Where Forecasts Go Bad
Improving the State-of-the-Art Global Weather Model

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Earth’s atmosphere is a *deterministic* system.
Earth’s atmosphere is a *deterministic* system.
The Foundation

Earth’s atmosphere is a *deterministic* system.
Achilles’ Heel

The Earth’s atmosphere is a chaotic system!
The Earth’s atmosphere is a *chaotic* system!
3 Stages

Stage 1
3 Stages

Stage 1

Stage 2
Stage 3
Where Forecasts Go Wrong

Each stage is subject to error, but a major culprit...
Where Forecasts Go Wrong

Each stage is subject to error, but a major culprit...

The weather model unmasked

(Image credit: Warner Bros.)
What IS the Global Forecast System?

It is the *state-of-the-art* in *global* weather system modeling.
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OK, so what IS it?

**Governing Equations**

- Conservation of momentum
- Conservation of mass
- Conservation of water mass
- Conservation of energy
- State of ideal gases
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OK, so what IS it?

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**Forcings and Parameters**
Resolution

(Image credit: spacetoday.org)
Resolution

(Background image credit: spacetoday.org)
Resolution

(Image credit: Geology.com)
Resolution

(Images credit: Geology.com)
Don’t Be Fooled!

The GFS is NOT magical...

(Image credit: Warner Bros.)
Don’t Be Fooled!

Look!

(Image credit: Warner Bros.)
The Key Questions

This research will answer the following questions.

- Does the GFS produce error patterns that depend on the state of the atmosphere?
- How much can the GFS be improved by correcting that error?
- Is it possible to pinpoint the source of error using these patterns?
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Forecast Error

u wind (m/s) at 200 hPa
3/15/2009 GMT: 12:00
Lead Time: 000 hours

Error at 6 hours
Forecast Error

u wind (m/s) at 200 hPa
3/15/2009   GMT: 12:00
Lead Time: 000 hours

Error at 3 days
Forecast Error

$u$ wind (m/s) at 200 hPa
3/15/2009 GMT: 12:00
Lead Time: 000 hours

Error at 10 days
The Blame Game

Rather than correcting the error, can we avoid it altogether?
The Blame Game

Rather than correcting the error, can we avoid it altogether?
Where we are

Done

- The GFS is installed on the VACC
- Initial condition data automatically downloaded daily
- The GFS automatically runs the 10-day forecasts
- Error data is automatically generated
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Next Steps

- Code and automate error pattern analysis
- Code and test on-line correction
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References