A statistical downscaling study on Antarctic Peninsula temperature variability based on Weather Type Classifications

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SCAR Open Science Conference 2016,
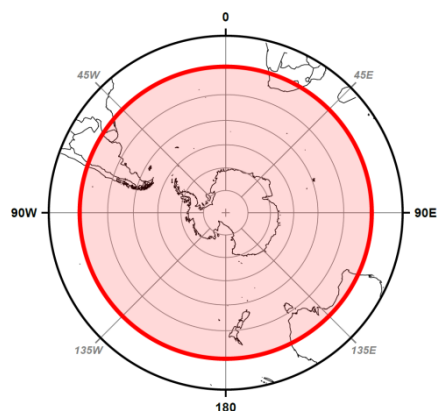Kuala Lumpur, Malaysia
22th – 26th August 2016

Knowledge for Tomorrow

DLR

Spatial Domains & Methods

- Relation between large-scale Atmospheric Circulation (ERA-Interim) and
 local Antarctic Peninsula (AP) Temperature Variability (Met. Surface Observation)

	S-Hemisphere (SAM) Domain
Investigation of	Variability Modes of atmospheric Circulation
Utilized Methods	Principle Component Analysis (PCA)
Results	Variability Patterns and temporal Score

Spatial Domains & Methods

- Relation between large-scale Atmospheric Circulation (ERA-Interim) and local Antarctic Peninsula (AP) Temperature Variability (Met. Observations)

|	S-Hemisphere (SAM) Domain	WA & AP Domain	AP Domain
Investigation of	Variability Modes of atmospheric Circulation	Circulation types (CT) at Sub-continental scale	Regional Circulation- and Weather Types (WT)
Utilized Methods	Principle Component Analysis (PCA)	(cond.) **Cluster Analysis,** Self-Organizing-Maps, (…)	(cond.) Cluster Analysis, **Prototype Classification**, (…)
Results	Variability Patterns and temporal Score	Frequencies and Internal characteristics of CTs	Frequencies and Internal characteristics of CTs
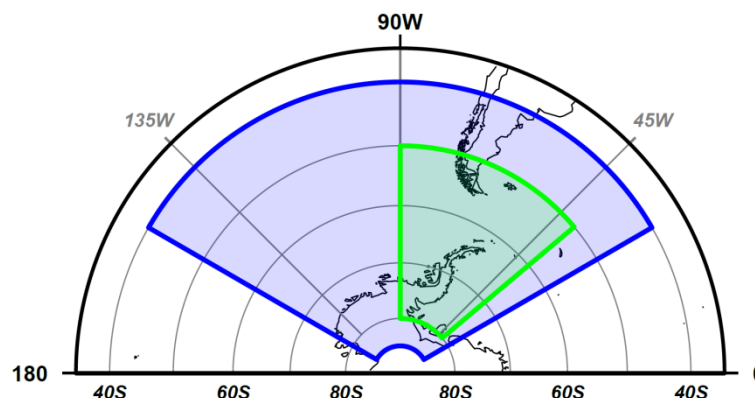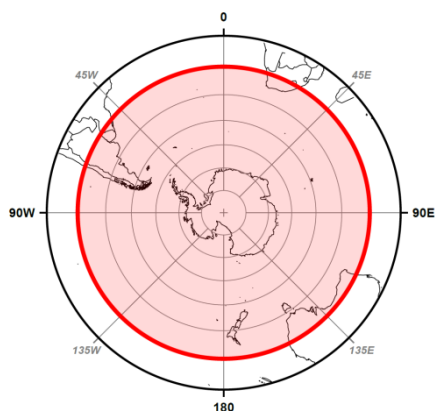
Temporal SAM characteristics

- Southern Annular Mode (SAM): circulation dynamics of the 700 hPa GPH (ERA-Interim)
- Turnaround in the temporal course in the late 1990s (e.g. Turner et al., 2016)
- Consistent with other Re-Analysis (NCEP-NCAR, JRA-55)

SAM pattern, ERA−Interim (700 hPa): 1980−1999

Mean SAM-Pattern structure

1st PC loading
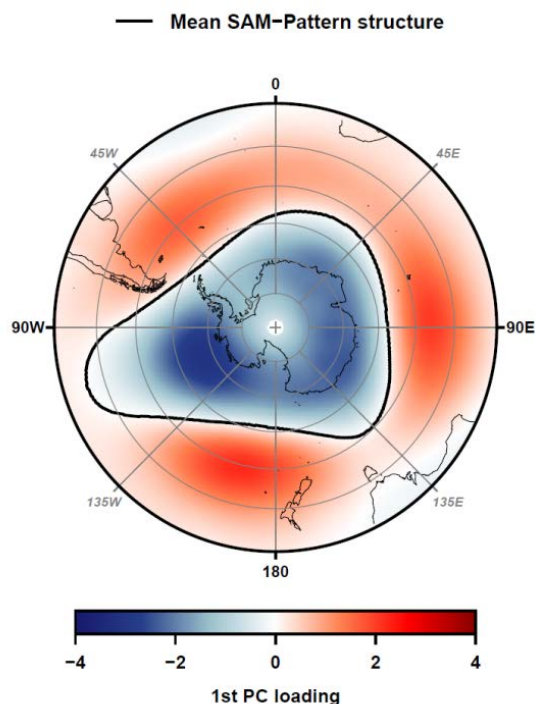
SAM index, ERA−Interim (700 hPa): 1979 − 2015

SAM index
stand. cumulative SAM index
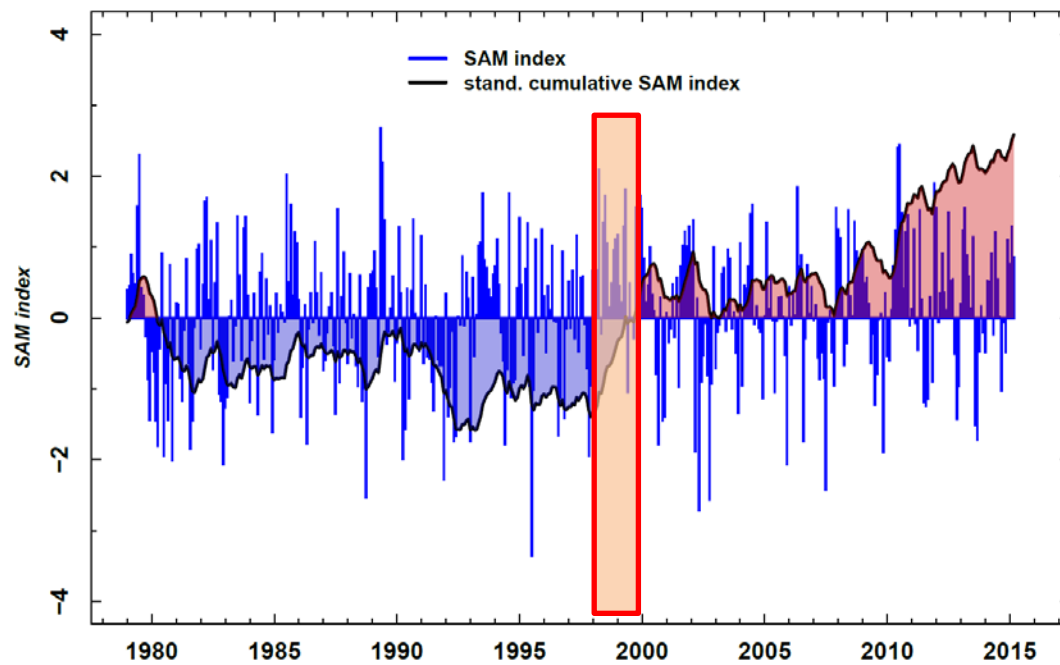
How to access spatio-temporal SAM variability?

- Modified SAM-Analysis, Focus on SAM-Pattern:

  - Applying PCA with a monthly moving window
    for 5-year intervals

  - ➔   ~375 runs comprising spatio-temporal
   resolved SAM-Pattern maps from 1982-2012
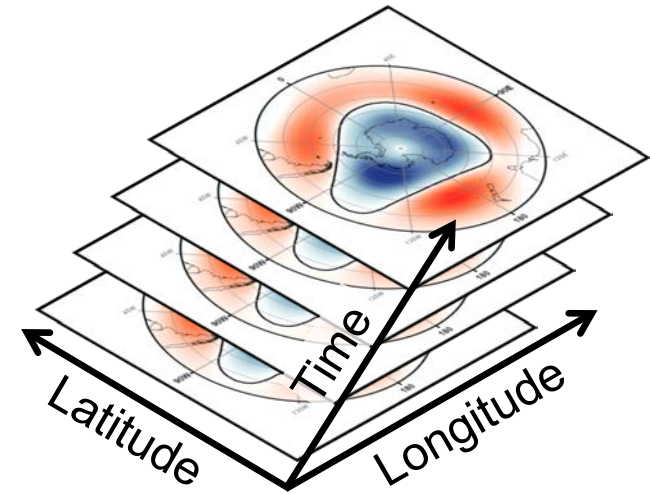
- Enables further analysis:

  - Correlation of SAM-Pattern data with AP temperature data (correlation map)
    ➔ relating spatio-temporal SAM-Pattern variability and AP temperature variability

  - Mapping the transition zone between mid and sub-polar latitudes
    ➔ detect spatial shifts of the SAM-Pattern since early 1980s. (*not shown here*)

Correlation of SAM-Pattern & AP Temperatures

- Correlation of each SAM-Pattern grid point with time congruent temperature series

  - Dominant hemispheric coupling pattern of SAM& Temperature variability

  - Regions of highest / lowest correlation approx. 180° located away from AP


O'Higgins [DMC] T2m & SAM−Pattern correlation   (100% data density)
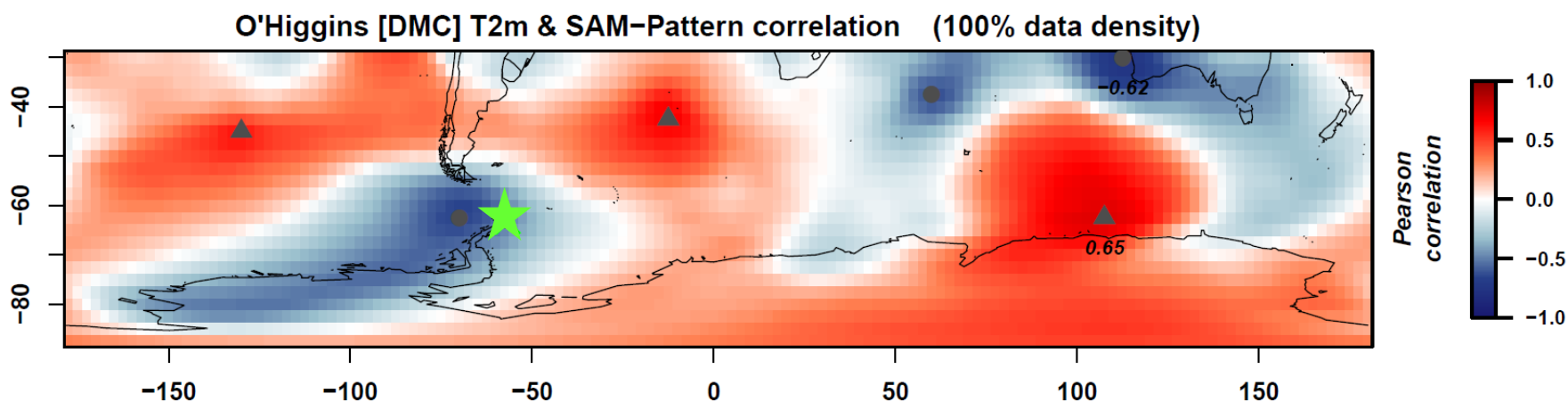
Correlation of SAM-Pattern & AP Temperatures

- ~ 40% of the temperature variability at O'Higgins explained by SAM-Pattern variability
- Late 1990s turnaround appears in this analysis
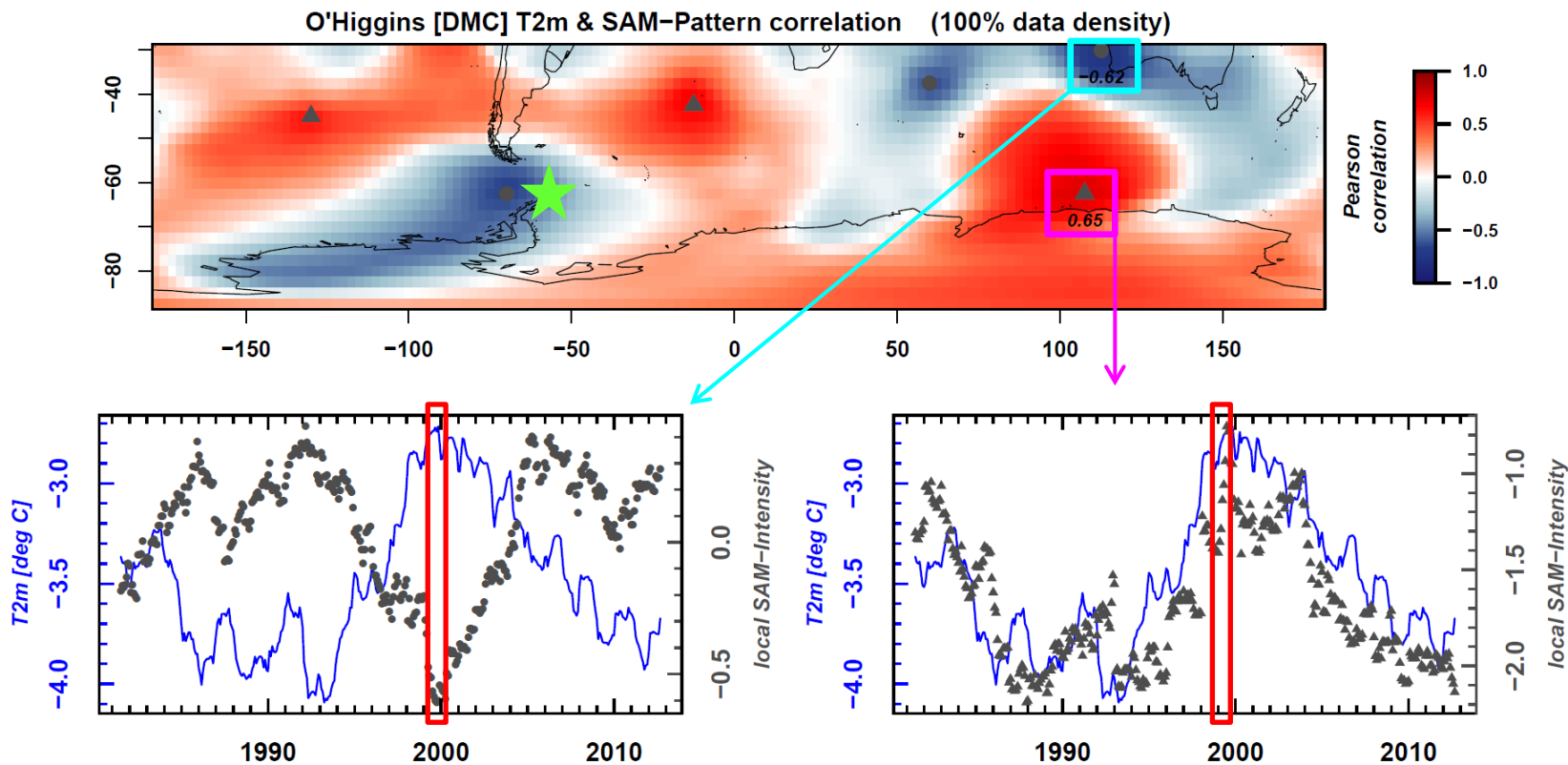
Circulation and Weather Type Classification

- Statistical Relation between an appropriate number of Circulation Types and respective Environmental Data characteristics
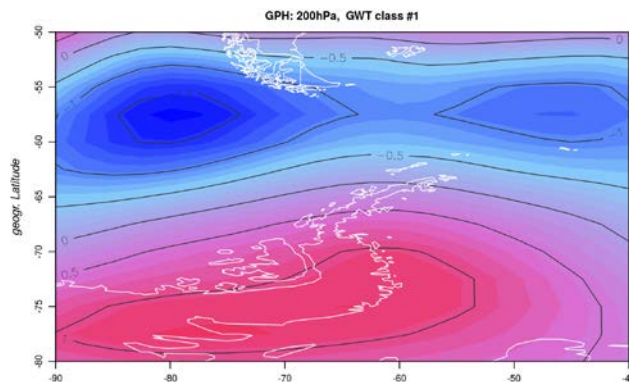
Circulation Data **e.g. GPH 1000 hPa**	***???***	Climate Variable **e.g. Temperature**
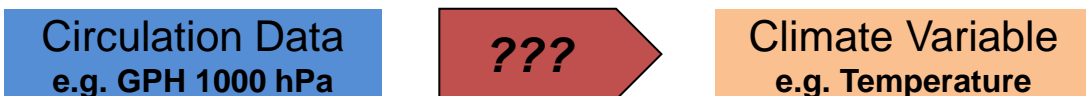
- (1) Circulation Type Classification (CTC) or (2) Conditioned CTC

-- Data Input --	*-- Results --*

Circulation Types

GPH: 200hPa, GWT class #1
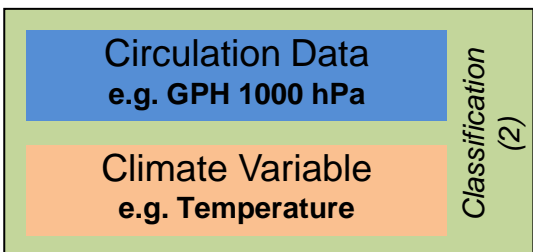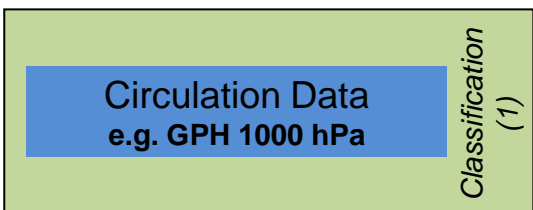
Classification Catalogue

```
1994  12   1  12      5
1994  12   2  12      5
. . .

1997   1  30  12      9
1997   1  31  12      9
1997   2   1  12      9
1997   2   2  12      9
. . .

1999   2  27  12      8
1999   2  28  12      9
```

Statistical Temperature Downscaling

- Every Circulation Type (CT) is statistically linked to a CT-specific Temperature


- Classification Catalogue (chronology of CTs) and Cluster-specific Temperatures

    ➜ Reconstruction of CT-based Temperature series for AP

    ➜ Dominant Types by Frequencies and/or its CT-specific Temperatures
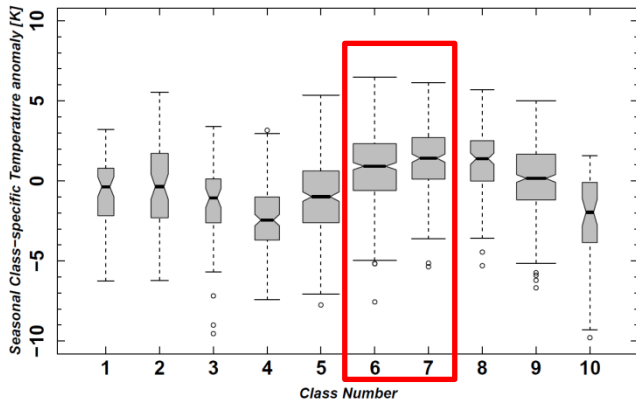
Prototype Classification

- Prototype Classification, Highest correlation of daily circulation fields and pre-defined CTs
  → Flow directions within Pressure maps are the dominant classification criterion
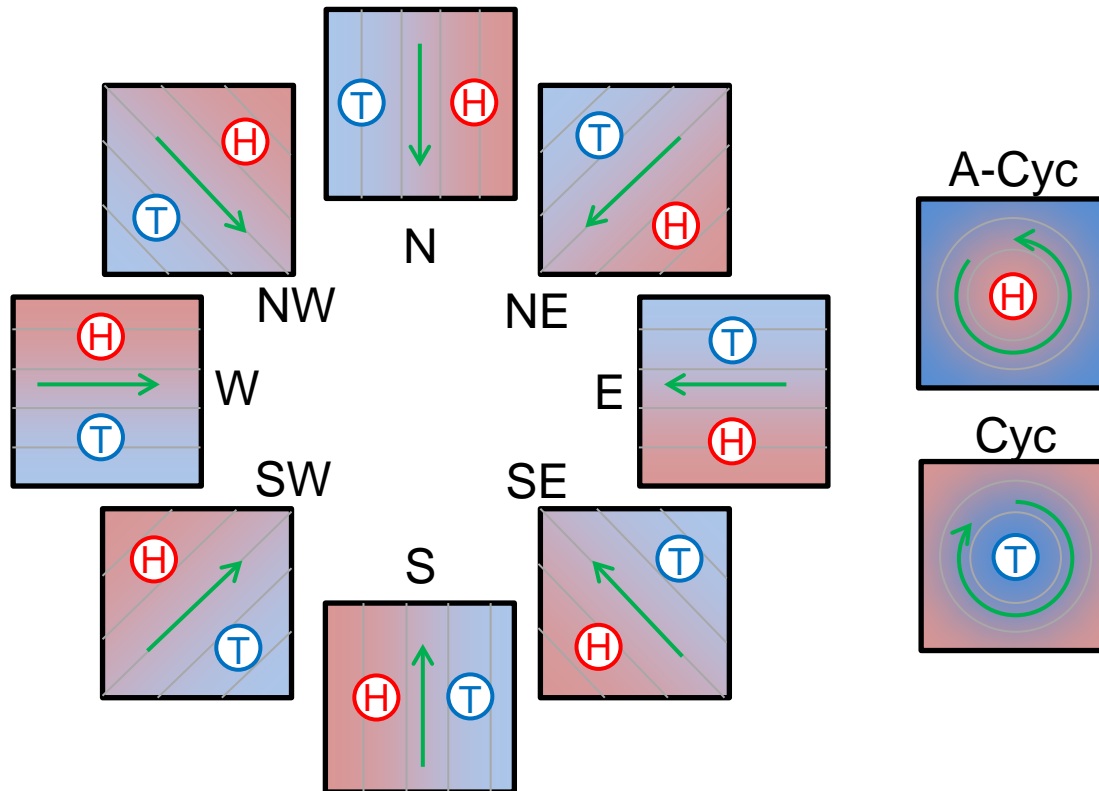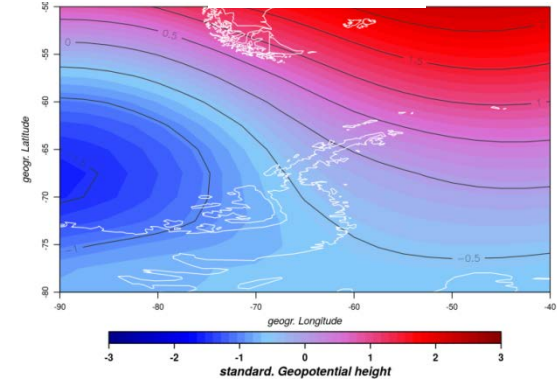
Results: Prototype Classification

- Prototype Classification, GPH 1000hPa, Winter season (JJA):
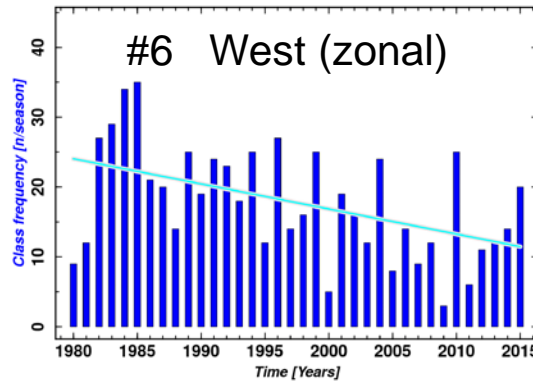 - Frequency decrease of western (zonal) and North-western Circulation Type
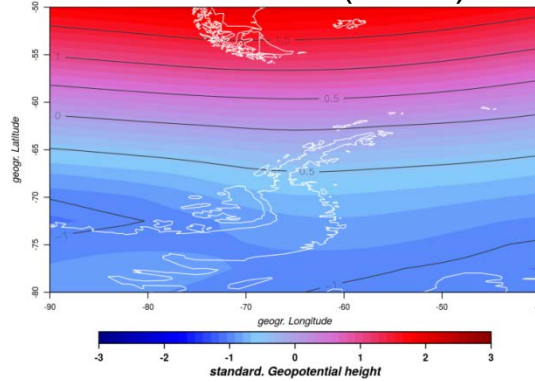
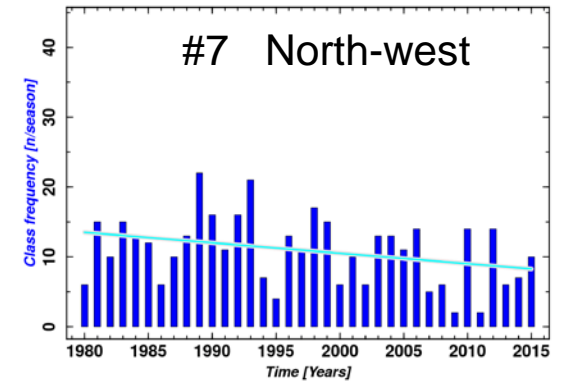# Results: Prototype Classification
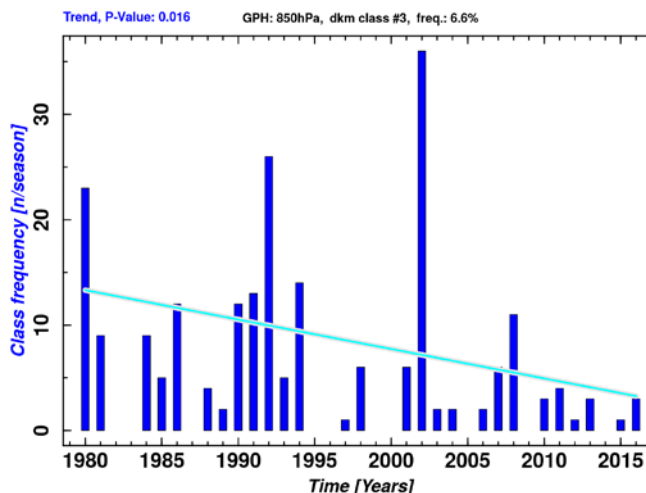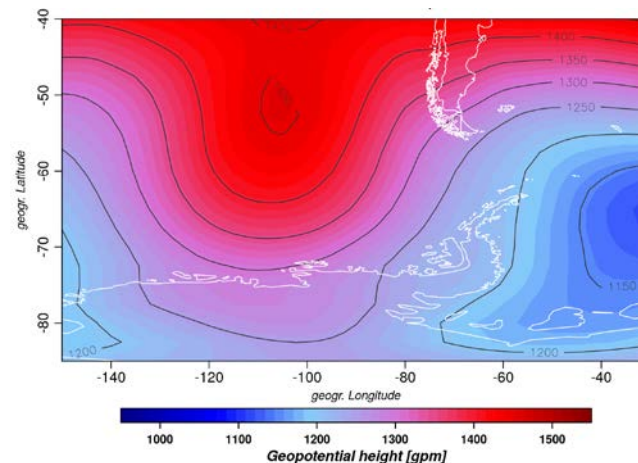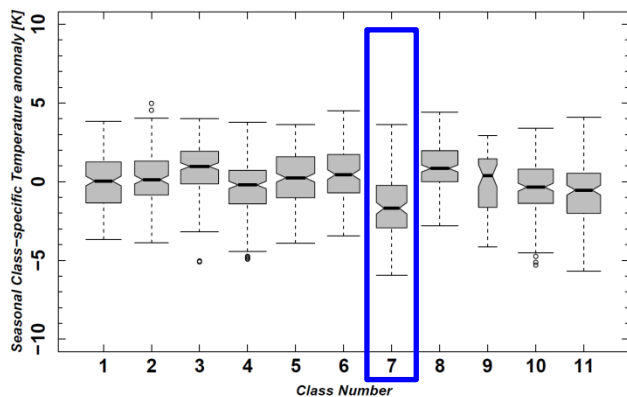
- Prototype Classification, GPH 1000hPa, Summer & Winter season (JJA):
  - Frequency increase of anti-cyclonal / Blocking-action Circulation Type

#10 anti-cyclonal
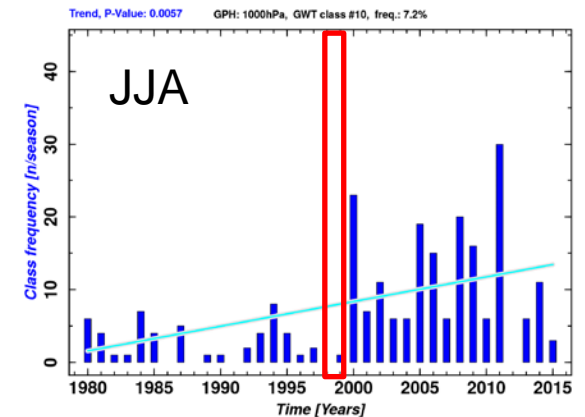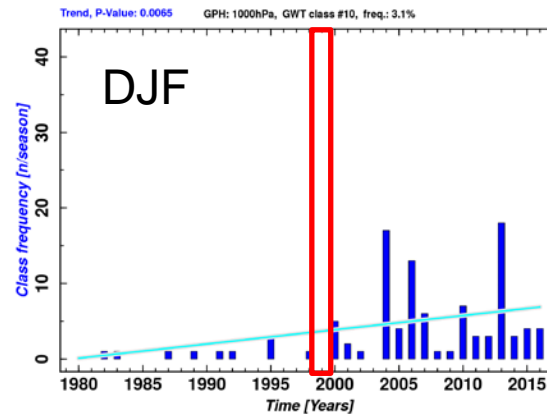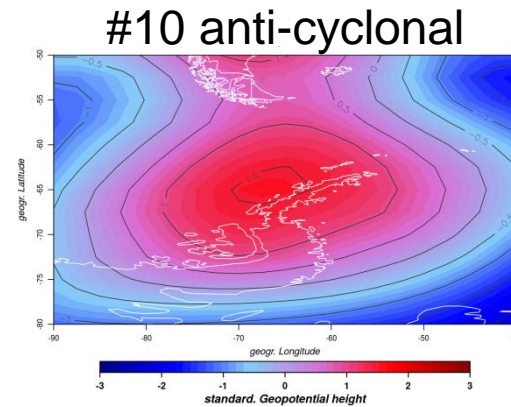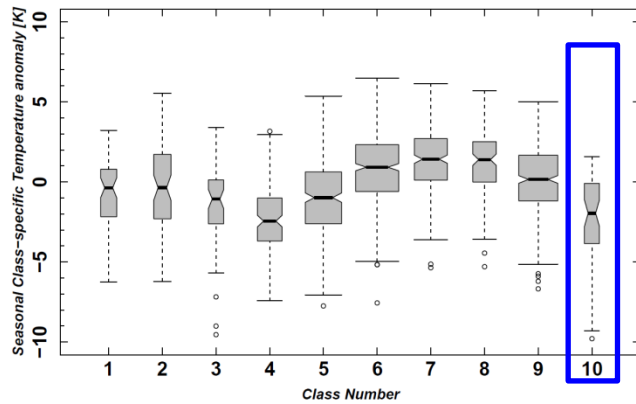
Results: Cluster Analysis

- Temperature-conditioned Classification (dk-means), autumn season (MAM).
- 1000 hPa, 850 hPa and 700 hPa heights
- Decrease of a cold CT

Summary

- Effect of spatio-temporal SAM characteristics on AP-Temperatures can be clearly identified

- Highly temperature-relevant Circulation Types changed their frequencies significantly

- Indications of a late 1990s turnaround in Atmospheric Circulation detected in both approaches

- **Acknowledgement** for providing Antarctic Temperature data:
  - READER Project, maintained by British Antarctic Survey
  - Dirección Meteorológica de Chile

  - Classification Tool: Cost733class, Augsburg University.

- Contact: Paul Wachter, paul.wachter@dlr.de

Thank You for Your attention!!