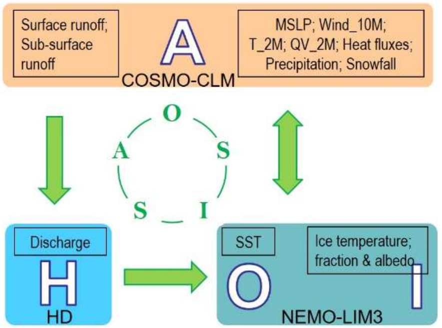
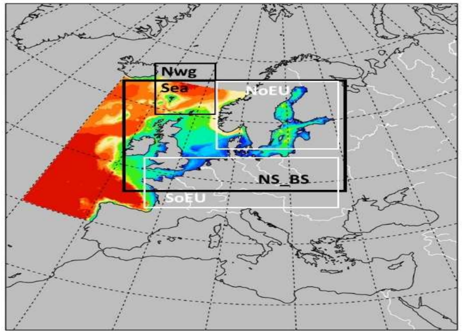
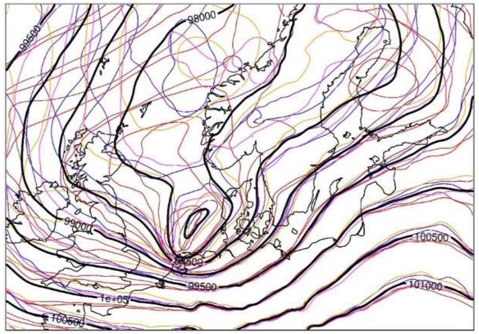
INTERNAL MODEL VARIABILITY IN THE REGIONAL COUPLED SYSTEM MODEL GCOAST-AHOI







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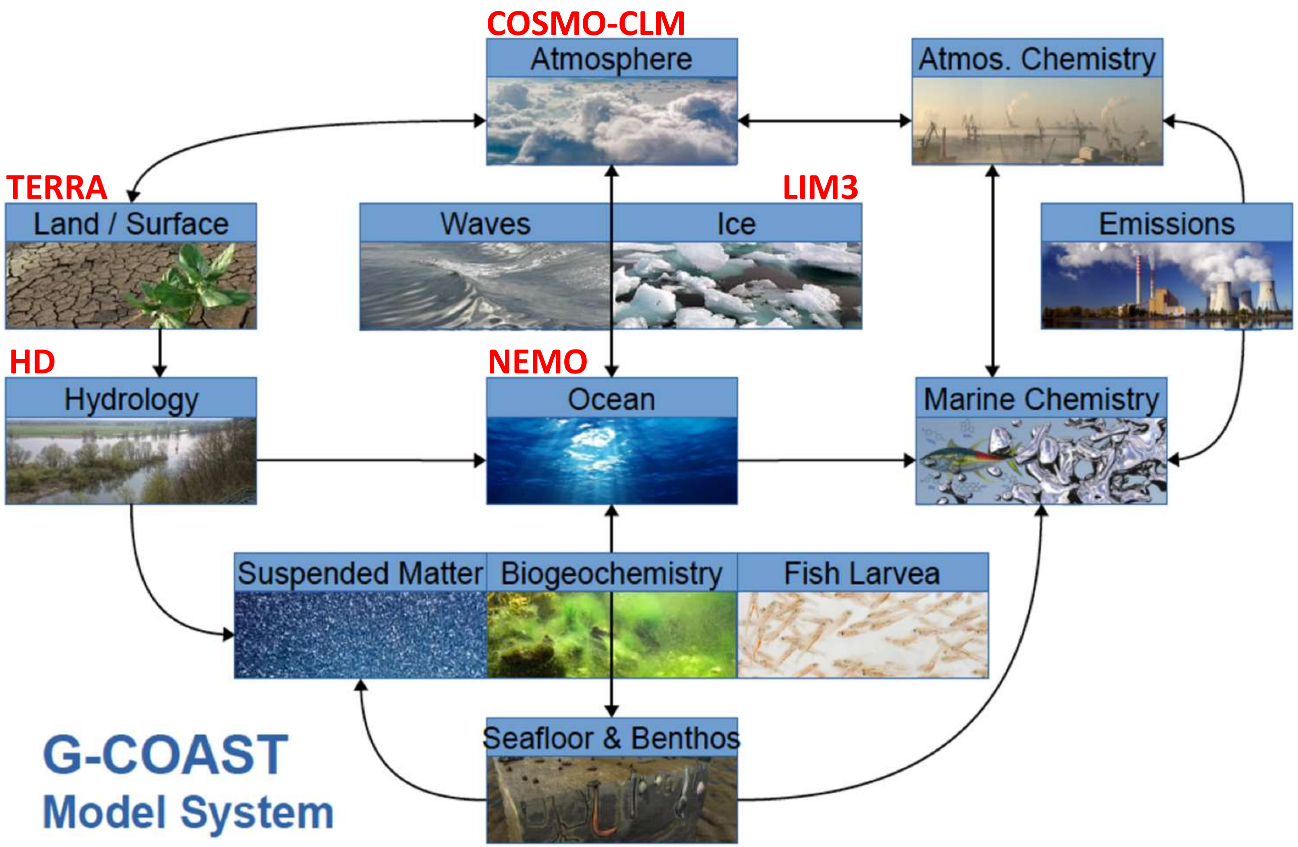
Helmholtz-Zentrum Geesthacht, Germany

CLM-Community Assembly 2020

17 September 2020

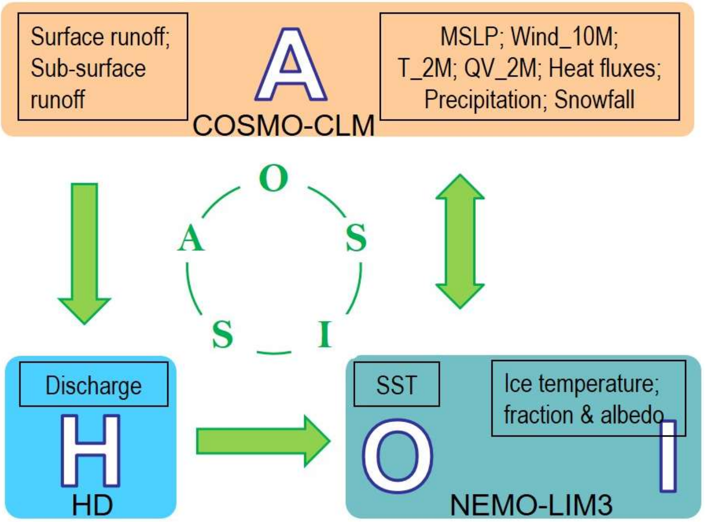


[https://wiki.coast.hzg.de]

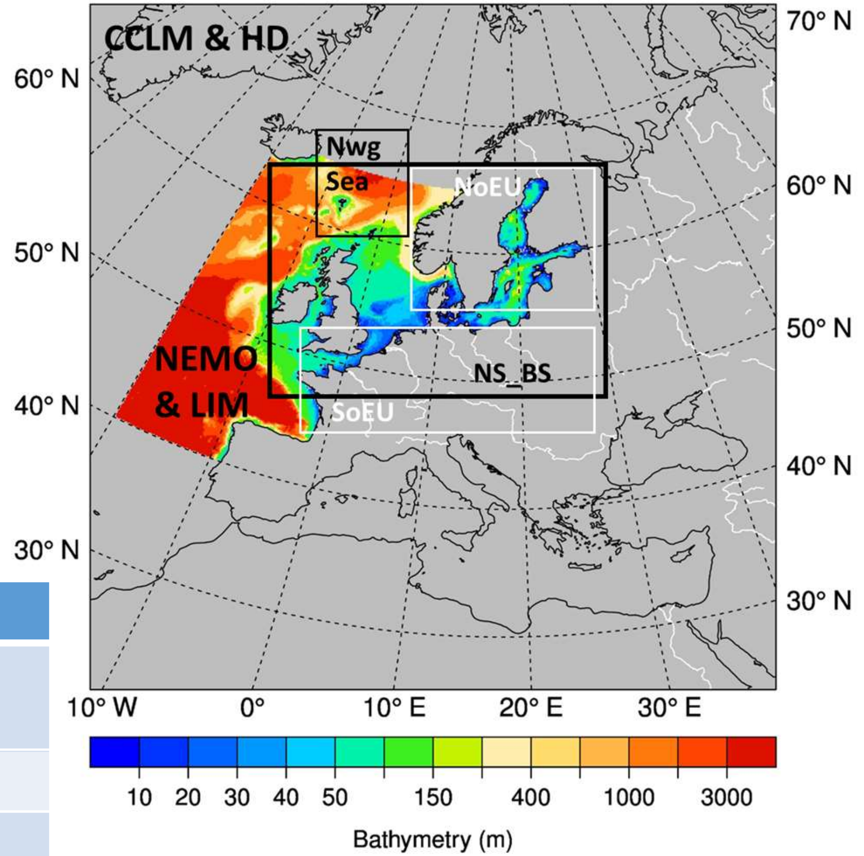
[Staneva et al., 2018; Pein et al., 2019; Ho-Hagemann et al., 2020]

GCOAST-AHOI

Configuration



Model	Res.	dT	Forcing
COSMO-CLM v5.0	~ 12 km, 40 levs	75 s	ERA5 (1-hr)
HD v4.0	~ 8-9 km	3600 s	
NEMO-LIM3 v3.6	~ 3.5 km, 56 levs	120 s	CMEMS UKMO; OSU tides
OASIS3-MCT v3		3600 s	



Model domains (CCLM andHD: Grey, NEMO: Color). Four rectangles: NwgSea (Norwegian Sea), NS_BS (the North and Baltic Sea), NoEU (north Europe), SoEU (south Europe).

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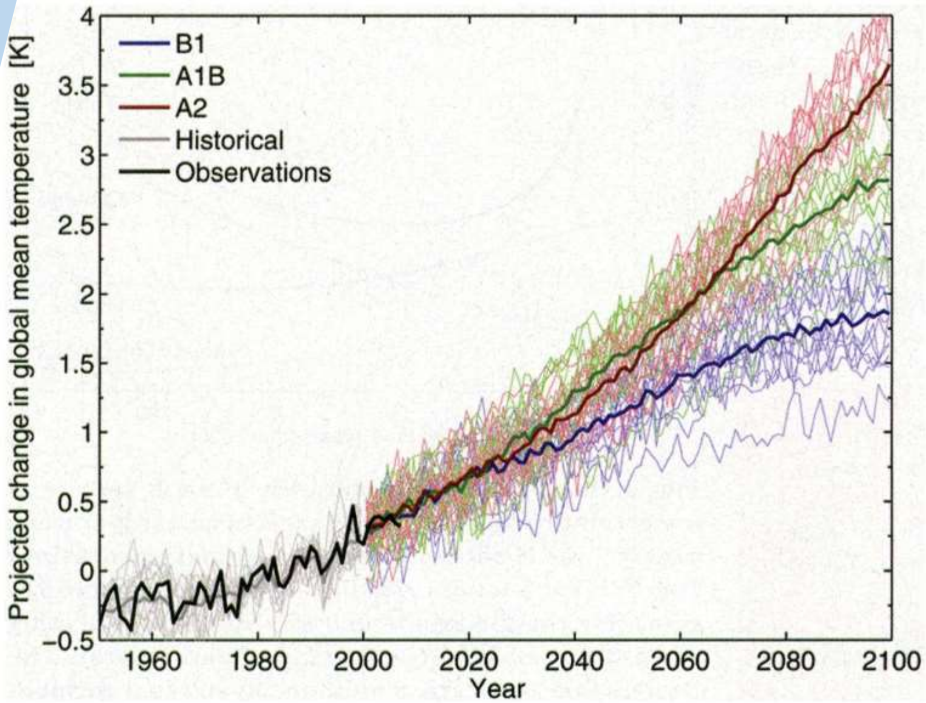
Model uncertainty, shown as model ***inter-member spread***, can be estimated by ***standard deviation*** (SD) of the ensemble:

$$SD = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where $\{x_1, x_2, \dots, x_N\}$ are the values of each member for a given variable $\bar{x}$ is the mean value of these members, and *N* is the number of the members.

[after Alexandru et al., 2007; Lucas-Picher et al., 2008]



[Hawkins and Sutton, BAMS, 2009]

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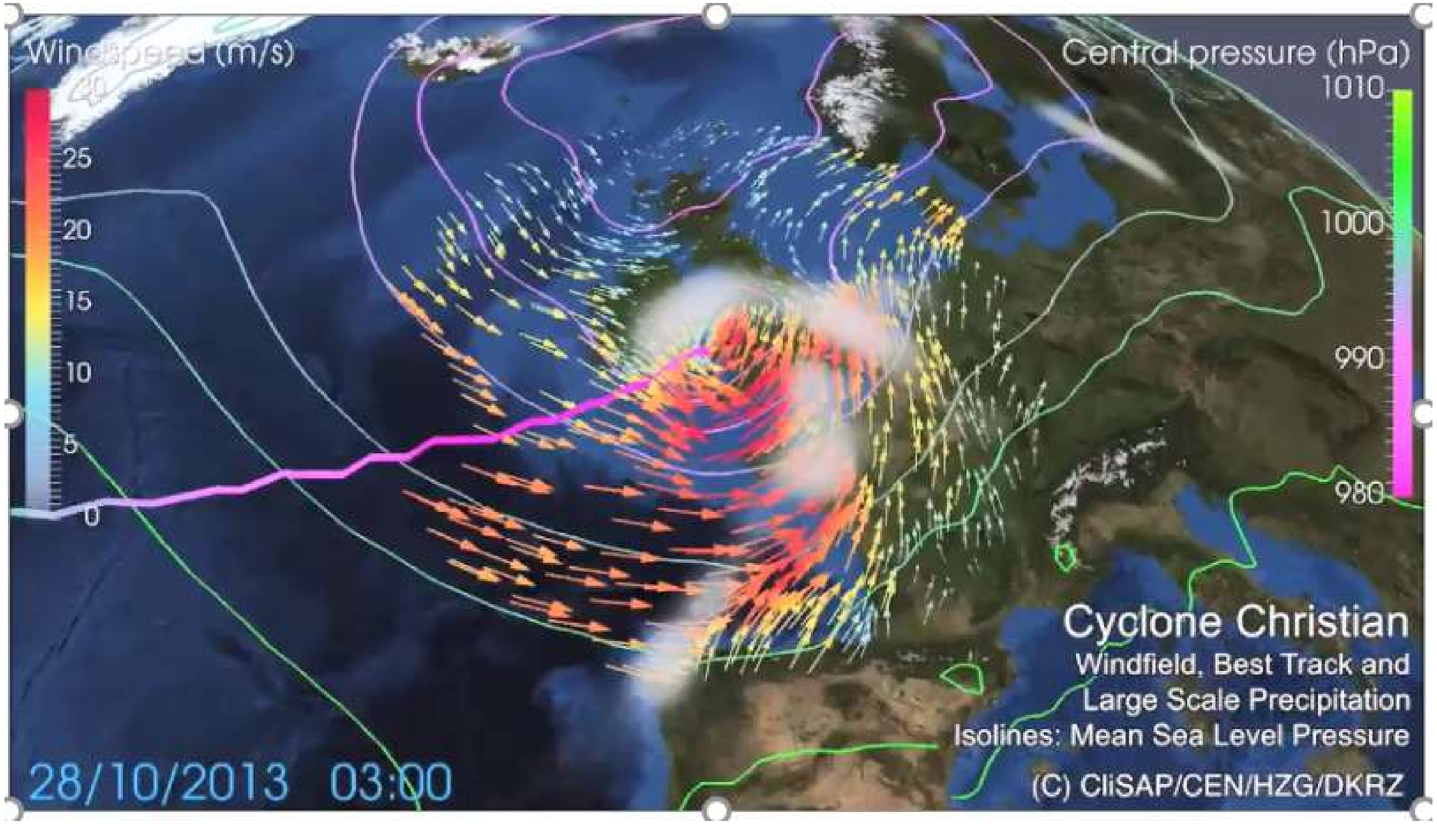


Storm Christian is a secondary depression of the low-pressure system Burkhard.

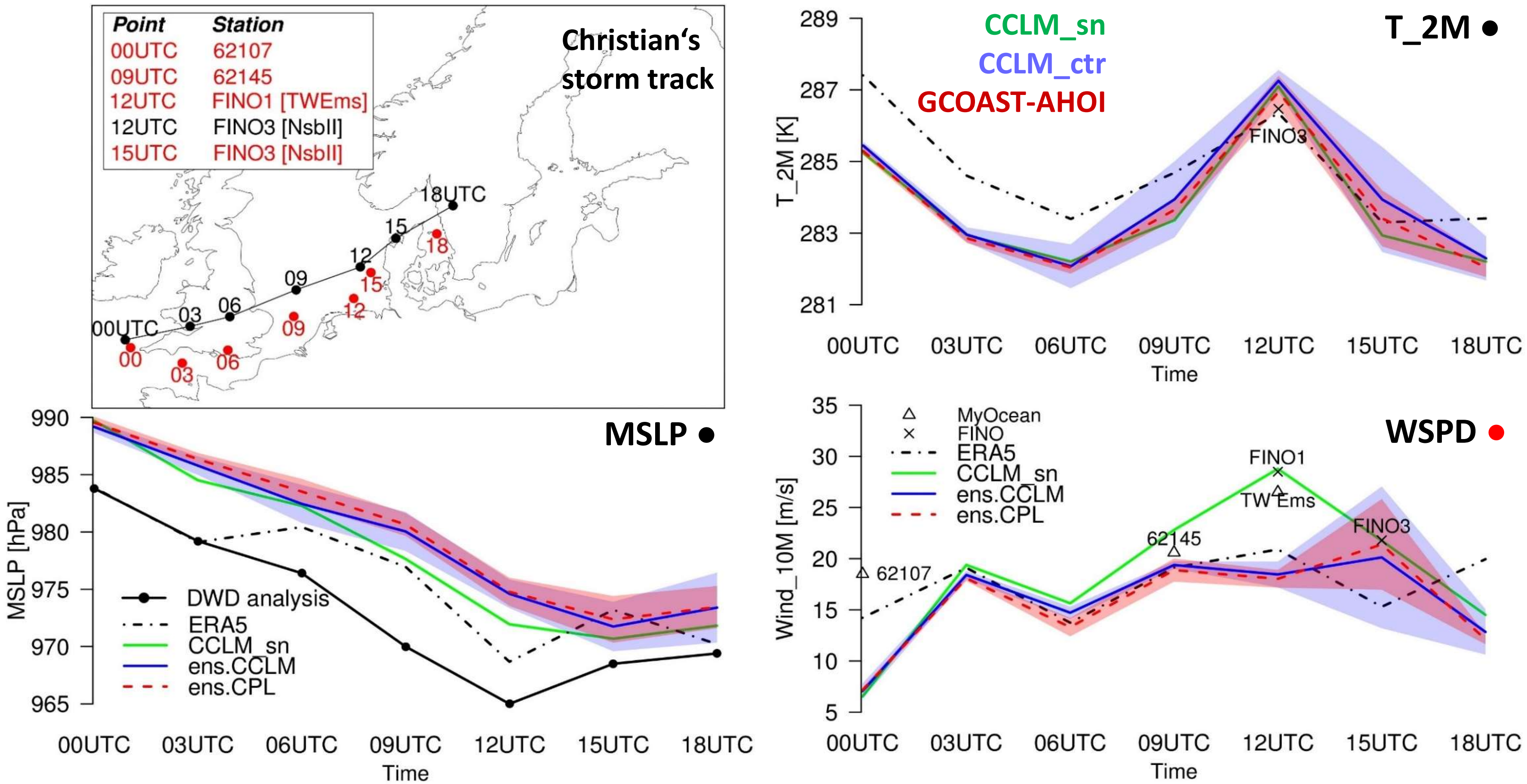
ECHAM6 T255
(res. ~32 km)

[F. Feser, M. Schubert-Frisius, F. Brisca/CliSAP, 2016]

RESULTS

Christian heavy storm

28 Oct 2013



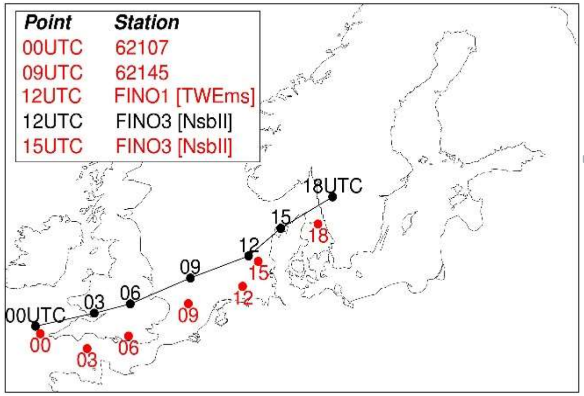
The storm track from DWD analysis (black line and points), locations of max. wind speed (red points) & the three-hourly evolution of several variables.

[Ho-Hagemann et al., 2020]

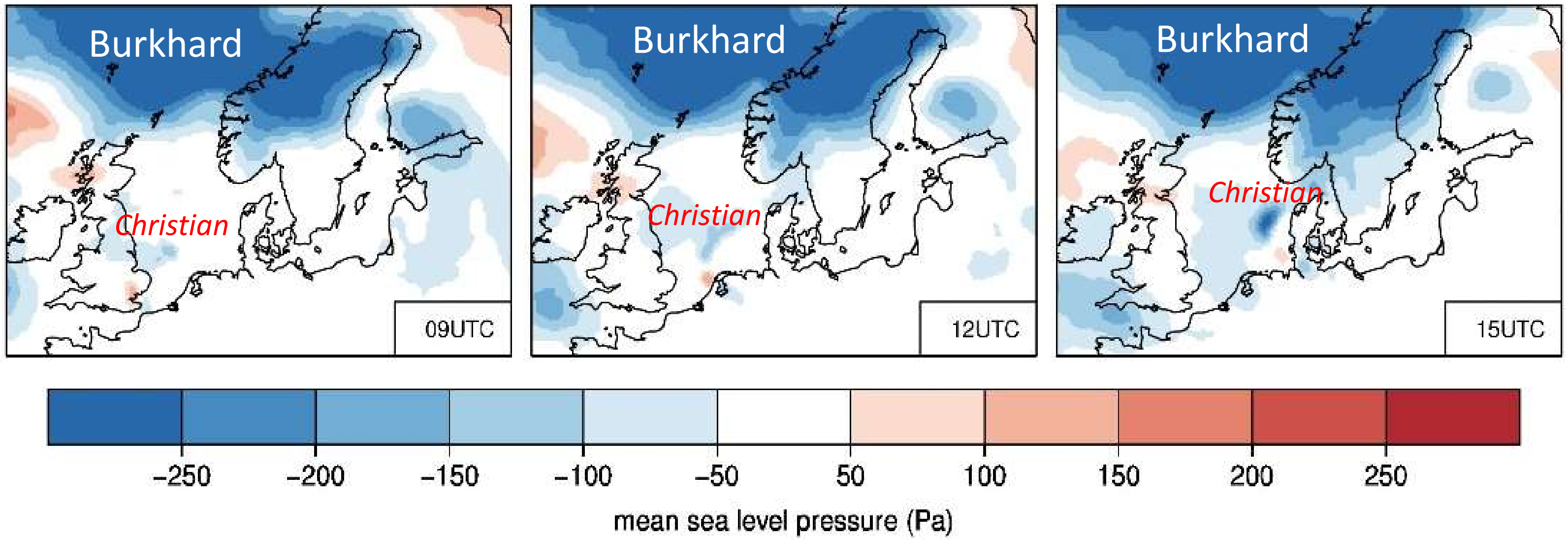
RESULTS

Mean Sea Level Pressure

28 Oct 2013



Ensemble spread GCOAST-AHOI – ensemble spread CCLM_ctr



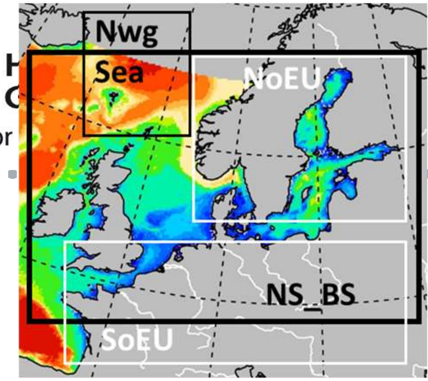
Difference in [Pa] of MSLP between ensemble spread of GCOAST-AHOI and CCLM_ctr for 09 UTC (left), 12 UTC (middle) and 15 (right) UTC on 28 Oct 2013.

[Ho-Hagemann et al., 2020]

RESULTS

10-M Wind speed

Sep – Oct 2013

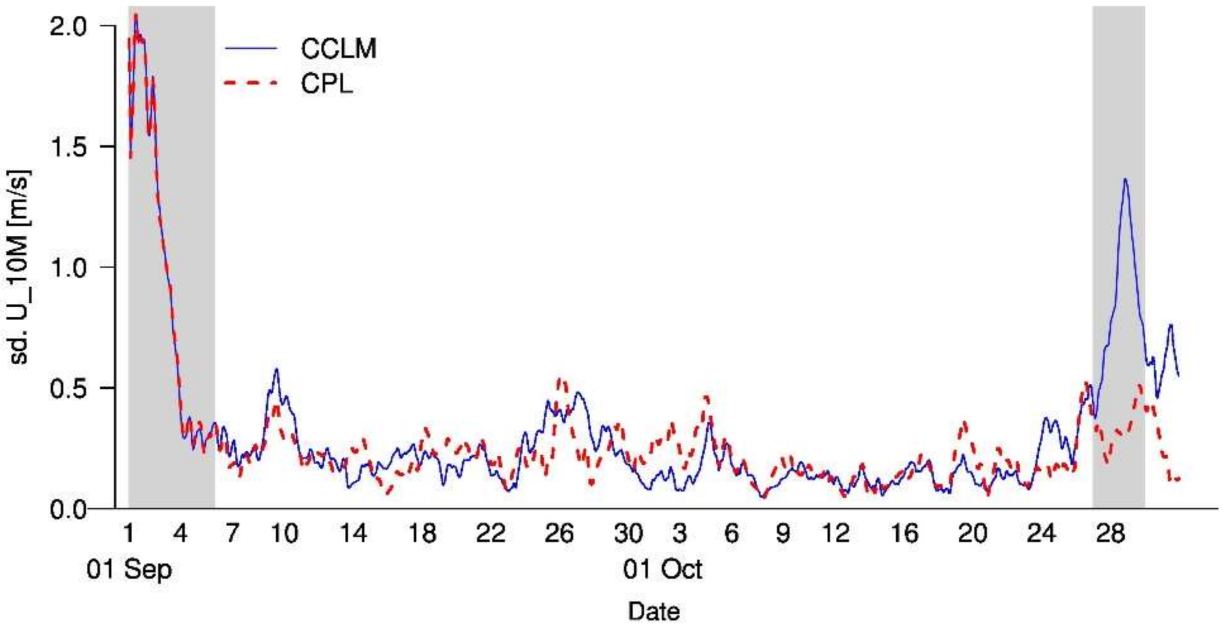


Spread of GCOAST-AHOI (CPL) and stand-alone CCLM_ctr (CCLM)

Averaged over the **NS_BS** area

Spin-up

Christian heavy storm



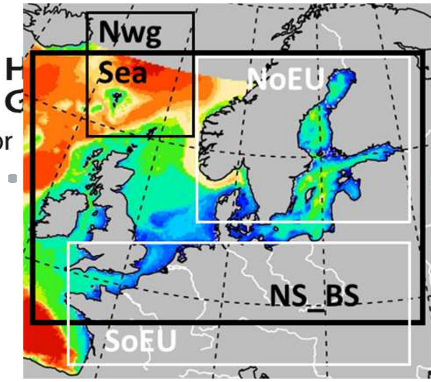
Hourly U_10M spread [m/s] averaged over the NS_BS area.
Time period: 1 September–31 October 2013.

[Ho-Hagemann et al., 2020]

RESULTS

Over land Daily mean standard deviation 01 Oct – 31 Dec 2013

Centre for



Outline

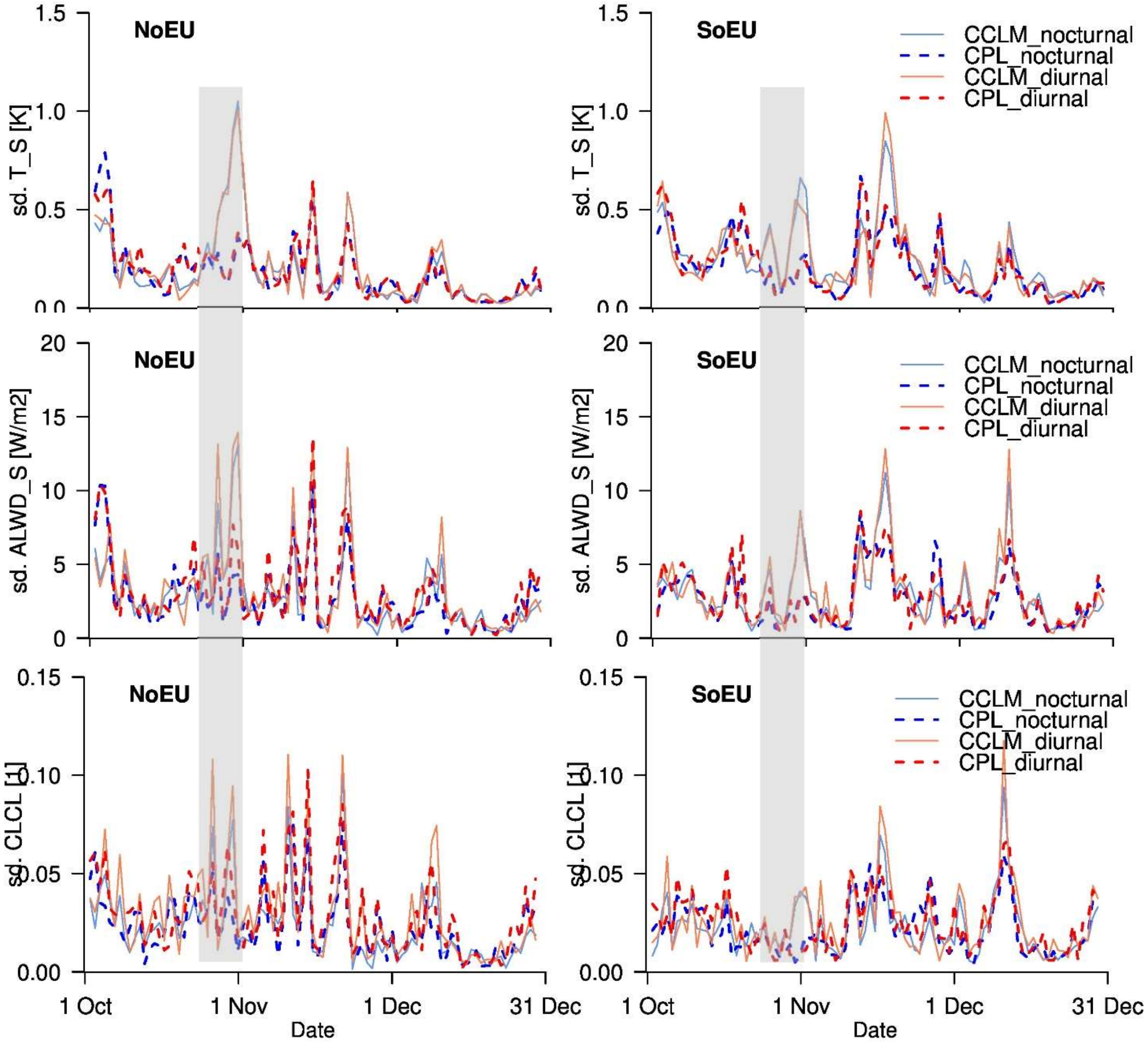
1. GCOAST-AHOI

2. Uncertainty

3. Storm Christian

4. Results

5. Summary



Surface temperature

Surface longwave downward radiation

Low-level cloud cover

[Ho-Hagemann et al., 2020]

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Outline

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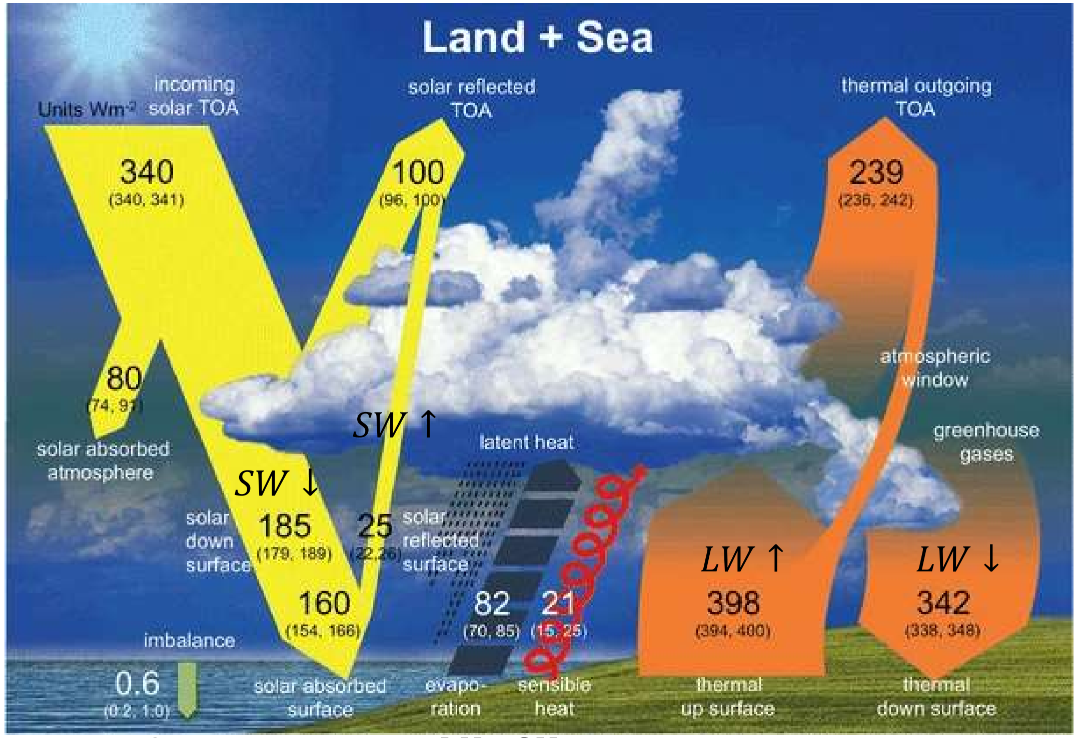
Global annual mean energy balance of the Earth



[Wild et al., 2014]

Numbers indicate best estimates for the magnitudes of the globally averaged energy balance components together with their uncertainty ranges in *parentheses*, representing present day climate conditions at the beginning of the twenty-first century.

Surface energy balance

$$SW + LW - LH - SH - G = 0$$

$$SW = SW\downarrow - SW\uparrow$$
$$LW = LW\downarrow - LW\uparrow$$

$$Rnet = SW\downarrow + LW\downarrow - SW\uparrow - LW\uparrow$$

$$Rnet = LH + SH + G$$

$$G = Rnet - LH - SH = Qnet$$

G is ground heat flux (or heat conducted away from the surface):

$$G = \rho HC \frac{dT}{dt}$$

Over water T is sea surface temperature, ρ is water density (1000 kg/m3), C is the heat capacity of water (4180 J/kg/K), H is the depth of the mixed layer.

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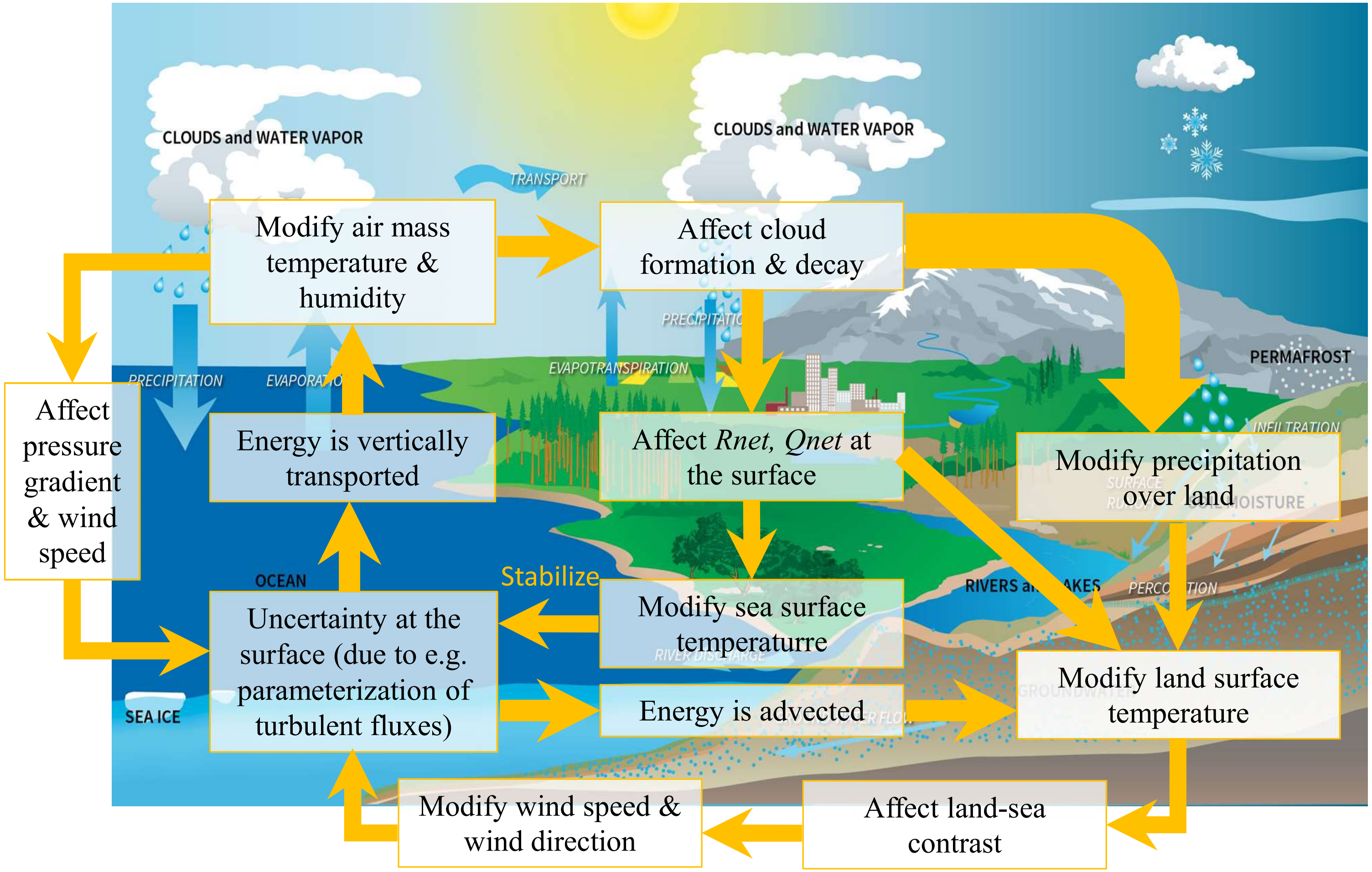
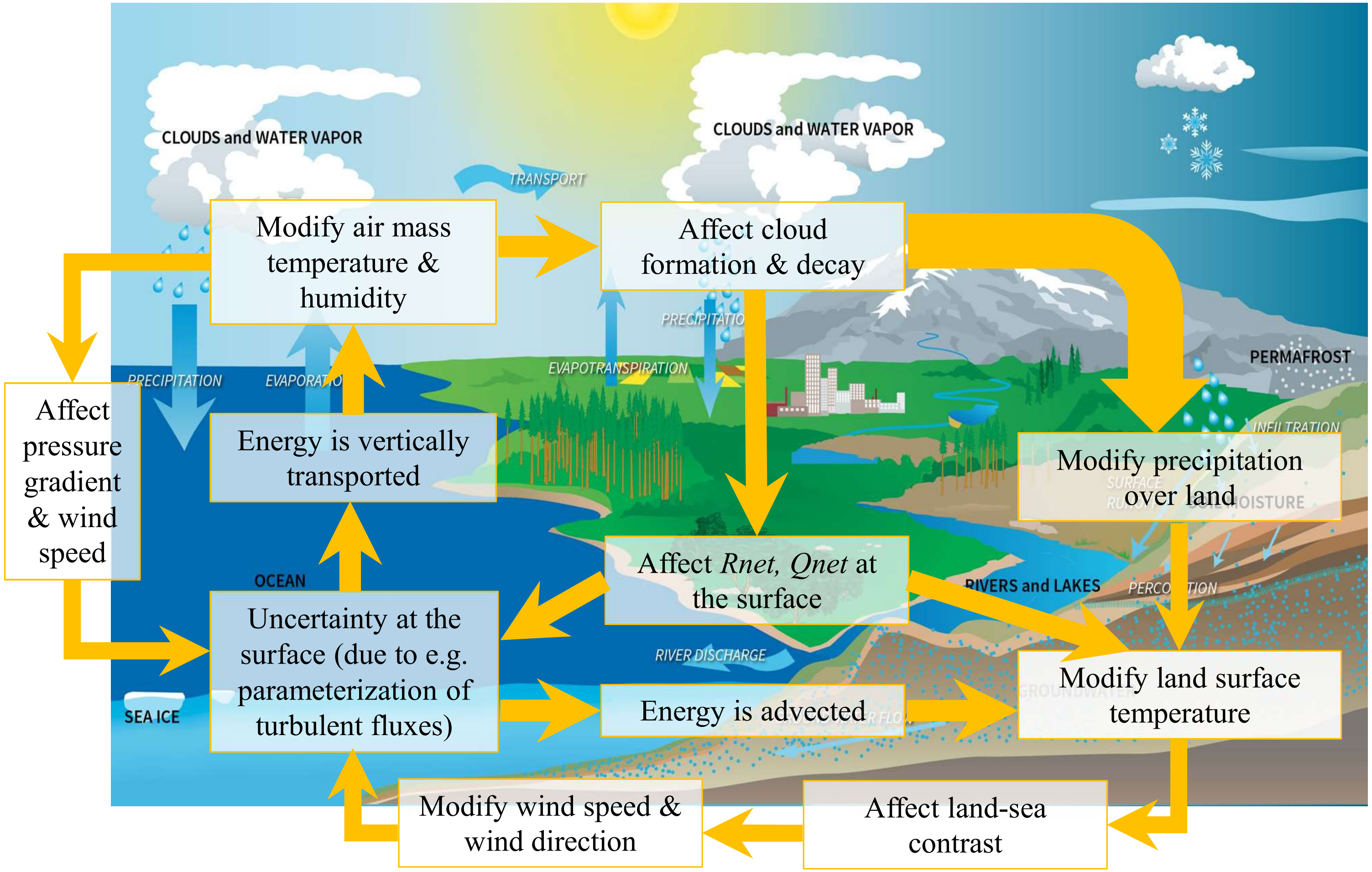
EARTH SYSTEM MODELING



Back ground: Global water cycle (NASA)

ATMOSPHERE ONLY



Back ground: Global water cycle (NASA)

- Simulations of the stand-alone CCLM (CCLM_ctr) vary largely amongst ensemble members during the storm Christian.
- The large uncertainty in CCLM_ctr is caused by a combination of
  - (1) uncertainty in cloud-radiation interaction in the atmosphere, and
  - (2) lack of an active two-way air-sea interaction.
- When CCLM is two-way coupled with the ocean model in GCOAST-AHOI, the spread is remarkably reduced
  - over the ocean where the coupling is done
  - also over land due to the land-sea interactions.

THANK YOU FOR YOUR ATTENTION !