CMUG Phase 2
Role of vegetation on hydrometeorological processes

Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)

CMUG Integration Meeting, Frascati, 25 October 2022

Climate Modelling User Group

CMUG Phase 2 – Role of vegetation on hydrometeorological processes
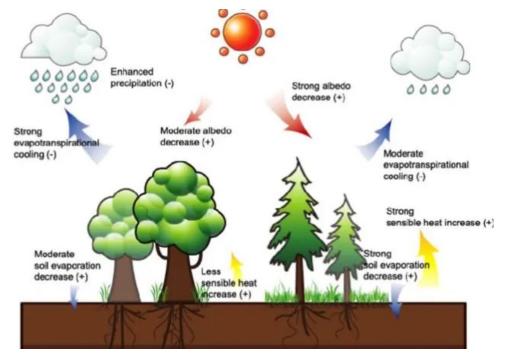Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)

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Hydrometeorological processes regulate the exchange of water and energy between the land surface and atmosphere influencing surface conditions and feedbacks
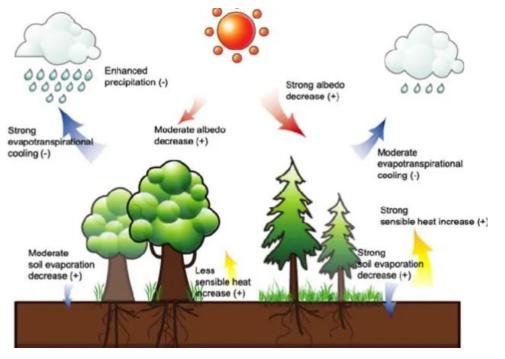

https://forestrypedia.com/vegetation-influence-on-precipitation/

Hydrometeorological processes regulate the exchange of water and energy between the land surface and atmosphere influencing surface conditions and feedbacks

Spatio-temporal variations in vegetation influence these exchanges

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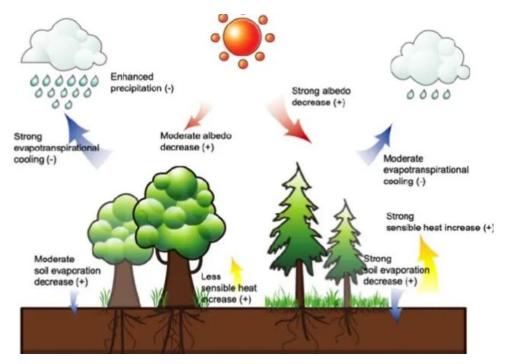
Climate Modelling User Group

European Space Agency

Hydrometeorological processes regulate the exchange of water and energy between the land surface and atmosphere influencing surface conditions and feedbacks

Spatio-temporal variations in vegetation influence these exchanges

For this reason, it is important to understand these relationships and sensitivities, and how they vary across biomes and spatio-temporal scales.

https://forestrypedia.com/vegetation-influence-on-precipitation/

Climate Modelling User Group

European Space Agency

The use of observed essential climate variables (ECVs) allow to assess:

- Spatio-temporal relationships;
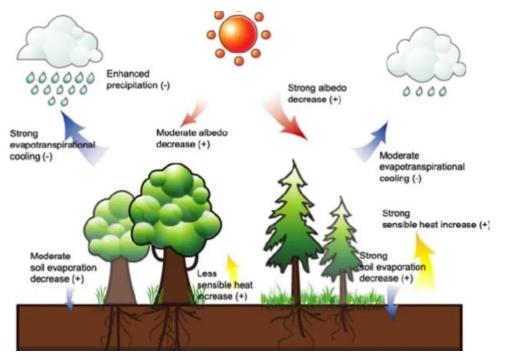- Sensitivity between vegetation and hydrometeorology processes.

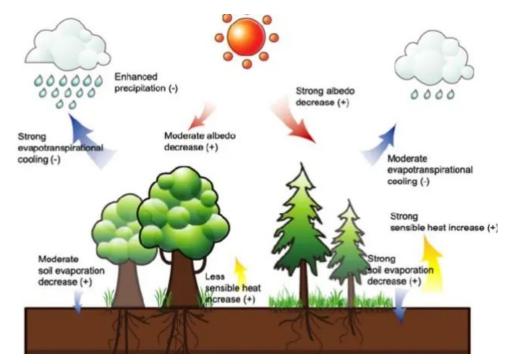https://forestrypedia.com/vegetation-influence-on-precipitation/

The use of observed essential climate variables (ECVs) allow to assess:

- Spatio-temporal relationships;
- Sensitivity between vegetation and hydrometeorology processes.

Focusing on specific scientific questions:

- How does vegetation influence spatio-temporal exchanges of water and energy between the land surface and atmosphere?

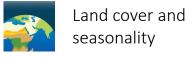- Which locations and biomes exert a strong influence on these exchanges?

https://forestrypedia.com/vegetation-influence-on-precipitation/

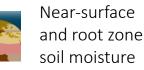The proposed analysis will use various ECVs datasets to represent Vegetation

Land cover and seasonality

Above ground biomass

The proposed analysis will use various ECVs datasets to represent Vegetation, Soil

 Land surface temperature

 Near-surface and root zone soil moisture

 Land cover and seasonality

 Above ground biomass

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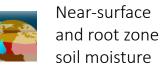Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)

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The proposed analysis will use various ECVs datasets to represent Vegetation, Soil and Atmosphere

Land surface temperature

Near-surface and root zone soil moisture

Land cover and seasonality

Snow cover and snow water equivalent

Above ground biomass

Total Column Water vapour

CMUG Phase 2 – Role of vegetation on hydrometeorological processes
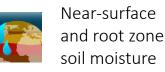Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)
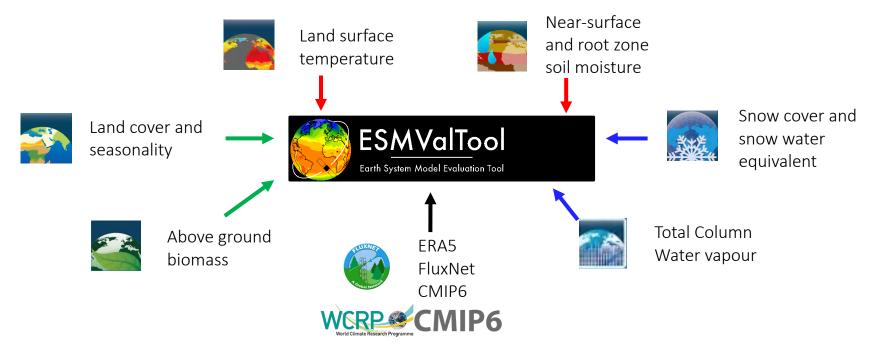
esa

The proposed analysis will use various ECVs datasets to represent Vegetation, Soil and Atmosphere
As well as in situ, reanalysis and model data

Land surface temperature

Near-surface and root zone soil moisture

Land cover and seasonality

Snow cover and snow water equivalent

Above ground biomass

FLUXNET
A Global Network

ERA5
FluxNet
CMIP6

Total Column Water vapour

WCRP
World Climate Research Programme
CMIP6

Task 1

Task 2

Task 1

Task 2

- Identify a set of indicators to characterize spatio-temporal variations in vegetation and hydrometeorological using relevant ECV data;

- Prepare data, such as collate ECVs and other relevant datasets (e.g.,reanalysis, Fluxnet, and models), and harmonise these data to enable comparison.

- Calculate the set of indicators using the harmonized datasets

Task 1

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- Calculate the set of indicators using the harmonized datasets

Task 2

- Analyse statistical relationships between vegetation and hydrometeorological indicators, using time series analyses and spatial analyses;

- Identify regions, biomes and time periods (seasonal) where vegetation has a positive and negative influence on the surface water budget. Show where and when vegetation exerts the largest influences on hydrometeorological processes.

- Submit a paper on key relationships and sensitivities between vegetation (different biomes, locations and seasonal timing) and hydrometeorological conditions and processes.

Various interactions may be evaluated in this framework.
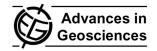For example previous literature focused on:

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Advances in Geosciences

Hydrometeorological and vegetation indices for the drought monitoring system in Tuscany Region, Italy

F. Caparrini[1,2] and F. Manzella[1]

[1]Centro Funzionale Regione Toscana, Pisa, Italy
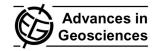[2]Eumechanos, Firenze, Italy

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Advances in Geosciences

Hydrometeorological and vegetation indices for the drought monitoring system in Tuscany Region, Italy

Geophysical Research Letters

RESEARCH LETTER

10.1029/2021GL092856

Revisiting Global Vegetation Controls Using Multi-Layer Soil Moisture

Wantong Li[1], Mirco Migliavacca[1], Matthias Forkel[2], Sophia Walther[1], Markus Reichstein[1], and René Orth[1]

[1]Department of Biogeochemical Integration, Max Planck Institute for Biogeochemistry, Jena, Germany, [2]Technische Universität Dresden, Institute of Photogrammetry and Remote Sensing, Dresden, Germany

Key Points:

- Vertically resolved soil moisture (SM) improves the understanding of large-scale vegetation productivity and yields extended water-related controls

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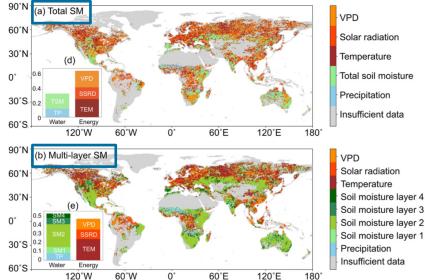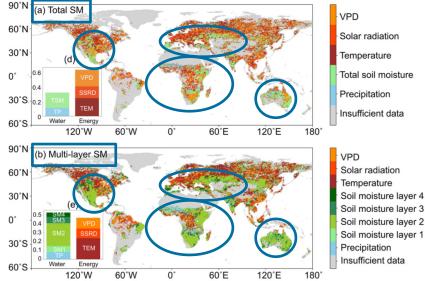## Geophysical Research Letters

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- Data-driven evidence

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Key Points:
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  contr
  Data

Wantong Li[1], Mirco Migliavacca[1], Matthias Forkel[2], Sophia Walther[1],

Snowmelt Events in Autumn Can Reduce or Cancel the Soil Warming Effect of Snow–Vegetation Interactions in the Arctic

MATHIEU BARRERE

Centre d'Études Nordiques, and Department of Geography, and Takuvik Joint International Laboratory, Université Laval, Québec City, Québec, Canada, and University of Grenoble Alpes–CNRS–IRD, IGE, Grenoble, France
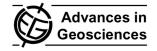
FLORENT DOMINE

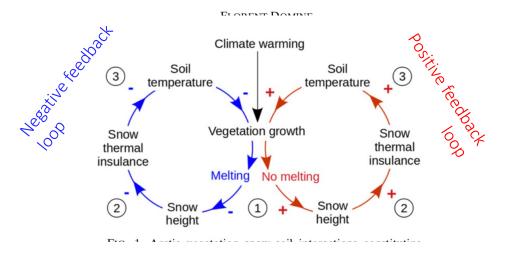Various interactions may be evaluated in this framework.

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FLORENT DOMINE

FIG. 1. Arctic vegetation–snow–soil interactions constituting

Possible indexes/analysis to be developed in this study

- Total column of water (land + atmosphere) to identify areas of dry and wet conditions and possible linkages to biomes and climate zones;

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- Land surface temperature and vegetation interactions;

- Interlinkages between snow and vegetation seasonality in transition areas and seasons;

Soil-snow-vegetation-atmosphere feedbacks

Chapin et al. 2005
Science, **310**, 657–660

Sturm et al. 2005
BioScience, **55**, 17–26

Myers-Smith and Hik, 2013
Ecology and Evolution, **3**, 3683–3700

Courtesy of R. Essery

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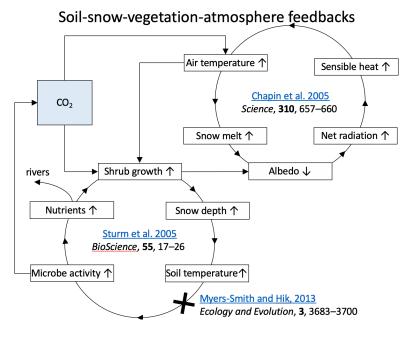Daniele Peano (CMCC), Deborah Hemming & Rob King (MO)

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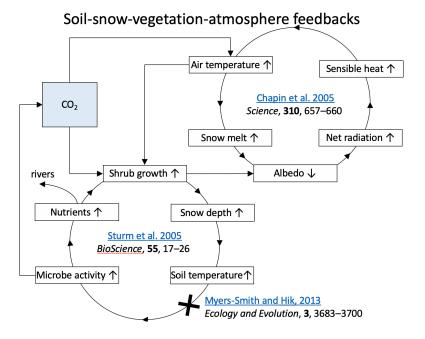
- Influence of snow melting season on soil moisture and land surface temperature in vegetated regions;

Soil-snow-vegetation-atmosphere feedbacks

Air temperature ↑

Sensible heat ↑

CO_2

Chapin et al. 2005
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Snow melt ↑

Net radiation ↑

rivers

Shrub growth ↑

Albedo ↓

Nutrients ↑

Snow depth ↑

Sturm et al. 2005
BioScience, **55**, 17–26

Microbe activity ↑

Soil temperature ↑

Myers-Smith and Hik, 2013
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Courtesy of R. Essery

EXTRA

CCI ECVs and other datasets	Data availability and updates
CCI Soil moisture	Near-surface soil moisture 1978 to 2020 (ESACCI-SOILMOISTURE-L3S-SSMV-COMBINED-*-fv06.1) data available on CEDA; v4.2 of CCI already implemented into ESMValTool – will be updated to version v6.1 on ESMValTool within 1st year of CMUG 2022-25 work. Root zone soil moisture product – available autumn 2022.
CCI Land cover	Land cover (ESACCI-BIOMASS-L4-AGB-MERGED-100m -2018-fv3.0) data available on CEDA; v1.6 of CCI already implemented into ESMValTool – will be updated to v2.0.7 on ESMValTool within 1st year of CMUG 2022-25 work. Land surface seasonality product.
CCI Land surface temperature	Land Surface Temperature 2003 to 2014 (Aqua) (ESACCI-LST-L3C-LST_MODISA-0.01deg_1MONTHLY_*-fv3.00) data already available on ESMValTool. Daily data is also available
CCI Biomass	Above-Ground Biomass for one of the periods, 2010, 2017 or 2018 (ESACCI-BIOMASS-L4-AGB-MERGED-100m -2018-fv3.0) data available on CEDA …also 2019 and 2020 available from CCI Biomass team.
CCI Snow	Snow water equivalent (esacci.SNOW.day.L3C.SWE.multi-sensor.multi-platform.MERGED.2-0.r1) data available via Climate Data Dashboard. Snow cover fraction – snow on ground (esacci.SNOW.day.L3C.SWE.multi-sensor.multi-platform.MERGED.2-0.r1) data available via Climate Data Dashboard; (esacci.SNOW.day.L3C.SCFG.MODIS.Terra.MODIS_TERRA.2-0.r1) data available via Climate Data Dashboard.
CCI Water vapour	Total column water vapour daily and/or monthly means from 2002 to 2017 (ESACCI-WATERVAPOUR-L3S-TCWV-*-fv3.1) data already implemented on ESMValTool.
CMIP6 model ensemble	CMIP6 (inc. LUMIP, LS3MIP) data available on ESMValTool Also available via CEDA - https://help.ceda.ac.uk/article/4801-cmip6-data
ERA5-Land reanalyses	ERA5-Land data - https://www.ecmwf.int/en/era5-land Including air temperature, Precipitation, runoff.