Sensing and Spatial Modeling for Earth Observation

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EPFL

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Welcome to the SSMEO course!

You will learn foundations in:

- Sensing "metricity"
  - How to <u>convert camera-data into a mapping product</u> of a certain quality?

- Geo-information extraction
  - How to <u>extract information from a geo-rectified image</u> & <u>3D digital model</u>?

- Geostatistical phenomena analysis & modelling
  - How to <u>analyze and model geographically related variables</u> in space and time?

Welcome to the SSMEO course!

▪ This translates into three rough big chapters

1. 3D reconstruction from images
   - How to match images acquired by drones / planes
   - How to create a 3D model
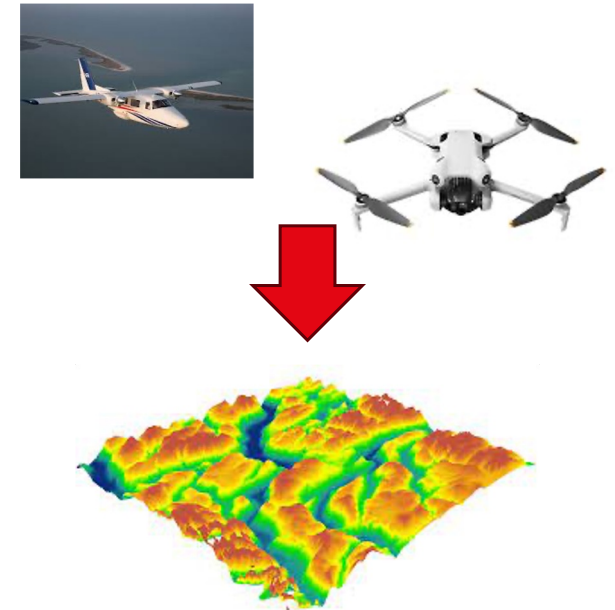
2. Feature extraction and learning
   - How to extract variables of interest from 3D information
   - How to build machine learning models to predict environmental targets

3. Geostatistics
   - How to model spatially correlated processes
   - How to interpolated spatialised measurements

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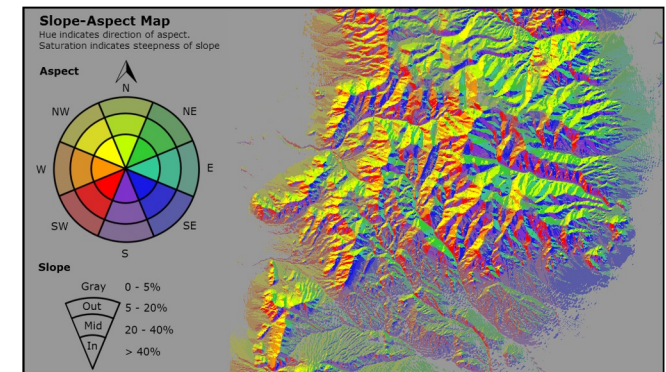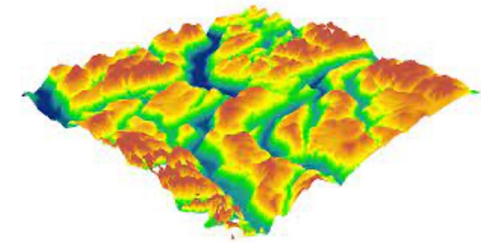1. 3D reconstruction from images
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Slope-Aspect Map
Hue indicates direction of aspect.
Saturation indicates steepness of slope

Aspect

NW — N — NE
W — — E
SW — S — SE

Slope

Gray   0 - 5%
Out   5 - 20%
Mid   20 - 40%
In   > 40%

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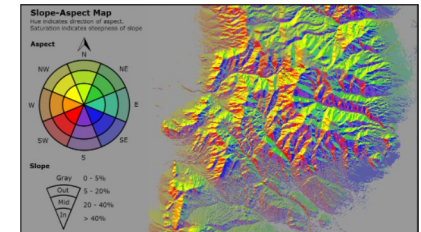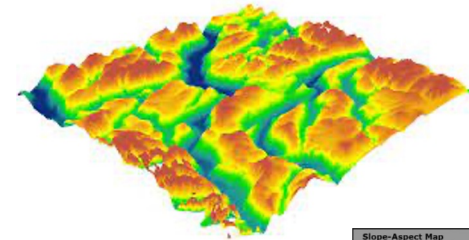1. 3D reconstruction from images
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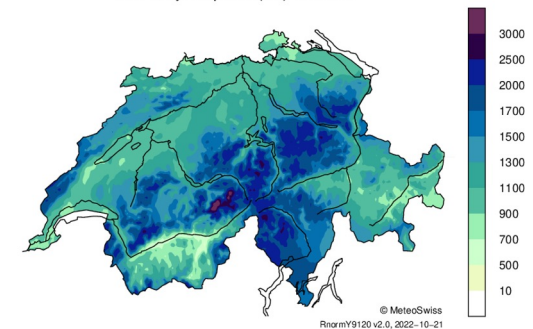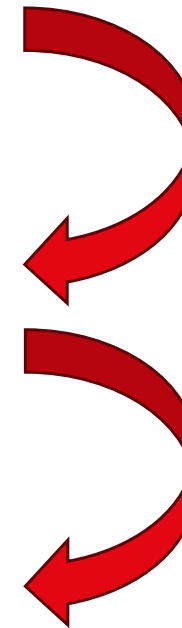2. Feature extraction and learning
   - How to extract variables of interest from 3D information
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3. Geostatistics
   - How to model spatially correlated processes
   - How to interpolated spatialised measurements

Slope-Aspect Map

Mean Yearly Precipitation (mm) 1991–2020

EPFL

D. Tuia. ECEO

Welcome to the SSMEO course!

SSMEO course, 20 February 2025

- The three parts are tightly related, we walk you through the entire processing chain

1. **3D reconstruction from images**
   - How to match images acquired by drones / planes
   - How to create a 3D model

   You need the 3D model to move to this step

2. **Feature extraction and learning**
   - How to extract variables of interest from 3D information
   - How to build machine learning models to predict environmental targets

   You will extend the AI models with geographical explicit approaches

3. **Geostatistics**
   - How to model spatially correlated processes
   - How to interpolated spatialised measurements

Some admin about ENV-408

- Core course

- 5 credits ECTS

- 5h / week,

    ~40%   lectures: Thursday afternoon 14h-16h

    ~60%   exercises (mostly Python-based, a bit of R): Friday morning 9h-12h

- Rooms:
    - INF 119 (here): lectures
    - GR B0 01: computer exercises

About the exercises

- Key for <u>understanding</u> the content of the lectures!

- They follow each other, and often you need the result of one as the input to the next!

- Come <u>prepared</u> and be <u>regular</u>

- Do it <u>yourself</u> & right

- They count for <u>20% of your final grade</u>!

About the exercises (2)

- Tools

  - Python programming, Jupiter Notebooks (parts 1 and 2)

  - R for geostat exercices (part 3)

  - Professional photogrammetry/CV software (part 1)

- The TA-s are there to help and we will provide solutions (in data and/or code) before the following week's one.

Evaluation

- Graded exercises: 20%:
  - Evaluate understanding of exercises

- Final exam: 80%
  - Theoretical exam covering all content

Schedule

Week	lecture	Block	Exact topic	Teacher	(Thursday)	(Friday)
1	20.02.2025		Intro	devis	1	
			Image creation	devis (ex by jan team)	1	3
2	27.02.2025	Images to Ortho-DEM	Keypoint generation & matching	devis	2	3
3	06.03.2025		Orientation - absolute	jan	2	3
4	13.03.2025		Orientation - relative	jan	2	3
5	20.03.2025		Orthophoto and DEM creation	jan	2	3
6	27.03.2025		Features from a DEM	devis	2	Self-study: Catchup with exercises
7	03.04.2025	Machine learning	intro ML	devis	2	3
8	10.04.2025		Regression with linear models, random forest	devis	2	3
9	17.04.2025		General intro - Structural analysis 1	alexis	2	no ex (vacances)
	24.04.2025		EASTER HOLIDAYS			
10	01.05.2025	Geostat	Structural analysis 2	alexis	2	3
11	08.05.2025		Kriging - 1	alexis	2	3
12	15.05.2025		Kriging - 2	alexis	2	3
13	22.05.2025		Kriging - 3	alexis	2	3
14	29.05.2025			alexis	no course (Ascension)	

Questions?