Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., author comment AC1
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Reply on RC1

Ryan Volz et al.

Author comment on "Four-dimensional mesospheric and lower thermospheric wind fields using Gaussian process regression on multistatic specular meteor radar observations" by Ryan Volz et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-40-AC1, 2021

Thanks for your thoughtful comments. We will address each of them in our formal reply and revised version, but for now we would like to comment on the following selected points:

1. (GPR as "non-parametric") We describe GPR as non-parametric in the same sense as it is used in the referenced Rasmussen and Williams (2006) book: an estimation method which does not compress the training data into a finite-dimensional parameter vector, in contrast to parametric methods like linear regression. The mean and covariance function parameters are usually called hyperparameters to emphasize that they are parameters of a non-parametric model. We also find this terminology confusing, so we will seek to clarify it in the next revision.

2. (Comparison to Tikhonov regularization) The methods are indeed related, and there is a good discussion of this topic throughout Rasmussen and Williams (2006), particularly in Chapter 6. The most direct difference is that Tikhonov regularization would best relate to GPR with a squared exponential covariance, whereas we have employed a Matern-5/2 covariance. That detail strikes at the heart of the difference between the two methods: it can often be more natural to express prior knowledge in terms of a GPR covariance than as a likelihood penalization. Practically, the difference also comes down to how it is more natural to perform non-gridded estimation and analyze uncertainty with GPR compared to regularization approaches. In many respects, the approaches are two sides of the same coin, which is why we see value in future inter-comparison that can help refine both approaches.

5. (Geometrical dilution of precision estimator) Perhaps it is clearer to say that the measurement geometry controls the wind estimate uncertainty, which we can calculate through the posterior covariance, and naturally there are (location, wind direction) pairs that have higher uncertainty. As far as we understand it, we can quantify the GDOP as a function of location in this case by taking the root mean square of the wind component uncertainties. If this doesn't describe what you were pointing toward, then we'd love to hear more details!

6. (Figure clarity) We very much would like these figures to be both expressive and interpretable, and we recognize that this is a difficult task given the amount of information that they attempt to include. We strived to use color scales for the different elements that

are distinct enough to be identifiably separate and thought we had achieved a good balance. Given that, we're uncertain about how exactly to make satisfying improvements, although we can try. Do you have specific detailed critiques that we could implement (e.g. the vertical wind colors on the streamlines are too hard to distinguish from the background colors, or the information conveyed with them is not worth the visual clutter)?