Wet Tropo, SSB round table

Jason-CS Configuration

For programmatic reasons, one of the Jason-CS configuration options under feasibility study is the embarkation of both US (Jason-2 heritage) and EU (ERS/Envisat heritage) radiometer

1. Are the scientific benefits of a three frequency radiometer over a two frequency system clear enough to recommend one or the other for Jason-CS?

2. Is there any science benefit to having two radiometers on-board? In particular:
   - Could the simultaneous operation of two radiometers be an asset in terms of estimation and effective minimisation of radiometer drift in wet tropospheric path delay retrievals?
   - Would there be any science benefit in having different centre frequencies for the two radiometers, considering the frequency channel used to estimate the cloud water content is already different between the MWR and AMR-C?

Jason-CS Climate Requirement

As a result of OSTST 2010 meeting (P.7, [AD-2]), the Jason-CS Mission Requirements Document states as a requirement,

"Jason-CS shall measure globally averaged sea level, relative to levels established during the calibration and validation phase, with zero bias ±1 mm (standard error) averaged over any one year period."

Consultation is requested in order to clarify the meaning of this requirement since it can be interpreted, as the system shall have no drift, see comment box in [AD-1], which is difficult to verify. The consultation should help identify how the requirement can be broken down in order that partner agencies can supply the hardware requirement to industry.

Also, consideration should be given whether this drift requirement must be met through instrument design or characterization or whether it can be left to the science team as a post-launch calibration effort.

- Technical report provided by E. Obligis et al., in response:

What type(s) of microwave radiometer for Jason-CS?

E. obligis, G. Dibarboure, B. Picard, CLS

J.D. Desjonqueres, CNES

The aim of this technical note is to provide feedback elements to the technical ESA note (JC-TN-ESA-MI-0034), regarding the radiometer(s) envisioned for Jason-CS.

1. Long term stability: the main issue for the Jason-CS radiometer(s)

Looking back at past and present missions from ERS-1 to Jason-2, all microwave radiometers have been providing a very good estimate of small scale variability of the atmospheric water vapour. However, all radiometers have also been affected by various brightness temperature drifts. Uncorrected, such an error can induce a significant error in the estimation of global mean sea level (GMSL) or regional mean sea level (RMSL) (**Figure 1**).

Error of global MSL trend

- The confidence on the global MSL trend is good

⇒ 3.25 mm/yr **+/- 0.6 mm/yr** in a confidence interval of **90%** (Ablain et al, 2009)

- The main sources of errors concerning the global MSL stability are

⇒ the wet troposphere correction +/- 0.3 mm/yr

⇒ the orbit calculation +/- 0.15 mm/yr

⇒ the bias uncertainty to link the altimetry missions together +/- 0.2 mm/yr

⇒ the altimeter parameters +/- 0.1 mm/yr

⇒ the atmospheric corrections +/- 0.1 mm/yr

- Instrumental drifts are by far the main weakness of the microwave radiometers used to correct altimeter data
  - Radiometer calibration on time scales longer than 1 month derived from ancillary data sources not under project control
  - With current radiometer system, climate monitoring **<u>can only be a goal</u>**, not a requirement
  - Wet tropo correction is largest source of uncertainty in GMSL trend estimation

- **<u>The main improvement the OSTST community could expect from the Jason-CS radiometer(s) is long term stability</u>**

Would there be any science benefit in having different centre frequencies for the two radiometers, considering the frequency channel used to estimate the cloud water content is already different between the MWR and AMR-C?

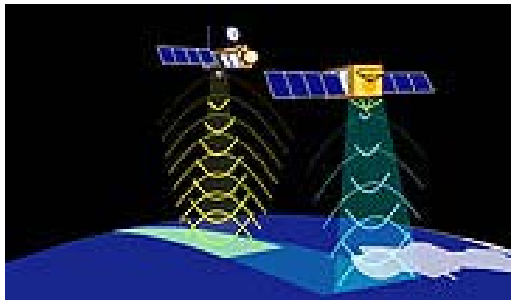
- **Significant benefit could be obtained if the second radiometer used high frequency channels (>90GHz)** and is able to resolve shorter scales of the atmospheric variability to significantly improve the quality/resolution of the wet tropospheric correction in coastal areas and for hydrology (smaller footprint, less corrupted by land emissivity).

- The atmospheric window being centered around 35 GHz, we do not expect additional information combining 34 and 36.5 GHz information (to be confirmed with simulation). In that context, the second radiometer should not provide a significant benefit with respect to the first one

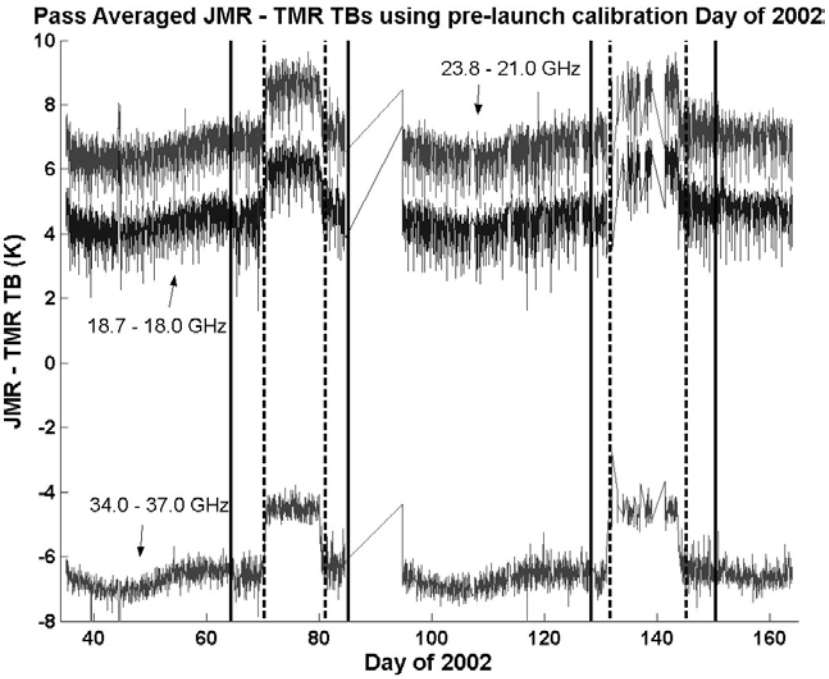
- After confirmation that both 34 and 36.5 GHz channels offer no significant benefit, for consistency with other planned and existing altimeter radiometers, it would be a benefit to have the primary radiometer channel be at 36.5 GHz (as opposed to 34 GHz)

- *Could the simultaneous operation of two radiometers be an asset in terms of estimation and effective minimisation of radiometer drift in wet tropospheric path delay retrievals?*

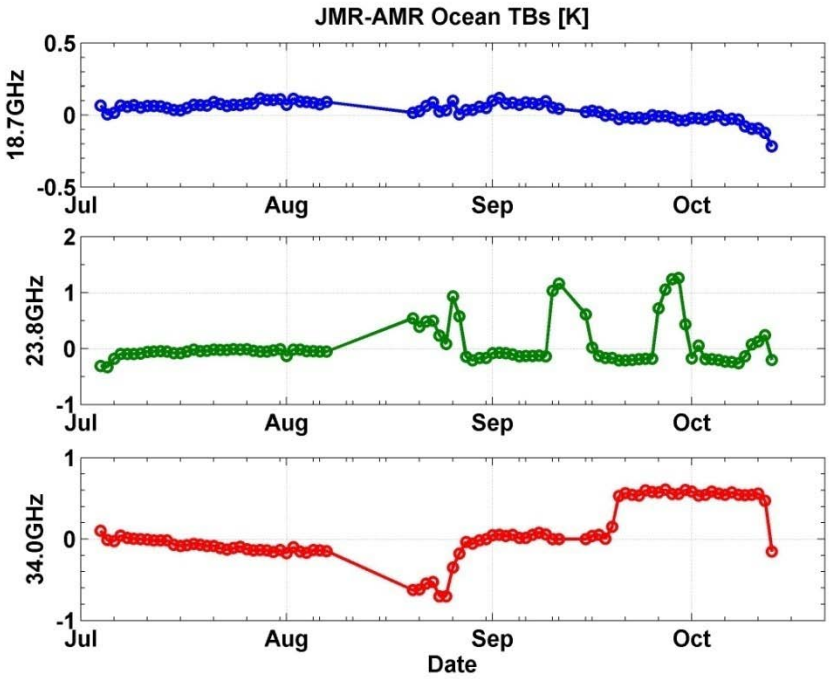
- Good method for identifying drifts and anomalies, but....



TMR/JMR Tandem

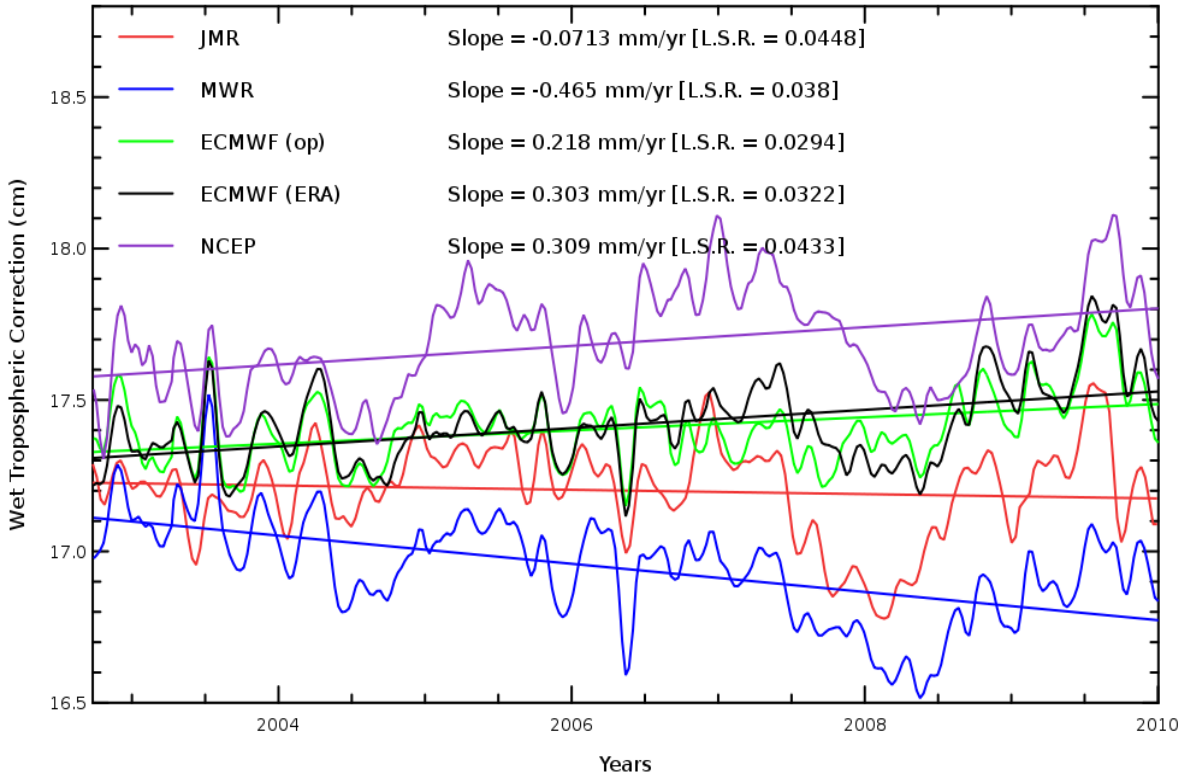


JMR/AMR Tandem



- *Could the simultaneous operation of two radiometers be an asset in terms of estimation and effective minimisation of radiometer drift in wet tropospheric path delay retrievals?*

- Good method for identifying drifts and anomalies, but not possible to determine which is the stable solution without reliance on ancillary sources
- **Therefore, having 2 radiometers on board will not necessarily help the Jason-CS system reach the required stability.**

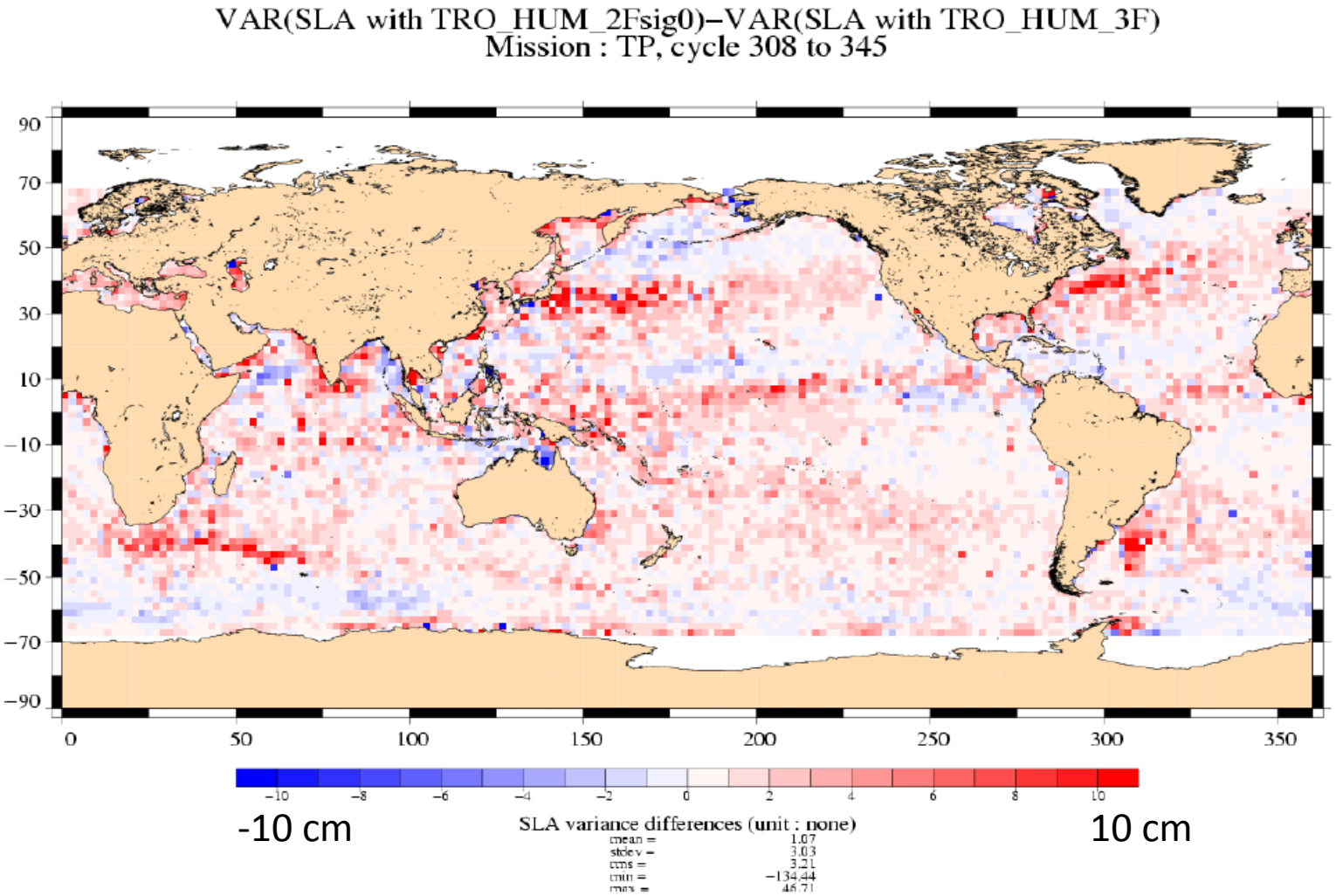


- *Are the scientific benefits of a three frequency radiometer over a two frequency system clear enough to recommend one or the other for Jason-CS?*

Analysis performed by CLS for ESA in the context of Sentinel-3 preparations

Shown is the variance increase of along-track sea surface height anomalies (SSHA) when the the 2F+Sig0 algorithm is compared to the 3F algorithm. **The improvement observed with the three channel algorithm is significant and consistent with the crossover differences**: 1 cm² or 1% of total SLA variance reduction. Locally the improvement can reach 10% of the SSHA variance.

<u>Using a third channel would be an asset for Jason-CS</u>



- **Recommendation 1: The main improvement the OSTST community could expect from the Jason-CS radiometer(s) is instrument enhancements to enable long term stability from the radiometer, eliminate dependence on ancillary data sources and reduce the latency of the final calibrated product.**

- **Recommendation 2: The most significant benefit from the embarkation of a second radiometer would be for the second radiometer to operate at high frequencies to resolve km-scale water vapor to improve coastaly altimetry and inland hydrology applications.**

Jason-CS Climate Requirement

"Jason-CS shall measure globally averaged sea level, relative to levels established during the calibration and validation phase, with root-mean-square uncertainty of 1mm when averaged over 1 year."

"Also, consideration should be given whether this drift requirement must be met through

instrument design or characterization or ← **Climate monitoring requirement**

whether it can be left to the science team as a post-launch calibration effort."

← **Climate monitoring goal**

- Instrumental drifts are by far the main weakness of the microwave radiometers used to correct altimeter data
  - Radiometer calibration on time scales longer than 1 month derived from ancillary data sources not under project control
  - With current radiometer system, climate monitoring **<u>can only be a goal</u>**, not a requirement

- **<u>The main improvement the OSTST community could expect from the Jason-CS radiometer(s) is long term stability</u>**