

# Challenges for remote sensing in northern conditions

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# Contents

**Snow cover**

**Daylight hours**

**Weather**

**UAV legislation**



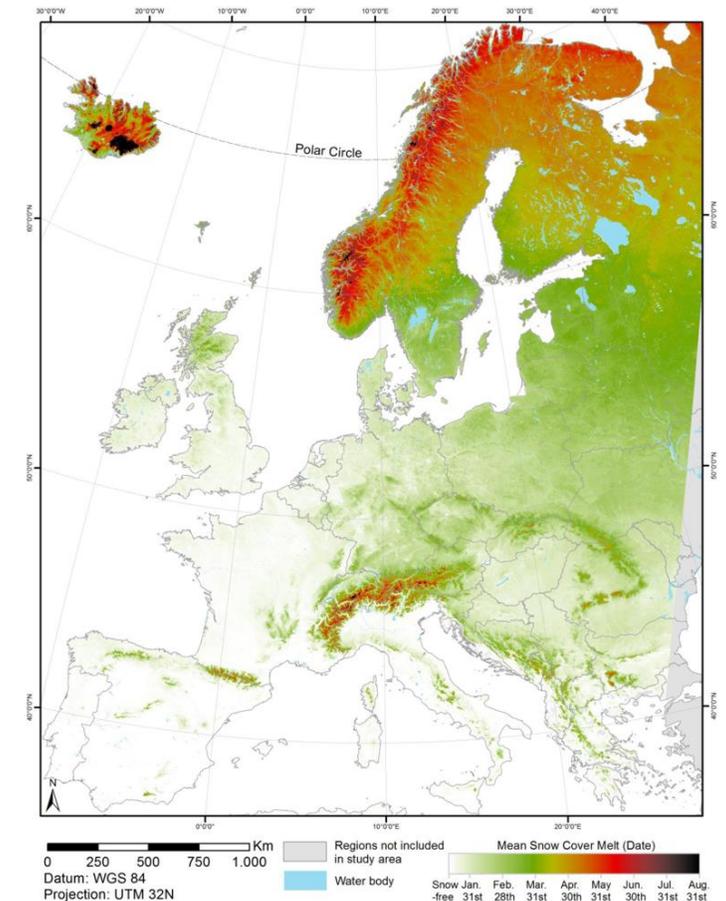
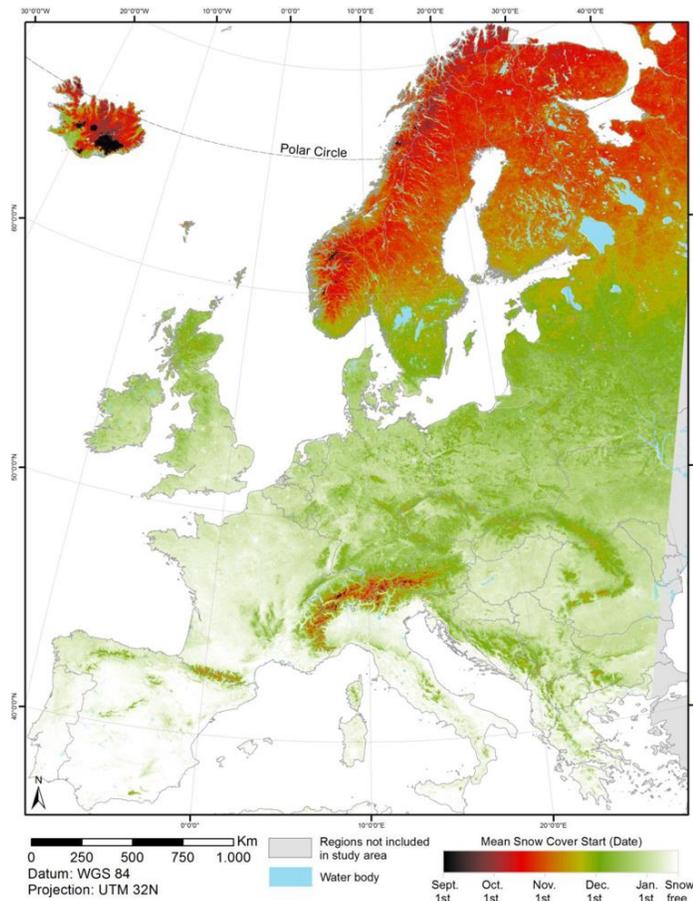
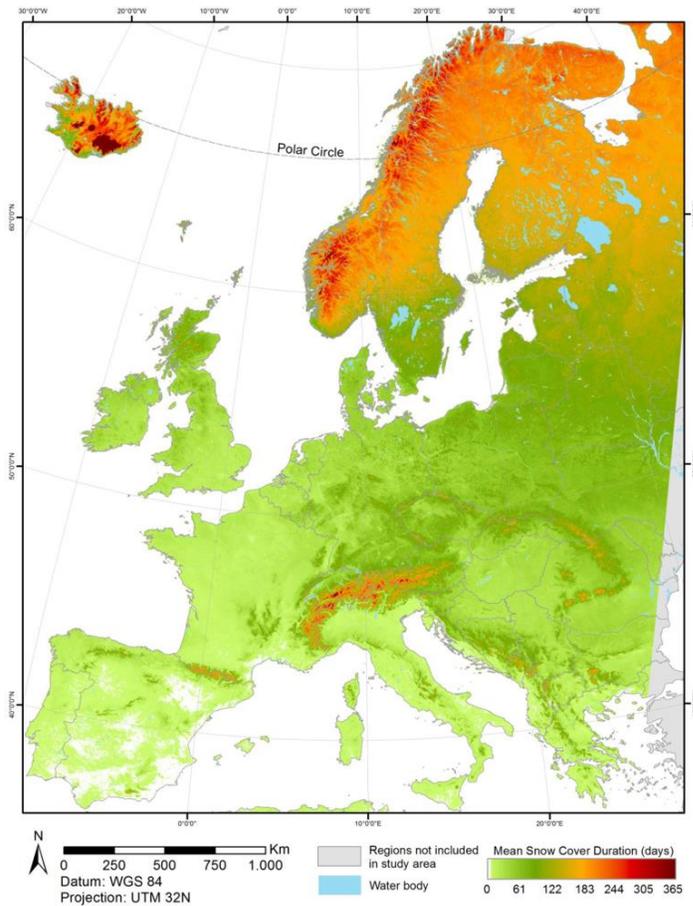
# Snow cover

- Snow cover is **arguably the biggest challenge** to remote sensing in northern areas as it effectively prevents seeing the bare ground surface.
- Thus it **prevents most remote sensing measurements** that rely on clear line-of-sight with the ground surface or object of interest.
- In northern areas, snow cover typically takes large portion of the year.
  - Must rely on in situ measurements and monitoring that can penetrate the snow cover.
- There are some exceptions:
  - Measuring snow is actually the objective.
  - Looking for spots where snow has melted due to for example leakage.



# Snow cover

- Mean snow cover **duration**, **start**, and **melt** (2000-2011) from MODIS snow index data (Dietz et al. 2012).





# Daylight hours

- Even if snow is not an obstacle, the **short days during wintertime** provide very short window for measurements with **daylight-dependent, passive sensors** (e.g. optical cameras).
- On the other hand, the **long days during summertime** provide ample time for measurements.
- However, the amount daylight hours is **not as big an issue as snow cover**, since active sensors such as radar and lidar can be utilized regardless of daylight.
- Should note that UAV regulations typically demand **special permission** to fly Beyond Visual Line of Sight (BVLOS) with the UAV.



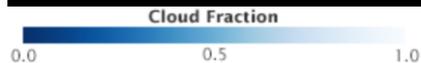
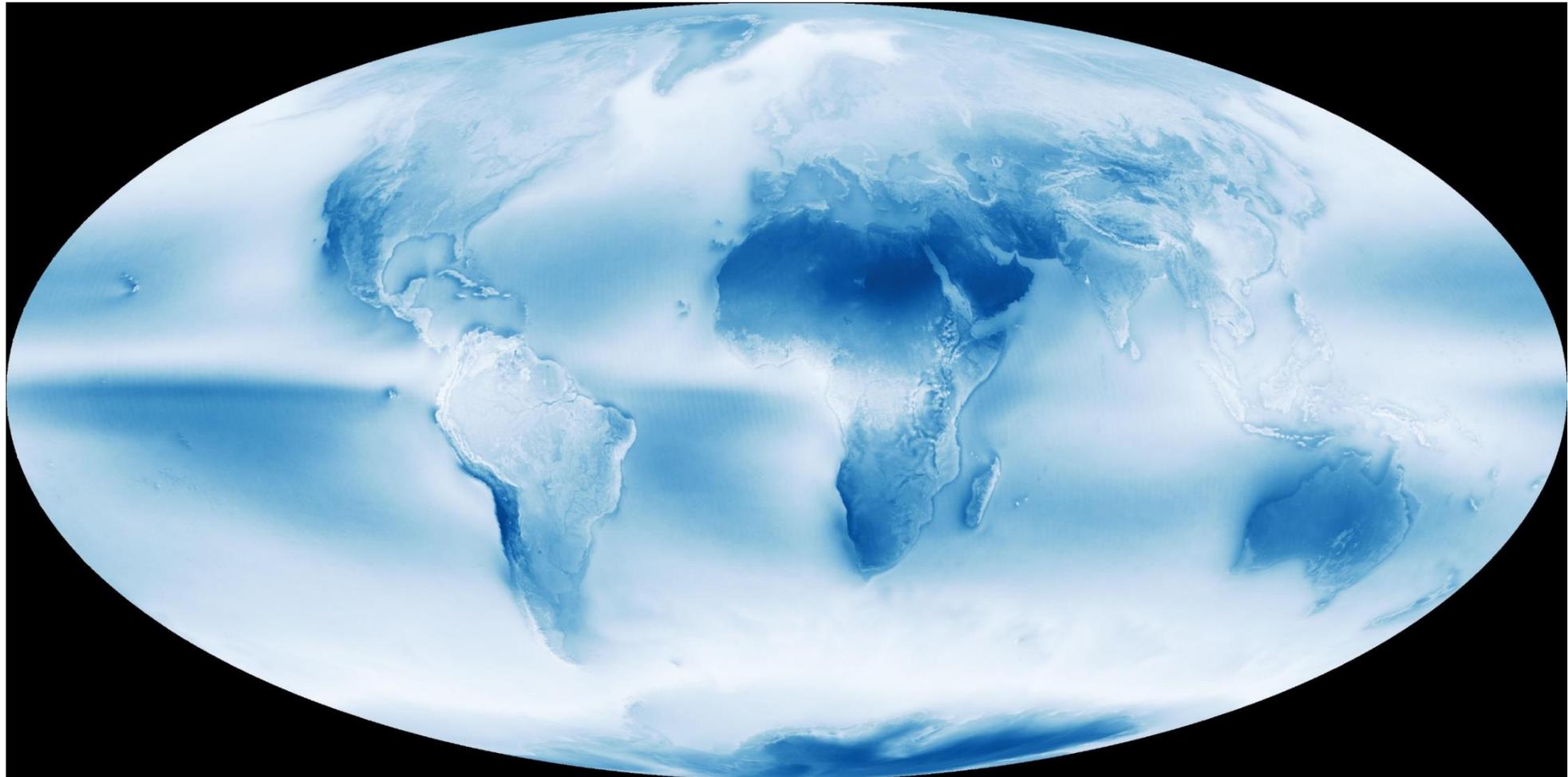
# Weather

- Cold temperature, precipitation, and high wind speeds might put **limitations to the use of UAVs**
  - Cold temperature can reduce battery life
  - High wind speeds and precipitation may compromise safety
- **Overcast sky** might be desirable in some applications (e.g. thermal remote sensing from UAV) **to reduce the effect of shadows** and other brightness variations, however, ...
- ... clouds can totally **prevent optical measurements from satellites.**
- Again, some techniques such as radar remote sensing are **less susceptible** to weather and clouds.



# Weather

- Average of satellite cloud observations 2002-2015 (MODIS)

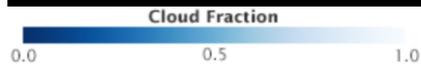
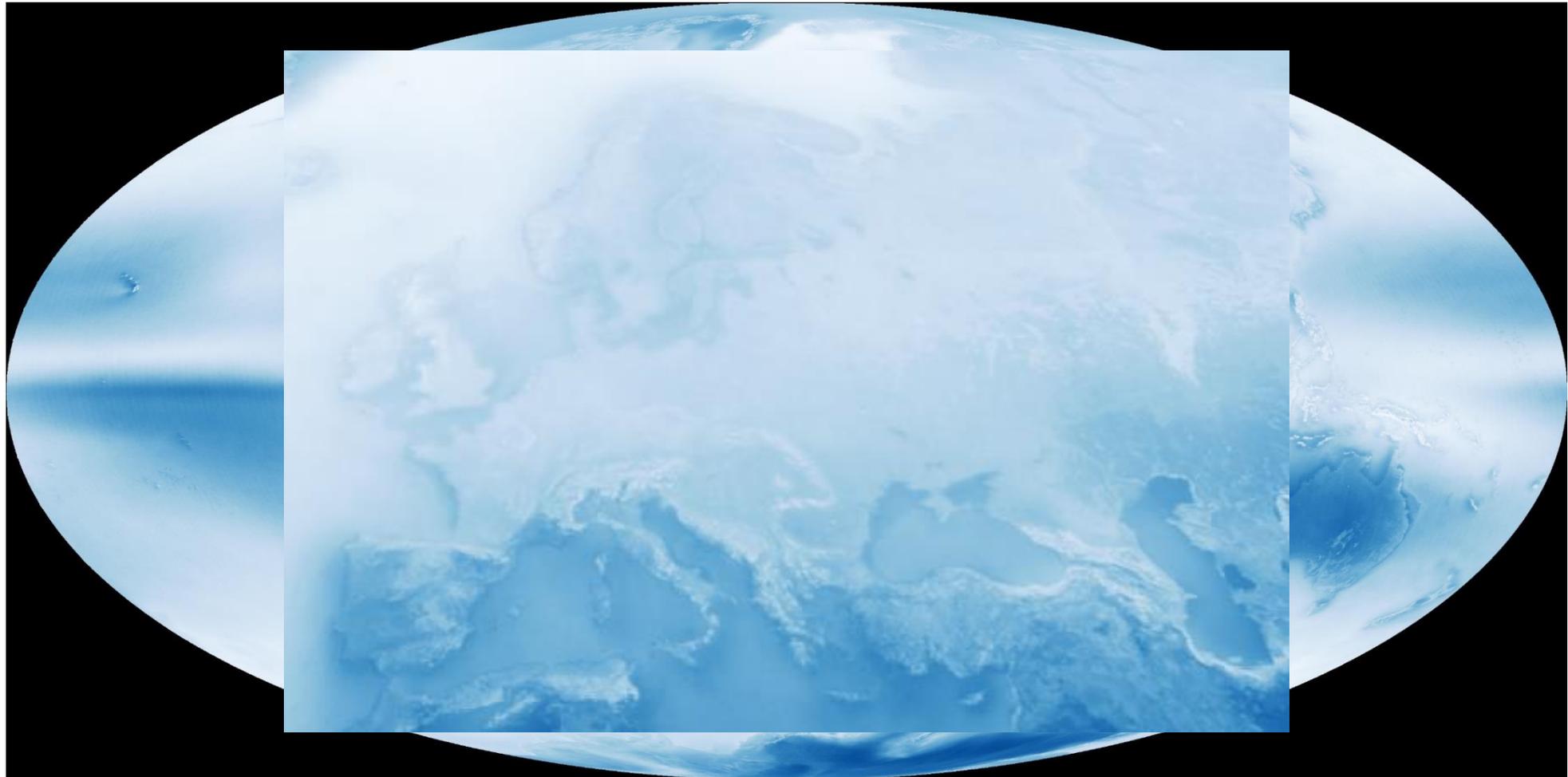


*Image credit: NASA Earth Observatory image by Jesse Allen and Kevin Ward, using data provided by the MODIS Atmosphere Science Team, NASA Goddard Space Flight Center*



# Weather

- Average of satellite cloud observations 2002-2015 (MODIS)



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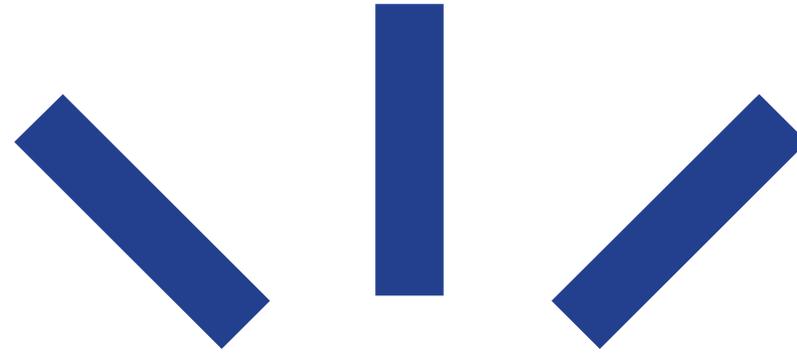
# UAV legislation

- Current legislation operates on country level
- **Finland** had little regulation before 2015, latest update 01/2017
  - Quite liberal regulation even in global terms
- **Sweden** started regulating 2003, latest update 02/2018
  - Not always so liberal: for example from late 2016 to early 2018, using a drone equipped with camera required a license from county administrator (länsstyrelse)
- European Aviation Safety Agency left their proposal for the **regulatory framework for the operation of UAVs** to EU Commission 6th Feb 2018
- EU Commission is expected to adopt the proposed regulation **by the end of 2018**



# Conclusions

- Must take **snow cover, availability of daylight, weather, cloudiness, UAV legislation**, etc., into account when planning for measurement campaign or monitoring programme.
- Some techniques such as radar remote sensing **don't require daylight and are less susceptible to weather**, but snow cover remains a challenge.
- Although remote sensing techniques continue to improve, the northern conditions may place additional **limitations to all-encompassing use**.
- Important to **assess cost-effective uses** where remote sensing and in situ monitoring can be effectively combined.



# THANK YOU!