

Interactive comment on “Empirical Mode Decomposition in 2-D space and time: a tool for space-time rainfall analysis and nowcasting” by S. Sinclair and G. G. S. Pegram

S. Sinclair and G. G. S. Pegram

Received and published: 13 May 2005

In the following text we respond to the comments of “Anonymous reviewer #3”, taking each of the comments in turn.

1. Identification of extrema

The reviewer comments that there are numerous possible techniques for identifying extrema in the rainfall field. This is indeed the case; Nunes et al. (2003) use a morphological reconstruction technique. One alternative, which we explored, is based on image segmentation (of integer data) and allows detection of extremal plateaus. However, our method of choice was to use a simple 8 neighbour search routine for identification of pixels with extreme values as done by Linderhed (2004). The choice was partly for convenience, but also because the majority of the (non-zero) extreme

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

values in the (floating point) rainfall fields studied turned out to consist of single pixels. There is a rich literature on image processing techniques and the reader is referred to an introductory text such as Sonka et al. (1999) to explore the field further.

2. Choice of interpolation technique

The reviewer suggests using an alternative interpolation technique to generate the bounding envelopes. Two alternatives are suggested; using a local version of the Kriging equations and inverse distance weighting. We agree that a more efficient choice of interpolation technique would be useful and more work could be done in this regard, however care is required. Moving neighbourhood Kriging can produce unwanted discontinuities in regions that are data sparse (Chiles & Delfiner, 1999, pp 201), such discontinuities would be amplified through the EMD sifting process. The particular choice of Ordinary Kriging as a method of generating the bounding envelopes was (partially) directed by the property that the estimates decay to the mean of the observed extrema. This is not the case with inverse distance weighting, which produces estimates that decay (geometrically) to zero with distance from the known data points.

3. Frequency distinction and spatial smoothing

The reviewer was concerned that the distinction between high and low frequencies is arbitrary. The distinction between high and low frequencies is a data driven one that occurs in a natural way based on the oscillatory modes observed in the data. Each IMS contains a narrow range of spatial frequencies (and amplitudes) which can be described by considering the portion of the original data's power spectrum, which in turn is described by the spectrum of the IMS (see Figures 9 & 10 - note that the wavenumber can be expressed as a wavelength).

The reviewer noted that the forecast smoothing filter described in Turner et al. (2004) produces forecasts that have increasing spatial smoothing with time and wanted to know how this would be achieved using the EMD technique. The forecast filter described by Turner et al. (2004) relies on the concept of the wavelet spectrum, we are

Interactive
Comment

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

not aware of a direct surrogate for the wavelet spectrum which applies to EMD therefore their method could not be applied directly. Investigation of forecasts using EMD is ongoing.

4. Temporal persistence of Power Spectra

The reviewer was concerned that Figures 11, 12 and 13 were difficult to interpret. We accept that the figures require a better explanation and will revise this in the final submission of the paper. The reviewer also noted that these figures showed that the statistical structure in the field, rather than the features, was persistent in time and noted that independent realisations could have the same spectrum. We acknowledge that the reviewer's comments are true. However, given the separated power spectra, the figures demonstrate that the high frequency components have low temporal persistence while the low frequency components exhibit strong temporal persistence.

References

- Chiles J.P. and Delfiner P.: "Geostatistics: Modelling spatial uncertainty". Wiley, 1999.
- Linderherd A.: Variable Sampling of the Empirical Mode Decomposition of Two-Dimensional Signals, Preprint, Special issue on Sampling and frames in Wavelet Theory and Time-frequency analysis, International Journal of Wavelets, Multiresolution and Image Processing, 2004.
- Nunes J.C., Bouaoune Y., Delechelle E., Niang O. and Bunel P.: Image analysis by bidimensional empirical mode decomposition, Image and Vision Computing, 21, 1019-1026, 2003.
- Sonka M., Hlavac V. and Boyle R.: Image Processing, Analysis and Machine Vision, 2nd Edition, PWS Publishing, Pacific Grove, 1999.
- Turner B.J., Zawadzki I. and Germann U.: Predictability of precipitation from continental radar images. Part III: Operational nowcasting implementation (MAPLE), Journal of Applied Meteorology, 43, 231-248, 2004.

Interactive
Comment

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 289, 2005.

HESSD

2, S160–S163, 2005

Interactive
Comment

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

S163

EGU