Real-time Automated Cloud Classification from Live Webcams

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The Big Question

Can a live webcam provide real-time quantitative information about the weather?

Motivation

Outdoor webcams provide a near-continuous dataset of weather observations. These observations can be used to classify cloud type (i.e. cumulus, stratus). Cloud type tells us about microphysical properties of clouds that are difficult to detect from radar or satellite-based measurements.

Methods

Three high resolution cameras capture images atop the Atmospheric, Oceanic, and Space Sciences (AO&SS) building at the UW-Madison. Based on RGB pixel values, a classification algorithm is used to determine cloud type present in each image.

Figure 1: High resolution rooftop cameras with images updated every 5 minutes. (Image credit: SSEC)

Results: Classification of Cumulus, Stratus, and Cirrus

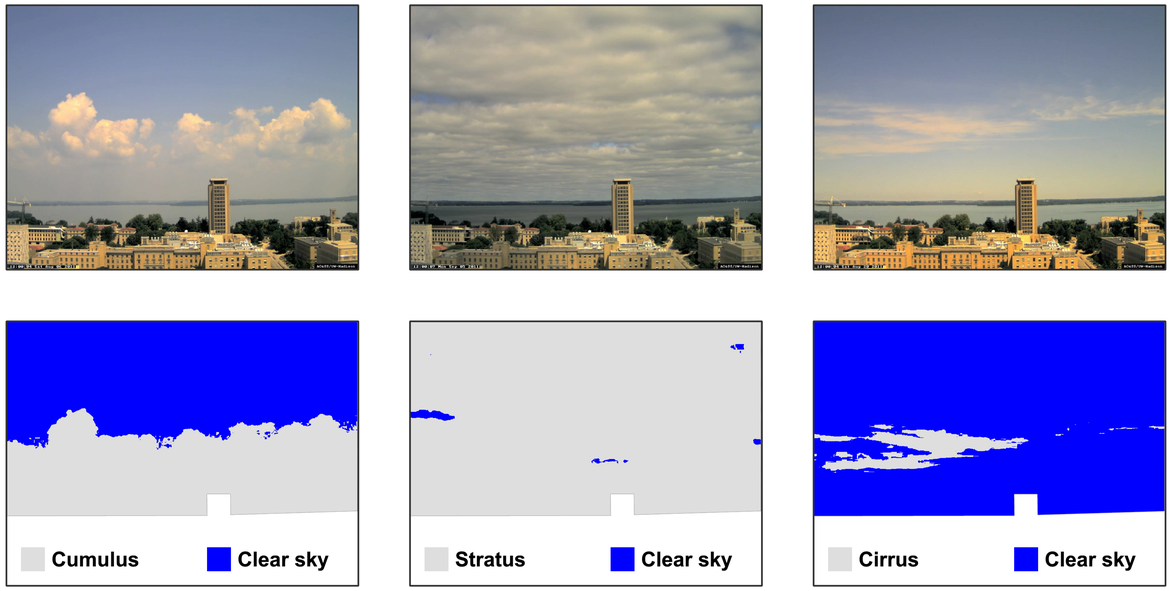

Figure 2: Three webcam images (top) along with classification output (bottom).

Figure 2 demonstrates the utility of the cloud classification algorithm on three uniquely different sky scenes. The left column shows cumulus clouds. The middle column shows stratus clouds. The right column shows cirrus clouds. The top row displays the original webcam image from the AO&SS rooftop (north) camera. The bottom row shows the classified image labeled based on cloud and clear sky pixel features. Table 1 displays the cloud-induced radiative forcing for various cloud types, based on Chen et al. (2000) [1]. Results show global annual (4-day average) mean overcast sky cloud-induced radiative flux changes at the surface, top of atmosphere (TOA), and in-atmosphere, for shortwave (SW), longwave (LW), and total (TL) radiative forcing.

Table 1: Cloud-Induced Radiative Forcing [Wm^{-2}]

	Surface			TOA			Atmosphere		
Cloud type	SW	LW	TL	SW	LW	TL	SW	LW	TL
Cirrus	-22.2	8.0	-14.2	-25.3	30.7	5.4	-3.1	22.7	19.6
Cirrostratus	-79.5	20.0	-59.5	-87.4	59.7	-27.7	-7.9	39.7	31.8
Deep convective	-118.6	16.3	-102.3	-126.2	60.7	-65.5	-7.6	44.4	36.8
Altocumulus	-28.7	20.3	-8.4	-29.3	13.0	-16.3	-0.6	-7.3	-7.9
Altostratus	-79.6	35.4	-44.2	-80.9	22.1	-58.8	-1.3	-13.3	-14.6
Nimbostratus	-98.2	32.4	-65.8	-98.8	20.6	-78.2	-0.6	-11.8	-12.4
Cumulus	-35.4	33.4	-2.0	-33.8	4.0	-29.8	1.6	-29.4	-27.8
Stratocumulus	-77.7	46.8	-30.9	-74.7	7.7	67.0	3.0	-39.1	-36.1
Stratus	-88.1	39.2	-48.9	-84.6	7.8	-76.8	3.5	-31.4	-27.9

Conclusions and Outlook

This algorithm provides a simple way to classify clouds from a digital webcam. Improvements to this algorithm will enable digital cameras to be used to classify various cloud types to provide insight into important microphysical and radiative properties. An vast network of live webcams currently exists in the United States. Automatic cloud classification from webcams has the potential to provide a cost effective means of sky observations in remote areas. Further research would be of great interest to the environmental remote sensing community.

Further Information

Have a smart phone? Scan the QR code now!
bit.ly/esip2012

References

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Acknowledgements

This project was supported by the NASA-funded Digital Earth Watch (DEW) grant. I acknowledge support from Annette Schloss and Picture Post program, developed through the DEW network at the University of New Hampshire. I thank the UW-SSEC/AOS for the maintenance and distribution of the AO&SS rooftop camera images at UW-Madison.

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