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# The new physics unveiled by the ICEBEAR radar in conjunction with with other auroral observations

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The multiple interferometry links of ICEBEAR have revolutionized how we look at the radar aurora. At first, we confirmed expectations from previous work: strongly field-aligned irregularities , a strong link with auroral indices, a preferred 100 to 110 km altitude range and Doppler shifts normally (not always) slower than the ion-acoustic speed Cs. The latter has stimulated theoretical work on the meaning of a saturation at Cs and on circumstances that break this rule, with Doppler shifts at the line-of-sight component of the ExB drift. Not expected was a clear tendency for the radar echoes to be in clusters separated by 1 to 5 km. This trend was linked to observed precipitation patterns. It could also relate to modulations of Farley-Buneman waves by gradient-drift waves. Monitoring radar echoes locations relative to the aurora, the echoes never come from centers of precipitation, being found along arc boundaries. More importantly and unexpectedly, the clusters motions follow the ExB drift of the plasma. The contradiction between observed Doppler shifts and much faster cluster motions was attributed to the ephemeral nature of unstable 3-m structures. Also, radar echoes are often found on only one side of auroral arcs; in those cases, the motion is very fast, reaching up to a few km/s. We explained these one-sided fast flows through a Cowling conductivity mechanism. Finally, we established that unstable situations deep in the magnetosphere map to the ionospheric location of radar echoes. In the process we also identified a cleft boundary signature in radar echo patterns.

## Keyword-1

ICEBEAR radar

## Keyword-2

Radar echoes in aurora

## Keyword-3

New electric field extraction

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