Verification of in-flight icing forecasts and diagnoses over Europe using ADWICE compared to PIREPS

16th Aviation, Range and Aerospace Meteorology Conference,
7 January 2013, Austin, TX

Frank Kalinka

Research & Development division,
Deutscher Wetterdienst, Offenbach, Germany

Why do we need a Post-processing like ADWICE?

- Risk/Intensity of icing is proportional to
  - Amount & size of supercooled large droplets (SLD)

- But no direct (or insufficient) information of SLD from NWP (here: COSMO-EU)!
  - Poster: Roloff et. al: “Usability of NWP Model Liquid Water Output for In-Flight Icing Forecasts” (Poster Number 251)

- Therefore, other techniques must be used:
  - e.g. ADWICE

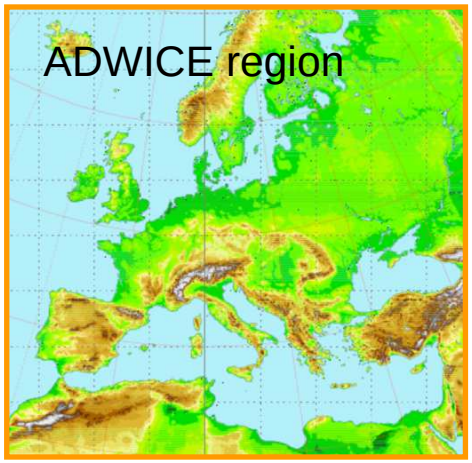
Prognostic Icing Algorithm (ADWICE PIA)

- pressure
- temperature
- humidity
- Top and bottom of convection

→ COSMO-EU (3D)

↓

Catalog for icing scenarios



freezing	convective	stratiform	general
Precipitation into a „warm nose“ T > -20°C	At least 3000m of conv., T up to -40°C	CTT > -12°C, rh > 85%	-20°C ≤ T ≤ 0°C 63% ≤ rh ≤ 82%

↓

Prognostic icing product (PIP)

↓

Icing intensity

- Layer thickness over super-saturation (ice)
- Degree of super-saturation (ice)
- Specific water content qc (COSMO-EU)
- Condensate (parcel method)
- Layer thickness of convection

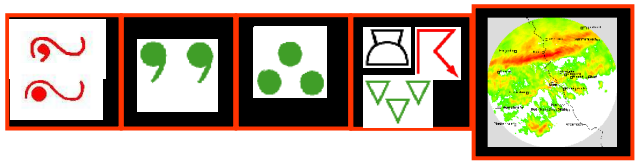
→ Fuzzy-logic →

- SEV
- MOD
- LGT

Exemption: „Freezing rain“ → SEV

Diagnostic Icing Algorithm (ADWICE DIA)

Observational data (2D)
SYNOP/METAR & RADAR



Catalog for icing scenarios

+ PIP (3D) (vertical information & missing Obs)

Diagnostic Icing Product (DIP)

Icing scenario

- *Freezing*
- *Stratiform*
- *Convective*
- *General*

Icing intensity

- *Severe*
- *Moderate*
- *Light*

Prognostic Icing Algorithm

- Updated twice a day (00h + 12h UTC)
- hourly forecasts up to +24h, 6 hourly up to +78h
- on 40 vertical model-levels, horizontal resolution on 7km grid

Diagnostic Icing Algorithm

- updated once every hour!

more information: Tendel, J. and Wolff, C., "Verification of ADWICE In-Flight Icing Forecasts: Performance vs PIREPS Compared to FIP," SAE Technical Paper 2011-38-0068, 2011, doi:10.4271/2011-38-0068.

Example: Icing intensity (Progn)

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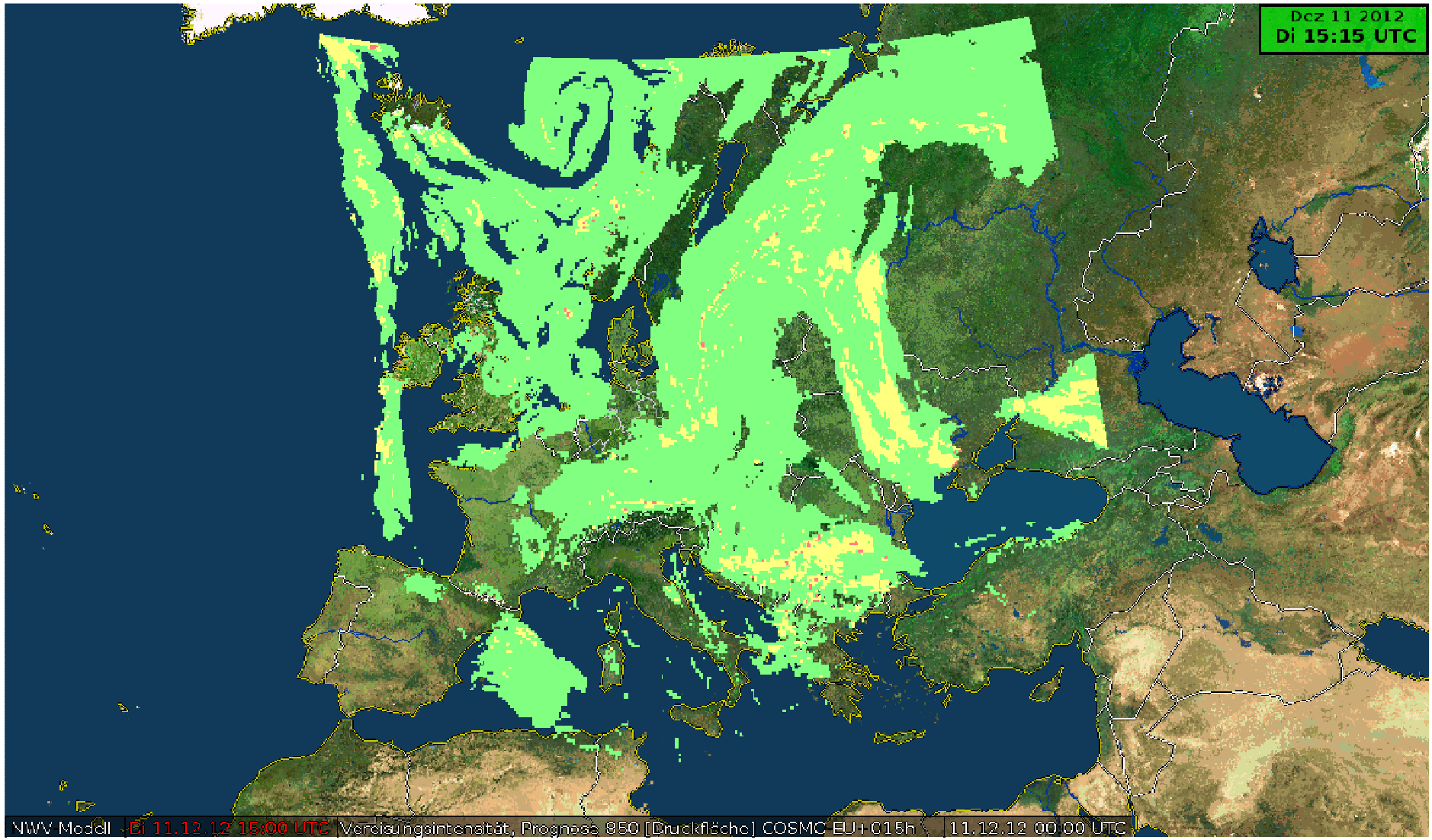

Verification

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➔ Verification period from 01.01.2010 until 31.08.2012

➔ Icing - PIREPS & AIREPS (incl. „CLR ABOVE“ for „no icing“)

Example: - **(…) B737 MOD ICE OBS AT 06:20Z OVR EDDL AT FL80**

➔ Most „positive“ PIREPS/AIREPS in late fall, wintertime and early spring

	total	„icing“ (LGT + MOD + SEV)	„no icing“ + „CLR above“
Obs	4320	1656	2663
%	100	38,33	61,64

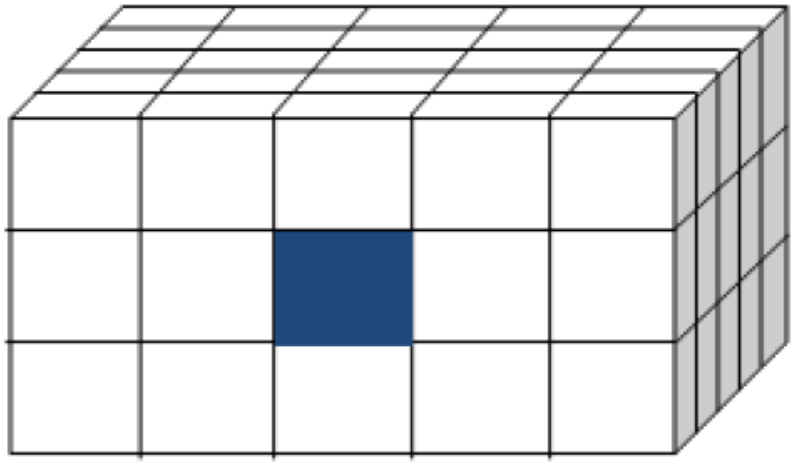
➔ compared with ADWICE prognosis and diagnosis (in 2010 & 2011 only COSMO-EU 00h UTC, for 2012 also 12h UTC)

PIREP/AIREP data quality

➔ PIREPs/AIREPs are neather exact in both, lat/lon nor height

➔Maximum of forecasted / diagnosed icing intensity in a model-cube was compared to the related PIREP/AIREP:

Height: +/- 1 grid point



Lon/lat: +/- 2 grid points (+/- 21 km)

Verification

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Statistics

		Observation	
		Yes („icing“)	No („no icing“)
Fore-cast	Yes	**Hits (H)**	**False Alarm (FA)**
	No	**Misses (M)**	**Correct rejection (CR)**

- **PODyes =** H / (H+M)
  = **75,32%** (prognosis)
  = **75,72%** (diagnosis)
- **PODno** = CR / (CR+FA)
  = **93,58%** (prognosis)
  = **93,17%** (diagnosis)

ROC-curve / AUC

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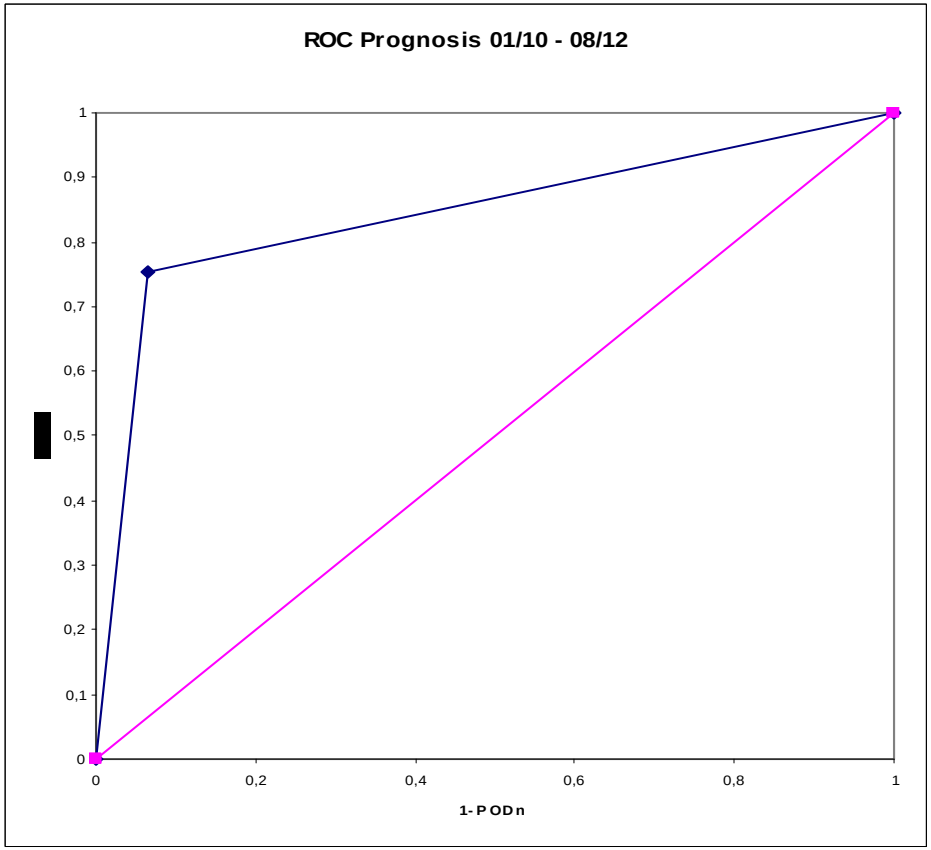
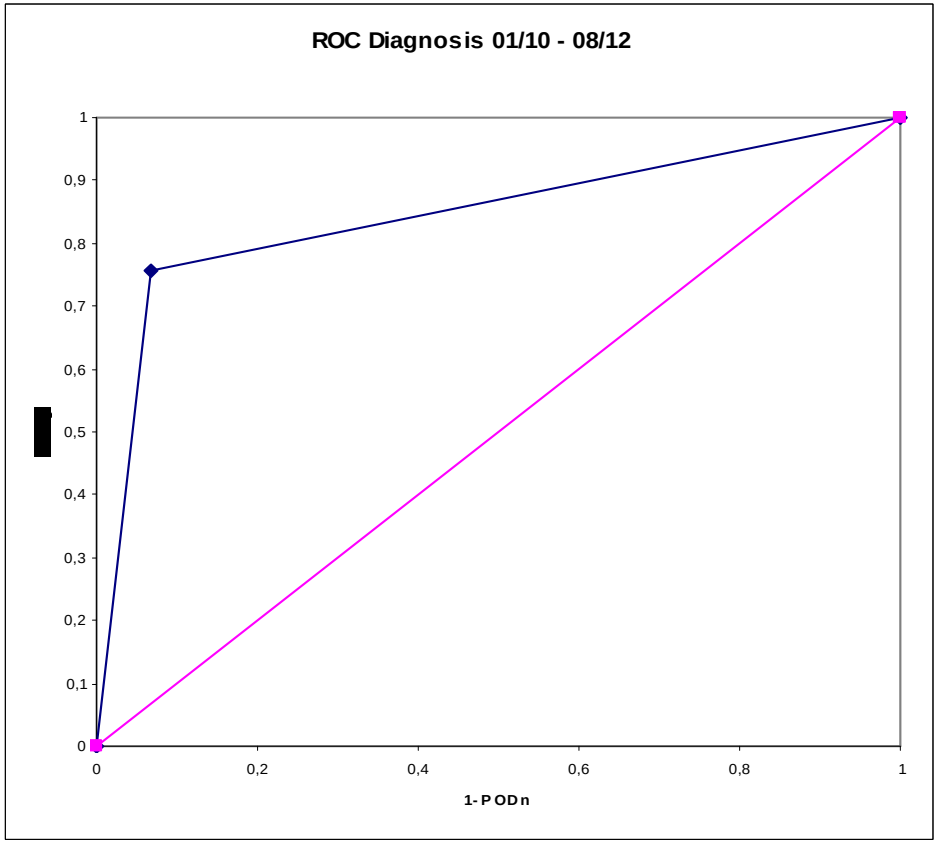
Relative Operating Characteristic (ROC) – curve:





Area under curve (AUC, prognosis) = 0,85

AUC (diagnosis) = 0,86

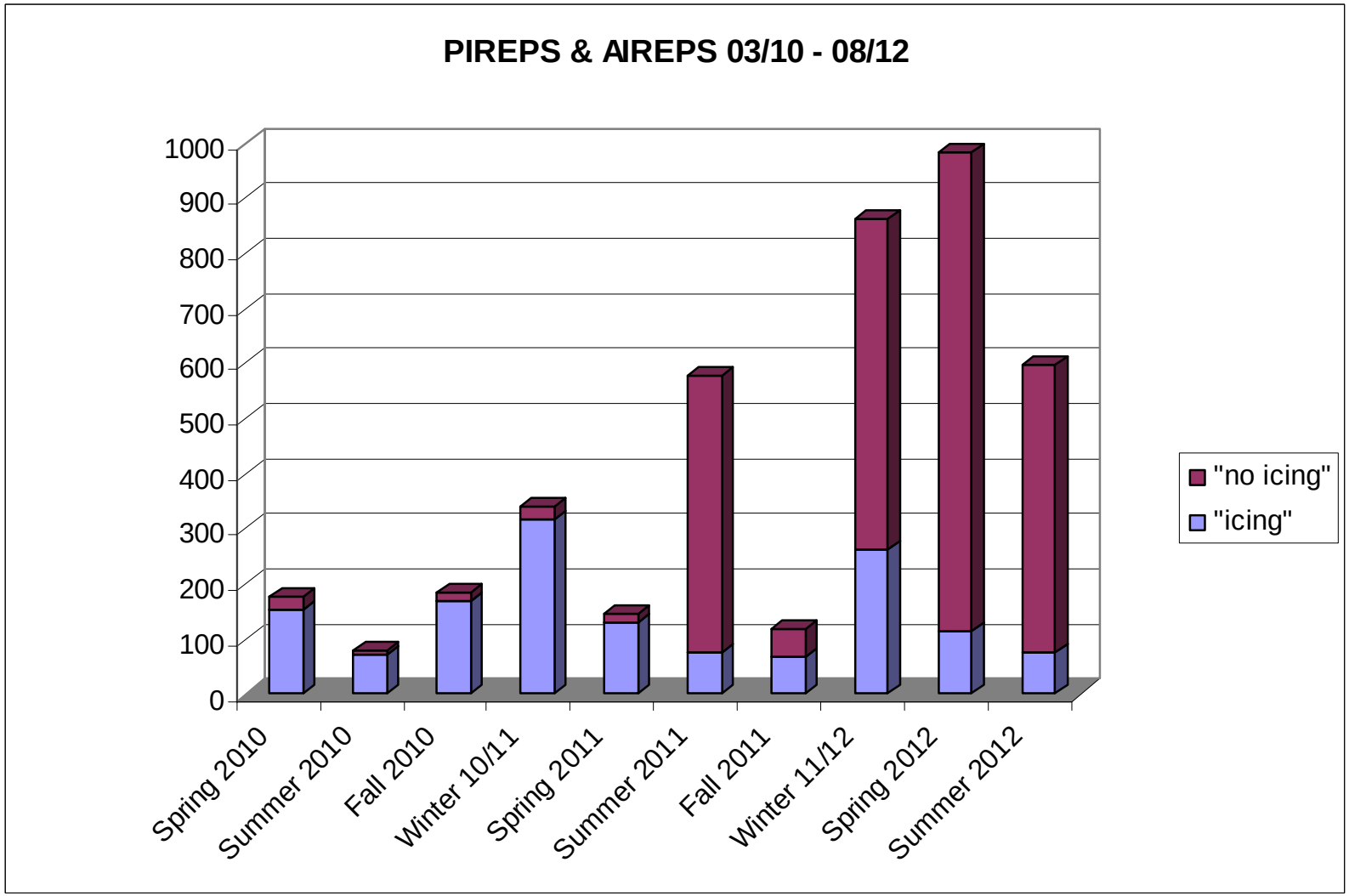
Conclusions

- Postprocessing ADWICE has two different parts:
  - prognostic
  - diagnostic
- It does not only calculate icing intensity, but also an icing scenario
- Verification over Europe shows good results for both, prognosis and diagnosis
- Further development:
  - Decrease „overforecast“ of icing by implementing Satellite data into the diagnostic mode

Thanks for your attention!

Questions?

Special thanks to Mr. Paul Maisey from UKMO for providing more PIREP/AIREP data!


PIREPS & AIREPS 03/10 - 08/12
1000
900
800
700
600
500
400
300
200
100
0
Spring 2010
Summer 2010
Fall 2010
Winter 10/11
Spring 2011
Summer 2011
Fall 2011
Winter 11/12
Spring 2012
Summer 2012
"no icing"
"icing"