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Estimating Water Vapor Transport Using a Multiple Satellite Network

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Problems

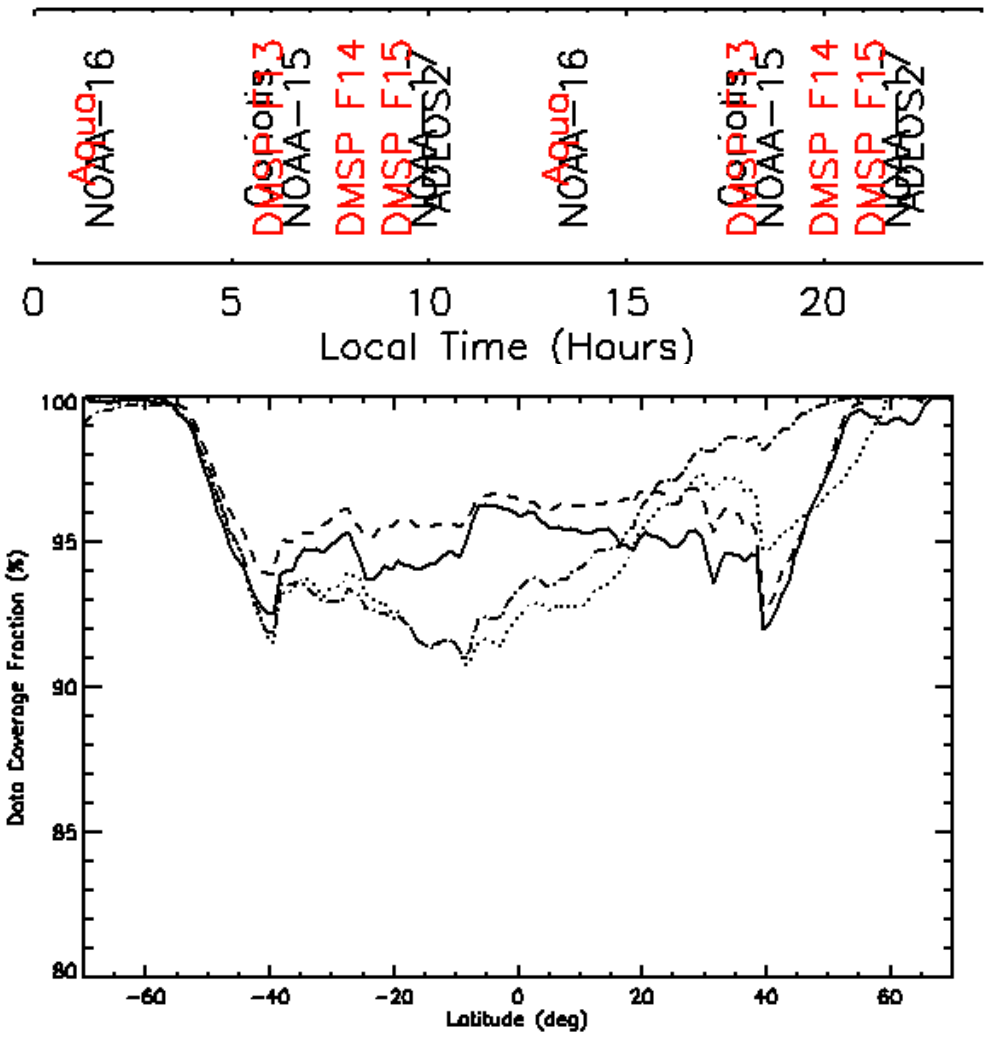
- Few independent comparison data for precipitation over the global oceans . . . i.e., over 70% of globe

- Desire to have hydrologically consistent set of products (Evaporation, Precipitation, Water Transport) using multiple sensors on multiple satellites

Opportunities

Satellite / Instrument	LECT (Asc. Node)
DMSP F13 / SSM/I	**18:15**
DMSP F14 / SSM/I	**20:20**
DMSP F15 / SSM/I	**21:30**
TRMM / TMI	**n/a**
Aqua / AMSR-E	**13:30**
NOAA-15 / AMSU	**18:57**
NOAA-16 / AMSU	**13:58**
NOAA-17 / AMSU	**22:09**
Coriolis / WindSat	**18:00**

Opportunities



Questions

- Can we track water vapor features to estimate water vapor transport?
  - Is the sampling adequate?
  - Is the technique robust?
- Can we deduce precipitation from satellite estimates of evaporation and WVT?

Questions (2)

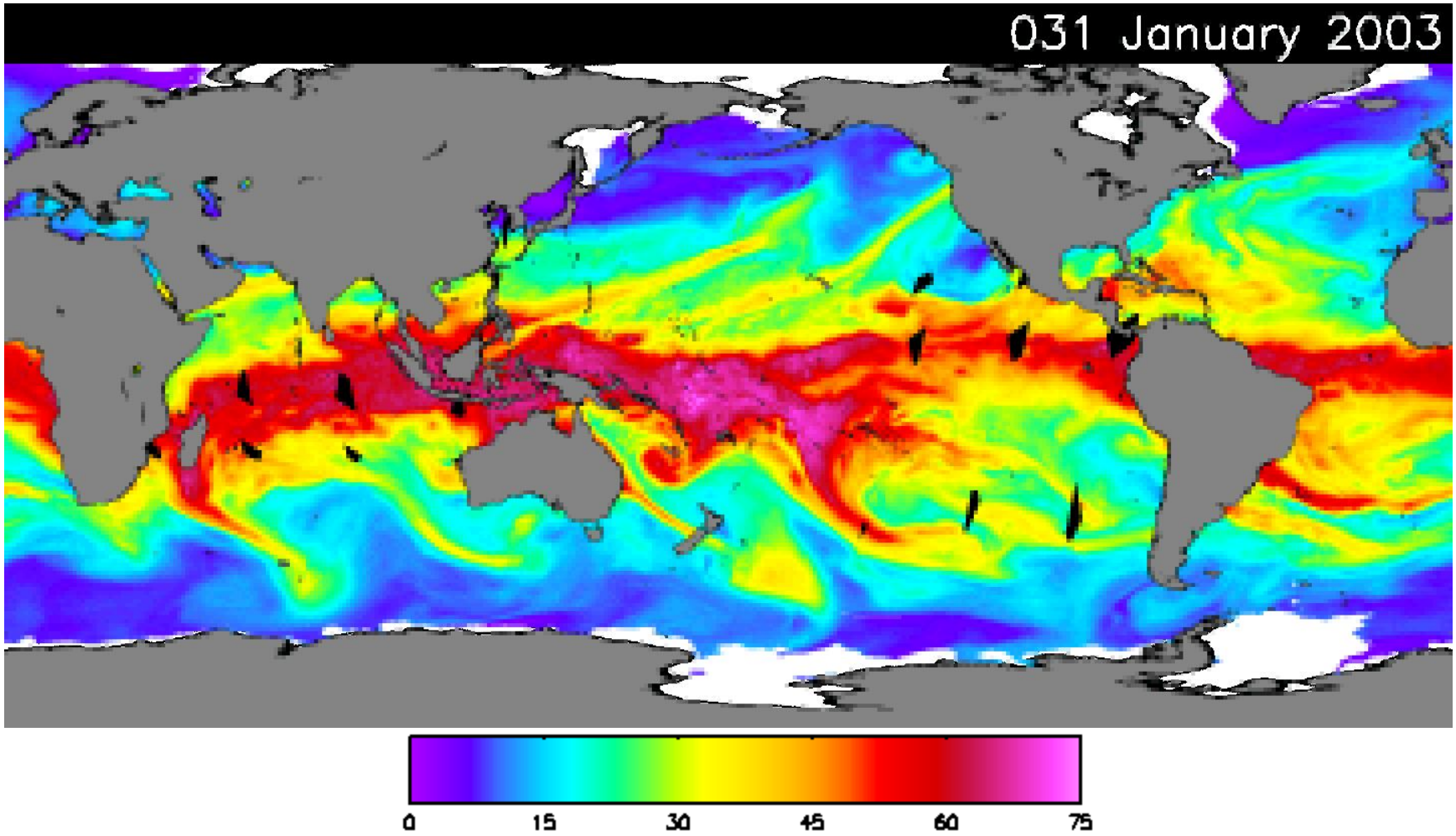
- Yes, closing the hydrological budget is subject to uncertainties, . . .
- But, how do these compare with the microphysical and sub-pixel uncertainties in traditional precipitation measurements?
  - Rain DSD, ratio of cloud to rain water, hydrometeor phase, ice
  - Vertical profile, horizontal sub-pixel variability (beamfilling)

Theoretical Basis

Storage + Divergence = Evaporation - Precipitation

Storage	$\frac{\partial V}{\partial t}$
Divergence	$\nabla \bullet V\vec{\mathbf{W}}$
Columnar Water Vapor	$V = \int_0^{p_0} q \frac{dp}{g}$
Effective Horizontal Velocity	$\vec{\mathbf{W}} = \frac{\int_0^{p_0} q\vec{w} \frac{dp}{g}}{V}$

Water Vapor Transport



Theoretical Basis:
Water Vapor Transport

- "Template Matching"
  - Jedlovec et al., 2000, JAM, p.15-41
- Template: 2.75 deg, uniformly placed
- "Match": Min (Abs Diff / Temp Avg), < 10%
- Search radius: max speed 77 m/s
- No Q/C used
- "Multi-grid" technique

Theoretical Basis:
Evaporation

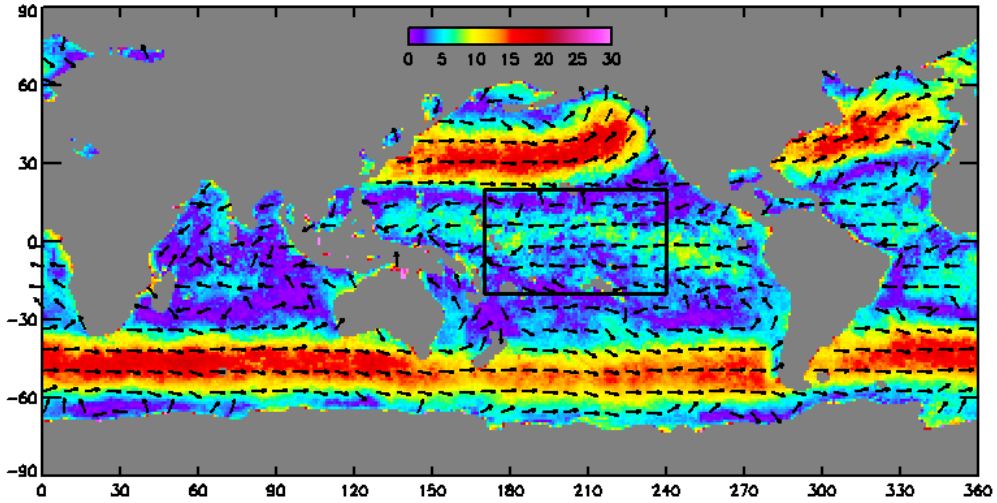
- Bulk formula:

$$E = 3.6 \rho_{air} C_E \left| \vec{w}_h - \vec{w}_s \right| \left(q_s - q_h \right)$$

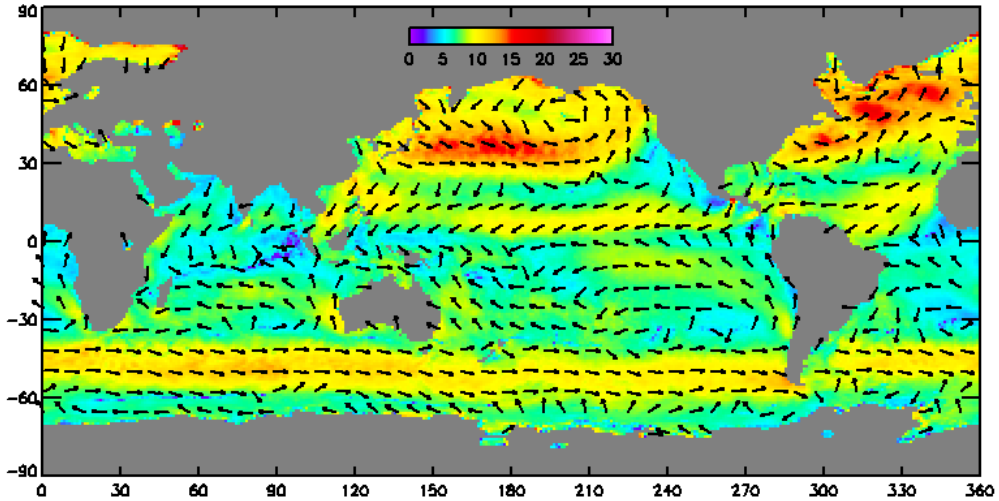
- Primary Influences:
  - Wind Speed
  - SST
- Secondary Influences:
  - 10-m Relative Humidity
  - Air-Sea Temperature Difference

Calculated WVT (Jan. 2003)

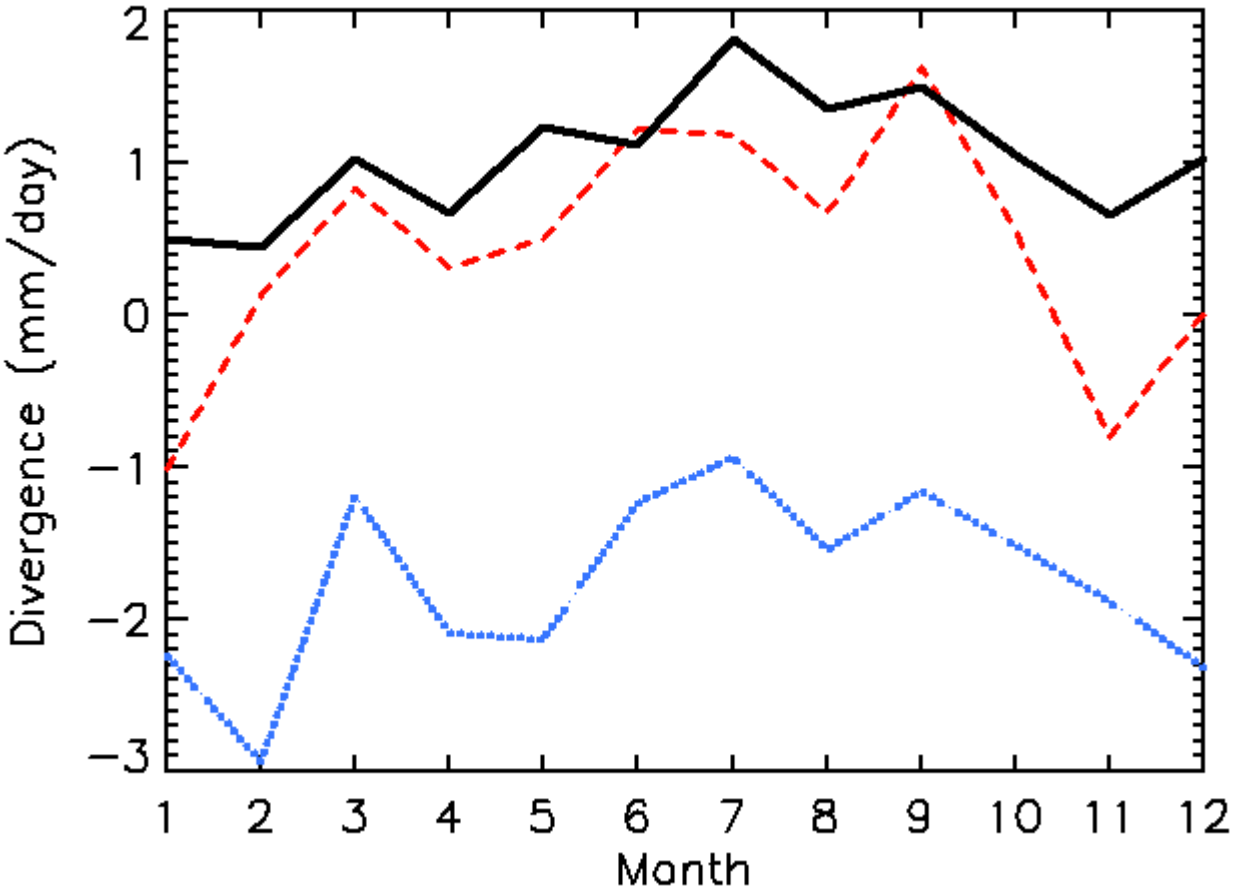
Multi-grid Template Matching Technique (with no Q/C)



QuikSCAT Surface Wind Vectors



Transport Out of Tropics

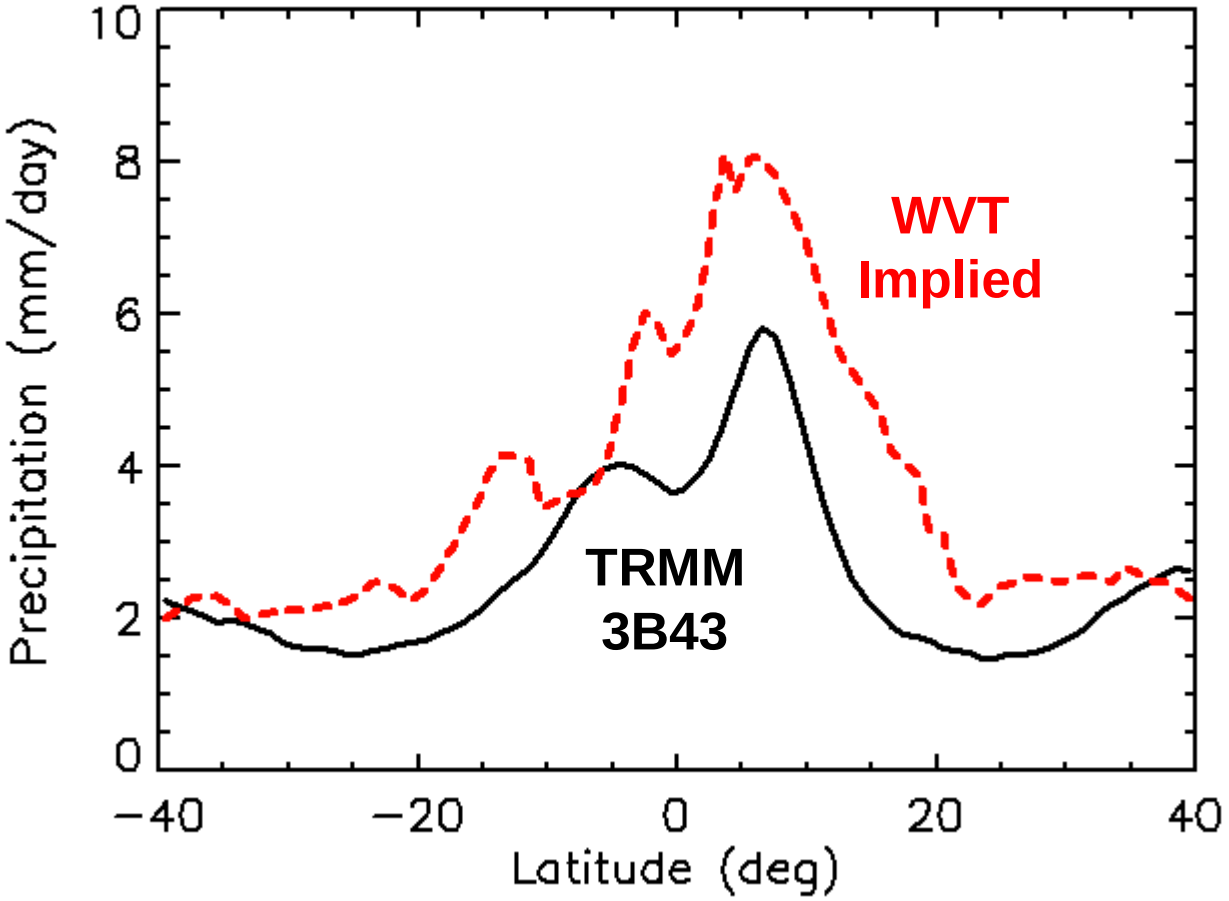


E - P
E: Bulk formula
P: TRMM 3B43

Feature Tracking

QuikSCAT + colloc. F13

Zonal Average Precipitation



Conclusions

- Feature tracking can be used successfully
  - Sampling is adequate
    - 5 satellites give 95% global coverage every 6 hours
  - Technique is robust
- Need to test feature tracking algorithm
  - Using NCEP vapor and wind profiles to simulate maps and compare with FT transport
  - Supplement FT algorithm with QuikSCAT?

Conclusions (2)

- It is possible to accurately estimate uncertainties for hydrological balance precipitation products.
  - Have an equation for evaporation
  - Use NCEP simulated WV maps to estimate WVT uncertainties
  - WV retrieval uncertainties well studied
    - Wentz and Meissner, 2000, (TABD, www.remss.com)