A statistical and dynamical analysis of fog dissipation based on geostationary satellite observations

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INTRODUCTION - OBJECTIVES

Scientific field of research: Energy Meteorology => forecasts for solar-based electricity production systems (solar panels and plants)

Main objective: develop a new intraday forecasting method of the evolution of fog and low-altitude stratus observed by geostationary satellite

Derived objective: forecast the next time step at the spatial granularity of the observations, and recursively simulate the evolution of the low-altitude stratus cloud

Objectives of this poster: On case studies, analyse spatial patterns of dissipation, associated processes and correlation with temporal evolution of reflectance

METHODOLOGY – SETUP DESCRIPTION

Observation domain: a 81x81 pixels centered on the SIRTA in Palaiseau, France.

Satellite channels:

- Temporal resolution: 15 min
- Spatial resolution:
  - HRV, High Resolution Visible
    1 pixel: 2km long latitude-wise, 1.1 km long longitude-wise
  - Infrared 8.7 and 10.8 µm:
    ⇒ 3*3 HRV pixels for 1 IR pixel

HRV channel: radiance is converted by EUMETSAT into a top-of-atmosphere bidirectional reflectance, without solar correction and with a scale factor 0.01

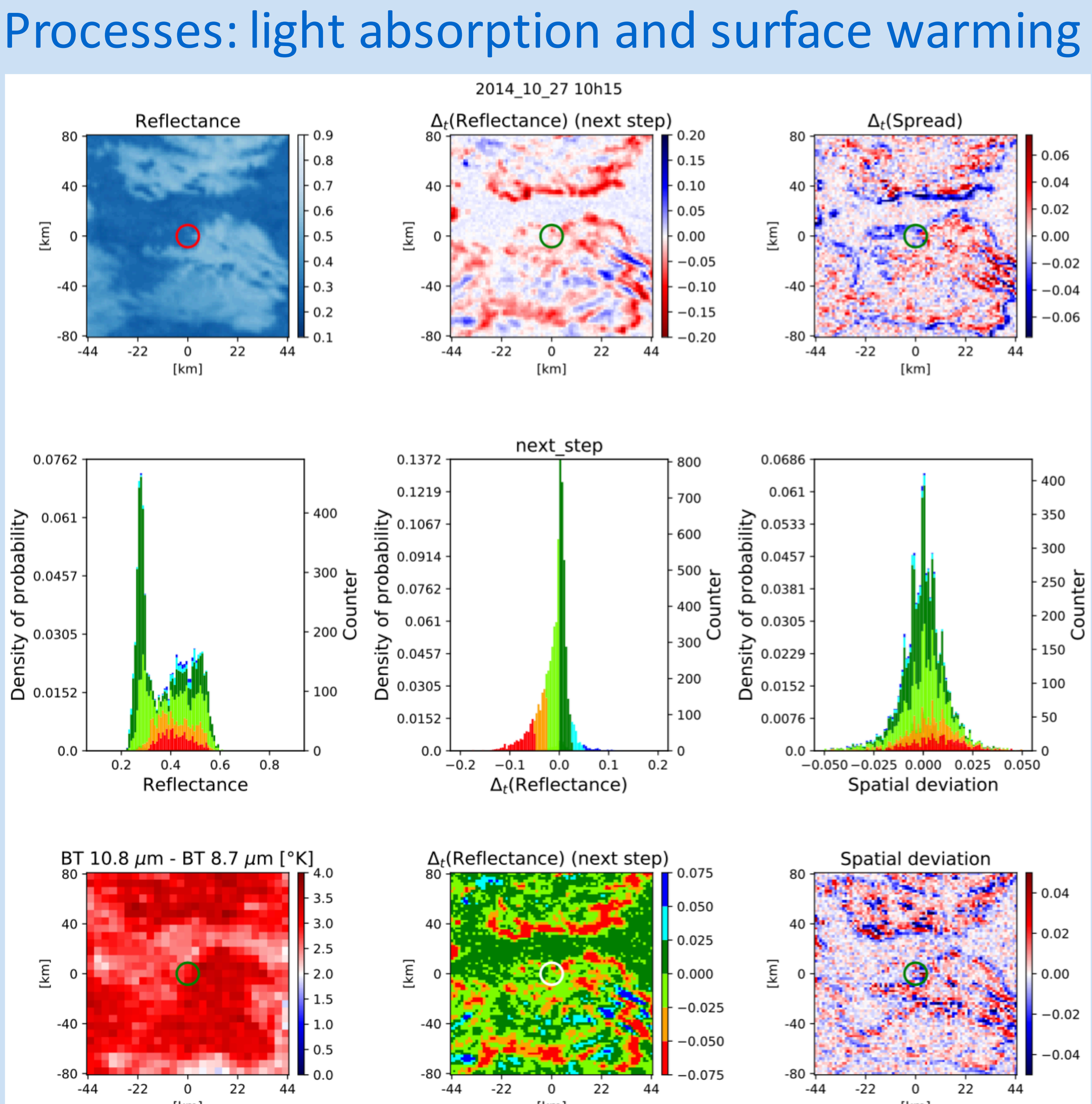
Reflectance correction: / $(100 \cdot \sin(\Theta_{\text{solar elevation}}))$

- Δ_t(Reflectance): temporal evolution of reflectance between 2 time steps
- spatial deviation: difference between pixel reflectance and average of Van Neumann's neighbours
- spread: spread between pixel reflectance and minimum of Van Neumann's neighbours
- BT 10.8 µm – BT 8.7 µm: difference of brightness temperatures, to refine cloud identification
- Colors for histograms and (lower) map of Δ_t(Reflectance): as per levels of Δ_t(Reflectance) at next time step

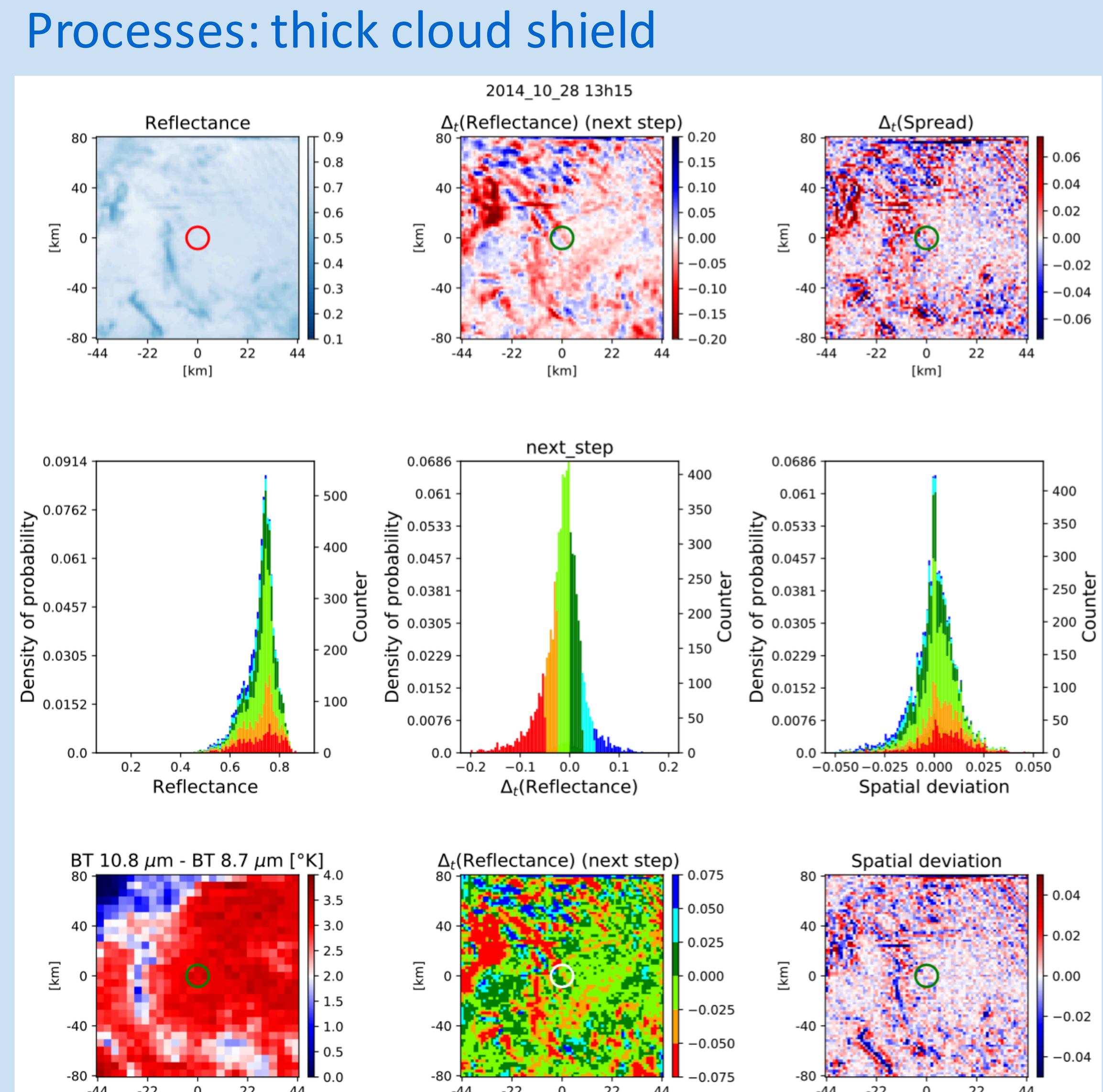
RESULTS – CONCLUSION

Results:

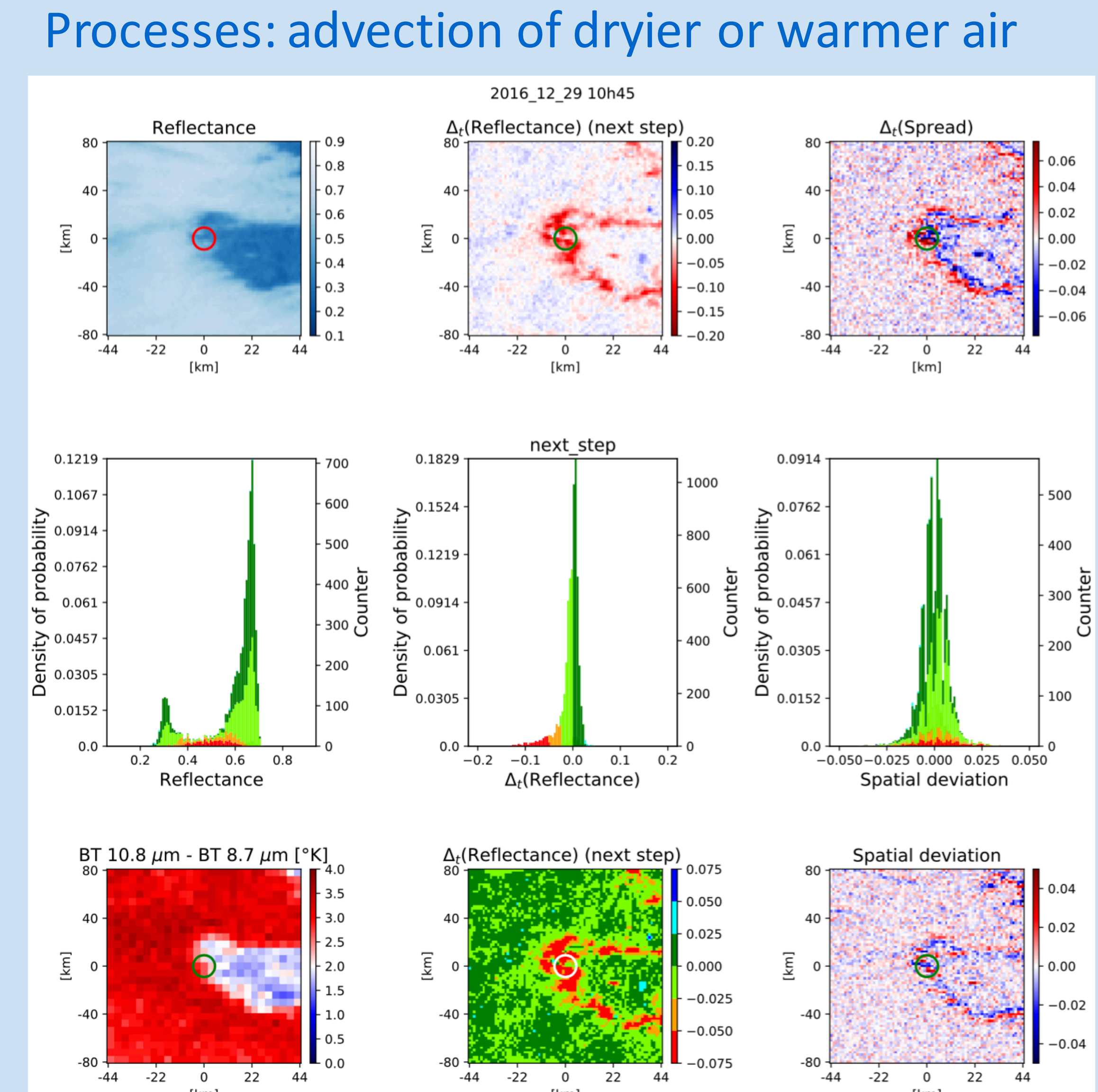
Dissipation patterns: homothetic down-scalings
Processes: light absorption and surface warming



Dissipation patterns: none (high reflectance)
Processes: thick cloud shield



Dissipation patterns: translating wavefront
Processes: advection of dryier or warmer air



Alternance of blue and red ridges of Δ_t(Spread) and spatial deviation indicates the direction of dissipation observed for next time step on the map of Δ_t(Reflectance): from blue to red ridge, after a shift of the width of the alternated ridges

Conclusion:

For the days with a tightened-enough distribution of Δ_t(Reflectance), observed patterns like alternated ridges and regularity of statistical distributions of spatial deviation suggest the possibility to build a deterministic model to forecast the evolution of fog and low-altitude stratus clouds.

Perspectives:

- An analysis of the correlation between alternated ridges and decrease of reflectance in the neighbour pixels
- A deterministic model of simulation based on these statistical laws observed
- A statistical assessment over several years of data of the above correlation and of the performances of the model

THANKS

This work was conducted in the frame of the PREVINERGY research program of EDF, in partnership with Ecole Polytechnique and LMD/IPSL research laboratory.