Atmosphere-Ocean Single-Column Model (AOSCM)
A tool to help improve coupled models

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Accelerating model development work
Single-column model – a link between scales and models

AOSCM.v1_EC-Earth3
OpenIFS cycle 40r1/43r3
OASIS3-MCT
LIM3
NEMO3.6

Hartung et al., 2018
GMD

APPLiCATE.eu
Advanced prediction in polar regions and beyond
Atmosphere-Ocean Single-Column Model
Same model components from weather to climate

Mean sea level pressure and wind speed at 850 hPa

ECMWF IFS 10-day forecast

Sea-ice concentration in EC-Earth

AOSCM

Allows for studies of fast processes in all model components and the coupling between them
Focusing on surface energy budget: What atmospheric processes do we need to get right?

- Cloud top cooling $\rightarrow$ mixing
- Solar heating $\rightarrow$ reduced mixing
- Precipitation & evaporation $\rightarrow$ deepening of cloud & reduced mixing
- Long-wave "equilibrium"
- Wind shear $\rightarrow$ mixing

$\sim 2 \text{ K}$, corresponds to $\sim 8 \text{ W m}^{-2}$

Courtesy Thorsten Mauritsen
Focusing on surface energy budget: What atmospheric processes do we need to get right?

Cloud top cooling → mixing

Solar heating → reduced mixing

Precipitation & evaporation → deepening of cloud & reduced mixing

Long-wave "equilibrium"

Wind shear → mixing

Horizontal and vertical advection

Coupling

~ 2 K, corresponds to ~ 8 W m⁻²

Courtesy Thorsten Mauritsen
AOSCM and observations

Allows for detailed comparison with observations
An extreme warm advection episode
Observations on icebreaker Oden, ACSE 2014

1 August (DoY 213)

7 August (DoY 219)

Icebreaker Oden track

Tjernström et al. 2015
An extreme warm advection episode
Observations on icebreaker Oden, ACSE 2014

Temperature (°C)

Spec. hum. (g kg\(^{-1}\))

Eq. pot. temp (°C)
Observed surface energy budget (atmospheric point of view)

\[ F = SW + LW + \text{Turb} \approx 70 \text{ W m}^{-2} \]
Idealized LES simulation
MIMICA, 06 UTC 1 Aug (DoY 213 + 76 h)

Cloud liquid water content (g kg$^{-1}$)

Temperature advection (K h$^{-1}$)
(Similar moisture advection)

Prescribed surface conditions and pressure gradient

Sotiropoulou et al., 2018
LES and ASCM
Cloud liquid water content

![Graph showing LES and ASCM for cloud liquid water content](image_url)
Sensitivity to advection
LES (MIMICA) and ASCM simulation of ACSE case

Moisture advection necessary to maintain the cloud

*Sotiropoulou et al., 2018*
Sensitivity to advection
LES (MIMICA) simulation of ACSE case

Sotiropoulou et al., 2018
Sensitivity to coupling
LES (MIMICA) simulation of ACSE case

Substantial change in net surface radiation coupled/uncoupled
Almost no sea-ice melt and constant mean albedo

Sotiropoulou et al., 2018
AOSCM\textsubscript{LES}
Cloud liquid water content

Time (hours)

LES
ASCM
AOSCM
AOSCM No Q adv.
AOSCM No T adv.

\textbf{g kg}^{-1}
LES AOSCM Updated surface roughness and skin temperature calculation
AOSCM Updated surface roughness
AOSCM Original code
AOSCM

Surface coupling

These changes also give rise to surface energy budget difference...
Concluding remarks

AOSCM makes it possible to study interactions ocean/sea-ice/snow/atmosphere with focus on vertical coupling processes, physical and technical

Large-scale advection and local vertical processes can be separated

AOSCM is developed and maintained within the EC-Earth development portal can also mimic the NWP model

Simulations of the ACSE case show that the coupling has large impact as well as the advection of moisture
AOSCM and MOSAiC

http://www.mosaic-expedition.org