The wet tropospheric correction for altimetry missions:
A mean sea level issue

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CONTEXT

- Water vapor: climatic variable itself & direct impact on mean sea level

- Main source of error affecting the MSL estimate
  - ✓ Related uncertainty estimated between 0.2 and 0.3 mm/yr for the global MSL and close to 1 mm/yr focusing in tropical areas

- Potentially contaminated by long-term instrumental drifts or problems
  - ✓ components ageing
  - ✓ internal temperature variations induced by manoeuvres
  - ✓ noise diode instabilities

- Detection of these instrumental problems is critical because water vapour in the atmosphere is subject to natural variations
  - ✓ Interannual variability (Nino - Nina)
  - ✓ Seasonal cycle
  - ✓ Climate change impact

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CONTEXT

- The risk is important to interpret an instrumental drift as a geophysical trend (artificial variations of the water vapour long time series) or on the contrary to interpret a geophysical signal as an instrumental drift (erroneous correction of a geophysical signal that should be taken into account in altimetry data processing)

Any error in wet tropospheric correction trend
will induce the same error on mean sea level

- Two main objectives:
  - ✓ Describe the error from radiometers (all altimeter missions) and models (operational ECMWF, NCEP)
  - ✓ Give some recommendations for instrument, processing, and calibration activities

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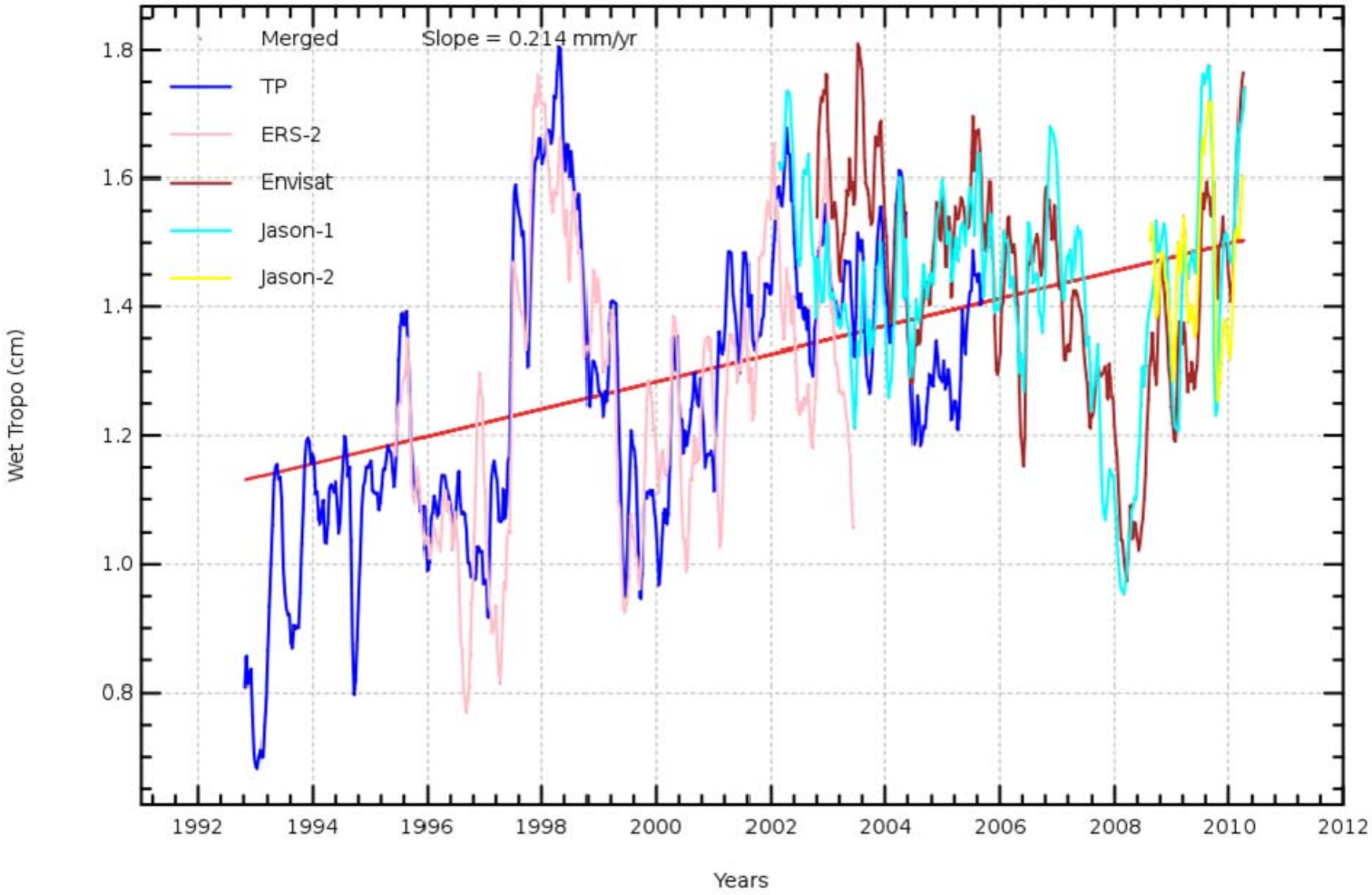
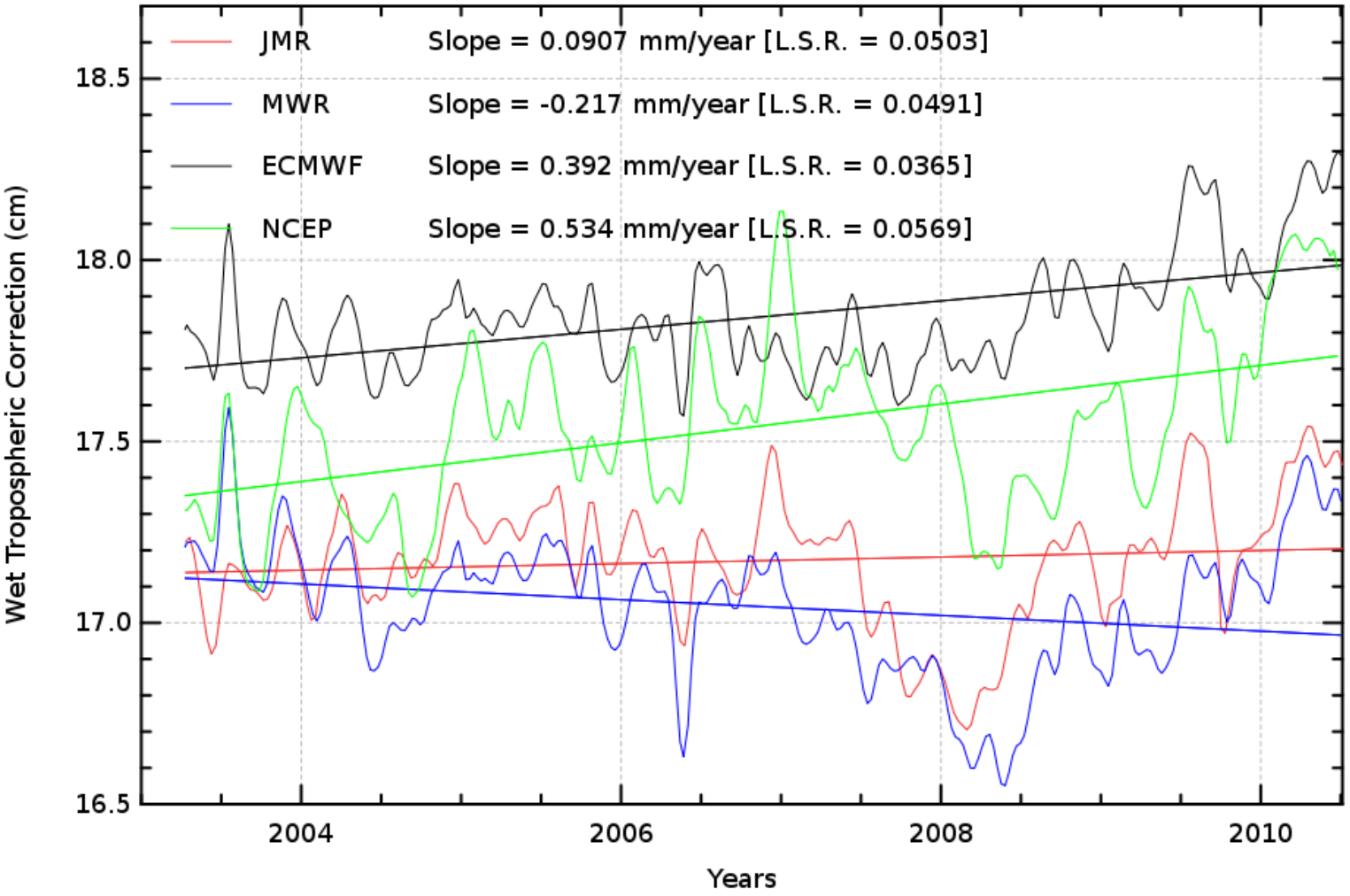
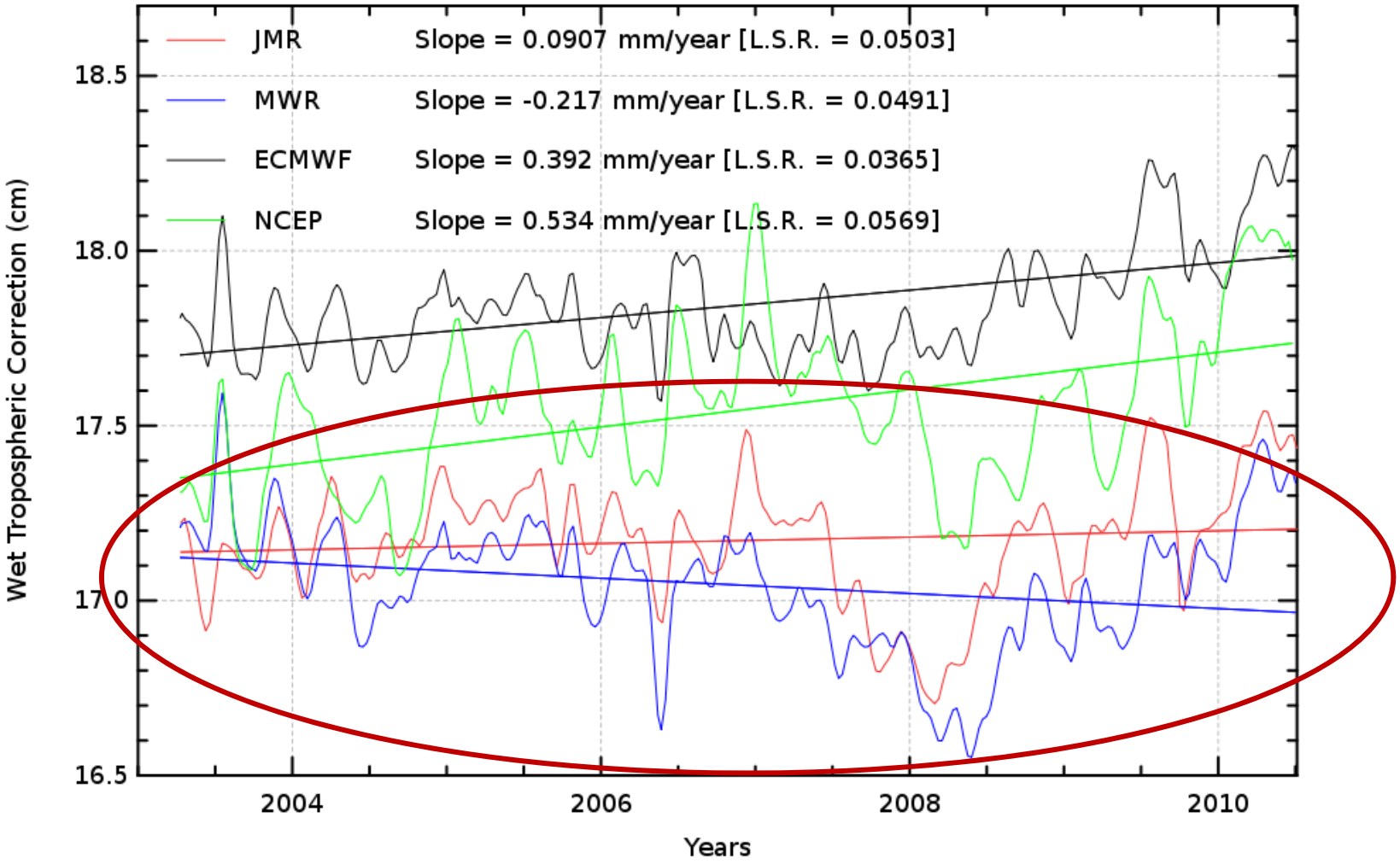
RESULT

- Inverse method to link the different instruments all together
- Global trend close to 0.2 mm/yr
- Value in agreement with publication showing elevation of water vapor for 30 years.
- Interannual variability well represented

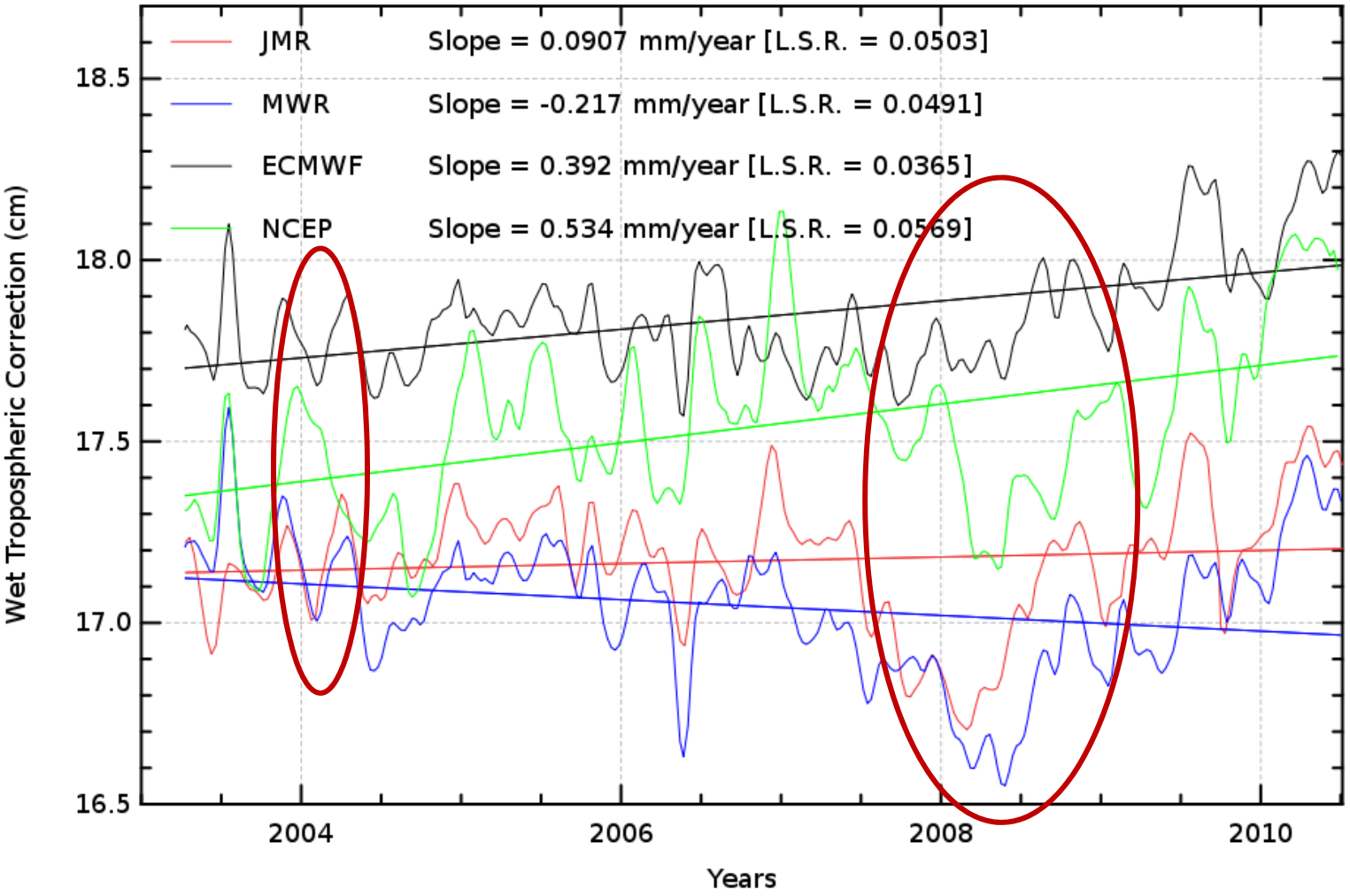




Monitoring of the **filtered** wet tropospheric correction (absolute value) from JMR, MWR, ECMWF and NCEP models (sampled by Envisat) with **adjustment of the annual signal** from Jason-1 and Envisat missions with restriction on the **Jason-1 spatial coverage**. Arbitrary bias is used to compare the datasets.

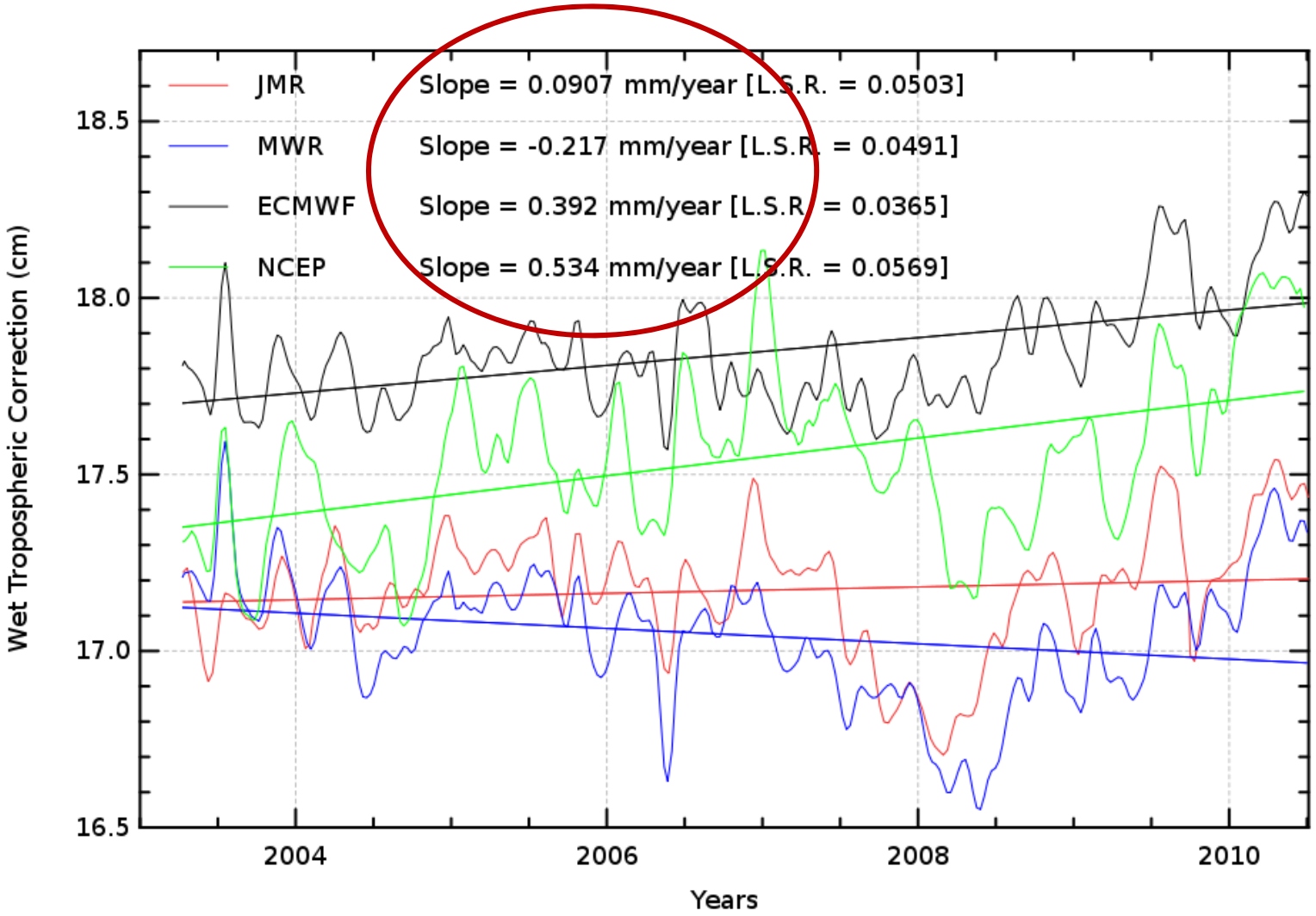


1. Extremely good correlation between both radiometers in terms of dynamics
   - ➢ Radiometers are reliable



3. Weaknesses of models to represent main events of interannual variability, like the 2008 drying-up associated to La Nina

➢ Critical for climatic purposes



4. Different slopes, resulting mainly from discrepancies for given periods : around 0.3 mm/year

➢ Critical for mean sea level study

What we know about radiometers

- Microwave radiometers, *in general*, have been proved quite stable with time
- But requirements for altimetry missions are much more stringent (sea level rise)
- Almost all radiometers onboard past or current altimetry missions suffered instrumental problems or drifts
  - ✓ 18.7 GHz channel for Topex/TMR
  - ✓ 23.8 GHz channel for ERS-2/MWR
  - ✓ Loss of an amplifier on ERS-2/MWR : 10 dB gain drop
  - ✓ Satellite attitude impact on TBs for Topex/TMR and Jason1/JMR : thermal effects
  - ✓ Gain decrease for 36.5 GHz channel for the Envisat/MWR ?
  - ✓ Noise diode stability for Jason1/JMR and Jason2/AMR (mainly 34 GHz)
- Different methods proposed to detect, quantify and correct possible drifts, based on:
  - ➢ Instrumental parameters
  - ➢ level 1 products (TBs) => Our experience, our recommendation
  - ➢ level 2 products (dh)

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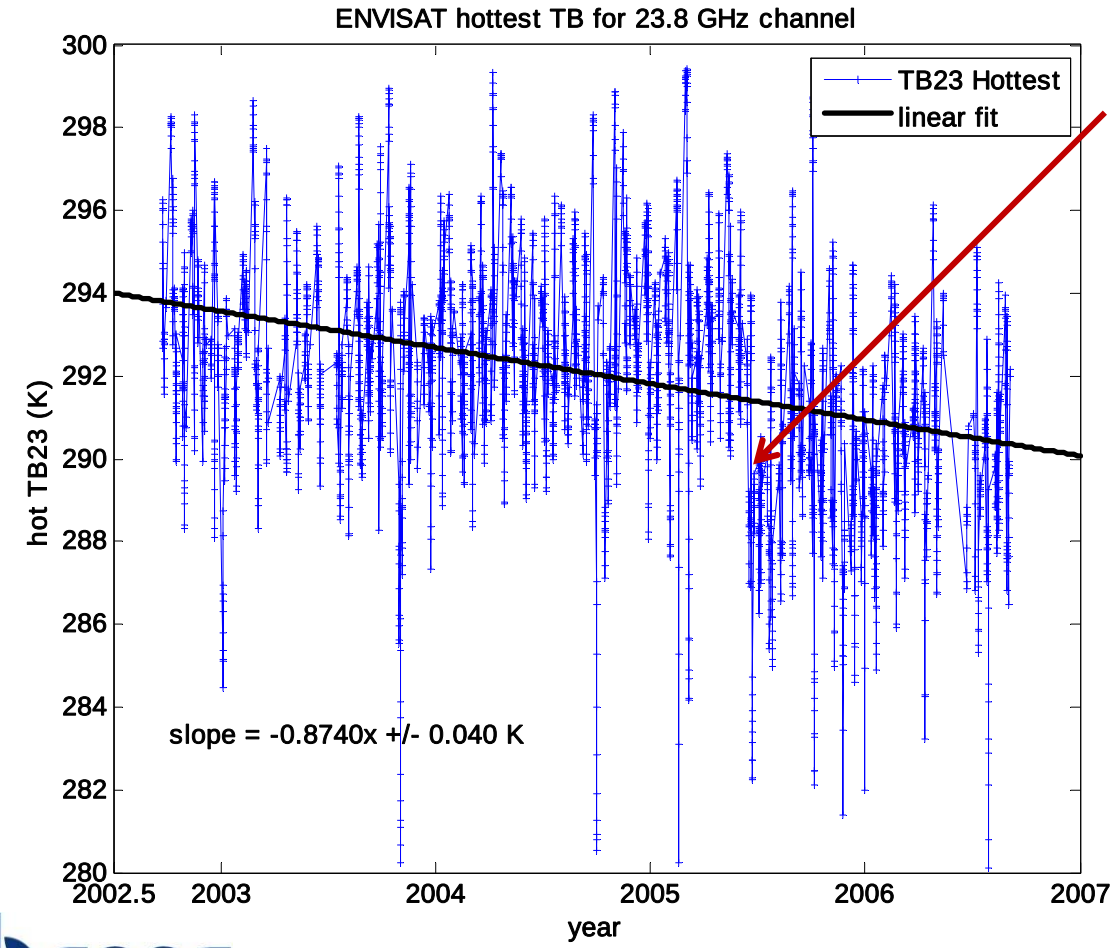
Some key points

- All the survey methods we use are very sensitive to any new calibration/algorithm

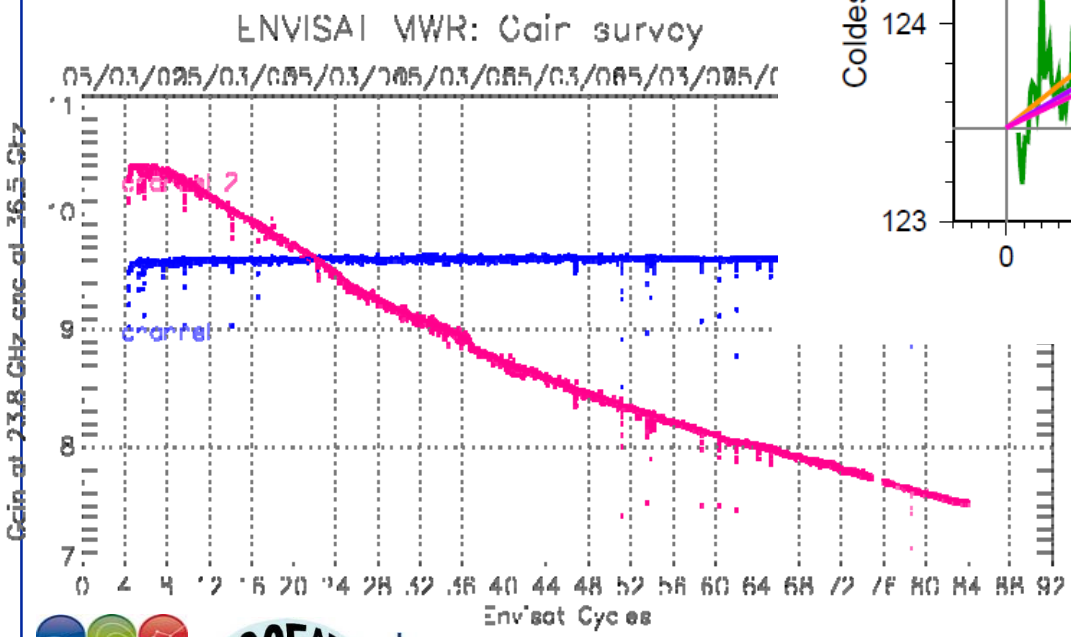
➢ necessary to look at consistent time series !

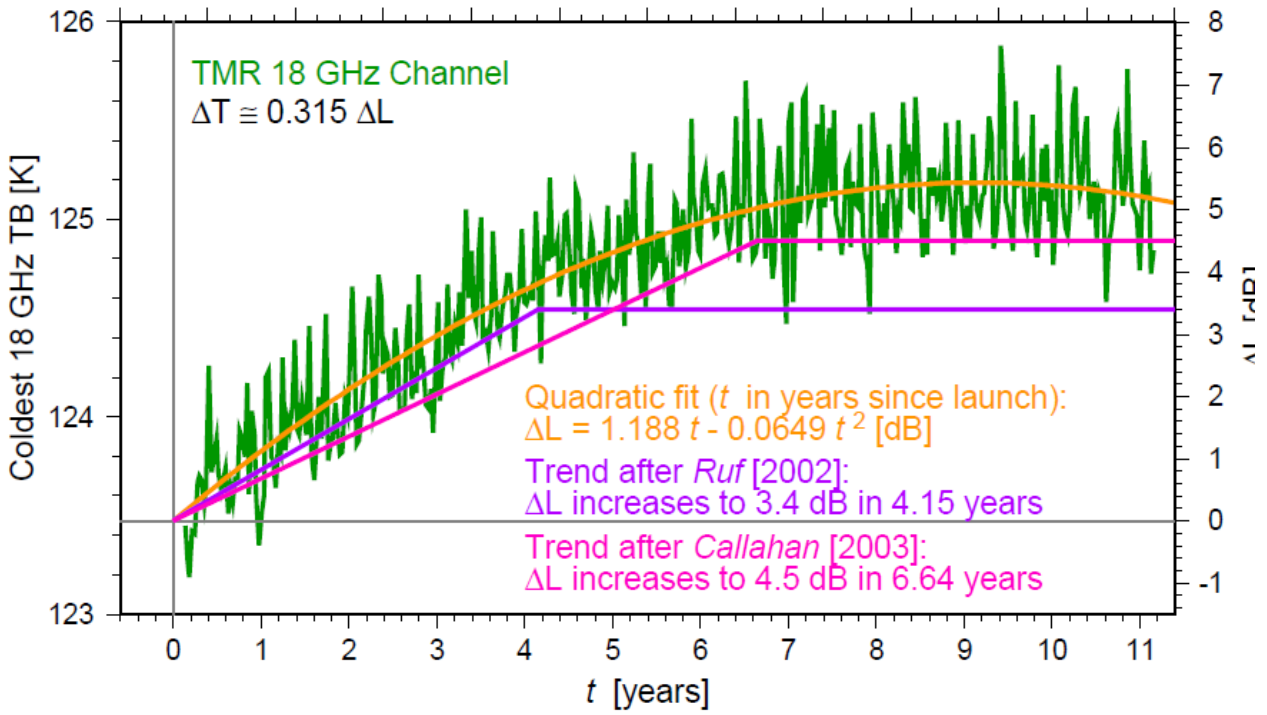


New side lobe algorithm

Some key points

- Experience shows that drift can be linear first, but often subside with time
- ➢ Be carefull with linear correction, extrapolated afterwards

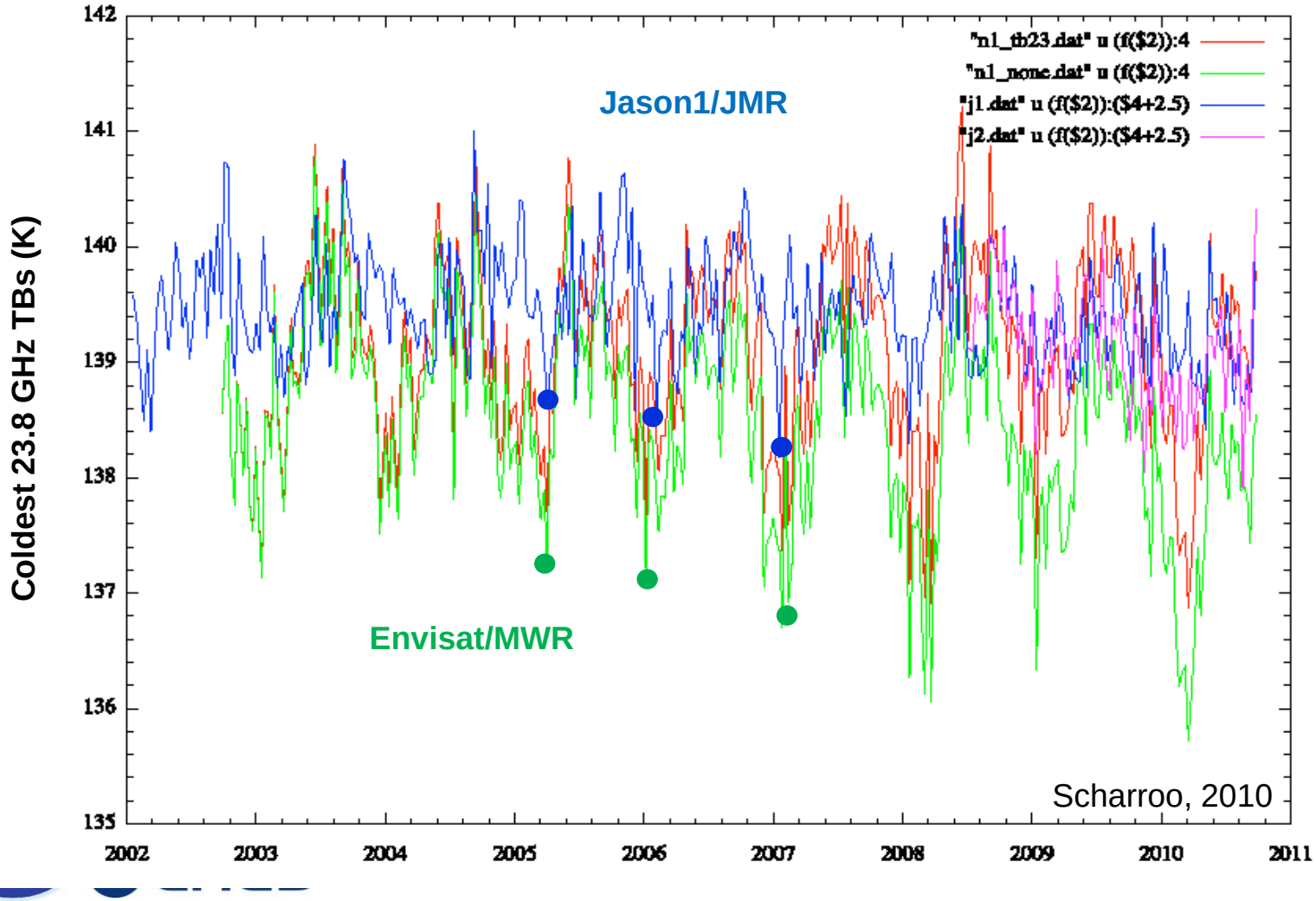




Scharroo, 2004

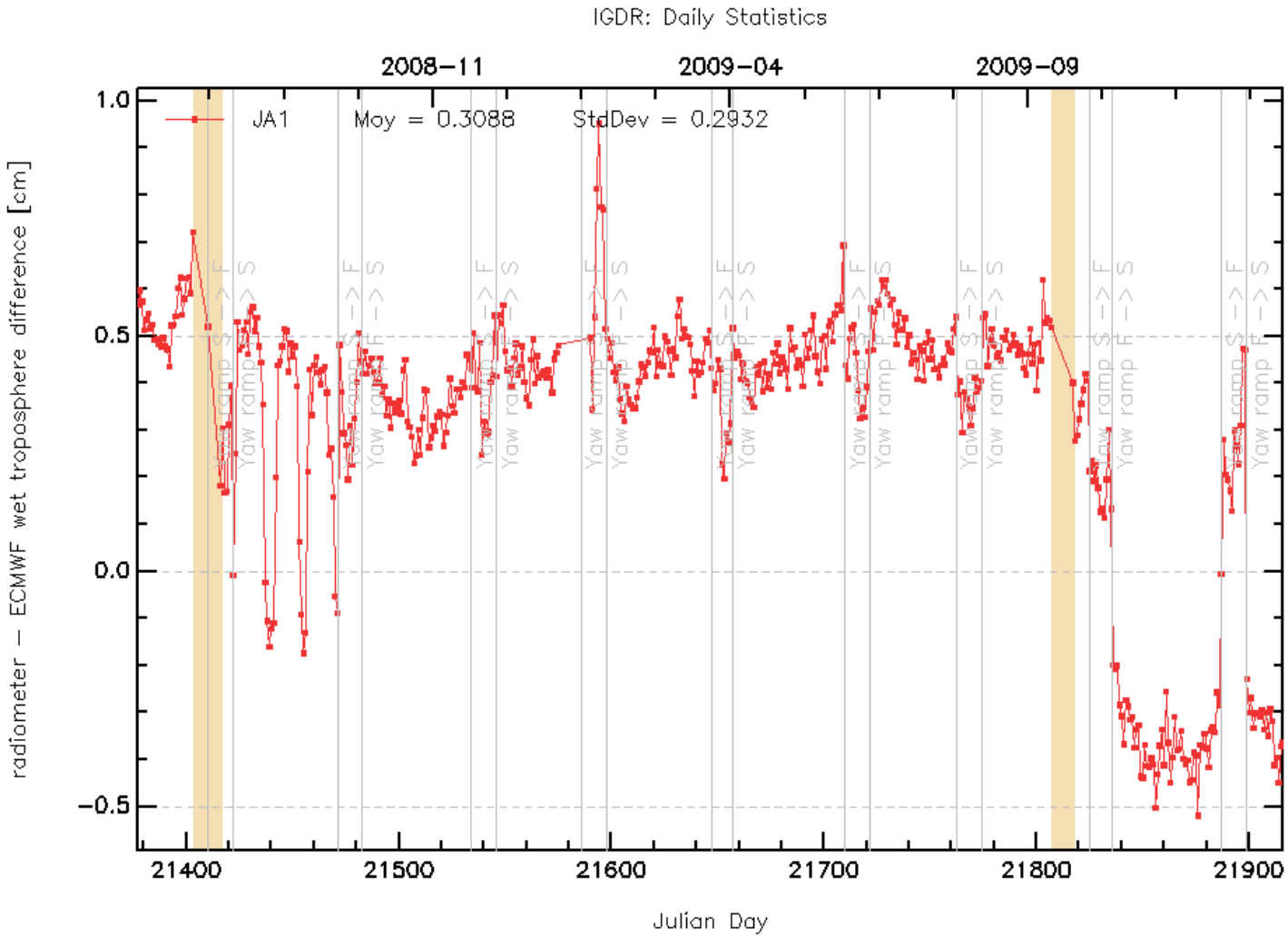
Some key points

- Vicarious methods are the best we have
- ➢ but they can be affected by geophysical signals



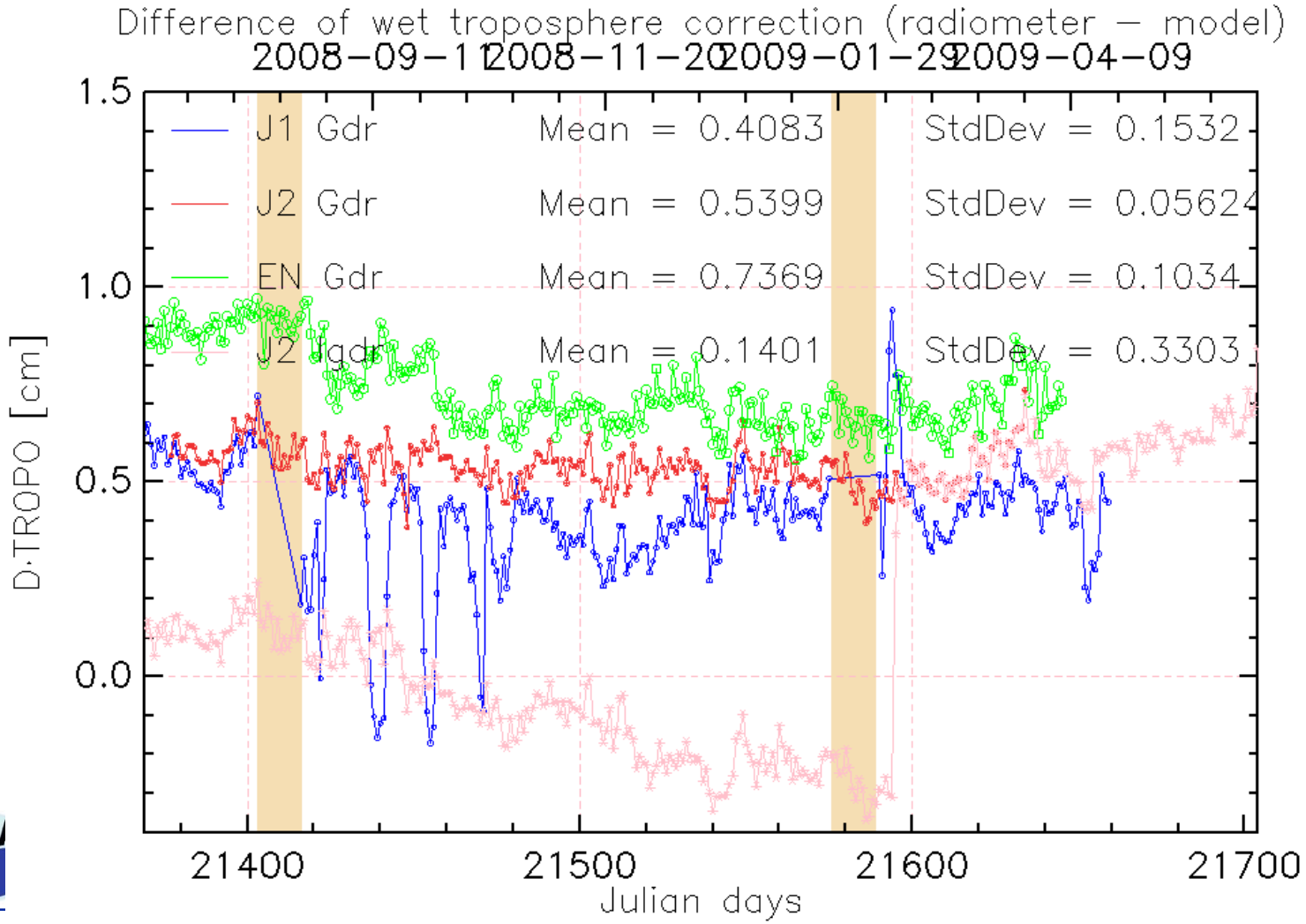
Some key points

- Comparison with models are really usefull
- But limited due to regular improvement => reanalyzed fileds



Some key points

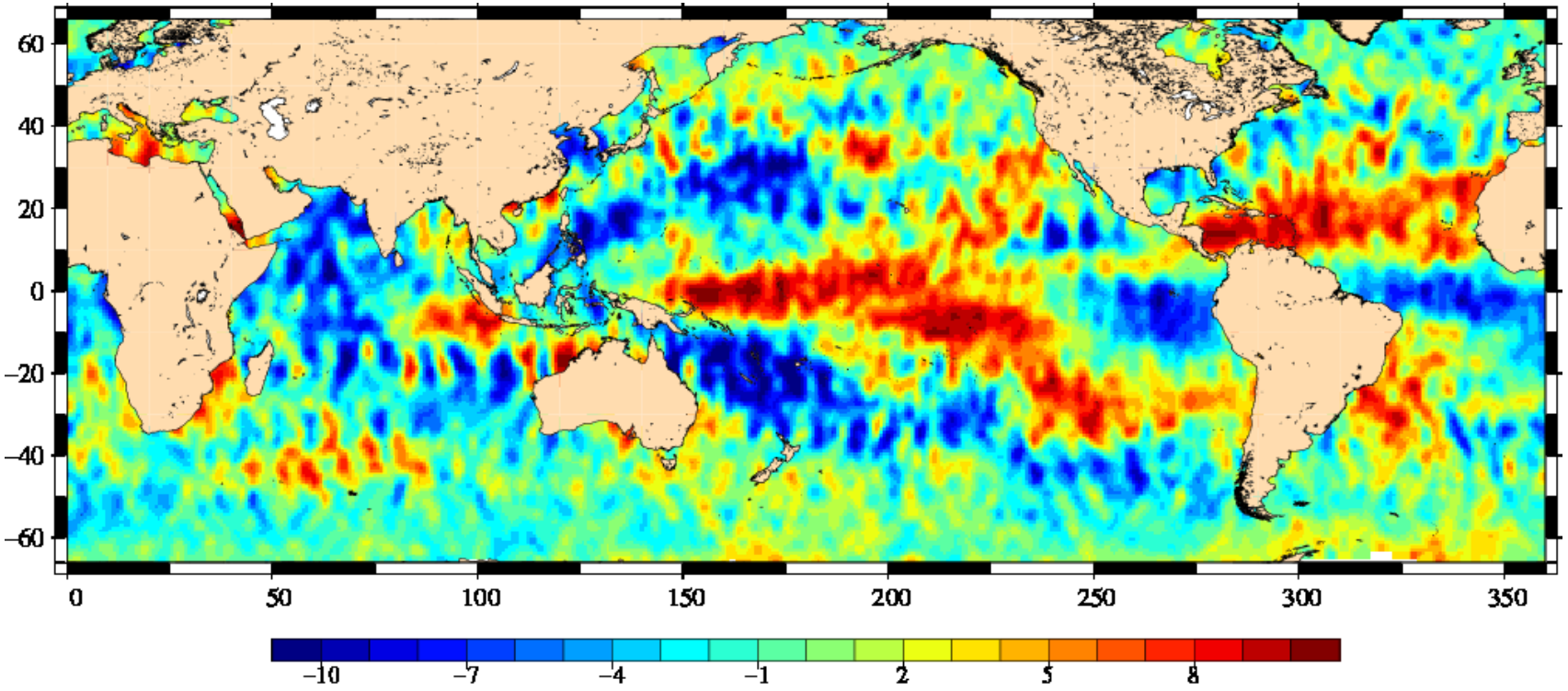
- An autonomous calibration correction is really tricky and dangerous…
- Instrument stability should not rely on on-ground processing but has to be provided by instrument design…



Some key points

- A specificity of the radiometer is that the drift will not be the same for all the brightness temperatures (higher at low TBs)
- This implies that a possible drift will not have a homogeneous global impact

➢ Distortion of sea level change map



Trend of MWR Wet tropo over mid 2005–mid 2008 (mm/y)

Conclusions

In this presentation, the following main conclusions have been highlighted:

- The difficulty to obtain accurate time data series in terms of global trend
- The natural increase of the wet vapor content is not negligible (+0.2 mm/year) maybe in relationship with climate warming
- The methods we use are very sensitive to the consistency of the data (radiometer, models)
- Models do not always represent the inter-annual variability
- Drifts are generally not linear for long periods
- The vicarious methods are not so reliable because even coldest Ocean TBs may be impacted by geophysical variations
- Comparison with models is fruitful but reanalyses should be preferred
- Autonomous calibration is tricky and may absorb part of a geophysical signal

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Recommendations:

Instrument stability should not rely on on-ground processing but has to be provided by instrument design…

Only the comparison with external water vapor information can help to characterize the water vapor trends and variability

- Radiosonde
- GPS
- All other in-flight radiometers
- Models
- …