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Key lessons from the DACCIWA project for forecasting the weather in West Africa

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The DACCIWA (Dynamics-Aerosol-Chemistry-Cloud Interactions in West Africa) project addressed weather, climate and air pollution problems, including impacts on human health. The DACCIWA region in southern West Africa, along the Guinea Coast, is a centre of rapid population growth, and growing anthropogenic aerosol emissions. The main DACCIWA field campaign in June-July 2016 produced the most comprehensive observational dataset of the atmosphere over this region to date. Improved atmospheric prediction across time-scales are important for development of greater resilience of the population to hazardous weather and climate change. The following conclusions from DACCIWA are highlighted as directly relevant to operational meteorological services.

It is well known that the operational meteorological station network in West Africa is sparse and existing data are not always available for research, limiting evaluation of model and satellite products. DACCIWA has shown how standard satellite cloud retrievals underestimate the frequency of low clouds during boreal summer by 20–30%, leading to errors in surface short-wave radiation. Inconsistent retrievals of short-wave absorption lead to uncertainty in estimating the total aerosol radiative effect. Satellite-based rainfall datasets tend to underestimate precipitation in the coastal zone (up to $\sim$8°N) with error compensations between different types of rainfall.

DACCIWA developed a new observations-based conceptual model for the crucial formation and dissolution of the extensive low cloud decks of southern West Africa that should be used as a benchmark for models. Warm rain and drizzle frequently occur in southern West Africa during the summer monsoon season impacting on cloud lifetime and the vertical distribution of moisture. Finally, convective organisation is a key element of the local meteorology, creating large sensitivities to model resolution.

DACCIWA has compiled a new inventory of human emissions for Africa, which when used to drive atmospheric chemistry models gives better comparisons with observations than standard emissions datasets. Emissions of particles and organic gases from vehicles in southern West African cities are higher than those in other locations. Burning seemingly similar materials can lead to very different emissions.

Skill of operational forecasts of rainfall and cloud prediction is very low overall, with some skill evident on the regional scale when synoptic-scale vortices are present. Forecasts tend to be too cold and dry at the immediate Guinea Coast during the summer monsoon, possibly due to problems with the Maritime Inflow phenomenon. Low clouds tend to be underestimated in many weather (and climate) models, leading to too much surface solar radiation. Not only can a more realistic representation of convection in West Africa improve forecasts over Africa, but also medium-range forecasts in the adjacent extratropics. Forecast improvements due to assimilating better observations are moderate at best, pointing to model errors being a substantial obstacle to better forecasts. Finally, DACCIWA has shown that prognostic aerosols have the potential to improve not only short & medium range NWP, but also seasonal predictions.