‘MIMIC’ morphed microwave animations: 2005 TCs and new displays

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Sponsored by The Oceanography of the Navy through the PEO C4I PMW-150 program office and the Naval Research Laboratory
85-91 GHz microwave band

DMSP SSM/I   TRMM TMI   Aqua AMSR-E

- 85-91 GHz channels of the: DMSP 13/14/15 SSM/I, DMSP 16 SSMIS, TRMM Thematic Mapping Imager (TMI) and Aqua AMSR-E

- Global coverage
85-91 GHz microwave band

- Signal is strongly attenuated by hydrometeors generated by deep convection, so it can be used as a proxy for precipitation (like radar)

- Unique tool for observing eyewall dynamics (such as eyewall formation, replacement cycles, motion of spiral bands delivering vorticity to the eye)
Problem: Irregular time gaps in LEO microwave imagery

What do we do about it now?
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1. Irregular time gaps are too difficult to piece together mentally.
   - This is worsened by the fact that most of us think we’re smart enough to do it.

10 Sept, 1220 UTC

10 Sept, 2257 UTC

11 Sept, 0202 UTC

11 Sept, 0537 UTC

11 Sept, 0641 UTC

11 Sept, 1131 UTC
Hurricane Ivan (2004): 10 Sept 1200 UTC - 11 Sept 1200 UTC
Morphing strategy

1) Axially symmetric rotation

10 Sept, 1829 UTC
Morphing strategy

2) ~Holland profile of windspeed (advection)

10 Sept, 1829 UTC
Morphing strategy

3) Advection proportional to reported maximum winds

10 Sept, 1829 UTC
3) Advection proportional to reported maximum winds

Morphing strategy
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4) No advection within ~55 km from the center

10 Sept, 1829 UTC
5) Blended images regenerate once per hour
Example: Wilma, 19-22 October 2005
2 major visualization problems

2. Intercomparison between images (esp. microwave and infrared) should be easy - that’s the programmer’s job, not the forecaster’s
• Microwave component uses the Polarization Corrected Temperature (PCT) - a proxy for precipitation

• The microwave layer is semitransparent

• Yellow areas are ‘no data’

‘MIMIC-IR’: Katrina, 27-29 Aug 2005
Latency issues with LEO microwave and geo IR

\(\text{t - 2hrs} \quad \text{t} \quad \text{t - 10hrs} \quad \text{t - 8hrs} \quad \text{t - 6hrs} \quad \text{t - 4hrs} \quad \text{t - 2hrs} \quad \text{t} \quad \text{15 min}\)
Microwave “persistence forecast” (7 hr latency)
Microwave “persistence forecast” (2 hr latency)
Persistence forecast: Lessons from 2005 TCs

- 3-6 hours is the optimal length of a persistence forecast
- 50% of the time, this strategy yields a well-developed nowcast of the TC precipitation structure
Main conclusion

Morphing does not add information to the image sequence from which it is built, but it can make the image sequence incredibly easier to visualize.
Tradeoffs of morphing

**Advantages**

- Easier to interpret than irregularly-spaced image sequences *(makes the most of the original imagery)*
- Can be calculated quickly on a desktop computer (on the order of minutes) without an atmospheric model or radiative transfer model

**Disadvantages**

- Still smoothes out the spatial detail somewhat
- Not sufficient for capturing transitions in rapidly developing events (cumulus development, rotation inside eyewall)
- Morphing can be deceptively convincing, even when it’s done wrong
For more information:

- **MIMIC website**
  - Real time TCs
  - Product description
  - FAQ
  - 2004-2005 archives
  - http://cimss.ssec.wisc.edu/tropic/real-time/marti/marti.html,
    or tinyurl.com/pec9s

- **MIMIC-IR website (NEW)**
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  - 2005 archives
  - http://cimss.ssec.wisc.edu/tropic/real-time/marti/mimic-ir.html,
    or tinyurl.com/pzxlo
Total Precipitable Water from DMSP-13/14/15
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(Cat 4 to Cat 2 in <18 hrs on 09/06)
MIMIC-IR persistence forecast

All data
Forecast (beginning at 0800 UTC)

QuickTime™ and a decompressor are needed to see this picture.
How do you deal with these obstacles to morphing?

- Average temporal spacing between images is 4-5 hours, but the lifetime of most features is shorter than that.
- Smaller features advect cyclonically with the windspeed, but larger areas of convection remain quasi-stationary.
- Many convective features regenerate repeatedly in the same location.
MIMIC: Morphed Integrated Microwave Imagery at CIMSS

QuickTime™ and a decompressor are needed to see this picture.

(insert MIMIC-IR Katrina avi)
Encounters of DMSP TRMM AMSRE with Hurricane Isabel, 09/06 - 09/19/03

Mean = 3.9
Median = 3.8
Encounters of DMSP AMSRE with Hurricane Isabel, 09/06 - 09/19/03

Mean = 5.3
Median = 5.1