WP1
Development and application of metrics for process-based evaluation and projections

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CERFACS

High Priority Metrics, CERFACS

Land-atmosphere interactions (summer)

Ensemble of metrics: e.g. interannual
(i) Standard deviation of the evaporative fraction
(ii) Correlation between soil moisture and evapotranspiration
(iii) Correlation between soil moisture and temperature …

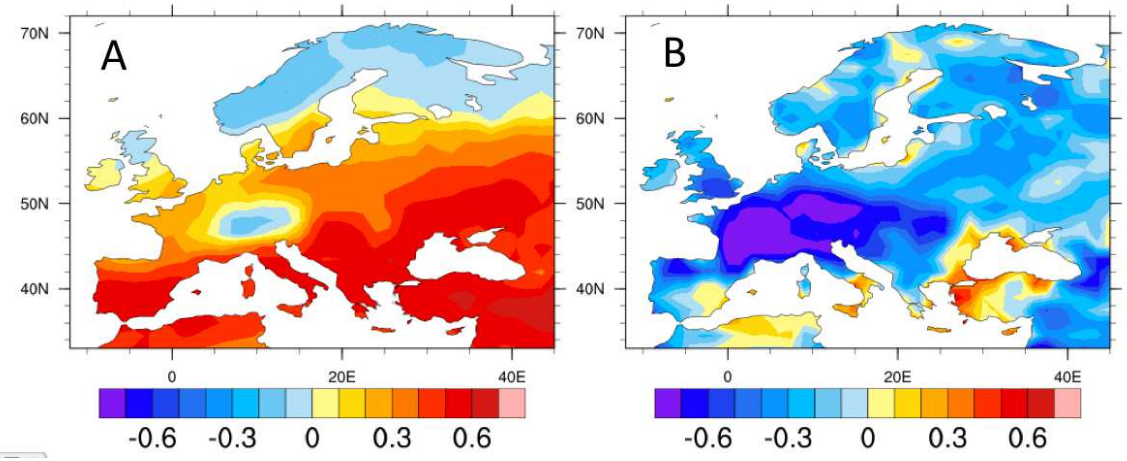
Coded (ncl), applied to CMIP5 models and a reference data-set (Global Land Data Assimilation System), characterization of the usefulness as metrics

Baroclinicity: Eady growth rate

Coded (ncl)

Air-sea coupling coefficient at small scales

Work in progress



A) Multi-model mean of (ii), 1970-2004
B) Intermodel correlation of (ii) and future change in evapotranspiration
CMIP5 models

CMCC

Metrics for PRIMAVERA WP1

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Centro Euro-Mediterraneo sui Cambiamenti Climatici

- The WP1 metrics developed by CMCC are defined in reference to the respective diagnostics developed for WP2 (as below).

  Blocking: 1D and 2D, including interannual variability.

  Eddy-driven jet: Teleconnectivity of u-wind and jet latitude PDF. A more elaborate, two-dimensional diagnostic is also proposed.

  Storm tracks: Storminess as TKE $\sqrt{v'v'}$ (linked to the e.d. jet)

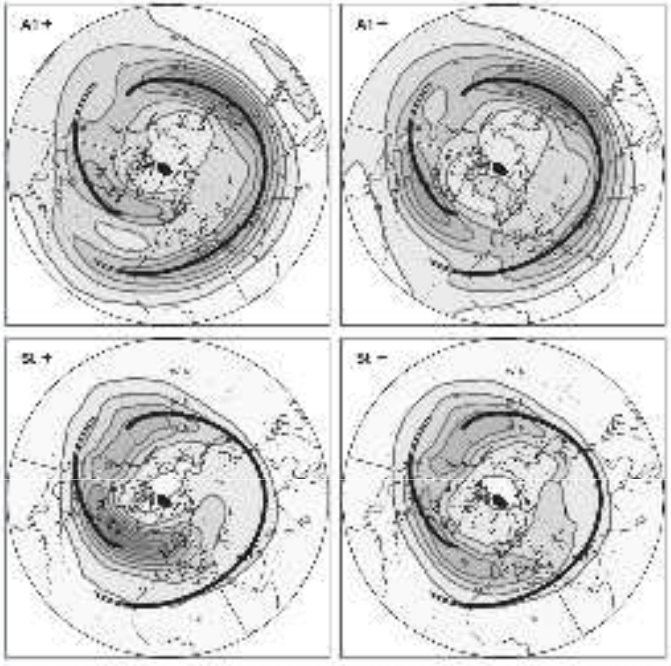
  E-vectors: The spatial distribution of each E-vector component will be assessed per calendar season separately for each sector.

- Applied to PRIMAVERA models, these diagnostics are used to quantify respective departures from the observed climate.

- The conversion of the diagnosed differences to metrics gives weight to the features that matter the most (open to discussion).

- Specifying the area of interest is left as a choice.

- Priority is given to the blocking metric (applied to UKMO model runs, to be finilized and delivered in December 2016).



Composites for the Atlantic PC1 of U250. Fields are averaged for absolute PC values exceeding 1 std for (top) $(u^2+v^2)^{1/2}$ at 250 hPa (contour interval = 10 m s^{-1}) and (bottom) $v'v'$ at 250 hPa (contour interval = 50 m^2 s^{-2}).

P. Athanasiadis, M. Wallace and J. Wettstein (2010).

CNR

WP1

CNR National Research Council of Italy

ISAC

METRICS

RMS and pattern correlation between observed and simulated patterns of variability modes...

...obtained through classification methods:

Example:

cluster analysis,

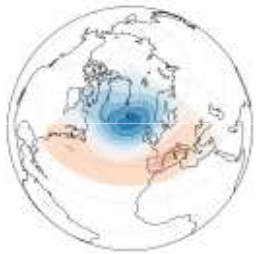
weather regimes for Euro-Atlantic region

Uncertainty in the metrics will refer to the difference in the metrics between ERA interim and NCEP

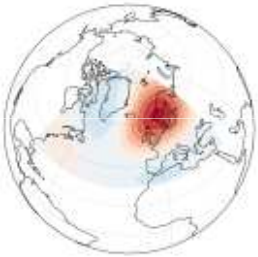
OBSERVATIONS

from NCEP/NCAR reanalysis
(1979-2008) Clusters for 9 PCs

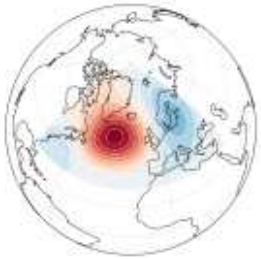
NAO+ 33.12%



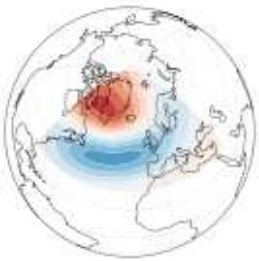
Blocking 26.74%



Atlantic Ridge 20.51%



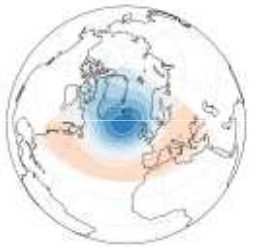
NAO- 19.63%



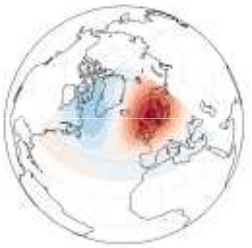
SIMULATIONS

from EC-EARTH3.1, T255, 10 members
(1979-2008) Clusters for 9 PCs

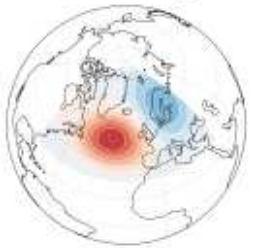
NAO+ 29.33%



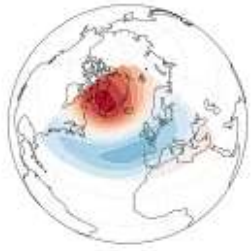
Blocking 24.56%

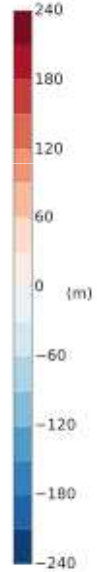


Atlantic Ridge 23.72%



NAO- 22.39%





KNMI

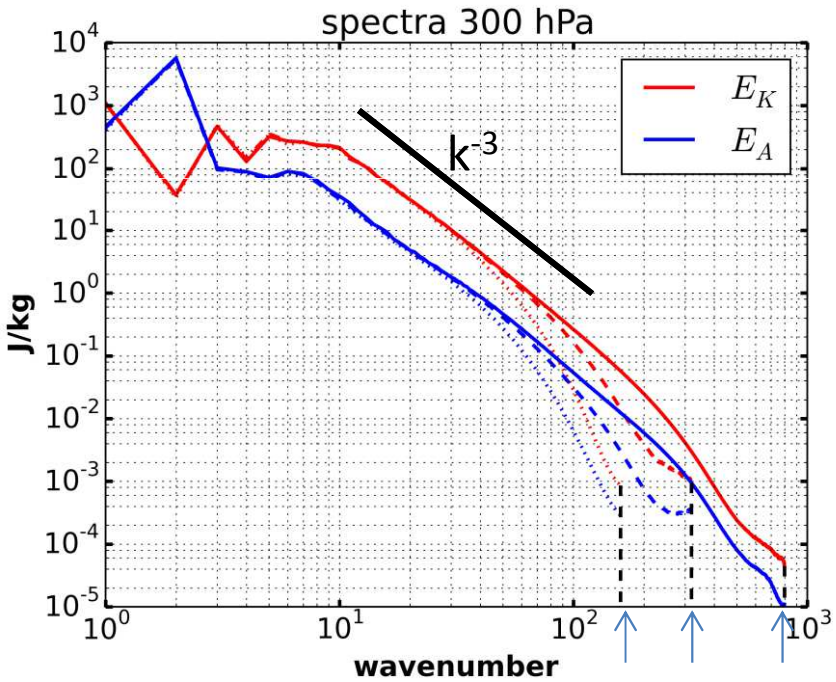
High priority metrics Atmosphere and Land (November 2016)

Atmospheric spectral energetics following Augier and Lindborg (2013)

- Python script to compute global energy spectra and energy transfer is ready
- Sensitivity to resolution in EC-Earth (T159, T319 and T799) is investigated.
- For energy spectra observations exist (e.g. Nastrom and Gage 1985) and is backed by theoretical arguments (K^{-3}, $K^{-5/3}$)
- For energy transfer this is more problematic, because reanalysis products are too much influenced by data assimilation.

KNMI

EC-Earth spectra for T159, T319 and T799



Dashed vertical lines are the 3 resolutions

Observed spectra near Tropopause

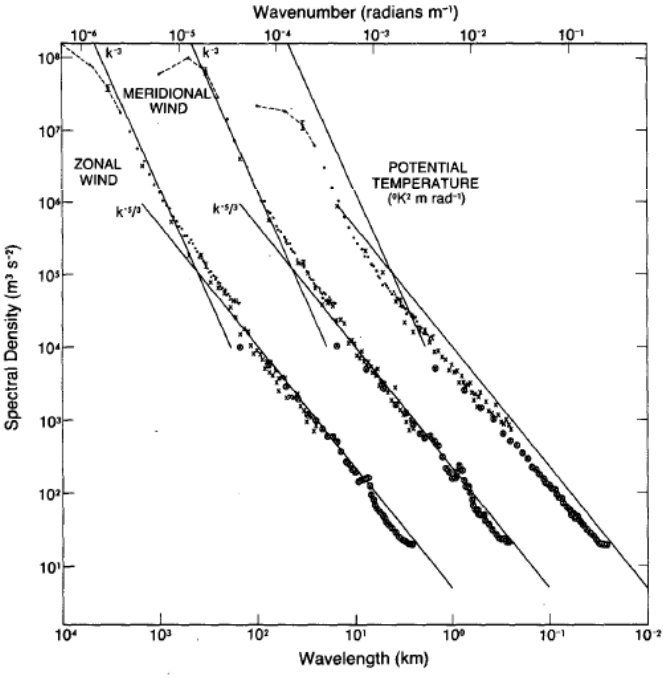
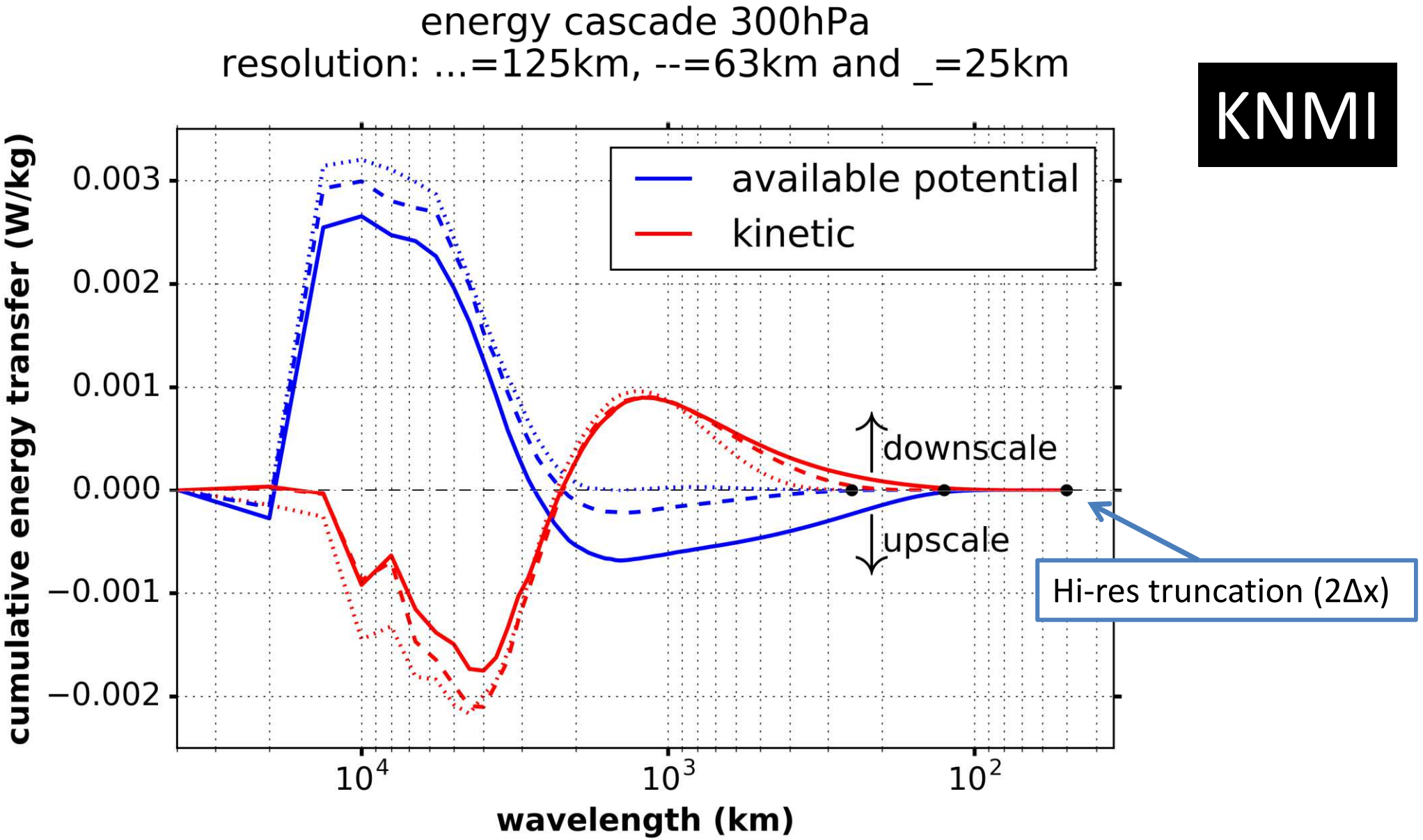


FIG. 3. Variance power spectra of wind and potential temperature near the tropopause from GASP aircraft data. The spectra for meridional wind and temperature are shifted one and two decades to the right, respectively; lines with slopes -3 and $-\frac{5}{3}$ are entered at the same relative coordinates for each variable for comparison.

Nastrom and Gage, JAS, 1985

Stronger APE cascade with resolution in EC-Earth (pre primavera):

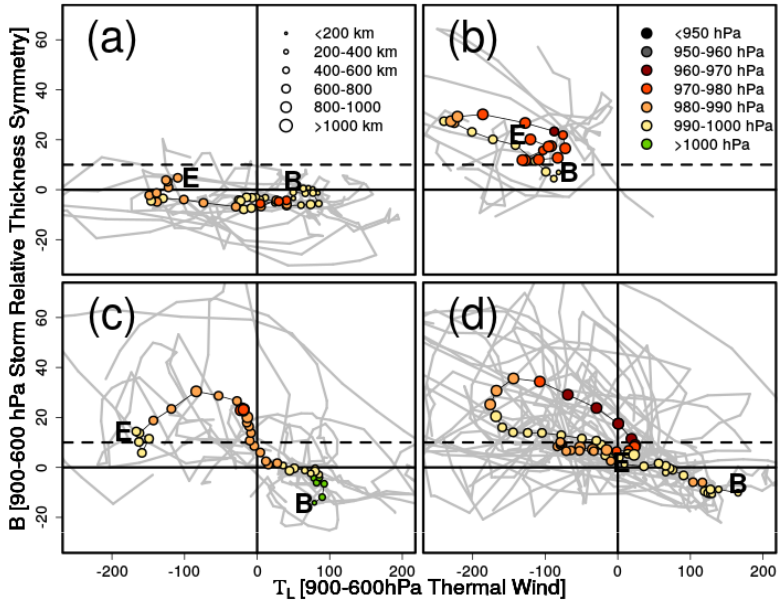
- **Upscale transfer from smallest scales**
- **Downscale transfer from large scales (from 4000 to 1400 km)**



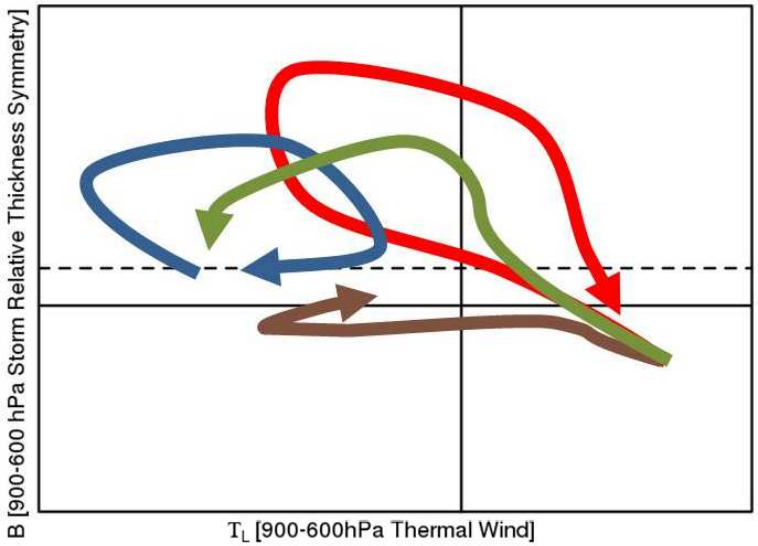
Life cycle metric

Tropical to extra-tropical transition of storms (Dekker et al., submitted, 2016)
Classification of life cycles of storms with tropical origin that reach Europe
Analyzed for MERRA reanalysis. Can be applied to PRIMAVERA runs.

Hart diagrams

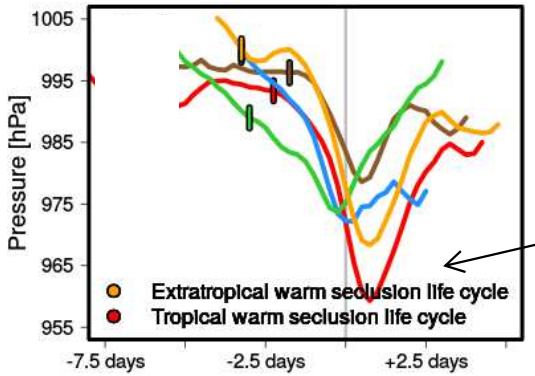


Schematic classification of life cycles



Life cycles

(a) Tropical — Brown
(b) Extratropical — Blue
(c) Classical extra tropical transition — Green
(d) Warm seclusion — Red



Warm seclusion storms are the strongest ones

MPI-M

WP1: Metrics development at MPI-M

- For scientific questions of interest, overflow transports across Greenland-Scotland-Ridge needed
- Daley Calvert (Met-Office) is developing Python-based routines for NEMO output and is happy to consider suggested quantities (overflow)
- For MPI-ESM output, there is a Fortran-based routine
- Ultimate goal is one routine for both / all models

Progress WP1

SMHI

High-Priority Metrics:

- Sea ice areas and variations in 8 Arctic sub areas. Applied and tested for all coupled standard and high-resolution pre-PRIMAVERA simulations.

- Surface heat release in the convection areas of Labrador and GIN-Seas.
  Applied and tested for all coupled standard and high-resolution pre-PRIMAVERA simulations.

- Timeseries, pattern, energy spectrum of a number of large scale modes (e.g. AMO, NAM, NAO, ENSO, PDO,…) with ESMVAL-tool. Tested for EC-Earth. Will be finalized in the next weeks.

Low-Priority Metrics:

- Deep convection in Labrador and GIN-Seas. Calculates the deep mixed volume below a critical depth to take only the convection into account that is relevant for the AMOC. Applied and tested for all coupled standard and high-resolution pre-PRIMAVERA simulations.

- Lag-correlations between Arctic sea ice area variations and atmospheric circulations. In work.

- Surface fronts: Tracking of maximum horizontal gradients in the North Atlantic. In work.

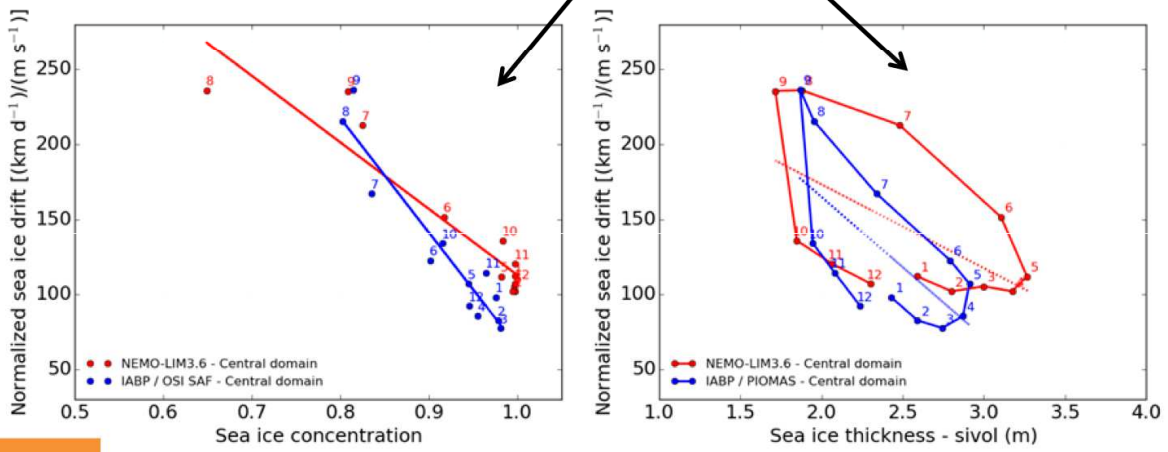
- SPEI-index: Drought and wetness indexes for different European regions. In work. Tested for EC-Earth

UCL

Sea ice drift-strength feedback (WP1, UCL)

High-priority metrics

Monthly mean averaged over 1979-2013
Numbers denote months



Starting point

- **Methodology** based on Olason & Notz (2014)
- **Model:** NEMO-LIM3.6 (ORCA1) forced by DFS5.2 (1958-2015)
- **Observations:** IABP (drift), OSI SAF (concentration and drift), ICESat and PIOMAS (thickness)

Metric development

- **Python**
- Metrics: slope ratios and normalized distances
- Use of different **domains** (central, wide)

Analysis

- Model can capture drift-strength feedback and agrees well with observations

Code sharing

- Code formatting
- Upload and test on **JASMIN**
- Documentation on wiki

- Docquier *et al.* (in prep.)
- Strategy with ESMVal

- **Submit** paper
- Need to be used by other partners
- Compare to **other models**

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EARTH & LIFE INSTITUTE

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UCL & BSC

Wintertime heat conduction (WP1, UCL+BSC)

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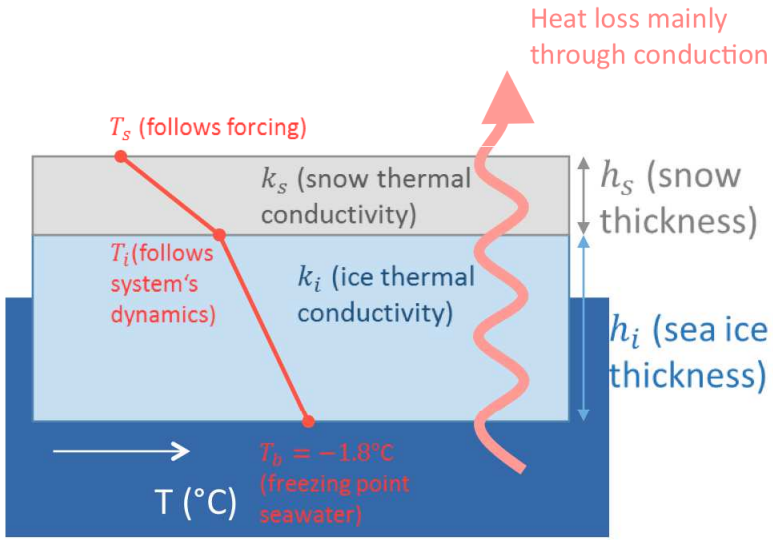
High-priority metrics



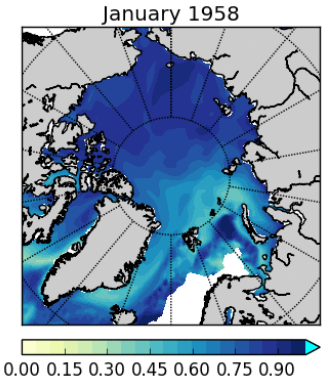
It can be shown that the « heat conduction index »

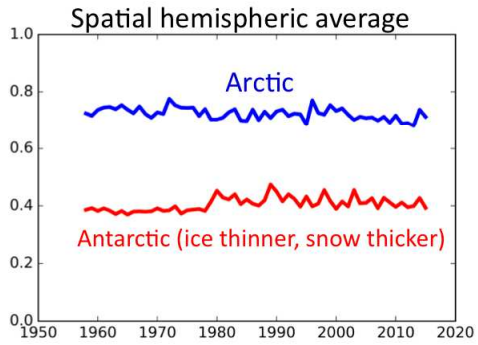
$$HCI = \frac{k_s h_i}{k_i h_s + k_s h_i}$$

measures the dependence of interfacial temperature T_i (a property of the system) to T_s (a property of the forcing), that is, the ability of a system to transport heat vertically from the warm ocean to the cold atmosphere through sea ice and snow.

We have diagnosed the heat conduction index from an ocean-sea ice stand-alone simulation at 1° (ORCA1) with NEMO3.6 and LIM3 sea ice model (atmospheric forcing: DFS5.2)

A remarkable property of that diagnostic is its stability





This is because the diagnostic measures a process (heat conduction), and processes do not vary with climate change.

Hence even observational data during a limited time span are enough to constrain the model. The next step will be to compute an equivalent observational estimate of *HCI* (from satellite data of snow and sea ice thickness).

UREAD

UREAD metrics development (WP1)

Metric	Status, Documentation	Applied to	Talk to
Global energy and water budgets, Trenberth-style diagrams	ready on JASMIN, Demory et al. 2014, http://proj.badc.rl.ac.uk/primavera-private/wiki/WP2/ModelAnalysisCode	HadGEM3, EC-Earth, CAM, MPI, MRI	Benoit Vanniere, Marie-Estelle Demory  
E-vectors	under development on JASMIN	HadGEM3 (UPSCALE)	
Tropical and Extratropical cyclones	ready on JASMIN, Hoskins & Hodges 2002, http://proj.badc.rl.ac.uk/primavera-private/wiki/WP2/StormTrackingCodes	HadGEM3 (UPSCALE) EC-Earth ERA-I, MERRA, MERRA2, NCEP-CFSR, JRA-25, JRA-55	Kevin Hodges, Pier Luigi Vidale  
Blocking (2D)	ready on JASMIN, Scherrer et al. 2006, Schiemann et al. 2016	HadGEM3 (UPSCALE), IFS (Athena), MRI, CAM5 ERA-40, ERA-I, MERRA	Alex Baker, Reinhard Schiemann  
Extreme precipitation (extreme value analysis)	under development on JASMIN	HadGEM3 (UPSCALE)	

BSC

Integration of the metrics in ESMVal tool

- ESMVal and Autoassess are the frameworks in which the WP1 metrics will be offered to the partners; they are now installed in Jasmin
- BSC will use the portal version control system to start integrating the priority metrics
- BSC is working on the ESMVal tool backend to ensure the rewrite of the tool can cope with high-resolution fields and that a workflow manager is offered
- Autoassess will be integrated in the ESMVal tool

Deliverables

- D1.1: First examples of the application of common process-based metrics to existing climate experiments with a focus on European climate variability and change (M18, UCL)
- D1.2: Tools for the process-based assessment of the PRIMAVERA climate experiments (M33, CMCC)
- D1.3: Strategy and package of metrics, in project repository coded using freely available software, for the analysis of the PRIMAVERA and CMIP6 experiments, with a focus on European climate variability and change (M45, BSC)