# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

Zuhal AKYUREK [1, 2] Semih KUTER [3] Kenan BOLAT [4]

[1] Middle East Technical University (METU), Faculty of Engineering, Dept. of Civil Engineering, Ankara, Turkey
[2] METU, Graduate School of Natural and Applied Sciences, Dept. of Geodetic and Geographic Information Technologies, Ankara, Turkey
[3] Çankırı Karatekin University, Faculty of Forestry, Dept. of Forest Engineering, Çankırı, Turkey
[4] Hidrosaf Ltd., METU Technopolis, Ankara, Turkey



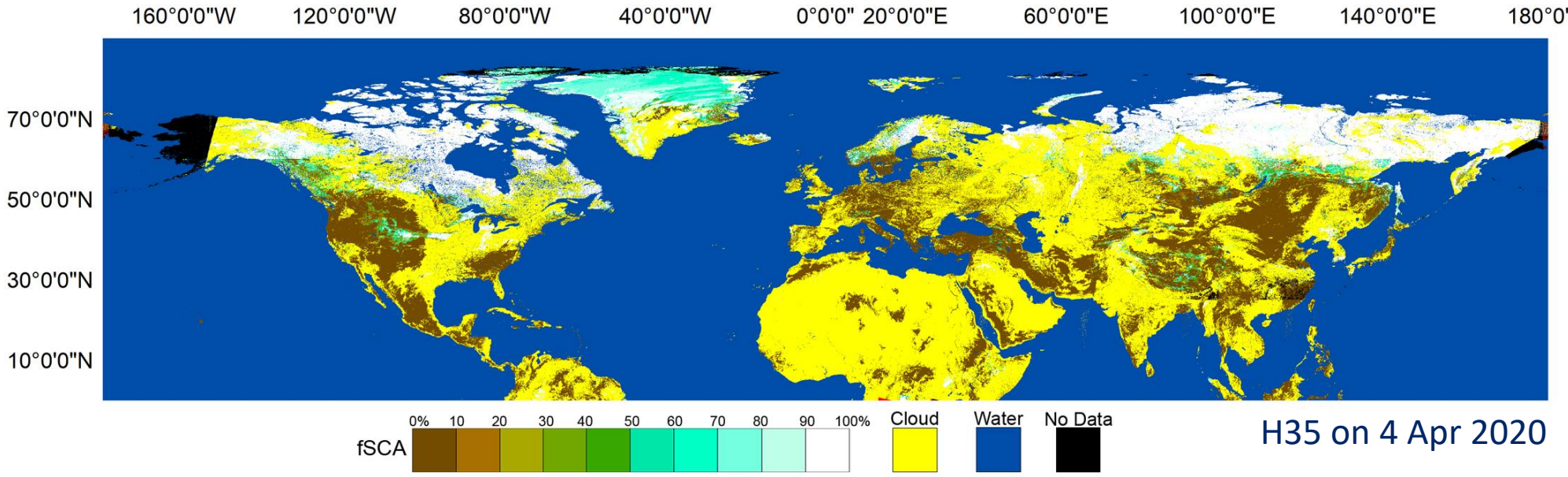
zakyurek@metu.edu.tr semihkuter@karatekin.edu.tr kenanbolat@hidrosaf.com

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- Pre-operational **H35 (SN-OBS-1P)** daily fractional snow-covered area (fSCA) product is developed within the frame of H-SAF (**available as of March 2019**).

- Cycle: Daily
- Coverage: Northern Hemisphere
- Grid/Projection: EPSG 4326 (Lat/Lon Grid)
- Resolution: 0.01 ° x 0.01 ° (~1 km )
- Formats: gzip compressed GRIB2

**Product digital coding:**
- [0, 100]: Ground - fSCA
- 101: Cloud
- 102: Sea/Water
- 104: Dark
- 105: No Data



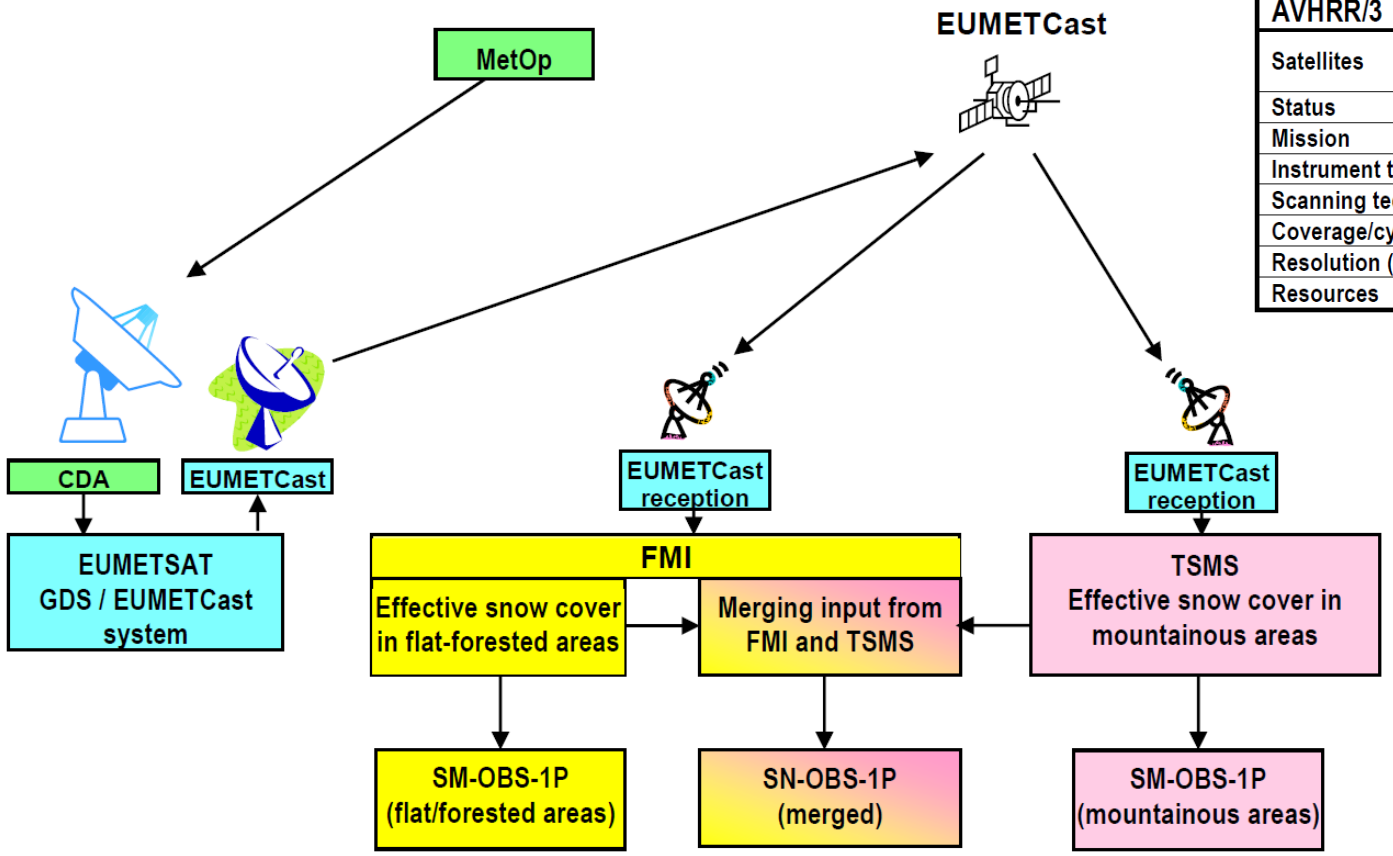

H35 on 4 Apr 2020

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- H35 product is generated using the spectral data from the **AVHRR** sensor onboard to **NOAA** and **MetOp** satellites by traditional **VIS/IR radiometry**.
- The product for the flat/forested regions: **Finnish Meteorological Institute (FMI)**
- The product for the mountainous areas: **Turkish State Meteorological Service (TSMS)**
- Both products, thereafter, are merged at FMI.
- A full disk H35 product: An image of **8,999** rows by **35,999** columns (i.e., **324M** pixels approximately)

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- Architecture of the H35 product generation chain




| AVHRR/3 | Advanced Very High Resolution Radiometer / 3 |
|---|---|
| Satellites | TIROS-N, NOAA 6 to 14, NOAA-15, NOAA-16, NOAA-17, NOAA-18, NOAA-19, MetOp-A, MetOp-B, MetOp-C |
| Status | **Operational** - Utilisation period: 1978 to ~ 2014 on NOAA, 2006 to ~ 2024 on MetOp |
| Mission | Multi-purpose imagery |
| Instrument type | Multi-purpose imaging VIS/IR radiometer - 6 channels (channel 1.6 and 3.7 alternative) |
| Scanning technique | Cross-track: 2048 pixel of 800 m s.s.p., swath 2900 km - Along-track: six 1.1-km lines/s |
| Coverage/cycle | Global coverage twice/day (IR) or once/day (VIS) |
| Resolution (s.s.p.) | 1.1 km IFOV |
| Resources | Mass: 33 kg - Power: 27 W - Data rate: 621.3 kbps |

| AVHRR/3 Spectral Bands (µm) | |
|---|---|
| | Band 1 : 0.580-0.680<br>Band 2 : 0.725-1.000<br>Band 3a : 1.580-1.640<br>Band 3b : 3.550-3.930<br>Band 4 : 10.300-11.300<br>Band 5 : 11.500-12.500 |

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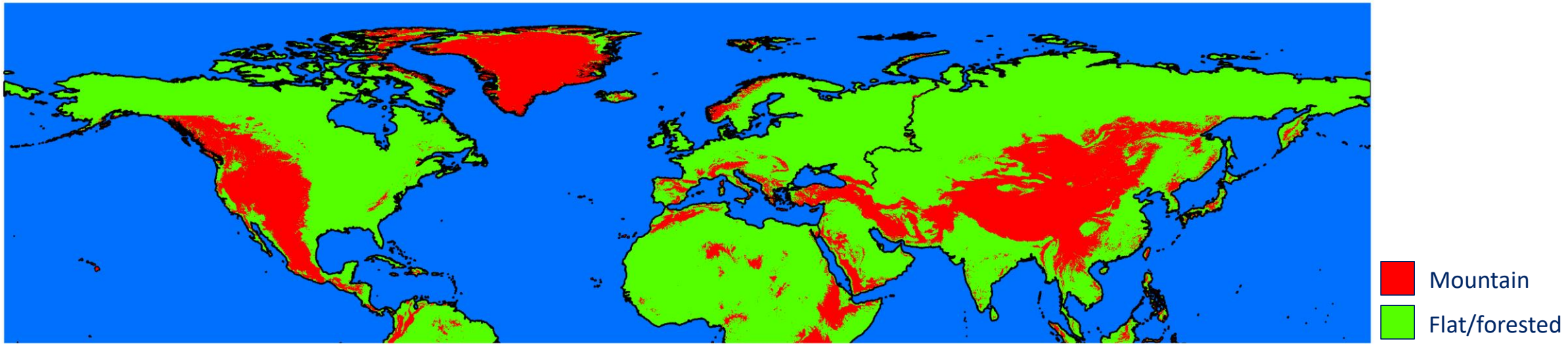
- **H35 Mask**: Flat/Forested vs Mountainous Areas



# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

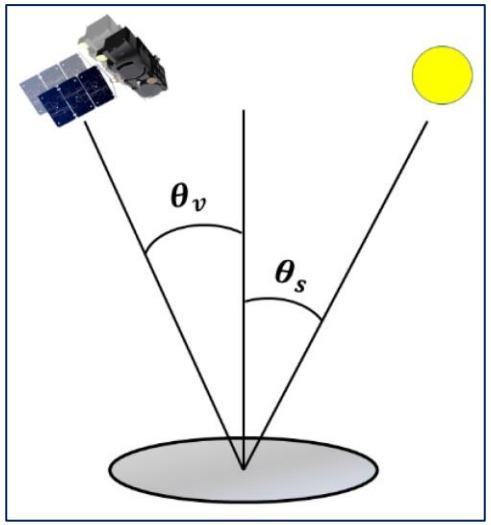
- **For forested areas**, it is essential to take accurate forest transmissivity into account.
  - Forest transmissivity map according to **Metsämäki et al., 2005**.

- **For mountainous areas**, the sun zenith and azimuth angles, as well as direction of observation relative to these are more limiting factors.
  - Lambertian cosine correction (**Vikhmar et al. 2004**; **Riano et al. 2003**) for topographic effects.

**Details are available here in the ATBD!**

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **The most ideal scenario for the detection of snow cover with high accuracy**
  - Clear sky
  - Good illumination and sensor viewing conditions
  - Snow cover with depth of several centimeters




# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

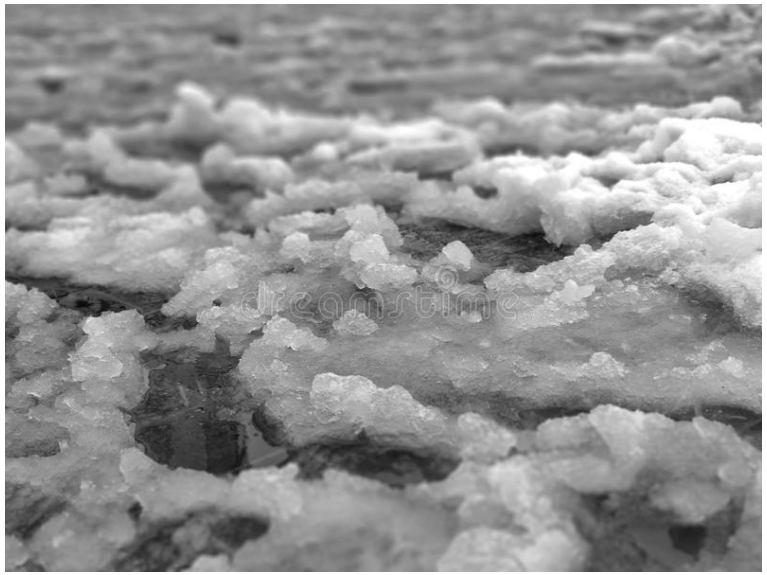
- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Mixed-pixel problem over the areas with complex and rough topography

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Patchy snow cover due to melting

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Wet and shallow snow cover
    - High FAR and low POD values across the snow/land boundaries at the fringes of the slopes



| | | *Reference Data* | | |
|---|---|---|---|---|
| | | **Snow** | **No Snow** | |
| ***Satellite Product*** | **Snow** | **HITS (A)** | **FALSE ALARMS (B)** | HITS + FALSE ALARMS |
| | **No Snow** | **MISSES (C)** | **CORRECT NEGATIVES (D)** | MISSES+ CORRECT NEGATIVES |
| | | HITS + MISSES | FALSE ALARMS + CORRECT NEGATIVES | |

**Probability of detection** (POD): A/(A+C)

**False alarm ratio** (FAR): B/(A+B)

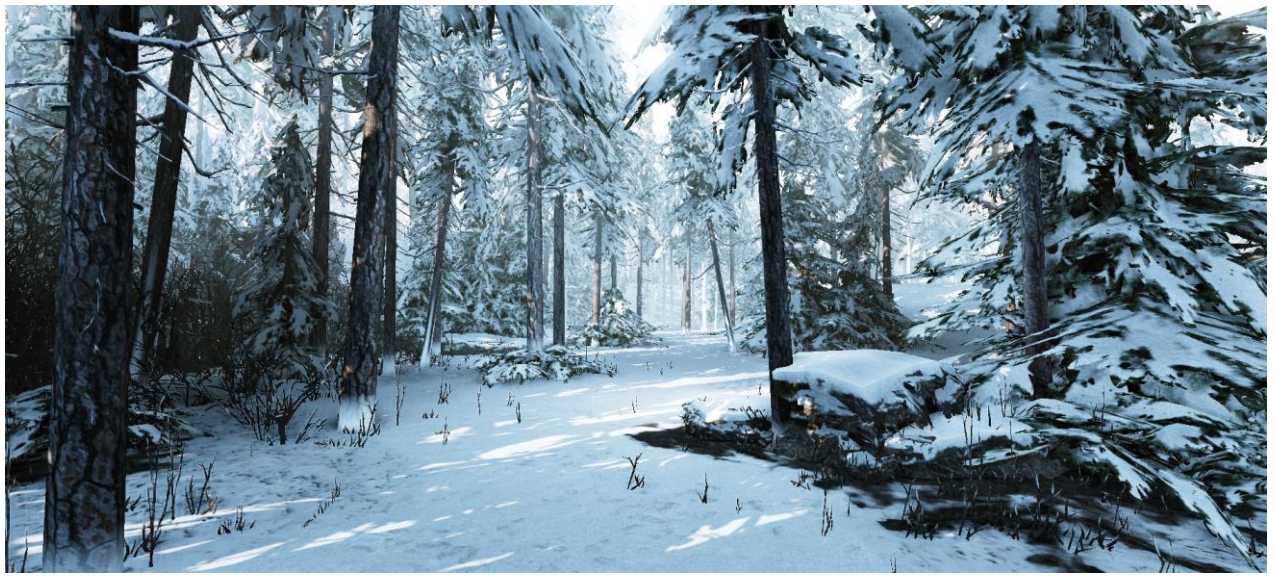
**Overall Accuracy** (ACC): (A+D)/(A+B+C+D)

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Cloud/Snow confusion

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Snow cover under dense forest canopy

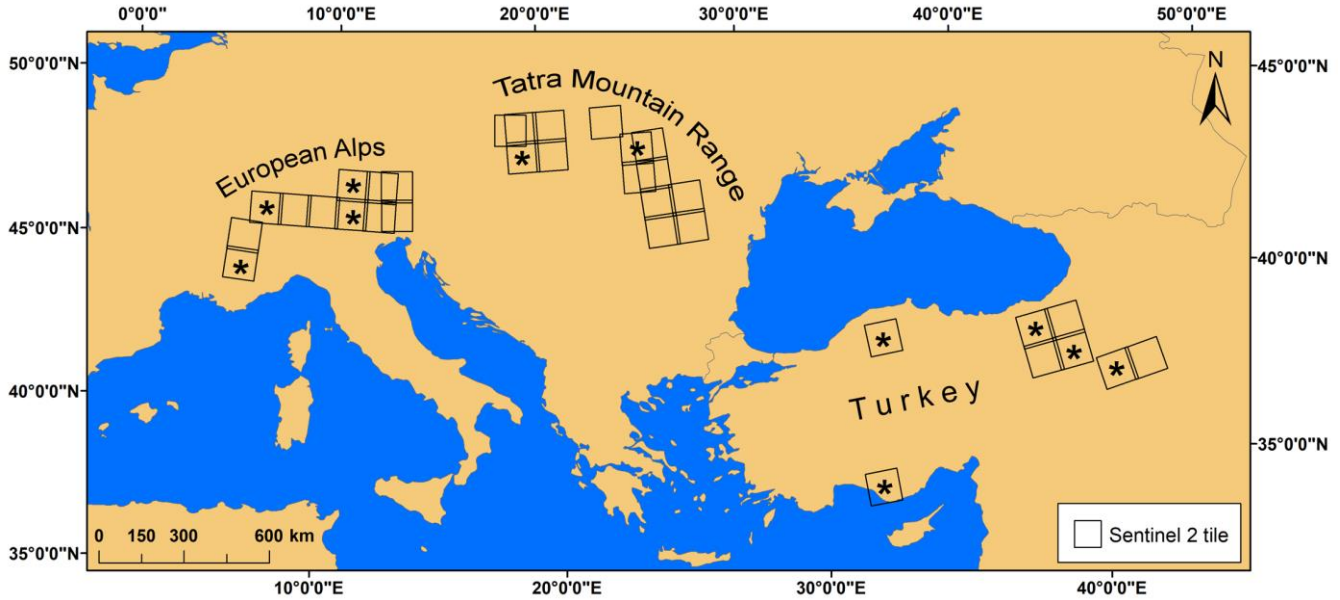


# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Known issues in snow cover retrieval by optical remote sensing at coarse resolution**
  - Variations in illumination conditions over rough mountainous terrains

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

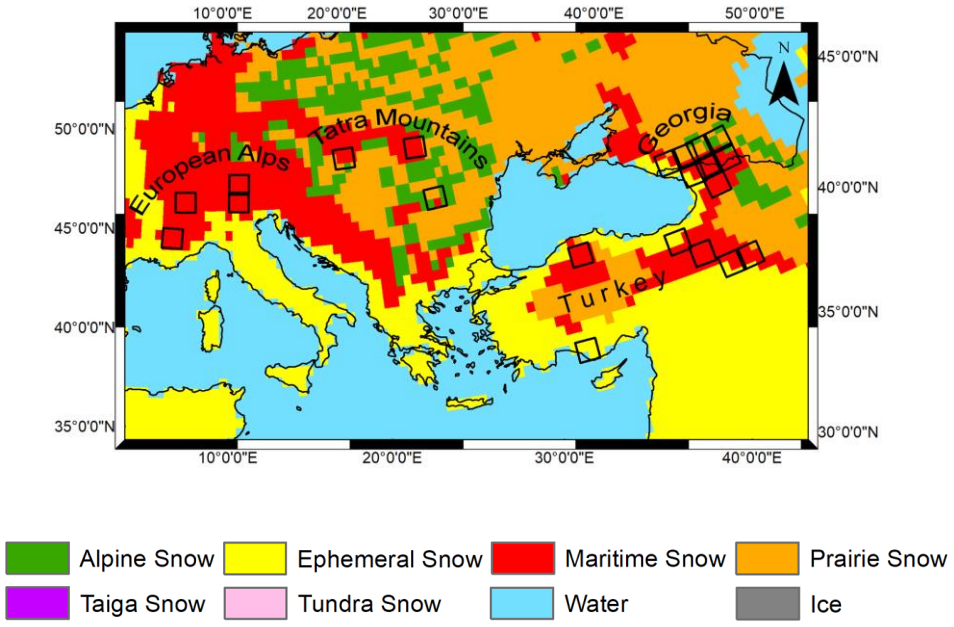
- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**
  - *Multivariate Adaptive Regression Splines* (**MARS**) (Friedman, 1991)
  - Reference data for training from higher resolution **Sentinel 2** imagery

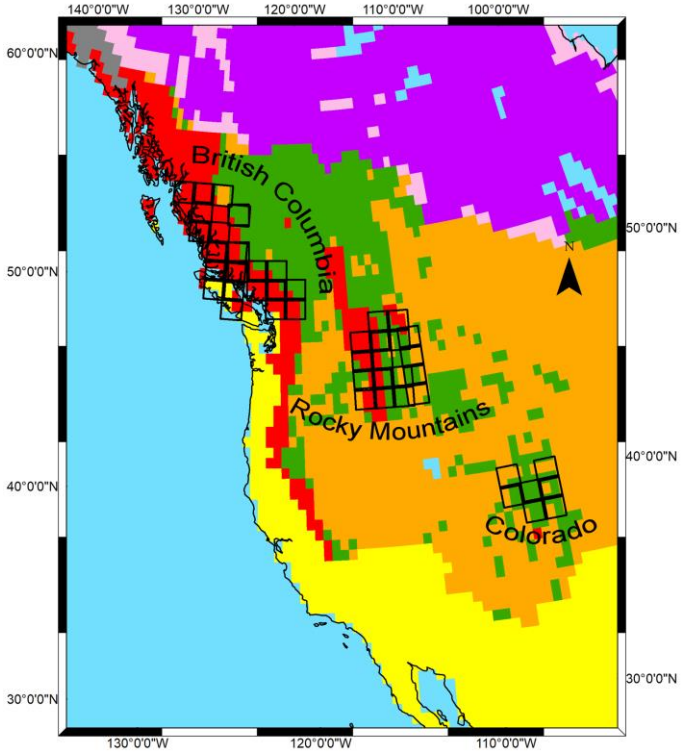


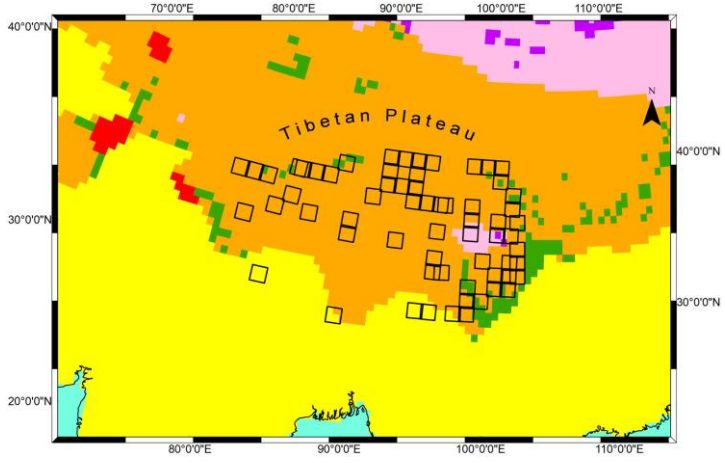
# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**

  – Testing with **reference fSCA maps: Sentinel 2** imagery wrt **Sturm's (1995)** snow cover types



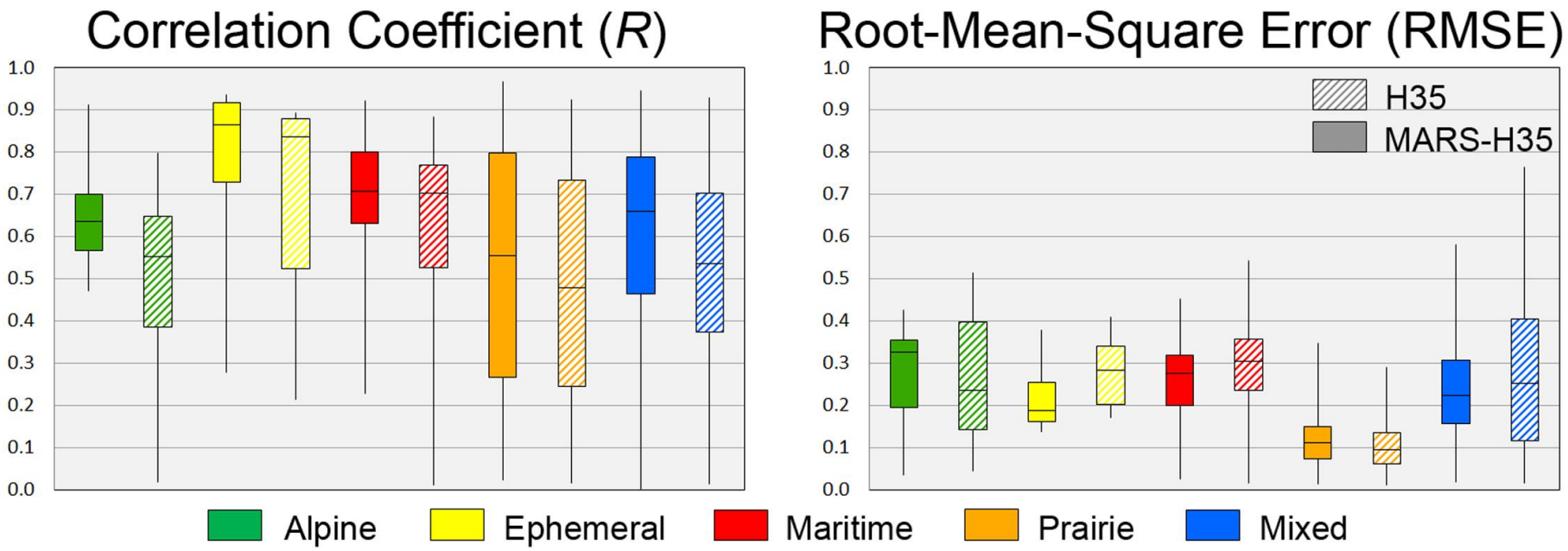




**450 Sentinel 2 images**

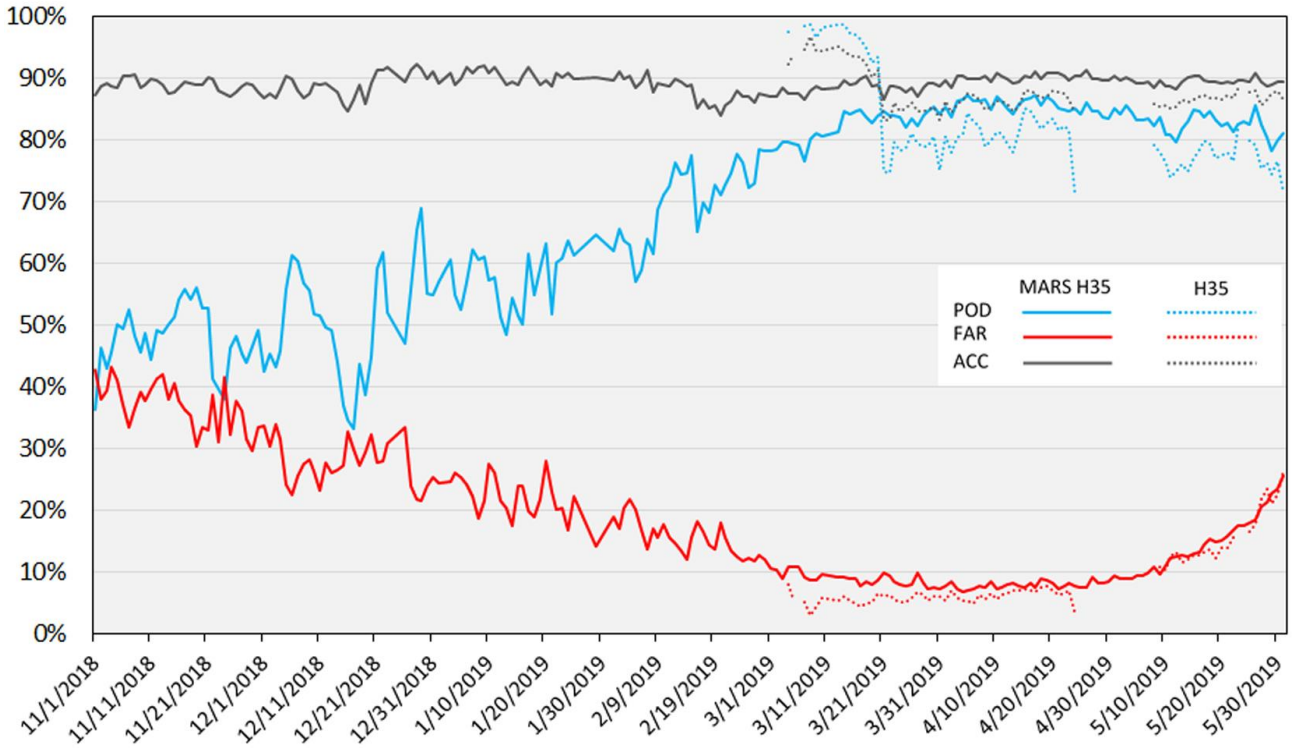
# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**
  - Testing with **reference fSCA maps: Sentinel 2** imagery wrt **Sturm's (1995)** snow cover types



# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

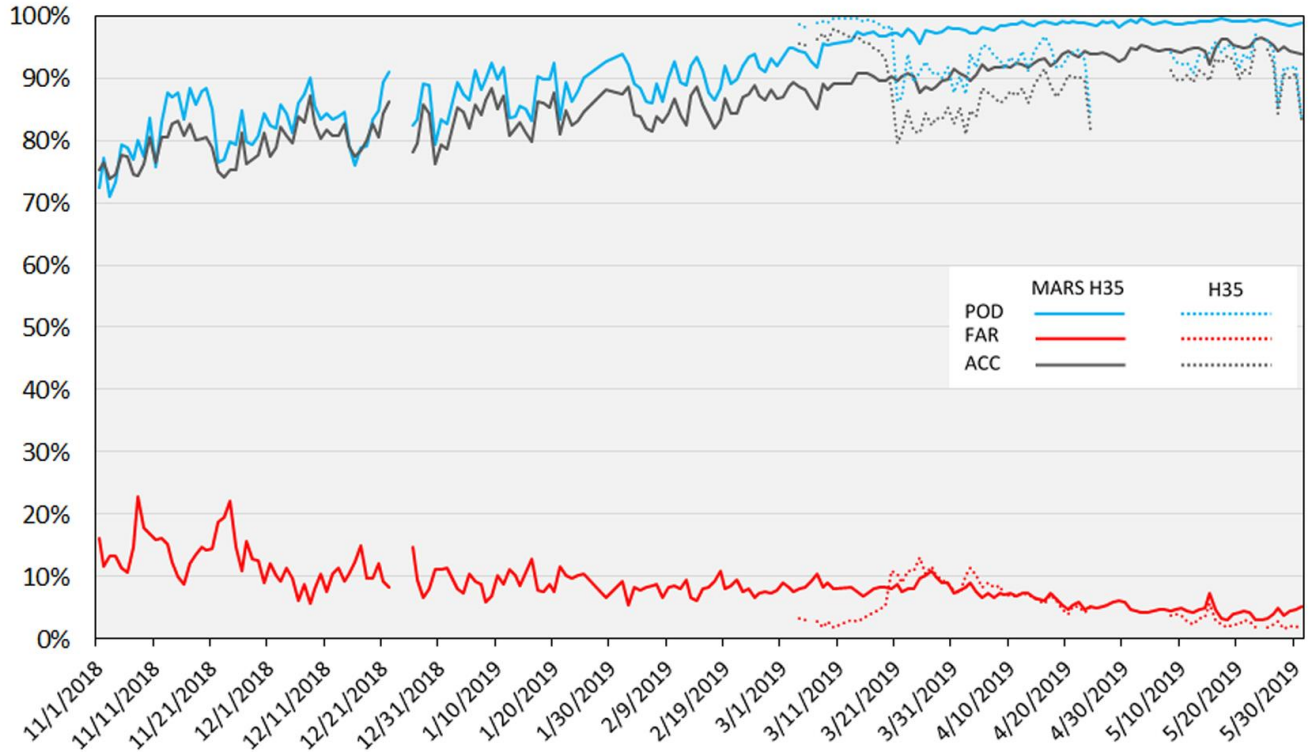
- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**
  - Testing with **ERA5-Land** snow depth data (Northern Hemisphere)



# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**

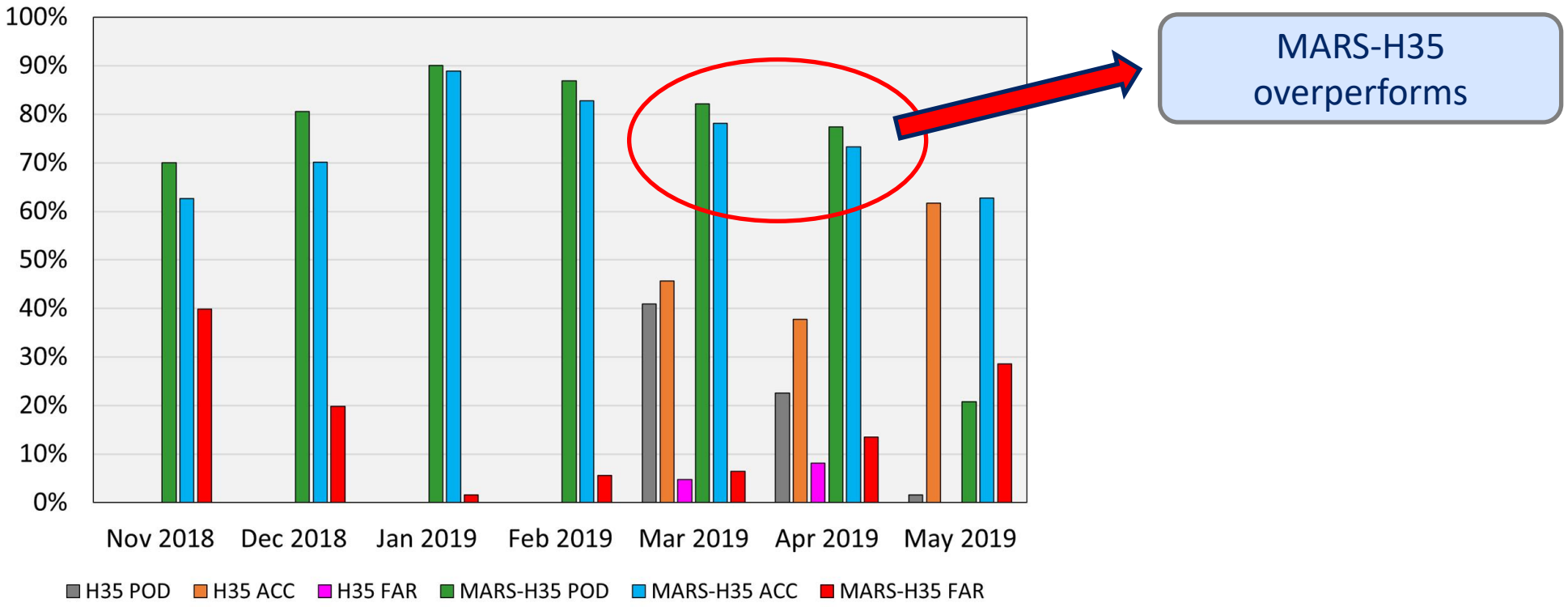
  – Testing with **MODIS MOD10A1 C6 NDSI** data (Northern Hemisphere)



# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **Improving the accuracy of H35 over mountainous terrains by Machine Learning**

  – Testing with **in-situ snow depth** data (Turkey)



# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **H86: Effective Snow Cover by EPS-SG METimage**
  - Successor of H35: Improved version by implementing **Machine Learning** (MARS)
  - Algorithm development and refinement is still in progress

Cycle: Daily
Coverage: Northern Hemisphere
Grid/Projection: Equidistant cylindrical
Resolution: 0.01° x 0.01°
Formats: HDF5, PNG quicklook
Operational status: **In development**

# H35 (SN-OBS-1P) Daily Effective Snow-Covered Area Product

- **References**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  - Sturm, M., Holmgren, J. and Liston, G. E. (1995). A Seasonal Snow Cover Classification System for Local to Global Applications. Journal of Climate, 8, 1261-1283.
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## Thank You...