Assimilation of satellite data in a coupled ocean-atmosphere system

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CERA-SAT – A coupled reanalysis

Atmosphere/Land

- **Model:** IFS (CY42R1_esuite, April 2016)
- **Resolution:** TL319 (~60 Km); 137 levels
- **Assimilation:** 24-hour window 4D-Var
- **Full observing system** (including reprocessed datasets)
- **Land surface analysis** weakly coupled

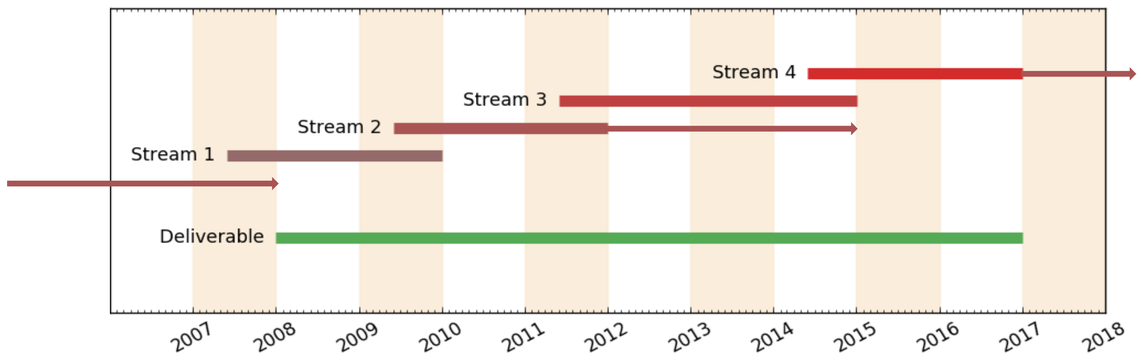
Ocean/Sea ice

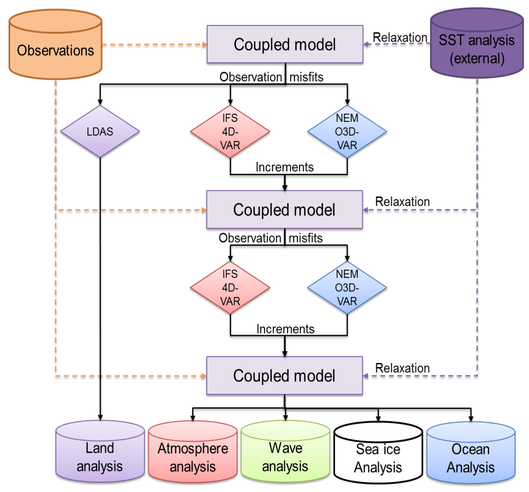
- **Model:** NEMO / LIM2 (CY42r1_nemo_E28)
- **Resolution** (1/4 degree; ORCA025) ~30 km; 75 levels
- **Assimilation:** 24-hour window 3D-Var FGAT
- **Observations:** salinity and temperature profiles, SSH, SI analysis (OSTIA L4)

Wave

- **Model:** WAM (CY42R1_esuite)
- **Resolution:** 0.5 degree
- **Assimilation:** 24-hour window
- **Observation:** ERA5 observing system

Production





Implementation of coupling in the outer loop of the 4D-Var system

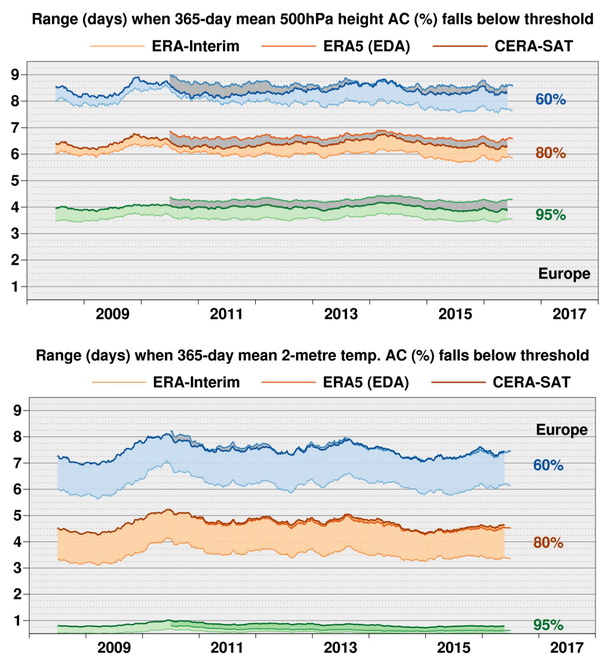
- Initially planned as a research dataset to span a total of eight years
- Four streams with half-a-year overlap to reduce spin-up effects
- Production completed in 11 months

- Currently producing an additional stream from 2004
- Extending Stream 4 beyond 2017
- Further spin-up studies to be based on Stream 2 extension

Performance

- In terms of headline forecast scores, CERA-SAT is better than ERA-Interim, but worse than ERA-5
- Verification of near-surface parameters, however, indicates similar or better performance level in CERA-SAT as in ERA-5

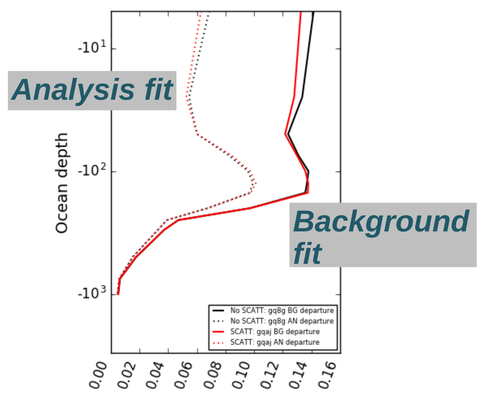
- The performance gap is (at least partially) attributed to longer time window in CERA-SAT (24 hours vs. 12 hours in ERA-5)



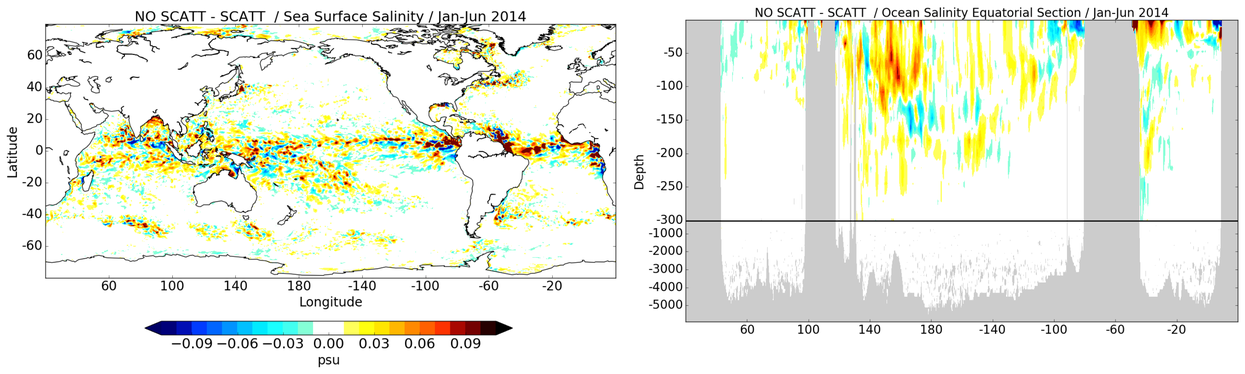
Forecast range at which anomaly correlation falls below given thresholds in Europe

Salinity impact from wind observations

- Through modifying the near-surface wind field, scatterometer data impact forecasted rain more directly than what would be possible without coupling
- More (less) rain means more (less) freshwater flux and less (more) ocean salinity



*Mean fit to in situ salinity data when scatterometer data are (**red**) or are not (**black**) used.*



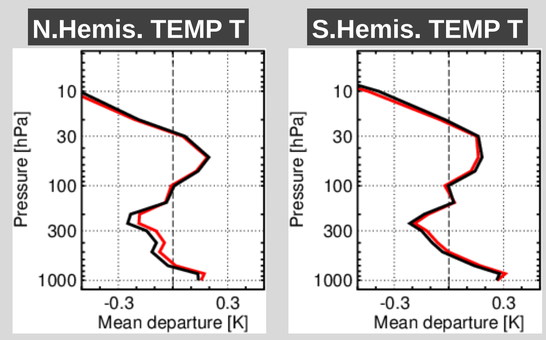
Impact of scatterometer wind data on mean salinity (left) at the sea surface and (right) in a vertical cross-section along the Equator.

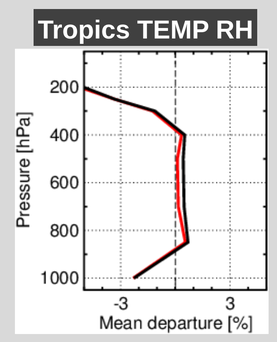
Impact of coupling on system performance

Impact of coupling is studied using a reference stream that is otherwise identical to the CERA-SAT system, but does not apply coupling in either analysis or forecast model. The comparison is made over a 16-month period starting in May 2015.

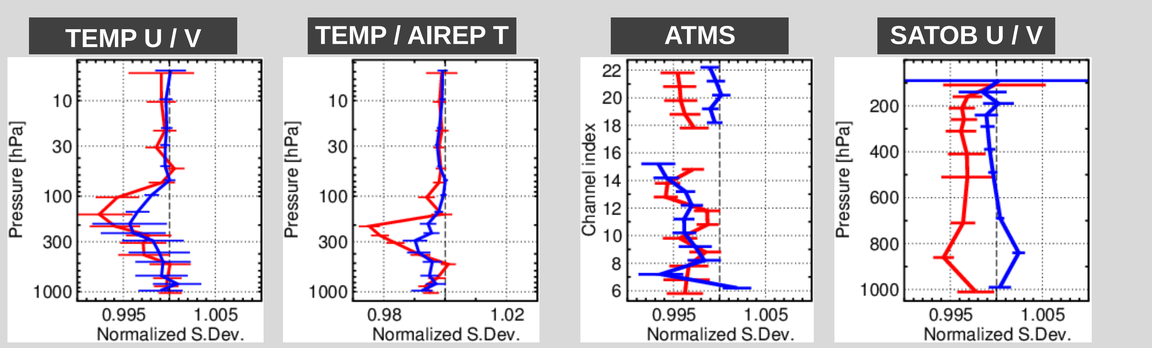
The coupled system being slightly colder and moister than the uncoupled reference, mean observation minus background (OmB) departure statistics suggest a generally positive impact from the coupling.

Conventional and satellite data are consistent in indicating more benefit in the Tropics than in the Extratropics. The medium-range forecast impact agrees with this finding.

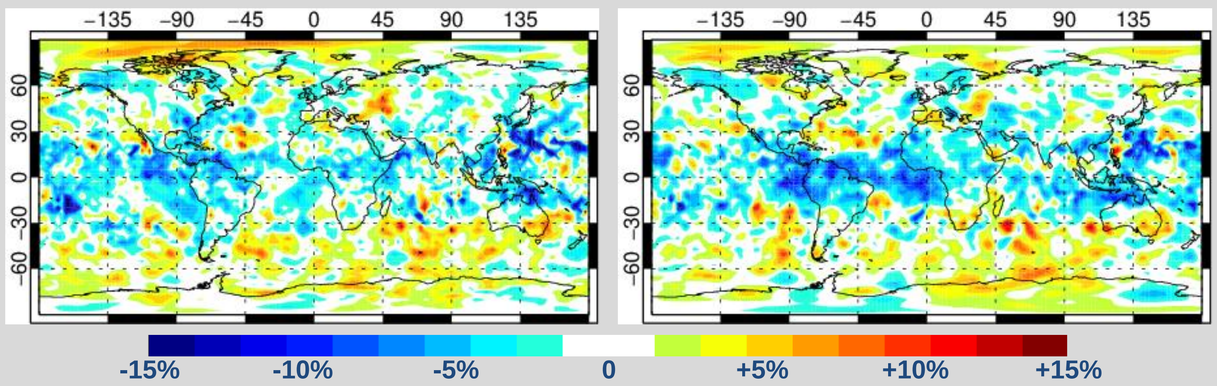




*Mean observation minus background departure fit in a **coupled (red)** and in an **uncoupled (black)** system.*



*Impact of coupling on observation to background fit in **Tropics (red)** and **Extratropics (blue)**. Bars indicate the 95% confidence intervals.*



Impact of coupling on five-day forecast of mean sea level pressure (left) and 500 hPa geopotential height (right). Blue indicates reduced forecast error standard deviation.

Acknowledgements

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