DestinE DL Biodiversity Use Case

Matti Mõttus, VTT Technical Research Centre of Finland
Otso Ovaskainen, University of Jyväskylä

20/10/2024 **VTT – beyond the obvious**

Destination Earth
Funded by the European Union
Implemented by ECMWF esa EUMETSAT

Biodiversity Digital Twin/Use Case

Task: biodiversity twinning in Finnish forests

1. Generic Digital Twin of forest
2. Representation of biodiversity in a forest

In collaboration between

- VTT Technical Research Centre of Finland
- University of Jyväskylä (prof. Otso

EUMETSAT

Implemented under contract by EUMETSAT with background from earlier activities:

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BIODT
biodiversitydigitaltwin

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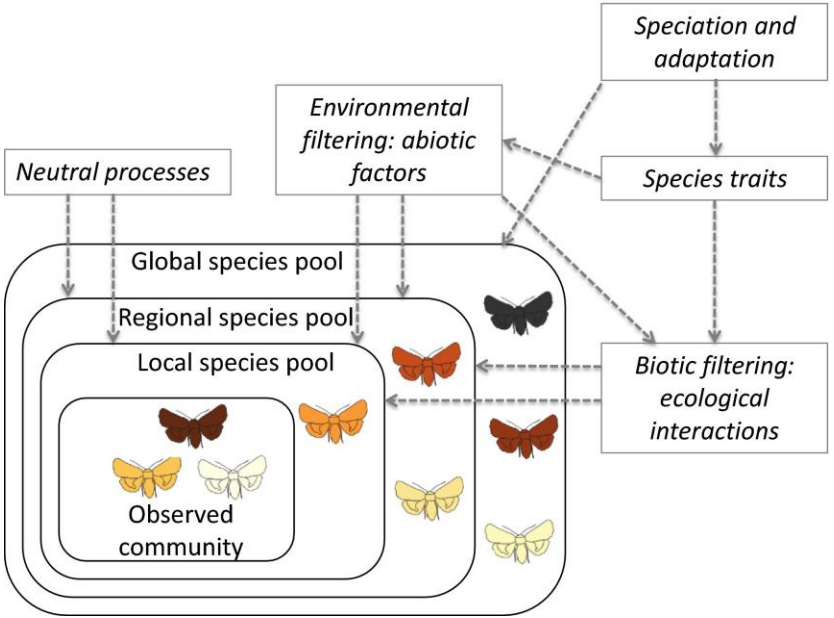
Forest DTEP

esa

Hierarchical Modelling of Species Communities

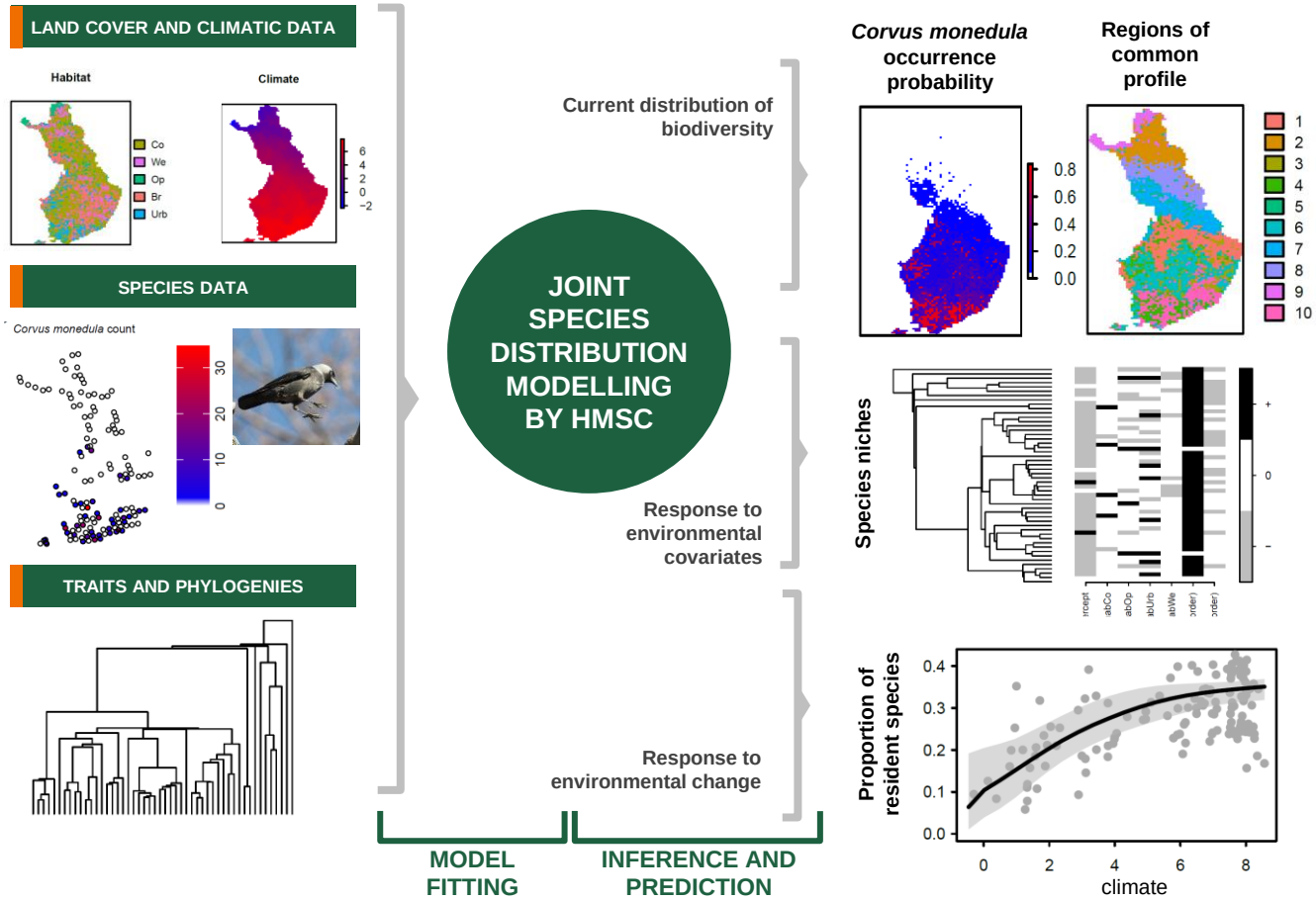
- A flexible framework for Joint Species Distribution Modelling (JSDMs)
- Relates species occurrences or abundances to environmental covariates, species traits and phylogenetic relationships
- Allows to estimate community level responses as well capture biotic interactions and the influence of missing covariates
- Available as HMSC R package



Ovaskainen et al. 2017: How to make more out of community data? A conceptual framework and its implementation as models and software. Ecology Letters 5, 561–576

HMSC input and output

EXAMPLE DATA ON 50 MOST COMMON SPECIES OF FINNISH BIRDS



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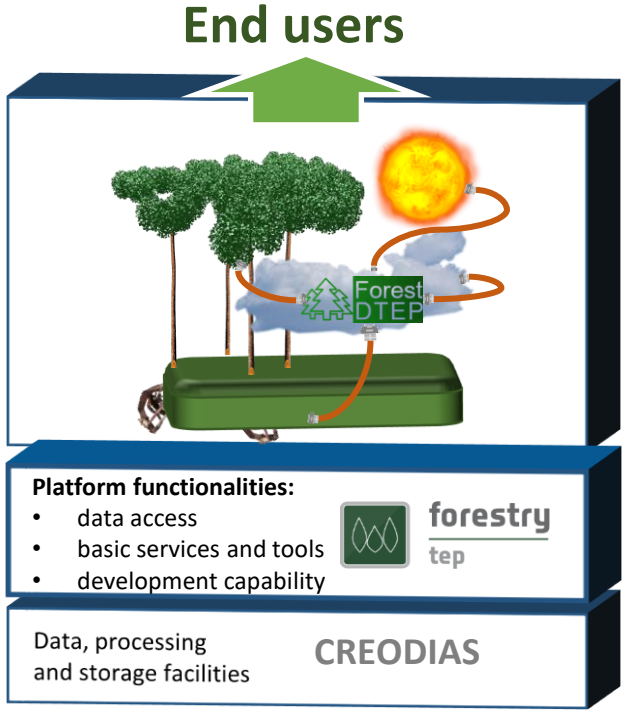
Forest Digital Twin Earth Precursor, 2020 – 2021

A **specialized Digital Twin of the Earth** to provide Earth system reconstruction

- for variables not directly accessible by land surface models, e.g., detailed radiation balance;
- at resolutions not possible using only EO data and generic land surface models (e.g., forest structure);
- providing unique process-based understanding on the circulation of carbon and water among the different forest elements (soil, canopy components);
- Implemented on a cloud platform close to data with a web interface and API access.
- Driven by the needs of users in the forest[ry] sector

Precursor funded by ESA 2020–2021



ARTISDIG project 2022–2024

Suomen Akatemia
Finlands Akademi
Research Council of Finland

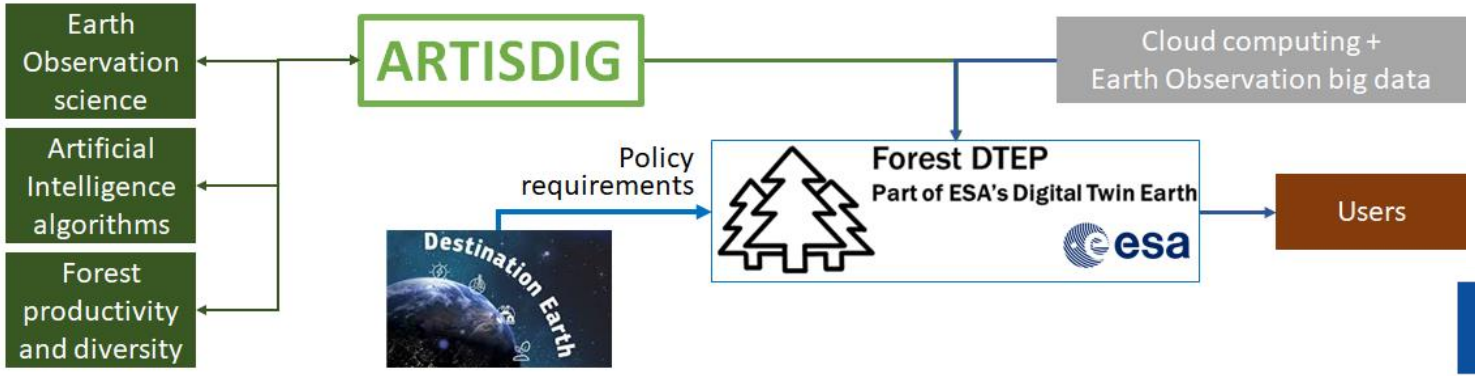
VTT

Artificial Intelligence for Twinning the Diversity, Productivity and Spectral Signature of Forests: to develop, implement and demonstrate the Earth observation and Earth system science required to integrate boreal forest biodiversity in the **Digital Twin of the Earth (DTE)**.

- making heavy use of Artificial Intelligence (AI)
- with a currently focuses on carbon science, i.e., mapping forest area, growing stock, productivity, and biomass.

To support actions on preserving forests as a natural environment, the digital twin needs to account also for the variation in its key input variables and the key biodiversity variables

- many of Essential Biodiversity Variables (EBVs) already part of Forest Digital Twin
- not surprising as biodiversity is strongly linked with forest productivity.



Luke
NATURAL RESOURCES INSTITUTE FINLAND

Aalto University

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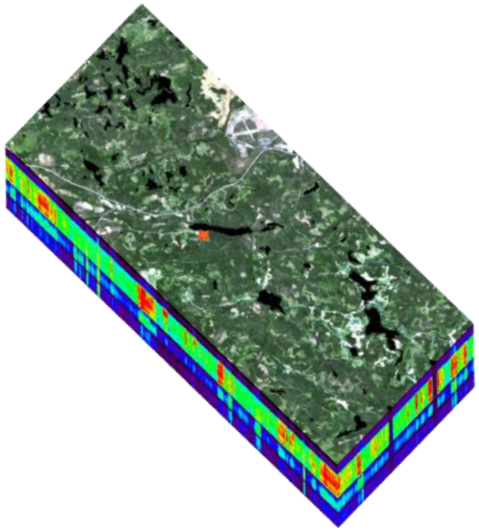
NextGenerationEU

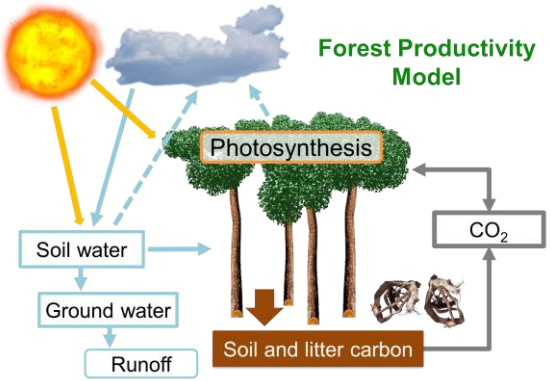
Forest Digital Twin

In:

- Sentinel-2: optical multispectral data
- Forestry field data and national data bases
- weather data and climate scenarios

ON DEDL: ready-made forest maps for fixed years (e.g., via Forestry TEP)





TO BE RUN ON DEDL

PRELES (light use efficiency model)
- inputs: Solar radiation, temperature, VPD, precipitation, LAI
- outputs: GPP, ET, NEE, …

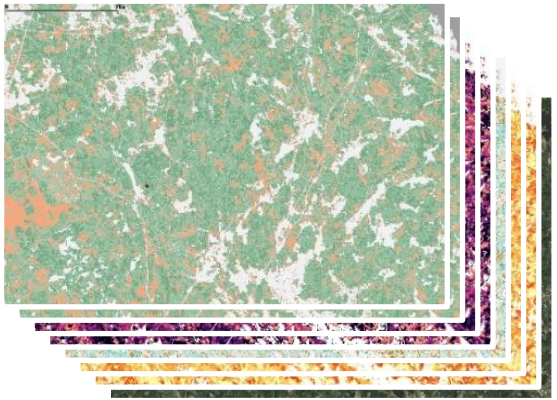
CROBAS (tree growth model)
- Inputs: stand variables (DBH, h, density, species)
- outputs: sand variables, biomasses, litterfall, …

YASSO15 (soil carbon model):
- inputs: litterfall, woody debris
- outputs: soil carbon, heterotrophic respiration

Out: Dynamic forest maps
- Above ground biomass (AGB)
- Below ground biomass
- Net Ecosystem Exchange
- Gross Primary Production
- Growing stock volume
- *etc.*

At very high resolution (Sentinel-2)

ON DEDL: to be used by the biodiversity computations



Forest biodiversity on DestinE Data Lake

- Implementation of forest models on DL using the standardized Earth Observation Exploitation Platform Common Architecture (EOEPCA)
- Forest data: publicly available Finnish multi-source NFI
- HMSC predictions for bird species suing forest and climate data
- Work in progress
  - To be finished by Christmas

Future developments:

- Integrating the Forest DT with Climate DT (with CSC)
- Implementing Forest DT on the DestinE Core User Platform (DESP)
- See also our poster!

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