

Visualization of forecast models verification

Author: **Bc. Marek Kružliak**

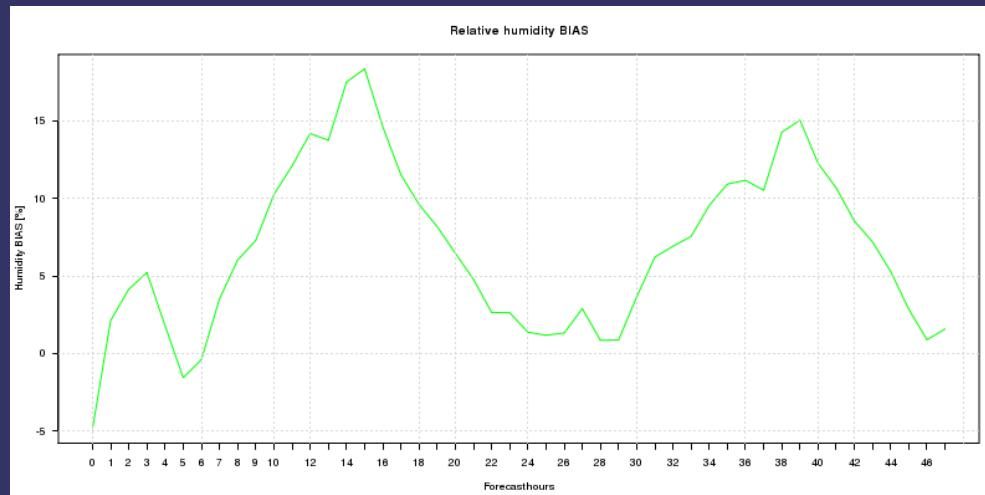
Supervisor: RNDr. Andrej Lúčny, PhD.

Meteorology expert: Mgr. Juraj Bartok, PhD.

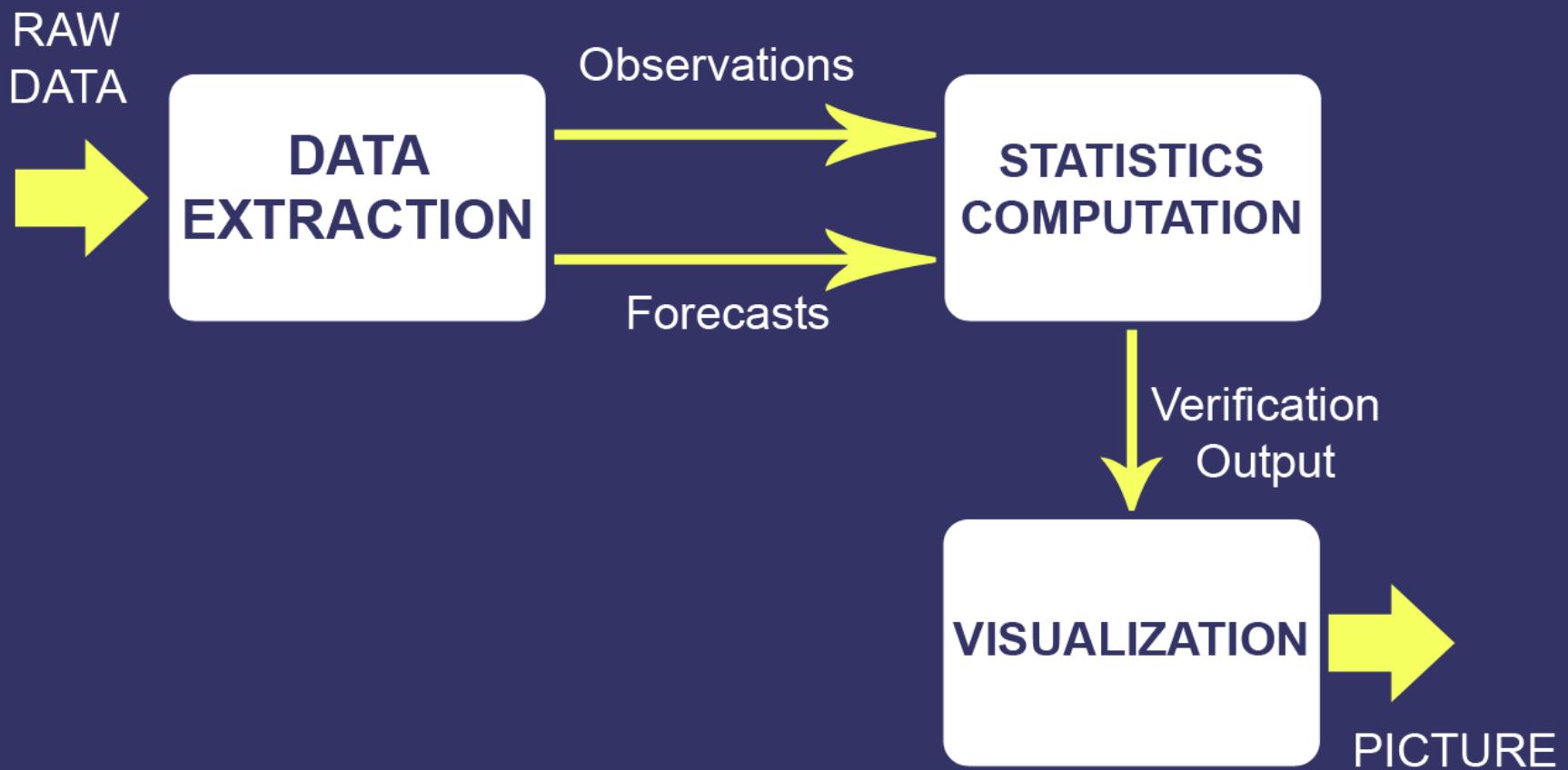
Company: MicroStep-MIS, spol. s r. o

Objectives

- Implementation of forecast model verification
- Visualization of verification data:
 - Multidimensional data in **one image**
 - Interactive application



System Design



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

Current Solution

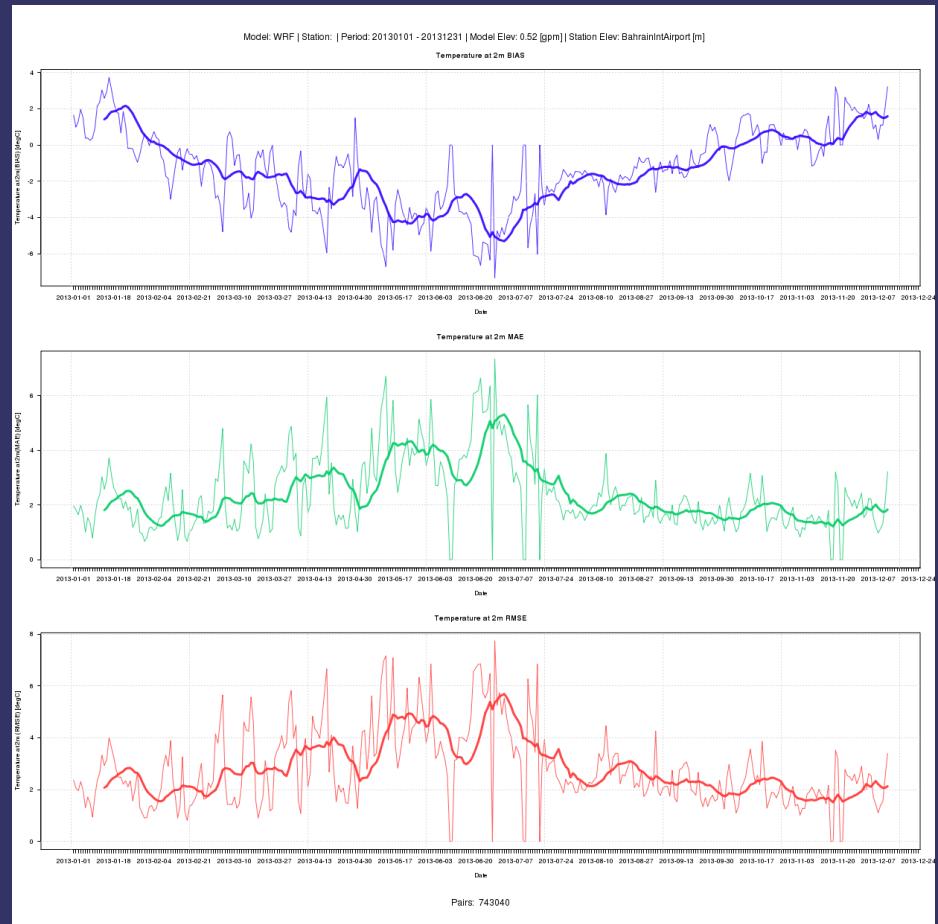
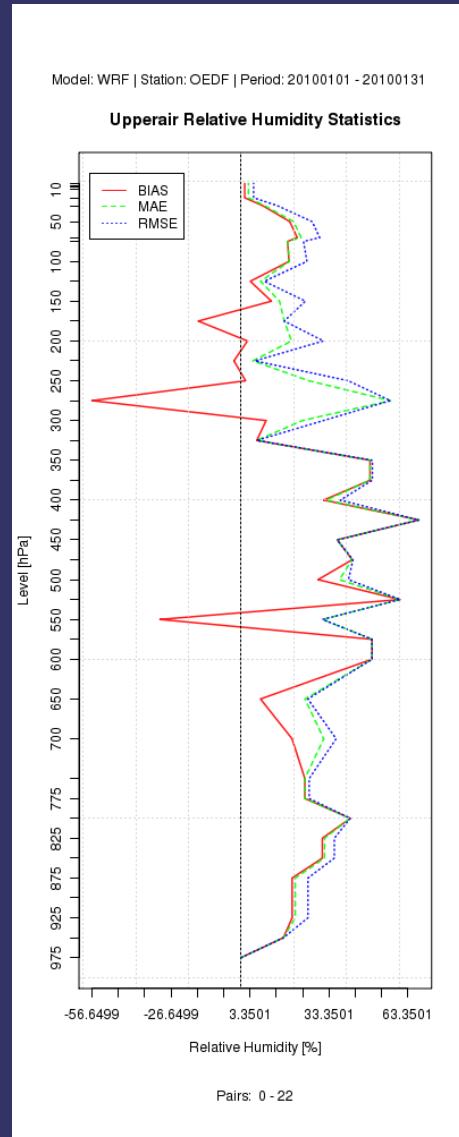
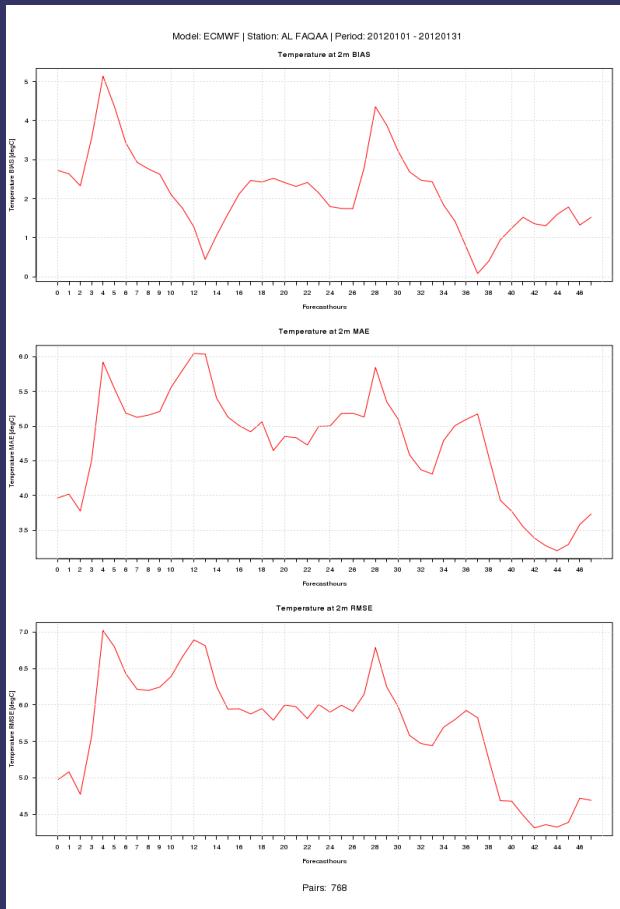
- DATA Extraction:
 - GRADS
 - Manually
- Statistics computation and Visualization:
 - R-Script
- Everything managed with few BASH scripts

Current Solution Drawbacks

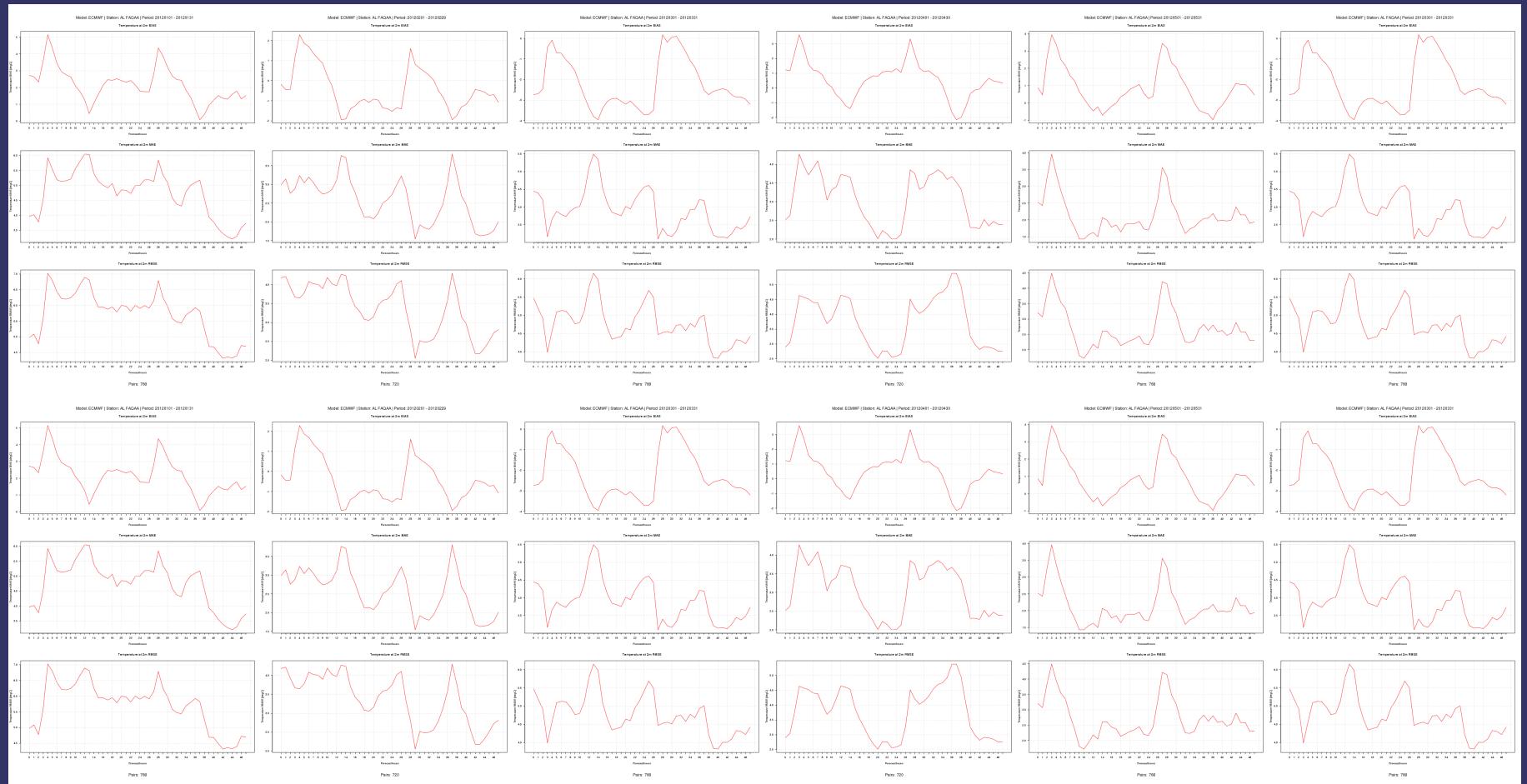
- **Usability:**

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

Verification Visualization today

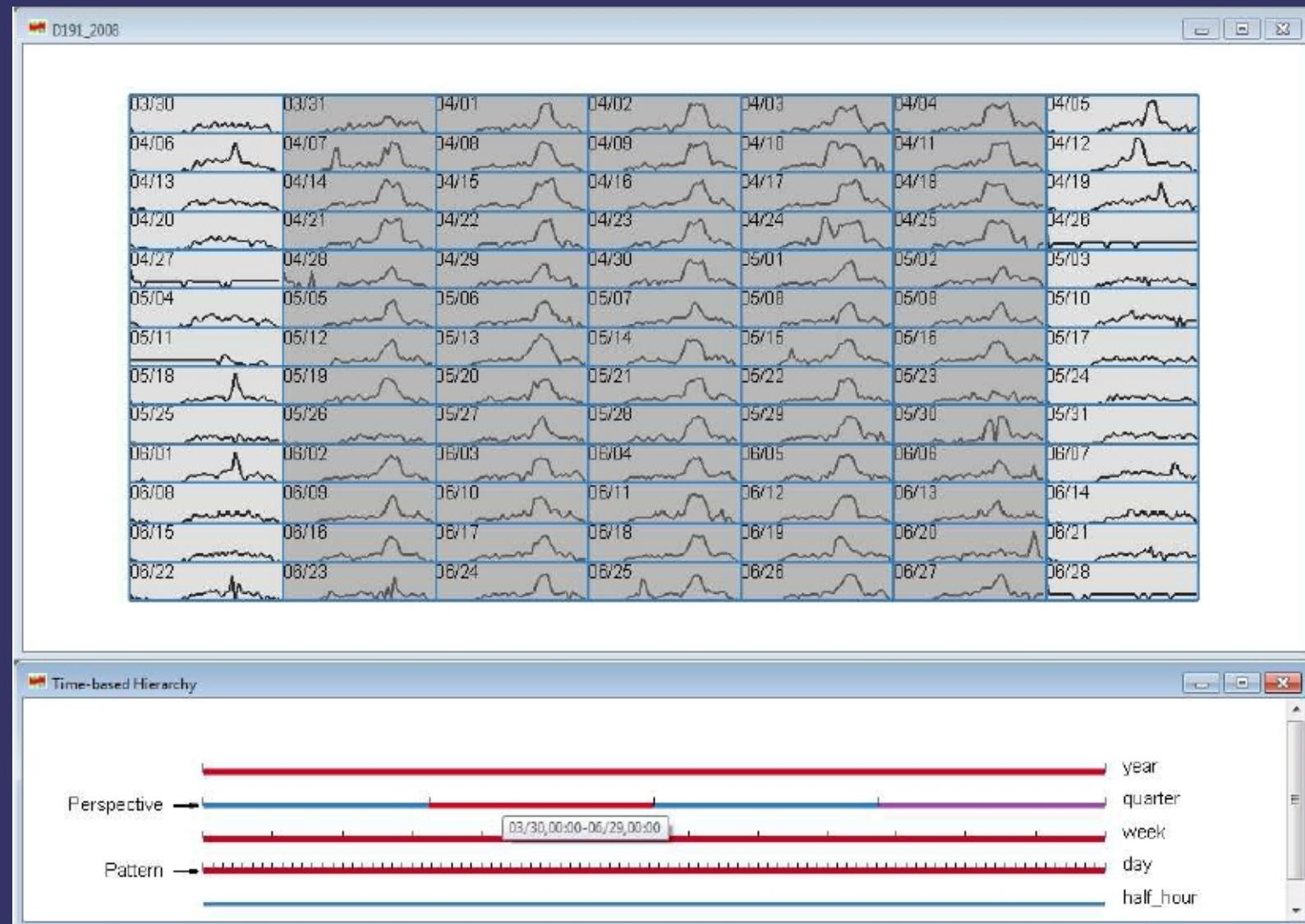


How to compare values in year?



This strongly resembles Nested Timelines [3]

Nested Timelines [3]



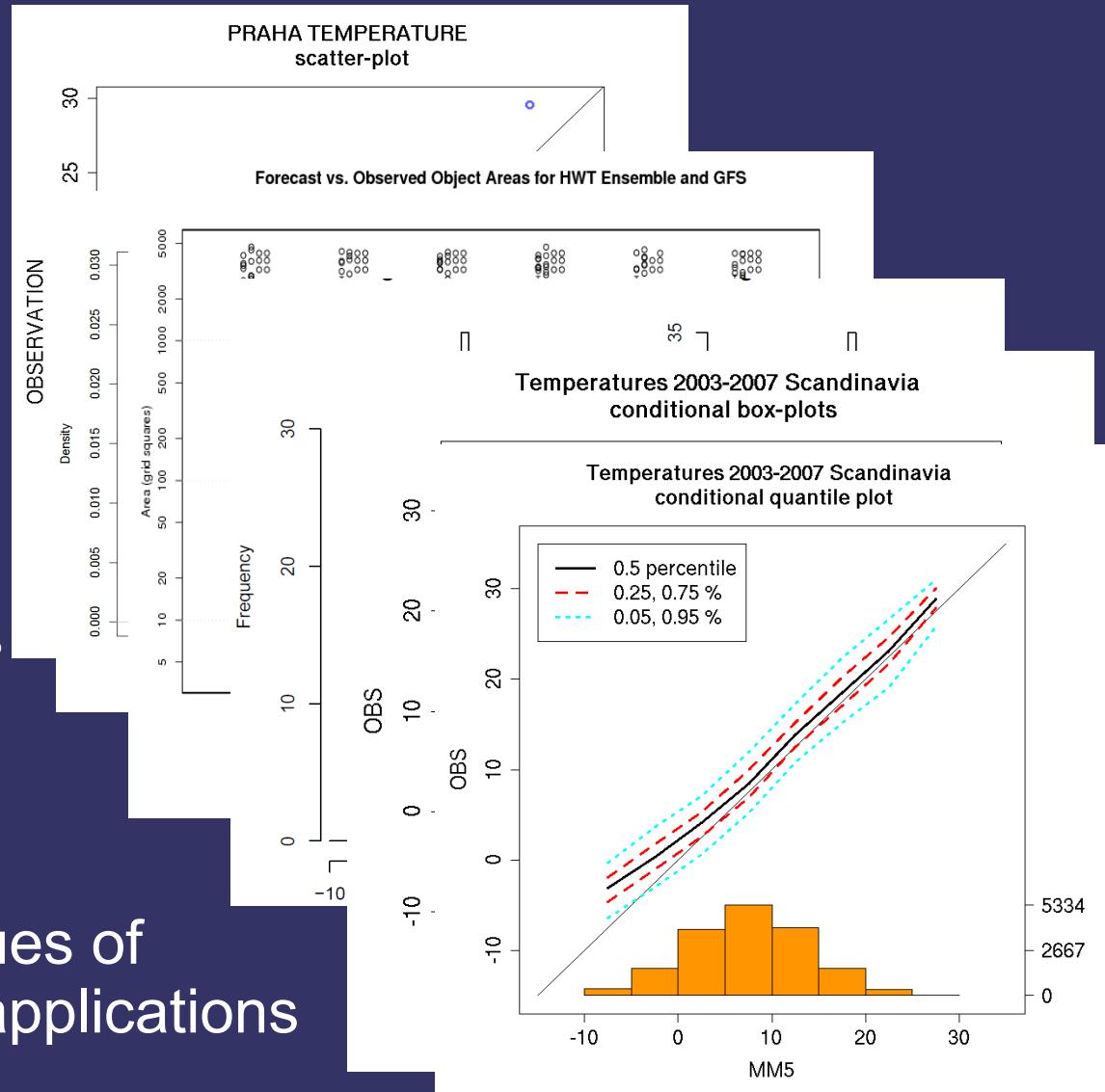
Why it isn't enough?

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

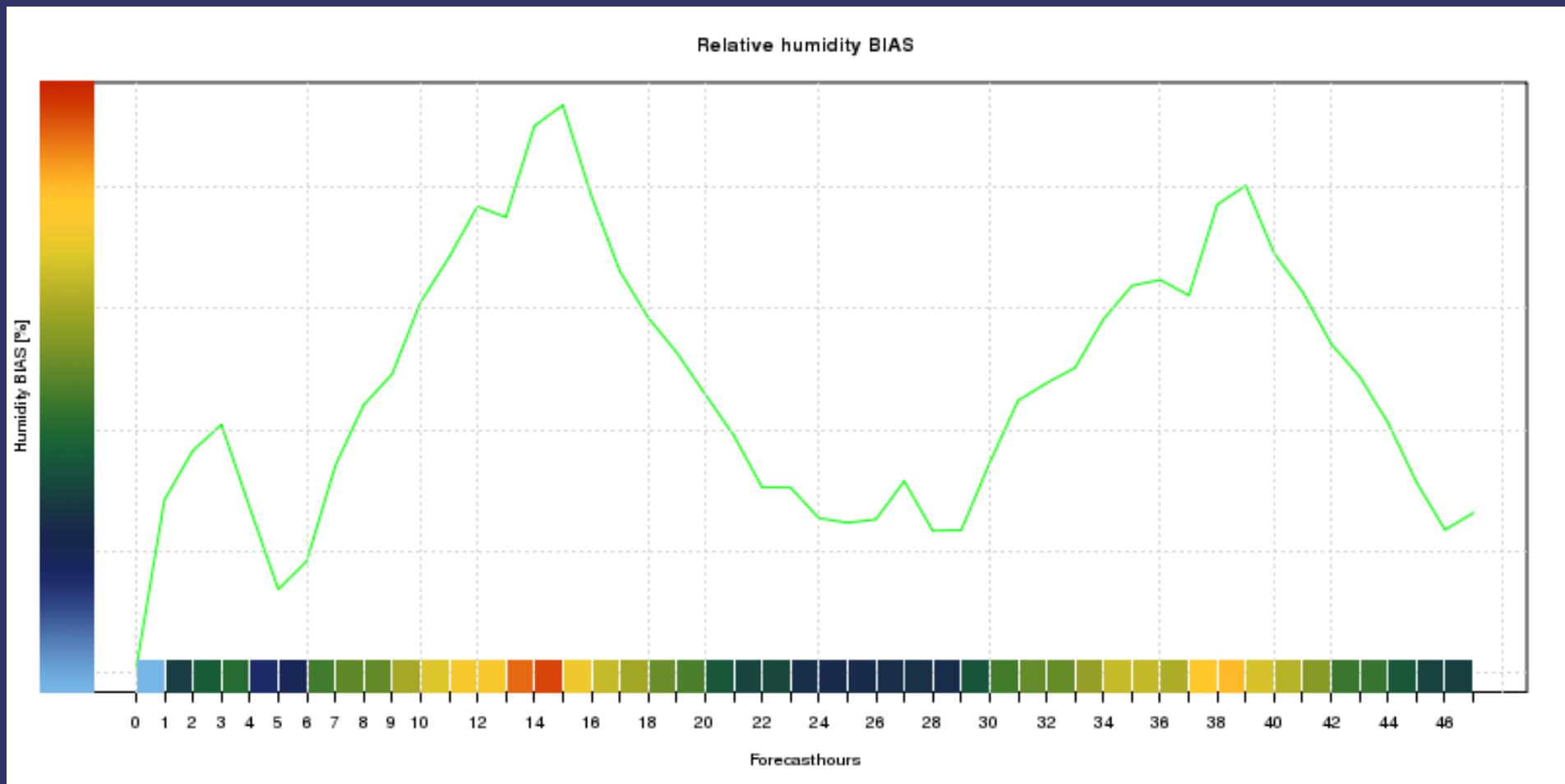
Other Solutions

- 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]

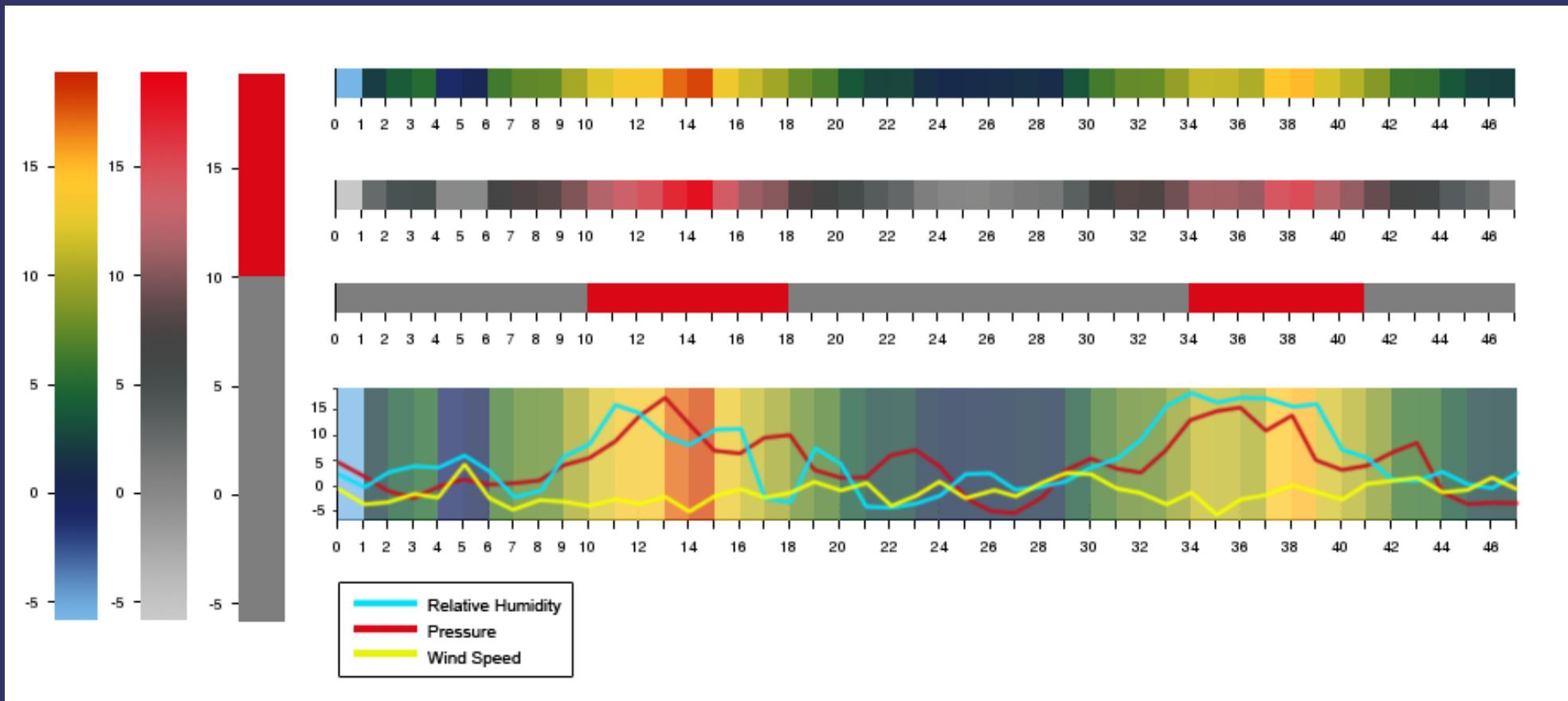


1st Visualization Design Mapping Error to Colors

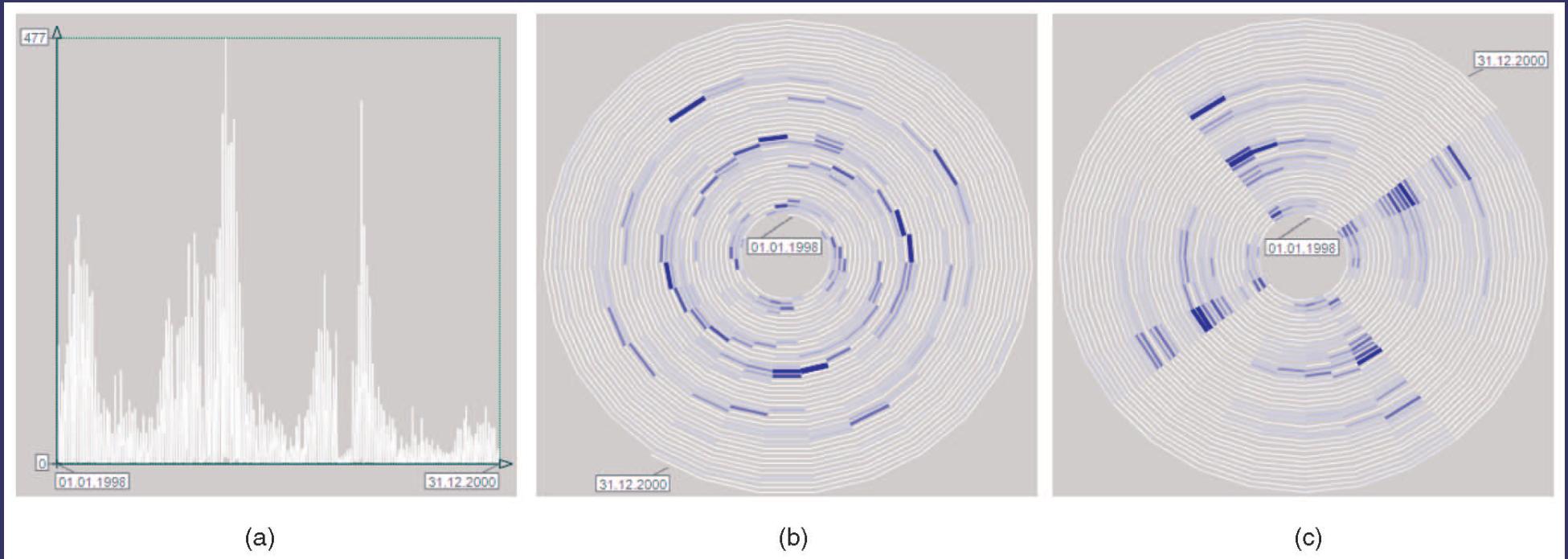


1st Visualization Design

Color Palette and Semantic Zoom



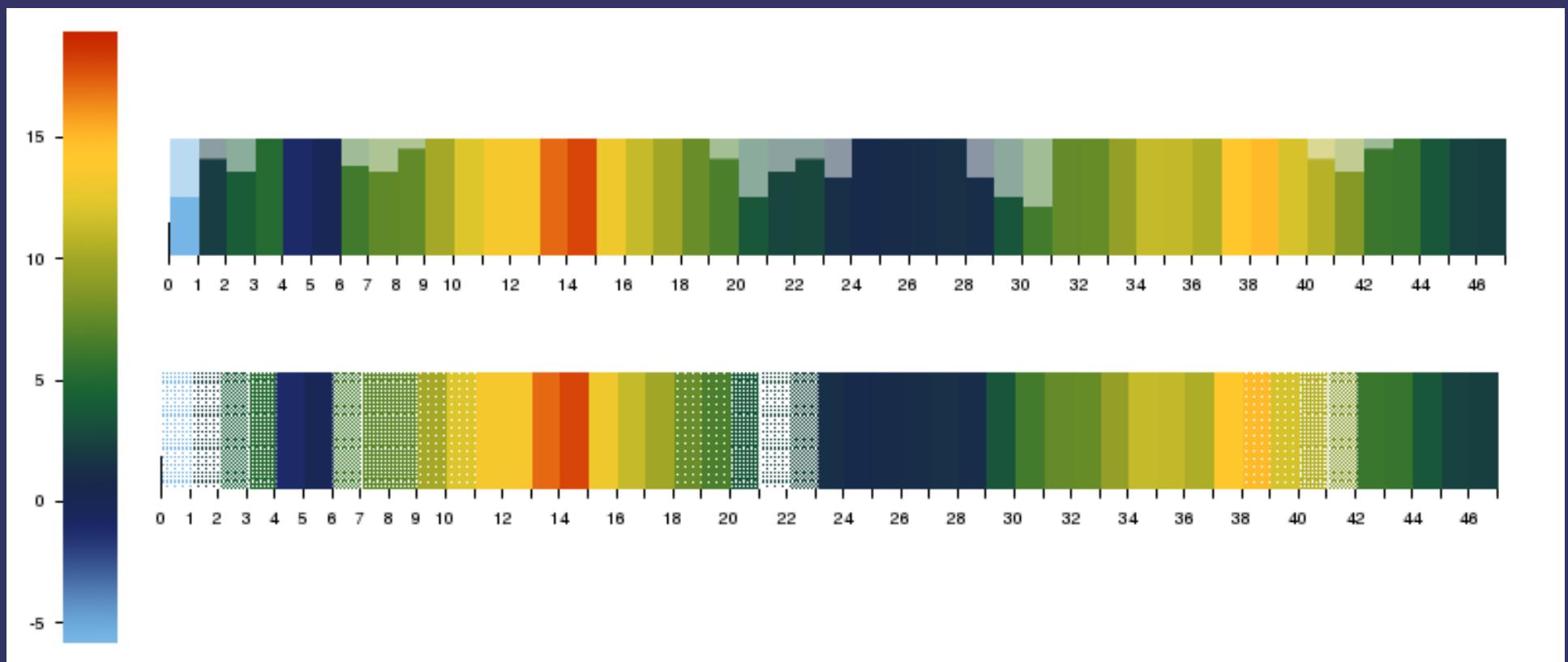
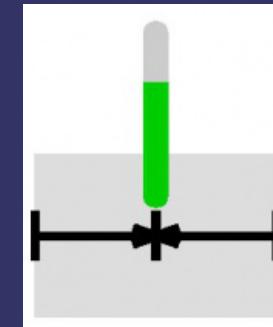
1st Visualization Design Cyclic Time



Suitable method to find patterns in forecast errors
during a year is **Spiral Graph** [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:
 - Protopis [7]
 - Cubism.js + D3.js [8]
 - R [9]

References 1

- [1] Lundblad, P. ; Swedish Meteorol. & Hydrol. Inst., Sweden ; Lofving, H. ; Elofsson, 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 Müller, 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, *Protopis*, <http://mbostock.github.io/protovis/protovis-java/>
- [8] Mike Bostock, *Data Driven 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