Intercalibration against in situ data (wind speed)

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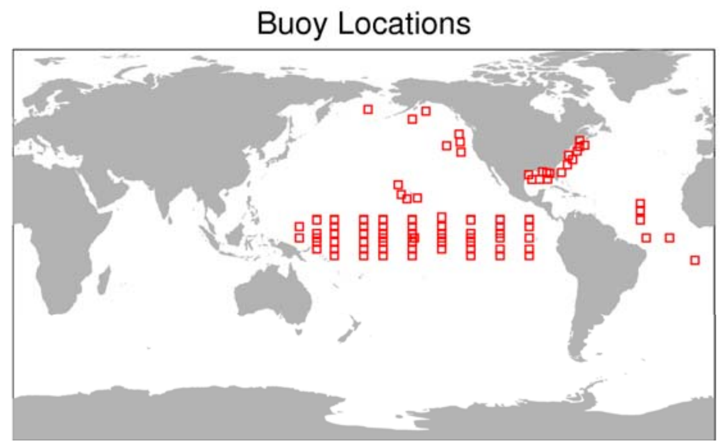
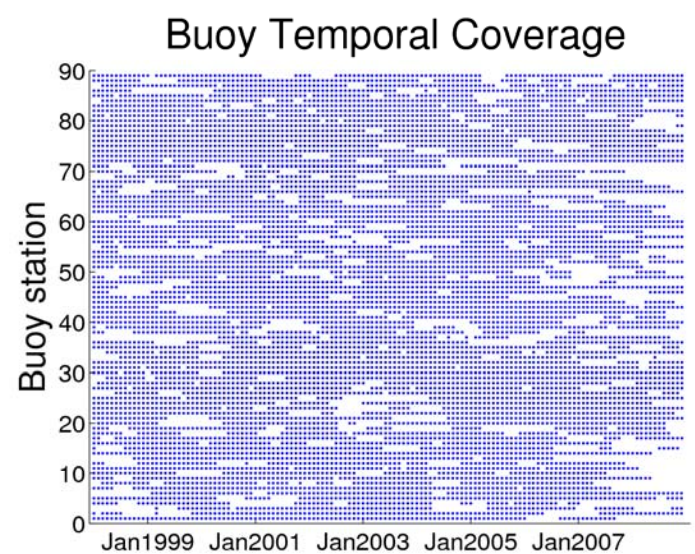
Introduction

- Intercalibration strategy is to compare several different approaches
  - Goal is to understand differences and use sensor information to select best solution
  - If not possible, will select one method and use others to describe uncertainty in Version 1 of the FCDR.
  - Aim to make sensors *physically consistent*
    - Does not include homogenizing time of day of observation to remove diurnal cycle/drift effects in FCDR
    - Does not include making synthetic 85 GHz based on SSMIS 91 GHz
- Four different approaches
  1. Coincident overpasses over polar regions [Fuzhong Weng] (F08 overpasses?)
  2. Coincident overpasses with common instrument: TRMM TMI (starts in 1998)
  3. Vicarious calibration [Chris Ruf] (85GHz?)
  4. <u>Comparison of geophysical parameter retrievals with in situ observations.</u> Start with Wind Speed comparison with buoy data

Methodology

- **Concept: calculate wind from SSM/I using multiple wind algorithms and compare with matching hourly buoy wind speed observations to get relative bias**
- Obtained hourly buoy wind speed from NOAA National Buoy Data Center and TAO/TRITON buoys
  - Included only stations with data over whole period: 89 stations
  - Used SSM/I data within ½ hour of buoy observation time; made 1° average centered on station location
  - Excluded observations where 3-hrly wind speed Standard Deviation was not low
- Buoy measurements are made at heights of 3.5, 4, 5 or 10m (most are at 4m); BUT: most wind speed algorithms retrieve for 19.5m
  - Assumed log wind profile to adjust observations to 19.5m





Wind algorithms

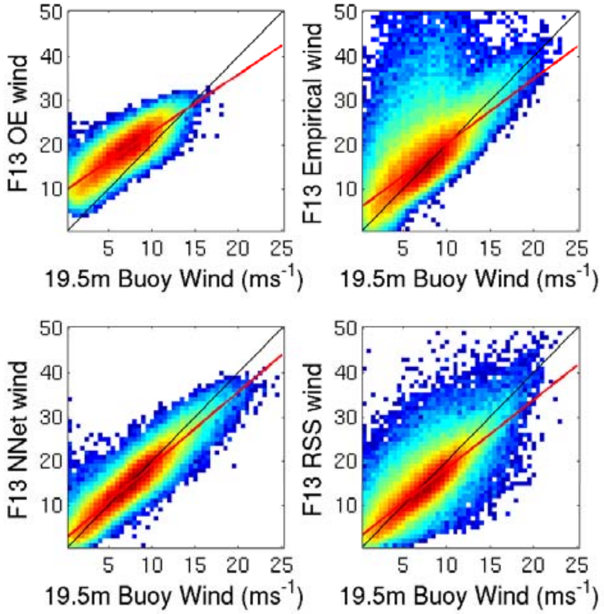
- Used several different approaches and combinations of channels (applied to SSMI and TMI): focus three main types of approaches today
  - Optimal Estimation, Empirical and Neural Network
  - Also included RSS estimate of wind (u37) from nearest gridbox to buoy

Name	Details	Other implementations not shown here
Optimal Estimation (OE) [Elsaesser and Kummerow, 2008]	Inversion of radiative transfer model to get wind , TPW and CLW values most consistent with input Tbs	Fitted versions with 85GHz removed and 22GHz removed; also fitted TMI version with 10 GHz
Petty Correction to Goodberlet et al. (1989)	Empirical regression based; uses 19v, 22v, 37v and 37h; fitted using early SSMI data with buoys	2 versions of D-Matrix,Goodberlet et al. (1989), Goodberlet and Swift (1992)
7 Channel Neural Network	Net for even years trained on odd years and vice versa; TMI Net includes IA to account for boost; Each sensor has own net	Fitted versions with 85GHz removed and 22GHz removed
RSS Wind estimate	Physically based; (used u37 for SSMI)	

Algorithm performance (Ex: F13)

Each Algorithm has advantages and challenges:

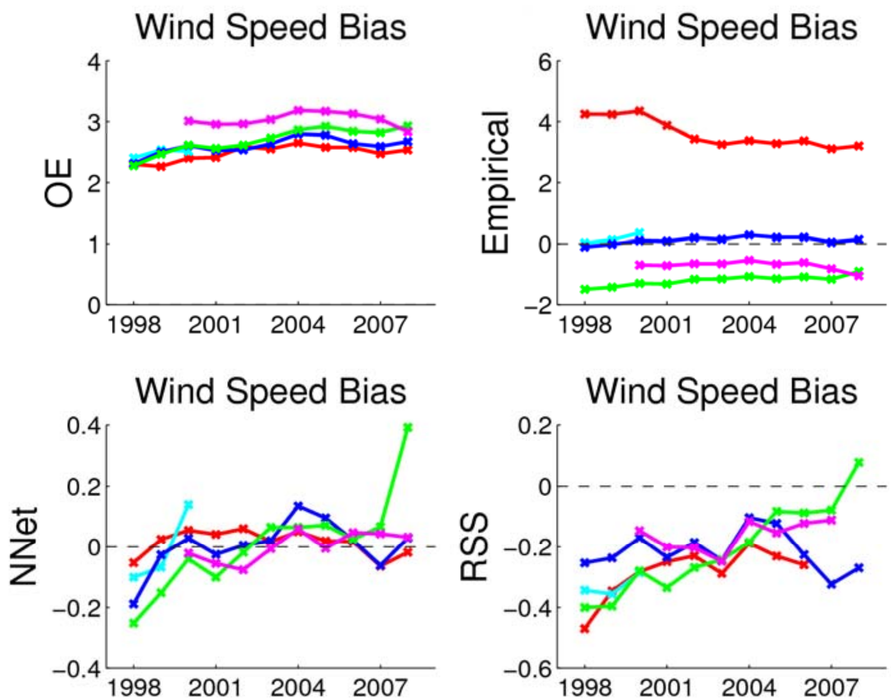
- OE: biased, but high correlation
- Empirical: Performs the worst – can this be useful?
- NNet: zero bias and high correlation, but separately for each sensor
  - Issues arise when combining all sensors: how to include sensor dependent variables such as IA?
- RSS: errors caused by use of nearest 1 degree box estimate



Algorithm	Bias	RMS	Corr	Slope
OE	-2.53	2.9	0.83	0.66
Empirical	-0.92	2.79	0.66	0.74
NNet	0	1.21	0.91	0.83
RSS	0.21	1.82	0.8	0.78

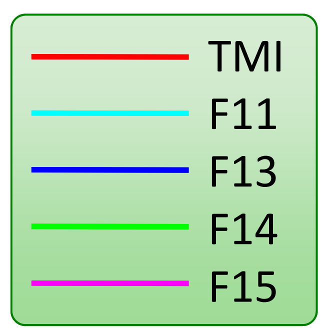
Wind Speed Bias – preliminary results

- Can use this analysis to get multiple realizations of WSB
  - How do we convert this to Tb offsets?
- Algorithm skill varies: how to assign value to each algorithm?
- Algorithm sensitivity also varies. Example: F14 in 2008
  - NNet technique (and RSS) shows recalibration required
  - OE and Empirical approach do not show this issue



Wind	TMI	F11	F13	F14	F15
OE	2.5	2.5	2.6	2.7	3.0
Empirical	3.6	0.2	0.1	-1.2	-0.7
NNet	0.0	0.0	0.0	0.0	0.0
RSS	-0.3	-0.3	-0.2	-0.2	-0.2

Mean Wind Speed Bias (ms^{-1})



Issues and further work

- Need to characterize and reduce noise in matchups
  - Reduce heterogeneity in matchups: subset by region, SST, Water vapor etc.
  - Sensitivity to log wind assumption? Test effect of better wind profile model
- Are there any spurious signals in the wind speed measurements that need to be corrected?
  - Drawback of comparison with in situ data is potential for the introduction of erroneous signals (artificial trends!)
  - Need further investigation into trends in buoy wind and changes in observing system
- How to use different algorithms: each yields results that reflect the sensitivity of the algorithm and the channels used
  - Can test this by comparison with coincident overpasses with TMI
- Need to convert Wind Speed Bias into Tb values
  - Potentially, this is a poorly constrained inversion problem; Intend to use an ensemble approach to solve
  - Unclear that wind has sufficient information content for all channels, so error may be larger for some channels.
- This approach can be applied with other variables – what other geophysical variables should we implement (if any)?