Session: B10 Oral presentation

A lagrangian moisture source and attribution model for Southern Africa

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A Lagrangian moisture source attribution model is developed in order to explore the regional moisture source dynamics of southern Africa. In particular, the model was developed in order to explore the role of the regional land surface as a source of moisture for regional precipitation. This work was prompted by previous studies suggesting that the land surface may play an important role in the regional climate system and particularly in the regional hydrological cycle. Existing moisture transport and source methodologies have a number of limitations. Correlation analysis, which is often used to identify linkages between moisture sources and precipitation, is limited by the inability to deduce causation or physical processes. Moisture flux analyses are constrained by certain assumptions regarding vertical structure as well as time averaging of the moisture fields. Likewise, bulk recycling methods rely on significant assumptions around mixing and time averaging. The model developed is based on Lagrangian principles and is driven by a Regional Climate Model (RCM) which provides the 3 dimensional wind and moisture fields required. The model operates in reversed time and as such traces moisture from the end point (precipitaiton event) backwards towards the moisture sources. The model converts the RCM moisture flux fields into Lagrangian moisture parcels at the boundaries of a precipitation target analysis domain. A precipitation diagnosis component determines the contribution of each parcel to precipitation events, both within the target analysis domain as well as along the remainder of the parcels path. Likewise, an evaporation contribution component determines the amount of moisture contributed to a parcel by the underlying land surface. A critical component of the model is the attribution coefficient. This coefficient captures the effects of along path precipitation events on the final absolute contributions of upstream moisture sources. The principle is that while an upstream moisture source may contribute a large amount of moisture to an overpassing air parcel, if the air parcel subsequently looses that moisture to a precipitation event then the total contribution of the original source is reduced. Further downstream evaporative sources, even if of smaller magnitude, can contribute a greater amount of moisture to the final precipitation event. The attribution coefficient captures this effect by reducing the moisture gain of further upstream evaporative events when the parcel looses moisture to a precipitation event along its path. A two summer season analysis of moisture sources for four target domains in South Africa was performed and the results analysed through a number of methods. Two interesting results can be highlighted. Firstly, the land surface is identified as being a very important source of moisture for precipitation with as much as 50% of moisture being sourced from the regional land surface. This is considerably higher than previous estimates placing this fraction at around 20%. Likewise, the regional ocean surface plays a secondary role as a moisture source. The traditionally understood eastern moisture sources are not nearly as strongly attributed as would be expected given the literature. Uncertainties in the model and forcing fields are discussed at length along with their implications for analysis and interpretation of the results. Conclusions drawn are that the model is robust at a qualitative level and provides new potential insights into the moisture dynamics of the region. Further possible developments are highlighted along with some interesting areas for exploration including the moisture leap frog process whereby moisture is transported across the continent through a series of evaporation-precipitation cycles.