SERVICE
ALTIMETRIE
&
LOCALISATION
PRECISE

Analysis of wind speed evolution over ocean derived from altimeter missions and models

M. Ablain, M. Urvoy, N.Tran (CLS)
E.Bronner, N.Picot (CNES)

Overview

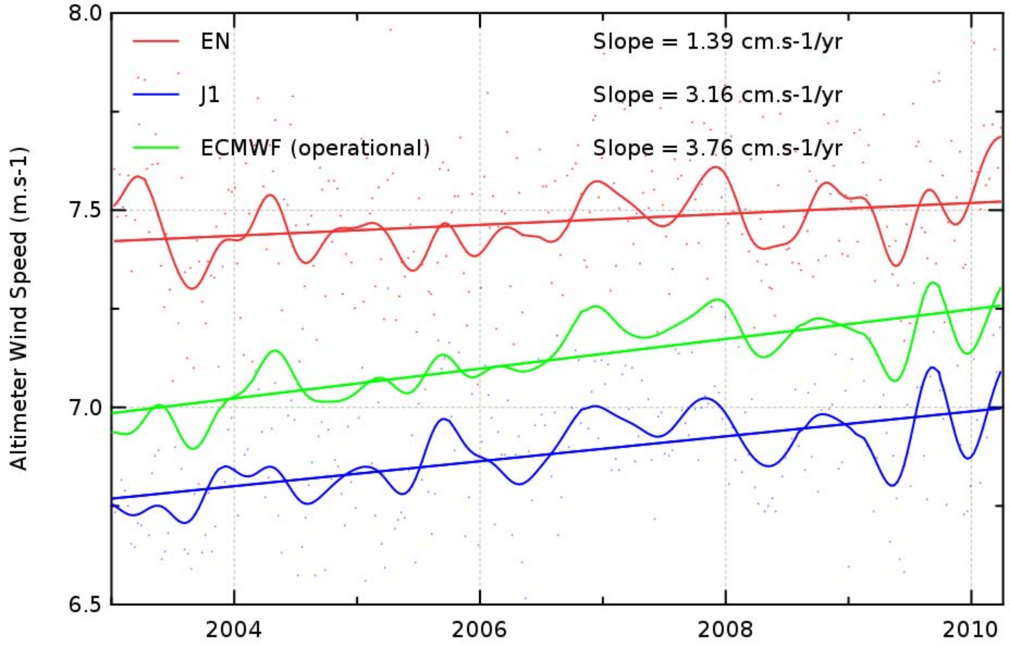
- The wind speed evolution derived from Jason-1 and Envisat Sigma-0, and ECMWF operational model has been already computed from 2003 to 2008 and displayed trend differences (Ablain et al. , 2009).

- Here, we have updated wind speed evolution until 2010.
- After removing annual and semi-annual signals and filtering out 6-months period, wind speed trend differences are highlighted:

⇒ Jason-1 : 3.2 cm.s-1/yr

⇒ Envisat : 1.4 cm.s-1/yr

⇒ ECMWF: 3.8 cm.s-1/yr



Objectives

- In this study, objectives are:

⇒ Analyze the stability of Jason-1 and Envisat Sigma 0 thanks to wind speed cross-comparisons between both altimeters and reanalyzed models such as ERA-interim (ECMWF) and NCEP.

⇒ Extend the analysis to TOPEX, ERS-2 and Jason-2 Sigma0

⇒ Deduce the evolution of wind speed over ocean from 1993 onwards

- Some comments about data used:

⇒ Wind speed is a by product of the altimeter processing, not assimilated in ECMWF model for example, mainly used to derive the SSB. But this parameter can be very important in the frame of the Climate evolution

⇒ ECMWF model is an operational model and it is impacted by jumps as a result of model evolutions

⇒ ERA-interim and NCEP wind speed reanalyses have not assimilated altimeter parameter, but they have both assimilated QuickSCAT data.

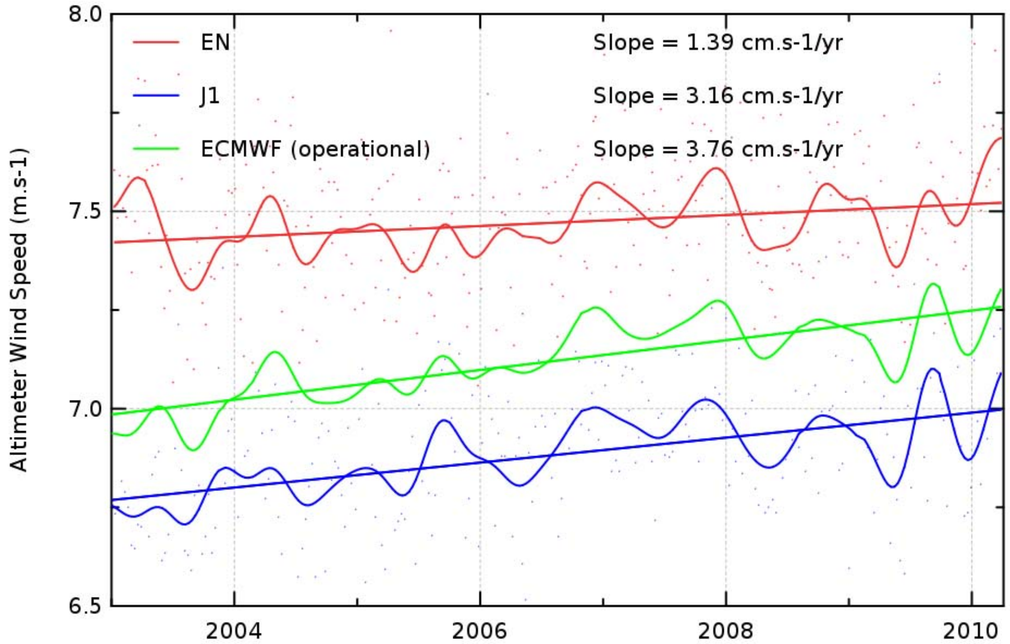
⇒ Envisat wind speed has been reprocessed with the same algorithm (Jensen, 2006).

⇒ Jason-1 wind speed is derived from GDR-C release (Collard algorithm)

⇒ TOPEX wind speed has been reprocessed with Gourrion algorithm from M-GDR products

Ocean Wind speed stability over Jason-1/Envisat period

- We have superimposed ERA-interim and NCEP to the global wind speed evolution over ocean derived from Jason-1, Envisat and ECMWF (operational)



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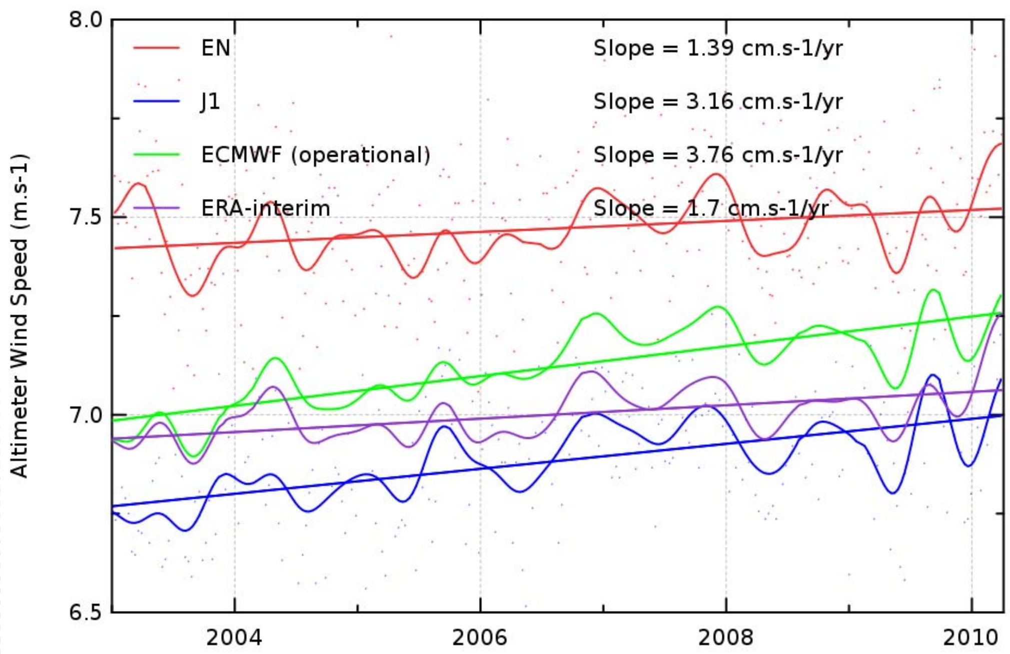

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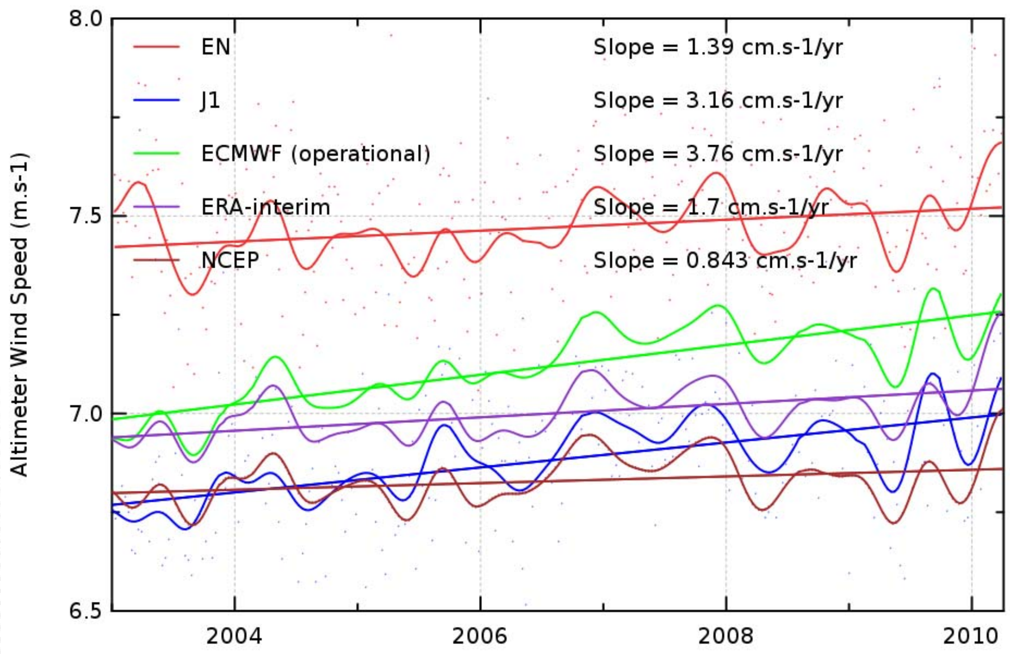
⇒ NCEP highlights a global trend close to 0.8 cm.s-1/yr

- Although all curves are very well correlated for signals < 1 year, global trends are quite different within 3 cm.s-1 /yr.

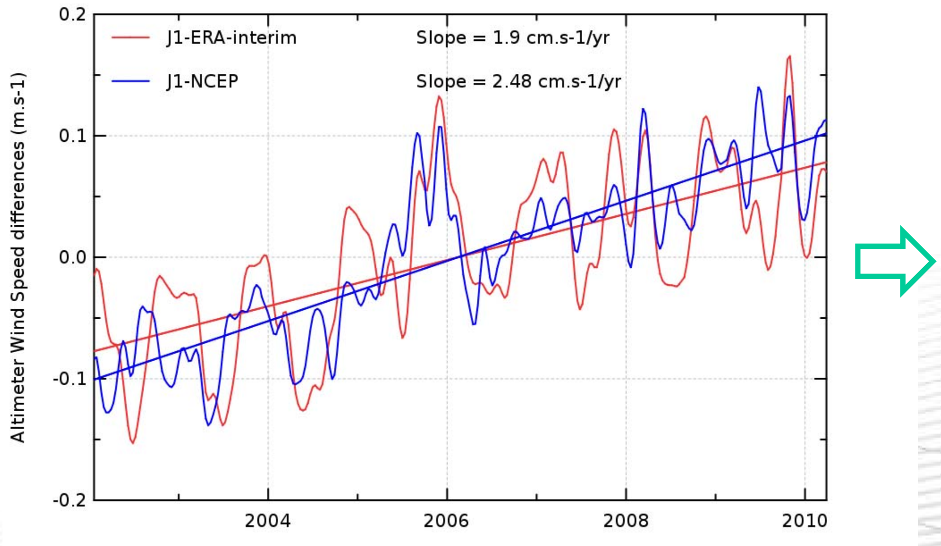
- But all curves display an ocean wind speed rise.

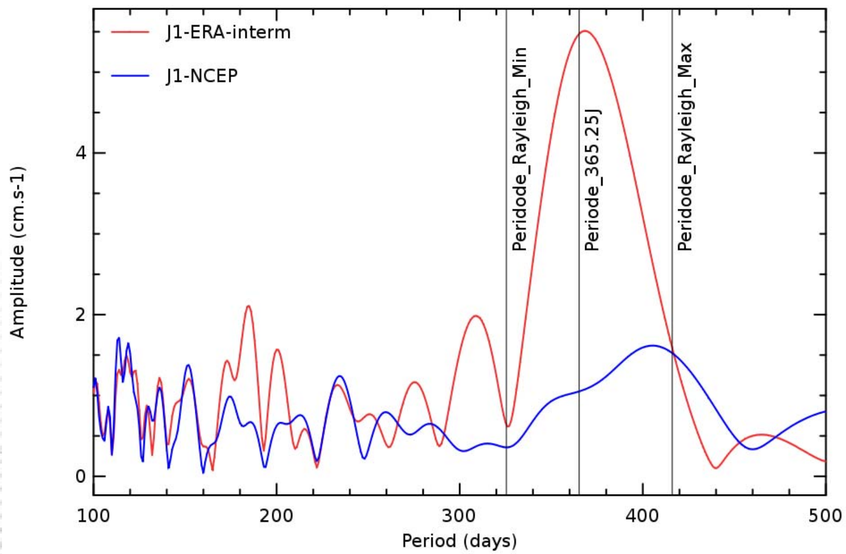


Ocean Wind speed stability over Jason-1/Envisat period

- We have calculated global ocean wind speed differences between altimeters (Jason-1, Envisat) and models (NCEP,ERA-interim)

⇒ NCEP is more consistent than ERA-interim with altimeter wind speed in terms of global annual signal : 6 cm.s-1 amplitude difference.





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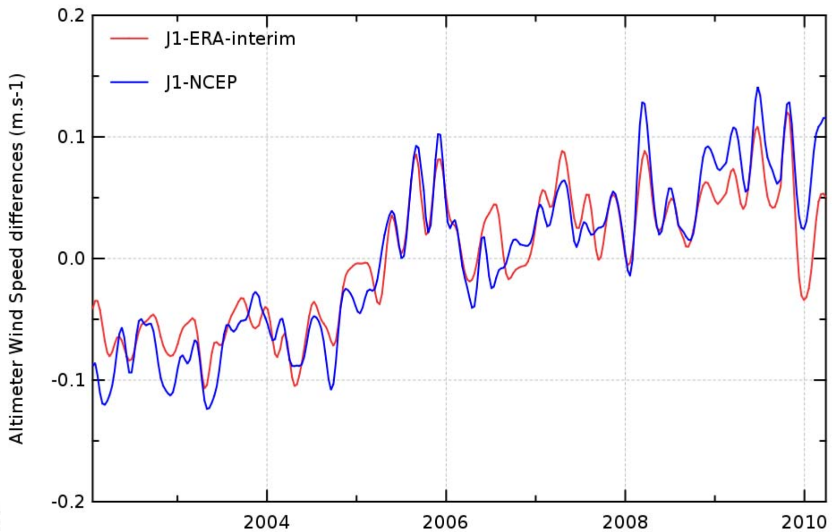

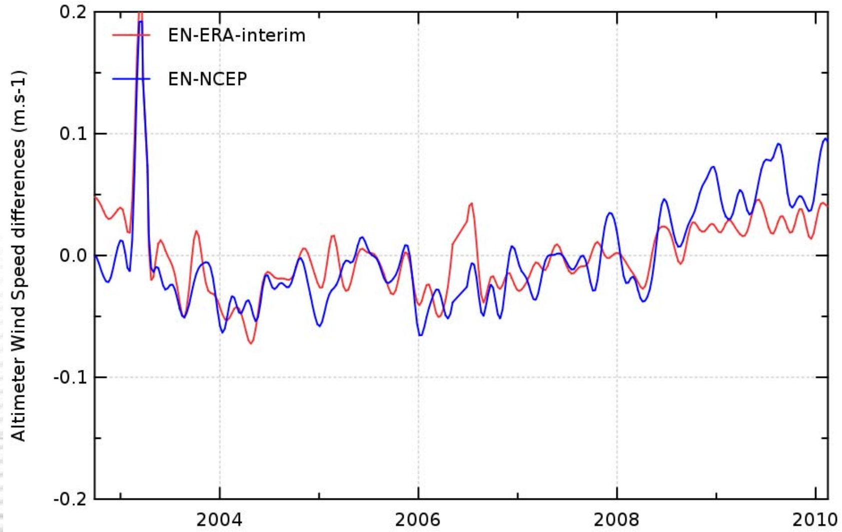

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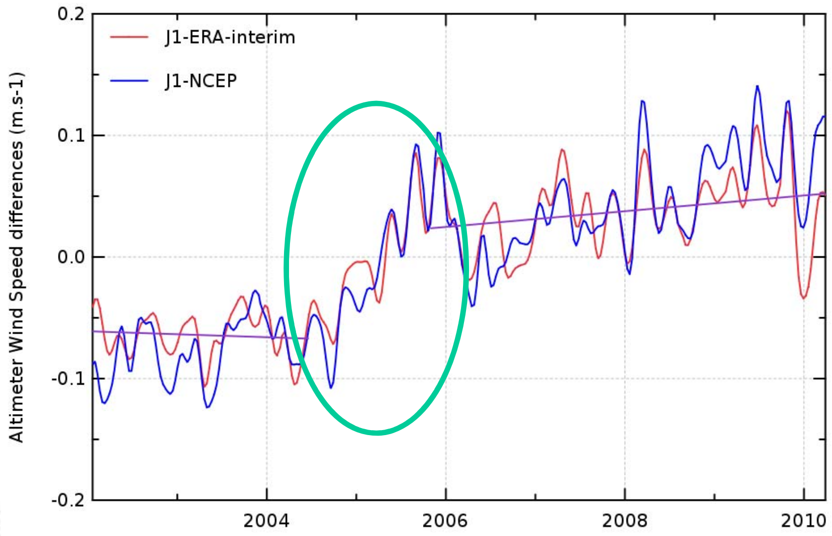

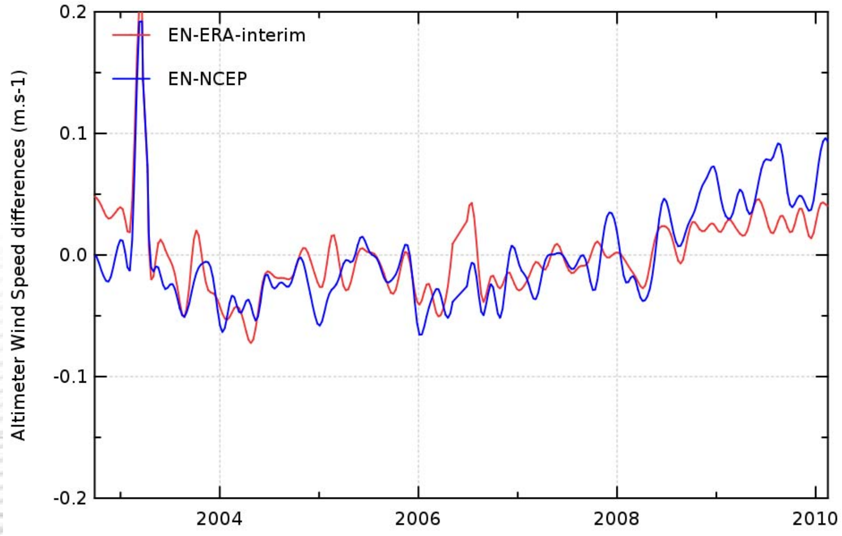

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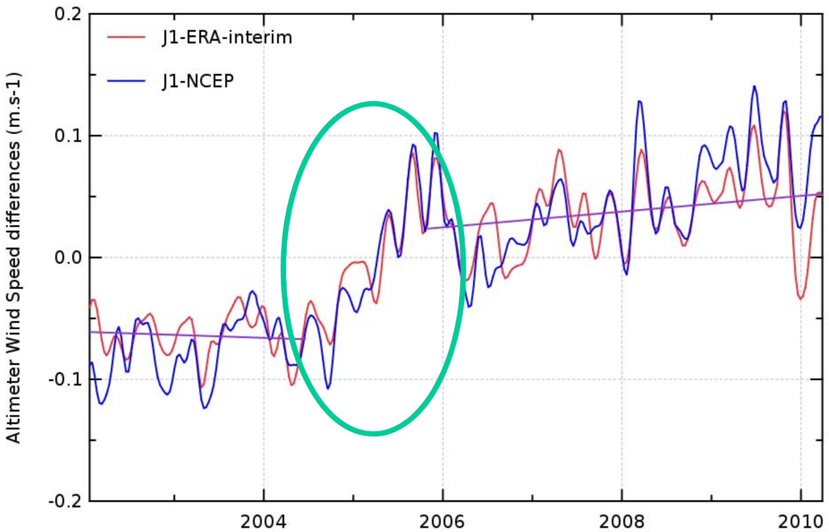
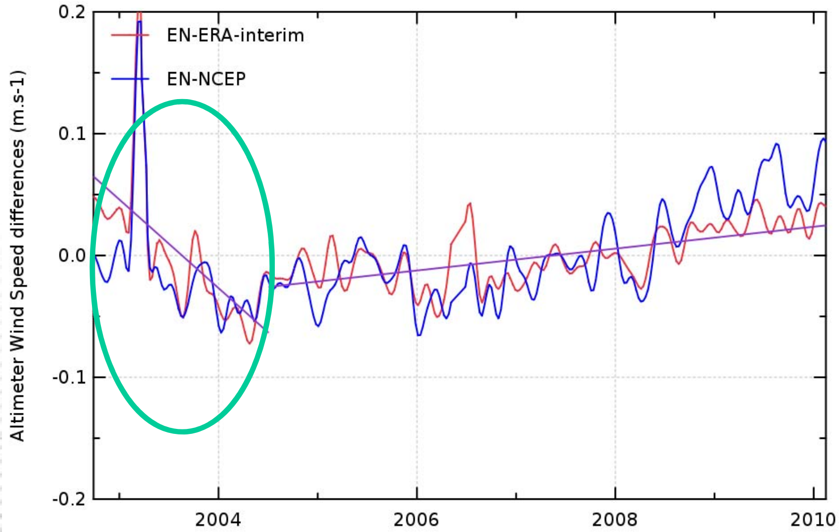
⇒ Envisat : ~10 cm.s-1 drift detected on 2003 (not seen on models and Jason-1)



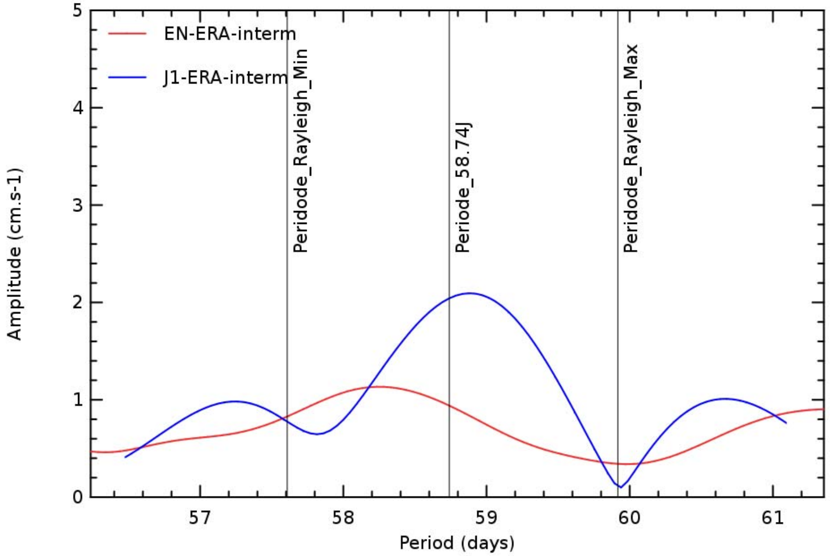


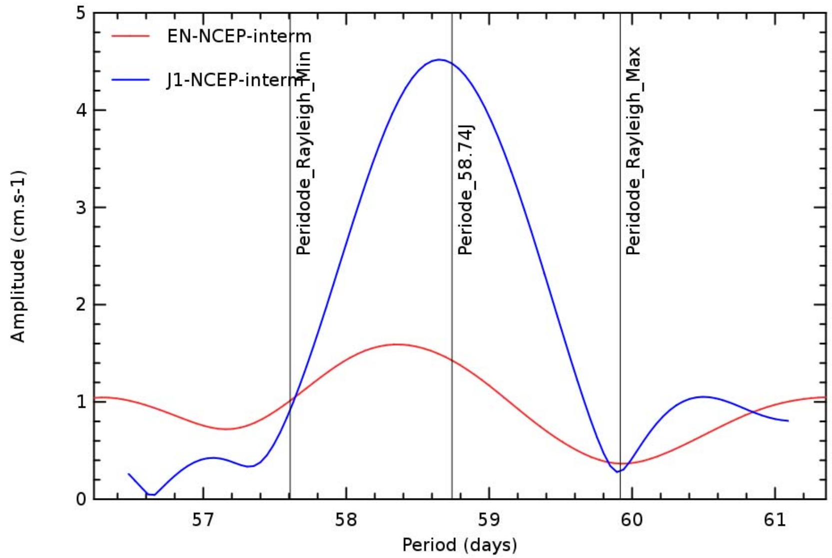
59-day signals on Jason-1 wind-speed

- We have also observed a better wind speed consistency for shorter wavelengths between Envisat and models than between Jason-1 and models.
- This could be due to a 59-day periodic signals detected on Jason-1 and not observed on models
  - ⇒ Amplitude is lower between Jason-1 and ERA-interim (2 cm.s-1) than between Jason-1 and NCEP (4.5 cm.s-1)
- The origin of this discrepancy has to be thoroughly studied:

⇒ It is maybe in relationship with Jason-1 mispointing (60-days variations)

⇒ Problem already detected by G.Quartly (Marine Geodesy. 2010)



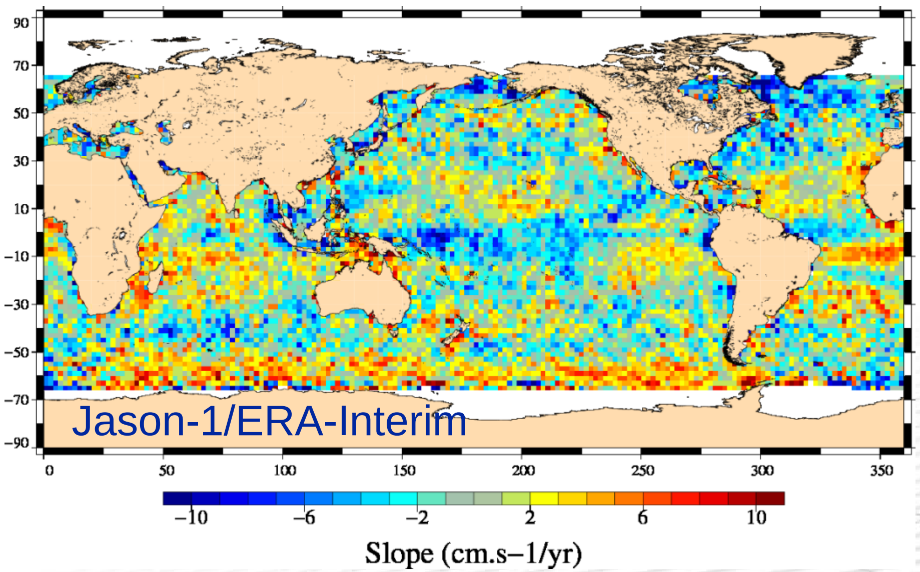


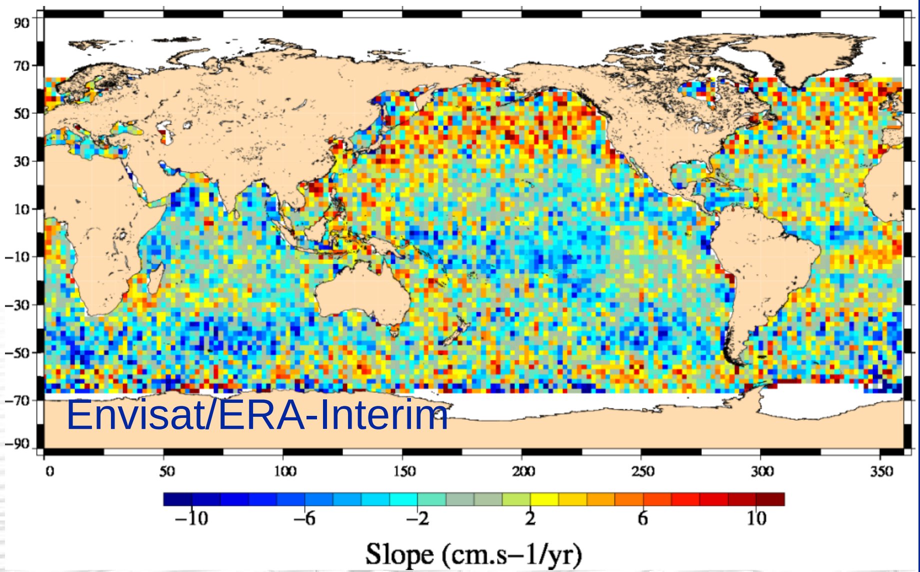
Spatial Wind speed trend differences over Jason-1/Envisat period

- We have calculated local trend differences between each altimeter and models
- Both altimeter wind speeds highlight local differences with ERA-interim between +/- 5 cm.s-1 but not very well correlated together especially at high latitudes :

⇒ It is maybe the impact of introducing SWH in Gourrion algorithm for Jason-1

- ERA-interim local trends are significantly more consistent with altimeter wind speed than NCEP ones (not shown here)

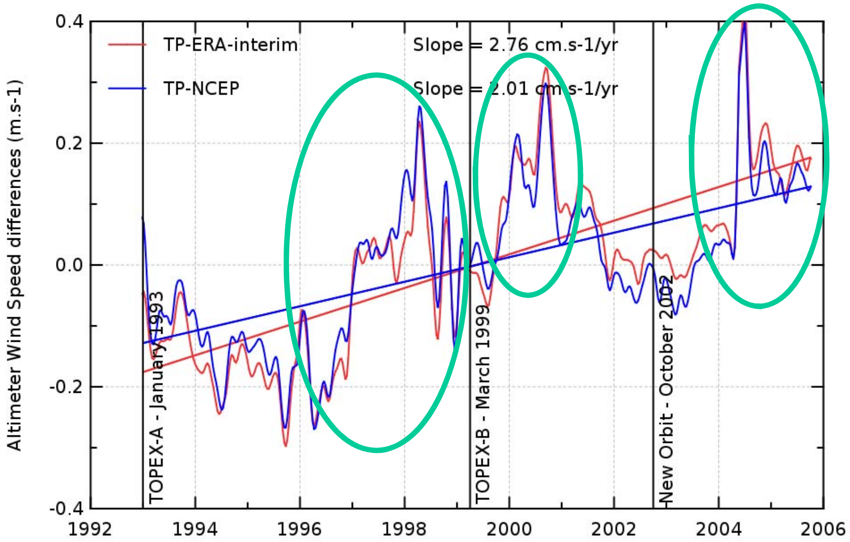




Local wind speed trend differences after centering on the average global trend

Ocean Wind speed stability over TOPEX/ERS-2 period

- We have also calculated global ocean wind speed differences from TOPEX and ERS-2 wind speed
- For TOPEX, we detect a jump (2004) and strong oscillations between 20 and 30 cm.s-1 between 1996 and 1999 and in 2001 : a strong drift is finally observed (+2.8 cm.s-1/yr)
- Correcting the TOPEX-B Sigma0 by delta correction not applied in M-GDR and proposed by D.W. Lockwood (NASA, 2006), oscillations are reduced but the slope remains strong.



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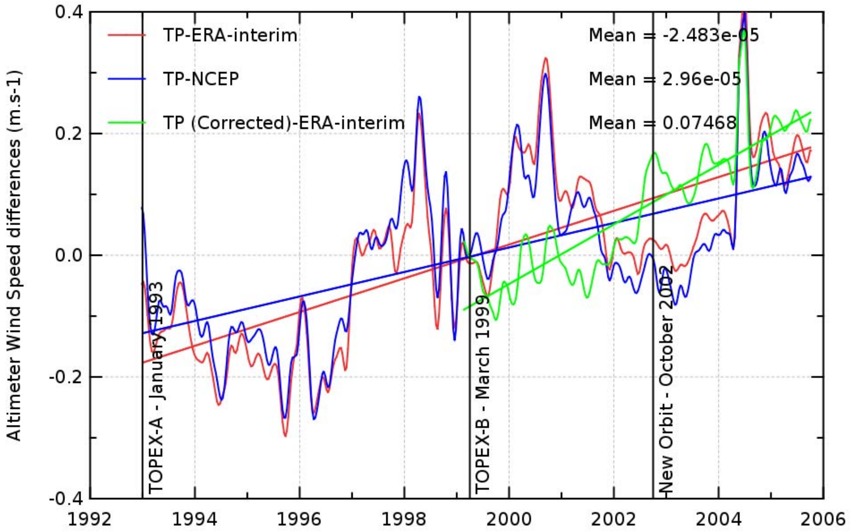
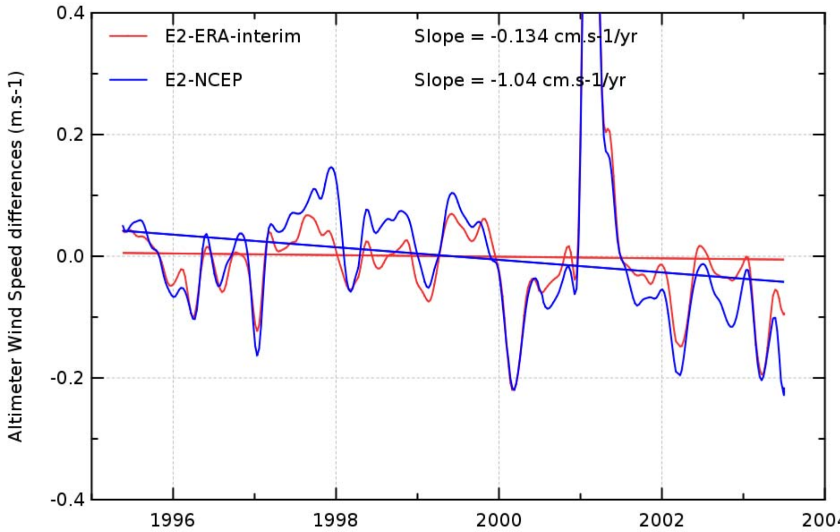
- For ERS-2, excepted a strong anomaly in 2001 (40 cm.s-1), differences are more stable and do not display patterns observed with TOPEX: a low negative drift is displayed.





Summary and conclusions

- As global ocean altimeter and model wind speed are very well correlated together at small temporal scales (<1yr), it is possible to detect small jumps, oscillations or drifts :

⇒ 10 cm.s-1 drift in for Jason-1 in 2004/2005 and Envisat in 2003

⇒ 20 cm.s-1 jumps for TOPEX (1996-1998,2002,2005)

⇒ 40 cm.s-1 jump for ERS-2 in 2001 with a small negative drift

- Keep in mind that a global 10 cm.s-1 wind speed jump corresponds to a 0.025 dB Sigma0 jump:
- Such small jumps are inside Sigma0 stability requirements but they could impact :

⇒ MSL accuracy through the SSB correction

⇒ Wind speed calculation and long-term evolution

- MSL issue :

⇒ Impact is low but not negligible :

  ⇒ Jason-1: 10 cm.s-1 wind speed jump in 2005 ⇔ jump of +0.6 mm on the SSH

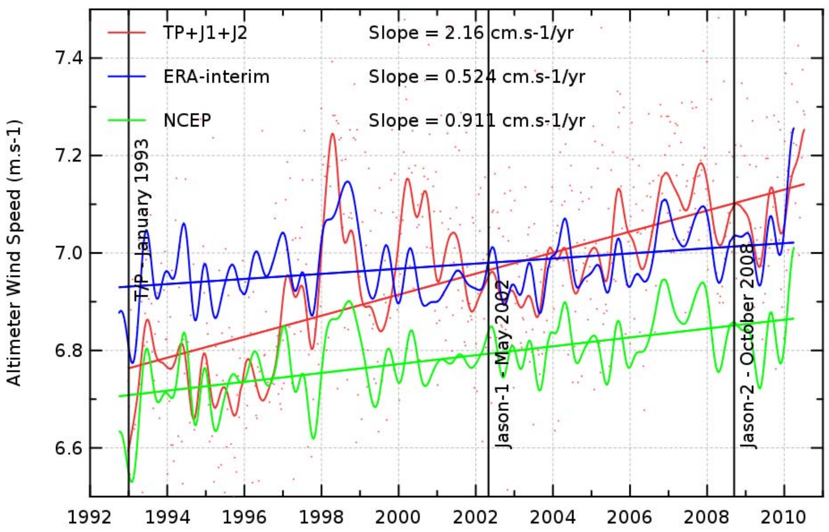
  ⇒ TOPEX : +2.5 cm.s-1/yr wind speed drift ⇔ drift of +0.15 mm/yr on the MSL

⇒ These Sigma0 instabilities can also highlight instrumental anomalies impacting MSL evolution more strongly : end of TOPEX-A, Envisat MSL drift in 2003, …

Summary and conclusions

- Thanks to this study, we can also characterize the ocean wind speed evolution better :

⇒ A positive global trend seems to be highlight from 1993 onwards : about +1 cm.s-1/yr within 0.5 cm.s-1/yr differences (+0.5 cm.s-1/yr for ERA-interim , +0.9 cm.s-1/yr for NCEP, +1.5 cm.s-1/yr after correcting anomalies).



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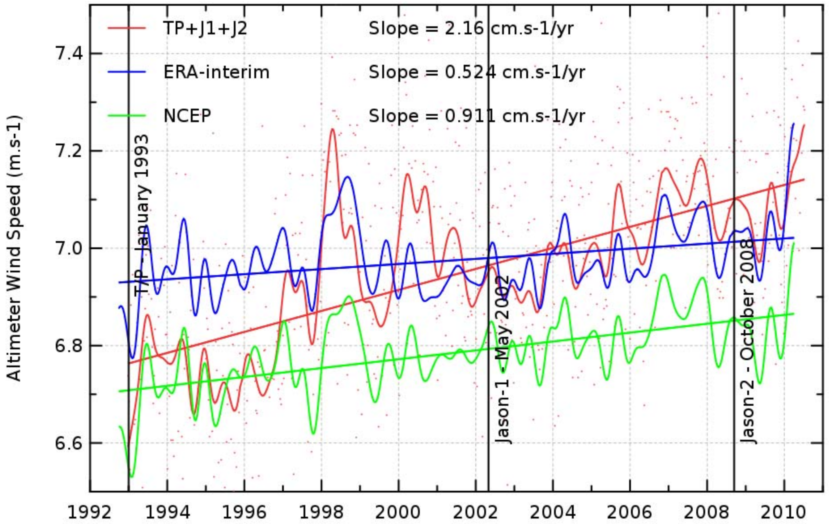
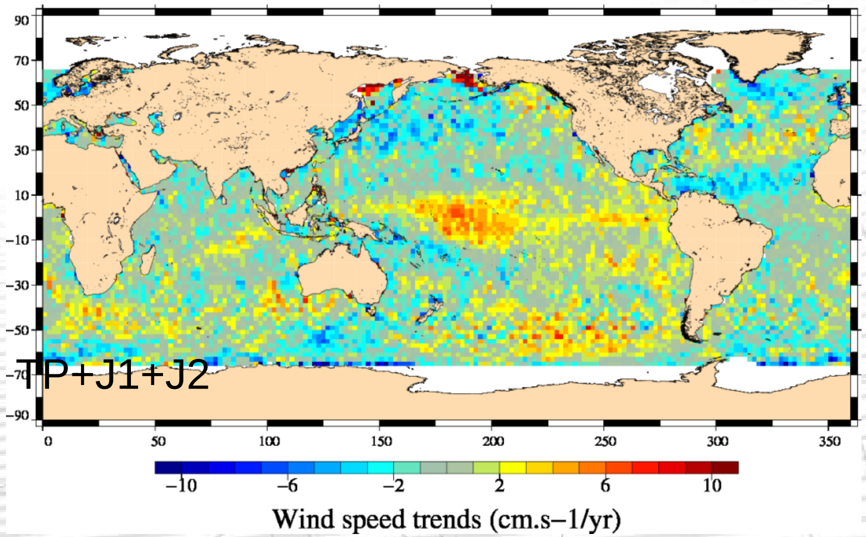
⇒ Local wind speed trends do not highlight the same spatial structures between altimetry and models together : +/- 5 cm.s-1/yr wind speed differences





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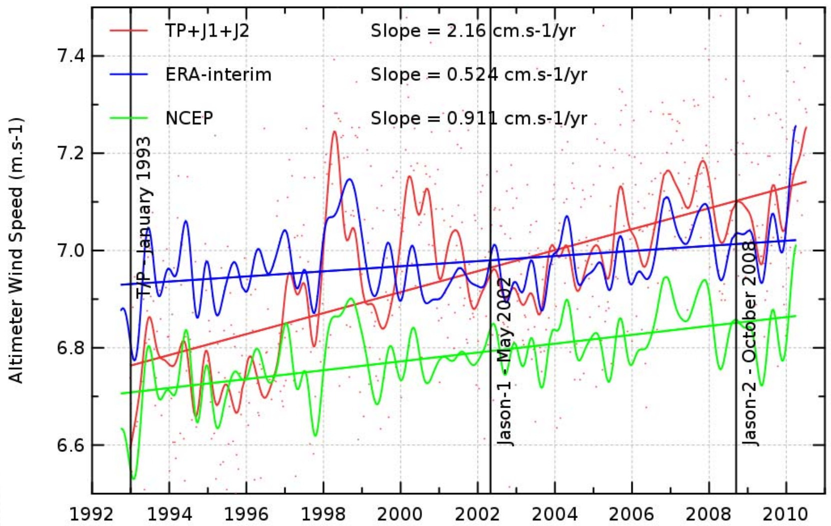

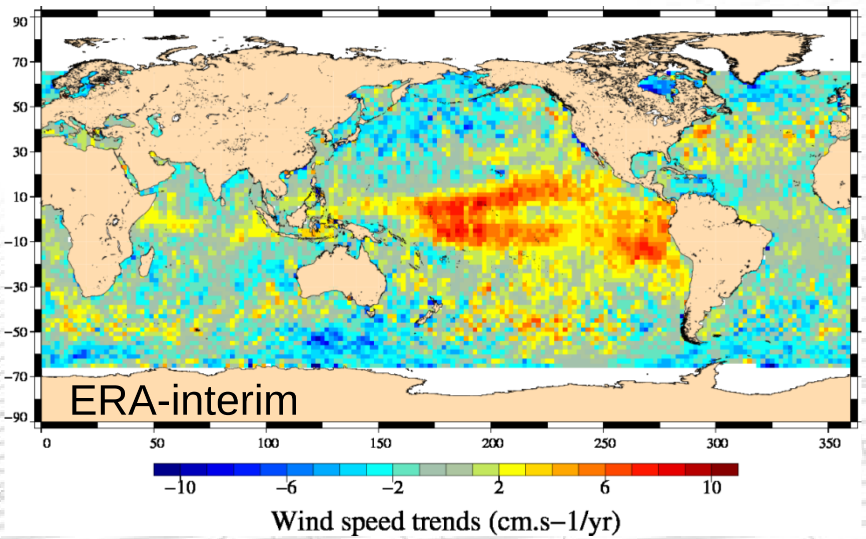

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- Given these differences between models and considering the wind speed evolution as an indicator of the climate change, it seems important to improve the long-term stability of altimeter wind speed and therefore the sigma-0 parameter for climate studies.