

# Empirical Orthogonal Function analysis

**Figure:** The EOF products from NCEP  $\Phi_{500hPa}$  reanalysis II: a) the leading PC, b) the EOF patterns, and c) the variance described by these modes. [stats\_uib\_8\_2.m]

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The spatial inter-dependence implies that there is a lot of redundant information stored in a  $n_x \times n_y$  map, and that the information can be compressed to just a few numbers describing the state of that field. The most common way to compress the data is through principal component analysis (PCA).

**In geophysics, geographically weighted PCAs are often used, which normally are referred to as *empirical orthogonal functions* (EOFs). The EOFs can be regarded as a kind of eigenvectors, which are aligned so that the leading EOFs describe the spatially coherent pattern that maximises its variance. The EOFs are often used as basis functions (a new set of axes or reference frame).**

**Figure:** *A comparison between EOFs and the 3 lowest mode wave functions obtained from a FT analysis. Whereas the EOFs do not have restrictions with respect to their shape, the FT results must be sinusoidal. The analysis is for the T(2m) from NCEP reanalysis [] [stats\_uib\_8\_3.m].*

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**The EOF analysis may be thought of as being analogous to data reconstruction based on Fourier transforms (FT), in the sense that both produce series (vectors) which form an orthogonal basis.**

**The transform  $f(x,t) \rightarrow F(k, \omega)$ , whereby the inverse transform for each of the wave numbers  $k_i$  give sinusoidal functions which are normal to the functions of other wave numbers.**