K. Jakob’s short term forecasts with neural networks.

# What has happened since Salzau 1993?

- **Two scientists have left** (R. Schnur and E. Zorita).
- **One PhD thesis (Schnur) and one Diploma thesis (H. Heyen)** have been submitted.
- **Papers in press:**
  - Tahvonen, von Storch and von Storch: Economic efficiency of CO<sub>2</sub> reduction programs, *Climate Research*
  - von Storch, Schriever, Arpe, Branstator, Legnani, Ulbrich: Numerical experiments on the atmospheric response to cold equatorial conditions (“La Niña”) during Northern summer. *Atmos. Oc. Sys.*
  - Cui, von Storch and Zorita: Coastal sea level and the large-scale climate state: a downscaling exercise for the Japanese Islands. *Tellus*
  - J. von Storch: Interdecadal variability in a global coupled model, *Tellus*
  - Gyliastras, von Storch, Fischlin and Beniston: Linking GCM simulated climatic changes to ecosystems models. Case studies of statistical downscaling in the Alps. *Climate Research*
  - von Storch, Bürger, Schnur and von Storch: Principal oscillation patterns. *J. Climate*
  - Zwiers and von Storch: Taking serial correlation into account in tests of the mean. *J. Climate*

## t-test and serially correlated data

We want to test  $H_0: \mu_x = 0$  with  $x \sim \mathcal{N}(\mu_x, \sigma)$

a) sample is not serially correlated

calculate  $\bar{x} = \frac{1}{n} \sum_i x_i$

$$s^2 = \frac{1}{n} \sum_i (x_i - \bar{x})^2$$

and the statistic

$$t = \frac{\bar{x}}{\sqrt{s^2/n}}$$

If  $H_0$  is true then  $t \sim t(n)$  and  $\text{Var}(\bar{x}) = \frac{s^2}{n}$ .

For large  $n (\geq 30)$ :  $t(n) = \mathcal{N}(0, 1)$ .

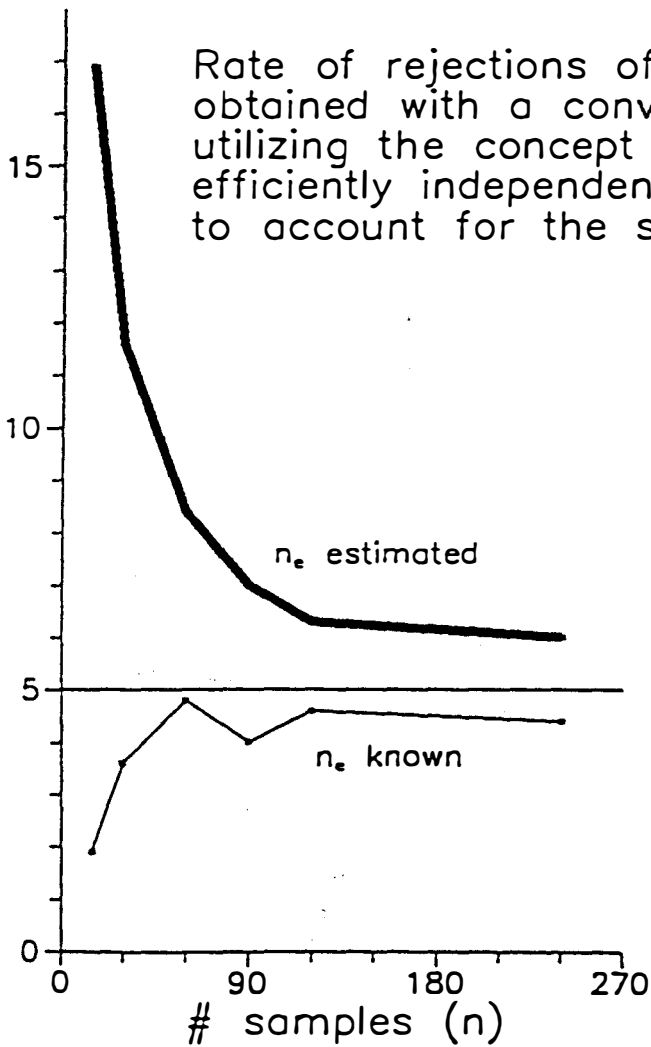
b.) sample is serially correlated.

Then the standard argument is

$$\text{Var}(\bar{x}) = \frac{s^2}{n_e} \quad \text{with } n_e = \text{"equivalent sample size"}$$

$$\Rightarrow t' = \frac{\bar{x}}{\sqrt{s^2/n_e}} \sim t(n_e)$$

provided  $H_0$  is true.



100 Monte Carlo Simulation were done for an AR(1)-process with memory 0.6.

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$$n_e = n / \frac{1+\alpha}{1-\alpha} = n/4$$

← solution  
 $t'$  is not  
 $t$ -distributed  
at all!

c) Cure

- if  $n_e \geq 30$  then  $t' \sim \mathcal{N}(0,1)$
- if  $n_e \leq 30$  use "Table look up-test", which operates with critical values derived in Monte Carlo experiments (with AR(1) - processes).

**6.6.9 The "Table Look Up Test".** A "Table Look Up Test" [155] is a small sample alternative to the conventional  $t$ -test, avoids the difficulties with estimating an equivalent sample size while remaining as efficient as the optimal asymptotic test when  $n'_X + n'_Y$  is large.

The table-lookup test procedure is as follows:

- The paired difference (or one-sample) case: To test " $H_0 : \mu = \mu_0$ " using a sample of size  $n_X$  compute

$$t = \frac{(\bar{x} - \mu_0)}{s_X / \sqrt{n_X}} \quad (6.27)$$

where  $\bar{x}$  is the sample mean and  $s_X^2$  is the sample variance

Compute the sample lag-1 correlation coefficient  $\hat{\alpha}_X$ . Use Tables F to determine the critical value for  $t$  which is appropriate to a sample of size  $n$  which has a lag-1 correlation coefficient  $\hat{\alpha}_X$ .

- The Two Sample Case: To test " $H_0 : \mu_y = \mu_x$ " using X- and Y-samples of size  $n_X$  and  $n_Y$  respectively compute

$$t = \frac{\bar{x} - \bar{y}}{S_p \sqrt{\frac{1}{n_X} + \frac{1}{n_Y}}} \quad (6.28)$$

where  $\bar{x}$  and  $\bar{y}$  are sample means and  $S_p$  is the pooled sample variance. Compute the pooled sample lag-1 correlation coefficient  $\hat{\alpha}$  using

$$\hat{\alpha} = \left[ \sum_{i=2}^{n_X} (x_i - \bar{x})(x_{i-1} - \bar{x}) + \sum_{i=2}^{n_Y} (y_i - \bar{y})(y_{i-1} - \bar{y}) \right] \times \left[ \sum_{i=1}^{n_X} (x_i - \bar{x})^2 + \sum_{i=1}^{n_Y} (y_i - \bar{y})^2 \right]^{-1} \quad (6.29)$$

Use Tables F to determine the critical value for  $t$  which is appropriate to a sample of size  $n_X + n_Y$  which has a lag-1 correlation coefficient  $\hat{\alpha}$ .

# External Projects of SAM

Natural Climate Variability.

- **Examination of various facets of the 1000 year run with the LSG/ECHAM model:** with LODYC (C. Frankignoul and E. Zorita) and others
- **Stationarity (or non-stationarity) of the storm and wave climate in the North Atlantic and in the North Sea:** with WASA group.

# External Projects of SAM

## Climate Change

- **Downscaling**

- Rainfall Generators: with D. Lettenmaier and R. Schnur.
- Hydrography of the North Sea - mean circulation and storm surges: with J. Sündermann and J. Backhaus.

- **Implications of climate change**

- Alpine sites and forest models: with D. Gyalistras
- Aquatic ecosystems; Case studies Helgoland Roads and Plussee: with Lampert, Greve und Kausch

- **Interaction of Climate and Economy.** Construction of highly aggregated integrated models of economy and climate; with O. Tahvonen and H. J. Oberle.

Decision making: with A. Murphy

- **Climate and Society.** The social perception of climate and climate change; with N. Stehr and D. Bray



# Sergej W. Steinhausen

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- **Born in 1920 in Latvia**
- **Studied Mathematics and Physics in Moscow and worked afterwards at the famous Latvian Institute for Mathematics until 1955** - in this time he wrote his famous monograph "On the p-property" (in Russian).
- **He disappeared in 1955 and resurfaced 1959 in Chicago, where he met J. Charney and published in 1962 his landmark theorem on the conservation of the p-property.**
- **After a productive scientific career in the USA he retired.** Rumors are that he is now with the Brigham Young University in Salt Lake City.

# Steinhausen-Preis

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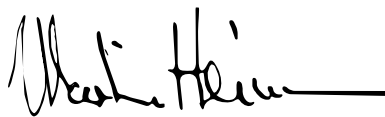
- **Wir sehen uns zwei Problemen gegenüber:**
  - In der Hasselmann Abteilung fehlt es an akademischer Würde.
  - Das Werk S.W. Steinhausens ist nicht seiner Bedeutung entsprechend bekannt.
- **Daher richten wir, Hans von Storch und Martin Heimann, als regelmässige Prozedur die Verleihung des Steinhausen Preises ein.**
- **Mit diesem Preis soll eine im vergangenen Jahr be-  
gangene GROSSTAT gewuerdigt werden.** Diese kann  
spezifiziert werden oder auch nicht.
- **Der Preis wird nur in diesem Jahre von den Stiftern  
verteilt, in den folgenden Jahren obliegt die Auswahl  
dem letztjährigen Preisträger.**
- **Der Preis besteht aus einer Büste Steinhausens und  
einer Urkunde.**

Hiermit wird  
Herrn Dr. Ulrich Cubasch  
der  
Steinhausen Preis 1994

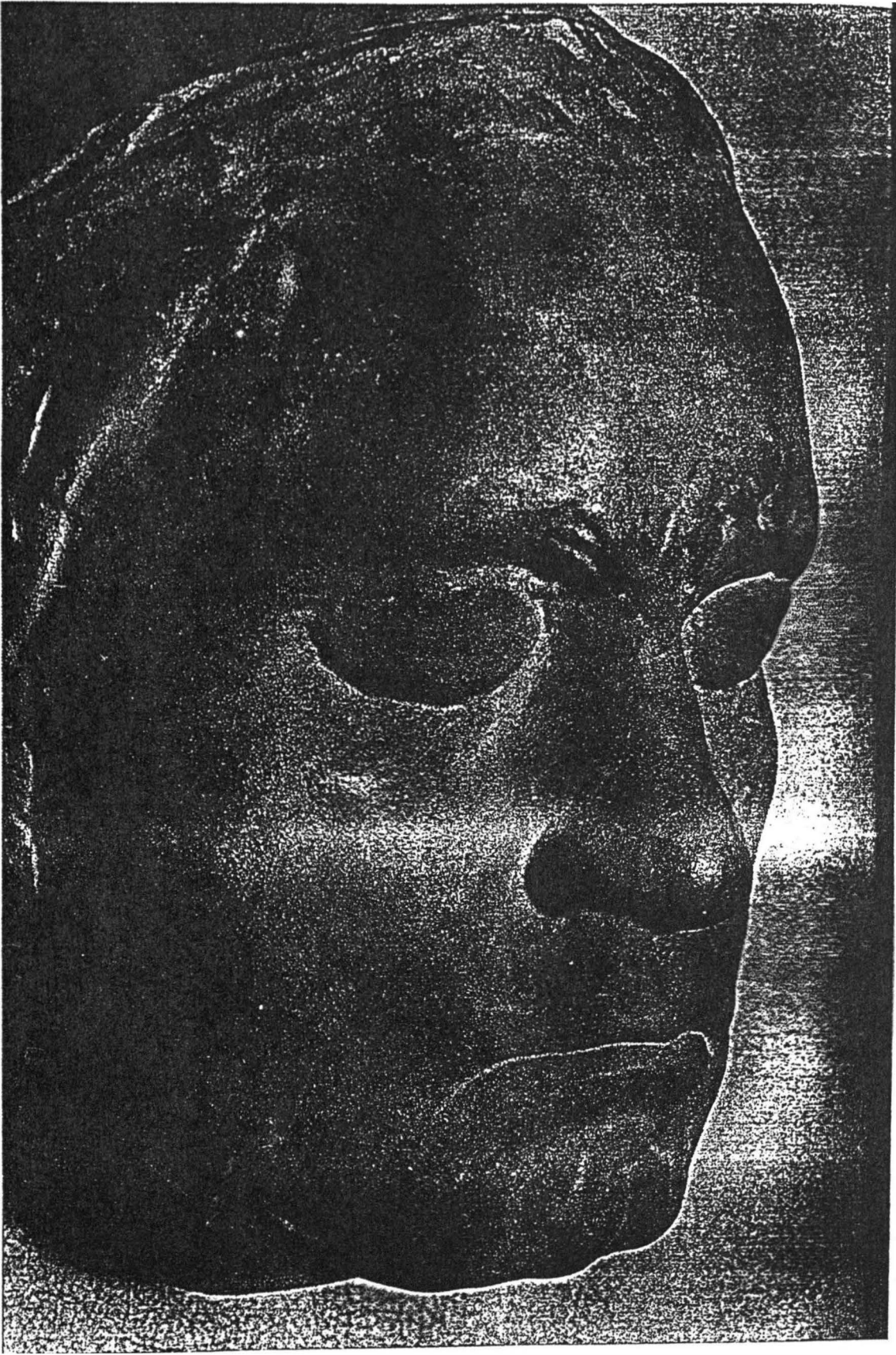
der Klimaabteilung des Max-Planck-Instituts für Meteorologie  
für eine konkrete aber unspezifizierte Grosstat  
im Zeitraum 17. Mai 1993 bis 16. Mai 1994  
verliehen.

Die Stifter des Steinhausen Preises

  
Hans von Storch

  
Martin Heimann

Salzau, 16. Mai 1994



# Steinhausen's theory on the p-property

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- **Theorem I:**

A process  $Y$  has the p-property if  $S(Y) > 1$ .

- **Lemma:**

A process with the p-property is non-stationary.

- **“Steinhausen”-Theorem:**

The p-property is conserved if and only if the zonal wind is westerly.

AUTHOR(s): Steinhausen, S.W.  
Ballantyne, D.  
Fretschner, M.  
TITLE(s): Sex differences in autoregulation of juxtamedullary  
glomerular blood flow in hydronephrotic rats.

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- 2 Steinhausen, S. W. (The international journal of eating 12/01/93)  
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- 4 Steinhausen, S. W. (Journal of the American Academy o... 09/01/93)  
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- 5 Steinhausen, S. W. (Acta psychiatrica scandinavica. 09/01/93)  
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- 6 Steinhausen, S. W. (The International journal of eati... 03/01/93)  
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-----UnCover-----

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