COST733 Working Group2

Implementation and development of weather types classification methods

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I.) A retrospect of WG2

II.) Relevance of classification algorithms

III.) Randomcent as a benchmark method

IV.) Randomcent for classification tuning

1.) WG1 phase (09/2005 to 09/2006)

2.) WG2 collection phase (2007)

3.) version 1.0 (01.02.2008) version 1.1 (17.02.2008) version 1.2 (12.07.2008)

4.) version 2.0 (21.11.2009)

1.) WG1 phase (to 09/2006) results of questionnaire:

- → daily scale
- \rightarrow spatial scale
- \rightarrow circulation data
- \rightarrow selected methods



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- → <u>spatial scale</u>
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2.) WG2 collection phase (2006/2007)

- 25 methods selected
- daily ERA40 12:00 SLP data distributed
- definition of the 12 domains
- calculation by authors
- upload on directory cost733.org
- many authors various formats
- need for versioning system

The COST733 spatial domains



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- 25 methods selected
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3.) Version 1.0 to 1.2 (02-07/2008)

- numbers of types \rightarrow 9, 18, 27
- SLP and full year (not seasonal)
- method revisions (e.g. E)
- 27 methods/catalogs (+ KH)
- single file version
- also available through wiki

	CEC	210007,2500	40	D00-D11	Enke et al.	Arne Spekat	
1	CECC10	SUP	10	D00,D07	Enke et al.	Arne Spekat	
1		SLP	20	D00.D07	Enke et al.	Arne Spekat	
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2	ESLPC10	SLP	10	D00-D11	Erplourn et al.	Michel Erploum	
2	ESLPC30	SLP	30	D00-D11	Erploum et al.	Michel Erploum	
2	EZ500C10	Z500	10	D00-D11	Erploum et al.	Michel Erploum	
2	EZ500C30	Z500	30	D00-D11	Erploum et al.	Michel Erploum	
2	EZ850C10	Z850	10	D00-D11	Erploum et al.	Michel Erploum	
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I.) Retrospect of WG2 V1 composite plots

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LUND Domain 11

Description:

Plot titles show 1.) method name, 2.) domain, 3.) class number, 4.) number of days, 5.) days in percent of season, 6.) months of season, 7.) dataset, 8.) variables. Spatial resolution used for all maps is 1x1°. Red box shows spatial domain used for classification.

Mean Sea Level Pressure [hPa]: ERA40 12Z mean isobars shown as contour lines (fixed interval 2hPa). Isobars below/above the spatial mean shown as solid/dashed lines.

Temperature scale [K]: ERA40 mean 12Z anomaly referring to long term monthly mean 1957-2002. Insignificant values (alpha=0.05) blanked out.



Precipitation scale [mm]: ERA40 (CP+LSP) mean sum from 06Z to 12Z (to be changed to daily sum in the future). (note: The ENSEMBLES WP5.1 gridded RR dataset should replace/complement the ERA40 data in the future.) Values less than 0.5 and insignificant values (alpha=0.05) blanked out.



Map table:



4.) Version 2.0 (11/2009)

- more meteorological parameters
- seasonal variants / sequences of days
- new nomenclature
- recalculations with cost733class
- 23 methods/catalogs (original and reproduced)
- 5 method groups established
- more than 5000 single catalogs

I.) Retrospect of WG2

YR_S01 (whole year, single days)

dat	~k	GWLo	OGWo	PECo	PERo	SUEo	ZMGo	GWT	эст	LWTo	LIT	LITO	WLK	WLKo	KRZ	KRZo	PXE	PXEo	РСТ	РСТо	РТТ	LND	KIR	ERP	ERPo	PTSo	СКМ	СКМо	NNWo	SOM	САР	CAPo	РХК	РХКо	SAN	RAC
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SP	09			X				X							X							X	X				X									
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SP - Z5 - Y5 - K5	18														X						X	X		X			<u>X</u>				<u>X</u>		<u>X</u>		<u>X</u>	
SP - Z5 - Y5 - K5	27														X		X		X		X	X		X			<u>X</u>				<u>X</u>		<u>X</u>		<u>X</u>	X
U7 - V7	09												X																							
U7 - V7 - Z9	18												X																							
U7 - V7 - Z9 - Z5	27												X	X																						
U7-V7-Z9-Z5-TW	27													X																						

YR_S04 (whole year, 4-day-sequences)

dat	~k	GWLo	OGWo	PECo	PERo	SUEo	ZMGo	GWT	зст	LWTo	LIT	LITO	WLK	WLKo	KRZ	KRZo	PXE	PXEo	РСТ	РСТо	РТТ	LND	KIR	ERP	ERPo	PTSo	скм	СКМо	NNWo	SOM	САР	CAPo	РХК	РХКо	SAN	RAC
SP	09														X						X	X		X			X								X	
SP	18														X						X	X		X			X								X	
SP	27														X						X	X		X			X								X	
SP-Z5	09																					X		X											X	
SP-Z5	18																					X		X											X	
SP-Z5	27																					X		X											X	
SP-K5	09														X						X	X		X			X								X	
SP-K5	18														X						X	X		X			X								X	
SP-K5	27														X						X	X		X			X								X	
SP-Y5	09																					X		X											X	
SP-Y5	18																					X		X											X	
SP-Y5	27																					X		X											X	
SP-Z5-Y5-K5	09														X						X	X		X			X								X	
SP-Z5-Y5-K5	18														X						X	X		X			X								<u>X</u>	
SP-Z5-Y5-K5	27														X						X	X		X			X								X	

SE_S01 (seasonal, single days)

dat	~k	GWLo	OGWo	PECo	PERo	SUEo	ZMGo	GWT	јст	LWTo	LIT	LITo	WLK	WLKo	KRZ	KRZo	PXE	PXEo	РСТ	РСТо	РТТ	LND	KIR	ERP	ERPo	PTSo	скм	СКМо	NNWo	SOM	САР	CAPo	РХК	РХКо	SAN	RAC
SP	27																							X			X									
Z1-Z5	27																																			
SP-Z5	27																							X			X									
SP-K5	27																							X			X									
SP-Y5	27																							X			X									
SP-Z5-Y5-K5	27																							X			X									

Datei Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe		
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cost733cat-2.0 centroid plots

See catalog table for existing configurations and explanation of abbreviations, visit cost733 wiki or cost733 main page for information about the COST Action 733.

classification method	number of types	preprocessing mode	classification input data	classification domain	centroid parameter	centroid level (for Z,R,T,VORT only)	centroid season	run
GWLo OGWo PECo PERo SUEo ZMGo GWT JCT LWTO LIT	00 09 18 27	YR 501 YR 504 SE_501	SP A Z8 Z5 Z1-Z5 SP-Z5 SP-Z5 SP-K5 SP-Y5 SP-Y5 SP-Z5-Y5-K5 U7-V7 U7-V7-Z9 V	00 01 02 03 04 05 06 07 07 08 09	Z MSLP PRC CP LSP R TWC 2mT T Z500-Z850	925 850 700 500 300	year A win spr sum aut	anomalies normalized map size: lon: [-47]:[+66] lat: [+20]:[+80] 800x600 ▼ draw box draw labels
LITO WLK WLKO KRZ	v	v	U7-V7-Z9-Z5 U7-V7-Z9-Z5-TW SP-RR SP-TT <u>v</u>	10 11	10mU 10mV U700 V700	v	v	 □ centroid data ✓ seasonal cycle ✓ interann. freq.

searching GWL009 YR S01 SP/GWL009 YR S01 SP_D00.txt... <u>GWL009 YR S01 SP</u> D00: <u>GWL009 YR S01 SP/GWL011 YR S01 SP_D00.txt</u> (actually 11 types) See statistics at GWL009 YR S01 SP/GWL011 YR S01 SP D00.stat

• Download <u>GWL009 YR S01 SP.tbz</u> (bzip2-compressed tar-archive including data, grads script and eps-plots).



MSLP(year) for GWLo09_YR_S01_SP_D00 type #02











MSLP(year) for GWLo09_YR_S01_SP_D00 type #01

<u>D</u> atei <u>B</u> earbeiten <u>A</u> nsicht <u>C</u> hroni	k <u>L</u> esezeichen E <u>x</u> tras <u>H</u> ilfe							
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🥃 cost733plot Geography Uni Aug	🕂							
cost733cat-2.0	O centroid plo	ts n of abbreviations, visit <u>cost73</u>	<u>33wiki</u> or <u>cost733 main page</u> f	or information about the COS	T Action 733.			
classification method	number of types	preprocessing mode	classification input data	classification domain	centroid parameter	centroid level (for Z,R,T,VORT only)	centroid season	run

classification method	number of types	preprocessing mode	classification input data	classification domain	centroid parameter	centroid level (for Z,R,T,VORT only)	centroid season	run
GWLo	00	YR_501	SP	00	Z	925	year 🔺	
OGWo		YR 504	Z8	01	MSLP	850	win	anomanes
PECo	18	SE_S01	Z5	02	PRC	700	spr	normalized
PERo	27		Z1-Z5	03	CP	500	sum	map size:
SUEo			SP-Z5	04	LSP	300	aut	lon: -47 · +60
ZMGo			SP-K5	05	R			
GWT			SP-Y5	06	TWC			lat: +20: +80 800x600 ▼
јст			SP-Z5-Y5-K5	07	2mT			□
LWTo			U7-V7	08	Т			O draw box
LIT			U7-V7-Z9	09	Z500-Z850			U draw labels
LITo			U7-V7-Z9-Z5	10	10mU			C centroid data
WLK			U7-V7-Z9-Z5-TW	11	10mV			
WLKo			SP-RR		U700			
KRZ 💌	V	v	SP-TT V	v	V700 v	v	V	interann. freq.

searching GWLo09_YR_S01_SP/GWLo09_YR_S01_SP_D00.txt..

GWL009 YR S01 SP D00: GWL009 YR S01 SP/GWL011 YR S01 SP D00.txt (actually 11 types) See statistics at GWL009 YR S01 SP/GWL011 YR S01 SP D00.stat

• Download <u>GWL009 YR S01 SP/GWL011 YR S01 SP D00.stat</u> Meeath Schuber Statistics at <u>GWL009 YR S01 SP.tbz</u> (bzip2-compressed tar-archive including data, grads schup an epstut). Seasonal Cycle

2mTano(year) for GWLo09_YR_S01_SP_D00 type #01



2mTano(year) for GWLo09_YR_S01_SP_D00 type #02



of type frequencies

Long term time series of type requencies



nthly frequency 1957-2002 type

3.2 2,8 2.6





II.) Relevance of classification algorithms for properties of the resulting frequencies



SUB

PCA

DR



II.) Relevance of the classification Algorithms for applications

Feedback from WG3 and WG4 concerning: temperature, precipitation and other applications:

 \rightarrow no general significant differences!

 \rightarrow does the method matter?

→ try (pseudo)randomly generated classifications

1.) select some daily patterns by random as key day



1.) select some daily patterns by random as key day

2.) assign each day to the most similar key day



1.) select some daily patterns by random as key day

2.) assign each day to the most similar key day

3.) do that 1000 times and compare those to the deliberate methods



III.) Randomcent: Explained variance of 2mT



III.) Randomcent: Explained variance of PRC



Counting 95th percentile exceedence for 2mT in all seasons and all domains







Counting 95th percentile exceedence for PRC in all seasons and all domains



~18 types



GWT18 JCT18 LWTo18 LIT18 LIT018 WLK18 WLK018 KRZ18 KRZ018 PXE018 PXE018 PCT018 PCT018 PTT18 LND18 KIR18 ERP18 ERP18 PXS018 CAM18 NNW018 SOM18 CAP18 CAP018 PXK018 PXK018 SAN18 RAC18



 \rightarrow A benchmark method for classifications

→ A method for testing classification tuning parameters excluding the (possibly random) influence of the classification algorithm:

Many (1000) realizations of RAC allow a robust estimate whether a certain tuning parameter is good in general or only by chance!

IV.) RAC for testing classification tuning parameters

RAC-variants done with cost733class software:

- meteorological parameter (input variables)
- PCA preprocessing (scores)
- time filtering of input data (high-/low-pass)
- sequence length (1-10-day sequences)
- distance metrics (Euclid, Pearson, Minkowski)

RAC testing meteorological parameter for 2mT D07



N = 1000 Bandwidth = 0.2646

RAC testing meteorological parameter for PRC D07



N = 1000 Bandwidth = 0.1213

RAC testing number of PCs for 2mT D06



RAC testing <u>number of PCs</u> for <u>PRC</u> D06



RAC testing time filter period for 2mT (Yea) D06



RAC testing time filter period for 2mT (DJF) D07



RAC testing sequence length for 2mT D07



RAC testing distance metrics for PRC D06



N = 1000 Bandwidth = 0.1742

Conclusions

- we haven't found/developed the ultimate classification
- but from the methodological point of view we have now much more insight into classification procedures
- for applications it seems not possible to highlight single method RAC can be used as benchmark
- data preprocessig/selection is more important, testing is simplified by cost733class software, RAC shows systematic rules
- optimum parameter search in conditioned classification still has a large potential to improve applications \rightarrow Downscaling
- further developments should distinguish between <u>pure circulation</u> <u>classifications</u> for basic (regime) research and conditioned <u>weather</u> <u>type classification</u> for application purposes

Classification tuning for applications in synoptic climatology

OPS Optimal Parameter selection
 → not only optimize assignment of days to classes for optimizing downscaling skill but

 \rightarrow also optimize:

- \rightarrow number of classes
- \rightarrow weight of grid points
- \rightarrow weight of parameters
- \rightarrow sequences
- \rightarrow time filtering

Bump-hunting for regimes in the PDF-plane → Circulation Dynamics

