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Possibilities to improve ground-based cloud cover observations using Satellite Application Facility (SAFNWC) products

Kristina Mockevičiutė,

Gintautas Stankūnavičius

Vilnius University,
e-mail: gintas.stankunavicius@gf.vu.lt,
kristina.mockeviciute@gf.vu.lt

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The study concerns the practical application of the new Satellite Application Facility is support of the Nowcasting and Very Short Range Forecasting (SAFNWC) product, Cloud Mask (CMa) for the cloud amount ground-based observations. The analysis covers a one-year period. The cloud cover observation scale was modified to adapt to remote sensing data. The results revealed various sizes and shapes of areas of influence of the different meteorological stations. These areas pertain to the major features of the main landscapes in Lithuania and could be a good measure of station representativeness. The analysis not only shows the possibility of observational network optimization, but also offers guidelines for improving the cloudiness climatology dataset.

Key words: remote sensing, cloud mask, station representativeness

INTRODUCTION

The formation and dynamics of clouds constitute one of nature's most complex and vital processes. Clouds differ dramatically in their reflection and absorption of sunlight and their ability to retain heat, influencing the climate of the planet.

Satellite-based remote sensing is used to analyse both large- and mesoscale cloud systems and structures. On the other hand, ground-based monitoring of the clouds is also important for the observation of their temporal changes in size and forms, vertical structure and other dynamical characteristics in both large and small scales (Diamandi, Dybbroe, 2001). Ground-based observations alone cannot catch cloud systems as a whole because observations of the upper clouds are often obscured by lower clouds and the nighttime observations are often incomplete due to imperfection of the human eyes. Another important factor which still serves as a short-range prediction deficiency is that there are no radar observations so far in the Lithuanian territory.

The simplest parameter of cloudiness is the cloud mask which is more often called the cloud fraction and represents total cloudiness in percentage, points or octas in the meteorological literature. This parameter also dominates in the textual forecasts as well as in the visual information like pictograms or meteograms. Cloud fraction, or cloud mask, is the everyday forecast product still demonstrating the lowest skill scores comparing with the geopotential height, sea level pressure, advection temperature, etc., although extreme air and surface temperatures and their appearance time as well as the presence of such meteorological phenomena as fog are highly influenced by it (Bougeault, 2003; Jolliffe, Stephenson, 2003).

There have been only few publications concerning cloud cover features and dynamics over Lithuania during the last 20 years, and these sources only deal with the monthly means in the context of the regional climate change (Bukantis, 2002; Bukantis, Pankauskas, 2006; Bukantis ir kt., 2001).

DATA AND METHODS

The cloud mask data from polar orbiting satellites were used in this study because the same product from geostationary satellite (CMa – SEVIRI) has a more sophisticated retrieval procedure and less reliability for such high latitudes (Derrien, Le Gléau, 2005). The Lithuanian Hydrometeorological Service is provided with cloudiness data eight times daily from 17 meteorological stations. The rejection of three stations from the analysis (the total number of national stations is 20) was made after preprocessing raw data and separating the stations (Panevėžys, Trakų Vokė and Vilnius airport) with the lowest quality of data or a largest number of gaps. The remaining number and position of meteorology stations is sufficient to cover all the Lithuanian territory and to provide proper results for the analysis. The study period included one-year data from August 1, 2004 till July 25, 2005. One of the reasons was that regular SAFNWC products started only in July 2004, and the second reason was to have a complete annual cycle.

Description of the database. Remote sensing data were kindly provided by the Swedish Meteorological and Hydrological Institute (SMHI) which participates in four of the total seven EUMETSAT Satellite Application Facilities (SAFs) now under development. The SAFs all have a lifetime of five years. At the end of the five years the SAFs are supposed to deliver either products or software (to extract products locally) to the member states via the EUMETSAT. The development for the SAF to support Nowcasting and very short range forecasting (SAFNWC) began in early 1997. The SMHI is playing a central role in the SAFNWC. In the framework of the SAFNWC, SMHI is developing software to extract cloud information from the data of the future NOAA / EPS and MSG satellites. Having the full responsibility of the software development and integration of the cloud mask, cloud type, cloud top temperature and height, and the precipitating clouds products from AVHRR (Advanced Very High Resolution Radiometer) and AMSU (Advanced Microwave Sounding Unit) data of the future polar NOAA / EPS satellites, the SMHI plays a key role in the SAFNWC project. Cloud mask retrieval algorithm and issues are presented in detail in the scientific user's manual for the AVHRR/AMSU cloud and precipitation products of the SAFNWC/PPS (2004). Besides the cloud mask, the SAFNWC includes Cloud Type (CTy), Cloud Top Temperature and Height (CTTH) and Precipitation Clouds (PC), however, they were not analysed in this study (Dybbroe et al., 2005).

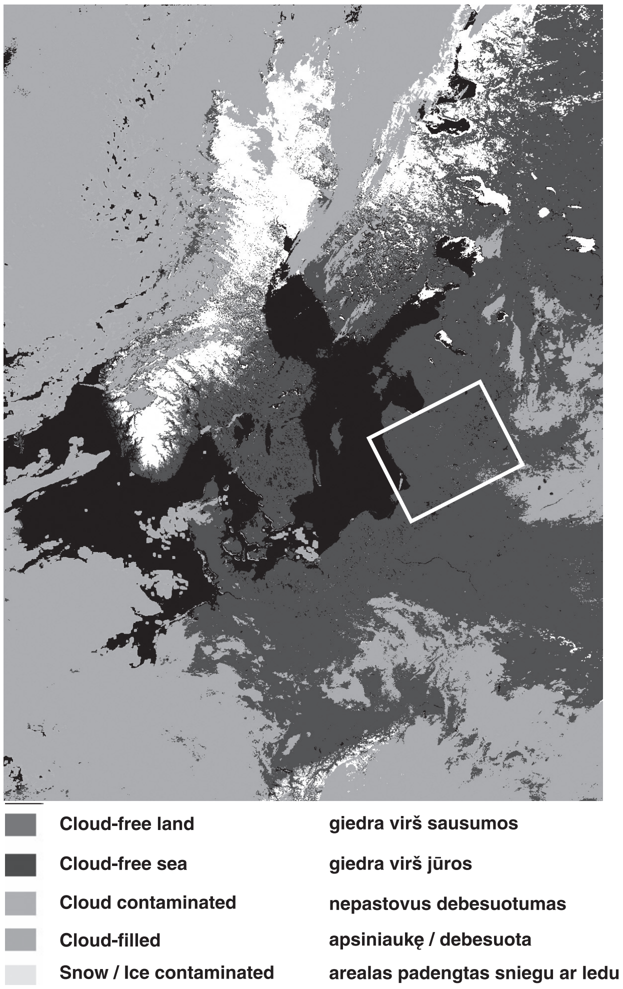

Fig. 1. Example of Cloud Mask product (CMa) and the area covered by the study (white rectangle)

1 pav. Debesų kiekio dydžio (CMa) pavyzdys bei analizuojama teritorija (baltas stačiakampis)

All other documentation concerning SAFNWC products and retrieval algorithms can be found on the specialized website http://nwcsaf.inm.es/.

Description of the product. This product attempts to delineate all absolutely cloud-free pixels in a satellite scene with a high confidence. The final product, besides satellite sensor scenes, requires additional inputs from NWP such as surface temperature, 950 hPa temperature, total precipitable water, and auxiliary data such as the Sun zenith, satellite view zenith, and sun-satellite view relative azimuth difference angle, 1 km land use data (including land / sea mask) and a 1 km digital elevation map. Product resolution is 1 km and product quality is guaranteed north of the 50N parallel. The main output (Fig. 1) is given by six categories (cloud-free land or sea, cloud-contaminated, cloud-filled, snow- / ice-contaminated and unclassified pixels) quality flag which has 10 options but generally could be labeled as a low quality pixel and dust / volcanic plume flag (not actual). Data are stored in the hierarchical data format – HDF–5. Since the data from SAFNWC cover the entire Baltic region, only the Lithuanian territory with surrounding regions was extracted from the entire dataset and the amount of data was optimized in this way (Fig. 1).

Satellite scene selection. Not all available scenes with the SAFNWC products were used in this study because of inconsistence between ground-based and remote sensing observation time terms. Meteorology stations report eight times a day strictly every three hours: 0, 3, 6, 9, 12, 15, 18, 21 UTC. The time and frequency for the Cloud Mask (CMa) product depend on the presence time of NOAA satellites over a particular region. The criteria for selecting an appropriate satellite data set were scenes for a period where comparisons could be made to ground-based observation data sets and reject all scenes containing at least one fourth low quality pixels. Only passes ranging ±15 minutes from synop observation terms were included into the analysis. Most of the analysed scenes were brackets to the time tics like 3, 6, 9, 12, 15 and 21 UTC and no scenes were analysed together with 18 and 24 UTC observations. However, such "temporal distribution" of the scenes has a minimal impact on the quality of the results because the visual nighttime observations are less reliable at all.

Matching the datasets. Ground-based cloud cover observations in Lithuania are based on a 10-point assessment scale at the ordinary meteorological stations or on the eight octas scale at airports. In the 10-point scale, 10 means completely overcast and 0 means clear, meanwhile, Cloud Mask provides a graphical representation of cloudiness, in which each point might have one of the following meanings: cloud-free, partly cloudy, and cloudy. The

Table 1. **Cloud amount categories in ground-based (MS) and remote sensing (SAFNWC) observations**

Lentelė 1. **Debesų kiekio kategorijos remiantis stebėjimais meteorologijos stotyse (MS) bei nuotoliniais metodais (SAFNWC)**

Cloud amount categories *Debesų kiekio kategorijos*				**Meaning** *Reikšmė*
MS points *Balai*	**MS octas** *Oktos*	**Airport abbreviations** *Oro uostuose vartojamos santrumpos*	**SAFNWC**	
0–2	0–1 (2)	SKC, FEW	1	Cloud-free *Giedra, mažas debesuotumas*
3–7	2–6	SCT, BKN	2	Partly cloudy, cloud contaminated *Dalinis ir besikeičiantis debesuotumas*
8–10	7–8	OVC	3	Cloudy, cloud filled *Debesuota su pragiedruliais, apsiniaukę*

cloud cover characteristic “partly cloudy” is the most frequent feature in the weather analysis and forecast, and it couples such general cloudiness description terms as “bright” or “sunny spells”, “partly cloudy”, “light clouds” and “variable cloudiness”. According to these definitions, the 10-point scale data were rearranged into three categories: 1) clear or few clouds; 2) total cloud cover – 3–7 points, and 3) overcast or overcast with breaks (Table 1).

Selection of the verification thresholds. All selected scenes were coupled chronologically, constructing 3-D cloudiness data matrices. Every selected remote sensing scene’s pixel has its own data range covering a one-year period and these ranges were correlated with rearranged meteorological data ranges in every station, using a nonparametric test of statistical dependence for a random sample of paired observations – Spearman's rank correlation coefficient. The choice fell to such nonparametric test because it does not require an assumption that the relationship between the variables is linear, nor does it require the variables to be measured on interval scales; it can be used for variables measured at the ordinal level (Čekanavičius, Murauskas, 2002). This correlation coefficient (ρ) as the linear coefficient ranges from minus one to one. Because of the large sample size and only a little number of categories, the 0.1 % significance level was used for analysis. Even such a low significance level allows covering all territory under analysis by reliable coefficients, and the decision was to range the correlation coefficients by the following scheme: poor correlation – ρ does not exceed 0.5, medium correlation – ρ varies between 0.5 and 0.6, and strong correlation – ρ exceeds 0.6. Using such an interpretation, the well represented areas (strong correlation) and areas of influence (higher than medium correlation) were defined for each meteorological station.

SPATIAL PATTERNS OF CORRELATIONS BETWEEN GROUND-BASED AND REMOTE SENSING DATA

We assumed that the spatial distribution of reliable coefficients shows the station influence zone in the field of cloud amount and so allows regionalizing the Lithuanian territory according to this relation. In order to find the utmost possible area of influence for each station or all stations together, the study period was divided into smaller timespans, e. g., months. The only problem was the unequal number of sample sizes in each month. After monthly sample size unification, the maximal area of influence fell to the cold season months and only confirmed the cloud cover climatology – the frontal and cyclone cloud systems prevail in this season.

Table 2. **Correlation coefficients among station-ranked data and remote sensing (SAFNWC) data and the size of the area of influence**

Lentelė 2. **Koreliacijos koeficientai tarp kategorizuotų stočių duomenų ir duomenų, gautų nuotoliniais metodais**

Meteorological station *Meteorologinė stotis*	**Maximal correlation coefficient** *Maksimalus koreliacijos koeficientas ρ_{max}*	**Size of the area of influence, km²** *Įtakos zonos plotas km²* **$\rho > \|0,5\|$**
Biržai	0.64	13 289.5
Dotnuva	0.66	21 137.4
Dūkštas	0.67	3 438.3
Laukuva	0.58	4 209.9
Lazdijai	0.62	6 792.6
Kaunas	0.62	28 769.6
Kybartai	0.64	6 352.0
Klaipėda	0.66	4 169.9
Nida	0.63	5 845.1
Palanga	0.64	4 561.7
Raseiniai	0.63	14 236.9
Šiauliai	0.59	2 814.6
Šilutė	0.56	1 447.3
Telšiai	0.58	3 454.3
Ukmergė	0.71	26 838.6
Utena	0.66	21 969.0
Varėna	0.62	5 397.3

No negative correlation coefficient was found in the whole territory, and the highest values for each station lay within its surroundings. However, the best correlations were found in the middle and northeastern parts of Lithuania as well as on the Baltic Sea coast, but the last finding is rather a product of selecting the position of the rectangular frame of analysis (Table 2). The cloudiness observed in the Klaipėda station represents a large area of the Baltic Sea where a uniform cloud cover prevails (Pajūrio klimatas, 2003). On the other hand, some stations did not exceed the “strong correlation” threshold, and all of them lie within the Žemaičiai Upland region.

The largest areas of influence and the highest correlations were also found in the middle and the northern parts of Lithuania, while substantially lesser areas could not be explained by a higher variation of the cloud cover over the Žemaičiai

Upland alone, but also by the boundary effect, e. g., Dūkštas and Klaipėda (Table 2).

All our analysis was based on the hypothesis: if there is a reliable correlation between the data, the spatial distribution of the correlation coefficients and the size and shape of the area of influence for all meteorology stations should be similar. Actually, the spatial distribution of the mean cloud cover is not uniform across the Lithuanian territory due to local factors, and there is a necessity to differentiate the analysis by geographical regions.

The first region is situated on the seacoast lowlands and represented by four meteorological stations: Palanga, Klaipėda, Nida and Šilutė. The first two are nearshore stations and often experience sea-land breeze circulation. Only the Palanga station is situated a few kilometres away from the coastal line. Probably it could be the main factor for a correlation with remote sensing data differences among the mentioned stations. Klaipėda has the highest values just offshore and they are distributed more or less uniformly over the sea, while the Palanga station influence zone involves also a large area in the Latvian territory (Fig. 2). Quite a similar picture represents the Nida station situated on a narrow sandy spit between the sea and the lagoon; station is shielded by comparatively high dunes from westerly winds. It also shows a good correlation with areas over the sea, lagoon and over the lowland east from the lagoon, but very poorly represents the other Curonian spit areas. Šilutė represents cloudiness over the sea least of all the four stations, nevertheless the coefficients there still exceed 0.5. However, the highest values are shifted to the Nemunas river delta region, the surrounding areas and to the southwestern slopes of the Žemaičių Upland. The common feature of the above-mentioned stations is a poor correlation with cloudiness in the eastern part of Lithuania, particularly in the north-east.

The second is the Žemaičiai Upland region where altitudes in some places exceed 150 m a. s. l. and the whole zone represents

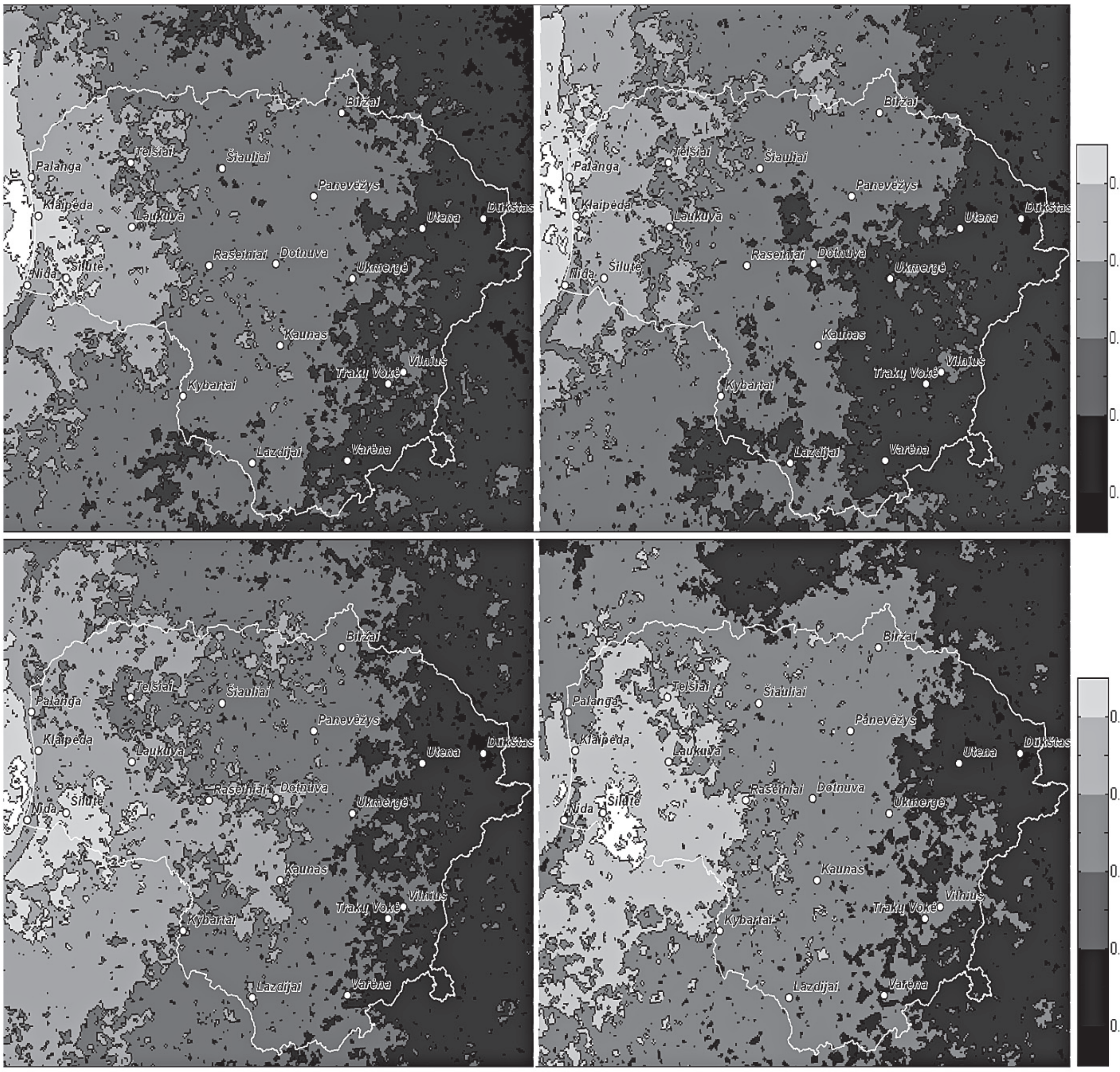

Fig. 2. Spatial distribution of Spearman's correlations between remotely sensed total cloud amount and that observed in the meteorological stations: Klaipėda (upper left), Palanga (upper right), Nida (lower left) and Šilutė (lower right)

2 pav. Erdvinis Spearmano koreliacijos koeficientas tarp nuotoliniais metodais gautų debesų kiekio dydžio bei bendro debesuotumo stebėjimų meteorologinėse stotyse: Klaipėdoje (kairėje, viršuje), Palangoje (dešinėje, viršuje), Nidoje (kairėje, apačioje) ir Šilutėje (dešinėje, apačioje) a compact hilly area. This region is represented by four stations: Laukuva and Telšiai, situated in the central-western part of the Upland and Šiauliai, and Raseiniai in the eastern side (gentle) slope of the upland. All these stations have a poor correlation both with the coastal region and the eastern side.

The Laukuva and Telšiai stations show the highest values in their surroundings and over the highest ridges of the upland, while the influence areas of the Šiauliai and Raseiniai stations are not so compact and extent far from the upland region to the east and south-southeast, respectively. On the other hand, these pairs of stations on average have lower correlation coefficient values (by approximately 0.05) as compared to the first region (Fig. 3).

Meteorological stations situated in the Middle Lithuanian Lowland due to its plain relief, have the largest areas of influence. The most central position is occupied by the Kaunas station: reliable correlation coefficients cover half of the national territory, with poor correlations only in the northwestern part. The picture is also similar for the Ukmergė station (not shown). The other stations – Biržai, Dotnuva and Kybartai – are climatic ones and represent a more regional character of cloudiness. Dotnuva has strong correlations in the central part of the lowland; the Biržai station influence zone from the northern part of the lowland extents far to the north into the Latvian territory; the Kybartai station, representing the southwestern part of the lowland, has strong correlations also with the lowland in the Kaliningrad region (Russia). The common feature of those stations is poor correlations with the northwestern part of the Žemaičiai Upland and only confirms the shielding effect of this upland on the prevailing westerly winds (Fig. 4).

The last analysed area covers all the Baltic ridge region, or the Eastern Upland (Fig. 5) which is not as compact as the Žemaičiai Upland. The area consists of several separate elevated zones and a few interjacent lowlands. Four stations represent that area in the analysis – one synop station (Utena) and three climatic

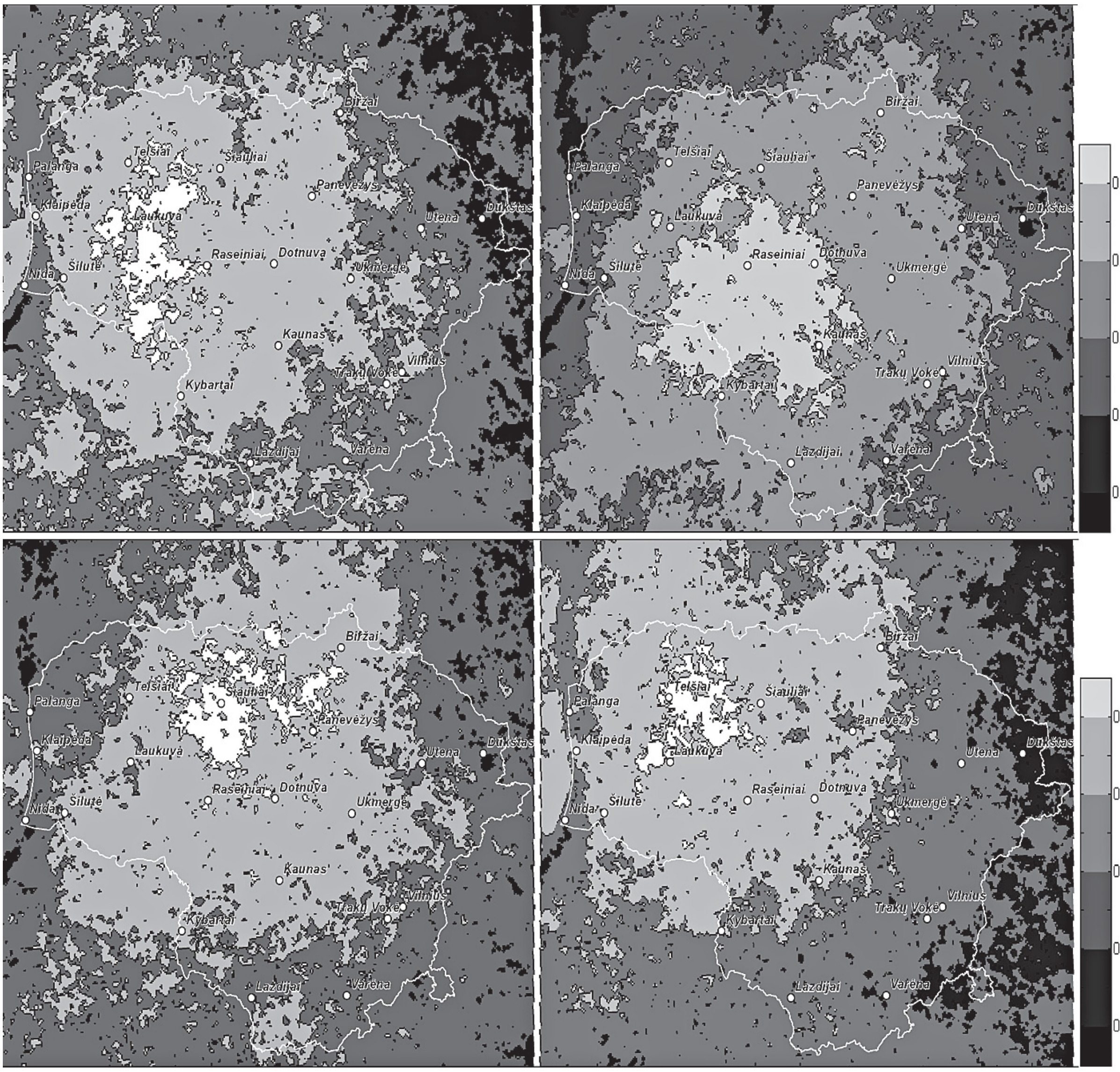

Fig. 3. The same as in Fig. 2, for Laukuva (upper left), Raseiniai (upper right), Šiauliai (lower left) and Telšiai (lower right) stations

3 pav. Tas pat, kaip ir 2 pav., tik Laukuvos (kairėje, viršuje), Raseinių (dešinėje, viršuje), Šiaulių (kairėje, apačioje) ir Telšių (dešinėje, apačioje) stotyse

(Lazdijai, Varėna and Dūkštas). The Utena influence zone is the largest in this region because of its position, while the other three are better to reflect the regional factors. For example, the Lazdijai zone, covered by strong correlation coefficients, occupies the southernmost part of Lithuania and extents to the west, to the Suvalkai Upland in Poland. The Varėna influence zone is best to represent the southeasterly lowland extending far to the northeast, and its strong correlation zone reaches even Vilnius (approx. 100 km away); this zone repeats well the contours of the lowland up to its northeastern tail. Dūkštas is situated on a complex elevated area with laky landscapes, and the strong correlation zone from Dūkštas surroundings penetrates far to the east, northeast and southeast, following similar landscapes in Latgala (Latvia) and Breslauja (Belarus).

THE SEASONAL CYCLE OF CLOUD AMOUNT

Analysis data of meteorological station showed that the mean monthly cloud amount during the study period varied from 6.5 to 7.3 points. The maximum cloud cover fell to December (8.4–9.5 points), and the minimum to July (4.5–6.5 points). The spatial distribution of the monthly maximum values showed the largest variation in the western part of the Lithuanian territory: from 7.3 points in Šilutė to 6.5 points in Dotnuva. Actually, a one-year period cannot be treated as climatologically indicative because the long-term mean data show the annual cloudiness peak in the eastern side while the minimum in the western part.

Correlations between *in situ* measurements and remote sensing data also show an evident seasonal cycle: the coefficients decrease from October to March, and only in the coastal region the maximal values fell to February. However, the areas of influence of various stations decrease from late autumn to early summer, and only a few stations show their minima in August–September.

A comparison of the cloudiness parameters in different seasons within a one year is rather trivial, because the winter and the summer cloud formation processes considerably differ. On the other hand, a detailed correlation analysis could only be

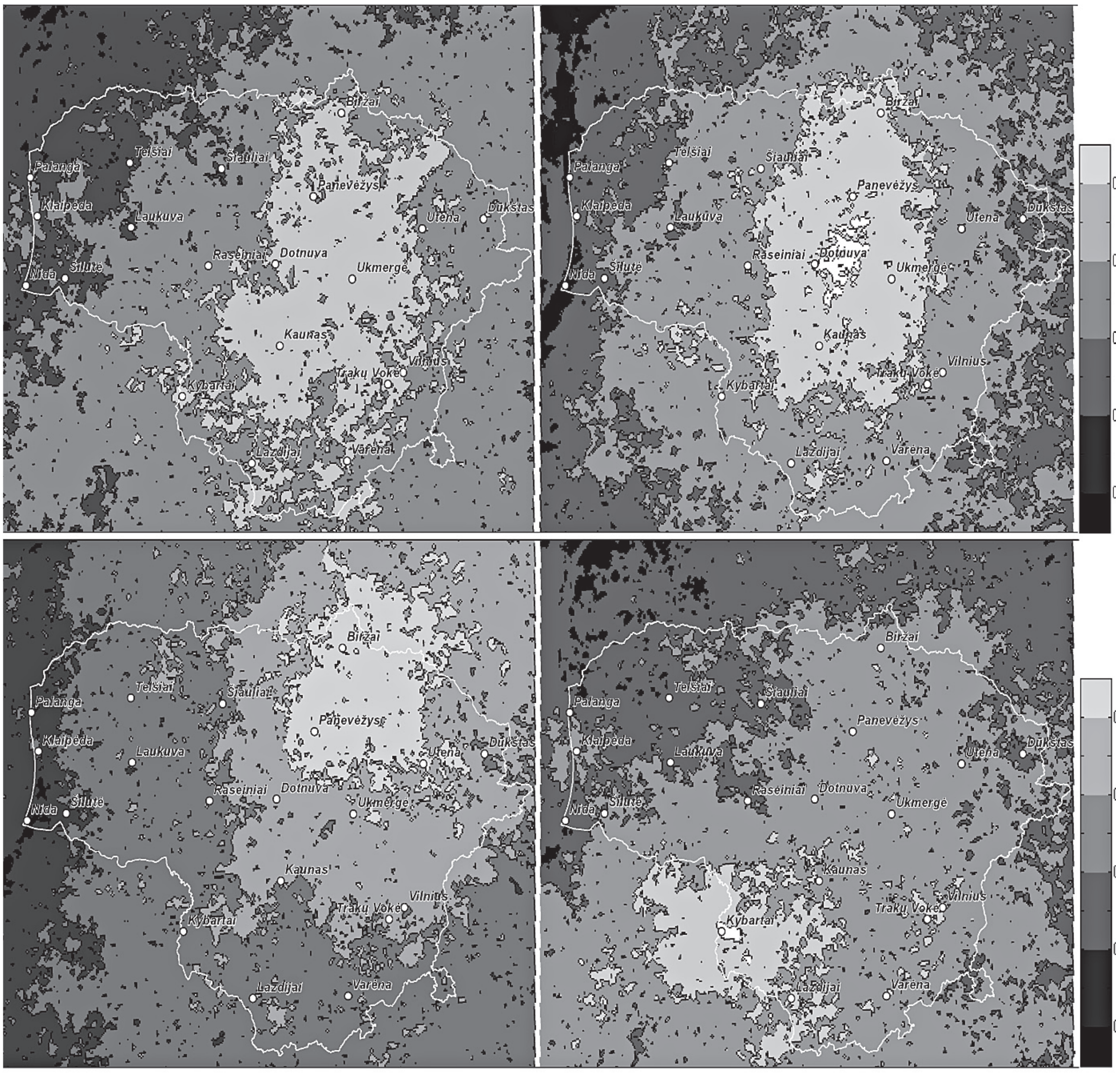

Fig. 4. The same as in Fig. 2, for Kaunas (upper left), Dotnuva (upper right), Biržai (lower left) and Kybartai (lower right) stations

4 pav. Tas pat, kaip ir 2 pav., tik Kauno (kairėje, viršuje), Dotnuvos (dešinėje, viršuje), Biržų (kairėje, apačioje) ir Kybartų (dešinėje, apačioje) stotyse based on the analysis of synoptic situation development, which is beyond the scope of this study.

Cloud cover parameters in the first half of the cold season (late autumn – early winter) over the Lithuanian territory except a narrow seacoast area show a better consistence with the remote sensing data than in warm season, and it satisfies the maximum probability density of the overcast sky conditions in that period. Favourable conditions for the overcast sky develop not only in the vicinity of the low pressure systems and atmospheric fronts crossing the Baltic region, but also under the influence of high pressure systems arriving from the North Atlantic because of the persistence lifted and surface temperature inversions within these systems.

DISCUSSION AND CONCLUSIONS

The use of the SAFNWC product in the current study first of all shows its great contribution to the exploration of the cloudiness spatial variation, at least over the Lithuanian territory. On the other hand, a comparison of two different kinds of datasets allows specifying the representativeness of each meteorological station in cloudiness parameters.

The partition of the cloudiness scale used in ground-based measurements seems to be imperfect, however, the study has revealed very important cloud fraction spatial variation mesoscale features. Cloudiness observed at coastal stations correlates with remote sensing data best of all over the sea near those stations, because the cloud cover is more uniform over the sea than over land. The correlation coefficients allow differentiating the central part of the Curonian lagoon from the prevailing land and sea cloudiness values, and it is worth attention because there is no one observation point. Another interesting finding is that two adjacent stations show quite different areas of influence while the distance between them is only 20 km. Such a spatial difference in the correlation coefficients seems to be affected by the position of a station. For example, the Palanga airport station is a few kilometers away from the coastline and is shielded from direct sea breeze wind by a pine forest, while the Klaipėda station situated on the seacoast represents three different contributions:

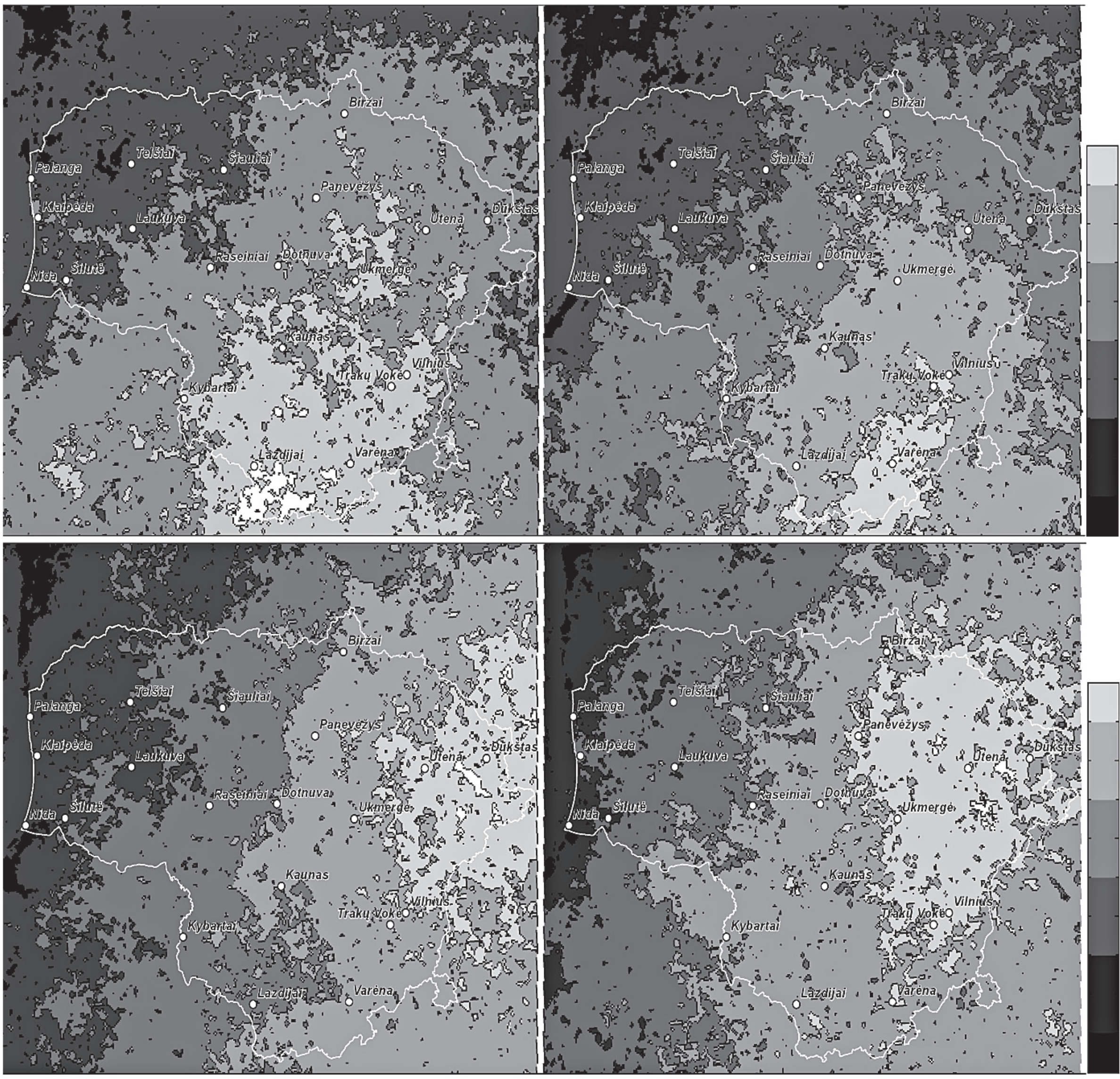

Fig. 5. The same as in Fig. 2, for Lazdijai (upper left), Varėna (upper right), Dūkštas (lower left) and Utena (lower right) stations

5 pav. Tas pat, kaip ir 2 pav., tik Lazdijų (kairėje, viršuje), Varėnos (dešinėje, viršuje), Dūkšto (kairėje, apačioje) ir Utenos (dešinėje, apačioje) stotyse large-scale, sea breeze and urban circulation, together with the mesoscale sea–lagoon interaction.

The areas of influence of the other stations also are shaped following terrestrial characteristics. For example, Varėna cloudiness correlates best of all with cloud parameters along the southeastern lowland because the station landscape also belongs to this type of landscape. On the other hand, some stations represent large terrestrial features such as part of the Baltic ridge (Utena, Lazdijai) or Žemaičiai Upland (Šiauliai, Laukuva) moraine landscapes or the middle Lithuanian lowland (Kaunas, Ukmergė, Dotnuva) and actually satisfy the requirements for synop stations. The other stations usually represent the climatic diversity of various meteorological parameters including cloudiness, and the highest correlations could be traced only over similar landscapes (Dūkštas, Telšiai, Kybartai, Nida, etc.).

Even a single CMa product (there are other three) has a wider application. The correlations could be very valuable when analysing similar synoptic objects – fronts, low-pressure systems or mesoscale convective systems; local cloudiness – sea breeze, urban effect, fog development or high pressure system cloud cover day cycle.

The specification of cloud parameters and a relative solar and long wave radiation climatology over a particular area is another direction of the product application. Some areas in Lithuania exhibit large gradients in the seasonal and annual cloud distribution and the density of meteorological observation network is limited, while actinometric measurements are available only in two stations.

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Kristina Mockevičiutė, Gintautas Stankūnavičius

ANTŽEMINIŲ DEBESUOTUMO STEBĖJIMŲ TOBULINIMO GALIMYBĖS NAUDOJANT PROGRAMINĖS PALYDOVŲ DUOMENŲ BAZĖS (SAFNWC) PRODUKTUS

Santrauka

Šiame tyrime palygintas bendras debesuotumas virš Lietuvos teritorijos pagal nuotoliniais metodais gautus duomenis. Iki šiol duomenys, gauti iš palydovų sensorių, būdavo lyginami su radarų arba radiozondų duomenimis (Diamandi, Dybbroe, 2001). Lietuvos meteorologijos stočių (MS) bendro debesuotumo duomenys buvo kategorizuoti, kad pagal pasikartojimo dažnį atitiktų SAFNWC duomenų bazės debesuotumo klases. SAFNWC yra programinė palydovų duomenų bazė (SAF), skirta sudaryti bei koreguoti ypač trumpos trukmės orų prognozes lygiagrečiai įtraukiant skaitmeninių modelių išvesties rezultatus. Pilnas šios duomenų bazės aprašymas pateiktas Švedijos Meteorologijos ir hidrologijos instituto (SMHI) tinklalapyje – http://produkter.smhi.se/. Šioje duomenų bazėje, be debesų kiekio dydžio CMa, yra dar trys, tačiau jų lyginamoji analizė su meteorologijos stotyse išmatuotais dydžiais yra beveik neįmanoma. Pagal bendradarbiavimo sutartį SMHI taip pat pateikė vienerių metų duomenis HDF-5 skaitmeniniame formate. Tyrime analizuojamas laikotarpis nuo 2004 m. rugpjūčio 1 d. iki 2005 m. liepos 31 d. Kiekvieną parą Lietuvos teritoriją palydovų duomenys visiškai padengia 4–8 kartus.

Duomenų palyginimui pirmiausia buvo atrinkti tik tie kosminiai vaizdai, kurių laikas skyrėsi ne daugiau kaip 15 min. nuo MS stebėjimo terminų, todėl kiekvienos paros bei mėnesio analizuojamų kosminių vaizdų skaičius buvo skirtingas ir nebuvo galima palyginti vidutinių mėnesio reikšmių. MS ir nuotoliniais metodais gauti duomenys buvo palyginti pagal Spearmano ranginės koreliacijos koeficientą.

Tyrimo rezultatai rodo, kad CMa dydis, be savo tiesioginės paskirties – papildyti ypač trumpos trukmės prognozę, gali išplėsti tiek operatyvius, tiek ir klimatinius meteorologinių stočių duomenis į aplinkinius regionus. Vienos sinoptinės situacijos, vieno ar kelių sinoptinių reiškinių vystymosi laikotarpiu (mėnesį, sezoną ar metus) kiekviena konkreti meteorologinė stotis reprezentuoja skirtingą Lietuvos teritorijos bei ją supančių regionų dalį.

SANWFC metodu gautas CMa dydis geriausiai dera antžeminiams matavimams šaltuoju metų laiku, kai apsiniaukusių ir debesuotų dienų tikimybė beveik visame Baltijos regione yra didžiausia. Į atskirą kategoriją galima išskirti pajūrio regioną, kuriam ši taisyklė nelabai tinka dėl brizinės cirkuliacijos įtakos debesų dangos formavimuisi ir pastovumui.

SAFNWC metodas negalėtų visiškai pakeisti stebėjimų meteorologijos stotyse, nes nagrinėjamas laikotarpis yra pernelyg trumpas, kad

būtų galima daryti tokias išvadas. Tačiau nustatyti ryšiai tarp meteorologijos stočių ir SAFNWC metodu gautų duomenų leidžia manyti, kad bent tamsiuoju paros metu CMa dydis galėtų papildyti tinkamus bei pakeisti klaidingus stočių duomenis.

Remiantis gautais rezultatais ateityje būtų galima nuodugniau ištirti šio dydžio teikiamas galimybes, pavyzdžiui, stebėti atskirų sinoptinių objektų (jų debesuotumo sistemų) mezomastelio rutuliojimosi ir judėjimo ypatumus, gerinti kritulių stebėseną ir geriau įvertinti jų erdvinę sklaidą, papildyti klimatinius duomenis naujomis charakteristikomis bei patikslinti klimatinį rajonavimą atsižvelgiant į saulės spinduliuotės bei debesuotumo geografinį pasiskirstymą.

Meteorologinėms prognozėms ypač padėtų šio dydžio paros ciklo tyrimas pasitelkiant reguliarius antžeminius matavimus.