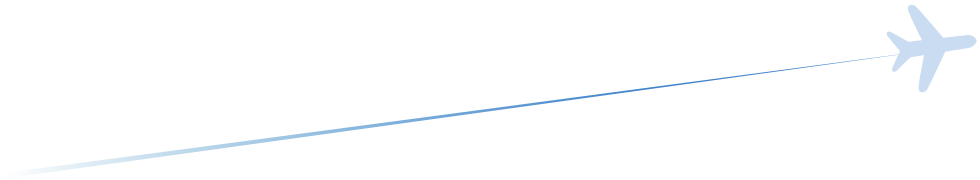

# Talks in conference and manuscripts for peer-reviewed journals

**D7.4 - TiCaMfPJ**

**PNOWWA**


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# PNOWWA

## PROBABILISTIC NOWCASTING OF WINTER WEATHER FOR AIRPORTS

This document is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 699221 under European Union's Horizon 2020 research and innovation programme.


### Abstract

This document gathers together the list of talks in conferences and manuscripts for peer-reviewed journals. There 4 were peer-reviewed journal papers, 14 peer-reviewed conference papers, 2 conference papers, 3 presentations and 1 other dissemination (webinar).

# Table of Contents

# Abbreviations

| | |
|---|---|
| ATM | Air Traffic Management |
| PNOWWA | Probabilistic Nowcasting of Winter Weather for Airports |
| WP | Work Package |

# List of Figures

None

# List of Tables

None

# Executive Summary

The Single European Sky Initiatieve (SESAR) coordinates all the European Union R&D activities concerning Ait Traffic Management (ATM). The SESAR Exploratory Research projects are the first research instruments to tackle a certain ATM discipline. PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports – is a SESAR exploratory research project developing methods to support the Air Traffic Management (ATM) challenged by winter weather.

# Introduction

PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports – is a research project developing methods to support the Air Traffic Management (ATM) challenged by winter weather. This includes developing new probabilistic radar-based nowcasting methods and tools, assessment of the potential of such ATM tools, and demonstrating the effect of those tools at airports during winter weather conditions. In the winter 2017, PNOWWA organized a real-time demonstration campaign providing to selected end-users very short-term (0-3h nowcast) probabilistic winter weather forecasts in 15min time resolution based on extrapolation of the movement of weather radar echoes.

This document brings together the list of publications to be collected within the deliverable 7.4. These publications/talks are published/held either in peer-reviewed journals, in the outcome of scientific webinars and meetings or in scientific conference proceedings.

# 1 Peer-reviewed journal papers

1. von Lerber, A., D. Moisseev, L.F. Bliven, W. Petersen, A. Harri, and V. Chandrasekar, 2017: Microphysical Properties of Snow and Their Link to $Z_e$–S Relations during BAECC 2014. *J. Appl. Meteor. Climatol.,* 56, 1561–1582, https://doi.org/10.1175/JAMC-D-16-0379.1
   - Available: https://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-16-0379.1

   This study utilizes surface observations of snowfall to investigate the connection between microphysical properties of snow and radar observations. The general hydrodynamic theory is applied to video-disdrometer measurements to retrieve masses of falling ice particles. From the derived microphysical properties, event-specific relations between the equivalent radar reflectivity factor $Z_e$ and snowfall precipitation rate $S$ ($Z_e = a_{zs} S^{b_{zs}}$) are determined. For the studied events, the prefactor of the $Z_e$–$S$ relation varied between 53 and 782 and the exponent was in the range of 1.19–1.61. The dependence of the factors $a_{zs}$ and $b_{zs}$ are investigated.

2. Moisseev, D., A. von Lerber, *and* J. Tiira *(*2017*),* Quantifying the effect of riming on snowfall using ground-based observations*,* J. Geophys. Res. Atmos.*,* 122*,* 4019–4037*,* *doi:10.1002/2016JD026272*.
   - Available: http://onlinelibrary.wiley.com/doi/10.1002/2016JD026272/abstract

   Ground-based observations of ice particle size distribution and ensemble mean density are used to quantify the effect of riming on snowfall. A rime mass fraction is determined in respect to the mass-dimensional relation of unrimed snow. Since dual-polarization radar observations are often used to detect riming, the impact of riming on dual-polarization radar variables is studied for differential reflectivity measurements. It is shown that the relation between rime mass fraction and differential reflectivity is ambiguous, other factors such as change in median volume diameter need also be considered. Given the current interest on sensitivity of precipitation to aerosol pollution, which could inhibit riming, the importance of riming for surface snow accumulation is investigated. It is found that riming is responsible for 5% to 40% of snowfall mass.

3. Tiira, J., Moisseev, D. N., von Lerber, A., Ori, D., Tokay, A., Bliven, L. F., and Petersen, W.: Ensemble mean density and its connection to other microphysical properties of falling snow as observed in Southern Finland, Atmos. Meas. Tech., 9, 4825-4841, https://doi.org/10.5194/amt-9-4825-2016, 2016.
   - Available: https://www.atmos-meas-tech.net/9/4825/2016/

   In this study measurements collected during winters 2013/2014 and 2014/2015 at the University of Helsinki measurement station in Hyytiälä are used to investigate connections between ensemble mean snow density, particle fall velocity and parameters of the particle

size distribution (PSD). The density of snow is derived from measurements of particle fall velocity and PSD, provided by a particle video imager, and weighing gauge measurements of precipitation rate. Validity of the retrieved density values is checked against snow depth measurements.

4. von Lerber, A., D. Moisseev, D.A. Marks, W. Petersen, A. Harri, and V. Chandrasekar, Early online release: Validation of GMI snowfall observations by using a combination of weather radar and surface measurements. *J. Appl. Meteor. Climatol.,* accepted, https://doi.org/10.1175/JAMC-D-17-0176.1
   - Not available yet.

   Currently, there are several space-borne microwave instruments suitable for detection and quantitative estimation of snowfall. To test and improve retrieval snowfall algorithms, ground validation datasets that combine detailed characterization of snowfall microphysics and spatial precipitation measurements are required. To this endpoint, measurements of snow microphysics are combined with large-scale weather radar observations to generate such a dataset. The feasibility of using this type of data to validate spaceborne snowfall measurements and algorithms is demonstrated with NASA GPM Microwave Imager (GMI) snowfall product.

# 2 Peer-reviewed conference papers

1. Pulkkinen S., Saltikoff E., von Lerber A. and Hagen M., 2017, Improving Snow Nowcasts for Airports, Seventh SESAR Innovation Days, November, 28-30, Belgrade, Serbia
   - Available: http://www.sesarju.eu/sites/default/files/documents/sid/2017/SIDs_2017_paper_43.pdf

   PNOWWA (Probabilistic Nowcasting of Winter Weather for Airports) project has studied methods to forecast snowfall for next few hours by extrapolating movement of radar echoes. Three different methods to create motion vectors (a simple method, a method used operationally and a new method) as well as three methods to produce probability forecasts with help of a motion vector field have been studied.

2. Pulkkinen S. and Koistinen J., 2016, Probabilistic Nowcasting of Snowfall for Aviation, the 9th European Conference on Radar in Meteorology and Hydrology (ERAD2016), 10-14 October, Antalya, Turkey.
   - Available: https://erad2016.mgm.gov.tr/abstracts?userId=235 (abstract)

   Reliable forecasts of heavy snowfall are critical for air traffic, as such events can cause major disruptions and additional costs. Aiming at aviation applications, we have developed a probabilistic radar-based nowcasting method for snowfall and associated phenomena. The presented approach is an extension of the stochastic ensemble prediction system (STEPS) [Seed 2003 and Bowler et al. 2004, 2006]. For estimating the advection field, we utilize an improved multiscale optical flow technique aiming at maximization of consistency between forward and backward flows [Pulkkinen et al. 2016]. We have studied the geographic, flow- and scale-dependency and growth and decay of snowfall and validated the nowcasting method by using the C-band dual-polarization radar located at Vantaa, Finland.

3. Pulkkinen S., Koistinen J. and Harri A.-M., 2016, Consistency-Driven Optical Flow Technique for Nowcasting and Temporal Interpolation, the 9th European Conference on Radar in Meteorology and Hydrology (ERAD2016), 10-14 October, Antalya, Turkey.
   - Available: https://erad2016.mgm.gov.tr/abstracts?userId=89 (abstract)

   Determination of motion vectors from consecutive precipitation fields is a key task in radar meteorology. A novel consistency-driven optical flow technique is proposed for motion estimation. The proposed method aims at minimization of a cost function that penalizes intensity changes.

4. Saltikoff E., Nuottokari J. and Mäkelä A., 2016, Dualpol analysis of graupel as indicator of cool season thunderstorms, the 9th European Conference on Radar in Meteorology and Hydrology (ERAD2016), 10-14 October, Antalya, Turkey.
   - Available: https://erad2016.mgm.gov.tr/abstracts?userId=55 (abstract)

   Graupel are soft and white millimeter-sized solid particles formed by riming in convective clouds. Although graupels do not have negative impacts at ground level nor for airplanes, graupels are interesting as an indirect indicator of other phenomena. In aviation meteorology, graupel observations are used as an indicator of icing conditions. The ice crystal–graupel collision charging mechanism is important in thunderstorm electrification process. Modern microphysic schemas of small-scale NWP models include graupel, and modelers are always looking for verifying observations. We have observed the presence of narrow, a few kilometers tall graupel towers in hydrometer classification products in association with thunderstorms outside of the traditional thunderstorm season. Systematic identification of these towers is a challenge to radar measurement geometry. In this study, we compared different approaches to visualize hydrometeor classification data in cold-season thunderstorm cases.

5. von Lerber A., D. Moisseev, L. F. Bliven, W. A. Petersen, A. M. Harri, V. Chandrasekar, 2017, Investigating dependences of Ze-S-relation on microphysical properties of snow, *the 38th AMS Radar Conference*, 28 August – 1 September 2017 Chicago, USA.
   - Available:https://ams.confex.com/ams/38RADAR/meetingapp.cgi/Paper/320773 (abstract)

   The method to retrieve the mass of falling snow particles utilizing the hydrodynamic theory is presented and the changes of mass-dimensional relation of snowfall is connected to snow growth processes, namely riming and aggregation. These can be linked to changes also in the factors of radar reflectivity factor (Ze) - snowfall rate (S) relation. The uncertainties of the determined Ze – S are shown.

6. Pulkkinen S. et al., accepted, Stochastic Nowcasting of Winter Precipitation in Finland, European Geosciences Union General Assembly 2018, 8–13 April 2018, Vienna, Austria.
   - Not available at the moment.

7. von Lerber A. et al., 2016, Documenting variability of ice mass-dimensional properties during winter storms in Finland, 17th International Conference on Clouds & Precipitation, 25 - 29 July, Manchester, UK.
   - Available upon request.

   This study investigates the microphysical properties of snow from the ground observations and links them to weather radar observations. The focus is on understanding microphysical processes and their evolution during winter storms. We have observed that snow microphysics can change within storms, and that the changes can happen on temporal scales of several minutes. To characterize the microphysics of winter precipitation we have implemented a procedure to retrieve mass-dimensional (m-D) properties of ice particles.

8. Hagen M. et al., accepted, On the influence of orography on the predictability of winter weather, European Geosciences Union General Assembly 2018, 8–13 April 2018, Vienna, Austria.

9. Kaltenboeck R. et al., 2017, PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports, *the 38th AMS Radar Conference*, 28 August – 1 September 2017 Chicago, USA.

10. Kaltenboeck R., et al., 2017, PNOWWA – Probabilistic Nowcasting of Winter Weahter for Airports. 2nd European Nowcasting Conference, 3-5. May 2017, Offenbach, Germany

11. Haukka H. et. al, accepted, Probabilistic Nowcasting to increase airport safety and capacity, European Geosciences Union General Assembly 2018, 8–13 April 2018, Vienna, Austria.

12. Kaltenboeck R. et al., accepted, PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports: Demonstration campaigns and airport stakeholder interactions. European Geosciences Union General Assembly 2018, 8–13 April 2018, Vienna, Austria.

13. Harri, A.-M., 2017, Winter Weather - Probabilistic Nowcasting to Increase Airport Safety and Capacity, Seventh SESAR Innovation Days, November, 28-30, Belgrade, Serbia.

14. Harri, A.-M., 2016, PNOWWA - Probabilistic Nowcasting of Winter Weather for Airports, Sixth SESAR Innovation Days, November, 8-10, Delft, Netherlands.

# 3 Conference papers

1. von Lerber A., Moisseev D., Ori D, Tiira J., and Petersen W., 2016, Documenting microphysical processes of winter precipitation and their connection to Ze-S, *8th IPWG and 5th IWSSM Joint Workshop*, October 3-7, Bologna, Italy.
   - Available: http://ipwg.isac.cnr.it/meetings/bologna-2016/Bologna2016_Posters/P1-56_vonLerber.pdf

   The focus of this study is to utilize a combination of microphysical surface measurements and large scale radar observations to validate the space-based snowfall products. The validation is demonstrated with GMI radiometer surface snowfall estimate related to ground-based weather radar estimate of snowfall rate. Clear underestimation of space-estimated snowfall rate is noticed.

2. Juntti H. et al, 2017, Probabilistic Winter Weather Nowcasting supporting Total Airport Management, *WMO Aeronautical Meteorology Scientific Conference*, , 6-10 November, Centre International de Conférences, Météo-France, Toulouse, France

# 4 Presentations

1. Saltikoff E., Juntti H. and Kaltenboeck, 2017, Snow forecasts for airports, *7th National Pyry-seminar organized together with EU:n COST ES1404/HARMOSNOW*, November 1, Helsinki, Finland.
2. Juntti H. et al. 2017, Provision of probabilistic nowcasts (PNOWWA project), International Workshop on Meteorology and Air Traffic Management "Management of Meteorological Uncertainty", May 24.-25, Sevilla, Spain.
3. Kaltenboeck, R. et al. 2017, Probability of snow nowcasting for airports, Seventh SESAR Innovation Days, November, 28-30, Belgrade, Serbia.

# 5 Other dissemination

1. Webinar, October 4, 2017
    - H. Juntti and R. Kaltenböck, Synthesis of user needs for Probabilistc Nowcasting of Snow at the Airports (WP4 and WP5)
    - Prof. M. Laine, Approaches of probability forecasting, guest speaker
    - E. Saltikoff, S. Pulkkinen and M.Hagen, Snow nowcasts with extrapolative methods. Case studies and lessons learned. (WP2 and WP3)

All webinar presentations are available in PNOWWA webpage http://pnowwa.fmi.fi.

# 6 Conclusions

PNOWWA project dissemination achieved it goals mainly as planned. Some planned articles were submitted later than planned and some were postponed for future or cancelled. PNOWWA was visible e.g. in SID's, AMS and EGU receiving a good reception from the ATM.

# References

- None