Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

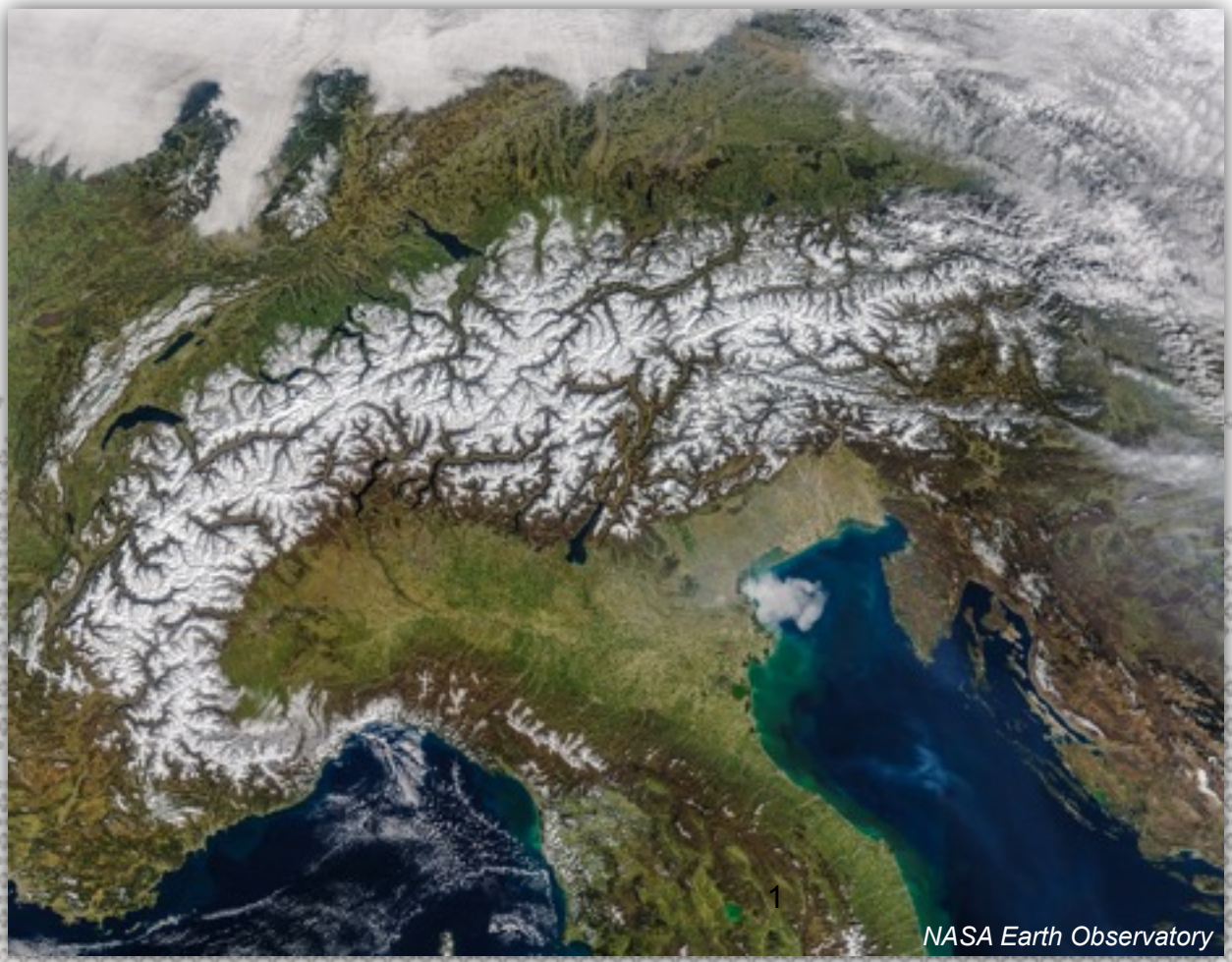
Eidgenössisches Departement des Innern EDI
**Bundesamt für Meteorologie und Klimatologie MeteoSchweiz**

# Snow mask inter-comparison

PT SAINT

Louise Braud

02.09.2020



*NASA Earth Observatory*

# Objectif : Quality assessment of the new MLS scheme

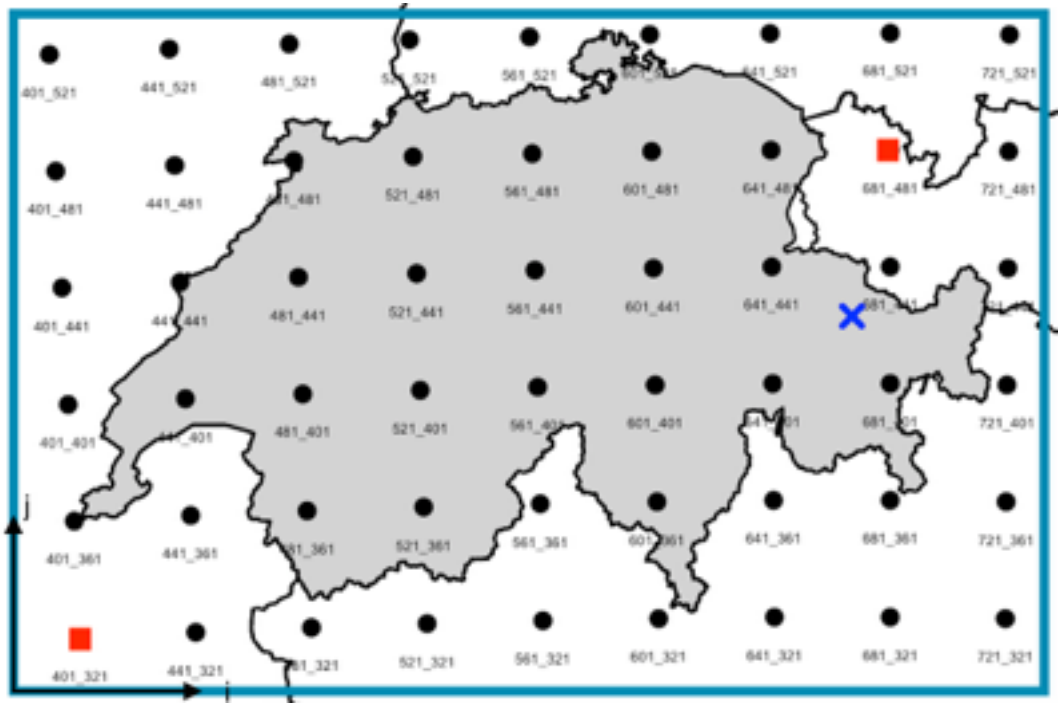
# Objectif : Quality assessment of the new MLS scheme

**Inter-comparison of the snow mask** generated by Snowpolino with those from other products.

# Objectif : Quality assessment of the new MLS scheme

**Inter-comparison of the snow mask** generated by Snowpolino with those from other products.

- **km-scale resolution** (20 m to 4 km) snow masks for a spatial domain covering Switzerland over **winter 2018/2019**



# Objectif : Quality assessment of the new MLS scheme

**Inter-comparison of the snow mask** generated by Snowpolino with those from other products.

- **km-scale resolution** (20m to 4 km) snow masks for a spatial domain covering Switzerland over **winter 2018/2019**

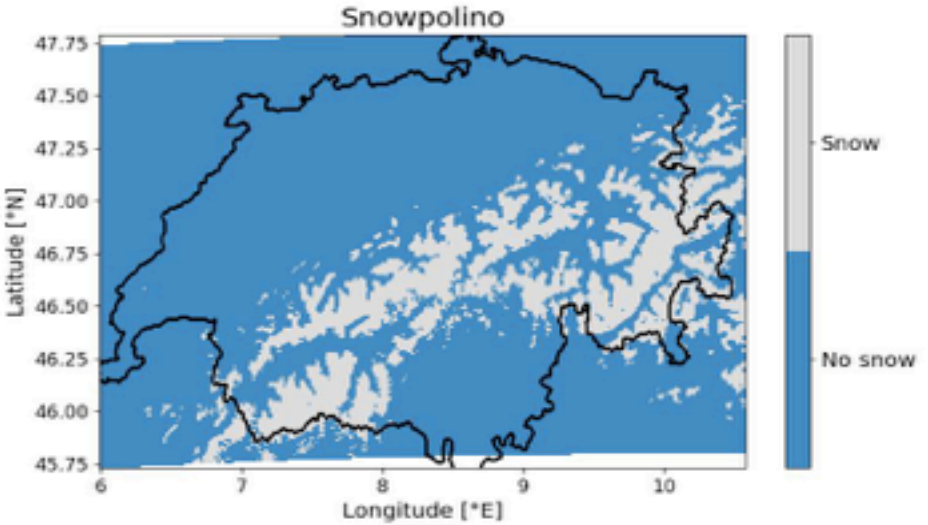
- ***Qualitative*** comparison - video of the snow cover evolution
- ***Quantitative*** comparison
  - evolution of the number of snow covered pixels
  - Contingency tables
  - Accuracy plot

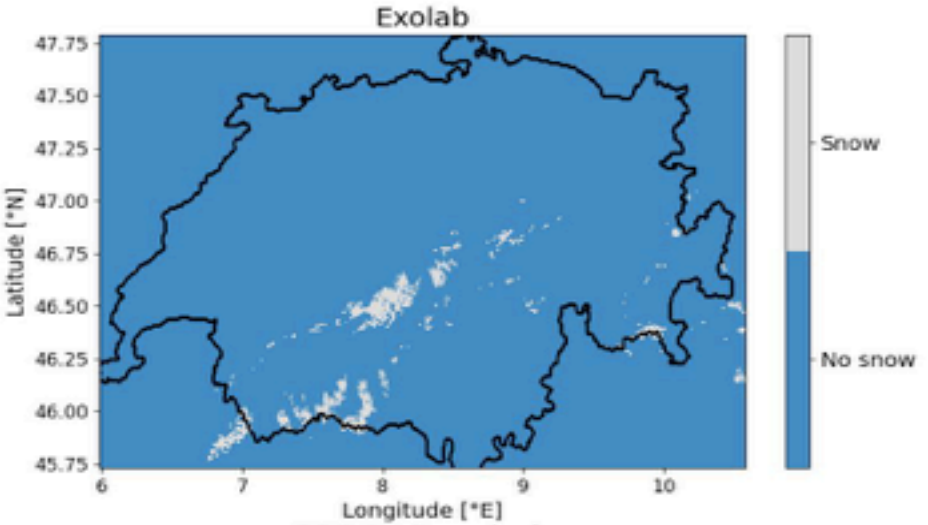
# Snow mask products

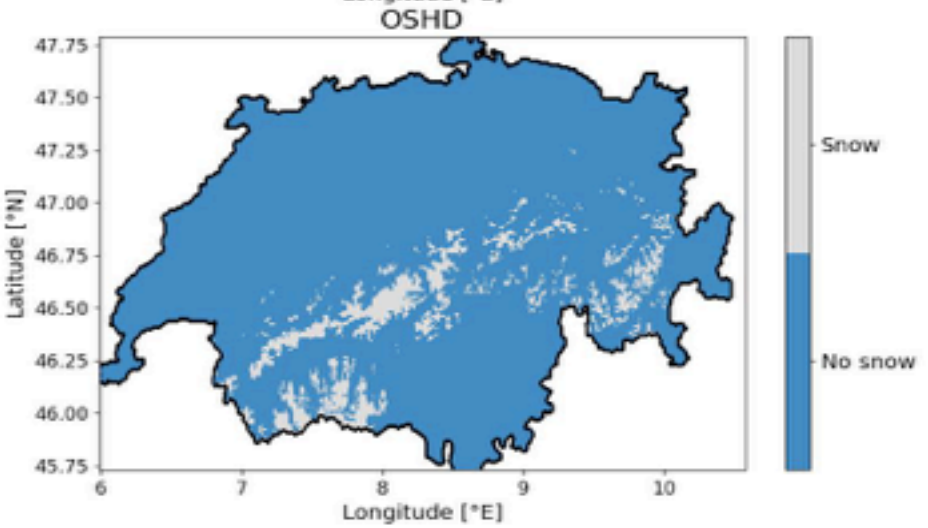
| | | Snowpolino | OSHD (SLF) | Exolab | COSMO-1 analysis |
|---|---|---|---|---|---|
| **Based on** | | Snow-hydrological model | Snow-hydrological model + Data assimilation (from IMIS measuring network) | Polar orbiting satellites | Meteosat (geostationary satellites) |
| **Resolution** | | 1 km | 1 km | 20 m | 4 km |
| **Provided quantity** | | Snow depth (HS) | Snow depth (HS) | Snow cover probability (P)<br>0 = confidently snow free<br>255 = confidently snow covered | Snow depth (HS) |
| **Snow mask** | **Snow** | HS > 0 | HS > 0 | P > 127 | HS > 0 |
| | **No snow** | HS <=0 | HS <=0 | P <=127 | HS <=0 |

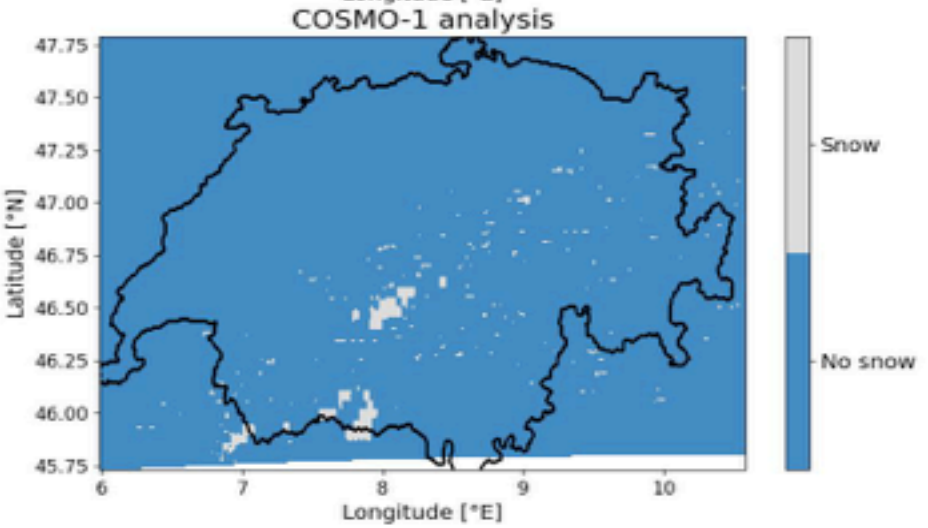
# Qualitative comparison - Video

2018-10-01



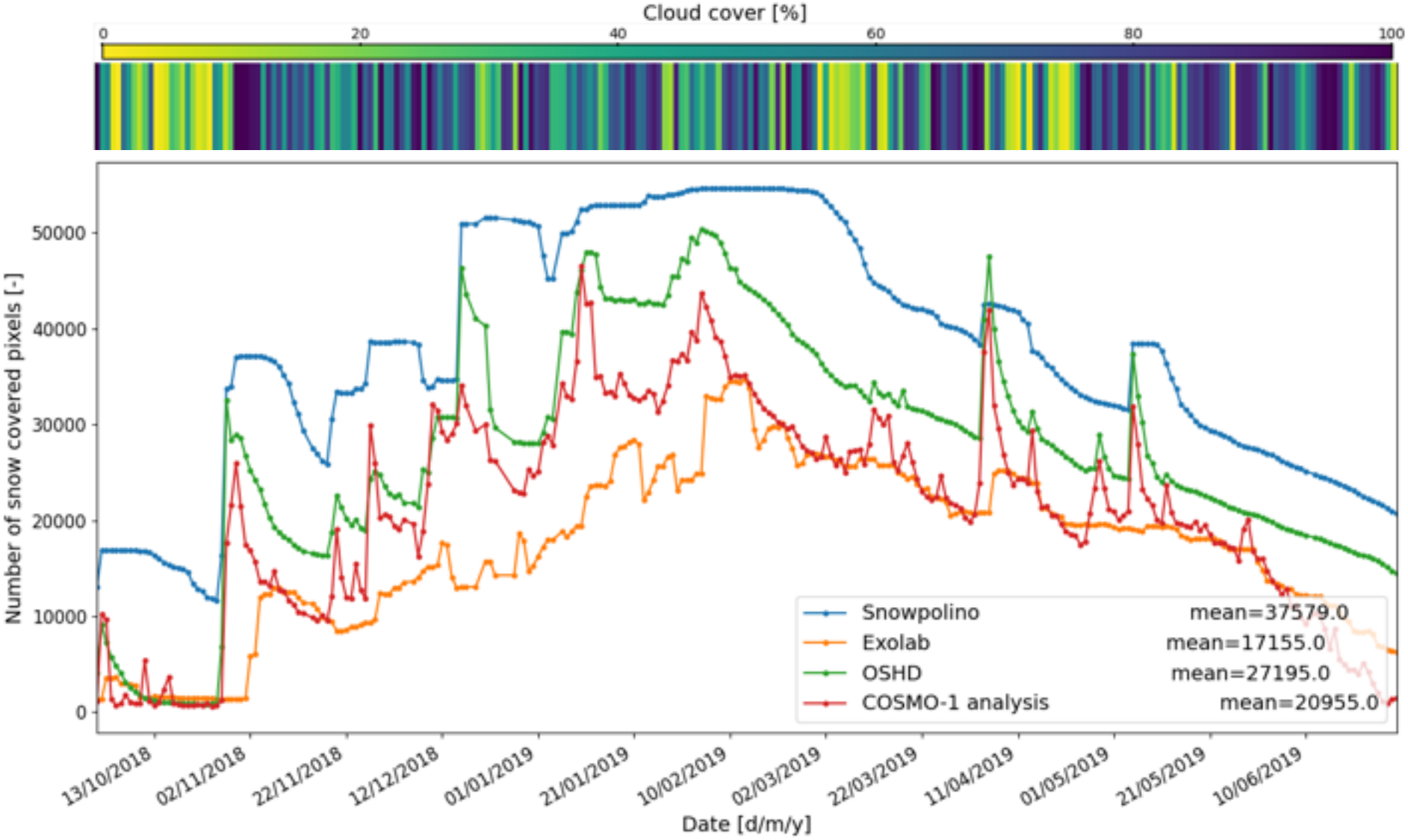



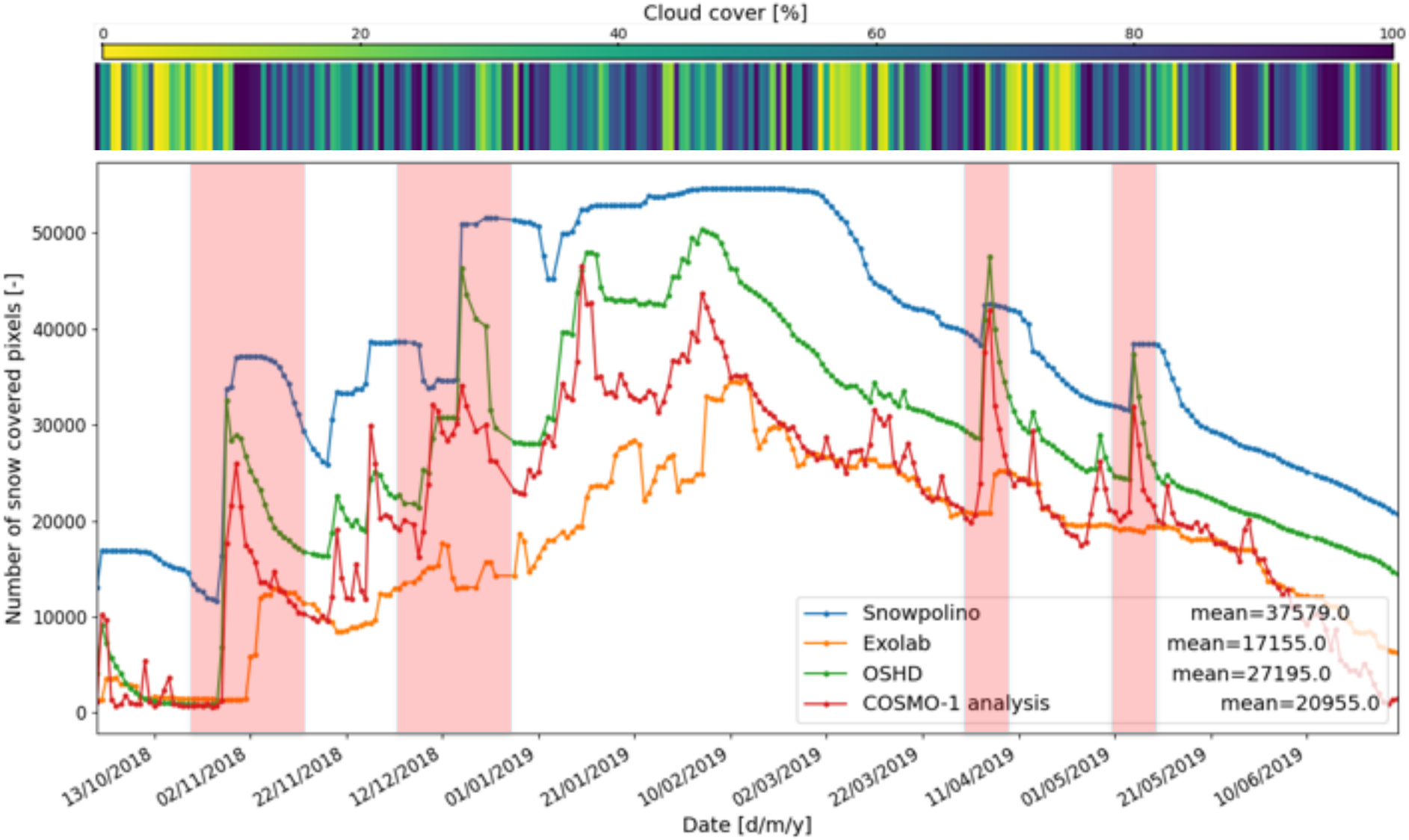
# Quantitative results

## Evolution of the number of snow covered pixels



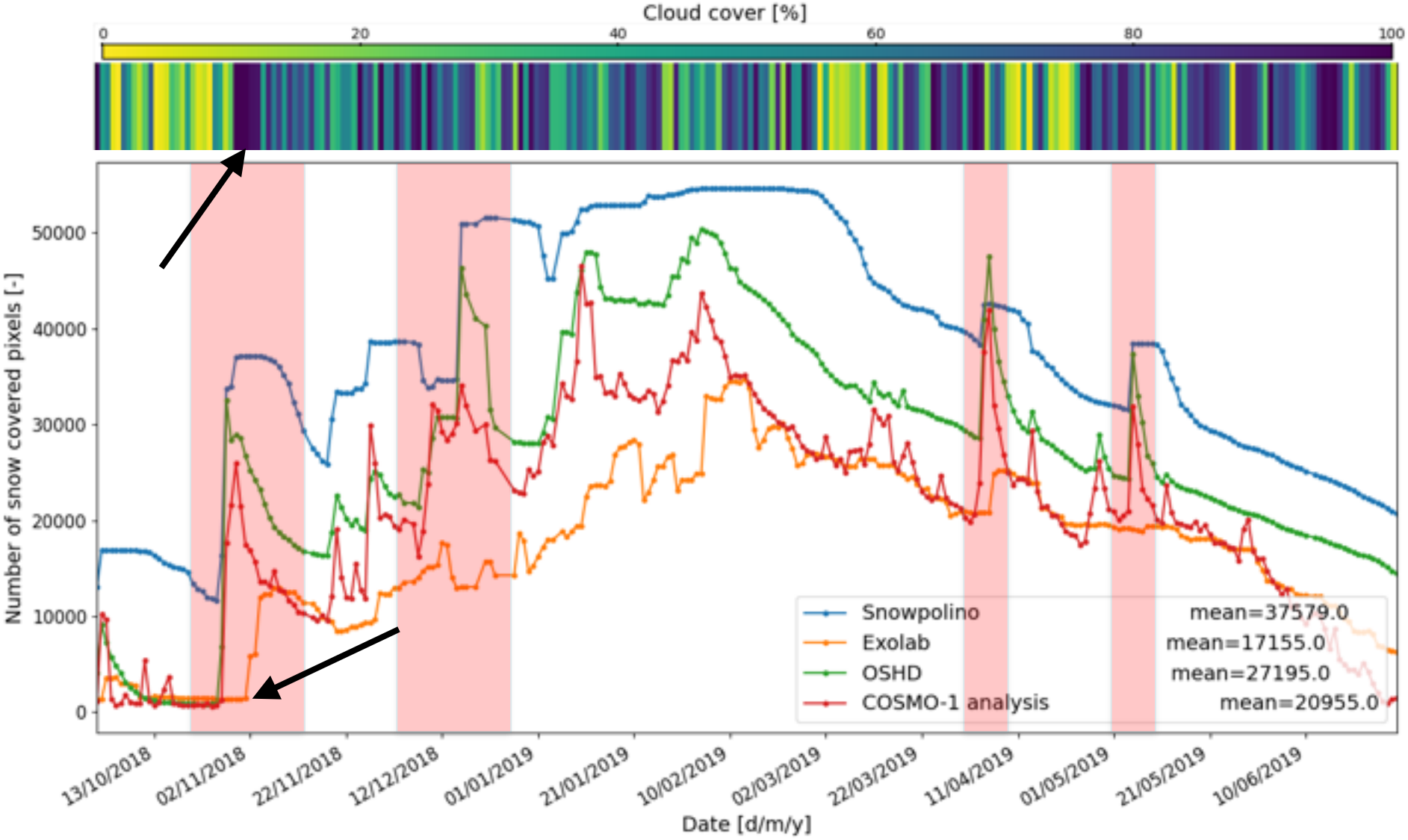
# Quantitative results

## Evolution of the number of snow covered pixels



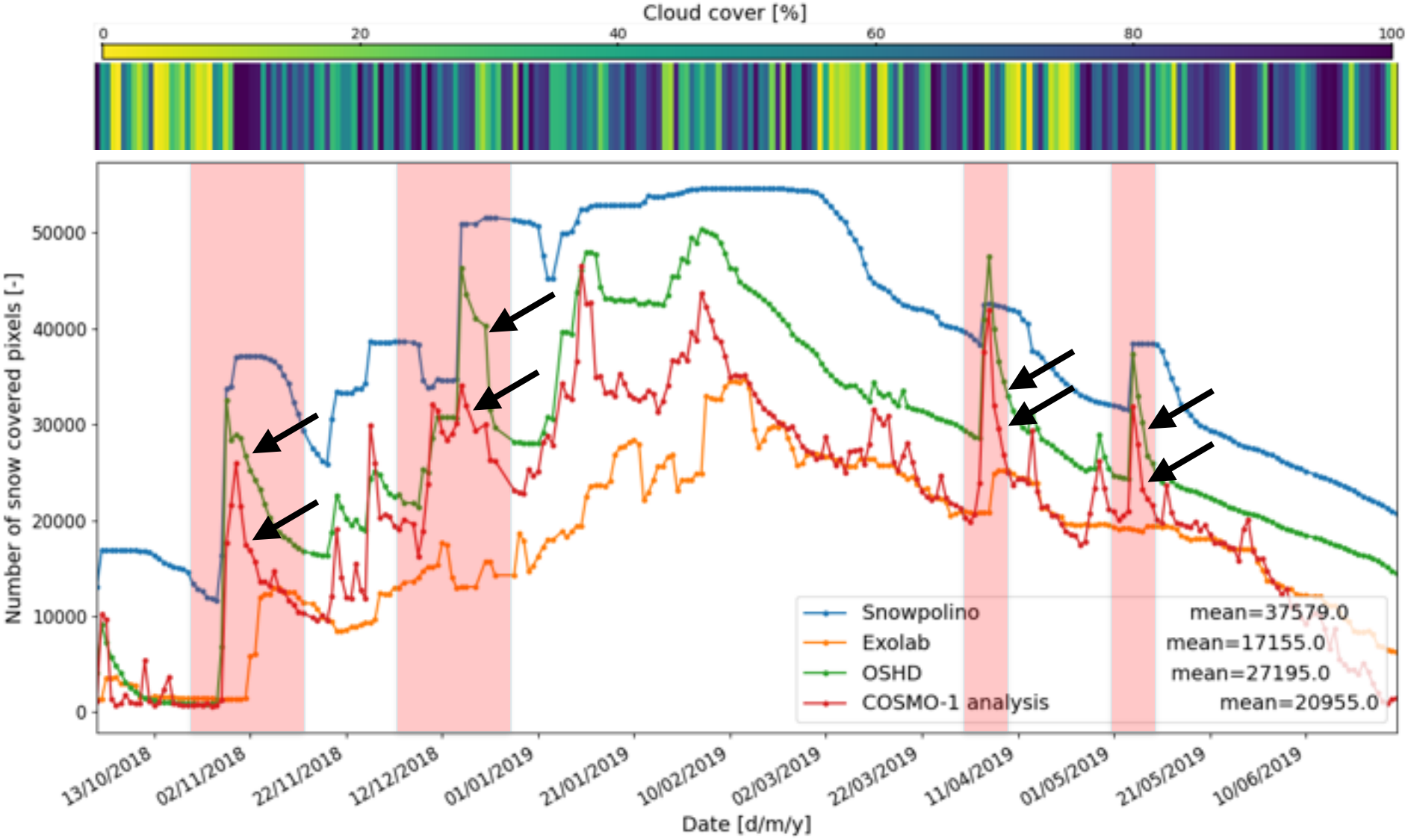
# Quantitative results

## Evolution of the number of snow covered pixels



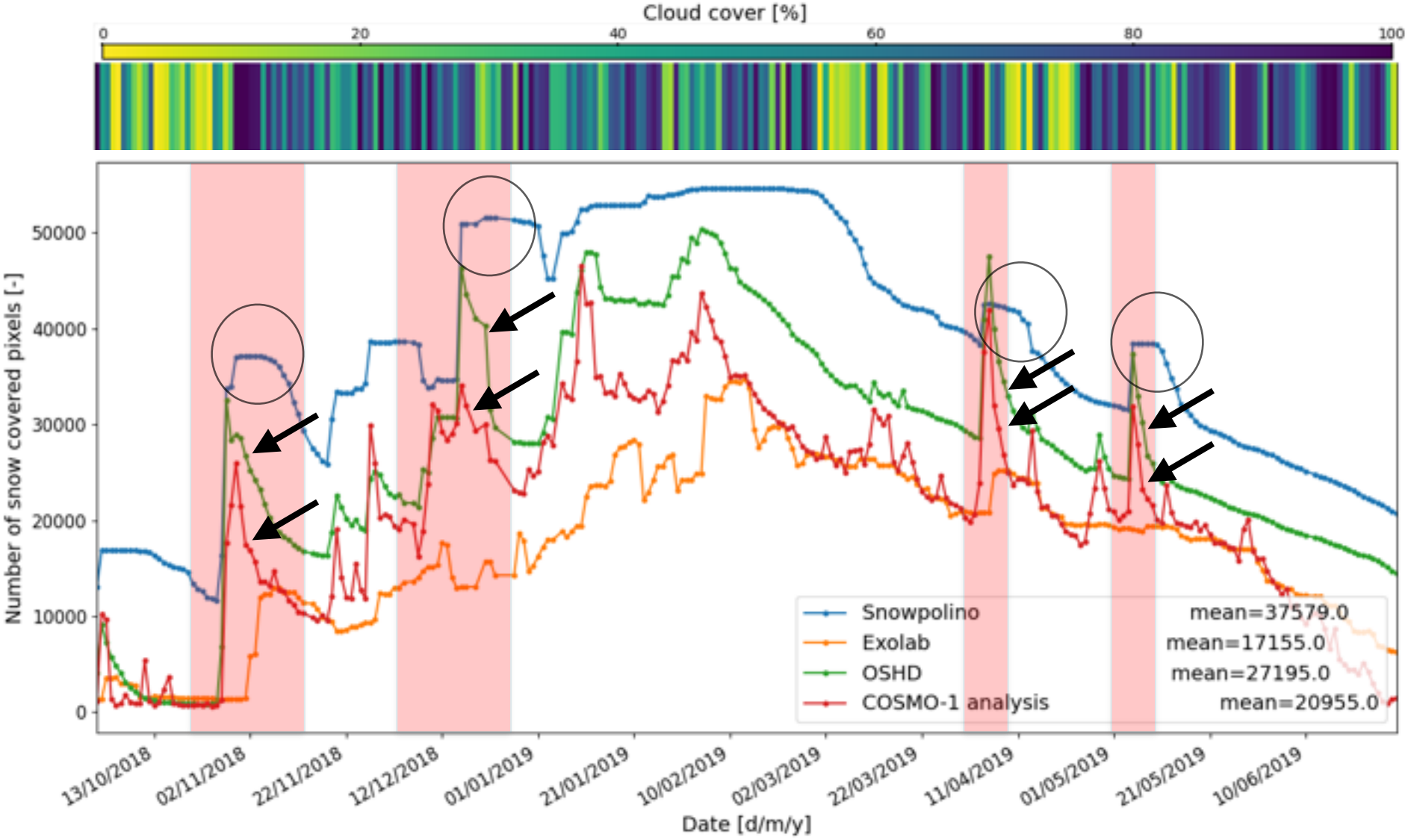
# Quantitative results

## Evolution of the number of snow covered pixels



# Quantitative results

## Evolution of the number of snow covered pixels



# Quantitative results

## Contingency tables

Measurement of the similarity between the snow masks generated by 2 different products.

| | | Product 2 | |
|---|---|---|---|
| | | No Snow | Snow |
| Product 1 | No Snow | a | b |
| | Snow | c | d |

# Quantitative results

## Contingency tables

Measurement of the similarity between the snow masks generated by 2 different products.

**The higher the score in the diagonal** cells, **the greater the similarity** between the snow masks.

| | | Product 2 | |
|---|---|---|---|
| | | **No Snow** | **Snow** |
| **Product 1** | **No Snow** | a | 0 |
| | **Snow** | 0 | d |

# Quantitative results

## Contingency tables

Measurement of the similarity between the snow masks generated by 2 different products.

*Definition:* **Accuracy** between 2 products

Total = a+b+c+d

Accuracy = (**a**+**d**)/Total

*(x 100 for result in %)*

| | | Product 2 | |
|---|---|---|---|
| | | No Snow | Snow |
| Product 1 | No Snow | a | b |
| | Snow | c | d |

# Quantitative results

## Contingency tables

Measurement of the similarity between the snow masks generated by 2 different products.

*Definition:* **Accuracy** between 2 products

Total = a+0+0+d

Accuracy = (**a**+**d**)/Total

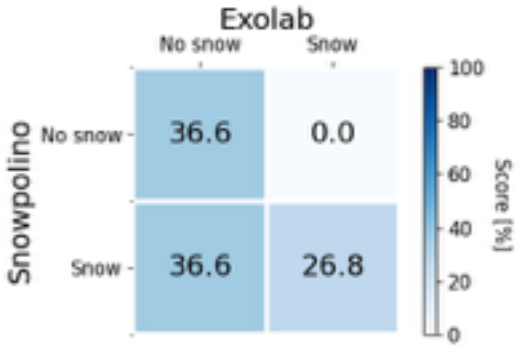
*(x 100 for result in %)*

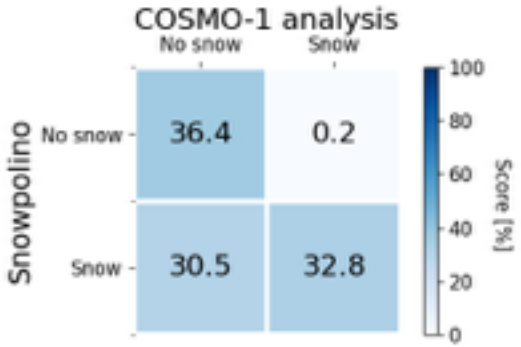
Accuracy = 100 %

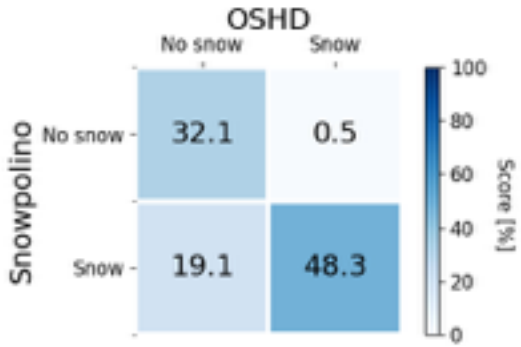
| | | Product 2 | |
|---|---|---|---|
| | | No Snow | Snow |
| Product 1 | No Snow | a | 0 |
| | Snow | 0 | d |

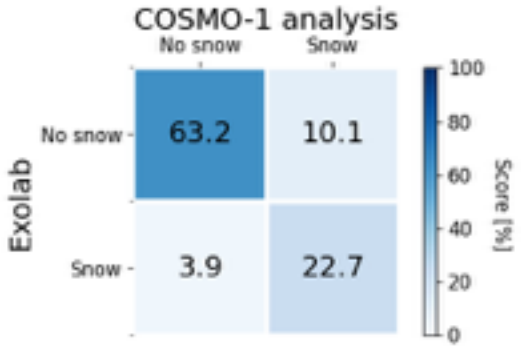
# Quantitative results

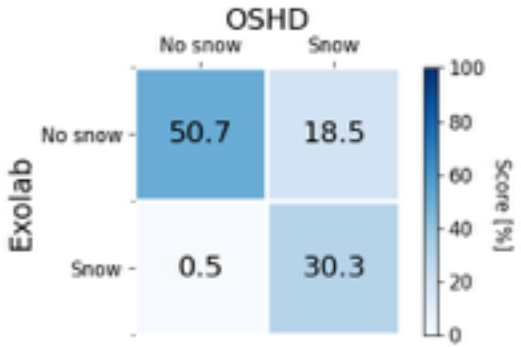
## Contingency tables - averaged over winter 2018/2019

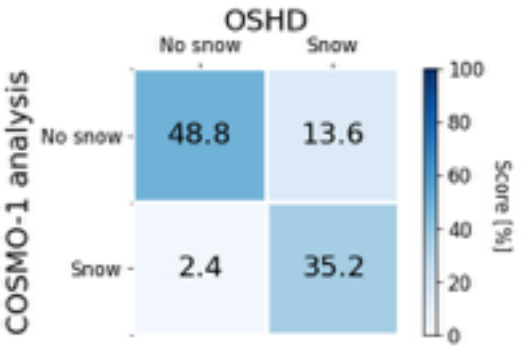


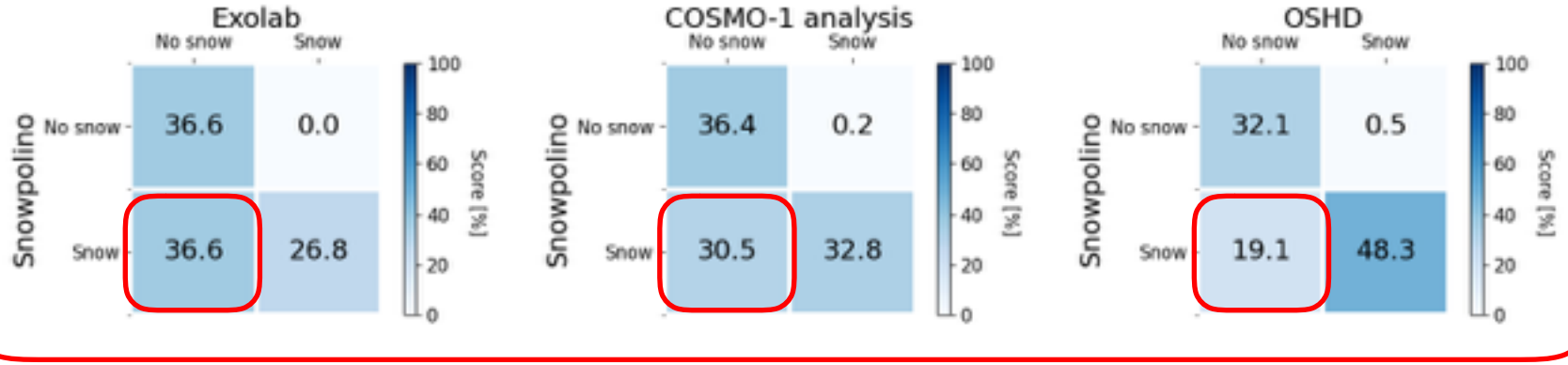



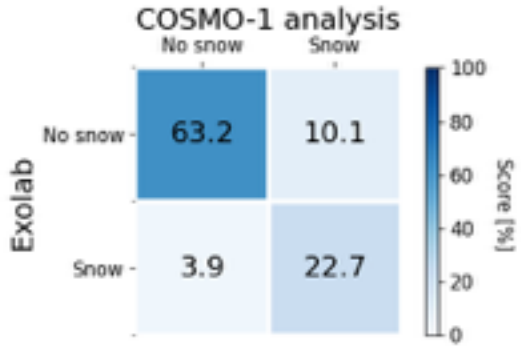



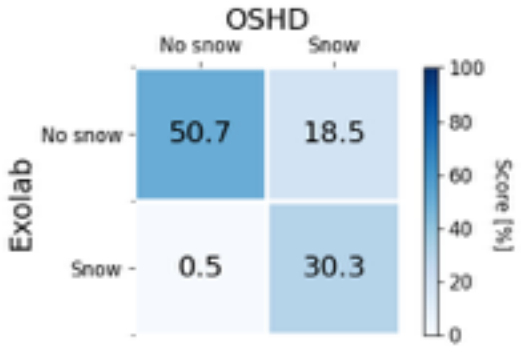



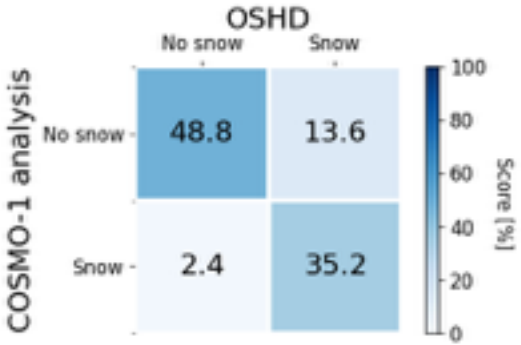
# Quantitative results

## Contingency tables - averaged over winter 2018/2019



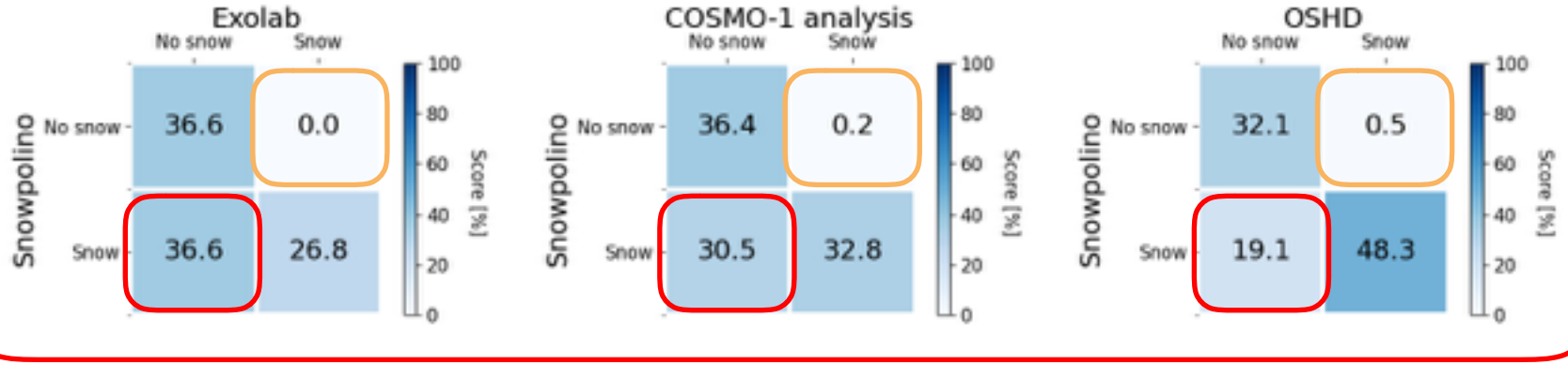



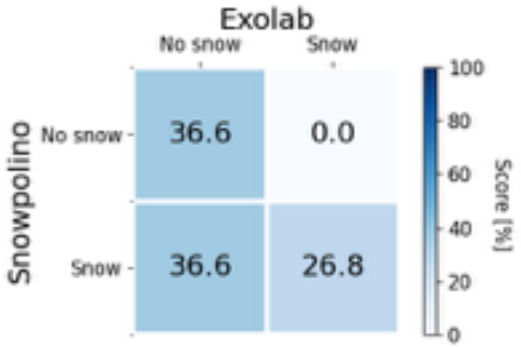
# Quantitative results

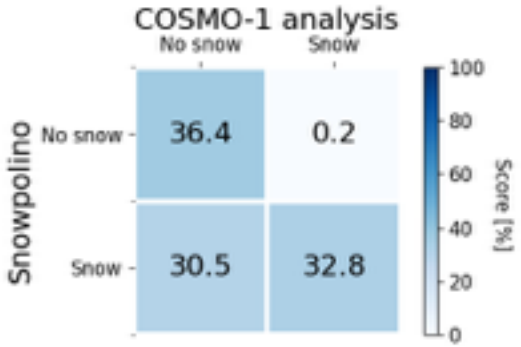
## Contingency tables - averaged over winter 2018/2019

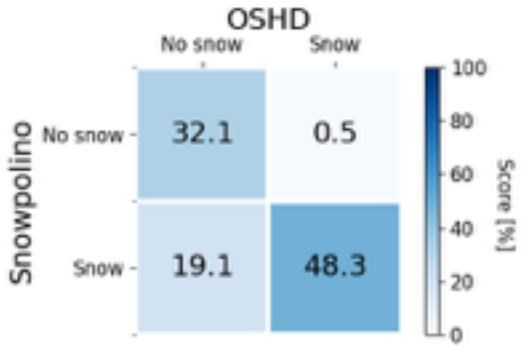


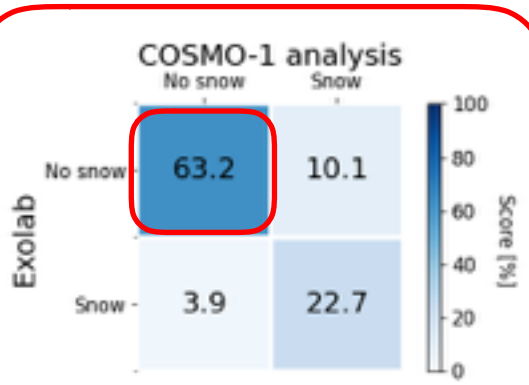
# Quantitative results

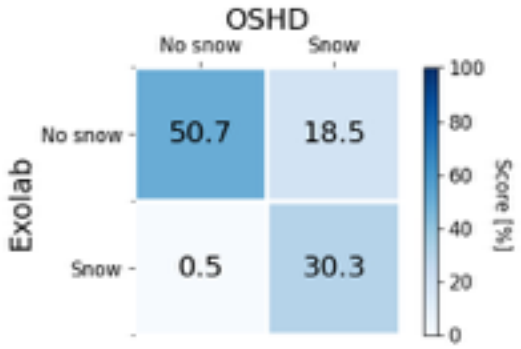
## Contingency tables - averaged over winter 2018/2019

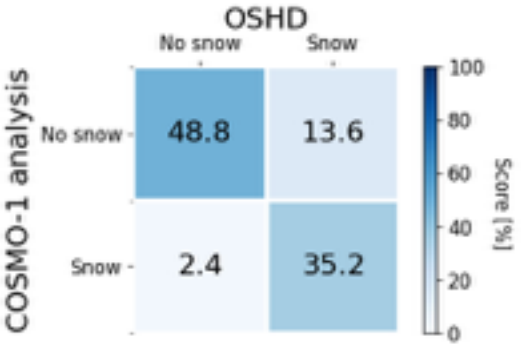


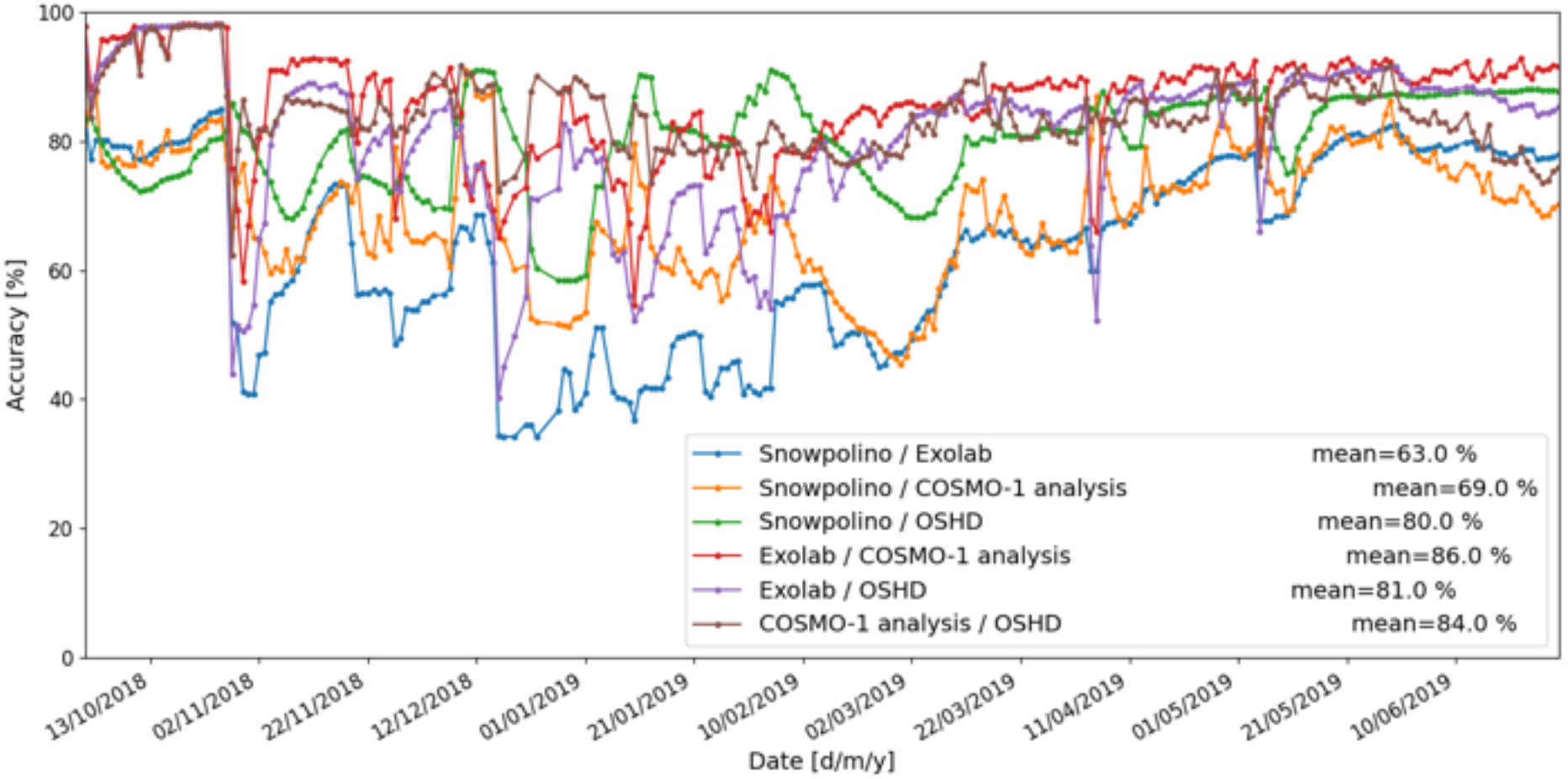



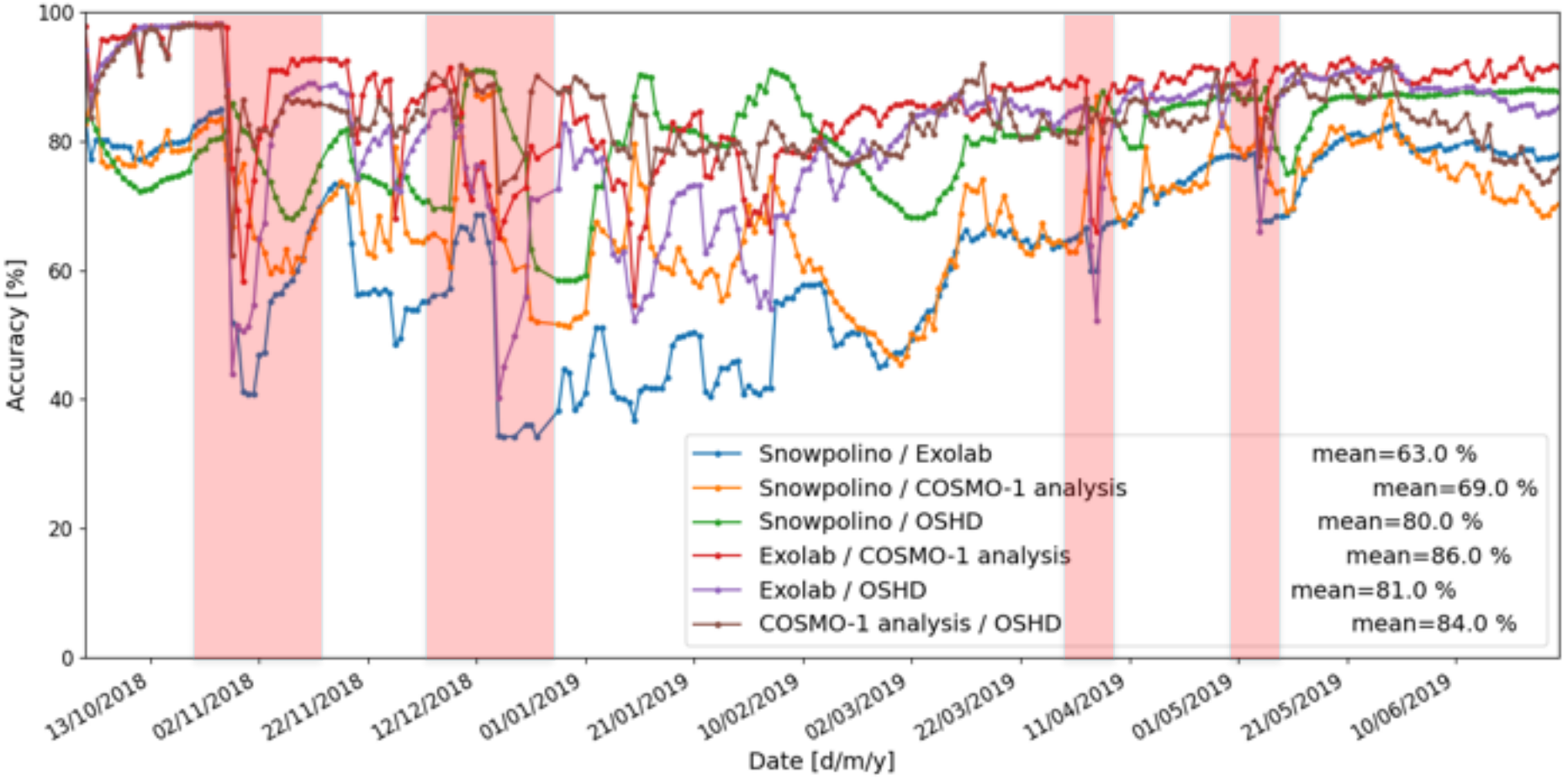
# Quantitative results

## Evolution of the accuracy between the different snow masks



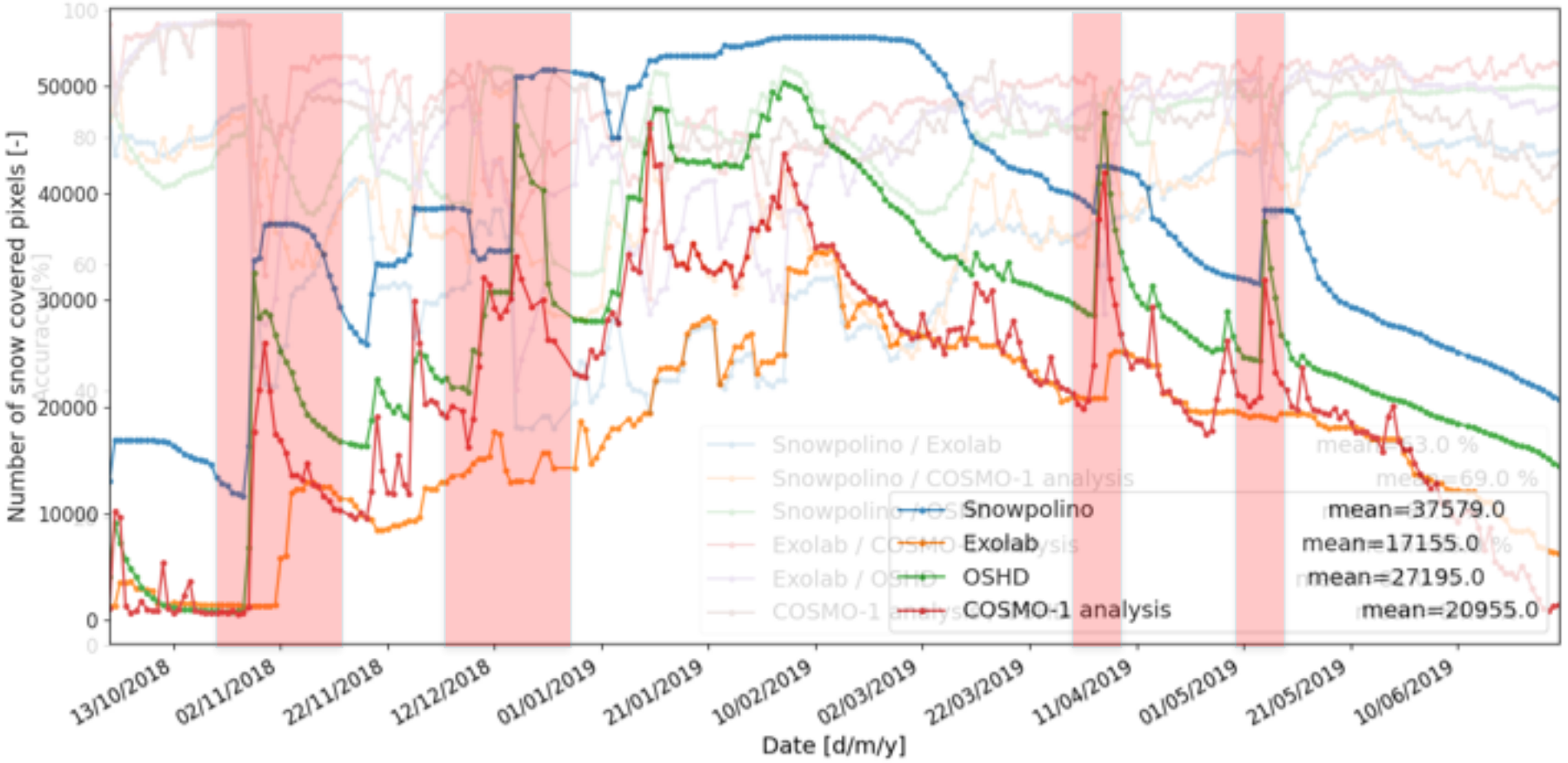
# Quantitative results

## Evolution of the accuracy between the different snow masks



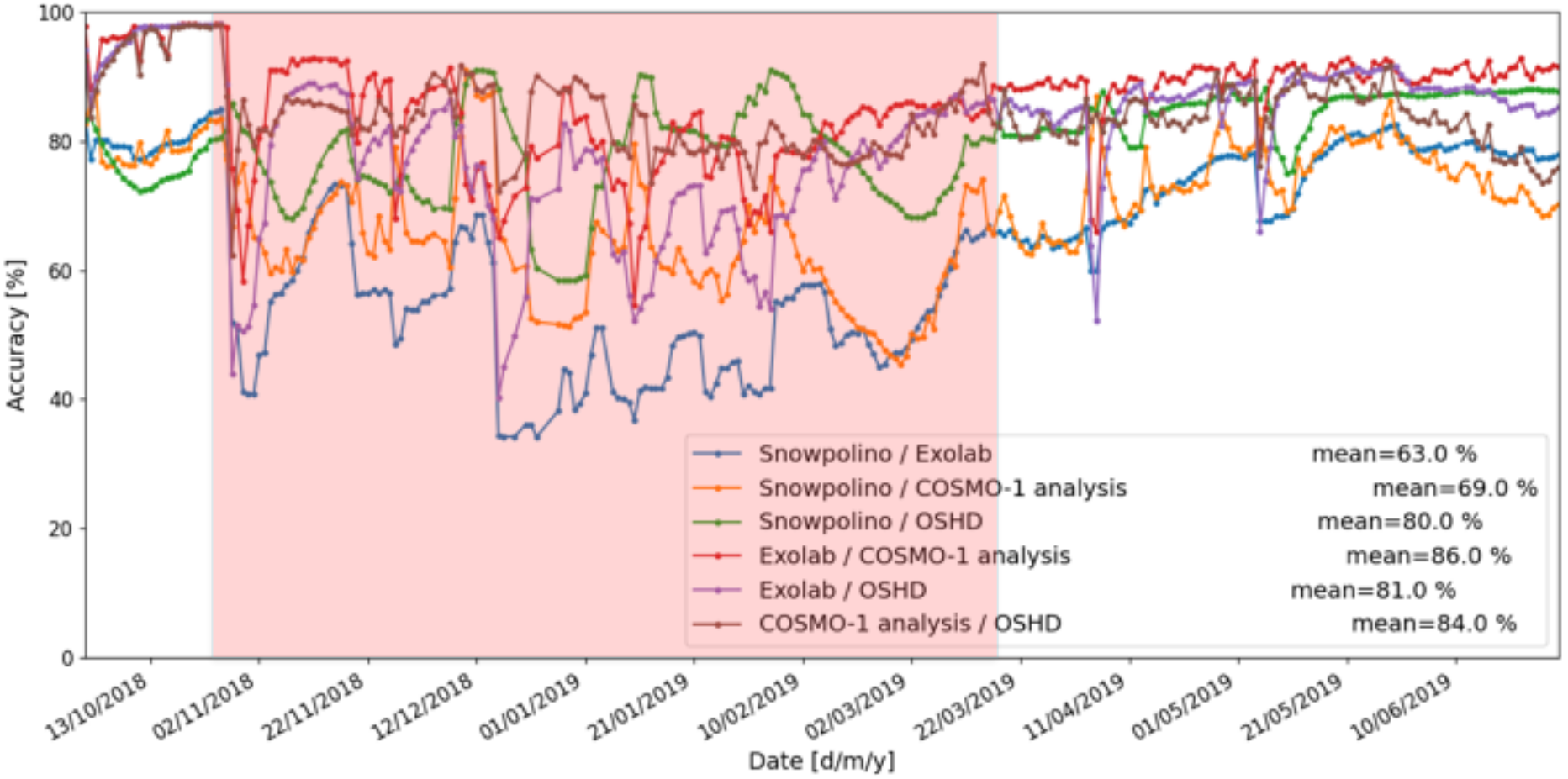
# Quantitative results

## Evolution of the accuracy between the different snow masks



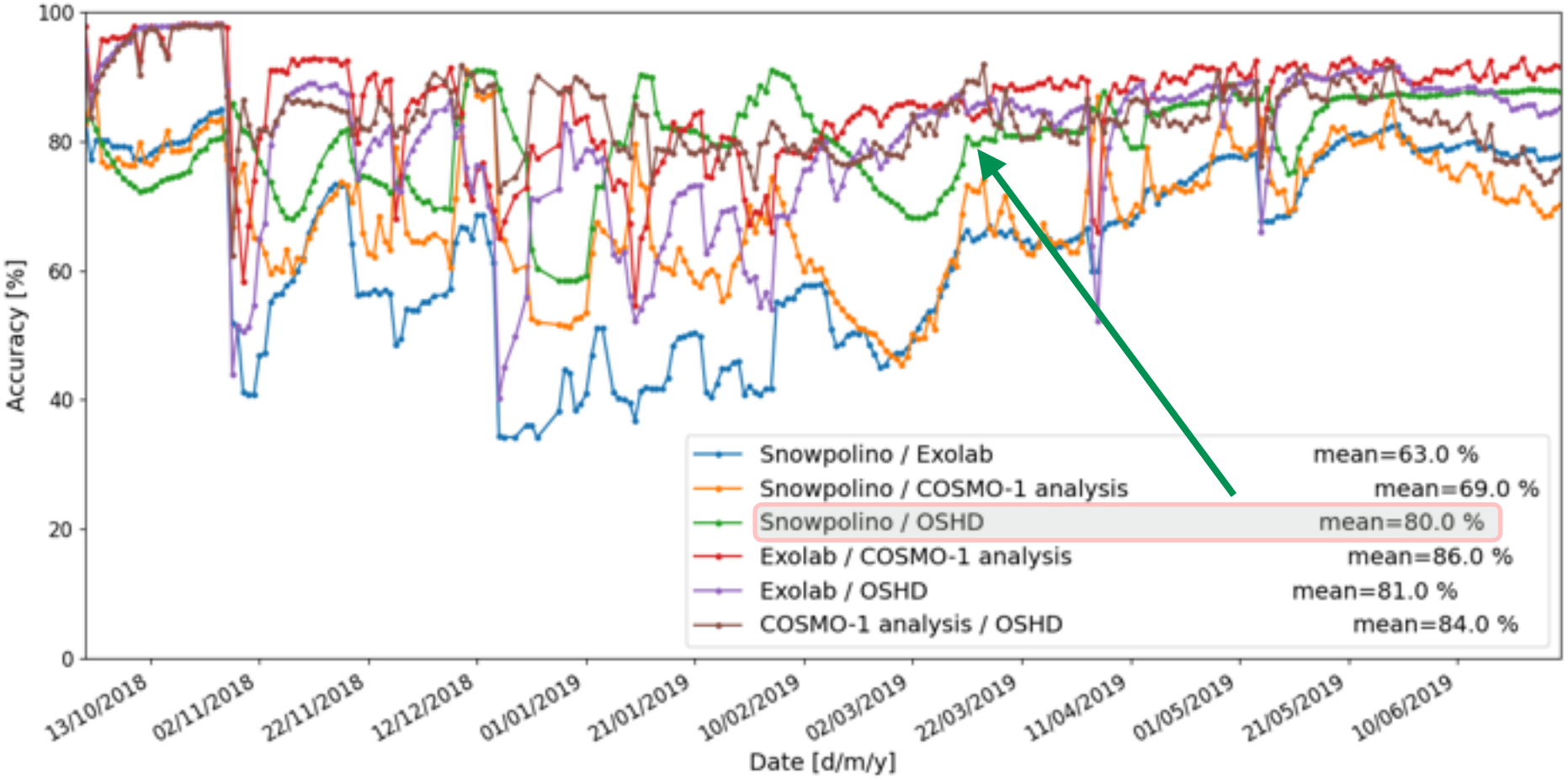
# Quantitative results

## Evolution of the accuracy between the different snow masks



# Quantitative results

## Evolution of the accuracy between the different snow masks



# Major results

- Promising results: quite good agreement especially with SLF's state-of-the-art model.

- Major issues:
  - **Overestimation of the snow cover extent**.
  - Too many snow covered pixels toward the end of the season.

# Hypothese - extended shallow snowpack

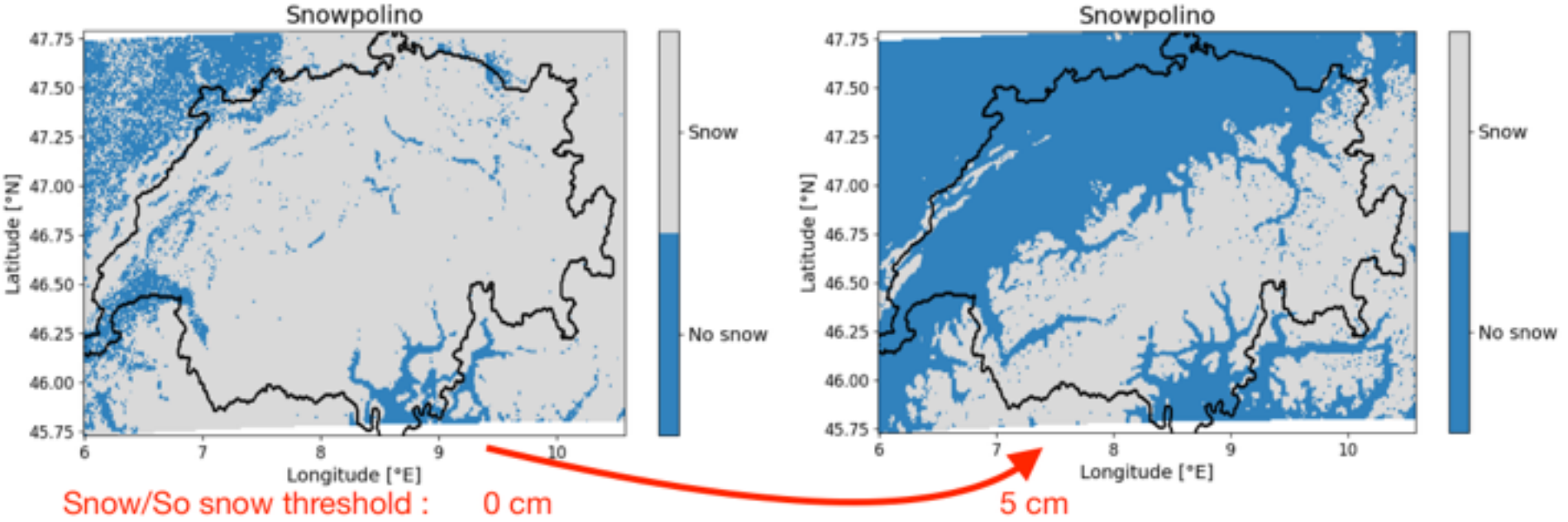
**Overestimation of the snow cover extent is due to a very thin layer of snow in low altitude regions**

# Hypothese - extended shallow snowpack

**Overestimation of the snow cover extent is due to a very thin layer of snow in low altitude regions**

to verify this assumption the **threshold for snow/no snow** classification to produce the snow mask from Snowpolino was **changed to 5 cm**

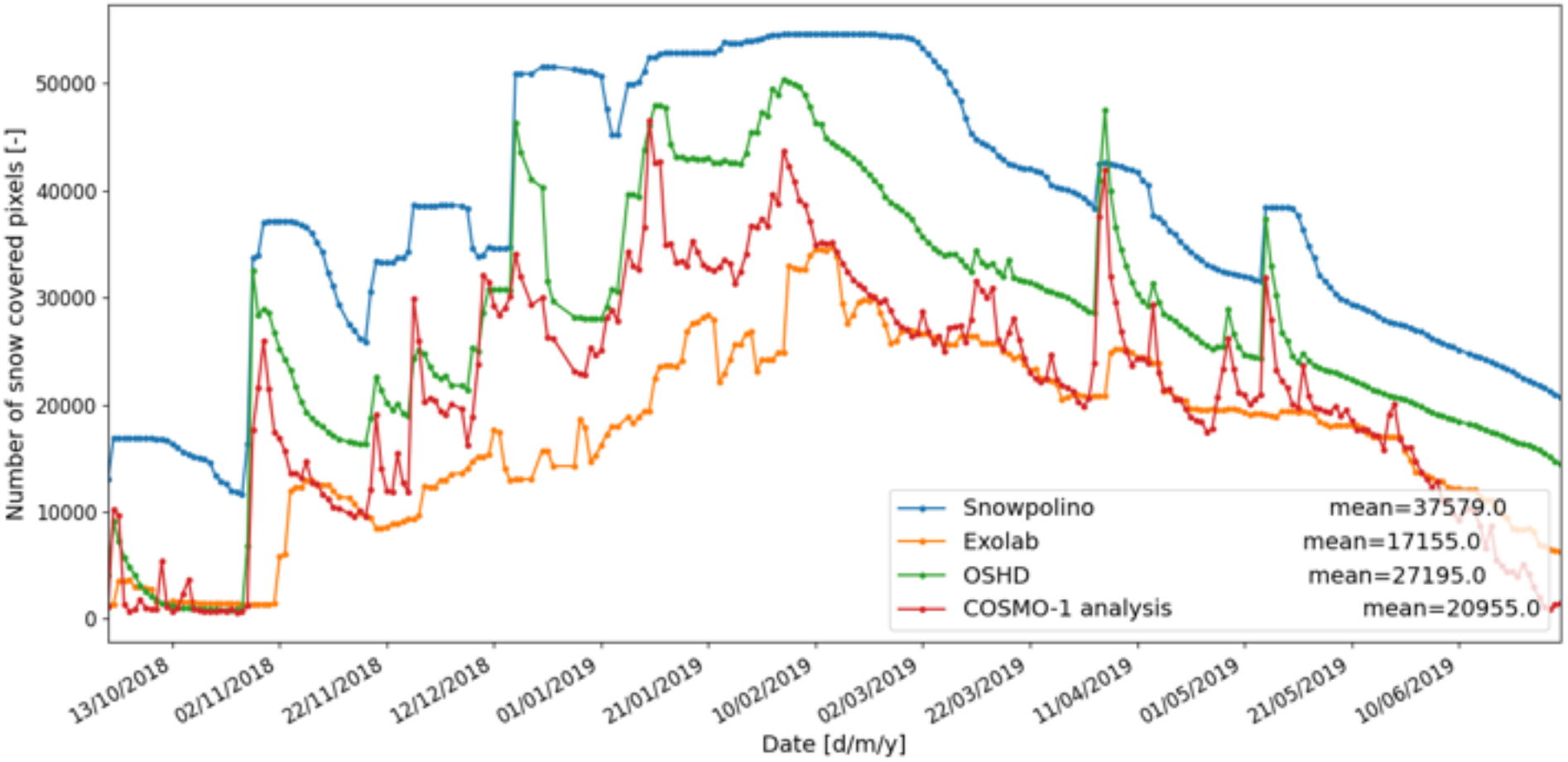
2019-01-01



# Results improvements

## Evolution of the number of snow covered pixels

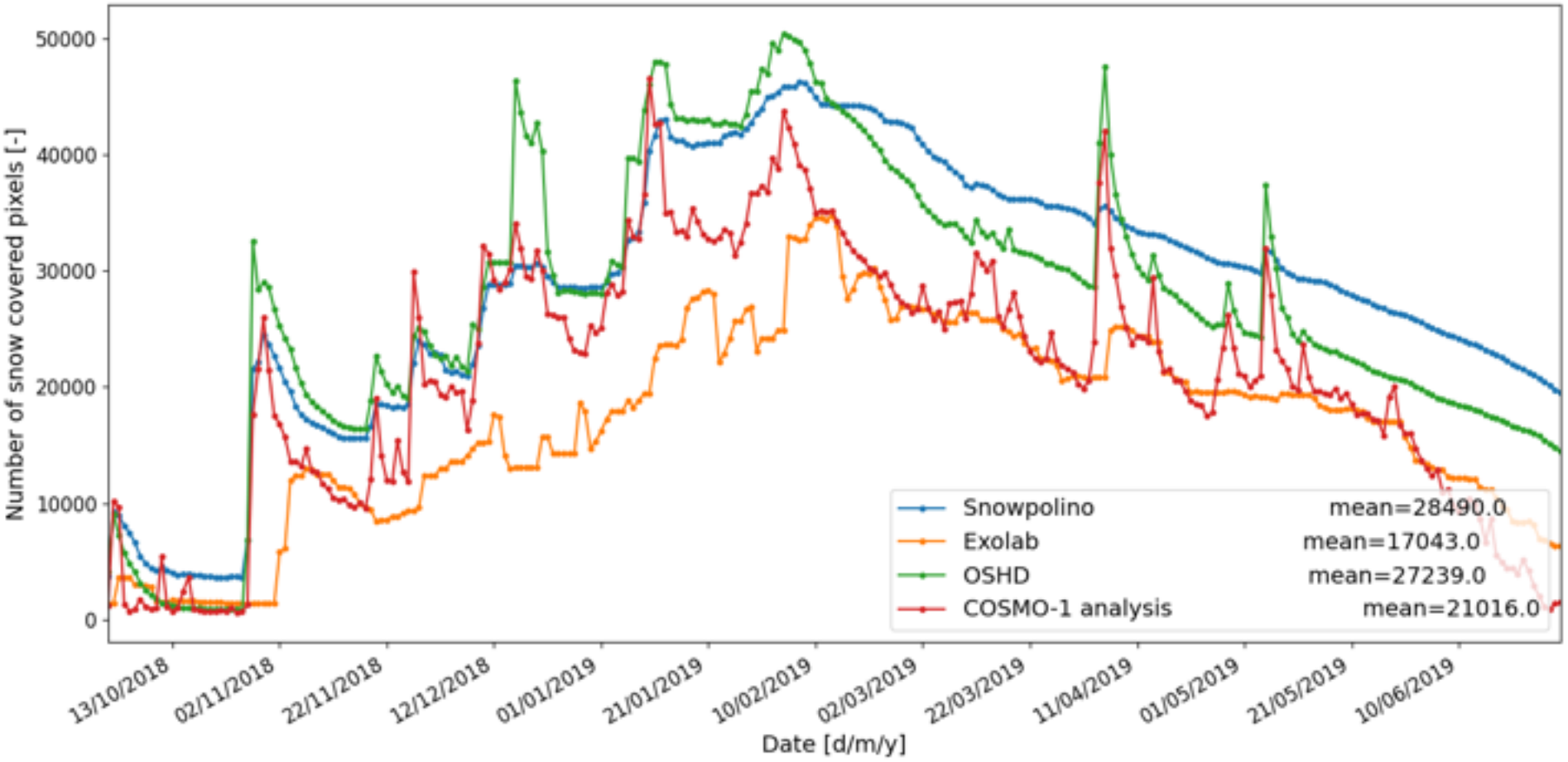
*threshold = 0 cm*



# Quantitative results

## Evolution of the number of snow covered pixels

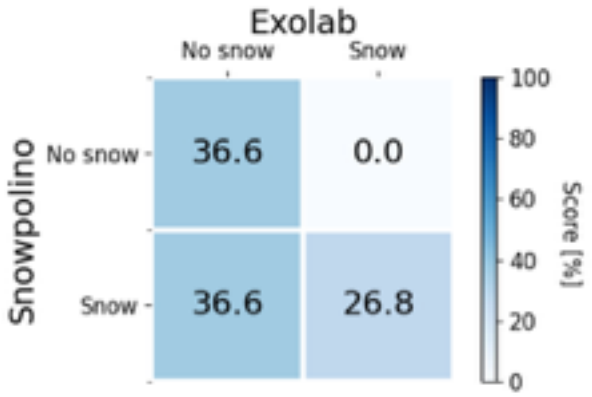
*threshold = 5 cm*

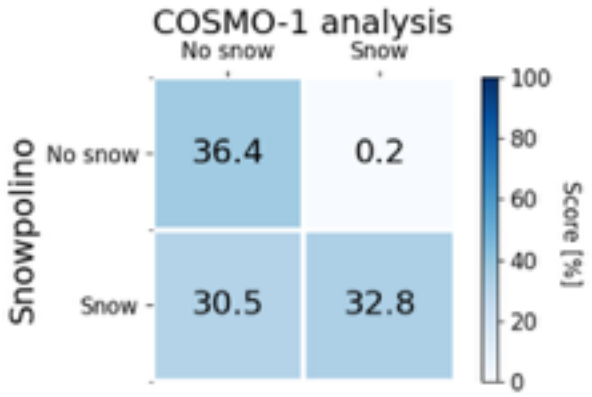


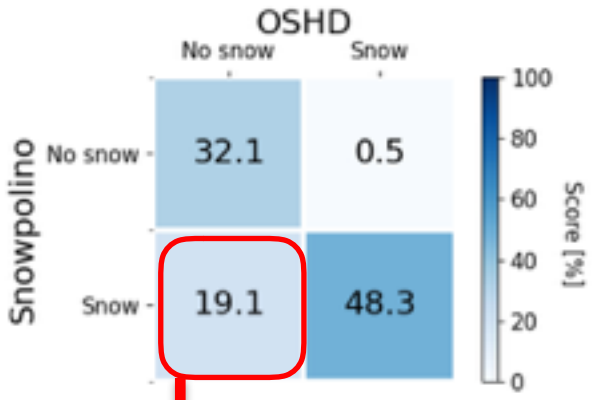
# Results improvements

## Contingency tables - averaged over winter 2018/2019

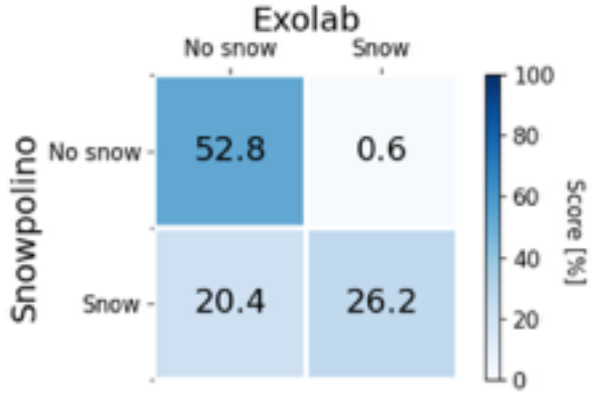
*threshold = 0 cm*

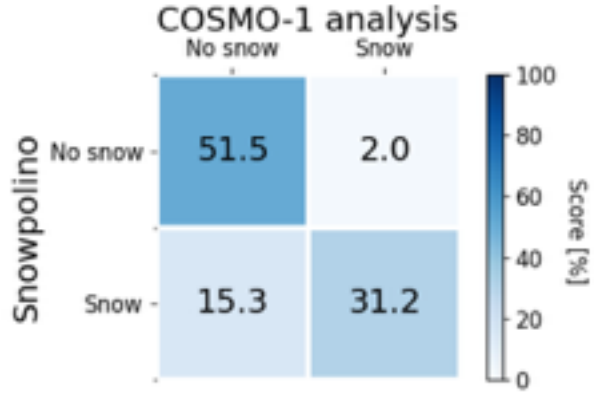


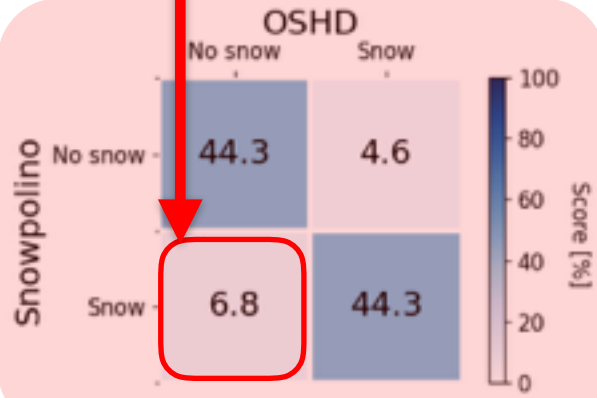




*threshold = 5 cm*



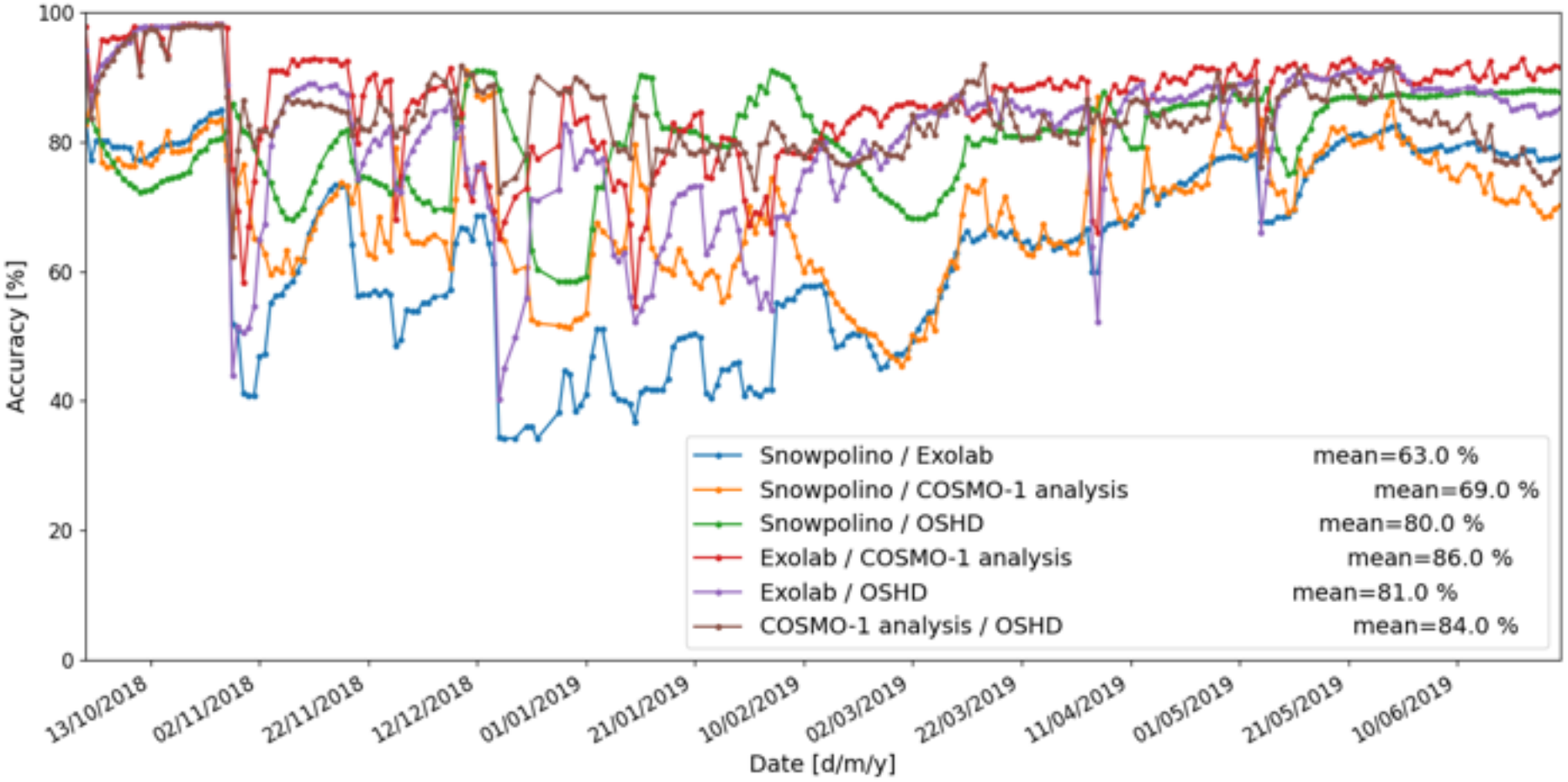



# Results improvements

## Evolution of the accuracy between the different snow masks

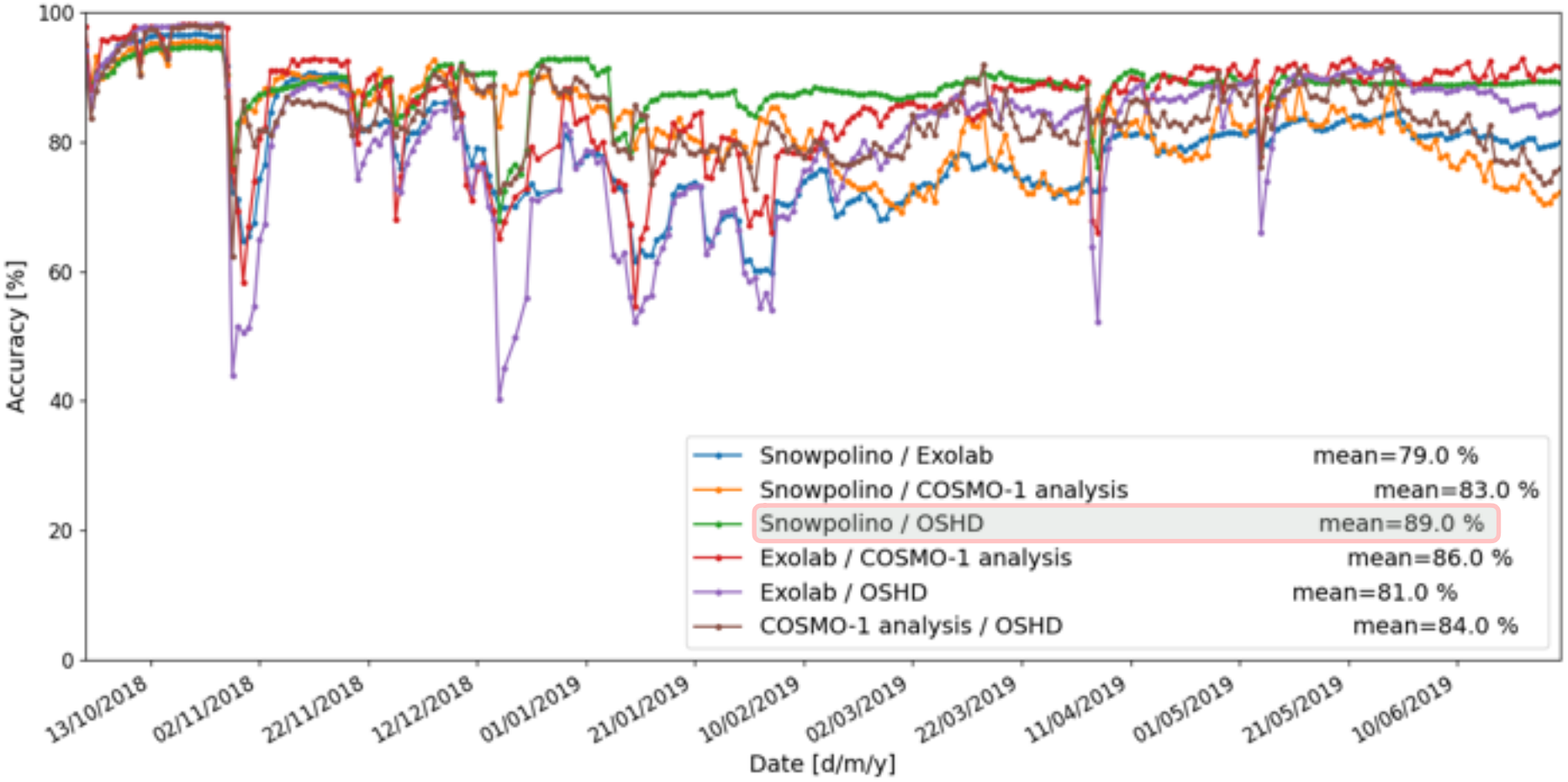
*threshold = 0 cm*



# Results improvements

## Evolution of the accuracy between the different snow masks

*threshold = 5 cm*



# Discussion

How to tune Snowpolino so that the unrealistic shallow snowpack at low altitudes is removed ?

# Discussion

How to tune Snowpolino so that the unrealistic shallow snowpack at low altitudes is removed ?

Currently, the Snowpolino standalone version is independent from the soil temperature.

# Discussion

How to tune Snowpolino so that the unrealistic shallow snowpack at low altitudes is removed ?

Currently, the Snowpolino standalone version is independent from the soil temperature.

Possible solution: add thermal forcing from the soil in the standalone version.

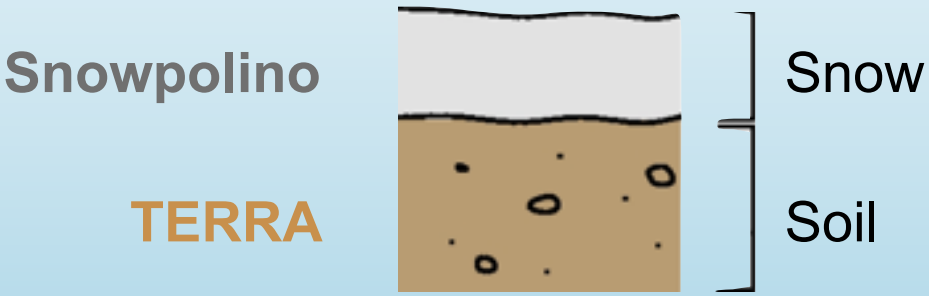
# Discussion

How to tune Snowpolino so that the unrealistic shallow snowpack at low altitudes is removed ?

Currently, the Snowpolino standalone version is independent from the soil temperature.

Possible solution: add thermal forcing from the soil in the standalone version.

Hopefully, the shallow snow cover issue will be solved once Snowpolino runs within COSMO as it will be coupled to the land surface model, TERRA. (ie. heat equation solved through the entire snow/soil column)



# Conclusion

- Promising results: quite good agreement of Snowpolino especially with OSHD.

# Conclusion

- Promising results: quite good agreement of Snowpolino especially with OSHD.

Major issues:

- **Overestimation of the snow cover extent**.
- Too many snow covered pixels toward the end of the season.

# Conclusion

- Promising results: quite good agreement of Snowpolino especially with OSHD.

Major issues:

- **Overestimation of the snow cover extent**.
- Too many snow covered pixels toward the end of the season.

Due to persisting shallow snowpack at low altitude.

# Conclusion

- Promising results: quite good agreement of Snowpolino especially with OSHD.

Major issues:

- **Overestimation of the snow cover extent**.
- Too many snow covered pixels toward the end of the season.

Due to persisting shallow snowpack at low altitude.

- Results can be significantly improved if we managed to tune Snowpolino in such a way that it removes this layer of a couple of cm.

# Conclusion

- Promising results: quite good agreement of Snowpolino especially with OSHD.

Major issues:

- **Overestimation of the snow cover extent**.
- Too many snow covered pixels toward the end of the season.

Due to persisting shallow snowpack at low altitude.

- Results can be significantly improved if we managed to tune Snowpolino in such a way that it removes this layer of a couple of cm.
- **Add snow/soil interaction** in Snowpolino standalone version (coupling with TERRA standalone).