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Analysis of drought variability in data sparse regions for drought foreshadowing in the Limpopo basin

Poster-
EGU2012-5635

Mathias Seibert
GFZ Helmholtz Centre Potsdam, Telegrafenberg, Potsdam

Our project background

"Improved Drought Early Warning and FORecasting to strengthen preparedness and adaption to droughts in Africa" (*www.dewfora.net*)

We are in the preliminary step of the development of a statistical seasonal drought foreshadowing model for the Limpopo

1. Analysis of meteorological drought variability case studies
2. Identification of climatic driving factors
3. Development of a statistical seasonal drought foreshadowing model

Background

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SPEI and SPI are established as powerful drought indexes that represent meteorological drought. Indexes and remotely sensed data are important tools of modern drought monitoring and drought early warning systems. These drought indexes are designed to ease the understanding of drought and have a strong potential to support decision making when reliable forecasting will be available to end users in the future.

Show the value of drought index forecasts to end users

However, the drought phenomenon is very complex and so is the interpretation of SPEI for end users. Assuming, that forecasts of drought indexes will become available in the coming decade, ways have to be developed to ease interpretation of SPEI in data sparse regions, where remotely sensed data serves as an essential supplement of drought monitoring. We show how meteorological drought affects vegetation status in the Limpopo region. Here, we present the current state of our ongoing preliminary analysis.

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The middle column contains an analysis of the relation between vegetation status and meteorological drought. In the right column we show first steps in the identification of climatological driving facors of meteorological drought.

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$$NDVI = (NIR - VIS) / (NIR + VIS).$$

Data & Methods

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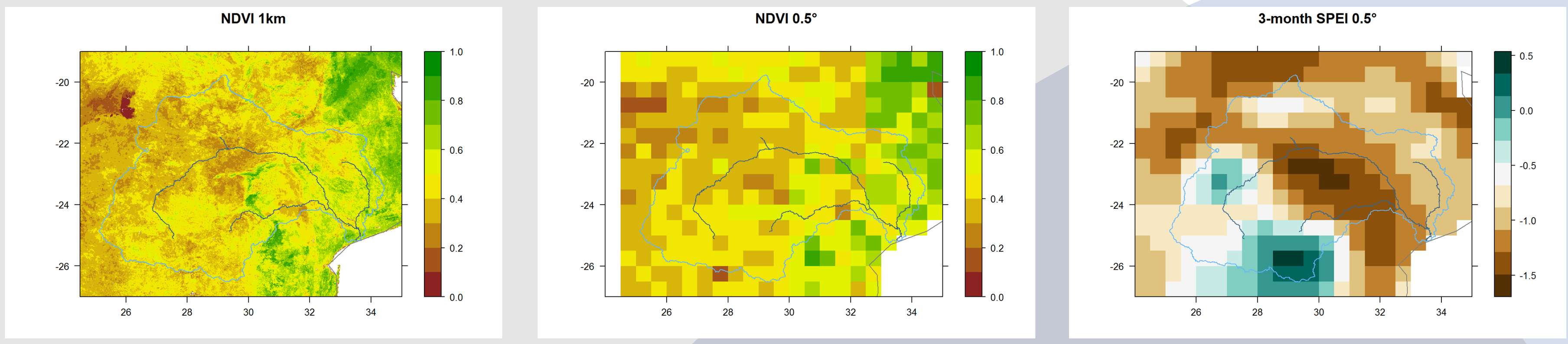
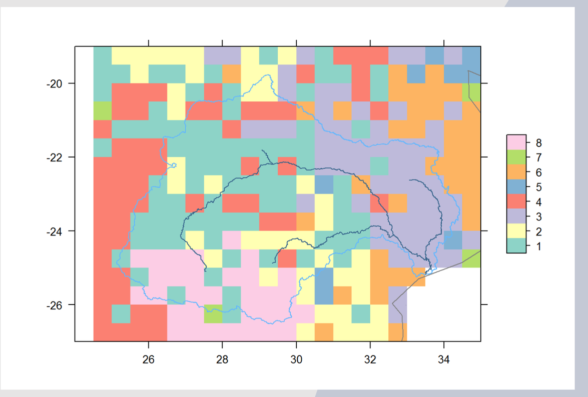


Fig. 1: April 2002: NDVI in 1km resolution (left), aggregated to 0.5° (middle) and 3-month SPEI (right)

Vegetation zones

Regions of similar conditions should change simultaneously. Therefore, hierarchical clustering (ward method) was applied to identify these regions. The clusters were scattered and overlapped, which indicates high local variation in NDVI.



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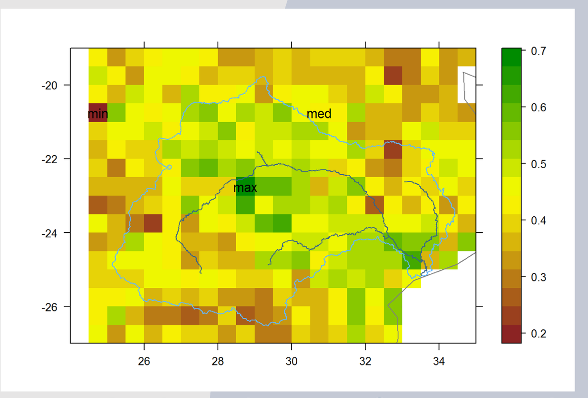

Fig. 3: Correlation of NDVI and 3-month SPEI

Relating NDVI and SPEI

NDVI and 3-month SPEI were correlated cellwise (see figure 3). Locally the sensitivity to SPEI can differ strongly. The central Limpopo region shows stronger sensitivity to SPEI. The Northeastern and Southwestern Regions are less sensitive. For three examples, scatterplots are shown to highlight the different relations (figure 4). Both, the maximum and median correlation examples point towards a threshold of -1 SPEI at which NDVI decreases strongly. In the median correlation example SPEI values > -1 are less affected by SPEI and in the minimal correlation example NDVI was hardly affected at all, since vegetation status is generally very low.

Conclusions

There are obvious regional differences in the sensitivity of vegetation status to SPEI. These differences tend to match the vegetation regions returned from clustering. By comparing NDVI and SPEI it is possible to identify regions of marked differences in sensitivity to rain anomalies. Hence, it can be shown, what regions can benefit from a forecast of a drought index like 3-month SPEI.

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In forecasting and warning systems finding thesholds is a bottleneck. The evalutaion with NDVI could be one way to establish regional thresholds, at which warnings could be issued.

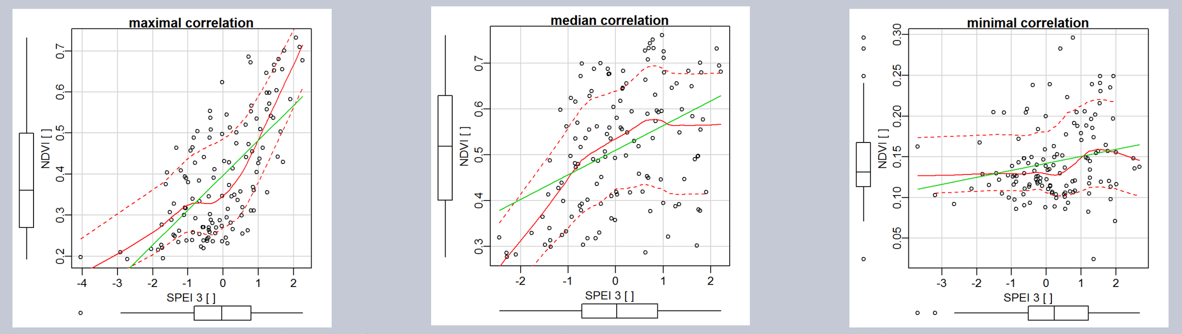

Fig. 4: Scatterplot of NDVI and 3-month SPEI at a location of high (left), median (middle) and low correlation (right).

Teleconnections of drought in the Limpopo region

Dominant drought patterns

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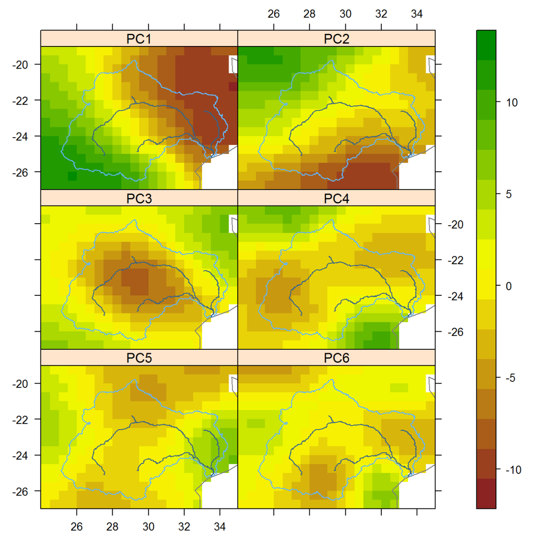

Fig. 5: PCA scores of PCs 1-6

Teleconnection of drought patterns

The occurence of the spatial patterns in time is represented by the PC loadings. These were related to Sea Surface Temperature (SST) and climate anomaly indexes. Teleconnections were found to :

- the equatorial Pacific and ENSO (PC 5 and 3) which represents the El-Nino phenomenon
- the equatorial Indian Ocean (PC 3 and 6).

(See table 1 and figure 6 below)

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The PC score pattern 5 is related to the El Nino anomaly and causes drought along a North-South transect in the Limpopo basin. PC 3 is related to El-Nino and to the Indian Ocean and shows a drought centrally located in the Limpopo basin. This implies that the Indian Ocean and El-Nino are relevant driving factors for drought. However, correlations were generally very low, which points to other important local factors.

Tab. 1: Correlation of PC loadings and climate anomaly indexes

	PC1	PC2	PC3	PC4	PC5	PC6
SOI anomaly	-0.06	0.05	-0.15	-0.05	**-0.25**	0.06
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ENSO3	0.15	-0.03	0.15	0.12	**0.27**	-0.02
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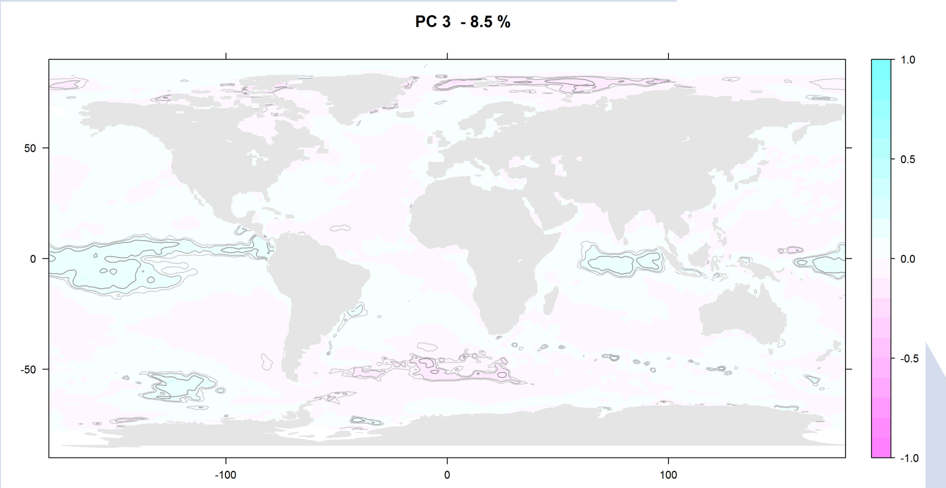

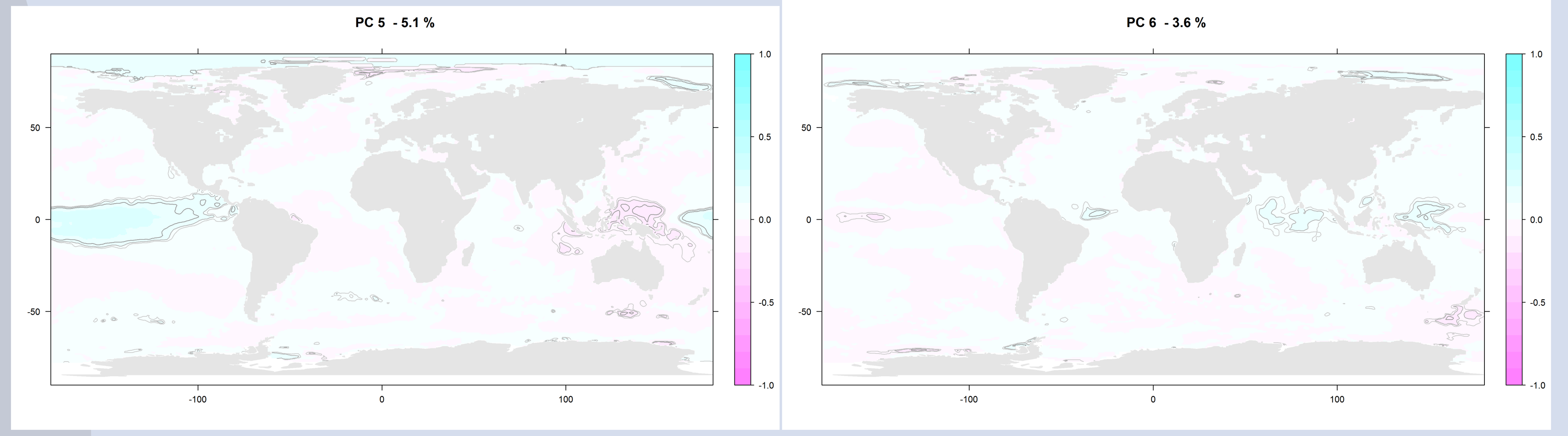

Fig. 6: Correlation of sea surface temperature and PC loadings PCA scores of principal components 3 (upper right), 5 (lower left) and 6 (lower right)

References

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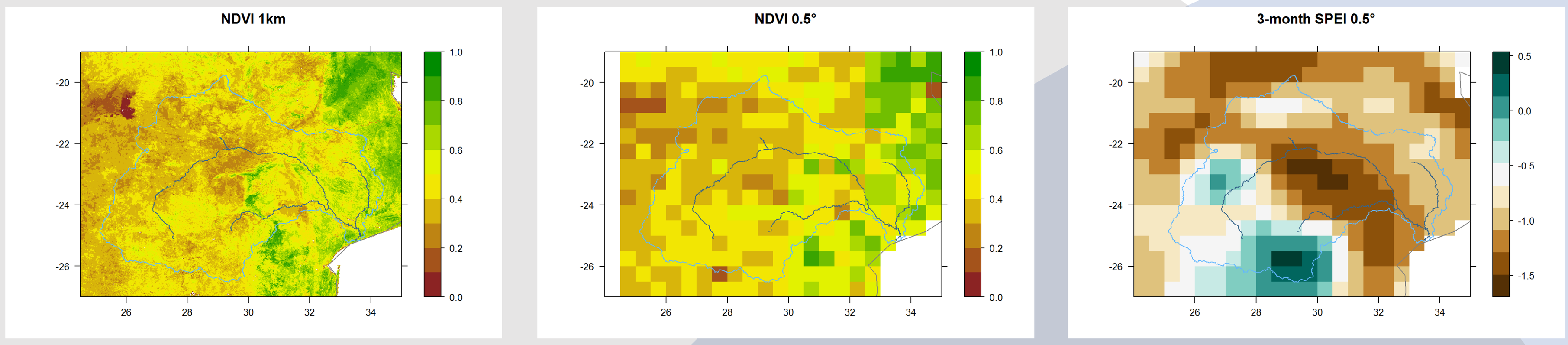

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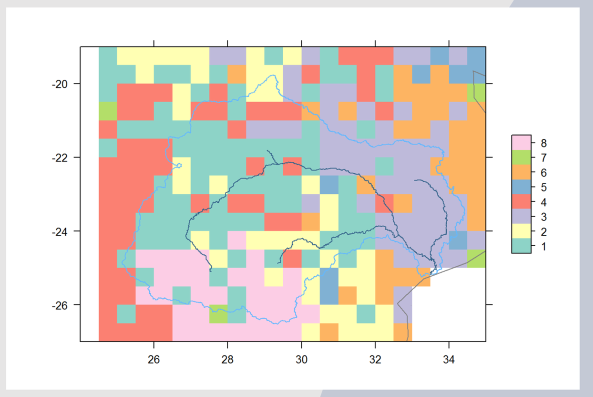

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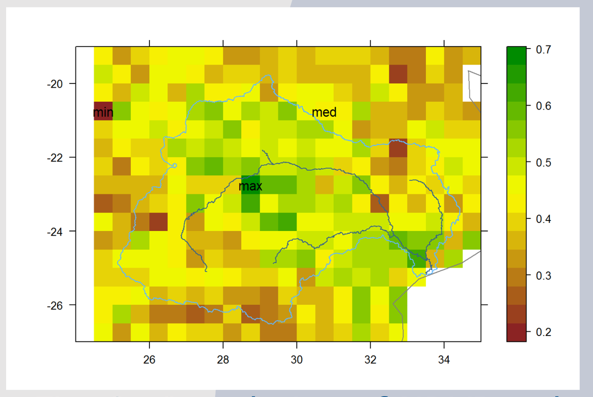

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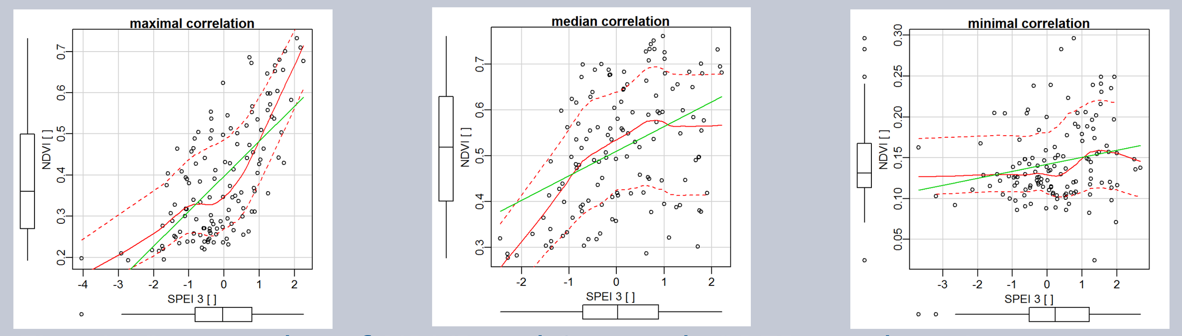

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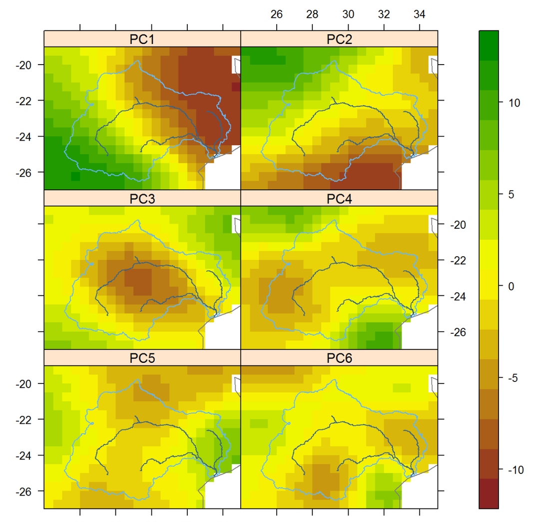

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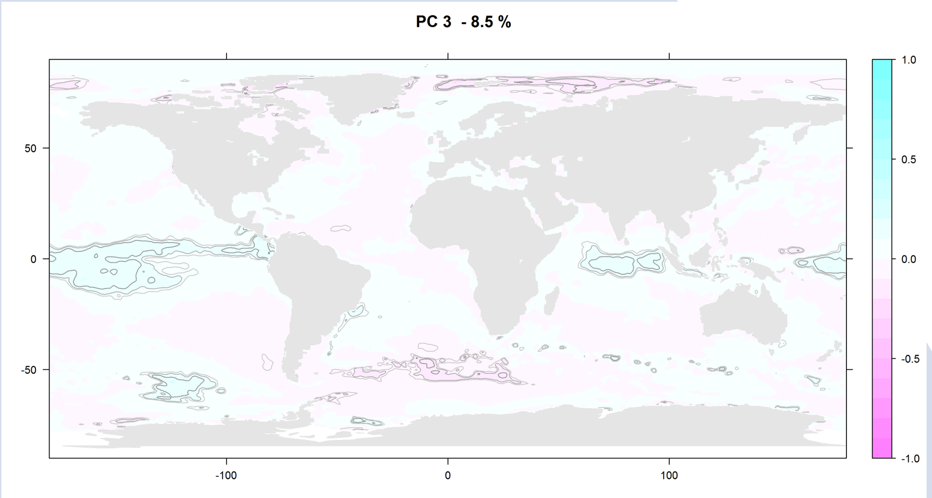

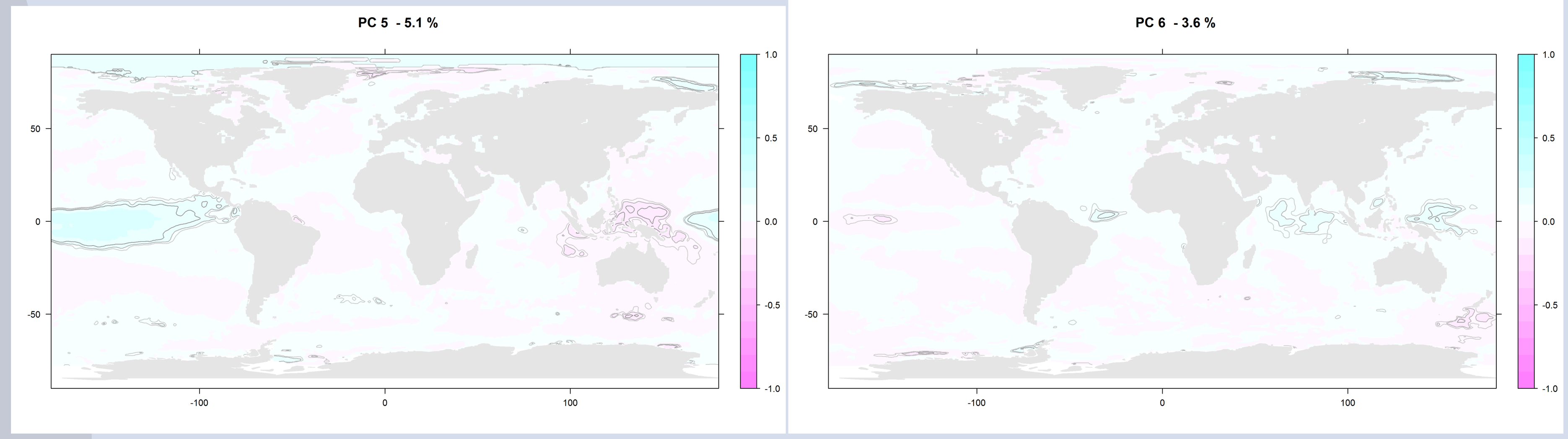

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