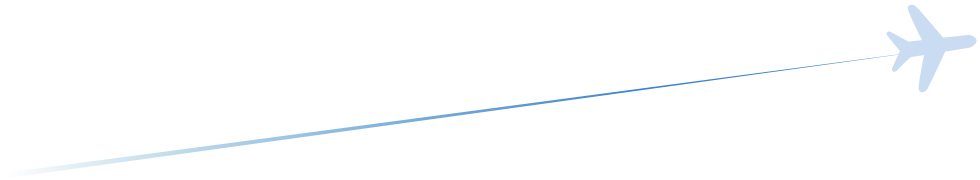

WP3 List of scientific publications

D3.6 - LoSP

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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 WP3 list of scientific publications. There were 4 peer-reviewed journal papers, 2 thesis, 6 peer-reviewed conference papers, 1 conference paper, 2 magazine articles 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 3.6. These publications are published either in peer-reviewed journals, in the outcome of scientific webinars and meetings or in scientific conference proceedings.

1 Peer-reviewed journal papers

1. 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.

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 Magazines

1. “Snow cannons and sea monsters – the lake effect snow”, Ilmailu, Elena Saltikoff et. al.

   The article is published on Ilmailu webpages. First the article is only available for subscribers of the eprinted version on 13th of March, and in printed version in May 2018. After publication the manuscript will released and published in the frame of the PNOWWA project either in PNOWWA webpage or by providing the direct link to the publication.

2. “Orographic enhancement of snowfall”, Geophysica, by Elena Saltikoff, Martin Hagen, et. al.

   This paper shows that lake effects along the coastlines or flow within the proximity of mountains degrade the forecast quality and the reliable lead time for nowcasts is shorter than for situations which are not affected by heterogeneous terrain.

3 Thesis

1. von Lerber, Annakaisa, 2018, Challenges in measuring winter precipitation: Advances in combining microwave remote sensing and surface observations. PhD thesis, Finnish Meteorological Institute Contributions 143, ISBN 978-952-336-045-7
   - Available: https://helda.helsinki.fi/handle/10138/231104

   In this thesis, the microphysical properties of snowfall are studied with ground-based measurements, and the changes in prevailing snow particle characteristics are linked to remote sensing observations. Detailed ground observations from heavily rimed snow particles to open structured low-density snowflakes are shown to be connected to collocated triple-frequency signatures. As a part of this work, two methods are implemented to retrieve mass estimates for an ensemble of snow particles combining observations of a video-disdrometer and a precipitation gauge. The changes in the retrieved mass-dimensional relations are shown to correspond to microphysical growth processes. The dependence of the C-band weather radar observations on the microphysical properties of snow is investigated and parametrized. The results apply to improve the accuracy of the radar-based snowfall estimation, and the developed methodology also provides uncertainties of the estimates. Furthermore, the created data set is utilized to validate space-borne snowfall measurements. This work demonstrates that the C-band weather radar signal propagating through a low melting layer can significantly be attenuated by the melting snow particles. The expected modeled attenuation is parametrized according to microphysical properties of snow at the top of the melting layer.

2. Knobloch, S., 2017, Zusammenhang der Schneefallintensität zu Sicht- und Radarmessung, (Relation between snowfall intensity and visibility and radar measurements), BSc Thesis, Leopold-Franzens-Universität Innsbruck, Austria, 56 pp.

   - Available: http://acinn.uibk.ac.at/teaching/bachelor-theses

4 Peer-reviewed conference papers

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

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

5 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.

6 Presentations

None

7 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.

8 Conclusions

PNOWWA project WP3 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