In-flight Icing Detection Using S-band Polarimetric Weather Data

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Overview

* The purpose of this effort is to develop an 'Icing Hazard Level' (IHL) algorithm using moment fields from the soon-to-be polarized network of >150 WSR-88d S-band weather radars.
* Supercooled liquid aloft is a contributing factor to a significant number of aviation accidents, CONUS detection a priority.

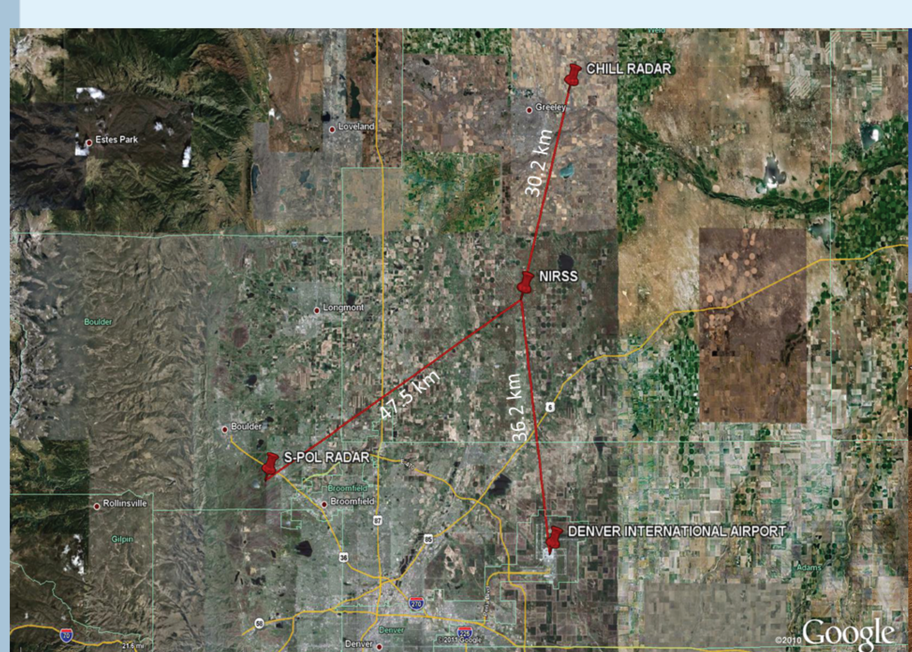
Background

* IHL prototype based on applying fuzzy logic membership functions to our knowledge of microphysical effects on radar returns and existing component algorithms:
  - Freezing level detection (Brandes and Ikeda 2004)
  - Freezing drizzle detection 'NDDA' (Ikeda et. al. 2009)
  - Particle Identification 'PID' (Vivekanandan et. al. 1999)
  - Mixed-phase Identification (Plummer et. al. 2010)
  - Current Icing Product (Bernstein et. al. 2005)

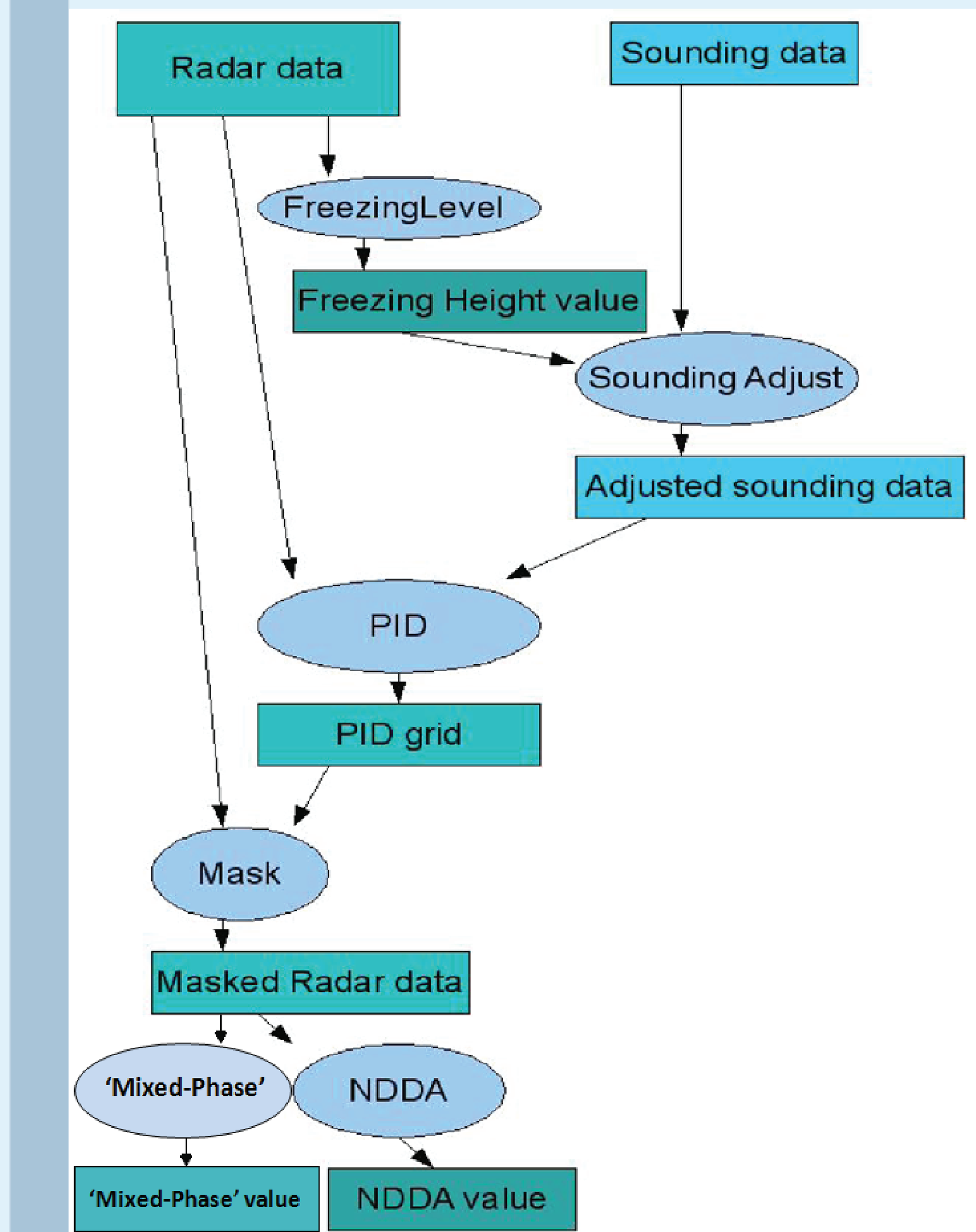
* 'Mixed-Phase' sub-algorithm based on icing flight campaign data analysis work by Plummer et al (2010) where the authors found distinguishable differences in polarimetric moment signatures for 'mixed-phase' and 'ice-only' radar views.
* Specifically, ZDR and KDP had smaller mean values and smaller standard deviations in 'mixed-phase' than 'ice-only'.

In-flight Icing Field Campaign

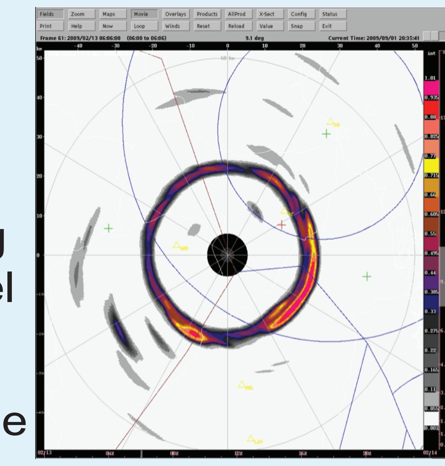
* Paper 16A.6 (thurs @ 5:15 pm) details the Winter 2010/2011 field campaign to collect data counducted at Platteville, Colorado.
* Colorado State's CHILL and NCAR's S-Pol S-band radars collected data over Platteville for these icing cases.
* Explore moment data, validate icing with NASA's Icing Remote Sensing System (NIRSS) positioned at Platteville, icing Pilot Reports.



IHL Algorithm



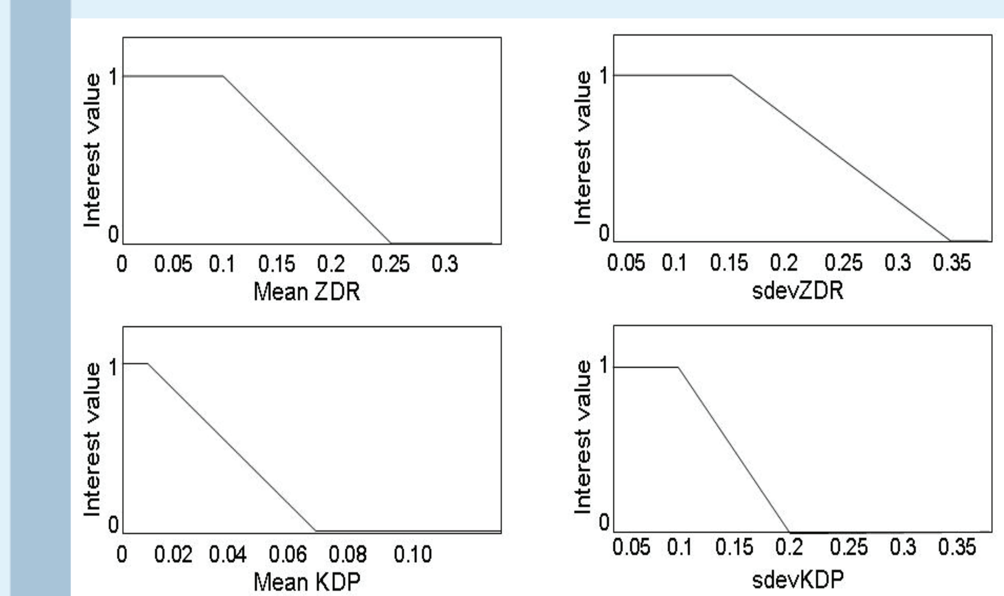
* Soundings are hourly RUC profiles at closest gridpoint to Platteville, CO
* Freezing Level output shown below: (ring due to enhanced moment values)



* Frz. hgt. value adjusts hourly model sounding to a best 0° level

* PID classifies the radar echoes with fuzzy logic and polarimetric membership functions at each gate.
* PID helps mask 'supercooled liquid', 'irregular crystal' and 'dry snow' types
* Other particle types excluded.

* NDDA uses numerous spatial statistical measures of reflectivity, converts into 'interest' scores with fuzzy logic. (Reflectivity median, STDEV and textures values over 15 and 100 km ranges from each gate.)
* 'Mixed-phase' algorithm uses similar approach but with polarized moments



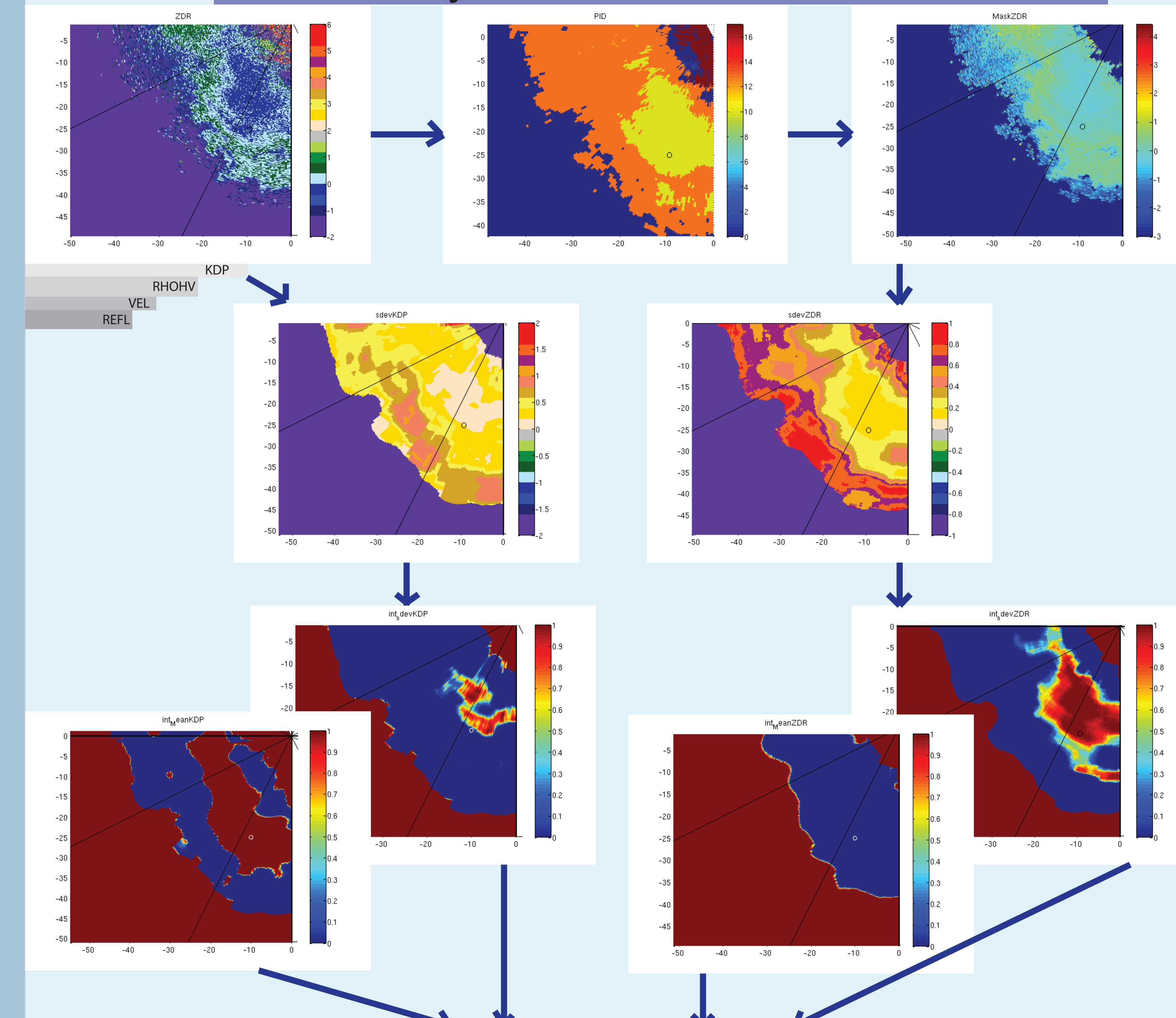
* Interest functions for four components of the current 'Mixed-phase detection' algorithm shown at left.

Mixed-phase_interest = (MeanZDR_int + MeanKDP_int + stdevZDR_int + stdevKDP_int) / 4

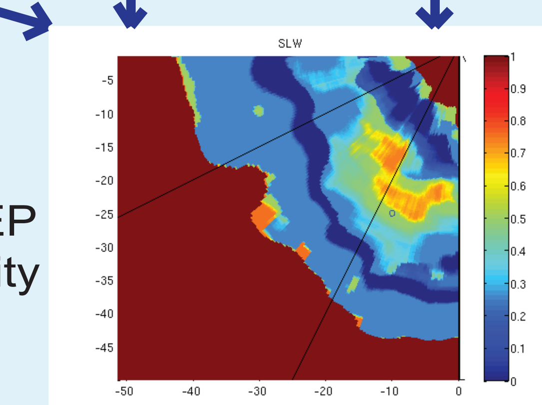
* If 'Mixed-phase Interest' > 0.5 then supercooled liquid exists

* The remainder of this poster will illustrate a case study example of the above IHL flow diagram for the 'Mixed-Phase' calculation only.

Case Study: 5/18/2011 at Platteville, CO



* CSU CHILL at upper right
* NIRSS at circle (-10,-25)
* Time shown: 19:54 UTC
  - Moderate severity PIREP
  - Moderate NIRSS severity



Summary

* The prototype IHL product derives a high interest value over Platteville, CO for known times of in-flight icing from localized PIREPs and output from NASA's Icing System during the 2010/2011 field campaign.
* Future work: 1) Validation with KCLE polarized radar 2012
  2) Tune algorithm against icing/non-icing cases
  3) Test against large drop/small drop cases

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