



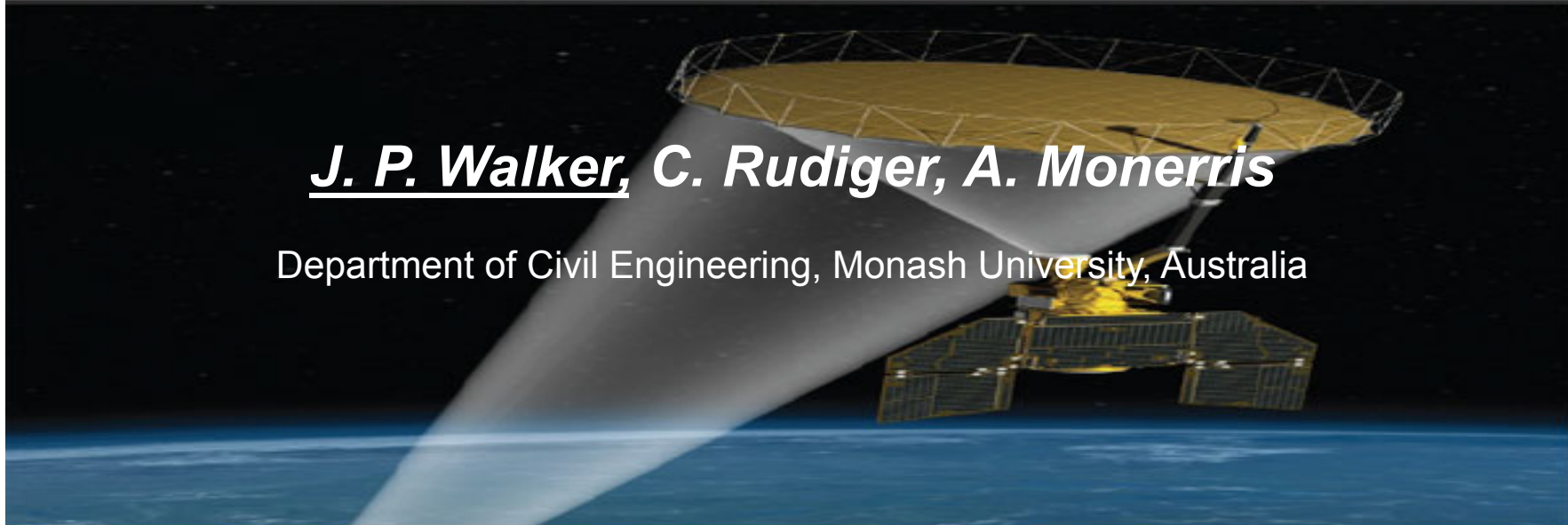
MONASH University

Engineering

# The state-of-the-art in soil moisture remote sensing

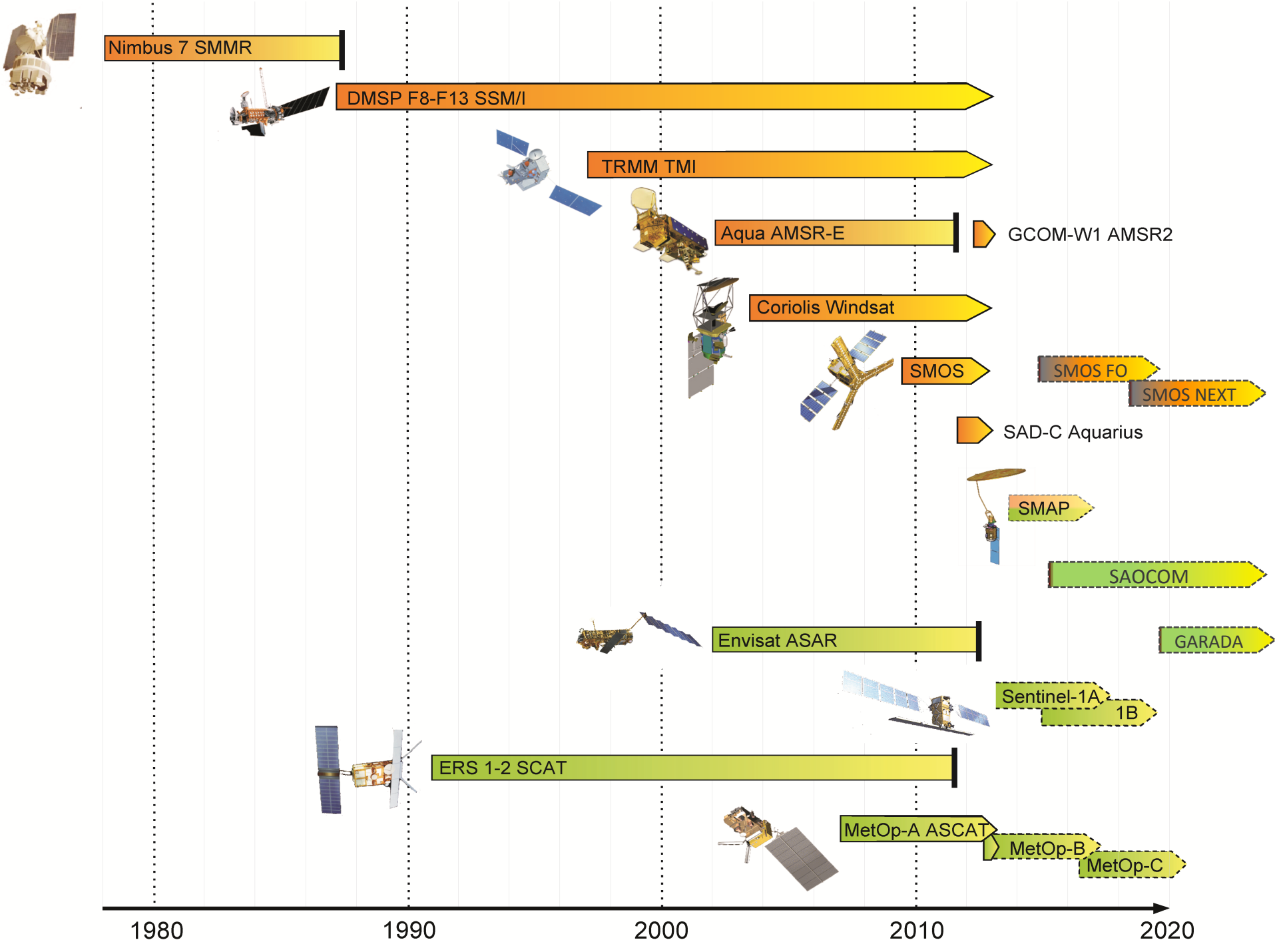
**J. P. Walker, C. Rudiger, A. Monerris**

Department of Civil Engineering, Monash University, Australia



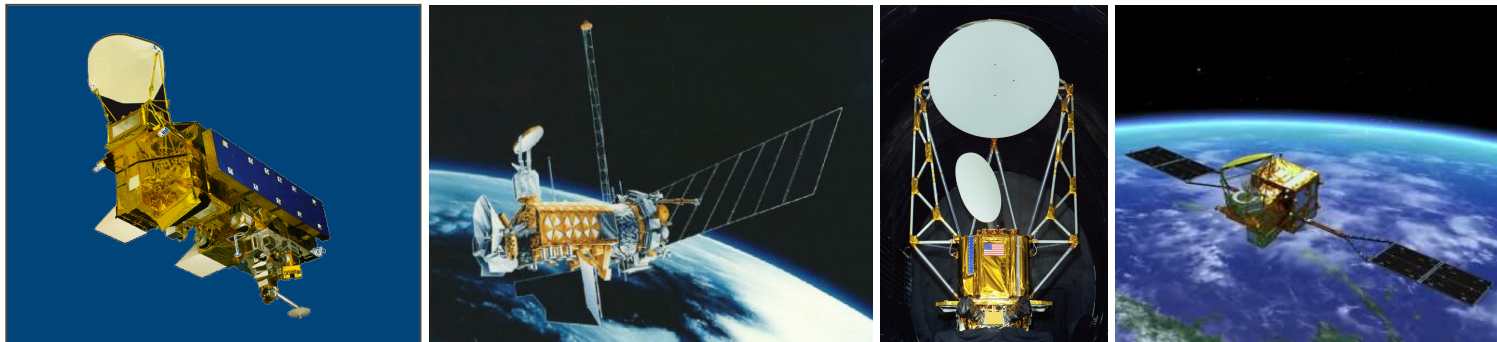
# Background

- Knowledge of the spatial and temporal distribution of soil moisture is **critical for meteorologic modelling due to land-atmosphere interactions**. Such information can only be provided using a combination of remote **sensing and models**.
- **Microwave** remote sensing is the only approach to have **all-weather** observing capabilities, and to have a response that is **directly affected by the water content** in the near-surface layer of soil.
- Despite their poor spatial resolution, passive microwave **radiometers are less affected by vegetation and surface roughness than radars**, making them the preferred option for dedicated soil moisture missions to date.
- While **passive microwave** soil moisture missions have a **0.04 vol/vol** accuracy target, **radar** products struggle to achieve a **0.06 vol/vol** accuracy.

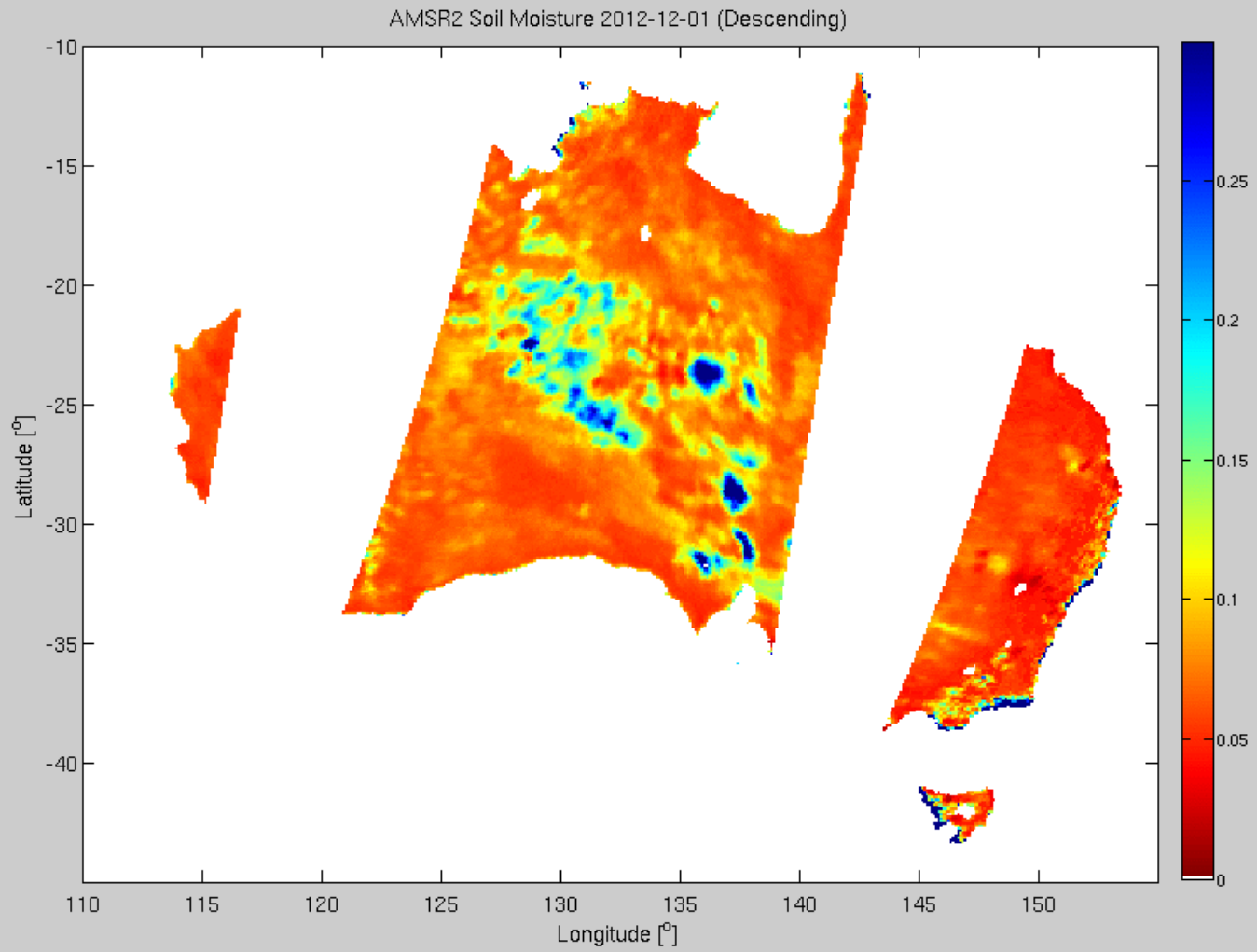


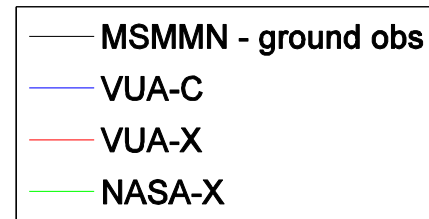
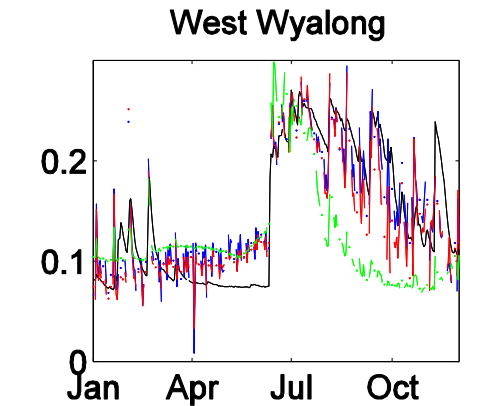
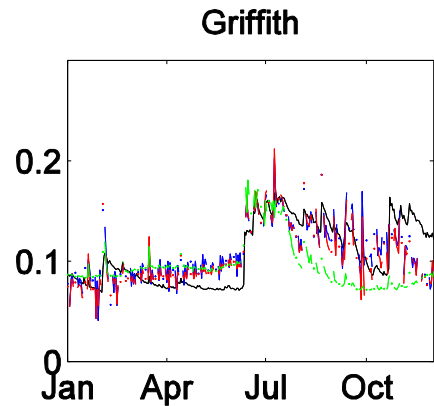
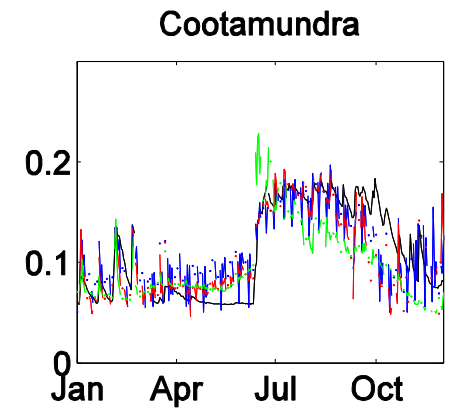
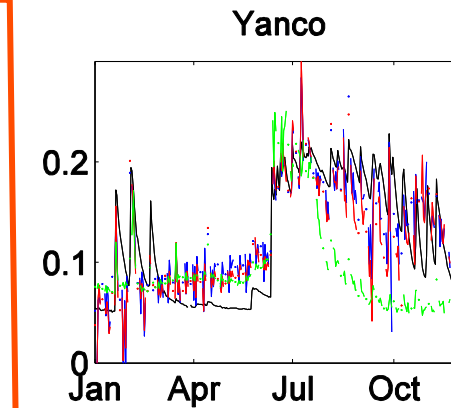
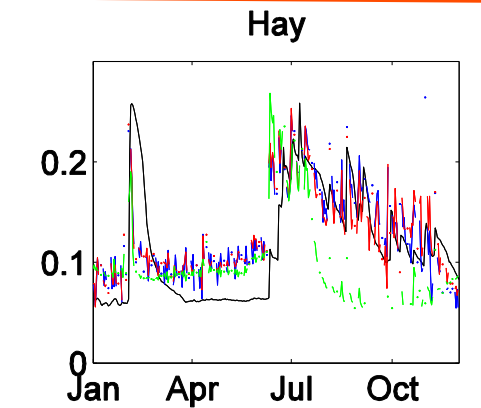
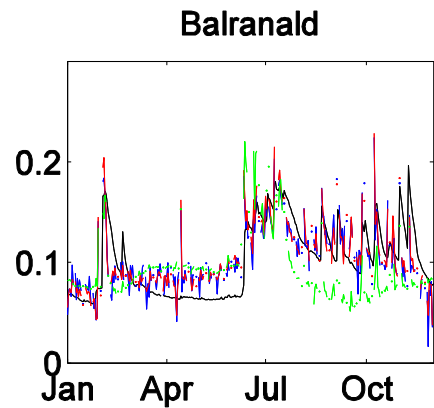
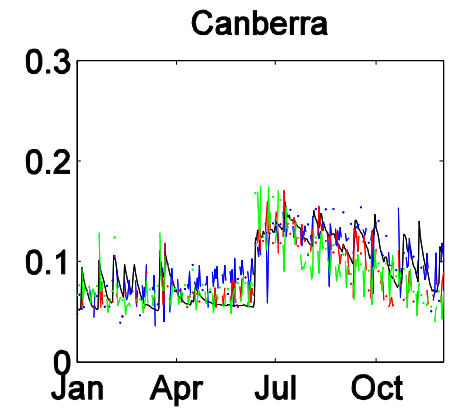
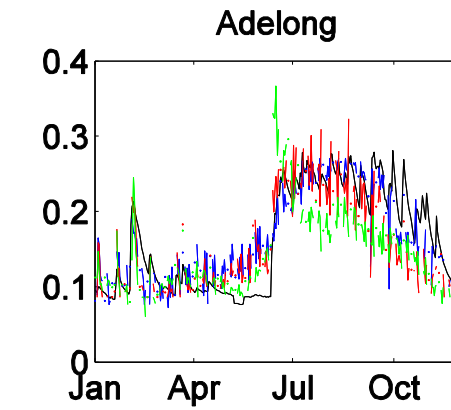
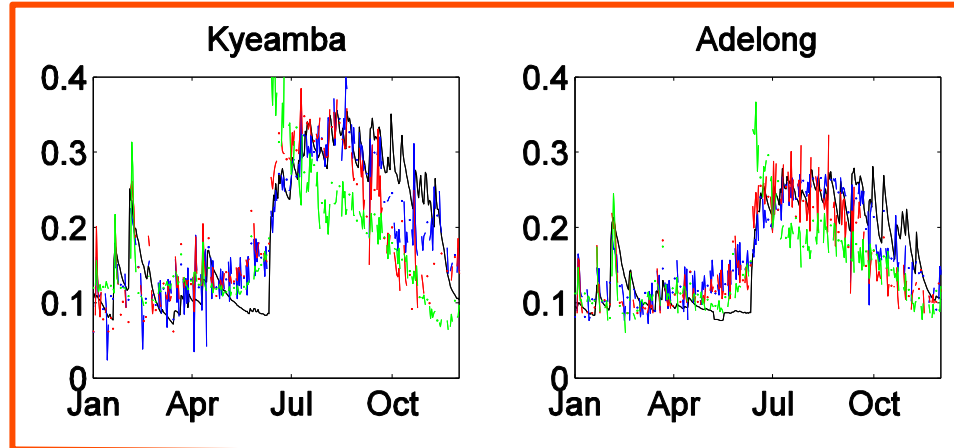
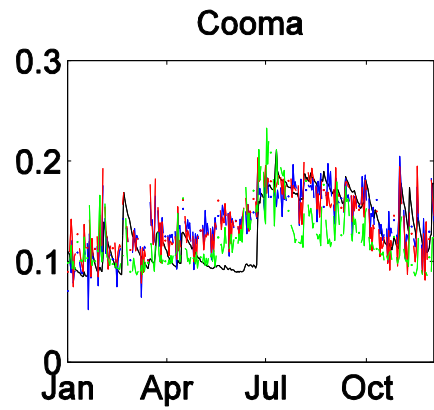
# Passive microwave C-band missions

- SMMR 1978-1987
  - AMSR-E 2002-2011
  - WindSat 2004- (5 years design life)
  - AMSR2 2012- (minimum 20 years series of satellites)
- Gap has been filled using SSM/I (k-band)
- Spatial resolution ~50 km
  - Repeat coverage 1-2 days





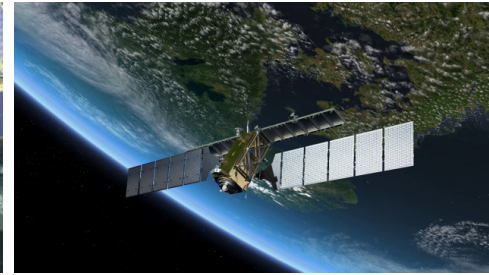
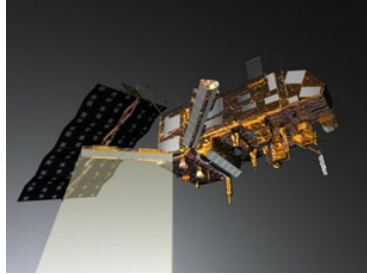






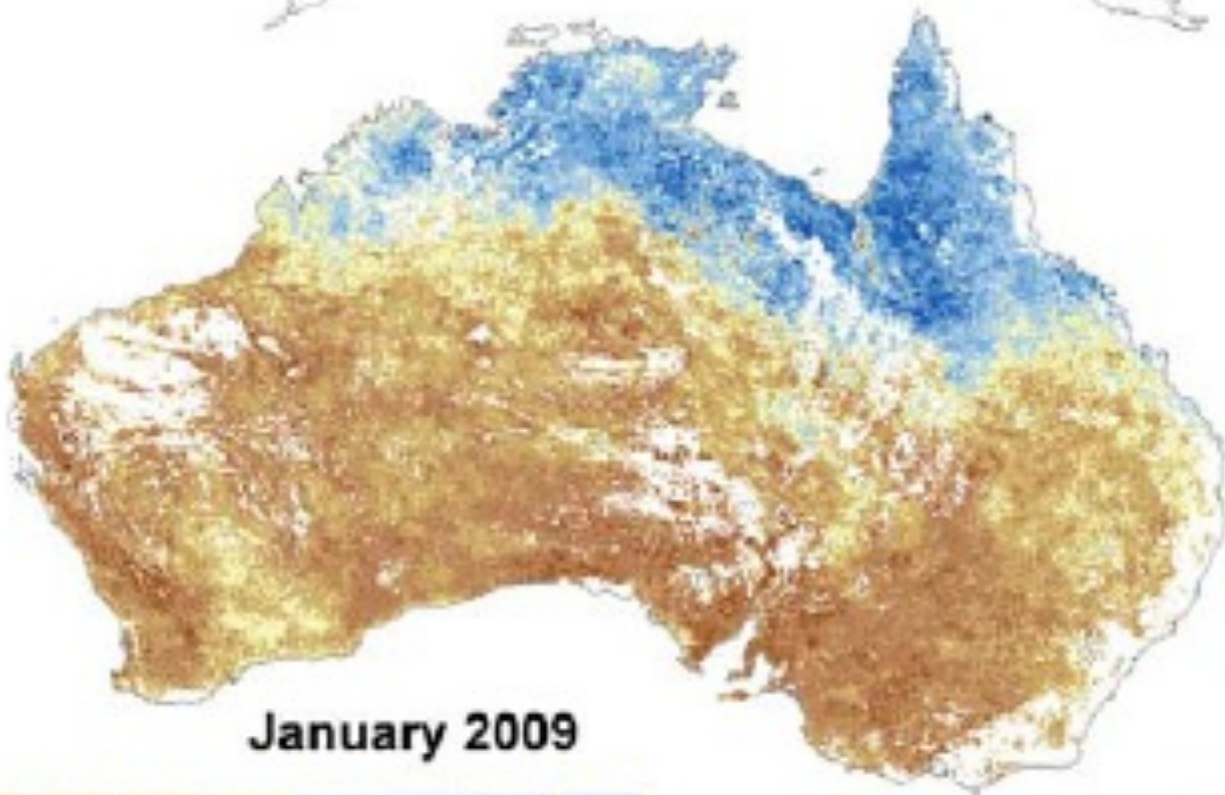
# Active microwave C-band missions

- ERS-1/2                      1992-2011
- MetOp ASCAT              2007- (guaranteed continuity to beyond 2020)
  - Spatial resolution              ~50 km
  - Repeat coverage                ~3 days
- EnviSat ASAR              2002-2012
  - Spatial resolution              1 km (global mode)
  - Repeat coverage                3-8 days
- Sentinel-1                  2014- (20 years operational cover, but global?)
  - Spatial resolution              1 km
  - Repeat coverage                6-12 days (2 satellites)





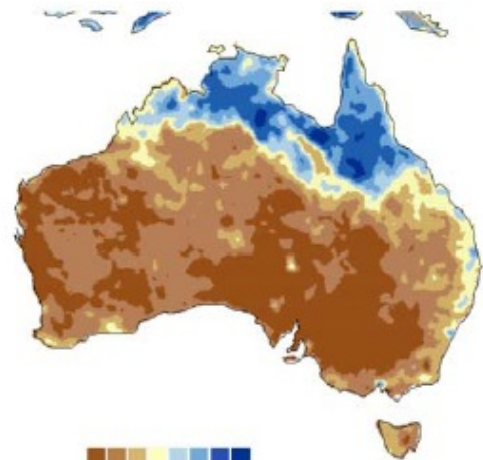
**ASAR**



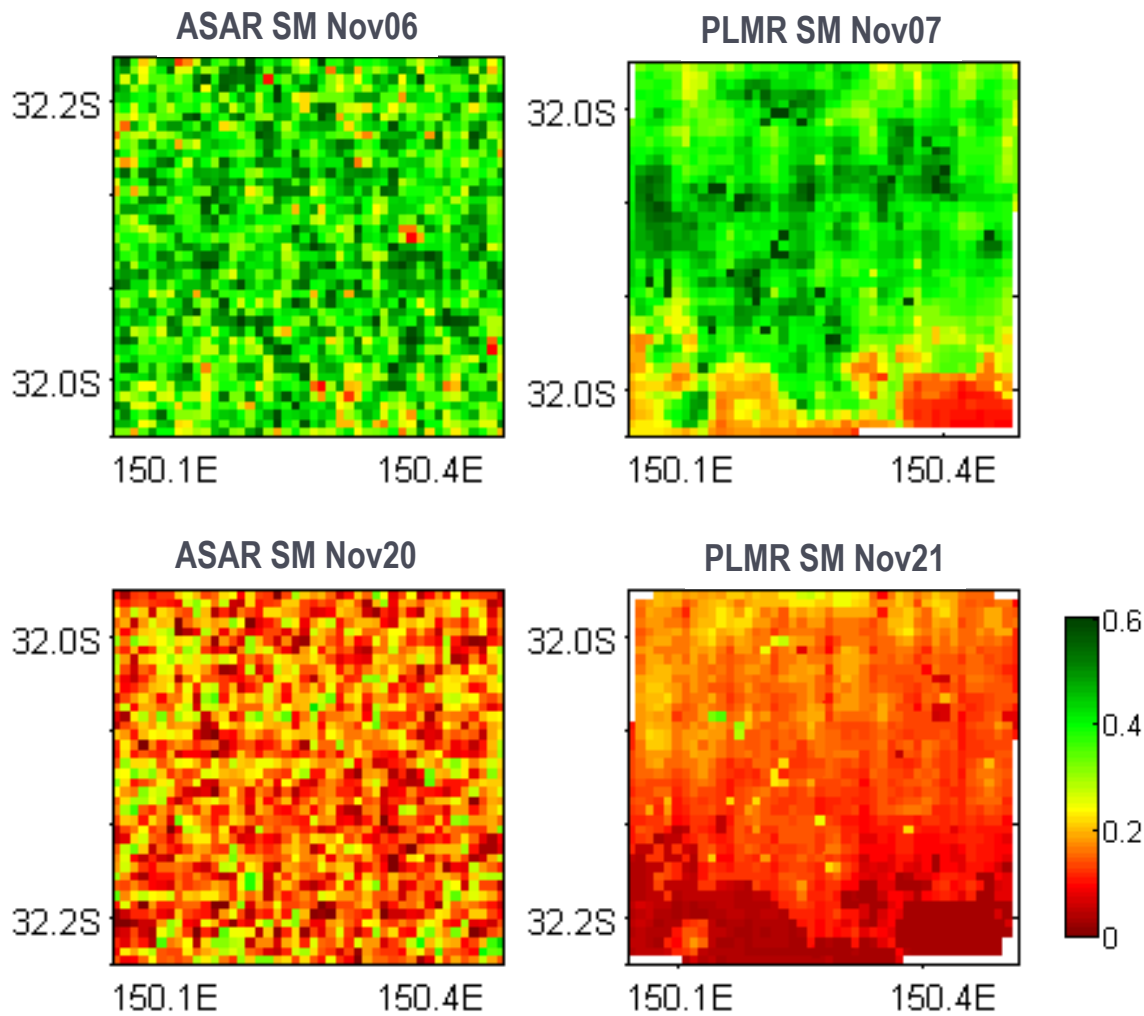
**January 2009**



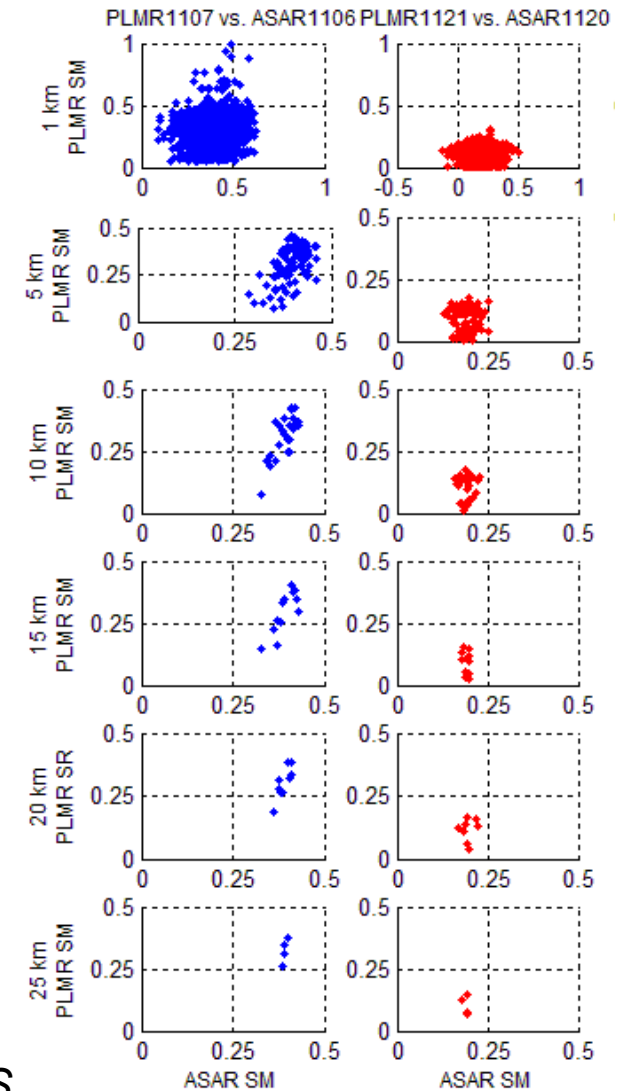
**ASCAT**



# ASAR



*Mladenova, Walker et al. (2010) TGARS*



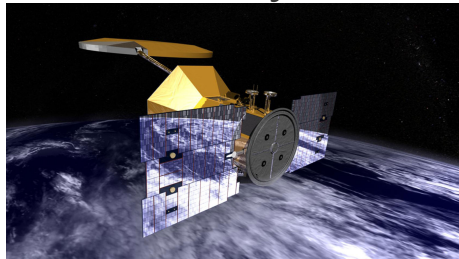
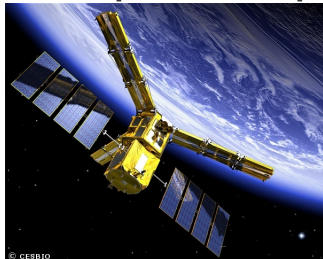


# Passive microwave L-band missions

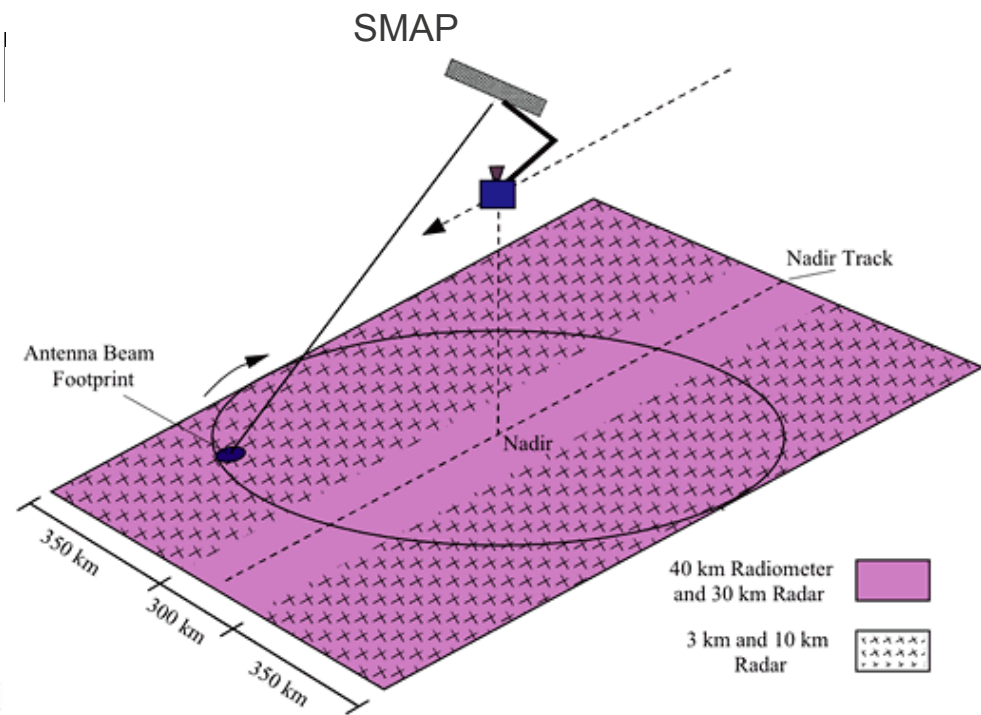
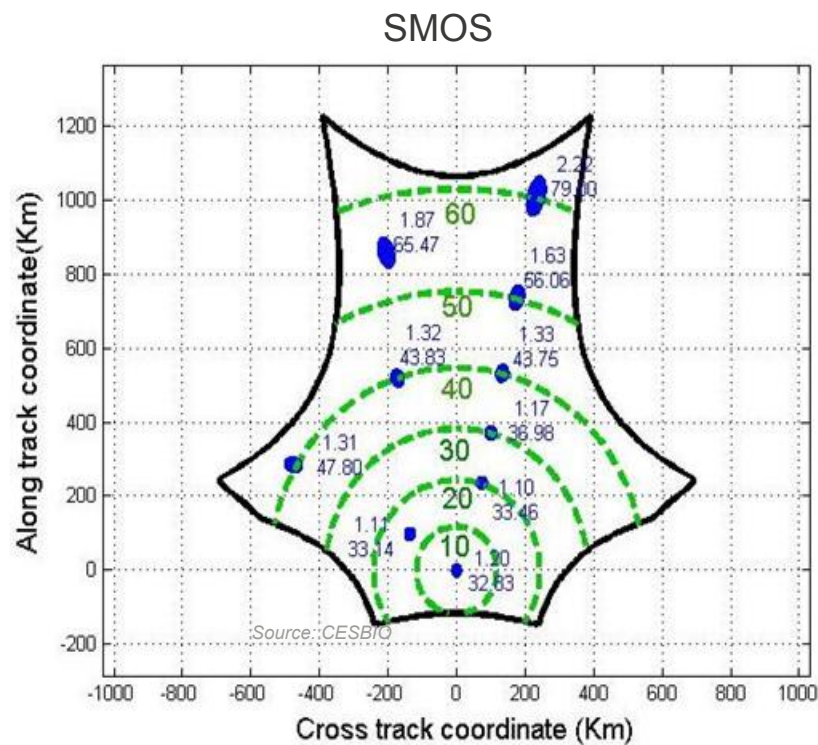
- SMOS 2009- (5 year design life)
- Aquarius\* 2010- (3 year design life)
- SMAP\* 2014- (3 year design life)
- SMOS Follow-on Proposal (possibly 2019)
- SMOS Next Proposal (possibly 2022)

\* Active and Passive

- Spatial resolution ~40 km radiometer, except for Aquarius (~100-150km) and SMOS Next (~4km)
- Temporal repeat 2-3 days, except for Aquarius (8 days)



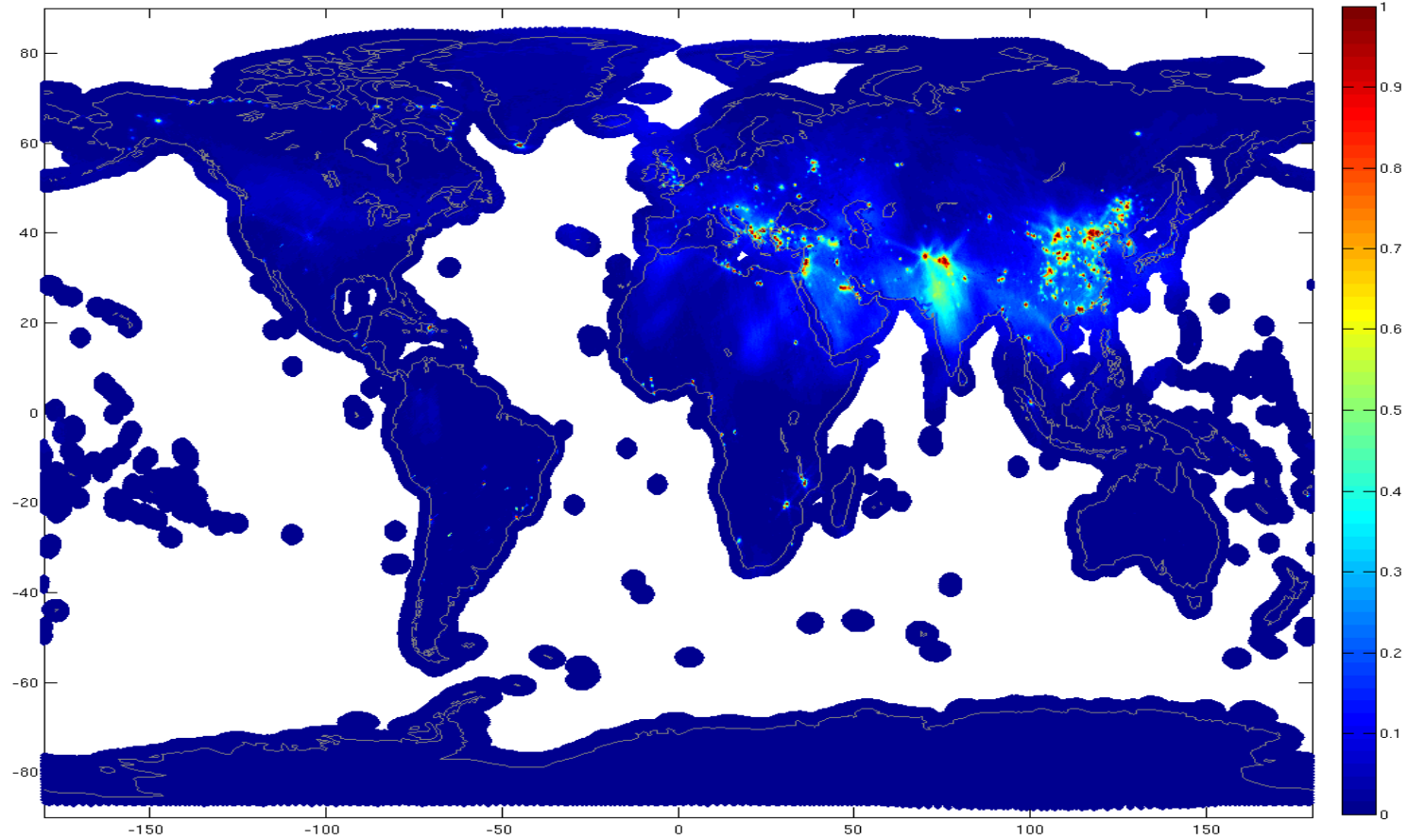
# SMOS vs SMAP





# RFI

Probability of sustained hard RFI occurrences (no outliers detection) for 20100810T002611\_20110109T215428 Period from BB post-processing of DPGS (OPER) SML2 UDP & DAP - ASCENDING only passes - Dual & Full polarizations products





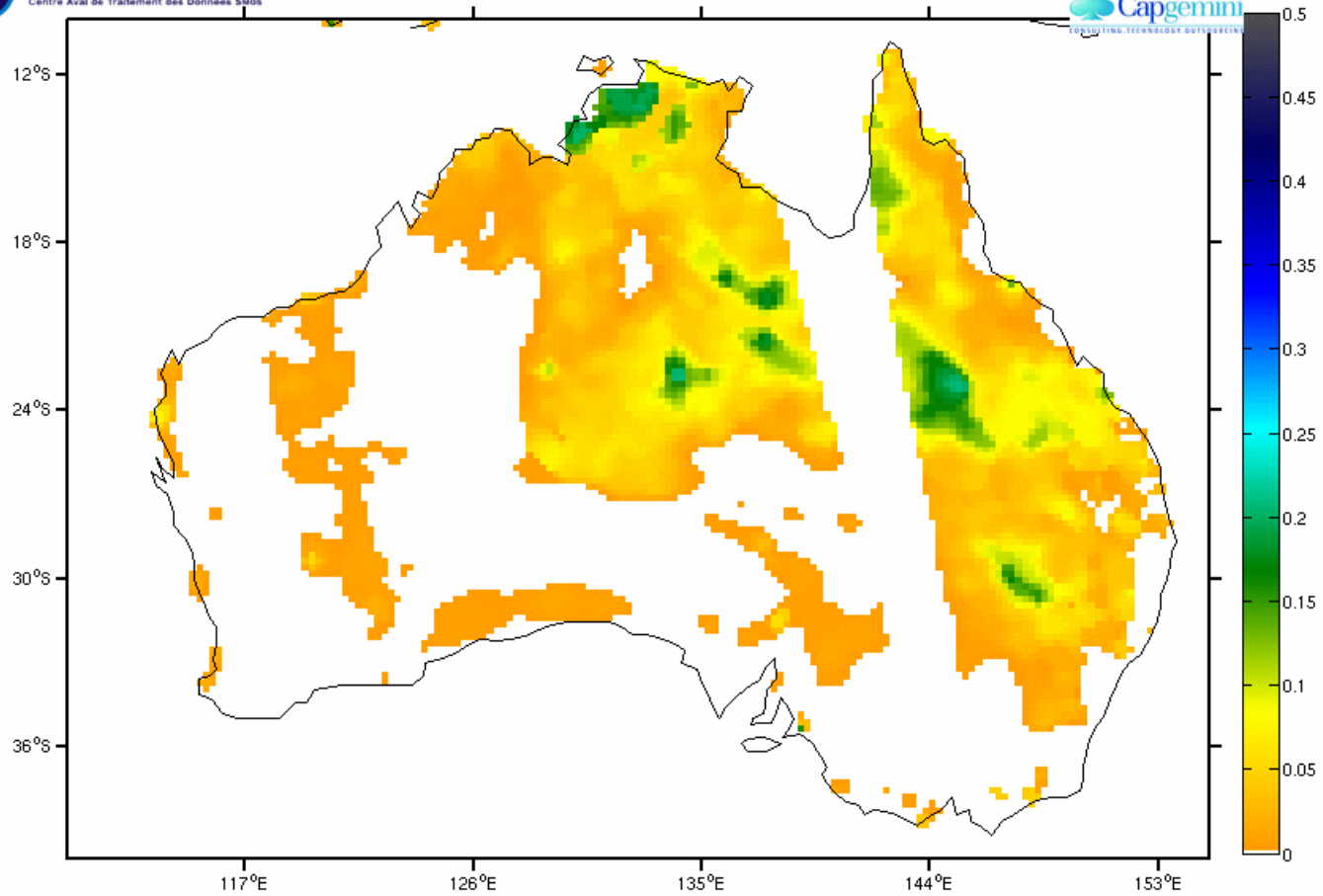
**CATDS**  
Centre Aval de Traitement des Données Spatiales

Three Day Soil Moisture CATDS product ( $\text{m}^3 \cdot \text{m}^{-3}$ ).

20100106-20100108. Ascending and Descending Orbits.



CENTRE NATIONAL D'ETUDES SPATIALES

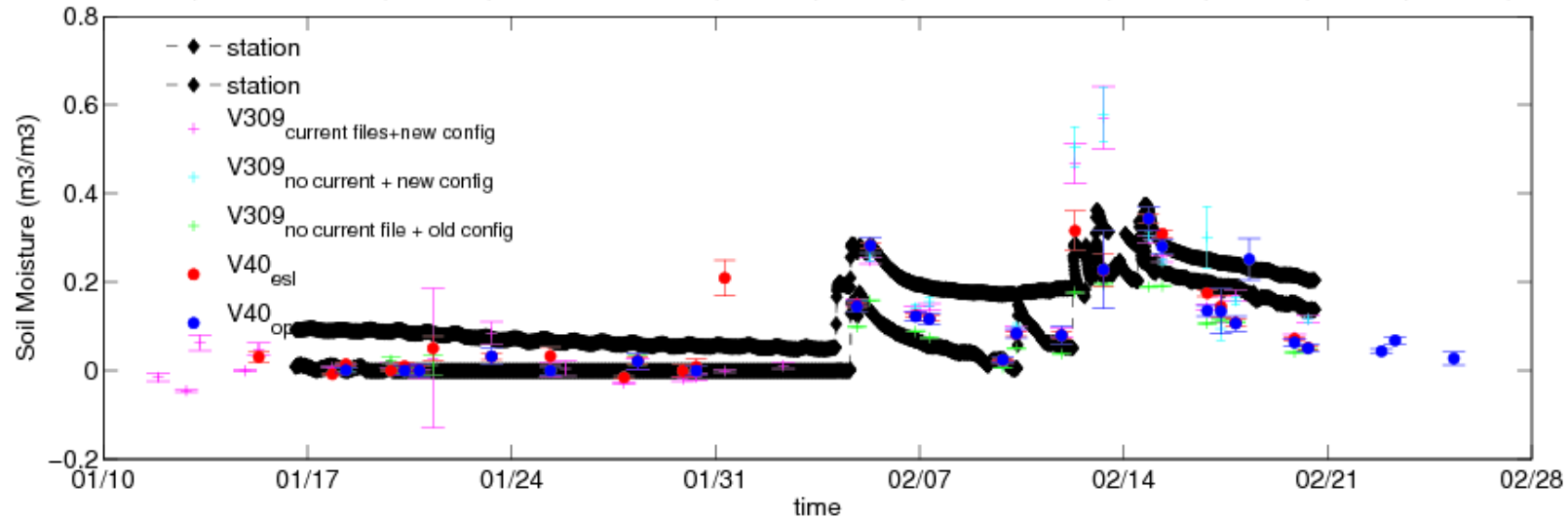


# SMOS

DGG : 8179375

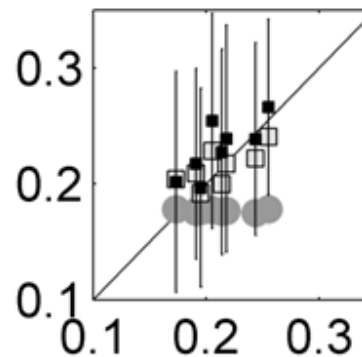
Station : k12 k13

FNO : 0.9274, FFO : 0.066011, FWL : 0, FWO : 0.00051881, FEB : 0, FTI : 0, FEU : 0.0060883, FTS : 0, FTM : 0, FRZ : 0, FSM : 0, FSW : 0



DOY 49, Farm 17

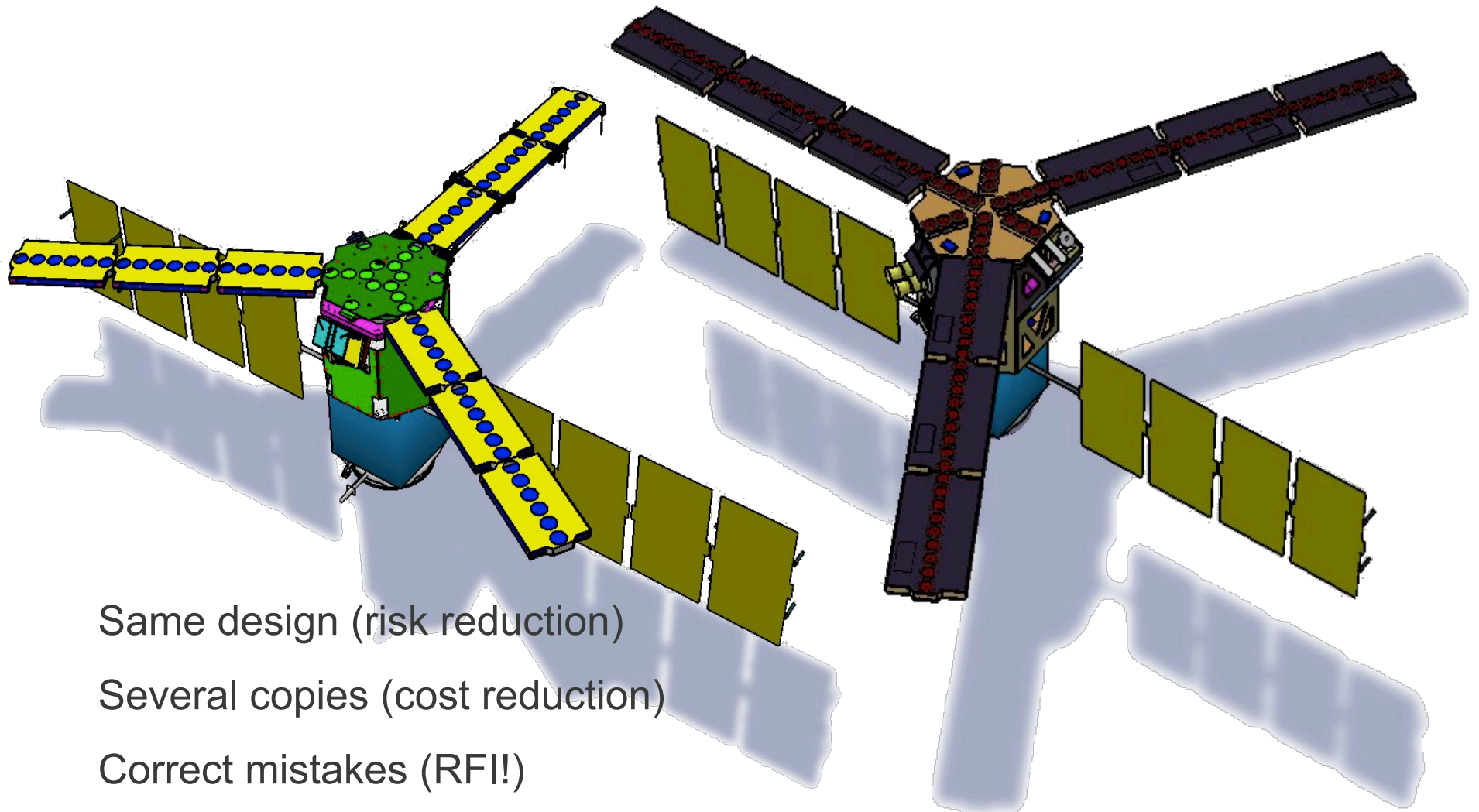
- SMOS data without disaggregation
- Disaggregated SMOS data (all pixels)
- Disaggregated SMOS data (evaporation-controlled only)



DisPATCH 1km  
downscaling

Merlin et al. (2011)

# SMOS Follow on



Same design (risk reduction)

Several copies (cost reduction)

Correct mistakes (RFI!)

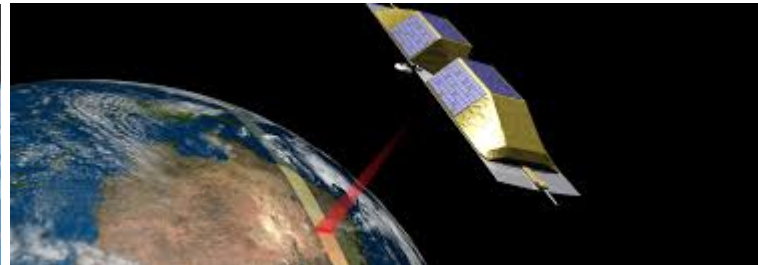
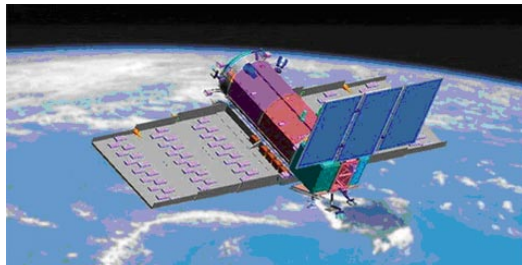
# SMOS Next

- Same specs as SMOS but resolution of 2-5km and 3x improvement in sensitivity
- Uses baselines in a different way
- Requires formation flying
- Uses space and time for image synthesis
- Phase 0 study at CNES



# Active microwave L-band missions

- SAOCOM 2015- (3-5 years design life)
  - Spatial resolution ~1 km
  - Repeat coverage 8 days (2 satellites)
  - Only Europe and Argentina?
- GARADA Proposal
  - Spatial resolution 100m
  - Repeat coverage 3 days (2 satellites)
  - Only Australia





# Closing remarks

- Best options for operational activities such as meteorological forecasting are currently:
  - AMSR2 (and its fore-runners)
  - ASCAT and/or Sentinel (if coverage is available)
- Would not use just one; they are complementary ...
- There are limitations in terms of sensing depth, spatial coverage (due to vegetation) and accuracy, as both are C-band missions
- Be aware of the limitations of operational soil moisture products from these missions