Operational Benefits and Limitations of Radar Refractivity

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A challenge to forecast operations is the prediction of convection initiation in the absence of high-temporal and spatial resolution moisture measurements. In warm conditions, refractivity retrievals obtained from Weather Surveillance Radar-1988 Doppler (WSR-88D) provide proxy measurements of near-surface moisture at spatial resolutions as small as 2 km and temporal resolutions ranging from 4.2 to 10 min, depending on the volume coverage pattern (VCP). In cases shown in this article, high absolute refractivity values indicate relatively moist air, whereas low absolute refractivity values indicate relatively dry air. Another field of interest is scan-to-scan refractivity change, as positive (negative) values denote a relative increase (decrease) in moisture. Examples of moisture variability depicted by radar refractivity retrievals are moisture gradients associated with outflow boundaries, cold fronts, and moisture advection (Fig. 1).

The Spring 2007 and 2008 KTLX Refractivity Experiments investigated the potential utility of high-resolution, near-surface refractivity measurements to operational forecasting. During these experiments, forecasters at the Norman, Oklahoma National Weather Service Forecast Office (NWSFO) assessed refractivity and scan-to-scan refractivity change fields retrieved from the WSR-88D near Oklahoma City (KTLX). Both quantitative and qualitative analysis methods were used to analyze the 41 responses from 7 forecasters to a questionnaire designed to measure the impact of refractivity fields on forecast operations. The analysis revealed that forecasts benefited from the refractivity fields on 25% of the days included in the evaluation. In each of these cases, the refractivity fields provided complementary information that somewhat enhanced the forecasters' capability to analyze the near-surface environment and boosted their confidence in moisture trends. A case in point was the ability to track a retreating dryline after its location was obscured by a weak reflectivity bloom caused by biological scatterers (Fig. 2). Forecasters unanimously agreed, however, that the impact of this complementary information on their forecasts was too insignificant to justify its addition as an operational data set. A way forward for increasing the utility of refractivity retrievals to forecasters is exploring the impact of moisture variability on convection initiation at spatial scales smaller than those resolved by current surface observation networks.

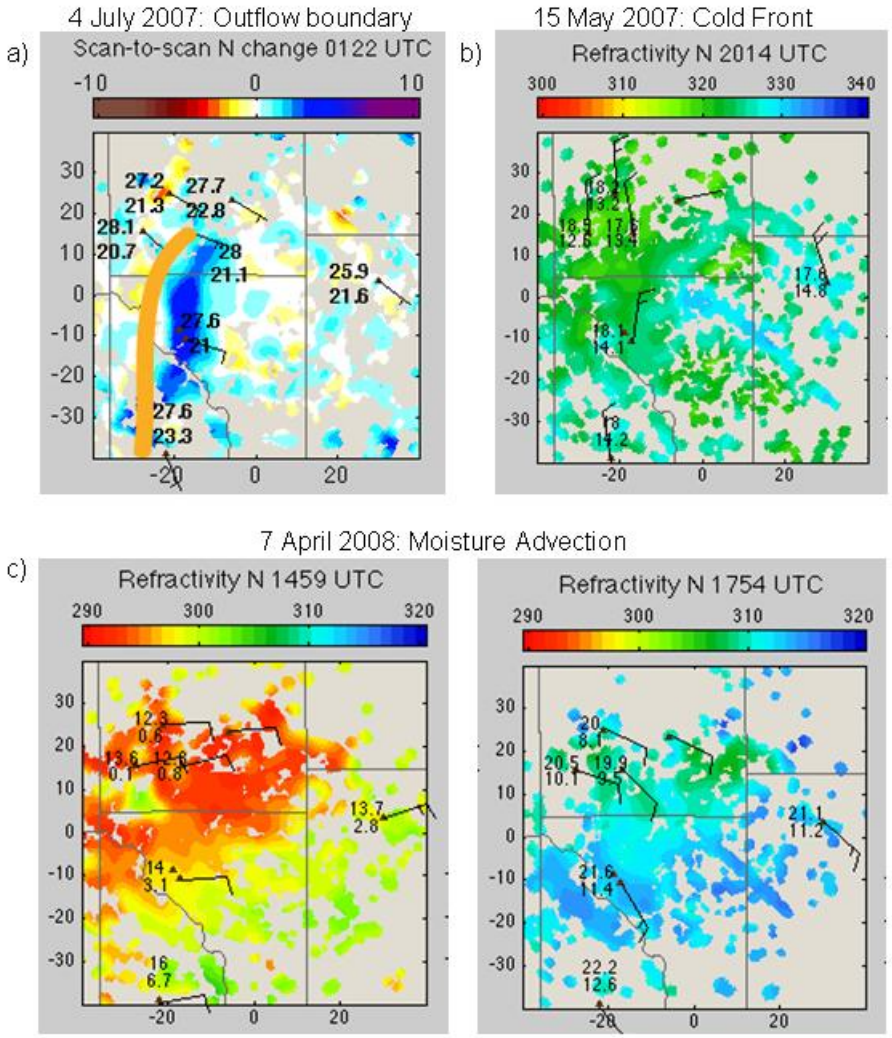

Fig. 1. Examples of the types of moisture variability depicted by radar refractivity fields: a) westward moving outflow boundary (orange line indicates the position of the reflectivity fine line), b) moisture gradient behind a cold front, and c) moisture advection.

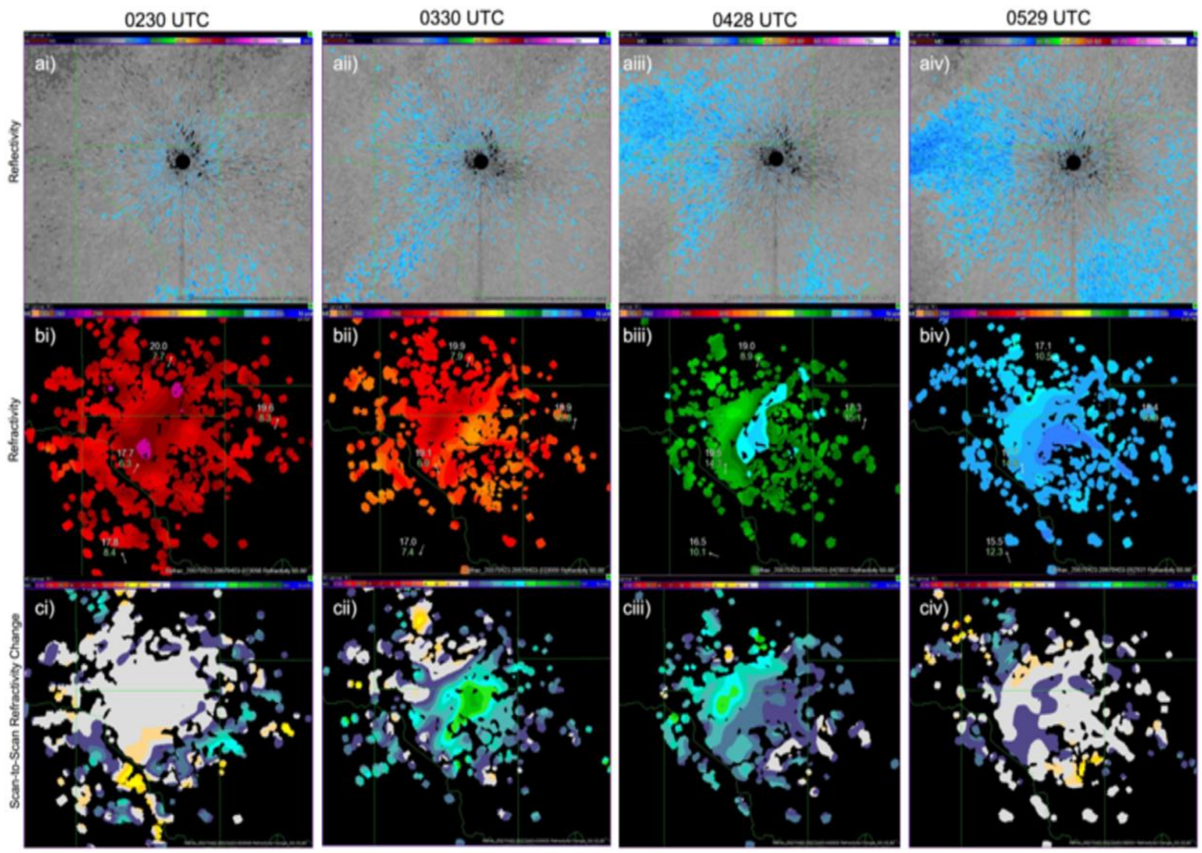

Fig. 2. Time sequence of a) reflectivity, b) refractivity, and c) scan-to-scan refractivity change depicting the northwestward retreat of the dryline during the evening on 22 April 2007 (23 April UTC).