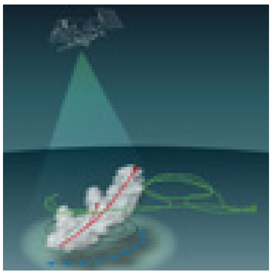

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Aspirations for the workshop - Bringing WCB understanding into forecast system development

Tuesday, 10 March 2020 09:35 (25 minutes)

This talk is largely about butterflies, of the Lorenz variety. In the ECMWF model, Warm Conveyor Belts (WCBs) not only lead to downstream developments such as the formation of blocking, they also act to strongly enhance downstream forecast uncertainty. In this way, WCBs can be thought of as Lorenz-type butterflies on the model's attractor. (A generalisation of the question "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?"). Interestingly, often the forecast models within the "TIGGE" archive do not agree on where the butterflies should be. Hence, there is a lot to learn about WCBs, and progress to be made in the practical realm of ensemble forecasting.

So why does a WCB act like a butterfly? Taking a single case-study (so far) in the ECMWF, we find that the representation of model uncertainty is a major factor in the increase in downstream uncertainty. The lack of a firm physical basis for the formulation of model uncertainty leads to different approaches at different forecasting centres, and this could well explain the different butterflies. Of course, we could all adopt the same representation of model uncertainty and our models may then put the butterflies in the same locations, but would they be right? A variance budget of the ensemble of data assimilations could help here because it can tell us if forecast uncertainty is consistent with forecast and observation errors. For the ECMWF model, there is some suggestion that the model is under-spread in a composite of WCB situations. Hence, in general, the presence of a WCB is likely to lead to poorer downstream forecast reliability.

This might be partly over-come at short lead-times in the ECMWF ensemble forecast by the application of singular vector perturbations to the initial conditions, which are shown to still have a strong positive impact on forecast uncertainty, even though the perturbation magnitudes have decreased over the years. Other experiments with the same case study suggest that the growth-rate can increase when the cloud scheme is given more of the work otherwise done by the convective parametrization. This suggests that the butterflies may be sensitive to model resolution.

In addition to such opportunities for forecast improvement from modelling development (better representation of the butterflies), we should also consider the forecast sharpness associated with better observational information. Ensemble forecast sensitivity to initial conditions suggests that a better analysis of the large-scale waves would help here - possibly by reducing the uncertainty of baroclinic development as well as of the embedded convection. These sensitivity results and data denial experiments suggest that observations and the analysis local to the WCB are also important.

While I will go quite quickly over these results, I hope that they will highlight some of the challenges we need to overcome if WCB understanding is to help improve forecast performance. Hopefully they provide some justification for the key questions of the workshop:

1. What are the key aspects of WCBs which lead to enhanced forecast uncertainty, and the implications for development strategy?
2. How well do we observe and initialise WCBs in our forecasts, and would new observation sources help?
3. How well do we represent the complex set of physical processes within a WCB, and what aspects deserve particular attention?
4. What role do WCBs play in weather extremes, regime transitions, and global climate?

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