NASA SILICON VALLEY

PODCAST

1
00:00:00,380 --> 00:00:05,440
Host (Matthew Buffington): Welcome to the
NASA In Silicon Valley Podcast, episode 65.

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00:00:05,440 --> 00:00:07,160
Joining me again today for the intro, we have
Kimberly!

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00:00:07,160 --> 00:00:08,370
Kimberly Minafra: Hey!

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00:00:08,370 --> 00:00:14,070
Host: Kimberly, tell us about our guest, actually
more like guests plural, for the podcast today.

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00:00:14,070 --> 00:00:15,389
Kimberly Minafra: No problem.

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00:00:15,389 --> 00:00:19,609
Basically, we have with us Bron Nelson and
Dimitris Menemenlis, who join us from the

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00:00:19,609 --> 00:00:21,832
NASA Advance Supercomputing Facility here
at Ames.

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00:00:21,832 --> 00:00:26,470
Host: Yeah, and this is a slightly different
episode from what we normally do, through

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00:00:26,470 --> 00:00:31,019
the magic of fiber optic connections.

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00:00:31,019 --> 00:00:36,520
We had Bron here in the studio, but Dimitris
was actually sitting over at JPL over in Pasadena.

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00:00:36,520 --> 00:00:37,750
Kimberly Minafra: Right.

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00:00:37,750 --> 00:00:44,200
So Bron, a computer programmer here at the
NASA Data Analysis and Visualization Group,

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00:00:44,200 --> 00:00:49,410
he specializes in most of the coding that
happens with our supercomputers, whereas Dimitris,

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00:00:49,410 --> 00:00:55,260
he’s a research scientist at JPL, where
he actually studies and uses the supercomputing

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00:00:55,260 --> 00:01:00,650
capabilities to analyze global ocean circulation
and its interaction with sea ice and all the

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00:01:00,650 --> 00:01:04,650
cool oceanography that happens to be displayed
on the hyper wall here at Ames.

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00:01:04,650 --> 00:01:08,479
Host: This is the really cool thing over at
NASA, you always think of space, but you know,

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00:01:08,479 --> 00:01:14,390
when it comes to supercomputing, everyone
uses the supercomputers, no matter what they’re

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00:01:14,390 --> 00:01:15,390
studying.

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00:01:15,390 --> 00:01:20,030
Kimberly Minafra: And it’s great because
the visualizations are very helpful in investigating

21
00:01:20,030 --> 00:01:24,659
the data they come with, that comes apart
from actually using the supercomputers.

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00:01:24,659 --> 00:01:28,549
Host: And I got a kick out of this one because
typically, being NASA in Silicon Valley, we

23
00:01:28,549 --> 00:01:34,289
talk about ourselves, but this was a situation
with a different NASA center whose using the

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00:01:34,289 --> 00:01:37,899
information, and this is typically how this
works.

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00:01:37,899 --> 00:01:40,850
You have other centers, other groups, all
working together.

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00:01:40,850 --> 00:01:46,880
But before too much into the podcast, or into
the episode, a little bit of housekeeping.

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00:01:46,880 --> 00:01:49,810
We would love for your comments and suggestions.

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00:01:49,810 --> 00:01:55,200
You can leave us a review on iTunes, Google
Play Music, wherever you find the podcast.

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00:01:55,200 --> 00:02:00,279
If you want to participate, or just send us
your thoughts, reviews, ideas, we’re using

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00:02:00,279 --> 00:02:02,319
the hashtag #NASASiliconValley.

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00:02:02,319 --> 00:02:05,599
We have a phone number, that’s (650) 604-1400.

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00:02:05,599 --> 00:02:11,550
Give us a call, we’d love to hear your thoughts,

and we’ll see how we can integrate that

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00:02:11,550 --> 00:02:13,720
into an episode.

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00:02:13,720 --> 00:02:14,720
But for today…

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00:02:14,720 --> 00:02:19,180
Kimberly Minafra: Here’s Bron and Dimitris.

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00:02:19,180 --> 00:02:29,820
[Music]

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00:02:29,820 --> 00:02:32,560
Matthew Buffington: Welcome Dimitris, welcome
Bron.

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00:02:32,560 --> 00:02:36,630
So for folks listening, this is a little bit
different because I'm sitting here talking

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00:02:36,630 --> 00:02:42,070
with Bron in our studio, and we have Dimitris
on the line, or through the magic of the interwebs,

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00:02:42,070 --> 00:02:45,390
from JPL coming and chatting with us.

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00:02:45,390 --> 00:02:49,060
We haven't done this way before, so this should
be a fun time.

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00:02:49,060 --> 00:02:56,310
So, Dimitris and Bron, we always like to start
the podcast with the same question, and it's,

43
00:02:56,310 --> 00:02:58,200
how did you join NASA?

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00:02:58,200 --> 00:03:03,730
For Bron, I would say, how did you end up
in Silicon Valley, but in this case, since

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00:03:03,730 --> 00:03:08,640
this is more NASA California, I'd say what
brought you to the Golden State?

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00:03:08,640 --> 00:03:09,770
So Bron, go ahead, man.

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00:03:09,770 --> 00:03:11,920
Bron: I actually grew up in Livermore.

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00:03:11,920 --> 00:03:12,920
Host: Okay, local.

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00:03:12,920 --> 00:03:16,570
Bron: Just 30 or 40 miles east of here.

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00:03:16,570 --> 00:03:22,560
I was actually born in Kansas but my family
moved out here when I was like two, so I'm

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00:03:22,560 --> 00:03:25,350
almost a native.

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00:03:25,350 --> 00:03:28,450
I was working for a variety of companies.

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00:03:28,450 --> 00:03:33,100
I'm a computer person and I've worked for
a number of different companies.

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00:03:33,100 --> 00:03:39,920
I was working for a firm named Silicon Graphics
and was assigned here onsite at NASA Ames

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00:03:39,920 --> 00:03:42,180
because they had bought a number of our computers.

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00:03:42,180 --> 00:03:45,800
Host: And they pulled you in.

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00:03:45,800 --> 00:03:54,470
Bron: Then after Silicon Graphics went bankrupt
again, and cut my salary again, even I could

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00:03:54,470 --> 00:03:56,810
see the handwriting on the wall at that point.

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00:03:56,810 --> 00:04:03,880
So I jumped ship, as it were, and went native
as they say in the biz, and started working

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00:04:03,880 --> 00:04:06,460
for the customer that I was previously supporting.

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00:04:06,460 --> 00:04:08,030
So that's how I ended up here at Ames.

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00:04:08,030 --> 00:04:09,030
Host: Nice.

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00:04:09,030 --> 00:04:12,130
So you were always into computers, not necessarily
-- I mean, NASA people are always thinking

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00:04:12,130 --> 00:04:17,100
rockets and, you know, space probes and stuff.

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00:04:17,100 --> 00:04:20,330
But you were always into the computers, so
that's how you came into this.

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00:04:20,330 --> 00:04:21,820

Bron: That's right.

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00:04:21,820 --> 00:04:25,900
Like I tell my kids, I am not a rocket scientist,
but I work with rocket scientists.

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00:04:25,900 --> 00:04:29,890
I know almost nothing about the physics involved.

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00:04:29,890 --> 00:04:32,890
Dimitris here works on the ocean modeling.

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00:04:32,890 --> 00:04:37,070
I don't know anything about that, but I know
a lot about computers so I'm often a member

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00:04:37,070 --> 00:04:41,690
of a team of people, and I help deal with
the computer problems that come up.

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00:04:41,690 --> 00:04:43,890
Host: It is teamwork that makes the dream
work.

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00:04:43,890 --> 00:04:46,070
Bron: What a horrible saying.

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00:04:46,070 --> 00:04:48,880
Host: I know.

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00:04:48,880 --> 00:04:52,510
I got that from your neck of the woods, Dimitris.

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00:04:52,510 --> 00:04:56,950
I think I heard it somewhere I was walking
around in L.A. I don't know if I was visiting

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00:04:56,950 --> 00:04:59,520
Disney or DreamWorks or something.

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00:04:59,520 --> 00:05:00,889
Dimitris: What did you hear?

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00:05:00,889 --> 00:05:03,340
Host: Somebody said, teamwork makes the dream
work.

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00:05:03,340 --> 00:05:04,340
Dimitris: Yes.

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00:05:04,340 --> 00:05:09,900
Well, okay, my story -- What I find really
amazing, and I don't know if it happens to

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00:05:09,900 --> 00:05:14,520
everyone, but as you grow up, the dreams that
you dreamed as a kid that get realized are

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00:05:14,520 --> 00:05:17,030
the ones that you really remember.

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00:05:17,030 --> 00:05:22,880
So, I'm sure I had tons of dreams when I was
a kid, but there were three of them that I

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00:05:22,880 --> 00:05:26,430
remember and that have been realized, and
that's pretty amazing.

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00:05:26,430 --> 00:05:34,170
When I was six, it was 1969, and we gathered
around the neighborhood TV.

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00:05:34,170 --> 00:05:41,420
I grew up in Greece, so TVs back then did
not exist.

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00:05:41,420 --> 00:05:42,860

Not every house had one.

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00:05:42,860 --> 00:05:44,669
My grandparents happened to have one.

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00:05:44,669 --> 00:05:51,070
So a lot of people gathered and we watched
the first astronaut land on the moon, and

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00:05:51,070 --> 00:05:54,520
that was like a super big impression on me.

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00:05:54,520 --> 00:05:57,660
And of course, a lot of kids who watched that
wanted to be astronauts.

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00:05:57,660 --> 00:06:01,220
I'm glad I didn't become one, because what
I'm doing now I think is even cooler.

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00:06:01,220 --> 00:06:02,300
Host: Nice.

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00:06:02,300 --> 00:06:10,480
Dimitris: Two more things that, it was a dream,
was MIT and Caltech.

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00:06:10,480 --> 00:06:16,150
Those two institutions were just -- So, NASA,
MIT, Caltech.

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00:06:16,150 --> 00:06:23,210
Somehow, I don't know, randomly, or accidentally,
or because these are the dreams that got realized

98
00:06:23,210 --> 00:06:27,320
that I remember, I ended up going from MIT
to Caltech NASA.

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00:06:27,320 --> 00:06:37,020
I was doing oceanography as a post-doc at
MIT, and there was this opportunity to JPL

100
00:06:37,020 --> 00:06:42,760
and work with this satellite that had been
launched a few years earlier called TOPEX/Poseidon

101
00:06:42,760 --> 00:06:47,770
that observed sea surface height from space.

102
00:06:47,770 --> 00:06:53,740
Sea surface height is like a dynamical boundary
condition for the ocean.

103
00:06:53,740 --> 00:06:58,990
It's like knowing low pressures and high pressures
in the atmosphere, and then you can tell the

104
00:06:58,990 --> 00:07:04,110
winds that they're going to go around the
low pressure and the high pressure.

105
00:07:04,110 --> 00:07:05,870
Same thing for sea surface height.

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00:07:05,870 --> 00:07:10,940
If you know sea surface height, you can tell
what the surface currents are.

107
00:07:10,940 --> 00:07:19,400
The really cool thing that we do is, from
space you can only see part of the ocean circulation.

108
00:07:19,400 --> 00:07:20,810
You can't observe everything.

109
00:07:20,810 --> 00:07:25,500
You can see surface variables, depth integrated
variables, and of course there's the sampling

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00:07:25,500 --> 00:07:26,560
issue.

111
00:07:26,560 --> 00:07:34,199
So in order to make a complete story you need
to have numerical circulation models.

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00:07:34,199 --> 00:07:40,110
Those are the really fun models that Bron
and others at NASA Ames help us to run on

113
00:07:40,110 --> 00:07:41,600
the NASA supercomputer.

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00:07:41,600 --> 00:07:46,419
Host: I was going to say, that's probably
the perfect transition almost, because I'm

115
00:07:46,419 --> 00:07:49,540
sure for folks listening, they think, Bron
and Dimitris?

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00:07:49,540 --> 00:07:55,419
You have one person working on a computer,
one person looking at the Earth from space,

117
00:07:55,419 --> 00:07:56,419
how does that match together?

118
00:07:56,419 --> 00:07:57,490
Dimitris: Bron, do you want to have a go at
it first?

119
00:07:57,490 --> 00:08:00,270
Bron: I'll have a go at it, sure.

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00:08:00,270 --> 00:08:02,470
Host: What brought you guys together?

121
00:08:02,470 --> 00:08:06,270
Bron: Well, NASA brought us together.

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00:08:06,270 --> 00:08:14,930
Dimitris was working with the people at MIT
on this thing that's called MIT GC, the MIT

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00:08:14,930 --> 00:08:16,850
global circulation model.

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00:08:16,850 --> 00:08:23,389
It does modeling of the weather, if you will,
the weather of the ocean as opposed to of

125
00:08:23,389 --> 00:08:25,509
the air.

126
00:08:25,509 --> 00:08:28,259
But it calculates a great number of things
about --

127
00:08:28,259 --> 00:08:31,270
Host: Is it like temperatures and currents
and stuff?

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00:08:31,270 --> 00:08:36,260
Bron: Temperatures and speeds and more things
than you could possibly imagine quite frankly.

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00:08:36,260 --> 00:08:40,820
Dimitris would be a much better source on
exactly what it does.

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00:08:40,820 --> 00:08:44,750
But as he mentioned, you have this sampling
problem.

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00:08:44,750 --> 00:08:50,460

You don't have sensors everywhere on the earth
gathering data every minute, so you have to

132
00:08:50,460 --> 00:08:53,850
essentially interpolate between observations.

133
00:08:53,850 --> 00:08:58,779
You know it was this temperature on June 21st,
you know it was this temperature on June 22nd,

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00:08:58,779 --> 00:09:01,640
what was it like in between?

135
00:09:01,640 --> 00:09:03,550
You don't want to just draw a straight line.

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00:09:03,550 --> 00:09:04,800
That's hardly very accurate.

137
00:09:04,800 --> 00:09:06,850
Host: That's hardly what we see in real life.

138
00:09:06,850 --> 00:09:07,850
Bron: Certainly not.

139
00:09:07,850 --> 00:09:10,480
And certainly not over the course of a full
year, right?

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00:09:10,480 --> 00:09:14,570
You can't just draw a straight line between
July and July and say that was the temperature

141
00:09:14,570 --> 00:09:15,570
that it was.

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00:09:15,570 --> 00:09:16,570
Host: Yeah, exactly.

143
00:09:16,570 --> 00:09:19,600
Bron: That is, of course, a drastic oversimplification.

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00:09:19,600 --> 00:09:25,440
But the MIT GCM essentially applies all the
known laws of physics, of climatology, of

145
00:09:25,440 --> 00:09:31,100
oceanography, of whatever you want to call
it, whatever -ology you happen to like, to

146
00:09:31,100 --> 00:09:35,290
try to decide how you got from this point
that you know about because you measured it

147
00:09:35,290 --> 00:09:41,420
to this other point that you know about because
you measured it, and what was it like in between?

148
00:09:41,420 --> 00:09:46,630
So you can get a good model of the way the
ocean works and what's going on at, potentially,

149
00:09:46,630 --> 00:09:49,990
a very fine resolution.

150
00:09:49,990 --> 00:09:55,290
But in order to do that, you have this very
complicated computer program, that I did not

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00:09:55,290 --> 00:09:57,900
write, let me make that clear.

152
00:09:57,900 --> 00:09:59,480
Other people wrote that.

153
00:09:59,480 --> 00:10:03,590
But then you need to run it on a very large
group of computers.

154
00:10:03,590 --> 00:10:05,910
Host: I was going to say, I just can't put
it on my PC at home.

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00:10:05,910 --> 00:10:06,910
It's not going to work.

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00:10:06,910 --> 00:10:07,910
Bron: No.

157
00:10:07,910 --> 00:10:10,360
So we ran this model on typically 30 --

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00:10:10,360 --> 00:10:11,360
Dimitris: 70 thousand.

159
00:10:11,360 --> 00:10:15,940
Bron: Yeah, we run it typically on 30 thousand,
but the particular thing that we work with

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00:10:15,940 --> 00:10:21,290
Dimitris with was 70 thousand processors simultaneously.

161
00:10:21,290 --> 00:10:25,800
We were trying to figure out both just how
to get it to do that, and how to get it to

162
00:10:25,800 --> 00:10:29,010
actually run faster as a result of doing that.

163
00:10:29,010 --> 00:10:33,450
The part that I was particularly involved
in was writing out the results.

164
00:10:33,450 --> 00:10:38,149
So you calculate all these numbers, but then
you want to save them so that later on you

165
00:10:38,149 --> 00:10:44,120
can analyze them or, in our case in particular,
we make movies out of them so you can see

166
00:10:44,120 --> 00:10:45,120
this --

167
00:10:45,120 --> 00:10:46,120
Host: Oh, like animations and stuff?

168
00:10:46,120 --> 00:10:49,060
Bron: Yes, and very detailed ones.

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00:10:49,060 --> 00:10:54,700
We have a piece of equipment called the hyper
wall, which is essentially a big array of

170
00:10:54,700 --> 00:11:03,170
TV screens, and a single frame, a single moment
in time, is about a quarter billion pixels

171
00:11:03,170 --> 00:11:05,160
of imaging.

172
00:11:05,160 --> 00:11:10,529
We have salt concentrations, and temperatures,
and velocities, an enormous amount of data

173
00:11:10,529 --> 00:11:15,830
that the model, MIT GCM, is producing.

174
00:11:15,830 --> 00:11:22,880
Just storing it all and saving it all is a
much bigger task than you might think off

175
00:11:22,880 --> 00:11:24,320
hand.

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00:11:24,320 --> 00:11:29,290
So we needed to not only produce these numbers
at some relatively fast rate, but then also

177
00:11:29,290 --> 00:11:35,240
to store all those numbers at that same rate
and not slow down the calculation.

178
00:11:35,240 --> 00:11:38,450
This was a whole team of people.

179
00:11:38,450 --> 00:11:42,930
I'm sitting here in this chair but there is
of course a whole bunch of people that were

180
00:11:42,930 --> 00:11:46,010
involved both in writing the code and getting
it to work.

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00:11:46,010 --> 00:11:53,190
Then all the support people who made the computers
themselves, and so on and so on and so on.

182
00:11:53,190 --> 00:11:54,200
Host: Of course.

183
00:11:54,200 --> 00:11:59,950
So, I was going to say, Dimitris, is this
just a matter of, you give Bron, or the team,

184
00:11:59,950 --> 00:12:05,430
some raw data, some stuff that you do know,
and then he works on that model and sample?

185
00:12:05,430 --> 00:12:09,970
Dimitris: Yeah, I'll answer that question,
but first I want to go back to something that

186
00:12:09,970 --> 00:12:18,040
Bron said earlier and I think is a fantastic

segue into explaining a little better what

187
00:12:18,040 --> 00:12:19,040
we do.

188
00:12:19,040 --> 00:12:21,160
So, a line.

189
00:12:21,160 --> 00:12:25,080
Bron said that our model is more complicated
than the line that it is.

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00:12:25,080 --> 00:12:29,170
But a line is a model, it's a model with two
parameters.

191
00:12:29,170 --> 00:12:34,779
And let's say you have observations of that
line and they're all over the place, they

192
00:12:34,779 --> 00:12:36,420
have some noise.

193
00:12:36,420 --> 00:12:45,120
And then you try to adjust these two parameters,
the place where it crosses the zero axis and

194
00:12:45,120 --> 00:12:50,720
its slope and you try to adjust these two
parameters in order to fit these points as

195
00:12:50,720 --> 00:12:58,040
well as you can because the observations have
errors, right?

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00:12:58,040 --> 00:13:04,529
In a way, and a very efficient way of doing
it, a very good way of doing it, is called

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00:13:04,529 --> 00:13:06,279
least squares.

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00:13:06,279 --> 00:13:13,730
You try to find the line that minimizes the
distance between the observations and the

199
00:13:13,730 --> 00:13:16,010
line in a least squares sense.

200
00:13:16,010 --> 00:13:17,120
Host: Okay.

201
00:13:17,120 --> 00:13:23,110
Dimitris: That is exactly what we do with
satellite observations and with our model.

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00:13:23,110 --> 00:13:31,290
Now, it's a hugely more complicate problem
because, as Bron said, the equations of the

203
00:13:31,290 --> 00:13:35,769
model are non-linear as opposed to a line
is linear.

204
00:13:35,769 --> 00:13:44,790
There's a lot more observations, but the degrees
of freedom of the model are hugely greater

205
00:13:44,790 --> 00:13:46,649
than the number of observations.

206
00:13:46,649 --> 00:13:50,260
So it's a so called under determined problem.

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00:13:50,260 --> 00:13:58,390
We're trying to fit a description of the large-scale
ocean circulation that passes to within some

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00:13:58,390 --> 00:14:07,430
distance of the observations from space, and
also there are instruments in the water, floats

209
00:14:07,430 --> 00:14:09,959
that profile the temperature and salinity.

210
00:14:09,959 --> 00:14:19,370
So, I like the fact that Bron mentioned a
line and I was waiting to pick up on that.

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00:14:19,370 --> 00:14:26,550
Your second question was in terms of how we
operate.

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00:14:26,550 --> 00:14:33,300
We have this numerical model which is called
the Massachusetts Institute of Technology,

213
00:14:33,300 --> 00:14:36,310
it's actually a general circulation model,
so MIT GCM.

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00:14:36,310 --> 00:14:37,310
Bron: Sorry.

215
00:14:37,310 --> 00:14:38,310
Dimitris: No, that's alright.

216
00:14:38,310 --> 00:14:40,260
Global is good because we do a lot of global
things.

217
00:14:40,260 --> 00:14:42,380
Bron: I was pretty close.

218
00:14:42,380 --> 00:14:44,510
Dimitris: You were pretty close.

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00:14:44,510 --> 00:14:49,459
You know, we can actually run that thing on
almost any platform.

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00:14:49,459 --> 00:14:54,300
We can run it on our laptop, we can run it
on workstations.

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00:14:54,300 --> 00:15:00,140
However, to do really interesting problems
where you -- The way that you run this model

222
00:15:00,140 --> 00:15:07,280
is you break up the ocean into little boxes
of water.

223
00:15:07,280 --> 00:15:12,960
The more of these little boxes of water you
have, the more realistic your model is.

224
00:15:12,960 --> 00:15:17,000
You're capturing more and more of the physics
of the ocean.

225
00:15:17,000 --> 00:15:20,850
At some point you can't just do it on your
laptop.

226
00:15:20,850 --> 00:15:28,000
That's when you go to people like Bron and
many, many, many others at NASA Ames -- the

227
00:15:28,000 --> 00:15:38,959
magicians, we call them -- who show us how
to scale up that problem.

228
00:15:38,959 --> 00:15:43,260
That's the first thing that they help us with,
which is just on its own is unbelievable.

229

00:15:43,260 --> 00:15:48,310
But the second thing that happens is once
you've run that thing, you have no idea what's

230
00:15:48,310 --> 00:15:52,070
in it because there's so many numbers.

231
00:15:52,070 --> 00:15:56,760
There we also need help in figuring out how
to look at those numbers.

232
00:15:56,760 --> 00:16:03,941
So the second thing that those magicians at
NASA Ames do is help us to animate, cut, look

233
00:16:03,941 --> 00:16:06,620
at the physics, look at processes.

234
00:16:06,620 --> 00:16:12,579
You know, one of the things I have to admit
that they do is find all the problems, all

235
00:16:12,579 --> 00:16:16,510
the bugs, all the things that are wrong with
the model.

236
00:16:16,510 --> 00:16:20,640
When they look at it, hey what's this, hey
what's this.

237
00:16:20,640 --> 00:16:23,889
Things, we had no clue.

238
00:16:23,889 --> 00:16:26,040
So it's really fun to work with them.

239
00:16:26,040 --> 00:16:27,900
Bron: It's a very good point.

240

00:16:27,900 --> 00:16:32,040
When you visualize something, when you make
a movie out of the data and then your eyes

241
00:16:32,040 --> 00:16:33,040
look at it.

242
00:16:33,040 --> 00:16:37,090
Your eyes are really good at picking out things
that are bad, whereas if you were looking

243
00:16:37,090 --> 00:16:43,010
at pages and pages of numbers, it would be
almost impossible to tell that something was

244
00:16:43,010 --> 00:16:44,010
amiss.

245
00:16:44,010 --> 00:16:47,329
Or that something was good, for that matter.

246
00:16:47,329 --> 00:16:53,889
I work with the people that do the visualizations
although I personally don't do the visualizations,

247
00:16:53,889 --> 00:16:55,560
but I work very closely with those people.

248
00:16:55,560 --> 00:16:59,380
Host: And I like to grab those visualizations,
turn them into a GIF, and put them online.

249
00:16:59,380 --> 00:17:00,380
Bron: Yes.

250
00:17:00,380 --> 00:17:04,970
I will be happy to supply you with unending
images I'm sure.

251

00:17:04,970 --> 00:17:09,000
Host: So, I'd imagine, sometimes does it go
both ways?

252
00:17:09,000 --> 00:17:16,660
I think of, over at Ames, the aeronautics
model where they have these theories of how,

253
00:17:16,660 --> 00:17:20,630
and the models in the supercomputer, of how
airflow works.

254
00:17:20,630 --> 00:17:24,069
But then sometimes you put a plane in a wind
tunnel to test it, kind of check the answers

255
00:17:24,069 --> 00:17:25,270
in the back of the book.

256
00:17:25,270 --> 00:17:28,840
Is there a similar thing going on with you
guys where, yes, you're using the model to

257
00:17:28,840 --> 00:17:33,870
find things that, for you Dimitris, that you
didn't know before, but also I'm guessing

258
00:17:33,870 --> 00:17:39,380
that there's some real data from the sensors
in the ocean that then can help modify and

259
00:17:39,380 --> 00:17:40,660
tweak that model as well?

260
00:17:40,660 --> 00:17:41,990
Dimitris: Yeah, absolutely.

261
00:17:41,990 --> 00:17:46,780
What I like to say when people come to me
and they say, oh, you're a modeler.

262
00:17:46,780 --> 00:17:50,740
I say no, and they say, oh, he's an observationalist.

263
00:17:50,740 --> 00:17:55,990
You can't use a model without observations,
and you cannot use observations without a

264
00:17:55,990 --> 00:17:57,210
model.

265
00:17:57,210 --> 00:18:05,049
Basically, the way science works at a very
basic level is, you look at data, you look

266
00:18:05,049 --> 00:18:09,220
at observations with your senses and your
augmented senses.

267
00:18:09,220 --> 00:18:12,790
You feel things around you and then you try
to explain them.

268
00:18:12,790 --> 00:18:15,770
And the way you explain them is you make models.

269
00:18:15,770 --> 00:18:17,960
The models can be very simple.

270
00:18:17,960 --> 00:18:23,299
They can be a line or they can be something
conceptual or something back of the envelope,

271
00:18:23,299 --> 00:18:24,640
or they can be very complicated.

272
00:18:24,640 --> 00:18:27,470
They're never the last models.

273
00:18:27,470 --> 00:18:32,120
So with the models what you want to be able
to do is you want to be able to reproduce

274
00:18:32,120 --> 00:18:33,820
the observations that you see.

275
00:18:33,820 --> 00:18:36,910
That's the very first thing.

276
00:18:36,910 --> 00:18:42,270
You adjust, you change, you tweak your model.

277
00:18:42,270 --> 00:18:48,049
You change the equations, you change the boundary
conditions until you can reproduce the observations

278
00:18:48,049 --> 00:18:51,950
to the degree that you believe the observations.

279
00:18:51,950 --> 00:18:55,490
Bron: As Dimitris said, the observations themselves
may have errors too, so you've got to be a

280
00:18:55,490 --> 00:18:56,490
little bit careful.

281
00:18:56,490 --> 00:18:59,870
You don't want to necessarily reproduce it
exactly.

282
00:18:59,870 --> 00:19:00,870
Dimitris: Exactly.

283
00:19:00,870 --> 00:19:04,460
And then, once you have that, now you can
make predictions.

284

00:19:04,460 --> 00:19:13,540
You can say well, given this, I expect such
and such events to happen, or such and such

285
00:19:13,540 --> 00:19:14,540
processes.

286
00:19:14,540 --> 00:19:19,600
Then you can go and make focused observations
to see if it's happening.

287
00:19:19,600 --> 00:19:26,831
Or you can go and gather observations that
you had thrown away and hadn't used and use

288
00:19:26,831 --> 00:19:36,070
them to see if they support or if they disqualify,
invalidate, your hypotheses.

289
00:19:36,070 --> 00:19:39,360
So that's one way that models are used.

290
00:19:39,360 --> 00:19:45,780
The other way, of course, is to try to better
understand the physics just from a scientific

291
00:19:45,780 --> 00:19:47,870
curiosity perspective.

292
00:19:47,870 --> 00:19:53,299
Host: Giving another shout out to another
NASA center on the other side of the country

293
00:19:53,299 --> 00:19:57,230
over at NASA Goddard Space Flight Center.

294
00:19:57,230 --> 00:20:00,820
I remember when I visited there, they also
had a hyper wall and they had some visualizations

295
00:20:00,820 --> 00:20:01,820
set up.

296
00:20:01,820 --> 00:20:05,830
I'm thinking this is along the same lines
where it was like, they had the globe, they

297
00:20:05,830 --> 00:20:09,540
had Earth, and then they would dive down into
their visualization and it would get into

298
00:20:09,540 --> 00:20:12,110
the ocean and it had all these arrows and
different things.

299
00:20:12,110 --> 00:20:14,370
And it was just showing the different currents
and the different flows.

300
00:20:14,370 --> 00:20:15,580
It's the same things.

301
00:20:15,580 --> 00:20:17,880
Bron: Yeah, very similar sort of thing.

302
00:20:17,880 --> 00:20:18,910
Exactly so.

303
00:20:18,910 --> 00:20:25,970
Dimitris: Actually, some of the very nice
Goddard visualizations are based on simulations

304
00:20:25,970 --> 00:20:28,780
that we did at NASA Ames.

305
00:20:28,780 --> 00:20:33,289
Host: I'd image that they're all shared back
and forth and that all these teams --

306
00:20:33,289 --> 00:20:39,180
Dimitris: Yeah, and one of the things we would
really like to do, they have a very good atmospheric

307
00:20:39,180 --> 00:20:41,970
model at Goddard.

308
00:20:41,970 --> 00:20:45,650
And obviously I believe we have a very good
oceanic model --

309
00:20:45,650 --> 00:20:47,200
Host: With their powers combined.

310
00:20:47,200 --> 00:20:52,280
Dimitris: It would be absolutely amazing to
put the two together.

311
00:20:52,280 --> 00:20:56,580
Because some of the most important things,
actually the things that make, why are we

312
00:20:56,580 --> 00:21:02,070
looking for oceans on other planets, on other
moons?

313
00:21:02,070 --> 00:21:12,950
Because one of the key things that makes life
possible is the presence of liquid, of ocean,

314
00:21:12,950 --> 00:21:14,070
to start with.

315
00:21:14,070 --> 00:21:18,890
But in our case, since we don't live in the
ocean, the interaction of the ocean with the

316
00:21:18,890 --> 00:21:19,890
atmosphere.

317
00:21:19,890 --> 00:21:28,059
The ocean allows climate to be moderate, meaning
that it doesn't get super-hot and super-cold.

318
00:21:28,059 --> 00:21:33,000
If you go to the desert, you'll realize at
night it can freeze even though in the daytime

319
00:21:33,000 --> 00:21:36,330
you can bake an egg, right?

320
00:21:36,330 --> 00:21:44,650
The oceans kind of store heat when it's very
hot, release it when it cold.

321
00:21:44,650 --> 00:21:47,240
They have a moderating impact on climate.

322
00:21:47,240 --> 00:21:56,630
At the same time, they do the same thing for
chemical quantities like carbon dioxide.

323
00:21:56,630 --> 00:22:04,590
Most of the carbon dioxide that we might burn
through fossil fuels and put in the atmosphere

324
00:22:04,590 --> 00:22:06,970
eventually will be absorbed by the ocean.

325
00:22:06,970 --> 00:22:16,230
The ocean is helping the atmosphere from really
exploding in greenhouse gasses, for example.

326
00:22:16,230 --> 00:22:18,760
There's many other examples.

327
00:22:18,760 --> 00:22:25,780
Therefore, what you really want to understand

very well is the exchange of properties between

328
00:22:25,780 --> 00:22:28,870
the atmosphere and the ocean.

329
00:22:28,870 --> 00:22:35,840
Therefore, if we were able to put those two
models together at very high resolution to

330
00:22:35,840 --> 00:22:44,350
make them realistic, you would gain a better
understanding of how things are transferred

331
00:22:44,350 --> 00:22:47,940
from one fluid, the atmosphere, to the other,
the ocean.

332
00:22:47,940 --> 00:22:51,549
Host: My mind immediately goes into the practical
application.

333
00:22:51,549 --> 00:22:56,830
If I was talking to my family in Ohio, explaining,
oh, this is so cool.

334
00:22:56,830 --> 00:23:02,610
My brain first goes to weather patterns, like
hurricanes.

335
00:23:02,610 --> 00:23:09,330
Understanding the ocean flow, understanding
the atmospheric flow, and computing this craziness

336
00:23:09,330 --> 00:23:10,660
and to understand it.

337
00:23:10,660 --> 00:23:13,240
Are there realistic applications in that way?

338

00:23:13,240 --> 00:23:18,220
Bron: It's not quite the same thing as predicting
where a hurricane is going to make landfall.

339
00:23:18,220 --> 00:23:23,780
This is much more retrospective about, you
take already existing data and try to munge

340
00:23:23,780 --> 00:23:25,299
it and try to understand.

341
00:23:25,299 --> 00:23:31,400
The application really is to gain deeper understanding
of how these processes work.

342
00:23:31,400 --> 00:23:34,990
Hopefully you'll be able to use that make
predictions, but at the very least, to be

343
00:23:34,990 --> 00:23:38,950
able to understand how and why things are
occurring the way they are.

344
00:23:38,950 --> 00:23:44,360
So, a lot of the data that we worked on was
actually gathered several years ago.

345
00:23:44,360 --> 00:23:45,360
Host: Oh, really?

346
00:23:45,360 --> 00:23:52,240
Bron: It's not like last month, but we're
trying to use that to gain an increased understanding

347
00:23:52,240 --> 00:23:54,419
of the physics of the model.

348
00:23:54,419 --> 00:23:55,710
To refine the model.

349
00:23:55,710 --> 00:24:00,150
You know, a straight line is not so good,
maybe a curve isn't so good, maybe it's got

350
00:24:00,150 --> 00:24:02,120
to be really squiggly.

351
00:24:02,120 --> 00:24:08,240
Whatever that model might be, how things behave,
we want to refine the understanding of that.

352
00:24:08,240 --> 00:24:14,150
So it's somewhat more theoretical than, you
know, is it going to be raining tomorrow?

353
00:24:14,150 --> 00:24:17,910
That's not really the kind of questions that
we're trying to answer.

354
00:24:17,910 --> 00:24:22,940
But it is sort of more fundamental science
about how and why do these things work.

355
00:24:22,940 --> 00:24:31,110
Dimitris: Bron is absolutely correct that
our specific investigations are more theoretical.

356
00:24:31,110 --> 00:24:37,700
They are nevertheless important for weather
patterns, eventually, in the sense that if

357
00:24:37,700 --> 00:24:42,350
you want to predict hurricanes and where they'll
make landfall and whether they'll grow or

358
00:24:42,350 --> 00:24:50,030
they won't grow, you need to have a good understanding
of air/sea interaction, and of mixed layer

359

00:24:50,030 --> 00:24:51,990
depth, for example.

360
00:24:51,990 --> 00:25:00,049
The amount of warm water that's stored near
the surface of the ocean.

361
00:25:00,049 --> 00:25:09,080
One way that I think of our work is a model,
a numerical model, is a reservoir of knowledge.

362
00:25:09,080 --> 00:25:18,270
So, as you learn more and more about processes,
you adjust things, change things in the model

363
00:25:18,270 --> 00:25:23,000
to make it a better representation of reality.

364
00:25:23,000 --> 00:25:30,120
Then these models in turn can be taken by
more operational agencies, like NOAA for example,

365
00:25:30,120 --> 00:25:34,500
and used for very practical applications.

366
00:25:34,500 --> 00:25:45,960
I would say the most practical applications
that we work on are not at the edge.

367
00:25:45,960 --> 00:25:51,380
The kind of model we're developing now will
be used for practical applications maybe in

368
00:25:51,380 --> 00:25:53,340
10 to 15 years.

369
00:25:53,340 --> 00:25:58,730
Right now really we're pushing the envelope,
we're exploring what's possible.

370
00:25:58,730 --> 00:26:00,520
We're learning.

371
00:26:00,520 --> 00:26:07,150
Ten years ago, or even 25 years ago, we were
also pushing the envelope, but with models

372
00:26:07,150 --> 00:26:11,960
that now are really easy to run because of
the increased computational power.

373
00:26:11,960 --> 00:26:20,870
So the models that we're actually using in
quasi-operational capacity as part of one

374
00:26:20,870 --> 00:26:29,130
of the projects that I'm involved with are
models that were cutting edge 15 or 20 years

375
00:26:29,130 --> 00:26:30,130
ago.

376
00:26:30,130 --> 00:26:36,940
So there is this progression where you improve
the model and then you start using it for

377
00:26:36,940 --> 00:26:37,960
more practical applications.

378
00:26:37,960 --> 00:26:42,260
Bron: There are certainly plenty of analogies
one could paint.

379
00:26:42,260 --> 00:26:47,180
If you say the wind tunnels, if you're doing,
shall we say, fundamental research in aerodynamics,

380
00:26:47,180 --> 00:26:50,240
do you want to know about turbulence, do you

want to know about streamlining?

381
00:26:50,240 --> 00:26:54,340
That's not the same thing as designing a car
that gets good gas mileage.

382
00:26:54,340 --> 00:26:59,520
But eventually you hope that because you did
all these experiments to gain increased understanding

383
00:26:59,520 --> 00:27:05,210
of the fundamental principles behind it, eventually
that knowledge will get incorporated into,

384
00:27:05,210 --> 00:27:08,450
as you say, more practical, every day applications.

385
00:27:08,450 --> 00:27:13,309
So, no you're not going to see the results
of the stuff that we work on on your local

386
00:27:13,309 --> 00:27:18,440
weather channel next week, but it is still
a very important investigation.

387
00:27:18,440 --> 00:27:24,679
Host: Talk a little bit about what you guys
see in the future.

388
00:27:24,679 --> 00:27:28,610
Looking five years, ten years from now, what
are you guys going to be sitting around working

389
00:27:28,610 --> 00:27:29,890
on?

390
00:27:29,890 --> 00:27:31,760
What numbers are you going to be crunching?

391

00:27:31,760 --> 00:27:34,270
Or where would you like to see things go I
guess?

392
00:27:34,270 --> 00:27:35,750
Bron: I'd like to be retired, myself.

393
00:27:35,750 --> 00:27:38,360
Dimitris: We're not going to let you retire,
Bron.

394
00:27:38,360 --> 00:27:40,100
You're too good.

395
00:27:40,110 --> 00:27:45,240
Bron: As soon as my kids graduate from college
then I'll think about retiring.

396
00:27:45,240 --> 00:27:48,730
Until my kids graduate and my mortgage is
paid, I think I'm kind of stuck.

397
00:27:48,730 --> 00:27:52,110
Dimitris: Come on, you like working with us.

398
00:27:52,110 --> 00:27:53,330
Bron: Yes, you're right.

399
00:27:53,330 --> 00:27:54,330
I do.

400
00:27:54,330 --> 00:27:56,770
It gets me out of bed in the morning.

401
00:27:56,770 --> 00:28:00,529
Or sometimes in the afternoon.

402
00:28:00,529 --> 00:28:05,770
Right now I really see the thing that Dimitris

mentioned, which is trying to couple this

403
00:28:05,770 --> 00:28:07,590
to other pieces.

404
00:28:07,590 --> 00:28:10,029
This is an ocean model and it's very large.

405
00:28:10,029 --> 00:28:12,779
We're doing whole earth simulations, not just--

406
00:28:12,779 --> 00:28:15,830
Host: Yeah, this isn't small scale.

407
00:28:15,830 --> 00:28:16,830
We're doing the big things.

408
00:28:16,830 --> 00:28:17,830
Bron: The big thing, yeah.

409
00:28:17,830 --> 00:28:21,230
And as Dimitris said, you do this by essentially
cutting the ocean up into little boxes and

410
00:28:21,230 --> 00:28:22,390
studying the boxes.

411
00:28:22,390 --> 00:28:28,090
Right now the boxes are about a kilometer
on a side, which, when you're talking about

412
00:28:28,090 --> 00:28:29,801
the whole Earth, that's a lot of boxes.

413
00:28:29,801 --> 00:28:32,030
Host: I was going to say.

414
00:28:32,030 --> 00:28:38,960

Bron: We just recently did a simulation where
the boxes were 250 meters on a side.

415
00:28:38,960 --> 00:28:39,820
Dimitris: And 25?

416
00:28:39,820 --> 00:28:40,840
Bron: Oh, that's right, 25.

417
00:28:40,840 --> 00:28:43,440
But that one didn't work for some reason,
right?

418
00:28:43,440 --> 00:28:44,860
Dimitris: No, it did.

419
00:28:44,860 --> 00:28:45,860
It did.

420
00:28:45,860 --> 00:28:49,990
Bron: But in any event, it's not over the
whole Earth, just over a small portion.

421
00:28:49,990 --> 00:28:58,929
So increasing the resolution, more processors,
better resolving of all of these factors,

422
00:28:58,929 --> 00:29:00,610
that's certainly a place.

423
00:29:00,610 --> 00:29:05,490
That's sort of a quantitative difference rather
than a qualitative one.

424
00:29:05,490 --> 00:29:13,200
It's the coupling of it with atmospheric models,
or with ice and so forth.

425
00:29:13,200 --> 00:29:15,559

Dimitris is heavy into ice.

426
00:29:15,559 --> 00:29:17,650
Dimitris: Ice is nice.

427
00:29:17,650 --> 00:29:24,150
Bron: That, I think, is the direction that
we want to -- the thing that will be new and

428
00:29:24,150 --> 00:29:25,150
interesting, if you will.

429
00:29:25,150 --> 00:29:29,480
So Dimitris, as long as I have you here on
the phone, could explain to me what the difference

430
00:29:29,480 --> 00:29:33,780
between coupling with a Goddard model and,
say, the MM5 or six, or whatever their up

431
00:29:33,780 --> 00:29:35,840
to now at NOAA is?

432
00:29:35,840 --> 00:29:38,200
Because that's coupling with land, water,
and everything.

433
00:29:38,200 --> 00:29:41,190
Host: This is a good way to get him to answer
that email you sent.

434
00:29:41,190 --> 00:29:44,070
Bron: Yeah, it is.

435
00:29:44,070 --> 00:29:48,549
Dimitris: No, there's no difference really.

436
00:29:48,549 --> 00:29:53,059
I want to beg to differ on one point.

437
00:29:53,059 --> 00:29:56,400
As you increase resolution, things change.

438
00:29:56,400 --> 00:30:03,791
If you want to think of the ocean not in space
time, but in frequency wave number, and those

439
00:30:03,791 --> 00:30:12,450
are big words that -- Frequency has to do
with wavelengths in time, and wavenumber is

440
00:30:12,450 --> 00:30:15,730
wavelength in space.

441
00:30:15,730 --> 00:30:18,740
You can draw bubbles, if you like.

442
00:30:18,740 --> 00:30:26,909
Bubbles for different processes that occupy
different lengths and timescales.

443
00:30:26,909 --> 00:30:36,480
With one kilometer, what we're capturing very
well is what's called geostrophic eddies.

444
00:30:36,480 --> 00:30:42,460
They are motions that feel the rotation of
the Earth.

445
00:30:42,460 --> 00:30:47,950
In the atmosphere these would be the storm
systems, if you like, which have thousand-kilometer

446
00:30:47,950 --> 00:30:48,950
scale.

447
00:30:48,950 --> 00:30:54,240
In the ocean, because the fluid has a different

density, and also the stratification.

448
00:30:54,240 --> 00:31:00,980
The fluid and also the stratification of the
density from the surface to the bottom of

449
00:31:00,980 --> 00:31:03,940
the ocean, the scales are much smaller.

450
00:31:03,940 --> 00:31:07,280
They range from like ten to a hundred kilometers.

451
00:31:07,280 --> 00:31:12,200
The scales that feel the rotation of the Earth,
that it.

452
00:31:12,200 --> 00:31:17,899
With a one kilometer grid we're capturing
those incredibly well, which is very nice.

453
00:31:17,899 --> 00:31:24,309
Because before that, we had to create Band-Aids
because we could not really resolve these

454
00:31:24,309 --> 00:31:30,309
in our models, we had these Band-Aids, they're
called parametrizations that would try to

455
00:31:30,309 --> 00:31:35,559
approximate how these things would work if
there's a lot of them.

456
00:31:35,559 --> 00:31:43,399
But these so-called parametrizations, they
just don't do justice to the complexity of

457
00:31:43,399 --> 00:31:45,590
the circulation of the ocean.

458

00:31:45,590 --> 00:31:51,090
So now with one kilometer we're capturing
these features, but then there's other bubbles

459
00:31:51,090 --> 00:31:54,120
that we're not capturing.

460
00:31:54,120 --> 00:31:57,409
There's something called sub-mesoscale processes.

461
00:31:57,409 --> 00:32:00,799
There's something called internal waves.

462
00:32:00,799 --> 00:32:07,150
We're starting to touch on those, we're starting
to see them in the same way that ten years

463
00:32:07,150 --> 00:32:13,310
ago, we could start to see eddies in our simulations,
but we were not fully resolving them.

464
00:32:13,310 --> 00:32:21,700
So we were kind of in this no man's land where,
should we be representing them, or parameterizing

465
00:32:21,700 --> 00:32:28,549
them, or should we trust these crude representations
in the model are useful?

466
00:32:28,549 --> 00:32:37,429
Now, there are a bunch of processes that we're
not resolving and that we are still representing

467
00:32:37,429 --> 00:32:38,860
in a crude way in the model.

468
00:32:38,860 --> 00:32:44,460
So as you increase resolution, it's not just
more of the same.

469
00:32:44,460 --> 00:32:47,230
There's different processes that kick in.

470
00:32:47,230 --> 00:32:51,049
So that's kind of really fun and instructive.

471
00:32:51,049 --> 00:32:53,440
Bron: Where are you going to go from here?

472
00:32:53,440 --> 00:33:03,540
I agree with you, I'm reminded of a maxim
of computer science that a factor ten in quantity,

473
00:33:03,540 --> 00:33:04,640
is a change in quality.

474
00:33:04,640 --> 00:33:05,640
Dimitris: Exactly.

475
00:33:05,640 --> 00:33:10,809
Bron: When something is ten times bigger,
things are different in some sense.

476
00:33:10,809 --> 00:33:12,770
Host: No judgement, but different.

477
00:33:12,770 --> 00:33:13,970
Better, smaller, better worse.

478
00:33:13,970 --> 00:33:18,049
Bron: When your computer is suddenly ten times
faster than it used to be, it's not just that

479
00:33:18,049 --> 00:33:19,760
you can do the old things ten times faster.

480
00:33:19,760 --> 00:33:23,590
You can now suddenly do new things that you

couldn't have done before.

481
00:33:23,590 --> 00:33:28,440
So in the same way, I think Dimitris is saying,
it's not just that you can see the same old

482
00:33:28,440 --> 00:33:32,190
things better, but there are these new things
that you didn't even know were there.

483
00:33:32,190 --> 00:33:36,820
Or that you knew were there but couldn't see
before, but now suddenly your magnifying glass

484
00:33:36,820 --> 00:33:41,039
is ten times more powerful than it used to
be, and you can actually see these processes.

485
00:33:41,039 --> 00:33:46,350
So, that's a very good point, and thanks to
Dimitris for correcting my off-hand comment.

486
00:33:46,350 --> 00:33:51,450
Dimitris: Like I said earlier, a model makes
predictions.

487
00:33:51,450 --> 00:33:55,820
So one of the things we're super interested
in is, we're going to make some predictions,

488
00:33:55,820 --> 00:34:04,429
and NASA is actually launching a very nice
satellite in 2020, or 2021, that's called

489
00:34:04,429 --> 00:34:06,570
surface wave ocean topography.

490
00:34:06,570 --> 00:34:12,579
We're going to make some predictions and that
satellite is going to tell us whether our

491
00:34:12,579 --> 00:34:22,559
predictions are correct, and also allow us
to change the model in order to better represent

492
00:34:22,559 --> 00:34:25,269
what the observations see.

493
00:34:25,269 --> 00:34:31,069
In terms of quasi-practical applications,
a couple of things that I'm really interested

494
00:34:31,069 --> 00:34:38,649
in and I'm involved with is application of
these simulations to study interaction of

495
00:34:38,649 --> 00:34:39,669
the ocean with ice.

496
00:34:39,669 --> 00:34:47,459
And when I say ice I mean both sea ice, which
is ice that forms when the air is very cold,

497
00:34:47,459 --> 00:34:55,929
which is formed from ocean water, and floats,
and cracks, and it's actually really beautiful

498
00:34:55,929 --> 00:35:04,440
both in the real world and also in the simulations.

499
00:35:04,440 --> 00:35:12,430
That sea ice is important because, think of
it as a piece of Styrofoam on top of the ocean.

500
00:35:12,430 --> 00:35:18,609
Where that sea ice is, it inhibits exchange
between the atmosphere and the ocean.

501
00:35:18,609 --> 00:35:25,279

When you remove it, you start exchanging things,
and that's important to know for many processes

502
00:35:25,279 --> 00:35:34,269
that have to do, for example, with regulation
of the weather patterns, and of how warm or

503
00:35:34,269 --> 00:35:37,799
cold the atmosphere is.

504
00:35:37,799 --> 00:35:40,480
But also in terms of biology.

505
00:35:40,480 --> 00:35:47,940
As soon as you remove the sea ice, some biology
that wasn't there can start to grow.

506
00:35:47,940 --> 00:35:53,150
In terms of uptake of carbon, sea ice is important
for that.

507
00:35:53,150 --> 00:35:57,789
A second type of ice we're very interested
in is land ice.

508
00:35:57,789 --> 00:36:02,599
That is ice that is formed by accumulation
from snow.

509
00:36:02,599 --> 00:36:10,859
If you have a region where the amount of snow
that falls every year is a little bit more

510
00:36:10,859 --> 00:36:18,710
than the amount of snow that melts every year,
you form what's called glaciers, or ice sheets,

511
00:36:18,710 --> 00:36:26,559
and these ice sheets are covering, for example,
Greenland and Antarctica, and they're on land.

512
00:36:26,559 --> 00:36:34,660
If these were to melt and to return to the
ocean, or if they were -- You know, we assume

513
00:36:34,660 --> 00:36:39,359
that they're in some sort of steady state
and the amount of snow that falls on them

514
00:36:39,359 --> 00:36:46,029
every year is about the same as the amount
of ice that melts at the edges.

515
00:36:46,029 --> 00:36:47,029
That's good.

516
00:36:47,029 --> 00:36:48,269
That means the sea level won't change.

517
00:36:48,269 --> 00:36:54,099
If they start melting a little faster, well
we care about that because it means sea level

518
00:36:54,099 --> 00:37:01,170
will rise and we need to know about it so
we can take action in terms of protective

519
00:37:01,170 --> 00:37:05,180
coastal environments from erosion and other
things.

520
00:37:05,180 --> 00:37:12,789
So, I think that, and also the interaction
of the ocean currents with biology, ecology,

521
00:37:12,789 --> 00:37:13,789
and carbon cycle.

522
00:37:13,789 --> 00:37:16,009

Those are some of the things that really interest
me.

523
00:37:16,009 --> 00:37:20,779
Host: So everybody should stay tuned for more
to come, especially in 2020, as the work gets

524
00:37:20,779 --> 00:37:26,650
further complicated, and Bron here is trying
to kick his kids out of the house.

525
00:37:26,650 --> 00:37:30,010
Bron: They're just going to come back.

526
00:37:30,010 --> 00:37:35,369
Host: So for folks that are listening that
want to get more information, we're on Twitter

527
00:37:35,369 --> 00:37:36,660
@NASAAmes.

528
00:37:36,660 --> 00:37:39,520
We use the hashtag #NASASiliconValley.

529
00:37:39,529 --> 00:37:47,950
Until we change the podcast name to NASA California,
that's what we're using in the meantime.

530
00:37:47,950 --> 00:37:50,400
But thanks a lot Bron for coming on over.

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00:37:50,400 --> 00:37:54,499
And Dimitris, this has been awesome, thanks
for calling in from beautiful Pasadena.

532
00:37:54,499 --> 00:37:55,529
Dimitris: Thank you very much.