WG SOILVEG AGENDA

- Room E0.A.31, 21th March, 13:00 to 14:00
- The impact of afforestation on the diurnal cycles of temperature and turbulent heat fluxes (Marcus Breil)
- Sensitivity of mid-latitude temperature to albedo parameterization in the regional climate model COSMO-CLM linked to extreme land use changes (Merja Tölle)
- Effects of deforestation and afforestation on regional weather conditions (Ekaterina Tatarinovich et al)
- Land surface data preprocessing and analysis (Mingyue Zhang)

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Sensitivity of temperature to albedo parameterization in COSMO-CLM linked to extreme land use changes

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WG soilveg ICCARUS 2019

Motivation and Objectives

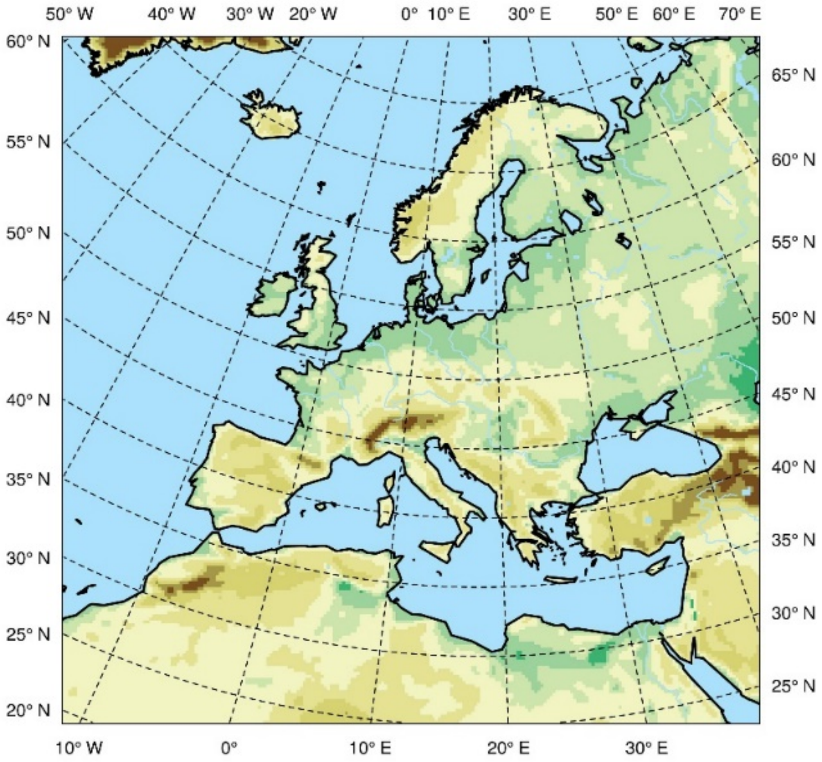
- Magnitude, distributional extent, and sign of afforestation on temperature varies between models (Pitman et al. 2009).
- Consensus about the impact of land cover change on climate in winter by the snow-masking effect in high latitudes (Bonan et al. 1992).
- High uncertainties occur in mid and southern Europe especially for summer, where the forest proportion is relatively small.
- Climatic extent of afforestation depends on the ratio between the increased net shortwave radiation and the increased aerodynamic roughness or evapotranspiration of forest.
- Ratio depends on the used regional climate model and its model uncertainties.

- Test the hypothesis that model uncertainties are higher than the potential impact of land cover change.
- Compare regional climate response due to different albedo parameterizations with impact of extreme land use change scenarios in the regional climate model COSMO-CLM.
- Extreme land use change scenarios (de-/af-forestation) help to estimate the maximal impact and elucidate processes.

Model set-up

	Simulation
Model	COSMO5.0-CLM9
Forcing	ERA-Interim 0.75° (Dee et al. 2011) 6 hr
Time period	1986-2015 with spin-up starting 1979
Land use class	MODIS 0.5° (Lawrence and Chase 2007)
Soiltype	FAO-DSMW 5´ (FAO 2003)
Aerosol	Tanré et al. (1999)
Orography	ASTER 1´´ (NASA 2015)
Soil temperature	CRU 0.5° UEA
Horizontal resolution	0.44° ~ 50 km
Atmos. levels, time step	40, 300 s
Domain	106 x 103 grid points, EURO-CORDEX
Time integration scheme	Runge-Kutta
Convection scheme	Tiedtke scheme
Configuration	EURO-CORDEX (Kotlarski et al. 2014)

EUR044 Domain



Experiment design

- Experiments:
  Bare soil fraction is common to both maps,
  desert area is conserved,
  shrub and crop not onsidered.

- Results:
  winter and summer period,
  differences
  (Δ = Experiment - Evaluation)

- Special attention given to mid- and southern Europe in summer.

Experiment name	Description	Land use/cover change forcing	Albedo
FOREST1	Maximized forest cover	Static map of potential forest (break down forest types) MODIS 0.5° (Lawrence and Chase, 2007)	Standard operational
FOREST2	Maximized forest cover	Static map of potential forest (break down forest types) MODIS 0.5° (Lawrence and Chase, 2007)	Modified by individual albedo for grass, evergreen/deciduous forest
FOREST3	Maximized forest cover	Static map of potential forest (break down forest types) MODIS 0.5° (Lawrence and Chase, 2007)	Modified by individual albedo for grass, evergreen/deciduous forest NO soil moisture dependency
GRASS	No forest, only grasses	Grassland only static map	Standard operational
EVALUATION	Current land use	MODIS 0.5° (Lawrence and Chase, 2007)	Standard operational

Solar albedo parameterization

- FOREST1, GRASS, EVALUATION (operational albedo):

$$\alpha = f_s \alpha_s + (1 - f_s) (f_v \alpha_v + (1 - f_v) \alpha_{so}(st, sm))$$

- FOREST2, FOREST3 additionally use for a_v:

$$\alpha_v = f_{ve} \alpha_{ve} + f_{vd} \alpha_{vd} + (1 - f_{ve} - f_{vd}) \alpha_{vg}$$

- Difference of FOREST3 to FOREST2:

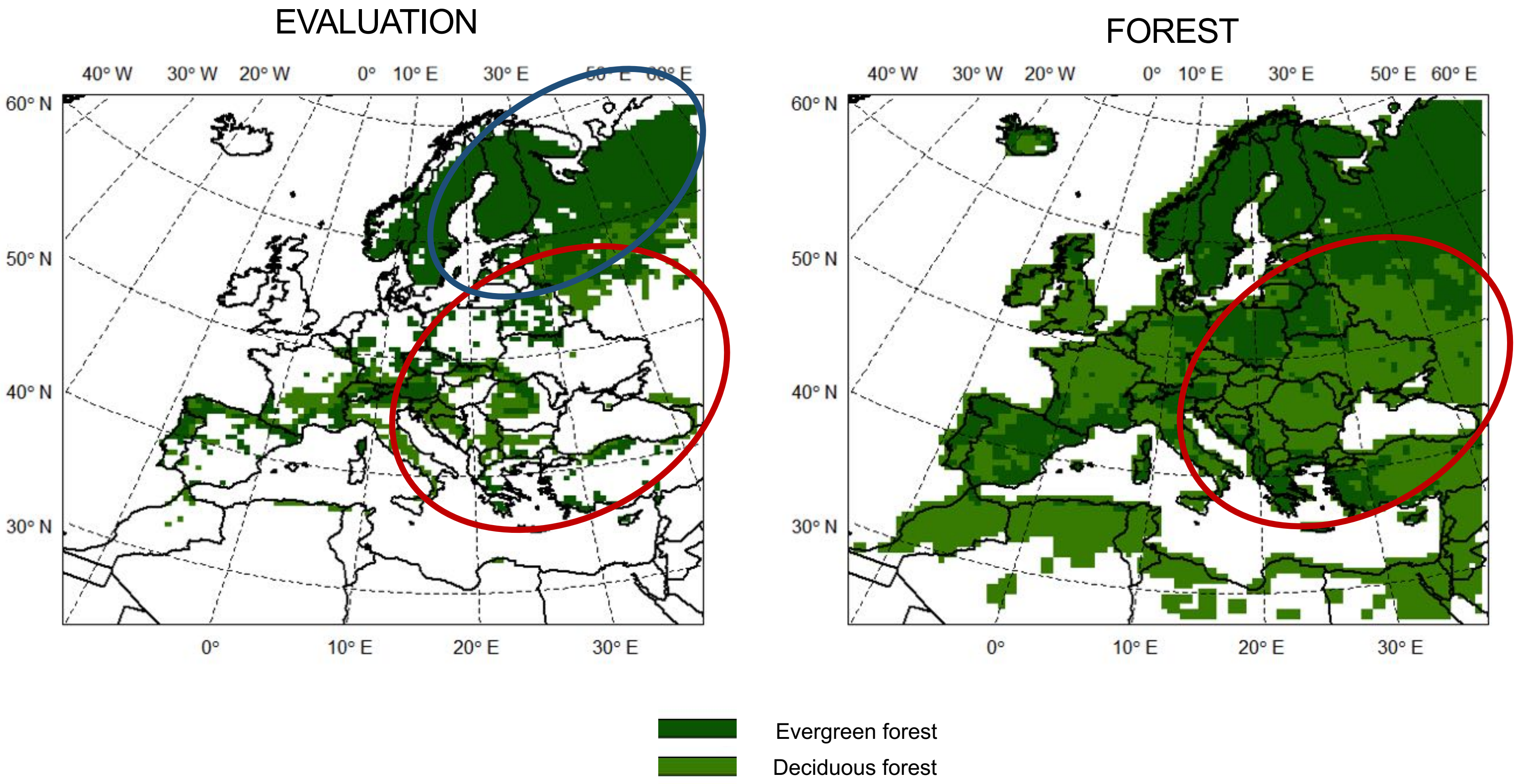
$$\alpha_{so}(st, sm)$$

f_s , f_v , f_{ve} , f_{vd} , $\alpha_v(0.15)$:
area fraction of snow, vegetation, evergreen and deciduous vegetation, albedo of vegetation

α_s , α_{so}, $\alpha_{ve}(0.1)$, $\alpha_{vd}(0.15)$, $\alpha_{vg}(0.2)$:
albedo of snow, soil, evergreen and deciduous vegetation, grass

st: soil type
sm: soil moisture

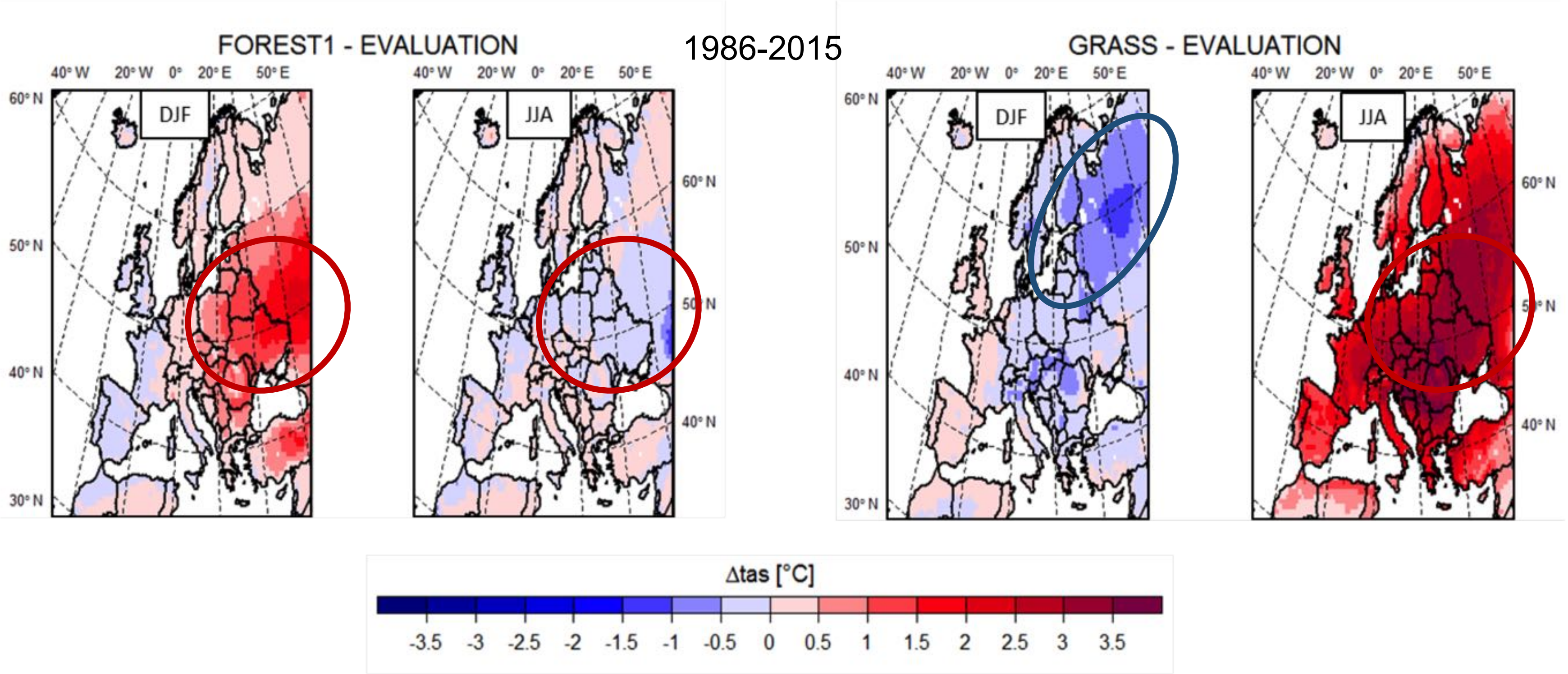
Forest coverage



- Forest coverage in a grid > 50% is displayed.

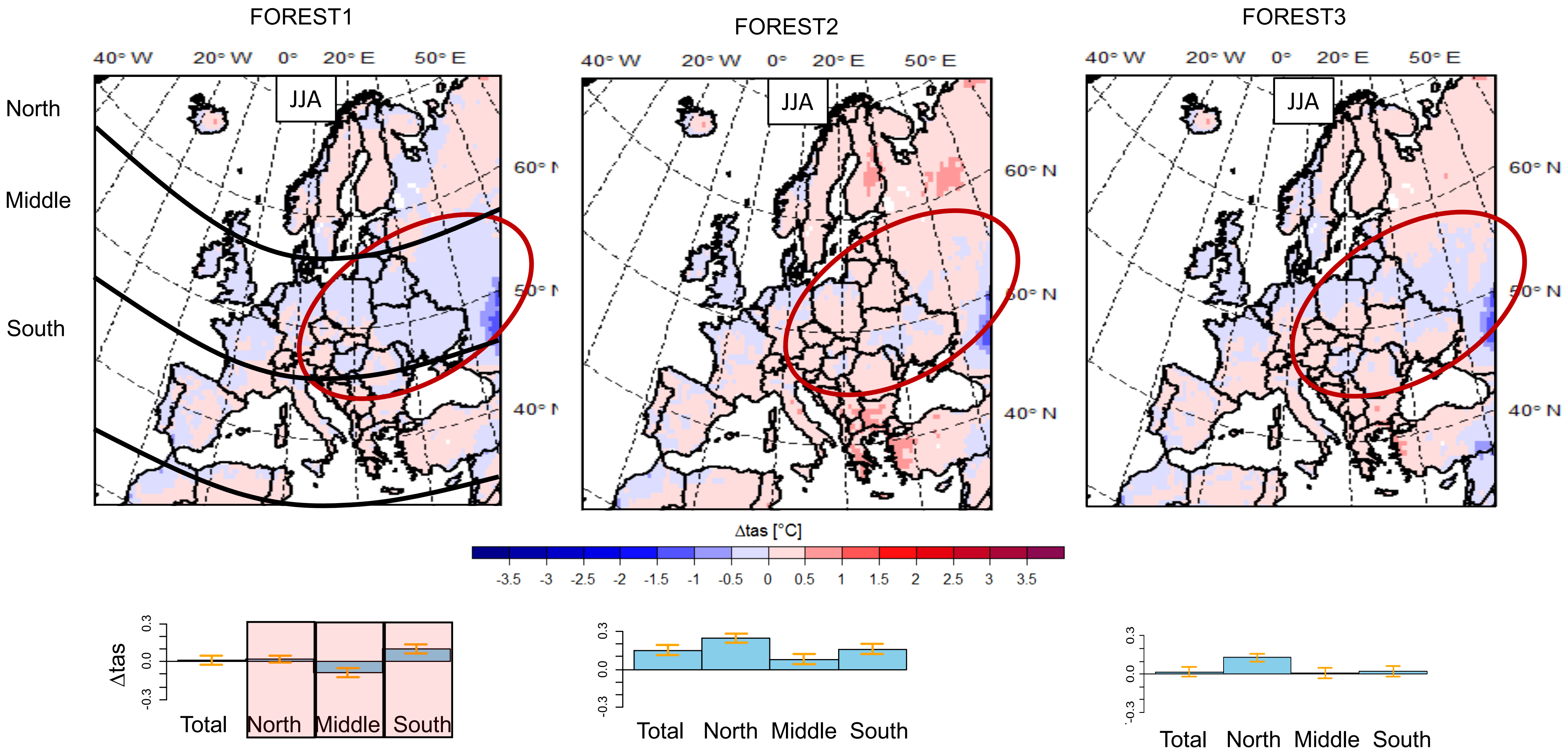
Changes in near-surface temperature

Experiment	Δtas [°C] (winter/summer)
GRASS	-0.19 / 1.6
FOREST1	0.4 / 0.012
FOREST2	0.42 / 0.153
FOREST3	0.27 / 0.017



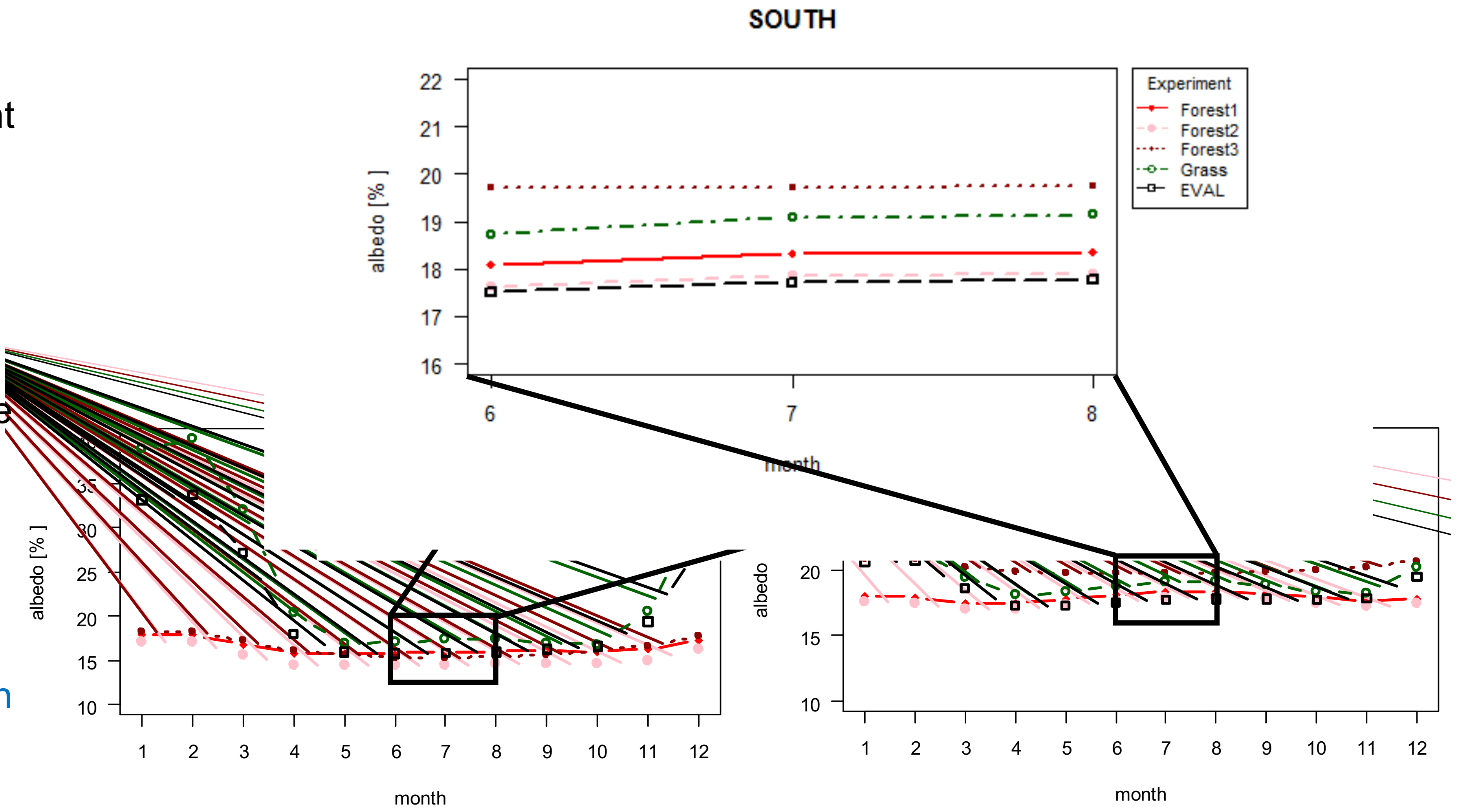
Tölle et al. 2018

Changes in summer temperature



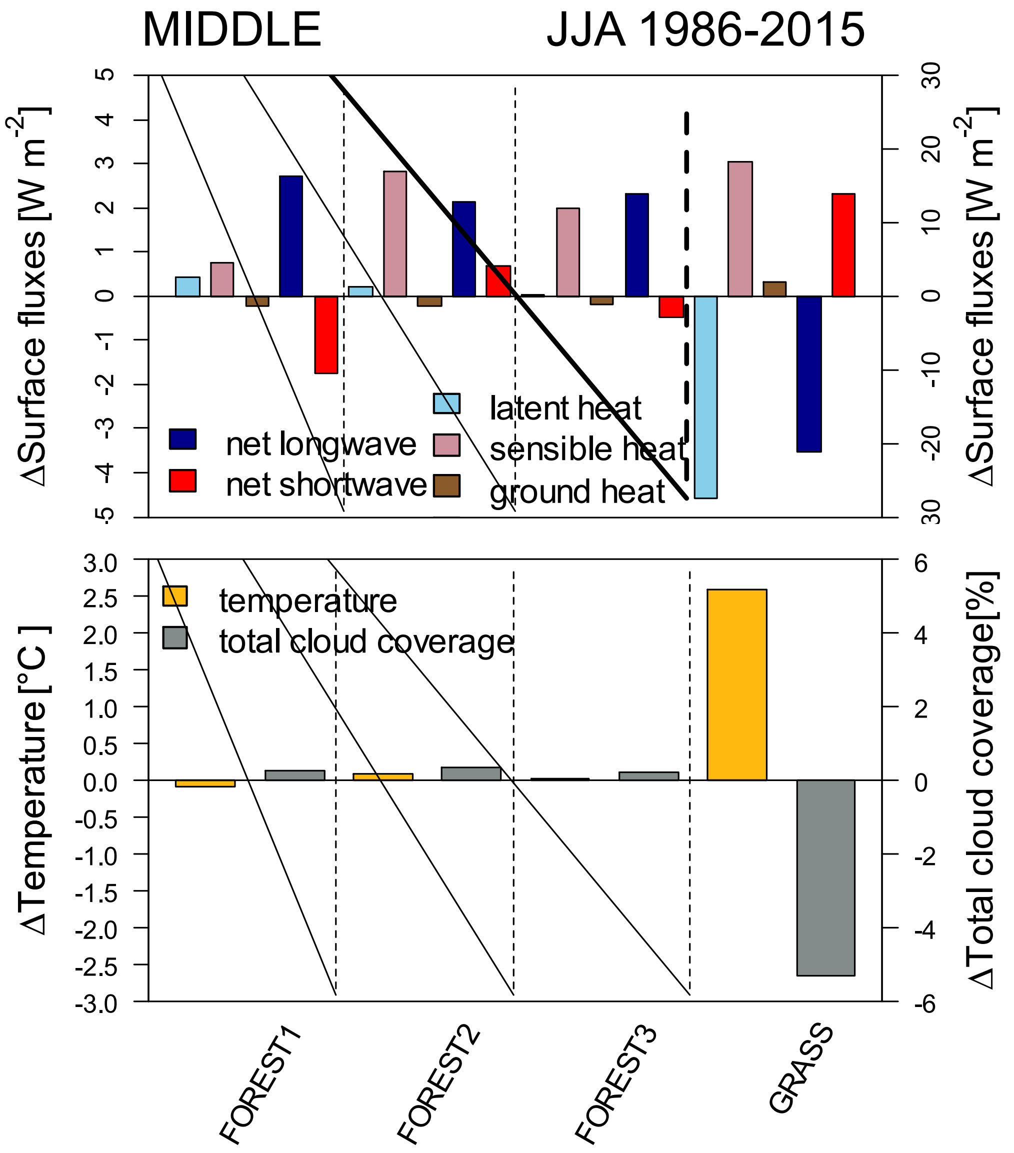
Seasonal changes in albedo

- Winter: major determinant is snow masking effect.
- Summer: albedo differences due to different vegetation covers.
- And to a minor extent due to the specified albedo parameterization in the model.
- Except for SOUTH, where albedo parameterization is a high uncertainty factor.



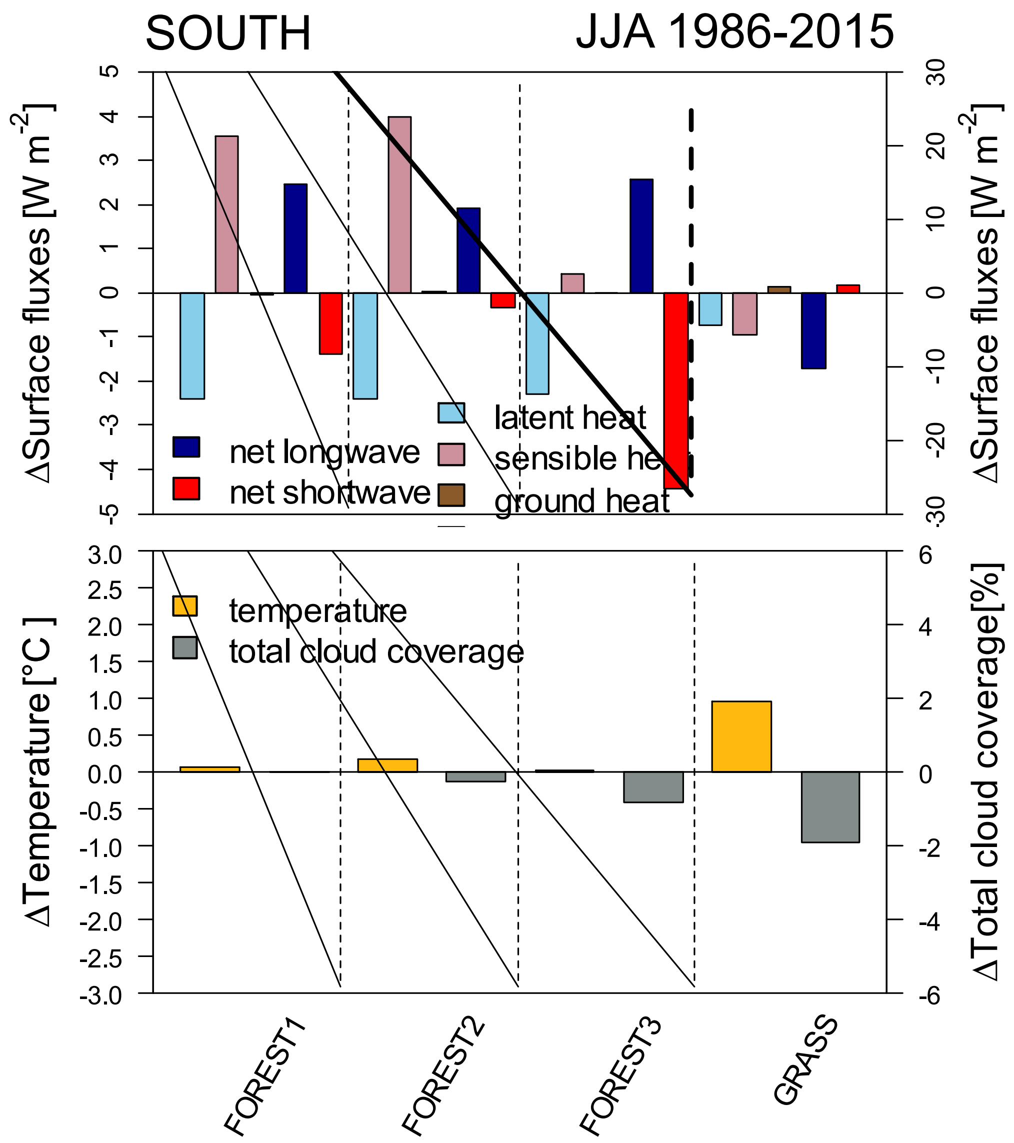
Changes in summer energy balance components

- FOREST1: climatic changes result mainly from changes in partitioning between turbulent fluxes and surface roughness.
- FOREST2, FOREST3: warming mainly due to increased net incoming radiation.
- GRASS: warming due to decrease/increase in latent/sensible heat, and less cloud cover resulting in increases in net incoming radiation.



Changes in summer energy balance components

- All FOREST simulations show warming due to increased Bowen ratio, and more sensible heat released to atmosphere.
- Sensible heat and net short wave radiation show the most variability among experiments.



Conclusions

- Former land cover determines strength of conversion and with that the biogeophysical characteristic changes.
- Latitutde is another determinant due to background climate and snow-masking effect.
- Parameterization of albedo determines the response of summer climate to afforestation in mid-latitudes.
- Albedo differences due to different land covers are higher than due to the specified parameterization in the model.
- Except for SOUTH, where albedo parameterization is a high uncertainty factor to estimate the impact of land cover change.
- Albedo parameterization need to account for different vegetation types.

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Thank you for your attention!

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Changes in total cloud cover