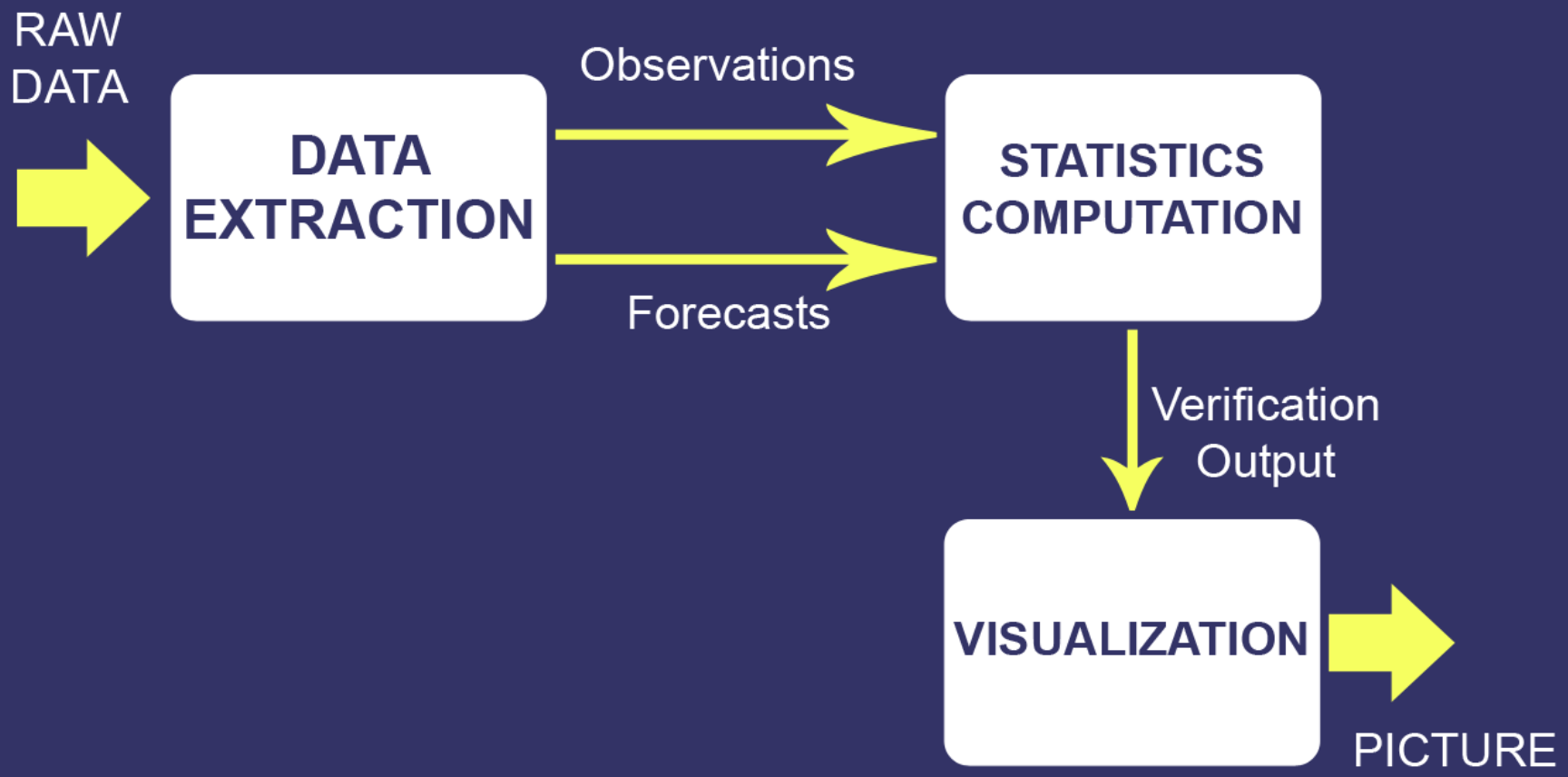
Visualization of forecast models verification

Author: **Bc. Marek Kružliak**
Supervisor: RNDr. Andrej Lúčny, PhD.
Meteorology expert: Mgr. Juraj Bartok, PhD.
Company: MicroStep-MIS, spol. s r. o

Objectives

- Implementation of forecast model verification
- Explaratory visualization of verification data

System Design



Simplified System Design inspired by NCAR's METviewer [2]

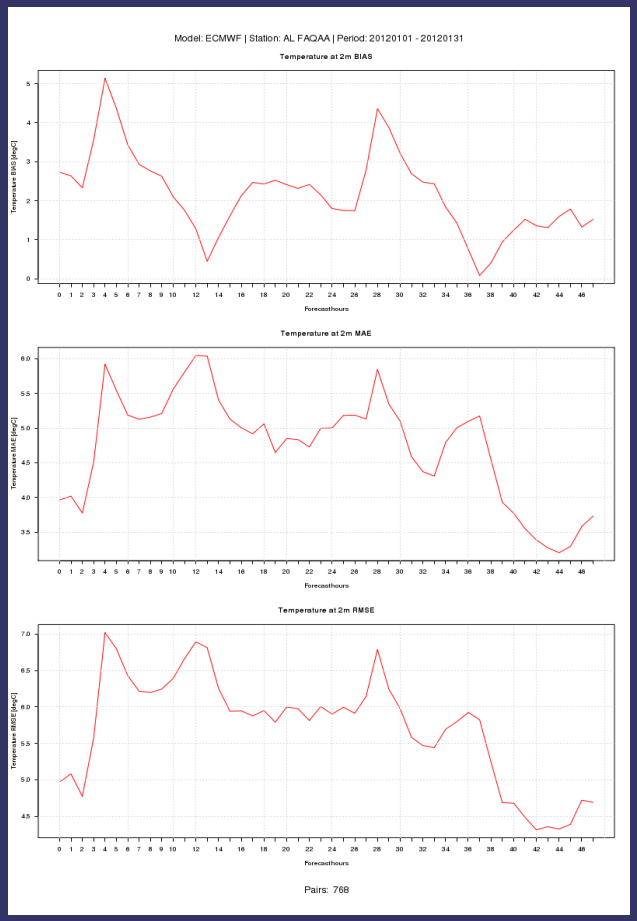
Current Solution

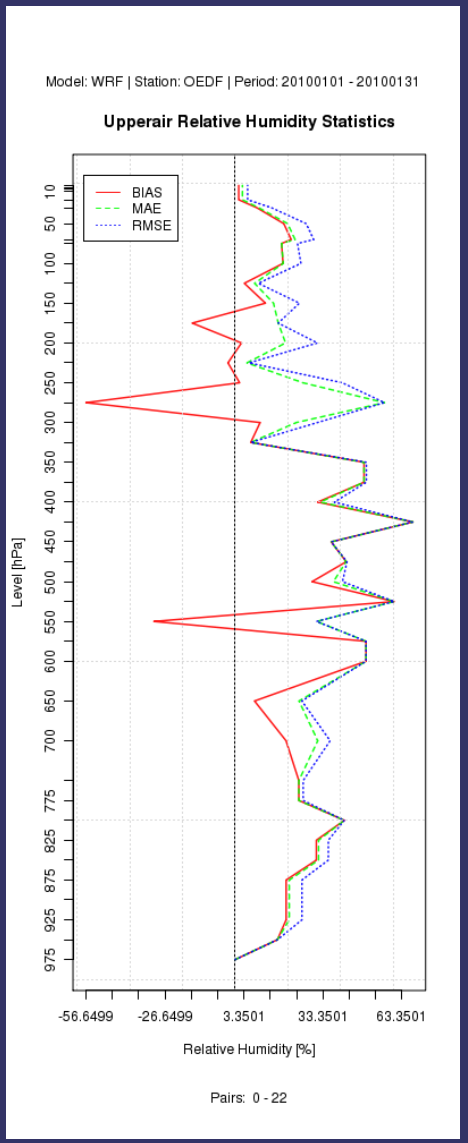
- DATA Extraction:
  - GRADS
  - Manually
- Statistics computation and Visualization:
  - R-Script
- Everything managed with few BASH scripts

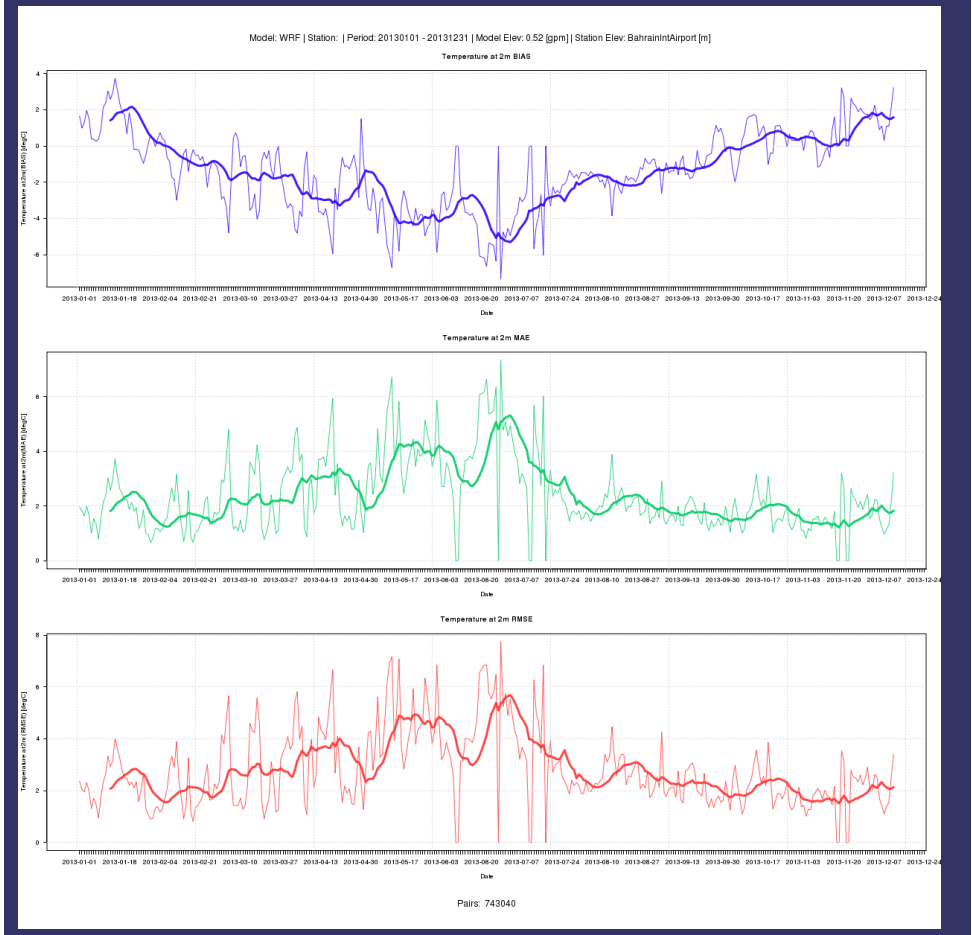
Current Solution Drawbacks

- **Usability:**
  - **User side:**
    - **No GUI**
    - **No Settings control**
    - **Only programmer can run it**
  - **Programmer side:**
    - **Not versitile (Hard to make changes)**
    - **Big mess**
    - **3rd party software (GRADS)**

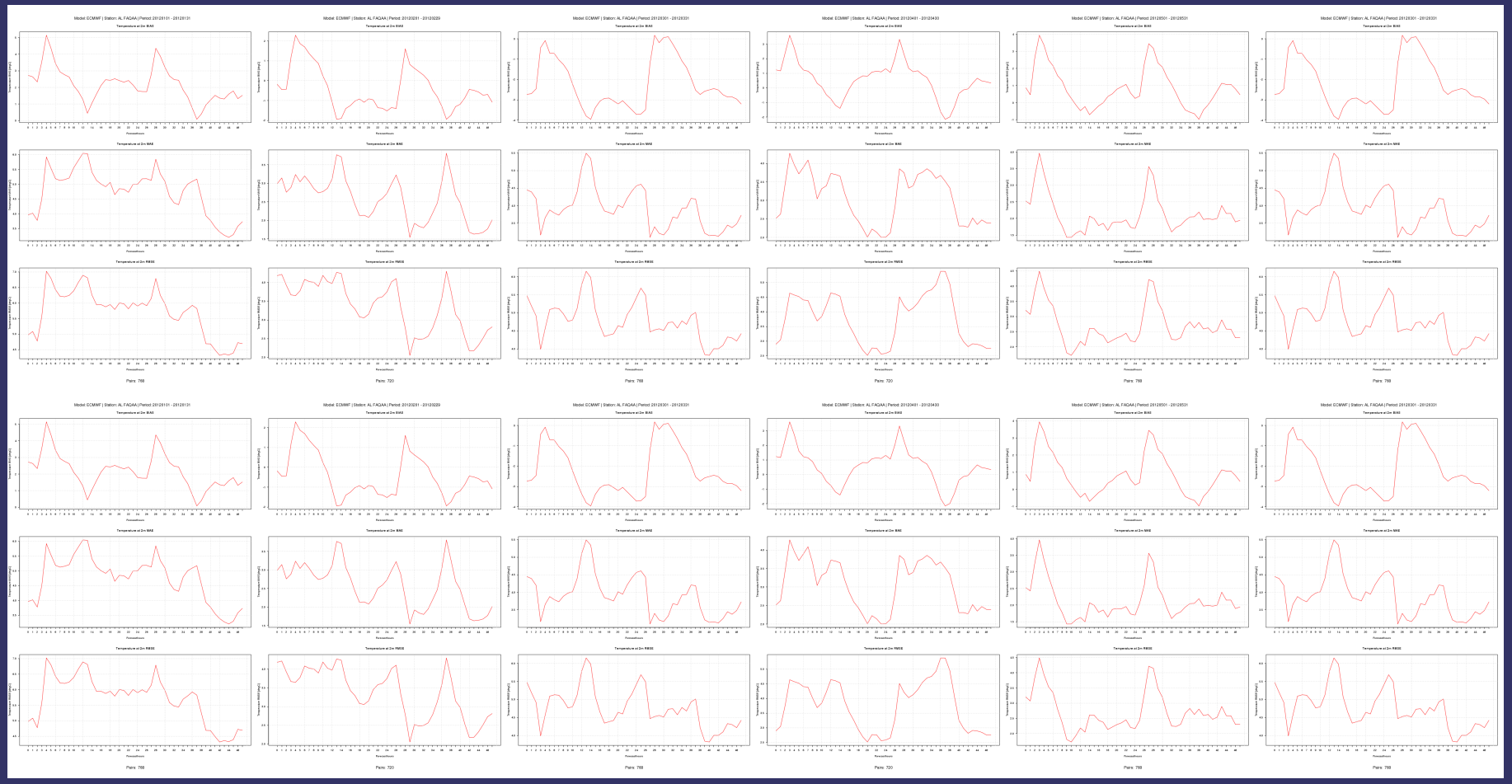
Verification Visualization today





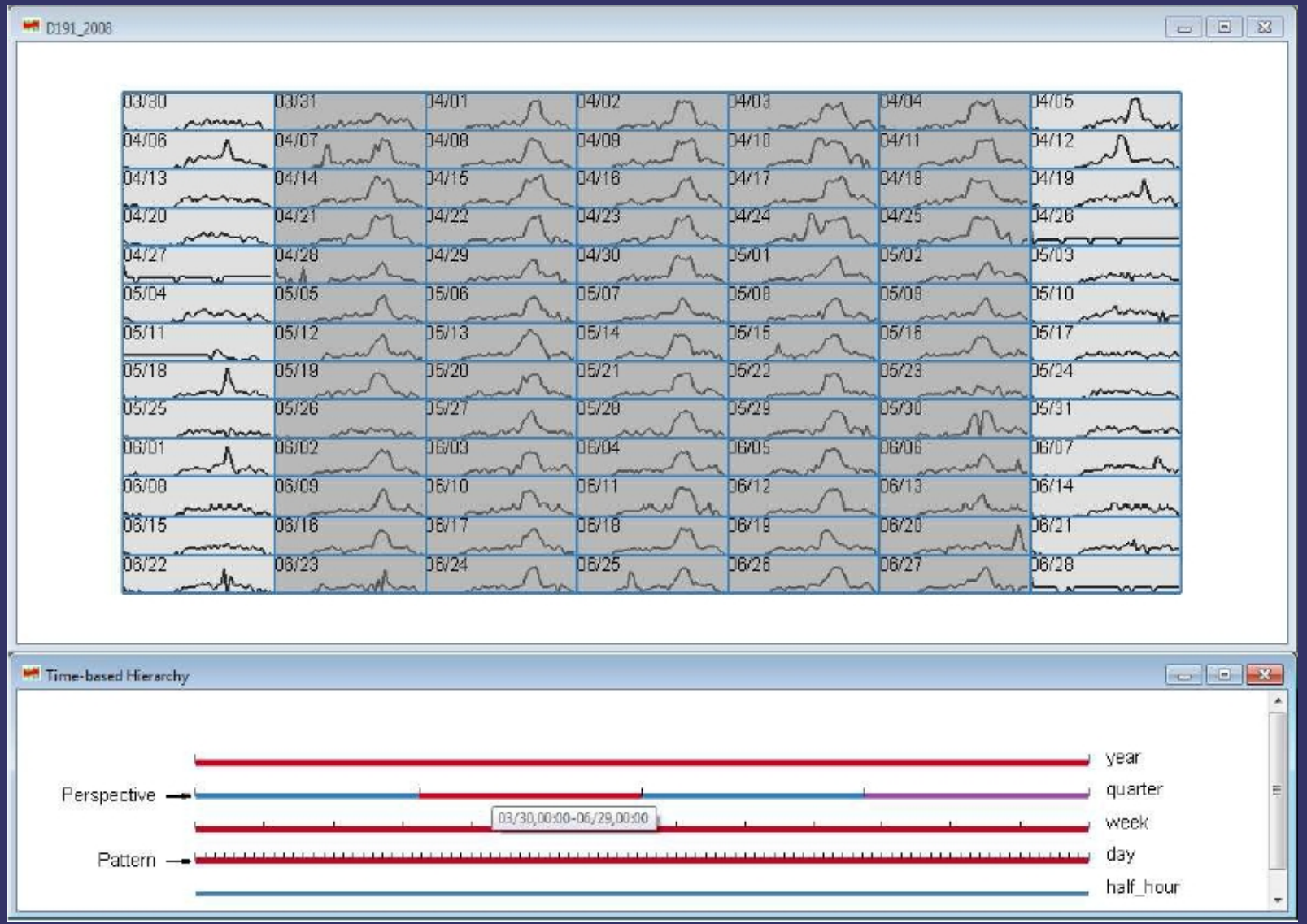


How to compare values in year?



This strongly resambles Nested Timelines [3]

Nested Timelines [3]

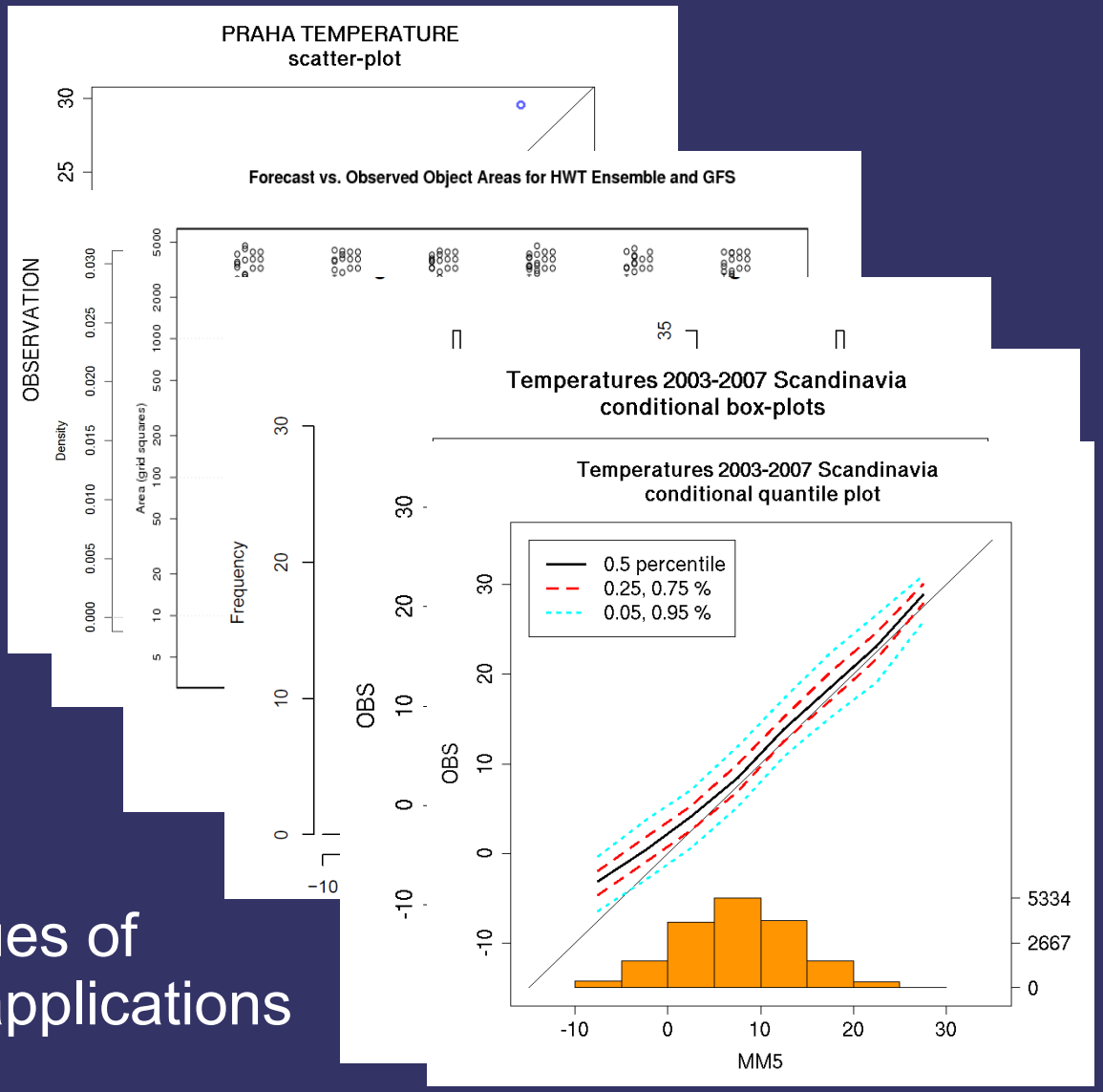


Why it isn't enough?

- Not eye appealing
- Screen Space consumption
- No interactivity
- Loss of information about relationships
- Hard to compare two/more time intervals

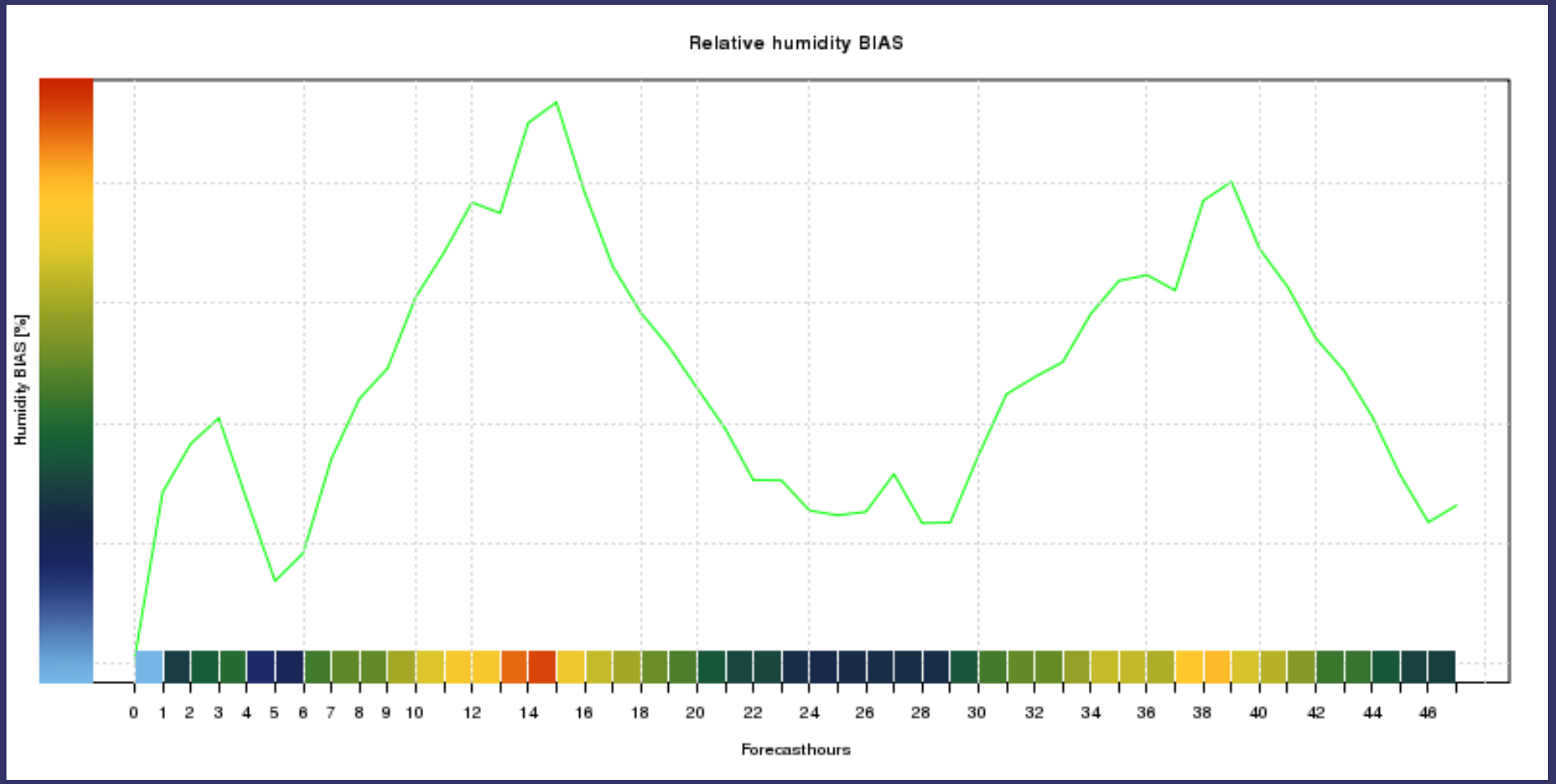
Other Solutions

- Scatter plots
- Density plots
- Box plots
- Histograms
- Cumulative distributions
- Quantile-Quantile plots
- Conditional quantile plots
- Conditional box plots

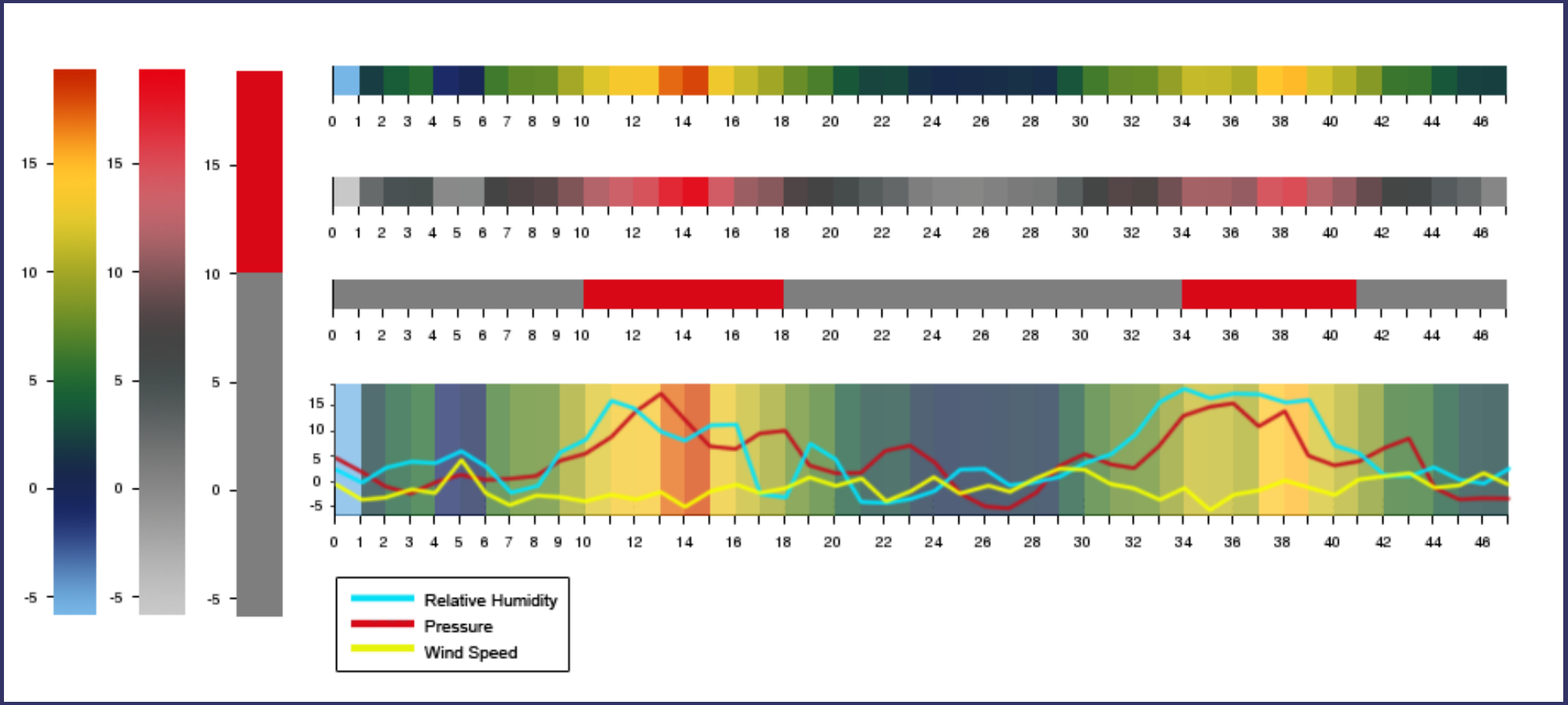


Visualisation techniques of verifications used in other applications [1] [2] [4]

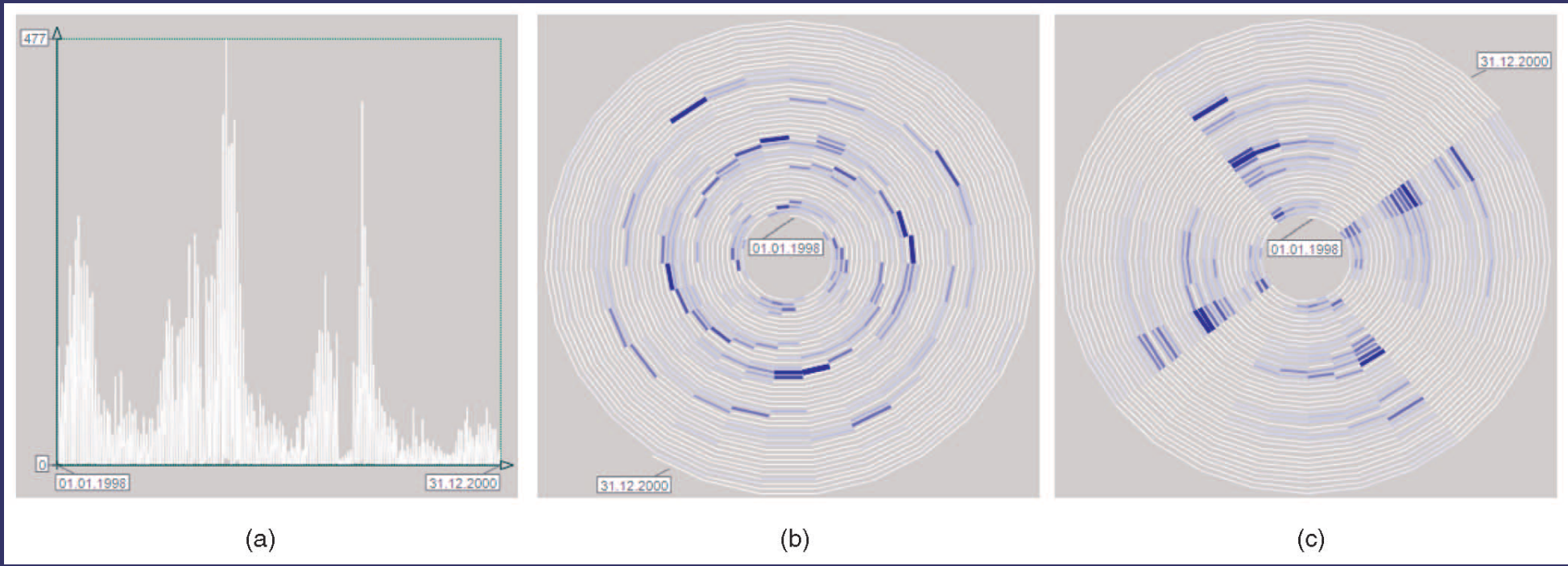
1st Visualization Design Mapping Error to Colors



1st Visualization Design
Color Palette and Semantic Zoom



1st Visualization Design
Cyclic Time

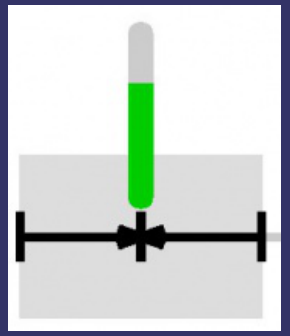


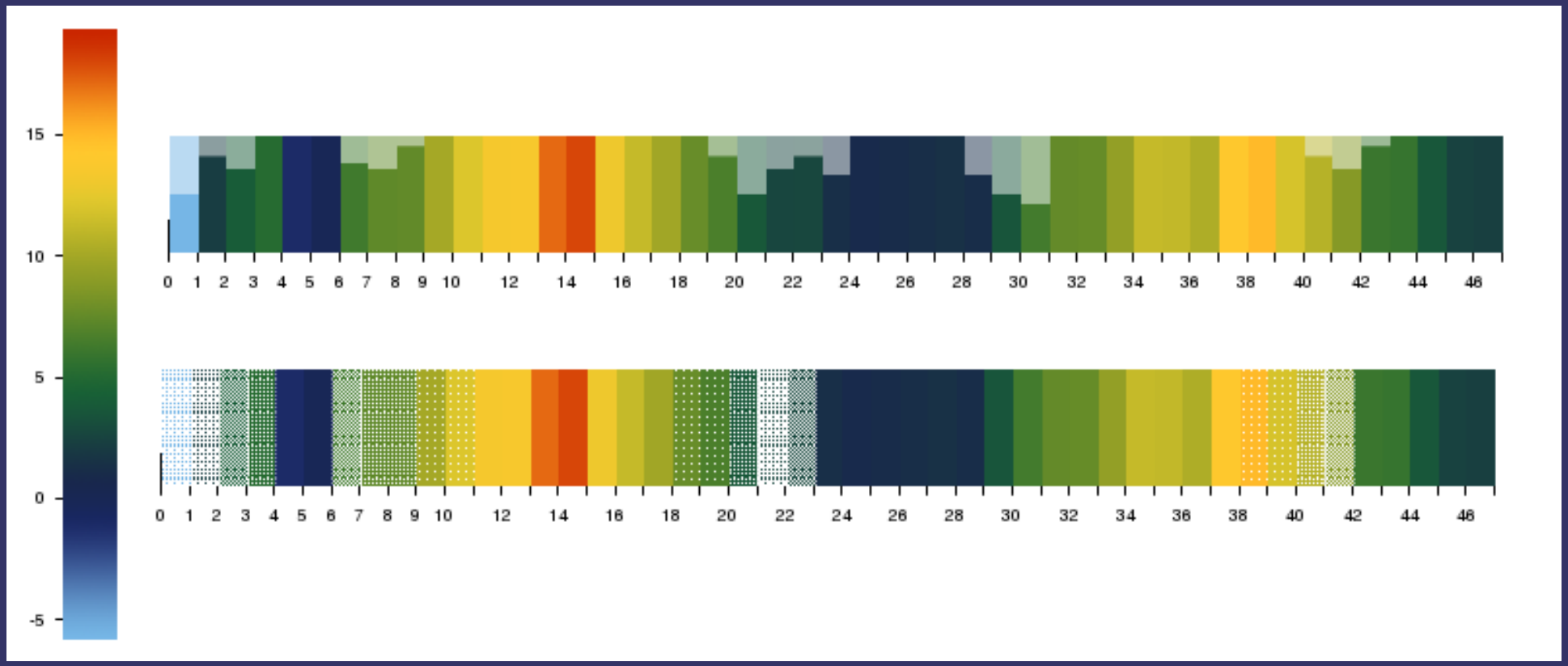
(a) (b) (c)

Suitable method to find patterns in forecast errors during a year is **Spiral Grahp** [5]

Data Credibility Visualization Design

- Data credibility vis by Bade and Shlechtweg [6]





Current State of Implementation

- Continuous,Categorical Statistics based on Barbara Brown's Verification tutorial [4]
- Data extraction from local GRIB database
- Visualization libraries and tools:
  - Protovis [7]
  - Cubism.js + D3.js [8]
  - R [9]

References 1

[1] Lundblad, P. ; Swedish Meteorol. & Hydrol. Inst., Sweden ; Lofving, H. ; Elovsson, A. ; Johansson, J., *Exploratory Visualization for Weather Data Verification*, 15th International Conference on Information Visualisation, 2011

[2] Oldenburg P. ; Halley Gotway J. ; Jensen T. ; *The Model Evaluation Tools (MET) verification statistics* visualization, poster NCAR / RAL / DTC, 2011

[3] Xie, Zaixian; Ward, Matthew O.; Rundensteiner, Elke A., *Exploring Large Scale Time-series Data Using Nested Timelines*, Oracle America Inc., 1 Oracle Drive, Nashua, NH, USA Worcester Polytechnic Institute, 100 Institute Road, Worcester, MA, USA , Proceedings of the SPIE, Volume 8654, 2013

[4] Barbara Brown, *Verification Tutorial*, National Center for Atmospheric Research, Boulder Colorado USA

References 2

[5] Wolfgang Aigner, Silvia Miksch, Wolfgang Mu¨ ller, Heidrun Schumann, and Christian Tominski, *Visual Methods for Analyzing Time-Oriented Data*, IEEE TRANSACTIONS ON VISUALIZATION AND COMPUTER GRAPHICS, VOL. 14, NO. 1, JANUARY/FEBRUARY 2008

[6] R. Bade, S. Schlechtweg, and S. Miksch, *Connecting Time-Oriented Data and Information to a Coherent Interactive Visualization*, Proc. 2004 Conf. Human Factors in Computing Systems (CHI '04), pp. 105-112, 2004.

[7] Jeff Heer and Mike Bostock of the Stanford Visualization Group, *Protovis*, http://mbostock.github.io/protovis/protovis-java/

[8] Mike Bostock, *Data Drivern Documents (D3)*, http://d3js.org/

[9] Robert Gentleman and Ross Ihaka, *R-script project*,

http://www.r-project.org/, Statistics Department of the University of Auckland

Thank You