Atmospheric Measurement Techniques Discussions

Interactive comment on "Correcting orbital drift signal in the time series of AVHRR derived convective cloud fraction using rotated empirical orthogonal function" *by* A. Devasthale et al.

Anonymous Referee #2

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General Comments:

This paper applies an empirical orthogonal analysis to separate signal due to the NOAA satellites drifting in their orbits from that nominally measured by the onboard AVHRR instruments. As the authors note, this is an important step in processing, since drift in the satellites' orbits introduce artefacts which can be mistakenly taken as trends in the data over time. However, the methodology section needs to be significantly fleshed out – with a bit more explicit information on the techniques use (rather than just pointing to references), and with a worked example. A synthetic example (described later in the

specific comments) would be most satisfying, since then the reader could be convinced of the proficiency of the method at actually eliminating the drift signal, as well as see the justification for the qualitative parts of the methodology which are selected 'visually'.

Specific Comments:

Page 3878

L2: Shouldn't use abbreviation in abstract. Write out AVHRRs and NOAA in full.

L4: 'during the life span of sensors' → 'during the life span of the sensors'

L5: 'Depending on' → 'Depending upon' and 'amplitude of a diurnal cycle' → 'amplitude of the diurnal cycle'

L7: 'to bracket' is awkward. Perhaps 'to estimate'?

L7-8: 'a rotated empirical orthogonal function analysis' → 'a rotated empirical orthogonal function analysis (REOF)'

L10: 'correcting' doesn't seem quite right . . . separating? subtracting?

L14: 'and their rigorous testing before' → 'and rigorous testing thereof before'

L16: write out 'year'

L18/20/21: I would hyphenate 'space-based', 'process-based' and 'climate-monitoring'

L19: 'resolutions' – are there more than one spatial resolution?

L20-24: It might be helpful to create a table showing the different spectral channels, and the meteorological products you get from each one. In this table you might also link to show how you detect and type clouds in the measurements, which you briefly discuss later.

Page 3879

L1: I think you should start a new paragraph with the sentence starting with 'However'.

I also think that after this first sentence you need to give a description of what 'drift' is. Are we talking about the spatial or temporal aspect here, or both? By how much, in time or space, as appropriate do satellites drift? Is it hours or minutes? (I struggle to see how minutes would greatly affect trends, but hours definitely would) Is it constant over their orbit? Does it increase in time? By what rate? Involving what aspects of the spacecraft's motion? Etc. Perhaps a schematic would help . . .

L3: 'The drifting leads to the delay' → 'the drifting leads to delay'

L4: I would hyphenate 'time sampling', and I think it's worth noting that it also results in inconsistent time sampling of other meteorological quantities other than clouds as well . . .

L9: 'other geophysical climate variables' → 'other geophysical climate variables from AVHRR'

L11: 'satellite platform change related biases' is quite awkward

L12: Is land surface skin temperature different from land surface temperature?

L15: I wouldn't capitalise Radiation Budget

L20: Would this work for less dynamically extreme regions where the background signal is less strong? How would you differentiate from a long slow trend? (A synthetic example would work wonders here for confidence in method . . .)

L23: 'data' → 'spectra'?

L24: I think you should give the wavelengths of the solar and thermal channels somehow, or point to a table, and I find the use of 'AVHRRs' as an abbreviation rather awkward: perhaps 'AVHRR sensors' would be better?

L27: no comma after 'therefore', and 'homogenization' → 'consistency'

Page 3880

L3: Perhaps a schematic on how you differentiate between cloud types, or at least in the most frequent cloud types?

L5: I'd hyphenate 'optically-thick'

L6: 'therefore the time series of these clouds most likely shows the spurious' → 'therefore it is probable the the time series of these clouds shows spurious'

L9 – 21: I think this paragraph is vastly insufficient to describe the methodology used here. This is effectively an algorithm description paper, and yet you don't really describe the algorithm! I think it is important to describe a bit of the theory here, instead of just referring the reader to citations. Describe the difference between rotated and non-rotated EOFs, what a varimax rotation is . . . etc. Then, when it comes to what you've actually done in your algorithm, you really do need to justify why, for instance, you retain only the first 20 modes, and why only the first 7 are rotated and used. Presumably this is to do with total variance captured by the first 20 or first 7 components, but you do have to explicitly state this, and perhaps show a plot of the variance captured by each successive component. How do you identify the modes contaminated with drift signal visually? Is there nothing quantitative? I certainly couldn't reproduce your algorithm given the information you've given – and that's rather the point of an technique paper, right?

If it were me, I would create a synthetic example, to go along with your description of your algorithm. Make it as simple as you like: say sinusoidal, with a period of 24 hrs to represent the diurnal variation in cloud, with an appropriate amplitude. Then impose a simple, but realistic drift on this 'nominal' signal. Go through each of the steps, showing what you do, and why you make the qualitative decisions you do, in terms of number of modes you consider and treat, and describe how you 'visually' can determine which of the REOFs contain variation due to the drift. How can you tell that they aren't trends? Then recombine, and show the drift-removed new dataset compared with the original synthetic signal (without the drift added) – and hopefully these should be about the

same – or at least closer than the original and the original+drift-added data. You could also do this for a smaller amplitude signal, so there is some justification for the assertion you make about this working even if you don't have clouds ...

L26: I think the first 3 REOFs do, but not the remaining 4/7 ...

Page 3881

L1-6: needs a clearer explanation. Why, for instance, do you say that a strong drift-signal is seen only in modes 1 and 3? Without telling us what a drift-signal looks like, we can't judge.

L5: 'The mode 2' → 'Mode 2'

L8-9: 'compute new synthetic loadings. They are shown in Fig. 3 in red color.' → 'compute new synthetic loadings (Fig. 3).' Does this mean that the synthetic loadings effectively interpolate the signal back to what if would be if there was no drift? It is awkward how you describe this.

L14: I don't agree that 60% correlation is 'very high'

L16: Give a reference for this statement about the amplitude of diurnal variation of clouds.

L19: take out word 'artificial'

L23: 'is not removed at the same time. Thus the remaining question is whether the natural' → 'is not removed at the same time – that is, whether the natural' Also, if you've done a synthetic example earlier, the reader already has a bit of confidence that you can separate the two components of signal, and makes the MODIS comparison more believable.

L25: Reference for MODIS?

L28: Time of overpass? Surely you can do better than 'afternoon' ... and there must

be an estimate of what time the NOAA satellite generally makes its overpass ...

L29: 'Therefore the REOF analysis' → 'The REOF analysis'

Page 3882

L1: stay in the present tense. 'Was' should be 'is'. And I'm not sure I understand how you've done this ... are you correlating 5 years of data against only 1 year of data? This doesn't seem right ... Perhaps more explanation of what you've actually done would clarify.

L9-10: 'drift signal from the dataset. Our comparison results support their argument.' → 'drift signal from the dataset: our comparison supports their argument.'

L12: 'We demonstrate that the REOFs efficiently' → 'We demonstrate that REOF analysis efficiently'

L13: 'series of convective cloud fraction' → 'series of convective cloud fraction for the example of the Indian Monsoon'

L13-14: You haven't really shown this ... for instance you haven't given magnitudes of the difference in trends you'd attribute – you've just said that it is important. Back it up with something quantitative to show the ramifications of leaving the drift signal in the data.

L16-17: remove 'which can be used for climate studies with emphasis on essential climate variables like clouds' – redundant.

L17: 'An accurate intercalibration of AVHRR sensors and the removal of orbital drift signal are the two issues that need to be addressed' → 'However, the two key issues of accurate intercalibration of AVHRR sensors and removal of orbital drift signal need to be addressed'

L22: 'the other important issue' → 'the orbital drift issue'

L24: Have you actually given the upper limit? I don't remember a number . . . or do you mean that monitoring of big convective clouds will be more impacted by drift than other meterological variables, like water vapour concentration or atmospheric temperature? How do you justify this?

Page 3883

L2-6: An expanded version of this should rather be in the results section, surely?

Fig. 2 What are the units of the colours in the plots? This should be on the plot somewhere

Fig. 3 Again, units of y-axis?

Fig. 4 Units for colour again!

Fig. 5 Label for y-axis, and units, please

Technical Comments:

Generally: I think you ought to change written-out-units to just units: ie. Micrometers $\rightarrow \mu$m and degrees $\rightarrow$ $^\circ$

Also, there is quite a lot of inconsistency in hyphenisation: in phrases like 'time series', 'long term', 'life span' and the like – some of the time you have them hyphenated and other times you don't ...

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