Three-Tiered LU Approach in LOTOS-EUROS

Cam aera GA m eeting June 2025

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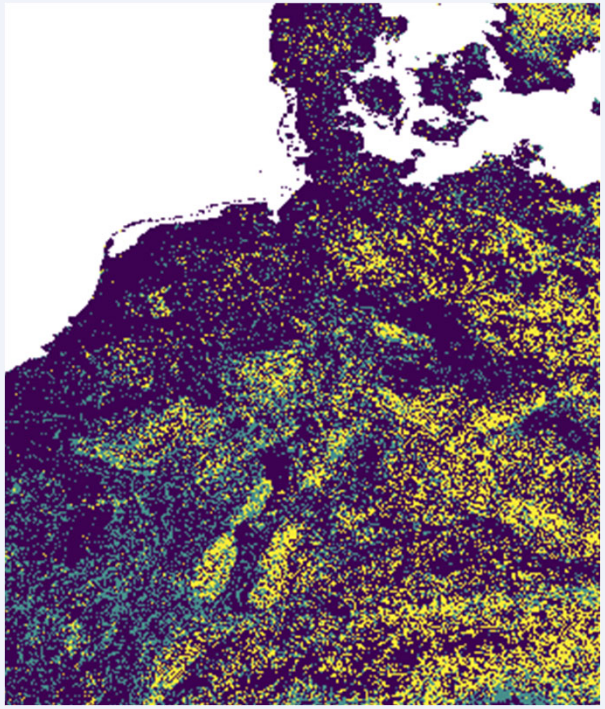
Work performed within WP5/6

Detailing spatial and temporal resolutions

1. Extended LOTOS-EUROS with 3-tiered Land Use Approach
2. Adapted deposition model parameters per vegetation type
3. Investigated effect of adapted LAI and Growing Season (more on this in Hannah's presentation)
4. Investigated effect of adapted tree species & height in German forests
5. Provided data for 0D aerosol deposition model comparison

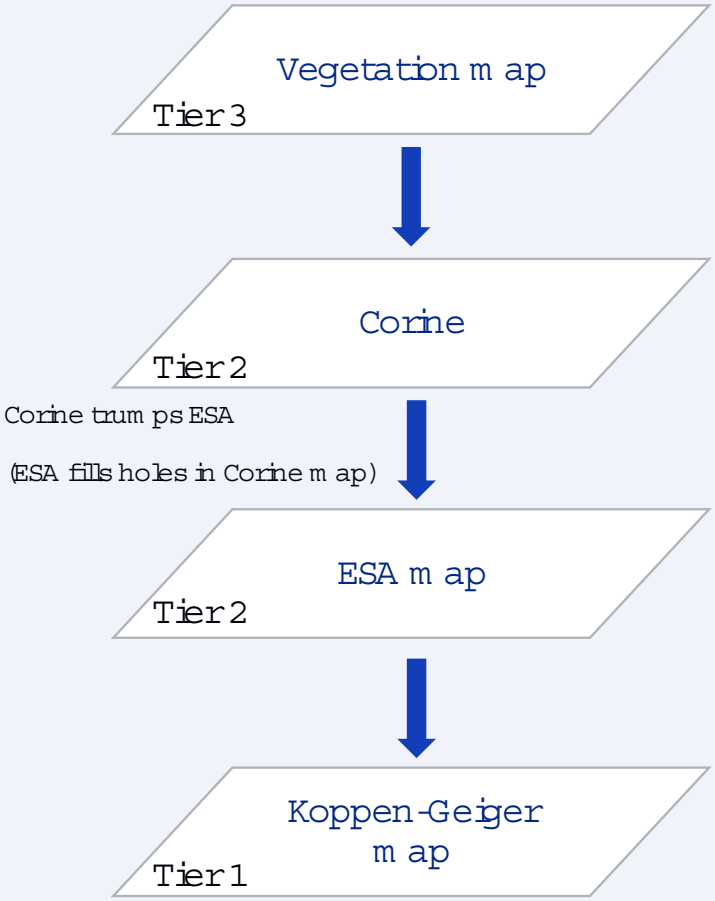
Most slides focus on Germany because of input data availability at the time



Three-tiered Land Use Approach in LOTOS-EUROS

- The Land Use Model in LOTOS-EUROS affects deposition of gases and particles, and biogenic emissions
- Land Use Model used to be very coarse:
  - Only 9 different land use classes
  - No differentiation in climate zones & vegetation types

- Three-Tiered Land Use Approach → LU map much more detailed
  - Tier 1: Climate zone
  - Tier 2: Land Use Class (e.g., arable, urban, etc.)
  - Tier 3: Vegetation Type

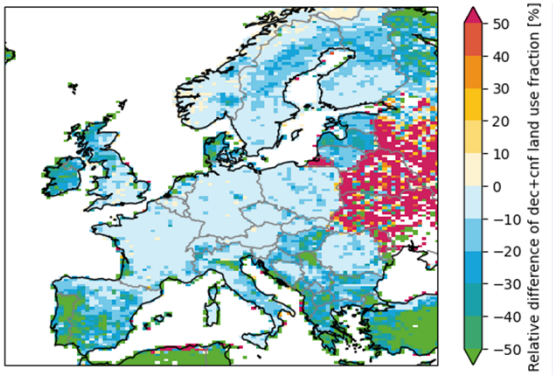


Effects of change to 3-TLU Approach

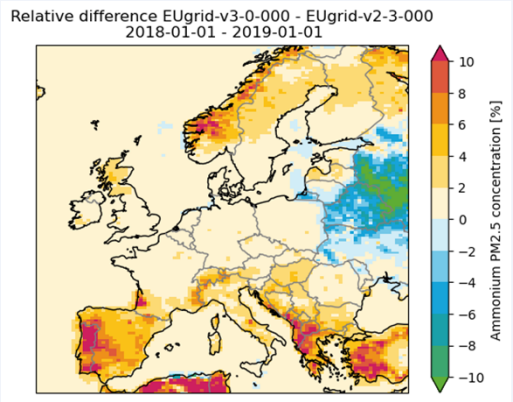
- Changes to the LU map:

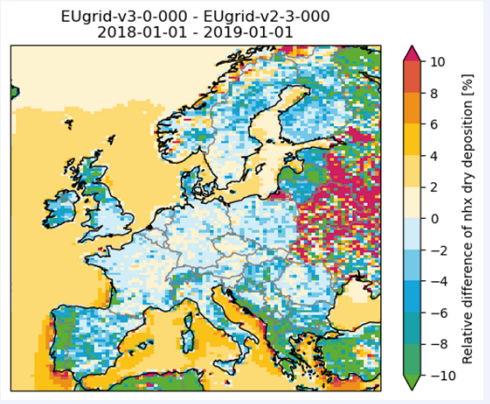
Domain	V2.3	V3.0	Remark
Outside EU	ESA 2000, EEA 2000	ESA 2015	Belarus, Ukraine, and parts of west Russia are defined by ESA2015
Water	Specific waterbody file	Corine 2018	Only visible at coastline
Europe	Corine 2018	Corine 2018	Translation to model classes changed

- Most affected are:
  - Forest SE of EU, due to update to ESA2015 (arable & crops → forest)
  - Coastline & some waterbodies → sea salt emissions & deposition
  - Mediterranean area: updated stomatal parameters
  - Moors, heathland & Sparsely vegetated areas → semi-natural class
    - cover 40% in Norway



Relative difference forest LU class

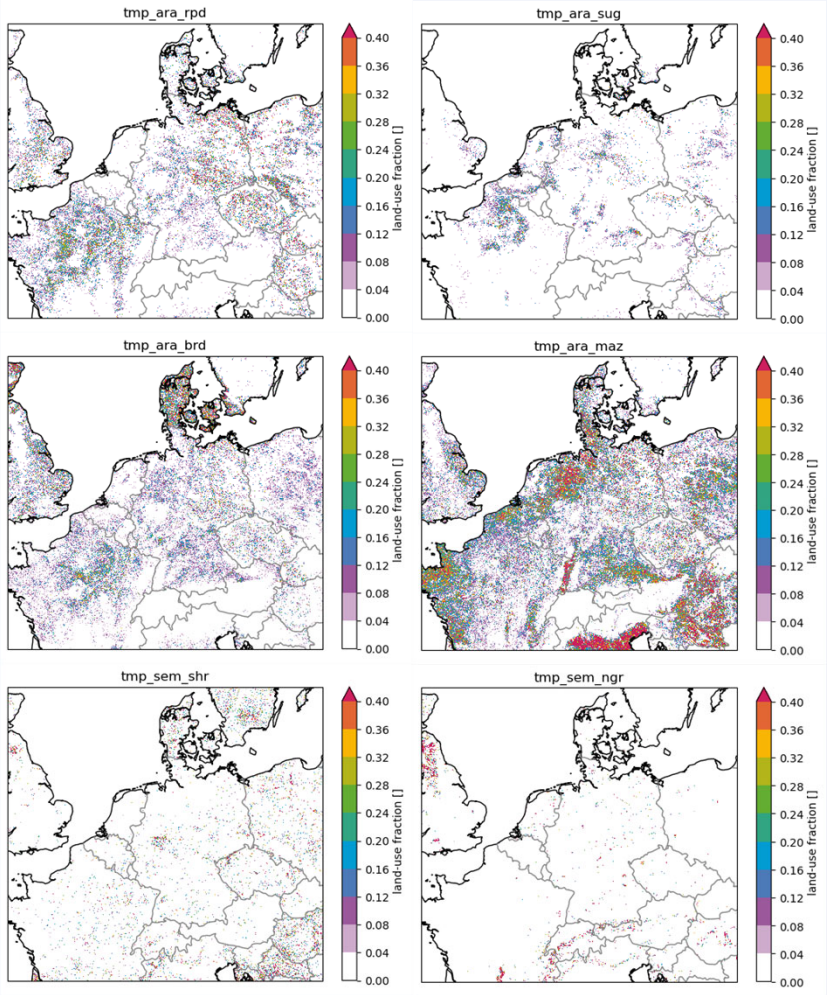




Relative difference of NH4 concentration and deposition flux

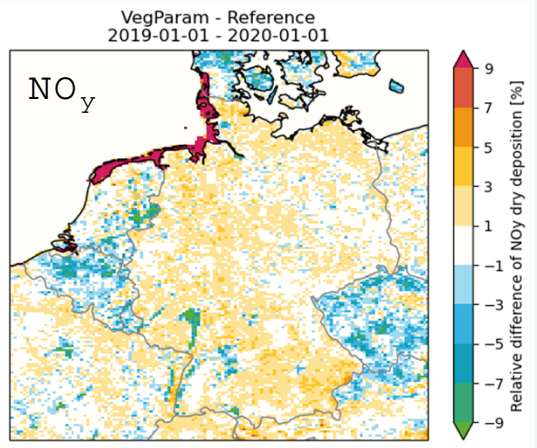
Updated vegetation parameters

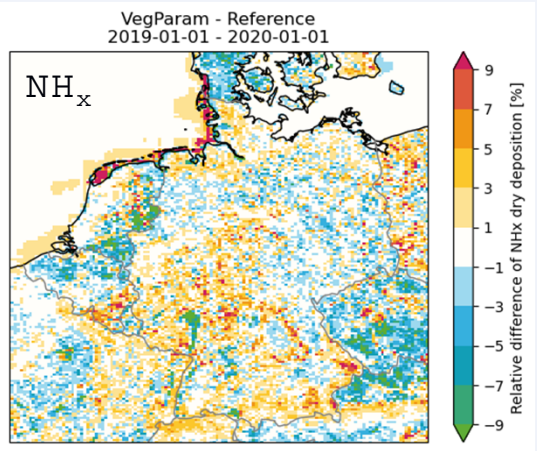
- Updated parameters (based on literature):
  - the full-grown vegetation height h,
  - Stomatal parameters like
    - temperature dependence $T_{opt}, T_{min}, T_{max}$
    - vapor pressure dependence vpd_{min}, vpd_{max}
    - the maximum stomatal conductance $g_{s,max}$
  - timing of the default growing season
  - maximal leaf area index LAI_{max}
- For 9 most prominent vegetation types on arable land (ara) and semi natural land (sem)



Effect of updated vegetation parameters

- Arable land: Maize, sunflower & fodder crops are affected most →
  - 5 - 10% higher reactive N-deposition flux over a year
  - Other crops: changes compensate each other
- Semi-natural land: Natural grassland affected most →
  - 4% lower reactive N-deposition over a year
- More NO_y deposition throughout country
  - Relatively constant NO_2 concentration profile → higher LAI, more deposition
- NH_x shows a spatially inhomogeneous pattern
  - Ammonia peak in spring due to manure application → maize & rapeseed LAI curve shift
  - Lower deposition → transport over longer distances



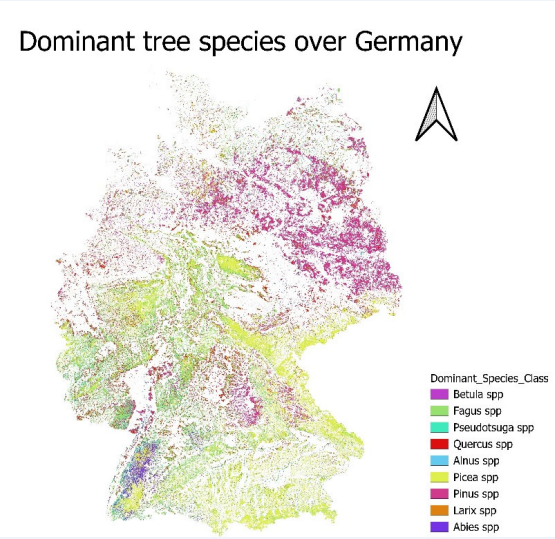


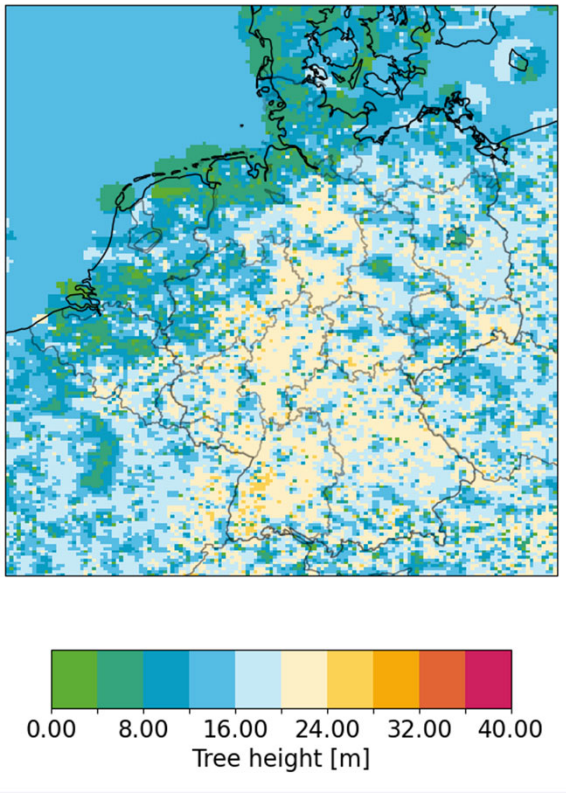
Adapted tree species and height

- Sentinel1/2 – based data by Blickensdörfer et al. (2024) → tree species map
- Turubanova et al. (2023) Landsat data + ALS + GEDI → tree height map
- Default value is 20 meters in the reference case
- Test case:
  - Lower trees in North Germany
    Mixed tree types (e.g., Oak, Spruce, 4-8 m)

    → Expect lower deposition in forests in the North
  - Higher trees in South-West Germany (Schwartzwald)
    (e.g., Beech, Douglas Fir, 25 m and up)

    → Expect higher deposition in Schwartzwald



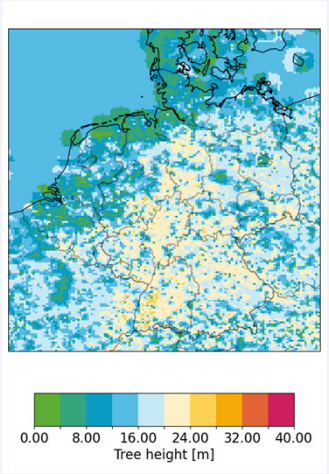


Effect of adapted tree species & height on deposition

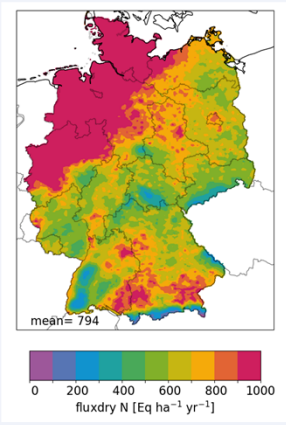
- Land use specific dry deposition flux
- Lower country average flux
- Over 10% decrease in north-west of Germany
- Increases of ~3% in central Germany

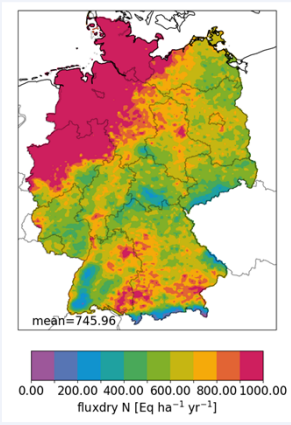
Total deposition	Ref eq N ha^{-1} yr^{-1}	Tree eq N ha^{-1} yr^{-1}	Ratio Tree/Ref -
Broadleaf	626	600	0.958
Coniferous	794	746	0.940

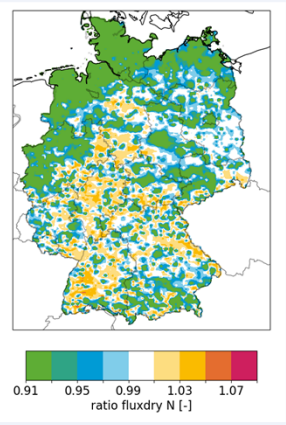
- Increased spatial variability of deposition
- More realistic description of local tree height



Reference | Tree height update | Ratio Tree/Ref







Current & future work

- Implementing and testing the improved deposition module in IFS (Task 6.3)

- Further development and evaluation of LAI parametrisation in deposition model
  - Location dependence?
  - Seasonal influence (e.g., dry vs wet years)?
- Development towards dynamic emissions (e.g., meteo dependence)