



## **A Comparison of Principal Component Analysis and Factor Analysis in Atmospheric and Climate Research**

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Factor analytic techniques such as Principal Component Analysis (PCA) or Factor Analysis (FA) are either used to reduce the number of variables or to classify variables by detecting structures in the relationships between variables. In theory, PCA is preferred for data reduction and FA is considered to be superior in structure detection. In our study we investigate the ability of both methods to uncover atmospheric and oceanic patterns.

Both methods have their roots in psychology. PCA is widely used for applications in natural sciences including atmospheric research, while the application of FA is still restricted to traditional fields such as psychology or social sciences. The main difference between the two methods is based on the treatment of the variances: PCA uses the whole variability in the analysis. FA in turn tries to separate the so-called common variance, which is affected by more than one variable, from the so-called unique variance. The latter is only affected by one variable and thus neglected in the resulting patterns. Our hypothesis is that the separation of common and unique variances might lead to improved and better interpretable results.

For the method comparison we employed two different data sets: atmospheric temperature climatologies (zonal monthly mean climatologies over five years from 09/2001 to 05/2006), retrieved at Wegener Center/Univ. of Graz from CHAMP (Challenging Minisatellite Payload) radio occultation measurements and a statistically homogenous record of sea surface temperature (SST) anomalies (monthly means of Kaplan SST anomalies and Reynolds and Smith NCEP SST anomalies for 01/1856 to 12/2005), available from the IRI/LDEO Climate Data Library. For computer algorithm checking

purposes we used a small test data set of a psychological study from literature. Different from PCA no single FA calculation method exists, thus three different techniques were considered and compared: Principal Factor Analysis, True Factor Analysis according to Joereskog, and Centroid Factor Analysis, the original technique. To check the sensitivity of the techniques, two different spatial resolutions of the atmospheric and oceanic fields were analyzed. The differences between PCA and FA results as well as the differences between the three FA techniques with respect to the data set resolutions are discussed on the basis of the selected atmospheric and oceanic patterns.