ES1404: "A European network for a harmonised monitoring of snow for the benefit of climate change scenarios, hydrology and numerical weather prediction"

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Modelling the effect of snow cover on variability of soil moisture and temperatures

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Czech University of Life Sciences Prague
Czech Republic

- Our contribution in this action will be modelling impact of various snow observations in situ on variability of soil moisture and temperature's regime.
- Changes in snow cover characteristics should not be neglected!!!!
- The snow cover melts progressively earlier, and there is less snow-based water available to recharge the soil profile to its maximum capacity, with various consequences.
  - The earlier end of snow cover and the earlier start of GS (up to 20 days in some regions), led to an increased ETa at the start of growing season that tends to deplete the soil moisture earlier,
    - leaving the soil more exposed to the impacts of rainfall variability (Trnka et al., 2014, Potopová et al. 2015).
  - The volume of snow precipitation decreases and the turnover (i.e. the time between snow deposition and melting) accelerates in many regions.

Modelling the effect of snow cover on variability of soil moisture and temperatures

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- The national project aims a new assessment of the effect of snow cover on variability of soil moisture and temperatures during the cold season of the year in the lowland, highland and mountains' sites in the Czech Republic.
- To accomplish this, the specific objectives of the present research were:

(i) to establish and monitor of experimental measurements at 5 calibration sites for analyzing the effect of snow cover on variability of soil moisture and temperatures;

(ii) an assessment on temperature and soil moisture variability and its driving factors during the cold season of the year at Doksany agrometeorological observatory as unique 100−years continuous series in the Czech Republic;

(iii) to develop and calibrate a snow cover-modelling technique to simulate snow cover presence/absence and sow depth within the cold season of the year for agrometeorological applications and snow cover climatology.

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- To create the model will be used unique 100-year series of measurements of snow depth, standard meteorological elements, incl. soil temperature and moisture from Doksan.
- The model will be calibrated based on experimental measurements at five locations with detailed monitoring on temperature regime in the snow cover and soil, the moisture regime, radiation balance and standard meteorological elements (eg. precipitation, air temperature and humidity, wind speed).
- To validate the model will be used data from a network of professional stations over the past 50 years from the Czech Republic and Central Europe from data obtained in the ongoing COST Action ES1404.
- We already beginning to analyse the link between the snowfall and the occurrence of spring/summer dry/wet periods (i.e., moisture deficit and excess of water in the soil).

I. Relationship between snowfall/snow depth characteristics and soil moisture during the growing season in the Czech Republic. Distinguishing the time scale of drought

Hindawi
Advances in Meteorology
Special Issue on
Migration of Drought: From Meteorological Drought to Hydrological and Agricultural Drought

- Firstly, we want to find the relationship between snowfall/snow depth characteristics and soil moisture during the growing season.
- We focus on soil moisture aiming to demonstrate the role of the drought and the snowfall during the cold season on soil moisture deficit during early summer (AMJ) and later summer (JAS).

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I. Relationship between snowfall/snow depth characteristics and soil moisture during the growing season in Czech Republic. Distinguishing the time scale of drought

Data:

A) The snow daily data for the cold season (November-March)

The snow characteristics:

1) The number of snow days per month/season (a given day was counted as one with snow cover when the snow height was at least 1 cm)

2) Daily snow depth (cm)

3) Snow cover duration

4) Snow water equivalent (mm)

B) Observational soil moisture data (April to September):

1) Daily soil water content (AV) is expresed as percentage of the soil saturation between the wilting point (AV=0%) and field capacity (AV=100%)

C) Temperature and precipitation dataset (January-December):

1) Monthly mean of Tmax, Tmin

2) Monthly precipitation total

D) Drought (moisture) indices (January-December):

SPI (1 from 12-mo lags)

SPEI (1 from 12-mo lags)

scPSDI (self calibrated Palmer Severity Drought Index)

Z-index

I. Relationship between snowfall/snow depth characteristics and soil moisture during the growing season in Czech Republic. Distinguishing the time scale of drought

Methodology:

This research includes the following steps:

i. Tendency of snow depth/ snow days (1951-2014 and 1991-2014)

ii. Snow phenology:

☞ Temporal variability of the last day (spring) and first day (autumn) of snow cover

iii. Relationship between the number of snow days for the cold season and soil moisture for each month of the growing season (April-September)

iv. Relationship between SWQ for the cold season and soil moisture for each month of growing season (April-September)

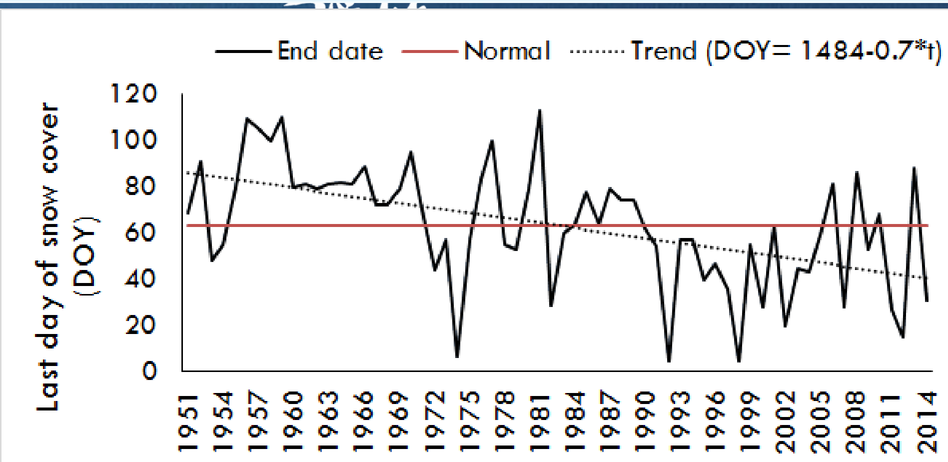
v. Lag correlation between monthly drought indices and monthly soil moisture of the early summer (AMJ) and later summer (JAS):

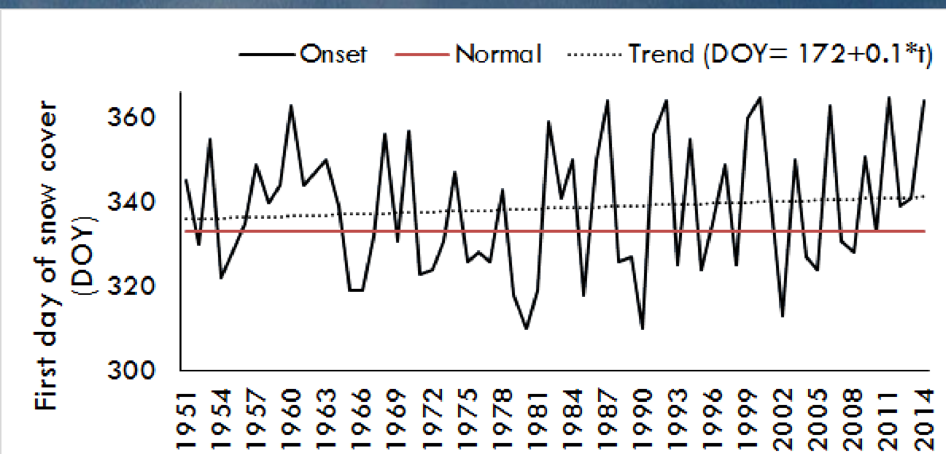
☞ The soil moisture-drought relationship has a strong dependence on the time scale of droughts.

vi. Large scale patterns (SST & SLP) in the North Atlantic associated to extreme snowfall and driest/wettest early summer (AMJ).

Preliminary results

Temporal variability of the last day and first day of snow cover in lowland (h=150 m a.s.l.)





1951-2014

- We caracterize temporal patterns of change in the snow onset and end dates.
- We first apllied the trend detection method to the time series of the onset and end date of the snow cover in yeach year at ech station.
- A trend towards an eralier end date of snow cover is found in lowland site (7d decade^{-1}).
- But shift in onset of snow cover has had no significant.
- Whereas the highland stations over the last 24 years has seen a more shift towards an earlier end to the snow cover.

Table 1: Observed long-term changes (days per year) in the snow onset and end dates over the CR (1991-2014)

station	Altitude m	Latitude, degree	Longitude, degree	Onset	End
Doksany	158	50.46	14.17	+0.1 *	-0.6 **
Kuchařovice	334	48.88	16.07	+0.4**	-0.3*
Cheb	483	50.07	12.39	+0.5**	-1.1**
Luká	510	49.65	16.95	+0.6**	-1.0**
Kocelovice	515	49.47	13.84	+0.8**	-1.0**
Kostelní Myslová	569	49.16	15.44	+0.8**	-1.4**
Svarouch	737	49.74	16.03	+1.2**	-0.3*

* - marginally significant ($0.01 < p \leq 0.05$)

** - significant ($0.001 < p \leq 0.01$)

- **The end date of snow cover over the last 24 years shows a rapid advance for** highland stations **(from 14 to 3 d decade^{-1}).**
- A trend towards an eralier end date of snow cover is found at 70% of the Eurosian sites, wit 28% of the sites showing an advancie of snowmelt in spring as fast as five days per decade (Peng et al. 2000)

Temporal variability of the last day and first day of snow cover

1991-2014